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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	I²C, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	17
Program Memory Size	14KB (8K x 14)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	512 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	A/D 12x10b; D/A 1x5b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	20-SSOP (0.209", 5.30mm Width)
Supplier Device Package	20-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16lf1509t-i-ss

Peripheral Features (Continued):

- Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART)
  - RS-232, RS-485 and LIN compatible
  - Auto-Baud Detect
  - Auto-wake-up on Start
- Four Configurable Logic Cell (CLC) modules:
  - 16 selectable input source signals
  - Four inputs per module
  - Software control of combinational/sequential logic/state/clock functions
  - AND/OR/XOR/D Flop/D Latch/SR/JK
  - Inputs from external and internal sources
  - Output available to pins and peripherals
  - Operation while in Sleep
- Numerically Controlled Oscillator (NCO):
  - 20-bit accumulator
  - 16-bit increment
  - True linear frequency control
  - High-speed clock input
  - Selectable Output modes
    - Fixed Duty Cycle (FDC) mode
    - Pulse Frequency (PF) mode
- Complementary Waveform Generator (CWG):
  - Eight selectable signal sources
  - Selectable falling and rising edge dead-band control
  - Polarity control
  - Four auto-shutdown sources
  - Multiple input sources: PWM, CLC, NCO

PIC12(L)F1501/PIC16(L)F150X FAMILY TYPES

Device	Data Sheet Index	Program Memory Flash (words)	Data SRAM (bytes)	I/O's(2)	10-bit ADC (ch)	Comparators	DAC	Timers (8/16-bit)	PWM	EUSART	MSSP (I^2C/SPI)	CWG	CLC	NCO	Debug(1)	XLP
PIC12(L)F1501	(1)	1024	64	6	4	1	1	2/1	4	—	—	1	2	1	H	—
PIC16(L)F1503	(2)	2048	128	12	8	2	1	2/1	4	—	1	1	2	1	H	—
PIC16(L)F1507	(3)	2048	128	18	12	—	—	2/1	4	—	—	1	2	1	H	—
PIC16(L)F1508	(4)	4096	256	18	12	2	1	2/1	4	1	1	1	4	1	I/H	Y
PIC16(L)F1509	(4)	8192	512	18	12	2	1	2/1	4	1	1	1	4	1	I/H	Y

Note 1: Debugging Methods: (I) - Integrated on Chip; (H) - using Debug Header; (E) - using Emulation Header.
2: One pin is input-only.

Data Sheet Index: (Unshaded devices are described in this document.)

1: DS40001615 PIC12(L)F1501 Data Sheet, 8-Pin Flash, 8-bit Microcontrollers.
2: DS40001607 PIC16(L)F1503 Data Sheet, 14-Pin Flash, 8-bit Microcontrollers.
3: DS40001586 PIC16(L)F1507 Data Sheet, 20-Pin Flash, 8-bit Microcontrollers.
4: DS40001609 PIC16(L)F1508/9 Data Sheet, 20-Pin Flash, 8-bit Microcontrollers.

Note: For other small form-factor package availability and marking information, please visit **http://www.microchip.com/packaging** or contact your local sales office.

2.1 Automatic Interrupt Context Saving

During interrupts, certain registers are automatically saved in shadow registers and restored when returning from the interrupt. This saves stack space and user code. See **Section 7.5 "Automatic Context Saving"**, for more information.

2.2 16-Level Stack with Overflow and Underflow

These devices have a hardware stack memory 15 bits wide and 16 words deep. A Stack Overflow or Underflow will set the appropriate bit (STKOVF or STKUNF) in the PCON register, and if enabled, will cause a software Reset. See **Section 3.5 "Stack"** for more details.

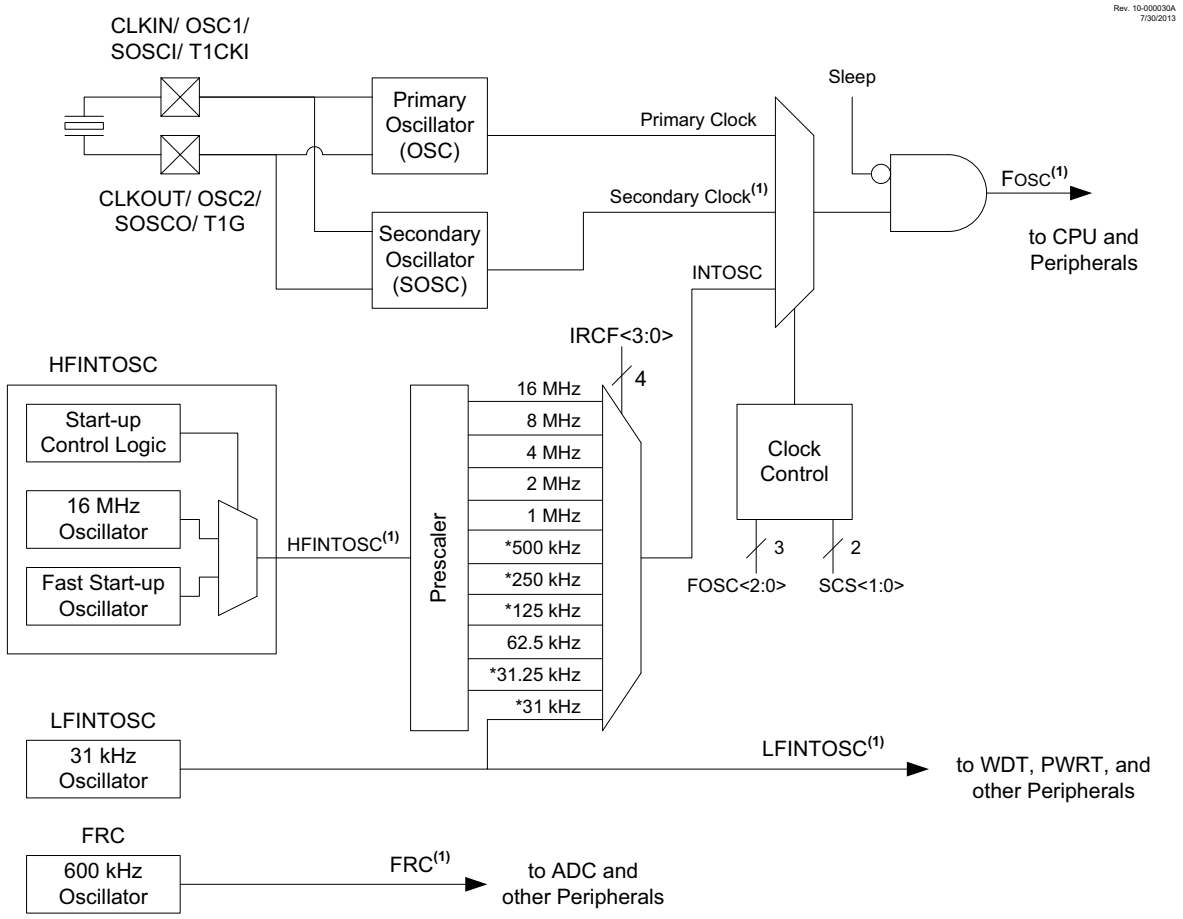
2.3 File Select Registers

There are two 16-bit File Select Registers (FSR). FSRs can access all file registers and program memory, which allows one Data Pointer for all memory. When an FSR points to program memory, there is one additional instruction cycle in instructions using INDF to allow the data to be fetched. General purpose memory can now also be addressed linearly, providing the ability to access contiguous data larger than 80 bytes. There are also new instructions to support the FSRs. See **Section 3.6 "Indirect Addressing"** for more details.

2.4 Instruction Set

There are 49 instructions for the enhanced mid-range CPU to support the features of the CPU. See **Section 28.0 "Instruction Set Summary"** for more details.

FIGURE 5-1: SIMPLIFIED PIC® MCU CLOCK SOURCE BLOCK DIAGRAM



Note 1: See **Section 5.2.2.4 "Peripheral Clock Sources"**.

6.0 RESETS

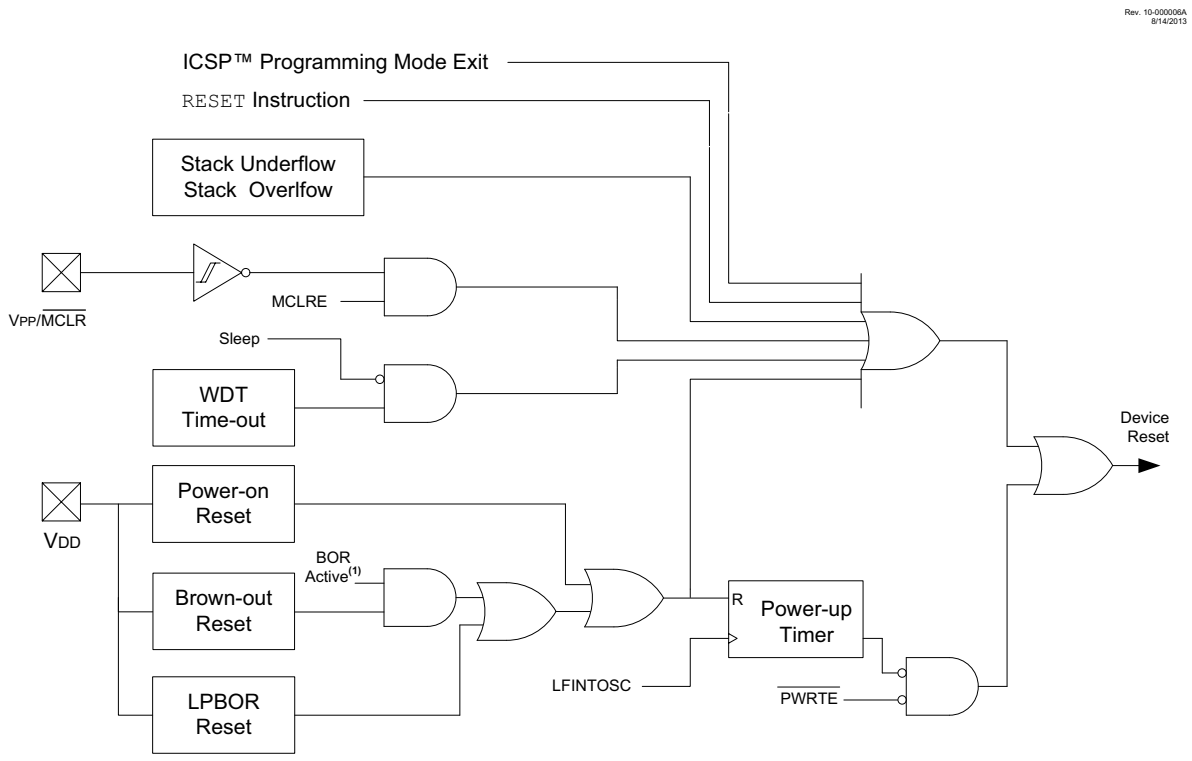
There are multiple ways to reset this device:

- Power-on Reset (POR)
- Brown-out Reset (BOR)
- Low-Power Brown-out Reset (LPBOR)
- $\overline{\text{MCLR}}$ Reset
- WDT Reset
- RESET instruction
- Stack Overflow
- Stack Underflow
- Programming mode exit

To allow VDD to stabilize, an optional power-up timer can be enabled to extend the Reset time after a BOR or POR event.

A simplified block diagram of the On-chip Reset Circuit is shown in Figure 6-1.

FIGURE 6-1: SIMPLIFIED BLOCK DIAGRAM OF ON-CHIP RESET CIRCUIT



Note 1: See Table 6-1 for BOR active conditions.

TABLE 6-5: SUMMARY OF REGISTERS ASSOCIATED WITH RESETS

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
BORCON	SBOREN	BORFS	—	—	—	—	—	BORRDY	64
PCON	STKOVF	STKUNF	—	$\overline{\text{RWDT}}$	$\overline{\text{RMCLR}}$	$\overline{\text{RI}}$	$\overline{\text{POR}}$	$\overline{\text{BOR}}$	68
STATUS	—	—	—	$\overline{\text{TO}}$	$\overline{\text{PD}}$	Z	DC	C	19
WDTCON	—	—	WDTPS<4:0>					SWDTEN	88

Legend: — = unimplemented bit, reads as '0'. Shaded cells are not used by Resets.

TABLE 6-6: SUMMARY OF CONFIGURATION WORD WITH RESETS

Name	Bits	Bit -/7	Bit -/6	Bit 13/5	Bit 12/4	Bit 11/3	Bit 10/2	Bit 9/1	Bit 8/0	Register on Page
CONFIG1	13:8	—	—	FCMEN	IESO	$\overline{\text{CLKOUTEN}}$	BOREN<1:0>		—	43
	7:0	$\overline{\text{CP}}$	MCLRE	$\overline{\text{PWRTE}}$	WDTE<1:0>		FOSC<2:0>			
CONFIG2	13:8	—	—	LVP	—	$\overline{\text{LPBOR}}$	BORV	STVREN	—	43
	7:0	—	—	—	—	—	—	WRT<1:0>		

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

7.1 Operation

Interrupts are disabled upon any device Reset. They are enabled by setting the following bits:

- GIE bit of the INTCON register
- Interrupt Enable bit(s) for the specific interrupt event(s)
- PEIE bit of the INTCON register (if the Interrupt Enable bit of the interrupt event is contained in the PIE1, PIE2 and PIE3 registers)

The INTCON, PIR1, PIR2 and PIR3 registers record individual interrupts via interrupt flag bits. Interrupt flag bits will be set, regardless of the status of the GIE, PEIE and individual interrupt enable bits.

The following events happen when an interrupt event occurs while the GIE bit is set:

- Current prefetched instruction is flushed
- GIE bit is cleared
- Current Program Counter (PC) is pushed onto the stack
- Critical registers are automatically saved to the shadow registers (See **"Section 7.5 "Automatic Context Saving"."**)
- PC is loaded with the interrupt vector 0004h

The firmware within the Interrupt Service Routine (ISR) should determine the source of the interrupt by polling the interrupt flag bits. The interrupt flag bits must be cleared before exiting the ISR to avoid repeated interrupts. Because the GIE bit is cleared, any interrupt that occurs while executing the ISR will be recorded through its interrupt flag, but will not cause the processor to redirect to the interrupt vector.

The `RETFIE` instruction exits the ISR by popping the previous address from the stack, restoring the saved context from the shadow registers and setting the GIE bit.

For additional information on a specific interrupt's operation, refer to its peripheral chapter.

Note 1:	Individual interrupt flag bits are set, regardless of the state of any other enable bits.
2:	All interrupts will be ignored while the GIE bit is cleared. Any interrupt occurring while the GIE bit is clear will be serviced when the GIE bit is set again.

7.2 Interrupt Latency

Interrupt latency is defined as the time from when the interrupt event occurs to the time code execution at the interrupt vector begins. The latency for synchronous interrupts is three or four instruction cycles. For asynchronous interrupts, the latency is three to five instruction cycles, depending on when the interrupt occurs. See Figure 7-2 and Figure 7-3 for more details.

REGISTER 7-5: PIR1: PERIPHERAL INTERRUPT REQUEST REGISTER 1

R/W-0/0	R/W-0/0	R-0/0	R/W-0/0	R/W-0/0	U-0	R/W-0/0	R/W-0/0
TMR1GIF	ADIF	RCIF	TXIF	SSP1IF	—	TMR2IF	TMR1IF
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 **TMR1GIF:** Timer1 Gate Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

bit 6 **ADIF:** ADC Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

bit 5 **RCIF:** USART Receive Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

bit 4 **TXIF:** USART Transmit Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

bit 3 **SSP1IF:** Synchronous Serial Port (MSSP) Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

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

bit 1 **TMR2IF:** Timer2 to PR2 Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

bit 0 **TMR1IF:** Timer1 Overflow Interrupt Flag bit
1 = Interrupt is pending
0 = Interrupt is not pending

Note: Interrupt flag bits are set when an interrupt condition occurs, regardless of the state of its corresponding enable bit or the Global Interrupt Enable bit, GIE of the INTCON register. User software should ensure the appropriate interrupt flag bits are clear prior to enabling an interrupt.

REGISTER 11-11: WPUB: WEAK PULL-UP PORTB REGISTER(1),(2)

R/W-1/1	R/W-1/1	R/W-1/1	R/W-1/1	U-0	U-0	U-0	U-0
WPUB7	WPUB6	WPUB5	WPUB4	—	—	—	—
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 **WPUB<7:4>**: Weak Pull-up Register bits
1 = Pull-up enabled
0 = Pull-up disabled

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

Note 1: Global $\overline{\text{WPUEN}}$ bit of the OPTION_REG register must be cleared for individual pull-ups to be enabled.
2: The weak pull-up device is automatically disabled if the pin is configured as an output.

TABLE 11-6: SUMMARY OF REGISTERS ASSOCIATED WITH PORTB

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
ANSELB	—	—	ANSB5	ANSB4	—	—	—	—	114
APFCON	—	—	—	SSSEL	T1GSEL	—	CLC1SEL	NCO1SEL	107
LATB	LATB7	LATB6	LATB5	LATB4	—	—	—	—	114
OPTION_REG	$\overline{\text{WPUEN}}$	INTEDG	TMR0CS	TMR0SE	PSA	PS<2:0>			154
PORTB	RB7	RB6	RB5	RB4	—	—	—	—	113
TRISB	TRISB7	TRISB6	TRISB5	TRISB4	—	—	—	—	113
WPUB	WPUB7	WPUB6	WPUB5	WPUB4	—	—	—	—	115

Legend: x = unknown, u = unchanged, – = unimplemented locations read as '0'. Shaded cells are not used by PORTB.
Note 1: Unimplemented, read as '1'.

TABLE 11-7: SUMMARY OF CONFIGURATION WORD WITH PORTB

Name	Bits	Bit -/7	Bit -/6	Bit 13/5	Bit 12/4	Bit 11/3	Bit 10/2	Bit 9/1	Bit 8/0	Register on Page
CONFIG1	13:8	—	—	FCMEN	IESO	$\overline{\text{CLKOUTEN}}$	BOREN<1:0>		—	41
	7:0	$\overline{\text{CP}}$	MCLRE	$\overline{\text{PWRTE}}$	WDTE<1:0>		FOSC<2:0>			

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

18.1.3 SOFTWARE PROGRAMMABLE PRESCALER

A software programmable prescaler is available for exclusive use with Timer0. The prescaler is enabled by clearing the PSA bit of the OPTION_REG register.

Note:	The Watchdog Timer (WDT) uses its own independent prescaler.

There are eight prescaler options for the Timer0 module ranging from 1:2 to 1:256. The prescale values are selectable via the PS<2:0> bits of the OPTION_REG register. In order to have a 1:1 prescaler value for the Timer0 module, the prescaler must be disabled by setting the PSA bit of the OPTION_REG register.

The prescaler is not readable or writable. All instructions writing to the TMR0 register will clear the prescaler.

18.1.4 TIMER0 INTERRUPT

Timer0 will generate an interrupt when the TMR0 register overflows from FFh to 00h. The TMR0IF interrupt flag bit of the INTCON register is set every time the TMR0 register overflows, regardless of whether or not the Timer0 interrupt is enabled. The TMR0IF bit can only be cleared in software. The Timer0 interrupt enable is the TMR0IE bit of the INTCON register.

Note:	The Timer0 interrupt cannot wake the processor from Sleep since the timer is frozen during Sleep.

18.1.5 8-BIT COUNTER MODE SYNCHRONIZATION

When in 8-Bit Counter mode, the incrementing edge on the T0CKI pin must be synchronized to the instruction clock. Synchronization can be accomplished by sampling the prescaler output on the Q2 and Q4 cycles of the instruction clock. The high and low periods of the external clocking source must meet the timing requirements as shown in **Section 29.0 "Electrical Specifications"**.

18.1.6 OPERATION DURING SLEEP

Timer0 cannot operate while the processor is in Sleep mode. The contents of the TMR0 register will remain unchanged while the processor is in Sleep mode.

21.5.6 CLOCK STRETCHING

Clock stretching occurs when a device on the bus holds the SCLx line low, effectively pausing communication. The slave may stretch the clock to allow more time to handle data or prepare a response for the master device. A master device is not concerned with stretching as anytime it is active on the bus and not transferring data it is stretching. Any stretching done by a slave is invisible to the master software and handled by the hardware that generates SCLx.

The CKP bit of the SSPxCON1 register is used to control stretching in software. Any time the CKP bit is cleared, the module will wait for the SCLx line to go low and then hold it. Setting CKP will release SCLx and allow more communication.

21.5.6.1 Normal Clock Stretching

Following an $\overline{ACK}$ if the R/$\overline{W}$ bit of SSPxSTAT is set, a read request, the slave hardware will clear CKP. This allows the slave time to update SSPxBUF with data to transfer to the master. If the SEN bit of SSPxCON2 is set, the slave hardware will always stretch the clock after the $\overline{ACK}$ sequence. Once the slave is ready, CKP is set by software and communication resumes.

Note 1: The BF bit has no effect on if the clock will be stretched or not. This is different than previous versions of the module that would not stretch the clock, clear CKP, if SSPxBUF was read before the ninth falling edge of SCLx.

2: Previous versions of the module did not stretch the clock for a transmission if SSPxBUF was loaded before the ninth falling edge of SCLx. It is now always cleared for read requests.

21.5.6.2 10-bit Addressing Mode

In 10-bit Addressing mode, when the UA bit is set, the clock is always stretched. This is the only time the SCLx is stretched without CKP being cleared. SCLx is released immediately after a write to SSPxADD.

Note: Previous versions of the module did not stretch the clock if the second address byte did not match.

21.5.6.3 Byte NACKing

When the AHEN bit of SSPxCON3 is set; CKP is cleared by hardware after the eighth falling edge of SCLx for a received matching address byte. When the DHEN bit of SSPxCON3 is set, CKP is cleared after the eighth falling edge of SCLx for received data.

Stretching after the eighth falling edge of SCLx allows the slave to look at the received address or data and decide if it wants to ACK the received data.

21.5.7 CLOCK SYNCHRONIZATION AND THE CKP BIT

Any time the CKP bit is cleared, the module will wait for the SCLx line to go low and then hold it. However, clearing the CKP bit will not assert the SCLx output low until the SCLx output is already sampled low. Therefore, the CKP bit will not assert the SCLx line until an external I^2C master device has already asserted the SCLx line. The SCLx output will remain low until the CKP bit is set and all other devices on the I^2C bus have released SCLx. This ensures that a write to the CKP bit will not violate the minimum high time requirement for SCLx (see Figure 21-23).

FIGURE 21-23: CLOCK SYNCHRONIZATION TIMING

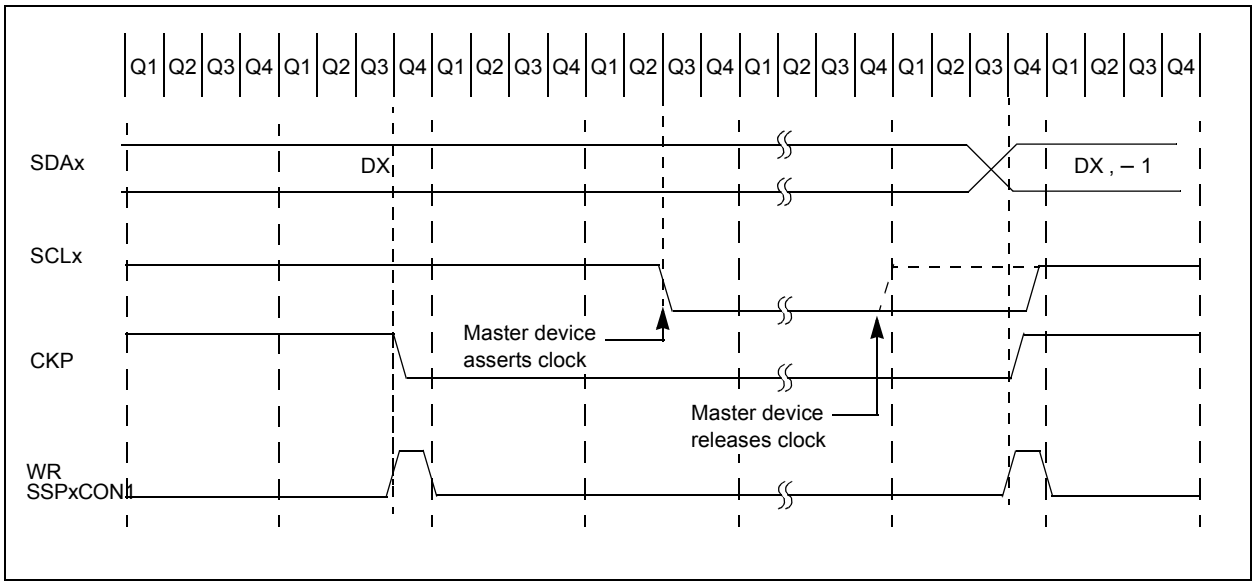
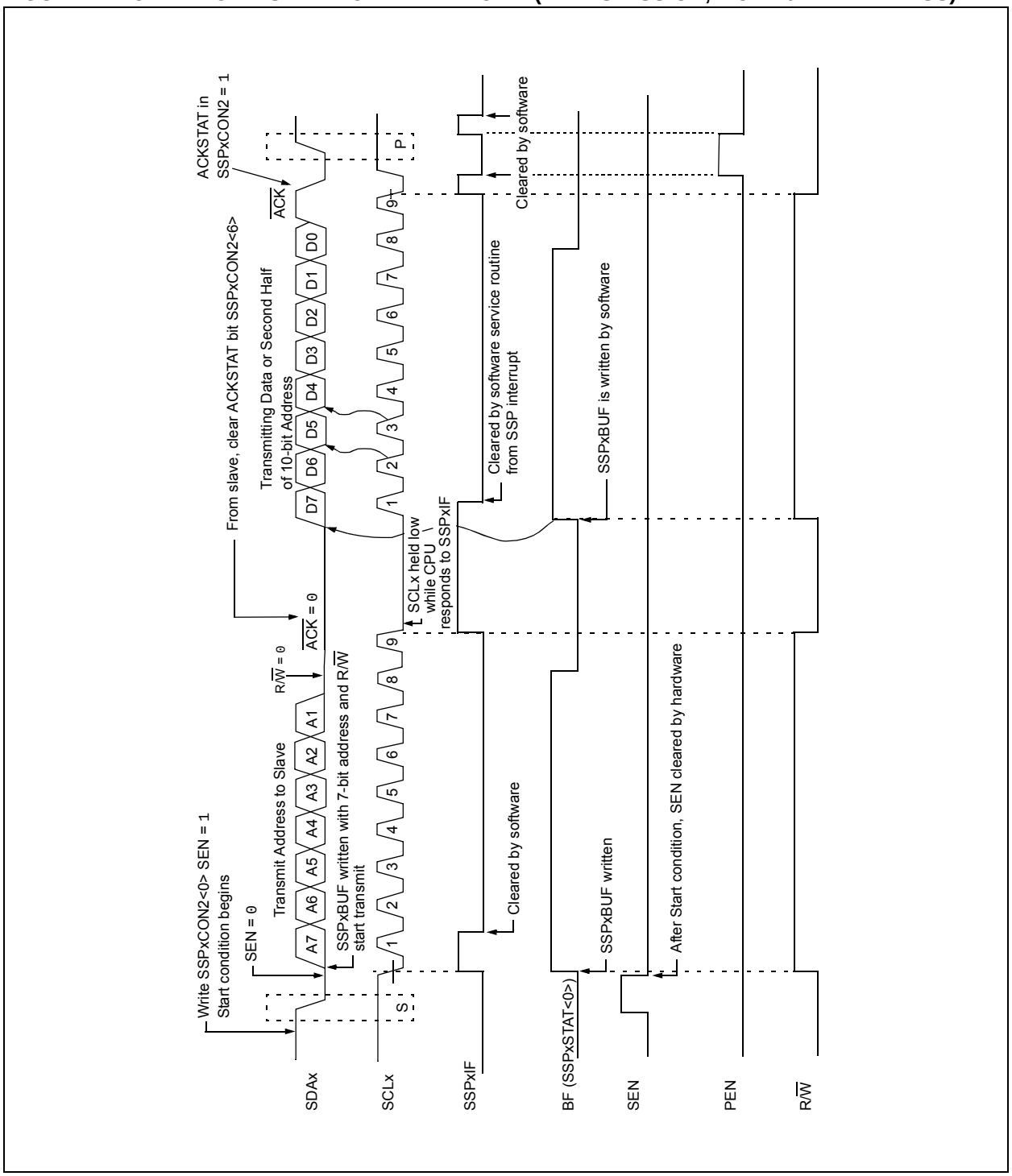


FIGURE 21-28: I²C MASTER MODE WAVEFORM (TRANSMISSION, 7 OR 10-BIT ADDRESS)



22.2 Clock Accuracy with Asynchronous Operation

The factory calibrates the internal oscillator block output (INTOSC). However, the INTOSC frequency may drift as VDD or temperature changes, and this directly affects the asynchronous baud rate.

The Auto-Baud Detect feature (see **Section22.4.1 "Auto-Baud Detect"**) can be used to compensate for changes in the INTOSC frequency.

There may not be fine enough resolution when adjusting the Baud Rate Generator to compensate for a gradual change in the peripheral clock frequency.

23.1 PWMx Pin Configuration

All PWM outputs are multiplexed with the PORT data latch. The user must configure the pins as outputs by clearing the associated TRIS bits.

Note:	Clearing the PWMxOE bit will relinquish control of the PWMx pin.

23.1.1 FUNDAMENTAL OPERATION

The PWM module produces a 10-bit resolution output. Timer2 and PR2 set the period of the PWM. The PWMxDCL and PWMxDCH registers configure the duty cycle. The period is common to all PWM modules, whereas the duty cycle is independently controlled.

Note:	The Timer2 postscaler is not used in the determination of the PWM frequency. The postscaler could be used to have a servo update rate at a different frequency than the PWM output.

All PWM outputs associated with Timer2 are set when TMR2 is cleared. Each PWMx is cleared when TMR2 is equal to the value specified in the corresponding PWMxDCH (8 MSb) and PWMxDCL<7:6> (2 LSb) registers. When the value is greater than or equal to PR2, the PWM output is never cleared (100% duty cycle).

Note:	The PWMxDCH and PWMxDCL registers are double buffered. The buffers are updated when Timer2 matches PR2. Care should be taken to update both registers before the timer match occurs.

23.1.2 PWM OUTPUT POLARITY

The output polarity is inverted by setting the PWMxPOL bit of the PWMxCON register.

23.1.3 PWM PERIOD

The PWM period is specified by the PR2 register of Timer2. The PWM period can be calculated using the formula of Equation 23-1.

EQUATION 23-1: PWM PERIOD

$$PWM\ Period = [(PR2) + 1] \bullet 4 \bullet T_{OSC} \bullet (TMR2\ Prescale\ Value)$$

Note: TOSC = 1/FOSC

When TMR2 is equal to PR2, the following three events occur on the next increment cycle:

- TMR2 is cleared
- The PWM output is active. (Exception: When the PWM duty cycle = 0%, the PWM output will remain inactive.)
- The PWMxDCH and PWMxDCL register values are latched into the buffers.

Note:	The Timer2 postscaler has no effect on the PWM operation.

23.1.4 PWM DUTY CYCLE

The PWM duty cycle is specified by writing a 10-bit value to the PWMxDCH and PWMxDCL register pair. The PWMxDCH register contains the eight MSbs and the PWMxDCL<7:6>, the two LSbs. The PWMxDCH and PWMxDCL registers can be written to at any time.

Equation 23-2 is used to calculate the PWM pulse width.

Equation 23-3 is used to calculate the PWM duty cycle ratio.

EQUATION 23-2: PULSE WIDTH

$$Pulse\ Width = (PWMxDCH:PWMxDCL<7:6>) \bullet T_{OSC} \bullet (TMR2\ Prescale\ Value)$$

Note: TOSC = 1/FOSC

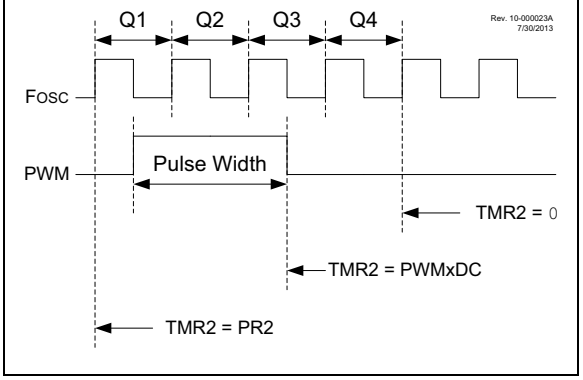
EQUATION 23-3: DUTY CYCLE RATIO

$$Duty\ Cycle\ Ratio = \frac{(PWMxDCH:PWMxDCL<7:6>)}{4(PR2 + 1)}$$

The 8-bit timer TMR2 register is concatenated with the two Least Significant bits of 1/FOSC, adjusted by the Timer2 prescaler to create the 10-bit time base. The system clock is used if the Timer2 prescaler is set to 1:1.

Figure 23-2 shows a waveform of the PWM signal when the duty cycle is set for the smallest possible pulse.

FIGURE 23-2: PWM OUTPUT



24.6 Register Definitions: CLC Control

REGISTER 24-1: CLCxCON: CONFIGURABLE LOGIC CELL CONTROL REGISTER

R/W-0/0	R/W-0/0	R-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
LCxEN	LCxOE	LCxOUT	LCxINTP	LCxINTN	LCxMODE<2:0>		
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	

bit 7 **LCxEN:** Configurable Logic Cell Enable bit
1 = Configurable logic cell is enabled and mixing input signals
0 = Configurable logic cell is disabled and has logic zero output

bit 6 **LCxOE:** Configurable Logic Cell Output Enable bit
1 = Configurable logic cell port pin output enabled
0 = Configurable logic cell port pin output disabled

bit 5 **LCxOUT:** Configurable Logic Cell Data Output bit
Read-only: logic cell output data, after LCxPOL; sampled from lcx_out wire.

bit 4 **LCxINTP:** Configurable Logic Cell Positive Edge Going Interrupt Enable bit
1 = CLCxIF will be set when a rising edge occurs on lcx_out
0 = CLCxIF will not be set

bit 3 **LCxINTN:** Configurable Logic Cell Negative Edge Going Interrupt Enable bit
1 = CLCxIF will be set when a falling edge occurs on lcx_out
0 = CLCxIF will not be set

bit 2-0 **LCxMODE<2:0>:** Configurable Logic Cell Functional Mode bits
111 = Cell is 1-input transparent latch with S and R
110 = Cell is J-K flip-flop with R
101 = Cell is 2-input D flip-flop with R
100 = Cell is 1-input D flip-flop with S and R
011 = Cell is S-R latch
010 = Cell is 4-input AND
001 = Cell is OR-XOR
000 = Cell is AND-OR

REGISTER 25-3: NCOxACCL: NCOx ACCUMULATOR REGISTER – LOW BYTE

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	R/W-0/0
NCOxACC<7:0>							
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	

bit 7-0 **NCOxACC<7:0>:** NCOx Accumulator, Low Byte

REGISTER 25-4: NCOxACCH: NCOx ACCUMULATOR REGISTER – HIGH BYTE

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	R/W-0/0
NCOxACC<15:8>							
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 **NCOxACC<15:8>:** NCOx Accumulator, High Byte

REGISTER 25-5: NCOxACCU: NCOx ACCUMULATOR REGISTER – UPPER BYTE

U-0	U-0	U-0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
—	—	—	—	NCOxACC<19:16>			
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 3-0 **NCOxACC<19:16>:** NCOx Accumulator, Upper Byte

29.3 DC Characteristics

TABLE 29-1: SUPPLY VOLTAGE

PIC16LF1508/9			Standard Operating Conditions (unless otherwise stated)				
PIC16F1508/9							
Param. No.	Sym.	Characteristic	Min.	Typ†	Max.	Units	Conditions
D001	VDD	**Supply Voltage**					
			VDDMIN		VDDMAX		
			1.8	—	3.6	V	FOSC ≤ 16 MHz
			2.5	—	3.6	V	FOSC ≤ 20 MHz
D001			2.3	—	5.5	V	FOSC ≤ 16 MHz
			2.5	—	5.5	V	FOSC ≤ 20 MHz
D002*	VDR	**RAM Data Retention Voltage(1)**					
			1.5	—	—	V	Device in Sleep mode
D002*			1.7	—	—	V	Device in Sleep mode
D002A*	VPOR	**Power-on Reset Release Voltage(2)**					
			—	1.6	—	V	
D002A*			—	1.6	—	V	
D002B*	VPORR*	**Power-on Reset Rearm Voltage(2)**					
			—	0.8	—	V	
D002B*			—	1.5	—	V	
D003	VFVR	**Fixed Voltage Reference Voltage**					
		1x gain (1.024V nominal)					VDD ≥ 2.5V, -40°C ≤ TA ≤ +85°C
		2x gain (2.048V nominal)	-4	—	+4	%	VDD ≥ 2.5V, -40°C ≤ TA ≤ +85°C
		4x gain (4.096V nominal)	-3	—	+7	%	VDD ≥ 4.75V, -40°C ≤ TA ≤ +85°C
D004*	SVDD	**VDD Rise Rate(2)**	0.05	—	—	V/ms	Ensures that the Power-on Reset signal is released properly.

* 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.

Note 1: This is the limit to which VDD can be lowered in Sleep mode without losing RAM data.

2: See Figure 29-3, POR and POR REARM with Slow Rising VDD.

TABLE 29-2: SUPPLY CURRENT (I_{DD})(1,2)

PIC16LF1508/9		Standard Operating Conditions (unless otherwise stated)					
PIC16F1508/9							
Param. No.	Device Characteristics	Min.	Typ†	Max.	Units	Conditions	
						V_{DD}	Note
D010		—	8	20	µA	1.8	F_{OSC} = 32 kHz, LP Oscillator, -40°C ≤ T_A ≤ +85°C
		—	10	25	µA	3.0	
D010		—	15	31	µA	2.3	F_{OSC} = 32 kHz, LP Oscillator, -40°C ≤ T_A ≤ +85°C
		—	17	33	µA	3.0	
		—	21	39	µA	5.0	
D011		—	60	100	µA	1.8	F_{OSC} = 1 MHz, XT Oscillator
		—	100	180	µA	3.0	
D011		—	100	180	µA	2.3	F_{OSC} = 1 MHz, XT Oscillator
		—	130	220	µA	3.0	
		—	170	280	µA	5.0	
D012		—	140	240	µA	1.8	F_{OSC} = 4 MHz, XT Oscillator
		—	250	360	µA	3.0	
D012		—	210	320	µA	2.3	F_{OSC} = 4 MHz, XT Oscillator
		—	280	410	µA	3.0	
		—	340	500	µA	5.0	
D013		—	30	65	µA	1.8	F_{OSC} = 1 MHz, External Clock (ECM), Medium Power mode
		—	55	100	µA	3.0	
D013		—	65	110	µA	2.3	F_{OSC} = 1 MHz, External Clock (ECM), Medium Power mode
		—	85	140	µA	3.0	
		—	115	190	µA	5.0	
D014		—	115	190	µA	1.8	F_{OSC} = 4 MHz, External Clock (ECM), Medium Power mode
		—	210	310	µA	3.0	
D014		—	180	270	µA	2.3	F_{OSC} = 4 MHz, External Clock (ECM), Medium Power mode
		—	240	365	µA	3.0	
		—	295	460	µA	5.0	
D015		—	3.2	12	µA	1.8	F_{OSC} = 31 kHz, LFINTOSC, -40°C ≤ T_A ≤ +85°C
		—	5.4	20	µA	3.0	
D015		—	13	28	µA	2.3	F_{OSC} = 31 kHz, LFINTOSC, -40°C ≤ T_A ≤ +85°C
		—	15	30	µA	3.0	
		—	17	36	µA	5.0	

* 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.

Note 1: The test conditions for all I_{DD} measurements in active operation mode are: OSC1 = external square wave, from rail-to-rail; all I/O pins tri-stated, pulled to V_{SS}; $\overline{MCLR}$ = V_{DD}; WDT disabled.

2: The supply current is mainly a function of the operating voltage and frequency. Other factors, such as I/O pin loading and switching rate, oscillator type, internal code execution pattern and temperature, also have an impact on the current consumption.

3: For RC oscillator configurations, current through R_{EXT} is not included. The current through the resistor can be extended by the formula IR = $V_{DD}/2R_{EXT}$ (mA) with R_{EXT} in kΩ.

FIGURE 30-9: IDD, EXTERNAL CLOCK (ECL), LOW-POWER MODE, FOSC = 500 kHz, PIC16LF1508/9 ONLY

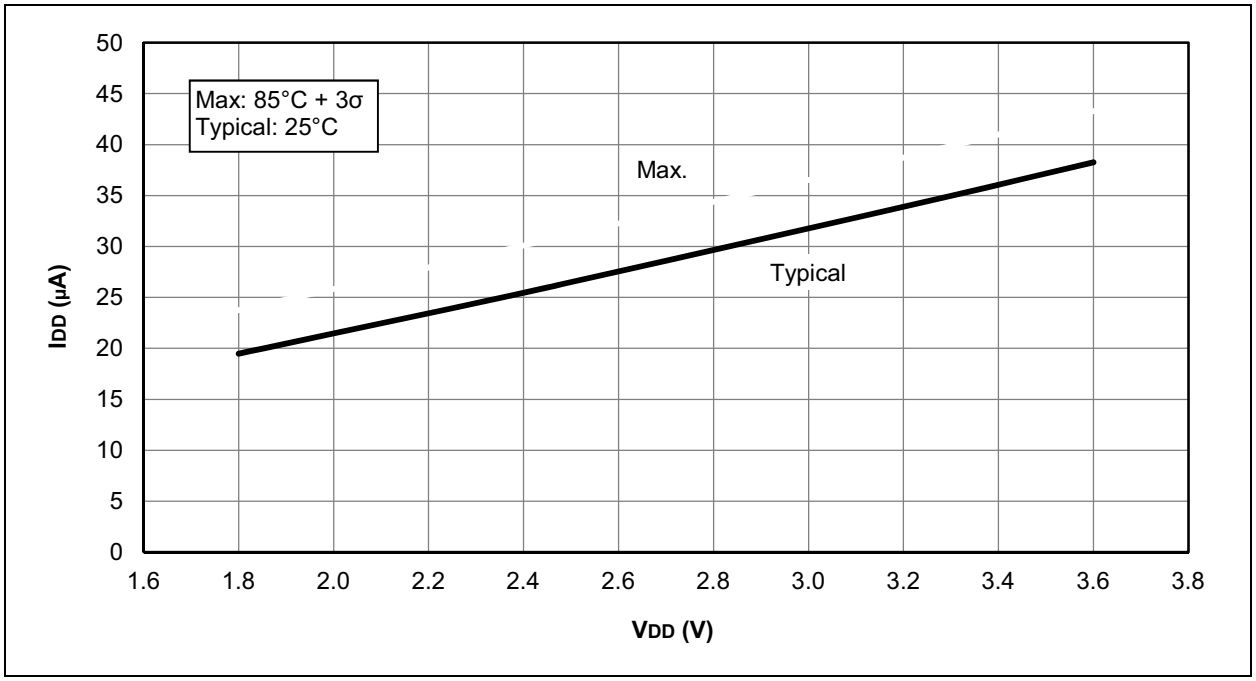
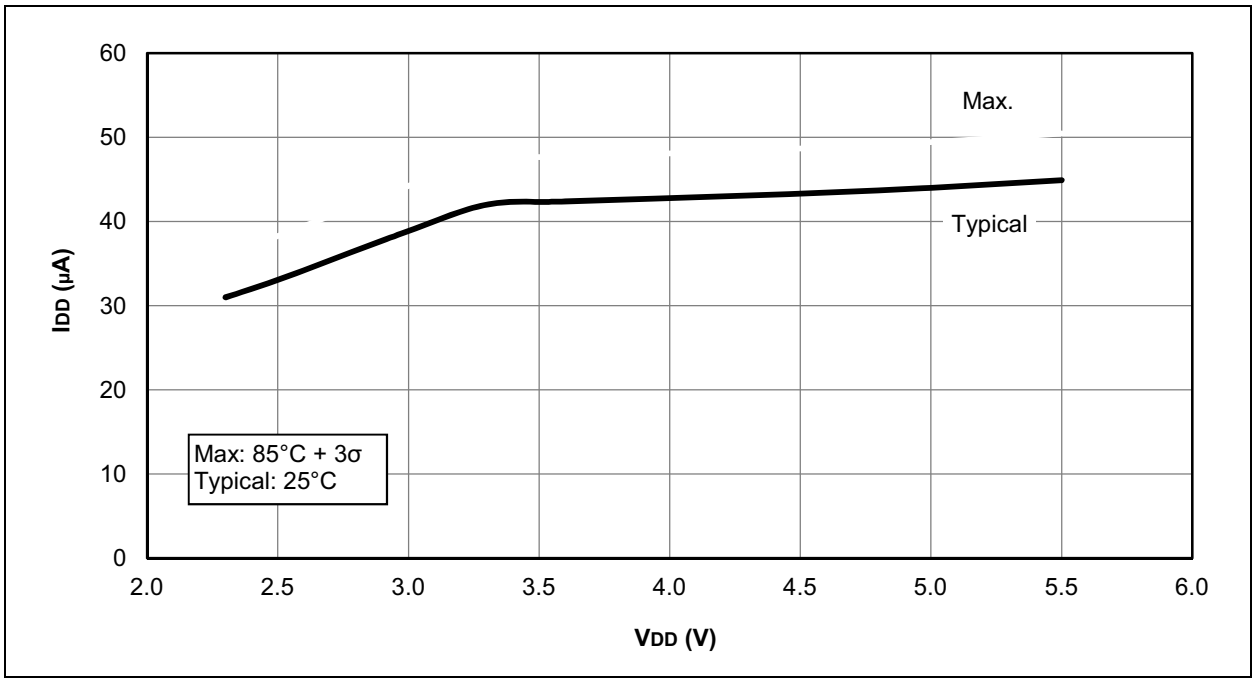
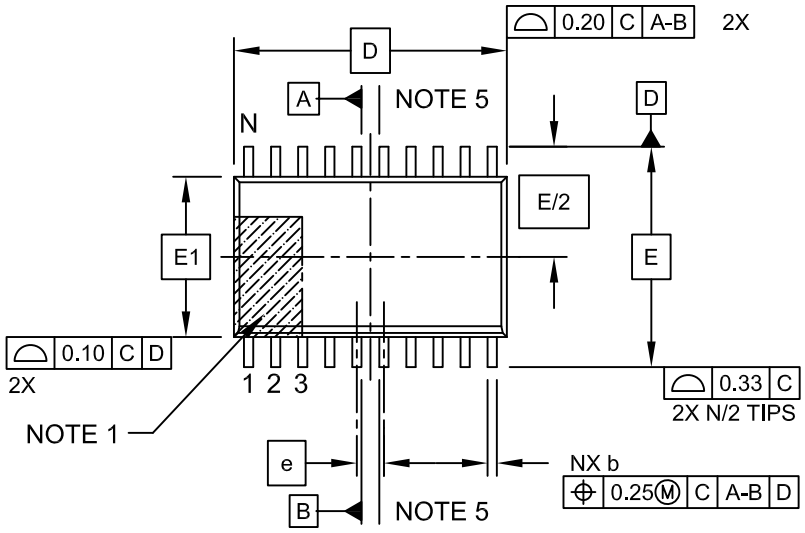


FIGURE 30-10: IDD, EXTERNAL CLOCK (ECL), LOW-POWER MODE, FOSC = 500 kHz, PIC16F1508/9 ONLY

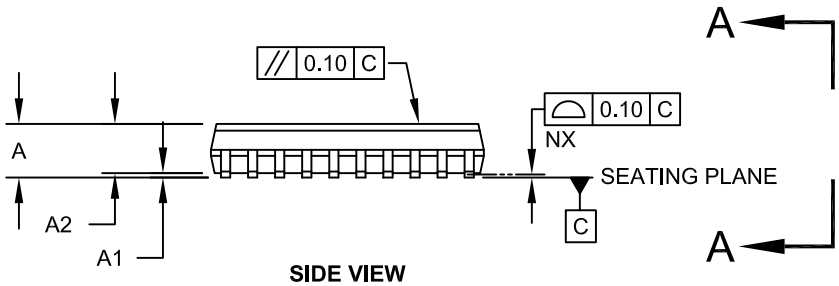


20-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

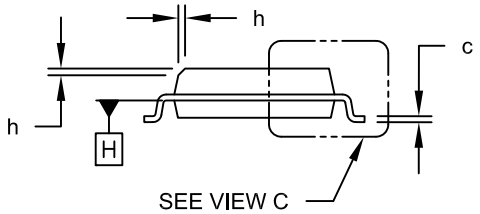
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

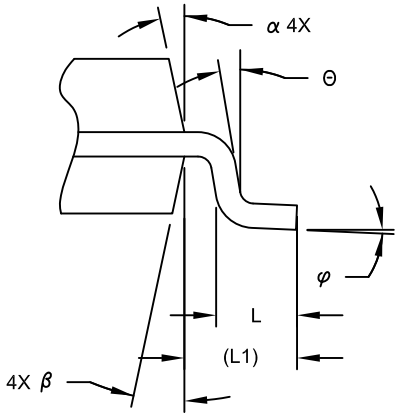


VIEW A-A

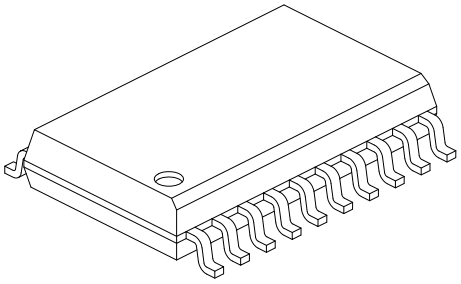
Microchip Technology Drawing C04-094C Sheet 1 of 2

20-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

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



VIEW C



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		20	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	2.65
Molded Package Thickness	A2	2.05	-	-
Standoff §	A1	0.10	-	0.30
Overall Width	E		10.30 BSC	
Molded Package Width	E1		7.50 BSC	
Overall Length	D		12.80 BSC	
Chamfer (Optional)	h	0.25	-	0.75
Foot Length	L	0.40	-	1.27
Footprint	L1		1.40 REF	
Lead Angle	Θ	0°	-	-
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.20	-	0.33
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

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

   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-094C Sheet 2 of 2