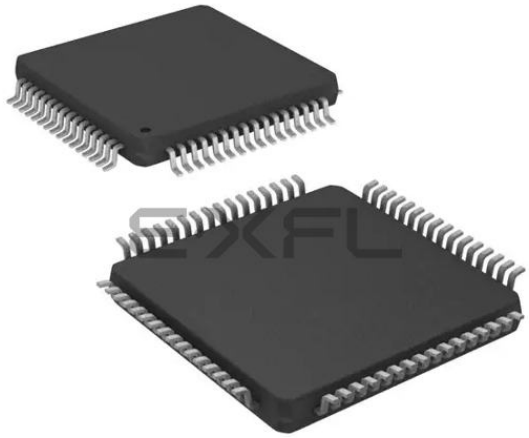
Microchip Technology - DSPIC33CK256MP506-I/PT Datasheet



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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	100MHz
Connectivity	CANbus, I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, Motor Control PWM, POR, PWM, QEI, WDT
Number of I/O	53
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	24K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 20x12b; D/A 3x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-TQFP
Supplier Device Package	64-TQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ck256mp506-i-pt

TABLE 2: dsPIC33CK256MP508 FAMILY WITHOUT CAN FD

Product Pins	Pins	Flash	Data RAM	ADC Module	ADC Channels	Timers	MCCP/SCCP	CAN FD	DMA Channels	SENT	UART	SPI	I^2C	QEI	CLC	PTG	CRC	PWM (High Speed)	Analog Comparators	12-Bit DAC	Op Amp	PMP	REFO Clock
dsPIC33CK256MP208	80	256K	24K	3	24	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK256MP206	64	256K	24K	3	20	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK256MP205	48	256K	24K	3	19	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK256MP203	36	256K	24K	3	16	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK256MP202	28	256K	24K	3	12	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	2	0	1
dsPIC33CK128MP208	80	128K	16K	3	24	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK128MP206	64	128K	16K	3	20	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK128MP205	48	128K	16K	3	19	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK128MP203	36	128K	16K	3	16	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK128MP202	28	128K	16K	3	12	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	2	0	1
dsPIC33CK64MP208	80	64k	8k	3	24	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK64MP206	64	64k	8k	3	20	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK64MP205	48	64k	8k	3	19	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK64MP203	36	64k	8k	3	16	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK64MP202	28	64k	8k	3	12	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	2	0	1
dsPIC33CK32MP206	64	32k	8k	3	20	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	1	1
dsPIC33CK32MP205	48	32k	8k	3	19	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK32MP203	36	32k	8k	3	16	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	3	0	1
dsPIC33CK32MP202	28	32k	8k	3	12	1	1/8	0	4	2	3	3	3	2	4	1	1	8	3	3	2	0	1

REGISTER 12-22: PGxLEBH: PWM GENERATOR x LEADING-EDGE BLANKING REGISTER HIGH

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	PWMPCI2(1)	PWMPCI1(1)	PWMPCI0(1)
bit 15							bit 8

U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	—	PHR	PHF	PLR	PLF
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-11 **Unimplemented:** Read as '0'

bit 10-8 **PWMPCI<2:0>:** PWM Source for PCI Selection bits(1)

111 = PWM Generator #8 output is made available to PCI logic
110 = PWM Generator #7 output is made available to PCI logic
101 = PWM Generator #6 output is made available to PCI logic
100 = PWM Generator #5 output is made available to PCI logic
011 = PWM Generator #4 output is made available to PCI logic
010 = PWM Generator #3 output is made available to PCI logic
001 = PWM Generator #2 output is made available to PCI logic
000 = PWM Generator #1 output is made available to PCI logic

bit 7-4 **Unimplemented:** Read as '0'

bit 3 **PHR:** PWMxH Rising Edge Trigger Enable bit

1 = Rising edge of PWMxH will trigger the LEB duration counter
0 = LEB ignores the rising edge of PWMxH

bit 2 **PHF:** PWMxH Falling Edge Trigger Enable bit

1 = Falling edge of PWMxH will trigger the LEB duration counter
0 = LEB ignores the falling edge of PWMxH

bit 1 **PLR:** PWMxL Rising Edge Trigger Enable bit

1 = Rising edge of PWMxL will trigger the LEB duration counter
0 = LEB ignores the rising edge of PWMxL

bit 0 **PLF:** PWMxL Falling Edge Trigger Enable bit

1 = Falling edge of PWMxL will trigger the LEB duration counter
0 = LEB ignores the falling edge of PWMxL

Note 1: The selected PWM Generator source does not affect the LEB counter. This source can be optionally used as a PCI input, PCI qualifier, PCI terminator or PCI terminator qualifier (see the description in Register 12-19 and Register 12-20 for more information).

REGISTER 13-21: ADMOD1L: ADC INPUT MODE CONTROL REGISTER 1 LOW

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
DIFF23	SIGN23	DIFF22	SIGN22	DIFF21	SIGN21	DIFF20	SIGN20
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
DIFF19	SIGN19	DIFF18	SIGN18	DIFF17	SIGN17	DIFF16	SIGN16
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 through bit 1 (odd) **DIFF<23:16>:** Differential-Mode for Corresponding Analog Inputs bits
1 = Channel is differential
0 = Channel is single-ended

bit 14 through bit 0 (even) **SIGN<23:16>:** Output Data Sign for Corresponding Analog Inputs bits
1 = Channel output data is signed
0 = Channel output data is unsigned

REGISTER 13-22: ADMOD1H: ADC INPUT MODE CONTROL REGISTER 1 HIGH

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

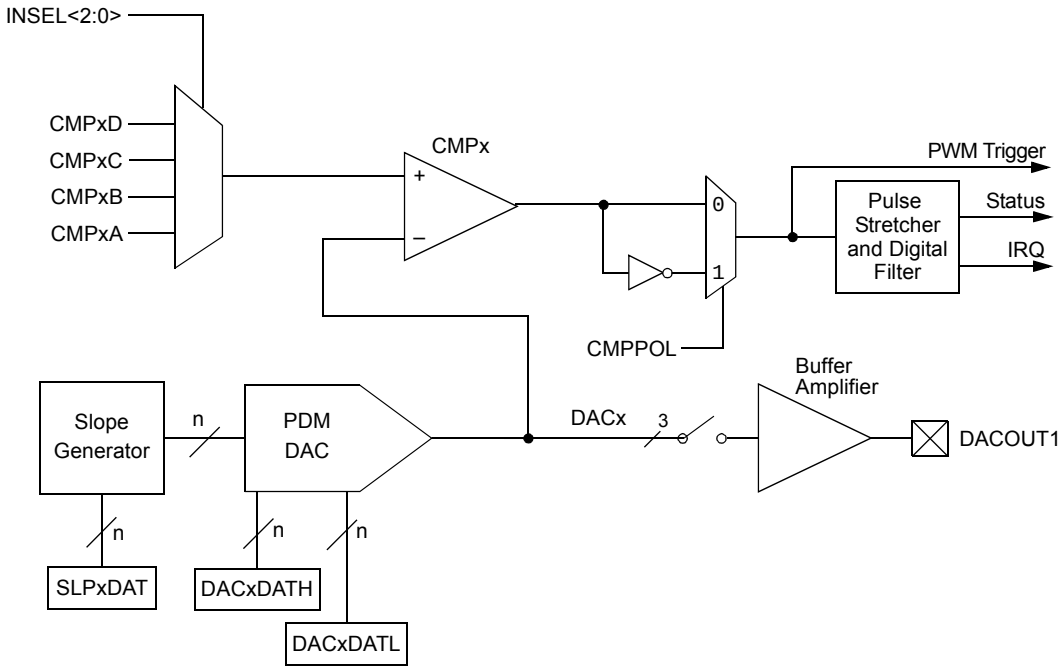
U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	—	DIFF25	SIGN25	DIFF24	SIGN24
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 3 through bit 1 (odd) **DIFF<25:24>:** Differential-Mode for Corresponding Analog Inputs bits
1 = Channel is differential
0 = Channel is single-ended

bit 2 through bit 0 (even) **SIGN<25:24>:** Output Data Sign for Corresponding Analog Inputs bits
1 = Channel output data is signed
0 = Channel output data is unsigned

FIGURE 14-1: HIGH-SPEED ANALOG COMPARATOR MODULE BLOCK DIAGRAM



Note: n = 16

REGISTER 15-2: QEIxIOC: QEIx I/O CONTROL REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
QCAPEN	FLTREN	QFDIV2	QFDIV1	QFDIV0	OUTFNC1	OUTFNC0	SWPAB
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R-x	R-x	R-x	R-x
HOMPOL	IDXPOL	QEBPOL	QEAPOL	HOME	INDEX	QEB	QEA
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **QCAPEN:** QEIx Position Counter Input Capture Enable bit
1 = HOMEx input event (positive edge) triggers a position capture event (HCAPEN must be cleared)
0 = HOMEx input event (positive edge) does not trigger a position capture event

bit 14 **FLTREN:** QEAx/QEBx/INDXx/HOMEx Digital Filter Enable bit
1 = Input pin digital filter is enabled
0 = Input pin digital filter is disabled (bypassed)

bit 13-11 **QFDIV<2:0>:** QEAx/QEBx/INDXx/HOMEx Digital Input Filter Clock Divide Select bits
111 = 1:256 clock divide
110 = 1:64 clock divide
101 = 1:32 clock divide
100 = 1:16 clock divide
011 = 1:8 clock divide
010 = 1:4 clock divide
001 = 1:2 clock divide
000 = 1:1 clock divide

bit 10-9 **OUTFNC<1:0>:** QEIx Module Output Function Mode Select bits
11 = The CNTCMPx pin goes high when POSxCNT ≤ QEIxLEC or POSxCNT ≥ QEIxGEC
10 = The CNTCMPx pin goes high when POSxCNT ≤ QEIxLEC
01 = The CNTCMPx pin goes high when POSxCNT ≥ QEIxGEC
00 = Output is disabled

bit 8 **SWPAB:** Swap QEAx and QEBx Inputs bit
1 = QEAx and QEBx are swapped prior to Quadrature Decoder logic
0 = QEAx and QEBx are not swapped

bit 7 **HOMPOL:** HOMEx Input Polarity Select bit
1 = Input is inverted
0 = Input is not inverted

bit 6 **IDXPOL:** INDXx Input Polarity Select bit
1 = Input is inverted
0 = Input is not inverted

bit 5 **QEBPOL:** QEBx Input Polarity Select bit
1 = Input is inverted
0 = Input is not inverted

bit 4 **QEAPOL:** QEAx Input Polarity Select bit
1 = Input is inverted
0 = Input is not inverted

bit 3 **HOME:** Status of HOMEx Input Pin After Polarity Control bit (read-only)
1 = Pin is at logic '1' if the HOMPOL bit is set to '0'; pin is at logic '0' if the HOMPOL bit is set to '1'
0 = Pin is at logic '0' if the HOMPOL bit is set to '0'; pin is at logic '1' if the HOMPOL bit is set to '1'

REGISTER 15-4: QEIxSTAT: QEIx STATUS REGISTER

U-0	U-0	R/C-0, HS	R/W-0	R/C-0, HS	R/W-0	R/C-0, HS	R/W-0
—	—	PCHEQIRQ	PCHEQIEN	PCLEQIRQ	PCLEQIEN	POSOVIRQ	POSOVIEN
bit 15							bit 8

R/C-0, HS	R/W-0	R/C-0, HS	R/W-0	R/C-0, HS	R/W-0	R/C-0, HS	R/W-0
PCIIRQ(1)	PCIIEN	VELOVIRQ	VELOVIEN	HOMIRQ	HOMIEN	IDXIRQ	IDXIEN
bit 7							bit 0

Legend:	C = Clearable bit	HS = Hardware Settable bit	
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-14 **Unimplemented:** Read as '0'

bit 13 **PCHEQIRQ:** Position Counter Greater Than Compare Status bit
1 = POSxCNT ≥ QEIxGEC
0 = POSxCNT < QEIxGEC

bit 12 **PCHEQIEN:** Position Counter Greater Than Compare Interrupt Enable bit
1 = Interrupt is enabled
0 = Interrupt is disabled

bit 11 **PCLEQIRQ:** Position Counter Less Than Compare Status bit
1 = POSxCNT ≤ QEIxLEC
0 = POSxCNT > QEIxLEC

bit 10 **PCLEQIEN:** Position Counter Less Than Compare Interrupt Enable bit
1 = Interrupt is enabled
0 = Interrupt is disabled

bit 9 **POSOVIRQ:** Position Counter Overflow Status bit
1 = Overflow has occurred
0 = No overflow has occurred

bit 8 **POSOVIEN:** Position Counter Overflow Interrupt Enable bit
1 = Interrupt is enabled
0 = Interrupt is disabled

bit 7 **PCIIRQ:** Position Counter (Homing) Initialization Process Complete Status bit(1)
1 = POSxCNT was reinitialized
0 = POSxCNT was not reinitialized

bit 6 **PCIIEN:** Position Counter (Homing) Initialization Process Complete Interrupt Enable bit
1 = Interrupt is enabled
0 = Interrupt is disabled

bit 5 **VELOVIRQ:** Velocity Counter Overflow Status bit
1 = Overflow has occurred
0 = No overflow has occurred

bit 4 **VELOVIEN:** Velocity Counter Overflow Interrupt Enable bit
1 = Interrupt is enabled
0 = Interrupt is disabled

bit 3 **HOMIRQ:** Status Flag for Home Event Status bit
1 = Home event has occurred
0 = No Home event has occurred

Note 1: This status bit is only applicable to PIMOD<2:0> modes, '011' and '100'.

REGISTER 15-5: POSxCNTL: POSITION x COUNTER REGISTER LOW

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
POSCNT<15:8>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
POSCNT<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **POSCNT<15:0>:** Low Word Used to Form 32-Bit Position Counter Register (POSxCNT) bits

REGISTER 15-6: POSxCNTH: POSITION x COUNTER REGISTER HIGH

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
POSCNT<31:24>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
POSCNT<23:16>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **POSCNT<31:16>:** High Word Used to Form 32-Bit Position Counter Register (POSxCNT) bits

REGISTER 16-13: UxTXCHK: UARTx TRANSMIT CHECKSUM REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
TXCHK<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-8 **Unimplemented:** Read as '0'

bit 7-0 **TXCHK<7:0>:** Transmit Checksum bits (calculated from TX words)

LIN Modes:
C0EN = 1: Sum of all transmitted data + addition carries, including PID.
C0EN = 0: Sum of all transmitted data + addition carries, excluding PID.

LIN Slave:
Cleared when Break is detected.

LIN Master/Slave:
Cleared when Break is detected.

Other Modes:
C0EN = 1: Sum of every byte transmitted + addition carries.
C0EN = 0: Value remains unchanged.

FIGURE 17-6: SPIx MASTER, FRAME SLAVE CONNECTION DIAGRAM

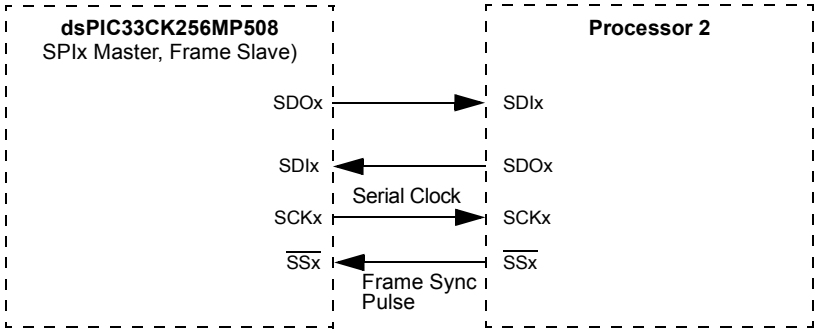


FIGURE 17-7: SPIx SLAVE, FRAME MASTER CONNECTION DIAGRAM

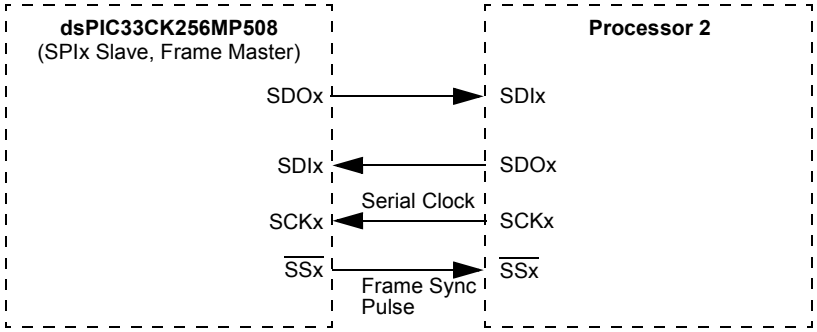
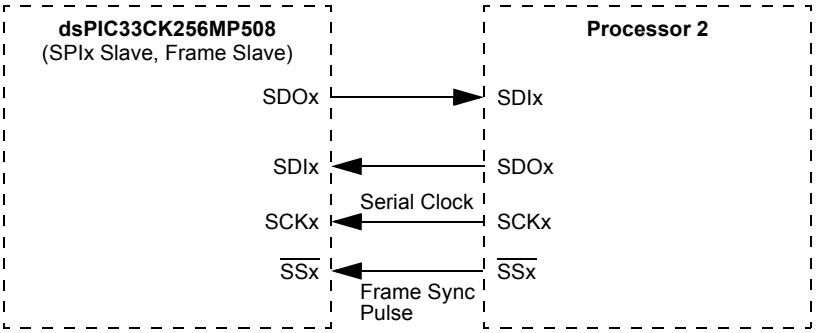


FIGURE 17-8: SPIx SLAVE, FRAME SLAVE CONNECTION DIAGRAM



EQUATION 17-1: RELATIONSHIP BETWEEN DEVICE AND SPIx CLOCK SPEED

$$Baud\ Rate = \frac{FPB}{(2 * (SPIxBRG + 1))}$$

Where:

FPB is the Peripheral Bus Clock Frequency.

REGISTER 20-1: SENTxCON1: SENTx CONTROL REGISTER 1 (CONTINUED)

bit 4 **PS:** SENTx Module Clock Prescaler (divider) bits
1 = Divide-by-4
0 = Divide-by-1

bit 3 **Unimplemented:** Read as '0'

bit 2-0 **NIBCNT<2:0>:** Nibble Count Control bits
111 = Reserved; do not use
110 = Module transmits/receives 6 data nibbles in a SENT data pocket
101 = Module transmits/receives 5 data nibbles in a SENT data pocket
100 = Module transmits/receives 4 data nibbles in a SENT data pocket
011 = Module transmits/receives 3 data nibbles in a SENT data pocket
010 = Module transmits/receives 2 data nibbles in a SENT data pocket
001 = Module transmits/receives 1 data nibble in a SENT data pocket
000 = Reserved; do not use

Note 1: This bit has no function in Receive mode (RCVEN = 1).
2: This bit has no function in Transmit mode (RCVEN = 0).

REGISTER 22-7: CCPxSTATL: CCPx STATUS REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R-0	W1-0	W1-0	R/C-0	R/C-0	R/C-0	R/C-0	R/C-0
CCPTRIG	TRSET	TRCLR	ASEVT	SCEVT	ICDIS	ICOV	ICBNE
bit 7							bit 0

Legend:	C = Clearable bit		
R = Readable bit	W1 = Write '1' Only bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-8 **Unimplemented:** Read as '0'

bit 7 **CCPTRIG:** CCPx Trigger Status bit
1 = Timer has been triggered and is running
0 = Timer has not been triggered and is held in Reset

bit 6 **TRSET:** CCPx Trigger Set Request bit
Writes '1' to this location to trigger the timer when TRIGEN = 1 (location always reads as '0').

bit 5 **TRCLR:** CCPx Trigger Clear Request bit
Writes '1' to this location to cancel the timer trigger when TRIGEN = 1 (location always reads as '0').

bit 4 **ASEVT:** CCPx Auto-Shutdown Event Status/Control bit
1 = A shutdown event is in progress; CCPx outputs are in the shutdown state
0 = CCPx outputs operate normally

bit 3 **SCEVT:** Single Edge Compare Event Status bit
1 = A single edge compare event has occurred
0 = A single edge compare event has not occurred

bit 2 **ICDIS:** Input Capture x Disable bit
1 = Event on Input Capture x pin (ICx) does not generate a capture event
0 = Event on Input Capture x pin will generate a capture event

bit 1 **ICOV:** Input Capture x Buffer Overflow Status bit
1 = The Input Capture x FIFO buffer has overflowed
0 = The Input Capture x FIFO buffer has not overflowed

bit 0 **ICBNE:** Input Capture x Buffer Status bit
1 = Input Capture x buffer has data available
0 = Input Capture x buffer is empty

23.0 CONFIGURABLE LOGIC CELL (CLC)

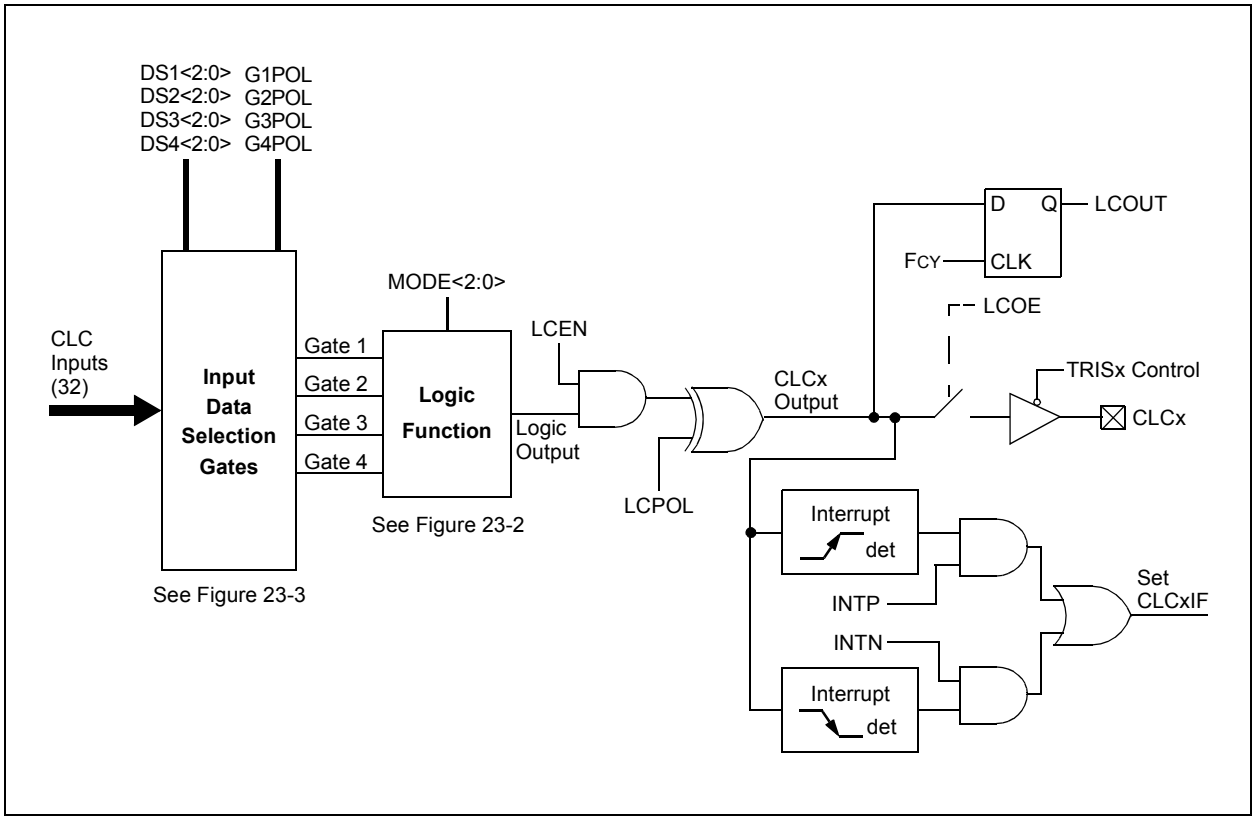
Note 1: This data sheet summarizes the features of the dsPIC33CK256MP508 family of devices. It is not intended to be a comprehensive reference source. For more information, refer to **"Configurable Logic Cell (CLC)"** (DS70005298) in the *"dsPIC33/PIC24 Family Reference Manual"*, which is available from the Microchip web site (www.microchip.com). The information in this data sheet supersedes the information in the FRM.

The Configurable Logic Cell (CLC) module allows the user to specify combinations of signals as inputs to a logic function and to use the logic output to control other peripherals or I/O pins. This provides greater flexibility and potential in embedded designs, since the CLC module can operate outside the limitations of software execution, and supports a vast amount of output designs.

There are four input gates to the selected logic function. These four input gates select from a pool of up to 32 signals that are selected using four data source selection multiplexers. Figure 23-1 shows an overview of the module.

Figure 23-3 shows the details of the data source multiplexers and Figure 23-2 shows the logic input gate connections.

FIGURE 23-1: CLCx MODULE



REGISTER 23-3: CLCxSEL: CLCx INPUT MUX SELECT REGISTER

U-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0
—	DS4<2:0>			—	DS3<2:0>		
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0
—	DS2<2:0>			—	DS1<2:0>		
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **Unimplemented:** Read as '0'

bit 14-12 **DS4<2:0>:** Data Selection MUX 4 Signal Selection bits
111 = SCCP3 auxiliary out
110 = SCCP1 auxiliary out
101 = CLCIND pin
100 = Reserved
011 = SPI1 Input (SDIx)(1)
010 = Comparator 3 output
001 = CLC2 output
000 = PWM Event A

bit 11 **Unimplemented:** Read as '0'

bit 10-8 **DS3<2:0>:** Data Selection MUX 3 Signal Selection bits
111 = SCCP4 Compare Event Flag (CCP4IF)
110 = SCCP3 Compare Event Flag (CCP3IF)
101 = CLC4 out
100 = UART1 RX output corresponding to CLCx module
011 = SPI1 Output (SDOx) corresponding to CLCx module(1)
010 = Comparator 2 output
001 = CLC1 output
000 = CLCINC I/O pin

bit 7 **Unimplemented:** Read as '0'

bit 6-4 **DS2<2:0>:** Data Selection MUX 2 Signal Selection bits
111 = SCCP2 OC (CCP2IF) out
110 = SCCP1 OC (CCP1IF) out
101 = Reserved
100 = Reserved
011 = UART1 TX input corresponding to CLCx module
010 = Comparator 1 output
001 = Reserved
000 = CLCINB I/O pin

bit 3 **Unimplemented:** Read as '0'

Note 1: Valid only when SPI is used on PPS.

REGISTER 23-5: CLCxGLSH: CLCx GATE LOGIC INPUT SELECT HIGH REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
G4D4T	G4D4N	G4D3T	G4D3N	G4D2T	G4D2N	G4D1T	G4D1N
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
G3D4T	G3D4N	G3D3T	G3D3N	G3D2T	G3D2N	G3D1T	G3D1N
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **G4D4T:** Gate 4 Data Source 4 True Enable bit
1 = Data Source 4 signal is enabled for Gate 4
0 = Data Source 4 signal is disabled for Gate 4

bit 14 **G4D4N:** Gate 4 Data Source 4 Negated Enable bit
1 = Data Source 4 inverted signal is enabled for Gate 4
0 = Data Source 4 inverted signal is disabled for Gate 4

bit 13 **G4D3T:** Gate 4 Data Source 3 True Enable bit
1 = Data Source 3 signal is enabled for Gate 4
0 = Data Source 3 signal is disabled for Gate 4

bit 12 **G4D3N:** Gate 4 Data Source 3 Negated Enable bit
1 = Data Source 3 inverted signal is enabled for Gate 4
0 = Data Source 3 inverted signal is disabled for Gate 4

bit 11 **G4D2T:** Gate 4 Data Source 2 True Enable bit
1 = Data Source 2 signal is enabled for Gate 4
0 = Data Source 2 signal is disabled for Gate 4

bit 10 **G4D2N:** Gate 4 Data Source 2 Negated Enable bit
1 = Data Source 2 inverted signal is enabled for Gate 4
0 = Data Source 2 inverted signal is disabled for Gate 4

bit 9 **G4D1T:** Gate 4 Data Source 1 True Enable bit
1 = Data Source 1 signal is enabled for Gate 4
0 = Data Source 1 signal is disabled for Gate 4

bit 8 **G4D1N:** Gate 4 Data Source 1 Negated Enable bit
1 = Data Source 1 inverted signal is enabled for Gate 4
0 = Data Source 1 inverted signal is disabled for Gate 4

bit 7 **G3D4T:** Gate 3 Data Source 4 True Enable bit
1 = Data Source 4 signal is enabled for Gate 3
0 = Data Source 4 signal is disabled for Gate 3

bit 6 **G3D4N:** Gate 3 Data Source 4 Negated Enable bit
1 = Data Source 4 inverted signal is enabled for Gate 3
0 = Data Source 4 inverted signal is disabled for Gate 3

bit 5 **G3D3T:** Gate 3 Data Source 3 True Enable bit
1 = Data Source 3 signal is enabled for Gate 3
0 = Data Source 3 signal is disabled for Gate 3

bit 4 **G3D3N:** Gate 3 Data Source 3 Negated Enable bit
1 = Data Source 3 inverted signal is enabled for Gate 3
0 = Data Source 3 inverted signal is disabled for Gate 3

REGISTER 24-7: PTGT1LIM: PTG TIMER1 LIMIT REGISTER(1)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTGT1LIM<15:8>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTGT1LIM<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **PTGT1LIM<15:0>:** PTG Timer1 Limit Register bits
General Purpose Timer1 Limit register.

Note 1: These bits are read-only when the module is executing Step commands.

REGISTER 24-8: PTGSDLIM: PTG STEP DELAY LIMIT REGISTER(1)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTGSDLIM<15:8>							
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTGSDLIM<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-0 **PTGSDLIM<15:0>:** PTG Step Delay Limit Register bits
This register holds a PTG Step delay value representing the number of additional PTG clocks between the start of a Step command and the completion of a Step command.

Note 1: These bits are read-only when the module is executing Step commands.

32.0 DEVELOPMENT SUPPORT

The PIC® microcontrollers (MCU) and dsPIC® digital signal controllers (DSC) are supported with a full range of software and hardware development tools:

- Integrated Development Environment
  - MPLAB® X IDE Software
- Compilers/Assemblers/Linkers
  - MPLAB XC Compiler
  - MPASM™ Assembler
  - MPLINK™ Object Linker/ MPLIB™ Object Librarian
  - MPLAB Assembler/Linker/Librarian for Various Device Families
- Simulators
  - MPLAB X SIM Software Simulator
- Emulators
  - MPLAB REAL ICE™ In-Circuit Emulator
- In-Circuit Debuggers/Programmers
  - MPLAB ICD 3
  - PICkit™ 3
- Device Programmers
  - MPLAB PM3 Device Programmer
- Low-Cost Demonstration/Development Boards, Evaluation Kits and Starter Kits
- Third-party development tools

32.1 MPLAB X Integrated Development Environment Software

The MPLAB X IDE is a single, unified graphical user interface for Microchip and third-party software, and hardware development tool that runs on Windows®, Linux and Mac OS® X. Based on the NetBeans IDE, MPLAB X IDE is an entirely new IDE with a host of free software components and plug-ins for high-performance application development and debugging. Moving between tools and upgrading from software simulators to hardware debugging and programming tools is simple with the seamless user interface.

With complete project management, visual call graphs, a configurable watch window and a feature-rich editor that includes code completion and context menus, MPLAB X IDE is flexible and friendly enough for new users. With the ability to support multiple tools on multiple projects with simultaneous debugging, MPLAB X IDE is also suitable for the needs of experienced users.

Feature-Rich Editor:

- Color syntax highlighting
- Smart code completion makes suggestions and provides hints as you type
- Automatic code formatting based on user-defined rules
- Live parsing

User-Friendly, Customizable Interface:

- Fully customizable interface: toolbars, toolbar buttons, windows, window placement, etc.
- Call graph window

Project-Based Workspaces:

- Multiple projects
- Multiple tools
- Multiple configurations
- Simultaneous debugging sessions

File History and Bug Tracking:

- Local file history feature
- Built-in support for Bugzilla issue tracker

32.11 Demonstration/Development Boards, Evaluation Kits and Starter Kits

A wide variety of demonstration, development and evaluation boards for various PIC MCUs and dsPIC DSCs allows quick application development on fully functional systems. Most boards include prototyping areas for adding custom circuitry and provide application firmware and source code for examination and modification.

The boards support a variety of features, including LEDs, temperature sensors, switches, speakers, RS-232 interfaces, LCD displays, potentiometers and additional EEPROM memory.

The demonstration and development boards can be used in teaching environments, for prototyping custom circuits and for learning about various microcontroller applications.

In addition to the PICDEM™ and dsPICDEM™ demonstration/development board series of circuits, Microchip has a line of evaluation kits and demonstration software for analog filter design, KEELOQ® security ICs, CAN, IrDA®, PowerSmart battery management, SEEVAL® evaluation system, Sigma-Delta ADC, flow rate sensing, plus many more.

Also available are starter kits that contain everything needed to experience the specified device. This usually includes a single application and debug capability, all on one board.

Check the Microchip web page (www.microchip.com) for the complete list of demonstration, development and evaluation kits.

32.12 Third-Party Development Tools

Microchip also offers a great collection of tools from third-party vendors. These tools are carefully selected to offer good value and unique functionality.

- Device Programmers and Gang Programmers from companies, such as SoftLog and CCS
- Software Tools from companies, such as Gimpel and Trace Systems
- Protocol Analyzers from companies, such as Saleae and Total Phase
- Demonstration Boards from companies, such as MikroElektronika, Digilent® and Olimex
- Embedded Ethernet Solutions from companies, such as EZ Web Lynx, WIZnet and IPLogika®

TABLE 33-15: I/O PIN INPUT SPECIFICATIONS

Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended							
Param No.	**Symbol**	**Characteristic**	**Min.(5)**	**Typ.(1)**	**Max.(6)**	**Units**	**Conditions**
	VIL	**Input Low Voltage**					
DI10		Any I/O Pin and $\overline{MCLR}$	VSS	—	0.2 VDD	V	
DI18		I/O Pins with SDAx, SCLx	VSS	—	0.3 VDD	V	SMBus disabled
DI19		I/O Pins with SDAx, SCLx	VSS	—	0.8	V	SMBus enabled
DI20	VIH	**Input High Voltage**					
		I/O Pins Not 5V Tolerant(3)	0.8 VDD	—	VDD	V	
		5V Tolerant I/O Pins and $\overline{MCLR}$(3)	0.8 VDD	—	5.5	V	
		5V Tolerant I/O Pins with SDAx, SCLx(3)	0.8 VDD	—	5.5	V	SMBus disabled
		5V Tolerant I/O Pins with SDAx, SCLx(3)	2.1	—	5.5	V	SMBus enabled
		I/O Pins with SDAx, SCLx Not 5V Tolerant(3)	0.8 VDD	—	VDD	V	SMBus disabled
		I/O Pins with SDAx, SCLx Not 5V Tolerant(3)	2.1	—	VDD	V	SMBus enabled
DI30	ICNPU	**Input Change Notification Pull-up Current(2,4)**	175	360	545	µA	VDD = 3.6V, VPIN = VSS
DI31	ICNPD	**Input Change Notification Pull-Down Current(4)**	65	215	360	µA	VDD = 3.6V, VPIN = VDD
DI50	IIL	**Input Leakage Current(2)**					
		I/O Pins 5V Tolerant(3)	-700	—	700	nA	
		I/O Pins Not 5V Tolerant(3)	-700	—	700	nA	
		$\overline{MCLR}$	-700	—	700	nA	
		OSCI	-700	—	700	nA	XT and HS modes

Note 1: Data in "Typ." column is at 3.3V, +25°C unless otherwise stated.

2: Negative current is defined as current sourced by the pin.

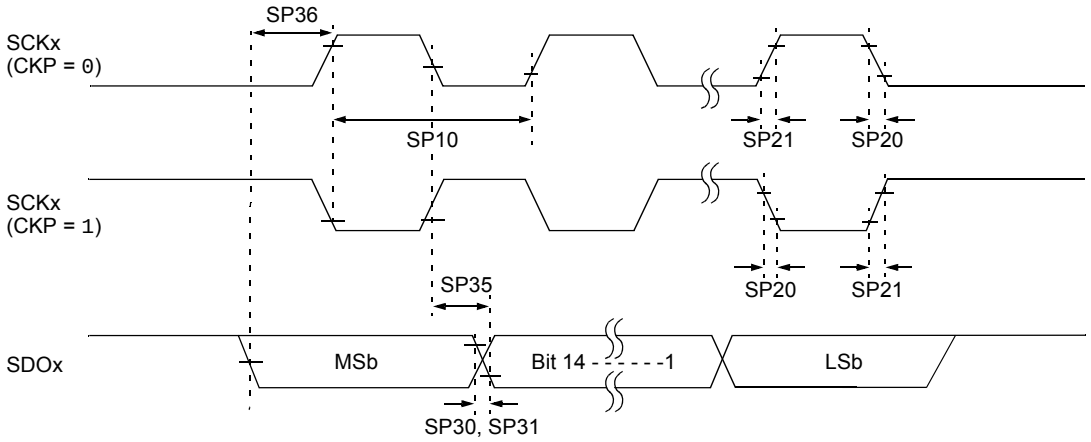
3: See the **"Pin Diagrams"** section for the 5V tolerant I/O pins.

4: Characterized but not tested.

5: VPIN = VSS.

6: VPIN = VDD.

FIGURE 33-8: SPIx MASTER MODE (HALF-DUPLEX, TRANSMIT ONLY, CKE = 1) TIMING CHARACTERISTICS



Note: Refer to Figure 33-1 for load conditions.

TABLE 33-28: SPIx MASTER MODE (HALF-DUPLEX, TRANSMIT ONLY) TIMING REQUIREMENTS

Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended							
Param No.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
SP10	FscP	Maximum SCKx Frequency	—	—	15	MHz	Using PPS pins
			—	—	40	MHz	SPIx dedicated pins
SP20	TscF	SCKx Output Fall Time	—	—	—	ns	See Parameter DO32
SP21	TscR	SCKx Output Rise Time	—	—	—	ns	See Parameter DO31
SP30	TdoF	SDOx Data Output Fall Time	—	—	—	ns	See Parameter DO32
SP31	TdoR	SDOx Data Output Rise Time	—	—	—	ns	See Parameter DO31
SP35	TscH2doV, TscL2doV	SDOx Data Output Valid After SCKx Edge	—	6	20	ns	
SP36	TdiV2scH, TdiV2scL	SDOx Data Output Setup to First SCKx Edge	30	—	—	ns	Using PPS pins
			3	—	—	ns	SPIx dedicated pins

Note 1: These parameters are characterized but not tested in manufacturing.

2: Data in "Typ." column is at 3.3V, +25°C unless otherwise stated.

S

T

U

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W

