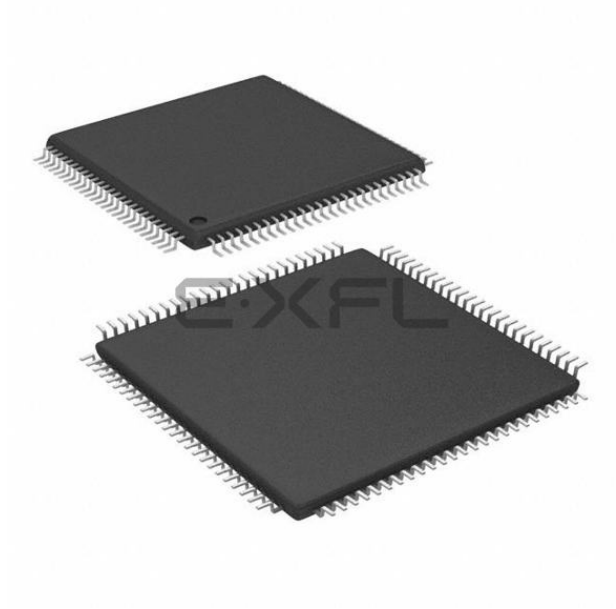
Microchip Technology - DSPIC33FJ64GP310-I/PF Datasheet



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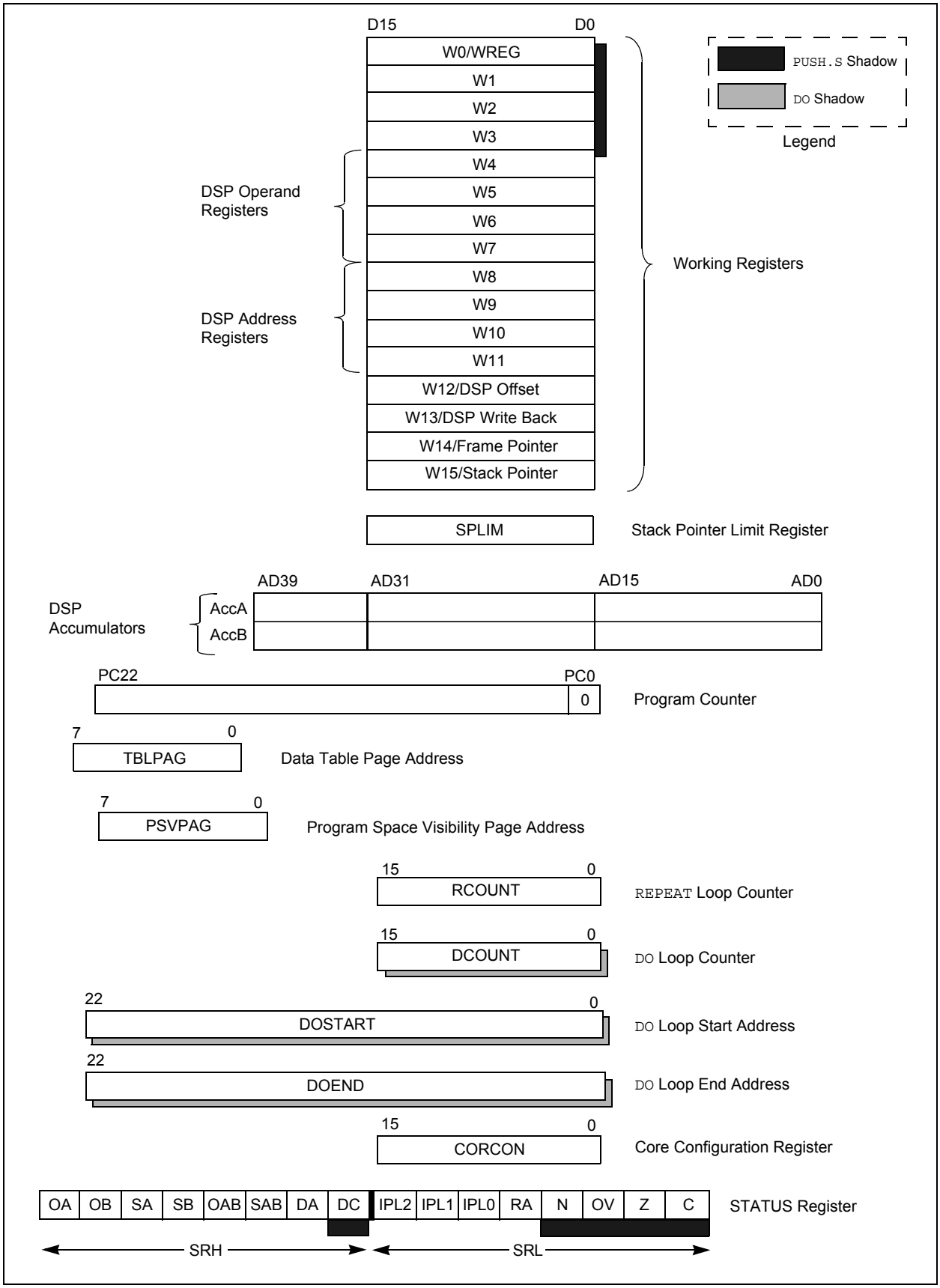
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	40 MIPs
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	AC'97, Brown-out Detect/Reset, DMA, I²S, POR, PWM, WDT
Number of I/O	85
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 32x10b/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-TQFP
Supplier Device Package	100-TQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33fj64gp310-i-pf

FIGURE 3-2: dsPIC33FJXXXGPX06/X08/X10 PROGRAMMER'S MODEL



3.5 Arithmetic Logic Unit (ALU)

The dsPIC33FJXXXGPX06/X08/X10 ALU is 16 bits wide and is capable of addition, subtraction, bit shifts and logic operations. Unless otherwise mentioned, arithmetic operations are 2's complement in nature. Depending on the operation, the ALU may affect the values of the Carry (C), Zero (Z), Negative (N), Overflow (OV) and Digit Carry (DC) Status bits in the SR register. The C and DC Status bits operate as Borrow and Digit Borrow bits, respectively, for subtraction operations.

The ALU can perform 8-bit or 16-bit operations, depending on the mode of the instruction that is used. Data for the ALU operation can come from the W register array, or data memory, depending on the addressing mode of the instruction. Likewise, output data from the ALU can be written to the W register array or a data memory location.

Refer to the "*dsPIC30F/33F Programmer's Reference Manual*" (DS70157) for information on the SR bits affected by each instruction.

The dsPIC33FJXXXGPX06/X08/X10 CPU incorporates hardware support for both multiplication and division. This includes a dedicated hardware multiplier and support hardware for 16-bit-divisor division.

3.5.1 MULTIPLIER

Using the high-speed 17-bit x 17-bit multiplier of the DSP engine, the ALU supports unsigned, signed or mixed-sign operation in several MCU multiplication modes:

1. 16-bit x 16-bit signed
2. 16-bit x 16-bit unsigned
3. 16-bit signed x 5-bit (literal) unsigned
4. 16-bit unsigned x 16-bit unsigned
5. 16-bit unsigned x 5-bit (literal) unsigned
6. 16-bit unsigned x 16-bit signed
7. 8-bit unsigned x 8-bit unsigned

3.5.2 DIVIDER

The divide block supports 32-bit/16-bit and 16-bit/16-bit signed and unsigned integer divide operations with the following data sizes:

1. 32-bit signed/16-bit signed divide
2. 32-bit unsigned/16-bit unsigned divide
3. 16-bit signed/16-bit signed divide
4. 16-bit unsigned/16-bit unsigned divide

The quotient for all divide instructions ends up in W0 and the remainder in W1. 16-bit signed and unsigned `DIV` instructions can specify any W register for both the 16-bit divisor (Wn) and any W register (aligned) pair (W(m + 1):Wm) for the 32-bit dividend. The divide algorithm takes one cycle per bit of divisor, so both 32-bit/16-bit and 16-bit/16-bit instructions take the same number of cycles to execute.

3.6 DSP Engine

The DSP engine consists of a high-speed, 17-bit x 17-bit multiplier, a barrel shifter and a 40-bit adder/subtracter (with two target accumulators, round and saturation logic).

The dsPIC33FJXXXGPX06/X08/X10 is a single-cycle, instruction flow architecture; therefore, concurrent operation of the DSP engine with MCU instruction flow is not possible. However, some MCU ALU and DSP engine resources may be used concurrently by the same instruction (e.g., ED, EDAC).

The DSP engine also has the capability to perform inherent accumulator-to-accumulator operations which require no additional data. These instructions are `ADD`, `SUB` and `NEG`.

The DSP engine has various options selected through various bits in the CPU Core Control register (CORCON), as listed below:

1. Fractional or integer DSP multiply (IF).
2. Signed or unsigned DSP multiply (US).
3. Conventional or convergent rounding (RND).
4. Automatic saturation on/off for AccA (SATA).
5. Automatic saturation on/off for AccB (SATB).
6. Automatic saturation on/off for writes to data memory (SATDW).
7. Accumulator Saturation mode selection (ACCSAT).

Table 3-1 provides a summary of DSP instructions. A block diagram of the DSP engine is shown in Figure 3-3.

TABLE 3-1: DSP INSTRUCTIONS SUMMARY

Instruction	Algebraic Operation	ACC Write Back
`CLR`	A = 0	Yes
`ED`	A = $(x – y)^2$	No
`EDAC`	A = A + $(x – y)^2$	No
`MAC`	A = A + (x * y)	Yes
`MAC`	A = A + x^2	No
`MOVSAC`	No change in A	Yes
`MPY`	A = x * y	No
`MPY`	A = x^2	No
`MPY.N`	A = – x * y	No
`MSC`	A = A – x * y	Yes

NOTES:

4.2 Data Address Space

The dsPIC33FJXXXGPX06/X08/X10 CPU has a separate 16-bit wide data memory space. The data space is accessed using separate Address Generation Units (AGUs) for read and write operations. Data memory maps of devices with different RAM sizes are shown in Figure 4-3 through Figure 4-5.

All Effective Addresses (EAs) in the data memory space are 16 bits wide and point to bytes within the data space. This arrangement gives a data space address range of 64 Kbytes or 32K words. The lower half of the data memory space (that is, when EA<15> = 0) is used for implemented memory addresses, while the upper half (EA<15> = 1) is reserved for the Program Space Visibility area (see **Section 4.6.3 "Reading Data from Program Memory Using Program Space Visibility"**).

dsPIC33FJXXXGPX06/X08/X10 devices implement a total of up to 30 Kbytes of data memory. Should an EA point to a location outside of this area, an all-zero word or byte will be returned.

4.2.1 DATA SPACE WIDTH

The data memory space is organized in byte addressable, 16-bit wide blocks. Data is aligned in data memory and registers as 16-bit words, but all data space EAs resolve to bytes. The Least Significant Bytes (LSBs) of each word have even addresses, while the Most Significant Bytes (MSBs) have odd addresses.

4.2.2 DATA MEMORY ORGANIZATION AND ALIGNMENT

To maintain backward compatibility with PIC® MCU devices and improve data space memory usage efficiency, the dsPIC33FJXXXGPX06/X08/X10 instruction set supports both word and byte operations. As a consequence of byte accessibility, all effective address calculations are internally scaled to step through word-aligned memory. For example, the core recognizes that Post-Modified Register Indirect Addressing mode [Ws++] will result in a value of Ws + 1 for byte operations and Ws + 2 for word operations.

Data byte reads will read the complete word that contains the byte, using the LSb of any EA to determine which byte to select. The selected byte is placed onto the LSb of the data path. That is, data memory and registers are organized as two parallel byte-wide entities with shared (word) address decode but separate write lines. Data byte writes only write to the corresponding side of the array or register which matches the byte address.

All word accesses must be aligned to an even address. Misaligned word data fetches are not supported, so care must be taken when mixing byte and word operations, or translating from 8-bit MCU code. If a misaligned read or write is attempted, an address error trap is generated. If the error occurred on a read, the instruction underway is completed; if it occurred on a write, the instruction will be executed but the write does not occur. In either case, a trap is then executed, allowing the system and/or user to examine the machine state prior to execution of the address Fault.

All byte loads into any W register are loaded into the Least Significant Byte. The Most Significant Byte is not modified.

A sign-extend instruction (SE) is provided to allow users to translate 8-bit signed data to 16-bit signed values. Alternatively, for 16-bit unsigned data, users can clear the MSb of any W register by executing a zero-extend (ZE) instruction on the appropriate address.

4.2.3 SFR SPACE

The first 2 Kbytes of the Near Data Space, from 0x0000 to 0x07FF, is primarily occupied by Special Function Registers (SFRs). These are used by the dsPIC33FJXXXGPX06/X08/X10 core and peripheral modules for controlling the operation of the device.

SFRs are distributed among the modules that they control, and are generally grouped together by module. Much of the SFR space contains unused addresses; these are read as '0'. A complete listing of implemented SFRs, including their addresses, is shown in Table 4-1 through Table 4-34.

Note:	The actual set of peripheral features and interrupts varies by the device. Please refer to the corresponding device tables and pinout diagrams for device-specific information.

4.2.4 NEAR DATA SPACE

The 8-Kbyte area between 0x0000 and 0x1FFF is referred to as the Near Data Space. Locations in this space are directly addressable via a 13-bit absolute address field within all memory direct instructions. Additionally, the whole data space is addressable using MOV instructions, which support Memory Direct Addressing mode with a 16-bit address field, or by using Indirect Addressing mode using a working register as an Address Pointer.

can operate on any W register pointer. However, it is not advisable to use W14 or W15 for Modulo Addressing since these two registers are used as the Stack Frame Pointer and Stack Pointer, respectively.

In general, any particular circular buffer can only be configured to operate in one direction as there are certain restrictions on the buffer start address (for incrementing buffers), or end address (for decrementing buffers), based upon the direction of the buffer.

The only exception to the usage restrictions is for buffers which have a power-of-2 length. As these buffers satisfy the start and end address criteria, they may operate in a bidirectional mode (i.e., address boundary checks will be performed on both the lower and upper address boundaries).

4.4.1 START AND END ADDRESS

The Modulo Addressing scheme requires that a starting and ending address be specified and loaded into the 16-bit Modulo Buffer Address registers: XMODSRT, XMODEND, YMODSRT and YMODEND (see Table 4-1).

Note:	Y space Modulo Addressing EA calculations assume word sized data (LSb of every EA is always clear).

The length of a circular buffer is not directly specified. It is determined by the difference between the corresponding start and end addresses. The maximum possible length of the circular buffer is 32K words (64 Kbytes).

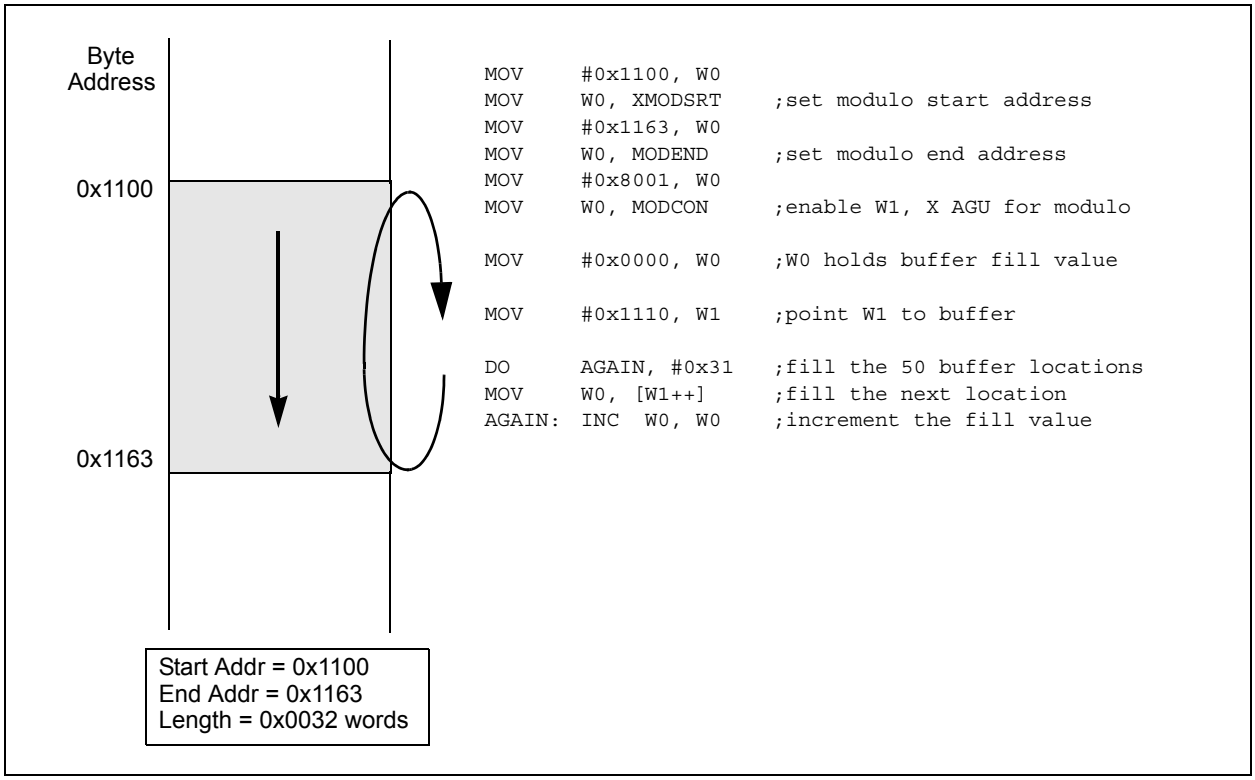
4.4.2 W ADDRESS REGISTER SELECTION

The Modulo and Bit-Reversed Addressing Control register, MODCON<15:0>, contains enable flags as well as a W register field to specify the W Address registers. The XWM and YWM fields select which registers will operate with Modulo Addressing. If XWM = `15`, X RAGU and X WAGU Modulo Addressing is disabled. Similarly, if YWM = `15`, Y AGU Modulo Addressing is disabled.

The X Address Space Pointer W register (XWM), to which Modulo Addressing is to be applied, is stored in MODCON<3:0> (see Table 4-1). Modulo Addressing is enabled for X data space when XWM is set to any value other than '`15`' and the XMODEN bit is set at MODCON<15>.

The Y Address Space Pointer W register (YWM) to which Modulo Addressing is to be applied is stored in MODCON<7:4>. Modulo Addressing is enabled for Y data space when YWM is set to any value other than '`15`' and the YMODEN bit is set at MODCON<14>.

FIGURE 4-7: MODULO ADDRESSING OPERATION EXAMPLE




```
MOV     #0x1100, W0
MOV     W0, XMODSRT     ;set modulo start address
MOV     #0x1163, W0
MOV     W0, MODEND      ;set modulo end address
MOV     #0x8001, W0
MOV     W0, MODCON      ;enable W1, X AGU for modulo

MOV     #0x0000, W0     ;W0 holds buffer fill value

MOV     #0x1110, W1     ;point W1 to buffer

DO      AGAIN, #0x31    ;fill the 50 buffer locations
MOV     W0, [W1++]      ;fill the next location
AGAIN:  INC  W0, W0     ;increment the fill value
```

TABLE 7-1: INTERRUPT VECTORS (CONTINUED)

Vector Number	Interrupt Request (IRQ) Number	IVT Address	AIVT Address	Interrupt Source
54	46	0x000070	0x000170	DMA4 – DMA Channel 4
55	47	0x000072	0x000172	T6 – Timer6
56	48	0x000074	0x000174	T7 – Timer7
57	49	0x000076	0x000176	SI2C2 – I2C2 Slave Events
58	50	0x000078	0x000178	MI2C2 – I2C2 Master Events
59	51	0x00007A	0x00017A	T8 – Timer8
60	52	0x00007C	0x00017C	T9 – Timer9
61	53	0x00007E	0x00017E	INT3 – External Interrupt 3
62	54	0x000080	0x000180	INT4 – External Interrupt 4
63	55	0x000082	0x000182	C2RX – ECAN2 Receive Data Ready
64	56	0x000084	0x000184	C2 – ECAN2 Event
65	57	0x000086	0x000186	Reserved
66	58	0x000088	0x000188	Reserved
67	59	0x00008A	0x00018A	DCIE – DCI Error
68	60	0x00008C	0x00018C	DCID – DCI Transfer Done
69	61	0x00008E	0x00018E	DMA5 – DMA Channel 5
70	62	0x000090	0x000190	Reserved
71	63	0x000092	0x000192	Reserved
72	64	0x000094	0x000194	Reserved
73	65	0x000096	0x000196	U1E – UART1 Error
74	66	0x000098	0x000198	U2E – UART2 Error
75	67	0x00009A	0x00019A	Reserved
76	68	0x00009C	0x00019C	DMA6 – DMA Channel 6
77	69	0x00009E	0x00019E	DMA7 – DMA Channel 7
78	70	0x0000A0	0x0001A0	C1TX – ECAN1 Transmit Data Request
79	71	0x0000A2	0x0001A2	C2TX – ECAN2 Transmit Data Request
80-125	72-117	0x0000A4-0x0000FE	0x0001A4-0x0001FE	Reserved

TABLE 7-2: TRAP VECTORS

Vector Number	IVT Address	AIVT Address	Trap Source
0	0x000004	0x000104	Reserved
1	0x000006	0x000106	Oscillator Failure
2	0x000008	0x000108	Address Error
3	0x00000A	0x00010A	Stack Error
4	0x00000C	0x00010C	Math Error
5	0x00000E	0x00010E	DMA Error Trap
6	0x000010	0x000110	Reserved
7	0x000012	0x000112	Reserved

REGISTER 7-12: IEC2: INTERRUPT ENABLE CONTROL REGISTER 2

R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
T6IE	DMA4IE	—	OC8IE	OC7IE	OC6IE	OC5IE	IC6IE
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
IC5IE	IC4IE	IC3IE	DMA3IE	C1IE	C1RXIE	SPI2IE	SPI2EIE
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 **T6IE:** Timer6 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 14 **DMA4IE:** DMA Channel 4 Data Transfer Complete Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 13 **Unimplemented:** Read as ‘0’

bit 12 **OC8IE:** Output Compare Channel 8 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 11 **OC7IE:** Output Compare Channel 7 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 10 **OC6IE:** Output Compare Channel 6 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 9 **OC5IE:** Output Compare Channel 5 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 8 **IC6IE:** Input Capture Channel 6 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 7 **IC5IE:** Input Capture Channel 5 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 6 **IC4IE:** Input Capture Channel 4 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 5 **IC3IE:** Input Capture Channel 3 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 4 **DMA3IE:** DMA Channel 3 Data Transfer Complete Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 3 **C1IE:** ECAN1 Event Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

REGISTER 7-21: IPC6: INTERRUPT PRIORITY CONTROL REGISTER 6

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	T4IP<2:0>			—	OC4IP<2:0>		
bit 15							bit 8

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	OC3IP<2:0>			—	DMA2IP<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 **T4IP<2:0>:** Timer4 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 10-8 **OC4IP<2:0>:** Output Compare Channel 4 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 6-4 **OC3IP<2:0>:** Output Compare Channel 3 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 2-0 **DMA2IP<2:0>:** DMA Channel 2 Data Transfer Complete Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

REGISTER 7-24: IPC9: INTERRUPT PRIORITY CONTROL REGISTER 9

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	IC5IP<2:0>			—	IC4IP<2:0>		
bit 15							bit 8

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	IC3IP<2:0>			—	DMA3IP<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 **IC5IP<2:0>:** Input Capture Channel 5 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 10-8 **IC4IP<2:0>:** Input Capture Channel 4 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 6-4 **IC3IP<2:0>:** Input Capture Channel 3 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 2-0 **DMA3IP<2:0>:** DMA Channel 3 Data Transfer Complete Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

REGISTER 9-2: CLKDIV: CLOCK DIVISOR REGISTER

R/W-0	R/W-0	R/W-1	R/W-1	R/W-0	R/W-0	R/W-0	R/W-0
ROI	DOZE<2:0>			DOZEN(1)	FRCDIV<2:0>		
bit 15							bit 8

R/W-0	R/W-1	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PLLPOST<1:0>		—	PLLPRE<4:0>				
bit 7							bit 0

Legend:	y = Value set from Configuration bits on POR		
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 **ROI:** Recover on Interrupt bit
1 = Interrupts will clear the DOZEN bit and the processor clock/peripheral clock ratio is set to 1:1
0 = Interrupts have no effect on the DOZEN bit

bit 14-12 **DOZE<2:0>:** Processor Clock Reduction Select bits
000 = FCY/1
001 = FCY/2
010 = FCY/4
011 = FCY/8 (default)
100 = FCY/16
101 = FCY/32
110 = FCY/64
111 = FCY/128

bit 11 **DOZEN:** DOZE Mode Enable bit(1)
1 = DOZE<2:0> field specifies the ratio between the peripheral clocks and the processor clocks
0 = Processor clock/peripheral clock ratio forced to 1:1

bit 10-8 **FRCDIV<2:0>:** Internal Fast RC Oscillator Postscaler bits
000 = FRC divide by 1 (default)
001 = FRC divide by 2
010 = FRC divide by 4
011 = FRC divide by 8
100 = FRC divide by 16
101 = FRC divide by 32
110 = FRC divide by 64
111 = FRC divide by 256

bit 7-6 **PLLPOST<1:0>:** PLL VCO Output Divider Select bits (also denoted as 'N2', PLL postscaler)
00 = Output/2
01 = Output/4 (default)
10 = Reserved
11 = Output/8

bit 5 **Unimplemented:** Read as '0'

bit 4-0 **PLLPRE<4:0>:** PLL Phase Detector Input Divider bits (also denoted as 'N1', PLL prescaler)
00000 = Input/2 (default)
00001 = Input/3
•
•
•
11111 = Input/33

Note 1: This bit is cleared when the ROI bit is set and an interrupt occurs.

REGISTER 9-3: PLLFBD: PLL FEEDBACK DIVISOR REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	R/W-0(1)
—	—	—	—	—	—	—	PLLDIV<8>
bit 15							bit 8

R/W-0	R/W-0	R/W-1	R/W-1	R/W-0	R/W-0	R/W-0	R/W-0
PLLDIV<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 15-9 **Unimplemented:** Read as '0'

bit 8-0 **PLLDIV<8:0>:** PLL Feedback Divisor bits (also denoted as 'M', PLL multiplier)

000000000 = 2
000000001 = 3
000000010 = 4
•
•
•
000110000 = 50 (default)
•
•
•
111111111 = 513

REGISTER 10-2: PMD2: PERIPHERAL MODULE DISABLE CONTROL REGISTER 2

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
IC8MD	IC7MD	IC6MD	IC5MD	IC4MD	IC3MD	IC2MD	IC1MD
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
OC8MD	OC7MD	OC6MD	OC5MD	OC4MD	OC3MD	OC2MD	OC1MD
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 **IC8MD:** Input Capture 8 Module Disable bit
1 = Input Capture 8 module is disabled
0 = Input Capture 8 module is enabled

bit 14 **IC7MD:** Input Capture 7 Module Disable bit
1 = Input Capture 7 module is disabled
0 = Input Capture 7 module is enabled

bit 13 **IC6MD:** Input Capture 6 Module Disable bit
1 = Input Capture 6 module is disabled
0 = Input Capture 6 module is enabled

bit 12 **IC5MD:** Input Capture 5 Module Disable bit
1 = Input Capture 5 module is disabled
0 = Input Capture 5 module is enabled

bit 11 **IC4MD:** Input Capture 4 Module Disable bit
1 = Input Capture 4 module is disabled
0 = Input Capture 4 module is enabled

bit 10 **IC3MD:** Input Capture 3 Module Disable bit
1 = Input Capture 3 module is disabled
0 = Input Capture 3 module is enabled

bit 9 **IC2MD:** Input Capture 2 Module Disable bit
1 = Input Capture 2 module is disabled
0 = Input Capture 2 module is enabled

bit 8 **IC1MD:** Input Capture 1 Module Disable bit
1 = Input Capture 1 module is disabled
0 = Input Capture 1 module is enabled

bit 7 **OC8MD:** Output Compare 8 Module Disable bit
1 = Output Compare 8 module is disabled
0 = Output Compare 8 module is enabled

bit 6 **OC7MD:** Output Compare 4 Module Disable bit
1 = Output Compare 7 module is disabled
0 = Output Compare 7 module is enabled

bit 5 **OC6MD:** Output Compare 6 Module Disable bit
1 = Output Compare 6 module is disabled
0 = Output Compare 6 module is enabled

bit 4 **OC5MD:** Output Compare 5 Module Disable bit
1 = Output Compare 5 module is disabled
0 = Output Compare 5 module is enabled

12.0 TIMER1

Note: This data sheet summarizes the features of the dsPIC33FJXXXGPX06/X08/X10 family of devices. However, it is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **Section 11. "Timers"** (DS70205) in the *"dsPIC33F Family Reference Manual"*, which is available from the Microchip web site (www.microchip.com).

The Timer1 module is a 16-bit timer, which can serve as the time counter for the real-time clock, or operate as a free-running interval timer/counter. Timer1 can operate in three modes:

- 16-bit Timer
- 16-bit Synchronous Counter
- 16-bit Asynchronous Counter

Timer1 also supports these features:

- Timer gate operation
- Selectable prescaler settings
- Timer operation during CPU Idle and Sleep modes
- Interrupt on 16-bit Period register match or falling edge of external gate signal

Figure 12-1 presents a block diagram of the 16-bit timer module.

To configure Timer1 for operation:

1. Set the TON bit (= 1) in the T1CON register.
2. Select the timer prescaler ratio using the TCKPS<1:0> bits in the T1CON register.
3. Set the Clock and Gating modes using the TCS and TGATE bits in the T1CON register.
4. Set or clear the TSYNC bit in T1CON to select synchronous or asynchronous operation.
5. Load the timer period value into the PR1 register.
6. If interrupts are required, set the interrupt enable bit, T1IE. Use the priority bits, T1IP<2:0>, to set the interrupt priority.

FIGURE 12-1: 16-BIT TIMER1 MODULE BLOCK DIAGRAM

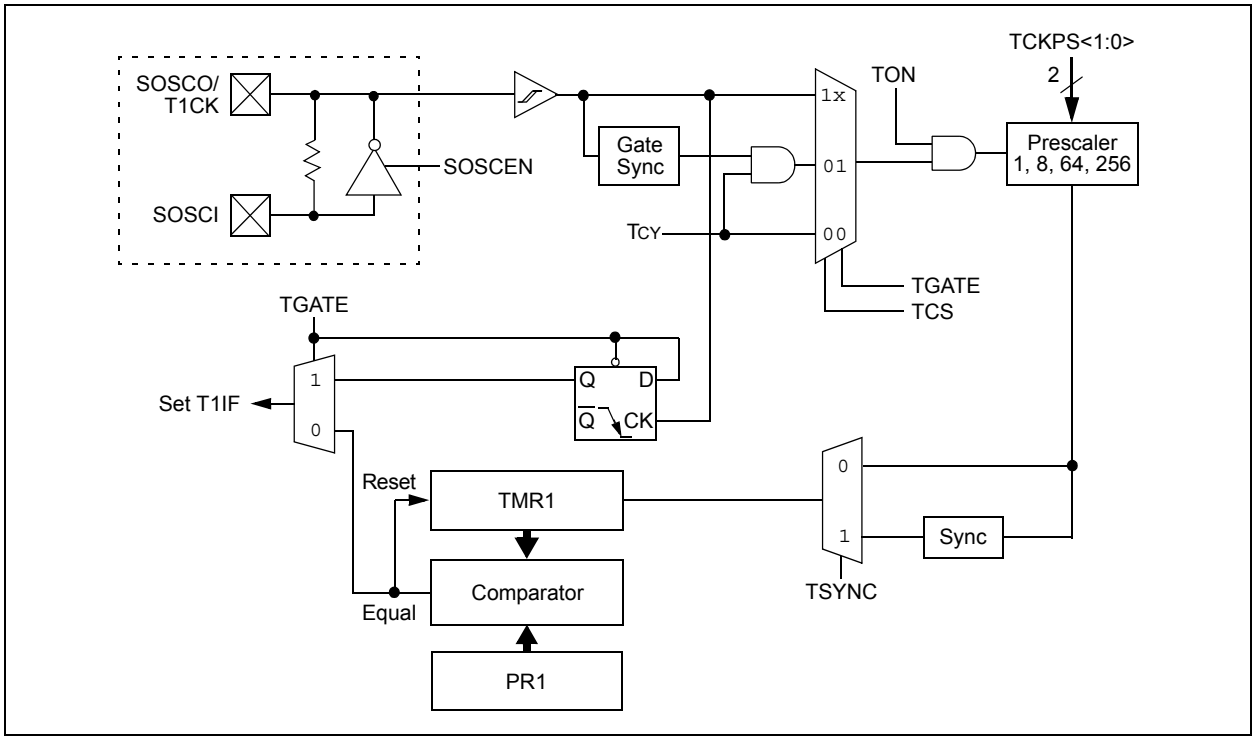
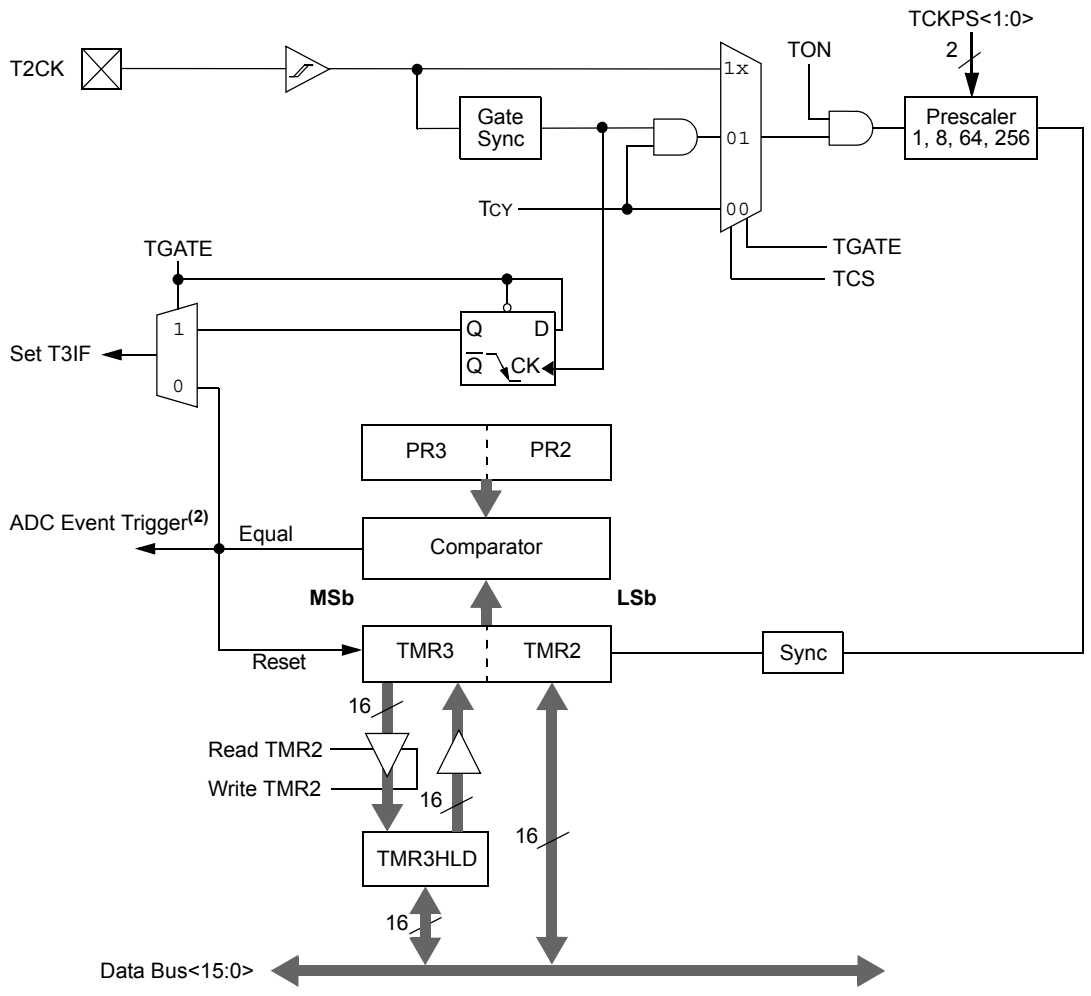


FIGURE 13-1: TIMER2/3 (32-BIT) BLOCK DIAGRAM(1)



Note 1: The 32-bit timer control bit, T32, must be set for 32-bit timer/counter operation. All control bits are respective to the T2CON register.

2: The ADC event trigger is available only on Timer2/3.

15.1 Output Compare Modes

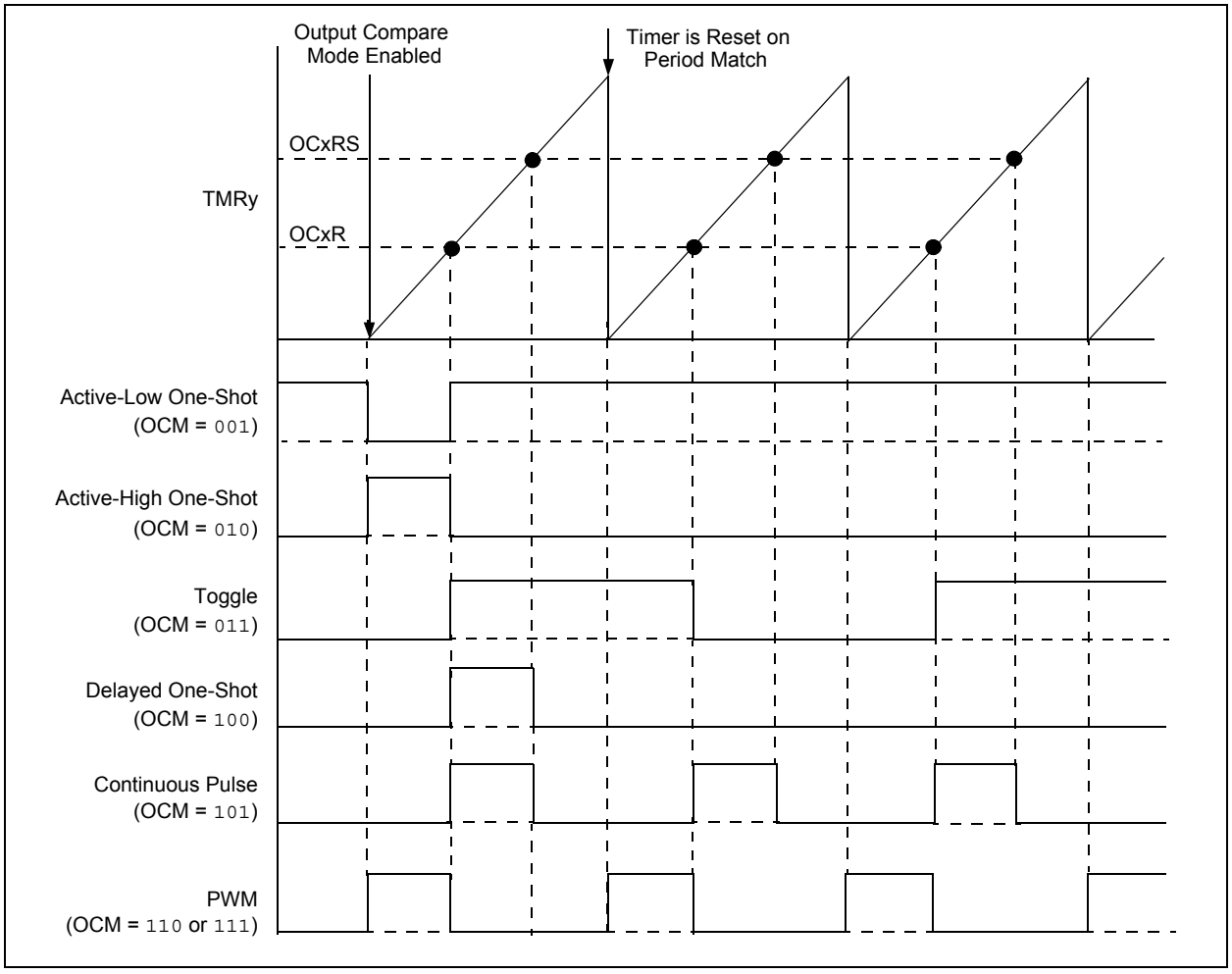
Configure the Output Compare modes by setting the appropriate Output Compare Mode (OCM<2:0>) bits in the Output Compare Control (OCxCON<2:0>) register. Table 15-1 lists the different bit settings for the Output Compare modes. Figure 15-2 illustrates the output compare operation for various modes. The user application must disable the associated timer when writing to the Output Compare Control registers to avoid malfunctions.

Note:	See **Section 13. "Output Compare" (**DS70209) in the *"dsPIC33F Family Reference Manual"* for OCxR and OCxRS register restrictions.

TABLE 15-1: OUTPUT COMPARE MODES

OCM<2:0>	Mode	OCx Pin Initial State	OCx Interrupt Generation
000	Module Disabled	Controlled by GPIO register	—
001	Active-Low One-Shot	0	OCx rising edge
010	Active-High One-Shot	1	OCx falling edge
011	Toggle	Current output is maintained	OCx rising and falling edge
100	Delayed One-Shot	0	OCx falling edge
101	Continuous Pulse	0	OCx falling edge
110	PWM without Fault Protection	'0', if OCxR is zero '1', if OCxR is non-zero	No interrupt
111	PWM with Fault Protection	'0', if OCxR is zero '1', if OCxR is non-zero	OCFA falling edge for OC1 to OC4

FIGURE 15-2: OUTPUT COMPARE OPERATION



16.0 SERIAL PERIPHERAL INTERFACE (SPI)

Note: This data sheet summarizes the features of the dsPIC33FJXXXGPX06/X08/X10 family of devices. However, it is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **Section 18. "Serial Peripheral Interface (SPI)"** (DS70206) in the *"dsPIC33F Family Reference Manual"*, which is available from the Microchip web site (www.microchip.com).

The Serial Peripheral Interface (SPI) module is a synchronous serial interface useful for communicating with other peripheral or microcontroller devices. These peripheral devices may be serial EEPROMs, shift registers, display drivers, ADC, etc. The SPI module is compatible with SPI and SIOP from Motorola®.

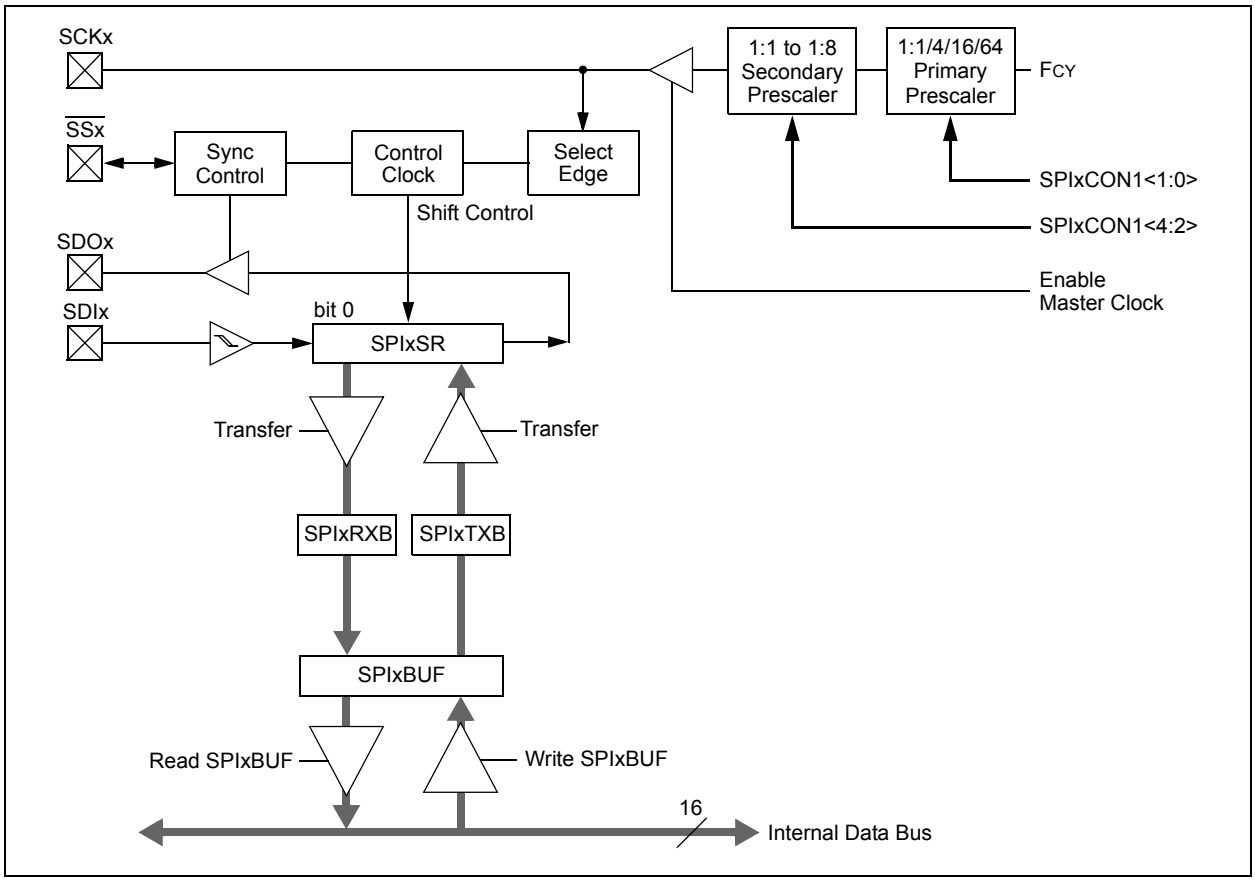
Note: In this section, the SPI modules are referred to together as SPIx, or separately as SPI1 and SPI2. Special Function Registers will follow a similar notation. For example, SPIxCON refers to the control register for the SPI1 or SPI2 module.

Each SPI module consists of a 16-bit shift register, SPIxSR (where x = 1 or 2), used for shifting data in and out, and a buffer register, SPIxBUF. A control register, SPIxCON, configures the module. Additionally, a status register, SPIxSTAT, indicates various status conditions.

The serial interface consists of 4 pins: SDIx (serial data input), SDOx (serial data output), SCKx (shift clock input or output), and SSx (active-low slave select).

In Master mode operation, SCK is a clock output but in Slave mode, it is a clock input.

FIGURE 16-1: SPI MODULE BLOCK DIAGRAM



REGISTER 19-19: CiFMSKSEL2: ECAN™ FILTER 15-8 MASK SELECTION 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
F15MSK<1:0>		F14MSK<1:0>		F13MSK<1:0>		F12MSK<1:0>	
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
F11MSK<1:0>		F10MSK<1:0>		F9MSK<1:0>		F8MSK<1:0>	
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 15-14 **F15MSK<1:0>:** Mask Source for Filter 15 bit
11 = Reserved
10 = Acceptance Mask 2 registers contain mask
01 = Acceptance Mask 1 registers contain mask
00 = Acceptance Mask 0 registers contain mask

bit 13-12 **F14MSK<1:0>:** Mask Source for Filter 14 bit (same values as bit 15-14)

bit 11-10 **F13MSK<1:0>:** Mask Source for Filter 13 bit (same values as bit 15-14)

bit 9-8 **F12MSK<1:0>:** Mask Source for Filter 12 bit (same values as bit 15-14)

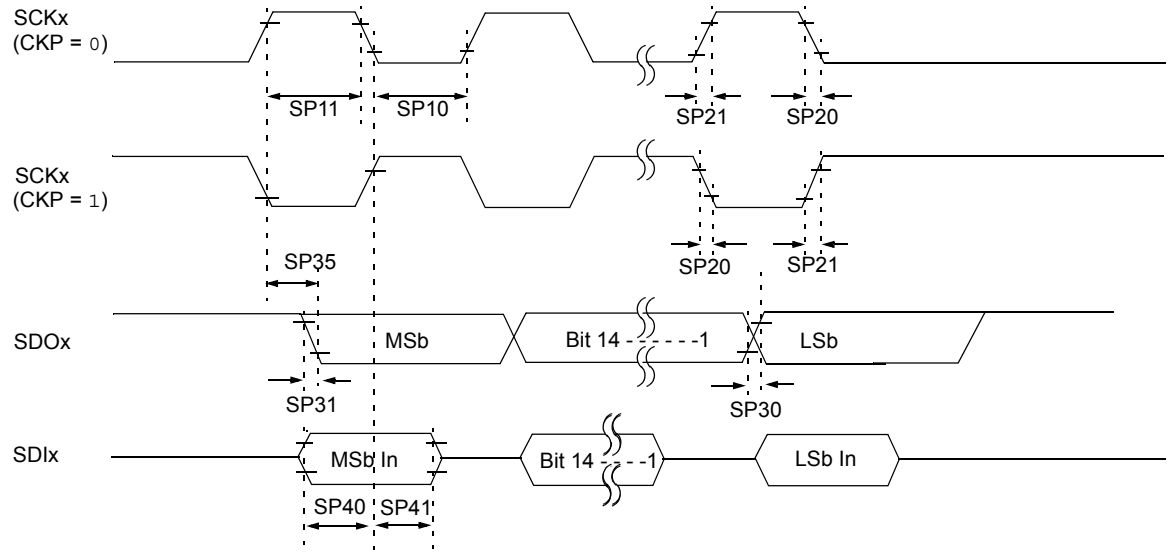
bit 7-6 **F11MSK<1:0>:** Mask Source for Filter 11 bit (same values as bit 15-14)

bit 5-4 **F10MSK<1:0>:** Mask Source for Filter 10 bit (same values as bit 15-14)

bit 3-2 **F9MSK<1:0>:** Mask Source for Filter 9 bit (same values as bit 15-14)

bit 1-0 **F8MSK<1:0>:** Mask Source for Filter 8 bit (same values as bit 15-14)

FIGURE 25-9: SPIx MODULE MASTER MODE (CKE = 0) TIMING CHARACTERISTICS



Note: Refer to Figure 25-1 for load conditions.

TABLE 25-28: SPIx MASTER MODE (CKE = 0) TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C				
Param No.	**Symbol**	**Characteristic(1)**	**Min**	**Typ(2)**	**Max**	**Units**	**Conditions**
SP10	TscL	SCKx Output Low Time	TCY/2	—	—	ns	See **Note 3**
SP11	TscH	SCKx Output High Time	TCY/2	—	—	ns	See **Note 3**
SP20	TscF	SCKx Output Fall Time	—	—	—	ns	See parameter D032 and **Note 4**
SP21	TscR	SCKx Output Rise Time	—	—	—	ns	See parameter D031 and **Note 4**
SP30	TdoF	SDOx Data Output Fall Time	—	—	—	ns	See parameter D032 and **Note 4**
SP31	TdoR	SDOx Data Output Rise Time	—	—	—	ns	See parameter D031 and **Note 4**
SP35	TscH2doV, TscL2doV	SDOx Data Output Valid after SCKx Edge	—	6	20	ns	—
SP40	TdiV2scH, TdiV2scL	Setup Time of SDIx Data Input to SCKx Edge	23	—	—	ns	—
SP41	TscH2diL, TscL2diL	Hold Time of SDIx Data Input to SCKx Edge	30	—	—	ns	—

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.

3: The minimum clock period for SCKx is 100 ns. Therefore, the clock generated in Master mode must not violate this specification.

4: Assumes 50 pF load on all SPIx pins.

APPENDIX A: REVISION HISTORY

Revision A (October 2006)

Initial release of this document.

Revision B (March 2008)

This revision includes minor typographical and formatting changes throughout the data sheet text.

The major changes are referenced by their respective section in the following table.

TABLE A-1: MAJOR SECTION UPDATES

Section Name	Update Description
Section 1.0 "Device Overview"	Added External Interrupt pin information (INT0 through INT4) to Table 1-1.
Section 3.0 "Memory Organization"	Updated Change Notification Register Map table title to reflect application with dsPIC33FJXXXMCX10 devices (Table 3-2). Added Change Notification Register Map tables (Table 3-3 and Table 3-4) for dsPIC33FJXXXMCX08 and dsPIC33FJXXXMCX06 devices, respectively. Updated the bit range for AD1CON3 (ADCS<7:0>) in the ADC1 Register Map and added Note 1 (Table 3-15). Updated the bit range for AD2CON3 (ADCS<7:0>) in the ADC2 Register Map (Table 3-16). Updated the Reset value for C1FEN1 (FFFF) in the ECAN1 Register Map When C1CTRL1.WIN = 0 or 1 (Table 3-18) and updated the title to reflect applicable devices. Updated the title in the ECAN1 Register Map When C1CTRL1.WIN = 0 to reflect applicable devices (Table 3-19). Updated the title in the ECAN1 Register Map When C1CTRL1.WIN = 1 to reflect applicable devices (Table 3-20). Updated the Reset value for C2FEN1 (FFFF) in the ECAN2 Register Map When C2CTRL1.WIN = 0 or 1 (Table 3-21) and updated the title to reflect applicable devices. Updated the title for the ECAN2 Register Map When C2CTRL1.WIN = 0 to reflect applicable devices (Table 3-22). Updated the title for the ECAN2 Register Map When C2CTRL1.WIN = 1 to reflect applicable devices (Table 3-23). Updated Reset value for TRISA (C6FF) and changed the bit 12 and bit 13 values for ODCA to unimplemented in the PORTA Register Map (Table 3-25). Changed the bit 10 and bit 9 values for PMD1 to unimplemented in the PMD Register Map (Table 3-34).
Section 5.0 "Reset"	Added POR and BOR references in Reset Flag Bit Operation (Table 5-1).
Section 7.0 "Direct Memory Access (DMA)"	Updated the table cross-reference in Note 2 in the DMAxREQ register (Register 7-2).

TABLE A-2: MAJOR SECTION UPDATES (CONTINUED)

Section Name	Update Description
Section 19.0 "Enhanced CAN (ECAN™) Module"	Changed bit 11 in the ECAN Control Register 1 (CiCTRL1) to Reserved (see Register 19-1). Added the ECAN Filter 15-8 Mask Selection (CiFMSKSEL2) register (see Register 19-19).
Section 21.0 "10-Bit/12-Bit Analog-to-Digital Converter (ADC)"	Replaced the ADC Module Block Diagram (see Figure 21-1) and removed Figure 21-2.
Section 22.0 "Special Features"	Added Note 2 to the Device Configuration Register Map (see Table 22-1)
Section 25.0 "Electrical Characteristics"	Updated Typical values for Thermal Packaging Characteristics (see Table 25-3). Updated Min and Max values for parameter DC12 (RAM Data Retention Voltage) and added Note 4 (see Table 25-4). Updated Power-Down Current Max values for parameters DC60b and DC60c (see Table 25-7). Updated Characteristics for I/O Pin Input Specifications (see Table 25-9). Updated Program Memory values for parameters 136, 137 and 138 (renamed to 136a, 137a and 138a), added parameters 136b, 137b and 138b, and added Note 2 (see Table 25-12). Added parameter OS42 (GM) to the External Clock Timing Requirements (see Table 25-16). Updated Watchdog Timer Time-out Period parameter SY20 (see Table 25-21).