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Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	40MHz
Connectivity	I ² C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, HLVD, POR, PWM, WDT
Number of I/O	36
Program Memory Size	64KB (32K x 16)
Program Memory Type	FLASH
EEPROM Size	1K x 8
RAM Size	3.8K x 8
Voltage - Supply (Vcc/Vdd)	4.2V ~ 5.5V
Data Converters	A/D 13x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	44-VQFN Exposed Pad
Supplier Device Package	44-QFN (8x8)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic18f4620t-i-ml

PIC18F2525/2620/4525/4620

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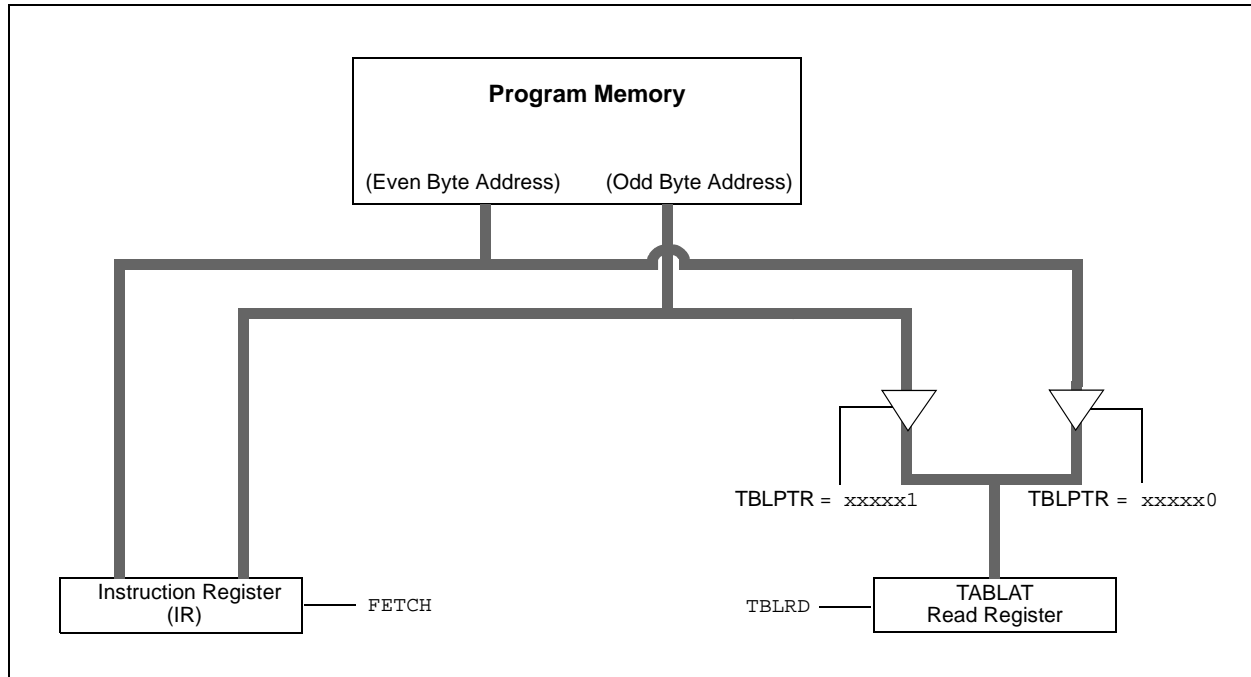
7.3 Reading the Flash Program Memory

The `TBLRD` instruction is used to retrieve data from program memory and places it into data RAM. Table reads from program memory are performed one byte at a time.

TBLPTR points to a byte address in program space. Executing `TBLRD` places the byte pointed to into TABLAT. In addition, TBLPTR can be modified automatically for the next table read operation.

The internal program memory is typically organized by words. The Least Significant bit of the address selects between the high and low bytes of the word. Figure 7-4 shows the interface between the internal program memory and the TABLAT.

FIGURE 7-4: READS FROM FLASH PROGRAM MEMORY



EXAMPLE 7-1: READING A FLASH PROGRAM MEMORY WORD

```

MOV LW CODE_ADDR_UPPER      ; Load TBLPTR with the base
MOV WF TBLPTRU              ; address of the word
MOV LW CODE_ADDR_HIGH
MOV WF TBLPTRH
MOV LW CODE_ADDR_LOW
MOV WF TBLPTRL

READ_WORD
TBLRD*+                    ; read into TABLAT and increment
MOV F TABLAT, W            ; get data
MOV WF WORD_EVEN
TBLRD*+                    ; read into TABLAT and increment
MOV F TABLAT, W            ; get data
MOV WF WORD_ODD
  
```

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TABLE 9-2: SUMMARY OF REGISTERS ASSOCIATED WITH PORTA

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Reset Values on page
PORTA	RA7 ⁽¹⁾	RA6 ⁽¹⁾	RA5	RA4	RA3	RA2	RA1	RA0	52
LATA	LATA7 ⁽¹⁾	LATA6 ⁽¹⁾	PORTA Data Latch Register (Read and Write to Data Latch)						52
TRISA	TRISA7 ⁽¹⁾	TRISA6 ⁽¹⁾	PORTA Data Direction Control Register						52
ADCON1	—	—	VCFG1	VCFG0	PCFG3	PCFG2	PCFG1	PCFG0	51
CMCON	C2OUT	C1OUT	C2INV	C1INV	CIS	CM2	CM1	CM0	51
CVRCON	CVREN	CVROE	CVRR	CVRSS	CVR3	CVR2	CVR1	CVR0	51

Legend: — = unimplemented, read as '0'. Shaded cells are not used by PORTA.

Note 1: RA7:RA6 and their associated latch and data direction bits are enabled as I/O pins based on oscillator configuration; otherwise, they are read as '0'.

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TABLE 9-3: PORTB I/O SUMMARY

Pin	Function	TRIS Setting	I/O	I/O Type	Description
RB0/INT0/FLT0/AN12	RB0	0	O	DIG	LATB<0> data output; not affected by analog input.
		1	I	TTL	PORTB<0> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared. Disabled when analog input enabled. ⁽¹⁾
	INT0	1	I	ST	External interrupt 0 input.
	FLT0	1	I	ST	Enhanced PWM Fault input (ECCP1 module); enabled in software.
	AN12	1	I	ANA	A/D input channel 12. ⁽¹⁾
RB1/INT1/AN10	RB1	0	O	DIG	LATB<1> data output; not affected by analog input.
		1	I	TTL	PORTB<1> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared. Disabled when analog input enabled. ⁽¹⁾
	INT1	1	I	ST	External interrupt 1 input.
	AN10	1	I	ANA	A/D input channel 10. ⁽¹⁾
RB2/INT2/AN8	RB2	0	O	DIG	LATB<2> data output; not affected by analog input.
		1	I	TTL	PORTB<2> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared. Disabled when analog input enabled. ⁽¹⁾
	INT2	1	I	ST	External interrupt 2 input.
	AN8	1	I	ANA	A/D input channel 8. ⁽¹⁾
RB3/AN9/CCP2	RB3	0	O	DIG	LATB<3> data output; not affected by analog input.
		1	I	TTL	PORTB<3> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared. Disabled when analog input enabled. ⁽¹⁾
	AN9	1	I	ANA	A/D input channel 9. ⁽¹⁾
	CCP2 ⁽²⁾	0	O	DIG	CCP2 compare and PWM output.
		1	I	ST	CCP2 capture input.
RB4/KBI0/AN11	RB4	0	O	DIG	LATB<4> data output; not affected by analog input.
		1	I	TTL	PORTB<4> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared. Disabled when analog input enabled. ⁽¹⁾
	KBI0	1	I	TTL	Interrupt on pin change.
	AN11	1	I	ANA	A/D input channel 11. ⁽¹⁾
RB5/KBI1/PGM	RB5	0	O	DIG	LATB<5> data output.
		1	I	TTL	PORTB<5> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared.
	KBI1	1	I	TTL	Interrupt on pin change.
	PGM	x	I	ST	Single-Supply Programming mode entry (ICSP™). Enabled by LVP Configuration bit; all other pin functions disabled.
RB6/KBI2/PGC	RB6	0	O	DIG	LATB<6> data output.
		1	I	TTL	PORTB<6> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared.
	KBI2	1	I	TTL	Interrupt on pin change.
	PGC	x	I	ST	Serial execution (ICSP™) clock input for ICSP and ICD operation. ⁽³⁾
RB7/KBI3/PGD	RB7	0	O	DIG	LATB<7> data output.
		1	I	TTL	PORTB<7> data input; weak pull-up when $\overline{\text{RBPU}}$ bit is cleared.
	KBI3	1	I	TTL	Interrupt on pin change.
	PGD	x	O	DIG	Serial execution data output for ICSP and ICD operation. ⁽³⁾
		x	I	ST	Serial execution data input for ICSP and ICD operation. ⁽³⁾

Legend: DIG = Digital level output; TTL = TTL input buffer; ST = Schmitt Trigger input buffer; ANA = Analog level input/output; x = Don't care (TRIS bit does not affect port direction or is overridden for this option).

Note 1: Configuration on POR is determined by the PBADEN Configuration bit. Pins are configured as analog inputs by default when PBADEN is set and digital inputs when PBADEN is cleared.

2: Alternate assignment for CCP2 when the CCP2MX Configuration bit is '0'. Default assignment is RC1.

3: All other pin functions are disabled when ICSP or ICD is enabled.

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FIGURE 9-3: PARALLEL SLAVE PORT WRITE WAVEFORMS

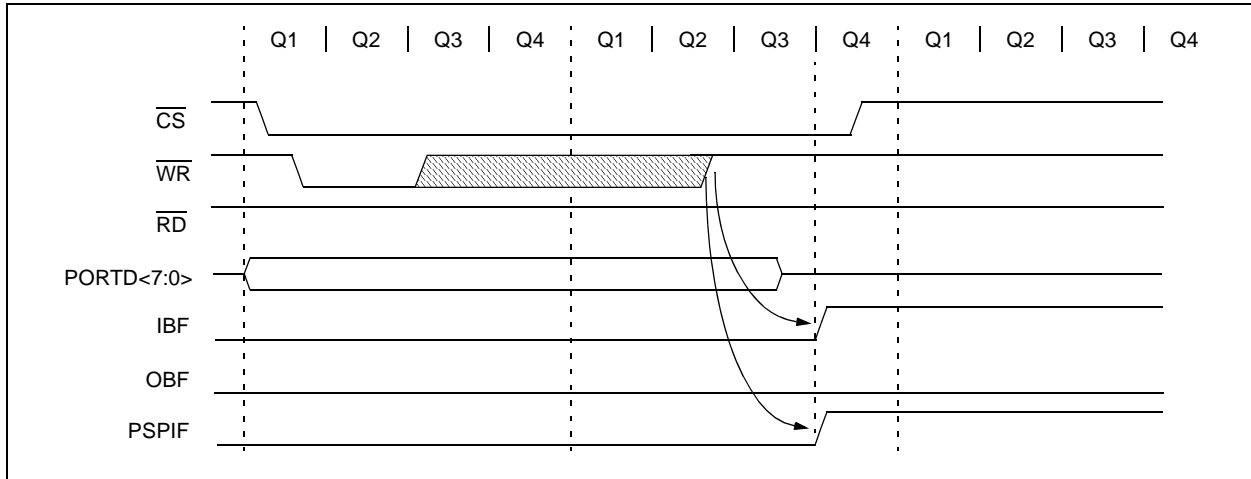


FIGURE 9-4: PARALLEL SLAVE PORT READ WAVEFORMS

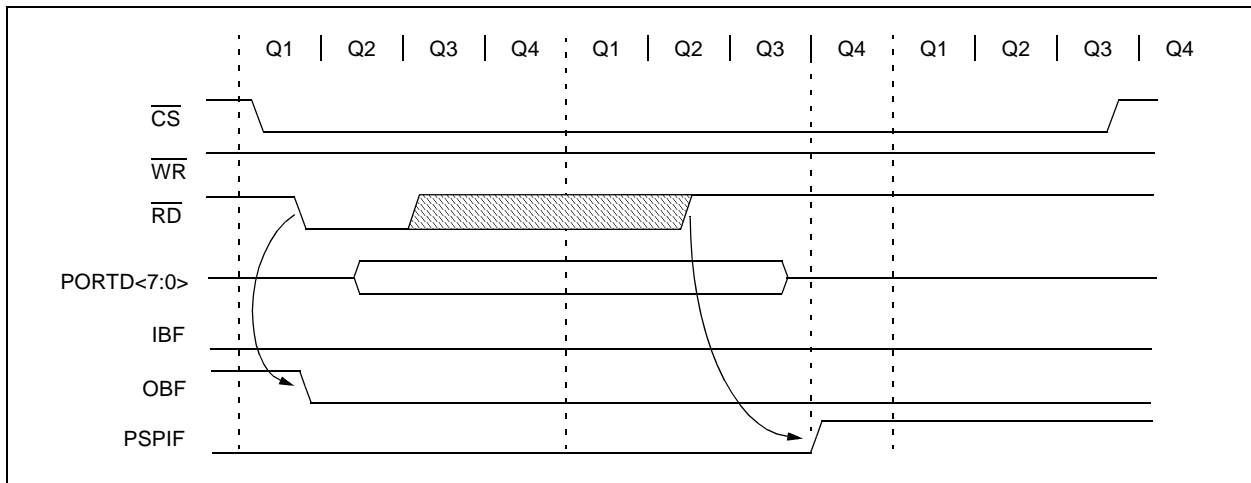


TABLE 9-11: REGISTERS ASSOCIATED WITH PARALLEL SLAVE PORT

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Reset Values on page
PORTD	RD7	RD6	RD5	RD4	RD3	RD2	RD1	RD0	52
LATD	PORTD Data Latch Register (Read and Write to Data Latch)								52
TRISD	PORTD Data Direction Control Register								52
PORTE	—	—	—	—	RE3	RE2	RE1	RE0	52
LATE	—	—	—	—	—	LATE Data Output bits			52
TRISE	IBF	OBF	IBOV	PSPMODE	—	TRISE2	TRISE1	TRISE0	52
INTCON	GIE/GIEH	PEIE/GIEL	TMR0IF	INT0IE	RBIE	TMR0IF	INT0IF	RBIF	49
PIR1	PSPIF ⁽¹⁾	ADIF	RCIF	TXIF	SSPIF	CCP1IF	TMR2IF	TMR1IF	52
PIE1	PSPIE ⁽¹⁾	ADIE	RCIE	TXIE	SSPIE	CCP1IE	TMR2IE	TMR1IE	52
IPR1	PSPIP ⁽¹⁾	ADIP	RCIP	TXIP	SSPIP	CCP1IP	TMR2IP	TMR1IP	52
ADCON1	—	—	VCFG1	VCFG0	PCFG3	PCFG2	PCFG1	PCFG0	51

Legend: — = unimplemented, read as '0'. Shaded cells are not used by the Parallel Slave Port.

Note 1: These bits are unimplemented on 28-pin devices and read as '0'.

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REGISTER 10-5: PIR2: PERIPHERAL INTERRUPT REQUEST (FLAG) 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
OSCFIF	CMIF	—	EEIF	BCLIF	HLVDIF	TMR3IF	CCP2IF
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 7 **OSCFIF:** Oscillator Fail Interrupt Flag bit
1 = Device oscillator failed, clock input has changed to INTOSC (must be cleared in software)
0 = Device clock operating
- bit 6 **CMIF:** Comparator Interrupt Flag bit
1 = Comparator input has changed (must be cleared in software)
0 = Comparator input has not changed
- bit 5 **Unimplemented:** Read as '0'
- bit 4 **EEIF:** Data EEPROM/Flash Write Operation Interrupt Flag bit
1 = The write operation is complete (must be cleared in software)
0 = The write operation is not complete or has not been started
- bit 3 **BCLIF:** Bus Collision Interrupt Flag bit
1 = A bus collision occurred (must be cleared in software)
0 = No bus collision occurred
- bit 2 **HLVDIF:** High/Low-Voltage Detect Interrupt Flag bit
1 = A high/low-voltage condition occurred (direction determined by VDIRMAG bit, HLVDCON<7>)
0 = A high/low-voltage condition has not occurred
- bit 1 **TMR3IF:** TMR3 Overflow Interrupt Flag bit
1 = TMR3 register overflowed (must be cleared in software)
0 = TMR3 register did not overflow
- bit 0 **CCP2IF:** CCP2 Interrupt Flag bit
Capture mode:
1 = A TMR1 register capture occurred (must be cleared in software)
0 = No TMR1 register capture occurred
Compare mode:
1 = A TMR1 register compare match occurred (must be cleared in software)
0 = No TMR1 register compare match occurred
PWM mode:
Unused in this mode.

11.0 TIMER0 MODULE

The Timer0 module incorporates the following features:

- Software selectable operation as a timer or counter in both 8-bit or 16-bit modes
- Readable and writable registers
- Dedicated 8-bit, software programmable prescaler
- Selectable clock source (internal or external)
- Edge select for external clock
- Interrupt-on-overflow

The T0CON register (Register 11-1) controls all aspects of the module's operation, including the prescale selection. It is both readable and writable.

A simplified block diagram of the Timer0 module in 8-bit mode is shown in Figure 11-1. Figure 11-2 shows a simplified block diagram of the Timer0 module in 16-bit mode.

REGISTER 11-1: T0CON: TIMER0 CONTROL REGISTER

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
TMR0ON	T08BIT	T0CS	T0SE	PSA	T0PS2	T0PS1	T0PS0
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 7	TMR0ON: Timer0 On/Off Control bit 1 = Enables Timer0 0 = Stops Timer0
bit 6	T08BIT: Timer0 8-Bit/16-Bit Control bit 1 = Timer0 is configured as an 8-bit timer/counter 0 = Timer0 is configured as a 16-bit timer/counter
bit 5	T0CS: Timer0 Clock Source Select bit 1 = Transition on T0CKI pin 0 = Internal instruction cycle clock (CLKO)
bit 4	T0SE: Timer0 Source Edge Select bit 1 = Increment on high-to-low transition on T0CKI pin 0 = Increment on low-to-high transition on T0CKI pin
bit 3	PSA: Timer0 Prescaler Assignment bit 1 = Timer0 prescaler is not assigned. Timer0 clock input bypasses prescaler. 0 = Timer0 prescaler is assigned. Timer0 clock input comes from prescaler output.
bit 2-0	T0PS2:T0PS0: Timer0 Prescaler Select bits 111 = 1:256 Prescale value 110 = 1:128 Prescale value 101 = 1:64 Prescale value 100 = 1:32 Prescale value 011 = 1:16 Prescale value 010 = 1:8 Prescale value 001 = 1:4 Prescale value 000 = 1:2 Prescale value

14.2 Timer3 16-Bit Read/Write Mode

Timer3 can be configured for 16-bit reads and writes (see Figure 14-2). When the RD16 control bit (T3CON<7>) is set, the address for TMR3H is mapped to a buffer register for the high byte of Timer3. A read from TMR3L will load the contents of the high byte of Timer3 into the Timer3 High Byte Buffer register. This provides the user with the ability to accurately read all 16 bits of Timer3 without having to determine whether a read of the high byte, followed by a read of the low byte, has become invalid due to a rollover between reads.

A write to the high byte of Timer3 must also take place through the TMR3H Buffer register. The Timer3 high byte is updated with the contents of TMR3H when a write occurs to TMR3L. This allows a user to write all 16 bits to both the high and low bytes of Timer3 at once.

The high byte of Timer3 is not directly readable or writable in this mode. All reads and writes must take place through the Timer3 High Byte Buffer register.

Writes to TMR3H do not clear the Timer3 prescaler. The prescaler is only cleared on writes to TMR3L.

14.3 Using the Timer1 Oscillator as the Timer3 Clock Source

The Timer1 internal oscillator may be used as the clock source for Timer3. The Timer1 oscillator is enabled by setting the T1OSCEN (T1CON<3>) bit. To use it as the Timer3 clock source, the TMR3CS bit must also be set. As previously noted, this also configures Timer3 to increment on every rising edge of the oscillator source.

The Timer1 oscillator is described in **Section 12.0 “Timer1 Module”**.

14.4 Timer3 Interrupt

The TMR3 register pair (TMR3H:TMR3L) increments from 0000h to FFFFh and overflows to 0000h. The Timer3 interrupt, if enabled, is generated on overflow and is latched in interrupt flag bit, TMR3IF (PIR2<1>). This interrupt can be enabled or disabled by setting or clearing the Timer3 Interrupt Enable bit, TMR3IE (PIE2<1>).

14.5 Resetting Timer3 Using the CCP Special Event Trigger

If either of the CCP modules is configured to use Timer3 and to generate a Special Event Trigger in Compare mode (CCP1M3:CCP1M0 or CCP2M3:CCP2M0 = 1011), this signal will reset Timer3. It will also start an A/D conversion if the A/D module is enabled (see **Section 15.3.4 “Special Event Trigger”** for more information).

The module must be configured as either a timer or synchronous counter to take advantage of this feature. When used this way, the CCPR2H:CCPR2L register pair effectively becomes a period register for Timer3.

If Timer3 is running in Asynchronous Counter mode, the Reset operation may not work.

In the event that a write to Timer3 coincides with a Special Event Trigger from a CCP module, the write will take precedence.

Note: The Special Event Triggers from the CCP2 module will not set the TMR3IF interrupt flag bit (PIR1<0>).

TABLE 14-1: REGISTERS ASSOCIATED WITH TIMER3 AS A TIMER/COUNTER

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Reset Values on page
INTCON	GIE/GIEH	PEIE/GIEL	TMR0IE	INT0IE	RBIE	TMR0IF	INT0IF	RBIF	49
PIR2	OSCFIF	CMIF	—	EEIF	BCLIF	HLVDIF	TMR3IF	CCP2IF	52
PIE2	OSCFIE	CMIE	—	EEIE	BCLIE	HLVDIE	TMR3IE	CCP2IE	52
IPR2	OSCFIP	CMIP	—	EEIP	BCLIP	HLVDIP	TMR3IP	CCP2IP	52
TMR3L	Timer3 Register Low Byte								51
TMR3H	Timer3 Register High Byte								51
T1CON	RD16	T1RUN	T1CKPS1	T1CKPS0	T1OSCEN	T1SYN \overline{C}	TMR1CS	TMR1ON	50
T3CON	RD16	T3CCP2	T3CKPS1	T3CKPS0	T3CCP1	T3SYN \overline{C}	TMR3CS	TMR3ON	51

Legend: — = unimplemented, read as ‘0’. Shaded cells are not used by the Timer3 module.

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17.4.9 I²C MASTER MODE REPEATED START CONDITION TIMING

A Repeated Start condition occurs when the RSEN bit (SSPCON2<1>) is programmed high and the I²C logic module is in the Idle state. When the RSEN bit is set, the SCL pin is asserted low. When the SCL pin is sampled low, the Baud Rate Generator is loaded with the contents of SSPADD<5:0> and begins counting. The SDA pin is released (brought high) for one Baud Rate Generator count (TBRG). When the Baud Rate Generator times out, if SDA is sampled high, the SCL pin will be deasserted (brought high). When SCL is sampled high, the Baud Rate Generator is reloaded with the contents of SSPADD<6:0> and begins counting. SDA and SCL must be sampled high for one TBRG. This action is then followed by assertion of the SDA pin (SDA = 0) for one TBRG while SCL is high. Following this, the RSEN bit (SSPCON2<1>) will be automatically cleared and the Baud Rate Generator will not be reloaded, leaving the SDA pin held low. As soon as a Start condition is detected on the SDA and SCL pins, the S bit (SSPSTAT<3>) will be set. The SSPIF bit will not be set until the Baud Rate Generator has timed out.

Note 1: If RSEN is programmed while any other event is in progress, it will not take effect.

2: A bus collision during the Repeated Start condition occurs if:

- SDA is sampled low when SCL goes from low-to-high.
- SCL goes low before SDA is asserted low. This may indicate that another master is attempting to transmit a data '1'.

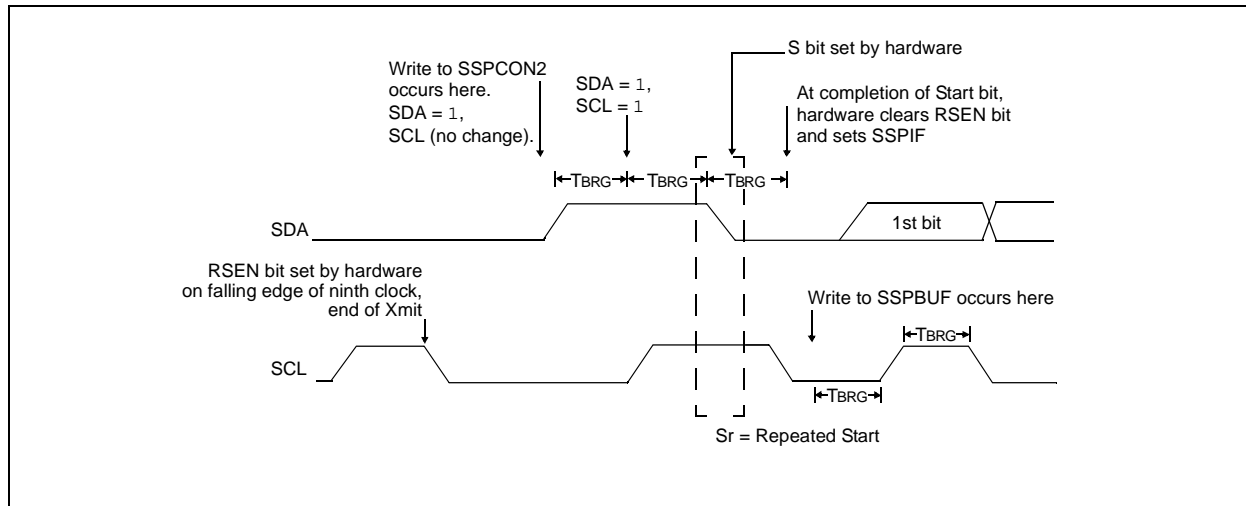
Immediately following the SSPIF bit getting set, the user may write the SSPBUF with the 7-bit address in 7-bit mode, or the default first address in 10-bit mode. After the first eight bits are transmitted and an ACK is received, the user may then transmit an additional eight bits of address (10-bit mode) or eight bits of data (7-bit mode).

17.4.9.1 WCOL Status Flag

If the user writes the SSPBUF when a Repeated Start sequence is in progress, the WCOL is set and the contents of the buffer are unchanged (the write doesn't occur).

Note: Because queueing of events is not allowed, writing of the lower 5 bits of SSPCON2 is disabled until the Repeated Start condition is complete.

FIGURE 17-20: REPEAT START CONDITION WAVEFORM



The value in the ADRESH:ADRESL registers is not modified for a Power-on Reset. The ADRESH:ADRESL registers will contain unknown data after a Power-on Reset.

After the A/D module has been configured as desired, the selected channel must be acquired before the conversion is started. The analog input channels must have their corresponding TRIS bits selected as an input. To determine acquisition time, see **Section 19.1 “A/D Acquisition Requirements”**. After this acquisition time has elapsed, the A/D conversion can be started. An acquisition time can be programmed to occur between setting the GO/DONE bit and the actual start of the conversion.

The following steps should be followed to perform an A/D conversion:

1. Configure the A/D module:
 - Configure analog pins, voltage reference and digital I/O (ADCON1)
 - Select A/D input channel (ADCON0)
 - Select A/D acquisition time (ADCON2)
 - Select A/D conversion clock (ADCON2)
 - Turn on A/D module (ADCON0)
2. Configure A/D interrupt (if desired):
 - Clear ADIF bit
 - Set ADIE bit
 - Set GIE bit
3. Wait the required acquisition time (if required).
4. Start conversion:
 - Set GO/DONE bit (ADCON0 register)

5. Wait for A/D conversion to complete, by either:
 - Polling for the GO/DONE bit to be cleared
 OR
 - Waiting for the A/D interrupt
6. Read A/D Result registers (ADRESH:ADRESL); clear bit ADIF, if required.
7. For next conversion, go to step 1 or step 2, as required. The A/D conversion time per bit is defined as T_{AD}. A minimum wait of 2 T_{AD} is required before the next acquisition starts.

FIGURE 19-2: A/D TRANSFER FUNCTION

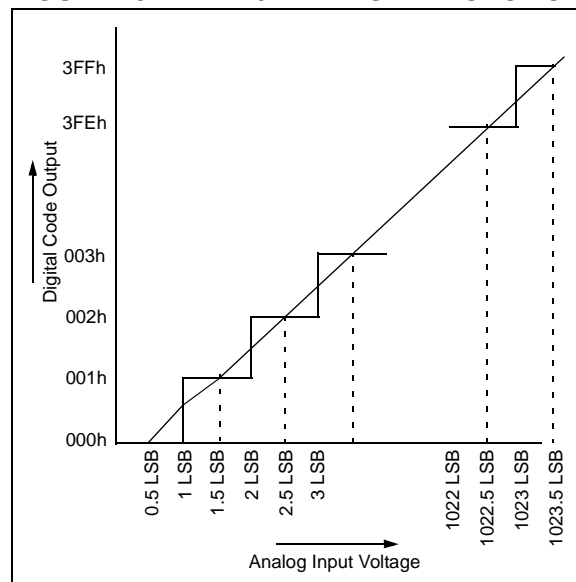
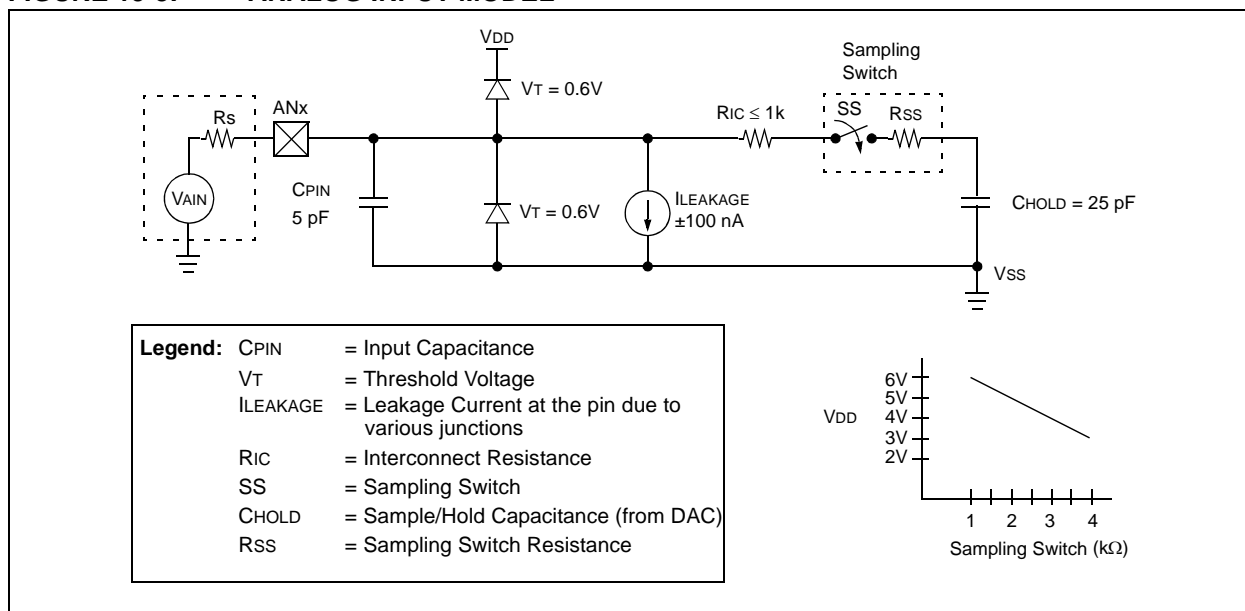


FIGURE 19-3: ANALOG INPUT MODEL



20.0 COMPARATOR MODULE

The analog comparator module contains two comparators that can be configured in a variety of ways. The inputs can be selected from the analog inputs multiplexed with pins RA0 through RA5, as well as the on-chip voltage reference (see **Section 21.0 “Comparator Voltage Reference Module”**). The digital outputs (normal or inverted) are available at the pin level and can also be read through the control register.

The CMCON register (Register 20-1) selects the comparator input and output configuration. Block diagrams of the various comparator configurations are shown in Figure 20-1.

REGISTER 20-1: CMCON: COMPARATOR CONTROL REGISTER

R-0	R-0	R/W-0	R/W-0	R/W-0	R/W-1	R/W-1	R/W-1
C2OUT	C1OUT	C2INV	C1INV	CIS	CM2	CM1	CM0
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 7 **C2OUT**: Comparator 2 Output bit

When C2INV = 0:

1 = C2 VIN+ > C2 VIN-

0 = C2 VIN+ < C2 VIN-

When C2INV = 1:

1 = C2 VIN+ < C2 VIN-

0 = C2 VIN+ > C2 VIN-

bit 6 **C1OUT**: Comparator 1 Output bit

When C1INV = 0:

1 = C1 VIN+ > C1 VIN-

0 = C1 VIN+ < C1 VIN-

When C1INV = 1:

1 = C1 VIN+ < C1 VIN-

0 = C1 VIN+ > C1 VIN-

bit 5 **C2INV**: Comparator 2 Output Inversion bit

1 = C2 output inverted

0 = C2 output not inverted

bit 4 **C1INV**: Comparator 1 Output Inversion bit

1 = C1 output inverted

0 = C1 output not inverted

bit 3 **CIS**: Comparator Input Switch bit

When CM2:CM0 = 110:

1 = C1 VIN- connects to RA3/AN3/VREF+

C2 VIN- connects to RA2/AN2/VREF-/CVREF

0 = C1 VIN- connects to RA0/AN0

C2 VIN- connects to RA1/AN1

bit 2-0 **CM2:CM0**: Comparator Mode bits

Figure 20-1 shows the Comparator modes and the CM2:CM0 bit settings.

22.2 HLVD Setup

The following steps are needed to set up the HLVD module:

1. Disable the module by clearing the HLVDEN bit (HLVDCON<4>).
2. Write the value to the HLVDL3:HLVDL0 bits that selects the desired HLVD trip point.
3. Set the VDIRMAG bit to detect high voltage (VDIRMAG = 1) or low voltage (VDIRMAG = 0).
4. Enable the HLVD module by setting the HLVDEN bit.
5. Clear the HLVD interrupt flag (PIR2<2>), which may have been set from a previous interrupt.
6. Enable the HLVD interrupt if interrupts are desired by setting the HLVDIE and GIE bits (PIE<2> and INTCON<7>). An interrupt will not be generated until the IRVST bit is set.

22.3 Current Consumption

When the module is enabled, the HLVD comparator and voltage divider are enabled and will consume static current. The total current consumption, when enabled, is specified in electrical specification parameter D022B.

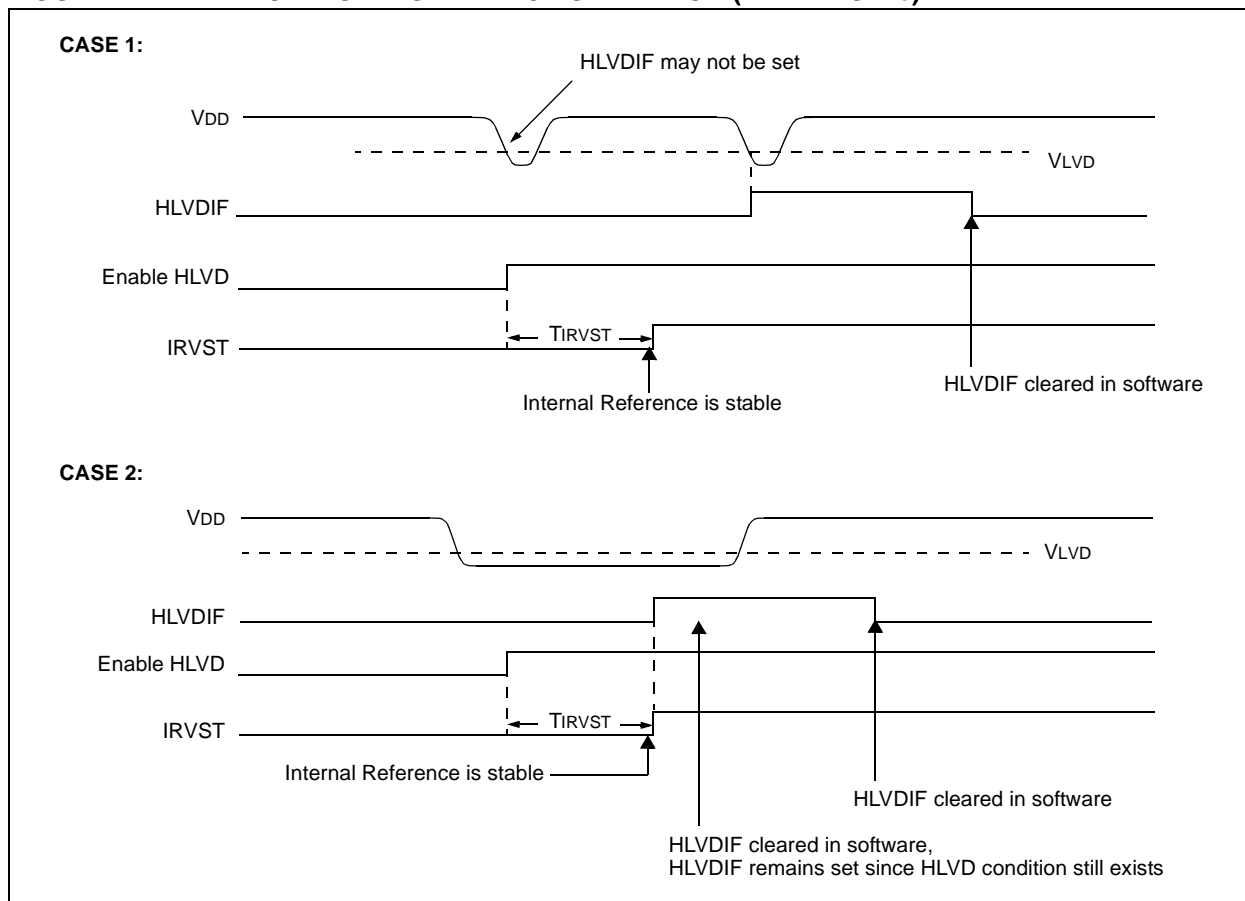
Depending on the application, the HLVD module does not need to be operating constantly. To decrease the current requirements, the HLVD circuitry may only need to be enabled for short periods where the voltage is checked. After doing the check, the HLVD module may be disabled.

22.4 HLVD Start-up Time

The internal reference voltage of the HLVD module, specified in electrical specification parameter D420, may be used by other internal circuitry, such as the Programmable Brown-out Reset. If the HLVD or other circuits using the voltage reference are disabled to lower the device's current consumption, the reference voltage circuit will require time to become stable before a low or high-voltage condition can be reliably detected. This start-up time, T_{IRVST}, is an interval that is independent of device clock speed. It is specified in electrical specification parameter 36.

The HLVD interrupt flag is not enabled until T_{IRVST} has expired and a stable reference voltage is reached. For this reason, brief excursions beyond the set point may not be detected during this interval. Refer to Figure 22-2 or Figure 22-3.

FIGURE 22-2: LOW-VOLTAGE DETECT OPERATION (VDIRMAG = 0)



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REGISTER 23-6: CONFIG5L: CONFIGURATION REGISTER 5 LOW (BYTE ADDRESS 300008h)

U-0	U-0	U-0	U-0	R/C-1	R/C-1	R/C-1	R/C-1
—	—	—	—	CP3 ⁽¹⁾	CP2	CP1	CP0
bit 7				bit 0			

Legend:

R = Readable bit

C = Clearable bit

U = Unimplemented bit, read as '0'

-n = Value when device is unprogrammed

u = Unchanged from programmed state

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

bit 3 **CP3:** Code Protection bit⁽¹⁾

1 = Block 3 (006000-007FFFh) not code-protected

0 = Block 3 (006000-007FFFh) code-protected

bit 2 **CP2:** Code Protection bit

1 = Block 2 (004000-005FFFh) not code-protected

0 = Block 2 (004000-005FFFh) code-protected

bit 1 **CP1:** Code Protection bit

1 = Block 1 (002000-003FFFh) not code-protected

0 = Block 1 (002000-003FFFh) code-protected

bit 0 **CP0:** Code Protection bit

1 = Block 0 (000800-001FFFh) not code-protected

0 = Block 0 (000800-001FFFh) code-protected

Note 1: Unimplemented in PIC18FX525 devices; maintain this bit set.

REGISTER 23-7: CONFIG5H: CONFIGURATION REGISTER 5 HIGH (BYTE ADDRESS 300009h)

R/C-1	R/C-1	U-0	U-0	U-0	U-0	U-0	U-0
CPD	CPB	—	—	—	—	—	—
bit 7				bit 0			

Legend:

R = Readable bit

C = Clearable bit

U = Unimplemented bit, read as '0'

-n = Value when device is unprogrammed

u = Unchanged from programmed state

bit 7 **CPD:** Data EEPROM Code Protection bit

1 = Data EEPROM not code-protected

0 = Data EEPROM code-protected

bit 6 **CPB:** Boot Block Code Protection bit

1 = Boot block (000000-0007FFFh) not code-protected

0 = Boot block (000000-0007FFFh) code-protected

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

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TABLE 24-2: PIC18FXXXX INSTRUCTION SET (CONTINUED)

Mnemonic, Operands	Description	Cycles	16-Bit Instruction Word				Status Affected	Notes	
			MSb		LSb				
LITERAL OPERATIONS									
ADDLW k	Add Literal and WREG	1	0000	1111	kkkk	kkkk	C, DC, Z, OV, N		
ANDLW k	AND Literal with WREG	1	0000	1011	kkkk	kkkk	Z, N		
IORLW k	Inclusive OR Literal with WREG	1	0000	1001	kkkk	kkkk	Z, N		
LFSR f, k	Move Literal (12-bit)2nd word to FSR(f) 1st word	2	1110	1110	00ff	kkkk	None		
			1111	0000	kkkk	kkkk			
MOVLB k	Move Literal to BSR<3:0>	1	0000	0001	0000	kkkk	None		
MOVLW k	Move Literal to WREG	1	0000	1110	kkkk	kkkk	None		
MULLW k	Multiply Literal with WREG	1	0000	1101	kkkk	kkkk	None		
RETLW k	Return with Literal in WREG	2	0000	1100	kkkk	kkkk	None		
SUBLW k	Subtract WREG from Literal	1	0000	1000	kkkk	kkkk	C, DC, Z, OV, N		
XORLW k	Exclusive OR Literal with WREG	1	0000	1010	kkkk	kkkk	Z, N		
DATA MEMORY ↔ PROGRAM MEMORY OPERATIONS									
TBLRD*	Table Read	2	0000	0000	0000	1000	None		
TBLRD*+	Table Read with Post-Increment		0000	0000	0000	1001	None		
TBLRD*-	Table Read with Post-Decrement		0000	0000	0000	1010	None		
TBLRD+*	Table Read with Pre-Increment		0000	0000	0000	1011	None		
TBLWT*	Table Write	2	0000	0000	0000	1100	None		
TBLWT*+	Table Write with Post-Increment		0000	0000	0000	1101	None		
TBLWT*-	Table Write with Post-Decrement		0000	0000	0000	1110	None		
TBLWT+*	Table Write with Pre-Increment		0000	0000	0000	1111	None		

- Note 1:** When a PORT register is modified as a function of itself (e.g., `MOVF PORTB, 1, 0`), the value used will be that value present on the pins themselves. For example, if the data latch is '1' for a pin configured as input and is driven low by an external device, the data will be written back with a '0'.
- 2:** If this instruction is executed on the TMR0 register (and where applicable, 'd' = 1), the prescaler will be cleared if assigned.
- 3:** If the Program Counter (PC) is modified or a conditional test is true, the instruction requires two cycles. The second cycle is executed as a NOP.
- 4:** Some instructions are two-word instructions. The second word of these instructions will be executed as a NOP unless the first word of the instruction retrieves the information embedded in these 16 bits. This ensures that all program memory locations have a valid instruction.

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SLEEP Enter Sleep mode

Syntax:	SLEEP				
Operands:	None				
Operation:	00h → WDT, 0 → WDT postscaler, 1 → \overline{TO} , 0 → \overline{PD}				
Status Affected:	\overline{TO} , \overline{PD}				
Encoding:	<table><tr><td>0000</td><td>0000</td><td>0000</td><td>0011</td></tr></table>	0000	0000	0000	0011
0000	0000	0000	0011		
Description:	<p>The Power-Down status bit (\overline{PD}) is cleared. The Time-out status bit (\overline{TO}) is set. Watchdog Timer and its postscaler are cleared.</p> <p>The processor is put into Sleep mode with the oscillator stopped.</p>				
Words:	1				
Cycles:	1				
Q Cycle Activity:					

Q1	Q2	Q3	Q4
Decode	No operation	Process Data	Go to Sleep

Example: SLEEP

Before Instruction

\overline{TO} = ?

\overline{PD} = ?

After Instruction

\overline{TO} = 1†

\overline{PD} = 0

† If WDT causes wake-up, this bit is cleared.

SUBFWB Subtract f from W with Borrow

Syntax:	SUBFWB f {,d {,a}}			
Operands:	$0 \leq f \leq 255$ $d \in [0,1]$ $a \in [0,1]$			
Operation:	$(W) - (f) - (\overline{C}) \rightarrow \text{dest}$			
Status Affected:	N, OV, C, DC, Z			
Encoding:	0101	01da	ffff	ffff
Description:	<p>Subtract register 'f' and Carry flag (borrow) from W (2's complement method). If 'd' is '0', the result is stored in W. If 'd' is '1', the result is stored in register 'f' (default).</p> <p>If 'a' is '0', the Access Bank is selected. If 'a' is '1', the BSR is used to select the GPR bank.</p> <p>If 'a' is '0' and the extended instruction set is enabled, this instruction operates in Indexed Literal Offset Addressing mode whenever $f \leq 95$ (5Fh). See Section 24.2.3 “Byte-Oriented and Bit-Oriented Instructions in Indexed Literal Offset Mode” for details.</p>			

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example 1: SUBFWB REG, 1, 0

Before Instruction

REG = 3

W = 2

C = 1

After Instruction

REG = FF

W = 2

C = 0

Z = 0

N = 1 ; result is negative

Example 2: SUBFWB REG, 0, 0

Before Instruction

REG = 2

W = 5

C = 1

After Instruction

REG = 2

W = 3

C = 1

Z = 0

N = 0 ; result is positive

Example 3: SUBFWB REG, 1, 0

Before Instruction

REG = 1

W = 2

C = 0

After Instruction

REG = 0

W = 2

C = 1

Z = 1 ; result is zero

N = 0

PIC18F2525/2620/4525/4620

26.1 DC Characteristics: Supply Voltage PIC18F2525/2620/4525/4620 (Industrial) PIC18LF2525/2620/4525/4620 (Industrial)

PIC18LF2525/2620/4525/4620 (Industrial)			Standard Operating Conditions (unless otherwise stated) Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial				
PIC18F2525/2620/4525/4620 (Industrial, Extended)			Standard Operating Conditions (unless otherwise stated) Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended				
Param No.	Symbol	Characteristic	Min	Typ	Max	Units	Conditions
D001	VDD	Supply Voltage					
		PIC18LFX525/X620	2.0	—	5.5	V	HS, XT, RC and LP Oscillator mode
		PIC18FX525/X620	4.2	—	5.5	V	
D002	VDR	RAM Data Retention Voltage⁽¹⁾	1.5	—	—	V	
D003	VPOR	VDD Start Voltage to ensure internal Power-on Reset signal	—	—	0.7	V	See section on Power-on Reset for details
D004	SVDD	VDD Rise Rate to ensure internal Power-on Reset signal	0.05	—	—	V/ms	See section on Power-on Reset for details
D005	VBOR	Brown-out Reset Voltage					
		PIC18LFX525/X620					
		BORV1:BORV0 = 11	2.00	2.11	2.22	V	
D005		BORV1:BORV0 = 10	2.65	2.79	2.93	V	
		All Devices					
		BORV1:BORV0 = 01 ⁽²⁾	4.11	4.33	4.55	V	
		BORV1:BORV0 = 00	4.36	4.59	4.82	V	

Legend: Shading of rows is to assist in readability of the table.

Note 1: This is the limit to which VDD can be lowered in Sleep mode, or during a device Reset, without losing RAM data.

Note 2: With BOR enabled, full-speed operation ($F_{\text{OSC}} = 40 \text{ MHz}$) is supported until a BOR occurs. This is valid although VDD may be below the minimum voltage for this frequency.

PIC18F2525/2620/4525/4620

FIGURE 26-16: EXAMPLE SPI SLAVE MODE TIMING (CKE = 1)

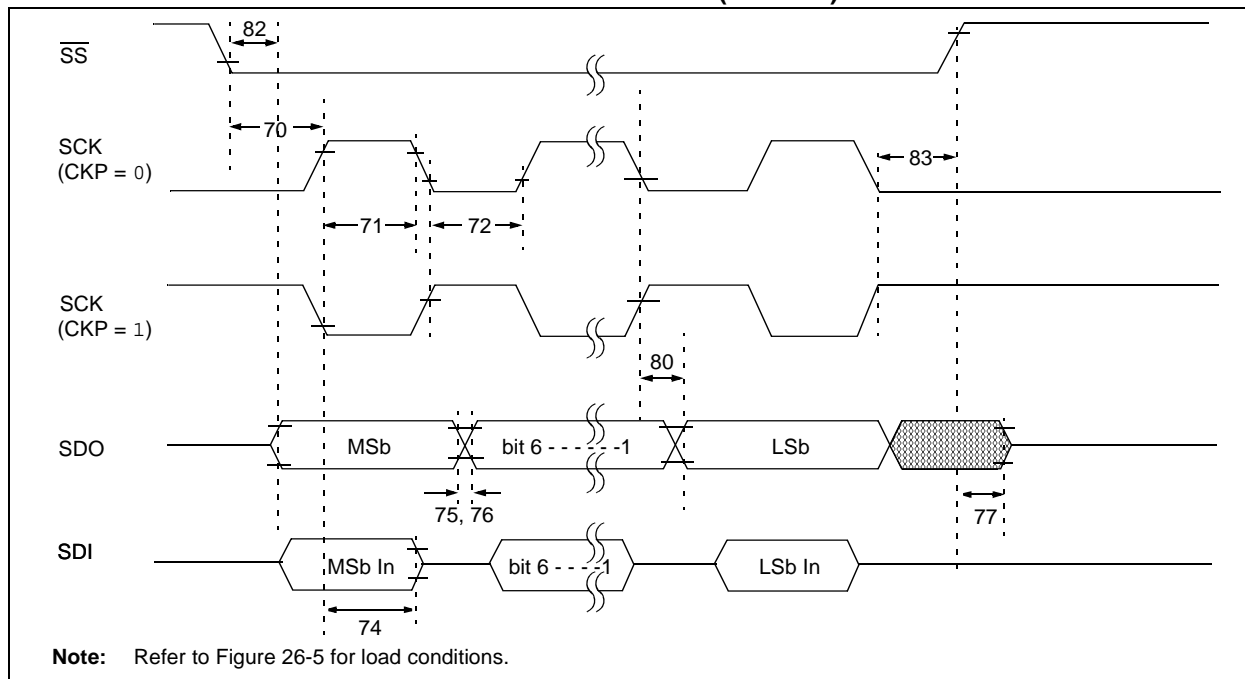


TABLE 26-17: EXAMPLE SPI SLAVE MODE REQUIREMENTS (CKE = 1)

Param No.	Symbol	Characteristic	Min	Max	Units	Conditions
70	TssL2scH, TssL2scL	$\overline{SS} \downarrow$ to SCK \downarrow or SCK \uparrow Input	3 Tcy	—	ns	
71	TscH	SCK Input High Time (Slave mode)	1.25 Tcy + 30	—	ns	
71A		Single Byte	40	—	ns	(Note 1)
72	TscL	SCK Input Low Time (Slave mode)	1.25 Tcy + 30	—	ns	
72A		Single Byte	40	—	ns	(Note 1)
73A	Tb2b	Last Clock Edge of Byte 1 to the First Clock Edge of Byte 2	1.5 Tcy + 40	—	ns	(Note 2)
74	Tsch2diL, TscL2diL	Hold Time of SDI Data Input to SCK Edge	40	—	ns	
75	TdoR	SDO Data Output Rise Time	—	25	ns	
		PIC18FXXXX	—	45	ns	VDD = 2.0V
76	TdoF	SDO Data Output Fall Time	—	25	ns	
77	TssH2doZ	$\overline{SS} \uparrow$ to SDO Output High-Impedance	10	50	ns	
78	TscR	SCK Output Rise Time (Master mode)	—	25	ns	
		PIC18FXXXX	—	45	ns	VDD = 2.0V
79	TscF	SCK Output Fall Time (Master mode)	—	25	ns	
80	Tsch2doV, TscL2doV	SDO Data Output Valid after SCK Edge	—	50	ns	
		PIC18FXXXX	—	100	ns	VDD = 2.0V
82	TssL2doV	SDO Data Output Valid after $\overline{SS} \downarrow$ Edge	—	50	ns	
		PIC18FXXXX	—	100	ns	VDD = 2.0V
83	Tsch2ssH, TscL2ssH	$\overline{SS} \uparrow$ after SCK Edge	1.5 Tcy + 40	—	ns	

Note 1: Requires the use of Parameter #73A.

Note 2: Only if Parameter #71A and #72A are used.

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