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"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)	2.3V ~ 5.5V
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-SOIC (0.295", 7.50mm Width)
Supplier Device Package	20-SOIC
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16f1509t-i-so

TABLE 3-9: SPECIAL FUNCTION REGISTER SUMMARY (CONTINUED)

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on POR, BOR	Value on all other Resets
Bank 10											
50Ch to 51Fh	—	Unimplemented								—	—
Bank 11											
58Ch to 59Fh	—	Unimplemented								—	—
Bank 12											
60Ch to 610h	—	Unimplemented								—	—
611h	PWM1DCL	PWM1DCL<7:6>		—	—	—	—	—	—	00-- ----	00-- ----
612h	PWM1DCH	PWM1DCH<7:0>								xxxx xxxx	uuuu uuuu
613h	PWM1CON0	PWM1EN	PWM1OE	PWM1OUT	PWM1POL	—	—	—	—	0000 ----	0000 ----
614h	PWM2DCL	PWM2DCL<7:6>		—	—	—	—	—	—	00-- ----	00-- ----
615h	PWM2DCH	PWM2DCH<7:0>								xxxx xxxx	uuuu uuuu
616h	PWM2CON0	PWM2EN	PWM2OE	PWM2OUT	PWM2POL	—	—	—	—	0000 ----	0000 ----
617h	PWM3DCL	PWM3DCL<7:6>		—	—	—	—	—	—	00-- ----	00-- ----
618h	PWM3DCH	PWM3DCH<7:0>								xxxx xxxx	uuuu uuuu
619h	PWM3CON0	PWM3EN	PWM3OE	PWM3OUT	PWM3POL	—	—	—	—	0000 ----	0000 ----
61Ah	PWM4DCL	PWM4DCL<7:6>		—	—	—	—	—	—	00-- ----	00-- ----
61Bh	PWM4DCH	PWM4DCH<7:0>								xxxx xxxx	uuuu uuuu
61Ch	PWM4CON0	PWM4EN	PWM4OE	PWM4OUT	PWM4POL	—	—	—	—	0000 ----	0000 ----
61Dh to 61Fh	—	Unimplemented								—	—
Bank 13											
68Ch to 690h	—	Unimplemented								—	—
691h	CWG1DBR	—	—	CWG1DBR<5:0>						--00 0000	--00 0000
692h	CWG1DBF	—	—	CWG1DBF<5:0>						--xx xxxx	--xx xxxx
693h	CWG1CON0	G1EN	G1OEB	G1OEA	G1POLB	G1POLA	—	—	G1CS0	0000 0--0	0000 0--0
694h	CWG1CON1	G1ASDLB<1:0>		G1ASDLA<1:0>		—	G1IS<2:0>			0000 -000	0000 -000
695h	CWG1CON2	G1ASE	G1ARSEN	—	—	G1ASDSC2	G1ASDSC1	G1ASDSFLT	G1ASDSCLC2	00-- 0000	00-- 0000
696h to 69Fh	—	Unimplemented								—	—

Legend: x = unknown, u = unchanged, q = value depends on condition, - = unimplemented, r = reserved. Shaded locations are unimplemented, read as '0'.
Note 1: PIC16F1508/9 only.
2: Unimplemented, read as '1'.

TABLE 3-9: SPECIAL FUNCTION REGISTER SUMMARY (CONTINUED)

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on POR, BOR	Value on all other Resets
Bank 31											
F8Ch — FE3h	—	Unimplemented								—	—
FE4h	STATUS_SHAD	—	—	—	—	—	Z_SHAD	DC_SHAD	C_SHAD	---- -xxx	---- -uuu
FE5h	WREG_SHAD	Working Register Shadow								xxxx xxxx	uuuu uuuu
FE6h	BSR_SHAD	—	—	—	Bank Select Register Shadow					---x xxxx	---u uuuu
FE7h	PCLATH_SHAD	—	Program Counter Latch High Register Shadow							-xxx xxxx	uuuu uuuu
FE8h	FSR0L_SHAD	Indirect Data Memory Address 0 Low Pointer Shadow								xxxx xxxx	uuuu uuuu
FE9h	FSR0H_SHAD	Indirect Data Memory Address 0 High Pointer Shadow								xxxx xxxx	uuuu uuuu
FEAh	FSR1L_SHAD	Indirect Data Memory Address 1 Low Pointer Shadow								xxxx xxxx	uuuu uuuu
FEBh	FSR1H_SHAD	Indirect Data Memory Address 1 High Pointer Shadow								xxxx xxxx	uuuu uuuu
FECh	—	Unimplemented								—	—
FEDh	STKPTR	—	—	—	Current Stack Pointer					---1 1111	---1 1111
FEEh	TOSL	Top-of-Stack Low byte								xxxx xxxx	uuuu uuuu
FEFh	TOSH	—	Top-of-Stack High byte							-xxx xxxx	-uuu uuuu

Legend: x = unknown, u = unchanged, q = value depends on condition, - = unimplemented, r = reserved. Shaded locations are unimplemented, read as '0'.
Note 1: PIC16F1508/9 only.
2: Unimplemented, read as '1'.

6.12 Determining the Cause of a Reset

Upon any Reset, multiple bits in the STATUS and PCON registers are updated to indicate the cause of the Reset. Table 6-3 and Table 6-4 show the Reset conditions of these registers.

TABLE 6-3: RESET STATUS BITS AND THEIR SIGNIFICANCE

STKOVF	STKUNF	$\overline{\text{RWDT}}$	$\overline{\text{RMCLR}}$	$\overline{\text{RI}}$	$\overline{\text{POR}}$	$\overline{\text{BOR}}$	$\overline{\text{TO}}$	$\overline{\text{PD}}$	Condition
0	0	1	1	1	0	x	1	1	Power-on Reset
0	0	1	1	1	0	x	0	x	Illegal, $\overline{\text{TO}}$ is set on $\overline{\text{POR}}$
0	0	1	1	1	0	x	x	0	Illegal, $\overline{\text{PD}}$ is set on $\overline{\text{POR}}$
0	0	u	1	1	u	0	1	1	Brown-out Reset
u	u	0	u	u	u	u	0	u	WDT Reset
u	u	u	u	u	u	u	0	0	WDT Wake-up from Sleep
u	u	u	u	u	u	u	1	0	Interrupt Wake-up from Sleep
u	u	u	0	u	u	u	u	u	$\overline{\text{MCLR}}$ Reset during normal operation
u	u	u	0	u	u	u	1	0	$\overline{\text{MCLR}}$ Reset during Sleep
u	u	u	u	0	u	u	u	u	RESET Instruction Executed
1	u	u	u	u	u	u	u	u	Stack Overflow Reset (STVREN = 1)
u	1	u	u	u	u	u	u	u	Stack Underflow Reset (STVREN = 1)

TABLE 6-4: RESET CONDITION FOR SPECIAL REGISTERS

Condition	Program Counter	STATUS Register	PCON Register
Power-on Reset	0000h	---1 1000	00-- 110x
$\overline{\text{MCLR}}$ Reset during normal operation	0000h	---u uuuuu	uu-- 0uuu
$\overline{\text{MCLR}}$ Reset during Sleep	0000h	---1 0uuu	uu-- 0uuu
WDT Reset	0000h	---0 uuuuu	uu-- uuuu
WDT Wake-up from Sleep	PC + 1	---0 0uuu	uu-- uuuu
Brown-out Reset	0000h	---1 1uuu	00-- 11u0
Interrupt Wake-up from Sleep	PC + 1(1)	---1 0uuu	uu-- uuuu
RESET Instruction Executed	0000h	---u uuuu	uu-- u0uu
Stack Overflow Reset (STVREN = 1)	0000h	---u uuuu	1u-- uuuu
Stack Underflow Reset (STVREN = 1)	0000h	---u uuuu	u1-- uuuu

Legend: u = unchanged, x = unknown, - = unimplemented bit, reads as '0'.

Note 1: When the wake-up is due to an interrupt and the Global Interrupt Enable bit (GIE) is set, the return address is pushed on the stack and PC is loaded with the interrupt vector (0004h) after execution of PC + 1.

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 7-4: PIE3: PERIPHERAL INTERRUPT ENABLE REGISTER 3

U-0	U-0	U-0	U-0	R/W-0/0	R/W-0/0	R/W-0/0	R/W-0/0
—	—	—	—	CLC4IE	CLC3IE	CLC2IE	CLC1IE
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 **CLC4IE:** Configurable Logic Block 4 Interrupt Enable bit
1 = Enables the CLC 4 interrupt
0 = Disables the CLC 4 interrupt

bit 2 **CLC3IE:** Configurable Logic Block 3 Interrupt Enable bit
1 = Enables the CLC 3 interrupt
0 = Disables the CLC 3 interrupt

bit 1 **CLC2IE:** Configurable Logic Block 2 Interrupt Enable bit
1 = Enables the CLC 2 interrupt
0 = Disables the CLC 2 interrupt

bit 0 **CLC1IE:** Configurable Logic Block 1 Interrupt Enable bit
1 = Enables the CLC 1 interrupt
0 = Disables the CLC 1 interrupt

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

TABLE 9-3: SUMMARY OF REGISTERS ASSOCIATED WITH WATCHDOG TIMER

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
OSCCON	—	IRCF<3:0>				—	SCS<1:0>		59
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: x = unknown, u = unchanged, – = unimplemented locations read as '0'. Shaded cells are not used by Watchdog Timer.

TABLE 9-4: SUMMARY OF CONFIGURATION WORD WITH WATCHDOG TIMER

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 Watchdog Timer.

11.0 I/O PORTS

Each port has three standard registers for its operation. These registers are:

- TRISx registers (data direction)
- PORTx registers (reads the levels on the pins of the device)
- LATx registers (output latch)

Some ports may have one or more of the following additional registers. These registers are:

- ANSELx (analog select)
- WPUx (weak pull-up)

In general, when a peripheral is enabled on a port pin, that pin cannot be used as a general purpose output. However, the pin can still be read.

TABLE 11-1: PORT AVAILABILITY PER DEVICE

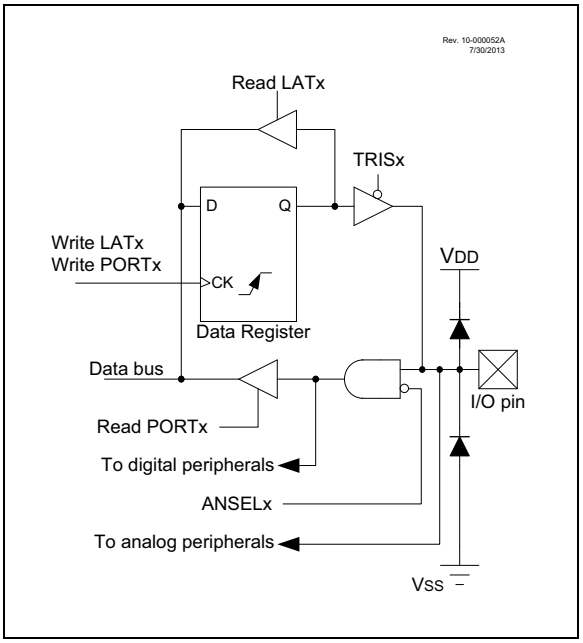
Device	PORTA	PORTB	PORTC
PIC16(L)F1508/9	●	●	●
PIC16(L)F1508/9	●	●	●

The Data Latch (LATx registers) is useful for read-modify-write operations on the value that the I/O pins are driving.

A write operation to the LATx register has the same effect as a write to the corresponding PORTx register. A read of the LATx register reads of the values held in the I/O PORT latches, while a read of the PORTx register reads the actual I/O pin value.

Ports that support analog inputs have an associated ANSELx register. When an ANSEL bit is set, the digital input buffer associated with that bit is disabled. Disabling the input buffer prevents analog signal levels on the pin between a logic high and low from causing excessive current in the logic input circuitry. A simplified model of a generic I/O port, without the interfaces to other peripherals, is shown in Figure 11-1.

FIGURE 11-1: GENERIC I/O PORT OPERATION



11.7 PORTC Registers

11.7.1 DATA REGISTER

PORTC is a 8-bit wide, bidirectional port. The corresponding data direction register is TRISC (Register 11-13). Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., disable the output driver). 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 11-12) 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).

11.7.2 DIRECTION CONTROL

The TRISC register (Register 11-13) 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 input always read '0'.

11.7.3 ANALOG CONTROL

The ANSELC register (Register 11-15) 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.

11.7.4 PORTC FUNCTIONS AND OUTPUT PRIORITIES

Each PORTC pin is multiplexed with other functions. The pins, their combined functions and their output priorities are shown in Table 11-8.

When multiple outputs are enabled, the actual pin control goes to the peripheral with the highest priority.

Analog input and some digital input functions are not included in the output priority list. These input functions can remain active when the pin is configured as an output. Certain digital input functions override other port functions and are included in the output priority list.

TABLE 11-8: PORTC OUTPUT PRIORITY

Pin Name	Function Priority(1)
RC0	CLC2 RC0
RC1	NCO1(2) PWM4 RC1
RC2	RC2
RC3	PWM2 RC3
RC4	CWG1B CLC4 C2OUT RC4
RC5	CWG1A CLC1(3) PWM1 RC5
RC6	NCO1(3) RC6
RC7	SDO RC7

Note 1: Priority listed from highest to lowest.
2: Default pin (see APFCON register).
3: Alternate pin (see APFCON register).

15.1.5 INTERRUPTS

The ADC module allows for the ability to generate an interrupt upon completion of an Analog-to-Digital conversion. The ADC Interrupt Flag is the ADIF bit in the PIR1 register. The ADC Interrupt Enable is the ADIE bit in the PIE1 register. The ADIF bit must be cleared in software.

Note 1:	The ADIF bit is set at the completion of every conversion, regardless of whether or not the ADC interrupt is enabled.
2:	The ADC operates during Sleep only when the FRC oscillator is selected.

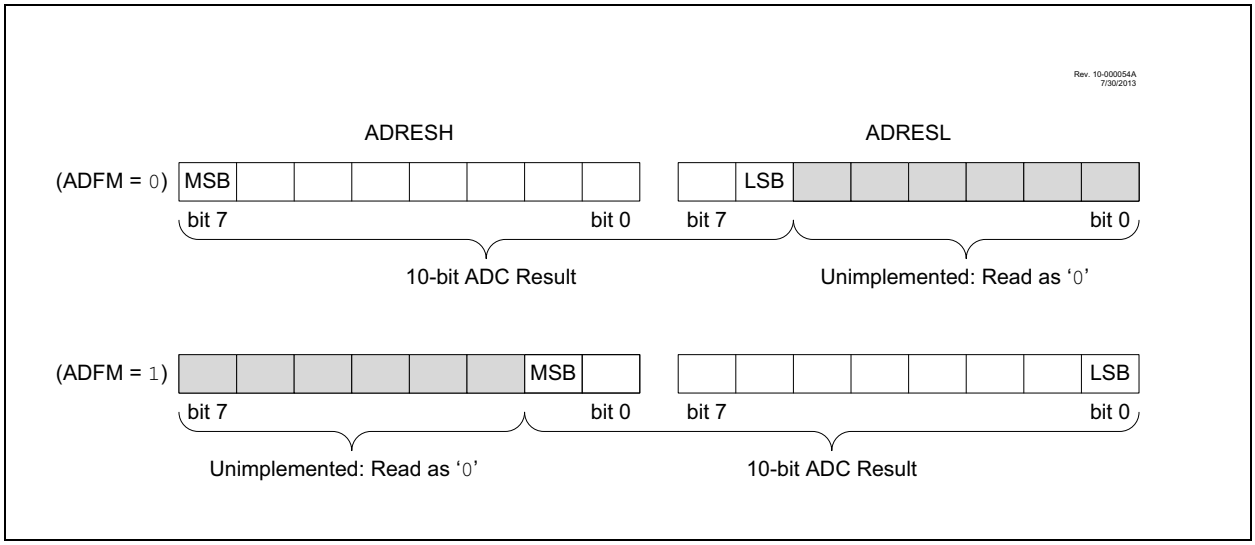
This interrupt can be generated while the device is operating or while in Sleep. If the device is in Sleep, the interrupt will wake-up the device. Upon waking from Sleep, the next instruction following the SLEEP instruction is always executed. If the user is attempting to wake-up from Sleep and resume in-line code execution, the GIE and PEIE bits of the INTCON register must be disabled. If the GIE and PEIE bits of the INTCON register are enabled, execution will switch to the Interrupt Service Routine.

15.1.6 RESULT FORMATTING

The 10-bit ADC conversion result can be supplied in two formats, left justified or right justified. The ADFM bit of the ADCON1 register controls the output format.

Figure 15-3 shows the two output formats.

FIGURE 15-3: 10-BIT ADC CONVERSION RESULT FORMAT



REGISTER 17-2: CMxCON1: COMPARATOR Cx CONTROL REGISTER 1

R/W-0/0	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
CxINTP	CxINTN	CxPCH<1:0>		—	CxNCH<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 **CxINTP:** Comparator Interrupt on Positive Going Edge Enable bits
1 = The CxIF interrupt flag will be set upon a positive going edge of the CxOUT bit
0 = No interrupt flag will be set on a positive going edge of the CxOUT bit

bit 6 **CxINTN:** Comparator Interrupt on Negative Going Edge Enable bits
1 = The CxIF interrupt flag will be set upon a negative going edge of the CxOUT bit
0 = No interrupt flag will be set on a negative going edge of the CxOUT bit

bit 5-4 **CxPCH<1:0>:** Comparator Positive Input Channel Select bits
11 = CxVP connects to VSS
10 = CxVP connects to FVR Voltage Reference
01 = CxVP connects to DAC Voltage Reference
00 = CxVP connects to CxIN+ pin

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

bit 2-0 **CxNCH<2:0>:** Comparator Negative Input Channel Select bits
111 = Reserved
110 = Reserved
101 = Reserved
100 = CxVN connects to FVR Voltage reference
011 = CxVN connects to CxIN3- pin
010 = CxVN connects to CxIN2- pin
001 = CxVN connects to CxIN1- pin
000 = CxVN connects to CxIN0- pin

REGISTER 17-3: CMOUT: COMPARATOR OUTPUT REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	R-0/0	R-0/0
—	—	—	—	—	—	MC2OUT	MC1OUT
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 7-2 **Unimplemented:** Read as '0'

bit 1 **MC2OUT:** Mirror Copy of C2OUT bit

bit 0 **MC1OUT:** Mirror Copy of C1OUT bit

18.2 Register Definitions: Option Register

REGISTER 18-1: OPTION_REG: OPTION 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
$\overline{\text{WPUEN}}$	INTEDG	TMR0CS	TMR0SE	PSA	PS<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 **$\overline{\text{WPUEN}}$:** Weak Pull-Up Enable bit
1 = All weak pull-ups are disabled (except $\overline{\text{MCLR}}$, if it is enabled)
0 = Weak pull-ups are enabled by individual WPUx latch values

bit 6 **INTEDG:** Interrupt Edge Select bit
1 = Interrupt on rising edge of INT pin
0 = Interrupt on falling edge of INT pin

bit 5 **TMR0CS:** Timer0 Clock Source Select bit
1 = Transition on T0CKI pin
0 = Internal instruction cycle clock (FOSC/4)

bit 4 **TMR0SE:** Timer0 Source Edge Select bit
1 = Increment on high-to-low transition on T0CKI pin
0 = Increment on low-to-high transition on T0CKI pin

bit 3 **PSA:** Prescaler Assignment bit
1 = Prescaler is not assigned to the Timer0 module
0 = Prescaler is assigned to the Timer0 module

bit 2-0 **PS<2:0>:** Prescaler Rate Select bits

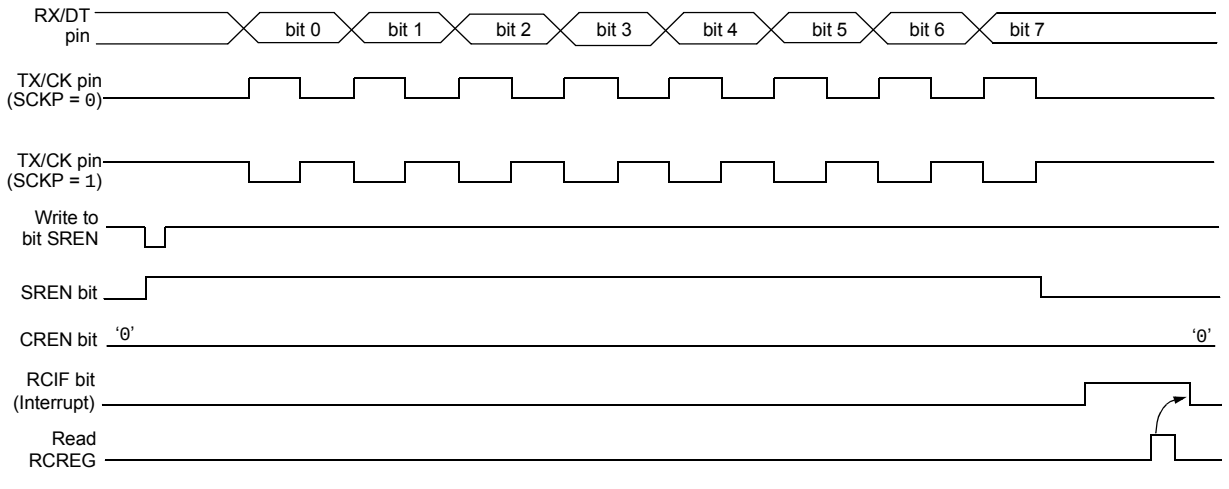
Bit Value	Timer0 Rate
000	1 : 2
001	1 : 4
010	1 : 8
011	1 : 16
100	1 : 32
101	1 : 64
110	1 : 128
111	1 : 256

TABLE 18-1: SUMMARY OF REGISTERS ASSOCIATED WITH TIMER0

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
ADCON2	TRIGSEL<3:0>				—	—	—	—	136
INTCON	GIE	PEIE	TMR0IE	INTE	IOCIE	TMR0IF	INTF	IOCIF	75
OPTION_REG	$\overline{\text{WPUEN}}$	INTEDG	TMR0CS	TMR0SE	PSA	PS<2:0>			154
TMR0	Holding Register for the 8-bit Timer0 Count								152*
TRISA	—	—	TRISA5	TRISA4	—(1)	TRISA2	TRISA1	TRISA0	109

Legend: — = Unimplemented location, read as '0'. Shaded cells are not used by the Timer0 module.
* Page provides register information.
Note 1: Unimplemented, read as '1'.

FIGURE 22-12: SYNCHRONOUS RECEPTION (MASTER MODE, SREN)



Note: Timing diagram demonstrates Sync Master mode with bit SREN = 1 and bit BRGH = 0.

TABLE 22-8: SUMMARY OF REGISTERS ASSOCIATED WITH SYNCHRONOUS MASTER RECEPTION

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Register on Page
BAUDCON	ABDOVF	RCIDL	—	SCKP	BRG16	—	WUE	ABDEN	235
INTCON	GIE	PEIE	TMR0IE	INTE	IOCIE	TMR0IF	INTF	IOCIF	75
PIE1	TMR1GIE	ADIE	RCIE	TXIE	SSP1IE	—	TMR2IE	TMR1IE	76
PIR1	TMR1GIF	ADIF	RCIF	TXIF	SSP1IF	—	TMR2IF	TMR1IF	79
RCREG	EUSART Receive Data Register								228*
RCSTA	SPEN	RX9	SREN	CREN	ADDEN	FERR	OERR	RX9D	234
SPBRGL	BRG<7:0>								236*
SPBRGH	BRG<15:8>								236*
TRISB	TRISB7	TRISB6	TRISB5	TRISB4	TRISB3	TRISB2	TRISB1	TRISB0	113
TXSTA	CSRC	TX9	TXEN	SYNC	SENDB	BRGH	TRMT	TX9D	233

Legend: — = unimplemented location, read as '0'. Shaded cells are not used for synchronous master reception.

* Page provides register information.

TABLE 29-4: I/O PORTS

Standard Operating Conditions (unless otherwise stated)							
Param. No.	**Sym.**	**Characteristic**	**Min.**	**Typ†**	**Max.**	**Units**	**Conditions**
	VIL	**Input Low Voltage**					
		I/O PORT:					
D030		with TTL buffer	—	—	0.8	V	4.5V ≤ VDD ≤ 5.5V
D030A			—	—	0.15 VDD	V	1.8V ≤ VDD ≤ 4.5V
D031		with Schmitt Trigger buffer	—	—	0.2 VDD	V	2.0V ≤ VDD ≤ 5.5V
		with I^2C levels	—	—	0.3 VDD	V	
		with SMbus levels	—	—	0.8	V	2.7V ≤ VDD ≤ 5.5V
D032		$\overline{MCLR}$, OSC1 (EXTRC mode)	—	—	0.2 VDD	V	**(Note 1)**
D033		OSC1 (HS mode)	—	—	0.3 VDD	V	
	VIH	**Input High Voltage**					
		I/O PORT:					
D040		with TTL buffer	2.0	—	—	V	4.5V ≤ VDD ≤ 5.5V
D040A			0.25 VDD + 0.8	—	—	V	1.8V ≤ VDD ≤ 4.5V
D041		with Schmitt Trigger buffer	0.8 VDD	—	—	V	2.0V ≤ VDD ≤ 5.5V
		with I^2C levels	0.7 VDD	—	—	V	
		with SMbus levels	2.1	—	—	V	2.7V ≤ VDD ≤ 5.5V
D042		$\overline{MCLR}$	0.8 VDD	—	—	V	
D043A		OSC1 (HS mode)	0.7 VDD	—	—	V	
D043B		OSC1 (EXTRC mode)	0.9 VDD	—	—	V	VDD > 2.0V **(Note 1)**
	IIL	**Input Leakage Current(2)**					
D060		I/O Ports	—	± 5	± 125	nA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance, 85°C
			—	± 5	± 1000	nA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance, 125°C
D061		$\overline{MCLR}$(3)	—	± 50	± 200	nA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance, 85°C
	IPUR	**Weak Pull-up Current**					
D070*			25	100	200	µA	VDD = 3.3V, VPIN = VSS
			25	140	300	µA	VDD = 5.0V, VPIN = VSS
	VOL	**Output Low Voltage**					
D080		I/O Ports	—	—	0.6	V	IOL = 8 mA, VDD = 5V IOL = 6 mA, VDD = 3.3V IOL = 1.8 mA, VDD = 1.8V
	VOH	**Output High Voltage**					
D090		I/O Ports	VDD - 0.7	—	—	V	IOH = 3.5 mA, VDD = 5V IOH = 3 mA, VDD = 3.3V IOH = 1 mA, VDD = 1.8V
D101*	COSC2	**Capacitive Loading Specifications on Output Pins**					
		OSC2 pin	—	—	15	pF	In XT, HS, LP modes when external clock is used to drive OSC1
D101A*	CIO	All I/O pins	—	—	50	pF	

* 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: In EXTRC oscillator configuration, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended to use an external clock in EXTRC mode.

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

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

FIGURE 29-12: ADC CONVERSION TIMING (ADC CLOCK FOSC-BASED)

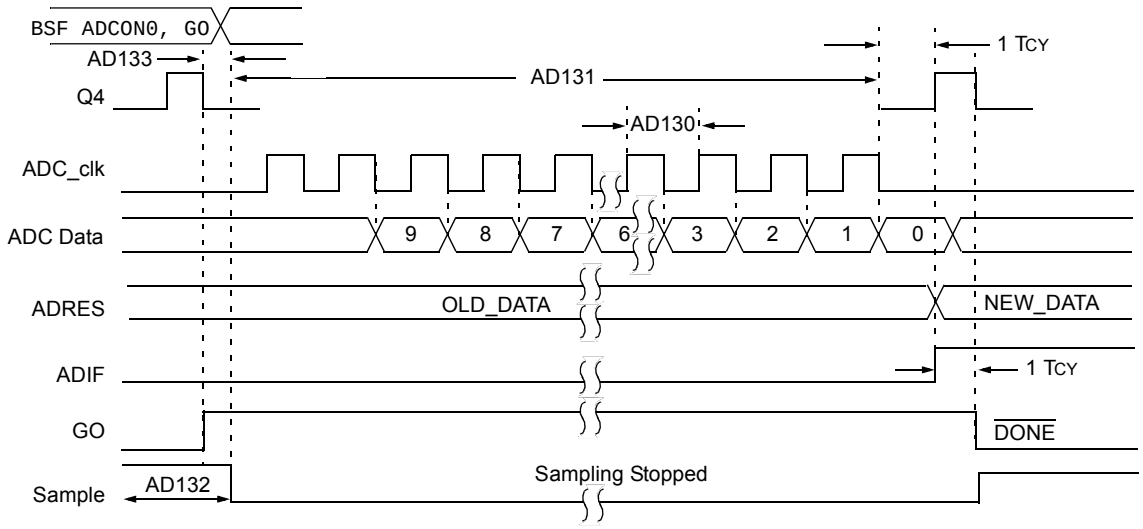
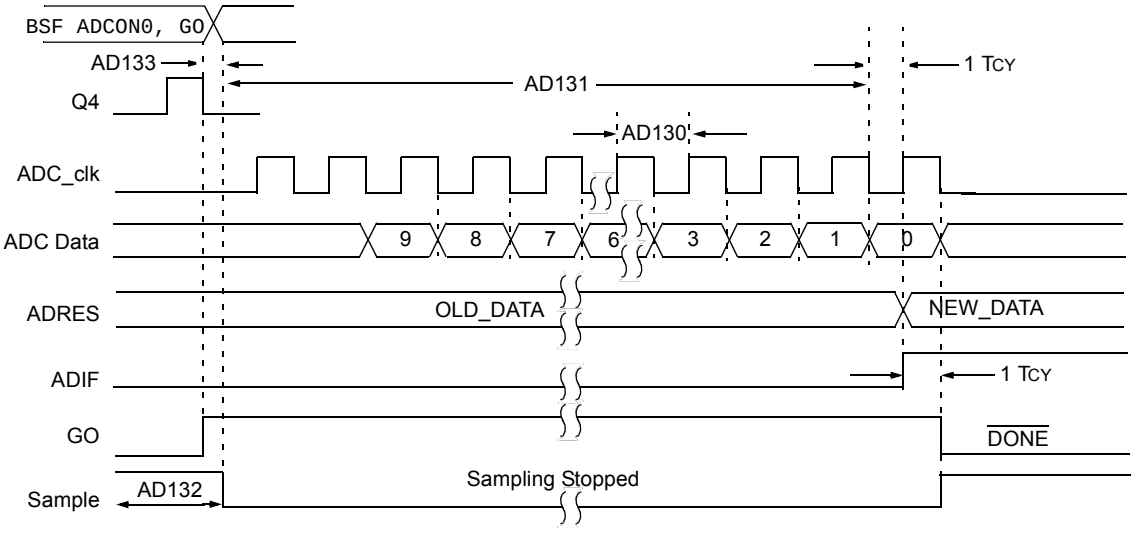


FIGURE 29-13: ADC CONVERSION TIMING (ADC CLOCK FROM FRC)



Note 1: If the ADC clock source is selected as FRC, a time of TCY is added before the ADC clock starts. This allows the SLEEP instruction to be executed.

FIGURE 30-29: IDD TYPICAL, HS OSCILLATOR, PIC16F1508/9 ONLY

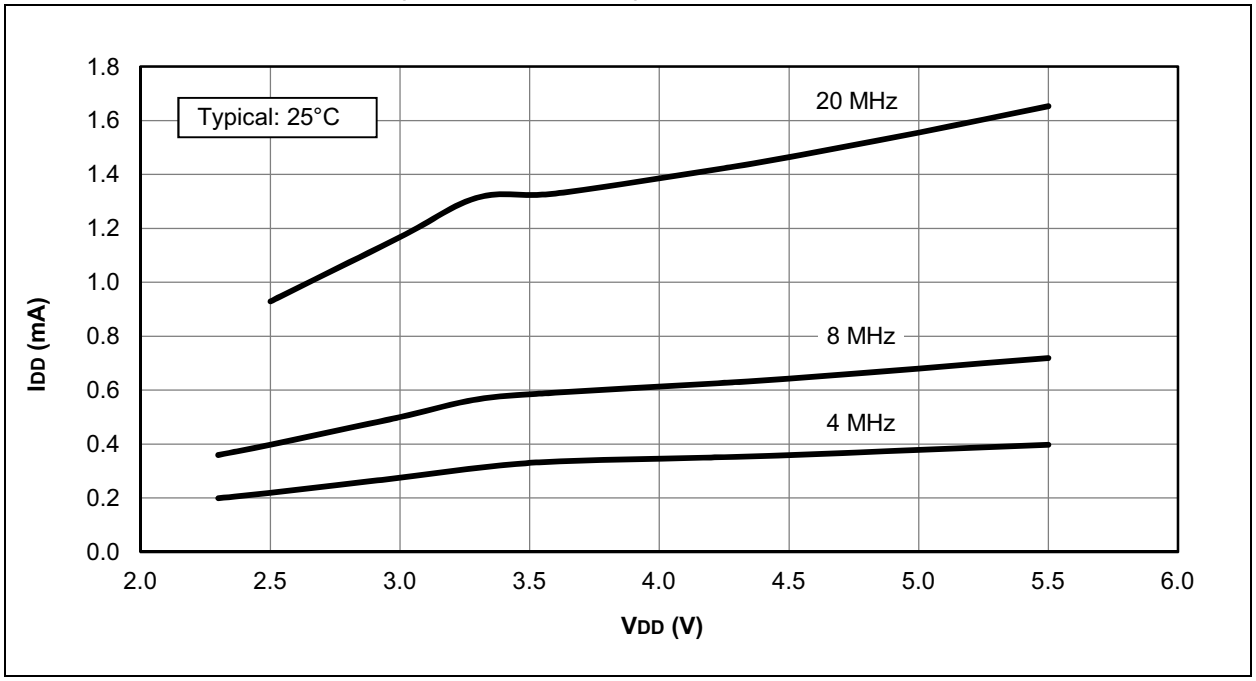


FIGURE 30-30: IDD MAXIMUM, HS OSCILLATOR, PIC16F1508/9 ONLY

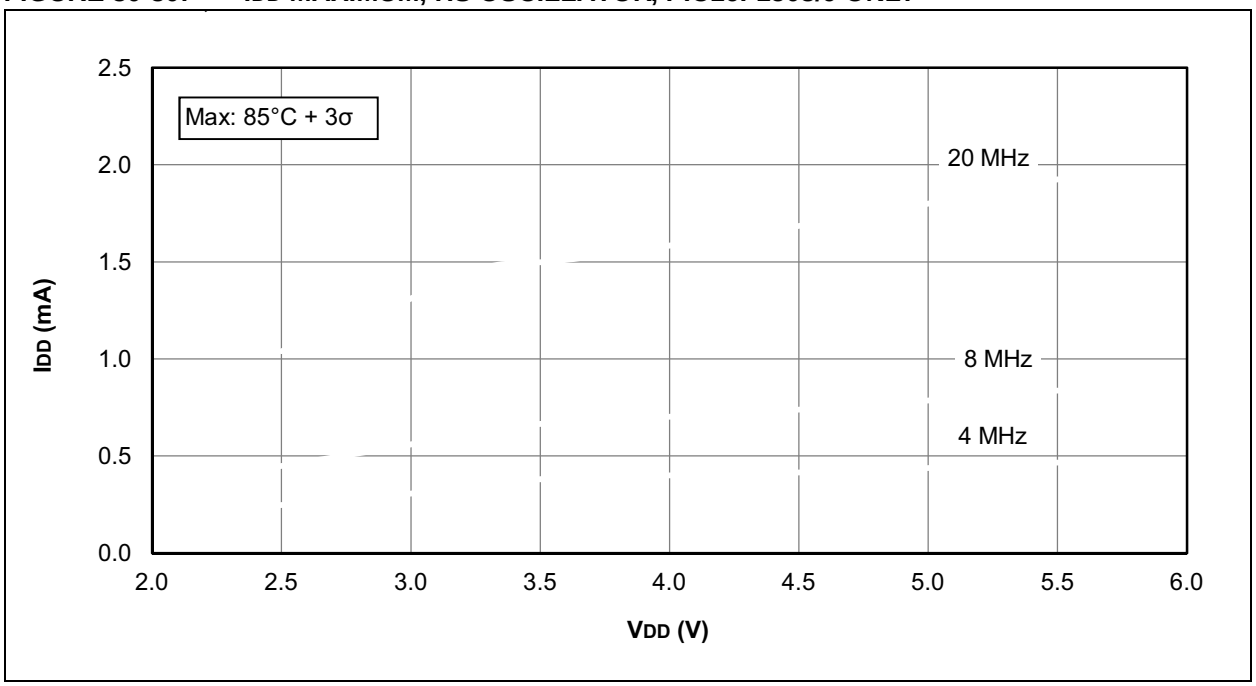


FIGURE 30-57: BROWN-OUT RESET VOLTAGE, BORV = 1, PIC16F1508/9 ONLY

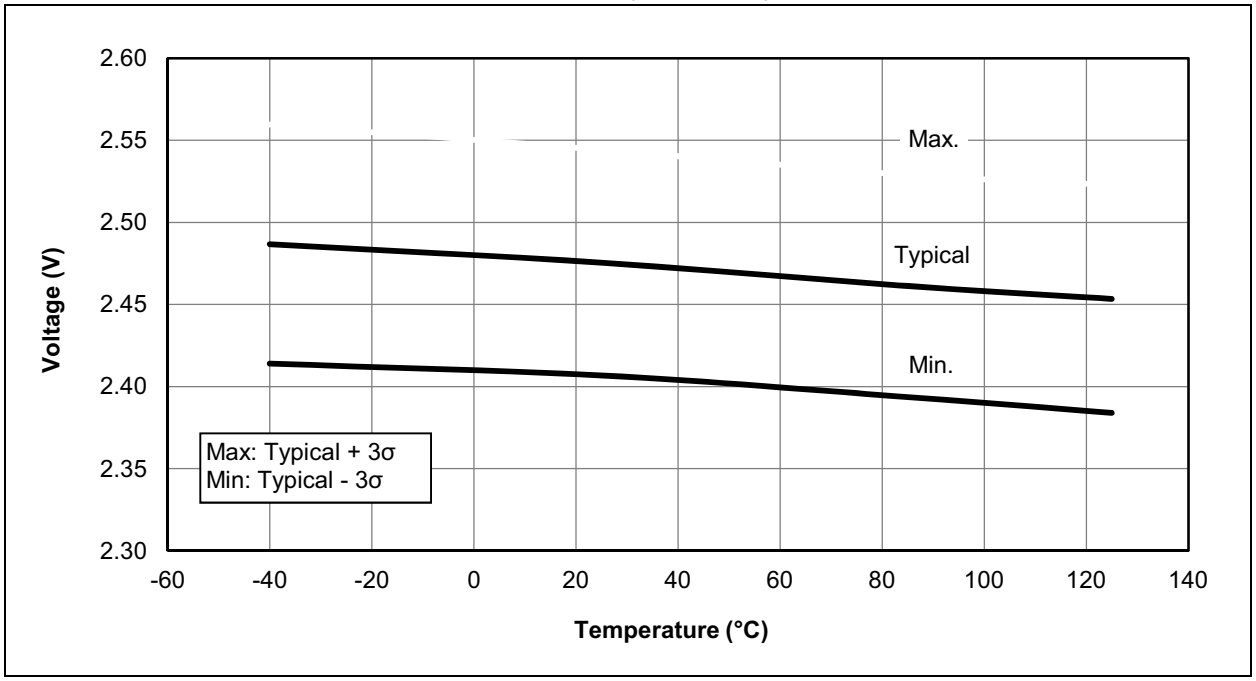


FIGURE 30-58: BROWN-OUT RESET HYSTERESIS, BORV = 1, PIC16F1508/9 ONLY

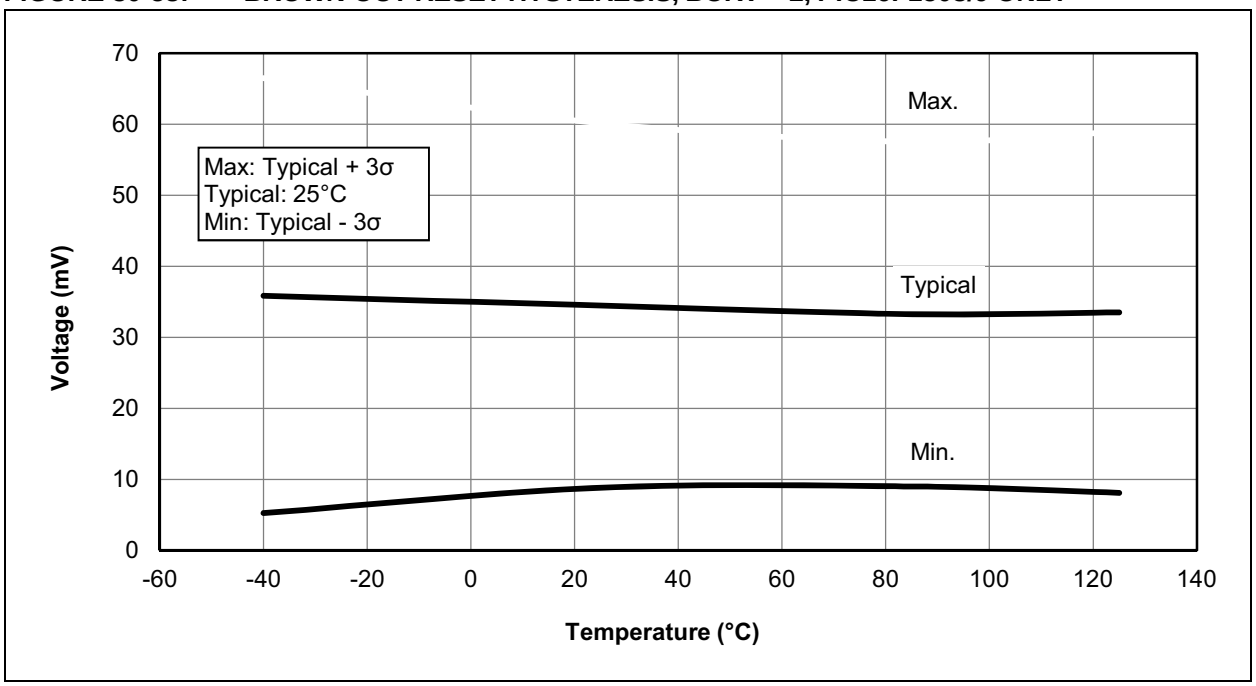


FIGURE 30-62: WDT TIME-OUT PERIOD

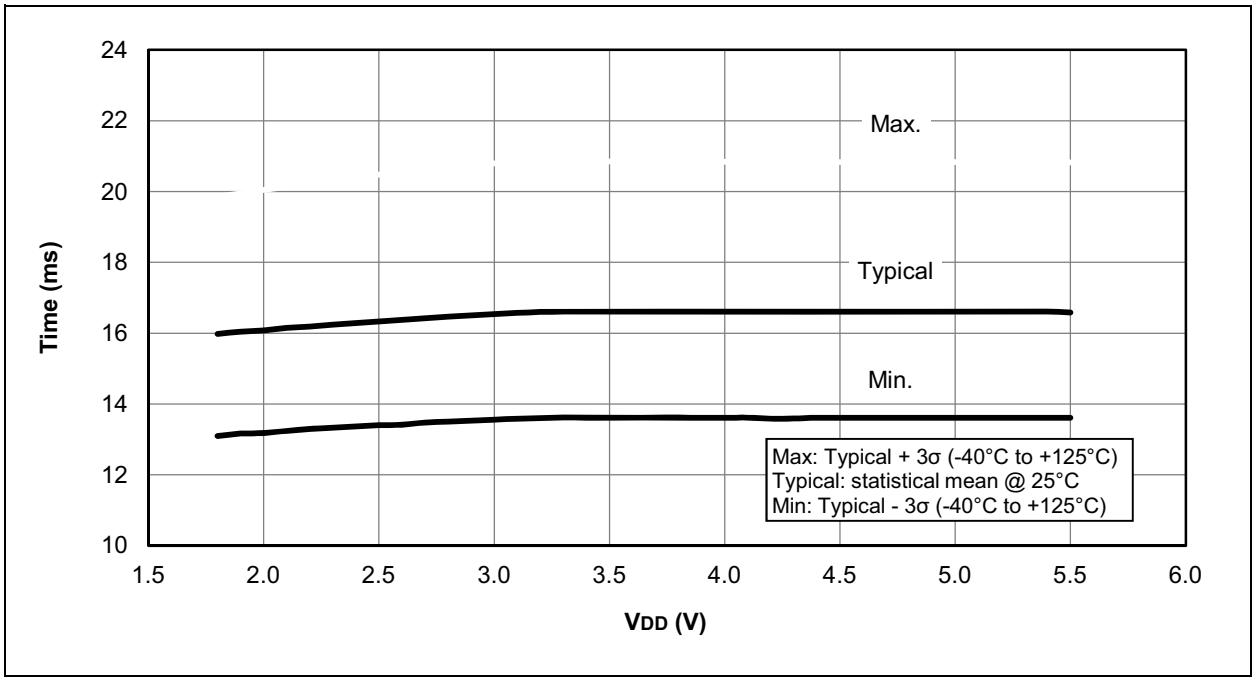
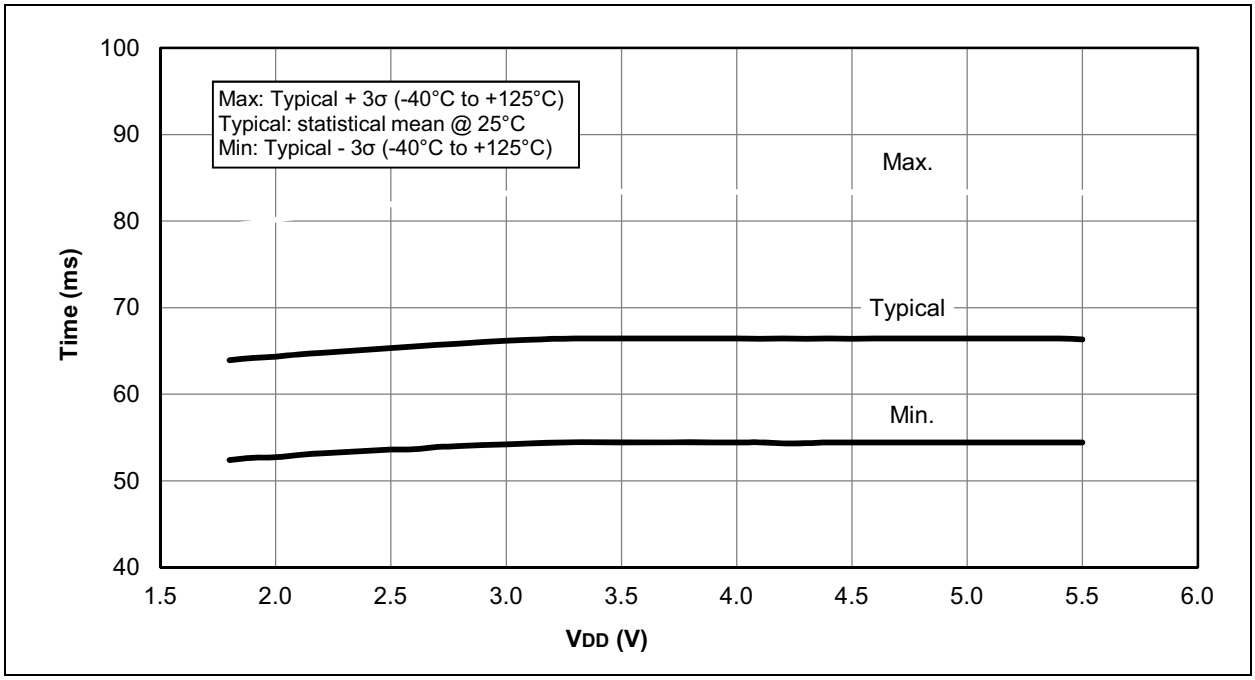
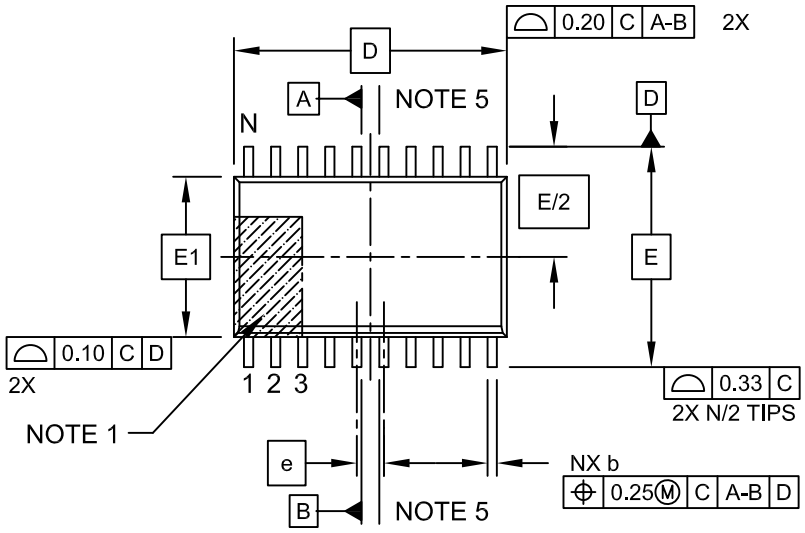


FIGURE 30-63: PWRT PERIOD

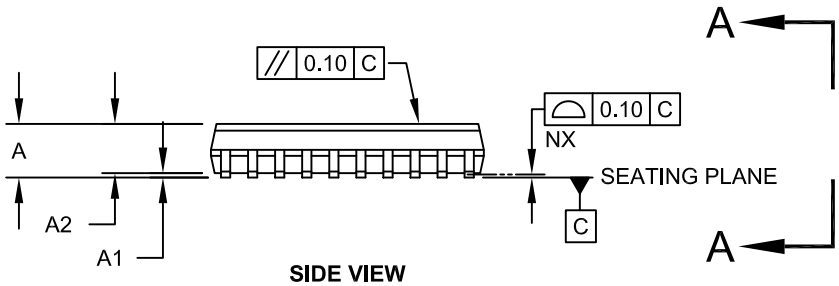


20-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

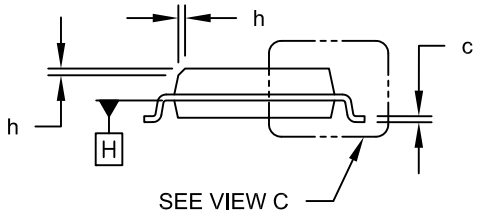
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

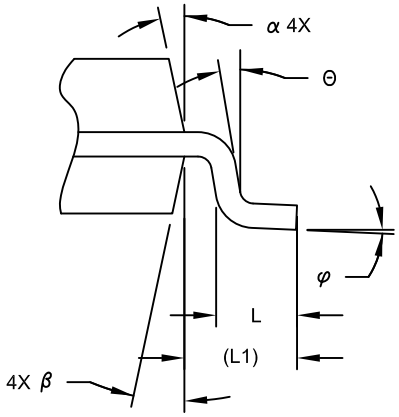


VIEW A-A

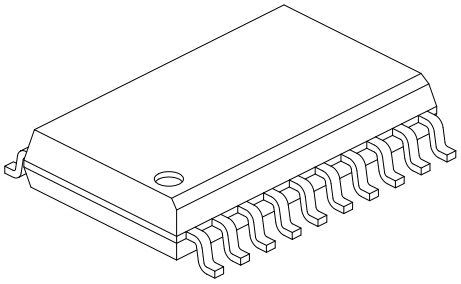
Microchip Technology Drawing C04-094C Sheet 1 of 2

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

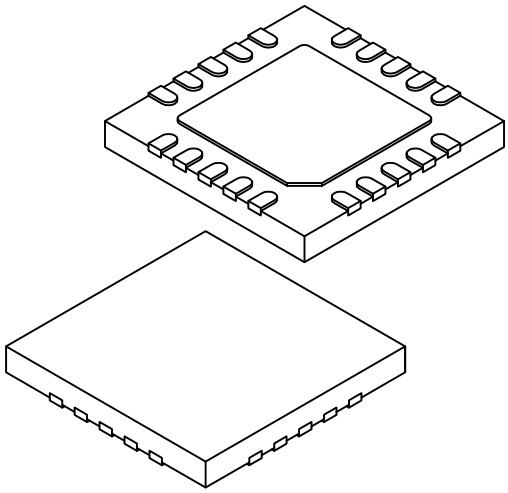
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   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

20-Lead Ultra Thin Plastic Quad Flat, No Lead Package (GZ) - 4x4x0.5 mm Body [UQFN]

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		20	
Pitch	e		0.50 BSC	
Overall Height	A	0.45	0.50	0.55
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.127 REF	
Overall Width	E		4.00 BSC	
Exposed Pad Width	E2	2.60	2.70	2.80
Overall Length	D		4.00 BSC	
Exposed Pad Length	D2	2.60	2.70	2.80
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.30	0.40	0.50
Terminal-to-Exposed-Pad	K	0.20	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. 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.

Microchip Technology Drawing C04-255A Sheet 2 of 2