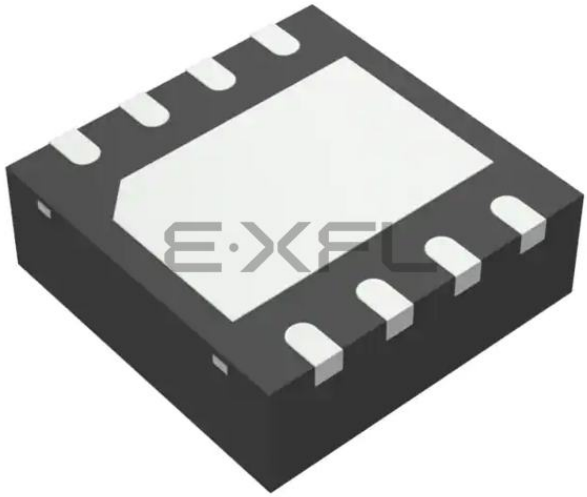

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Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	-
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	5
Program Memory Size	1.75KB (1K x 14)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	64 x 8
Voltage - Supply (Vcc/Vdd)	2V ~ 5.5V
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/pic12f609-i-md

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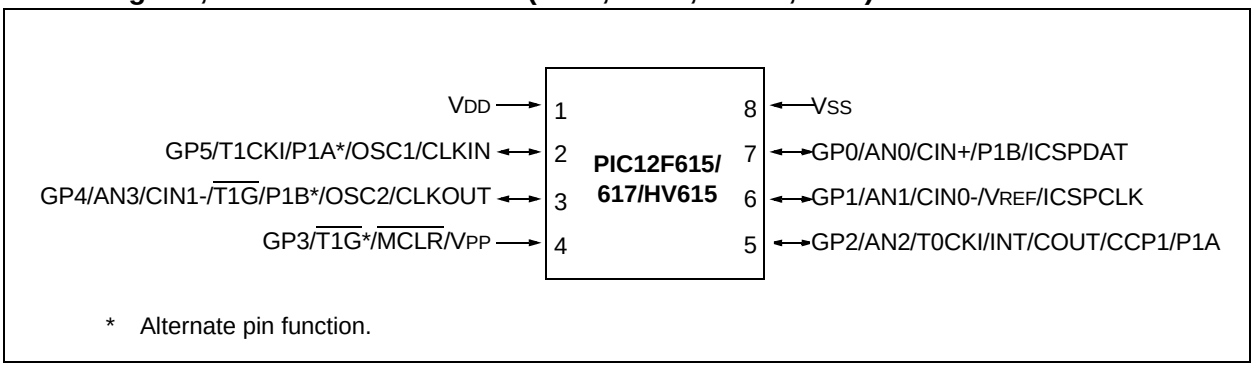
8-Pin Diagram, PIC12F615/617/HV615 (PDIP, SOIC, MSOP, DFN)



* Alternate pin function.

TABLE 2: PIC12F615/617/HV615 PIN SUMMARY (PDIP, SOIC, MSOP, DFN)

I/O	Pin	Analog	Comparators	Timer	CCP	Interrupts	Pull-ups	Basic
GP0	7	AN0	CIN+	—	P1B	IOC	Y	ICSPDAT
GP1	6	AN1	CIN0-	—	—	IOC	Y	ICSPCLK/VREF
GP2	5	AN2	COUT	T0CKI	CCP1/P1A	INT/IOC	Y	—
GP3(1)	4	—	—	T1G*	—	IOC	Y(2)	MCLR/VPP
GP4	3	AN3	CIN1-	T1G	P1B*	IOC	Y	OSC2/CLKOUT
GP5	2	—	—	T1CKI	P1A*	IOC	Y	OSC1/CLKIN
—	1	—	—	—	—	—	—	VDD
—	8	—	—	—	—	—	—	VSS

* Alternate pin function.

Note 1: Input only.

2: Only when pin is configured for external MCLR.

TABLE 1-2: PIC12F615/617/HV615 PINOUT DESCRIPTION

Name	Function	Input Type	Output Type	Description
GP0/AN0/CIN+/P1B/ICSPDAT	GP0	TTL	CMOS	General purpose I/O with prog. pull-up and interrupt-on-change
	AN0	AN	—	A/D Channel 0 input
	CIN+	AN	—	Comparator non-inverting input
	P1B	—	CMOS	PWM output
	ICSPDAT	ST	CMOS	Serial Programming Data I/O
GP1/AN1/CIN0-/VREF/ICSPCLK	GP1	TTL	CMOS	General purpose I/O with prog. pull-up and interrupt-on-change
	AN1	AN	—	A/D Channel 1 input
	CIN0-	AN	—	Comparator inverting input
	VREF	AN	—	External Voltage Reference for A/D
	ICSPCLK	ST	—	Serial Programming Clock
GP2/AN2/T0CKI/INT/COUT/CCP1/P1A	GP2	ST	CMOS	General purpose I/O with prog. pull-up and interrupt-on-change
	AN2	AN	—	A/D Channel 2 input
	T0CKI	ST	—	Timer0 clock input
	INT	ST	—	External Interrupt
	COUT	—	CMOS	Comparator output
	CCP1	ST	CMOS	Capture input/Compare input/PWM output
	P1A	—	CMOS	PWM output
GP3/$\overline{\text{T1G}}$*/$\overline{\text{MCLR}}$/VPP	GP3	TTL	—	General purpose input with interrupt-on-change
	$\overline{\text{T1G}}$*	ST	—	Timer1 gate (count enable), alternate pin
	$\overline{\text{MCLR}}$	ST	—	Master Clear w/internal pull-up
	VPP	HV	—	Programming voltage
GP4/AN3/CIN1-/$\overline{\text{T1G}}$/P1B*/OSC2/CLKOUT	GP4	TTL	CMOS	General purpose I/O with prog. pull-up and interrupt-on-change
	AN3	AN	—	A/D Channel 3 input
	CIN1-	AN	—	Comparator inverting input
	$\overline{\text{T1G}}$	ST	—	Timer1 gate (count enable)
	P1B*	—	CMOS	PWM output, alternate pin
	OSC2	—	XTAL	Crystal/Resonator
	CLKOUT	—	CMOS	FOSC/4 output
GP5/T1CKI/P1A*/OSC1/CLKIN	GP5	TTL	CMOS	General purpose I/O with prog. pull-up and interrupt-on-change
	T1CKI	ST	—	Timer1 clock input
	P1A*	—	CMOS	PWM output, alternate pin
	OSC1	XTAL	—	Crystal/Resonator
	CLKIN	ST	—	External clock input/RC oscillator connection
VDD	VDD	Power	—	Positive supply
VSS	VSS	Power	—	Ground reference

* Alternate pin function.

Legend: AN=Analog input or output CMOS=CMOS compatible input or output HV= High Voltage
ST=Schmitt Trigger input with CMOS levels TTL = TTL compatible input XTAL=Crystal

TABLE 2-4: PIC12F615/617/HV615 SPECIAL FUNCTION REGISTERS SUMMARY BANK 1

Addr	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on POR, BOR	Page
Bank 1											
80h	INDF	Addressing this location uses contents of FSR to address data memory (not a physical register)								xxxx xxxx	25, 116
81h	OPTION_REG	$\overline{GPPU}$	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0	1111 1111	19, 116
82h	PCL	Program Counter's (PC) Least Significant Byte								0000 0000	25, 116
83h	STATUS	IRP(1)	RP1(1)	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C	0001 1xxx	18, 116
84h	FSR	Indirect Data Memory Address Pointer								xxxx xxxx	25, 116
85h	TRISIO	—	—	TRISIO5	TRISIO4	TRISIO3(4)	TRISIO2	TRISIO1	TRISIO0	--11 1111	44, 116
86h	—	Unimplemented								—	—
87h	—	Unimplemented								—	—
88h	—	Unimplemented								—	—
89h	—	Unimplemented								—	—
8Ah	PCLATH	—	—	—	Write Buffer for upper 5 bits of Program Counter					---0 0000	25, 116
8Bh	INTCON	GIE	PEIE	T0IE	INTE	GPIE	T0IF	INTF	GPIF(3)	0000 0000	20, 116
8Ch	PIE1	—	ADIE	CCP1IE	—	CMIE	—	TMR2IE	TMR1IE	-00- 0-00	21, 116
8Dh	—	Unimplemented								—	—
8Eh	PCON	—	—	—	—	—	—	$\overline{POR}$	$\overline{BOR}$	---- --qq	23, 116
8Fh	—	Unimplemented								—	—
90h	OSCTUNE	—	—	—	TUN4	TUN3	TUN2	TUN1	TUN0	---0 0000	41, 116
91h	—	Unimplemented								—	—
92h	PR2	Timer2 Module Period Register								1111 1111	65, 116
93h	APFCON	—	—	—	T1GSEL	—	—	P1BSEL	P1ASEL	---0 --00	21, 116
94h	—	Unimplemented								—	—
95h	WPU(2)	—	—	WPU5	WPU4	—	WPU2	WPU1	WPU0	--11 -111	46, 116
96h	IOC	—	—	IOC5	IOC4	IOC3	IOC2	IOC1	IOC0	--00 0000	46, 116
97h	—	Unimplemented								—	—
98h	PMCON1(7)	—	—	—	—	—	WREN	WR	RD	---- -000	29
99h	PMCON2(7)	Program Memory Control Register 2 (not a physical register).								---- ----	—
9Ah	PMADRL(7)	PMADRL7	PMADRL6	PMADRL5	PMADRL4	PMADRL3	PMADRL2	PMADRL1	PMADRL0	0000 0000	28
9Bh	PMADRH(7)	—	—	—	—	—	PMADRH2	PMADRH1	PMADRH0	---- -000	28
9Ch	PMDATL(7)	PMDATL7	PMDATL6	PMDATL5	PMDATL4	PMDATL3	PMDATL2	PMDATL1	PMDATL0	0000 0000	28
9Dh	PMDATH(7)	—	—	Program Memory Data Register High Byte.						--00 0000	28
9Eh	ADRESL(5, 6)	Least Significant 2 bits of the left shifted result or 8 bits of the right shifted result								xxxx xxxx	85, 117
9Fh	ANSEL	—	ADCS2	ADCS1	ADCS0	ANS3	ANS2	ANS1	ANS0	-000 1111	45, 117

Legend: – = Unimplemented locations read as '0', u = unchanged, x = unknown, q = value depends on condition, shaded = unimplemented

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

2: GP3 pull-up is enabled when MCLRE is '1' in the Configuration Word register.

3: $\overline{MCLR}$ and WDT Reset does not affect the previous value data latch. The GPIF bit will clear upon Reset but will set again if the mismatch exists.

4: TRISIO3 always reads as '1' since it is an input only pin.

5: Read only register.

6: PIC12F615/617/HV615 only.

7: PIC12F617 only.

2.2.2.1 STATUS Register

The STATUS register, shown in Register 2-1, contains:

- the arithmetic status of the ALU
- the Reset status
- the bank select bits for data memory (RAM)

The STATUS register can be the destination for any instruction, like any other register. If the STATUS register is the destination for an instruction that affects the Z, DC or C bits, then the write to these three bits is disabled. These bits are set or cleared according to the device logic. Furthermore, the $\overline{TO}$ and $\overline{PD}$ bits are not writable. Therefore, the result of an instruction with the STATUS register as destination may be different than intended.

For example, `CLRF STATUS,` will clear the upper three bits and set the Z bit. This leaves the STATUS register as `'000u u1uu'` (where u = unchanged).

It is recommended, therefore, that only `BCF, BSF, SWAPF` and `MOVWF` instructions are used to alter the STATUS register, because these instructions do not affect any Status bits. For other instructions not affecting any Status bits, see the **Section 14.0 "Instruction Set Summary"**.

Note 1:	Bits IRP and RP1 of the STATUS register are not used by the PIC12F609/615/617/12HV609/615 and should be maintained as clear. Use of these bits is not recommended, since this may affect upward compatibility with future products.
2:	The C and DC bits operate as a $\overline{Borrow}$ and Digit $\overline{Borrow}$ out bit, respectively, in subtraction. See the `SUBLW` and `SUBWF` instructions for examples.

REGISTER 2-1: STATUS: STATUS REGISTER

Reserved	Reserved	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
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 **IRP:** This bit is reserved and should be maintained as '0'

bit 6 **RP1:** This bit is reserved and should be maintained as '0'

bit 5 **RP0:** Register Bank Select bit (used for direct addressing)
1 = Bank 1 (80h – FFh)
0 = Bank 0 (00h – 7Fh)

bit 4 **$\overline{TO}$:** Time-out bit
1 = After power-up, `CLRWDT` instruction or `SLEEP` instruction
0 = A WDT time-out occurred

bit 3 **$\overline{PD}$:** Power-down bit
1 = After power-up or by the `CLRWDT` instruction
0 = By execution of the `SLEEP` instruction

bit 2 **Z:** Zero bit
1 = The result of an arithmetic or logic operation is zero
0 = The result of an arithmetic or logic operation is not zero

bit 1 **DC:** Digit Carry/$\overline{Borrow}$ bit (`ADDWF, ADDLW, SUBLW, SUBWF` instructions), For $\overline{Borrow}$, the polarity is reversed.
1 = A carry-out from the 4th low-order bit of the result occurred
0 = No carry-out from the 4th low-order bit of the result

bit 0 **C:** Carry/$\overline{Borrow}$ bit(1) (`ADDWF, ADDLW, SUBLW, SUBWF` instructions)
1 = A carry-out from the Most Significant bit of the result occurred
0 = No carry-out from the Most Significant bit of the result occurred

Note 1: For $\overline{Borrow}$, the polarity is reversed. A subtraction is executed by adding the two's complement of the second operand. For rotate (`RRF, RLF`) instructions, this bit is loaded with either the high-order or low-order bit of the source register.

FIGURE 3-2: BLOCK WRITES TO 2K FLASH PROGRAM MEMORY

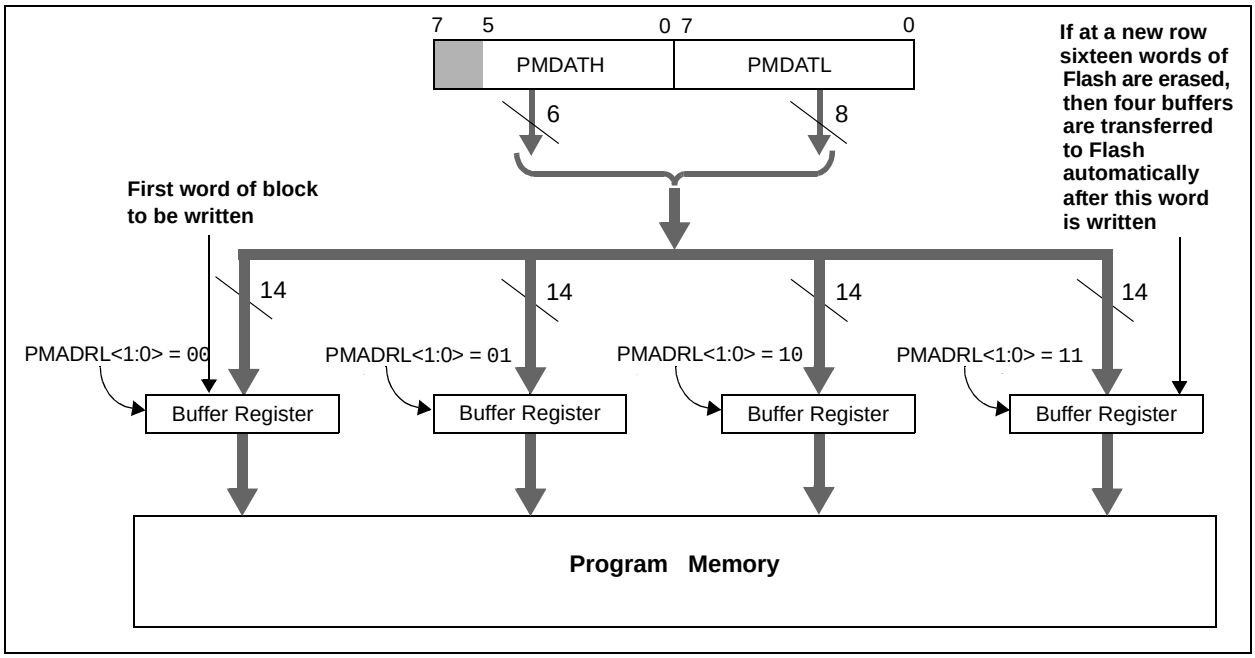
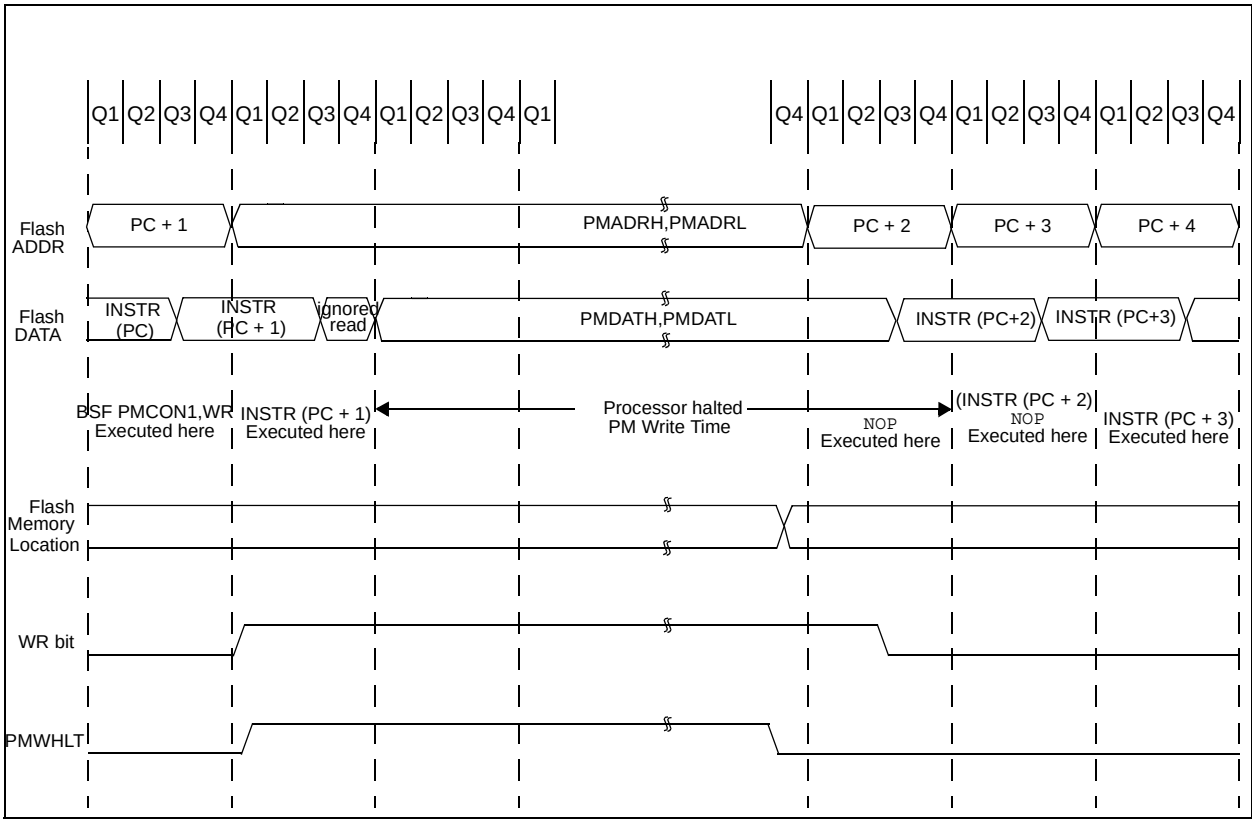


FIGURE 3-3: FLASH PROGRAM MEMORY LONG WRITE CYCLE EXECUTION



4.4.1.1 OSCTUNE Register

The oscillator is factory calibrated but can be adjusted in software by writing to the OSCTUNE register (Register 4-1).

The default value of the OSCTUNE register is '0'. The value is a 5-bit two's complement number.

When the OSCTUNE register is modified, the frequency will begin shifting to the new frequency. Code execution continues during this shift. There is no indication that the shift has occurred.

REGISTER 4-1: OSCTUNE: OSCILLATOR TUNING REGISTER

U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	TUN4	TUN3	TUN2	TUN1	TUN0
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 7-5 **Unimplemented:** Read as '0'

bit 4-0 **TUN<4:0>:** Frequency Tuning bits

01111 = Maximum frequency
01110 =
•
•
•
00001 =
00000 = Oscillator module is running at the calibrated frequency.
11111 =
•
•
•
10000 = Minimum frequency

TABLE 4-2: SUMMARY OF REGISTERS ASSOCIATED WITH CLOCK SOURCES

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)
CONFIG(2)	IOSCFS	$\overline{CP}$	MCLRE	$\overline{PWRTE}$	WDTE	FOSC2	FOSC1	FOSC0	—	—
OSCTUNE	—	—	—	TUN4	TUN3	TUN2	TUN1	TUN0	---0 0000	---u uuuu

Legend: x = unknown, u = unchanged, – = unimplemented locations read as '0'. Shaded cells are not used by oscillators.
Note 1: Other (non Power-up) Resets include $\overline{MCLR}$ Reset and Watchdog Timer Reset during normal operation.
2: See Configuration Word register (Register 12-1) for operation of all register bits.

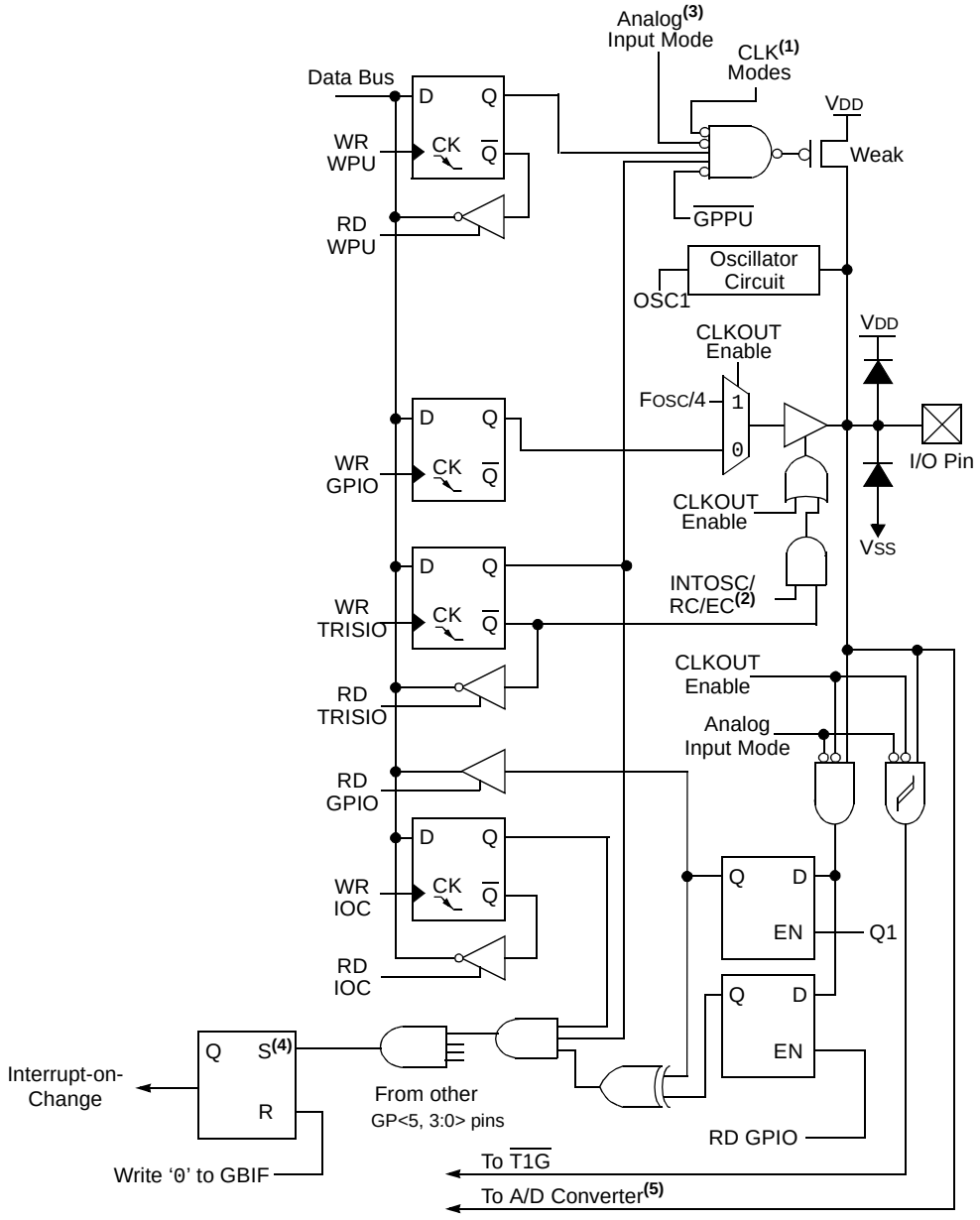
5.2.4.5 GP4/AN3(2)/CIN1-/$\overline{T1G}$/P1B(1, 2)/OSC2/CLKOUT

Figure 5-4 shows the diagram for this pin. The GP4 pin is configurable to function as one of the following:

- a general purpose I/O
- an analog input for the ADC(2)
- Comparator inverting input
- a Timer1 gate (count enable)
- PWM output, alternate pin(1, 2)
- a crystal/resonator connection
- a clock output

Note 1: Alternate pin function.
2: PIC12F615/617/HV615 only.

FIGURE 5-4: BLOCK DIAGRAM OF GP4



Note 1: CLK modes are XT, HS, LP, TMR1 LP and CLKOUT Enable.
2: With CLKOUT option.
3: Analog Input mode comes from ANSEL.
4: Set has priority over Reset.
5: PIC12F615/617/HV615 only.

NOTES:

9.2 Analog Input Connection Considerations

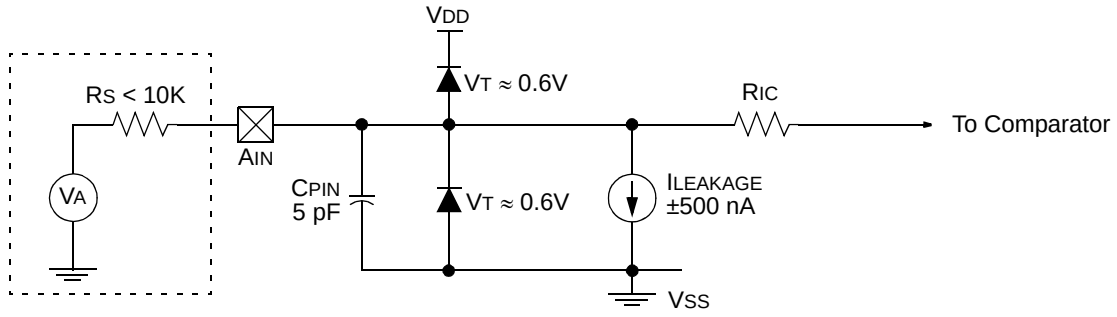
A simplified circuit for an analog input is shown in Figure 9-3. Since the analog input pins share their connection with a digital input, they have reverse biased ESD protection diodes to VDD and VSS. The analog input, therefore, must be between VSS and VDD. If the input voltage deviates from this range by more than 0.6V in either direction, one of the diodes is forward biased and a latch-up may occur.

A maximum source impedance of 10 kΩ is recommended for the analog sources. Also, any external component connected to an analog input pin, such as a capacitor or a Zener diode, should have very little leakage current to minimize inaccuracies introduced.

Note 1: When reading a GPIO register, all pins configured as analog inputs will read as a '0'. Pins configured as digital inputs will convert as an analog input, according to the input specification.

2: Analog levels on any pin defined as a digital input, may cause the input buffer to consume more current than is specified.

FIGURE 9-3: ANALOG INPUT MODEL



Legend: CPIN = Input Capacitance
ILEAKAGE = Leakage Current at the pin due to various junctions
RIC = Interconnect Resistance
RS = Source Impedance
VA = Analog Voltage
VT = Threshold Voltage

10.0 ANALOG-TO-DIGITAL CONVERTER (ADC) MODULE (PIC12F615/617/HV615 ONLY)

The Analog-to-Digital Converter (ADC) allows conversion of an analog input signal to a 10-bit binary representation of that signal. This device uses analog inputs, which are multiplexed into a single sample and hold circuit. The output of the sample and hold is connected to the input of the converter. The converter generates a 10-bit binary result via successive approximation and stores the conversion result into the ADC result registers (ADRESL and ADRESH).

The ADC voltage reference is software selectable to either VDD or a voltage applied to the external reference pins.

The ADC can generate an interrupt upon completion of a conversion. This interrupt can be used to wake-up the device from Sleep.

Figure 10-1 shows the block diagram of the ADC.

Note: The ADRESL and ADRESH registers are Read Only.

FIGURE 10-1: ADC BLOCK DIAGRAM

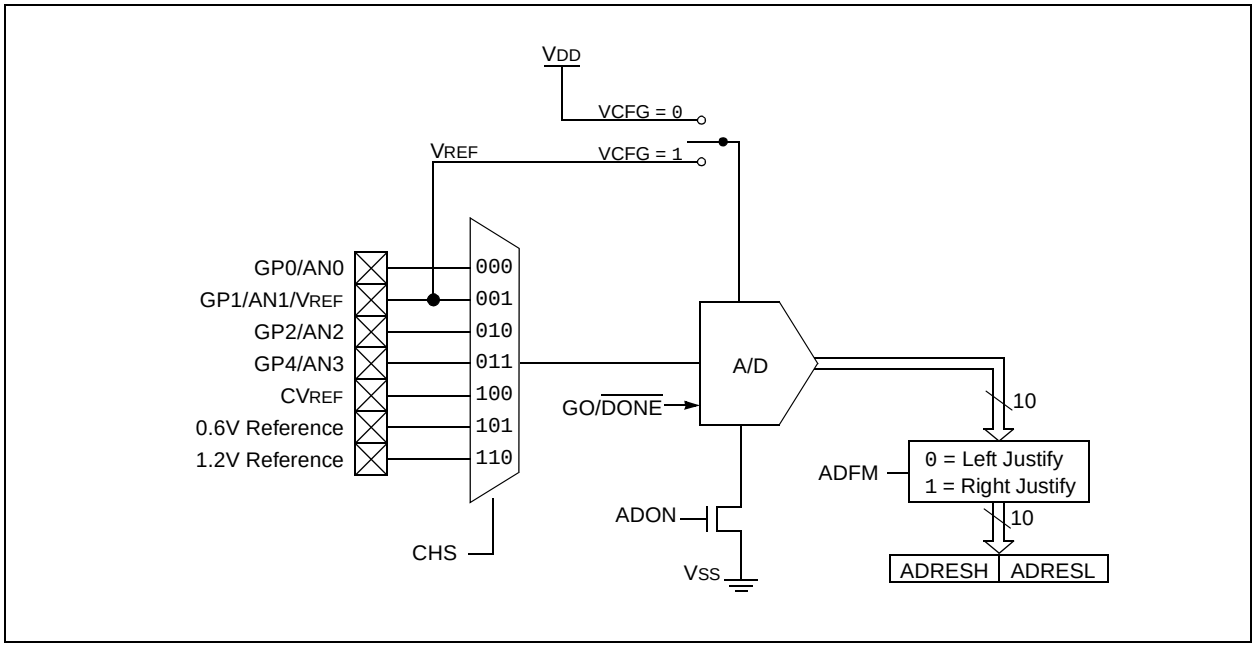


TABLE 11-3: SUMMARY OF REGISTERS ASSOCIATED WITH COMPARE

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
CCP1CON	P1M	—	DC1B1	DC1B0	CCP1M3	CCP1M2	CCP1M1	CCP1M0	0-00 0000	0-00 0000
CCPR1L	Capture/Compare/PWM Register 1 Low Byte								xxxx xxxx	uuuu uuuu
CCPR1H	Capture/Compare/PWM Register 1 High Byte								xxxx xxxx	uuuu uuuu
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
T1CON	T1GINV	TMR1GE	T1CKPS1	T1CKPS0	T1OSCEN	$\overline{\text{T1SYNC}}$	TMR1CS	TMR1ON	0000 0000	uuuu uuuu
TMR1L	Holding Register for the Least Significant Byte of the 16-bit TMR1 Register								xxxx xxxx	uuuu uuuu
TMR1H	Holding Register for the Most Significant Byte of the 16-bit TMR1 Register								xxxx xxxx	uuuu uuuu
TMR2	Timer2 Module Register								0000 0000	0000 0000
TRISIO	—	—	TRISIO5	TRISIO4	TRISIO3	TRISIO2	TRISIO1	TRISIO0	--11 1111	--11 1111

Legend: - = Unimplemented locations, read as '0', u = unchanged, x = unknown. Shaded cells are not used by the Compare.

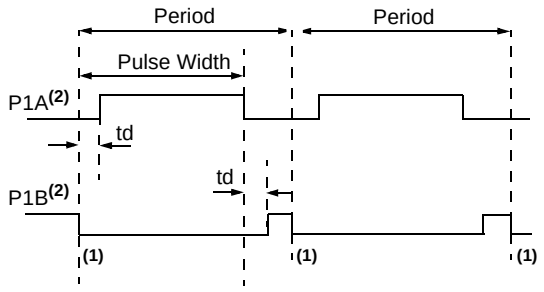
Note 1: For PIC12F615/617/HV615 only.

11.4.6 PROGRAMMABLE DEAD-BAND DELAY MODE

In Half-Bridge applications where all power switches are modulated at the PWM frequency, the power switches normally require more time to turn off than to turn on. If both the upper and lower power switches are switched at the same time (one turned on, and the other turned off), both switches may be on for a short period of time until one switch completely turns off. During this brief interval, a very high current (*shoot-through current*) will flow through both power switches, shorting the bridge supply. To avoid this potentially destructive shoot-through current from flowing during switching, turning on either of the power switches is normally delayed to allow the other switch to completely turn off.

In Half-Bridge mode, a digitally programmable dead-band delay is available to avoid shoot-through current from destroying the bridge power switches. The delay occurs at the signal transition from the non-active state to the active state. See Figure 11-13 for illustration. The lower seven bits of the associated PWMxCON register (Register 11-3) sets the delay period in terms of microcontroller instruction cycles (TCY or 4 TOSC).

FIGURE 11-13: EXAMPLE OF HALF-BRIDGE PWM OUTPUT

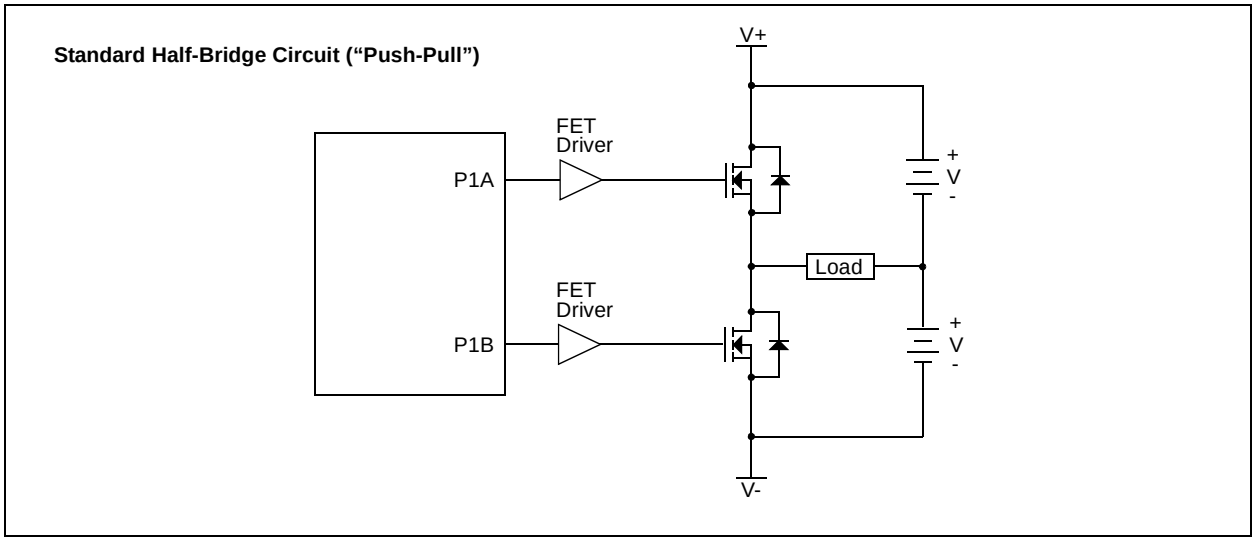


td = Dead-Band Delay

Note 1: At this time, the TMR2 register is equal to the PR2 register.

2: Output signals are shown as active-high.

FIGURE 11-14: EXAMPLE OF HALF-BRIDGE APPLICATIONS



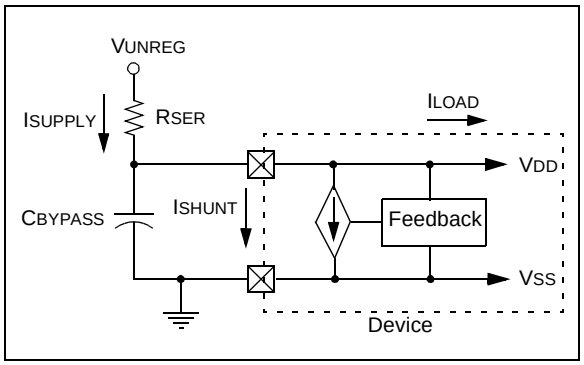
13.0 VOLTAGE REGULATOR

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).

BTFSS	Bit Test f, Skip if Set
Syntax:	[*label*] BTFSS f,b
Operands:	$0 \le f \le 127$ $0 \le b < 7$
Operation:	skip if (f<b>) = 1
Status Affected:	None
Description:	If bit 'b' in register 'f' is '0', the next instruction is executed. If bit 'b' is '1', then the next instruction is discarded and a NOP is executed instead, making this a two-cycle instruction.

CALL	Call Subroutine
Syntax:	[*label*] CALL k
Operands:	$0 \le k \le 2047$
Operation:	(PC)+ 1→ TOS, k → PC<10:0>, (PCLATH<4:3>) → PC<12:11>
Status Affected:	None
Description:	Call Subroutine. First, return address (PC + 1) is pushed onto the stack. The eleven-bit immediate address is loaded into PC bits <10:0>. The upper bits of the PC are loaded from PCLATH. CALL is a two-cycle instruction.

CLRF	Clear f
Syntax:	[*label*] CLRF f
Operands:	$0 \le f \le 127$
Operation:	00h → (f) 1 → Z
Status Affected:	Z
Description:	The contents of register 'f' are cleared and the Z bit is set.

CLRW	Clear W
Syntax:	[*label*] CLRW
Operands:	None
Operation:	00h → (W) 1 → Z
Status Affected:	Z
Description:	W register is cleared. Zero bit (Z) is set.

CLRWDT	Clear Watchdog Timer
Syntax:	[*label*] CLRWDT
Operands:	None
Operation:	00h → WDT 0 → WDT prescaler, 1 → $\overline{TO}$ 1 → $\overline{PD}$
Status Affected:	$\overline{TO}$, $\overline{PD}$
Description:	CLRWDT instruction resets the Watchdog Timer. It also resets the prescaler of the WDT. Status bits $\overline{TO}$ and $\overline{PD}$ are set.

COMF	Complement f
Syntax:	[*label*] COMF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	$(\bar{f}) \rightarrow$ (destination)
Status Affected:	Z
Description:	The contents of register 'f' are complemented. If 'd' is '0', the result is stored in W. If 'd' is '1', the result is stored back in register 'f'.

DECF	Decrement f
Syntax:	[*label*] DECF f,d
Operands:	$0 \le f \le 127$ $d \in [0,1]$
Operation:	(f) - 1 → (destination)
Status Affected:	Z
Description:	Decrement register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

SUBWF **Subtract W from f**

Syntax: [*label*] SUBWF f,d

Operands: $0 \le f \le 127$
$d \in [0,1]$

Operation: (f) - (W) → (destination)

Status Affected: C, DC, Z

Description: Subtract (2's complement method) W register from register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

C = 0	W > f
C = 1	W ≤ f
DC = 0	W<3:0> > f<3:0>
DC = 1	W<3:0> ≤ f<3:0>

SWAPF **Swap Nibbles in f**

Syntax: [*label*] SWAPF f,d

Operands: $0 \le f \le 127$
$d \in [0,1]$

Operation: (f<3:0>) → (destination<7:4>),
(f<7:4>) → (destination<3:0>)

Status Affected: None

Description: The upper and lower nibbles of register 'f' are exchanged. If 'd' is '0', the result is placed in the W register. If 'd' is '1', the result is placed in register 'f'.

XORLW **Exclusive OR literal with W**

Syntax: [*label*] XORLW k

Operands: $0 \le k \le 255$

Operation: (W) .XOR. k → (W)

Status Affected: Z

Description: The contents of the W register are XOR'ed with the eight-bit literal 'k'. The result is placed in the W register.

XORWF **Exclusive OR W with f**

Syntax: [*label*] XORWF f,d

Operands: $0 \le f \le 127$
$d \in [0,1]$

Operation: (W) .XOR. (f) → (destination)

Status Affected: Z

Description: Exclusive OR the contents of the W register with register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

16.1 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**
	VDD	**Supply Voltage**					
D001		PIC12F609/615/617	2.0	—	5.5	V	FOSC < = 4 MHz
D001		PIC12HV609/615	2.0	—	—(2)	V	FOSC < = 4 MHz
D001B		PIC12F609/615/617	2.0	—	5.5	V	FOSC < = 8 MHz
D001B		PIC12HV609/615	2.0	—	—(2)	V	FOSC < = 8 MHz
D001C		PIC12F609/615/617	3.0	—	5.5	V	FOSC < = 10 MHz
D001C		PIC12HV609/615	3.0	—	—(2)	V	FOSC < = 10 MHz
D001D		PIC12F609/615/617	4.5	—	5.5	V	FOSC < = 20 MHz
D001D		PIC12HV609/615	4.5	—	—(2)	V	FOSC < = 20 MHz
D002*	VDR	**RAM Data Retention Voltage(1)**	1.5	—	—	V	Device in Sleep mode
D003	VPOR	**VDD Start Voltage** to ensure internal Power-on Reset signal	—	VSS	—	V	See **Section 12.3.1 "Power-on Reset (POR)"** for details.
D004*	SVDD	**VDD Rise Rate** to ensure internal Power-on Reset signal	0.05	—	—	V/ms	See **Section 12.3.1 "Power-on Reset (POR)"** for details.

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

2: User defined. Voltage across the shunt regulator should not exceed 5V.

16.5 DC Characteristics: PIC12F609/615/617 - E (Extended)

DC CHARACTERISTICS		Standard Operating Conditions (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +125°C for extended					
Param No.	Device Characteristics	Min	Typ†	Max	Units	Conditions	
						VDD	Note
D020E	**Power-down Base Current (IPD)(2)** PIC12F609/615/617	—	0.05	4.0	µA	2.0	WDT, BOR, Comparator, VREF and T1OSC disabled
		—	0.15	5.0	µA	3.0	
		—	0.35	8.5	µA	5.0	
D021E		—	0.5	5.0	µA	2.0	WDT Current(1)
		—	2.5	8.0	µA	3.0	
		—	9.5	19	µA	5.0	
D022E		—	5.0	15	µA	3.0	BOR Current(1)
		—	6.0	19	µA	5.0	
D023E		—	50	70	µA	2.0	Comparator Current(1), single comparator enabled
		—	55	75	µA	3.0	
		—	60	80	µA	5.0	
D024E		—	30	40	µA	2.0	CVREF Current(1) (high range)
		—	45	60	µA	3.0	
		—	75	105	µA	5.0	
D025E*		—	39	50	µA	2.0	CVREF Current(1) (low range)
		—	59	80	µA	3.0	
		—	98	130	µA	5.0	
D026E		—	5.5	16	µA	2.0	T1OSC Current(1), 32.768 kHz
		—	7.0	18	µA	3.0	
		—	8.5	22	µA	5.0	
D027E		—	0.2	6.5	µA	3.0	A/D Current(1), no conversion in progress
		—	0.36	10	µA	5.0	

* 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: The peripheral current is the sum of the base IDD or IPD and the additional current consumed when this peripheral is enabled. The peripheral Δ current can be determined by subtracting the base IDD or IPD current from this limit. Max values should be used when calculating total current consumption.

2: The power-down current in Sleep mode does not depend on the oscillator type. Power-down current is measured with the part in Sleep mode, with all I/O pins in high-impedance state and tied to VDD.

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

FIGURE 16-4: CLOCK TIMING

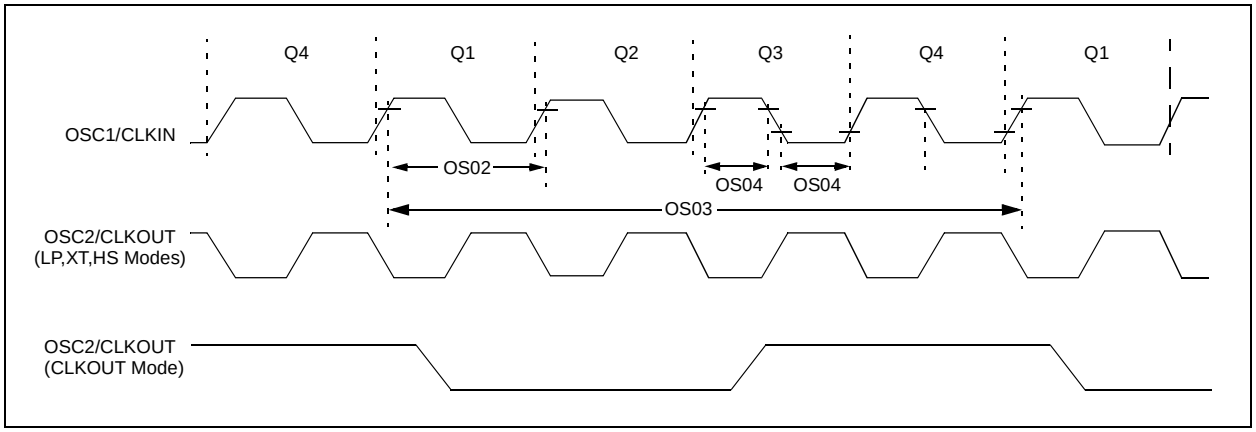


TABLE 16-1: CLOCK OSCILLATOR TIMING REQUIREMENTS

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 17-21: PIC12HV609/615 IDD XT (1 MHz) vs. VDD

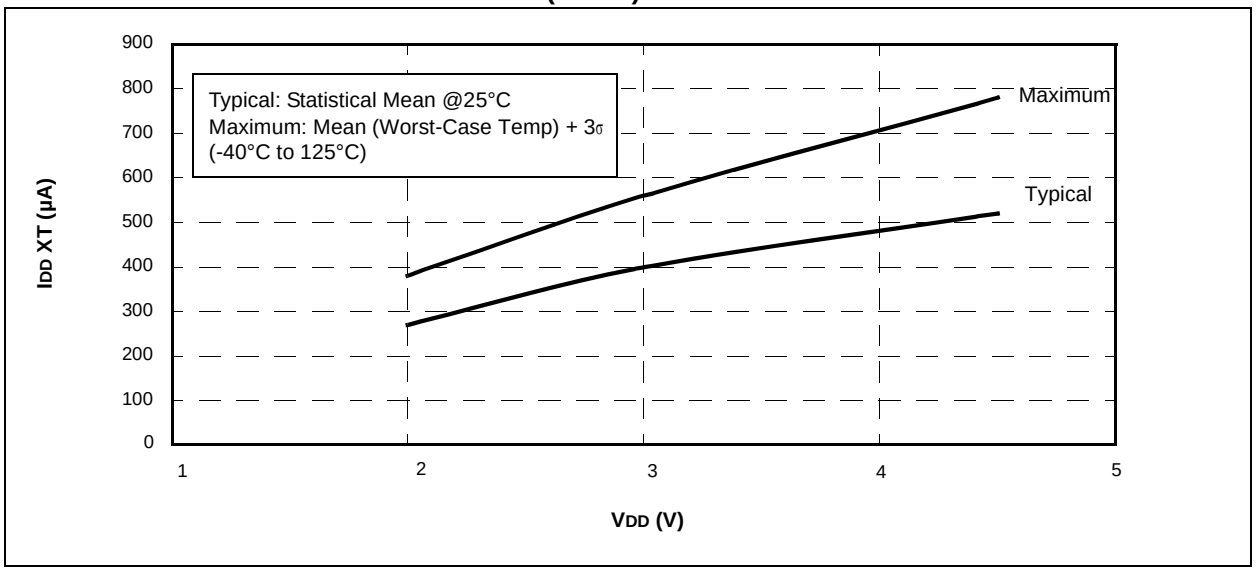


FIGURE 17-22: PIC12HV609/615 IDD XT (4 MHz) vs. VDD

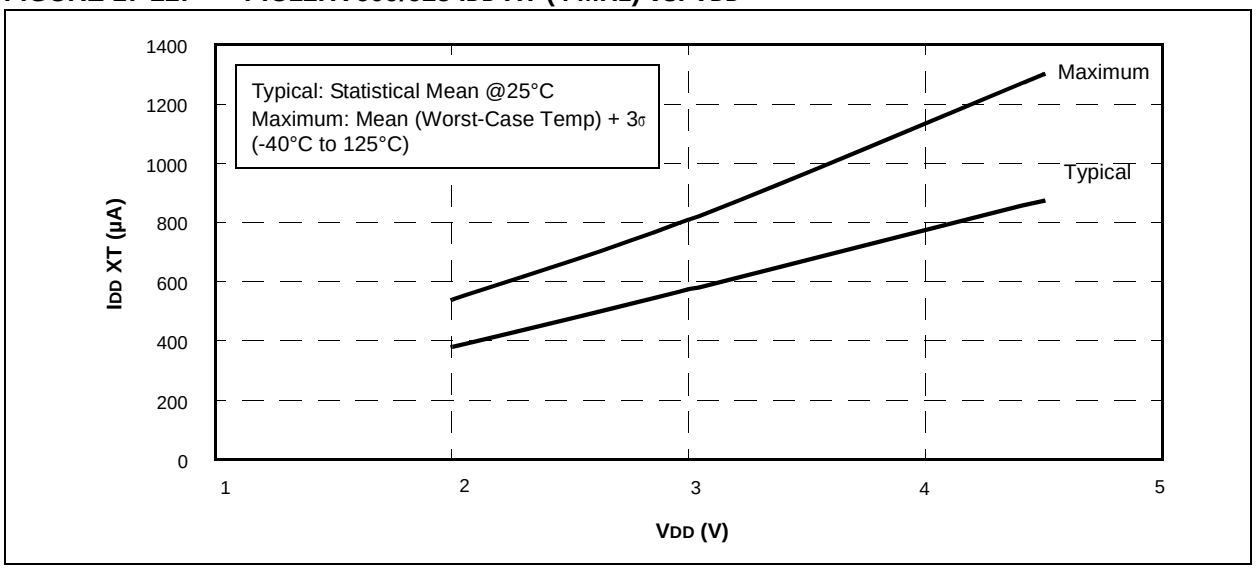


FIGURE 17-23: PIC12HV609/615 IDD INTOSC (4 MHz) vs. VDD