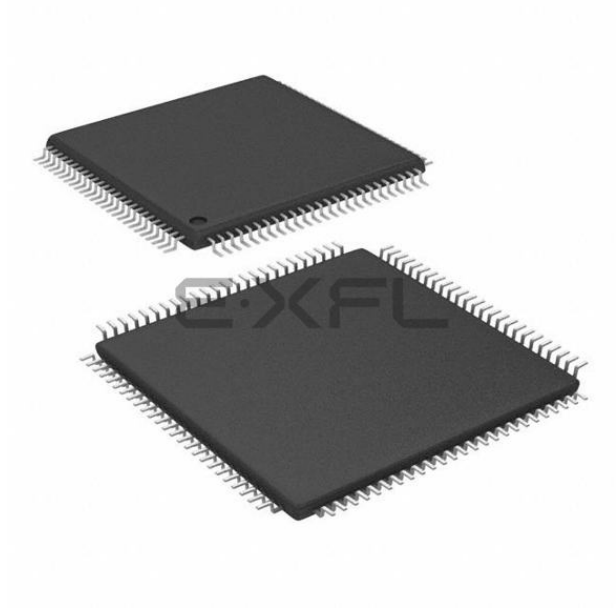
Microchip Technology - DSPIC33FJ256GP510-I/PF Datasheet



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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	40 MIPs
Connectivity	CANbus, 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	256KB (256K 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/dspic33fj256gp510-i-pf

Pin Diagrams (Continued)

64-Pin TQFP

■ = Pins are up to 5V tolerant

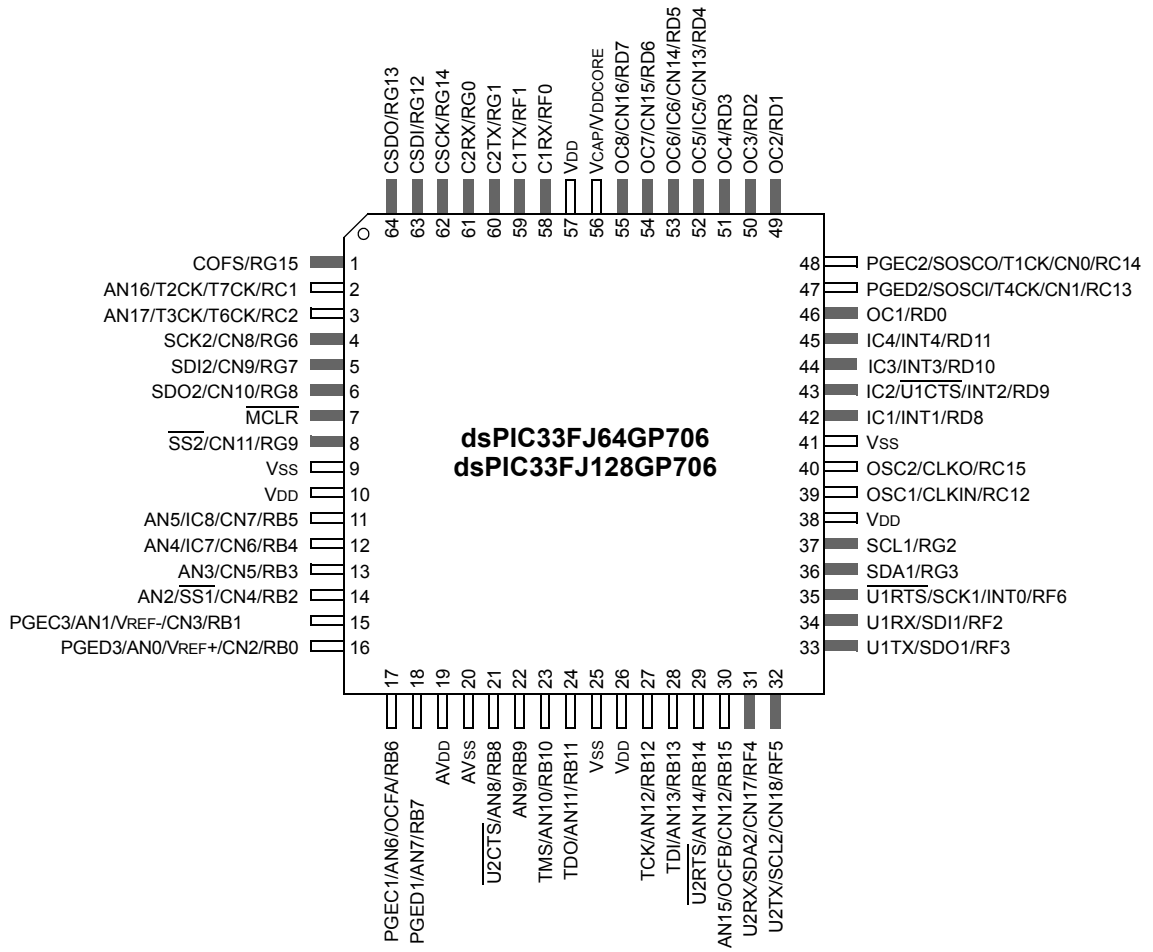


TABLE 4-17: DMA REGISTER MAP (CONTINUED)

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
DMA5CNT	03C6	—	—	—	—	—	—	CNT<9:0>										0000
DMA6CON	03C8	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE<1:0>		—	—	MODE<1:0>		0000
DMA6REQ	03CA	FORCE	—	—	—	—	—	—	—	—	IRQSEL<6:0>							0000
DMA6STA	03CC	STA<15:0>																0000
DMA6STB	03CE	STB<15:0>																0000
DMA6PAD	03D0	PAD<15:0>																0000
DMA6CNT	03D2	—	—	—	—	—	—	CNT<9:0>										0000
DMA7CON	03D4	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE<1:0>		—	—	MODE<1:0>		0000
DMA7REQ	03D6	FORCE	—	—	—	—	—	—	—	—	IRQSEL<6:0>							0000
DMA7STA	03D8	STA<15:0>																0000
DMA7STB	03DA	STB<15:0>																0000
DMA7PAD	03DC	PAD<15:0>																0000
DMA7CNT	03DE	—	—	—	—	—	—	CNT<9:0>										0000
DMACS0	03E0	PWCOL7	PWCOL6	PWCOL5	PWCOL4	PWCOL3	PWCOL2	PWCOL1	PWCOL0	XWCOL7	XWCOL6	XWCOL5	XWCOL4	XWCOL3	XWCOL2	XWCOL1	XWCOL0	0000
DMACS1	03E2	—	—	—	—	LSTCH<3:0>				PPST7	PPST6	PPST5	PPST4	PPST3	PPST2	PPST1	PPST0	0000
DSADR	03E4	DSADR<15:0>																0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-20: ECAN1 REGISTER MAP WHEN C1CTRL1.WIN = 1 FOR dsPIC33FJXXXGP506/510/706/708/710 DEVICES ONLY (CONTINUED)

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
C1RXF11SID	046C	SID<10:3>								SID<2:0>			—	EXIDE	—	EID<17:16>		xxxx
C1RXF11EID	046E	EID<15:8>								EID<7:0>								xxxx
C1RXF12SID	0470	SID<10:3>								SID<2:0>			—	EXIDE	—	EID<17:16>		xxxx
C1RXF12EID	0472	EID<15:8>								EID<7:0>								xxxx
C1RXF13SID	0474	SID<10:3>								SID<2:0>			—	EXIDE	—	EID<17:16>		xxxx
C1RXF13EID	0476	EID<15:8>								EID<7:0>								xxxx
C1RXF14SID	0478	SID<10:3>								SID<2:0>			—	EXIDE	—	EID<17:16>		xxxx
C1RXF14EID	047A	EID<15:8>								EID<7:0>								xxxx
C1RXF15SID	047C	SID<10:3>								SID<2:0>			—	EXIDE	—	EID<17:16>		xxxx
C1RXF15EID	047E	EID<15:8>								EID<7:0>								xxxx

Legend: x = unknown value on Reset, — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

EXAMPLE 5-2: LOADING THE WRITE BUFFERS

```
; Set up NVMCON for row programming operations
       MOV     #0x4001, W0                     ;
       MOV     W0, NVMCON                      ; Initialize NVMCON
; Set up a pointer to the first program memory location to be written
; program memory selected, and writes enabled
       MOV     #0x0000, W0                     ;
       MOV     W0, TBLPAG                      ; Initialize PM Page Boundary SFR
       MOV     #0x6000, W0                     ; An example program memory address
; Perform the TBLWT instructions to write the latches
; 0th_program_word
       MOV     #LOW_WORD_0, W2                 ;
       MOV     #HIGH_BYTE_0, W3                ;
       TBLWTL  W2, [W0]                        ; Write PM low word into program latch
       TBLWTH  W3, [W0++]                      ; Write PM high byte into program latch
; 1st_program_word
       MOV     #LOW_WORD_1, W2                 ;
       MOV     #HIGH_BYTE_1, W3                ;
       TBLWTL  W2, [W0]                        ; Write PM low word into program latch
       TBLWTH  W3, [W0++]                      ; Write PM high byte into program latch
;  2nd_program_word
       MOV     #LOW_WORD_2, W2                 ;
       MOV     #HIGH_BYTE_2, W3                ;
       TBLWTL  W2, [W0]                        ; Write PM low word into program latch
       TBLWTH  W3, [W0++]                      ; Write PM high byte into program latch
       •
       •
       •
; 63rd_program_word
       MOV     #LOW_WORD_31, W2                ;
       MOV     #HIGH_BYTE_31, W3               ;
       TBLWTL  W2, [W0]                        ; Write PM low word into program latch
       TBLWTH  W3, [W0++]                      ; Write PM high byte into program latch
```

EXAMPLE 5-3: INITIATING A PROGRAMMING SEQUENCE

```
       DISI    #5                      ; Block all interrupts with priority <7
                                       ; for next 5 instructions
       MOV     #0x55, W0
       MOV     W0, NVMKEY              ; Write the 55 key
       MOV     #0xAA, W1               ;
       MOV     W1, NVMKEY              ; Write the AA key
       BSET    NVMCON, #WR             ; Start the erase sequence
       NOP                             ; Insert two NOPs after the
       NOP                             ; erase command is asserted
```

TABLE 6-3: RESET DELAY TIMES FOR VARIOUS DEVICE RESETS

Reset Type	Clock Source	$\overline{\text{SYSRST}}$ Delay	System Clock Delay	FSCM Delay	Notes
POR	EC, FRC, LPRC	TPOR + TSTARTUP + TRST	—	—	**1, 2, 3**
	ECPLL, FRCPLL	TPOR + TSTARTUP + TRST	TLOCK	TFSCM	**1, 2, 3, 5, 6**
	XT, HS, SOSC	TPOR + TSTARTUP + TRST	TOST	TFSCM	**1, 2, 3, 4, 6**
	XTPLL, HSPLL	TPOR + TSTARTUP + TRST	TOST + TLOCK	TFSCM	**1, 2, 3, 4, 5, 6**
BOR	EC, FRC, LPRC	TSTARTUP + TRST	—	—	**3**
	ECPLL, FRCPLL	TSTARTUP + TRST	TLOCK	TFSCM	**3, 5, 6**
	XT, HS, SOSC	TSTARTUP + TRST	TOST	TFSCM	**3, 4, 6**
	XTPLL, HSPLL	TSTARTUP + TRST	TOST + TLOCK	TFSCM	**3, 4, 5, 6**
$\overline{\text{MCLR}}$	Any Clock	TRST	—	—	**3**
WDT	Any Clock	TRST	—	—	**3**
Software	Any Clock	TRST	—	—	**3**
Illegal Opcode	Any Clock	TRST	—	—	**3**
Uninitialized W	Any Clock	TRST	—	—	**3**
Trap Conflict	Any Clock	TRST	—	—	**3**

Note 1: TPOR = Power-on Reset delay (10 μs nominal).

2: TSTARTUP = Conditional POR delay of 20 μs nominal (if on-chip regulator is enabled) or 64 ms nominal Power-up Timer delay (if regulator is disabled). TSTARTUP is also applied to all returns from powered-down states, including waking from Sleep mode, only if the regulator is enabled.

3: TRST = Internal state Reset time (20 μs nominal).

4: TOST = Oscillator Start-up Timer. A 10-bit counter counts 1024 oscillator periods before releasing the oscillator clock to the system.

5: TLOCK = PLL lock time (20 μs nominal).

6: TFSCM = Fail-Safe Clock Monitor delay (100 μs nominal).

6.2.1 POR AND LONG OSCILLATOR START-UP TIMES

The oscillator start-up circuitry and its associated delay timers are not linked to the device Reset delays that occur at power-up. Some crystal circuits (especially low-frequency crystals) have a relatively long start-up time. Therefore, one or more of the following conditions is possible after $\overline{\text{SYSRST}}$ is released:

- The oscillator circuit has not begun to oscillate.
- The Oscillator Start-up Timer has not expired (if a crystal oscillator is used).
- The PLL has not achieved a lock (if PLL is used).

The device will not begin to execute code until a valid clock source has been released to the system. Therefore, the oscillator and PLL start-up delays must be considered when the Reset delay time must be known.

6.2.2 FAIL-SAFE CLOCK MONITOR (FSCM) AND DEVICE RESETS

If the FSCM is enabled, it begins to monitor the system clock source when $\overline{\text{SYSRST}}$ is released. If a valid clock source is not available at this time, the device automatically switches to the FRC oscillator and the user can switch to the desired crystal oscillator in the Trap Service Routine.

6.2.2.1 FSCM Delay for Crystal and PLL Clock Sources

When the system clock source is provided by a crystal oscillator and/or the PLL, a small delay, TFSCM, is automatically inserted after the POR and PWRT delay times. The FSCM does not begin to monitor the system clock source until this delay expires. The FSCM delay time is nominally 500 μs and provides additional time for the oscillator and/or PLL to stabilize. In most cases, the FSCM delay prevents an oscillator failure trap at a device Reset when the PWRT is disabled.

6.3 Special Function Register Reset States

Most of the Special Function Registers (SFRs) associated with the CPU and peripherals are reset to a particular value at a device Reset. The SFRs are grouped by their peripheral or CPU function and their Reset values are specified in each section of this manual.

The Reset value for each SFR does not depend on the type of Reset, with the exception of two registers. The Reset value for the Reset Control register, RCON, depends on the type of device Reset. The Reset value for the Oscillator Control register, OSCCON, depends on the type of Reset and the programmed values of the oscillator Configuration bits in the FOSC Configuration register.

REGISTER 7-5: IFS0: INTERRUPT FLAG STATUS REGISTER 0

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	DMA1IF	AD1IF	U1TXIF	U1RXIF	SPI1IF	SPI1EIF	T3IF
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
T2IF	OC2IF	IC2IF	DMA01IF	T1IF	OC1IF	IC1IF	INT0IF
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 **DMA1IF:** DMA Channel 1 Data Transfer Complete Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 13 **AD1IF:** ADC1 Conversion Complete Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 12 **U1TXIF:** UART1 Transmitter Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 11 **U1RXIF:** UART1 Receiver Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 10 **SPI1IF:** SPI1 Event Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 9 **SPI1EIF:** SPI1 Fault Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 8 **T3IF:** Timer3 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 7 **T2IF:** Timer2 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 6 **OC2IF:** Output Compare Channel 2 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 5 **IC2IF:** Input Capture Channel 2 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 4 **DMA01IF:** DMA Channel 0 Data Transfer Complete Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 3 **T1IF:** Timer1 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

REGISTER 7-6: IFS1: INTERRUPT FLAG STATUS REGISTER 1 (CONTINUED)

bit 3 **CNIF:** Input Change Notification Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 2 **Unimplemented:** Read as '0'

bit 1 **MI2C1IF:** I2C1 Master Events Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 0 **SI2C1IF:** I2C1 Slave Events Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

REGISTER 7-10: IEC0: INTERRUPT ENABLE CONTROL REGISTER 0

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	DMA1IE	AD1IE	U1TXIE	U1RXIE	SPI1IE	SPI1EIE	T3IE
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
T2IE	OC2IE	IC2IE	DMA0IE	T1IE	OC1IE	IC1IE	INT0IE
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 **DMA1IE:** DMA Channel 1 Data Transfer Complete Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 13 **AD1IE:** ADC1 Conversion Complete Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 12 **U1TXIE:** UART1 Transmitter Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 11 **U1RXIE:** UART1 Receiver Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 10 **SPI1IE:** SPI1 Event Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 9 **SPI1EIE:** SPI1 Error Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 8 **T3IE:** Timer3 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 7 **T2IE:** Timer2 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 6 **OC2IE:** Output Compare Channel 2 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 5 **IC2IE:** Input Capture Channel 2 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 4 **DMA0IE:** DMA Channel 0 Data Transfer Complete Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 3 **T1IE:** Timer1 Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

REGISTER 7-11: IEC1: INTERRUPT ENABLE CONTROL REGISTER 1 (CONTINUED)

bit 3 **CNIE:** Input Change Notification Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 2 **Unimplemented:** Read as '0'

bit 1 **MI2C1IE:** I2C1 Master Events Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 0 **SI2C1IE:** I2C1 Slave Events Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

REGISTER 7-22: IPC7: INTERRUPT PRIORITY CONTROL REGISTER 7

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	U2TXIP<2:0>			—	U2RXIP<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
—	INT2IP<2:0>			—	T5IP<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 **U2TXIP<2:0>:** UART2 Transmitter 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 **U2RXIP<2:0>:** UART2 Receiver 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 **INT2IP<2:0>:** External Interrupt 2 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 **T5IP<2:0>:** Timer5 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

REGISTER 7-32: IPC17: INTERRUPT PRIORITY CONTROL REGISTER 17

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	C2TXIP<2:0>			—	C1TXIP<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
—	DMA7IP<2:0>			—	DMA6IP<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 **C2TXIP<2:0>:** ECAN2 Transmit Data Request 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 **C1TXIP<2:0>:** ECAN1 Transmit Data Request 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 **DMA7IP<2:0>:** DMA Channel 7 Data Transfer Complete 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 **DMA6IP<2:0>:** DMA Channel 6 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 8-3: DMAxSTA: DMA CHANNEL x RAM START ADDRESS OFFSET REGISTER A

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
STA<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
STA<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 **STA<15:0>:** Primary DMA RAM Start Address bits (source or destination)

REGISTER 8-4: DMAxSTB: DMA CHANNEL x RAM START ADDRESS OFFSET REGISTER B

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
STB<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
STB<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 **STB<15:0>:** Secondary DMA RAM Start Address bits (source or destination)

REGISTER 13-2: TyCON (T3CON, T5CON, T7CON OR T9CON) CONTROL REGISTER

R/W-0	U-0	R/W-0	U-0	U-0	U-0	U-0	U-0
TON(1)	—	TSIDL(2)	—	—	—	—	—
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	U-0	U-0	R/W-0	U-0
—	TGATE(1)	TCKPS<1:0>(1)		—	—	TCS(1,3)	—
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 **TON:** Timery On bit(1)
1 = Starts 16-bit Timery
0 = Stops 16-bit Timery

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

bit 13 **TSIDL:** Stop in Idle Mode bit(2)
1 = Discontinue module operation when device enters Idle mode
0 = Continue module operation in Idle mode

bit 12-7 **Unimplemented:** Read as '0'

bit 6 **TGATE:** Timery Gated Time Accumulation Enable bit(1)
When TCS = 1:
This bit is ignored.
When TCS = 0:
1 = Gated time accumulation enabled
0 = Gated time accumulation disabled

bit 5-4 **TCKPS<1:0>:** Timer3 Input Clock Prescale Select bits(1)
11 = 1:256
10 = 1:64
01 = 1:8
00 = 1:1

bit 3-2 **Unimplemented:** Read as '0'

bit 1 **TCS:** Timery Clock Source Select bit(1,3)
1 = External clock from pin TyCK (on the rising edge)
0 = Internal clock (FCY)

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

Note 1: When 32-bit operation is enabled (T2CON<3> = 1), these bits have no effect on Timery operation; all timer functions are set through T2CON.

2: When 32-bit timer operation is enabled (T32 = 1) in the Timer Control register (TxCON<3>), the TSIDL bit must be cleared to operate the 32-bit timer in Idle mode.

3: The TyCK pin is not available on all timers. Refer to the **"Pin Diagrams"** section for the available pins.

21.0 10-BIT/12-BIT ANALOG-TO-DIGITAL CONVERTER (ADC)

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 16. "Analog-to-Digital Converter (ADC)"** (DS70183) in the *"dsPIC33F Family Reference Manual"*, which is available from the Microchip web site (www.microchip.com).

The dsPIC33FJXXXGPX06/X08/X10 devices have up to 32 ADC input channels. These devices also have up to 2 ADC modules (ADCx, where 'x' = 1 or 2), each with its own set of Special Function Registers.

The AD12B bit (ADxCON1<10>) allows each of the ADC modules to be configured by the user as either a 10-bit, 4-sample/hold ADC (default configuration) or a 12-bit, 1-sample/hold ADC.

Note:	The ADC module needs to be disabled before modifying the AD12B bit.

21.1 Key Features

The 10-bit ADC configuration has the following key features:

- Successive Approximation (SAR) conversion
- Conversion speeds of up to 1.1 Msps
- Up to 32 analog input pins
- External voltage reference input pins
- Simultaneous sampling of up to four analog input pins
- Automatic Channel Scan mode
- Selectable conversion trigger source
- Selectable Buffer Fill modes
- Four result alignment options (signed/unsigned, fractional/integer)
- Operation during CPU Sleep and Idle modes

The 12-bit ADC configuration supports all the above features, except:

- In the 12-bit configuration, conversion speeds of up to 500 ksps are supported
- There is only 1 sample/hold amplifier in the 12-bit configuration, so simultaneous sampling of multiple channels is not supported.

Depending on the particular device pinout, the ADC can have up to 32 analog input pins, designated AN0 through AN31. In addition, there are two analog input pins for external voltage reference connections. These voltage reference inputs may be shared with other analog input pins. The actual number of analog input pins and external voltage reference input configuration will depend on the specific device. Refer to the device data sheet for further details.

A block diagram of the ADC is shown in Figure 21-1.

21.2 ADC Initialization

The following configuration steps should be performed.

1. Configure the ADC module:
   a) Select port pins as analog inputs (ADxPCFGH<15:0> or ADxPCFGL<15:0>)
   b) Select voltage reference source to match expected range on analog inputs (ADxCON2<15:13>)
   c) Select the analog conversion clock to match desired data rate with processor clock (ADxCON3<7:0>)
   d) Determine how many S/H channels will be used (ADxCON2<9:8> and ADxPCFGH<15:0> or ADxPCFGL<15:0>)
   e) Select the appropriate sample/conversion sequence (ADxCON1<7:5> and ADxCON3<12:8>)
   f) Select how conversion results are presented in the buffer (ADxCON1<9:8>)
   g) Turn on ADC module (ADxCON1<15>)
2. Configure ADC interrupt (if required):
   a) Clear the ADxIF bit
   b) Select ADC interrupt priority

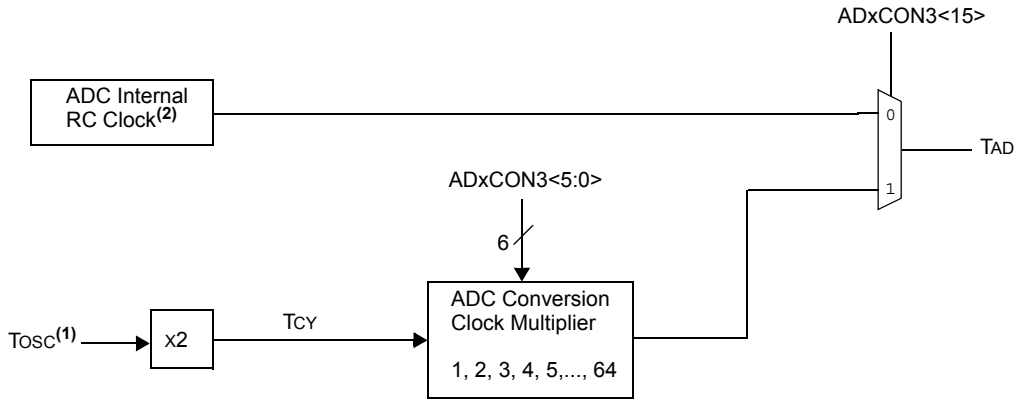
21.3 ADC and DMA

If more than one conversion result needs to be buffered before triggering an interrupt, DMA data transfers can be used. Both ADC1 and ADC2 can trigger a DMA data transfer. If ADC1 or ADC2 is selected as the DMA IRQ source, a DMA transfer occurs when the AD1IF or AD2IF bit gets set as a result of an ADC1 or ADC2 sample conversion sequence.

The SMPI<3:0> bits (ADxCON2<5:2>) are used to select how often the DMA RAM buffer pointer is incremented.

The ADDMABM bit (ADxCON1<12>) determines how the conversion results are filled in the DMA RAM buffer area being used for ADC. If this bit is set, DMA buffers are written in the order of conversion. The module will provide an address to the DMA channel that is the same as the address used for the non-DMA stand-alone buffer. If the ADDMABM bit is cleared, then DMA buffers are written in Scatter/Gather mode. The module will provide a scatter/gather address to the DMA channel, based on the index of the analog input and the size of the DMA buffer.

FIGURE 21-2: ADC CONVERSION CLOCK PERIOD BLOCK DIAGRAM



Note 1: Refer to Figure 9-2 for the derivation of FOSC when the PLL is enabled. If the PLL is not used, FOSC is equal to the clock source frequency. TOSC = 1/FOSC.

2: See the ADC electrical specifications for the exact RC clock value.

22.4 Watchdog Timer (WDT)

For dsPIC33FJXXXGPX06/X08/X10 devices, the WDT is driven by the LPRC oscillator. When the WDT is enabled, the clock source is also enabled.

The nominal WDT clock source from LPRC is 32 kHz. This feeds a prescaler and then can be configured for either 5-bit (divide-by-32) or 7-bit (divide-by-128) operation. The prescaler is set by the WDTPRE Configuration bit. With a 32 kHz input, the prescaler yields a nominal WDT time-out period (T_{WDT}) of 1 ms in 5-bit mode, or 4 ms in 7-bit mode.

A variable postscaler divides down the WDT prescaler output and allows for a wide range of time-out periods. The postscaler is controlled by the WDTPOST<3:0> Configuration bits (FWDT<3:0>) which allow the selection of a total of 16 settings, from 1:1 to 1:32,768. Using the prescaler and postscaler, time-out periods ranging from 1 ms to 131 seconds can be achieved.

The WDT, prescaler and postscaler are reset:

- On any device Reset
- On the completion of a clock switch, whether invoked by software (i.e., setting the OSWEN bit after changing the NOSC bits) or by hardware (i.e., Fail-Safe Clock Monitor)
- When a PWRSAV instruction is executed (i.e., Sleep or Idle mode is entered)
- When the device exits Sleep or Idle mode to resume normal operation
- By a CLRWDT instruction during normal execution

If the WDT is enabled, it will continue to run during Sleep or Idle modes. When the WDT time-out occurs, the device will wake the device and code execution will continue from where the PWRSAV instruction was executed. The corresponding SLEEP or IDLE bits (RCON<3,2>) will need to be cleared in software after the device wakes up.

The WDT flag bit, WDTO (RCON<4>), is not automatically cleared following a WDT time-out. To detect subsequent WDT events, the flag must be cleared in software.

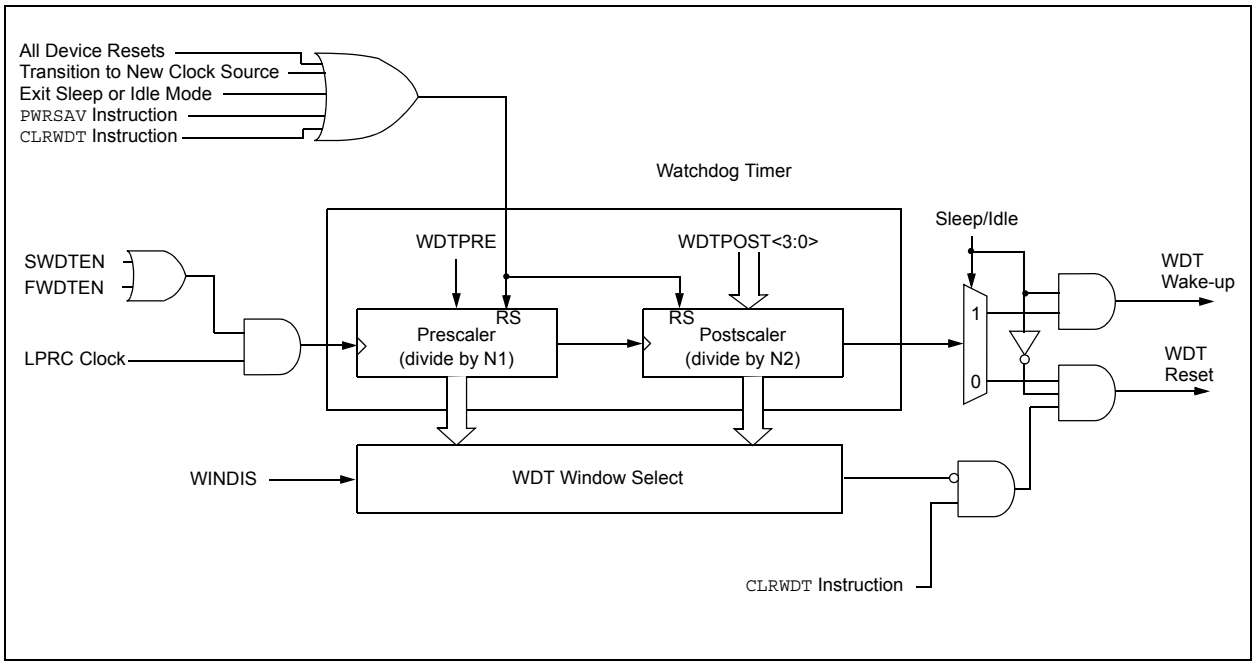
Note:	The CLRWDT and PWRSAV instructions clear the prescaler and postscaler counts when executed.

The WDT is enabled or disabled by the FWDTEN Configuration bit in the FWDT Configuration register. When the FWDTEN Configuration bit is set, the WDT is always enabled.

The WDT can be optionally controlled in software when the FWDTEN Configuration bit has been programmed to '0'. The WDT is enabled in software by setting the SWDTEN control bit (RCON<5>). The SWDTEN control bit is cleared on any device Reset. The software WDT option allows the user to enable the WDT for critical code segments and disable the WDT during non-critical segments for maximum power savings.

Note:	If the WINDIS bit (FWDT<6>) is cleared, the CLRWDT instruction should be executed by the application software only during the last 1/4 of the WDT period. This CLRWDT window can be determined by using a timer. If a CLRWDT instruction is executed before this window, a WDT Reset occurs.

FIGURE 22-2: WDT BLOCK DIAGRAM



24.11 PICSTART Plus Development Programmer

The PICSTART Plus Development Programmer is an easy-to-use, low-cost, prototype programmer. It connects to the PC via a COM (RS-232) port. MPLAB Integrated Development Environment software makes using the programmer simple and efficient. The PICSTART Plus Development Programmer supports most PIC devices in DIP packages up to 40 pins. Larger pin count devices, such as the PIC16C92X and PIC17C76X, may be supported with an adapter socket. The PICSTART Plus Development Programmer is CE compliant.

24.12 PICkit 2 Development Programmer

The PICkit 2 Development Programmer is a low-cost programmer and selected Flash device debugger with an easy-to-use interface for programming many of Microchip's baseline, mid-range and PIC18F families of Flash memory microcontrollers. The PICkit 2 Starter Kit includes a prototyping development board, twelve sequential lessons, software and HI-TECH's PICC™ Lite C compiler, and is designed to help get up to speed quickly using PIC microcontrollers. The kit provides everything needed to program, evaluate and develop applications using Microchip's powerful, mid-range Flash memory family of microcontrollers.

24.13 Demonstration, Development and Evaluation Boards

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.

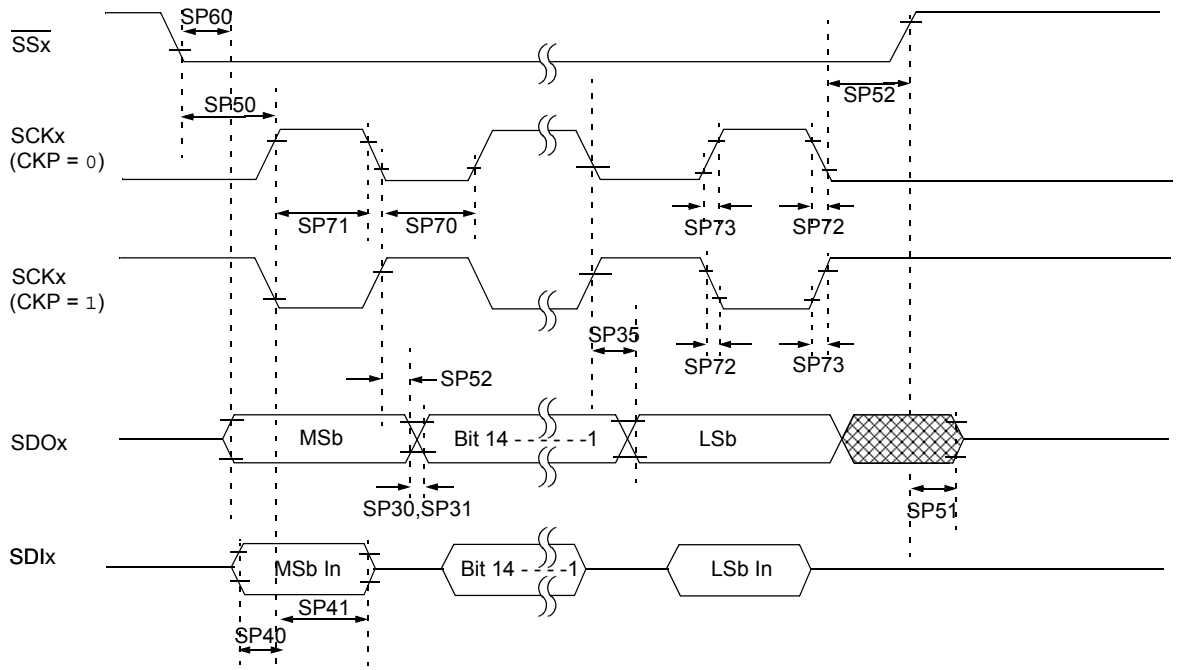
The boards support a variety of features, including LEDs, temperature sensors, switches, speakers, RS-232 interfaces, LCD displays, potentiometers and additional EEPROM memory.

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.

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

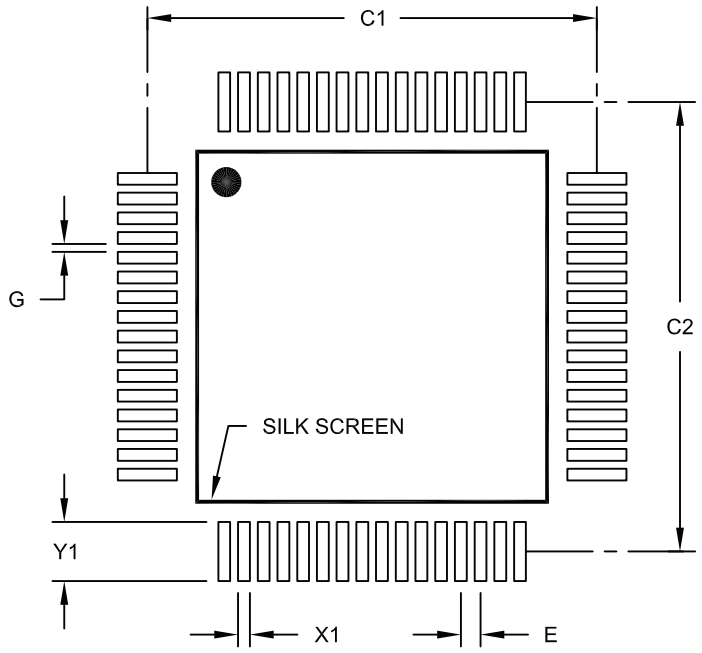
FIGURE 25-12: SPIx MODULE SLAVE MODE (CKE = 1) TIMING CHARACTERISTICS



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

64-Lead Plastic Thin Quad Flatpack (PT) – 10x10x1 mm Body, 2.00 mm [TQFP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Contact Pad Spacing	C1		11.40	
Contact Pad Spacing	C2		11.40	
Contact Pad Width (X64)	X1			0.30
Contact Pad Length (X64)	Y1			1.50
Distance Between Pads	G	0.20		

Notes:

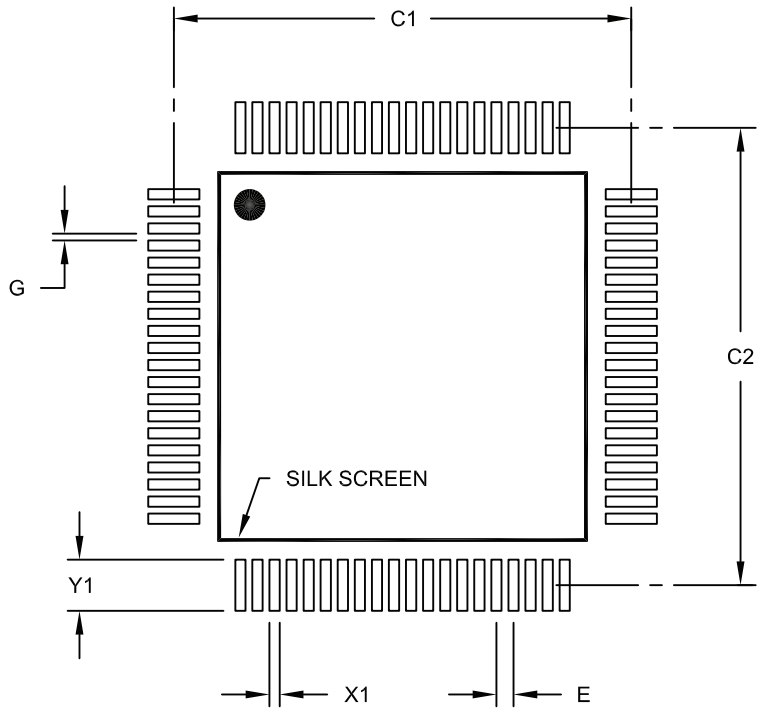
1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2085A

80-Lead Plastic Thin Quad Flatpack (PT) – 12x12x1 mm Body, 2.00 mm [TQFP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Contact Pad Spacing	C1		13.40	
Contact Pad Spacing	C2		13.40	
Contact Pad Width (X80)	X1			0.30
Contact Pad Length (X80)	Y1			1.50
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2092A