

# C2000 Real-Time Control MCU Peripherals

## Reference Guide



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## **C2000 Real-Time Control MCU Peripherals**

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This reference guide describes all the peripherals available for TMS320x28xx and TMS320x28xxx devices. [Section 2](#) shows the peripherals used by each device. [Section 3](#) provides descriptions of the peripherals. You can download a document by clicking on the literature number, which is linked to the portable document format (pdf) file.

### **1 Abbreviations**

Throughout this document and other peripheral guides, the following abbreviations are used for a series of 28x microcontrollers:

- **TMS320x28xx** refers to TMS320x281x and TMS320x280x devices.
- **TMS320x28xxx** refers to TMS320x2801x, TMS320x2802x, TMS320x2803x, TMS320x2804x, TMS320x2805x, TMS320x2806x, TMS320x2807x, TMS320x2823x, TMS320x2833x, TMS320x2834x, TMS320x2837xD, and TMS320x2837xS devices.
- **TMS320x28M3xx** refers to F28M35x and F28M36x devices.
- **TMS320F28004x** refers to F28004x devices.
- **TMS320F28002x** refers to F28002x devices.
- **TMS320F2838x** refers to F2838x devices.

Specific device abbreviations are listed in [Table 1](#).

#### **1.1 Trademarks**

InstaSPIN, InstaSPIN-FOC, FAST, InstaSPIN-MOTION, C2000, controlSUITE are trademarks of Texas Instruments.

Stellaris is a registered trademark of Texas Instruments.

Arm, Cortex are registered trademarks of Arm Limited (or its subsidiaries).

EtherCAT is a registered trademark of Beckhoff Automation GmbH.

SpinTAC is a trademark of Linestream Technologies.

**Table 1. Abbreviation Matrix**

Family	Device <sup>(1)</sup>	Device Abbreviation Used	Group Abbreviation
TMS320x280x	TMS320F2801, TMS320C2801, TMS320F2801-60	2801	280x
	TMS320F2802, TMS320C2802, TMS320F2802-60	2802	
	TMS320F2806, TMS320F2806	2806	
	TMS320F2808	2808	
	TMS320F2809	2809	
TMS320x281x	TMS320F2810, TMS320C2810	2810	281x
	TMS320F2811, TMS320C2811, TMS320R2811	2811	
	TMS320F2812, TMS320C2812, TMS320R2812	2812	
TMS320x2801x	TMS320F28016	28016	2801x
	TMS320F28015	28015	
TMS320F2802x	TMS320F28027F	28027F	2802x
	TMS320F28026F	28026F	
	TMS320F28027	28027	
	TMS320F28026	28026	
	TMS320F28023	28023	
	TMS320F28022	28022	
	TMS320F28021	28021	
	TMS320F28020	28020	
	TMS320F2803x	TMS320F28035	
TMS320F28034		28034	
TMS320F28033		28033	
TMS320F28032		28032	
TMS320F28031		28031	
TMS320F28030		28030	
TMS320x2804x	TMS320F28044	28044	2804x
TMS320F2805x	TMS320F28055	28055	2805x
	TMS320F28054	28054	
	TMS320F28054M	28054M	
	TMS320F28054F	28054F	
	TMS320F28053	28053	
	TMS320F28052	28052	
	TMS320F28052M	28052M	
	TMS320F28052F	28052F	
	TMS320F28051	28051	
	TMS320F28050	28050	

<sup>(1)</sup> Where F precedes the device abbreviation, it stands for Flash memory; C stands for RAM.

**Table 1. Abbreviation Matrix (continued)**

Family	Device <sup>(1)</sup>	Device Abbreviation Used	Group Abbreviation
TMS320F2806x	TMS320F28069	28069	2806x
	TMS320F28068	28068	
	TMS320F28067	28067	
	TMS320F28066	28066	
	TMS320F28065	28065	
	TMS320F28064	28064	
	TMS320F28063	28063	
	TMS320F28062	28062	
	TMS32028069U	28069U	
	TMS32028068U	28068U	
	TMS32028067U	28067U	
	TMS32028066U	28066U	
	TMS32028065U	28065U	
	TMS32028064U	28064U	
	TMS32028063U	28063U	
	TMS32028062U	28062U	
	TMS320F28069M	28069M	
	TMS320F28068M	28068M	
	TMS320F28069F	28069F	
	TMS320F28068F	28068F	
TMS320F28062F	28062F		
TMS320F2807x	TMS320F28075	28075	2807x
	TMS320F28076	28076	
TMS320F28002x	TMS320F280025C	280025C	28002x
	TMS320F280025	280025	
	TMS320F280024C	280024C	
	TMS320F280024	280024	
	TMS320F280023C	280023C	
	TMS320F280023	280023	
	TMS320F280022	280022	
	TMS320F280021	280021	
TMS320F28004x	TMS320F280049C	280049C	28004x
	TMS320F280049	280049	
	TMS320F280048C	280048C	
	TMS320F280048	280048	
	TMS320F280045	280045	
	TMS320F280041C	280041C	
	TMS320F280041	280041	
	TMS320F280040C	280040C	
	TMS320F280040	280040	
TMS320F2823x	TMS320F28235	28235	2823x
	TMS320F28234	28234	
	TMS320F28232	28232	
TMS320F2833x	TMS320F28335	28335	2833x
	TMS320F28334	28334	
	TMS320F28333	28333	
	TMS320F28332	28332	

**Table 1. Abbreviation Matrix (continued)**

Family	Device <sup>(1)</sup>	Device Abbreviation Used	Group Abbreviation
TMS320x2834x	TMS320C28346	28346	2834x
	TMS320C28345	28345	
	TMS320C28344	28344	
	TMS320C28343	28343	
	TMS320C28342	28342	
	TMS320C28341	28341	
TMS320F2837xD	TMS320F28379D	28379D	2837xD
	TMS320F28377D	28377D	
	TMS320F28376D	28376D	
	TMS320F28375D	28375D	
	TMS320F28374D	28374D	
TMS320F2837xS	TMS320F28379S	28379S	2837xS
	TMS320F28377S	28377S	
	TMS320F28376S	28376S	
	TMS320F28375S	28375S	
	TMS320F28374S	28374S	
TMS320F2838x	TMS320F28388D	28388D	2838x
	TMS320F28388S	28388S	
	TMS320F28386D	28386D	
	TMS320F28386S	28386S	
	TMS320F28384D	28384D	
	TMS320F28384S	28384S	
TMS320F28M35x	F28M35H52C	35H52C	M35x
	F28M35H22C	35H22C	
	F28M35M52C	35M52C	
	F28M35M22C	35M22C	
	F28M35M20B	35M20B	
	F28M35E20B	35E20B	
TMS320F28M36x	F28M36P63C	M36P63C	M36x
	F28M36P53C	M36P53C	
	F28M36H53C	M36H53C	
	F28M36H53B	M36H53B	
	F28M36H33C	M36H33C	
	F28M36H33B	M36H33B	



## 2 Peripherals Available Per Device

This section lists the peripherals available for each of the 28xx, 28xxx devices. The literature number is a link to the document that can be downloaded.

### 2.1 TMS320x280x, TMS320x2801x Peripherals

[Table 2](#) lists the peripherals available on the TMS320x280x and TMS320x2801x devices.

**Table 2. TMS320x280x, TMS320x2801x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	2809, 2808, 2806, 2802, 2801	28016	28015
System Control and Interrupts	<a href="#">SPRU712</a>	–	X	X	X
Boot ROM	<a href="#">SPRU722</a>	–	X	X	X
Analog-to-Digital Converter (ADC)	<a href="#">SPRU716</a>	1	X	X	X
Analog-to-Digital Converter Wrapper	<a href="#">SPRU716</a>	0	X	X	X
Serial Communications Interface (SCI)	<a href="#">SPRUFK7</a>	0	X	X	X
Serial Peripheral Interface (SPI)	<a href="#">SPRUG72</a>	0	X	X	X
Enhanced Controller Area Network (eCAN)	<a href="#">SPRUEU0</a>	0	X	X	–
Enhanced Quadrature Encoder Pulse (eQEP)	<a href="#">SPRU790</a>	0	X	–	–
Enhanced Pulse Width Modulator Module (ePWM)	<a href="#">SPRU791</a>	0	X	X	X
Enhanced Capture (eCAP) Module	<a href="#">SPRU807</a>	0	X	X	X
Inter-Integrated Circuit (I2C)	<a href="#">SPRU721</a>	0	X	X	X
High-Resolution Pulse-Width Modulator (HRPWM)	<a href="#">SPRU924</a>	0	X	X	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the peripheral reference guides.

### 2.2 TMS320x281x Peripherals

[Table 3](#) lists the peripherals available on the TMS320x281x device.

**Table 3. TMS320x281x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	2812	2811, 2810
System Control and Interrupts	<a href="#">SPRU078</a>	–	X	X
Boot ROM	<a href="#">SPRU095</a>	–	X	X
Analog-to-Digital Converter (ADC)	<a href="#">SPRU060</a>	0	X	X
Analog-to-Digital Converter Wrapper	<a href="#">SPRU060</a>	0	X	X
External Interface (XINTF)	<a href="#">SPRU067</a>	0	X	–
Enhanced Controller Area Network (eCAN)	<a href="#">SPRU074</a>	0	X	X
Event Manager (EV)	<a href="#">SPRU065</a>	0	X	X
Multichannel Buffered Serial Port (McBSP)	<a href="#">SPRU061</a>	0	X	X
Serial Communications Interface (SCI)	<a href="#">SPRU051</a>	0	X	X
Serial Peripheral Interface (SPI)	<a href="#">SPRU059</a>	0	X	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the peripheral reference guides.

### 2.3 TMS320F2802x Peripherals

Table 4 lists the peripherals available on the TMS320F2802x device.

**Table 4. TMS320F2802x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28027, 28026, 28023, 28022	28021, 28020, 280200
System Control and Interrupts	Please see <a href="#">SPRUJ09</a> for all F2802x peripherals shown here	–	X	X
Boot ROM		–	X	X
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X
Analog-to-Digital Converter Wrapper		1	X	X
Comparator Module (COMP)		0	X	X
Serial Communications Interface (SCI)		0	X	X
Serial Peripheral Interface (SPI)		1	X	X
Enhanced Pulse Width Modulator Module (ePWM)		1	X	X
Enhanced Capture Module (eCAP)		0	X	X
Inter-Integrated Circuit (I2C)		0	X	X
High-Resolution Pulse-Width Modulator (HRPWM)		1	X	–
InstaSPIN-FOC		<a href="#">SPRUHJ1</a>	–	X <sup>(3)</sup>

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 0.

<sup>(3)</sup> InstaSPIN-FOC™ is available only on TMS320F2802xF devices.

### 2.4 TMS320F2803x Peripherals

Table 5 lists the peripherals available on the TMS320F2803x device.

**Table 5. TMS320F2803x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28035, 28033	28034, 28032	28031, 28030	
System Control and Interrupts	Please see <a href="#">SPRUJ10</a> for all F2803x peripherals shown here	–	X	X	X	
Boot ROM		–	X	X	X	
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X	X	
Analog-to-Digital Converter Wrapper		1	X	X	X	
Comparator Module (COMP)		0	X	X	X	
Serial Communications Interface (SCI)		0	X	X	X	
Serial Peripheral Interface (SPI)		1	X	X	X	
Enhanced Controller Area Network (eCAN)		0	X	X	X	
Enhanced Quadrature Encoder Pulse (eQEP)		0	X	X	X	
Enhanced Pulse Width Modulator (ePWM)		1	X	X	X	
Enhanced Capture Module (eCAP)		0	X	X	X	
Inter-Integrated Circuit (I2C)		0	X	X	X	
Local Interconnect Network (LIN)		0	X	X	X	
High-Resolution Pulse-Width Modulator (HRPWM)		1	X	X	–	
High-Resolution Capture (HRCAP)		0	X	X	–	
Control Law Accelerator (CLA)		0	0	X	–	–

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 0.

## 2.5 TMS320x2804x Peripherals

Table 6 lists the peripherals available on the TMS320x2804x device.

**Table 6. TMS320x2804x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28044
System Control and Interrupts	<a href="#">SPRU712</a>	–	X
Boot ROM	<a href="#">SPRU722</a>	–	X
Analog-to-Digital Converter (ADC)	<a href="#">SPRU716</a>	1	X
Analog-to-Digital Converter Wrapper	<a href="#">SPRU716</a>	0	X
Serial Communications Interface (SCI)	<a href="#">SPRUFK7</a>	0	X
Serial Peripheral Interface (SPI)	<a href="#">SPRUG72</a>	0	X
Enhanced Pulse Width Modulator Module (ePWM)	<a href="#">SPRU791</a>	0	X
Inter-Integrated Circuit (I2C)	<a href="#">SPRU721</a>	0	X
High-Resolution Pulse-Width Modulator (HRPWM)	<a href="#">SPRU924</a>	0	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the peripheral reference guides.

## 2.6 TMS320F2805x Peripherals

Table 7 lists the peripherals available on the TMS320F2805x device.

**Table 7. TMS320F2805x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28055, 28054, 28053	28052, 28051, 28050
System Control and Interrupts	Please see <a href="#">SPRUHE5</a> for all F2805x peripherals shown here	–	X	X
Boot ROM		–	X	X
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X
Analog-to-Digital Converter Wrapper		1	X	X
Comparator Module (COMP)		1	X	X
Buffered Digital-to-Analog Converter (DAC)		0	X	X
Programmable Gain Amplifiers (PGA)		0	X	X
Serial Communications Interface (SCI)		0	X	X
Serial Peripheral Interface (SPI)		1	X	X
Enhanced Controller Area Network (eCAN)		0	X	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X	X
Enhanced Pulse Width Modulator (ePWM)		1	X	X
Enhanced Capture Module (eCAP)		0	X	X
Inter-Integrated Circuit (I2C)		0	X	X
Control Law Accelerator (CLA)		0	X	–
InstaSPIN-FOC	<a href="#">SPRUHW0</a>	X <sup>(3)</sup>	X <sup>(3)</sup>	X <sup>(3)</sup>
InstaSPIN-MOTION	<a href="#">SPRUHW1</a>	X <sup>(4)</sup>	X <sup>(4)</sup>	X <sup>(4)</sup>

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the peripheral reference guides.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 1.

<sup>(3)</sup> InstaSPIN-FOC™ is available only on TMS320F2805xF and TMS320F2805xM devices.

<sup>(4)</sup> InstaSPIN-MOTION™ is available only on TMS320F2805xM devices.

## 2.7 TMS320F2806x Peripherals

Table 8 lists the peripherals available on the TMS320F2806x device.

**Table 8. TMS320F2806x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28069, 28065	28068, 28064	28067, 28066, 28063, 28062
System Control and Interrupts	Please see <a href="#">SPRUH18</a> for all F2806x peripherals shown here	–	X	X	X
Boot ROM		–	X	X	X
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X	X
Analog-to-Digital Converter Wrapper		1	X	X	X
Comparator Module (COMP)		0	X	X	X
Serial Communications Interface (SCI)		0	X	X	X
Serial Peripheral Interface (SPI)		1	X	X	X
Enhanced Controller Area Network (eCAN)		0	X	X	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X	X	X
Enhanced Pulse Width Modulator (ePWM)		1	X	X	X
Enhanced Capture Module (eCAP)		0	X	X	X
Inter-Integrated Circuit (I2C)		0	X	X	X
High-Resolution Capture (HRCAP)		0	X	X	X
High-Resolution Pulse-Width Modulator (HRPWM)		1	X	X	X
Control Law Accelerator (CLA)		0	X	–	–
Direct Memory Access (DMA)		0	X	X	X
Multichannel Buffered Serial Port (McBSP)		1	X	X	X
Universal Serial Bus (USB)		0	X <sup>(3)</sup>	X <sup>(3)</sup>	X <sup>(3)</sup>
InstaSPIN-FOC	<a href="#">SPRUHI9</a>	–	X <sup>(4)</sup>	X <sup>(4)</sup>	X <sup>(4)</sup>
InstaSPIN-MOTION	<a href="#">SPRUHJ0</a>	–	X <sup>(5)</sup>	X <sup>(5)</sup>	X <sup>(5)</sup>
Floating-Point Unit (FPU)	<a href="#">SPRUHS1</a>	–	X	X	X
Viterbi, Complex Math and CRC Unit (VCU)		1	X	X	–

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 0.

<sup>(3)</sup> USB is available only on TMS320F2806xU, TMS320F2806xF, and TMS320F2806xM devices.

<sup>(4)</sup> InstaSPIN-FOC™ is available only on TMS320F2806xF and TMS320F2806xM devices.

<sup>(5)</sup> InstaSPIN-MOTION™ is available only on TMS320F2806xM devices.

## 2.8 TMS320F2807x Peripherals

Table 9 lists the peripherals available on the TMS320F2807x device.

**Table 9. TMS320F2807x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28076	28075
System Control and Interrupts	Please see <a href="#">SPRUHM9</a> for all F2807x peripherals shown here	–	X	X
ROM Code and Peripheral Booting		–	X	X
Analog-to-Digital Converter (ADC)		4	X	X
Analog-to-Digital Converter Wrapper		3	X	X
Direct Memory Access (DMA)		0	X	X
Control Law Accelerator (CLA)		1	X	X
General-Purpose Input /Output (GPIO)		–	X	X
Comparator Subsystem (CMPSS)		0	X	X
Configurable Logic Block (CLB)		1	X	–
Buffered Digital to Analog Converter (DAC)		1	X	X
Sigma Delta Filter Module (SDFM)		0	X	X
High-Resolution Pulse-Width Modulator (HRPWM)		4	X	X
Enhanced Capture Module (eCAP)		0	X	X
Enhanced Pulse Width Modulator (ePWM)		4	X	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X	X
Serial Peripheral Interface (SPI)		2	X	X
Serial Communications Interface (SCI)		0	X	X
Inter-Integrated Circuit (I2C)		0	X	X
Multichannel Buffered Serial Port (McBSP)		1	X	X
Controller Area Network (CAN)		0	X	X
Universal Serial Bus (USB)	0	X	X	
External Memory Interface (EMIF)	0	X	X	
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	0	X	X
Floating-Point Unit (FPU)		–	X	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

## 2.9 TMS320F28002x Peripherals

Table 10 lists the peripherals available on the TMS320F28002x device.

**Table 10. TMS320F28002x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	280025C, 280024C, 280023C	280025, 280024, 280023, 280022, 280021
System Control and Interrupts	Please see <a href="#">SPRUIN7</a> for all F28002x peripherals shown here	–	X	X
ROM Code and Peripheral Booting		–	X	X
Analog-to-Digital Converter (ADC)		5	X	X
Analog-to-Digital Converter Wrapper		3	X	X
Direct Memory Access (DMA)		0	X	X
General-Purpose Input/Output (GPIO)		–	X	X
Temperature Sensor		–	X	X
Comparator Subsystem (CMPSS)		1	X	X
Configurable Logic Block (CLB)		3	X	-
Enhanced Pulse Width Modulator (ePWM)		4	X	X
Enhanced Capture Module (eCAP)		2	X	X
Enhanced Quadrature Encoder Pulse (eQEP)		2	X	X
High-Resolution Capture Module (HRCAP)		1	X	X
High-Resolution Pulse-Width Modulator (HRPWM)		4	X	X
Serial Peripheral Interface (SPI)		2	X	X
Serial Communications Interface (SCI)		0	X	X
Inter-Integrated Circuit (I2C)		1	X	X
Local Interconnect Network (LIN)		1	X	X
Fast Serial Interface (FSI)		1	X	X
Power Management Bust Module (PMBus)		0	X	X
Host Interface Controller (HIC)	0	X	X	
Background CRC-32 (BGCR32)	0	X	X	
Controller Area Network (CAN)	0	X	X	
Embedded Real-time Analysis and Diagnostic (ERAD)	1	X	X	
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	1	X	X
Cyclic Redundancy Check (VCRC)		–	X	X
Floating-Point Unit (FPU)		–	X	X
InstaSPIN-FOC	<a href="#">SPRUHJ1</a>	X <sup>(2)</sup>	X <sup>(2)</sup>	–

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

<sup>(2)</sup> InstaSPIN-FOC™ is available only on TMS320F28002xC devices.

## 2.10 TMS320F28004x Peripherals

Table 11 lists the peripherals available on the TMS320F28004x device.

**Table 11. TMS320F28004x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	280049C, 280049, 280048C, 280048, 280045, 280041C, 280041, 280040C, 280040
System Control and Interrupts	Please see <a href="#">SPRU133</a> for all F28004x peripherals shown here	–	X
ROM Code and Peripheral Booting		–	X
Analog-to-Digital Converter (ADC)		5	X
Analog-to-Digital Converter Wrapper		3	X
Direct Memory Access (DMA)		0	X
Control Law Accelerator (CLA)		2	X
Configurable Logic Block (CLB)		2	Only parts with "C"
General-Purpose Input/Output (GPIO)		–	X
Temperature Sensor		–	X
Comparator Subsystem (CMPSS)		1	X
Buffered Digital to Analog Converter (DAC)		2	X
Programmable Gain Amplifier (PGA)		1	X
Sigma Delta Filter Module (SDFM)		1	X
Enhanced Pulse Width Modulator (ePWM)		4	X
Enhanced Capture Module (eCAP)		1	X
Enhanced Quadrature Encoder Pulse (eQEP)		1	X
High-Resolution Pulse-Width Modulator (HRPWM)		4	X
High-Resolution Capture Module (HRCAP)		1	X
Serial Peripheral Interface (SPI)		2	X
Serial Communications Interface (SCI)		0	X
Inter-Integrated Circuit (I2C)	1	X	
Local Interconnect Network (LIN)	1	X	
Fast Serial Interface (FSI)	0	X	
Power Management Bust Module (PMBus)	0	X	
CLA Program ROM CRC (CLAPROMCRC)	0	X	
Controller Area Network (CAN)	0	X	
Embedded Real-time Analysis and Diagnostic (ERAD)	0	X	
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	0	X
Viterbi, Complex Math, and CRC Unit (VCU-I)		1	X
Floating-Point Unit (FPU)		–	X
InstaSPIN-FOC	<a href="#">SPRUHJ1</a>	X <sup>(2)</sup>	X <sup>(2)</sup>

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

<sup>(2)</sup> InstaSPIN-FOC™ is available only on TMS320F28004xC devices.

## 2.11 TMS320F2823x Peripherals

Table 12 lists the peripherals available on the TMS320F2823x device.

**Table 12. TMS320F2823x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28235, 28234, 28232
System Control and Interrupts	Please see <a href="#">SPRUJ07</a> for all F2823x peripherals shown here	–	X
Boot ROM		–	X
Analog-to-Digital Converter (ADC)		2	X
Analog-to-Digital Converter Wrapper		0	X
Multichannel Buffered Serial Port (McBSP)		1	X
Serial Communications Interface (SCI)		0	X
Serial Peripheral Interface (SPI)		0	X
Enhanced Controller Area Network (eCAN)		0	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X
Enhanced Pulse Width Modulator Module (ePWM)		0	X
Enhanced Capture Module (eCAP)		0	X
Inter-Integrated Circuit (I2C)		0	X
High-Resolution Pulse-Width Modulator (HRPWM)		0	X
Direct Memory Access (DMA)		0	X
External Interface (XINTF)		1	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM.



## 2.12 TMS320F2833x Peripherals

Table 13 lists the peripherals available on the TMS320F2833x device.

**Table 13. TMS320F2833x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28335, 28334, 28333, 28332
System Control and Interrupts	Please see <a href="#">SPRUJ07</a> for all F2833x peripherals shown here	–	X
Boot ROM		–	X
Analog-to-Digital Converter (ADC)		2	X
Analog-to-Digital Converter Wrapper		0	X
Multichannel Buffered Serial Port (McBSP)		1	X
Serial Communications Interface (SCI)		0	X
Serial Peripheral Interface (SPI)		0	X
Enhanced Controller Area Network (eCAN)		0	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X
Enhanced Pulse Width Modulator Module (ePWM)		0	X
Enhanced Capture Module (eCAP)		0	X
Inter-Integrated Circuit (I2C)		0	X
High-Resolution Pulse-Width Modulator (HRPWM)		0	X
Direct Memory Access (DMA)		0	X
External Interface (XINTF)		1	X
Floating-Point Unit (FPU)	<a href="#">SPRUHS1</a>	–	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM or peripheral reference guide.

## 2.13 TMS320x2834x Peripherals

Table 14 lists the peripherals available on the TMS320x2834x device.

**Table 14. TMS320x2834x Peripheral Selection Guide**

Peripheral	Lit. No.	TYPE <sup>(1)</sup>	28346, 28345, 28344, 28343, 28342, 28341
System Control and Interrupts	<a href="#">SPRUFN1</a>	–	X
Boot ROM	<a href="#">SPRUFN5</a>	–	X
Multichannel Buffered Serial Port (McBSP)	<a href="#">SPRUG80</a>	1	X
Serial Communications Interface (SCI)	<a href="#">SPRUG75</a>	0	X
Serial Peripheral Interface (SPI)	<a href="#">SPRUG73</a>	0	X
Enhanced Controller Area Network (eCAN)	<a href="#">SPRUEU4</a>	0	X
Enhanced Quadrature Encoder Pulse (eQEP)	<a href="#">SPRUG74</a>	0	X
Enhanced Pulse Width Modulator Module (ePWM)	<a href="#">SPRUFZ6</a>	0	X
Enhanced Capture Module (eCAP)	<a href="#">SPRUG79</a>	0	X
Inter-Integrated Circuit (I2C)	<a href="#">SPRUG76</a>	0	X
High-Resolution Pulse-Width Modulator (HRPWM)	<a href="#">SPRUG77</a>	0	X
Direct Memory Access (DMA)	<a href="#">SPRUG78</a>	0	X
External Interface (XINTF)	<a href="#">SPRUFN4</a>	1	X
Floating-Point Unit (FPU)	<a href="#">SPRUHS1</a>	–	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the peripheral reference guide.

## 2.14 TMS320F2837xD Peripherals

Table 15 lists the peripherals available on the TMS320F2837xD device.

**Table 15. TMS320F2837xD Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28379D, 28377D, 28376D, 28375D, 28374D
System Control and Interrupts	Please see <a href="#">SPRUHM8</a> for all F2837xD peripherals shown here	–	X
ROM Code and Peripheral Booting		–	X
Analog-to-Digital Converter (ADC)		4	X
Analog-to-Digital Converter Wrapper		3	X
Temperature Sensor		–	X
Direct Memory Access (DMA)		0	X
Control Law Accelerator (CLA)		1	X
Configurable Logic Block (CLB)		1	X
Inter-processor Communication (IPC)		–	X
General-Purpose Input/Output (GPIO)		–	X
Comparator Subsystem (CMPSS)		0	X
Buffered Digital to Analog Converter (DAC)		1	X
Sigma Delta Filter Module (SDFM)		0	X
High-Resolution Pulse-Width Modulator (HRPWM)		4	X
Enhanced Pulse Width Modulator (ePWM)		4	X
Enhanced Capture Module (eCAP)		0	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X
Serial Peripheral Interface (SPI)		2	X
Serial Communications Interface (SCI)		0	X
Inter-Integrated Circuit (I2C)		0	X
Multichannel Buffered Serial Port (McBSP)	1	X	
Controller Area Network (CAN)	0	X	
Universal Serial Bus (USB)	0	X	
Universal Parallel Port (uPP)	0	X	
External Memory Interface (EMIF)	0	X	
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	0	X
Viterbi, Complex Math, and CRC Unit (VCU-II)		2	X
Floating-Point Unit (FPU)		–	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM or peripheral reference guide.

## 2.15 TMS320F2837xS Peripherals

Table 16 lists the peripherals available on the TMS320F2837xS device.

**Table 16. TMS320F2837xS Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28379S, 28377S, 28376S, 28375S, 28374S
System Control and Interrupts	Please see <a href="#">SPRUHX5</a> for all F2837xS peripherals shown here	–	X
ROM Code and Peripheral Booting		–	X
Analog-to-Digital Converter (ADC)		4	X
Analog-to-Digital Converter Wrapper		3	X
Temperature Sensor		–	X
Direct Memory Access (DMA)		0	X
Control Law Accelerator (CLA)		1	X
Configurable Logic Block (CLB)		1	X
General-Purpose Input/Output (GPIO)		–	X
Comparator Subsystem (CMPSS)		0	X
Buffered Digital to Analog Converter (DAC)		1	X
Sigma Delta Filter Module (SDFM)		0	X
High-Resolution Pulse-Width Modulator (HRPWM)		4	X
Enhanced Pulse Width Modulator (ePWM)		4	X
Enhanced Capture Module (eCAP)		0	X
Enhanced Quadrature Encoder Pulse (eQEP)		0	X
Serial Peripheral Interface (SPI)		2	X
Serial Communications Interface (SCI)		0	X
Inter-Integrated Circuit (I2C)		0	X
Multichannel Buffered Serial Port (McBSP)		1	X
Controller Area Network (CAN)	0	X	
Universal Serial Bus (USB)	0	X	
Universal Parallel Port (uPP)	0	X	
External Memory Interface (EMIF)	0	X	
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	0	X
Viterbi, Complex Math, and CRC Unit (VCU-II)		2	X
Floating-Point Unit (FPU)		–	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM or peripheral reference guide.

## 2.16 TMS320F2838x Peripherals

Table 17 lists the peripherals available on the TMS320F2838x device.

**Table 17. TMS320F2838x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	28388D, 28388S	28386D, 28386S	28384D, 28384S	
System Control and Interrupts	Please see <a href="#">SPRUJ10</a> for all F2838x peripherals shown here	–	X	X	X	
ROM Code and Peripheral Booting		–	X	X	X	
Analog-to-Digital Converter (ADC)		4	X	X	X	
Analog-to-Digital Converter Wrapper		3	X	X	X	
Temperature Sensor		–	X	X	X	
Direct Memory Access (DMA)		0	X	X	X	
Control Law Accelerator (CLA)		2	X	X	X	
Configurable Logic Logic (CLB)		3	X	X	–	
Inter-processor Communication (IPC)		–	X	X	X	
General-Purpose Input/Output (GPIO)		–	X	X	X	
Comparator Subsystem (CMPSS)		1	X	X	X	
Embedded Real-time Analysis and Diagnostic (ERAD)		1	X	X	X	
<b>Connectivity Manager - Arm® Cortex®-M4 Peripherals</b>						
EtherCAT Slave Controller (ESC)		0	X	–	–	
Ethernet Media Access Controller (EMAC)	0	X	X	X		
Modular Controller Area Network (MCAN)	–	X	X	X		
CM Inter-Integrated Circuit (I2C)	–	X	X	X		
Synchronous Serial Interface (SSI)	0	X	X	X		
Universal Asynchronous Receiver/Transmitter (UART)	0	X	X	X		
<b>TI C28x Peripherals</b>						
Buffered Digital to Analog Converter (DAC)	1	X	X	X		
Sigma Delta Filter Module (SDFM)	2	X	X	X		
Enhanced Pulse Width Modulator (ePWM)	4	X	X	X		
High-Resolution Pulse-Width Modulator (HRPWM)	4	X	X	X		
Enhanced Capture Module (eCAP)	2	X	X	X		
High-Resolution Capture Module (HRCAP)	1	X	X	X		
Enhanced Quadrature Encoder Pulse (eQEP)	2	X	X	X		
Serial Peripheral Interface (SPI)	2	X	X	X		
Serial Communications Interface (SCI)	0	X	X	X		
Inter-Integrated Circuit (I2C)	1	X	X	X		
Multichannel Buffered Serial Port (McBSP)	1	X	X	X		
Controller Area Network (CAN)	0	X	X	X		
Universal Serial Bus (USB)	0	X	X	X		
Background CRC-32 (BGCRC)	0	X	X	X		
Generic Cyclic Redundancy Check (GCRC)	–	X	X	X		
External Memory Interface (EMIF)	0	X	X	X		
Fast Serial Interface (FSI)	1	X	X	X		
Power Management Bus (PMBus)	0	X	X	X		
Trigonometric Math Unit (TMU)	<a href="#">SPRUHS1</a>	0	X	X	X	
Cyclic Redundancy Check (VCRC)		–	X	X	X	
Floating-Point Unit (FPU32 and FPU64)		–	X	X	X	

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices which do not affect the basic functionality of the module. These device-specific differences are listed in [Section 3](#) and in the TRM or peripheral reference guide.

## 2.17 TMS320F28M35x Peripherals

Table 18 lists the peripherals available on the TMS320F28M35x device.

**Table 18. TMS320F28M35x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	M35xx2C	M35xx0B	
System Control and Interrupts	Please see <a href="#">SPRUH22</a> for all F28M35x peripherals shown here	–	X	X	
Boot ROM		–	X	X	
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X	
Analog-to-Digital Converter Wrapper		2	X	X	
Comparator Module (COMP)		0	X	X	
External Peripheral Interface (EPI)		0	X	X	
Hardware Logic Self-Test Module (HWBIST)		0	X	X	
<b>Master Subsystem - Arm® Cortex®-M3 Peripherals</b>					
Ethernet Media Access Controller (EMAC)		0	X	X	–
Synchronous Serial Interface (SSI)	0	X	X	X	
Controller Area Network (CAN)	0	X	X	X	
Universal Serial Bus (USB)	0	X	X	–	
M3 Inter-Integrated Circuit (I2C)	0	X	X	X	
Universal Asynchronous Receiver/Transmitter (UART)	0	X	X	X	
Micro Cyclic Redundancy Check Module (μCRC)	0	X	X	X	
Direct Memory Access (μDMA)	0	X	X	X	
<b>Control Subsystem - TI C28x Peripherals</b>					
Serial Communications Interface (SCI)	0	X	X	X	
Enhanced Quadrature Encoder Pulse (eQEP)	0	X	X	X	
Enhanced Pulse-Width Modulator (ePWM)	2	X	X	X	
High-Resolution Pulse-Width Modulator (HRPWM)	2	X	X	X	
Enhanced Capture Module (eCAP)	0	X	X	X	
Inter-Integrated Circuit (I2C)	0	X	X	X	
Direct Memory Access Module (DMA)	0	X	X	X	
Multichannel Buffered Serial Port (McBSP)	1	X	X	X	
Serial Peripheral Interface (SPI)	0	X	X	X	
Viterbi, Complex Math and CRC Unit (VCU)	<a href="#">SPRUHS1</a>	0	X	X	
Floating-Point Unit (FPU)		–	X	X	

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 0.

## 2.18 TMS320F28M36x Peripherals

Table 19 lists the peripherals available on the TMS320F28M36x device.

**Table 19. TMS320F28M36x Peripheral Selection Guide**

Peripheral	Lit. No.	Type <sup>(1)</sup>	M36xxxC	M36xxxB
System Control and Interrupts	Please see <a href="#">SPRUHE8</a> for all F28M36x peripherals shown here	–	X	X
Boot ROM		–	X	X
Analog-to-Digital Converter (ADC) <sup>(2)</sup>		3	X	X
Analog-to-Digital Converter Wrapper		2	X	X
Comparator Module (COMP)		0	X	X
External Peripheral Interface (EPI) <sup>(3)</sup>		0	X	X
Hardware Logic Self-Test Module (HWBIST)		0	X	X
<b>Master Subsystem - Arm® Cortex®-M3 Peripherals</b>				
Ethernet Media Access Controller (EMAC)	0	X	–	
Synchronous Serial Interface (SSI)	0	X	X	
Controller Area Network (CAN)	0	X	X	
Universal Serial Bus (USB)	0	X	–	
M3 Inter-Integrated Circuit (I2C)	0	X	X	
Universal Asynchronous Receiver/Transmitter (UART)	0	X	X	
Micro Cyclic Redundancy Check Module (μCRC)	0	X	X	
Direct Memory Access (μDMA)	0	X	X	
<b>Control Subsystem - TI C28x Peripherals</b>				
Serial Communications Interface (SCI)	0	X	X	
Enhanced Quadrature Encoder Pulse (eQEP)	0	X	X	
Enhanced Pulse Width Modulator (ePWM)	2	X	X	
High-Resolution Pulse-Width Modulator (HRPWM)	2	X	X	
Enhanced Capture Module (eCAP)	0	X	X	
Inter-Integrated Circuit (I2C)	0	X	X	
Direct Memory Access (DMA)	0	X	X	
Multichannel Buffered Serial Port (McBSP)	1	X	X	
Serial Peripheral Interface (SPI)	0	X	X	
Viterbi, Complex Math and CRC Unit (VCU)	<a href="#">SPRUHS1</a>	0	X	X
Floating-Point Unit (FPU)		–	X	X

<sup>(1)</sup> A type change represents a major functional feature difference in a peripheral module. Within a peripheral type, there may be minor differences between devices that do not affect the basic functionality of the module. These device-specific differences are listed in the TRM or peripheral reference guide.

<sup>(2)</sup> The ADC module is Type 3 and the Comparator module is Type 0.

<sup>(3)</sup> The EPI module can be controlled by either CPU. Refer to the relevant section of the technical reference manual for more information.

### 3 Peripheral Descriptions

Brief descriptions of the peripherals are included in the following sections.

#### 3.1 Coprocessor and C28x Extended Instruction Sets

##### 3.1.1 Control Law Accelerator (CLA) Module

The C28x Control Law Accelerator (CLA) module is an independent, fully-programmable, 32-bit floating-point math processor that brings concurrent control-loop execution to the C28x family. The low interrupt-latency of the CLA allows it to read ADC samples "just-in-time." This significantly reduces the ADC sample to output delay to enable faster system response and higher MHz control loops. By using the CLA to service time-critical control loops, the main CPU is free to perform other system tasks such as communications and diagnostics.

Refer to the device-specific technical reference manual for more information.

[Table 20](#) lists the CLA types, including device-specific differences within each type.

**Table 20. Control Law Accelerator (CLA) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original CLA Module Type	2803x	Only supports data RAM0 and 1 and does not allow CPU access when CLA data RAM is enabled.
		2805x, 2806x	Adds supports for data RAM2 and adds option to enable CPU access to data RAMs.
1	Increased Program address reachability to 16-bits; added instructions to support the new address reach; added two new offset addressing modes; CLA program memory is now user selectable and can reside anywhere in the lower 64k address space (excluding the M0 and M1 space). The job of giving control to the CLA and assigning triggers to a task is now done at the system level; a task can now fire an interrupt to main CPU mid execution.	2807x, 2837xD, 2837xS	–
2	Added Background-code mode, that can run task like communications and clean-up routines in Background; Background tasks runs continuously until disable or device/soft reset; Background task can be triggered by a peripheral or software; other foreground tasks can interrupt background task in the priority order defined; added provision for making sections of background code uninterruptible; added debug enhancements which has true software breakpoint support, where CLA re-fetches from the same address where halted during debug stop.	28004x, 2838x	–



### 3.1.2 Floating-Point Unit (FPU)

The C28x plus floating-point (C28x+FPU) processor extends the capabilities of the C28x fixed-point CPU by adding registers and instructions to support IEEE single-precision floating point operations. Devices with the C28x+FPU include the standard C28x register set plus an additional set of floating-point unit registers. The additional floating-point unit registers are the following:

- Eight floating-point result registers, RnH (where n = 0–7)
- Floating-point Status Register (STF)
- Repeat Block Register (RB)

All of the floating-point registers, except the repeat block register, are shadowed. This shadowing can be used in high-priority interrupts for fast context save and restore of the floating-point registers.

For more information, see the [TMS320C28x Extended Instruction Sets Technical Reference Manual](#).

[Table 21](#) lists the FPU types, including device-specific differences within each type.

**Table 21. Floating-Point Unit (FPU) Type Description**

Type	Description	Devices Covered	Device-Specific Options
–	Original FPU Instruction Set	2806x, 2807x, 28004x, 2833x, 2834x, 2837xD, 2837xS, M35x, M36x	–
		28002x	New instructions for Fast Integer Division.
		2838x	Additional double precision float instruction set (FPU64). New instructions for Fast Integer Division.

### 3.1.3 Viterbi, Complex Math, and CRC Unit (VCU)

The C28x Viterbi, Complex Math and CRC Unit (VCU) is a fully-programmable block that accelerates the performance of communications-based algorithms by up to a factor of 8x over the C28x CPU alone. In addition to eliminating the need for a second processor to manage the communications link, the performance gains of the VCU provides headroom for future system growth and higher bit rates or, conversely, enables devices to operate at a lower MHz to reduce system cost and power consumption.

For more information, see the [TMS320C28x Extended Instruction Sets Technical Reference Manual](#).

[Table 22](#) lists the VCU types, including device-specific differences within each type.

**Table 22. Viterbi, Complex Math, and CRC Unit (VCU) Type Description**

Type	Description	Devices Covered	Device-Specific Options
0/1	Original VCU Module Type (both types are equivalent)	2806x, 28004x, M35x, M36x	–
2	Added instructions to improve performance in Viterbi decoding, complex arithmetic instructions, complex FFT, AES encryption and decryption. Added instructions for direct register access between VCU and C28x. Added Interrupt to PIE.	2837xD, 2837xS	–

### 3.1.4 Cyclic Redundancy Check (VCRC) Module

The C28x with VCRC (C28x+VCRC) processor extends the capabilities of the C28x CPU by adding registers and instructions to support CRC. CRC algorithms provide a straightforward method for verifying data integrity over large data blocks, communication packets, or code sections. The C28x+VCRC can perform 8-, 16-, 24-, and 32-bit CRCs.

For more information, see the [TMS320C28x Extended Instruction Sets Technical Reference Manual](#).

[Table 23](#) lists the VCRC types, including device-specific differences within each type.

**Table 23. Cyclic Redundancy Check (VCRC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
–	Original VCRC Module Type	28002x, 2838x	–

### 3.1.5 Trigonometric Math Unit (TMU)

The Trigonometric Math Unit (TMU) is an accelerator that extends the capabilities of the C28x+FPU, specifically designed to speed up the execution of common trigonometric and arithmetic operations.

For more information, see the [TMS320C28x Extended Instruction Sets Technical Reference Manual](#).

[Table 24](#) lists the TMU types, including device-specific differences within each type.

**Table 24. Trigonometric Math Unit (TMU) Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original TMU Module Type	2807x, 28004x, 2837xD, 2837xS, 2838x	–
1	Added new instructions supporting NLPID	28002x	–

## 3.2 System Peripherals

The following sections describe the system peripherals.

### 3.2.1 Boot ROM

The boot ROM is factory-programmable with bootloading software. Boot-mode signals (general-purpose I/Os) are used to tell the bootloader software which mode to use. The Boot ROM also contains standard math tables such as SIN/COS for use in IQ math related algorithms.

The device-specific Boot ROM guides are:

- [TMS320x281x Boot ROM Reference Guide](#)
- [TMS320x280x, 2801x, 2804x DSP Boot ROM Reference Guide](#)
- [TMS320x2834x Boot ROM Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

### 3.2.2 Direct Memory Access (DMA) Module

The Direct Memory Access (DMA) module provides a hardware method of transferring data between peripherals and/or memory without intervention from the CPU, thereby freeing up bandwidth for other system functions. Additionally, the DMA has the capability to orthogonally rearrange the data as it is transferred as well as “ping-pong” data between buffers. These features are useful for structuring data into blocks for optimal CPU processing.

The device-specific DMA guide is:

- [TMS320x2834x Direct Memory Access \(DMA\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 25](#) lists the DMA types, including device-specific differences within each type.

**Table 25. Direct Memory Access (DMA) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original DMA Module Type	2834x	DMA does not interface to ePWM.
		2823x, 2833x, M35x, M36x	Added interface to ADC and ePWM.
		2806x	Added interface to USB.
		2807x, 28002x, 28004x, 2837xD, 2837xS, 2838x	Added interface to SPI and SDFM. Modified Peripheral Interrupt Event Trigger configuration registers.

### 3.2.3 External Memory Interface (EMIF)

The External Memory Interface (EMIF) is a data port that provides ease and flexibility when connecting to a variety of external devices including SDR SDRAM and asynchronous devices. EMIF is compliant with JESD21-C memories utilizing 32-bit or 16-bit data buses.

Refer to the device-specific technical reference manual for more information.

[Table 26](#) lists the EMIF types, including device specific differences within each type.

**Table 26. External Memory Interface (EMIF) Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original EMIF Module Type	2807x, 2837xD, 2837xS	–
		2838x	With optional re-mapping of SDRAM in lower 22 bits address range of memory.

### 3.2.4 External Peripheral Interface (EPI)

The External Peripheral Interface (EPI) is a high-speed parallel interface to external peripherals or memories. The EPI supports  $\mu$ DMA access, clocking control, 8/16/32 bit dedicated parallel bus, blocking and non-blocking reads, and three functional modes: Synchronous Dynamic Random Access Memory (SDRAM), Host-bus, and General Purpose.

Refer to the device-specific technical reference manual for more information.

[Table 27](#) lists the EPI types, including device-specific differences within each type.

**Table 27. External Peripheral Interface (EPI) Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original EPI Module Type	M35x, M36x	–

### 3.2.5 Event Manager (EV) Module

The Event Manager (EV) module includes general-purpose timers, full-compare/pulse-width modulation (PWM) units, capture inputs (CAP) and quadrature-encoder pulse (QEP) circuits. Two such event managers are provided, which enable two three-phase motors to be driven or four two-phase motors. The event managers on the F281x are compatible to the event managers on the 240x devices (with some minor enhancements).

The device-specific EV guide is:

- [TMS320x281x DSP Event Manager \(EV\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 28](#) lists the EV types, including device-specific differences within each type.

**Table 28. Event Manager (EV) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original EV Module Type	281x	–

### 3.2.6 External Interface (XINTF) Module

The External Interface (XINTF) module is an asynchronous bus that is used to interface to external devices and memory.

The device-specific XINTF guides are:

- [TMS320x281x External Interface \(XINTF\) Reference Guide](#)
- [TMS320x2834x External Interface \(XINTF\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 29](#) lists the XINTF types, including device-specific differences within each type.

**Table 29. External Interface (XINTF) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	External Interface with x16 Data Bus	281x	–
1	External Interface with x16 or x32 Data Bus	2823x, 2833x, 2834x	–

### 3.2.7 Hardware Built-in Self-Test (HWBIST) Module

The Hardware Built-in Self-Test (HWBIST) module is capable of testing the CPU, VCU, FPU, and TMU for defective circuitry. The library routine can be executed whenever convenient in an application to detect if the circuitry is defective or damaged, and allow the system code to manage the fault condition in a controlled manner. This module produces coverage up to 99%. The execution of this routine can be adjusted to meet performance and latency requirements within the system.

Refer to the device-specific technical reference manual for more information.

[Table 30](#) lists the HWBIST types, including device-specific differences within each type.

**Table 30. Hardware Built-in Self-Test (HWBIST) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original HWBIST Module Type	M35x, M36x	–

### 3.2.8 System Control and Interrupts

The device-specific System Control and Interrupts guides are:

- [TMS320x281x System Control and Interrupts Reference Guide](#)
- [TMS320x280x, 2801x, and 2804x System Control and Interrupts Reference Guide](#)
- [TMS320x2834x System Control and Interrupts Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

These guides include information on the following modules:

- Memory, including Flash and OTP configuration
- Code security module (CSM)
- Dual Code Security Module (DCSM)
- Clocking and low-power modes
- 32-bit CPU-Timers
- Watchdog Timer
- General-purpose inputs/outputs (GPIO)
- Peripheral frames
- Peripheral interrupt expansion (PIE)
- Low-power modes
- External Interrupts

### 3.2.9 Micro Cyclic Redundancy Check (μCRC) Module

The Micro Cyclic Redundancy Check (μCRC) module can be used to compute CRC on data and program data in specified memory locations. The μCRC supports the CRC8, CRC16-1, CRC16-2, CRC32 polynomials.

Refer to the device-specific technical reference manual for more information.

[Table 31](#) lists the μCRC types, including device-specific differences within each type.

**Table 31. Micro Cyclic Redundancy Check (μCRC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original μCRC Module Type	M35x, M36x	–

### 3.2.10 Background CRC-32 (BGCR) Module

The Background CRC (BGCR) module computes a CRC-32 on a configurable block of memory. It accomplishes this by fetching the specified block of memory during idle cycles (when the CPU, CLA, or DMA is not accessing the memory block). The calculated CRC-32 value is compared against a golden CRC-32 value to indicate a pass or fail. In essence, the BGCR helps identify memory faults and corruption.

Refer to the device-specific technical reference manual for more information.

[Table 32](#) lists the BGCR types, including device-specific differences within each type.

**Table 32. Background CRC-32 (BGCR) Module Type Description**

Type	Description	Devices Covered	Device- Specific Options
0	Original BGCR Module Type	28002x, 2838x	–

### 3.2.11 Host Interface Controller (HIC) Module

The Host Interface Controller (HIC) module allows an external host controller (master) to directly access resources of the device (slave) by emulating the ASRAM protocol. It has two modes of operation: direct access and mailbox access. In direct access mode, device resources is written to and read from directly by the external host. In mailbox access mode, external host and device write to and read from a buffer and notify each other when the buffer write/read is complete.

Refer to the device-specific technical reference manual for more information.

[Table 33](#) lists the HIC types, including device-specific differences within each type.

**Table 33. Host Interface Controller (HIC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original HIC Module Type	28002x	–

### 3.2.12 Embedded Real-time Analysis and Diagnostic (ERAD) Module

The Embedded Real-time Analysis and Diagnostic (ERAD) module enhances the debug and system-analysis capabilities of the device. The debug and system-analysis enhancements provided by the ERAD module is done outside of the CPU. The ERAD module is accessible by the debugger and by the application software, which significantly increases the debug capabilities of many real-time systems, especially in situations where debuggers are not connected.

Refer to the device-specific technical reference manual for more information.

[Table 34](#) lists the ERAD types, including device-specific differences within each type.

**Table 34. Embedded Real-time Analysis and Diagnostic (ERAD) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original ERAD Module Type	28004x	–
1	Addition of CRC block Addition of EVENT masking and exporting feature	28002x, 2838x	–

### 3.3 Control Peripherals

The following sections describe the Control peripherals.

#### 3.3.1 Analog-to-Digital Converter (ADC) Modules

The device-specific ADC guides are:

- [TMS320x281x Analog-to-Digital Converter \(ADC\) Reference Guide](#)
- [TMS320x280x 2801x, 2804x Analog-to-Digital Converter \(ADC\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

##### 3.3.1.1 Analog-to-Digital Converter (ADC) Module

The Analog-to-Digital Converter (ADC) module samples an analog signal and converts it to a digital value for use in an application.

Refer to the device-specific technical reference manual for more information.

[Table 35](#) lists the ADC types, including device-specific differences within each type.

**Table 35. Analog-to-Digital Converter (ADC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original ADC Module Type. Fixed reference range of 0V to 3.0V. 12-bit pipelined architecture.	281x	–
1	Added Offset Trim and Reference Select registers.	280x, 2801x, 2804x	–
2	Added Internal/External Trim registers (OTP trim).	2823x, 2833x	–
3	Fixed internal reference range from 0V to 3.3V or ratiometric external reference. 12-bit hybrid pipeline/SAR architecture.	2802x, 2803x, 2805x, 2806x, M35x, M36x	–
4	12-bit or 16-bit SAR architecture. Ratiometric external reference. Single-ended or differential inputs. Trimmed for gain, offset, and linearity.	2807x, 2837xD, 2837xS, 2838x	–
5	12-bit, single-ended mode ONLY; 16-bit, differential mode not applicable.	28002x, 28004x	–

##### 3.3.1.2 Analog-to-Digital Converter (ADC) Wrapper Module

The Analog-to-Digital Converter (ADC) Wrapper module provides control and sequencing of the ADC.

Refer to the device-specific technical reference manual for more information.

[Table 36](#) lists the ADC wrapper types, including device-specific differences within each type.

**Table 36. Analog-to-Digital Converter (ADC) Wrapper Module Type Descriptions**

Type	Description	Devices Covered	Device-Specific Options
0	Original ADC wrapper type. Dual 8-channel sequencer architecture.	280x, 281x, 2801x, 2804x, 2823x, 2833x	–
1	Start-of conversion (SOC) x16 architecture.	2802x, 2803x, 2805x, 2806x	–
2	Modified Type 1 accessed through ACIB.	M35x, M36x	–
3	Modified Type 1. Added burst mode, integrated post-processing blocks.	2807x, 28002x, 28004x 2837xD, 2837xS, 2838x	–

### 3.3.2 Configurable Logic Block (CLB) Module

The Configurable Logic Block (CLB) module is a collection of blocks that can be interconnected using software to implement custom digital logic functions or enhance existing on-chip peripherals. The CLB is able to enhance existing peripherals through a set of crossbar interconnections, which provide a high level of connectivity to existing control peripherals such as enhanced pulse width modulators (ePWM), enhanced capture modules (eCAP), and enhanced quadrature encoder pulse modules (eQEP).

Refer to the device-specific technical reference manual for more information.

Table 37 lists the CLB types, including device-specific differences within each type.

**Table 37. Configurable Logic Block (CLB) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
1	Original CLB module.	2807x, 2837xD, 2837xS	–
2	<ul style="list-style-type: none"> <li>- The CLB Counter module includes a prescaler, shift register/serializer mode.</li> <li>- The CLB module includes an Output Conditioning Block that can gate CLB output signals through combinational logic.</li> <li>- The CLB HLC module can generate events based on both the rising and falling edge of the EVENT signals.</li> <li>- The CLB Tiles have 32 outputs instead of 16 outputs.</li> <li>- The CLB modules can generate NMIs.</li> </ul>	28004x	–
3	<ul style="list-style-type: none"> <li>- The CLB Counter module contains a PIPELINE mode. This allows the add/sub/shift operations, which are triggered by an event, to use the value of the counter in the previous cycle.</li> <li>- The CLB HLC module has access to CLB TILE outputs delayed by one cycle.</li> </ul>	28002x, 2838x	–

### 3.3.3 Comparator (COMP) Module

The Comparator (COMP) module is built around an analog voltage comparator with a digital output that can signal the on-chip ePWM modules when a trip condition is detected. The positive input of the comparator is sourced directly from a device pin. The negative input of the comparator is sourced by a programmable, full-scale internal reference DAC.

Refer to the device-specific technical reference manual for more information.

Table 38 lists the COMP types, including device-specific differences within each type.

**Table 38. Comparator (COMP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original Comparator module. Internal reference DAC has 10-bit resolution. Qualification stage for glitch filtering. Ramp generator logic.	2802x, 2803x, 2806x, M35x, M36x	–
1	Internal reference DAC has 6-bit resolution. Digital filter stage for glitch filtering. No ramp generator logic.	2805x	–



### 3.3.4 Comparator Subsystem (CMPSS) Module

The Comparator Subsystem (CMPSS) module consists of analog comparators and supporting components that are combined into a topology that is useful for power applications such as peak current mode control, switched-mode power, power factor correction and voltage trip monitoring. Each CMPSS module includes two analog comparators, two programmable 12-bit DACs, one ramp generator, and two digital filters. CMPSS has the ability to synchronize with PWMSYNC signals.

Refer to the device-specific technical reference manual for more information.

[Table 39](#) lists the CMPSS types, including device-specific differences within each type.

**Table 39. Comparator Subsystem (CMPSS) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original CMPSS Module Type	F2807x, F2837xD, F2837xS	–
1	Blanking capability added that helps clear and reset the existing/imminent trip conditions near ePWM boundaries. Fixed Trip vs Clear-and-reset arbitration when the RAMP generator is used.	28002x, 28004x, 2838x	–

### 3.3.5 Digital-to-Analog Converter (DAC) Module

The Buffered Digital-to-Analog Converter (DAC) module is able to output arbitrary DC voltages to the device pins.

Refer to the device-specific technical reference manual for more information.

[Table 40](#) lists the DAC types, including device-specific differences within each type.

**Table 40. Digital-to-Analog Converter (DAC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original DAC module. 6-bit programmable range.	2805x	–
1	12-bit programmable range.	2807x, 2837xD, 2837xS, 2838x	–
2	Pull-down register on the output removed: 1x and 2x gain options added; increased load support.	28004x	–

### 3.3.6 Enhanced Capture (eCAP) Module

The Enhanced Capture (eCAP) module is essential in systems where accurate timing of external events is important. Uses for eCAP include:

- Speed measurements of rotating machinery (for example, toothed sprockets sensed via Hall sensors)
- Elapsed time measurements between position sensor triggers
- Period and duty cycle measurements of pulse train signals
- Decoding current or voltage amplitude derived from duty cycle encoded current/voltage sensors

The eCAP guides are:

- [TMS320x280x, 2801x, 2804x Enhanced Capture \(eCAP\) Module Reference Guide](#)
- [TMS320x2834x Enhanced Capture \(eCAP\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 41](#) lists the eCAP types, including device-specific differences within each type.

**Table 41. Enhanced Capture (eCAP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original eCAP Module Type	280x, 2801x	eCAP 1 SYNCIN is fed from the ePWM module. Then all other eCAP modules have their SYNCINs fed from the eCAP module numerically preceding them.
		2802x, 2803x, 2805x, 2806x, 2807x, 2823x, 2833x, 2834x, 2837xD, 2837xS, M35x, M36x	eCAP 1 SYNCIN and eCAP4 SYNCIN are fed from the ePWM module. Then eCAP 2, 3, 5, and 6 SYNCINs are fed from the eCAP modules numerically preceding them.
1	Clears event filter, modulo counter, and any pending interrupt flags. Provides a separate DMA trigger on every capture event. Critical registers are EALLOW protected. High-Resolution capture (HRCAP) capability now an extension of eCAP.	28004x	eCAP-1 to eCAP-5 are normal eCAP. eCAP-6 and eCAP-7 have HRCAP functionality enabled.
2	Sync related enhancements	28002x	eCAP-1 to eCAP-3 are normal eCAP. eCAP-3 has HRCAP functionality enabled.
		2838x	eCAP-1 to eCAP-5 are normal eCAP. eCAP-6 and eCAP-7 have HRCAP functionality enabled.

### 3.3.7 Enhanced Pulse Width Modulator (ePWM) Module

The Enhanced Pulse Width Modulator (ePWM) module controls many of the power-related systems found in both commercial and industrial equipments. The main systems include digital motor control, switch mode power supply control, uninterruptible power supplies (UPS), and other forms of power conversion. The PWM peripheral performs a DAC function, where the duty cycle is equivalent to a DAC analog value; it is sometimes referred to as a Power DAC.

The ePWM guides are:

- [TMS320x280x, 2801x, 2804x Enhanced Pulse Width Modulator \(ePWM\) Module Reference Guide](#)
- [TMS320x2834x Enhanced Pulse Width Modulator \(ePWM\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 42](#) lists the ePWM types, including device-specific differences within each type.

**Table 42. Enhanced Pulse Width Modulator (ePWM) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original ePWM Module Type	280x <sup>(1)</sup> , 2801x	Time-base synchronization scheme 1: ePWM1 SYNC out is fed to eCAP1 and ePWM2. All other ePWM modules have their SYNCIN signals fed from the ePWM module numerically preceding them.
		2804x, 2809	Time-base synchronization scheme 2: Two ePWM pinouts are possible: A-channel only or 280x compatible. If the ePWM pinout is configured for A-channel only mode, ePWM1 SYNC out is fed to eCAP1, ePWM2, ePWM5, ePWM9, and ePWM13. All other ePWM modules have their SYNCIN signals fed from the ePWM module numerically preceding them. If the ePWM pinout is configured for 280x-compatible mode, synchronization scheme 1 is used.
		2823x, 2833x, 28234	Time-base synchronization scheme 3: ePWM1 SYNC out is fed to eCAP1, ePWM2, and ePWM4. All other ePWM modules have their SYNCINs fed from the ePWM module numerically preceding them.
1	Doubled deadband resolution, interrupts and ADC SOC can be generated on both CTR = 0 or CTR = PRD, added digital compare submodule, added hooks for high-resolution period.	2802x, 2803x, 2805x, 2806x	–
2	Expanded Register set, added High-Resolution to Dead-band RED and FED, added Dead-band generator module enhancements, added HRPWM capability to ePWMxB channels, added enhancements to Counter Compare Module, Event Trigger Module, and Digital Compare Module. Supports Simultaneous writes to TBPRD and CMPx Registers, added Shadow to Active Load on SYNC of TBPRD and CMP registers.	M35x, M36x	–
3	This type is not used.	–	–
4	Remapped address space for ease of use, Added Delayed Trip functionality, Dead-band Generator Module enhancements, One shot and Global reload of Registers, Trip Zone Module Enhancements, and PWM SYNC related enhancements.	2807x, 28004x, 2837xD, 2837xS	–
	Enhancements to enable independent PWM action configuration on a CBC and an OST trip event, Changes to enable it to work at the max SYSCLK frequency, Changes to enable a simplified SYNC scheme, Addition of DCA/BEVTs as SYNCOUT sources, One-shot syncout synchronized to one-shot global load of shadow registers, Individual HRPWM module clocked from the respective EPWMxCLK, Separate clock to HRCAL.	28002x, 2838x	–

<sup>(1)</sup> The time-base synchronization scheme 1 is not available in the TMS320F2809 part.

### 3.3.8 Enhanced Quadrature Encoder Pulse (eQEP) Module

The Enhanced Quadrature Encoder Pulse (eQEP) module is used for direct interface with a linear or rotary incremental encoder to get position, direction, and speed information from a rotating machine for use in a high-performance motion and position-control system.

The eQEP module guides are:

- [TMS320x280x, 2801x, 2804x Enhanced Quadrature Encoder Pulse \(eQEP\) Module Reference Guide](#)
- [TMS320x2834x Enhanced Quadrature Encoder Pulse \(eQEP\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 43](#) lists the eQEP types, including device-specific differences within each type.

**Table 43. Enhanced Quadrature Encoder Pulse (eQEP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original eQEP Module Type	280x, 2803x, 2805x, 2806x, 2807x, 2823x, 2833x, 2834x, 2837xD, 2837xS, M35x, M36x	–
1	Addition of QMA (QEP Mode Adapter) Block : - Error detection logic to detect illegal transitions on eQEPA and eQEPB input signals. - xCLKMOD block that looks at transitions on input signals to generate clock signal going into eQEP module. - xDIRMOD block that looks at transitions on input signals to generate direction signal going into eQEP module.	28004x	–
2	Latching Position count on ADCSOC from PWM module. Support for SinCos transducers.	28002x, 2838x	–

### 3.3.9 High-Resolution Capture (HRCAP) Module

The High-Resolution Capture (HRCAP) module captures the width of pulses with a typical resolution of hundreds of picoseconds and performs both conventional and high-resolution delta time measurements.

Uses for the HRCAP include:

- Capacitive touch applications
- High-resolution period and duty cycle measurements of pulse train cycles
- Instantaneous speed measurements
- Instantaneous frequency measurements
- Voltage measurements across an isolation boundary
- Distance/sonar measurement and scanning

Refer to the device-specific technical reference manual for more information.

[Table 44](#) lists the HRCAP types, including device-specific differences within each type.

**Table 44. High-Resolution Capture (HRCAP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original HRCAP Module Type	2803x, 2806x	–
1	Simplified calibration scheme: HRCAP is always functional, never offline, always running calibration on the background which drastically reduces SW overhead to calibrate. Fractional and integer are packed into 32 bits. All eCAP hardware is accessible while using HRCAP.	28004x	eCAP-1 to eCAP-5 are normal eCAP. eCAP-6 and eCAP-7 have HRCAP functionality enabled.
		28002x	eCAP-3 has HRCAP functionality enabled.
	Sync related enhancements	2838x	eCAP-6 and eCAP-7 have HRCAP functionality enabled.

### 3.3.10 High-Resolution Pulse Width Modulator (HRPWM) Module

The High-Resolution Pulse Width Modulator (HRPWM) module extends the time resolution capabilities of the conventionally derived digital pulse width modulator (PWM). HRPWM is typically used when PWM resolution falls below approximately 9-10 bits.

The HRPWM guides are:

- [TMS320x280x, 2801x, 2804x High-Resolution Pulse Width Modulator \(HRPWM\) Module Reference Guide](#)
- [TMS320x2834x High Resolution Pulse Width Modulator \(HRPWM\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

Table 45 lists the HRPWM types, including device-specific differences within each type.

**Table 45. High-Resolution Pulse Width Modulator (HRPWM) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original HRPWM Module Type	280x, 2801x, 2804x, 2823x, 2833x, 2834x	–
1	Added high-resolution period support, added option to select high-resolution B output, added automatic micro-step conversion.	2802x, 2803x, 2806x	–
2	Added independent high-resolution control on B-channel output, added dead band control for falling and rising edge delay, added additional delay lines per ePWM module, added SYNC pulse timings.	M35x, M36x	–
3	This type is not used.	–	–
4	Remapped address space. Added global shadow-to-active reload. Added one-shot shadow-to-active reload.	2807x, 28004x, 2837xD, 2837xS	–
	Clocks to individual HRPWM modules would be hooked up to the respective ePWMs.	28002x, 2838x	–

### 3.3.11 InstaSPIN™ Solutions

InstaSPIN™ three-phase motor solutions make designing motor control applications easier whether you have a simple application or a complex design.

#### 3.3.11.1 InstaSPIN-FOC™

InstaSPIN-FOC™ is a three-phase motor field-oriented torque control solution which can identify, tune the torque controller, and efficiently control your motor in minutes, without the use of any mechanical rotor sensors. It includes the Flux Angle Speed Torque (FAST™) estimator and additional motor control functions needed for cascaded speed and torque loops for efficient three-phase field-oriented motor control. InstaSPIN-FOC is made available in ROM with user callable APIs. The user also has the option of executing all FOC functions in user memory (FLASH or RAM), which then makes calls to the proprietary FAST estimator firmware in ROM.

The device-specific InstaSPIN-FOC™ technical reference manuals are:

- [TMS320F28026F, TMS320F28027F InstaSPIN™-FOC Software Technical Reference Manual](#)
- [TMS320F28069F, TMS320F28068F, TMS320F28062F InstaSPIN™-FOC Software Technical Reference Manual](#)
- [TMS320F28054F, TMS320F28052F InstaSPIN-FOC™ Software Technical Reference Manual](#)
- [InstaSPIN-FOC™ and InstaSPIN-MOTION™ User's Guide](#)

#### 3.3.11.2 InstaSPIN-MOTION™

InstaSPIN-MOTION™ is the first offering from Texas Instruments to combine TI 32-bit C2000™ microcontrollers with comprehensive motor-, motion-, speed-, and position-control software. InstaSPIN-MOTION delivers robust velocity and position control at the highest efficiency for motor applications that operate in various motion state transitions. InstaSPIN-MOTION is a sensorless or sensed field-oriented motor control (FOC) solution that can identify, tune, and control your motor in minutes. InstaSPIN-MOTION features the Flux Angle Speed Torque (FAST™) premium software sensor and the SpinTAC™ Motion controller.

The device-specific InstaSPIN-MOTION™ technical reference manuals are:

- [TMS320F28069M, TMS320F28068M InstaSPIN™-MOTION Software Technical Reference Manual](#)
- [TMS320F28054M, TMS320F28052M InstaSPIN-MOTION™ Software Technical Reference Manual](#)
- [InstaSPIN-FOC™ and InstaSPIN-MOTION™ User's Guide](#)

Table 46 lists the InstaSPIN™ modules, including device-specific differences within each module.

**Table 46. InstaSPIN™ Module Type Description**

Module	Description	Devices	Device-Specific Options
InstaSPIN-FOC	InstaSPIN-FOC ROM	28062F, 28068F, 28069F, 280040C, 280041C, 280048C, 280049C	1 or 2 motors
		28026F, 28027F, 28052F, 28054F	1 motor
InstaSPIN-MOTION	InstaSPIN-MOTION ROM	28052M, 28054M, 28068M, 28069M	–

### 3.3.12 Programmable Gain Amplifier (PGA) Module

The Programmable Gain Amplifier (PGA) module is designed to buffer and amplify small input signals into an output range that is better suited for the on-chip ADC and Comparator modules.

Refer to the device-specific technical reference manual for more information.

[Table 47](#) lists the PGA types, including device-specific differences within each type.

**Table 47. Programmable Gain Amplifier (PGA) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original PGA module	2805x	Programmable gain modes: 3x, 6x, 11x
1	Added gain mode of 24x. Supports Low-Pass Filtering. Features Hardware-based trims to reduce offset and gain errors.	28004x	Programmable gain modes: 3x, 6x, 12x, 24x

### 3.3.13 Sigma Delta Filter Module (SDFM)

The Sigma Delta Filter Module (SDFM) is a four-channel digital filter designed specifically for current measurement and resolver position decoding in motor control applications. Each input channel can receive an independent sigma-delta ( $\Sigma\Delta$ ) modulated bit stream. The bit streams are processed by four individually programmable digital decimation filters. The filter set includes a fast comparator (secondary filter) for immediate digital threshold comparisons for over-current and under-current monitoring, and zeros-crossing detection.

Refer to the device-specific technical reference manual for more information.

[Table 48](#) lists the SDFM types, including device-specific differences within each type.

**Table 48. Sigma Delta Filter (SDFM) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original SDFM Module Type	2807x, 2837xD, 2837xS	–
1	Data filter changes: - Added 16-deep x 32-bit FIFO - Wait for Sync feature - FIFO freeze feature - Type 0 saturation bug resolved - Any PWMx.SOCA/SOCB event can trigger SDSYNC event - Each filter module data acknowledge event can trigger CPU interrupt  Comparator filter changes: - Added zeros threshold comparator - All comparator events MUXed to ECAPxIN signal	28004x	–
2	- SDFM Input Qualification - SDFM Clock Control  Comparator filter changes: - Added additional lower threshold and higher threshold comparators - Digital filter to comparator events	2838x	Supports only Mode 0



### 3.4 Communication Peripherals

The communications peripherals are described in the following sections.

#### 3.4.1 Controller Area Network (DCAN) Module

The Controller Area Network (CAN) is a serial communications protocol that efficiently supports distributed real-time control with a high level of reliability. The DCAN module is compliant with the ISO11898-1 (CAN 2.0B) protocol specification. It supports bit rates up to 1 Mbits/s, programmable FIFO, parity checking, individual identifier masks, and interrupts. This module is similar to the Arm® Cortex®-M3 DCAN module.

**Note:** The DCAN is not software compatible with the C28x eCAN module.

Refer to the device-specific technical reference manual for more information.

[Table 49](#) lists the DCAN types, including device-specific differences within each type.

**Table 49. Controller Area Network (DCAN) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original DCAN Design. Not Software compatible with eCAN	2807x, 28002x, 28004x, 2837xD, 2837xS, 2838x, M35x, M36x	–

#### 3.4.2 Enhanced Controller Area Network (eCAN) Module

The Enhanced Controller Area Network (eCAN) module supports 32 mailboxes, time stamping of messages, and is ISO11898-1 (CAN 2.0B) compliant.

**Note:** The eCAN module is not software compatible with the DCAN module.

The eCAN guides are:

- [TMS320x281x DSP Enhanced Controller Area Network \(eCAN\) Reference Guide](#)
- [TMS320x280x, 2801x DSP Enhanced Controller Area Network \(eCAN\) Reference Guide](#)
- [TMS320x2834x Enhanced Controller Area Network \(eCAN\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 50](#) lists the eCAN types, including device-specific differences within each type.

**Table 50. Enhanced Controller Area Network (eCAN) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original eCAN Module Type	280x, 2801x, 281x, 28016	CAN module clock = SYSCLK
		2803x, 2805x, 2806x, 2823x, 2833x	CAN module clock = SYSCLK/2
		2834x	CAN module clock = SYSCLK/4

### 3.4.3 Ethernet Media Access Controller (EMAC) Module

The Ethernet Media Access Controller (EMAC) module conforms to the IEEE 802.3- 2002 specifications and fully supports 10BASE-T and 100BASE-TX standards. It supports data rates of 10/100Mbps, CRC error-rejection control, user-configurable interrupts, and efficient transfers using the Micro Direct Memory Access Controller.

Refer to the device-specific technical reference manual for more information.

[Table 51](#) lists the EMAC types, including device-specific differences within each type.

**Table 51. Ethernet Media Access Controller (EMAC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original EMAC Module Type	2838x, M35x, M36x	–

### 3.4.4 C28x Inter-Integrated Circuit (I2C) Module

The C28x Inter-Integrated Circuit (I2C) module provides an interface between one of these DSPs and devices compliant with Philips Semiconductors Inter-IC bus (I2C-bus) specification version 2.1 and connected by way of an I2C-bus. External components attached to this 2-wire serial bus can transmit/receive 1- to 8-bit data to/from the DSP through the I2C module. This guide assumes the reader is familiar with the I2C-bus specification.

The C28x I2C guides are:

- [TMS320x280x, 2801x, 2804x Inter-Integrated Circuit \(I2C\) Module Reference Guide](#)
- [TMS320x2834x Inter-Integrated Circuit \(I2C\) Module Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 52](#) lists the C28x I2C types, including device-specific differences within each type.

**Table 52. C28x Inter-Integrated Circuit (I2C) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original C28x I2C Module Type. Not software compatible with M3 I2C.	280x, 2801x, 2804x, 2807x, 2823x, 2833x, 2834x, 2837xD, 2837xS, M35x, M36x	16-level FIFO
		2802x, 2803x, 2805x, 2806x	4-level FIFO
1	Fixed the bug from Type-0 related to timing of XRDY transmit interrupt.	28002x, 28004x, 2838x	16-level FIFO

### 3.4.5 M3 Inter-Integrated Circuit (I2C) Module Type Description

The M3 Inter-Integrated Circuit (I2C) module provides an interface between one of these DSPs and devices compliant with Philips Semiconductors Inter-IC bus (I2C-bus) specification version 2.1 and connected by way of an I2C-bus. External components attached to this 2-wire serial bus can transmit/receive 1- to 8-bit data to/from the DSP through the I2C module. This guide assumes the reader is familiar with the I2C-bus specification.

Refer to the device-specific technical reference manual for more information.

[Table 53](#) lists the M3 I2C types, including device specific differences within each type.

**Table 53. M3 Inter-Integrated Circuit (I2C) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original M3 I2C Module Type. Not software compatible with C28x I2C.	M35x, M36x	–

### 3.4.6 Local Interconnect Network (LIN) Module

The Local Interconnect Network (LIN) module provides a serial communications structure at a hardware and software level. It provides a low-cost solution where the bandwidth and fault tolerance of a Controller Area Network (CAN) are not required. The Type 0 LIN module is compliant to the LIN1.3 and 2.0 protocols. The Type 1 is compliant to 2.1.

Refer to the device-specific technical reference manual for more information.

[Table 54](#) lists the LIN types, including device-specific differences within each type.

**Table 54. Local Interconnect Network (LIN) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original LIN Module Type	2803x	–
1	Compliant to the LIN 2.1 protocol specifications.	28002x, 28004x	–

### 3.4.7 Multichannel Buffered Serial Port (McBSP) Module

The Multichannel Buffered Serial Port (McBSP) module is used to connect to E1/T1 lines, phone-quality codecs for modem applications or high-quality stereo-quality Audio DAC devices. The McBSP receive and transmit registers are supported by a 16-level FIFO. This significantly reduces the overhead for servicing this peripheral.

The McBSP guides are:

- [TMS320x281x Multichannel Buffered Serial Port \(McBSP\) Reference Guide](#)
- [TMS320x2834x Multichannel Buffered Serial Port \(McBSP\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 55](#) lists the McBSP types, including device-specific differences within each type.

**Table 55. Multichannel Buffered Serial Port (McBSP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original McBSP Module Type	281x	–
1	Removed FIFO to allow interconnect with DMA module. Removed FIFO-related registers (MFFTX, MFFRX, MFFCT, MFFST).	2806x, 2807x, 2823x, 2833x, 2834x, 2837xD, 2837xS, 2838x, M35x, M36x	–

### 3.4.8 Serial Communications Interface (SCI) Module

The Serial Communications Interface (SCI) module is a two-wire asynchronous serial port, commonly known as UART. The SCI supports a receive and transmit FIFO for reducing servicing overhead.

The SCI guides are:

- [TMS320x281x Serial Communications Interface \(SCI\) Reference Guide](#)
- [TMS320x280x, 2801x, 2804x Serial Communications Interface \(SCI\) Reference Guide](#)
- [TMS320x2834x Serial Communications Interface \(SCI\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 56](#) lists the SCI types, including device-specific differences within each type.

**Table 56. Serial Communications Interface (SCI) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original SCI Module Type	280x, 281x, 2801x, 2804x, 2807x, 28002x, 28004x, 2823x, 2833x, 2834x, 2837xD, 2837xS, 2838x, M35x, M36x	16-level FIFO
		2802x, 2803x, 2805x, 2806x	4-level FIFO

### 3.4.9 Serial Peripheral Interface (SPI) Module

The Serial Peripheral Interface (SPI) module is a high-speed, synchronous serial I/O port that allows a serial bit stream of programmed length (one to sixteen bits) to be shifted into and out of the device at a programmable bit-transfer rate. Normally, the SPI is used for communications between the DSP controller and external peripherals or another processor. Typical applications include external I/O or peripheral expansion through devices such as shift registers, display drivers, and ADCs. Multi-device communications are supported by the master/slave operation of the SPI. The port supports a receive and transmit FIFO for reducing servicing overhead.

The SPI guides are:

- [TMS320x281x Serial Peripheral Interface \(SPI\) Reference Guide](#)
- [TMS320x280, 2801x, 2804x Serial Peripheral Interface \(SPI\) Reference Guide](#)
- [TMS320x2834x Serial Peripheral Interface \(SPI\) Reference Guide](#)

For devices not listed above, refer to the device-specific technical reference manual.

[Table 57](#) lists the SPI types, including device-specific differences within each type.

**Table 57. Serial Peripheral Interface (SPI) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original SPI Module Type	280x, 281x, 2801x, 2804x, 2823x, 2833x, 2834x, M35x, M36x	–
1	Added support for 3-wire bidirectional mode and reduced to 4-level FIFO.	2802x	No STEINV bit
		2803x, 2805x, 2806x	Added STEINV bit (inverts SPISTE signal to support digital audio receive mode with 2 SPIs).
2	Type 1 with STEINV. Added high-speed mode. Added DMA support; increased to 16-level FIFO.	2807x, 28004x, 2837xD, 2837xS	–
	Support for custom CLB interface to update RXBUF.	28002x, 2838x	–

### 3.4.10 Synchronous Serial Interface (SSI) Module

The Synchronous Serial Interface (SSI) module is a synchronous serial I/O port that supports communication with peripheral devices that have Texas Instruments Synchronous Serial Interfaces, SPI, or Freescale serial formats. This module supports master or slave operation, programmable clock bit rates, 16-bit and 8-deep transmit and receive FIFOs, interrupts, and  $\mu$ DMA access.

Refer to the device-specific technical reference manual for more information.

[Table 58](#) lists the SSI types, including device-specific differences within each type.

**Table 58. Synchronous Serial Interface (SSI) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original SSI Module Type	2838x, M35x, M36x	–

### 3.4.11 Universal Asynchronous Receiver/Transmitter (UART) Module

The Universal Asynchronous Receiver/Transmitter (UART) module is a serial communication port that supports programmable baud-rate generation, 16/8 TX and RX FIFOS, serial-to-parallel and parallel-to-serial conversions,  $\mu$ DMA access, and interrupts.

Refer to the device-specific technical reference manual for more information.

[Table 59](#) lists the UART types, including device-specific differences within each type.

**Table 59. Universal Asynchronous Receiver/Transmitter (UART) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original UART Module Type	2838x, M35x, M36x	–

### 3.4.12 Universal Parallel Port (uPP) Module

The Universal Parallel Port (uPP) module is a high-speed parallel interface with dedicated data lines and minimal control signals. The uPP is designed to interface with high-speed ADCs, DACs, FPGAs, or other uPP devices. The supports single channel 8-bit input or output as well as 50MHz SDR and 25MHz DDR interface clock frequencies.

Refer to the device-specific technical reference manual for more information.

[Table 60](#) lists the uPP types, including device specific differences within each type.

**Table 60. Universal Parallel Port (uPP) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original uPP Module Type	2837xD, 2837xS	–

### 3.4.13 Universal Serial Bus (USB) Module

The Universal Serial Port (USB) module is a USB 2.0 compliant USB Controller and PHY. The USB supports full speed operation as a device and both low- and full-speed in host operating modes. TI provides drivers for the USB controller as well as a protocol stack free of charge in our [controlSUITE™](#) software package. Both the USB controller and its corresponding software package are very similar to that of the Stellaris® family of microcontrollers, so migration of USB applications between the two platforms requires minimal effort.

Refer to the device-specific technical reference manual for more information.

[Table 61](#) lists the USB types, including device specific differences within each type.

**Table 61. Universal Serial Bus (USB) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original USB Module Type	2806x <sup>(1)</sup> , 2807x, 2837xD, 2837xS	No USB-OTG support
		M35x, M36x	USB-OTG supported
	Global interrupt enable, flag and clear registers added.	2838x	No USB-OTG support

<sup>(1)</sup> Original USB module type is only available on devices with TMS320F2806xU, TMS320F2806xF, and TMS320F2806xM part numbers.

### 3.4.14 Fast Serial Interface (FSI) Module

The Fast Serial Interface (FSI) module is a serial communication peripheral capable of reliable, high-speed communication across isolation devices. Galvanic isolation devices are used in situations where two different electronic circuits, which do not have common power and ground connections, must exchange information. Though isolation devices facilitate these signal communications, they can also introduce a large delay on the signal lines and add skew between the signals. The FSI is designed specifically to ensure reliable high-speed communication for system scenarios that involve communication across isolation barriers without adding components.

Refer to the device-specific technical reference manual for more information.

[Table 62](#) lists the FSI types, including device-specific differences with each type.

**Table 62. Fast Serial Interface (FSI) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original FSI Module Type	28004x	–
1	Enhanced to feed TDM_IN port on to TX port controlled by a CLB output. Added tag match notification scheme.	28002x, 2838x	–

### 3.4.15 Power Management Bus (PMBus) Module

The Power Management Bus (PMBus) module provides an interface between the microcontroller and devices compliant with the SMI Forum PMBus Specification Part I version 1.0 and Part II version 1.1 PMBus is based on SMBus, which uses a similar physical layer to I2C.

Refer to the device-specific technical reference manual for more information.

[Table 63](#) lists the PMBus types, including device-specific differences with each type.

**Table 63. Power Management Bus (PMBus) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original PMBus Module Type	28002x, 28004x, 2838x	–

### 3.4.16 EtherCAT® Slave Controller (ESC) Module

Ethernet for Control Automation Technology (EtherCAT®) is an Ethernet-based fieldbus system, invented by Beckhoff Automation and is standardized in IEC 61158. All the slave nodes connected to the bus interpret, process, and modify the data addressed to them in progress, without having to buffer the frame inside the node.

The frames are directly forwarded with minimum additional delay. This real-time behavior, frame processing and forwarding requirements are implemented by the EtherCAT® slave controller hardware. EtherCAT® does not require software interaction for data transmission inside the slaves. EtherCAT® only defines the MAC layer while the higher layer protocols and stack are implemented in software on the microcontrollers connected to the ESC.

Refer to the device-specific technical reference manual for more information.

[Table 64](#) lists the ESC types, including device-specific differences within each type.

**Table 64. EtherCAT® Slave Controller (ESC) Module Type Description**

Type	Description	Devices Covered	Device-Specific Options
0	Original ECAT Module Type	2838x	–



## Revision History

Changes from March 30, 2018 to May 19, 2020 (from M Revision (March 2018) to N Revision)	Page
• Added TMS320x2823x to <a href="#">Section 1</a> .....	5
• Added Trademark section .....	5
• Added TMS320F28076 to <a href="#">Table 1</a> .....	6
• Added TMS320F28002x family to <a href="#">Table 1</a> .....	6
• Added TMS320F2838x family to <a href="#">Table 1</a> .....	6
• <a href="#">Section 2</a> has been reordered. Review the entire section for your specific device. ....	9
• Changed Lit No. column to SPRUI09 in <a href="#">Table 4</a> .....	10
• Changed InstaSPIN-FOC literature number to SPRUJ1 in <a href="#">Table 4</a> .....	10
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 4</a> .....	10
• Changed Lit No. column to SPRUI10 in <a href="#">Table 5</a> .....	10
• Added 28031, 28030 column in <a href="#">Table 5</a> .....	10
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 5</a> .....	10
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 7</a> .....	11
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 8</a> .....	12
• Added 28076 column and deleted 28074 in <a href="#">Table 9</a> .....	13
• Added Configurable Logic Block (CLB) in <a href="#">Table 9</a> .....	13
• Changed High-Resolution Pulse-Width Modulator (HRPWM) type to 4 in <a href="#">Table 9</a> .....	13
• Changed Controller Area Network (CAN) type to 0 in <a href="#">Table 9</a> .....	13
• Added <a href="#">Section 2.9</a> , TMS320F28002x Peripherals .....	14
• Changed Analog-to-Digital Converter (ADC) type to 5 in <a href="#">Table 11</a> .....	15
• Added Embedded Real-time Analysis and Diagnostic (ERAD) in <a href="#">Table 11</a> .....	15
• Added InstaSPIN-FOC literature number in <a href="#">Table 11</a> .....	15
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• Changed High-Resolution Pulse-Width Modulator (HRPWM) type to 4 in <a href="#">Table 16</a> .....	20
• Changed Controller Area Network (CAN) type to 0 in <a href="#">Table 16</a> .....	20
• Added Configurable Logic Block (CLB) in <a href="#">Table 16</a> .....	20
• Added <a href="#">Section 2.16</a> , TMS320F2838x Peripherals .....	21
• Changed M3 Inter-Integrated Circuit (I2C) type to 0 in <a href="#">Table 18</a> .....	22
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 18</a> .....	22
• Changed M3 Inter-Integrated Circuit (I2C) and Serial Peripheral Interface (SPI) type to 0 in <a href="#">Table 19</a> .....	23
• Added footnote to Analog-to-Digital Converter (ADC) in <a href="#">Table 19</a> .....	23
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• Changed second paragraph in <a href="#">Section 3.1.5</a> .....	26
• Changed Type 1 row and Description in <a href="#">Table 24</a> .....	26
• Deleted TMS320x2833x, 2823x Boot ROM Reference Guide (SPRU963), TMS320x2802x Piccolo Boot ROM Reference Guide (SPRUFN6), and TMS320x2803x Piccolo Boot ROM Reference Guide (SPRUGO0) in <a href="#">Section 3.2.1</a> .....	27



• Deleted TMS320x2833x, 2823x Direct Memory Access (DMA) Module Reference Guide (SPRUFB8) in <a href="#">Section 3.2.2</a> .	27
• Added 28002x, 2838x in <a href="#">Table 25</a> .....	27
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• Deleted TMS320x2833x System Control and Interrupts Reference Guide (SPRUFB0), TMS320x2802x Piccolo System Control and Interrupts Reference Guide (SPRUFN3), and TMS320x2803x Piccolo System Control and Interrupts Reference Guide (SPRUGL8) in <a href="#">Section 3.2.8</a> .....	29
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• Deleted TMS320x2833x, 2823x Analog-to-Digital Controller (ADC) Module Reference Guide (SPRU812) in <a href="#">Section 3.3.1</a> .....	31
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