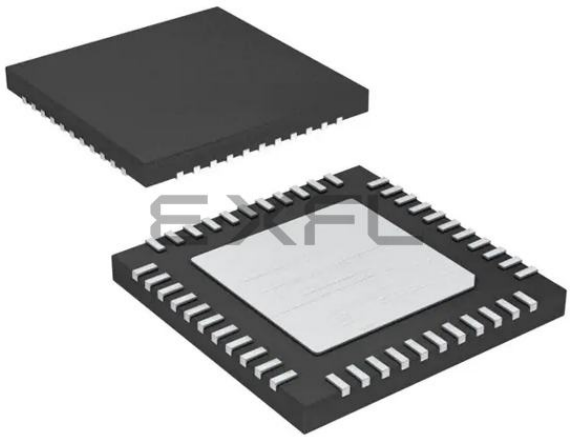

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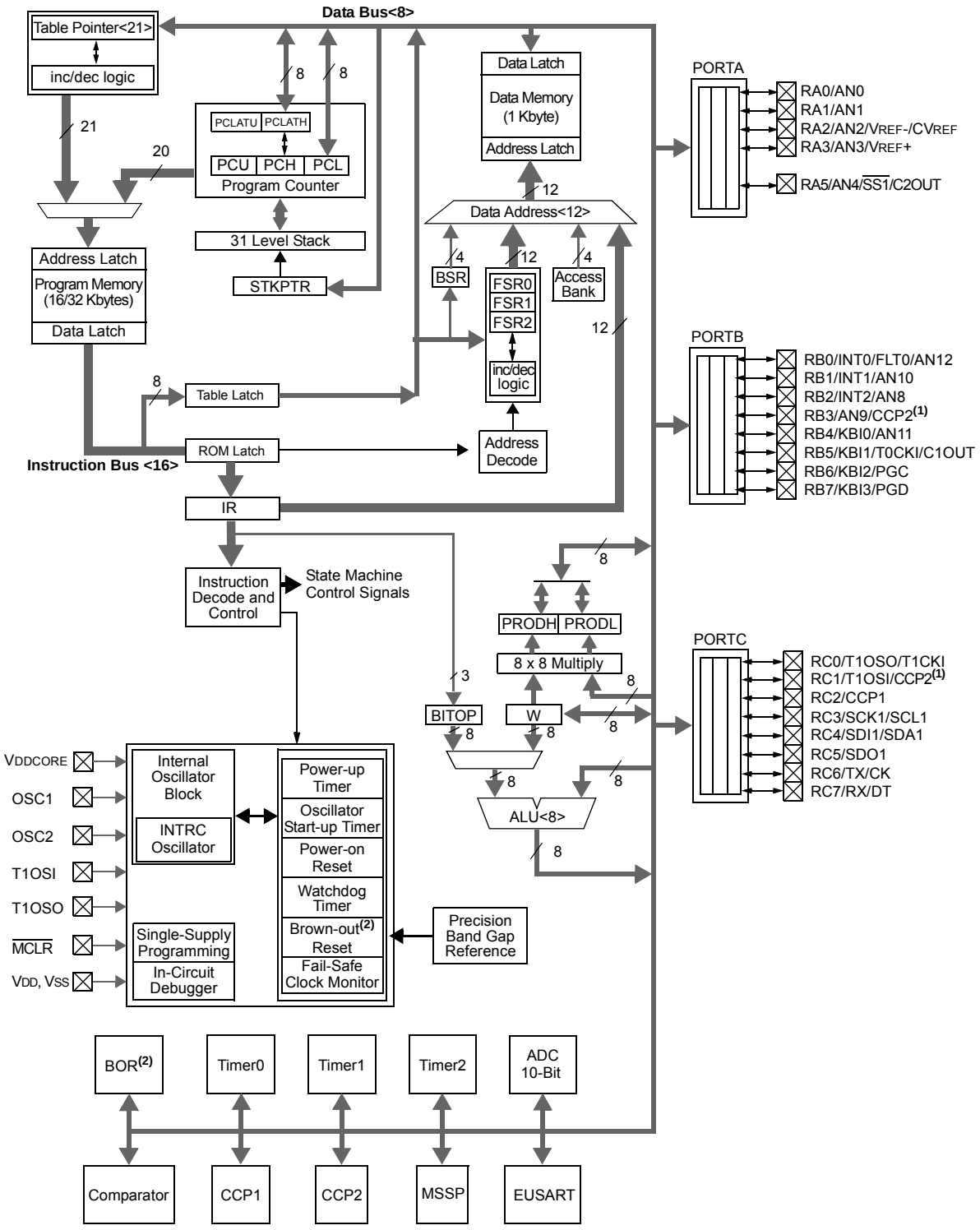
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	40MHz
Connectivity	I²C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	32
Program Memory Size	16KB (8K x 16)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
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/pic18f44j10-i-ml

FIGURE 1-1: PIC18F24J10/25J10 (28-PIN) BLOCK DIAGRAM



Note 1: CCP2 is multiplexed with RC1 when Configuration bit, CCP2MX, is set, or RB3 when CCP2MX is not set.

2: Brown-out Reset is not available in PIC18LF2XJ10/4XJ10 devices.

TABLE 1-3: PIC18F44J10/45J10 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTD is a bidirectional I/O port or a Parallel Slave Port (PSP) for interfacing to a microprocessor port. These pins have TTL input buffers when PSP module is enabled.
RD0/PSP0/SCK2/SCL2	19	38	38			
RD0				I/O	ST	Digital I/O.
PSP0				I/O	TTL	Parallel Slave Port data.
SCK2				I/O	ST	Synchronous serial clock input/output for SPI mode.
SCL2				I/O	ST	Synchronous serial clock input/output for I^2C™ mode.
RD1/PSP1/SDI2/SDA2	20	39	39			
RD1				I/O	ST	Digital I/O.
PSP1				I/O	TTL	Parallel Slave Port data.
SDI2				I	ST	SPI data in.
SDA2				I/O	ST	I^2C data I/O.
RD2/PSP2/SDO2	21	40	40			
RD2				I/O	ST	Digital I/O.
PSP2				I/O	TTL	Parallel Slave Port data.
SDO2				O	—	SPI data out.
RD3/PSP3/$\overline{SS2}$	22	41	41			
RD3				I/O	ST	Digital I/O.
PSP3				I/O	TTL	Parallel Slave Port data.
$\overline{SS2}$				I	TTL	SPI slave select input.
RD4/PSP4	27	2	2			
RD4				I/O	ST	Digital I/O.
PSP4				I/O	TTL	Parallel Slave Port data.
RD5/PSP5/P1B	28	3	3			
RD5				I/O	ST	Digital I/O.
PSP5				I/O	TTL	Parallel Slave Port data.
P1B				O	—	Enhanced CCP1 output.
RD6/PSP6/P1C	29	4	4			
RD6				I/O	ST	Digital I/O.
PSP6				I/O	TTL	Parallel Slave Port data.
P1C				O	—	Enhanced CCP1 output.
RD7/PSP7/P1D	30	5	5			
RD7				I/O	ST	Digital I/O.
PSP7				I/O	TTL	Parallel Slave Port data.
P1D				O	—	Enhanced CCP1 output.

Legend: TTL = TTL compatible input
CMOS = CMOS compatible input or output
ST = Schmitt Trigger input with CMOS levels
I = Input
O = Output
P = Power

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.
2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

NOTES:

6.2 PIC18 Instruction Cycle

6.2.1 CLOCKING SCHEME

The microcontroller clock input, whether from an internal or external source, is internally divided by four to generate four non-overlapping quadrature clocks (Q1, Q2, Q3 and Q4). Internally, the program counter is incremented on every Q1; the instruction is fetched from the program memory and latched into the instruction register during Q4. The instruction is decoded and executed during the following Q1 through Q4. The clocks and instruction execution flow are shown in Figure 6-4.

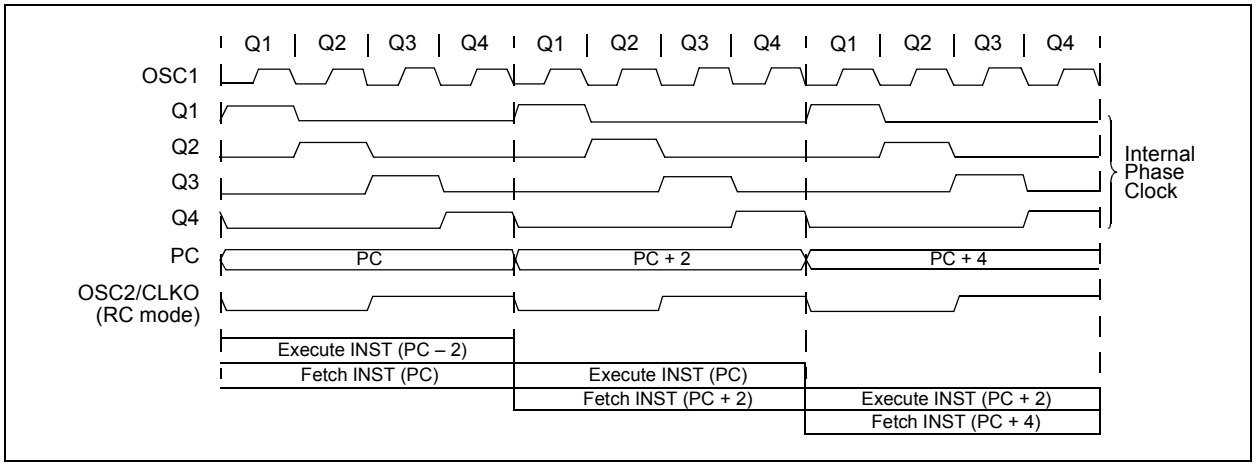
6.2.2 INSTRUCTION FLOW/PIPELINING

An “Instruction Cycle” consists of four Q cycles: Q1 through Q4. The instruction fetch and execute are pipelined in such a manner that a fetch takes one instruction cycle, while the decode and execute take another instruction cycle. However, due to the pipelining, each instruction effectively executes in one cycle. If an instruction causes the program counter to change (e.g., GOTO), then two cycles are required to complete the instruction (Example 6-3).

A fetch cycle begins with the Program Counter (PC) incrementing in Q1.

In the execution cycle, the fetched instruction is latched into the Instruction Register (IR) in cycle Q1. This instruction is then decoded and executed during the Q2, Q3 and Q4 cycles. Data memory is read during Q2 (operand read) and written during Q4 (destination write).

FIGURE 6-4: CLOCK/INSTRUCTION CYCLE



EXAMPLE 6-3: INSTRUCTION PIPELINE FLOW

	TCY0	TCY1	TCY2	TCY3	TCY4	TCY5
1. MOVLW 55h	Fetch 1	Execute 1				
2. MOVWF PORTB		Fetch 2	Execute 2			
3. BRA SUB_1			Fetch 3	Execute 3		
4. BSF PORTA, BIT3 (Forced NOP)				Fetch 4	Flush (NOP)	
5. Instruction @ address SUB_1					Fetch SUB_1	Execute SUB_1

All instructions are single cycle, except for any program branches. These take two cycles since the fetch instruction is “flushed” from the pipeline while the new instruction is being fetched and then executed.

REGISTER 9-8: PIE2: PERIPHERAL INTERRUPT ENABLE REGISTER 2

R/W-0	R/W-0	U-0	U-0	R/W-0	U-0	U-0	R/W-0
OSCFIE	CMIE	—	—	BCL1IE	—	—	CCP2IE
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 **OSCFIE:** Oscillator Fail Interrupt Enable bit
1 = Enabled
0 = Disabled

bit 6 **CMIE:** Comparator Interrupt Enable bit
1 = Enabled
0 = Disabled

bit 5-4 **Unimplemented:** Read as '0'

bit 3 **BCL1IE:** Bus Collision Interrupt Enable bit (MSSP1 module)
1 = Enabled
0 = Disabled

bit 2-1 **Unimplemented:** Read as '0'

bit 0 **CCP2IE:** CCP2 Interrupt Enable bit
1 = Enabled
0 = Disabled

REGISTER 9-9: PIE3: PERIPHERAL INTERRUPT ENABLE REGISTER 3

R/W-0	R/W-0	U-0	U-0	U-0	U-0	U-0	U-0
SSP2IE	BCL2IE	—	—	—	—	—	—
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 **SSP2IE:** Master Synchronous Serial Port 2 Interrupt Enable bit
1 = Enabled
0 = Disabled

bit 6 **BCL2IE:** Bus Collision Interrupt Enable bit (MSSP2 module)
1 = Enabled
0 = Disabled

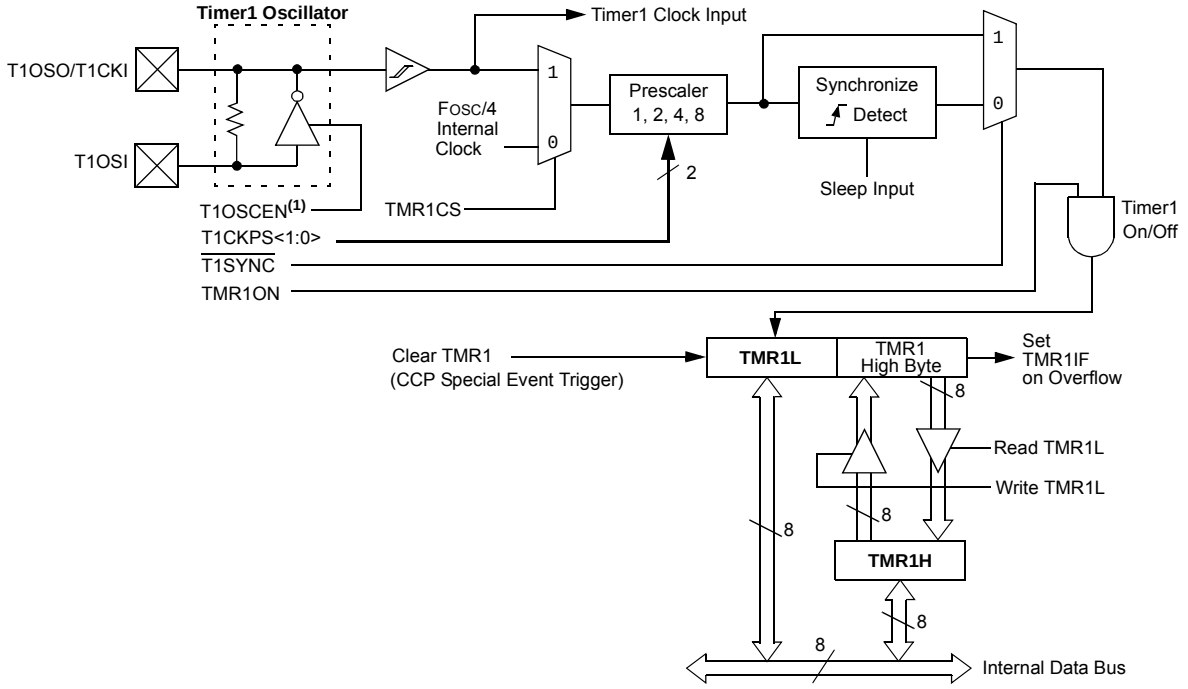
bit 5-0 **Unimplemented:** Read as '0'

TABLE 10-9: PORTD I/O SUMMARY

Pin	Function	TRIS Setting	I/O	I/O Type	Description
RD0/PSP0/SCK2/SCL2	RD0	0	O	DIG	LATD<0> data output.
		1	I	ST	PORTD<0> data input.
	PSP0	x	O	DIG	PSP read data output (LATD<0>); takes priority over port data.
		x	I	TTL	PSP write data input.
	SCK2	0	O	DIG	SPI clock output (MSSP2 module); takes priority over port data.
		1	I	ST	SPI clock input (MSSP2 module).
	SCL2	0	O	DIG	I^2C™ clock output (MSSP2 module); takes priority over port data.
		1	I	I^2C/SMB	I^2C clock input (MSSP2 module); input type depends on module setting.
RD1/PSP1/SDI2/SDA2	RD1	0	O	DIG	LATD<1> data output.
		1	I	ST	PORTD<1> data input.
	PSP1	x	O	DIG	PSP read data output (LATD<1>); takes priority over port data.
		x	I	TTL	PSP write data input.
	SDI2	1	I	ST	SPI data input (MSSP2 module).
	SDA2	1	O	DIG	I^2C data output (MSSP2 module); takes priority over port data.
		1	I	I^2C/SMB	I^2C data input (MSSP2 module); input type depends on module setting.
RD2/PSP2/SDO2	RD2	0	O	DIG	LATD<2> data output.
		1	I	ST	PORTD<2> data input.
	PSP2	x	O	DIG	PSP read data output (LATD<2>); takes priority over port data.
		x	I	TTL	PSP write data input.
	SDO2	0	O	DIG	SPI data output (MSSP2 module); takes priority over port data.
RD3/PSP3/$\overline{SS2}$	RD3	0	O	DIG	LATD<3> data output.
		1	I	ST	PORTD<3> data input.
	PSP3	x	O	DIG	PSP read data output (LATD<3>); takes priority over port data.
		x	I	TTL	PSP write data input.
	$\overline{SS2}$	1	I	TTL	Slave select input for MSSP2 (MSSP2 module).
RD4/PSP4	RD4	0	O	DIG	LATD<4> data output.
		1	I	ST	PORTD<4> data input.
	PSP4	x	O	DIG	PSP read data output (LATD<4>); takes priority over port data.
		x	I	TTL	PSP write data input.
RD5/PSP5/P1B	RD5	0	O	DIG	LATD<5> data output.
		1	I	ST	PORTD<5> data input.
	PSP5	x	O	DIG	PSP read data output (LATD<5>); takes priority over port data.
		x	I	TTL	PSP write data input.
	P1B	0	O	DIG	ECCP1 Enhanced PWM output, Channel B; takes priority over port and PSP data. May be configured for tri-state during Enhanced PWM shutdown events.
RD6/PSP6/P1C	RD6	0	O	DIG	LATD<6> data output.
		1	I	ST	PORTD<6> data input.
	PSP6	x	O	DIG	PSP read data output (LATD<6>); takes priority over port data.
		x	I	TTL	PSP write data input.
	P1C	0	O	DIG	ECCP1 Enhanced PWM output, Channel C; takes priority over port and PSP data. May be configured for tri-state during Enhanced PWM shutdown events.
RD7/PSP7/P1D	RD7	0	O	DIG	LATD<7> data output.
		1	I	ST	PORTD<7> data input.
	PSP7	x	O	DIG	PSP read data output (LATD<7>); takes priority over port data.
		x	I	TTL	PSP write data input.
	P1D	0	O	DIG	ECCP1 Enhanced PWM output, Channel D; takes priority over port and PSP data. May be configured for tri-state during Enhanced PWM shutdown events.

Legend: DIG = Digital level output; TTL = TTL input buffer; ST = Schmitt Trigger input buffer; I^2C™/SMB = I^2C/SMBus input buffer; x = Don't care (TRIS bit does not affect port direction or is overridden for this option).

FIGURE 12-2: TIMER1 BLOCK DIAGRAM (16-BIT READ/WRITE MODE)



Note 1: When enable bit, T1OSCEN, is cleared, the inverter and feedback resistor are turned off to eliminate power drain.

12.2 Timer1 16-Bit Read/Write Mode

Timer1 can be configured for 16-bit reads and writes (see Figure 12-2). When the RD16 control bit (T1CON<7>) is set, the address for TMR1H is mapped to a buffer register for the high byte of Timer1. A read from TMR1L will load the contents of the high byte of Timer1 into the Timer1 High Byte Buffer register. This provides the user with the ability to accurately read all 16 bits of Timer1 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 Timer1 must also take place through the TMR1H Buffer register. The Timer1 high byte is updated with the contents of TMR1H when a write occurs to TMR1L. This allows a user to write all 16 bits to both the high and low bytes of Timer1 at once.

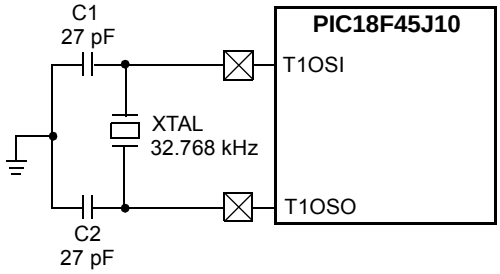
The high byte of Timer1 is not directly readable or writable in this mode. All reads and writes must take place through the Timer1 High Byte Buffer register. Writes to TMR1H do not clear the Timer1 prescaler. The prescaler is only cleared on writes to TMR1L.

12.3 Timer1 Oscillator

An on-chip crystal oscillator circuit is incorporated between pins T1OSI (input) and T1OSO (amplifier output). It is enabled by setting the Timer1 Oscillator Enable bit, T1OSCEN (T1CON<3>). The oscillator is a low-power circuit rated for 32 kHz crystals. It will continue to run during all power-managed modes. The circuit for a typical oscillator is shown in Figure 12-3. Table 12-1 shows the capacitor selection for the Timer1 oscillator.

The user must provide a software time delay to ensure proper start-up of the Timer1 oscillator.

FIGURE 12-3: EXTERNAL COMPONENTS FOR THE TIMER1 OSCILLATOR



Note: See the Notes with Table 12-1 for additional information about capacitor selection.

14.1 CCP Module Configuration

Each Capture/Compare/PWM module is associated with a control register (generically, CCPxCON) and a data register (CCPRx). The data register, in turn, is comprised of two 8-bit registers: CCPRxL (low byte) and CCPRxH (high byte). All registers are both readable and writable.

14.1.1 CCP MODULES AND TIMER RESOURCES

The CCP modules utilize Timers 1 or 2, depending on the mode selected. Timer1 is available to modules in Capture or Compare modes, while Timer2 is available for modules in PWM mode.

TABLE 14-1: ECCP/CCP MODE – TIMER RESOURCE

ECCP/CCP Mode	Timer Resource
Capture	Timer1
Compare	Timer1
PWM	Timer2

Both modules may be active at any given time and may share the same timer resource if they are configured to operate in the same mode (Capture/Compare or PWM) at the same time. The interactions between the two modules are summarized in Figure 14-1 and Figure 14-2. In Timer1 in Asynchronous Counter mode, the capture operation will not work.

14.1.2 CCP2 PIN ASSIGNMENT

The pin assignment for CCP2 (Capture input, Compare and PWM output) can change, based on device configuration. The CCP2MX Configuration bit determines which pin CCP2 is multiplexed to. By default, it is assigned to RC1 (CCP2MX = 1). If the Configuration bit is cleared, CCP2 is multiplexed with RB3.

Changing the pin assignment of CCP2 does not automatically change any requirements for configuring the port pin. Users must always verify that the appropriate TRIS register is configured correctly for CCP2 operation regardless of where it is located.

TABLE 14-2: INTERACTIONS BETWEEN ECCP1/CCP1 AND CCP2 FOR TIMER RESOURCES

CCP1 Mode	CCP2 Mode	Interaction
Capture	Capture	Each module uses TMR1 as the time base.
Capture	Compare	CCP2 can be configured for the Special Event Trigger to reset TMR1. Automatic A/D conversions on the trigger event can also be done. Operation of ECCP1/CCP1 will be affected.
Compare	Capture	ECCP1/CCP1 can be configured for the Special Event Trigger to reset TMR1. Operation of CCP2 will be affected.
Compare	Compare	Either module can be configured for the Special Event Trigger to reset TMR1. Automatic A/D conversions on the CCP2 trigger event can be done.
Capture	PWM(1)	None
Compare	PWM(1)	None
PWM(1)	Capture	None
PWM(1)	Compare	None
PWM(1)	PWM	Both PWMs will have the same frequency and update rate (TMR2 interrupt).

Note 1: Includes standard and Enhanced PWM operation.

FIGURE 15-2: PWM OUTPUT RELATIONSHIPS (ACTIVE-HIGH STATE)

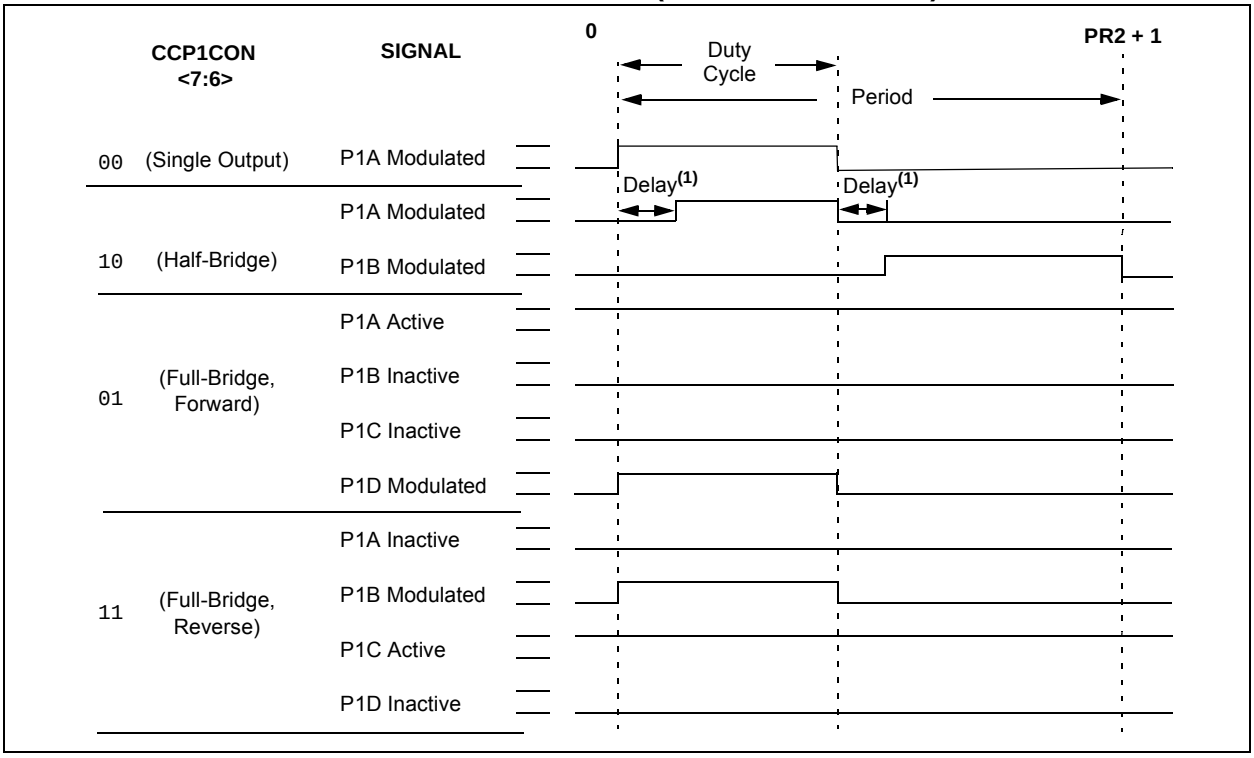
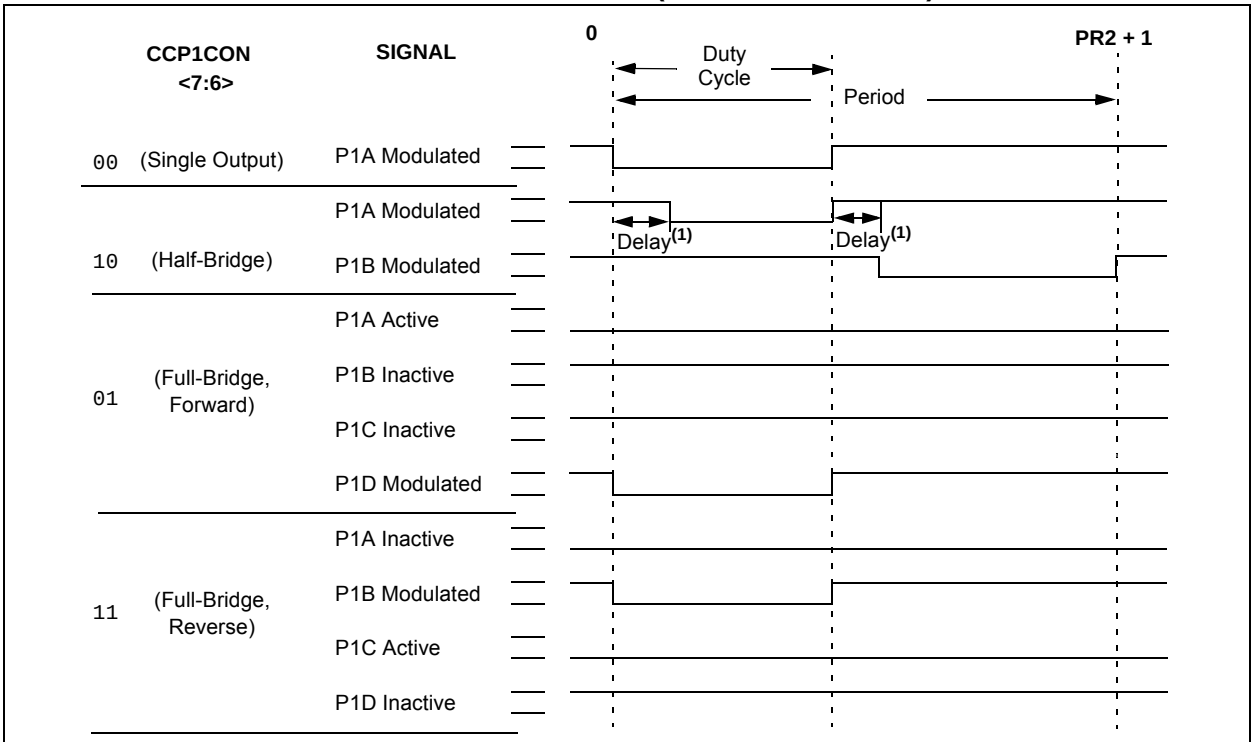


FIGURE 15-3: PWM OUTPUT RELATIONSHIPS (ACTIVE-LOW STATE)



Relationships:

- Period = 4 * TOSC * (PR2 + 1) * (TMR2 Prescale Value)
- Duty Cycle = TOSC * (CCPR1L<7:0>:CCP1CON<5:4>) * (TMR2 Prescale Value)
- Delay = 4 * TOSC * (ECCP1DEL<6:0>)

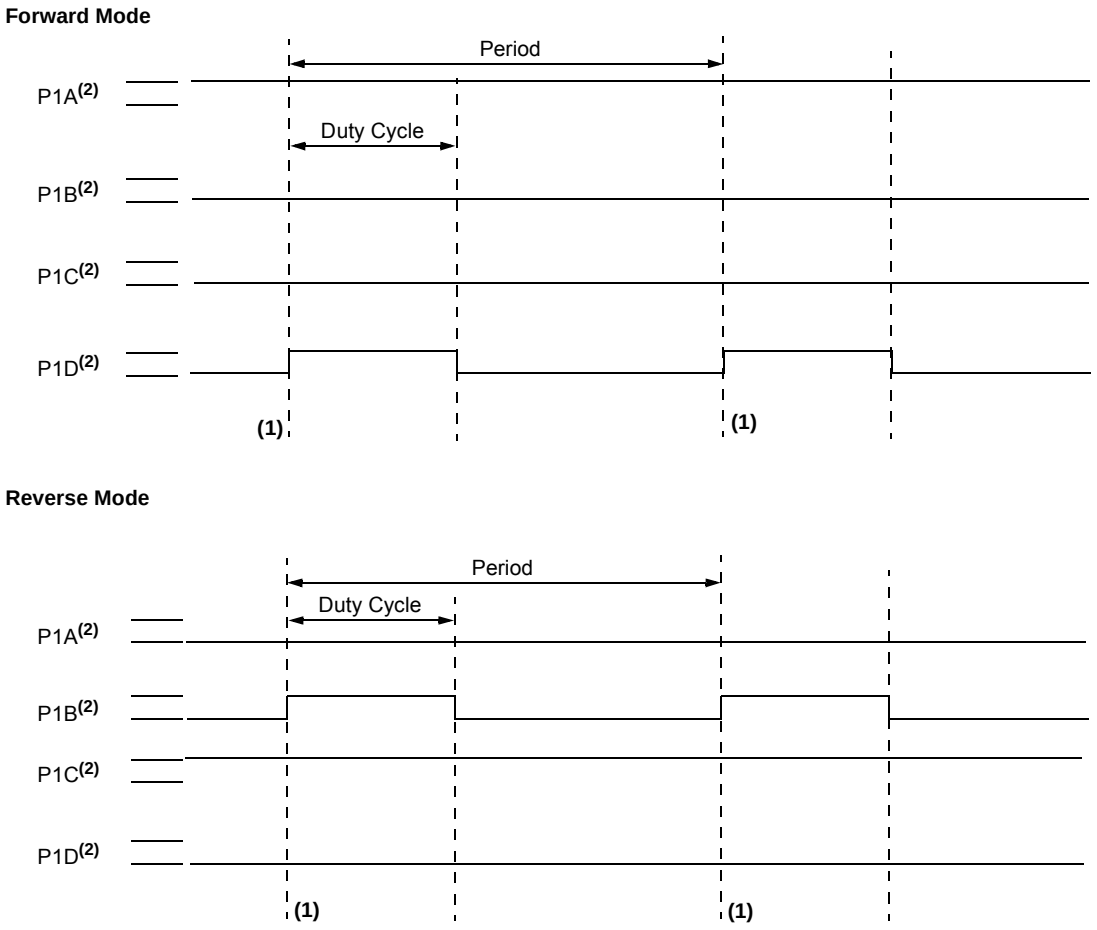
Note 1: Dead-band delay is programmed using the ECCP1DEL register (see **Section 15.4.6 "Programmable Dead-Band Delay"**).

15.4.5 FULL-BRIDGE MODE

In Full-Bridge Output mode, four pins are used as outputs; however, only two outputs are active at a time. In the Forward mode, pin P1A is continuously active and pin P1D is modulated. In the Reverse mode, pin P1C is continuously active and pin P1B is modulated. These are illustrated in Figure 15-6.

P1A, P1B, P1C and P1D outputs are multiplexed with the PORTC<2> and PORTD<7:5> data latches. The TRISC<2> and TRISD<7:5> bits must be cleared to make the P1A, P1B, P1C and P1D pins outputs.

FIGURE 15-6: FULL-BRIDGE PWM OUTPUT



Note 1: At this time, the TMR2 register is equal to the PR2 register.
2: Output signal is shown as active-high.

REGISTER 15-3: ECCP1AS: ENHANCED CAPTURE/COMPARE/PWM AUTO-SHUTDOWN CONTROL REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ECCPASE	ECCPAS2	ECCPAS1	ECCPAS0	PSSAC1	PSSAC0	PSSBD1(1)	PSSBD0(1)
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 **ECCPASE:** ECCP Auto-Shutdown Event Status bit
1 = A shutdown event has occurred; ECCP outputs are in shutdown state
0 = ECCP outputs are operating

bit 6-4 **ECCPAS<2:0>:** ECCP Auto-Shutdown Source Select bits
111 = FLT0, Comparator 1 or Comparator 2
110 = FLT0 or Comparator 2
101 = FLT0 or Comparator 1
100 = FLT0
011 = Either Comparator 1 or 2
010 = Comparator 2 output
001 = Comparator 1 output
000 = Auto-shutdown is disabled

bit 3-2 **PSSAC<1:0>:** Pins A and C Shutdown State Control bits
1x = Pins A and C are tri-state (40/44-pin devices); PWM output is tri-state (28-pin devices)
01 = Drive Pins A and C to '1'
00 = Drive Pins A and C to '0'

bit 1-0 **PSSBD<1:0>:** Pins B and D Shutdown State Control bits(1)
1x = Pins B and D tri-state
01 = Drive Pins B and D to '1'
00 = Drive Pins B and D to '0'

Note 1: Reserved on 28-pin devices; maintain these bits clear.

FIGURE 16-5: SPI MODE WAVEFORM (SLAVE MODE WITH CKE = 0)

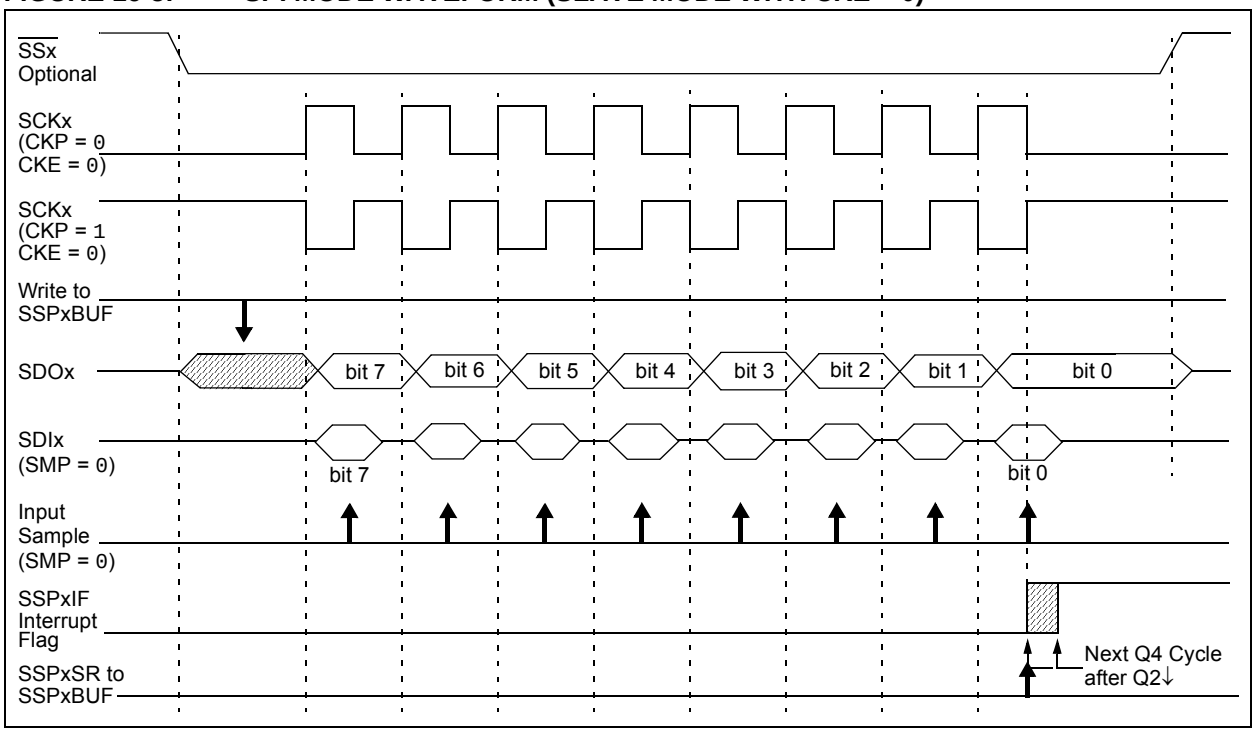


FIGURE 16-6: SPI MODE WAVEFORM (SLAVE MODE WITH CKE = 1)

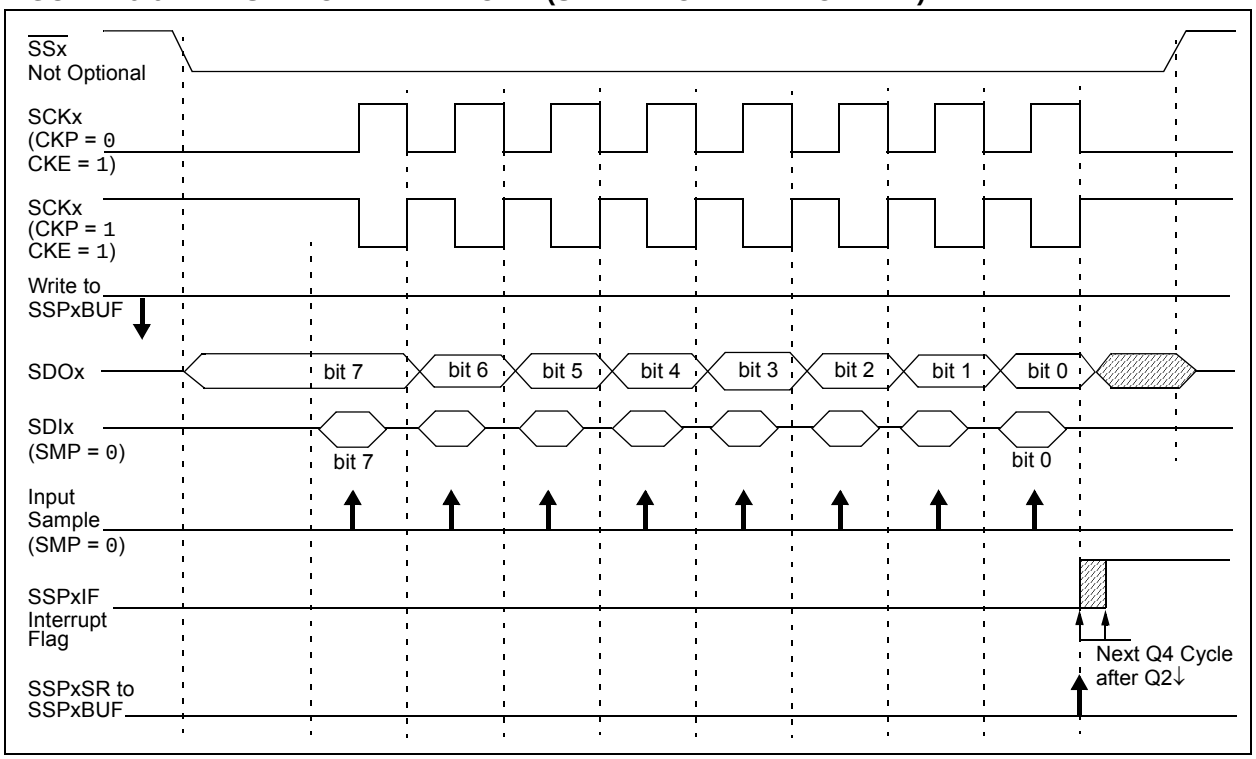
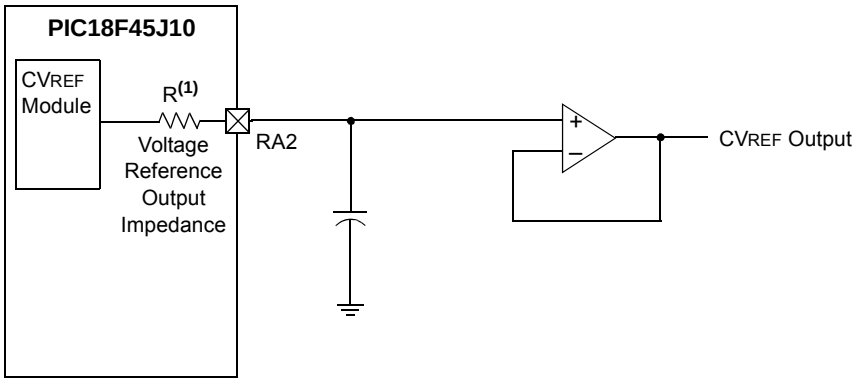


FIGURE 20-2: COMPARATOR VOLTAGE REFERENCE OUTPUT BUFFER EXAMPLE



Note 1: R is dependent upon the voltage reference configuration bits, CVRCON<3:0> and CVRCON<5>.

TABLE 20-1: REGISTERS ASSOCIATED WITH COMPARATOR VOLTAGE REFERENCE

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Reset Values on page
CVRCON	CVREN	CVROE	CVRR	CVRSS	CVR3	CVR2	CVR1	CVR0	49
CMCON	C2OUT	C1OUT	C2INV	C1INV	CIS	CM2	CM1	CM0	49
TRISA	—	—	TRISA5	—	TRISA3	TRISA2	TRISA1	TRISA0	50

Legend: Shaded cells are not used with the comparator voltage reference.

21.2 Watchdog Timer (WDT)

For PIC18F45J10 family devices, the WDT is driven by the INTRC oscillator. When the WDT is enabled, the clock source is also enabled. The nominal WDT period is 4 ms and has the same stability as the INTRC oscillator.

The 4 ms period of the WDT is multiplied by a 16-bit postscaler. Any output of the WDT postscaler is selected by a multiplexor, controlled by the WDTPS bits in Configuration Register 2H. Available periods range from about 4 ms to 135 seconds (2.25 minutes) depending on voltage, temperature and Watchdog postscaler. The WDT and postscaler are cleared whenever a SLEEP or CLRWDT instruction is executed, or a clock failure (primary or Timer1 oscillator) has occurred.

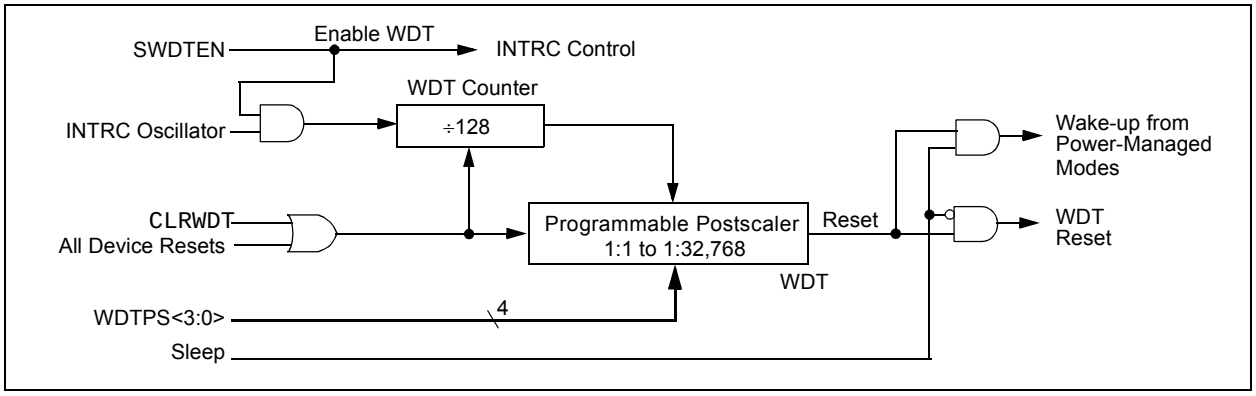
Note 1: The CLRWDT and SLEEP instructions clear the WDT and postscaler counts when executed.

2: When a CLRWDT instruction is executed, the postscaler count will be cleared.

21.2.1 CONTROL REGISTER

The WDTCON register (Register 21-9) is a readable and writable register. The SWDTEN bit enables or disables WDT operation.

FIGURE 21-1: WDT BLOCK DIAGRAM



REGISTER 21-9: WDTCON: WATCHDOG TIMER CONTROL REGISTER

u-0	U-0	U-0	U-0	U-0	U-0	U-0	R/W-0
—	—	—	—	—	—	—	SWDTEN(1)
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 7-1 **Unimplemented**: Read as '0'

bit 0 **SWDTEN:** Software Controlled Watchdog Timer Enable bit(1)
1 = Watchdog Timer is on
0 = Watchdog Timer is off

Note 1: This bit has no effect if the Configuration bit, WDTEN, is enabled.

TABLE 21-2: SUMMARY OF WATCHDOG TIMER REGISTERS

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Reset Values on page
RCON	IPEN	—	$\overline{CM}$	$\overline{RI}$	$\overline{TO}$	$\overline{PD}$	$\overline{POR}$	$\overline{BOR}$	48
WDTCON	—	—	—	—	—	—	—	SWDTEN	48

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

BCF **Bit Clear f**

Syntax: BCF f, b {,a}

Operands: $0 \le f \le 255$
$0 \le b \le 7$
$a \in [0,1]$

Operation: $0 \rightarrow f<b>$

Status Affected: None

Encoding:

1001	bbba	ffff	ffff

Description: Bit 'b' in register 'f' is cleared.
If 'a' is '0', the Access Bank is selected.
If 'a' is '1', the BSR is used to select the GPR bank (default).
If 'a' is '0' and the extended instruction set is enabled, this instruction operates in Indexed Literal Offset Addressing mode whenever $f \le 95$ (5Fh). See **Section 22.2.3 "Byte-Oriented and Bit-Oriented Instructions in Indexed Literal Offset Mode"** for details.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example: `BCF FLAG_REG, 7, 0`

Before Instruction
FLAG_REG = C7h
After Instruction
FLAG_REG = 47h

BN **Branch if Negative**

Syntax: BN n

Operands: $-128 \le n \le 127$

Operation: if Negative bit is '1',
$(PC) + 2 + 2n \rightarrow PC$

Status Affected: None

Encoding:

1110	0110	nnnn	nnnn

Description: If the Negative bit is '1', then the program will branch.
The 2's complement number, '2n', is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC + 2 + 2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:
If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example: `HERE BN Jump`

Before Instruction
PC = address (HERE)
After Instruction
If Negative = 1;
PC = address (Jump)
If Negative = 0;
PC = address (HERE + 2)

CLRF **Clear f**

Syntax: CLRF f {,a}

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: 000h → f,
1 → Z

Status Affected: Z

Encoding:

0110	101a	ffff	ffff

Description: Clears the contents of the specified register.
If 'a' is '0', the Access Bank is selected.
If 'a' is '1', the BSR is used to select the GPR bank (default).
If 'a' is '0' and the extended instruction set is enabled, this instruction operates in Indexed Literal Offset Addressing mode whenever $f \le 95$ (5Fh). See **Section 22.2.3 "Byte-Oriented and Bit-Oriented Instructions in Indexed Literal Offset Mode"** for details.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example: CLRF FLAG_REG, 1

Before Instruction
FLAG_REG = 5Ah
After Instruction
FLAG_REG = 00h

CLRWDT **Clear Watchdog Timer**

Syntax: CLRWDT

Operands: None

Operation: 000h → WDT,
000h → WDT postscaler,
1 → $\overline{TO}$,
1 → $\overline{PD}$

Status Affected: $\overline{TO}$, $\overline{PD}$

Encoding:

0000	0000	0000	0100

Description: CLRWDT instruction resets the Watchdog Timer. It also resets the postscaler of the WDT. Status bits, $\overline{TO}$ and $\overline{PD}$, are set.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	Process Data	No operation

Example: CLRWDT

Before Instruction
WDT Counter = ?
After Instruction
WDT Counter = 00h
WDT Postscaler = 0
$\overline{TO}$ = 1
$\overline{PD}$ = 1

TSTFSZ **Test f, Skip if 0**

Syntax: TSTFSZ f {,a}

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: skip if f = 0

Status Affected: None

Encoding:

0110	011a	ffff	ffff

Description: If 'f' = 0, the next instruction fetched during the current instruction execution is discarded and a NOP is executed, making this a two-cycle instruction.
If 'a' is '0', the Access Bank is selected.
If 'a' is '1', the BSR is used to select the GPR bank (default).
If 'a' is '0' and the extended instruction set is enabled, this instruction operates in Indexed Literal Offset Addressing mode whenever $f \le 95$ (5Fh). See **Section 22.2.3 "Byte-Oriented and Bit-Oriented Instructions in Indexed Literal Offset Mode"** for details.

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction.

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    TSTFSZ  CNT, 1
NZERO   :
ZERO    :
```
Before Instruction
PC = Address (HERE)
After Instruction
If CNT = 00h,
PC = Address (ZERO)
If CNT ≠ 00h,
PC = Address (NZERO)

XORLW **Exclusive OR Literal with W**

Syntax: XORLW k

Operands: $0 \le k \le 255$

Operation: (W) .XOR. k → W

Status Affected: N, Z

Encoding:

0000	1010	kkkk	kkkk

Description: The contents of W are XORed with the 8-bit literal 'k'. The result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example:
```
XORLW   0AFh
```
Before Instruction
W = B5h
After Instruction
W = 1Ah

22.2.2 EXTENDED INSTRUCTION SET

ADDFSR **Add Literal to FSR**

Syntax: ADDFSR f, k

Operands: $0 \le k \le 63$
$f \in [0, 1, 2]$

Operation: FSR(f) + k → FSR(f)

Status Affected: None

Encoding:

1110	1000	ffkk	kkkk

Description: The 6-bit literal 'k' is added to the contents of the FSR specified by 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to FSR

Example: `ADDFSR 2, 23h`

Before Instruction
FSR2 = 03FFh
After Instruction
FSR2 = 0422h

ADDULNK **Add Literal to FSR2 and Return**

Syntax: ADDULNK k

Operands: $0 \le k \le 63$

Operation: FSR2 + k → FSR2,
(TOS) → PC

Status Affected: None

Encoding:

1110	1000	11kk	kkkk

Description: The 6-bit literal 'k' is added to the contents of FSR2. A RETURN is then executed by loading the PC with the TOS.
The instruction takes two cycles to execute; a NOP is performed during the second cycle.
This may be thought of as a special case of the ADDFSR instruction, where f = 3 (binary '11'); it operates only on FSR2.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to FSR
No Operation	No Operation	No Operation	No Operation

Example: `ADDULNK 23h`

Before Instruction
FSR2 = 03FFh
PC = 0100h
After Instruction
FSR2 = 0422h
PC = (TOS)

Note: All PIC18 instructions may take an optional label argument preceding the instruction mnemonic for use in symbolic addressing. If a label is used, the instruction syntax then becomes: {label} instruction argument(s).

MOVSS **Move Indexed to Indexed**

Syntax: MOVSS [z_s], [z_d]

Operands: $0 \le z_s \le 127$
$0 \le z_d \le 127$

Operation: ((FSR2) + z_s) → ((FSR2) + z_d)

Status Affected: None

Encoding:

1st word (source)	1110	1011	1zzz	$zzzz_s$
2nd word (dest.)	1111	xxxx	xzzz	$zzzz_d$

Description: The contents of the source register are moved to the destination register. The addresses of the source and destination registers are determined by adding the 7-bit literal offsets 'z_s' or 'z_d', respectively, to the value of FSR2. Both registers can be located anywhere in the 4096-byte data memory space (000h to FFFh).
The MOVSS instruction cannot use the PCL, TOSU, TOSH or TOSL as the destination register.
If the resultant source address points to an indirect addressing register, the value returned will be 00h. If the resultant destination address points to an indirect addressing register, the instruction will execute as a NOP.

Words: 2

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Determine source addr	Determine source addr	Read source reg
Decode	Determine dest addr	Determine dest addr	Write to dest reg

Example:
```
MOVSS [05h], [06h]
```
Before Instruction
FSR2 = 80h
Contents of 85h = 33h
Contents of 86h = 11h
After Instruction
FSR2 = 80h
Contents of 85h = 33h
Contents of 86h = 33h

PUSHL **Store Literal at FSR2, Decrement FSR2**

Syntax: PUSHL k

Operands: $0 \le k \le 255$

Operation: k → (FSR2),
FSR2 – 1 → FSR2

Status Affected: None

Encoding:

1111	1010	kkkk	kkkk

Description: The 8-bit literal 'k' is written to the data memory address specified by FSR2. FSR2 is decremented by 1 after the operation. This instruction allows users to push values onto a software stack.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read 'k'	Process data	Write to destination

Example:
```
PUSHL 08h
```
Before Instruction
FSR2H:FSR2L = 01ECh
Memory (01ECh) = 00h

After Instruction
FSR2H:FSR2L = 01EBh
Memory (01ECh) = 08h

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