AM62Ax Sitara™ Processors

1 Features

Processor Cores:

- Up to Quad 64-bit Arm®Cortex®-A53 microprocessor subsystem at up to 1.4GHz
  - Quad-core Cortex-A53 cluster with 512KB L2 shared cache with SECDED ECC
  - Each A53 core has 32KB L1 DCache with SECDED ECC and 32KB L1 ICache with Parity protection
- Single-core Arm®Cortex®-R5F at up to 800MHz, integrated as part of MCU Channel with FFI
  - 32KB ICache, 32KB L1 DCache, and 64KB TCM with SECDED ECC on all memories
  - 512KB SRAM with SECDED ECC
- Single-core Arm®Cortex®-R5F at up to 800MHz, integrated to support Device Management
  - 32KB ICache, 32KB L1 DCache, and 64KB TCM with SECDED ECC on all memories
- Neural Processing Unit based on Single-core C7™ DSP
  - Floating point, 256-bit Vector C7™ DSP, up to 40 GFLOPS at 1.0GHz
  - Matrix Multiply Accelerator (MMA), up to 2TOPS (8b) at 1.0GHz
  - 64KB L1 DCache with SECDED ECC and 32KB L1 ICache with Parity protection
  - 1.25MB of L2 SRAM with SECDED ECC
- Vision Processing Accelerators (VPAC) with Image Signal Processor (ISP) and multiple vision assist accelerators:
  - 315MPixel/s ISP; Up to 5MP @ 60fps
  - Support for 12-bit RGB-IR
  - Support for up to 16-bit input RAW format
  - Line support up to 4096
  - Wide Dynamic Range (WDR), Lens Distortion Correction (LDC), Vision Imaging Subsystem (VISS), and Multi-Scalar (MSC) support
    - Output color format : 8-bits, 12-bits, and YUV 4:2:2, YUV 4:2:0, RGB, HSV/HSL

Multimedia:

- Display subsystem
  - Single display support
  - Up to 1920x1080 @ 60fps
  - Up to 165 MHz pixel clock support with independent PLL
  - DPI 24-bit RGB parallel interface
  - Supports safety features such as freeze frame detection and MISR data check
- One Camera Serial interface (CSI-2) Receiver with 4-Lane D-PHY
  - MIPI® CSI-2 v1.3 Compliant + MIPI D-PHY 1.2
  - Support for 1,2,3 or 4 data lane mode up to 2.5Gbps per lane
  - ECC verification/correction with CRC check + ECC on RAM
  - Virtual Channel support (up to 16)
  - Ability to write stream data directly to DDR via DMA
- Video Encoder/Decoder
  - Support for HEVC (H.265) Main profiles at Level 5.1 High-tier
  - Support for H.264 BaseLine/Main/High Profiles at Level 5.2
  - Support for up to 4K UHD resolution (3840 × 2160)
    - Clocking options supporting 240MPixels/s, 120MPixels/s, *or* 60MPixels/s
- Motion JPEG encode at 416MPixels/s with resolutions up to 4K UHD (3840 × 2160)

Memory Subsystem:

- Up to 2.29MB of On-chip RAM
  - 64KB of On-Chip RAM (OCRAM) with SECDED ECC, can be divided into smaller banks in increments of 32KB for as many as 2 separate memory banks
  - 256KB of On-Chip RAM with SECDED ECC in SMS Subsystem
  - 176KB of On-Chip RAM with SECDED ECC in SMS Subsystem for TI security firmware
  - 512KB of On-chip RAM with SECDED ECC in Cortex-R5F MCU Subsystem
  - 64KB of On-chip RAM with SECDED ECC in Device/Power Manager Subsystem
  - 1.25MB of L2 SRAM with SECDED ECC in Neural Processing Unit
- DDR Subsystem (DDRSS)
  - Supports LPDDR4
  - 32-bit data bus with inline ECC
  - Supports speeds up to 3733MT/s
  - Max addressable range of 8GBytes

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Functional Safety:

- Functional Safety-Compliant targeted [Automotive]
  - Developed for functional safety applications
  - Documentation will be available to aid ISO 26262 functional safety system design
  - Systematic capability up to ASIL D targeted
  - Hardware integrity up to ASIL B targeted
  - Safety-related certification
    - ISO 26262 by TÜV SÜD planned
- AEC - Q100 qualified [Automotive]

Security:

- Secure boot supported
  - Hardware-enforced Root-of-Trust (RoT)
  - Support to switch RoT via backup key
  - Support for takeover protection, IP protection, and anti-roll back protection
- Trusted Execution Environment (TEE) supported
  - Arm TrustZone® based TEE
  - Extensive firewall support for isolation
  - Secure watchdog/timer/IPC
  - Secure storage support
  - Replay Protected Memory Block (RPMB) support
- Dedicated Security Controller with user programmable HSM core and dedicated security DMA & IPC subsystem for isolated processing
- Cryptographic acceleration supported
  - Session-aware cryptographic engine with ability to auto-switch key-material based on incoming data stream
    - Supports cryptographic cores
  - AES – 128-/192-/256-Bit key sizes
  - SHA2 – 224-/256-/384-/512-Bit key sizes
  - DRBG with true random number generator
  - PKA (Public Key Accelerator) to Assist in RSA/ECC processing for secure boot
- Debugging security
  - Secure software controlled debug access
  - Security aware debugging

High-Speed Interfaces:

- Integrated Ethernet switch supporting (total 2 external ports)
  - RMII(10/100) or RGMII (10/100/1000)
  - IEEE1588 (Annex D, Annex E, Annex F with 802.1AS PTP)
  - Clause 45 MDIO PHY management
  - Packet Classifier based on ALE engine with 512 classifiers
  - Priority based flow control
  - Time Sensitive Networking (TSN) support
  - Four CPU H/W interrupt Pacing
  - IP/UDP/TCP checksum offload in hardware
- Two USB2.0 Ports
  - Port configurable as USB host, USB peripheral, or USB Dual-Role Device (DRD mode)
  - Integrated USB VBUS detection

General Connectivity:

- 9x Universal Asynchronous Receiver-Transmitters (UART)
- 5x Serial Peripheral Interface (SPI) controllers
- 6x Inter-Integrated Circuit (I^2C) ports
- 3x Multichannel Audio Serial Ports (McASP)
  - Transmit and Receive Clocks up to 50MHz
  - Up to 4/6/16 Serial Data Pins across 3x McASP with Independent TX and RX Clocks
  - Supports Time Division Multiplexing (TDM), Inter-IC Sound (I2S), and Similar Formats
  - Supports Digital Audio Interface Transmission (SPDIF, IEC60958-1, and AES-3 Formats)
  - FIFO Buffers for Transmit and Receive (256 Bytes)
  - Support for audio reference output clock
- 3x enhanced PWM modules (ePWM)
- 3x enhanced Quadrature Encoder Pulse modules (eQEP)
- 3x enhanced Capture modules (eCAP)
- General-Purpose I/O (GPIO), All LVCMOS I/O can be configured as GPIO
- 3x Controller Area Network (CAN) modules with CAN-FD support
  - Conforms w/ CAN Protocol 2.0 A, B and ISO 11898-1
  - Full CAN FD support (up to 64 data bytes)
  - Parity/ECC check for Message RAM
  - Speed up to 8Mbps

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Media and Data Storage:

- 3x Multi-Media Card/Secure Digital® (MMC/SD®/SDIO) interface
  - 1x 8-bit eMMC interface up to HS200 speed
  - 2x 4-bit SD/SDIO interface up to UHS-I
  - Compliant with eMMC 5.1, SD 3.0, and SDIO Version 3.0
- 1× General-Purpose Memory Controller (GPMC) up to 133MHz
  - Flexible 8- and 16-bit Asynchronous Memory Interface with up to four Chip (22-bit address) Selects (NAND, NOR, Muxed-NOR, and SRAM)
  - Uses BCH code to support 4-, 8-, or 16-bit ECC
  - Uses Hamming code to support 1-bit ECC
  - Error Locator Module (ELM)
    - Used with the GPMC to locate addresses of data errors from syndrome polynomials generated using a BCH algorithm
    - Supports 4-, 8-, and 16-bit per 512-Byte block error location based on BCH algorithms
- OSPI/QSPI with DDR / SDR support
  - Support for Serial NAND and Serial NOR Flash devices
  - 4GBytes memory address support
  - XIP mode with optional on-the-fly encryption

Power Management:

- Low-power modes supported by Device/Power Manager
  - Partial IO support for CAN/GPIO/UART wakeup
  - DeepSleep : I/O + DDR (suspend to RAM)
  - DeepSleep
  - MCU Only
  - Standby
  - Dynamic frequency scaling for Cortex-A53

Boot Options:

- UART
- I^2C EEPROM
- OSPI/QSPI Flash
- GPMC NOR/NAND Flash
- Serial NAND Flash
- SD Card
- eMMC
- USB (host) boot from Mass Storage device
- USB (device) boot from external host (DFU mode)
- Ethernet

Technology / Package:

- 16-nm FinFET technology
- 18mm x 18mm, 0.8mm pitch full-array, 484-pin FCBGA (AMB)
- 18mm x 18mm, 0.8mm pitch full-array, 484-pin FCCSP (ANF)

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2 Applications

- Driver Monitoring System (DMS) / Occupancy Monitoring System (OMS)
- eMirror/Camera Mirror System (CMS)
- Machine Vision Camera
- Barcode scanner
- Front camera system
- Stick up camera / Video doorbell
- Autonomous Mobile Robots (AMR)

3 Description

AM62Ax is an extension of the Sitara™ automotive-grade family of heterogeneous Arm® processors with embedded Deep Learning (DL), Video and Vision Processing acceleration, display interface and extensive automotive peripheral and networking options. AM62Ax is built for a set of cost-sensitive automotive applications including driver and in-cabin monitoring systems, next generation of eMirror system, as well as a broad set of industrial applications in Factory Automation, Building Automation, Robotics, and other markets. The cost optimized AM62Ax provides high-performance compute for both traditional and deep learning algorithms at industry leading power/performance ratios with a high level of system integration to enable scalability and lower costs for advanced automotive platforms supporting multiple sensor modalities in stand-alone Electronic Control Units (ECUs).

AM62Ax contains up to four Arm® Cortex®-A53 cores with 64-bit architecture, a Vision Processing Accelerator (VPAC) with Image Signal Processor (ISP) and multiple vision assist accelerators, Deep Learning (DL) and video accelerators, a Cortex®-R5F MCU Channel core and a Cortex®-R5F Device Management core. The Cortex-A53s provide the powerful computing elements necessary for Linux applications as well as the implementation of traditional vision computing based-algorithms such as driver monitoring. Building on the existing world-class ISP, TI's 7th generation ISP includes flexibility to process a broader sensor suite including RGB-InfraRed (RGB-IR), support for higher bit depth, and features targeting analytics applications. Key cores include the next generation C7000™ DSP from Texas Instruments (C7™ DSP) with scalar and vector cores, dedicated "MMA" deep learning accelerator enabling performance up to 2 TOPS within the lowest power envelope in the industry when operating at the typical automotive worst case junction temperature of 125°C.

The 3-port Gigabit Ethernet switch has one internal port and two external ports with TSN support and can be used to enable industrial networking options. In addition, an extensive peripherals set is included in AM62Ax to enable system level connectivity such as USB, MMC/SD, Camera interface, OSPI, CAN-FD and GPMC for parallel host interface to an external ASIC/FPGA. AM62Ax supports secure boot for IP protection with the built-in HSM (Hardware Security Module) and also employs advanced power management support for portable and power-sensitive applications.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
AM62A7	AMB (FCBGA, 484) ANF (FCCSP, 484)	18mm × 18mm
AM62A7-Q1	AMB (FCBGA, 484) ANF (FCCSP, 484)	18mm × 18mm
AM62A3	AMB (FCBGA, 484) ANF (FCCSP, 484)	18mm × 18mm
AM62A3-Q1	AMB (FCBGA, 484) ANF (FCCSP, 484)	18mm × 18mm
AM62A1-Q1	AMB (FCBGA, 484) ANF (FCCSP, 484)	18mm × 18mm

(1) For more information, see Mechanical, Packaging, and Orderable Information.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

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3.1 Functional Block Diagram

Figure 3-1 is functional block diagram for the device.

Note

To understand what device features are currently supported by TI Software Development Kits (SDKs), search for the *AM62Ax Software Build Sheet* located in the Downloads tab option provided at **Processor-SDK-AM62Ax**.

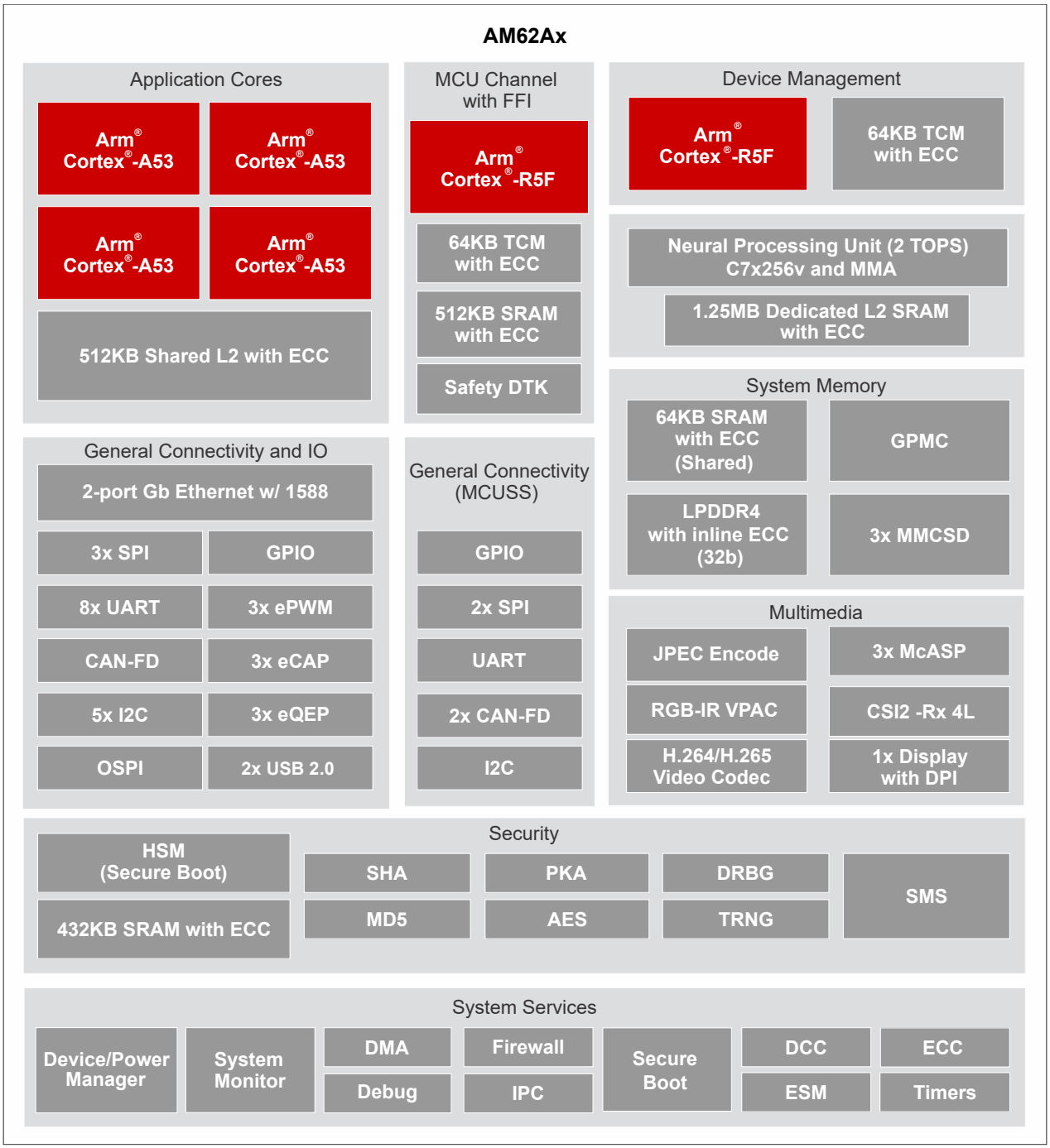


Figure 3-1. Functional Block Diagram

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4 Device Comparison

Table 4-1 shows a comparison between devices, highlighting the differences.

Note

Availability of features listed in this table are a function of shared IO pins, where IO signals associated with many of the features are multiplexed to a limited number of pins. The SysConfig tool should be used to assign signal functions to pins. This will provide a better understanding of limitations associated with pin multiplexing.

Note

To understand what device features are currently supported by TI Software Development Kits (SDKs), search for the *AM62Ax Software Build Sheet* located in the Downloads tab option provided at **Processor-SDK-AM62Ax**.

Table 4-1. Device Comparison

FEATURES	REFERENCE NAME	AM62A7, AM62A7-Q1		AM62A3, AM62A3-Q1			AM62A1-Q1	
		AM62A74	**AM62A72**	**AM62A34**	**AM62A32**	**AM62A31**	**AM62A14**	**AM62A12**
WKUP_CTRL_MMR_CFG0_JTAG_USER_ID[31:13] (1) Register bit values by device "Features" code (See Nomenclature Description table for more information on device features)								
L:		–	0x253AC	0x251EC	0x251AC	0x2518C	–	–
M:		0x253ED	0x253AD	0x251ED	0x251AD	–	0x250ED	0x250AD
PROCESSORS AND ACCELERATORS								
Speed Grades		See Table 6-1, *Device Speed Grades*						
Arm Cortex-A53 Microprocessor Subsystem	Arm A53	Quad Core	Dual Core	Quad Core	Dual Core	Single Core	Quad Core	Dual Core
Arm Cortex-R5F in MCU domain	MCU_R5F	Single Core Functional Safety Optional(4)						
Neural Processing Unit - C7™ DSP + MMA	NPU	Up to 2 TOPS		Up to 1 TOPS			No (0 TOPS)	
Vision Processing Accelerators	VPAC	Up to 5MP @ 60 fps						
Video Encoder / Decoder	VENC/VDEC	Yes						
Motion JPEG Encoder	MJPEG	Yes						
Device Management Subsystem	WKUP_R5F	Single Core						
Hardware Security Module	HSM	Yes						
Crypto Accelerators	Security	Yes						
PROGRAM AND DATA STORAGE								
On-Chip Shared Memory (RAM) in MAIN Domain	OCSRAM	64KB						
On-Chip Shared Memory (RAM) in MCU Domain	MCU_MSRAM	512KB						
LPDDR4 DDR Subsystem	DDRSS	32-bit data with inline ECC up to 8GB						
General-Purpose Memory Controller	GPMC	Up to 128MB with ECC						
PERIPHERALS								
Display Subsystem(2)	DSS	1x DPI (Optional)						
Modular Controller Area Network Interface	MCAN	3						
Full CAN-FD Support	CAN-FD	Yes						
General-Purpose I/O	GPIO	Up to 168						
Inter-Integrated Circuit Interface	I2C	6						
Multichannel Audio Serial Port	MCASP	3						
Multichannel Serial Peripheral Interface	MCSPI	5						

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Table 4-1. Device Comparison (continued)

FEATURES	REFERENCE NAME	AM62A7, AM62A7-Q1		AM62A3, AM62A3-Q1			AM62A1-Q1	
		AM62A74	AM62A72	AM62A34	AM62A32	AM62A31	AM62A14	AM62A12
Multi-Media Card/ Secure Digital Interface	MM/CSD	1x eMMC (8-bits)						
		2x SD/SDIO (4-bits)						
OSPI/QSPI/SPI(3) Flash Subsystem	OSPI	Yes						
Gigabit Ethernet Interface	CPSW3G	Yes						
General-Purpose Timers	TIMER	12 (4 in MCU Channel)						
Enhanced Pulse-Width Modulator Module	EPWM	3						
Enhanced Capture Module	ECAP	3						
Enhanced Quadrature Encoder Pulse Module	EQEP	3						
Universal Asynchronous Receiver and Transmitter	UART	9						
CSI2-RX Controller with DPHY	CSI-RX	1						
USB2.0 Controller with PHY	USB 2.0	2						

(1) For more details about the CTRLMMR_WKUP_JTAG_DEVICE_ID register and DEVICE_ID bit field, see the device TRM.
(2) Display Subsystem is available when selecting an orderable part number that includes a feature code of M. Refer to Device Naming Convention for definition of feature codes.
(3) A single instance of an OSPI flash host configured to operate with OSPI/QSPI/SPI devices.
(4) Functional Safety is available when selecting an orderable part number that includes a feature code of S to Z. Refer to Device Naming Convention for definition of feature codes.

4.1 Related Products

Sitara™ processors Broad family of scalable processors based on Arm® Cortex®-A cores with flexible accelerators, peripherals, connectivity, and unified software support – a good choice for sensors to servers. Sitara processors have the reliability and functional safety support required for use in automotive applications.

Sitara™ microcontrollers Best-in-class Arm®-based 32-bit microcontrollers (MCUs) offer you a scalable portfolio of high-performance and power-efficient devices to help meet your system needs. Bring capabilities such as functional safety, power efficiency, real-time control, advanced networking, analytics, and security to your designs.

AM64x Sitara™ processors target industrial applications such as Factory Automation and Control (FAC), and motor control that utilize Linux application processing cores (Cortex®-A53), real-time processing cores (Cortex®-R5F), and Industrial Communication Subsystems (PRU_ICSSGs) to support protocols such as EtherCAT, Profinet, or EtherNet/IP. AM64x implements one CPSW3G and two PRU_ICSSGs for supporting up to five gigabit Ethernet ports. The device also supports an extensive set of peripherals including a single lane of PCIe Gen2 or USB SuperSpeed Gen1, functional safety options, secure boot, and run-time security.

AM623 Sitara™ processors Internet of Things (IoT) and gateway SoC with Arm® Cortex®-A53-based object and gesture recognition. The low-cost AM623 Sitara™ MPU family of application processors are built for Linux® application development. With scalable Arm® Cortex®-A53 performance, embedded features such as dual-display support, and an extensive set of peripherals make the AM623 device well-suited for a broad range of industrial and automotive applications.

AM625 Sitara™ processors human-machine-interaction SoC with Arm® Cortex®-A53-and full-HD dual display. The low-cost AM625 Sitara™ MPU family of application processors are built for Linux® application development. With scalable Arm® Cortex®-A53 performance, embedded features such as dual-display support, 3D graphics acceleration, and an extensive set of peripherals make the AM625 device well-suited for a broad range of industrial and automotive applications.

Products to complete your design:

- Ethernet PHYs
- Power Management

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- Clocks and timing
- CAN Transceivers
- ESD Protection

Please reference the AM62Ax EVM schematic for details of how these devices are implemented in a system design, and bill of materials for specific part number recommendations.

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5 Terminal Configuration and Functions

5.1 Pin Diagrams

Note

The terms "ball", "pin", and "terminal" are used interchangeably throughout the document. An attempt is made to use "ball" only when referring to the physical package.

Figure 5-1 shows the ball locations for the 484-ball flip chip ball grid array (FCBGA and FCCSP) packages, where the HTML version provides additional information when hovering your cursor over a ball. This figure is used in conjunction with Section 5.2.1 through Section 5.4 (*Pin Attributes table and all Signal Descriptions tables, including the Pin Connectivity Requirements table*).

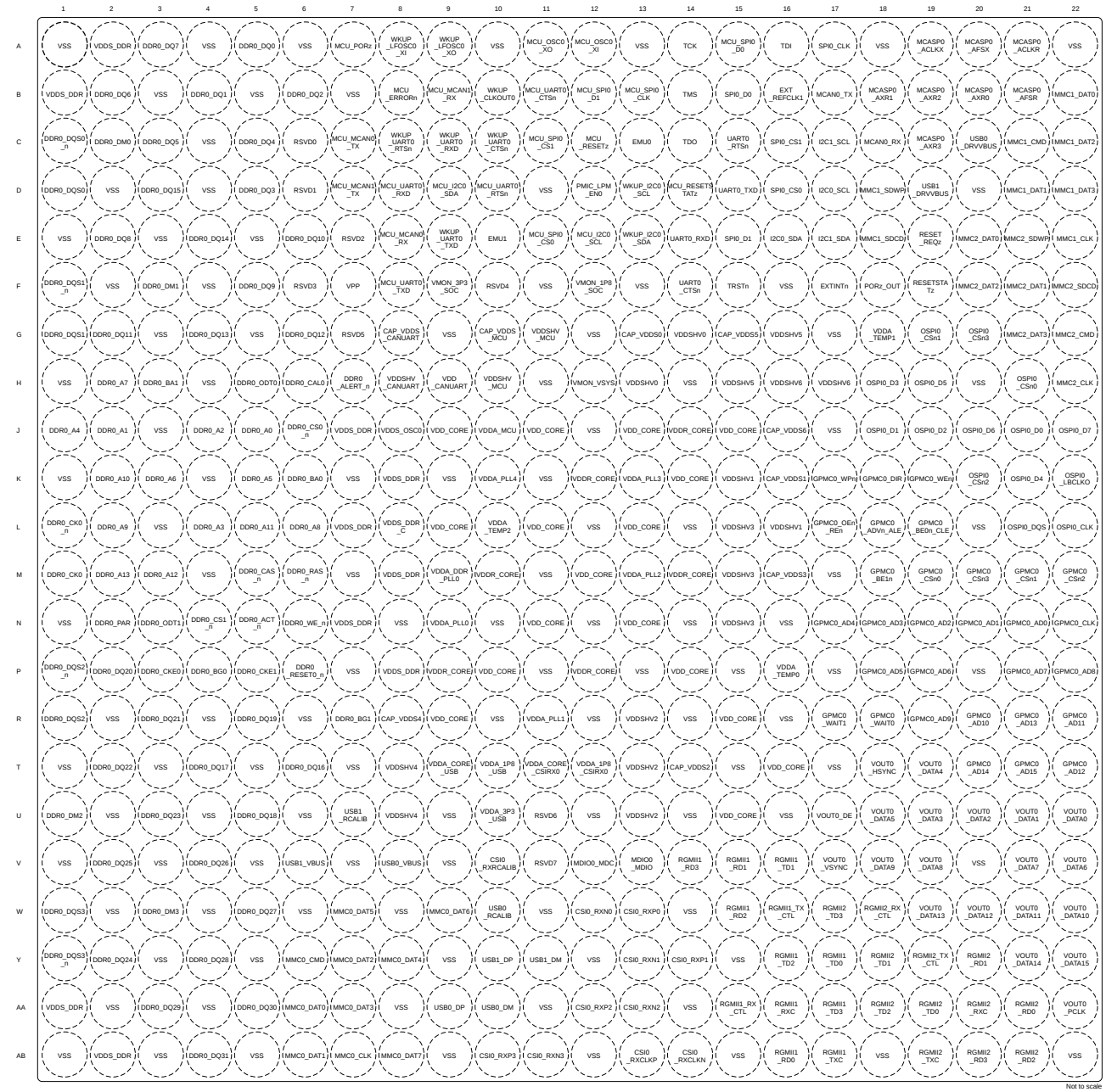


Figure 5-1. AMB FCBGA and ANF FCCSP Pin Diagram (Top View)

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5.2 Pin Attributes

The following list describes the contents of each column in Table 5-1, *Pin Attributes (AMB, ANF Packages)*:

1. **BALL NUMBER:** Ball numbers assigned to each terminal of the Ball Grid Array package.
2. **BALL NAME:** Ball name assigned to each terminal of the Ball Grid Array package (this name is typically taken from the primary MUXMODE 0 signal function).
3. **SIGNAL NAME:** Signal name(s) of all dedicated and pin multiplexed signal functions associated with a ball.

Note

Many device pins support multiple signal functions. Some signal functions are selected via a single layer of multiplexers associated with pins. Other signal functions are selected via two or more layers of multiplexers, where one layer is associated with the pins and other layers are associated with peripheral logic functions.

Table 5-1, *Pin Attributes (AMB, ANF Packages)* only defines signal multiplexing at the pins. For more information, related to signal multiplexing at the pins, see *Pad Configuration Registers* section in *Device Configuration* chapter of the device TRM. Refer to the respective peripheral chapter in the device TRM for information associated with peripheral signal multiplexing.

4. **MUX MODE:** The MUXMODE value associated with each pin multiplexed signal function:
   a. MUXMODE 0 is the primary pin multiplexed signal function. However, the primary pin multiplexed signal function is not necessarily the default pin multiplexed signal function.

Note

The value found in the MUX MODE AFTER RESET column defines the default pin multiplexed signal function selected when MCU_PORz is deasserted.

   a. MUXMODE values 1 through 15 are possible for pin multiplexed signal functions. However, not all MUXMODE values have been implemented. The only valid MUXMODE values are those defined as pin multiplexed signal functions within the Section 5.2.1 table. Only valid values of MUXMODE should be used.
   b. Bootstrap defines SOC configuration pins, where the logic state applied to each pin is latched on the rising edge of PORz_OUT. These input signal functions are fixed to their respective pins and are not programmable via MUXMODE.
   c. An empty box means Not Applicable.

Note

The following configurations of MUXMODE must be avoided for proper device operation.

- Configuring multiple pins operating as inputs to the same pin multiplexed signal function is not supported as it can yield unexpected results.
- Configuring a pin to an undefined pin multiplexing mode will cause the pin behavior to be undefined.

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5. **TYPE:** Signal type and direction:
   - I = Input
   - O = Output
   - OD = Output, with open-drain output function
   - IO = Input, Output, or simultaneously Input and Output
   - IOD = Input, Output, or simultaneously Input and Output, with open-drain output function
   - IOZ = Input, Output, or simultaneously Input and Output, with three-state output function
   - OZ = Output with three-state output function
   - A = Analog
   - PWR = Power
   - GND = Ground
   - CAP = LDO Capacitor.
6. **DSIS:** The deselected input state (DSIS) indicates the state driven to the subsystem input (logic "0", logic "1", or "pad" level) when the pin multiplexed signal function is not selected by MUXMODE.
   - 0: Logic 0 driven to the subsystem input.
   - 1: Logic 1 driven to the subsystem input.
   - pad: Logic state of the pad is driven to the subsystem input.
   - An empty box means Not Applicable.
7. **BALL STATE DURING RESET RX/TX/PULL:** State of the terminal while MCU_PORz is asserted, where RX defines the state of the input buffer, TX defines the state of the output buffer, and PULL defines the state of internal pull resistors:
   - RX (Input buffer)
     - Off: The input buffer is disabled.
     - On: The input buffer is enabled.
   - TX (Output buffer)
     - Off: The output buffer is disabled.
     - Low: The output buffer is enabled and drives V_{OL}.
   - PULL (Internal pull resistors)
     - Off: Internal pull resistors are turned off.
     - Up: Internal pull-up resistor is turned on.
     - Down: Internal pull-down resistor is turned on.
     - NA: Not Applicable.
   - An empty box means Not Applicable.
8. **BALL STATE AFTER RESET RX/TX/PULL:** State of the terminal after MCU_PORz is deasserted, where RX defines the state of the input buffer, TX defines the state of the output buffer, and PULL defines the state of internal pull resistors:
   - RX (Input buffer)
     - Off: The input buffer is disabled.
     - On: The input buffer is enabled.
   - TX (Output buffer)
     - Off: The output buffer is disabled.
     - SS: The subsystem selected with MUXMODE determines the output buffer state.
   - PULL (Internal pull resistors)
     - Off: Internal pull resistors are turned off.
     - Up: Internal pull-up resistor is turned on.
     - Down: Internal pull-down resistor is turned on.
     - NA: Not Applicable.
   - An empty box means Not Applicable.
9. **MUX MODE AFTER RESET:** The value found in this column defines the default pin multiplexed signal function after MCU_PORz is deasserted.

   An empty box means Not Applicable.

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10. **I/O OPERATING VOLTAGE**: This column describes I/O operating voltage options of the respective power supply, when applicable.

    An empty box means Not Applicable.

    For more information, see valid operating voltage range(s) defined for each power supply in Section 6.5, *Recommended Operating Conditions*.

11. **POWER:** The power supply of the associated I/O, when applicable.

    An empty box means Not Applicable.

12. **HYS:** Indicates if the input buffer associated with this I/O has hysteresis:
    - Yes: With hysteresis
    - No: Without hysteresis
    - An empty box means Not Applicable.

    For more information, see the hysteresis values in Section 6.8, *Electrical Characteristics*.

13. **BUFFER TYPE:** This column defines the buffer type associated with a terminal. This information can be used to determine which Electrical Characteristics table is applicable.

    An empty box means Not Applicable.

    For electrical characteristics, refer to the appropriate buffer type table in Section 6.8, *Electrical Characteristics*.

14. **PULL UP/DOWN TYPE:** Indicates the presence of an internal pullup or pulldown resistor. Pullup and pulldown resistors can be enabled or disabled via software.
    - PU: Internal pull-up
    - PD: Internal pull-down
    - PU/PD: Internal pull-up and pull-down
    - An empty box means No internal pull.

15. **PADCONFIG Register:**Name of the IO pad configuration register associated with Ball.

16. **PADCONFIG Address:**Physical address of the IO pad configuration register associated with Ball.

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Table 5-1. Pin Attributes (AMB, ANF Packages)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
G13	G13	CAP_VDDS0	CAP_VDDS0		CAP									
K16	K16	CAP_VDDS1	CAP_VDDS1		CAP									
T14	T14	CAP_VDDS2	CAP_VDDS2		CAP									
M16	M16	CAP_VDDS3	CAP_VDDS3		CAP									
R8	R8	CAP_VDDS4	CAP_VDDS4		CAP									
G15	G15	CAP_VDDS5	CAP_VDDS5		CAP									
J16	J16	CAP_VDDS6	CAP_VDDS6		CAP									
G8	G8	CAP_VDDS_CANUART	CAP_VDDS_CANUART		CAP									
G10	G10	CAP_VDDS_MCU	CAP_VDDS_MCU		CAP									
AB14	AB14	CSI0_RXCLKN	CSI0_RXCLKN		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
AB13	AB13	CSI0_RXCLKP	CSI0_RXCLKP		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
V10	V10	CSI0_RXRCALIB	CSI0_RXRCALIB		A					1.8V	VDDA_1P8_CSIRX		D-PHY	
W12	W12	CSI0_RXN0	CSI0_RXN0		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
Y13	Y13	CSI0_RXN1	CSI0_RXN1		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
AA13	AA13	CSI0_RXN2	CSI0_RXN2		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
AB11	AB11	CSI0_RXN3	CSI0_RXN3		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
W13	W13	CSI0_RXP0	CSI0_RXP0		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
Y14	Y14	CSI0_RXP1	CSI0_RXP1		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
AA12	AA12	CSI0_RXP2	CSI0_RXP2		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
AB10	AB10	CSI0_RXP3	CSI0_RXP3		I					1.8V	VDDA_1P8_CSIRX		D-PHY	
N5	N5	DDR0_ACT_n	DDR0_ACT_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
H7	H7	DDR0_ALERT_n	DDR0_ALERT_n		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
M5	M5	DDR0_CAS_n	DDR0_CAS_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
N2	N2	DDR0_PAR	DDR0_PAR		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
M6	M6	DDR0_RAS_n	DDR0_RAS_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
N6	N6	DDR0_WE_n	DDR0_WE_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
J5	J5	DDR0_A0	DDR0_A0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
J2	J2	DDR0_A1	DDR0_A1		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
J4	J4	DDR0_A2	DDR0_A2		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
L4	L4	DDR0_A3	DDR0_A3		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
J1	J1	DDR0_A4	DDR0_A4		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
K5	K5	DDR0_A5	DDR0_A5		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
K3	K3	DDR0_A6	DDR0_A6		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
H2	H2	DDR0_A7	DDR0_A7		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
L6	L6	DDR0_A8	DDR0_A8		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
L2	L2	DDR0_A9	DDR0_A9		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
K2	K2	DDR0_A10	DDR0_A10		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
L5	L5	DDR0_A11	DDR0_A11		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
M3	M3	DDR0_A12	DDR0_A12		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
M2	M2	DDR0_A13	DDR0_A13		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
K6	K6	DDR0_BA0	DDR0_BA0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
H3	H3	DDR0_BA1	DDR0_BA1		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P4	P4	DDR0_BG0	DDR0_BG0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
R7	R7	DDR0_BG1	DDR0_BG1		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
H6	H6	DDR0_CAL0	DDR0_CAL0		A					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
M1	M1	DDR0_CK0	DDR0_CK0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
L1	L1	DDR0_CK0_n	DDR0_CK0_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P3	P3	DDR0_CKE0	DDR0_CKE0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P5	P5	DDR0_CKE1	DDR0_CKE1		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
J6	J6	DDR0_CS0_n	DDR0_CS0_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
N4	N4	DDR0_CS1_n	DDR0_CS1_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
C2	C2	DDR0_DM0	DDR0_DM0		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
F3	F3	DDR0_DM1	DDR0_DM1		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
U1	U1	DDR0_DM2	DDR0_DM2		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
W3	W3	DDR0_DM3	DDR0_DM3		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
A5	A5	DDR0_DQ0	DDR0_DQ0		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
B4	B4	DDR0_DQ1	DDR0_DQ1		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
B6	B6	DDR0_DQ2	DDR0_DQ2		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
D5	D5	DDR0_DQ3	DDR0_DQ3		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
C5	C5	DDR0_DQ4	DDR0_DQ4		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
C3	C3	DDR0_DQ5	DDR0_DQ5		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
B2	B2	DDR0_DQ6	DDR0_DQ6		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
A3	A3	DDR0_DQ7	DDR0_DQ7		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
E2	E2	DDR0_DQ8	DDR0_DQ8		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
F5	F5	DDR0_DQ9	DDR0_DQ9		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
E6	E6	DDR0_DQ10	DDR0_DQ10		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
G2	G2	DDR0_DQ11	DDR0_DQ11		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
G6	G6	DDR0_DQ12	DDR0_DQ12		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
G4	G4	DDR0_DQ13	DDR0_DQ13		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
E4	E4	DDR0_DQ14	DDR0_DQ14		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
D3	D3	DDR0_DQ15	DDR0_DQ15		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
T6	T6	DDR0_DQ16	DDR0_DQ16		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
T4	T4	DDR0_DQ17	DDR0_DQ17		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
U5	U5	DDR0_DQ18	DDR0_DQ18		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
R5	R5	DDR0_DQ19	DDR0_DQ19		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P2	P2	DDR0_DQ20	DDR0_DQ20		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
R3	R3	DDR0_DQ21	DDR0_DQ21		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
T2	T2	DDR0_DQ22	DDR0_DQ22		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
U3	U3	DDR0_DQ23	DDR0_DQ23		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
Y2	Y2	DDR0_DQ24	DDR0_DQ24		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
V2	V2	DDR0_DQ25	DDR0_DQ25		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
V4	V4	DDR0_DQ26	DDR0_DQ26		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
W5	W5	DDR0_DQ27	DDR0_DQ27		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
Y4	Y4	DDR0_DQ28	DDR0_DQ28		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
AA3	AA3	DDR0_DQ29	DDR0_DQ29		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
AA5	AA5	DDR0_DQ30	DDR0_DQ30		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
AB4	AB4	DDR0_DQ31	DDR0_DQ31		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
D1	D1	DDR0_DQS0	DDR0_DQS0		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
C1	C1	DDR0_DQS0_n	DDR0_DQS0_n		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
G1	G1	DDR0_DQS1	DDR0_DQS1		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
F1	F1	DDR0_DQS1_n	DDR0_DQS1_n		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
R1	R1	DDR0_DQS2	DDR0_DQS2		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P1	P1	DDR0_DQS2_n	DDR0_DQS2_n		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
W1	W1	DDR0_DQS3	DDR0_DQS3		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
Y1	Y1	DDR0_DQS3_n	DDR0_DQS3_n		IO					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
H5	H5	DDR0_ODT0	DDR0_ODT0		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
N3	N3	DDR0_ODT1	DDR0_ODT1		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
P6	P6	DDR0_RESET0_n	DDR0_RESET0_n		O					1.1V	VDDS_DDR, VDDS_DDR_C		DDR	
C13	C13	EMU0 PADCONFIG: MCU_PADCONFIG30 0x04084078	EMU0	0	IO	0	On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
E10	E10	EMU1 PADCONFIG: MCU_PADCONFIG31 0x0408407C	EMU1	0	IO	0	On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
F17	F17	EXTINTn PADCONFIG: PADCONFIG125 0x000F41F4	EXTINTn	0	I	1	Off / Off / NA	Off / Off / NA	7	1.8V / 3.3V	VDDSHV0	Yes	I2C OD FS	
			GPIO1_31	7	IOD	pad								
B16	B16	EXT_REFCLK1 PADCONFIG: PADCONFIG124 0x000F41F0	EXT_REFCLK1	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SYNC1_OUT	1	O									
			SPI2_CS3	2	IO	1								
			SYSCLKOUT0	3	O									
			TIMER_IO4	4	IO	0								
			CLKOUT0	5	O									
			CP_GEMAC_CPTS0_RFT_CLK	6	I	0								
			GPIO1_30	7	IO	pad								
			ECAP0_IN_APWM_OUT	8	IO	0								
L18	L18	GPMC0_ADVn_ALE PADCONFIG: PADCONFIG33 0x000F4084	GPMC0_ADVn_ALE	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_AXR2	2	IO	0								
			TRC_DATA7	6	O									
			GPIO0_32	7	IO	pad								
N22	N22	GPMC0_CLK PADCONFIG: PADCONFIG31 0x000F407C	GPMC0_CLK	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_AXR3	2	IO	0								
			GPMC0_FCLK_MUX	3	O									
			TRC_DATA6	6	O									
			GPIO0_31	7	IO	pad								
K18	K18	GPMC0_DIR PADCONFIG: PADCONFIG41 0x000F40A4	GPMC0_DIR	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR13	3	IO	0								
			TRC_DATA14	6	O									
			GPIO0_40	7	IO	pad								
			EQEP2_S	8	IO	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
L17	L17	GPMC0_OEn_REn PADCONFIG: PADCONFIG34 0x000F4088	GPMC0_OEn_REn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_AXR1	2	IO	0								
			TRC_DATA8	6	O									
			GPIO0_33	7	IO	pad								
K19	K19	GPMC0_WEn PADCONFIG: PADCONFIG35 0x000F408C	GPMC0_WEn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_AXR0	2	IO	0								
			TRC_DATA9	6	O									
			GPIO0_34	7	IO	pad								
K17	K17	GPMC0_WPn PADCONFIG: PADCONFIG40 0x000F40A0	GPMC0_WPn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			AUDIO_EXT_REFCLK1	1	IO	0								
			GPMC0_A22	2	OZ									
			UART6_TXD	3	O									
			TRC_DATA13	6	O									
			GPIO0_39	7	IO	pad								
N21	N21	GPMC0_AD0 PADCONFIG: PADCONFIG15 0x000F403C	GPMC0_AD0	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR4	3	IO	0								
			TRC_CLK	6	O									
			GPIO0_15	7	IO	pad								
			BOOTMODE00	Bootstrap	I									
N20	N20	GPMC0_AD1 PADCONFIG: PADCONFIG16 0x000F4040	GPMC0_AD1	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR5	3	IO	0								
			TRC_CTL	6	O									
			GPIO0_16	7	IO	pad								
			BOOTMODE01	Bootstrap	I									
N19	N19	GPMC0_AD2 PADCONFIG: PADCONFIG17 0x000F4044	GPMC0_AD2	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR6	3	IO	0								
			TRC_DATA0	6	O									
			GPIO0_17	7	IO	pad								
			BOOTMODE02	Bootstrap	I									
N18	N18	GPMC0_AD3 PADCONFIG: PADCONFIG18 0x000F4048	GPMC0_AD3	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR7	3	IO	0								
			TRC_DATA1	6	O									
			GPIO0_18	7	IO	pad								
			BOOTMODE03	Bootstrap	I									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
N17	N17	GPMC0_AD4 PADCONFIG: PADCONFIG19 0x000F404C	GPMC0_AD4	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR8	3	IO	0								
			TRC_DATA2	6	O									
			GPIO0_19	7	IO	pad								
			BOOTMODE04	Bootstrap	I									
P18	P18	GPMC0_AD5 PADCONFIG: PADCONFIG20 0x000F4050	GPMC0_AD5	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR9	3	IO	0								
			TRC_DATA3	6	O									
			GPIO0_20	7	IO	pad								
			BOOTMODE05	Bootstrap	I									
P19	P19	GPMC0_AD6 PADCONFIG: PADCONFIG21 0x000F4054	GPMC0_AD6	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR10	3	IO	0								
			TRC_DATA4	6	O									
			GPIO0_21	7	IO	pad								
			BOOTMODE06	Bootstrap	I									
P21	P21	GPMC0_AD7 PADCONFIG: PADCONFIG22 0x000F4058	GPMC0_AD7	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR11	3	IO	0								
			TRC_DATA5	6	O									
			GPIO0_22	7	IO	pad								
			BOOTMODE07	Bootstrap	I									
P22	P22	GPMC0_AD8 PADCONFIG: PADCONFIG23 0x000F405C	GPMC0_AD8	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA16	1	O									
			UART2_RXD	2	I	1								
			MCASP2_AXR0	3	IO	0								
			GPIO0_23	7	IO	pad								
			BOOTMODE08	Bootstrap	I									
R19	R19	GPMC0_AD9 PADCONFIG: PADCONFIG24 0x000F4060	GPMC0_AD9	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA17	1	O									
			UART2_TXD	2	O									
			MCASP2_AXR1	3	IO	0								
			GPIO0_24	7	IO	pad								
			BOOTMODE09	Bootstrap	I									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
R20	R20	GPMC0_AD10 PADCONFIG: PADCONFIG25 0x000F4064	GPMC0_AD10	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA18	1	O									
			UART3_RXD	2	I	1								
			MCASP2_AXR2	3	IO	0								
			GPIO0_25	7	IO	pad								
			OBSCLK0	8	O									
			BOOTMODE10	Bootstrap	I									
R22	R22	GPMC0_AD11 PADCONFIG: PADCONFIG26 0x000F4068	GPMC0_AD11	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA19	1	O									
			UART3_TXD	2	O									
			MCASP2_AXR3	3	IO	0								
			TRC_DATA23	6	O									
			GPIO0_26	7	IO	pad								
			BOOTMODE11	Bootstrap	I									
T22	T22	GPMC0_AD12 PADCONFIG: PADCONFIG27 0x000F406C	GPMC0_AD12	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA20	1	O									
			UART4_RXD	2	I	1								
			MCASP2_AFSX	3	IO	0								
			TRC_DATA22	6	O									
			GPIO0_27	7	IO	pad								
			BOOTMODE12	Bootstrap	I									
R21	R21	GPMC0_AD13 PADCONFIG: PADCONFIG28 0x000F4070	GPMC0_AD13	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA21	1	O									
			UART4_TXD	2	O									
			MCASP2_ACLKX	3	IO	0								
			TRC_DATA21	6	O									
			GPIO0_28	7	IO	pad								
			BOOTMODE13	Bootstrap	I									
T20	T20	GPMC0_AD14 PADCONFIG: PADCONFIG29 0x000F4074	GPMC0_AD14	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA22	1	O									
			UART5_RXD	2	I	1								
			MCASP2_AFSR	3	IO	0								
			TRC_DATA20	6	O									
			GPIO0_29	7	IO	pad								
			UART2_CTSn	8	I	1								
			BOOTMODE14	Bootstrap	I									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
T21	T21	GPMC0_AD15 PADCONFIG: PADCONFIG30 0x000F4078	GPMC0_AD15	0	IO	0	On / Off / Off	On / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_DATA23	1	O									
			UART5_TXD	2	O									
			MCASP2_ACLKR	3	IO	0								
			TRC_DATA19	6	O									
			GPIO0_30	7	IO	pad								
			UART2_RTSn	8	O									
			BOOTMODE15	Bootstrap	I									
L19	L19	GPMC0_BE0n_CLE PADCONFIG: PADCONFIG36 0x000F4090	GPMC0_BE0n_CLE	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_ACLKX	2	IO	0								
			TRC_DATA10	6	O									
			GPIO0_35	7	IO	pad								
M18	M18	GPMC0_BE1n PADCONFIG: PADCONFIG37 0x000F4094	GPMC0_BE1n	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR12	3	IO	0								
			TRC_DATA11	6	O									
			GPIO0_36	7	IO	pad								
M19	M19	GPMC0_CSn0 PADCONFIG: PADCONFIG42 0x000F40A8	GPMC0_CSn0	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR14	3	IO	0								
			TRC_DATA15	6	O									
			GPIO0_41	7	IO	pad								
M21	M21	GPMC0_CSn1 PADCONFIG: PADCONFIG43 0x000F40AC	GPMC0_CSn1	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP2_AXR15	3	IO	0								
			TRC_DATA16	6	O									
			GPIO0_42	7	IO	pad								
M22	M22	GPMC0_CSn2 PADCONFIG: PADCONFIG44 0x000F40B0	GPMC0_CSn2	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			I2C2_SCL	1	IOD	1								
			MCASP1_AXR4	2	IO	0								
			UART4_RXD	3	I	1								
			TRC_DATA17	6	O									
			GPIO0_43	7	IO	pad								
			MCASP1_AFSR	8	IO	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
M20	M20	GPMC0_CSn3 PADCONFIG: PADCONFIG45 0x000F40B4	GPMC0_CSn3	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			I2C2_SDA	1	IOD	1								
			GPMC0_A20	2	OZ									
			UART4_TXD	3	O									
			MCASP1_AXR5	4	IO	0								
			TRC_DATA18	6	O									
			GPIO0_44	7	IO	pad								
			MCASP1_ACLKR	8	IO	0								
R18	R18	GPMC0_WAIT0 PADCONFIG: PADCONFIG38 0x000F4098	GPMC0_WAIT0	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			MCASP1_AFSX	2	IO	0								
			TRC_DATA12	6	O									
			GPIO0_37	7	IO	pad								
R17	R17	GPMC0_WAIT1 PADCONFIG: PADCONFIG39 0x000F409C	GPMC0_WAIT1	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			VOUT0_EXTPCLKIN	1	I	0								
			GPMC0_A21	2	OZ									
			UART6_RXD	3	I	1								
			GPIO0_38	7	IO	pad								
			EQEP2_I	8	IO	0								
D17	D17	I2C0_SCL PADCONFIG: PADCONFIG120 0x000F41E0	I2C0_SCL	0	IOD	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SYNC0_OUT	2	O									
			OBSCLK1	3	O									
			UART1_DCDn	4	I	1								
			EQEP2_A	5	I	0								
			EHRPWM_SOCA	6	O									
			GPIO1_26	7	IO	pad								
			ECAP1_IN_APWM_OUT	8	IO	0								
			SPI2_CS0	9	IO	1								
E16	E16	I2C0_SDA PADCONFIG: PADCONFIG121 0x000F41E4	I2C0_SDA	0	IOD	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CS2	2	IO	1								
			TIMER_IO5	3	IO	0								
			UART1_DSRn	4	I	1								
			EQEP2_B	5	I	0								
			EHRPWM_SOCB	6	O									
			GPIO1_27	7	IO	pad								
			ECAP2_IN_APWM_OUT	8	IO	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
C17	C17	I2C1_SCL PADCONFIG: PADCONFIG122 0x000F41E8	I2C1_SCL	0	IOD	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART1_RXD	1	I	1								
			TIMER_IO0	2	IO	0								
			SPI2_CS1	3	IO	1								
			EHRPWM0_SYNCI	4	I	0								
			GPIO1_28	7	IO	pad								
			EHRPWM2_A	8	IO	0								
			MMC2_SDCD	9	I	0								
E17	E17	I2C1_SDA PADCONFIG: PADCONFIG123 0x000F41EC	I2C1_SDA	0	IOD	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART1_TXD	1	O									
			TIMER_IO1	2	IO	0								
			SPI2_CLK	3	IO	0								
			EHRPWM0_SYNCO	4	O									
			GPIO1_29	7	IO	pad								
			EHRPWM2_B	8	IO	0								
			MMC2_SDWP	9	I	0								
C18	C18	MCAN0_RX PADCONFIG: PADCONFIG119 0x000F41DC	MCAN0_RX	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART5_TXD	1	O									
			TIMER_IO3	2	IO	0								
			SYNC3_OUT	3	O									
			UART1_RIn	4	I	1								
			EQEP2_S	5	IO	0								
			GPIO1_25	7	IO	pad								
			MCASP2_AXR1	8	IO	0								
			EHRPWM_TZn_IN4	9	I	0								
B17	B17	MCAN0_TX PADCONFIG: PADCONFIG118 0x000F41D8	MCAN0_TX	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART5_RXD	1	I	1								
			TIMER_IO2	2	IO	0								
			SYNC2_OUT	3	O									
			UART1_DTRn	4	O									
			EQEP2_I	5	IO	0								
			GPIO1_24	7	IO	pad								
			MCASP2_AXR0	8	IO	0								
			EHRPWM_TZn_IN3	9	I	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
A21	A21	MCASP0_ACLKR PADCONFIG: PADCONFIG108 0x000F41B0	MCASP0_ACLKR	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CLK	1	IO	0								
			UART1_TXD	2	O									
			EHRPWM0_B	6	IO	0								
			GPIO1_14	7	IO	pad								
			EQEP1_I	8	IO	0								
A19	A19	MCASP0_ACLKX PADCONFIG: PADCONFIG105 0x000F41A4	MCASP0_ACLKX	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CS1	1	IO	1								
			ECAP2_IN_APWM_OUT	2	IO	0								
			GPIO1_11	7	IO	pad								
			EQEP1_A	8	I	0								
B21	B21	MCASP0_AFSR PADCONFIG: PADCONFIG107 0x000F41AC	MCASP0_AFSR	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CS0	1	IO	1								
			UART1_RXD	2	I	1								
			EHRPWM0_A	6	IO	0								
			GPIO1_13	7	IO	pad								
			EQEP1_S	8	IO	0								
A20	A20	MCASP0_AFSX PADCONFIG: PADCONFIG106 0x000F41A8	MCASP0_AFSX	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CS3	1	IO	1								
			AUDIO_EXT_REFCLK1	2	IO	0								
			GPIO1_12	7	IO	pad								
			EQEP1_B	8	I	0								
B20	B20	MCASP0_AXR0 PADCONFIG: PADCONFIG104 0x000F41A0	MCASP0_AXR0	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			AUDIO_EXT_REFCLK0	2	IO	0								
			EHRPWM1_B	6	IO	0								
			GPIO1_10	7	IO	pad								
			EQEP0_I	8	IO	0								
B18	B18	MCASP0_AXR1 PADCONFIG: PADCONFIG103 0x000F419C	MCASP0_AXR1	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_CS2	1	IO	1								
			ECAP1_IN_APWM_OUT	2	IO	0								
			EHRPWM1_A	6	IO	0								
			GPIO1_9	7	IO	pad								
			EQEP0_S	8	IO	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
B19	B19	MCASP0_AXR2 PADCONFIG: PADCONFIG102 0x000F4198	MCASP0_AXR2	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_D1	1	IO	0								
			UART1_RTSn	2	O									
			UART6_TXD	3	O									
			ECAP2_IN_APWM_OUT	5	IO	0								
			GPIO1_8	7	IO	pad								
			EQEP0_B	8	I	0								
C19	C19	MCASP0_AXR3 PADCONFIG: PADCONFIG101 0x000F4194	MCASP0_AXR3	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI2_D0	1	IO	0								
			UART1_CTSn	2	I	1								
			UART6_RXD	3	I	1								
			ECAP1_IN_APWM_OUT	5	IO	0								
			GPIO1_7	7	IO	pad								
			EQEP0_A	8	I	0								
B8	B8	MCU_ERRORn PADCONFIG: MCU_PADCONFIG24 0x04084060	MCU_ERRORn	0	IO		Off / Off / Down	On / SS / Down	0	1.8V	VDDS_OSC0	Yes	LVCMOS	PU/PD
E12	E12	MCU_I2C0_SCL PADCONFIG: MCU_PADCONFIG17 0x04084044	MCU_I2C0_SCL	0	IOD	1	Off / Off / NA	On / SS / NA	7	1.8V / 3.3V	VDDSHV_MCU	Yes	I2C OD FS	
			MCU_GPIO0_17	7	IOD	pad								
D9	D9	MCU_I2C0_SDA PADCONFIG: MCU_PADCONFIG18 0x04084048	MCU_I2C0_SDA	0	IOD	1	Off / Off / NA	On / SS / NA	7	1.8V / 3.3V	VDDSHV_MCU	Yes	I2C OD FS	
			MCU_GPIO0_18	7	IOD	pad								
E8	E8	MCU_MCAN0_RX PADCONFIG: MCU_PADCONFIG14 0x04084038	MCU_MCAN0_RX	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_TIMER_IO0	1	IO	0								
			MCU_SPI1_CS3	2	IO	1								
			MCU_GPIO0_14	7	IO	pad								
C7	C7	MCU_MCAN0_TX PADCONFIG: MCU_PADCONFIG13 0x04084034	MCU_MCAN0_TX	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			WKUP_TIMER_IO0	1	IO	0								
			MCU_SPI0_CS3	2	IO	1								
			MCU_GPIO0_13	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
B9	B9	MCU_MCAN1_RX PADCONFIG: MCU_PADCONFIG16 0x04084040	MCU_MCAN1_RX	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_TIMER_IO3	1	IO	0								
			MCU_SPI0_CS2	2	IO	1								
			MCU_SPI1_CS2	3	IO	1								
			MCU_SPI1_CLK	4	IO	0								
			MCU_GPIO0_16	7	IO	pad								
D7	D7	MCU_MCAN1_TX PADCONFIG: MCU_PADCONFIG15 0x0408403C	MCU_MCAN1_TX	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_TIMER_IO2	1	IO	0								
			MCU_SPI1_CS1	3	IO	1								
			MCU_EXT_REFCLK0	4	I	0								
			MCU_GPIO0_15	7	IO	pad								
A12	A12	MCU_OSC0_XI	MCU_OSC0_XI		I					1.8V	VDDS_OSC0		HFOSC	
A11	A11	MCU_OSC0_XO	MCU_OSC0_XO		O					1.8V	VDDS_OSC0		HFOSC	
A7	A7	MCU_PORz PADCONFIG: MCU_PADCONFIG22 0x04084058	MCU_PORz	0	I				0	1.8V	VDDS_OSC0	Yes	FS RESET	
D14	D14	MCU_RESETSTATz	MCU_RESETSTATz	0	O		Off / Low / Off	Off / SS / Off	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
		PADCONFIG: MCU_PADCONFIG23 0x0408405C	MCU_GPIO0_21	7	IO	pad								
C12	C12	MCU_RESETz PADCONFIG: MCU_PADCONFIG21 0x04084054	MCU_RESETz	0	I		On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
B13	B13	MCU_SPI0_CLK	MCU_SPI0_CLK	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
		PADCONFIG: MCU_PADCONFIG2 0x04084008	MCU_GPIO0_2	7	IO	pad								
E11	E11	MCU_SPI0_CS0 PADCONFIG: MCU_PADCONFIG0 0x04084000	MCU_SPI0_CS0	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
			WKUP_TIMER_IO1	4	IO	0								
			MCU_GPIO0_0	7	IO	pad								
C11	C11	MCU_SPI0_CS1 PADCONFIG: MCU_PADCONFIG1 0x04084004	MCU_SPI0_CS1	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
			MCU_OBSCLK0	1	O									
			MCU_SYSCLKOUT0	2	O									
			MCU_EXT_REFCLK0	3	I	0								
			MCU_TIMER_IO1	4	IO	0								
			MCU_GPIO0_1	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
A15	A15	MCU_SPI0_D0 PADCONFIG: MCU_PADCONFIG3 0x0408400C	MCU_SPI0_D0	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
			MCU_GPIO0_3	7	IO	pad								
B12	B12	MCU_SPI0_D1 PADCONFIG: MCU_PADCONFIG4 0x04084010	MCU_SPI0_D1	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
			MCU_GPIO0_4	7	IO	pad								
B11	B11	MCU_UART0_CTSn PADCONFIG: MCU_PADCONFIG7 0x0408401C	MCU_UART0_CTSn	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_TIMER_IO0	1	IO	0								
			MCU_SPI1_D0	3	IO	0								
			MCU_GPIO0_7	7	IO	pad								
D10	D10	MCU_UART0_RTSn PADCONFIG: MCU_PADCONFIG8 0x04084020	MCU_UART0_RTSn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_TIMER_IO1	1	IO	0								
			MCU_SPI1_D1	3	IO	0								
			MCU_GPIO0_8	7	IO	pad								
D8	D8	MCU_UART0_RXD PADCONFIG: MCU_PADCONFIG5 0x04084014	MCU_UART0_RXD	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_GPIO0_5	7	IO	pad								
F8	F8	MCU_UART0_TXD PADCONFIG: MCU_PADCONFIG6 0x04084018	MCU_UART0_TXD	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_GPIO0_6	7	IO	pad								
V12	V12	MDIO0_MDC PADCONFIG: PADCONFIG88 0x000F4160	MDIO0_MDC	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			GPIO0_86	7	IO	pad								
V13	V13	MDIO0_MDIO PADCONFIG: PADCONFIG87 0x000F415C	MDIO0_MDIO	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			GPIO0_85	7	IO	pad								
AB7	AB7	MMC0_CLK PADCONFIG: PADCONFIG134 0x000F4218	MMC0_CLK	0	O	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			I2C3_SCL	1	IOD	1								
			EHRPWM2_A	2	IO	0								
			SPI1_CS1	5	IO	1								
			TIMER_IO4	6	IO	0								
			GPIO1_40	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
Y6	Y6	MMC0_CMD PADCONFIG: PADCONFIG136 0x000F4220	MMC0_CMD	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			I2C3_SDA	1	IOD	1								
			EHRPWM2_B	2	IO	0								
			SPI1_CS2	5	IO	1								
			TIMER_IO5	6	IO	0								
			GPIO1_41	7	IO	pad								
E22	E22	MMC1_CLK PADCONFIG: PADCONFIG141 0x000F4234	MMC1_CLK	0	O	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			TIMER_IO4	2	IO	0								
			UART3_RXD	3	I	1								
			GPIO1_46	7	IO	pad								
C21	C21	MMC1_CMD PADCONFIG: PADCONFIG143 0x000F423C	MMC1_CMD	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			TIMER_IO5	2	IO	0								
			UART3_TXD	3	O									
			GPIO1_47	7	IO	pad								
E18	E18	MMC1_SDCD PADCONFIG: PADCONFIG144 0x000F4240	MMC1_SDCD	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART6_RXD	1	I	1								
			TIMER_IO6	2	IO	0								
			UART3_RTSn	3	O									
			GPIO1_48	7	IO	pad								
D18	D18	MMC1_SDWP PADCONFIG: PADCONFIG145 0x000F4244	MMC1_SDWP	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			UART6_TXD	1	O									
			TIMER_IO7	2	IO	0								
			UART3_CTSn	3	I	1								
			GPIO1_49	7	IO	pad								
H22	H22	MMC2_CLK PADCONFIG: PADCONFIG70 0x000F4118	MMC2_CLK	0	O	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_ACLKR	1	IO	0								
			MCASP1_AXR5	2	IO	0								
			UART6_RXD	3	I	1								
			GPIO0_69	7	IO	pad								
G22	G22	MMC2_CMD PADCONFIG: PADCONFIG72 0x000F4120	MMC2_CMD	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_AFSR	1	IO	0								
			MCASP1_AXR4	2	IO	0								
			UART6_TXD	3	O									
			GPIO0_70	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
F22	F22	MMC2_SDCD PADCONFIG: PADCONFIG73 0x000F4124	MMC2_SDCD	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	LVCMOS	PU/PD
			MCASP1_ACLKX	1	IO	0								
			UART4_RXD	3	I	1								
			GPIO0_71	7	IO	pad								
E21	E21	MMC2_SDWP PADCONFIG: PADCONFIG74 0x000F4128	MMC2_SDWP	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	LVCMOS	PU/PD
			MCASP1_AFSX	1	IO	0								
			UART4_TXD	3	O									
			GPIO0_72	7	IO	pad								
AA6	AA6	MMC0_DAT0 PADCONFIG: PADCONFIG133 0x000F4214	MMC0_DAT0	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART3_CTSn	1	I	1								
			EHRPWM_TZn_IN1	2	I	0								
			SPI2_CLK	6	IO	0								
			GPIO1_39	7	IO	pad								
AB6	AB6	MMC0_DAT1 PADCONFIG: PADCONFIG132 0x000F4210	MMC0_DAT1	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART3_RTSn	1	O									
			EHRPWM1_B	2	IO	0								
			SPI1_CS3	5	IO	1								
			SPI2_CS0	6	IO	1								
			GPIO1_38	7	IO	pad								
Y7	Y7	MMC0_DAT2 PADCONFIG: PADCONFIG131 0x000F420C	MMC0_DAT2	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART3_TXD	1	O									
			EHRPWM1_A	2	IO	0								
			SPI1_CLK	5	IO	0								
			TIMER_IO0	6	IO	0								
			GPIO1_37	7	IO	pad								
AA7	AA7	MMC0_DAT3 PADCONFIG: PADCONFIG130 0x000F4208	MMC0_DAT3	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART3_RXD	1	I	1								
			EHRPWM0_B	2	IO	0								
			SPI1_CS0	5	IO	1								
			SPI2_CS2	6	IO	1								
			GPIO1_36	7	IO	pad								
Y8	Y8	MMC0_DAT4 PADCONFIG: PADCONFIG129 0x000F4204	MMC0_DAT4	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART2_CTSn	1	I	1								
			EHRPWM0_A	2	IO	0								
			SPI2_D1	6	IO	0								
			GPIO1_35	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
W7	W7	MMC0_DAT5 PADCONFIG: PADCONFIG128 0x000F4200	MMC0_DAT5	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART2_RTSn	1	O									
			EHRPWM_TZn_IN2	2	I	0								
			SPI2_D0	6	IO	0								
			GPIO1_34	7	IO	pad								
W9	W9	MMC0_DAT6 PADCONFIG: PADCONFIG127 0x000F41FC	MMC0_DAT6	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART2_TXD	1	O									
			EHRPWM0_SYNCO	2	O									
			SPI1_D1	5	IO	0								
			SPI2_CS3	6	IO	1								
			GPIO1_33	7	IO	pad								
AB8	AB8	MMC0_DAT7 PADCONFIG: PADCONFIG126 0x000F41F8	MMC0_DAT7	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV4	Yes	SDIO	PU/PD
			UART2_RXD	1	I	1								
			EHRPWM0_SYNCI	2	I	0								
			SPI1_D0	5	IO	0								
			SPI2_CS1	6	IO	1								
			GPIO1_32	7	IO	pad								
B22	B22	MMC1_DAT0 PADCONFIG: PADCONFIG140 0x000F4230	MMC1_DAT0	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			CP_GEMAC_CPTS0_HW2TSPUSH	1	I	0								
			TIMER_IO3	2	IO	0								
			UART2_CTSn	3	I	1								
			ECAP2_IN_APWM_OUT	4	IO	0								
			GPIO1_45	7	IO	pad								
D21	D21	MMC1_DAT1 PADCONFIG: PADCONFIG139 0x000F422C	MMC1_DAT1	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			CP_GEMAC_CPTS0_HW1TSPUSH	1	I	0								
			TIMER_IO2	2	IO	0								
			UART2_RTSn	3	O									
			ECAP1_IN_APWM_OUT	4	IO	0								
			GPIO1_44	7	IO	pad								
C22	C22	MMC1_DAT2 PADCONFIG: PADCONFIG138 0x000F4228	MMC1_DAT2	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			CP_GEMAC_CPTS0_TS_SYNC	1	O									
			TIMER_IO1	2	IO	0								
			UART2_TXD	3	O									
			GPIO1_43	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
D22	D22	MMC1_DAT3 PADCONFIG: PADCONFIG137 0x000F4224	MMC1_DAT3	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV5	Yes	SDIO	PU/PD
			CP_GEMAC_CPTS0_TS_COMP	1	O									
			TIMER_IO0	2	IO	0								
			UART2_RXD	3	I	1								
			GPIO1_42	7	IO	pad								
E20	E20	MMC2_DAT0 PADCONFIG: PADCONFIG69 0x000F4114	MMC2_DAT0	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_AXR0	1	IO	0								
			GPIO0_68	7	IO	pad								
F21	F21	MMC2_DAT1 PADCONFIG: PADCONFIG68 0x000F4110	MMC2_DAT1	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_AXR1	1	IO	0								
			GPIO0_67	7	IO	pad								
F20	F20	MMC2_DAT2 PADCONFIG: PADCONFIG67 0x000F410C	MMC2_DAT2	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_AXR2	1	IO	0								
			UART5_TXD	3	O									
			GPIO0_66	7	IO	pad								
G21	G21	MMC2_DAT3 PADCONFIG: PADCONFIG66 0x000F4108	MMC2_DAT3	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV6	Yes	SDIO	PU/PD
			MCASP1_AXR3	1	IO	0								
			UART5_RXD	3	I	1								
			GPIO0_65	7	IO	pad								
L22	L22	OSPI0_CLK PADCONFIG: PADCONFIG0 0x000F4000	OSPI0_CLK	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_0	7	IO	pad								
L21	L21	OSPI0_DQS PADCONFIG: PADCONFIG2 0x000F4008	OSPI0_DQS	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			UART5_CTSn	5	I	1								
			GPIO0_2	7	IO	pad								
K22	K22	OSPI0_LBCLKO PADCONFIG: PADCONFIG1 0x000F4004	OSPI0_LBCLKO	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			UART5_RTSn	5	O									
			GPIO0_1	7	IO	pad								
H21	H21	OSPI0_CSn0 PADCONFIG: PADCONFIG11 0x000F402C	OSPI0_CSn0	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_11	7	IO	pad								
G19	G19	OSPI0_CSn1 PADCONFIG: PADCONFIG12 0x000F4030	OSPI0_CSn1	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_12	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
K20	K20	OSPI0_CSn2 PADCONFIG: PADCONFIG13 0x000F4034	OSPI0_CSn2	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			SPI1_CS1	1	IO	1								
			OSPI0_RESET_OUT1	2	O									
			MCASP1_AFSR	3	IO	0								
			MCASP1_AXR2	4	IO	0								
			UART5_RXD	5	I	1								
			GPIO0_13	7	IO	pad								
G20	G20	OSPI0_CSn3 PADCONFIG: PADCONFIG14 0x000F4038	OSPI0_CSn3	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			OSPI0_RESET_OUT0	1	O									
			OSPI0_ECC_FAIL	2	I	1								
			MCASP1_ACLKR	3	IO	0								
			MCASP1_AXR3	4	IO	0								
			UART5_TXD	5	O									
			GPIO0_14	7	IO	pad								
J21	J21	OSPI0_D0 PADCONFIG: PADCONFIG3 0x000F400C	OSPI0_D0	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_3	7	IO	pad								
J18	J18	OSPI0_D1 PADCONFIG: PADCONFIG4 0x000F4010	OSPI0_D1	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_4	7	IO	pad								
J19	J19	OSPI0_D2 PADCONFIG: PADCONFIG5 0x000F4014	OSPI0_D2	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_5	7	IO	pad								
H18	H18	OSPI0_D3 PADCONFIG: PADCONFIG6 0x000F4018	OSPI0_D3	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			GPIO0_6	7	IO	pad								
K21	K21	OSPI0_D4 PADCONFIG: PADCONFIG7 0x000F401C	OSPI0_D4	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			SPI1_CS0	1	IO	1								
			MCASP1_AXR1	2	IO	0								
			UART6_RXD	3	I	1								
			GPIO0_7	7	IO	pad								
H19	H19	OSPI0_D5 PADCONFIG: PADCONFIG8 0x000F4020	OSPI0_D5	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			SPI1_CLK	1	IO	0								
			MCASP1_AXR0	2	IO	0								
			UART6_TXD	3	O									
			GPIO0_8	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
J20	J20	OSPI0_D6 PADCONFIG: PADCONFIG9 0x000F4024	OSPI0_D6	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			SPI1_D0	1	IO	0								
			MCASP1_ACLKX	2	IO	0								
			UART6_RTSn	3	O									
			GPIO0_9	7	IO	pad								
J22	J22	OSPI0_D7 PADCONFIG: PADCONFIG10 0x000F4028	OSPI0_D7	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV1	Yes	LVCMOS	PU/PD
			SPI1_D1	1	IO	0								
			MCASP1_AFSX	2	IO	0								
			UART6_CTSn	3	I	1								
			GPIO0_10	7	IO	pad								
D12	D12	PMIC_LPM_EN0 PADCONFIG: MCU_PADCONFIG32 0x04084080	PMIC_LPM_EN0	0	O		Off / Off / Off	Off / SS / Off	0	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_GPIO0_22	7	IO	pad								
F18	F18	PORz_OUT PADCONFIG: PADCONFIG148 0x000F4250	PORz_OUT	0	O		Off / Low / Off	Off / SS / Off	0	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
F19	F19	RESETSTATz PADCONFIG: PADCONFIG147 0x000F424C	RESETSTATz	0	O		Off / Low / Off	Off / SS / Off	0	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
E19	E19	RESET_REQz PADCONFIG: PADCONFIG146 0x000F4248	RESET_REQz	0	I		On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
AA16	AA16	RGMII1_RXC PADCONFIG: PADCONFIG82 0x000F4148	RGMII1_RXC	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_REF_CLK	1	I	0								
			GPIO0_80	7	IO	pad								
AA15	AA15	RGMII1_RX_CTL PADCONFIG: PADCONFIG81 0x000F4144	RGMII1_RX_CTL	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_RX_ER	1	I	0								
			GPIO0_79	7	IO	pad								
AB17	AB17	RGMII1_TXC PADCONFIG: PADCONFIG76 0x000F4130	RGMII1_TXC	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_CRS_DV	1	I	0								
			GPIO0_74	7	IO	pad								
W16	W16	RGMII1_TX_CTL PADCONFIG: PADCONFIG75 0x000F412C	RGMII1_TX_CTL	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_TX_EN	1	O									
			GPIO0_73	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
AA20	AA20	RGMII2_RXC PADCONFIG: PADCONFIG96 0x000F4180	RGMII2_RXC	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_REF_CLK	1	I	0								
			MCASP2_AXR1	2	IO	0								
			GPIO1_2	7	IO	pad								
W18	W18	RGMII2_RX_CTL PADCONFIG: PADCONFIG95 0x000F417C	RGMII2_RX_CTL	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_RX_ER	1	I	0								
			MCASP2_AXR3	2	IO	0								
			GPIO1_1	7	IO	pad								
AB19	AB19	RGMII2_TXC PADCONFIG: PADCONFIG90 0x000F4168	RGMII2_TXC	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_CRS_DV	1	I	0								
			MCASP2_AXR5	2	IO	0								
			GPIO0_88	7	IO	pad								
Y19	Y19	RGMII2_TX_CTL PADCONFIG: PADCONFIG89 0x000F4164	RGMII2_TX_CTL	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_TX_EN	1	O									
			MCASP2_AXR4	2	IO	0								
			GPIO0_87	7	IO	pad								
AB16	AB16	RGMII1_RD0 PADCONFIG: PADCONFIG83 0x000F414C	RGMII1_RD0	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_RXD0	1	I	0								
			GPIO0_81	7	IO	pad								
V15	V15	RGMII1_RD1 PADCONFIG: PADCONFIG84 0x000F4150	RGMII1_RD1	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_RXD1	1	I	0								
			GPIO0_82	7	IO	pad								
W15	W15	RGMII1_RD2 PADCONFIG: PADCONFIG85 0x000F4154	RGMII1_RD2	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			GPIO0_83	7	IO	pad								
V14	V14	RGMII1_RD3 PADCONFIG: PADCONFIG86 0x000F4158	RGMII1_RD3	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			GPIO0_84	7	IO	pad								
Y17	Y17	RGMII1_TD0 PADCONFIG: PADCONFIG77 0x000F4134	RGMII1_TD0	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_TXD0	1	O									
			GPIO0_75	7	IO	pad								
V16	V16	RGMII1_TD1 PADCONFIG: PADCONFIG78 0x000F4138	RGMII1_TD1	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII1_TXD1	1	O									
			GPIO0_76	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
Y16	Y16	RGMII1_TD2 PADCONFIG: PADCONFIG79 0x000F413C	RGMII1_TD2	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			GPIO0_77	7	IO	pad								
AA17	AA17	RGMII1_TD3 PADCONFIG: PADCONFIG80 0x000F4140	RGMII1_TD3	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			CLKOUT0	1	O									
			GPIO0_78	7	IO	pad								
AA21	AA21	RGMII2_RD0 PADCONFIG: PADCONFIG97 0x000F4184	RGMII2_RD0	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_RXD0	1	I	0								
			MCASP2_AXR2	2	IO	0								
			GPIO1_3	7	IO	pad								
Y20	Y20	RGMII2_RD1 PADCONFIG: PADCONFIG98 0x000F4188	RGMII2_RD1	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_RXD1	1	I	0								
			MCASP2_AFSR	2	IO	0								
			MCASP2_AXR7	5	IO	0								
			GPIO1_4	7	IO	pad								
AB21	AB21	RGMII2_RD2 PADCONFIG: PADCONFIG99 0x000F418C	RGMII2_RD2	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			MCASP2_AXR0	2	IO	0								
			GPIO1_5	7	IO	pad								
			EQEP2_A	8	I	0								
AB20	AB20	RGMII2_RD3 PADCONFIG: PADCONFIG100 0x000F4190	RGMII2_RD3	0	I	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			AUDIO_EXT_REFCLK0	2	IO	0								
			GPIO1_6	7	IO	pad								
			EQEP2_B	8	I	0								
AA19	AA19	RGMII2_TD0 PADCONFIG: PADCONFIG91 0x000F416C	RGMII2_TD0	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_TXD0	1	O									
			MCASP2_AXR6	2	IO	0								
			GPIO0_89	7	IO	pad								
Y18	Y18	RGMII2_TD1 PADCONFIG: PADCONFIG92 0x000F4170	RGMII2_TD1	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			RMII2_TXD1	1	O									
			MCASP2_ACLKR	2	IO	0								
			MCASP2_AXR8	5	IO	0								
			GPIO0_90	7	IO	pad								
AA18	AA18	RGMII2_TD2 PADCONFIG: PADCONFIG93 0x000F4174	RGMII2_TD2	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			MCASP2_AFSX	2	IO	0								
			GPIO0_91	7	IO	pad								
			EQEP2_I	8	IO	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
W17	W17	RGMII2_TD3 PADCONFIG: PADCONFIG94 0x000F4178	RGMII2_TD3	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV2	Yes	LVCMOS	PU/PD
			CLKOUT0	1	O									
			MCASP2_ACLKX	2	IO	0								
			GPIO1_0	7	IO	pad								
			EQEP2_S	8	IO	0								
C6	C6	RSVD0	RSVD0		N/A									
D6	D6	RSVD1	RSVD1		N/A									
E7	E7	RSVD2	RSVD2		N/A									
F6	F6	RSVD3	RSVD3		N/A									
F10	F10	RSVD4	RSVD4		N/A									
G7	G7	RSVD5	RSVD5		N/A									
U11	U11	RSVD6	RSVD6		N/A									
V11	V11	RSVD7	RSVD7		N/A									
A17	A17	SPI0_CLK PADCONFIG: PADCONFIG111 0x000F41BC	SPI0_CLK	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			CP_GEMAC_CPTS0_TS_SYNC	1	O									
			EHRPWM1_A	2	IO	0								
			GPIO1_17	7	IO	pad								
D16	D16	SPI0_CS0 PADCONFIG: PADCONFIG109 0x000F41B4	SPI0_CS0	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			EHRPWM0_A	2	IO	0								
			GPIO1_15	7	IO	pad								
C16	C16	SPI0_CS1 PADCONFIG: PADCONFIG110 0x000F41B8	SPI0_CS1	0	IO	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			CP_GEMAC_CPTS0_TS_COMP	1	O									
			EHRPWM0_B	2	IO	0								
			ECAP0_IN_APWM_OUT	3	IO	0								
			GPIO1_16	7	IO	pad								
			EHRPWM_TZn_IN5	9	I	0								
B15	B15	SPI0_D0 PADCONFIG: PADCONFIG112 0x000F41C0	SPI0_D0	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			CP_GEMAC_CPTS0_HW1TSPUSH	1	I	0								
			EHRPWM1_B	2	IO	0								
			GPIO1_18	7	IO	pad								
E15	E15	SPI0_D1 PADCONFIG: PADCONFIG113 0x000F41C4	SPI0_D1	0	IO	0	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			CP_GEMAC_CPTS0_HW2TSPUSH	1	I	0								
			EHRPWM_TZn_IN0	2	I	0								
			GPIO1_19	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
A14	A14	TCK PADCONFIG: MCU_PADCONFIG25 0x04084064	TCK	0	I		On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
A16	A16	TDI PADCONFIG: MCU_PADCONFIG27 0x0408406C	TDI	0	I		On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
C14	C14	TDO PADCONFIG: MCU_PADCONFIG28 0x04084070	TDO	0	OZ		Off / Off / Up	Off / SS / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
B14	B14	TMS PADCONFIG: MCU_PADCONFIG29 0x04084074	TMS	0	I		On / Off / Up	On / Off / Up	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
F15	F15	TRSTn PADCONFIG: MCU_PADCONFIG26 0x04084068	TRSTn	0	I		On / Off / Down	On / Off / Down	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
F14	F14	UART0_CTSn PADCONFIG: PADCONFIG116 0x000F41D0	UART0_CTSn	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI0_CS2	1	IO	1								
			I2C3_SCL	2	IOD	1								
			UART2_RXD	3	I	1								
			TIMER_IO6	4	IO	0								
			AUDIO_EXT_REFCLK0	5	IO	0								
			GPIO1_22	7	IO	pad								
			MCASP2_AFSX	8	IO	0								
			MMC2_SDCD	9	I	0								
C15	C15	UART0_RTSn PADCONFIG: PADCONFIG117 0x000F41D4	UART0_RTSn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			SPI0_CS3	1	IO	1								
			I2C3_SDA	2	IOD	1								
			UART2_TXD	3	O									
			TIMER_IO7	4	IO	0								
			AUDIO_EXT_REFCLK1	5	IO	0								
			GPIO1_23	7	IO	pad								
			MCASP2_ACLKX	8	IO	0								
			MMC2_SDWP	9	I	0								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
E14	E14	UART0_RXD PADCONFIG: PADCONFIG114 0x000F41C8	UART0_RXD	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			ECAP1_IN_APWM_OUT	1	IO	0								
			SPI2_D0	2	IO	0								
			EHRPWM2_A	3	IO	0								
			GPIO1_20	7	IO	pad								
D15	D15	UART0_TXD PADCONFIG: PADCONFIG115 0x000F41CC	UART0_TXD	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			ECAP2_IN_APWM_OUT	1	IO	0								
			SPI2_D1	2	IO	0								
			EHRPWM2_B	3	IO	0								
			GPIO1_21	7	IO	pad								
AA10	AA10	USB0_DM	USB0_DM		IO					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
AA9	AA9	USB0_DP	USB0_DP		IO					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
C20	C20	USB0_DRVVBUS PADCONFIG: PADCONFIG149 0x000F4254	USB0_DRVVBUS	0	O		Off / Off / Down	Off / Off / Down	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			GPIO1_50	7	IO	pad								
W10	W10	USB0_RCALIB	USB0_RCALIB		A					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
V8	V8	USB0_VBUS	USB0_VBUS		A					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
Y11	Y11	USB1_DM	USB1_DM		IO					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
Y10	Y10	USB1_DP	USB1_DP		IO					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
D19	D19	USB1_DRVVBUS PADCONFIG: PADCONFIG150 0x000F4258	USB1_DRVVBUS	0	O		Off / Off / Down	Off / Off / Down	7	1.8V / 3.3V	VDDSHV0	Yes	LVCMOS	PU/PD
			GPIO1_51	7	IO	pad								
U7	U7	USB1_RCALIB	USB1_RCALIB		A					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
V6	V6	USB1_VBUS	USB1_VBUS		A					1.8V / 3.3V	VDDA_1P8_USB, VDDA_3P3_USB		USB2PHY	
T10	T10	VDDA_1P8_USB	VDDA_1P8_USB		PWR									
T12	T12	VDDA_1P8_CSIRX0	VDDA_1P8_CSIRX0		PWR									
U10	U10	VDDA_3P3_USB	VDDA_3P3_USB		PWR									
T11	T11	VDDA_CORE_CSIRX0	VDDA_CORE_CSIRX0		PWR									
T9	T9	VDDA_CORE_USB	VDDA_CORE_USB		PWR									
M9	M9	VDDA_DDR_PLL0	VDDA_DDR_PLL0		PWR									
J10	J10	VDDA_MCU	VDDA_MCU		PWR									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
N9	N9	VDDA_PLL0	VDDA_PLL0		PWR									
R11	R11	VDDA_PLL1	VDDA_PLL1		PWR									
M13	M13	VDDA_PLL2	VDDA_PLL2		PWR									
K13	K13	VDDA_PLL3	VDDA_PLL3		PWR									
K10	K10	VDDA_PLL4	VDDA_PLL4		PWR									
P16	P16	VDDA_TEMP0	VDDA_TEMP0		PWR									
G18	G18	VDDA_TEMP1	VDDA_TEMP1		PWR									
L10	L10	VDDA_TEMP2	VDDA_TEMP2		PWR									
J14, K12, M10, M14, P12, P9	J14, K12, M10, M14, P12, P9	VDDR_CORE	VDDR_CORE		PWR									
G14, H13	G14, H13	VDDSHV0	VDDSHV0		PWR									
K15, L16	K15, L16	VDDSHV1	VDDSHV1		PWR									
R13, T13, U13	R13, T13, U13	VDDSHV2	VDDSHV2		PWR									
L15, M15, N15	L15, M15, N15	VDDSHV3	VDDSHV3		PWR									
T8, U8	T8, U8	VDDSHV4	VDDSHV4		PWR									
G16, H15	G16, H15	VDDSHV5	VDDSHV5		PWR									
H16, H17	H16, H17	VDDSHV6	VDDSHV6		PWR									
H8	H8	VDDSHV_CANUART	VDDSHV_CANUART		PWR									
G11, H10	G11, H10	VDDSHV_MCU	VDDSHV_MCU		PWR									
A2, AA1, AB2, B1, J7, K8, L7, M8, N7, P8	A2, AA1, AB2, B1, J7, K8, L7, M8, N7, P8	VDDS_DDR	VDDS_DDR		PWR									
L8	L8	VDDS_DDR_C	VDDS_DDR_C		PWR									
J8	J8	VDDS_OSC0	VDDS_OSC0		PWR									
H9	H9	VDD_CANUART	VDD_CANUART		PWR									
J11, J13, J15, J9, K14, L11, L13, L9, M12, N11, N13, P10, P14, R15, R9, T16, U15	J11, J13, J15, J9, K14, L11, L13, L9, M12, N11, N13, P10, P14, R15, R9, T16, U15	VDD_CORE	VDD_CORE		PWR									
F12	F12	VMON_1P8_SOC	VMON_1P8_SOC		A									
F9	F9	VMON_3P3_SOC	VMON_3P3_SOC		A									
H12	H12	VMON_VSYS	VMON_VSYS		A									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
U17	U17	VOUT0_DE PADCONFIG: PADCONFIG63 0x000F40FC	VOUT0_DE	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A17	1	OZ									
			UART3_CTSn	4	I	1								
			GPIO0_62	7	IO	pad								
T18	T18	VOUT0_HSYNC PADCONFIG: PADCONFIG62 0x000F40F8	VOUT0_HSYNC	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A16	1	OZ									
			UART3_RTSn	4	O									
			GPIO0_61	7	IO	pad								
AA22	AA22	VOUT0_PCLK PADCONFIG: PADCONFIG65 0x000F4104	VOUT0_PCLK	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A19	1	OZ									
			UART2_CTSn	4	I	1								
			GPIO0_64	7	IO	pad								
V17	V17	VOUT0_VSYNC PADCONFIG: PADCONFIG64 0x000F4100	VOUT0_VSYNC	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A18	1	OZ									
			UART2_RTSn	4	O									
			GPIO0_63	7	IO	pad								
U22	U22	VOUT0_DATA0 PADCONFIG: PADCONFIG46 0x000F40B8	VOUT0_DATA0	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A0	1	OZ									
			UART2_RXD	4	I	1								
			GPIO0_45	7	IO	pad								
U21	U21	VOUT0_DATA1 PADCONFIG: PADCONFIG47 0x000F40BC	VOUT0_DATA1	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A1	1	OZ									
			UART2_TXD	4	O									
			GPIO0_46	7	IO	pad								
U20	U20	VOUT0_DATA2 PADCONFIG: PADCONFIG48 0x000F40C0	VOUT0_DATA2	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A2	1	OZ									
			UART3_RXD	4	I	1								
			GPIO0_47	7	IO	pad								
U19	U19	VOUT0_DATA3 PADCONFIG: PADCONFIG49 0x000F40C4	VOUT0_DATA3	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A3	1	OZ									
			UART3_TXD	4	O									
			GPIO0_48	7	IO	pad								
T19	T19	VOUT0_DATA4 PADCONFIG: PADCONFIG50 0x000F40C8	VOUT0_DATA4	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A4	1	OZ									
			UART4_RXD	4	I	1								
			GPIO0_49	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
U18	U18	VOUT0_DATA5 PADCONFIG: PADCONFIG51 0x000F40CC	VOUT0_DATA5	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A5	1	OZ									
			UART4_TXD	4	O									
			GPIO0_50	7	IO	pad								
V22	V22	VOUT0_DATA6 PADCONFIG: PADCONFIG52 0x000F40D0	VOUT0_DATA6	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A6	1	OZ									
			UART5_RXD	4	I	1								
			GPIO0_51	7	IO	pad								
V21	V21	VOUT0_DATA7 PADCONFIG: PADCONFIG53 0x000F40D4	VOUT0_DATA7	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A7	1	OZ									
			UART5_TXD	4	O									
			GPIO0_52	7	IO	pad								
V19	V19	VOUT0_DATA8 PADCONFIG: PADCONFIG54 0x000F40D8	VOUT0_DATA8	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A8	1	OZ									
			UART6_RXD	4	I	1								
			GPIO0_53	7	IO	pad								
V18	V18	VOUT0_DATA9 PADCONFIG: PADCONFIG55 0x000F40DC	VOUT0_DATA9	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A9	1	OZ									
			UART6_TXD	4	O									
			GPIO0_54	7	IO	pad								
W22	W22	VOUT0_DATA10 PADCONFIG: PADCONFIG56 0x000F40E0	VOUT0_DATA10	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A10	1	OZ									
			UART6_RTSn	4	O									
			GPIO0_55	7	IO	pad								
W21	W21	VOUT0_DATA11 PADCONFIG: PADCONFIG57 0x000F40E4	VOUT0_DATA11	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A11	1	OZ									
			UART6_CTSn	4	I	1								
			GPIO0_56	7	IO	pad								
W20	W20	VOUT0_DATA12 PADCONFIG: PADCONFIG58 0x000F40E8	VOUT0_DATA12	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A12	1	OZ									
			UART5_RTSn	4	O									
			GPIO0_57	7	IO	pad								
W19	W19	VOUT0_DATA13 PADCONFIG: PADCONFIG59 0x000F40EC	VOUT0_DATA13	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A13	1	OZ									
			UART5_CTSn	4	I	1								
			GPIO0_58	7	IO	pad								

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
Y21	Y21	VOUT0_DATA14 PADCONFIG: PADCONFIG60 0x000F40F0	VOUT0_DATA14	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A14	1	OZ									
			UART4_RTSn	4	O									
			GPIO0_59	7	IO	pad								
Y22	Y22	VOUT0_DATA15 PADCONFIG: PADCONFIG61 0x000F40F4	VOUT0_DATA15	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV3	Yes	LVCMOS	PU/PD
			GPMC0_A15	1	OZ									
			UART4_CTSn	4	I	1								
			GPIO0_60	7	IO	pad								
F7	F7	VPP	VPP		PWR									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
A1, A10, A13, A18, A22, A4, A6, AA11, AA14, AA2, AA4, AA8, AB1, AB12, AB15, AB18, AB22, AB3, AB5, AB9, B3, B5, B7, C4, D11, D2, D20, D4, E1, E3, E5, F11, F13, F16, F2, F4, G12, G17, G3, G5, G9, H1, H11, H14, H20, H4, J12, J17, J3, K1, K11, K4, K7, K9, L12, L14, L20, L3, M11, M17, M4, M7, N1, N10, N12, N14, N16, N8, P11, P13, P15, P17, P20, P7, R10, R12, R14, R16, R2, R4, R6, T1, T15, T17, T3, T5, T7, U12, U14, U16, U2, U4, U6, U9, V1, V20, V3, V5, V7, V9, W11, W14, W2, W4, W6, W8, Y12, Y15, Y3, Y5, Y9	A1, A10, A13, A18, A22, A4, A6, AA11, AA14, AA2, AA4, AA8, AB1, AB12, AB15, AB18, AB22, AB3, AB5, AB9, B3, B5, B7, C4, D11, D2, D20, D4, E1, E3, E5, F11, F13, F16, F2, F4, G12, G17, G3, G5, G9, H1, H11, H14, H20, H4, J12, J17, J3, K1, K11, K4, K7, K9, L12, L14, L20, L3, M11, M17, M4, M7, N1, N10, N12, N14, N16, N8, P11, P13, P15, P17, P20, P7, R10, R12, R14, R16, R2, R4, R6, T1, T15, T17, T3, T5, T7, U12, U14, U16, U2, U4, U6, U9, V1, V20, V3, V5, V7, V9, W11, W14, W2, W4, W6, W8, Y12, Y15, Y3, Y5, Y9	VSS	VSS		PWR									

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Table 5-1. Pin Attributes (AMB, ANF Packages) (continued)

AMB BALL NUMBER [1]	ANF BALL NUMBER [1]	BALL NAME [2] PADCONFIG Register [15] PADCONFIG Address [16]	SIGNAL NAME [3]	MUX MODE [4]	TYPE [5]	DSIS [6]	BALL STATE DURING RESET (RX/TX/PULL) [7]	BALL STATE AFTER RESET (RX/TX/PULL) [8]	MUX MODE AFTER RESET [9]	I/O OPERATING VOLTAGE [10]	POWER [11]	HYS [12]	BUFFER TYPE [13]	PULL UP/DOWN TYPE [14]
B10	B10	WKUP_CLKOUT0 PADCONFIG: MCU_PADCONFIG33 0x04084084	WKUP_CLKOUT0	0	O		Off / Off / Off	Off / SS / Off	0	1.8V / 3.3V	VDDSHV_MCU	Yes	LVCMOS	PU/PD
			MCU_GPIO0_23	7	IO	pad								
D13	D13	WKUP_I2C0_SCL PADCONFIG: MCU_PADCONFIG19 0x0408404C	WKUP_I2C0_SCL	0	IOD	1	Off / Off / NA	On / SS / NA	7	1.8V / 3.3V	VDDSHV_MCU	Yes	I2C OD FS	
			MCU_GPIO0_19	7	IOD	pad								
E13	E13	WKUP_I2C0_SDA PADCONFIG: MCU_PADCONFIG20 0x04084050	WKUP_I2C0_SDA	0	IOD	1	Off / Off / NA	On / SS / NA	7	1.8V / 3.3V	VDDSHV_MCU	Yes	I2C OD FS	
			MCU_GPIO0_20	7	IOD	pad								
A8	A8	WKUP_LFOSC0_XI	WKUP_LFOSC0_XI		I					1.8V	VDDS_OSC0		LFXOSC	
A9	A9	WKUP_LFOSC0_XO	WKUP_LFOSC0_XO		O					1.8V	VDDS_OSC0		LFXOSC	
C10	C10	WKUP_UART0_CTSn PADCONFIG: MCU_PADCONFIG11 0x0408402C	WKUP_UART0_CTSn	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			WKUP_TIMER_IO0	1	IO	0								
			MCU_SPI1_CS0	3	IO	1								
			MCU_GPIO0_11	7	IO	pad								
C8	C8	WKUP_UART0_RTSn PADCONFIG: MCU_PADCONFIG12 0x04084030	WKUP_UART0_RTSn	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			WKUP_TIMER_IO1	1	IO	0								
			MCU_SPI1_CLK	3	IO	0								
			MCU_GPIO0_12	7	IO	pad								
C9	C9	WKUP_UART0_RXD PADCONFIG: MCU_PADCONFIG9 0x04084024	WKUP_UART0_RXD	0	I	1	Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_SPI0_CS2	2	IO	1								
			MCU_GPIO0_9	7	IO	pad								
E9	E9	WKUP_UART0_TXD PADCONFIG: MCU_PADCONFIG10 0x04084028	WKUP_UART0_TXD	0	O		Off / Off / Off	Off / Off / Off	7	1.8V / 3.3V	VDDSHV_CANUART	Yes	LVCMOS	PU/PD
			MCU_SPI1_CS2	2	IO	1								
			MCU_GPIO0_10	7	IO	pad								

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5.3 Signal Descriptions

Many signals are available on multiple pins, according to the software configuration of the pin multiplexing options.

The following list describes the column headers:

1. **SIGNAL NAME:** The name of the signal passing through the pin.

Note

Signal names and descriptions provided in each Signal Descriptions table, represent the pin multiplexed signal function which is implemented at the pin and selected via PADCONFIG registers. Device subsystems may provide secondary multiplexing of signal functions, which are not described in these tables. For more information on secondary multiplexed signal functions, see the respective peripheral chapter of the device TRM.

2. **SIGNAL TYPE:** Signal direction and type:
   - I = Input
   - O = Output
   - OD = Output, with open-drain output function
   - IO = Input, Output, or simultaneously Input and Output
   - IOD = Input, Output, or simultaneously Input and Output with open-drain output function
   - IOZ = Input, Output, or simultaneously Input and Output with three-state output function
   - OZ = Output with three-state output function
   - A = Analog
   - PWR = Power
   - GND = Ground
   - CAP = LDO Capacitor
3. **DESCRIPTION:** Description of the signal
4. **BALL:** Ball number(s) associated with signal

For more information on the IO cell configurations, see the *Pad Configuration Registers* section in *Device Configuration* chapter of the device TRM.

5.3.1 CPSW3G

5.3.1.1 MAIN Domain

Table 5-2. CPSW3G0 RGMII1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
RGMII1_RXC	I	RGMII Receive Clock	AA16	AA16
RGMII1_RX_CTL	I	RGMII Receive Control	AA15	AA15
RGMII1_TXC	IO	RGMII Transmit Clock	AB17	AB17
RGMII1_TX_CTL	O	RGMII Transmit Control	W16	W16
RGMII1_RD0	I	RGMII Receive Data 0	AB16	AB16
RGMII1_RD1	I	RGMII Receive Data 1	V15	V15
RGMII1_RD2	I	RGMII Receive Data 2	W15	W15
RGMII1_RD3	I	RGMII Receive Data 3	V14	V14
RGMII1_TD0	O	RGMII Transmit Data 0	Y17	Y17
RGMII1_TD1	O	RGMII Transmit Data 1	V16	V16
RGMII1_TD2	O	RGMII Transmit Data 2	Y16	Y16
RGMII1_TD3	O	RGMII Transmit Data 3	AA17	AA17

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Table 5-3. CPSW3G0 RGMII2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
RGMII2_RXC	I	RGMII Receive Clock	AA20	AA20
RGMII2_RX_CTL	I	RGMII Receive Control	W18	W18
RGMII2_TXC	IO	RGMII Transmit Clock	AB19	AB19
RGMII2_TX_CTL	O	RGMII Transmit Control	Y19	Y19
RGMII2_RD0	I	RGMII Receive Data 0	AA21	AA21
RGMII2_RD1	I	RGMII Receive Data 1	Y20	Y20
RGMII2_RD2	I	RGMII Receive Data 2	AB21	AB21
RGMII2_RD3	I	RGMII Receive Data 3	AB20	AB20
RGMII2_TD0	O	RGMII Transmit Data 0	AA19	AA19
RGMII2_TD1	O	RGMII Transmit Data 1	Y18	Y18
RGMII2_TD2	O	RGMII Transmit Data 2	AA18	AA18
RGMII2_TD3	O	RGMII Transmit Data 3	W17	W17

Table 5-4. CPSW3G0 RMII1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
RMII1_CRS_DV	I	RMII Carrier Sense / Data Valid	AB17	AB17
RMII1_REF_CLK	I	RMII Reference Clock	AA16	AA16
RMII1_RX_ER	I	RMII Receive Data Error	AA15	AA15
RMII1_TX_EN	O	RMII Transmit Enable	W16	W16
RMII1_RXD0	I	RMII Receive Data 0	AB16	AB16
RMII1_RXD1	I	RMII Receive Data 1	V15	V15
RMII1_TXD0	O	RMII Transmit Data 0	Y17	Y17
RMII1_TXD1	O	RMII Transmit Data 1	V16	V16

Table 5-5. CPSW3G0 RMII2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
RMII2_CRS_DV	I	RMII Carrier Sense / Data Valid	AB19	AB19
RMII2_REF_CLK	I	RMII Reference Clock	AA20	AA20
RMII2_RX_ER	I	RMII Receive Data Error	W18	W18
RMII2_TX_EN	O	RMII Transmit Enable	Y19	Y19
RMII2_RXD0	I	RMII Receive Data 0	AA21	AA21
RMII2_RXD1	I	RMII Receive Data 1	Y20	Y20
RMII2_TXD0	O	RMII Transmit Data 0	AA19	AA19
RMII2_TXD1	O	RMII Transmit Data 1	Y18	Y18

5.3.2 CPTS

Note

Some CPTS signals are connected directly to CPTS modules within the device. Other CPTS signals are connected to the Time Sync Router and fanned out to peripherals linked to the router. Input signals are sent to the peripherals while output signals are sourced from the peripherals. For more information, see the Time Sync and Compare Events section in the Time Sync chapter in the device TRM.

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5.3.2.1 MAIN Domain

Table 5-6. CPTS Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
CP_GEMAC_CPTS0_RFT_CLK	I	CPTS Reference Clock Input	B16	B16
CP_GEMAC_CPTS0_TS_COMP	O	CPTS Time Stamp Counter Compare Output from CPSW3G0 CPTS	C16, D22	C16, D22
CP_GEMAC_CPTS0_TS_SYNC	O	CPTS Time Stamp Counter Bit Output from CPSW3G0 CPTS	A17, C22	A17, C22
CP_GEMAC_CPTS0_HW1TSPUSH	I	CPTS Hardware Time Stamp Push Input to Time Sync Router	B15, D21	B15, D21
CP_GEMAC_CPTS0_HW2TSPUSH	I	CPTS Hardware Time Stamp Push Input to Time Sync Router	B22, E15	B22, E15
SYNC0_OUT	O	CPTS Time Stamp Generator Bit 0 Output from Time Sync Router	D17	D17
SYNC1_OUT	O	CPTS Time Stamp Generator Bit 1 Output from Time Sync Router	B16	B16
SYNC2_OUT	O	CPTS Time Stamp Generator Bit 2 Output from Time Sync Router	B17	B17
SYNC3_OUT	O	CPTS Time Stamp Generator Bit 3 Output from Time Sync Router	C18	C18

5.3.3 CSI-2

5.3.3.1 MAIN Domain

Table 5-7. CSIRX0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
CSI0_RXCLKN	I	CSI Differential Receive Clock Input (negative)	AB14	AB14
CSI0_RXCLKP	I	CSI Differential Receive Clock Input (positive)	AB13	AB13
CSI0_RXRCALIB (1)	A	CSI pin connected to external resistor for on-chip resistor calibration	V10	V10
CSI0_RXN0	I	CSI Differential Receive Input (negative)	W12	W12
CSI0_RXN1	I	CSI Differential Receive Input (negative)	Y13	Y13
CSI0_RXN2	I	CSI Differential Receive Input (negative)	AA13	AA13
CSI0_RXN3	I	CSI Differential Receive Input (negative)	AB11	AB11
CSI0_RXP0	I	CSI Differential Receive Input (positive)	W13	W13
CSI0_RXP1	I	CSI Differential Receive Input (positive)	Y14	Y14
CSI0_RXP2	I	CSI Differential Receive Input (positive)	AA12	AA12
CSI0_RXP3	I	CSI Differential Receive Input (positive)	AB10	AB10

(1) An external 499Ω ±1% resistor must be connected between this pin and VSS and the maximum power dissipation for the resistor is 7.2mW. No external voltage should be applied to this pin.

5.3.4 DDRSS

5.3.4.1 MAIN Domain

Table 5-8. DDRSS0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
DDR0_ACT_n	O	DDRSS Activation Command	N5	N5
DDR0_ALERT_n	IO	DDRSS Alert	H7	H7
DDR0_CAS_n (1)	O	DDR4 Column Address Strobe / LPDDR4 Chip Select 1B	M5	M5

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Table 5-8. DDRSS0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
DDR0_PAR	O	DDRSS Command and Address Parity	N2	N2
DDR0_RAS_n (1)	O	DDR4 Row Address Strobe / LPDDR4 Chip Select 0B	M6	M6
DDR0_WE_n	O	DDRSS Write Enable	N6	N6
DDR0_A0	O	DDRSS Address Bus	J5	J5
DDR0_A1	O	DDRSS Address Bus	J2	J2
DDR0_A2	O	DDRSS Address Bus	J4	J4
DDR0_A3	O	DDRSS Address Bus	L4	L4
DDR0_A4	O	DDRSS Address Bus	J1	J1
DDR0_A5	O	DDRSS Address Bus	K5	K5
DDR0_A6	O	DDRSS Address Bus	K3	K3
DDR0_A7	O	DDRSS Address Bus	H2	H2
DDR0_A8	O	DDRSS Address Bus	L6	L6
DDR0_A9	O	DDRSS Address Bus	L2	L2
DDR0_A10	O	DDRSS Address Bus	K2	K2
DDR0_A11	O	DDRSS Address Bus	L5	L5
DDR0_A12	O	DDRSS Address Bus	M3	M3
DDR0_A13	O	DDRSS Address Bus	M2	M2
DDR0_BA0	O	DDRSS Bank Address	K6	K6
DDR0_BA1	O	DDRSS Bank Address	H3	H3
DDR0_BG0	O	DDRSS Bank Group	P4	P4
DDR0_BG1	O	DDRSS Bank Group	R7	R7
DDR0_CAL0 (2)	A	IO Pad Calibration Resistor	H6	H6
DDR0_CK0	O	DDRSS Clock	M1	M1
DDR0_CK0_n	O	DDRSS Negative Clock	L1	L1
DDR0_CKE0	O	DDRSS Clock Enable	P3	P3
DDR0_CKE1	O	DDRSS Clock Enable	P5	P5
DDR0_CS0_n (1)	O	DDR4 Chip Select 0 / LPDDR4 Chip Select 0A	J6	J6
DDR0_CS1_n (1)	O	DDR4 Chip Select 1 / LPDDR4 Chip Select 1A	N4	N4
DDR0_DM0	IO	DDRSS Data Mask	C2	C2
DDR0_DM1	IO	DDRSS Data Mask	F3	F3
DDR0_DM2	IO	DDRSS Data Mask	U1	U1
DDR0_DM3	IO	DDRSS Data Mask	W3	W3
DDR0_DQ0	IO	DDRSS Data	A5	A5
DDR0_DQ1	IO	DDRSS Data	B4	B4
DDR0_DQ2	IO	DDRSS Data	B6	B6
DDR0_DQ3	IO	DDRSS Data	D5	D5
DDR0_DQ4	IO	DDRSS Data	C5	C5
DDR0_DQ5	IO	DDRSS Data	C3	C3
DDR0_DQ6	IO	DDRSS Data	B2	B2
DDR0_DQ7	IO	DDRSS Data	A3	A3
DDR0_DQ8	IO	DDRSS Data	E2	E2
DDR0_DQ9	IO	DDRSS Data	F5	F5
DDR0_DQ10	IO	DDRSS Data	E6	E6
DDR0_DQ11	IO	DDRSS Data	G2	G2

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Table 5-8. DDRSS0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
DDR0_DQ12	IO	DDRSS Data	G6	G6
DDR0_DQ13	IO	DDRSS Data	G4	G4
DDR0_DQ14	IO	DDRSS Data	E4	E4
DDR0_DQ15	IO	DDRSS Data	D3	D3
DDR0_DQ16	IO	DDRSS Data	T6	T6
DDR0_DQ17	IO	DDRSS Data	T4	T4
DDR0_DQ18	IO	DDRSS Data	U5	U5
DDR0_DQ19	IO	DDRSS Data	R5	R5
DDR0_DQ20	IO	DDRSS Data	P2	P2
DDR0_DQ21	IO	DDRSS Data	R3	R3
DDR0_DQ22	IO	DDRSS Data	T2	T2
DDR0_DQ23	IO	DDRSS Data	U3	U3
DDR0_DQ24	IO	DDRSS Data	Y2	Y2
DDR0_DQ25	IO	DDRSS Data	V2	V2
DDR0_DQ26	IO	DDRSS Data	V4	V4
DDR0_DQ27	IO	DDRSS Data	W5	W5
DDR0_DQ28	IO	DDRSS Data	Y4	Y4
DDR0_DQ29	IO	DDRSS Data	AA3	AA3
DDR0_DQ30	IO	DDRSS Data	AA5	AA5
DDR0_DQ31	IO	DDRSS Data	AB4	AB4
DDR0_DQS0	IO	DDRSS Data Strobe	D1	D1
DDR0_DQS0_n	IO	DDRSS Complimentary Data Strobe	C1	C1
DDR0_DQS1	IO	DDRSS Data Strobe	G1	G1
DDR0_DQS1_n	IO	DDRSS Complimentary Data Strobe	F1	F1
DDR0_DQS2	IO	DDRSS Data Strobe	R1	R1
DDR0_DQS2_n	IO	DDRSS Complimentary Data Strobe	P1	P1
DDR0_DQS3	IO	DDRSS Data Strobe	W1	W1
DDR0_DQS3_n	IO	DDRSS Complimentary Data Strobe	Y1	Y1
DDR0_ODT0	O	DDRSS On-Die Termination for Chip Select 0	H5	H5
DDR0_ODT1	O	DDRSS On-Die Termination for Chip Select 1	N3	N3
DDR0_RESET0_n	O	DDRSS Reset	P6	P6

(1) DDRSS implements different signal functions on these signals based on the attached memory device type. The signals function as Column Address Strobe, Row Address Strobe, Chip Select 0, and Chip Select 1 when DDRSS is configured to operate with DDR4 memory devices. The signals function as Chip Select 1B, Chip Select 0B, Chip Select 0A, and Chip Select 1A respectively when DDRSS is configured to operate with LPDDR4 memory devices. For more information, refer to Section 8.2.1, *DDR Board Design and Layout Guidelines*.
(2) An external 240Ω ±1% resistor must be connected between this pin and VSS. No external voltage should be applied to this pin.

5.3.5 DSS

5.3.5.1 MAIN Domain

Table 5-9. DSS0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VOUT0_DE	O	Video Output Data Enable	U17	U17
VOUT0_EXTPCLKIN	I	Video Output External Pixel Clock Input	R17	R17
VOUT0_HSYNC	O	Video Output Horizontal Sync	T18	T18

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Table 5-9. DSS0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VOUT0_PCLK	O	Video Output Pixel Clock Output	AA22	AA22
VOUT0_VSYNC	O	Video Output Vertical Sync	V17	V17
VOUT0_DATA0	O	Video Output Data 0	U22	U22
VOUT0_DATA1	O	Video Output Data 1	U21	U21
VOUT0_DATA2	O	Video Output Data 2	U20	U20
VOUT0_DATA3	O	Video Output Data 3	U19	U19
VOUT0_DATA4	O	Video Output Data 4	T19	T19
VOUT0_DATA5	O	Video Output Data 5	U18	U18
VOUT0_DATA6	O	Video Output Data 6	V22	V22
VOUT0_DATA7	O	Video Output Data 7	V21	V21
VOUT0_DATA8	O	Video Output Data 8	V19	V19
VOUT0_DATA9	O	Video Output Data 9	V18	V18
VOUT0_DATA10	O	Video Output Data 10	W22	W22
VOUT0_DATA11	O	Video Output Data 11	W21	W21
VOUT0_DATA12	O	Video Output Data 12	W20	W20
VOUT0_DATA13	O	Video Output Data 13	W19	W19
VOUT0_DATA14	O	Video Output Data 14	Y21	Y21
VOUT0_DATA15	O	Video Output Data 15	Y22	Y22
VOUT0_DATA16	O	Video Output Data 16	P22	P22
VOUT0_DATA17	O	Video Output Data 17	R19	R19
VOUT0_DATA18	O	Video Output Data 18	R20	R20
VOUT0_DATA19	O	Video Output Data 19	R22	R22
VOUT0_DATA20	O	Video Output Data 20	T22	T22
VOUT0_DATA21	O	Video Output Data 21	R21	R21
VOUT0_DATA22	O	Video Output Data 22	T20	T20
VOUT0_DATA23	O	Video Output Data 23	T21	T21

5.3.6 ECAP

5.3.6.1 MAIN Domain

Table 5-10. ECAP0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
ECAP0_IN_APWM_OUT	IO	Enhanced Capture (ECAP) Input or Auxiliary PWM (APWM) Output	B16, C16	B16, C16

Table 5-11. ECAP1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
ECAP1_IN_APWM_OUT	IO	Enhanced Capture (ECAP) Input or Auxiliary PWM (APWM) Output	B18, C19, D17, D21, E14	B18, C19, D17, D21, E14

Table 5-12. ECAP2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
ECAP2_IN_APWM_OUT	IO	Enhanced Capture (ECAP) Input or Auxiliary PWM (APWM) Output	A19, B19, B22, D15, E16	A19, B19, B22, D15, E16

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5.3.7 Emulation and Debug

5.3.7.1 MAIN Domain

Table 5-13. Trace Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
TRC_CLK	O	Trace Clock	N21	N21
TRC_CTL	O	Trace Control	N20	N20
TRC_DATA0	O	Trace Data 0	N19	N19
TRC_DATA1	O	Trace Data 1	N18	N18
TRC_DATA2	O	Trace Data 2	N17	N17
TRC_DATA3	O	Trace Data 3	P18	P18
TRC_DATA4	O	Trace Data 4	P19	P19
TRC_DATA5	O	Trace Data 5	P21	P21
TRC_DATA6	O	Trace Data 6	N22	N22
TRC_DATA7	O	Trace Data 7	L18	L18
TRC_DATA8	O	Trace Data 8	L17	L17
TRC_DATA9	O	Trace Data 9	K19	K19
TRC_DATA10	O	Trace Data 10	L19	L19
TRC_DATA11	O	Trace Data 11	M18	M18
TRC_DATA12	O	Trace Data 12	R18	R18
TRC_DATA13	O	Trace Data 13	K17	K17
TRC_DATA14	O	Trace Data 14	K18	K18
TRC_DATA15	O	Trace Data 15	M19	M19
TRC_DATA16	O	Trace Data 16	M21	M21
TRC_DATA17	O	Trace Data 17	M22	M22
TRC_DATA18	O	Trace Data 18	M20	M20
TRC_DATA19	O	Trace Data 19	T21	T21
TRC_DATA20	O	Trace Data 20	T20	T20
TRC_DATA21	O	Trace Data 21	R21	R21
TRC_DATA22	O	Trace Data 22	T22	T22
TRC_DATA23	O	Trace Data 23	R22	R22

5.3.7.2 MCU Domain

Table 5-14. JTAG Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EMU0	IO	Emulation Control 0	C13	C13
EMU1	IO	Emulation Control 1	E10	E10
TCK	I	JTAG Test Clock Input	A14	A14
TDI	I	JTAG Test Data Input	A16	A16
TDO	OZ	JTAG Test Data Output	C14	C14
TMS	I	JTAG Test Mode Select Input	B14	B14
TRSTn	I	JTAG Reset	F15	F15

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5.3.8 EPWM

5.3.8.1 MAIN Domain

Table 5-15. EPWM Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EHRPWM_SOCA	O	EHRPWM Start of Conversion A	D17	D17
EHRPWM_SOCB	O	EHRPWM Start of Conversion B	E16	E16
EHRPWM_TZn_IN0	I	EHRPWM Trip Zone Input 0 (active low)	E15	E15
EHRPWM_TZn_IN1	I	EHRPWM Trip Zone Input 1 (active low)	AA6	AA6
EHRPWM_TZn_IN2	I	EHRPWM Trip Zone Input 2 (active low)	W7	W7
EHRPWM_TZn_IN3	I	EHRPWM Trip Zone Input 3 (active low)	B17	B17
EHRPWM_TZn_IN4	I	EHRPWM Trip Zone Input 4 (active low)	C18	C18
EHRPWM_TZn_IN5	I	EHRPWM Trip Zone Input 5 (active low)	C16	C16

Table 5-16. EPWM0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EHRPWM0_A	IO	EHRPWM Output A	B21, D16, Y8	B21, D16, Y8
EHRPWM0_B	IO	EHRPWM Output B	A21, AA7, C16	A21, AA7, C16
EHRPWM0_SYNCI	I	Sync Input to EHRPWM module from an external pin	AB8, C17	AB8, C17
EHRPWM0_SYNCO	O	Sync Output from EHRPWM module to an external pin	E17, W9	E17, W9

Table 5-17. EPWM1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EHRPWM1_A	IO	EHRPWM Output A	A17, B18, Y7	A17, B18, Y7
EHRPWM1_B	IO	EHRPWM Output B	AB6, B15, B20	AB6, B15, B20

Table 5-18. EPWM2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EHRPWM2_A	IO	EHRPWM Output A	AB7, C17, E14	AB7, C17, E14
EHRPWM2_B	IO	EHRPWM Output B	D15, E17, Y6	D15, E17, Y6

5.3.9 EQEP

5.3.9.1 MAIN Domain

Table 5-19. EQEP0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EQEP0_A (1)	I	EQEP Quadrature Input A	C19	C19
EQEP0_B (1)	I	EQEP Quadrature Input B	B19	B19
EQEP0_I (1)	IO	EQEP Index	B20	B20
EQEP0_S (1)	IO	EQEP Strobe	B18	B18

(1) This EQEP input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

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Table 5-20. EQEP1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EQEP1_A (1)	I	EQEP Quadrature Input A	A19	A19
EQEP1_B (1)	I	EQEP Quadrature Input B	A20	A20
EQEP1_I (1)	IO	EQEP Index	A21	A21
EQEP1_S (1)	IO	EQEP Strobe	B21	B21

(1) This EQEP input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

Table 5-21. EQEP2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
EQEP2_A (1)	I	EQEP Quadrature Input A	AB21, D17	AB21, D17
EQEP2_B (1)	I	EQEP Quadrature Input B	AB20, E16	AB20, E16
EQEP2_I (1)	IO	EQEP Index	AA18, B17, R17	AA18, B17, R17
EQEP2_S (1)	IO	EQEP Strobe	C18, K18, W17	C18, K18, W17

(1) This EQEP input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

5.3.10 GPIO

5.3.10.1 MAIN Domain

Table 5-22. GPIO0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPIO0_0	IO	General Purpose Input/Output	L22	L22
GPIO0_1	IO	General Purpose Input/Output	K22	K22
GPIO0_2	IO	General Purpose Input/Output	L21	L21
GPIO0_3	IO	General Purpose Input/Output	J21	J21
GPIO0_4	IO	General Purpose Input/Output	J18	J18
GPIO0_5	IO	General Purpose Input/Output	J19	J19
GPIO0_6	IO	General Purpose Input/Output	H18	H18
GPIO0_7	IO	General Purpose Input/Output	K21	K21
GPIO0_8	IO	General Purpose Input/Output	H19	H19
GPIO0_9	IO	General Purpose Input/Output	J20	J20
GPIO0_10	IO	General Purpose Input/Output	J22	J22
GPIO0_11	IO	General Purpose Input/Output	H21	H21
GPIO0_12	IO	General Purpose Input/Output	G19	G19
GPIO0_13 (1)	IO	General Purpose Input/Output	K20	K20
GPIO0_14 (1)	IO	General Purpose Input/Output	G20	G20
GPIO0_15	IO	General Purpose Input/Output	N21	N21
GPIO0_16	IO	General Purpose Input/Output	N20	N20
GPIO0_17	IO	General Purpose Input/Output	N19	N19
GPIO0_18	IO	General Purpose Input/Output	N18	N18
GPIO0_19	IO	General Purpose Input/Output	N17	N17
GPIO0_20	IO	General Purpose Input/Output	P18	P18
GPIO0_21	IO	General Purpose Input/Output	P19	P19
GPIO0_22	IO	General Purpose Input/Output	P21	P21

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Table 5-22. GPIO0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPIO0_23	IO	General Purpose Input/Output	P22	P22
GPIO0_24	IO	General Purpose Input/Output	R19	R19
GPIO0_25	IO	General Purpose Input/Output	R20	R20
GPIO0_26	IO	General Purpose Input/Output	R22	R22
GPIO0_27	IO	General Purpose Input/Output	T22	T22
GPIO0_28	IO	General Purpose Input/Output	R21	R21
GPIO0_29	IO	General Purpose Input/Output	T20	T20
GPIO0_30	IO	General Purpose Input/Output	T21	T21
GPIO0_31	IO	General Purpose Input/Output	N22	N22
GPIO0_32	IO	General Purpose Input/Output	L18	L18
GPIO0_33	IO	General Purpose Input/Output	L17	L17
GPIO0_34	IO	General Purpose Input/Output	K19	K19
GPIO0_35	IO	General Purpose Input/Output	L19	L19
GPIO0_36	IO	General Purpose Input/Output	M18	M18
GPIO0_37	IO	General Purpose Input/Output	R18	R18
GPIO0_38	IO	General Purpose Input/Output	R17	R17
GPIO0_39	IO	General Purpose Input/Output	K17	K17
GPIO0_40	IO	General Purpose Input/Output	K18	K18
GPIO0_41	IO	General Purpose Input/Output	M19	M19
GPIO0_42	IO	General Purpose Input/Output	M21	M21
GPIO0_43 (1)	IO	General Purpose Input/Output	M22	M22
GPIO0_44 (1)	IO	General Purpose Input/Output	M20	M20
GPIO0_45	IO	General Purpose Input/Output	U22	U22
GPIO0_46	IO	General Purpose Input/Output	U21	U21
GPIO0_47	IO	General Purpose Input/Output	U20	U20
GPIO0_48	IO	General Purpose Input/Output	U19	U19
GPIO0_49	IO	General Purpose Input/Output	T19	T19
GPIO0_50	IO	General Purpose Input/Output	U18	U18
GPIO0_51	IO	General Purpose Input/Output	V22	V22
GPIO0_52	IO	General Purpose Input/Output	V21	V21
GPIO0_53	IO	General Purpose Input/Output	V19	V19
GPIO0_54	IO	General Purpose Input/Output	V18	V18
GPIO0_55	IO	General Purpose Input/Output	W22	W22
GPIO0_56	IO	General Purpose Input/Output	W21	W21
GPIO0_57	IO	General Purpose Input/Output	W20	W20
GPIO0_58	IO	General Purpose Input/Output	W19	W19
GPIO0_59	IO	General Purpose Input/Output	Y21	Y21
GPIO0_60	IO	General Purpose Input/Output	Y22	Y22
GPIO0_61	IO	General Purpose Input/Output	T18	T18
GPIO0_62	IO	General Purpose Input/Output	U17	U17
GPIO0_63	IO	General Purpose Input/Output	V17	V17
GPIO0_64	IO	General Purpose Input/Output	AA22	AA22
GPIO0_65 (1)	IO	General Purpose Input/Output	G21	G21
GPIO0_66 (1)	IO	General Purpose Input/Output	F20	F20

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Table 5-22. GPIO0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPIO0_67 (1)	IO	General Purpose Input/Output	F21	F21
GPIO0_68 (1)	IO	General Purpose Input/Output	E20	E20
GPIO0_69 (1)	IO	General Purpose Input/Output	H22	H22
GPIO0_70 (1)	IO	General Purpose Input/Output	G22	G22
GPIO0_71 (1)	IO	General Purpose Input/Output	F22	F22
GPIO0_72 (1)	IO	General Purpose Input/Output	E21	E21
GPIO0_73	IO	General Purpose Input/Output	W16	W16
GPIO0_74	IO	General Purpose Input/Output	AB17	AB17
GPIO0_75	IO	General Purpose Input/Output	Y17	Y17
GPIO0_76	IO	General Purpose Input/Output	V16	V16
GPIO0_77	IO	General Purpose Input/Output	Y16	Y16
GPIO0_78	IO	General Purpose Input/Output	AA17	AA17
GPIO0_79	IO	General Purpose Input/Output	AA15	AA15
GPIO0_80	IO	General Purpose Input/Output	AA16	AA16
GPIO0_81	IO	General Purpose Input/Output	AB16	AB16
GPIO0_82	IO	General Purpose Input/Output	V15	V15
GPIO0_83	IO	General Purpose Input/Output	W15	W15
GPIO0_84	IO	General Purpose Input/Output	V14	V14
GPIO0_85	IO	General Purpose Input/Output	V13	V13
GPIO0_86	IO	General Purpose Input/Output	V12	V12
GPIO0_87	IO	General Purpose Input/Output	Y19	Y19
GPIO0_88	IO	General Purpose Input/Output	AB19	AB19
GPIO0_89	IO	General Purpose Input/Output	AA19	AA19
GPIO0_90	IO	General Purpose Input/Output	Y18	Y18
GPIO0_91	IO	General Purpose Input/Output	AA18	AA18

(1) This GPIO input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

Table 5-23. GPIO1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPIO1_0	IO	General Purpose Input/Output	W17	W17
GPIO1_1	IO	General Purpose Input/Output	W18	W18
GPIO1_2	IO	General Purpose Input/Output	AA20	AA20
GPIO1_3	IO	General Purpose Input/Output	AA21	AA21
GPIO1_4	IO	General Purpose Input/Output	Y20	Y20
GPIO1_5	IO	General Purpose Input/Output	AB21	AB21
GPIO1_6	IO	General Purpose Input/Output	AB20	AB20
GPIO1_7	IO	General Purpose Input/Output	C19	C19
GPIO1_8	IO	General Purpose Input/Output	B19	B19
GPIO1_9	IO	General Purpose Input/Output	B18	B18
GPIO1_10	IO	General Purpose Input/Output	B20	B20
GPIO1_11	IO	General Purpose Input/Output	A19	A19
GPIO1_12	IO	General Purpose Input/Output	A20	A20
GPIO1_13	IO	General Purpose Input/Output	B21	B21

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Table 5-23. GPIO1 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPIO1_14	IO	General Purpose Input/Output	A21	A21
GPIO1_15	IO	General Purpose Input/Output	D16	D16
GPIO1_16 (1)	IO	General Purpose Input/Output	C16	C16
GPIO1_17	IO	General Purpose Input/Output	A17	A17
GPIO1_18	IO	General Purpose Input/Output	B15	B15
GPIO1_19	IO	General Purpose Input/Output	E15	E15
GPIO1_20	IO	General Purpose Input/Output	E14	E14
GPIO1_21	IO	General Purpose Input/Output	D15	D15
GPIO1_22	IO	General Purpose Input/Output	F14	F14
GPIO1_23	IO	General Purpose Input/Output	C15	C15
GPIO1_24	IO	General Purpose Input/Output	B17	B17
GPIO1_25	IO	General Purpose Input/Output	C18	C18
GPIO1_26	IO	General Purpose Input/Output	D17	D17
GPIO1_27	IO	General Purpose Input/Output	E16	E16
GPIO1_28	IO	General Purpose Input/Output	C17	C17
GPIO1_29	IO	General Purpose Input/Output	E17	E17
GPIO1_30	IO	General Purpose Input/Output	B16	B16
GPIO1_31 (1)	IOD	General Purpose Input/Output	F17	F17
GPIO1_32 (1)	IO	General Purpose Input/Output	AB8	AB8
GPIO1_33 (1)	IO	General Purpose Input/Output	W9	W9
GPIO1_34 (1)	IO	General Purpose Input/Output	W7	W7
GPIO1_35 (1)	IO	General Purpose Input/Output	Y8	Y8
GPIO1_36 (1)	IO	General Purpose Input/Output	AA7	AA7
GPIO1_37 (1)	IO	General Purpose Input/Output	Y7	Y7
GPIO1_38 (1)	IO	General Purpose Input/Output	AB6	AB6
GPIO1_39 (1)	IO	General Purpose Input/Output	AA6	AA6
GPIO1_40 (1)	IO	General Purpose Input/Output	AB7	AB7
GPIO1_41 (1)	IO	General Purpose Input/Output	Y6	Y6
GPIO1_42 (1)	IO	General Purpose Input/Output	D22	D22
GPIO1_43 (1)	IO	General Purpose Input/Output	C22	C22
GPIO1_44 (1)	IO	General Purpose Input/Output	D21	D21
GPIO1_45 (1)	IO	General Purpose Input/Output	B22	B22
GPIO1_46 (1)	IO	General Purpose Input/Output	E22	E22
GPIO1_47 (1)	IO	General Purpose Input/Output	C21	C21
GPIO1_48 (1)	IO	General Purpose Input/Output	E18	E18
GPIO1_49 (1)	IO	General Purpose Input/Output	D18	D18
GPIO1_50	IO	General Purpose Input/Output	C20	C20
GPIO1_51	IO	General Purpose Input/Output	D19	D19

(1) This GPIO input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

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5.3.10.2 MCU Domain

Table 5-24. MCU_GPIO0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_GPIO0_0 (1)	IO	General Purpose Input/Output	E11	E11
MCU_GPIO0_1 (1)	IO	General Purpose Input/Output	C11	C11
MCU_GPIO0_2	IO	General Purpose Input/Output	B13	B13
MCU_GPIO0_3	IO	General Purpose Input/Output	A15	A15
MCU_GPIO0_4	IO	General Purpose Input/Output	B12	B12
MCU_GPIO0_5	IO	General Purpose Input/Output	D8	D8
MCU_GPIO0_6	IO	General Purpose Input/Output	F8	F8
MCU_GPIO0_7 (1)	IO	General Purpose Input/Output	B11	B11
MCU_GPIO0_8 (1)	IO	General Purpose Input/Output	D10	D10
MCU_GPIO0_9	IO	General Purpose Input/Output	C9	C9
MCU_GPIO0_10	IO	General Purpose Input/Output	E9	E9
MCU_GPIO0_11 (1)	IO	General Purpose Input/Output	C10	C10
MCU_GPIO0_12 (1)	IO	General Purpose Input/Output	C8	C8
MCU_GPIO0_13	IO	General Purpose Input/Output	C7	C7
MCU_GPIO0_14	IO	General Purpose Input/Output	E8	E8
MCU_GPIO0_15 (1)	IO	General Purpose Input/Output	D7	D7
MCU_GPIO0_16 (1)	IO	General Purpose Input/Output	B9	B9
MCU_GPIO0_17	IOD	General Purpose Input/Output	E12	E12
MCU_GPIO0_18	IOD	General Purpose Input/Output	D9	D9
MCU_GPIO0_19	IOD	General Purpose Input/Output	D13	D13
MCU_GPIO0_20	IOD	General Purpose Input/Output	E13	E13
MCU_GPIO0_21	IO	General Purpose Input/Output	D14	D14
MCU_GPIO0_22	IO	General Purpose Input/Output	D12	D12
MCU_GPIO0_23	IO	General Purpose Input/Output	B10	B10

(1) This GPIO input signal has a debounce function. For more information on I/O Debounce configuration, see the TRM *Device Configuration* chapter.

5.3.11 GPMC

5.3.11.1 MAIN Domain

Table 5-25. GPMC0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPMC0_ADVn_ALE	O	GPMC Address Valid (active low) or Address Latch Enable	L18	L18
GPMC0_CLK	O	GPMC clock	N22	N22
GPMC0_DIR	O	GPMC Data Bus Signal Direction Control	K18	K18
GPMC0_FCLK_MUX	O	GPMC functional clock output	N22	N22
GPMC0_OEn_REn	O	GPMC Output Enable (active low) or Read Enable (active low)	L17	L17
GPMC0_WEn	O	GPMC Write Enable (active low)	K19	K19
GPMC0_WPn	O	GPMC Flash Write Protect (active low)	K17	K17
GPMC0_A0	OZ	GPMC Address 0 Output. Only used to effectively address 8-bit data non-multiplexed memories	U22	U22

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Table 5-25. GPMC0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPMC0_A1	OZ	GPMC address 1 Output in A/D non-multiplexed mode and Address 17 in A/D multiplexed mode	U21	U21
GPMC0_A2	OZ	GPMC address 2 Output in A/D non-multiplexed mode and Address 18 in A/D multiplexed mode	U20	U20
GPMC0_A3	OZ	GPMC address 3 Output in A/D non-multiplexed mode and Address 19 in A/D multiplexed mode	U19	U19
GPMC0_A4	OZ	GPMC address 4 Output in A/D non-multiplexed mode and Address 20 in A/D multiplexed mode	T19	T19
GPMC0_A5	OZ	GPMC address 5 Output in A/D non-multiplexed mode and Address 21 in A/D multiplexed mode	U18	U18
GPMC0_A6	OZ	GPMC address 6 Output in A/D non-multiplexed mode and Address 22 in A/D multiplexed mode	V22	V22
GPMC0_A7	OZ	GPMC address 7 Output in A/D non-multiplexed mode and Address 23 in A/D multiplexed mode	V21	V21
GPMC0_A8	OZ	GPMC address 8 Output in A/D non-multiplexed mode and Address 24 in A/D multiplexed mode	V19	V19
GPMC0_A9	OZ	GPMC address 9 Output in A/D non-multiplexed mode and Address 25 in A/D multiplexed mode	V18	V18
GPMC0_A10	OZ	GPMC address 10 Output in A/D non-multiplexed mode and Address 26 in A/D multiplexed mode	W22	W22
GPMC0_A11	OZ	GPMC address 11 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	W21	W21
GPMC0_A12	OZ	GPMC address 12 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	W20	W20
GPMC0_A13	OZ	GPMC address 13 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	W19	W19
GPMC0_A14	OZ	GPMC address 14 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	Y21	Y21
GPMC0_A15	OZ	GPMC address 15 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	Y22	Y22
GPMC0_A16	OZ	GPMC address 16 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	T18	T18
GPMC0_A17	OZ	GPMC address 17 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	U17	U17
GPMC0_A18	OZ	GPMC address 18 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	V17	V17
GPMC0_A19	OZ	GPMC address 19 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	AA22	AA22
GPMC0_A20	OZ	GPMC address 20 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	M20	M20
GPMC0_A21	OZ	GPMC address 21 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	R17	R17

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Table 5-25. GPMC0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPMC0_A22	OZ	GPMC address 22 Output in A/D non-multiplexed mode and unused in A/D multiplexed mode	K17	K17
GPMC0_AD0	IO	GPMC Data 0 Input/Output in A/D non-multiplexed mode and additionally Address 1 Output in A/D multiplexed mode	N21	N21
GPMC0_AD1	IO	GPMC Data 1 Input/Output in A/D non-multiplexed mode and additionally Address 2 Output in A/D multiplexed mode	N20	N20
GPMC0_AD2	IO	GPMC Data 2 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	N19	N19
GPMC0_AD3	IO	GPMC Data 3 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	N18	N18
GPMC0_AD4	IO	GPMC Data 4 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	N17	N17
GPMC0_AD5	IO	GPMC Data 5 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	P18	P18
GPMC0_AD6	IO	GPMC Data 6 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	P19	P19
GPMC0_AD7	IO	GPMC Data 7 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	P21	P21
GPMC0_AD8	IO	GPMC Data 8 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	P22	P22
GPMC0_AD9	IO	GPMC Data 9 Input/Output in A/D non-multiplexed mode and additionally Address 3 Output in A/D multiplexed mode	R19	R19
GPMC0_AD10	IO	GPMC Data 10 Input/Output in A/D non-multiplexed mode and additionally Address 11 Output in A/D multiplexed mode	R20	R20
GPMC0_AD11	IO	GPMC Data 11 Input/Output in A/D non-multiplexed mode and additionally Address 12 Output in A/D multiplexed mode	R22	R22
GPMC0_AD12	IO	GPMC Data 12 Input/Output in A/D non-multiplexed mode and additionally Address 13 Output in A/D multiplexed mode	T22	T22
GPMC0_AD13	IO	GPMC Data 13 Input/Output in A/D non-multiplexed mode and additionally Address 14 Output in A/D multiplexed mode	R21	R21
GPMC0_AD14	IO	GPMC Data 14 Input/Output in A/D non-multiplexed mode and additionally Address 15 Output in A/D multiplexed mode	T20	T20
GPMC0_AD15	IO	GPMC Data 15 Input/Output in A/D non-multiplexed mode and additionally Address 16 Output in A/D multiplexed mode	T21	T21
GPMC0_BE0n_CLE	O	GPMC Lower-Byte Enable (active low) or Command Latch Enable	L19	L19
GPMC0_BE1n	O	GPMC Upper-Byte Enable (active low)	M18	M18
GPMC0_CSn0	O	GPMC Chip Select 0 (active low)	M19	M19

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Table 5-25. GPMC0 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
GPMC0_CSn1	O	GPMC Chip Select 1 (active low)	M21	M21
GPMC0_CSn2	O	GPMC Chip Select 2 (active low)	M22	M22
GPMC0_CSn3	O	GPMC Chip Select 3 (active low)	M20	M20
GPMC0_WAIT0	I	GPMC External Indication of Wait	R18	R18
GPMC0_WAIT1	I	GPMC External Indication of Wait	R17	R17

5.3.12 I2C

5.3.12.1 MAIN Domain

Table 5-26. I2C0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
I2C0_SCL	IOD	I2C Clock	D17	D17
I2C0_SDA	IOD	I2C Data	E16	E16

Table 5-27. I2C1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
I2C1_SCL	IOD	I2C Clock	C17	C17
I2C1_SDA	IOD	I2C Data	E17	E17

Table 5-28. I2C2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
I2C2_SCL	IOD	I2C Clock	M22	M22
I2C2_SDA	IOD	I2C Data	M20	M20

Table 5-29. I2C3 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
I2C3_SCL	IOD	I2C Clock	AB7, F14	AB7, F14
I2C3_SDA	IOD	I2C Data	C15, Y6	C15, Y6

5.3.12.2 MCU Domain

Table 5-30. MCU_I2C0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_I2C0_SCL	IOD	I2C Clock	E12	E12
MCU_I2C0_SDA	IOD	I2C Data	D9	D9

5.3.12.3 WKUP Domain

Table 5-31. WKUP_I2C0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
WKUP_I2C0_SCL	IOD	I2C Clock	D13	D13
WKUP_I2C0_SDA	IOD	I2C Data	E13	E13

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5.3.13 MCAN

5.3.13.1 MAIN Domain

Table 5-32. MCAN0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCAN0_RX	I	MCAN Receive Data	C18	C18
MCAN0_TX	O	MCAN Transmit Data	B17	B17

5.3.13.2 MCU Domain

Table 5-33. MCU_MCAN0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_MCAN0_RX	I	MCAN Receive Data	E8	E8
MCU_MCAN0_TX	O	MCAN Transmit Data	C7	C7

Table 5-34. MCU_MCAN1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_MCAN1_RX	I	MCAN Receive Data	B9	B9
MCU_MCAN1_TX	O	MCAN Transmit Data	D7	D7

5.3.14 MCASP

5.3.14.1 MAIN Domain

Table 5-35. MCASP0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCASP0_ACLKR	IO	MCASP Receive Bit Clock	A21	A21
MCASP0_ACLKX	IO	MCASP Transmit Bit Clock	A19	A19
MCASP0_AFSR	IO	MCASP Receive Frame Sync	B21	B21
MCASP0_AFSX	IO	MCASP Transmit Frame Sync	A20	A20
MCASP0_AXR0	IO	MCASP Serial Data (Input/Output)	B20	B20
MCASP0_AXR1	IO	MCASP Serial Data (Input/Output)	B18	B18
MCASP0_AXR2	IO	MCASP Serial Data (Input/Output)	B19	B19
MCASP0_AXR3	IO	MCASP Serial Data (Input/Output)	C19	C19

Table 5-36. MCASP1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCASP1_ACLKR	IO	MCASP Receive Bit Clock	G20, H22, M20	G20, H22, M20
MCASP1_ACLKX	IO	MCASP Transmit Bit Clock	F22, J20, L19	F22, J20, L19
MCASP1_AFSR	IO	MCASP Receive Frame Sync	G22, K20, M22	G22, K20, M22
MCASP1_AFSX	IO	MCASP Transmit Frame Sync	E21, J22, R18	E21, J22, R18
MCASP1_AXR0	IO	MCASP Serial Data (Input/Output)	E20, H19, K19	E20, H19, K19
MCASP1_AXR1	IO	MCASP Serial Data (Input/Output)	F21, K21, L17	F21, K21, L17
MCASP1_AXR2	IO	MCASP Serial Data (Input/Output)	F20, K20, L18	F20, K20, L18
MCASP1_AXR3	IO	MCASP Serial Data (Input/Output)	G20, G21, N22	G20, G21, N22
MCASP1_AXR4	IO	MCASP Serial Data (Input/Output)	G22, M22	G22, M22
MCASP1_AXR5	IO	MCASP Serial Data (Input/Output)	H22, M20	H22, M20

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Table 5-37. MCASP2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCASP2_ACLKR	IO	MCASP Receive Bit Clock	T21, Y18	T21, Y18
MCASP2_ACLKX	IO	MCASP Transmit Bit Clock	C15, R21, W17	C15, R21, W17
MCASP2_AFSR	IO	MCASP Receive Frame Sync	T20, Y20	T20, Y20
MCASP2_AFSX	IO	MCASP Transmit Frame Sync	AA18, F14, T22	AA18, F14, T22
MCASP2_AXR0	IO	MCASP Serial Data (Input/Output)	AB21, B17, P22	AB21, B17, P22
MCASP2_AXR1	IO	MCASP Serial Data (Input/Output)	AA20, C18, R19	AA20, C18, R19
MCASP2_AXR2	IO	MCASP Serial Data (Input/Output)	AA21, R20	AA21, R20
MCASP2_AXR3	IO	MCASP Serial Data (Input/Output)	R22, W18	R22, W18
MCASP2_AXR4	IO	MCASP Serial Data (Input/Output)	N21, Y19	N21, Y19
MCASP2_AXR5	IO	MCASP Serial Data (Input/Output)	AB19, N20	AB19, N20
MCASP2_AXR6	IO	MCASP Serial Data (Input/Output)	AA19, N19	AA19, N19
MCASP2_AXR7	IO	MCASP Serial Data (Input/Output)	N18, Y20	N18, Y20
MCASP2_AXR8	IO	MCASP Serial Data (Input/Output)	N17, Y18	N17, Y18
MCASP2_AXR9	IO	MCASP Serial Data (Input/Output)	P18	P18
MCASP2_AXR10	IO	MCASP Serial Data (Input/Output)	P19	P19
MCASP2_AXR11	IO	MCASP Serial Data (Input/Output)	P21	P21
MCASP2_AXR12	IO	MCASP Serial Data (Input/Output)	M18	M18
MCASP2_AXR13	IO	MCASP Serial Data (Input/Output)	K18	K18
MCASP2_AXR14	IO	MCASP Serial Data (Input/Output)	M19	M19
MCASP2_AXR15	IO	MCASP Serial Data (Input/Output)	M21	M21

5.3.15 MCSPI

5.3.15.1 MAIN Domain

Table 5-38. MCSPI0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
SPI0_CLK	IO	SPI Clock	A17	A17
SPI0_CS0	IO	SPI Chip Select 0	D16	D16
SPI0_CS1	IO	SPI Chip Select 1	C16	C16
SPI0_CS2	IO	SPI Chip Select 2	F14	F14
SPI0_CS3	IO	SPI Chip Select 3	C15	C15
SPI0_D0	IO	SPI Data 0	B15	B15
SPI0_D1	IO	SPI Data 1	E15	E15

Table 5-39. MCSPI1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
SPI1_CLK	IO	SPI Clock	H19, Y7	H19, Y7
SPI1_CS0	IO	SPI Chip Select 0	AA7, K21	AA7, K21
SPI1_CS1	IO	SPI Chip Select 1	AB7, K20	AB7, K20
SPI1_CS2	IO	SPI Chip Select 2	Y6	Y6
SPI1_CS3	IO	SPI Chip Select 3	AB6	AB6

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Table 5-39. MCSPI1 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
SPI1_D0	IO	SPI Data 0	AB8, J20	AB8, J20
SPI1_D1	IO	SPI Data 1	J22, W9	J22, W9

Table 5-40. MCSPI2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
SPI2_CLK	IO	SPI Clock	A21, AA6, E17	A21, AA6, E17
SPI2_CS0	IO	SPI Chip Select 0	AB6, B21, D17	AB6, B21, D17
SPI2_CS1	IO	SPI Chip Select 1	A19, AB8, C17	A19, AB8, C17
SPI2_CS2	IO	SPI Chip Select 2	AA7, B18, E16	AA7, B18, E16
SPI2_CS3	IO	SPI Chip Select 3	A20, B16, W9	A20, B16, W9
SPI2_D0	IO	SPI Data 0	C19, E14, W7	C19, E14, W7
SPI2_D1	IO	SPI Data 1	B19, D15, Y8	B19, D15, Y8

5.3.15.2 MCU Domain

Table 5-41. MCU_MCSPI0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_SPI0_CLK	IO	SPI Clock	B13	B13
MCU_SPI0_CS0	IO	SPI Chip Select 0	E11	E11
MCU_SPI0_CS1	IO	SPI Chip Select 1	C11	C11
MCU_SPI0_CS2	IO	SPI Chip Select 2	B9, C9	B9, C9
MCU_SPI0_CS3	IO	SPI Chip Select 3	C7	C7
MCU_SPI0_D0	IO	SPI Data 0	A15	A15
MCU_SPI0_D1	IO	SPI Data 1	B12	B12

Table 5-42. MCU_MCSPI1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_SPI1_CLK	IO	SPI Clock	B9, C8	B9, C8
MCU_SPI1_CS0	IO	SPI Chip Select 0	C10	C10
MCU_SPI1_CS1	IO	SPI Chip Select 1	D7	D7
MCU_SPI1_CS2	IO	SPI Chip Select 2	B9, E9	B9, E9
MCU_SPI1_CS3	IO	SPI Chip Select 3	E8	E8
MCU_SPI1_D0	IO	SPI Data 0	B11	B11
MCU_SPI1_D1	IO	SPI Data 1	D10	D10

5.3.16 MDIO

5.3.16.1 MAIN Domain

Table 5-43. MDIO0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MDIO0_MDC	O	MDIO Clock	V12	V12
MDIO0_MDIO	IO	MDIO Data	V13	V13

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5.3.17 MMC

5.3.17.1 MAIN Domain

Table 5-44. MMC0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MMC0_CLK	O	MMC/SD/SDIO Clock	AB7	AB7
MMC0_CMD	IO	MMC/SD/SDIO Command	Y6	Y6
MMC0_DAT0	IO	MMC/SD/SDIO Data	AA6	AA6
MMC0_DAT1	IO	MMC/SD/SDIO Data	AB6	AB6
MMC0_DAT2	IO	MMC/SD/SDIO Data	Y7	Y7
MMC0_DAT3	IO	MMC/SD/SDIO Data	AA7	AA7
MMC0_DAT4	IO	MMC/SD/SDIO Data	Y8	Y8
MMC0_DAT5	IO	MMC/SD/SDIO Data	W7	W7
MMC0_DAT6	IO	MMC/SD/SDIO Data	W9	W9
MMC0_DAT7	IO	MMC/SD/SDIO Data	AB8	AB8

Table 5-45. MMC1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MMC1_CLK	O	MMC/SD/SDIO Clock	E22	E22
MMC1_CMD	IO	MMC/SD/SDIO Command	C21	C21
MMC1_SDCD	I	SD Card Detect	E18	E18
MMC1_SDWP	I	SD Write Protect	D18	D18
MMC1_DAT0	IO	MMC/SD/SDIO Data	B22	B22
MMC1_DAT1	IO	MMC/SD/SDIO Data	D21	D21
MMC1_DAT2	IO	MMC/SD/SDIO Data	C22	C22
MMC1_DAT3	IO	MMC/SD/SDIO Data	D22	D22

Table 5-46. MMC2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MMC2_CLK (1)	O	MMC/SD/SDIO Clock	H22	H22
MMC2_CMD	IO	MMC/SD/SDIO Command	G22	G22
MMC2_SDCD (2)	I	SD Card Detect	C17, F14, F22	C17, F14, F22
MMC2_SDWP (2)	I	SD Write Protect	C15, E17, E21	C15, E17, E21
MMC2_DAT0	IO	MMC/SD/SDIO Data	E20	E20
MMC2_DAT1	IO	MMC/SD/SDIO Data	F21	F21
MMC2_DAT2	IO	MMC/SD/SDIO Data	F20	F20
MMC2_DAT3	IO	MMC/SD/SDIO Data	G21	G21

(1) For MMC2 to work properly, the CTRLMMR_PADCONFIG71 register must be configured to set (1) the RXACTIVE bit and reset (0) the TX_DIS bit.

(2) These MMCSD2 host controller input signals must be multiplexed to pins which are powered by the VDDSHV0 IO power rail rather than the VDDSHV6 IO power rail when the MMC2 port is connected to a UHS-I SD Card that requires the VDDSHV6 IO power rail to change its operating voltage from 3.3V to 1.8V when transitioning to one of the UHS-I data transfer modes.

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5.3.18 OSPI

5.3.18.1 MAIN Domain

Table 5-47. OSPI0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
OSPI0_CLK	O	OSPI Clock	L22	L22
OSPI0_DQS	I	OSPI Data Strobe (DQS) or Loopback Clock Input	L21	L21
OSPI0_ECC_FAIL	I	OSPI ECC Status	G20	G20
OSPI0_LBCLKO	IO	OSPI Loopback Clock Output	K22	K22
OSPI0_CSn0	O	OSPI Chip Select 0 (active low)	H21	H21
OSPI0_CSn1	O	OSPI Chip Select 1 (active low)	G19	G19
OSPI0_CSn2	O	OSPI Chip Select 2 (active low)	K20	K20
OSPI0_CSn3	O	OSPI Chip Select 3 (active low)	G20	G20
OSPI0_D0	IO	OSPI Data 0	J21	J21
OSPI0_D1	IO	OSPI Data 1	J18	J18
OSPI0_D2	IO	OSPI Data 2	J19	J19
OSPI0_D3	IO	OSPI Data 3	H18	H18
OSPI0_D4	IO	OSPI Data 4	K21	K21
OSPI0_D5	IO	OSPI Data 5	H19	H19
OSPI0_D6	IO	OSPI Data 6	J20	J20
OSPI0_D7	IO	OSPI Data 7	J22	J22
OSPI0_RESET_OUT0	O	OSPI Reset	G20	G20
OSPI0_RESET_OUT1	O	OSPI Reset	K20	K20

5.3.19 Power Supply

Table 5-48. Power Supply Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
CAP_VDDS0 (1)	CAP	External capacitor connection for IO group 0	G13	G13
CAP_VDDS1 (1)	CAP	External capacitor connection for IO group 1	K16	K16
CAP_VDDS2 (1)	CAP	External capacitor connection for IO group 2	T14	T14
CAP_VDDS3 (1)	CAP	External capacitor connection for IO group 3	M16	M16
CAP_VDDS4 (1)	CAP	External capacitor connection for IO group 4	R8	R8
CAP_VDDS5 (1)	CAP	External capacitor connection for IO group 5	G15	G15
CAP_VDDS6 (1)	CAP	External capacitor connection for IO group 6	J16	J16
CAP_VDDS_CANUART (1)	CAP	External capacitor connection for IO CANUART	G8	G8
CAP_VDDS_MCU (1)	CAP	External capacitor connection for IO MCU	G10	G10
VDDA_1P8_USB	PWR	USB0 and USB1 1.8V analog supply	T10	T10
VDDA_1P8_CSIRX0	PWR	CSIRX0 1.8V analog supply	T12	T12
VDDA_3P3_USB	PWR	USB0 and USB1 3.3V analog supply	U10	U10
VDDA_CORE_CSIRX0	PWR	CSIRX0 core supply	T11	T11
VDDA_CORE_USB	PWR	USB0 and USB1 core supply	T9	T9
VDDA_DDR_PLL0	PWR	DDR Deskew PLL supply	M9	M9
VDDA_MCU	PWR	RCOSC, POR, POK, and MCU_PLL0 analog supply	J10	J10
VDDA_PLL0	PWR	MAIN_PLL0 and MAIN_PLL5 analog supply	N9	N9
VDDA_PLL1	PWR	MAIN_PLL1 and MAIN_PLL2 analog supply	R11	R11

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Table 5-48. Power Supply Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VDDA_PLL2	PWR	MAIN_PLL7 and MAIN_PLL17 analog supply	M13	M13
VDDA_PLL3	PWR	MAIN_PLL8 and MAIN_PLL15 analog supply	K13	K13
VDDA_PLL4	PWR	MAIN_PLL12 analog supply	K10	K10
VDDA_TEMP0	PWR	TEMP0 analog supply	P16	P16
VDDA_TEMP1	PWR	TEMP1 analog supply	G18	G18
VDDA_TEMP2	PWR	TEMP2 analog supply	L10	L10
VDDR_CORE	PWR	RAM supply	J14, K12, M10, M14, P12, P9	J14, K12, M10, M14, P12, P9
VDDSHV0	PWR	IO supply for IO group 0	G14, H13	G14, H13
VDDSHV1	PWR	IO supply for IO group 1	K15, L16	K15, L16
VDDSHV2	PWR	IO supply for IO group 2	R13, T13, U13	R13, T13, U13
VDDSHV3	PWR	IO supply for IO group 3	L15, M15, N15	L15, M15, N15
VDDSHV4	PWR	IO supply for IO group 4	T8, U8	T8, U8
VDDSHV5	PWR	IO supply for IO group 5	G16, H15	G16, H15
VDDSHV6	PWR	IO supply for IO group 6	H16, H17	H16, H17
VDDSHV_CANUART	PWR	IO supply for IO CANUART	H8	H8
VDDSHV_MCU	PWR	IO supply for IO MCU	G11, H10	G11, H10
VDDS_DDR	PWR	DDR PHY IO supply	A2, AA1, AB2, B1, J7, K8, L7, M8, N7, P8	A2, AA1, AB2, B1, J7, K8, L7, M8, N7, P8
VDDS_DDR_C	PWR	DDR clock IO supply	L8	L8
VDDS_OSC0	PWR	MCU_OSC0 supply	J8	J8
VDD_CANUART	PWR	CANUART Core Supply	H9	H9
VDD_CORE	PWR	Core supply	J11, J13, J15, J9, K14, L11, L13, L9, M12, N11, N13, P10, P14, R15, R9, T16, U15	J11, J13, J15, J9, K14, L11, L13, L9, M12, N11, N13, P10, P14, R15, R9, T16, U15
VPP	PWR	eFuse ROM programming supply	F7	F7

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Table 5-48. Power Supply Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VSS	PWR	Ground	A1, A10, A13, A18, A22, A4, A6, AA11, AA14, AA2, AA4, AA8, AB1, AB12, AB15, AB18, AB22, AB3, AB5, AB9, B3, B5, B7, C4, D11, D2, D20, D4, E1, E3, E5, F11, F13, F16, F2, F4, G12, G17, G3, G5, G9, H1, H11, H14, H20, H4, J12, J17, J3, K1, K11, K4, K7, K9, L12, L14, L20, L3, M11, M17, M4, M7, N1, N10, N12, N14, N16, N8, P11, P13, P15, P17, P20, P7, R10, R12, R14, R16, R2, R4, R6, T1, T15, T17, T3, T5, T7, U12, U14, U16, U2, U4, U6, U9, V1, V20, V3, V5, V7, V9, W11, W14, W2, W4, W6, W8, Y12, Y15, Y3, Y5, Y9	A1, A10, A13, A18, A22, A4, A6, AA11, AA14, AA2, AA4, AA8, AB1, AB12, AB15, AB18, AB22, AB3, AB5, AB9, B3, B5, B7, C4, D11, D2, D20, D4, E1, E3, E5, F11, F13, F16, F2, F4, G12, G17, G3, G5, G9, H1, H11, H14, H20, H4, J12, J17, J3, K1, K11, K4, K7, K9, L12, L14, L20, L3, M11, M17, M4, M7, N1, N10, N12, N14, N16, N8, P11, P13, P15, P17, P20, P7, R10, R12, R14, R16, R2, R4, R6, T1, T15, T17, T3, T5, T7, U12, U14, U16, U2, U4, U6, U9, V1, V20, V3, V5, V7, V9, W11, W14, W2, W4, W6, W8, Y12, Y15, Y3, Y5, Y9

(1) This pin must always be connected via a 6.3V or greater, 0.8uF to 1.5µF capacitor to VSS if the respective VDDSHVx pin is ever operated at 3.3V. The capacitor selected must provide a capacitance within the defined range after it has been derated for DC-bias, operating temperature, and aging effects. There are three connection options if the respective VDDSHVx pin is only operated at 1.8V. The pin can be connected to the same decoupling capacitor that is required for 3.3V operation, it can be left unconnected, or it can be connected to the same 1.8V power source as the respective VDDSHVx pin.

5.3.20 Reserved

Table 5-49. Reserved Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
RSVD0	N/A	Reserved, must be left unconnected	C6	C6
RSVD1	N/A	Reserved, must be left unconnected	D6	D6
RSVD2	N/A	Reserved, must be left unconnected	E7	E7
RSVD3	N/A	Reserved, must be left unconnected	F6	F6
RSVD4	N/A	Reserved, must be left unconnected	F10	F10
RSVD5	N/A	Reserved, must be left unconnected	G7	G7
RSVD6	N/A	Reserved, must be left unconnected	U11	U11
RSVD7	N/A	Reserved, must be left unconnected	V11	V11

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5.3.21 System and Miscellaneous

5.3.21.1 Boot Mode Configuration

5.3.21.1.1 MAIN Domain

Table 5-50. Sysboot Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
BOOTMODE00	I	Bootmode pin 0	N21	N21
BOOTMODE01	I	Bootmode pin 1	N20	N20
BOOTMODE02	I	Bootmode pin 2	N19	N19
BOOTMODE03	I	Bootmode pin 3	N18	N18
BOOTMODE04	I	Bootmode pin 4	N17	N17
BOOTMODE05	I	Bootmode pin 5	P18	P18
BOOTMODE06	I	Bootmode pin 6	P19	P19
BOOTMODE07	I	Bootmode pin 7	P21	P21
BOOTMODE08	I	Bootmode pin 8	P22	P22
BOOTMODE09	I	Bootmode pin 9	R19	R19
BOOTMODE10	I	Bootmode pin 10	R20	R20
BOOTMODE11	I	Bootmode pin 11	R22	R22
BOOTMODE12	I	Bootmode pin 12	T22	T22
BOOTMODE13	I	Bootmode pin 13	R21	R21
BOOTMODE14	I	Bootmode pin 14	T20	T20
BOOTMODE15	I	Bootmode pin 15	T21	T21

5.3.21.2 Clock

5.3.21.2.1 MCU Domain

Table 5-51. MCU Clock Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_OSC0_XI	I	High frequency oscillator input	A12	A12
MCU_OSC0_XO	O	High frequency oscillator output	A11	A11

5.3.21.2.2 WKUP Domain

Table 5-52. WKUP Clock Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
WKUP_LFOSC0_XI	I	Low frequency (32.768KHz) oscillator input	A8	A8
WKUP_LFOSC0_XO	O	Low frequency (32.768KHz) oscillator output	A9	A9

5.3.21.3 System

5.3.21.3.1 MAIN Domain

Table 5-53. System Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
AUDIO_EXT_REFCLK0	IO	External clock input to McASP or output from McASP	AB20, B20, F14	AB20, B20, F14
AUDIO_EXT_REFCLK1	IO	External clock input to McASP or output from McASP	A20, C15, K17	A20, C15, K17

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Table 5-53. System Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
CLKOUT0	O	RMII Clock Output (50MHz). This pin is used for clock source to the external RMII PHY and must also be routed back to the respective RMII[x]_REF_CLK pin for proper device operation.	AA17, B16, W17	AA17, B16, W17
EXTINTn	I	External Interrupt	F17	F17
EXT_REFCLK1	I	External clock input to Main Domain	B16	B16
OBSCLK0	O	Main Domain Observation clock output for test and debug purposes only	R20	R20
OBSCLK1	O	Main Domain Observation clock output for test and debug purposes only	D17	D17
PORz_OUT	O	Main Domain POR status output	F18	F18
RESETSTATz	O	Main Domain warm reset status output	F19	F19
RESET_REQz	I	Main Domain external warm reset request input	E19	E19
SYSCLKOUT0	O	Main Domain system clock output (divided by 4) for test and debug purposes only	B16	B16

5.3.21.3.2 MCU Domain

Table 5-54. MCU System Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_ERRORn	IO	Error signal output from MCU Domain ESM	B8	B8
MCU_EXT_REFCLK0	I	External input to MCU Domain	C11, D7	C11, D7
MCU_OBSCLK0	O	MCU Domain Observation clock output for test and debug purposes only	C11	C11
MCU_PORz	I	MCU and Main Domain cold reset	A7	A7
MCU_RESETSTATz	O	MCU Domain warm reset status output	D14	D14
MCU_RESETz	I	MCU and Main Domain warm reset	C12	C12
MCU_SYSCLKOUT0	O	MCU Domain system clock output (divided by 4) for test and debug purposes only	C11	C11

5.3.21.3.3 WKUP Domain

Table 5-55. WKUP System Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
PMIC_LPM_EN0	O	Dual-function PMIC control output, Low Power Mode (active low) or PMIC Enable (active high)	D12	D12
WKUP_CLKOUT0	O	WKUP Domain CLKOUT0 output	B10	B10

5.3.21.4 VMON

Table 5-56. VMON Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VMON_1P8_SOC	A	Voltage monitor input for 1.8V SoC power supply	F12	F12
VMON_3P3_SOC	A	Voltage monitor input for 3.3V SoC power supply	F9	F9

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Table 5-56. VMON Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
VMON_VSYS	A	Voltage monitor input, fixed 0.45 V (+/-3%) threshold. Use with external precision voltage divider to monitor a higher voltage rail such as the PMIC input supply.	H12	H12

5.3.22 TIMER

5.3.22.1 MAIN Domain

Table 5-57. TIMER Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
TIMER_IO0	IO	Timer Inputs and Outputs (not tied to single timer instance)	C17, D22, Y7	C17, D22, Y7
TIMER_IO1	IO	Timer Inputs and Outputs (not tied to single timer instance)	C22, E17	C22, E17
TIMER_IO2	IO	Timer Inputs and Outputs (not tied to single timer instance)	B17, D21	B17, D21
TIMER_IO3	IO	Timer Inputs and Outputs (not tied to single timer instance)	B22, C18	B22, C18
TIMER_IO4	IO	Timer Inputs and Outputs (not tied to single timer instance)	AB7, B16, E22	AB7, B16, E22
TIMER_IO5	IO	Timer Inputs and Outputs (not tied to single timer instance)	C21, E16, Y6	C21, E16, Y6
TIMER_IO6	IO	Timer Inputs and Outputs (not tied to single timer instance)	E18, F14	E18, F14
TIMER_IO7	IO	Timer Inputs and Outputs (not tied to single timer instance)	C15, D18	C15, D18

5.3.22.2 MCU Domain

Table 5-58. MCU_TIMER Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_TIMER_IO0	IO	Timer Inputs and Outputs (not tied to single timer instance)	B11, E8	B11, E8
MCU_TIMER_IO1	IO	Timer Inputs and Outputs (not tied to single timer instance)	C11, D10	C11, D10
MCU_TIMER_IO2	IO	Timer Inputs and Outputs (not tied to single timer instance)	D7	D7
MCU_TIMER_IO3	IO	Timer Inputs and Outputs (not tied to single timer instance)	B9	B9

5.3.22.3 WKUP Domain

Table 5-59. WKUP_TIMER Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
WKUP_TIMER_IO0	IO	Timer Inputs and Outputs (not tied to single timer instance)	C10, C7	C10, C7
WKUP_TIMER_IO1	IO	Timer Inputs and Outputs (not tied to single timer instance)	C8, E11	C8, E11

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5.3.23 UART

5.3.23.1 MAIN Domain

Table 5-60. UART0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART0_CTSn	I	UART Clear to Send (active low)	F14	F14
UART0_RTSn	O	UART Request to Send (active low)	C15	C15
UART0_RXD	I	UART Receive Data	E14	E14
UART0_TXD	O	UART Transmit Data	D15	D15

Table 5-61. UART1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART1_CTSn	I	UART Clear to Send (active low)	C19	C19
UART1_DCDn	I	UART Data Carrier Detect (active low)	D17	D17
UART1_DSRn	I	UART Data Set Ready (active low)	E16	E16
UART1_DTRn	O	UART Data Terminal Ready (active low)	B17	B17
UART1_RIn	I	UART Ring Indicator	C18	C18
UART1_RTSn	O	UART Request to Send (active low)	B19	B19
UART1_RXD	I	UART Receive Data	B21, C17	B21, C17
UART1_TXD	O	UART Transmit Data	A21, E17	A21, E17

Table 5-62. UART2 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART2_CTSn	I	UART Clear to Send (active low)	AA22, B22, T20, Y8	AA22, B22, T20, Y8
UART2_RTSn	O	UART Request to Send (active low)	D21, T21, V17, W7	D21, T21, V17, W7
UART2_RXD	I	UART Receive Data	AB8, D22, F14, P22, U22	AB8, D22, F14, P22, U22
UART2_TXD	O	UART Transmit Data	C15, C22, R19, U21, W9	C15, C22, R19, U21, W9

Table 5-63. UART3 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART3_CTSn	I	UART Clear to Send (active low)	AA6, D18, U17	AA6, D18, U17
UART3_RTSn	O	UART Request to Send (active low)	AB6, E18, T18	AB6, E18, T18
UART3_RXD	I	UART Receive Data	AA7, E22, R20, U20	AA7, E22, R20, U20
UART3_TXD	O	UART Transmit Data	C21, R22, U19, Y7	C21, R22, U19, Y7

Table 5-64. UART4 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART4_CTSn	I	UART Clear to Send (active low)	Y22	Y22
UART4_RTSn	O	UART Request to Send (active low)	Y21	Y21
UART4_RXD	I	UART Receive Data	F22, M22, T19, T22	F22, M22, T19, T22

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Table 5-64. UART4 Signal Descriptions (continued)

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART4_TXD	O	UART Transmit Data	E21, M20, R21, U18	E21, M20, R21, U18

Table 5-65. UART5 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART5_CTSn	I	UART Clear to Send (active low)	L21, W19	L21, W19
UART5_RTSn	O	UART Request to Send (active low)	K22, W20	K22, W20
UART5_RXD	I	UART Receive Data	B17, G21, K20, T20, V22	B17, G21, K20, T20, V22
UART5_TXD	O	UART Transmit Data	C18, F20, G20, T21, V21	C18, F20, G20, T21, V21

Table 5-66. UART6 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
UART6_CTSn	I	UART Clear to Send (active low)	J22, W21	J22, W21
UART6_RTSn	O	UART Request to Send (active low)	J20, W22	J20, W22
UART6_RXD	I	UART Receive Data	C19, E18, H22, K21, R17, V19	C19, E18, H22, K21, R17, V19
UART6_TXD	O	UART Transmit Data	B19, D18, G22, H19, K17, V18	B19, D18, G22, H19, K17, V18

5.3.23.2 MCU Domain

Table 5-67. MCU_UART0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
MCU_UART0_CTSn	I	UART Clear to Send (active low)	B11	B11
MCU_UART0_RTSn	O	UART Request to Send (active low)	D10	D10
MCU_UART0_RXD	I	UART Receive Data	D8	D8
MCU_UART0_TXD	O	UART Transmit Data	F8	F8

5.3.23.3 WKUP Domain

Table 5-68. WKUP_UART0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
WKUP_UART0_CTSn	I	UART Clear to Send (active low)	C10	C10
WKUP_UART0_RTSn	O	UART Request to Send (active low)	C8	C8
WKUP_UART0_RXD	I	UART Receive Data	C9	C9
WKUP_UART0_TXD	O	UART Transmit Data	E9	E9

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5.3.24 USB

5.3.24.1 MAIN Domain

Table 5-69. USB0 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
USB0_DM	IO	USB 2.0 Differential Data (negative)	AA10	AA10
USB0_DP	IO	USB 2.0 Differential Data (positive)	AA9	AA9
USB0_DRVVBUS	O	USB VBUS control output (active high)	C20	C20
USB0_RCALIB (1)	A	Pin to connect to calibration resistor	W10	W10
USB0_VBUS (2)	A	USB Level-shifted VBUS Input	V8	V8

(1) An external 499Ω ±1% resistor must be connected between this pin and VSS and the maximum power dissipation for the resistor is 7.2mW. No external voltage should be applied to this pin.
(2) An external resistor divider is required to limit the voltage applied to the device pin. For more information, see Section 8.2.3, *USB VBUS Design Guidelines*.

Table 5-70. USB1 Signal Descriptions

SIGNAL NAME [1]	SIGNAL TYPE [2]	DESCRIPTION [3]	AMB PIN [4]	ANF PIN [4]
USB1_DM	IO	USB 2.0 Differential Data (negative)	Y11	Y11
USB1_DP	IO	USB 2.0 Differential Data (positive)	Y10	Y10
USB1_DRVVBUS	O	USB VBUS control output (active high)	D19	D19
USB1_RCALIB (1)	A	Pin to connect to calibration resistor	U7	U7
USB1_VBUS (2)	A	USB Level-shifted VBUS Input	V6	V6

(1) An external 499Ω ±1% resistor must be connected between this pin and VSS and the maximum power dissipation for the resistor is 7.2mW. No external voltage should be applied to this pin.
(2) An external resistor divider is required to limit the voltage applied to the device pin. For more information, see Section 8.2.3, *USB VBUS Design Guidelines*.

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5.4 Pin Connectivity Requirements

This section describes connectivity requirements for package balls that have specific connectivity requirements and unused package balls.

Note

All power pins must be supplied with the voltages specified in Section 6.5, *Recommended Operating Conditions*, unless otherwise specified.

Note

For additional clarification, "leave unconnected" or "no connect" (NC) means **no** signal traces can be connected to these device ball numbers.

Table 5-71. Connectivity Requirements

AMB BALL NUMBER	ANF BALL NUMBER	BALL NAME	CONNECTION REQUIREMENTS
B8 F15	B8 F15	MCU_ERRORn TRSTn	Each of these balls must be connected to VSS through separate external pull resistors to ensure the inputs associated with these balls are held to a valid logic low level if a PCB signal trace is connected and not actively driven by an attached device. The internal pull-down can be used to hold a valid logic low level if no PCB signal trace is connected to the ball.
C13 E10 C12 E19 A14 A16 B14	C13 E10 C12 E19 A14 A16 B14	EMU0 EMU1 MCU_RESETz RESET_REQz TCK TDI TMS	Each of these balls must be connected to the corresponding power supply(1) through separate external pull resistors to ensure the inputs associated with these balls are held to a valid logic high level if a PCB signal trace is connected and not actively driven by an attached device. The internal pull-up can be used to hold a valid logic high level if no PCB signal trace is connected to the ball.
E12 D9 D13 E13	E12 D9 D13 E13	MCU_I2C0_SCL MCU_I2C0_SDA WKUP_I2C0_SCL WKUP_I2C0_SDA	Each of these balls must be connected to the corresponding power supply(1) or VSS through separate external pull resistors to ensure the inputs associated with these balls are held to a valid logic high or low level as appropriate for the selected signal function.
N21 N20 N19 N18 N17 P18 P19 P21 P22 R19 R20 R22 T22 R21 T20 T21	N21 N20 N19 N18 N17 P18 P19 P21 P22 R19 R20 R22 T22 R21 T20 T21	GPMC0_AD0 GPMC0_AD1 GPMC0_AD2 GPMC0_AD3 GPMC0_AD4 GPMC0_AD5 GPMC0_AD6 GPMC0_AD7 GPMC0_AD8 GPMC0_AD9 GPMC0_AD10 GPMC0_AD11 GPMC0_AD12 GPMC0_AD13 GPMC0_AD14 GPMC0_AD15	Each of these balls must be connected to the corresponding power supply(1) or VSS through separate external pull resistors to ensure the inputs associated with these balls are held to a valid logic high or low level as appropriate to select the desired device boot mode.
A2 AA1 AB2 B1 J7 K8 L7 M8 N7 P8 L8	A2 AA1 AB2 B1 J7 K8 L7 M8 N7 P8 L8	VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR VDDS_DDR_C	If DDRSS is not used, each of these balls must be connected directly to VSS.

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Table 5-71. Connectivity Requirements (continued)

AMB BALL NUMBER	ANF BALL NUMBER	BALL NAME	CONNECTION REQUIREMENTS
N5	N5	DDR0_ACT_n	
H7	H7	DDR0_ALERT_n	
M5	M5	DDR0_CAS_n	
N2	N2	DDR0_PAR	
M6	M6	DDR0_RAS_n	
N6	N6	DDR0_WE_n	
J5	J5	DDR0_A0	
J2	J2	DDR0_A1	
J4	J4	DDR0_A2	
L4	L4	DDR0_A3	
J1	J1	DDR0_A4	
K5	K5	DDR0_A5	
K3	K3	DDR0_A6	
H2	H2	DDR0_A7	
L6	L6	DDR0_A8	
L2	L2	DDR0_A9	
K2	K2	DDR0_A10	
L5	L5	DDR0_A11	
M3	M3	DDR0_A12	
M2	M2	DDR0_A13	
K6	K6	DDR0_BA0	
H3	H3	DDR0_BA1	
P4	P4	DDR0_BG0	
R7	R7	DDR0_BG1	
H6	H6	DDR0_CAL0	
M1	M1	DDR0_CK0	
L1	L1	DDR0_CK0_n	
P3	P3	DDR0_CKE0	
P5	P5	DDR0_CKE1	
J6	J6	DDR0_CS0_n	If DDRSS is not used, leave unconnected. Note: The DDR0 pins in this list can only be left unconnected when VDDS_DDR and VDDS_DDR_C are connected to VSS. The DDR0 pins must be connected as defined in the DDR Board Design and Layout Guidelines, when VDDS_DDR and VDDS_DDR_C are connected to a power source.
N4	N4	DDR0_CS1_n	
C2	C2	DDR0_DM0	
F3	F3	DDR0_DM1	
U1	U1	DDR0_DM2	
W3	W3	DDR0_DM3	
A5	A5	DDR0_DQ0	
B4	B4	DDR0_DQ1	
B6	B6	DDR0_DQ2	
D5	D5	DDR0_DQ3	
C5	C5	DDR0_DQ4	
C3	C3	DDR0_DQ5	
B2	B2	DDR0_DQ6	
A3	A3	DDR0_DQ7	
E2	E2	DDR0_DQ8	
F5	F5	DDR0_DQ9	
E6	E6	DDR0_DQ10	
G2	G2	DDR0_DQ11	
G6	G6	DDR0_DQ12	
G4	G4	DDR0_DQ13	
E4	E4	DDR0_DQ14	
D3	D3	DDR0_DQ15	
T6	T6	DDR0_DQ16	
T4	T4	DDR0_DQ17	
U5	U5	DDR0_DQ18	
R5	R5	DDR0_DQ19	
P2	P2	DDR0_DQ20	
R3	R3	DDR0_DQ21	
T2	T2	DDR0_DQ22	
U3	U3	DDR0_DQ23	
Y2	Y2	DDR0_DQ24	
V2	V2	DDR0_DQ25	
V4	V4	DDR0_DQ26	
W5	W5	DDR0_DQ27	

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Table 5-71. Connectivity Requirements (continued)

AMB BALL NUMBER	ANF BALL NUMBER	BALL NAME	CONNECTION REQUIREMENTS
Y4 AA3 AA5 AB4 D1 C1 G1 F1 R1 P1 W1 Y1 H5 N3 P6	Y4 AA3 AA5 AB4 D1 C1 G1 F1 R1 P1 W1 Y1 H5 N3 P6	DDR0_DQ28 DDR0_DQ29 DDR0_DQ30 DDR0_DQ31 DDR0_DQS0 DDR0_DQS0_n DDR0_DQS1 DDR0_DQS1_n DDR0_DQS2 DDR0_DQS2_n DDR0_DQS2 DDR0_DQS2_n DDR0_ODT0 DDR0_ODT1 DDR0_RESET0_n	
T9 T10 U10	T9 T10 U10	VDDA_CORE_USB VDDA_1P8_USB VDDA_3P3_USB	USB0 and USB1 share these power rails, so each of these balls must be connected to valid power sources when either USB0 or USB1 is used. If USB0 and USB1 are not used, each of these balls must be connected directly to VSS.
AA10 AA9 W10 V8 Y11 Y10 U7 V6	AA10 AA9 W10 V8 Y11 Y10 U7 V6	USB0_DM USB0_DP USB0_RCALIB USB0_VBUS USB1_DM USB1_DP USB1_RCALIB USB1_VBUS	If USB0 or USB1 is not used, leave the respective DM, DP, and VBUS balls unconnected. Note: The USB0_RCALIB and USB1_RCALIB pins can only be left unconnected when VDDA_CORE_USB, VDDA_1P8_USB, and VDDA_3P3_USB are connected to VSS. The USB0_RCALIB and USB1_RCALIB pins must be connected to VSS through separate appropriate external resistors when VDDA_CORE_USB, VDDA_1P8_USB, and VDDA_3P3_USB are connected to power sources.
T11 T12	T11 T12	VDDA_CORE_CSIRX0 VDDA_1P8_CSIRX0	If CSIRX0 is not used and the device boundary scan function is required, each of these balls must be connected to valid power sources. If CSIRX0 is not used and the device boundary scan function is not required, each of these balls can alternatively be connected directly to VSS.
AB14 AB13 W12 W13 V10	AB14 AB13 W12 W13 V10	CSI0_RXCLKN CSI0_RXCLKP CSI0_RXN0 CSI0_RXP0 CSI0_RXRCALIB	If CSIRX0 is not used, leave unconnected.
Y13 Y14	Y13 Y14	CSI0_RXN1 CSI0_RXP1	If CSIRX0 is not used or only operated in 1-lane mode, leave unconnected.
AA13 AA12	AA13 AA12	CSI0_RXN2 CSI0_RXP2	If CSIRX0 is not used or only operated in 1-lane or 2-lane mode, leave unconnected.
AB11 AB10	AB11 AB10	CSI0_RXN3 CSI0_RXP3	If CSIRX0 is not used or only operated in 1-lane, 2-lane, or 3-lane mode, leave unconnected.
H12	H12	VMON_VSYS	If VMON_VSYS is not used, this ball must be connected directly to VSS.
F12	F12	VMON_1P8_SOC	If VMON_1P8_SOC is not used to monitor the SOC power rail, this ball must remain connected to a 1.8V power rail.
F9	F9	VMON_3P3_SOC	If VMON_3P3_SOC is not used to monitor the SOC power rail, this ball must remain connected to a 3.3V power rail or connected directly to VSS.

(1) To determine which power supply is associated with any IO, see the POWER column of the *Pin Attributes* table.

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Note

Internal pull resistors are weak and may not source enough current to maintain a valid logic level for some operating conditions. This can be the case when connected to components with leakage to the opposite logic level, or when external noise sources couple to signal traces attached to balls which are only pulled to a valid logic level by the internal resistor. Therefore, external pull resistors are recommended to hold a valid logic level on balls with external connections.

Many of the device IOs are turned off by default and external pull resistors may be required to hold inputs of any attached device in a valid logic state until software initializes the respective IOs. The state of configurable device IOs are defined in the BALL STATE DURING RESET RX/TX/PULL and BALL STATE AFTER RESET RX/TX/PULL columns of the *Pin Attributes* table. Any IO with its input buffer (RX) turned off is allowed to float without damaging the device. However, any IO with its input buffer (RX) turned on shall never be allowed to float to any potential between V_{ILSS} and V_{IHSS}. The input buffer can enter a high-current state which could damage the IO cell if allowed to float between these levels.

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6 Specifications

6.1 Absolute Maximum Ratings

over operating junction temperature range (unless otherwise noted)[1][2]

PARAMETER			MIN	MAX	UNIT
VDD_CORE	Core supply		-0.3	1.05	V
VDDR_CORE	RAM supply		-0.3	1.05	V
VDD_CANUART	CANUART core supply		-0.3	1.05	V
VDDA_CORE_CSIRX0	CSIRX0 core supply		-0.3	1.05	V
VDDA_CORE_USB	USB0 and USB1 core supply		-0.3	1.05	V
VDDA_DDR_PLL0	DDR Deskew PLL supply		-0.3	1.05	V
VDDS_DDR	DDR PHY IO supply		-0.3	1.57	V
VDDS_DDR_C	DDR clock IO supply		-0.3	1.57	V
VDDS_OSC0	MCU_OSC0 supply		-0.3	1.98	V
VDDA_MCU	RCOSC, POR, POK, and MCU_PLL0 analog supply		-0.3	1.98	V
VDDA_PLL0	MAIN_PLL0 and MAIN_PLL5 analog supply		-0.3	1.98	V
VDDA_PLL1	MAIN_PLL1 and MAIN_PLL2 analog supply		-0.3	1.98	V
VDDA_PLL2	MAIN_PLL7 and MAIN_PLL17 analog supply		-0.3	2.2	V
VDDA_PLL3	MAIN_PLL8 and MAIN_PLL15 analog supply		-0.3	1.98	V
VDDA_PLL4	MAIN_PLL12 analog supply		-0.3	1.98	V
VDDA_1P8_CSIRX0	CSIRX0 1.8V analog supply		-0.3	1.98	V
VDDA_1P8_USB	USB0 and USB1 1.8V analog supply		-0.3	1.98	V
VDDA_TEMP0	TEMP0 analog supply		-0.3	1.98	V
VDDA_TEMP1	TEMP1 analog supply		-0.3	2.2	V
VDDA_TEMP2	TEMP2 analog supply		-0.3	1.98	V
VPP	eFuse ROM programming supply		-0.3	1.98	V
VDDSHV_MCU	IO supply for IO MCU		-0.3	3.63	V
VDDSHV_CANUART	IO supply for IO CANUART		-0.3	3.63	V
VDDSHV0	IO supply for IO group 0		-0.3	3.63	V
VDDSHV1	IO supply for IO group 1		-0.3	3.63	V
VDDSHV2	IO supply for IO group 2		-0.3	3.63	V
VDDSHV3	IO supply for IO group 3		-0.3	3.63	V
VDDSHV4	IO supply for IO group 4		-0.3	3.63	V
VDDSHV5	IO supply for IO group 5		-0.3	3.63	V
VDDSHV6	IO supply for IO group 6		-0.3	3.63	V
VDDA_3P3_USB	USB0 and USB1 3.3V analog supply		-0.3	3.63	V
Steady-state max voltage at all fail-safe IO pins		MCU_PORz	-0.3	3.63	V
		MCU_I2C0_SCL, MCU_I2C0_SDA, WKUP_I2C0_SCL, WKUP_I2C0_SDA, EXTINTn When operating at 1.8V	-0.3	1.98[3]	V
		MCU_I2C0_SCL, MCU_I2C0_SDA, WKUP_I2C0_SCL, WKUP_I2C0_SDA, EXTINTn When operating at 3.3V	-0.3	3.63[3]	
		VMON_1P8_SOC	-0.3	1.98	V
		VMON_3P3_SOC	-0.3	3.63	V
		VMON_VSYS[4]	-0.3	1.98	V

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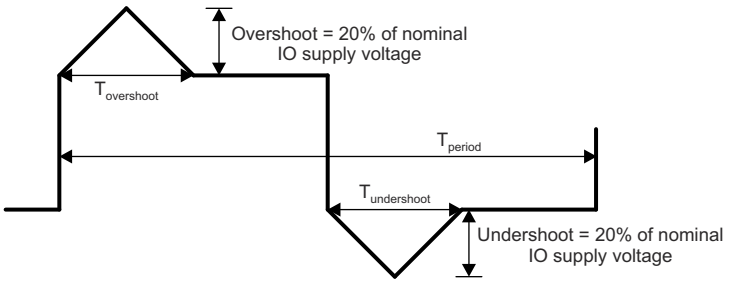
over operating junction temperature range (unless otherwise noted)[1][2]

PARAMETER			MIN	MAX	UNIT
Steady-state max voltage at all other IO pins[5]		USB0_VBUS, USB1_VBUS[6]	-0.3	3.6	V
		All other IO pins	-0.3	IO supply voltage + 0.3	V
Transient overshoot and undershoot at IO pin		20% of IO supply voltage for up to 20% of the signal period (see Figure 6-1, *IO Transient Voltage Ranges*)		0.2 × VDD[7]	V
Latch-up performance[8]		I-Test	-100	100	mA
		Over-Voltage (OV) Test		1.5 x VDD[7]	V
T_{STG}	Storage temperature		-55	+150	°C

(1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Section 6.5, *Recommended Operating Conditions* but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) All voltage values are with respect to VSS, unless otherwise noted.
(3) The absolute maximum ratings for these fail-safe pins depends on their IO supply operating voltage. Therefore, this value is also defined by the maximum V_{IH} value found in the *I2C Open-Drain, and Fail-Safe (I2C OD FS) Electrical Characteristics* section, where the electrical characteristics table has separate parameter values for 1.8V mode and 3.3V mode.
(4) The VMON_VSYS pin provides a way to monitor the system power supply. For more information, see Section 8.2.4, *System Power Supply Monitor Design Guidelines*.
(5) This parameter applies to all IO pins which are not fail-safe and the requirement applies to all values of IO supply voltage. For example, if the voltage applied to a specific IO supply is 0 volts the valid input voltage range for any IO powered by that supply will be –0.3 to +0.3 volts. Special attention should be applied anytime peripheral devices are not powered from the same power sources used to power the respective IO supply. It is important the attached peripheral never sources a voltage outside the valid input voltage range, including power supply ramp-up and ramp-down sequences.
(6) An external resistor divider is required to limit the voltage applied to this device pin. For more information, see Section 8.2.3, *USB Design Guidelines*.
(7) VDD is the voltage on the corresponding power-supply pin(s) for the IO.
(8) For current pulse injection (I-Test):
- Pins stressed per JEDEC JESD78 (Class II) and passed with specified I/O pin injection current and clamp voltage of 1.5 times maximum recommended I/O voltage and negative 0.5 times maximum recommended I/O voltage.

For over-voltage performance (Over-Voltage (OV) Test):
- Supplies stressed per JEDEC JESD78 (Class II) and passed specified voltage injection.

Fail-safe IO terminals are designed such they do not have dependencies on the respective IO power supply voltage. This allows external voltage sources to be connected to these IO terminals when the respective IO power supplies are turned off. The MCU_I2C0_SCL, MCU_I2C0_SDA, WKUP_I2C0_SCL, WKUP_I2C0_SDA, EXTINTn, VMON_1P8_SOC, VMON_3P3_SOC, and MCU_PORz are the only fail-safe IO terminals. All other IO terminals are not fail-safe and the voltage applied to them should be limited to the value defined by the *Steady-state max voltage at all other IO pins* parameter in Section 6.1.



A. $T_{overshoot} + T_{undershoot} < 20\%$ of T_{period}

Figure 6-1. IO Transient Voltage Ranges

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6.2 ESD Ratings for Devices which are not AEC - Q100 Qualified

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge (ESD)	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±1000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	±250	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

6.3 ESD Ratings for AEC - Q100 Qualified Devices

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC - Q100-002(1)		±1000	V
		Charged-device model (CDM), per AEC - Q100-011	Corner pins (A1, A22, AB1, and AB22)	±750	
			All other pins	±250	

(1) AEC - Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.4 Power-On Hours (POH)

POWER ON HOURS (POH)(1)(2)(3)		
JUNCTION TEMPERATURE RANGE (T_J)		LIFETIME (POH)
EXTENDED	-40°C to 105°C	100000
AUTOMOTIVE	-40°C to 125°C	20000(4)

(1) This information is provided solely for your convenience and does not extend or modify the warranty provided under TI's standard terms and conditions for TI semiconductor products.
(2) Unless specified in the table above, all voltage domains and operating conditions are supported in the device at the noted temperatures.
(3) POH is a function of voltage, temperature and time. Usage at higher voltages and temperatures will result in a reduction in POH.
(4) Automotive profile is defined as 20000 power on hours with a junction temperature as follows: 5%@-40°C, 65%@70°C, 20%@110°C, and 10%@125°C.

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6.5 Recommended Operating Conditions

over operating junction temperature range (unless otherwise noted)

SUPPLY NAME	DESCRIPTION		MIN(1)	NOM	MAX(1)	UNIT
VDD_CORE(2) VDDA_CORE_CSIRX0(2) VDDA_CORE_USB(2) VDDA_DDR_PLL0(2)	Core supply CSIRX0 core supply USB0 and USB1 core supply DDR Deskew PLL supply	0.75V operation	0.715	0.75	0.79	V
		0.85V operation	0.81	0.85	0.895	V
VDD_CANUART(3)	CANUART core supply	0.75V operation	0.715	0.75	0.79	V
		0.85V operation	0.81	0.85	0.895	V
VDDR_CORE	RAM supply		0.81	0.85	0.895	V
VDDS_DDR(4) VDDS_DDR_C(4)	DDR PHY IO supply DDR clock IO supply	1.1V operation	1.06	1.1	1.17	V
VDDS_OSC0	MCU_OSC0 supply		1.71	1.8	1.89	V
VDDA_MCU	RCOSC, POR, POK, and MCU_PLL0 analog supply		1.71	1.8	1.89	V
VDDA_PLL0	MAIN_PLL0 and MAIN_PLL5 analog supply		1.71	1.8	1.89	V
VDDA_PLL1	MAIN_PLL1 and MAIN_PLL2 analog supply		1.71	1.8	1.89	V
VDDA_PLL2	MAIN_PLL7 and MAIN_PLL17 analog supply		1.71	1.8	1.89	V
VDDA_PLL3	MAIN_PLL8 and MAIN_PLL15 analog supply		1.71	1.8	1.89	V
VDDA_PLL4	MAIN_PLL12 analog supply		1.71	1.8	1.89	V
VDDA_1P8_CSIRX0	CSIRX0 1.8V analog supply		1.71	1.8	1.89	V
VDDA_1P8_USB	USB0 and USB1 1.8V analog supply		1.71	1.8	1.89	V
VDDA_TEMP0	TEMP0 analog supply		1.71	1.8	1.89	V
VDDA_TEMP1	TEMP1 analog supply		1.71	1.8	1.89	V
VDDA_TEMP2	TEMP2 analog supply		1.71	1.8	1.89	V
VPP	eFuse ROM programming supply		see(5)	see(5)	see(5)	V
VMON_1P8_SOC	Voltage monitor for 1.8V SoC power supply		1.71	1.8	1.89	V
VDDA_3P3_USB	USB0 and USB1 3.3V analog supply		3.135	3.3	3.465	V
VMON_3P3_SOC	Voltage monitor for 3.3V SoC power supply		3.135	3.3	3.465	V
VMON_VSYS	Voltage monitor pin		0	see(6)	1	V
USB0_VBUS	USB0 Level-shifted VBUS Input		0	see(7)	3.465	V
USB1_VBUS	USB1 Level-shifted VBUS Input		0	see(7)	3.465	V
VDDSHV_CANUART(8)	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV_MCU	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV0	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV1	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV2	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV3	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV4	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
VDDSHV5	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V

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over operating junction temperature range (unless otherwise noted)

SUPPLY NAME	DESCRIPTION		MIN(1)	NOM	MAX(1)	UNIT
VDDSHV6	Dual-voltage IO supply	1.8V operation	1.71	1.8	1.89	V
		3.3V operation	3.135	3.3	3.465	V
T_J	Operating junction temperature range	Automotive	-40		125	°C
		Extended Industrial	-40		105	°C

(1) The voltage at the device ball must never drop below the MIN voltage or rise above the MAX voltage for any amount of time during normal device operation.
(2) VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB, and VDDA_DDR_PLL0 shall be sourced from the same power source. Care should be taken to ensure that voltage differential between VDD_CORE and VDDA_CORE_USB is within +/- 1%.
(3) VDD_CANUART shall be connected to an always on power source when using Partial IO low power mode. VDD_CANUART shall be connected to the same power source as VDD_CORE, VDDA_CORE_CSI_DSI, VDDA_CORE_USB, and VDDA_DDR_PLL0 when not using Partial IO low power mode.
(4) VDDS_DDR and VDDS_DDR_C shall be sourced from the same power source.
(5) Refer to the Recommended Operating Conditions for OTP eFuse Programming table for VPP supply voltages based on eFuse usage.
(6) The VMON_VSYS pin provides a way to monitor the system power supply. For more information, see Section 8.2.4, *System Power Supply Monitor Design Guidelines*.
(7) An external resistor divider is required to limit the voltage applied to this device pin. For more information, see Section 8.2.3, *USB Design Guidelines*.
(8) VDDSHV_CANUART shall be connected to an always on power source when using Partial IO low power mode. VDDSHV_CANUART shall be connected to any valid IO power source when not using Partial IO low power mode.

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6.6 Operating Performance Points

Table 6-1 defines the maximum operating frequency of the clocks for each device speed grade and Table 6-2 defines the only valid Operating Performance Points (OPPs) for the device subsystem and core clocks.

Table 6-1. Device Speed Grades

Speed Grade	VDD_CORE (V)(1)	MAXIMUM OPERATING FREQUENCY (MHz)									MAXIMUM TRANSITION RATE (MT/s) (2)
		A53SS (Cortex-A53x)	C7 DSP	MAIN SYSCLK	MCU R5F / SYSCLK	DEVICE MANAGER R5F / CLK	HSM	VPAC	VENC / VDEC	MJPEG	LPDDR4
M	0.75/0.85	800	500	500	800 / 400	800 / 400	400	375	400	250	3200
N	0.75	800	850	500	800 / 400	800 / 400	400	375	400	250	3200
	0.85		1000								
O	0.75/0.85	1000	500	500	800 / 400	800 / 400	400	375	400	250	3200
P	0.75/0.85	1000	500	500	800 / 400	800 / 400	400	375	400	250	3733
Q	0.75	1000	850	500	800 / 400	800 / 400	400	375	400	250	3200
	0.85		1000								
R	0.75	1000	850	500	800 / 400	800 / 400	400	375	400	250	3733
	0.85		1000								
S	0.75	1250	500	500	800 / 400	800 / 400	400	375	400	250	3200
	0.85	1400									
T	0.75	1250	500	500	800 / 400	800 / 400	400	375	400	250	3733
	0.85	1400									
U	0.75	1250	850	500	800 / 400	800 / 400	400	375	400	250	3200
	0.85	1400	1000								
V	0.75	1250	850	500	800 / 400	800 / 400	400	375	400	250	3733
	0.85	1400	1000								

(1) Nominal operating voltage, see *Recommended Operating Conditions*.
(2) Maximum DDR Frequency will be limited based on the specific memory type (vendor) used in a system and by PCB implementation. Refer to DDR Board Design and Layout Guidelines for the proper PCB implementation to achieve maximum DDR frequency.

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Table 6-2. Device Operating Performance Points

OPP	A53SS[1]	C7 DSP	FIXED OPERATING FREQUENCY OPTIONS (MHz)[2]							MT/s[3]
			MAIN SYSCLK	MCU R5F / SYSCLK	DEVICE MANAGER R5F / CLK	HSM	VPAC	VENC / VDEC	MJPEG	LPDDR4
High	From ARM0 PLL Bypass to Speed Grade Maximum	From C7 DSP PLL Bypass to Speed Grade Maximum	500	800 / 400	800 / 400	400	187.5, or 375	400, 200, or 100	250	From DDR PLL Bypass[4] to Speed Grade Maximum
Low			250	400 / 200	400 / 133	133				

(1) Default operating frequency, set by software at boot. Supports Dynamic Frequency Scaling after boot.
(2) Fixed operating frequency, set by software at boot.
(3) Maximum DDR Frequency will be limited based on the specific memory type (vendor) used in a system and by PCB implementation. Refer to DDR Board Design and Layout Guidelines for the proper PCB implementation to achieve maximum DDR frequency.
(4) The DDR PLL output, which sources DDR0_CK0 and DDR0_CK0_n, is typically defined in units of frequency. So the "DDR PLL Bypass" transaction rate is equal to 2x the DDR PLL output frequency when operating in bypass mode.

6.7 Power Consumption Summary

For information on the device power consumption, see the AM62Ax Power Estimation Tool application note.

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6.8 Electrical Characteristics

Note

The interfaces or signals described in Section 6.8 correspond to the interfaces or signals available in multiplexing mode 0 (Primary Signal Function).

All interfaces or signals multiplexed on the balls described in these tables have the same DC electrical characteristics, unless multiplexing involves a PHY and GPIO combination, in which case different DC electrical characteristics are specified for the different multiplexing modes (Functions).

6.8.1 I2C Open-Drain, and Fail-Safe (I2C OD FS) Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
1.8V MODE						
V_{IL}	Input Low Voltage				0.3 × VDD[1]	V
V_{ILSS}	Input Low Voltage Steady State				0.3 × VDD[1]	V
V_{IH}	Input High Voltage		0.7 × VDD[1]		1.98[2]	V
V_{IHSS}	Input High Voltage Steady State		0.7 × VDD[1]			V
V_{HYS}	Input Hysteresis Voltage		0.1 × VDD[1]			mV
I_{IN}[3]	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA
V_{OL}	Output Low Voltage				0.2 × VDD[1]	V
I_{OL}[4]	Low Level Output Current	$V_{OL(MAX)}$	10			mA
SR_I[6]	Input Slew Rate		18f[5] or 1.8E+6			V/s
3.3V MODE[7]						
V_{IL}	Input Low Voltage				0.3 × VDD[1]	V
V_{ILSS}	Input Low Voltage Steady State				0.25 × VDD[1]	V
V_{IH}	Input High Voltage		0.7 × VDD[1]		3.63[2]	V
V_{IHSS}	Input High Voltage Steady State		0.7 × VDD[1]			V
V_{HYS}	Input Hysteresis Voltage		0.05 × VDD[1]			mV
I_{IN}[3]	Input Leakage Current.	V_I = 3.3V			10	µA
		V_I = 0V			-10	µA
V_{OL}	Output Low Voltage				0.4	V
I_{OL}[4]	Low Level Output Current	$V_{OL(MAX)}$	10			mA
SR_I[6]	Input Slew Rate		33f[5] or 3.3E+6		8E+7	V/s

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.
(2) This value also defines the Absolute Maximum Ratings value the IO.
(3) This parameter defines leakage current when the terminal is operating as an input, undriven output, or both input and undriven output.
(4) The I_{OL} parameter defines the minimum Low Level Output Current for which the device is able to maintain the specified V_{OL} value. The value defined by this parameter should be considered the maximum current available to a system implementation which needs to maintain the specified V_{OL} value for attached components.
(5) f = toggle frequency of the input signal in Hz.
(6) This MIN parameter only applies to input signal functions which are not defined in their respective *Timing and Switching Characteristics* sections. Select the MIN parameter which results in the largest value.
(7) I2C Hs-mode is not supported when operating the IO in 3.3V mode.

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6.8.2 Fail-Safe Reset (FS RESET) Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IL}	Input Low Voltage				0.3 × VDDS_OSC0	V
V_{ILSS}	Input Low Voltage Steady State				0.3 × VDDS_OSC0	V
V_{IH}	Input High Voltage		0.7 × VDDS_OSC0			V
V_{IHSS}	Input High Voltage Steady State		0.7 × VDDS_OSC0			V
V_{HYS}	Input Hysteresis Voltage		200			mV
I_{IN}(1)	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA
SR_I(3)	Input Slew Rate		18f(2) or 1.8E+6			V/s

(1) This parameter defines leakage current when the terminal is operating as an input.
(2) f = toggle frequency of the input signal in Hz.
(3) This MIN parameter only applies to input signal functions which are not defined in their respective *Timing and Switching Characteristics* sections. Select the MIN parameter which results in the largest value.

6.8.3 High-Frequency Oscillator (HFOSC) Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IL}	Input Low Voltage				0.35 × VDDS_OSC0	V
V_{IH}	Input High Voltage		0.65 × VDDS_OSC0			V
V_{HYS}	Input Hysteresis Voltage			49		mV
I_{IN}(1)	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA

(1) This parameter defines leakage current when the terminal is operating as an input.

6.8.4 Low-Frequency Oscillator (LFXOSC) Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IL}	Input Low Voltage				0.30 × VDDS_OSC0	V
V_{IH}	Input High Voltage		0.70 × VDDS_OSC0			V
V_{HYS}	Input Hysteresis Voltage	Active Mode		85		mV
		Bypass Mode		324		mV
I_{IN}(1)	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA

(1) This parameter defines leakage current when the terminal is operating as an input.

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6.8.5 SDIO Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
1.8V MODE						
V_{IL}	Input Low Voltage				0.58	V
V_{ILSS}	Input Low Voltage Steady State				0.58	V
V_{IH}	Input High Voltage		1.27			V
V_{IHSS}	Input High Voltage Steady State		1.7			V
V_{HYS}	Input Hysteresis Voltage		150			mV
I_{IN}(1)	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA
R_{PU}	Pull-up Resistor		40	50	60	kΩ
R_{PD}	Pull-down Resistor		40	50	60	kΩ
V_{OL}	Output Low Voltage				0.45	V
V_{OH}	Output High Voltage		VDD(2) - 0.45			V
I_{OL}(3)	Low Level Output Current	$V_{OL(MAX)}$	4			mA
I_{OH}(3)	High Level Output Current	$V_{OH(MIN)}$	4			mA
SR_I(5)	Input Slew Rate		18f(4) or 1.8E+6			V/s
3.3V MODE						
V_{IL}	Input Low Voltage				0.25 × VDD(2)	V
V_{ILSS}	Input Low Voltage Steady State				0.15 × VDD(2)	V
V_{IH}	Input High Voltage		0.625 × VDD(2)			V
V_{IHSS}	Input High Voltage Steady State		0.625 × VDD(2)			V
V_{HYS}	Input Hysteresis Voltage		150			mV
I_{IN}(1)	Input Leakage Current.	V_I = 3.3V			10	µA
		V_I = 0V			-10	µA
R_{PU}	Pull-up Resistor		40	50	60	kΩ
R_{PD}	Pull-down Resistor		40	50	60	kΩ
V_{OL}	Output Low Voltage				0.125 × VDD(2)	V
V_{OH}	Output High Voltage		0.75 × VDD(2)			V
I_{OL}(3)	Low Level Output Current	$V_{OL(MAX)}$	6			mA
I_{OH}(3)	High Level Output Current	$V_{OH(MIN)}$	10			mA
SR_I(5)	Input Slew Rate		33f(4) or 3.3E+6			V/s

(1) This parameter defines leakage current when the terminal is operating as an input, undriven output, or both input and undriven output, without internal pulls enabled.
(2) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.
(3) The I_{OL} and I_{OH} parameters define the minimum Low Level Output Current and High Level Output Current for which the device is able to maintain the specified V_{OL} and V_{OH} values. Values defined by these parameters should be considered the maximum current available to a system implementation which needs to maintain the specified V_{OL} and V_{OH} values for attached components.
(4) f = toggle frequency of the input signal in Hz.
(5) This MIN parameter only applies to input signal functions which are not defined in their respective *Timing and Switching Characteristics* sections. Select the MIN parameter which results in the largest value.

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6.8.6 LVCMOS Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
1.8V MODE						
V_{IL}	Input Low Voltage				0.35 × VDD(1)	V
V_{ILSS}	Input Low Voltage Steady State				0.3 × VDD(1)	V
V_{IH}	Input High Voltage		0.65 × VDD(1)			V
V_{IHSS}	Input High Voltage Steady State		0.85 × VDD(1)			V
V_{HYS}	Input Hysteresis Voltage		150			mV
I_{IN}(2)	Input Leakage Current.	V_I = 1.8V			10	µA
		V_I = 0V			-10	µA
R_{PU}	Pull-up Resistor		15	22	30	kΩ
R_{PD}	Pull-down Resistor		15	22	30	kΩ
V_{OL}	Output Low Voltage				0.45	V
V_{OH}	Output High Voltage		VDD(1) - 0.45			V
I_{OL}(3)	Low Level Output Current	$V_{OL(MAX)}$	3			mA
I_{OH}(3)	High Level Output Current	$V_{OH(MIN)}$	3			mA
SR_I(5)	Input Slew Rate		18f(4) or 1.8E+6			V/s
3.3V MODE						
V_{IL}	Input Low Voltage				0.8	V
V_{ILSS}	Input Low Voltage Steady State				0.6	V
V_{IH}	Input High Voltage		2.0			V
V_{IHSS}	Input High Voltage Steady State		2.0			V
V_{HYS}	Input Hysteresis Voltage		150			mV
I_{IN}(2)	Input Leakage Current.	V_I = 3.3V			10	µA
		V_I = 0V			-10	µA
R_{PU}	Pull-up Resistor		15	22	30	kΩ
R_{PD}	Pull-down Resistor		15	22	30	kΩ
V_{OL}	Output Low Voltage				0.4	V
V_{OH}	Output High Voltage		2.4			V
I_{OL}(3)	Low Level Output Current	$V_{OL(MAX)}$	5			mA
I_{OH}(3)	High Level Output Current	$V_{OH(MIN)}$	9			mA
SR_I(5)	Input Slew Rate		33f(4) or 3.3E+6			V/s

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.
(2) This parameter defines leakage current when the terminal is operating as an input, undriven output, or both input and undriven output, without internal pulls enabled.
(3) The I_{OL} and I_{OH} parameters define the minimum Low Level Output Current and High Level Output Current for which the device is able to maintain the specified V_{OL} and V_{OH} values. Values defined by these parameters should be considered the maximum current available to a system implementation which needs to maintain the specified V_{OL} and V_{OH} values for attached components.
(4) f = toggle frequency of the input signal in Hz.
(5) This MIN parameter only applies to input signal functions which are not defined in their respective *Timing and Switching Characteristics* sections. Select the MIN parameter which results in the largest value.

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6.8.7 CSI-2 (D-PHY) Electrical Characteristics

Note

CSIRX0 is compliant with MIPI DPHY v1.2 dated August 1, 2014, including ECNs and Errata as applicable.

6.8.8 USB2PHY Electrical Characteristics

Note

The USB0 and USB1 interfaces are compliant with Universal Serial Bus Revision 2.0 Specification dated April 27, 2000 including ECNs and Errata as applicable.

6.8.9 DDR Electrical Characteristics

Note

The DDR interface is compatible with LPDDR4 devices that are **JESD209-4B standard-compliant**

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6.9 VPP Specifications for One-Time Programmable (OTP) eFuses

This section specifies the operating conditions required for programming the OTP eFuses .

6.9.1 Recommended Operating Conditions for OTP eFuse Programming

over operating junction temperature range (unless otherwise noted)

PARAMETER	DESCRIPTION	MIN	NOM	MAX	UNIT
VDD_CORE	Supply voltage range for the core domain during OTP operation		See Section 6.5		V
VPP	Supply voltage range for the eFuse ROM domain during normal operation without hardware support to program eFuse ROM		NC(1)		V
	Supply voltage range for the eFuse ROM domain during normal operation with hardware support to program eFuse ROM		0		V
	Supply voltage range for the eFuse ROM domain during OTP programming(2)	1.71	1.8	1.89	V
$I_{(VPP)}$	VPP current			400	mA
$SR_{(VPP)}$	VPP Power-up Slew Rate			6E + 4	V/s
Tj	Operating junction temperature range while programming eFuse ROM.	0	25	85	°C

(1) NC indicates No Connect.
(2) Supply voltage range includes DC errors and peak-to-peak noise.

6.9.2 Hardware Requirements

The following hardware requirements must be met when programming keys in the OTP eFuses:

- The VPP power supply must be disabled when not programming OTP registers.
- The VPP power supply must be ramped up after the proper device power-up sequence (for more details, see Section 6.12.2.2, *Power Supply Sequencing*).

6.9.3 Programming Sequence

Programming sequence for OTP eFuses:

- Power on the board per the power-up sequencing. No voltage should be applied on the VPP terminal during power up and normal operation.
- Load the OTP write software required to program the eFuse (contact your local TI representative for the OTP software package).
- Apply the voltage on the VPP terminal according to the specification in Section 6.9.1.
- Run the software that programs the OTP registers.
- After validating the content of the OTP registers, remove the voltage from the VPP terminal.

6.9.4 Impact to Your Hardware Warranty

You accept that eFusing the TI Devices with security keys permanently alters them. You acknowledge that the eFuse can fail, for example, due to incorrect or aborted program sequence or if you omit a sequence step. Further the TI device may fail to secure boot if the error code correction check fails for the Production Keys or if the image is not signed and optionally encrypted with the current active Production Keys. These types of situations will render the TI device inoperable and TI will be unable to confirm whether the TI devices conformed to their specifications prior to the attempted eFuse. Consequently, TI will have no liability (*warranty or otherwise*) for any TI devices that have been incorrectly eFused by customers.

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6.10 Thermal Resistance Characteristics

This section provides the thermal resistance characteristics used on this device.

For reliability and operability concerns, the maximum junction temperature of the device has to be at or below the T_J value identified in Section 6.5, *Recommended Operating Conditions*.

Note

The thermal parameters are generated following JEDEC standard JESD51x and are not intended for design parameters. If you need a more accurate thermal representation, download the processor thermal model and import your PCB design into a thermal simulation environment. For details on thermal implementation guidelines, see the Thermal Solution Guidance section.

6.10.1 Thermal Resistance Characteristics for AMB and ANF Packages

It is recommended to perform thermal simulations at the system level with the worst case device power consumption.

NO.	PARAMETER	DESCRIPTION	AMB PACKAGE °C/W(1)(2)	ANF PACKAGE °C/W(1)(2)	AIR FLOW (m/s)(3)
T1	$R\Theta_{JC}$	Junction-to-case	0.77	0.68	N/A
T2	$R\Theta_{JB}$	Junction-to-board	3.3	3.22	N/A
T3	$R\Theta_{JA}$	Junction-to-free air	12.5	12.3	0
T4		Junction-to-moving air	8.6	8.5	1
T5			7.6	7.6	2
T6			7.0	7.0	3
T7	Ψ_{JT}	Junction-to-package top	0.39	0.41	0
T8			0.41	0.44	1
T9			0.42	0.45	2
T10			0.43	0.46	3
T11	Ψ_{JB}	Junction-to-board	3.1	3.1	0
T12			2.8	2.7	1
T13			2.7	2.6	2
T14			2.6	2.6	3

(1) °C/W = degrees Celsius per watt.
(2) These values are based on a JEDEC defined 2S2P system (with the exception of the Theta JC [RΘJC] value, which is based on a JEDEC defined 1S0P system) and will change based on environment as well as application. For more information, see these EIA/JEDEC standards:
- JESD51-2, *Integrated Circuits Thermal Test Method Environment Conditions - Natural Convection (Still Air)*
- JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-6, *Integrated Circuit Thermal Test Method Environmental Conditions - Forced Convection (Moving Air)*
- JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-9, *Test Boards for Area Array Surface Mount Packages*

(3) m/s = meters per second.

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6.11 Temperature Sensor Characteristics

This section summarizes the Voltage and Temperature Module (VTM) on die temperature sensor characteristics.

For operation and reliability concerns, the maximum junction temperature of the device must be equal to or less than the T_J value identified in *Recommended Operating Conditions*.

Table 6-3. VTM Die Temperature Sensor Characteristics

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
T_{acc}	VTM temperature sensor accuracy	–40℃ to 125℃	–5		5	℃

6.12 Timing and Switching Characteristics

Note

The Timing Requirements and Switching Characteristics values may change following the silicon characterization result.

Note

The default SLEWRATE settings in each pad configuration register must be used to ensure timings, unless specific instructions are given otherwise.

6.12.1 Timing Parameters and Information

The timing parameter symbols used in Section 6.12, *Timing and Switching Characteristics* are created in accordance with JEDEC Standard 100. To shorten the symbols, some pin names and other related terminologies have been abbreviated in Table 6-4:

Table 6-4. Timing Parameters Subscripts

SYMBOL	PARAMETER
c	Cycle time (period)
d	Delay time
dis	Disable time
en	Enable time
h	Hold time
su	Setup time
START	Start bit
t	Transition time
v	Valid time
w	Pulse duration (width)
X	Unknown, changing, or don't care level
F	Fall time
H	High
L	Low
R	Rise time
V	Valid
IV	Invalid
AE	Active Edge
FE	First Edge
LE	Last Edge
Z	High impedance

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6.12.2 Power Supply Requirements

This section describes the power supply requirements to ensure proper device operation.

Note

All power balls must be supplied with the voltages specified in the *Recommended Operating Conditions* section, unless otherwise specified in *Signal Descriptions* and *Pin Connectivity Requirements*.

6.12.2.1 Power Supply Slew Rate Requirement

To maintain the safe operating range of the internal ESD protection devices, TI recommends limiting the maximum slew rate of supplies to be less than 18mV/µs. For instance, as shown in Figure 6-2, TI recommends having the supply ramp slew for a 1.8V supply of more than 100µs.

Figure 6-2 describes the Power Supply Slew Rate Requirement in the device.

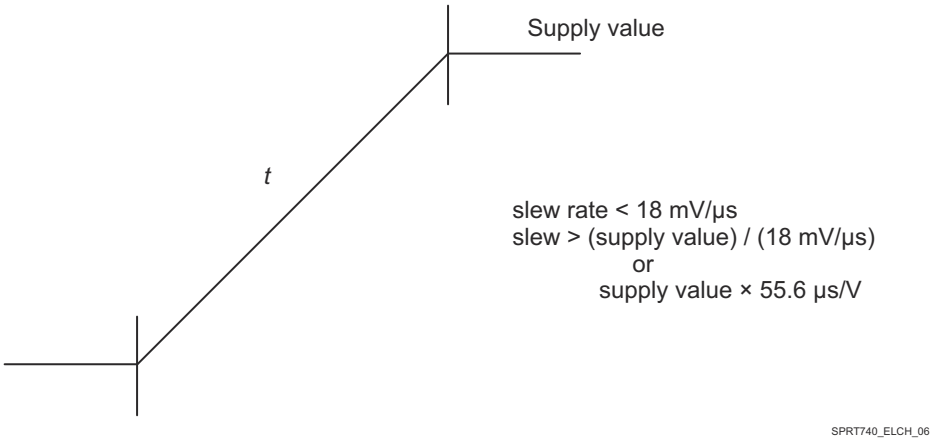


Figure 6-2. Power Supply Slew and Slew Rate

6.12.2.2 Power Supply Sequencing

This section describes power sequence requirements using power sequence diagrams and associated notes. Each power sequence diagram demonstrates the sequential order expected for each device power rail. This is done by assigning each device power rail to one or more waveform. A dual-voltage power rail may be associated with more than one waveform and the associated note will describe which waveform is applicable. Each waveform defines a transition region for the associated power rails and shows its sequential relationship to the transition regions of other power rails. The notes associated with the power sequence diagram provides further detail of these requirements. See the *Power-up Sequence* section for details on power-up requirements, and the *Power-down Sequence* section for details on power-down requirements.

Two types of power supply transition regions are used to simplify the power supply sequencing diagrams. The legends shown in Figure 6-3 and Figure 6-4 along with their descriptions are provided to clarify what each transition regions represents.

Figure 6-3 defines a transition region with multiple power rails which may be sourced from multiple power supplies or a single power supply. Transitions shown within the transition region represent a use case where multiple power supplies are used to source power rails associated with this waveform, and these power supplies are allowed to ramp at different times within the region since they do not have any specific sequence requirement relative to each other.

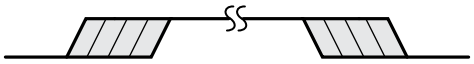


Figure 6-3. Multiple Power Supply Transition Legend

Figure 6-4 defines a transition region with one or more power rails which must be sourced from a single common power supply. No transitions are shown within the region to represent a single ramp within the transition region.

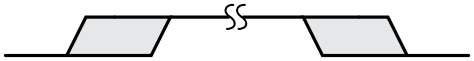


Figure 6-4. Single Common Power Supply Transition Legend

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6.12.2.2.1 Power-Up Sequencing

Table 6-5 and Figure 6-5 describes the device power-up sequencing.

Note

The power supply sequencing requirements defined in this section does not include entry or exit from low power modes. See Section 6.12.2.2.3, *Partial IO Power Sequencing* for more information on power supply sequence requirements when entering or exiting low power modes.

Note

All power rails must be turned off and decay below 300mV before initiating a new power-up sequence anytime a power rail drops below the minimum value defined in *Recommended Operating Conditions*. The only exception is when entering/exiting Partial IO low power mode with VDDSHV_CANUART and VDD_CANUART sourced from an always on power source. For this use case the VDDSHV_CANUART and VDD_CANUART power rails are allowed to remain on.

Table 6-5. Power-Up Sequencing – Supply / Signal Assignments

See: Figure 6-5

WAVEFORM	SUPPLY / SIGNAL NAME
A	VSYS(1), VMON_VSYS(2)
B	VDDSHV_CANUART(3), VDDSHV_MCU(3), VDDSHV0(3), VDDSHV1(3), VDDSHV2(3), VDDSHV3(3), VDDA_3P3_USB, VMON_3P3_SOC(4)
C	VDDSHV_CANUART(5), VDDSHV_MCU(5), VDDSHV0(5), VDDSHV1(5), VDDSHV2(5), VDDSHV3(5), VDDA_MCU, VDDS_OSC0, VDDA_PLL0, VDDA_PLL1, VDDA_PLL2, VDDA_PLL3, VDDA_PLL4, VDDA_1P8_CSIRX0, VDDA_1P8_USB, VDDA_TEMP0, VDDA_TEMP1, VDDA_TEMP2, VMON_1P8_SOC(6)
D	VDDSHV4(7), VDDSHV5(7), VDDSHV6(7)
E	VDDS_DDR(8), VDDS_DDR_C(8)
F	VDD_CANUART(9)
G	VDD_CANUART(10), VDD_CORE(10)(12), VDDA_CORE_CSIRX0(10), VDDA_CORE_USB0(10), VDDA_DDR_PLL0(10)
H	VDD_CANUART(11), VDD_CORE(11)(12), VDDA_CORE_CSIRX0(11), VDDA_CORE_USB0(11), VDDA_DDR_PLL0(11), VDDR_CORE(12)
I	VPP(13)
J	MCU_PORz
K	MCU_OSC0_XI, MCU_OSC0_XO

(1) VSYS represents the name of a supply which sources power to the entire system. This supply is expected to be a pre-regulated supply that sources power management devices which source all other supplies.

(2) VMON_VSYS input is used to monitor VSYS via an external resistor divider circuit. For more information, see the *System Power Supply Monitor Design Guidelines*.

(3) VDDSHV_CANUART, VDDSHV_MCU, and VDDSHVx [x=0-3] are dual voltage IO supplies which can be operated at 1.8V or 3.3V depending on the application requirements.

VDDSHV_CANUART shall be connected to an always-on power source when using Partial IO low power mode, or connected to any valid IO power source when not using Partial IO low power mode. When VDDSHV_CANUART is not connected to an always-on power source and is operating at 3.3V, it shall be ramped up with other 3.3V supplies during the 3.3V ramp period defined by this waveform.

When any of the VDDSHV_MCU and VDDSHVx [x=0-3] IO supplies are operating at 3.3V, they shall be ramped up with other 3.3V supplies during the 3.3V ramp period defined by this waveform.

(4) The VMON_3P3_SOC input is used to monitor supply voltage and shall be connected to the respective 3.3V supply source.

(5) VDDSHV_CANUART, VDDSHV_MCU, and VDDSHVx [x=0-3] are dual voltage IO supplies which can be operated at 1.8V or 3.3V depending on the application requirements.

VDDSHV_CANUART shall be connected to an always-on power source when using Partial IO low power mode, or connected to any valid IO power source when not using Partial IO low power mode. When VDDSHV_CANUART is not connected to an always-on power source and is operating at 1.8V, it shall be ramped up with other 1.8V supplies during the 1.8V ramp period defined by this waveform.

When any of the VDDSHV_MCU and VDDSHVx [x=0-3] IO supplies are operating at 1.8V, they shall be ramped up with other 1.8V supplies during the 1.8V ramp period defined by this waveform.

(6) The VMON_1P8_SOC input is used to monitor supply voltage and shall be connected to the respective 1.8V supply source.

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(7) VDDSHV4, VDDSHV5, and VDDSHV6 were designed to support power-up, power-down, or dynamic voltage change without any dependency on other power rails. This capability is required to support UHS-I SD Cards.

(8) VDDS_DDR and VDDS_DDR_C are expected to be powered by the same source such that they ramp together.

(9) VDD_CANUART shall be connected to an always-on power source when using Partial IO low power mode.

When VDD_CANUART is connected to an always-on power source, the potential applied to VDD_CORE must never be greater than the potential applied to VDD_CANUART + 0.18V during power-up or power-down. This requires VDD_CANUART to ramp up before and ramp down after VDD_CORE. VDD_CANUART does not have any ramp requirements beyond the one defined for VDD_CORE.

(10) VDD_CANUART shall be connected to the same power source as VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB, and VDDA_DDR_PLL0 when not using Partial IO low power mode.

VDD_CANUART, VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB, and VDDA_DDR_PLL0 can be operated at 0.75V or 0.85V. When these supplies are operating at 0.75V, they shall be ramped up prior to VDDR_CORE as defined by this waveform.

(11) VDD_CANUART shall be connected to the same power source as VDD_CORE, VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB, and VDDA_DDR_PLL0 when not using Partial IO low power mode.

VDD_CANUART, VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB, and VDDA_DDR_PLL0 can be operated at 0.75V or 0.85V. When these supplies are operating at 0.85V, they shall be powered from the same source as VDDR_CORE and ramped during the 0.85V ramp period defined by this waveform.

(12) The potential applied to VDDR_CORE must never be greater than the potential applied to VDD_CORE + 0.18V during power-up or power-down. This requires VDD_CORE to ramp up before and ramp down after VDDR_CORE when VDD_CORE is operating at 0.75V. VDD_CORE does not have any ramp requirements beyond the one defined for VDDR_CORE.

VDD_CORE and VDDR_CORE are expected to be powered by the same source so they ramp together when VDD_CORE is operating at 0.85V.

(13) VPP is the 1.8V eFuse programming supply, which shall be left floating (HiZ) or grounded during power-up/down sequences and during normal device operation. This supply shall only be sourced while programming eFuse.

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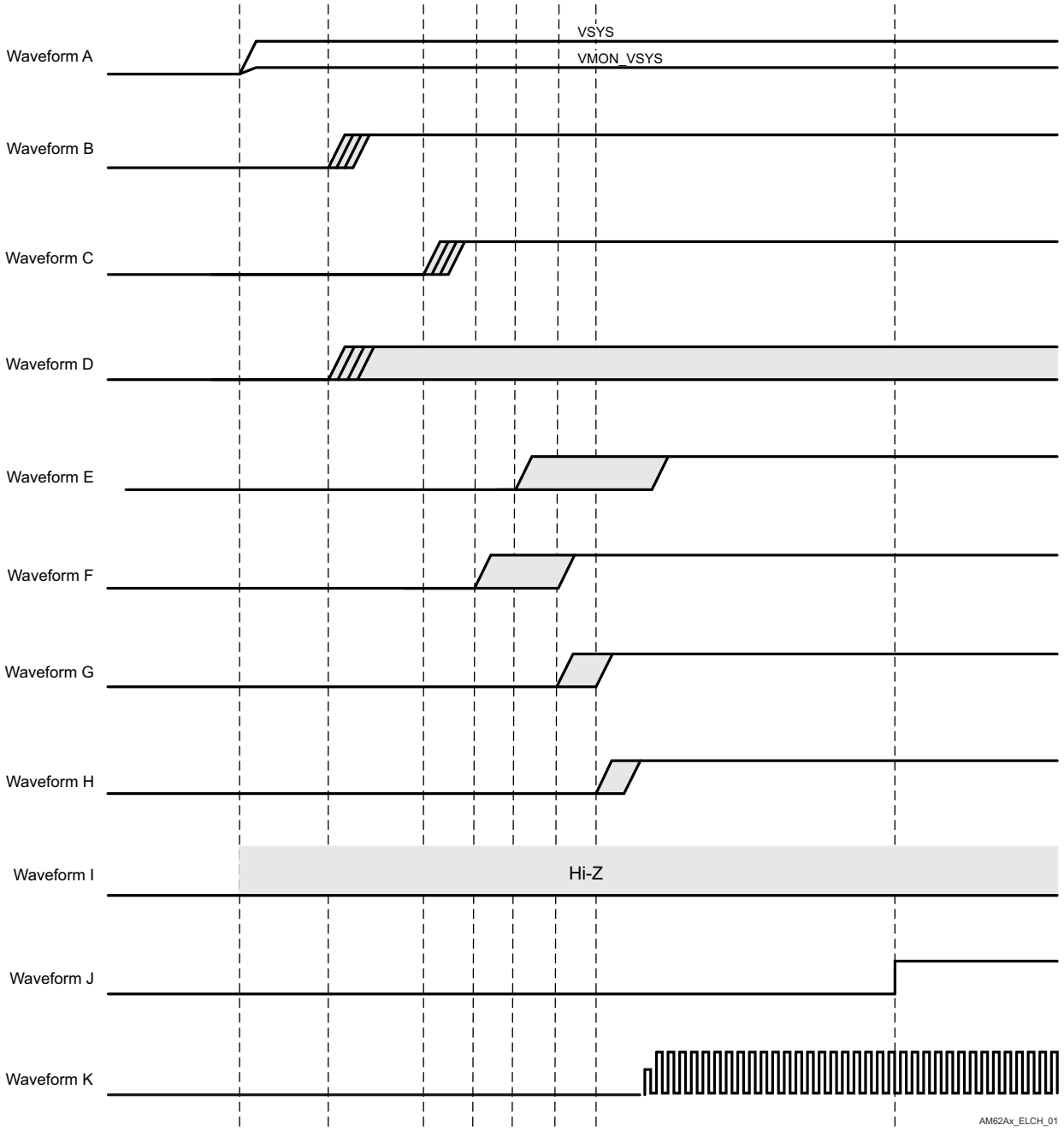


Figure 6-5. Power-Up Sequencing

6.12.2.2.2 Power-Down Sequencing

Table 6-6 and Figure 6-6 describes the device power-down sequencing.

Note

The power supply sequencing requirements defined in this section does not include entry or exit from low power modes. See Section 6.12.2.2.3, *Partial IO Power Sequencing* for more information on power supply sequence requirements when entering or exiting low power modes.

Note

All power rails must be turned off and decay below 300mV before initiating a new power-up sequence anytime a power rail drops below the minimum value defined in *Recommended Operating Conditions*. The only exception is when entering/exiting Partial IO low power mode with VDDSHV_CANUART and VDD_CANUART sourced from an always on power source. For this use case the VDDSHV_CANUART and VDD_CANUART power rails are allowed to remain on.

Table 6-6. Power-Down Sequencing – Supply / Signal Assignments

See: Figure 6-6

WAVEFORM	SUPPLY / SIGNAL NAME
A	VSYS, VMON_VSYS
B	VDDSHV_CANUART(1), VDDSHV_MCU(1), VDDSHV0(1), VDDSHV1(1), VDDSHV2(1), VDDSHV3(1), VDDA_3P3_USB, VMON_3P3_SOC
C	VDDSHV_CANUART(2), VDDSHV_MCU(2), VDDSHV0(2), VDDSHV1(2), VDDSHV2(2), VDDSHV3(2), VDDA_MCU, VDDS_OSC0, VDDA_PLL0, VDDA_PLL1, VDDA_PLL2, VDDA_PLL3, VDDA_PLL4, VDDA_1P8_CSIRX0, VDDA_1P8_USB, VDDA_TEMP0, VDDA_TEMP1, VDDA_TEMP2, VMON_1P8_SOC
D	VDDSHV4(3), VDDSHV5(3), VDDSHV6(3)
E	VDDS_DDR, VDDS_DDR_C
F	VDD_CANUART(4)
G	VDD_CANUART(5), VDD_CORE(5), VDDA_CORE_CSIRX0(5), VDDA_CORE_USB0(5), VDDA_DDR_PLL0(5)
H	VDD_CANUART(6), VDD_CORE(6), VDDA_CORE_CSIRX0(6), VDDA_CORE_USB0(6), VDDA_DDR_PLL0(6), VDDR_CORE
I	VPP
J	MCU_PORz
K	MCU_OSC0_XI, MCU_OSC0_XO

(1) VDDSHV_CANUART, VDDSHV_MCU, and VDDSHVx [x=0-3] when operating at 3.3V.

(2) VDDSHV_CANUART, VDDSHV_MCU, and VDDSHVx [x=0-3] when operating at 1.8V.

(3) VDDSHV4, VDDSHV5, and VDDSHV6 were designed to support power-up, power-down, or dynamic voltage change without any dependency on other power rails. This capability is required to support UHS-I SD Cards.

(4) VDD_CANUART when connected to an always-on power source for Partial IO low power mode.

(5) VDD_CANUART, VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB0, and VDDA_DDR_PLL0 when operating at 0.75V

(6) VDD_CANUART, VDD_CORE, VDDA_CORE_CSIRX0, VDDA_CORE_USB0, and VDDA_DDR_PLL0 when operating at 0.85V

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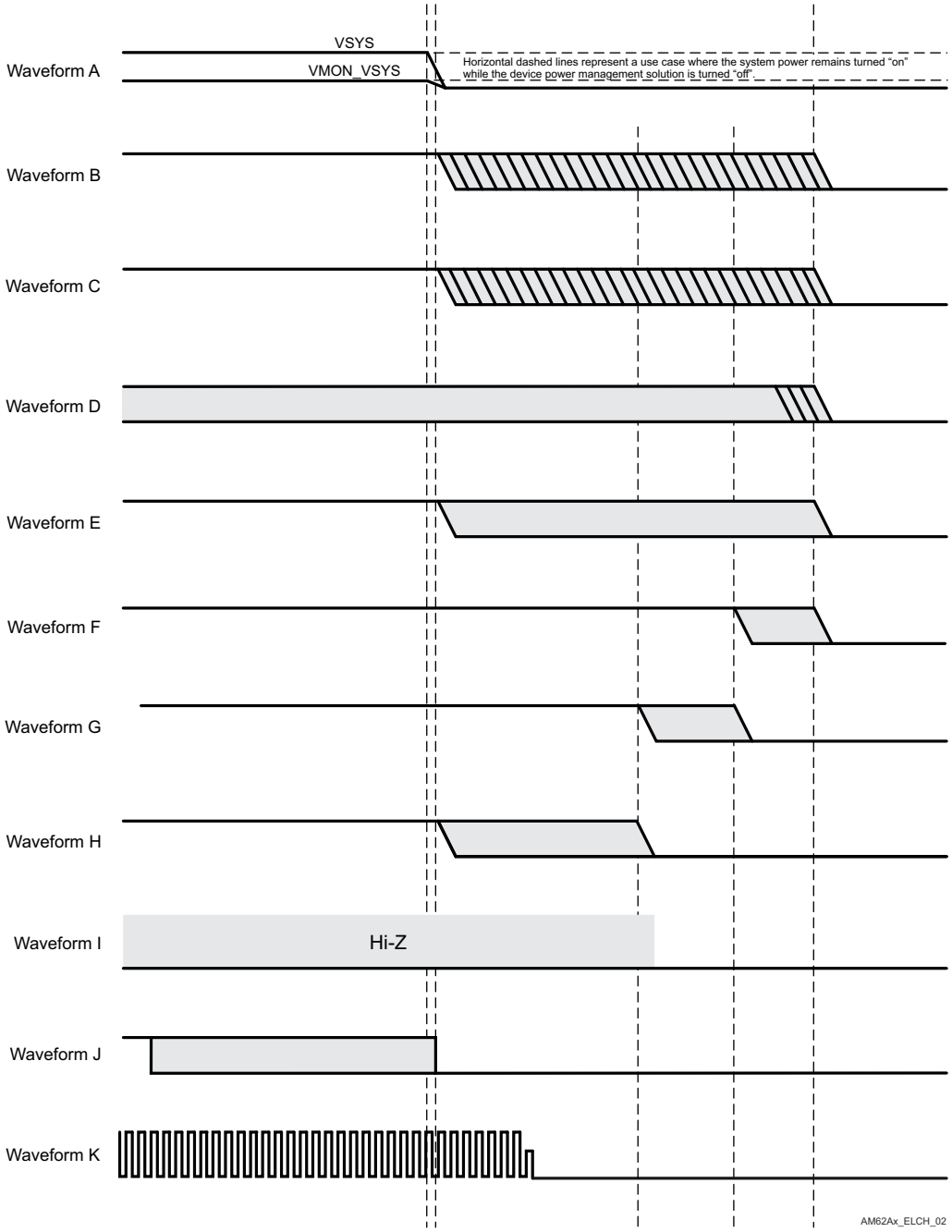


Figure 6-6. Power-Down Sequencing

6.12.2.2.3 Partial IO Power Sequencing

This section describes power supply sequence requirements when entering or exiting low power modes.

For more information on low power modes supported by this device and the names assigned to each low power mode, see the Power Modes section in the Device Configuration chapter of the Technical Reference Manual.

Partial IO is the only low power mode that requires power supply changes to the device power rails. All power supply rails except VDD_CANUART and VDDSHV_CANUART are turned off when operating in Partial IO mode. The power sequence required to enter Partial IO is the same sequence defined in Section 6.12.2.2.2, *Power-Down Sequencing* with the exception of VDD_CANUART and VDDSHV_CANUART, which remain powered. The power sequence required to exit Partial IO is the same sequence defined in Section 6.12.2.2.1, *Power-Up Sequencing* with the exception of VDD_CANUART and VDDSHV_CANUART, which are already powered.

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6.12.3 System Timing

For more details about features and additional description information on the subsystem multiplexing signals, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

6.12.3.1 Reset Timing

Tables and figures provided in this section define timing conditions, timing requirements, and switching characteristics for reset related signals.

Table 6-7. Reset Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate	VDD(1) = 1.8V	0.0018		V/ns
		VDD(1) = 3.3V	0.0033		V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance			30	pF

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.

Table 6-8. MCU_PORz Timing Requirements

see Figure 6-7

NO.	PARAMETER		MIN	MAX	UNIT
RST1	$t_{h(SUPPLIES_VALID - MCU_PORz)}$	Hold time, MCU_PORz active (low) at Power-up after supplies valid (using external crystal circuit)	9500000		ns
RST2		Hold time, MCU_PORz active (low) at Power-up after supplies valid and external clock stable (using external LVCMOS clock source)	1200		ns
RST3	$t_{w(MCU_PORzL)}$	Pulse Width, MCU_PORz low after Power-up (without removal of Power or system reference clock MCU_OSC0_XI/XO)	1200		ns

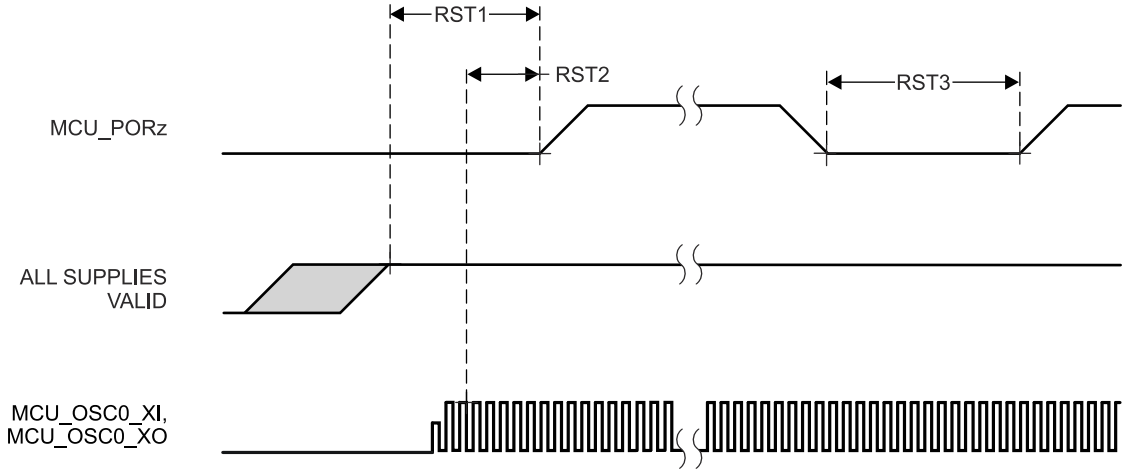


Figure 6-7. MCU_PORz Timing Requirements

Table 6-9. MCU_RESETSTATz, and RESETSTATz Switching Characteristics

see Figure 6-8

NO.	PARAMETER		MIN	MAX	UNIT
RST4	$t_{d(MCU_PORzL-MCU_RESETSTATzL)}$	Delay time, MCU_PORz active (low) to MCU_RESETSTATz active (low)	0		ns
RST5	$t_{d(MCU_PORzH-MCU_RESETSTATzH)}$	Delay time, MCU_PORz inactive (high) to MCU_RESETSTATz inactive (high)	6120*S(1)		ns
RST6	$t_{d(MCU_PORzL-RESETSTATzL)}$	Delay time, MCU_PORz active (low) to RESETSTATz active (low)	0		ns
RST7	$t_{d(MCU_PORzH-RESETSTATzH)}$	Delay time, MCU_PORz inactive (high) to RESETSTATz inactive (high)	9195*S(1)		ns
RST8	$t_{w(MCU_RESETSTATzL)}$	Pulse Width, MCU_RESETSTATz low (SW_MCU_WARMRST)	966*S(1)		ns
RST9	$t_{w(RESETSTATzL)}$	Pulse Width, RESETSTATz low (SW_MCU_WARMRST, SW_MAIN_PORz, or SW_MAIN_WARMRST)	4040*S		ns

(1) S = MCU_OSC0_XI/XO clock period in ns.

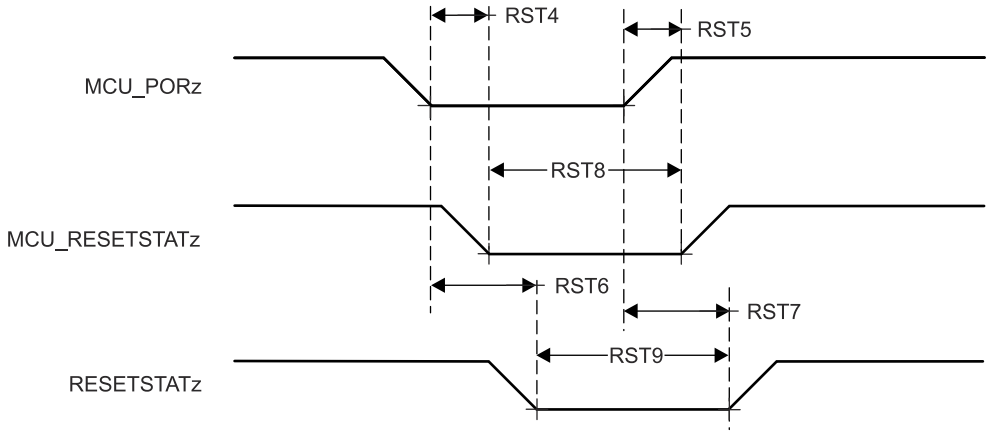


Figure 6-8. MCU_RESETSTATz, and RESETSTATz Switching Characteristics

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Table 6-10. MCU_RESETz Timing Requirements

see Figure 6-9

NO.	PARAMETER		MIN	MAX	UNIT
RST10	$t_{w(MCU_RESETzL)}$(1)	Pulse Width, MCU_RESETz active (low)	1200		ns

(1) This timing parameter is valid only after all supplies are valid and MCU_PORz has been asserted for the specified time.

Table 6-11. MCU_RESETSTATz, and RESETSTATz Switching Characteristics

see Figure 6-9

NO.	PARAMETER		MIN	MAX	UNIT
RST11	$t_{d(MCU_RESETzL-MCU_RESETSTATzL)}$	Delay time, MCU_RESETz active (low) to MCU_RESETSTATz active (low)	0		ns
RST12	$t_{d(MCU_RESETzH-MCU_RESETSTATzH)}$	Delay time, MCU_RESETz inactive (high) to MCU_RESETSTATz inactive (high)	966*S(1)		ns
RST13	$t_{d(MCU_RESETzL-RESETSTATzL)}$	Delay time, MCU_RESETz active (low) to RESETSTATz active (low)	960		ns
RST14	$t_{d(MCU_RESETzH-RESETSTATzH)}$	Delay time, MCU_RESETz inactive (high) to RESETSTATz inactive (high)	4040*S(1)		ns

(1) S = MCU_OSC0_XI/XO clock period in ns.

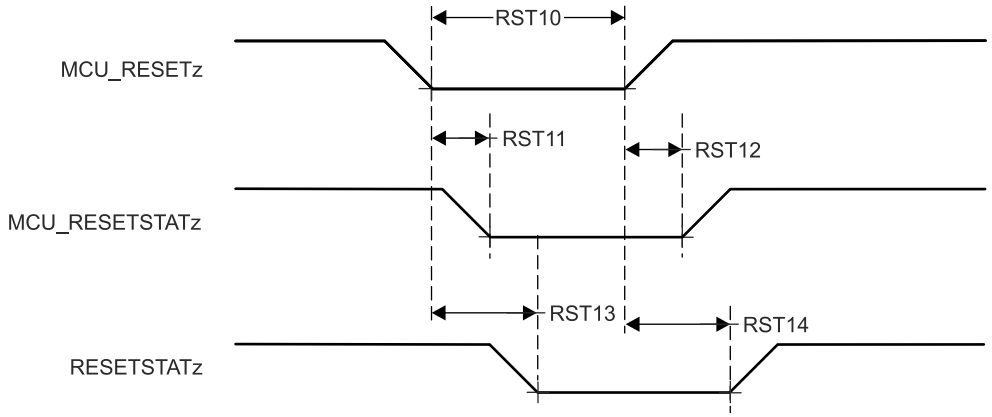


Figure 6-9. MCU_RESETz, MCU_RESETSTATz, and RESETSTATz Timing Requirements and Switching Characteristics

Table 6-12. RESET_REQz Timing Requirements

see Figure 6-10

NO.	PARAMETER		MIN	MAX	UNIT
RST15	$t_{w(RESET_REQzL)}$(1)	Pulse Width, RESET_REQz active (low)	1200		ns

(1) This timing parameter is valid only after all supplies are valid and MCU_PORz has been asserted for the specified time.

Table 6-13. RESETSTATz Switching Characteristics

see Figure 6-10

NO.	PARAMETER		MIN	MAX	UNIT
RST16	$t_{d(RESET_REQzL-RESETSTATzL)}$	Delay time, RESET_REQz active (low) to RESETSTATz active (low)	900*T(1)		ns
RST17	$t_{d(RESET_REQzH-RESETSTATzH)}$	Delay time, RESET_REQz inactive (high) to RESETSTATz inactive (high)	4040*S(2)		ns

(1) T = Reset Isolation Time (Software Dependent)
(2) S = MCU_OSC0_XI/XO clock period in ns.

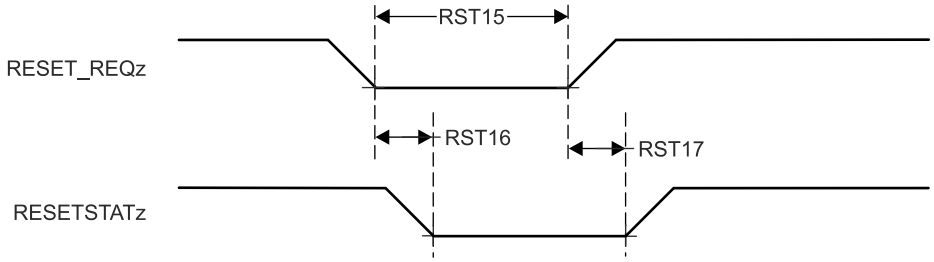


Figure 6-10. RESET_REQz and RESETSTATz Timing Requirements and Switching Characteristics

Table 6-14. EMUx Timing Requirements

see Figure 6-11

NO.	PARAMETER		MIN	MAX	UNIT
RST18	$t_{su(EMUx-MCU_PORz)}$	Setup time, EMU[1:0] before MCU_PORz inactive (high)	3*S(1)		ns
RST19	$t_{h(MCU_PORz - EMUx)}$	Hold time, EMU[1:0] after MCU_PORz inactive (high)	10		ns

(1) S = MCU_OSC0_XI/XO clock period in ns.

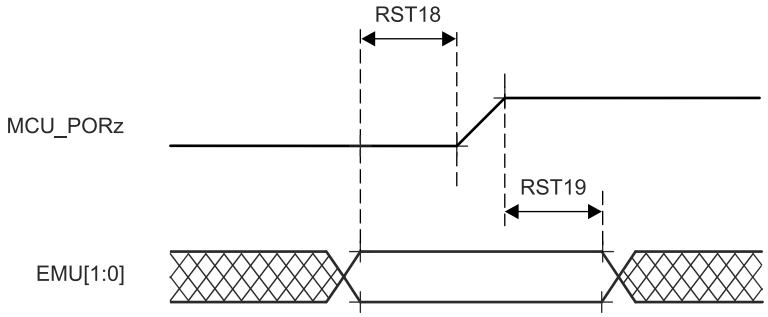


Figure 6-11. EMUx Timing Requirements

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Table 6-15. BOOTMODE Timing Requirements

see Figure 6-12

NO.	PARAMETER		MIN	MAX	UNIT
RST23	$t_{su(BOOTMODE-PORz_OUT)}$	Setup time, BOOTMODE[15:00] valid before PORz_OUT high (External MCU PORz event or Software SW_MAIN_PORz)	3*S(1)		ns
RST24	$t_{h(PORz_OUT - BOOTMODE)}$	Hold time, BOOTMODE[15:00] valid after PORz_OUT high (External MCU PORz event, or Software SW_MAIN_PORz)	0		ns

(1) S = MCU_OSC0_XI/XO clock period in ns.

Table 6-16. PORz_OUT Switching Characteristics

see Figure 6-12

NO.	PARAMETER		MIN	MAX	UNIT
RST25	$t_{d(MCU_PORzL-PORz_OUT)}$	Delay time, MCU_PORz active (low) to PORz_OUT active (low)	0		ns
RST26	$t_{d(MCU_PORzH-PORz_OUT)}$	Delay time, MCU_PORz inactive (high) to PORz_OUT inactive (high)	1840		ns
RST27	$t_{w(PORz_OUTL)}$	Pulse Width, PORz_OUT low (MCU_PORz or SW_MAIN_PORz)	1200		ns

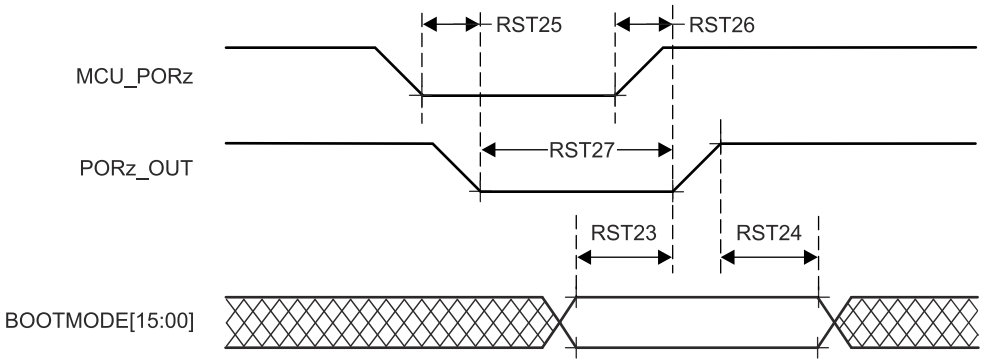


Figure 6-12. BOOTMODE Timing Requirements and PORz_OUT Switching Characteristics

6.12.3.2 Error Signal Timing

Tables and figures provided in this section define timing conditions and switching characteristics for MCU_ERRORn.

Table 6-17. Error Signal Timing Conditions

PARAMETER		MIN	MAX	UNIT
OUTPUT CONDITIONS				
C_L	Output load capacitance		30	pF

Table 6-18. MCU_ERRORn Switching Characteristics

see Figure 6-13

NO.	PARAMETER		MIN	MAX	UNIT
ERR1	$t_{c(MCU_ERRORn)}$	Cycle time minimum, MCU_ERRORn (PWM mode enabled)	(P*H)+(P*L)(1)(3)(4)		ns
ERR2	$t_{w(MCU_ERRORn)}$	Pulse width minimum, MCU_ERRORn active (PWM mode disabled)(5)	P*R(1)(2)		ns
ERR3	$t_{d\ (ERROR_CONDITION-MCU_ERRORnL)}$	Delay time, ERROR CONDITION to MCU_ERRORn active(5)	50*P(1)		ns

(1) P = ESM functional clock period in ns.
(2) R = Error Pin Counter Pre-Load Register count value.
(3) H = Error Pin PWM High Pre-Load Register count value.
(4) L = Error Pin PWM Low Pre-Load Register count value.
(5) When PWM mode is enabled, MCU_ERRORn stops toggling after ERR3 and will maintain its value (either high or low) until the error is cleared. When PWM mode is disabled, MCU_ERRORn is active low.

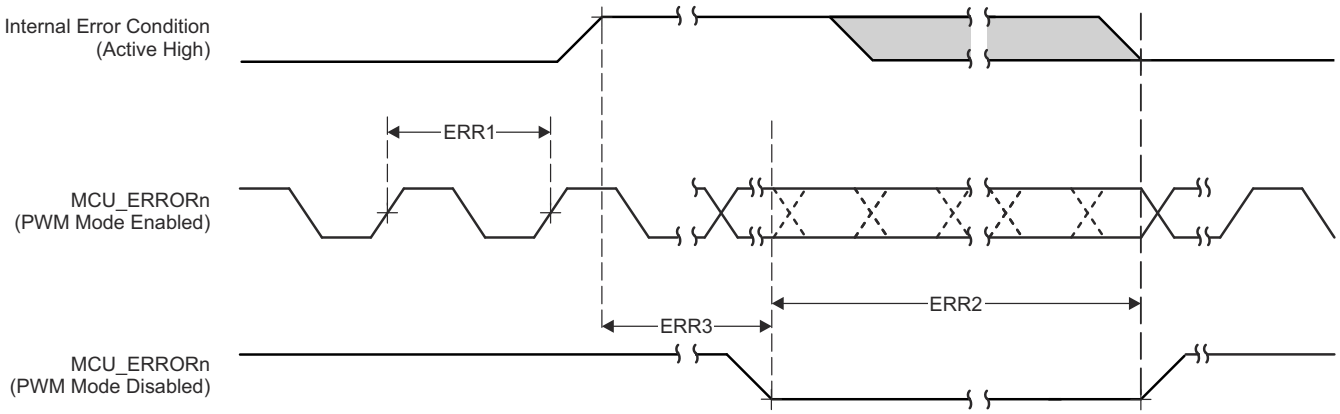


Figure 6-13. MCU_ERRORn Timing Requirements and Switching Characteristics

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6.12.3.3 Clock Timing

Tables and figures provided in this section define timing conditions, timing requirements, and switching characteristics for clock signals.

Table 6-19. Clock Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate		0.5		V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance	5ns ≤ t_c < 8ns		5	pF
		8ns ≤ t_c < 20ns		10	pF
		20ns ≤ t_c		30	pF

Table 6-20. Clock Timing Requirements

see Figure 6-14

NO.			MIN	MAX	UNIT
CLK1	$t_{c(EXT_REFCLK1)}$	Cycle time minimum, EXT_REFCLK1	10		ns
CLK2	$t_{w(EXT_REFCLK1H)}$	Pulse Duration, EXT_REFCLK1 high	E*0.45(1)	E*0.55(1)	ns
CLK3	$t_{w(EXT_REFCLK1L)}$	Pulse Duration, EXT_REFCLK1 low	E*0.45(1)	E*0.55(1)	ns
CLK1	$t_{c(MCU_EXT_REFCLK0)}$	Cycle time minimum, MCU_EXT_REFCLK0	10		ns
CLK2	$t_{w(MCU_EXT_REFCLK0H)}$	Pulse Duration, MCU_EXT_REFCLK0 high	F*0.45(2)	F*0.55(2)	ns
CLK3	$t_{w(MCU_EXT_REFCLK0L)}$	Pulse Duration, MCU_EXT_REFCLK0 low	F*0.45(2)	F*0.55(2)	ns
CLK1	$t_{c(AUDIO_EXT_REFCLK0)}$	Cycle time minimum, AUDIO_EXT_REFCLK0	20		ns
CLK2	$t_{w(AUDIO_EXT_REFCLK0H)}$	Pulse Duration, AUDIO_EXT_REFCLK0 high	G*0.45(3)	G*0.55(3)	ns
CLK3	$t_{w(AUDIO_EXT_REFCLK0L)}$	Pulse Duration, AUDIO_EXT_REFCLK0 low	G*0.45(3)	G*0.55(3)	ns
CLK1	$t_{c(AUDIO_EXT_REFCLK1)}$	Cycle time minimum, AUDIO_EXT_REFCLK1	20		ns
CLK2	$t_{w(AUDIO_EXT_REFCLK1H)}$	Pulse Duration, AUDIO_EXT_REFCLK1 high	H*0.45(4)	H*0.55(4)	ns
CLK3	$t_{w(AUDIO_EXT_REFCLK1L)}$	Pulse Duration, AUDIO_EXT_REFCLK1 low	H*0.45(4)	H*0.55(4)	ns

(1) E = EXT_REFCLK1 cycle time in ns.
(2) F = MCU_EXT_REFCLK0 cycle time in ns.
(3) G = AUDIO_EXT_REFCLK0 cycle time in ns.
(4) H = AUDIO_EXT_REFCLK1 cycle time in ns.

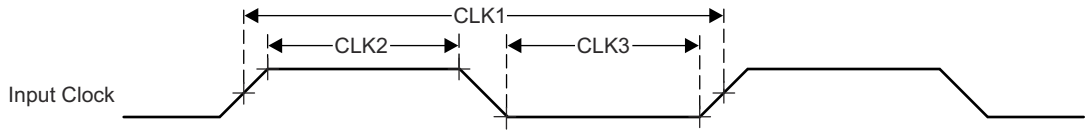


Figure 6-14. Clock Timing Requirements

Table 6-21. Clock Switching Characteristics

see Figure 6-15

NO.	PARAMETER		MIN	MAX	UNIT
CLK4	$t_{c(SYSCLKOUT0)}$	Cycle time minimum,SYSCLKOUT0	8		ns
CLK5	$t_{w(SYSCLKOUT0H)}$	Pulse Duration, SYSCLKOUT0 high	A*0.4(1)	A*0.6(1)	ns
CLK6	$t_{w(SYSCLKOUT0L)}$	Pulse Duration, SYSCLKOUT0 low	A*0.4(1)	A*0.6(1)	ns
CLK4	$t_{c(OBSCLK0)}$	Cycle time minimum, OBSCLK0	5		ns
CLK5	$t_{w(OBSCLK0H)}$	Pulse Duration, OBSCLK0 high	B*0.45(2)	B*0.55(2)	ns
CLK6	$t_{w(OBSCLK0L)}$	Pulse Duration, OBSCLK0 low	B*0.45(2)	B*0.55(2)	ns
CLK4	$t_{c(OBSCLK1)}$	Cycle time minimum, OBSCLK1	5		ns
CLK5	$t_{w(OBSCLK1H)}$	Pulse Duration, OBSCLK1 high	F*0.45(3)	F*0.55(3)	ns
CLK6	$t_{w(OBSCLK1L)}$	Pulse Duration, OBSCLK1 low	F*0.45(3)	F*0.55(3)	ns
CLK4	$t_{c(CLKOUT0)}$	Cycle time minimum, CLKOUT0	20		ns
CLK5	$t_{w(CLKOUT0H)}$	Pulse Duration, CLKOUT0 high	C*0.4(4)	C*0.6(4)	ns
CLK6	$t_{w(CLKOUT0L)}$	Pulse Duration, CLKOUT0 low	C*0.4(4)	C*0.6(4)	ns
CLK4	$t_{c(MCU_SYSCLKOUT0)}$	Cycle time minimum, MCU_SYSCLKOUT0	10		ns
CLK5	$t_{w(MCU_SYSCLKOUT0H)}$	Pulse Duration, MCU_SYSCLKOUT0 high	E*0.4(5)	E*0.6(5)	ns
CLK6	$t_{w(MCU_SYSCLKOUT0L)}$	Pulse Duration, MCU_SYSCLKOUT0 low	E*0.4(5)	E*0.6(5)	ns
CLK4	$t_{c(MCU_OBSCLK0)}$	Cycle time minimum, MCU_OBSCLK0	5		ns
CLK5	$t_{w(MCU_OBSCLK0H)}$	Pulse Duration, MCU_OBSCLK0 high	D*0.45(6)	D*0.55(6)	ns
CLK6	$t_{w(MCU_OBSCLK0L)}$	Pulse Duration, MCU_OBSCLK0 low	D*0.45(6)	D*0.55(6)	ns
CLK4	$t_{c(WKUP_CLKOUT0)}$	Cycle time minimum, WKUP_CLKOUT0	5		ns
CLK5	$t_{w(WKUP_CLKOUT0H)}$	Pulse Duration, WKUP_CLKOUT0 high	W*0.4(7)	W*0.6(7)	ns
CLK6	$t_{w(WKUP_CLKOUT0L)}$	Pulse Duration, WKUP_CLKOUT0 low	W*0.4(7)	W*0.6(7)	ns
CLK4	$t_{c(AUDIO_EXT_REFCLK0)}$	Cycle time minimum, AUDIO_EXT_REFCLK0 (McASP Clock Source)	20		ns
		Cycle time minimum, AUDIO_EXT_REFCLK0 (PLL Clock Source)	10		ns
CLK5	$t_{w(AUDIO_EXT_REFCLK0\ H)}$	Pulse Duration, AUDIO_EXT_REFCLK0 high	G*0.4(8)	G*0.6(8)	ns
CLK6	$t_{w(AUDIO_EXT_REFCLK0\ L)}$	Pulse Duration, AUDIO_EXT_REFCLK0 low	G*0.4(8)	G*0.6(8)	ns
CLK4	$t_{c(AUDIO_EXT_REFCLK1)}$	Cycle time minimum, AUDIO_EXT_REFCLK1 (McASP Clock Source)	20		ns
		Cycle time minimum, AUDIO_EXT_REFCLK1 (PLL Clock Source)	10		ns
CLK5	$t_{w(AUDIO_EXT_REFCLK1\ H)}$	Pulse Duration, AUDIO_EXT_REFCLK1 high	J*0.4(9)	J*0.6(9)	ns
CLK6	$t_{w(AUDIO_EXT_REFCLK1\ L)}$	Pulse Duration, AUDIO_EXT_REFCLK1 low	J*0.4(9)	J*0.6(9)	ns

(1) A = SYSCLKOUT0 cycle time in ns.
(2) B = OBSCLK0 cycle time in ns.
(3) F = OBSCLK1 cycle time in ns.
(4) C = CLKOUT0 cycle time in ns.
(5) E = MCU_SYSCLKOUT0 cycle time in ns.
(6) D = MCU_OBSCLK0 cycle time in ns.
(7) W = WKUP_CLKOUT0 cycle time in ns.
(8) G = AUDIO_EXT_REFCLK0 cycle time in ns.
(9) J = AUDIO_EXT_REFCLK1 cycle time in ns.

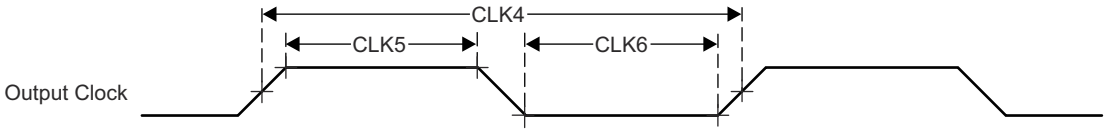


Figure 6-15. Clock Switching Characteristics

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6.12.4 Clock Specifications

6.12.4.1 Input Clocks / Oscillators

Various external clock inputs/outputs are needed to drive the device. Summary of these input clock signals is as follows:

- MCU_OSC0_XO/MCU_OSC0_XI — external main crystal interface pins connected to the internal high-frequency oscillator (MCU_HFOSC0), which is the default clock source for internal reference clock HFOSC0_CLKOUT.
- WKUP_LFOSC0_XO/WKUP_LFOSC0_XI — external crystal interface pins connected to internal low-frequency oscillator (WKUP_LFOSC0), which sources optional 32768Hz reference clock.
- General purpose clock inputs
  - MCU_EXT_REFCLK0 — optional external system clock.
  - EXT_REFCLK1 — optional external system clock.
- External video pixel clock input
  - VOUT0_EXTPCLKIN — optional for the DPI0 port of DSS.
- External CPTS reference clock input
  - CP_GEMAC_CPTS0_RFT_CLK — optional reference clock input for CPTS_RFT_CLK.
- External audio reference clock inputs/outputs
  - AUDIO_EXT_REFCLK[1:0] — optional McASP high-frequency input clocks when configured to operate as an input.

For more information about Input clock interfaces, see *Clocking* section in *Device Configuration* chapter in the device TRM.

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6.12.4.1.1 MCU_OSC0 Internal Oscillator Clock Source

Figure 6-16 shows the recommended crystal circuit. All discrete components used to implement the oscillator circuit must be placed as close as possible to the MCU_OSC0_XI and MCU_OSC0_XO pins.

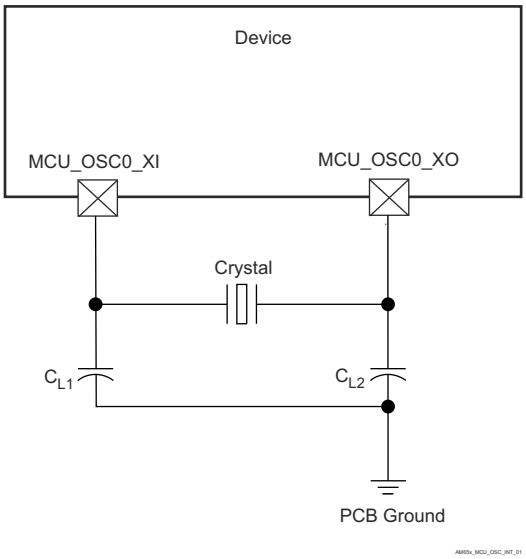


Figure 6-16. MCU_OSC0 Crystal Implementation

The crystal must be in the fundamental mode of operation and parallel resonant. Table 6-22 summarizes the required electrical constraints.

Table 6-22. MCU_OSC0 Crystal Circuit Requirements

PARAMETER				MIN	TYP	MAX	UNIT
F_{xtal}	Crystal Parallel Resonance Frequency				25		MHz
F_{xtal}	Crystal Frequency Stability and Tolerance		Ethernet RGMII and RMII not used			±100	ppm
			Ethernet RGMII and RMII using derived clock			±50	
$C_{L1+PCBXI}$	Capacitance of C_{L1} + C_{PCBXI}			12		24	pF
$C_{L2+PCBXO}$	Capacitance of C_{L2} + C_{PCBXO}			12		24	pF
C_L	Crystal Load Capacitance			6		12	pF
C_{shunt}	Crystal Circuit Shunt Capacitance	ESR_{xtal} = 30Ω	25MHz			7	pF
		ESR_{xtal} = 40Ω	25MHz			5	pF
		ESR_{xtal} = 50Ω	25MHz			5	pF
ESR_{xtal}	Crystal Effective Series Resistance					(1)	Ω

(1) The maximum ESR of the crystal is a function of the crystal frequency and shunt capacitance. See the C_{shunt} parameter.

When selecting a crystal, the system design must consider temperature and aging characteristics of the crystal based on worst case environment and expected life expectancy of the system.

Table 6-23 details the switching characteristics of the oscillator.

Table 6-23. MCU_OSC0 Switching Characteristics - Crystal Mode

PARAMETER		MIN	TYP	MAX	UNIT
C_{XI}	XI Capacitance			2.04	pF
C_{XO}	XO Capacitance			1.91	pF
C_{XIXO}	XI to XO Mutual Capacitance			0.01	pF

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Table 6-23. MCU_OSC0 Switching Characteristics - Crystal Mode (continued)

PARAMETER		MIN	TYP	MAX	UNIT
t_s	Start-up Time		4		ms

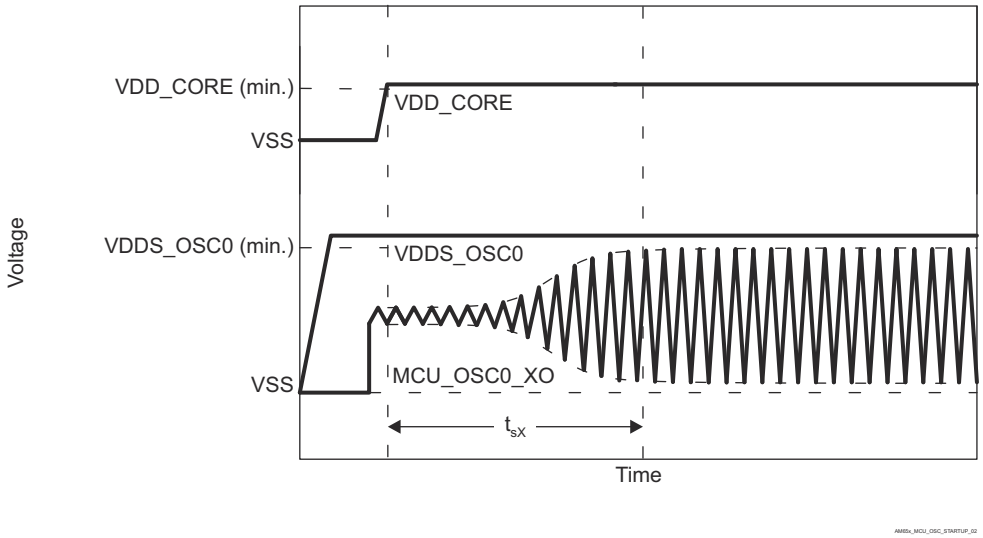


Figure 6-17. MCU_OSC0 Start-up Time

6.12.4.1.1.1 Load Capacitance

The crystal circuit must be designed such that it applies the appropriate capacitive load to the crystal, as defined by the crystal manufacturer. The capacitive load, C_L, of this circuit is a combination of discrete capacitors C_{L1}, C_{L2}, and several parasitic contributions. PCB signal traces which connect crystal circuit components to MCU_OSC0_XI and MCU_OSC0_XO have parasitic capacitance to ground, C_{PCBXI} and C_{PCBXO}, where the PCB designer should be able to extract parasitic capacitance for each signal trace. The MCU_OSC0 circuits and device package have combined parasitic capacitance to ground, C_{PCBXI} and C_{PCBXO}, where these parasitic capacitance values are defined in Table 6-23.

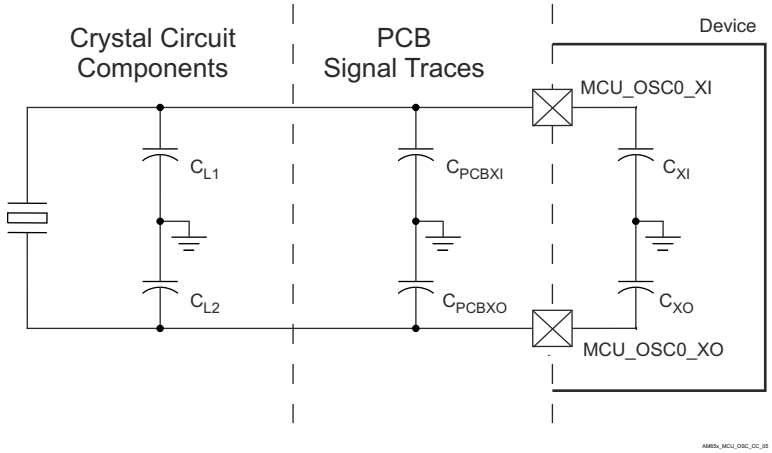


Figure 6-18. Load Capacitance

Load capacitors, C_{L1} and C_{L2} in Figure 6-16, should be chosen such that the below equation is satisfied. C_L in the equation is the load specified by the crystal manufacturer.

$$C_L = [(C_{L1} + C_{PCBXI} + C_{XI}) \times (C_{L2} + C_{PCBXO} + C_{XO})] / [(C_{L1} + C_{PCBXI} + C_{XI}) + (C_{L2} + C_{PCBXO} + C_{XO})]$$

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To determine the value of C_{L1} and C_{L2}, multiply the capacitive load value C_L by 2. Using this result, subtract the combined values of C_{PCBXI} + C_{XI} to determine the value of C_{L1} and the combined values of C_{PCBXO} + C_{XO} to determine the value of C_{L2}. For example, if C_L = 10pF, C_{PCBXI} = 2.9pF, C_{XI} = 0.5pF,C_{PCBXO} = 3.7pF, C_{XO} = 0.5pF, the value of C_{L1} = [(2C_L) - (C_{PCBXI} + C_{XI})] = [(2 × 10pF) - 2.9pF - 0.5pF)] = 16.6pF and C_{L2} = [(2C_L) - (C_{PCBXO} + C_{XO})] = [(2 × 10pF) - 3.7pF - 0.5pF)] = 15.8pF

6.12.4.1.1.2 Shunt Capacitance

The crystal circuit must also be designed such that it does not exceed the maximum shunt capacitance for MCU_OSC0 operating conditions defined in Table 6-22. Shunt capacitance, C_{shunt}, of the crystal circuit is a combination of crystal shunt capacitance and parasitic contributions. PCB signal traces which connect crystal circuit components to MCU_OSC0 have mutual parasitic capacitance to each other, $C_{PCBXIXO}$, where the PCB designer should be able to extract mutual parasitic capacitance between these signal traces. The device package also has mutual parasitic capacitance, C_{XIXO}, where this mutual parasitic capacitance value is defined in Table 6-23.

PCB routing should be designed to minimize mutual capacitance between XI and XO signal traces. This is typically done by keeping signal traces short and not routing them in close proximity. Mutual capacitance can also be minimized by placing a ground trace between these signals when the layout requires them to be routed in close proximity. It is important to minimize the mutual capacitance on the PCB to provide as much margin as possible when selecting a crystal.

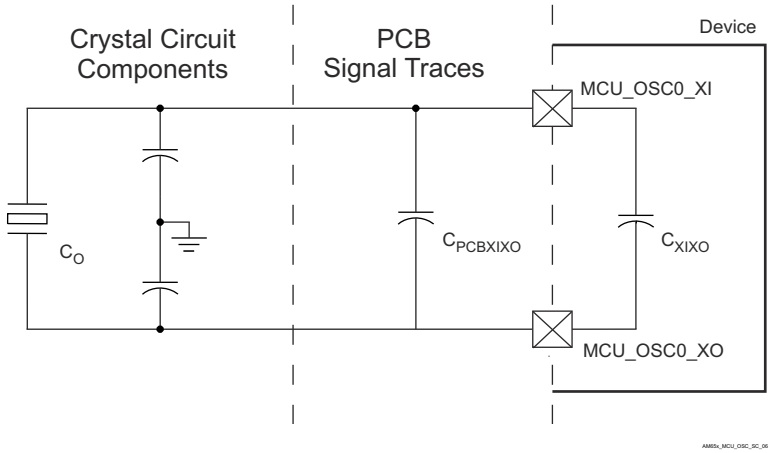


Figure 6-19. Shunt Capacitance

A crystal should be chosen such that the below equation is satisfied. C_O in the equation is the maximum shunt capacitance specified by the crystal manufacturer.

$C_{shunt} \geq C_O + C_{PCBXIXO} + C_{XIXO}$

For example, the equation would be satisfied when the crystal being used is 25MHz with an ESR = 30Ω, $C_{PCBXIXO}$ = 0.04pF, C_{XIXO} = 0.01pF, and shunt capacitance of the crystal is less than or equal to 6.95pF.

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6.12.4.1.2 MCU_OSC0 LVCMOS Digital Clock Source

Figure 6-20 shows the recommended oscillator connections when MCU_OSC0_XI is connected to a 1.8V LVCMOS square-wave digital clock source.

Note

1. A DC steady-state condition is not allowed on MCU_OSC0_XI when the oscillator is powered up. This is not allowed because MCU_OSC0_XI is internally AC coupled to a comparator that can enter an unknown state when DC is applied to the input. Therefore, application software must power down MCU_OSC0 any time MCU_OSC0_XI is not toggling between logic states.

2. The LVCMOS clock signal sourcing the MCU_OSC0_XI input must have monotonic transitions. The clock source should be connected to MCU_OSC0_XI with a point-to-point connection, via a series termination resistor placed near the clock source. The series termination resistor value should match the clock source output impedance to the transmission line impedance. For example, the series termination resistor value needs to be 20 ohms if the clock source has an output impedance of 30 ohms and the PCB signal trace has a characteristic impedance of 50 ohms. This allows the reflection that returns from the far end of the un-terminated transmission line to be completely absorbed such that is does not introduce any non-monotonic events on the signal.

3. The PCB trace length connecting the LVCMOS clock source to MCU_OSC0_XI should be minimized. This reduces capacitive loading and decreases probability of external noise sources coupling into the clock signal. Reduced capacitive loading improves rise/fall times of the clock signal which reduces the probability of jitter being introduced in the system.

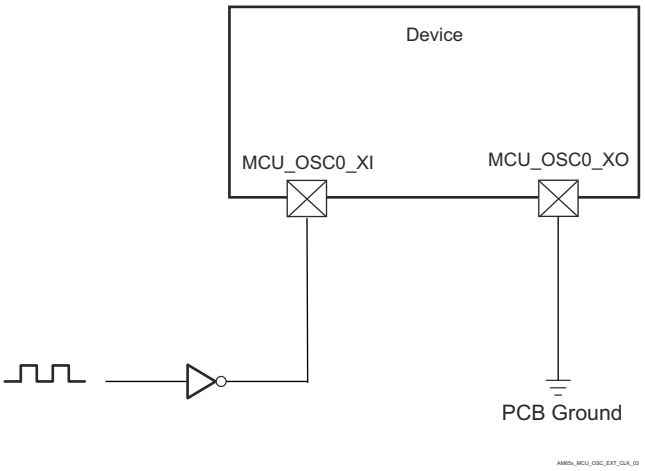


Figure 6-20. 1.8V LVCMOS-Compatible Clock Input

Table 6-24. MCU_OSC0 LVCMOS Digital Clock Source Requirements

PARAMETER			MIN	TYP	MAX	UNIT
F_{xtal}	Frequency			25		MHz
	Frequency Stability and Tolerance	Ethernet RGMII and RMII not used			±100	ppm
		Ethernet RGMII and RMII using derived clock			±50	
DC	Duty Cycle		45		55	%
$t_{R/F}$	Rise/Fall Time (10%-90% rise, 90%-10% fall)				4(1)	ns
$J_{Period(RMS)}$	Period Jitter, RMS (100k samples)				20	ps
$J_{Period(PK-PK)}$	Period Jitter, Peak to Peak (100k samples)				300	ps
$J_{Phase(RMS)}$	Phase Jitter, RMS (BW 100Hz to 1MHz)				10(2)	ps

(1) Most LVCMOS oscillator datasheets define their maximum Output Rise/Fall times with a capacitive load much larger than the actual load that will be applied by the combined PCB trace capacitance and MCU_OSC0_XI input capacitance. It should not be difficult to find a LVCMOS oscillator that meets this requirement. However, the system designer must confirm the LVCMOS oscillator selected will provide the appropriate rise/fall time to MCU_OSC0_XI input.

(2) Most LVCMOS oscillator datasheets define their max RMS Phase Jitter using a larger bandwidth integration range than required by this device. To get a more appropriate value, it may be necessary to contact the LVCMOS oscillator manufacture and ask them to provide a maximum RMS Phase Jitter using the same bandwidth integration range that has been defined for this parameter.

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6.12.4.1.3 WKUP_LFOSC0 Internal Oscillator Clock Source

Figure 6-21 shows the recommended crystal circuit. It is recommended that preproduction printed-circuit board (PCB) designs include the two optional resistors R_{bias} and R_d in case they are required for proper oscillator operation when combined with production crystal circuit components. In most cases, R_{bias} is not required and R_d is a 0-Ω resistor. These resistors may be removed from production PCB designs after evaluating oscillator performance with production crystal circuit components installed on preproduction PCBs.

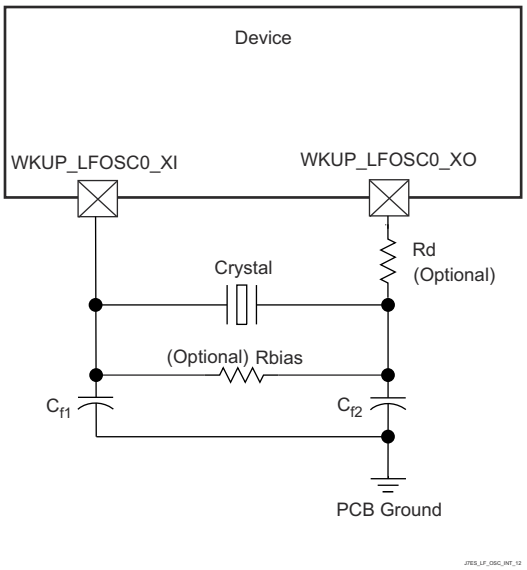


Figure 6-21. WKUP_LFOSC0 Crystal Implementation

Table 6-25 presents LFXOSC modes of operation.

Table 6-25. LFXOSC Modes of Operation

MODE	BP_C	PD_C	XI	XO	CLK_OUT	DESCRIPTION
ACTIVE	0	0	XTAL	XTAL	CLK_OUT	Active oscillator mode providing 32kHz
PWRDN	0	1	X	PD	LOW	Output will be pulled down to LOW. PAD to be tri-stated. Active mode disabled
BYPASS	1	0	CLK	PD	CLK	XI is driven by external clock source. XO is pulled down to LOW. Due to ESD diode to supply, XI should not be driven unless oscillator supply is present.

Note

User should set CTRLMMR_WKUP_LFXOSC_TRIM[18:16] i_mult = 3b’001 for CL in the range 6pf to 9.5pf. CTRLMMR_WKUP_LFXOSC_TRIM [18:16] i_mult = 3b’010 for CL in the range 8.5pf to 12pf. Default setting is 3b’010.

Note

The load capacitors, C_{f1} and C_{f2} in Figure 6-22, should be chosen such that the below equation is satisfied. C_L in the equation is the load specified by the crystal manufacturer. All discrete components used to implement the oscillator circuit should be placed as close as possible to the associated oscillator WKUP_LFOSC0_XI, WKUP_LFOSC0_XO, and VSS pins.

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$$C_L = \frac{C_{f1} C_{f2}}{(C_{f1} + C_{f2})}$$

JTES_CL_MATH_03

Figure 6-22. Load Capacitance Equation

The crystal must be in the fundamental mode of operation and parallel resonant. Table 6-26 summarizes the required electrical constraints.

Table 6-26. WKUP_LFOSC0 Crystal Electrical Characteristics

NAME	DESCRIPTION		MIN	TYP	MAX	UNIT
f_p	Parallel resonance crystal frequency			32768		Hz
	Crystal Frequency Stability and Tolerance				±100	PPM
C_{f1}	C_{f1} load capacitance for crystal parallel resonance with $C_{f1} = C_{f2}$		12		24	pF
C_{f2}	C_{f2} load capacitance for crystal parallel resonance with $C_{f1} = C_{f2}$		12		24	pF
C_{shunt}	Shunt capacitance	ESRxtal – 40 kΩ			4	pF
		ESRxtal – 60 kΩ			3	pF
		ESRxtal – 80 kΩ			2	pF
		ESRxtal – 100 kΩ			1	pF
ESR	Crystal effective series resistance				(1)	Ω

(1) The maximum ESR of the crystal is a function of the crystal frequency and shunt capacitance. See the C_{shunt} parameter.

When selecting a crystal, the system design must consider the temperature and aging characteristics of a based on the worst case environment and expected life expectancy of the system.

Table 6-27 details the switching characteristics of the oscillator and the requirements of the input clock.

Table 6-27. WKUP_LFOSC0 Switching Characteristics – Crystal Mode

NAME	DESCRIPTION	MIN	TYP	MAX	UNIT
f_{xtal}	Oscillation frequency		32768		Hz
t_{sX}	Start-up time			96.5	ms

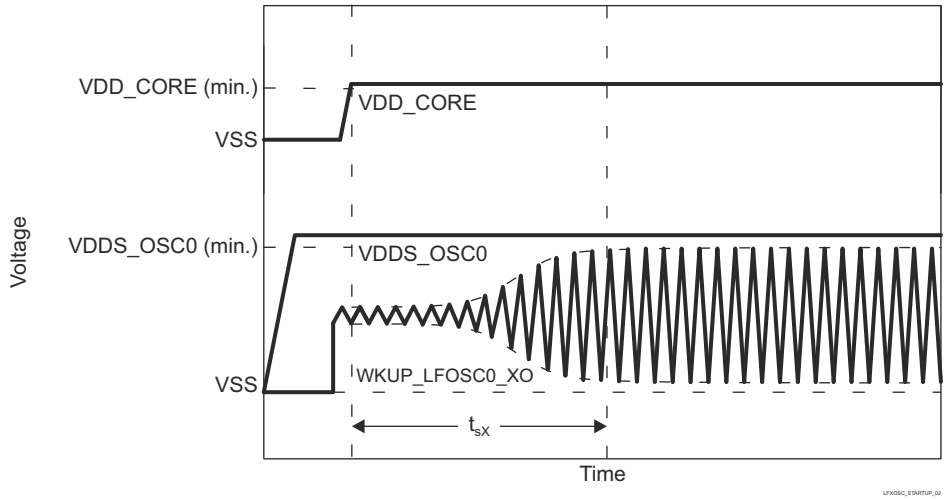


Figure 6-23. WKUP_LFOSC0 Start-up Time

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6.12.4.1.4 WKUP_LFOSC0 LVCMOS Digital Clock Source

Figure 6-24 shows the recommended oscillator connections when WKUP_LFOSC0_XI is connected to a 1.8V LVCMOS square-wave digital clock source.

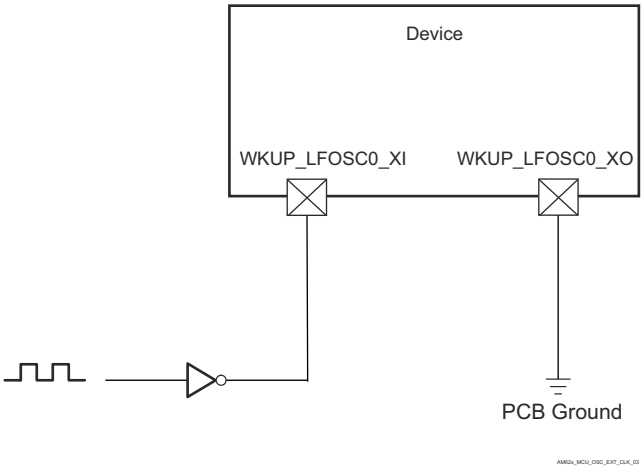


Figure 6-24. 1.8V LVCMOS-Compatible Clock Input

6.12.4.1.5 WKUP_LFOSC0 Not Used

Figure 6-25 shows the recommended oscillator connections when WKUP_LFOSC0 is not used.

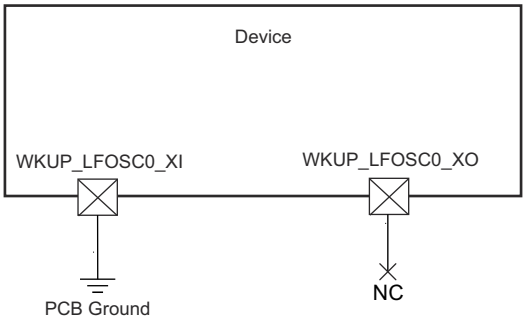


Figure 6-25. WKUP_LFOSC0 Not Used

6.12.4.2 Output Clocks

The device provides several system clock outputs. Summary of these output clocks are as follows:

- **MCU_SYSCLKOUT0**
  - MCU_PLL0_HSDIV0_CLKOUT (MCU_SYSCLKOUT0) divided by 4 and sent out of the device as MCU_SYSCLKOUT0. This clock output is provided for test and debug purposes only.
- **MCU_OBSCLK0**
  - Observation clock output for test and debug purposes only.
- **WKUP_CLKOUT0**
  - WKUP domain CLKOUT0 output.
- **SYSCLKOUT0**
  - MAIN_PLL0_HSDIV0_CLKOUT (SYSCLKOUT0) divided by 4 and then sent out of the device as SYSCLKOUT0. This clock output is provided for test and debug purposes only.
- **CLKOUT0**
  - CLKOUT0 is the Ethernet subsystem clock (MAIN_PLL2_HSDIV1_CLKOUT) divided-by-5 or divided-by-10. This clock output was provided as an optional source to the external PHY. When configured to operate as the RMII Clock source (50MHz) the signal must also be routed back to the respective RMII[x]_REF_CLK pin for proper device operation.
- **OBSCLK[1:0]**
  - Observation clock outputs for test and debug purposes only.
- **AUDIO_EXT_REFCLK[1:0]**
  - Option of sourcing one of six McASP high-frequency audio reference clocks, MAIN_PLL1_HSDIV6_CLKOUT, or MAIN_PLL2_HSDIV8_CLKOUT when configured to operate as an output.

6.12.4.3 PLLs

Power is supplied to the Phase-Locked Loop circuits (PLLs) by internal regulators that derive their power from off-chip power-sources.

There is one PLL in the MCU domain:

- MCU_PLL0 (MCU PLL)

There are nine PLLs in the MAIN domain:

- MAIN_PLL0 (MAIN PLL)
- MAIN_PLL1 (PER0 PLL)
- MAIN_PLL2 (PER1 PLL)
- MAIN_PLL5 (VIDEO PLL)
- MAIN_PLL7 (C7 DSP PLL)
- MAIN_PLL8 (ARM0 PLL)
- MAIN_PLL12 (DDR PLL)
- MAIN_PLL15 (SMS PLL)
- MAIN_PLL17 (DSS PLL)

The system designer should consider the reference clock source start-up time and the PLL lock requirements before configuring and using any of the PLL outputs as clock sources. The device reference clock input requirements are defined in Section 6.12.4.1, *Input Clocks / Oscillators*. PLL configuration details are described in the device TRM.

For more information on PLLs, see the *PLL* subsection in the *Clocking* subsection of the *Device Configuration* section in the device TRM.

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6.12.4.4 Recommended System Precautions for Clock and Control Signal Transitions

All clock and strobe signals must transition between V_{IH} and V_{IL} (or between V_{IL} and V_{IH}) in a monotonic manner.

Monotonic transitions are more likely to occur with fast signal transitions. It is easy for noise to create non-monotonic events on a signal with slow transitions. Therefore, avoid slow signal transitions on all clock and control signals since they are more likely to generate glitches inside the device.

6.12.5 Peripherals

6.12.5.1 CPSW3G

For more details about features and additional description information on the device Gigabit Ethernet MAC, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

6.12.5.1.1 CPSW3G MDIO Timing

Table 6-28, Table 6-29, Table 6-30, and Figure 6-26 present timing conditions, timing requirements, and switching characteristics for CPSW3G MDIO.

Table 6-28. CPSW3G MDIO Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.9	3.6	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	10	470	pF
PCB CONNECTIVITY REQUIREMENTS				
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	0	5	ns
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces		1	ns

Table 6-29. CPSW3G MDIO Timing Requirements

see Figure 6-26

NO.	PARAMETER		MIN	MAX	UNIT
MDIO1	$t_{su(MDIO_MDC)}$	Setup time, MDIO[x]_MDIO valid before MDIO[x]_MDC high	45		ns
MDIO2	$t_{h(MDC_MDIO)}$	Hold time, MDIO[x]_MDIO valid after MDIO[x]_MDC high	0		ns

Table 6-30. CPSW3G MDIO Switching Characteristics

see Figure 6-26

NO.	PARAMETER		MIN	MAX	UNIT
MDIO3	$t_{c(MDC)}$	Cycle time, MDIO[x]_MDC	400		ns
MDIO4	$t_{w(MDCH)}$	Pulse Duration, MDIO[x]_MDC high	160		ns
MDIO5	$t_{w(MDCL)}$	Pulse Duration, MDIO[x]_MDC low	160		ns
MDIO7	$t_{d(MDC_MDIO)}$	Delay time, MDIO[x]_MDC low to MDIO[x]_MDIO valid	-10	10	ns

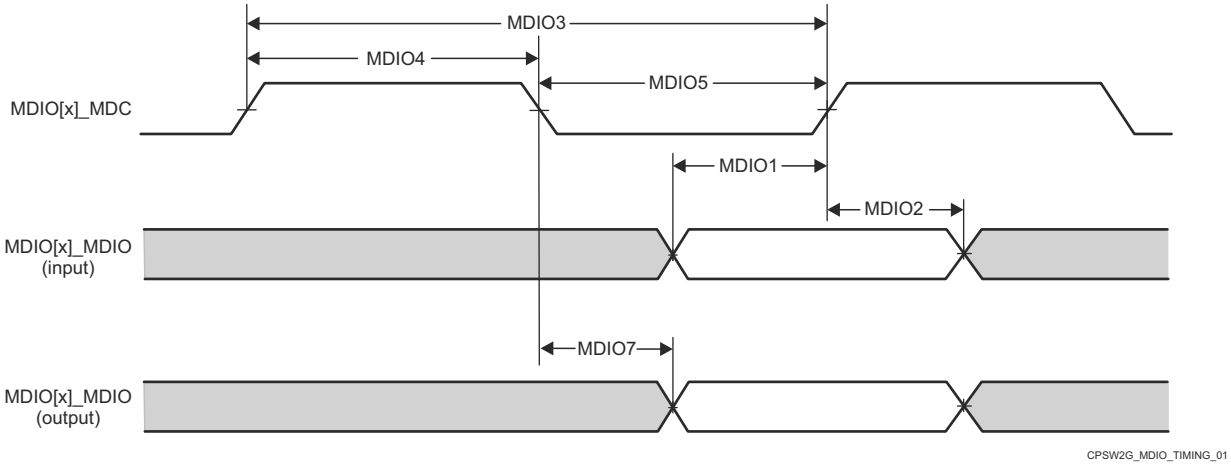


Figure 6-26. CPSW3G MDIO Timing Requirements and Switching Characteristics

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6.12.5.1.2 CPSW3G RMII Timing

Table 6-31, Table 6-32, Figure 6-27, Table 6-33, Figure 6-28, Table 6-34, and Figure 6-29 present timing conditions, timing requirements, and switching characteristics for CPSW3G RMII.

Table 6-31. CPSW3G RMII Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate	VDD(1) = 1.8V	0.18	5	V/ns
		VDD(1) = 3.3V	0.4	5	
OUTPUT CONDITIONS					
C_L	Output load capacitance		3	25	pF

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.

Table 6-32. RMII[x]_REF_CLK Timing Requirements – RMII Mode

see Figure 6-27

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
RMII1	$t_{c(REF_CLK)}$	Cycle time, RMII[x]_REF_CLK	19.999	20.001	ns
RMII2	$t_{w(REF_CLKH)}$	Pulse Duration, RMII[x]_REF_CLK High	7	13	ns
RMII3	$t_{w(REF_CLKL)}$	Pulse Duration, RMII[x]_REF_CLK Low	7	13	ns

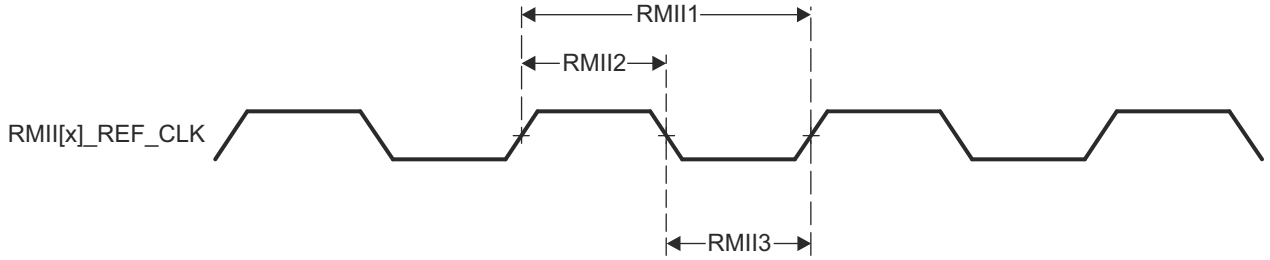


Figure 6-27. CPSW3G RMII[x]_REF_CLK Timing Requirements – RMII Mode

Table 6-33. RMII[x]_RXD[1:0], RMII[x]_CRS_DV, and RMII[x]_RX_ER Timing Requirements – RMII Mode

see Figure 6-28

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
RMII4	$t_{su(RXD-REF_CLK)}$	Setup time, RMII[x]_RXD[1:0] valid before RMII[x]_REF_CLK	4		ns
	$t_{su(CRS_DV-REF_CLK)}$	Setup time, RMII[x]_CRS_DV valid before RMII[x]_REF_CLK	4		ns
	$t_{su(RX_ER-REF_CLK)}$	Setup time, RMII[x]_RX_ER valid before RMII[x]_REF_CLK	4		ns
RMII5	$t_{h(REF_CLK-RXD)}$	Hold time RMII[x]_RXD[1:0] valid after RMII[x]_REF_CLK	2		ns
	$t_{h(REF_CLK-CRS_DV)}$	Hold time, RMII[x]_CRS_DV valid after RMII[x]_REF_CLK	2		ns
	$t_{h(REF_CLK-RX_ER)}$	Hold time, RMII[x]_RX_ER valid after RMII[x]_REF_CLK	2		ns

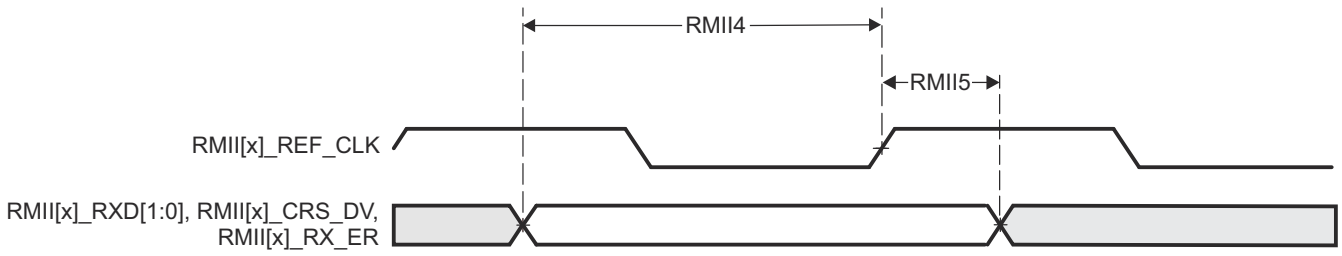


Figure 6-28. CPSW3G RMII[x]_RXD[1:0], RMII[x]_CRS_DV, RMII[x]_RX_ER Timing Requirements – RMII Mode

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Table 6-34. RMII[x]_TXD[1:0], and RMII[x]_TX_EN Switching Characteristics – RMII Mode

see Figure 6-29

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
RMII6	$t_{d(REF_CLK-TXD)}$	Delay time, RMII[x]_REF_CLK High to RMII[x]_TXD[1:0] valid	2	10	ns
	$t_{d(REF_CLK-TX_EN)}$	Delay time, RMII[x]_REF_CLK to RMII[x]_TX_EN valid	2	10	ns

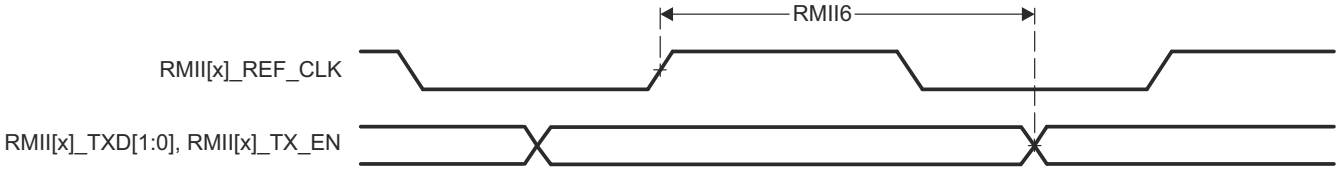


Figure 6-29. RMII[x]_TXD[1:0], and RMII[x]_TX_EN Switching Characteristics – RMII Mode

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6.12.5.1.3 CPSW3G RGMII Timing

Table 6-35, Table 6-36, Table 6-37, Figure 6-30, Table 6-38, Table 6-39, and Figure 6-31 present timing conditions, timing requirements, and switching characteristics for CPSW3G RGMII.

Table 6-35. CPSW3G RGMII Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate	VDD[1] = 1.8V	1.44	5	V/ns
		VDD[1] = 3.3V	2.64	5	
OUTPUT CONDITIONS					
C_L	Output load capacitance		2	20	pF
PCB CONNECTIVITY REQUIREMENTS					
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces	RGMII[x]_RXC, RGMII[x]_RD[3:0], RGMII[x]_RX_CTL		50	ps
		RGMII[x]_TXC, RGMII[x]_TD[3:0], RGMII[x]_TX_CTL		50	ps

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.

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Table 6-36. RGMII[x]_RXC Timing Requirements – RGMII Mode

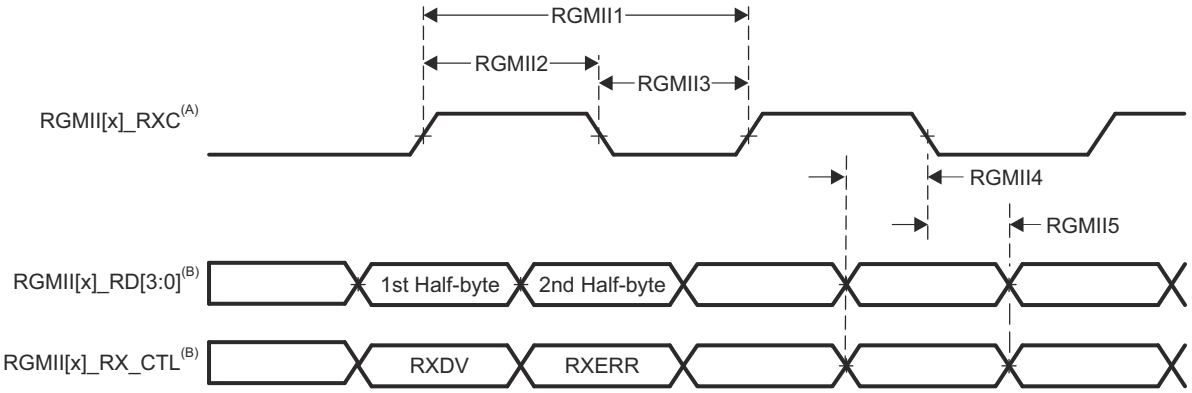
see Figure 6-30

NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
RGMII1	$t_{c(RXC)}$	Cycle time, RGMII[x]_RXC	10Mbps	360	440	ns
			100Mbps	36	44	ns
			1000Mbps	7.2	8.8	ns
RGMII2	$t_{w(RXCH)}$	Pulse duration, RGMII[x]_RXC high	10Mbps	160	240	ns
			100Mbps	16	24	ns
			1000Mbps	3.6	4.4	ns
RGMII3	$t_{w(RXCL)}$	Pulse duration, RGMII[x]_RXC low	10Mbps	160	240	ns
			100Mbps	16	24	ns
			1000Mbps	3.6	4.4	ns

Table 6-37. RGMII[x]_RD[3:0], and RGMII[x]_RX_CTL Timing Requirements – RGMII Mode

see Figure 6-30

NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
RGMII4	$t_{su(RD-RXC)}$	Setup time, RGMII[x]_RD[3:0] valid before RGMII[x]_RXC high/low	10Mbps	1		ns
			100Mbps	1		ns
			1000Mbps	1		ns
	$t_{su(RX_CTL-RXC)}$	Setup time, RGMII[x]_RX_CTL valid before RGMII[x]_RXC high/low	10Mbps	1		ns
			100Mbps	1		ns
			1000Mbps	1		ns
RGMII5	$t_{h(RXC-RD)}$	Hold time, RGMII[x]_RD[3:0] valid after RGMII[x]_RXC high/low	10Mbps	1		ns
			100Mbps	1		ns
			1000Mbps	1		ns
	$t_{h(RXC-RX_CTL)}$	Hold time, RGMII[x]_RX_CTL valid after RGMII[x]_RXC high/low	10Mbps	1		ns
			100Mbps	1		ns
			1000Mbps	1		ns



A. RGMII[x]_RXC must be externally delayed relative to the data and control pins.

B. Data and control information is received using both edges of the clocks. RGMII[x]_RD[3:0] carries data bits 3-0 on the rising edge of RGMII[x]_RXC and data bits 7-4 on the falling edge of RGMII[x]_RXC. Similarly, RGMII[x]_RX_CTL carries RXDV on rising edge of RGMII[x]_RXC and RXERR on falling edge of RGMII[x]_RXC.

Figure 6-30. CPSW3G RGMII[x]_RXC, RGMII[x]_RD[3:0], RGMII[x]_RX_CTL Timing Requirements - RGMII Mode

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Table 6-38. RGMII[x]_TXC Switching Characteristics – RGMII Mode

see Figure 6-31

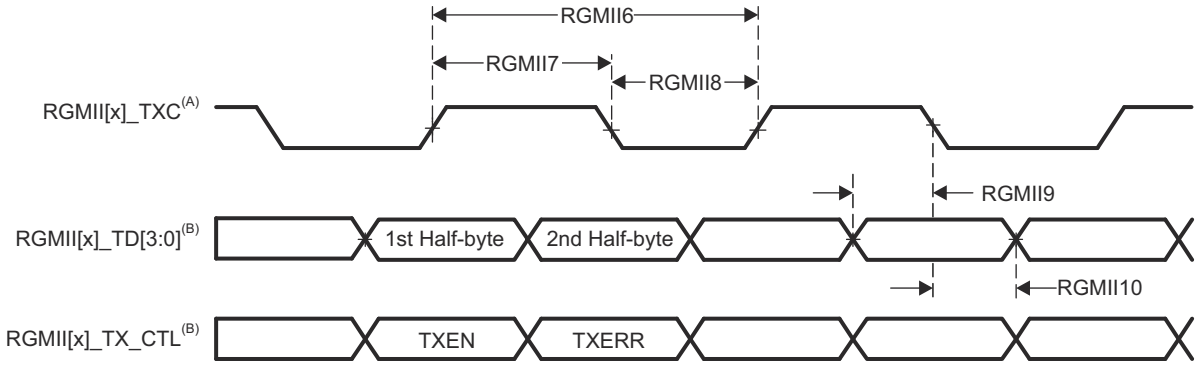
NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
RGMII6	$t_{c(TXC)}$	Cycle time, RGMII[x]_TXC	10Mbps	360	440	ns
			100Mbps	36	44	ns
			1000Mbps	7.2	8.8	ns
RGMII7	$t_{w(TXCH)}$	Pulse duration, RGMII[x]_TXC high	10Mbps	160	240	ns
			100Mbps	16	24	ns
			1000Mbps	3.6	4.4	ns
RGMII8	$t_{w(TXCL)}$	Pulse duration, RGMII[x]_TXC low	10Mbps	160	240	ns
			100Mbps	16	24	ns
			1000Mbps	3.6	4.4	ns

Table 6-39. RGMII[x]_TD[3:0] and RGMII[x]_TX_CTL Switching Characteristics – RGMII Mode

see Figure 6-31

NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
RGMII9	$t_{osu(TD-TXC)}$	Output setup time(1), RGMII[x]_TD[3:0] valid to RGMII[x]_TXC high/low	10Mbps	1.2		ns
			100Mbps	1.2		ns
			1000Mbps	1.2		ns
	$t_{osu(TX_CTL-TXC)}$	Output setup time(1), RGMII[x]_TX_CTL valid to RGMII[x]_TXC high/low	10Mbps	1.2		ns
			100Mbps	1.2		ns
			1000Mbps	1.2		ns
RGMII10	$t_{oh(TXC-TD)}$	Output hold time(1), RGMII[x]_TD[3:0] valid after RGMII[x]_TXC high/low	10Mbps	1.2		ns
			100Mbps	1.2		ns
			1000Mbps	1.2		ns
	$t_{oh(TXC-TX_CTL)}$	Output hold time(1), RGMII[x]_TX_CTL valid after RGMII[x]_TXC high/low	10Mbps	1.2		ns
			100Mbps	1.2		ns
			1000Mbps	1.2		ns

(1) Output setup/hold times are defining a delay relationship of the transmit data and control outputs relative to the transmit clock output, but this output relationship is being presented as the minimum setup/hold times provided to the attached receiver. This approach matches how the output timing relationships are defined in the RGMII specification.



A. TXC is delayed internally before being driven to the RGMII[x]_TXC pin. This internal delay is always enabled.

B. Data and control information is received using both edges of the clocks. RGMII[x]_TD[3:0] carries data bits 3-0 on the rising edge of RGMII[x]_TXC and data bits 7-4 on the falling edge of RGMII[x]_TXC. Similarly, RGMII[x]_TX_CTL carries TXEN on rising edge of RGMII[x]_TXC and TXERR on falling edge of RGMII[x]_TXC.

Figure 6-31. CPSW3G RGMII[x]_TXC, RGMII[x]_TD[3:0], and RGMII[x]_TX_CTL Switching Characteristics - RGMII Mode

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6.12.5.2 CPTS

Table 6-40, Table 6-41, Figure 6-32, Table 6-42, and Figure 6-33 present timing conditions, timing requirements, and switching characteristics for CPTS.

Table 6-40. CPTS Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.5	5	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	10	pF

Table 6-41. CPTS Timing Requirements

see Figure 6-32

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
T1	$t_{w(HWTSPUSHH)}$	Pulse duration, HWnTSPUSH high	12P(1) + 2		ns
T2	$t_{w(HWTSPUSHL)}$	Pulse duration, HWnTSPUSH low	12P(1) + 2		ns
T3	$t_{c(RFT_CLK)}$	Cycle time, RFT_CLK	5	8	ns
T4	$t_{w(RFT_CLKH)}$	Pulse duration, RFT_CLK high	0.45T(2)		ns
T5	$t_{w(RFT_CLKL)}$	Pulse duration, RFT_CLK low	0.45T(2)		ns

(1) P = functional clock period in ns.
(2) T = RFT_CLK cycle time in ns.

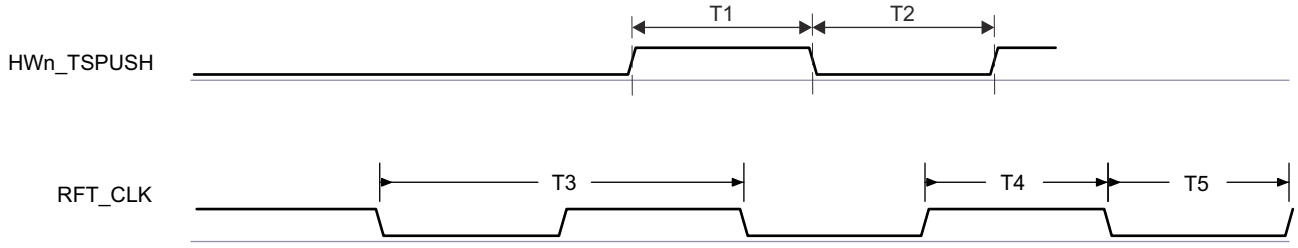


Figure 6-32. CPTS Timing Requirements

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Table 6-42. CPTS Switching Characteristics

see Figure 6-33

NO.	PARAMETER	DESCRIPTION	SOURCE	MIN	MAX	UNIT
T6	$t_{w(TS_COMPH)}$	Pulse duration, TS_COMP high		36P(1) - 2		ns
T7	$t_{w(TS_COMPL)}$	Pulse duration, TS_COMP low		36P(1) - 2		ns
T8	$t_{w(TS_SYNCH)}$	Pulse duration, TS_SYNC high		36P(1) - 2		ns
T9	$t_{w(TS_SYNCL)}$	Pulse duration, TS_SYNC low		36P(1) - 2		ns
T10	$t_{w(SYNC_OUTH)}$	Pulse duration, SYNCn_OUT high	TS_SYNC	36P(1) - 2		ns
			GENF	5P(1) - 2		ns
T11	$t_{w(SYNC_OUTL)}$	Pulse duration, SYNCn_OUT low	TS_SYNC	36P(1) - 2		ns
			GENF	5P(1) - 2		ns

(1) P = functional clock period in ns.

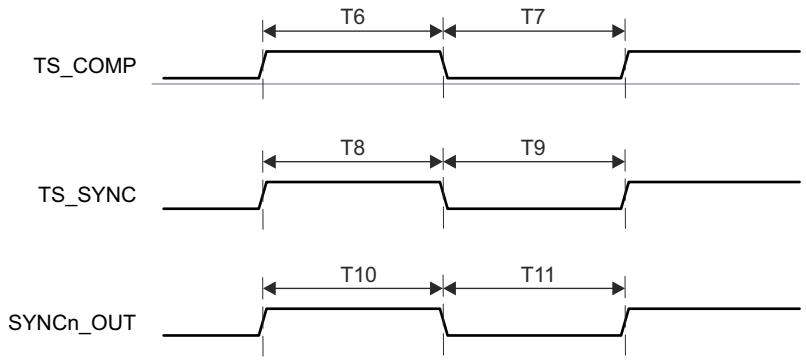


Figure 6-33. CPTS Switching Characteristics

For more information, see *Common Platform Time Sync (CPTS)* chapter in the device TRM.

6.12.5.3 CSI-2

Note

For more information, see the *Camera Serial Interface Receiver (CSI_RX_IF)* section in the device TRM. The CSI_RX_IF is connected to device port instances named CSIRXn, where n is the instance number.

The CSI_RX_IF and associated D-PHY implements a CSI-2 port (CSIRX0) compliant with the MIPI D-PHY specification v1.2 and the MIPI CSI-2 specification v1.3, with 4 differential data lanes plus 1 differential clock lane operating in synchronous double data rate mode. For CSI-2 timing details, see the respective MIPI specifications mentioned above.

- Support for 1-, 2-, 3- or 4-lane data transfer modes up to 2.5Gbps per lane.

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6.12.5.4 DDRSS

For more details about features and additional description information on the device LPDDR4 Memory Interface, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-43 and Figure 6-34 present switching characteristics for DDRSS.

Table 6-43. DDRSS Switching Characteristics

see Figure 6-34

NO.	PARAMETER		DDR TYPE	MIN	MAX	UNIT
1	$t_{c(DDR_CKP/DDR_CKN)}$	Cycle time, DDR_CKP and DDR_CKN	LPDDR4	0.5358[1]	20	ns

(1) Minimum DDR clock Cycle time will be limited based on the specific memory type (vendor) used in a system and by PCB implementation. Refer to *AM62Ax DDR Board Design and Layout Guidelines* for the proper PCB implementation to achieve maximum DDR frequency.

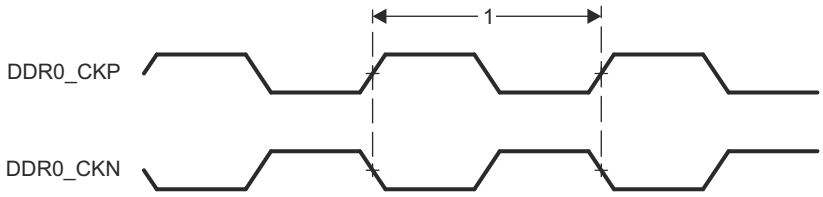


Figure 6-34. DDRSS Switching Characteristics

For more information, see *DDR Subsystem (DDRSS)* section in *Memory Controllers* chapter in the device TRM.

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6.12.5.5 DSS

Table 6-44, Table 6-45, Figure 6-35, Table 6-46 and Figure 6-36 present timing conditions, timing requirements, and switching characteristics for DSS.

Table 6-44. DSS Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	1.44	26.4	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	1.5	5	pF
PCB CONNECTIVITY REQUIREMENTS				
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces		100	ps

Table 6-45. DSS External Pixel Clock Timing Requirements

see Figure 6-35

NO.			MIN	MAX	UNIT
D6	$t_{c(extpclkin)}$	Cycle time, VOUT(x)_EXTPCLKIN(2)	6.06		ns
D7	$t_{w(extpclkinL)}$	Pulse duration, VOUT(x)_EXTPCLKIN(2) low	0.475P(1)		ns
D8	$t_{w(extpclkinH)}$	Pulse duration, VOUT(x)_EXTPCLKIN(2) high	0.475P(1)		ns

(1) P = VOUT(x)_EXTPCLKIN cycle time in ns
(2) x in VOUT(x) = 0

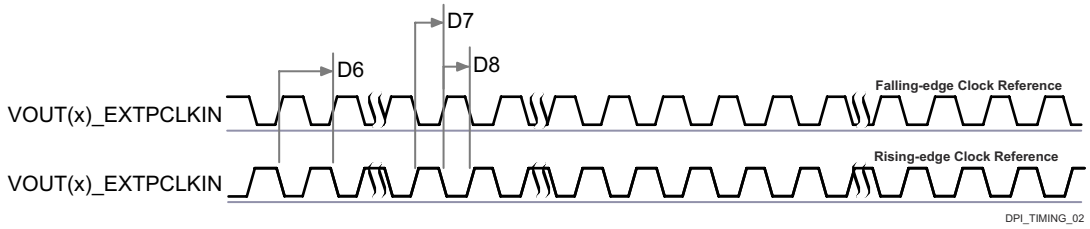


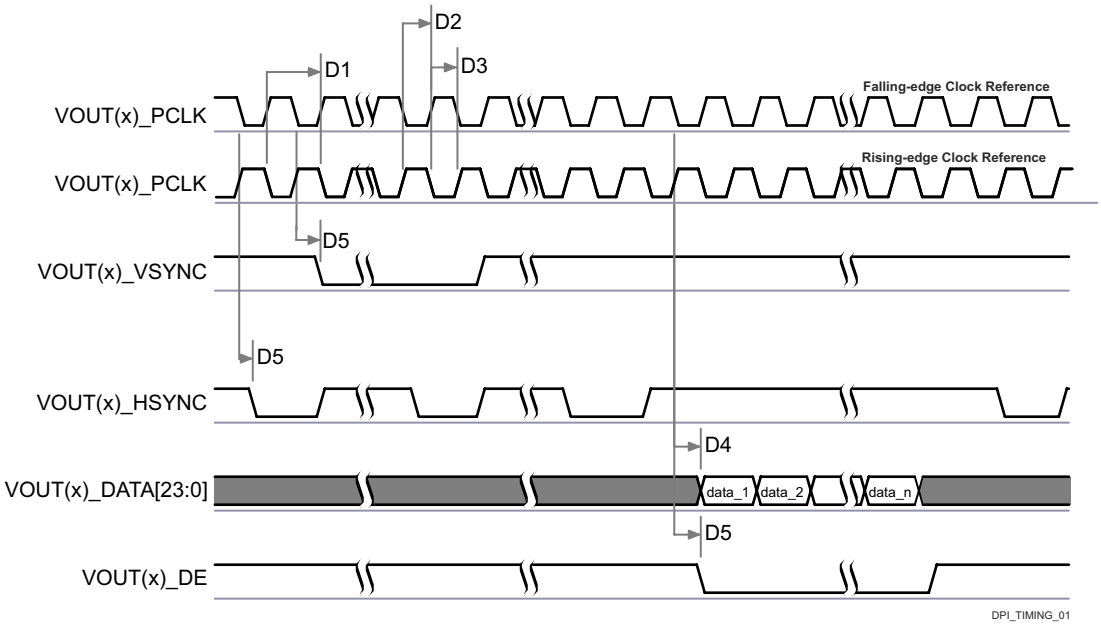
Figure 6-35. DSS External Pixel Clock Timing Requirements

Table 6-46. DSS Switching Characteristics

see Figure 6-36

NO.	PARAMETER		MODE	MIN	MAX	UNIT
D1	$t_{c(pclk)}$	Cycle time, VOUT(x)_PCLK(2)		6.06		ns
D2	$t_{w(pclkL)}$	Pulse duration, VOUT(x)_PCLK(2) low	Internal PLL	0.475P(1) - 0.3		ns
			EXTPCLKIN	Y(3) - 0.45		ns
D3	$t_{w(pclkH)}$	Pulse duration, VOUT(x)_PCLK(2) high	Internal PLL	0.475P(1) -0.3		ns
			EXTPCLKIN	Z(4) - 0.45		ns
D4	$t_{d(pclkV-dataV)}$	Delay time, VOUT(x)_PCLK(2) transition to VOUT(x)_DATA[23:0](2) transition	Internal PLL	-0.68	1.78	ns
			EXTPCLKIN	-0.68	1.78	ns
D5	$t_{d(pclkV-ctrlL)}$	Delay time, VOUT(x)_PCLK(2) transition to control signals VOUT(x)_VSYNC(2), VOUT(x)_HSYNC(2), VOUT(x)_DE(2) falling edge	Internal PLL	-0.68	1.78	ns
			EXTPCLKIN	-0.68	1.78	ns

(1) P = VOUT(x)_PCLK cycle time in ns
(2) x in VOUT(x) = 0
(3) Y = $t_{w(extpclkinL)}$, parameter D7 from Table 6-45, *DSS External Pixel Clock Timing Requirements*
(4) Z = $t_{w(extpclkinH)}$, parameter D8 from Table 6-45, *DSS External Pixel Clock Timing Requirements*



A. The assertion of data can be programmed to occur on the falling or rising edge of the pixel clock. Refer to *Display Subsystem (DSS)* section in *Peripherals* chapter in the device TRM.
B. The polarity and pulse width of VOUT(x)_HSYNC and VOUT(x)_VSYNC are programmable, refer to *Display Subsystem (DSS)* section in *Peripherals* chapter in the device TRM.
C. The VOUT(x)_PCLK frequency is configurable, refer to *Display Subsystem* section in *Peripherals* chapter in the device TRM.

Figure 6-36. DSS Switching Characteristics

For more information, see *Display Subsystem (DSS) and Peripherals* section in *Peripherals* chapter of the device TRM.

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6.12.5.6 ECAP

Table 6-47, Table 6-48, Figure 6-37, Table 6-49, and Figure 6-38 present timing conditions, timing requirements, and switching characteristics for ECAP.

Table 6-47. ECAP Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	1	4	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	7	pF

Table 6-48. ECAP Timing Requirements

see Figure 6-37

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
CAP1	$t_{w(CAP)}$	Pulse duration, CAP (asynchronous)	2P(1) + 2		ns

(1) P = MAIN_SYSCLK0/4 period in ns.

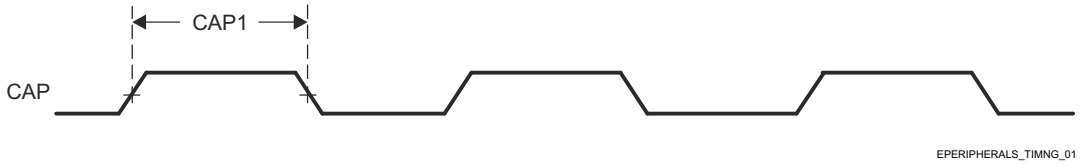


Figure 6-37. ECAP Timings Requirements

Table 6-49. ECAP Switching Characteristics

see Figure 6-38

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
CAP2	$t_{w(APWM)}$	Pulse duration, APWMx high/low	2P(1) - 2		ns

(1) P = MAIN_SYSCLK0/4 period in ns.

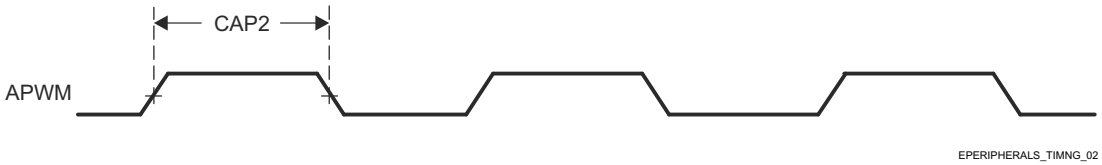


Figure 6-38. ECAP Switching Characteristics

For more information, see *Enhanced Capture (ECAP) Module* section in *Peripherals* chapter in the device TRM.

6.12.5.7 Emulation and Debug

For more details about features and additional description information on the device Trace and JTAG interfaces, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

6.12.5.7.1 Trace

Table 6-50. Trace Timing Conditions

PARAMETER		MIN	MAX	UNIT
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	5	pF
PCB CONNECTIVITY REQUIREMENTS				
$t_{d(Trace\ Mismatch)}$	Propagation delay mismatch across all traces		200	ps

Table 6-51. Trace Switching Characteristics

NO.	PARAMETER		MIN	MAX	UNIT
1.8V Mode					
DBTR1	$t_{c(TRC_CLK)}$	Cycle time, TRC_CLK	6.83		ns
DBTR2	$t_{w(TRC_CLKH)}$	Pulse width, TRC_CLK high	2.66		ns
DBTR3	$t_{w(TRC_CLKL)}$	Pulse width, TRC_CLK low	2.66		ns
DBTR4	$t_{osu(TRC_DATAV-TRC_CLK)}$	Output setup time, TRC_DATA valid to TRC_CLK edge	0.85		ns
DBTR5	$t_{oh(TRC_CLK-TRC_DATAI)}$	Output hold time, TRC_CLK edge to TRC_DATA invalid	0.85		ns
DBTR6	$t_{osu(TRC_CTLV-TRC_CLK)}$	Output setup time, TRC_CTL valid to TRC_CLK edge	0.85		ns
DBTR7	$t_{oh(TRC_CLK-TRC_CTLI)}$	Output hold time, TRC_CLK edge to TRC_CTL invalid	0.85		ns
3.3V Mode					
DBTR1	$t_{c(TRC_CLK)}$	Cycle time, TRC_CLK	8.78		ns
DBTR2	$t_{w(TRC_CLKH)}$	Pulse width, TRC_CLK high	3.64		ns
DBTR3	$t_{w(TRC_CLKL)}$	Pulse width, TRC_CLK low	3.64		ns
DBTR4	$t_{osu(TRC_DATAV-TRC_CLK)}$	Output setup time, TRC_DATA valid to TRC_CLK edge	1.10		ns
DBTR5	$t_{oh(TRC_CLK-TRC_DATAI)}$	Output hold time, TRC_CLK edge to TRC_DATA invalid	1.10		ns
DBTR6	$t_{osu(TRC_CTLV-TRC_CLK)}$	Output setup time, TRC_CTL valid to TRC_CLK edge	1.10		ns
DBTR7	$t_{oh(TRC_CLK-TRC_CTLI)}$	Output hold time, TRC_CLK edge to TRC_CTL invalid	1.10		ns

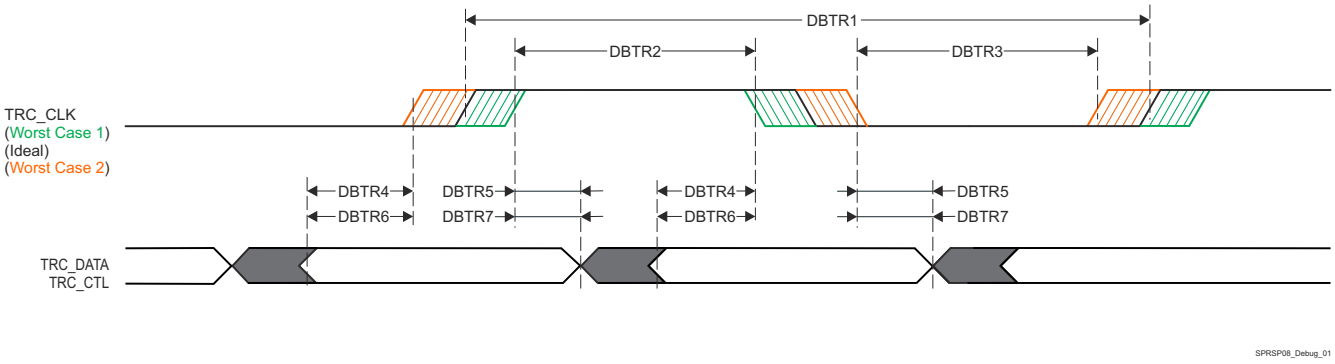


Figure 6-39. Trace Switching Characteristics

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6.12.5.7.2 JTAG

Table 6-52. JTAG Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.5	2.0	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	5	15	pF
PCB CONNECTIVITY REQUIREMENTS				
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	83.5	1000(1)	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces		100	ps

(1) Maximum propagation delay associated with the JTAG signal traces has a significant impact on maximum TCK operating frequency. It may be possible to increase the trace delay beyond this value, but the operating frequency of TCK must be reduced to account for the additional trace delay.

Table 6-53. JTAG Timing Requirements

see Figure 6-40

NO.			MIN	MAX	UNIT
J1	$t_{c(TCK)}$	Cycle time minimum, TCK	40(1)		ns
J2	$t_{w(TCKH)}$	Pulse width minimum, TCK high	0.4P(2)		ns
J3	$t_{w(TCKL)}$	Pulse width minimum, TCK low	0.4P(2)		ns
J4	$t_{su(TDI-TCK)}$	Input setup time minimum, TDI valid to TCK high	2		ns
	$t_{su(TMS-TCK)}$	Input setup time minimum, TMS valid to TCK high	2		ns
J5	$t_{h(TCK-TDI)}$	Input hold time minimum, TDI valid from TCK high	3		ns
	$t_{h(TCK-TMS)}$	Input hold time minimum, TMS valid from TCK high	3		ns

(1) The maximum TCK operating frequency assumes the following timing requirements and switching characteristis for the attached debugger. The operating frequency of TCK must be reduced to provide appropriate timing margin if the debugger exceeds any of these assumptions.
- Minimum TDO setup time of 2ns relative to the rising edge of TCK
- TDI and TMS output delay in the range of -12.9ns to 13.9ns relative to the falling edge of TCK

(2) P = TCK cycle time in ns

Table 6-54. JTAG Switching Characteristics

see Figure 6-40

NO.	PARAMETER		MIN	MAX	UNIT
J6	$t_{d(TCKL-TDOI)}$	Delay time minimum, TCK low to TDO invalid	0		ns
J7	$t_{d(TCKL-TDOV)}$	Delay time maximum, TCK low to TDO valid		12	ns

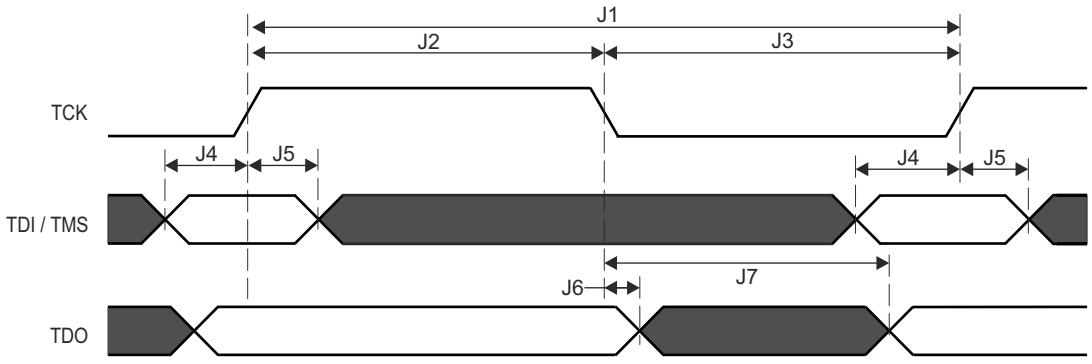


Figure 6-40. JTAG Timing Requirements and Switching Characteristics

6.12.5.8 EPWM

Table 6-55, Table 6-56, Figure 6-41, Table 6-57, Figure 6-42, Figure 6-43, and Figure 6-44 present timing conditions, timing requirements, and switching characteristics for EPWM.

Table 6-55. EPWM Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	1	4	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	7	pF

Table 6-56. EPWM Timing Requirements

see Figure 6-41

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
PWM6	$t_{w(SYNCIN)}$	Pulse duration, EHRPWM_SYNCI	2P(1) + 2		ns
PWM7	$t_{w(TZ)}$	Pulse duration, EHRPWM_TZn_IN low	3P(1) + 2		ns

(1) P = MAIN_SYSCLK0/2 period in ns.

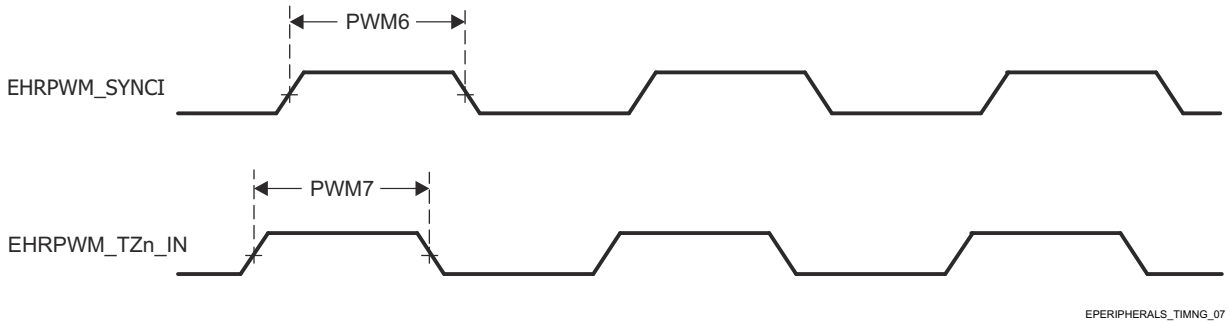


Figure 6-41. EPWM Timing Requirements

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Table 6-57. EPWM Switching Characteristics

see Figure 6-42, Figure 6-43, and Figure 6-44

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
PWM1	$t_{w(PWM)}$	Pulse duration, EHRPWM_A/B high/low	P(1) - 3		ns
PWM2	$t_{w(SYNCOUT)}$	Pulse duration, EHRPWM_SYNCO	P(1) - 3		ns
PWM3	$t_{d(TZ-PWM)}$	Delay time, EHRPWM_TZn_IN active to EHRPWM_A/B forced high/low		11	ns
PWM4	$t_{d(TZ-PWMZ)}$	Delay time, EHRPWM_TZn_IN active to EHRPWM_A/B Hi-Z		11	ns
PWM5	$t_{w(SOC)}$	Pulse duration, EHRPWM_SOCA/B output	P(1) - 3		ns

(1) P = MAIN_SYSCLK0/2 period in ns.

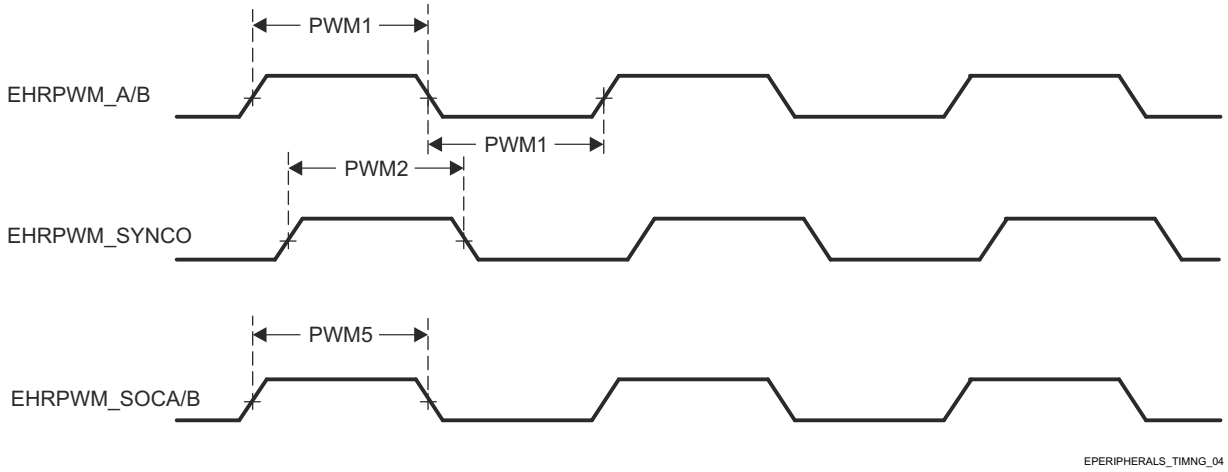


Figure 6-42. EHRPWM Switching Characteristics

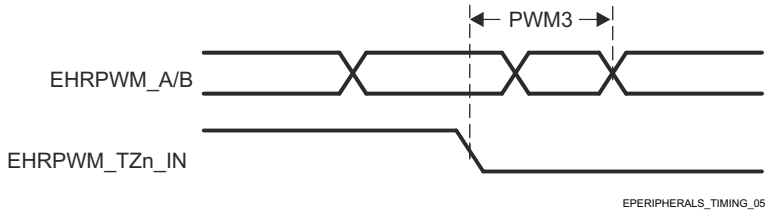


Figure 6-43. EHRPWM_TZn_IN to EHRPWM_A/B Forced Switching Characteristics

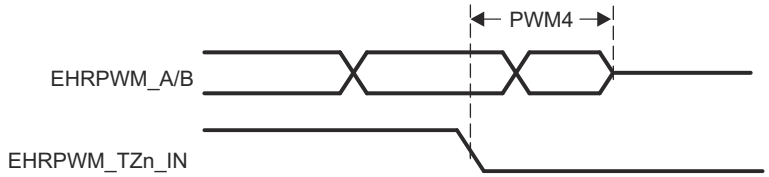


Figure 6-44. EHRPWM_TZn_IN to EHRPWM_A/B Hi-Z Switching Characteristics

For more information, see *Enhanced Pulse Width Modulation (EPWM) Module* section in *Peripherals* chapter in the device TRM.

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6.12.5.9 EQEP

Table 6-58, Table 6-59, Figure 6-45, and Table 6-60 present timing conditions, timing requirements, and switching characteristics for EQEP.

Table 6-58. EQEP Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	1	4	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	7	pF

Table 6-59. EQEP Timing Requirements

see Figure 6-45

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
QEP1	$t_{w(QEP)}$	Pulse duration, QEP_A/B	2P(1) + 2		ns
QEP2	$t_{w(QEPIH)}$	Pulse duration, QEP_I high	2P(1) + 2		ns
QEP3	$t_{w(QEPIL)}$	Pulse duration, QEP_I low	2P(1) + 2		ns
QEP4	$t_{w(QEPSH)}$	Pulse duration, QEP_S high	2P(1) + 2		ns
QEP5	$t_{w(QEPSL)}$	Pulse duration, QEP_S low	2P(1) + 2		ns

(1) P = MAIN_SYSCLK0/4 period in ns.

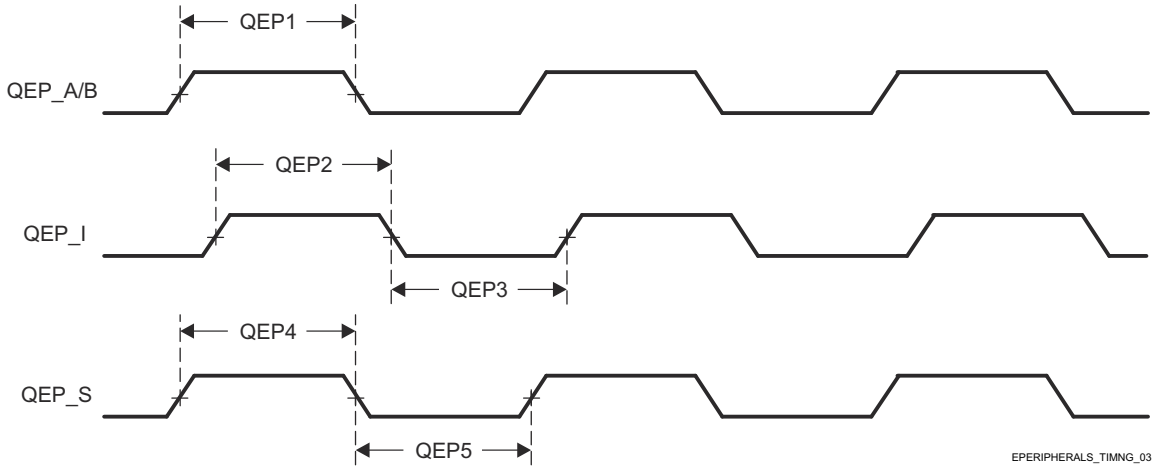


Figure 6-45. EQEP Timing Requirements

Table 6-60. EQEP Switching Characteristics

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
QEP6	$t_{d(QEP-CNTR)}$	Delay time, external clock to counter increment		24	ns

For more information, see *Enhanced Quadrature Encoder Pulse (EQEP) Module* section in *Peripherals* chapter in the device TRM.

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6.12.5.10 GPIO

Table 6-61, Table 6-62, and Table 6-63 present timing conditions, timing requirements, and switching characteristics for GPIO.

The device has three instances of the GPIO module.

- MCU_GPIO0
- GPIO0
- GPIO1

Note

GPIOn_x is generic name used to describe a GPIO signal, where n represents the specific GPIO module and x represents one of the input/output signals associated with the module.

For additional description information on the device GPIO, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-61. GPIO Timing Conditions

PARAMETER		BUFFER TYPE	MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate	LVCMOS (VDD(1) = 1.8V)	0.0018	6.6	V/ns
		LVCMOS (VDD(1) = 3.3V)	0.0033	6.6	V/ns
		I2C OD FS (VDD(1) = 1.8V)	0.0018	6.6	V/ns
		I2C OD FS (VDD(1) = 3.3V)	0.0033	0.08	V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance	LVCMOS	3	10	pF
		I2C OD FS	3	100	pF

(1) VDD stands for corresponding power supply. For more information on the power supply name and the corresponding ball(s), see POWER column of the *Pin Attributes* table.

Table 6-62. GPIO Timing Requirements

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
GPIO1	$t_{w(GPIO_IN)}$	Pulse width, GPIOn_x	2P(1) + 30		ns

(1) P = functional clock period in ns.

Table 6-63. GPIO Switching Characteristics

NO.	PARAMETER	DESCRIPTION	BUFFER TYPE	MIN	MAX	UNIT
GPIO2	$t_{w(GPIO_OUT)}$	Pulse width, GPIOn_x	LVCMOS	0.975P(1) - 3.6		ns
			I2C OD FS	160		ns

(1) P = functional clock period in ns.

For more information, see *General-Purpose Interface (GPIO)* section in *Peripherals* chapter in the device TRM.

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6.12.5.11 GPMC

For more details about features and additional description information on the device General-Purpose Memory Controller, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-64 presents timing conditions for GPMC.

Table 6-64. GPMC Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate		1.65	4	V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance		2	20	pF
PCB CONNECTIVITY REQUIREMENTS					
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	133MHz Synchronous Mode	140	360	ps
		All other modes	140	720	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces			200	ps

For more information, see *General-Purpose Memory Controller (GPMC)* section in *Peripherals* chapter in the device TRM.

6.12.5.11.1 GPMC and NOR Flash — Synchronous Mode

Table 6-65 and Table 6-66 present timing requirements and switching characteristics for GPMC and NOR Flash - Synchronous Mode.

Table 6-65. GPMC and NOR Flash Timing Requirements — Synchronous Mode

see Figure 6-46, Figure 6-47, and Figure 6-50

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
F12	$t_{su(dV-clkH)}$	Setup time, GPMC_AD[15:0] valid before GPMC_CLK high	0.92		ns
F13	$t_{h(clkH-dV)}$	Hold time, GPMC_AD[15:0] valid after GPMC_CLK high	2.09		ns
F21	$t_{su(waitV-clkH)}$	Setup time, GPMC_WAIT[j](1)(2) valid before GPMC_CLK high	0.92		ns
F22	$t_{h(clkH-waitV)}$	Hold time, GPMC_WAIT[j](1)(2) valid after GPMC_CLK high	2.09		ns

(1) In GPMC_WAIT[j], j is equal to 0 or 1.
(2) Wait monitoring support is limited to a WaitMonitoringTime value > 0. For a full description of wait monitoring feature, see *General-Purpose Memory Controller (GPMC)* section in the device TRM.

Table 6-66. GPMC and NOR Flash Switching Characteristics – Synchronous Mode

see Figure 6-46, Figure 6-47, Figure 6-48, Figure 6-49, and Figure 6-50

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
F0	$t_{c(clk)}$	Cycle time, GPMC_CLK(16)	7.52		ns
F1	$t_{w(clkH)}$	Typical pulse duration, GPMC_CLK high	0.475P(13) - 0.3		ns
F1	$t_{w(clkL)}$	Typical pulse duration, GPMC_CLK low	0.475P(13) - 0.3		ns
F2	$t_{d(clkH-csnV)}$	Delay time, GPMC_CLK rising edge to GPMC_CSn[i] transition(12)	F(5) - 2.2	F(5) + 3.75	ns
F3	$t_{d(clkH-CSn[i]V)}$	Delay time, GPMC_CLK rising edge to GPMC_CSn[i] invalid(12)	D(4) - 2.2	D(4) + 4.5	ns
F4	$t_{d(aV-clk)}$	Delay time, GPMC_A[27:1] valid to GPMC_CLK first edge	B(2) - 2.3	B(2) + 4.5	ns
F5	$t_{d(clkH-aIV)}$	Delay time, GPMC_CLK rising edge to GPMC_A[27:1] invalid	-2.3	4.5	ns

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Table 6-66. GPMC and NOR Flash Switching Characteristics – Synchronous Mode (continued)

see Figure 6-46, Figure 6-47, Figure 6-48, Figure 6-49, and Figure 6-50

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
F6	$t_{d(be[x]nV-clk)}$	Delay time, GPMC_BE0n_CLE, GPMC_BE1n valid to GPMC_CLK first edge	B(2) - 2.3	B(2) + 1.9	ns
F7	$t_{d(clkH-be[x]nIV)}$	Delay time, GPMC_CLK rising edge to GPMC_BE0n_CLE, GPMC_BE1n invalid	D(4) - 2.3	D(4) + 1.9	ns
F8	$t_{d(clkH-advn)}$	Delay time, GPMC_CLK rising edge to GPMC_ADVn_ALE transition	G(6) - 2.3	G(6) + 4.5	ns
F9	$t_{d(clkH-advnIV)}$	Delay time, GPMC_CLK rising edge to GPMC_ADVn_ALE invalid	D(4) - 2.3	D(4) + 4.5	ns
F10	$t_{d(clkH-oen)}$	Delay time, GPMC_CLK rising edge to GPMC_OEn_REn transition	H(7) - 2.3	H(7) + 3.5	ns
F11	$t_{d(clkH-oenIV)}$	Delay time, GPMC_CLK rising edge to GPMC_OEn_REn invalid	D(4) - 2.3	D(4) + 3.5	ns
F14	$t_{d(clkH-wen)}$	Delay time, GPMC_CLK rising edge to GPMC_WEn transition	I(8) - 2.3	I(8) + 4.5	ns
F15	$t_{d(clkH-do)}$	Delay time, GPMC_CLK rising edge to GPMC_AD[15:0] transition(9)	- 2.3	+ 2.7	ns
F15	$t_{d(clkL-do)}$	Delay time, GPMC_CLK falling edge to GPMC_AD[15:0] data bus transition(10)	- 2.3	+ 2.7	ns
F15	$t_{d(clkL-do).}$	Delay time, GPMC_CLK falling edge to GPMC_AD[15:0] data bus transition(11)	- 2.3	+ 2.7	ns
F17	$t_{d(clkH-be[x]n)}$	Delay time, GPMC_CLK rising edge to GPMC_BE0n_CLE, GPMC_BE1n transition(9)	- 2.3	+ 1.9	ns
F17	$t_{d(clkL-be[x]n)}$	Delay time, GPMC_CLK falling edge to GPMC_BE0n_CLE, GPMC_BE1n transition(10)	- 2.3	+ 1.9	ns
F17	$t_{d(clkL-be[x]n).}$	Delay time, GPMC_CLK falling edge to GPMC_BE0n_CLE, GPMC_BE1n transition(11)	- 2.3	+ 1.9	ns
F18	$t_{w(csnV)}$	Pulse duration, GPMC_CSn[i](12) low	A(1)		ns
F19	$t_{w(be[x]nV)}$	Pulse duration, GPMC_BE0n_CLE, GPMC_BE1n low	C(3)		ns
F20	$t_{w(advnV)}$	Pulse duration, GPMC_ADVn_ALE low	K(14)		ns

(1) For single read: A = (CSRdOffTime - CSOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For single write: A = (CSWrOffTime - CSOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst read: A = (CSRdOffTime - CSOnTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst write: A = (CSWrOffTime - CSOnTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
With n being the page burst access number.

(2) Address bus / Byte Enables become valid at start of cycle, GPMC_CLK activation time may be delayed after start of cycle B = ClkActivationTime × GPMC_FCLK(15)

(3) For single read: C = RdCycleTime × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For single write: C = WrCycleTime × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst read: C = (RdCycleTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst write: C = (WrCycleTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
With n being the page burst access number.

(4) For single read: D = (RdCycleTime - RdAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For single write: D = (WrCycleTime - WrAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst read: D = (RdCycleTime - RdAccessTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For burst write: D = (WrCycleTime - WrAccessTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
With n being the page burst access number.

(5) For CSn falling edge (CS activated):
- Case GPMCFCLKDIVIDER = 0:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and CSOnTime are odd) or (ClkActivationTime and CSOnTime are even)
  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if ((CSOnTime - ClkActivationTime) is a multiple of 3)

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  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSOnTime - ClkActivationTime - 1) is a multiple of 3)
  - F = (2 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSOnTime - ClkActivationTime - 2) is a multiple of 3)

For CSn rising edge (CS deactivated) in Reading mode:

- Case GPMCFCLKDIVIDER = 0:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and CSRdOffTime are odd) or (ClkActivationTime and CSRdOffTime are even)
  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if ((CSRdOffTime - ClkActivationTime) is a multiple of 3)
  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSRdOffTime - ClkActivationTime - 1) is a multiple of 3)
  - F = (2 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSRdOffTime - ClkActivationTime - 2) is a multiple of 3)

For CSn rising edge (CS deactivated) in Writing mode:

- Case GPMCFCLKDIVIDER = 0:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and CSWrOffTime are odd) or (ClkActivationTime and CSWrOffTime are even)
  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - F = 0.5 × CSExtraDelay × GPMC_FCLK(15) if ((CSWrOffTime - ClkActivationTime) is a multiple of 3)
  - F = (1 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSWrOffTime - ClkActivationTime - 1) is a multiple of 3)
  - F = (2 + 0.5 × CSExtraDelay) × GPMC_FCLK(15) if ((CSWrOffTime - ClkActivationTime - 2) is a multiple of 3)

(6) For ADV falling edge (ADV activated):

- Case GPMCFCLKDIVIDER = 0:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and ADVOnTime are odd) or (ClkActivationTime and ADVOnTime are even)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if ((ADVOnTime - ClkActivationTime) is a multiple of 3)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVOnTime - ClkActivationTime - 1) is a multiple of 3)
  - G = (2 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVOnTime - ClkActivationTime - 2) is a multiple of 3)

For ADV rising edge (ADV deactivated) in Reading mode:

- Case GPMCFCLKDIVIDER = 0:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and ADVRdOffTime are odd) or (ClkActivationTime and ADVRdOffTime are even)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if ((ADVRdOffTime - ClkActivationTime) is a multiple of 3)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVRdOffTime - ClkActivationTime - 1) is a multiple of 3)
  - G = (2 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVRdOffTime - ClkActivationTime - 2) is a multiple of 3)

For ADV rising edge (ADV deactivated) in Writing mode:

- Case GPMCFCLKDIVIDER = 0:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:

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  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and ADVWrOffTime are odd) or (ClkActivationTime and ADVWrOffTime are even)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - G = 0.5 × ADVExtraDelay × GPMC_FCLK(15) if ((ADVWrOffTime - ClkActivationTime) is a multiple of 3)
  - G = (1 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVWrOffTime - ClkActivationTime - 1) is a multiple of 3)
  - G = (2 + 0.5 × ADVExtraDelay) × GPMC_FCLK(15) if ((ADVWrOffTime - ClkActivationTime - 2) is a multiple of 3)

(7) For OE falling edge (OE activated) and IO DIR rising edge (Data Bus input direction):

- Case GPMCFCLKDIVIDER = 0:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and OEOnTime are odd) or (ClkActivationTime and OEOnTime are even)
  - H = (1 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15) if ((OEOnTime - ClkActivationTime) is a multiple of 3)
  - H = (1 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) if ((OEOnTime - ClkActivationTime - 1) is a multiple of 3)
  - H = (2 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) if ((OEOnTime - ClkActivationTime - 2) is a multiple of 3)

For OE rising edge (OE deactivated):

- Case GPMCFCLKDIVIDER = 0:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and OEOffTime are odd) or (ClkActivationTime and OEOffTime are even)
  - H = (1 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - H = 0.5 × OEExtraDelay × GPMC_FCLK(15) if ((OEOffTime - ClkActivationTime) is a multiple of 3)
  - H = (1 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) if ((OEOffTime - ClkActivationTime - 1) is a multiple of 3)
  - H = (2 + 0.5 × OEExtraDelay) × GPMC_FCLK(15) if ((OEOffTime - ClkActivationTime - 2) is a multiple of 3)

(8) For WE falling edge (WE activated):

- Case GPMCFCLKDIVIDER = 0:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK(15)
- Case GPMCFCLKDIVIDER = 1:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and WEOnTime are odd) or (ClkActivationTime and WEOnTime are even)
  - I = (1 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK(15) if ((WEOnTime - ClkActivationTime) is a multiple of 3)
  - I = (1 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) if ((WEOnTime - ClkActivationTime - 1) is a multiple of 3)
  - I = (2 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) if ((WEOnTime - ClkActivationTime - 2) is a multiple of 3)

For WE rising edge (WE deactivated):

- Case GPMCFCLKDIVIDER = 0:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK (13)
- Case GPMCFCLKDIVIDER = 1:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK(15) if (ClkActivationTime and WEOffTime are odd) or (ClkActivationTime and WEOffTime are even)
  - I = (1 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) otherwise
- Case GPMCFCLKDIVIDER = 2:
  - I = 0.5 × WEExtraDelay × GPMC_FCLK(15) if ((WEOffTime - ClkActivationTime) is a multiple of 3)
  - I = (1 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) if ((WEOffTime - ClkActivationTime - 1) is a multiple of 3)
  - I = (2 + 0.5 × WEExtraDelay) × GPMC_FCLK(15) if ((WEOffTime - ClkActivationTime - 2) is a multiple of 3)

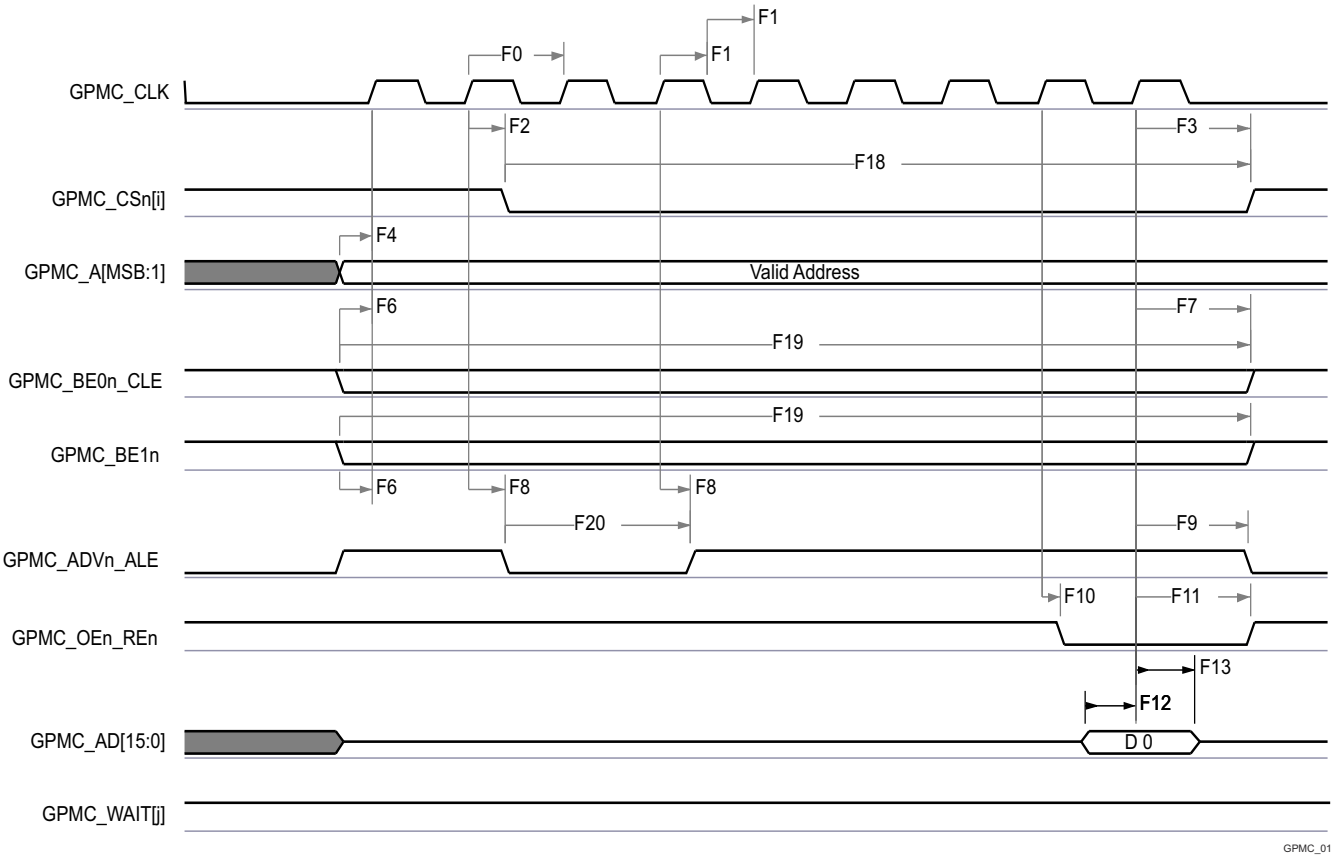
(9) Case CLK DIV 1 mode, first transfer only: Data and byte enables transition on rise edge of GPMC_CLK

- Non-multiplexed mode: data transition at start of cycle

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- Multiplexed mode: data transition at WRDATAONADMUXBUS × (TimeParaGranularity + 1) × GPMC_FCLK(15)

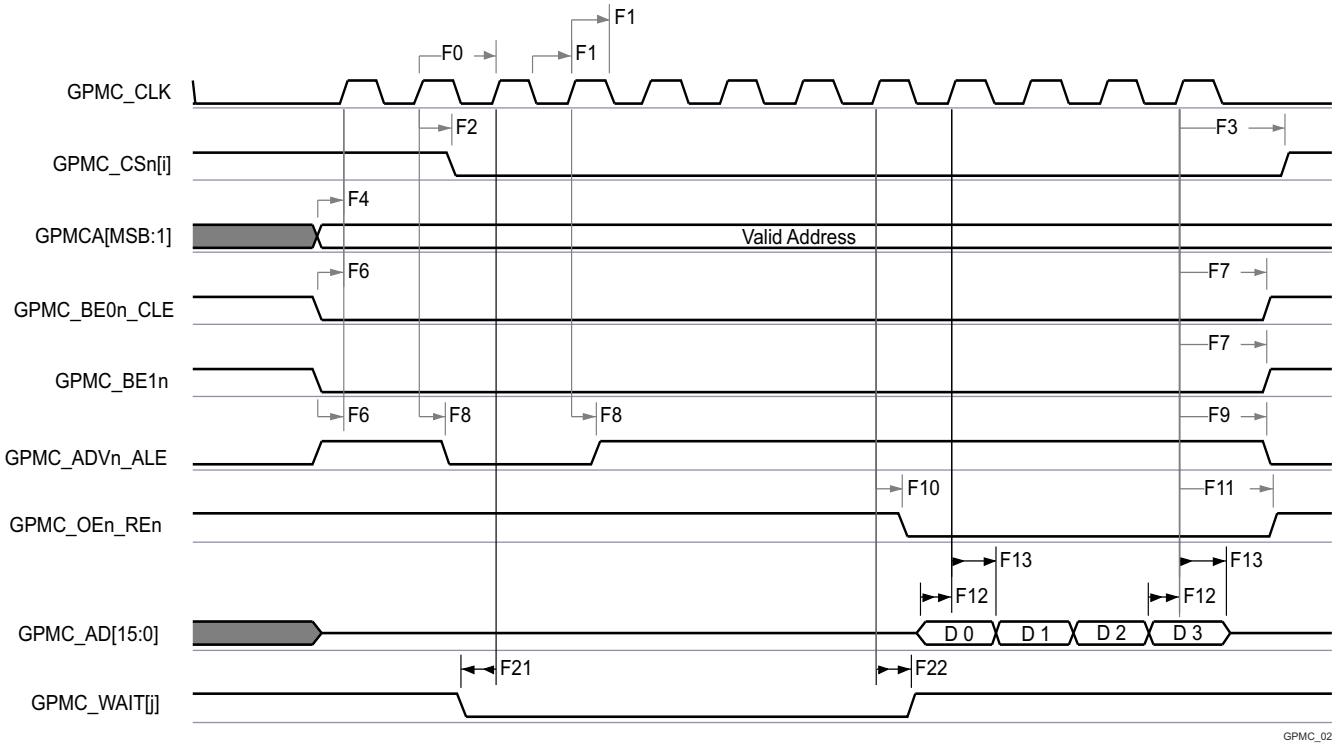
(10) Case CLK DIV 1 mode, all data and byte enables after initial transfer: Data and byte enables transition on fall edge of GPMC_CLK (Half cycle of GPMC_CLK)
(11) Case modes other than CLK DIV 1 mode (GPMC_CLK divided down from GPMC_FCLK): All data and byte enables transition on fall edge of GPMC_CLK (Half cycle of GPMC_CLK). ClkActivationTime, GPMCFCLKDIVIDER, RDACCESSTIME/WRACCESSTIME, and PAGEBURSTACCESSTIME configuration must be configured to enforce data and byte enables transition on falling edge of GPMC_CLK (to be latched on rise edge of GPMC_CLK)
(12) In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
(13) P = GPMC_CLK period in ns
(14) For read: K = (ADVRdOffTime - ADVOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
For write: K = (ADVWrOffTime - ADVOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(15)
(15) GPMC_FCLK is general-purpose memory controller internal functional clock period in ns.
(16) Related to the GPMC_CLK output clock maximum and minimum frequencies programmable in the GPMC module by setting the GPMC_CONFIG1_i configuration register bit field GPMCFCLKDIVIDER.



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
B. In GPMC_WAIT[j], j is equal to 0 or 1.

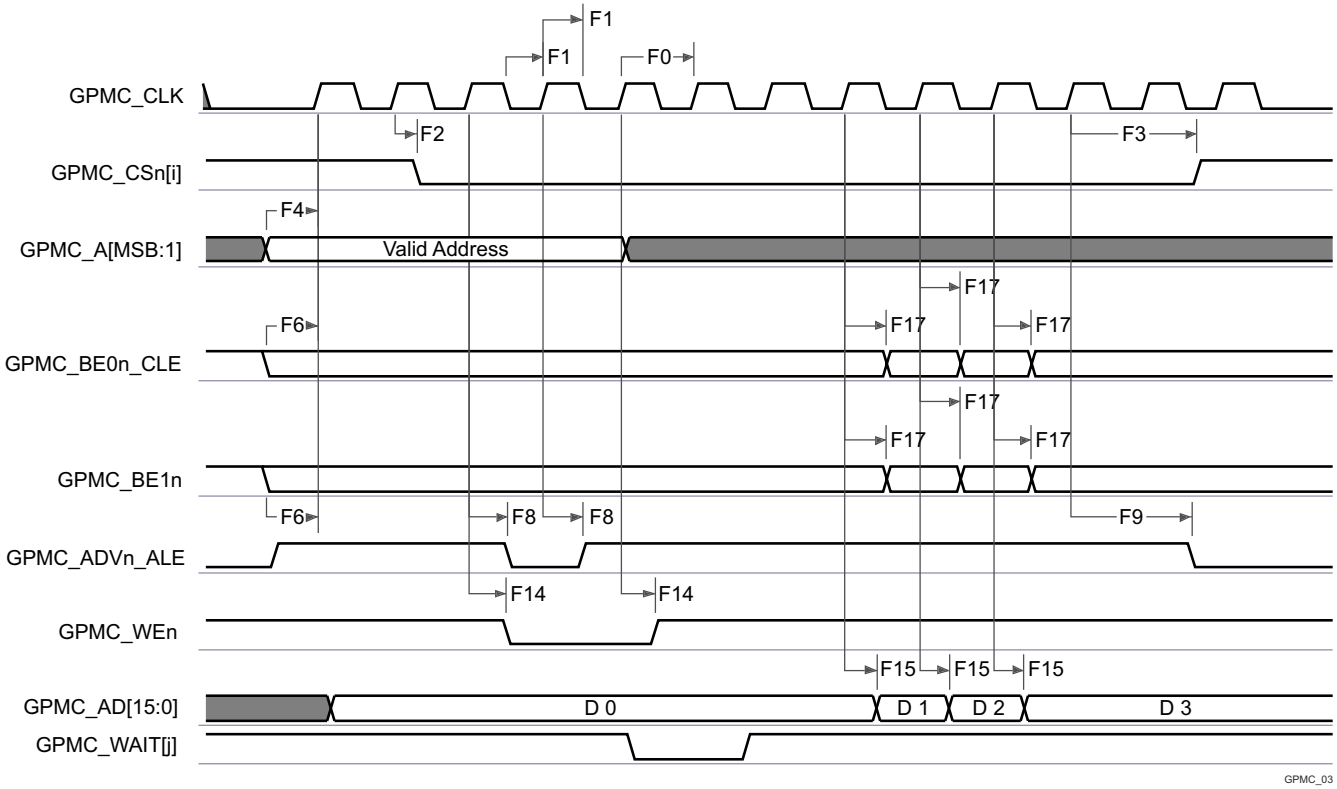
Figure 6-46. GPMC and NOR Flash — Synchronous Single Read (GPMCFCLKDIVIDER = 0)

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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
B. In GPMC_WAIT[j], j is equal to 0 or 1.

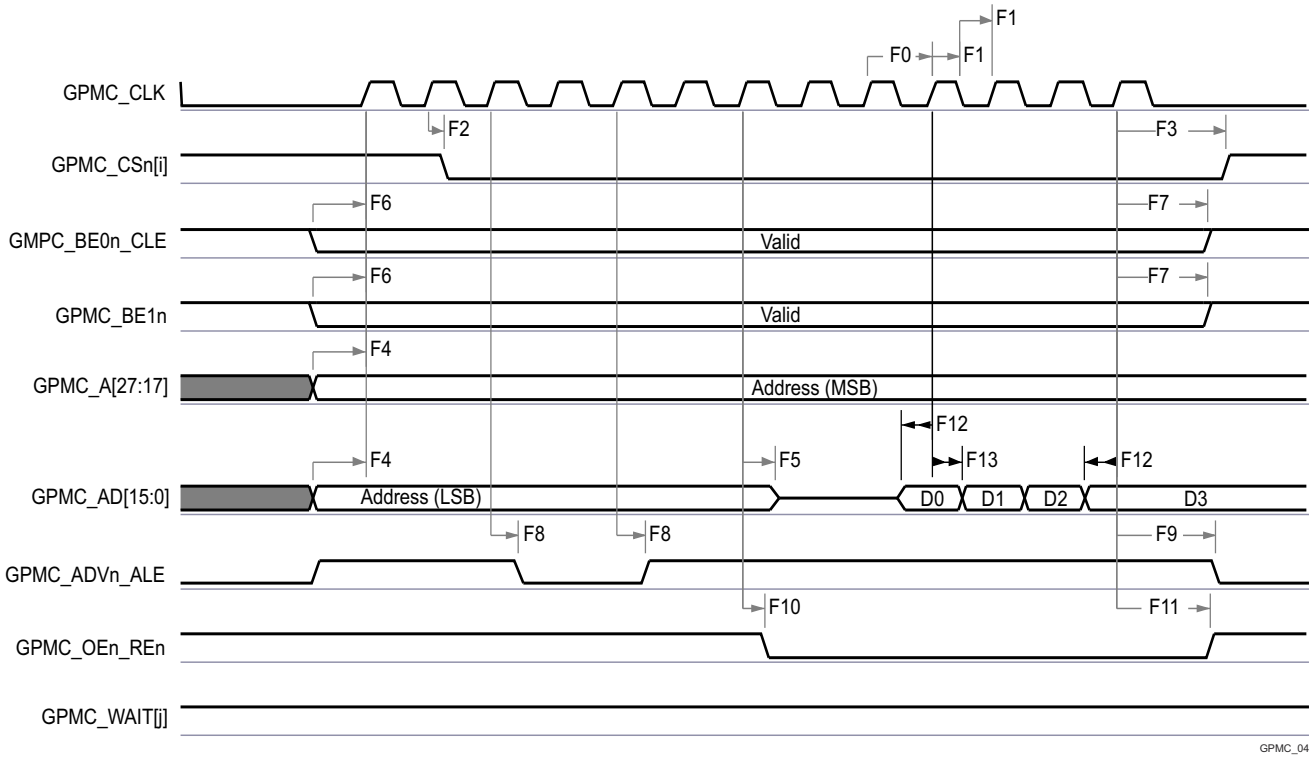
Figure 6-47. GPMC and NOR Flash — Synchronous Burst Read — 4x16–bit (GPMCFCLKDIVIDER = 0)



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.

B. In GPMC_WAIT[j], j is equal to 0 or 1.

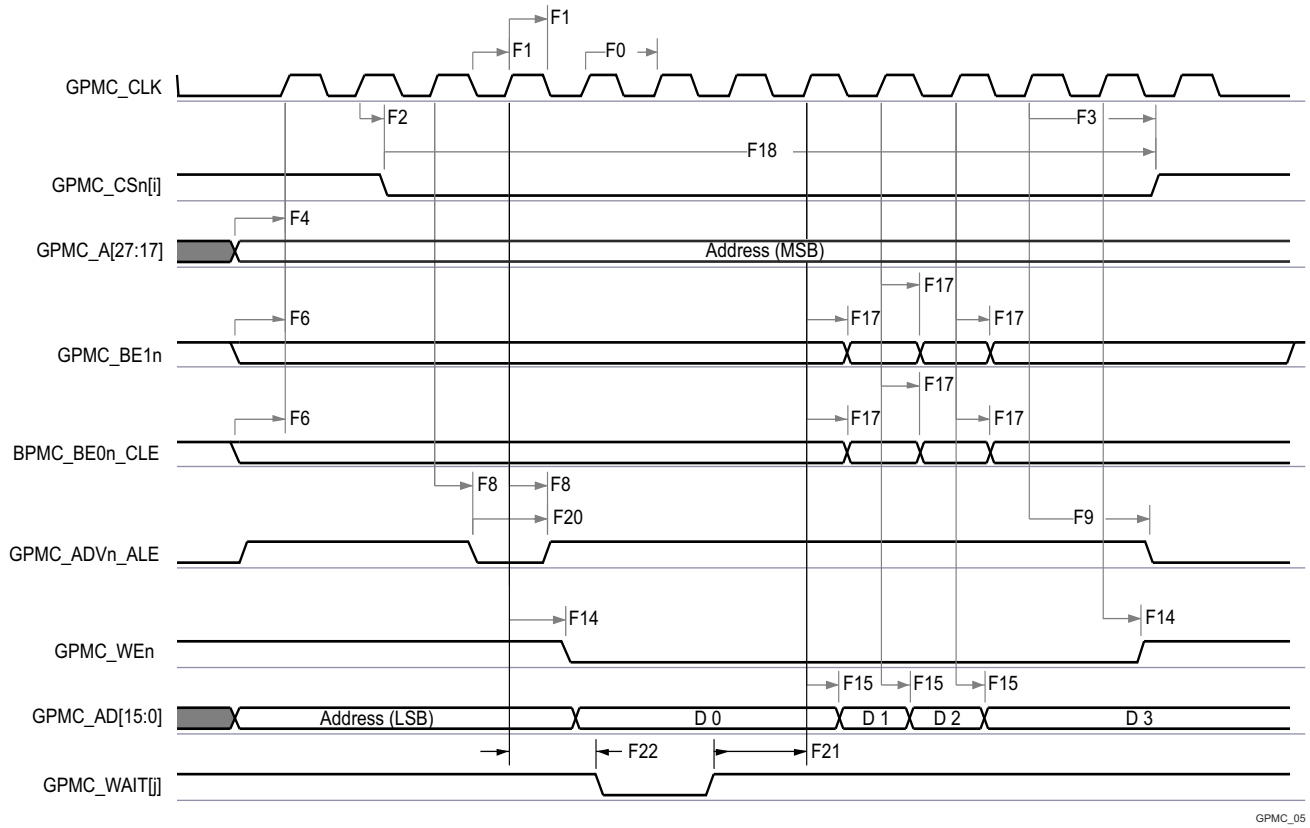
Figure 6-48. GPMC and NOR Flash—Synchronous Burst Write (GPMCFCLKDIVIDER = 0)



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
B. In GPMC_WAIT[j], j is equal to 0 or 1.

Figure 6-49. GPMC and Multiplexed NOR Flash — Synchronous Burst Read

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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
B. In GPMC_WAIT[j], j is equal to 0 or 1.

Figure 6-50. GPMC and Multiplexed NOR Flash — Synchronous Burst Write

6.12.5.11.2 GPMC and NOR Flash — Asynchronous Mode

Table 6-67 and Table 6-68 present timing requirements and switching characteristics for GPMC and NOR Flash — Asynchronous Mode.

Table 6-67. GPMC and NOR Flash Timing Requirements – Asynchronous Mode

see Figure 6-51, Figure 6-52, Figure 6-53, and Figure 6-55

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
FA5(1)	$t_{acc(d)}$	Data access time		H(5)	ns
FA20(2)	$t_{acc1\text{-}pgmode(d)}$	Page mode successive data access time		P(4)	ns
FA21(3)	$t_{acc2\text{-}pgmode(d)}$	Page mode first data access time		H(5)	ns

(1) The FA5 parameter illustrates the amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA5 functional clock cycles, input data is internally sampled by active functional clock edge. FA5 value must be stored inside the AccessTime register bit field.
(2) The FA20 parameter illustrates amount of time required to internally sample successive input page data. It is expressed in number of GPMC functional clock cycles. After each access to input page data, next input page data is internally sampled by active functional clock edge after FA20 functional clock cycles. The FA20 value must be stored in the PageBurstAccessTime register bit field.
(3) The FA21 parameter illustrates amount of time required to internally sample first input page data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA21 functional clock cycles, first input page data is internally sampled by active functional clock edge. FA21 value must be stored inside the AccessTime register bit field.
(4) P = PageBurstAccessTime × (TimeParaGranularity + 1) × GPMC_FCLK(6)
(5) H = AccessTime × (TimeParaGranularity + 1) × GPMC_FCLK(6)
(6) GPMC_FCLK is general-purpose memory controller internal functional clock period in ns.

Table 6-68. GPMC and NOR Flash Switching Characteristics – Asynchronous Mode

see Figure 6-51, Figure 6-52, Figure 6-53, Figure 6-54, Figure 6-55, and Figure 6-56

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
FA0	$t_{w(be[x]nV)}$	Pulse duration, output lower-byte enable and command latch enable GPMC_BE0n_CLE, output upper-byte enable GPMC_BE1n valid time		N(12)	ns
FA1	$t_{w(csnV)}$	Pulse duration, output chip select GPMC_CSn[i](13) low		A(1)	ns
FA3	$t_{d(csnV\text{-}advnIV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output address valid and address latch enable GPMC_ADVn_ALE invalid	B(2) - 2	B(2) + 2	ns
FA4	$t_{d(csnV\text{-}oenIV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output enable GPMC_OEn_REn invalid (Single read)	C(3) - 2	C(3) + 2	ns
FA9	$t_{d(aV\text{-}csnV)}$	Delay time, output address GPMC_A[27:1] valid to output chip select GPMC_CSn[i](13) valid	J(9) - 2	J(9) + 2	ns
FA10	$t_{d(be[x]nV\text{-}csnV)}$	Delay time, output lower-byte enable and command latch enable GPMC_BE0n_CLE, output upper-byte enable GPMC_BE1n valid to output chip select GPMC_CSn[i](13) valid	J(9) - 2	J(9) + 2	ns
FA12	$t_{d(csnV\text{-}advnV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output address valid and address latch enable GPMC_ADVn_ALE valid	K(10) - 2	K(10) + 2	ns
FA13	$t_{d(csnV\text{-}oenV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output enable GPMC_OEn_REn valid	L(11) - 2	L(11) + 2	ns
FA16	$t_{w(aIV)}$	Pulse duration output address GPMC_A[26:1] invalid between 2 successive read and write accesses	G(7)		ns
FA18	$t_{d(csnV\text{-}oenIV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output enable GPMC_OEn_REn invalid (Burst read)	I(8) - 2	I(8) + 2	ns
FA20	$t_{w(aV)}$	Pulse duration, output address GPMC_A[27:1] valid - 2nd, 3rd, and 4th accesses	D(4)		ns
FA25	$t_{d(csnV\text{-}wenV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output write enable GPMC_WEn valid	E(5) - 2	E(5) + 2	ns
FA27	$t_{d(csnV\text{-}wenIV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output write enable GPMC_WEn invalid	F(6) - 2	F(6) + 2	ns
FA28	$t_{d(wenV\text{-}dV)}$	Delay time, output write enable GPMC_WEn valid to output data GPMC_AD[15:0] valid		2	ns

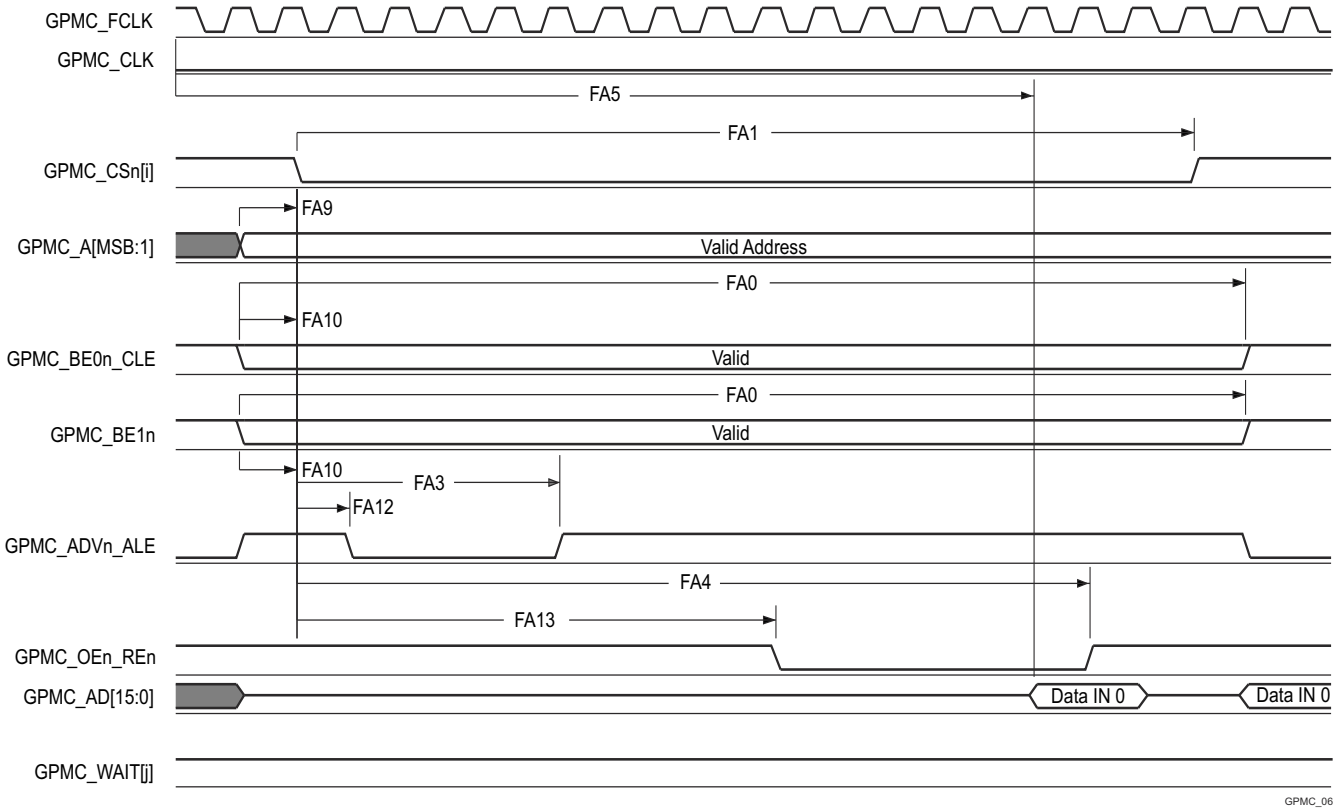
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Table 6-68. GPMC and NOR Flash Switching Characteristics – Asynchronous Mode (continued)

see Figure 6-51, Figure 6-52, Figure 6-53, Figure 6-54, Figure 6-55, and Figure 6-56

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
FA29	$t_{d(dV\text{-}csnV)}$	Delay time, output data GPMC_AD[15:0] valid to output chip select GPMC_CSn[i](13) valid	J(9) - 2	J(9) + 2	ns
FA37	$t_{d(oenV\text{-}alV)}$	Delay time, output enable GPMC_OEn_REn valid to output address GPMC_AD[15:0] phase end		2	ns

(1) For single read: A = (CSRdOffTime - CSOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For single write: A = (CSWrOffTime - CSOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For burst read: A = (CSRdOffTime - CSOnTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For burst write: A = (CSWrOffTime - CSOnTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
with n being the page burst access number
(2) For reading: B = ((ADVRdOffTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (ADVExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
For writing: B = ((ADVWrOffTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (ADVExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(3) C = ((OEOffTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (OEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(4) D = PageBurstAccessTime × (TimeParaGranularity + 1) × GPMC_FCLK(14)
(5) E = ((WEOnTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (WEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(6) F = ((WEOffTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (WEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(7) G = Cycle2CycleDelay × GPMC_FCLK(14)
(8) I = ((OEOffTime + (n - 1) × PageBurstAccessTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (OEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(9) J = (CSOnTime × (TimeParaGranularity + 1) + 0.5 × CSExtraDelay) × GPMC_FCLK(14)
(10) K = ((ADVOnTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (ADVExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(11) L = ((OEOnTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (OEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(12) For single read: N = RdCycleTime × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For single write: N = WrCycleTime × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For burst read: N = (RdCycleTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
For burst write: N = (WrCycleTime + (n - 1) × PageBurstAccessTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
(13) In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
(14) GPMC_FCLK is general-purpose memory controller internal functional clock period in ns.

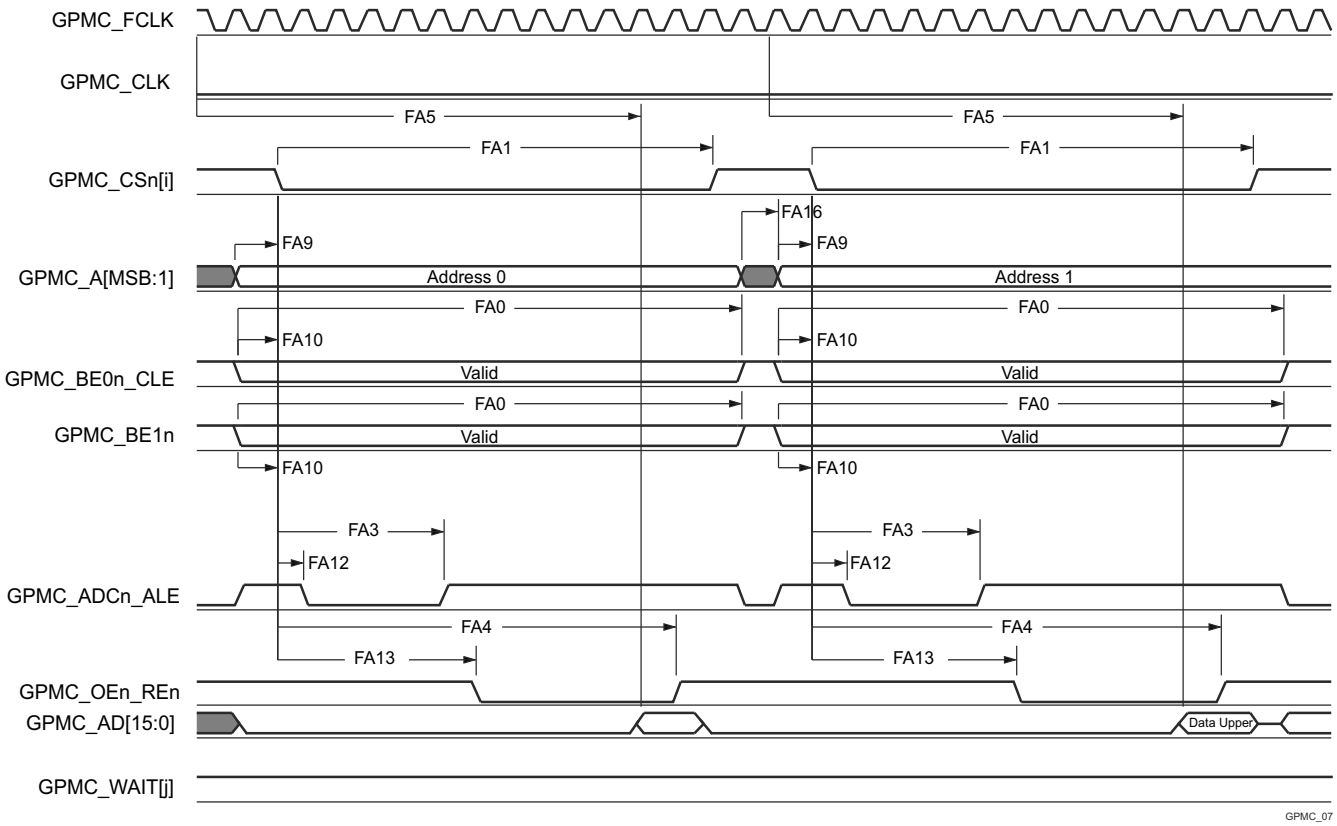


A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], jis equal to 0 or 1.

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B. FA5 parameter illustrates amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA5 functional clock cycles, input data will be internally sampled by active functional clock edge. FA5 value must be stored inside AccessTime register bits field.
C. GPMC_FCLK is an internal clock (GPMC functional clock) not provided externally.

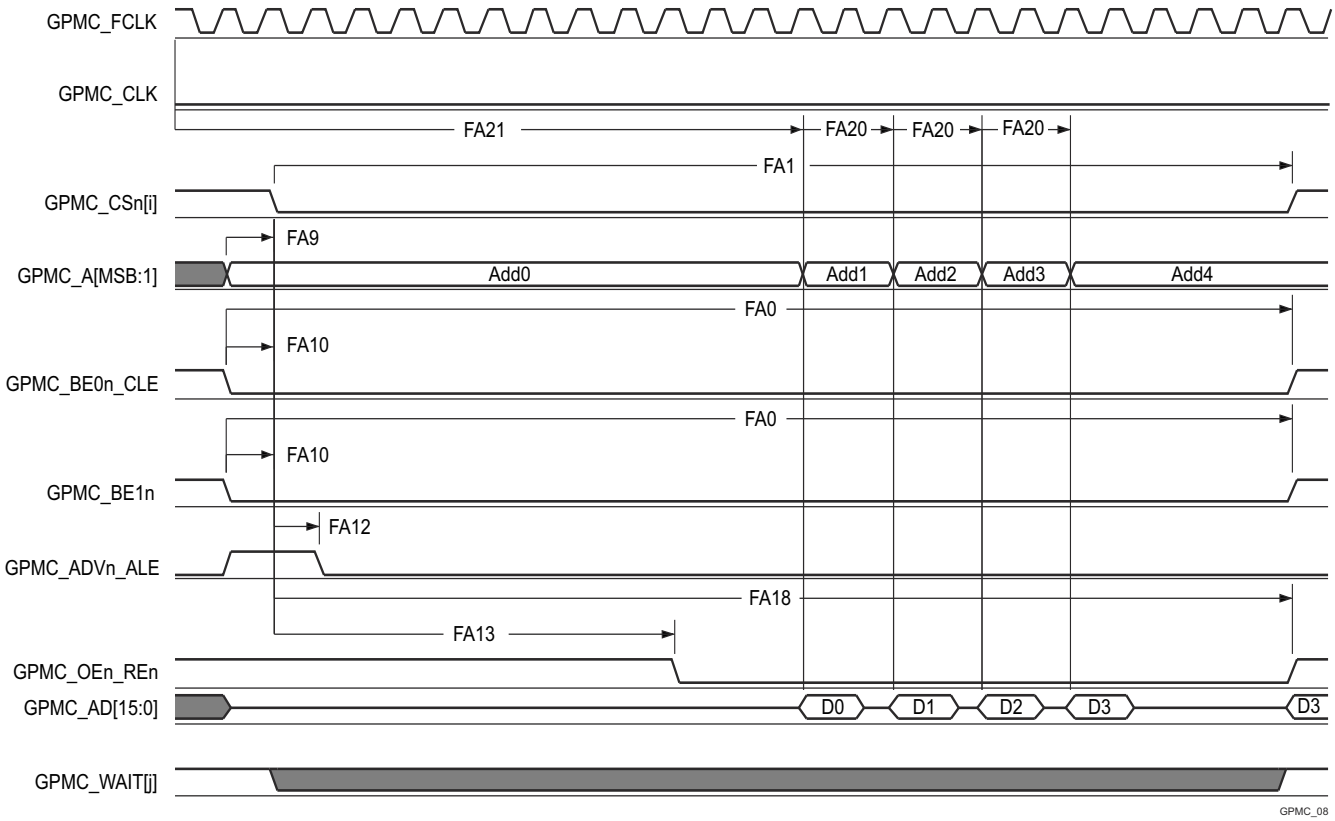
Figure 6-51. GPMC and NOR Flash — Asynchronous Read — Single Word



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.
B. FA5 parameter illustrates amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA5 functional clock cycles, input data will be internally sampled by active functional clock edge. FA5 value must be stored inside AccessTime register bits field.
C. GPMC_FCLK is an internal clock (GPMC functional clock) not provided externally.

Figure 6-52. GPMC and NOR Flash — Asynchronous Read — 32–Bit

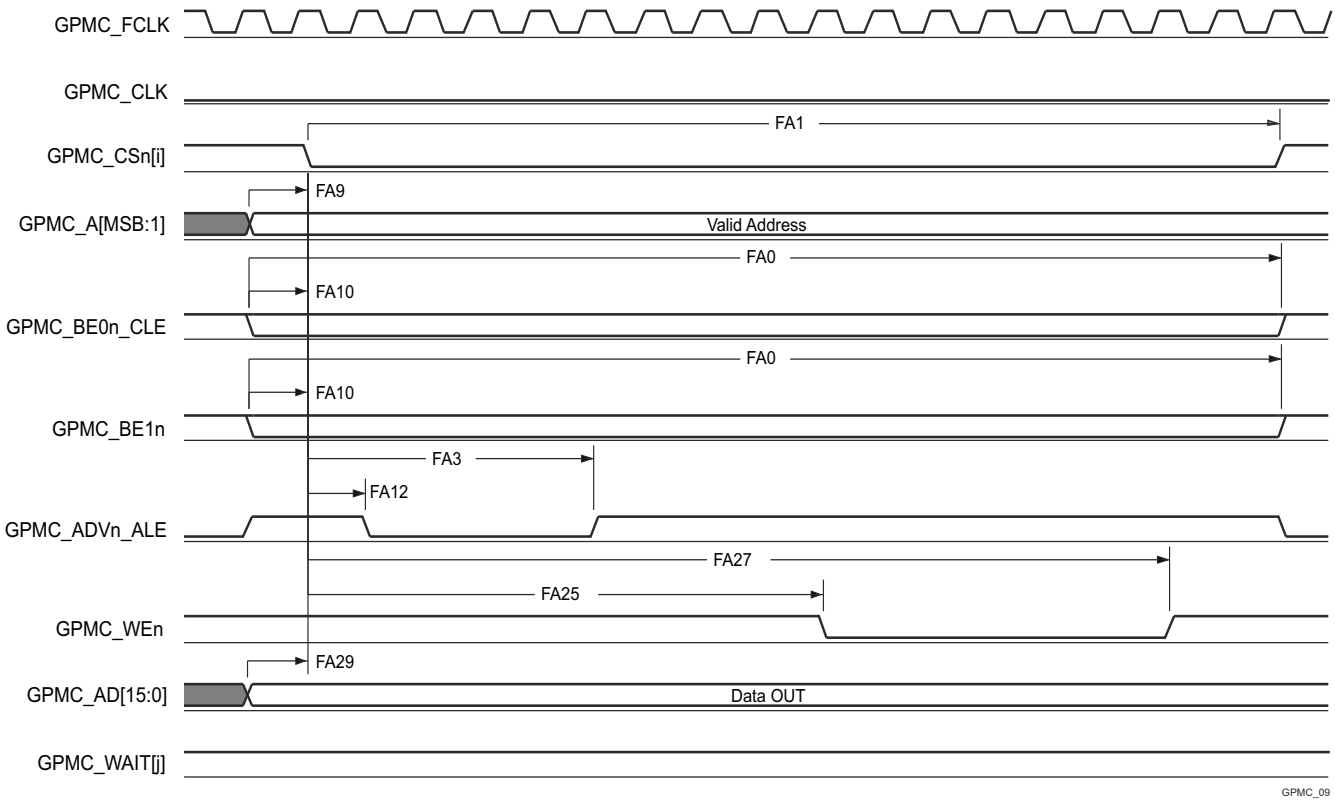
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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.
B. FA21 parameter illustrates amount of time required to internally sample first input page data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA21 functional clock cycles, first input page data will be internally sampled by active functional clock edge. FA21 calculation must be stored inside AccessTime register bits field.
C. FA20 parameter illustrates amount of time required to internally sample successive input page data. It is expressed in number of GPMC functional clock cycles. After each access to input page data, next input page data will be internally sampled by active functional clock edge after FA20 functional clock cycles. FA20 is also the duration of address phases for successive input page data (excluding first input page data). FA20 value must be stored in PageBurstAccessTime register bits field.
D. GPMC_FCLK is an internal clock (GPMC functional clock) not provided externally.

Figure 6-53. GPMC and NOR Flash — Asynchronous Read — Page Mode 4x16–Bit

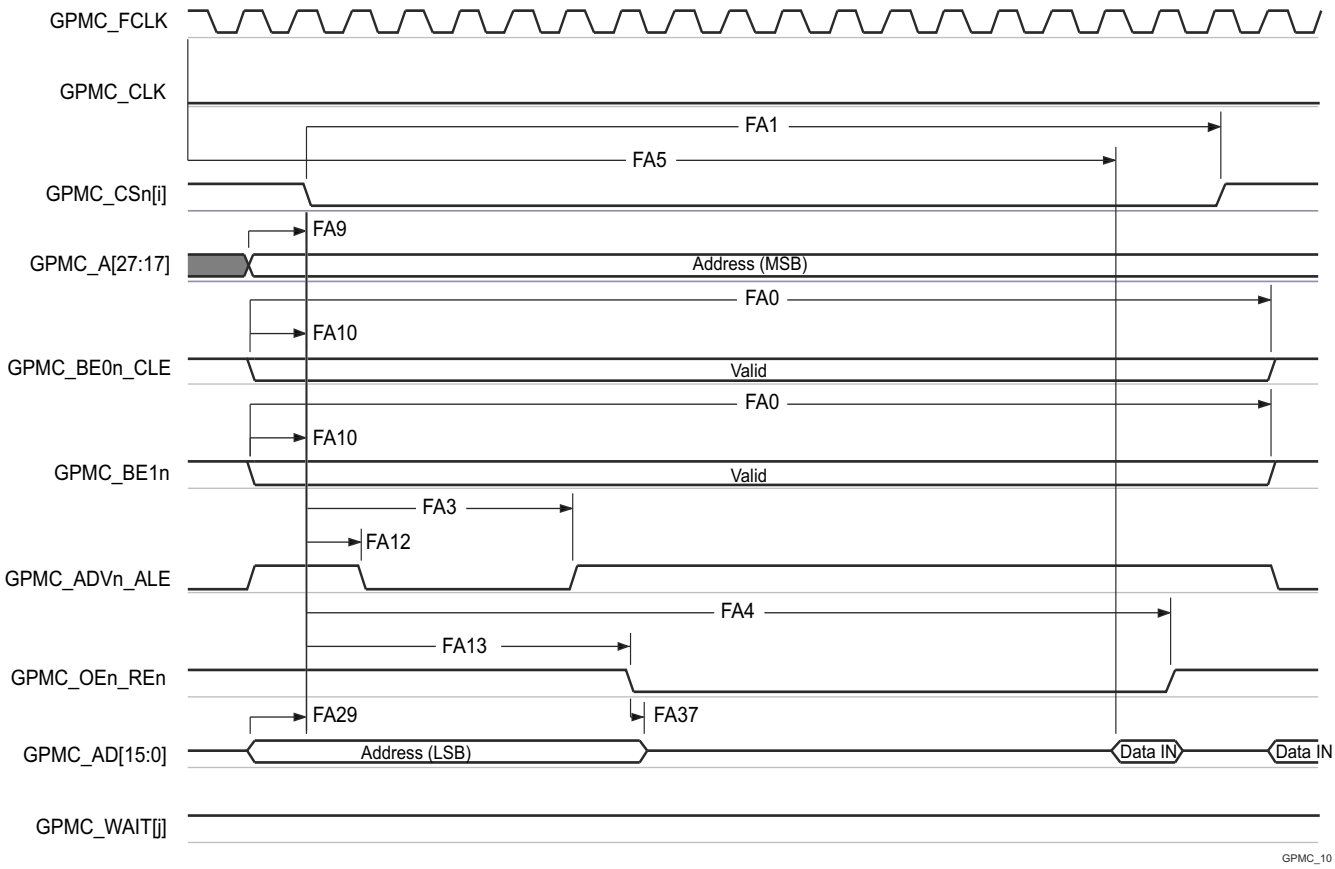
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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.

Figure 6-54. GPMC and NOR Flash — Asynchronous Write — Single Word

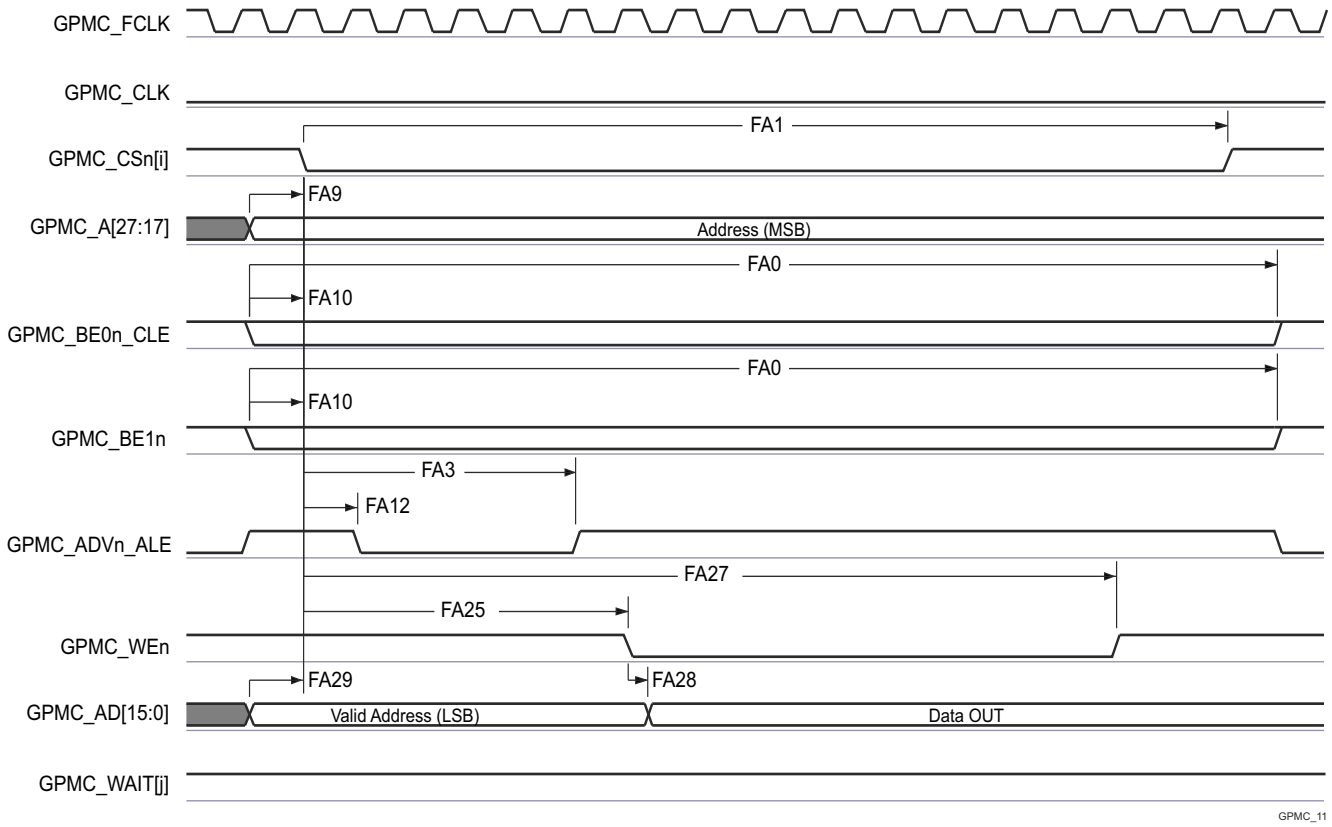
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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.
B. FA5 parameter illustrates amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after FA5 functional clock cycles, input data will be internally sampled by active functional clock edge. FA5 value must be stored inside AccessTime register bits field.
C. GPMC_FCLK is an internal clock (GPMC functional clock) not provided externally.

Figure 6-55. GPMC and Multiplexed NOR Flash — Asynchronous Read — Single Word

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A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.

Figure 6-56. GPMC and Multiplexed NOR Flash — Asynchronous Write — Single Word

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6.12.5.11.3 GPMC and NAND Flash — Asynchronous Mode

Table 6-69 and Table 6-70 present timing requirements and switching characteristics for GPMC and NAND Flash — Asynchronous Mode.

Table 6-69. GPMC and NAND Flash Timing Requirements – Asynchronous Mode

see Figure 6-59

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
GNF12(1)	$t_{acc(d)}$	Access time, input data GPMC_AD[15:0]		J(2)	ns

(1) The GNF12 parameter illustrates the amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of the read cycle and after GNF12 functional clock cycles, input data is internally sampled by the active functional clock edge. The GNF12 value must be stored inside AccessTime register bit field.
(2) J = AccessTime × (TimeParaGranularity + 1) × GPMC_FCLK(3)
(3) GPMC_FCLK is general-purpose memory controller internal functional clock period in ns.

Table 6-70. GPMC and NAND Flash Switching Characteristics – Asynchronous Mode

see Figure 6-57, Figure 6-58, Figure 6-59 and Figure 6-60

NO.	PARAMETER		MIN	MAX	UNIT
GNF0	$t_{w(wenV)}$	Pulse duration, output write enable GPMC_WEn valid	A(1)		ns
GNF1	$t_{d(csnV-wenV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output write enable GPMC_WEn valid	B(2) - 2	B(2) + 2	ns
GNF2	$t_{w(cleH-wenV)}$	Delay time, output lower-byte enable and command latch enable GPMC_BE0n_CLE high to output write enable GPMC_WEn valid	C(3) - 2	C(3) + 2	ns
GNF3	$t_{w(wenV-dV)}$	Delay time, output data GPMC_AD[15:0] valid to output write enable GPMC_WEn valid	D(4) - 2	D(4) + 2	ns
GNF4	$t_{w(wenIV-dIV)}$	Delay time, output write enable GPMC_WEn invalid to output data GPMC_AD[15:0] invalid	E(5) - 2	E(5) + 2	ns
GNF5	$t_{w(wenIV-cleIV)}$	Delay time, output write enable GPMC_WEn invalid to output lower-byte enable and command latch enable GPMC_BE0n_CLE invalid	F(6) - 2	F(6) + 2	ns
GNF6	$t_{w(wenIV-CSn[i]V)}$	Delay time, output write enable GPMC_WEn invalid to output chip select GPMC_CSn[i](13) invalid	G(7) - 2	G(7) + 2	ns
GNF7	$t_{w(aleH-wenV)}$	Delay time, output address valid and address latch enable GPMC_ADVn_ALE high to output write enable GPMC_WEn valid	C(3) - 2	C(3) + 2	ns
GNF8	$t_{w(wenIV-aleIV)}$	Delay time, output write enable GPMC_WEn invalid to output address valid and address latch enable GPMC_ADVn_ALE invalid	F(6) - 2	F(6) + 2	ns
GNF9	$t_{c(wen)}$	Cycle time, write		H(8)	ns
GNF10	$t_{d(csnV-oenV)}$	Delay time, output chip select GPMC_CSn[i](13) valid to output enable GPMC_OEn_REn valid	I(9) - 2	I(9) + 2	ns
GNF13	$t_{w(oenV)}$	Pulse duration, output enable GPMC_OEn_REn valid		K(10)	ns
GNF14	$t_{c(oen)}$	Cycle time, read	L(11)		ns
GNF15	$t_{w(oenIV-CSn[i]V)}$	Delay time, output enable GPMC_OEn_REn invalid to output chip select GPMC_CSn[i](13) invalid	M(12) - 2	M(12) + 2	ns

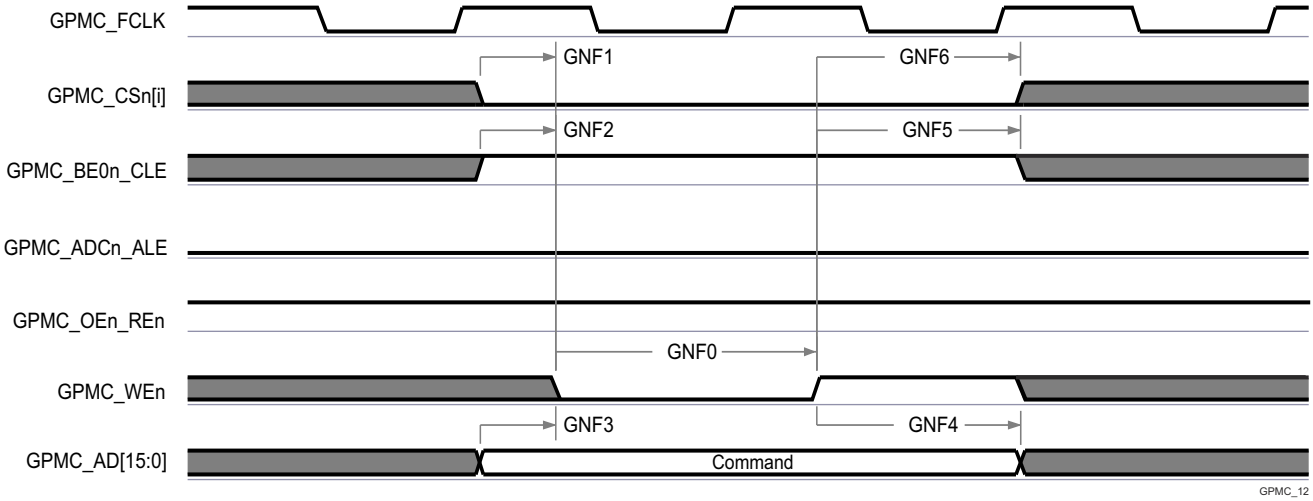
(1) A = (WEOffTime - WEOnTime) × (TimeParaGranularity + 1) × GPMC_FCLK(14)
(2) B = ((WEOnTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (WEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(3) C = ((WEOnTime - ADVOnTime) × (TimeParaGranularity + 1) + 0.5 × (WEExtraDelay - ADVExtraDelay)) × GPMC_FCLK(14) Note: For DeviceType: NAND
- During Command Latch Cycle: CLE signal is controlled by the ADVOnTime and ADVWrOffTime timing parameters
- During Address Latch Cycle: ALE signal is controlled by the ADVOnTime and ADVWrOffTime timing parameters.

(4) D = (WEOnTime × (TimeParaGranularity + 1) + 0.5 × WEExtraDelay) × GPMC_FCLK(14)
(5) E = ((WrCycleTime - WEOffTime) × (TimeParaGranularity + 1) - 0.5 × WEExtraDelay) × GPMC_FCLK(14)
(6) F = ((ADVWrOffTime - WEOffTime) × (TimeParaGranularity + 1) + 0.5 × (ADVExtraDelay - WEExtraDelay)) × GPMC_FCLK(14) Note: For DeviceType: NAND
- During Command Latch Cycle: CLE signal is controlled by the ADVOnTime and ADVWrOffTime timing parameters
- During Address Latch Cycle: ALE signal is controlled by the ADVOnTime and ADVWrOffTime timing parameters.

(7) G = ((CSWrOffTime - WEOffTime) × (TimeParaGranularity + 1) + 0.5 × (CSExtraDelay - WEExtraDelay)) × GPMC_FCLK(14)
(8) H = WrCycleTime × (1 + TimeParaGranularity) × GPMC_FCLK(14)

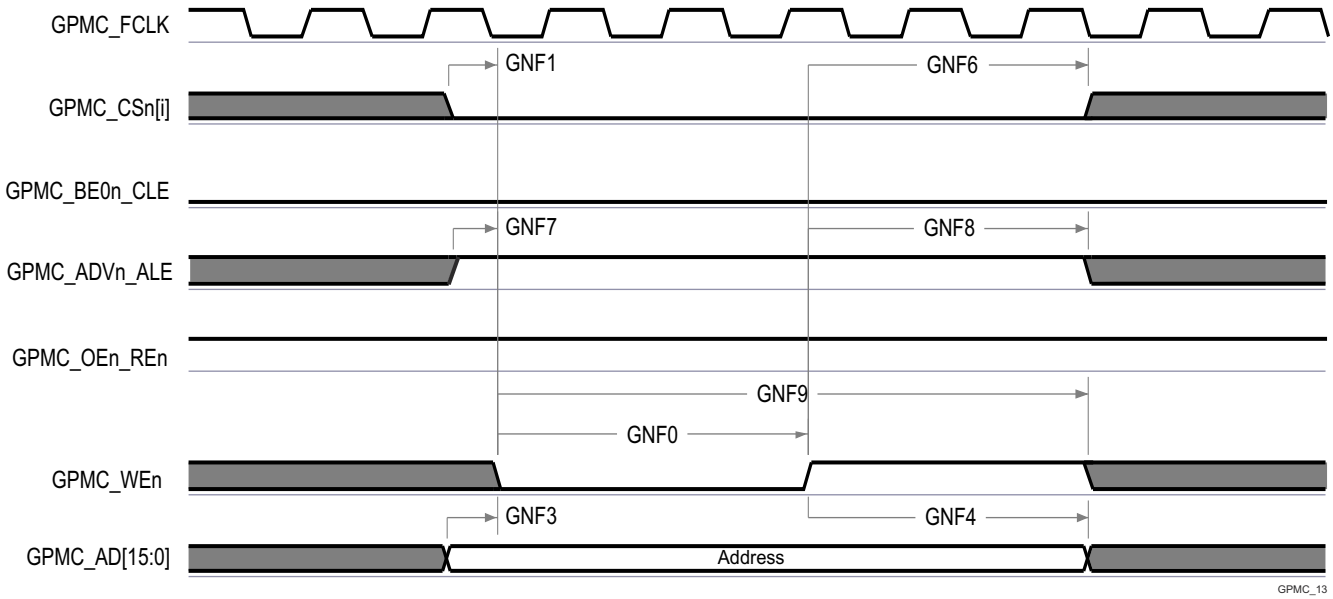
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(9) I = ((OEOnTime - CSOnTime) × (TimeParaGranularity + 1) + 0.5 × (OEExtraDelay - CSExtraDelay)) × GPMC_FCLK(14)
(10) K = (OEOffTime - OEOnTime) × (1 + TimeParaGranularity) × GPMC_FCLK(14)
(11) L = RdCycleTime × (1 + TimeParaGranularity) × GPMC_FCLK(14)
(12) M = ((CSRdOffTime - OEOffTime) × (TimeParaGranularity + 1) + 0.5 × (CSExtraDelay - OEExtraDelay)) × GPMC_FCLK(14)
(13) In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.
(14) GPMC_FCLK is general-purpose memory controller internal functional clock period in ns.



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.

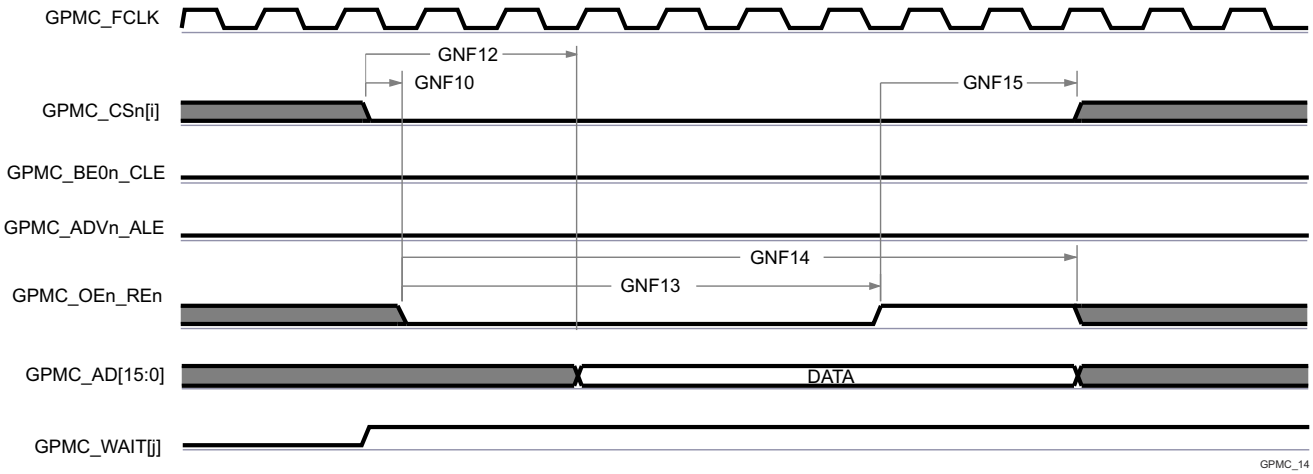
Figure 6-57. GPMC and NAND Flash — Command Latch Cycle



A. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.

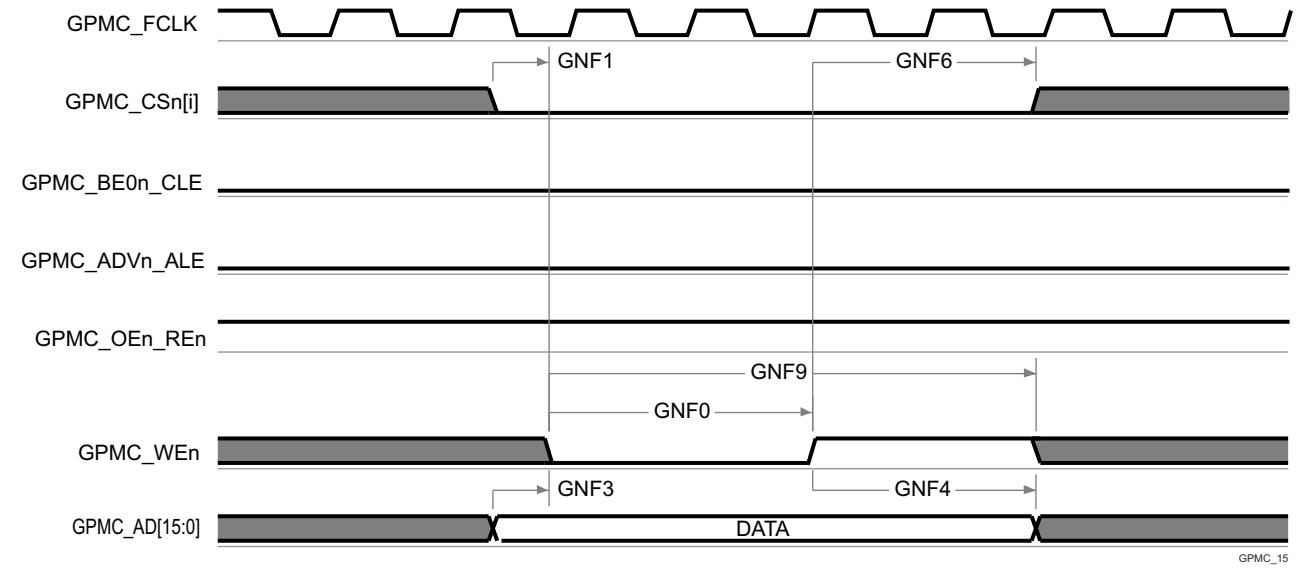
Figure 6-58. GPMC and NAND Flash — Address Latch Cycle

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A. GNF12 parameter illustrates amount of time required to internally sample input data. It is expressed in number of GPMC functional clock cycles. From start of read cycle and after GNF12 functional clock cycles, input data will be internally sampled by active functional clock edge. GNF12 value must be stored inside AccessTime register bits field.
B. GPMC_FCLK is an internal clock (GPMC functional clock) not provided externally.
C. In GPMC_CSn[i], i is equal to 0, 1, 2 or 3. In GPMC_WAIT[j], j is equal to 0 or 1.

Figure 6-59. GPMC and NAND Flash — Data Read Cycle



A. `In GPMC_CSn[i], i is equal to 0, 1, 2 or 3.

Figure 6-60. GPMC and NAND Flash — Data Write Cycle

6.12.5.12 I2C

The device contains six multicontroller Inter-Integrated Circuit (I2C) controllers. Each I2C controller was designed to be compliant to the Philips I^{2}C-bus™ specification version 2.1. However, the device IOs are not fully compliant to the I2C electrical specification. The speeds supported and exceptions are described per IO buffer type. See the BUFFER TYPE column of the *Pin Attributes* table to determine which IO buffer type is associated with a specific I2C instance.

- **LVCMOS or SDIO**
  - Speeds:
    - Standard-mode (up to 100Kbits/s)
      - 1.8V
      - 3.3V
    - Fast-mode (up to 400Kbits/s)
      - 1.8V
      - 3.3V
  - Exceptions:
    - The IOs associated with these ports are not compliant to the fall time requirements defined in the I2C specification because they are implemented with higher performance LVCMOS push-pull IOs that were designed to support other signal functions that could not be implemented with I2C compatible IOs. The LVCMOS IOs being used on these ports are connected such they emulate open-drain outputs. This emulation is achieved by forcing a constant low output and disabling the output buffer to enter the Hi-Z state.
    - The I2C specification defines a maximum input voltage V_{IH} of ($V_{DD_{max}}$ + 0.5V), which exceeds the absolute maximum ratings for the device IOs. The system must be designed to ensure the I2C signals never exceed the limits defined in the *Absolute Maximum Ratings* section of this datasheet.
- **I2C OD FS**
  - Speeds:
    - Standard-mode (up to 100Kbits/s)
      - 1.8V
      - 3.3V
    - Fast-mode (up to 400Kbits/s)
      - 1.8V
      - 3.3V
    - Hs-mode (up to 3.4Mbits/s)
      - 1.8V
  - Exceptions:
    - The IOs associated with these ports were not design to support Hs-mode while operating at 3.3V. So Hs-mode is limited to 1.8V operation.
    - The rise and fall times of the I2C signals connected to these ports must not exceed a slew rate of 0.08V/ns (or 8E+7V/s). This limit is more restrictive than the minimum fall time limits defined in the I2C specification. Therefore, it may be necessary to add additional capacitance to the I2C signals to slow the rise and fall times such that they do not exceed a slew rate of 0.08V/ns.
    - The I2C specification defines a maximum input voltage V_{IH} of ($V_{DD_{max}}$ + 0.5V), which exceeds the absolute maximum ratings for the device IOs. The system must be designed to ensure the I2C signals never exceed the limits defined in the *Absolute Maximum Ratings* section of this datasheet.

Note

I2C3 has one or more signals which can be multiplexed to more than one pin. Timing requirements and switching characteristics defined in this section are only valid for specific pin combinations known as IOSETs. Valid pin combinations or IOSETs for this interface are defined in the **SysConfig-PinMux Tool**.

Refer to the Philips I2C-bus specification version 2.1 for timing details.

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For more details about features and additional description information on the device Inter-Integrated Circuit, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

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6.12.5.13 MCAN

Table 6-71 and Table 6-72 presents timing conditions and switching characteristics for MCAN.

For more details about features and additional description information on the device Controller Area Network Interface, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Note

The device has multiple MCAN modules. MCANn is a generic prefix applied to MCAN signal names, where n represents the specific MCAN module.

Table 6-71. MCAN Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	2	15	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	5	20	pF

Table 6-72. MCAN Switching Characteristics

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
MCAN1	$t_{d(MCAN_TX)}$	Delay time, transmit shift register to MCANn_TX		10	ns
MCAN2	$t_{d(MCAN_RX)}$	Delay time, MCANn_RX to receive shift register		10	ns

For more information, see *Modular Controller Area Network (MCAN)* section in *Peripherals* chapter in the device TRM.

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6.12.5.14 MCASP

Note

MCASP1 and MCASP2 have one or more signals which can be multiplexed to more than one pin. Timing requirements and switching characteristics defined in this section are only valid for specific pin combinations known as IOSETs. Valid pin combinations or IOSETs for this interface are defined in the **SysConfig-PinMux Tool**.

Table 6-73, Table 6-74, Figure 6-61, Table 6-75, and Figure 6-62 present timing conditions, timing requirements, and switching characteristics for MCASP.

Table 6-73. MCASP Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.7	5	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	1	10	pF
PCB CONNECTIVITY REQUIREMENTS				
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	100	1100	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces		100	ps

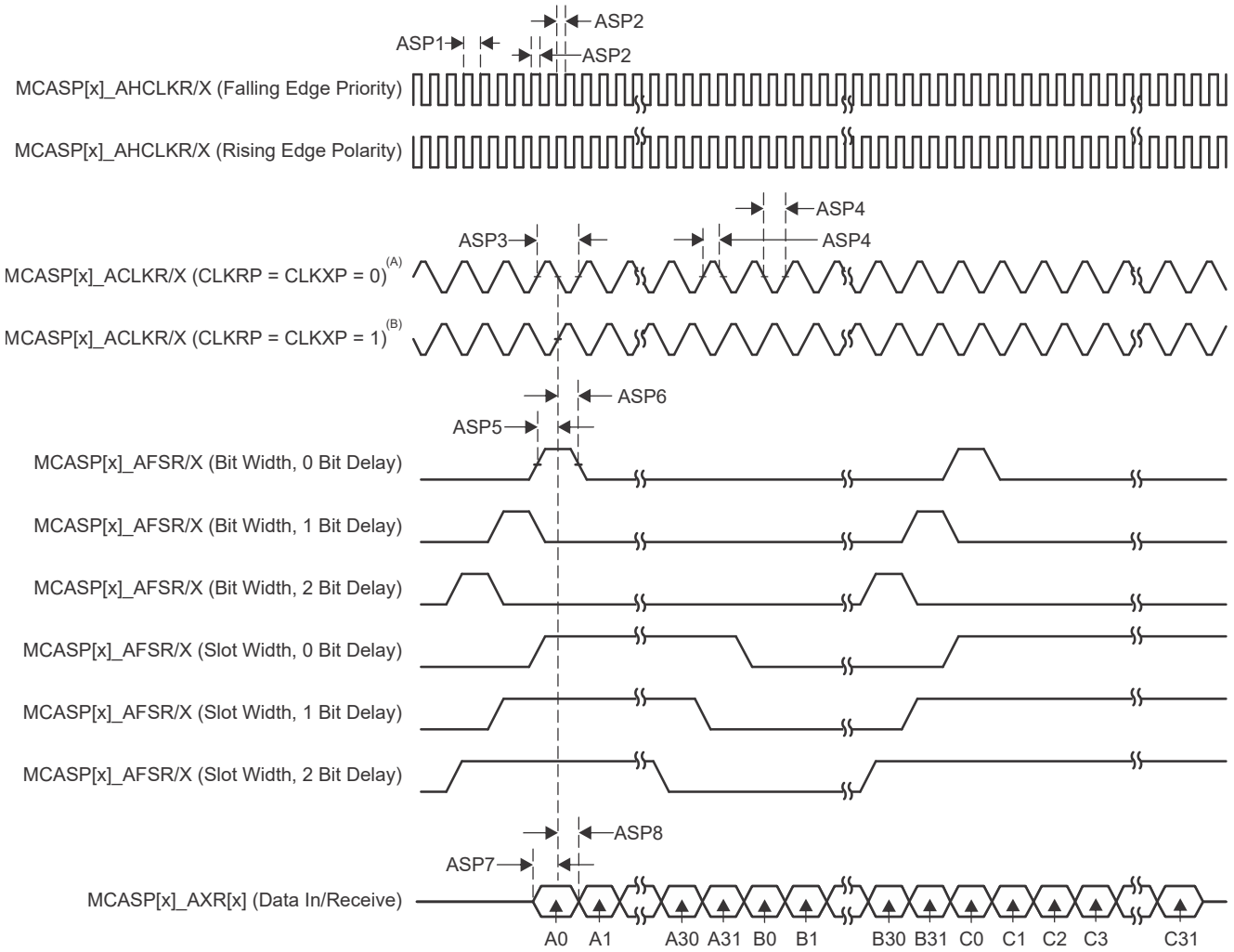
Table 6-74. MCASP Timing Requirements

see Figure 6-61

NO.			MODE(1)	MIN	MAX	UNIT
ASP1	$t_{c(AHCLKRX)}$	Cycle time, MCASP[x]_AHCLKR/X(4)		20		ns
ASP2	$t_{w(AHCLKRX)}$	Pulse duration, MCASP[x]_AHCLKR/X(4) high or low		0.5P(2) - 1.53		ns
ASP3	$t_{c(ACLKRX)}$	Cycle time, MCASP[x]_ACLKR/X(4)		20		ns
ASP4	$t_{w(ACLKRX)}$	Pulse duration, MCASP[x]_ACLKR/X(4) high or low		0.5R(3) - 1.53		ns
ASP5	$t_{su(AFSRX-ACLKRX)}$	Setup time, MCASP[x]_AFSR/X(4) input valid before MCASP[x]_ACLKR/X(4)	ACLKR/X int	9.29		ns
			ACLKR/X ext in/out	4		
ASP6	$t_{h(ACLKRX-AFSRX)}$	Hold time, MCASP[x]_AFSR/X(4) input valid after MCASP[x]_ACLKR/X(4)	ACLKR/X int	-1		ns
			ACLKR/X ext in/out	1.6		
ASP7	$t_{su(AXR-ACLKRX)}$	Setup time, MCASP[x]_AXR(4) input valid before MCASP[x]_ACLKR/X(4)	ACLKR/X int	9.29		ns
			ACLKR/X ext in/out	4		
ASP8	$t_{h(ACLKRX-AXR)}$	Hold time, MCASP[x]_AXR(4) input valid after MCASP[x]_ACLKR/X(4)	ACLKR/X int	-1		ns
			ACLKR/X ext in/out	1.6		

(1) ACLKR internal: ACLKRCTL.CLKRM=1, PDIR.ACLKR = 1
ACLKR external input: ACLKRCTL.CLKRM=0, PDIR.ACLKR=0
ACLKR external output: ACLKRCTL.CLKRM=0, PDIR.ACLKR=1
ACLKX internal: ACLKXCTL.CLKXM=1, PDIR.ACLKX = 1
ACLKX external input: ACLKXCTL.CLKXM=0, PDIR.ACLKX=0
ACLKX external output: ACLKXCTL.CLKXM=0, PDIR.ACLKX=1
(2) P = AHCLKR/X period in ns. For details on AHCLKR/X clock source options, see the McASP Clocks table in the Multichannel Audio Serial Port (MCASP) section of the Module Integration chapter found in the Technical Reference Manual.
(3) R = ACLKR/X period in ns.
(4) x in MCASP[x]_* is 0, 1 or 2

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A. For CLKRP = CLKXP = 0, the MCASP transmitter is configured for rising edge (to shift data out) and the MCASP receiver is configured for falling edge (to shift data in).

B. For CLKRP = CLKXP = 1, the MCASP transmitter is configured for falling edge (to shift data out) and the MCASP receiver is configured for rising edge (to shift data in).

Figure 6-61. MCASP Timing Requirements

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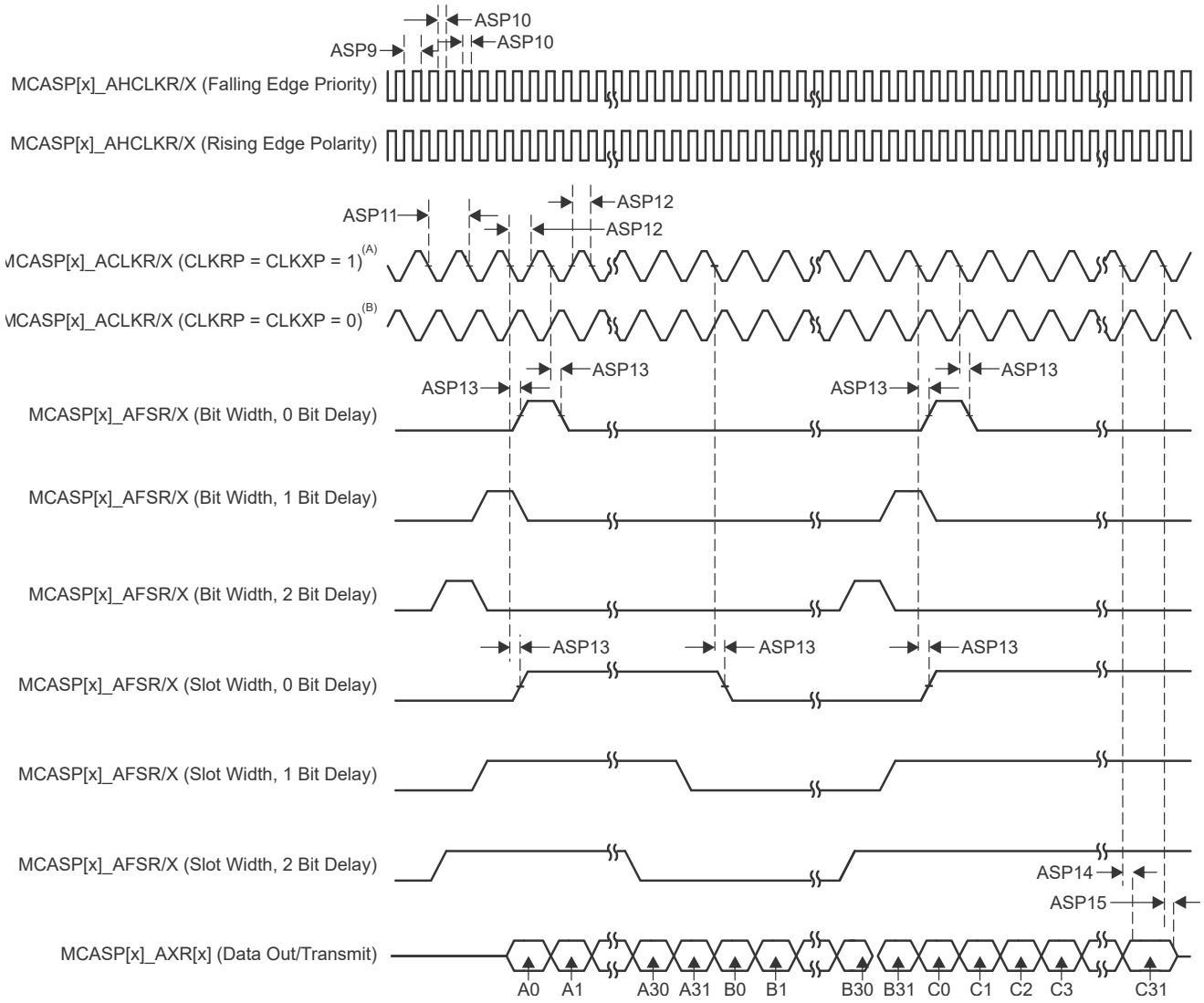
Table 6-75. MCASP Switching Characteristics

see Figure 6-62

NO.	PARAMETER	DESCRIPTION	MODE(1)	MIN	MAX	UNIT
ASP9	$t_{c(AHCLKRX)}$	Cycle time, MCASP[x]_AHCLKR/X(4)		20		ns
ASP10	$t_{w(AHCLKRX)}$	Pulse duration, MCASP[x]_AHCLKR/X(4) high or low		0.5P(2) - 2		ns
ASP11	$t_{c(ACLKRX)}$	Cycle time, MCASP[x]_ACLKR/X(4)		20		ns
ASP12	$t_{w(ACLKRX)}$	Pulse duration, MCASP[x]_ACLKR/X(4) high or low		0.5R(3) - 2		ns
ASP13	$t_{d(ACLKRX-AFSRX)}$	Delay time, MCASP[x]_ACLKR/X(4) transmit edge to MCASP[x]_AFSR/X(4) output valid	ACLKR/X int	-1	7.25	ns
			ACLKR/X ext in/out	-15.29	12.84	
ASP14	$t_{d(ACLKX-AXR)}$	Delay time, MCASP[x]_ACLKX(4) transmit edge to MCASP[x]_AXR(4) output valid	ACLKR/X int	-1	7.25	ns
			ACLKR/X ext in/out	-15.29	12.84	
ASP15	$t_{dis(ACLKX-AXR)}$	Disable time, MCASP[x]_ACLKX(4) transmit edge to MCASP[x]_AXR(4) output high impedance	ACLKR/X int	-1	7.25	ns
			ACLKR/X ext in/out	-14.9	14	

(1) ACLKR internal: ACLKRCTL.CLKRM=1, PDIR.ACLKR = 1
ACLKR external input: ACLKRCTL.CLKRM=0, PDIR.ACLKR=0
ACLKR external output: ACLKRCTL.CLKRM=0, PDIR.ACLKR=1
ACLKX internal: ACLKXCTL.CLKXM=1, PDIR.ACLKX = 1
ACLKX external input: ACLKXCTL.CLKXM=0, PDIR.ACLKX=0
ACLKX external output: ACLKXCTL.CLKXM=0, PDIR.ACLKX=1
(2) P = AHCLKR/X period in ns. For details on AHCLKR/X clock source options, see the McASP Clocks table in the Multichannel Audio Serial Port (MCASP) section of the Module Integration chapter found in the Technical Reference Manual.
(3) R = ACLKR/X period in ns.
(4) x in MCASP[x]_* is 0, 1 or 2

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A. For CLKRP = CLKXP = 1, the MCASP transmitter is configured for falling edge (to shift data out) and the MCASP receiver is configured for rising edge (to shift data in).

B. For CLKRP = CLKXP = 0, the MCASP transmitter is configured for rising edge (to shift data out) and the MCASP receiver is configured for falling edge (to shift data in).

Figure 6-62. MCASP Switching Characteristics

For more information, see *Multichannel Audio Serial Port (MCASP)* section in *Peripherals* chapter in the device TRM.

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6.12.5.15 MCSPI

Note

MCSPI1, MCSPI2, MCU_MCSPI0, and MCU_MCSPI1 have one or more signals which can be multiplexed to more than one pin. Timing requirements and switching characteristics defined in this section are only valid for specific pin combinations known as IOSETs. Valid pin combinations or IOSETs for this interface are defined in the **SysConfig-PinMux Tool**.

For more details about features and additional description information on the device Serial Port Interface, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-76 presents timing conditions for MCSPI.

Table 6-76. MCSPI Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	2	8.5	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	6	12	pF

For more information, see *Multichannel Serial Peripheral Interface (MCSPI)* section in *Peripherals* chapter in the device TRM.

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6.12.5.15.1 MCSPI — Controller Mode

Table 6-77, Figure 6-63, Table 6-78, and Figure 6-64 present timing requirements and switching characteristics for SPI – Controller Mode.

Table 6-77. MCSPI Timing Requirements – Controller Mode

see Figure 6-63

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
SM4	$t_{su(POCI-SPICLK)}$	Setup time, SPIn_D[x] valid before SPIn_CLK active edge	2.8		ns
SM5	$t_{h(SPICLK-POCI)}$	Hold time, SPIn_D[x] valid after SPIn_CLK active edge	3		ns

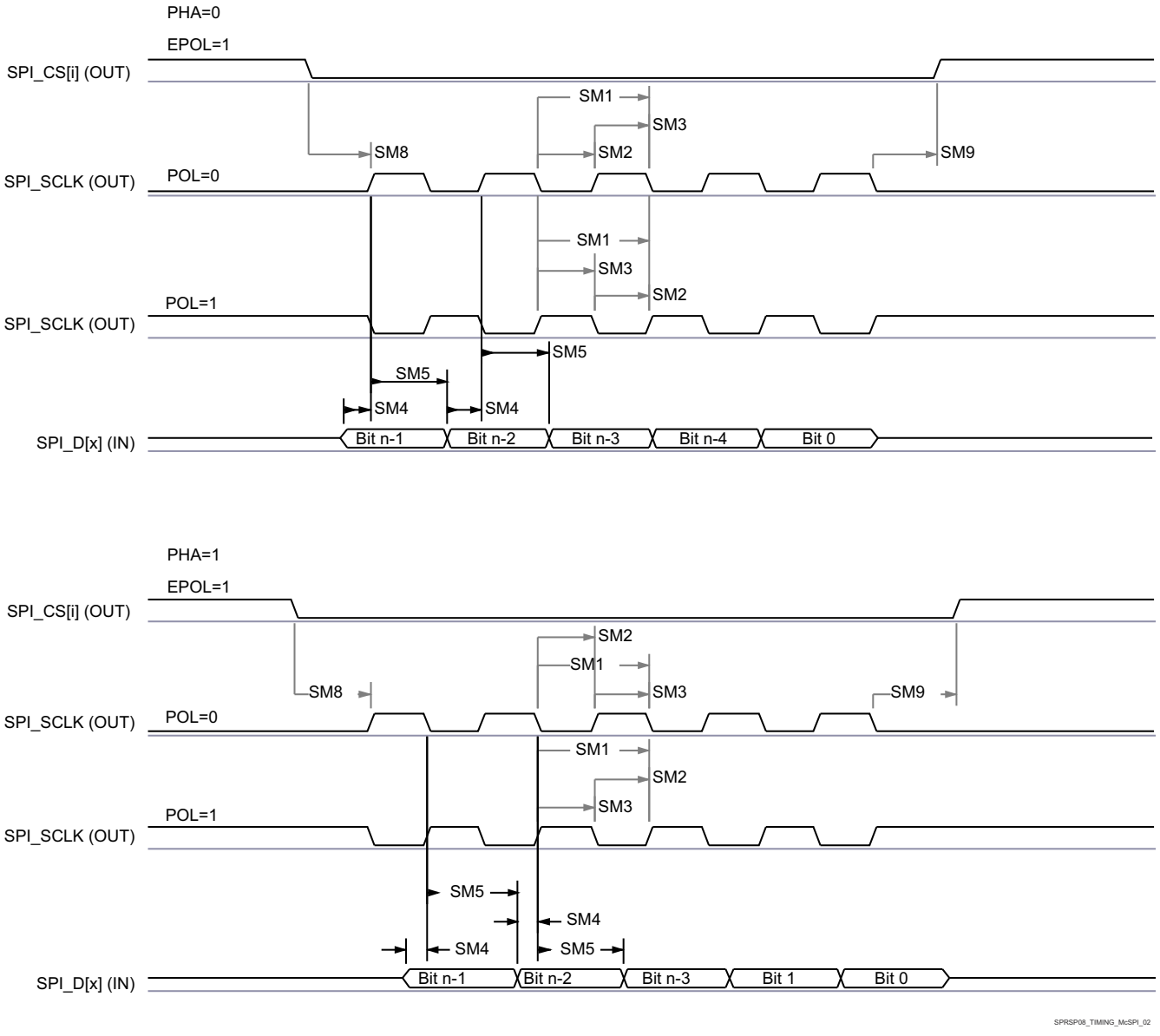


Figure 6-63. SPI Controller Mode Receive Timing

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Table 6-78. MCSPI Switching Characteristics - Controller Mode

see Figure 6-64

NO.	PARAMETER			MIN	MAX	UNIT
SM1	$t_{c(SPICLK)}$	Cycle time, SPIn_CLK		20		ns
SM2	$t_{w(SPICLKL)}$	Pulse duration, SPIn_CLK low		0.5P - 1 (1)		ns
SM3	$t_{w(SPICLKH)}$	Pulse duration, SPIn_CLK high		0.5P - 1 (1)		ns
SM6	$t_{d(SPICLK-PICO)}$	Delay time, SPIn_CLK active edge to SPIn_D[x]		-3	2.5	ns
SM7	$t_{d(CS-PICO)}$	Delay time, SPIn_CSi active edge to SPIn_D[x]		5		ns
SM8	$t_{d(CS-SPICLK)}$	Delay time, SPIn_CSi active to SPIn_CLK first edge	PHA = 0	B - 4 (2)		ns
			PHA = 1	A - 4 (3)		ns
SM9	$t_{d(SPICLK-CS)}$	Delay time, SPIn_CLK last edge to SPIn_CSi inactive	PHA = 0	A - 4 (4)		ns
			PHA = 1	B - 4 (5)		ns

(1) P = SPIn_CLK period in ns.

(2) T_ref is the period of the McSPI functional clock in ns. Fratio is the divide ratio of McSPI functional clock frequency to SPIn_CLK clock frequency, controlled by the CLKD and CLKG bit fields in the MCSPI_CH(i)CONF register and the EXTCLK bit field in the MCSPI_CH(i)CTRL register. TCS(i) is the value programmed into the chip select time control bit field of the MCSPI_CH(i)CONF register.

- When Fratio = 1; B = (TCS(i) + 0.5) * T_ref.
- When Fratio ≥ 2 and even value; B = (TCS(i) + 0.5) * Fratio * T_ref.
- When Fratio ≥ 3 and odd value; B = ((TCS(i) * Fratio) + ((Fratio + 1) / 2)) * T_ref.

(3) T_ref is the period of the McSPI functional clock. Fratio is the divide ratio of McSPI functional clock frequency to SPIn_CLK clock frequency, controlled by the CLKD and CLKG bit fields in the MCSPI_CH(i)CONF register and the EXTCLK bit field in the MCSPI_CH(i)CTRL register. TCS(i) is the value programmed into the chip select time control bit field of the MCSPI_CH(i)CONF register.

- When Fratio = 1; A = (TCS(i) + 1) * T_ref.
- When Fratio ≥ 2 and even value; A = (TCS(i) + 0.5) * Fratio * T_ref.
- When Fratio ≥ 3 and odd value; A = ((TCS(i) * Fratio) + ((Fratio - 1) / 2)) * T_ref.

(4) T_ref is the period of the McSPI functional clock. Fratio is the divide ratio of McSPI functional clock frequency to SPIn_CLK clock frequency, controlled by the CLKD and CLKG bit fields in the MCSPI_CH(i)CONF register and the EXTCLK bit field in the MCSPI_CH(i)CTRL register. TCS(i) is the value programmed into the chip select time control bit field of the MCSPI_CH(i)CONF register.

- When Fratio = 1; A = (TCS(i) + 1) * T_ref.
- When Fratio ≥ 2 and even value; A = (TCS(i) + 0.5) * Fratio * T_ref.
- When Fratio ≥ 3 and odd value; A = ((TCS(i) * Fratio) + ((Fratio + 1) / 2)) * T_ref.

(5) T_ref is the period of the McSPI functional clock. Fratio is the divide ratio of McSPI functional clock frequency to SPIn_CLK clock frequency, controlled by the CLKD and CLKG bit fields in the MCSPI_CH(i)CONF register and the EXTCLK bit field in the MCSPI_CH(i)CTRL register. TCS(i) is the value programmed into the chip select time control bit field of the MCSPI_CH(i)CONF register.

- When Fratio = 1; B = (TCS(i) + 0.5) * T_ref.
- When Fratio ≥ 2 and even value; B = (TCS(i) + 0.5) * Fratio * T_ref.
- When Fratio ≥ 3 and odd value; B = ((TCS(i) * Fratio) + ((Fratio - 1) / 2)) * T_ref.

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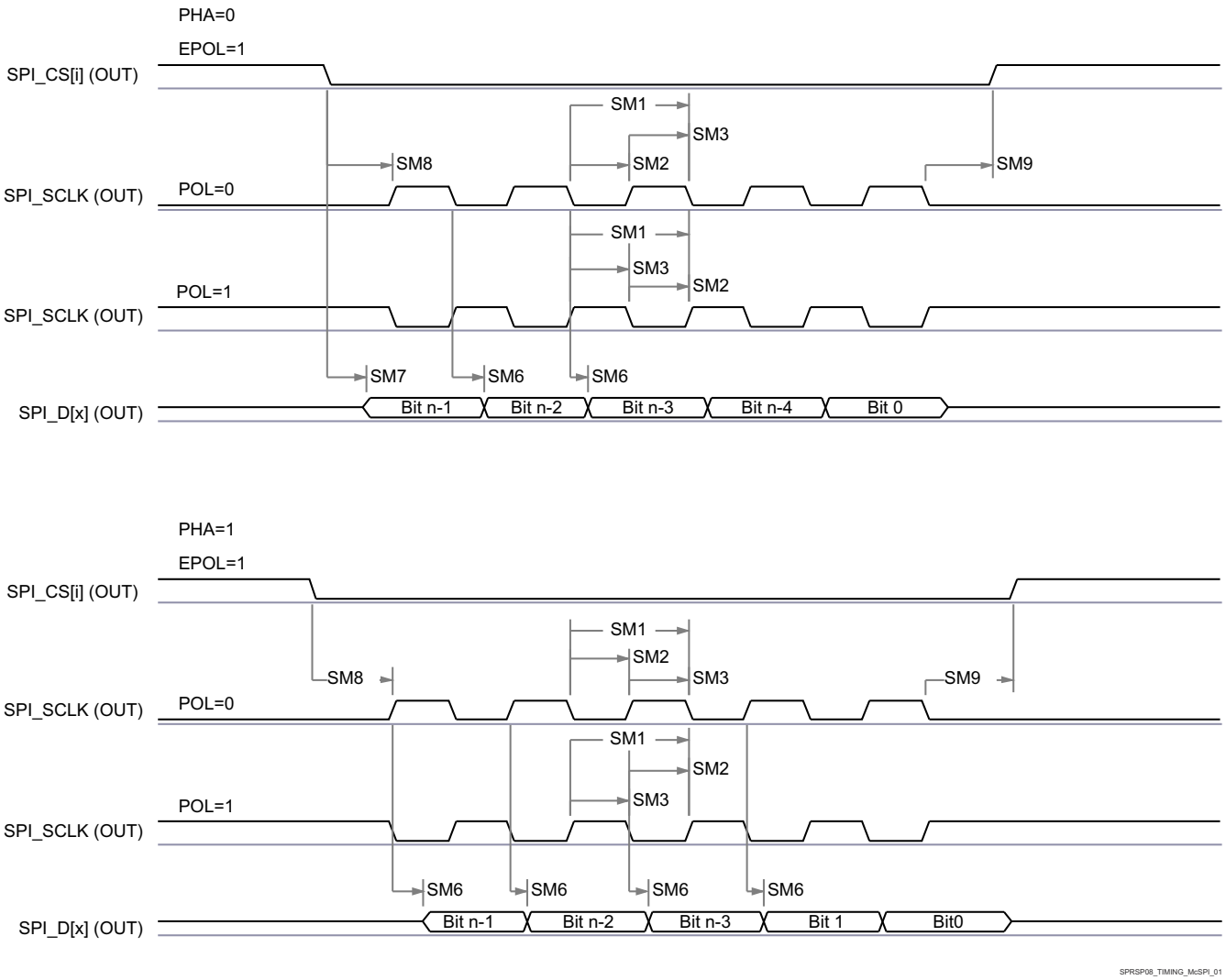


Figure 6-64. SPI Controller Mode Transmit Timing

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6.12.5.15.2 MCSPI — Peripheral Mode

Table 6-79, Figure 6-65, Table 6-80, and Figure 6-66 present timing requirements and switching characteristics for SPI – Peripheral Mode.

Table 6-79. MCSPI Timing Requirements – Peripheral Mode

see Figure 6-65

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
SS1	$t_{c(SPICLK)}$	Cycle time, SPIn_CLK	20		ns
SS2	$t_{w(SPICLKL)}$	Pulse duration, SPIn_CLK low	0.45P(1)		ns
SS3	$t_{w(SPICLKH)}$	Pulse duration, SPIn_CLK high	0.45P(1)		ns
SS4	$t_{su(PICO-SPICLK)}$	Setup time, SPIn_D[x] valid before SPIn_CLK active edge	5		ns
SS5	$t_{h(SPICLK-PICO)}$	Hold time, SPIn_D[x] valid after SPIn_CLK active edge	5		ns
SS8	$t_{su(CS-SPICLK)}$	Setup time, SPIn_CSi valid before SPIn_CLK first edge	5		ns
SS9	$t_{h(SPICLK-CS)}$	Hold time, SPIn_CSi valid after SPIn_CLK last edge	5		ns

(1) P = SPIn_CLK period in ns.

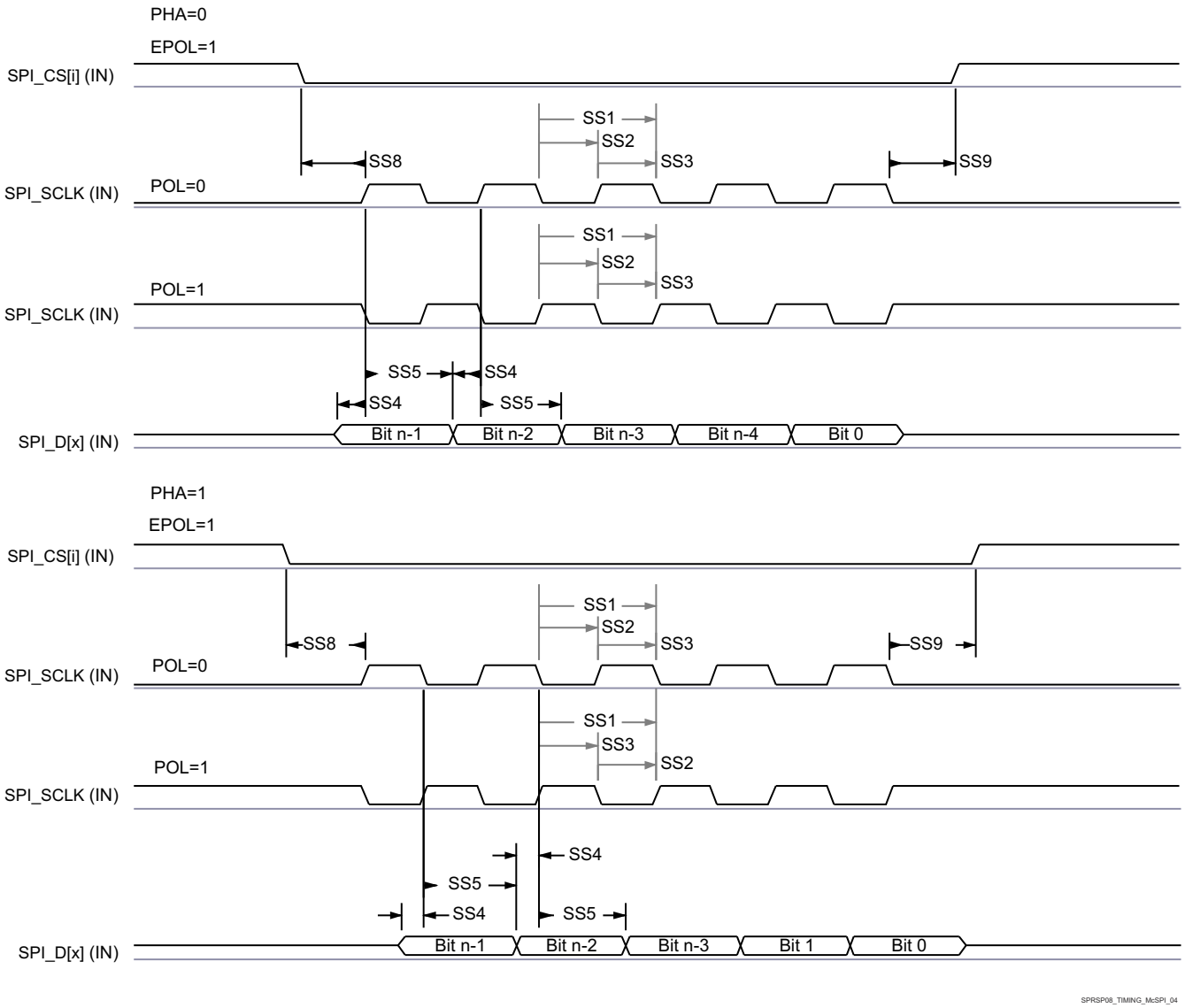


Figure 6-65. SPI Peripheral Mode Receive Timing

Table 6-80. MCSPI Switching Characteristics – Peripheral Mode

see Figure 6-66

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
SS6	$t_{d(SPICLK-POCI)}$	Delay time, SPIn_CLK active edge to SPIn_D[x]	2	12.5	ns
SS7	$t_{sk(CS-POCI)}$	Delay time, SPIn_CSi active edge to SPIn_D[x]		19	ns

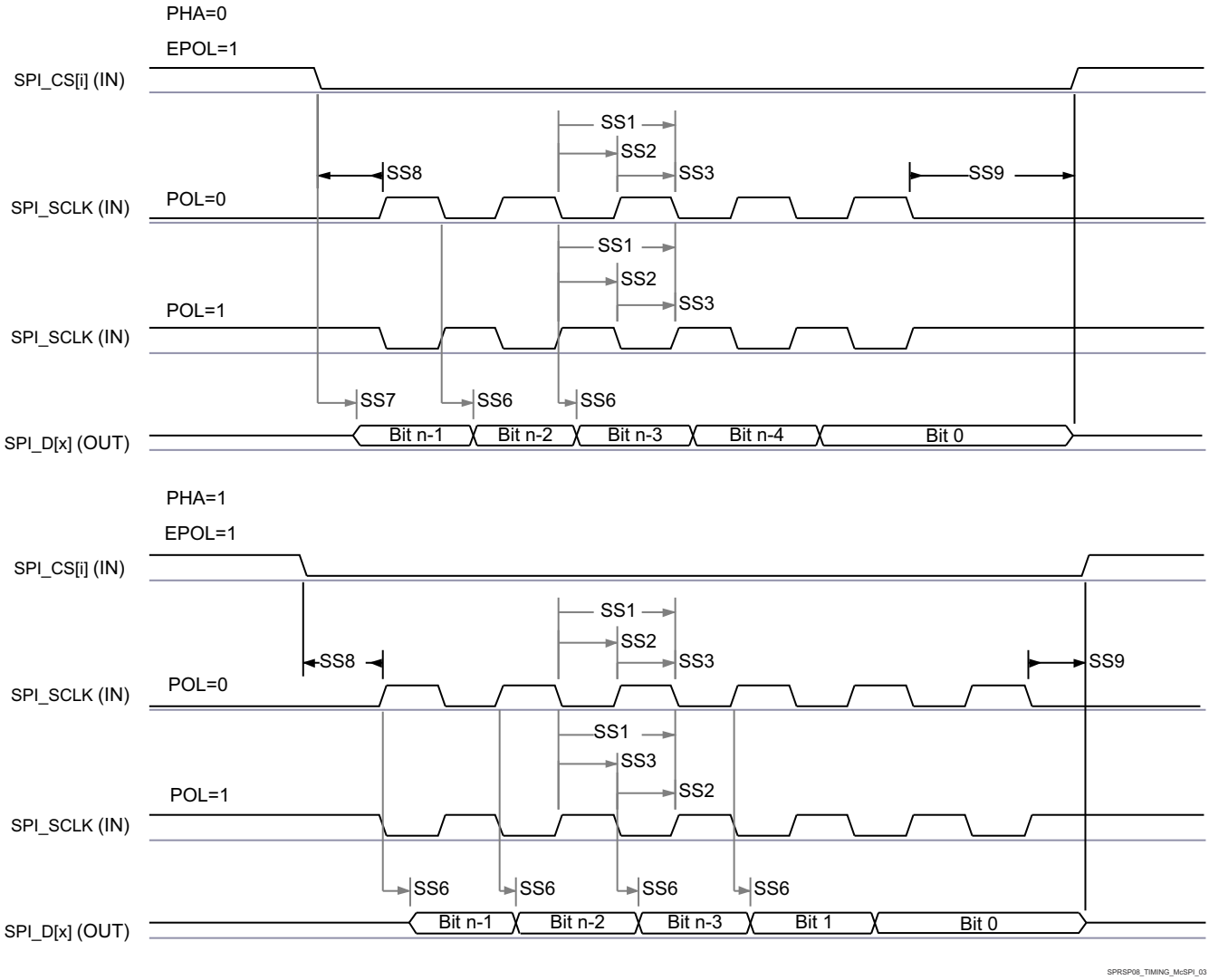


Figure 6-66. SPI Peripheral Mode Transmit Timing

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6.12.5.16 MMCSD

The MMCSD Host Controller provides an interface to embedded Multi-Media Card (MMC), Secure Digital (SD), and Secure Digital IO (SDIO) devices. The MMCSD Host Controller deals with MMC/SD/SDIO protocol at transmission level, data packing, adding cyclic redundancy checks (CRCs), start/end bit insertion, and checking for syntactical correctness.

For more details about MMCSD interfaces, see the corresponding MMC0, MMC1, and MMC2 subsections within *Signal Descriptions* and *Detailed Description* sections.

Note

Some operating modes require software configuration of the MMC DLL delay settings, as shown in Table 6-81 and Table 6-102.

The modes which show a value of "Tuning" in the ITAPDLYSEL column of Table 6-81 and Table 6-102 require a tuning algorithm to be used for optimizing input timing. Refer to the MMCSD Programming Guide in the device TRM for more information on the tuning algorithm and configuration of input delays required to optimize input timing.

For more information, see *Multi-Media Card/Secure Digital (MMCSD) Interface* section in *Peripherals* chapter in the device TRM.

6.12.5.16.1 MMC0 - eMMC/SD/SDIO Interface

MMC0 interface is compliant with the JEDEC eMMC electrical standard v5.1 (JESD84-B51) and it supports the following eMMC applications:

- Legacy SDR
- High Speed SDR
- High Speed DDR
- HS200

MMC0 interface is also compliant with the SD Host Controller Standard Specification 4.10 and SD Physical Layer Specification v3.01 as well as SDIO Specification v3.00. The following data transfer modes are only available for connectivity to embedded SDIO devices:

- Default Speed
- High Speed
- UHS–I SDR12
- UHS–I SDR25

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Table 6-81 presents the required DLL software configuration settings for MMC0 timing modes.

Table 6-81. MMC0 DLL Delay Mapping for all Timing Modes

REGISTER NAME		MMCSD0_MMC_SSCFG_PHY_CTRL_4_REG			
BIT FIELD		[20]	[16:12]	[8]	[4:0]
BIT FIELD NAME		OTAPDLYENA	OTAPDLYSEL	ITAPDLYENA	ITAPDLYSEL
MODE	DESCRIPTION	OUTPUT DELAY ENABLE	OUTPUT DELAY VALUE	INPUT DELAY ENABLE	INPUT DELAY VALUE
Legacy SDR	8-bit PHY operating 1.8V, 25MHz	NA(1)	NA(1)	0x0	NA(2)
	8-bit PHY operating 3.3V, 25MHz	NA(1)	NA(1)	0x0	NA(2)
High Speed SDR	8-bit PHY operating 1.8V, 50MHz	NA(1)	NA(1)	0x0	NA(2)
	8-bit PHY operating 3.3V, 50MHz	NA(1)	NA(1)	0x0	NA(2)
High Speed DDR	8-bit PHY operating 1.8V, 40MHz	0x1	0x15	0x1	0x2
	8-bit PHY operating 3.3V, 40MHz	0x1	0x15	0x1	0x2
HS200	8-bit PHY operating 1.8V, 200MHz	0x1	0x6	0x1	Tuning(3)
Default Speed	4-bit PHY operating 3.3V, 25MHz	NA(1)	NA(1)	0x1	0x0
High Speed	4-bit PHY operating 3.3V, 50MHz	NA(1)	NA(1)	0x1	0x0
UHS-I SDR12	4-bit PHY operating 1.8V, 25MHz	0x1	0xF	0x1	0x0
UHS-I SDR25	4-bit PHY operating 1.8V, 50MHz	0x1	0xF	0x1	0x0

(1) NA means this register field has no function when operating with half-cycle timing, which is required for this mode.
(2) NA means this register field has no function when ITAPDLYENA is set to 0x0.
(3) Tuning means this mode requires a tuning algorithm to be used to determine optimal input timing

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Table 6-82 presents timing conditions for MMC0.

Table 6-82. MMC0 Timing Conditions

PARAMETER			MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate	Legacy SDR @ 3.3V High Speed SDR @ 3.3V Default Speed High Speed	0.69	2.06	V/ns
		Legacy SDR @ 1.8V UHS-I SDR12	0.14	1.44	V/ns
		High Speed SDR @ 1.8V UHS-I SDR25	0.3	1.34	V/ns
		High Speed DDR UHS-I DDR50	1	2	V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance	HS200 UHS-I SDR104	1	10	pF
		All other modes	1	12	pF
PCB CONNECTIVITY REQUIREMENTS					
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	Legacy SDR High Speed SDR High Speed DDR HS200	126	756	ps
		Default Speed High Speed UHS-I SDR12 UHS-I SDR25 UHS-I SDR50 UHS-I SDR104	126	1386	ps
		UHS-I DDR50	239	1134	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces	High Speed SDR HS200 High Speed UHS-I SDR104		8	ps
		High Speed DDR UHS-I DDR50		20	ps
		All other modes		100	ps

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6.12.5.16.1.1 Legacy SDR Mode

Table 6-83, Figure 6-67, Table 6-84, and Figure 6-68 present timing requirements and switching characteristics for MMC0 – Legacy SDR Mode.

Table 6-83. MMC0 Timing Requirements – Legacy SDR Mode

see Figure 6-67

NO.			IO Operating Voltage	MIN	MAX	UNIT
LSDR1	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	1.8V	4.2		ns
			3.3V	2.15		ns
LSDR2	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.8V	0.87		ns
			3.3V	1.67		ns
LSDR3	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[7:0] valid before MMC0_CLK rising edge	1.8V	4.2		ns
			3.3V	2.15		ns
LSDR4	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[7:0] valid after MMC0_CLK rising edge	1.8V	0.87		ns
			3.3V	1.67		ns

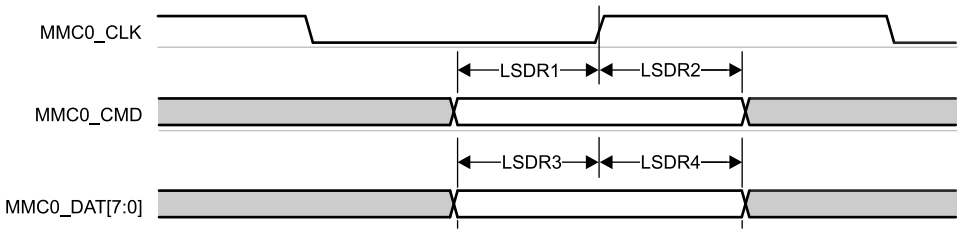


Figure 6-67. MMC0 – Legacy SDR – Receive Mode

Table 6-84. MMC0 Switching Characteristics – Legacy SDR Mode

see Figure 6-68

NO.	PARAMETER		IO Operating Voltage	MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK			25	MHz
LSDR5	$t_{c(clk)}$	Cycle time, MMC0_CLK		40		ns
LSDR6	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high		18.7		ns
LSDR7	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low		18.7		ns
LSDR8	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK falling edge to MMC0_CMD transition	1.8V	-2.1	2.1	ns
			3.3V	-1.8	2.2	ns
LSDR9	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK falling edge to MMC0_DAT[7:0] transition	1.8V	-2.1	2.1	ns
			3.3V	-1.8	2.2	ns

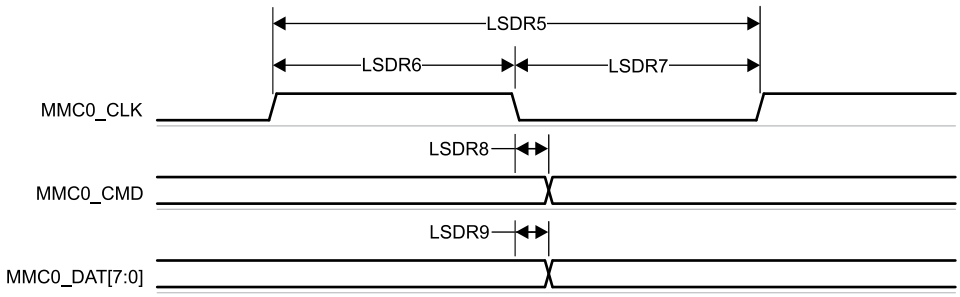


Figure 6-68. MMC0 – Legacy SDR – Transmit Mode

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6.12.5.16.1.2 High Speed SDR Mode

Table 6-85, Figure 6-69, Table 6-86, and Figure 6-70 present timing requirements and switching characteristics for MMC0 – High Speed SDR Mode.

Table 6-85. MMC0 Timing Requirements – High Speed SDR Mode

see Figure 6-69

NO.			IO Operating Voltage	MIN	MAX	UNIT
HSSDR1	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	1.8V	2.15		ns
			3.3V	2.24		ns
HSSDR2	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.8V	1.27		ns
			3.3V	1.66		ns
HSSDR3	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[7:0] valid before MMC0_CLK rising edge	1.8V	2.15		ns
			3.3V	2.24		ns
HSSDR4	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[7:0] valid after MMC0_CLK rising edge	1.8V	1.27		ns
			3.3V	1.66		ns

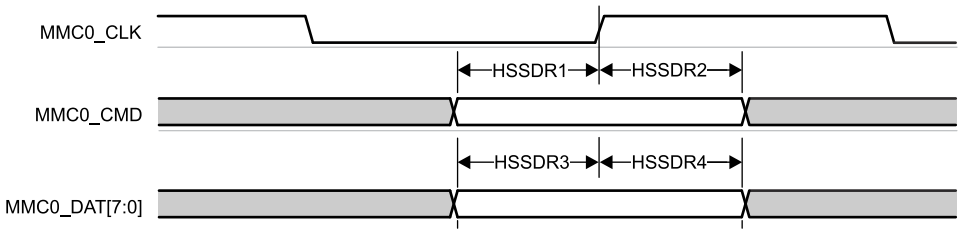


Figure 6-69. MMC0 – High Speed SDR Mode – Receive Mode

Table 6-86. MMC0 Switching Characteristics – High Speed SDR Mode

see Figure 6-70

NO.	PARAMETER		IO Operating Voltage	MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK			50	MHz
HSSDR5	$t_{c(clk)}$	Cycle time, MMC0_CLK		20		ns
HSSDR6	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high		9.2		ns
HSSDR7	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low		9.2		ns
HSSDR8	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK falling edge to MMC0_CMD transition	1.8V	-1.55	3.05	ns
			3.3V	-1.8	2.2	ns
HSSDR9	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK falling edge to MMC0_DAT[7:0] transition	1.8V	-1.55	3.05	ns
			3.3V	-1.8	2.2	ns

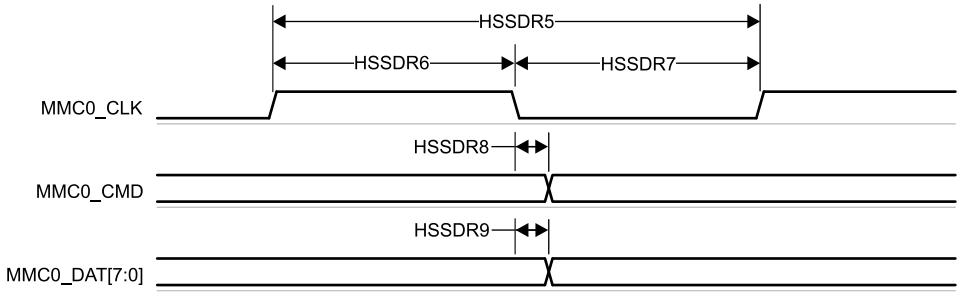


Figure 6-70. MMC0 – High Speed SDR Mode – Transmit Mode

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6.12.5.16.1.3 High Speed DDR Mode

Table 6-87, Figure 6-71, Table 6-88, and Figure 6-72 present timing requirements and switching characteristics for MMC0 – High Speed DDR Mode.

Table 6-87. MMC0 Timing Requirements – High Speed DDR Mode

see Figure 6-71

NO.			IO Operating Voltage	MIN	MAX	UNIT
HSDDR1	$t_{su(cmdV-clk)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	1.8V	0.02		ns
			3.3V	1.5		ns
HSDDR2	$t_{h(clk-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.8V	1.99		ns
			3.3V	1.75		ns
HSDDR3	$t_{su(dV-clk)}$	Setup time, MMC0_DAT[7:0] valid before MMC0_CLK transition	1.8V	0.02		ns
			3.3V	1.5		ns
HSDDR4	$t_{h(clk-dV)}$	Hold time, MMC0_DAT[7:0] valid after MMC0_CLK transition	1.8V	1.99		ns
			3.3V	1.75		ns

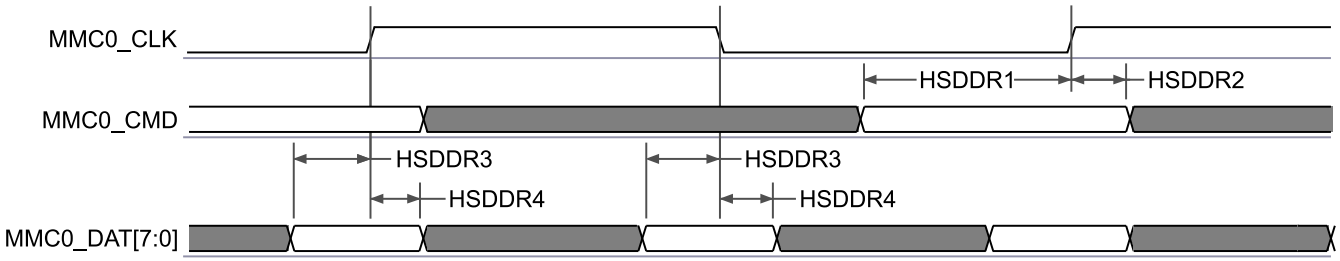


Figure 6-71. MMC0 – High Speed DDR Mode – Receive Mode

Table 6-88. MMC0 Switching Characteristics – High Speed DDR Mode

see Figure 6-72

NO.	PARAMETER		IO Operating Voltage	MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK			40	MHz
HSDDR5	$t_{c(clk)}$	Cycle time, MMC0_CLK		25		ns
HSDDR6	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high		11.58		ns
HSDDR7	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low		11.58		ns
HSDDR8	$t_{d(clk-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.8V	1.2	5.6	ns
			3.3V	3.32	9.3	ns
HSDDR9	$t_{d(clk-dV)}$	Delay time, MMC0_CLK transition to MMC0_DAT[7:0] transition	1.8V	1.2	4.8	ns
			3.3V	3.2	8.9	ns

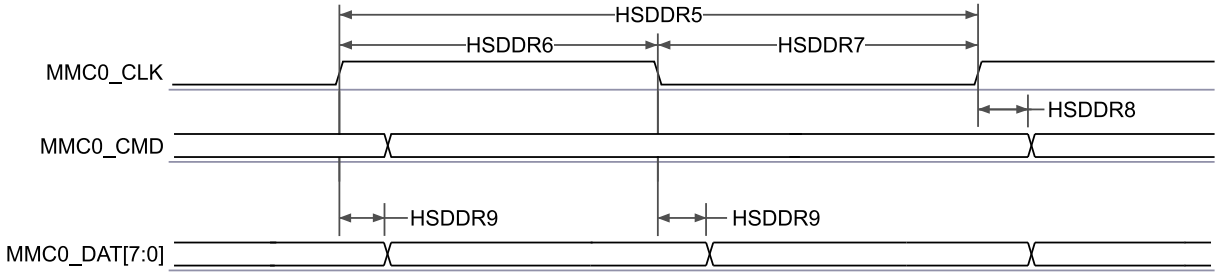


Figure 6-72. MMC0 – High Speed DDR Mode – Transmit Mode

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6.12.5.16.1.4 HS200 Mode

Table 6-89, Figure 6-73, Table 6-90, and Figure 6-74 present both timing requirements and switching characteristics for MMC0 – HS200 Mode.

Table 6-89. MMC0 Timing Requirements – HS200 Mode

see Figure 6-73

NO.			MIN	MAX	UNIT
HS2004	t_{DVW}	Input data valid window, MMC0_CMD and MMC0_DAT[7:0]	2.0(1)		ns

(1) This parameter defines the minimum data valid window required by the host, where any data valid window presented to the host greater than this value ensures the host is able to capture valid data. The value defined by this parameter is smaller than the smallest possible data valid window defined for any eMMC device operating in HS200 mode.

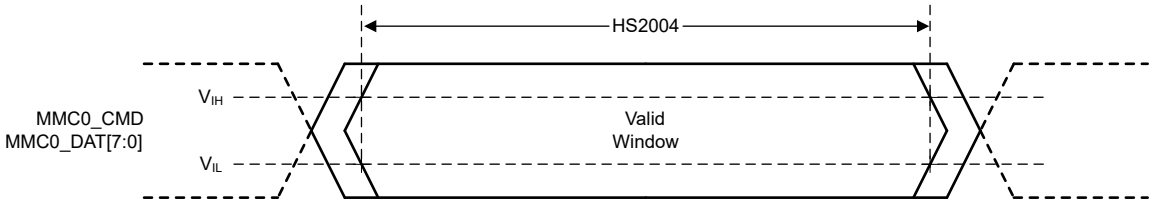


Figure 6-73. MMC0 – HS200 – Receive Mode

Table 6-90. MMC0 Switching Characteristics – HS200 Mode

see Figure 6-74

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		200	MHz
HS2005	$t_{c(clk)}$	Cycle time, MMC0_CLK	5		ns
HS2006	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	2.12		ns
HS2007	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	2.12		ns
HS2008	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.07	3.21	ns
HS2009	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK rising edge to MMC0_DAT[7:0] transition	1.07	3.21	ns

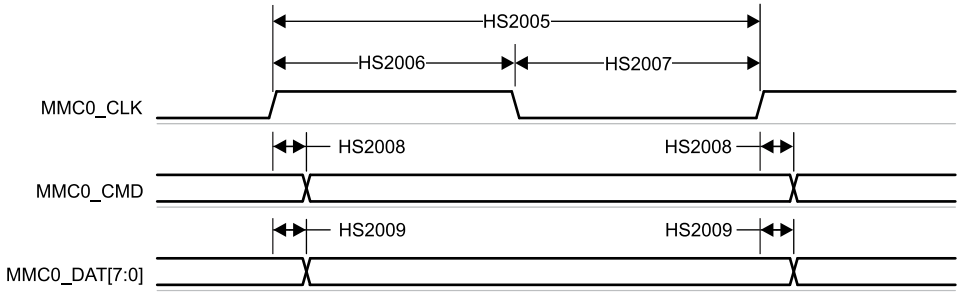


Figure 6-74. MMC0 – HS200 Mode – Transmit Mode

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6.12.5.16.1.5 Default Speed Mode

Table 6-91, Figure 6-75, Table 6-92, and Figure 6-76 present timing requirements and switching characteristics for MMC0 – Default Speed Mode.

Table 6-91. Timing Requirements for MMC0 – Default Speed Mode

see Figure 6-75

NO.			MIN	MAX	UNIT
DS1	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	2.15		ns
DS2	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.67		ns
DS3	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[3:0] valid before MMC0_CLK rising edge	2.15		ns
DS4	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[3:0] valid after MMC0_CLK rising edge	1.67		ns

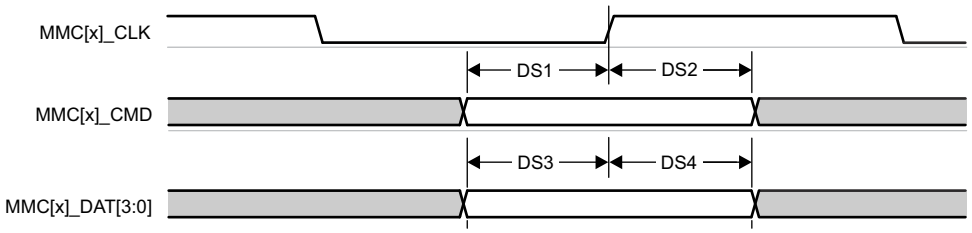


Figure 6-75. MMC0 – Default Speed – Receive Mode

Table 6-92. Switching Characteristics for MMC0 – Default Speed Mode

see Figure 6-76

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		25	MHz
DS5	$t_{c(clk)}$	Cycle time, MMC0_CLK	40		ns
DS6	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	18.7		ns
DS7	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	18.7		ns
DS8	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK falling edge to MMC0_CMD transition	- 1.8	2.2	ns
DS9	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK falling edge to MMC0_DAT[3:0] transition	- 1.8	2.2	ns

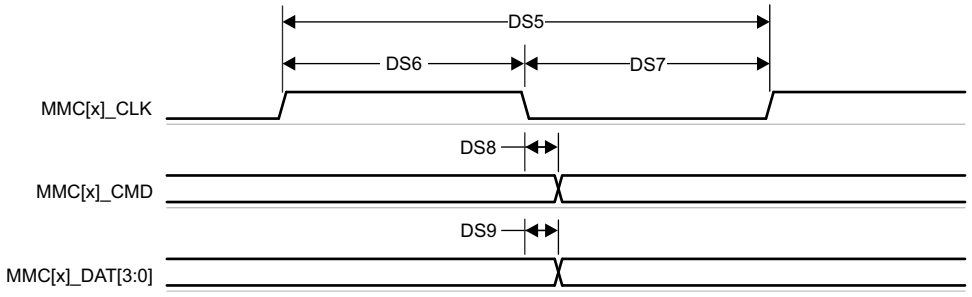


Figure 6-76. MMC0 – Default Speed – Transmit Mode

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6.12.5.16.1.6 High Speed Mode

Table 6-93, Figure 6-77, Table 6-94, and Figure 6-78 present timing requirements and switching characteristics for MMC0 – High Speed Mode.

Table 6-93. Timing Requirements for MMC0 – High Speed Mode

see Figure 6-77

NO.			MIN	MAX	UNIT
HS1	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	2.24		ns
HS2	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.66		ns
HS3	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[3:0] valid before MMC0_CLK rising edge	2.24		ns
HS4	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[3:0] valid after MMC0_CLK rising edge	1.66		ns

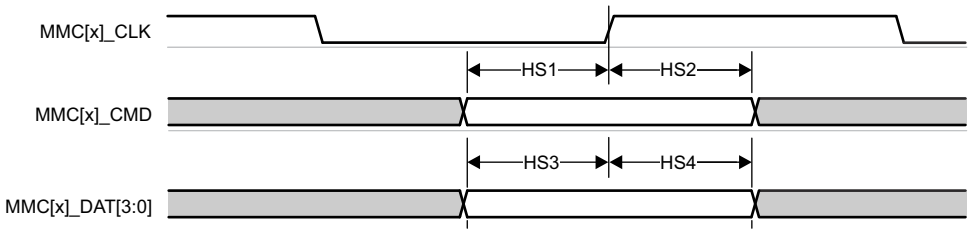


Figure 6-77. MMC0 – High Speed – Receive Mode

Table 6-94. Switching Characteristics for MMC0 – High Speed Mode

see Figure 6-78

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		50	MHz
HS5	$t_{c(clk)}$	Cycle time. MMC0_CLK	20		ns
HS6	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	9.2		ns
HS7	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	9.2		ns
HS8	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK falling edge to MMC0_CMD transition	-1.8	2.2	ns
HS9	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK falling edge to MMC0_DAT[3:0] transition	-1.8	2.2	ns

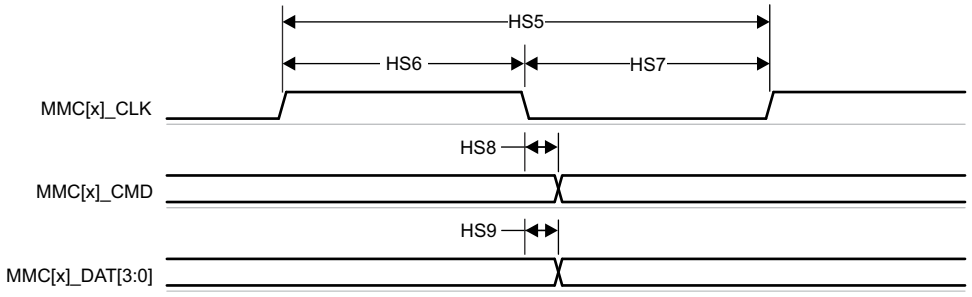


Figure 6-78. MMC0 – High Speed – Transmit Mode

6.12.5.16.1.7 UHS–I SDR12 Mode

Table 6-95, Figure 6-79, Table 6-96, and Figure 6-80 present timing requirements and switching characteristics for MMC0 – UHS-I SDR12 Mode.

Table 6-95. Timing Requirements for MMC0 – UHS-I SDR12 Mode

see Figure 6-79

NO.			MIN	MAX	UNIT
SDR121	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	4.2		ns
SDR122	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	0.87		ns
SDR123	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[3:0] valid before MMC0_CLK rising edge	4.2		ns
SDR124	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[3:0] valid after MMC0_CLK rising edge	0.87		ns

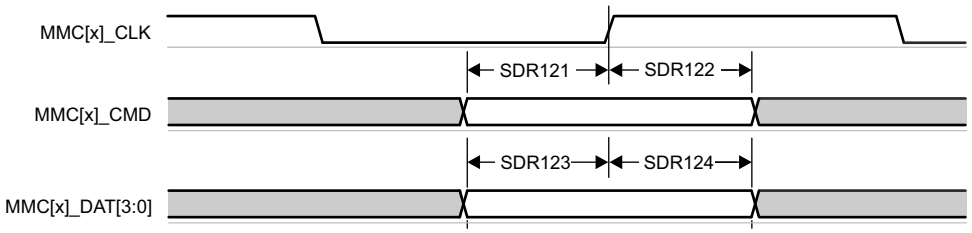


Figure 6-79. MMC0 – UHS-I SDR12 – Receive Mode

Table 6-96. Switching Characteristics for MMC0 – UHS-I SDR12 Mode

see Figure 6-80

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		25	MHz
SDR125	$t_{c(clk)}$	Cycle time, MMC0_CLK	40		ns
SDR126	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	18.7		ns
SDR127	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	18.7		ns
SDR128	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.5	8.6	ns
SDR129	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK rising edge to MMC0_DAT[3:0] transition	1.5	8.6	ns

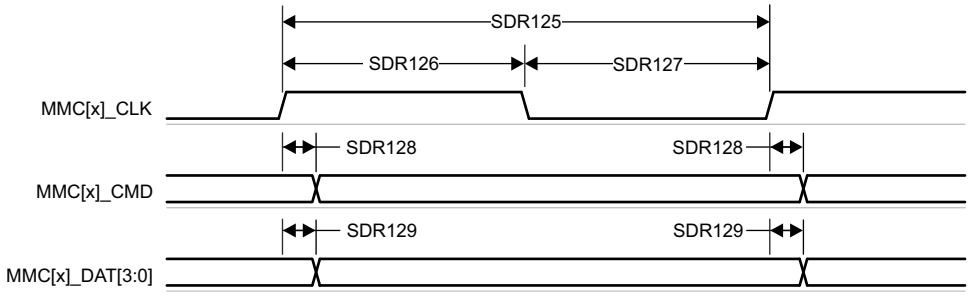


Figure 6-80. MMC0 – UHS-I SDR12 – Transmit Mode

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6.12.5.16.1.8 UHS–I SDR25 Mode

Table 6-97, Figure 6-81, Table 6-98, and Figure 6-82 present timing requirements and switching characteristics for MMC0 – UHS-I SDR25 Mode.

Table 6-97. Timing Requirements for MMC0 – UHS-I SDR25 Mode

see Figure 6-81

NO.			MIN	MAX	UNIT
SDR251	$t_{su(cmdV-clkH)}$	Setup time, MMC0_CMD valid before MMC0_CLK rising edge	2.15		ns
SDR252	$t_{h(clkH-cmdV)}$	Hold time, MMC0_CMD valid after MMC0_CLK rising edge	1.27		ns
SDR253	$t_{su(dV-clkH)}$	Setup time, MMC0_DAT[3:0] valid before MMC0_CLK rising edge	2.15		ns
SDR254	$t_{h(clkH-dV)}$	Hold time, MMC0_DAT[3:0] valid after MMC0_CLK rising edge	1.27		ns

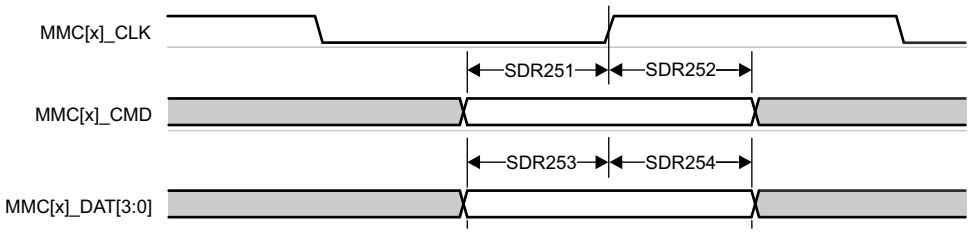


Figure 6-81. MMC0 – UHS-I SDR25 – Receive Mode

Table 6-98. Switching Characteristics for MMC0 – UHS-I SDR25 Mode

see Figure 6-82

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		50	MHz
SDR255	$t_{c(clk)}$	Cycle time, MMC0_CLK	20		ns
SDR256	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	9.2		ns
SDR257	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	9.2		ns
SDR258	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	2.4	8.1	ns
SDR259	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK rising edge to MMC0_DAT[3:0] transition	2.4	8.1	ns

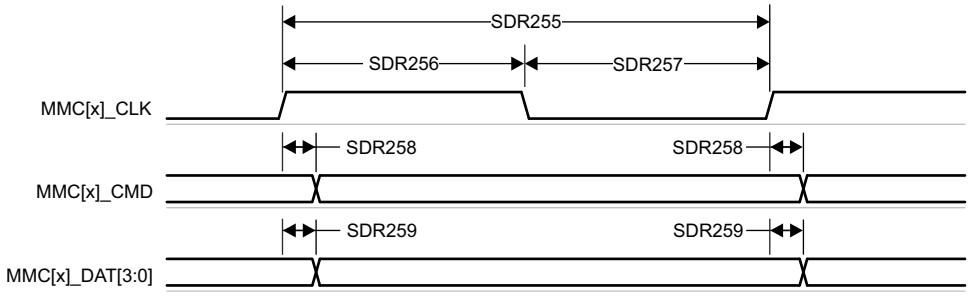


Figure 6-82. MMC0 – UHS-I SDR25 – Transmit Mode

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6.12.5.16.1.9 UHS–I SDR50 Mode

Table 6-99 and Figure 6-83 presents switching characteristics for MMC0 – UHS-I SDR50 Mode.

Table 6-99. Switching Characteristics for MMC0 – UHS-I SDR50 Mode

see Figure 6-83

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		100	MHz
SDR505	$t_{c(clk)}$	Cycle time, MMC0_CLK	10		ns
SDR506	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	4.45		ns
SDR507	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	4.45		ns
SDR508	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.2	6.35	ns
SDR509	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK rising edge to MMC0_DAT[3:0] transition	1.2	6.35	ns

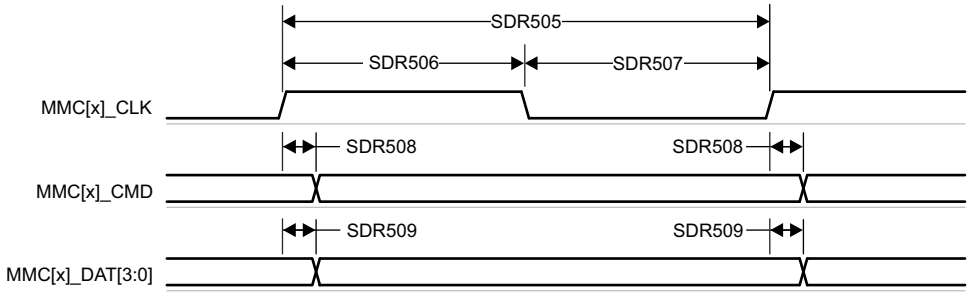


Figure 6-83. MMC0 – UHS-I SDR50 – Transmit Mode

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6.12.5.16.1.10 UHS–I DDR50 Mode

Table 6-100 and Figure 6-84 present switching characteristics for MMC0 – UHS-I DDR50 Mode.

Table 6-100. Switching Characteristics for MMC0 – UHS-I DDR50 Mode

see Figure 6-84

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		50	MHz
DDR505	$t_{c(clk)}$	Cycle time, MMC0_CLK	20		ns
DDR506	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	9.2		ns
DDR507	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	9.2		ns
DDR508	$t_{d(clk-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.12	6.43	ns
DDR509	$t_{d(clk-dV)}$	Delay time, MMC0_CLK transition to MMC0_DAT[3:0] transition	1.12	6.43	ns

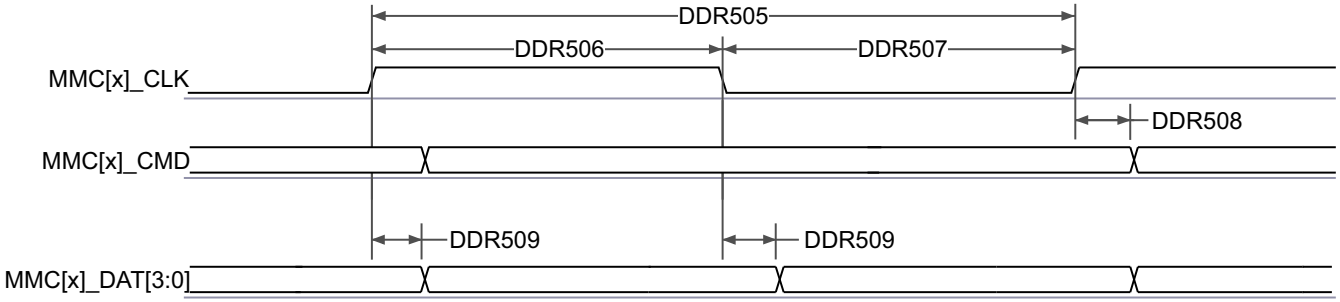


Figure 6-84. MMC0 – UHS-I DDR50 – Transmit Mode

6.12.5.16.1.11 UHS–I SDR104 Mode

Table 6-101 and Figure 6-85 present switching characteristics for MMC0 – UHS-I SDR104 Mode.

Table 6-101. Switching Characteristics for MMC0 – UHS-I SDR104 Mode

see Figure 6-85

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMC0_CLK		200	MHz
SDR1045	$t_{c(clk)}$	Cycle time, MMC0_CLK	5		ns
SDR1046	$t_{w(clkH)}$	Pulse duration, MMC0_CLK high	2.12		ns
SDR1047	$t_{w(clkL)}$	Pulse duration, MMC0_CLK low	2.12		ns
SDR1048	$t_{d(clkL-cmdV)}$	Delay time, MMC0_CLK rising edge to MMC0_CMD transition	1.07	3.21	ns
SDR1049	$t_{d(clkL-dV)}$	Delay time, MMC0_CLK rising edge to MMC0_DAT[3:0] transition	1.07	3.21	ns

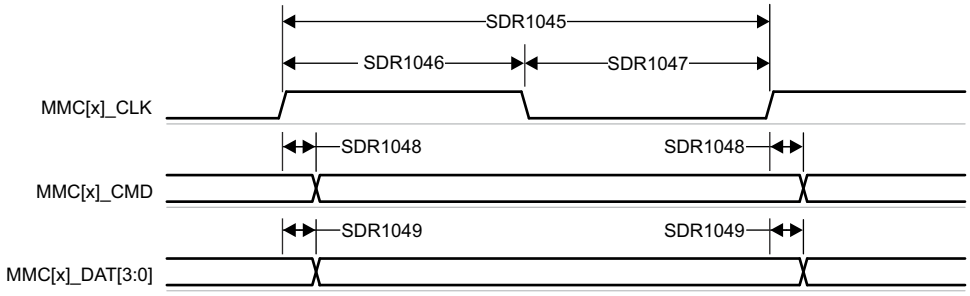


Figure 6-85. MMC0 – UHS-I SDR104 – Transmit Mode

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6.12.5.16.2 MMC1/MMC2 - SD/SDIO Interface

MMC1/MMC2 interface is compliant with the SD Host Controller Standard Specification 4.10 and SD Physical Layer Specification v3.01 as well as SDIO Specification v3.00 and it supports the following SD Card applications:

- Default speed
- High speed
- UHS–I SDR12
- UHS–I SDR25
- UHS–I SDR50
- UHS–I DDR50
- UHS–I SDR104

Table 6-102 presents the required DLL software configuration settings for MMC1/2 timing modes.

Table 6-102. MMC1/MMC2 DLL Delay Mapping for all Timing Modes

REGISTER NAME		MMCSD1_MMC_SSCFG_PHY_CTRL_4_REG MMCSD2_MMC_SSCFG_PHY_CTRL_4_REG			
BIT FIELD		[20]	[15:12]	[8]	[4:0]
BIT FIELD NAME		OTAPDLYENA	OTAPDLYSEL	ITAPDLYENA	ITAPDLYSEL
MODE	DESCRIPTION	DELAY ENABLE	DELAY VALUE	INPUT DELAY ENABLE	INPUT DELAY VALUE
Default Speed	4-bit PHY operating 3.3V, 25MHz	NA(1)	NA(1)	0x1	0x0
High Speed	4-bit PHY operating 3.3V, 50MHz	NA(1)	NA(1)	0x1	0x0
UHS-I SDR12	4-bit PHY operating 1.8V, 25MHz	0x1	0xF	0x1	0x0
UHS-I SDR25	4-bit PHY operating 1.8V, 50MHz	0x1	0xF	0x1	0x0
UHS-I SDR50	4-bit PHY operating 1.8V, 100MHz	0x1	0xC	0x1	Tuning(2)
UHS-I DDR50	4-bit PHY operating 1.8V, 50MHz	0x1	0x9	0x1	Tuning(2)
UHS-I SDR104	4-bit PHY operating 1.8V, 200MHz	0x1	0x6	0x1	Tuning(2)

(1) NA means this register field has no function when operating with half-cycle timing, which is required for this mode.
(2) Tuning means this mode requires a tuning algorithm to be used to determine optimal input timing

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Table 6-103 presents timing conditions for MMC1.

Table 6-103. MMC1/MMC2 Timing Conditions

PARAMETER			MIN	MAX	UNIT
Input Conditions					
SR_I	Input slew rate	Default Speed High Speed	0.69	2.06	V/ns
		UHS–I SDR12 UHS–I SDR25	0.34	1.34	V/ns
		UHS–I DDR50	1	2	V/ns
Output Conditions					
C_L	Output load capacitance	All modes	1	10	pF
PCB Connectivity Requirements					
$t_{d(Trace\ Delay)}$	Propagation delay of each trace	UHS–I DDR50	239	1134	ps
		All other modes	126	1386	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch across all traces	High Speed UHS–I SDR104		8	ps
		UHS–I DDR50		20	ps
		All other modes		100	ps

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6.12.5.16.2.1 Default Speed Mode

Table 6-104, Figure 6-86, Table 6-105, and Figure 6-87 present timing requirements and switching characteristics for MMC1/MMC2 – Default Speed Mode.

Table 6-104. Timing Requirements for MMC1/MMC2 – Default Speed Mode

see Figure 6-86

NO.			MIN	MAX	UNIT
DS1	$t_{su(cmdV-clkH)}$	Setup time, MMCx_CMD valid before MMCx_CLK rising edge	2.15		ns
DS2	$t_{h(clkH-cmdV)}$	Hold time, MMCx_CMD valid after MMCx_CLK rising edge	1.67		ns
DS3	$t_{su(dV-clkH)}$	Setup time, MMCx_DAT[3:0] valid before MMCx_CLK rising edge	2.15		ns
DS4	$t_{h(clkH-dV)}$	Hold time, MMCx_DAT[3:0] valid after MMCx_CLK rising edge	1.67		ns

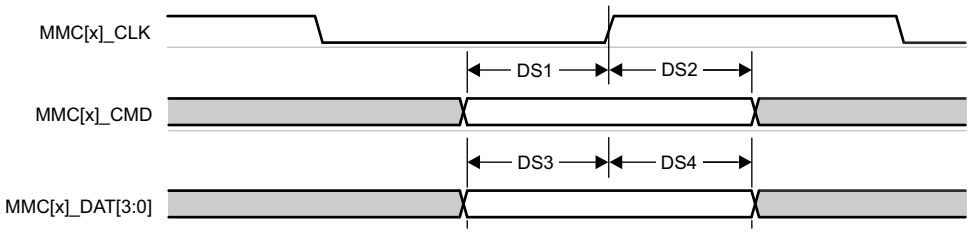


Figure 6-86. MMC1/MMC2 – Default Speed – Receive Mode

Table 6-105. Switching Characteristics for MMC1/MMC2 – Default Speed Mode

see Figure 6-87

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		25	MHz
DS5	$t_{c(clk)}$	Cycle time, MMCx_CLK	40		ns
DS6	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	18.7		ns
DS7	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	18.7		ns
DS8	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK falling edge to MMCx_CMD transition	- 1.8	2.2	ns
DS9	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK falling edge to MMCx_DAT[3:0] transition	- 1.8	2.2	ns

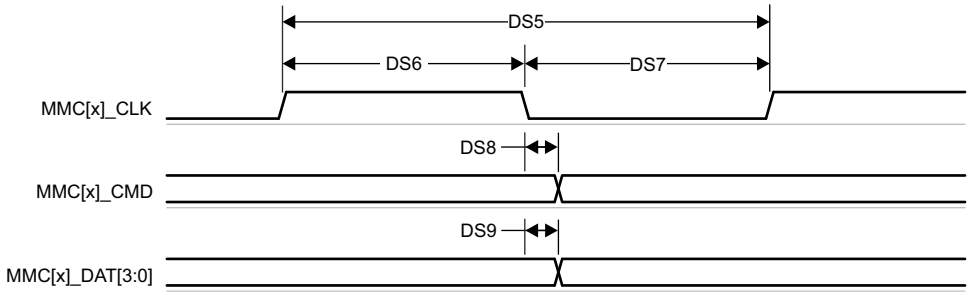


Figure 6-87. MMC1/MMC2 – Default Speed – Transmit Mode

6.12.5.16.2.2 High Speed Mode

Table 6-106, Figure 6-88, Table 6-107, and Figure 6-89 present timing requirements and switching characteristics for MMC1/MMC2 – High Speed Mode.

Table 6-106. Timing Requirements for MMC1/MMC2 – High Speed Mode

see Figure 6-88

NO.			MIN	MAX	UNIT
HS1	$t_{su(cmdV-clkH)}$	Setup time, MMCx_CMD valid before MMCx_CLK rising edge	2.24		ns
HS2	$t_{h(clkH-cmdV)}$	Hold time, MMCx_CMD valid after MMCx_CLK rising edge	1.66		ns
HS3	$t_{su(dV-clkH)}$	Setup time, MMCx_DAT[3:0] valid before MMCx_CLK rising edge	2.24		ns
HS4	$t_{h(clkH-dV)}$	Hold time, MMCx_DAT[3:0] valid after MMCx_CLK rising edge	1.66		ns

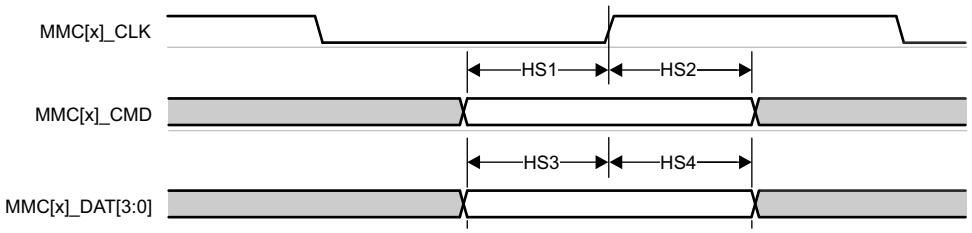


Figure 6-88. MMC1/MMC2 – High Speed – Receive Mode

Table 6-107. Switching Characteristics for MMC1/MMC2 – High Speed Mode

see Figure 6-89

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		50	MHz
HS5	$t_{c(clk)}$	Cycle time. MMCx_CLK	20		ns
HS6	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	9.2		ns
HS7	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	9.2		ns
HS8	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK falling edge to MMCx_CMD transition	- 1.8	2.2	ns
HS9	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK falling edge to MMCx_DAT[3:0] transition	- 1.8	2.2	ns

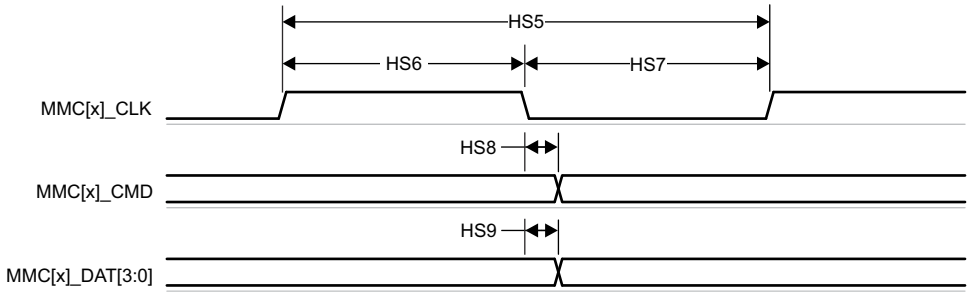


Figure 6-89. MMC1/MMC2 – High Speed – Transmit Mode

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6.12.5.16.2.3 UHS–I SDR12 Mode

Table 6-108, Figure 6-90, Table 6-109, and Figure 6-91 present timing requirements and switching characteristics for MMC1/MMC2 – UHS-I SDR12 Mode.

Table 6-108. Timing Requirements for MMC1/MMC2 – UHS-I SDR12 Mode

see Figure 6-90

NO.			MIN	MAX	UNIT
SDR121	$t_{su(cmdV-clkH)}$	Setup time, MMCx_CMD valid before MMCx_CLK rising edge	4.2		ns
SDR122	$t_{h(clkH-cmdV)}$	Hold time, MMCx_CMD valid after MMCx_CLK rising edge	0.87		ns
SDR123	$t_{su(dV-clkH)}$	Setup time, MMCx_DAT[3:0] valid before MMCx_CLK rising edge	4.2		ns
SDR124	$t_{h(clkH-dV)}$	Hold time, MMCx_DAT[3:0] valid after MMCx_CLK rising edge	0.87		ns

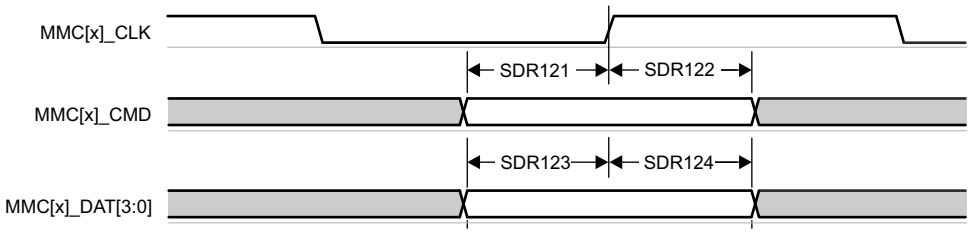


Figure 6-90. MMC1/MMC2 – UHS-I SDR12 – Receive Mode

Table 6-109. Switching Characteristics for MMC1/MMC2 – UHS-I SDR12 Mode

see Figure 6-91

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		25	MHz
SDR125	$t_{c(clk)}$	Cycle time, MMCx_CLK	40		ns
SDR126	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	18.7		ns
SDR127	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	18.7		ns
SDR128	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK rising edge to MMCx_CMD transition	1.5	8.6	ns
SDR129	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK rising edge to MMCx_DAT[3:0] transition	1.5	8.6	ns

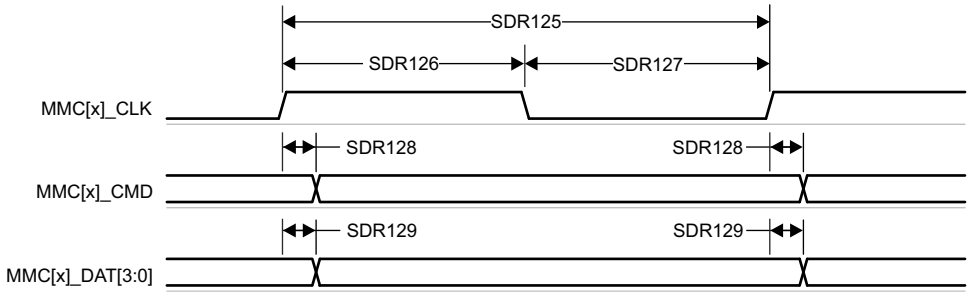


Figure 6-91. MMC1/MMC2 – UHS-I SDR12 – Transmit Mode

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6.12.5.16.2.4 UHS–I SDR25 Mode

Table 6-110, Figure 6-92, Table 6-111, and Figure 6-93 present timing requirements and switching characteristics for MMC1/MMC2 – UHS-I SDR25 Mode.

Table 6-110. Timing Requirements for MMC1/MMC2 – UHS-I SDR25 Mode

see Figure 6-92

NO.			MIN	MAX	UNIT
SDR251	$t_{su(cmdV-clkH)}$	Setup time, MMCx_CMD valid before MMCx_CLK rising edge	2.15		ns
SDR252	$t_{h(clkH-cmdV)}$	Hold time, MMCx_CMD valid after MMCx_CLK rising edge	1.27		ns
SDR253	$t_{su(dV-clkH)}$	Setup time, MMCx_DAT[3:0] valid before MMCx_CLK rising edge	2.15		ns
SDR254	$t_{h(clkH-dV)}$	Hold time, MMCx_DAT[3:0] valid after MMCx_CLK rising edge	1.27		ns

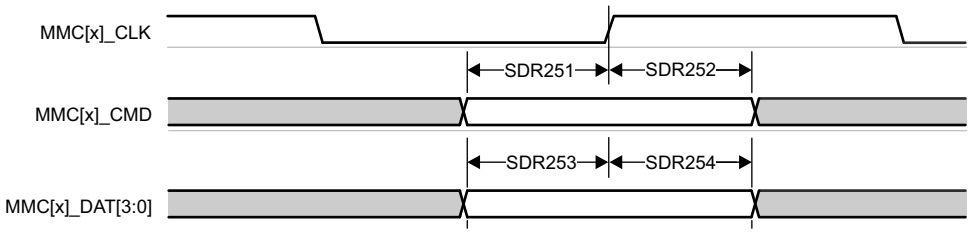


Figure 6-92. MMC1/MMC2 – UHS-I SDR25 – Receive Mode

Table 6-111. Switching Characteristics for MMC1/MMC2 – UHS-I SDR25 Mode

see Figure 6-93

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		50	MHz
SDR255	$t_{c(clk)}$	Cycle time, MMCx_CLK	20		ns
SDR256	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	9.2		ns
SDR257	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	9.2		ns
SDR258	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK rising edge to MMCx_CMD transition	2.4	8.1	ns
SDR259	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK rising edge to MMCx_DAT[3:0] transition	2.4	8.1	ns

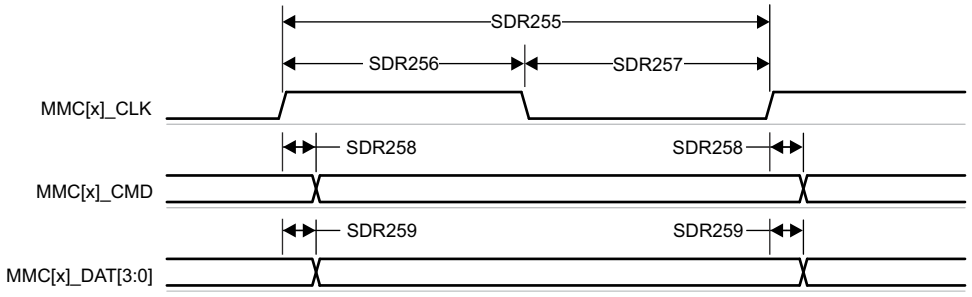


Figure 6-93. MMC1/MMC2 – UHS-I SDR25 – Transmit Mode

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6.12.5.16.2.5 UHS–I SDR50 Mode

Table 6-112 and Figure 6-94 presents switching characteristics for MMC1/MMC2 – UHS-I SDR50 Mode.

Table 6-112. Switching Characteristics for MMC1/MMC2 – UHS-I SDR50 Mode

see Figure 6-94

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		100	MHz
SDR505	$t_{c(clk)}$	Cycle time, MMCx_CLK	10		ns
SDR506	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	4.45		ns
SDR507	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	4.45		ns
SDR508	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK rising edge to MMCx_CMD transition	1.2	6.35	ns
SDR509	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK rising edge to MMCx_DAT[3:0] transition	1.2	6.35	ns

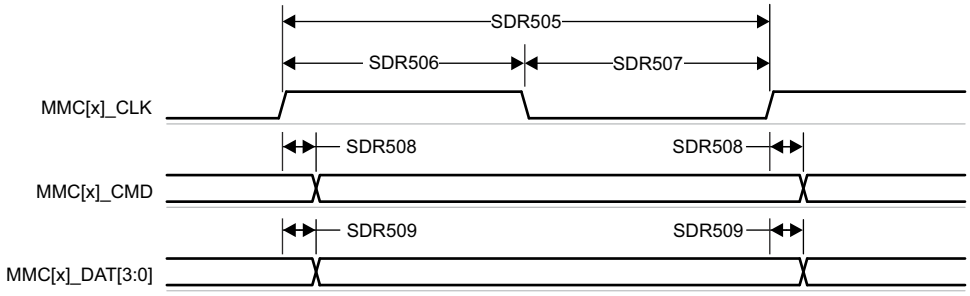


Figure 6-94. MMC1/MMC2 – UHS-I SDR50 – Transmit Mode

6.12.5.16.2.6 UHS–I DDR50 Mode

Table 6-113 and Figure 6-95 present switching characteristics for MMC1/MMC2 – UHS-I DDR50 Mode.

Table 6-113. Switching Characteristics for MMC1/MMC2 – UHS-I DDR50 Mode

see Figure 6-95

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		50	MHz
DDR505	$t_{c(clk)}$	Cycle time, MMCx_CLK	20		ns
DDR506	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	9.2		ns
DDR507	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	9.2		ns
DDR508	$t_{d(clk-cmdV)}$	Delay time, MMCx_CLK rising edge to MMCx_CMD transition	1.12	6.43	ns
DDR509	$t_{d(clk-dV)}$	Delay time, MMCx_CLK transition to MMCx_DAT[3:0] transition	1.12	6.43	ns

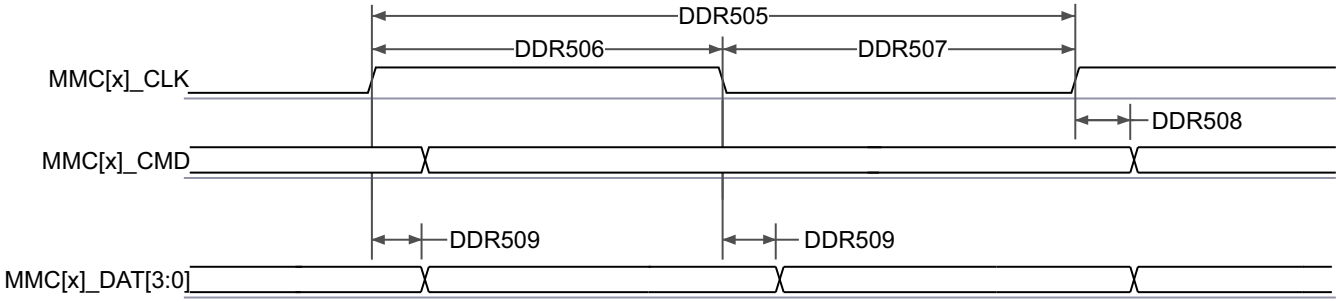


Figure 6-95. MMC1/MMC2 – UHS-I DDR50 – Transmit Mode

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6.12.5.16.2.7 UHS–I SDR104 Mode

Table 6-114 and Figure 6-96 present switching characteristics for MMC1/MMC2 – UHS-I SDR104 Mode.

Table 6-114. Switching Characteristics for MMC1/MMC2 – UHS-I SDR104 Mode

see Figure 6-96

NO.	PARAMETER		MIN	MAX	UNIT
	$f_{op(clk)}$	Operating frequency, MMCx_CLK		200	MHz
SDR1045	$t_{c(clk)}$	Cycle time, MMCx_CLK	5		ns
SDR1046	$t_{w(clkH)}$	Pulse duration, MMCx_CLK high	2.12		ns
SDR1047	$t_{w(clkL)}$	Pulse duration, MMCx_CLK low	2.12		ns
SDR1048	$t_{d(clkL-cmdV)}$	Delay time, MMCx_CLK rising edge to MMCx_CMD transition	1.07	3.21	ns
SDR1049	$t_{d(clkL-dV)}$	Delay time, MMCx_CLK rising edge to MMCx_DAT[3:0] transition	1.07	3.21	ns

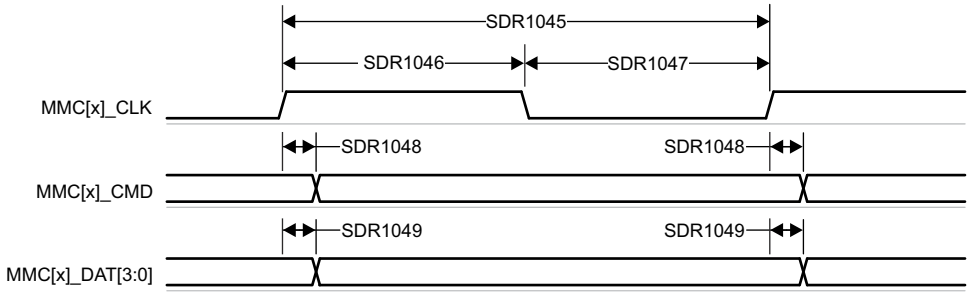


Figure 6-96. MMC1/MMC2 – UHS-I SDR104 – Transmit Mode

6.12.5.17 OSPI

OSPI0 offers two data capture modes, PHY mode and Tap mode.

PHY mode uses an internal reference clock to transmit and receive data via a DLL based PHY, where each reference clock cycle produces a single cycle of OSPI0_CLK for Single Data Rate (SDR) transfers or a half cycle of OSPI0_CLK for Double Data Rate (DDR) transfers. PHY mode supports four clocking topologies for the receive data capture clock. Internal PHY Loopback - uses the internal reference clock as the PHY receive data capture clock. Internal Pad Loopback - uses OSPI0_LBCLKO looped back into the PHY from the OSPI0_LBCLKO pin as the PHY receive data capture clock. External Board Loopback - uses OSPI0_LBCLKO looped back into the PHY from the OSPI0_DQS pin as the PHY receive data capture clock. DQS - uses the DQS output from the attached device as the PHY receive data capture clock. SDR transfers are not supported when using the Internal Pad Loopback and DQS clocking topologies. DDR transfers are not supported when using the Internal PHY Loopback or Internal Pad Loopback clocking topologies.

Tap mode uses an internal reference clock with selectable taps to adjusted data transmit and receive capture delays relative to OSPI0_CLK, which is a divide by 4 of the internal reference clock for SDR transfers or a divide by 8 of the internal reference clock for DDR transfers. Tap mode only supports one clocking topology for the receive data capture clock. No Loopback - uses the internal reference clock as the Tap receive data capture clock. This clocking topology supports a maximum internal reference clock rate of 200MHz, which produces an OSPI0_CLK rate up to 50MHz for SDR mode or 25MHz for DDR mode.

For more information, see *Octal Serial Peripheral Interface (OSPI)* section in *Peripherals* chapter in the device TRM.

For more details about features and additional description information on the device Octal Serial Peripheral Interface, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Section 6.12.5.17.1 defines timing requirements and switching characteristics associated with PHY mode and Section 6.12.5.17.2 defines timing requirements and switching characteristics associated with Tap mode.

Table 6-115 presents timing conditions for OSPI0.

Table 6-115. OSPI0 Timing Conditions

PARAMETER		MODE	MIN	MAX	UNIT
INPUT CONDITIONS					
SR_I	Input slew rate		1	6	V/ns
OUTPUT CONDITIONS					
C_L	Output load capacitance		3	10	pF
PCB CONNECTIVITY REQUIREMENTS					
$t_{d(Trace\ Delay)}$	Propagation delay of OSPI0_CLK trace	No Loopback Internal PHY Loopback Internal Pad Loopback		450	ps
	Propagation delay of OSPI0_LBCLKO trace	External Board Loopback	2L(1) - 30	2L(1) + 30	ps
	Propagation delay of OSPI0_DQS trace	DQS	L(1) - 30	L(1) + 30	ps
$t_{d(Trace\ Mismatch\ Delay)}$	Propagation delay mismatch of OSPI0_D[7:0] and OSPI0_CSn[3:0] relative to OSPI0_CLK	All modes		60	ps

(1) L = Propagation delay of OSPI0_CLK trace

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6.12.5.17.1 OSPI0 PHY Mode

6.12.5.17.1.1 OSPI0 With PHY Data Training

Read and write data valid windows will shift due to variation in process, voltage, temperature, and operating frequency. A data training method may be implemented to dynamically configure optimal read and write timing. Implementing data training enables proper operation across temperature with a specific process, voltage, and frequency operating condition, while achieving a higher operating frequency.

Data transmit and receive timing parameters are not defined for the data training use case since they are dynamically adjusted based on the operating condition.

Table 6-116 defines DLL delays required for OSPI0 with Data Training. Table 6-117, Figure 6-97, Figure 6-98, Table 6-118, Figure 6-99, and Figure 6-100 present timing requirements and switching characteristics for OSPI0 with Data Training.

Table 6-116. OSPI0 DLL Delay Mapping for PHY Data Training

MODE	REGISTER BIT FIELD	DELAY VALUE
OSPI_PHY_CONFIGURATION_REG		
Transmit		
All modes	PHY_CONFIG_TX_DLL_DELAY_FLD	(1)
Receive		
All modes	PHY_CONFIG_RX_DLL_DELAY_FLD	(2)
PHY_MASTER_CONTROL_REG		
All modes	PHY_MASTER_PHASE_DETECT_SELECTOR_FLD	0x3

(1) Transmit DLL delay value determined by training software
(2) Receive DLL delay value determined by training software

Table 6-117. OSPI0 Timing Requirements – PHY Data Training

see Figure 6-97, and Figure 6-98

NO.			MODE	MIN	MAX	UNIT
O15	$t_{su(D-LBCLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_DQS edge	DDR with DQS	(1)		ns
O16	$t_{h(LBCLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_DQS edge	DDR with DQS	(1)		ns
O21	$t_{su(D-LBCLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_DQS edge	SDR with External Board Loopback	(1)		ns
O22	$t_{h(LBCLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_DQS edge	SDR with External Board Loopback	(1)		ns
	t_{DVW}	Data valid window (O15 + O16)	1.8V, DDR with DQS	1.6		ns
			3.3V, DDR with DQS	2.2		ns
		Data valid window (O21 + O22)	1.8V, SDR with External Board Loopback	2.3		ns
			3.3V, SDR with External Board Loopback	2.9		ns

(1) Minimum setup and hold time requirements for OSPI0_D[7:0] inputs are not defined when Data Training is used to find the optimum data valid window. The t_{DVW} parameter defines the minimum data invalid window required. This parameter is provided in lieu of minimum setup and minimum hold times, where it must be used to check compatibility with the data valid window provided by an attached device.

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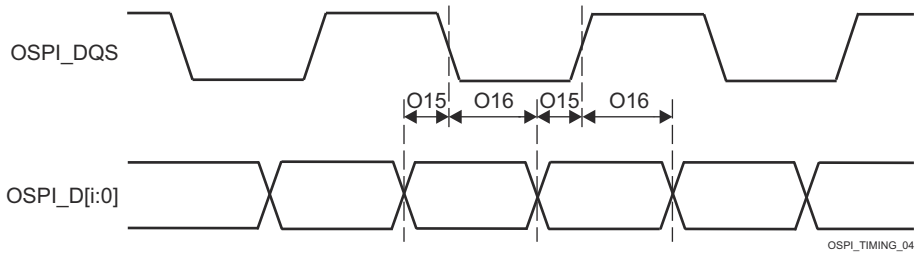


Figure 6-97. OSPI0 Timing Requirements – PHY Data Training, DDR with DQS

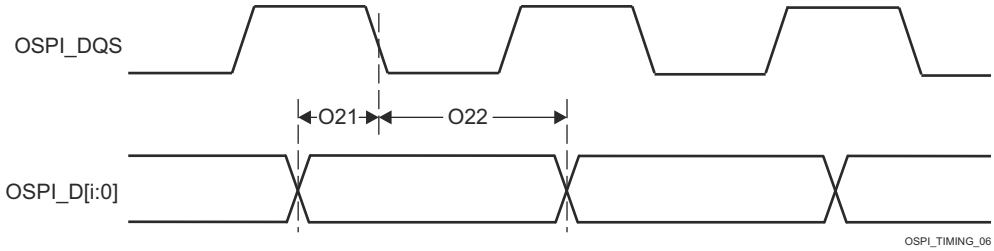


Figure 6-98. OSPI0 Timing Requirements – PHY Data Training, SDR with External Board Loopback

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Table 6-118. OSPI Switching Characteristics – PHY Data Training

See Figure 6-99 and Figure 6-100

NO.	PARAMETER		MODE	MIN	MAX	UNIT
O1	$t_{c(CLK)}$	Cycle time, OSPI0_CLK	1.8V, DDR	6.0	10	ns
			3.3V, DDR	7.5	10	ns
O7			1.8V, SDR	6.0	10	ns
			3.3V, SDR	7.5	10	ns
O2	$t_{w(CLKL)}$	Pulse duration, OSPI0_CLK low	DDR	((0.475P(1)) - 0.3)		ns
O8			SDR			
O3	$t_{w(CLKH)}$	Pulse duration, OSPI0_CLK high	DDR	((0.475P(1)) - 0.3)		ns
O9			SDR			
O4	$t_{d(CSn-CLK)}$	Delay time, OSPI0_CSn[3:0] active edge to OSPI0_CLK rising edge	DDR	((0.475P(1)) + (0.975M(2)R(4)) + (0.04TD(5)) - 1)	((0.525P(1)) + (1.025M(2)R(4)) + (0.11TD(5)) + 1)	ns
O10			SDR			
O5	$t_{d(CLK-CSn)}$	Delay time, OSPI0_CLK rising edge to OSPI0_CSn[3:0] inactive edge	DDR	((0.475P(1)) + (0.975N(3)R(4)) - (0.11TD(5)) - 1)	((0.525P(1)) + (1.025N(3)R(4)) - (0.04TD(5)) + 1)	ns
O11			SDR			
O6	$t_{d(CLK-D)}$	Delay time, OSPI0_CLK active edge to OSPI0_D[7:0] transition	DDR	(6)	(6)	ns
O12			SDR			
	t_{DIVW}	Data invalid window (O6 Max - Min)	DDR		1.6	ns
		Data invalid window (O12 Max - Min)	SDR			

(1) P = SCLK cycle time in ns = OSPI0_CLK cycle time in ns
(2) M = OSPI_DEV_DELAY_REG[D_INIT_FLD]
(3) N = OSPI_DEV_DELAY_REG[D_AFTER_FLD]
(4) R = reference clock cycle time in ns
(5) TD = PHY_CONFIG_TX_DLL_DELAY_FLD
(6) Minimum and maximum delay times for OSPI0_D[7:0] outputs are not defined when Data Training is used to find the optimum data valid window. The t_{DIVW} parameter defines the maximum data invalid window. This parameter is provided in lieu of minimum and maximum delay times, where it must be used to check compatibility with the data valid window requirements of an attached device.

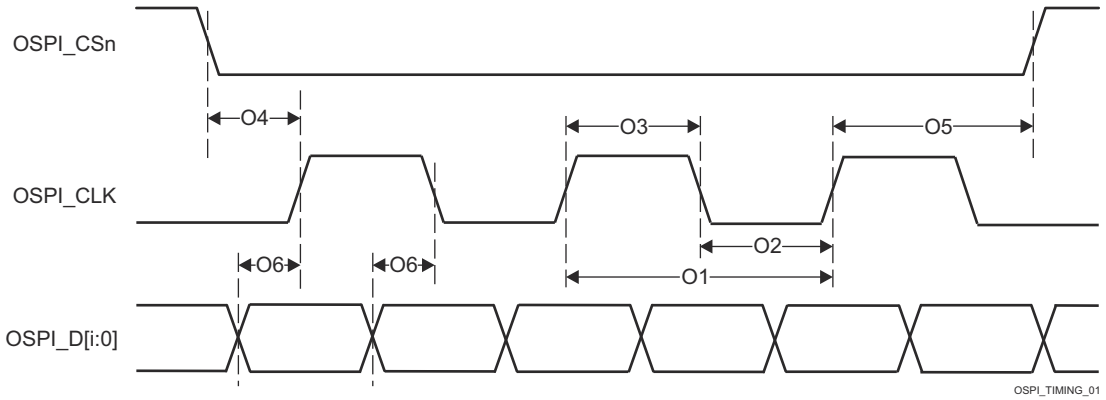


Figure 6-99. OSPI0 Switching Characteristics – PHY DDR Data Training

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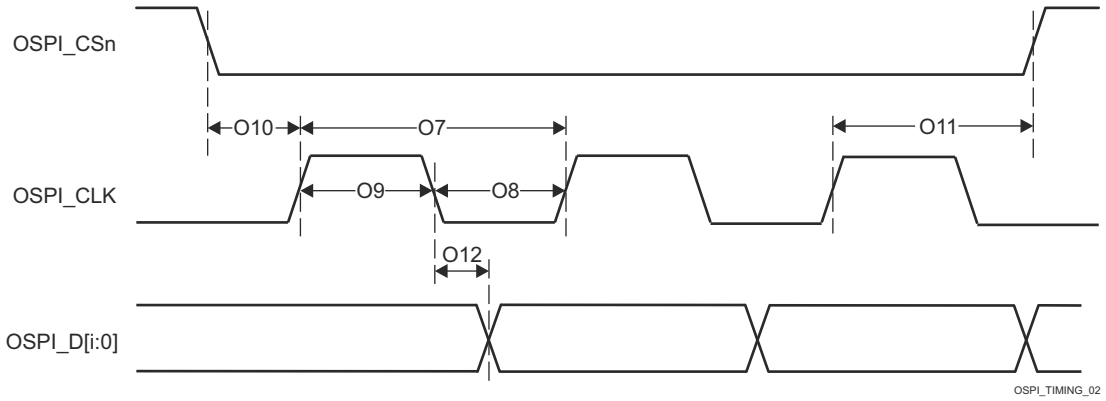


Figure 6-100. OSPI0 Switching Characteristics – PHY SDR Data Training

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6.12.5.17.1.2 OSPI0 Without Data Training

Note

Timing parameters defined in this section are only applicable when data training is not implemented and DLL delays are configured as described in Table 6-119 and Table 6-122.

6.12.5.17.1.2.1 OSPI0 PHY SDR Timing

Table 6-119 defines DLL delays required for OSPI0 PHY SDR Mode. Table 6-120, Figure 6-101, Figure 6-102, Table 6-121, and Figure 6-103 present timing requirements and switching characteristics for OSPI0 PHY SDR Mode.

Table 6-119. OSPI0 DLL Delay Mapping for PHY SDR Timing Modes

MODE	REGISTER BIT FIELD	DELAY VALUE
OSPI_PHY_CONFIGURATION_REG		
Transmit		
All modes	PHY_CONFIG_TX_DLL_DELAY_FLD	0x0
Receive		
All modes	PHY_CONFIG_RX_DLL_DELAY_FLD	0x0
PHY_MASTER_CONTROL_REG		
All modes	PHY_MASTER_PHASE_DETECT_SELECTOR_FLD	0x3

Table 6-120. OSPI0 Timing Requirements – PHY SDR Mode

see Figure 6-101 and Figure 6-102

NO.			MODE	MIN	MAX	UNIT
O19	$t_{su(D-CLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_CLK edge	1.8V, SDR with Internal PHY Loopback	4.8		ns
			3.3V, SDR with Internal PHY Loopback	5.19		ns
O20	$t_{h(CLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_CLK edge	1.8V, SDR with Internal PHY Loopback	-0.5		ns
			3.3V, SDR with Internal PHY Loopback	-0.5		ns
O21	$t_{su(D-LBCLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_DQS edge	1.8V, SDR with External Board Loopback	0.6		ns
			3.3V, SDR with External Board Loopback	0.9		ns
O22	$t_{h(LBCLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_DQS edge	1.8V, SDR with External Board Loopback	1.7		ns
			3.3V, SDR with External Board Loopback	2.0		ns

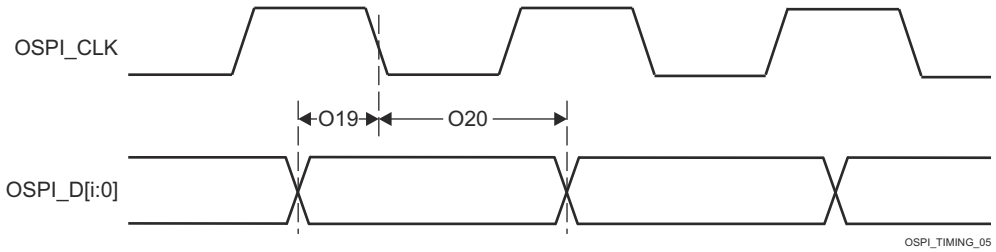


Figure 6-101. OSPI0 Timing Requirements – PHY SDR with Internal PHY Loopback

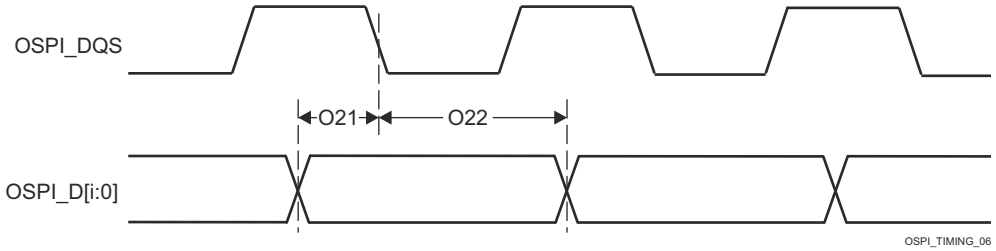


Figure 6-102. OSPI0 Timing Requirements – PHY SDR with External Board Loopback

Table 6-121. OSPI0 Switching Characteristics – PHY SDR Mode

see Figure 6-103

NO.	PARAMETER		MODE	MIN	MAX	UNIT
O7	$t_{c(CLK)}$	Cycle time, OSPI0_CLK	1.8V	7		ns
			3.3V	6.03		ns
O8	$t_{w(CLKL)}$	Pulse duration, OSPI0_CLK low		((0.475P(1)) - 0.3)		ns
O9	$t_{w(CLKH)}$	Pulse duration, OSPI0_CLK high		((0.475P(1)) - 0.3)		ns
O10	$t_{d(CSn-CLK)}$	Delay time, OSPI0_CSn[3:0] active edge to OSPI0_CLK rising edge		((0.475P(1)) + (0.975M(2)R(4)) + (0.04TD(5)) - 1)	((0.525P(1)) + (1.025M(2)R(4)) + (0.11TD(5)) + 1)	ns
O11	$t_{d(CLK-CSn)}$	Delay time, OSPI0_CLK rising edge to OSPI0_CSn[3:0] inactive edge		((0.475P(1)) + (0.975N(3)R(4)) - (0.11TD(5)) - 1)	((0.525P(1)) + (1.025N(3)R(4)) - (0.04TD(5)) + 1)	ns
O12	$t_{d(CLK-D)}$	Delay time, OSPI0_CLK active edge to OSPI0_D[7:0] transition	1.8V	-1.16	1.25	ns
			3.3V	-1.33	1.51	ns

(1) P = SCLK cycle time in ns = OSPI0_CLK cycle time in ns
(2) M = OSPI_DEV_DELAY_REG[D_INIT_FLD]
(3) N = OSPI_DEV_DELAY_REG[D_AFTER_FLD]
(4) R = reference clock cycle time in ns
(5) TD = PHY_CONFIG_TX_DLL_DELAY_FLD

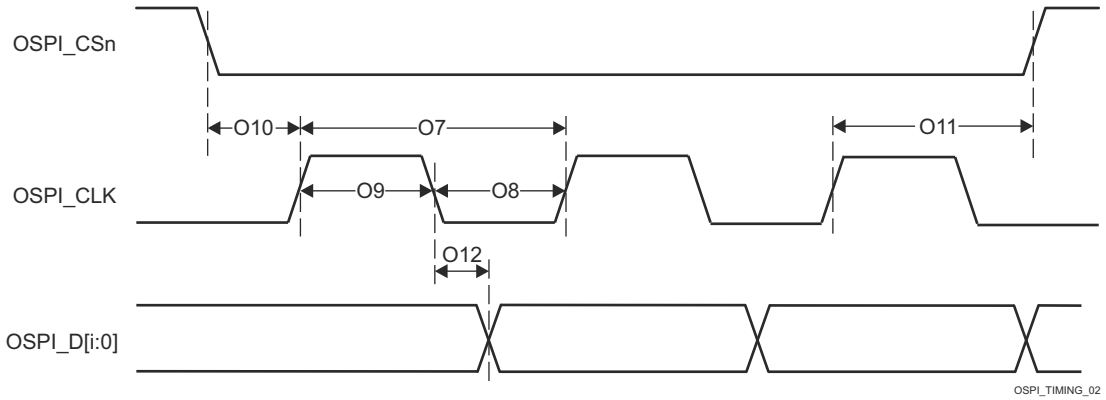


Figure 6-103. OSPI0 Switching Characteristics – PHY SDR

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6.12.5.17.1.2.2 OSPI0 PHY DDR Timing

Table 6-122 defines DLL delays required for OSPI0 PHY DDR Mode. Table 6-123, Figure 6-104, Table 6-124, and Figure 6-105 present timing requirements and switching characteristics for OSPI0 PHY DDR Mode.

Table 6-122. OSPI0 DLL Delay Mapping for PHY DDR Timing Modes

MODE	REGISTER BIT FIELD	DELAY VALUE
OSPI_PHY_CONFIGURATION_REG		
Transmit		
1.8V	PHY_CONFIG_TX_DLL_DELAY_FLD	0x46
3.3V	PHY_CONFIG_TX_DLL_DELAY_FLD	0x43
Receive		
1.8V, DQS	PHY_CONFIG_RX_DLL_DELAY_FLD	0x15
3.3V, DQS	PHY_CONFIG_RX_DLL_DELAY_FLD	0x3A
All other modes	PHY_CONFIG_RX_DLL_DELAY_FLD	0x0
PHY_MASTER_CONTROL_REG		
All modes	PHY_MASTER_PHASE_DETECT_SELECTOR_FLD	0x3

Table 6-123. OSPI0 Timing Requirements – PHY DDR Mode

see Figure 6-104

NO.			MODE	MIN	MAX	UNIT
O15	$t_{su(D-LBCLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_DQS edge	1.8V, DDR with External Board Loopback	0.53		ns
			1.8V, DDR with DQS	-0.46		ns
			3.3V, DDR with External Board Loopback	1.23		ns
			3.3V, DDR with DQS	-0.66		ns
O16	$t_{h(LBCLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_DQS edge	1.8V, DDR with External Board Loopback	1.24(1)		ns
			1.8V, DDR with DQS	3.59		ns
			3.3V, DDR with External Board Loopback	1.44(1)		ns
			3.3V, DDR with DQS	7.92		ns

(1) This Hold time requirement is larger than the Hold time provided by a typical OSPI/QSPI/SPI device. Therefore, the trace length between the SoC and attached OSPI/QSPI/SPI device must be sufficiently long enough to ensure that the Hold time is met at the SoC. The length of the SoC's external loopback clock (OSPI0_LBCLKO to OSPI0_DQS) may need to be shortened to compensate.

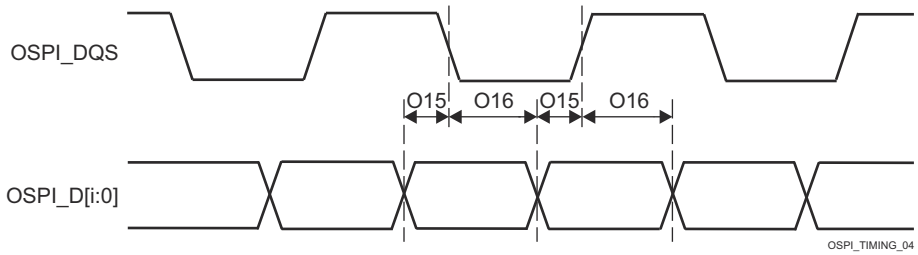


Figure 6-104. OSPI0 Timing Requirements – PHY DDR with External Board Loopback or DQS

Table 6-124. OSPI0 Switching Characteristics – PHY DDR Mode

see Figure 6-105

NO.	PARAMETER		MODE	MIN	MAX	UNIT
O1	$t_{c(CLK)}$	Cycle time, OSPI0_CLK		19		ns
O2	$t_{w(CLKL)}$	Pulse duration, OSPI0_CLK low		((0.475P(1)) - 0.3)		ns
O3	$t_{w(CLKH)}$	Pulse duration, OSPI0_CLK high		((0.475P(1)) - 0.3)		ns
O4	$t_{d(CSn-CLK)}$	Delay time, OSPI0_CSn[3:0] active edge to OSPI0_CLK rising edge		((0.475P(1)) + (0.975M(2)R(4)) + (0.04TD(5)) - 1)	((0.525P(1)) + (1.025M(2)R(4)) + (0.11TD(5)) + 1)	ns
O5	$t_{d(CLK-CSn)}$	Delay time, OSPI0_CLK rising edge to OSPI0_CSn[3:0] inactive edge		((0.475P(1)) + (0.975N(3)R(4)) - (0.11TD(5)) - 1)	((0.525P(1)) + (1.025N(3)R(4)) - (0.04TD(5)) + 1)	ns
O6	$t_{d(CLK-D)}$	Delay time, OSPI0_CLK active edge to OSPI0_D[7:0] transition	1.8V	-7.71	-1.56	ns
			3.3V	-7.71	-1.56	ns

(1) P = SCLK cycle time in ns = OSPI0_CLK cycle time in ns
(2) M = OSPI_DEV_DELAY_REG[D_INIT_FLD]
(3) N = OSPI_DEV_DELAY_REG[D_AFTER_FLD]
(4) R = reference clock cycle time in ns
(5) TD = PHY_CONFIG_TX_DLL_DELAY_FLD

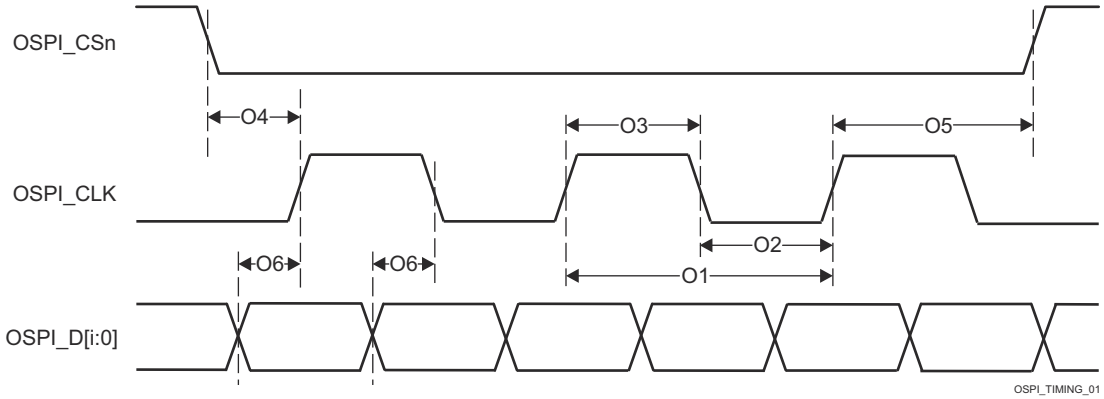


Figure 6-105. OSPI0 Switching Characteristics – PHY DDR

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6.12.5.17.2 OSPI0 Tap Mode

6.12.5.17.2.1 OSPI0 Tap SDR Timing

Table 6-125, Figure 6-106, Table 6-126, and Figure 6-107 present timing requirements and switching characteristics for OSPI0 Tap SDR Mode.

Table 6-125. OSPI0 Timing Requirements – Tap SDR Mode

see Figure 6-106

NO.			MODE	MIN	MAX	UNIT
O19	$t_{su(D-CLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_CLK edge	No Loopback	(15.4 - (0.975T(1)R(2)))		ns
O20	$t_{h(CLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_CLK edge	No Loopback	(- 4.3 + (0.975T(1)R(2)))		ns

(1) T = OSPI_RD_DATA_CAPTURE_REG[DELAY_FLD]
(2) R = reference clock cycle time in ns

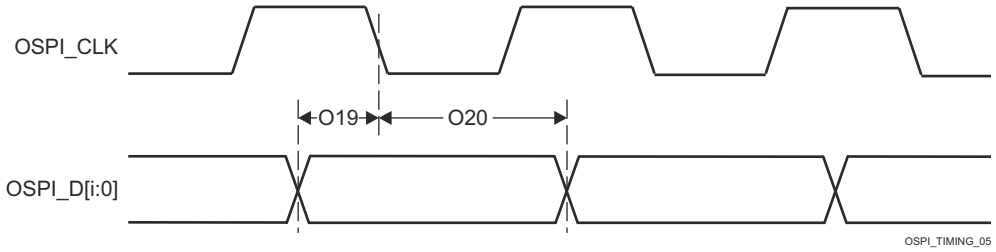


Figure 6-106. OSPI0 Timing Requirements – Tap SDR, No Loopback

Table 6-126. OSPI0 Switching Characteristics – Tap SDR Mode

see Figure 6-107

NO.	PARAMETER		MODE	MIN	MAX	UNIT
O7	$t_{c(CLK)}$	Cycle time, OSPI0_CLK		20		ns
O8	$t_{w(CLKL)}$	Pulse duration, OSPI0_CLK low		((0.475P(1)) - 0.3)		ns
O9	$t_{w(CLKH)}$	Pulse duration, OSPI0_CLK high		((0.475P(1)) - 0.3)		ns
O10	$t_{d(CSn-CLK)}$	Delay time, OSPI0_CSn[3:0] active edge to OSPI0_CLK rising edge		((0.475P(1)) + (0.975M(2)R(4)) - 1)	((0.525P(1)) + (1.025M(2)R(4)) + 1)	ns
O11	$t_{d(CLK-CSn)}$	Delay time, OSPI0_CLK rising edge to OSPI0_CSn[3:0] inactive edge		((0.475P(1)) + (0.975N(3)R(4)) - 1)	((0.525P(1)) + (1.025N(3)R(4)) + 1)	ns
O12	$t_{d(CLK-D)}$	Delay time, OSPI0_CLK active edge to OSPI0_D[7:0] transition		- 4.25	7.25	ns

(1) P = SCLK cycle time in ns = OSPI0_CLK cycle time in ns
(2) M = OSPI_DEV_DELAY_REG[D_INIT_FLD]
(3) N = OSPI_DEV_DELAY_REG[D_AFTER_FLD]
(4) R = reference clock cycle time in ns

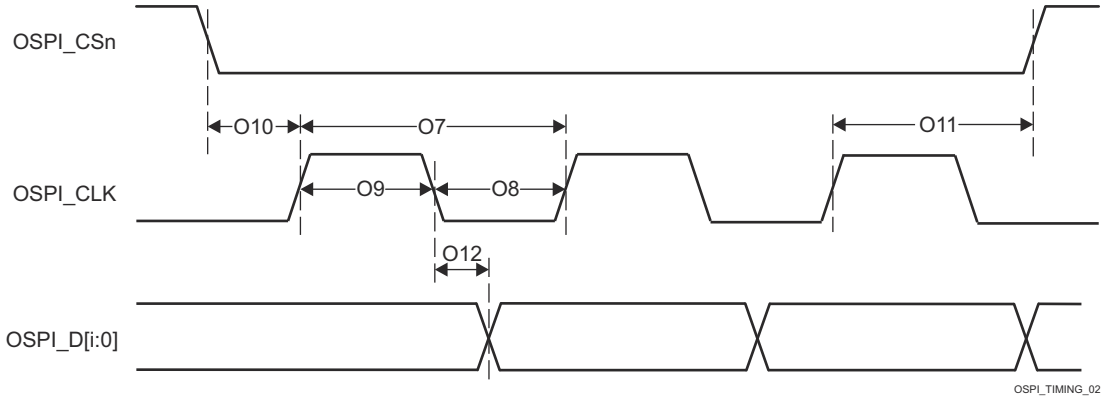


Figure 6-107. OSPI0 Switching Characteristics – Tap SDR, No Loopback

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6.12.5.17.2.2 OSPI0 Tap DDR Timing

Table 6-127, Figure 6-108, Table 6-128, and Figure 6-109 present timing requirements and switching characteristics for OSPI0 Tap DDR Mode.

Table 6-127. OSPI0 Timing Requirements – Tap DDR Mode

see Figure 6-108

NO.			MODE	MIN	MAX	UNIT
O13	$t_{su(D-CLK)}$	Setup time, OSPI0_D[7:0] valid before active OSPI0_CLK edge	No Loopback	(17.04 - (0.975T(1)R(2)))		ns
O14	$t_{h(CLK-D)}$	Hold time, OSPI0_D[7:0] valid after active OSPI0_CLK edge	No Loopback	(- 3.16 + (0.975T(1)R(2)))		ns

(1) T = OSPI_RD_DATA_CAPTURE_REG[DELAY_FLD]
(2) R = reference clock cycle time in ns

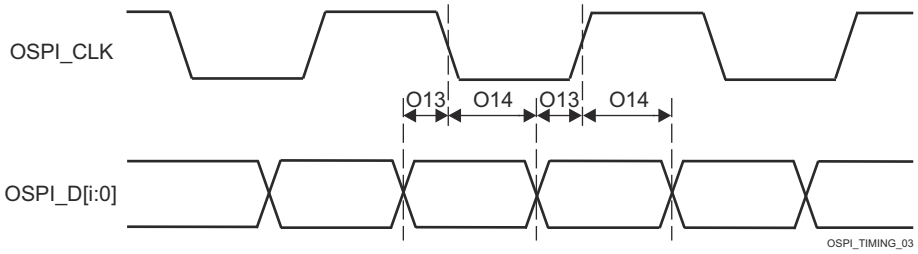


Figure 6-108. OSPI0 Timing Requirements – Tap DDR, No Loopback

Table 6-128. OSPI0 Switching Characteristics – Tap DDR Mode

see Figure 6-109

NO.	PARAMETER		MODE	MIN	MAX	UNIT
O1	$t_{c(CLK)}$	Cycle time, OSPI0_CLK		40		ns
O2	$t_{w(CLKL)}$	Pulse duration, OSPI0_CLK low		((0.475P(1)) - 0.3)		ns
O3	$t_{w(CLKH)}$	Pulse duration, OSPI0_CLK high		((0.475P(1)) - 0.3)		ns
O4	$t_{d(CSn-CLK)}$	Delay time, OSPI0_CSn[3:0] active edge to OSPI0_CLK rising edge		((0.475P(1)) + ((0.975M(2)R(5)) - 1)	((0.525P(1)) + (1.025M(2)R(5)) + 1)	ns
O5	$t_{d(CLK-CSn)}$	Delay time, OSPI0_CLK rising edge to OSPI0_CSn[3:0] inactive edge		((0.475P(1)) + (0.975N(3)R(5)) - 1)	((0.525P(1)) + (1.025N(3)R(5)) + 1)	ns
O6	$t_{d(CLK-D)}$	Delay time, OSPI0_CLK active edge to OSPI0_D[7:0] transition		(- 5.04 + (0.975(T(4) + 1)R(5)) - (0.525P(1)))	(3.64 + (1.025(T(4) + 1)R(5)) - (0.475P(1)))	ns

(1) P = SCLK cycle time in ns = OSPI0_CLK cycle time in ns
(2) M = OSPI_DEV_DELAY_REG[D_INIT_FLD]
(3) N = OSPI_DEV_DELAY_REG[D_AFTER_FLD]
(4) T = OSPI_RD_DATA_CAPTURE_REG[DDR_READ_DELAY_FLD]
(5) R = reference clock cycle time in ns

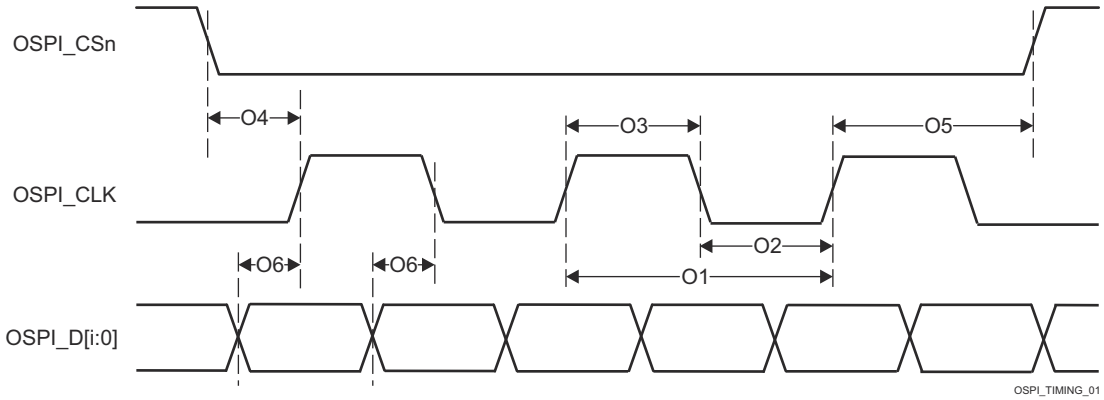


Figure 6-109. OSPI0 Switching Characteristics – Tap DDR, No Loopback

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6.12.5.18 Timers

For more details about features and additional description information on the device Timers, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-129. Timer Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.5	5	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	2	10	pF

Table 6-130. Timer Input Timing Requirements

see Figure 6-110

NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
T1	$t_{w(TINPH)}$	Pulse duration, high	CAPTURE	4P(1)+ 2.5		ns
T2	$t_{w(TINPL)}$	Pulse duration, low	CAPTURE	4P(1)+ 2.5		ns

(1) P = functional clock period in ns.

Table 6-131. Timer Output Switching Characteristics

see Figure 6-110

NO.	PARAMETER	DESCRIPTION	MODE	MIN	MAX	UNIT
T3	$t_{w(TOUTH)}$	Pulse duration, high	PWM	4P(1) - 2.5		ns
T4	$t_{w(TOUTL)}$	Pulse duration, low	PWM	4P(1) - 2.5		ns

(1) P = functional clock period in ns.

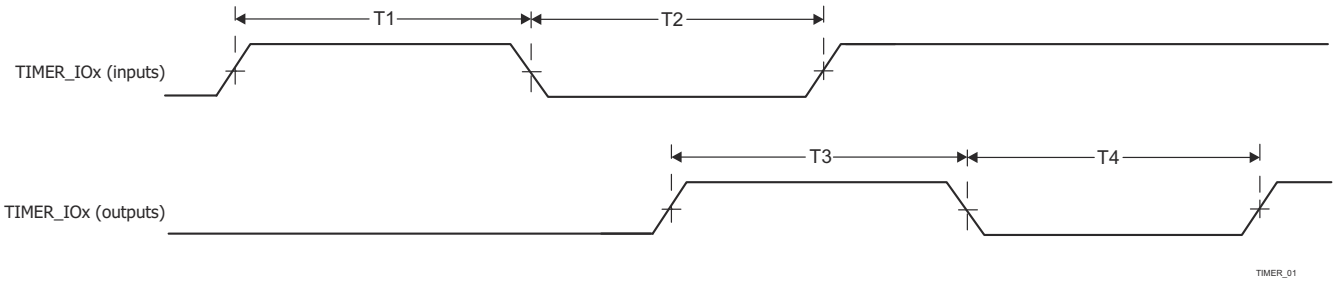


Figure 6-110. Timer Timing Requirements and Switching Characteristics

For more information, see *Timers* section in *Peripherals* chapter in the device TRM.

6.12.5.19 UART

For more details about features and additional description information on the device Universal Asynchronous Receiver Transmitter, see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

Table 6-132. UART Timing Conditions

PARAMETER		MIN	MAX	UNIT
INPUT CONDITIONS				
SR_I	Input slew rate	0.5	5	V/ns
OUTPUT CONDITIONS				
C_L	Output load capacitance	1	30(1)	pF

(1) This value represents an absolute maximum load capacitance. As the UART baud rate increases, it may be necessary to reduce the load capacitance to a value less than this maximum limit to provide enough timing margin for the attached device. The output rise/fall times increase as capacitive load increases, which decreases the time data is valid for the receiver of the attached devices. Therefore, it is important to understand the minimum data valid time required by the attached device at the operating baud rate. Then use the device IBIS models to verify the actual load capacitance on the UART signals does not increase the rise/fall times beyond the point where the minimum data valid time of the attached device is violated.

Table 6-133. UART Timing Requirements

see Figure 6-111

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
1	$t_{w(RXD)}$	Pulse width, receive data bit high or low	0.95U(1)(2)	1.05U(1)(2)	ns
2	$t_{w(RXDS)}$	Pulse width, receive start bit low	0.95U(1)(2)		ns

(1) U = UART baud time in ns = 1/programmed baud rate.
(2) This value defines the data valid time, where the input voltage is required to be above V_{IH} or below V_{IL}.

Table 6-134. UART Switching Characteristics

see Figure 6-111

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
	$f_{(baud)}$	Programmable baud rate for Main Domain UARTs		12	Mbps
		Programmable baud rate for MCU and WKUP Domain UARTs		3.7	Mbps
3	$t_{w(TXD)}$	Pulse width, transmit data bit high or low	U(1) - 2	U(1) + 2	ns
4	$t_{w(TXDS)}$	Pulse width, transmit start bit low	U(1) - 2		ns

(1) U = UART baud time in ns = 1/actual baud rate, where the actual baud rate is defined in the UART Baud Rate Settings table of the device TRM.

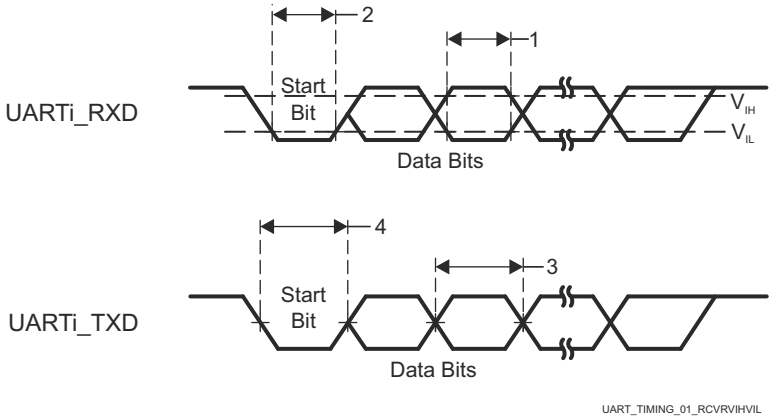


Figure 6-111. UART Timing Requirements and Switching Characteristics

For more information, see *Universal Asynchronous Receiver/Transmitter (UART)* section in *Peripherals* chapter in the device TRM.

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6.12.5.20 USB

The USB 2.0 subsystem is compliant with the Universal Serial Bus (USB) Specification, revision 2.0. Refer to the specification for timing details.

For more details about features and additional description information on the device Universal Serial Bus Subsystem (USB), see the corresponding subsections within *Signal Descriptions* and *Detailed Description* sections.

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7 Detailed Description

7.1 Overview

AM62Ax is an extension of the Sitara™ automotive-grade family of heterogeneous Arm® processors with embedded Deep Learning (DL), Video and Vision Processing acceleration, display interface and extensive automotive peripheral and networking options. AM62Ax is built for a set of cost-sensitive automotive applications including driver and in-cabin monitoring systems, next generation of eMirror system, as well as a broad set of industrial applications in Factory Automation, Building Automation, Robotics, and other markets. The cost optimized AM62Ax provides high-performance compute for both traditional and deep learning algorithms at industry leading power/performance ratios with a high level of system integration to enable scalability and lower costs for advanced automotive platforms supporting multiple sensor modalities in stand-alone Electronic Control Units (ECUs).

AM62Ax contains up to four Arm® Cortex®-A53 cores with 64-bit architecture, a Vision Processing Accelerator (VPAC) with Image Signal Processor (ISP) and multiple vision assist accelerators, Deep Learning (DL) and video accelerators, a Cortex®-R5F MCU Channel core and a Cortex®-R5F Device Management core. The Cortex-A53s provide the powerful computing elements necessary for Linux applications as well as the implementation of traditional vision computing based-algorithms such as driver monitoring. Building on the existing world-class ISP, TI's 7th generation ISP includes flexibility to process a broader sensor suite including RGB-InfraRed (RGB-IR), support for higher bit depth, and features targeting analytics applications. Key cores include the next generation C7000™ DSP from Texas Instruments (C7™ DSP) with scalar and vector cores, dedicated "MMA" deep learning accelerator enabling performance up to 2 TOPS within the lowest power envelope in the industry when operating at the typical automotive worst case junction temperature of 125°C.

The 3-port Gigabit Ethernet switch has one internal port and two external ports with TSN support and can be used to enable industrial networking options. In addition, an extensive peripherals set is included in AM62Ax to enable system level connectivity such as USB, MMC/SD, Camera interface, OSPI, CAN-FD and GPMC for parallel host interface to an external ASIC/FPGA. AM62Ax supports secure boot for IP protection with the built-in HSM (Hardware Security Module) and also employs advanced power management support for portable and power-sensitive applications.

Note

For more information on features, subsystems, and architecture of superset device System on Chip (SoC), see the device TRM.

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7.2 Processor Subsystems

7.2.1 Arm Cortex-A53 Subsystem (A53SS)

The SoC implements one cluster of quad-core Arm® Cortex®-A53 MPCore™, with 32KB L1 instruction, 32KB L1 data, per core and 512KB L2 shared cache.

The Cortex®-A53 cores are general-purpose processors that can be used for running customer applications.

The A53SS is built around the Cortex®-A53 MPCore™ (Arm®-A53 Cluster), which is provided by Arm and configured by TI. It is based on the symmetric multiprocessor (SMP) architecture, and thus, it delivers high performance and optimal power management, debug and emulation capabilities.

The A53 processor is a multi-issue out-of-order superscalar execution engine with integrated L1 Instruction and Data Caches, compatible with Arm®v8-A architecture. It delivers significantly more performance than its predecessors at a higher level of power efficiency.

The Arm®v8-A architecture brings a number of new features. These include 64-bit data processing, extended virtual addressing and 64-bit general purpose registers. The A53 processor is Arm's first Arm®v8-A processor aimed at providing power-efficient 64-bit processing. It features an in-order, 8-stage, dual-issue pipeline, and improved integer, Arm® Neon™, Floating-Point Unit (FPU) and memory performance.

The A53 CPU supports two execution states: AArch32 and AArch64. The AArch64 state gives the A53 CPU its ability to execute 64-bit applications, while the AArch32 state allows the processor to execute existing Arm®v7-A applications.

The A53SS integrates advanced features including Arm®v8 Cryptography Extensions, GICv3 architecture, ECC and parity protection for caches, dedicated watchdog timers per core, high-throughput 256-bit VBUSM interfaces, and a PBIST controller with BISOR for built-in self-test and reliability.

For more information, see *Arm Cortex-A53 Subsystem* section in *Processors and Accelerators* chapter in the device TRM.

7.2.2 Device/Power Manager

The WKUP_R5FSS is a single-core implementation of the Arm® Cortex®-R5F processor that acts as the Device Manager responsible for boot, resource management, and power management functions. It also includes accompanying memories (L1 caches and tightly-coupled memories), standard Arm® CoreSight™ debug and trace architecture, integrated vectored interrupt manager (VIM), ECC aggregators, and various other modules for protocol conversion and address translation for easy integration into the SoC.

For more information, see *Device Manager Cortex R5F Subsystem* section in *Processors and Accelerators* chapter in the device TRM.

7.2.3 MCU Arm Cortex-R5F Subsystem

The MCU_R5FSS is an Arm® Cortex®-R5F based subsystem that can run safety processing or be used as a general purpose MCU. The processor includes 32KB instruction Cache, 32KB data cache, and 64KB Tightly Coupled Memory.

For more information, see *Cortex R5F Subsystem* section in *Processors and Accelerators* chapter in the device TRM.

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7.3 Accelerators and Coprocessors

7.3.1 C7™ Neural Processing Unit

Single Core C7™ DSP + MMA subsystem with 32KB Instruction cache and 64KB data cache

7.3.2 Vision Pre-processing Accelerator

The Vision Pre-processing Accelerator (VPAC) subsystem is a set of common vision primitive functions, performing pixel data processing tasks, such as: color processing and enhancement, noise filtering, wide dynamic range (WDR) processing, lens distortion correction, pixel remap for de-warping, on-the-fly scale generation, on-the-fly pyramid generation. The VPAC offloads these common tasks from the main SoC processors (ARM, DSP, etc.), so these CPUs can be utilized for differentiated high-lelvel algorithms. The VPAC is designed to support multiple cameras by working in time-multiplexing mode. The VPAC also includes an imaging pipe, which can be integrated on-the-fly with external camera sensor, as well as does memory-to-memory (M2M) processing on pixel data

The VPAC subsystem provides 4 processing blocks: Vision Imaging Sub-System (VISS), Lens Distortion Correction (LDC), Multi-Scalar (MSC) and Noise Filter (NF), along with Hardware Thread Scheduler (HTS), Load Store Engin (LSE), and 512 KB of internal L2 memory.

For more information, see *Vision Pre-processing Accelerator (VPAC)* section in *Processors and Accelerators* chapter in the device TRM.

7.3.3 JPEG Encoder

The JPEG Encoder is a scalable performance still image encoder. It supports the JPEG baseline still image encode. The source is raw picture data and the output is the fully constructed compressed image. The JPEG Encoder receives the image source through the memory interface (via MMU). It supports 4:2:2 and 4:2:0 YCbCr picture formats. As a coprocessor, the host processor needs only to manage the higher level control code functions such as providing the image to encode and choosing compression settings.

For more information, see *JPEG Encoder* section in *Processors and Accelerators* chapter in the device TRM.

7.3.4 Video Accelerator

The Video Accelerator is a 4K codec that supports both HEVC and H.264/AVC video formats. It provides high performance encode and decode capability up to 8bit 4K@60fps with a single-core architecture.

The Video Accelerator can encode and/or decode any resolution up to 8192 x 4320. It guarantees real-time performance for encoding/decoding 4K 60fps based on its sophisticated, latency tolerant hardware architecture. The Video Accelerator is highly optimized for memory bandwidth loading and excellent power management.

The Video Accelerator contains a 32-bit processor called V-CPU, which is responsible for parsing bitstream syntax in decoder orencoding bitstream syntax in encoder from sequence to slice header unit, pre-scanning slice data, controlling the underlying video hardware blocks called V-CORE. The V-CPU also communicates with host CPU through host register interface. The V-CORE performs actual processing of coded slice data: entropy decoding, inverse scan, inverse transform/quantization, motion compensation, and loop filtering in decoder and motion estimation, intra prediction, RDO, and entropy coding in encoder. This software and hardware combined architecture can provide flexibility and high throughput at the same time.

For more information, see *Video Accelerator* section in *Processors and Accelerators* chapter in the device TRM.

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7.4 Other Subsystems

7.4.1 Dual Clock Comparator (DCC)

The Dual Clock Comparator (DCC) is used to determine the accuracy of a clock signal during the time execution of an application. Specifically, the DCC is designed to detect drifts from the expected clock frequency. The desired accuracy can be programed based on calculation for each application. The DCC measures the frequency of a selectable clock source using another input clock as a reference.

For more information, see *Dual Clock Comparator* section in *Peripherals* chapter in the device TRM.

7.4.2 Data Movement Subsystem (DMSS)

The DMSS module provides data movement (DMA) and bridges between crossbar module CBASS switched interconnect and the packet streaming fabric (network on chip) on the device.

The Data Movement Subsystem (DMSS) consists of DMA/Queue Management components and Peripherals:

- Packet DMA (PKTDMA)
- Block Copy DMA (BCDMA)
- Ring Accelerator
- Packet Streaming Interface (PSILSS)
- Infrastructure components such as CBASS, secure proxy, and an interrupt aggregator

For more information, see *Data Movement Architecture Overview* section in *Peripherals* chapter in the device TRM.

7.4.3 Memory Cyclic Redundancy Check (MCRC)

VBUSM CRC controller is a module which is used to perform CRC (Cyclic Redundancy Check) to verify the integrity of a memory system. A signature representing the contents of the memory is obtained when the contents of the memory are read into MCRC Controller. The responsibility of MCRC controller is to calculate the signature for a set of data and then compare the calculated signature value against a pre-determined good signature value. MCRC controller provides four channels to perform CRC calculation on multiple memories in parallel and can be used on any memory system.

For more information, see *Memory Cyclic Redundancy Check* section in *Peripherals* chapter in the device TRM.

7.4.4 Peripheral DMA Controller (PDMA)

The Peripheral DMA is a simple DMA which has been architected to specifically meet the data transfer needs of peripherals, which perform data transfers using memory mapped registers (MMRs) accessed via a standard non-coherent bus fabric. The PDMA module is located close to one or more peripherals which require an external DMA for data movement.

The PDMA is only responsible for performing the data movement transactions which interact with the peripherals themselves. Data which is read from a given peripheral is packed by a PDMA source channel into a PSI-L data stream which is then sent to a remote peer DMSS destination channel which then performs the movement of the data into memory. Likewise, a remote DMSS source channel fetches data from memory and transfers it to a peer PDMA destination channel over PSI-L which then performs the writes to the peripheral.

The PDMA architecture is intentionally heterogeneous (DMSS + PDMA) to right size the data transfer complexity at each point in the system to match the requirements of whatever is being transferred to or from. Peripherals are typically FIFO based and do not require multi-dimensional transfers beyond their FIFO dimensioning requirements, so the PDMA transfer engines are kept simple with only a few dimensions (typically for sample size and FIFO depth), hardcoded address maps, and simple triggering capabilities.

Multiple source and destination channels are provided within the PDMA which allow multiple simultaneous transfer operations to be ongoing. The DMA controller maintains state information for each of the channels and employs round-robin scheduling between channels in order to share the underlying DMA hardware.

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Each peripheral with PDMA support has its own dedicated state machine to track the transmit and receives of the data for each peripheral.

For more information, see *Data Movement Architecture Overview* section in *Peripherals* chapter in the device TRM.

7.4.5 Real-Time Clock (RTC)

The basic purpose for the RTC is to keep time of day. The other equally important purpose of RTC is for Digital Rights management. Some degree of tamper proofing is needed to ensure that simply stopping, resetting, or corrupting the RTC does not go unnoticed so that if this occurs, the application can re-acquire the time of day from a trusted source.

For more information, see *Real-Time Clock* section in *Peripherals* chapter in the device TRM.

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7.5 Peripherals

7.5.1 Gigabit Ethernet Switch (CPSW3G)

The 3-port Gigabit Ethernet Switch (CPSW3G) subsystem provides Ethernet packet communication for the device and can be configured as an Ethernet switch. It supports two external 10/100/1000Mbps Ethernet ports with selectable RGMII and RMII interfaces and one internal Communications Port Programming Interface (CPPI) port.

For more information, see *Gigabit Ethernet Switch* section in *Peripherals* chapter in the device TRM.

7.5.2 Camera Serial Interface Receiver (CSI_RX_IF)

The integration of the CSI_RX_IF module allows the device to stream video inputs from multiple cameras to internal memory.

For more information, see *Camera Serial Interface Receiver* section in *Peripherals* chapter in the device TRM.

7.5.3 Display Subsystem (DSS)

The Display Subsystem (DSS) is a flexible, multi-pipeline subsystem that supports high-resolution display outputs. DSS includes input pipelines providing multi-layer blending with transparency to enable on-the-fly composition. Various pixel processing capabilities are supported, such as color space conversion and scaling, among others. DSS includes a DMA engine, which allows direct access to the frame buffer (device system memory). Display outputs can directly drive device pads as a Display Parallel Interface (DPI).

For more information, see *Display Subsystem* section in *Peripherals* chapter in the device TRM.

7.5.4 Enhanced Capture (ECAP)

The Enhanced Capture (ECAP) module is a timing peripheral designed to accurately capture and measure external signal characteristics such as period, frequency, duty cycle, or pulse width. ECAP operates using a 32-bit time-stamp counter and up to four 32-bit capture registers. Captured values can be used to calculate timing intervals, generate interrupts, or trigger other peripherals.

The module can generate interrupts on any of the capture events and supports both absolute time-capture and delta-time stamp capture modes, programmable edge polarity for each capture event, and can operate in auxiliary PWM (APWM) mode to generate a PWM output when not used for capture. The ECAP also supports one-shot capture mode of up to four time-stamp events, and continuous capture mode of time stamps in a four-deep circular buffer.

These capabilities make the ECAP module useful for speed measurement, position sensing, and precise input signal monitoring control applications.

For more information, see *Enhanced Capture (ECAP) Module* section in *Peripherals* chapter in the device TRM.

7.5.5 Error Location Module (ELM)

The Error Location Module (ELM) operates in conjunction with the General-Purpose Memory Controller (GPMC) to support error detection and correction for NAND flash memories. It processes syndrome polynomials generated during NAND page reads using a Bose–Chaudhuri–Hocquenghem (BCH) algorithm to identify error locations within a data block. The ELM supports 4-, 8-, and 16-bit error correction per 512-byte block, with interrupt generation upon completion and register-based access to error count and location data.

For more information, see *Error Location Module (ELM)* section in *Peripherals* chapter in the device TRM.

7.5.6 Enhanced Pulse Width Modulation (EPWM)

Enhanced Pulse Width Modulation (EPWM) module is a highly flexible timer-based peripheral used for generating precise pulse-width modulated waveforms for motor control, digital power, and general-purpose timing applications.

The EPWM module provides programmable period, duty cycle, and phase control, with features such as dead-band generation with independent rising- and falling-edge delay control, trip-zone inputs for fault handling,

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time-base synchronization input/output signals for synchronization with other EPWM modules, and ability to generate events to trigger CPU interrupts and ADC conversions, thus enabling precise synchronization between control loops and waveform generation.

Additional capabilities include PWM chopping by a high-frequency carrier signal to reduce EMI and improve signal quality, and programmable event prescaling functionality for fine-grained control over how often PWM events trigger actions.

For more information, see *Enhanced Pulse Width Modulation (EPWM)* section in *Peripherals* chapter in the device TRM.

7.5.7 Error Signaling Module (ESM)

The Error Signaling Module (ESM) aggregates events and/or errors from throughout the device into one location. It can signal both low and high priority interrupts to a processor to deal with an event and/or manipulate an I/O error pin to signal an external hardware that an error has occurred. Therefore an external controller is able to reset the device or keep the system in a safe, known state.

For more information, see *Error Signaling Module* section in *Peripherals* chapter in the device TRM.

7.5.8 Enhanced Quadrature Encoder Pulse (EQEP)

The Enhanced Quadrature Encoder Pulse (EQEP) peripheral is used to interface with quadrature-encoded signals from rotary or linear encoders, commonly used in high performance motion and position control systems, providing accurate position, direction, and speed information.

The EQEP module supports decoding of A-phase and B-phase signals, along with index signal (QEPI) for absolute position reference.

The 32-bit EQEP module features a position counter and control unit for position measurement with programmable reset, a quadrature edge-capture unit for low-speed measurement, a unit time base for real-time speed measurement, along with a watchdog timer for loss of encoder activity. The EQEP also generates interrupts on compare, overflow/underflow, and index events, supporting flexible motion control algorithms.

For more information, see *Enhanced Quadrature Encoder Pulse (EQEP)* section in *Peripherals* chapter in the device TRM.

7.5.9 General-Purpose Interface (GPIO)

The General-Purpose Input/Output (GPIO) peripheral provides dedicated general-purpose pins that can be configured as either inputs or outputs. When configured as an output, the user can write to an internal register to control the state driven on the output pin. When configured as an input, user can obtain the state of the input by reading the state of an internal register.

A GPIO module supports up to 144 dedicated signals distributed in 9 banks, each one comprising up to 16 GPIO signals.

Interrupt generation can be enabled independently for each bank of 16 GPIO signals. Interrupts can be triggered by rising and/or falling edge, specified for each interrupt capable GPIO signal.

In addition, the GPIO peripheral can produce DMA synchronization events in different event generation modes. GPIO signals set/clear functionality is also available.

For more information, see *General-Purpose Interface* section in *Peripherals* chapter in the device TRM.

7.5.10 General-Purpose Memory Controller (GPMC)

The General-Purpose Memory Controller is a unified memory controller dedicated for interfacing with external memory devices like:

- Asynchronous SRAM-like memories and application-specific integrated circuit (ASIC) devices
- Asynchronous, synchronous, and page mode (available only in non-multiplexed mode) burst NOR flash devices

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- NAND flash
- Pseudo-SRAM devices

For more information, see *General-Purpose Memory Controller* section in *Peripherals* chapter in the device TRM.

7.5.11 Global Timebase Counter (GTC)

The GTC module is a 64-bit free-running up-counter compliant with Arm®v8 system counter requirments, with no rollover over the device lifetime when the full 64-bit counter is used, and support of selectable counter-bit outputs as a push events.

The GTC provides a unified time reference across all cores and peripherals for consistent timestamping and synchronization.

For more information, see *Global Timebase Counter* section in *Peripherals* chapter in the device TRM.

7.5.12 Inter-Integrated Circuit (I2C)

The Inter-Integrated Circuit (I2C) controller provides an interface between a local host (LH), such as an Arm and any I^2C-bus-compatible device that connects via the I^2C serial bus. External components attached to the I^2C bus can serially transmit and receive up to 8 bits of data to and from the LH device through the 2-wire I^2C interface.

Each multicontroller I^2C module can be configured to act like a target or controller I^2C-compatible device.

The I^2C instances are implemented with I^2C compliant, open-drain I/O buffers, or with standard push-pull I/O buffers. The I^2C instances associated with I^2C open-drain I/O buffers can support HS-mode (up to 3.4Mbps when operating at 1.8V, and limited to 400kbps when operating at 3.3V).

The I^2C instances associated with standard push-pull I/O buffers can support Fast-mode (up to 400kbps). The standard push-pull I/O buffers being used on these ports are connected such they emulate open-drain outputs. This emulation is achieved by forcing a constant low output and disabling the output buffer to enter the Hi-Z state.

For more information, see *Inter-Integrated Circuit* section in *Peripherals* chapter in the device TRM.

7.5.13 Modular Controller Area Network (MCAN)

The Controller Area Network (CAN) is a serial communications protocol which efficiently supports distributed real-time control with a high level of security. CAN has high immunity to electrical interference and the ability to self-diagnose and repair data errors. In a CAN network, many short messages are broadcast to the entire network, which provides for data consistency in every node of the system.

The MCAN module supports both classic CAN and CAN FD (CAN with Flexible Data-Rate) specifications. CAN FD feature allows high throughput and increased payload per data frame. The classic CAN and CAN FD devices can coexist on the same network without any conflict.

CAN and CAN FD devices connect to the physical layer of the CAN network through external (for the device) transceivers. Each MCAN module supports flexible bit rates greather than 1Mbps and is compliant to ISO 11898-1:2015.

For more information, see *Modular Controller Area Network (MCAN)* section in *Peripherals* chapter in the device TRM.

7.5.14 Multichannel Audio Serial Port (MCASP)

The MCASP functions as a general-purpose audio serial port, optimized for the requirements of various audio applications. The MCASP module can operate in both transmit and receive modes. The MCASP is useful for time-division multiplexed (TDM) stream, Inter-IC Sound (I2S) protocols reception and transmission as well as for an inter-component digital audio interface transmission (DIT). The MCASP has the flexibility to gluelessly connect to a Sony/Philips digital interface (S/PDIF) transmit physical layer component.

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Although inter-component digital audio interface reception (DIR) mode (this is, S/PDIF stream receiving) is not natively supported by the MCASP module, a specific TDM mode implementation for the MCASP receivers allows an easy connection to external DIR components (for example, S/PDIF to I2S format converters).

For more information, see *Multichannel Audio Serial Port* section in *Peripherals* chapter in the device TRM.

7.5.15 Multichannel Serial Peripheral Interface (MCSPI)

The MCSPI is an enhanced SPI module that supports multichannel transmit/receive communication and can operate in both controller and peripheral modes. In controller mode the module can interface with up to four channels, while in peripheral mode supports a single channel.

Each channel supports two independent DMA requests (one for read and one for write) and one interrupt for efficient data transfer, a programmable start-bit (Last Output Stop Start Insertion (LOSSI) mode) to ensure proper framing and synchronization in multi-channel communication, a built-in FIFO for data throughput and word access efficiency, and a serial clock with programmable frequency, polarity and phase.

The MCSPI module supports configurable SPI word length in the range of 4 to 32 bits. Additionally, programmable shift operations and timing control between chip select and external clock generation are provided.

For more information, see *Multichannel Serial Peripheral Interface* section in *Peripherals* chapter in the device TRM.

7.5.16 Multi-Media Card Secure Digital (MMCSD)

The MMCSD Host Controller provides an interface to embedded Multi-Media Card (MMC), Secure Digital (SD), and Secure Digital IO (SDIO) devices. The MMC/SD controller deals with MMC/SD/SDIO protocol at transmission level — packing data, adding CRC, start/end bit, and checking for syntactical correctness.

The MMCSD Host Controller has been implemented as a 4-bit subsystem and 8-bit subsystem. The 4-bit subsystem supports removable SD cards compliant with the SD Physical Layer Specification v3.01, and embedded SDIO devices compliant with the SDIO Specification v3.00. The 8-bit subsystem supports eMMC devices compliant with the JEDEC eMMC electrical standard v5.1 (JESD84-B51), and embedded SDIO devices compliant with the SDIO Specification v3.00.

For more information, see *Multi-Media Card Secure Digital (MMCSD) Interface* section in *Peripherals* chapter in the device TRM.

7.5.17 Octal Serial Peripheral Interface (OSPI)

The Octal Serial Peripheral Interface (OSPI) module is a Serial Peripheral Interface (SPI) module which allows single, dual, quad or octal read and write access to external flash devices with dual (DDR) or single (SDR) data rate. This module has a memory mapped register interface, which provides a direct memory interface for accessing data from external flash devices, simplifying software requirements.

The module supports DDR and DTR protocols (including Octal DDR with DQS), XIP (continuous mode), programmable device sizes and delays, and write protection regions. Additional features include bidirectional CRC, ECC error handling, programmable interrupt generation, and a programmable data decoder for continuous addressing and device boundary detection.

For more information, see *Octal Serial Peripheral Interface (OSPI)* section in *Peripherals* chapter in the device TRM.

7.5.18 Timers

The general-purpose timer (TIMER) is a 32-bit module that supports timer mode for periodic event generation, capture mode for precise timestamping of external events, and compare mode for match-based interrupts. TIMER modules support cascading two 32-bit timers to form a 64-bit counter.

TIMER contains a free running upward counter with auto reload capability on overflow and can be read and written on the fly (while counting). TIMER supports interrupts generated on overflow, compare and capture

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events. All internal timer interrupt sources are merged in one module interrupt line and one wake-up line and each internal interrupt source can be independently enabled or disabled.

TIMER modules can generate 1-ms tick with 32768-Hz functional clock.

For more information, see *Timers* section in *Peripherals* chapter in the device TRM.

7.5.19 Universal Asynchronous Receiver/Transmitter (UART)

The UART is a peripheral that utilizes the DMA for data transfer or interrupt polling via host CPU. All UART modules support IrDA and CIR modes when 48MHz function clock is used. Each UART can be used for configuration and data exchange with a number of external peripheral devices or interprocessor communication between devices.

The UART module supports high-speed communication up to 3.6Mbps with a 64-byte FIFO buffer for both transmission and reception, and includes advanced features like auto flow control, configurable data formats, sleep mode, and extended modem control signals. It also offers programmable interrupt levels, auto-baud detection, and internal loopback for testing.

For more information, see *Universal Synchronous/Asynchronous Receiver/Transmitter* section in *Peripherals* chapter in the device TRM.

7.5.20 Universal Serial Bus Subsystem (USBSS)

The Universal Serial Bus Subsystem (USBSS) provides a connectivity solution for numerous consumer portable devices by implementing a mechanism for data transfer between USB devices.

USBSS features Dual Role Device (DRD) functionality, enabling operation in Host mode at High-Speed (480Mbps), Full-Speed (12Mbps), or Low-Speed (1.5Mbps), and Peripheral mode at High-Speed (480Mbps) or Full-Speed (12Mbps), offering flexible operation and integrated VBUS detection. The subsystem is compliant with the xHCI 1.1 specification for host controller interface compatibility.

For more information, see *Universal Serial Bus Subsystem (USBSS)* section in *Peripherals* chapter in the device TRM.

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8 Applications, Implementation, and Layout

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Device Connection and Layout Fundamentals

8.1.1 Power Supply

8.1.1.1 Power Supply Designs

The Power Management IC (PMIC) recommended for the AM62Ax processor and its principal peripherals, along with its operational details can be found in the PMIC Solution for AM62Ax application note.

List of benefits when using the recommended PMIC to power AM62Ax:

- Cost and space optimized solution specifically designed to power the AM62Ax processor
- Full device performance entitlement as validated on TI Evaluation boards
- Factory programmed configurations support power rail load steps, supply voltage accuracies, and maximum load currents with margins
- Factory programmed configuration to support LPDDR4 memory
- Meets all AM62Ax voltage and sequencing requirements, refer to Section 6.5, *Recommended Operating Conditions* and Section 6.12.2.2, *Power Supply Sequencing*

8.1.1.2 Power Distribution Network Implementation Guidance

The Sitara Processor Power Distribution Networks: Implementation and Analysis provides guidance for successful implementation of the power distribution network. This includes PCB stackup guidance as well as guidance for optimizing the selection and placement of the decoupling capacitors. TI *only* supports designs that follow the board design guidelines contained in the application report.

8.1.2 External Oscillator

For more information about External Oscillators, see the *Clock Specifications* section.

8.1.3 JTAG, EMU, and TRACE

Texas Instruments supports a variety of eXtended Development System (XDS™) JTAG controllers with various debug capabilities beyond only JTAG support. A summary of this information is available in the XDS Target Connection Guide.

For recommendations on JTAG, EMU, and TRACE routing, see the Emulation and Trace Headers Technical Reference Manual

8.1.4 Unused Pins

For more information about Unused Pins, see Section 5.4, *Pin Connectivity Requirements*

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8.2 Peripheral- and Interface-Specific Design Information

8.2.1 DDR Board Design and Layout Guidelines

The goal of the **AM62Ax/AM62Dx/AM62Px LPDDR4 Board Design and Layout Guidelines** is to make the DDR system implementation straightforward for all designers. Requirements have been distilled down to a set of layout and routing rules that allow designers to successfully implement a robust design for the topologies that TI supports. TI only supports board designs using LPDDR4 memories that follow the guidelines in this document.

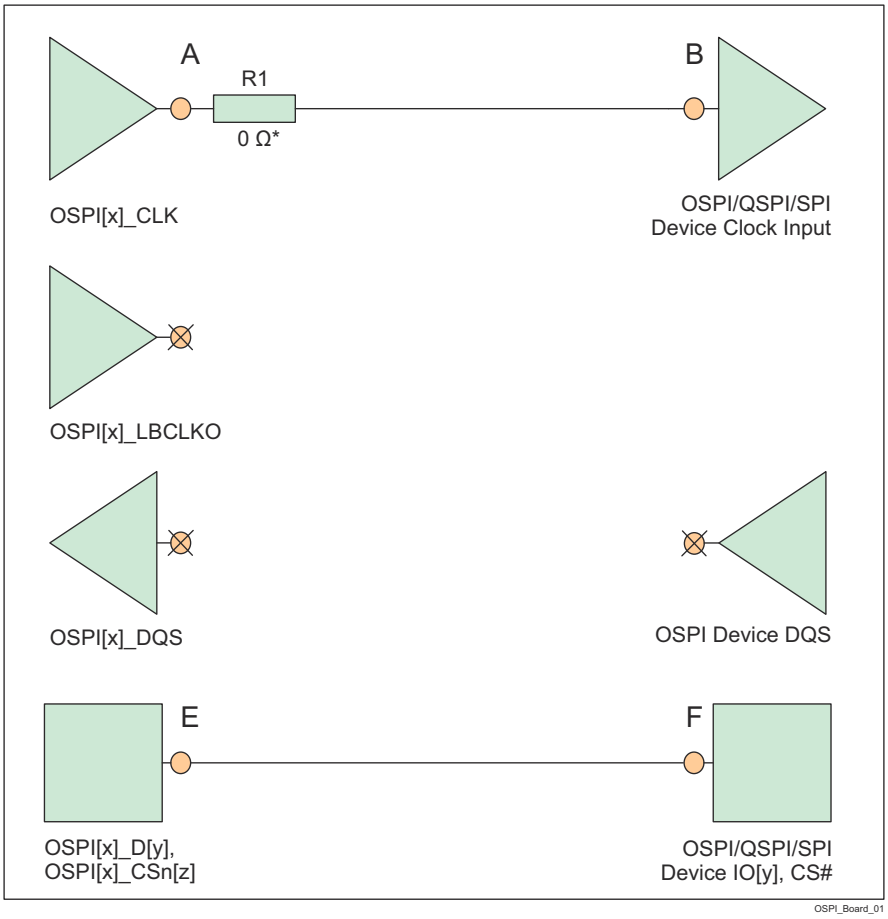
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8.2.2 OSPI/QSPI/SPI Board Design and Layout Guidelines

The following section details the PCB routing guidelines that must be observed when connecting OSPI, QSPI, or SPI devices.

8.2.2.1 No Loopback, Internal PHY Loopback, and Internal Pad Loopback

- The OSPI[x]_CLK output pin must be connected to the CLK input pin of the attached OSPI/QSPI/SPI device
- The signal propagation delay from the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B) must be ≤ 450ps (~7cm as stripline or ~8cm as microstrip)
- The signal propagation delay of each OSPI[x]_D[y] and OSPI[x]_CSn[z] pin to the corresponding attached OSPI/QSPI/SPI device data and control pin (E to F, or F to E) must be approximately equal to the signal propagation delay from the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B)
- 50Ω PCB routing is recommended along with series terminations, as shown in Figure 8-1
- Propagation delays and matching:
  - (A to B) ≤ 450ps
  - (E to F, or F to E) = ((A to B) ± 60ps)



* 0Ω resistor (R1), located as close as possible to the OSPI[x]_CLK pin, is placeholder for fine tuning, if needed.

Figure 8-1. OSPI Connectivity Schematic for No Loopback, Internal PHY Loopback, and Internal Pad Loopback

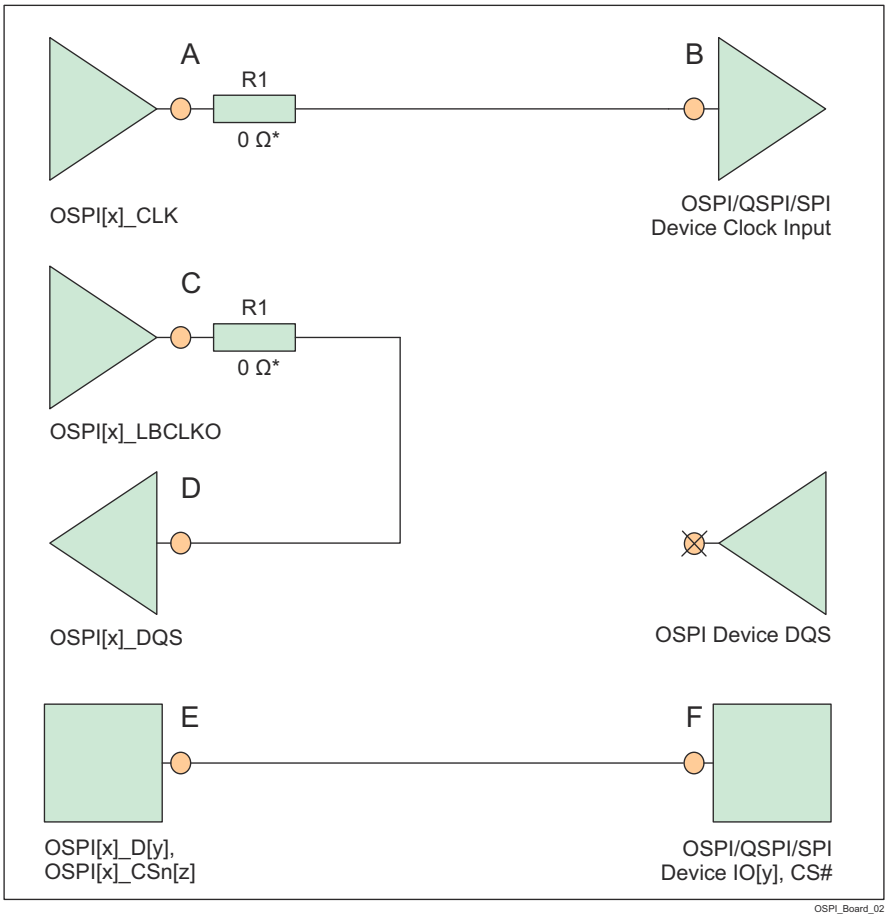
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8.2.2.2 External Board Loopback

- The OSPI[x]_CLK output pin must be connected to the CLK input pin of the attached OSPI/QSPI/SPI device
- The OSPI[x]_LBCLKO output pin must be looped back to the OSPI[x]_DQS input pin
- The signal propagation delay of the OSPI[x]_LBCLKO pin to the OSPI[x]_DQS pin (C to D) must be approximately twice the propagation delay of the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B)
- The signal propagation delay of each OSPI[x]_D[y] and OSPI[x]_CSn[z] pin to the corresponding attached OSPI/QSPI/SPI device data and control pin (E to F, or F to E) must be approximately equal to the signal propagation delay from the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B)
- 50Ω PCB routing is recommended along with series terminations, as shown in Figure 8-2
- Propagation delays and matching:
  - (C to D) = 2 x ((A to B) ± 30ps), see the exception note below.
  - (E to F, or F to E) = ((A to B) ± 60ps)

Note

The External Board Loopback hold time requirement (defined by parameter number O16 in the *OSPI0 Timing Requirements - PHY DDR Mode* section) may be larger than the hold time provided by a typical OSPI/QSPI/SPI device. In this case, the propagation delay of OPSI[x]_LBCLKO pin to the OSPI[x]_DQS pin (C to D) can be reduced to provide additional hold time.

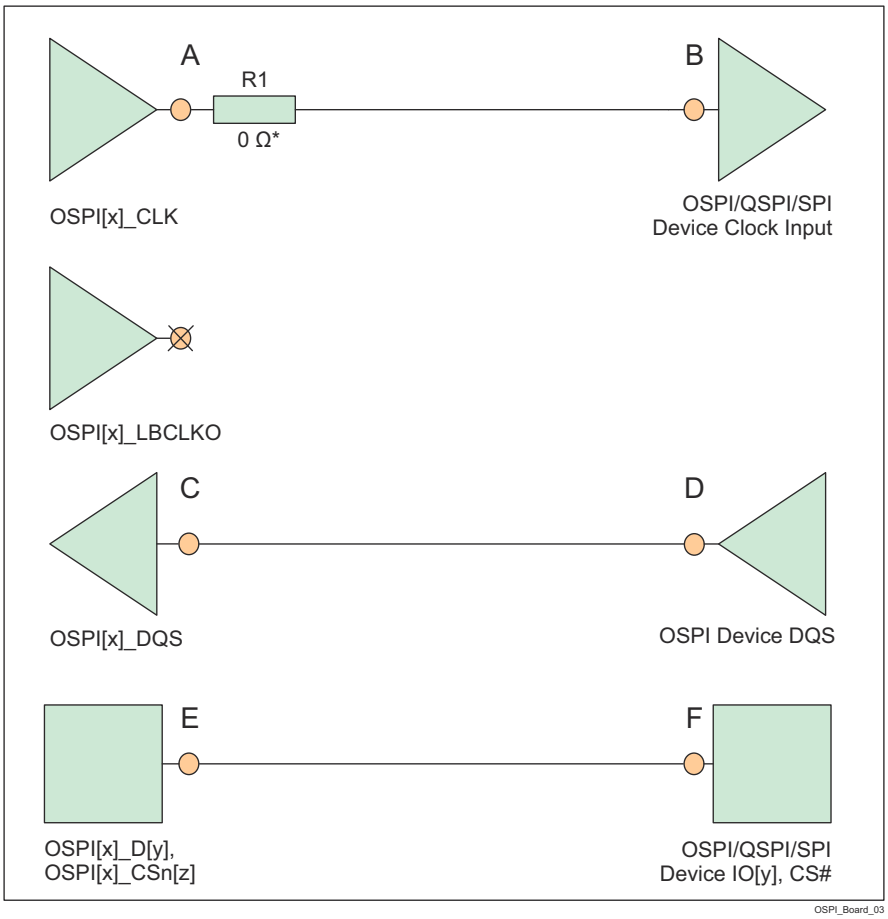


* 0Ω resistor (R1), located as close as possible to the OSPI[x]_CLK and OSPI[x]_LBCLKO pins, is a placeholder for fine tuning, if needed.

Figure 8-2. OSPI Connectivity Schematic for External Board Loopback

8.2.2.3 DQS (only available in Octal SPI devices)

- The OSPI[x]_CLK output pin must be connected to the CLK input pin of the attached OSPI/QSPI/SPI device
- The DQS pin of the attached OSPI/QSPI/SPI device must be connected to OSPI[x]_DQS pin
- The signal propagation delay from the attached OSPI/QSPI/SPI device DQS pin to the OSPI[x]_DQS pin (D to C) must be approximately equal to the signal propagation delay from the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B)
- The signal propagation delay of each OSPI[x]_D[y] and OSPI[x]_CSn[z] pin to the corresponding attached OSPI/QSPI/SPI device data and control pin (E to F, or F to E) must be approximately equal to the signal propagation delay from the OSPI[x]_CLK pin to the attached OSPI/QSPI/SPI device CLK pin (A to B)
- 50Ω PCB routing is recommended along with series terminations, as shown in Figure 8-3
- Propagation delays and matching:
  - (D to C) = ((A to B) ± 30ps)
  - (E to F, or F to E) = ((A to B) ± 60ps)



* 0Ω resistor (R1), located as close as possible to the OSPI[x]_CLK pin, is a placeholder for fine tuning, if needed.

Figure 8-3. OSPI Connectivity Schematic for DQS

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8.2.3 USB VBUS Design Guidelines

The USB 3.1 specification allows the VBUS voltage to be as high as 5.5V for normal operation, and as high as 20V when the Power Delivery addendum is supported. Some automotive applications require a max voltage to be 30V.

The device requires the VBUS signal voltage be scaled down using an external resistor divider (as shown in the Figure 8-4), which limits the voltage applied to the actual device pin (USB0_VBUS). The tolerance of these external resistors should be equal to or less than 1%, and the leakage current of Zener diode at 5V should be less than 100nA.

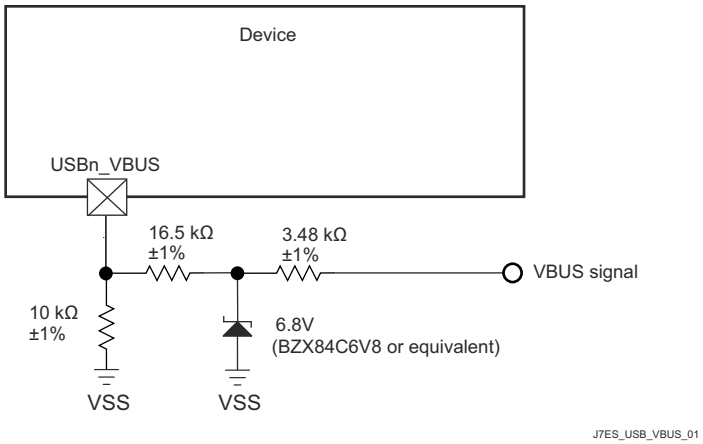


Figure 8-4. USB VBUS Detect Voltage Divider / Clamp Circuit

The USB0_VBUS pin can be considered to be fail-safe because the external circuit in Figure 8-4 limits the input current to the actual device pin in a case where VBUS is applied while the device is powered off.

8.2.4 System Power Supply Monitor Design Guidelines

The VMON_VSYS pin provides a way to monitor a system power supply. This system power supply is typically a single pre-regulated power source for the entire system and can be connected to the VMON_VSYS pin via and external resistor divider circuit. This system supply is monitored by comparing the external voltage divider output voltage to an internal voltage reference, where a power fail event is triggered when the voltage applied to VMON_VSYS drops below the internal reference voltage. The actual system power supply voltage trip point is determined by the system designer when selecting component values used to implement the external resistor voltage divider circuit.

When designing the resistor divider circuit the designer must understand various factors which contribute to variability in the system power supply monitor trip point. The first thing to consider is the initial accuracy of the VMON_VSYS input threshold which has a nominal value of 0.45V, with a variation of ±3%. Precision 1% resistors with similar thermal coefficient are recommended for implementing the resistor voltage divider. This minimizes variability contributed by resistor value tolerances. Input leakage current associated with VMON_VSYS must also be considered since any current flowing into the pin creates a loading error on the voltage divider output. The VMON_VSYS input leakage current can be in the range of 10nA to 2.5µA when applying 0.45V.

Note

The resistor voltage divider shall be designed such that the output voltage never exceeds the maximum value defined in the *Recommended Operating Conditions* section, during normal operating conditions.

Figure 8-5 presents an example, where the system power supply is nominally 5V and the maximum trigger threshold is 5V - 10%, or 4.5V.

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For this example, the designer must understand which variables effect the maximum trigger threshold when selecting resistor values. A device which has a VMON_VSYS input threshold of 0.45V + 3% needs to be considered when trying to design a voltage divider that doesn't trip until the system supply drops 10%. The effect of resistor tolerance and input leakage also needs to be considered, but the contribution to the maximum trigger point is not obvious. When selecting component values which produce a maximum trigger voltage, the system designer must consider a condition where the value of R1 is 1% low and the value of R2 is 1% high combined with a condition where input leakage current for the VMON_VSYS pin is 2.5µA. When implementing a resistor divider where R1 = 4.81KΩ and R2 = 40.2KΩ, the result is a maximum trigger threshold of 4.517V.

Once component values have been selected to satisfy the maximum trigger voltage as described above, the system designer can determine the minimum trigger voltage by calculating the applied voltage that produces an output voltage of 0.45V - 3% when the value of R1 is 1% high and the value of R2 is 1% low, and the input leakage current is 10nA, or zero. Using an input leakage of zero with the resistor values given above, the result is a minimum trigger threshold of 4.013V.

This example demonstrates a system power supply voltage trip point that ranges from 4.013V to 4.517V. Approximately 250mV of this range is introduced by VMON_VSYS input threshold accuracy of ±3%, approximately 150 mV of this range is introduced by resistor tolerance of ±1%, and approximately 100mV of this range is introduced by loading error when VMON_VSYS input leakage current is 2.5µA.

The resistor values selected in this example produces approximately 100µA of bias current through the resistor divider when the system supply is 4.5V. The 100mV of loading error mentioned above can be reduced to about 10mV by increasing the bias current through the resistor divider to approximately 1mA. So resistor divider bias current vs loading error is something the system designer needs to consider when selecting component values.

The system designer must also consider implementing a noise filter on the voltage divider output since VMON_VSYS has minimum hysteresis and a high-bandwidth response to transients. This can be done by installing a capacitor across R1 as shown in Figure 8-5. However, the system designer must determine the response time of this filter based on system supply noise and expected response to transient events.

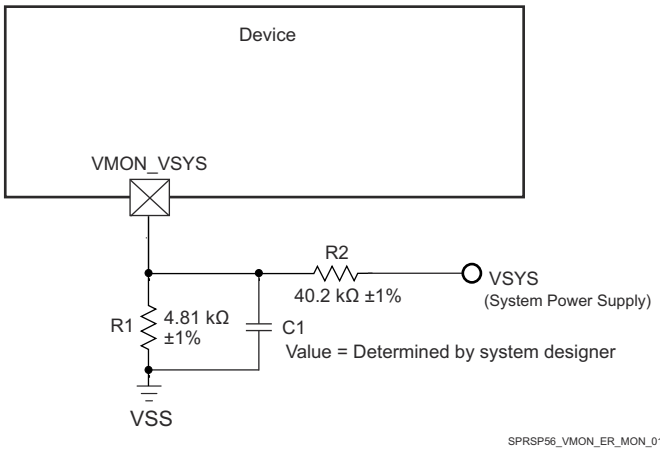


Figure 8-5. System Supply Monitor Voltage Divider Circuit

VMON_1P8_SOC pin provides a way to monitor external 1.8V power supplies. This pin must be connected directly to their respective power source. An internal resistor divider with software control is implemented inside the SoC for each of these pins. Software can program each internal resistor divider to create appropriate under voltage and over voltage interrupts.

VMON_3P3_SOC pin provides a way to monitor external 3.3V power supplies. This pin must be connected directly to their respective power source. An internal resistor divider with software control is implemented inside the SoC for each of these pins. Software can program each internal resistor divider to create appropriate under voltage and over voltage interrupts.

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8.2.5 High Speed Differential Signal Routing Guidance

The High Speed Interface Layout Guidelines provides guidance for successful routing of the high speed differential signals. This includes PCB stackup and materials guidance as well as routing skew, length and spacing limits. TI supports *only* designs that follow the board design guidelines contained in the application note.

8.2.6 Thermal Solution Guidance

The Thermal Design Guide for DSP and ARM Application Processors provides guidance for successful implementation of a thermal solution for system designs containing this device. This document provides background information on common terms and methods related to thermal solutions. TI only supports designs that follow system design guidelines contained in the application note.

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8.3 Clock Routing Guidelines

8.3.1 Oscillator Routing

When designing the printed-circuit board:

- Place all crystal circuit components as close as possible to the respective device pins.
- Route the crystal circuit traces on the outer layer of the PCB and minimize trace lengths to reduce parasitic capacitance and minimize crosstalk from other signals.
- Place a continuous ground plane on the adjacent layer of the PCB such that it is under all crystal circuit components and crystal circuit traces.
- Route a ground guard around the crystal circuit components to shield it from any adjacent signals routed on the same layer as the crystal circuit traces. Insert multiple vias to stitch down the ground guard such that it does not have any unterminated stubs.
- Route a ground guard between the MCU_OSC0_XI and MCU_OSC0_XO signals to shield the MCU_OSC0_XI signal from the MCU_OSC0_X0 signal. Insert multiple vias to stitch down the ground guard such that it does not have any unterminated stubs.
- Connect all crystal circuit ground connections and ground guard connections directly to the adjacent layer ground plane, and the device VSS ground plane if they are implemented separately on different layers of the PCB.

Note

Implementing a ground guard between the MCU_OSC0_XI and MCU_OSC0_XO signals is critical to minimize shunt capacitance between the two signals. Routing these two signals adjacent to each other without a ground guard between them will effectively reduce the gain of the oscillator amplifier, which reduces its ability to start oscillation.

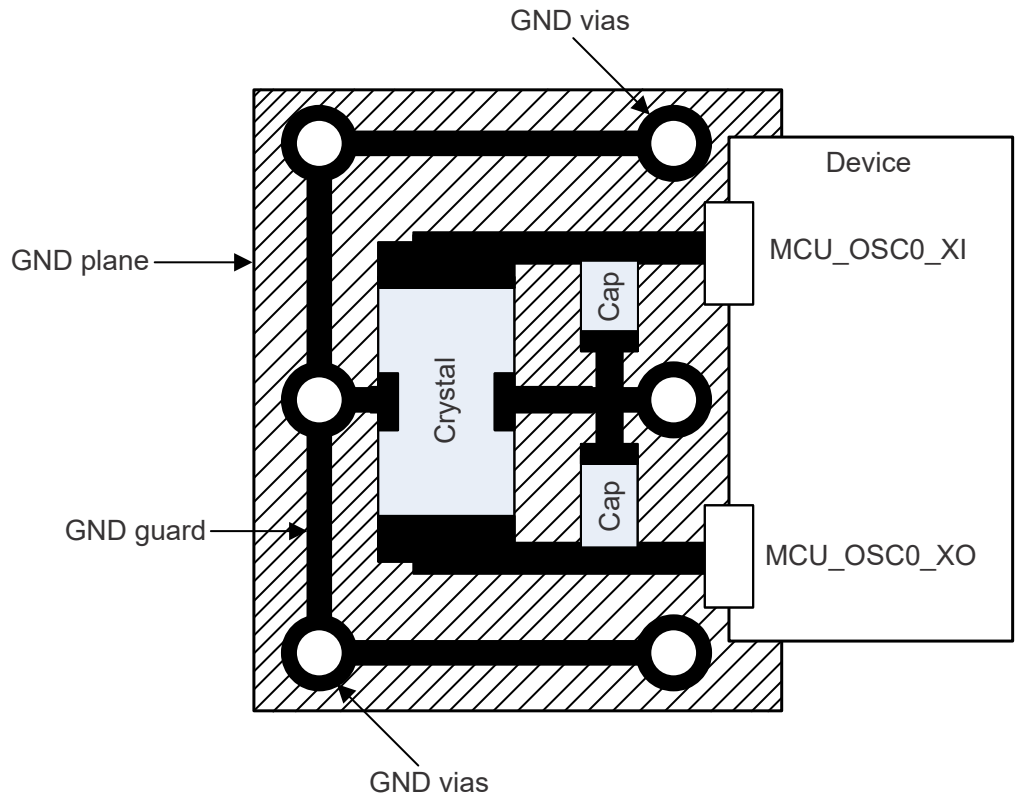


Figure 8-6. MCU_OSC0 PCB requirements

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9 Device and Documentation Support

9.1 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all microprocessors (MPUs) and support tools. Each device has one of three prefixes: X, P, or null (no prefix) (for example, AM62AxAMB). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices and tools (TMDS).

Device development evolutionary flow:

X Experimental device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow.

P Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.

null Production version of the silicon die that is fully qualified.

Support tool development evolutionary flow:

TMDX Development-support product that has not yet completed Texas Instruments internal qualification testing.

TMDS Fully-qualified development-support product.

X and P devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

Production devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

For orderable part numbers of AM62Ax devices in the AMB or ANF package type, see the Package Option Addendum of this document, the TI website (ti.com), or contact your TI sales representative.

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9.1.1 Standard Package Symbolization

Note

Some devices may have a cosmetic circular marking visible on the top of the device package which results from the production test process. In addition, some devices may also show a color variation in the package substrate which results from the substrate manufacturer. These differences are cosmetic only with no reliability impact.

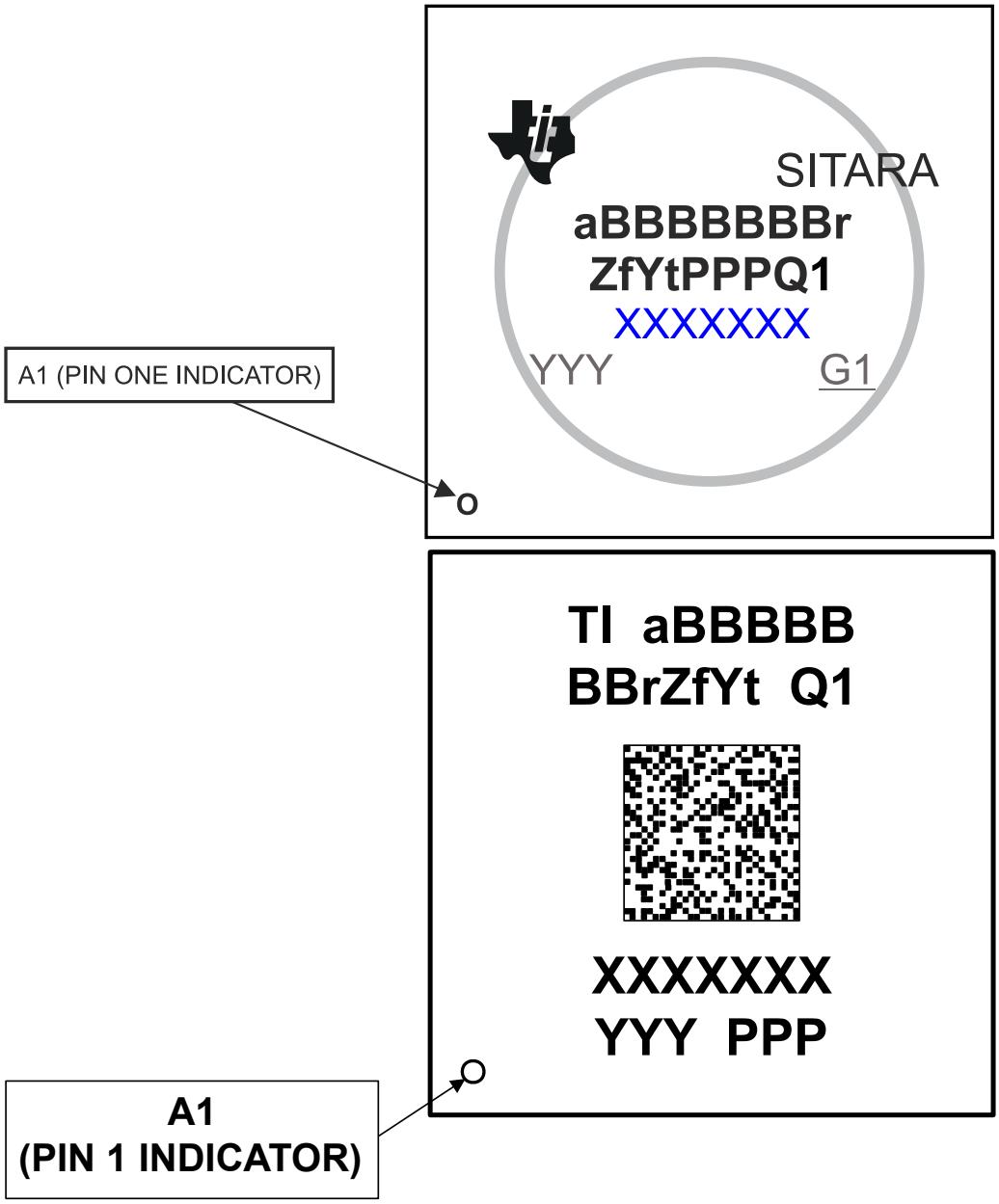


Figure 9-1. Printed Device Reference

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9.1.2 Device Naming Convention

Table 9-1. Nomenclature Description

FIELD PARAMETER	FIELD DESCRIPTION	VALUE	DESCRIPTION
TI(1)	Device manufacturer	TI	Texas Instruments [The letters "TI" are used rather than the Texas Instruments logo]
a	Device evolution stage	X(2)	Prototype
		P	Preproduction (production test flow, no reliability data)
		BLANK(3)	Production
BBBBBBB	Base production part number	AM62A74	see Device Comparison
		AM62A72	
		AM62A34	
		AM62A32	
		AM62A31	
		AM62A14	
		AM62A12	
r	Device revision	A	SR1.0
Z	Device Speed Grade	M	See Device Speed Grades
		N	
		O	
		P	
		Q	
		R	
		S	
		T	
		U	
		V	
f	Features (see Device Comparison)	G	Base
		L	Features supported by G, plus Multimedia JPEG Encoder
		M	Features supported by L, plus Display Subsystem
Y	Security / Functional Safety	1 to 9	Secure with Dummy Key / No Functional Safety
		H to R	Secure with Production Key / No Functional Safety
		S to Z	Secure with Production Key / Functional Safety
t	Temperature(4)	A	–40°C to 105°C - Extended Industrial (see Recommended Operation Conditions)
		I	–40°C to 125°C - Automotive (see Recommended Operation Conditions)
PPP	Package Designator	AMB	FCBGA (484-pin)
		ANF	FCCSP (484-pin)
Q1	Automotive Designator	Q1	Auto Qualified (AEC - Q100)
		BLANK(3)	Standard
(1)	2D Barcode	Varies	Optional 2D barcode, provides additional device information
		BLANK(3)	
XXXXXXX			Lot Trace Code (LTC)
YYY			Production Code, For TI use only
O			Pin one designator
G1(5)			ECAT - Green package designator

(1) Applies to ANF package only.

(2) Device symbolization was changed after prototype devices began to ship. The prototype devices were symbolized **XAM62A74ATMGHIAMB**, which does not match the naming convention defined by this table. The prototype device symbolization corresponds to device **XAM62A74AUMHIAMB**.
(3) BLANK in the symbol or part number is collapsed so there are no gaps between characters.
(4) Applies to device max junction temperature.
(5) Applies to AMB package only.

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9.2 Tools and Software

The following Development Tools support development for TI's Embedded Processing platforms:

Development Tools

CCStudio™ecosystem overview: The CCStudio ecosystem is a group of development software tools for TI's embedded processing customers to develop microcontrollers, microprocessors, wireless connectivity and mmWave radar sensors faster at a lower cost. They are intuitive, comprehensive and accessible to our customers. Some of the tools include CCStudio SysConfi g, CCStudio IDE, CCStudio UniFlash, CCStudio Edge AI Studio and more. They are available to download or can be used via the cloud on theTI Developer Zone.

SysConfig Tool The System Configuration tool provides a graphical user interface (GUI) that simplifies device configuration. The tool is designed to simplify hardware and software configuration challenges to accelerate software development. SysConfig is available as part of the Code Composer Studio™ integrated development environment as well as a standalone application. Additionally SysConfig can be run in the cloud by visiting the **TI developer zone**.

SysConfig allows developers to configure pins, peripherals, and other components, and automatically detects, exposes, and resolves conflicts to speed software development. In addition, the clock tree tool provides a visual implementation of the device clock connectivity.

The SysConfig tool generates output C header/code files that can be imported into software development kits (SDKs), enabling customers to configure their software in alignment with the specific hardware requirements.

For a complete listing of development-support tools for the processor platform, visit the Texas Instruments website at ti.com. For information on pricing and availability, contact the nearest TI field sales office or authorized distributor.

9.3 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The following documents describe the AM62Ax devices.

Technical Reference Manual

AM62Ax Sitara Processors Technical Reference Manual: Details the integration, the environment, the functional description, and the programming models for each peripheral and subsystem in the AM62Ax family of devices.

Errata

AM62Ax Sitara Processors Silicon Errata: Describes the known exceptions to the functional specifications for the device.

9.4 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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9.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.7 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

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10 Revision History

Changes from April 21, 2026 to November 2, 2026 (from Revision E (APRIL 2026) to Revision F (NOVEMBER 2026)) **Page**

- **Global:** Added trademark to C7™ NPU references throughout the document....1
- (Features): Updated DSS output resolution.... 1
- (Pin Attributes - MMC0_CLK, MMC1_CLK, and MMC2_CLK): Changed "IO" to "O" in the "TYPE" column... 14
- (MCU_MCSPI1 Signal Descriptions): Corrected MCU_SPI1_CS1 Signal Description.... 64
- (MMC0/1/2 Signal Descriptions): Updated the Signal Type of MMC0_CLK, MMC1_CLK, and MMC2_CLK to "O"....65
- (MCSPI Switching Characteristics – Peripheral Mode) Updated SS6 delay time parameter from 17.12ns to 12.5ns. The SS7 delay time specification value updated from 20.95ns to 19ns, and the parameter is moved from the MIN column to the MAX column....169
- Display Subsystem (DSS): Removed OLDI references, as this feature is not supported by the device.....215
- (Tools and Software): Added trademark to CCStudio™ ecosystem....233

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11 Mechanical, Packaging, and Orderable Information

11.1 Packaging Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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