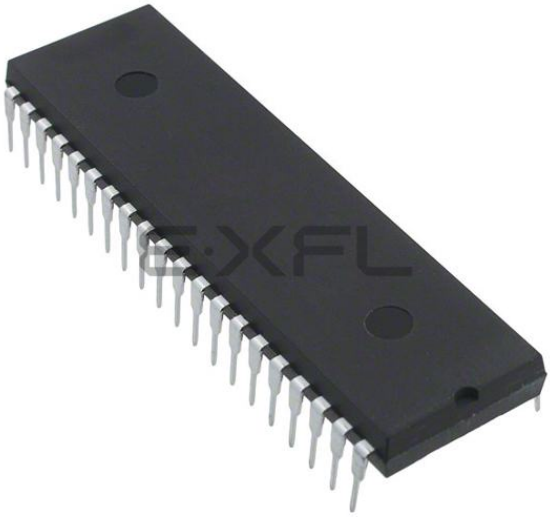

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	32MHz
Connectivity	I²C, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	36
Program Memory Size	28KB (16K x 14)
Program Memory Type	FLASH
EEPROM Size	128 x 8
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	A/D 28x10b; D/A 4x5b, 4x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Through Hole
Package / Case	40-DIP (0.600", 15.24mm)
Supplier Device Package	40-PDIP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16lf1779-e-p

TABLE 1-2: PIC16(L)F1778 PINOUT DESCRIPTION (CONTINUED)

Name	Function	Input Type	Output Type	Description
RC3/AN15/C1IN4-/C2IN4-/ C3IN4-/C4IN4-/C5IN4-/C6IN4-/ T2IN//MD2CL/SCL	RC3	TTL/ST	CMOS	General purpose I/O.
	AN15	AN	—	ADC Channel 15 input.
	C1IN4-	AN	—	Comparator 1 negative input.
	C2IN4-	AN	—	Comparator 2 negative input.
	C3IN4-	AN	—	Comparator 3 negative input.
	C4IN4-	AN	—	Comparator 4 negative input.
	C5IN4-	AN	—	Comparator 5 negative input.
	C6IN4-	AN	—	Comparator 6 negative input.
	T2IN(1)	TTL/ST	—	Timer2 gate input.
	MD2CL(1)	TTL/ST	—	Data signal modulator 2 low carrier input.
	SCL	I^2C	OD	I^2C clock.
RC4/AN16/C5IN3-/C6IN3-/T8IN/ PRG3R/MD2CH/SDA	RC4	TTL/ST	CMOS	General purpose I/O.
	AN16	AN	—	ADC Channel 16 input.
	C5IN3-	AN	—	Comparator 5 negative input.
	C6IN3-	AN	—	Comparator 6 negative input.
	T8IN(1)	TTL/ST	—	Timer8 gate input.
	PRG3R(1)	TTL/ST	—	Ramp generator set_rising input.
	MD2CH(1)	TTL/ST	—	Data signal modulator 2 high carrier input.
	SDA	I^2C	OD	I^2C data input/output.
RC5/AN17/OPA3IN0+/T4IN/ PRG3F/MD2MOD	RC5	TTL/ST	CMOS	General purpose I/O.
	AN17	AN	—	ADC Channel 17 input.
	OPA3IN0+	AN	—	Operational amplifier 3 inverting input.
	T4IN(1)	TTL/ST	—	Timer4 gate input.
	PRG3F(1)	TTL/ST	—	Ramp generator set_falling input.
	MD2MOD(1)	TTL/ST	—	Data signal modulator modulation input.
RC6/AN18/PRG3IN0/C5IN1-/ C6IN1-/OPA3OUT	RC6	TTL/ST	CMOS	General purpose I/O.
	AN18	AN	—	ADC Channel 18 input.
	PRG3IN0	AN	—	Ramp generator 3 reference voltage input.
	C5IN1-	AN	—	Comparator 5 negative input.
	C6IN1-	AN	—	Comparator 6 negative input.
	OPA3OUT	—	AN	Operational amplifier 3 output.
RC7/AN19/OPA3IN0-	RC7	TTL/ST	CMOS	General purpose I/O.
	AN19	AN	—	ADC Channel 19 input.
	OPA3IN0-	AN	—	Operational amplifier 3 non-inverting input.
RE3/$\overline{MCLR}$	RE3	TTL/ST	CMOS	General purpose input.
	$\overline{MCLR}$	ST	—	Master clear input.
V_{DD}	V_{DD}	Power	—	Positive supply.
V_{SS}	V_{SS}	Power	—	Ground reference.

Legend: AN = Analog input or output CMOS = CMOS compatible input or output OD = Open-Drain
TTL = TTL compatible input ST = Schmitt Trigger input with CMOS levels I^2C = Schmitt Trigger input with I^2C
HP = High Power XTAL = Crystal levels

Note 1: Default peripheral input. Alternate pins can be selected as the peripheral input with the PPS input selection registers.
2: All pin digital outputs default to PORT latch data. Alternate outputs can be selected as the peripheral digital output with the PPS output selection registers.
3: These peripheral functions are bidirectional. The output pin selections must be the same as the input pin selections.

TABLE 3-13: PIC16(L)F1779 MEMORY MAP, BANK 24-31

BANK 24		BANK 25		BANK 26		BANK 27		BANK 28		BANK 29		BANK 30		BANK 31	
C00h	Core Registers (Table 3-2)	C80h	Core Registers (Table 3-2)	D00h	Core Registers (Table 3-2)	D80h	Core Registers (Table 3-2)	E00h	Core Registers (Table 3-2)	E80h	Core Registers (Table 3-2)	F00h	Core Registers (Table 3-2)	F80h	Core Registers (Table 3-2)
C0Bh		C8Bh		D0Bh		D8Bh		E0Bh		E8Bh		F0Bh		F8Bh	
C0Ch	—	C8Ch	—	D0Ch	—										
C0Dh	—	C8Dh	—	D0Dh	—										
C0Eh	—	C8Eh	—	D0Eh	—										
C0Fh	—	C8Fh	—	D0Fh	—										
C10h	—	C90h	—	D10h	—										
C11h	—	C91h	—	D11h	—										
C12h	—	C92h	—	D12h	—										
C13h	—	C93h	—	D13h	—										
C14h	—	C94h	—	D14h	—										
C15h	—	C95h	—	D15h	—										
C16h	—	C96h	—	D16h	—										
C17h	—	C97h	—	D17h	—										
C18h	—	C98h	—	D18h	—		See Table 3-15 for register mapping details		See Table 3-15 for register mapping details		See Table 3-15 for register mapping details		See Table 3-15 for register mapping details		See Table 3-16 for register mapping details
C19h	—	C99h	—	D19h	—										
C1Ah	—	C9Ah	—	D1Ah	—										
C1Bh	—	C9Bh	—	D1Bh	MD4CON0										
C1Ch	—	C9Ch	—	D1Ch	MD4CON1										
C1Dh	—	C9Dh	—	D1Dh	MD4SRC										
C1Eh	—	C9Eh	—	D1Eh	MD4CARL										
C1Fh	—	C9Fh	—	D1Fh	MD4CARH										
C20h	General Purpose Register 80 Bytes	CA0h	General Purpose Register 32 Bytes	D20h	Unimplemented Read as '0'										
C6Fh		CBFh		D6Fh		DEFh		E6Fh		EEFh		F6Fh		FEFh	
C70h	Accesses 70h – 7Fh	CC0h	Unimplemented Read as '0'	D70h	Accesses 70h – 7Fh	DF0h	Accesses 70h – 7Fh	E70h	Accesses 70h – 7Fh	EF0h	Accesses 70h – 7Fh	F70h	Accesses 70h – 7Fh	FF0h	Accesses 70h – 7Fh
CFFh		CFFh		D7Fh		DFFh		E7Fh		EFFh		F7Fh		FFFh	

Legend: = Unimplemented data memory locations, read as '0'.

REGISTER 7-3: PIE2: PERIPHERAL INTERRUPT ENABLE REGISTER 2

R/W-0/0	R/W-0/0	R/W-0/0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
OSFIE	C2IE	C1IE	COG1IE	BCL1IE	C4IE	C3IE	CCP2IE
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7 **OSFIE:** Oscillator Fail Interrupt Enable bit
- 1 = Enables the Oscillator Fail interrupt
- 0 = Disables the Oscillator Fail interrupt

bit 6 **C2IE:** Comparator C2 Interrupt Enable bit
- 1 = Enables the Comparator C2 interrupt
- 0 = Disables the Comparator C2 interrupt

bit 5 **C1IE:** Comparator C1 Interrupt Enable bit
- 1 = Enables the Comparator C1 interrupt
- 0 = Disables the Comparator C1 interrupt

bit 4 **COG1IE:** COG1 Auto-Shutdown Interrupt Enable bit
- 1 = COG1 interrupt enabled
- 0 = COG1 interrupt disabled

bit 3 **BCL1IE:** MSSP Bus Collision Interrupt Enable bit
- 1 = Enables the MSSP Bus Collision interrupt
- 0 = Disables the MSSP Bus Collision interrupt

bit 2 **C4IE:** TMR6 to T6PR Match Interrupt Enable bit
- 1 = Enables the Comparator C4 interrupt
- 0 = Disables the Comparator C4 interrupt

bit 1 **C3IE:** TMR4 to T4PR Match Interrupt Enable bit
- 1 = Enables the Comparator C3 interrupt
- 0 = Disables the Comparator C3 interrupt

bit 0 **CCP2IE:** CCP2 Interrupt Enable bit
- 1 = Enables the CCP2 interrupt
- 0 = Disables the CCP2 interrupt

Note: Bit PEIE of the INTCON register must be set to enable any peripheral interrupt.

11.4 Register Definitions: PORTB

REGISTER 11-9: PORTB: PORTB REGISTER

R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u
RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7-0 **RB<7:0>**: PORTB General Purpose I/O Pin bits(1)
1 = Port pin is ≥ VIH
0 = Port pin is ≤ VIL

Note 1: Writes to PORTB are actually written to corresponding LATB register. Reads from PORTB register is return of actual I/O pin values.

REGISTER 11-10: TRISB: PORTB TRI-STATE REGISTER

R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1
TRISB7	TRISB6	TRISB5	TRISB4	TRISB3	TRISB2	TRISB1	TRISB0
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7-0 **TRISB<7:0>:** PORTB Tri-State Control bits
1 = PORTB pin configured as an input (tri-stated)
0 = PORTB pin configured as an output

REGISTER 11-11: LATB: PORTB DATA LATCH REGISTER

R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u	R/W-x/u
LATB7	LATB6	LATB5	LATB4	LATB3	LATB2	LATB1	LATB0
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7-0 **LATB<7:0>**: PORTB Output Latch Value bits(1)

Note 1: Writes to PORTB are actually written to corresponding LATB register. Reads from PORTB register is return of actual I/O pin values.

11.5 PORTC Registers

11.5.1 DATA REGISTER

PORTC is an 8-bit wide bidirectional port in the PIC16(L)F1777/8/9 devices. The corresponding data direction register is TRISC (Register 11-19). Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output (i.e., enable the output driver and put the contents of the output latch on the selected pin). Example 11-1 shows how to initialize an I/O port.

Reading the PORTC register (Register 11-18) reads the status 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 (LATC).

11.5.2 DIRECTION CONTROL

The TRISC register (Register 11-19) controls the PORTC pin output drivers, even when they are being used as analog inputs. The user should ensure the bits in the TRISC register are maintained set when using them as analog inputs. I/O pins configured as analog inputs always read '0'.

11.5.3 INPUT THRESHOLD CONTROL

The INLVLC register (Register 11-25) controls the input voltage threshold for each of the available PORTC input pins. A selection between the Schmitt Trigger CMOS or the TTL Compatible thresholds is available. The input threshold is important in determining the value of a read of the PORTC register and also the level at which an interrupt-on-change occurs, if that feature is enabled. See Table 36-4: I/O Ports for more information on threshold levels.

Note:	Changing the input threshold selection should be performed while all peripheral modules are disabled. Changing the threshold level during the time a module is active may inadvertently generate a transition associated with an input pin, regardless of the actual voltage level on that pin.

11.5.4 OPEN-DRAIN CONTROL

The ODCONC register (Register 11-23) controls the open-drain feature of the port. Open-drain operation is independently selected for each pin. When an ODCONC bit is set, the corresponding port output becomes an open-drain driver capable of sinking current only. When an ODCONC bit is cleared, the corresponding port output pin is the standard push-pull drive capable of sourcing and sinking current.

11.5.5 SLEW RATE CONTROL

The SLRCONC register (Register 11-24) controls the slew rate option for each port pin. Slew rate control is independently selectable for each port pin. When an SLRCONC bit is set, the corresponding port pin drive is slew rate limited. When an SLRCONC bit is cleared, The corresponding port pin drive slews at the maximum rate possible.

11.5.6 ANALOG CONTROL

The ANSELC register (Register 11-21) is used to configure the Input mode of an I/O pin to analog. Setting the appropriate ANSELC bit high will cause all digital reads on the pin to be read as '0' and allow analog functions on the pin to operate correctly.

The state of the ANSELC bits has no effect on digital output functions. A pin with TRIS clear and ANSELC set will still operate as a digital output, but the Input mode will be analog. This can cause unexpected behavior when executing read-modify-write instructions on the affected port.

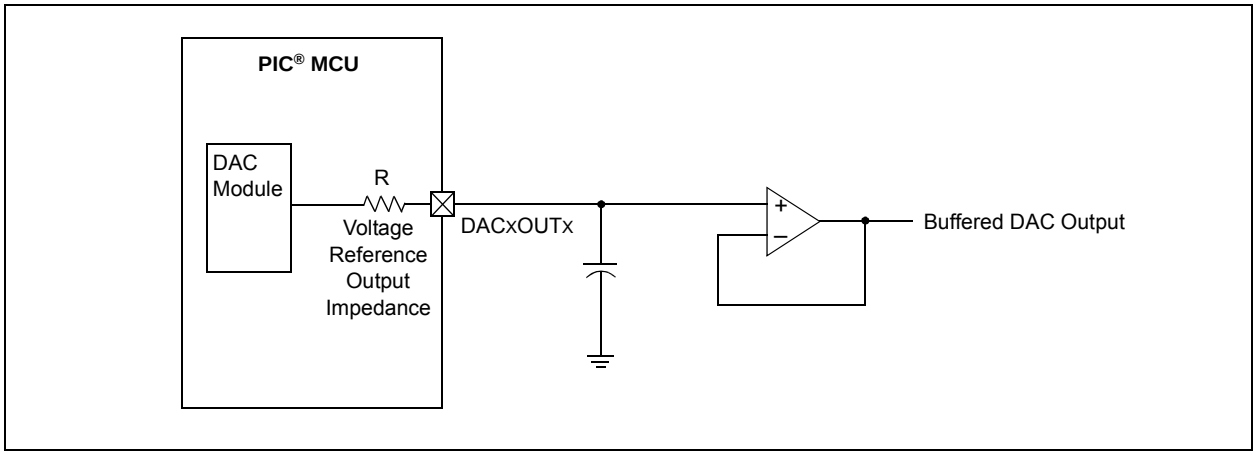
Note:	The ANSELC bits default to the Analog mode after reset. To use any pins as digital general purpose or peripheral inputs, the corresponding ANSEL bits must be initialized to '0' by user software.

11.5.7 PORTC FUNCTIONS AND OUTPUT PRIORITIES

Each pin defaults to the PORT latch data after reset. Other functions are selected with the peripheral pin select logic. See **Section 12.0 "Peripheral Pin Select (PPS) Module"** for more information.

Analog input functions, such as ADC and comparator inputs, are not shown in the peripheral pin select lists. These inputs are active when the I/O pin is set for Analog mode using the ANSELC register. Digital output functions may continue to control the pin when it is in Analog mode.

FIGURE 18-3: VOLTAGE REFERENCE OUTPUT BUFFER EXAMPLE



18.5 Operation During Sleep

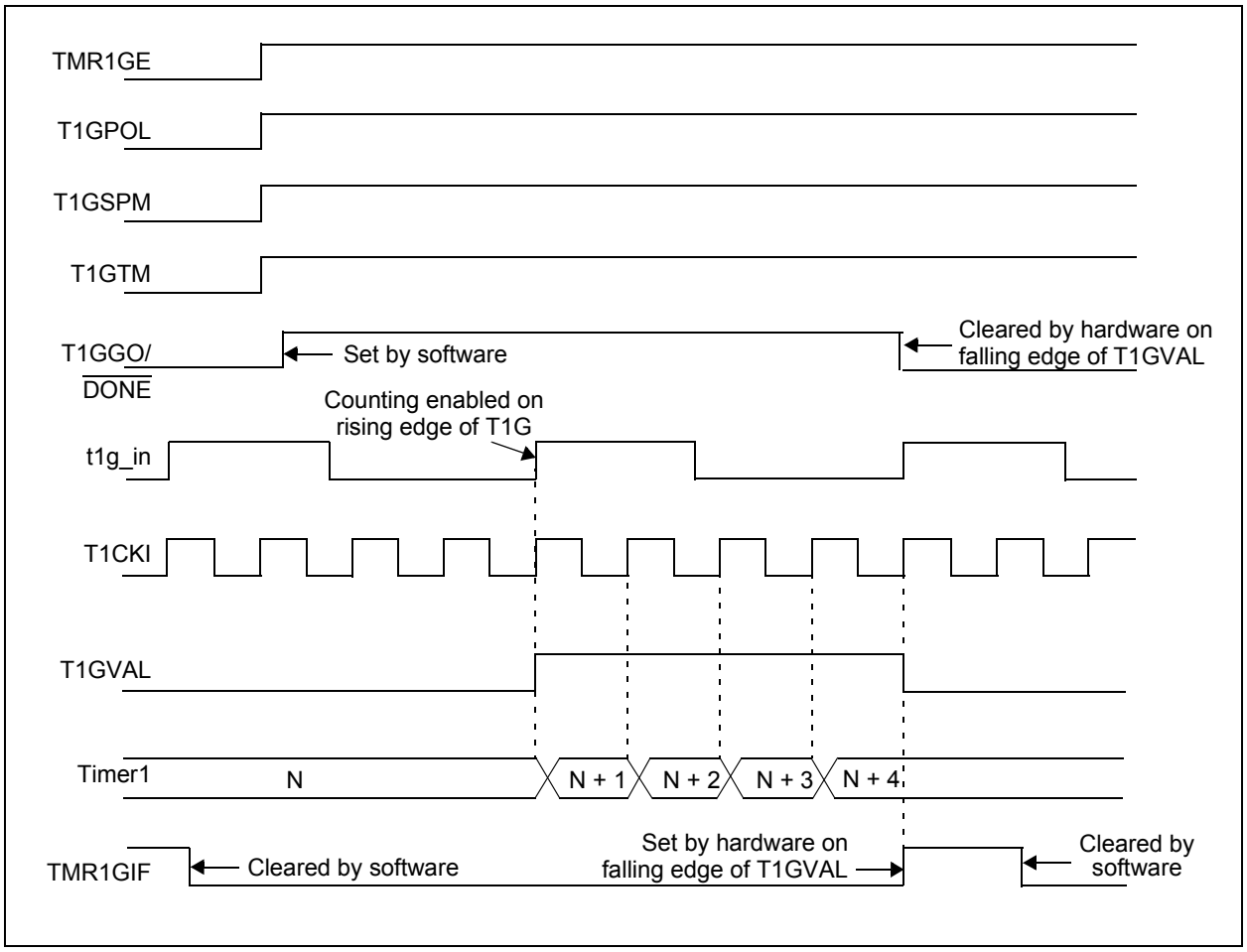
When the device wakes up from Sleep as the result of an interrupt or a Watchdog Timer time-out, the contents of the DACxCON0 register are not affected. To minimize current consumption in Sleep mode, the voltage reference should be disabled.

18.6 Effects of a Reset

A device Reset affects the following:

- DAC is disabled
- DAC output voltage is removed from the DACxOUTx pin
- The REF<9:0> reference selection bits are cleared

FIGURE 22-6: TIMER1 GATE SINGLE-PULSE AND TOGGLE COMBINED MODE



23.6.6 EDGE-TRIGGERED ONE-SHOT MODE

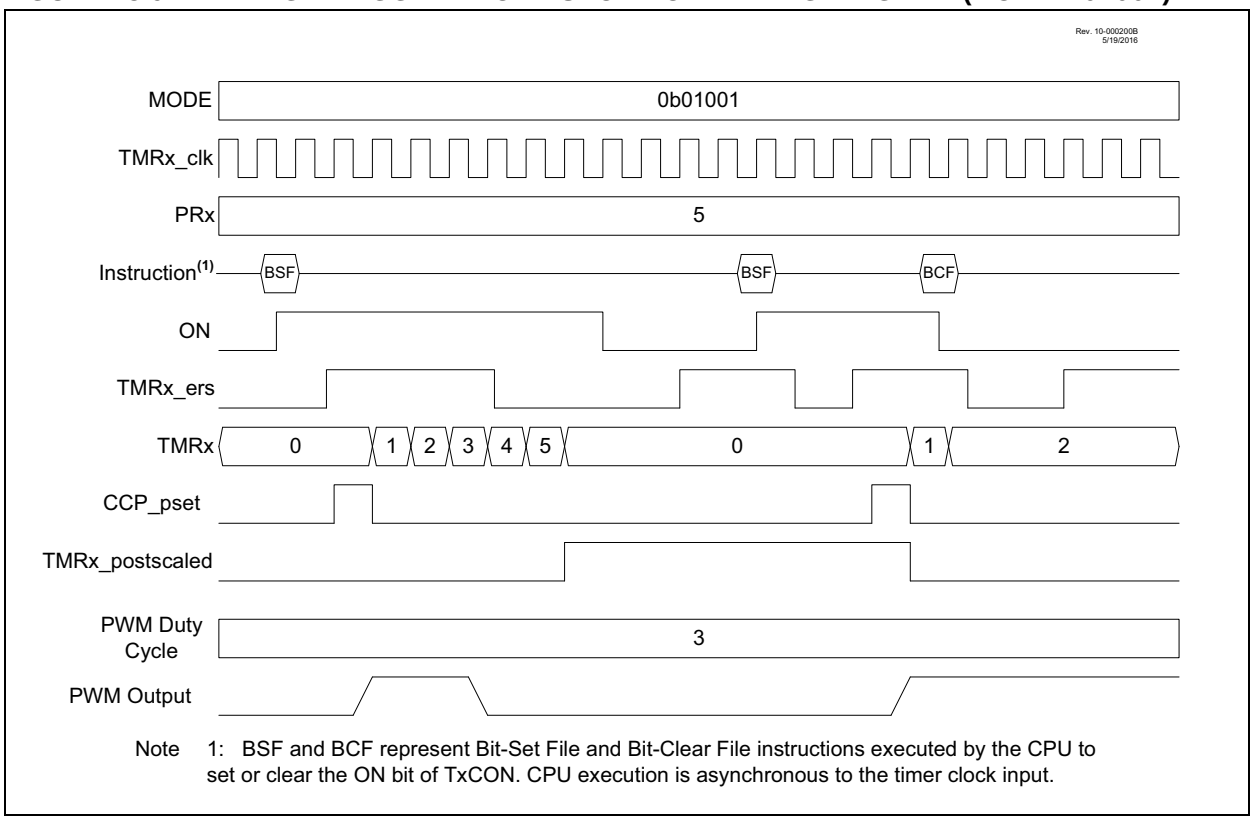
The Edge-Triggered One-Shot modes start the timer on an edge from the external signal input, after the ON bit is set, and clear the ON bit when the timer matches the PRx period value. The following edges will start the timer:

- Rising edge (MODE<4:0> = 01001)
- Falling edge (MODE<4:0> = 01010)
- Rising or Falling edge (MODE<4:0> = 01011)

If the timer is halted by clearing the ON bit then another TMRx_ers edge is required after the ON bit is set to resume counting. Figure 23-9 illustrates operation in the rising edge One-Shot mode.

When Edge-Triggered One-Shot mode is used in conjunction with the CCP then the edge-trigger will activate the PWM drive and the PWM drive will deactivate when the timer matches the CCPRx pulse width value and stay deactivated when the timer halts at the PRx period count match.

FIGURE 23-9: EDGE-TRIGGERED ONE-SHOT MODE TIMING DIAGRAM (MODE = 01001)



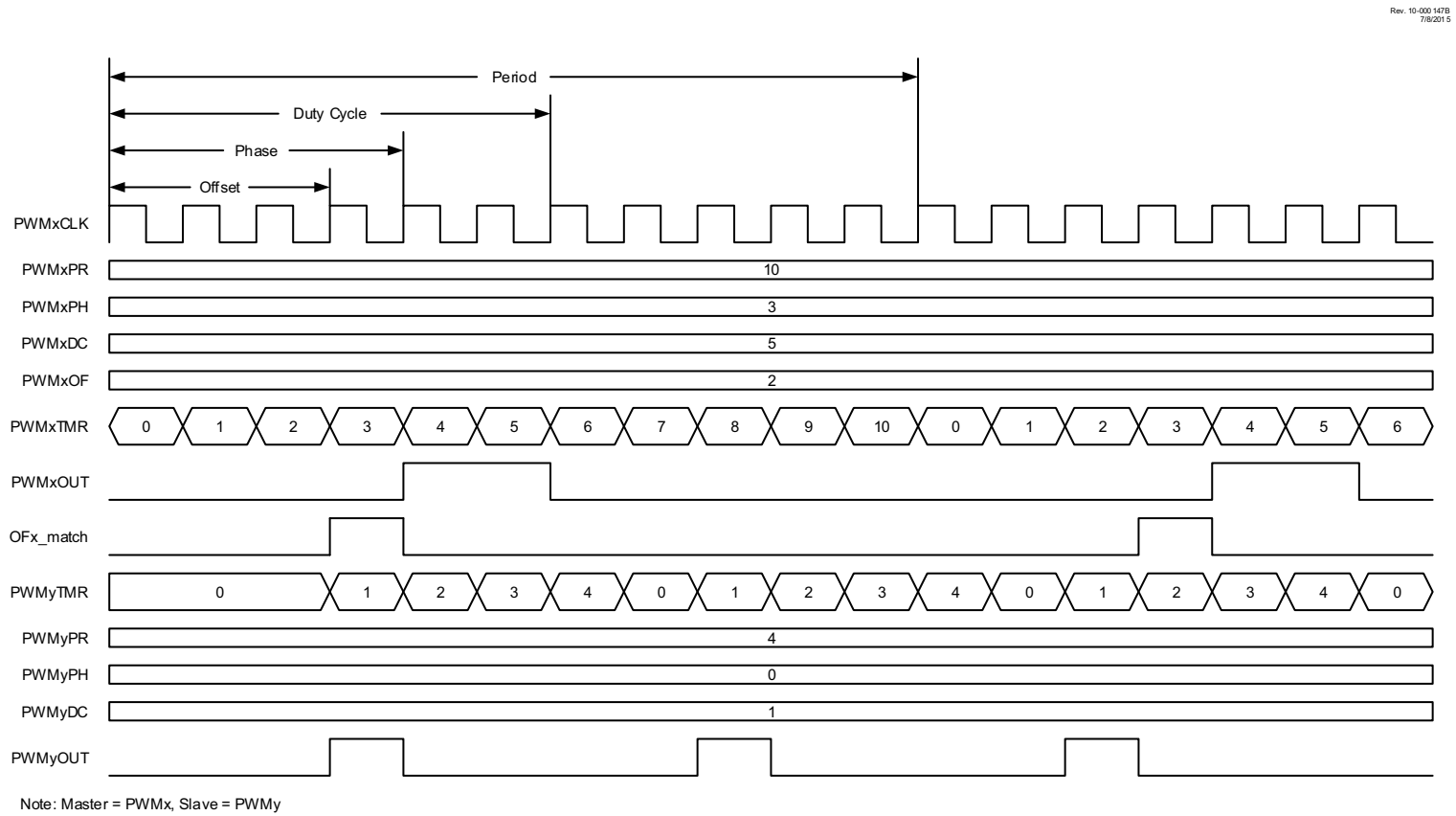
Note 1: BSF and BCF represent Bit-Set File and Bit-Clear File instructions executed by the CPU to set or clear the ON bit of TxCON. CPU execution is asynchronous to the timer clock input.

TABLE 24-4: SUMMARY OF REGISTERS ASSOCIATED WITH STANDARD PWM

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
CCPxCAP	—	—	—	—	CTS<3:0>				321
CCPxCON	EN	—	OUT	FMT	MODE<3:0>				319
CCPRxL	Capture/Compare/PWM Register x (LSB)								320
CCPRxH	Capture/Compare/PWM Register x (MSB)								320
CCPTMRS1	C8TSEL<1:0>(1)		C7TSEL<1:0>		C2TSEL<1:0>		C1TSEL<1:0>		323
CCPTMRS2	P10TSEL<1:0>(1)		P9TSEL<1:0>		P4TSEL<1:0>		P3TSEL<1:0>		323
INTCON	GIE	PEIE	TMR0IE	INTE	IOCIE	TMR0IF	INTF	IOCIF	132
PIE1	TMR1GIE	ADIE	RCIE	TXIE	SSP1IE	CCP1IE	TMR2IE	TMR1IE	133
PIE2	OSFIE	C2IE	C1IE	COG1IE	BCL1IE	C4IE	C3IE	CCP2IE	134
PIE5	CCP8IE(1)	CCP7IE	COG4IE(1)	COG3IE	C8IE(1)	C7IE(1)	C6IE	C5IE	137
PIR1	TMR1GIF	ADIF	RCIF	TXIF	SSP1IF	CCP1IF	TMR2IF	TMR1IF	139
PIR2	OSFIF	C2IF	C1IF	COG1IF	BCL1IF	C4IF	C3IF	CCP2IF	140
PIR5	CCP8IF(1)	CCP7IF	COG4IF(1)	COG3IF	C8IF(1)	C7IF(1)	C6IF	C5IF	143
T2PR	Timer2 Period Register								287*
T2CON	ON	CKPS<2:0>			OUTPS<3:0>				307
TMR2	Timer2 Module Register								287
T4PR	Timer4 Period Register								287*
T4CON	ON	CKPS<2:0>			OUTPS<3:0>				307
TMR4	Timer4 Module Register								287
T6PR	Timer6 Period Register								287*
T6CON	ON	CKPS<2:0>			OUTPS<3:0>				307
TMR6	Timer6 Module Register								287
T8PR	Timer8 Period Register								287*
T8CON	ON	CKPS<2:0>			OUTPS<3:0>				307
TMR8	Timer8 Module Register								287

Legend: — = Unimplemented location, read as '0'. Shaded cells are not used by the PWM.
* Page provides register information.
Note 1: PIC16(L)F1777/9 only.

FIGURE 26-9: SLAVE RUN MODE WITH SYNC START TIMING DIAGRAM



26.7 Register Definitions: PWM Control

Long bit name prefixes for the 16-bit PWM peripherals are shown in Table 26-2. Refer to **Section 1.1 "Register and Bit naming conventions"** for more information

TABLE 26-2:

Peripheral	Bit Name Prefix
PWM5	PWM5
PWM6	PWM6
PWM11	PWM11
PWM12(1)	PWM12

Note 1: PIC16(L)F1777/9 only.

REGISTER 26-1: PWMxCON: PWM CONTROL REGISTER

R/W-0/0	U-0	R/HS/HC-0/0	R/W-0/0	R/W-0/0	R/W-0/0	U-0	U-0
EN	—	OUT	POL	MODE<1:0>		—	—
bit 7							bit 0

Legend:		
HC = Bit is cleared by hardware		HS = Bit is set by hardware
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7 **EN:** PWM Module Enable bit
1 = Module is enabled
0 = Module is disabled

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

bit 5 **OUT:** Output State of the PWM module

bit 4 **POL:** PWM Output Polarity Control bit
1 = PWM output active state is low
0 = PWM output active state is high

bit 3-2 **MODE<1:0>:** PWM Mode Control bits
11 = Center Aligned mode
10 = Toggle On Match mode
01 = Set On Match mode
00 = Standard PWM mode

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

REGISTER 26-2: PWMxINTE: PWM INTERRUPT ENABLE REGISTER

U-0	U-0	U-0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
—	—	—	—	OFIE	PHIE	DCIE	PRIE
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

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

bit 3 **OFIE**: Offset Interrupt Enable bit
1 = Interrupt CPU on Offset Match
0 = Do not interrupt CPU on Offset Match

bit 2 **PHIE:** Phase Interrupt Enable bit
1 = Interrupt CPU on Phase Match
0 = Do not Interrupt CPU on Phase Match

bit 1 **DCIE:** Duty Cycle Interrupt Enable bit
1 = Interrupt CPU on Duty Cycle Match
0 = Do not interrupt CPU on Duty Cycle Match

bit 0 **PRIE:** Period Interrupt Enable bit
1 = Interrupt CPU on Period Match
0 = Do not interrupt CPU on Period Match

REGISTER 26-3: PWMxINTF: PWM INTERRUPT REQUEST REGISTER

U-0	U-0	U-0	U-0	R/W/HS-0/0	R/W/HS-0/0	R/W/HS-0/0	R/W/HS-0/0
—	—	—	—	OFIF	PHIF	DCIF	PRIF
bit 7							bit 0

Legend:		
HC = Bit is cleared by hardware		HS = Bit is set by hardware
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

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

bit 3 **OFIF**: Offset Interrupt Flag bit(1)
1 = Offset Match Event occurred
0 = Offset Match Event did not occur

bit 2 **PHIF:** Phase Interrupt Flag bit(1)
1 = Phase Match Event occurred
0 = Phase Match Event did not occur

bit 1 **DCIF:** Duty Cycle Interrupt Flag bit(1)
1 = Duty Cycle Match Event occurred
0 = Duty Cycle Match Event did not occur

bit 0 **PRIF:** Period Interrupt Flag bit(1)
1 = Period Match Event occurred
0 = Period Match Event did not occur

Note 1: Bit is forced clear by hardware while module is disabled (EN = 0).

REGISTER 30-5: PRGxRTSS: SET_RISING TIMING SOURCE SELECT REGISTER

U-0	U-0	U-0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
—	—	—	—	RTSS<3:0>			
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
‘1’ = Bit is set	‘0’ = Bit is cleared	q = value depends on configuration bits

bit 7-4 **Unimplemented:** Read as ‘0’

bit 3-0 **RTSS<3:0>:** Set_rising Timing Source Select bits
See Table 30-5.

REGISTER 30-6: PRGxFTSS: SET_FALLING TIMING SOURCE SELECT REGISTER

U-0	U-0	U-0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
—	—	—	—	FTSS<3:0>			
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
‘1’ = Bit is set	‘0’ = Bit is cleared	q = value depends on configuration bits

bit 7-4 **Unimplemented:** Read as ‘0’

bit 3-0 **FTSS<3:0>:** Set_falling Timing Source Select bits
See Table 30-5.

TABLE 30-6: SUMMARY OF REGISTERS ASSOCIATED WITH THE PRG MODULE(1)

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
PRGxCON0	EN	—	FEDG	REDG	MODE<1:0>		OS	GO	421
PRGxCON1	—	—	—	—	—	RDY	FPOL	RPOL	422
PRGxCON2	—	—	—	ISET<4:0>					423
PRGxINS	—	—	—	—	INS<3:0>				422
PRGxRPPS	—	—	PRGxRPPS<5:0>						424
PRGxFPPS	—	—	PRGxFPPS<5:0>						424
PRGxRTSS	—	—	—	—	RTSS<3:0>				205, 207
PRGxFTSS	—	—	—	—	FTSS<3:0>				205, 207
PORTC	RC7	RC6	RC5	RC4	RC3	RC2	RC1	RC0	186
TRISC	TRISC7	TRISC6	TRISC5	TRISC4	TRISC3	TRISC2	TRISC1	TRISC0	186
ANSELC	ANSC7	ANSC6	ANSC5	ANSC4	ANSC3	ANSC2	—	—	187
WPUC	WPUC7	WPUC6	WPUC5	WPUC4	WPUC3	WPUC2	WPUC1	WPUC0	188

Legend: — = unimplemented, read as '0'. Shaded cells are unused by the PRG module.

Note 1: PRG4 available on PIC16(L)F1777/9 only.

FIGURE 31-5: CARRIER LOW SYNCHRONIZATION (MDCHSYNC = 0, MDCLSYNC = 1)

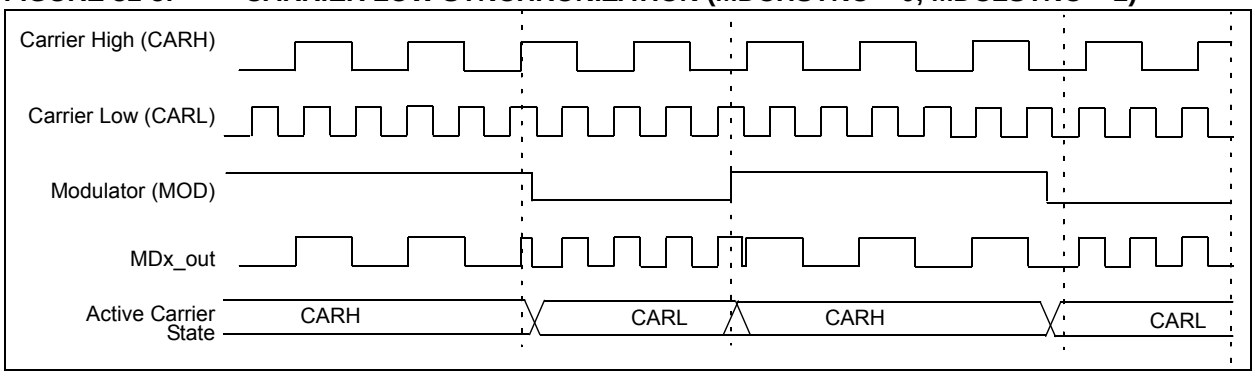
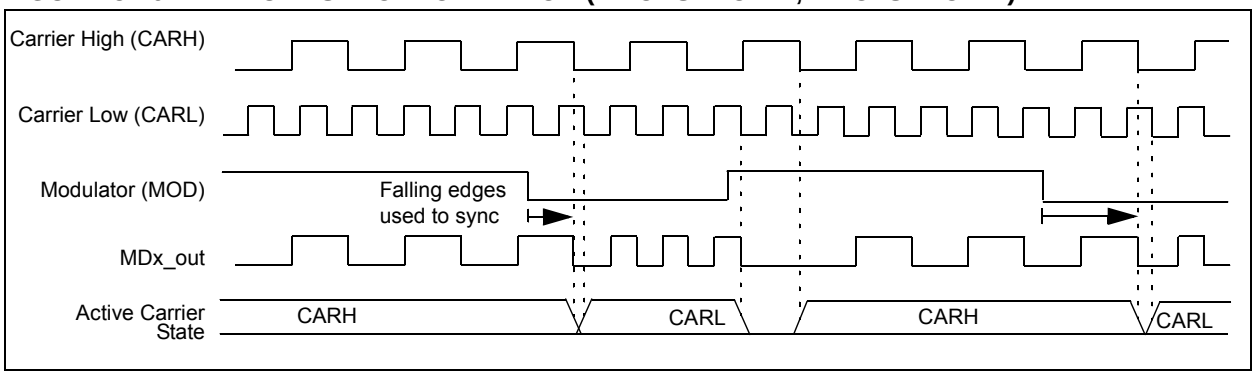


FIGURE 31-6: FULL SYNCHRONIZATION (MDCHSYNC = 1, MDCLSYNC = 1)



REGISTER 32-4: SSP1CON3: SSP CONTROL REGISTER 3

R-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
ACKTIM(3)	PCIE	SCIE	BOEN	SDAHT	SBCDE	AHEN	DHEN
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7 **ACKTIM:** Acknowledge Time Status bit (I^2C mode only)(3)
1 = Indicates the I^2C bus is in an Acknowledge sequence, set on eighth falling edge of SCL clock
0 = Not an Acknowledge sequence, cleared on ninth rising edge of SCL clock

bit 6 **PCIE**: Stop Condition Interrupt Enable bit (I^2C slave mode only)
1 = Enable interrupt on detection of Stop condition
0 = Stop detection interrupts are disabled(2)

bit 5 **SCIE**: Start Condition Interrupt Enable bit (I^2C slave mode only)
1 = Enable interrupt on detection of Start or Restart conditions
0 = Start detection interrupts are disabled(2)

bit 4 **BOEN:** Buffer Overwrite Enable bit
In SPI Slave mode:(1)
1 = SSP1BUF updates every time that a new data byte is shifted in ignoring the BF bit
0 = If new byte is received with BF bit of the SSP1STAT register already set, SSPOV bit of the SSP1CON1 register is set, and the buffer is not updated
In I^2C Master mode and SPI Master mode:
This bit is ignored.
In I^2C Slave mode:
1 = SSP1BUF is updated and $\overline{ACK}$ is generated for a received address/data byte, ignoring the state of the SSPOV bit only if the BF bit = 0.
0 = SSP1BUF is only updated when SSPOV is clear

bit 3 **SDAHT:** SDA Hold Time Selection bit (I^2C mode only)
1 = Minimum of 300 ns hold time on SDA after the falling edge of SCL
0 = Minimum of 100 ns hold time on SDA after the falling edge of SCL

bit 2 **SBCDE:** Slave Mode Bus Collision Detect Enable bit (I^2C Slave mode only)
If, on the rising edge of SCL, SDA is sampled low when the module is outputting a high state, the BCL1IF bit of the PIR2 register is set, and bus goes idle
1 = Enable slave bus collision interrupts
0 = Slave bus collision interrupts are disabled

bit 1 **AHEN:** Address Hold Enable bit (I^2C Slave mode only)
1 = Following the eighth falling edge of SCL for a matching received address byte; CKP bit of the SSP1CON1 register will be cleared and the SCL will be held low.
0 = Address holding is disabled

bit 0 **DHEN:** Data Hold Enable bit (I^2C Slave mode only)
1 = Following the eighth falling edge of SCL for a received data byte; slave hardware clears the CKP bit of the SSP1CON1 register and SCL is held low.
0 = Data holding is disabled

Note 1: For daisy-chained SPI operation; allows the user to ignore all but the last received byte. SSPOV is still set when a new byte is received and BF = 1, but hardware continues to write the most recent byte to SSP1BUF.
2: This bit has no effect in Slave modes that Start and Stop condition detection is explicitly listed as enabled.
3: The ACKTIM Status bit is only active when the AHEN bit or DHEN bit is set.

33.4.1 AUTO-BAUD DETECT

The EUSART module supports automatic detection and calibration of the baud rate.

In the Auto-Baud Detect (ABD) mode, the clock to the BRG is reversed. Rather than the BRG clocking the incoming RX signal, the RX signal is timing the BRG. The Baud Rate Generator is used to time the period of a received 55h (ASCII "U") which is the Sync character for the LIN bus. The unique feature of this character is that it has five rising edges including the Stop bit edge.

Setting the ABDEN bit of the BAUDxCON register starts the auto-baud calibration sequence. While the ABD sequence takes place, the EUSART state machine is held in Idle. On the first rising edge of the receive line, after the Start bit, the SPxBRG begins counting up using the BRG counter clock as shown in Figure 33-6. The fifth rising edge will occur on the RX pin at the end of the eighth bit period. At that time, an accumulated value totaling the proper BRG period is left in the SPxBRGH:SPxBRGL register pair, the ABDEN bit is automatically cleared and the RCIF interrupt flag is set. The value in the RCxREG needs to be read to clear the RCIF interrupt. RCxREG content should be discarded. When calibrating for modes that do not use the SPxBRGH register the user can verify that the SPxBRGL register did not overflow by checking for 00h in the SPxBRGH register.

The BRG auto-baud clock is determined by the BRG16 and BRGH bits as shown in Table 33-6. During ABD, both the SPxBRGH and SPxBRGL registers are used as a 16-bit counter, independent of the BRG16 bit setting. While calibrating the baud rate period, the SPxBRGH and SPxBRGL registers are clocked at 1/8th the BRG base clock rate. The resulting byte measurement is the average bit time when clocked at full speed.

Note 1: If the WUE bit is set with the ABDEN bit, auto-baud detection will occur on the byte following the Break character (see **Section 33.4.3 "Auto-Wake-up on Break"**).

2: It is up to the user to determine that the incoming character baud rate is within the range of the selected BRG clock source. Some combinations of oscillator frequency and EUSART baud rates are not possible.

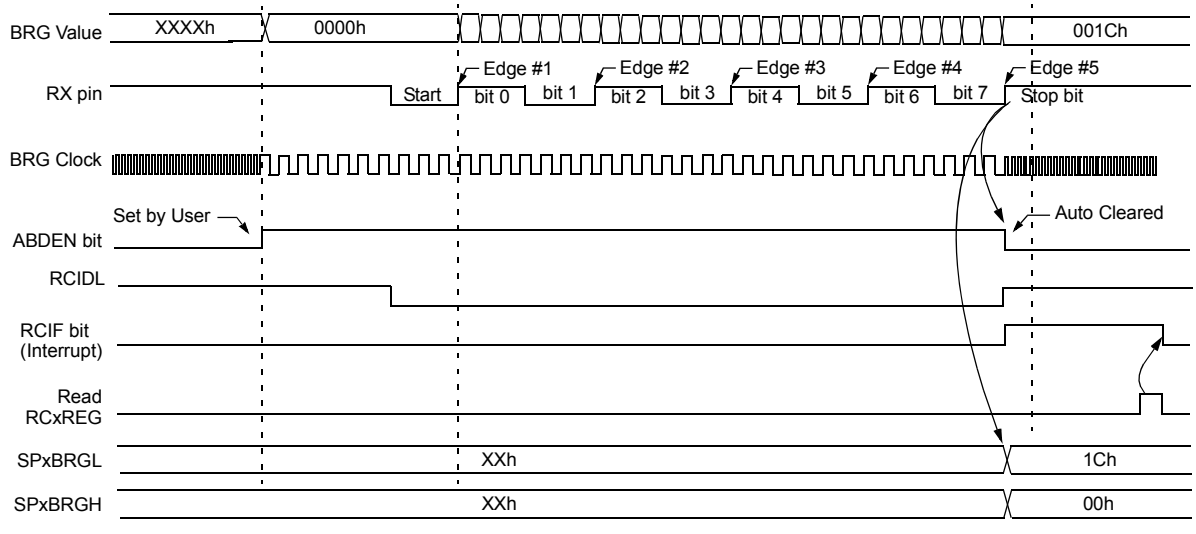
3: During the auto-baud process, the auto-baud counter starts counting at one. Upon completion of the auto-baud sequence, to achieve maximum accuracy, subtract 1 from the SPxBRGH:SPxBRGL register pair.

TABLE 33-6: BRG COUNTER CLOCK RATES

BRG16	BRGH	BRG Base Clock	BRG ABD Clock
0	0	FOSC/64	FOSC/512
0	1	FOSC/16	FOSC/128
1	0	FOSC/16	FOSC/128
1	1	FOSC/4	FOSC/32

Note: During the ABD sequence, SPxBRGL and SPxBRGH registers are both used as a 16-bit counter, independent of the BRG16 setting.

FIGURE 33-6: AUTOMATIC BAUD RATE CALIBRATION(1)



Note 1: The ABD sequence requires the **EUSART** module to be configured in Asynchronous mode.

33.5 EUSART Synchronous Mode

Synchronous serial communications are typically used in systems with a single master and one or more slaves. The master device contains the necessary circuitry for baud rate generation and supplies the clock for all devices in the system. Slave devices can take advantage of the master clock by eliminating the internal clock generation circuitry.

There are two signal lines in Synchronous mode: a bidirectional data line and a clock line. Slaves use the external clock supplied by the master to shift the serial data into and out of their respective receive and transmit shift registers. Since the data line is bidirectional, synchronous operation is half-duplex only. Half-duplex refers to the fact that master and slave devices can receive and transmit data but not both simultaneously. The EUSART can operate as either a master or slave device.

Start and Stop bits are not used in synchronous transmissions.

33.5.1 SYNCHRONOUS MASTER MODE

The following bits are used to configure the EUSART for synchronous master operation:

- SYNC = 1
- CSRC = 1
- SREN = 0 (for transmit); SREN = 1 (for receive)
- CREN = 0 (for transmit); CREN = 1 (for receive)
- SPEN = 1

Setting the SYNC bit of the TXxSTA register configures the device for synchronous operation. Setting the CSRC bit of the TXxSTA register configures the device as a master. Clearing the SREN and CREN bits of the RCxSTA register ensures that the device is in the Transmit mode, otherwise the device will be configured to receive. Setting the SPEN bit of the RCxSTA register enables the EUSART.

33.5.1.1 Master Clock

Synchronous data transfers use a separate clock line, which is synchronous with the data. A device configured as a master transmits the clock on the TX/CK line. The TX/CK pin output driver is automatically enabled when the EUSART is configured for synchronous transmit or receive operation. Serial data bits change on the leading edge to ensure they are valid at the trailing edge of each clock. One clock cycle is generated for each data bit. Only as many clock cycles are generated as there are data bits.

33.5.1.2 Clock Polarity

A clock polarity option is provided for Microwire compatibility. Clock polarity is selected with the SCKP bit of the BAUDxCON register. Setting the SCKP bit sets the clock Idle state as high. When the SCKP bit is set, the data changes on the falling edge of each clock. Clearing the SCKP bit sets the Idle state as low. When the SCKP bit is cleared, the data changes on the rising edge of each clock.

33.5.1.3 Synchronous Master Transmission

Data is transferred out of the device on the RX/DT pin. The RX/DT and TX/CK pin output drivers are automatically enabled when the EUSART is configured for synchronous master transmit operation.

A transmission is initiated by writing a character to the TXxREG register. If the TSR still contains all or part of a previous character the new character data is held in the TXxREG until the last bit of the previous character has been transmitted. If this is the first character, or the previous character has been completely flushed from the TSR, the data in the TXxREG is immediately transferred to the TSR. The transmission of the character commences immediately following the transfer of the data to the TSR from the TXxREG.

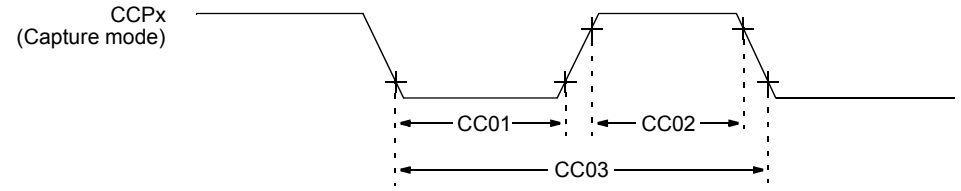
Each data bit changes on the leading edge of the master clock and remains valid until the subsequent leading clock edge.

Note:	The TSR register is not mapped in data memory, so it is not available to the user.

33.5.1.4 Synchronous Master Transmission Set-up:

1. Initialize the SPxBRGH:SPxBRGL register pair and the BRGH and BRG16 bits to achieve the desired baud rate (see **Section 33.4 “EUSART Baud Rate Generator (BRG)”**).
2. Enable the synchronous master serial port by setting bits SYNC, SPEN and CSRC.
3. Disable Receive mode by clearing bits SREN and CREN.
4. Enable Transmit mode by setting the TXEN bit.
5. If 9-bit transmission is desired, set the TX9 bit.
6. If interrupts are desired, set the TXIE bit of the PIE1 register and the GIE and PEIE bits of the INTCON register.
7. If 9-bit transmission is selected, the ninth bit should be loaded in the TX9D bit.
8. Start transmission by loading data to the TXxREG register.

FIGURE 36-11: CAPTURE/COMPARE/PWM TIMINGS (CCP)



Note: Refer to Figure 36-4 for load conditions.

TABLE 36-13: CAPTURE/COMPARE/PWM REQUIREMENTS (CCP)

Standard Operating Conditions (unless otherwise stated)								
Param No.	**Sym.**	**Characteristic**		**Min.**	**Typ†**	**Max.**	**Units**	**Conditions**
CC01*	TccL	CCPx Input Low Time	No Prescaler	0.5TCY + 20	—	—	ns	
			With Prescaler	20	—	—	ns	
CC02*	TccH	CCPx Input High Time	No Prescaler	0.5TCY + 20	—	—	ns	
			With Prescaler	20	—	—	ns	
CC03*	TccP	CCPx Input Period		(3TCY + 40)*N	—	—	ns	N = prescale value

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

TABLE 36-27: I^2C BUS DATA REQUIREMENTS

Standard Operating Conditions (unless otherwise stated)							
Param. No.	**Symbol**	**Characteristic**		**Min.**	**Max.**	**Units**	**Conditions**
SP100*	THIGH	Clock high time	100 kHz mode	4.0	—	μs	Device must operate at a minimum of 1.5 MHz
			400 kHz mode	0.6	—	μs	Device must operate at a minimum of 10 MHz
			SSP module	1.5TCY	—		
SP101*	TLOW	Clock low time	100 kHz mode	4.7	—	μs	Device must operate at a minimum of 1.5 MHz
			400 kHz mode	1.3	—	μs	Device must operate at a minimum of 10 MHz
			SSP module	1.5TCY	—		
SP102*	TR	SDA and SCL rise time	100 kHz mode	—	1000	ns	
			400 kHz mode	20 + 0.1CB	300	ns	CB is specified to be from 10-400 pF
SP103*	TF	SDA and SCL fall time	100 kHz mode	—	250	ns	
			400 kHz mode	20 + 0.1CB	250	ns	CB is specified to be from 10-400 pF
SP106*	THD:DAT	Data input hold time	100 kHz mode	0	—	ns	
			400 kHz mode	0	0.9	μs	
SP107*	TSU:DAT	Data input setup time	100 kHz mode	250	—	ns	**(Note 2)**
			400 kHz mode	100	—	ns	
SP109*	TAA	Output valid from clock	100 kHz mode	—	3500	ns	**(Note 1)**
			400 kHz mode	—	—	ns	
SP110*	TBUF	Bus free time	100 kHz mode	4.7	—	μs	Time the bus must be free before a new transmission can start
			400 kHz mode	1.3	—	μs	
SP111	CB	Bus capacitive loading		—	400	pF	

* These parameters are characterized but not tested.

Note 1: As a transmitter, the device must provide this internal minimum delay time to bridge the undefined region (min. 300 ns) of the falling edge of SCL to avoid unintended generation of Start or Stop conditions.

2: A Fast mode (400 kHz) I^2C bus device can be used in a Standard mode (100 kHz) I^2C bus system, but the requirement $T_{SU:DAT} \geq 250$ ns must then be met. This will automatically be the case if the device does not stretch the low period of the SCL signal. If such a device does stretch the low period of the SCL signal, it must output the next data bit to the SDA line T_R max. + $T_{SU:DAT}$ = 1000 + 250 = 1250 ns (according to the Standard mode I^2C bus specification), before the SCL line is released.