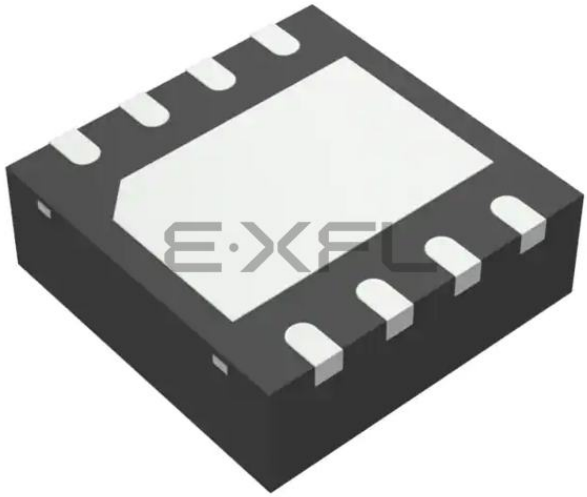

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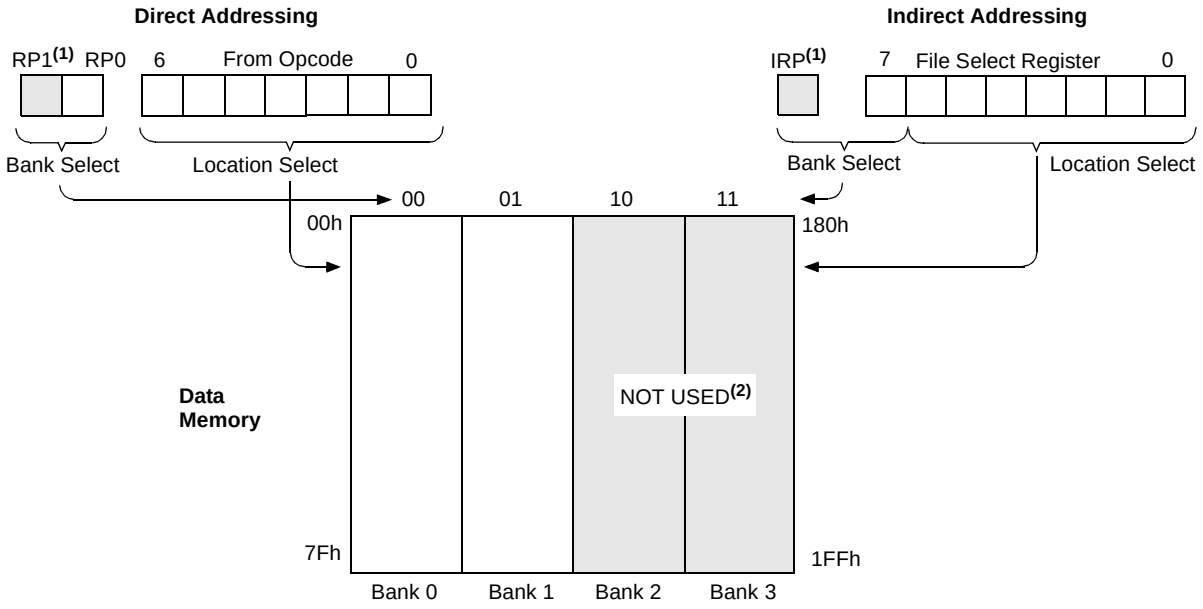
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	-
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	5
Program Memory Size	1.75KB (1K x 14)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	64 x 8
Voltage - Supply (Vcc/Vdd)	2V ~ 5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	8-VDFN Exposed Pad
Supplier Device Package	8-DFN (4x4)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic12hv609-i-md

FIGURE 2-6: DIRECT/INDIRECT ADDRESSING PIC12F609/615/617/12HV609/615



For memory map detail, see Figure 2-3.

Note 1: The RP1 and IRP bits are reserved; always maintain these bits clear.

2: Accesses in this area are mirrored back into Bank 0 and Bank 1.

REGISTER 3-1: PMDATL: PROGRAM MEMORY DATA REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PMDATL7	PMDATL6	PMDATL5	PMDATL4	PMDATL3	PMDATL2	PMDATL1	PMDATL0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 7-0 **PMDATL<7:0>**: 8 Least Significant Address bits to Write or Read from Program Memory

REGISTER 3-2: PMADRL: PROGRAM MEMORY ADDRESS REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PMADRL7	PMADRL6	PMADRL5	PMADRL4	PMADRL3	PMADRL2	PMADRL1	PMADRL0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 7-0 **PMADRL<7:0>**: 8 Least Significant Address bits for Program Memory Read/Write Operation

REGISTER 3-3: PMDATH: PROGRAM MEMORY DATA HIGH BYTE REGISTER

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	PMDATH5	PMDATH4	PMDATH3	PMDATH2	PMDATH1	PMDATH0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 7-6 **Unimplemented:** Read as ‘0’

bit 5-0 **PMDATH<5:0>**: 6 Most Significant Data bits from Program Memory

REGISTER 3-4: PMADRH: PROGRAM MEMORY ADDRESS HIGH BYTE REGISTER

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	PMADRH2	PMADRH1	PMADRH0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 3 **Unimplemented:** Read as ‘0’

bit 2-0 **PMADRH<2:0>**: Specifies the 3 Most Significant Address bits or high bits for program memory reads.

4.2 Clock Source Modes

Clock Source modes can be classified as external or internal.

- External Clock modes rely on external circuitry for the clock source. Examples are: Oscillator modules (EC mode), quartz crystal resonators or ceramic resonators (LP, XT and HS modes) and Resistor-Capacitor (RC) mode circuits.
- Internal clock sources are contained internally within the Oscillator module. The Oscillator module has two selectable clock frequencies: 4 MHz and 8 MHz

The system clock can be selected between external or internal clock sources via the FOSC<2:0> bits of the Configuration Word register.

4.3 External Clock Modes

4.3.1 OSCILLATOR START-UP TIMER (OST)

If the Oscillator module is configured for LP, XT or HS modes, the Oscillator Start-up Timer (OST) counts 1024 oscillations from OSC1. This occurs following a Power-on Reset (POR) and when the Power-up Timer (PWRT) has expired (if configured), or a wake-up from Sleep. During this time, the program counter does not increment and program execution is suspended. The OST ensures that the oscillator circuit, using a quartz crystal resonator or ceramic resonator, has started and is providing a stable system clock to the Oscillator module. When switching between clock sources, a delay is required to allow the new clock to stabilize. These oscillator delays are shown in Table 4-1.

TABLE 4-1: OSCILLATOR DELAY EXAMPLES

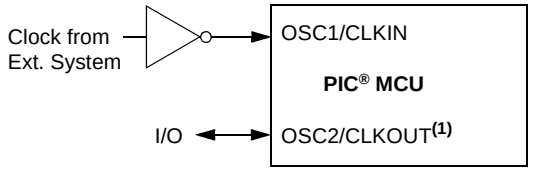
Switch From	Switch To	Frequency	Oscillator Delay
Sleep/POR	INTOSC	125 kHz to 8 MHz	Oscillator Warm-Up Delay (TWARM)
Sleep/POR	EC, RC	DC – 20 MHz	2 instruction cycles
Sleep/POR	LP, XT, HS	32 kHz to 20 MHz	1024 Clock Cycles (OST)

4.3.2 EC MODE

The External Clock (EC) mode allows an externally generated logic level as the system clock source. When operating in this mode, an external clock source is connected to the OSC1 input and the OSC2 is available for general purpose I/O. Figure 4-2 shows the pin connections for EC mode.

The Oscillator Start-up Timer (OST) is disabled when EC mode is selected. Therefore, there is no delay in operation after a Power-on Reset (POR) or wake-up from Sleep. Because the PIC® MCU design is fully static, stopping the external clock input will have the effect of halting the device while leaving all data intact. Upon restarting the external clock, the device will resume operation as if no time had elapsed.

FIGURE 4-2: EXTERNAL CLOCK (EC) MODE OPERATION



Note 1: Alternate pin functions are listed in the **Section 1.0 "Device Overview"**.

7.10 ECCP Special Event Trigger (PIC12F615/617/HV615 only)

If a ECCP is configured to trigger a special event, the trigger will clear the TMR1H:TMR1L register pair. This special event does not cause a Timer1 interrupt. The ECCP module may still be configured to generate a ECCP interrupt.

In this mode of operation, the CCPR1H:CCPR1L register pair effectively becomes the period register for Timer1.

Timer1 should be synchronized to the FOSC to utilize the Special Event Trigger. Asynchronous operation of Timer1 can cause a Special Event Trigger to be missed.

In the event that a write to TMR1H or TMR1L coincides with a Special Event Trigger from the ECCP, the write will take precedence.

For more information, see **Section 11.0 "Enhanced Capture/Compare/PWM (With Auto-Shutdown and Dead Band) Module (PIC12F615/617/HV615 only)"**.

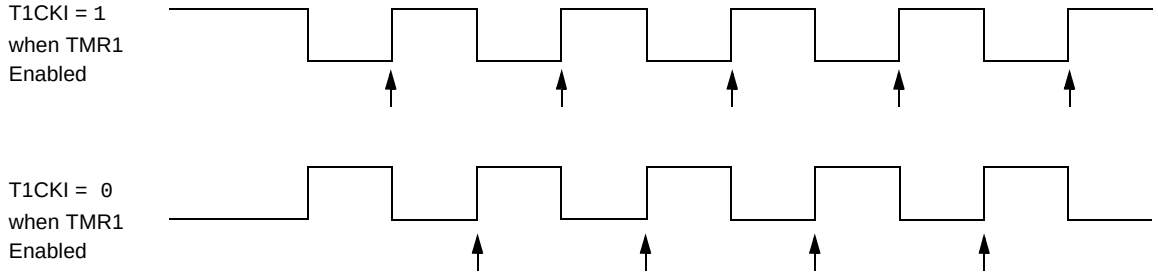
7.11 Comparator Synchronization

The same clock used to increment Timer1 can also be used to synchronize the comparator output. This feature is enabled in the Comparator module.

When using the comparator for Timer1 gate, the comparator output should be synchronized to Timer1. This ensures Timer1 does not miss an increment if the comparator changes.

For more information, see **Section 9.0 "Comparator Module"**.

FIGURE 7-2: TIMER1 INCREMENTING EDGE



Note 1: Arrows indicate counter increments.

2: In Counter mode, a falling edge must be registered by the counter prior to the first incrementing rising edge of the clock.

NOTES:

REGISTER 8-1: T2CON: TIMER 2 CONTROL REGISTER

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

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

bit 6-3 **TOUTPS<3:0>:** Timer2 Output Postscaler Select bits
0000 =1:1 Postscaler
0001 =1:2 Postscaler
0010 =1:3 Postscaler
0011 =1:4 Postscaler
0100 =1:5 Postscaler
0101 =1:6 Postscaler
0110 =1:7 Postscaler
0111 =1:8 Postscaler
1000 =1:9 Postscaler
1001 =1:10 Postscaler
1010 =1:11 Postscaler
1011 =1:12 Postscaler
1100 =1:13 Postscaler
1101 =1:14 Postscaler
1110 =1:15 Postscaler
1111 =1:16 Postscaler

bit 2 **TMR2ON:** Timer2 On bit
1 = Timer2 is on
0 = Timer2 is off

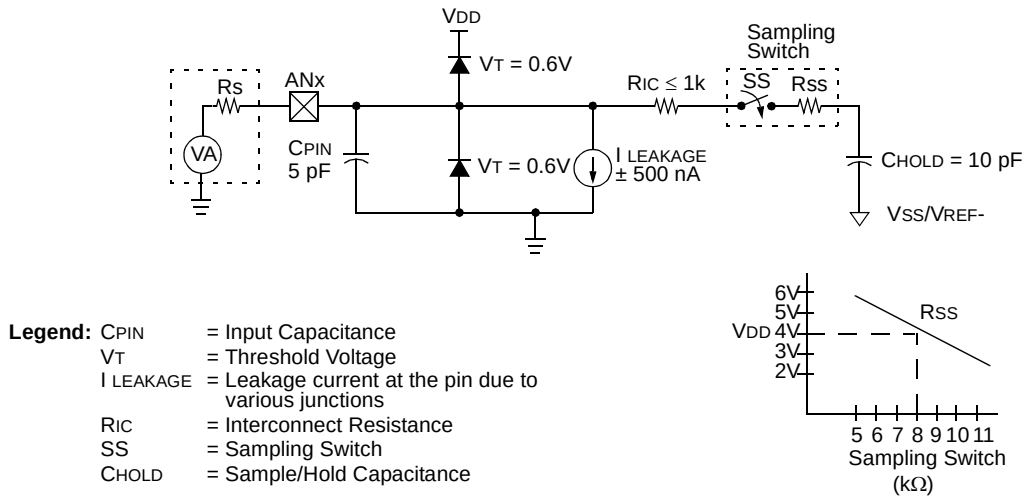
bit 1-0 **T2CKPS<1:0>:** Timer2 Clock Prescale Select bits
00 =Prescaler is 1
01 =Prescaler is 4
1x =Prescaler is 16

TABLE 8-1: SUMMARY OF REGISTERS ASSOCIATED WITH TIMER2

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
INTCON	GIE	PEIE	T0IE	INTE	GPIE	T0IF	INTF	GPIF	0000 0000	0000 0000
PIE1	—	ADIE(1)	CCP1IE(1)	—	CMIE	—	TMR2IE(1)	TMR1IE	-00- 0-00	-00- 0-00
PIR1	—	ADIF(1)	CCP1IF(1)	—	CMIF	—	TMR2IF(1)	TMR1IF	-00- 0-00	-00- 0-00
PR2(1)	Timer2 Module Period Register								1111 1111	1111 1111
TMR2(1)	Holding Register for the 8-bit TMR2 Register								0000 0000	0000 0000
T2CON(1)	—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0	-000 0000	-000 0000

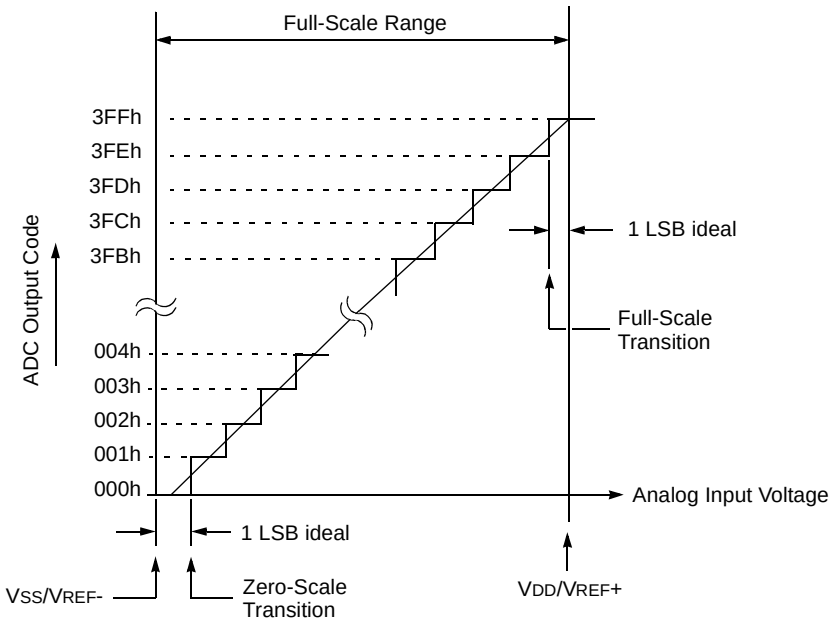
Legend: x = unknown, u = unchanged, - = unimplemented read as '0'. Shaded cells are not used for Timer2 module.
Note 1: For PIC12F615/617/HV615 only.

FIGURE 10-4: ANALOG INPUT MODEL



Legend: CPIN = Input Capacitance
VT = Threshold Voltage
I LEAKAGE = Leakage current at the pin due to various junctions
RIC = Interconnect Resistance
SS = Sampling Switch
CHOLD = Sample/Hold Capacitance

FIGURE 10-5: ADC TRANSFER FUNCTION



REGISTER 12-1: CONFIG: CONFIGURATION WORD REGISTER (ADDRESS: 2007h) FOR PIC12F609/615/HV609/615 ONLY

U-1	U-1	U-1	U-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1
—	—	—	—	BOREN1(1)	BOREN0(1)	IOSCFS	$\overline{CP}$(2)	MCLRE(3)	$\overline{PWRTE}$	WDTE	FOSC2	FOSC1	FOSC0
bit 13													bit 0

Legend:			
R = Readable bit	W = Writable bit	P = Programmable	U = Unimplemented bit, read as ‘0’
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 13-10 **Unimplemented**: Read as ‘1’

bit 9-8 **BOREN<1:0>:** Brown-out Reset Selection bits(1)
11 = BOR enabled
10 = BOR enabled during operation and disabled in Sleep
0x = BOR disabled

bit 7 **IOSCFS:** Internal Oscillator Frequency Select bit
1 = 8 MHz
0 = 4 MHz

bit 6 **$\overline{CP}$:** Code Protection bit(2)
1 = Program memory code protection is disabled
0 = Program memory code protection is enabled

bit 5 **MCLRE:** $\overline{MCLR}$ Pin Function Select bit(3)
1 = $\overline{MCLR}$ pin function is $\overline{MCLR}$
0 = $\overline{MCLR}$ pin function is digital input, $\overline{MCLR}$ internally tied to V_{DD}

bit 4 **$\overline{PWRTE}$:** Power-up Timer Enable bit
1 = PWRT disabled
0 = PWRT enabled

bit 3 **WDTE:** Watchdog Timer Enable bit
1 = WDT enabled
0 = WDT disabled

bit 2-0 **FOSC<2:0>:** Oscillator Selection bits
111 =RC oscillator: CLKOUT function on GP4/OSC2/CLKOUT pin, RC on GP5/OSC1/CLKIN
110 =RCIO oscillator: I/O function on GP4/OSC2/CLKOUT pin, RC on GP5/OSC1/CLKIN
101 =INTOSC oscillator: CLKOUT function on GP4/OSC2/CLKOUT pin, I/O function on GP5/OSC1/CLKIN
100 = INTOSCIO oscillator: I/O function on GP4/OSC2/CLKOUT pin, I/O function on GP5/OSC1/CLKIN
011 =EC: I/O function on GP4/OSC2/CLKOUT pin, CLKIN on GP5/OSC1/CLKIN
010 =HS oscillator: High-speed crystal/resonator on GP4/OSC2/CLKOUT and GP5/OSC1/CLKIN
001 = XT oscillator: Crystal/resonator on GP4/OSC2/CLKOUT and GP5/OSC1/CLKIN
000 = LP oscillator: Low-power crystal on GP4/OSC2/CLKOUT and GP5/OSC1/CLKIN

Note 1: Enabling Brown-out Reset does not automatically enable Power-up Timer.
2: The entire program memory will be erased when the code protection is turned off.
3: When $\overline{MCLR}$ is asserted in INTOSC or RC mode, the internal clock oscillator is disabled.

12.3.5 TIME-OUT SEQUENCE

On power-up, the time-out sequence is as follows:

- PWRT time-out is invoked after POR has expired.
- OST is activated after the PWRT time-out has expired.

The total time-out will vary based on oscillator configuration and $\overline{PWRTE}$ bit status. For example, in EC mode with $\overline{PWRTE}$ bit erased (PWRT disabled), there will be no time-out at all. Figure 12-4, Figure 12-5 and Figure 12-6 depict time-out sequences.

Since the time-outs occur from the POR pulse, if $\overline{MCLR}$ is kept low long enough, the time-outs will expire. Then, bringing $\overline{MCLR}$ high will begin execution immediately (see Figure 12-5). This is useful for testing purposes or to synchronize more than one PIC12F609/615/617/12HV609/615 device operating in parallel.

Table 12-6 shows the Reset conditions for some special registers, while Table 12-5 shows the Reset conditions for all the registers.

12.3.6 POWER CONTROL (PCON) REGISTER

The Power Control register PCON (address 8Eh) has two Status bits to indicate what type of Reset occurred last.

Bit 0 is $\overline{BOR}$ (Brown-out). $\overline{BOR}$ is unknown on Power-on Reset. It must then be set by the user and checked on subsequent Resets to see if $\overline{BOR}$ = 0, indicating that a Brown-out has occurred. The $\overline{BOR}$ Status bit is a "don't care" and is not necessarily predictable if the brown-out circuit is disabled (BOREN<1:0> = 00 in the Configuration Word register).

Bit 1 is $\overline{POR}$ (Power-on Reset). It is a '0' on Power-on Reset and unaffected otherwise. The user must write a '1' to this bit following a Power-on Reset. On a subsequent Reset, if $\overline{POR}$ is '0', it will indicate that a Power-on Reset has occurred (i.e., V_{DD} may have gone too low).

For more information, see **Section 12.3.4 "Brown-out Reset (BOR)"**.

TABLE 12-1: TIME-OUT IN VARIOUS SITUATIONS

Oscillator Configuration	Power-up		Brown-out Reset		Wake-up from Sleep
	$\overline{PWRTE}$ = 0	$\overline{PWRTE}$ = 1	$\overline{PWRTE}$ = 0	$\overline{PWRTE}$ = 1	
XT, HS, LP	T_{PWRT} + 1024 • T_{OSC}	1024 • T_{OSC}	T_{PWRT} + 1024 • T_{OSC}	1024 • T_{OSC}	1024 • T_{OSC}
RC, EC, INTOSC	T_{PWRT}	—	T_{PWRT}	—	—

TABLE 12-2: STATUS/PCON BITS AND THEIR SIGNIFICANCE

$\overline{POR}$	$\overline{BOR}$	$\overline{TO}$	$\overline{PD}$	Condition
0	x	1	1	Power-on Reset
u	0	1	1	Brown-out Reset
u	u	0	u	WDT Reset
u	u	0	0	WDT Wake-up
u	u	u	u	$\overline{MCLR}$ Reset during normal operation
u	u	1	0	$\overline{MCLR}$ Reset during Sleep

Legend: u = unchanged, x = unknown

TABLE 12-3: SUMMARY OF REGISTERS ASSOCIATED WITH BROWN-OUT RESET

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(1)
PCON	—	—	—	—	—	—	$\overline{POR}$	$\overline{BOR}$	---- --qq	---- --uu
STATUS	IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C	0001 1xxx	000q quuu

Legend: u = unchanged, x = unknown, – = unimplemented bit, reads as '0', q = value depends on condition. Shaded cells are not used by BOR.

Note 1: Other (non Power-up) Resets include $\overline{MCLR}$ Reset and Watchdog Timer Reset during normal operation.

TABLE 12-5: INITIALIZATION CONDITION FOR REGISTERS (PIC12F615/617/HV615)

Register	Address	Power-on Reset	$\overline{\text{MCLR}}$ Reset WDT Reset Brown-out Reset(1)	Wake-up from Sleep through Interrupt Wake-up from Sleep through WDT Time-out
W	—	xxxx xxxx	uuuu uuuu	uuuu uuuu
INDF	00h/80h	xxxx xxxx	xxxx xxxx	uuuu uuuu
TMR0	01h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PCL	02h/82h	0000 0000	0000 0000	PC + 1(3)
STATUS	03h/83h	0001 1xxx	000q quuu(4)	uuuq quuu(4)
FSR	04h/84h	xxxx xxxx	uuuu uuuu	uuuu uuuu
GPIO	05h	--x0 x000	--u0 u000	--uu uuuu
PCLATH	0Ah/8Ah	---0 0000	---0 0000	---u uuuu
INTCON	0Bh/8Bh	0000 0000	0000 0000	uuuu uuuu(2)
PIR1	0Ch	-000 0-00	-000 0-00	-uuu u-uu(2)
TMR1L	0Eh	xxxx xxxx	uuuu uuuu	uuuu uuuu
TMR1H	0Fh	xxxx xxxx	uuuu uuuu	uuuu uuuu
T1CON	10h	0000 0000	uuuu uuuu	-uuu uuuu
TMR2(1)	11h	0000 0000	0000 0000	uuuu uuuu
T2CON(1)	12h	-000 0000	-000 0000	-uuu uuuu
CCPR1L(1)	13h	xxxx xxxx	uuuu uuuu	uuuu uuuu
CCPR1H(1)	14h	xxxx xxxx	uuuu uuuu	uuuu uuuu
CCP1CON(1)	15h	0-00 0000	0-00 0000	u-uu uuuu
PWM1CON(1)	16h	0000 0000	0000 0000	uuuu uuuu
ECCPAS(1)	17h	0000 0000	0000 0000	uuuu uuuu
VRCON	19h	0-00 0000	0-00 0000	u-uu uuuu
CMCON0	1Ah	0000 -0-0	0000 -0-0	uuuu -u-u
CMCON1	1Ch	---0 0-10	---0 0-10	---u u-qu
ADRESH(1)	1Eh	xxxx xxxx	uuuu uuuu	uuuu uuuu
ADCON0(1)	1Fh	00-0 0000	00-0 0000	uu-u uuuu
OPTION_REG	81h	1111 1111	1111 1111	uuuu uuuu
TRISIO	85h	--11 1111	--11 1111	--uu uuuu
PIE1	8Ch	-00- 0-00	-00- 0-00	-uu- u-uu
PCON	8Eh	---- --0x	---- --uu(1, 5)	---- --uu
OSCTUNE	90h	---0 0000	---u uuuu	---u uuuu
PR2	92h	1111 1111	1111 1111	1111 1111
APFCON	93h	---0 --00	---0 --00	---u --uu
WPU	95h	--11 -111	--11 -111	--uu -uuu
IOC	96h	--00 0000	--00 0000	--uu uuuu
PMCON1(6)	98h	---- -000	---- -000	---- -uuu
PMCON2(6)	99h	---- ----	---- ----	---- ----
PMADRL(6)	9Ah	0000 0000	0000 0000	uuuu uuuu

Legend: u = unchanged, x = unknown, – = unimplemented bit, reads as '0', q = value depends on condition.

Note 1: If VDD goes too low, Power-on Reset will be activated and registers will be affected differently.

2: One or more bits in INTCON and/or PIR1 will be affected (to cause wake-up).

3: When the wake-up is due to an interrupt and the GIE bit is set, the PC is loaded with the interrupt vector (0004h).

4: See Table 12-6 for Reset value for specific condition.

5: If Reset was due to brown-out, then bit 0 = 0. All other Resets will cause bit 0 = u.

6: For PIC12F617 only.

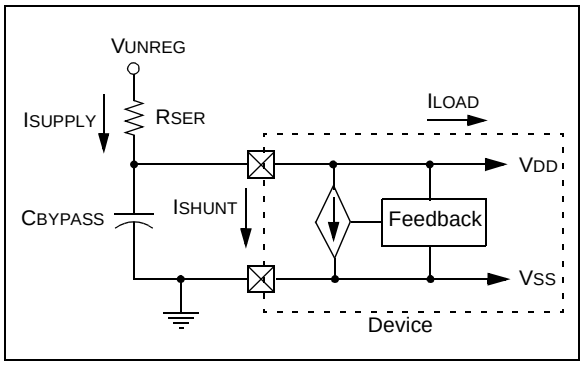
13.0 VOLTAGE REGULATOR

The PIC12HV609/HV615 devices include a permanent internal 5 volt (nominal) shunt regulator in parallel with the VDD pin. This eliminates the need for an external voltage regulator in systems sourced by an unregulated supply. All external devices connected directly to the VDD pin will share the regulated supply voltage and contribute to the total VDD supply current (ILOAD).

13.1 Regulator Operation

A shunt regulator generates a specific supply voltage by creating a voltage drop across a pass resistor RSER. The voltage at the VDD pin of the microcontroller is monitored and compared to an internal voltage reference. The current through the resistor is then adjusted, based on the result of the comparison, to produce a voltage drop equal to the difference between the supply voltage VUNREG and the VDD of the microcontroller. See Figure 13-1 for voltage regulator schematic.

FIGURE 13-1: VOLTAGE REGULATOR



An external current limiting resistor, RSER, located between the unregulated supply, VUNREG, and the VDD pin, drops the difference in voltage between VUNREG and VDD. RSER must be between RMAX and RMIN as defined by Equation 13-1.

EQUATION 13-1: RSER LIMITING RESISTOR

$$R_{MAX} = \frac{(VU_{MIN} - 5V)}{1.05 \bullet (4\ mA + I_{LOAD})}$$

$$R_{MIN} = \frac{(VU_{MAX} - 5V)}{0.95 \bullet (50\ mA)}$$

Where:

RMAX = maximum value of RSER (ohms)

RMIN = minimum value of RSER (ohms)

VUMIN = minimum value of VUNREG

VUMAX = maximum value of VUNREG

VDD = regulated voltage (5V nominal)

ILOAD = maximum expected load current in mA including I/O pin currents and external circuits connected to VDD.

1.05 = compensation for +5% tolerance of RSER

0.95 = compensation for -5% tolerance of RSER

13.2 Regulator Considerations

The supply voltage VUNREG and load current are not constant. Therefore, the current range of the regulator is limited. Selecting a value for RSER must take these three factors into consideration.

Since the regulator uses the band gap voltage as the regulated voltage reference, this voltage reference is permanently enabled in the PIC12HV609/HV615 devices.

The shunt regulator will still consume current when below operating voltage range for the shunt regulator.

13.3 Design Considerations

For more information on using the shunt regulator and managing current load, see Application Note AN1035, "*Designing with HV Microcontrollers"* (DS01035).

NOTES:

16.8 DC Characteristics: PIC12F609/615/617/12HV609/615-I (Industrial) PIC12F609/615/617/12HV609/615-E (Extended)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for industrial -40°C ≤ TA ≤ +125°C for extended				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
	VIL	**Input Low Voltage**					
		I/O port:					
D030		with TTL buffer	Vss	—	0.8	V	4.5V ≤ VDD ≤ 5.5V
D030A			Vss	—	0.15 VDD	V	2.0V ≤ VDD ≤ 4.5V
D031		with Schmitt Trigger buffer	Vss	—	0.2 VDD	V	2.0V ≤ VDD ≤ 5.5V
D032		$\overline{MCLR}$, OSC1 (RC mode)	Vss	—	0.2 VDD	V	**(NOTE 1)**
D033		OSC1 (XT and LP modes)	Vss	—	0.3	V	
D033A		OSC1 (HS mode)	Vss	—	0.3 VDD	V	
	VIH	**Input High Voltage**					
		I/O ports:		—			
D040		with TTL buffer	2.0	—	VDD	V	4.5V ≤ VDD ≤ 5.5V
D040A			0.25 VDD + 0.8	—	VDD	V	2.0V ≤ VDD ≤ 4.5V
D041		with Schmitt Trigger buffer	0.8 VDD	—	VDD	V	2.0V ≤ VDD ≤ 5.5V
D042		$\overline{MCLR}$	0.8 VDD	—	VDD	V	
D043		OSC1 (XT and LP modes)	1.6	—	VDD	V	
D043A		OSC1 (HS mode)	0.7 VDD	—	VDD	V	
D043B		OSC1 (RC mode)	0.9 VDD	—	VDD	V	**(NOTE 1)**
	IIL	**Input Leakage Current(2,3)**					
D060		I/O ports	—	± 0.1	± 1	µA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance
D061		GP3/$\overline{MCLR}$(3,4)	—	± 0.7	± 5	µA	VSS ≤ VPIN ≤ VDD
D063		OSC1	—	± 0.1	± 5	µA	VSS ≤ VPIN ≤ VDD, XT, HS and LP oscillator configuration
D070*	IPUR	**GPIO Weak Pull-up Current(5)**	50	250	400	µA	VDD = 5.0V, VPIN = VSS
	VOL	**Output Low Voltage**	—	—	0.6	V	IOL = 7.0 mA, VDD = 4.5V, -40°C to +125°C
D080		I/O ports	—	—	0.6	V	IOL = 8.5 mA, VDD = 4.5V, -40°C to +85°C
	VOH	**Output High Voltage**	VDD – 0.7	—	—	V	IOH = -2.5mA, VDD = 4.5V, -40°C to +125°C
D090		I/O ports(2)	VDD – 0.7	—	—	V	IOH = -3.0 mA, VDD = 4.5V, -40°C to +85°C

* These parameters are characterized but not tested.

† Data in "Typ" column is at 5.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: In RC oscillator configuration, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended to use an external clock in RC 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.

4: This specification applies to GP3/$\overline{MCLR}$ configured as GP3 with the internal weak pull-up disabled.

5: This specification applies to all weak pull-up pins, including the weak pull-up found on GP3/$\overline{MCLR}$. When GP3/$\overline{MCLR}$ is configured as $\overline{MCLR}$ reset pin, the weak pull-up is always enabled.

6: Applies to PIC12F617 only.

16.11 AC Characteristics: PIC12F609/615/617/12HV609/615 (Industrial, Extended)

FIGURE 16-4: CLOCK TIMING

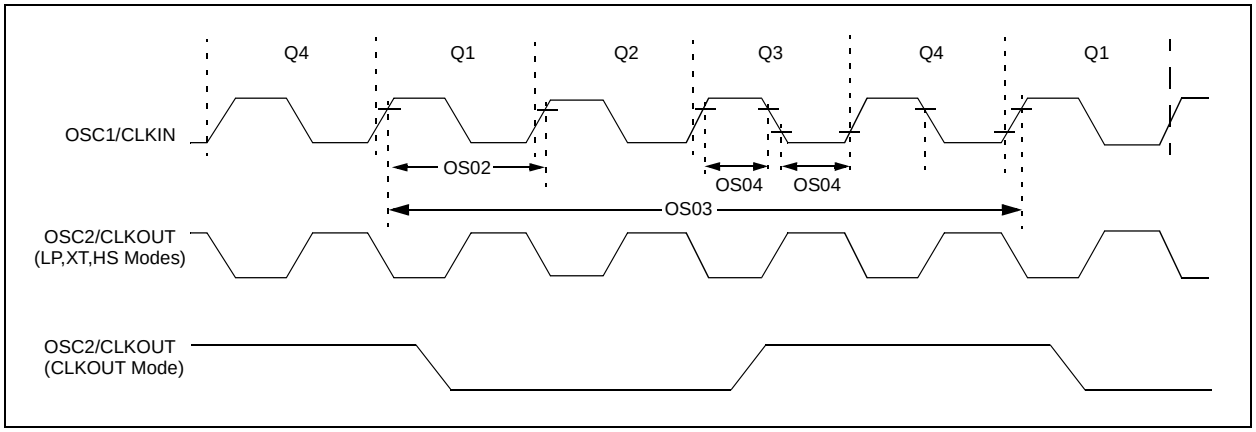


TABLE 16-1: CLOCK OSCILLATOR TIMING REQUIREMENTS

Standard Operating Conditions (unless otherwise stated)
Operating temperature -40°C ≤ TA ≤ +125°C

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
OS01	FOSC	External CLKIN Frequency(1)	DC	—	37	kHz	LP Oscillator mode
			DC	—	4	MHz	XT Oscillator mode
			DC	—	20	MHz	HS Oscillator mode
			DC	—	20	MHz	EC Oscillator mode
		Oscillator Frequency(1)	—	32.768	—	kHz	LP Oscillator mode
			0.1	—	4	MHz	XT Oscillator mode
			1	—	20	MHz	HS Oscillator mode
			DC	—	4	MHz	RC Oscillator mode
OS02	TOSC	External CLKIN Period(1)	27	—	∞	µs	LP Oscillator mode
			250	—	∞	ns	XT Oscillator mode
			50	—	∞	ns	HS Oscillator mode
			50	—	∞	ns	EC Oscillator mode
		Oscillator Period(1)	—	30.5	—	µs	LP Oscillator mode
			250	—	10,000	ns	XT Oscillator mode
			50	—	1,000	ns	HS Oscillator mode
			250	—	—	ns	RC Oscillator mode
OS03	TCY	Instruction Cycle Time(1)	200	TCY	DC	ns	TCY = 4/FOSC
OS04*	TOSH, TOSL	External CLKIN High, External CLKIN Low	2	—	—	µs	LP oscillator
			100	—	—	ns	XT oscillator
			20	—	—	ns	HS oscillator
OS05*	TOSR, TOSF	External CLKIN Rise, External CLKIN Fall	0	—	∞	ns	LP oscillator
			0	—	∞	ns	XT oscillator
			0	—	∞	ns	HS oscillator

* These parameters are characterized but not tested.

† Data in "Typ" column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Instruction cycle period (TCY) equals four times the input oscillator time base period. All specified values are based on characterization data for that particular oscillator type under standard operating conditions with the device executing code. Exceeding these specified limits may result in an unstable oscillator operation and/or higher than expected current consumption. All devices are tested to operate at "min" values with an external clock applied to OSC1 pin. When an external clock input is used, the "max" cycle time limit is "DC" (no clock) for all devices.

FIGURE 17-10: PIC12F609/615/617 IPD BASE vs. VDD

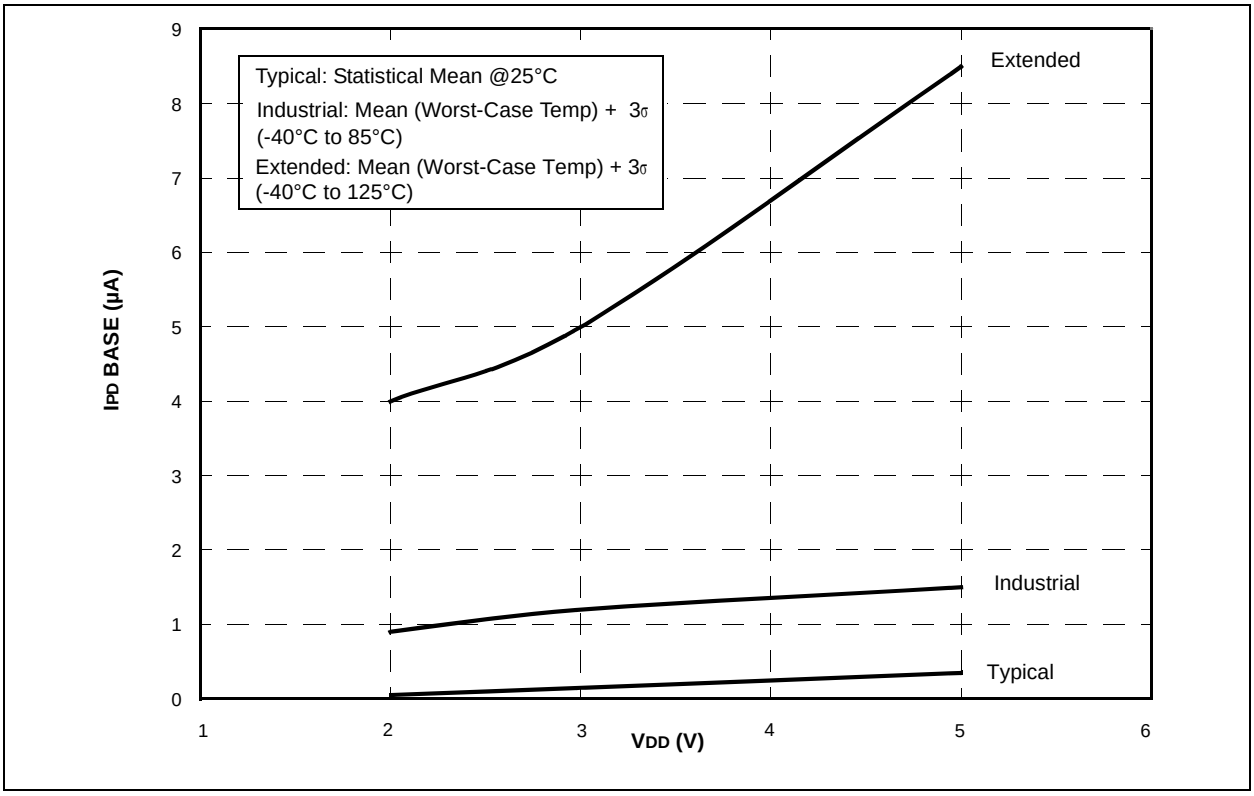


FIGURE 17-11: PIC12F609/615/617 IPD COMPARATOR (SINGLE ON) vs. VDD

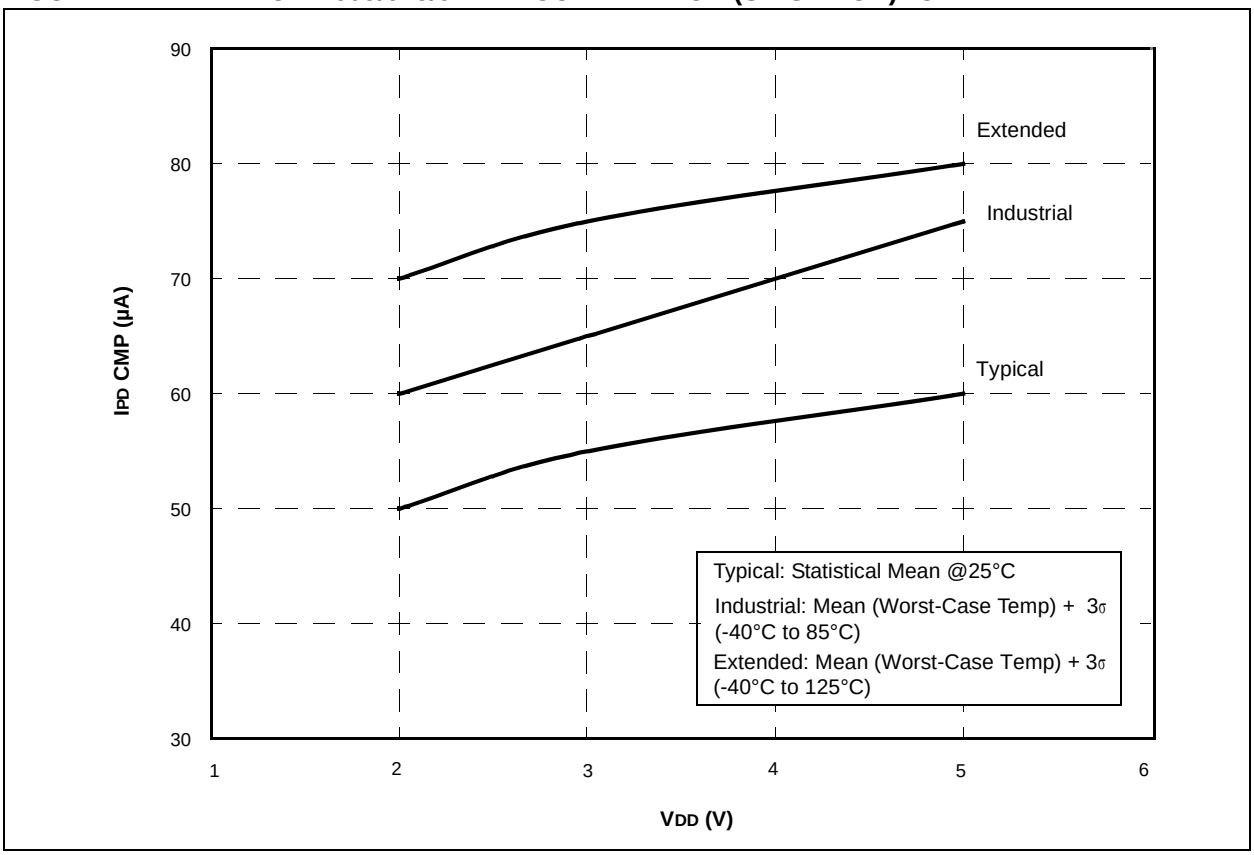


FIGURE 17-16: PIC12F609/615/617 IPD T1OSC vs. VDD

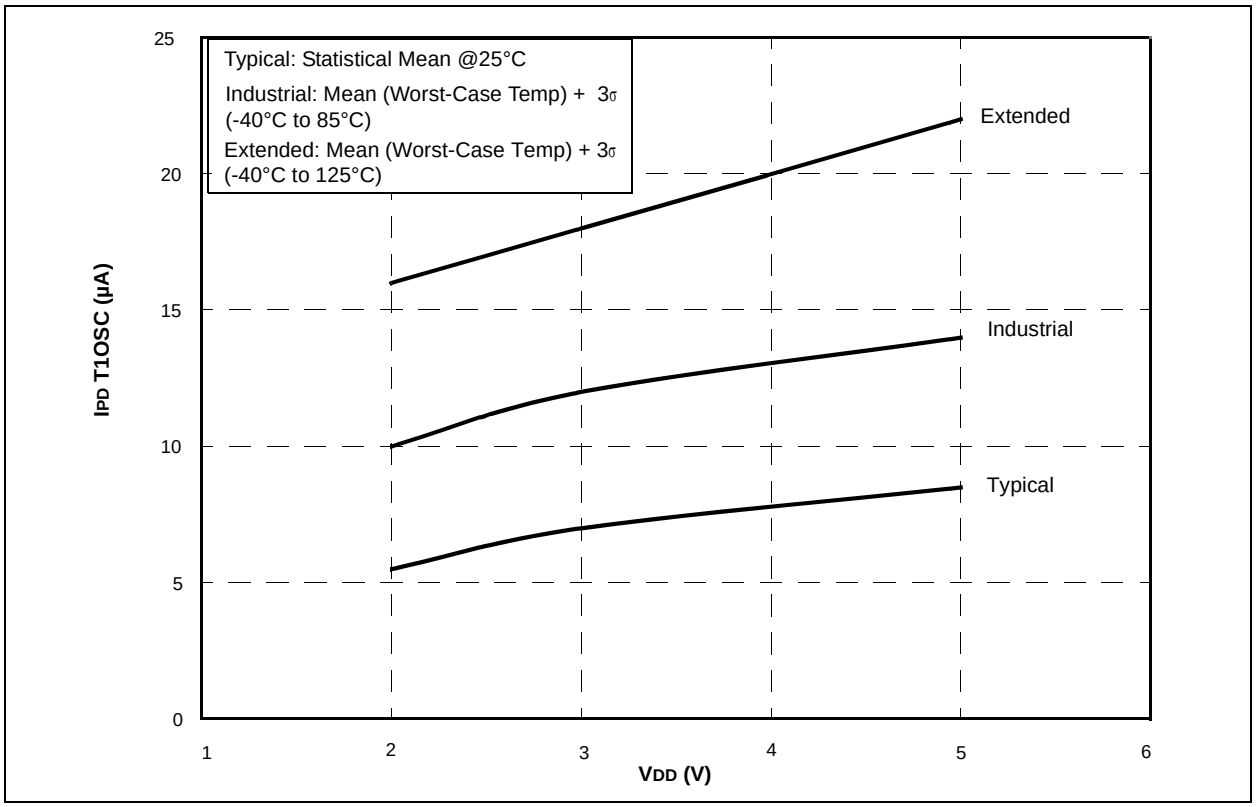


FIGURE 17-17: PIC12F615/617 IPD A/D vs. VDD

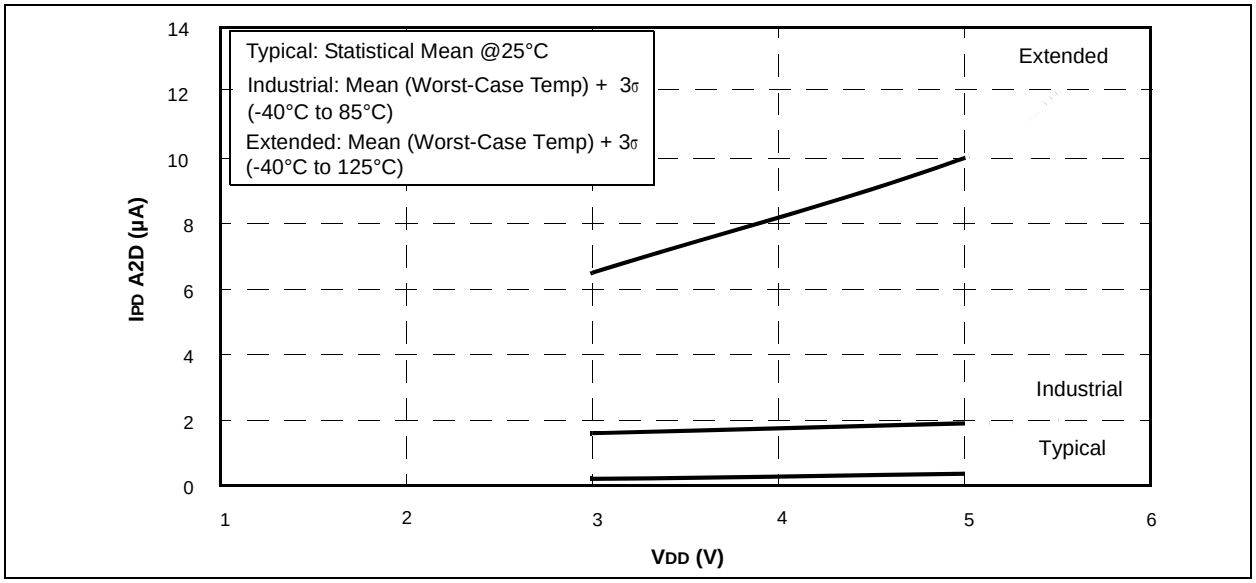


FIGURE 17-27: PIC12HV609/615 IPD COMPARATOR (SINGLE ON) vs. VDD

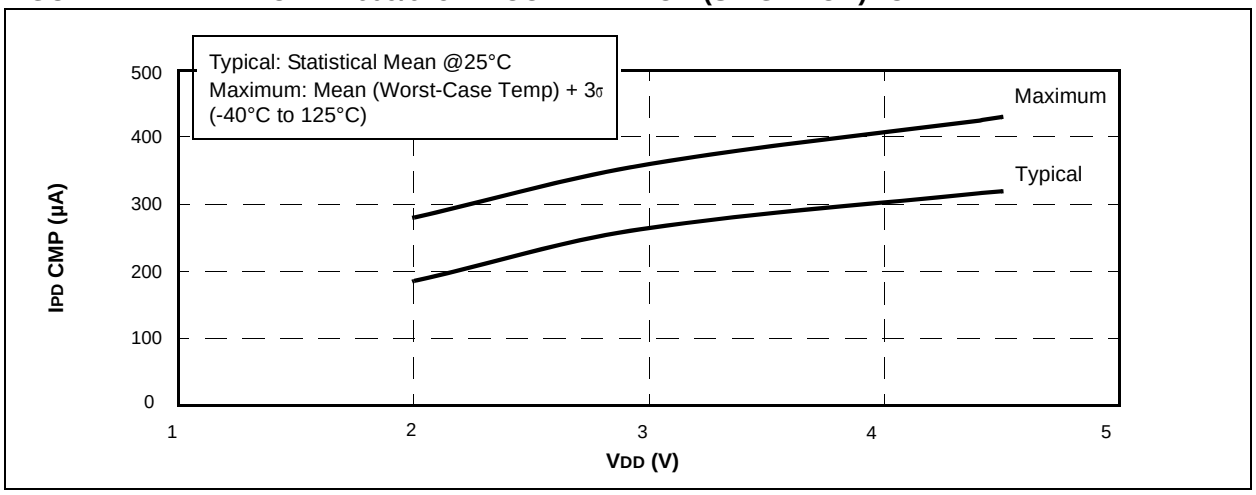


FIGURE 17-28: PIC12HV609/615 IPD WDT vs. VDD

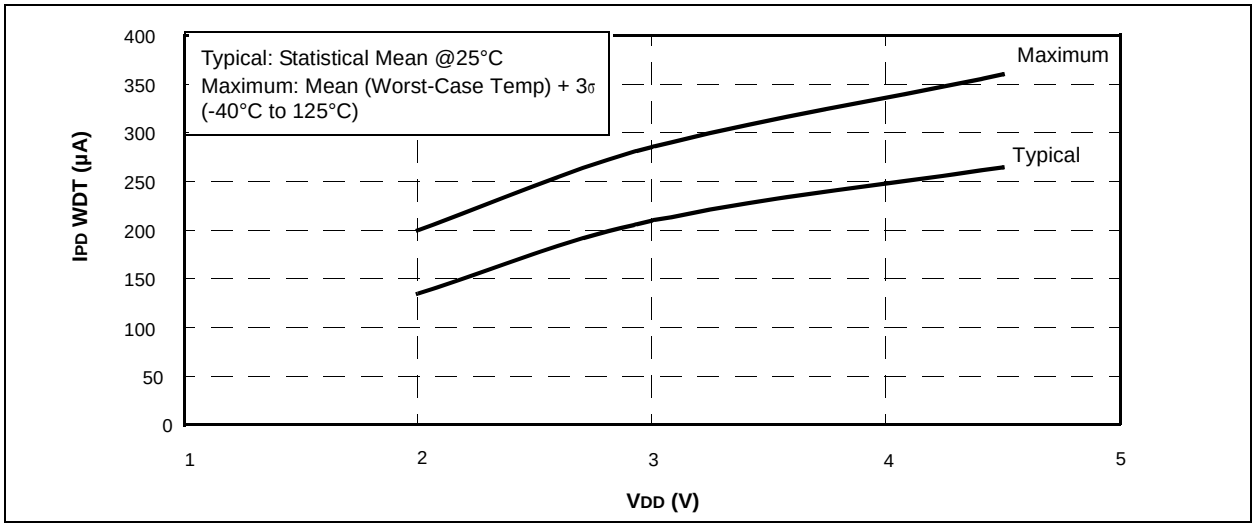


FIGURE 17-29: PIC12HV609/615 IPD BOR vs. VDD

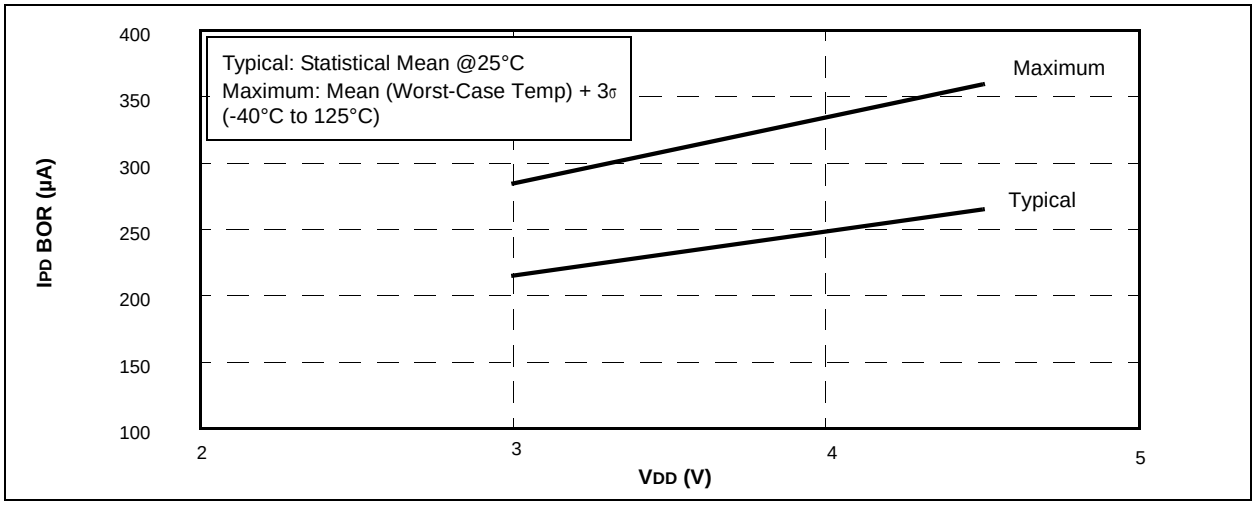


FIGURE 17-52: COMPARATOR RESPONSE TIME (FALLING EDGE)

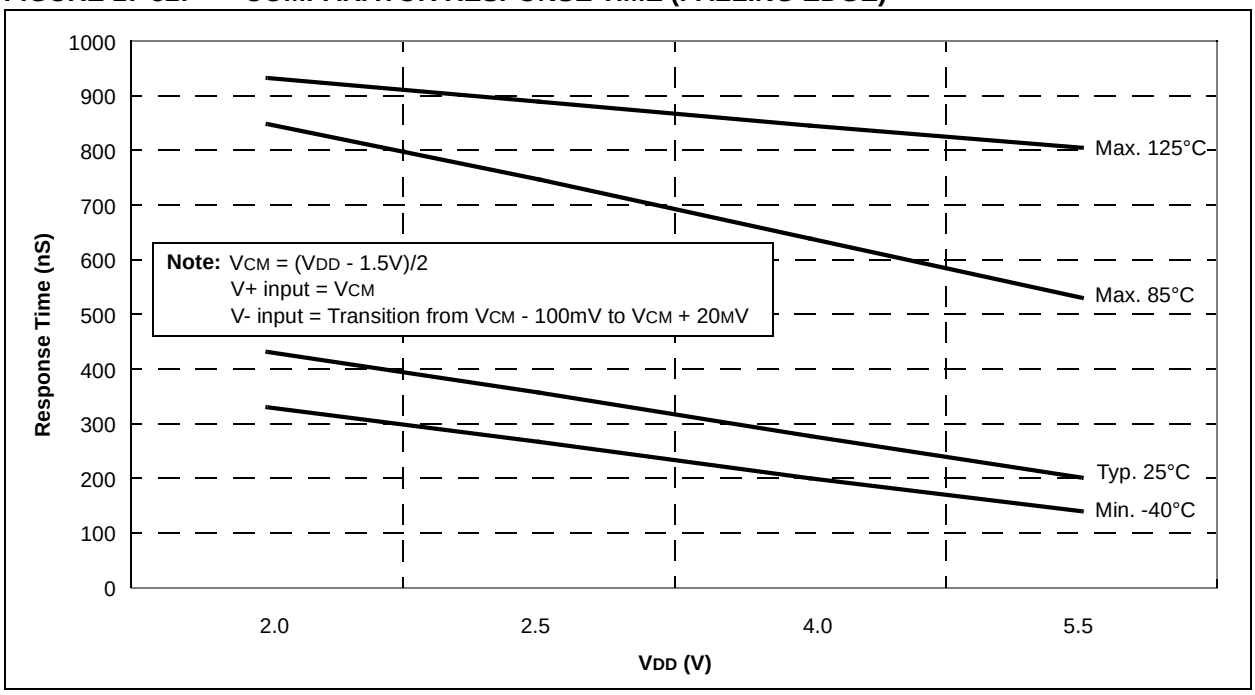
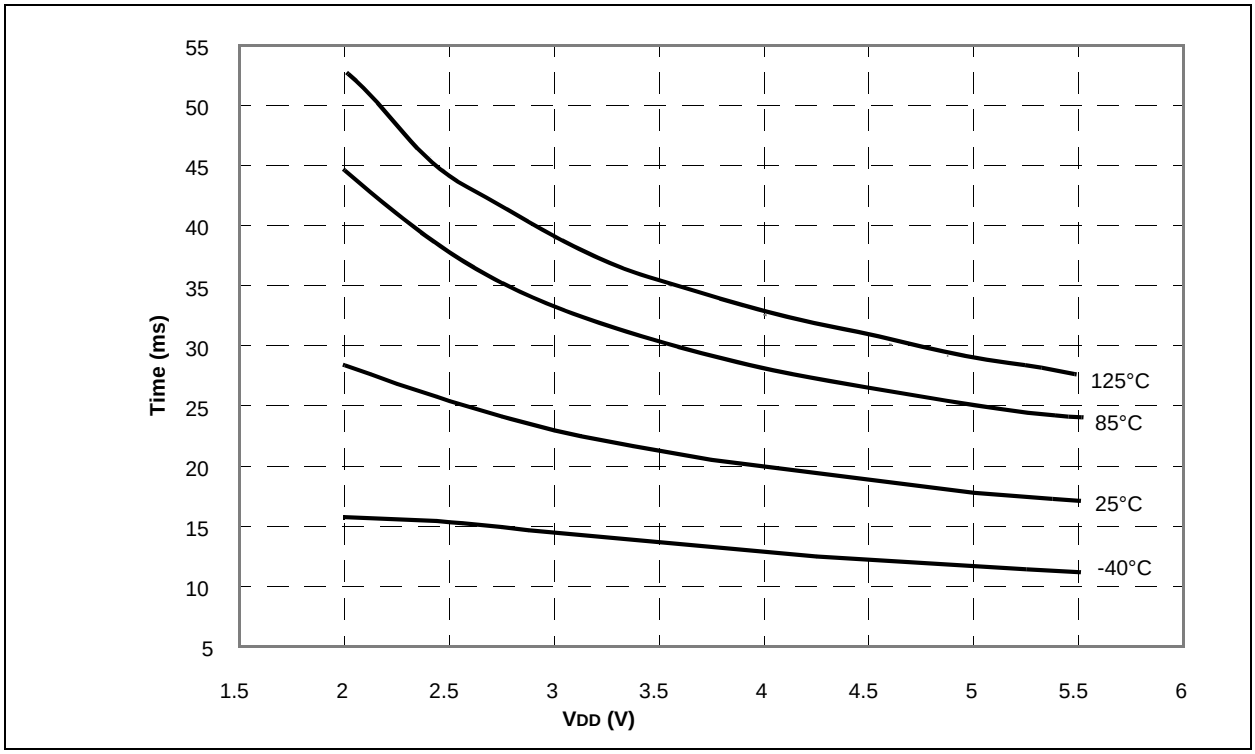
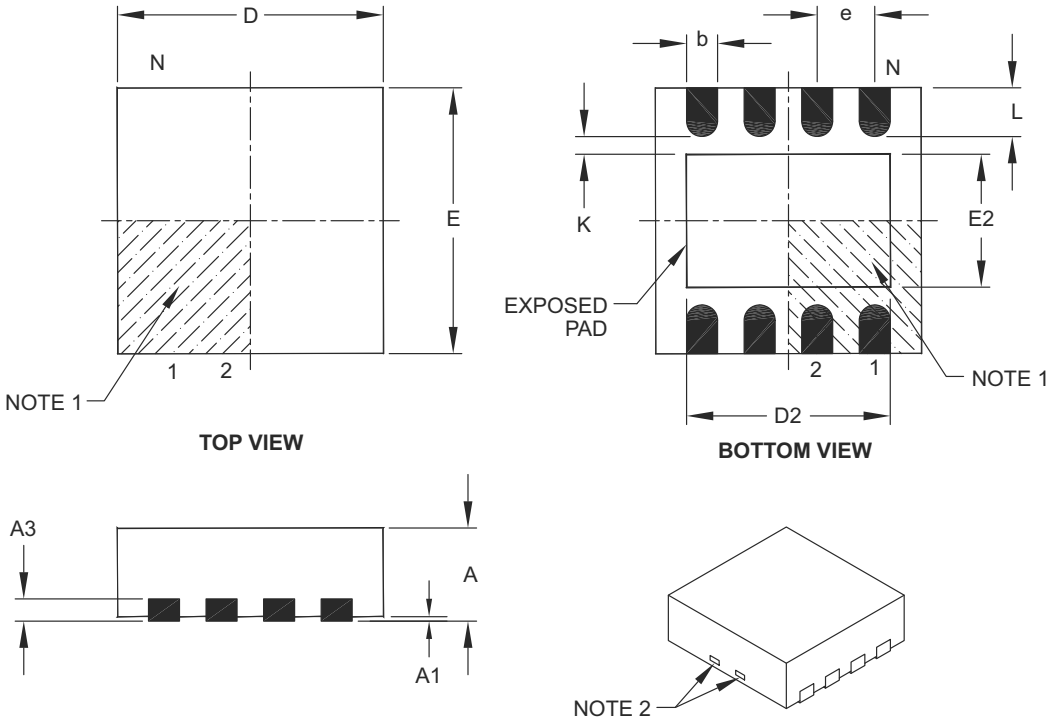


FIGURE 17-53: WDT TIME-OUT PERIOD vs. VDD OVER TEMPERATURE



8-Lead Plastic Dual Flat, No Lead Package (MD) – 4x4x0.9 mm Body [DFN]

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 Pins	N		8	
Pitch	e		0.80 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		4.00 BSC	
Exposed Pad Width	E2	0.00	2.20	2.80
Overall Width	E		4.00 BSC	
Exposed Pad Length	D2	0.00	3.00	3.60
Contact Width	b	0.25	0.30	0.35
Contact Length	L	0.30	0.40	0.50
Contact-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 may have one or more exposed tie bars at ends.
3. Package is saw singulated.
4. Dimensioning and tolerancing per ASME Y14.5M.

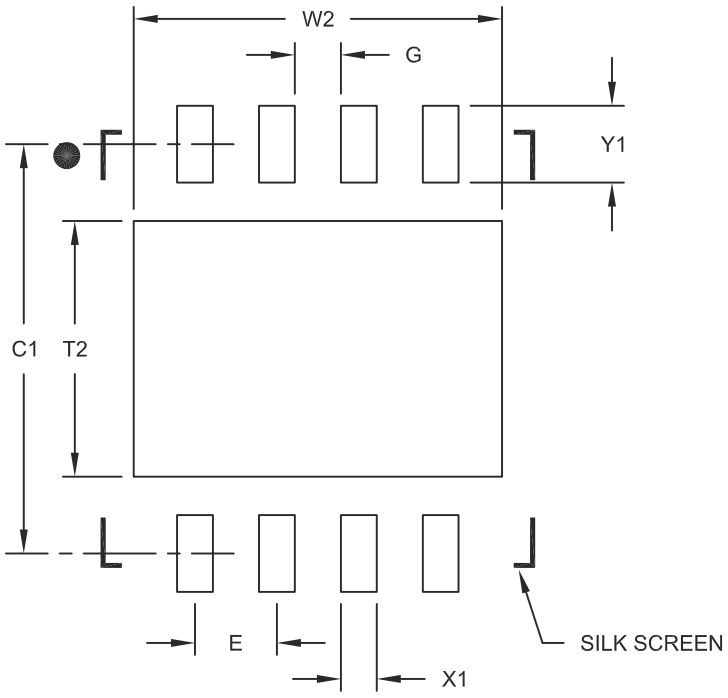
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-131D

8-Lead Plastic Dual Flat, No Lead Package (MD) – 4x4x0.9 mm Body [DFN]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.80 BSC	
Optional Center Pad Width	W2			3.60
Optional Center Pad Length	T2			2.50
Contact Pad Spacing	C1		4.00	
Contact Pad Width (X8)	X1			0.35
Contact Pad Length (X8)	Y1			0.75
Distance Between Pads	G	0.45		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2131B