

TMS320x28xx, 28xxx DSP Peripheral Reference Guide

Reference Guide

Literature Number: SPRU566D
June 2003–Revised October 2006



Contents

1	Abbreviations	5
2	Peripherals Available Per Device	6
3	Peripheral Descriptions	8
3.1	System Control and Interrupts (281x: SPRU078 and 280x, 2801x, and 2804x: SPRU712)	8
3.2	TMS320x281x External Interface (XINTF) (SPRU067)	8
3.3	TMS320x28xx, 28xxx Enhanced Controller Area Network (eCAN) (SPRU074)	9
3.4	TMS320x281x Event Manager (EV) (SPRU065)	9
3.5	Analog-to-Digital Converter (ADC) (281x: SPRU060 and 280x, 2801x, and 2804x: SPRU716)	9
3.6	TMS320x281x Multichannel Buffered Serial Port (McBSP) (SPRU061)	9
3.7	TMS320x28xx, 28xxx Serial Communications Interface (SCI) (SPRU051)	9
3.8	TMS320x28xx, 28xxx Serial Peripheral Interface (SPI) (SPRU059)	9
3.9	Boot ROM (281x: SPRU095 and 280x, 2801x, and 2804x: SPRU722)	9
3.10	TMS320x28xx, 28xxx Inter-Integrated Circuit (I2C) (SPRU721)	9
3.11	TMS320x28xx, 28xxx Enhanced Quadrature Encoder Pulse (eQEP) Module (SPRU790)	10
3.12	TMS320x28xx, 28xxx Enhanced Capture (eCAP) Module (SPRU807)	10
3.13	TMS320x28xx, 28xxx Enhanced PWM (ePWM) Module (SPRU791)	10
3.14	TMS320x28xx 280xxx High Resolution PWM (HRPWM) Module (SPRU924)	10
Appendix A	Revision History	11
A.1	Changes Made in This Revision	11

List of Tables

1	Peripheral Selection Guide	7
---	----------------------------------	---

TMS320x28xx, 28xxx DSP Peripherals

This overview guide describes all the peripherals available for TMS320x28xx and TMS320x28xxx devices. [Table 1](#) shows the peripherals used by each device. You can download the peripheral guide by clicking on the literature number, which is linked to the portable document format (pdf) file.

Note: The Event Manager (281x only) and the SCI and SPI peripherals include enhanced features. Otherwise, these peripherals are identical to those available on the 240x devices. See the respective documents for details.

1 Abbreviations

Throughout this document and other peripheral guides, the following abbreviations are used:

- **TMS320x28xx** refers to TMS320x281x and TMS320x280x devices
- **TMS320x28xxx** refers to TMS320x2801x and TMS320x2804x devices.
- **TMS320x281x Devices:**
 - TMS320F2810, TMS320F2811, and TMS320F2812 are abbreviated as F2810, F2811, and F2812, respectively. F281x denotes all three flash devices.
 - TMS320C2810, TMS320C2811, and TMS320C2812 are abbreviated as C2810, C2811, and C2812, respectively. C281x denotes all three ROM devices.
 - TMS320R2811 and TMS320R2812 are abbreviated as R2811 and R2812, respectively. R281x denotes both RAM only devices.
 - 2810 denotes both F2810 and C2810 devices; 2811 denotes F2811, C2811, and R2811 devices; and 2812 denotes F2812, C2812 and R2812 devices.
 - Collectively these devices are known as TMS320x281x or 281x.
- **SM320x28xx-EP Devices**
 - SM320F2808-EP is abbreviated as F2808-EP.
 - SM320F2810-EP, SM320F2811-EP, SM320F2812-EP, SM320C2810-EP, SM320C2811-EP, and SM320C2812-EP military devices are abbreviated as F2810-EP, F2811-EP, F2812-EP, C2810-EP, C2811-EP, and C2812-EP, respectively.
- **TMS320x280x Devices:**
 - TMS320F2801, TMS320F2802, TMS320F2806, TMS320F2808, and TMS320F2809 are abbreviated as F2801, F2802, F2806, F2808, and F2809, respectively. F280x denotes all five flash devices.
 - TMS320C2801 and TMS320C2802 are abbreviated as C2801 and C2802, respectively. C280x denotes both ROM devices.
 - UCD9501 is abbreviated as 9501.
 - 2801 denotes both F2801 and C2801 devices; 2802 denotes F2802, C2802 devices.
 - Collectively these devices are known as TMS320x280x or 280x.
- **TMS320x2801x Devices:**
 - TMS320F28015 and TMS320F28016 are abbreviated as F28015 and F28016.
 - 2801x denotes both devices

- **TMS320x2804x Devices:**
 - TMS320F28044 is abbreviated as 2804x

2 Peripherals Available Per Device

[Table 1](#) shows the peripherals that are available for each of the 28xx, 28xxx devices.

Table 1. Peripheral Selection Guide

Peripheral	Lit. No.	2812	2811 2810	2801, 9501 2802, 2806 2808, 2809	2801x	2804x
TMS320x281x System Control and Interrupts	SPRU078	X	X			
TMS320x280x, 2801x, 2804x System Control and Interrupts	SPRU712			X	X	X
TMS320x281x External Interface (XINTF)	SPRU067	X				
TMS320x28xx, 28xxx Enhanced Controller Area Network (eCAN)	SPRU074	X	X	X	X	X
TMS320x281x Event Manager (EV)	SPRU065	X	X			
TMS320x281x Analog-to-Digital Converter (ADC)	SPRU060	X	X			
TMS320x280x, 2801x, 2804x Analog-to-Digital Converter (ADC)	SPRU716			X	X	X
TMS320x281x Multichannel Buffered Serial Port (McBSP)	SPRU061	X	X			
TMS320x28xx, 28xxx Serial Communications Interface (SCI)	SPRU051	X	X	X	X	X
TMS320x28xx, 28xxx Serial Peripheral Interface (SPI)	SPRU059	X	X	X	X	X
TMS320x281x Boot ROM	SPRU095	X	X			
TMS320x280x, 2801x, 2804x Boot ROM	SPRU722			X	X	X
TMS320x28xx, 28xxx Enhanced Quadrature Encoder Pulse (eQEP)	SPRU790			X	X	X
TMS320x28xx, 28xxx Enhanced Pulse Width Modulator (ePWM) Module	SPRU791			X	X	X
TMS320x28xx, 28xxx Enhanced Capture (eCAP) Module	SPRU807			X	X	X
TMS320x28xx, 28xxx Inter-Integrated Circuit (I2C)	SPRU721			X	X	X
TMS320x28xx. 28xxx High-Resolution Pulse-Width Modulator (HRPWM)	SPRU924			X	X	X

3 Peripheral Descriptions

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

3.1 System Control and Interrupts (281x: [SPRU078](#) and 280x, 2801x, and 2804x: [SPRU712](#))

The *TMS320x281x System Control and Interrupts Peripheral Guide* ([SPRU078](#)) and the *TMS320x280x, 2801x, and 2804x System Control and Interrupts Peripheral Guide* ([SPRU712](#)) include information on the following modules:

- **Memory, including Flash and OTP configuration**
- **Code security module (CSM)**
Security is defined with respect to the access of the on-chip program memory and prevents unauthorized copying of proprietary code. The code security module (CSM) blocks access to several on-chip program memory blocks.
- **Clocking and Low-Power Modes**
The clocks to each individual peripheral can be enabled/disabled so as to reduce power consumption when a peripheral is not in use. Additionally, the system clock to the serial ports and the event managers, CAP and QEP blocks can be scaled relative to the CPU clock. This enables the timing of peripherals to be decoupled from increasing CPU clock speeds.
- **32-bit CPU-Timers**
CPU-Timers 0, 1, and 2 are identical 32-bit timers with presetable periods and with 16-bit clock prescaling. The timers have a 32-bit count down register, which generates an interrupt when the counter reaches zero. The counter is decremented at the CPU clock speed divided by the prescale value setting. When the counter reaches zero, it is automatically reloaded with a 32-bit period value. CPU-Timers 1 and 2 are reserved for Real-Time OS (RTOS) applications. CPU-Timer 2 is connected to INT14 of the CPU. CPU-Timer 1 can be connected to INT13 of the CPU. CPU-Timer 0 is for general use and is connected to the PIE block.
- **Watchdog Timer**
The 28x devices support a watchdog timer. The user software must regularly reset the watchdog counter within a certain time frame; otherwise, the watchdog generates a reset to the processor. The watchdog can be disabled if necessary.
- **General-purpose inputs/outputs (GPIO)**
Most of the peripheral signals are multiplexed with general-purpose I/O (GPIO) signals. This enables you to use a pin as GPIO if the peripheral signal or function is not used. On reset, all GPIO pins are configured as inputs. You can then individually program each pin for GPIO mode or peripheral signal mode. For specific inputs, you can also select the number of input qualification cycles to filter unwanted noise glitches.
- **Peripheral frames**
The 28x devices contain three peripheral register spaces. Some registers within these frames can be protected from CPU writes by the EALLOW protection mechanism.
- **Peripheral interrupt expansion (PIE)**
The PIE block multiplexes numerous interrupt sources into a smaller set of interrupt inputs. The interrupts are grouped into blocks of eight and each group is fed into one of 12 CPU interrupt lines (INT1 to INT12). Each of the 96 interrupts is supported by its own vector stored in a dedicated RAM block that can be overwritten by the user. The vector is automatically fetched by the CPU on servicing the interrupt. It takes nine CPU clock cycles to fetch the vector and save critical CPU registers. Therefore, the CPU can respond quickly to interrupt events. Prioritization of interrupts is controlled in hardware and software. Each individual interrupt can be enabled/disabled within the PIE block.
- **External Interrupts**

3.2 TMS320x281x External Interface (XINTF) ([SPRU067](#))

The external interface (XINTF) on the 2812 device is a nonmultiplexed asynchronous bus that is used to interface to external devices and memory.

3.3 TMS320x28xx, 28xxx Enhanced Controller Area Network (eCAN) ([SPRU074](#))

This is the enhanced version of the CAN peripheral. It supports 32 mailboxes, time stamping of messages, and is CAN 2.0B-compliant.

3.4 TMS320x281x Event Manager (EV) ([SPRU065](#))

The event manager 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).

3.5 Analog-to-Digital Converter (ADC) (281x: [SPRU060](#) and 280x, 2801x, and 2804x: [SPRU716](#))

The ADC block is a 12-bit converter, single ended, 16-channels. It contains two sample-and-hold units for simultaneous sampling. See the *TMS320x281x Analog-to-Digital Converter (ADC) Reference Guide* (literature number [SPRU060](#)) or the *TMS320x280x, 2801x, 2804x Analog-to-Digital Converter (ADC) Reference Guide* (literature number [SPRU716](#)) for details on how to use the ADC for your device.

3.6 TMS320x281x Multichannel Buffered Serial Port (McBSP) ([SPRU061](#))

The McBSP 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.

3.7 TMS320x28xx, 28xxx Serial Communications Interface (SCI) ([SPRU051](#))

The SCI is a two-wire asynchronous serial port, commonly known as UART. The SCI supports a 16-level, receive and transmit FIFO for reducing servicing overhead.

3.8 TMS320x28xx, 28xxx Serial Peripheral Interface (SPI) ([SPRU059](#))

The SPI 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 16-level, receive and transmit FIFO for reducing servicing overhead.

3.9 Boot ROM (281x: [SPRU095](#) and 280x, 2801x, and 2804x: [SPRU722](#))

The boot ROM is factory-programmable with boot-loading 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. See the *TMS320x281x Boot ROM Reference Guide* (literature number [SPRU095](#)) or the *TMS320x280x, 2801x, 2804x Boot ROM Reference Guide* ([SPRU722](#)) for details.

3.10 TMS320x28xx, 28xxx Inter-Integrated Circuit (I2C) ([SPRU721](#))

This guide describes the features and operation of the inter-integrated circuit (I2C) module. The 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 280x DSP through the I2C module. This guide assumes the reader is familiar with the I2C-bus specification.

3.11 TMS320x28xx, 28xxx Enhanced Quadrature Encoder Pulse (eQEP) Module ([SPRU790](#))

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.

3.12 TMS320x28xx, 28xxx Enhanced Capture (eCAP) Module ([SPRU807](#))

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 (e.g., 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

3.13 TMS320x28xx, 28xxx Enhanced PWM (ePWM) Module ([SPRU791](#))

The enhanced pulse width modulator (ePWM) peripheral 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.

3.14 TMS320x28xx 280xxx High Resolution PWM (HRPWM) Module ([SPRU924](#))

This document is used in conjunction with the *TMS320x28xx, 28xxx Enhanced Pulse Width Modulator (ePWM) Module Reference Guide* literature number ([SPRU791](#).)

The 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 ~ 9-10 bits. This occurs at PWM frequencies greater than ~200 kHz when using a CPU/system clock of 100 MHz.

Appendix A Revision History

This document was revised to SPRU566D from SPRU566C. The scope of the revisions was limited to technical changes as described in Section A.1. This appendix lists only revisions made in the most recent version.

A.1 *Changes Made in This Revision*

The following changes were made in this revision:

Global	Added the TMS320x2801x and 2804x devices
	Changed all the peripheral guide titles to include new devices

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
Low Power Wireless	www.ti.com/lpw	Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265