



# Stellaris<sup>®</sup> LM3S6100 Microcontroller

## DATA SHEET

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**TEXAS  
INSTRUMENTS**



**Cortex**  
Intelligent Processors by ARM®

# Table of Contents

<b>Revision History .....</b>	<b>20</b>
<b>About This Document .....</b>	<b>25</b>
Audience .....	25
About This Manual .....	25
Related Documents .....	25
Documentation Conventions .....	26
<b>1 Architectural Overview .....</b>	<b>28</b>
1.1 Product Features .....	28
1.2 Target Applications .....	34
1.3 High-Level Block Diagram .....	34
1.4 Functional Overview .....	36
1.4.1 ARM Cortex™-M3 .....	36
1.4.2 Motor Control Peripherals .....	37
1.4.3 Analog Peripherals .....	37
1.4.4 Serial Communications Peripherals .....	37
1.4.5 System Peripherals .....	39
1.4.6 Memory Peripherals .....	39
1.4.7 Additional Features .....	40
1.4.8 Hardware Details .....	40
<b>2 The Cortex-M3 Processor .....</b>	<b>41</b>
2.1 Block Diagram .....	42
2.2 Overview .....	43
2.2.1 System-Level Interface .....	43
2.2.2 Integrated Configurable Debug .....	43
2.2.3 Trace Port Interface Unit (TPIU) .....	44
2.2.4 Cortex-M3 System Component Details .....	44
2.3 Programming Model .....	45
2.3.1 Processor Mode and Privilege Levels for Software Execution .....	45
2.3.2 Stacks .....	45
2.3.3 Register Map .....	46
2.3.4 Register Descriptions .....	47
2.3.5 Exceptions and Interrupts .....	60
2.3.6 Data Types .....	60
2.4 Memory Model .....	60
2.4.1 Memory Regions, Types and Attributes .....	61
2.4.2 Memory System Ordering of Memory Accesses .....	62
2.4.3 Behavior of Memory Accesses .....	62
2.4.4 Software Ordering of Memory Accesses .....	63
2.4.5 Bit-Banding .....	64
2.4.6 Data Storage .....	66
2.4.7 Synchronization Primitives .....	67
2.5 Exception Model .....	68
2.5.1 Exception States .....	69
2.5.2 Exception Types .....	69
2.5.3 Exception Handlers .....	71

2.5.4	Vector Table .....	72
2.5.5	Exception Priorities .....	73
2.5.6	Interrupt Priority Grouping .....	73
2.5.7	Exception Entry and Return .....	73
2.6	Fault Handling .....	75
2.6.1	Fault Types .....	76
2.6.2	Fault Escalation and Hard Faults .....	76
2.6.3	Fault Status Registers and Fault Address Registers .....	77
2.6.4	Lockup .....	77
2.7	Power Management .....	78
2.7.1	Entering Sleep Modes .....	78
2.7.2	Wake Up from Sleep Mode .....	78
2.8	Instruction Set Summary .....	79
<b>3</b>	<b>Cortex-M3 Peripherals .....</b>	<b>83</b>
3.1	Functional Description .....	83
3.1.1	System Timer (SysTick) .....	83
3.1.2	Nested Vectored Interrupt Controller (NVIC) .....	84
3.1.3	System Control Block (SCB) .....	86
3.1.4	Memory Protection Unit (MPU) .....	86
3.2	Register Map .....	91
3.3	System Timer (SysTick) Register Descriptions .....	93
3.4	NVIC Register Descriptions .....	97
3.5	System Control Block (SCB) Register Descriptions .....	110
3.6	Memory Protection Unit (MPU) Register Descriptions .....	137
<b>4</b>	<b>JTAG Interface .....</b>	<b>147</b>
4.1	Block Diagram .....	148
4.2	Signal Description .....	148
4.3	Functional Description .....	149
4.3.1	JTAG Interface Pins .....	149
4.3.2	JTAG TAP Controller .....	151
4.3.3	Shift Registers .....	152
4.3.4	Operational Considerations .....	152
4.4	Initialization and Configuration .....	155
4.5	Register Descriptions .....	155
4.5.1	Instruction Register (IR) .....	155
4.5.2	Data Registers .....	158
<b>5</b>	<b>System Control .....</b>	<b>160</b>
5.1	Signal Description .....	160
5.2	Functional Description .....	160
5.2.1	Device Identification .....	161
5.2.2	Reset Control .....	161
5.2.3	Power Control .....	165
5.2.4	Clock Control .....	166
5.2.5	System Control .....	171
5.3	Initialization and Configuration .....	172
5.4	Register Map .....	172
5.5	Register Descriptions .....	173

<b>6</b>	<b>Internal Memory .....</b>	<b>216</b>
6.1	Block Diagram .....	216
6.2	Functional Description .....	216
6.2.1	SRAM Memory .....	216
6.2.2	Flash Memory .....	217
6.3	Flash Memory Initialization and Configuration .....	219
6.3.1	Flash Programming .....	219
6.3.2	Nonvolatile Register Programming .....	220
6.4	Register Map .....	221
6.5	Flash Register Descriptions (Flash Control Offset) .....	222
6.6	Flash Register Descriptions (System Control Offset) .....	230
<b>7</b>	<b>General-Purpose Input/Outputs (GPIOs) .....</b>	<b>243</b>
7.1	Signal Description .....	243
7.2	Functional Description .....	247
7.2.1	Data Control .....	248
7.2.2	Interrupt Control .....	249
7.2.3	Mode Control .....	250
7.2.4	Commit Control .....	250
7.2.5	Pad Control .....	250
7.2.6	Identification .....	250
7.3	Initialization and Configuration .....	250
7.4	Register Map .....	251
7.5	Register Descriptions .....	253
<b>8</b>	<b>General-Purpose Timers .....</b>	<b>288</b>
8.1	Block Diagram .....	288
8.2	Signal Description .....	289
8.3	Functional Description .....	290
8.3.1	GPTM Reset Conditions .....	290
8.3.2	32-Bit Timer Operating Modes .....	290
8.3.3	16-Bit Timer Operating Modes .....	292
8.4	Initialization and Configuration .....	295
8.4.1	32-Bit One-Shot/Periodic Timer Mode .....	295
8.4.2	32-Bit Real-Time Clock (RTC) Mode .....	296
8.4.3	16-Bit One-Shot/Periodic Timer Mode .....	296
8.4.4	16-Bit Input Edge Count Mode .....	297
8.4.5	16-Bit Input Edge Timing Mode .....	297
8.4.6	16-Bit PWM Mode .....	298
8.5	Register Map .....	298
8.6	Register Descriptions .....	299
<b>9</b>	<b>Watchdog Timer .....</b>	<b>324</b>
9.1	Block Diagram .....	325
9.2	Functional Description .....	325
9.3	Initialization and Configuration .....	326
9.4	Register Map .....	326
9.5	Register Descriptions .....	327
<b>10</b>	<b>Universal Asynchronous Receivers/Transmitters (UARTs) .....</b>	<b>348</b>
10.1	Block Diagram .....	349

10.2	Signal Description .....	349
10.3	Functional Description .....	350
10.3.1	Transmit/Receive Logic .....	350
10.3.2	Baud-Rate Generation .....	350
10.3.3	Data Transmission .....	351
10.3.4	Serial IR (SIR) .....	352
10.3.5	FIFO Operation .....	353
10.3.6	Interrupts .....	353
10.3.7	Loopback Operation .....	354
10.3.8	IrDA SIR block .....	354
10.4	Initialization and Configuration .....	354
10.5	Register Map .....	355
10.6	Register Descriptions .....	356
<b>11</b>	<b>Synchronous Serial Interface (SSI) .....</b>	<b>390</b>
11.1	Block Diagram .....	390
11.2	Signal Description .....	390
11.3	Functional Description .....	391
11.3.1	Bit Rate Generation .....	391
11.3.2	FIFO Operation .....	392
11.3.3	Interrupts .....	392
11.3.4	Frame Formats .....	392
11.4	Initialization and Configuration .....	400
11.5	Register Map .....	401
11.6	Register Descriptions .....	402
<b>12</b>	<b>Ethernet Controller .....</b>	<b>428</b>
12.1	Block Diagram .....	428
12.2	Signal Description .....	429
12.3	Functional Description .....	431
12.3.1	MAC Operation .....	431
12.3.2	Internal MII Operation .....	434
12.3.3	PHY Operation .....	434
12.3.4	Interrupts .....	435
12.4	Initialization and Configuration .....	436
12.4.1	Hardware Configuration .....	436
12.4.2	Software Configuration .....	437
12.5	Ethernet Register Map .....	438
12.6	Ethernet MAC Register Descriptions .....	439
12.7	MII Management Register Descriptions .....	457
<b>13</b>	<b>Analog Comparator .....</b>	<b>476</b>
13.1	Block Diagram .....	476
13.2	Signal Description .....	476
13.3	Functional Description .....	477
13.3.1	Internal Reference Programming .....	478
13.4	Initialization and Configuration .....	479
13.5	Register Map .....	479
13.6	Register Descriptions .....	480

<b>14</b>	<b>Pin Diagram</b> .....	<b>488</b>
<b>15</b>	<b>Signal Tables</b> .....	<b>490</b>
15.1	100-Pin LQFP Package Pin Tables .....	490
15.1.1	Signals by Pin Number .....	490
15.1.2	Signals by Signal Name .....	494
15.1.3	Signals by Function, Except for GPIO .....	497
15.1.4	GPIO Pins and Alternate Functions .....	499
15.2	108-Ball BGA Package Pin Tables .....	500
15.2.1	Signals by Pin Number .....	500
15.2.2	Signals by Signal Name .....	504
15.2.3	Signals by Function, Except for GPIO .....	507
15.2.4	GPIO Pins and Alternate Functions .....	510
15.3	Connections for Unused Signals .....	511
<b>16</b>	<b>Operating Characteristics</b> .....	<b>513</b>
<b>17</b>	<b>Electrical Characteristics</b> .....	<b>514</b>
17.1	DC Characteristics .....	514
17.1.1	Maximum Ratings .....	514
17.1.2	Recommended DC Operating Conditions .....	514
17.1.3	On-Chip Low Drop-Out (LDO) Regulator Characteristics .....	515
17.1.4	GPIO Module Characteristics .....	515
17.1.5	Power Specifications .....	515
17.1.6	Flash Memory Characteristics .....	516
17.1.7	Ethernet Controller .....	517
17.2	AC Characteristics .....	517
17.2.1	Load Conditions .....	517
17.2.2	Clocks .....	517
17.2.3	JTAG and Boundary Scan .....	519
17.2.4	Reset .....	520
17.2.5	Sleep Modes .....	522
17.2.6	General-Purpose I/O (GPIO) .....	522
17.2.7	Synchronous Serial Interface (SSI) .....	522
17.2.8	Ethernet Controller .....	524
17.2.9	Analog Comparator .....	527
<b>A</b>	<b>Serial Flash Loader</b> .....	<b>528</b>
A.1	Serial Flash Loader .....	528
A.2	Interfaces .....	528
A.2.1	UART .....	528
A.2.2	SSI .....	528
A.3	Packet Handling .....	529
A.3.1	Packet Format .....	529
A.3.2	Sending Packets .....	529
A.3.3	Receiving Packets .....	529
A.4	Commands .....	530
A.4.1	COMMAND_PING (0x20) .....	530
A.4.2	COMMAND_GET_STATUS (0x23) .....	530
A.4.3	COMMAND_DOWNLOAD (0x21) .....	530
A.4.4	COMMAND_SEND_DATA (0x24) .....	531

A.4.5	COMMAND_RUN (0x22) .....	531
A.4.6	COMMAND_RESET (0x25) .....	531
<b>B</b>	<b>Register Quick Reference .....</b>	<b>533</b>
<b>C</b>	<b>Ordering and Contact Information .....</b>	<b>550</b>
C.1	Ordering Information .....	550
C.2	Part Markings .....	550
C.3	Kits .....	550
C.4	Support Information .....	551
<b>D</b>	<b>Package Information .....</b>	<b>552</b>
D.1	100-Pin LQFP Package .....	552
D.1.1	Package Dimensions .....	552
D.1.2	Tray Dimensions .....	554
D.1.3	Tape and Reel Dimensions .....	554
D.2	108-Ball BGA Package .....	556
D.2.1	Package Dimensions .....	556
D.2.2	Tray Dimensions .....	558
D.2.3	Tape and Reel Dimensions .....	559

## List of Figures

Figure 1-1.	Stellaris LM3S6100 Microcontroller High-Level Block Diagram .....	35
Figure 2-1.	CPU Block Diagram .....	43
Figure 2-2.	TPIU Block Diagram .....	44
Figure 2-3.	Cortex-M3 Register Set .....	46
Figure 2-4.	Bit-Band Mapping .....	66
Figure 2-5.	Data Storage .....	67
Figure 2-6.	Vector Table .....	72
Figure 2-7.	Exception Stack Frame .....	74
Figure 3-1.	SRD Use Example .....	89
Figure 4-1.	JTAG Module Block Diagram .....	148
Figure 4-2.	Test Access Port State Machine .....	152
Figure 4-3.	IDCODE Register Format .....	158
Figure 4-4.	BYPASS Register Format .....	158
Figure 4-5.	Boundary Scan Register Format .....	159
Figure 5-1.	Basic RST Configuration .....	162
Figure 5-2.	External Circuitry to Extend Power-On Reset .....	163
Figure 5-3.	Reset Circuit Controlled by Switch .....	163
Figure 5-4.	Power Architecture .....	166
Figure 5-5.	Main Clock Tree .....	168
Figure 6-1.	Flash Block Diagram .....	216
Figure 7-1.	GPIO Port Block Diagram .....	248
Figure 7-2.	GPIO DATA Write Example .....	249
Figure 7-3.	GPIO DATA Read Example .....	249
Figure 8-1.	GPTM Module Block Diagram .....	289
Figure 8-2.	16-Bit Input Edge Count Mode Example .....	293
Figure 8-3.	16-Bit Input Edge Time Mode Example .....	294
Figure 8-4.	16-Bit PWM Mode Example .....	295
Figure 9-1.	WDT Module Block Diagram .....	325
Figure 10-1.	UART Module Block Diagram .....	349
Figure 10-2.	UART Character Frame .....	350
Figure 10-3.	IrDA Data Modulation .....	352
Figure 11-1.	SSI Module Block Diagram .....	390
Figure 11-2.	TI Synchronous Serial Frame Format (Single Transfer) .....	393
Figure 11-3.	TI Synchronous Serial Frame Format (Continuous Transfer) .....	394
Figure 11-4.	FreescalE SPI Format (Single Transfer) with SPO=0 and SPH=0 .....	394
Figure 11-5.	FreescalE SPI Format (Continuous Transfer) with SPO=0 and SPH=0 .....	395
Figure 11-6.	FreescalE SPI Frame Format with SPO=0 and SPH=1 .....	396
Figure 11-7.	FreescalE SPI Frame Format (Single Transfer) with SPO=1 and SPH=0 .....	396
Figure 11-8.	FreescalE SPI Frame Format (Continuous Transfer) with SPO=1 and SPH=0 .....	397
Figure 11-9.	FreescalE SPI Frame Format with SPO=1 and SPH=1 .....	398
Figure 11-10.	MICROWIRE Frame Format (Single Frame) .....	398
Figure 11-11.	MICROWIRE Frame Format (Continuous Transfer) .....	399
Figure 11-12.	MICROWIRE Frame Format, SSIFss Input Setup and Hold Requirements .....	400
Figure 12-1.	Ethernet Controller .....	429
Figure 12-2.	Ethernet Controller Block Diagram .....	429
Figure 12-3.	Ethernet Frame .....	431

Figure 12-4.	Interface to an Ethernet Jack .....	437
Figure 13-1.	Analog Comparator Module Block Diagram .....	476
Figure 13-2.	Structure of Comparator Unit .....	477
Figure 13-3.	Comparator Internal Reference Structure .....	478
Figure 14-1.	100-Pin LQFP Package Pin Diagram .....	488
Figure 14-2.	108-Ball BGA Package Pin Diagram (Top View) .....	489
Figure 17-1.	Load Conditions .....	517
Figure 17-2.	JTAG Test Clock Input Timing .....	519
Figure 17-3.	JTAG Test Access Port (TAP) Timing .....	520
Figure 17-4.	JTAG TRST Timing .....	520
Figure 17-5.	External Reset Timing ( $\overline{\text{RST}}$ ) .....	521
Figure 17-6.	Power-On Reset Timing .....	521
Figure 17-7.	Brown-Out Reset Timing .....	521
Figure 17-8.	Software Reset Timing .....	521
Figure 17-9.	Watchdog Reset Timing .....	522
Figure 17-10.	SSI Timing for TI Frame Format (FRF=01), Single Transfer Timing Measurement .....	523
Figure 17-11.	SSI Timing for MICROWIRE Frame Format (FRF=10), Single Transfer .....	523
Figure 17-12.	SSI Timing for SPI Frame Format (FRF=00), with SPH=1 .....	524
Figure 17-13.	External XTLP Oscillator Characteristics .....	526
Figure D-1.	Stellaris LM3S6100 100-Pin LQFP Package Dimensions .....	552
Figure D-2.	100-Pin LQFP Tray Dimensions .....	554
Figure D-3.	100-Pin LQFP Tape and Reel Dimensions .....	555
Figure D-4.	Stellaris LM3S6100 108-Ball BGA Package Dimensions .....	556
Figure D-5.	108-Ball BGA Tray Dimensions .....	558
Figure D-6.	108-Ball BGA Tape and Reel Dimensions .....	559

## List of Tables

Table 1.	Revision History .....	20
Table 2.	Documentation Conventions .....	26
Table 2-1.	Summary of Processor Mode, Privilege Level, and Stack Use .....	46
Table 2-2.	Processor Register Map .....	47
Table 2-3.	PSR Register Combinations .....	52
Table 2-4.	Memory Map .....	60
Table 2-5.	Memory Access Behavior .....	62
Table 2-6.	SRAM Memory Bit-Banding Regions .....	64
Table 2-7.	Peripheral Memory Bit-Banding Regions .....	64
Table 2-8.	Exception Types .....	70
Table 2-9.	Interrupts .....	71
Table 2-10.	Exception Return Behavior .....	75
Table 2-11.	Faults .....	76
Table 2-12.	Fault Status and Fault Address Registers .....	77
Table 2-13.	Cortex-M3 Instruction Summary .....	79
Table 3-1.	Core Peripheral Register Regions .....	83
Table 3-2.	Memory Attributes Summary .....	86
Table 3-3.	TEX, S, C, and B Bit Field Encoding .....	89
Table 3-4.	Cache Policy for Memory Attribute Encoding .....	90
Table 3-5.	AP Bit Field Encoding .....	90
Table 3-6.	Memory Region Attributes for Stellaris Microcontrollers .....	90
Table 3-7.	Peripherals Register Map .....	91
Table 3-8.	Interrupt Priority Levels .....	116
Table 3-9.	Example SIZE Field Values .....	144
Table 4-1.	JTAG_SWD_SWO Signals (100LQFP) .....	148
Table 4-2.	JTAG_SWD_SWO Signals (108BGA) .....	149
Table 4-3.	JTAG Port Pins Reset State .....	149
Table 4-4.	JTAG Instruction Register Commands .....	156
Table 5-1.	System Control & Clocks Signals (100LQFP) .....	160
Table 5-2.	System Control & Clocks Signals (108BGA) .....	160
Table 5-3.	Reset Sources .....	161
Table 5-4.	Clock Source Options .....	167
Table 5-5.	Possible System Clock Frequencies Using the SYSDIV Field .....	169
Table 5-6.	Examples of Possible System Clock Frequencies Using the SYSDIV2 Field .....	169
Table 5-7.	System Control Register Map .....	172
Table 5-8.	RCC2 Fields that Override RCC fields .....	186
Table 6-1.	Flash Protection Policy Combinations .....	217
Table 6-2.	User-Programmable Flash Memory Resident Registers .....	221
Table 6-3.	Flash Register Map .....	221
Table 7-1.	GPIO Pins With Non-Zero Reset Values .....	244
Table 7-2.	GPIO Pins and Alternate Functions (100LQFP) .....	244
Table 7-3.	GPIO Pins and Alternate Functions (108BGA) .....	244
Table 7-4.	GPIO Signals (100LQFP) .....	245
Table 7-5.	GPIO Signals (108BGA) .....	246
Table 7-6.	GPIO Pad Configuration Examples .....	251
Table 7-7.	GPIO Interrupt Configuration Example .....	251

Table 7-8.	GPIO Register Map .....	252
Table 8-1.	Available CCP Pins .....	289
Table 8-2.	General-Purpose Timers Signals (100LQFP) .....	289
Table 8-3.	General-Purpose Timers Signals (108BGA) .....	290
Table 8-4.	16-Bit Timer With Prescaler Configurations .....	292
Table 8-5.	Timers Register Map .....	299
Table 9-1.	Watchdog Timer Register Map .....	326
Table 10-1.	UART Signals (100LQFP) .....	349
Table 10-2.	UART Signals (108BGA) .....	350
Table 10-3.	UART Register Map .....	355
Table 11-1.	SSI Signals (100LQFP) .....	391
Table 11-2.	SSI Signals (108BGA) .....	391
Table 11-3.	SSI Register Map .....	401
Table 12-1.	Ethernet Signals (100LQFP) .....	430
Table 12-2.	Ethernet Signals (108BGA) .....	430
Table 12-3.	TX & RX FIFO Organization .....	433
Table 12-4.	Ethernet Register Map .....	438
Table 13-1.	Analog Comparators Signals (100LQFP) .....	477
Table 13-2.	Analog Comparators Signals (108BGA) .....	477
Table 13-3.	Internal Reference Voltage and ACREFTL Field Values .....	478
Table 13-4.	Analog Comparators Register Map .....	480
Table 15-1.	Signals by Pin Number .....	490
Table 15-2.	Signals by Signal Name .....	494
Table 15-3.	Signals by Function, Except for GPIO .....	497
Table 15-4.	GPIO Pins and Alternate Functions .....	499
Table 15-5.	Signals by Pin Number .....	500
Table 15-6.	Signals by Signal Name .....	504
Table 15-7.	Signals by Function, Except for GPIO .....	507
Table 15-8.	GPIO Pins and Alternate Functions .....	510
Table 15-9.	Connections for Unused Signals (100-pin LQFP) .....	511
Table 15-10.	Connections for Unused Signals, 108-pin BGA .....	512
Table 16-1.	Temperature Characteristics .....	513
Table 16-2.	Thermal Characteristics .....	513
Table 16-3.	ESD Absolute Maximum Ratings .....	513
Table 17-1.	Maximum Ratings .....	514
Table 17-2.	Recommended DC Operating Conditions .....	514
Table 17-3.	LDO Regulator Characteristics .....	515
Table 17-4.	GPIO Module DC Characteristics .....	515
Table 17-5.	Detailed Power Specifications .....	516
Table 17-6.	Flash Memory Characteristics .....	516
Table 17-7.	Ethernet Controller DC Characteristics .....	517
Table 17-8.	Phase Locked Loop (PLL) Characteristics .....	517
Table 17-9.	Actual PLL Frequency .....	518
Table 17-10.	Clock Characteristics .....	518
Table 17-11.	Crystal Characteristics .....	518
Table 17-12.	JTAG Characteristics .....	519
Table 17-13.	Reset Characteristics .....	520
Table 17-14.	Sleep Modes AC Characteristics .....	522

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Table 17-15.	GPIO Characteristics .....	522
Table 17-16.	SSI Characteristics .....	522
Table 17-17.	100BASE-TX Transmitter Characteristics .....	524
Table 17-18.	100BASE-TX Transmitter Characteristics (informative) .....	524
Table 17-19.	100BASE-TX Receiver Characteristics .....	524
Table 17-20.	10BASE-T Transmitter Characteristics .....	525
Table 17-21.	10BASE-T Transmitter Characteristics (informative) .....	525
Table 17-22.	10BASE-T Receiver Characteristics .....	525
Table 17-23.	Isolation Transformers .....	525
Table 17-24.	Ethernet Reference Crystal .....	526
Table 17-25.	External XTLP Oscillator Characteristics .....	526
Table 17-26.	Analog Comparator Characteristics .....	527
Table 17-27.	Analog Comparator Voltage Reference Characteristics .....	527

# List of Registers

<b>The Cortex-M3 Processor .....</b>	<b>41</b>
Register 1: Cortex General-Purpose Register 0 (R0) .....	48
Register 2: Cortex General-Purpose Register 1 (R1) .....	48
Register 3: Cortex General-Purpose Register 2 (R2) .....	48
Register 4: Cortex General-Purpose Register 3 (R3) .....	48
Register 5: Cortex General-Purpose Register 4 (R4) .....	48
Register 6: Cortex General-Purpose Register 5 (R5) .....	48
Register 7: Cortex General-Purpose Register 6 (R6) .....	48
Register 8: Cortex General-Purpose Register 7 (R7) .....	48
Register 9: Cortex General-Purpose Register 8 (R8) .....	48
Register 10: Cortex General-Purpose Register 9 (R9) .....	48
Register 11: Cortex General-Purpose Register 10 (R10) .....	48
Register 12: Cortex General-Purpose Register 11 (R11) .....	48
Register 13: Cortex General-Purpose Register 12 (R12) .....	48
Register 14: Stack Pointer (SP) .....	49
Register 15: Link Register (LR) .....	50
Register 16: Program Counter (PC) .....	51
Register 17: Program Status Register (PSR) .....	52
Register 18: Priority Mask Register (PRIMASK) .....	56
Register 19: Fault Mask Register (FAULTMASK) .....	57
Register 20: Base Priority Mask Register (BASEPRI) .....	58
Register 21: Control Register (CONTROL) .....	59
<b>Cortex-M3 Peripherals .....</b>	<b>83</b>
Register 1: SysTick Control and Status Register (STCTRL), offset 0x010 .....	94
Register 2: SysTick Reload Value Register (STRELOAD), offset 0x014 .....	96
Register 3: SysTick Current Value Register (STCURRENT), offset 0x018 .....	97
Register 4: Interrupt 0-31 Set Enable (EN0), offset 0x100 .....	98
Register 5: Interrupt 32-43 Set Enable (EN1), offset 0x104 .....	99
Register 6: Interrupt 0-31 Clear Enable (DIS0), offset 0x180 .....	100
Register 7: Interrupt 32-43 Clear Enable (DIS1), offset 0x184 .....	101
Register 8: Interrupt 0-31 Set Pending (PEND0), offset 0x200 .....	102
Register 9: Interrupt 32-43 Set Pending (PEND1), offset 0x204 .....	103
Register 10: Interrupt 0-31 Clear Pending (UNPEND0), offset 0x280 .....	104
Register 11: Interrupt 32-43 Clear Pending (UNPEND1), offset 0x284 .....	105
Register 12: Interrupt 0-31 Active Bit (ACTIVE0), offset 0x300 .....	106
Register 13: Interrupt 32-43 Active Bit (ACTIVE1), offset 0x304 .....	107
Register 14: Interrupt 0-3 Priority (PRI0), offset 0x400 .....	108
Register 15: Interrupt 4-7 Priority (PRI1), offset 0x404 .....	108
Register 16: Interrupt 8-11 Priority (PRI2), offset 0x408 .....	108
Register 17: Interrupt 12-15 Priority (PRI3), offset 0x40C .....	108
Register 18: Interrupt 16-19 Priority (PRI4), offset 0x410 .....	108
Register 19: Interrupt 20-23 Priority (PRI5), offset 0x414 .....	108
Register 20: Interrupt 24-27 Priority (PRI6), offset 0x418 .....	108
Register 21: Interrupt 28-31 Priority (PRI7), offset 0x41C .....	108
Register 22: Interrupt 32-35 Priority (PRI8), offset 0x420 .....	108

Register 23:	Interrupt 36-39 Priority (PRI9), offset 0x424 .....	108
Register 24:	Interrupt 40-43 Priority (PRI10), offset 0x428 .....	108
Register 25:	Software Trigger Interrupt (SWTRIG), offset 0xF00 .....	110
Register 26:	CPU ID Base (CPUID), offset 0xD00 .....	111
Register 27:	Interrupt Control and State (INTCTRL), offset 0xD04 .....	112
Register 28:	Vector Table Offset (VTABLE), offset 0xD08 .....	115
Register 29:	Application Interrupt and Reset Control (APINT), offset 0xD0C .....	116
Register 30:	System Control (SYSCTRL), offset 0xD10 .....	118
Register 31:	Configuration and Control (CFGCTRL), offset 0xD14 .....	120
Register 32:	System Handler Priority 1 (SYSPRI1), offset 0xD18 .....	122
Register 33:	System Handler Priority 2 (SYSPRI2), offset 0xD1C .....	123
Register 34:	System Handler Priority 3 (SYSPRI3), offset 0xD20 .....	124
Register 35:	System Handler Control and State (SYSHNDCTRL), offset 0xD24 .....	125
Register 36:	Configurable Fault Status (FAULTSTAT), offset 0xD28 .....	129
Register 37:	Hard Fault Status (HFAULTSTAT), offset 0xD2C .....	135
Register 38:	Memory Management Fault Address (MMADDR), offset 0xD34 .....	136
Register 39:	Bus Fault Address (FAULTADDR), offset 0xD38 .....	137
Register 40:	MPU Type (MPUTYPE), offset 0xD90 .....	138
Register 41:	MPU Control (MPUCTRL), offset 0xD94 .....	139
Register 42:	MPU Region Number (MPUNUMBER), offset 0xD98 .....	141
Register 43:	MPU Region Base Address (MPUBASE), offset 0xD9C .....	142
Register 44:	MPU Region Base Address Alias 1 (MPUBASE1), offset 0xDA4 .....	142
Register 45:	MPU Region Base Address Alias 2 (MPUBASE2), offset 0xDAC .....	142
Register 46:	MPU Region Base Address Alias 3 (MPUBASE3), offset 0xDB4 .....	142
Register 47:	MPU Region Attribute and Size (MPUATTR), offset 0xDA0 .....	144
Register 48:	MPU Region Attribute and Size Alias 1 (MPUATTR1), offset 0xDA8 .....	144
Register 49:	MPU Region Attribute and Size Alias 2 (MPUATTR2), offset 0xDB0 .....	144
Register 50:	MPU Region Attribute and Size Alias 3 (MPUATTR3), offset 0xDB8 .....	144
<b>System Control</b> .....		<b>160</b>
Register 1:	Device Identification 0 (DID0), offset 0x000 .....	174
Register 2:	Brown-Out Reset Control (PBORCTL), offset 0x030 .....	176
Register 3:	LDO Power Control (LDOPCTL), offset 0x034 .....	177
Register 4:	Raw Interrupt Status (RIS), offset 0x050 .....	178
Register 5:	Interrupt Mask Control (IMC), offset 0x054 .....	179
Register 6:	Masked Interrupt Status and Clear (MISC), offset 0x058 .....	180
Register 7:	Reset Cause (RESC), offset 0x05C .....	181
Register 8:	Run-Mode Clock Configuration (RCC), offset 0x060 .....	182
Register 9:	XTAL to PLL Translation (PLLCFG), offset 0x064 .....	185
Register 10:	Run-Mode Clock Configuration 2 (RCC2), offset 0x070 .....	186
Register 11:	Deep Sleep Clock Configuration (DSLPCCLKCFG), offset 0x144 .....	188
Register 12:	Device Identification 1 (DID1), offset 0x004 .....	189
Register 13:	Device Capabilities 0 (DC0), offset 0x008 .....	191
Register 14:	Device Capabilities 1 (DC1), offset 0x010 .....	192
Register 15:	Device Capabilities 2 (DC2), offset 0x014 .....	194
Register 16:	Device Capabilities 3 (DC3), offset 0x018 .....	195
Register 17:	Device Capabilities 4 (DC4), offset 0x01C .....	196
Register 18:	Run Mode Clock Gating Control Register 0 (RCGC0), offset 0x100 .....	198
Register 19:	Sleep Mode Clock Gating Control Register 0 (SCGC0), offset 0x110 .....	199

Register 20:	Deep Sleep Mode Clock Gating Control Register 0 (DCGC0), offset 0x120 .....	200
Register 21:	Run Mode Clock Gating Control Register 1 (RCGC1), offset 0x104 .....	201
Register 22:	Sleep Mode Clock Gating Control Register 1 (SCGC1), offset 0x114 .....	203
Register 23:	Deep Sleep Mode Clock Gating Control Register 1 (DCGC1), offset 0x124 .....	205
Register 24:	Run Mode Clock Gating Control Register 2 (RCGC2), offset 0x108 .....	207
Register 25:	Sleep Mode Clock Gating Control Register 2 (SCGC2), offset 0x118 .....	209
Register 26:	Deep Sleep Mode Clock Gating Control Register 2 (DCGC2), offset 0x128 .....	211
Register 27:	Software Reset Control 0 (SRCR0), offset 0x040 .....	213
Register 28:	Software Reset Control 1 (SRCR1), offset 0x044 .....	214
Register 29:	Software Reset Control 2 (SRCR2), offset 0x048 .....	215
<b>Internal Memory</b> .....		<b>216</b>
Register 1:	Flash Memory Address (FMA), offset 0x000 .....	223
Register 2:	Flash Memory Data (FMD), offset 0x004 .....	224
Register 3:	Flash Memory Control (FMC), offset 0x008 .....	225
Register 4:	Flash Controller Raw Interrupt Status (FCRIS), offset 0x00C .....	227
Register 5:	Flash Controller Interrupt Mask (FCIM), offset 0x010 .....	228
Register 6:	Flash Controller Masked Interrupt Status and Clear (FCMISC), offset 0x014 .....	229
Register 7:	USec Reload (USECRL), offset 0x140 .....	231
Register 8:	Flash Memory Protection Read Enable 0 (FMPRE0), offset 0x130 and 0x200 .....	232
Register 9:	Flash Memory Protection Program Enable 0 (FMPPE0), offset 0x134 and 0x400 .....	233
Register 10:	User Debug (USER_DBG), offset 0x1D0 .....	234
Register 11:	User Register 0 (USER_REG0), offset 0x1E0 .....	235
Register 12:	User Register 1 (USER_REG1), offset 0x1E4 .....	236
Register 13:	Flash Memory Protection Read Enable 1 (FMPRE1), offset 0x204 .....	237
Register 14:	Flash Memory Protection Read Enable 2 (FMPRE2), offset 0x208 .....	238
Register 15:	Flash Memory Protection Read Enable 3 (FMPRE3), offset 0x20C .....	239
Register 16:	Flash Memory Protection Program Enable 1 (FMPPE1), offset 0x404 .....	240
Register 17:	Flash Memory Protection Program Enable 2 (FMPPE2), offset 0x408 .....	241
Register 18:	Flash Memory Protection Program Enable 3 (FMPPE3), offset 0x40C .....	242
<b>General-Purpose Input/Outputs (GPIOs)</b> .....		<b>243</b>
Register 1:	GPIO Data (GPIODATA), offset 0x000 .....	254
Register 2:	GPIO Direction (GPIODIR), offset 0x400 .....	255
Register 3:	GPIO Interrupt Sense (GPIOIS), offset 0x404 .....	256
Register 4:	GPIO Interrupt Both Edges (GPIOIBE), offset 0x408 .....	257
Register 5:	GPIO Interrupt Event (GPIOIEV), offset 0x40C .....	258
Register 6:	GPIO Interrupt Mask (GPIOIM), offset 0x410 .....	259
Register 7:	GPIO Raw Interrupt Status (GPIORIS), offset 0x414 .....	260
Register 8:	GPIO Masked Interrupt Status (GPIOMIS), offset 0x418 .....	261
Register 9:	GPIO Interrupt Clear (GPIOICR), offset 0x41C .....	262
Register 10:	GPIO Alternate Function Select (GPIOAFSEL), offset 0x420 .....	263
Register 11:	GPIO 2-mA Drive Select (GPIODR2R), offset 0x500 .....	265
Register 12:	GPIO 4-mA Drive Select (GPIODR4R), offset 0x504 .....	266
Register 13:	GPIO 8-mA Drive Select (GPIODR8R), offset 0x508 .....	267
Register 14:	GPIO Open Drain Select (GPIOODR), offset 0x50C .....	268
Register 15:	GPIO Pull-Up Select (GPIOPUR), offset 0x510 .....	269
Register 16:	GPIO Pull-Down Select (GPIOPDR), offset 0x514 .....	270
Register 17:	GPIO Slew Rate Control Select (GPIOSLR), offset 0x518 .....	271
Register 18:	GPIO Digital Enable (GPIODEN), offset 0x51C .....	272

Register 19:	GPIO Lock (GPIOLOCK), offset 0x520 .....	273
Register 20:	GPIO Commit (GPIOCR), offset 0x524 .....	274
Register 21:	GPIO Peripheral Identification 4 (GPIOPeriphID4), offset 0xFD0 .....	276
Register 22:	GPIO Peripheral Identification 5 (GPIOPeriphID5), offset 0xFD4 .....	277
Register 23:	GPIO Peripheral Identification 6 (GPIOPeriphID6), offset 0xFD8 .....	278
Register 24:	GPIO Peripheral Identification 7 (GPIOPeriphID7), offset 0xFDC .....	279
Register 25:	GPIO Peripheral Identification 0 (GPIOPeriphID0), offset 0xFE0 .....	280
Register 26:	GPIO Peripheral Identification 1 (GPIOPeriphID1), offset 0xFE4 .....	281
Register 27:	GPIO Peripheral Identification 2 (GPIOPeriphID2), offset 0xFE8 .....	282
Register 28:	GPIO Peripheral Identification 3 (GPIOPeriphID3), offset 0xFEC .....	283
Register 29:	GPIO PrimeCell Identification 0 (GPIOPCellID0), offset 0xFF0 .....	284
Register 30:	GPIO PrimeCell Identification 1 (GPIOPCellID1), offset 0xFF4 .....	285
Register 31:	GPIO PrimeCell Identification 2 (GPIOPCellID2), offset 0xFF8 .....	286
Register 32:	GPIO PrimeCell Identification 3 (GPIOPCellID3), offset 0xFFC .....	287
<b>General-Purpose Timers .....</b>	<b>288</b>	
Register 1:	GPTM Configuration (GPTMCFG), offset 0x000 .....	300
Register 2:	GPTM TimerA Mode (GPTMTAMR), offset 0x004 .....	301
Register 3:	GPTM TimerB Mode (GPTMTBMR), offset 0x008 .....	303
Register 4:	GPTM Control (GPTMCTL), offset 0x00C .....	305
Register 5:	GPTM Interrupt Mask (GPTMIMR), offset 0x018 .....	308
Register 6:	GPTM Raw Interrupt Status (GPTMRIS), offset 0x01C .....	310
Register 7:	GPTM Masked Interrupt Status (GPTMMIS), offset 0x020 .....	311
Register 8:	GPTM Interrupt Clear (GPTMICR), offset 0x024 .....	312
Register 9:	GPTM TimerA Interval Load (GPTMTAILR), offset 0x028 .....	314
Register 10:	GPTM TimerB Interval Load (GPTMTBILR), offset 0x02C .....	315
Register 11:	GPTM TimerA Match (GPTMTAMATCHR), offset 0x030 .....	316
Register 12:	GPTM TimerB Match (GPTMTBMATCHR), offset 0x034 .....	317
Register 13:	GPTM TimerA Prescale (GPTMTAPR), offset 0x038 .....	318
Register 14:	GPTM TimerB Prescale (GPTMTBPR), offset 0x03C .....	319
Register 15:	GPTM TimerA Prescale Match (GPTMTAPMR), offset 0x040 .....	320
Register 16:	GPTM TimerB Prescale Match (GPTMTBPMR), offset 0x044 .....	321
Register 17:	GPTM TimerA (GPTMTAR), offset 0x048 .....	322
Register 18:	GPTM TimerB (GPTMTBR), offset 0x04C .....	323
<b>Watchdog Timer .....</b>	<b>324</b>	
Register 1:	Watchdog Load (WDTLOAD), offset 0x000 .....	328
Register 2:	Watchdog Value (WDTVALUE), offset 0x004 .....	329
Register 3:	Watchdog Control (WDTCTL), offset 0x008 .....	330
Register 4:	Watchdog Interrupt Clear (WDTICR), offset 0x00C .....	331
Register 5:	Watchdog Raw Interrupt Status (WDTRIS), offset 0x010 .....	332
Register 6:	Watchdog Masked Interrupt Status (WDTMIS), offset 0x014 .....	333
Register 7:	Watchdog Test (WDTTEST), offset 0x418 .....	334
Register 8:	Watchdog Lock (WDTLOCK), offset 0xC00 .....	335
Register 9:	Watchdog Peripheral Identification 4 (WDTPeriphID4), offset 0xFD0 .....	336
Register 10:	Watchdog Peripheral Identification 5 (WDTPeriphID5), offset 0xFD4 .....	337
Register 11:	Watchdog Peripheral Identification 6 (WDTPeriphID6), offset 0xFD8 .....	338
Register 12:	Watchdog Peripheral Identification 7 (WDTPeriphID7), offset 0xFDC .....	339
Register 13:	Watchdog Peripheral Identification 0 (WDTPeriphID0), offset 0xFE0 .....	340
Register 14:	Watchdog Peripheral Identification 1 (WDTPeriphID1), offset 0xFE4 .....	341

Register 15:	Watchdog Peripheral Identification 2 (WDTPeriphID2), offset 0xFE8 .....	342
Register 16:	Watchdog Peripheral Identification 3 (WDTPeriphID3), offset 0xFEC .....	343
Register 17:	Watchdog PrimeCell Identification 0 (WDTPCellID0), offset 0xFF0 .....	344
Register 18:	Watchdog PrimeCell Identification 1 (WDTPCellID1), offset 0xFF4 .....	345
Register 19:	Watchdog PrimeCell Identification 2 (WDTPCellID2), offset 0xFF8 .....	346
Register 20:	Watchdog PrimeCell Identification 3 (WDTPCellID3), offset 0xFFC .....	347
<b>Universal Asynchronous Receivers/Transmitters (UARTs) .....</b>		<b>348</b>
Register 1:	UART Data (UARTDR), offset 0x000 .....	357
Register 2:	UART Receive Status/Error Clear (UARTRSR/UARTECR), offset 0x004 .....	359
Register 3:	UART Flag (UARTFR), offset 0x018 .....	361
Register 4:	UART IrDA Low-Power Register (UARTILPR), offset 0x020 .....	363
Register 5:	UART Integer Baud-Rate Divisor (UARTIBRD), offset 0x024 .....	364
Register 6:	UART Fractional Baud-Rate Divisor (UARTFBRD), offset 0x028 .....	365
Register 7:	UART Line Control (UARTLCRH), offset 0x02C .....	366
Register 8:	UART Control (UARTCTL), offset 0x030 .....	368
Register 9:	UART Interrupt FIFO Level Select (UARTIFLS), offset 0x034 .....	370
Register 10:	UART Interrupt Mask (UARTIM), offset 0x038 .....	372
Register 11:	UART Raw Interrupt Status (UARTRIS), offset 0x03C .....	374
Register 12:	UART Masked Interrupt Status (UARTMIS), offset 0x040 .....	375
Register 13:	UART Interrupt Clear (UARTICR), offset 0x044 .....	376
Register 14:	UART Peripheral Identification 4 (UARTPeriphID4), offset 0xFD0 .....	378
Register 15:	UART Peripheral Identification 5 (UARTPeriphID5), offset 0xFD4 .....	379
Register 16:	UART Peripheral Identification 6 (UARTPeriphID6), offset 0xFD8 .....	380
Register 17:	UART Peripheral Identification 7 (UARTPeriphID7), offset 0xFDC .....	381
Register 18:	UART Peripheral Identification 0 (UARTPeriphID0), offset 0xFE0 .....	382
Register 19:	UART Peripheral Identification 1 (UARTPeriphID1), offset 0xFE4 .....	383
Register 20:	UART Peripheral Identification 2 (UARTPeriphID2), offset 0xFE8 .....	384
Register 21:	UART Peripheral Identification 3 (UARTPeriphID3), offset 0xFEC .....	385
Register 22:	UART PrimeCell Identification 0 (UARTPCellID0), offset 0xFF0 .....	386
Register 23:	UART PrimeCell Identification 1 (UARTPCellID1), offset 0xFF4 .....	387
Register 24:	UART PrimeCell Identification 2 (UARTPCellID2), offset 0xFF8 .....	388
Register 25:	UART PrimeCell Identification 3 (UARTPCellID3), offset 0xFFC .....	389
<b>Synchronous Serial Interface (SSI) .....</b>		<b>390</b>
Register 1:	SSI Control 0 (SSICR0), offset 0x000 .....	403
Register 2:	SSI Control 1 (SSICR1), offset 0x004 .....	405
Register 3:	SSI Data (SSIDR), offset 0x008 .....	407
Register 4:	SSI Status (SSISR), offset 0x00C .....	408
Register 5:	SSI Clock Prescale (SSICPSR), offset 0x010 .....	410
Register 6:	SSI Interrupt Mask (SSIIM), offset 0x014 .....	411
Register 7:	SSI Raw Interrupt Status (SSIRIS), offset 0x018 .....	413
Register 8:	SSI Masked Interrupt Status (SSIMIS), offset 0x01C .....	414
Register 9:	SSI Interrupt Clear (SSIICR), offset 0x020 .....	415
Register 10:	SSI Peripheral Identification 4 (SSIPeriphID4), offset 0xFD0 .....	416
Register 11:	SSI Peripheral Identification 5 (SSIPeriphID5), offset 0xFD4 .....	417
Register 12:	SSI Peripheral Identification 6 (SSIPeriphID6), offset 0xFD8 .....	418
Register 13:	SSI Peripheral Identification 7 (SSIPeriphID7), offset 0xFDC .....	419
Register 14:	SSI Peripheral Identification 0 (SSIPeriphID0), offset 0xFE0 .....	420
Register 15:	SSI Peripheral Identification 1 (SSIPeriphID1), offset 0xFE4 .....	421

Register 16:	SSI Peripheral Identification 2 (SSIPeriphID2), offset 0xFE8 .....	422
Register 17:	SSI Peripheral Identification 3 (SSIPeriphID3), offset 0xFEC .....	423
Register 18:	SSI PrimeCell Identification 0 (SSIPCellID0), offset 0xFF0 .....	424
Register 19:	SSI PrimeCell Identification 1 (SSIPCellID1), offset 0xFF4 .....	425
Register 20:	SSI PrimeCell Identification 2 (SSIPCellID2), offset 0xFF8 .....	426
Register 21:	SSI PrimeCell Identification 3 (SSIPCellID3), offset 0xFFC .....	427
<b>Ethernet Controller .....</b>		<b>428</b>
Register 1:	Ethernet MAC Raw Interrupt Status/Acknowledge (MACRIS/MACIACK), offset 0x000 .....	440
Register 2:	Ethernet MAC Interrupt Mask (MACIM), offset 0x004 .....	443
Register 3:	Ethernet MAC Receive Control (MACRCTL), offset 0x008 .....	444
Register 4:	Ethernet MAC Transmit Control (MACTCTL), offset 0x00C .....	445
Register 5:	Ethernet MAC Data (MACDATA), offset 0x010 .....	446
Register 6:	Ethernet MAC Individual Address 0 (MACIA0), offset 0x014 .....	448
Register 7:	Ethernet MAC Individual Address 1 (MACIA1), offset 0x018 .....	449
Register 8:	Ethernet MAC Threshold (MACTHR), offset 0x01C .....	450
Register 9:	Ethernet MAC Management Control (MACMCTL), offset 0x020 .....	452
Register 10:	Ethernet MAC Management Divider (MACMDV), offset 0x024 .....	453
Register 11:	Ethernet MAC Management Transmit Data (MACMTXD), offset 0x02C .....	454
Register 12:	Ethernet MAC Management Receive Data (MACMRXD), offset 0x030 .....	455
Register 13:	Ethernet MAC Number of Packets (MACNP), offset 0x034 .....	456
Register 14:	Ethernet MAC Transmission Request (MACTR), offset 0x038 .....	457
Register 15:	Ethernet PHY Management Register 0 – Control (MR0), address 0x00 .....	458
Register 16:	Ethernet PHY Management Register 1 – Status (MR1), address 0x01 .....	460
Register 17:	Ethernet PHY Management Register 2 – PHY Identifier 1 (MR2), address 0x02 .....	462
Register 18:	Ethernet PHY Management Register 3 – PHY Identifier 2 (MR3), address 0x03 .....	463
Register 19:	Ethernet PHY Management Register 4 – Auto-Negotiation Advertisement (MR4), address 0x04 .....	464
Register 20:	Ethernet PHY Management Register 5 – Auto-Negotiation Link Partner Base Page Ability (MR5), address 0x05 .....	466
Register 21:	Ethernet PHY Management Register 6 – Auto-Negotiation Expansion (MR6), address 0x06 .....	467
Register 22:	Ethernet PHY Management Register 16 – Vendor-Specific (MR16), address 0x10 .....	468
Register 23:	Ethernet PHY Management Register 17 – Interrupt Control/Status (MR17), address 0x11 .....	470
Register 24:	Ethernet PHY Management Register 18 – Diagnostic (MR18), address 0x12 .....	472
Register 25:	Ethernet PHY Management Register 19 – Transceiver Control (MR19), address 0x13 .....	473
Register 26:	Ethernet PHY Management Register 23 – LED Configuration (MR23), address 0x17 .....	474
Register 27:	Ethernet PHY Management Register 24 –MDI/MDIX Control (MR24), address 0x18 .....	475
<b>Analog Comparator .....</b>		<b>476</b>
Register 1:	Analog Comparator Masked Interrupt Status (ACMIS), offset 0x000 .....	481
Register 2:	Analog Comparator Raw Interrupt Status (ACRIS), offset 0x004 .....	482
Register 3:	Analog Comparator Interrupt Enable (ACINTEN), offset 0x008 .....	483
Register 4:	Analog Comparator Reference Voltage Control (ACREFCTL), offset 0x010 .....	484
Register 5:	Analog Comparator Status 0 (ACSTAT0), offset 0x020 .....	485
Register 6:	Analog Comparator Control 0 (ACCTL0), offset 0x024 .....	486

# Revision History

The revision history table notes changes made between the indicated revisions of the LM3S6100 data sheet.

**Table 1. Revision History**

Date	Revision	Description
July 2014	15852.2743	<ul style="list-style-type: none"> <li>■ In JTAG chapter, clarified JTAG-to-SWD Switching and SWD-to-JTAG Switching.</li> <li>■ In System Control chapter, clarified behavior of <b>Reset Cause (RESC)</b> register external reset bit.</li> <li>■ In Internal Memory chapter:               <ul style="list-style-type: none"> <li>– Added sections on Execute-Only Protection, Read-Only Protection, and Permanently Disabling Debug.</li> <li>– Noted that the <b>Boot Configuration (BOOTCFG)</b> register requires a POR before committed changes to the Flash-resident registers take effect.</li> </ul> </li> <li>■ In UART chapter:               <ul style="list-style-type: none"> <li>– Clarified that the transmit interrupt is based on a transition through level.</li> <li>– Corrected reset for <b>UART Raw Interrupt Status (UARTRIS)</b> register.</li> </ul> </li> <li>■ In Electrical Characteristics chapter, updated Crystal Characteristics and Ethernet Reference Crystal tables.</li> <li>■ In Ordering and Contact Information appendix, moved orderable part numbers table to addendum.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
June 2012	12746.2515	<ul style="list-style-type: none"> <li>■ Removed extended temperature package.</li> <li>■ Minor data sheet clarifications and corrections.</li> </ul>
November 2011	11108	<ul style="list-style-type: none"> <li>■ Added module-specific pin tables to each chapter in the new Signal Description sections.</li> <li>■ In Timer chapter, clarified that in 16-Bit Input Edge Time Mode, the timer is capable of capturing three types of events: rising edge, falling edge, or both.</li> <li>■ In UART chapter, clarified interrupt behavior.</li> <li>■ In SSI chapter, corrected SSIClk in the figure "Synchronous Serial Frame Format (Single Transfer)".</li> <li>■ In Signal Tables chapter:               <ul style="list-style-type: none"> <li>– Corrected pin numbers in table "Connections for Unused Signals" (other pin tables were correct).</li> </ul> </li> <li>■ In Electrical Characteristics chapter:               <ul style="list-style-type: none"> <li>– Added parameter "Input voltage for a GPIO configured as an analog input" to the "Maximum Ratings" table.</li> <li>– Corrected Nom values for parameters "TCK clock Low time" and "TCK clock High time" in "JTAG Characteristics" table.</li> </ul> </li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>

Table 1. Revision History (continued)

Date	Revision	Description
January 2011	9102	<ul style="list-style-type: none"> <li>■ In <b>Application Interrupt and Reset Control (APINT)</b> register, changed bit name from <code>SYSRESETREQ</code> to <code>SYSRESREQ</code>.</li> <li>■ Added <code>DEBUG</code> (Debug Priority) bit field to <b>System Handler Priority 3 (SYSPRI3)</b> register.</li> <li>■ Added "Reset Sources" table to System Control chapter.</li> <li>■ Removed mention of false-start bit detection in the UART chapter. This feature is not supported.</li> <li>■ Added note that specific module clocks must be enabled before that module's registers can be programmed. There must be a delay of 3 system clocks after the module clock is enabled before any of that module's registers are accessed.</li> <li>■ Added <code>GNDPHY</code> and <code>VCCPHY</code> to Connections for Unused Signals tables.</li> <li>■ Added specification for maximum input voltage on a non-power pin when the microcontroller is unpowered (<math>V_{NON}</math> parameter in Maximum Ratings table).</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
September 2010	7787	<ul style="list-style-type: none"> <li>■ Reorganized ARM Cortex-M3 Processor Core, Memory Map and Interrupts chapters, creating two new chapters, The Cortex-M3 Processor and Cortex-M3 Peripherals. Much additional content was added, including all the Cortex-M3 registers.</li> <li>■ Changed register names to be consistent with StellarisWare® names: the Cortex-M3 <b>Interrupt Control and Status (ICSR)</b> register to the <b>Interrupt Control and State (INTCTRL)</b> register, and the Cortex-M3 <b>Interrupt Set Enable (SETNA)</b> register to the <b>Interrupt 0-31 Set Enable (EN0)</b> register.</li> <li>■ Added clarification of instruction execution during Flash operations.</li> <li>■ Modified Figure 7-1 on page 248 to clarify operation of the GPIO inputs when used as an alternate function.</li> <li>■ Added caution not to apply a Low value to <code>PB7</code> when debugging; a Low value on the pin causes the JTAG controller to be reset, resulting in a loss of JTAG communication.</li> <li>■ In General-Purpose Timers chapter, clarified operation of the 32-bit RTC mode.</li> <li>■ In Electrical Characteristics chapter: <ul style="list-style-type: none"> <li>– Added <math>I_{LKG}</math> parameter (GPIO input leakage current) to Table 17-4 on page 515.</li> <li>– Corrected values for <math>t_{CLKRF}</math> parameter (<math>SSIClk</math> rise/fall time) in Table 17-16 on page 522.</li> <li>– Added "Ethernet Controller DC Characteristics" table (see Table 17-7 on page 517).</li> </ul> </li> <li>■ Added dimensions for Tray and Tape and Reel shipping mediums.</li> </ul>
June 2010	7393	<ul style="list-style-type: none"> <li>■ Corrected base address for SRAM in architectural overview chapter.</li> <li>■ Clarified system clock operation, adding content to "Clock Control" on page 166.</li> <li>■ In Signal Tables chapter, added table "Connections for Unused Signals."</li> <li>■ In "Thermal Characteristics" table, corrected thermal resistance value from 34 to 32.</li> <li>■ In "Reset Characteristics" table, corrected value for supply voltage (VDD) rise time.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>

Table 1. Revision History (continued)

Date	Revision	Description
April 2010	7007	<ul style="list-style-type: none"> <li>■ Added caution note to the <b>I<sup>2</sup>C Master Timer Period (I2CMTPR)</b> register description and changed field width to 7 bits.</li> <li>■ Removed erroneous text about restoring the Flash Protection registers.</li> <li>■ Added note about <math>\overline{\text{RST}}</math> signal routing.</li> <li>■ Clarified the function of the <math>\text{TRSTALL}</math> bit in the <b>GPTMCTL</b> register.</li> <li>■ Corrected <math>\text{XTALNPHY}</math> pin description.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
January 2010	6712	<ul style="list-style-type: none"> <li>■ In "System Control" section, clarified Debug Access Port operation after Sleep modes.</li> <li>■ Clarified wording on Flash memory access errors.</li> <li>■ Added section on Flash interrupts.</li> <li>■ Clarified operation of SSI transmit FIFO.</li> <li>■ Made these changes to the Operating Characteristics chapter: <ul style="list-style-type: none"> <li>– Added storage temperature ratings to "Temperature Characteristics" table</li> <li>– Added "ESD Absolute Maximum Ratings" table</li> </ul> </li> <li>■ Made these changes to the Electrical Characteristics chapter: <ul style="list-style-type: none"> <li>– In "Flash Memory Characteristics" table, corrected Mass erase time</li> <li>– Added sleep and deep-sleep wake-up times ("Sleep Modes AC Characteristics" table)</li> <li>– In "Reset Characteristics" table, corrected units for supply voltage (VDD) rise time</li> </ul> </li> </ul>
October 2009	6462	<ul style="list-style-type: none"> <li>■ Deleted reset value for 16-bit mode from <b>GPTMTAILR</b>, <b>GPTMTAMATCHR</b>, and <b>GPTMTAR</b> registers because the module resets in 32-bit mode.</li> <li>■ Made these changes to the Electrical Characteristics chapter: <ul style="list-style-type: none"> <li>– Removed <math>V_{\text{SIH}}</math> and <math>V_{\text{SIL}}</math> parameters from Operating Conditions table.</li> <li>– Added table showing actual PLL frequency depending on input crystal.</li> <li>– Changed the name of the <math>t_{\text{HIB\_REG\_WRITE}}</math> parameter to <math>t_{\text{HIB\_REG\_ACCESS}}</math>.</li> <li>– Changed SSI set up and hold times to be expressed in system clocks, not ns.</li> </ul> </li> </ul>
July 2009	5920	Corrected ordering numbers.

Table 1. Revision History (continued)

Date	Revision	Description
July 2009	5902	<ul style="list-style-type: none"> <li>■ Clarified Power-on reset and <math>\overline{\text{RST}}</math> pin operation; added new diagrams.</li> <li>■ Clarified explanation of nonvolatile register programming in Internal Memory chapter.</li> <li>■ Added explanation of reset value to <b>FMPRE0/1/2/3</b>, <b>FMPPE0/1/2/3</b>, <b>USER_DBG</b>, and <b>USER_REG0/1</b> registers.</li> <li>■ Added description for Ethernet PHY power-saving modes.</li> <li>■ Corrected the reset values for bits 6 and 7 in the Ethernet <b>MR24</b> register.</li> <li>■ Changed buffer type for <math>\overline{\text{WAKE}}</math> pin to TTL and <math>\overline{\text{HIB}}</math> pin to OD.</li> <li>■ In ADC characteristics table, changed Max value for <b>GAIN</b> parameter from <math>\pm 1</math> to <math>\pm 3</math> and added <math>E_{\text{IR}}</math> (Internal voltage reference error) parameter.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
April 2009	5367	<ul style="list-style-type: none"> <li>■ Added JTAG/SWD clarification (see "Communication with JTAG/SWD" on page 154).</li> <li>■ Added clarification that the PLL operates at 400 MHz, but is divided by two prior to the application of the output divisor.</li> <li>■ Added "GPIO Module DC Characteristics" table (see Table 17-4 on page 515).</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
January 2009	4660	<ul style="list-style-type: none"> <li>■ Corrected bit type for RELOAD bit field in SysTick Reload Value register; changed to R/W.</li> <li>■ Clarification added as to what happens when the SSI in slave mode is required to transmit but there is no data in the TX FIFO.</li> <li>■ Added "Hardware Configuration" section to Ethernet Controller chapter.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
November 2008	4283	<ul style="list-style-type: none"> <li>■ Revised High-Level Block Diagram.</li> <li>■ Additional minor data sheet clarifications and corrections were made.</li> </ul>
October 2008	4149	<ul style="list-style-type: none"> <li>■ Corrected values for <b>DSOSCSRC</b> bit field in <b>Deep Sleep Clock Configuration (DSLCLKCFG)</b> register.</li> <li>■ The <b>FMA</b> value for the <b>FMPRE3</b> register was incorrect in the Flash Resident Registers table in the Internal Memory chapter. The correct value is 0x0000.0006.</li> <li>■ In the Ethernet chapter, major improvements were made including a rewrite of the conceptual information and the addition of new figures to clarify how to use the Ethernet Controller interface.</li> <li>■ Incorrect Comparator Operating Modes tables were removed from the Analog Comparators chapter.</li> </ul>
August 2008	3447	<ul style="list-style-type: none"> <li>■ Added note on clearing interrupts to Interrupts chapter.</li> <li>■ Added Power Architecture diagram to System Control chapter.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
July 2008	3108	<ul style="list-style-type: none"> <li>■ Corrected resistor value in <b>ERBIAS</b> signal description.</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>

Table 1. Revision History (continued)

Date	Revision	Description
May 2008	2972	<ul style="list-style-type: none"> <li>■ As noted in the PCN, three of the nine Ethernet LED configuration options are no longer supported: TX Activity (0x2), RX Activity (0x3), and Collision (0x4). These values for the LED0 and LED1 bit fields in the MR23 register are now marked as reserved.</li> <li>■ As noted in the PCN, the option to provide VDD25 power from external sources was removed. Use the LDO output as the source of VDD25 input.</li> <li>■ As noted in the PCN, pin 41 (ball K3 on the BGA package) was renamed from GNDPHY to ERBIAS. A 12.4-kΩ resistor should be connected between ERBIAS and ground to accommodate future device revisions (see "Functional Description" on page 431).</li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
April 2008	2881	<ul style="list-style-type: none"> <li>■ The <math>\Theta_{JA}</math> value was changed from 55.3 to 34 in the "Thermal Characteristics" table in the Operating Characteristics chapter.</li> <li>■ Bit 31 of the DC3 register was incorrectly described in prior versions of the data sheet. A reset of 1 indicates that an even CCP pin is present and can be used as a 32-KHz input clock.</li> <li>■ Values for I<sub>DD_HIBERNATE</sub> were added to the "Detailed Power Specifications" table in the "Electrical Characteristics" chapter.</li> <li>■ The "Hibernation Module DC Electricals" table was added to the "Electrical Characteristics" chapter.</li> <li>■ The maximum value on Core supply voltage (V<sub>DD25</sub>) in the "Maximum Ratings" table in the "Electrical Characteristics" chapter was changed from 4 to 3.</li> <li>■ The operational frequency of the internal 30-kHz oscillator clock source is 30 kHz ± 50% (prior data sheets incorrectly noted it as 30 kHz ± 30%).</li> <li>■ A value of 0x3 in bits 5:4 of the MISC register (OSCSRC) indicates the 30-KHz internal oscillator is the input source for the oscillator. Prior data sheets incorrectly noted 0x3 as a reserved value.</li> <li>■ The reset for bits 6:4 of the RCC2 register (OSCSRC2) is 0x1 (IOSC). Prior data sheets incorrectly noted the reset was 0x0 (MOSC).</li> <li>■ A note on high-current applications was added to the GPIO chapter: For special high-current applications, the GPIO output buffers may be used with the following restrictions. With the GPIO pins configured as 8-mA output drivers, a total of four GPIO outputs may be used to sink current loads up to 18 mA each. At 18-mA sink current loading, the VOL value is specified as 1.2 V. The high-current GPIO package pins must be selected such that there are only a maximum of two per side of the physical package or BGA pin group with the total number of high-current GPIO outputs not exceeding four for the entire package.</li> <li>■ A note on Schmitt inputs was added to the GPIO chapter: Pins configured as digital inputs are Schmitt-triggered.</li> <li>■ The Buffer type on the WAKE pin changed from OD to - in the Signal Tables.</li> <li>■ The "Differential Sampling Range" figures in the ADC chapter were clarified.</li> <li>■ The last revision of the data sheet (revision 2550) introduced two errors that have now been corrected: <ul style="list-style-type: none"> <li>– The LQFP pin diagrams and pin tables were missing the comparator positive and negative input pins.</li> <li>– The base address was listed incorrectly in the FMPRE0 and FMPPE0 register bit diagrams.</li> </ul> </li> <li>■ Additional minor data sheet clarifications and corrections.</li> </ul>
March 2008	2550	Started tracking revision history.

## About This Document

This data sheet provides reference information for the LM3S6100 microcontroller, describing the functional blocks of the system-on-chip (SoC) device designed around the ARM® Cortex™-M3 core.

### Audience

This manual is intended for system software developers, hardware designers, and application developers.

### About This Manual

This document is organized into sections that correspond to each major feature.

### Related Documents

The following related documents are available on the Stellaris® web site at [www.ti.com/stellaris](http://www.ti.com/stellaris):

- *Stellaris® Errata*
- *ARM® Cortex™-M3 Errata*
- *Cortex™-M3/M4 Instruction Set Technical User's Manual*
- *Stellaris® Graphics Library User's Guide*
- *Stellaris® Peripheral Driver Library User's Guide*

The following related documents are also referenced:

- *ARM® Debug Interface V5 Architecture Specification*
- *ARM® Embedded Trace Macrocell Architecture Specification*
- *IEEE Standard 1149.1-Test Access Port and Boundary-Scan Architecture*

This documentation list was current as of publication date. Please check the web site for additional documentation, including application notes and white papers.

## Documentation Conventions

This document uses the conventions shown in Table 2 on page 26.

**Table 2. Documentation Conventions**

Notation	Meaning
<b>General Register Notation</b>	
<b>REGISTER</b>	APB registers are indicated in uppercase bold. For example, <b>PBORCTL</b> is the Power-On and Brown-Out Reset Control register. If a register name contains a lowercase n, it represents more than one register. For example, <b>SRCRn</b> represents any (or all) of the three Software Reset Control registers: <b>SRCR0</b> , <b>SRCR1</b> , and <b>SRCR2</b> .
bit	A single bit in a register.
bit field	Two or more consecutive and related bits.
offset 0xnnn	A hexadecimal increment to a register's address, relative to that module's base address as specified in Table 2-4 on page 60.
Register N	Registers are numbered consecutively throughout the document to aid in referencing them. The register number has no meaning to software.
reserved	Register bits marked <i>reserved</i> are reserved for future use. In most cases, reserved bits are set to 0; however, user software should not rely on the value of a reserved bit. To provide software compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
yy:xx	The range of register bits inclusive from xx to yy. For example, 31:15 means bits 15 through 31 in that register.
<b>Register Bit/Field Types</b>	
RC	Software can read this field. The bit or field is cleared by hardware after reading the bit/field.
RO	Software can read this field. Always write the chip reset value.
R/W	Software can read or write this field.
R/WC	Software can read or write this field. Writing to it with any value clears the register.
R/W1C	Software can read or write this field. A write of a 0 to a W1C bit does not affect the bit value in the register. A write of a 1 clears the value of the bit in the register; the remaining bits remain unchanged. This register type is primarily used for clearing interrupt status bits where the read operation provides the interrupt status and the write of the read value clears only the interrupts being reported at the time the register was read.
R/W1S	Software can read or write a 1 to this field. A write of a 0 to a R/W1S bit does not affect the bit value in the register.
W1C	Software can write this field. A write of a 0 to a W1C bit does not affect the bit value in the register. A write of a 1 clears the value of the bit in the register; the remaining bits remain unchanged. A read of the register returns no meaningful data. This register is typically used to clear the corresponding bit in an interrupt register.
WO	Only a write by software is valid; a read of the register returns no meaningful data.
<b>Register Bit/Field Reset Value</b>	
0	Bit cleared to 0 on chip reset.
1	Bit set to 1 on chip reset.
-	Nondeterministic.
<b>Pin/Signal Notation</b>	
[ ]	Pin alternate function; a pin defaults to the signal without the brackets.
pin	Refers to the physical connection on the package.
signal	Refers to the electrical signal encoding of a pin.

**Table 2. Documentation Conventions (continued)**

Notation	Meaning
assert a signal	Change the value of the signal from the logically False state to the logically True state. For active High signals, the asserted signal value is 1 (High); for active Low signals, the asserted signal value is 0 (Low). The active polarity (High or Low) is defined by the signal name (see <code>SIGNAL</code> and <code><math>\overline{\text{SIGNAL}}</math></code> below).
deassert a signal	Change the value of the signal from the logically True state to the logically False state.
<code><math>\overline{\text{SIGNAL}}</math></code>	Signal names are in uppercase and in the Courier font. An overbar on a signal name indicates that it is active Low. To assert <code><math>\overline{\text{SIGNAL}}</math></code> is to drive it Low; to deassert <code><math>\overline{\text{SIGNAL}}</math></code> is to drive it High.
<code>SIGNAL</code>	Signal names are in uppercase and in the Courier font. An active High signal has no overbar. To assert <code>SIGNAL</code> is to drive it High; to deassert <code>SIGNAL</code> is to drive it Low.
<b>Numbers</b>	
X	An uppercase X indicates any of several values is allowed, where X can be any legal pattern. For example, a binary value of 0X00 can be either 0100 or 0000, a hex value of 0xX is 0x0 or 0x1, and so on.
0x	Hexadecimal numbers have a prefix of 0x. For example, 0x00FF is the hexadecimal number FF. All other numbers within register tables are assumed to be binary. Within conceptual information, binary numbers are indicated with a b suffix, for example, 1011b, and decimal numbers are written without a prefix or suffix.

# 1 Architectural Overview

The Stellaris® family of microcontrollers—the first ARM® Cortex™-M3 based controllers—brings high-performance 32-bit computing to cost-sensitive embedded microcontroller applications. These pioneering parts deliver customers 32-bit performance at a cost equivalent to legacy 8- and 16-bit devices, all in a package with a small footprint.

The Stellaris family offers efficient performance and extensive integration, favorably positioning the device into cost-conscious applications requiring significant control-processing and connectivity capabilities. The Stellaris LM3S6000 series combines both a 10/100 Ethernet Media Access Control (MAC) and Physical (PHY) layer, marking the first time that integrated connectivity is available with an ARM Cortex-M3 MCU and the only integrated 10/100 Ethernet MAC and PHY available in an ARM architecture MCU.

The LM3S6100 microcontroller is targeted for industrial applications, including remote monitoring, electronic point-of-sale machines, test and measurement equipment, network appliances and switches, factory automation, HVAC and building control, gaming equipment, motion control, medical instrumentation, and fire and security.

In addition, the LM3S6100 microcontroller offers the advantages of ARM's widely available development tools, System-on-Chip (SoC) infrastructure IP applications, and a large user community. Additionally, the microcontroller uses ARM's Thumb®-compatible Thumb-2 instruction set to reduce memory requirements and, thereby, cost. Finally, the LM3S6100 microcontroller is code-compatible to all members of the extensive Stellaris family; providing flexibility to fit our customers' precise needs.

Texas Instruments offers a complete solution to get to market quickly, with evaluation and development boards, white papers and application notes, an easy-to-use peripheral driver library, and a strong support, sales, and distributor network. See "Ordering and Contact Information" on page 550 for ordering information for Stellaris family devices.

## 1.1 Product Features

The LM3S6100 microcontroller includes the following product features:

- 32-Bit RISC Performance
  - 32-bit ARM® Cortex™-M3 v7M architecture optimized for small-footprint embedded applications
  - System timer (SysTick), providing a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism
  - Thumb®-compatible Thumb-2-only instruction set processor core for high code density
  - 25-MHz operation
  - Hardware-division and single-cycle-multiplication
  - Integrated Nested Vectored Interrupt Controller (NVIC) providing deterministic interrupt handling
  - 20 interrupts with eight priority levels

- Memory protection unit (MPU), providing a privileged mode for protected operating system functionality
- Unaligned data access, enabling data to be efficiently packed into memory
- Atomic bit manipulation (bit-banding), delivering maximum memory utilization and streamlined peripheral control
- ARM® Cortex™-M3 Processor Core
  - Compact core.
  - Thumb-2 instruction set, delivering the high-performance expected of an ARM core in the memory size usually associated with 8- and 16-bit devices; typically in the range of a few kilobytes of memory for microcontroller class applications.
  - Rapid application execution through Harvard architecture characterized by separate buses for instruction and data.
  - Exceptional interrupt handling, by implementing the register manipulations required for handling an interrupt in hardware.
  - Deterministic, fast interrupt processing: always 12 cycles, or just 6 cycles with tail-chaining
  - Memory protection unit (MPU) to provide a privileged mode of operation for complex applications.
  - Migration from the ARM7™ processor family for better performance and power efficiency.
  - Full-featured debug solution
    - Serial Wire JTAG Debug Port (SWJ-DP)
    - Flash Patch and Breakpoint (FPB) unit for implementing breakpoints
    - Data Watchpoint and Trigger (DWT) unit for implementing watchpoints, trigger resources, and system profiling
    - Instrumentation Trace Macrocell (ITM) for support of printf style debugging
    - Trace Port Interface Unit (TPIU) for bridging to a Trace Port Analyzer
  - Optimized for single-cycle flash usage
  - Three sleep modes with clock gating for low power
  - Single-cycle multiply instruction and hardware divide
  - Atomic operations
  - ARM Thumb2 mixed 16-/32-bit instruction set
  - 1.25 DMIPS/MHz
- JTAG

- IEEE 1149.1-1990 compatible Test Access Port (TAP) controller
- Four-bit Instruction Register (IR) chain for storing JTAG instructions
- IEEE standard instructions: BYPASS, IDCODE, SAMPLE/PRELOAD, EXTEST and INTTEST
- ARM additional instructions: APACC, DPACC and ABORT
- Integrated ARM Serial Wire Debug (SWD)
- Internal Memory
  - 64 KB single-cycle flash
    - User-managed flash block protection on a 2-KB block basis
    - User-managed flash data programming
    - User-defined and managed flash-protection block
  - 16 KB single-cycle SRAM
- GPIOs
  - 10-30 GPIOs, depending on configuration
  - 5-V-tolerant in input configuration
  - Fast toggle capable of a change every two clock cycles
  - Programmable control for GPIO interrupts
    - Interrupt generation masking
    - Edge-triggered on rising, falling, or both
    - Level-sensitive on High or Low values
  - Bit masking in both read and write operations through address lines
  - Pins configured as digital inputs are Schmitt-triggered.
  - Programmable control for GPIO pad configuration
    - Weak pull-up or pull-down resistors
    - 2-mA, 4-mA, and 8-mA pad drive for digital communication; up to four pads can be configured with an 18-mA pad drive for high-current applications
    - Slew rate control for the 8-mA drive
    - Open drain enables
    - Digital input enables
- General-Purpose Timers

- Three General-Purpose Timer Modules (GPTM), each of which provides two 16-bit timers/counters. Each GPTM can be configured to operate independently:
  - As a single 32-bit timer
  - As one 32-bit Real-Time Clock (RTC) to event capture
  - For Pulse Width Modulation (PWM)
- 32-bit Timer modes
  - Programmable one-shot timer
  - Programmable periodic timer
  - Real-Time Clock when using an external 32.768-KHz clock as the input
  - User-enabled stalling when the controller asserts CPU Halt flag during debug
- 16-bit Timer modes
  - General-purpose timer function with an 8-bit prescaler (for one-shot and periodic modes only)
  - Programmable one-shot timer
  - Programmable periodic timer
  - User-enabled stalling when the controller asserts CPU Halt flag during debug
- 16-bit Input Capture modes
  - Input edge count capture
  - Input edge time capture
- 16-bit PWM mode
  - Simple PWM mode with software-programmable output inversion of the PWM signal
- ARM FiRM-compliant Watchdog Timer
  - 32-bit down counter with a programmable load register
  - Separate watchdog clock with an enable
  - Programmable interrupt generation logic with interrupt masking
  - Lock register protection from runaway software
  - Reset generation logic with an enable/disable
  - User-enabled stalling when the controller asserts the CPU Halt flag during debug
- UART
  - Fully programmable 16C550-type UART with IrDA support

- Separate 16x8 transmit (TX) and receive (RX) FIFOs to reduce CPU interrupt service loading
- Programmable baud-rate generator allowing speeds up to 1.5625 Mbps
- Programmable FIFO length, including 1-byte deep operation providing conventional double-buffered interface
- FIFO trigger levels of 1/8, 1/4, 1/2, 3/4, and 7/8
- Standard asynchronous communication bits for start, stop, and parity
- Line-break generation and detection
- Fully programmable serial interface characteristics
  - 5, 6, 7, or 8 data bits
  - Even, odd, stick, or no-parity bit generation/detection
  - 1 or 2 stop bit generation
- IrDA serial-IR (SIR) encoder/decoder providing
  - Programmable use of IrDA Serial Infrared (SIR) or UART input/output
  - Support of IrDA SIR encoder/decoder functions for data rates up to 115.2 Kbps half-duplex
  - Support of normal 3/16 and low-power (1.41-2.23  $\mu$ s) bit durations
  - Programmable internal clock generator enabling division of reference clock by 1 to 256 for low-power mode bit duration
- Synchronous Serial Interface (SSI)
  - Master or slave operation
  - Programmable clock bit rate and prescale
  - Separate transmit and receive FIFOs, 16 bits wide, 8 locations deep
  - Programmable interface operation for Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces
  - Programmable data frame size from 4 to 16 bits
  - Internal loopback test mode for diagnostic/debug testing
- 10/100 Ethernet Controller
  - Conforms to the *IEEE 802.3-2002 specification*
    - 10BASE-T/100BASE-TX IEEE-802.3 compliant. Requires only a dual 1:1 isolation transformer interface to the line
    - 10BASE-T/100BASE-TX ENDEC, 100BASE-TX scrambler/descrambler
    - Full-featured auto-negotiation

- Multiple operational modes
  - Full- and half-duplex 100 Mbps
  - Full- and half-duplex 10 Mbps
  - Power-saving and power-down modes
- Highly configurable
  - Programmable MAC address
  - LED activity selection
  - Promiscuous mode support
  - CRC error-rejection control
  - User-configurable interrupts
- Physical media manipulation
  - Automatic MDI/MDI-X cross-over correction
  - Register-programmable transmit amplitude
  - Automatic polarity correction and 10BASE-T signal reception
- Analog Comparators
  - One integrated analog comparator
  - Configurable for output to drive an output pin or generate an interrupt
  - Compare external pin input to external pin input or to internal programmable voltage reference
  - Compare a test voltage against any one of these voltages
    - An individual external reference voltage
    - A shared single external reference voltage
    - A shared internal reference voltage
- Power
  - On-chip Low Drop-Out (LDO) voltage regulator, with programmable output user-adjustable from 2.25 V to 2.75 V
  - Low-power options on controller: Sleep and Deep-sleep modes
  - Low-power options for peripherals: software controls shutdown of individual peripherals
  - 3.3-V supply brown-out detection and reporting via interrupt or reset
- Flexible Reset Sources

- Power-on reset (POR)
- Reset pin assertion
- Brown-out (BOR) detector alerts to system power drops
- Software reset
- Watchdog timer reset
- Internal low drop-out (LDO) regulator output goes unregulated
- Industrial temperature 100-pin RoHS-compliant LQFP package
- Industrial-range 108-ball RoHS-compliant BGA package

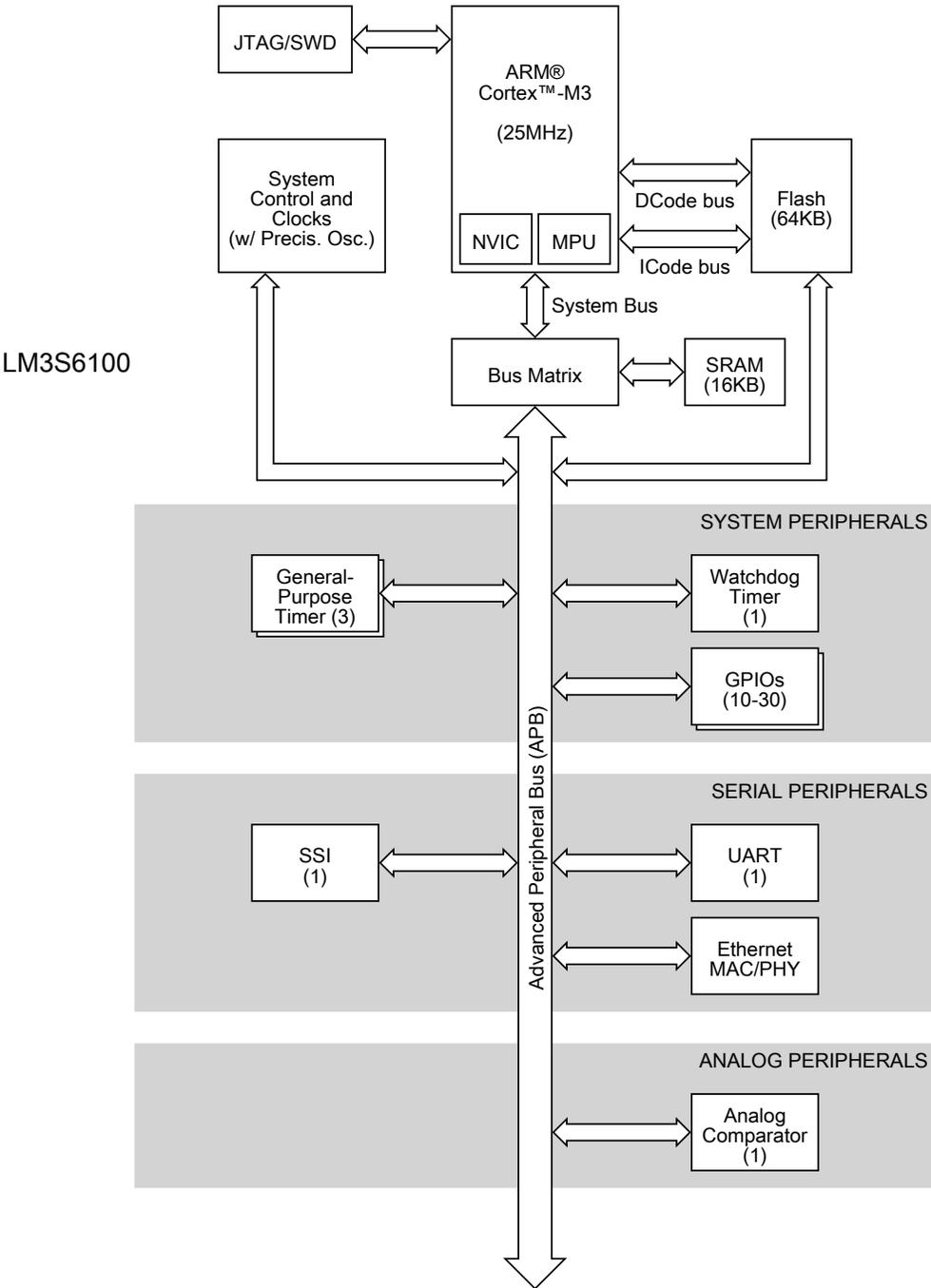
## 1.2 Target Applications

- Remote monitoring
- Electronic point-of-sale (POS) machines
- Test and measurement equipment
- Network appliances and switches
- Factory automation
- HVAC and building control
- Gaming equipment
- Motion control
- Medical instrumentation
- Fire and security
- Power and energy
- Transportation

## 1.3 High-Level Block Diagram

Figure 1-1 on page 35 depicts the features on the Stellaris LM3S6100 microcontroller.

Figure 1-1. Stellaris LM3S6100 Microcontroller High-Level Block Diagram



## 1.4 Functional Overview

The following sections provide an overview of the features of the LM3S6100 microcontroller. The page number in parenthesis indicates where that feature is discussed in detail. Ordering and support information can be found in “Ordering and Contact Information” on page 550.

### 1.4.1 ARM Cortex™-M3

#### 1.4.1.1 Processor Core (see page 41)

All members of the Stellaris product family, including the LM3S6100 microcontroller, are designed around an ARM Cortex™-M3 processor core. The ARM Cortex-M3 processor provides the core for a high-performance, low-cost platform that meets the needs of minimal memory implementation, reduced pin count, and low-power consumption, while delivering outstanding computational performance and exceptional system response to interrupts.

#### 1.4.1.2 Memory Map (see page 60)

A memory map lists the location of instructions and data in memory. The memory map for the LM3S6100 controller can be found in Table 2-4 on page 60. Register addresses are given as a hexadecimal increment, relative to the module's base address as shown in the memory map.

#### 1.4.1.3 System Timer (SysTick) (see page 83)

Cortex-M3 includes an integrated system timer, SysTick. SysTick provides a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism. The counter can be used in several different ways, for example:

- An RTOS tick timer which fires at a programmable rate (for example, 100 Hz) and invokes a SysTick routine.
- A high-speed alarm timer using the system clock.
- A variable rate alarm or signal timer—the duration is range-dependent on the reference clock used and the dynamic range of the counter.
- A simple counter. Software can use this to measure time to completion and time used.
- An internal clock source control based on missing/meeting durations. The COUNTFLAG bit-field in the control and status register can be used to determine if an action completed within a set duration, as part of a dynamic clock management control loop.

#### 1.4.1.4 Nested Vectored Interrupt Controller (NVIC) (see page 84)

The LM3S6100 controller includes the ARM Nested Vectored Interrupt Controller (NVIC) on the ARM® Cortex™-M3 core. The NVIC and Cortex-M3 prioritize and handle all exceptions. All exceptions are handled in Handler Mode. The processor state is automatically stored to the stack on an exception, and automatically restored from the stack at the end of the Interrupt Service Routine (ISR). The vector is fetched in parallel to the state saving, which enables efficient interrupt entry. The processor supports tail-chaining, which enables back-to-back interrupts to be performed without the overhead of state saving and restoration. Software can set eight priority levels on 7 exceptions (system handlers) and 20 interrupts.

#### 1.4.1.5 System Control Block (SCB) (see page 86)

The SCB provides system implementation information and system control, including configuration, control, and reporting of system exceptions.

#### 1.4.1.6 Memory Protection Unit (MPU) (see page 86)

The MPU supports the standard ARMv7 Protected Memory System Architecture (PMSA) model. The MPU provides full support for protection regions, overlapping protection regions, access permissions, and exporting memory attributes to the system.

### 1.4.2 Motor Control Peripherals

To enhance motor control, the LM3S6100 controller features Pulse Width Modulation (PWM) outputs.

#### 1.4.2.1 PWM

Pulse width modulation (PWM) is a powerful technique for digitally encoding analog signal levels. High-resolution counters are used to generate a square wave, and the duty cycle of the square wave is modulated to encode an analog signal. Typical applications include switching power supplies and motor control.

On the LM3S6100, PWM motion control functionality can be achieved through:

- The motion control features of the general-purpose timers using the CCP pins

##### **CCP Pins (see page 294)**

The General-Purpose Timer Module's CCP (Capture Compare PWM) pins are software programmable to support a simple PWM mode with a software-programmable output inversion of the PWM signal.

### 1.4.3 Analog Peripherals

For support of analog signals, the LM3S6100 microcontroller offers one analog comparator.

#### 1.4.3.1 Analog Comparators (see page 476)

An analog comparator is a peripheral that compares two analog voltages, and provides a logical output that signals the comparison result.

The LM3S6100 microcontroller provides one analog comparator that can be configured to drive an output or generate an interrupt .

A comparator can compare a test voltage against any one of these voltages:

- An individual external reference voltage
- A shared single external reference voltage
- A shared internal reference voltage

The comparator can provide its output to a device pin, acting as a replacement for an analog comparator on the board, or it can be used to signal the application via interrupts to cause it to start capturing a sample sequence.

### 1.4.4 Serial Communications Peripherals

The LM3S6100 controller supports both asynchronous and synchronous serial communications with:

- One fully programmable 16C550-type UART
- One SSI module
- Ethernet controller

#### 1.4.4.1 UART (see page 348)

A Universal Asynchronous Receiver/Transmitter (UART) is an integrated circuit used for RS-232C serial communications, containing a transmitter (parallel-to-serial converter) and a receiver (serial-to-parallel converter), each clocked separately.

The LM3S6100 controller includes one fully programmable 16C550-type UART that supports data transfer speeds up to 1.5625 Mbps. (Although similar in functionality to a 16C550 UART, it is not register-compatible.) In addition, each UART is capable of supporting IrDA.

Separate 16x8 transmit (TX) and receive (RX) FIFOs reduce CPU interrupt service loading. The UART can generate individually masked interrupts from the RX, TX, modem status, and error conditions. The module provides a single combined interrupt when any of the interrupts are asserted and are unmasked.

#### 1.4.4.2 SSI (see page 390)

Synchronous Serial Interface (SSI) is a four-wire bi-directional full and low-speed communications interface.

The LM3S6100 controller includes one SSI module that provides the functionality for synchronous serial communications with peripheral devices, and can be configured to use the Freescale SPI, MICROWIRE, or TI synchronous serial interface frame formats. The size of the data frame is also configurable, and can be set between 4 and 16 bits, inclusive.

The SSI module performs serial-to-parallel conversion on data received from a peripheral device, and parallel-to-serial conversion on data transmitted to a peripheral device. The TX and RX paths are buffered with internal FIFOs, allowing up to eight 16-bit values to be stored independently.

The SSI module can be configured as either a master or slave device. As a slave device, the SSI module can also be configured to disable its output, which allows a master device to be coupled with multiple slave devices.

The SSI module also includes a programmable bit rate clock divider and prescaler to generate the output serial clock derived from the SSI module's input clock. Bit rates are generated based on the input clock and the maximum bit rate is determined by the connected peripheral.

#### 1.4.4.3 Ethernet Controller (see page 428)

Ethernet is a frame-based computer networking technology for local area networks (LANs). Ethernet has been standardized as IEEE 802.3. It defines a number of wiring and signaling standards for the physical layer, two means of network access at the Media Access Control (MAC)/Data Link Layer, and a common addressing format.

The Stellaris® Ethernet Controller consists of a fully integrated media access controller (MAC) and network physical (PHY) interface device. The Ethernet Controller conforms to IEEE 802.3 specifications and fully supports 10BASE-T and 100BASE-TX standards. In addition, the Ethernet Controller supports automatic MDI/MDI-X cross-over correction.

## 1.4.5 System Peripherals

### 1.4.5.1 Programmable GPIOs (see page 243)

General-purpose input/output (GPIO) pins offer flexibility for a variety of connections.

The Stellaris GPIO module is comprised of seven physical GPIO blocks, each corresponding to an individual GPIO port. The GPIO module is FiRM-compliant (compliant to the ARM Foundation IP for Real-Time Microcontrollers specification) and supports 10-30 programmable input/output pins. The number of GPIOs available depends on the peripherals being used (see “Signal Tables” on page 490 for the signals available to each GPIO pin).

The GPIO module features programmable interrupt generation as either edge-triggered or level-sensitive on all pins, programmable control for GPIO pad configuration, and bit masking in both read and write operations through address lines. Pins configured as digital inputs are Schmitt-triggered.

### 1.4.5.2 Three Programmable Timers (see page 288)

Programmable timers can be used to count or time external events that drive the Timer input pins.

The Stellaris General-Purpose Timer Module (GPTM) contains three GPTM blocks. Each GPTM block provides two 16-bit timers/counters that can be configured to operate independently as timers or event counters, or configured to operate as one 32-bit timer or one 32-bit Real-Time Clock (RTC).

When configured in 32-bit mode, a timer can run as a Real-Time Clock (RTC), one-shot timer or periodic timer. When in 16-bit mode, a timer can run as a one-shot timer or periodic timer, and can extend its precision by using an 8-bit prescaler. A 16-bit timer can also be configured for event capture or Pulse Width Modulation (PWM) generation.

### 1.4.5.3 Watchdog Timer (see page 324)

A watchdog timer can generate an interrupt or a reset when a time-out value is reached. The watchdog timer is used to regain control when a system has failed due to a software error or to the failure of an external device to respond in the expected way.

The Stellaris Watchdog Timer module consists of a 32-bit down counter, a programmable load register, interrupt generation logic, and a locking register.

The Watchdog Timer can be configured to generate an interrupt to the controller on its first time-out, and to generate a reset signal on its second time-out. Once the Watchdog Timer has been configured, the lock register can be written to prevent the timer configuration from being inadvertently altered.

## 1.4.6 Memory Peripherals

The LM3S6100 controller offers both single-cycle SRAM and single-cycle Flash memory.

### 1.4.6.1 SRAM (see page 216)

The LM3S6100 static random access memory (SRAM) controller supports 16 KB SRAM. The internal SRAM of the Stellaris devices starts at base address 0x2000.0000 of the device memory map. To reduce the number of time-consuming read-modify-write (RMW) operations, ARM has introduced *bit-banding* technology in the new Cortex-M3 processor. With a bit-band-enabled processor, certain regions in the memory map (SRAM and peripheral space) can use address aliases to access individual bits in a single, atomic operation.

### 1.4.6.2 Flash (see page 217)

The LM3S6100 Flash controller supports 64 KB of flash memory. The flash is organized as a set of 1-KB blocks that can be individually erased. Erasing a block causes the entire contents of the block to be reset to all 1s. These blocks are paired into a set of 2-KB blocks that can be individually protected. The blocks can be marked as read-only or execute-only, providing different levels of code protection. Read-only blocks cannot be erased or programmed, protecting the contents of those blocks from being modified. Execute-only blocks cannot be erased or programmed, and can only be read by the controller instruction fetch mechanism, protecting the contents of those blocks from being read by either the controller or by a debugger.

## 1.4.7 Additional Features

### 1.4.7.1 JTAG TAP Controller (see page 147)

The Joint Test Action Group (JTAG) port is an IEEE standard that defines a Test Access Port and Boundary Scan Architecture for digital integrated circuits and provides a standardized serial interface for controlling the associated test logic. The TAP, Instruction Register (IR), and Data Registers (DR) can be used to test the interconnections of assembled printed circuit boards and obtain manufacturing information on the components. The JTAG Port also provides a means of accessing and controlling design-for-test features such as I/O pin observation and control, scan testing, and debugging.

The JTAG port is composed of the standard five pins:  $\overline{\text{TRST}}$ , TCK, TMS, TDI, and TDO. Data is transmitted serially into the controller on TDI and out of the controller on TDO. The interpretation of this data is dependent on the current state of the TAP controller. For detailed information on the operation of the JTAG port and TAP controller, please refer to the *IEEE Standard 1149.1-Test Access Port and Boundary-Scan Architecture*.

The Stellaris JTAG controller works with the ARM JTAG controller built into the Cortex-M3 core. This is implemented by multiplexing the TDO outputs from both JTAG controllers. ARM JTAG instructions select the ARM TDO output while Stellaris JTAG instructions select the Stellaris TDO outputs. The multiplexer is controlled by the Stellaris JTAG controller, which has comprehensive programming for the ARM, Stellaris, and unimplemented JTAG instructions.

### 1.4.7.2 System Control and Clocks (see page 160)

System control determines the overall operation of the device. It provides information about the device, controls the clocking of the device and individual peripherals, and handles reset detection and reporting.

## 1.4.8 Hardware Details

Details on the pins and package can be found in the following sections:

- “Pin Diagram” on page 488
- “Signal Tables” on page 490
- “Operating Characteristics” on page 513
- “Electrical Characteristics” on page 514
- “Package Information” on page 552

## 2 The Cortex-M3 Processor

The ARM® Cortex™-M3 processor provides a high-performance, low-cost platform that meets the system requirements of minimal memory implementation, reduced pin count, and low power consumption, while delivering outstanding computational performance and exceptional system response to interrupts. Features include:

- Compact core.
- Thumb-2 instruction set, delivering the high-performance expected of an ARM core in the memory size usually associated with 8- and 16-bit devices; typically in the range of a few kilobytes of memory for microcontroller class applications.
- Rapid application execution through Harvard architecture characterized by separate buses for instruction and data.
- Exceptional interrupt handling, by implementing the register manipulations required for handling an interrupt in hardware.
- Deterministic, fast interrupt processing: always 12 cycles, or just 6 cycles with tail-chaining
- Memory protection unit (MPU) to provide a privileged mode of operation for complex applications.
- Migration from the ARM7™ processor family for better performance and power efficiency.
- Full-featured debug solution
  - Serial Wire JTAG Debug Port (SWJ-DP)
  - Flash Patch and Breakpoint (FPB) unit for implementing breakpoints
  - Data Watchpoint and Trigger (DWT) unit for implementing watchpoints, trigger resources, and system profiling
  - Instrumentation Trace Macrocell (ITM) for support of printf style debugging
  - Trace Port Interface Unit (TPIU) for bridging to a Trace Port Analyzer
- Optimized for single-cycle flash usage
- Three sleep modes with clock gating for low power
- Single-cycle multiply instruction and hardware divide
- Atomic operations
- ARM Thumb2 mixed 16-/32-bit instruction set
- 1.25 DMIPS/MHz

The Stellaris® family of microcontrollers builds on this core to bring high-performance 32-bit computing to cost-sensitive embedded microcontroller applications, such as factory automation and control, industrial control power devices, building and home automation, and stepper motor control.

This chapter provides information on the Stellaris implementation of the Cortex-M3 processor, including the programming model, the memory model, the exception model, fault handling, and power management.

For technical details on the instruction set, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

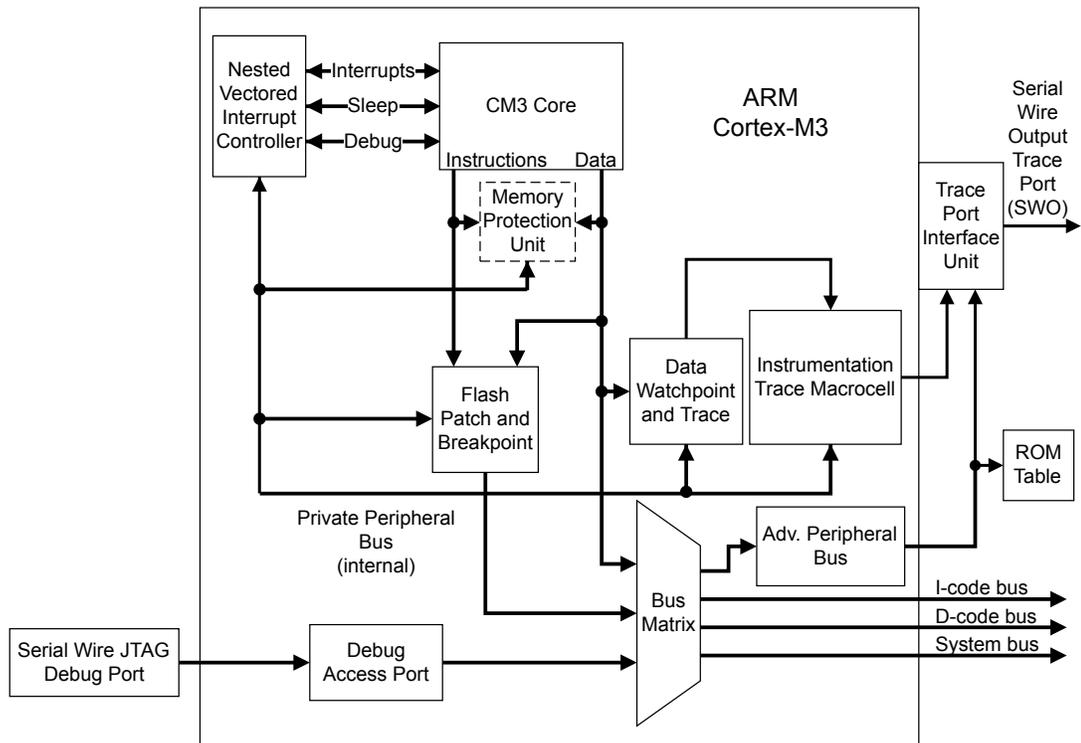
## 2.1 Block Diagram

The Cortex-M3 processor is built on a high-performance processor core, with a 3-stage pipeline Harvard architecture, making it ideal for demanding embedded applications. The processor delivers exceptional power efficiency through an efficient instruction set and extensively optimized design, providing high-end processing hardware including a range of single-cycle and SIMD multiplication and multiply-with-accumulate capabilities, saturating arithmetic and dedicated hardware division.

To facilitate the design of cost-sensitive devices, the Cortex-M3 processor implements tightly coupled system components that reduce processor area while significantly improving interrupt handling and system debug capabilities. The Cortex-M3 processor implements a version of the Thumb® instruction set based on Thumb-2 technology, ensuring high code density and reduced program memory requirements. The Cortex-M3 instruction set provides the exceptional performance expected of a modern 32-bit architecture, with the high code density of 8-bit and 16-bit microcontrollers.

The Cortex-M3 processor closely integrates a nested interrupt controller (NVIC), to deliver industry-leading interrupt performance. The Stellaris NVIC includes a non-maskable interrupt (NMI) and provides eight interrupt priority levels. The tight integration of the processor core and NVIC provides fast execution of interrupt service routines (ISRs), dramatically reducing interrupt latency. The hardware stacking of registers and the ability to suspend load-multiple and store-multiple operations further reduce interrupt latency. Interrupt handlers do not require any assembler stubs which removes code overhead from the ISRs. Tail-chaining optimization also significantly reduces the overhead when switching from one ISR to another. To optimize low-power designs, the NVIC integrates with the sleep modes, including Deep-sleep mode, which enables the entire device to be rapidly powered down.

Figure 2-1. CPU Block Diagram



## 2.2 Overview

### 2.2.1 System-Level Interface

The Cortex-M3 processor provides multiple interfaces using AMBA® technology to provide high-speed, low-latency memory accesses. The core supports unaligned data accesses and implements atomic bit manipulation that enables faster peripheral controls, system spinlocks, and thread-safe Boolean data handling.

The Cortex-M3 processor has a memory protection unit (MPU) that provides fine-grain memory control, enabling applications to implement security privilege levels and separate code, data and stack on a task-by-task basis.

### 2.2.2 Integrated Configurable Debug

The Cortex-M3 processor implements a complete hardware debug solution, providing high system visibility of the processor and memory through either a traditional JTAG port or a 2-pin Serial Wire Debug (SWD) port that is ideal for microcontrollers and other small package devices. The Stellaris implementation replaces the ARM SW-DP and JTAG-DP with the ARM CoreSight™-compliant Serial Wire JTAG Debug Port (SWJ-DP) interface. The SWJ-DP interface combines the SWD and JTAG debug ports into one module. See the *ARM® Debug Interface V5 Architecture Specification* for details on SWJ-DP.

For system trace, the processor integrates an Instrumentation Trace Macrocell (ITM) alongside data watchpoints and a profiling unit. To enable simple and cost-effective profiling of the system trace events, a Serial Wire Viewer (SWV) can export a stream of software-generated messages, data trace, and profiling information through a single pin.

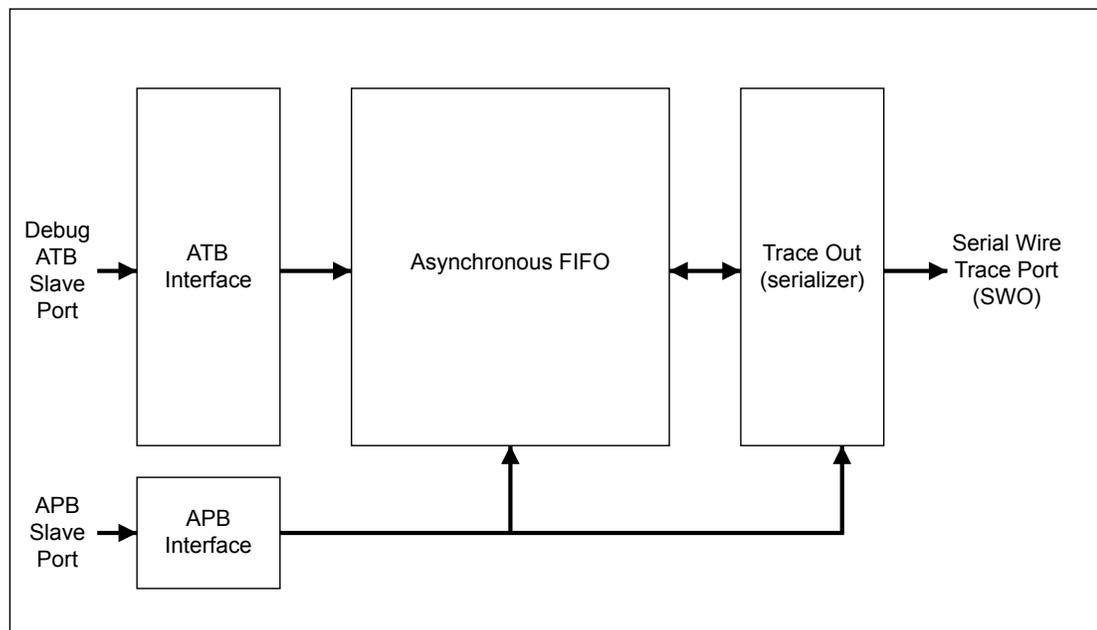
The Flash Patch and Breakpoint Unit (FPB) provides up to eight hardware breakpoint comparators that debuggers can use. The comparators in the FPB also provide remap functions of up to eight words in the program code in the CODE memory region. This enables applications stored in a read-only area of Flash memory to be patched in another area of on-chip SRAM or Flash memory. If a patch is required, the application programs the FPB to remap a number of addresses. When those addresses are accessed, the accesses are redirected to a remap table specified in the FPB configuration.

For more information on the Cortex-M3 debug capabilities, see the *ARM® Debug Interface V5 Architecture Specification*.

### 2.2.3 Trace Port Interface Unit (TPIU)

The TPIU acts as a bridge between the Cortex-M3 trace data from the ITM, and an off-chip Trace Port Analyzer, as shown in Figure 2-2 on page 44.

**Figure 2-2. TPIU Block Diagram**



### 2.2.4 Cortex-M3 System Component Details

The Cortex-M3 includes the following system components:

- **SysTick**  
A 24-bit count-down timer that can be used as a Real-Time Operating System (RTOS) tick timer or as a simple counter (see “System Timer (SysTick)” on page 83).
- **Nested Vectored Interrupt Controller (NVIC)**  
An embedded interrupt controller that supports low latency interrupt processing (see “Nested Vectored Interrupt Controller (NVIC)” on page 84).
- **System Control Block (SCB)**

The programming model interface to the processor. The SCB provides system implementation information and system control, including configuration, control, and reporting of system exceptions (see “System Control Block (SCB)” on page 86).

- Memory Protection Unit (MPU)

Improves system reliability by defining the memory attributes for different memory regions. The MPU provides up to eight different regions and an optional predefined background region (see “Memory Protection Unit (MPU)” on page 86).

## 2.3 Programming Model

This section describes the Cortex-M3 programming model. In addition to the individual core register descriptions, information about the processor modes and privilege levels for software execution and stacks is included.

### 2.3.1 Processor Mode and Privilege Levels for Software Execution

The Cortex-M3 has two modes of operation:

- Thread mode

Used to execute application software. The processor enters Thread mode when it comes out of reset.

- Handler mode

Used to handle exceptions. When the processor has finished exception processing, it returns to Thread mode.

In addition, the Cortex-M3 has two privilege levels:

- Unprivileged

In this mode, software has the following restrictions:

- Limited access to the `MSR` and `MRS` instructions and no use of the `CPS` instruction
- No access to the system timer, NVIC, or system control block
- Possibly restricted access to memory or peripherals

- Privileged

In this mode, software can use all the instructions and has access to all resources.

In Thread mode, the **CONTROL** register (see page 59) controls whether software execution is privileged or unprivileged. In Handler mode, software execution is always privileged.

Only privileged software can write to the **CONTROL** register to change the privilege level for software execution in Thread mode. Unprivileged software can use the `SVC` instruction to make a supervisor call to transfer control to privileged software.

### 2.3.2 Stacks

The processor uses a full descending stack, meaning that the stack pointer indicates the last stacked item on the memory. When the processor pushes a new item onto the stack, it decrements the stack pointer and then writes the item to the new memory location. The processor implements two stacks:

the main stack and the process stack, with a pointer for each held in independent registers (see the **SP** register on page 49).

In Thread mode, the **CONTROL** register (see page 59) controls whether the processor uses the main stack or the process stack. In Handler mode, the processor always uses the main stack. The options for processor operations are shown in Table 2-1 on page 46.

**Table 2-1. Summary of Processor Mode, Privilege Level, and Stack Use**

Processor Mode	Use	Privilege Level	Stack Used
Thread	Applications	Privileged or unprivileged <sup>a</sup>	Main stack or process stack <sup>a</sup>
Handler	Exception handlers	Always privileged	Main stack

a. See **CONTROL** (page 59).

### 2.3.3 Register Map

Figure 2-3 on page 46 shows the Cortex-M3 register set. Table 2-2 on page 47 lists the Core registers. The core registers are not memory mapped and are accessed by register name, so the base address is n/a (not applicable) and there is no offset.

**Figure 2-3. Cortex-M3 Register Set**

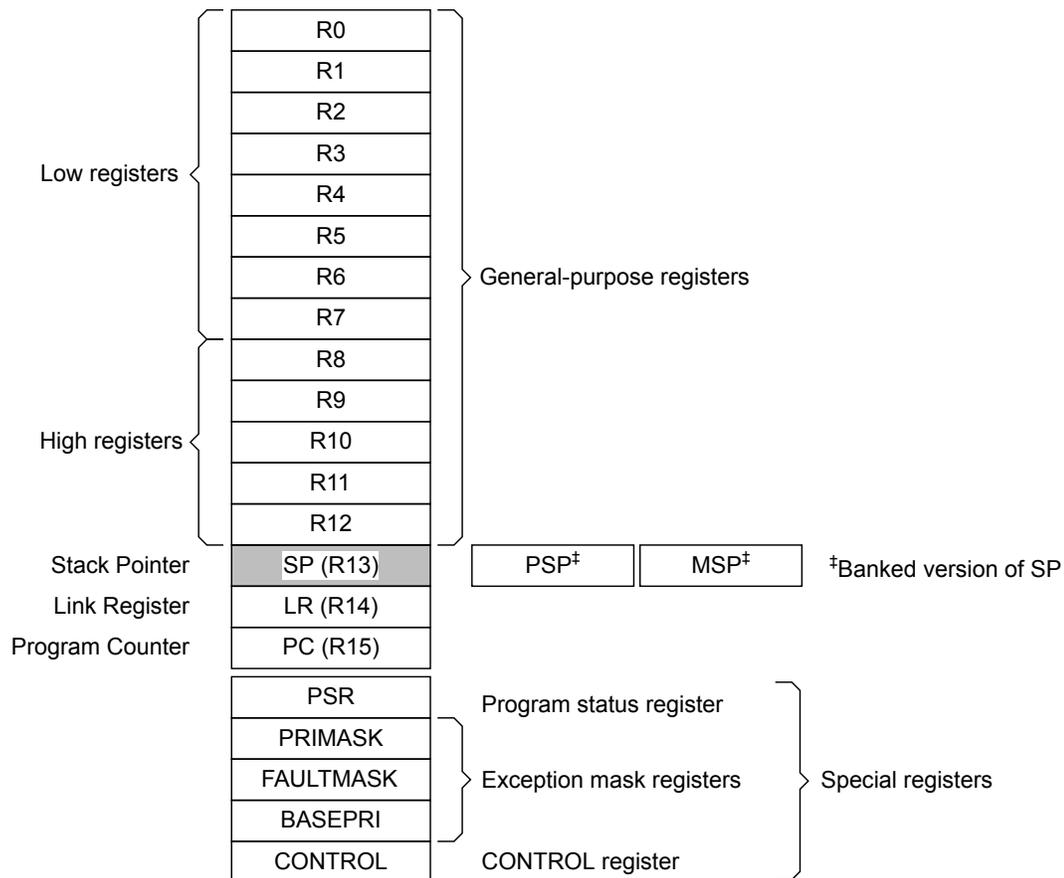


Table 2-2. Processor Register Map

Offset	Name	Type	Reset	Description	See page
-	R0	R/W	-	Cortex General-Purpose Register 0	48
-	R1	R/W	-	Cortex General-Purpose Register 1	48
-	R2	R/W	-	Cortex General-Purpose Register 2	48
-	R3	R/W	-	Cortex General-Purpose Register 3	48
-	R4	R/W	-	Cortex General-Purpose Register 4	48
-	R5	R/W	-	Cortex General-Purpose Register 5	48
-	R6	R/W	-	Cortex General-Purpose Register 6	48
-	R7	R/W	-	Cortex General-Purpose Register 7	48
-	R8	R/W	-	Cortex General-Purpose Register 8	48
-	R9	R/W	-	Cortex General-Purpose Register 9	48
-	R10	R/W	-	Cortex General-Purpose Register 10	48
-	R11	R/W	-	Cortex General-Purpose Register 11	48
-	R12	R/W	-	Cortex General-Purpose Register 12	48
-	SP	R/W	-	Stack Pointer	49
-	LR	R/W	0xFFFF.FFFF	Link Register	50
-	PC	R/W	-	Program Counter	51
-	PSR	R/W	0x0100.0000	Program Status Register	52
-	PRIMASK	R/W	0x0000.0000	Priority Mask Register	56
-	FAULTMASK	R/W	0x0000.0000	Fault Mask Register	57
-	BASEPRI	R/W	0x0000.0000	Base Priority Mask Register	58
-	CONTROL	R/W	0x0000.0000	Control Register	59

### 2.3.4 Register Descriptions

This section lists and describes the Cortex-M3 registers, in the order shown in Figure 2-3 on page 46. The core registers are not memory mapped and are accessed by register name rather than offset.

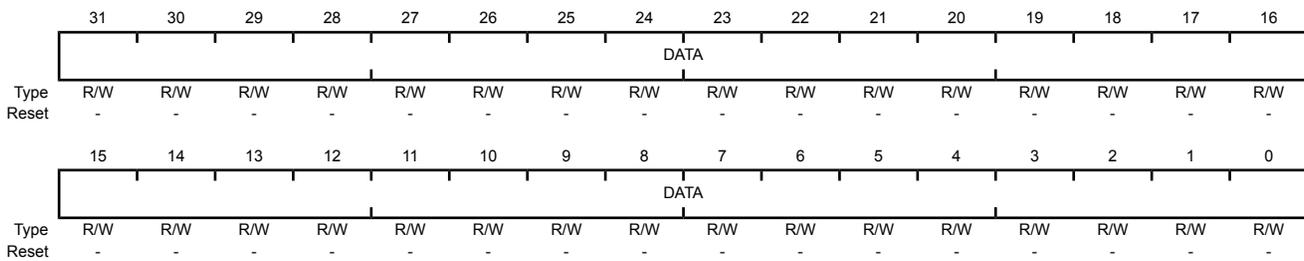
**Note:** The register type shown in the register descriptions refers to type during program execution in Thread mode and Handler mode. Debug access can differ.

- Register 1: Cortex General-Purpose Register 0 (R0)**
- Register 2: Cortex General-Purpose Register 1 (R1)**
- Register 3: Cortex General-Purpose Register 2 (R2)**
- Register 4: Cortex General-Purpose Register 3 (R3)**
- Register 5: Cortex General-Purpose Register 4 (R4)**
- Register 6: Cortex General-Purpose Register 5 (R5)**
- Register 7: Cortex General-Purpose Register 6 (R6)**
- Register 8: Cortex General-Purpose Register 7 (R7)**
- Register 9: Cortex General-Purpose Register 8 (R8)**
- Register 10: Cortex General-Purpose Register 9 (R9)**
- Register 11: Cortex General-Purpose Register 10 (R10)**
- Register 12: Cortex General-Purpose Register 11 (R11)**
- Register 13: Cortex General-Purpose Register 12 (R12)**

The **Rn** registers are 32-bit general-purpose registers for data operations and can be accessed from either privileged or unprivileged mode.

Cortex General-Purpose Register 0 (R0)

Type R/W, reset -



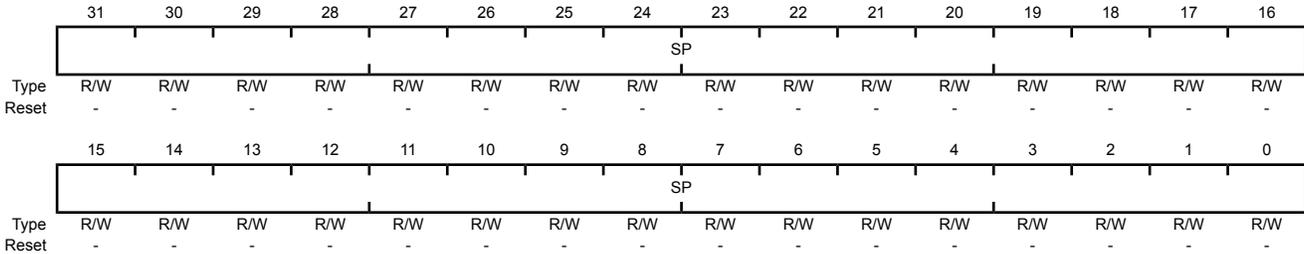
Bit/Field	Name	Type	Reset	Description
31:0	DATA	R/W	-	Register data.

**Register 14: Stack Pointer (SP)**

The **Stack Pointer (SP)** is register R13. In Thread mode, the function of this register changes depending on the `ASP` bit in the **Control Register (CONTROL)** register. When the `ASP` bit is clear, this register is the **Main Stack Pointer (MSP)**. When the `ASP` bit is set, this register is the **Process Stack Pointer (PSP)**. On reset, the `ASP` bit is clear, and the processor loads the **MSP** with the value from address `0x0000.0000`. The **MSP** can only be accessed in privileged mode; the **PSP** can be accessed in either privileged or unprivileged mode.

Stack Pointer (SP)

Type R/W, reset -



Bit/Field	Name	Type	Reset	Description
31:0	SP	R/W	-	This field is the address of the stack pointer.

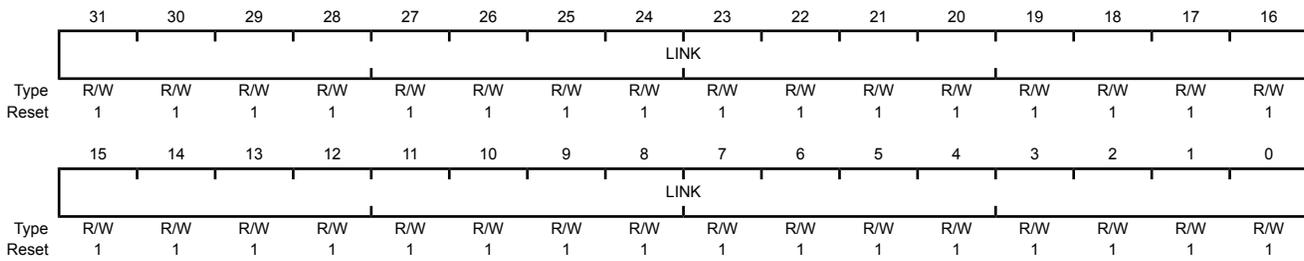
### Register 15: Link Register (LR)

The **Link Register (LR)** is register R14, and it stores the return information for subroutines, function calls, and exceptions. **LR** can be accessed from either privileged or unprivileged mode.

EXC\_RETURN is loaded into **LR** on exception entry. See Table 2-10 on page 75 for the values and description.

#### Link Register (LR)

Type R/W, reset 0xFFFF.FFFF



Bit/Field	Name	Type	Reset	Description
31:0	LINK	R/W	0xFFFF.FFFF	This field is the return address.

## Register 16: Program Counter (PC)

The **Program Counter (PC)** is register R15, and it contains the current program address. On reset, the processor loads the **PC** with the value of the reset vector, which is at address 0x0000.0004. Bit 0 of the reset vector is loaded into the **THUMB** bit of the **EPSR** at reset and must be 1. The **PC** register can be accessed in either privileged or unprivileged mode.

### Program Counter (PC)

Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	PC															
Type	R/W															
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	PC															
Type	R/W															
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:0	PC	R/W	-	This field is the current program address.

### Register 17: Program Status Register (PSR)

**Note:** This register is also referred to as **xPSR**.

The **Program Status Register (PSR)** has three functions, and the register bits are assigned to the different functions:

- **Application Program Status Register (APSR)**, bits 31:27,
- **Execution Program Status Register (EPSR)**, bits 26:24, 15:10
- **Interrupt Program Status Register (IPSR)**, bits 5:0

The **PSR**, **IPSR**, and **EPSR** registers can only be accessed in privileged mode; the **APSR** register can be accessed in either privileged or unprivileged mode.

**APSR** contains the current state of the condition flags from previous instruction executions.

**EPSR** contains the Thumb state bit and the execution state bits for the If-Then (**IT**) instruction or the Interruptible-Continuable Instruction (**ICI**) field for an interrupted load multiple or store multiple instruction. Attempts to read the **EPSR** directly through application software using the **MSR** instruction always return zero. Attempts to write the **EPSR** using the **MSR** instruction in application software are always ignored. Fault handlers can examine the **EPSR** value in the stacked **PSR** to determine the operation that faulted (see “Exception Entry and Return” on page 73).

**IPSR** contains the exception type number of the current Interrupt Service Routine (**ISR**).

These registers can be accessed individually or as a combination of any two or all three registers, using the register name as an argument to the **MSR** or **MRS** instructions. For example, all of the registers can be read using **PSR** with the **MRS** instruction, or **APSR** only can be written to using **APSR** with the **MSR** instruction. page 52 shows the possible register combinations for the **PSR**. See the **MRS** and **MSR** instruction descriptions in the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information about how to access the program status registers.

**Table 2-3. PSR Register Combinations**

Register	Type	Combination
<b>PSR</b>	R/W <sup>a, b</sup>	<b>APSR</b> , <b>EPSR</b> , and <b>IPSR</b>
<b>IEPSR</b>	RO	<b>EPSR</b> and <b>IPSR</b>
<b>IAPSR</b>	R/W <sup>a</sup>	<b>APSR</b> and <b>IPSR</b>
<b>EAPSR</b>	R/W <sup>b</sup>	<b>APSR</b> and <b>EPSR</b>

a. The processor ignores writes to the **IPSR** bits.

b. Reads of the **EPSR** bits return zero, and the processor ignores writes to these bits.

#### Program Status Register (PSR)

Type R/W, reset 0x0100.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	N	Z	C	V	Q	ICI / IT		THUMB	reserved							
Type	R/W	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ICI / IT					reserved					ISRNUM					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31	N	R/W	0	<p><b>APSR Negative or Less Flag</b></p> <p>Value Description</p> <p>1 The previous operation result was negative or less than.</p> <p>0 The previous operation result was positive, zero, greater than, or equal.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>APSR</b>.</p>
30	Z	R/W	0	<p><b>APSR Zero Flag</b></p> <p>Value Description</p> <p>1 The previous operation result was zero.</p> <p>0 The previous operation result was non-zero.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>APSR</b>.</p>
29	C	R/W	0	<p><b>APSR Carry or Borrow Flag</b></p> <p>Value Description</p> <p>1 The previous add operation resulted in a carry bit or the previous subtract operation did not result in a borrow bit.</p> <p>0 The previous add operation did not result in a carry bit or the previous subtract operation resulted in a borrow bit.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>APSR</b>.</p>
28	V	R/W	0	<p><b>APSR Overflow Flag</b></p> <p>Value Description</p> <p>1 The previous operation resulted in an overflow.</p> <p>0 The previous operation did not result in an overflow.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>APSR</b>.</p>
27	Q	R/W	0	<p><b>APSR DSP Overflow and Saturation Flag</b></p> <p>Value Description</p> <p>1 DSP Overflow or saturation has occurred.</p> <p>0 DSP overflow or saturation has not occurred since reset or since the bit was last cleared.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>APSR</b>. This bit is cleared by software using an <b>MRS</b> instruction.</p>

Bit/Field	Name	Type	Reset	Description
26:25	ICI / IT	RO	0x0	<p><b>EPSR ICI / IT status</b></p> <p>These bits, along with bits 15:10, contain the Interruptible-Continuable Instruction (ICI) field for an interrupted load multiple or store multiple instruction or the execution state bits of the IT instruction.</p> <p>When <b>EPSR</b> holds the ICI execution state, bits 26:25 are zero.</p> <p>The If-Then block contains up to four instructions following an IT instruction. Each instruction in the block is conditional. The conditions for the instructions are either all the same, or some can be the inverse of others. See the <i>Cortex™-M3/M4 Instruction Set Technical User's Manual</i> for more information.</p> <p>The value of this field is only meaningful when accessing <b>PSR</b> or <b>EPSR</b>.</p>
24	THUMB	RO	1	<p><b>EPSR Thumb State</b></p> <p>This bit indicates the Thumb state and should always be set.</p> <p>The following can clear the THUMB bit:</p> <ul style="list-style-type: none"> <li>■ The BLX, BX and POP{PC} instructions</li> <li>■ Restoration from the stacked xPSR value on an exception return</li> <li>■ Bit 0 of the vector value on an exception entry or reset</li> </ul> <p>Attempting to execute instructions when this bit is clear results in a fault or lockup. See “Lockup” on page 77 for more information.</p> <p>The value of this bit is only meaningful when accessing <b>PSR</b> or <b>EPSR</b>.</p>
23:16	reserved	RO	0x00	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>
15:10	ICI / IT	RO	0x0	<p><b>EPSR ICI / IT status</b></p> <p>These bits, along with bits 26:25, contain the Interruptible-Continuable Instruction (ICI) field for an interrupted load multiple or store multiple instruction or the execution state bits of the IT instruction.</p> <p>When an interrupt occurs during the execution of an LDM, STM, PUSH or POP instruction, the processor stops the load multiple or store multiple instruction operation temporarily and stores the next register operand in the multiple operation to bits 15:12. After servicing the interrupt, the processor returns to the register pointed to by bits 15:12 and resumes execution of the multiple load or store instruction. When <b>EPSR</b> holds the ICI execution state, bits 11:10 are zero.</p> <p>The If-Then block contains up to four instructions following a 16-bit IT instruction. Each instruction in the block is conditional. The conditions for the instructions are either all the same, or some can be the inverse of others. See the <i>Cortex™-M3/M4 Instruction Set Technical User's Manual</i> for more information.</p> <p>The value of this field is only meaningful when accessing <b>PSR</b> or <b>EPSR</b>.</p>
9:6	reserved	RO	0x0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>

Bit/Field	Name	Type	Reset	Description																																						
5:0	ISRNUM	RO	0x00	<p><b>IPSR</b> ISR Number</p> <p>This field contains the exception type number of the current Interrupt Service Routine (ISR).</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>Thread mode</td></tr> <tr><td>0x01</td><td>Reserved</td></tr> <tr><td>0x02</td><td>NMI</td></tr> <tr><td>0x03</td><td>Hard fault</td></tr> <tr><td>0x04</td><td>Memory management fault</td></tr> <tr><td>0x05</td><td>Bus fault</td></tr> <tr><td>0x06</td><td>Usage fault</td></tr> <tr><td>0x07-0x0A</td><td>Reserved</td></tr> <tr><td>0x0B</td><td>SVCall</td></tr> <tr><td>0x0C</td><td>Reserved for Debug</td></tr> <tr><td>0x0D</td><td>Reserved</td></tr> <tr><td>0x0E</td><td>PendSV</td></tr> <tr><td>0x0F</td><td>SysTick</td></tr> <tr><td>0x10</td><td>Interrupt Vector 0</td></tr> <tr><td>0x11</td><td>Interrupt Vector 1</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>0x3B</td><td>Interrupt Vector 43</td></tr> <tr><td>0x3C-0x3F</td><td>Reserved</td></tr> </tbody> </table>	Value	Description	0x00	Thread mode	0x01	Reserved	0x02	NMI	0x03	Hard fault	0x04	Memory management fault	0x05	Bus fault	0x06	Usage fault	0x07-0x0A	Reserved	0x0B	SVCall	0x0C	Reserved for Debug	0x0D	Reserved	0x0E	PendSV	0x0F	SysTick	0x10	Interrupt Vector 0	0x11	Interrupt Vector 1	...	...	0x3B	Interrupt Vector 43	0x3C-0x3F	Reserved
Value	Description																																									
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0x0B	SVCall																																									
0x0C	Reserved for Debug																																									
0x0D	Reserved																																									
0x0E	PendSV																																									
0x0F	SysTick																																									
0x10	Interrupt Vector 0																																									
0x11	Interrupt Vector 1																																									
...	...																																									
0x3B	Interrupt Vector 43																																									
0x3C-0x3F	Reserved																																									

See “Exception Types” on page 69 for more information.

The value of this field is only meaningful when accessing **PSR** or **IPSR**.

### Register 18: Priority Mask Register (PRIMASK)

The **PRIMASK** register prevents activation of all exceptions with programmable priority. Reset, non-maskable interrupt (NMI), and hard fault are the only exceptions with fixed priority. Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. The **MSR** and **MRS** instructions are used to access the **PRIMASK** register, and the **CPS** instruction may be used to change the value of the **PRIMASK** register. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information on these instructions. For more information on exception priority levels, see “Exception Types” on page 69.

#### Priority Mask Register (PRIMASK)

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															PRIMASK
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	PRIMASK	R/W	0	Priority Mask
				Value Description
				1 Prevents the activation of all exceptions with configurable priority.
				0 No effect.

## Register 19: Fault Mask Register (FAULTMASK)

The **FAULTMASK** register prevents activation of all exceptions except for the Non-Maskable Interrupt (NMI). Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. The **MSR** and **MRS** instructions are used to access the **FAULTMASK** register, and the **CPS** instruction may be used to change the value of the **FAULTMASK** register. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information on these instructions. For more information on exception priority levels, see “Exception Types” on page 69.

### Fault Mask Register (FAULTMASK)

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															FAULTMASK
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	FAULTMASK	R/W	0	Fault Mask

#### Value Description

1	Prevents the activation of all exceptions except for NMI.
0	No effect.

The processor clears the **FAULTMASK** bit on exit from any exception handler except the NMI handler.

### Register 20: Base Priority Mask Register (BASEPRI)

The **BASEPRI** register defines the minimum priority for exception processing. When **BASEPRI** is set to a nonzero value, it prevents the activation of all exceptions with the same or lower priority level as the **BASEPRI** value. Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. For more information on exception priority levels, see “Exception Types” on page 69.

#### Base Priority Mask Register (BASEPRI)

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								BASEPRI			reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description																		
31:8	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																		
7:5	BASEPRI	R/W	0x0	<p>Base Priority</p> <p>Any exception that has a programmable priority level with the same or lower priority as the value of this field is masked. The <b>PRIMASK</b> register can be used to mask all exceptions with programmable priority levels. Higher priority exceptions have lower priority levels.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>All exceptions are unmasked.</td> </tr> <tr> <td>0x1</td> <td>All exceptions with priority level 1-7 are masked.</td> </tr> <tr> <td>0x2</td> <td>All exceptions with priority level 2-7 are masked.</td> </tr> <tr> <td>0x3</td> <td>All exceptions with priority level 3-7 are masked.</td> </tr> <tr> <td>0x4</td> <td>All exceptions with priority level 4-7 are masked.</td> </tr> <tr> <td>0x5</td> <td>All exceptions with priority level 5-7 are masked.</td> </tr> <tr> <td>0x6</td> <td>All exceptions with priority level 6-7 are masked.</td> </tr> <tr> <td>0x7</td> <td>All exceptions with priority level 7 are masked.</td> </tr> </tbody> </table>	Value	Description	0x0	All exceptions are unmasked.	0x1	All exceptions with priority level 1-7 are masked.	0x2	All exceptions with priority level 2-7 are masked.	0x3	All exceptions with priority level 3-7 are masked.	0x4	All exceptions with priority level 4-7 are masked.	0x5	All exceptions with priority level 5-7 are masked.	0x6	All exceptions with priority level 6-7 are masked.	0x7	All exceptions with priority level 7 are masked.
Value	Description																					
0x0	All exceptions are unmasked.																					
0x1	All exceptions with priority level 1-7 are masked.																					
0x2	All exceptions with priority level 2-7 are masked.																					
0x3	All exceptions with priority level 3-7 are masked.																					
0x4	All exceptions with priority level 4-7 are masked.																					
0x5	All exceptions with priority level 5-7 are masked.																					
0x6	All exceptions with priority level 6-7 are masked.																					
0x7	All exceptions with priority level 7 are masked.																					
4:0	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																		

## Register 21: Control Register (CONTROL)

The **CONTROL** register controls the stack used and the privilege level for software execution when the processor is in Thread mode. This register is only accessible in privileged mode.

Handler mode always uses **MSP**, so the processor ignores explicit writes to the **ASP** bit of the **CONTROL** register when in Handler mode. The exception entry and return mechanisms automatically update the **CONTROL** register based on the **EXC\_RETURN** value (see Table 2-10 on page 75). In an OS environment, threads running in Thread mode should use the process stack and the kernel and exception handlers should use the main stack. By default, Thread mode uses **MSP**. To switch the stack pointer used in Thread mode to **PSP**, either use the **MSR** instruction to set the **ASP** bit, as detailed in the *Cortex™-M3/M4 Instruction Set Technical User's Manual*, or perform an exception return to Thread mode with the appropriate **EXC\_RETURN** value, as shown in Table 2-10 on page 75.

**Note:** When changing the stack pointer, software must use an **ISB** instruction immediately after the **MSR** instruction, ensuring that instructions after the **ISB** execute use the new stack pointer. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

### Control Register (CONTROL)

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved														ASP	TMPL
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	ASP	R/W	0	Active Stack Pointer  Value Description 1 <b>PSP</b> is the current stack pointer. 0 <b>MSP</b> is the current stack pointer  In Handler mode, this bit reads as zero and ignores writes. The Cortex-M3 updates this bit automatically on exception return.
0	TMPL	R/W	0	Thread Mode Privilege Level  Value Description 1 Unprivileged software can be executed in Thread mode. 0 Only privileged software can be executed in Thread mode.

### 2.3.5 Exceptions and Interrupts

The Cortex-M3 processor supports interrupts and system exceptions. The processor and the Nested Vectored Interrupt Controller (NVIC) prioritize and handle all exceptions. An exception changes the normal flow of software control. The processor uses Handler mode to handle all exceptions except for reset. See “Exception Entry and Return” on page 73 for more information.

The NVIC registers control interrupt handling. See “Nested Vectored Interrupt Controller (NVIC)” on page 84 for more information.

### 2.3.6 Data Types

The Cortex-M3 supports 32-bit words, 16-bit halfwords, and 8-bit bytes. The processor also supports 64-bit data transfer instructions. All instruction and data memory accesses are little endian. See “Memory Regions, Types and Attributes” on page 61 for more information.

## 2.4 Memory Model

This section describes the processor memory map, the behavior of memory accesses, and the bit-banding features. The processor has a fixed memory map that provides up to 4 GB of addressable memory.

The memory map for the LM3S6100 controller is provided in Table 2-4 on page 60. In this manual, register addresses are given as a hexadecimal increment, relative to the module’s base address as shown in the memory map.

The regions for SRAM and peripherals include bit-band regions. Bit-banding provides atomic operations to bit data (see “Bit-Banding” on page 64).

The processor reserves regions of the Private peripheral bus (PPB) address range for core peripheral registers (see “Cortex-M3 Peripherals” on page 83).

**Note:** Within the memory map, all reserved space returns a bus fault when read or written.

**Table 2-4. Memory Map**

Start	End	Description	For details, see page ...
<b>Memory</b>			
0x0000.0000	0x0000.FFFF	On-chip Flash	222
0x0001.0000	0x1FFF.FFFF	Reserved	-
0x2000.0000	0x2000.3FFF	Bit-banded on-chip SRAM	216
0x2000.4000	0x21FF.FFFF	Reserved	-
0x2200.0000	0x2207.FFFF	Bit-band alias of bit-banded on-chip SRAM starting at 0x2000.0000	216
0x2208.0000	0x3FFF.FFFF	Reserved	-
<b>FiRM Peripherals</b>			
0x4000.0000	0x4000.0FFF	Watchdog timer 0	327
0x4000.1000	0x4000.3FFF	Reserved	-
0x4000.4000	0x4000.4FFF	GPIO Port A	253
0x4000.5000	0x4000.5FFF	GPIO Port B	253
0x4000.6000	0x4000.6FFF	GPIO Port C	253
0x4000.7000	0x4000.7FFF	GPIO Port D	253
0x4000.8000	0x4000.8FFF	SSI0	402

Table 2-4. Memory Map (continued)

Start	End	Description	For details, see page ...
0x4000.9000	0x4000.BFFF	Reserved	-
0x4000.C000	0x4000.CFFF	UART0	356
0x4000.D000	0x4001.FFFF	Reserved	-
<b>Peripherals</b>			
0x4002.0000	0x4002.3FFF	Reserved	-
0x4002.4000	0x4002.4FFF	GPIO Port E	253
0x4002.5000	0x4002.5FFF	GPIO Port F	253
0x4002.6000	0x4002.6FFF	GPIO Port G	253
0x4002.7000	0x4002.FFFF	Reserved	-
0x4003.0000	0x4003.0FFF	Timer 0	299
0x4003.1000	0x4003.1FFF	Timer 1	299
0x4003.2000	0x4003.2FFF	Timer 2	299
0x4003.3000	0x4003.BFFF	Reserved	-
0x4003.C000	0x4003.CFFF	Analog Comparators	476
0x4003.D000	0x400F.CFFF	Reserved	-
0x400F.D000	0x400F.DFFF	Flash memory control	222
0x400F.E000	0x400F.EFFF	System control	173
0x400F.F000	0x41FF.FFFF	Reserved	-
0x4200.0000	0x43FF.FFFF	Bit-banded alias of 0x4000.0000 through 0x400F.FFFF	-
0x4400.0000	0xDFFF.FFFF	Reserved	-
<b>Private Peripheral Bus</b>			
0xE000.0000	0xE000.0FFF	Instrumentation Trace Macrocell (ITM)	43
0xE000.1000	0xE000.1FFF	Data Watchpoint and Trace (DWT)	43
0xE000.2000	0xE000.2FFF	Flash Patch and Breakpoint (FPB)	43
0xE000.3000	0xE000.DFFF	Reserved	-
0xE000.E000	0xE000.EFFF	Cortex-M3 Peripherals (SysTick, NVIC, MPU and SCB)	91
0xE000.F000	0xE003.FFFF	Reserved	-
0xE004.0000	0xE004.0FFF	Trace Port Interface Unit (TPIU)	44
0xE004.1000	0xFFFF.FFFF	Reserved	-

### 2.4.1 Memory Regions, Types and Attributes

The memory map and the programming of the MPU split the memory map into regions. Each region has a defined memory type, and some regions have additional memory attributes. The memory type and attributes determine the behavior of accesses to the region.

The memory types are:

- Normal: The processor can re-order transactions for efficiency and perform speculative reads.
- Device: The processor preserves transaction order relative to other transactions to Device or Strongly Ordered memory.
- Strongly Ordered: The processor preserves transaction order relative to all other transactions.

The different ordering requirements for Device and Strongly Ordered memory mean that the memory system can buffer a write to Device memory but must not buffer a write to Strongly Ordered memory.

An additional memory attribute is Execute Never (XN), which means the processor prevents instruction accesses. A fault exception is generated only on execution of an instruction executed from an XN region.

## 2.4.2 Memory System Ordering of Memory Accesses

For most memory accesses caused by explicit memory access instructions, the memory system does not guarantee that the order in which the accesses complete matches the program order of the instructions, providing the order does not affect the behavior of the instruction sequence. Normally, if correct program execution depends on two memory accesses completing in program order, software must insert a memory barrier instruction between the memory access instructions (see “Software Ordering of Memory Accesses” on page 63).

However, the memory system does guarantee ordering of accesses to Device and Strongly Ordered memory. For two memory access instructions A1 and A2, if both A1 and A2 are accesses to either Device or Strongly Ordered memory, and if A1 occurs before A2 in program order, A1 is always observed before A2.

## 2.4.3 Behavior of Memory Accesses

Table 2-5 on page 62 shows the behavior of accesses to each region in the memory map. See “Memory Regions, Types and Attributes” on page 61 for more information on memory types and the XN attribute. Stellaris devices may have reserved memory areas within the address ranges shown below (refer to Table 2-4 on page 60 for more information).

**Table 2-5. Memory Access Behavior**

Address Range	Memory Region	Memory Type	Execute Never (XN)	Description
0x0000.0000 - 0x1FFF.FFFF	Code	Normal	-	This executable region is for program code. Data can also be stored here.
0x2000.0000 - 0x3FFF.FFFF	SRAM	Normal	-	This executable region is for data. Code can also be stored here. This region includes bit band and bit band alias areas (see Table 2-6 on page 64).
0x4000.0000 - 0x5FFF.FFFF	Peripheral	Device	XN	This region includes bit band and bit band alias areas (see Table 2-7 on page 64).
0x6000.0000 - 0x9FFF.FFFF	External RAM	Normal	-	This executable region is for data.
0xA000.0000 - 0xDFFF.FFFF	External device	Device	XN	This region is for external device memory.
0xE000.0000 - 0xE00F.FFFF	Private peripheral bus	Strongly Ordered	XN	This region includes the NVIC, system timer, and system control block.
0xE010.0000 - 0xFFFF.FFFF	Reserved	-	-	-

The Code, SRAM, and external RAM regions can hold programs. However, it is recommended that programs always use the Code region because the Cortex-M3 has separate buses that can perform instruction fetches and data accesses simultaneously.

The MPU can override the default memory access behavior described in this section. For more information, see “Memory Protection Unit (MPU)” on page 86.

The Cortex-M3 prefetches instructions ahead of execution and speculatively prefetches from branch target addresses.

## 2.4.4 Software Ordering of Memory Accesses

The order of instructions in the program flow does not always guarantee the order of the corresponding memory transactions for the following reasons:

- The processor can reorder some memory accesses to improve efficiency, providing this does not affect the behavior of the instruction sequence.
- The processor has multiple bus interfaces.
- Memory or devices in the memory map have different wait states.
- Some memory accesses are buffered or speculative.

“Memory System Ordering of Memory Accesses” on page 62 describes the cases where the memory system guarantees the order of memory accesses. Otherwise, if the order of memory accesses is critical, software must include memory barrier instructions to force that ordering. The Cortex-M3 has the following memory barrier instructions:

- The Data Memory Barrier (DMB) instruction ensures that outstanding memory transactions complete before subsequent memory transactions.
- The Data Synchronization Barrier (DSB) instruction ensures that outstanding memory transactions complete before subsequent instructions execute.
- The Instruction Synchronization Barrier (ISB) instruction ensures that the effect of all completed memory transactions is recognizable by subsequent instructions.

Memory barrier instructions can be used in the following situations:

- MPU programming
  - If the MPU settings are changed and the change must be effective on the very next instruction, use a DSB instruction to ensure the effect of the MPU takes place immediately at the end of context switching.
  - Use an ISB instruction to ensure the new MPU setting takes effect immediately after programming the MPU region or regions, if the MPU configuration code was accessed using a branch or call. If the MPU configuration code is entered using exception mechanisms, then an ISB instruction is not required.
- Vector table

If the program changes an entry in the vector table and then enables the corresponding exception, use a DMB instruction between the operations. The DMB instruction ensures that if the exception is taken immediately after being enabled, the processor uses the new exception vector.
- Self-modifying code

If a program contains self-modifying code, use an ISB instruction immediately after the code modification in the program. The ISB instruction ensures subsequent instruction execution uses the updated program.
- Memory map switching

If the system contains a memory map switching mechanism, use a `DSB` instruction after switching the memory map in the program. The `DSB` instruction ensures subsequent instruction execution uses the updated memory map.

- Dynamic exception priority change

When an exception priority has to change when the exception is pending or active, use `DSB` instructions after the change. The change then takes effect on completion of the `DSB` instruction.

Memory accesses to Strongly Ordered memory, such as the System Control Block, do not require the use of `DMB` instructions.

For more information on the memory barrier instructions, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

## 2.4.5 Bit-Banding

A bit-band region maps each word in a bit-band alias region to a single bit in the bit-band region. The bit-band regions occupy the lowest 1 MB of the SRAM and peripheral memory regions. Accesses to the 32-MB SRAM alias region map to the 1-MB SRAM bit-band region, as shown in Table 2-6 on page 64. Accesses to the 32-MB peripheral alias region map to the 1-MB peripheral bit-band region, as shown in Table 2-7 on page 64. For the specific address range of the bit-band regions, see Table 2-4 on page 60.

**Note:** A word access to the SRAM or the peripheral bit-band alias region maps to a single bit in the SRAM or peripheral bit-band region.

A word access to a bit band address results in a word access to the underlying memory, and similarly for halfword and byte accesses. This allows bit band accesses to match the access requirements of the underlying peripheral.

**Table 2-6. SRAM Memory Bit-Banding Regions**

Address Range		Memory Region	Instruction and Data Accesses
Start	End		
0x2000.0000	0x2000.3FFF	SRAM bit-band region	Direct accesses to this memory range behave as SRAM memory accesses, but this region is also bit addressable through bit-band alias.
0x2200.0000	0x2207.FFFF	SRAM bit-band alias	Data accesses to this region are remapped to bit band region. A write operation is performed as read-modify-write. Instruction accesses are not remapped.

**Table 2-7. Peripheral Memory Bit-Banding Regions**

Address Range		Memory Region	Instruction and Data Accesses
Start	End		
0x4000.0000	0x400F.FFFF	Peripheral bit-band region	Direct accesses to this memory range behave as peripheral memory accesses, but this region is also bit addressable through bit-band alias.
0x4200.0000	0x43FF.FFFF	Peripheral bit-band alias	Data accesses to this region are remapped to bit band region. A write operation is performed as read-modify-write. Instruction accesses are not permitted.

The following formula shows how the alias region maps onto the bit-band region:

$$\text{bit\_word\_offset} = (\text{byte\_offset} \times 32) + (\text{bit\_number} \times 4)$$

$\text{bit\_word\_addr} = \text{bit\_band\_base} + \text{bit\_word\_offset}$

where:

$\text{bit\_word\_offset}$

The position of the target bit in the bit-band memory region.

$\text{bit\_word\_addr}$

The address of the word in the alias memory region that maps to the targeted bit.

$\text{bit\_band\_base}$

The starting address of the alias region.

$\text{byte\_offset}$

The number of the byte in the bit-band region that contains the targeted bit.

$\text{bit\_number}$

The bit position, 0-7, of the targeted bit.

Figure 2-4 on page 66 shows examples of bit-band mapping between the SRAM bit-band alias region and the SRAM bit-band region:

- The alias word at 0x23FF.FFE0 maps to bit 0 of the bit-band byte at 0x200F.FFFF:

$$0x23FF.FFE0 = 0x2200.0000 + (0x000F.FFFF * 32) + (0 * 4)$$

- The alias word at 0x23FF.FFFC maps to bit 7 of the bit-band byte at 0x200F.FFFF:

$$0x23FF.FFFC = 0x2200.0000 + (0x000F.FFFF * 32) + (7 * 4)$$

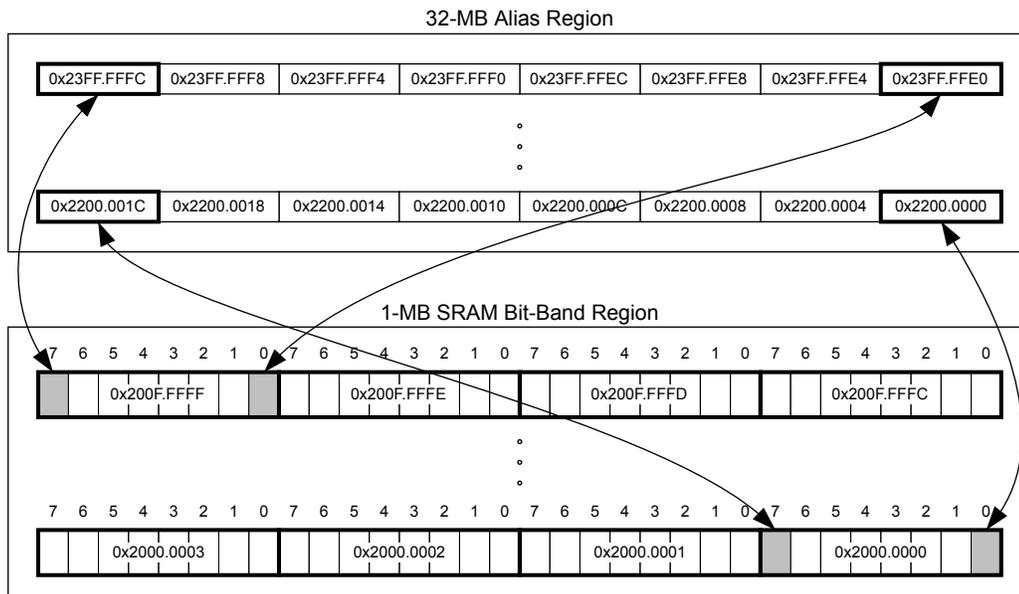
- The alias word at 0x2200.0000 maps to bit 0 of the bit-band byte at 0x2000.0000:

$$0x2200.0000 = 0x2200.0000 + (0 * 32) + (0 * 4)$$

- The alias word at 0x2200.001C maps to bit 7 of the bit-band byte at 0x2000.0000:

$$0x2200.001C = 0x2200.0000 + (0 * 32) + (7 * 4)$$

Figure 2-4. Bit-Band Mapping



### 2.4.5.1 Directly Accessing an Alias Region

Writing to a word in the alias region updates a single bit in the bit-band region.

Bit 0 of the value written to a word in the alias region determines the value written to the targeted bit in the bit-band region. Writing a value with bit 0 set writes a 1 to the bit-band bit, and writing a value with bit 0 clear writes a 0 to the bit-band bit.

Bits 31:1 of the alias word have no effect on the bit-band bit. Writing 0x01 has the same effect as writing 0xFF. Writing 0x00 has the same effect as writing 0x0E.

When reading a word in the alias region, 0x0000.0000 indicates that the targeted bit in the bit-band region is clear and 0x0000.0001 indicates that the targeted bit in the bit-band region is set.

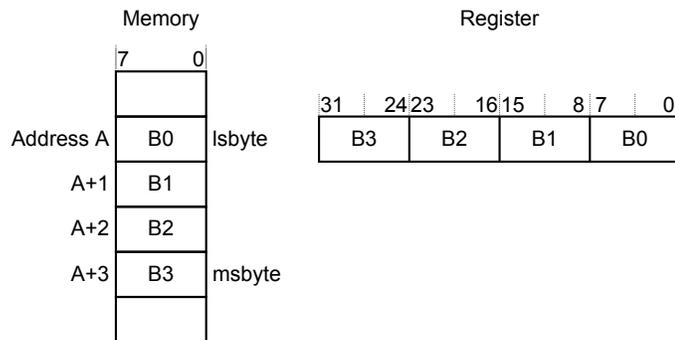
### 2.4.5.2 Directly Accessing a Bit-Band Region

“Behavior of Memory Accesses” on page 62 describes the behavior of direct byte, halfword, or word accesses to the bit-band regions.

### 2.4.6 Data Storage

The processor views memory as a linear collection of bytes numbered in ascending order from zero. For example, bytes 0-3 hold the first stored word, and bytes 4-7 hold the second stored word. Data is stored in little-endian format, with the least-significant byte (lsbyte) of a word stored at the lowest-numbered byte, and the most-significant byte (msbyte) stored at the highest-numbered byte. Figure 2-5 on page 67 illustrates how data is stored.

Figure 2-5. Data Storage



### 2.4.7 Synchronization Primitives

The Cortex-M3 instruction set includes pairs of synchronization primitives which provide a non-blocking mechanism that a thread or process can use to obtain exclusive access to a memory location. Software can use these primitives to perform a guaranteed read-modify-write memory update sequence or for a semaphore mechanism.

A pair of synchronization primitives consists of:

- A Load-Exclusive instruction, which is used to read the value of a memory location and requests exclusive access to that location.
- A Store-Exclusive instruction, which is used to attempt to write to the same memory location and returns a status bit to a register. If this status bit is clear, it indicates that the thread or process gained exclusive access to the memory and the write succeeds; if this status bit is set, it indicates that the thread or process did not gain exclusive access to the memory and no write was performed.

The pairs of Load-Exclusive and Store-Exclusive instructions are:

- The word instructions `LDREX` and `STREX`
- The halfword instructions `LDREXH` and `STREXH`
- The byte instructions `LDREXB` and `STREXB`

Software must use a Load-Exclusive instruction with the corresponding Store-Exclusive instruction.

To perform an exclusive read-modify-write of a memory location, software must:

1. Use a Load-Exclusive instruction to read the value of the location.
2. Modify the value, as required.
3. Use a Store-Exclusive instruction to attempt to write the new value back to the memory location.
4. Test the returned status bit.

If the status bit is clear, the read-modify-write completed successfully. If the status bit is set, no write was performed, which indicates that the value returned at step 1 might be out of date. The software must retry the entire read-modify-write sequence.

Software can use the synchronization primitives to implement a semaphore as follows:

1. Use a Load-Exclusive instruction to read from the semaphore address to check whether the semaphore is free.
2. If the semaphore is free, use a Store-Exclusive to write the claim value to the semaphore address.
3. If the returned status bit from step 2 indicates that the Store-Exclusive succeeded, then the software has claimed the semaphore. However, if the Store-Exclusive failed, another process might have claimed the semaphore after the software performed step 1.

The Cortex-M3 includes an exclusive access monitor that tags the fact that the processor has executed a Load-Exclusive instruction. The processor removes its exclusive access tag if:

- It executes a CLREX instruction.
- It executes a Store-Exclusive instruction, regardless of whether the write succeeds.
- An exception occurs, which means the processor can resolve semaphore conflicts between different threads.

For more information about the synchronization primitive instructions, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

## 2.5 Exception Model

The ARM Cortex-M3 processor and the Nested Vectored Interrupt Controller (NVIC) prioritize and handle all exceptions in Handler Mode. The processor state is automatically stored to the stack on an exception and automatically restored from the stack at the end of the Interrupt Service Routine (ISR). The vector is fetched in parallel to the state saving, enabling efficient interrupt entry. The processor supports tail-chaining, which enables back-to-back interrupts to be performed without the overhead of state saving and restoration.

Table 2-8 on page 70 lists all exception types. Software can set eight priority levels on seven of these exceptions (system handlers) as well as on 20 interrupts (listed in Table 2-9 on page 71).

Priorities on the system handlers are set with the NVIC **System Handler Priority n (SYSPRIn)** registers. Interrupts are enabled through the NVIC **Interrupt Set Enable n (ENn)** register and prioritized with the NVIC **Interrupt Priority n (PRIn)** registers. Priorities can be grouped by splitting priority levels into preemption priorities and subpriorities. All the interrupt registers are described in “Nested Vectored Interrupt Controller (NVIC)” on page 84.

Internally, the highest user-programmable priority (0) is treated as fourth priority, after a Reset, Non-Maskable Interrupt (NMI), and a Hard Fault, in that order. Note that 0 is the default priority for all the programmable priorities.

---

**Important:** After a write to clear an interrupt source, it may take several processor cycles for the NVIC to see the interrupt source de-assert. Thus if the interrupt clear is done as the last action in an interrupt handler, it is possible for the interrupt handler to complete while the NVIC sees the interrupt as still asserted, causing the interrupt handler to be re-entered errantly. This situation can be avoided by either clearing the interrupt source at the beginning of the interrupt handler or by performing a read or write after the write to clear the interrupt source (and flush the write buffer).

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See “Nested Vectored Interrupt Controller (NVIC)” on page 84 for more information on exceptions and interrupts.

## 2.5.1 Exception States

Each exception is in one of the following states:

- **Inactive.** The exception is not active and not pending.
- **Pending.** The exception is waiting to be serviced by the processor. An interrupt request from a peripheral or from software can change the state of the corresponding interrupt to pending.
- **Active.** An exception that is being serviced by the processor but has not completed.  
**Note:** An exception handler can interrupt the execution of another exception handler. In this case, both exceptions are in the active state.
- **Active and Pending.** The exception is being serviced by the processor, and there is a pending exception from the same source.

## 2.5.2 Exception Types

The exception types are:

- **Reset.** Reset is invoked on power up or a warm reset. The exception model treats reset as a special form of exception. When reset is asserted, the operation of the processor stops, potentially at any point in an instruction. When reset is deasserted, execution restarts from the address provided by the reset entry in the vector table. Execution restarts as privileged execution in Thread mode.
- **NMI.** A non-maskable Interrupt (NMI) can be signaled using the NMI signal or triggered by software using the **Interrupt Control and State (INTCTRL)** register. This exception has the highest priority other than reset. NMI is permanently enabled and has a fixed priority of -2. NMIs cannot be masked or prevented from activation by any other exception or preempted by any exception other than reset.
- **Hard Fault.** A hard fault is an exception that occurs because of an error during exception processing, or because an exception cannot be managed by any other exception mechanism. Hard faults have a fixed priority of -1, meaning they have higher priority than any exception with configurable priority.
- **Memory Management Fault.** A memory management fault is an exception that occurs because of a memory protection related fault, including access violation and no match. The MPU or the fixed memory protection constraints determine this fault, for both instruction and data memory transactions. This fault is used to abort instruction accesses to Execute Never (XN) memory regions, even if the MPU is disabled.
- **Bus Fault.** A bus fault is an exception that occurs because of a memory-related fault for an instruction or data memory transaction such as a prefetch fault or a memory access fault. This fault can be enabled or disabled.
- **Usage Fault.** A usage fault is an exception that occurs because of a fault related to instruction execution, such as:
  - An undefined instruction
  - An illegal unaligned access
  - Invalid state on instruction execution

- An error on exception return

An unaligned address on a word or halfword memory access or division by zero can cause a usage fault when the core is properly configured.

- **SVC**all. A supervisor call (SVC) is an exception that is triggered by the SVC instruction. In an OS environment, applications can use SVC instructions to access OS kernel functions and device drivers.
- **Debug Monitor**. This exception is caused by the debug monitor (when not halting). This exception is only active when enabled. This exception does not activate if it is a lower priority than the current activation.
- **PendSV**. PendSV is a pendable, interrupt-driven request for system-level service. In an OS environment, use PendSV for context switching when no other exception is active. PendSV is triggered using the **Interrupt Control and State (INTCTRL)** register.
- **SysTick**. A SysTick exception is an exception that the system timer generates when it reaches zero when it is enabled to generate an interrupt. Software can also generate a SysTick exception using the **Interrupt Control and State (INTCTRL)** register. In an OS environment, the processor can use this exception as system tick.
- **Interrupt (IRQ)**. An interrupt, or IRQ, is an exception signaled by a peripheral or generated by a software request and fed through the NVIC (prioritized). All interrupts are asynchronous to instruction execution. In the system, peripherals use interrupts to communicate with the processor. Table 2-9 on page 71 lists the interrupts on the LM3S6100 controller.

For an asynchronous exception, other than reset, the processor can execute another instruction between when the exception is triggered and when the processor enters the exception handler.

Privileged software can disable the exceptions that Table 2-8 on page 70 shows as having configurable priority (see the **SYSHNDCTRL** register on page 125 and the **DIS0** register on page 100).

For more information about hard faults, memory management faults, bus faults, and usage faults, see “Fault Handling” on page 75.

**Table 2-8. Exception Types**

Exception Type	Vector Number	Priority <sup>a</sup>	Vector Address or Offset <sup>b</sup>	Activation
-	0	-	0x0000.0000	Stack top is loaded from the first entry of the vector table on reset.
Reset	1	-3 (highest)	0x0000.0004	Asynchronous
Non-Maskable Interrupt (NMI)	2	-2	0x0000.0008	Asynchronous
Hard Fault	3	-1	0x0000.000C	-
Memory Management	4	programmable <sup>c</sup>	0x0000.0010	Synchronous
Bus Fault	5	programmable <sup>c</sup>	0x0000.0014	Synchronous when precise and asynchronous when imprecise
Usage Fault	6	programmable <sup>c</sup>	0x0000.0018	Synchronous
-	7-10	-	-	Reserved
SVCall	11	programmable <sup>c</sup>	0x0000.002C	Synchronous
Debug Monitor	12	programmable <sup>c</sup>	0x0000.0030	Synchronous
-	13	-	-	Reserved

**Table 2-8. Exception Types (continued)**

Exception Type	Vector Number	Priority <sup>a</sup>	Vector Address or Offset <sup>b</sup>	Activation
PendSV	14	programmable <sup>c</sup>	0x0000.0038	Asynchronous
SysTick	15	programmable <sup>c</sup>	0x0000.003C	Asynchronous
Interrupts	16 and above	programmable <sup>d</sup>	0x0000.0040 and above	Asynchronous

a. 0 is the default priority for all the programmable priorities.

b. See "Vector Table" on page 72.

c. See **SYSPRI1** on page 122.

d. See **PRIn** registers on page 108.

**Table 2-9. Interrupts**

Vector Number	Interrupt Number (Bit in Interrupt Registers)	Vector Address or Offset	Description
0-15	-	0x0000.0000 - 0x0000.003C	Processor exceptions
16	0	0x0000.0040	GPIO Port A
17	1	0x0000.0044	GPIO Port B
18	2	0x0000.0048	GPIO Port C
19	3	0x0000.004C	GPIO Port D
20	4	0x0000.0050	GPIO Port E
21	5	0x0000.0054	UART0
22	6	-	Reserved
23	7	0x0000.005C	SSI0
24-33	8-17	-	Reserved
34	18	0x0000.0088	Watchdog Timer 0
35	19	0x0000.008C	Timer 0A
36	20	0x0000.0090	Timer 0B
37	21	0x0000.0094	Timer 1A
38	22	0x0000.0098	Timer 1B
39	23	0x0000.009C	Timer 2A
40	24	0x0000.00A0	Timer 2B
41	25	0x0000.00A4	Analog Comparator 0
42-43	26-27	-	Reserved
44	28	0x0000.00B0	System Control
45	29	0x0000.00B4	Flash Memory Control
46	30	0x0000.00B8	GPIO Port F
47	31	0x0000.00BC	GPIO Port G
48-57	32-41	-	Reserved
58	42	0x0000.00E8	Ethernet Controller
59	43	-	Reserved

### 2.5.3 Exception Handlers

The processor handles exceptions using:

- **Interrupt Service Routines (ISRs).** Interrupts (IRQx) are the exceptions handled by ISRs.

- **Fault Handlers.** Hard fault, memory management fault, usage fault, and bus fault are fault exceptions handled by the fault handlers.
- **System Handlers.** NMI, PendSV, SVCcall, SysTick, and the fault exceptions are all system exceptions that are handled by system handlers.

## 2.5.4 Vector Table

The vector table contains the reset value of the stack pointer and the start addresses, also called exception vectors, for all exception handlers. The vector table is constructed using the vector address or offset shown in Table 2-8 on page 70. Figure 2-6 on page 72 shows the order of the exception vectors in the vector table. The least-significant bit of each vector must be 1, indicating that the exception handler is Thumb code

**Figure 2-6. Vector Table**

Exception number	IRQ number	Offset	Vector
59	43	0x00EC	IRQ43
.	.	.	.
.	.	.	.
.	.	.	.
18	2	0x004C	IRQ2
17	1	0x0048	IRQ1
16	0	0x0044	IRQ0
15	-1	0x0040	Systick
14	-2	0x003C	PendSV
13		0x0038	Reserved
12			Reserved for Debug
11	-5	0x002C	SVCcall
10			Reserved
9			
8			
7			
6	-10		Usage fault
5	-11	0x0018	Bus fault
4	-12	0x0014	Memory management fault
3	-13	0x0010	Hard fault
2	-14	0x000C	NMI
1		0x0008	Reset
		0x0004	Initial SP value
		0x0000	

On system reset, the vector table is fixed at address 0x0000.0000. Privileged software can write to the **Vector Table Offset (VTABLE)** register to relocate the vector table start address to a different memory location, in the range 0x0000.0100 to 0x3FFF.FF00 (see “Vector Table” on page 72). Note that when configuring the **VTABLE** register, the offset must be aligned on a 256-byte boundary.

## 2.5.5 Exception Priorities

As Table 2-8 on page 70 shows, all exceptions have an associated priority, with a lower priority value indicating a higher priority and configurable priorities for all exceptions except Reset, Hard fault, and NMI. If software does not configure any priorities, then all exceptions with a configurable priority have a priority of 0. For information about configuring exception priorities, see page 122 and page 108.

**Note:** Configurable priority values for the Stellaris implementation are in the range 0-7. This means that the Reset, Hard fault, and NMI exceptions, with fixed negative priority values, always have higher priority than any other exception.

For example, assigning a higher priority value to IRQ[0] and a lower priority value to IRQ[1] means that IRQ[1] has higher priority than IRQ[0]. If both IRQ[1] and IRQ[0] are asserted, IRQ[1] is processed before IRQ[0].

If multiple pending exceptions have the same priority, the pending exception with the lowest exception number takes precedence. For example, if both IRQ[0] and IRQ[1] are pending and have the same priority, then IRQ[0] is processed before IRQ[1].

When the processor is executing an exception handler, the exception handler is preempted if a higher priority exception occurs. If an exception occurs with the same priority as the exception being handled, the handler is not preempted, irrespective of the exception number. However, the status of the new interrupt changes to pending.

## 2.5.6 Interrupt Priority Grouping

To increase priority control in systems with interrupts, the NVIC supports priority grouping. This grouping divides each interrupt priority register entry into two fields:

- An upper field that defines the group priority
- A lower field that defines a subpriority within the group

Only the group priority determines preemption of interrupt exceptions. When the processor is executing an interrupt exception handler, another interrupt with the same group priority as the interrupt being handled does not preempt the handler.

If multiple pending interrupts have the same group priority, the subpriority field determines the order in which they are processed. If multiple pending interrupts have the same group priority and subpriority, the interrupt with the lowest IRQ number is processed first.

For information about splitting the interrupt priority fields into group priority and subpriority, see page 116.

## 2.5.7 Exception Entry and Return

Descriptions of exception handling use the following terms:

- **Preemption.** When the processor is executing an exception handler, an exception can preempt the exception handler if its priority is higher than the priority of the exception being handled. See “Interrupt Priority Grouping” on page 73 for more information about preemption by an interrupt. When one exception preempts another, the exceptions are called nested exceptions. See “Exception Entry” on page 74 more information.
- **Return.** Return occurs when the exception handler is completed, and there is no pending exception with sufficient priority to be serviced and the completed exception handler was not

handling a late-arriving exception. The processor pops the stack and restores the processor state to the state it had before the interrupt occurred. See “Exception Return” on page 75 for more information.

- **Tail-Chaining.** This mechanism speeds up exception servicing. On completion of an exception handler, if there is a pending exception that meets the requirements for exception entry, the stack pop is skipped and control transfers to the new exception handler.
- **Late-Arriving.** This mechanism speeds up preemption. If a higher priority exception occurs during state saving for a previous exception, the processor switches to handle the higher priority exception and initiates the vector fetch for that exception. State saving is not affected by late arrival because the state saved is the same for both exceptions. Therefore, the state saving continues uninterrupted. The processor can accept a late arriving exception until the first instruction of the exception handler of the original exception enters the execute stage of the processor. On return from the exception handler of the late-arriving exception, the normal tail-chaining rules apply.

### 2.5.7.1 Exception Entry

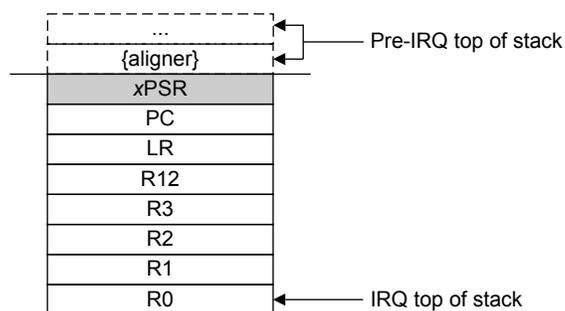
Exception entry occurs when there is a pending exception with sufficient priority and either the processor is in Thread mode or the new exception is of higher priority than the exception being handled, in which case the new exception preempts the original exception.

When one exception preempts another, the exceptions are nested.

Sufficient priority means the exception has more priority than any limits set by the mask registers (see **PRIMASK** on page 56, **FAULTMASK** on page 57, and **BASEPRI** on page 58). An exception with less priority than this is pending but is not handled by the processor.

When the processor takes an exception, unless the exception is a tail-chained or a late-arriving exception, the processor pushes information onto the current stack. This operation is referred to as *stacking* and the structure of eight data words is referred to as *stack frame*.

**Figure 2-7. Exception Stack Frame**



Immediately after stacking, the stack pointer indicates the lowest address in the stack frame. Unless stack alignment is disabled, the stack frame is aligned to a double-word address. If the **STKALIGN** bit of the **Configuration Control (CCR)** register is set, stack align adjustment is performed during stacking.

The stack frame includes the return address, which is the address of the next instruction in the interrupted program. This value is restored to the **PC** at exception return so that the interrupted program resumes.

In parallel to the stacking operation, the processor performs a vector fetch that reads the exception handler start address from the vector table. When stacking is complete, the processor starts executing the exception handler. At the same time, the processor writes an EXC\_RETURN value to the **LR**, indicating which stack pointer corresponds to the stack frame and what operation mode the processor was in before the entry occurred.

If no higher-priority exception occurs during exception entry, the processor starts executing the exception handler and automatically changes the status of the corresponding pending interrupt to active.

If another higher-priority exception occurs during exception entry, known as late arrival, the processor starts executing the exception handler for this exception and does not change the pending status of the earlier exception.

### 2.5.7.2 Exception Return

Exception return occurs when the processor is in Handler mode and executes one of the following instructions to load the EXC\_RETURN value into the **PC**:

- An **LDM** or **POP** instruction that loads the **PC**
- A **BX** instruction using any register
- An **LDR** instruction with the **PC** as the destination

EXC\_RETURN is the value loaded into the **LR** on exception entry. The exception mechanism relies on this value to detect when the processor has completed an exception handler. The lowest four bits of this value provide information on the return stack and processor mode. Table 2-10 on page 75 shows the EXC\_RETURN values with a description of the exception return behavior.

EXC\_RETURN bits 31:4 are all set. When this value is loaded into the **PC**, it indicates to the processor that the exception is complete, and the processor initiates the appropriate exception return sequence.

**Table 2-10. Exception Return Behavior**

EXC_RETURN[31:0]	Description
0xFFFF.FFF0	Reserved
0xFFFF.FFF1	Return to Handler mode. Exception return uses state from <b>MSP</b> . Execution uses <b>MSP</b> after return.
0xFFFF.FFF2 - 0xFFFF.FFF8	Reserved
0xFFFF.FFF9	Return to Thread mode. Exception return uses state from <b>MSP</b> . Execution uses <b>MSP</b> after return.
0xFFFF.FFFA - 0xFFFF.FFFC	Reserved
0xFFFF.FFFD	Return to Thread mode. Exception return uses state from <b>PSP</b> . Execution uses <b>PSP</b> after return.
0xFFFF.FFFE - 0xFFFF.FFFF	Reserved

## 2.6 Fault Handling

Faults are a subset of the exceptions (see “Exception Model” on page 68). The following conditions generate a fault:

- A bus error on an instruction fetch or vector table load or a data access.
- An internally detected error such as an undefined instruction or an attempt to change state with a BX instruction.
- Attempting to execute an instruction from a memory region marked as Non-Executable (XN).
- An MPU fault because of a privilege violation or an attempt to access an unmanaged region.

### 2.6.1 Fault Types

Table 2-11 on page 76 shows the types of fault, the handler used for the fault, the corresponding fault status register, and the register bit that indicates the fault has occurred. See page 129 for more information about the fault status registers.

**Table 2-11. Faults**

Fault	Handler	Fault Status Register	Bit Name
Bus error on a vector read	Hard fault	Hard Fault Status (HFAULTSTAT)	VECT
Fault escalated to a hard fault	Hard fault	Hard Fault Status (HFAULTSTAT)	FORCED
MPU or default memory mismatch on instruction access	Memory management fault	Memory Management Fault Status (MFAULTSTAT)	IERR <sup>a</sup>
MPU or default memory mismatch on data access	Memory management fault	Memory Management Fault Status (MFAULTSTAT)	DERR
MPU or default memory mismatch on exception stacking	Memory management fault	Memory Management Fault Status (MFAULTSTAT)	MSTKE
MPU or default memory mismatch on exception unstacking	Memory management fault	Memory Management Fault Status (MFAULTSTAT)	MUSTKE
Bus error during exception stacking	Bus fault	Bus Fault Status (BFAULTSTAT)	BSTKE
Bus error during exception unstacking	Bus fault	Bus Fault Status (BFAULTSTAT)	BUSTKE
Bus error during instruction prefetch	Bus fault	Bus Fault Status (BFAULTSTAT)	IBUS
Precise data bus error	Bus fault	Bus Fault Status (BFAULTSTAT)	PRECISE
Imprecise data bus error	Bus fault	Bus Fault Status (BFAULTSTAT)	IMPRE
Attempt to access a coprocessor	Usage fault	Usage Fault Status (UFAULTSTAT)	NOCP
Undefined instruction	Usage fault	Usage Fault Status (UFAULTSTAT)	UNDEF
Attempt to enter an invalid instruction set state <sup>b</sup>	Usage fault	Usage Fault Status (UFAULTSTAT)	INVSTAT
Invalid EXC_RETURN value	Usage fault	Usage Fault Status (UFAULTSTAT)	INVPC
Illegal unaligned load or store	Usage fault	Usage Fault Status (UFAULTSTAT)	UNALIGN
Divide by 0	Usage fault	Usage Fault Status (UFAULTSTAT)	DIV0

a. Occurs on an access to an XN region even if the MPU is disabled.

b. Attempting to use an instruction set other than the Thumb instruction set, or returning to a non load-store-multiple instruction with ICI continuation.

### 2.6.2 Fault Escalation and Hard Faults

All fault exceptions except for hard fault have configurable exception priority (see **SYSPRI1** on page 122). Software can disable execution of the handlers for these faults (see **SYSHNDCTRL** on page 125).

Usually, the exception priority, together with the values of the exception mask registers, determines whether the processor enters the fault handler, and whether a fault handler can preempt another fault handler as described in “Exception Model” on page 68.

In some situations, a fault with configurable priority is treated as a hard fault. This process is called priority escalation, and the fault is described as *escalated to hard fault*. Escalation to hard fault occurs when:

- A fault handler causes the same kind of fault as the one it is servicing. This escalation to hard fault occurs because a fault handler cannot preempt itself because it must have the same priority as the current priority level.
- A fault handler causes a fault with the same or lower priority as the fault it is servicing. This situation happens because the handler for the new fault cannot preempt the currently executing fault handler.
- An exception handler causes a fault for which the priority is the same as or lower than the currently executing exception.
- A fault occurs and the handler for that fault is not enabled.

If a bus fault occurs during a stack push when entering a bus fault handler, the bus fault does not escalate to a hard fault. Thus if a corrupted stack causes a fault, the fault handler executes even though the stack push for the handler failed. The fault handler operates but the stack contents are corrupted.

**Note:** Only Reset and NMI can preempt the fixed priority hard fault. A hard fault can preempt any exception other than Reset, NMI, or another hard fault.

### 2.6.3 Fault Status Registers and Fault Address Registers

The fault status registers indicate the cause of a fault. For bus faults and memory management faults, the fault address register indicates the address accessed by the operation that caused the fault, as shown in Table 2-12 on page 77.

**Table 2-12. Fault Status and Fault Address Registers**

Handler	Status Register Name	Address Register Name	Register Description
Hard fault	<b>Hard Fault Status (HFAULTSTAT)</b>	-	page 135
Memory management fault	<b>Memory Management Fault Status (MFAULTSTAT)</b>	<b>Memory Management Fault Address (MMADDR)</b>	page 129 page 136
Bus fault	<b>Bus Fault Status (BFAULTSTAT)</b>	<b>Bus Fault Address (FAULTADDR)</b>	page 129 page 137
Usage fault	<b>Usage Fault Status (UFAULTSTAT)</b>	-	page 129

### 2.6.4 Lockup

The processor enters a lockup state if a hard fault occurs when executing the NMI or hard fault handlers. When the processor is in the lockup state, it does not execute any instructions. The processor remains in lockup state until it is reset, an NMI occurs, or it is halted by a debugger.

**Note:** If the lockup state occurs from the NMI handler, a subsequent NMI does not cause the processor to leave the lockup state.

## 2.7 Power Management

The Cortex-M3 processor sleep modes reduce power consumption:

- Sleep mode stops the processor clock.
- Deep-sleep mode stops the system clock and switches off the PLL and Flash memory.

The `SLEEPDEEP` bit of the **System Control (SYSCTRL)** register selects which sleep mode is used (see page 118). For more information about the behavior of the sleep modes, see “System Control” on page 171.

This section describes the mechanisms for entering sleep mode and the conditions for waking up from sleep mode, both of which apply to Sleep mode and Deep-sleep mode.

### 2.7.1 Entering Sleep Modes

This section describes the mechanisms software can use to put the processor into one of the sleep modes.

The system can generate spurious wake-up events, for example a debug operation wakes up the processor. Therefore, software must be able to put the processor back into sleep mode after such an event. A program might have an idle loop to put the processor back to sleep mode.

#### 2.7.1.1 Wait for Interrupt

The wait for interrupt instruction, `WFI`, causes immediate entry to sleep mode unless the wake-up condition is true (see “Wake Up from WFI or Sleep-on-Exit” on page 79). When the processor executes a `WFI` instruction, it stops executing instructions and enters sleep mode. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information.

#### 2.7.1.2 Wait for Event

The wait for event instruction, `WFE`, causes entry to sleep mode conditional on the value of a one-bit event register. When the processor executes a `WFE` instruction, it checks the event register. If the register is 0, the processor stops executing instructions and enters sleep mode. If the register is 1, the processor clears the register and continues executing instructions without entering sleep mode.

If the event register is 1, the processor must not enter sleep mode on execution of a `WFE` instruction. Typically, this situation occurs if an `SEV` instruction has been executed. Software cannot access this register directly.

See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information.

#### 2.7.1.3 Sleep-on-Exit

If the `SLEEPEXIT` bit of the **SYSCTRL** register is set, when the processor completes the execution of all exception handlers, it returns to Thread mode and immediately enters sleep mode. This mechanism can be used in applications that only require the processor to run when an exception occurs.

### 2.7.2 Wake Up from Sleep Mode

The conditions for the processor to wake up depend on the mechanism that cause it to enter sleep mode.

### 2.7.2.1 Wake Up from WFI or Sleep-on-Exit

Normally, the processor wakes up only when the NVIC detects an exception with sufficient priority to cause exception entry. Some embedded systems might have to execute system restore tasks after the processor wakes up and before executing an interrupt handler. Entry to the interrupt handler can be delayed by setting the `PRIMASK` bit and clearing the `FAULTMASK` bit. If an interrupt arrives that is enabled and has a higher priority than current exception priority, the processor wakes up but does not execute the interrupt handler until the processor clears `PRIMASK`. For more information about **PRIMASK** and **FAULTMASK**, see page 56 and page 57.

### 2.7.2.2 Wake Up from WFE

The processor wakes up if it detects an exception with sufficient priority to cause exception entry.

In addition, if the `SEVONPEND` bit in the **SYSCTRL** register is set, any new pending interrupt triggers an event and wakes up the processor, even if the interrupt is disabled or has insufficient priority to cause exception entry. For more information about **SYSCTRL**, see page 118.

## 2.8 Instruction Set Summary

The processor implements a version of the Thumb instruction set. Table 2-13 on page 79 lists the supported instructions.

**Note:** In Table 2-13 on page 79:

- Angle brackets, `<>`, enclose alternative forms of the operand
- Braces, `{}`, enclose optional operands
- The Operands column is not exhaustive
- `Op2` is a flexible second operand that can be either a register or a constant
- Most instructions can use an optional condition code suffix

For more information on the instructions and operands, see the instruction descriptions in the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

**Table 2-13. Cortex-M3 Instruction Summary**

Mnemonic	Operands	Brief Description	Flags
ADC, ADCS	{Rd,} Rn, Op2	Add with carry	N, Z, C, V
ADD, ADDS	{Rd,} Rn, Op2	Add	N, Z, C, V
ADD, ADDW	{Rd,} Rn, #imm12	Add	N, Z, C, V
ADR	Rd, label	Load PC-relative address	-
AND, ANDS	{Rd,} Rn, Op2	Logical AND	N, Z, C
ASR, ASRS	Rd, Rm, <Rs #n>	Arithmetic shift right	N, Z, C
B	label	Branch	-
BFC	Rd, #lsb, #width	Bit field clear	-
BFI	Rd, Rn, #lsb, #width	Bit field insert	-
BIC, BICS	{Rd,} Rn, Op2	Bit clear	N, Z, C
BKPT	#imm	Breakpoint	-
BL	label	Branch with link	-
BLX	Rm	Branch indirect with link	-
BX	Rm	Branch indirect	-
CBNZ	Rn, label	Compare and branch if non-zero	-

Table 2-13. Cortex-M3 Instruction Summary (continued)

Mnemonic	Operands	Brief Description	Flags
CBZ	Rn, label	Compare and branch if zero	-
CLREX	-	Clear exclusive	-
CLZ	Rd, Rm	Count leading zeros	-
CMN	Rn, Op2	Compare negative	N, Z, C, V
CMP	Rn, Op2	Compare	N, Z, C, V
CPSID	i	Change processor state, disable interrupts	-
CPSIE	i	Change processor state, enable interrupts	-
DMB	-	Data memory barrier	-
DSB	-	Data synchronization barrier	-
EOR, EORS	{Rd,} Rn, Op2	Exclusive OR	N, Z, C
ISB	-	Instruction synchronization barrier	-
IT	-	If-Then condition block	-
LDM	Rn{!}, reglist	Load multiple registers, increment after	-
LDMDB, LDMEA	Rn{!}, reglist	Load multiple registers, decrement before	-
LDMFD, LDMIA	Rn{!}, reglist	Load multiple registers, increment after	-
LDR	Rt, [Rn, #offset]	Load register with word	-
LDRB, LDRBT	Rt, [Rn, #offset]	Load register with byte	-
LDRD	Rt, Rt2, [Rn, #offset]	Load register with two bytes	-
LDREX	Rt, [Rn, #offset]	Load register exclusive	-
LDREXB	Rt, [Rn]	Load register exclusive with byte	-
LDREXH	Rt, [Rn]	Load register exclusive with halfword	-
LDRH, LDRHT	Rt, [Rn, #offset]	Load register with halfword	-
LDRSB, LDRSBT	Rt, [Rn, #offset]	Load register with signed byte	-
LDRSH, LDRSHT	Rt, [Rn, #offset]	Load register with signed halfword	-
LDRT	Rt, [Rn, #offset]	Load register with word	-
LSL, LSLS	Rd, Rm, <Rs #n>	Logical shift left	N, Z, C
LSR, LSRS	Rd, Rm, <Rs #n>	Logical shift right	N, Z, C
MLA	Rd, Rn, Rm, Ra	Multiply with accumulate, 32-bit result	-
MLS	Rd, Rn, Rm, Ra	Multiply and subtract, 32-bit result	-
MOV, MOVS	Rd, Op2	Move	N, Z, C
MOV, MOVW	Rd, #imm16	Move 16-bit constant	N, Z, C
MOVT	Rd, #imm16	Move top	-
MRS	Rd, spec_reg	Move from special register to general register	-
MSR	spec_reg, Rm	Move from general register to special register	N, Z, C, V
MUL, MULS	{Rd,} Rn, Rm	Multiply, 32-bit result	N, Z
MVN, MVNS	Rd, Op2	Move NOT	N, Z, C
NOP	-	No operation	-
ORN, ORNS	{Rd,} Rn, Op2	Logical OR NOT	N, Z, C

Table 2-13. Cortex-M3 Instruction Summary (continued)

Mnemonic	Operands	Brief Description	Flags
ORR, ORRS	{Rd,} Rn, Op2	Logical OR	N, Z, C
POP	reglist	Pop registers from stack	-
PUSH	reglist	Push registers onto stack	-
RBIT	Rd, Rn	Reverse bits	-
REV	Rd, Rn	Reverse byte order in a word	-
REV16	Rd, Rn	Reverse byte order in each halfword	-
REVSH	Rd, Rn	Reverse byte order in bottom halfword and sign extend	-
ROR, RORS	Rd, Rm, <Rs #n>	Rotate right	N, Z, C
RRX, RRXS	Rd, Rm	Rotate right with extend	N, Z, C
RSB, RSBS	{Rd,} Rn, Op2	Reverse subtract	N, Z, C, V
SBC, SBSC	{Rd,} Rn, Op2	Subtract with carry	N, Z, C, V
SBFX	Rd, Rn, #lsb, #width	Signed bit field extract	-
SDIV	{Rd,} Rn, Rm	Signed divide	-
SEV	-	Send event	-
SMLAL	RdLo, RdHi, Rn, Rm	Signed multiply with accumulate (32x32+64), 64-bit result	-
SMULL	RdLo, RdHi, Rn, Rm	Signed multiply (32x32), 64-bit result	-
SSAT	Rd, #n, Rm {,shift #s}	Signed saturate	Q
STM	Rn{!}, reglist	Store multiple registers, increment after	-
STMDB, STMEA	Rn{!}, reglist	Store multiple registers, decrement before	-
STMFD, STMIA	Rn{!}, reglist	Store multiple registers, increment after	-
STR	Rt, [Rn {, #offset}]	Store register word	-
STRB, STRBT	Rt, [Rn {, #offset}]	Store register byte	-
STRD	Rt, Rt2, [Rn {, #offset}]	Store register two words	-
STREX	Rt, Rt, [Rn {, #offset}]	Store register exclusive	-
STREXB	Rd, Rt, [Rn]	Store register exclusive byte	-
STREXH	Rd, Rt, [Rn]	Store register exclusive halfword	-
STRH, STRHT	Rt, [Rn {, #offset}]	Store register halfword	-
STRSB, STRSBT	Rt, [Rn {, #offset}]	Store register signed byte	-
STRSH, STRSHT	Rt, [Rn {, #offset}]	Store register signed halfword	-
STRT	Rt, [Rn {, #offset}]	Store register word	-
SUB, SUBS	{Rd,} Rn, Op2	Subtract	N, Z, C, V
SUB, SUBW	{Rd,} Rn, #imm12	Subtract 12-bit constant	N, Z, C, V
SVC	#imm	Supervisor call	-
SXTB	{Rd,} Rm {,ROR #n}	Sign extend a byte	-
SXTH	{Rd,} Rm {,ROR #n}	Sign extend a halfword	-
TBB	[Rn, Rm]	Table branch byte	-
TBH	[Rn, Rm, LSL #1]	Table branch halfword	-
TEQ	Rn, Op2	Test equivalence	N, Z, C
TST	Rn, Op2	Test	N, Z, C

Table 2-13. Cortex-M3 Instruction Summary (continued)

Mnemonic	Operands	Brief Description	Flags
UBFX	Rd, Rn, #lsb, #width	Unsigned bit field extract	-
UDIV	{Rd,} Rn, Rm	Unsigned divide	-
UMLAL	RdLo, RdHi, Rn, Rm	Unsigned multiply with accumulate (32x32+32+32), 64-bit result	-
UMULL	RdLo, RdHi, Rn, Rm	Unsigned multiply (32x 2), 64-bit result	-
USAT	Rd, #n, Rm {,shift #s}	Unsigned Saturate	Q
UXTB	{Rd,} Rm, {,ROR #n}	Zero extend a Byte	-
UXTH	{Rd,} Rm, {,ROR #n}	Zero extend a Halfword	-
WFE	-	Wait for event	-
WFI	-	Wait for interrupt	-

## 3 Cortex-M3 Peripherals

This chapter provides information on the Stellaris® implementation of the Cortex-M3 processor peripherals, including:

- SysTick (see page 83)
  - Provides a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism.
- Nested Vectored Interrupt Controller (NVIC) (see page 84)
  - Facilitates low-latency exception and interrupt handling
  - Controls power management
  - Implements system control registers
- System Control Block (SCB) (see page 86)
  - Provides system implementation information and system control, including configuration, control, and reporting of system exceptions.
- Memory Protection Unit (MPU) (see page 86)
  - Supports the standard ARMv7 Protected Memory System Architecture (PMSA) model. The MPU provides full support for protection regions, overlapping protection regions, access permissions, and exporting memory attributes to the system.

Table 3-1 on page 83 shows the address map of the Private Peripheral Bus (PPB). Some peripheral register regions are split into two address regions, as indicated by two addresses listed.

**Table 3-1. Core Peripheral Register Regions**

Address	Core Peripheral	Description (see page ...)
0xE000.E010-0xE000.E01F	System Timer	83
0xE000.E100-0xE000.E4EF 0xE000.EF00-0xE000.EF03	Nested Vectored Interrupt Controller	84
0xE000.ED00-0xE000.ED3F	System Control Block	86
0xE000.ED90-0xE000.EDB8	Memory Protection Unit	86

### 3.1 Functional Description

This chapter provides information on the Stellaris implementation of the Cortex-M3 processor peripherals: SysTick, NVIC, SCB and MPU.

#### 3.1.1 System Timer (SysTick)

Cortex-M3 includes an integrated system timer, SysTick, which provides a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism. The counter can be used in several different ways, for example as:

- An RTOS tick timer that fires at a programmable rate (for example, 100 Hz) and invokes a SysTick routine.
- A high-speed alarm timer using the system clock.

- A variable rate alarm or signal timer—the duration is range-dependent on the reference clock used and the dynamic range of the counter.
- A simple counter used to measure time to completion and time used.
- An internal clock source control based on missing/meeting durations. The `COUNT` bit in the **STCTRL** control and status register can be used to determine if an action completed within a set duration, as part of a dynamic clock management control loop.

The timer consists of three registers:

- **SysTick Control and Status (STCTRL)**: A control and status counter to configure its clock, enable the counter, enable the SysTick interrupt, and determine counter status.
- **SysTick Reload Value (STRELOAD)**: The reload value for the counter, used to provide the counter's wrap value.
- **SysTick Current Value (STCURRENT)**: The current value of the counter.

When enabled, the timer counts down on each clock from the reload value to zero, reloads (wraps) to the value in the **STRELOAD** register on the next clock edge, then decrements on subsequent clocks. Clearing the **STRELOAD** register disables the counter on the next wrap. When the counter reaches zero, the `COUNT` status bit is set. The `COUNT` bit clears on reads.

Writing to the **STCURRENT** register clears the register and the `COUNT` status bit. The write does not trigger the SysTick exception logic. On a read, the current value is the value of the register at the time the register is accessed.

The SysTick counter runs on the system clock. If this clock signal is stopped for low power mode, the SysTick counter stops. Ensure software uses aligned word accesses to access the SysTick registers.

**Note:** When the processor is halted for debugging, the counter does not decrement.

### 3.1.2 Nested Vectored Interrupt Controller (NVIC)

This section describes the Nested Vectored Interrupt Controller (NVIC) and the registers it uses. The NVIC supports:

- 20 interrupts.
- A programmable priority level of 0-7 for each interrupt. A higher level corresponds to a lower priority, so level 0 is the highest interrupt priority.
- Low-latency exception and interrupt handling.
- Level and pulse detection of interrupt signals.
- Dynamic reprioritization of interrupts.
- Grouping of priority values into group priority and subpriority fields.
- Interrupt tail-chaining.
- An external Non-maskable interrupt (NMI).

The processor automatically stacks its state on exception entry and unstacks this state on exception exit, with no instruction overhead, providing low latency exception handling.

### 3.1.2.1 Level-Sensitive and Pulse Interrupts

The processor supports both level-sensitive and pulse interrupts. Pulse interrupts are also described as edge-triggered interrupts.

A level-sensitive interrupt is held asserted until the peripheral deasserts the interrupt signal. Typically this happens because the ISR accesses the peripheral, causing it to clear the interrupt request. A pulse interrupt is an interrupt signal sampled synchronously on the rising edge of the processor clock. To ensure the NVIC detects the interrupt, the peripheral must assert the interrupt signal for at least one clock cycle, during which the NVIC detects the pulse and latches the interrupt.

When the processor enters the ISR, it automatically removes the pending state from the interrupt (see “Hardware and Software Control of Interrupts” on page 85 for more information). For a level-sensitive interrupt, if the signal is not deasserted before the processor returns from the ISR, the interrupt becomes pending again, and the processor must execute its ISR again. As a result, the peripheral can hold the interrupt signal asserted until it no longer needs servicing.

### 3.1.2.2 Hardware and Software Control of Interrupts

The Cortex-M3 latches all interrupts. A peripheral interrupt becomes pending for one of the following reasons:

- The NVIC detects that the interrupt signal is High and the interrupt is not active.
- The NVIC detects a rising edge on the interrupt signal.
- Software writes to the corresponding interrupt set-pending register bit, or to the **Software Trigger Interrupt (SWTRIG)** register to make a Software-Generated Interrupt pending. See the `INT` bit in the `PEND0` register on page 102 or **SWTRIG** on page 110.

A pending interrupt remains pending until one of the following:

- The processor enters the ISR for the interrupt, changing the state of the interrupt from pending to active. Then:
  - For a level-sensitive interrupt, when the processor returns from the ISR, the NVIC samples the interrupt signal. If the signal is asserted, the state of the interrupt changes to pending, which might cause the processor to immediately re-enter the ISR. Otherwise, the state of the interrupt changes to inactive.
  - For a pulse interrupt, the NVIC continues to monitor the interrupt signal, and if this is pulsed the state of the interrupt changes to pending and active. In this case, when the processor returns from the ISR the state of the interrupt changes to pending, which might cause the processor to immediately re-enter the ISR.

If the interrupt signal is not pulsed while the processor is in the ISR, when the processor returns from the ISR the state of the interrupt changes to inactive.
- Software writes to the corresponding interrupt clear-pending register bit
  - For a level-sensitive interrupt, if the interrupt signal is still asserted, the state of the interrupt does not change. Otherwise, the state of the interrupt changes to inactive.

- For a pulse interrupt, the state of the interrupt changes to inactive, if the state was pending or to active, if the state was active and pending.

### 3.1.3 System Control Block (SCB)

The System Control Block (SCB) provides system implementation information and system control, including configuration, control, and reporting of the system exceptions.

### 3.1.4 Memory Protection Unit (MPU)

This section describes the Memory protection unit (MPU). The MPU divides the memory map into a number of regions and defines the location, size, access permissions, and memory attributes of each region. The MPU supports independent attribute settings for each region, overlapping regions, and export of memory attributes to the system.

The memory attributes affect the behavior of memory accesses to the region. The Cortex-M3 MPU defines eight separate memory regions, 0-7, and a background region.

When memory regions overlap, a memory access is affected by the attributes of the region with the highest number. For example, the attributes for region 7 take precedence over the attributes of any region that overlaps region 7.

The background region has the same memory access attributes as the default memory map, but is accessible from privileged software only.

The Cortex-M3 MPU memory map is unified, meaning that instruction accesses and data accesses have the same region settings.

If a program accesses a memory location that is prohibited by the MPU, the processor generates a memory management fault, causing a fault exception and possibly causing termination of the process in an OS environment. In an OS environment, the kernel can update the MPU region setting dynamically based on the process to be executed. Typically, an embedded OS uses the MPU for memory protection.

Configuration of MPU regions is based on memory types (see “Memory Regions, Types and Attributes” on page 61 for more information).

Table 3-2 on page 86 shows the possible MPU region attributes. See the section called “MPU Configuration for a Stellaris Microcontroller” on page 90 for guidelines for programming a microcontroller implementation.

**Table 3-2. Memory Attributes Summary**

Memory Type	Description
Strongly Ordered	All accesses to Strongly Ordered memory occur in program order.
Device	Memory-mapped peripherals
Normal	Normal memory

To avoid unexpected behavior, disable the interrupts before updating the attributes of a region that the interrupt handlers might access.

Ensure software uses aligned accesses of the correct size to access MPU registers:

- Except for the **MPU Region Attribute and Size (MPUATTR)** register, all MPU registers must be accessed with aligned word accesses.
- The **MPUATTR** register can be accessed with byte or aligned halfword or word accesses.

The processor does not support unaligned accesses to MPU registers.

When setting up the MPU, and if the MPU has previously been programmed, disable unused regions to prevent any previous region settings from affecting the new MPU setup.

### 3.1.4.1 Updating an MPU Region

To update the attributes for an MPU region, the **MPU Region Number (MPUNUMBER)**, **MPU Region Base Address (MPUBASE)** and **MPUATTR** registers must be updated. Each register can be programmed separately or with a multiple-word write to program all of these registers. You can use the **MPUBASEx** and **MPUATTRx** aliases to program up to four regions simultaneously using an STM instruction.

#### *Updating an MPU Region Using Separate Words*

This example simple code configures one region:

```

; R1 = region number
; R2 = size/enable
; R3 = attributes
; R4 = address
LDR R0,=MPUNUMBER           ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0]         ; Region Number
STR R4, [R0, #0x4]         ; Region Base Address
STRH R2, [R0, #0x8]        ; Region Size and Enable
STRH R3, [R0, #0xA]        ; Region Attribute

```

Disable a region before writing new region settings to the MPU if you have previously enabled the region being changed. For example:

```

; R1 = region number
; R2 = size/enable
; R3 = attributes
; R4 = address
LDR R0,=MPUNUMBER           ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0]         ; Region Number
BIC R2, R2, #1              ; Disable
STRH R2, [R0, #0x8]        ; Region Size and Enable
STR R4, [R0, #0x4]         ; Region Base Address
STRH R3, [R0, #0xA]        ; Region Attribute
ORR R2, #1                  ; Enable
STRH R2, [R0, #0x8]        ; Region Size and Enable

```

Software must use memory barrier instructions:

- Before MPU setup, if there might be outstanding memory transfers, such as buffered writes, that might be affected by the change in MPU settings.
- After MPU setup, if it includes memory transfers that must use the new MPU settings.

However, memory barrier instructions are not required if the MPU setup process starts by entering an exception handler, or is followed by an exception return, because the exception entry and exception return mechanism cause memory barrier behavior.

Software does not need any memory barrier instructions during MPU setup, because it accesses the MPU through the Private Peripheral Bus (PPB), which is a Strongly Ordered memory region.

For example, if all of the memory access behavior is intended to take effect immediately after the programming sequence, then a `DSB` instruction and an `ISB` instruction should be used. A `DSB` is required after changing MPU settings, such as at the end of context switch. An `ISB` is required if the code that programs the MPU region or regions is entered using a branch or call. If the programming sequence is entered using a return from exception, or by taking an exception, then an `ISB` is not required.

### **Updating an MPU Region Using Multi-Word Writes**

The MPU can be programmed directly using multi-word writes, depending how the information is divided. Consider the following reprogramming:

```
; R1 = region number
; R2 = address
; R3 = size, attributes in one
LDR R0, =MPUNUMBER ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0] ; Region Number
STR R2, [R0, #0x4] ; Region Base Address
STR R3, [R0, #0x8] ; Region Attribute, Size and Enable
```

An `STM` instruction can be used to optimize this:

```
; R1 = region number
; R2 = address
; R3 = size, attributes in one
LDR R0, =MPUNUMBER ; 0xE000ED98, MPU region number register
STM R0, {R1-R3} ; Region number, address, attribute, size and enable
```

This operation can be done in two words for pre-packed information, meaning that the **MPU Region Base Address (MPUBASE)** register (see page 142) contains the required region number and has the `VALID` bit set. This method can be used when the data is statically packed, for example in a boot loader:

```
; R1 = address and region number in one
; R2 = size and attributes in one
LDR R0, =MPUBASE ; 0xE000ED9C, MPU Region Base register
STR R1, [R0, #0x0] ; Region base address and region number combined
; with VALID (bit 4) set
STR R2, [R0, #0x4] ; Region Attribute, Size and Enable
```

### **Subregions**

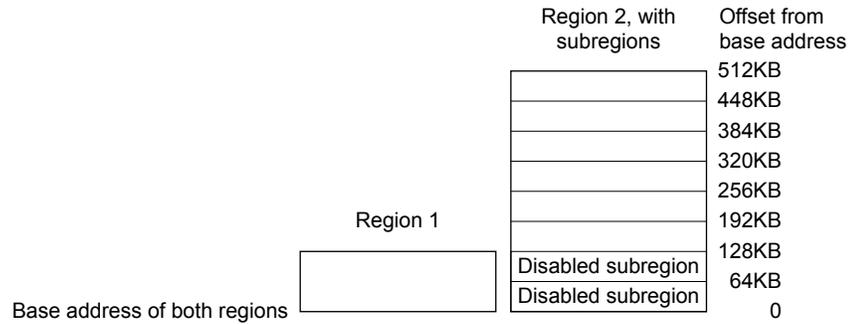
Regions of 256 bytes or more are divided into eight equal-sized subregions. Set the corresponding bit in the `SRD` field of the **MPU Region Attribute and Size (MPUATTR)** register (see page 144) to disable a subregion. The least-significant bit of the `SRD` field controls the first subregion, and the most-significant bit controls the last subregion. Disabling a subregion means another region overlapping the disabled range matches instead. If no other enabled region overlaps the disabled subregion, the MPU issues a fault.

Regions of 32, 64, and 128 bytes do not support subregions. With regions of these sizes, the `SRD` field must be configured to `0x00`, otherwise the MPU behavior is unpredictable.

### Example of SRD Use

Two regions with the same base address overlap. Region one is 128 KB, and region two is 512 KB. To ensure the attributes from region one apply to the first 128 KB region, configure the SRD field for region two to 0x03 to disable the first two subregions, as Figure 3-1 on page 89 shows.

**Figure 3-1. SRD Use Example**



### 3.1.4.2 MPU Access Permission Attributes

The access permission bits, TEX, S, C, B, AP, and XN of the MPUATTR register, control access to the corresponding memory region. If an access is made to an area of memory without the required permissions, then the MPU generates a permission fault.

Table 3-3 on page 89 shows the encodings for the TEX, C, B, and S access permission bits. All encodings are shown for completeness, however the current implementation of the Cortex-M3 does not support the concept of cacheability or shareability. Refer to the section called “MPU Configuration for a Stellaris Microcontroller” on page 90 for information on programming the MPU for Stellaris implementations.

**Table 3-3. TEX, S, C, and B Bit Field Encoding**

TEX	S	C	B	Memory Type	Shareability	Other Attributes
000b	x <sup>a</sup>	0	0	Strongly Ordered	Shareable	-
000	x <sup>a</sup>	0	1	Device	Shareable	-
000	0	1	0	Normal	Not shareable	Outer and inner write-through. No write allocate.
000	1	1	0	Normal	Shareable	
000	0	1	1	Normal	Not shareable	
000	1	1	1	Normal	Shareable	
001	0	0	0	Normal	Not shareable	Outer and inner noncacheable.
001	1	0	0	Normal	Shareable	
001	x <sup>a</sup>	0	1	Reserved encoding	-	-
001	x <sup>a</sup>	1	0	Reserved encoding	-	-
001	0	1	1	Normal	Not shareable	Outer and inner write-back. Write and read allocate.
001	1	1	1	Normal	Shareable	
010	x <sup>a</sup>	0	0	Device	Not shareable	Nonshared Device.
010	x <sup>a</sup>	0	1	Reserved encoding	-	-
010	x <sup>a</sup>	1	x <sup>a</sup>	Reserved encoding	-	-

**Table 3-3. TEX, S, C, and B Bit Field Encoding (continued)**

TEX	S	C	B	Memory Type	Shareability	Other Attributes
1BB	0	A	A	Normal	Not shareable	Cached memory (BB = outer policy, AA = inner policy). See Table 3-4 for the encoding of the AA and BB bits.
1BB	1	A	A	Normal	Shareable	

a. The MPU ignores the value of this bit.

Table 3-4 on page 90 shows the cache policy for memory attribute encodings with a TEX value in the range of 0x4-0x7.

**Table 3-4. Cache Policy for Memory Attribute Encoding**

Encoding, AA or BB	Corresponding Cache Policy
00	Non-cacheable
01	Write back, write and read allocate
10	Write through, no write allocate
11	Write back, no write allocate

Table 3-5 on page 90 shows the AP encodings in the MPUATTR register that define the access permissions for privileged and unprivileged software.

**Table 3-5. AP Bit Field Encoding**

AP Bit Field	Privileged Permissions	Unprivileged Permissions	Description
000	No access	No access	All accesses generate a permission fault.
001	R/W	No access	Access from privileged software only.
010	R/W	RO	Writes by unprivileged software generate a permission fault.
011	R/W	R/W	Full access.
100	Unpredictable	Unpredictable	Reserved.
101	RO	No access	Reads by privileged software only.
110	RO	RO	Read-only, by privileged or unprivileged software.
111	RO	RO	Read-only, by privileged or unprivileged software.

### **MPU Configuration for a Stellaris Microcontroller**

Stellaris microcontrollers have only a single processor and no caches. As a result, the MPU should be programmed as shown in Table 3-6 on page 90.

**Table 3-6. Memory Region Attributes for Stellaris Microcontrollers**

Memory Region	TEX	S	C	B	Memory Type and Attributes
Flash memory	000b	0	1	0	Normal memory, non-shareable, write-through
Internal SRAM	000b	1	1	0	Normal memory, shareable, write-through
External SRAM	000b	1	1	1	Normal memory, shareable, write-back, write-allocate
Peripherals	000b	1	0	1	Device memory, shareable

In current Stellaris microcontroller implementations, the shareability and cache policy attributes do not affect the system behavior. However, using these settings for the MPU regions can make the application code more portable. The values given are for typical situations.

### 3.1.4.3 MPU Mismatch

When an access violates the MPU permissions, the processor generates a memory management fault (see “Exceptions and Interrupts” on page 60 for more information). The **MFAULTSTAT** register indicates the cause of the fault. See page 129 for more information.

## 3.2 Register Map

Table 3-7 on page 91 lists the Cortex-M3 Peripheral SysTick, NVIC, MPU and SCB registers. The offset listed is a hexadecimal increment to the register's address, relative to the Core Peripherals base address of 0xE000.E000.

**Note:** Register spaces that are not used are reserved for future or internal use. Software should not modify any reserved memory address.

**Table 3-7. Peripherals Register Map**

Offset	Name	Type	Reset	Description	See page
<b>System Timer (SysTick) Registers</b>					
0x010	STCTRL	R/W	0x0000.0000	SysTick Control and Status Register	94
0x014	STRELOAD	R/W	0x0000.0000	SysTick Reload Value Register	96
0x018	STCURRENT	R/WC	0x0000.0000	SysTick Current Value Register	97
<b>Nested Vectored Interrupt Controller (NVIC) Registers</b>					
0x100	EN0	R/W	0x0000.0000	Interrupt 0-31 Set Enable	98
0x104	EN1	R/W	0x0000.0000	Interrupt 32-43 Set Enable	99
0x180	DIS0	R/W	0x0000.0000	Interrupt 0-31 Clear Enable	100
0x184	DIS1	R/W	0x0000.0000	Interrupt 32-43 Clear Enable	101
0x200	PEND0	R/W	0x0000.0000	Interrupt 0-31 Set Pending	102
0x204	PEND1	R/W	0x0000.0000	Interrupt 32-43 Set Pending	103
0x280	UNPEND0	R/W	0x0000.0000	Interrupt 0-31 Clear Pending	104
0x284	UNPEND1	R/W	0x0000.0000	Interrupt 32-43 Clear Pending	105
0x300	ACTIVE0	RO	0x0000.0000	Interrupt 0-31 Active Bit	106
0x304	ACTIVE1	RO	0x0000.0000	Interrupt 32-43 Active Bit	107
0x400	PRI0	R/W	0x0000.0000	Interrupt 0-3 Priority	108
0x404	PRI1	R/W	0x0000.0000	Interrupt 4-7 Priority	108
0x408	PRI2	R/W	0x0000.0000	Interrupt 8-11 Priority	108
0x40C	PRI3	R/W	0x0000.0000	Interrupt 12-15 Priority	108
0x410	PRI4	R/W	0x0000.0000	Interrupt 16-19 Priority	108

Table 3-7. Peripherals Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x414	PRI5	R/W	0x0000.0000	Interrupt 20-23 Priority	108
0x418	PRI6	R/W	0x0000.0000	Interrupt 24-27 Priority	108
0x41C	PRI7	R/W	0x0000.0000	Interrupt 28-31 Priority	108
0x420	PRI8	R/W	0x0000.0000	Interrupt 32-35 Priority	108
0x424	PRI9	R/W	0x0000.0000	Interrupt 36-39 Priority	108
0x428	PRI10	R/W	0x0000.0000	Interrupt 40-43 Priority	108
0xF00	SWTRIG	WO	0x0000.0000	Software Trigger Interrupt	110
<b>System Control Block (SCB) Registers</b>					
0xD00	CPUID	RO	0x411F.C231	CPU ID Base	111
0xD04	INTCTRL	R/W	0x0000.0000	Interrupt Control and State	112
0xD08	VTABLE	R/W	0x0000.0000	Vector Table Offset	115
0xD0C	APINT	R/W	0xFA05.0000	Application Interrupt and Reset Control	116
0xD10	SYSCTRL	R/W	0x0000.0000	System Control	118
0xD14	CFGCTRL	R/W	0x0000.0000	Configuration and Control	120
0xD18	SYSPRI1	R/W	0x0000.0000	System Handler Priority 1	122
0xD1C	SYSPRI2	R/W	0x0000.0000	System Handler Priority 2	123
0xD20	SYSPRI3	R/W	0x0000.0000	System Handler Priority 3	124
0xD24	SYSHNDCTRL	R/W	0x0000.0000	System Handler Control and State	125
0xD28	FAULTSTAT	R/W1C	0x0000.0000	Configurable Fault Status	129
0xD2C	HFAULTSTAT	R/W1C	0x0000.0000	Hard Fault Status	135
0xD34	MMADDR	R/W	-	Memory Management Fault Address	136
0xD38	FAULTADDR	R/W	-	Bus Fault Address	137
<b>Memory Protection Unit (MPU) Registers</b>					
0xD90	MPUTYPE	RO	0x0000.0800	MPU Type	138
0xD94	MPUCTRL	R/W	0x0000.0000	MPU Control	139
0xD98	MPUNUMBER	R/W	0x0000.0000	MPU Region Number	141
0xD9C	MPUBASE	R/W	0x0000.0000	MPU Region Base Address	142
0xDA0	MPUATTR	R/W	0x0000.0000	MPU Region Attribute and Size	144
0xDA4	MPUBASE1	R/W	0x0000.0000	MPU Region Base Address Alias 1	142
0xDA8	MPUATTR1	R/W	0x0000.0000	MPU Region Attribute and Size Alias 1	144
0xDAC	MPUBASE2	R/W	0x0000.0000	MPU Region Base Address Alias 2	142
0xDB0	MPUATTR2	R/W	0x0000.0000	MPU Region Attribute and Size Alias 2	144

**Table 3-7. Peripherals Register Map (continued)**

Offset	Name	Type	Reset	Description	See page
0xDB4	MPUBASE3	R/W	0x0000.0000	MPU Region Base Address Alias 3	142
0xDB8	MPUATTR3	R/W	0x0000.0000	MPU Region Attribute and Size Alias 3	144

### 3.3 System Timer (SysTick) Register Descriptions

This section lists and describes the System Timer registers, in numerical order by address offset.

## Register 1: SysTick Control and Status Register (STCTRL), offset 0x010

**Note:** This register can only be accessed from privileged mode.

The SysTick **STCTRL** register enables the SysTick features.

### SysTick Control and Status Register (STCTRL)

Base 0xE000.E000

Offset 0x010

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved															COUNT	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved													CLK_SRC	INTEN	ENABLE	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description						
31:17	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
16	COUNT	RO	0	Count Flag						
				<table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The SysTick timer has not counted to 0 since the last time this bit was read.</td> </tr> <tr> <td>1</td> <td>The SysTick timer has counted to 0 since the last time this bit was read.</td> </tr> </table> <p>This bit is cleared by a read of the register or if the <b>STCURRENT</b> register is written with any value.</p> <p>If read by the debugger using the DAP, this bit is cleared only if the <b>MasterType</b> bit in the <b>AHB-AP Control Register</b> is clear. Otherwise, the <b>COUNT</b> bit is not changed by the debugger read. See the <i>ARM® Debug Interface V5 Architecture Specification</i> for more information on <b>MasterType</b>.</p>	Value	Description	0	The SysTick timer has not counted to 0 since the last time this bit was read.	1	The SysTick timer has counted to 0 since the last time this bit was read.
Value	Description									
0	The SysTick timer has not counted to 0 since the last time this bit was read.									
1	The SysTick timer has counted to 0 since the last time this bit was read.									
15:3	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
2	CLK_SRC	R/W	0	Clock Source						
				<table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>External reference clock. (Not implemented for most Stellaris microcontrollers.)</td> </tr> <tr> <td>1</td> <td>System clock</td> </tr> </table> <p>Because an external reference clock is not implemented, this bit must be set in order for SysTick to operate.</p>	Value	Description	0	External reference clock. (Not implemented for most Stellaris microcontrollers.)	1	System clock
Value	Description									
0	External reference clock. (Not implemented for most Stellaris microcontrollers.)									
1	System clock									

---

Bit/Field	Name	Type	Reset	Description
1	INTEN	R/W	0	Interrupt Enable  Value    Description 0        Interrupt generation is disabled. Software can use the <code>COUNT</code> bit to determine if the counter has ever reached 0. 1        An interrupt is generated to the NVIC when SysTick counts to 0.
0	ENABLE	R/W	0	Enable  Value    Description 0        The counter is disabled. 1        Enables SysTick to operate in a multi-shot way. That is, the counter loads the <code>RELOAD</code> value and begins counting down. On reaching 0, the <code>COUNT</code> bit is set and an interrupt is generated if enabled by <code>INTEN</code> . The counter then loads the <code>RELOAD</code> value again and begins counting.

**Register 2: SysTick Reload Value Register (STRELOAD), offset 0x014**

**Note:** This register can only be accessed from privileged mode.

The **STRELOAD** register specifies the start value to load into the **SysTick Current Value (STCURRENT)** register when the counter reaches 0. The start value can be between 0x1 and 0x00FF.FFFF. A start value of 0 is possible but has no effect because the SysTick interrupt and the **COUNT** bit are activated when counting from 1 to 0.

SysTick can be configured as a multi-shot timer, repeated over and over, firing every N+1 clock pulses, where N is any value from 1 to 0x00FF.FFFF. For example, if a tick interrupt is required every 100 clock pulses, 99 must be written into the **RELOAD** field.

**SysTick Reload Value Register (STRELOAD)**

Base 0xE000.E000

Offset 0x014

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved								RELOAD							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	RELOAD															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:24	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:0	RELOAD	R/W	0x00.0000	Reload Value Value to load into the <b>SysTick Current Value (STCURRENT)</b> register when the counter reaches 0.

### Register 3: SysTick Current Value Register (STCURRENT), offset 0x018

**Note:** This register can only be accessed from privileged mode.

The **STCURRENT** register contains the current value of the SysTick counter.

#### SysTick Current Value Register (STCURRENT)

Base 0xE000.E000

Offset 0x018

Type R/WC, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved								CURRENT							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	CURRENT															
Type	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:24	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:0	CURRENT	R/WC	0x00.0000	Current Value This field contains the current value at the time the register is accessed. No read-modify-write protection is provided, so change with care. This register is write-clear. Writing to it with any value clears the register. Clearing this register also clears the <b>COUNT</b> bit of the <b>STCTRL</b> register.

## 3.4 NVIC Register Descriptions

This section lists and describes the NVIC registers, in numerical order by address offset.

The NVIC registers can only be fully accessed from privileged mode, but interrupts can be pended while in unprivileged mode by enabling the **Configuration and Control (CFGCTRL)** register. Any other unprivileged mode access causes a bus fault.

Ensure software uses correctly aligned register accesses. The processor does not support unaligned accesses to NVIC registers.

An interrupt can enter the pending state even if it is disabled.

Before programming the **VTABLE** register to relocate the vector table, ensure the vector table entries of the new vector table are set up for fault handlers, NMI, and all enabled exceptions such as interrupts. For more information, see page 115.

**Register 4: Interrupt 0-31 Set Enable (EN0), offset 0x100**

**Note:** This register can only be accessed from privileged mode.

The **EN0** register enables interrupts and shows which interrupts are enabled. Bit 0 corresponds to Interrupt 0; bit 31 corresponds to Interrupt 31.

See Table 2-9 on page 71 for interrupt assignments.

If a pending interrupt is enabled, the NVIC activates the interrupt based on its priority. If an interrupt is not enabled, asserting its interrupt signal changes the interrupt state to pending, but the NVIC never activates the interrupt, regardless of its priority.

**Interrupt 0-31 Set Enable (EN0)**

Base 0xE000.E000

Offset 0x100

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	INT															
Type	R/W															
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	INT															
Type	R/W															
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	INT	R/W	0x0000.0000	Interrupt Enable

Value	Description
0	On a read, indicates the interrupt is disabled. On a write, no effect.
1	On a read, indicates the interrupt is enabled. On a write, enables the interrupt.

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **DISn** register.

## Register 5: Interrupt 32-43 Set Enable (EN1), offset 0x104

**Note:** This register can only be accessed from privileged mode.

The **EN1** register enables interrupts and shows which interrupts are enabled. Bit 0 corresponds to Interrupt 32; bit 11 corresponds to Interrupt 43. See Table 2-9 on page 71 for interrupt assignments.

If a pending interrupt is enabled, the NVIC activates the interrupt based on its priority. If an interrupt is not enabled, asserting its interrupt signal changes the interrupt state to pending, but the NVIC never activates the interrupt, regardless of its priority.

### Interrupt 32-43 Set Enable (EN1)

Base 0xE000.E000

Offset 0x104

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				INT											
Type	RO	RO	RO	RO	R/W											
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:12	reserved	RO	0x0000.0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
11:0	INT	R/W	0x000	Interrupt Enable
	Value	Description		
	0	On a read, indicates the interrupt is disabled. On a write, no effect.		
	1	On a read, indicates the interrupt is enabled. On a write, enables the interrupt.		

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **DIS1** register.

### Register 6: Interrupt 0-31 Clear Enable (DIS0), offset 0x180

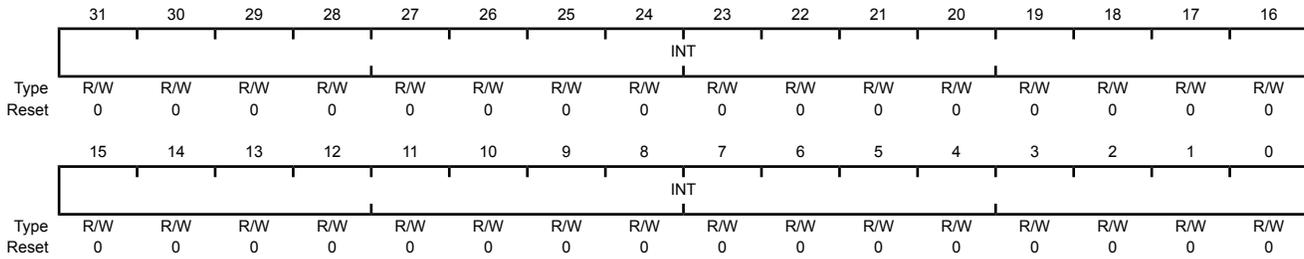
**Note:** This register can only be accessed from privileged mode.

The **DIS0** register disables interrupts. Bit 0 corresponds to Interrupt 0; bit 31 corresponds to Interrupt 31.

See Table 2-9 on page 71 for interrupt assignments.

#### Interrupt 0-31 Clear Enable (DIS0)

Base 0xE000.E000  
 Offset 0x180  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	INT	R/W	0x0000.0000	Interrupt Disable

Value	Description
0	On a read, indicates the interrupt is disabled. On a write, no effect.
1	On a read, indicates the interrupt is enabled. On a write, clears the corresponding <code>INT[n]</code> bit in the <b>EN0</b> register, disabling interrupt [n].

**Register 7: Interrupt 32-43 Clear Enable (DIS1), offset 0x184**

**Note:** This register can only be accessed from privileged mode.

The **DIS1** register disables interrupts. Bit 0 corresponds to Interrupt 32; bit 11 corresponds to Interrupt 43. See Table 2-9 on page 71 for interrupt assignments.

## Interrupt 32-43 Clear Enable (DIS1)

Base 0xE000.E000

Offset 0x184

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				INT											
Type	RO	RO	RO	RO	R/W											
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:12	reserved	RO	0x0000.0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

11:0	INT	R/W	0x000	Interrupt Disable
------	-----	-----	-------	-------------------

## Value Description

0	On a read, indicates the interrupt is disabled.
---	---

	On a write, no effect.
--	------------------------

1	On a read, indicates the interrupt is enabled.
---	--

	On a write, clears the corresponding <code>INT[n]</code> bit in the <b>EN1</b> register, disabling interrupt [n].
--	---

**Register 8: Interrupt 0-31 Set Pending (PEND0), offset 0x200**

**Note:** This register can only be accessed from privileged mode.

The **PEND0** register forces interrupts into the pending state and shows which interrupts are pending. Bit 0 corresponds to Interrupt 0; bit 31 corresponds to Interrupt 31.

See Table 2-9 on page 71 for interrupt assignments.

## Interrupt 0-31 Set Pending (PEND0)

Base 0xE000.E000

Offset 0x200

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	INT															
Type	R/W															
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	INT															
Type	R/W															
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	INT	R/W	0x0000.0000	Interrupt Set Pending
				Value      Description
				0            On a read, indicates that the interrupt is not pending. On a write, no effect.
				1            On a read, indicates that the interrupt is pending. On a write, the corresponding interrupt is set to pending even if it is disabled.
				If the corresponding interrupt is already pending, setting a bit has no effect.
				A bit can only be cleared by setting the corresponding <code>INT[n]</code> bit in the <b>UNPEND0</b> register.

## Register 9: Interrupt 32-43 Set Pending (PEND1), offset 0x204

**Note:** This register can only be accessed from privileged mode.

The **PEND1** register forces interrupts into the pending state and shows which interrupts are pending. Bit 0 corresponds to Interrupt 32; bit 11 corresponds to Interrupt 43. See Table 2-9 on page 71 for interrupt assignments.

### Interrupt 32-43 Set Pending (PEND1)

Base 0xE000.E000

Offset 0x204

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				INT											
Type	RO	RO	RO	RO	R/W											
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:12	reserved	RO	0x0000.0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
11:0	INT	R/W	0x000	Interrupt Set Pending

Value	Description
0	On a read, indicates that the interrupt is not pending. On a write, no effect.
1	On a read, indicates that the interrupt is pending. On a write, the corresponding interrupt is set to pending even if it is disabled.

If the corresponding interrupt is already pending, setting a bit has no effect.

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **UNPEND1** register.

**Register 10: Interrupt 0-31 Clear Pending (UNPEND0), offset 0x280**

**Note:** This register can only be accessed from privileged mode.

The **UNPEND0** register shows which interrupts are pending and removes the pending state from interrupts. Bit 0 corresponds to Interrupt 0; bit 31 corresponds to Interrupt 31.

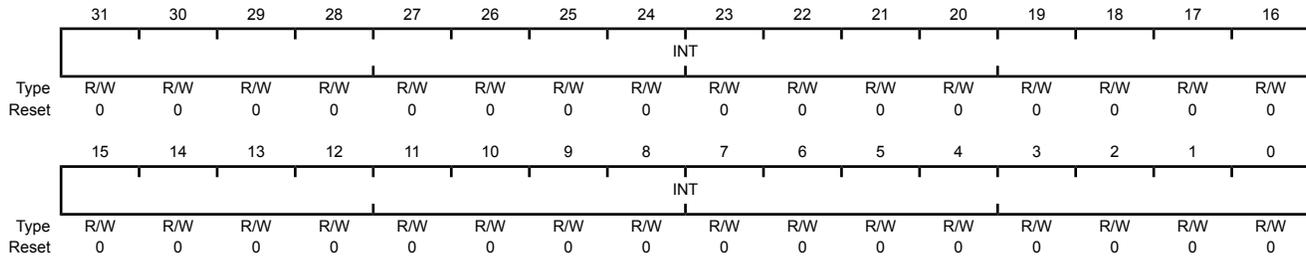
See Table 2-9 on page 71 for interrupt assignments.

## Interrupt 0-31 Clear Pending (UNPEND0)

Base 0xE000.E000

Offset 0x280

Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	INT	R/W	0x0000.0000	Interrupt Clear Pending

## Value Description

0 On a read, indicates that the interrupt is not pending.

On a write, no effect.

1 On a read, indicates that the interrupt is pending.

On a write, clears the corresponding `INT[n]` bit in the **PEND0** register, so that interrupt [n] is no longer pending.

Setting a bit does not affect the active state of the corresponding interrupt.

**Register 11: Interrupt 32-43 Clear Pending (UNPEND1), offset 0x284**

**Note:** This register can only be accessed from privileged mode.

The **UNPEND1** register shows which interrupts are pending and removes the pending state from interrupts. Bit 0 corresponds to Interrupt 32; bit 11 corresponds to Interrupt 43. See Table 2-9 on page 71 for interrupt assignments.

## Interrupt 32-43 Clear Pending (UNPEND1)

Base 0xE000.E000

Offset 0x284

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				INT											
Type	RO	RO	RO	RO	R/W											
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:12	reserved	RO	0x0000.0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
11:0	INT	R/W	0x000	Interrupt Clear Pending

## Value Description

0 On a read, indicates that the interrupt is not pending.  
On a write, no effect.

1 On a read, indicates that the interrupt is pending.  
On a write, clears the corresponding `INT[n]` bit in the **PEND1** register, so that interrupt [n] is no longer pending.  
Setting a bit does not affect the active state of the corresponding interrupt.

**Register 12: Interrupt 0-31 Active Bit (ACTIVE0), offset 0x300**

**Note:** This register can only be accessed from privileged mode.

The **ACTIVE0** register indicates which interrupts are active. Bit 0 corresponds to Interrupt 0; bit 31 corresponds to Interrupt 31.

See Table 2-9 on page 71 for interrupt assignments.

**Caution – Do not manually set or clear the bits in this register.**

## Interrupt 0-31 Active Bit (ACTIVE0)

Base 0xE000.E000

Offset 0x300

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	INT															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	INT															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	INT	RO	0x0000.0000	Interrupt Active

## Value Description

0 The corresponding interrupt is not active.

1 The corresponding interrupt is active, or active and pending.

**Register 13: Interrupt 32-43 Active Bit (ACTIVE1), offset 0x304**

**Note:** This register can only be accessed from privileged mode.

The **ACTIVE1** register indicates which interrupts are active. Bit 0 corresponds to Interrupt 32; bit 11 corresponds to Interrupt 43. See Table 2-9 on page 71 for interrupt assignments.

**Caution – Do not manually set or clear the bits in this register.**

## Interrupt 32-43 Active Bit (ACTIVE1)

Base 0xE000.E000

Offset 0x304

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				INT											
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:12	reserved	RO	0x0000.0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
11:0	INT	RO	0x000	Interrupt Active
				Value Description
				0 The corresponding interrupt is not active.
				1 The corresponding interrupt is active, or active and pending.

**Register 14: Interrupt 0-3 Priority (PRI0), offset 0x400**

**Register 15: Interrupt 4-7 Priority (PRI1), offset 0x404**

**Register 16: Interrupt 8-11 Priority (PRI2), offset 0x408**

**Register 17: Interrupt 12-15 Priority (PRI3), offset 0x40C**

**Register 18: Interrupt 16-19 Priority (PRI4), offset 0x410**

**Register 19: Interrupt 20-23 Priority (PRI5), offset 0x414**

**Register 20: Interrupt 24-27 Priority (PRI6), offset 0x418**

**Register 21: Interrupt 28-31 Priority (PRI7), offset 0x41C**

**Register 22: Interrupt 32-35 Priority (PRI8), offset 0x420**

**Register 23: Interrupt 36-39 Priority (PRI9), offset 0x424**

**Register 24: Interrupt 40-43 Priority (PRI10), offset 0x428**

**Note:** This register can only be accessed from privileged mode.

The **PRIn** registers provide 3-bit priority fields for each interrupt. These registers are byte accessible. Each register holds four priority fields that are assigned to interrupts as follows:

PRIn Register Bit Field	Interrupt
Bits 31:29	Interrupt [4n+3]
Bits 23:21	Interrupt [4n+2]
Bits 15:13	Interrupt [4n+1]
Bits 7:5	Interrupt [4n]

See Table 2-9 on page 71 for interrupt assignments.

Each priority level can be split into separate group priority and subpriority fields. The **PRIGROUP** field in the **Application Interrupt and Reset Control (APINT)** register (see page 116) indicates the position of the binary point that splits the priority and subpriority fields.

These registers can only be accessed from privileged mode.

#### Interrupt 0-3 Priority (PRI0)

Base 0xE000.E000

Offset 0x400

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	INTD			reserved					INTC			reserved				
Type	R/W	R/W	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	INTB			reserved					INTA			reserved				
Type	R/W	R/W	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:29	INTD	R/W	0x0	Interrupt Priority for Interrupt [4n+3] This field holds a priority value, 0-7, for the interrupt with the number [4n+3], where n is the number of the <b>Interrupt Priority</b> register (n=0 for <b>PRIO</b> , and so on). The lower the value, the greater the priority of the corresponding interrupt.
28:24	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:21	INTC	R/W	0x0	Interrupt Priority for Interrupt [4n+2] This field holds a priority value, 0-7, for the interrupt with the number [4n+2], where n is the number of the <b>Interrupt Priority</b> register (n=0 for <b>PRIO</b> , and so on). The lower the value, the greater the priority of the corresponding interrupt.
20:16	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:13	INTB	R/W	0x0	Interrupt Priority for Interrupt [4n+1] This field holds a priority value, 0-7, for the interrupt with the number [4n+1], where n is the number of the <b>Interrupt Priority</b> register (n=0 for <b>PRIO</b> , and so on). The lower the value, the greater the priority of the corresponding interrupt.
12:8	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:5	INTA	R/W	0x0	Interrupt Priority for Interrupt [4n] This field holds a priority value, 0-7, for the interrupt with the number [4n], where n is the number of the <b>Interrupt Priority</b> register (n=0 for <b>PRIO</b> , and so on). The lower the value, the greater the priority of the corresponding interrupt.
4:0	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 25: Software Trigger Interrupt (SWTRIG), offset 0xF00**

**Note:** Only privileged software can enable unprivileged access to the **SWTRIG** register.

Writing an interrupt number to the **SWTRIG** register generates a Software Generated Interrupt (SGI). See Table 2-9 on page 71 for interrupt assignments.

When the **MAINPEND** bit in the **Configuration and Control (CFGCTRL)** register (see page 120) is set, unprivileged software can access the **SWTRIG** register.

## Software Trigger Interrupt (SWTRIG)

Base 0xE000.E000

Offset 0xF00

Type WO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved										INTID					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	WO	WO	WO	WO	WO	WO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:0	INTID	WO	0x00	Interrupt ID This field holds the interrupt ID of the required SGI. For example, a value of 0x3 generates an interrupt on IRQ3.

**3.5 System Control Block (SCB) Register Descriptions**

This section lists and describes the System Control Block (SCB) registers, in numerical order by address offset. The SCB registers can only be accessed from privileged mode.

All registers must be accessed with aligned word accesses except for the **FAULTSTAT** and **SYSPRI1-SYSPRI3** registers, which can be accessed with byte or aligned halfword or word accesses. The processor does not support unaligned accesses to system control block registers.

**Register 26: CPU ID Base (CPUID), offset 0xD00**

**Note:** This register can only be accessed from privileged mode.

The **CPUID** register contains the ARM® Cortex™-M3 processor part number, version, and implementation information.

## CPU ID Base (CPUID)

Base 0xE000.E000

Offset 0xD00

Type RO, reset 0x411F.C231

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	IMP								VAR				CON			
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	PARTNO												REV			
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:24	IMP	RO	0x41	Implementer Code  Value Description 0x41 ARM
23:20	VAR	RO	0x1	Variant Number  Value Description 0x1 The rn value in the mpn product revision identifier, for example, the 1 in r1p1.
19:16	CON	RO	0xF	Constant  Value Description 0xF Always reads as 0xF.
15:4	PARTNO	RO	0xC23	Part Number  Value Description 0xC23 Cortex-M3 processor.
3:0	REV	RO	0x1	Revision Number  Value Description 0x1 The pn value in the mpn product revision identifier, for example, the 1 in r1p1.

**Register 27: Interrupt Control and State (INTCTRL), offset 0xD04**

**Note:** This register can only be accessed from privileged mode.

The **INCTRL** register provides a set-pending bit for the NMI exception, and set-pending and clear-pending bits for the PendSV and SysTick exceptions. In addition, bits in this register indicate the exception number of the exception being processed, whether there are preempted active exceptions, the exception number of the highest priority pending exception, and whether any interrupts are pending.

When writing to **INCTRL**, the effect is unpredictable when writing a 1 to both the **PENDSV** and **UNPENDSV** bits, or writing a 1 to both the **PENDSTSET** and **PENDSTCLR** bits.

**Interrupt Control and State (INTCTRL)**

Base 0xE000.E000

Offset 0xD04

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	NMISSET	reserved		PENDSV	UNPENDSV	PENDSTSET	PENDSTCLR	reserved	ISRPRE	ISRPEND	reserved			VECPEND		
Type	R/W	RO	RO	R/W	WO	R/W	WO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	VECPEND				RETBASE	reserved					VECACT					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
-----------	------	------	-------	-------------

31	NMISSET	R/W	0	NMI Set Pending
----	---------	-----	---	-----------------

Value Description

0	On a read, indicates an NMI exception is not pending. On a write, no effect.
---	---

1	On a read, indicates an NMI exception is pending. On a write, changes the NMI exception state to pending.
---	--

Because NMI is the highest-priority exception, normally the processor enters the NMI exception handler as soon as it registers the setting of this bit, and clears this bit on entering the interrupt handler. A read of this bit by the NMI exception handler returns 1 only if the **NMI** signal is reasserted while the processor is executing that handler.

30:29	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
-------	----------	----	-----	---

28	PENDSV	R/W	0	PendSV Set Pending
----	--------	-----	---	--------------------

Value Description

0	On a read, indicates a PendSV exception is not pending. On a write, no effect.
---	---

1	On a read, indicates a PendSV exception is pending. On a write, changes the PendSV exception state to pending.
---	---

Setting this bit is the only way to set the PendSV exception state to pending. This bit is cleared by writing a 1 to the **UNPENDSV** bit.

Bit/Field	Name	Type	Reset	Description
27	UNPENDSV	WO	0	<p>PendSV Clear Pending</p> <p>Value Description</p> <p>0 On a write, no effect.</p> <p>1 On a write, removes the pending state from the PendSV exception.</p> <p>This bit is write only; on a register read, its value is unknown.</p>
26	PENDSTSET	R/W	0	<p>SysTick Set Pending</p> <p>Value Description</p> <p>0 On a read, indicates a SysTick exception is not pending. On a write, no effect.</p> <p>1 On a read, indicates a SysTick exception is pending. On a write, changes the SysTick exception state to pending.</p> <p>This bit is cleared by writing a 1 to the PENDSTCLR bit.</p>
25	PENDSTCLR	WO	0	<p>SysTick Clear Pending</p> <p>Value Description</p> <p>0 On a write, no effect.</p> <p>1 On a write, removes the pending state from the SysTick exception.</p> <p>This bit is write only; on a register read, its value is unknown.</p>
24	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23	ISRPRE	RO	0	<p>Debug Interrupt Handling</p> <p>Value Description</p> <p>0 The release from halt does not take an interrupt.</p> <p>1 The release from halt takes an interrupt.</p> <p>This bit is only meaningful in Debug mode and reads as zero when the processor is not in Debug mode.</p>
22	ISRPEND	RO	0	<p>Interrupt Pending</p> <p>Value Description</p> <p>0 No interrupt is pending.</p> <p>1 An interrupt is pending.</p> <p>This bit provides status for all interrupts excluding NMI and Faults.</p>
21:18	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description																																						
17:12	VECPEND	RO	0x00	<p>Interrupt Pending Vector Number</p> <p>This field contains the exception number of the highest priority pending enabled exception. The value indicated by this field includes the effect of the <b>BASEPRI</b> and <b>FAULTMASK</b> registers, but not any effect of the <b>PRIMASK</b> register.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>No exceptions are pending</td></tr> <tr><td>0x01</td><td>Reserved</td></tr> <tr><td>0x02</td><td>NMI</td></tr> <tr><td>0x03</td><td>Hard fault</td></tr> <tr><td>0x04</td><td>Memory management fault</td></tr> <tr><td>0x05</td><td>Bus fault</td></tr> <tr><td>0x06</td><td>Usage fault</td></tr> <tr><td>0x07-0x0A</td><td>Reserved</td></tr> <tr><td>0x0B</td><td>SVCall</td></tr> <tr><td>0x0C</td><td>Reserved for Debug</td></tr> <tr><td>0x0D</td><td>Reserved</td></tr> <tr><td>0x0E</td><td>PendSV</td></tr> <tr><td>0x0F</td><td>SysTick</td></tr> <tr><td>0x10</td><td>Interrupt Vector 0</td></tr> <tr><td>0x11</td><td>Interrupt Vector 1</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>0x3B</td><td>Interrupt Vector 43</td></tr> <tr><td>0x3C-0x3F</td><td>Reserved</td></tr> </tbody> </table>	Value	Description	0x00	No exceptions are pending	0x01	Reserved	0x02	NMI	0x03	Hard fault	0x04	Memory management fault	0x05	Bus fault	0x06	Usage fault	0x07-0x0A	Reserved	0x0B	SVCall	0x0C	Reserved for Debug	0x0D	Reserved	0x0E	PendSV	0x0F	SysTick	0x10	Interrupt Vector 0	0x11	Interrupt Vector 1	...	...	0x3B	Interrupt Vector 43	0x3C-0x3F	Reserved
Value	Description																																									
0x00	No exceptions are pending																																									
0x01	Reserved																																									
0x02	NMI																																									
0x03	Hard fault																																									
0x04	Memory management fault																																									
0x05	Bus fault																																									
0x06	Usage fault																																									
0x07-0x0A	Reserved																																									
0x0B	SVCall																																									
0x0C	Reserved for Debug																																									
0x0D	Reserved																																									
0x0E	PendSV																																									
0x0F	SysTick																																									
0x10	Interrupt Vector 0																																									
0x11	Interrupt Vector 1																																									
...	...																																									
0x3B	Interrupt Vector 43																																									
0x3C-0x3F	Reserved																																									
11	RETBASE	RO	0	<p>Return to Base</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0</td><td>There are preempted active exceptions to execute.</td></tr> <tr><td>1</td><td>There are no active exceptions, or the currently executing exception is the only active exception.</td></tr> </tbody> </table> <p>This bit provides status for all interrupts excluding NMI and Faults. This bit only has meaning if the processor is currently executing an ISR (the <b>Interrupt Program Status (IPSR)</b> register is non-zero).</p>	Value	Description	0	There are preempted active exceptions to execute.	1	There are no active exceptions, or the currently executing exception is the only active exception.																																
Value	Description																																									
0	There are preempted active exceptions to execute.																																									
1	There are no active exceptions, or the currently executing exception is the only active exception.																																									
10:6	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																																						
5:0	VECACT	RO	0x00	<p>Interrupt Pending Vector Number</p> <p>This field contains the active exception number. The exception numbers can be found in the description for the <b>VECPEND</b> field. If this field is clear, the processor is in Thread mode. This field contains the same value as the <b>ISRNUM</b> field in the <b>IPSR</b> register.</p> <p>Subtract 16 from this value to obtain the IRQ number required to index into the <b>Interrupt Set Enable (ENn)</b>, <b>Interrupt Clear Enable (DISn)</b>, <b>Interrupt Set Pending (PENDn)</b>, <b>Interrupt Clear Pending (UNPENDn)</b>, and <b>Interrupt Priority (PRIn)</b> registers (see page 52).</p>																																						

**Register 28: Vector Table Offset (VTABLE), offset 0xD08**

**Note:** This register can only be accessed from privileged mode.

The **VTABLE** register indicates the offset of the vector table base address from memory address 0x0000.0000.

## Vector Table Offset (VTABLE)

Base 0xE000.E000

Offset 0xD08

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved		BASE	OFFSET												
Type	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	OFFSET								reserved							
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:30	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
29	BASE	R/W	0	Vector Table Base  Value Description 0 The vector table is in the code memory region. 1 The vector table is in the SRAM memory region.
28:8	OFFSET	R/W	0x000.00	Vector Table Offset  When configuring the <i>OFFSET</i> field, the offset must be aligned to the number of exception entries in the vector table. Because there are 43 interrupts, the offset must be aligned on a 256-byte boundary.
7:0	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 29: Application Interrupt and Reset Control (APINT), offset 0xD0C

**Note:** This register can only be accessed from privileged mode.

The **APINT** register provides priority grouping control for the exception model, endian status for data accesses, and reset control of the system. To write to this register, 0x05FA must be written to the **VECTKEY** field, otherwise the write is ignored.

The **PRIGROUP** field indicates the position of the binary point that splits the **INTx** fields in the **Interrupt Priority (PRIx)** registers into separate group priority and subpriority fields. Table 3-8 on page 116 shows how the **PRIGROUP** value controls this split. The bit numbers in the Group Priority Field and Subpriority Field columns in the table refer to the bits in the **INTA** field. For the **INTB** field, the corresponding bits are 15:13; for **INTC**, 23:21; and for **INTD**, 31:29.

**Note:** Determining preemption of an exception uses only the group priority field.

**Table 3-8. Interrupt Priority Levels**

PRIGROUP Bit Field	Binary Point <sup>a</sup>	Group Priority Field	Subpriority Field	Group Priorities	Subpriorities
0x0 - 0x4	bxxx.	[7:5]	None	8	1
0x5	bxx.y	[7:6]	[5]	4	2
0x6	bx.yy	[7]	[6:5]	2	4
0x7	b.yyy	None	[7:5]	1	8

a. **INTx** field showing the binary point. An x denotes a group priority field bit, and a y denotes a subpriority field bit.

### Application Interrupt and Reset Control (APINT)

Base 0xE000.E000

Offset 0xD0C

Type R/W, reset 0xFA05.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	VECTKEY															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	0	1	0	0	0	0	0	0	1	0	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ENDIANESS	reserved				PRIGROUP				reserved				SYSRESREQ	VECTLRACT	VECTRESET
Type	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO	WO	WO	WO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	VECTKEY	R/W	0xFA05	Register Key This field is used to guard against accidental writes to this register. 0x05FA must be written to this field in order to change the bits in this register. On a read, 0xFA05 is returned.
15	ENDIANESS	RO	0	Data Endianess The Stellaris implementation uses only little-endian mode so this is cleared to 0.
14:11	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
10:8	PRIGROUP	R/W	0x0	Interrupt Priority Grouping This field determines the split of group priority from subpriority (see Table 3-8 on page 116 for more information).
7:3	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2	SYSRESREQ	WO	0	System Reset Request  Value Description 0 No effect. 1 Resets the core and all on-chip peripherals except the Debug interface.  This bit is automatically cleared during the reset of the core and reads as 0.
1	VECTCLRACT	WO	0	Clear Active NMI / Fault This bit is reserved for Debug use and reads as 0. This bit must be written as a 0, otherwise behavior is unpredictable.
0	VECTRESET	WO	0	System Reset This bit is reserved for Debug use and reads as 0. This bit must be written as a 0, otherwise behavior is unpredictable.

**Register 30: System Control (SYSCTRL), offset 0xD10**

**Note:** This register can only be accessed from privileged mode.

The **SYSCTRL** register controls features of entry to and exit from low-power state.

**System Control (SYSCTRL)**

Base 0xE000.E000

Offset 0xD10

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												SEVONPEND	reserved	SLEEPDEEP	SLEEPEXIT	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	R/W	R/W	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:5	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SEVONPEND	R/W	0	<p>Wake Up on Pending</p> <p>Value Description</p> <p>0 Only enabled interrupts or events can wake up the processor; disabled interrupts are excluded.</p> <p>1 Enabled events and all interrupts, including disabled interrupts, can wake up the processor.</p> <p>When an event or interrupt enters the pending state, the event signal wakes up the processor from <i>WFE</i>. If the processor is not waiting for an event, the event is registered and affects the next <i>WFE</i>. The processor also wakes up on execution of a <i>SEV</i> instruction or an external event.</p>
3	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2	SLEEPDEEP	R/W	0	<p>Deep Sleep Enable</p> <p>Value Description</p> <p>0 Use Sleep mode as the low power mode.</p> <p>1 Use Deep-sleep mode as the low power mode.</p>

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Bit/Field	Name	Type	Reset	Description
1	SLEEPEXIT	R/W	0	Sleep on ISR Exit  Value Description 0 When returning from Handler mode to Thread mode, do not sleep when returning to Thread mode. 1 When returning from Handler mode to Thread mode, enter sleep or deep sleep on return from an ISR.  Setting this bit enables an interrupt-driven application to avoid returning to an empty main application.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 31: Configuration and Control (CFGCTRL), offset 0xD14**

**Note:** This register can only be accessed from privileged mode.

The **CFGCTRL** register controls entry to Thread mode and enables: the handlers for NMI, hard fault and faults escalated by the **FAULTMASK** register to ignore bus faults; trapping of divide by zero and unaligned accesses; and access to the **SWTRIG** register by unprivileged software (see page 110).

## Configuration and Control (CFGCTRL)

Base 0xE000.E000

Offset 0xD14

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved						STKALIGN	BHFHNMIGN	reserved				DIV0	UNALIGNED	reserved	MAINPEND	BASETHR
Type	RO	RO	RO	RO	RO	RO	R/W	R/W	RO	RO	RO	R/W	R/W	RO	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:10	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
9	STKALIGN	R/W	0	Stack Alignment on Exception Entry  Value Description 0 The stack is 4-byte aligned. 1 The stack is 8-byte aligned.  On exception entry, the processor uses bit 9 of the stacked <b>PSR</b> to indicate the stack alignment. On return from the exception, it uses this stacked bit to restore the correct stack alignment.
8	BHFHNMIGN	R/W	0	Ignore Bus Fault in NMI and Fault  This bit enables handlers with priority -1 or -2 to ignore data bus faults caused by load and store instructions. The setting of this bit applies to the hard fault, NMI, and <b>FAULTMASK</b> escalated handlers.  Value Description 0 Data bus faults caused by load and store instructions cause a lock-up. 1 Handlers running at priority -1 and -2 ignore data bus faults caused by load and store instructions.  Set this bit only when the handler and its data are in absolutely safe memory. The normal use of this bit is to probe system devices and bridges to detect control path problems and fix them.
7:5	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
4	DIV0	R/W	0	<p>Trap on Divide by 0</p> <p>This bit enables faulting or halting when the processor executes an <i>SDIV</i> or <i>UDIV</i> instruction with a divisor of 0.</p> <p>Value Description</p> <p>0 Do not trap on divide by 0. A divide by zero returns a quotient of 0.</p> <p>1 Trap on divide by 0.</p>
3	UNALIGNED	R/W	0	<p>Trap on Unaligned Access</p> <p>Value Description</p> <p>0 Do not trap on unaligned halfword and word accesses.</p> <p>1 Trap on unaligned halfword and word accesses. An unaligned access generates a usage fault.</p> <p>Unaligned <i>LDM</i>, <i>STM</i>, <i>LDRD</i>, and <i>STRD</i> instructions always fault regardless of whether <i>UNALIGNED</i> is set.</p>
2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	MAINPEND	R/W	0	<p>Allow Main Interrupt Trigger</p> <p>Value Description</p> <p>0 Disables unprivileged software access to the <b>SWTRIG</b> register.</p> <p>1 Enables unprivileged software access to the <b>SWTRIG</b> register (see page 110).</p>
0	BASETHR	R/W	0	<p>Thread State Control</p> <p>Value Description</p> <p>0 The processor can enter Thread mode only when no exception is active.</p> <p>1 The processor can enter Thread mode from any level under the control of an <i>EXC_RETURN</i> value (see "Exception Return" on page 75 for more information).</p>

**Register 32: System Handler Priority 1 (SYSPRI1), offset 0xD18**

**Note:** This register can only be accessed from privileged mode.

The **SYSPRI1** register configures the priority level, 0 to 7 of the usage fault, bus fault, and memory management fault exception handlers. This register is byte-accessible.

## System Handler Priority 1 (SYSPRI1)

Base 0xE000.E000

Offset 0xD18

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved								USAGE			reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	BUS			reserved					MEM			reserved				
Type	R/W	R/W	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:24	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:21	USAGE	R/W	0x0	Usage Fault Priority This field configures the priority level of the usage fault. Configurable priority values are in the range 0-7, with lower values having higher priority.
20:16	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:13	BUS	R/W	0x0	Bus Fault Priority This field configures the priority level of the bus fault. Configurable priority values are in the range 0-7, with lower values having higher priority.
12:8	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:5	MEM	R/W	0x0	Memory Management Fault Priority This field configures the priority level of the memory management fault. Configurable priority values are in the range 0-7, with lower values having higher priority.
4:0	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 33: System Handler Priority 2 (SYSPRI2), offset 0xD1C**

**Note:** This register can only be accessed from privileged mode.

The **SYSPRI2** register configures the priority level, 0 to 7 of the SVCcall handler. This register is byte-accessible.

**System Handler Priority 2 (SYSPRI2)**

Base 0xE000.E000

Offset 0xD1C

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	SVC			reserved												
Type	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:29	SVC	R/W	0x0	SVCcall Priority This field configures the priority level of SVCcall. Configurable priority values are in the range 0-7, with lower values having higher priority.
28:0	reserved	RO	0x000.0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 34: System Handler Priority 3 (SYSPRI3), offset 0xD20**

**Note:** This register can only be accessed from privileged mode.

The **SYSPRI3** register configures the priority level, 0 to 7 of the SysTick exception and PendSV handlers. This register is byte-accessible.

## System Handler Priority 3 (SYSPRI3)

Base 0xE000.E000

Offset 0xD20

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	TICK			reserved					PENDSV			reserved				
Type	R/W	R/W	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DEBUG			reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:29	TICK	R/W	0x0	SysTick Exception Priority This field configures the priority level of the SysTick exception. Configurable priority values are in the range 0-7, with lower values having higher priority.
28:24	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:21	PENDSV	R/W	0x0	PendSV Priority This field configures the priority level of PendSV. Configurable priority values are in the range 0-7, with lower values having higher priority.
20:8	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:5	DEBUG	R/W	0x0	Debug Priority This field configures the priority level of Debug. Configurable priority values are in the range 0-7, with lower values having higher priority.
4:0	reserved	RO	0x0.0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 35: System Handler Control and State (SYSHNDCTRL), offset 0xD24**

**Note:** This register can only be accessed from privileged mode.

The **SYSHNDCTRL** register enables the system handlers, and indicates the pending status of the usage fault, bus fault, memory management fault, and SVC exceptions as well as the active status of the system handlers.

If a system handler is disabled and the corresponding fault occurs, the processor treats the fault as a hard fault.

This register can be modified to change the pending or active status of system exceptions. An OS kernel can write to the active bits to perform a context switch that changes the current exception type.

**Caution – Software that changes the value of an active bit in this register without correct adjustment to the stacked content can cause the processor to generate a fault exception. Ensure software that writes to this register retains and subsequently restores the current active status.**

**If the value of a bit in this register must be modified after enabling the system handlers, a read-modify-write procedure must be used to ensure that only the required bit is modified.**

## System Handler Control and State (SYSHNDCTRL)

Base 0xE000.E000

Offset 0xD24

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved													USAGE	BUS	MEM
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	SVC	BUSP	MEMP	USAGEP	TICK	PNDSV	reserved	MON	SVCA	reserved			USGA	reserved	BUSA	MEMA
Type	R/W	R/W	R/W	R/W	R/W	R/W	RO	R/W	R/W	RO	RO	RO	R/W	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:19	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	USAGE	R/W	0	Usage Fault Enable  Value Description 0 Disables the usage fault exception. 1 Enables the usage fault exception.
17	BUS	R/W	0	Bus Fault Enable  Value Description 0 Disables the bus fault exception. 1 Enables the bus fault exception.

Bit/Field	Name	Type	Reset	Description
16	MEM	R/W	0	<p>Memory Management Fault Enable</p> <p>Value Description</p> <p>0 Disables the memory management fault exception.</p> <p>1 Enables the memory management fault exception.</p>
15	SVC	R/W	0	<p>SVC Call Pending</p> <p>Value Description</p> <p>0 An SVC call exception is not pending.</p> <p>1 An SVC call exception is pending.</p> <p>This bit can be modified to change the pending status of the SVC call exception.</p>
14	BUSP	R/W	0	<p>Bus Fault Pending</p> <p>Value Description</p> <p>0 A bus fault exception is not pending.</p> <p>1 A bus fault exception is pending.</p> <p>This bit can be modified to change the pending status of the bus fault exception.</p>
13	MEMP	R/W	0	<p>Memory Management Fault Pending</p> <p>Value Description</p> <p>0 A memory management fault exception is not pending.</p> <p>1 A memory management fault exception is pending.</p> <p>This bit can be modified to change the pending status of the memory management fault exception.</p>
12	USAGEP	R/W	0	<p>Usage Fault Pending</p> <p>Value Description</p> <p>0 A usage fault exception is not pending.</p> <p>1 A usage fault exception is pending.</p> <p>This bit can be modified to change the pending status of the usage fault exception.</p>
11	TICK	R/W	0	<p>SysTick Exception Active</p> <p>Value Description</p> <p>0 A SysTick exception is not active.</p> <p>1 A SysTick exception is active.</p> <p>This bit can be modified to change the active status of the SysTick exception, however, see the Caution above before setting this bit.</p>

Bit/Field	Name	Type	Reset	Description
10	PNDV	R/W	0	<p>PendSV Exception Active</p> <p>Value Description</p> <p>0 A PendSV exception is not active.</p> <p>1 A PendSV exception is active.</p> <p>This bit can be modified to change the active status of the PendSV exception, however, see the Caution above before setting this bit.</p>
9	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
8	MON	R/W	0	<p>Debug Monitor Active</p> <p>Value Description</p> <p>0 The Debug monitor is not active.</p> <p>1 The Debug monitor is active.</p>
7	SVCA	R/W	0	<p>SVC Call Active</p> <p>Value Description</p> <p>0 SVC call is not active.</p> <p>1 SVC call is active.</p> <p>This bit can be modified to change the active status of the SVC call exception, however, see the Caution above before setting this bit.</p>
6:4	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	USGA	R/W	0	<p>Usage Fault Active</p> <p>Value Description</p> <p>0 Usage fault is not active.</p> <p>1 Usage fault is active.</p> <p>This bit can be modified to change the active status of the usage fault exception, however, see the Caution above before setting this bit.</p>
2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	BUSA	R/W	0	<p>Bus Fault Active</p> <p>Value Description</p> <p>0 Bus fault is not active.</p> <p>1 Bus fault is active.</p> <p>This bit can be modified to change the active status of the bus fault exception, however, see the Caution above before setting this bit.</p>

Bit/Field	Name	Type	Reset	Description
0	MEMA	R/W	0	Memory Management Fault Active
				Value Description
				0 Memory management fault is not active.
				1 Memory management fault is active.
				This bit can be modified to change the active status of the memory management fault exception, however, see the Caution above before setting this bit.

## Register 36: Configurable Fault Status (FAULTSTAT), offset 0xD28

**Note:** This register can only be accessed from privileged mode.

The **FAULTSTAT** register indicates the cause of a memory management fault, bus fault, or usage fault. Each of these functions is assigned to a subregister as follows:

- **Usage Fault Status (UFAULTSTAT)**, bits 31:16
- **Bus Fault Status (BFAULTSTAT)**, bits 15:8
- **Memory Management Fault Status (MFAULTSTAT)**, bits 7:0

**FAULTSTAT** is byte accessible. **FAULTSTAT** or its subregisters can be accessed as follows:

- The complete **FAULTSTAT** register, with a word access to offset 0xD28
- The **MFAULTSTAT**, with a byte access to offset 0xD28
- The **MFAULTSTAT** and **BFAULTSTAT**, with a halfword access to offset 0xD28
- The **BFAULTSTAT**, with a byte access to offset 0xD29
- The **UFAULTSTAT**, with a halfword access to offset 0xD2A

Bits are cleared by writing a 1 to them.

In a fault handler, the true faulting address can be determined by:

1. Read and save the **Memory Management Fault Address (MMADDR)** or **Bus Fault Address (FAULTADDR)** value.
2. Read the **MMARV** bit in **MFAULTSTAT**, or the **BFARV** bit in **BFAULTSTAT** to determine if the **MMADDR** or **FAULTADDR** contents are valid.

Software must follow this sequence because another higher priority exception might change the **MMADDR** or **FAULTADDR** value. For example, if a higher priority handler preempts the current fault handler, the other fault might change the **MMADDR** or **FAULTADDR** value.

### Configurable Fault Status (FAULTSTAT)

Base 0xE000.E000

Offset 0xD28

Type R/W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved						DIV0	UNALIGN	reserved				NOCP	INVPC	INVSTAT	UNDEF
Type	RO	RO	RO	RO	RO	RO	R/W1C	R/W1C	RO	RO	RO	RO	R/W1C	R/W1C	R/W1C	R/W1C
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	BFARV	reserved		BSTKE	BUSTKE	IMPRE	PRECISE	IBUS	MMARV	reserved		MSTKE	MUSTKE	reserved	DERR	IERR
Type	R/W1C	RO	RO	R/W1C	R/W1C	R/W1C	R/W1C	R/W1C	R/W1C	RO	RO	R/W1C	R/W1C	RO	R/W1C	R/W1C
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:26	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
25	DIV0	R/W1C	0	<p>Divide-by-Zero Usage Fault</p> <p>Value Description</p> <p>0 No divide-by-zero fault has occurred, or divide-by-zero trapping is not enabled.</p> <p>1 The processor has executed an <code>SDIV</code> or <code>UDIV</code> instruction with a divisor of 0.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the instruction that performed the divide by zero.</p> <p>Trapping on divide-by-zero is enabled by setting the <code>DIV0</code> bit in the <b>Configuration and Control (CFGCTRL)</b> register (see page 120).</p> <p>This bit is cleared by writing a 1 to it.</p>
24	UNALIGN	R/W1C	0	<p>Unaligned Access Usage Fault</p> <p>Value Description</p> <p>0 No unaligned access fault has occurred, or unaligned access trapping is not enabled.</p> <p>1 The processor has made an unaligned memory access.</p> <p>Unaligned <code>LDM</code>, <code>STM</code>, <code>LDRD</code>, and <code>STRD</code> instructions always fault regardless of the configuration of this bit.</p> <p>Trapping on unaligned access is enabled by setting the <code>UNALIGNED</code> bit in the <b>CFGCTRL</b> register (see page 120).</p> <p>This bit is cleared by writing a 1 to it.</p>
23:20	reserved	RO	0x00	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>
19	NOCP	R/W1C	0	<p>No Coprocessor Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by attempting to access a coprocessor.</p> <p>1 The processor has attempted to access a coprocessor.</p> <p>This bit is cleared by writing a 1 to it.</p>
18	INVPC	R/W1C	0	<p>Invalid PC Load Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by attempting to load an invalid <b>PC</b> value.</p> <p>1 The processor has attempted an illegal load of <code>EXC_RETURN</code> to the <b>PC</b> as a result of an invalid context or an invalid <code>EXC_RETURN</code> value.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the instruction that tried to perform the illegal load of the <b>PC</b>.</p> <p>This bit is cleared by writing a 1 to it.</p>

Bit/Field	Name	Type	Reset	Description
17	INVSTAT	R/W1C	0	<p>Invalid State Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by an invalid state.</p> <p>1 The processor has attempted to execute an instruction that makes illegal use of the <b>EPSR</b> register.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the instruction that attempted the illegal use of the <b>Execution Program Status Register (EPSR)</b> register.</p> <p>This bit is not set if an undefined instruction uses the <b>EPSR</b> register. This bit is cleared by writing a 1 to it.</p>
16	UNDEF	R/W1C	0	<p>Undefined Instruction Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by an undefined instruction.</p> <p>1 The processor has attempted to execute an undefined instruction.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the undefined instruction.</p> <p>An undefined instruction is an instruction that the processor cannot decode.</p> <p>This bit is cleared by writing a 1 to it.</p>
15	BFARV	R/W1C	0	<p>Bus Fault Address Register Valid</p> <p>Value Description</p> <p>0 The value in the <b>Bus Fault Address (FAULTADDR)</b> register is not a valid fault address.</p> <p>1 The <b>FAULTADDR</b> register is holding a valid fault address.</p> <p>This bit is set after a bus fault, where the address is known. Other faults can clear this bit, such as a memory management fault occurring later. If a bus fault occurs and is escalated to a hard fault because of priority, the hard fault handler must clear this bit. This action prevents problems if returning to a stacked active bus fault handler whose <b>FAULTADDR</b> register value has been overwritten.</p> <p>This bit is cleared by writing a 1 to it.</p>
14:13	reserved	RO	0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>

Bit/Field	Name	Type	Reset	Description
12	BSTKE	R/W1C	0	<p>Stack Bus Fault</p> <p>Value Description</p> <p>0 No bus fault has occurred on stacking for exception entry.</p> <p>1 Stacking for an exception entry has caused one or more bus faults.</p> <p>When this bit is set, the <b>SP</b> is still adjusted but the values in the context area on the stack might be incorrect. A fault address is not written to the <b>FAULTADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>
11	BUSTKE	R/W1C	0	<p>Unstack Bus Fault</p> <p>Value Description</p> <p>0 No bus fault has occurred on unstacking for a return from exception.</p> <p>1 Unstacking for a return from exception has caused one or more bus faults.</p> <p>This fault is chained to the handler. Thus, when this bit is set, the original return stack is still present. The <b>SP</b> is not adjusted from the failing return, a new save is not performed, and a fault address is not written to the <b>FAULTADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>
10	IMPRE	R/W1C	0	<p>Imprecise Data Bus Error</p> <p>Value Description</p> <p>0 An imprecise data bus error has not occurred.</p> <p>1 A data bus error has occurred, but the return address in the stack frame is not related to the instruction that caused the error.</p> <p>When this bit is set, a fault address is not written to the <b>FAULTADDR</b> register.</p> <p>This fault is asynchronous. Therefore, if the fault is detected when the priority of the current process is higher than the bus fault priority, the bus fault becomes pending and becomes active only when the processor returns from all higher-priority processes. If a precise fault occurs before the processor enters the handler for the imprecise bus fault, the handler detects that both the <b>IMPRE</b> bit is set and one of the precise fault status bits is set.</p> <p>This bit is cleared by writing a 1 to it.</p>
9	PRECISE	R/W1C	0	<p>Precise Data Bus Error</p> <p>Value Description</p> <p>0 A precise data bus error has not occurred.</p> <p>1 A data bus error has occurred, and the <b>PC</b> value stacked for the exception return points to the instruction that caused the fault.</p> <p>When this bit is set, the fault address is written to the <b>FAULTADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>

Bit/Field	Name	Type	Reset	Description
8	IBUS	R/W1C	0	<p>Instruction Bus Error</p> <p>Value Description</p> <p>0 An instruction bus error has not occurred.</p> <p>1 An instruction bus error has occurred.</p> <p>The processor detects the instruction bus error on prefetching an instruction, but sets this bit only if it attempts to issue the faulting instruction.</p> <p>When this bit is set, a fault address is not written to the <b>FAULTADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>
7	MMARV	R/W1C	0	<p>Memory Management Fault Address Register Valid</p> <p>Value Description</p> <p>0 The value in the <b>Memory Management Fault Address (MMADDR)</b> register is not a valid fault address.</p> <p>1 The <b>MMADDR</b> register is holding a valid fault address.</p> <p>If a memory management fault occurs and is escalated to a hard fault because of priority, the hard fault handler must clear this bit. This action prevents problems if returning to a stacked active memory management fault handler whose <b>MMADDR</b> register value has been overwritten.</p> <p>This bit is cleared by writing a 1 to it.</p>
6:5	reserved	RO	0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>
4	MSTKE	R/W1C	0	<p>Stack Access Violation</p> <p>Value Description</p> <p>0 No memory management fault has occurred on stacking for exception entry.</p> <p>1 Stacking for an exception entry has caused one or more access violations.</p> <p>When this bit is set, the <b>SP</b> is still adjusted but the values in the context area on the stack might be incorrect. A fault address is not written to the <b>MMADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>

Bit/Field	Name	Type	Reset	Description
3	MUSTKE	R/W1C	0	<p>Unstack Access Violation</p> <p>Value Description</p> <p>0 No memory management fault has occurred on unstacking for a return from exception.</p> <p>1 Unstacking for a return from exception has caused one or more access violations.</p> <p>This fault is chained to the handler. Thus, when this bit is set, the original return stack is still present. The <b>SP</b> is not adjusted from the failing return, a new save is not performed, and a fault address is not written to the <b>MMADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>
2	reserved	RO	0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>
1	DERR	R/W1C	0	<p>Data Access Violation</p> <p>Value Description</p> <p>0 A data access violation has not occurred.</p> <p>1 The processor attempted a load or store at a location that does not permit the operation.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the faulting instruction and the address of the attempted access is written to the <b>MMADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>
0	IERR	R/W1C	0	<p>Instruction Access Violation</p> <p>Value Description</p> <p>0 An instruction access violation has not occurred.</p> <p>1 The processor attempted an instruction fetch from a location that does not permit execution.</p> <p>This fault occurs on any access to an XN region, even when the MPU is disabled or not present.</p> <p>When this bit is set, the <b>PC</b> value stacked for the exception return points to the faulting instruction and the address of the attempted access is not written to the <b>MMADDR</b> register.</p> <p>This bit is cleared by writing a 1 to it.</p>

**Register 37: Hard Fault Status (HFAULTSTAT), offset 0xD2C**

**Note:** This register can only be accessed from privileged mode.

The **HFAULTSTAT** register gives information about events that activate the hard fault handler.

Bits are cleared by writing a 1 to them.

**Hard Fault Status (HFAULTSTAT)**

Base 0xE000.E000

Offset 0xD2C

Type R/W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	DBG	FORCED	reserved														
Type	R/W1C	R/W1C	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved														VECT	reserved	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W1C	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31	DBG	R/W1C	0	Debug Event This bit is reserved for Debug use. This bit must be written as a 0, otherwise behavior is unpredictable.
30	FORCED	R/W1C	0	Forced Hard Fault  Value Description 0 No forced hard fault has occurred. 1 A forced hard fault has been generated by escalation of a fault with configurable priority that cannot be handled, either because of priority or because it is disabled.  When this bit is set, the hard fault handler must read the other fault status registers to find the cause of the fault. This bit is cleared by writing a 1 to it.
29:2	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	VECT	R/W1C	0	Vector Table Read Fault  Value Description 0 No bus fault has occurred on a vector table read. 1 A bus fault occurred on a vector table read.  This error is always handled by the hard fault handler. When this bit is set, the <b>PC</b> value stacked for the exception return points to the instruction that was preempted by the exception. This bit is cleared by writing a 1 to it.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 38: Memory Management Fault Address (MMADDR), offset 0xD34**

**Note:** This register can only be accessed from privileged mode.

The **MMADDR** register contains the address of the location that generated a memory management fault. When an unaligned access faults, the address in the **MMADDR** register is the actual address that faulted. Because a single read or write instruction can be split into multiple aligned accesses, the fault address can be any address in the range of the requested access size. Bits in the **Memory Management Fault Status (MFAULTSTAT)** register indicate the cause of the fault and whether the value in the **MMADDR** register is valid (see page 129).

## Memory Management Fault Address (MMADDR)

Base 0xE000.E000

Offset 0xD34

Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	ADDR															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDR															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:0	ADDR	R/W	-	Fault Address When the <b>MMARV</b> bit of <b>MFAULTSTAT</b> is set, this field holds the address of the location that generated the memory management fault.

## Register 39: Bus Fault Address (FAULTADDR), offset 0xD38

**Note:** This register can only be accessed from privileged mode.

The **FAULTADDR** register contains the address of the location that generated a bus fault. When an unaligned access faults, the address in the **FAULTADDR** register is the one requested by the instruction, even if it is not the address of the fault. Bits in the **Bus Fault Status (BFAULTSTAT)** register indicate the cause of the fault and whether the value in the **FAULTADDR** register is valid (see page 129).

### Bus Fault Address (FAULTADDR)

Base 0xE000.E000

Offset 0xD38

Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	ADDR															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDR															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:0	ADDR	R/W	-	Fault Address When the <b>FAULTADDRV</b> bit of <b>BFAULTSTAT</b> is set, this field holds the address of the location that generated the bus fault.

## 3.6 Memory Protection Unit (MPU) Register Descriptions

This section lists and describes the Memory Protection Unit (MPU) registers, in numerical order by address offset.

The MPU registers can only be accessed from privileged mode.

**Register 40: MPU Type (MPUTYPE), offset 0xD90**

**Note:** This register can only be accessed from privileged mode.

The **MPUTYPE** register indicates whether the MPU is present, and if so, how many regions it supports.

**MPU Type (MPUTYPE)**

Base 0xE000.E000

Offset 0xD90

Type RO, reset 0x0000.0800

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved								IREGION							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DREGION								reserved							SEPARATE
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:24	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
23:16	IREGION	RO	0x00	Number of I Regions This field indicates the number of supported MPU instruction regions. This field always contains 0x00. The MPU memory map is unified and is described by the DREGION field.
15:8	DREGION	RO	0x08	Number of D Regions  Value Description 0x08 Indicates there are eight supported MPU data regions.
7:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	SEPARATE	RO	0	Separate or Unified MPU  Value Description 0 Indicates the MPU is unified.

**Register 41: MPU Control (MPUCTRL), offset 0xD94**

**Note:** This register can only be accessed from privileged mode.

The **MPUCTRL** register enables the MPU, enables the default memory map background region, and enables use of the MPU when in the hard fault, Non-maskable Interrupt (NMI), and **Fault Mask Register (FAULTMASK)** escalated handlers.

When the `ENABLE` and `PRIVDEFEN` bits are both set:

- For privileged accesses, the default memory map is as described in “Memory Model” on page 60. Any access by privileged software that does not address an enabled memory region behaves as defined by the default memory map.
- Any access by unprivileged software that does not address an enabled memory region causes a memory management fault.

Execute Never (XN) and Strongly Ordered rules always apply to the System Control Space regardless of the value of the `ENABLE` bit.

When the `ENABLE` bit is set, at least one region of the memory map must be enabled for the system to function unless the `PRIVDEFEN` bit is set. If the `PRIVDEFEN` bit is set and no regions are enabled, then only privileged software can operate.

When the `ENABLE` bit is clear, the system uses the default memory map, which has the same memory attributes as if the MPU is not implemented (see Table 2-5 on page 62 for more information). The default memory map applies to accesses from both privileged and unprivileged software.

When the MPU is enabled, accesses to the System Control Space and vector table are always permitted. Other areas are accessible based on regions and whether `PRIVDEFEN` is set.

Unless `HFNMIEANA` is set, the MPU is not enabled when the processor is executing the handler for an exception with priority –1 or –2. These priorities are only possible when handling a hard fault or NMI exception or when **FAULTMASK** is enabled. Setting the `HFNMIEANA` bit enables the MPU when operating with these two priorities.

**MPU Control (MPUCTRL)**

Base 0xE000.E000

Offset 0xD94

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved													PRIVDEFEN	HFNMIEANA	ENABLE	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:3	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
2	PRIVDEFEN	R/W	0	<p>MPU Default Region</p> <p>This bit enables privileged software access to the default memory map.</p> <p>Value Description</p> <p>0 If the MPU is enabled, this bit disables use of the default memory map. Any memory access to a location not covered by any enabled region causes a fault.</p> <p>1 If the MPU is enabled, this bit enables use of the default memory map as a background region for privileged software accesses.</p> <p>When this bit is set, the background region acts as if it is region number -1. Any region that is defined and enabled has priority over this default map.</p> <p>If the MPU is disabled, the processor ignores this bit.</p>
1	HFNMIENA	R/W	0	<p>MPU Enabled During Faults</p> <p>This bit controls the operation of the MPU during hard fault, NMI, and <b>FAULTMASK</b> handlers.</p> <p>Value Description</p> <p>0 The MPU is disabled during hard fault, NMI, and <b>FAULTMASK</b> handlers, regardless of the value of the <i>ENABLE</i> bit.</p> <p>1 The MPU is enabled during hard fault, NMI, and <b>FAULTMASK</b> handlers.</p> <p>When the MPU is disabled and this bit is set, the resulting behavior is unpredictable.</p>
0	ENABLE	R/W	0	<p>MPU Enable</p> <p>Value Description</p> <p>0 The MPU is disabled.</p> <p>1 The MPU is enabled.</p> <p>When the MPU is disabled and the <i>HFNMIENA</i> bit is set, the resulting behavior is unpredictable.</p>

**Register 42: MPU Region Number (MPUNUMBER), offset 0xD98**

**Note:** This register can only be accessed from privileged mode.

The **MPUNUMBER** register selects which memory region is referenced by the **MPU Region Base Address (MPUBASE)** and **MPU Region Attribute and Size (MPUATTR)** registers. Normally, the required region number should be written to this register before accessing the **MPUBASE** or the **MPUATTR** register. However, the region number can be changed by writing to the **MPUBASE** register with the **VALID** bit set (see page 142). This write updates the value of the **REGION** field.

**MPU Region Number (MPUNUMBER)**

Base 0xE000.E000

Offset 0xD98

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved													NUMBER			
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:3	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2:0	NUMBER	R/W	0x0	MPU Region to Access This field indicates the MPU region referenced by the <b>MPUBASE</b> and <b>MPUATTR</b> registers. The MPU supports eight memory regions.

**Register 43: MPU Region Base Address (MPUBASE), offset 0xD9C****Register 44: MPU Region Base Address Alias 1 (MPUBASE1), offset 0xDA4****Register 45: MPU Region Base Address Alias 2 (MPUBASE2), offset 0xDAC****Register 46: MPU Region Base Address Alias 3 (MPUBASE3), offset 0xDB4**

**Note:** This register can only be accessed from privileged mode.

The **MPUBASE** register defines the base address of the MPU region selected by the **MPU Region Number (MPUNUMBER)** register and can update the value of the **MPUNUMBER** register. To change the current region number and update the **MPUNUMBER** register, write the **MPUBASE** register with the **VALID** bit set.

The **ADDR** field is bits 31:*N* of the **MPUBASE** register. Bits (*N*-1):5 are reserved. The region size, as specified by the **SIZE** field in the **MPU Region Attribute and Size (MPUATTR)** register, defines the value of *N* where:

$$N = \text{Log}_2(\text{Region size in bytes})$$

If the region size is configured to 4 GB in the **MPUATTR** register, there is no valid **ADDR** field. In this case, the region occupies the complete memory map, and the base address is 0x0000.0000.

The base address is aligned to the size of the region. For example, a 64-KB region must be aligned on a multiple of 64 KB, for example, at 0x0001.0000 or 0x0002.0000.

**MPU Region Base Address (MPUBASE)**

Base 0xE000.E000

Offset 0xD9C

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	ADDR																
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	ADDR												VALID	reserved	REGION		
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	WO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:5	ADDR	R/W	0x0000.000	<p>Base Address Mask</p> <p>Bits 31:<i>N</i> in this field contain the region base address. The value of <i>N</i> depends on the region size, as shown above. The remaining bits (<i>N</i>-1):5 are reserved.</p> <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>

Bit/Field	Name	Type	Reset	Description
4	VALID	WO	0	<p>Region Number Valid</p> <p>Value Description</p> <p>0 The <b>MPUNUMBER</b> register is not changed and the processor updates the base address for the region specified in the <b>MPUNUMBER</b> register and ignores the value of the <b>REGION</b> field.</p> <p>1 The <b>MPUNUMBER</b> register is updated with the value of the <b>REGION</b> field and the base address is updated for the region specified in the <b>REGION</b> field.</p> <p>This bit is always read as 0.</p>
3	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2:0	REGION	R/W	0x0	<p>Region Number</p> <p>On a write, contains the value to be written to the <b>MPUNUMBER</b> register. On a read, returns the current region number in the <b>MPUNUMBER</b> register.</p>

**Register 47: MPU Region Attribute and Size (MPUATTR), offset 0xDA0****Register 48: MPU Region Attribute and Size Alias 1 (MPUATTR1), offset 0xDA8****Register 49: MPU Region Attribute and Size Alias 2 (MPUATTR2), offset 0xDB0****Register 50: MPU Region Attribute and Size Alias 3 (MPUATTR3), offset 0xDB8**

**Note:** This register can only be accessed from privileged mode.

The **MPUATTR** register defines the region size and memory attributes of the MPU region specified by the **MPU Region Number (MPUNUMBER)** register and enables that region and any subregions.

The **MPUATTR** register is accessible using word or halfword accesses with the most-significant halfword holding the region attributes and the least-significant halfword holds the region size and the region and subregion enable bits.

The MPU access permission attribute bits, **XN**, **AP**, **TEX**, **S**, **C**, and **B**, control access to the corresponding memory region. If an access is made to an area of memory without the required permissions, then the MPU generates a permission fault.

The **SIZE** field defines the size of the MPU memory region specified by the **MPUNUMBER** register as follows:

$$(\text{Region size in bytes}) = 2^{(\text{SIZE}+1)}$$

The smallest permitted region size is 32 bytes, corresponding to a **SIZE** value of 4. Table 3-9 on page 144 gives example **SIZE** values with the corresponding region size and value of **N** in the **MPU Region Base Address (MPUBASE)** register.

**Table 3-9. Example SIZE Field Values**

SIZE Encoding	Region Size	Value of N <sup>a</sup>	Note
00100b (0x4)	32 B	5	Minimum permitted size
01001b (0x9)	1 KB	10	-
10011b (0x13)	1 MB	20	-
11101b (0x1D)	1 GB	30	-
11111b (0x1F)	4 GB	No valid <b>ADDR</b> field in <b>MPUBASE</b> ; the region occupies the complete memory map.	Maximum possible size

a. Refers to the **N** parameter in the **MPUBASE** register (see page 142).

### MPU Region Attribute and Size (MPUATTR)

Base 0xE000.E000

Offset 0xDA0

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved			XN	reserved	AP		reserved			TEX		S	C	B	
Type	RO	RO	RO	R/W	RO	R/W	R/W	R/W	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	SRD								reserved			SIZE				ENABLE
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:29	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	XN	R/W	0	Instruction Access Disable  Value Description 0 Instruction fetches are enabled. 1 Instruction fetches are disabled.
27	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
26:24	AP	R/W	0	Access Privilege For information on using this bit field, see Table 3-5 on page 90.
23:22	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
21:19	TEX	R/W	0x0	Type Extension Mask For information on using this bit field, see Table 3-3 on page 89.
18	S	R/W	0	Shareable For information on using this bit, see Table 3-3 on page 89.
17	C	R/W	0	Cacheable For information on using this bit, see Table 3-3 on page 89.
16	B	R/W	0	Bufferable For information on using this bit, see Table 3-3 on page 89.
15:8	SRD	R/W	0x00	Subregion Disable Bits  Value Description 0 The corresponding subregion is enabled. 1 The corresponding subregion is disabled.  Region sizes of 128 bytes and less do not support subregions. When writing the attributes for such a region, configure the SRD field as 0x00. See the section called "Subregions" on page 88 for more information.
7:6	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:1	SIZE	R/W	0x0	Region Size Mask The SIZE field defines the size of the MPU memory region specified by the MPUNUMBER register. Refer to Table 3-9 on page 144 for more information.

Bit/Field	Name	Type	Reset	Description
0	ENABLE	R/W	0	Region Enable
				Value Description
				0 The region is disabled.
				1 The region is enabled.

## 4 JTAG Interface

The Joint Test Action Group (JTAG) port is an IEEE standard that defines a Test Access Port and Boundary Scan Architecture for digital integrated circuits and provides a standardized serial interface for controlling the associated test logic. The TAP, Instruction Register (IR), and Data Registers (DR) can be used to test the interconnections of assembled printed circuit boards and obtain manufacturing information on the components. The JTAG Port also provides a means of accessing and controlling design-for-test features such as I/O pin observation and control, scan testing, and debugging.

The JTAG port is comprised of five pins:  $\overline{\text{TRST}}$ , TCK, TMS, TDI, and TDO. Data is transmitted serially into the controller on TDI and out of the controller on TDO. The interpretation of this data is dependent on the current state of the TAP controller. For detailed information on the operation of the JTAG port and TAP controller, please refer to the *IEEE Standard 1149.1-Test Access Port and Boundary-Scan Architecture*.

The Stellaris® JTAG controller works with the ARM JTAG controller built into the Cortex-M3 core. This is implemented by multiplexing the TDO outputs from both JTAG controllers. ARM JTAG instructions select the ARM TDO output while Stellaris JTAG instructions select the Stellaris TDO outputs. The multiplexer is controlled by the Stellaris JTAG controller, which has comprehensive programming for the ARM, Stellaris, and unimplemented JTAG instructions.

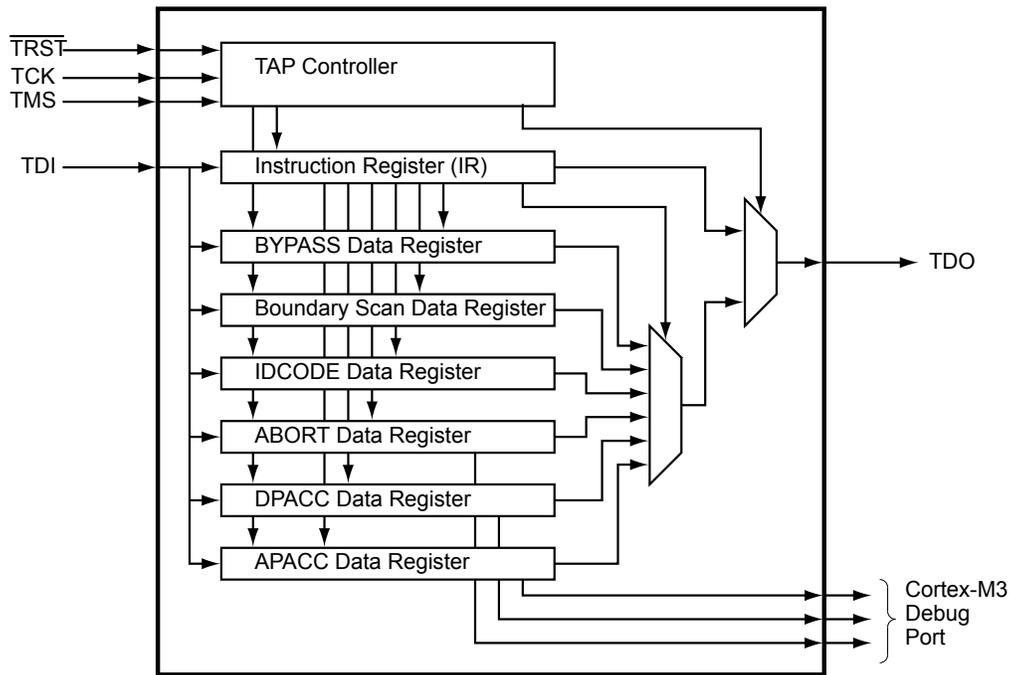
The Stellaris JTAG module has the following features:

- IEEE 1149.1-1990 compatible Test Access Port (TAP) controller
- Four-bit Instruction Register (IR) chain for storing JTAG instructions
- IEEE standard instructions: BYPASS, IDCODE, SAMPLE/PRELOAD, EXTEST and INTEST
- ARM additional instructions: APACC, DPACC and ABORT
- Integrated ARM Serial Wire Debug (SWD)

See the *ARM® Debug Interface V5 Architecture Specification* for more information on the ARM JTAG controller.

## 4.1 Block Diagram

Figure 4-1. JTAG Module Block Diagram



## 4.2 Signal Description

Table 4-1 on page 148 and Table 4-2 on page 149 list the external signals of the JTAG/SWD controller and describe the function of each. The JTAG/SWD controller signals are alternate functions for some GPIO signals, however note that the reset state of the pins is for the JTAG/SWD function. The JTAG/SWD controller signals are under commit protection and require a special process to be configured as GPIOs, see “Commit Control” on page 250. The column in the table below titled “Pin Assignment” lists the GPIO pin placement for the JTAG/SWD controller signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) is set to choose the JTAG/SWD function. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 243.

Table 4-1. JTAG\_SWD\_SWO Signals (100LQFP)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
SWCLK	80	I	TTL	JTAG/SWD CLK.
SWDIO	79	I/O	TTL	JTAG TMS and SWDIO.
SWO	77	O	TTL	JTAG TDO and SWO.
TCK	80	I	TTL	JTAG/SWD CLK.
TDI	78	I	TTL	JTAG TDI.
TDO	77	O	TTL	JTAG TDO and SWO.
TMS	79	I/O	TTL	JTAG TMS and SWDIO.
TRST	89	I	TTL	JTAG TRST.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 4-2. JTAG\_SWD\_SWO Signals (108BGA)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
SWCLK	A9	I	TTL	JTAG/SWD CLK.
SWDIO	B9	I/O	TTL	JTAG TMS and SWDIO.
SWO	A10	O	TTL	JTAG TDO and SWO.
TCK	A9	I	TTL	JTAG/SWD CLK.
TDI	B8	I	TTL	JTAG TDI.
TDO	A10	O	TTL	JTAG TDO and SWO.
TMS	B9	I/O	TTL	JTAG TMS and SWDIO.
$\overline{\text{TRST}}$	A8	I	TTL	JTAG $\overline{\text{TRST}}$ .

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 4.3 Functional Description

A high-level conceptual drawing of the JTAG module is shown in Figure 4-1 on page 148. The JTAG module is composed of the Test Access Port (TAP) controller and serial shift chains with parallel update registers. The TAP controller is a simple state machine controlled by the  $\overline{\text{TRST}}$ , TCK and TMS inputs. The current state of the TAP controller depends on the current value of  $\overline{\text{TRST}}$  and the sequence of values captured on TMS at the rising edge of TCK. The TAP controller determines when the serial shift chains capture new data, shift data from TDI towards TDO, and update the parallel load registers. The current state of the TAP controller also determines whether the Instruction Register (IR) chain or one of the Data Register (DR) chains is being accessed.

The serial shift chains with parallel load registers are comprised of a single Instruction Register (IR) chain and multiple Data Register (DR) chains. The current instruction loaded in the parallel load register determines which DR chain is captured, shifted, or updated during the sequencing of the TAP controller.

Some instructions, like EXTEST and INTEST, operate on data currently in a DR chain and do not capture, shift, or update any of the chains. Instructions that are not implemented decode to the BYPASS instruction to ensure that the serial path between TDI and TDO is always connected (see Table 4-4 on page 156 for a list of implemented instructions).

See “JTAG and Boundary Scan” on page 519 for JTAG timing diagrams.

### 4.3.1 JTAG Interface Pins

The JTAG interface consists of five standard pins:  $\overline{\text{TRST}}$ , TCK, TMS, TDI, and TDO. These pins and their associated reset state are given in Table 4-3 on page 149. Detailed information on each pin follows.

Table 4-3. JTAG Port Pins Reset State

Pin Name	Data Direction	Internal Pull-Up	Internal Pull-Down	Drive Strength	Drive Value
$\overline{\text{TRST}}$	Input	Enabled	Disabled	N/A	N/A
TCK	Input	Enabled	Disabled	N/A	N/A
TMS	Input	Enabled	Disabled	N/A	N/A
TDI	Input	Enabled	Disabled	N/A	N/A
TDO	Output	Enabled	Disabled	2-mA driver	High-Z

#### 4.3.1.1 Test Reset Input ( $\overline{\text{TRST}}$ )

The  $\overline{\text{TRST}}$  pin is an asynchronous active Low input signal for initializing and resetting the JTAG TAP controller and associated JTAG circuitry. When  $\overline{\text{TRST}}$  is asserted, the TAP controller resets to the Test-Logic-Reset state and remains there while  $\overline{\text{TRST}}$  is asserted. When the TAP controller enters the Test-Logic-Reset state, the JTAG Instruction Register (IR) resets to the default instruction, IDCODE.

By default, the internal pull-up resistor on the  $\overline{\text{TRST}}$  pin is enabled after reset. Changes to the pull-up resistor settings on GPIO Port B should ensure that the internal pull-up resistor remains enabled on PB7/ $\overline{\text{TRST}}$ ; otherwise JTAG communication could be lost.

#### 4.3.1.2 Test Clock Input (TCK)

The TCK pin is the clock for the JTAG module. This clock is provided so the test logic can operate independently of any other system clocks. In addition, it ensures that multiple JTAG TAP controllers that are daisy-chained together can synchronously communicate serial test data between components. During normal operation, TCK is driven by a free-running clock with a nominal 50% duty cycle. When necessary, TCK can be stopped at 0 or 1 for extended periods of time. While TCK is stopped at 0 or 1, the state of the TAP controller does not change and data in the JTAG Instruction and Data Registers is not lost.

By default, the internal pull-up resistor on the TCK pin is enabled after reset. This assures that no clocking occurs if the pin is not driven from an external source. The internal pull-up and pull-down resistors can be turned off to save internal power as long as the TCK pin is constantly being driven by an external source.

#### 4.3.1.3 Test Mode Select (TMS)

The TMS pin selects the next state of the JTAG TAP controller. TMS is sampled on the rising edge of TCK. Depending on the current TAP state and the sampled value of TMS, the next state is entered. Because the TMS pin is sampled on the rising edge of TCK, the *IEEE Standard 1149.1* expects the value on TMS to change on the falling edge of TCK.

Holding TMS high for five consecutive TCK cycles drives the TAP controller state machine to the Test-Logic-Reset state. When the TAP controller enters the Test-Logic-Reset state, the JTAG Instruction Register (IR) resets to the default instruction, IDCODE. Therefore, this sequence can be used as a reset mechanism, similar to asserting  $\overline{\text{TRST}}$ . The JTAG Test Access Port state machine can be seen in its entirety in Figure 4-2 on page 152.

By default, the internal pull-up resistor on the TMS pin is enabled after reset. Changes to the pull-up resistor settings on GPIO Port C should ensure that the internal pull-up resistor remains enabled on PC1/TMS; otherwise JTAG communication could be lost.

#### 4.3.1.4 Test Data Input (TDI)

The TDI pin provides a stream of serial information to the IR chain and the DR chains. TDI is sampled on the rising edge of TCK and, depending on the current TAP state and the current instruction, presents this data to the proper shift register chain. Because the TDI pin is sampled on the rising edge of TCK, the *IEEE Standard 1149.1* expects the value on TDI to change on the falling edge of TCK.

By default, the internal pull-up resistor on the TDI pin is enabled after reset. Changes to the pull-up resistor settings on GPIO Port C should ensure that the internal pull-up resistor remains enabled on PC2/TDI; otherwise JTAG communication could be lost.

#### 4.3.1.5 Test Data Output (TDO)

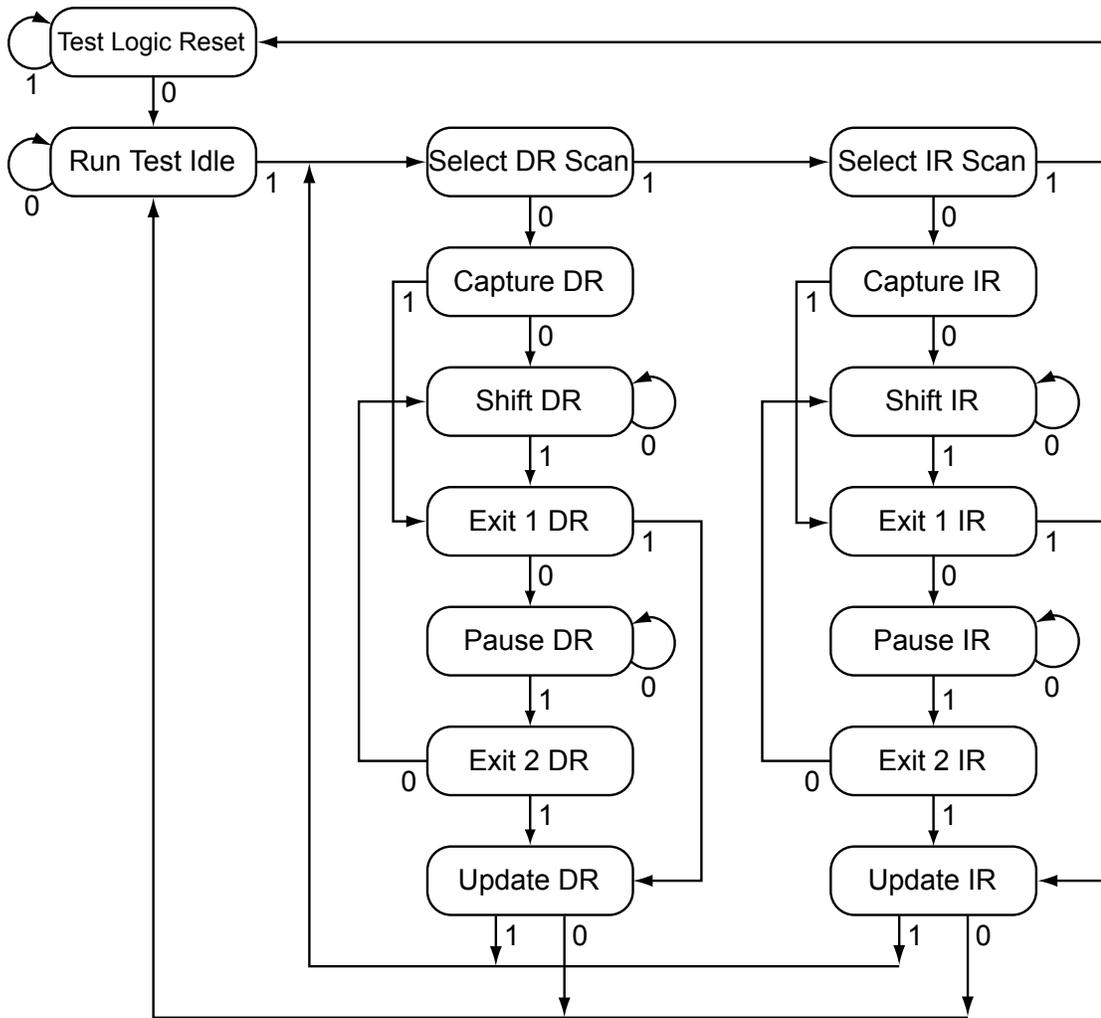
The TDO pin provides an output stream of serial information from the IR chain or the DR chains. The value of TDO depends on the current TAP state, the current instruction, and the data in the chain being accessed. In order to save power when the JTAG port is not being used, the TDO pin is placed in an inactive drive state when not actively shifting out data. Because TDO can be connected to the TDI of another controller in a daisy-chain configuration, the *IEEE Standard 1149.1* expects the value on TDO to change on the falling edge of TCK.

By default, the internal pull-up resistor on the TDO pin is enabled after reset. This assures that the pin remains at a constant logic level when the JTAG port is not being used. The internal pull-up and pull-down resistors can be turned off to save internal power if a High-Z output value is acceptable during certain TAP controller states.

#### 4.3.2 JTAG TAP Controller

The JTAG TAP controller state machine is shown in Figure 4-2 on page 152. The TAP controller state machine is reset to the Test-Logic-Reset state on the assertion of a Power-On-Reset (POR) or the assertion of  $\overline{\text{TRST}}$ . Asserting the correct sequence on the TMS pin allows the JTAG module to shift in new instructions, shift in data, or idle during extended testing sequences. For detailed information on the function of the TAP controller and the operations that occur in each state, please refer to *IEEE Standard 1149.1*.

Figure 4-2. Test Access Port State Machine



### 4.3.3 Shift Registers

The Shift Registers consist of a serial shift register chain and a parallel load register. The serial shift register chain samples specific information during the TAP controller’s CAPTURE states and allows this information to be shifted out of TDO during the TAP controller’s SHIFT states. While the sampled data is being shifted out of the chain on TDO, new data is being shifted into the serial shift register on TDI. This new data is stored in the parallel load register during the TAP controller’s UPDATE states. Each of the shift registers is discussed in detail in “Register Descriptions” on page 155.

### 4.3.4 Operational Considerations

There are certain operational considerations when using the JTAG module. Because the JTAG pins can be programmed to be GPIOs, board configuration and reset conditions on these pins must be considered. In addition, because the JTAG module has integrated ARM Serial Wire Debug, the method for switching between these two operational modes is described below.

#### 4.3.4.1 GPIO Functionality

When the controller is reset with either a POR or  $\overline{\text{RST}}$ , the JTAG/SWD port pins default to their JTAG/SWD configurations. The default configuration includes enabling digital functionality (setting **GPIODEN** to 1), enabling the pull-up resistors (setting **GPIOPUR** to 1), and enabling the alternate hardware function (setting **GPIOAFSEL** to 1) for the  $\text{PB7}$  and  $\text{PC}[3:0]$  JTAG/SWD pins.

It is possible for software to configure these pins as GPIOs after reset by writing 0s to  $\text{PB7}$  and  $\text{PC}[3:0]$  in the **GPIOAFSEL** register. If the user does not require the JTAG/SWD port for debugging or board-level testing, this provides five more GPIOs for use in the design.

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**Caution – It is possible to create a software sequence that prevents the debugger from connecting to the Stellaris microcontroller. If the program code loaded into flash immediately changes the JTAG pins to their GPIO functionality, the debugger may not have enough time to connect and halt the controller before the JTAG pin functionality switches. This may lock the debugger out of the part. This can be avoided with a software routine that restores JTAG functionality based on an external or software trigger.**

---

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is currently provided for the five JTAG/SWD pins ( $\text{PB7}$  and  $\text{PC}[3:0]$ ). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 263) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 273) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 274) have been set to 1.

##### **Recovering a "Locked" Device**

**Note:** The mass erase of the flash memory caused by the below sequence erases the entire flash memory, regardless of the settings in the **Flash Memory Protection Program Enable n (FMPPEn)** registers. Performing the sequence below does not affect the nonvolatile registers discussed in "Nonvolatile Register Programming" on page 220.

If software configures any of the JTAG/SWD pins as GPIO and loses the ability to communicate with the debugger, there is a debug sequence that can be used to recover the device. Performing a total of ten JTAG-to-SWD and SWD-to-JTAG switch sequences while holding the device in reset mass erases the flash memory. The sequence to recover the device is:

1. Assert and hold the  $\overline{\text{RST}}$  signal.
2. Apply power to the device.
3. Perform the JTAG-to-SWD switch sequence.
4. Perform the SWD-to-JTAG switch sequence.
5. Perform the JTAG-to-SWD switch sequence.
6. Perform the SWD-to-JTAG switch sequence.
7. Perform the JTAG-to-SWD switch sequence.
8. Perform the SWD-to-JTAG switch sequence.
9. Perform the JTAG-to-SWD switch sequence.
10. Perform the SWD-to-JTAG switch sequence.

11. Perform the JTAG-to-SWD switch sequence.
12. Perform the SWD-to-JTAG switch sequence.
13. Release the  $\overline{RST}$  signal.
14. Wait 400 ms.
15. Power-cycle the device.

The JTAG-to-SWD and SWD-to-JTAG switch sequences are described in “ARM Serial Wire Debug (SWD)” on page 154. When performing switch sequences for the purpose of recovering the debug capabilities of the device, only steps 1 and 2 of the switch sequence in the section called “JTAG-to-SWD Switching” on page 154 must be performed.

#### 4.3.4.2 Communication with JTAG/SWD

Because the debug clock and the system clock can be running at different frequencies, care must be taken to maintain reliable communication with the JTAG/SWD interface. In the Capture-DR state, the result of the previous transaction, if any, is returned, together with a 3-bit ACK response. Software should check the ACK response to see if the previous operation has completed before initiating a new transaction. Alternatively, if the system clock is at least 8 times faster than the debug clock ( $TCK$  or  $SWCLK$ ), the previous operation has enough time to complete and the ACK bits do not have to be checked.

#### 4.3.4.3 ARM Serial Wire Debug (SWD)

In order to seamlessly integrate the ARM Serial Wire Debug (SWD) functionality, a serial-wire debugger must be able to connect to the Cortex-M3 core without having to perform, or have any knowledge of, JTAG cycles. This is accomplished with a SWD preamble that is issued before the SWD session begins.

The switching preamble used to enable the SWD interface of the SWJ-DP module starts with the TAP controller in the Test-Logic-Reset state. From here, the preamble sequences the TAP controller through the following states: Run Test Idle, Select DR, Select IR, Test Logic Reset, Test Logic Reset, Run Test Idle, Run Test Idle, Select DR, Select IR, Test Logic Reset, Test Logic Reset, Run Test Idle, Run Test Idle, Select DR, Select IR, and Test Logic Reset states.

Stepping through this sequences of the TAP state machine enables the SWD interface and disables the JTAG interface. For more information on this operation and the SWD interface, see the *ARM® Debug Interface V5 Architecture Specification*.

Because this sequence is a valid series of JTAG operations that could be issued, the ARM JTAG TAP controller is not fully compliant to the *IEEE Standard 1149.1*. This is the only instance where the ARM JTAG TAP controller does not meet full compliance with the specification. Due to the low probability of this sequence occurring during normal operation of the TAP controller, it should not affect normal performance of the JTAG interface.

#### **JTAG-to-SWD Switching**

To switch the operating mode of the Debug Access Port (DAP) from JTAG to SWD mode, the external debug hardware must send the switching preamble to the microcontroller. The 16-bit TMS/SWDIO command for switching to SWD mode is defined as b1110.0111.1001.1110, transmitted LSB first. This command can also be represented as 0xE79E when transmitted LSB first. The complete switch sequence should consist of the following transactions on the  $TCK/SWCLK$  and  $TMS/SWDIO$  signals:

1. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that both JTAG and SWD are in their reset states.
2. Send the 16-bit JTAG-to-SWD switch command, 0xE79E, on TMS/SWDIO.
3. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that if SWJ-DP was already in SWD mode before sending the switch sequence, the SWD goes into the line reset state.

To verify that the Debug Access Port (DAP) has switched to the Serial Wire Debug (SWD) operating mode, perform a SWD READID operation. The ID value can be compared against the device's known ID to verify the switch.

### **SWD-to-JTAG Switching**

To switch the operating mode of the Debug Access Port (DAP) from SWD to JTAG mode, the external debug hardware must send a switch command to the microcontroller. The 16-bit TMS/SWDIO command for switching to JTAG mode is defined as b1110.0111.0011.1100, transmitted LSB first. This command can also be represented as 0xE73C when transmitted LSB first. The complete switch sequence should consist of the following transactions on the TCK/SWCLK and TMS/SWDIO signals:

1. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that both JTAG and SWD are in their reset states.
2. Send the 16-bit SWD-to-JTAG switch command, 0xE73C, on TMS/SWDIO.
3. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that if SWJ-DP was already in JTAG mode before sending the switch sequence, the JTAG goes into the Test Logic Reset state.

To verify that the Debug Access Port (DAP) has switched to the JTAG operating mode, set the JTAG Instruction Register (IR) to the IDCODE instruction and shift out the Data Register (DR). The DR value can be compared against the device's known IDCODE to verify the switch.

## **4.4 Initialization and Configuration**

After a Power-On-Reset or an external reset ( $\overline{RST}$ ), the JTAG pins are automatically configured for JTAG communication. No user-defined initialization or configuration is needed. However, if the user application changes these pins to their GPIO function, they must be configured back to their JTAG functionality before JTAG communication can be restored. This is done by enabling the five JTAG pins ( $PB7$  and  $PC[3:0]$ ) for their alternate function using the **GPIOAFSEL** register. In addition to enabling the alternate functions, any other changes to the GPIO pad configurations on the five JTAG pins ( $PB7$  and  $PC[3:0]$ ) should be reverted to their default settings.

## **4.5 Register Descriptions**

There are no APB-accessible registers in the JTAG TAP Controller or Shift Register chains. The registers within the JTAG controller are all accessed serially through the TAP Controller. The registers can be broken down into two main categories: Instruction Registers and Data Registers.

### **4.5.1 Instruction Register (IR)**

The JTAG TAP Instruction Register (IR) is a four-bit serial scan chain connected between the JTAG TDI and TDO pins with a parallel load register. When the TAP Controller is placed in the correct states, bits can be shifted into the Instruction Register. Once these bits have been shifted into the chain and updated, they are interpreted as the current instruction. The decode of the Instruction

Register bits is shown in Table 4-4 on page 156. A detailed explanation of each instruction, along with its associated Data Register, follows.

**Table 4-4. JTAG Instruction Register Commands**

IR[3:0]	Instruction	Description
0000	EXTEST	Drives the values preloaded into the Boundary Scan Chain by the SAMPLE/PRELOAD instruction onto the pads.
0001	INTEST	Drives the values preloaded into the Boundary Scan Chain by the SAMPLE/PRELOAD instruction into the controller.
0010	SAMPLE / PRELOAD	Captures the current I/O values and shifts the sampled values out of the Boundary Scan Chain while new preload data is shifted in.
1000	ABORT	Shifts data into the ARM Debug Port Abort Register.
1010	DPACC	Shifts data into and out of the ARM DP Access Register.
1011	APACC	Shifts data into and out of the ARM AC Access Register.
1110	IDCODE	Loads manufacturing information defined by the <i>IEEE Standard 1149.1</i> into the IDCODE chain and shifts it out.
1111	BYPASS	Connects TDI to TDO through a single Shift Register chain.
All Others	Reserved	Defaults to the BYPASS instruction to ensure that TDI is always connected to TDO.

#### 4.5.1.1 EXTEST Instruction

The EXTEST instruction is not associated with its own Data Register chain. The EXTEST instruction uses the data that has been preloaded into the Boundary Scan Data Register using the SAMPLE/PRELOAD instruction. When the EXTEST instruction is present in the Instruction Register, the preloaded data in the Boundary Scan Data Register associated with the outputs and output enables are used to drive the GPIO pads rather than the signals coming from the core. This allows tests to be developed that drive known values out of the controller, which can be used to verify connectivity. While the EXTEST instruction is present in the Instruction Register, the Boundary Scan Data Register can be accessed to sample and shift out the current data and load new data into the Boundary Scan Data Register.

#### 4.5.1.2 INTEST Instruction

The INTEST instruction is not associated with its own Data Register chain. The INTEST instruction uses the data that has been preloaded into the Boundary Scan Data Register using the SAMPLE/PRELOAD instruction. When the INTEST instruction is present in the Instruction Register, the preloaded data in the Boundary Scan Data Register associated with the inputs are used to drive the signals going into the core rather than the signals coming from the GPIO pads. This allows tests to be developed that drive known values into the controller, which can be used for testing. It is important to note that although the  $\overline{\text{RST}}$  input pin is on the Boundary Scan Data Register chain, it is only observable. While the INTEXT instruction is present in the Instruction Register, the Boundary Scan Data Register can be accessed to sample and shift out the current data and load new data into the Boundary Scan Data Register.

#### 4.5.1.3 SAMPLE/PRELOAD Instruction

The SAMPLE/PRELOAD instruction connects the Boundary Scan Data Register chain between TDI and TDO. This instruction samples the current state of the pad pins for observation and preloads new test data. Each GPIO pad has an associated input, output, and output enable signal. When the TAP controller enters the Capture DR state during this instruction, the input, output, and output-enable signals to each of the GPIO pads are captured. These samples are serially shifted out of TDO while

the TAP controller is in the Shift DR state and can be used for observation or comparison in various tests.

While these samples of the inputs, outputs, and output enables are being shifted out of the Boundary Scan Data Register, new data is being shifted into the Boundary Scan Data Register from TDI. Once the new data has been shifted into the Boundary Scan Data Register, the data is saved in the parallel load registers when the TAP controller enters the Update DR state. This update of the parallel load register preloads data into the Boundary Scan Data Register that is associated with each input, output, and output enable. This preloaded data can be used with the EXTEST and INTEST instructions to drive data into or out of the controller. Please see “Boundary Scan Data Register” on page 158 for more information.

#### 4.5.1.4 ABORT Instruction

The ABORT instruction connects the associated ABORT Data Register chain between TDI and TDO. This instruction provides read and write access to the ABORT Register of the ARM Debug Access Port (DAP). Shifting the proper data into this Data Register clears various error bits or initiates a DAP abort of a previous request. Please see the “ABORT Data Register” on page 159 for more information.

#### 4.5.1.5 DPACC Instruction

The DPACC instruction connects the associated DPACC Data Register chain between TDI and TDO. This instruction provides read and write access to the DPACC Register of the ARM Debug Access Port (DAP). Shifting the proper data into this register and reading the data output from this register allows read and write access to the ARM debug and status registers. Please see “DPACC Data Register” on page 159 for more information.

#### 4.5.1.6 APACC Instruction

The APACC instruction connects the associated APACC Data Register chain between TDI and TDO. This instruction provides read and write access to the APACC Register of the ARM Debug Access Port (DAP). Shifting the proper data into this register and reading the data output from this register allows read and write access to internal components and buses through the Debug Port. Please see “APACC Data Register” on page 159 for more information.

#### 4.5.1.7 IDCODE Instruction

The IDCODE instruction connects the associated IDCODE Data Register chain between TDI and TDO. This instruction provides information on the manufacturer, part number, and version of the ARM core. This information can be used by testing equipment and debuggers to automatically configure their input and output data streams. IDCODE is the default instruction that is loaded into the JTAG Instruction Register when a Power-On-Reset (POR) is asserted,  $\overline{\text{TRST}}$  is asserted, or the Test-Logic-Reset state is entered. Please see “IDCODE Data Register” on page 158 for more information.

#### 4.5.1.8 BYPASS Instruction

The BYPASS instruction connects the associated BYPASS Data Register chain between TDI and TDO. This instruction is used to create a minimum length serial path between the TDI and TDO ports. The BYPASS Data Register is a single-bit shift register. This instruction improves test efficiency by allowing components that are not needed for a specific test to be bypassed in the JTAG scan chain by loading them with the BYPASS instruction. Please see “BYPASS Data Register” on page 158 for more information.

## 4.5.2 Data Registers

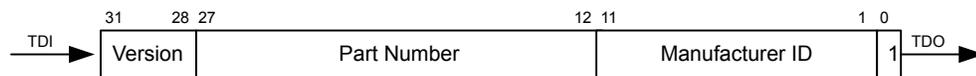
The JTAG module contains six Data Registers. These include: IDCODE, BYPASS, Boundary Scan, APACC, DPACC, and ABORT serial Data Register chains. Each of these Data Registers is discussed in the following sections.

### 4.5.2.1 IDCODE Data Register

The format for the 32-bit IDCODE Data Register defined by the *IEEE Standard 1149.1* is shown in Figure 4-3 on page 158. The standard requires that every JTAG-compliant device implement either the IDCODE instruction or the BYPASS instruction as the default instruction. The LSB of the IDCODE Data Register is defined to be a 1 to distinguish it from the BYPASS instruction, which has an LSB of 0. This allows auto configuration test tools to determine which instruction is the default instruction.

The major uses of the JTAG port are for manufacturer testing of component assembly, and program development and debug. To facilitate the use of auto-configuration debug tools, the IDCODE instruction outputs a value of 0x3BA0.0477. This allows the debuggers to automatically configure themselves to work correctly with the Cortex-M3 during debug.

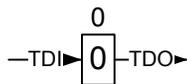
**Figure 4-3. IDCODE Register Format**



### 4.5.2.2 BYPASS Data Register

The format for the 1-bit BYPASS Data Register defined by the *IEEE Standard 1149.1* is shown in Figure 4-4 on page 158. The standard requires that every JTAG-compliant device implement either the BYPASS instruction or the IDCODE instruction as the default instruction. The LSB of the BYPASS Data Register is defined to be a 0 to distinguish it from the IDCODE instruction, which has an LSB of 1. This allows auto configuration test tools to determine which instruction is the default instruction.

**Figure 4-4. BYPASS Register Format**



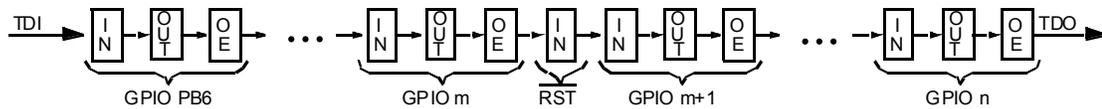
### 4.5.2.3 Boundary Scan Data Register

The format of the Boundary Scan Data Register is shown in Figure 4-5 on page 159. Each GPIO pin, starting with a GPIO pin next to the JTAG port pins, is included in the Boundary Scan Data Register. Each GPIO pin has three associated digital signals that are included in the chain. These signals are input, output, and output enable, and are arranged in that order as can be seen in the figure.

When the Boundary Scan Data Register is accessed with the SAMPLE/PRELOAD instruction, the input, output, and output enable from each digital pad are sampled and then shifted out of the chain to be verified. The sampling of these values occurs on the rising edge of  $T_{CK}$  in the Capture DR state of the TAP controller. While the sampled data is being shifted out of the Boundary Scan chain in the Shift DR state of the TAP controller, new data can be preloaded into the chain for use with

the EXTEST and INTEST instructions. These instructions either force data out of the controller, with the EXTEST instruction, or into the controller, with the INTEST instruction.

**Figure 4-5. Boundary Scan Register Format**



#### 4.5.2.4 APACC Data Register

The format for the 35-bit APACC Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

#### 4.5.2.5 DPACC Data Register

The format for the 35-bit DPACC Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

#### 4.5.2.6 ABORT Data Register

The format for the 35-bit ABORT Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

## 5 System Control

System control determines the overall operation of the device. It provides information about the device, controls the clocking to the core and individual peripherals, and handles reset detection and reporting.

### 5.1 Signal Description

Table 5-1 on page 160 and Table 5-2 on page 160 list the external signals of the System Control module and describe the function of each. The  $\overline{\text{NMI}}$  signal is the alternate function for and functions as a GPIO after reset. Under commit protection and require a special process to be configured as any alternate function or to subsequently return to the GPIO function, see “Commit Control” on page 250. The column in the table below titled “Pin Assignment” lists the GPIO pin placement for the  $\overline{\text{NMI}}$  signal. The  $\text{AFSEL}$  bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the NMI function. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 243. The remaining signals (with the word “fixed” in the Pin Assignment column) have a fixed pin assignment and function.

**Table 5-1. System Control & Clocks Signals (100LQFP)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
CMOD0	65	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
CMOD1	76	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
OSC0	48	I	Analog	Main oscillator crystal input or an external clock reference input.
OSC1	49	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
$\overline{\text{RST}}$	64	I	TTL	System reset input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

**Table 5-2. System Control & Clocks Signals (108BGA)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
CMOD0	E11	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
CMOD1	B10	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
OSC0	L11	I	Analog	Main oscillator crystal input or an external clock reference input.
OSC1	M11	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
$\overline{\text{RST}}$	H11	I	TTL	System reset input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

### 5.2 Functional Description

The System Control module provides the following capabilities:

- Device identification (see “Device Identification” on page 161)

- Local control, such as reset (see “Reset Control” on page 161), power (see “Power Control” on page 165) and clock control (see “Clock Control” on page 166)
- System control (Run, Sleep, and Deep-Sleep modes); see “System Control” on page 171

## 5.2.1 Device Identification

Several read-only registers provide software with information on the microcontroller, such as version, part number, SRAM size, flash size, and other features. See the **DID0**, **DID1**, and **DC0-DC4** registers.

## 5.2.2 Reset Control

This section discusses aspects of hardware functions during reset as well as system software requirements following the reset sequence.

### 5.2.2.1 CMOD0 and CMOD1 Test-Mode Control Pins

Two pins, **CMOD0** and **CMOD1**, are defined for internal use for testing the microcontroller during manufacture. They have no end-user function and should not be used. The **CMOD** pins should be connected to ground.

### 5.2.2.2 Reset Sources

The controller has five sources of reset:

1. External reset input pin ( $\overline{\text{RST}}$ ) assertion; see “External  $\overline{\text{RST}}$  Pin” on page 162.
2. Power-on reset (POR); see “Power-On Reset (POR)” on page 162.
3. Internal brown-out (BOR) detector; see “Brown-Out Reset (BOR)” on page 163.
4. Software-initiated reset (with the software reset registers); see “Software Reset” on page 164.
5. A watchdog timer reset condition violation; see “Watchdog Timer Reset” on page 164.

Table 5-3 provides a summary of results of the various reset operations.

**Table 5-3. Reset Sources**

Reset Source	Core Reset?	JTAG Reset?	On-Chip Peripherals Reset?
Power-On Reset	Yes	Yes	Yes
$\overline{\text{RST}}$	Yes	Pin Config Only	Yes
Brown-Out Reset	Yes	No	Yes
Software System Request Reset <sup>a</sup>	Yes	No	Yes
Software Peripheral Reset	No	No	Yes <sup>b</sup>
Watchdog Reset	Yes	No	Yes

a. By using the **SYSRESREQ** bit in the ARM Cortex-M3 **Application Interrupt and Reset Control (APINT)** register

b. Programmable on a module-by-module basis using the Software Reset Control Registers.

After a reset, the **Reset Cause (RESC)** register is set with the reset cause. The bits in this register are sticky and maintain their state across multiple reset sequences, except when an internal POR or an external reset is the cause, and then all the other bits in the **RESC** register are cleared except for the **POR** or **EXT** indicator.

### 5.2.2.3 Power-On Reset (POR)

**Note:** The power-on reset also resets the JTAG controller. An external reset does not.

The internal Power-On Reset (POR) circuit monitors the power supply voltage ( $V_{DD}$ ) and generates a reset signal to all of the internal logic including JTAG when the power supply ramp reaches a threshold value ( $V_{TH}$ ). The microcontroller must be operating within the specified operating parameters when the on-chip power-on reset pulse is complete. The 3.3-V power supply to the microcontroller must reach 3.0 V within 10 msec of  $V_{DD}$  crossing 2.0 V to guarantee proper operation. For applications that require the use of an external reset signal to hold the microcontroller in reset longer than the internal POR, the  $\overline{RST}$  input may be used as discussed in “External  $\overline{RST}$  Pin” on page 162.

The Power-On Reset sequence is as follows:

1. The microcontroller waits for internal POR to go inactive.
2. The internal reset is released and the core loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

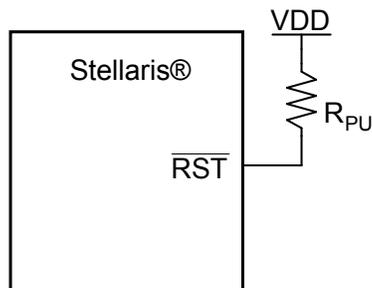
The internal POR is only active on the initial power-up of the microcontroller. The Power-On Reset timing is shown in Figure 17-6 on page 521.

### 5.2.2.4 External $\overline{RST}$ Pin

**Note:** It is recommended that the trace for the  $\overline{RST}$  signal must be kept as short as possible. Be sure to place any components connected to the  $\overline{RST}$  signal as close to the microcontroller as possible.

If the application only uses the internal POR circuit, the  $\overline{RST}$  input must be connected to the power supply ( $V_{DD}$ ) through an optional pull-up resistor (0 to 100K  $\Omega$ ) as shown in Figure 5-1 on page 162.

**Figure 5-1. Basic  $\overline{RST}$  Configuration**



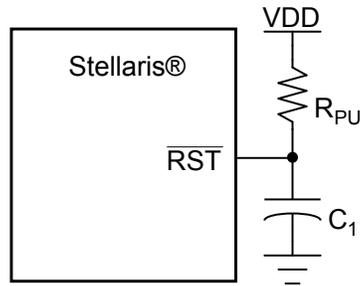
$R_{PU} = 0$  to 100 k $\Omega$

The external reset pin ( $\overline{RST}$ ) resets the microcontroller including the core and all the on-chip peripherals except the JTAG TAP controller (see “JTAG Interface” on page 147). The external reset sequence is as follows:

1. The external reset pin ( $\overline{RST}$ ) is asserted for the duration specified by  $T_{MIN}$  and then de-asserted (see “Reset” on page 520).
2. The internal reset is released and the core loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

To improve noise immunity and/or to delay reset at power up, the  $\overline{\text{RST}}$  input may be connected to an RC network as shown in Figure 5-2 on page 163.

**Figure 5-2. External Circuitry to Extend Power-On Reset**

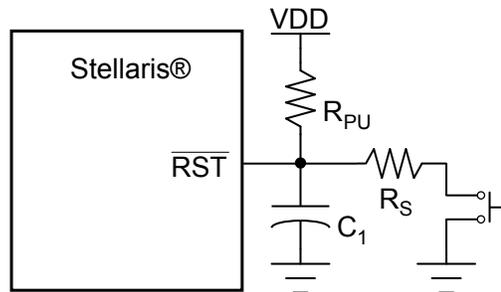


$$R_{PU} = 1 \text{ k}\Omega \text{ to } 100 \text{ k}\Omega$$

$$C_1 = 1 \text{ nF to } 10 \text{ }\mu\text{F}$$

If the application requires the use of an external reset switch, Figure 5-3 on page 163 shows the proper circuitry to use.

**Figure 5-3. Reset Circuit Controlled by Switch**



$$\text{Typical } R_{PU} = 10 \text{ k}\Omega$$

$$\text{Typical } R_S = 470 \text{ }\Omega$$

$$C_1 = 10 \text{ nF}$$

The  $R_{PU}$  and  $C_1$  components define the power-on delay.

The external reset timing is shown in Figure 17-5 on page 521.

### 5.2.2.5 Brown-Out Reset (BOR)

A drop in the input voltage resulting in the assertion of the internal brown-out detector can be used to reset the controller. This is initially disabled and may be enabled by software.

The system provides a brown-out detection circuit that triggers if the power supply ( $V_{DD}$ ) drops below a brown-out threshold voltage ( $V_{BTH}$ ). If a brown-out condition is detected, the system may generate a controller interrupt or a system reset.

Brown-out resets are controlled with the **Power-On and Brown-Out Reset Control (PBORCTL)** register. The  $BORIOR$  bit in the **PBORCTL** register must be set for a brown-out condition to trigger a reset.

The brown-out reset is equivalent to an assertion of the external  $\overline{RST}$  input and the reset is held active until the proper  $V_{DD}$  level is restored. The **RESC** register can be examined in the reset interrupt handler to determine if a Brown-Out condition was the cause of the reset, thus allowing software to determine what actions are required to recover.

The internal Brown-Out Reset timing is shown in Figure 17-7 on page 521.

### 5.2.2.6 Software Reset

Software can reset a specific peripheral or generate a reset to the entire system .

Peripherals can be individually reset by software via three registers that control reset signals to each peripheral (see the **SRCRn** registers). If the bit position corresponding to a peripheral is set and subsequently cleared, the peripheral is reset. The encoding of the reset registers is consistent with the encoding of the clock gating control for peripherals and on-chip functions (see “System Control” on page 171). Note that all reset signals for all clocks of the specified unit are asserted as a result of a software-initiated reset.

The entire system can be reset by software by setting the SYSRESETREQ bit in the Cortex-M3 Application Interrupt and Reset Control register resets the entire system including the core. The software-initiated system reset sequence is as follows:

1. A software system reset is initiated by writing the SYSRESETREQ bit in the ARM Cortex-M3 Application Interrupt and Reset Control register.
2. An internal reset is asserted.
3. The internal reset is deasserted and the controller loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

The software-initiated system reset timing is shown in Figure 17-8 on page 521.

### 5.2.2.7 Watchdog Timer Reset

The watchdog timer module's function is to prevent system hangs. The watchdog timer can be configured to generate an interrupt to the controller on its first time-out, and to generate a reset signal on its second time-out.

After the first time-out event, the 32-bit counter is reloaded with the value of the **Watchdog Timer Load (WDTLOAD)** register, and the timer resumes counting down from that value. If the timer counts down to its zero state again before the first time-out interrupt is cleared, and the reset signal has been enabled, the watchdog timer asserts its reset signal to the system. The watchdog timer reset sequence is as follows:

1. The watchdog timer times out for the second time without being serviced.
2. An internal reset is asserted.
3. The internal reset is released and the controller loads from memory the initial stack pointer, the initial program counter, the first instruction designated by the program counter, and begins execution.

The watchdog reset timing is shown in Figure 17-9 on page 522.

### 5.2.3 Power Control

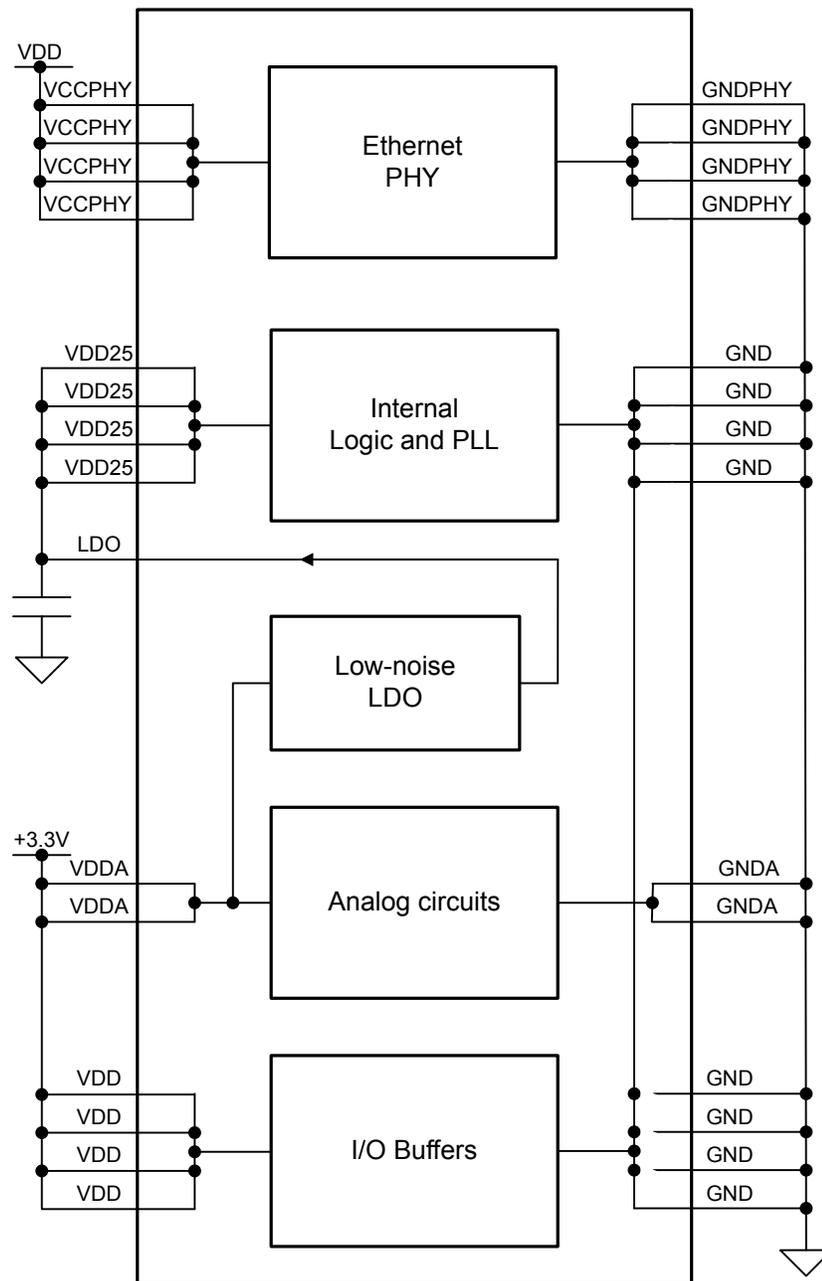
The Stellaris® microcontroller provides an integrated LDO regulator that is used to provide power to the majority of the controller's internal logic. For power reduction, the LDO regulator provides software a mechanism to adjust the regulated value, in small increments (VSTEP), over the range of 2.25 V to 2.75 V (inclusive)—or  $2.5\text{ V} \pm 10\%$ . The adjustment is made by changing the value of the VADJ field in the **LDO Power Control (LDOPCTL)** register.

Figure 5-4 on page 166 shows the power architecture.

**Note:** On the printed circuit board, use the LDO output as the source of VDD25 input. Do not use an external regulator to supply the voltage to VDD25. In addition, the LDO requires decoupling capacitors. See “On-Chip Low Drop-Out (LDO) Regulator Characteristics” on page 515.

VDDA must be supplied with 3.3 V, or the microcontroller does not function properly. VDDA is the supply for all of the analog circuitry on the device, including the LDO and the clock circuitry.

Figure 5-4. Power Architecture



## 5.2.4 Clock Control

System control determines the control of clocks in this part.

### 5.2.4.1 Fundamental Clock Sources

There are multiple clock sources for use in the device:

- Internal Oscillator (IOSC).** The internal oscillator is an on-chip clock source. It does not require the use of any external components. The frequency of the internal oscillator is  $12 \text{ MHz} \pm 30\%$ .

Applications that do not depend on accurate clock sources may use this clock source to reduce system cost. The internal oscillator is the clock source the device uses during and following POR. If the main oscillator is required, software must enable the main oscillator following reset and allow the main oscillator to stabilize before changing the clock reference.

- **Main Oscillator (MOSC).** The main oscillator provides a frequency-accurate clock source by one of two means: an external single-ended clock source is connected to the `OSC0` input pin, or an external crystal is connected across the `OSC0` input and `OSC1` output pins. If the PLL is being used, the crystal value must be one of the supported frequencies between 3.579545 MHz through 8.192 MHz (inclusive). If the PLL is not being used, the crystal may be any one of the supported frequencies between 1 MHz and 8.192 MHz. The single-ended clock source range is from DC through the specified speed of the device. The supported crystals are listed in the `XTAL` bit field in the **RCC** register (see page 182).
- **Internal 30-kHz Oscillator.** The internal 30-kHz oscillator is similar to the internal oscillator, except that it provides an operational frequency of 30 kHz  $\pm$  50%. It is intended for use during Deep-Sleep power-saving modes. This power-savings mode benefits from reduced internal switching and also allows the main oscillator to be powered down.

The internal system clock (SysClk), is derived from any of the above sources plus two others: the output of the main internal PLL, and the internal oscillator divided by four (3 MHz  $\pm$  30%). The frequency of the PLL clock reference must be in the range of 3.579545 MHz to 8.192 MHz (inclusive). Table 5-4 on page 167 shows how the various clock sources can be used in a system.

**Table 5-4. Clock Source Options**

Clock Source	Drive PLL?		Used as SysClk?	
Internal Oscillator (12 MHz)	No	BYPASS = 1	Yes	BYPASS = 1, OSCSRC = 0x1
Internal Oscillator divide by 4 (3 MHz)	No	BYPASS = 1	Yes	BYPASS = 1, OSCSRC = 0x2
Main Oscillator	Yes	BYPASS = 0, OSCSRC = 0x0	Yes	BYPASS = 1, OSCSRC = 0x0
Internal 30-kHz Oscillator	No	BYPASS = 1	Yes	BYPASS = 1, OSCSRC = 0x3

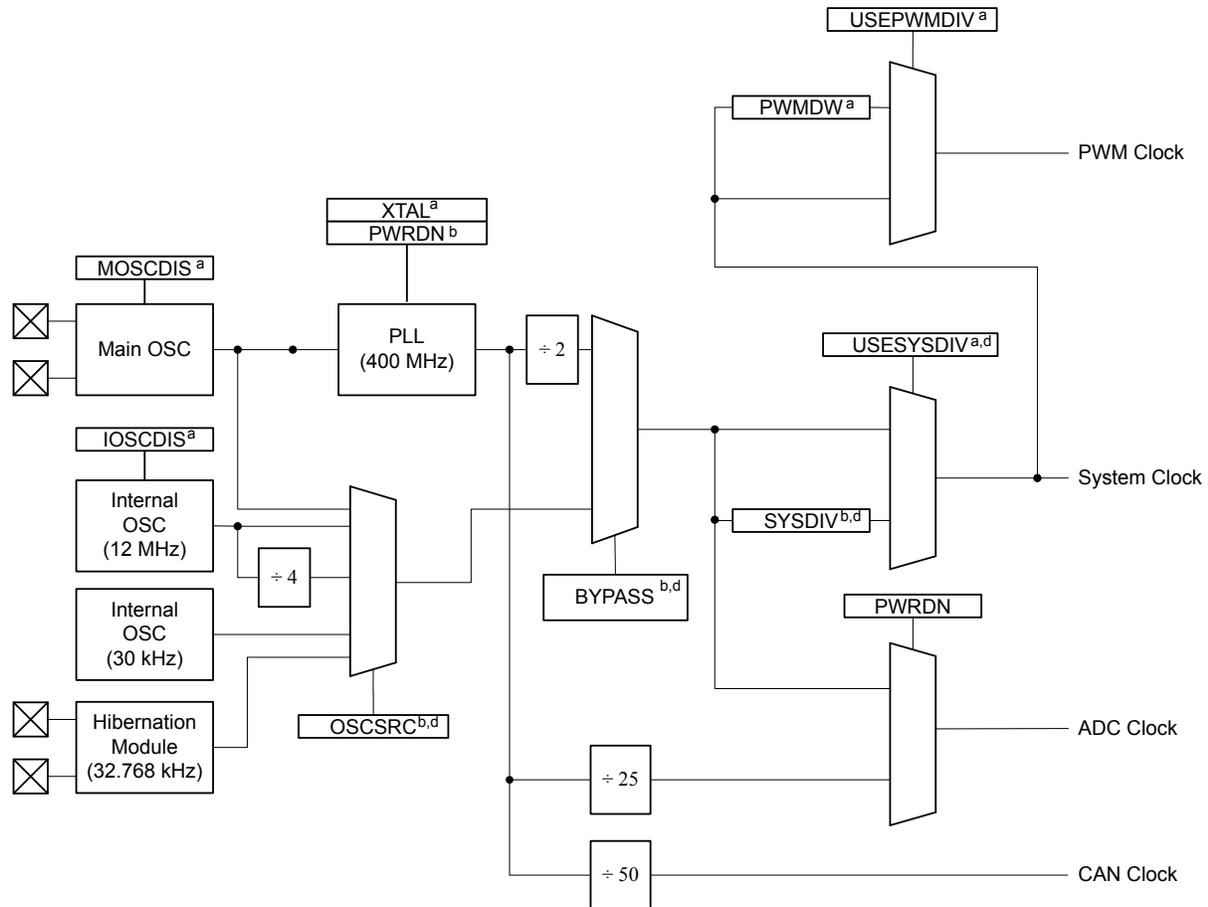
### 5.2.4.2 Clock Configuration

The **Run-Mode Clock Configuration (RCC)** and **Run-Mode Clock Configuration 2 (RCC2)** registers provide control for the system clock. The **RCC2** register is provided to extend fields that offer additional encodings over the **RCC** register. When used, the **RCC2** register field values are used by the logic over the corresponding field in the **RCC** register. In particular, **RCC2** provides for a larger assortment of clock configuration options. These registers control the following clock functionality:

- Source of clocks in sleep and deep-sleep modes
- System clock derived from PLL or other clock source
- Enabling/disabling of oscillators and PLL
- Clock divisors
- Crystal input selection

Figure 5-5 on page 168 shows the logic for the main clock tree. The peripheral blocks are driven by the system clock signal and can be individually enabled/disabled.

**Figure 5-5. Main Clock Tree**



- a. Control provided by RCC register bit/field.  
 b. Control provided by RCC register bit/field or RCC2 register bit/field, if overridden with RCC2 register bit USERCC2.  
 c. Control provided by RCC2 register bit/field.  
 d. Also may be controlled by DSLPCLKCFG when in deep sleep mode.

**Note:** The figure above shows all features available on all Stellaris® Fury-class devices. Not all peripherals may be available on this device.

In the **RCC** register, the **SYSDIV** field specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the **BYPASS** bit in this register is configured). When using the PLL, the VCO frequency of 400 MHz is predivided by 2 before the divisor is applied. Table 5-5 shows how the **SYSDIV** encoding affects the system clock frequency, depending on whether the PLL is used (**BYPASS**=0) or another clock source is used (**BYPASS**=1). The divisor is equivalent to the **SYSDIV** encoding plus 1. For a list of possible clock sources, see Table 5-4 on page 167.

**Table 5-5. Possible System Clock Frequencies Using the SYSDIV Field**

SYSDIV	Divisor	Frequency (BYPASS=0)	Frequency (BYPASS=1)	StellarisWare Parameter <sup>a</sup>
0x0	/1	reserved	Clock source frequency/2	SYSCCTL_SYSDIV_1 <sup>b</sup>
0x1	/2	reserved	Clock source frequency/2	SYSCCTL_SYSDIV_2
0x2	/3	reserved	Clock source frequency/3	SYSCCTL_SYSDIV_3
0x3	/4	reserved	Clock source frequency/4	SYSCCTL_SYSDIV_4
0x4	/5	reserved	Clock source frequency/5	SYSCCTL_SYSDIV_5
0x5	/6	reserved	Clock source frequency/6	SYSCCTL_SYSDIV_6
0x6	/7	reserved	Clock source frequency/7	SYSCCTL_SYSDIV_7
0x7	/8	25 MHz	Clock source frequency/8	SYSCCTL_SYSDIV_8
0x8	/9	reserved	Clock source frequency/9	SYSCCTL_SYSDIV_9
0x9	/10	20 MHz	Clock source frequency/10	SYSCCTL_SYSDIV_10
0xA	/11	18.18 MHz	Clock source frequency/11	SYSCCTL_SYSDIV_11
0xB	/12	16.67 MHz	Clock source frequency/12	SYSCCTL_SYSDIV_12
0xC	/13	15.38 MHz	Clock source frequency/13	SYSCCTL_SYSDIV_13
0xD	/14	14.29 MHz	Clock source frequency/14	SYSCCTL_SYSDIV_14
0xE	/15	13.33 MHz	Clock source frequency/15	SYSCCTL_SYSDIV_15
0xF	/16	12.5 MHz (default)	Clock source frequency/16	SYSCCTL_SYSDIV_16

a. This parameter is used in functions such as SysCtlClockSet() in the Stellaris Peripheral Driver Library.

b. SYSCCTL\_SYSDIV\_1 does not set the USESYSYSDIV bit. As a result, using this parameter without enabling the PLL results in the system clock having the same frequency as the clock source.

The SYSDIV2 field in the **RCC2** register is 2 bits wider than the SYSDIV field in the **RCC** register so that additional larger divisors up to /64 are possible, allowing a lower system clock frequency for improved Deep Sleep power consumption. When using the PLL, the VCO frequency of 400 MHz is predivided by 2 before the divisor is applied. The divisor is equivalent to the SYSDIV2 encoding plus 1. Table 5-6 shows how the SYSDIV2 encoding affects the system clock frequency, depending on whether the PLL is used (BYPASS2=0) or another clock source is used (BYPASS2=1). For a list of possible clock sources, see Table 5-4 on page 167.

**Table 5-6. Examples of Possible System Clock Frequencies Using the SYSDIV2 Field**

SYSDIV2	Divisor	Frequency (BYPASS2=0)	Frequency (BYPASS2=1)	StellarisWare Parameter <sup>a</sup>
0x00	/1	reserved	Clock source frequency/2	SYSCCTL_SYSDIV_1 <sup>b</sup>
0x01	/2	reserved	Clock source frequency/2	SYSCCTL_SYSDIV_2
0x02	/3	reserved	Clock source frequency/3	SYSCCTL_SYSDIV_3
0x03	/4	reserved	Clock source frequency/4	SYSCCTL_SYSDIV_4
0x04	/5	reserved	Clock source frequency/5	SYSCCTL_SYSDIV_5
0x05	/6	reserved	Clock source frequency/6	SYSCCTL_SYSDIV_6
0x06	/7	reserved	Clock source frequency/7	SYSCCTL_SYSDIV_7
0x07	/8	reserved	Clock source frequency/8	SYSCCTL_SYSDIV_8
0x08	/9	reserved	Clock source frequency/9	SYSCCTL_SYSDIV_9
0x09	/10	20 MHz	Clock source frequency/10	SYSCCTL_SYSDIV_10
...	...	...	...	...

**Table 5-6. Examples of Possible System Clock Frequencies Using the SYSDIV2 Field**  
(continued)

SYSDIV2	Divisor	Frequency (BYPASS2=0)	Frequency (BYPASS2=1)	StellarisWare Parameter <sup>a</sup>
0x3F	/64	3.125 MHz	Clock source frequency/64	SYSTCTL_SYSDIV_64

a. This parameter is used in functions such as SysCtlClockSet() in the Stellaris Peripheral Driver Library.

b. SYSTCTL\_SYSDIV\_1 does not set the USESYSDIV bit. As a result, using this parameter without enabling the PLL results in the system clock having the same frequency as the clock source.

### 5.2.4.3 Crystal Configuration for the Main Oscillator (MOSC)

The main oscillator supports the use of a select number of crystals. If the main oscillator is used by the PLL as a reference clock, the supported range of crystals is 3.579545 to 8.192 MHz, otherwise, the range of supported crystals is 1 to 8.192 MHz.

The XTAL bit in the **RCC** register (see page 182) describes the available crystal choices and default programming values.

Software configures the **RCC** register XTAL field with the crystal number. If the PLL is used in the design, the XTAL field value is internally translated to the PLL settings.

### 5.2.4.4 Main PLL Frequency Configuration

The main PLL is disabled by default during power-on reset and is enabled later by software if required. Software specifies the output divisor to set the system clock frequency, and enables the main PLL to drive the output. The PLL operates at 400 MHz, but is divided by two prior to the application of the output divisor.

If the main oscillator provides the clock reference to the main PLL, the translation provided by hardware and used to program the PLL is available for software in the **XTAL to PLL Translation (PLLCFG)** register (see page 185). The internal translation provides a translation within  $\pm 1\%$  of the targeted PLL VCO frequency. Table 17-9 on page 518 shows the actual PLL frequency and error for a given crystal choice.

The Crystal Value field (XTAL) in the **Run-Mode Clock Configuration (RCC)** register (see page 182) describes the available crystal choices and default programming of the **PLLCFG** register. Any time the XTAL field changes, the new settings are translated and the internal PLL settings are updated.

### 5.2.4.5 PLL Modes

The PLL has two modes of operation: Normal and Power-Down

- Normal: The PLL multiplies the input clock reference and drives the output.
- Power-Down: Most of the PLL internal circuitry is disabled and the PLL does not drive the output.

The modes are programmed using the **RCC/RCC2** register fields (see page 182 and page 186).

### 5.2.4.6 PLL Operation

If a PLL configuration is changed, the PLL output frequency is unstable until it reconverges (relocks) to the new setting. The time between the configuration change and relock is  $T_{\text{READY}}$  (see Table 17-8 on page 517). During the relock time, the affected PLL is not usable as a clock reference.

PLL is changed by one of the following:

- Change to the XTAL value in the **RCC** register—writes of the same value do not cause a relock.

- Change in the PLL from Power-Down to Normal mode.

A counter is defined to measure the  $T_{\text{READY}}$  requirement. The counter is clocked by the main oscillator. The range of the main oscillator has been taken into account and the down counter is set to 0x1200 (that is, ~600  $\mu\text{s}$  at an 8.192 MHz external oscillator clock). Hardware is provided to keep the PLL from being used as a system clock until the  $T_{\text{READY}}$  condition is met after one of the two changes above. It is the user's responsibility to have a stable clock source (like the main oscillator) before the **RCC/RCC2** register is switched to use the PLL.

If the main PLL is enabled and the system clock is switched to use the PLL in one step, the system control hardware continues to clock the controller from the oscillator selected by the **RCC/RCC2** register until the main PLL is stable ( $T_{\text{READY}}$  time met), after which it changes to the PLL. Software can use many methods to ensure that the system is clocked from the main PLL, including periodically polling the **PLLLRIS** bit in the **Raw Interrupt Status (RIS)** register, and enabling the PLL Lock interrupt.

### 5.2.5 System Control

For power-savings purposes, the **RCGCn**, **SCGCn**, and **DCGCn** registers control the clock gating logic for each peripheral or block in the system while the controller is in Run, Sleep, and Deep-Sleep mode, respectively.

There are four levels of operation for the device defined as:

- **Run Mode.** In Run mode, the controller actively executes code. Run mode provides normal operation of the processor and all of the peripherals that are currently enabled by the **RCGCn** registers. The system clock can be any of the available clock sources including the PLL.
- **Sleep Mode.** In Sleep mode, the clock frequency of the active peripherals is unchanged, but the processor and the memory subsystem are not clocked and therefore no longer execute code. Sleep mode is entered by the Cortex-M3 core executing a **WFI**(Wait for Interrupt) instruction. Any properly configured interrupt event in the system will bring the processor back into Run mode. See "Power Management" on page 78 for more details.

Peripherals are clocked that are enabled in the **SCGCn** register when auto-clock gating is enabled (see the **RCC** register) or the **RCGCn** register when the auto-clock gating is disabled. The system clock has the same source and frequency as that during Run mode.

- **Deep-Sleep Mode.** In Deep-Sleep mode, the clock frequency of the active peripherals may change (depending on the Run mode clock configuration) in addition to the processor clock being stopped. An interrupt returns the device to Run mode from one of the sleep modes; the sleep modes are entered on request from the code. Deep-Sleep mode is entered by first writing the Deep Sleep Enable bit in the ARM Cortex-M3 NVIC system control register and then executing a **WFI** instruction. Any properly configured interrupt event in the system will bring the processor back into Run mode. See "Power Management" on page 78 for more details.

The Cortex-M3 processor core and the memory subsystem are not clocked. Peripherals are clocked that are enabled in the **DCGCn** register when auto-clock gating is enabled (see the **RCC** register) or the **RCGCn** register when auto-clock gating is disabled. The system clock source is the main oscillator by default or the internal oscillator specified in the **DSLPCCLKCFG** register if one is enabled. When the **DSLPCCLKCFG** register is used, the internal oscillator is powered up, if necessary, and the main oscillator is powered down. If the PLL is running at the time of the **WFI** instruction, hardware will power the PLL down and override the **SYSDIV** field of the active **RCC/RCC2** register, to be determined by the **DSDIVORIDE** setting in the **DSLPCCLKCFG** register, up to /16 or /64 respectively. When the Deep-Sleep exit event occurs, hardware brings the system

clock back to the source and frequency it had at the onset of Deep-Sleep mode before enabling the clocks that had been stopped during the Deep-Sleep duration.

**Caution – If the Cortex-M3 Debug Access Port (DAP) has been enabled, and the device wakes from a low power sleep or deep-sleep mode, the core may start executing code before all clocks to peripherals have been restored to their run mode configuration. The DAP is usually enabled by software tools accessing the JTAG or SWD interface when debugging or flash programming. If this condition occurs, a Hard Fault is triggered when software accesses a peripheral with an invalid clock.**

A software delay loop can be used at the beginning of the interrupt routine that is used to wake up a system from a WFI (Wait For Interrupt) instruction. This stalls the execution of any code that accesses a peripheral register that might cause a fault. This loop can be removed for production software as the DAP is most likely not enabled during normal execution.

Because the DAP is disabled by default (power on reset), the user can also power-cycle the device. The DAP is not enabled unless it is enabled through the JTAG or SWD interface.

### 5.3 Initialization and Configuration

The PLL is configured using direct register writes to the **RCC/RCC2** register. If the **RCC2** register is being used, the **USERCC2** bit must be set and the appropriate **RCC2** bit/field is used. The steps required to successfully change the PLL-based system clock are:

1. Bypass the PLL and system clock divider by setting the **BYPASS** bit and clearing the **USESYS** bit in the **RCC** register. This configures the system to run off a “raw” clock source and allows for the new PLL configuration to be validated before switching the system clock to the PLL.
2. Select the crystal value (**XTAL**) and oscillator source (**OSCSRC**), and clear the **PWRDN** bit in **RCC/RCC2**. Setting the **XTAL** field automatically pulls valid PLL configuration data for the appropriate crystal, and clearing the **PWRDN** bit powers and enables the PLL and its output.
3. Select the desired system divider (**SYSDIV**) in **RCC/RCC2** and set the **USESYS** bit in **RCC**. The **SYSDIV** field determines the system frequency for the microcontroller.
4. Wait for the PLL to lock by polling the **PLLLRIS** bit in the **Raw Interrupt Status (RIS)** register.
5. Enable use of the PLL by clearing the **BYPASS** bit in **RCC/RCC2**.

### 5.4 Register Map

Table 5-7 on page 172 lists the System Control registers, grouped by function. The offset listed is a hexadecimal increment to the register's address, relative to the System Control base address of 0x400F.E000.

**Note:** Spaces in the System Control register space that are not used are reserved for future or internal use. Software should not modify any reserved memory address.

**Table 5-7. System Control Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	DID0	RO	-	Device Identification 0	174
0x004	DID1	RO	-	Device Identification 1	189

Table 5-7. System Control Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x008	DC0	RO	0x003F.001F	Device Capabilities 0	191
0x010	DC1	RO	0x0000.709F	Device Capabilities 1	192
0x014	DC2	RO	0x0107.0011	Device Capabilities 2	194
0x018	DC3	RO	0x8F00.01C0	Device Capabilities 3	195
0x01C	DC4	RO	0x5000.007F	Device Capabilities 4	196
0x030	PBORCTL	R/W	0x0000.7FFD	Brown-Out Reset Control	176
0x034	LDOPCTL	R/W	0x0000.0000	LDO Power Control	177
0x040	SRCR0	R/W	0x00000000	Software Reset Control 0	213
0x044	SRCR1	R/W	0x00000000	Software Reset Control 1	214
0x048	SRCR2	R/W	0x00000000	Software Reset Control 2	215
0x050	RIS	RO	0x0000.0000	Raw Interrupt Status	178
0x054	IMC	R/W	0x0000.0000	Interrupt Mask Control	179
0x058	MISC	R/W1C	0x0000.0000	Masked Interrupt Status and Clear	180
0x05C	RESC	R/W	-	Reset Cause	181
0x060	RCC	R/W	0x0780.3AD1	Run-Mode Clock Configuration	182
0x064	PLLCFG	RO	-	XTAL to PLL Translation	185
0x070	RCC2	R/W	0x0780.2810	Run-Mode Clock Configuration 2	186
0x100	RCGC0	R/W	0x00000040	Run Mode Clock Gating Control Register 0	198
0x104	RCGC1	R/W	0x00000000	Run Mode Clock Gating Control Register 1	201
0x108	RCGC2	R/W	0x00000000	Run Mode Clock Gating Control Register 2	207
0x110	SCGC0	R/W	0x00000040	Sleep Mode Clock Gating Control Register 0	199
0x114	SCGC1	R/W	0x00000000	Sleep Mode Clock Gating Control Register 1	203
0x118	SCGC2	R/W	0x00000000	Sleep Mode Clock Gating Control Register 2	209
0x120	DCGC0	R/W	0x00000040	Deep Sleep Mode Clock Gating Control Register 0	200
0x124	DCGC1	R/W	0x00000000	Deep Sleep Mode Clock Gating Control Register 1	205
0x128	DCGC2	R/W	0x00000000	Deep Sleep Mode Clock Gating Control Register 2	211
0x144	DSLPCCLKCFG	R/W	0x0780.0000	Deep Sleep Clock Configuration	188

## 5.5 Register Descriptions

All addresses given are relative to the System Control base address of 0x400F.E000.

### Register 1: Device Identification 0 (DID0), offset 0x000

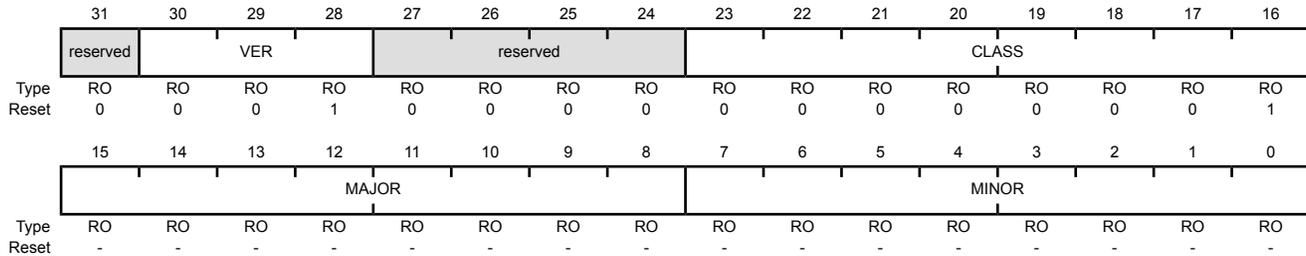
This register identifies the version of the microcontroller. Each microcontroller is uniquely identified by the combined values of the CLASS field in the **DID0** register and the PARTNO field in the **DID1** register.

#### Device Identification 0 (DID0)

Base 0x400F.E000

Offset 0x000

Type RO, reset -



Bit/Field	Name	Type	Reset	Description				
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.				
30:28	VER	RO	0x1	<p>DID0 Version</p> <p>This field defines the <b>DID0</b> register format version. The version number is numeric. The value of the VER field is encoded as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x1</td> <td>Second version of the <b>DID0</b> register format.</td> </tr> </tbody> </table>	Value	Description	0x1	Second version of the <b>DID0</b> register format.
Value	Description							
0x1	Second version of the <b>DID0</b> register format.							
27:24	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.				
23:16	CLASS	RO	0x1	<p>Device Class</p> <p>The CLASS field value identifies the internal design from which all mask sets are generated for all devices in a particular product line. The CLASS field value is changed for new product lines, for changes in fab process (for example, a remap or shrink), or any case where the MAJOR or MINOR fields require differentiation from prior devices. The value of the CLASS field is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x1</td> <td>Stellaris® Fury-class devices.</td> </tr> </tbody> </table>	Value	Description	0x1	Stellaris® Fury-class devices.
Value	Description							
0x1	Stellaris® Fury-class devices.							

Bit/Field	Name	Type	Reset	Description								
15:8	MAJOR	RO	-	<p>Major Revision</p> <p>This field specifies the major revision number of the device. The major revision reflects changes to base layers of the design. The major revision number is indicated in the part number as a letter (A for first revision, B for second, and so on). This field is encoded as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Revision A (initial device)</td> </tr> <tr> <td>0x1</td> <td>Revision B (first base layer revision)</td> </tr> <tr> <td>0x2</td> <td>Revision C (second base layer revision)</td> </tr> </tbody> </table> <p>and so on.</p>	Value	Description	0x0	Revision A (initial device)	0x1	Revision B (first base layer revision)	0x2	Revision C (second base layer revision)
Value	Description											
0x0	Revision A (initial device)											
0x1	Revision B (first base layer revision)											
0x2	Revision C (second base layer revision)											
7:0	MINOR	RO	-	<p>Minor Revision</p> <p>This field specifies the minor revision number of the device. The minor revision reflects changes to the metal layers of the design. The <code>MINOR</code> field value is reset when the <code>MAJOR</code> field is changed. This field is numeric and is encoded as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Initial device, or a major revision update.</td> </tr> <tr> <td>0x1</td> <td>First metal layer change.</td> </tr> <tr> <td>0x2</td> <td>Second metal layer change.</td> </tr> </tbody> </table> <p>and so on.</p>	Value	Description	0x0	Initial device, or a major revision update.	0x1	First metal layer change.	0x2	Second metal layer change.
Value	Description											
0x0	Initial device, or a major revision update.											
0x1	First metal layer change.											
0x2	Second metal layer change.											

## Register 2: Brown-Out Reset Control (PBORCTL), offset 0x030

This register is responsible for controlling reset conditions after initial power-on reset.

### Brown-Out Reset Control (PBORCTL)

Base 0x400F.E000

Offset 0x030

Type R/W, reset 0x0000.7FFD

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved															BORIOR	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	BORIOR	R/W	0	BOR Interrupt or Reset This bit controls how a BOR event is signaled to the controller. If set, a reset is signaled. Otherwise, an interrupt is signaled.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 3: LDO Power Control (LDOPCTL), offset 0x034**

The  $V_{ADJ}$  field in this register adjusts the on-chip output voltage ( $V_{OUT}$ ).

**LDO Power Control (LDOPCTL)**

Base 0x400F.E000

Offset 0x034

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved										VADJ					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:0	VADJ	R/W	0x0	LDO Output Voltage This field sets the on-chip output voltage. The programming values for the $V_{ADJ}$ field are provided below.
	Value	$V_{OUT}$ (V)		
	0x00	2.50		
	0x01	2.45		
	0x02	2.40		
	0x03	2.35		
	0x04	2.30		
	0x05	2.25		
	0x06-0x3F	Reserved		
	0x1B	2.75		
	0x1C	2.70		
	0x1D	2.65		
	0x1E	2.60		
	0x1F	2.55		

## Register 4: Raw Interrupt Status (RIS), offset 0x050

Central location for system control raw interrupts. These are set and cleared by hardware.

### Raw Interrupt Status (RIS)

Base 0x400F.E000  
 Offset 0x050  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PLLLRIS	reserved				BORRIS	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PLLLRIS	RO	0	PLL Lock Raw Interrupt Status This bit is set when the PLL T <sub>READY</sub> Timer asserts.
5:2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	BORRIS	RO	0	Brown-Out Reset Raw Interrupt Status This bit is the raw interrupt status for any brown-out conditions. If set, a brown-out condition is currently active. This is an unregistered signal from the brown-out detection circuit. An interrupt is reported if the BORIM bit in the IMC register is set and the BORIOR bit in the PBORCTL register is cleared.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 5: Interrupt Mask Control (IMC), offset 0x054**

Central location for system control interrupt masks.

## Interrupt Mask Control (IMC)

Base 0x400F.E000

Offset 0x054

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PLLLIM	reserved				BORIM	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PLLLIM	R/W	0	PLL Lock Interrupt Mask This bit specifies whether a PLL Lock interrupt is promoted to a controller interrupt. If set, an interrupt is generated if <code>PLLLRIS</code> in <b>RIS</b> is set; otherwise, an interrupt is not generated.
5:2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	BORIM	R/W	0	Brown-Out Reset Interrupt Mask This bit specifies whether a brown-out condition is promoted to a controller interrupt. If set, an interrupt is generated if <code>BORRIS</code> is set; otherwise, an interrupt is not generated.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 6: Masked Interrupt Status and Clear (MISC), offset 0x058

On a read, this register gives the current masked status value of the corresponding interrupt. All of the bits are R/W1C and this action also clears the corresponding raw interrupt bit in the **RIS** register (see page 178).

### Masked Interrupt Status and Clear (MISC)

Base 0x400F.E000  
Offset 0x058  
Type R/W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PLLLMIS	reserved				BORMIS	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W1C	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PLLLMIS	R/W1C	0	PLL Lock Masked Interrupt Status This bit is set when the PLL T <sub>READY</sub> timer asserts. The interrupt is cleared by writing a 1 to this bit.
5:2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	BORMIS	R/W1C	0	BOR Masked Interrupt Status The BORMIS is simply the BORRIS ANDed with the mask value, BORIM.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 7: Reset Cause (RESC), offset 0x05C**

This register is set with the reset cause after reset. The bits in this register are sticky and maintain their state across multiple reset sequences, except when a power- on reset or an external reset is the cause, in which case, all bits other than `POR` or `EXT` in the **RESC** register are cleared.

**Reset Cause (RESC)**

Base 0x400F.E000

Offset 0x05C

Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												SW	WDT	BOR	POR	EXT
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SW	R/W	-	Software Reset When set, indicates a software reset is the cause of the reset event.
3	WDT	R/W	-	Watchdog Timer Reset When set, indicates a watchdog reset is the cause of the reset event.
2	BOR	R/W	-	Brown-Out Reset When set, indicates a brown-out reset is the cause of the reset event.
1	POR	R/W	-	Power-On Reset When set, indicates a power-on reset is the cause of the reset event.
0	EXT	R/W	-	External Reset When set, indicates an external reset ( $\overline{RST}$ assertion) is the cause of the reset event.

## Register 8: Run-Mode Clock Configuration (RCC), offset 0x060

This register is defined to provide source control and frequency speed.

### Run-Mode Clock Configuration (RCC)

Base 0x400F.E000

Offset 0x060

Type R/W, reset 0x0780.3AD1

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved				ACG	SYSDIV				USESYSDIV	reserved					
Type	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved		PWRDN	reserved	BYPASS	reserved	XTAL				OSCSRC		reserved		IOSCDIS	MOSCDIS
Type	RO	RO	R/W	RO	R/W	RO	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	R/W	R/W
Reset	0	0	1	1	1	0	1	0	1	1	0	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:28	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
27	ACG	R/W	0	<p>Auto Clock Gating</p> <p>This bit specifies whether the system uses the <b>Sleep-Mode Clock Gating Control (SCGCn)</b> registers and <b>Deep-Sleep-Mode Clock Gating Control (DCGCn)</b> registers if the controller enters a Sleep or Deep-Sleep mode (respectively). If set, the <b>SCGCn</b> or <b>DCGCn</b> registers are used to control the clocks distributed to the peripherals when the controller is in a sleep mode. Otherwise, the <b>Run-Mode Clock Gating Control (RCGCn)</b> registers are used when the controller enters a sleep mode.</p> <p>The <b>RCGCn</b> registers are always used to control the clocks in Run mode.</p> <p>This allows peripherals to consume less power when the controller is in a sleep mode and the peripheral is unused.</p>
26:23	SYSDIV	R/W	0xF	<p>System Clock Divisor</p> <p>Specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the <b>BYPASS</b> bit in this register is configured). See Table 5-5 on page 169 for bit encodings.</p> <p>If the <b>SYSDIV</b> value is less than <b>MINSYSDIV</b> (see page 192), and the PLL is being used, then the <b>MINSYSDIV</b> value is used as the divisor.</p> <p>If the PLL is not being used, the <b>SYSDIV</b> value can be less than <b>MINSYSDIV</b>.</p>
22	USESYSDIV	R/W	0	<p>Enable System Clock Divider</p> <p>Use the system clock divider as the source for the system clock. The system clock divider is forced to be used when the PLL is selected as the source.</p> <p>If the <b>USERCC2</b> bit in the <b>RCC2</b> register is set, then the <b>SYSDIV2</b> field in the <b>RCC2</b> register is used as the system clock divider rather than the <b>SYSDIV</b> field in this register.</p>

Bit/Field	Name	Type	Reset	Description																																																			
21:14	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																																																			
13	PWRDN	R/W	1	PLL Power Down This bit connects to the PLL PWRDN input. The reset value of 1 powers down the PLL.																																																			
12	reserved	RO	1	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																																																			
11	BYPASS	R/W	1	PLL Bypass Chooses whether the system clock is derived from the PLL output or the OSC source. If set, the clock that drives the system is the OSC source. Otherwise, the clock that drives the system is the PLL output clock divided by the system divider. See Table 5-5 on page 169 for programming guidelines.																																																			
10	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																																																			
9:6	XTAL	R/W	0xB	Crystal Value This field specifies the crystal value attached to the main oscillator. The encoding for this field is provided below. Depending on the crystal used, the PLL frequency may not be exactly 400 MHz (see Table 17-9 on page 518 for more information).  <table border="1"> <thead> <tr> <th>Value</th> <th>Crystal Frequency (MHz) Not Using the PLL</th> <th>Crystal Frequency (MHz) Using the PLL</th> </tr> </thead> <tbody> <tr><td>0x0</td><td>1.000</td><td>reserved</td></tr> <tr><td>0x1</td><td>1.8432</td><td>reserved</td></tr> <tr><td>0x2</td><td>2.000</td><td>reserved</td></tr> <tr><td>0x3</td><td>2.4576</td><td>reserved</td></tr> <tr><td>0x4</td><td></td><td>3.579545 MHz</td></tr> <tr><td>0x5</td><td></td><td>3.6864 MHz</td></tr> <tr><td>0x6</td><td></td><td>4 MHz</td></tr> <tr><td>0x7</td><td></td><td>4.096 MHz</td></tr> <tr><td>0x8</td><td></td><td>4.9152 MHz</td></tr> <tr><td>0x9</td><td></td><td>5 MHz</td></tr> <tr><td>0xA</td><td></td><td>5.12 MHz</td></tr> <tr><td>0xB</td><td></td><td>6 MHz (reset value)</td></tr> <tr><td>0xC</td><td></td><td>6.144 MHz</td></tr> <tr><td>0xD</td><td></td><td>7.3728 MHz</td></tr> <tr><td>0xE</td><td></td><td>8 MHz</td></tr> <tr><td>0xF</td><td></td><td>8.192 MHz</td></tr> </tbody> </table>	Value	Crystal Frequency (MHz) Not Using the PLL	Crystal Frequency (MHz) Using the PLL	0x0	1.000	reserved	0x1	1.8432	reserved	0x2	2.000	reserved	0x3	2.4576	reserved	0x4		3.579545 MHz	0x5		3.6864 MHz	0x6		4 MHz	0x7		4.096 MHz	0x8		4.9152 MHz	0x9		5 MHz	0xA		5.12 MHz	0xB		6 MHz (reset value)	0xC		6.144 MHz	0xD		7.3728 MHz	0xE		8 MHz	0xF		8.192 MHz
Value	Crystal Frequency (MHz) Not Using the PLL	Crystal Frequency (MHz) Using the PLL																																																					
0x0	1.000	reserved																																																					
0x1	1.8432	reserved																																																					
0x2	2.000	reserved																																																					
0x3	2.4576	reserved																																																					
0x4		3.579545 MHz																																																					
0x5		3.6864 MHz																																																					
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0x7		4.096 MHz																																																					
0x8		4.9152 MHz																																																					
0x9		5 MHz																																																					
0xA		5.12 MHz																																																					
0xB		6 MHz (reset value)																																																					
0xC		6.144 MHz																																																					
0xD		7.3728 MHz																																																					
0xE		8 MHz																																																					
0xF		8.192 MHz																																																					

Bit/Field	Name	Type	Reset	Description										
5:4	OSCSRC	R/W	0x1	<p>Oscillator Source</p> <p>Selects the input source for the OSC. The values are:</p> <table border="0"> <tr> <td>Value</td> <td>Input Source</td> </tr> <tr> <td>0x0</td> <td>MOSC Main oscillator</td> </tr> <tr> <td>0x1</td> <td>IOSC Internal oscillator (default)</td> </tr> <tr> <td>0x2</td> <td>IOSC/4 Internal oscillator / 4</td> </tr> <tr> <td>0x3</td> <td>30 kHz 30-KHz internal oscillator</td> </tr> </table> <p>For additional oscillator sources, see the <b>RCC2</b> register.</p>	Value	Input Source	0x0	MOSC Main oscillator	0x1	IOSC Internal oscillator (default)	0x2	IOSC/4 Internal oscillator / 4	0x3	30 kHz 30-KHz internal oscillator
Value	Input Source													
0x0	MOSC Main oscillator													
0x1	IOSC Internal oscillator (default)													
0x2	IOSC/4 Internal oscillator / 4													
0x3	30 kHz 30-KHz internal oscillator													
3:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
1	IOSCDIS	R/W	0	<p>Internal Oscillator Disable</p> <p>0: Internal oscillator (IOSC) is enabled. 1: Internal oscillator is disabled.</p>										
0	MOSCDIS	R/W	1	<p>Main Oscillator Disable</p> <p>0: Main oscillator is enabled . 1: Main oscillator is disabled (default).</p>										

## Register 9: XTAL to PLL Translation (PLLCFG), offset 0x064

This register provides a means of translating external crystal frequencies into the appropriate PLL settings. This register is initialized during the reset sequence and updated anytime that the XTAL field changes in the **Run-Mode Clock Configuration (RCC)** register (see page 182).

The PLL frequency is calculated using the **PLLCFG** field values, as follows:

$$\text{PLLFreq} = \text{OSCFreq} * F / (R + 1)$$

### XTAL to PLL Translation (PLLCFG)

Base 0x400F.E000

Offset 0x064

Type RO, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved		F										R			
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:14	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
13:5	F	RO	-	PLL F Value This field specifies the value supplied to the PLL's F input.
4:0	R	RO	-	PLL R Value This field specifies the value supplied to the PLL's R input.

## Register 10: Run-Mode Clock Configuration 2 (RCC2), offset 0x070

This register overrides the **RCC** equivalent register fields, as shown in Table 5-8, when the `USERCC2` bit is set, allowing the extended capabilities of the **RCC2** register to be used while also providing a means to be backward-compatible to previous parts. Each **RCC2** field that supersedes an **RCC** field is located at the same LSB bit position; however, some **RCC2** fields are larger than the corresponding **RCC** field.

**Table 5-8. RCC2 Fields that Override RCC fields**

RCC2 Field...	Overrides RCC Field
<code>SYSDIV2</code> , bits[28:23]	<code>SYSDIV</code> , bits[26:23]
<code>PWRDN2</code> , bit[13]	<code>PWRDN</code> , bit[13]
<code>BYPASS2</code> , bit[11]	<code>BYPASS</code> , bit[11]
<code>OSCSRC2</code> , bits[6:4]	<code>OSCSRC</code> , bits[5:4]

### Run-Mode Clock Configuration 2 (RCC2)

Base 0x400F.E000

Offset 0x070

Type R/W, reset 0x0780.2810

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	USERCC2	reserved		SYSDIV2						reserved						
Type	R/W	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved		PWRDN2	reserved	BYPASS2	reserved			OSCSRC2			reserved				
Type	RO	RO	R/W	RO	R/W	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO
Reset	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31	USERCC2	R/W	0	Use RCC2 When set, overrides the <b>RCC</b> register fields.
30:29	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28:23	SYSDIV2	R/W	0x0F	System Clock Divisor Specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the <code>BYPASS2</code> bit is configured). <code>SYSDIV2</code> is used for the divisor when both the <code>USESYSCLK</code> bit in the <b>RCC</b> register and the <code>USERCC2</code> bit in this register are set. See Table 5-6 on page 169 for programming guidelines.
22:14	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
13	PWRDN2	R/W	1	Power-Down PLL When set, powers down the PLL.
12	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description																		
11	BYPASS2	R/W	1	Bypass PLL When set, bypasses the PLL for the clock source. See Table 5-6 on page 169 for programming guidelines.																		
10:7	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																		
6:4	OSCSRC2	R/W	0x1	Oscillator Source Selects the input source for the OSC. The values are:  <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>MOSC Main oscillator</td> </tr> <tr> <td>0x1</td> <td>IOSC Internal oscillator</td> </tr> <tr> <td>0x2</td> <td>IOSC/4 Internal oscillator / 4</td> </tr> <tr> <td>0x3</td> <td>30 kHz 30-kHz internal oscillator</td> </tr> <tr> <td>0x4</td> <td>Reserved</td> </tr> <tr> <td>0x5</td> <td>Reserved</td> </tr> <tr> <td>0x6</td> <td>Reserved</td> </tr> <tr> <td>0x7</td> <td>Reserved</td> </tr> </tbody> </table>	Value	Description	0x0	MOSC Main oscillator	0x1	IOSC Internal oscillator	0x2	IOSC/4 Internal oscillator / 4	0x3	30 kHz 30-kHz internal oscillator	0x4	Reserved	0x5	Reserved	0x6	Reserved	0x7	Reserved
Value	Description																					
0x0	MOSC Main oscillator																					
0x1	IOSC Internal oscillator																					
0x2	IOSC/4 Internal oscillator / 4																					
0x3	30 kHz 30-kHz internal oscillator																					
0x4	Reserved																					
0x5	Reserved																					
0x6	Reserved																					
0x7	Reserved																					
3:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																		

## Register 11: Deep Sleep Clock Configuration (DSLPCCLKCFG), offset 0x144

This register provides configuration information for the hardware control of Deep Sleep Mode.

### Deep Sleep Clock Configuration (DSLPCCLKCFG)

Base 0x400F.E000  
 Offset 0x144  
 Type R/W, reset 0x0780.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved			DSDIVORIDE						reserved						
Type	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved						DSOSCSRC				reserved					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:29	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28:23	DSDIVORIDE	R/W	0x0F	Divider Field Override 6-bit system divider field to override when Deep-Sleep occurs with PLL running.
22:7	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6:4	DSOSCSRC	R/W	0x0	Clock Source Specifies the clock source during Deep-Sleep mode.
				Value Description
			0x0	MOSC Use main oscillator as source.
			0x1	IOSC Use internal 12-MHz oscillator as source.
			0x2	Reserved
			0x3	30 kHz Use 30-kHz internal oscillator as source.
			0x4	Reserved
			0x5	Reserved
			0x6	Reserved
			0x7	Reserved
3:0	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 12: Device Identification 1 (DID1), offset 0x004

This register identifies the device family, part number, temperature range, pin count, and package type. Each microcontroller is uniquely identified by the combined values of the `CLASS` field in the `DID0` register and the `PARTNO` field in the `DID1` register.

### Device Identification 1 (DID1)

Base 0x400F.E000

Offset 0x004

Type RO, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	VER				FAM				PARTNO							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	PINCOUNT			reserved				TEMP			PKG		ROHS	QUAL		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	1	0	0	0	0	0	0	-	-	-	-	-	1	-	-

Bit/Field	Name	Type	Reset	Description				
31:28	VER	RO	0x1	<p>DID1 Version</p> <p>This field defines the <b>DID1</b> register format version. The version number is numeric. The value of the <code>VER</code> field is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x1</td> <td>Second version of the <b>DID1</b> register format.</td> </tr> </tbody> </table>	Value	Description	0x1	Second version of the <b>DID1</b> register format.
Value	Description							
0x1	Second version of the <b>DID1</b> register format.							
27:24	FAM	RO	0x0	<p>Family</p> <p>This field provides the family identification of the device within the Luminary Micro product portfolio. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S.</td> </tr> </tbody> </table>	Value	Description	0x0	Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S.
Value	Description							
0x0	Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S.							
23:16	PARTNO	RO	0xA1	<p>Part Number</p> <p>This field provides the part number of the device within the family. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0xA1</td> <td>LM3S6100</td> </tr> </tbody> </table>	Value	Description	0xA1	LM3S6100
Value	Description							
0xA1	LM3S6100							
15:13	PINCOUNT	RO	0x2	<p>Package Pin Count</p> <p>This field specifies the number of pins on the device package. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x2</td> <td>100-pin or 108-ball package</td> </tr> </tbody> </table>	Value	Description	0x2	100-pin or 108-ball package
Value	Description							
0x2	100-pin or 108-ball package							

Bit/Field	Name	Type	Reset	Description
12:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:5	TEMP	RO	-	Temperature Range This field specifies the temperature rating of the device. The value is encoded as follows (all other encodings are reserved):  Value Description 0x0 Commercial temperature range (0°C to 70°C) 0x1 Industrial temperature range (-40°C to 85°C) 0x2 Extended temperature range (-40°C to 105°C)
4:3	PKG	RO	-	Package Type This field specifies the package type. The value is encoded as follows (all other encodings are reserved):  Value Description 0x0 SOIC package 0x1 LQFP package 0x2 BGA package
2	ROHS	RO	1	RoHS-Compliance This bit specifies whether the device is RoHS-compliant. A 1 indicates the part is RoHS-compliant.
1:0	QUAL	RO	-	Qualification Status This field specifies the qualification status of the device. The value is encoded as follows (all other encodings are reserved):  Value Description 0x0 Engineering Sample (unqualified) 0x1 Pilot Production (unqualified) 0x2 Fully Qualified

**Register 13: Device Capabilities 0 (DC0), offset 0x008**

This register is predefined by the part and can be used to verify features.

**Device Capabilities 0 (DC0)**

Base 0x400F.E000

Offset 0x008

Type RO, reset 0x003F.001F

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	SRAMSZ															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	FLASHSZ															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:16	SRAMSZ	RO	0x003F	SRAM Size Indicates the size of the on-chip SRAM memory.  Value Description 0x003F 16 KB of SRAM
15:0	FLASHSZ	RO	0x001F	Flash Size Indicates the size of the on-chip flash memory.  Value Description 0x001F 64 KB of Flash

## Register 14: Device Capabilities 1 (DC1), offset 0x010

This register provides a list of features available in the system. The Stellaris family uses this register format to indicate the availability of the following family features in the specific device: CANs, PWM, ADC, Watchdog timer, Hibernation module, and debug capabilities. This register also indicates the maximum clock frequency and maximum ADC sample rate. The format of this register is consistent with the **RCGC0**, **SCGC0**, and **DCGC0** clock control registers and the **SRCR0** software reset control register.

### Device Capabilities 1 (DC1)

Base 0x400F.E000  
 Offset 0x010  
 Type RO, reset 0x0000.709F

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MINSYSDIV				reserved				MPU	reserved		PLL	WDT	SWO	SWD	JTAG
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	1	1	1	0	0	0	0	1	0	0	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:12	MINSYSDIV	RO	0x7	System Clock Divider Minimum 4-bit divider value for system clock. The reset value is hardware-dependent. See the <b>RCC</b> register for how to change the system clock divisor using the <b>SYSDIV</b> bit.  Value Description 0x7 Specifies a 25-MHz clock with a PLL divider of 8.
11:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7	MPU	RO	1	MPU Present When set, indicates that the Cortex-M3 Memory Protection Unit (MPU) module is present. See the "Cortex-M3 Peripherals" chapter in the Stellaris Data Sheet for details on the MPU.
6:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	PLL	RO	1	PLL Present When set, indicates that the on-chip Phase Locked Loop (PLL) is present.
3	WDT	RO	1	Watchdog Timer Present When set, indicates that a watchdog timer is present.

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Bit/Field	Name	Type	Reset	Description
2	SWO	RO	1	SWO Trace Port Present When set, indicates that the Serial Wire Output (SWO) trace port is present.
1	SWD	RO	1	SWD Present When set, indicates that the Serial Wire Debugger (SWD) is present.
0	JTAG	RO	1	JTAG Present When set, indicates that the JTAG debugger interface is present.

## Register 15: Device Capabilities 2 (DC2), offset 0x014

This register provides a list of features available in the system. The Stellaris family uses this register format to indicate the availability of the following family features in the specific device: Analog Comparators, General-Purpose Timers, I2Cs, QEIs, SSIs, and UARTs. The format of this register is consistent with the **RCGC1**, **SCGC1**, and **DCGC1** clock control registers and the **SRCR1** software reset control register.

### Device Capabilities 2 (DC2)

Base 0x400F.E000

Offset 0x014

Type RO, reset 0x0107.0011

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved							COMP0	reserved						TIMER2	TIMER1	TIMER0
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved											SSI0	reserved		UART0		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	

Bit/Field	Name	Type	Reset	Description
31:25	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
24	COMP0	RO	1	Analog Comparator 0 Present When set, indicates that analog comparator 0 is present.
23:19	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	TIMER2	RO	1	Timer 2 Present When set, indicates that General-Purpose Timer module 2 is present.
17	TIMER1	RO	1	Timer 1 Present When set, indicates that General-Purpose Timer module 1 is present.
16	TIMER0	RO	1	Timer 0 Present When set, indicates that General-Purpose Timer module 0 is present.
15:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SSI0	RO	1	SSI0 Present When set, indicates that SSI module 0 is present.
3:1	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	UART0	RO	1	UART0 Present When set, indicates that UART module 0 is present.

## Register 16: Device Capabilities 3 (DC3), offset 0x018

This register provides a list of features available in the system. The Stellaris family uses this register format to indicate the availability of the following family features in the specific device: Analog Comparator I/Os, CCP I/Os, ADC I/Os, and PWM I/Os.

### Device Capabilities 3 (DC3)

Base 0x400F.E000  
Offset 0x018  
Type RO, reset 0x8F00.01C0

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	32KHZ	reserved			CCP3	CCP2	CCP1	CCP0	reserved							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved							C00	C0PLUS	C0MINUS	reserved					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31	32KHZ	RO	1	32KHz Input Clock Available When set, indicates an even CCP pin is present and can be used as a 32-KHz input clock.
30:28	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
27	CCP3	RO	1	CCP3 Pin Present When set, indicates that Capture/Compare/PWM pin 3 is present.
26	CCP2	RO	1	CCP2 Pin Present When set, indicates that Capture/Compare/PWM pin 2 is present.
25	CCP1	RO	1	CCP1 Pin Present When set, indicates that Capture/Compare/PWM pin 1 is present.
24	CCP0	RO	1	CCP0 Pin Present When set, indicates that Capture/Compare/PWM pin 0 is present.
23:9	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
8	C00	RO	1	C0o Pin Present When set, indicates that the analog comparator 0 output pin is present.
7	C0PLUS	RO	1	C0+ Pin Present When set, indicates that the analog comparator 0 (+) input pin is present.
6	C0MINUS	RO	1	C0- Pin Present When set, indicates that the analog comparator 0 (-) input pin is present.
5:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 17: Device Capabilities 4 (DC4), offset 0x01C

This register provides a list of features available in the system. The Stellaris family uses this register format to indicate the availability of the following family features in the specific device: Ethernet MAC and PHY, GPIOs, and CCP I/Os. The format of this register is consistent with the **RCGC2**, **SCGC2**, and **DCGC2** clock control registers and the **SRCR2** software reset control register.

### Device Capabilities 4 (DC4)

Base 0x400F.E000  
 Offset 0x01C  
 Type RO, reset 0x5000.007F

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved	EPHY0	reserved	EMAC0	reserved												
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										GPIOG	GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	

Bit/Field	Name	Type	Reset	Description
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
30	EPHY0	RO	1	Ethernet PHY0 Present When set, indicates that Ethernet PHY module 0 is present.
29	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	EMAC0	RO	1	Ethernet MAC0 Present When set, indicates that Ethernet MAC module 0 is present.
27:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	GPIOG	RO	1	GPIO Port G Present When set, indicates that GPIO Port G is present.
5	GPIOF	RO	1	GPIO Port F Present When set, indicates that GPIO Port F is present.
4	GPIOE	RO	1	GPIO Port E Present When set, indicates that GPIO Port E is present.
3	GPIOD	RO	1	GPIO Port D Present When set, indicates that GPIO Port D is present.
2	GPIOC	RO	1	GPIO Port C Present When set, indicates that GPIO Port C is present.
1	GPIOB	RO	1	GPIO Port B Present When set, indicates that GPIO Port B is present.

Bit/Field	Name	Type	Reset	Description
0	GPIOA	RO	1	GPIO Port A Present When set, indicates that GPIO Port A is present.

### Register 18: Run Mode Clock Gating Control Register 0 (RCGC0), offset 0x100

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled (saving power). If the unit is unclocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

#### Run Mode Clock Gating Control Register 0 (RCGC0)

Base 0x400F.E000  
 Offset 0x100  
 Type R/W, reset 0x00000040

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											reserved	reserved	WDT	reserved	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	reserved	RO	1	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	WDT	R/W	0	WDT Clock Gating Control  This bit controls the clock gating for the WDT module. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, a read or write to the unit generates a bus fault.
2:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 19: Sleep Mode Clock Gating Control Register 0 (SCGC0), offset 0x110

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled (saving power). If the unit is unclocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Sleep Mode Clock Gating Control Register 0 (SCGC0)

Base 0x400F.E000  
Offset 0x110  
Type R/W, reset 0x00000040

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											reserved	reserved	WDT	reserved	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	reserved	RO	1	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	WDT	R/W	0	WDT Clock Gating Control This bit controls the clock gating for the WDT module. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, a read or write to the unit generates a bus fault.
2:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 20: Deep Sleep Mode Clock Gating Control Register 0 (DCGC0), offset 0x120

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled (saving power). If the unit is unclocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Deep Sleep Mode Clock Gating Control Register 0 (DCGC0)

Base 0x400F.E000  
 Offset 0x120  
 Type R/W, reset 0x00000040

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											reserved	reserved	WDT	reserved	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	reserved	RO	1	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	WDT	R/W	0	WDT Clock Gating Control This bit controls the clock gating for the WDT module. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, a read or write to the unit generates a bus fault.
2:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 21: Run Mode Clock Gating Control Register 1 (RCGC1), offset 0x104

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled (saving power). If the unit is unclocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Run Mode Clock Gating Control Register 1 (RCGC1)

Base 0x400F.E000

Offset 0x104

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
	reserved							COMP0	reserved							TIMER2	TIMER1	TIMER0
Type	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
	reserved												SSI0	reserved		UART0		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Bit/Field	Name	Type	Reset	Description
31:25	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
24	COMP0	R/W	0	Analog Comparator 0 Clock Gating This bit controls the clock gating for analog comparator 0. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, reads or writes to the unit will generate a bus fault.
23:19	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	TIMER2	R/W	0	Timer 2 Clock Gating Control This bit controls the clock gating for General-Purpose Timer module 2. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, reads or writes to the unit will generate a bus fault.
17	TIMER1	R/W	0	Timer 1 Clock Gating Control This bit controls the clock gating for General-Purpose Timer module 1. If set, the unit receives a clock and functions. Otherwise, the unit is unclocked and disabled. If the unit is unclocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
16	TIMER0	R/W	0	<b>Timer 0 Clock Gating Control</b> This bit controls the clock gating for General-Purpose Timer module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
15:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SSI0	R/W	0	<b>SSI0 Clock Gating Control</b> This bit controls the clock gating for SSI module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3:1	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	UART0	R/W	0	<b>UART0 Clock Gating Control</b> This bit controls the clock gating for UART module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

## Register 22: Sleep Mode Clock Gating Control Register 1 (SCGC1), offset 0x114

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled (saving power). If the unit is unlocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Sleep Mode Clock Gating Control Register 1 (SCGC1)

Base 0x400F.E000  
Offset 0x114  
Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
	reserved							COMP0	reserved							TIMER2	TIMER1	TIMER0
Type	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
	reserved												SSI0	reserved		UART0		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Bit/Field	Name	Type	Reset	Description
31:25	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
24	COMP0	R/W	0	Analog Comparator 0 Clock Gating  This bit controls the clock gating for analog comparator 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
23:19	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	TIMER2	R/W	0	Timer 2 Clock Gating Control  This bit controls the clock gating for General-Purpose Timer module 2. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
17	TIMER1	R/W	0	Timer 1 Clock Gating Control  This bit controls the clock gating for General-Purpose Timer module 1. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
16	TIMER0	R/W	0	Timer 0 Clock Gating Control This bit controls the clock gating for General-Purpose Timer module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
15:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SSI0	R/W	0	SSI0 Clock Gating Control This bit controls the clock gating for SSI module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3:1	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	UART0	R/W	0	UART0 Clock Gating Control This bit controls the clock gating for UART module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

## Register 23: Deep Sleep Mode Clock Gating Control Register 1 (DCGC1), offset 0x124

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled (saving power). If the unit is unlocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Deep Sleep Mode Clock Gating Control Register 1 (DCGC1)

Base 0x400F.E000

Offset 0x124

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
	reserved							COMP0	reserved							TIMER2	TIMER1	TIMER0
Type	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
	reserved												SSI0	reserved		UART0		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	R/W		
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Bit/Field	Name	Type	Reset	Description
31:25	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
24	COMP0	R/W	0	Analog Comparator 0 Clock Gating  This bit controls the clock gating for analog comparator 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
23:19	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	TIMER2	R/W	0	Timer 2 Clock Gating Control  This bit controls the clock gating for General-Purpose Timer module 2. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
17	TIMER1	R/W	0	Timer 1 Clock Gating Control  This bit controls the clock gating for General-Purpose Timer module 1. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
16	TIMER0	R/W	0	Timer 0 Clock Gating Control This bit controls the clock gating for General-Purpose Timer module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
15:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SSI0	R/W	0	SSI0 Clock Gating Control This bit controls the clock gating for SSI module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3:1	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	UART0	R/W	0	UART0 Clock Gating Control This bit controls the clock gating for UART module 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

## Register 24: Run Mode Clock Gating Control Register 2 (RCGC2), offset 0x108

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled (saving power). If the unit is unlocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Run Mode Clock Gating Control Register 2 (RCGC2)

Base 0x400F.E000  
Offset 0x108  
Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved	EPHY0	reserved	EMAC0	reserved												
Type	RO	R/W	RO	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										GPIOG	GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
30	EPHY0	R/W	0	PHY0 Clock Gating Control This bit controls the clock gating for Ethernet PHY unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
29	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	EMAC0	R/W	0	MAC0 Clock Gating Control This bit controls the clock gating for Ethernet MAC unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
27:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	GPIOG	R/W	0	Port G Clock Gating Control This bit controls the clock gating for Port G. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
5	GPIOF	R/W	0	Port F Clock Gating Control This bit controls the clock gating for Port F. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
4	GPIOE	R/W	0	Port E Clock Gating Control This bit controls the clock gating for Port E. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3	GPIOD	R/W	0	Port D Clock Gating Control This bit controls the clock gating for Port D. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
2	GPIOC	R/W	0	Port C Clock Gating Control This bit controls the clock gating for Port C. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
1	GPIOB	R/W	0	Port B Clock Gating Control This bit controls the clock gating for Port B. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
0	GPIOA	R/W	0	Port A Clock Gating Control This bit controls the clock gating for Port A. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

## Register 25: Sleep Mode Clock Gating Control Register 2 (SCGC2), offset 0x118

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled (saving power). If the unit is unlocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Sleep Mode Clock Gating Control Register 2 (SCGC2)

Base 0x400F.E000

Offset 0x118

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved	EPHY0	reserved	EMAC0	reserved												
Type	RO	R/W	RO	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										GPIOG	GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
30	EPHY0	R/W	0	PHY0 Clock Gating Control  This bit controls the clock gating for Ethernet PHY unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
29	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	EMAC0	R/W	0	MAC0 Clock Gating Control  This bit controls the clock gating for Ethernet MAC unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
27:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	GPIOG	R/W	0	Port G Clock Gating Control  This bit controls the clock gating for Port G. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
5	GPIOF	R/W	0	Port F Clock Gating Control This bit controls the clock gating for Port F. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
4	GPIOE	R/W	0	Port E Clock Gating Control This bit controls the clock gating for Port E. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3	GPIOD	R/W	0	Port D Clock Gating Control This bit controls the clock gating for Port D. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
2	GPIOC	R/W	0	Port C Clock Gating Control This bit controls the clock gating for Port C. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
1	GPIOB	R/W	0	Port B Clock Gating Control This bit controls the clock gating for Port B. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
0	GPIOA	R/W	0	Port A Clock Gating Control This bit controls the clock gating for Port A. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

## Register 26: Deep Sleep Mode Clock Gating Control Register 2 (DCGC2), offset 0x128

This register controls the clock gating logic. Each bit controls a clock enable for a given interface, function, or unit. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled (saving power). If the unit is unlocked, reads or writes to the unit will generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional units are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or units to control. This is to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

### Deep Sleep Mode Clock Gating Control Register 2 (DCGC2)

Base 0x400F.E000

Offset 0x128

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved	EPHY0	reserved	EMAC0	reserved												
Type	RO	R/W	RO	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										GPIOG	GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
30	EPHY0	R/W	0	PHY0 Clock Gating Control  This bit controls the clock gating for Ethernet PHY unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
29	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	EMAC0	R/W	0	MAC0 Clock Gating Control  This bit controls the clock gating for Ethernet MAC unit 0. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
27:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	GPIOG	R/W	0	Port G Clock Gating Control  This bit controls the clock gating for Port G. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

Bit/Field	Name	Type	Reset	Description
5	GPIOF	R/W	0	Port F Clock Gating Control This bit controls the clock gating for Port F. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
4	GPIOE	R/W	0	Port E Clock Gating Control This bit controls the clock gating for Port E. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
3	GPIOD	R/W	0	Port D Clock Gating Control This bit controls the clock gating for Port D. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
2	GPIOC	R/W	0	Port C Clock Gating Control This bit controls the clock gating for Port C. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
1	GPIOB	R/W	0	Port B Clock Gating Control This bit controls the clock gating for Port B. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.
0	GPIOA	R/W	0	Port A Clock Gating Control This bit controls the clock gating for Port A. If set, the unit receives a clock and functions. Otherwise, the unit is unlocked and disabled. If the unit is unlocked, reads or writes to the unit will generate a bus fault.

**Register 27: Software Reset Control 0 (SRCR0), offset 0x040**Writes to this register are masked by the bits in the **Device Capabilities 1 (DC1)** register.

## Software Reset Control 0 (SRCR0)

Base 0x400F.E000

Offset 0x040

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved												WDT	reserved		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	WDT	R/W	0	WDT Reset Control Reset control for Watchdog unit.
2:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 28: Software Reset Control 1 (SRCR1), offset 0x044**Writes to this register are masked by the bits in the **Device Capabilities 2 (DC2)** register.

## Software Reset Control 1 (SRCR1)

Base 0x400F.E000

Offset 0x044

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved							COMP0	reserved					TIMER2	TIMER1	TIMER0
Type	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											SSI0	reserved		UART0	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:25	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
24	COMP0	R/W	0	Analog Comp 0 Reset Control Reset control for analog comparator 0.
23:19	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
18	TIMER2	R/W	0	Timer 2 Reset Control Reset control for General-Purpose Timer module 2.
17	TIMER1	R/W	0	Timer 1 Reset Control Reset control for General-Purpose Timer module 1.
16	TIMER0	R/W	0	Timer 0 Reset Control Reset control for General-Purpose Timer module 0.
15:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	SSI0	R/W	0	SSI0 Reset Control Reset control for SSI unit 0.
3:1	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	UART0	R/W	0	UART0 Reset Control Reset control for UART unit 0.

**Register 29: Software Reset Control 2 (SRCR2), offset 0x048**Writes to this register are masked by the bits in the **Device Capabilities 4 (DC4)** register.

## Software Reset Control 2 (SRCR2)

Base 0x400F.E000

Offset 0x048

Type R/W, reset 0x00000000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved	EPHY0	reserved	EMAC0	reserved												
Type	RO	R/W	RO	R/W	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										GPIOG	GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
30	EPHY0	R/W	0	PHY0 Reset Control Reset control for Ethernet PHY unit 0.
29	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
28	EMAC0	R/W	0	MAC0 Reset Control Reset control for Ethernet MAC unit 0.
27:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	GPIOG	R/W	0	Port G Reset Control Reset control for GPIO Port G.
5	GPIOF	R/W	0	Port F Reset Control Reset control for GPIO Port F.
4	GPIOE	R/W	0	Port E Reset Control Reset control for GPIO Port E.
3	GPIOD	R/W	0	Port D Reset Control Reset control for GPIO Port D.
2	GPIOC	R/W	0	Port C Reset Control Reset control for GPIO Port C.
1	GPIOB	R/W	0	Port B Reset Control Reset control for GPIO Port B.
0	GPIOA	R/W	0	Port A Reset Control Reset control for GPIO Port A.

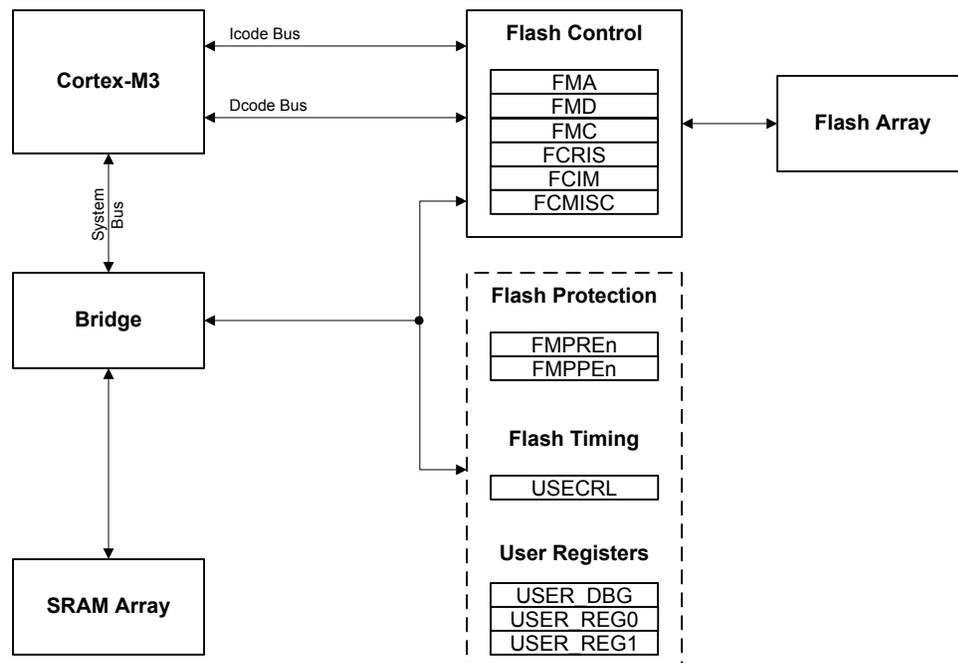
## 6 Internal Memory

The LM3S6100 microcontroller comes with 16 KB of bit-banded SRAM and 64 KB of flash memory. The flash controller provides a user-friendly interface, making flash programming a simple task. Flash protection can be applied to the flash memory on a 2-KB block basis.

### 6.1 Block Diagram

Figure 6-1 on page 216 illustrates the Flash functions. The dashed boxes in the figure indicate registers residing in the System Control module rather than the Flash Control module.

Figure 6-1. Flash Block Diagram



### 6.2 Functional Description

This section describes the functionality of the SRAM and Flash memories.

#### 6.2.1 SRAM Memory

The internal SRAM of the Stellaris® devices is located at address 0x2000.0000 of the device memory map. To reduce the number of time consuming read-modify-write (RMW) operations, ARM has introduced *bit-banding* technology in the Cortex-M3 processor. With a bit-band-enabled processor, certain regions in the memory map (SRAM and peripheral space) can use address aliases to access individual bits in a single, atomic operation.

The bit-band alias is calculated by using the formula:

$$\text{bit-band alias} = \text{bit-band base} + (\text{byte offset} * 32) + (\text{bit number} * 4)$$

For example, if bit 3 at address 0x2000.1000 is to be modified, the bit-band alias is calculated as:

$$0x2200.0000 + (0x1000 * 32) + (3 * 4) = 0x2202.000C$$

With the alias address calculated, an instruction performing a read/write to address 0x2202.000C allows direct access to only bit 3 of the byte at address 0x2000.1000.

For details about bit-banding, see “Bit-Banding” on page 64.

## 6.2.2 Flash Memory

The flash is organized as a set of 1-KB blocks that can be individually erased. Erasing a block causes the entire contents of the block to be reset to all 1s. An individual 32-bit word can be programmed to change bits that are currently 1 to a 0. These blocks are paired into a set of 2-KB blocks that can be individually protected. The protection allows blocks to be marked as read-only or execute-only, providing different levels of code protection. Read-only blocks cannot be erased or programmed, protecting the contents of those blocks from being modified. Execute-only blocks cannot be erased or programmed, and can only be read by the controller instruction fetch mechanism, protecting the contents of those blocks from being read by either the controller or by a debugger.

See also “Serial Flash Loader” on page 528 for a preprogrammed flash-resident utility used to download code to the flash memory of a device without the use of a debug interface.

### 6.2.2.1 Flash Memory Timing

The timing for the flash is automatically handled by the flash controller. However, in order to do so, it must know the clock rate of the system in order to time its internal signals properly. The number of clock cycles per microsecond must be provided to the flash controller for it to accomplish this timing. It is software's responsibility to keep the flash controller updated with this information via the **USEC Reload (USECRL)** register.

On reset, the **USECRL** register is loaded with a value that configures the flash timing so that it works with the maximum clock rate of the part. If software changes the system operating frequency, the new operating frequency minus 1 (in MHz) must be loaded into **USECRL** before any flash modifications are attempted. For example, if the device is operating at a speed of 20 MHz, a value of 0x13 (20-1) must be written to the **USECRL** register.

### 6.2.2.2 Flash Memory Protection

The user is provided two forms of flash protection per 2-KB flash blocks in one pair of 32-bit wide registers. The protection policy for each form is controlled by individual bits (per policy per block) in the **FMPPEn** and **FMPREn** registers.

- **Flash Memory Protection Program Enable (FMPPEn)**: If set, the block may be programmed (written) or erased. If cleared, the block may not be changed.
- **Flash Memory Protection Read Enable (FMPREn)**: If a bit is set, the corresponding block may be executed or read by software or debuggers. If a bit is cleared, the corresponding block may only be executed, and contents of the memory block are prohibited from being read as data.

The policies may be combined as shown in Table 6-1 on page 217.

**Table 6-1. Flash Protection Policy Combinations**

FMPPEn	FMPREn	Protection
0	0	Execute-only protection. The block may only be executed and may not be written or erased. This mode is used to protect code.

**Table 6-1. Flash Protection Policy Combinations (continued)**

FMPPEn	FMPREn	Protection
1	0	The block may be written, erased or executed, but not read. This combination is unlikely to be used.
0	1	Read-only protection. The block may be read or executed but may not be written or erased. This mode is used to lock the block from further modification while allowing any read or execute access.
1	1	No protection. The block may be written, erased, executed or read.

A Flash memory access that attempts to read a read-protected block (**FMPREn** bit is set) is prohibited and generates a bus fault. A Flash memory access that attempts to program or erase a program-protected block (**FMPPEn** bit is set) is prohibited and can optionally generate an interrupt (by setting the **AMASK** bit in the **Flash Controller Interrupt Mask (FCIM)** register) to alert software developers of poorly behaving software during the development and debug phases.

The factory settings for the **FMPREn** and **FMPPEn** registers are a value of 1 for all implemented banks. These settings create a policy of open access and programmability. The register bits may be changed by clearing the specific register bit. The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The changes are committed using the **Flash Memory Control (FMC)** register. Details on programming these bits are discussed in “Nonvolatile Register Programming” on page 220.

### 6.2.2.3 Execute-Only Protection

Execute-only protection prevents both modification and visibility to a protected flash block. This mode is intended to be used in situations where a device requires debug capability, yet portions of the application space must be protected from external access. An example of this is a company who wishes to sell Stellaris devices with their proprietary software pre-programmed, yet allow the end user to add custom code to an unprotected region of the flash (such as a motor control module with a customizable motor configuration section in flash).

Literal data introduces a complication to the protection mechanism. When C code is compiled and linked, literal data (constants, and so on) is typically placed in the text section, between functions, by the compiler. The literal data is accessed at run time through the use of the LDR instruction, which loads the data from memory using a PC-relative memory address. The execution of the LDR instruction generates a read transaction across the Cortex-M3's DCode bus, which is subject to the execute-only protection mechanism. If the accessed block is marked as execute only, the transaction is blocked, and the processor is prevented from loading the constant data and, therefore, inhibiting correct execution. Therefore, using execute-only protection requires that literal data be handled differently. There are three ways to address this:

1. Use a compiler that allows literal data to be collected into a separate section that is put into one or more read-enabled flash blocks. Note that the LDR instruction may use a PC-relative address—in which case the literal pool cannot be located outside the span of the offset—or the software may reserve a register to point to the base address of the literal pool and the LDR offset is relative to the beginning of the pool.
2. Use a compiler that generates literal data from arithmetic instruction immediate data and subsequent computation.
3. Use method 1 or 2, but in assembly language, if the compiler does not support either method.

#### 6.2.2.4 Read-Only Protection

Read-only protection prevents the contents of the flash block from being re-programmed, while still allowing the content to be read by processor or the debug interface. Note that if a **FMPREn** bit is cleared, all read accesses to the Flash memory block are disallowed, including any data accesses. Care must be taken not to store required data in a Flash memory block that has the associated **FMPREn** bit cleared.

The read-only mode does not prevent read access to the stored program, but it does provide protection against accidental (or malicious) erasure or programming. Read-only is especially useful for utilities like the boot loader when the debug interface is permanently disabled. In such combinations, the boot loader, which provides access control to the Flash memory, is protected from being erased or modified.

#### 6.2.2.5 Permanently Disabling Debug

For extremely sensitive applications, the debug interface to the processor and peripherals can be permanently disabled, blocking all accesses to the device through the JTAG or SWD interfaces. With the debug interface disabled, it is still possible to perform standard IEEE instructions (such as boundary scan operations), but access to the processor and peripherals is blocked.

The **DBG0** and **DBG1** bits of the **User Debug (USER\_DBG)** register control whether the debug interface is turned on or off.

The debug interface should not be permanently disabled without providing some mechanism—such as the boot loader—to provide customer-installable updates or bug fixes. Disabling the debug interface is permanent and cannot be reversed.

#### 6.2.2.6 Interrupts

The Flash memory controller can generate interrupts when the following conditions are observed:

- Programming Interrupt - signals when a program or erase action is complete.
- Access Interrupt - signals when a program or erase action has been attempted on a 2-kB block of memory that is protected by its corresponding **FMPPEn** bit.

The interrupt events that can trigger a controller-level interrupt are defined in the **Flash Controller Masked Interrupt Status (FCMIS)** register (see page 228) by setting the corresponding **MASK** bits. If interrupts are not used, the raw interrupt status is always visible via the **Flash Controller Raw Interrupt Status (FCRIS)** register (see page 227).

Interrupts are always cleared (for both the **FCMIS** and **FCRIS** registers) by writing a 1 to the corresponding bit in the **Flash Controller Masked Interrupt Status and Clear (FCMISC)** register (see page 229).

### 6.3 Flash Memory Initialization and Configuration

#### 6.3.1 Flash Programming

The Stellaris devices provide a user-friendly interface for flash programming. All erase/program operations are handled via three registers: **FMA**, **FMD**, and **FMC**.

During a Flash memory operation (write, page erase, or mass erase) access to the Flash memory is inhibited. As a result, instruction and literal fetches are held off until the Flash memory operation is complete. If instruction execution is required during a Flash memory operation, the code that is executing must be placed in SRAM and executed from there while the flash operation is in progress.

### 6.3.1.1 To program a 32-bit word

1. Write source data to the **FMD** register.
2. Write the target address to the **FMA** register.
3. Write the flash write key and the `WRITE` bit (a value of 0xA442.0001) to the **FMC** register.
4. Poll the **FMC** register until the `WRITE` bit is cleared.

### 6.3.1.2 To perform an erase of a 1-KB page

1. Write the page address to the **FMA** register.
2. Write the flash write key and the `ERASE` bit (a value of 0xA442.0002) to the **FMC** register.
3. Poll the **FMC** register until the `ERASE` bit is cleared.

### 6.3.1.3 To perform a mass erase of the flash

1. Write the flash write key and the `MERASE` bit (a value of 0xA442.0004) to the **FMC** register.
2. Poll the **FMC** register until the `MERASE` bit is cleared.

## 6.3.2 Nonvolatile Register Programming

**Note:** The **USER\_DBG** register requires a POR before the committed changes take effect.

This section discusses how to update registers that are resident within the Flash memory itself. These registers exist in a separate space from the main Flash memory array and are not affected by an ERASE or MASS ERASE operation. The bits in these registers can be changed from 1 to 0 with a write operation. Prior to being committed, the register contents are unaffected by any reset condition except power-on reset, which returns the register contents to the original value. By committing the register values using the `COMT` bit in the **FMC** register, the register contents become nonvolatile and are therefore retained following power cycling. Once the register contents are committed, the contents are permanent, and they cannot be restored to their factory default values.

With the exception of the **USER\_DBG** register, the settings in these registers can be tested before committing them to Flash memory. For the **USER\_DBG** register, the data to be written is loaded into the **FMD** register before it is committed. The **FMD** register is read only and does not allow the **USER\_DBG** operation to be tried before committing it to nonvolatile memory.

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**Important:** The Flash memory registers can only have bits changed from 1 to 0 by user programming and can only be committed once. After being committed, these registers cannot be restored to their factory default values.

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In addition, the **USER\_REG0**, **USER\_REG1**, **USER\_REG2**, **USER\_REG3**, and **USER\_DBG** registers each use bit 31 (`NW`) to indicate that they have not been committed and bits in the register may be changed from 1 to 0. These five registers can only be committed once whereas the Flash memory protection registers may be committed multiple times. Table 6-2 on page 221 provides the **FMA** address required for commitment of each of the registers and the source of the data to be written when the **FMC** register is written with a value of 0xA442.0008. After writing the `COMT` bit, the user may poll the **FMC** register to wait for the commit operation to complete.

**Table 6-2. User-Programmable Flash Memory Resident Registers**

Register to be Committed	FMA Value	Data Source
FMPRE0	0x0000.0000	FMPRE0
FMPPE0	0x0000.0001	FMPPE0
USER_REG0	0x8000.0000	USER_REG0
USER_REG1	0x8000.0001	USER_REG1
USER_REG2	0x8000.0002	USER_REG2
USER_REG3	0x8000.0003	USER_REG3
USER_DBG	0x7510.0000	FMD

## 6.4 Register Map

Table 6-3 on page 221 lists the Flash memory and control registers. The offset listed is a hexadecimal increment to the register's address. The **FMA**, **FMD**, **FMC**, **FCRIS**, **FCIM**, and **FCMISC** register offsets are relative to the Flash memory control base address of 0x400F.D000. The Flash memory protection register offsets are relative to the System Control base address of 0x400F.E000.

**Table 6-3. Flash Register Map**

Offset	Name	Type	Reset	Description	See page
<b>Flash Memory Control Registers (Flash Control Offset)</b>					
0x000	FMA	R/W	0x0000.0000	Flash Memory Address	223
0x004	FMD	R/W	0x0000.0000	Flash Memory Data	224
0x008	FMC	R/W	0x0000.0000	Flash Memory Control	225
0x00C	FCRIS	RO	0x0000.0000	Flash Controller Raw Interrupt Status	227
0x010	FCIM	R/W	0x0000.0000	Flash Controller Interrupt Mask	228
0x014	FCMISC	R/W1C	0x0000.0000	Flash Controller Masked Interrupt Status and Clear	229
<b>Flash Memory Protection Registers (System Control Offset)</b>					
0x130	FMPRE0	R/W	0xFFFF.FFFF	Flash Memory Protection Read Enable 0	232
0x200	FMPRE0	R/W	0xFFFF.FFFF	Flash Memory Protection Read Enable 0	232
0x134	FMPPE0	R/W	0xFFFF.FFFF	Flash Memory Protection Program Enable 0	233
0x400	FMPPE0	R/W	0xFFFF.FFFF	Flash Memory Protection Program Enable 0	233
0x140	USECRL	R/W	0x18	USec Reload	231
0x1D0	USER_DBG	R/W	0xFFFF.FFFE	User Debug	234
0x1E0	USER_REG0	R/W	0xFFFF.FFFF	User Register 0	235
0x1E4	USER_REG1	R/W	0xFFFF.FFFF	User Register 1	236
0x204	FMPRE1	R/W	0x0000.0000	Flash Memory Protection Read Enable 1	237
0x208	FMPRE2	R/W	0x0000.0000	Flash Memory Protection Read Enable 2	238
0x20C	FMPRE3	R/W	0x0000.0000	Flash Memory Protection Read Enable 3	239
0x404	FMPPE1	R/W	0x0000.0000	Flash Memory Protection Program Enable 1	240

**Table 6-3. Flash Register Map (continued)**

Offset	Name	Type	Reset	Description	See page
0x408	FMPPE2	R/W	0x0000.0000	Flash Memory Protection Program Enable 2	241
0x40C	FMPPE3	R/W	0x0000.0000	Flash Memory Protection Program Enable 3	242

## 6.5 Flash Register Descriptions (Flash Control Offset)

This section lists and describes the Flash Memory registers, in numerical order by address offset. Registers in this section are relative to the Flash control base address of 0x400F.D000.

## Register 1: Flash Memory Address (FMA), offset 0x000

During a write operation, this register contains a 4-byte-aligned address and specifies where the data is written. During erase operations, this register contains a 1 KB-aligned address and specifies which page is erased. Note that the alignment requirements must be met by software or the results of the operation are unpredictable.

### Flash Memory Address (FMA)

Base 0x400F.D000

Offset 0x000

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	OFFSET															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	OFFSET	R/W	0x0	Address Offset Address offset in flash where operation is performed, except for nonvolatile registers (see "Nonvolatile Register Programming" on page 220 for details on values for this field).

## Register 2: Flash Memory Data (FMD), offset 0x004

This register contains the data to be written during the programming cycle or read during the read cycle. Note that the contents of this register are undefined for a read access of an execute-only block. This register is not used during the erase cycles.

### Flash Memory Data (FMD)

Base 0x400F.D000

Offset 0x004

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	DATA	R/W	0x0	Data Value Data value for write operation.

### Register 3: Flash Memory Control (FMC), offset 0x008

When this register is written, the flash controller initiates the appropriate access cycle for the location specified by the **Flash Memory Address (FMA)** register (see page 223). If the access is a write access, the data contained in the **Flash Memory Data (FMD)** register (see page 224) is written.

This is the final register written and initiates the memory operation. There are four control bits in the lower byte of this register that, when set, initiate the memory operation. The most used of these register bits are the `ERASE` and `WRITE` bits.

It is a programming error to write multiple control bits and the results of such an operation are unpredictable.

#### Flash Memory Control (FMC)

Base 0x400F.D000  
Offset 0x008  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	WRKEY															
Type	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved												COMT	MERASE	ERASE	WRITE
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	WRKEY	WO	0x0	Flash Write Key This field contains a write key, which is used to minimize the incidence of accidental flash writes. The value 0xA442 must be written into this field for a write to occur. Writes to the <b>FMC</b> register without this <code>WRKEY</code> value are ignored. A read of this field returns the value 0.
15:4	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	COMT	R/W	0	Commit Register Value Commit (write) of register value to nonvolatile storage. A write of 0 has no effect on the state of this bit. If read, the state of the previous commit access is provided. If the previous commit access is complete, a 0 is returned; otherwise, if the commit access is not complete, a 1 is returned. This can take up to 50 $\mu$ s.
2	MERASE	R/W	0	Mass Erase Flash Memory If this bit is set, the flash main memory of the device is all erased. A write of 0 has no effect on the state of this bit. If read, the state of the previous mass erase access is provided. If the previous mass erase access is complete, a 0 is returned; otherwise, if the previous mass erase access is not complete, a 1 is returned. This can take up to 250 ms.

Bit/Field	Name	Type	Reset	Description
1	ERASE	R/W	0	<p>Erase a Page of Flash Memory</p> <p>If this bit is set, the page of flash main memory as specified by the contents of <b>FMA</b> is erased. A write of 0 has no effect on the state of this bit.</p> <p>If read, the state of the previous erase access is provided. If the previous erase access is complete, a 0 is returned; otherwise, if the previous erase access is not complete, a 1 is returned.</p> <p>This can take up to 25 ms.</p>
0	WRITE	R/W	0	<p>Write a Word into Flash Memory</p> <p>If this bit is set, the data stored in <b>FMD</b> is written into the location as specified by the contents of <b>FMA</b>. A write of 0 has no effect on the state of this bit.</p> <p>If read, the state of the previous write update is provided. If the previous write access is complete, a 0 is returned; otherwise, if the write access is not complete, a 1 is returned.</p> <p>This can take up to 50 <math>\mu</math>s.</p>

**Register 4: Flash Controller Raw Interrupt Status (FCRIS), offset 0x00C**

This register indicates that the flash controller has an interrupt condition. An interrupt is only signaled if the corresponding **FCIM** register bit is set.

## Flash Controller Raw Interrupt Status (FCRIS)

Base 0x400F.D000

Offset 0x00C

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved														PRIS	ARIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	PRIS	RO	0	<p>Programming Raw Interrupt Status</p> <p>This bit provides status on programming cycles which are write or erase actions generated through the <b>FMC</b> register bits (see page 225).</p> <p>Value Description</p> <p>1 The programming cycle has completed.</p> <p>0 The programming cycle has not completed.</p> <p>This status is sent to the interrupt controller when the <b>PMASK</b> bit in the <b>FCIM</b> register is set.</p> <p>This bit is cleared by writing a 1 to the <b>PMISC</b> bit in the <b>FCMISC</b> register.</p>
0	ARIS	RO	0	<p>Access Raw Interrupt Status</p> <p>Value Description</p> <p>1 A program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the <b>FMPPEn</b> registers.</p> <p>0 No access has tried to improperly program or erase the Flash memory.</p> <p>This status is sent to the interrupt controller when the <b>AMASK</b> bit in the <b>FCIM</b> register is set.</p> <p>This bit is cleared by writing a 1 to the <b>AMISC</b> bit in the <b>FCMISC</b> register.</p>

## Register 5: Flash Controller Interrupt Mask (FCIM), offset 0x010

This register controls whether the flash controller generates interrupts to the controller.

### Flash Controller Interrupt Mask (FCIM)

Base 0x400F.D000

Offset 0x010

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved														PMASK	AMASK	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description				
31:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.				
1	PMASK	R/W	0	<p>Programming Interrupt Mask</p> <p>This bit controls the reporting of the programming raw interrupt status to the interrupt controller.</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set.</td> </tr> <tr> <td>0</td> <td>The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller.</td> </tr> </table>	1	An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set.	0	The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller.
1	An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set.							
0	The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller.							
0	AMASK	R/W	0	<p>Access Interrupt Mask</p> <p>This bit controls the reporting of the access raw interrupt status to the interrupt controller.</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set.</td> </tr> <tr> <td>0</td> <td>The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller.</td> </tr> </table>	1	An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set.	0	The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller.
1	An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set.							
0	The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller.							

## Register 6: Flash Controller Masked Interrupt Status and Clear (FCMISC), offset 0x014

This register provides two functions. First, it reports the cause of an interrupt by indicating which interrupt source or sources are signalling the interrupt. Second, it serves as the method to clear the interrupt reporting.

### Flash Controller Masked Interrupt Status and Clear (FCMISC)

Base 0x400F.D000

Offset 0x014

Type R/W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved															PMISC	AMISC
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W1C	R/W1C	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	PMISC	R/W1C	0	Programming Masked Interrupt Status and Clear  <div style="margin-left: 20px;">           Value Description            1 When read, a 1 indicates that an unmasked interrupt was signaled because a programming cycle completed.            Writing a 1 to this bit clears <code>PMISC</code> and also the <code>PRIS</code> bit in the <code>FCRIS</code> register (see page 227).            0 When read, a 0 indicates that a programming cycle complete interrupt has not occurred.            A write of 0 has no effect on the state of this bit.         </div>
0	AMISC	R/W1C	0	Access Masked Interrupt Status and Clear  <div style="margin-left: 20px;">           Value Description            1 When read, a 1 indicates that an unmasked interrupt was signaled because a program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the <code>FMPPEn</code> registers.            Writing a 1 to this bit clears <code>AMISC</code> and also the <code>ARIS</code> bit in the <code>FCRIS</code> register (see page 227).            0 When read, a 0 indicates that no improper accesses have occurred.            A write of 0 has no effect on the state of this bit.         </div>

## **6.6 Flash Register Descriptions (System Control Offset)**

The remainder of this section lists and describes the Flash Memory registers, in numerical order by address offset. Registers in this section are relative to the System Control base address of 0x400F.E000.

**Register 7: USec Reload (USECRL), offset 0x140**

**Note:** Offset is relative to System Control base address of 0x400F.E000

This register is provided as a means of creating a 1- $\mu$ s tick divider reload value for the flash controller. The internal flash has specific minimum and maximum requirements on the length of time the high voltage write pulse can be applied. It is required that this register contain the operating frequency (in MHz -1) whenever the flash is being erased or programmed. The user is required to change this value if the clocking conditions are changed for a flash erase/program operation.

## USec Reload (USECRL)

Base 0x400F.E000

Offset 0x140

Type R/W, reset 0x18

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								USEC							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	USEC	R/W	0x18	Microsecond Reload Value MHz -1 of the controller clock when the flash is being erased or programmed. If the maximum system frequency is being used, USEC should be set to 0x18 (24 MHz) whenever the flash is being erased or programmed.

## Register 8: Flash Memory Protection Read Enable 0 (FMPRE0), offset 0x130 and 0x200

**Note:** This register is aliased for backwards compatibility.

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. For additional information, see the "Flash Memory Protection" section.

### Flash Memory Protection Read Enable 0 (FMPRE0)

Base 0x400F.E000  
Offset 0x130 and 0x200  
Type R/W, reset 0xFFFF.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:0	READ_ENABLE	R/W	0xFFFFFFFF	Flash Read Enable. Enables 2-KB Flash memory blocks to be executed or read. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
				Value      Description
				0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory up to the total of 64 KB.

## Register 9: Flash Memory Protection Program Enable 0 (FMPPE0), offset 0x134 and 0x400

**Note:** This register is aliased for backwards compatibility.

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPREN** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPEN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEN** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. For additional information, see the "Flash Memory Protection" section.

### Flash Memory Protection Program Enable 0 (FMPPE0)

Base 0x400F.E000  
Offset 0x134 and 0x400  
Type R/W, reset 0xFFFF.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	PROG_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	PROG_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:0	PROG_ENABLE	R/W	0xFFFFFFFF	Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
	Value		Description	
	0xFFFFFFFF		Bits [31:0] each enable protection on a 2-KB block of Flash memory up to the total of 64 KB.	

**Register 10: User Debug (USER\_DBG), offset 0x1D0**

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register provides a write-once mechanism to disable external debugger access to the device in addition to 27 additional bits of user-defined data. The DBG0 bit (bit 0) is set to 0 from the factory and the DBG1 bit (bit 1) is set to 1, which enables external debuggers. Changing the DBG1 bit to 0 disables any external debugger access to the device permanently, starting with the next power-up cycle of the device. The NW bit (bit 31) indicates that the register has not yet been committed and is controlled through hardware to ensure that the register is only committed once. Prior to being committed, bits can only be changed from 1 to 0. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, this register cannot be restored to the factory default value.

**User Debug (USER\_DBG)**

Base 0x400F.E000

Offset 0x1D0

Type R/W, reset 0xFFFF.FFFE

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	NW	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	DATA														DBG1	DBG0	
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

Bit/Field	Name	Type	Reset	Description
31	NW	R/W	1	User Debug Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again.
30:2	DATA	R/W	0x1FFFFFFF	User Data Contains the user data value. This field is initialized to all 1s and can only be committed once.
1	DBG1	R/W	1	Debug Control 1 The DBG1 bit must be 1 and DBG0 must be 0 for debug to be available.
0	DBG0	R/W	0	Debug Control 0 The DBG1 bit must be 1 and DBG0 must be 0 for debug to be available.

**Register 11: User Register 0 (USER\_REG0), offset 0x1E0**

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be committed once. Bit 31 indicates that the register is available to be committed and is controlled through hardware to ensure that the register is only committed once. Prior to being committed, bits can only be changed from 1 to 0. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device. Once committed, this register cannot be restored to the factory default value.

**User Register 0 (USER\_REG0)**

Base 0x400F.E000

Offset 0x1E0

Type R/W, reset 0xFFFF.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	NW	DATA														
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31	NW	R/W	1	Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again.
30:0	DATA	R/W	0x7FFFFFFF	User Data Contains the user data value. This field is initialized to all 1s and can only be committed once.

### Register 12: User Register 1 (USER\_REG1), offset 0x1E4

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be committed once. Bit 31 indicates that the register is available to be committed and is controlled through hardware to ensure that the register is only committed once. Prior to being committed, bits can only be changed from 1 to 0. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device. Once committed, this register cannot be restored to the factory default value.

#### User Register 1 (USER\_REG1)

Base 0x400F.E000  
 Offset 0x1E4  
 Type R/W, reset 0xFFFF.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	NW	DATA														
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31	NW	R/W	1	Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again.
30:0	DATA	R/W	0x7FFFFFFF	User Data Contains the user data value. This field is initialized to all 1s and can only be committed once.

**Register 13: Flash Memory Protection Read Enable 1 (FMPRE1), offset 0x204**

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREn** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. If the Flash memory size on the device is less than 64 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see the "Flash Memory Protection" section.

## Flash Memory Protection Read Enable 1 (FMPRE1)

Base 0x400F.E000

Offset 0x204

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	READ_ENABLE	R/W	0x00000000	Flash Read Enable. Enables 2-KB Flash memory blocks to be executed or read. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
	Value	Description		
	0x00000000	Bits [31:0] each enable protection on a 2-KB block of Flash memory in memory range from 65 to 128 KB.		

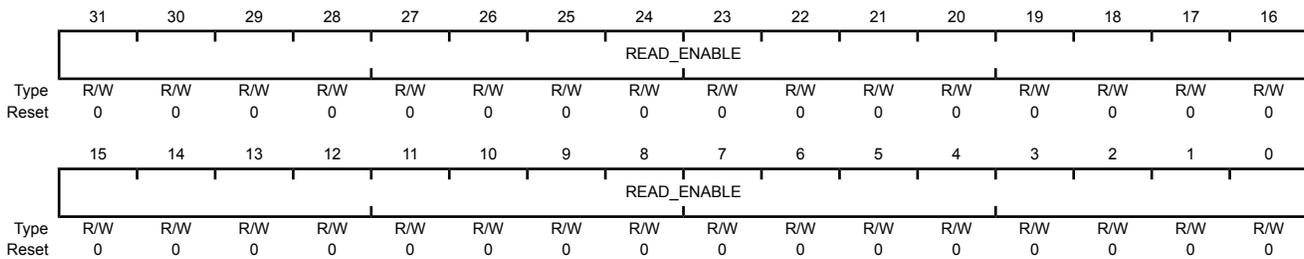
### Register 14: Flash Memory Protection Read Enable 2 (FMPRE2), offset 0x208

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). For additional information, see the "Flash Memory Protection" section.

#### Flash Memory Protection Read Enable 2 (FMPRE2)

Base 0x400F.E000  
 Offset 0x208  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	READ_ENABLE	R/W	0x00000000	Flash Read Enable Enables 2-KB flash blocks to be executed or read. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
				Value      Description
				0x00000000 Enables 64 KB of flash.

**Register 15: Flash Memory Protection Read Enable 3 (FMPRE3), offset 0x20C**

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. For additional information, see the "Flash Memory Protection" section.

## Flash Memory Protection Read Enable 3 (FMPRE3)

Base 0x400F.E000

Offset 0x20C

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	READ_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	READ_ENABLE	R/W	0x00000000	Flash Read Enable Enables 2-KB flash blocks to be executed or read. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
				Value      Description
			0x00000000	Enables 64 KB of flash.

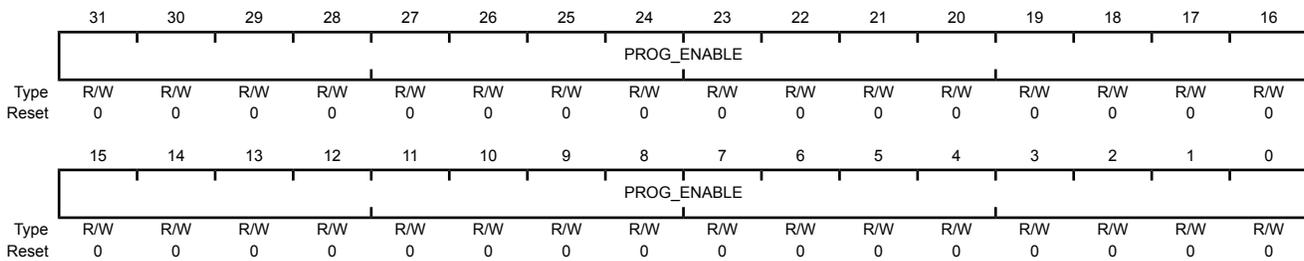
### Register 16: Flash Memory Protection Program Enable 1 (FMPPE1), offset 0x404

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE<sub>n</sub>** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE<sub>n</sub>** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE<sub>n</sub>** and **FMPPE<sub>n</sub>** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. If the Flash memory size on the device is less than 64 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see the "Flash Memory Protection" section.

#### Flash Memory Protection Program Enable 1 (FMPPE1)

Base 0x400F.E000  
 Offset 0x404  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	PROG_ENABLE	R/W	0x00000000	Flash Programming Enable

Value	Description
0x00000000	Bits [31:0] each enable protection on a 2-KB block of Flash memory in memory range from 65 to 128 KB.

## Register 17: Flash Memory Protection Program Enable 2 (FMPPE2), offset 0x408

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPREn** stores the execute-only bits). This register is loaded during the power-on reset sequence. The factory settings for the **FMPREn** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. For additional information, see the "Flash Memory Protection" section.

### Flash Memory Protection Program Enable 2 (FMPPE2)

Base 0x400F.E000

Offset 0x408

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	PROG_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	PROG_ENABLE															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:0	PROG_ENABLE	R/W	0x00000000	Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
				Value      Description
				0x00000000 Enables 64 KB of flash.

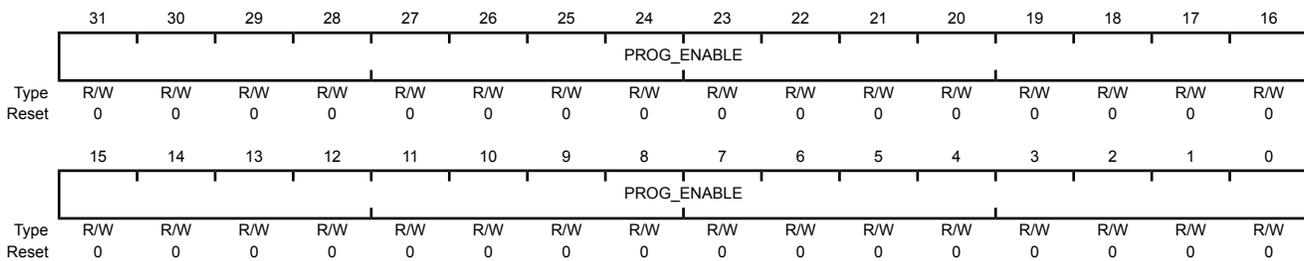
### Register 18: Flash Memory Protection Program Enable 3 (FMPPE3), offset 0x40C

**Note:** Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPREn** stores the execute-only bits). This register is loaded during the power-on reset sequence. The factory settings for the **FMPREn** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. For additional information, see the "Flash Memory Protection" section.

#### Flash Memory Protection Program Enable 3 (FMPPE3)

Base 0x400F.E000  
 Offset 0x40C  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	PROG_ENABLE	R/W	0x00000000	Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations".
				Value      Description
				0x00000000 Enables 64 KB of flash.

## 7 General-Purpose Input/Outputs (GPIOs)

The GPIO module is composed of seven physical GPIO blocks, each corresponding to an individual GPIO port (Port A, Port B, Port C, Port D, Port E, Port F, Port G). The GPIO module supports 10-30 programmable input/output pins, depending on the peripherals being used.

The GPIO module has the following features:

- 10-30 GPIOs, depending on configuration
- 5-V-tolerant in input configuration
- Fast toggle capable of a change every two clock cycles
- Programmable control for GPIO interrupts
  - Interrupt generation masking
  - Edge-triggered on rising, falling, or both
  - Level-sensitive on High or Low values
- Bit masking in both read and write operations through address lines
- Pins configured as digital inputs are Schmitt-triggered.
- Programmable control for GPIO pad configuration
  - Weak pull-up or pull-down resistors
  - 2-mA, 4-mA, and 8-mA pad drive for digital communication; up to four pads can be configured with an 18-mA pad drive for high-current applications
  - Slew rate control for the 8-mA drive
  - Open drain enables
  - Digital input enables

### 7.1 Signal Description

GPIO signals have alternate hardware functions. Table 7-4 on page 245 and Table 7-5 on page 246 list the GPIO pins and the digital alternate functions. Other analog signals are 5-V tolerant and are connected directly to their circuitry (C0-, C0+). These signals are configured by clearing the DEN bit in the **GPIO Digital Enable (GPIODEN)** register. The digital alternate hardware functions are enabled by setting the appropriate bit in the **GPIO Alternate Function Select (GPIOAFSEL)** and **GPIODEN** registers and configuring the PMC<sub>x</sub> bit field in the **GPIO Port Control (GPIOPCTL)** register to the numeric encoding shown in the table below. Note that each pin must be programmed individually; no type of grouping is implied by the columns in the table.

---

**Important:** All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GPIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOPCTL**=0, with the exception of the four JTAG/SWD pins (shown in the table below). A Power-On-Reset (**POR**) or asserting **RST** puts the pins back to their default state.

**Table 7-1. GPIO Pins With Non-Zero Reset Values**

GPIO Pins	Default State	GPIOAFSEL	GPIOIDEN	GPIOPDR	GPIOPUR	GPIOPCTL
PA[1:0]	UART0	1	1	0	0	0x1
PA[5:2]	SSI0	1	1	0	0	0x1
PC[3:0]	JTAG/SWD	1	1	0	1	0x3

**Table 7-2. GPIO Pins and Alternate Functions (100LQFP)**

IO	Pin Number	Multiplexed Function	Multiplexed Function
PA0	26	U0Rx	
PA1	27	U0Tx	
PA2	28	SSI0Clk	
PA3	29	SSI0Fss	
PA4	30	SSI0Rx	
PA5	31	SSI0Tx	
PA6	34	CCP1	
PB0	66	CCP0	
PB1	67	CCP2	
PB2	70		
PB3	71		
PB4	92	C0-	
PB5	91	C0o	
PB6	90	C0+	
PB7	89	TRST	
PC0	80	TCK	SWCLK
PC1	79	TMS	SWDIO
PC2	78	TDI	
PC3	77	TDO	SWO
PC4	25		
PC5	24		
PC6	23	CCP3	
PD0	10		
PD1	11		
PD2	12		
PD3	13		
PF0	47		
PF1	61		
PF2	60	LED1	
PF3	59	LED0	

**Table 7-3. GPIO Pins and Alternate Functions (108BGA)**

IO	Pin Number	Multiplexed Function	Multiplexed Function
PA0	L3	U0Rx	

Table 7-3. GPIO Pins and Alternate Functions (108BGA) (continued)

IO	Pin Number	Multiplexed Function	Multiplexed Function
PA1	M3	U0Tx	
PA2	M4	SSI0Clk	
PA3	L4	SSI0Fss	
PA4	L5	SSI0Rx	
PA5	M5	SSI0Tx	
PA6	L6	CCP1	
PB0	E12	CCP0	
PB1	D12	CCP2	
PB2	C11		
PB3	C12		
PB4	A6	C0-	
PB5	B7	C0o	
PB6	A7	C0+	
PB7	A8	TRST	
PC0	A9	TCK	SWCLK
PC1	B9	TMS	SWDIO
PC2	B8	TDI	
PC3	A10	TDO	SWO
PC4	L1		
PC5	M1		
PC6	M2	CCP3	
PD0	G1		
PD1	G2		
PD2	H2		
PD3	H1		
PF0	M9		
PF1	H12		
PF2	J11	LED1	
PF3	J12	LED0	

Table 7-4. GPIO Signals (100LQFP)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PA0	26	I/O	TTL	GPIO port A bit 0.
PA1	27	I/O	TTL	GPIO port A bit 1.
PA2	28	I/O	TTL	GPIO port A bit 2.
PA3	29	I/O	TTL	GPIO port A bit 3.
PA4	30	I/O	TTL	GPIO port A bit 4.
PA5	31	I/O	TTL	GPIO port A bit 5.
PA6	34	I/O	TTL	GPIO port A bit 6.
PB0	66	I/O	TTL	GPIO port B bit 0.
PB1	67	I/O	TTL	GPIO port B bit 1.

Table 7-4. GPIO Signals (100LQFP) (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PB2	70	I/O	TTL	GPIO port B bit 2.
PB3	71	I/O	TTL	GPIO port B bit 3.
PB4	92	I/O	TTL	GPIO port B bit 4.
PB5	91	I/O	TTL	GPIO port B bit 5.
PB6	90	I/O	TTL	GPIO port B bit 6.
PB7	89	I/O	TTL	GPIO port B bit 7.
PC0	80	I/O	TTL	GPIO port C bit 0.
PC1	79	I/O	TTL	GPIO port C bit 1.
PC2	78	I/O	TTL	GPIO port C bit 2.
PC3	77	I/O	TTL	GPIO port C bit 3.
PC4	25	I/O	TTL	GPIO port C bit 4.
PC5	24	I/O	TTL	GPIO port C bit 5.
PC6	23	I/O	TTL	GPIO port C bit 6.
PD0	10	I/O	TTL	GPIO port D bit 0.
PD1	11	I/O	TTL	GPIO port D bit 1.
PD2	12	I/O	TTL	GPIO port D bit 2.
PD3	13	I/O	TTL	GPIO port D bit 3.
PF0	47	I/O	TTL	GPIO port F bit 0.
PF1	61	I/O	TTL	GPIO port F bit 1.
PF2	60	I/O	TTL	GPIO port F bit 2.
PF3	59	I/O	TTL	GPIO port F bit 3.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 7-5. GPIO Signals (108BGA)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PA0	L3	I/O	TTL	GPIO port A bit 0.
PA1	M3	I/O	TTL	GPIO port A bit 1.
PA2	M4	I/O	TTL	GPIO port A bit 2.
PA3	L4	I/O	TTL	GPIO port A bit 3.
PA4	L5	I/O	TTL	GPIO port A bit 4.
PA5	M5	I/O	TTL	GPIO port A bit 5.
PA6	L6	I/O	TTL	GPIO port A bit 6.
PB0	E12	I/O	TTL	GPIO port B bit 0.
PB1	D12	I/O	TTL	GPIO port B bit 1.
PB2	C11	I/O	TTL	GPIO port B bit 2.
PB3	C12	I/O	TTL	GPIO port B bit 3.
PB4	A6	I/O	TTL	GPIO port B bit 4.
PB5	B7	I/O	TTL	GPIO port B bit 5.
PB6	A7	I/O	TTL	GPIO port B bit 6.
PB7	A8	I/O	TTL	GPIO port B bit 7.
PC0	A9	I/O	TTL	GPIO port C bit 0.

Table 7-5. GPIO Signals (108BGA) (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PC1	B9	I/O	TTL	GPIO port C bit 1.
PC2	B8	I/O	TTL	GPIO port C bit 2.
PC3	A10	I/O	TTL	GPIO port C bit 3.
PC4	L1	I/O	TTL	GPIO port C bit 4.
PC5	M1	I/O	TTL	GPIO port C bit 5.
PC6	M2	I/O	TTL	GPIO port C bit 6.
PD0	G1	I/O	TTL	GPIO port D bit 0.
PD1	G2	I/O	TTL	GPIO port D bit 1.
PD2	H2	I/O	TTL	GPIO port D bit 2.
PD3	H1	I/O	TTL	GPIO port D bit 3.
PF0	M9	I/O	TTL	GPIO port F bit 0.
PF1	H12	I/O	TTL	GPIO port F bit 1.
PF2	J11	I/O	TTL	GPIO port F bit 2.
PF3	J12	I/O	TTL	GPIO port F bit 3.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

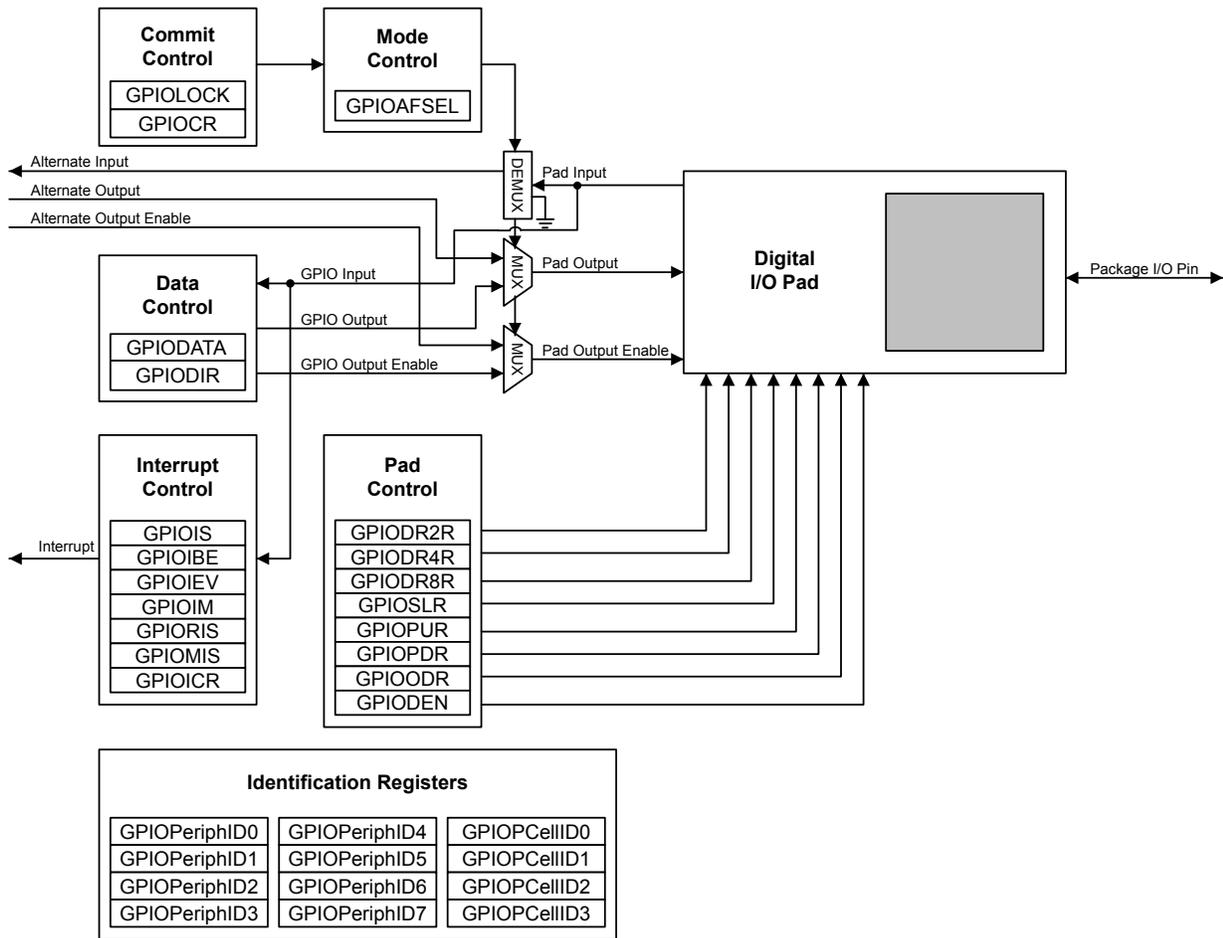
## 7.2 Functional Description

**Important:** All GPIO pins are tri-stated by default (**GPIOAFSEL=0**, **GPIODEN=0**, **GPIOPDR=0**, and **GPIOPUR=0**), with the exception of the five JTAG/SWD pins (**PB7** and **PC[3:0]**). The JTAG/SWD pins default to their JTAG/SWD functionality (**GPIOAFSEL=1**, **GPIODEN=1** and **GPIOPUR=1**). A Power-On-Reset (**POR**) or asserting **RST** puts both groups of pins back to their default state.

While debugging systems where **PB7** is being used as a GPIO, care must be taken to ensure that a low value is not applied to the pin when the part is reset. Because **PB7** reverts to the **TRST** function after reset, a Low value on the pin causes the JTAG controller to be reset, resulting in a loss of JTAG communication.

Each GPIO port is a separate hardware instantiation of the same physical block (see Figure 7-1 on page 248). The LM3S6100 microcontroller contains seven ports and thus seven of these physical GPIO blocks.

Figure 7-1. GPIO Port Block Diagram



## 7.2.1 Data Control

The data control registers allow software to configure the operational modes of the GPIOs. The data direction register configures the GPIO as an input or an output while the data register either captures incoming data or drives it out to the pads.

### 7.2.1.1 Data Direction Operation

The **GPIO Direction (GPIODIR)** register (see page 255) is used to configure each individual pin as an input or output. When the data direction bit is set to 0, the GPIO is configured as an input and the corresponding data register bit will capture and store the value on the GPIO port. When the data direction bit is set to 1, the GPIO is configured as an output and the corresponding data register bit will be driven out on the GPIO port.

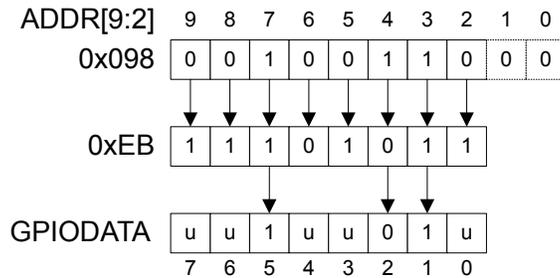
### 7.2.1.2 Data Register Operation

To aid in the efficiency of software, the GPIO ports allow for the modification of individual bits in the **GPIO Data (GPIODATA)** register (see page 254) by using bits [9:2] of the address bus as a mask. This allows software drivers to modify individual GPIO pins in a single instruction, without affecting the state of the other pins. This is in contrast to the "typical" method of doing a read-modify-write operation to set or clear an individual GPIO pin. To accommodate this feature, the **GPIODATA** register covers 256 locations in the memory map.

During a write, if the address bit associated with that data bit is set to 1, the value of the **GPIODATA** register is altered. If it is cleared to 0, it is left unchanged.

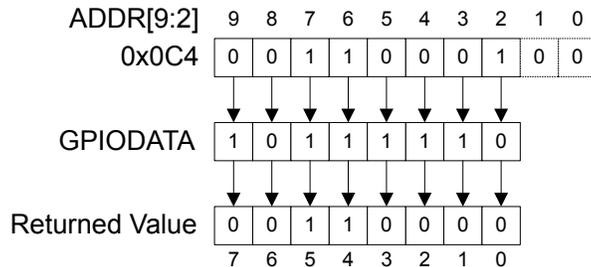
For example, writing a value of 0xEB to the address **GPIODATA** + 0x098 would yield as shown in Figure 7-2 on page 249, where *u* is data unchanged by the write.

**Figure 7-2. GPIODATA Write Example**



During a read, if the address bit associated with the data bit is set to 1, the value is read. If the address bit associated with the data bit is set to 0, it is read as a zero, regardless of its actual value. For example, reading address **GPIODATA** + 0x0C4 yields as shown in Figure 7-3 on page 249.

**Figure 7-3. GPIODATA Read Example**



## 7.2.2 Interrupt Control

The interrupt capabilities of each GPIO port are controlled by a set of seven registers. With these registers, it is possible to select the source of the interrupt, its polarity, and the edge properties. When one or more GPIO inputs cause an interrupt, a single interrupt output is sent to the interrupt controller for the entire GPIO port. For edge-triggered interrupts, software must clear the interrupt to enable any further interrupts. For a level-sensitive interrupt, it is assumed that the external source holds the level constant for the interrupt to be recognized by the controller.

Three registers are required to define the edge or sense that causes interrupts:

- **GPIO Interrupt Sense (GPIOIS)** register (see page 256)
- **GPIO Interrupt Both Edges (GPIOIBE)** register (see page 257)
- **GPIO Interrupt Event (GPIOIEV)** register (see page 258)

Interrupts are enabled/disabled via the **GPIO Interrupt Mask (GPIOIM)** register (see page 259).

When an interrupt condition occurs, the state of the interrupt signal can be viewed in two locations: the **GPIO Raw Interrupt Status (GPIORIS)** and **GPIO Masked Interrupt Status (GPIOMIS)** registers (see page 260 and page 261). As the name implies, the **GPIOMIS** register only shows interrupt

conditions that are allowed to be passed to the controller. The **GPORIS** register indicates that a GPIO pin meets the conditions for an interrupt, but has not necessarily been sent to the controller.

Interrupts are cleared by writing a 1 to the appropriate bit of the **GPIO Interrupt Clear (GPIOICR)** register (see page 262).

When programming the following interrupt control registers, the interrupts should be masked (**GPIOIM** set to 0). Writing any value to an interrupt control register (**GPIOIS**, **GPIOIBE**, or **GPIOIEV**) can generate a spurious interrupt if the corresponding bits are enabled.

### 7.2.3 Mode Control

The GPIO pins can be controlled by either hardware or software. When hardware control is enabled via the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 263), the pin state is controlled by its alternate function (that is, the peripheral). Software control corresponds to GPIO mode, where the **GPIO DATA** register is used to read/write the corresponding pins.

### 7.2.4 Commit Control

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is currently provided for the five JTAG/SWD pins ( $PB7$  and  $PC[3:0]$ ). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 263) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 273) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 274) have been set to 1.

### 7.2.5 Pad Control

The pad control registers allow for GPIO pad configuration by software based on the application requirements. The pad control registers include the **GPIO DR2R**, **GPIO DR4R**, **GPIO DR8R**, **GPIO DR**, **GPIO PUR**, **GPIO PDR**, **GPIO SLR**, and **GPIO DEN** registers. These registers control drive strength, open-drain configuration, pull-up and pull-down resistors, slew-rate control and digital enable.

For special high-current applications, the GPIO output buffers may be used with the following restrictions. With the GPIO pins configured as 8-mA output drivers, a total of four GPIO outputs may be used to sink current loads up to 18 mA each. At 18-mA sink current loading, the  $V_{OL}$  value is specified as 1.2 V. The high-current GPIO package pins must be selected such that there are only a maximum of two per side of the physical package or BGA pin group with the total number of high-current GPIO outputs not exceeding four for the entire package.

### 7.2.6 Identification

The identification registers configured at reset allow software to detect and identify the module as a GPIO block. The identification registers include the **GPIO PeriphID0-GPIO PeriphID7** registers as well as the **GPIO CellID0-GPIO CellID3** registers.

## 7.3 Initialization and Configuration

To use the GPIO, the peripheral clock must be enabled by setting the appropriate GPIO Port bit field ( $GPIO_n$ ) in the **RCGC2** register.

On reset, all GPIO pins (except for the five JTAG pins) are configured out of reset to be undriven (tristate): **GPIOAFSEL**=0, **GPIO DEN**=0, **GPIO PDR**=0, and **GPIO PUR**=0. Table 7-6 on page 251 shows all possible configurations of the GPIO pads and the control register settings required to achieve them. Table 7-7 on page 251 shows how a rising edge interrupt would be configured for pin 2 of a GPIO port.

**Table 7-6. GPIO Pad Configuration Examples**

Configuration	GPIO Register Bit Value <sup>a</sup>									
	AFSEL	DIR	ODR	DEN	PUR	PDR	DR2R	DR4R	DR8R	SLR
Digital Input (GPIO)	0	0	0	1	?	?	X	X	X	X
Digital Output (GPIO)	0	1	0	1	?	?	?	?	?	?
Open Drain Output (GPIO)	0	1	1	1	X	X	?	?	?	?
Digital Input (Timer CCP)	1	X	0	1	?	?	X	X	X	X
Digital Output (Timer PWM)	1	X	0	1	?	?	?	?	?	?
Digital Input/Output (SSI)	1	X	0	1	?	?	?	?	?	?
Digital Input/Output (UART)	1	X	0	1	?	?	?	?	?	?
Analog Input (Comparator)	0	0	0	0	0	0	X	X	X	X
Digital Output (Comparator)	1	X	0	1	?	?	?	?	?	?

a. X=Ignored (don't care bit)

?=Can be either 0 or 1, depending on the configuration

**Table 7-7. GPIO Interrupt Configuration Example**

Register	Desired Interrupt Event Trigger	Pin 2 Bit Value <sup>a</sup>							
		7	6	5	4	3	2	1	0
GPIOIS	0=edge 1=level	X	X	X	X	X	0	X	X
GPIOIBE	0=single edge 1=both edges	X	X	X	X	X	0	X	X
GPIOIEV	0=Low level, or negative edge 1=High level, or positive edge	X	X	X	X	X	1	X	X
GPIOIM	0=masked 1=not masked	0	0	0	0	0	1	0	0

a. X=Ignored (don't care bit)

## 7.4 Register Map

Table 7-8 on page 252 lists the GPIO registers. The offset listed is a hexadecimal increment to the register's address, relative to that GPIO port's base address:

- GPIO Port A: 0x4000.4000
- GPIO Port B: 0x4000.5000

- GPIO Port C: 0x4000.6000
- GPIO Port D: 0x4000.7000
- GPIO Port E: 0x4002.4000
- GPIO Port F: 0x4002.5000
- GPIO Port G: 0x4002.6000

Note that the GPIO module clock must be enabled before the registers can be programmed (see page 207). There must be a delay of 3 system clocks after the GPIO module clock is enabled before any GPIO module registers are accessed.

**Important:** The GPIO registers in this chapter are duplicated in each GPIO block; however, depending on the block, all eight bits may not be connected to a GPIO pad. In those cases, writing to those unconnected bits has no effect, and reading those unconnected bits returns no meaningful data.

**Note:** The default reset value for the **GPIOAFSEL**, **GPIOPUR**, and **GPIODEN** registers are 0x0000.0000 for all GPIO pins, with the exception of the five JTAG/SWD pins (**PB7** and **PC[3:0]**). These five pins default to JTAG/SWD functionality. Because of this, the default reset value of these registers for GPIO Port B is 0x0000.0080 while the default reset value for Port C is 0x0000.000F.

The default register type for the **GPIOCR** register is RO for all GPIO pins with the exception of the five JTAG/SWD pins (**PB7** and **PC[3:0]**). These five pins are currently the only GPIOs that are protected by the **GPIOCR** register. Because of this, the register type for GPIO Port B7 and GPIO Port C[3:0] is R/W.

The default reset value for the **GPIOCR** register is 0x0000.00FF for all GPIO pins, with the exception of the five JTAG/SWD pins (**PB7** and **PC[3:0]**). To ensure that the JTAG port is not accidentally programmed as a GPIO, these five pins default to non-committable. Because of this, the default reset value of **GPIOCR** for GPIO Port B is 0x0000.007F while the default reset value of GPIOCR for Port C is 0x0000.00F0.

**Table 7-8. GPIO Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	GPIODATA	R/W	0x0000.0000	GPIO Data	254
0x400	GPIODIR	R/W	0x0000.0000	GPIO Direction	255
0x404	GPIOIS	R/W	0x0000.0000	GPIO Interrupt Sense	256
0x408	GPIOIBE	R/W	0x0000.0000	GPIO Interrupt Both Edges	257
0x40C	GPIOIEV	R/W	0x0000.0000	GPIO Interrupt Event	258
0x410	GPIOIM	R/W	0x0000.0000	GPIO Interrupt Mask	259
0x414	GPIORIS	RO	0x0000.0000	GPIO Raw Interrupt Status	260
0x418	GPIONIS	RO	0x0000.0000	GPIO Masked Interrupt Status	261
0x41C	GPIOICR	W1C	0x0000.0000	GPIO Interrupt Clear	262
0x420	GPIOAFSEL	R/W	-	GPIO Alternate Function Select	263
0x500	GPIODR2R	R/W	0x0000.00FF	GPIO 2-mA Drive Select	265
0x504	GPIODR4R	R/W	0x0000.0000	GPIO 4-mA Drive Select	266

Table 7-8. GPIO Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x508	GPIODR8R	R/W	0x0000.0000	GPIO 8-mA Drive Select	267
0x50C	GPIOODR	R/W	0x0000.0000	GPIO Open Drain Select	268
0x510	GPIOPUR	R/W	-	GPIO Pull-Up Select	269
0x514	GPIOPDR	R/W	0x0000.0000	GPIO Pull-Down Select	270
0x518	GPIOSLR	R/W	0x0000.0000	GPIO Slew Rate Control Select	271
0x51C	GIODEN	R/W	-	GPIO Digital Enable	272
0x520	GPIOLOCK	R/W	0x0000.0001	GPIO Lock	273
0x524	GPIOCR	-	-	GPIO Commit	274
0xFD0	GPIOPeriphID4	RO	0x0000.0000	GPIO Peripheral Identification 4	276
0xFD4	GPIOPeriphID5	RO	0x0000.0000	GPIO Peripheral Identification 5	277
0xFD8	GPIOPeriphID6	RO	0x0000.0000	GPIO Peripheral Identification 6	278
0xFDC	GPIOPeriphID7	RO	0x0000.0000	GPIO Peripheral Identification 7	279
0xFE0	GPIOPeriphID0	RO	0x0000.0061	GPIO Peripheral Identification 0	280
0xFE4	GPIOPeriphID1	RO	0x0000.0000	GPIO Peripheral Identification 1	281
0xFE8	GPIOPeriphID2	RO	0x0000.0018	GPIO Peripheral Identification 2	282
0xFEC	GPIOPeriphID3	RO	0x0000.0001	GPIO Peripheral Identification 3	283
0xFF0	GPIOPCellID0	RO	0x0000.000D	GPIO PrimeCell Identification 0	284
0xFF4	GPIOPCellID1	RO	0x0000.00F0	GPIO PrimeCell Identification 1	285
0xFF8	GPIOPCellID2	RO	0x0000.0005	GPIO PrimeCell Identification 2	286
0xFFC	GPIOPCellID3	RO	0x0000.00B1	GPIO PrimeCell Identification 3	287

## 7.5 Register Descriptions

The remainder of this section lists and describes the GPIO registers, in numerical order by address offset.

### Register 1: GPIO Data (GPIODATA), offset 0x000

The **GPIODATA** register is the data register. In software control mode, values written in the **GPIODATA** register are transferred onto the GPIO port pins if the respective pins have been configured as outputs through the **GPIO Direction (GPIODIR)** register (see page 255).

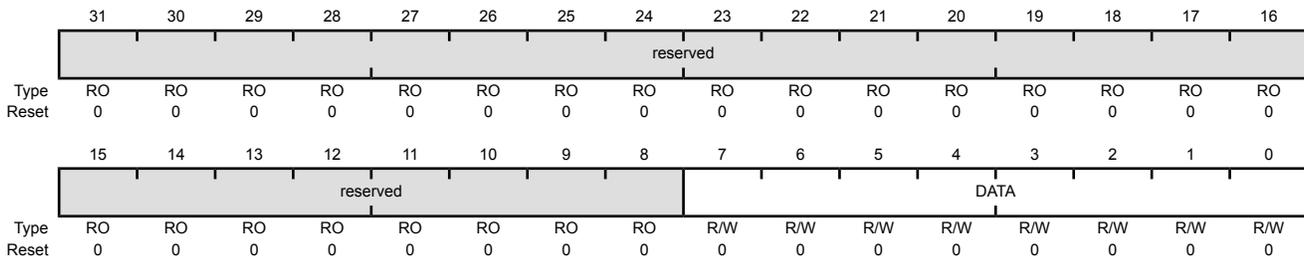
In order to write to **GPIODATA**, the corresponding bits in the mask, resulting from the address bus bits [9:2], must be High. Otherwise, the bit values remain unchanged by the write.

Similarly, the values read from this register are determined for each bit by the mask bit derived from the address used to access the data register, bits [9:2]. Bits that are 1 in the address mask cause the corresponding bits in **GPIODATA** to be read, and bits that are 0 in the address mask cause the corresponding bits in **GPIODATA** to be read as 0, regardless of their value.

A read from **GPIODATA** returns the last bit value written if the respective pins are configured as outputs, or it returns the value on the corresponding input pin when these are configured as inputs. All bits are cleared by a reset.

#### GPIO Data (GPIODATA)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x000  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DATA	R/W	0x00	GPIO Data This register is virtually mapped to 256 locations in the address space. To facilitate the reading and writing of data to these registers by independent drivers, the data read from and the data written to the registers are masked by the eight address lines <code>ipaddr[9:2]</code> . Reads from this register return its current state. Writes to this register only affect bits that are not masked by <code>ipaddr[9:2]</code> and are configured as outputs. See "Data Register Operation" on page 248 for examples of reads and writes.

## Register 2: GPIO Direction (GPIODIR), offset 0x400

The **GPIODIR** register is the data direction register. Bits set to 1 in the **GPIODIR** register configure the corresponding pin to be an output, while bits set to 0 configure the pins to be inputs. All bits are cleared by a reset, meaning all GPIO pins are inputs by default.

### GPIO Direction (GPIODIR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x400  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DIR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

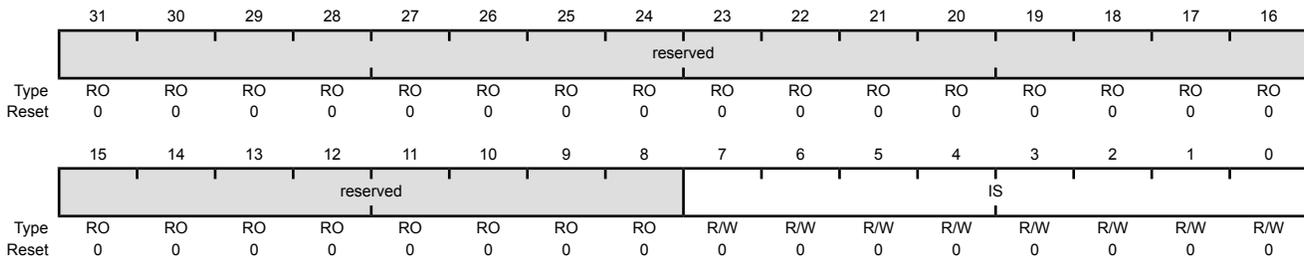
Bit/Field	Name	Type	Reset	Description						
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
7:0	DIR	R/W	0x00	GPIO Data Direction The <b>DIR</b> values are defined as follows:  <table border="0"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Pins are inputs.</td> </tr> <tr> <td>1</td> <td>Pins are outputs.</td> </tr> </tbody> </table>	Value	Description	0	Pins are inputs.	1	Pins are outputs.
Value	Description									
0	Pins are inputs.									
1	Pins are outputs.									

### Register 3: GPIO Interrupt Sense (GPIOIS), offset 0x404

The **GPIOIS** register is the interrupt sense register. Bits set to 1 in **GPIOIS** configure the corresponding pins to detect levels, while bits set to 0 configure the pins to detect edges. All bits are cleared by a reset.

#### GPIO Interrupt Sense (GPIOIS)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x404  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	IS	R/W	0x00	GPIO Interrupt Sense The IS values are defined as follows:
				Value Description
				0 Edge on corresponding pin is detected (edge-sensitive).
				1 Level on corresponding pin is detected (level-sensitive).

## Register 4: GPIO Interrupt Both Edges (GPIOIBE), offset 0x408

The **GPIOIBE** register is the interrupt both-edges register. When the corresponding bit in the **GPIO Interrupt Sense (GPIOIS)** register (see page 256) is set to detect edges, bits set to High in **GPIOIBE** configure the corresponding pin to detect both rising and falling edges, regardless of the corresponding bit in the **GPIO Interrupt Event (GPIOIEV)** register (see page 258). Clearing a bit configures the pin to be controlled by **GPIOIEV**. All bits are cleared by a reset.

### GPIO Interrupt Both Edges (GPIOIBE)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x408  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								IBE							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	IBE	R/W	0x00	GPIO Interrupt Both Edges The <b>IBE</b> values are defined as follows:

#### Value Description

- |   |  |
|---|--|
| 0 | Interrupt generation is controlled by the <b>GPIO Interrupt Event (GPIOIEV)</b> register (see page 258). |
| 1 | Both edges on the corresponding pin trigger an interrupt.  |

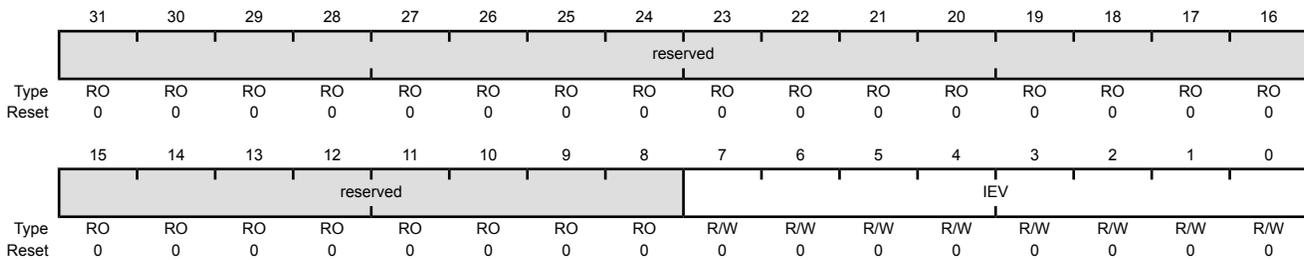
**Note:** Single edge is determined by the corresponding bit in **GPIOIEV**.

### Register 5: GPIO Interrupt Event (GPIOIEV), offset 0x40C

The **GPIOIEV** register is the interrupt event register. Bits set to High in **GPIOIEV** configure the corresponding pin to detect rising edges or high levels, depending on the corresponding bit value in the **GPIO Interrupt Sense (GPIOIS)** register (see page 256). Clearing a bit configures the pin to detect falling edges or low levels, depending on the corresponding bit value in **GPIOIS**. All bits are cleared by a reset.

#### GPIO Interrupt Event (GPIOIEV)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x40C  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	IEV	R/W	0x00	GPIO Interrupt Event The <b>IEV</b> values are defined as follows:  Value Description 0 Falling edge or Low levels on corresponding pins trigger interrupts. 1 Rising edge or High levels on corresponding pins trigger interrupts.

## Register 6: GPIO Interrupt Mask (GPIOIM), offset 0x410

The **GPIOIM** register is the interrupt mask register. Bits set to High in **GPIOIM** allow the corresponding pins to trigger their individual interrupts and the combined **GPIOINTR** line. Clearing a bit disables interrupt triggering on that pin. All bits are cleared by a reset.

### GPIO Interrupt Mask (GPIOIM)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x410  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								IME							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

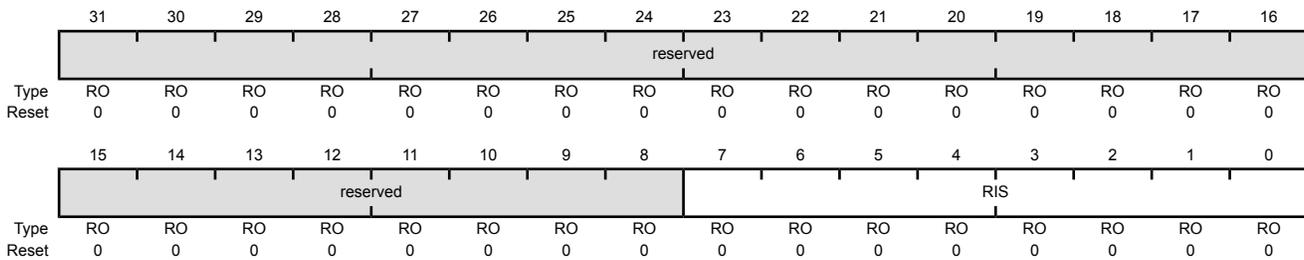
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	IME	R/W	0x00	GPIO Interrupt Mask Enable The <b>IME</b> values are defined as follows:
				Value Description
				0 Corresponding pin interrupt is masked.
				1 Corresponding pin interrupt is not masked.

### Register 7: GPIO Raw Interrupt Status (GPIORIS), offset 0x414

The **GPIORIS** register is the raw interrupt status register. Bits read High in **GPIORIS** reflect the status of interrupt trigger conditions detected (raw, prior to masking), indicating that all the requirements have been met, before they are finally allowed to trigger by the **GPIO Interrupt Mask (GPIOIM)** register (see page 259). Bits read as zero indicate that corresponding input pins have not initiated an interrupt. All bits are cleared by a reset.

#### GPIO Raw Interrupt Status (GPIORIS)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x414  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	RIS	RO	0x00	GPIO Interrupt Raw Status

Reflects the status of interrupt trigger condition detection on pins (raw, prior to masking).  
 The RIS values are defined as follows:

Value	Description
0	Corresponding pin interrupt requirements not met.
1	Corresponding pin interrupt has met requirements.

## Register 8: GPIO Masked Interrupt Status (GPIOMIS), offset 0x418

The **GPIOMIS** register is the masked interrupt status register. Bits read High in **GPIOMIS** reflect the status of input lines triggering an interrupt. Bits read as Low indicate that either no interrupt has been generated, or the interrupt is masked.

**GPIOMIS** is the state of the interrupt after masking.

### GPIO Masked Interrupt Status (GPIOMIS)

GPIO Port A base: 0x4000.4000

GPIO Port B base: 0x4000.5000

GPIO Port C base: 0x4000.6000

GPIO Port D base: 0x4000.7000

GPIO Port E base: 0x4002.4000

GPIO Port F base: 0x4002.5000

GPIO Port G base: 0x4002.6000

Offset 0x418

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								MIS							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

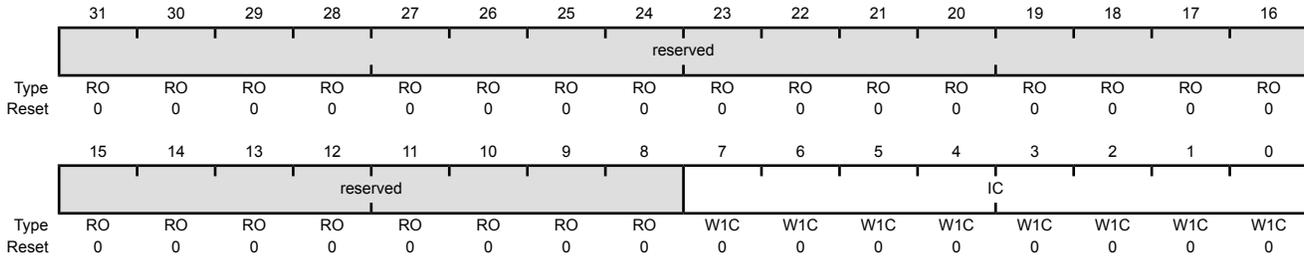
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	MIS	RO	0x00	GPIO Masked Interrupt Status Masked value of interrupt due to corresponding pin. The MIS values are defined as follows:  Value Description 0 Corresponding GPIO line interrupt not active. 1 Corresponding GPIO line asserting interrupt.

### Register 9: GPIO Interrupt Clear (GPIOICR), offset 0x41C

The **GPIOICR** register is the interrupt clear register. Writing a 1 to a bit in this register clears the corresponding interrupt edge detection logic register. Writing a 0 has no effect.

#### GPIO Interrupt Clear (GPIOICR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x41C  
 Type W1C, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	IC	W1C	0x00	GPIO Interrupt Clear The IC values are defined as follows:  Value Description 0 Corresponding interrupt is unaffected. 1 Corresponding interrupt is cleared.

## Register 10: GPIO Alternate Function Select (GPIOAFSEL), offset 0x420

The **GPIOAFSEL** register is the mode control select register. Writing a 1 to any bit in this register selects the hardware control for the corresponding GPIO line. All bits are cleared by a reset, therefore no GPIO line is set to hardware control by default.

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is currently provided for the five JTAG/SWD pins ( $PB7$  and  $PC[3:0]$ ). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 263) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 273) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 274) have been set to 1.

**Important:** All GPIO pins are tri-stated by default (**GPIOAFSEL**=0, **GIODEN**=0, **GIOPDR**=0, and **GIOPUR**=0), with the exception of the five JTAG/SWD pins ( $PB7$  and  $PC[3:0]$ ). The JTAG/SWD pins default to their JTAG/SWD functionality (**GPIOAFSEL**=1, **GIODEN**=1 and **GIOPUR**=1). A Power-On-Reset ( $\overline{POR}$ ) or asserting  $\overline{RST}$  puts both groups of pins back to their default state.

While debugging systems where  $PB7$  is being used as a GPIO, care must be taken to ensure that a low value is not applied to the pin when the part is reset. Because  $PB7$  reverts to the  $\overline{TRST}$  function after reset, a Low value on the pin causes the JTAG controller to be reset, resulting in a loss of JTAG communication.

**Caution – It is possible to create a software sequence that prevents the debugger from connecting to the Stellaris® microcontroller. If the program code loaded into flash immediately changes the JTAG pins to their GPIO functionality, the debugger may not have enough time to connect and halt the controller before the JTAG pin functionality switches. This may lock the debugger out of the part. This can be avoided with a software routine that restores JTAG functionality based on an external or software trigger.**

### GPIO Alternate Function Select (GPIOAFSEL)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x420  
 Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								AFSEL							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description						
7:0	AFSEL	R/W	-	<p>GPIO Alternate Function Select</p> <p>The AFSEL values are defined as follows:</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>Software control of corresponding GPIO line (GPIO mode).</td></tr><tr><td>1</td><td>Hardware control of corresponding GPIO line (alternate hardware function).</td></tr></tbody></table> <p><b>Note:</b> The default reset value for the <b>GPIOAFSEL</b>, <b>GPIOPUR</b>, and <b>GPIODEN</b> registers are 0x0000.0000 for all GPIO pins, with the exception of the five JTAG/SWD pins (<b>PB7</b> and <b>PC[3:0]</b>). These five pins default to JTAG/SWD functionality. Because of this, the default reset value of these registers for GPIO Port B is 0x0000.0080 while the default reset value for Port C is 0x0000.000F.</p>	Value	Description	0	Software control of corresponding GPIO line (GPIO mode).	1	Hardware control of corresponding GPIO line (alternate hardware function).
Value	Description									
0	Software control of corresponding GPIO line (GPIO mode).									
1	Hardware control of corresponding GPIO line (alternate hardware function).									

## Register 11: GPIO 2-mA Drive Select (GPIODR2R), offset 0x500

The **GPIODR2R** register is the 2-mA drive control register. It allows for each GPIO signal in the port to be individually configured without affecting the other pads. When writing a **DRV2** bit for a GPIO signal, the corresponding **DRV4** bit in the **GPIODR4R** register and the **DRV8** bit in the **GPIODR8R** register are automatically cleared by hardware.

### GPIO 2-mA Drive Select (GPIODR2R)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x500  
 Type R/W, reset 0x0000.00FF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DRV2							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

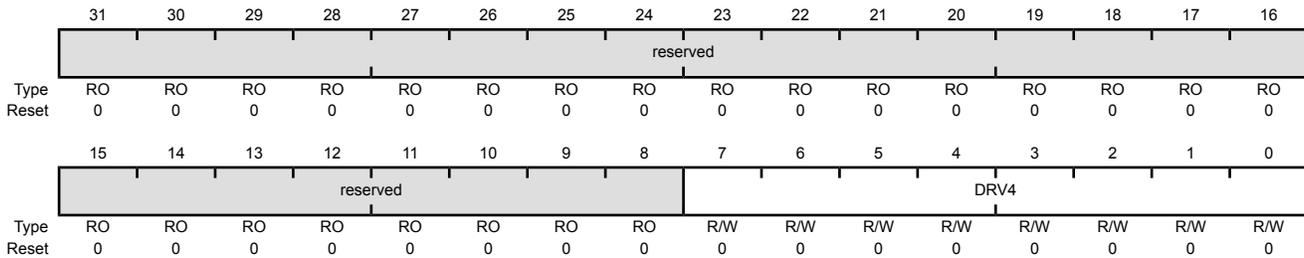
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DRV2	R/W	0xFF	Output Pad 2-mA Drive Enable A write of 1 to either <b>GPIODR4[n]</b> or <b>GPIODR8[n]</b> clears the corresponding 2-mA enable bit. The change is effective on the second clock cycle after the write.

### Register 12: GPIO 4-mA Drive Select (GPIODR4R), offset 0x504

The **GPIODR4R** register is the 4-mA drive control register. It allows for each GPIO signal in the port to be individually configured without affecting the other pads. When writing the **DRV4** bit for a GPIO signal, the corresponding **DRV2** bit in the **GPIODR2R** register and the **DRV8** bit in the **GPIODR8R** register are automatically cleared by hardware.

#### GPIO 4-mA Drive Select (GPIODR4R)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x504  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DRV4	R/W	0x00	Output Pad 4-mA Drive Enable A write of 1 to either <b>GPIODR2[n]</b> or <b>GPIODR8[n]</b> clears the corresponding 4-mA enable bit. The change is effective on the second clock cycle after the write.

### Register 13: GPIO 8-mA Drive Select (GPIODR8R), offset 0x508

The **GPIODR8R** register is the 8-mA drive control register. It allows for each GPIO signal in the port to be individually configured without affecting the other pads. When writing the **DRV8** bit for a GPIO signal, the corresponding **DRV2** bit in the **GPIODR2R** register and the **DRV4** bit in the **GPIODR4R** register are automatically cleared by hardware.

#### GPIO 8-mA Drive Select (GPIODR8R)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x508  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DRV8							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

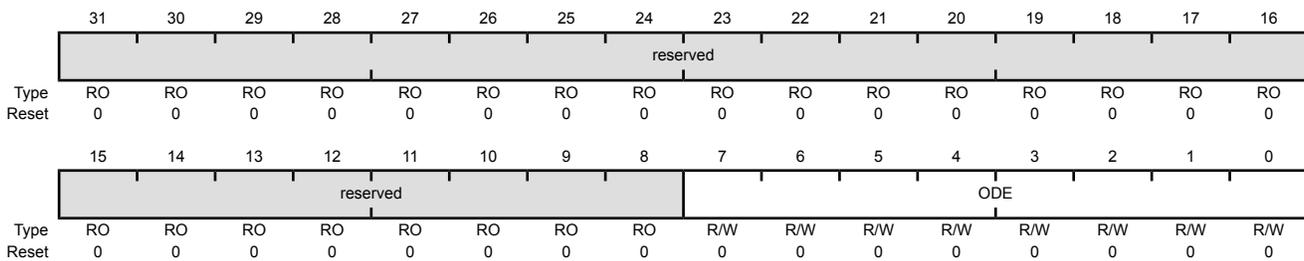
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DRV8	R/W	0x00	Output Pad 8-mA Drive Enable A write of 1 to either <b>GPIODR2[n]</b> or <b>GPIODR4[n]</b> clears the corresponding 8-mA enable bit. The change is effective on the second clock cycle after the write.

### Register 14: GPIO Open Drain Select (GPIOODR), offset 0x50C

The **GPIOODR** register is the open drain control register. Setting a bit in this register enables the open drain configuration of the corresponding GPIO pad. When open drain mode is enabled, the corresponding bit should also be set in the **GPIO Digital Enable (GPIODEN)** register (see page 272). Corresponding bits in the drive strength registers (**GPIODR2R**, **GPIODR4R**, **GPIODR8R**, and **GPIOSLR**) can be set to achieve the desired rise and fall times. The GPIO acts as an open-drain input if the corresponding bit in the **GPIODIR** register is cleared. If open drain is selected while the GPIO is configured as an input, the GPIO will remain an input and the open-drain selection has no effect until the GPIO is changed to an output.

#### GPIO Open Drain Select (GPIOODR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x50C  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	ODE	R/W	0x00	Output Pad Open Drain Enable The ODE values are defined as follows:
				Value Description
				0 Open drain configuration is disabled.
				1 Open drain configuration is enabled.

## Register 15: GPIO Pull-Up Select (GPIOPUR), offset 0x510

The **GPIOPUR** register is the pull-up control register. When a bit is set to 1, it enables a weak pull-up resistor on the corresponding GPIO signal. Setting a bit in **GPIOPUR** automatically clears the corresponding bit in the **GPIO Pull-Down Select (GPIOPDR)** register (see page 270).

### GPIO Pull-Up Select (GPIOPUR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x510  
 Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PUE							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PUE	R/W	-	Pad Weak Pull-Up Enable

#### Value Description

Value	Description
0	The corresponding pin's weak pull-up resistor is disabled.
1	The corresponding pin's weak pull-up resistor is enabled.

A write of 1 to **GPIOPDR[n]** clears the corresponding **GPIOPUR[n]** enables. The change is effective on the second clock cycle after the write.

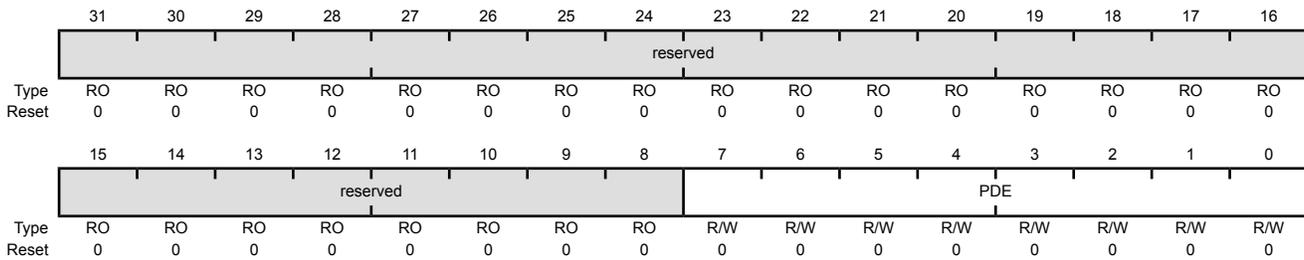
**Note:** The default reset value for the **GPIOPUR**, **GPIODEN**, and **GPIODEN** registers are 0x0000.0000 for all GPIO pins, with the exception of the five JTAG/SWD pins (**PEB7** and **PC[3:0]**). These five pins default to JTAG/SWD functionality. Because of this, the default reset value of these registers for GPIO Port B is 0x0000.0080 while the default reset value for Port C is 0x0000.000F.

### Register 16: GPIO Pull-Down Select (GPIOPDR), offset 0x514

The **GPIOPDR** register is the pull-down control register. When a bit is set to 1, it enables a weak pull-down resistor on the corresponding GPIO signal. Setting a bit in **GPIOPDR** automatically clears the corresponding bit in the **GPIO Pull-Up Select (GPIOPUR)** register (see page 269).

#### GPIO Pull-Down Select (GPIOPDR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x514  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PDE	R/W	0x00	Pad Weak Pull-Down Enable

Value	Description
0	The corresponding pin's weak pull-down resistor is disabled.
1	The corresponding pin's weak pull-down resistor is enabled.

A write of 1 to **GPIOPUR[n]** clears the corresponding **GPIOPDR[n]** enables. The change is effective on the second clock cycle after the write.

**Register 17: GPIO Slew Rate Control Select (GPIOSLR), offset 0x518**

The **GPIOSLR** register is the slew rate control register. Slew rate control is only available when using the 8-mA drive strength option via the **GPIO 8-mA Drive Select (GPIO8R)** register (see page 267).

**GPIO Slew Rate Control Select (GPIOSLR)**

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x518  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								SRL							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	SRL	R/W	0x00	Slew Rate Limit Enable (8-mA drive only) The SRL values are defined as follows:  Value Description 0 Slew rate control disabled. 1 Slew rate control enabled.

### Register 18: GPIO Digital Enable (GPIODEN), offset 0x51C

**Note:** Pins configured as digital inputs are Schmitt-triggered.

The **GPIODEN** register is the digital enable register. By default, with the exception of the GPIO signals used for JTAG/SWD function, all other GPIO signals are configured out of reset to be undriven (tristate). Their digital function is disabled; they do not drive a logic value on the pin and they do not allow the pin voltage into the GPIO receiver. To use the pin in a digital function (either GPIO or alternate function), the corresponding **GPIODEN** bit must be set.

#### GPIO Digital Enable (GPIODEN)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x51C  
 Type R/W, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DEN							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DEN	R/W	-	Digital Enable

The **DEN** values are defined as follows:

Value	Description
0	Digital functions disabled.
1	Digital functions enabled.

**Note:** The default reset value for the **GPIOAFSEL**, **GPIOPUR**, and **GPIODEN** registers are 0x0000.0000 for all GPIO pins, with the exception of the five JTAG/SWD pins (**PB7** and **PC[3:0]**). These five pins default to JTAG/SWD functionality. Because of this, the default reset value of these registers for GPIO Port B is 0x0000.0080 while the default reset value for Port C is 0x0000.000F.

**Register 19: GPIO Lock (GPIOLOCK), offset 0x520**

The **GPIOLOCK** register enables write access to the **GPIOCR** register (see page 274). Writing 0x1ACC.E551 to the **GPIOLOCK** register will unlock the **GPIOCR** register. Writing any other value to the **GPIOLOCK** register re-enables the locked state. Reading the **GPIOLOCK** register returns the lock status rather than the 32-bit value that was previously written. Therefore, when write accesses are disabled, or locked, reading the **GPIOLOCK** register returns 0x00000001. When write accesses are enabled, or unlocked, reading the **GPIOLOCK** register returns 0x00000000.

**GPIO Lock (GPIOLOCK)**

GPIO Port A base: 0x4000.4000

GPIO Port B base: 0x4000.5000

GPIO Port C base: 0x4000.6000

GPIO Port D base: 0x4000.7000

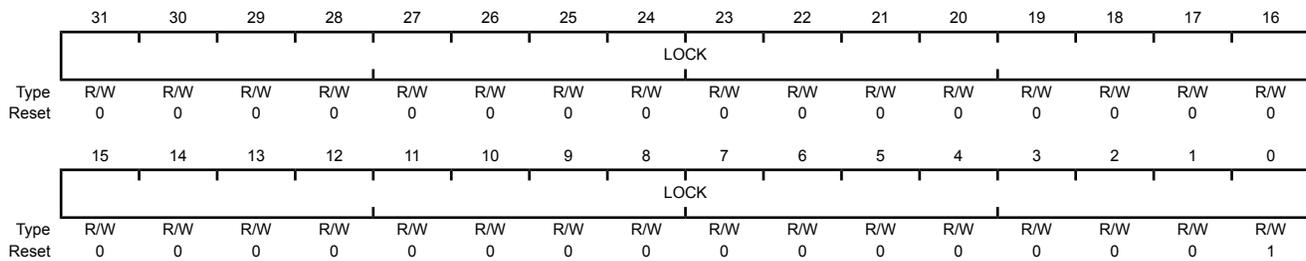
GPIO Port E base: 0x4002.4000

GPIO Port F base: 0x4002.5000

GPIO Port G base: 0x4002.6000

Offset 0x520

Type R/W, reset 0x0000.0001



Bit/Field	Name	Type	Reset	Description
31:0	LOCK	R/W	0x0000.0001	GPIO Lock

A write of the value 0x1ACC.E551 unlocks the **GPIO Commit (GPIOCR)** register for write access.

A write of any other value or a write to the **GPIOCR** register reapplies the lock, preventing any register updates. A read of this register returns the following values:

Value	Description
0x0000.0001	Locked
0x0000.0000	Unlocked

### Register 20: GPIO Commit (GPIOCR), offset 0x524

The **GPIOCR** register is the commit register. The value of the **GPIOCR** register determines which bits of the **GPIOAFSEL** register are committed when a write to the **GPIOAFSEL** register is performed. If a bit in the **GPIOCR** register is a zero, the data being written to the corresponding bit in the **GPIOAFSEL** register will not be committed and will retain its previous value. If a bit in the **GPIOCR** register is a one, the data being written to the corresponding bit of the **GPIOAFSEL** register will be committed to the register and will reflect the new value.

The contents of the **GPIOCR** register can only be modified if the **GPIOLOCK** register is unlocked. Writes to the **GPIOCR** register are ignored if the **GPIOLOCK** register is locked.

**Important:** This register is designed to prevent accidental programming of the registers that control connectivity to the JTAG/SWD debug hardware. By initializing the bits of the **GPIOCR** register to 0 for **PB7** and **PC[3:0]**, the JTAG/SWD debug port can only be converted to GPIOs through a deliberate set of writes to the **GPIOLOCK**, **GPIOCR**, and the corresponding registers.

Because this protection is currently only implemented on the JTAG/SWD pins on **PB7** and **PC[3:0]**, all of the other bits in the **GPIOCR** registers cannot be written with 0x0. These bits are hardwired to 0x1, ensuring that it is always possible to commit new values to the **GPIOAFSEL** register bits of these other pins.

#### GPIO Commit (GPIOCR)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0x524  
 Type -, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	-	-	-	-	-	-	-	-
Reset	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

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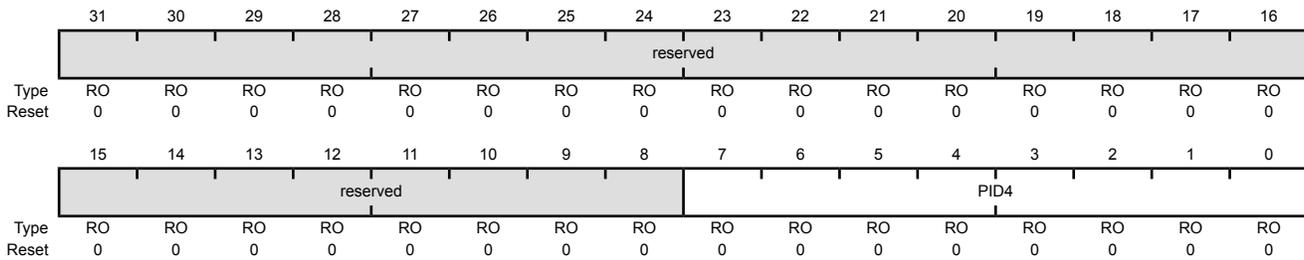
Bit/Field	Name	Type	Reset	Description
7:0	CR	-	-	<p>GPIO Commit</p> <p>On a bit-wise basis, any bit set allows the corresponding <b>GPIOAFSEL</b> bit to be set to its alternate function.</p> <p><b>Note:</b> The default register type for the <b>GPIOCR</b> register is RO for all GPIO pins with the exception of the five JTAG/SWD pins (<math>\text{PB}7</math> and <math>\text{PC}[3:0]</math>). These five pins are currently the only GPIOs that are protected by the <b>GPIOCR</b> register. Because of this, the register type for GPIO Port B7 and GPIO Port C[3:0] is R/W.</p> <p>The default reset value for the <b>GPIOCR</b> register is 0x0000.00FF for all GPIO pins, with the exception of the five JTAG/SWD pins (<math>\text{PB}7</math> and <math>\text{PC}[3:0]</math>). To ensure that the JTAG port is not accidentally programmed as a GPIO, these five pins default to non-committable. Because of this, the default reset value of <b>GPIOCR</b> for GPIO Port B is 0x0000.007F while the default reset value of GPIOCR for Port C is 0x0000.00F0.</p>

**Register 21: GPIO Peripheral Identification 4 (GPIOPeriphID4), offset 0xFD0**

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 4 (GPIOPeriphID4)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFD0  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID4	RO	0x00	GPIO Peripheral ID Register[7:0]

**Register 22: GPIO Peripheral Identification 5 (GPIOPeriphID5), offset 0xFD4**

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

## GPIO Peripheral Identification 5 (GPIOPeriphID5)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFD4  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID5							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

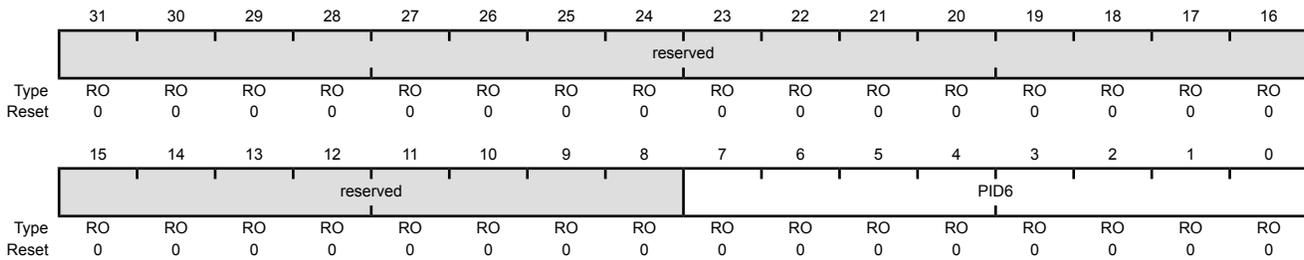
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID5	RO	0x00	GPIO Peripheral ID Register[15:8]

**Register 23: GPIO Peripheral Identification 6 (GPIOPeriphID6), offset 0xFD8**

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 6 (GPIOPeriphID6)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFD8  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID6	RO	0x00	GPIO Peripheral ID Register[23:16]

**Register 24: GPIO Peripheral Identification 7 (GPIOPeriphID7), offset 0xFDC**

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

## GPIO Peripheral Identification 7 (GPIOPeriphID7)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFDC  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID7							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

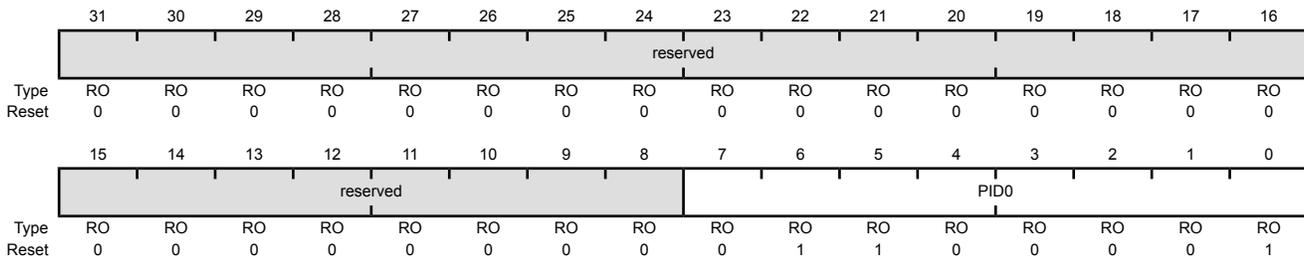
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID7	RO	0x00	GPIO Peripheral ID Register[31:24]

**Register 25: GPIO Peripheral Identification 0 (GPIOPeriphID0), offset 0xFE0**

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 0 (GPIOPeriphID0)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFE0  
 Type RO, reset 0x0000.0061



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID0	RO	0x61	GPIO Peripheral ID Register[7:0] Can be used by software to identify the presence of this peripheral.

**Register 26: GPIO Peripheral Identification 1 (GPIOPeriphID1), offset 0xFE4**

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

## GPIO Peripheral Identification 1 (GPIOPeriphID1)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFE4  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

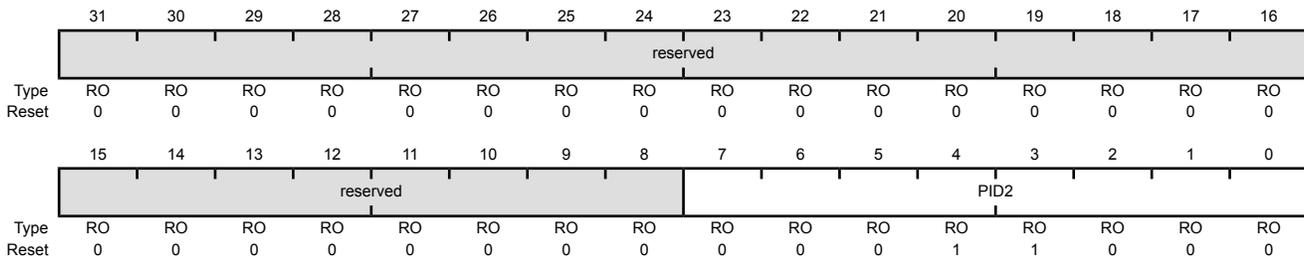
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID1	RO	0x00	GPIO Peripheral ID Register[15:8] Can be used by software to identify the presence of this peripheral.

**Register 27: GPIO Peripheral Identification 2 (GPIOPeriphID2), offset 0xFE8**

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 2 (GPIOPeriphID2)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFE8  
 Type RO, reset 0x0000.0018



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID2	RO	0x18	GPIO Peripheral ID Register[23:16] Can be used by software to identify the presence of this peripheral.

**Register 28: GPIO Peripheral Identification 3 (GPIOPeriphID3), offset 0xFEC**

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

## GPIO Peripheral Identification 3 (GPIOPeriphID3)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFEC  
 Type RO, reset 0x0000.0001

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

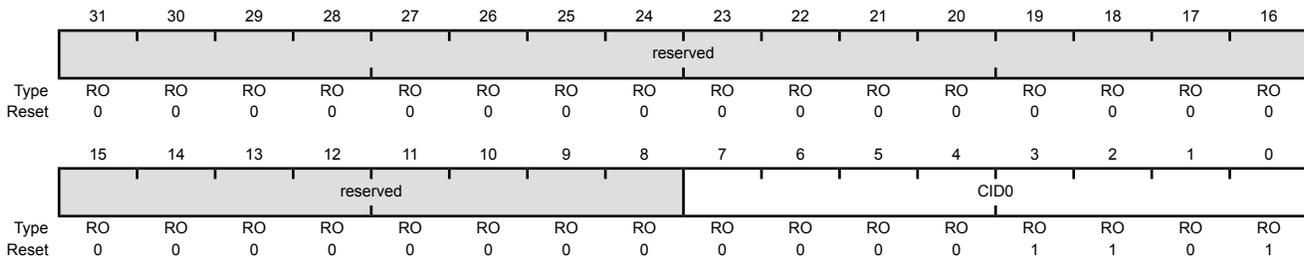
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID3	RO	0x01	GPIO Peripheral ID Register[31:24] Can be used by software to identify the presence of this peripheral.

**Register 29: GPIO PrimeCell Identification 0 (GPIOCellID0), offset 0xFF0**

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

GPIO PrimeCell Identification 0 (GPIOCellID0)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFF0  
 Type RO, reset 0x0000.000D



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID0	RO	0x0D	GPIO PrimeCell ID Register[7:0] Provides software a standard cross-peripheral identification system.

**Register 30: GPIO PrimeCell Identification 1 (GPIOCellID1), offset 0xFF4**

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

## GPIO PrimeCell Identification 1 (GPIOCellID1)

GPIO Port A base: 0x4000.4000

GPIO Port B base: 0x4000.5000

GPIO Port C base: 0x4000.6000

GPIO Port D base: 0x4000.7000

GPIO Port E base: 0x4002.4000

GPIO Port F base: 0x4002.5000

GPIO Port G base: 0x4002.6000

Offset 0xFF4

Type RO, reset 0x0000.00F0

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0

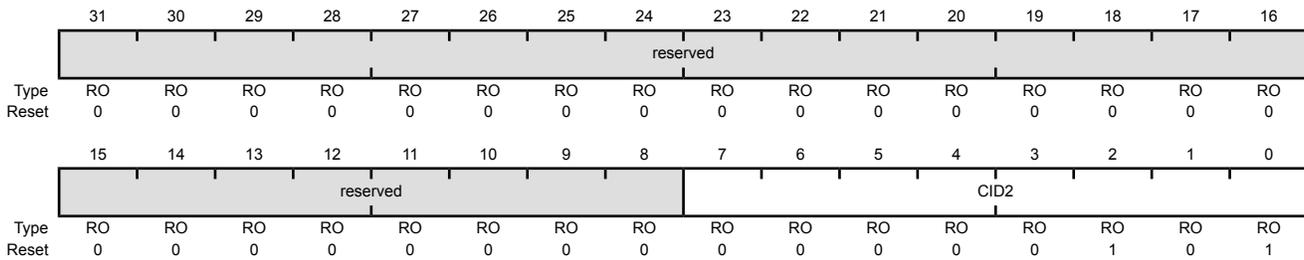
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID1	RO	0xF0	GPIO PrimeCell ID Register[15:8] Provides software a standard cross-peripheral identification system.

### Register 31: GPIO PrimeCell Identification 2 (GPIOCellID2), offset 0xFF8

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

#### GPIO PrimeCell Identification 2 (GPIOCellID2)

GPIO Port A base: 0x4000.4000  
 GPIO Port B base: 0x4000.5000  
 GPIO Port C base: 0x4000.6000  
 GPIO Port D base: 0x4000.7000  
 GPIO Port E base: 0x4002.4000  
 GPIO Port F base: 0x4002.5000  
 GPIO Port G base: 0x4002.6000  
 Offset 0xFF8  
 Type RO, reset 0x0000.0005



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID2	RO	0x05	GPIO PrimeCell ID Register[23:16] Provides software a standard cross-peripheral identification system.

**Register 32: GPIO PrimeCell Identification 3 (GPIOCellID3), offset 0xFFC**

The **GPIOCellIID0**, **GPIOCellIID1**, **GPIOCellIID2**, and **GPIOCellIID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

## GPIO PrimeCell Identification 3 (GPIOCellID3)

GPIO Port A base: 0x4000.4000

GPIO Port B base: 0x4000.5000

GPIO Port C base: 0x4000.6000

GPIO Port D base: 0x4000.7000

GPIO Port E base: 0x4002.4000

GPIO Port F base: 0x4002.5000

GPIO Port G base: 0x4002.6000

Offset 0xFFC

Type RO, reset 0x0000.00B1

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID3	RO	0xB1	GPIO PrimeCell ID Register[31:24] Provides software a standard cross-peripheral identification system.

## 8 General-Purpose Timers

Programmable timers can be used to count or time external events that drive the Timer input pins. The Stellaris<sup>®</sup> General-Purpose Timer Module (GPTM) contains three GPTM blocks (Timer0, Timer1, and Timer 2). Each GPTM block provides two 16-bit timers/counters (referred to as TimerA and TimerB) that can be configured to operate independently as timers or event counters, or configured to operate as one 32-bit timer or one 32-bit Real-Time Clock (RTC).

The GPT Module is one timing resource available on the Stellaris microcontrollers. Other timer resources include the System Timer (SysTick) (see 83).

The General-Purpose Timers provide the following features:

- Three General-Purpose Timer Modules (GPTM), each of which provides two 16-bit timers/counters. Each GPTM can be configured to operate independently:
  - As a single 32-bit timer
  - As one 32-bit Real-Time Clock (RTC) to event capture
  - For Pulse Width Modulation (PWM)
- 32-bit Timer modes
  - Programmable one-shot timer
  - Programmable periodic timer
  - Real-Time Clock when using an external 32.768-KHz clock as the input
  - User-enabled stalling when the controller asserts CPU Halt flag during debug
- 16-bit Timer modes
  - General-purpose timer function with an 8-bit prescaler (for one-shot and periodic modes only)
  - Programmable one-shot timer
  - Programmable periodic timer
  - User-enabled stalling when the controller asserts CPU Halt flag during debug
- 16-bit Input Capture modes
  - Input edge count capture
  - Input edge time capture
- 16-bit PWM mode
  - Simple PWM mode with software-programmable output inversion of the PWM signal

### 8.1 Block Diagram

**Note:** In Figure 8-1 on page 289, the specific CCP pins available depend on the Stellaris device. See Table 8-1 on page 289 for the available CCPs.

Figure 8-1. GPTM Module Block Diagram

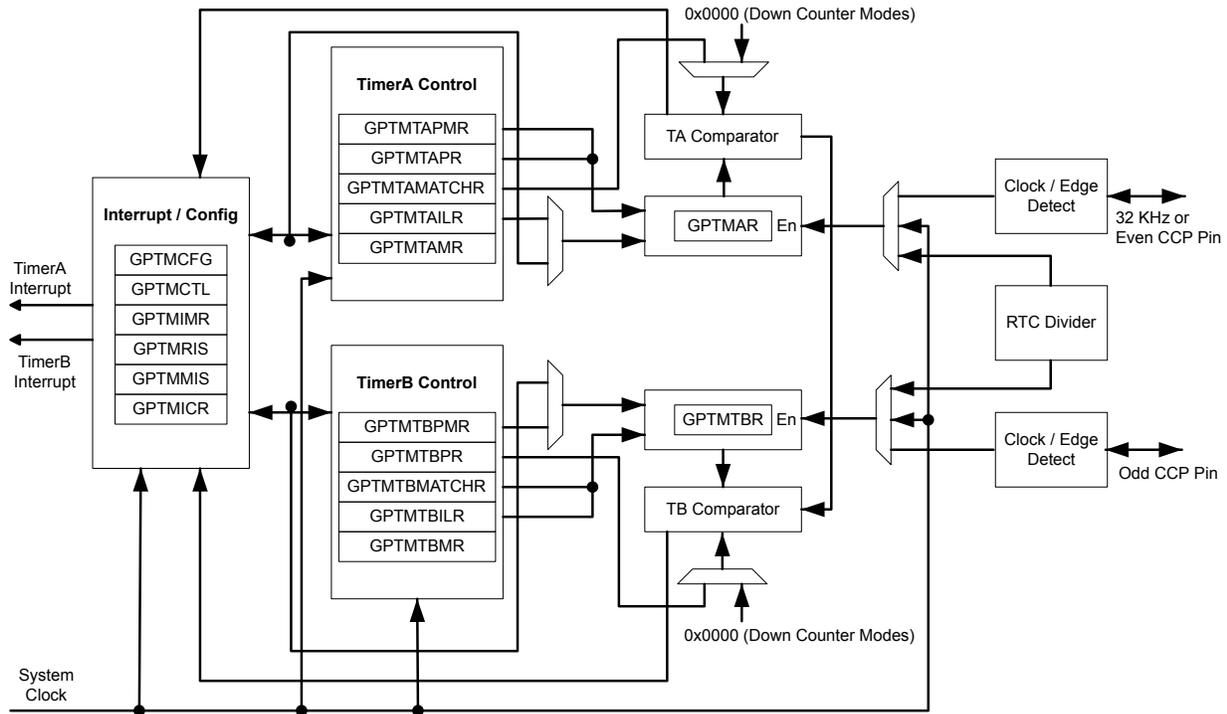


Table 8-1. Available CCP Pins

Timer	16-Bit Up/Down Counter	Even CCP Pin	Odd CCP Pin
Timer 0	TimerA	CCP0	-
	TimerB	-	CCP1
Timer 1	TimerA	CCP2	-
	TimerB	-	CCP3
Timer 2	TimerA	-	-
	TimerB	-	-

## 8.2 Signal Description

Table 8-2 on page 289 and Table 8-3 on page 290 list the external signals of the GP Timer module and describe the function of each. The GP Timer signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Assignment" lists the possible GPIO pin placements for these GP Timer signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the GP Timer function. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 243.

Table 8-2. General-Purpose Timers Signals (100LQFP)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
CCP0	66	I/O	TTL	Capture/Compare/PWM 0.
CCP1	34	I/O	TTL	Capture/Compare/PWM 1.

**Table 8-2. General-Purpose Timers Signals (100LQFP) (continued)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
CCP2	67	I/O	TTL	Capture/Compare/PWM 2.
CCP3	23	I/O	TTL	Capture/Compare/PWM 3.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

**Table 8-3. General-Purpose Timers Signals (108BGA)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
CCP0	E12	I/O	TTL	Capture/Compare/PWM 0.
CCP1	L6	I/O	TTL	Capture/Compare/PWM 1.
CCP2	D12	I/O	TTL	Capture/Compare/PWM 2.
CCP3	M2	I/O	TTL	Capture/Compare/PWM 3.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 8.3 Functional Description

The main components of each GPTM block are two free-running 16-bit up/down counters (referred to as TimerA and TimerB), two 16-bit match registers, two prescaler match registers, and two 16-bit load/initialization registers and their associated control functions. The exact functionality of each GPTM is controlled by software and configured through the register interface.

Software configures the GPTM using the **GPTM Configuration (GPTMCFG)** register (see page 300), the **GPTM TimerA Mode (GPTMTAMR)** register (see page 301), and the **GPTM TimerB Mode (GPTMTBMR)** register (see page 303). When in one of the 32-bit modes, the timer can only act as a 32-bit timer. However, when configured in 16-bit mode, the GPTM can have its two 16-bit timers configured in any combination of the 16-bit modes.

### 8.3.1 GPTM Reset Conditions

After reset has been applied to the GPTM module, the module is in an inactive state, and all control registers are cleared and in their default states. Counters TimerA and TimerB are initialized to 0xFFFF, along with their corresponding load registers: the **GPTM TimerA Interval Load (GPTMTAILR)** register (see page 314) and the **GPTM TimerB Interval Load (GPTMTBILR)** register (see page 315). The prescale counters are initialized to 0x00: the **GPTM TimerA Prescale (GPTMTAPR)** register (see page 318) and the **GPTM TimerB Prescale (GPTMTBPR)** register (see page 319).

### 8.3.2 32-Bit Timer Operating Modes

This section describes the three GPTM 32-bit timer modes (One-Shot, Periodic, and RTC) and their configuration.

The GPTM is placed into 32-bit mode by writing a 0 (One-Shot/Periodic 32-bit timer mode) or a 1 (RTC mode) to the **GPTM Configuration (GPTMCFG)** register. In both configurations, certain GPTM registers are concatenated to form pseudo 32-bit registers. These registers include:

- **GPTM TimerA Interval Load (GPTMTAILR)** register [15:0], see page 314
- **GPTM TimerB Interval Load (GPTMTBILR)** register [15:0], see page 315
- **GPTM TimerA (GPTMTAR)** register [15:0], see page 322
- **GPTM TimerB (GPTMTBR)** register [15:0], see page 323

In the 32-bit modes, the GPTM translates a 32-bit write access to **GPTMTAILR** into a write access to both **GPTMTAILR** and **GPTMTBILR**. The resulting word ordering for such a write operation is:

```
GPTMTBILR[15:0]:GPTMTAILR[15:0]
```

Likewise, a read access to **GPTMTAR** returns the value:

```
GPTMTBR[15:0]:GPTMTAR[15:0]
```

### 8.3.2.1 32-Bit One-Shot/Periodic Timer Mode

In 32-bit one-shot and periodic timer modes, the concatenated versions of the TimerA and TimerB registers are configured as a 32-bit down-counter. The selection of one-shot or periodic mode is determined by the value written to the **TAMR** field of the **GPTM TimerA Mode (GPTMTAMR)** register (see page 301), and there is no need to write to the **GPTM TimerB Mode (GPTMTBMR)** register.

When software writes the **TAEN** bit in the **GPTM Control (GPTMCTL)** register (see page 305), the timer begins counting down from its preloaded value. Once the 0x0000.0000 state is reached, the timer reloads its start value from the concatenated **GPTMTAILR** on the next cycle. If configured to be a one-shot timer, the timer stops counting and clears the **TAEN** bit in the **GPTMCTL** register. If configured as a periodic timer, it continues counting.

In addition to reloading the count value, the GPTM generates interrupts and triggers when it reaches the 0x000.0000 state. The GPTM sets the **TATORIS** bit in the **GPTM Raw Interrupt Status (GPTMRIS)** register (see page 310), and holds it until it is cleared by writing the **GPTM Interrupt Clear (GPTMICR)** register (see page 312). If the time-out interrupt is enabled in the **GPTM Interrupt Mask (GPTMIMR)** register (see page 308), the GPTM also sets the **TATOMIS** bit in the **GPTM Masked Interrupt Status (GPTMMIS)** register (see page 311).

If software reloads the **GPTMTAILR** register while the counter is running, the counter loads the new value on the next clock cycle and continues counting from the new value.

If the **TASTALL** bit in the **GPTMCTL** register is set, the timer freezes counting while the processor is halted by the debugger. The timer resumes counting when the processor resumes execution.

### 8.3.2.2 32-Bit Real-Time Clock Timer Mode

In Real-Time Clock (RTC) mode, the concatenated versions of the TimerA and TimerB registers are configured as a 32-bit up-counter. When RTC mode is selected for the first time, the counter is loaded with a value of 0x0000.0001. All subsequent load values must be written to the **GPTM TimerA Match (GPTMTAMATCHR)** register (see page 316) by the controller.

The input clock on an even CCP input is required to be 32.768 KHz in RTC mode. The clock signal is then divided down to a 1 Hz rate and is passed along to the input of the 32-bit counter.

When software writes the **TAEN** bit in the **GPTMCTL** register, the counter starts counting up from its preloaded value of 0x0000.0001. When the current count value matches the preloaded value in the **GPTMTAMATCHR** register, it rolls over to a value of 0x0000.0000 and continues counting until either a hardware reset, or it is disabled by software (clearing the **TAEN** bit). When a match occurs, the GPTM asserts the **RTCRES** bit in **GPTMRIS**. If the RTC interrupt is enabled in **GPTMIMR**, the GPTM also sets the **RTCMIS** bit in **GPTMMIS** and generates a controller interrupt. The status flags are cleared by writing the **RTCCINT** bit in **GPTMICR**.

If the **TASTALL** and/or **TBSTALL** bits in the **GPTMCTL** register are set, the timer does not freeze if the **RTCEN** bit is set in **GPTMCTL**.

### 8.3.3 16-Bit Timer Operating Modes

The GPTM is placed into global 16-bit mode by writing a value of 0x4 to the **GPTM Configuration (GPTMCFG)** register (see page 300). This section describes each of the GPTM 16-bit modes of operation. TimerA and TimerB have identical modes, so a single description is given using an *n* to reference both.

#### 8.3.3.1 16-Bit One-Shot/Periodic Timer Mode

In 16-bit one-shot and periodic timer modes, the timer is configured as a 16-bit down-counter with an optional 8-bit prescaler that effectively extends the counting range of the timer to 24 bits. The selection of one-shot or periodic mode is determined by the value written to the  $T_nMR$  field of the **GPTMTnMR** register. The optional prescaler is loaded into the **GPTM Timern Prescale (GPTMTnPR)** register.

When software writes the  $T_nEN$  bit in the **GPTMCTL** register, the timer begins counting down from its preloaded value. Once the 0x0000 state is reached, the timer reloads its start value from **GPTMTnILR** and **GPTMTnPR** on the next cycle. If configured to be a one-shot timer, the timer stops counting and clears the  $T_nEN$  bit in the **GPTMCTL** register. If configured as a periodic timer, it continues counting.

In addition to reloading the count value, the timer generates interrupts and triggers when it reaches the 0x0000 state. The GPTM sets the  $T_nTORIS$  bit in the **GPTMRIS** register, and holds it until it is cleared by writing the **GPTMICR** register. If the time-out interrupt is enabled in **GPTMIMR**, the GPTM also sets the  $T_nTOMIS$  bit in **GPTMISR** and generates a controller interrupt.

If software reloads the **GPTMTAILR** register while the counter is running, the counter loads the new value on the next clock cycle and continues counting from the new value.

If the  $T_nSTALL$  bit in the **GPTMCTL** register is set, the timer freezes counting while the processor is halted by the debugger. The timer resumes counting when the processor resumes execution.

The following example shows a variety of configurations for a 16-bit free running timer while using the prescaler. All values assume a 25-MHz clock with  $T_c=20$  ns (clock period).

**Table 8-4. 16-Bit Timer With Prescaler Configurations**

Prescale	#Clock ( $T_c$ ) <sup>a</sup>	Max Time	Units
00000000	1	2.6214	mS
00000001	2	5.2428	mS
00000010	3	7.8642	mS
-----	--	--	--
11111101	254	665.8458	mS
11111110	255	668.4672	mS
11111111	256	671.0886	mS

a.  $T_c$  is the clock period.

#### 8.3.3.2 16-Bit Input Edge Count Mode

**Note:** For rising-edge detection, the input signal must be High for at least two system clock periods following the rising edge. Similarly, for falling-edge detection, the input signal must be Low for at least two system clock periods following the falling edge. Based on this criteria, the maximum input frequency for edge detection is 1/4 of the system frequency.

**Note:** The prescaler is not available in 16-Bit Input Edge Count mode.

In Edge Count mode, the timer is configured as a down-counter capable of capturing three types of events: rising edge, falling edge, or both. To place the timer in Edge Count mode, the  $T_nCMR$  bit of the **GPTMTnMR** register must be set to 0. The type of edge that the timer counts is determined by the  $T_nEVENT$  fields of the **GPTMCTL** register. During initialization, the **GPTM Timern Match (GPTMTnMATCHR)** register is configured so that the difference between the value in the **GPTMTnILR** register and the **GPTMTnMATCHR** register equals the number of edge events that must be counted.

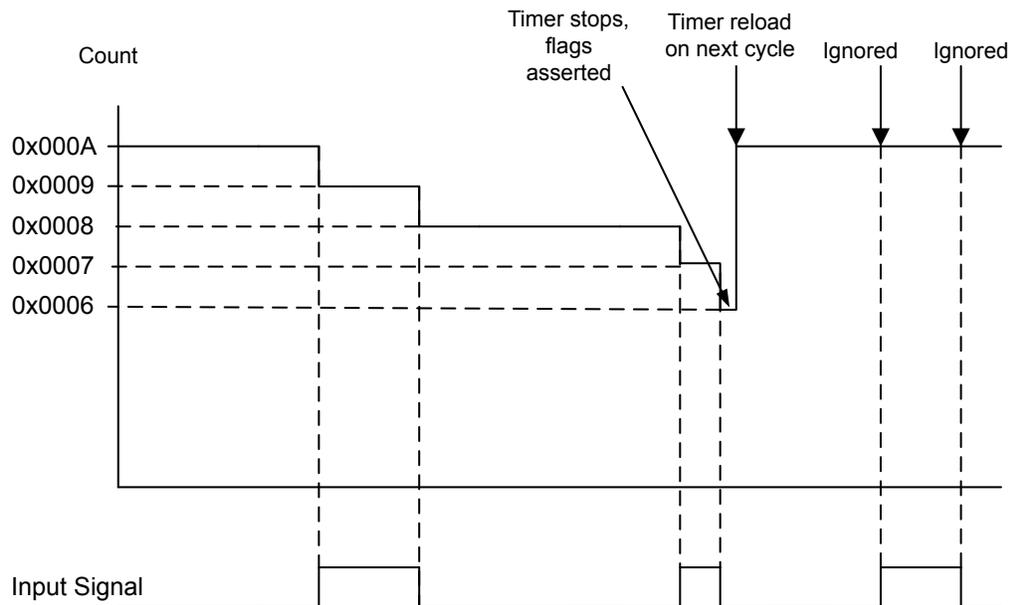
When software writes the  $T_nEN$  bit in the **GPTM Control (GPTMCTL)** register, the timer is enabled for event capture. Each input event on the **CCP** pin decrements the counter by 1 until the event count matches **GPTMTnMATCHR**. When the counts match, the GPTM asserts the  $C_nMRIS$  bit in the **GPTMRIS** register (and the  $C_nMMIS$  bit, if the interrupt is not masked).

The counter is then reloaded using the value in **GPTMTnILR**, and stopped since the GPTM automatically clears the  $T_nEN$  bit in the **GPTMCTL** register. Once the event count has been reached, all further events are ignored until  $T_nEN$  is re-enabled by software.

Figure 8-2 on page 293 shows how input edge count mode works. In this case, the timer start value is set to **GPTMTnILR** = 0x000A and the match value is set to **GPTMTnMATCHR** = 0x0006 so that four edge events are counted. The counter is configured to detect both edges of the input signal.

Note that the last two edges are not counted since the timer automatically clears the  $T_nEN$  bit after the current count matches the value in the **GPTMTnMATCHR** register.

**Figure 8-2. 16-Bit Input Edge Count Mode Example**



### 8.3.3.3 16-Bit Input Edge Time Mode

**Note:** For rising-edge detection, the input signal must be High for at least two system clock periods following the rising edge. Similarly, for falling edge detection, the input signal must be Low for at least two system clock periods following the falling edge. Based on this criteria, the maximum input frequency for edge detection is 1/4 of the system frequency.

**Note:** The prescaler is not available in 16-Bit Input Edge Time mode.

In Edge Time mode, the timer is configured as a free-running down-counter initialized to the value loaded in the **GPTMTnILR** register (or 0xFFFF at reset). The timer is capable of capturing three types of events: rising edge, falling edge, or both. The timer is placed into Edge Time mode by setting the  $T_nCMR$  bit in the **GPTMTnMR** register, and the type of event that the timer captures is determined by the  $T_nEVENT$  fields of the **GPTMCTL** register.

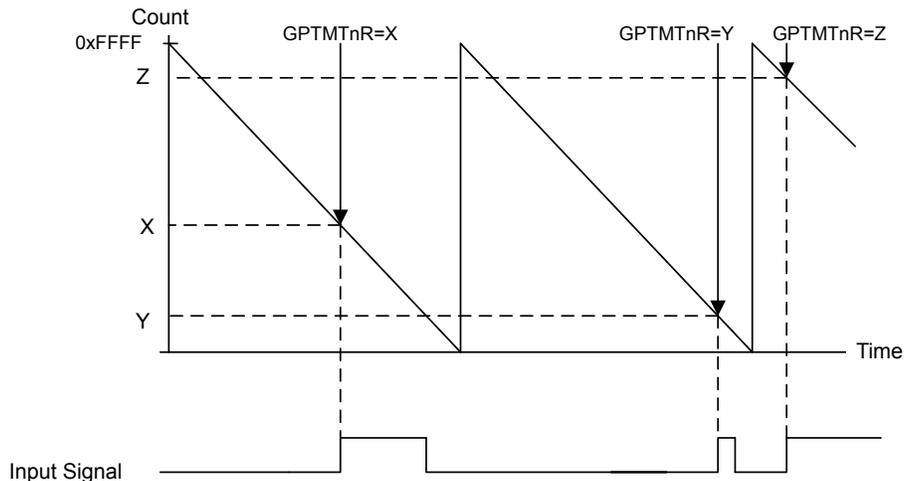
When software writes the  $T_nEN$  bit in the **GPTMCTL** register, the timer is enabled for event capture. When the selected input event is detected, the current  $T_n$  counter value is captured in the **GPTMTnR** register and is available to be read by the controller. The GPTM then asserts the  $C_nERIS$  bit (and the  $C_nEMIS$  bit, if the interrupt is not masked).

After an event has been captured, the timer does not stop counting. It continues to count until the  $T_nEN$  bit is cleared. When the timer reaches the 0x0000 state, it is reloaded with the value from the **GPTMTnILR** register.

Figure 8-3 on page 294 shows how input edge timing mode works. In the diagram, it is assumed that the start value of the timer is the default value of 0xFFFF, and the timer is configured to capture rising edge events.

Each time a rising edge event is detected, the current count value is loaded into the **GPTMTnR** register, and is held there until another rising edge is detected (at which point the new count value is loaded into **GPTMTnR**).

**Figure 8-3. 16-Bit Input Edge Time Mode Example**



### 8.3.3.4 16-Bit PWM Mode

**Note:** The prescaler is not available in 16-Bit PWM mode.

The GPTM supports a simple PWM generation mode. In PWM mode, the timer is configured as a down-counter with a start value (and thus period) defined by **GPTMTnILR**. In this mode, the PWM frequency and period are synchronous events and therefore guaranteed to be glitch free. PWM mode is enabled with the **GPTMTnMR** register by setting the  $T_nAMS$  bit to 0x1, the  $T_nCMR$  bit to 0x0, and the  $T_nMR$  field to 0x2.

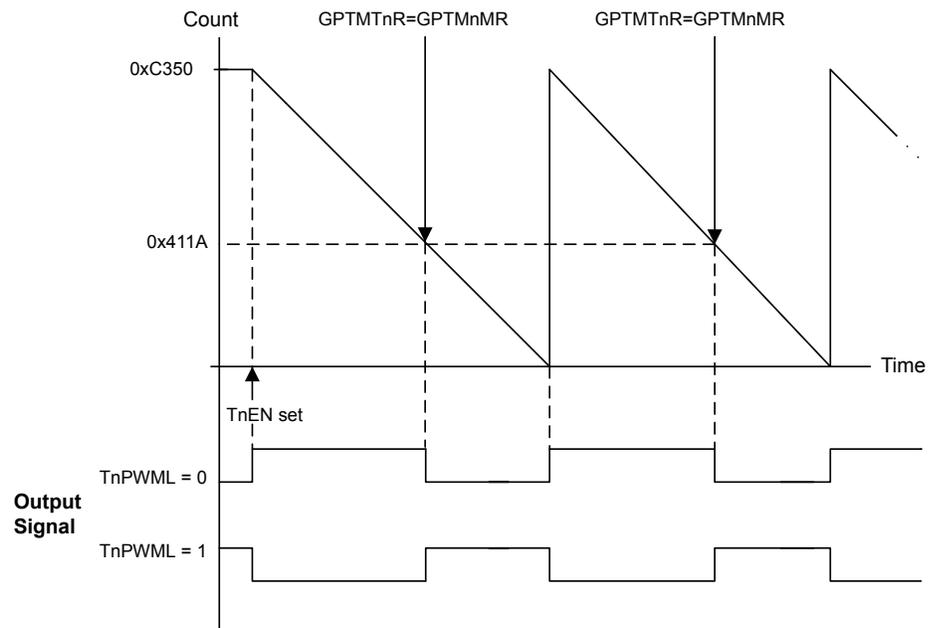
When software writes the  $T_nEN$  bit in the **GPTMCTL** register, the counter begins counting down until it reaches the 0x0000 state. On the next counter cycle, the counter reloads its start value from

**GPTMTnILR** and continues counting until disabled by software clearing the **TnEN** bit in the **GPTMCTL** register. No interrupts or status bits are asserted in PWM mode.

The output PWM signal asserts when the counter is at the value of the **GPTMTnILR** register (its start state), and is deasserted when the counter value equals the value in the **GPTM Timern Match Register (GPTMTnMATCHR)**. Software has the capability of inverting the output PWM signal by setting the **TnPWML** bit in the **GPTMCTL** register.

Figure 8-4 on page 295 shows how to generate an output PWM with a 1-ms period and a 66% duty cycle assuming a 50-MHz input clock and **TnPWML = 0** (duty cycle would be 33% for the **TnPWML = 1** configuration). For this example, the start value is **GPTMTnIRL=0xC350** and the match value is **GPTMTnMATCHR=0x411A**.

**Figure 8-4. 16-Bit PWM Mode Example**



## 8.4 Initialization and Configuration

To use the general-purpose timers, the peripheral clock must be enabled by setting the **TIMER0**, **TIMER1**, and **TIMER2** bits in the **RCGC1** register.

This section shows module initialization and configuration examples for each of the supported timer modes.

### 8.4.1 32-Bit One-Shot/Periodic Timer Mode

The GPTM is configured for 32-bit One-Shot and Periodic modes by the following sequence:

1. Ensure the timer is disabled (the **TAEN** bit in the **GPTMCTL** register is cleared) before making any changes.
2. Write the **GPTM Configuration Register (GPTMCFG)** with a value of 0x0.

3. Set the `TAMR` field in the **GPTM TimerA Mode Register (GPTMTAMR)**:
  - a. Write a value of 0x1 for One-Shot mode.
  - b. Write a value of 0x2 for Periodic mode.
4. Load the start value into the **GPTM TimerA Interval Load Register (GPTMTAILR)**.
5. If interrupts are required, set the `TATOIM` bit in the **GPTM Interrupt Mask Register (GPTMIMR)**.
6. Set the `TAEN` bit in the **GPTMCTL** register to enable the timer and start counting.
7. Poll the `TATORIS` bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the `TATOCINT` bit of the **GPTM Interrupt Clear Register (GPTMICR)**.

In One-Shot mode, the timer stops counting after step 7 on page 296. To re-enable the timer, repeat the sequence. A timer configured in Periodic mode does not stop counting after it times out.

### 8.4.2 32-Bit Real-Time Clock (RTC) Mode

To use the RTC mode, the timer must have a 32.768-KHz input signal on an even CCP input. To enable the RTC feature, follow these steps:

1. Ensure the timer is disabled (the `TAEN` bit is cleared) before making any changes.
2. Write the **GPTM Configuration Register (GPTMCFG)** with a value of 0x1.
3. Write the desired match value to the **GPTM TimerA Match Register (GPTMTAMATCHR)**.
4. Set/clear the `RTCEN` bit in the **GPTM Control Register (GPTMCTL)** as desired.
5. If interrupts are required, set the `RTCIM` bit in the **GPTM Interrupt Mask Register (GPTMIMR)**.
6. Set the `TAEN` bit in the **GPTMCTL** register to enable the timer and start counting.

When the timer count equals the value in the **GPTMTAMATCHR** register, the GPTM asserts the `RTCRIS` bit in the **GPTMRIS** register and continues counting until Timer A is disabled or a hardware reset. The interrupt is cleared by writing the `RTCCINT` bit in the **GPTMICR** register.

### 8.4.3 16-Bit One-Shot/Periodic Timer Mode

A timer is configured for 16-bit One-Shot and Periodic modes by the following sequence:

1. Ensure the timer is disabled (the `TnEN` bit is cleared) before making any changes.
2. Write the **GPTM Configuration Register (GPTMCFG)** with a value of 0x4.
3. Set the `TnMR` field in the **GPTM Timer Mode (GPTMTnMR)** register:
  - a. Write a value of 0x1 for One-Shot mode.
  - b. Write a value of 0x2 for Periodic mode.
4. If a prescaler is to be used, write the prescale value to the **GPTM Timern Prescale Register (GPTMTnPR)**.

5. Load the start value into the **GPTM Timer Interval Load Register (GPTMTnILR)**.
6. If interrupts are required, set the **TnTOIM** bit in the **GPTM Interrupt Mask Register (GPTMIMR)**.
7. Set the **TnEN** bit in the **GPTM Control Register (GPTMCTL)** to enable the timer and start counting.
8. Poll the **TnTORIS** bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the **TnTOCINT** bit of the **GPTM Interrupt Clear Register (GPTMICR)**.

In One-Shot mode, the timer stops counting after step 8 on page 297. To re-enable the timer, repeat the sequence. A timer configured in Periodic mode does not stop counting after it times out.

#### 8.4.4 16-Bit Input Edge Count Mode

A timer is configured to Input Edge Count mode by the following sequence:

1. Ensure the timer is disabled (the **TnEN** bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x4.
3. In the **GPTM Timer Mode (GPTMTnMR)** register, write the **TnCMR** field to 0x0 and the **TnMR** field to 0x3.
4. Configure the type of event(s) that the timer captures by writing the **TnEVENT** field of the **GPTM Control (GPTMCTL)** register.
5. Load the timer start value into the **GPTM Timern Interval Load (GPTMTnILR)** register.
6. Load the desired event count into the **GPTM Timern Match (GPTMTnMATCHR)** register.
7. If interrupts are required, set the **CnMIM** bit in the **GPTM Interrupt Mask (GPTMIMR)** register.
8. Set the **TnEN** bit in the **GPTMCTL** register to enable the timer and begin waiting for edge events.
9. Poll the **CnMRIS** bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the **CnMCINT** bit of the **GPTM Interrupt Clear (GPTMICR)** register.

In Input Edge Count Mode, the timer stops after the desired number of edge events has been detected. To re-enable the timer, ensure that the **TnEN** bit is cleared and repeat step 4 on page 297 through step 9 on page 297.

#### 8.4.5 16-Bit Input Edge Timing Mode

A timer is configured to Input Edge Timing mode by the following sequence:

1. Ensure the timer is disabled (the **TnEN** bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x4.
3. In the **GPTM Timer Mode (GPTMTnMR)** register, write the **TnCMR** field to 0x1 and the **TnMR** field to 0x3.

4. Configure the type of event that the timer captures by writing the `TnEVENT` field of the **GPTM Control (GPTMCTL)** register.
5. Load the timer start value into the **GPTM Timern Interval Load (GPTMTnILR)** register.
6. If interrupts are required, set the `CnEIM` bit in the **GPTM Interrupt Mask (GPTMIMR)** register.
7. Set the `TnEN` bit in the **GPTM Control (GPTMCTL)** register to enable the timer and start counting.
8. Poll the `CnERIS` bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the `CnECINT` bit of the **GPTM Interrupt Clear (GPTMICR)** register. The time at which the event happened can be obtained by reading the **GPTM Timern (GPTMTnR)** register.

In Input Edge Timing mode, the timer continues running after an edge event has been detected, but the timer interval can be changed at any time by writing the **GPTMTnILR** register. The change takes effect at the next cycle after the write.

#### 8.4.6 16-Bit PWM Mode

A timer is configured to PWM mode using the following sequence:

1. Ensure the timer is disabled (the `TnEN` bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x4.
3. In the **GPTM Timer Mode (GPTMTnMR)** register, set the `TnAMS` bit to 0x1, the `TnCMR` bit to 0x0, and the `TnMR` field to 0x2.
4. Configure the output state of the PWM signal (whether or not it is inverted) in the `TnPWML` field of the **GPTM Control (GPTMCTL)** register.
5. Load the timer start value into the **GPTM Timern Interval Load (GPTMTnILR)** register.
6. Load the **GPTM Timern Match (GPTMTnMATCHR)** register with the desired value.
7. Set the `TnEN` bit in the **GPTM Control (GPTMCTL)** register to enable the timer and begin generation of the output PWM signal.

In PWM Timing mode, the timer continues running after the PWM signal has been generated. The PWM period can be adjusted at any time by writing the **GPTMTnILR** register, and the change takes effect at the next cycle after the write.

## 8.5 Register Map

Table 8-5 on page 299 lists the GPTM registers. The offset listed is a hexadecimal increment to the register's address, relative to that timer's base address:

- Timer0: 0x4003.0000
- Timer1: 0x4003.1000
- Timer2: 0x4003.2000

Note that the Timer module clock must be enabled before the registers can be programmed (see page 201). There must be a delay of 3 system clocks after the Timer module clock is enabled before any Timer module registers are accessed.

**Table 8-5. Timers Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	GPTMCFG	R/W	0x0000.0000	GPTM Configuration	300
0x004	GPTMTAMR	R/W	0x0000.0000	GPTM TimerA Mode	301
0x008	GPTMTBMR	R/W	0x0000.0000	GPTM TimerB Mode	303
0x00C	GPTMCTL	R/W	0x0000.0000	GPTM Control	305
0x018	GPTMIMR	R/W	0x0000.0000	GPTM Interrupt Mask	308
0x01C	GPTMRIS	RO	0x0000.0000	GPTM Raw Interrupt Status	310
0x020	GPTMMIS	RO	0x0000.0000	GPTM Masked Interrupt Status	311
0x024	GPTMICR	W1C	0x0000.0000	GPTM Interrupt Clear	312
0x028	GPTMTAILR	R/W	0xFFFF.FFFF	GPTM TimerA Interval Load	314
0x02C	GPTMTBILR	R/W	0x0000.FFFF	GPTM TimerB Interval Load	315
0x030	GPTMTAMATCHR	R/W	0xFFFF.FFFF	GPTM TimerA Match	316
0x034	GPTMTBMATCHR	R/W	0x0000.FFFF	GPTM TimerB Match	317
0x038	GPTMTAPR	R/W	0x0000.0000	GPTM TimerA Prescale	318
0x03C	GPTMTBPR	R/W	0x0000.0000	GPTM TimerB Prescale	319
0x040	GPTMTAPMR	R/W	0x0000.0000	GPTM TimerA Prescale Match	320
0x044	GPTMTBPMR	R/W	0x0000.0000	GPTM TimerB Prescale Match	321
0x048	GPTMTAR	RO	0xFFFF.FFFF	GPTM TimerA	322
0x04C	GPTMTBR	RO	0x0000.FFFF	GPTM TimerB	323

## 8.6 Register Descriptions

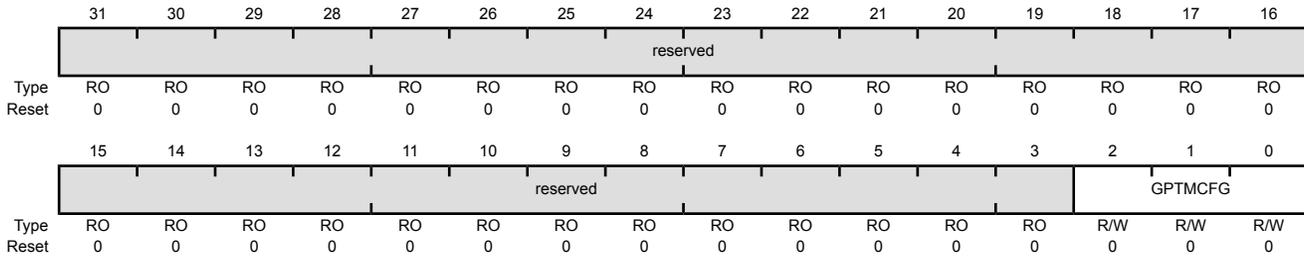
The remainder of this section lists and describes the GPTM registers, in numerical order by address offset.

### Register 1: GPTM Configuration (GPTMCFG), offset 0x000

This register configures the global operation of the GPTM module. The value written to this register determines whether the GPTM is in 32- or 16-bit mode.

#### GPTM Configuration (GPTMCFG)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x000  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:3	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2:0	GPTMCFG	R/W	0x0	GPTM Configuration

The GPTMCFG values are defined as follows:

Value	Description
0x0	32-bit timer configuration.
0x1	32-bit real-time clock (RTC) counter configuration.
0x2	Reserved
0x3	Reserved
0x4-0x7	16-bit timer configuration, function is controlled by bits 1:0 of GPTMTAMR and GPTMTBMR.

## Register 2: GPTM TimerA Mode (GPTMTAMR), offset 0x004

This register configures the GPTM based on the configuration selected in the **GPTMCFG** register. When in 16-bit PWM mode, set the **TAAMS** bit to 0x1, the **TACMR** bit to 0x0, and the **TAMR** field to 0x2.

### GPTM TimerA Mode (GPTMTAMR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x004  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved												TAAMS	TACMR	TAMR	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description						
31:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
3	TAAMS	R/W	0	GPTM TimerA Alternate Mode Select The <b>TAAMS</b> values are defined as follows:  <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Capture mode is enabled.</td> </tr> <tr> <td>1</td> <td>PWM mode is enabled.</td> </tr> </table> <p><b>Note:</b> To enable PWM mode, you must also clear the <b>TACMR</b> bit and set the <b>TAMR</b> field to 0x2.</p>	Value	Description	0	Capture mode is enabled.	1	PWM mode is enabled.
Value	Description									
0	Capture mode is enabled.									
1	PWM mode is enabled.									
2	TACMR	R/W	0	GPTM TimerA Capture Mode The <b>TACMR</b> values are defined as follows:  <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Edge-Count mode</td> </tr> <tr> <td>1</td> <td>Edge-Time mode</td> </tr> </table>	Value	Description	0	Edge-Count mode	1	Edge-Time mode
Value	Description									
0	Edge-Count mode									
1	Edge-Time mode									

Bit/Field	Name	Type	Reset	Description										
1:0	TAMR	R/W	0x0	<p>GPTM TimerA Mode</p> <p>The TAMR values are defined as follows:</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0x0</td><td>Reserved</td></tr><tr><td>0x1</td><td>One-Shot Timer mode</td></tr><tr><td>0x2</td><td>Periodic Timer mode</td></tr><tr><td>0x3</td><td>Capture mode</td></tr></tbody></table> <p>The Timer mode is based on the timer configuration defined by bits 2:0 in the <b>GPTMCFG</b> register (16-or 32-bit).</p> <p>In 16-bit timer configuration, TAMR controls the 16-bit timer modes for TimerA.</p> <p>In 32-bit timer configuration, this register controls the mode and the contents of <b>GPTMTBMR</b> are ignored.</p>	Value	Description	0x0	Reserved	0x1	One-Shot Timer mode	0x2	Periodic Timer mode	0x3	Capture mode
Value	Description													
0x0	Reserved													
0x1	One-Shot Timer mode													
0x2	Periodic Timer mode													
0x3	Capture mode													

### Register 3: GPTM TimerB Mode (GPTMTBMR), offset 0x008

This register configures the GPTM based on the configuration selected in the **GPTMCFG** register. When in 16-bit PWM mode, set the **TBAMS** bit to 0x1, the **TBCMR** bit to 0x0, and the **TBMR** field to 0x2.

#### GPTM TimerB Mode (GPTMTBMR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x008  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												TBAMS	TBCMR	TBMR		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description						
31:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
3	TBAMS	R/W	0	GPTM TimerB Alternate Mode Select The <b>TBAMS</b> values are defined as follows:  <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Capture mode is enabled.</td> </tr> <tr> <td>1</td> <td>PWM mode is enabled.</td> </tr> </table> <p><b>Note:</b> To enable PWM mode, you must also clear the <b>TBCMR</b> bit and set the <b>TBMR</b> field to 0x2.</p>	Value	Description	0	Capture mode is enabled.	1	PWM mode is enabled.
Value	Description									
0	Capture mode is enabled.									
1	PWM mode is enabled.									
2	TBCMR	R/W	0	GPTM TimerB Capture Mode The <b>TBCMR</b> values are defined as follows:  <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Edge-Count mode</td> </tr> <tr> <td>1</td> <td>Edge-Time mode</td> </tr> </table>	Value	Description	0	Edge-Count mode	1	Edge-Time mode
Value	Description									
0	Edge-Count mode									
1	Edge-Time mode									

Bit/Field	Name	Type	Reset	Description										
1:0	TBMR	R/W	0x0	<p>GPTM TimerB Mode</p> <p>The TBMR values are defined as follows:</p> <table border="1"><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0x0</td><td>Reserved</td></tr><tr><td>0x1</td><td>One-Shot Timer mode</td></tr><tr><td>0x2</td><td>Periodic Timer mode</td></tr><tr><td>0x3</td><td>Capture mode</td></tr></tbody></table> <p>The timer mode is based on the timer configuration defined by bits 2:0 in the <b>GPTMCFG</b> register.</p> <p>In 16-bit timer configuration, these bits control the 16-bit timer modes for TimerB.</p> <p>In 32-bit timer configuration, this register's contents are ignored and <b>GPTMTAMR</b> is used.</p>	Value	Description	0x0	Reserved	0x1	One-Shot Timer mode	0x2	Periodic Timer mode	0x3	Capture mode
Value	Description													
0x0	Reserved													
0x1	One-Shot Timer mode													
0x2	Periodic Timer mode													
0x3	Capture mode													

## Register 4: GPTM Control (GPTMCTL), offset 0x00C

This register is used alongside the **GPTMCFG** and **GMTMTnMR** registers to fine-tune the timer configuration, and to enable other features such as timer stall.

### GPTM Control (GPTMCTL)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x00C  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved	TBPWML	reserved		TBEVENT		TBSTALL	TBEN	reserved	TAPWML	reserved	RTCEN	TAEVENT		TASTALL	TAEN
Type	RO	R/W	RO	RO	R/W	R/W	R/W	R/W	RO	R/W	RO	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:15	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
14	TBPWML	R/W	0	GPTM TimerB PWM Output Level The TBPWML values are defined as follows:  Value Description 0 Output is unaffected. 1 Output is inverted.
13:12	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
11:10	TBEVENT	R/W	0x0	GPTM TimerB Event Mode The TBEVENT values are defined as follows:  Value Description 0x0 Positive edge 0x1 Negative edge 0x2 Reserved 0x3 Both edges

Bit/Field	Name	Type	Reset	Description										
9	TBSTALL	R/W	0	<p>GPTM Timer B Stall Enable</p> <p>The <code>TBSTALL</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer B continues counting while the processor is halted by the debugger.</td> </tr> <tr> <td>1</td> <td>Timer B freezes counting while the processor is halted by the debugger.</td> </tr> </tbody> </table> <p>If the processor is executing normally, the <code>TBSTALL</code> bit is ignored.</p>	Value	Description	0	Timer B continues counting while the processor is halted by the debugger.	1	Timer B freezes counting while the processor is halted by the debugger.				
Value	Description													
0	Timer B continues counting while the processor is halted by the debugger.													
1	Timer B freezes counting while the processor is halted by the debugger.													
8	TBEN	R/W	0	<p>GPTM TimerB Enable</p> <p>The <code>TBEN</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>TimerB is disabled.</td> </tr> <tr> <td>1</td> <td>TimerB is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register.</td> </tr> </tbody> </table>	Value	Description	0	TimerB is disabled.	1	TimerB is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register.				
Value	Description													
0	TimerB is disabled.													
1	TimerB is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register.													
7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
6	TAPWML	R/W	0	<p>GPTM TimerA PWM Output Level</p> <p>The <code>TAPWML</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Output is unaffected.</td> </tr> <tr> <td>1</td> <td>Output is inverted.</td> </tr> </tbody> </table>	Value	Description	0	Output is unaffected.	1	Output is inverted.				
Value	Description													
0	Output is unaffected.													
1	Output is inverted.													
5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
4	RTCEN	R/W	0	<p>GPTM RTC Enable</p> <p>The <code>RTCEN</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>RTC counting is disabled.</td> </tr> <tr> <td>1</td> <td>RTC counting is enabled.</td> </tr> </tbody> </table>	Value	Description	0	RTC counting is disabled.	1	RTC counting is enabled.				
Value	Description													
0	RTC counting is disabled.													
1	RTC counting is enabled.													
3:2	TAEVENT	R/W	0x0	<p>GPTM TimerA Event Mode</p> <p>The <code>TAEVENT</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Positive edge</td> </tr> <tr> <td>0x1</td> <td>Negative edge</td> </tr> <tr> <td>0x2</td> <td>Reserved</td> </tr> <tr> <td>0x3</td> <td>Both edges</td> </tr> </tbody> </table>	Value	Description	0x0	Positive edge	0x1	Negative edge	0x2	Reserved	0x3	Both edges
Value	Description													
0x0	Positive edge													
0x1	Negative edge													
0x2	Reserved													
0x3	Both edges													

Bit/Field	Name	Type	Reset	Description						
1	TASTALL	R/W	0	<p>GPTM Timer A Stall Enable</p> <p>The TASTALL values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer A continues counting while the processor is halted by the debugger.</td> </tr> <tr> <td>1</td> <td>Timer A freezes counting while the processor is halted by the debugger.</td> </tr> </tbody> </table> <p>If the processor is executing normally, the TASTALL bit is ignored.</p>	Value	Description	0	Timer A continues counting while the processor is halted by the debugger.	1	Timer A freezes counting while the processor is halted by the debugger.
Value	Description									
0	Timer A continues counting while the processor is halted by the debugger.									
1	Timer A freezes counting while the processor is halted by the debugger.									
0	TAEN	R/W	0	<p>GPTM TimerA Enable</p> <p>The TAEN values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>TimerA is disabled.</td> </tr> <tr> <td>1</td> <td>TimerA is enabled and begins counting or the capture logic is enabled based on the <b>GPTMCFG</b> register.</td> </tr> </tbody> </table>	Value	Description	0	TimerA is disabled.	1	TimerA is enabled and begins counting or the capture logic is enabled based on the <b>GPTMCFG</b> register.
Value	Description									
0	TimerA is disabled.									
1	TimerA is enabled and begins counting or the capture logic is enabled based on the <b>GPTMCFG</b> register.									

### Register 5: GPTM Interrupt Mask (GPTMIMR), offset 0x018

This register allows software to enable/disable GPTM controller-level interrupts. Writing a 1 enables the interrupt, while writing a 0 disables it.

#### GPTM Interrupt Mask (GPTMIMR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x018  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				CBEIM	CBMIM	TBTOIM	reserved					RTCIM	CAEIM	CAMIM	TATOIM
Type	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	CBEIM	R/W	0	GPTM CaptureB Event Interrupt Mask The CBEIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
9	CBMIM	R/W	0	GPTM CaptureB Match Interrupt Mask The CBMIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
8	TBTOIM	R/W	0	GPTM TimerB Time-Out Interrupt Mask The TBTOIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
7:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
3	RTCIM	R/W	0	GPTM RTC Interrupt Mask The RTCIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
2	CAEIM	R/W	0	GPTM CaptureA Event Interrupt Mask The CAEIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
1	CAMIM	R/W	0	GPTM CaptureA Match Interrupt Mask The CAMIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.
0	TATOIM	R/W	0	GPTM TimerA Time-Out Interrupt Mask The TATOIM values are defined as follows:  Value Description 0 Interrupt is disabled. 1 Interrupt is enabled.

### Register 6: GPTM Raw Interrupt Status (GPTMRIS), offset 0x01C

This register shows the state of the GPTM's internal interrupt signal. These bits are set whether or not the interrupt is masked in the **GPTMIMR** register. Each bit can be cleared by writing a 1 to its corresponding bit in **GPTMICR**.

#### GPTM Raw Interrupt Status (GPTMRIS)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x01C  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved					CBERIS	CBMRIS	TBTORIS	reserved				RTCRIS	CAERIS	CAMRIS	TATORIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	CBERIS	RO	0	GPTM CaptureB Event Raw Interrupt This is the CaptureB Event interrupt status prior to masking.
9	CBMRIS	RO	0	GPTM CaptureB Match Raw Interrupt This is the CaptureB Match interrupt status prior to masking.
8	TBTORIS	RO	0	GPTM TimerB Time-Out Raw Interrupt This is the TimerB time-out interrupt status prior to masking.
7:4	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	RTCRIS	RO	0	GPTM RTC Raw Interrupt This is the RTC Event interrupt status prior to masking.
2	CAERIS	RO	0	GPTM CaptureA Event Raw Interrupt This is the CaptureA Event interrupt status prior to masking.
1	CAMRIS	RO	0	GPTM CaptureA Match Raw Interrupt This is the CaptureA Match interrupt status prior to masking.
0	TATORIS	RO	0	GPTM TimerA Time-Out Raw Interrupt This the TimerA time-out interrupt status prior to masking.

## Register 7: GPTM Masked Interrupt Status (GPTMMIS), offset 0x020

This register show the state of the GPTM's controller-level interrupt. If an interrupt is unmasked in **GPTMIMR**, and there is an event that causes the interrupt to be asserted, the corresponding bit is set in this register. All bits are cleared by writing a 1 to the corresponding bit in **GPTMICR**.

### GPTM Masked Interrupt Status (GPTMMIS)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x020  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				CBEMIS	CBMMIS	TBTOMIS	reserved				RTCMIS	CAEMIS	CAMMIS	TATOMIS	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	CBEMIS	RO	0	GPTM CaptureB Event Masked Interrupt This is the CaptureB event interrupt status after masking.
9	CBMMIS	RO	0	GPTM CaptureB Match Masked Interrupt This is the CaptureB match interrupt status after masking.
8	TBTOMIS	RO	0	GPTM TimerB Time-Out Masked Interrupt This is the TimerB time-out interrupt status after masking.
7:4	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	RTCMIS	RO	0	GPTM RTC Masked Interrupt This is the RTC event interrupt status after masking.
2	CAEMIS	RO	0	GPTM CaptureA Event Masked Interrupt This is the CaptureA event interrupt status after masking.
1	CAMMIS	RO	0	GPTM CaptureA Match Masked Interrupt This is the CaptureA match interrupt status after masking.
0	TATOMIS	RO	0	GPTM TimerA Time-Out Masked Interrupt This is the TimerA time-out interrupt status after masking.

### Register 8: GPTM Interrupt Clear (GPTMICR), offset 0x024

This register is used to clear the status bits in the **GPTMRIS** and **GPTMMIS** registers. Writing a 1 to a bit clears the corresponding bit in the **GPTMRIS** and **GPTMMIS** registers.

#### GPTM Interrupt Clear (GPTMICR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x024  
 Type W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved					CBECINT	CBMCINT	TBTOCINT	reserved					RTCCINT	CAECINT	CAMCINT	TATOCINT
Type	RO	RO	RO	RO	RO	W1C	W1C	W1C	RO	RO	RO	RO	W1C	W1C	W1C	W1C	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	CBECINT	W1C	0	GPTM CaptureB Event Interrupt Clear The <b>CBECINT</b> values are defined as follows:  Value Description 0 The interrupt is unaffected. 1 The interrupt is cleared.
9	CBMCINT	W1C	0	GPTM CaptureB Match Interrupt Clear The <b>CBMCINT</b> values are defined as follows:  Value Description 0 The interrupt is unaffected. 1 The interrupt is cleared.
8	TBTOCINT	W1C	0	GPTM TimerB Time-Out Interrupt Clear The <b>TBTOCINT</b> values are defined as follows:  Value Description 0 The interrupt is unaffected. 1 The interrupt is cleared.
7:4	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

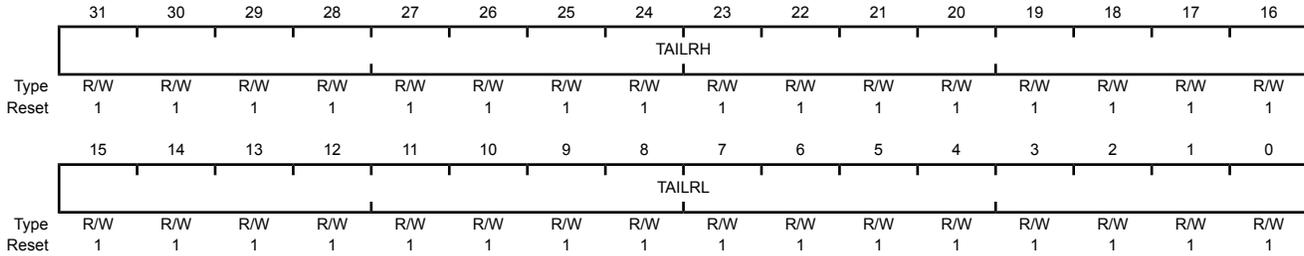
Bit/Field	Name	Type	Reset	Description
3	RTCCINT	W1C	0	<p>GPTM RTC Interrupt Clear</p> <p>The <code>RTCCINT</code> values are defined as follows:</p> <p>Value Description</p> <p>0 The interrupt is unaffected.</p> <p>1 The interrupt is cleared.</p>
2	CAECINT	W1C	0	<p>GPTM CaptureA Event Interrupt Clear</p> <p>The <code>CAECINT</code> values are defined as follows:</p> <p>Value Description</p> <p>0 The interrupt is unaffected.</p> <p>1 The interrupt is cleared.</p>
1	CAMCINT	W1C	0	<p>GPTM CaptureA Match Interrupt Clear</p> <p>The <code>CAMCINT</code> values are defined as follows:</p> <p>Value Description</p> <p>0 The interrupt is unaffected.</p> <p>1 The interrupt is cleared.</p>
0	TATOCINT	W1C	0	<p>GPTM TimerA Time-Out Interrupt Clear</p> <p>The <code>TATOCINT</code> values are defined as follows:</p> <p>Value Description</p> <p>0 The interrupt is unaffected.</p> <p>1 The interrupt is cleared.</p>

### Register 9: GPTM TimerA Interval Load (GPTMTAILR), offset 0x028

This register is used to load the starting count value into the timer. When GPTM is configured to one of the 32-bit modes, **GPTMTAILR** appears as a 32-bit register (the upper 16-bits correspond to the contents of the **GPTM TimerB Interval Load (GPTMTBILR)** register). In 16-bit mode, the upper 16 bits of this register read as 0s and have no effect on the state of **GPTMTBILR**.

#### GPTM TimerA Interval Load (GPTMTAILR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x028  
 Type R/W, reset 0xFFFF.FFFF



Bit/Field	Name	Type	Reset	Description
31:16	TAILRH	R/W	0xFFFF	GPTM TimerA Interval Load Register High When configured for 32-bit mode via the <b>GPTMCFG</b> register, the <b>GPTM TimerB Interval Load (GPTMTBILR)</b> register loads this value on a write. A read returns the current value of <b>GPTMTBILR</b> . In 16-bit mode, this field reads as 0 and does not have an effect on the state of <b>GPTMTBILR</b> .
15:0	TAILRL	R/W	0xFFFF	GPTM TimerA Interval Load Register Low For both 16- and 32-bit modes, writing this field loads the counter for TimerA. A read returns the current value of <b>GPTMTAILR</b> .

## Register 10: GPTM TimerB Interval Load (GPTMTBILR), offset 0x02C

This register is used to load the starting count value into TimerB. When the GPTM is configured to a 32-bit mode, **GPTMTBILR** returns the current value of TimerB and ignores writes.

### GPTM TimerB Interval Load (GPTMTBILR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x02C  
 Type R/W, reset 0x0000.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	TBILRL															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

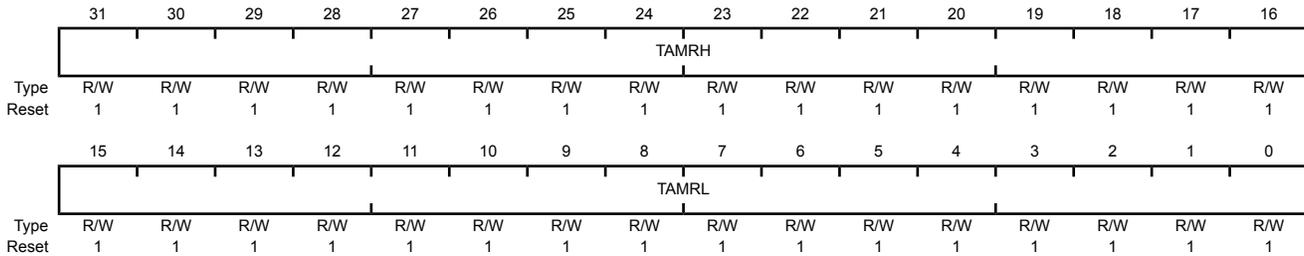
Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	TBILRL	R/W	0xFFFF	GPTM TimerB Interval Load Register When the GPTM is not configured as a 32-bit timer, a write to this field updates <b>GPTMTBILR</b> . In 32-bit mode, writes are ignored, and reads return the current value of <b>GPTMTBILR</b> .

### Register 11: GPTM TimerA Match (GPTMTAMATCHR), offset 0x030

This register is used in 32-bit Real-Time Clock mode and 16-bit PWM and Input Edge Count modes.

#### GPTM TimerA Match (GPTMTAMATCHR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x030  
 Type R/W, reset 0xFFFF.FFFF



Bit/Field	Name	Type	Reset	Description
31:16	TAMRH	R/W	0xFFFF	<p>GPTM TimerA Match Register High</p> <p>When configured for 32-bit Real-Time Clock (RTC) mode via the <b>GPTMCFG</b> register, this value is compared to the upper half of <b>GPTMTAR</b>, to determine match events.</p> <p>In 16-bit mode, this field reads as 0 and does not have an effect on the state of <b>GPTMTBMATCHR</b>.</p>
15:0	TAMRL	R/W	0xFFFF	<p>GPTM TimerA Match Register Low</p> <p>When configured for 32-bit Real-Time Clock (RTC) mode via the <b>GPTMCFG</b> register, this value is compared to the lower half of <b>GPTMTAR</b>, to determine match events.</p> <p>When configured for PWM mode, this value along with <b>GPTMTAILR</b>, determines the duty cycle of the output PWM signal.</p> <p>When configured for Edge Count mode, this value along with <b>GPTMTAILR</b>, determines how many edge events are counted. The total number of edge events counted is equal to the value in <b>GPTMTAILR</b> minus this value.</p>

**Register 12: GPTM TimerB Match (GPTMTBMATCHR), offset 0x034**

This register is used in 16-bit PWM and Input Edge Count modes.

**GPTM TimerB Match (GPTMTBMATCHR)**

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x034  
 Type R/W, reset 0x0000.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	TBMRL															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	TBMRL	R/W	0xFFFF	GPTM TimerB Match Register Low When configured for PWM mode, this value along with <b>GPTMTBILR</b> , determines the duty cycle of the output PWM signal. When configured for Edge Count mode, this value along with <b>GPTMTBILR</b> , determines how many edge events are counted. The total number of edge events counted is equal to the value in <b>GPTMTBILR</b> minus this value.

### Register 13: GPTM TimerA Prescale (GPTMTAPR), offset 0x038

This register allows software to extend the range of the 16-bit timers when operating in one-shot or periodic mode.

#### GPTM TimerA Prescale (GPTMTAPR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x038  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								TAPSR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	TAPSR	R/W	0x00	GPTM TimerA Prescale The register loads this value on a write. A read returns the current value of the register. Refer to Table 8-4 on page 292 for more details and an example.

**Register 14: GPTM TimerB Prescale (GPTMTBPR), offset 0x03C**

This register allows software to extend the range of the 16-bit timers when operating in one-shot or periodic mode.

**GPTM TimerB Prescale (GPTMTBPR)**

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x03C  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								TBPSR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

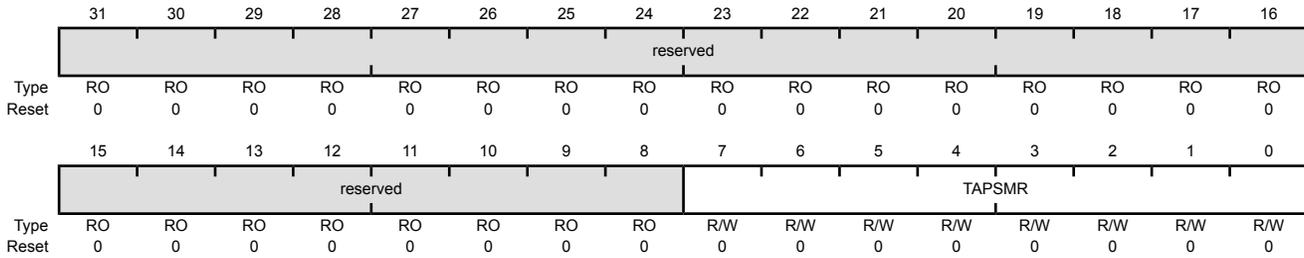
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	TBPSR	R/W	0x00	GPTM TimerB Prescale The register loads this value on a write. A read returns the current value of this register. Refer to Table 8-4 on page 292 for more details and an example.

**Register 15: GPTM TimerA Prescale Match (GPTMTAPMR), offset 0x040**

This register effectively extends the range of **GPTMTAMATCHR** to 24 bits when operating in 16-bit one-shot or periodic mode.

GPTM TimerA Prescale Match (GPTMTAPMR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x040  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	TAPSMR	R/W	0x00	GPTM TimerA Prescale Match This value is used alongside <b>GPTMTAMATCHR</b> to detect timer match events while using a prescaler.

**Register 16: GPTM TimerB Prescale Match (GPTMTBPMR), offset 0x044**

This register effectively extends the range of **GPTMTBMATCHR** to 24 bits when operating in 16-bit one-shot or periodic mode.

**GPTM TimerB Prescale Match (GPTMTBPMR)**

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x044  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								TBPSMR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

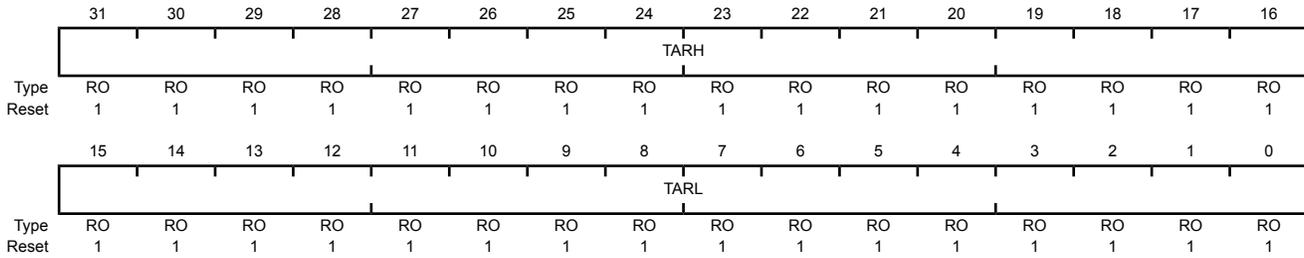
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	TBPSMR	R/W	0x00	GPTM TimerB Prescale Match This value is used alongside <b>GPTMTBMATCHR</b> to detect timer match events while using a prescaler.

### Register 17: GPTM TimerA (GPTMTAR), offset 0x048

This register shows the current value of the TimerA counter in all cases except for Input Edge Count mode. When in this mode, this register contains the number of edges that have occurred.

#### GPTM TimerA (GPTMTAR)

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x048  
 Type RO, reset 0xFFFF.FFFF



Bit/Field	Name	Type	Reset	Description
31:16	TARH	RO	0xFFFF	GPTM TimerA Register High If the <b>GPTMCFG</b> is in a 32-bit mode, TimerB value is read. If the <b>GPTMCFG</b> is in a 16-bit mode, this is read as zero.
15:0	TARL	RO	0xFFFF	GPTM TimerA Register Low A read returns the current value of the <b>GPTM TimerA Count Register</b> , except in Input Edge-Count mode, when it returns the number of edges that have occurred.

**Register 18: GPTM TimerB (GPTMTBR), offset 0x04C**

This register shows the current value of the TimerB counter in all cases except for Input Edge Count mode. When in this mode, this register contains the number of edges that have occurred.

**GPTM TimerB (GPTMTBR)**

Timer0 base: 0x4003.0000  
 Timer1 base: 0x4003.1000  
 Timer2 base: 0x4003.2000  
 Offset 0x04C  
 Type RO, reset 0x0000.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	TBRL															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	TBRL	RO	0xFFFF	GPTM TimerB A read returns the current value of the <b>GPTM TimerB Count Register</b> , except in Input Edge-Count mode, when it returns the number of edges that have occurred.

## 9 Watchdog Timer

A watchdog timer can generate nonmaskable interrupts (NMIs) or a reset when a time-out value is reached. The watchdog timer is used to regain control when a system has failed due to a software error or due to the failure of an external device to respond in the expected way.

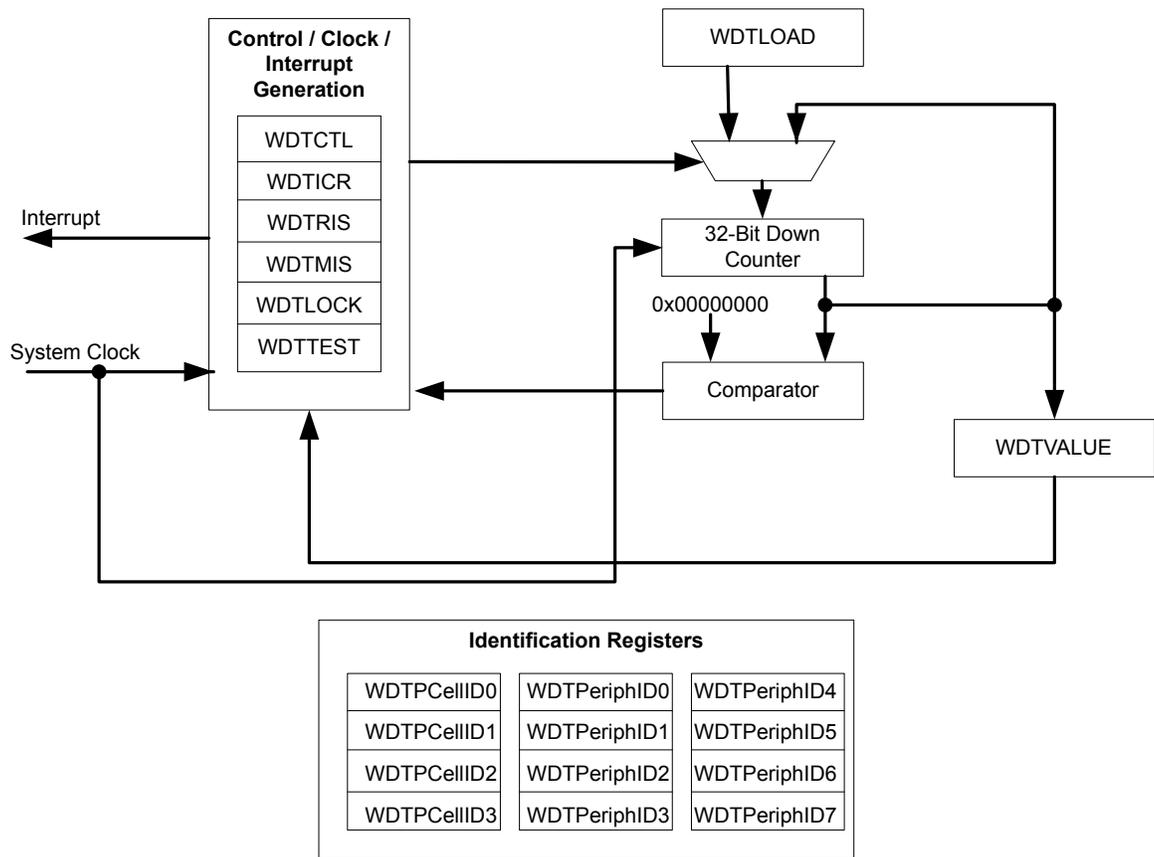
The Stellaris<sup>®</sup> Watchdog Timer module has the following features:

- 32-bit down counter with a programmable load register
- Separate watchdog clock with an enable
- Programmable interrupt generation logic with interrupt masking
- Lock register protection from runaway software
- Reset generation logic with an enable/disable
- User-enabled stalling when the controller asserts the CPU Halt flag during debug

The Watchdog Timer can be configured to generate an interrupt to the controller on its first time-out, and to generate a reset signal on its second time-out. Once the Watchdog Timer has been configured, the lock register can be written to prevent the timer configuration from being inadvertently altered.

## 9.1 Block Diagram

Figure 9-1. WDT Module Block Diagram



## 9.2 Functional Description

The Watchdog Timer module generates the first time-out signal when the 32-bit counter reaches the zero state after being enabled; enabling the counter also enables the watchdog timer interrupt. After the first time-out event, the 32-bit counter is re-loaded with the value of the **Watchdog Timer Load (WDTLOAD)** register, and the timer resumes counting down from that value. Once the Watchdog Timer has been configured, the **Watchdog Timer Lock (WDTLOCK)** register is written, which prevents the timer configuration from being inadvertently altered by software.

If the timer counts down to its zero state again before the first time-out interrupt is cleared, and the reset signal has been enabled (via the `WatchdogResetEnable` function), the Watchdog timer asserts its reset signal to the system. If the interrupt is cleared before the 32-bit counter reaches its second time-out, the 32-bit counter is loaded with the value in the **WDTLOAD** register, and counting resumes from that value.

If **WDTLOAD** is written with a new value while the Watchdog Timer counter is counting, then the counter is loaded with the new value and continues counting.

Writing to **WDTLOAD** does not clear an active interrupt. An interrupt must be specifically cleared by writing to the **Watchdog Interrupt Clear (WDTICR)** register.

The Watchdog module interrupt and reset generation can be enabled or disabled as required. When the interrupt is re-enabled, the 32-bit counter is preloaded with the load register value and not its last state.

### 9.3 Initialization and Configuration

To use the WDT, its peripheral clock must be enabled by setting the **WDT** bit in the **RCGC0** register. The Watchdog Timer is configured using the following sequence:

1. Load the **WDTLOAD** register with the desired timer load value.
2. If the Watchdog is configured to trigger system resets, set the **RESEN** bit in the **WDTCTL** register.
3. Set the **INTEN** bit in the **WDTCTL** register to enable the Watchdog and lock the control register.

If software requires that all of the watchdog registers are locked, the Watchdog Timer module can be fully locked by writing any value to the **WDTLOCK** register. To unlock the Watchdog Timer, write a value of 0x1ACC.E551.

### 9.4 Register Map

Table 9-1 on page 326 lists the Watchdog registers. The offset listed is a hexadecimal increment to the register's address, relative to the Watchdog Timer base address of 0x4000.0000.

**Table 9-1. Watchdog Timer Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	WDTLOAD	R/W	0xFFFF.FFFF	Watchdog Load	328
0x004	WDTVALUE	RO	0xFFFF.FFFF	Watchdog Value	329
0x008	WDTCTL	R/W	0x0000.0000	Watchdog Control	330
0x00C	WDTICR	WO	-	Watchdog Interrupt Clear	331
0x010	WDTRIS	RO	0x0000.0000	Watchdog Raw Interrupt Status	332
0x014	WDTMIS	RO	0x0000.0000	Watchdog Masked Interrupt Status	333
0x418	WDTTEST	R/W	0x0000.0000	Watchdog Test	334
0xC00	WDTLOCK	R/W	0x0000.0000	Watchdog Lock	335
0xFD0	WDTPeriphID4	RO	0x0000.0000	Watchdog Peripheral Identification 4	336
0xFD4	WDTPeriphID5	RO	0x0000.0000	Watchdog Peripheral Identification 5	337
0xFD8	WDTPeriphID6	RO	0x0000.0000	Watchdog Peripheral Identification 6	338
0xFDC	WDTPeriphID7	RO	0x0000.0000	Watchdog Peripheral Identification 7	339
0xFE0	WDTPeriphID0	RO	0x0000.0005	Watchdog Peripheral Identification 0	340
0xFE4	WDTPeriphID1	RO	0x0000.0018	Watchdog Peripheral Identification 1	341
0xFE8	WDTPeriphID2	RO	0x0000.0018	Watchdog Peripheral Identification 2	342

**Table 9-1. Watchdog Timer Register Map (continued)**

Offset	Name	Type	Reset	Description	See page
0xFEC	WDTPeriphID3	RO	0x0000.0001	Watchdog Peripheral Identification 3	343
0xFF0	WDTPCellID0	RO	0x0000.000D	Watchdog PrimeCell Identification 0	344
0xFF4	WDTPCellID1	RO	0x0000.00F0	Watchdog PrimeCell Identification 1	345
0xFF8	WDTPCellID2	RO	0x0000.0005	Watchdog PrimeCell Identification 2	346
0xFFC	WDTPCellID3	RO	0x0000.00B1	Watchdog PrimeCell Identification 3	347

## 9.5 Register Descriptions

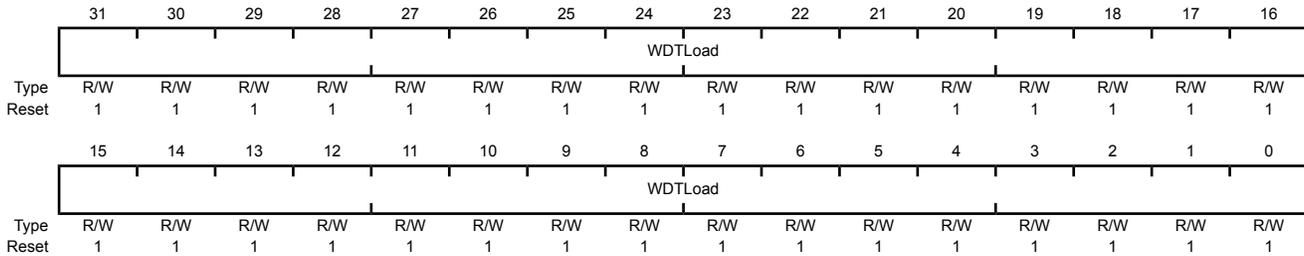
The remainder of this section lists and describes the WDT registers, in numerical order by address offset.

### Register 1: Watchdog Load (WDTLOAD), offset 0x000

This register is the 32-bit interval value used by the 32-bit counter. When this register is written, the value is immediately loaded and the counter restarts counting down from the new value. If the **WDTLOAD** register is loaded with 0x0000.0000, an interrupt is immediately generated.

#### Watchdog Load (WDTLOAD)

Base 0x4000.0000  
 Offset 0x000  
 Type R/W, reset 0xFFFF.FFFF



Bit/Field	Name	Type	Reset	Description
31:0	WDTLoad	R/W	0xFFFF.FFFF	Watchdog Load Value

**Register 2: Watchdog Value (WDTVALUE), offset 0x004**

This register contains the current count value of the timer.

**Watchdog Value (WDTVALUE)**

Base 0x4000.0000

Offset 0x004

Type RO, reset 0xFFFF.FFFF

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	WDTValue															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	WDTValue															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:0	WDTValue	RO	0xFFFF.FFFF	Watchdog Value Current value of the 32-bit down counter.

### Register 3: Watchdog Control (WDTCTL), offset 0x008

This register is the watchdog control register. The watchdog timer can be configured to generate a reset signal (on second time-out) or an interrupt on time-out.

When the watchdog interrupt has been enabled, all subsequent writes to the control register are ignored. The only mechanism that can re-enable writes is a hardware reset.

#### Watchdog Control (WDTCTL)

Base 0x4000.0000  
 Offset 0x008  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved															RESEN	INTEN
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	RESEN	R/W	0	Watchdog Reset Enable The RESEN values are defined as follows:  Value Description 0 Disabled. 1 Enable the Watchdog module reset output.
0	INTEN	R/W	0	Watchdog Interrupt Enable The INTEN values are defined as follows:  Value Description 0 Interrupt event disabled (once this bit is set, it can only be cleared by a hardware reset). 1 Interrupt event enabled. Once enabled, all writes are ignored.

**Register 4: Watchdog Interrupt Clear (WDTICR), offset 0x00C**

This register is the interrupt clear register. A write of any value to this register clears the Watchdog interrupt and reloads the 32-bit counter from the **WDTLOAD** register. Value for a read or reset is indeterminate.

## Watchdog Interrupt Clear (WDTICR)

Base 0x4000.0000

Offset 0x00C

Type WO, reset -

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	WDTIntClr															
Type	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	WDTIntClr															
Type	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO	WO
Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit/Field	Name	Type	Reset	Description
31:0	WDTIntClr	WO	-	Watchdog Interrupt Clear

### Register 5: Watchdog Raw Interrupt Status (WDTRIS), offset 0x010

This register is the raw interrupt status register. Watchdog interrupt events can be monitored via this register if the controller interrupt is masked.

#### Watchdog Raw Interrupt Status (WDTRIS)

Base 0x4000.0000  
 Offset 0x010  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															WDTRIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	WDTRIS	RO	0	Watchdog Raw Interrupt Status Gives the raw interrupt state (prior to masking) of <b>WDTINTR</b> .

**Register 6: Watchdog Masked Interrupt Status (WDTMIS), offset 0x014**

This register is the masked interrupt status register. The value of this register is the logical AND of the raw interrupt bit and the Watchdog interrupt enable bit.

**Watchdog Masked Interrupt Status (WDTMIS)**

Base 0x4000.0000

Offset 0x014

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															WDTMIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	WDTMIS	RO	0	Watchdog Masked Interrupt Status Gives the masked interrupt state (after masking) of the <b>WDTINTR</b> interrupt.

### Register 7: Watchdog Test (WDTTEST), offset 0x418

This register provides user-enabled stalling when the microcontroller asserts the CPU halt flag during debug.

#### Watchdog Test (WDTTEST)

Base 0x4000.0000  
 Offset 0x418  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved							STALL	reserved							
Type	RO	RO	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:9	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
8	STALL	R/W	0	Watchdog Stall Enable When set to 1, if the Stellaris microcontroller is stopped with a debugger, the watchdog timer stops counting. Once the microcontroller is restarted, the watchdog timer resumes counting.
7:0	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 8: Watchdog Lock (WDTLOCK), offset 0xC00**

Writing 0x1ACC.E551 to the **WDTLOCK** register enables write access to all other registers. Writing any other value to the **WDTLOCK** register re-enables the locked state for register writes to all the other registers. Reading the **WDTLOCK** register returns the lock status rather than the 32-bit value written. Therefore, when write accesses are disabled, reading the **WDTLOCK** register returns 0x0000.0001 (when locked; otherwise, the returned value is 0x0000.0000 (unlocked)).

**Watchdog Lock (WDTLOCK)**

Base 0x4000.0000  
Offset 0xC00  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	WDTLock															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	WDTLock															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

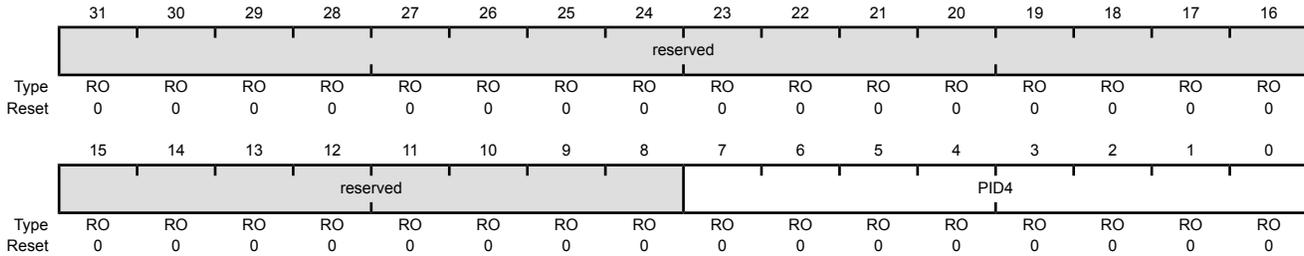
Bit/Field	Name	Type	Reset	Description						
31:0	WDTLock	R/W	0x0000	Watchdog Lock A write of the value 0x1ACC.E551 unlocks the watchdog registers for write access. A write of any other value reapplies the lock, preventing any register updates. A read of this register returns the following values: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0000.0001</td> <td>Locked</td> </tr> <tr> <td>0x0000.0000</td> <td>Unlocked</td> </tr> </tbody> </table>	Value	Description	0x0000.0001	Locked	0x0000.0000	Unlocked
Value	Description									
0x0000.0001	Locked									
0x0000.0000	Unlocked									

### Register 9: Watchdog Peripheral Identification 4 (WDTPeriphID4), offset 0xFD0

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### Watchdog Peripheral Identification 4 (WDTPeriphID4)

Base 0x4000.0000  
 Offset 0xFD0  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID4	RO	0x00	WDT Peripheral ID Register[7:0]

## Register 10: Watchdog Peripheral Identification 5 (WDTPeriphID5), offset 0xFD4

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### Watchdog Peripheral Identification 5 (WDTPeriphID5)

Base 0x4000.0000

Offset 0xFD4

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID5							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID5	RO	0x00	WDT Peripheral ID Register[15:8]

### Register 11: Watchdog Peripheral Identification 6 (WDTPeriphID6), offset 0xFD8

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### Watchdog Peripheral Identification 6 (WDTPeriphID6)

Base 0x4000.0000  
 Offset 0xFD8  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID6							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID6	RO	0x00	WDT Peripheral ID Register[23:16]

## Register 12: Watchdog Peripheral Identification 7 (WDTPeriphID7), offset 0xFDC

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### Watchdog Peripheral Identification 7 (WDTPeriphID7)

Base 0x4000.0000

Offset 0xFDC

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID7							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID7	RO	0x00	WDT Peripheral ID Register[31:24]

### Register 13: Watchdog Peripheral Identification 0 (WDTPeriphID0), offset 0xFE0

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### Watchdog Peripheral Identification 0 (WDTPeriphID0)

Base 0x4000.0000  
 Offset 0xFE0  
 Type RO, reset 0x0000.0005

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID0							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID0	RO	0x05	Watchdog Peripheral ID Register[7:0]

## Register 14: Watchdog Peripheral Identification 1 (WDTPeriphID1), offset 0xFE4

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### Watchdog Peripheral Identification 1 (WDTPeriphID1)

Base 0x4000.0000  
Offset 0xFE4  
Type RO, reset 0x0000.0018

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID1	RO	0x18	Watchdog Peripheral ID Register[15:8]

## Register 15: Watchdog Peripheral Identification 2 (WDTPeriphID2), offset 0xFE8

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### Watchdog Peripheral Identification 2 (WDTPeriphID2)

Base 0x4000.0000  
 Offset 0xFE8  
 Type RO, reset 0x0000.0018

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID2							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID2	RO	0x18	Watchdog Peripheral ID Register[23:16]

## Register 16: Watchdog Peripheral Identification 3 (WDTPeriphID3), offset 0xFEC

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### Watchdog Peripheral Identification 3 (WDTPeriphID3)

Base 0x4000.0000

Offset 0xFEC

Type RO, reset 0x0000.0001

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID3	RO	0x01	Watchdog Peripheral ID Register[31:24]

### Register 17: Watchdog PrimeCell Identification 0 (WDTPCellID0), offset 0xFF0

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

#### Watchdog PrimeCell Identification 0 (WDTPCellID0)

Base 0x4000.0000  
 Offset 0xFF0  
 Type RO, reset 0x0000.000D

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID0							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID0	RO	0x0D	Watchdog PrimeCell ID Register[7:0]

**Register 18: Watchdog PrimeCell Identification 1 (WDTPCellID1), offset 0xFF4**

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

## Watchdog PrimeCell Identification 1 (WDTPCellID1)

Base 0x4000.0000

Offset 0xFF4

Type RO, reset 0x0000.00F0

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0

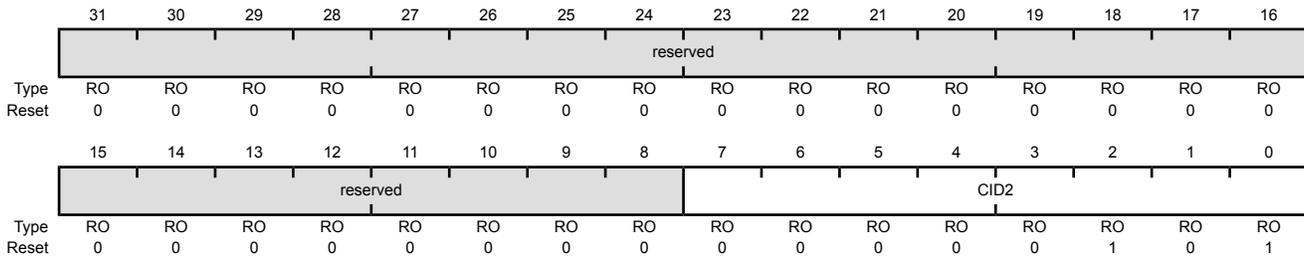
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID1	RO	0xF0	Watchdog PrimeCell ID Register[15:8]

### Register 19: Watchdog PrimeCell Identification 2 (WDTPCellID2), offset 0xFF8

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

#### Watchdog PrimeCell Identification 2 (WDTPCellID2)

Base 0x4000.0000  
 Offset 0xFF8  
 Type RO, reset 0x0000.0005



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID2	RO	0x05	Watchdog PrimeCell ID Register[23:16]

**Register 20: Watchdog PrimeCell Identification 3 (WDTPCellID3), offset 0xFFC**

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

## Watchdog PrimeCell Identification 3 (WDTPCellID3)

Base 0x4000.0000

Offset 0xFFC

Type RO, reset 0x0000.00B1

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID3	RO	0xB1	Watchdog PrimeCell ID Register[31:24]

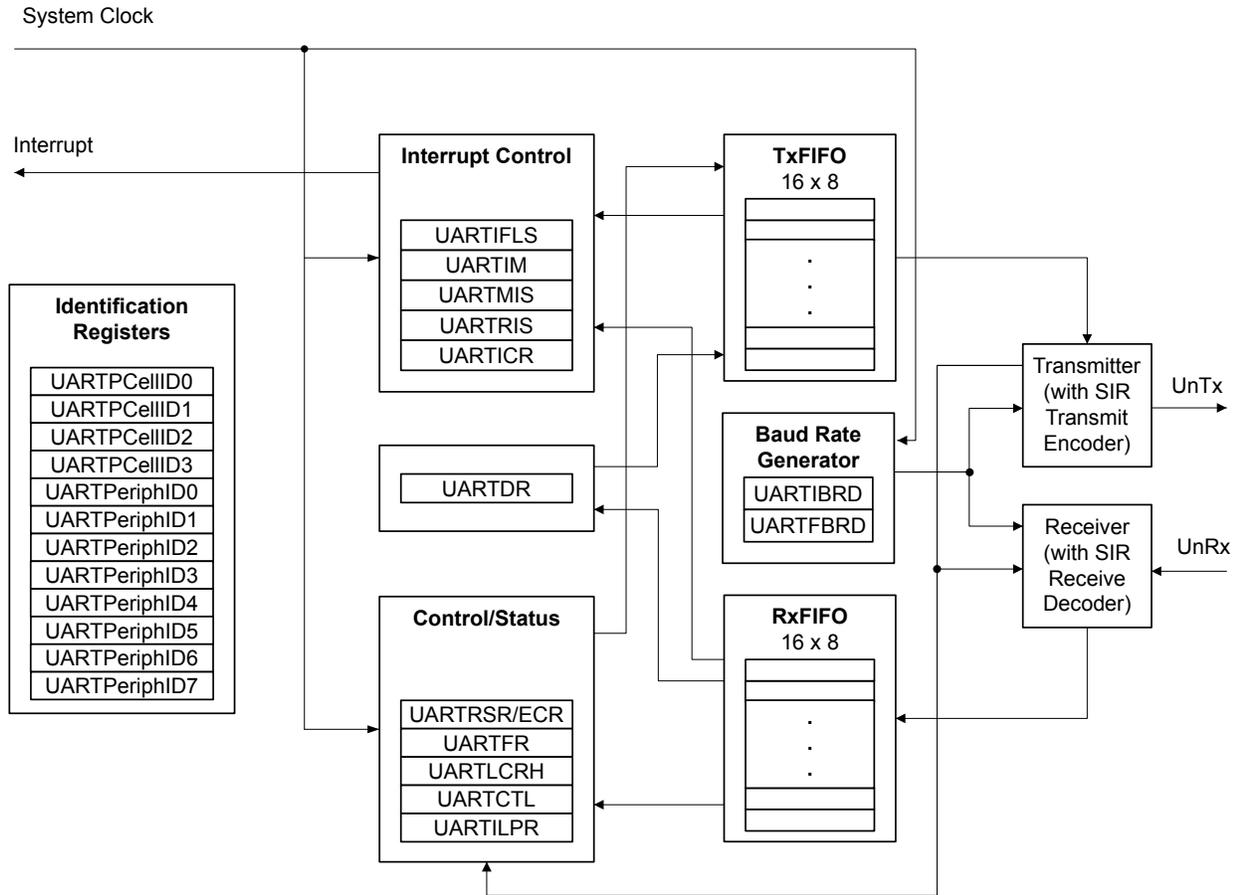
## 10 Universal Asynchronous Receivers/Transmitters (UARTs)

The Stellaris<sup>®</sup> Universal Asynchronous Receiver/Transmitter (UART) has the following features:

- Fully programmable 16C550-type UART with IrDA support
- Separate 16x8 transmit (TX) and receive (RX) FIFOs to reduce CPU interrupt service loading
- Programmable baud-rate generator allowing speeds up to 1.5625 Mbps
- Programmable FIFO length, including 1-byte deep operation providing conventional double-buffered interface
- FIFO trigger levels of 1/8, 1/4, 1/2, 3/4, and 7/8
- Standard asynchronous communication bits for start, stop, and parity
- Line-break generation and detection
- Fully programmable serial interface characteristics
  - 5, 6, 7, or 8 data bits
  - Even, odd, stick, or no-parity bit generation/detection
  - 1 or 2 stop bit generation
- IrDA serial-IR (SIR) encoder/decoder providing
  - Programmable use of IrDA Serial Infrared (SIR) or UART input/output
  - Support of IrDA SIR encoder/decoder functions for data rates up to 115.2 Kbps half-duplex
  - Support of normal 3/16 and low-power (1.41-2.23  $\mu$ s) bit durations
  - Programmable internal clock generator enabling division of reference clock by 1 to 256 for low-power mode bit duration

## 10.1 Block Diagram

Figure 10-1. UART Module Block Diagram



## 10.2 Signal Description

Table 10-1 on page 349 and Table 10-2 on page 350 list the external signals of the UART module and describe the function of each. The UART signals are alternate functions for some GPIO signals and default to be GPIO signals at reset, with the exception of the U0Rx and U0Tx pins which default to the UART function. The column in the table below titled "Pin Assignment" lists the possible GPIO pin placements for these UART signals. The AFSEL bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the UART function. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 243.

Table 10-1. UART Signals (100LQFP)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
U0Rx	26	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
U0Tx	27	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

**Table 10-2. UART Signals (108BGA)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
U0Rx	L3	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
U0Tx	M3	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 10.3 Functional Description

Each Stellaris UART performs the functions of parallel-to-serial and serial-to-parallel conversions. It is similar in functionality to a 16C550 UART, but is not register compatible.

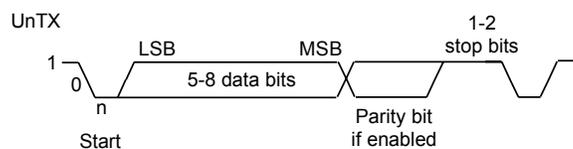
The UART is configured for transmit and/or receive via the `TXE` and `RXE` bits of the **UART Control (UARTCTL)** register (see page 368). Transmit and receive are both enabled out of reset. Before any control registers are programmed, the UART must be disabled by clearing the `UARTEN` bit in **UARTCTL**. If the UART is disabled during a TX or RX operation, the current transaction is completed prior to the UART stopping.

The UART peripheral also includes a serial IR (SIR) encoder/decoder block that can be connected to an infrared transceiver to implement an IrDA SIR physical layer. The SIR function is programmed using the **UARTCTL** register.

### 10.3.1 Transmit/Receive Logic

The transmit logic performs parallel-to-serial conversion on the data read from the transmit FIFO. The control logic outputs the serial bit stream beginning with a start bit, and followed by the data bits (LSB first), parity bit, and the stop bits according to the programmed configuration in the control registers. See Figure 10-2 on page 350 for details.

The receive logic performs serial-to-parallel conversion on the received bit stream after a valid start pulse has been detected. Overrun, parity, frame error checking, and line-break detection are also performed, and their status accompanies the data that is written to the receive FIFO.

**Figure 10-2. UART Character Frame**


### 10.3.2 Baud-Rate Generation

The baud-rate divisor is a 22-bit number consisting of a 16-bit integer and a 6-bit fractional part. The number formed by these two values is used by the baud-rate generator to determine the bit period. Having a fractional baud-rate divisor allows the UART to generate all the standard baud rates.

The 16-bit integer is loaded through the **UART Integer Baud-Rate Divisor (UARTIBRD)** register (see page 364) and the 6-bit fractional part is loaded with the **UART Fractional Baud-Rate Divisor (UARTFBRD)** register (see page 365). The baud-rate divisor (BRD) has the following relationship to the system clock (where *BRDI* is the integer part of the BRD and *BRDF* is the fractional part, separated by a decimal place.)

$$\text{BRD} = \text{BRDI} + \text{BRDF} = \text{UARTSysClk} / (16 * \text{Baud Rate})$$

where `UARTSysClk` is the system clock connected to the UART.

The 6-bit fractional number (that is to be loaded into the `DIVFRAC` bit field in the `UARTFBRD` register) can be calculated by taking the fractional part of the baud-rate divisor, multiplying it by 64, and adding 0.5 to account for rounding errors:

$$\text{UARTFBRD}[\text{DIVFRAC}] = \text{integer}(\text{BRDF} * 64 + 0.5)$$

The UART generates an internal baud-rate reference clock at 16x the baud-rate (referred to as `Baud16`). This reference clock is divided by 16 to generate the transmit clock, and is used for error detection during receive operations.

Along with the **UART Line Control, High Byte (UARTLCRH)** register (see page 366), the `UARTIBRD` and `UARTFBRD` registers form an internal 30-bit register. This internal register is only updated when a write operation to `UARTLCRH` is performed, so any changes to the baud-rate divisor must be followed by a write to the `UARTLCRH` register for the changes to take effect.

To update the baud-rate registers, there are four possible sequences:

- `UARTIBRD` write, `UARTFBRD` write, and `UARTLCRH` write
- `UARTFBRD` write, `UARTIBRD` write, and `UARTLCRH` write
- `UARTIBRD` write and `UARTLCRH` write
- `UARTFBRD` write and `UARTLCRH` write

### 10.3.3 Data Transmission

Data received or transmitted is stored in two 16-byte FIFOs, though the receive FIFO has an extra four bits per character for status information. For transmission, data is written into the transmit FIFO. If the UART is enabled, it causes a data frame to start transmitting with the parameters indicated in the `UARTLCRH` register. Data continues to be transmitted until there is no data left in the transmit FIFO. The `BUSY` bit in the **UART Flag (UARTFR)** register (see page 361) is asserted as soon as data is written to the transmit FIFO (that is, if the FIFO is non-empty) and remains asserted while data is being transmitted. The `BUSY` bit is negated only when the transmit FIFO is empty, and the last character has been transmitted from the shift register, including the stop bits. The UART can indicate that it is busy even though the UART may no longer be enabled.

When the receiver is idle (the `UnRx` is continuously 1) and the data input goes Low (a start bit has been received), the receive counter begins running and data is sampled on the eighth cycle of `Baud16` (described in “Transmit/Receive Logic” on page 350).

The start bit is valid and recognized if `UnRx` is still low on the eighth cycle of `Baud16`, otherwise it is ignored. After a valid start bit is detected, successive data bits are sampled on every 16th cycle of `Baud16` (that is, one bit period later) according to the programmed length of the data characters. The parity bit is then checked if parity mode was enabled. Data length and parity are defined in the `UARTLCRH` register.

Lastly, a valid stop bit is confirmed if `UnRx` is High, otherwise a framing error has occurred. When a full word is received, the data is stored in the receive FIFO, with any error bits associated with that word.

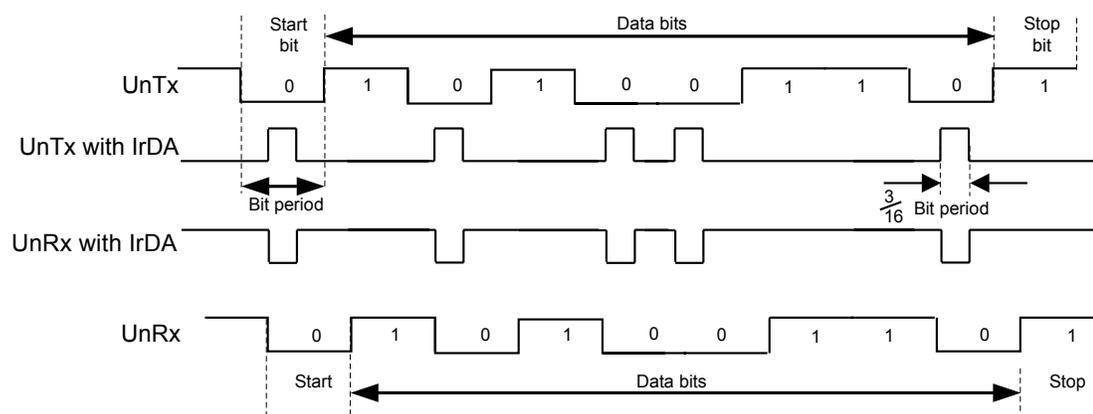
### 10.3.4 Serial IR (SIR)

The UART peripheral includes an IrDA serial-IR (SIR) encoder/decoder block. The IrDA SIR block provides functionality that converts between an asynchronous UART data stream, and half-duplex serial SIR interface. No analog processing is performed on-chip. The role of the SIR block is to provide a digital encoded output and decoded input to the UART. The UART signal pins can be connected to an infrared transceiver to implement an IrDA SIR physical layer link. The SIR block has two modes of operation:

- In normal IrDA mode, a zero logic level is transmitted as high pulse of  $\frac{3}{16}$ th duration of the selected baud rate bit period on the output pin, while logic one levels are transmitted as a static LOW signal. These levels control the driver of an infrared transmitter, sending a pulse of light for each zero. On the reception side, the incoming light pulses energize the photo transistor base of the receiver, pulling its output LOW. This drives the UART input pin LOW.
- In low-power IrDA mode, the width of the transmitted infrared pulse is set to three times the period of the internally generated IrLPBaud16 signal ( $1.63 \mu\text{s}$ , assuming a nominal 1.8432 MHz frequency) by changing the appropriate bit in the **UARTCR** register. See page 363 for more information on IrDA low-power pulse-duration configuration.

Figure 10-3 on page 352 shows the UART transmit and receive signals, with and without IrDA modulation.

**Figure 10-3. IrDA Data Modulation**



In both normal and low-power IrDA modes:

- During transmission, the UART data bit is used as the base for encoding
- During reception, the decoded bits are transferred to the UART receive logic

The IrDA SIR physical layer specifies a half-duplex communication link, with a minimum 10 ms delay between transmission and reception. This delay must be generated by software because it is not automatically supported by the UART. The delay is required because the infrared receiver electronics might become biased, or even saturated from the optical power coupled from the adjacent transmitter LED. This delay is known as latency, or receiver setup time.

If the application does not require the use of the  $\text{UnRx}$  signal, the GPIO pin that has the  $\text{UnRx}$  signal as an alternate function must be configured as the  $\text{UnRx}$  signal and pulled High.

### 10.3.5 FIFO Operation

The UART has two 16-entry FIFOs; one for transmit and one for receive. Both FIFOs are accessed via the **UART Data (UARTDR)** register (see page 357). Read operations of the **UARTDR** register return a 12-bit value consisting of 8 data bits and 4 error flags while write operations place 8-bit data in the transmit FIFO.

Out of reset, both FIFOs are disabled and act as 1-byte-deep holding registers. The FIFOs are enabled by setting the `FEN` bit in **UARTLCRH** (page 366).

FIFO status can be monitored via the **UART Flag (UARTFR)** register (see page 361) and the **UART Receive Status (UARTRSR)** register. Hardware monitors empty, full and overrun conditions. The **UARTFR** register contains empty and full flags (`TXFE`, `TXFF`, `RXFE`, and `RXFF` bits) and the **UARTRSR** register shows overrun status via the `OE` bit.

The trigger points at which the FIFOs generate interrupts is controlled via the **UART Interrupt FIFO Level Select (UARTIFLS)** register (see page 370). Both FIFOs can be individually configured to trigger interrupts at different levels. Available configurations include  $1/8$ ,  $1/4$ ,  $1/2$ ,  $3/4$ , and  $7/8$ . For example, if the  $1/4$  option is selected for the receive FIFO, the UART generates a receive interrupt after 4 data bytes are received. Out of reset, both FIFOs are configured to trigger an interrupt at the  $1/2$  mark.

### 10.3.6 Interrupts

The UART can generate interrupts when the following conditions are observed:

- Overrun Error
- Break Error
- Parity Error
- Framing Error
- Receive Timeout
- Transmit (when condition defined in the `TXIFLSEL` bit in the **UARTIFLS** register is met)
- Receive (when condition defined in the `RXIFLSEL` bit in the **UARTIFLS** register is met)

All of the interrupt events are ORed together before being sent to the interrupt controller, so the UART can only generate a single interrupt request to the controller at any given time. Software can service multiple interrupt events in a single interrupt service routine by reading the **UART Masked Interrupt Status (UARTMIS)** register (see page 375).

The interrupt events that can trigger a controller-level interrupt are defined in the **UART Interrupt Mask (UARTIM)** register (see page 372) by setting the corresponding `IM` bit to 1. If interrupts are not used, the raw interrupt status is always visible via the **UART Raw Interrupt Status (UARTRIS)** register (see page 374).

Interrupts are always cleared (for both the **UARTMIS** and **UARTRIS** registers) by setting the corresponding bit in the **UART Interrupt Clear (UARTICR)** register (see page 376).

The receive interrupt changes state when one of the following events occurs:

- If the FIFOs are enabled and the receive FIFO reaches the programmed trigger level, the `RXRIS` bit is set. The receive interrupt is cleared by reading data from the receive FIFO until it becomes less than the trigger level, or by clearing the interrupt by writing a 1 to the `RXIC` bit.
- If the FIFOs are disabled (have a depth of one location) and data is received thereby filling the location, the `RXRIS` bit is set. The receive interrupt is cleared by performing a single read of the receive FIFO, or by clearing the interrupt by writing a 1 to the `RXIC` bit.

The transmit interrupt changes state when one of the following events occurs:

- If the FIFOs are enabled and the transmit FIFO progresses through the programmed trigger level, the `TXRIS` bit is set. The transmit interrupt is based on a transition through level, therefore the FIFO must be written past the programmed trigger level otherwise no further transmit interrupts will be generated. The transmit interrupt is cleared by writing data to the transmit FIFO until it becomes greater than the trigger level, or by clearing the interrupt by writing a 1 to the `TXIC` bit.
- If the FIFOs are disabled (have a depth of one location) and there is no data present in the transmitters single location, the `TXRIS` bit is set. It is cleared by performing a single write to the transmit FIFO, or by clearing the interrupt by writing a 1 to the `TXIC` bit.

### 10.3.7 Loopback Operation

The UART can be placed into an internal loopback mode for diagnostic or debug work. This is accomplished by setting the `LBE` bit in the `UARTCTL` register (see page 368). In loopback mode, data transmitted on `UnTx` is received on the `UnRx` input.

### 10.3.8 IrDA SIR block

The IrDA SIR block contains an IrDA serial IR (SIR) protocol encoder/decoder. When enabled, the SIR block uses the `UnTx` and `UnRx` pins for the SIR protocol, which should be connected to an IR transceiver.

The SIR block can receive and transmit, but it is only half-duplex so it cannot do both at the same time. Transmission must be stopped before data can be received. The IrDA SIR physical layer specifies a minimum 10-ms delay between transmission and reception.

## 10.4 Initialization and Configuration

To use the UART, the peripheral clock must be enabled by setting the `UART0` bit in the `RCGC1` register.

This section discusses the steps that are required to use a UART module. For this example, the UART clock is assumed to be 20 MHz and the desired UART configuration is:

- 115200 baud rate
- Data length of 8 bits
- One stop bit
- No parity
- FIFOs disabled
- No interrupts

The first thing to consider when programming the UART is the baud-rate divisor (BRD), since the **UARTIBRD** and **UARTFBRD** registers must be written before the **UARTLCRH** register. Using the equation described in “Baud-Rate Generation” on page 350, the BRD can be calculated:

$$\text{BRD} = 20,000,000 / (16 * 115,200) = 10.8507$$

which means that the `DIVINT` field of the **UARTIBRD** register (see page 364) should be set to 10. The value to be loaded into the **UARTFBRD** register (see page 365) is calculated by the equation:

$$\text{UARTFBRD}[\text{DIVFRAC}] = \text{integer}(0.8507 * 64 + 0.5) = 54$$

With the BRD values in hand, the UART configuration is written to the module in the following order:

1. Disable the UART by clearing the `UARTEN` bit in the **UARTCTL** register.
2. Write the integer portion of the BRD to the **UARTIBRD** register.
3. Write the fractional portion of the BRD to the **UARTFBRD** register.
4. Write the desired serial parameters to the **UARTLCRH** register (in this case, a value of 0x0000.0060).
5. Enable the UART by setting the `UARTEN` bit in the **UARTCTL** register.

## 10.5 Register Map

Table 10-3 on page 355 lists the UART registers. The offset listed is a hexadecimal increment to the register’s address, relative to that UART’s base address:

- UART0: 0x4000.C000

Note that the UART module clock must be enabled before the registers can be programmed (see page 201). There must be a delay of 3 system clocks after the UART module clock is enabled before any UART module registers are accessed.

**Note:** The UART must be disabled (see the `UARTEN` bit in the **UARTCTL** register on page 368) before any of the control registers are reprogrammed. When the UART is disabled during a TX or RX operation, the current transaction is completed prior to the UART stopping.

**Table 10-3. UART Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	UARTDR	R/W	0x0000.0000	UART Data	357
0x004	UARTSR/UARTECR	R/W	0x0000.0000	UART Receive Status/Error Clear	359
0x018	UARTFR	RO	0x0000.0090	UART Flag	361
0x020	UARTILPR	R/W	0x0000.0000	UART IrDA Low-Power Register	363
0x024	UARTIBRD	R/W	0x0000.0000	UART Integer Baud-Rate Divisor	364
0x028	UARTFBRD	R/W	0x0000.0000	UART Fractional Baud-Rate Divisor	365
0x02C	UARTLCRH	R/W	0x0000.0000	UART Line Control	366
0x030	UARTCTL	R/W	0x0000.0300	UART Control	368

Table 10-3. UART Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x034	UARTIFLS	R/W	0x0000.0012	UART Interrupt FIFO Level Select	370
0x038	UARTIM	R/W	0x0000.0000	UART Interrupt Mask	372
0x03C	UARTRIS	RO	0x0000.0000	UART Raw Interrupt Status	374
0x040	UARTMIS	RO	0x0000.0000	UART Masked Interrupt Status	375
0x044	UARTICR	W1C	0x0000.0000	UART Interrupt Clear	376
0xFD0	UARTPeriphID4	RO	0x0000.0000	UART Peripheral Identification 4	378
0xFD4	UARTPeriphID5	RO	0x0000.0000	UART Peripheral Identification 5	379
0xFD8	UARTPeriphID6	RO	0x0000.0000	UART Peripheral Identification 6	380
0xFDC	UARTPeriphID7	RO	0x0000.0000	UART Peripheral Identification 7	381
0xFE0	UARTPeriphID0	RO	0x0000.0011	UART Peripheral Identification 0	382
0xFE4	UARTPeriphID1	RO	0x0000.0000	UART Peripheral Identification 1	383
0xFE8	UARTPeriphID2	RO	0x0000.0018	UART Peripheral Identification 2	384
0xFEC	UARTPeriphID3	RO	0x0000.0001	UART Peripheral Identification 3	385
0xFF0	UARTPCellID0	RO	0x0000.000D	UART PrimeCell Identification 0	386
0xFF4	UARTPCellID1	RO	0x0000.00F0	UART PrimeCell Identification 1	387
0xFF8	UARTPCellID2	RO	0x0000.0005	UART PrimeCell Identification 2	388
0xFFC	UARTPCellID3	RO	0x0000.00B1	UART PrimeCell Identification 3	389

## 10.6 Register Descriptions

The remainder of this section lists and describes the UART registers, in numerical order by address offset.

## Register 1: UART Data (UARTDR), offset 0x000

**Important:** This register is read-sensitive. See the register description for details.

This register is the data register (the interface to the FIFOs).

When FIFOs are enabled, data written to this location is pushed onto the transmit FIFO. If FIFOs are disabled, data is stored in the transmitter holding register (the bottom word of the transmit FIFO). A write to this register initiates a transmission from the UART.

For received data, if the FIFO is enabled, the data byte and the 4-bit status (break, frame, parity, and overrun) is pushed onto the 12-bit wide receive FIFO. If FIFOs are disabled, the data byte and status are stored in the receiving holding register (the bottom word of the receive FIFO). The received data can be retrieved by reading this register.

### UART Data (UARTDR)

UART0 base: 0x4000.C000

Offset 0x000

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				OE	BE	PE	FE	DATA							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description						
31:12	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.						
11	OE	RO	0	UART Overrun Error The OE values are defined as follows:  <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>There has been no data loss due to a FIFO overrun.</td> </tr> <tr> <td>1</td> <td>New data was received when the FIFO was full, resulting in data loss.</td> </tr> </tbody> </table>	Value	Description	0	There has been no data loss due to a FIFO overrun.	1	New data was received when the FIFO was full, resulting in data loss.
Value	Description									
0	There has been no data loss due to a FIFO overrun.									
1	New data was received when the FIFO was full, resulting in data loss.									
10	BE	RO	0	UART Break Error This bit is set to 1 when a break condition is detected, indicating that the receive data input was held Low for longer than a full-word transmission time (defined as start, data, parity, and stop bits). In FIFO mode, this error is associated with the character at the top of the FIFO. When a break occurs, only one 0 character is loaded into the FIFO. The next character is only enabled after the received data input goes to a 1 (marking state) and the next valid start bit is received.						

Bit/Field	Name	Type	Reset	Description
9	PE	RO	0	<b>UART Parity Error</b> This bit is set to 1 when the parity of the received data character does not match the parity defined by bits 2 and 7 of the <b>UARTLCRH</b> register. In FIFO mode, this error is associated with the character at the top of the FIFO.
8	FE	RO	0	<b>UART Framing Error</b> This bit is set to 1 when the received character does not have a valid stop bit (a valid stop bit is 1).
7:0	DATA	R/W	0	<b>Data Transmitted or Received</b> When written, the data that is to be transmitted via the UART. When read, the data that was received by the UART.

## Register 2: UART Receive Status/Error Clear (UARTRSR/UARTECR), offset 0x004

The **UARTRSR/UARTECR** register is the receive status register/error clear register.

In addition to the **UARTDR** register, receive status can also be read from the **UARTRSR** register. If the status is read from this register, then the status information corresponds to the entry read from **UARTDR** prior to reading **UARTRSR**. The status information for overrun is set immediately when an overrun condition occurs.

The **UARTRSR** register cannot be written.

A write of any value to the **UARTECR** register clears the framing, parity, break, and overrun errors. All the bits are cleared to 0 on reset.

### Reads

#### UART Receive Status/Error Clear (UARTRSR/UARTECR)

UART0 base: 0x4000.C000

Offset 0x004

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved													OE	BE	PE	FE
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

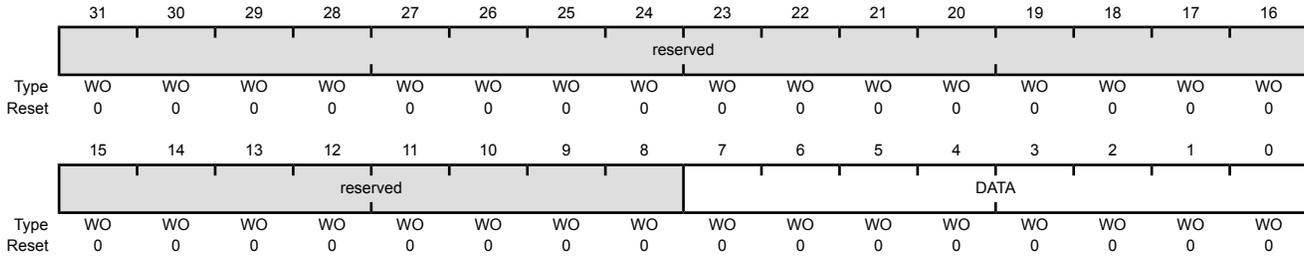
Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	OE	RO	0	<p>UART Overrun Error</p> <p>When this bit is set to 1, data is received and the FIFO is already full. This bit is cleared to 0 by a write to <b>UARTECR</b>.</p> <p>The FIFO contents remain valid since no further data is written when the FIFO is full, only the contents of the shift register are overwritten. The CPU must now read the data in order to empty the FIFO.</p>
2	BE	RO	0	<p>UART Break Error</p> <p>This bit is set to 1 when a break condition is detected, indicating that the received data input was held Low for longer than a full-word transmission time (defined as start, data, parity, and stop bits).</p> <p>This bit is cleared to 0 by a write to <b>UARTECR</b>.</p> <p>In FIFO mode, this error is associated with the character at the top of the FIFO. When a break occurs, only one 0 character is loaded into the FIFO. The next character is only enabled after the receive data input goes to a 1 (marking state) and the next valid start bit is received.</p>

Bit/Field	Name	Type	Reset	Description
1	PE	RO	0	<p>UART Parity Error</p> <p>This bit is set to 1 when the parity of the received data character does not match the parity defined by bits 2 and 7 of the <b>UARTLCRH</b> register. This bit is cleared to 0 by a write to <b>UARTECR</b>.</p>
0	FE	RO	0	<p>UART Framing Error</p> <p>This bit is set to 1 when the received character does not have a valid stop bit (a valid stop bit is 1). This bit is cleared to 0 by a write to <b>UARTECR</b>.</p> <p>In FIFO mode, this error is associated with the character at the top of the FIFO.</p>

**Writes**

UART Receive Status/Error Clear (UARTRSR/UARTECR)

UART0 base: 0x4000.C000  
 Offset 0x004  
 Type WO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	WO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DATA	WO	0	<p>Error Clear</p> <p>A write to this register of any data clears the framing, parity, break, and overrun flags.</p>

### Register 3: UART Flag (UARTFR), offset 0x018

The **UARTFR** register is the flag register. After reset, the **TXFF**, **RXFF**, and **BUSY** bits are 0, and **TXFE** and **RXFE** bits are 1.

#### UART Flag (UARTFR)

UART0 base: 0x4000.C000

Offset 0x018

Type RO, reset 0x0000.0090

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								TXFE	RXFF	TXFF	RXFE	BUSY	reserved		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7	TXFE	RO	1	UART Transmit FIFO Empty The meaning of this bit depends on the state of the <b>FEN</b> bit in the <b>UARTLCRH</b> register. If the FIFO is disabled ( <b>FEN</b> is 0), this bit is set when the transmit holding register is empty. If the FIFO is enabled ( <b>FEN</b> is 1), this bit is set when the transmit FIFO is empty.
6	RXFF	RO	0	UART Receive FIFO Full The meaning of this bit depends on the state of the <b>FEN</b> bit in the <b>UARTLCRH</b> register. If the FIFO is disabled, this bit is set when the receive holding register is full. If the FIFO is enabled, this bit is set when the receive FIFO is full.
5	TXFF	RO	0	UART Transmit FIFO Full The meaning of this bit depends on the state of the <b>FEN</b> bit in the <b>UARTLCRH</b> register. If the FIFO is disabled, this bit is set when the transmit holding register is full. If the FIFO is enabled, this bit is set when the transmit FIFO is full.
4	RXFE	RO	1	UART Receive FIFO Empty The meaning of this bit depends on the state of the <b>FEN</b> bit in the <b>UARTLCRH</b> register. If the FIFO is disabled, this bit is set when the receive holding register is empty. If the FIFO is enabled, this bit is set when the receive FIFO is empty.

Bit/Field	Name	Type	Reset	Description
3	BUSY	RO	0	<p>UART Busy</p> <p>When this bit is 1, the UART is busy transmitting data. This bit remains set until the complete byte, including all stop bits, has been sent from the shift register.</p> <p>This bit is set as soon as the transmit FIFO becomes non-empty (regardless of whether UART is enabled).</p>
2:0	reserved	RO	0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>

## Register 4: UART IrDA Low-Power Register (UARTILPR), offset 0x020

The **UARTILPR** register is an 8-bit read/write register that stores the low-power counter divisor value used to derive the low-power SIR pulse width clock by dividing down the system clock (SysClk). All the bits are cleared to 0 when reset.

The internal  $F_{IrLPBaud16}$  clock is generated by dividing down SysClk according to the low-power divisor value written to **UARTILPR**. The duration of SIR pulses generated when low-power mode is enabled is three times the period of the  $F_{IrLPBaud16}$  clock. The low-power divisor value is calculated as follows:

$$ILPDVSR = SysClk / F_{IrLPBaud16}$$

where  $F_{IrLPBaud16}$  is nominally 1.8432 MHz.

You must choose the divisor so that  $1.42 \text{ MHz} < F_{IrLPBaud16} < 2.12 \text{ MHz}$ , which results in a low-power pulse duration of 1.41–2.11  $\mu\text{s}$  (three times the period of  $F_{IrLPBaud16}$ ). The minimum frequency of  $F_{IrLPBaud16}$  ensures that pulses less than one period of  $F_{IrLPBaud16}$  are rejected, but that pulses greater than 1.4  $\mu\text{s}$  are accepted as valid pulses.

**Note:** Zero is an illegal value. Programming a zero value results in no  $F_{IrLPBaud16}$  pulses being generated.

### UART IrDA Low-Power Register (UARTILPR)

UART0 base: 0x4000.C000  
Offset 0x020  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								ILPDVSR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

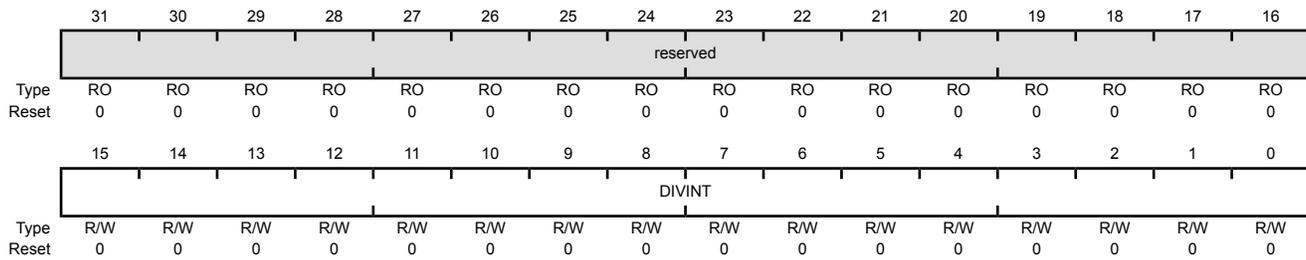
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	ILPDVSR	R/W	0x00	IrDA Low-Power Divisor This is an 8-bit low-power divisor value.

### Register 5: UART Integer Baud-Rate Divisor (UARTIBRD), offset 0x024

The **UARTIBRD** register is the integer part of the baud-rate divisor value. All the bits are cleared on reset. The minimum possible divide ratio is 1 (when **UARTIBRD**=0), in which case the **UARTFBRD** register is ignored. When changing the **UARTIBRD** register, the new value does not take effect until transmission/reception of the current character is complete. Any changes to the baud-rate divisor must be followed by a write to the **UARTLCRH** register. See “Baud-Rate Generation” on page 350 for configuration details.

#### UART Integer Baud-Rate Divisor (UARTIBRD)

UART0 base: 0x4000.C000  
 Offset 0x024  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	DIVINT	R/W	0x0000	Integer Baud-Rate Divisor

## Register 6: UART Fractional Baud-Rate Divisor (UARTFBRD), offset 0x028

The **UARTFBRD** register is the fractional part of the baud-rate divisor value. All the bits are cleared on reset. When changing the **UARTFBRD** register, the new value does not take effect until transmission/reception of the current character is complete. Any changes to the baud-rate divisor must be followed by a write to the **UARTLCRH** register. See “Baud-Rate Generation” on page 350 for configuration details.

### UART Fractional Baud-Rate Divisor (UARTFBRD)

UART0 base: 0x4000.C000  
Offset 0x028  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved										DIVFRAC					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:0	DIVFRAC	R/W	0x000	Fractional Baud-Rate Divisor

## Register 7: UART Line Control (UARTLCRH), offset 0x02C

The **UARTLCRH** register is the line control register. Serial parameters such as data length, parity, and stop bit selection are implemented in this register.

When updating the baud-rate divisor (**UARTIBRD** and/or **UARTIFRD**), the **UARTLCRH** register must also be written. The write strobe for the baud-rate divisor registers is tied to the **UARTLCRH** register.

### UART Line Control (UARTLCRH)

UART0 base: 0x4000.C000  
Offset 0x02C  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								SPS	WLEN		FEN	STP2	EPS	PEN	BRK
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description										
31:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
7	SPS	R/W	0	<p>UART Stick Parity Select</p> <p>When bits 1, 2, and 7 of <b>UARTLCRH</b> are set, the parity bit is transmitted and checked as a 0. When bits 1 and 7 are set and 2 is cleared, the parity bit is transmitted and checked as a 1.</p> <p>When this bit is cleared, stick parity is disabled.</p>										
6:5	WLEN	R/W	0	<p>UART Word Length</p> <p>The bits indicate the number of data bits transmitted or received in a frame as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x3</td> <td>8 bits</td> </tr> <tr> <td>0x2</td> <td>7 bits</td> </tr> <tr> <td>0x1</td> <td>6 bits</td> </tr> <tr> <td>0x0</td> <td>5 bits (default)</td> </tr> </tbody> </table>	Value	Description	0x3	8 bits	0x2	7 bits	0x1	6 bits	0x0	5 bits (default)
Value	Description													
0x3	8 bits													
0x2	7 bits													
0x1	6 bits													
0x0	5 bits (default)													
4	FEN	R/W	0	<p>UART Enable FIFOs</p> <p>If this bit is set to 1, transmit and receive FIFO buffers are enabled (FIFO mode).</p> <p>When cleared to 0, FIFOs are disabled (Character mode). The FIFOs become 1-byte-deep holding registers.</p>										
3	STP2	R/W	0	<p>UART Two Stop Bits Select</p> <p>If this bit is set to 1, two stop bits are transmitted at the end of a frame. The receive logic does not check for two stop bits being received.</p>										

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Bit/Field	Name	Type	Reset	Description
2	EPS	R/W	0	<p>UART Even Parity Select</p> <p>If this bit is set to 1, even parity generation and checking is performed during transmission and reception, which checks for an even number of 1s in data and parity bits.</p> <p>When cleared to 0, then odd parity is performed, which checks for an odd number of 1s.</p> <p>This bit has no effect when parity is disabled by the PEN bit.</p>
1	PEN	R/W	0	<p>UART Parity Enable</p> <p>If this bit is set to 1, parity checking and generation is enabled; otherwise, parity is disabled and no parity bit is added to the data frame.</p>
0	BRK	R/W	0	<p>UART Send Break</p> <p>If this bit is set to 1, a Low level is continually output on the UnTX output, after completing transmission of the current character. For the proper execution of the break command, the software must set this bit for at least two frames (character periods). For normal use, this bit must be cleared to 0.</p>

### Register 8: UART Control (UARTCTL), offset 0x030

The **UARTCTL** register is the control register. All the bits are cleared on reset except for the Transmit Enable (TXE) and Receive Enable (RXE) bits, which are set to 1.

To enable the UART module, the **UARTEN** bit must be set to 1. If software requires a configuration change in the module, the **UARTEN** bit must be cleared before the configuration changes are written. If the UART is disabled during a transmit or receive operation, the current transaction is completed prior to the UART stopping.

**Note:** The **UARTCTL** register should not be changed while the UART is enabled or else the results are unpredictable. The following sequence is recommended for making changes to the **UARTCTL** register.

1. Disable the UART.
2. Wait for the end of transmission or reception of the current character.
3. Flush the transmit FIFO by disabling bit 4 (**FEN**) in the line control register (**UARTLCRH**).
4. Reprogram the control register.
5. Enable the UART.

#### UART Control (UARTCTL)

UART0 base: 0x4000.C000  
 Offset 0x030  
 Type R/W, reset 0x0000.0300

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved						RXE	TXE	LBE	reserved				SIRLP	SIREN	UARTEN
Type	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	RO	RO	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:10	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
9	RXE	R/W	1	UART Receive Enable  If this bit is set to 1, the receive section of the UART is enabled. When the UART is disabled in the middle of a receive, it completes the current character before stopping.  <b>Note:</b> To enable reception, the <b>UARTEN</b> bit must also be set.
8	TXE	R/W	1	UART Transmit Enable  If this bit is set to 1, the transmit section of the UART is enabled. When the UART is disabled in the middle of a transmission, it completes the current character before stopping.  <b>Note:</b> To enable transmission, the <b>UARTEN</b> bit must also be set.

Bit/Field	Name	Type	Reset	Description
7	LBE	R/W	0	UART Loop Back Enable If this bit is set to 1, the $U_nTX$ path is fed through the $U_nRX$ path.
6:3	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2	SIRLP	R/W	0	UART SIR Low Power Mode This bit selects the IrDA encoding mode. If this bit is cleared to 0, low-level bits are transmitted as an active High pulse with a width of 3/16th of the bit period. If this bit is set to 1, low-level bits are transmitted with a pulse width which is 3 times the period of the $I_rLPBaud16$ input signal, regardless of the selected bit rate. Setting this bit uses less power, but might reduce transmission distances. See page 363 for more information.
1	SIREN	R/W	0	UART SIR Enable If this bit is set to 1, the IrDA SIR block is enabled, and the UART will transmit and receive data using SIR protocol.
0	UARTEN	R/W	0	UART Enable If this bit is set to 1, the UART is enabled. When the UART is disabled in the middle of transmission or reception, it completes the current character before stopping.

### Register 9: UART Interrupt FIFO Level Select (UARTIFLS), offset 0x034

The **UARTIFLS** register is the interrupt FIFO level select register. You can use this register to define the FIFO level at which the **TXRIS** and **RXRIS** bits in the **UARTRIS** register are triggered.

The interrupts are generated based on a transition through a level rather than being based on the level. That is, the interrupts are generated when the fill level progresses through the trigger level. For example, if the receive trigger level is set to the half-way mark, the interrupt is triggered as the module is receiving the 9th character.

Out of reset, the **TXIFLSEL** and **RXIFLSEL** bits are configured so that the FIFOs trigger an interrupt at the half-way mark.

#### UART Interrupt FIFO Level Select (UARTIFLS)

UART0 base: 0x4000.C000  
 Offset 0x034  
 Type R/W, reset 0x0000.0012

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved										RXIFLSEL			TXIFLSEL		
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

5:3	RXIFLSEL	R/W	0x2	UART Receive Interrupt FIFO Level Select The trigger points for the receive interrupt are as follows:
-----	----------	-----	-----	--

Value	Description
0x0	RX FIFO $\geq \frac{1}{8}$ full
0x1	RX FIFO $\geq \frac{1}{4}$ full
0x2	RX FIFO $\geq \frac{1}{2}$ full (default)
0x3	RX FIFO $\geq \frac{3}{4}$ full
0x4	RX FIFO $\geq \frac{7}{8}$ full
0x5-0x7	Reserved

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Bit/Field	Name	Type	Reset	Description
2:0	TXIFLSEL	R/W	0x2	UART Transmit Interrupt FIFO Level Select The trigger points for the transmit interrupt are as follows:  Value    Description 0x0    TX FIFO $\leq$ $\frac{1}{8}$ empty 0x1    TX FIFO $\leq$ $\frac{3}{4}$ empty 0x2    TX FIFO $\leq$ $\frac{1}{2}$ empty (default) 0x3    TX FIFO $\leq$ $\frac{1}{4}$ empty 0x4    TX FIFO $\leq$ $\frac{1}{8}$ empty 0x5-0x7 Reserved

## Register 10: UART Interrupt Mask (UARTIM), offset 0x038

The **UARTIM** register is the interrupt mask set/clear register.

On a read, this register gives the current value of the mask on the relevant interrupt. Writing a 1 to a bit allows the corresponding raw interrupt signal to be routed to the interrupt controller. Writing a 0 prevents the raw interrupt signal from being sent to the interrupt controller.

### UART Interrupt Mask (UARTIM)

UART0 base: 0x4000.C000  
 Offset 0x038  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved					OEIM	BEIM	PEIM	FEIM	RTIM	TXIM	RXIM	reserved			
Type	RO	RO	RO	RO	RO	R/W	RO	RO	RO	RO						
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	OEIM	R/W	0	UART Overrun Error Interrupt Mask On a read, the current mask for the <b>OEIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>OEIM</b> interrupt to the interrupt controller.
9	BEIM	R/W	0	UART Break Error Interrupt Mask On a read, the current mask for the <b>BEIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>BEIM</b> interrupt to the interrupt controller.
8	PEIM	R/W	0	UART Parity Error Interrupt Mask On a read, the current mask for the <b>PEIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>PEIM</b> interrupt to the interrupt controller.
7	FEIM	R/W	0	UART Framing Error Interrupt Mask On a read, the current mask for the <b>FEIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>FEIM</b> interrupt to the interrupt controller.
6	RTIM	R/W	0	UART Receive Time-Out Interrupt Mask On a read, the current mask for the <b>RTIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>RTIM</b> interrupt to the interrupt controller.
5	TXIM	R/W	0	UART Transmit Interrupt Mask On a read, the current mask for the <b>TXIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>TXIM</b> interrupt to the interrupt controller.
4	RXIM	R/W	0	UART Receive Interrupt Mask On a read, the current mask for the <b>RXIM</b> interrupt is returned. Setting this bit to 1 promotes the <b>RXIM</b> interrupt to the interrupt controller.

Bit/Field	Name	Type	Reset	Description
3:0	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 11: UART Raw Interrupt Status (UARTRIS), offset 0x03C

The **UARTRIS** register is the raw interrupt status register. On a read, this register gives the current raw status value of the corresponding interrupt. A write has no effect.

### UART Raw Interrupt Status (UARTRIS)

UART0 base: 0x4000.C000

Offset 0x03C

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				OERIS	BERIS	PERIS	FERIS	RTRIS	TXRIS	RXRIS	reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	OERIS	RO	0	UART Overrun Error Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
9	BERIS	RO	0	UART Break Error Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
8	PERIS	RO	0	UART Parity Error Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
7	FERIS	RO	0	UART Framing Error Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
6	RTRIS	RO	0	UART Receive Time-Out Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
5	TXRIS	RO	0	UART Transmit Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
4	RXRIS	RO	0	UART Receive Raw Interrupt Status Gives the raw interrupt state (prior to masking) of this interrupt.
3:0	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

**Register 12: UART Masked Interrupt Status (UARTMIS), offset 0x040**

The **UARTMIS** register is the masked interrupt status register. On a read, this register gives the current masked status value of the corresponding interrupt. A write has no effect.

**UART Masked Interrupt Status (UARTMIS)**

UART0 base: 0x4000.C000

Offset 0x040

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				OEMIS	BEMIS	PEMIS	FEMIS	RTMIS	TXMIS	RXMIS	reserved				
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	OEMIS	RO	0	UART Overrun Error Masked Interrupt Status Gives the masked interrupt state of this interrupt.
9	BEMIS	RO	0	UART Break Error Masked Interrupt Status Gives the masked interrupt state of this interrupt.
8	PEMIS	RO	0	UART Parity Error Masked Interrupt Status Gives the masked interrupt state of this interrupt.
7	FEMIS	RO	0	UART Framing Error Masked Interrupt Status Gives the masked interrupt state of this interrupt.
6	RTMIS	RO	0	UART Receive Time-Out Masked Interrupt Status Gives the masked interrupt state of this interrupt.
5	TXMIS	RO	0	UART Transmit Masked Interrupt Status Gives the masked interrupt state of this interrupt.
4	RXMIS	RO	0	UART Receive Masked Interrupt Status Gives the masked interrupt state of this interrupt.
3:0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

### Register 13: UART Interrupt Clear (UARTICR), offset 0x044

The **UARTICR** register is the interrupt clear register. On a write of 1, the corresponding interrupt (both raw interrupt and masked interrupt, if enabled) is cleared. A write of 0 has no effect.

#### UART Interrupt Clear (UARTICR)

UART0 base: 0x4000.C000  
 Offset 0x044  
 Type W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved					OEIC	BEIC	PEIC	FEIC	RTIC	TXIC	RXIC	reserved			
Type	RO	RO	RO	RO	RO	W1C	RO	RO	RO	RO						
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
10	OEIC	W1C	0	Overrun Error Interrupt Clear The <b>OEIC</b> values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
9	BEIC	W1C	0	Break Error Interrupt Clear The <b>BEIC</b> values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
8	PEIC	W1C	0	Parity Error Interrupt Clear The <b>PEIC</b> values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
7	FEIC	W1C	0	Framing Error Interrupt Clear The <b>FEIC</b> values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.

Bit/Field	Name	Type	Reset	Description
6	RTIC	W1C	0	Receive Time-Out Interrupt Clear The RTIC values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
5	TXIC	W1C	0	Transmit Interrupt Clear The TXIC values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
4	RXIC	W1C	0	Receive Interrupt Clear The RXIC values are defined as follows:  Value Description 0 No effect on the interrupt. 1 Clears interrupt.
3:0	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

### Register 14: UART Peripheral Identification 4 (UARTPeriphID4), offset 0xFD0

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

#### UART Peripheral Identification 4 (UARTPeriphID4)

UART0 base: 0x4000.C000

Offset 0xFD0

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID4							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID4	RO	0x0000	UART Peripheral ID Register[7:0] Can be used by software to identify the presence of this peripheral.

**Register 15: UART Peripheral Identification 5 (UARTPeriphID5), offset 0xFD4**

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART Peripheral Identification 5 (UARTPeriphID5)

UART0 base: 0x4000.C000

Offset 0xFD4

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID5							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID5	RO	0x0000	UART Peripheral ID Register[15:8] Can be used by software to identify the presence of this peripheral.

### Register 16: UART Peripheral Identification 6 (UARTPeriphID6), offset 0xFD8

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

#### UART Peripheral Identification 6 (UARTPeriphID6)

UART0 base: 0x4000.C000

Offset 0xFD8

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID6							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID6	RO	0x0000	UART Peripheral ID Register[23:16] Can be used by software to identify the presence of this peripheral.

**Register 17: UART Peripheral Identification 7 (UARTPeriphID7), offset 0xFDC**

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART Peripheral Identification 7 (UARTPeriphID7)

UART0 base: 0x4000.C000

Offset 0xFDC

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID7							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID7	RO	0x0000	UART Peripheral ID Register[31:24] Can be used by software to identify the presence of this peripheral.

### Register 18: UART Peripheral Identification 0 (UARTPeriphID0), offset 0xFE0

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

#### UART Peripheral Identification 0 (UARTPeriphID0)

UART0 base: 0x4000.C000

Offset 0xFE0

Type RO, reset 0x0000.0011

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID0							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID0	RO	0x11	UART Peripheral ID Register[7:0] Can be used by software to identify the presence of this peripheral.

**Register 19: UART Peripheral Identification 1 (UARTPeriphID1), offset 0xFE4**

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART Peripheral Identification 1 (UARTPeriphID1)

UART0 base: 0x4000.C000

Offset 0xFE4

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID1	RO	0x00	UART Peripheral ID Register[15:8] Can be used by software to identify the presence of this peripheral.

## Register 20: UART Peripheral Identification 2 (UARTPeriphID2), offset 0xFE8

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

### UART Peripheral Identification 2 (UARTPeriphID2)

UART0 base: 0x4000.C000

Offset 0xFE8

Type RO, reset 0x0000.0018

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID2							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID2	RO	0x18	UART Peripheral ID Register[23:16] Can be used by software to identify the presence of this peripheral.

**Register 21: UART Peripheral Identification 3 (UARTPeriphID3), offset 0xFEC**

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART Peripheral Identification 3 (UARTPeriphID3)

UART0 base: 0x4000.C000

Offset 0xFEC

Type RO, reset 0x0000.0001

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

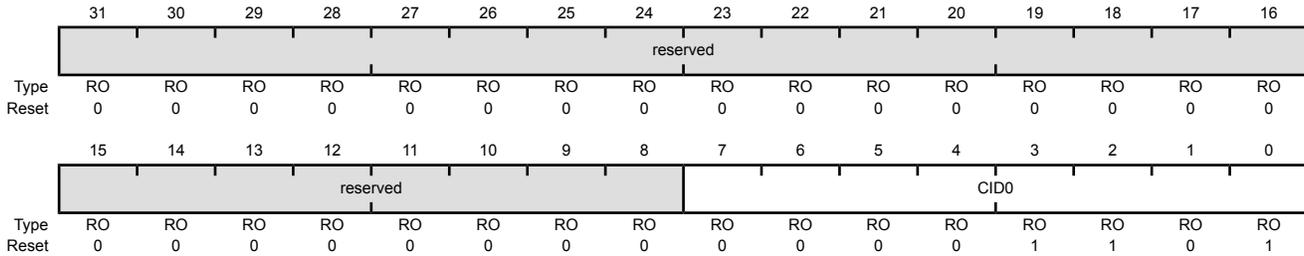
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID3	RO	0x01	UART Peripheral ID Register[31:24] Can be used by software to identify the presence of this peripheral.

### Register 22: UART PrimeCell Identification 0 (UARTPCIID0), offset 0xFF0

The **UARTPCIIDn** registers are hard-coded and the fields within the registers determine the reset values.

#### UART PrimeCell Identification 0 (UARTPCIID0)

UART0 base: 0x4000.C000  
 Offset 0xFF0  
 Type RO, reset 0x0000.000D



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID0	RO	0x0D	UART PrimeCell ID Register[7:0] Provides software a standard cross-peripheral identification system.

**Register 23: UART PrimeCell Identification 1 (UARTPCellID1), offset 0xFF4**

The **UARTPCellIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART PrimeCell Identification 1 (UARTPCellID1)

UART0 base: 0x4000.C000

Offset 0xFF4

Type RO, reset 0x0000.00F0

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID1	RO	0xF0	UART PrimeCell ID Register[15:8] Provides software a standard cross-peripheral identification system.

### Register 24: UART PrimeCell Identification 2 (UARTPCellID2), offset 0xFF8

The **UARTPCellIDn** registers are hard-coded and the fields within the registers determine the reset values.

#### UART PrimeCell Identification 2 (UARTPCellID2)

UART0 base: 0x4000.C000

Offset 0xFF8

Type RO, reset 0x0000.0005

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID2							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID2	RO	0x05	UART PrimeCell ID Register[23:16] Provides software a standard cross-peripheral identification system.

**Register 25: UART PrimeCell Identification 3 (UARTPCelIID3), offset 0xFFC**

The **UARTPCelIIDn** registers are hard-coded and the fields within the registers determine the reset values.

## UART PrimeCell Identification 3 (UARTPCelIID3)

UART0 base: 0x4000.C000

Offset 0xFFC

Type RO, reset 0x0000.00B1

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID3	RO	0xB1	UART PrimeCell ID Register[31:24] Provides software a standard cross-peripheral identification system.

# 11 Synchronous Serial Interface (SSI)

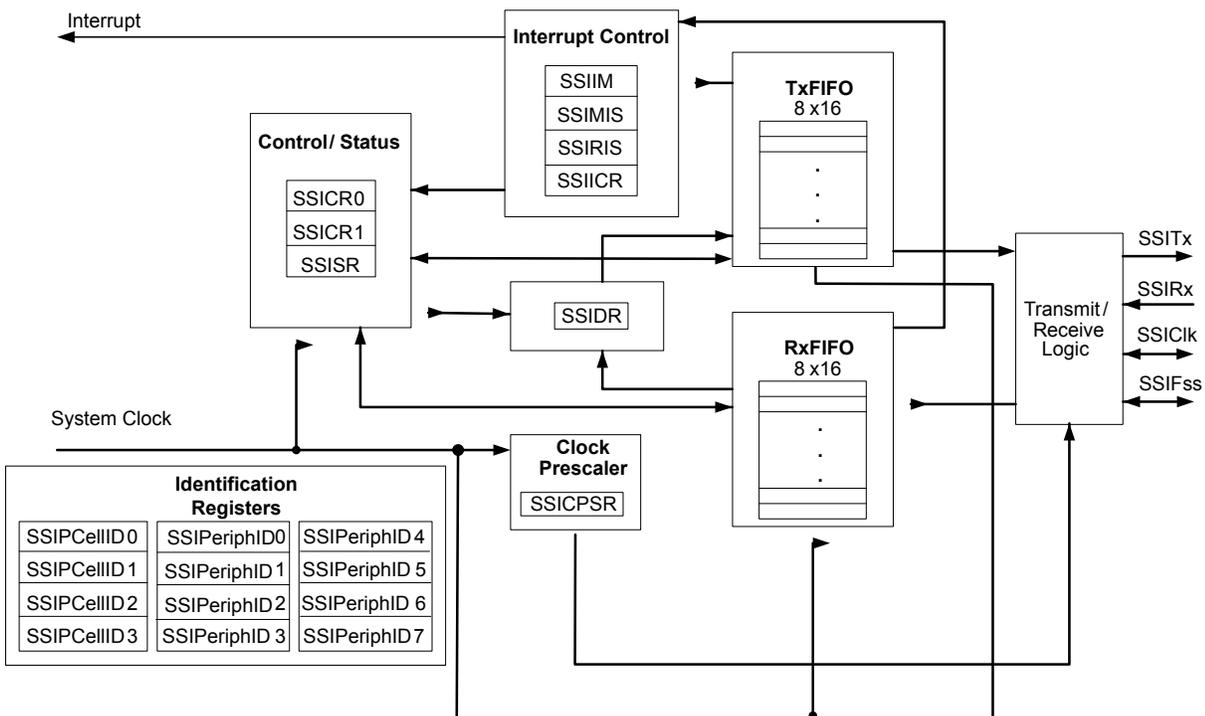
The Stellaris<sup>®</sup> Synchronous Serial Interface (SSI) is a master or slave interface for synchronous serial communication with peripheral devices that have either Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces.

The Stellaris SSI module has the following features:

- Master or slave operation
- Programmable clock bit rate and prescale
- Separate transmit and receive FIFOs, 16 bits wide, 8 locations deep
- Programmable interface operation for Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces
- Programmable data frame size from 4 to 16 bits
- Internal loopback test mode for diagnostic/debug testing

## 11.1 Block Diagram

Figure 11-1. SSI Module Block Diagram



## 11.2 Signal Description

Table 11-1 on page 391 and Table 11-2 on page 391 list the external signals of the SSI module and describe the function of each. The SSI signals are alternate functions for some GPIO signals and

default to be GPIO signals at reset., with the exception of the SSI0Clk, SSI0Fss, SSI0Rx, and SSI0Tx pins which default to the SSI function. The column in the table below titled "Pin Assignment" lists the possible GPIO pin placements for the SSI signals. The AFSEL bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the SSI function. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 243.

**Table 11-1. SSI Signals (100LQFP)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
SSI0Clk	28	I/O	TTL	SSI module 0 clock.
SSI0Fss	29	I/O	TTL	SSI module 0 frame signal.
SSI0Rx	30	I	TTL	SSI module 0 receive.
SSI0Tx	31	O	TTL	SSI module 0 transmit.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

**Table 11-2. SSI Signals (108BGA)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
SSI0Clk	M4	I/O	TTL	SSI module 0 clock.
SSI0Fss	L4	I/O	TTL	SSI module 0 frame signal.
SSI0Rx	L5	I	TTL	SSI module 0 receive.
SSI0Tx	M5	O	TTL	SSI module 0 transmit.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 11.3 Functional Description

The SSI performs serial-to-parallel conversion on data received from a peripheral device. The CPU accesses data, control, and status information. The transmit and receive paths are buffered with internal FIFO memories allowing up to eight 16-bit values to be stored independently in both transmit and receive modes.

### 11.3.1 Bit Rate Generation

The SSI includes a programmable bit rate clock divider and prescaler to generate the serial output clock. Bit rates are supported to 2 MHz and higher, although maximum bit rate is determined by peripheral devices.

The serial bit rate is derived by dividing down the input clock (FSysClk). The clock is first divided by an even prescale value CPSDVSR from 2 to 254, which is programmed in the **SSI Clock Prescale (SSICPSR)** register (see page 410). The clock is further divided by a value from 1 to 256, which is  $1 + SCR$ , where SCR is the value programmed in the **SSI Control0 (SSICR0)** register (see page 403).

The frequency of the output clock SSI0Clk is defined by:

$$SSI0Clk = F_{SysClk} / (CPSDVSR * (1 + SCR))$$

**Note:** For master mode, the system clock must be at least two times faster than the SSI0Clk. For slave mode, the system clock must be at least 12 times faster than the SSI0Clk.

See "Synchronous Serial Interface (SSI)" on page 522 to view SSI timing parameters.

## 11.3.2 FIFO Operation

### 11.3.2.1 Transmit FIFO

The common transmit FIFO is a 16-bit wide, 8-locations deep, first-in, first-out memory buffer. The CPU writes data to the FIFO by writing the **SSI Data (SSIDR)** register (see page 407), and data is stored in the FIFO until it is read out by the transmission logic.

When configured as a master or a slave, parallel data is written into the transmit FIFO prior to serial conversion and transmission to the attached slave or master, respectively, through the **SSIT<sub>x</sub>** pin.

In slave mode, the SSI transmits data each time the master initiates a transaction. If the transmit FIFO is empty and the master initiates, the slave transmits the 8th most recent value in the transmit FIFO. If less than 8 values have been written to the transmit FIFO since the SSI module clock was enabled using the **SSI** bit in the **RGCG1** register, then 0 is transmitted. Care should be taken to ensure that valid data is in the FIFO as needed. The SSI can be configured to generate an interrupt when the FIFO is empty.

### 11.3.2.2 Receive FIFO

The common receive FIFO is a 16-bit wide, 8-locations deep, first-in, first-out memory buffer. Received data from the serial interface is stored in the buffer until read out by the CPU, which accesses the read FIFO by reading the **SSIDR** register.

When configured as a master or slave, serial data received through the **SSIR<sub>x</sub>** pin is registered prior to parallel loading into the attached slave or master receive FIFO, respectively.

## 11.3.3 Interrupts

The SSI can generate interrupts when the following conditions are observed:

- Transmit FIFO service
- Receive FIFO service
- Receive FIFO time-out
- Receive FIFO overrun

All of the interrupt events are ORed together before being sent to the interrupt controller, so the SSI can only generate a single interrupt request to the controller at any given time. You can mask each of the four individual maskable interrupts by setting the appropriate bits in the **SSI Interrupt Mask (SSIIM)** register (see page 411). Setting the appropriate mask bit to 1 enables the interrupt.

Provision of the individual outputs, as well as a combined interrupt output, allows use of either a global interrupt service routine, or modular device drivers to handle interrupts. The transmit and receive dynamic dataflow interrupts have been separated from the status interrupts so that data can be read or written in response to the FIFO trigger levels. The status of the individual interrupt sources can be read from the **SSI Raw Interrupt Status (SSIRIS)** and **SSI Masked Interrupt Status (SSIMIS)** registers (see page 413 and page 414, respectively).

## 11.3.4 Frame Formats

Each data frame is between 4 and 16 bits long, depending on the size of data programmed, and is transmitted starting with the MSB. There are three basic frame types that can be selected:

- Texas Instruments synchronous serial

- Freescale SPI
- MICROWIRE

For all three formats, the serial clock ( $SSIClk$ ) is held inactive while the SSI is idle, and  $SSIClk$  transitions at the programmed frequency only during active transmission or reception of data. The idle state of  $SSIClk$  is utilized to provide a receive timeout indication that occurs when the receive FIFO still contains data after a timeout period.

For Freescale SPI and MICROWIRE frame formats, the serial frame ( $SSIFss$ ) pin is active Low, and is asserted (pulled down) during the entire transmission of the frame.

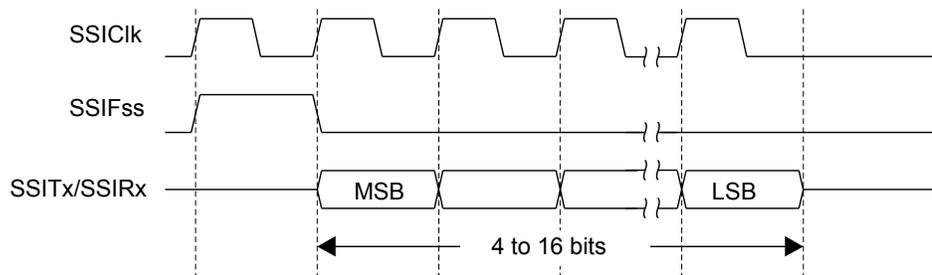
For Texas Instruments synchronous serial frame format, the  $SSIFss$  pin is pulsed for one serial clock period starting at its rising edge, prior to the transmission of each frame. For this frame format, both the SSI and the off-chip slave device drive their output data on the rising edge of  $SSIClk$ , and latch data from the other device on the falling edge.

Unlike the full-duplex transmission of the other two frame formats, the MICROWIRE format uses a special master-slave messaging technique, which operates at half-duplex. In this mode, when a frame begins, an 8-bit control message is transmitted to the off-chip slave. During this transmit, no incoming data is received by the SSI. After the message has been sent, the off-chip slave decodes it and, after waiting one serial clock after the last bit of the 8-bit control message has been sent, responds with the requested data. The returned data can be 4 to 16 bits in length, making the total frame length anywhere from 13 to 25 bits.

#### 11.3.4.1 Texas Instruments Synchronous Serial Frame Format

Figure 11-2 on page 393 shows the Texas Instruments synchronous serial frame format for a single transmitted frame.

**Figure 11-2. TI Synchronous Serial Frame Format (Single Transfer)**

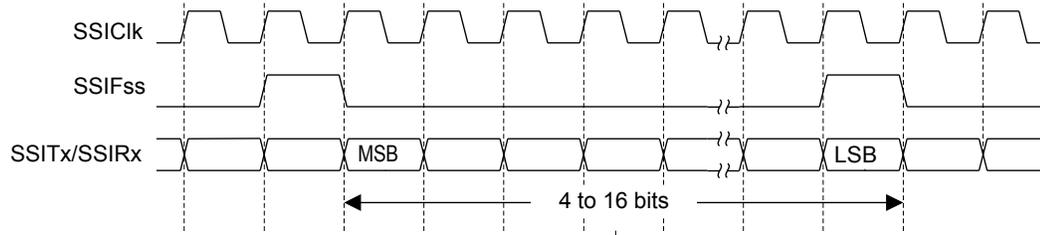


In this mode,  $SSIClk$  and  $SSIFss$  are forced Low, and the transmit data line  $SSITx$  is tristated whenever the SSI is idle. Once the bottom entry of the transmit FIFO contains data,  $SSIFss$  is pulsed High for one  $SSIClk$  period. The value to be transmitted is also transferred from the transmit FIFO to the serial shift register of the transmit logic. On the next rising edge of  $SSIClk$ , the MSB of the 4 to 16-bit data frame is shifted out on the  $SSITx$  pin. Likewise, the MSB of the received data is shifted onto the  $SSIRx$  pin by the off-chip serial slave device.

Both the SSI and the off-chip serial slave device then clock each data bit into their serial shifter on the falling edge of each  $SSIClk$ . The received data is transferred from the serial shifter to the receive FIFO on the first rising edge of  $SSIClk$  after the LSB has been latched.

Figure 11-3 on page 394 shows the Texas Instruments synchronous serial frame format when back-to-back frames are transmitted.

Figure 11-3. TI Synchronous Serial Frame Format (Continuous Transfer)



#### 11.3.4.2 Freescale SPI Frame Format

The Freescale SPI interface is a four-wire interface where the `SSIFss` signal behaves as a slave select. The main feature of the Freescale SPI format is that the inactive state and phase of the `SSIClk` signal are programmable through the `SPO` and `SPH` bits within the `SSISCR0` control register.

##### *SPO Clock Polarity Bit*

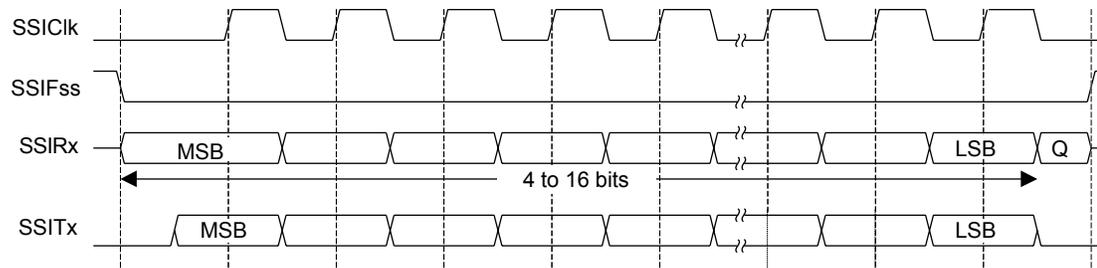
When the `SPO` clock polarity control bit is Low, it produces a steady state Low value on the `SSIClk` pin. If the `SPO` bit is High, a steady state High value is placed on the `SSIClk` pin when data is not being transferred.

##### *SPH Phase Control Bit*

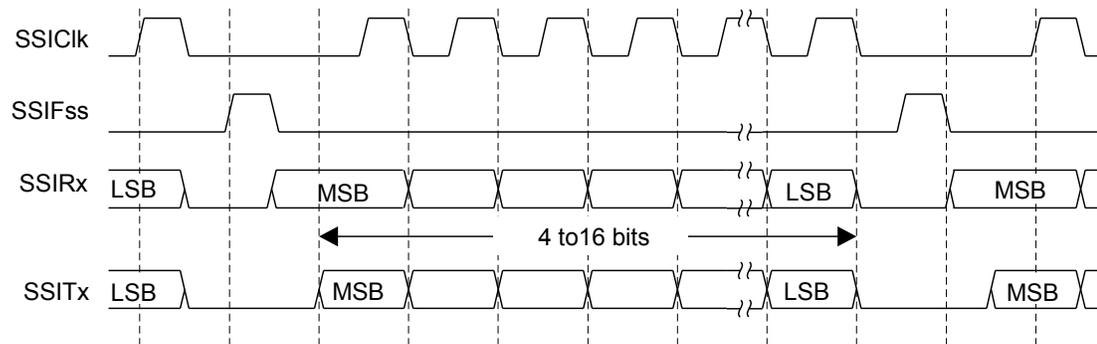
The `SPH` phase control bit selects the clock edge that captures data and allows it to change state. It has the most impact on the first bit transmitted by either allowing or not allowing a clock transition before the first data capture edge. When the `SPH` phase control bit is Low, data is captured on the first clock edge transition. If the `SPH` bit is High, data is captured on the second clock edge transition.

#### 11.3.4.3 Freescale SPI Frame Format with `SPO=0` and `SPH=0`

Single and continuous transmission signal sequences for Freescale SPI format with `SPO=0` and `SPH=0` are shown in Figure 11-4 on page 394 and Figure 11-5 on page 395.

Figure 11-4. Freescale SPI Format (Single Transfer) with `SPO=0` and `SPH=0`

Note: Q is undefined.

**Figure 11-5. Freescale SPI Format (Continuous Transfer) with SPO=0 and SPH=0**

In this configuration, during idle periods:

- SSIClk is forced Low
- SSIFss is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and there is valid data within the transmit FIFO, the start of transmission is signified by the SSIFss master signal being driven Low. This causes slave data to be enabled onto the SSIRx input line of the master. The master SSITx output pad is enabled.

One half SSIClk period later, valid master data is transferred to the SSITx pin. Now that both the master and slave data have been set, the SSIClk master clock pin goes High after one further half SSIClk period.

The data is now captured on the rising and propagated on the falling edges of the SSIClk signal.

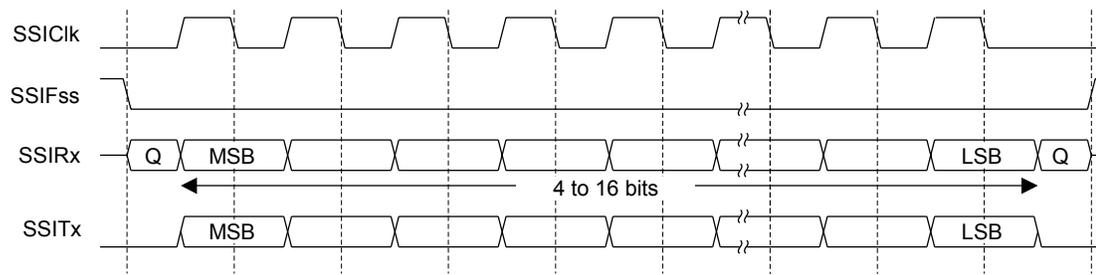
In the case of a single word transmission, after all bits of the data word have been transferred, the SSIFss line is returned to its idle High state one SSIClk period after the last bit has been captured.

However, in the case of continuous back-to-back transmissions, the SSIFss signal must be pulsed High between each data word transfer. This is because the slave select pin freezes the data in its serial peripheral register and does not allow it to be altered if the SPH bit is logic zero. Therefore, the master device must raise the SSIFss pin of the slave device between each data transfer to enable the serial peripheral data write. On completion of the continuous transfer, the SSIFss pin is returned to its idle state one SSIClk period after the last bit has been captured.

#### 11.3.4.4 Freescale SPI Frame Format with SPO=0 and SPH=1

The transfer signal sequence for Freescale SPI format with SPO=0 and SPH=1 is shown in Figure 11-6 on page 396, which covers both single and continuous transfers.

**Figure 11-6. Freescale SPI Frame Format with SPO=0 and SPH=1**



**Note:** Q is undefined.

In this configuration, during idle periods:

- SSIClk is forced Low
- SSIFss is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and there is valid data within the transmit FIFO, the start of transmission is signified by the SSIFss master signal being driven Low. The master SSITx output is enabled. After a further one half SSIClk period, both master and slave valid data is enabled onto their respective transmission lines. At the same time, the SSIClk is enabled with a rising edge transition.

Data is then captured on the falling edges and propagated on the rising edges of the SSIClk signal.

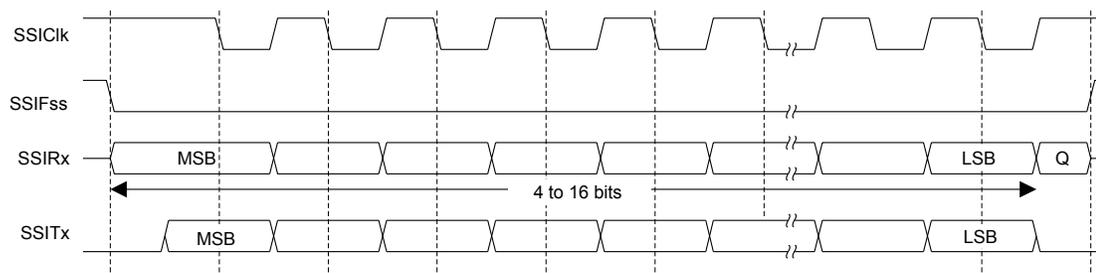
In the case of a single word transfer, after all bits have been transferred, the SSIFss line is returned to its idle High state one SSIClk period after the last bit has been captured.

For continuous back-to-back transfers, the SSIFss pin is held Low between successive data words and termination is the same as that of the single word transfer.

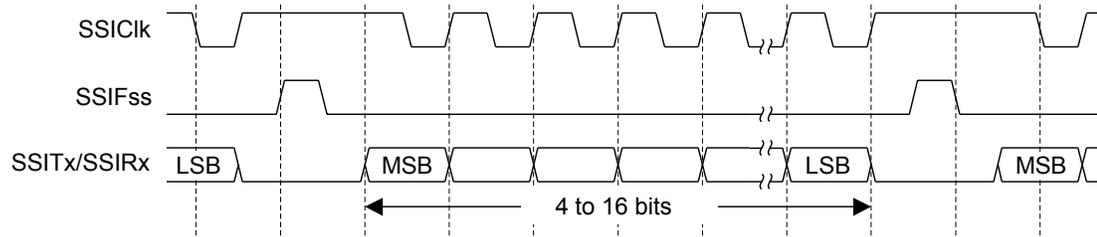
#### 11.3.4.5 Freescale SPI Frame Format with SPO=1 and SPH=0

Single and continuous transmission signal sequences for Freescale SPI format with SPO=1 and SPH=0 are shown in Figure 11-7 on page 396 and Figure 11-8 on page 397.

**Figure 11-7. Freescale SPI Frame Format (Single Transfer) with SPO=1 and SPH=0**



**Note:** Q is undefined.

**Figure 11-8. Freescale SPI Frame Format (Continuous Transfer) with SPO=1 and SPH=0**

In this configuration, during idle periods:

- SSIClk is forced High
- SSIFss is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and there is valid data within the transmit FIFO, the start of transmission is signified by the SSIFss master signal being driven Low, which causes slave data to be immediately transferred onto the SSIRx line of the master. The master SSITx output pad is enabled.

One half period later, valid master data is transferred to the SSITx line. Now that both the master and slave data have been set, the SSIClk master clock pin becomes Low after one further half SSIClk period. This means that data is captured on the falling edges and propagated on the rising edges of the SSIClk signal.

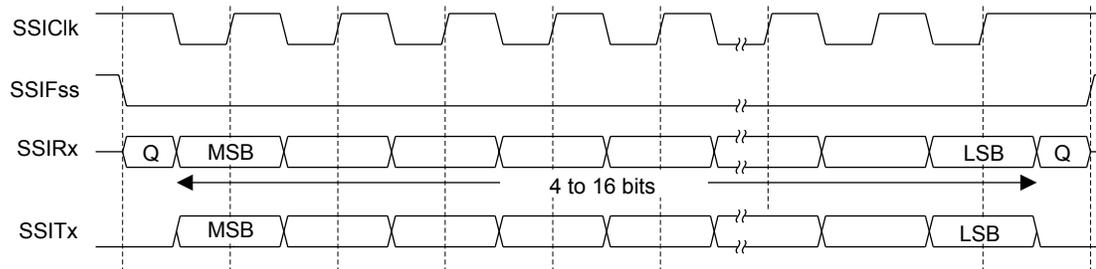
In the case of a single word transmission, after all bits of the data word are transferred, the SSIFss line is returned to its idle High state one SSIClk period after the last bit has been captured.

However, in the case of continuous back-to-back transmissions, the SSIFss signal must be pulsed High between each data word transfer. This is because the slave select pin freezes the data in its serial peripheral register and does not allow it to be altered if the SPH bit is logic zero. Therefore, the master device must raise the SSIFss pin of the slave device between each data transfer to enable the serial peripheral data write. On completion of the continuous transfer, the SSIFss pin is returned to its idle state one SSIClk period after the last bit has been captured.

#### 11.3.4.6 Freescale SPI Frame Format with SPO=1 and SPH=1

The transfer signal sequence for Freescale SPI format with SPO=1 and SPH=1 is shown in Figure 11-9 on page 398, which covers both single and continuous transfers.

**Figure 11-9. Freescale SPI Frame Format with SPO=1 and SPH=1**



**Note:** Q is undefined.

In this configuration, during idle periods:

- SSIClk is forced High
- SSIFss is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and there is valid data within the transmit FIFO, the start of transmission is signified by the SSIFss master signal being driven Low. The master SSITx output pad is enabled. After a further one-half SSIClk period, both master and slave data are enabled onto their respective transmission lines. At the same time, SSIClk is enabled with a falling edge transition. Data is then captured on the rising edges and propagated on the falling edges of the SSIClk signal.

After all bits have been transferred, in the case of a single word transmission, the SSIFss line is returned to its idle high state one SSIClk period after the last bit has been captured.

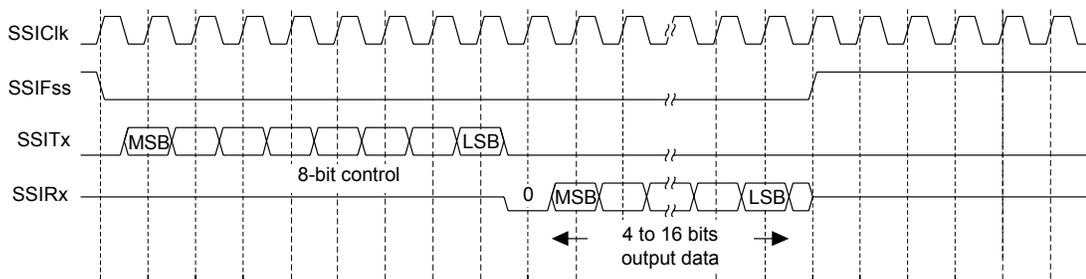
For continuous back-to-back transmissions, the SSIFss pin remains in its active Low state, until the final bit of the last word has been captured, and then returns to its idle state as described above.

For continuous back-to-back transfers, the SSIFss pin is held Low between successive data words and termination is the same as that of the single word transfer.

### 11.3.4.7 MICROWIRE Frame Format

Figure 11-10 on page 398 shows the MICROWIRE frame format, again for a single frame. Figure 11-11 on page 399 shows the same format when back-to-back frames are transmitted.

**Figure 11-10. MICROWIRE Frame Format (Single Frame)**



MICROWIRE format is very similar to SPI format, except that transmission is half-duplex instead of full-duplex, using a master-slave message passing technique. Each serial transmission begins with an 8-bit control word that is transmitted from the SSI to the off-chip slave device. During this transmission, no incoming data is received by the SSI. After the message has been sent, the off-chip slave decodes it and, after waiting one serial clock after the last bit of the 8-bit control message has been sent, responds with the required data. The returned data is 4 to 16 bits in length, making the total frame length anywhere from 13 to 25 bits.

In this configuration, during idle periods:

- SSIClk is forced Low
- SSIFss is forced High
- The transmit data line SSITx is arbitrarily forced Low

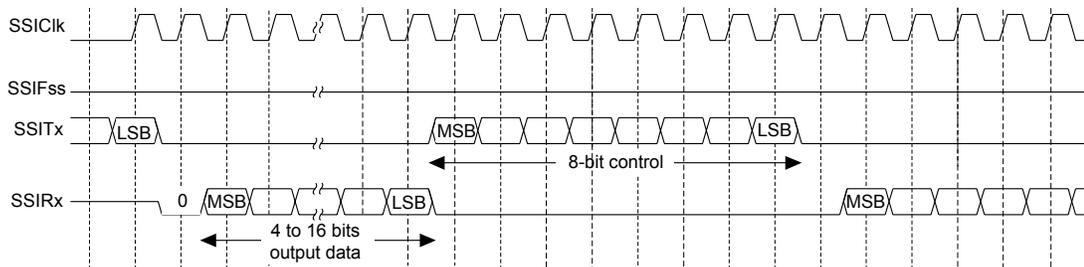
A transmission is triggered by writing a control byte to the transmit FIFO. The falling edge of SSIFss causes the value contained in the bottom entry of the transmit FIFO to be transferred to the serial shift register of the transmit logic, and the MSB of the 8-bit control frame to be shifted out onto the SSITx pin. SSIFss remains Low for the duration of the frame transmission. The SSIRx pin remains tristated during this transmission.

The off-chip serial slave device latches each control bit into its serial shifter on the rising edge of each SSIClk. After the last bit is latched by the slave device, the control byte is decoded during a one clock wait-state, and the slave responds by transmitting data back to the SSI. Each bit is driven onto the SSIRx line on the falling edge of SSIClk. The SSI in turn latches each bit on the rising edge of SSIClk. At the end of the frame, for single transfers, the SSIFss signal is pulled High one clock period after the last bit has been latched in the receive serial shifter, which causes the data to be transferred to the receive FIFO.

**Note:** The off-chip slave device can tristate the receive line either on the falling edge of SSIClk after the LSB has been latched by the receive shifter, or when the SSIFss pin goes High.

For continuous transfers, data transmission begins and ends in the same manner as a single transfer. However, the SSIFss line is continuously asserted (held Low) and transmission of data occurs back-to-back. The control byte of the next frame follows directly after the LSB of the received data from the current frame. Each of the received values is transferred from the receive shifter on the falling edge of SSIClk, after the LSB of the frame has been latched into the SSI.

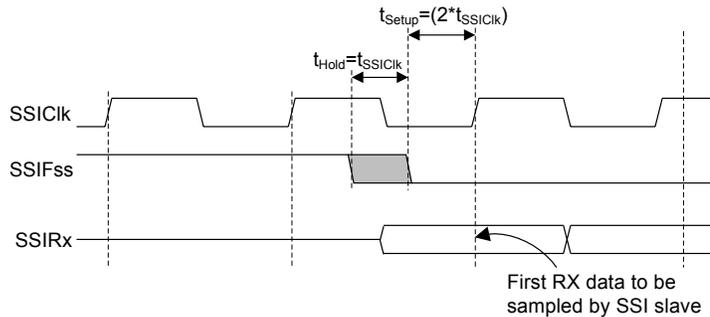
**Figure 11-11. MICROWIRE Frame Format (Continuous Transfer)**



In the MICROWIRE mode, the SSI slave samples the first bit of receive data on the rising edge of SSIClk after SSIFss has gone Low. Masters that drive a free-running SSIClk must ensure that the SSIFss signal has sufficient setup and hold margins with respect to the rising edge of SSIClk.

Figure 11-12 on page 400 illustrates these setup and hold time requirements. With respect to the  $SSIClk$  rising edge on which the first bit of receive data is to be sampled by the SSI slave,  $SSIFss$  must have a setup of at least two times the period of  $SSIClk$  on which the SSI operates. With respect to the  $SSIClk$  rising edge previous to this edge,  $SSIFss$  must have a hold of at least one  $SSIClk$  period.

**Figure 11-12. MICROWIRE Frame Format, SSIFss Input Setup and Hold Requirements**



## 11.4 Initialization and Configuration

To use the SSI, its peripheral clock must be enabled by setting the  $SSI$  bit in the **RCGC1** register.

For each of the frame formats, the SSI is configured using the following steps:

1. Ensure that the  $SSE$  bit in the **SSICR1** register is disabled before making any configuration changes.
2. Select whether the SSI is a master or slave:
  - a. For master operations, set the **SSICR1** register to 0x0000.0000.
  - b. For slave mode (output enabled), set the **SSICR1** register to 0x0000.0004.
  - c. For slave mode (output disabled), set the **SSICR1** register to 0x0000.000C.
3. Configure the clock prescale divisor by writing the **SSICPSR** register.
4. Write the **SSICR0** register with the following configuration:
  - Serial clock rate ( $SCR$ )
  - Desired clock phase/polarity, if using Freescale SPI mode ( $SPH$  and  $SPO$ )
  - The protocol mode: Freescale SPI, TI SSF, MICROWIRE ( $FRF$ )
  - The data size ( $DSS$ )
5. Enable the SSI by setting the  $SSE$  bit in the **SSICR1** register.

As an example, assume the SSI must be configured to operate with the following parameters:

- Master operation

- Freescale SPI mode (SPO=1, SPH=1)
- 1 Mbps bit rate
- 8 data bits

Assuming the system clock is 20 MHz, the bit rate calculation would be:

$$F_{SSIClk} = F_{SysClk} / (CPSDVSR * (1 + SCR))$$

$$1 \times 10^6 = 20 \times 10^6 / (CPSDVSR * (1 + SCR))$$

In this case, if CPSDVSR=2, SCR must be 9.

The configuration sequence would be as follows:

1. Ensure that the SSE bit in the **SSICR1** register is disabled.
2. Write the **SSICR1** register with a value of 0x0000.0000.
3. Write the **SSICPSR** register with a value of 0x0000.0002.
4. Write the **SSICR0** register with a value of 0x0000.09C7.
5. The SSI is then enabled by setting the SSE bit in the **SSICR1** register to 1.

## 11.5 Register Map

Table 11-3 on page 401 lists the SSI registers. The offset listed is a hexadecimal increment to the register's address, relative to that SSI module's base address:

- SSI0: 0x4000.8000

Note that the SSI module clock must be enabled before the registers can be programmed (see page 201). There must be a delay of 3 system clocks after the SSI module clock is enabled before any SSI module registers are accessed.

**Note:** The SSI must be disabled (see the SSE bit in the **SSICR1** register) before any of the control registers are reprogrammed.

**Table 11-3. SSI Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	SSICR0	R/W	0x0000.0000	SSI Control 0	403
0x004	SSICR1	R/W	0x0000.0000	SSI Control 1	405
0x008	SSIDR	R/W	0x0000.0000	SSI Data	407
0x00C	SSISR	RO	0x0000.0003	SSI Status	408
0x010	SSICPSR	R/W	0x0000.0000	SSI Clock Prescale	410
0x014	SSIIM	R/W	0x0000.0000	SSI Interrupt Mask	411
0x018	SSIRIS	RO	0x0000.0008	SSI Raw Interrupt Status	413
0x01C	SSIMIS	RO	0x0000.0000	SSI Masked Interrupt Status	414

Table 11-3. SSI Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x020	SSIICR	W1C	0x0000.0000	SSI Interrupt Clear	415
0xFD0	SSIPeriphID4	RO	0x0000.0000	SSI Peripheral Identification 4	416
0xFD4	SSIPeriphID5	RO	0x0000.0000	SSI Peripheral Identification 5	417
0xFD8	SSIPeriphID6	RO	0x0000.0000	SSI Peripheral Identification 6	418
0xFDC	SSIPeriphID7	RO	0x0000.0000	SSI Peripheral Identification 7	419
0xFE0	SSIPeriphID0	RO	0x0000.0022	SSI Peripheral Identification 0	420
0xFE4	SSIPeriphID1	RO	0x0000.0000	SSI Peripheral Identification 1	421
0xFE8	SSIPeriphID2	RO	0x0000.0018	SSI Peripheral Identification 2	422
0xFEC	SSIPeriphID3	RO	0x0000.0001	SSI Peripheral Identification 3	423
0xFF0	SSIPCellID0	RO	0x0000.000D	SSI PrimeCell Identification 0	424
0xFF4	SSIPCellID1	RO	0x0000.00F0	SSI PrimeCell Identification 1	425
0xFF8	SSIPCellID2	RO	0x0000.0005	SSI PrimeCell Identification 2	426
0xFFC	SSIPCellID3	RO	0x0000.00B1	SSI PrimeCell Identification 3	427

## 11.6 Register Descriptions

The remainder of this section lists and describes the SSI registers, in numerical order by address offset.

## Register 1: SSI Control 0 (SSICR0), offset 0x000

**SSICR0** is control register 0 and contains bit fields that control various functions within the SSI module. Functionality such as protocol mode, clock rate, and data size are configured in this register.

### SSI Control 0 (SSICR0)

SSI0 base: 0x4000.8000  
Offset 0x000  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	SCR								SPH	SPO	FRF		DSS			
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:8	SCR	R/W	0x0000	SSI Serial Clock Rate The value <i>SCR</i> is used to generate the transmit and receive bit rate of the SSI. The bit rate is: $BR = F_{SSIClk} / (CPSDVSR * (1 + SCR))$ where <i>CPSDVSR</i> is an even value from 2-254 programmed in the <b>SSICPSR</b> register, and <i>SCR</i> is a value from 0-255.
7	SPH	R/W	0	SSI Serial Clock Phase This bit is only applicable to the Freescale SPI Format. The <i>SPH</i> control bit selects the clock edge that captures data and allows it to change state. It has the most impact on the first bit transmitted by either allowing or not allowing a clock transition before the first data capture edge. When the <i>SPH</i> bit is 0, data is captured on the first clock edge transition. If <i>SPH</i> is 1, data is captured on the second clock edge transition.
6	SPO	R/W	0	SSI Serial Clock Polarity This bit is only applicable to the Freescale SPI Format. When the <i>SPO</i> bit is 0, it produces a steady state Low value on the <i>SSIClk</i> pin. If <i>SPO</i> is 1, a steady state High value is placed on the <i>SSIClk</i> pin when data is not being transferred.
5:4	FRF	R/W	0x0	SSI Frame Format Select The <i>FRF</i> values are defined as follows:  Value    Frame Format 0x0    Freescale SPI Frame Format 0x1    Texas Instruments Synchronous Serial Frame Format 0x2    MICROWIRE Frame Format 0x3    Reserved

Bit/Field	Name	Type	Reset	Description
3:0	DSS	R/W	0x00	SSI Data Size Select The DSS values are defined as follows:  Value    Data Size 0x0-0x2    Reserved 0x3    4-bit data 0x4    5-bit data 0x5    6-bit data 0x6    7-bit data 0x7    8-bit data 0x8    9-bit data 0x9    10-bit data 0xA    11-bit data 0xB    12-bit data 0xC    13-bit data 0xD    14-bit data 0xE    15-bit data 0xF    16-bit data

## Register 2: SSI Control 1 (SSICR1), offset 0x004

**SSICR1** is control register 1 and contains bit fields that control various functions within the SSI module. Master and slave mode functionality is controlled by this register.

### SSI Control 1 (SSICR1)

SSI0 base: 0x4000.8000  
Offset 0x004  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												SOD	MS	SSE	LBM	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	SOD	R/W	0	SSI Slave Mode Output Disable This bit is relevant only in the Slave mode ( $MS=1$ ). In multiple-slave systems, it is possible for the SSI master to broadcast a message to all slaves in the system while ensuring that only one slave drives data onto the serial output line. In such systems, the TXD lines from multiple slaves could be tied together. To operate in such a system, the SOD bit can be configured so that the SSI slave does not drive the SSITx pin. The SOD values are defined as follows:  Value Description 0 SSI can drive SSITx output in Slave Output mode. 1 SSI must not drive the SSITx output in Slave mode.
2	MS	R/W	0	SSI Master/Slave Select This bit selects Master or Slave mode and can be modified only when SSI is disabled ( $SSE=0$ ). The MS values are defined as follows:  Value Description 0 Device configured as a master. 1 Device configured as a slave.

Bit/Field	Name	Type	Reset	Description						
1	SSE	R/W	0	<p>SSI Synchronous Serial Port Enable Setting this bit enables SSI operation. The <code>SSE</code> values are defined as follows:</p> <table border="1"><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>SSI operation disabled.</td></tr><tr><td>1</td><td>SSI operation enabled.</td></tr></tbody></table> <p><b>Note:</b> This bit must be set to 0 before any control registers are reprogrammed.</p>	Value	Description	0	SSI operation disabled.	1	SSI operation enabled.
Value	Description									
0	SSI operation disabled.									
1	SSI operation enabled.									
0	LBM	R/W	0	<p>SSI Loopback Mode Setting this bit enables Loopback Test mode. The <code>LBM</code> values are defined as follows:</p> <table border="1"><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>Normal serial port operation enabled.</td></tr><tr><td>1</td><td>Output of the transmit serial shift register is connected internally to the input of the receive serial shift register.</td></tr></tbody></table>	Value	Description	0	Normal serial port operation enabled.	1	Output of the transmit serial shift register is connected internally to the input of the receive serial shift register.
Value	Description									
0	Normal serial port operation enabled.									
1	Output of the transmit serial shift register is connected internally to the input of the receive serial shift register.									

### Register 3: SSI Data (SSIDR), offset 0x008

**Important:** This register is read-sensitive. See the register description for details.

**SSIDR** is the data register and is 16-bits wide. When **SSIDR** is read, the entry in the receive FIFO (pointed to by the current FIFO read pointer) is accessed. As data values are removed by the SSI receive logic from the incoming data frame, they are placed into the entry in the receive FIFO (pointed to by the current FIFO write pointer).

When **SSIDR** is written to, the entry in the transmit FIFO (pointed to by the write pointer) is written to. Data values are removed from the transmit FIFO one value at a time by the transmit logic. It is loaded into the transmit serial shifter, then serially shifted out onto the **SSITx** pin at the programmed bit rate.

When a data size of less than 16 bits is selected, the user must right-justify data written to the transmit FIFO. The transmit logic ignores the unused bits. Received data less than 16 bits is automatically right-justified in the receive buffer.

When the SSI is programmed for MICROWIRE frame format, the default size for transmit data is eight bits (the most significant byte is ignored). The receive data size is controlled by the programmer. The transmit FIFO and the receive FIFO are not cleared even when the **SSE** bit in the **SSICR1** register is set to zero. This allows the software to fill the transmit FIFO before enabling the SSI.

#### SSI Data (SSIDR)

SSI0 base: 0x4000.8000  
Offset 0x008  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DATA															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	DATA	R/W	0x0000	SSI Receive/Transmit Data A read operation reads the receive FIFO. A write operation writes the transmit FIFO. Software must right-justify data when the SSI is programmed for a data size that is less than 16 bits. Unused bits at the top are ignored by the transmit logic. The receive logic automatically right-justifies the data.

**Register 4: SSI Status (SSISR), offset 0x00C**

**SSISR** is a status register that contains bits that indicate the FIFO fill status and the SSI busy status.

**SSI Status (SSISR)**

SSI0 base: 0x4000.8000

Offset 0x00C

Type RO, reset 0x0000.0003

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												BSY	RFF	RNE	TNF	TFE
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	

Bit/Field	Name	Type	Reset	Description
31:5	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	BSY	RO	0	SSI Busy Bit The <b>BSY</b> values are defined as follows:  Value Description 0 SSI is idle. 1 SSI is currently transmitting and/or receiving a frame, or the transmit FIFO is not empty.
3	RFF	RO	0	SSI Receive FIFO Full The <b>RFF</b> values are defined as follows:  Value Description 0 Receive FIFO is not full. 1 Receive FIFO is full.
2	RNE	RO	0	SSI Receive FIFO Not Empty The <b>RNE</b> values are defined as follows:  Value Description 0 Receive FIFO is empty. 1 Receive FIFO is not empty.
1	TNF	RO	1	SSI Transmit FIFO Not Full The <b>TNF</b> values are defined as follows:  Value Description 0 Transmit FIFO is full. 1 Transmit FIFO is not full.

---

Bit/Field	Name	Type	Reset	Description
0	TFE	R0	1	SSI Transmit FIFO Empty The TFE values are defined as follows:  Value Description 0 Transmit FIFO is not empty. 1 Transmit FIFO is empty.

**Register 5: SSI Clock Prescale (SSICPSR), offset 0x010**

**SSICPSR** is the clock prescale register and specifies the division factor by which the system clock must be internally divided before further use.

The value programmed into this register must be an even number between 2 and 254. The least-significant bit of the programmed number is hard-coded to zero. If an odd number is written to this register, data read back from this register has the least-significant bit as zero.

## SSI Clock Prescale (SSICPSR)

SSI0 base: 0x4000.8000  
Offset 0x010  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CPSDVSR							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CPSDVSR	R/W	0x00	SSI Clock Prescale Divisor This value must be an even number from 2 to 254, depending on the frequency of SSI0CLK. The LSB always returns 0 on reads.

## Register 6: SSI Interrupt Mask (SSIIM), offset 0x014

The **SSIIM** register is the interrupt mask set or clear register. It is a read/write register and all bits are cleared to 0 on reset.

On a read, this register gives the current value of the mask on the relevant interrupt. A write of 1 to the particular bit sets the mask, enabling the interrupt to be read. A write of 0 clears the corresponding mask.

### SSI Interrupt Mask (SSIIM)

SSI0 base: 0x4000.8000  
Offset 0x014  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												TXIM	RXIM	RTIM	RORIM	
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	TXIM	R/W	0	SSI Transmit FIFO Interrupt Mask The <b>TXIM</b> values are defined as follows:  Value Description 0 TX FIFO half-empty or less condition interrupt is masked. 1 TX FIFO half-empty or less condition interrupt is not masked.
2	RXIM	R/W	0	SSI Receive FIFO Interrupt Mask The <b>RXIM</b> values are defined as follows:  Value Description 0 RX FIFO half-full or more condition interrupt is masked. 1 RX FIFO half-full or more condition interrupt is not masked.
1	RTIM	R/W	0	SSI Receive Time-Out Interrupt Mask The <b>RTIM</b> values are defined as follows:  Value Description 0 RX FIFO time-out interrupt is masked. 1 RX FIFO time-out interrupt is not masked.

Bit/Field	Name	Type	Reset	Description
0	RORIM	R/W	0	SSI Receive Overrun Interrupt Mask The RORIM values are defined as follows:  Value Description 0 RX FIFO overrun interrupt is masked. 1 RX FIFO overrun interrupt is not masked.

## Register 7: SSI Raw Interrupt Status (SSIRIS), offset 0x018

The **SSIRIS** register is the raw interrupt status register. On a read, this register gives the current raw status value of the corresponding interrupt prior to masking. A write has no effect.

### SSI Raw Interrupt Status (SSIRIS)

SSI0 base: 0x4000.8000  
Offset 0x018  
Type RO, reset 0x0000.0008

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved												TXRIS	RXRIS	RTRIS	RORRIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	TXRIS	RO	1	SSI Transmit FIFO Raw Interrupt Status Indicates that the transmit FIFO is half empty or less, when set.
2	RXRIS	RO	0	SSI Receive FIFO Raw Interrupt Status Indicates that the receive FIFO is half full or more, when set.
1	RTRIS	RO	0	SSI Receive Time-Out Raw Interrupt Status Indicates that the receive time-out has occurred, when set.
0	RORRIS	RO	0	SSI Receive Overrun Raw Interrupt Status Indicates that the receive FIFO has overflowed, when set.

**Register 8: SSI Masked Interrupt Status (SSIMIS), offset 0x01C**

The **SSIMIS** register is the masked interrupt status register. On a read, this register gives the current masked status value of the corresponding interrupt. A write has no effect.

## SSI Masked Interrupt Status (SSIMIS)

SSI0 base: 0x4000.8000

Offset 0x01C

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved												TXMIS	RXMIS	RTMIS	RORMIS
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:4	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3	TXMIS	RO	0	SSI Transmit FIFO Masked Interrupt Status Indicates that the transmit FIFO is half empty or less, when set.
2	RXMIS	RO	0	SSI Receive FIFO Masked Interrupt Status Indicates that the receive FIFO is half full or more, when set.
1	RTMIS	RO	0	SSI Receive Time-Out Masked Interrupt Status Indicates that the receive time-out has occurred, when set.
0	RORMIS	RO	0	SSI Receive Overrun Masked Interrupt Status Indicates that the receive FIFO has overflowed, when set.

## Register 9: SSI Interrupt Clear (SSIICR), offset 0x020

The **SSIICR** register is the interrupt clear register. On a write of 1, the corresponding interrupt is cleared. A write of 0 has no effect.

### SSI Interrupt Clear (SSIICR)

SSI0 base: 0x4000.8000  
Offset 0x020  
Type W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved														RTIC	RORIC
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	W1C	W1C
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

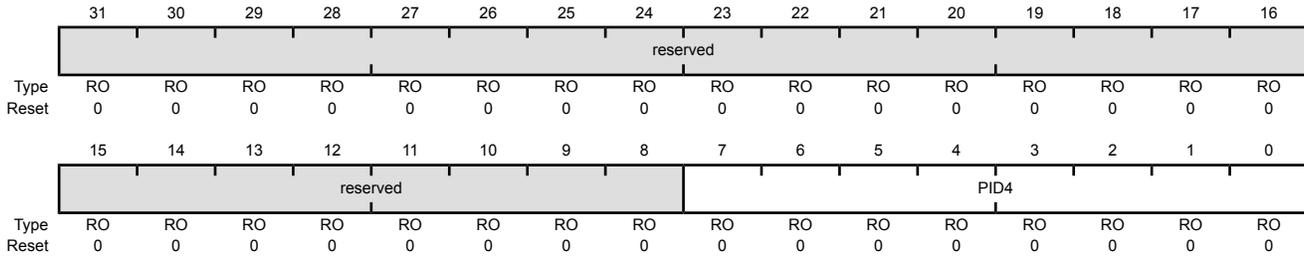
Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	RTIC	W1C	0	SSI Receive Time-Out Interrupt Clear The <b>RTIC</b> values are defined as follows:  Value Description 0 No effect on interrupt. 1 Clears interrupt.
0	RORIC	W1C	0	SSI Receive Overrun Interrupt Clear The <b>RORIC</b> values are defined as follows:  Value Description 0 No effect on interrupt. 1 Clears interrupt.

**Register 10: SSI Peripheral Identification 4 (SSIPeriphID4), offset 0xFD0**

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 4 (SSIPeriphID4)

SSI0 base: 0x4000.8000  
 Offset 0xFD0  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID4	RO	0x00	SSI Peripheral ID Register[7:0] Can be used by software to identify the presence of this peripheral.

**Register 11: SSI Peripheral Identification 5 (SSIPeriphID5), offset 0xFD4**

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

**SSI Peripheral Identification 5 (SSIPeriphID5)**

SSI0 base: 0x4000.8000

Offset 0xFD4

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID5							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

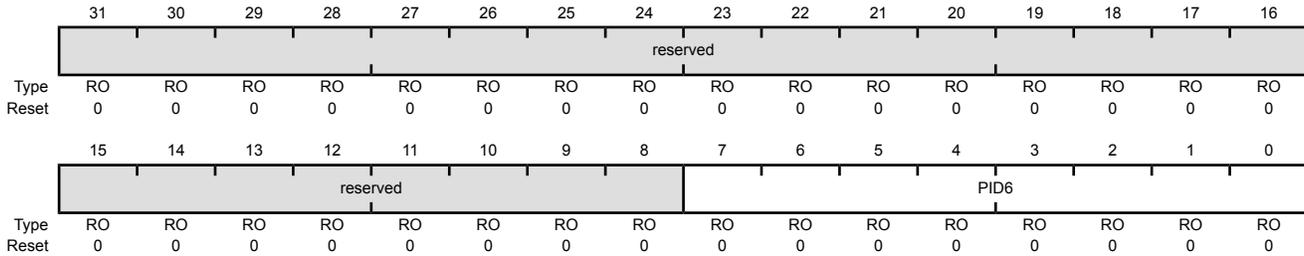
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID5	RO	0x00	SSI Peripheral ID Register[15:8] Can be used by software to identify the presence of this peripheral.

### Register 12: SSI Peripheral Identification 6 (SSIPeriphID6), offset 0xFD8

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### SSI Peripheral Identification 6 (SSIPeriphID6)

SSI0 base: 0x4000.8000  
 Offset 0xFD8  
 Type RO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID6	RO	0x00	SSI Peripheral ID Register[23:16] Can be used by software to identify the presence of this peripheral.

## Register 13: SSI Peripheral Identification 7 (SSIPeriphID7), offset 0xFDC

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

### SSI Peripheral Identification 7 (SSIPeriphID7)

SSI0 base: 0x4000.8000

Offset 0xFDC

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID7							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID7	RO	0x00	SSI Peripheral ID Register[31:24] Can be used by software to identify the presence of this peripheral.

### Register 14: SSI Peripheral Identification 0 (SSIPeriphID0), offset 0xFE0

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### SSI Peripheral Identification 0 (SSIPeriphID0)

SSI0 base: 0x4000.8000  
 Offset 0xFE0  
 Type RO, reset 0x0000.0022

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID0							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID0	RO	0x22	SSI Peripheral ID Register[7:0] Can be used by software to identify the presence of this peripheral.

**Register 15: SSI Peripheral Identification 1 (SSIPeriphID1), offset 0xFE4**

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

## SSI Peripheral Identification 1 (SSIPeriphID1)

SSI0 base: 0x4000.8000

Offset 0xFE4

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

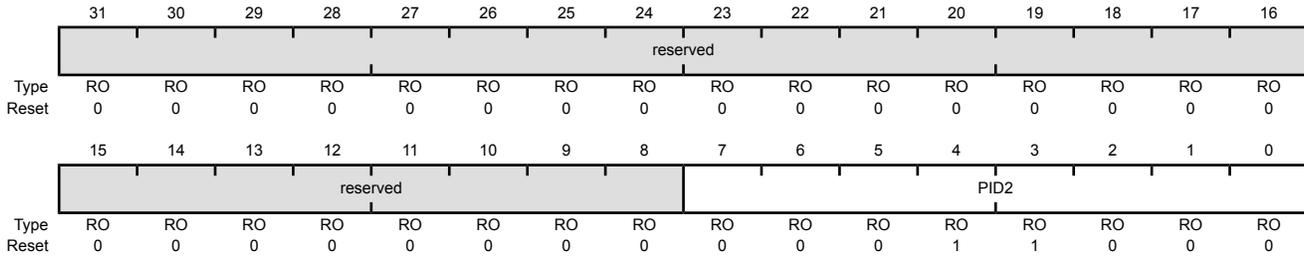
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID1	RO	0x00	SSI Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral.

### Register 16: SSI Peripheral Identification 2 (SSIPeriphID2), offset 0xFE8

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

#### SSI Peripheral Identification 2 (SSIPeriphID2)

SSI0 base: 0x4000.8000  
 Offset 0xFE8  
 Type RO, reset 0x0000.0018



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID2	RO	0x18	SSI Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral.

**Register 17: SSI Peripheral Identification 3 (SSIPeriphID3), offset 0xFEC**

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

**SSI Peripheral Identification 3 (SSIPeriphID3)**

SSI0 base: 0x4000.8000

Offset 0xFEC

Type RO, reset 0x0000.0001

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

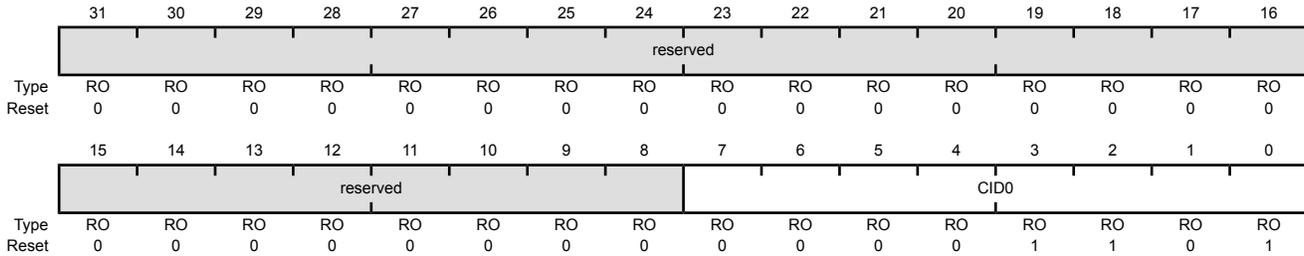
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	PID3	RO	0x01	SSI Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral.

### Register 18: SSI PrimeCell Identification 0 (SSIPCellID0), offset 0xFF0

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

#### SSI PrimeCell Identification 0 (SSIPCellID0)

SSI0 base: 0x4000.8000  
 Offset 0xFF0  
 Type RO, reset 0x0000.000D



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID0	RO	0x0D	SSI PrimeCell ID Register [7:0] Provides software a standard cross-peripheral identification system.

**Register 19: SSI PrimeCell Identification 1 (SSIPCellID1), offset 0xFF4**

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

## SSI PrimeCell Identification 1 (SSIPCellID1)

SSI0 base: 0x4000.8000

Offset 0xFF4

Type RO, reset 0x0000.00F0

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID1							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0

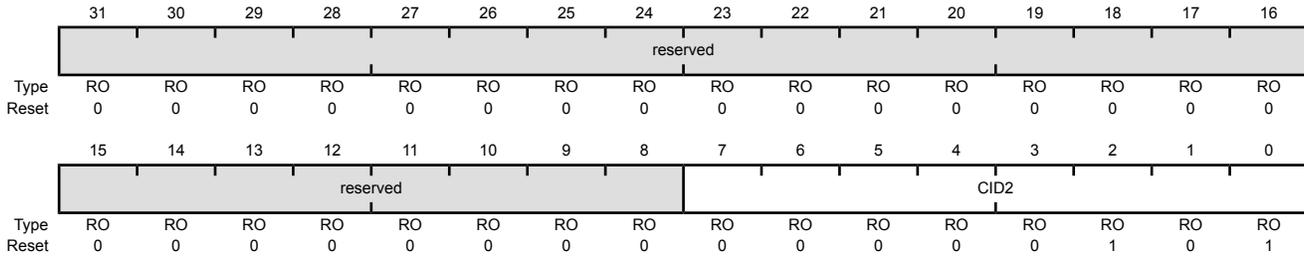
Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID1	RO	0xF0	SSI PrimeCell ID Register [15:8] Provides software a standard cross-peripheral identification system.

### Register 20: SSI PrimeCell Identification 2 (SSIPCellID2), offset 0xFF8

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

#### SSI PrimeCell Identification 2 (SSIPCellID2)

SSI0 base: 0x4000.8000  
 Offset 0xFF8  
 Type RO, reset 0x0000.0005



Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID2	RO	0x05	SSI PrimeCell ID Register [23:16] Provides software a standard cross-peripheral identification system.

**Register 21: SSI PrimeCell Identification 3 (SSIPCellID3), offset 0xFFC**

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

**SSI PrimeCell Identification 3 (SSIPCellID3)**

SSI0 base: 0x4000.8000

Offset 0xFFC

Type RO, reset 0x0000.00B1

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								CID3							
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	CID3	RO	0xB1	SSI PrimeCell ID Register [31:24] Provides software a standard cross-peripheral identification system.

## 12 Ethernet Controller

The Stellaris® Ethernet Controller consists of a fully integrated media access controller (MAC) and network physical (PHY) interface. The Ethernet Controller conforms to *IEEE 802.3* specifications and fully supports 10BASE-T and 100BASE-TX standards.

The Stellaris Ethernet Controller module has the following features:

- Conforms to the *IEEE 802.3-2002 specification*
  - 10BASE-T/100BASE-TX IEEE-802.3 compliant. Requires only a dual 1:1 isolation transformer interface to the line
  - 10BASE-T/100BASE-TX ENDEC, 100BASE-TX scrambler/descrambler
  - Full-featured auto-negotiation
- Multiple operational modes
  - Full- and half-duplex 100 Mbps
  - Full- and half-duplex 10 Mbps
  - Power-saving and power-down modes
- Highly configurable
  - Programmable MAC address
  - LED activity selection
  - Promiscuous mode support
  - CRC error-rejection control
  - User-configurable interrupts
- Physical media manipulation
  - Automatic MDI/MDI-X cross-over correction
  - Register-programmable transmit amplitude
  - Automatic polarity correction and 10BASE-T signal reception

### 12.1 Block Diagram

As shown in Figure 12-1 on page 429, the Ethernet Controller is functionally divided into two layers: the Media Access Controller (MAC) layer and the Network Physical (PHY) layer. These layers correspond to the OSI model layers 2 and 1. The CPU accesses the Ethernet Controller via the MAC layer. The MAC layer provides transmit and receive processing for Ethernet frames. The MAC layer also provides the interface to the PHY layer via an internal Media Independent Interface (MII). The PHY layer communicates with the Ethernet bus.

Figure 12-1. Ethernet Controller

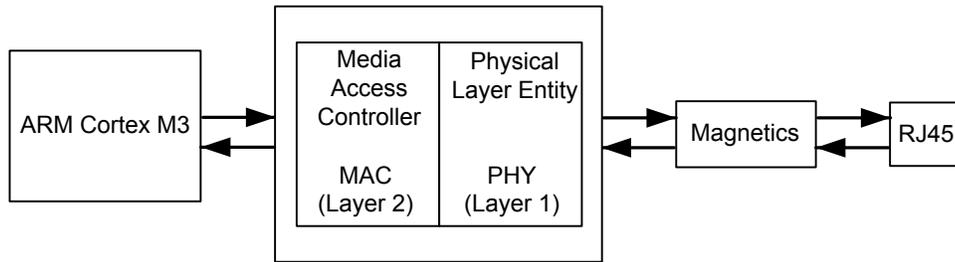
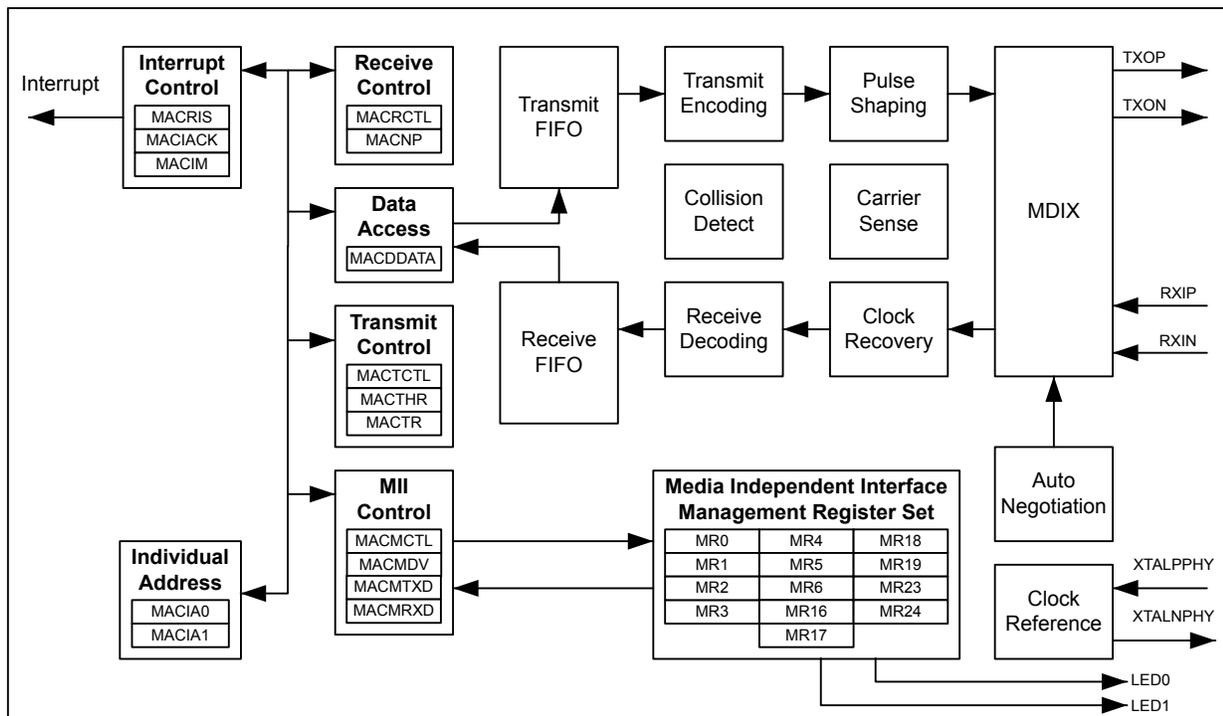


Figure 12-2 on page 429 shows more detail of the internal structure of the Ethernet Controller and how the register set relates to various functions.

Figure 12-2. Ethernet Controller Block Diagram



## 12.2 Signal Description

Table 12-1 on page 430 and Table 12-2 on page 430 list the external signals of the Ethernet Controller and describe the function of each. The Ethernet LED signals are alternate functions for GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Assignment" lists the GPIO pin placement for the LED signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the LED function. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 243. The remaining signals (with the word "fixed" in the Pin Mux/Pin Assignment column) have a fixed pin assignment and function.

Table 12-1. Ethernet Signals (100LQFP)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
ERBIAS	41	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
GNDPHY	42 85 86	-	Power	GND of the Ethernet PHY.
LED0	59	O	TTL	Ethernet LED 0.
LED1	60	O	TTL	Ethernet LED 1.
MDIO	58	I/O	TTL	MDIO of the Ethernet PHY.
RXIN	37	I	Analog	RXIN of the Ethernet PHY.
RXIP	40	I	Analog	RXIP of the Ethernet PHY.
TXON	46	O	Analog	TXON of the Ethernet PHY.
TXOP	43	O	Analog	TXOP of the Ethernet PHY.
VCCPHY	36 83 84	-	Power	VCC of the Ethernet PHY.
XTALNPHY	17	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	16	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 12-2. Ethernet Signals (108BGA)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
ERBIAS	K3	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
GNDPHY	C8 C9 K4	-	Power	GND of the Ethernet PHY.
LED0	J12	O	TTL	Ethernet LED 0.
LED1	J11	O	TTL	Ethernet LED 1.
MDIO	L9	I/O	TTL	MDIO of the Ethernet PHY.
RXIN	L7	I	Analog	RXIN of the Ethernet PHY.
RXIP	M7	I	Analog	RXIP of the Ethernet PHY.
TXON	L8	O	Analog	TXON of the Ethernet PHY.
TXOP	M8	O	Analog	TXOP of the Ethernet PHY.
VCCPHY	C10 D10 D11	-	Power	VCC of the Ethernet PHY.
XTALNPHY	J1	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	J2	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 12.3 Functional Description

**Note:** A 12.4-kΩ resistor should be connected between the ERBIAS and ground. The 12.4-kΩ resistor should have a 1% tolerance and should be located in close proximity to the ERBIAS pin. Power dissipation in the resistor is low, so a chip resistor of any geometry may be used.

The functional description of the Ethernet Controller is discussed in the following sections.

### 12.3.1 MAC Operation

The following sections describe the operation of the MAC unit, including an overview of the Ethernet frame format, the MAC layer FIFOs, Ethernet transmission and reception options, and LED indicators.

#### 12.3.1.1 Ethernet Frame Format

Ethernet data is carried by Ethernet frames. The basic frame format is shown in Figure 12-3 on page 431.

**Figure 12-3. Ethernet Frame**

Preamble	SFD	Destination Address	Source Address	Length/ Type	Data	FCS
7 Bytes	1 Byte	6 Bytes	6 Bytes	2 Bytes	46 - 1500 Bytes	4 Bytes

The seven fields of the frame are transmitted from left to right. The bits within the frame are transmitted from least to most significant bit.

- Preamble

The Preamble field is used to synchronize with the received frame's timing. The preamble is 7 octets long.

- Start Frame Delimiter (SFD)

The SFD field follows the preamble pattern and indicates the start of the frame. Its value is 1010.1011.

- Destination Address (DA)

This field specifies destination addresses for which the frame is intended. The LSB (bit 16 of DA oct 1 in the frame, see Table 12-3 on page 433) of the DA determines whether the address is an individual (0), or group/multicast (1) address.

- Source Address (SA)

The source address field identifies the station from which the frame was initiated.

- Length/Type Field

The meaning of this field depends on its numeric value. This field can be interpreted as length or type code. The maximum length of the data field is 1500 octets. If the value of the Length/Type field is less than or equal to 1500 decimal, it indicates the number of MAC client data octets. If the value of this field is greater than or equal to 1536 decimal, then it is type interpretation. The meaning of the Length/Type field when the value is between 1500 and 1536 decimal is unspecified by the IEEE 802.3 standard. However, the Ethernet Controller assumes type interpretation if the

value of the Length/Type field is greater than 1500 decimal. The definition of the Type field is specified in the IEEE 802.3 standard. The first of the two octets in this field is most significant.

- Data

The data field is a sequence of octets that is at least 46 in length, up to 1500 in length. Full data transparency is provided so any values can appear in this field. A minimum frame size of 46 octets is required to meet the IEEE standard. If the frame size is too small, the Ethernet Controller automatically appends extra bits (a pad), thus the pad can have a size of 0 to 46 octets. Data padding can be disabled by clearing the `PADEN` bit in the **Ethernet MAC Transmit Control (MACTCTL)** register.

For the Ethernet Controller, data sent/received can be larger than 1500 bytes without causing a Frame Too Long error. Instead, a FIFO overrun error is reported using the `FOV` bit in the **Ethernet MAC Raw Interrupt Status(MACRIS)** register when the frame received is too large to fit into the Ethernet Controller's 2K RAM.

- Frame Check Sequence (FCS)

The frame check sequence carries the cyclic redundancy check (CRC) value. The CRC is computed over the destination address, source address, length/type, and data (including pad) fields using the CRC-32 algorithm. The Ethernet Controller computes the FCS value one nibble at a time. For transmitted frames, this field is automatically inserted by the MAC layer, unless disabled by clearing the `CRC` bit in the **MACTCTL** register. For received frames, this field is automatically checked. If the FCS does not pass, the frame is not placed in the RX FIFO, unless the FCS check is disabled by clearing the `BADCRC` bit in the **MACRCTL** register.

### 12.3.1.2 MAC Layer FIFOs

The Ethernet Controller is capable of simultaneous transmission and reception. This feature is enabled by setting the `DUPLX` bit in the **MACTCTL** register.

For Ethernet frame transmission, a 2 KB transmit FIFO is provided that can be used to store a single frame. While the *IEEE 802.3 specification* limits the size of an Ethernet frame's payload section to 1500 Bytes, the Ethernet Controller places no such limit. The full buffer can be used, for a payload of up to 2032 bytes (as the first 16 bytes in the FIFO are reserved for destination address, source address and length/type information).

For Ethernet frame reception, a 2-KB receive FIFO is provided that can be used to store multiple frames, up to a maximum of 31 frames. If a frame is received, and there is insufficient space in the RX FIFO, an overflow error is indicated using the `FOV` bit in the **MACRIS** register.

For details regarding the TX and RX FIFO layout, refer to Table 12-3 on page 433. Please note the following difference between TX and RX FIFO layout. For the TX FIFO, the Data Length field in the first FIFO word refers to the Ethernet frame data payload, as shown in the 5th to nth FIFO positions. For the RX FIFO, the Frame Length field is the total length of the received Ethernet frame, including the Length/Type bytes and the FCS bits.

If FCS generation is disabled by clearing the `CRC` bit in the **MACTCTL** register, the last word in the TX FIFO must contain the FCS bytes for the frame that has been written to the FIFO.

Also note that if the length of the data payload section is not a multiple of 4, the FCS field is not be aligned on a word boundary in the FIFO. However, for the RX FIFO the beginning of the next frame is always on a word boundary.

Table 12-3. TX &amp; RX FIFO Organization

FIFO Word Read/Write Sequence	Word Bit Fields	TX FIFO (Write)	RX FIFO (Read)
1st	7:0	Data Length Least Significant Byte	Frame Length Least Significant Byte
	15:8	Data Length Most Significant Byte	Frame Length Most Significant Byte
	23:16		DA oct 1
	31:24		DA oct 2
2nd	7:0		DA oct 3
	15:8		DA oct 4
	23:16		DA oct 5
	31:24		DA oct 6
3rd	7:0		SA oct 1
	15:8		SA oct 2
	23:16		SA oct 3
	31:24		SA oct 4
4th	7:0		SA oct 5
	15:8		SA oct 6
	23:16		Len/Type Most Significant Byte
	31:24		Len/Type Least Significant Byte
5th to nth	7:0		data oct n
	15:8		data oct n+1
	23:16		data oct n+2
	31:24		data oct n+3
last	7:0		FCS 1
	15:8		FCS 2
	23:16		FCS 3
	31:24		FCS 4

**Note:** If the CRC bit in the **MACTCTL** register is clear, the FCS bytes must be written with the correct CRC. If the CRC bit is set, the Ethernet Controller automatically writes the FCS bytes.

### 12.3.1.3 Ethernet Transmission Options

At the MAC layer, the transmitter can be configured for both full-duplex and half-duplex operation by using the **DUPLEX** bit in the **MACTCTL** register.

The Ethernet Controller automatically generates and inserts the Frame Check Sequence (FCS) at the end of the transmit frame when the CRC bit in the **MACTCTL** register is set. However, for test purposes, this feature can be disabled in order to generate a frame with an invalid CRC by clearing the CRC bit.

The *IEEE 802.3 specification* requires that the Ethernet frame payload section be a minimum of 46 bytes. The Ethernet Controller automatically pads the data section if the payload data section loaded into the FIFO is less than the minimum 46 bytes when the **PADEN** bit in the **MACTCTL** register is set. This feature can be disabled by clearing the **PADEN** bit.

The transmitter must be enabled by setting the **TXEN** bit in the **TCTL** register.

#### 12.3.1.4 Ethernet Reception Options

The Ethernet Controller RX FIFO should be cleared during software initialization. The receiver should first be disabled by clearing the `RXEN` bit in the **Ethernet MAC Receive Control (MACRCTL)** register, then the FIFO can be cleared by setting the `RSTFIFO` bit in the **MACRCTL** register.

The receiver automatically rejects frames that contain bad CRC values in the FCS field. In this case, a Receive Error interrupt is generated and the receive data is lost. To accept all frames, clear the `BADCRC` bit in the **MACRCTL** register.

In normal operating mode, the receiver accepts only those frames that have a destination address that matches the address programmed into the **Ethernet MAC Individual Address 0 (MACIA0)** and **Ethernet MAC Individual Address 1 (MACIA1)** registers. However, the Ethernet receiver can also be configured for Promiscuous and Multicast modes by setting the `PRMS` and `AMUL` bits in the **MACRCTL** register.

#### 12.3.2 Internal MII Operation

For the MII management interface to function properly, the `MDIO` signal must be connected through a 10k  $\Omega$  pull-up resistor to the +3.3 V supply. Failure to connect this pull-up resistor prevents management transactions on this internal MII to function. Note that it is possible for data transmission across the MII to still function since the PHY layer auto-negotiates the link parameters by default.

For the MII management interface to function properly, the internal clock must be divided down from the system clock to a frequency no greater than 2.5 MHz. The **Ethernet MAC Management Divider (MACMDV)** register contains the divider used for scaling down the system clock. See page 453 for more details about the use of this register.

#### 12.3.3 PHY Operation

The Physical Layer (PHY) in the Ethernet Controller includes integrated ENDECs, scrambler/descrambler, dual-speed clock recovery, and full-featured auto-negotiation functions. The transmitter includes an on-chip pulse shaper and a low-power line driver. The receiver has an adaptive equalizer and a baseline restoration circuit required for accurate clock and data recovery. The transceiver interfaces to Category-5 unshielded twisted pair (Cat-5 UTP) cabling for 100BASE-TX applications, and Category-3 unshielded twisted pair (Cat-3 UTP) for 10BASE-T applications. The Ethernet Controller is connected to the line media via dual 1:1 isolation transformers. No external filter is required.

##### 12.3.3.1 Clock Selection

The Ethernet Controller has an on-chip crystal oscillator which can also be driven by an external oscillator. In this mode of operation, a 25-MHz crystal should be connected between the `XTALPPHY` and `XTALNPHY` pins. Alternatively, an external 25-MHz clock input can be connected to the `XTALPPHY` pin. In this mode of operation, a crystal is not required and the `XTALNPHY` pin must be tied to ground.

##### 12.3.3.2 Auto-Negotiation

The Ethernet Controller supports the auto-negotiation functions of Clause 28 of the *IEEE 802.3* standard for 10/100 Mbps operation over copper wiring. This function is controlled via register settings. The auto-negotiation function is turned on by default, and the `ANEGEN` bit in the **Ethernet PHY Management Register 0 - Control (MR0)** is set after reset. Software can disable the auto-negotiation function by clearing the `ANEGEN` bit. The contents of the **Ethernet PHY Management Register - Auto-Negotiation Advertisement (MR4)** are reflected to the Ethernet Controller's link partner during auto-negotiation via fast-link pulse coding.

Once auto-negotiation is complete, the `DPLX` and `RATE` bits in the **Ethernet PHY Management Register 18 - Diagnostic (MR18)** register reflect the actual speed and duplex condition. If auto-negotiation fails to establish a link for any reason, the `ANEGF` bit in the **MR18** register reflects this and auto-negotiation restarts from the beginning. Setting the `RANEG` bit in the **MR0** register also causes auto-negotiation to restart.

### 12.3.3.3 Polarity Correction

The Ethernet Controller is capable of either automatic or manual polarity reversal for 10BASE-T and auto-negotiation functions. Bits 4 and 5 (`RVSPOL` and `APOL`) in the **Ethernet PHY Management Register 16 - Vendor-Specific (MR16)** control this feature. The default is automatic mode, where `APOL` is clear and `RVSPOL` indicates if the detection circuitry has inverted the input signal. To enter manual mode, `APOL` should be set. In manual mode `RVSPOL` controls the signal polarity.

### 12.3.3.4 MDI/MDI-X Configuration

The Ethernet Controller supports the MDI/MDI-X configuration as defined in *IEEE 802.3-2002 specification*. The MDI/MDI-X configuration eliminates the need for cross-over cables when connecting to another device, such as a hub. The algorithm is controlled via settings in the **Ethernet PHY Management Register 24 - MDI/MIDIX Control (MR24)**. Refer to page 475 for additional details about these settings.

### 12.3.3.5 Power Management

The PHY has two power-saving modes:

- Power-Down
- Receive Power Management

Power-down mode is activated by setting the `PWRDN` bit in the **MR0** register. When the PHY is in power-down mode, it consumes minimum power. While in the power-down state, the Ethernet Controller still responds to management transactions.

Receive power management (RXCC mode) is activated by setting the `RXCC` bit in the **MR16** register. In this mode of operation, the adaptive equalizer, the clock recovery phase lock loop (PLL), and all other receive circuitry are powered down. As soon as a valid signal is detected, all circuits are automatically powered up to resume normal operation. Note that the RXCC mode is not supported during 10BASE-T operation.

### 12.3.3.6 LED Indicators

The Ethernet Controller supports two LED signals that can be used to indicate various states of operation. These signals are mapped to the `LED0` and `LED1` pins. By default, these pins are configured as GPIO signals (`PF3` and `PF2`). For the PHY layer to drive these signals, they must be reconfigured to their alternate function. See “General-Purpose Input/Outputs (GPIOs)” on page 243 for additional details. The function of these pins is programmable via the PHY layer **Ethernet PHY Management Register 23 - LED Configuration (MR23)**. Refer to page 474 for additional details on how to program these LED functions.

## 12.3.4 Interrupts

The Ethernet Controller can generate an interrupt for one or more of the following conditions:

- A frame has been received into an empty RX FIFO

- A frame transmission error has occurred
- A frame has been transmitted successfully
- A frame has been received with inadequate room in the RX FIFO (overrun)
- A frame has been received with one or more error conditions (for example, FCS failed)
- An MII management transaction between the MAC and PHY layers has completed
- One or more of the following PHY layer conditions occurs:
  - Auto-Negotiate Complete
  - Remote Fault
  - Link Status Change
  - Link Partner Acknowledge
  - Parallel Detect Fault
  - Page Received
  - Receive Error
  - Jabber Event Detected

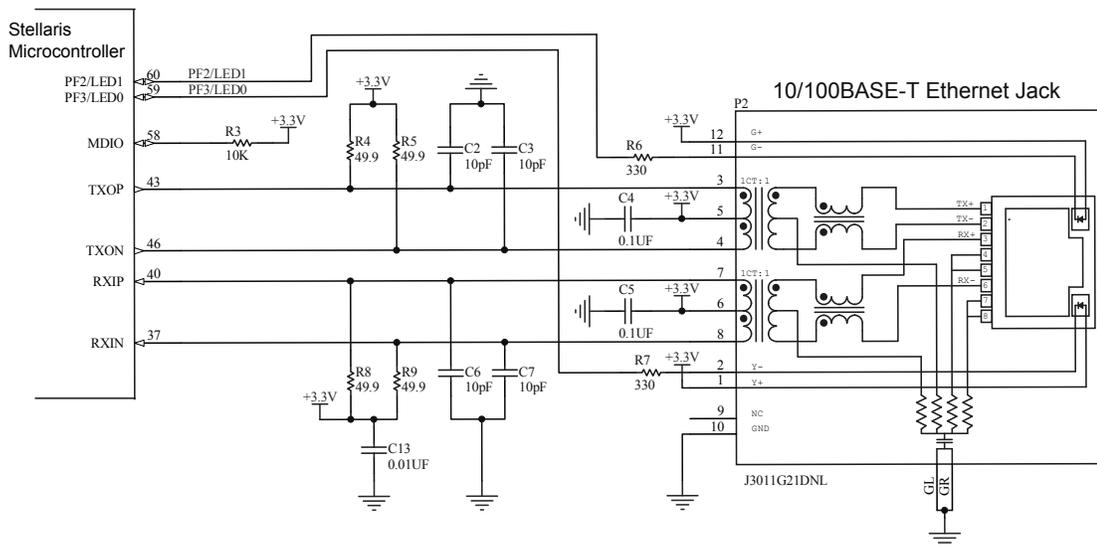
## 12.4 Initialization and Configuration

The following sections describe the hardware and software configuration required to set up the Ethernet Controller.

### 12.4.1 Hardware Configuration

Figure 12-4 on page 437 shows the proper method for interfacing the Ethernet Controller to a 10/100BASE-T Ethernet jack.

Figure 12-4. Interface to an Ethernet Jack



The following isolation transformers have been tested and are known to successfully interface to the Ethernet PHY layer.

- Isolation Transformers
  - TDK TLA-6T103
  - Bel-Fuse S558-5999-46
  - Halo TG22-3506ND
  - Pulse PE-68515
  - Valor ST6118
  - YCL 20PMT04
- Isolation transformers in low profile packages (0.100 in/2.5 mm or less)
  - TDK TLA-6T118
  - Halo TG110-S050
  - PCA EPF8023G
- Isolation transformers with integrated RJ45 connector
  - TDK TLA-6T704
  - Delta RJS-1A08T089A
- Isolation transformers with integrated RJ45 connector, LEDs and termination resistors
  - Pulse J0011D21B/E
  - Pulse J3011G21DNL

## 12.4.2 Software Configuration

To use the Ethernet Controller, it must be enabled by setting the `EPHY0` and `EMAC0` bits in the `RCGC2` register (see page 207). The following steps can then be used to configure the Ethernet Controller for basic operation.

1. Program the `MACDIV` register to obtain a 2.5 MHz clock (or less) on the internal MII. Assuming a 20-MHz system clock, the `MACDIV` value should be 0x03 or greater.
2. Program the `MACIA0` and `MACIA1` register for address filtering.
3. Program the `MACTCTL` register for Auto CRC generation, padding, and full-duplex operation using a value of 0x16.

4. Program the **MACRCTL** register to flush the receive FIFO and reject frames with bad FCS using a value of 0x18.
5. Enable both the Transmitter and Receive by setting the LSB in both the **MACTCTL** and **MACRCTL** registers.
6. To transmit a frame, write the frame into the TX FIFO using the **Ethernet MAC Data (MACDATA)** register. Then set the **NEWTX** bit in the **Ethernet Mac Transmission Request (MACTR)** register to initiate the transmit process. When the **NEWTX** bit has been cleared, the TX FIFO is available for the next transmit frame.
7. To receive a frame, wait for the **NPR** field in the **Ethernet MAC Number of Packets (MACNP)** register to be non-zero. Then begin reading the frame from the RX FIFO by using the **MACDATA** register. To ensure that the entire packet is received, either use the DriverLib EthernetPacketGet() API or compare the number of bytes received to the Length field from the frame to determine when the packet has been completely read.

## 12.5 Ethernet Register Map

Table 12-4 on page 438 lists the Ethernet MAC registers. All addresses given are relative to the Ethernet MAC base address of 0x4004.8000. Note that the Ethernet module clock must be enabled before the registers can be programmed (see page 207). There must be a delay of 3 system clocks after the Ethernet module clock is enabled before any Ethernet module registers are accessed.

The *IEEE 802.3* standard specifies a register set for controlling and gathering status from the PHY layer. The registers are collectively known as the MII Management registers and are detailed in Section 22.2.4 of the *IEEE 802.3 specification*. Table 12-4 on page 438 also lists these MII Management registers. *All addresses given are absolute and are written directly to the REGADDR field of the Ethernet MAC Management Control (MACMCTL) register.* The format of registers 0 to 15 are defined by the IEEE specification and are common to all PHY layer implementations. The only variance allowed is for features that may or may not be supported by a specific PHY implementation. Registers 16 to 31 are vendor-specific registers, used to support features that are specific to a vendor's PHY implementation. Vendor-specific registers not listed are reserved.

**Table 12-4. Ethernet Register Map**

Offset	Name	Type	Reset	Description	See page
<b>Ethernet MAC</b>					
0x000	MACRIS/MACIACK	R/W1C	0x0000.0000	Ethernet MAC Raw Interrupt Status/Acknowledge	440
0x004	MACIM	R/W	0x0000.007F	Ethernet MAC Interrupt Mask	443
0x008	MACRCTL	R/W	0x0000.0008	Ethernet MAC Receive Control	444
0x00C	MACTCTL	R/W	0x0000.0000	Ethernet MAC Transmit Control	445
0x010	MACDATA	R/W	0x0000.0000	Ethernet MAC Data	446
0x014	MACIA0	R/W	0x0000.0000	Ethernet MAC Individual Address 0	448
0x018	MACIA1	R/W	0x0000.0000	Ethernet MAC Individual Address 1	449
0x01C	MACTHR	R/W	0x0000.003F	Ethernet MAC Threshold	450
0x020	MACMCTL	R/W	0x0000.0000	Ethernet MAC Management Control	452

Table 12-4. Ethernet Register Map (continued)

Offset	Name	Type	Reset	Description	See page
0x024	MACMDV	R/W	0x0000.0080	Ethernet MAC Management Divider	453
0x02C	MACMTXD	R/W	0x0000.0000	Ethernet MAC Management Transmit Data	454
0x030	MACMRXD	R/W	0x0000.0000	Ethernet MAC Management Receive Data	455
0x034	MACNP	RO	0x0000.0000	Ethernet MAC Number of Packets	456
0x038	MACTR	R/W	0x0000.0000	Ethernet MAC Transmission Request	457
<b>MII Management</b>					
-	MR0	R/W	0x3100	Ethernet PHY Management Register 0 – Control	458
-	MR1	RO	0x7849	Ethernet PHY Management Register 1 – Status	460
-	MR2	RO	0x000E	Ethernet PHY Management Register 2 – PHY Identifier 1	462
-	MR3	RO	0x7237	Ethernet PHY Management Register 3 – PHY Identifier 2	463
-	MR4	R/W	0x01E1	Ethernet PHY Management Register 4 – Auto-Negotiation Advertisement	464
-	MR5	RO	0x0000	Ethernet PHY Management Register 5 – Auto-Negotiation Link Partner Base Page Ability	466
-	MR6	RO	0x0000	Ethernet PHY Management Register 6 – Auto-Negotiation Expansion	467
-	MR16	R/W	0x0140	Ethernet PHY Management Register 16 – Vendor-Specific	468
-	MR17	R/W	0x0000	Ethernet PHY Management Register 17 – Interrupt Control/Status	470
-	MR18	RO	0x0000	Ethernet PHY Management Register 18 – Diagnostic	472
-	MR19	R/W	0x4000	Ethernet PHY Management Register 19 – Transceiver Control	473
-	MR23	R/W	0x0010	Ethernet PHY Management Register 23 – LED Configuration	474
-	MR24	R/W	0x00C0	Ethernet PHY Management Register 24 –MDI/MDIX Control	475

## 12.6 Ethernet MAC Register Descriptions

The remainder of this section lists and describes the Ethernet MAC registers, in numerical order by address offset. Also see “MII Management Register Descriptions” on page 457.

## Register 1: Ethernet MAC Raw Interrupt Status/Acknowledge (MACRIS/MACIACK), offset 0x000

The **MACRIS/MACIACK** register is the interrupt status and acknowledge register. On a read, this register gives the current status value of the corresponding interrupt prior to masking. On a write, setting any bit clears the corresponding interrupt status bit.

### Reads

#### Ethernet MAC Raw Interrupt Status/Acknowledge (MACRIS/MACIACK)

Base 0x4004.8000

Offset 0x000

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PHYINT	MDINT	RXER	FOV	TXEMP	TXER	RXINT
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PHYINT	RO	0	PHY Interrupt When set, indicates that an enabled interrupt in the PHY layer has occurred. <b>MR17</b> in the PHY must be read to determine the specific PHY event that triggered this interrupt.
5	MDINT	RO	0	MII Transaction Complete When set, indicates that a transaction (read or write) on the MII interface has completed successfully.
4	RXER	RO	0	Receive Error This bit indicates that an error was encountered on the receiver. The possible errors that can cause this interrupt bit to be set are: <ul style="list-style-type: none"> <li>■ A receive error occurs during the reception of a frame (100 Mb/s only).</li> <li>■ The frame is not an integer number of bytes (dribble bits) due to an alignment error.</li> <li>■ The CRC of the frame does not pass the FCS check.</li> <li>■ The length/type field is inconsistent with the frame data size when interpreted as a length field.</li> </ul>
3	FOV	RO	0	FIFO Overrun When set, indicates that an overrun was encountered on the receive FIFO.

Bit/Field	Name	Type	Reset	Description
2	TXEMP	RO	0	Transmit FIFO Empty When set, indicates that the packet was transmitted and that the TX FIFO is empty.
1	TXER	RO	0	Transmit Error When set, indicates that an error was encountered on the transmitter. The possible errors that can cause this interrupt bit to be set are: <ul style="list-style-type: none"> <li>■ The data length field stored in the TX FIFO exceeds 2032 decimal (buffer length - 16 bytes of header data). The frame is not sent when this error occurs.</li> <li>■ The retransmission attempts during the backoff process have exceeded the maximum limit of 16 decimal.</li> </ul>
0	RXINT	RO	0	Packet Received When set, indicates that at least one packet has been received and is stored in the receiver FIFO.

## Writes

### Ethernet MAC Raw Interrupt Status/Acknowledge (MACRIS/MACIACK)

Base 0x4004.8000  
Offset 0x000  
Type WO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PHYINT	MDINT	RXER	FOV	TXEMP	TXER	RXINT
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	W1C	W1C	W1C	W1C	W1C	W1C	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PHYINT	W1C	0	Clear PHY Interrupt Setting this bit clears the PHYINT interrupt in the <b>MACRIS</b> register.
5	MDINT	W1C	0	Clear MII Transaction Complete Setting this bit clears the MDINT interrupt in the <b>MACRIS</b> register.
4	RXER	W1C	0	Clear Receive Error Setting this bit clears the RXER interrupt in the <b>MACRIS</b> register.
3	FOV	W1C	0	Clear FIFO Overrun Setting this bit clears the FOV interrupt in the <b>MACRIS</b> register.

Bit/Field	Name	Type	Reset	Description
2	TXEMP	W1C	0	Clear Transmit FIFO Empty Setting this bit clears the TXEMP interrupt in the <b>MACRIS</b> register.
1	TXER	W1C	0	Clear Transmit Error Setting this bit clears the TXER interrupt in the <b>MACRIS</b> register and resets the TX FIFO write pointer.
0	RXINT	W1C	0	Clear Packet Received Setting this bit clears the RXINT interrupt in the <b>MACRIS</b> register.

## Register 2: Ethernet MAC Interrupt Mask (MACIM), offset 0x004

This register allows software to enable/disable Ethernet MAC interrupts. Clearing a bit disables the interrupt, while setting the bit enables it.

### Ethernet MAC Interrupt Mask (MACIM)

Base 0x4004.8000  
Offset 0x004  
Type R/W, reset 0x0000.007F

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved										PHYINTM	MDINTM	RXERM	FOVM	TXEMPM	TXERM	RXINTM
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	

Bit/Field	Name	Type	Reset	Description
31:7	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	PHYINTM	R/W	1	Mask PHY Interrupt Clearing this bit masks the <code>PHYINT</code> bit in the <b>MACRIS</b> register from being set.
5	MDINTM	R/W	1	Mask MII Transaction Complete Clearing this bit masks the <code>MDINT</code> bit in the <b>MACRIS</b> register from being set.
4	RXERM	R/W	1	Mask Receive Error Clearing this bit masks the <code>RXER</code> bit in the <b>MACRIS</b> register from being set.
3	FOVM	R/W	1	Mask FIFO Overrun Clearing this bit masks the <code>FOV</code> bit in the <b>MACRIS</b> register from being set.
2	TXEMPM	R/W	1	Mask Transmit FIFO Empty Clearing this bit masks the <code>TXEMP</code> bit in the <b>MACRIS</b> register from being set.
1	TXERM	R/W	1	Mask Transmit Error Clearing this bit masks the <code>TXER</code> bit in the <b>MACRIS</b> register from being set.
0	RXINTM	R/W	1	Mask Packet Received Clearing this bit masks the <code>RXINT</code> bit in the <b>MACRIS</b> register from being set.

### Register 3: Ethernet MAC Receive Control (MACRCTL), offset 0x008

This register configures the receiver and controls the types of frames that are received.

It is important to note that when the receiver is enabled, all valid frames with a broadcast address of FF-FF-FF-FF-FF-FF in the Destination Address field are received and stored in the RX FIFO, even if the `AMUL` bit is not set.

#### Ethernet MAC Receive Control (MACRCTL)

Base 0x4004.8000  
Offset 0x008  
Type R/W, reset 0x0000.0008

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved												RSTFIFO	BADCRC	PRMS	AMUL	RXEN
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Bit/Field	Name	Type	Reset	Description
31:5	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	RSTFIFO	R/W	0	<p>Clear Receive FIFO</p> <p>When set, this bit clears the receive FIFO. This should be done when software initialization is performed.</p> <p>It is recommended that the receiver be disabled (<code>RXEN = 0</code>), before a reset is initiated (<code>RSTFIFO = 1</code>). This sequence flushes and resets the RX FIFO.</p> <p>This bit is automatically cleared when read.</p>
3	BADCRC	R/W	1	<p>Enable Reject Bad CRC</p> <p>When set, the <code>BADCRC</code> bit enables the rejection of frames with an incorrectly calculated CRC. If a bad CRC is encountered, the <code>RXER</code> bit in the <code>MACRIS</code> register is set and the receiver FIFO is reset.</p>
2	PRMS	R/W	0	<p>Enable Promiscuous Mode</p> <p>When set, the <code>PRMS</code> bit enables Promiscuous mode, which accepts all valid frames, regardless of the specified Destination Address.</p>
1	AMUL	R/W	0	<p>Enable Multicast Frames</p> <p>When set, the <code>AMUL</code> bit enables the reception of multicast frames.</p>
0	RXEN	R/W	0	<p>Enable Receiver</p> <p>When set the <code>RXEN</code> bit enables the Ethernet receiver. When this bit is clear, the receiver is disabled and all frames are ignored.</p>

**Register 4: Ethernet MAC Transmit Control (MACTCTL), offset 0x00C**

This register configures the transmitter and controls the frames that are transmitted.

## Ethernet MAC Transmit Control (MACTCTL)

Base 0x4004.8000  
Offset 0x00C  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											DUPLEX	reserved	CRC	PADEN	TXEN
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	RO	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:5	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	DUPLEX	R/W	0	Enable Duplex Mode When set, this bit enables Duplex mode, allowing simultaneous transmission and reception.
3	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
2	CRC	R/W	0	Enable CRC Generation When set this bit enables the automatic generation of the CRC and its placement at the end of the packet. If this bit is clear, the frames placed in the TX FIFO are sent exactly as they are written into the FIFO. Note that this bit should generally be set.
1	PADEN	R/W	0	Enable Packet Padding When set, this bit enables the automatic padding of packets that do not meet the minimum frame size. Note that this bit should generally be set.
0	TXEN	R/W	0	Enable Transmitter When set, this bit enables the transmitter. When this bit is clear, the transmitter is disabled.

## Register 5: Ethernet MAC Data (MACDATA), offset 0x010

**Important:** This register is read-sensitive. See the register description for details.

This register enables software to access the TX and RX FIFOs.

Reads from this register return the data stored in the RX FIFO from the location indicated by the read pointer. The read pointer is then auto incremented to the next RX FIFO location. Reading from the RX FIFO when a frame has not been received or is in the process of being received will return indeterminate data and not increment the read pointer.

Writes to this register store the data in the TX FIFO at the location indicated by the write pointer. The write pointer is the auto incremented to the next TX FIFO location. Writing more data into the TX FIFO than indicated in the length field will result in the data being lost. Writing less data into the TX FIFO than indicated in the length field will result in indeterminate data being appended to the end of the frame to achieve the indicated length. Attempting to write the next frame into the TX FIFO before transmission of the first has completed will result in the data being lost.

There is no mechanism for randomly accessing bytes in either the RX or TX FIFOs. Data must be read from the RX FIFO sequentially and stored in a buffer for further processing. Once a read has been performed, the data in the FIFO cannot be re-read. Data must be written to the TX FIFO sequentially. If an error is made in placing the frame into the TX FIFO, the write pointer can be reset to the start of the TX FIFO by writing the `TXER` bit of the `MACIACK` register and then the data re-written.

### Reads

#### Ethernet MAC Data (MACDATA)

Base 0x4004.8000  
Offset 0x010  
Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	RXDATA															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	RXDATA															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
-----------	------	------	-------	-------------

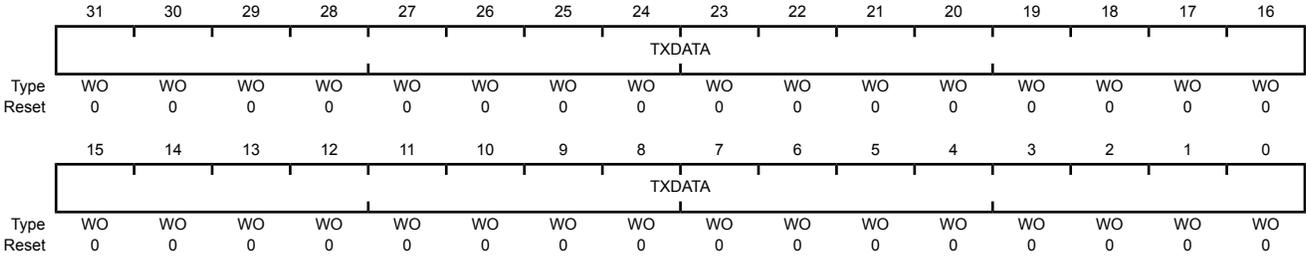
31:0	RXDATA	RO	0x0000.0000	Receive FIFO Data
------	--------	----	-------------	-------------------

The `RXDATA` bits represent the next word of data stored in the RX FIFO.

**Writes**

**Ethernet MAC Data (MACDATA)**

Base 0x4004.8000  
 Offset 0x010  
 Type WO, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:0	TXDATA	WO	0x0000.0000	Transmit FIFO Data The TXDATA bits represent the next word of data to place in the TX FIFO for transmission.

**Register 6: Ethernet MAC Individual Address 0 (MACIA0), offset 0x014**

This register enables software to program the first four bytes of the hardware MAC address of the Network Interface Card (NIC). (The last two bytes are in **MACIA1**). The 6-byte Individual Address is compared against the incoming Destination Address fields to determine whether the frame should be received.

## Ethernet MAC Individual Address 0 (MACIA0)

Base 0x4004.8000  
Offset 0x014  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	MACOCT4								MACOCT3							
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MACOCT2								MACOCT1							
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:24	MACOCT4	R/W	0x00	MAC Address Octet 4 The <b>MACOCT4</b> bits represent the fourth octet of the MAC address used to uniquely identify the Ethernet Controller.
23:16	MACOCT3	R/W	0x00	MAC Address Octet 3 The <b>MACOCT3</b> bits represent the third octet of the MAC address used to uniquely identify the Ethernet Controller.
15:8	MACOCT2	R/W	0x00	MAC Address Octet 2 The <b>MACOCT2</b> bits represent the second octet of the MAC address used to uniquely identify the Ethernet Controller.
7:0	MACOCT1	R/W	0x00	MAC Address Octet 1 The <b>MACOCT1</b> bits represent the first octet of the MAC address used to uniquely identify the Ethernet Controller.

**Register 7: Ethernet MAC Individual Address 1 (MACIA1), offset 0x018**

This register enables software to program the last two bytes of the hardware MAC address of the Network Interface Card (NIC). (The first four bytes are in **MACIA0**). The 6-byte IAR is compared against the incoming Destination Address fields to determine whether the frame should be received.

## Ethernet MAC Individual Address 1 (MACIA1)

Base 0x4004.8000  
Offset 0x018  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MACOCT6								MACOCT5							
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:8	MACOCT6	R/W	0x00	MAC Address Octet 6 The <b>MACOCT6</b> bits represent the sixth octet of the MAC address used to uniquely identify each Ethernet Controller.
7:0	MACOCT5	R/W	0x00	MAC Address Octet 5 The <b>MACOCT5</b> bits represent the fifth octet of the MAC address used to uniquely identify the Ethernet Controller.

### Register 8: Ethernet MAC Threshold (MACTHR), offset 0x01C

In order to increase the transmission rate, it is possible to program the Ethernet Controller to begin transmission of the next frame prior to the completion of the transmission of the current frame. Note: Extreme care must be used when implementing this function. Software must be able to guarantee that the complete frame is able to be stored in the transmission FIFO prior to the completion of the transmission frame.

This register enables software to set the threshold level at which the transmission of the frame begins. If the THRESH bits are set to 0x3F, which is the reset value, the early transmission feature is disabled, and transmission does not start until the NEWTX bit is set in the MACTR register.

Writing the THRESH bits to any value besides 0x3F enables the early transmission feature. Once the byte count of data in the TX FIFO reaches the value derived from the THRESH bits as shown below, transmission of the frame begins. When THRESH is set to all 0s, transmission of the frame begins after 4 bytes (a single write) are stored in the TX FIFO. Each increment of the THRESH bit field waits for an additional 32 bytes of data (eight writes) to be stored in the TX FIFO. Therefore, a value of 0x01 causes the transmitter to wait for 36 bytes of data to be written while a value of 0x02 makes the wait equal to 68 bytes of written data. In general, early transmission starts when:

$$\text{Number of Bytes} \geq 4 (\text{THRESH} \times 8 + 1)$$

Reaching the threshold level has the same effect as setting the NEWTX bit in the MACTR register. Transmission of the frame begins and then the number of bytes indicated by the Data Length field is transmitted. Because under-run checking is not performed, if any event, such as an interrupt, delays the filling of the FIFO, the tail pointer may reach and pass the write pointer in the TX FIFO. In this event, indeterminate values are transmitted rather than the end of the frame. Therefore, sufficient bus bandwidth for writing to the TX FIFO must be guaranteed by the software.

If a frame smaller than the threshold level must be sent, the NEWTX bit in the MACTR register must be set with an explicit write. This initiates the transmission of the frame even though the threshold limit has not been reached.

If the threshold level is set too small, it is possible for the transmitter to underrun. If this occurs, the transmit frame is aborted, and a transmit error occurs. Note that in this case, the TXER bit in the MACRIS is not set meaning that the CPU receives no indication that a transmit error happened.

#### Ethernet MAC Threshold (MACTHR)

Base 0x4004.8000  
 Offset 0x01C  
 Type R/W, reset 0x0000.003F

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved										THRESH					
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

Bit/Field	Name	Type	Reset	Description
5:0	THRESH	R/W	0x3F	Threshold Value The THRESH bits represent the early transmit threshold. Once the amount of data in the TX FIFO exceeds the value represented by the above equation, transmission of the packet begins.

**Register 9: Ethernet MAC Management Control (MACMCTL), offset 0x020**

This register enables software to control the transfer of data to and from the MII Management registers in the Ethernet PHY layer. The address, name, type, reset configuration, and functional description of each of these registers can be found in Table 12-4 on page 438 and in “MII Management Register Descriptions” on page 457.

In order to initiate a *read* transaction from the MII Management registers, the `WRITE` bit must be cleared during the same cycle that the `START` bit is set.

In order to initiate a *write* transaction to the MII Management registers, the `WRITE` bit must be set during the same cycle that the `START` bit is set.

## Ethernet MAC Management Control (MACMCTL)

Base 0x4004.8000  
Offset 0x020  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								REGADR				reserved	WRITE	START	
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	R/W	R/W	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:3	REGADR	R/W	0x0	MII Register Address The <code>REGADR</code> bit field represents the MII Management register address for the next MII management interface transaction. Refer to Table 12-4 on page 438 for the PHY register offsets. Note that any address that is not valid in the register map should not be written to and any data read should be ignored.
2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	WRITE	R/W	0	MII Register Transaction Type The <code>WRITE</code> bit represents the operation of the next MII management interface transaction. If <code>WRITE</code> is set, the next operation is a write; if <code>WRITE</code> is clear, the next transaction is a read.
0	START	R/W	0	MII Register Transaction Enable The <code>START</code> bit represents the initiation of the next MII management interface transaction. When this bit is set, the MII register located at <code>REGADR</code> is read ( <code>WRITE=0</code> ) or written ( <code>WRITE=1</code> ).

**Register 10: Ethernet MAC Management Divider (MACMDV), offset 0x024**

This register enables software to set the clock divider for the Management Data Clock (MDC). This clock is used to synchronize read and write transactions between the system and the MII Management registers. The frequency of the MDC clock can be calculated from the following formula:

$$F_{mdc} = \frac{F_{ipclk}}{2 \times (MACDVR + 1)}$$

The clock divider must be written with a value that ensures that the MDC clock does not exceed a frequency of 2.5 MHz.

**Ethernet MAC Management Divider (MACMDV)**

Base 0x4004.8000

Offset 0x024

Type R/W, reset 0x0000.0080

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								DIV							
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W							
Reset	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:8	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7:0	DIV	R/W	0x80	Clock Divider The <code>DIV</code> bits are used to set the clock divider for the MDC clock used to transmit data between the MAC and PHY layers over the serial MII interface.

## Register 11: Ethernet MAC Management Transmit Data (MACMTXD), offset 0x02C

This register holds the next value to be written to the MII Management registers.

### Ethernet MAC Management Transmit Data (MACMTXD)

Base 0x4004.8000  
 Offset 0x02C  
 Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MDTX															
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

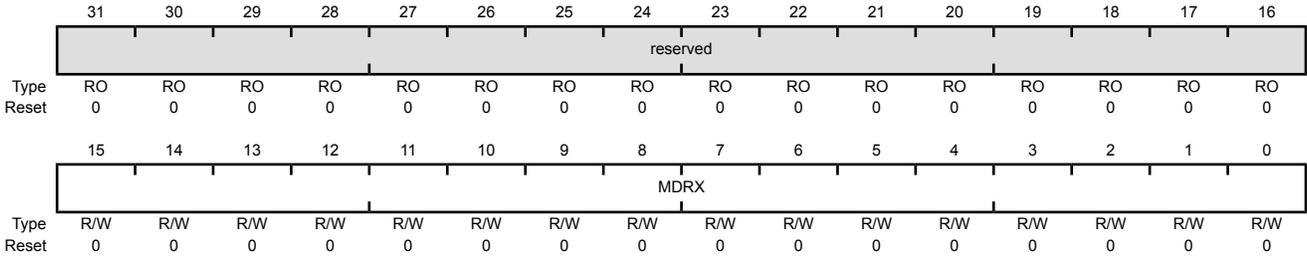
Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	MDTX	R/W	0x0000	MII Register Transmit Data The MDTX bits represent the data that will be written in the next MII management transaction.

**Register 12: Ethernet MAC Management Receive Data (MACMRXD), offset 0x030**

This register holds the last value read from the MII Management registers.

Ethernet MAC Management Receive Data (MACMRXD)

Base 0x4004.8000  
 Offset 0x030  
 Type R/W, reset 0x0000.0000



Bit/Field	Name	Type	Reset	Description
31:16	reserved	RO	0x0000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
15:0	MDRX	R/W	0x0000	MII Register Receive Data The MDRX bits represent the data that was read in the previous MII management transaction.

### Register 13: Ethernet MAC Number of Packets (MACNP), offset 0x034

This register holds the number of frames that are currently in the RX FIFO. When `NPR` is 0, there are no frames in the RX FIFO, and the `RXINT` bit is clear. When `NPR` is any other value, at least one frame is in the RX FIFO, and the `RXINT` bit in the **MACRIS** register is set.

**Note:** The FCS bytes are not included in the `NPR` value. As a result, the `NPR` value could be zero before the FCS bytes are read from the FIFO. In addition, a new packet could be received before the `NPR` value reaches zero. To ensure that the entire packet is received, either use the `DriverLib EthernetPacketGet()` API or compare the number of bytes received to the Length field from the frame to determine when the packet has been completely read.

#### Ethernet MAC Number of Packets (MACNP)

Base 0x4004.8000  
 Offset 0x034  
 Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											NPR				
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:6	reserved	RO	0x0000.00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
5:0	NPR	RO	0x00	Number of Packets in Receive FIFO The <code>NPR</code> bits represent the number of packets stored in the RX FIFO. While the <code>NPR</code> field is greater than 0, the <code>RXINT</code> interrupt in the <b>MACRIS</b> register is set.

## Register 14: Ethernet MAC Transmission Request (MACTR), offset 0x038

This register enables software to initiate the transmission of the frame currently located in the TX FIFO. Once the frame has been transmitted from the TX FIFO or a transmission error has been encountered, the `NEWTX` bit is automatically cleared.

### Ethernet MAC Transmission Request (MACTR)

Base 0x4004.8000  
Offset 0x038  
Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															NEWTX
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x0000.000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	NEWTX	R/W	0	<p>New Transmission</p> <p>When set, the <code>NEWTX</code> bit initiates an Ethernet transmission once the packet has been placed in the TX FIFO. This bit is cleared once the transmission has been completed. If early transmission is being used (see the <code>MACTHR</code> register), this bit does not need to be set.</p>

## 12.7 MII Management Register Descriptions

The *IEEE 802.3 standard* specifies a register set for controlling and gathering status from the PHY layer. The registers are collectively known as the MII Management registers. All addresses given are absolute. Addresses not listed are reserved; these addresses should not be written to and any data read should be ignored. Also see “Ethernet MAC Register Descriptions” on page 439.

## Register 15: Ethernet PHY Management Register 0 – Control (MR0), address 0x00

This register enables software to configure the operation of the PHY layer. The default settings of these registers are designed to initialize the Ethernet Controller to a normal operational mode without configuration.

### Ethernet PHY Management Register 0 – Control (MR0)

Base 0x4004.8000  
Address 0x00  
Type R/W, reset 0x3100

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	RESET	LOOPBK	SPEEDSL	ANEGEN	PWRDN	ISO	RANEG	DUPLEX	COLT	reserved						
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description						
15	RESET	R/W	0	<p>Reset Registers</p> <p>When set, this bit resets the PHY layer registers to their default state and reinitializes internal state machines. Once the reset operation has completed, this bit is cleared by hardware.</p>						
14	LOOPBK	R/W	0	<p>Loopback Mode</p> <p>When set, this bit enables the Loopback mode of operation. The receiver ignores external inputs and receives the data that is transmitted by the transmitter.</p>						
13	SPEEDSL	R/W	1	<p>Speed Select</p> <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>1</td> <td>Enables the 100 Mb/s mode of operation (100BASE-TX).</td> </tr> <tr> <td>0</td> <td>Enables the 10 Mb/s mode of operation (10BASE-T).</td> </tr> </table>	Value	Description	1	Enables the 100 Mb/s mode of operation (100BASE-TX).	0	Enables the 10 Mb/s mode of operation (10BASE-T).
Value	Description									
1	Enables the 100 Mb/s mode of operation (100BASE-TX).									
0	Enables the 10 Mb/s mode of operation (10BASE-T).									
12	ANEGEN	R/W	1	<p>Auto-Negotiation Enable</p> <p>When set, this bit enables the auto-negotiation process.</p>						
11	PWRDN	R/W	0	<p>Power Down</p> <p>When set, this bit places the PHY layer into a low-power consuming state. All data on the data inputs is ignored.</p>						
10	ISO	R/W	0	<p>Isolate</p> <p>When set, this bit isolates the transmit and receive data paths and ignores all data being transmitted and received.</p>						
9	RANEG	R/W	0	<p>Restart Auto-Negotiation</p> <p>When set, this bit restarts the auto-negotiation process. Once the restart has initiated, this bit is cleared by hardware.</p>						

Bit/Field	Name	Type	Reset	Description
8	DUPLEX	R/W	1	Set Duplex Mode  Value Description 1 Enables the Full-Duplex mode of operation. This bit can be set by software in a manual configuration process or by the auto-negotiation process. 0 Enables the Half-Duplex mode of operation.
7	COLT	R/W	0	Collision Test When set, this bit enables the Collision Test mode of operation. The COLT bit is set after the initiation of a transmission and is cleared once the transmission is halted.
6:0	reserved	R/W	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. These bits should always be written as zero.

## Register 16: Ethernet PHY Management Register 1 – Status (MR1), address 0x01

This register enables software to determine the capabilities of the PHY layer and perform its initialization and operation appropriately.

### Ethernet PHY Management Register 1 – Status (MR1)

Base 0x4004.8000

Address 0x01

Type RO, reset 0x7849

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved	100X_F	100X_H	10T_F	10T_H	reserved				MFPS	ANEGC	RFAULT	ANEGA	LINK	JAB	EXTD
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RC	RO	RO	RC	RO
Reset	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0	1

Bit/Field	Name	Type	Reset	Description
15	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
14	100X_F	RO	1	100BASE-TX Full-Duplex Mode When set, this bit indicates that the Ethernet Controller is capable of supporting 100BASE-TX Full-Duplex mode.
13	100X_H	RO	1	100BASE-TX Half-Duplex Mode When set, this bit indicates that the Ethernet Controller is capable of supporting 100BASE-TX Half-Duplex mode.
12	10T_F	RO	1	10BASE-T Full-Duplex Mode When set, this bit indicates that the Ethernet Controller is capable of 10BASE-T Full-Duplex mode.
11	10T_H	RO	1	10BASE-T Half-Duplex Mode When set, this bit indicates that the Ethernet Controller is capable of supporting 10BASE-T Half-Duplex mode.
10:7	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
6	MFPS	RO	1	Management Frames with Preamble Suppressed When set, this bit indicates that the Management Interface is capable of receiving management frames with the preamble suppressed.
5	ANEGC	RO	0	Auto-Negotiation Complete When set, this bit indicates that the auto-negotiation process has been completed and that the extended registers defined by the auto-negotiation protocol are valid.
4	RFAULT	RC	0	Remote Fault When set, this bit indicates that a remote fault condition has been detected. This bit remains set until it is read, even if the condition no longer exists.
3	ANEGA	RO	1	Auto-Negotiation When set, this bit indicates that the Ethernet Controller has the ability to perform auto-negotiation.

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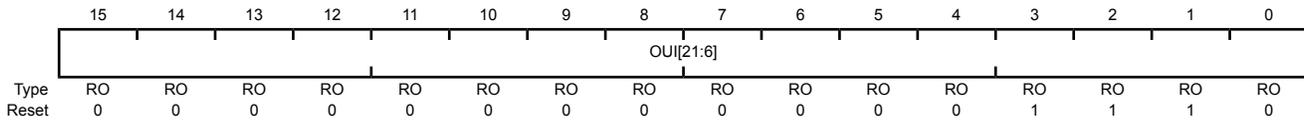
Bit/Field	Name	Type	Reset	Description
2	LINK	RO	0	Link Made When set, this bit indicates that a valid link has been established by the Ethernet Controller.
1	JAB	RC	0	Jabber Condition When set, this bit indicates that a jabber condition has been detected by the Ethernet Controller. This bit remains set until it is read, even if the jabber condition no longer exists.
0	EXTD	RO	1	Extended Capabilities When set, this bit indicates that the Ethernet Controller provides an extended set of capabilities that can be accessed through the extended register set.

**Register 17: Ethernet PHY Management Register 2 – PHY Identifier 1 (MR2), address 0x02**

This register, along with **MR3**, provides a 32-bit value indicating the manufacturer, model, and revision information.

Ethernet PHY Management Register 2 – PHY Identifier 1 (MR2)

Base 0x4004.8000  
 Address 0x02  
 Type RO, reset 0x000E



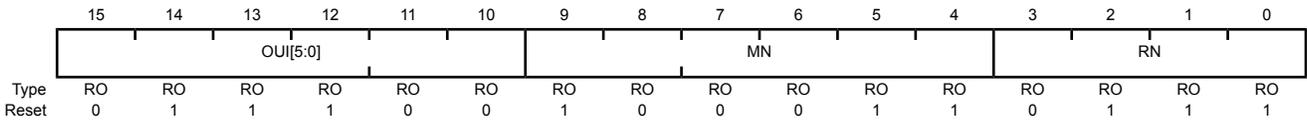
Bit/Field	Name	Type	Reset	Description
15:0	OUI[21:6]	RO	0x000E	Organizationally Unique Identifier[21:6] This field, along with the OUI[5:0] field in <b>MR3</b> , makes up the Organizationally Unique Identifier indicating the PHY manufacturer.

**Register 18: Ethernet PHY Management Register 3 – PHY Identifier 2 (MR3), address 0x03**

This register, along with **MR2**, provides a 32-bit value indicating the manufacturer, model, and revision information.

Ethernet PHY Management Register 3 – PHY Identifier 2 (MR3)

Base 0x4004.8000  
 Address 0x03  
 Type RO, reset 0x7237



Bit/Field	Name	Type	Reset	Description
15:10	OUI[5:0]	RO	0x1C	Organizationally Unique Identifier[5:0] This field, along with the OUI [ 21 : 6 ] field in <b>MR2</b> , makes up the Organizationally Unique Identifier indicating the PHY manufacturer.
9:4	MN	RO	0x23	Model Number The MN field represents the Model Number of the PHY.
3:0	RN	RO	0x7	Revision Number The RN field represents the Revision Number of the PHY implementation.

## Register 19: Ethernet PHY Management Register 4 – Auto-Negotiation Advertisement (MR4), address 0x04

This register provides the advertised abilities of the Ethernet Controller used during auto-negotiation. Bits 8:5 represent the Technology Ability Field bits. This field can be overwritten by software to auto-negotiate to an alternate common technology. Writing to this register has no effect until auto-negotiation is re-initiated by setting the `RANEG` bit in the **MR0** register.

### Ethernet PHY Management Register 4 – Auto-Negotiation Advertisement (MR4)

Base 0x4004.8000  
Address 0x04  
Type R/W, reset 0x01E1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	NP	reserved	RF	reserved			A3	A2	A1	A0	S					
Type	RO	RO	R/W	RO	RO	RO	RO	R/W	R/W	R/W	R/W	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1

Bit/Field	Name	Type	Reset	Description
15	NP	RO	0	Next Page When set, this bit indicates the Ethernet Controller is capable of Next Page exchanges to provide more detailed information on the PHY layer's capabilities.
14	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
13	RF	R/W	0	Remote Fault When set, this bit indicates to the link partner that a Remote Fault condition has been encountered.
12:9	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
8	A3	R/W	1	Technology Ability Field[3] When set, this bit indicates that the Ethernet Controller supports the 100Base-TX full-duplex signaling protocol. If software wants to ensure that this mode is not used, this bit can be cleared and auto-negotiation re-initiated with the <code>RANEG</code> bit in the <b>MR0</b> register.
7	A2	R/W	1	Technology Ability Field[2] When set, this bit indicates that the Ethernet Controller supports the 100Base-TX half-duplex signaling protocol. If software wants to ensure that this mode is not used, this bit can be cleared and auto-negotiation re-initiated with the <code>RANEG</code> bit in the <b>MR0</b> register.
6	A1	R/W	1	Technology Ability Field[1] When set, this bit indicates that the Ethernet Controller supports the 10BASE-T full-duplex signaling protocol. If software wants to ensure that this mode is not used, this bit can be cleared and auto-negotiation re-initiated with the <code>RANEG</code> bit in the <b>MR0</b> register..

---

Bit/Field	Name	Type	Reset	Description
5	A0	R/W	1	Technology Ability Field[0] When set, this bit indicates that the Ethernet Controller supports the 10BASE-T half-duplex signaling protocol. If software wants to ensure that this mode is not used, this bit can be cleared and auto-negotiation re-initiated with the <code>RANEG</code> bit in the <b>MRO</b> register..
4:0	S	RO	0x1	Selector Field The <code>s</code> field encodes 32 possible messages for communicating between Ethernet Controllers. This field is hard-coded to 0x01, indicating that the Stellaris Ethernet Controller is <i>IEEE 802.3</i> compliant.

## Register 20: Ethernet PHY Management Register 5 – Auto-Negotiation Link Partner Base Page Ability (MR5), address 0x05

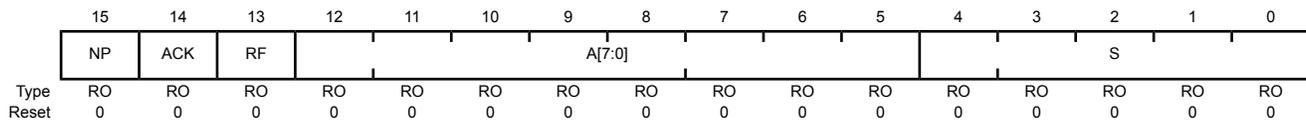
This register provides the advertised abilities of the link partner's Ethernet Controller that are received and stored during auto-negotiation.

### Ethernet PHY Management Register 5 – Auto-Negotiation Link Partner Base Page Ability (MR5)

Base 0x4004.8000

Address 0x05

Type RO, reset 0x0000



Bit/Field	Name	Type	Reset	Description														
15	NP	RO	0	<p>Next Page</p> <p>When set, this bit indicates that the link partner's Ethernet Controller is capable of Next page exchanges to provide more detailed information on the Ethernet Controller's capabilities.</p>														
14	ACK	RO	0	<p>Acknowledge</p> <p>When set, this bit indicates that the Ethernet Controller has successfully received the link partner's advertised abilities during auto-negotiation.</p>														
13	RF	RO	0	<p>Remote Fault</p> <p>Used as a standard transport mechanism for transmitting simple fault information from the link partner.</p>														
12:5	A[7:0]	RO	0x00	<p>Technology Ability Field</p> <p>The A[7:0] field encodes individual technologies that are supported by the Ethernet Controller. See the <b>MR4</b> register for definitions. Note that bits 12:9 describe functions that are not implemented on the Stellaris Ethernet Controller. Refer to the IEEE 802.3 standard for definitions.</p>														
4:0	S	RO	0x00	<p>Selector Field</p> <p>The S field encodes possible messages for communicating between Ethernet Controllers.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x00</td> <td>Reserved</td> </tr> <tr> <td>0x01</td> <td>IEEE Std 802.3</td> </tr> <tr> <td>0x02</td> <td>IEEE Std 802.9 ISLAN-16T</td> </tr> <tr> <td>0x03</td> <td>IEEE Std 802.5</td> </tr> <tr> <td>0x04</td> <td>IEEE Std 1394</td> </tr> <tr> <td>0x05–0x1F</td> <td>Reserved</td> </tr> </tbody> </table>	Value	Description	0x00	Reserved	0x01	IEEE Std 802.3	0x02	IEEE Std 802.9 ISLAN-16T	0x03	IEEE Std 802.5	0x04	IEEE Std 1394	0x05–0x1F	Reserved
Value	Description																	
0x00	Reserved																	
0x01	IEEE Std 802.3																	
0x02	IEEE Std 802.9 ISLAN-16T																	
0x03	IEEE Std 802.5																	
0x04	IEEE Std 1394																	
0x05–0x1F	Reserved																	

## Register 21: Ethernet PHY Management Register 6 – Auto-Negotiation Expansion (MR6), address 0x06

This register enables software to determine the auto-negotiation and next page capabilities of the Ethernet Controller and the link partner after auto-negotiation.

### Ethernet PHY Management Register 6 – Auto-Negotiation Expansion (MR6)

Base 0x4004.8000

Address 0x06

Type RO, reset 0x0000

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved											PDF	LPNPA	reserved	PRX	LPANEGA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RC	RO	RO	RC	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
15:5	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
4	PDF	RC	0	Parallel Detection Fault When set, this bit indicates that more than one technology has been detected at link up. This bit is cleared when read.
3	LPNPA	RO	0	Link Partner is Next Page Able When set, this bit indicates that the link partner is enabled to support next page.
2	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	PRX	RC	0	New Page Received When set, this bit indicates that a new page has been received from the link partner and stored. This bit remains set until the register is read.
0	LPANEGA	RO	0	Link Partner is Auto-Negotiation Able When set, this bit indicates that the link partner is enabled to support auto-negotiation.

## Register 22: Ethernet PHY Management Register 16 – Vendor-Specific (MR16), address 0x10

This register enables software to configure the operation of vendor-specific modes of the Ethernet Controller.

### Ethernet PHY Management Register 16 – Vendor-Specific (MR16)

Base 0x4004.8000

Address 0x10

Type R/W, reset 0x0140

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Type	R/W	R/W0	RO	R/W	R/W	R/W	RO	RO	RO	RO	R/W	R/W	RO	RO	R/W	R/W
Reset	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
15	RPTR	R/W	0	<p>Repeater Mode</p> <p>When set, this bit enables the repeater mode of operation. In this mode, full-duplex is not allowed and the Carrier Sense signal only responds to receive activity.</p>
14	INPOL	R/W0	0	<p>Interrupt Polarity</p> <p>Value Description</p> <p>1 Sets the polarity of the PHY interrupt to be active High.</p> <p>0 Sets the polarity of the PHY interrupt to active Low.</p>
13	reserved	RO	0	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>
12	TXHIM	R/W	0	<p>Transmit High Impedance Mode</p> <p>When set, this bit enables the transmitter High Impedance mode. In this mode, the TXOP and TXON transmitter pins are put into a high impedance state. The RXIP and RXIN pins remain fully functional.</p>
11	SQEI	R/W	0	<p>SQE Inhibit Testing</p> <p>When set, this bit prohibits 10BASE-T SQE testing.</p> <p>When clear, the SQE testing is performed by generating a collision pulse following the completion of the transmission of a frame.</p>
10	NL10	R/W	0	<p>Natural Loopback Mode</p> <p>When set, this bit enables the 10BASE-T Natural Loopback mode. In this mode, the transmission data received by the Ethernet Controller is looped back onto the receive data path when 10BASE-T mode is enabled.</p>
9:6	reserved	RO	0x5	<p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p>

**Important:** Because the Media Access Controller expects active Low interrupts from the PHY, this bit must always be written with a 0 to ensure proper operation.

Bit/Field	Name	Type	Reset	Description
5	APOL	R/W	0	<p>Auto-Polarity Disable</p> <p>When set, this bit disables the Ethernet Controller's auto-polarity function. If this bit is clear, the Ethernet Controller automatically inverts the received signal due to a wrong polarity connection during auto-negotiation when in 10BASE-T mode.</p>
4	RVSPOL	R/W	0	<p>Receive Data Polarity</p> <p>This bit indicates whether the receive data pulses are being inverted. If the APOL bit is 0, then the RVSPOL bit is read-only and indicates whether the auto-polarity circuitry is reversing the polarity. In this case, if RVSPOL is set, it indicates that the receive data is inverted; if RVSPOL is clear, it indicates that the receive data is not inverted. If the APOL bit is 1, then the RVSPOL bit is writable and software can force the receive data to be inverted. Setting RVSPOL to 1 forces the receive data to be inverted; clearing RVSPOL does not invert the receive data.</p>
3:2	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	PCSBP	R/W	0	<p>PCS Bypass</p> <p>When set, this bit enables the bypass of the PCS and scrambling/descrambling functions in 100BASE-TX mode. This mode is only valid when auto-negotiation is disabled and 100BASE-TX mode is enabled.</p>
0	RXCC	R/W	0	<p>Receive Clock Control</p> <p>When set, this bit enables the Receive Clock Control power saving mode if the Ethernet Controller is configured in 100BASE-TX mode. This mode shuts down the receive clock when no data is being received to save power. This mode should not be used when PCSBP is enabled and is automatically disabled when the LOOPBK bit in the MR0 register is set.</p>

## Register 23: Ethernet PHY Management Register 17 – Interrupt Control/Status (MR17), address 0x11

This register provides the means for controlling and observing the events which trigger a PHY layer interrupt in the **MACRIS** register. This register can also be used in a polling mode via the Media Independent Interface as a means to observe key events within the PHY layer via one register address. Bits 0 through 7 are status bits which are each set based on an event. These bits are cleared after the register is read. Bits 8 through 15 of this register, when set, enable the corresponding bit in the lower byte to signal a PHY layer interrupt in the **MACRIS** register.

### Ethernet PHY Management Register 17 – Interrupt Control/Status (MR17)

Base 0x4004.8000

Address 0x11

Type R/W, reset 0x0000

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	JABBER_IE	RXER_IE	PRX_IE	PDF_IE	LPACK_IE	LSCHG_IE	RFAULT_IE	ANEGCOMP_IE	JABBER_INT	RXER_INT	PRX_INT	PDF_INT	LPACK_INT	LSCHG_INT	RFAULT_INT	ANEGCOMP_INT
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	RC	RC	RC	RC	RC	RC	RC	RC
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
15	JABBER_IE	R/W	0	Jabber Interrupt Enable When set, this bit enables system interrupts when a Jabber condition is detected by the Ethernet Controller.
14	RXER_IE	R/W	0	Receive Error Interrupt Enable When set, this bit enables system interrupts when a receive error is detected by the Ethernet Controller.
13	PRX_IE	R/W	0	Page Received Interrupt Enable When set, this bit enables system interrupts when a new page is received by the Ethernet Controller.
12	PDF_IE	R/W	0	Parallel Detection Fault Interrupt Enable When set, this bit enables system interrupts when a Parallel Detection Fault is detected by the Ethernet Controller.
11	LPACK_IE	R/W	0	LP Acknowledge Interrupt Enable When set, this bit enables system interrupts when FLP bursts are received with the <b>ACK</b> bit in the <b>MR5</b> register during auto-negotiation.
10	LSCHG_IE	R/W	0	Link Status Change Interrupt Enable When set, this bit enables system interrupts when the link status changes from OK to FAIL.
9	RFAULT_IE	R/W	0	Remote Fault Interrupt Enable When set, this bit enables system interrupts when a remote fault condition is signaled by the link partner.
8	ANEGCOMP_IE	R/W	0	Auto-Negotiation Complete Interrupt Enable When set, this bit enables system interrupts when the auto-negotiation sequence has completed successfully.

Bit/Field	Name	Type	Reset	Description
7	JABBER_INT	RC	0	Jabber Event Interrupt When set, this bit indicates that a Jabber event has been detected by the 10BASE-T circuitry.
6	RXER_INT	RC	0	Receive Error Interrupt When set, this bit indicates that a receive error has been detected by the Ethernet Controller.
5	PRX_INT	RC	0	Page Receive Interrupt When set, this bit indicates that a new page has been received from the link partner during auto-negotiation.
4	PDF_INT	RC	0	Parallel Detection Fault Interrupt When set, this bit indicates that a parallel detection fault has been detected by the Ethernet Controller during the auto-negotiation process.
3	LPACK_INT	RC	0	LP Acknowledge Interrupt When set, this bit indicates that an FLP burst has been received with the ACK bit set in the MR5 register during auto-negotiation.
2	LSCHG_INT	RC	0	Link Status Change Interrupt When set, this bit indicates that the link status has changed from OK to FAIL.
1	RFAULT_INT	RC	0	Remote Fault Interrupt When set, this bit indicates that a remote fault condition has been signaled by the link partner.
0	ANEGCOMP_INT	RC	0	Auto-Negotiation Complete Interrupt When set, this bit indicates that the auto-negotiation sequence has completed successfully.

## Register 24: Ethernet PHY Management Register 18 – Diagnostic (MR18), address 0x12

This register enables software to diagnose the results of the previous auto-negotiation.

### Ethernet PHY Management Register 18 – Diagnostic (MR18)

Base 0x4004.8000

Address 0x12

Type RO, reset 0x0000

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved			ANEGF	DPLX	RATE	RXSD	RX_LOCK	reserved							
Type	RO	RO	RO	RC	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
15:13	reserved	RO	0x0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
12	ANEGF	RC	0	Auto-Negotiation Failure When set, this bit indicates that no common technology was found during auto-negotiation and auto-negotiation has failed. This bit remains set until read.
11	DPLX	RO	0	Duplex Mode When set, this bit indicates that Full-Duplex was the highest common denominator found during the auto-negotiation process. Otherwise, Half-Duplex was the highest common denominator found.
10	RATE	RO	0	Rate When set, this bit indicates that 100BASE-TX was the highest common denominator found during the auto-negotiation process. Otherwise, 10BASE-T was the highest common denominator found.
9	RXSD	RO	0	Receive Detection When set, this bit indicates that receive signal detection has occurred (in 100BASE-TX mode) or that Manchester-encoded data has been detected (in 10BASE-T mode).
8	RX_LOCK	RO	0	Receive PLL Lock When set, this bit indicates that the Receive PLL has locked onto the receive signal for the selected speed of operation (10BASE-T or 100BASE-TX).
7:0	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 25: Ethernet PHY Management Register 19 – Transceiver Control (MR19), address 0x13

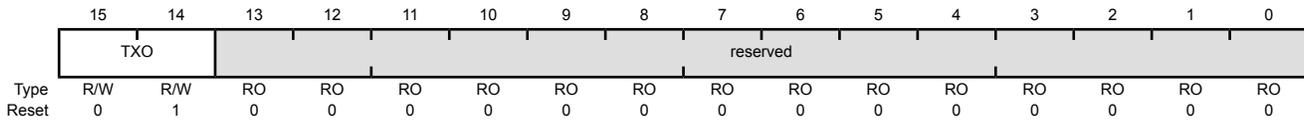
This register enables software to set the gain of the transmit output to compensate for transformer loss.

### Ethernet PHY Management Register 19 – Transceiver Control (MR19)

Base 0x4004.8000

Address 0x13

Type R/W, reset 0x4000



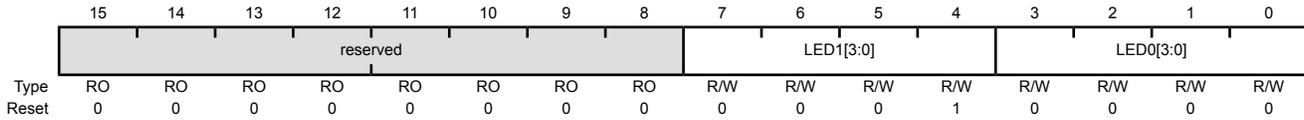
Bit/Field	Name	Type	Reset	Description
15:14	TXO	R/W	0x1	Transmit Amplitude Selection The TXO field sets the transmit output amplitude to account for transmit transformer insertion loss.
				Value Description 0x0 Gain set for 0.0dB of insertion loss 0x1 Gain set for 0.4dB of insertion loss 0x2 Gain set for 0.8dB of insertion loss 0x3 Gain set for 1.2dB of insertion loss
13:0	reserved	RO	0x000	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 26: Ethernet PHY Management Register 23 – LED Configuration (MR23), address 0x17

This register enables software to select the source that causes the LED1 and LED0 signals to toggle.

### Ethernet PHY Management Register 23 – LED Configuration (MR23)

Base 0x4004.8000  
 Address 0x17  
 Type R/W, reset 0x0010



Bit/Field	Name	Type	Reset	Description																				
15:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.																				
7:4	LED1[3:0]	R/W	0x1	<p>LED1 Source</p> <p>The LED1 field selects the source that toggles the LED1 signal.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x0</td><td>Link OK</td></tr> <tr><td>0x1</td><td>RX or TX Activity (Default LED1)</td></tr> <tr><td>0x2</td><td>Reserved</td></tr> <tr><td>0x3</td><td>Reserved</td></tr> <tr><td>0x4</td><td>Reserved</td></tr> <tr><td>0x5</td><td>100BASE-TX mode</td></tr> <tr><td>0x6</td><td>10BASE-T mode</td></tr> <tr><td>0x7</td><td>Full-Duplex</td></tr> <tr><td>0x8</td><td>Link OK &amp; Blink=RX or TX Activity</td></tr> </tbody> </table>	Value	Description	0x0	Link OK	0x1	RX or TX Activity (Default LED1)	0x2	Reserved	0x3	Reserved	0x4	Reserved	0x5	100BASE-TX mode	0x6	10BASE-T mode	0x7	Full-Duplex	0x8	Link OK & Blink=RX or TX Activity
Value	Description																							
0x0	Link OK																							
0x1	RX or TX Activity (Default LED1)																							
0x2	Reserved																							
0x3	Reserved																							
0x4	Reserved																							
0x5	100BASE-TX mode																							
0x6	10BASE-T mode																							
0x7	Full-Duplex																							
0x8	Link OK & Blink=RX or TX Activity																							
3:0	LED0[3:0]	R/W	0x0	<p>LED0 Source</p> <p>The LED0 field selects the source that toggles the LED0 signal.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x0</td><td>Link OK (Default LED0)</td></tr> <tr><td>0x1</td><td>RX or TX Activity</td></tr> <tr><td>0x2</td><td>Reserved</td></tr> <tr><td>0x3</td><td>Reserved</td></tr> <tr><td>0x4</td><td>Reserved</td></tr> <tr><td>0x5</td><td>100BASE-TX mode</td></tr> <tr><td>0x6</td><td>10BASE-T mode</td></tr> <tr><td>0x7</td><td>Full-Duplex</td></tr> <tr><td>0x8</td><td>Link OK &amp; Blink=RX or TX Activity</td></tr> </tbody> </table>	Value	Description	0x0	Link OK (Default LED0)	0x1	RX or TX Activity	0x2	Reserved	0x3	Reserved	0x4	Reserved	0x5	100BASE-TX mode	0x6	10BASE-T mode	0x7	Full-Duplex	0x8	Link OK & Blink=RX or TX Activity
Value	Description																							
0x0	Link OK (Default LED0)																							
0x1	RX or TX Activity																							
0x2	Reserved																							
0x3	Reserved																							
0x4	Reserved																							
0x5	100BASE-TX mode																							
0x6	10BASE-T mode																							
0x7	Full-Duplex																							
0x8	Link OK & Blink=RX or TX Activity																							

## Register 27: Ethernet PHY Management Register 24 –MDI/MDIX Control (MR24), address 0x18

This register enables software to control the behavior of the MDI/MDIX mux and its switching capabilities.

### Ethernet PHY Management Register 24 –MDI/MDIX Control (MR24)

Base 0x4004.8000

Address 0x18

Type R/W, reset 0x00C0

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved								PD_MODE	AUTO_SW	MDIX	MDIX_CM	MDIX_SD			
Type	RO	RO	RO	RO	RO	RO	RO	RO	R/W	R/W	R/W	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
15:8	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
7	PD_MODE	R/W	1	Parallel Detection Mode When set, enables the Parallel Detection mode and allows auto-switching to work when auto-negotiation is not enabled.
6	AUTO_SW	R/W	1	Auto-Switching Enable When set, enables Auto-Switching of the MDI/MDIX mux.
5	MDIX	R/W	0	Auto-Switching Configuration When set, indicates that the MDI/MDIX mux is in the crossover (MDIX) configuration. When 0, it indicates that the mux is in the pass-through (MDI) configuration. When the AUTO_SW bit is 1, the MDIX bit is read-only. When the AUTO_SW bit is 0, the MDIX bit is read/write and can be configured manually.
4	MDIX_CM	RO	0	Auto-Switching Complete When set, indicates that the auto-switching sequence has completed. If 0, it indicates that the sequence has not completed or that auto-switching is disabled.
3:0	MDIX_SD	R/W	0x0	Auto-Switching Seed This field provides the initial seed for the switching algorithm. This seed directly affects the number of attempts [5,4] respectively to write bits [3:0]. A 0 sets the seed to 0x5.

## 13 Analog Comparator

An analog comparator is a peripheral that compares two analog voltages, and provides a logical output that signals the comparison result.

**Note:** Not all comparators have the option to drive an output pin.

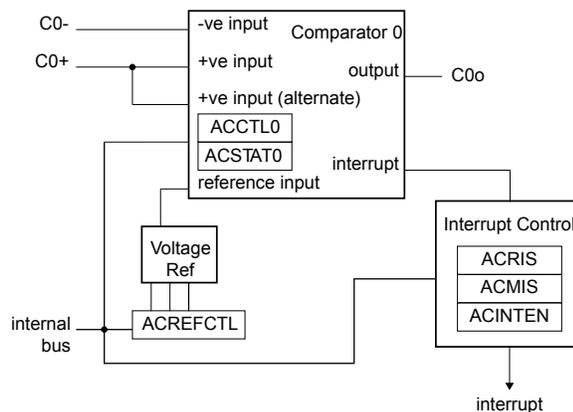
The comparator can provide its output to a device pin, acting as a replacement for an analog comparator on the board, or it can be used to signal the application via interrupts to cause it to start capturing a sample sequence.

The Stellaris® Analog Comparators module has the following features:

- One integrated analog comparator
- Configurable for output to drive an output pin or generate an interrupt
- Compare external pin input to external pin input or to internal programmable voltage reference
- Compare a test voltage against any one of these voltages
  - An individual external reference voltage
  - A shared single external reference voltage
  - A shared internal reference voltage

### 13.1 Block Diagram

Figure 13-1. Analog Comparator Module Block Diagram



### 13.2 Signal Description

Table 13-1 on page 477 and Table 13-2 on page 477 list the external signals of the Analog Comparators and describe the function of each. The Analog Comparator output signal is an alternate functions for a GPIO signal and default to be a GPIO signal at reset. The column in the table below titled "Pin Assignment" lists the possible GPIO pin placements for the Analog Comparator signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 263) should be set to choose the Analog Comparator function. The positive and negative input signal are configured by clearing

the DEN bit in the **GPIO Digital Enable (GPIODEN)** register. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 243.

**Table 13-1. Analog Comparators Signals (100LQFP)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
C0+	90	I	Analog	Analog comparator 0 positive input.
C0-	92	I	Analog	Analog comparator 0 negative input.
C0o	91	O	TTL	Analog comparator 0 output.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

**Table 13-2. Analog Comparators Signals (108BGA)**

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
C0+	A7	I	Analog	Analog comparator 0 positive input.
C0-	A6	I	Analog	Analog comparator 0 negative input.
C0o	B7	O	TTL	Analog comparator 0 output.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

### 13.3 Functional Description

**Important:** It is recommended that the Digital-Input enable (the GPIODEN bit in the GPIO module) for the analog input pin be disabled to prevent excessive current draw from the I/O pads.

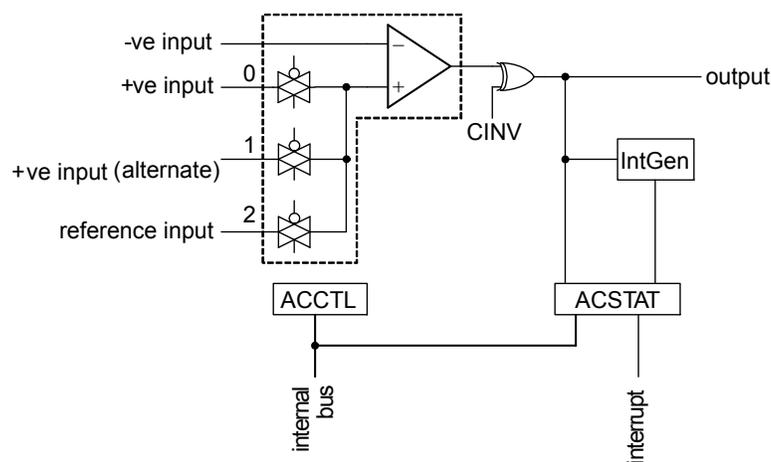
The comparator compares the VIN- and VIN+ inputs to produce an output, VOUT.

$$VIN- < VIN+, VOUT = 1$$

$$VIN- > VIN+, VOUT = 0$$

As shown in Figure 13-2 on page 477, the input source for VIN- is an external input. In addition to an external input, input sources for VIN+ can be the +ve input of comparator 0 or an internal reference.

**Figure 13-2. Structure of Comparator Unit**



A comparator is configured through two status/control registers (**ACCTL** and **ACSTAT**). The internal reference is configured through one control register (**ACREFCTL**). Interrupt status and control is configured through three registers (**ACMIS**, **ACRIS**, and **ACINTEN**).

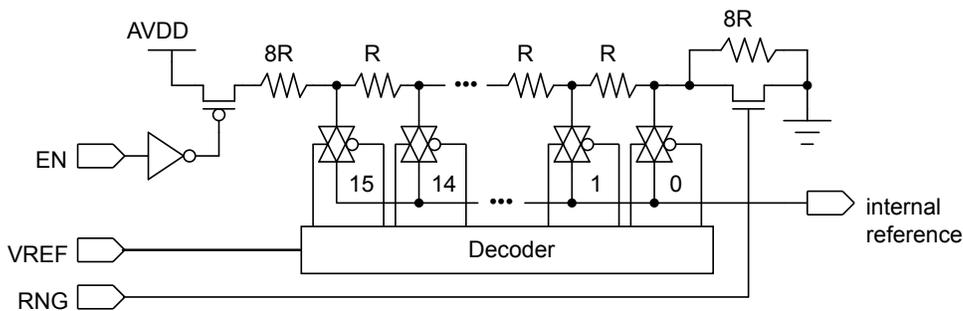
Typically, the comparator output is used internally to generate controller interrupts. It may also be used to drive an external pin.

**Important:** The **ASRCP** bits in the **ACCTLn** register must be set before using the analog comparators.

### 13.3.1 Internal Reference Programming

The structure of the internal reference is shown in Figure 13-3 on page 478. This is controlled by a single configuration register (**ACREFCTL**). Table 13-3 on page 478 shows the programming options to develop specific internal reference values, to compare an external voltage against a particular voltage generated internally.

**Figure 13-3. Comparator Internal Reference Structure**



**Table 13-3. Internal Reference Voltage and ACREFCTL Field Values**

ACREFCTL Register		Output Reference Voltage Based on VREF Field Value
EN Bit Value	RNG Bit Value	
EN=0	RNG=X	0 V (GND) for any value of VREF; however, it is recommended that RNG=1 and VREF=0 for the least noisy ground reference.

Table 13-3. Internal Reference Voltage and ACREFCTL Field Values (continued)

ACREFCTL Register		Output Reference Voltage Based on VREF Field Value
EN Bit Value	RNG Bit Value	
EN=1	RNG=0	<p>Total resistance in ladder is 31 R.</p> $V_{REF} = AV_{DD} \times \frac{R_{VREF}}{R_T}$ $V_{REF} = AV_{DD} \times \frac{(VREF + 8)}{31}$ $V_{REF} = 0.85 + 0.106 \times VREF$ <p>The range of internal reference in this mode is 0.85-2.448 V.</p>
	RNG=1	<p>Total resistance in ladder is 23 R.</p> $V_{REF} = AV_{DD} \times \frac{R_{VREF}}{R_T}$ $V_{REF} = AV_{DD} \times \frac{VREF}{23}$ $V_{REF} = 0.143 \times VREF$ <p>The range of internal reference for this mode is 0-2.152 V.</p>

## 13.4 Initialization and Configuration

The following example shows how to configure an analog comparator to read back its output value from an internal register.

1. Enable the analog comparator 0 clock by writing a value of 0x0010.0000 to the **RCGC1** register in the System Control module.
2. In the GPIO module, enable the GPIO port/pin associated with C0- as a GPIO input.
3. Configure the internal voltage reference to 1.65 V by writing the **ACREFCTL** register with the value 0x0000.030C.
4. Configure comparator 0 to use the internal voltage reference and to *not* invert the output by writing the **ACCTL0** register with the value of 0x0000.040C.
5. Delay for some time.
6. Read the comparator output value by reading the **ACSTAT0** register's OVAL value.

Change the level of the signal input on C0- to see the OVAL value change.

## 13.5 Register Map

Table 13-4 on page 480 lists the comparator registers. The offset listed is a hexadecimal increment to the register's address, relative to the Analog Comparator base address of 0x4003.C000.

Note that the analog comparator module clock must be enabled before the registers can be programmed (see page 201). There must be a delay of 3 system clocks after the ADC module clock is enabled before any ADC module registers are accessed.

**Table 13-4. Analog Comparators Register Map**

Offset	Name	Type	Reset	Description	See page
0x000	ACMIS	R/W1C	0x0000.0000	Analog Comparator Masked Interrupt Status	481
0x004	ACRIS	RO	0x0000.0000	Analog Comparator Raw Interrupt Status	482
0x008	ACINTEN	R/W	0x0000.0000	Analog Comparator Interrupt Enable	483
0x010	ACREFCTL	R/W	0x0000.0000	Analog Comparator Reference Voltage Control	484
0x020	ACSTAT0	RO	0x0000.0000	Analog Comparator Status 0	485
0x024	ACCTL0	R/W	0x0000.0000	Analog Comparator Control 0	486

## 13.6 Register Descriptions

The remainder of this section lists and describes the Analog Comparator registers, in numerical order by address offset.

**Register 1: Analog Comparator Masked Interrupt Status (ACMIS), offset 0x000**

This register provides a summary of the interrupt status (masked) of the comparator.

**Analog Comparator Masked Interrupt Status (ACMIS)**

Base 0x4003.C000

Offset 0x000

Type R/W1C, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W1C
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	IN0	R/W1C	0	Comparator 0 Masked Interrupt Status Gives the masked interrupt state of this interrupt. Write 1 to this bit to clear the pending interrupt.

## Register 2: Analog Comparator Raw Interrupt Status (ACRIS), offset 0x004

This register provides a summary of the interrupt status (raw) of the comparator.

### Analog Comparator Raw Interrupt Status (ACRIS)

Base 0x4003.C000

Offset 0x004

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	IN0	RO	0	Comparator 0 Interrupt Status When set, indicates that an interrupt has been generated by comparator 0.

**Register 3: Analog Comparator Interrupt Enable (ACINTEN), offset 0x008**

This register provides the interrupt enable for the comparator.

**Analog Comparator Interrupt Enable (ACINTEN)**

Base 0x4003.C000

Offset 0x008

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved															IN0
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:1	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
0	IN0	R/W	0	Comparator 0 Interrupt Enable When set, enables the controller interrupt from the comparator 0 output.

## Register 4: Analog Comparator Reference Voltage Control (ACREFCTL), offset 0x010

This register specifies whether the resistor ladder is powered on as well as the range and tap.

### Analog Comparator Reference Voltage Control (ACREFCTL)

Base 0x4003.C000

Offset 0x010

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved						EN	RNG	reserved				VREF			
Type	RO	RO	RO	RO	RO	RO	R/W	R/W	RO	RO	RO	RO	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:10	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
9	EN	R/W	0	<p>Resistor Ladder Enable</p> <p>The EN bit specifies whether the resistor ladder is powered on. If 0, the resistor ladder is unpowered. If 1, the resistor ladder is connected to the analog <math>V_{DD}</math>.</p> <p>This bit is reset to 0 so that the internal reference consumes the least amount of power if not used and programmed.</p>
8	RNG	R/W	0	<p>Resistor Ladder Range</p> <p>The RNG bit specifies the range of the resistor ladder. If 0, the resistor ladder has a total resistance of 31 R. If 1, the resistor ladder has a total resistance of 23 R.</p>
7:4	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
3:0	VREF	R/W	0x00	<p>Resistor Ladder Voltage Ref</p> <p>The VREF bit field specifies the resistor ladder tap that is passed through an analog multiplexer. The voltage corresponding to the tap position is the internal reference voltage available for comparison. See Table 13-3 on page 478 for some output reference voltage examples.</p>

**Register 5: Analog Comparator Status 0 (ACSTAT0), offset 0x020**

This register specifies the current output value of the comparator.

**Analog Comparator Status 0 (ACSTAT0)**

Base 0x4003.C000

Offset 0x020

Type RO, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
	reserved																
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	reserved															OVAL	reserved
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description
31:2	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.
1	OVAL	RO	0	Comparator Output Value The OVAL bit specifies the current output value of the comparator.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

## Register 6: Analog Comparator Control 0 (ACCTL0), offset 0x024

This register configures the comparator's input and output.

### Analog Comparator Control 0 (ACCTL0)

Base 0x4003.C000

Offset 0x024

Type R/W, reset 0x0000.0000

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	reserved				ASRCP		reserved				ISLVAL	ISEN		CINV	reserved	
Type	RO	RO	RO	RO	RO	R/W	R/W	RO	RO	RO	RO	R/W	R/W	R/W	R/W	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit/Field	Name	Type	Reset	Description										
31:11	reserved	RO	0x00	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
10:9	ASRCP	R/W	0x00	<p>Analog Source Positive</p> <p>The <code>ASRCP</code> field specifies the source of input voltage to the <code>VIN+</code> terminal of the comparator. The encodings for this field are as follows:</p> <table border="0"> <tr> <td>Value</td> <td>Function</td> </tr> <tr> <td>0x0</td> <td>Pin value</td> </tr> <tr> <td>0x1</td> <td>Pin value of C0+</td> </tr> <tr> <td>0x2</td> <td>Internal voltage reference</td> </tr> <tr> <td>0x3</td> <td>Reserved</td> </tr> </table>	Value	Function	0x0	Pin value	0x1	Pin value of C0+	0x2	Internal voltage reference	0x3	Reserved
Value	Function													
0x0	Pin value													
0x1	Pin value of C0+													
0x2	Internal voltage reference													
0x3	Reserved													
8:5	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.										
4	ISLVAL	R/W	0	<p>Interrupt Sense Level Value</p> <p>The <code>ISLVAL</code> bit specifies the sense value of the input that generates an interrupt if in Level Sense mode. If 0, an interrupt is generated if the comparator output is Low. Otherwise, an interrupt is generated if the comparator output is High.</p>										
3:2	ISEN	R/W	0x0	<p>Interrupt Sense</p> <p>The <code>ISEN</code> field specifies the sense of the comparator output that generates an interrupt. The sense conditioning is as follows:</p> <table border="0"> <tr> <td>Value</td> <td>Function</td> </tr> <tr> <td>0x0</td> <td>Level sense, see <code>ISLVAL</code></td> </tr> <tr> <td>0x1</td> <td>Falling edge</td> </tr> <tr> <td>0x2</td> <td>Rising edge</td> </tr> <tr> <td>0x3</td> <td>Either edge</td> </tr> </table>	Value	Function	0x0	Level sense, see <code>ISLVAL</code>	0x1	Falling edge	0x2	Rising edge	0x3	Either edge
Value	Function													
0x0	Level sense, see <code>ISLVAL</code>													
0x1	Falling edge													
0x2	Rising edge													
0x3	Either edge													

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Bit/Field	Name	Type	Reset	Description
1	CINV	R/W	0	Comparator Output Invert The CINV bit conditionally inverts the output of the comparator. If 0, the output of the comparator is unchanged. If 1, the output of the comparator is inverted prior to being processed by hardware.
0	reserved	RO	0	Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.

# 14 Pin Diagram

The LM3S6100 microcontroller pin diagrams are shown below.

Figure 14-1. 100-Pin LQFP Package Pin Diagram

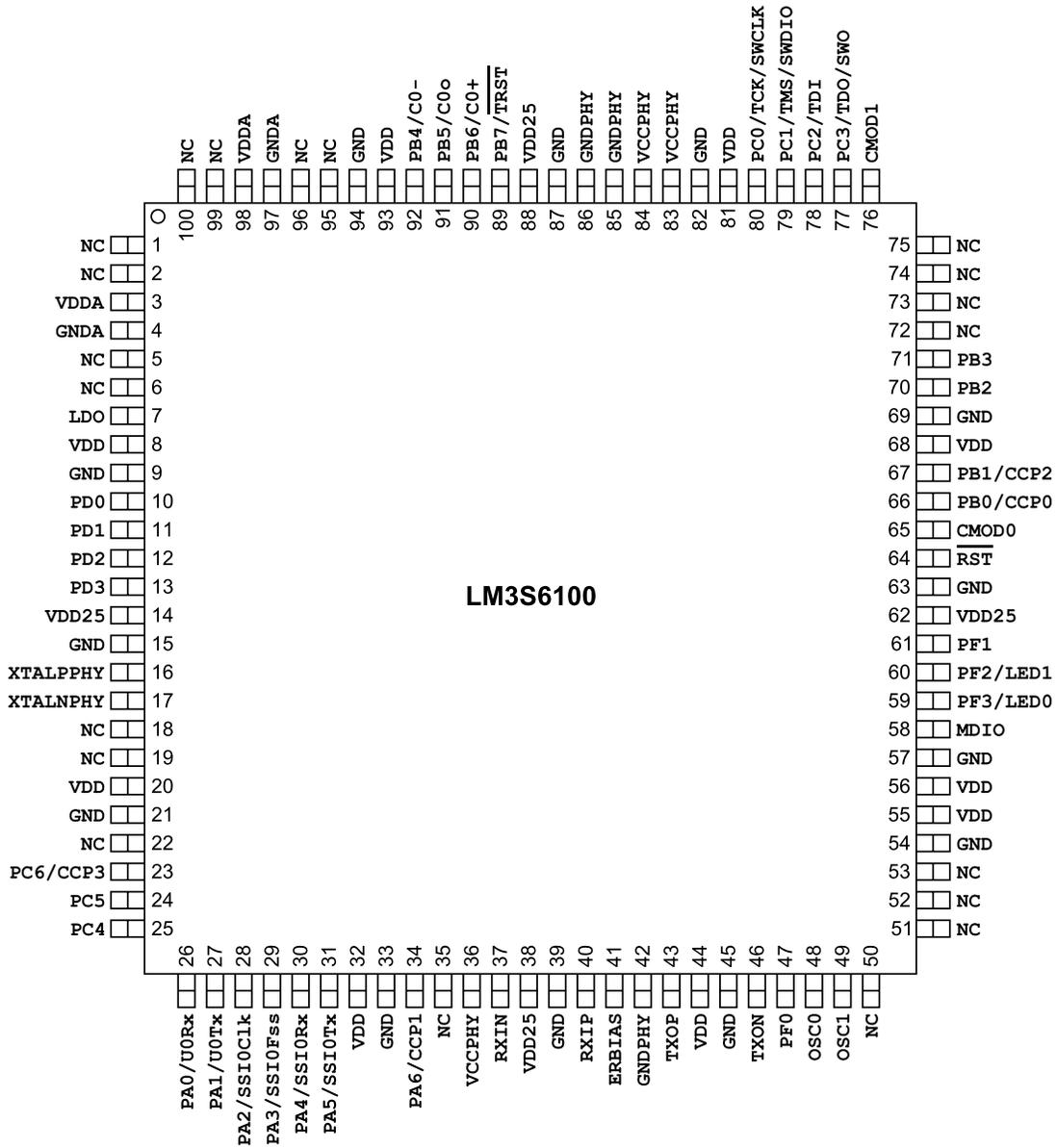
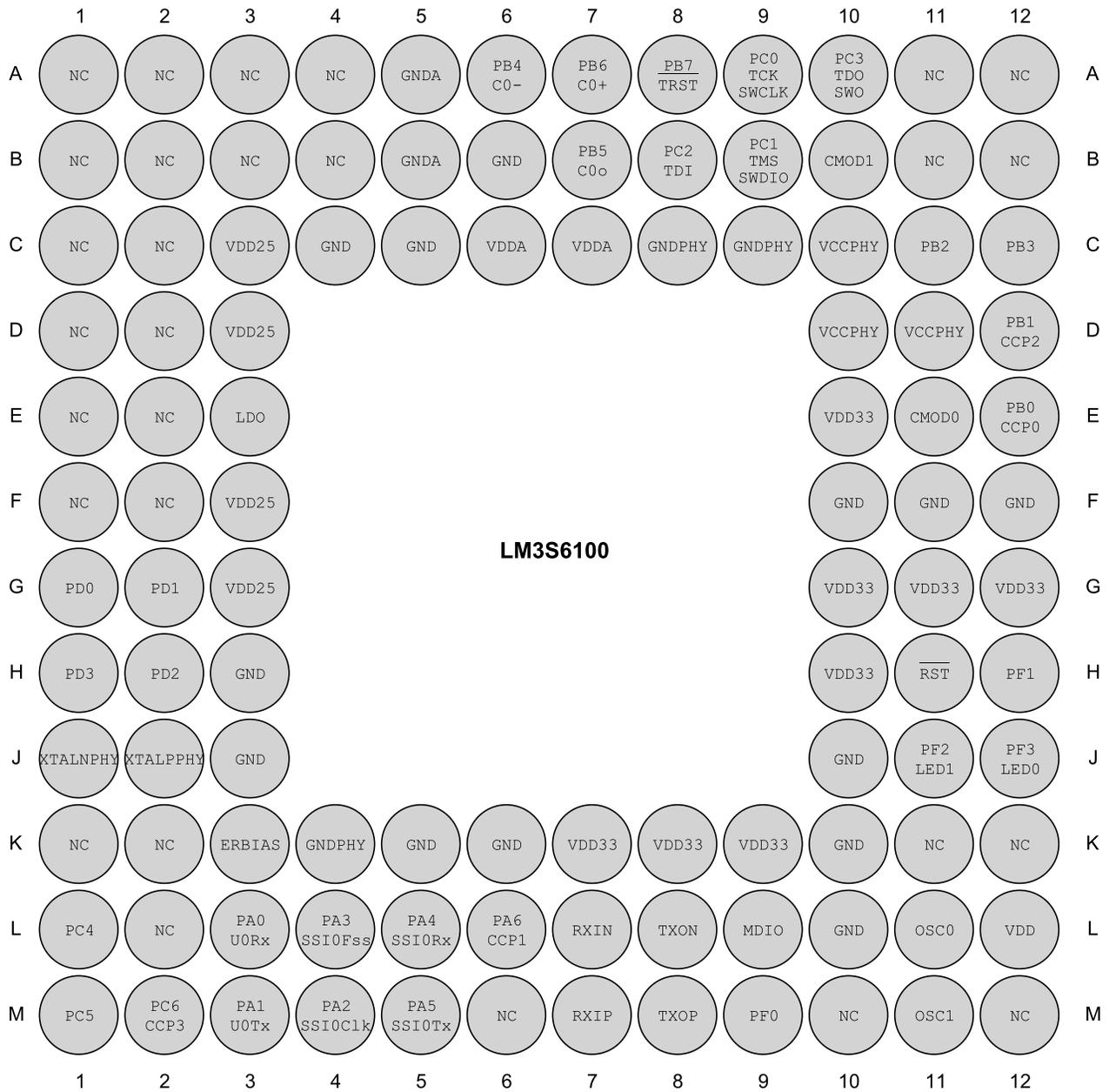


Figure 14-2. 108-Ball BGA Package Pin Diagram (Top View)



## 15 Signal Tables

**Important:** All multiplexed pins are GPIOs by default, with the exception of the five JTAG pins ( $PB7$  and  $PC[3:0]$ ) which default to the JTAG functionality.

The following tables list the signals available for each pin. Functionality is enabled by software with the **GPIOAFSEL** register. All digital inputs are Schmitt triggered.

- Signals by Pin Number
- Signals by Signal Name
- Signals by Function, Except for GPIO
- GPIO Pins and Alternate Functions
- Connections for Unused Signals

### 15.1 100-Pin LQFP Package Pin Tables

#### 15.1.1 Signals by Pin Number

Table 15-1. Signals by Pin Number

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
3	VDDA	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
4	GNDA	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
5	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
6	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
7	LDO	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 $\mu$ F or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
8	VDD	-	Power	Positive supply for I/O and some logic.
9	GND	-	Power	Ground reference for logic and I/O pins.
10	PD0	I/O	TTL	GPIO port D bit 0.
11	PD1	I/O	TTL	GPIO port D bit 1.
12	PD2	I/O	TTL	GPIO port D bit 2.
13	PD3	I/O	TTL	GPIO port D bit 3.
14	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
15	GND	-	Power	Ground reference for logic and I/O pins.
16	XTALPPHY	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.

Table 15-1. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
17	XTALNPHY	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
18	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
19	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
20	VDD	-	Power	Positive supply for I/O and some logic.
21	GND	-	Power	Ground reference for logic and I/O pins.
22	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
23	PC6	I/O	TTL	GPIO port C bit 6.
	CCP3	I/O	TTL	Capture/Compare/PWM 3.
24	PC5	I/O	TTL	GPIO port C bit 5.
25	PC4	I/O	TTL	GPIO port C bit 4.
26	PA0	I/O	TTL	GPIO port A bit 0.
	U0Rx	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
27	PA1	I/O	TTL	GPIO port A bit 1.
	U0Tx	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.
28	PA2	I/O	TTL	GPIO port A bit 2.
	SSI0Clk	I/O	TTL	SSI module 0 clock.
29	PA3	I/O	TTL	GPIO port A bit 3.
	SSI0Fss	I/O	TTL	SSI module 0 frame signal.
30	PA4	I/O	TTL	GPIO port A bit 4.
	SSI0Rx	I	TTL	SSI module 0 receive.
31	PA5	I/O	TTL	GPIO port A bit 5.
	SSI0Tx	O	TTL	SSI module 0 transmit.
32	VDD	-	Power	Positive supply for I/O and some logic.
33	GND	-	Power	Ground reference for logic and I/O pins.
34	PA6	I/O	TTL	GPIO port A bit 6.
	CCP1	I/O	TTL	Capture/Compare/PWM 1.
35	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
36	VCCPHY	-	Power	VCC of the Ethernet PHY.
37	RXIN	I	Analog	RXIN of the Ethernet PHY.
38	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
39	GND	-	Power	Ground reference for logic and I/O pins.
40	RXIP	I	Analog	RXIP of the Ethernet PHY.
41	ERBIAS	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
42	GNDPHY	-	Power	GND of the Ethernet PHY.
43	TXOP	O	Analog	TXOP of the Ethernet PHY.
44	VDD	-	Power	Positive supply for I/O and some logic.
45	GND	-	Power	Ground reference for logic and I/O pins.
46	TXON	O	Analog	TXON of the Ethernet PHY.

Table 15-1. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
47	PF0	I/O	TTL	GPIO port F bit 0.
48	OSC0	I	Analog	Main oscillator crystal input or an external clock reference input.
49	OSC1	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
50	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
51	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
52	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
53	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
54	GND	-	Power	Ground reference for logic and I/O pins.
55	VDD	-	Power	Positive supply for I/O and some logic.
56	VDD	-	Power	Positive supply for I/O and some logic.
57	GND	-	Power	Ground reference for logic and I/O pins.
58	MDIO	I/O	TTL	MDIO of the Ethernet PHY.
59	PF3	I/O	TTL	GPIO port F bit 3.
	LED0	O	TTL	Ethernet LED 0.
60	PF2	I/O	TTL	GPIO port F bit 2.
	LED1	O	TTL	Ethernet LED 1.
61	PF1	I/O	TTL	GPIO port F bit 1.
62	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
63	GND	-	Power	Ground reference for logic and I/O pins.
64	RST	I	TTL	System reset input.
65	CMOD0	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
66	PB0	I/O	TTL	GPIO port B bit 0.
	CCP0	I/O	TTL	Capture/Compare/PWM 0.
67	PB1	I/O	TTL	GPIO port B bit 1.
	CCP2	I/O	TTL	Capture/Compare/PWM 2.
68	VDD	-	Power	Positive supply for I/O and some logic.
69	GND	-	Power	Ground reference for logic and I/O pins.
70	PB2	I/O	TTL	GPIO port B bit 2.
71	PB3	I/O	TTL	GPIO port B bit 3.
72	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
73	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
74	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
75	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
76	CMOD1	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
77	PC3	I/O	TTL	GPIO port C bit 3.
	SWO	O	TTL	JTAG TDO and SWO.
	TDO	O	TTL	JTAG TDO and SWO.
78	PC2	I/O	TTL	GPIO port C bit 2.
	TDI	I	TTL	JTAG TDI.

Table 15-1. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
79	PC1	I/O	TTL	GPIO port C bit 1.
	SWDIO	I/O	TTL	JTAG TMS and SWDIO.
	TMS	I/O	TTL	JTAG TMS and SWDIO.
80	PC0	I/O	TTL	GPIO port C bit 0.
	SWCLK	I	TTL	JTAG/SWD CLK.
	TCK	I	TTL	JTAG/SWD CLK.
81	VDD	-	Power	Positive supply for I/O and some logic.
82	GND	-	Power	Ground reference for logic and I/O pins.
83	VCCPHY	-	Power	VCC of the Ethernet PHY.
84	VCCPHY	-	Power	VCC of the Ethernet PHY.
85	GNDPHY	-	Power	GND of the Ethernet PHY.
86	GNDPHY	-	Power	GND of the Ethernet PHY.
87	GND	-	Power	Ground reference for logic and I/O pins.
88	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
89	PB7	I/O	TTL	GPIO port B bit 7.
	$\overline{\text{TRST}}$	I	TTL	JTAG $\overline{\text{TRST}}$ .
90	PB6	I/O	TTL	GPIO port B bit 6.
	C0+	I	Analog	Analog comparator 0 positive input.
91	PB5	I/O	TTL	GPIO port B bit 5.
	C0o	O	TTL	Analog comparator 0 output.
92	PB4	I/O	TTL	GPIO port B bit 4.
	C0-	I	Analog	Analog comparator 0 negative input.
93	VDD	-	Power	Positive supply for I/O and some logic.
94	GND	-	Power	Ground reference for logic and I/O pins.
95	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
96	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
97	GNDA	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
98	VDDA	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
99	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
100	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 15.1.2 Signals by Signal Name

Table 15-2. Signals by Signal Name

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
C0+	90	I	Analog	Analog comparator 0 positive input.
C0-	92	I	Analog	Analog comparator 0 negative input.
C0o	91	O	TTL	Analog comparator 0 output.
CCP0	66	I/O	TTL	Capture/Compare/PWM 0.
CCP1	34	I/O	TTL	Capture/Compare/PWM 1.
CCP2	67	I/O	TTL	Capture/Compare/PWM 2.
CCP3	23	I/O	TTL	Capture/Compare/PWM 3.
CMOD0	65	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
CMOD1	76	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
ERBIAS	41	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
GND	9 15 21 33 39 45 54 57 63 69 82 87 94	-	Power	Ground reference for logic and I/O pins.
GND A	4 97	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
GND PHY	42 85 86	-	Power	GND of the Ethernet PHY.
LDO	7	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μF or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
LED0	59	O	TTL	Ethernet LED 0.
LED1	60	O	TTL	Ethernet LED 1.
MDIO	58	I/O	TTL	MDIO of the Ethernet PHY.

Table 15-2. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
NC	1 2 5 6 18 19 22 35 50 51 52 53 72 73 74 75 95 96 99 100	-	-	No connect. Leave the pin electrically unconnected/isolated.
OSC0	48	I	Analog	Main oscillator crystal input or an external clock reference input.
OSC1	49	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
PA0	26	I/O	TTL	GPIO port A bit 0.
PA1	27	I/O	TTL	GPIO port A bit 1.
PA2	28	I/O	TTL	GPIO port A bit 2.
PA3	29	I/O	TTL	GPIO port A bit 3.
PA4	30	I/O	TTL	GPIO port A bit 4.
PA5	31	I/O	TTL	GPIO port A bit 5.
PA6	34	I/O	TTL	GPIO port A bit 6.
PB0	66	I/O	TTL	GPIO port B bit 0.
PB1	67	I/O	TTL	GPIO port B bit 1.
PB2	70	I/O	TTL	GPIO port B bit 2.
PB3	71	I/O	TTL	GPIO port B bit 3.
PB4	92	I/O	TTL	GPIO port B bit 4.
PB5	91	I/O	TTL	GPIO port B bit 5.
PB6	90	I/O	TTL	GPIO port B bit 6.
PB7	89	I/O	TTL	GPIO port B bit 7.
PC0	80	I/O	TTL	GPIO port C bit 0.
PC1	79	I/O	TTL	GPIO port C bit 1.
PC2	78	I/O	TTL	GPIO port C bit 2.
PC3	77	I/O	TTL	GPIO port C bit 3.
PC4	25	I/O	TTL	GPIO port C bit 4.
PC5	24	I/O	TTL	GPIO port C bit 5.
PC6	23	I/O	TTL	GPIO port C bit 6.
PD0	10	I/O	TTL	GPIO port D bit 0.
PD1	11	I/O	TTL	GPIO port D bit 1.

Table 15-2. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PD2	12	I/O	TTL	GPIO port D bit 2.
PD3	13	I/O	TTL	GPIO port D bit 3.
PF0	47	I/O	TTL	GPIO port F bit 0.
PF1	61	I/O	TTL	GPIO port F bit 1.
PF2	60	I/O	TTL	GPIO port F bit 2.
PF3	59	I/O	TTL	GPIO port F bit 3.
RST	64	I	TTL	System reset input.
RXIN	37	I	Analog	RXIN of the Ethernet PHY.
RXIP	40	I	Analog	RXIP of the Ethernet PHY.
SSI0Clk	28	I/O	TTL	SSI module 0 clock.
SSI0Fss	29	I/O	TTL	SSI module 0 frame signal.
SSI0Rx	30	I	TTL	SSI module 0 receive.
SSI0Tx	31	O	TTL	SSI module 0 transmit.
SWCLK	80	I	TTL	JTAG/SWD CLK.
SWDIO	79	I/O	TTL	JTAG TMS and SWDIO.
SWO	77	O	TTL	JTAG TDO and SWO.
TCK	80	I	TTL	JTAG/SWD CLK.
TDI	78	I	TTL	JTAG TDI.
TDO	77	O	TTL	JTAG TDO and SWO.
TMS	79	I/O	TTL	JTAG TMS and SWDIO.
TRST	89	I	TTL	JTAG TRST.
TXON	46	O	Analog	TXON of the Ethernet PHY.
TXOP	43	O	Analog	TXOP of the Ethernet PHY.
U0Rx	26	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
U0Tx	27	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.
VCCPHY	36 83 84	-	Power	VCC of the Ethernet PHY.
VDD	8 20 32 44 55 56 68 81 93	-	Power	Positive supply for I/O and some logic.
VDD25	14 38 62 88	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.

Table 15-2. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
VDDA	3 98	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in “Recommended DC Operating Conditions” on page 514, regardless of system implementation.
XTALNPHY	17	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	16	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

### 15.1.3 Signals by Function, Except for GPIO

Table 15-3. Signals by Function, Except for GPIO

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
Analog Comparators	C0+	90	I	Analog	Analog comparator 0 positive input.
	C0-	92	I	Analog	Analog comparator 0 negative input.
	C0o	91	O	TTL	Analog comparator 0 output.
Ethernet	ERBIAS	41	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
	GNDPHY	42 85 86	-	Power	GND of the Ethernet PHY.
	LED0	59	O	TTL	Ethernet LED 0.
	LED1	60	O	TTL	Ethernet LED 1.
	MDIO	58	I/O	TTL	MDIO of the Ethernet PHY.
	RXIN	37	I	Analog	RXIN of the Ethernet PHY.
	RXIP	40	I	Analog	RXIP of the Ethernet PHY.
	TXON	46	O	Analog	TXON of the Ethernet PHY.
	TXOP	43	O	Analog	TXOP of the Ethernet PHY.
	VCCPHY	36 83 84	-	Power	VCC of the Ethernet PHY.
	XTALNPHY	17	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	16	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.	
General-Purpose Timers	CCP0	66	I/O	TTL	Capture/Compare/PWM 0.
	CCP1	34	I/O	TTL	Capture/Compare/PWM 1.
	CCP2	67	I/O	TTL	Capture/Compare/PWM 2.
	CCP3	23	I/O	TTL	Capture/Compare/PWM 3.

Table 15-3. Signals by Function, Except for GPIO (continued)

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
JTAG/SWD/SWO	SWCLK	80	I	TTL	JTAG/SWD CLK.
	SWDIO	79	I/O	TTL	JTAG TMS and SWDIO.
	SWO	77	O	TTL	JTAG TDO and SWO.
	TCK	80	I	TTL	JTAG/SWD CLK.
	TDI	78	I	TTL	JTAG TDI.
	TDO	77	O	TTL	JTAG TDO and SWO.
	TMS	79	I/O	TTL	JTAG TMS and SWDIO.
	TRST	89	I	TTL	JTAG TRST.
Power	GND	9 15 21 33 39 45 54 57 63 69 82 87 94	-	Power	Ground reference for logic and I/O pins.
	GNDA	4 97	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
	LDO	7	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 $\mu$ F or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
	VDD	8 20 32 44 55 56 68 81 93	-	Power	Positive supply for I/O and some logic.
	VDD25	14 38 62 88	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
	VDDA	3 98	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.

Table 15-3. Signals by Function, Except for GPIO (continued)

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
SSI	SSI0Clk	28	I/O	TTL	SSI module 0 clock.
	SSI0Fss	29	I/O	TTL	SSI module 0 frame signal.
	SSI0Rx	30	I	TTL	SSI module 0 receive.
	SSI0Tx	31	O	TTL	SSI module 0 transmit.
System Control & Clocks	CMOD0	65	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
	CMOD1	76	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
	OSC0	48	I	Analog	Main oscillator crystal input or an external clock reference input.
	OSC1	49	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
	RST	64	I	TTL	System reset input.
UART	U0Rx	26	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
	U0Tx	27	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

### 15.1.4 GPIO Pins and Alternate Functions

Table 15-4. GPIO Pins and Alternate Functions

IO	Pin Number	Multiplexed Function	Multiplexed Function
PA0	26	U0Rx	
PA1	27	U0Tx	
PA2	28	SSI0Clk	
PA3	29	SSI0Fss	
PA4	30	SSI0Rx	
PA5	31	SSI0Tx	
PA6	34	CCP1	
PB0	66	CCP0	
PB1	67	CCP2	
PB2	70		
PB3	71		
PB4	92	C0-	
PB5	91	C0o	
PB6	90	C0+	
PB7	89	TRST	
PC0	80	TCK	SWCLK
PC1	79	TMS	SWDIO
PC2	78	TDI	
PC3	77	TDO	SWO
PC4	25		
PC5	24		

Table 15-4. GPIO Pins and Alternate Functions (*continued*)

IO	Pin Number	Multiplexed Function	Multiplexed Function
PC6	23	CCP3	
PD0	10		
PD1	11		
PD2	12		
PD3	13		
PF0	47		
PF1	61		
PF2	60	LED1	
PF3	59	LED0	

## 15.2 108-Ball BGA Package Pin Tables

### 15.2.1 Signals by Pin Number

Table 15-5. Signals by Pin Number

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
A1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
A2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
A3	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
A4	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
A5	GNDA	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
A6	PB4	I/O	TTL	GPIO port B bit 4.
	C0-	I	Analog	Analog comparator 0 negative input.
A7	PB6	I/O	TTL	GPIO port B bit 6.
	C0+	I	Analog	Analog comparator 0 positive input.
A8	PB7	I/O	TTL	GPIO port B bit 7.
	TRST	I	TTL	JTAG TRST.
A9	PC0	I/O	TTL	GPIO port C bit 0.
	SWCLK	I	TTL	JTAG/SWD CLK.
	TCK	I	TTL	JTAG/SWD CLK.
A10	PC3	I/O	TTL	GPIO port C bit 3.
	SWO	O	TTL	JTAG TDO and SWO.
	TDO	O	TTL	JTAG TDO and SWO.
A11	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
A12	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
B1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
B2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
B3	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
B4	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.

Table 15-5. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
B5	GNDA	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
B6	GND	-	Power	Ground reference for logic and I/O pins.
B7	PB5	I/O	TTL	GPIO port B bit 5.
	CO <sub>o</sub>	O	TTL	Analog comparator 0 output.
B8	PC2	I/O	TTL	GPIO port C bit 2.
	TDI	I	TTL	JTAG TDI.
B9	PC1	I/O	TTL	GPIO port C bit 1.
	SWDIO	I/O	TTL	JTAG TMS and SWDIO.
	TMS	I/O	TTL	JTAG TMS and SWDIO.
B10	CMOD1	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
B11	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
B12	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
C1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
C2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
C3	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
C4	GND	-	Power	Ground reference for logic and I/O pins.
C5	GND	-	Power	Ground reference for logic and I/O pins.
C6	VDDA	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
	VDDA	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
C7	VDDA	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
C8	GNDPHY	-	Power	GND of the Ethernet PHY.
C9	GNDPHY	-	Power	GND of the Ethernet PHY.
C10	VCCPHY	-	Power	VCC of the Ethernet PHY.
C11	PB2	I/O	TTL	GPIO port B bit 2.
C12	PB3	I/O	TTL	GPIO port B bit 3.
D1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
D2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
D3	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
D10	VCCPHY	-	Power	VCC of the Ethernet PHY.
D11	VCCPHY	-	Power	VCC of the Ethernet PHY.
D12	PB1	I/O	TTL	GPIO port B bit 1.
	CCP2	I/O	TTL	Capture/Compare/PWM 2.

Table 15-5. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
E1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
E2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
E3	LDO	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 $\mu$ F or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
E10	VDD33	-	Power	Positive supply for I/O and some logic.
E11	CMOD0	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
E12	PB0	I/O	TTL	GPIO port B bit 0.
	CCP0	I/O	TTL	Capture/Compare/PWM 0.
F1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
F2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
F3	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
F10	GND	-	Power	Ground reference for logic and I/O pins.
F11	GND	-	Power	Ground reference for logic and I/O pins.
F12	GND	-	Power	Ground reference for logic and I/O pins.
G1	PD0	I/O	TTL	GPIO port D bit 0.
G2	PD1	I/O	TTL	GPIO port D bit 1.
G3	VDD25	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
G10	VDD33	-	Power	Positive supply for I/O and some logic.
G11	VDD33	-	Power	Positive supply for I/O and some logic.
G12	VDD33	-	Power	Positive supply for I/O and some logic.
H1	PD3	I/O	TTL	GPIO port D bit 3.
H2	PD2	I/O	TTL	GPIO port D bit 2.
H3	GND	-	Power	Ground reference for logic and I/O pins.
H10	VDD33	-	Power	Positive supply for I/O and some logic.
H11	RST	I	TTL	System reset input.
H12	PF1	I/O	TTL	GPIO port F bit 1.
J1	XTALNPHY	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
J2	XTALPPHY	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.
J3	GND	-	Power	Ground reference for logic and I/O pins.
J10	GND	-	Power	Ground reference for logic and I/O pins.
J11	PF2	I/O	TTL	GPIO port F bit 2.
	LED1	O	TTL	Ethernet LED 1.
J12	PF3	I/O	TTL	GPIO port F bit 3.
	LED0	O	TTL	Ethernet LED 0.
K1	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
K2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.

Table 15-5. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
K3	ERBIAS	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
K4	GNDPHY	-	Power	GND of the Ethernet PHY.
K5	GND	-	Power	Ground reference for logic and I/O pins.
K6	GND	-	Power	Ground reference for logic and I/O pins.
K7	VDD33	-	Power	Positive supply for I/O and some logic.
K8	VDD33	-	Power	Positive supply for I/O and some logic.
K9	VDD33	-	Power	Positive supply for I/O and some logic.
K10	GND	-	Power	Ground reference for logic and I/O pins.
K11	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
K12	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
L1	PC4	I/O	TTL	GPIO port C bit 4.
L2	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
L3	PA0	I/O	TTL	GPIO port A bit 0.
	U0Rx	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
L4	PA3	I/O	TTL	GPIO port A bit 3.
	SSI0Fss	I/O	TTL	SSI module 0 frame signal.
L5	PA4	I/O	TTL	GPIO port A bit 4.
	SSI0Rx	I	TTL	SSI module 0 receive.
L6	PA6	I/O	TTL	GPIO port A bit 6.
	CCP1	I/O	TTL	Capture/Compare/PWM 1.
L7	RXIN	I	Analog	RXIN of the Ethernet PHY.
L8	TXON	O	Analog	TXON of the Ethernet PHY.
L9	MDIO	I/O	TTL	MDIO of the Ethernet PHY.
L10	GND	-	Power	Ground reference for logic and I/O pins.
L11	OSC0	I	Analog	Main oscillator crystal input or an external clock reference input.
L12	VDD	-	Power	Positive supply for I/O and some logic.
M1	PC5	I/O	TTL	GPIO port C bit 5.
M2	PC6	I/O	TTL	GPIO port C bit 6.
	CCP3	I/O	TTL	Capture/Compare/PWM 3.
M3	PA1	I/O	TTL	GPIO port A bit 1.
	U0Tx	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.
M4	PA2	I/O	TTL	GPIO port A bit 2.
	SSI0Clk	I/O	TTL	SSI module 0 clock.
M5	PA5	I/O	TTL	GPIO port A bit 5.
	SSI0Tx	O	TTL	SSI module 0 transmit.
M6	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.
M7	RXIP	I	Analog	RXIP of the Ethernet PHY.
M8	TXOP	O	Analog	TXOP of the Ethernet PHY.
M9	PF0	I/O	TTL	GPIO port F bit 0.
M10	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.

Table 15-5. Signals by Pin Number (continued)

Pin Number	Pin Name	Pin Type	Buffer Type <sup>a</sup>	Description
M11	OSC1	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
M12	NC	-	-	No connect. Leave the pin electrically unconnected/isolated.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 15.2.2 Signals by Signal Name

Table 15-6. Signals by Signal Name

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
C0+	A7	I	Analog	Analog comparator 0 positive input.
C0-	A6	I	Analog	Analog comparator 0 negative input.
C0o	B7	O	TTL	Analog comparator 0 output.
CCP0	E12	I/O	TTL	Capture/Compare/PWM 0.
CCP1	L6	I/O	TTL	Capture/Compare/PWM 1.
CCP2	D12	I/O	TTL	Capture/Compare/PWM 2.
CCP3	M2	I/O	TTL	Capture/Compare/PWM 3.
CMOD0	E11	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
CMOD1	B10	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
ERBIAS	K3	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
GND	B6 C4 C5 F10 F11 F12 H3 J3 J10 K5 K6 K10 L10	-	Power	Ground reference for logic and I/O pins.
GNDA	A5 B5	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
GNDPHY	C8 C9 K4	-	Power	GND of the Ethernet PHY.
LDO	E3	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μF or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
LED0	J12	O	TTL	Ethernet LED 0.
LED1	J11	O	TTL	Ethernet LED 1.

Table 15-6. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
MDIO	L9	I/O	TTL	MDIO of the Ethernet PHY.
NC	A1 A2 A3 A4 A11 A12 B1 B2 B3 B4 B11 B12 C1 C2 D1 D2 E1 E2 F1 F2 K1 K2 K11 K12 L2 M6 M10 M12	-	-	No connect. Leave the pin electrically unconnected/isolated.
OSC0	L11	I	Analog	Main oscillator crystal input or an external clock reference input.
OSC1	M11	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
PA0	L3	I/O	TTL	GPIO port A bit 0.
PA1	M3	I/O	TTL	GPIO port A bit 1.
PA2	M4	I/O	TTL	GPIO port A bit 2.
PA3	L4	I/O	TTL	GPIO port A bit 3.
PA4	L5	I/O	TTL	GPIO port A bit 4.
PA5	M5	I/O	TTL	GPIO port A bit 5.
PA6	L6	I/O	TTL	GPIO port A bit 6.
PB0	E12	I/O	TTL	GPIO port B bit 0.
PB1	D12	I/O	TTL	GPIO port B bit 1.
PB2	C11	I/O	TTL	GPIO port B bit 2.
PB3	C12	I/O	TTL	GPIO port B bit 3.
PB4	A6	I/O	TTL	GPIO port B bit 4.
PB5	B7	I/O	TTL	GPIO port B bit 5.
PB6	A7	I/O	TTL	GPIO port B bit 6.
PB7	A8	I/O	TTL	GPIO port B bit 7.
PC0	A9	I/O	TTL	GPIO port C bit 0.
PC1	B9	I/O	TTL	GPIO port C bit 1.

Table 15-6. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
PC2	B8	I/O	TTL	GPIO port C bit 2.
PC3	A10	I/O	TTL	GPIO port C bit 3.
PC4	L1	I/O	TTL	GPIO port C bit 4.
PC5	M1	I/O	TTL	GPIO port C bit 5.
PC6	M2	I/O	TTL	GPIO port C bit 6.
PD0	G1	I/O	TTL	GPIO port D bit 0.
PD1	G2	I/O	TTL	GPIO port D bit 1.
PD2	H2	I/O	TTL	GPIO port D bit 2.
PD3	H1	I/O	TTL	GPIO port D bit 3.
PF0	M9	I/O	TTL	GPIO port F bit 0.
PF1	H12	I/O	TTL	GPIO port F bit 1.
PF2	J11	I/O	TTL	GPIO port F bit 2.
PF3	J12	I/O	TTL	GPIO port F bit 3.
RST	H11	I	TTL	System reset input.
RXIN	L7	I	Analog	RXIN of the Ethernet PHY.
RXIP	M7	I	Analog	RXIP of the Ethernet PHY.
SSI0Clk	M4	I/O	TTL	SSI module 0 clock.
SSI0Fss	L4	I/O	TTL	SSI module 0 frame signal.
SSI0Rx	L5	I	TTL	SSI module 0 receive.
SSI0Tx	M5	O	TTL	SSI module 0 transmit.
SWCLK	A9	I	TTL	JTAG/SWD CLK.
SWDIO	B9	I/O	TTL	JTAG TMS and SWDIO.
SWO	A10	O	TTL	JTAG TDO and SWO.
TCK	A9	I	TTL	JTAG/SWD CLK.
TDI	B8	I	TTL	JTAG TDI.
TDO	A10	O	TTL	JTAG TDO and SWO.
TMS	B9	I/O	TTL	JTAG TMS and SWDIO.
TRST	A8	I	TTL	JTAG TRST.
TXON	L8	O	Analog	TXON of the Ethernet PHY.
TXOP	M8	O	Analog	TXOP of the Ethernet PHY.
U0Rx	L3	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
U0Tx	M3	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.
VCCPHY	C10 D10 D11	-	Power	VCC of the Ethernet PHY.
VDD	L12	-	Power	Positive supply for I/O and some logic.
VDD25	C3 D3 F3 G3	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.

Table 15-6. Signals by Signal Name (continued)

Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
VDD33	E10 G10 G11 G12 H10 K7 K8 K9	-	Power	Positive supply for I/O and some logic.
VDDA	C6 C7	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in “Recommended DC Operating Conditions” on page 514, regardless of system implementation.
XTALNPHY	J1	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	J2	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

### 15.2.3 Signals by Function, Except for GPIO

Table 15-7. Signals by Function, Except for GPIO

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
Analog Comparators	C0+	A7	I	Analog	Analog comparator 0 positive input.
	C0-	A6	I	Analog	Analog comparator 0 negative input.
	C0o	B7	O	TTL	Analog comparator 0 output.

Table 15-7. Signals by Function, Except for GPIO (continued)

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
Ethernet	ERBIAS	K3	I	Analog	12.4-kΩ resistor (1% precision) used internally for Ethernet PHY.
	GNDPHY	C8 C9 K4	-	Power	GND of the Ethernet PHY.
	LED0	J12	O	TTL	Ethernet LED 0.
	LED1	J11	O	TTL	Ethernet LED 1.
	MDIO	L9	I/O	TTL	MDIO of the Ethernet PHY.
	RXIN	L7	I	Analog	RXIN of the Ethernet PHY.
	RXIP	M7	I	Analog	RXIP of the Ethernet PHY.
	TXON	L8	O	Analog	TXON of the Ethernet PHY.
	TXOP	M8	O	Analog	TXOP of the Ethernet PHY.
	VCCPHY	C10 D10 D11	-	Power	VCC of the Ethernet PHY.
	XTALNPHY	J1	O	TTL	Ethernet PHY XTALN 25-MHz oscillator crystal output. Connect this pin to ground when using a single-ended 25-MHz clock input connected to the XTALPPHY pin.
XTALPPHY	J2	I	TTL	Ethernet PHY XTALP 25-MHz oscillator crystal input or external clock reference input.	
General-Purpose Timers	CCP0	E12	I/O	TTL	Capture/Compare/PWM 0.
	CCP1	L6	I/O	TTL	Capture/Compare/PWM 1.
	CCP2	D12	I/O	TTL	Capture/Compare/PWM 2.
	CCP3	M2	I/O	TTL	Capture/Compare/PWM 3.
JTAG/SWD/SWO	SWCLK	A9	I	TTL	JTAG/SWD CLK.
	SWDIO	B9	I/O	TTL	JTAG TMS and SWDIO.
	SWO	A10	O	TTL	JTAG TDO and SWO.
	TCK	A9	I	TTL	JTAG/SWD CLK.
	TDI	B8	I	TTL	JTAG TDI.
	TDO	A10	O	TTL	JTAG TDO and SWO.
	TMS	B9	I/O	TTL	JTAG TMS and SWDIO.
$\overline{\text{TRST}}$	A8	I	TTL	JTAG $\overline{\text{TRST}}$ .	

Table 15-7. Signals by Function, Except for GPIO (continued)

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
Power	GND	B6 C4 C5 F10 F11 F12 H3 J3 J10 K5 K6 K10 L10	-	Power	Ground reference for logic and I/O pins.
	GNDA	A5 B5	-	Power	The ground reference for the analog circuits ( Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions.
	LDO	E3	-	Power	Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 µF or greater. The LDO pin must also be connected to the VDD25 pins at the board level in addition to the decoupling capacitor(s).
	VDD	L12	-	Power	Positive supply for I/O and some logic.
	VDD25	C3 D3 F3 G3	-	Power	Positive supply for most of the logic function, including the processor core and most peripherals.
	VDD33	E10 G10 G11 G12 H10 K7 K8 K9	-	Power	Positive supply for I/O and some logic.
	VDDA	C6 C7	-	Power	The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in "Recommended DC Operating Conditions" on page 514, regardless of system implementation.
SSI	SSI0Clk	M4	I/O	TTL	SSI module 0 clock.
	SSI0Fss	L4	I/O	TTL	SSI module 0 frame signal.
	SSI0Rx	L5	I	TTL	SSI module 0 receive.
	SSI0Tx	M5	O	TTL	SSI module 0 transmit.

Table 15-7. Signals by Function, Except for GPIO (*continued*)

Function	Pin Name	Pin Number	Pin Type	Buffer Type <sup>a</sup>	Description
System Control & Clocks	CMOD0	E11	I	TTL	CPU Mode bit 0. Input must be set to logic 0 (grounded); other encodings reserved.
	CMOD1	B10	I	TTL	CPU Mode bit 1. Input must be set to logic 0 (grounded); other encodings reserved.
	OSC0	L11	I	Analog	Main oscillator crystal input or an external clock reference input.
	OSC1	M11	O	Analog	Main oscillator crystal output. Leave unconnected when using a single-ended clock source.
	RST	H11	I	TTL	System reset input.
UART	U0Rx	L3	I	TTL	UART module 0 receive. When in IrDA mode, this signal has IrDA modulation.
	U0Tx	M3	O	TTL	UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

## 15.2.4 GPIO Pins and Alternate Functions

Table 15-8. GPIO Pins and Alternate Functions

IO	Pin Number	Multiplexed Function	Multiplexed Function
PA0	L3	U0Rx	
PA1	M3	U0Tx	
PA2	M4	SSI0Clk	
PA3	L4	SSI0Fss	
PA4	L5	SSI0Rx	
PA5	M5	SSI0Tx	
PA6	L6	CCP1	
PB0	E12	CCP0	
PB1	D12	CCP2	
PB2	C11		
PB3	C12		
PB4	A6	C0-	
PB5	B7	C0o	
PB6	A7	C0+	
PB7	A8	TRST	
PC0	A9	TCK	SWCLK
PC1	B9	TMS	SWDIO
PC2	B8	TDI	
PC3	A10	TDO	SWO
PC4	L1		
PC5	M1		
PC6	M2	CCP3	
PD0	G1		
PD1	G2		
PD2	H2		

Table 15-8. GPIO Pins and Alternate Functions (continued)

IO	Pin Number	Multiplexed Function	Multiplexed Function
PD3	H1		
PF0	M9		
PF1	H12		
PF2	J11	LED1	
PF3	J12	LED0	

## 15.3 Connections for Unused Signals

Table 15-9 on page 511 show how to handle signals for functions that are not used in a particular system implementation for devices that are in a 100-pin LQFP package. Two options are shown in the table: an acceptable practice and a preferred practice for reduced power consumption and improved EMC characteristics. If a module is not used in a system, and its inputs are grounded, it is important that the clock to the module is never enabled by setting the corresponding bit in the **RCGCx** register.

Table 15-9. Connections for Unused Signals (100-pin LQFP)

Function	Signal Name	Pin Number	Acceptable Practice	Preferred Practice
Ethernet	ERBIAS	41	Connect to GND through 12.4-kΩ resistor.	Connect to GND through 12.4-kΩ resistor.
	GNDPHY	42	GND	GND
		85		
		86		
	MDIO <sup>a</sup>	58	NC	NC
	RXIN	37	NC	GND
	RXIP	40	NC	GND
	TXON	46	NC	GND
	TXOP	43	NC	GND
	VCCPHY	36	VDD	VDD
83				
84				
XTALNPHY <sup>a</sup>	17	NC	NC	
XTALPPHY <sup>a</sup>	16	NC	GND	
GPIO	All unused GPIOs	-	NC	GND
No Connects	NC	-	NC	NC
System Control	OSC0	48	NC	GND
	OSC1	49	NC	NC
	$\overline{\text{RST}}$	64	Pull up as shown in Figure 5-1 on page 162	Connect through a capacitor to GND as close to pin as possible

a. Note that the Ethernet PHY is powered up by default. The PHY cannot be powered down unless a clock source is provided and the MDIO pin is pulled up through a 10-kΩ resistor.

Table 15-10 on page 512 show how to handle signals for functions that are not used in a particular system implementation for devices that are in a 108-pin BGA package. Two options are shown in the table: an acceptable practice and a preferred practice for reduced power consumption and improved EMC characteristics. If a module is not used in a system, and its inputs are grounded, it

is important that the clock to the module is never enabled by setting the corresponding bit in the **RCGCx** register.

**Table 15-10. Connections for Unused Signals, 108-pin BGA**

Function	Signal Name	Pin Number	Acceptable Practice	Preferred Practice
Ethernet	ERBIAS	K3	Connect to GND through 12.4-k $\Omega$ resistor.	Connect to GND through 12.4-k $\Omega$ resistor.
	GNDPHY	C8 C9 K4	GND	GND
	MDIO <sup>a</sup>	L9	NC	NC
	RXIN	L7	NC	GND
	RXIP	M7	NC	GND
	TXON	L8	NC	GND
	TXOP	M8	NC	GND
	VCCPHY	C10 D10 D11	VDD	VDD
	XTALNPHY <sup>a</sup>	J1	NC	NC
	XTALPPHY <sup>a</sup>	J2	NC	GND
GPIO	All unused GPIOs	-	NC	GND
No Connects	NC	-	NC	NC
System Control	OSC0	L11	NC	GND
	OSC1	M11	NC	NC
	$\overline{\text{RST}}$	H11	Pull up as shown in Figure 5-1 on page 162	Connect through a capacitor to GND as close to pin as possible

a. Note that the Ethernet PHY is powered up by default. The PHY cannot be powered down unless a clock source is provided and the MDIO pin is pulled up through a 10-k $\Omega$  resistor.

## 16 Operating Characteristics

**Table 16-1. Temperature Characteristics**

Characteristic	Symbol	Value	Unit
Industrial operating temperature range	$T_A$	-40 to +85	°C
Unpowered storage temperature range	$T_S$	-65 to +150	°C

**Table 16-2. Thermal Characteristics**

Characteristic	Symbol	Value	Unit
Thermal resistance (junction to ambient) <sup>a</sup>	$\Theta_{JA}$	32	°C/W
Junction temperature <sup>b</sup>	$T_J$	$T_A + (P \cdot \Theta_{JA})$	°C

a. Junction to ambient thermal resistance  $\Theta_{JA}$  numbers are determined by a package simulator.

b. Power dissipation is a function of temperature.

**Table 16-3. ESD Absolute Maximum Ratings<sup>a</sup>**

Parameter Name	Min	Nom	Max	Unit
$V_{ESDHBM}$	-	-	2.0	kV
$V_{ESDCDM}$	-	-	1.0	kV
$V_{ESDMM}$	-	-	100	V

a. All Stellaris parts are ESD tested following the JEDEC standard.

## 17 Electrical Characteristics

### 17.1 DC Characteristics

#### 17.1.1 Maximum Ratings

The maximum ratings are the limits to which the device can be subjected without permanently damaging the device.

**Note:** The device is not guaranteed to operate properly at the maximum ratings.

**Table 17-1. Maximum Ratings**

Characteristic <sup>a</sup>	Symbol	Value		Unit
		Min	Max	
I/O supply voltage ( $V_{DD}$ )	$V_{DD}$	0	4	V
Core supply voltage ( $V_{DD25}$ )	$V_{DD25}$	0	3	V
Analog supply voltage ( $V_{DDA}$ )	$V_{DDA}$	0	4	V
Ethernet PHY supply voltage ( $V_{CCPHY}$ )	$V_{CCPHY}$	0	4	V
Input voltage	$V_{IN}$	-0.3	5.5	V
Input voltage for a GPIO configured as an analog input		-0.3	$V_{DD} + 0.3$	V
Maximum current per output pins	I	-	25	mA
Maximum input voltage on a non-power pin when the microcontroller is unpowered	$V_{NON}$	-	300	mV

a. Voltages are measured with respect to GND.

**Important:** This device contains circuitry to protect the inputs against damage due to high-static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are connected to an appropriate logic voltage level (for example, either GND or  $V_{DD}$ ).

#### 17.1.2 Recommended DC Operating Conditions

For special high-current applications, the GPIO output buffers may be used with the following restrictions. With the GPIO pins configured as 8-mA output drivers, a total of four GPIO outputs may be used to sink current loads up to 18 mA each. At 18-mA sink current loading, the  $V_{OL}$  value is specified as 1.2 V. The high-current GPIO package pins must be selected such that there are only a maximum of two per side of the physical package or BGA pin group with the total number of high-current GPIO outputs not exceeding four for the entire package.

**Table 17-2. Recommended DC Operating Conditions**

Parameter	Parameter Name	Min	Nom	Max	Unit
$V_{DD}$	I/O supply voltage	3.0	3.3	3.6	V
$V_{DD25}$	Core supply voltage	2.25	2.5	2.75	V
$V_{DDA}$	Analog supply voltage	3.0	3.3	3.6	V
$V_{CCPHY}$	Ethernet PHY supply voltage	3.0	3.3	3.6	V
$V_{IH}$	High-level input voltage	2.0	-	5.0	V
$V_{IL}$	Low-level input voltage	-0.3	-	1.3	V

**Table 17-2. Recommended DC Operating Conditions (continued)**

Parameter	Parameter Name	Min	Nom	Max	Unit
$V_{OH}^a$	High-level output voltage	2.4	-	-	V
$V_{OL}^a$	Low-level output voltage	-	-	0.4	V
$I_{OH}$	High-level source current, $V_{OH}=2.4$ V				
	2-mA Drive	2.0	-	-	mA
	4-mA Drive	4.0	-	-	mA
	8-mA Drive	8.0	-	-	mA
$I_{OL}$	Low-level sink current, $V_{OL}=0.4$ V				
	2-mA Drive	2.0	-	-	mA
	4-mA Drive	4.0	-	-	mA
	8-mA Drive	8.0	-	-	mA

a.  $V_{OL}$  and  $V_{OH}$  shift to 1.2 V when using high-current GPIOs.

### 17.1.3 On-Chip Low Drop-Out (LDO) Regulator Characteristics

**Table 17-3. LDO Regulator Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
$V_{LDOOUT}$	Programmable internal (logic) power supply output value	2.25	2.5	2.75	V
	Output voltage accuracy	-	2%	-	%
$t_{PON}$	Power-on time	-	-	100	$\mu$ s
$t_{ON}$	Time on	-	-	200	$\mu$ s
$t_{OFF}$	Time off	-	-	100	$\mu$ s
$V_{STEP}$	Step programming incremental voltage	-	50	-	mV
$C_{LDO}$	External filter capacitor size for internal power supply	1.0	-	3.0	$\mu$ F

### 17.1.4 GPIO Module Characteristics

**Table 17-4. GPIO Module DC Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
$R_{GPIOPU}$	GPIO internal pull-up resistor	50	-	110	k $\Omega$
$R_{GPIOPD}$	GPIO internal pull-down resistor	55	-	180	k $\Omega$
$I_{LKG}$	GPIO input leakage current <sup>a</sup>	-	-	2	$\mu$ A

a. The leakage current is measured with GND or  $V_{DD}$  applied to the corresponding pin(s). The leakage of digital port pins is measured individually. The port pin is configured as an input and the pullup/pulldown resistor is disabled.

### 17.1.5 Power Specifications

The power measurements specified in the tables that follow are run on the core processor using SRAM with the following specifications (except as noted):

- $V_{DD} = 3.3$  V
- $V_{DD25} = 2.50$  V

- $V_{DDA} = 3.3\text{ V}$
- $V_{DDPHY} = 3.3\text{ V}$
- Temperature =  $25^{\circ}\text{C}$
- Clock Source (MOSC) = 3.579545 MHz Crystal Oscillator
- Main oscillator (MOSC) = enabled
- Internal oscillator (IOSC) = disabled

**Table 17-5. Detailed Power Specifications**

Parameter	Parameter Name	Conditions	3.3 V $V_{DD}$ , $V_{DDA}$ , $V_{DDPHY}$		2.5 V $V_{DD25}$		Unit
			Nom	Max	Nom	Max	
$I_{DD\_RUN}$	Run mode 1 (Flash loop)	$V_{DD25} = 2.50\text{ V}$ Code= while(1){} executed out of Flash Peripherals = All ON System Clock = 25 MHz (with PLL)	48	pending <sup>a</sup>	64	pending <sup>a</sup>	mA
	Run mode 2 (Flash loop)	$V_{DD25} = 2.50\text{ V}$ Code= while(1){} executed out of Flash Peripherals = All OFF System Clock = 25 MHz (with PLL)	5	pending <sup>a</sup>	33	pending <sup>a</sup>	mA
	Run mode 1 (SRAM loop)	$V_{DD25} = 2.50\text{ V}$ Code= while(1){} executed in SRAM Peripherals = All ON System Clock = 25 MHz (with PLL)	48	pending <sup>a</sup>	56	pending <sup>a</sup>	mA
	Run mode 2 (SRAM loop)	$V_{DD25} = 2.50\text{ V}$ Code= while(1){} executed in SRAM Peripherals = All OFF System Clock = 25 MHz (with PLL)	5	pending <sup>a</sup>	26	pending <sup>a</sup>	mA
$I_{DD\_SLEEP}$	Sleep mode	$V_{DD25} = 2.50\text{ V}$ Peripherals = All OFF System Clock = 25 MHz (with PLL)	5	pending <sup>a</sup>	12	pending <sup>a</sup>	mA
$I_{DD\_DEEPSLEEP}$	Deep-Sleep mode	LDO = 2.25 V Peripherals = All OFF System Clock = IOSC30KHZ/64	4.6	pending <sup>a</sup>	0.21	pending <sup>a</sup>	mA

a. Pending characterization completion.

### 17.1.6 Flash Memory Characteristics

**Table 17-6. Flash Memory Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
$PE_{CYC}$	Number of guaranteed program/erase cycles before failure <sup>a</sup>	10,000	100,000	-	cycles

**Table 17-6. Flash Memory Characteristics (continued)**

Parameter	Parameter Name	Min	Nom	Max	Unit
T <sub>RET</sub>	Data retention at average operating temperature of 85°C	10	-	-	years
T <sub>PROG</sub>	Word program time	20	-	-	µs
T <sub>ERASE</sub>	Page erase time	20	-	-	ms
T <sub>ME</sub>	Mass erase time	-	-	250	ms

a. A program/erase cycle is defined as switching the bits from 1-> 0 -> 1.

## 17.1.7 Ethernet Controller

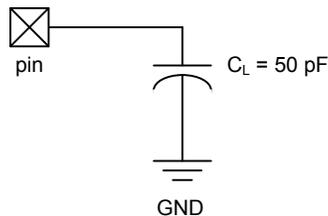
**Table 17-7. Ethernet Controller DC Characteristics**

Parameter	Parameter Name	Value	Unit
R <sub>EBIAS</sub>	Value of the pull-down resistor on the ERBIAS pin	12.4K ± 1 %	Ω

## 17.2 AC Characteristics

### 17.2.1 Load Conditions

Unless otherwise specified, the following conditions are true for all timing measurements. Timing measurements are for 4-mA drive strength.

**Figure 17-1. Load Conditions**

### 17.2.2 Clocks

**Table 17-8. Phase Locked Loop (PLL) Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
f <sub>ref_crystal</sub>	Crystal reference <sup>a</sup>	3.579545	-	8.192	MHz
f <sub>ref_ext</sub>	External clock reference <sup>a</sup>	3.579545	-	8.192	MHz
f <sub>pll</sub>	PLL frequency <sup>b</sup>	-	400	-	MHz
T <sub>READY</sub>	PLL lock time	-	-	0.5	ms

a. The exact value is determined by the crystal value programmed into the XTAL field of the **Run-Mode Clock Configuration (RCC)** register.

b. PLL frequency is automatically calculated by the hardware based on the XTAL field of the **RCC** register.

Table 17-9 on page 518 shows the actual frequency of the PLL based on the crystal frequency used (defined by the XTAL field in the **RCC** register).

**Table 17-9. Actual PLL Frequency**

XTAL	Crystal Frequency (MHz)	PLL Frequency (MHz)	Error
0x4	3.5795	400.904	0.0023%
0x5	3.6864	398.1312	0.0047%
0x6	4.0	400	-
0x7	4.096	401.408	0.0035%
0x8	4.9152	398.1312	0.0047%
0x9	5.0	400	-
0xA	5.12	399.36	0.0016%
0xB	6.0	400	-
0xC	6.144	399.36	0.0016%
0xD	7.3728	398.1312	0.0047%
0xE	8.0	400	0.0047%
0xF	8.192	398.6773333	0.0033%

**Table 17-10. Clock Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
f <sub>IOSC</sub>	Internal 12 MHz oscillator frequency	8.4	12	15.6	MHz
f <sub>IOSC30KHZ</sub>	Internal 30 KHz oscillator frequency	15	30	45	KHz
f <sub>MOSC</sub>	Main oscillator frequency	1	-	8.192	MHz
t <sub>MOSC_per</sub>	Main oscillator period	125	-	1000	ns
f <sub>ref_crystal_bypass</sub>	Crystal reference using the main oscillator (PLL in BYPASS mode)	1	-	8.192	MHz
f <sub>ref_ext_bypass</sub>	External clock reference (PLL in BYPASS mode)	0	-	25	MHz
f <sub>system_clock</sub>	System clock	0	-	25	MHz

**Table 17-11. Crystal Characteristics**

Parameter Name	Value				Units
	8	6	4	3.5	
Frequency	8	6	4	3.5	MHz
Frequency tolerance <sup>a</sup>	±50	±50	±50	±50	ppm
Oscillation mode	Parallel	Parallel	Parallel	Parallel	-
Motional capacitance (typ)	27.8	37.0	55.6	63.5	pF
Motional inductance (typ)	14.3	19.1	28.6	32.7	mH
Equivalent series resistance (max)	120	160	200	220	Ω
Shunt capacitance (max)	10	10	10	10	pF
Load capacitance (typ)	16	16	16	16	pF
Drive level (typ)	100	100	100	100	μW

a. This tolerance provides a guard band for temperature stability and aging drift.

### 17.2.3 JTAG and Boundary Scan

Table 17-12. JTAG Characteristics

Parameter No.	Parameter	Parameter Name	Min	Nom	Max	Unit
J1	$f_{TCK}$	TCK operational clock frequency	0	-	10	MHz
J2	$t_{TCK}$	TCK operational clock period	100	-	-	ns
J3	$t_{TCK\_LOW}$	TCK clock Low time	-	$t_{TCK}/2$	-	ns
J4	$t_{TCK\_HIGH}$	TCK clock High time	-	$t_{TCK}/2$	-	ns
J5	$t_{TCK\_R}$	TCK rise time	0	-	10	ns
J6	$t_{TCK\_F}$	TCK fall time	0	-	10	ns
J7	$t_{TMS\_SU}$	TMS setup time to TCK rise	20	-	-	ns
J8	$t_{TMS\_HLD}$	TMS hold time from TCK rise	20	-	-	ns
J9	$t_{TDI\_SU}$	TDI setup time to TCK rise	25	-	-	ns
J10	$t_{TDI\_HLD}$	TDI hold time from TCK rise	25	-	-	ns
J11 $t_{TDO\_ZDV}$	TCK fall to Data Valid from High-Z	2-mA drive	-	23	35	ns
		4-mA drive		15	26	ns
		8-mA drive		14	25	ns
		8-mA drive with slew rate control		18	29	ns
J12 $t_{TDO\_DV}$	TCK fall to Data Valid from Data Valid	2-mA drive	-	21	35	ns
		4-mA drive		14	25	ns
		8-mA drive		13	24	ns
		8-mA drive with slew rate control		18	28	ns
J13 $t_{TDO\_DVZ}$	TCK fall to High-Z from Data Valid	2-mA drive	-	9	11	ns
		4-mA drive		7	9	ns
		8-mA drive		6	8	ns
		8-mA drive with slew rate control		7	9	ns
J14	$t_{TRST}$	$\overline{TRST}$ assertion time	100	-	-	ns
J15	$t_{TRST\_SU}$	$\overline{TRST}$ setup time to TCK rise	10	-	-	ns

Figure 17-2. JTAG Test Clock Input Timing

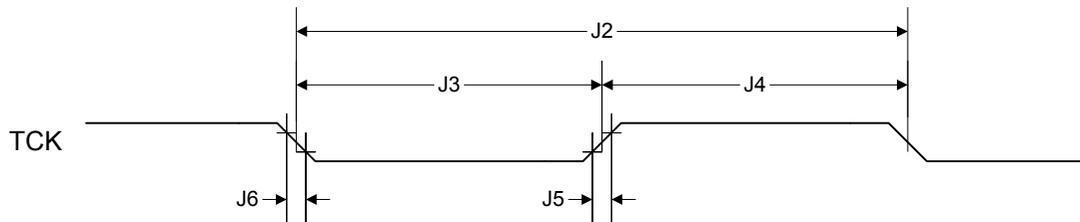


Figure 17-3. JTAG Test Access Port (TAP) Timing

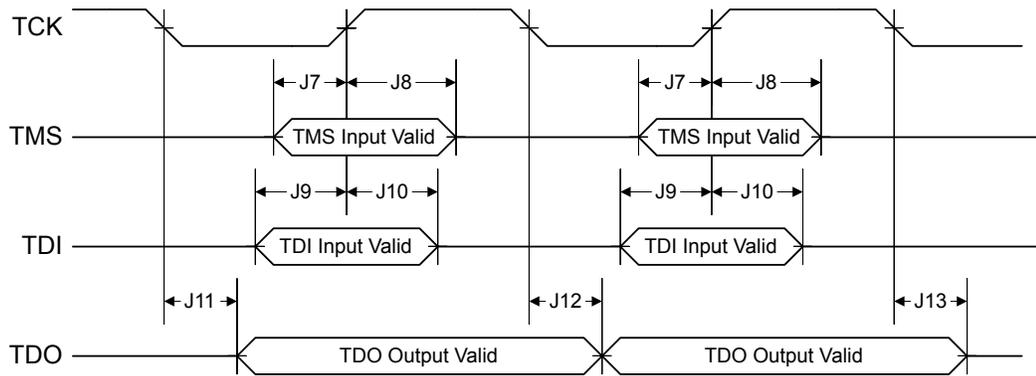
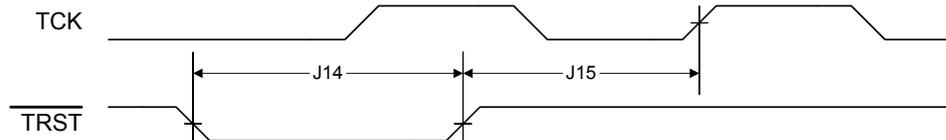


Figure 17-4. JTAG TRST Timing



## 17.2.4 Reset

Table 17-13. Reset Characteristics

Parameter No.	Parameter	Parameter Name	Min	Nom	Max	Unit
R1	$V_{TH}$	Reset threshold	-	2.0	-	V
R2	$V_{BTH}$	Brown-Out threshold	2.85	2.9	2.95	V
R3	$T_{POR}$	Power-On Reset timeout	-	10	-	ms
R4	$T_{BOR}$	Brown-Out timeout	-	500	-	$\mu$ s
R5	$T_{IRPOR}$	Internal reset timeout after POR	6	-	11	ms
R6	$T_{IRBOR}$	Internal reset timeout after BOR <sup>a</sup>	0	-	1	$\mu$ s
R7	$T_{IRHWR}$	Internal reset timeout after hardware reset ( $\overline{RST}$ pin)	0	-	1	ms
R8	$T_{IRSWR}$	Internal reset timeout after software-initiated system reset <sup>a</sup>	2.5	-	20	$\mu$ s
R9	$T_{IRWDR}$	Internal reset timeout after watchdog reset <sup>a</sup>	2.5	-	20	$\mu$ s
R10	$T_{VDDRISE}$	Supply voltage ( $V_{DD}$ ) rise time (0V-3.3V)	-	-	100	ms
R11	$T_{MIN}$	Minimum $\overline{RST}$ pulse width	2	-	-	$\mu$ s

a.  $20 * t_{MOSC\_per}$

Figure 17-5. External Reset Timing ( $\overline{\text{RST}}$ )

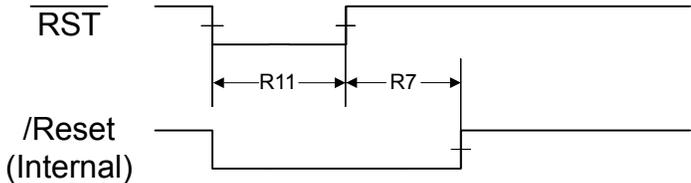


Figure 17-6. Power-On Reset Timing

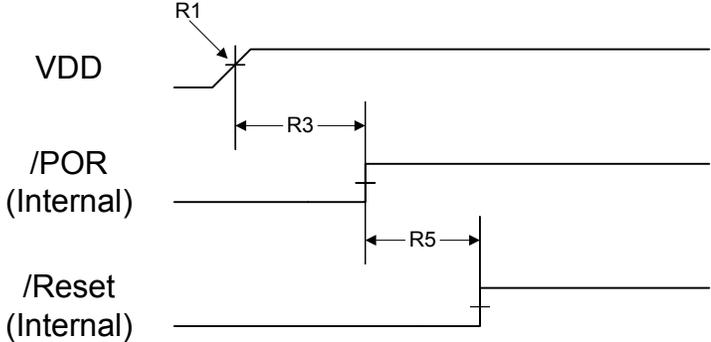


Figure 17-7. Brown-Out Reset Timing

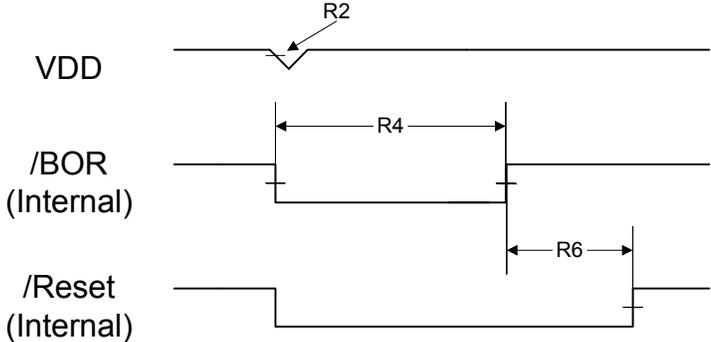


Figure 17-8. Software Reset Timing

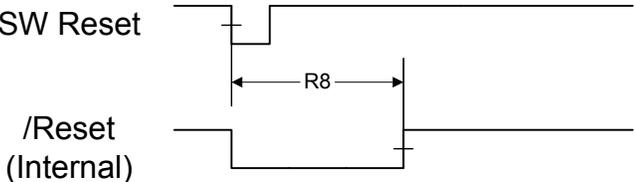
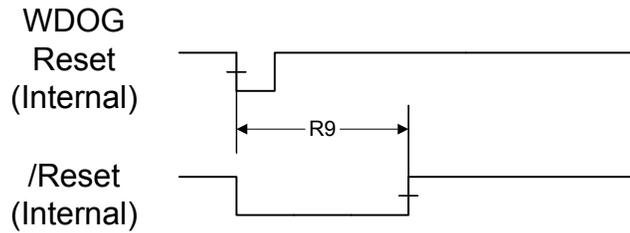


Figure 17-9. Watchdog Reset Timing



## 17.2.5 Sleep Modes

Table 17-14. Sleep Modes AC Characteristics<sup>a</sup>

Parameter No	Parameter	Parameter Name	Min	Nom	Max	Unit
D1	$t_{\text{WAKE\_S}}$	Time to wake from interrupt in sleep or deep-sleep mode, not using the PLL	-	-	7	system clocks
D2	$t_{\text{WAKE\_PLL\_S}}$	Time to wake from interrupt in sleep or deep-sleep mode when using the PLL	-	-	$T_{\text{READY}}$	ms

a. Values in this table assume the IOSC is the clock source during sleep or deep-sleep mode.

## 17.2.6 General-Purpose I/O (GPIO)

**Note:** All GPIOs are 5 V-tolerant.

Table 17-15. GPIO Characteristics

Parameter	Parameter Name	Condition	Min	Nom	Max	Unit
$t_{\text{GPIO R}}$	GPIO Rise Time (from 20% to 80% of $V_{\text{DD}}$ )	2-mA drive	-	17	26	ns
		4-mA drive		9	13	ns
		8-mA drive		6	9	ns
		8-mA drive with slew rate control		10	12	ns
$t_{\text{GPIO F}}$	GPIO Fall Time (from 80% to 20% of $V_{\text{DD}}$ )	2-mA drive	-	17	25	ns
		4-mA drive		8	12	ns
		8-mA drive		6	10	ns
		8-mA drive with slew rate control		11	13	ns

## 17.2.7 Synchronous Serial Interface (SSI)

Table 17-16. SSI Characteristics

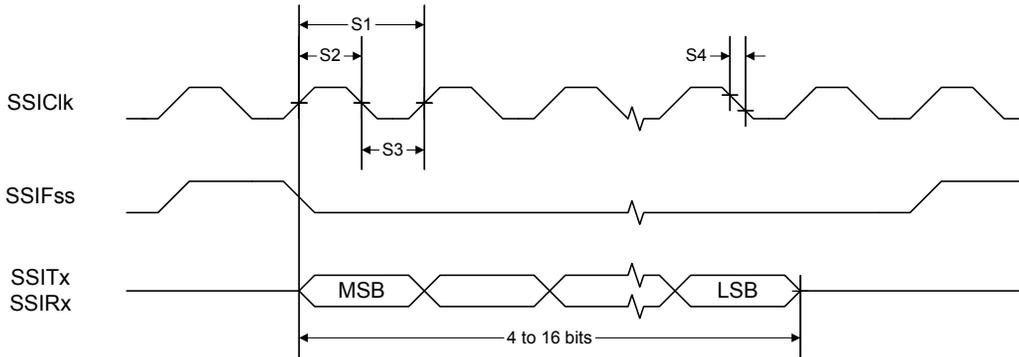
Parameter No.	Parameter	Parameter Name	Min	Nom	Max	Unit
S1	$t_{\text{clk\_per}}$	SSIClk cycle time	2	-	65024	system clocks
S2	$t_{\text{clk\_high}}$	SSIClk high time	-	0.5	-	t clk_per
S3	$t_{\text{clk\_low}}$	SSIClk low time	-	0.5	-	t clk_per
S4	$t_{\text{clkrf}}$	SSIClk rise/fall time <sup>a</sup>	-	6	10	ns
S5	$t_{\text{DMd}}$	Data from master valid delay time	0	-	1	system clocks
S6	$t_{\text{DMs}}$	Data from master setup time	1	-	-	system clocks
S7	$t_{\text{DMh}}$	Data from master hold time	2	-	-	system clocks
S8	$t_{\text{DSs}}$	Data from slave setup time	1	-	-	system clocks

**Table 17-16. SSI Characteristics (continued)**

Parameter No.	Parameter	Parameter Name	Min	Nom	Max	Unit
S9	$t_{DSh}$	Data from slave hold time	2	-	-	system clocks

a. Note that the delays shown are using 8-mA drive strength.

**Figure 17-10. SSI Timing for TI Frame Format (FRF=01), Single Transfer Timing Measurement**



**Figure 17-11. SSI Timing for MICROWIRE Frame Format (FRF=10), Single Transfer**

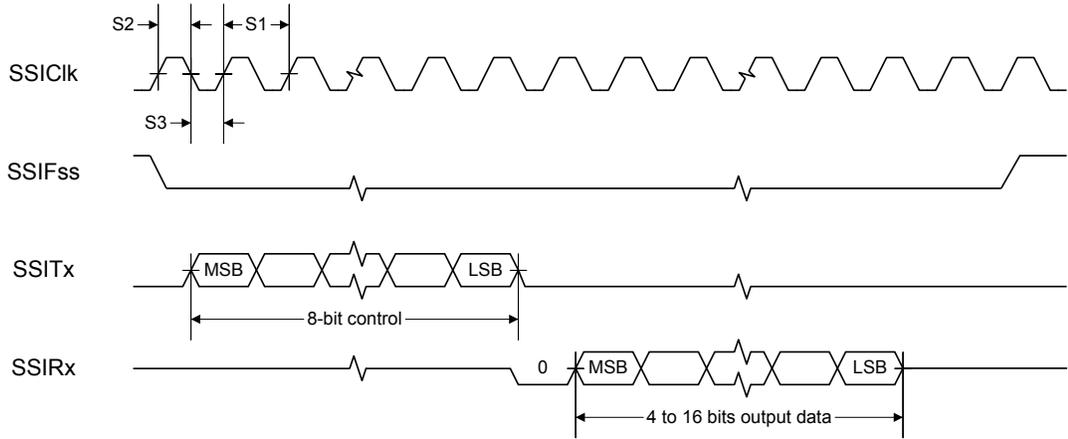
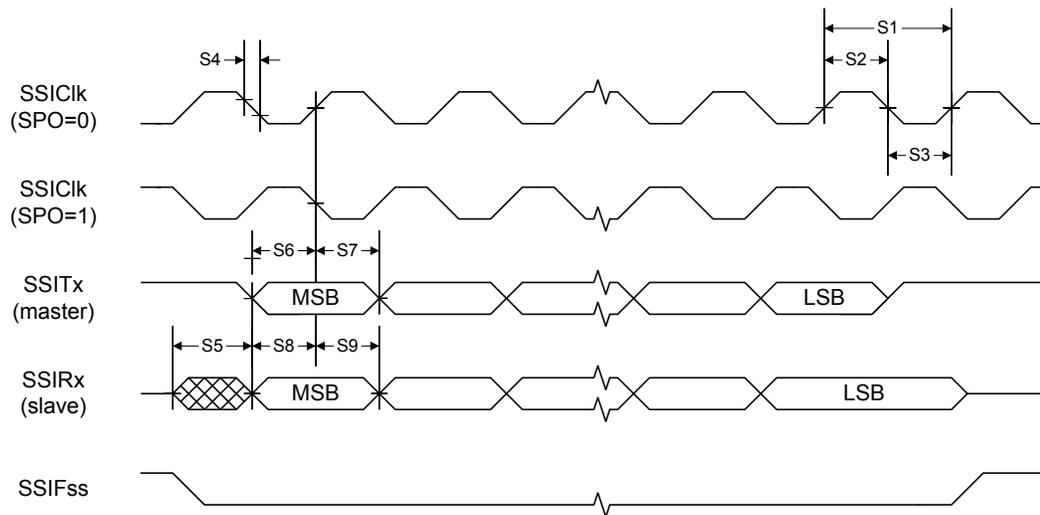


Figure 17-12. SSI Timing for SPI Frame Format (FRF=00), with SPH=1



## 17.2.8 Ethernet Controller

Table 17-17. 100BASE-TX Transmitter Characteristics<sup>a</sup>

Parameter Name	Min	Nom	Max	Unit
Peak output amplitude	950	-	1050	mVpk
Output amplitude symmetry	98	-	102	%
Output overshoot	-	-	5	%
Rise/Fall time	3	-	5	ns
Rise/Fall time imbalance	-	-	500	ps
Duty cycle distortion	-	-	-	ps
Jitter	-	-	1.4	ns

a. Measured at the line side of the transformer.

Table 17-18. 100BASE-TX Transmitter Characteristics (informative)<sup>a</sup>

Parameter Name	Min	Nom	Max	Unit
Return loss	16	-	-	dB
Open-circuit inductance	350	-	-	μH

a. The specifications in this table are included for information only. They are mainly a function of the external transformer and termination resistors used for measurements.

Table 17-19. 100BASE-TX Receiver Characteristics

Parameter Name	Min	Nom	Max	Unit
Signal detect assertion threshold	600	700	-	mVppd
Signal detect de-assertion threshold	350	425	-	mVppd
Differential input resistance	-	20	-	kΩ

**Table 17-19. 100BASE-TX Receiver Characteristics (continued)**

Parameter Name	Min	Nom	Max	Unit
Jitter tolerance (pk-pk)	4	-	-	ns
Baseline wander tracking	-75	-	+75	%
Signal detect assertion time	-	-	1000	µs
Signal detect de-assertion time	-	-	4	µs

**Table 17-20. 10BASE-T Transmitter Characteristics<sup>a</sup>**

Parameter Name	Min	Nom	Max	Unit
Peak differential output signal	2.2	-	2.8	V
Harmonic content	27	-	-	dB
Link pulse width	-	100	-	ns
Start-of-idle pulse width	-	300 350	-	ns

a. The Manchester-encoded data pulses, the link pulse and the start-of-idle pulse are tested against the templates and using the procedures found in Clause 14 of *IEEE 802.3*.

**Table 17-21. 10BASE-T Transmitter Characteristics (informative)<sup>a</sup>**

Parameter Name	Min	Nom	Max	Unit
Output return loss	15	-	-	dB
Output impedance balance	$29-17\log(f/10)$	-	-	dB
Peak common-mode output voltage	-	-	50	mV
Common-mode rejection	-	-	100	mV
Common-mode rejection jitter	-	-	1	ns

a. The specifications in this table are included for information only. They are mainly a function of the external transformer and termination resistors used for measurements.

**Table 17-22. 10BASE-T Receiver Characteristics**

Parameter Name	Min	Nom	Max	Unit
Jitter tolerance (pk-pk)	30	-	-	ns
Input squelched threshold	500	600	700	mVppd
Differential input resistance	-	20	-	kΩ
Common-mode rejection	25	-	-	V

**Table 17-23. Isolation Transformers<sup>a</sup>**

Name	Value	Condition
Turns ratio	1 CT : 1 CT	+/- 5%
Open-circuit inductance	350 µH (min)	@ 10 mV, 10 kHz
Leakage inductance	0.40 µH (max)	@ 1 MHz (min)
Inter-winding capacitance	25 pF (max)	
DC resistance	0.9 Ohm (max)	
Insertion loss	0.4 dB (typ)	0-65 MHz

**Table 17-23. Isolation Transformers (continued)**

Name	Value	Condition
HIPOT	1500	Vrms

a. Two simple 1:1 isolation transformers are required at the line interface. Transformers with integrated common-mode chokes are recommended for exceeding FCC requirements. This table gives the recommended line transformer characteristics.

**Note:** The 100Base-TX amplitude specifications assume a transformer loss of 0.4 dB. For the transmit line transformer with higher insertion losses, up to 1.2 dB of insertion loss can be compensated by selecting the appropriate setting in the Transmit Amplitude Selection (TXO) bits in the MR19 register.

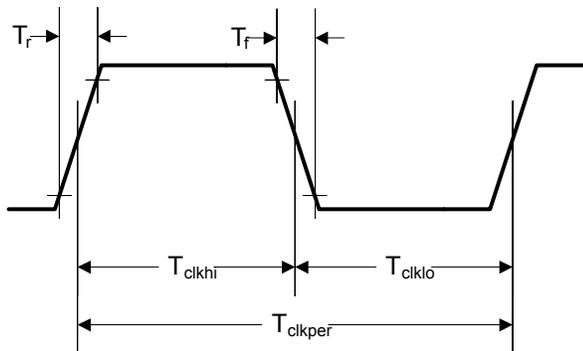
**Table 17-24. Ethernet Reference Crystal<sup>a</sup>**

Name	Value	Condition
Frequency	25.00000	MHz
Frequency tolerance <sup>b</sup>	±50	PPM
Oscillation mode	Parallel resonance, fundamental mode	
Parameters at 25° C ±2° C; Drive level = 0.5 mW		
Drive level (typ)	50-100	µW
Shunt capacitance (max)	10	pF
Motional capacitance (min)	10	fF
Series resistance (max)	60	Ω
Spurious response (max)	> 5 dB below main within 500 kHz	

a. If the internal crystal oscillator is used, select a crystal that meets these specifications.

b. This tolerance provides a guard band for temperature stability and aging drift.

**Figure 17-13. External XTLP Oscillator Characteristics**



**Table 17-25. External XTLP Oscillator Characteristics**

Parameter Name	Symbol	Min	Nom	Max	Unit
XTLN Input Low Voltage	XTLN <sub>ILV</sub>	-	-	0.8	-
XTLP Frequency <sup>a</sup>	XTLP <sub>f</sub>	-	25.0	-	-

**Table 17-25. External XTLP Oscillator Characteristics (continued)**

Parameter Name	Symbol	Min	Nom	Max	Unit
XTLP Period <sup>b</sup>	$T_{clkper}$	-	40	-	-
XTLP Duty Cycle	$XTLP_{DC}$	40 40	-	60 60	%
Rise/Fall Time	$T_r, T_f$	-	-	4.0	ns
Absolute Jitter	$T_{JITTER}$	-	-	0.1	ns

a. IEEE 802.3 frequency tolerance  $\pm 50$  ppm.

b. IEEE 802.3 frequency tolerance  $\pm 50$  ppm.

## 17.2.9 Analog Comparator

**Table 17-26. Analog Comparator Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
$V_{OS}$	Input offset voltage	-	$\pm 10$	$\pm 25$	mV
$V_{CM}$	Input common mode voltage range	0	-	$V_{DD}-1.5$	V
$C_{MRR}$	Common mode rejection ratio	50	-	-	dB
$T_{RT}$	Response time	-	-	1	$\mu s$
$T_{MC}$	Comparator mode change to Output Valid	-	-	10	$\mu s$

**Table 17-27. Analog Comparator Voltage Reference Characteristics**

Parameter	Parameter Name	Min	Nom	Max	Unit
$R_{HR}$	Resolution high range	-	$V_{DD}/31$	-	LSB
$R_{LR}$	Resolution low range	-	$V_{DD}/23$	-	LSB
$A_{HR}$	Absolute accuracy high range	-	-	$\pm 1/2$	LSB
$A_{LR}$	Absolute accuracy low range	-	-	$\pm 1/4$	LSB

## A Serial Flash Loader

### A.1 Serial Flash Loader

The Stellaris<sup>®</sup> serial flash loader is a preprogrammed flash-resident utility used to download code to the flash memory of a device without the use of a debug interface. The serial flash loader uses a simple packet interface to provide synchronous communication with the device. The flash loader runs off the crystal and does not enable the PLL, so its speed is determined by the crystal used. The two serial interfaces that can be used are the UART0 and SSI0 interfaces. For simplicity, both the data format and communication protocol are identical for both serial interfaces.

### A.2 Interfaces

Once communication with the flash loader is established via one of the serial interfaces, that interface is used until the flash loader is reset or new code takes over. For example, once you start communicating using the SSI port, communications with the flash loader via the UART are disabled until the device is reset.

#### A.2.1 UART

The Universal Asynchronous Receivers/Transmitters (UART) communication uses a fixed serial format of 8 bits of data, no parity, and 1 stop bit. The baud rate used for communication is automatically detected by the flash loader and can be any valid baud rate supported by the host and the device. The auto detection sequence requires that the baud rate should be no more than 1/32 the crystal frequency of the board that is running the serial flash loader. This is actually the same as the hardware limitation for the maximum baud rate for any UART on a Stellaris device which is calculated as follows:

$$\text{Max Baud Rate} = \text{System Clock Frequency} / 16$$

In order to determine the baud rate, the serial flash loader needs to determine the relationship between its own crystal frequency and the baud rate. This is enough information for the flash loader to configure its UART to the same baud rate as the host. This automatic baud-rate detection allows the host to use any valid baud rate that it wants to communicate with the device.

The method used to perform this automatic synchronization relies on the host sending the flash loader two bytes that are both 0x55. This generates a series of pulses to the flash loader that it can use to calculate the ratios needed to program the UART to match the host's baud rate. After the host sends the pattern, it attempts to read back one byte of data from the UART. The flash loader returns the value of 0xCC to indicate successful detection of the baud rate. If this byte is not received after at least twice the time required to transfer the two bytes, the host can resend another pattern of 0x55, 0x55, and wait for the 0xCC byte again until the flash loader acknowledges that it has received a synchronization pattern correctly. For example, the time to wait for data back from the flash loader should be calculated as at least  $2 * (20(\text{bits/sync}) / \text{baud rate} (\text{bits/sec}))$ . For a baud rate of 115200, this time is  $2 * (20 / 115200)$  or 0.35 ms.

#### A.2.2 SSI

The Synchronous Serial Interface (SSI) port also uses a fixed serial format for communications, with the framing defined as Motorola format with SPH set to 1 and SPO set to 1. See "Frame Formats" on page 392 in the SSI chapter for more information on formats for this transfer protocol. Like the UART, this interface has hardware requirements that limit the maximum speed that the SSI clock can run. This allows the SSI clock to be at most 1/12 the crystal frequency of the board running

the flash loader. Since the host device is the master, the SSI on the flash loader device does not need to determine the clock as it is provided directly by the host.

## A.3 Packet Handling

All communications, with the exception of the UART auto-baud, are done via defined packets that are acknowledged (ACK) or not acknowledged (NAK) by the devices. The packets use the same format for receiving and sending packets, including the method used to acknowledge successful or unsuccessful reception of a packet.

### A.3.1 Packet Format

All packets sent and received from the device use the following byte-packed format.

```
struct
{
  unsigned char ucSize;
  unsigned char ucChecksum;
  unsigned char Data[];
};
```

ucSize	The first byte received holds the total size of the transfer including the size and checksum bytes.
ucChecksum	This holds a simple checksum of the bytes in the data buffer only. The algorithm is $Data[0]+Data[1]+\dots+Data[ucSize-3]$ .
Data	This is the raw data intended for the device, which is formatted in some form of command interface. There should be $ucSize-2$ bytes of data provided in this buffer to or from the device.

### A.3.2 Sending Packets

The actual bytes of the packet can be sent individually or all at once; the only limitation is that commands that cause flash memory access should limit the download sizes to prevent losing bytes during flash programming. This limitation is discussed further in the section that describes the serial flash loader command, `COMMAND_SEND_DATA` (see “`COMMAND_SEND_DATA (0x24)`” on page 531).

Once the packet has been formatted correctly by the host, it should be sent out over the UART or SSI interface. Then the host should poll the UART or SSI interface for the first non-zero data returned from the device. The first non-zero byte will either be an ACK (0xCC) or a NAK (0x33) byte from the device indicating the packet was received successfully (ACK) or unsuccessfully (NAK). This does not indicate that the actual contents of the command issued in the data portion of the packet were valid, just that the packet was received correctly.

### A.3.3 Receiving Packets

The flash loader sends a packet of data in the same format that it receives a packet. The flash loader may transfer leading zero data before the first actual byte of data is sent out. The first non-zero byte is the size of the packet followed by a checksum byte, and finally followed by the data itself. There is no break in the data after the first non-zero byte is sent from the flash loader. Once the device communicating with the flash loader receives all the bytes, it must either ACK or NAK the packet to indicate that the transmission was successful. The appropriate response after sending a NAK to the flash loader is to resend the command that failed and request the data again. If needed, the host may send leading zeros before sending down the ACK/NAK signal to the flash loader, as the

flash loader only accepts the first non-zero data as a valid response. This zero padding is needed by the SSI interface in order to receive data to or from the flash loader.

## A.4 Commands

The next section defines the list of commands that can be sent to the flash loader. The first byte of the data should always be one of the defined commands, followed by data or parameters as determined by the command that is sent.

### A.4.1 COMMAND\_PING (0x20)

This command simply accepts the command and sets the global status to success. The format of the packet is as follows:

```
Byte[0] = 0x03;  
Byte[1] = checksum(Byte[2]);  
Byte[2] = COMMAND_PING;
```

The ping command has 3 bytes and the value for `COMMAND_PING` is 0x20 and the checksum of one byte is that same byte, making `Byte[1]` also 0x20. Since the ping command has no real return status, the receipt of an ACK can be interpreted as a successful ping to the flash loader.

### A.4.2 COMMAND\_GET\_STATUS (0x23)

This command returns the status of the last command that was issued. Typically, this command should be sent after every command to ensure that the previous command was successful or to properly respond to a failure. The command requires one byte in the data of the packet and should be followed by reading a packet with one byte of data that contains a status code. The last step is to ACK or NAK the received data so the flash loader knows that the data has been read.

```
Byte[0] = 0x03  
Byte[1] = checksum(Byte[2])  
Byte[2] = COMMAND_GET_STATUS
```

### A.4.3 COMMAND\_DOWNLOAD (0x21)

This command is sent to the flash loader to indicate where to store data and how many bytes will be sent by the `COMMAND_SEND_DATA` commands that follow. The command consists of two 32-bit values that are both transferred MSB first. The first 32-bit value is the address to start programming data into, while the second is the 32-bit size of the data that will be sent. This command also triggers an erase of the full area to be programmed so this command takes longer than other commands. This results in a longer time to receive the ACK/NAK back from the board. This command should be followed by a `COMMAND_GET_STATUS` to ensure that the Program Address and Program size are valid for the device running the flash loader.

The format of the packet to send this command is a follows:

```
Byte[0] = 11  
Byte[1] = checksum(Bytes[2:10])  
Byte[2] = COMMAND_DOWNLOAD  
Byte[3] = Program Address [31:24]  
Byte[4] = Program Address [23:16]  
Byte[5] = Program Address [15:8]  
Byte[6] = Program Address [7:0]  
Byte[7] = Program Size [31:24]
```

```

Byte[8] = Program Size [23:16]
Byte[9] = Program Size [15:8]
Byte[10] = Program Size [7:0]

```

#### A.4.4 COMMAND\_SEND\_DATA (0x24)

This command should only follow a `COMMAND_DOWNLOAD` command or another `COMMAND_SEND_DATA` command if more data is needed. Consecutive send data commands automatically increment address and continue programming from the previous location. The caller should limit transfers of data to a maximum 8 bytes of packet data to allow the flash to program successfully and not overflow input buffers of the serial interfaces. The command terminates programming once the number of bytes indicated by the `COMMAND_DOWNLOAD` command has been received. Each time this function is called it should be followed by a `COMMAND_GET_STATUS` to ensure that the data was successfully programmed into the flash. If the flash loader sends a NAK to this command, the flash loader does not increment the current address to allow retransmission of the previous data.

```

Byte[0] = 11
Byte[1] = checksum(Bytes[2:10])
Byte[2] = COMMAND_SEND_DATA
Byte[3] = Data[0]
Byte[4] = Data[1]
Byte[5] = Data[2]
Byte[6] = Data[3]
Byte[7] = Data[4]
Byte[8] = Data[5]
Byte[9] = Data[6]
Byte[10] = Data[7]

```

#### A.4.5 COMMAND\_RUN (0x22)

This command is used to tell the flash loader to execute from the address passed as the parameter in this command. This command consists of a single 32-bit value that is interpreted as the address to execute. The 32-bit value is transmitted MSB first and the flash loader responds with an ACK signal back to the host device before actually executing the code at the given address. This allows the host to know that the command was received successfully and the code is now running.

```

Byte[0] = 7
Byte[1] = checksum(Bytes[2:6])
Byte[2] = COMMAND_RUN
Byte[3] = Execute Address[31:24]
Byte[4] = Execute Address[23:16]
Byte[5] = Execute Address[15:8]
Byte[6] = Execute Address[7:0]

```

#### A.4.6 COMMAND\_RESET (0x25)

This command is used to tell the flash loader device to reset. This is useful when downloading a new image that overwrote the flash loader and wants to start from a full reset. Unlike the `COMMAND_RUN` command, this allows the initial stack pointer to be read by the hardware and set up for the new code. It can also be used to reset the flash loader if a critical error occurs and the host device wants to restart communication with the flash loader.

```
Byte[0] = 3  
Byte[1] = checksum(Byte[2])  
Byte[2] = COMMAND_RESET
```

The flash loader responds with an ACK signal back to the host device before actually executing the software reset to the device running the flash loader. This allows the host to know that the command was received successfully and the part will be reset.

## B Register Quick Reference

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>The Cortex-M3 Processor</b>															
<b>R0, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R1, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R2, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R3, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R4, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R5, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R6, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R7, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R8, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R9, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R10, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R11, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>R12, type R/W, , reset - (see page 48)</b>															
DATA															
DATA															
<b>SP, type R/W, , reset - (see page 49)</b>															
SP															
SP															
<b>LR, type R/W, , reset 0xFFFF.FFFF (see page 50)</b>															
LINK															
LINK															
<b>PC, type R/W, , reset - (see page 51)</b>															
PC															
PC															

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
<b>PSR, type R/W, , reset 0x0100.0000</b> (see page 52)																
N	Z	C	V	Q	ICI / IT			THUMB					ISRNUM			
ICI / IT																
<b>PRIMASK, type R/W, , reset 0x0000.0000</b> (see page 56)																
															PRIMASK	
<b>FAULTMASK, type R/W, , reset 0x0000.0000</b> (see page 57)																
															FAULTMASK	
<b>BASEPRI, type R/W, , reset 0x0000.0000</b> (see page 58)																
								BASEPRI								
<b>CONTROL, type R/W, , reset 0x0000.0000</b> (see page 59)																
														ASP	TMPL	
<b>Cortex-M3 Peripherals</b>																
<b>System Timer (SysTick) Registers</b>																
Base 0xE000.E000																
<b>STCTRL, type R/W, offset 0x010, reset 0x0000.0000</b>																
												CLK_SRC	INTEN	COUNT	ENABLE	
<b>STRELOAD, type R/W, offset 0x014, reset 0x0000.0000</b>																
												RELOAD				
												RELOAD				
<b>STCURRENT, type R/W, offset 0x018, reset 0x0000.0000</b>																
												CURRENT				
												CURRENT				
<b>Cortex-M3 Peripherals</b>																
<b>Nested Vectored Interrupt Controller (NVIC) Registers</b>																
Base 0xE000.E000																
<b>EN0, type R/W, offset 0x100, reset 0x0000.0000</b>																
												INT				
												INT				
<b>EN1, type R/W, offset 0x104, reset 0x0000.0000</b>																
												INT				
<b>DIS0, type R/W, offset 0x180, reset 0x0000.0000</b>																
												INT				
												INT				
<b>DIS1, type R/W, offset 0x184, reset 0x0000.0000</b>																
												INT				
<b>PEND0, type R/W, offset 0x200, reset 0x0000.0000</b>																
												INT				
												INT				
<b>PEND1, type R/W, offset 0x204, reset 0x0000.0000</b>																
												INT				
<b>UNPEND0, type R/W, offset 0x280, reset 0x0000.0000</b>																
												INT				
												INT				

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>UNPEND1, type R/W, offset 0x284, reset 0x0000.0000</b>															
INT															
<b>ACTIVE0, type RO, offset 0x300, reset 0x0000.0000</b>															
INT															
<b>ACTIVE1, type RO, offset 0x304, reset 0x0000.0000</b>															
INT															
<b>PRI0, type R/W, offset 0x400, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI1, type R/W, offset 0x404, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI2, type R/W, offset 0x408, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI3, type R/W, offset 0x40C, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI4, type R/W, offset 0x410, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI5, type R/W, offset 0x414, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI6, type R/W, offset 0x418, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI7, type R/W, offset 0x41C, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI8, type R/W, offset 0x420, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI9, type R/W, offset 0x424, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>PRI10, type R/W, offset 0x428, reset 0x0000.0000</b>															
INTD								INTC							
INTB								INTA							
<b>SWTRIG, type WO, offset 0xF00, reset 0x0000.0000</b>															
INTID															
<b>Cortex-M3 Peripherals</b>															
<b>System Control Block (SCB) Registers</b>															
Base 0xE000.E000															
<b>CPUID, type RO, offset 0xD00, reset 0x411F.C231</b>															
IMP								VAR				CON			
PARTNO												REV			

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16												
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0												
<b>INTCTRL, type R/W, offset 0xD04, reset 0x0000.0000</b>																											
NMISSET				PENDSV		UNPENDSV		PENDSTSET		PENDSTCLR		ISRPRE		ISRPEND		VECPEND											
VECPEND				RETBASE								VECACT															
<b>VTABLE, type R/W, offset 0xD08, reset 0x0000.0000</b>																											
BASE				OFFSET																							
OFFSET																											
<b>APINT, type R/W, offset 0xD0C, reset 0xFA05.0000</b>																											
VECTKEY																											
ENDIANESS						PRIGROUP						SYSRESREQ		VECTQRACT		VECTRESET											
<b>SYSCTRL, type R/W, offset 0xD10, reset 0x0000.0000</b>																											
										SEVONPEND		SLEEPDEEP		SLEEPEXIT													
<b>CFGCTRL, type R/W, offset 0xD14, reset 0x0000.0000</b>																											
				STKALIGN				BFHFNIGN				DIV0		UNALIGNED		MAINPEND		BASETHR									
<b>SYSPRI1, type R/W, offset 0xD18, reset 0x0000.0000</b>																											
BUS								USAGE				MEM															
<b>SYSPRI2, type R/W, offset 0xD1C, reset 0x0000.0000</b>																											
SVC																											
<b>SYSPRI3, type R/W, offset 0xD20, reset 0x0000.0000</b>																											
TICK								PENDSV																			
DEBUG																											
<b>SYSHNDCTRL, type R/W, offset 0xD24, reset 0x0000.0000</b>																											
SVC		BUSP		MEMP		USAGEP		TICK		PNDSV		MON		SVCA		USGA		USAGE		BUS		MEM					
<b>FAULTSTAT, type R/W1C, offset 0xD28, reset 0x0000.0000</b>																											
BFARV				BSTKE		BUSTKE		IMPRES		PRECISE		IBUS		MMARV		MSTKE		MUSTKE		NOCP		INVPC		INVSTAT		UNDEF	
<b>HFAULTSTAT, type R/W1C, offset 0xD2C, reset 0x0000.0000</b>																											
DBG		FORCED														VECT											
<b>MMADDR, type R/W, offset 0xD34, reset -</b>																											
ADDR																											
ADDR																											
<b>FAULTADDR, type R/W, offset 0xD38, reset -</b>																											
ADDR																											
ADDR																											
<b>Cortex-M3 Peripherals</b>																											
<b>Memory Protection Unit (MPU) Registers</b>																											
Base 0xE000.E000																											
<b>MPUTYPE, type RO, offset 0xD90, reset 0x0000.0800</b>																											
										IREGION																	
DREGION										SEPARATE																	
<b>MPUCTRL, type R/W, offset 0xD94, reset 0x0000.0000</b>																											
										PRIVDEFEN		HFNMIENA		ENABLE													
<b>MPUNUMBER, type R/W, offset 0xD98, reset 0x0000.0000</b>																											
NUMBER																											

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
<b>MPUBASE, type R/W, offset 0xD9C, reset 0x0000.0000</b>																	
ADDR																	
ADDR												VALID		REGION			
<b>MPUBASE1, type R/W, offset 0xDA4, reset 0x0000.0000</b>																	
ADDR																	
ADDR												VALID		REGION			
<b>MPUBASE2, type R/W, offset 0xDAC, reset 0x0000.0000</b>																	
ADDR																	
ADDR												VALID		REGION			
<b>MPUBASE3, type R/W, offset 0xDB4, reset 0x0000.0000</b>																	
ADDR																	
ADDR												VALID		REGION			
<b>MPUATTR, type R/W, offset 0xDA0, reset 0x0000.0000</b>																	
				XN					AP					TEX	S	C	B
				SRD								SIZE				ENABLE	
<b>MPUATTR1, type R/W, offset 0xDA8, reset 0x0000.0000</b>																	
				XN					AP					TEX	S	C	B
				SRD								SIZE				ENABLE	
<b>MPUATTR2, type R/W, offset 0xDB0, reset 0x0000.0000</b>																	
				XN					AP					TEX	S	C	B
				SRD								SIZE				ENABLE	
<b>MPUATTR3, type R/W, offset 0xDB8, reset 0x0000.0000</b>																	
				XN					AP					TEX	S	C	B
				SRD								SIZE				ENABLE	
<b>System Control</b>																	
Base 0x400F.E000																	
<b>DID0, type RO, offset 0x000, reset - (see page 174)</b>																	
VER								CLASS									
MAJOR								MINOR									
<b>PBORCTL, type R/W, offset 0x030, reset 0x0000.7FFD (see page 176)</b>																	
														BORIOR			
<b>LDOPCTL, type R/W, offset 0x034, reset 0x0000.0000 (see page 177)</b>																	
														VADJ			
<b>RIS, type RO, offset 0x050, reset 0x0000.0000 (see page 178)</b>																	
										PLLLRIS			BORRIS				
<b>IMC, type R/W, offset 0x054, reset 0x0000.0000 (see page 179)</b>																	
										PLLLIM			BORIM				
<b>MISC, type R/W1C, offset 0x058, reset 0x0000.0000 (see page 180)</b>																	
										PLLLMIS			BORMIS				
<b>RESC, type R/W, offset 0x05C, reset - (see page 181)</b>																	
										SW	WDT	BOR	POR	EXT			
<b>RCC, type R/W, offset 0x060, reset 0x0780.3AD1 (see page 182)</b>																	
				ACG	SYSDIV				USESYS								
PWRDN				BYPASS	XTAL				OSCSRC				IOSCDIS	MOSCDIS			
<b>PLLCFG, type RO, offset 0x064, reset - (see page 185)</b>																	
										F			R				

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16										
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0										
<b>RCC2, type R/W, offset 0x070, reset 0x0780.2810</b> (see page 186)																									
USERCC2				SYSDIV2																					
PWRDN2				BYPASS2				OSCSRC2																	
<b>DSLCLKCFG, type R/W, offset 0x144, reset 0x0780.0000</b> (see page 188)																									
DSDIVORIDE																									
								DSOSCSRC																	
<b>DID1, type RO, offset 0x004, reset -</b> (see page 189)																									
VER				FAM				PARTNO																	
PINCOUNT								TEMP				PKG		ROHS		QUAL									
<b>DC0, type RO, offset 0x008, reset 0x003F.001F</b> (see page 191)																									
								SRAMSZ																	
								FLASHSZ																	
<b>DC1, type RO, offset 0x010, reset 0x0000.709F</b> (see page 192)																									
MINSYSDIV								MPU		PLL		WDT		SWO		SWD		JTAG							
<b>DC2, type RO, offset 0x014, reset 0x0107.0011</b> (see page 194)																									
								COMP0						TIMER2		TIMER1		TIMER0							
										SSI0								UART0							
<b>DC3, type RO, offset 0x018, reset 0x8F00.01C0</b> (see page 195)																									
32KHZ				CCP3		CCP2		CCP1		CCP0															
								C00		C0PLUS		C0MINUS													
<b>DC4, type RO, offset 0x01C, reset 0x5000.007F</b> (see page 196)																									
EPHY0				EMAC0								GPIOG		GPIOF		GPIOE		GPIOD		GPIOC		GPIOB		GPIOA	
<b>RCGC0, type R/W, offset 0x100, reset 0x00000040</b> (see page 198)																									
																WDT									
<b>SCGC0, type R/W, offset 0x110, reset 0x00000040</b> (see page 199)																									
																WDT									
<b>DCGC0, type R/W, offset 0x120, reset 0x00000040</b> (see page 200)																									
																WDT									
<b>RCGC1, type R/W, offset 0x104, reset 0x00000000</b> (see page 201)																									
								COMP0								TIMER2		TIMER1		TIMER0					
										SSI0										UART0					
<b>SCGC1, type R/W, offset 0x114, reset 0x00000000</b> (see page 203)																									
								COMP0								TIMER2		TIMER1		TIMER0					
										SSI0										UART0					
<b>DCGC1, type R/W, offset 0x124, reset 0x00000000</b> (see page 205)																									
								COMP0								TIMER2		TIMER1		TIMER0					
										SSI0										UART0					
<b>RCGC2, type R/W, offset 0x108, reset 0x00000000</b> (see page 207)																									
EPHY0				EMAC0								GPIOG		GPIOF		GPIOE		GPIOD		GPIOC		GPIOB		GPIOA	
<b>SCGC2, type R/W, offset 0x118, reset 0x00000000</b> (see page 209)																									
EPHY0				EMAC0								GPIOG		GPIOF		GPIOE		GPIOD		GPIOC		GPIOB		GPIOA	
<b>DCGC2, type R/W, offset 0x128, reset 0x00000000</b> (see page 211)																									
EPHY0				EMAC0								GPIOG		GPIOF		GPIOE		GPIOD		GPIOC		GPIOB		GPIOA	

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16				
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0				
<b>SRCR0, type R/W, offset 0x040, reset 0x00000000</b> (see page 213)																			
												WDT							
<b>SRCR1, type R/W, offset 0x044, reset 0x00000000</b> (see page 214)																			
								COMPO						TIMER2		TIMER1	TIMER0		
												SSIO						UART0	
<b>SRCR2, type R/W, offset 0x048, reset 0x00000000</b> (see page 215)																			
EPHY0				EMAC0								GPIOG		GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA
<b>Internal Memory</b>																			
<b>Flash Memory Control Registers (Flash Control Offset)</b>																			
Base 0x400F.D000																			
<b>FMA, type R/W, offset 0x000, reset 0x0000.0000</b>																			
OFFSET																			
<b>FMD, type R/W, offset 0x004, reset 0x0000.0000</b>																			
DATA																			
DATA																			
<b>FMC, type R/W, offset 0x008, reset 0x0000.0000</b>																			
WRKEY																			
												COMT	MERASE	ERASE	WRITE				
<b>FCRIS, type RO, offset 0x00C, reset 0x0000.0000</b>																			
														PRIS	ARIS				
<b>FCIM, type R/W, offset 0x010, reset 0x0000.0000</b>																			
														PMASK	AMASK				
<b>FCMISC, type R/W1C, offset 0x014, reset 0x0000.0000</b>																			
														PMISC	AMISC				
<b>Internal Memory</b>																			
<b>Flash Memory Protection Registers (System Control Offset)</b>																			
Base 0x400F.E000																			
<b>USECRL, type R/W, offset 0x140, reset 0x18</b>																			
USEC																			
<b>FMPRE0, type R/W, offset 0x130 and 0x200, reset 0xFFFF.FFFF</b>																			
READ_ENABLE																			
READ_ENABLE																			
<b>FMPPE0, type R/W, offset 0x134 and 0x400, reset 0xFFFF.FFFF</b>																			
PROG_ENABLE																			
PROG_ENABLE																			
<b>USER_DBG, type R/W, offset 0x1D0, reset 0xFFFF.FFFE</b>																			
NW				DATA															
DATA												DBG1		DBG0					
<b>USER_REG0, type R/W, offset 0x1E0, reset 0xFFFF.FFFF</b>																			
NW				DATA															
DATA																			
<b>USER_REG1, type R/W, offset 0x1E4, reset 0xFFFF.FFFF</b>																			
NW				DATA															
DATA																			

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>FMPRE1, type R/W, offset 0x204, reset 0x0000.0000</b>															
READ_ENABLE															
READ_ENABLE															
<b>FMPRE2, type R/W, offset 0x208, reset 0x0000.0000</b>															
READ_ENABLE															
READ_ENABLE															
<b>FMPRE3, type R/W, offset 0x20C, reset 0x0000.0000</b>															
READ_ENABLE															
READ_ENABLE															
<b>FMPPE1, type R/W, offset 0x404, reset 0x0000.0000</b>															
PROG_ENABLE															
PROG_ENABLE															
<b>FMPPE2, type R/W, offset 0x408, reset 0x0000.0000</b>															
PROG_ENABLE															
PROG_ENABLE															
<b>FMPPE3, type R/W, offset 0x40C, reset 0x0000.0000</b>															
PROG_ENABLE															
PROG_ENABLE															
<b>General-Purpose Input/Outputs (GPIOs)</b>															
GPIO Port A base: 0x4000.4000															
GPIO Port B base: 0x4000.5000															
GPIO Port C base: 0x4000.6000															
GPIO Port D base: 0x4000.7000															
GPIO Port E base: 0x4002.4000															
GPIO Port F base: 0x4002.5000															
GPIO Port G base: 0x4002.6000															
<b>GPIODATA, type R/W, offset 0x000, reset 0x0000.0000 (see page 254)</b>															
DATA															
<b>GPIODIR, type R/W, offset 0x400, reset 0x0000.0000 (see page 255)</b>															
DIR															
<b>GPIOIS, type R/W, offset 0x404, reset 0x0000.0000 (see page 256)</b>															
IS															
<b>GPIOIBE, type R/W, offset 0x408, reset 0x0000.0000 (see page 257)</b>															
IBE															
<b>GPIOIEV, type R/W, offset 0x40C, reset 0x0000.0000 (see page 258)</b>															
IEV															
<b>GPIOIM, type R/W, offset 0x410, reset 0x0000.0000 (see page 259)</b>															
IME															
<b>GPIOIRIS, type RO, offset 0x414, reset 0x0000.0000 (see page 260)</b>															
RIS															
<b>GPIOMIS, type RO, offset 0x418, reset 0x0000.0000 (see page 261)</b>															
MIS															
<b>GPIOICR, type W1C, offset 0x41C, reset 0x0000.0000 (see page 262)</b>															
IC															

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
GPIOAFSEL, type R/W, offset 0x420, reset - (see page 263)															
AFSEL															
GPIODR2R, type R/W, offset 0x500, reset 0x0000.00FF (see page 265)															
DRV2															
GPIODR4R, type R/W, offset 0x504, reset 0x0000.0000 (see page 266)															
DRV4															
GPIODR8R, type R/W, offset 0x508, reset 0x0000.0000 (see page 267)															
DRV8															
GPIOODR, type R/W, offset 0x50C, reset 0x0000.0000 (see page 268)															
ODE															
GPIOPUR, type R/W, offset 0x510, reset - (see page 269)															
PUE															
GPIOPDR, type R/W, offset 0x514, reset 0x0000.0000 (see page 270)															
PDE															
GPIOSLR, type R/W, offset 0x518, reset 0x0000.0000 (see page 271)															
SRL															
GPIODEN, type R/W, offset 0x51C, reset - (see page 272)															
DEN															
GPIOLOCK, type R/W, offset 0x520, reset 0x0000.0001 (see page 273)															
LOCK															
LOCK															
GPIOCR, type -, offset 0x524, reset - (see page 274)															
CR															
GPIOPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 276)															
PID4															
GPIOPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 277)															
PID5															
GPIOPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 278)															
PID6															
GPIOPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 279)															
PID7															
GPIOPeriphID0, type RO, offset 0xFE0, reset 0x0000.0061 (see page 280)															
PID0															
GPIOPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 281)															
PID1															

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16								
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0								
<b>GPIOPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 282)</b>																							
												PID2											
<b>GPIOPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 283)</b>																							
												PID3											
<b>GPIOCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 284)</b>																							
												CID0											
<b>GPIOCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 285)</b>																							
												CID1											
<b>GPIOCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 286)</b>																							
												CID2											
<b>GPIOCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 287)</b>																							
												CID3											
<b>General-Purpose Timers</b> Timer0 base: 0x4003.0000 Timer1 base: 0x4003.1000 Timer2 base: 0x4003.2000																							
<b>GPTMCFG, type R/W, offset 0x000, reset 0x0000.0000 (see page 300)</b>																							
												GPTMCFG											
<b>GPTMTAMR, type R/W, offset 0x004, reset 0x0000.0000 (see page 301)</b>																							
												TAAMS	TACMR	TAMR									
<b>GPTMTBMR, type R/W, offset 0x008, reset 0x0000.0000 (see page 303)</b>																							
												TBAMS	TBCMR	TBMR									
<b>GPTMCTL, type R/W, offset 0x00C, reset 0x0000.0000 (see page 305)</b>																							
TBPWML				TBEVENT				TBSTALL	TBEN	TAPWML				RTCEN	TAEVENT		TASTALL	TAEN					
<b>GPTMIMR, type R/W, offset 0x018, reset 0x0000.0000 (see page 308)</b>																							
												CBEIM		CBMIM	TBTOIM					RTCIM	CAEIM	CAMIM	TATOIM
<b>GPTMRIS, type RO, offset 0x01C, reset 0x0000.0000 (see page 310)</b>																							
												CBERIS		CBMRIS	TBTORIS					RTCIS	CAERIS	CAMRIS	TATORIS
<b>GPTMMIS, type RO, offset 0x020, reset 0x0000.0000 (see page 311)</b>																							
												CBEMIS		CBMMIS	TBTOMIS					RTCMIS	CAEMIS	CAMMIS	TATOMIS
<b>GPTMICR, type W1C, offset 0x024, reset 0x0000.0000 (see page 312)</b>																							
												CBECINT		CBMCINT	TBTCINT					RTCCINT	CAECINT	CAMCINT	TATOCINT
<b>GPTMTAILR, type R/W, offset 0x028, reset 0xFFFF.FFFF (see page 314)</b>																							
												TAILRH											
												TAILRL											
<b>GPTMTBILR, type R/W, offset 0x02C, reset 0x0000.FFFF (see page 315)</b>																							
												TBILRL											

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
GPTMTAMATCHR, type R/W, offset 0x030, reset 0xFFFF.FFFF (see page 316)															
TAMRH															
TAMRL															
GPTMTBMATCHR, type R/W, offset 0x034, reset 0x0000.FFFF (see page 317)															
TBMRL															
GPTMTAPR, type R/W, offset 0x038, reset 0x0000.0000 (see page 318)															
TAPSR															
GPTMTBPR, type R/W, offset 0x03C, reset 0x0000.0000 (see page 319)															
TBPSR															
GPTMTAPMR, type R/W, offset 0x040, reset 0x0000.0000 (see page 320)															
TAPSMR															
GPTMTBPMR, type R/W, offset 0x044, reset 0x0000.0000 (see page 321)															
TBPSMR															
GPTMTAR, type RO, offset 0x048, reset 0xFFFF.FFFF (see page 322)															
TARH															
TARL															
GPTMTBR, type RO, offset 0x04C, reset 0x0000.FFFF (see page 323)															
TBRL															
<b>Watchdog Timer</b>															
Base 0x4000.0000															
WDTLOAD, type R/W, offset 0x000, reset 0xFFFF.FFFF (see page 328)															
WDTLoad															
WDTLoad															
WDTVALUE, type RO, offset 0x004, reset 0xFFFF.FFFF (see page 329)															
WDTValue															
WDTValue															
WDTCTL, type R/W, offset 0x008, reset 0x0000.0000 (see page 330)															
														RESEN	INTEN
WDTICR, type WO, offset 0x00C, reset - (see page 331)															
WDTIntClr															
WDTIntClr															
WDTRIS, type RO, offset 0x010, reset 0x0000.0000 (see page 332)															
WDTRIS															
WDTMIS, type RO, offset 0x014, reset 0x0000.0000 (see page 333)															
WDTMIS															
WDTTEST, type R/W, offset 0x418, reset 0x0000.0000 (see page 334)															
STALL															
WDTLOCK, type R/W, offset 0xC00, reset 0x0000.0000 (see page 335)															
WDTLock															
WDTLock															
WDTPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 336)															
PID4															

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WDTPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 337)															
												PID5			
WDTPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 338)															
												PID6			
WDTPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 339)															
												PID7			
WDTPeriphID0, type RO, offset 0xFE0, reset 0x0000.0005 (see page 340)															
												PID0			
WDTPeriphID1, type RO, offset 0xFE4, reset 0x0000.0018 (see page 341)															
												PID1			
WDTPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 342)															
												PID2			
WDTPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 343)															
												PID3			
WDTPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 344)															
												CID0			
WDTPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 345)															
												CID1			
WDTPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 346)															
												CID2			
WDTPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 347)															
												CID3			
<b>Universal Asynchronous Receivers/Transmitters (UARTs)</b>															
UART0 base: 0x4000.C000															
UARTDR, type R/W, offset 0x000, reset 0x0000.0000 (see page 357)															
				OE	BE	PE	FE	DATA							
UARTRSR/UARTECR, type RO, offset 0x004, reset 0x0000.0000 (Reads) (see page 359)															
												OE	BE	PE	FE
UARTRSR/UARTECR, type WO, offset 0x004, reset 0x0000.0000 (Writes) (see page 359)															
												DATA			
UARTFR, type RO, offset 0x018, reset 0x0000.0090 (see page 361)															
								TXFE	RXFF	TXFF	RXFE	BUSY			
UARTILPR, type R/W, offset 0x020, reset 0x0000.0000 (see page 363)															
												ILPDVSR			
UARTIBRD, type R/W, offset 0x024, reset 0x0000.0000 (see page 364)															
												DIVINT			

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
UARTFBRD, type R/W, offset 0x028, reset 0x0000.0000 (see page 365)															
DIVFRAC															
UARTLCRH, type R/W, offset 0x02C, reset 0x0000.0000 (see page 366)															
SPS WLEN FEN STP2 EPS PEN BRK															
UARTCTL, type R/W, offset 0x030, reset 0x0000.0300 (see page 368)															
RXE TXE LBE SIRLP SIREN UARTEN															
UARTIFLS, type R/W, offset 0x034, reset 0x0000.0012 (see page 370)															
RXIFLSEL TXIFLSEL															
UARTIM, type R/W, offset 0x038, reset 0x0000.0000 (see page 372)															
OEIM BEIM PEIM FEIM RTIM TXIM RXIM															
UARTRIS, type RO, offset 0x03C, reset 0x0000.0000 (see page 374)															
OERIS BERIS PERIS FERIS RTRIS TXRIS RXRIS															
UARTMIS, type RO, offset 0x040, reset 0x0000.0000 (see page 375)															
OEMIS BEMIS PEMIS FEMIS RTMIS TXMIS RXMIS															
UARTICR, type W1C, offset 0x044, reset 0x0000.0000 (see page 376)															
OEIC BEIC PEIC FEIC RTIC TXIC RXIC															
UARTPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 378)															
PID4															
UARTPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 379)															
PID5															
UARTPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 380)															
PID6															
UARTPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 381)															
PID7															
UARTPeriphID0, type RO, offset 0xFE0, reset 0x0000.0011 (see page 382)															
PID0															
UARTPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 383)															
PID1															
UARTPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 384)															
PID2															
UARTPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 385)															
PID3															
UARTPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 386)															
CID0															

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
UARTPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 387)																
CID1																
UARTPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 388)																
CID2																
UARTPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 389)																
CID3																
<b>Synchronous Serial Interface (SSI)</b>																
SSIO base: 0x4000.8000																
SSICR0, type R/W, offset 0x000, reset 0x0000.0000 (see page 403)																
SCR				SPH		SPO		FRF		DSS						
SSICR1, type R/W, offset 0x004, reset 0x0000.0000 (see page 405)																
												SOD		MS	SSE	LBM
SSIDR, type R/W, offset 0x008, reset 0x0000.0000 (see page 407)																
DATA																
SSISR, type RO, offset 0x00C, reset 0x0000.0003 (see page 408)																
												BSY	RFF	RNE	TNF	TFE
SSICPSR, type R/W, offset 0x010, reset 0x0000.0000 (see page 410)																
CPSDVSR																
SSIIM, type R/W, offset 0x014, reset 0x0000.0000 (see page 411)																
												TXIM	RXIM	RTIM	RORIM	
SSIRIS, type RO, offset 0x018, reset 0x0000.0008 (see page 413)																
												TXRIS	RXRIS	RTRIS	RORRIS	
SSIMIS, type RO, offset 0x01C, reset 0x0000.0000 (see page 414)																
												TXMIS	RXMIS	RTMIS	RORMIS	
SSIICR, type W1C, offset 0x020, reset 0x0000.0000 (see page 415)																
														RTIC	RORIC	
SSIPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 416)																
PID4																
SSIPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 417)																
PID5																
SSIPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 418)																
PID6																
SSIPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 419)																
PID7																
SSIPeriphID0, type RO, offset 0xFE0, reset 0x0000.0022 (see page 420)																
PID0																

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>SSIPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 421)</b>															
												PID1			
<b>SSIPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 422)</b>															
												PID2			
<b>SSIPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 423)</b>															
												PID3			
<b>SSIPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 424)</b>															
												CID0			
<b>SSIPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 425)</b>															
												CID1			
<b>SSIPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 426)</b>															
												CID2			
<b>SSIPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 427)</b>															
												CID3			
<b>Ethernet Controller</b>															
<b>Ethernet MAC</b>															
Base 0x4004.8000															
<b>MACRIS/MACIACK, type RO, offset 0x000, reset 0x0000.0000 (Reads)</b>															
								PHYINT	MDINT	RXER	FOV	TXEMP	TXER	RXINT	
<b>MACRIS/MACIACK, type WO, offset 0x000, reset 0x0000.0000 (Writes)</b>															
								PHYINT	MDINT	RXER	FOV	TXEMP	TXER	RXINT	
<b>MACIM, type R/W, offset 0x004, reset 0x0000.007F</b>															
								PHYINTM	MDINTM	RXERM	FOVM	TXEMPM	TXERM	RXINTM	
<b>MACRCTL, type R/W, offset 0x008, reset 0x0000.0008</b>															
								RSTFIFO	BADCRC	PRMS	AMUL	RXEN			
<b>MACTCTL, type R/W, offset 0x00C, reset 0x0000.0000</b>															
								DUPLEX		CRC	PADEN	TXEN			
<b>MACDATA, type RO, offset 0x010, reset 0x0000.0000 (Reads)</b>															
								RXDATA							
								RXDATA							
<b>MACDATA, type WO, offset 0x010, reset 0x0000.0000 (Writes)</b>															
								TXDATA							
								TXDATA							
<b>MACIA0, type R/W, offset 0x014, reset 0x0000.0000</b>															
								MACOCT4				MACOCT3			
								MACOCT2				MACOCT1			
<b>MACIA1, type R/W, offset 0x018, reset 0x0000.0000</b>															
								MACOCT6				MACOCT5			

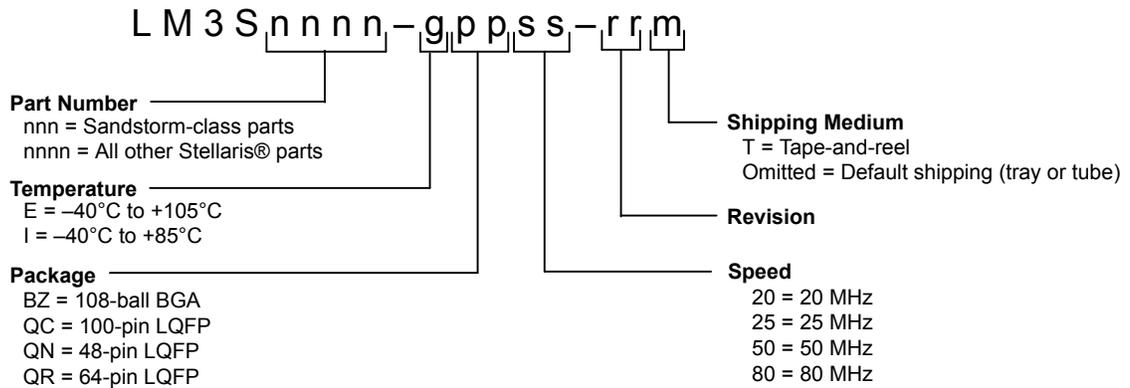
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
<b>MACTHR, type R/W, offset 0x01C, reset 0x0000.003F</b>																	
												THRESH					
<b>MACMCTL, type R/W, offset 0x020, reset 0x0000.0000</b>																	
												REGADR		WRITE		START	
<b>MACMDV, type R/W, offset 0x024, reset 0x0000.0080</b>																	
												DIV					
<b>MACMTXD, type R/W, offset 0x02C, reset 0x0000.0000</b>																	
												MDTX					
<b>MACMRXD, type R/W, offset 0x030, reset 0x0000.0000</b>																	
												MDRX					
<b>MACNP, type RO, offset 0x034, reset 0x0000.0000</b>																	
												NPR					
<b>MACTR, type R/W, offset 0x038, reset 0x0000.0000</b>																	
												NEWTX					
<b>Ethernet Controller</b>																	
<b>MII Management</b>																	
<b>MR0, type R/W, address 0x00, reset 0x3100</b>																	
RESET	LOOPBK	SPEEDSL	ANEGEN	PWRDN	ISO	RANEG	DUPLEX	COLT									
<b>MR1, type RO, address 0x01, reset 0x7849</b>																	
100X_F		100X_H		10T_F		10T_H				MFPS	ANEGC	RFAULT	ANEGA	LINK	JAB	EXTD	
<b>MR2, type RO, address 0x02, reset 0x000E</b>																	
												OUI[2:6]					
<b>MR3, type RO, address 0x03, reset 0x7237</b>																	
OUI[5:0]					MN					RN							
<b>MR4, type R/W, address 0x04, reset 0x01E1</b>																	
NP	RF					A3	A2	A1	A0	S							
<b>MR5, type RO, address 0x05, reset 0x0000</b>																	
NP	ACK	RF	A[7:0]						S								
<b>MR6, type RO, address 0x06, reset 0x0000</b>																	
												PDF	LPNPA	PRX		LPANEGA	
<b>MR16, type R/W, address 0x10, reset 0x0140</b>																	
RPTR	INPOL	TXHIM		SQEI	NL10				APOL	RVSPOL	PCSBP		RXCC				
<b>MR17, type R/W, address 0x11, reset 0x0000</b>																	
JABBER_IE	RXER_IE	PRX_IE	PDF_IE	LPACK_IE	LSCHG_IE	RFAULT_IE	ANEGCOMP_IE	JABBER_INT	RXER_INT	PRX_INT	PDF_INT	LPACK_INT	LSCHG_INT	RFAULT_INT	ANEGCOMP_INT		
<b>MR18, type RO, address 0x12, reset 0x0000</b>																	
				ANEGF	DPLX	RATE	RXSD	RX_LOCK									
<b>MR19, type R/W, address 0x13, reset 0x4000</b>																	
TXO																	
<b>MR23, type R/W, address 0x17, reset 0x0010</b>																	
												LED1[3:0]		LED0[3:0]			
<b>MR24, type R/W, address 0x18, reset 0x00C0</b>																	
								PD_MODE	AUTO_SW	MDIX	MDIX_CM	MDIX_SD					

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>Analog Comparator</b>															
Base 0x4003.C000															
ACMIS, type R/W1C, offset 0x000, reset 0x0000.0000 (see page 481)															
															IN0
ACRIS, type RO, offset 0x004, reset 0x0000.0000 (see page 482)															
															IN0
ACINTEN, type R/W, offset 0x008, reset 0x0000.0000 (see page 483)															
															IN0
ACREFCTL, type R/W, offset 0x010, reset 0x0000.0000 (see page 484)															
							EN	RNG							VREF
ACSTAT0, type RO, offset 0x020, reset 0x0000.0000 (see page 485)															
															OVAL
ACCTL0, type R/W, offset 0x024, reset 0x0000.0000 (see page 486)															
							ASRCP				ISLVAL	ISEN	CINV		

## C Ordering and Contact Information

### C.1 Ordering Information

The figure below defines the full set of potential orderable part numbers for all the Stellaris® LM3S microcontrollers. See the Package Option Addendum for the valid orderable part numbers for the LM3S6100 microcontroller.



### C.2 Part Markings

The Stellaris microcontrollers are marked with an identifying number. This code contains the following information:

- The first line indicates the part number, for example, LM3S9B90.
- In the second line, the first eight characters indicate the temperature, package, speed, revision, and product status. For example in the figure below, IQC80C0X indicates an Industrial temperature (I), 100-pin LQFP package (QC), 80-MHz (80), revision C0 (C0) device. The letter immediately following the revision indicates product status. An X indicates experimental and requires a waiver; an S indicates the part is fully qualified and released to production.
- The remaining characters contain internal tracking numbers.



### C.3 Kits

The Stellaris Family provides the hardware and software tools that engineers need to begin development quickly.

- Reference Design Kits accelerate product development by providing ready-to-run hardware and comprehensive documentation including hardware design files
- Evaluation Kits provide a low-cost and effective means of evaluating Stellaris microcontrollers before purchase
- Development Kits provide you with all the tools you need to develop and prototype embedded applications right out of the box

See the website at [www.ti.com/stellaris](http://www.ti.com/stellaris) for the latest tools available, or ask your distributor.

## C.4 Support Information

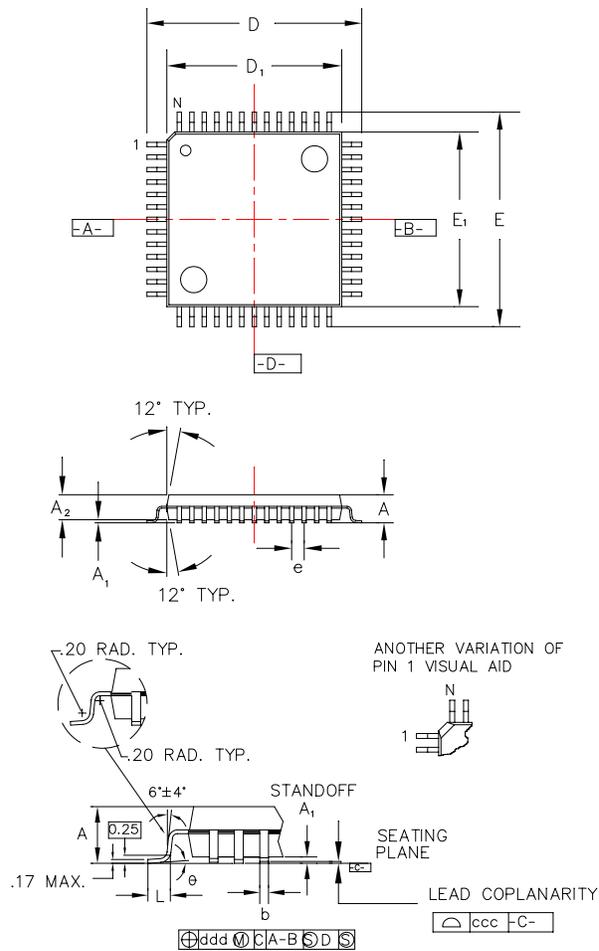
For support on Stellaris products, contact the TI Worldwide Product Information Center nearest you: <http://www-k.ext.ti.com/sc/technical-support/product-information-centers.htm>.

## D Package Information

### D.1 100-Pin LQFP Package

#### D.1.1 Package Dimensions

Figure D-1. Stellaris LM3S6100 100-Pin LQFP Package Dimensions



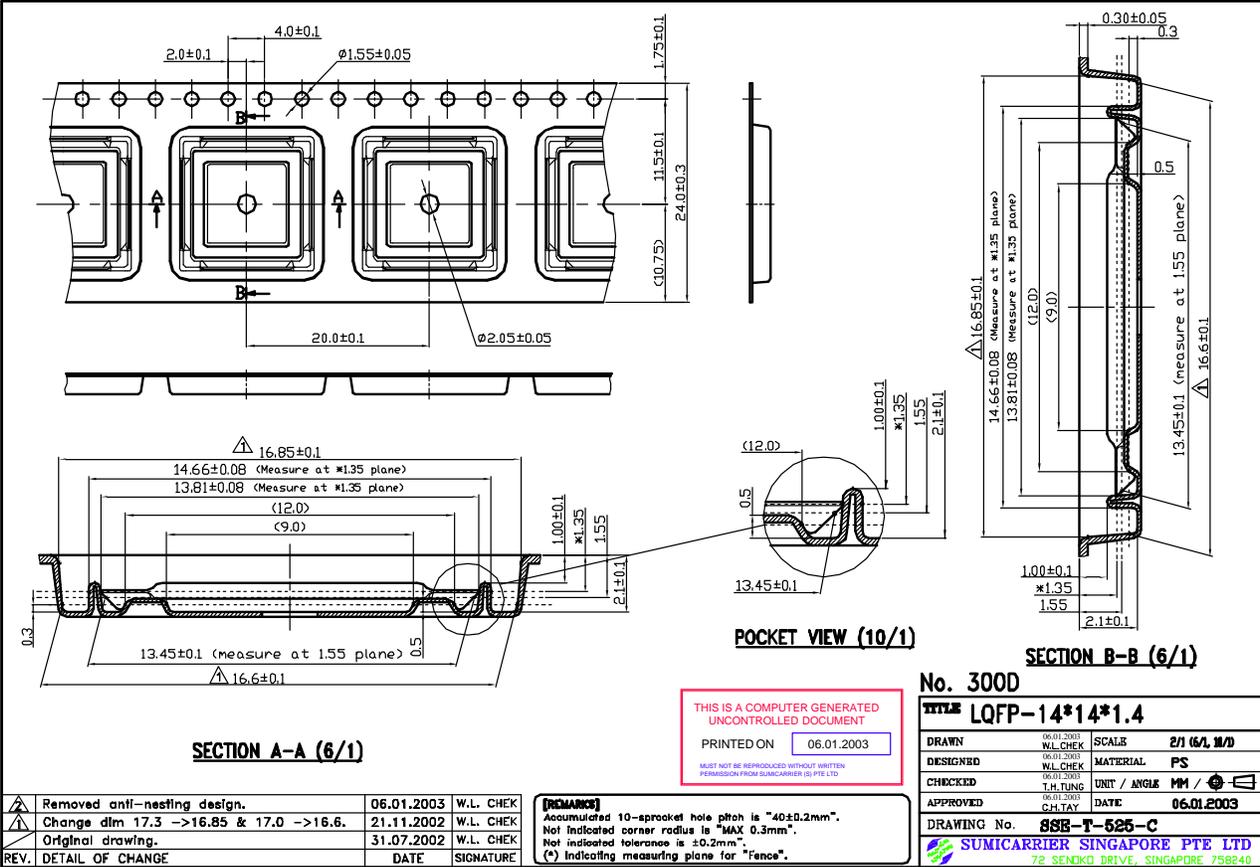
**Note:** The following notes apply to the package drawing.

1. All dimensions shown in mm.
2. Dimensions shown are nominal with tolerances indicated.
3. Foot length 'L' is measured at gage plane 0.25 mm above seating plane.

Body +2.00 mm Footprint, 1.4 mm package thickness		
Symbols	Leads	100L
A	Max.	1.60
A <sub>1</sub>	-	0.05 Min./0.15 Max.
A <sub>2</sub>	±0.05	1.40
D	±0.20	16.00
D <sub>1</sub>	±0.05	14.00
E	±0.20	16.00
E <sub>1</sub>	±0.05	14.00
L	+0.15/-0.10	0.60
e	Basic	0.50
b	+0.05	0.22
θ	-	0°-7°
ddd	Max.	0.08
ccc	Max.	0.08
JEDEC Reference Drawing		MS-026
Variation Designator		BED



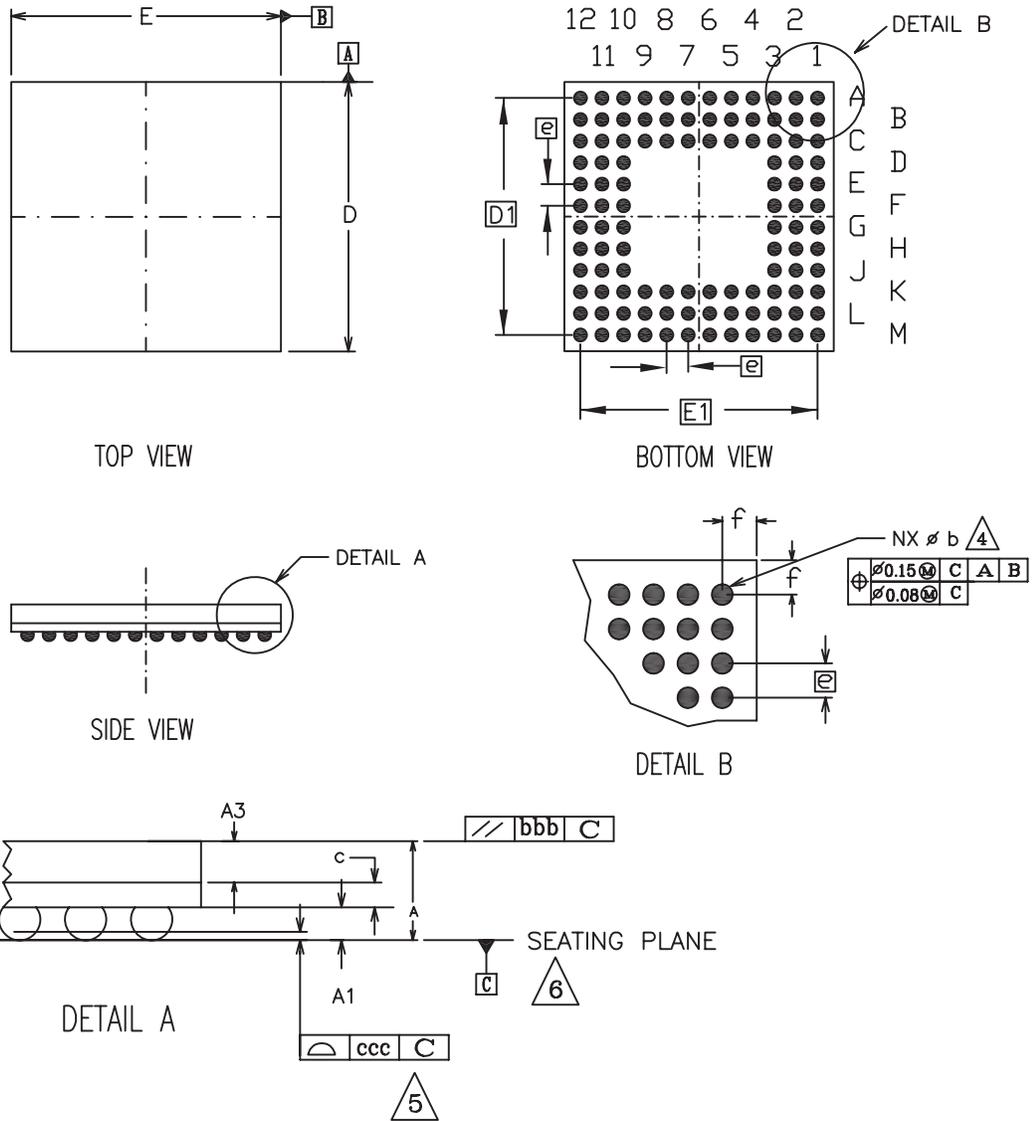
Figure D-3. 100-Pin LQFP Tape and Reel Dimensions



## D.2 108-Ball BGA Package

### D.2.1 Package Dimensions

Figure D-4. Stellaris LM3S6100 108-Ball BGA Package Dimensions



**Note:** The following notes apply to the package drawing.

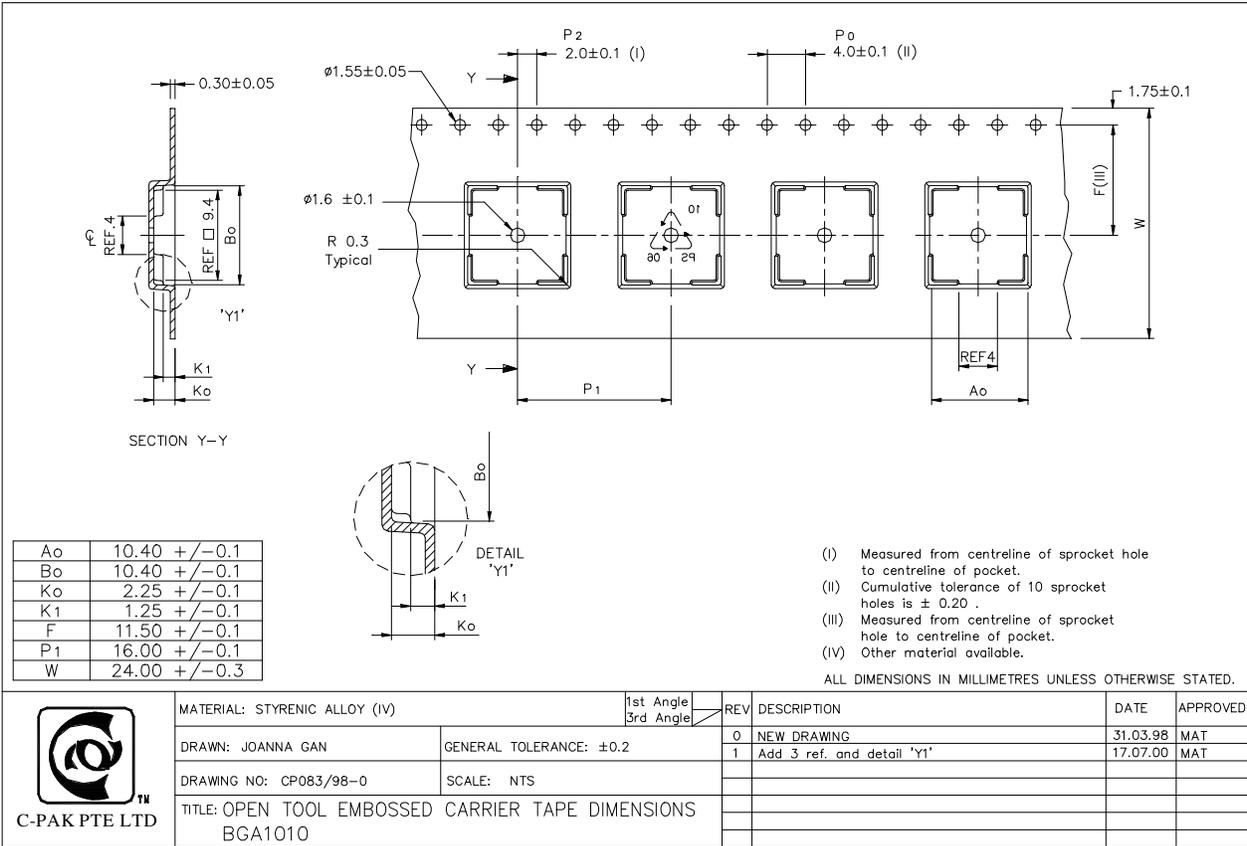
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. 'e' REPRESENTS THE BASIC SOLDER BALL GRID PITCH.
  3. 'M' REPRESENTS THE BASIC SOLDER BALL MATRIX SIZE.  
AND SYMBOL 'N' IS THE NUMBER OF BALLS AFTER DEPOPULATING.
  4. 'b' IS MEASURABLE AT THE MAXIMUM SOLDER BALL DIAMETER AFTER REFLOW  
PARALLEL TO PRIMARY DATUM [C].
  5. DIMENSION 'ccc' IS MEASURED PARALLEL TO PRIMARY DATUM [C].
  6. PRIMARY DATUM [C] AND SEATING PLANE ARE DEFINED BY THE SPHERICAL  
CROWNS OF THE SOLDER BALLS.
  7. PACKAGE SURFACE SHALL BE MATTE FINISH CHARMILLES 24 TO 27.
  8. SUBSTRATE MATERIAL BASE IS BT RESIN.
  9. THE OVERALL PACKAGE THICKNESS "A" ALREADY CONSIDERS COLLAPSE BALLS
  10. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
11. EXCEPT DIMENSION b.

Symbols	MIN	NOM	MAX
A	1.22	1.36	1.50
A1	0.29	0.34	0.39
A3	0.65	0.70	0.75
c	0.28	0.32	0.36
D	9.85	10.00	10.15
D1	8.80 BSC		
E	9.85	10.00	10.15
E1	8.80 BSC		
b	0.43	0.48	0.53
bbb	.20		
ddd	.12		
e	0.80 BSC		
f	-	0.60	-
M	12		
n	108		
REF: JEDEC MO-219F			



D.2.3 Tape and Reel Dimensions

Figure D-6. 108-Ball BGA Tape and Reel Dimensions



THIS DRAWING CONTAINS INFORMATION THAT IS PROPRIETARY TO C-PAK PTE.LTD.

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM3S6100-IQC25-A2	NRND	Production	LQFP (PZ)   100	90   null	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	LM3S6100 IQC25
LM3S6100-IQC25-A2.A	NRND	Production	LQFP (PZ)   100	90   null	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	LM3S6100 IQC25
LM3S6100-IQC25-A2.B	NRND	Production	LQFP (PZ)   100	90   null	-	Call TI	Call TI	-40 to 85	

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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