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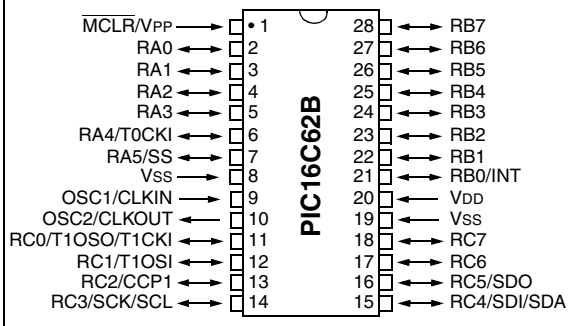
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	4MHz
Connectivity	I²C, SPI
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	22
Program Memory Size	3.5KB (2K x 14)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	128 x 8
Voltage - Supply (Vcc/Vdd)	4V ~ 5.5V
Data Converters	A/D 5x8b
Oscillator Type	External
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	28-SSOP (0.209", 5.30mm Width)
Supplier Device Package	28-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16c72a-04e-ss

Pin Diagrams

SDIP, SOIC, SSOP, Windowed CERDIP



Key Features PIC® Mid-Range Reference Manual (DS33023)	PIC16C62B	PIC16C72A
Operating Frequency	DC - 20 MHz	DC - 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
Program Memory (14-bit words)	2K	2K
Data Memory (bytes)	128	128
Interrupts	7	8
I/O Ports	Ports A,B,C	Ports A,B,C
Timers	3	3
Capture/Compare/PWM modules	1	1
Serial Communications	SSP	SSP
8-bit Analog-to-Digital Module	—	5 input channels

2.2.2 SPECIAL FUNCTION REGISTERS

The Special Function Registers are registers used by the CPU and Peripheral Modules for controlling the desired operation of the device. These registers are implemented as static RAM. A list of these registers is given in Table 2-1.

The Special Function Registers can be classified into two sets; core (CPU) and peripheral. Those registers associated with the core functions are described in detail in this section. Those related to the operation of the peripheral features are described in detail in the peripheral feature section.

TABLE 2-1 SPECIAL FUNCTION REGISTER SUMMARY

Addr	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other resets (4)
Bank 0											
00h	INDF(1)	Addressing this location uses contents of FSR to address data memory (not a physical register)								0000 0000	0000 0000
01h	TMR0	Timer0 module's register								xxxx xxxx	uuuu uuuu
02h	PCL(1)	Program Counter's (PC) Least Significant Byte								0000 0000	0000 0000
03h	STATUS(1)	IRP(5)	RP1(5)	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C	0001 1xxx	000q quuu
04h	FSR(1)	Indirect data memory address pointer								xxxx xxxx	uuuu uuuu
05h	PORTA(6,7)	—	—	PORTA Data Latch when written: PORTA pins when read						--0x 0000	--0u 0000
06h	PORTB(6,7)	PORTB Data Latch when written: PORTB pins when read								xxxx xxxx	uuuu uuuu
07h	PORTC(6,7)	PORTC Data Latch when written: PORTC pins when read								xxxx xxxx	uuuu uuuu
08h-09h	—	Unimplemented								—	—
0Ah	PCLATH(1,2)	—	—	—	Write Buffer for the upper 5 bits of the Program Counter					---0 0000	---0 0000
0Bh	INTCON(1)	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF	0000 000x	0000 000u
0Ch	PIR1	—	ADIF(3)	—	—	SSPIF	CCP1IF	TMR2IF	TMR1IF	-0-- 0000	-0-- 0000
0Dh	—	Unimplemented								—	—
0Eh	TMR1L	Holding register for the Least Significant Byte of the 16-bit TMR1 register								xxxx xxxx	uuuu uuuu
0Fh	TMR1H	Holding register for the Most Significant Byte of the 16-bit TMR1 register								xxxx xxxx	uuuu uuuu
10h	T1CON	—	—	T1CKPS1	T1CKPS0	T1OSCEN	$\overline{T1SYNC}$	TMR1CS	TMR1ON	--00 0000	--uu uuuu
11h	TMR2	Timer2 module's register								0000 0000	0000 0000
12h	T2CON	—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0	-000 0000	-000 0000
13h	SSPBUF	Synchronous Serial Port Receive Buffer/Transmit Register								xxxx xxxx	uuuu uuuu
14h	SSPCON	WCOL	SSPOV	SSPEN	CKP	SSPM3	SSPM2	SSPM1	SSPM0	0000 0000	0000 0000
15h	CCPR1L	Capture/Compare/PWM Register1 (LSB)								xxxx xxxx	uuuu uuuu
16h	CCPR1H	Capture/Compare/PWM Register1 (MSB)								xxxx xxxx	uuuu uuuu
17h	CCP1CON	—	—	CCP1X	CCP1Y	CCP1M3	CCP1M2	CCP1M1	CCP1M0	--00 0000	--00 0000
18h-1Dh	—	Unimplemented								—	—
1Eh	ADRES(3)	A/D Result Register								xxxx xxxx	uuuu uuuu
1Fh	ADCON0(3)	ADCS1	ADCS0	CHS2	CHS1	CHS0	GO/$\overline{DONE}$	—	ADON	0000 00-0	0000 00-0

Legend: x = unknown, u = unchanged, q = value depends on condition, - = unimplemented, read as '0', Shaded locations are unimplemented, read as '0'.

Note 1: These registers can be addressed from either bank.

2: The upper byte of the program counter is not directly accessible. PCLATH is a holding register for PC<12:8> whose contents are transferred to the upper byte of the program counter.

3: A/D not implemented on the PIC16C62B, maintain as '0'.

4: Other (non power-up) resets include: external reset through $\overline{MCLR}$ and the Watchdog Timer Reset.

5: The IRP and RP1 bits are reserved. Always maintain these bits clear.

6: On any device reset, these pins are configured as inputs.

7: This is the value that will be in the port output latch.

3.0 I/O PORTS

Some I/O port pins are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

Additional information on I/O ports may be found in the PIC® MCU Mid-Range Reference Manual, (DS33023).

3.1 PORTA and the TRISA Register

PORTA is a 6-bit wide bi-directional port. The corresponding data direction register is TRISA. Setting a TRISA bit (=1) will make the corresponding PORTA pin an input, i.e., put the corresponding output driver in a hi-impedance mode. Clearing a TRISA bit (=0) will make the corresponding PORTA pin an output, (i.e., put the contents of the output latch on the selected pin).

The PORTA register reads the state of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read, this value is modified, and then written to the port data latch.

Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open drain output. All other RA port pins have TTL input levels and full CMOS output drivers.

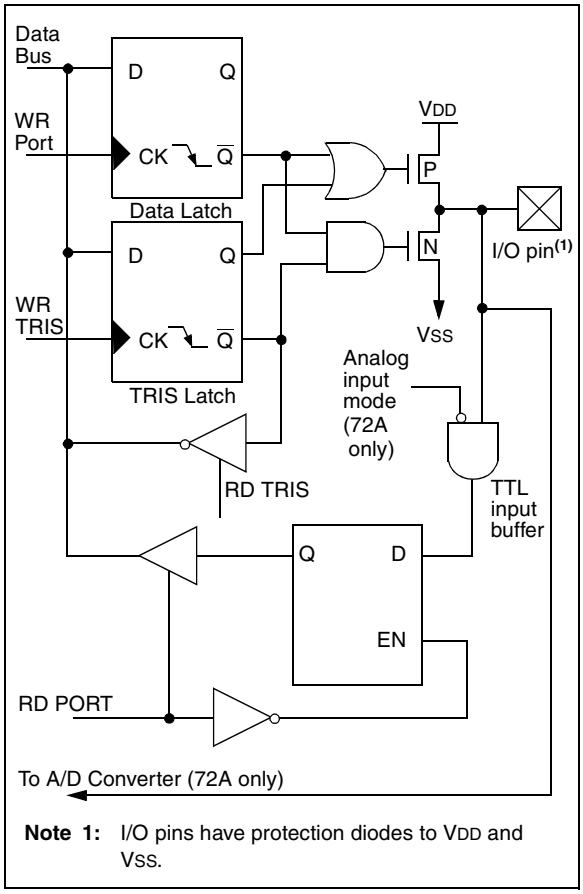
Pin RA5 is multiplexed with the SSP to become the RA5/$\overline{SS}$ pin.

On the PIC16C72A device, other PORTA pins are multiplexed with analog inputs and analog VREF input. The operation of each pin is selected by clearing/setting the control bits in the ADCON1 register (A/D Control Register1).

Note:	On a Power-on Reset, pins with analog functions are configured as analog inputs with digital input buffers disabled . A digital read of these pins will return '0'.

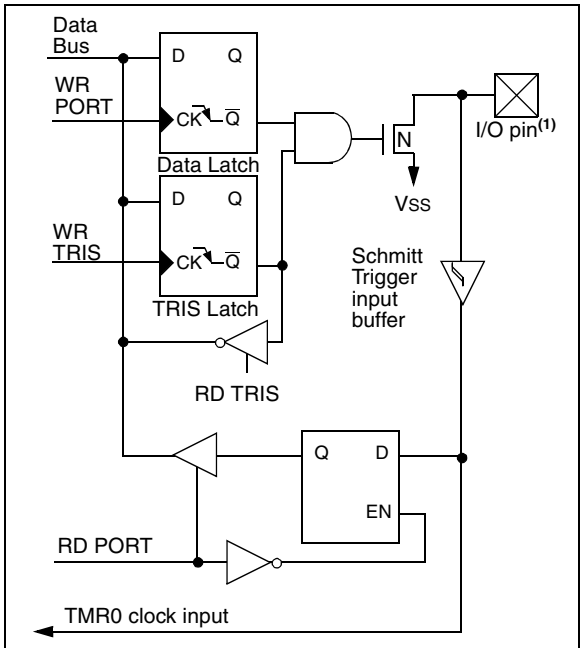
The TRISA register controls the direction of the RA pins, even when they are being used as analog inputs. The user must ensure the bits in the TRISA register are maintained set when using them as analog inputs.

FIGURE 3-1: BLOCK DIAGRAM OF RA3:RA0 AND RA5 PINS



Note 1: I/O pins have protection diodes to VDD and VSS.

FIGURE 3-2: BLOCK DIAGRAM OF RA4/T0CKI PIN



Note 1: I/O pin has protection diodes to VSS only.

7.0 CAPTURE/COMPARE/PWM (CCP) MODULE

The CCP (Capture/Compare/PWM) module contains a 16-bit register, which can operate as a 16-bit capture register, as a 16-bit compare register or as a PWM master/slave duty cycle register. Table 7-1 shows the timer resources of the CCP module modes.

Capture/Compare/PWM Register 1 (CCPR1) is comprised of two 8-bit registers: CCPR1L (low byte) and CCPR1H (high byte). The CCP1CON register controls the operation of CCP1. All are readable and writable.

Additional information on the CCP module is available in the PIC® MCU Mid-Range Reference Manual, (DS33023).

TABLE 7-1 CCP MODE - TIMER RESOURCE

CCP Mode	Timer Resource
Capture	Timer1
Compare	Timer1
PWM	Timer2

TABLE 7-2 INTERACTION OF TWO CCP MODULES

CCPx Mode	CCPy Mode	Interaction
Capture	Capture	Same TMR1 time-base.
Capture	Compare	The compare should be configured for the special event trigger, which clears TMR1.
Compare	Compare	The compare(s) should be configured for the special event trigger, which clears TMR1.
PWM	PWM	The PWMs will have the same frequency and update rate (TMR2 interrupt).
PWM	Capture	None.
PWM	Compare	None.

REGISTER 7-1:CCP1CON REGISTER (ADDRESS 17h)

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	CCP1X	CCP1Y	CCP1M3	CCP1M2	$\overline{\text{CCP1M1}}$	$\overline{\text{CCP1M0}}$
bit7							bit0

R = Readable bit
W = Writable bit
U = Unimplemented bit, read as '0'
- n =Value at POR reset

bit 7-6: **Unimplemented:** Read as '0'

bit 5-4: **CCP1X:CCP1Y**: PWM Least Significant bits
Capture Mode: Unused
Compare Mode: Unused
PWM Mode: These bits are the two LSbs of the PWM duty cycle. The eight MSbs are found in CCPR1L.

bit 3-0: **CCP1M3:CCP1M0**: CCP1 Mode Select bits
0000 = Capture/Compare/PWM off (resets CCP1 module)
0100 = Capture mode, every falling edge
0101 = Capture mode, every rising edge
0110 = Capture mode, every 4th rising edge
0111 = Capture mode, every 16th rising edge
1000 = Compare mode, set output on match (CCP1IF bit is set)
1001 = Compare mode, clear output on match (CCP1IF bit is set)
1010 = Compare mode, generate software interrupt on match (CCP1IF bit is set, CCP1 pin is unaffected)
1011 = Compare mode, trigger special event (CCP1IF bit is set; CCP1 resets TMR1 and starts an A/D conversion (if A/D module is enabled))
11xx = PWM mode

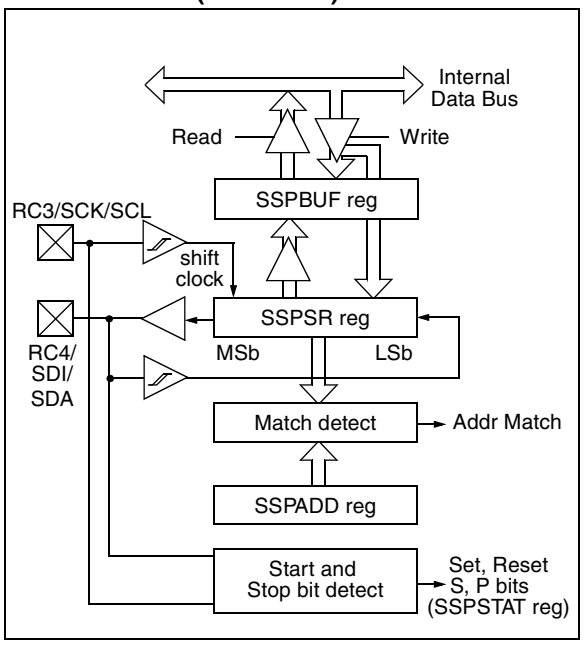
8.3 SSP I²C Operation

The SSP module in I²C mode fully implements all slave functions, except general call support, and provides interrupts on start and stop bits in hardware to support firmware implementations of the master functions. The SSP module implements the standard mode specifications, as well as 7-bit and 10-bit addressing.

Two pins are used for data transfer. These are the RC3/SCK/SCL pin, which is the clock (SCL), and the RC4/SDI/SDA pin, which is the data (SDA). The user must configure these pins as inputs or outputs through the TRISC<4:3> bits.

The SSP module functions are enabled by setting SSP Enable bit SSPEN (SSPCON<5>).

FIGURE 8-2: SSP BLOCK DIAGRAM (I²C MODE)



The SSP module has five registers for I²C operation. These are the:

- SSP Control Register (SSPCON)
- SSP Status Register (SSPSTAT)
- Serial Receive/Transmit Buffer (SSPBUF)
- SSP Shift Register (SSPSR) - Not accessible
- SSP Address Register (SSPADD)

The SSPCON register allows control of the I²C operation. Four mode selection bits (SSPCON<3:0>) allow one of the following I²C modes to be selected:

- I²C Slave mode (7-bit address)
- I²C Slave mode (10-bit address)
- I²C Slave mode (7-bit address), with start and stop bit interrupts enabled for firmware master mode support
- I²C Slave mode (10-bit address), with start and stop bit interrupts enabled for firmware master mode support
- I²C start and stop bit interrupts enabled for firmware master mode support, slave mode idle

Selection of any I²C mode, with the SSPEN bit set, forces the SCL and SDA pins to be operated as open drain outputs, provided these pins are programmed to inputs by setting the appropriate TRISC bits.

Additional information on SSP I²C operation may be found in the PIC® MCU Mid-Range Reference Manual, (DS33023).

8.3.1 SLAVE MODE

In slave mode, the SCL and SDA pins must be configured as inputs (TRISC<4:3> set). The SSP module will override the input state with the output data when required (slave-transmitter).

When an address is matched or the data transfer after an address match is received, the hardware automatically will generate the acknowledge ($\overline{ACK}$) pulse, and load the SSPBUF register with the received value in the SSPSR register.

There are certain conditions that will cause the SSP module not to give this $\overline{ACK}$ pulse. This happens if either of the following conditions occur:

a) The buffer full bit BF (SSPSTAT<0>) was set before the transfer was completed.

b) The overflow bit SSPOV (SSPCON<6>) was set before the transfer was completed.

In this case, the SSPSR register value is not loaded into the SSPBUF, but bit SSPIF (PIR1<3>) is set. Table 8-2 shows what happens when a data transfer byte is received, given the status of bits BF and SSPOV. The shaded cells show the condition where user software did not properly clear the overflow condition. Flag bit BF is cleared by reading the SSPBUF register, while bit SSPOV is cleared through software.

The SCL clock input must have a minimum high and low for proper operation. The high and low times of the I²C specification, as well as the requirement of the SSP module, is shown in timing parameter #100, THIGH, and parameter #101, TLOW.

NOTES:

9.1 A/D Acquisition Requirements

For the A/D converter to meet its specified accuracy, the charge holding capacitor (CHOLD) must be allowed to fully charge to the input channel voltage level. The analog input model is shown in Figure 9-2. The source impedance (RS) and the internal sampling switch (RSS) impedance directly affect the time required to charge the capacitor CHOLD. The sampling switch (RSS) impedance varies over the device voltage (VDD). The source impedance affects the offset voltage at the analog input (due to pin leakage current). **The maximum recommended impedance for analog sources is 10 kΩ**. After the analog input channel is selected (changed), this acquisition must pass before the conversion can be started.

To calculate the minimum acquisition time, TACQ, see Equation 9-1. This equation calculates the acquisition time to within 1/2 LSb error (512 steps for the A/D). The 1/2 LSb error is the maximum error allowed for the A/D to meet its specified accuracy.

Note:	When the conversion is started, the holding capacitor is disconnected from the input pin.

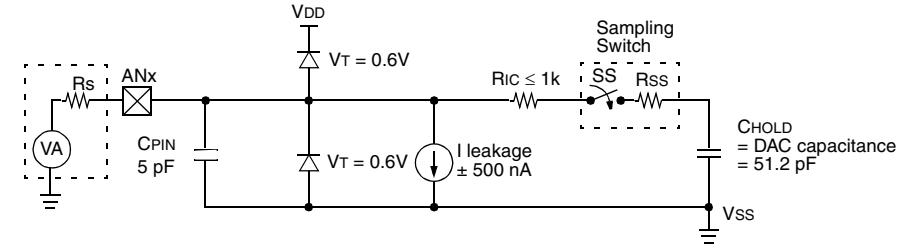
In general;

Assuming RS = 10kΩ
Vdd = 3.0V (RSS = 10kΩ)
Temp. = 50°C (122°F)

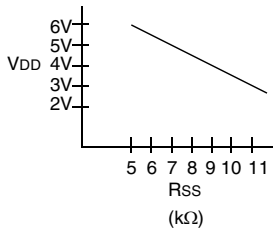
TACQ ≈ 13.0 μSec

By increasing VDD and reducing RS and Temp., TACQ can be substantially reduced.

FIGURE 9-2: ANALOG INPUT MODEL



Legend		
	CPIN	= input capacitance
	VT	= threshold voltage
	I leakage	= leakage current at the pin due to various junctions
	RIC	= interconnect resistance
	SS	= sampling switch
	CHOLD	= sample/hold capacitance (from DAC)



EQUATION 9-1: ACQUISITION TIME

TACQ = Amplifier Settling Time +
Hold Capacitor Charging Time +
Temperature Coefficient

= TAMP + TC + TCOFF
TAMP = 5μS
TC = - (51.2pF)(1kΩ + RSS + RS) In(1/511)
TCOFF = (Temp -25°C)(0.05μS/°C)

TABLE 10-6 INITIALIZATION CONDITIONS FOR ALL REGISTERS

Register	Applicable Devices		Power-on Reset, Brown-out Reset	$\overline{\text{MCLR}}$ Resets WDT Reset	Wake-up via WDT or Interrupt
W	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
INDF	62B	72A	N/A	N/A	N/A
TMR0	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
PCL	62B	72A	0000h	0000h	PC + 1(2)
STATUS	62B	72A	0001 1xxx	000q quuu(3)	uuuq quuu(3)
FSR	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORTA(4)	62B	72A	--0x 0000	--0u 0000	--uu uuuu
PORTB(5)	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORTC(5)	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
PCLATH	62B	72A	---0 0000	---0 0000	---u uuuu
INTCON	62B	72A	0000 000x	0000 000u	uuuu uuuu(1)
PIR1	62B	72A	---- 0000	---- 0000	---- uuuu(1)
	62B	72A	-0-- 0000	-0-- 0000	-u-- uuuu(1)
TMR1L	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
TMR1H	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
T1CON	62B	72A	--00 0000	--uu uuuu	--uu uuuu
TMR2	62B	72A	0000 0000	0000 0000	uuuu uuuu
T2CON	62B	72A	-000 0000	-000 0000	-uuu uuuu
SSPBUF	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
SSPCON	62B	72A	0000 0000	0000 0000	uuuu uuuu
CCPR1L	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
CCPR1H	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
CCP1CON	62B	72A	--00 0000	--00 0000	--uu uuuu
ADRES	62B	72A	xxxx xxxx	uuuu uuuu	uuuu uuuu
ADCON0	62B	72A	0000 00-0	0000 00-0	uuuu uu-u
OPTION_REG	62B	72A	1111 1111	1111 1111	uuuu uuuu
TRISA	62B	72A	--11 1111	--11 1111	--uu uuuu
TRISB	62B	72A	1111 1111	1111 1111	uuuu uuuu
TRISC	62B	72A	1111 1111	1111 1111	uuuu uuuu
PIE1	62B	72A	---- 0000	---- 0000	---- uuuu
	62B	72A	-0-- 0000	-0-- 0000	-u-- uuuu
PCON	62B	72A	---- --0q	---- --uq	---- --uq
PR2	62B	72A	1111 1111	1111 1111	1111 1111
SSPADD	62B	72A	0000 0000	0000 0000	uuuu uuuu
SSPSTAT	62B	72A	0000 0000	0000 0000	uuuu uuuu
ADCON1	62B	72A	---- -000	---- -000	---- -uuu

Legend: u = unchanged, x = unknown, - = unimplemented bit, read as '0', q = value depends on condition

Note 1: One or more bits in INTCON and/or PIR1 will be affected (to cause wake-up).

2: When the wake-up is due to an interrupt and the GIE bit is set, the PC is loaded with the interrupt vector (0004h).

3: See Table 10-5 for reset value for specific condition.

4: On any device reset, these pins are configured as inputs.

5: This is the value that will be in the port output latch.

10.12 Watchdog Timer (WDT)

The Watchdog Timer is a free running on-chip RC oscillator which does not require any external components. This RC oscillator is separate from the RC oscillator of the OSC1/CLKIN pin. The WDT will run, even if the clock on the OSC1/CLKIN and OSC2/CLKOUT pins of the device has been stopped, for example, by execution of a SLEEP instruction.

During normal operation, a WDT time-out generates a device RESET (Watchdog Timer Reset). If the device is in SLEEP mode, a WDT time-out causes the device to wake-up and continue with normal operation (Watchdog Timer Wake-up). The $\overline{TO}$ bit in the STATUS register will be cleared upon a Watchdog Timer time-out.

The WDT can be permanently disabled by clearing configuration bit WDTE (Section 10.1).

The WDT time-out period (TWDT, parameter #31) is multiplied by the prescaler ratio, when the prescaler is assigned to the WDT. The prescaler assignment (assigned to either the WDT or Timer0) and prescaler ratio are set in the OPTION_REG register.

Note:	The CLRWDT and SLEEP instructions clear the WDT and the postscaler, if assigned to the WDT, and prevent it from timing out and generating a device RESET condition.

.

Note:	When a CLRWDT instruction is executed and the prescaler is assigned to the WDT, the prescaler count will be cleared, but the prescaler assignment is not changed.

FIGURE 10-8: WATCHDOG TIMER BLOCK DIAGRAM

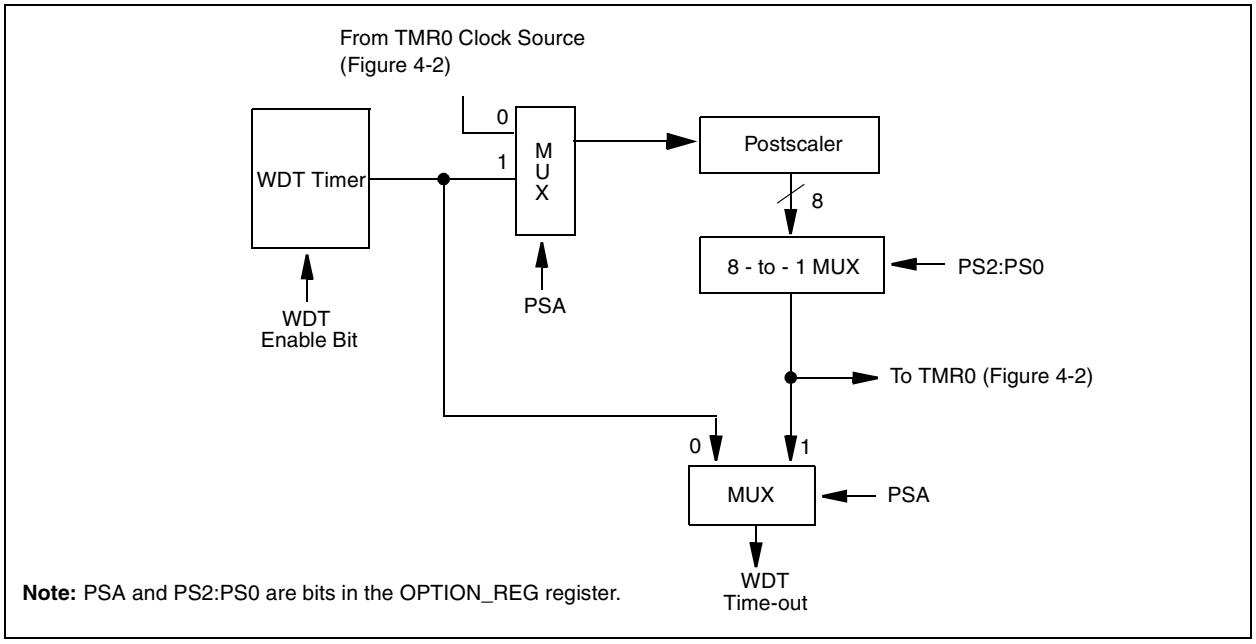


FIGURE 10-9: SUMMARY OF WATCHDOG TIMER REGISTERS

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2007h	Config. bits		BODEN	CP1	CP0	$\overline{PWRTE}$	WDTE	FOSC1	FOSC0
81h	OPTION_REG	$\overline{RBPU}$	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0

Legend: Shaded cells are not used by the Watchdog Timer.

11.1 Instruction Descriptions

ADDLW	Add Literal and W
Syntax:	[*label*] ADDLW k
Operands:	$0 \le k \le 255$
Operation:	(W) + k → (W)
Status Affected:	C, DC, Z
Description:	The contents of the W register are added to the eight bit literal 'k' and the result is placed in the W register.

ADDWF	Add W and f
Syntax:	[*label*] ADDWF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	(W) + (f) → (destination)
Status Affected:	C, DC, Z
Description:	Add the contents of the W register with register 'f'. If 'd' is 0, the result is stored in the W register. If 'd' is 1, the result is stored back in register 'f'.

ANDLW	AND Literal with W
Syntax:	[*label*] ANDLW k
Operands:	$0 \le k \le 255$
Operation:	(W) .AND. (k) → (W)
Status Affected:	Z
Description:	The contents of W register are AND'ed with the eight bit literal 'k'. The result is placed in the W register.

ANDWF	AND W with f
Syntax:	[*label*] ANDWF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	(W) .AND. (f) → (destination)
Status Affected:	Z
Description:	AND the W register with register 'f'. If 'd' is 0, the result is stored in the W register. If 'd' is 1, the result is stored back in register 'f'.

BCF	Bit Clear f
Syntax:	[*label*] BCF f,b
Operands:	$0 \le f \le 127$ $0 \le b \le 7$
Operation:	0 → (f<b>)
Status Affected:	None
Description:	Bit 'b' in register 'f' is cleared.

BSF	Bit Set f
Syntax:	[*label*] BSF f,b
Operands:	$0 \le f \le 127$ $0 \le b \le 7$
Operation:	1 → (f<b>)
Status Affected:	None
Description:	Bit 'b' in register 'f' is set.

IORLW	Inclusive OR Literal with W
Syntax:	[*label*] IORLW k
Operands:	$0 \le k \le 255$
Operation:	(W) .OR. k → (W)
Status Affected:	Z
Description:	The contents of the W register is OR'ed with the eight bit literal 'k'. The result is placed in the W register.

IORWF	Inclusive OR W with f
Syntax:	[*label*] IORWF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	(W) .OR. (f) → (destination)
Status Affected:	Z
Description:	Inclusive OR the W register with register 'f'. If 'd' is 0, the result is placed in the W register. If 'd' is 1, the result is placed back in register 'f'.

MOVF	Move f
Syntax:	[*label*] MOVF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	(f) → (destination)
Status Affected:	Z
Description:	The contents of register f is moved to a destination dependant upon the status of d. If d = 0, destination is W register. If d = 1, the destination is file register f itself. d = 1 is useful to test a file register since status flag Z is affected.

MOVLW	Move Literal to W
Syntax:	[*label*] MOVLW k
Operands:	$0 \le k \le 255$
Operation:	k → (W)
Status Affected:	None
Description:	The eight bit literal 'k' is loaded into W register. The don't cares will assemble as 0's.

MOVWF	Move W to f
Syntax:	[*label*] MOVWF f
Operands:	$0 \le f \le 127$
Operation:	(W) → (f)
Status Affected:	None
Description:	Move data from W register to register 'f'.

NOP	No Operation
Syntax:	[*label*] NOP
Operands:	None
Operation:	No operation
Status Affected:	None
Description:	No operation.

TABLE 12-1: DEVELOPMENT TOOLS FROM MICROCHIP

		PIC12CXXX	PIC14000	PIC16C5X	PIC16C6X	PIC16CXXX	PIC16F62X	PIC16C7X	PIC16C7XX	PIC16C8X	PIC16F8XX	PIC16C9XX	PIC17C4X	PIC17C7XX	PIC18CXX2	24CXX/ 25CXX/ 93CXX	HCSXXX	MCRFXXX	MCP2510
Software Tools	MPLAB™ Integrated Development Environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
	MPLAB™ C17 Compiler												✓	✓					
	MPLAB™ C18 Compiler														✓				
	MPASM/MPLINK	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Emulators	MPLAB™-ICE	✓	✓	✓	✓	✓	✓**	✓	✓	✓	✓	✓	✓	✓	✓				
	PICMASTER/PICMASTER-CE	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓					
	ICEPIC™ Low-Cost In-Circuit Emulator	✓		✓	✓	✓		✓	✓	✓		✓							
Debugger	MPLAB-ICD In-Circuit Debugger				✓*			✓*			✓								
Programmers	PICSTART®Plus Low-Cost Universal Dev. Kit	✓	✓	✓	✓	✓	✓**	✓	✓	✓	✓	✓	✓	✓	✓				
	PRO MATE® II Universal Programmer	✓	✓	✓	✓	✓	✓**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Demo Boards and Eval Kits	SIMICE	✓		✓															
	PICDEM-1			✓		✓		✓†		✓			✓						
	PICDEM-2				✓†			✓†							✓				
	PICDEM-3											✓							
	PICDEM-14A		✓																
	PICDEM-17													✓					
	KEELOQ® Evaluation Kit																✓		
	KEELOQ Transponder Kit																✓		
	microID™ Programmer's Kit																	✓	
	125 kHz microID Developer's Kit																	✓	
	125 kHz Anticollision microID Developer's Kit																	✓	
	13.56 MHz Anticollision microID Developer's Kit																	✓	
	MCP2510 CAN Developer's Kit																		✓

* Contact the Microchip Technology Inc. web site at www.microchip.com for information on how to use the MPLAB-ICD In-Circuit Debugger (DV164001) with PIC16C62, 63, 64, 65, 72, 73, 74, 76, 77

** Contact Microchip Technology Inc. for availability date.

† Development tool is available on select devices.

13.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (†)

Ambient temperature under bias ..... -55°C to +125°C

Storage temperature ..... -65°C to +150°C

Voltage on any pin with respect to V_{SS} (except V_{DD}, $\overline{MCLR}$, and RA4) ..... -0.3V to (V_{DD} + 0.3V)

Voltage on V_{DD} with respect to V_{SS} ..... -0.3V to +7.5V

Voltage on $\overline{MCLR}$ with respect to V_{SS} (Note 2) ..... 0V to +13.25V

Voltage on RA4 with respect to Vss ..... 0V to +8.5V

Total power dissipation (Note 1) 1.0W

Maximum current out of V_{SS} pin ..... 300 mA

Maximum current into V_{DD} pin ..... 250 mA

Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD}) ..... ±20 mA

Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DD}) ..... ±20 mA

Maximum output current sunk by any I/O pin ..... 25 mA

Maximum output current sourced by any I/O pin ..... 25 mA

Maximum current sunk by PORTA and PORTB (combined) ..... 200 mA

Maximum current sourced by PORTA and PORTB (combined) ..... 200 mA

Maximum current sunk by PORTC ..... 200 mA

Maximum current sourced by PORTC ..... 200 mA

Note 1: Power dissipation is calculated as follows: $P_{dis} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD}-V_{OH}) \times I_{OH}\} + \sum(V_{ol} \times I_{OL})$

2: Voltage spikes below V_{SS} at the $\overline{MCLR}/V_{PP}$ pin, inducing currents greater than 80 mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a "low" level to the $\overline{MCLR}/V_{PP}$ pin, rather than pulling this pin directly to V_{SS}.

† NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

FIGURE 13-1: PIC16C62B/72A-20 VOLTAGE-FREQUENCY GRAPH

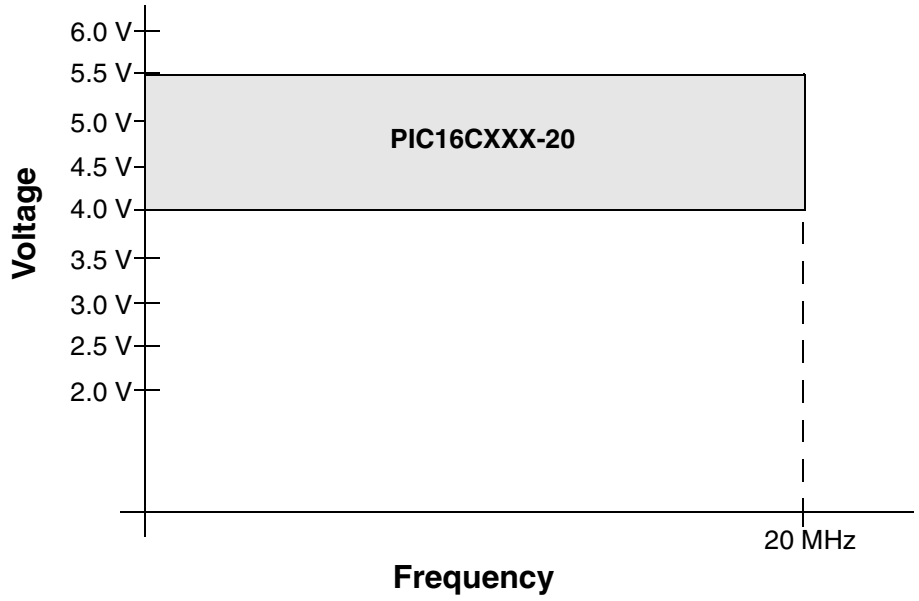
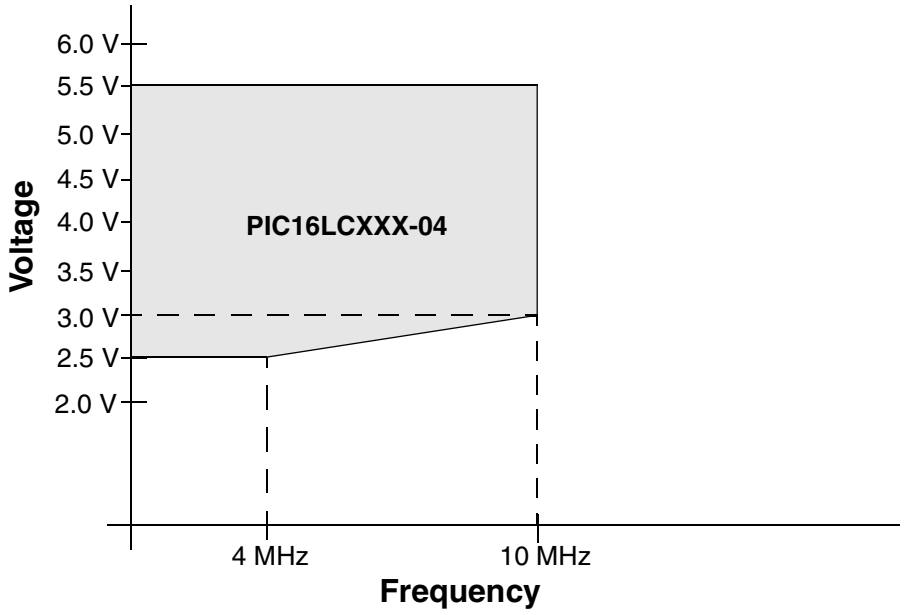


FIGURE 13-2: PIC16LC62B/72A AND PIC16C62B/72A/JW VOLTAGE-FREQUENCY GRAPH



FMAX = (12.0 MHz/V) (VDDAPPMIN - 2.5 V) + 4 MHz

Note: VDDAPPMIN is the minimum voltage of the PIC® device in the application. Fmax is no greater than 10 MHz.

13.3 DC Characteristics: PIC16C62B/72A-04 (Commercial, Industrial, Extended) PIC16C62B/72A-20 (Commercial, Industrial, Extended) PIC16LC62B/72A-04 (Commercial, Industrial)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature 0°C ≤ TA ≤ +70°C for commercial -40°C ≤ TA ≤ +85°C for industrial -40°C ≤ TA ≤+125°C for extended Operating voltage VDD range as described in DC spec Section 13.1 and Section 13.2				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
		Input Low Voltage					
	VIL	I/O ports					
D030		with TTL buffer	VSS	-	0.15VDD	V	For entire VDD range
D030A			Vss	-	0.8V	V	4.5V ≤ VDD ≤ 5.5V
D031		with Schmitt Trigger buffer	VSS	-	0.2VDD	V	
D032		$\overline{MCLR}$, OSC1 (in RC mode)	Vss	-	0.2VDD	V	
D033		OSC1 (in XT, HS and LP modes)	Vss	-	0.3VDD	V	Note1
		Input High Voltage					
	VIH	I/O ports		-			
D040		with TTL buffer	2.0	-	VDD	V	4.5V ≤ VDD ≤ 5.5V
D040A			0.25VDD + 0.8V	-	Vdd	V	For entire VDD range
D041		with Schmitt Trigger buffer	0.8VDD	-	VDD	V	For entire VDD range
D042		MCLR	0.8VDD	-	VDD	V	
D042A		OSC1 (XT, HS and LP modes)	0.7VDD	-	VDD	V	Note1
D043		OSC1 (in RC mode)	0.9VDD	-	Vdd	V	
		Input Leakage Current (Notes 2, 3)					
D060	IIL	I/O ports	-	-	±1	µA	Vss ≤ VPIN ≤ VDD, Pin at hi-impedance
D061		$\overline{MCLR}$, RA4/T0CKI	-	-	±5	µA	Vss ≤ VPIN ≤ VDD
D063		OSC1	-	-	±5	µA	Vss ≤ VPIN ≤ VDD, XT, HS and LP osc modes
D070	IPURB	**PORTB weak pull-up current**	50	250	400	µA	VDD = 5V, VPIN = VSS
		Output Low Voltage					
D080	VOL	I/O ports	-	-	0.6	V	IOL = 8.5 mA, VDD = 4.5V, -40°C to +85°C

* These parameters are characterized but not tested.

† Data in "Typ" column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: In RC oscillator mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the device be driven with external clock in RC mode.

2: The leakage current on the $\overline{MCLR}$/VPP pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.

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

13.4.3 TIMING DIAGRAMS AND SPECIFICATIONS

FIGURE 13-5: EXTERNAL CLOCK TIMING

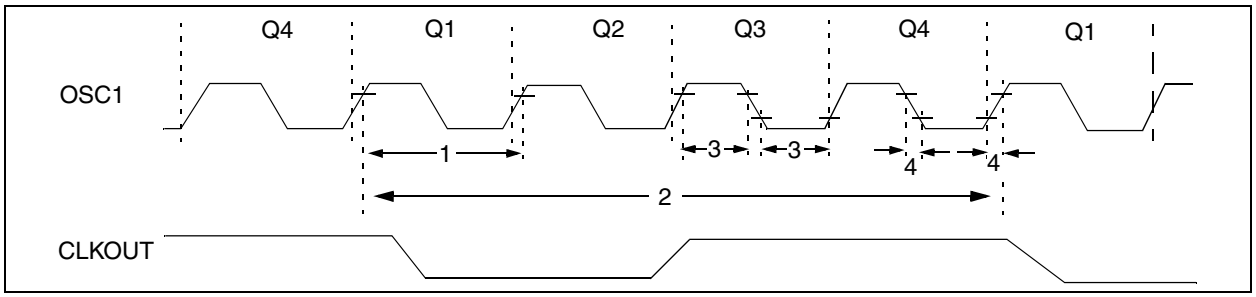


TABLE 13-2: EXTERNAL CLOCK TIMING REQUIREMENTS

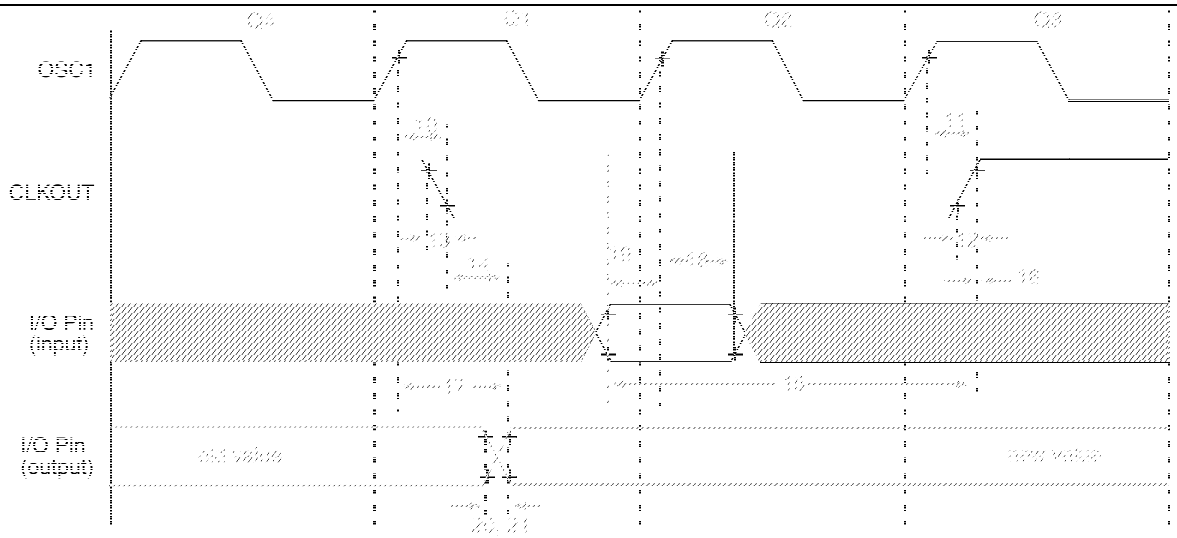
Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
1A	Fosc	External CLKIN Frequency (Note 1)	DC	—	4	MHz	RC and XT osc modes
			DC	—	4	MHz	HS osc mode (-04)
			DC	—	20	MHz	HS osc mode (-20)
			DC	—	200	kHz	LP osc mode
		Oscillator Frequency (Note 1)	DC	—	4	MHz	RC osc mode
			0.1	—	4	MHz	XT osc mode
			4	—	20	MHz	HS osc mode
			5	—	200	kHz	LP osc mode
1	Tosc	External CLKIN Period (Note 1)	250	—	—	ns	RC and XT osc modes
			250	—	—	ns	HS osc mode (-04)
			50	—	—	ns	HS osc mode (-20)
			5	—	—	µs	LP osc mode
		Oscillator Period (Note 1)	250	—	—	ns	RC osc mode
			250	—	10,000	ns	XT osc mode
			250	—	250	ns	HS osc mode (-04)
			50	—	250	ns	HS osc mode (-20)
			5	—	—	µs	LP osc mode
2	TCY	Instruction Cycle Time (Note 1)	200	—	DC	ns	TCY = 4/FOSC
3*	TosL, TosH	External Clock in (OSC1) High or Low Time	100	—	—	ns	XT oscillator
			2.5	—	—	µs	LP oscillator
			15	—	—	ns	HS oscillator
4*	TosR, TosF	External Clock in (OSC1) Rise or Fall Time	—	—	25	ns	XT oscillator
			—	—	50	ns	LP oscillator
			—	—	15	ns	HS oscillator

* These parameters are characterized but not tested.

† Data in "Typ" column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Instruction cycle period (TCY) equals four times the input oscillator time-base period. All specified values are based on characterization data for that particular oscillator type under standard operating conditions with the device executing code. Exceeding these specified limits may result in an unstable oscillator operation and/or higher than expected current consumption. All devices are tested to operate at "min." values with an external clock applied to the OSC1/CLKIN pin.
When an external clock input is used, the "Max." cycle time limit is "DC" (no clock) for all devices.

FIGURE 13-6: CLKOUT AND I/O TIMING



Note: Refer to Figure 13-4 for load conditions.

TABLE 13-3: CLKOUT AND I/O TIMING REQUIREMENTS

Param No.	Sym	Characteristic		Min	Typ†	Max	Units	Conditions
10*	TosH2ckL	OSC1↑ to CLKOUT↓		—	75	200	ns	Note 1
11*	TosH2ckH	OSC1↑ to CLKOUT↑		—	75	200	ns	Note 1
12*	TckR	CLKOUT rise time		—	35	100	ns	Note 1
13*	TckF	CLKOUT fall time		—	35	100	ns	Note 1
14*	TckL2ioV	CLKOUT ↓ to Port out valid		—	—	0.5TCY + 20	ns	Note 1
15*	TioV2ckH	Port in valid before CLKOUT ↑		Tosc + 200	—	—	ns	Note 1
16*	TckH2ioI	Port in hold after CLKOUT ↑		0	—	—	ns	Note 1
17*	TosH2ioV	OSC1↑ (Q1 cycle) to Port out valid		—	50	150	ns	
18*	TosH2ioI	OSC1↑ (Q2 cycle) to Port input invalid (I/O in hold time)	**PIC16CXX**	100	—	—	ns	
18A*			**PIC16LCXX**	200	—	—	ns	
19*	TioV2osH	Port input valid to OSC1↑ (I/O in setup time)		0	—	—	ns	
20*	TioR	Port output rise time	**PIC16CXX**	—	10	40	ns	
20A*			**PIC16LCXX**	—	—	80	ns	
21*	TioF	Port output fall time	**PIC16CXX**	—	10	40	ns	
21A*			**PIC16LCXX**	—	—	80	ns	
22††*	Tinp	INT pin high or low time		TCY	—	—	ns	
23††*	Trbp	RB7:RB4 change INT high or low time		TCY	—	—	ns	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

†† These parameters are asynchronous events not related to any internal clock edge.

Note 1: Measurements are taken in RC Mode where CLKOUT output is 4 x TOSC.

FIGURE 13-14: EXAMPLE SPI SLAVE MODE TIMING (CKE = 1)

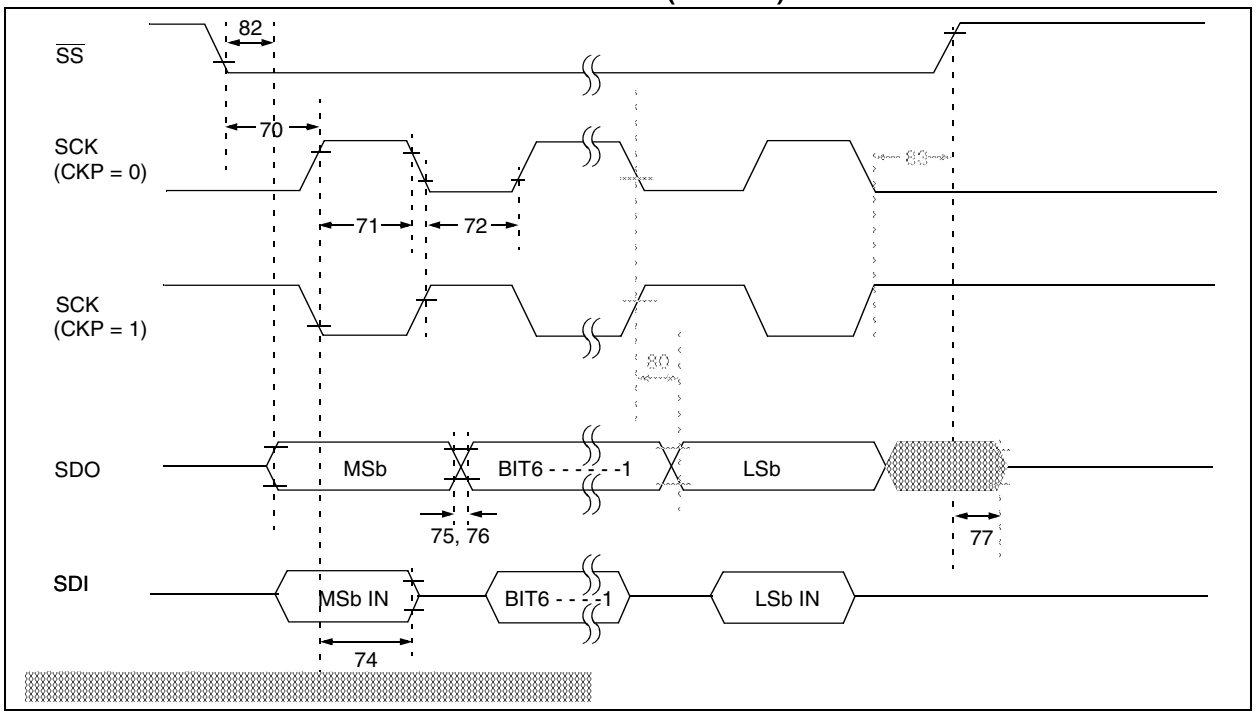


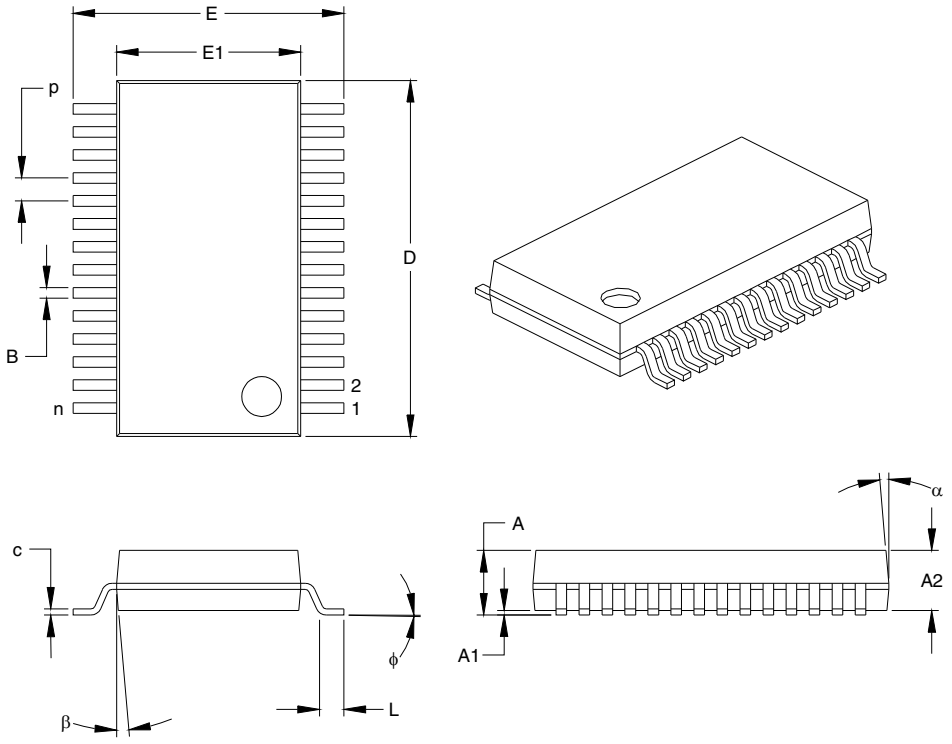
TABLE 13-10: EXAMPLE SPI SLAVE MODE REQUIREMENTS (CKE = 1)

Param. No.	Symbol	Characteristic		Min	Typ†	Max	Units	Conditions
70	TssL2scH, TssL2scL	$\overline{SS}$↓ to SCK↓ or SCK↑ input		TCY	—	—	ns	
71	TscH	SCK input high time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
71A			Single Byte	40	—	—	ns	Note 1
72	TscL	SCK input low time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
72A			Single Byte	40	—	—	ns	Note 1
73A	TB2B	Last clock edge of Byte1 to the 1st clock edge of Byte2		1.5TCY + 40	—	—	ns	Note 1
74	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75	TdoR	SDO data output rise time	**PIC16CXX**	—	10	25	ns	
			PIC16LCXX		20	45	ns	
76	TdoF	SDO data output fall time		—	10	25	ns	
77	TssH2doZ	$\overline{SS}$↑ to SDO output hi-impedance		10	—	50	ns	
78	TscR	SCK output rise time (master mode)	**PIC16CXX**	—	10	25	ns	
			PIC16LCXX	—	20	45	ns	
79	TscF	SCK output fall time (master mode)		—	10	25	ns	
80	TscH2doV, TscL2doV	SDO data output valid after SCK edge	**PIC16CXX**	—	—	50	ns	
			PIC16LCXX	—	—	100	ns	
82	TssL2doV	SDO data output valid after $\overline{SS}$↓ edge	**PIC16CXX**	—	—	50	ns	
			PIC16LCXX	—	—	100	ns	
83	TscH2ssH, TscL2ssH	$\overline{SS}$ ↑ after SCK edge		1.5TCY + 40	—	—	ns	

† Data in "Typ" column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Specification 73A is only required if specifications 71A and 72A are used.

15.5 28-Lead Plastic Shrink Small Outline (SS) – 209 mil, 5.30 mm (SSOP)



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		28			28	
Pitch	p		.026			0.66	
Overall Height	A	.068	.073	.078	1.73	1.85	1.98
Molded Package Thickness	A2	.064	.068	.072	1.63	1.73	1.83
Standoff	A1	.002	.006	.010	0.05	0.15	0.25
Overall Width	E	.299	.309	.319	7.59	7.85	8.10
Molded Package Width	E1	.201	.207	.212	5.11	5.25	5.38
Overall Length	D	.396	.402	.407	10.06	10.20	10.34
Foot Length	L	.022	.030	.037	0.56	0.75	0.94
Lead Thickness	c	.004	.007	.010	0.10	0.18	0.25
Foot Angle	φ	0	4	8	0.00	101.60	203.20
Lead Width	B	.010	.013	.015	0.25	0.32	0.38
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.

JEDEC Equivalent: MS-150

Drawing No. C04-073

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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