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Details

Product Status	Obsolete
Core Processor	PIC
Core Size	8-Bit
Speed	8MHz
Connectivity	UART/USART
Peripherals	POR, PWM, WDT
Number of I/O	33
Program Memory Size	8KB (4K x 16)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	454 x 8
Voltage - Supply (Vcc/Vdd)	2.5V ~ 6V
Data Converters	-
Oscillator Type	External
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	44-QFP
Supplier Device Package	44-MQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic17lc43-08-pq

4.0 RESET

The PIC17CXX differentiates between various kinds of reset:

- Power-on Reset (POR)
- $\overline{\text{MCLR}}$ reset during normal operation
- WDT Reset (normal operation)

Some registers are not affected in any reset condition; their status is unknown on POR and unchanged in any other reset. Most other registers are forced to a "reset state" on Power-on Reset (POR), on $\overline{\text{MCLR}}$ or WDT Reset and on $\overline{\text{MCLR}}$ reset during SLEEP. They are not affected by a WDT Reset during SLEEP, since this reset is viewed as the resumption of normal operation. The $\overline{\text{TO}}$ and $\overline{\text{PD}}$ bits are set or cleared differently in different reset situations as indicated in Table 4-3. These bits are used in software to determine the nature of reset. See Table 4-4 for a full description of reset states of all registers.

Note: While the device is in a reset state, the internal phase clock is held in the Q1 state. Any processor mode that allows external execution will force the RE0/ALE pin as a low output and the RE1/ $\overline{\text{OE}}$ and RE2/ $\overline{\text{WR}}$ pins as high outputs.

A simplified block diagram of the on-chip reset circuit is shown in Figure 4-1.

4.1 Power-on Reset (POR), Power-up Timer (PWRT), and Oscillator Start-up Timer (OST)

4.1.1 POWER-ON RESET (POR)

The Power-on Reset circuit holds the device in reset until V_{DD} is above the trip point (in the range of 1.4V - 2.3V). The PIC17C42 does not produce an internal reset when V_{DD} declines. All other devices will produce an internal reset for both rising and falling V_{DD} . To take advantage of the POR, just tie the $\overline{\text{MCLR}}/\text{VPP}$ pin directly (or through a resistor) to V_{DD} . This will eliminate external RC components usually needed to create Power-on Reset. A minimum rise time for V_{DD} is required. See Electrical Specifications for details.

4.1.2 POWER-UP TIMER (PWRT)

The Power-up Timer provides a fixed 96 ms time-out (nominal) on power-up. This occurs from rising edge of the POR signal and after the first rising edge of $\overline{\text{MCLR}}$ (detected high). The Power-up Timer operates on an internal RC oscillator. The chip is kept in RESET as long as the PWRT is active. In most cases the PWRT delay allows the V_{DD} to rise to an acceptable level.

The power-up time delay will vary from chip to chip and to V_{DD} and temperature. See DC parameters for details.

FIGURE 4-1: SIMPLIFIED BLOCK DIAGRAM OF ON-CHIP RESET CIRCUIT

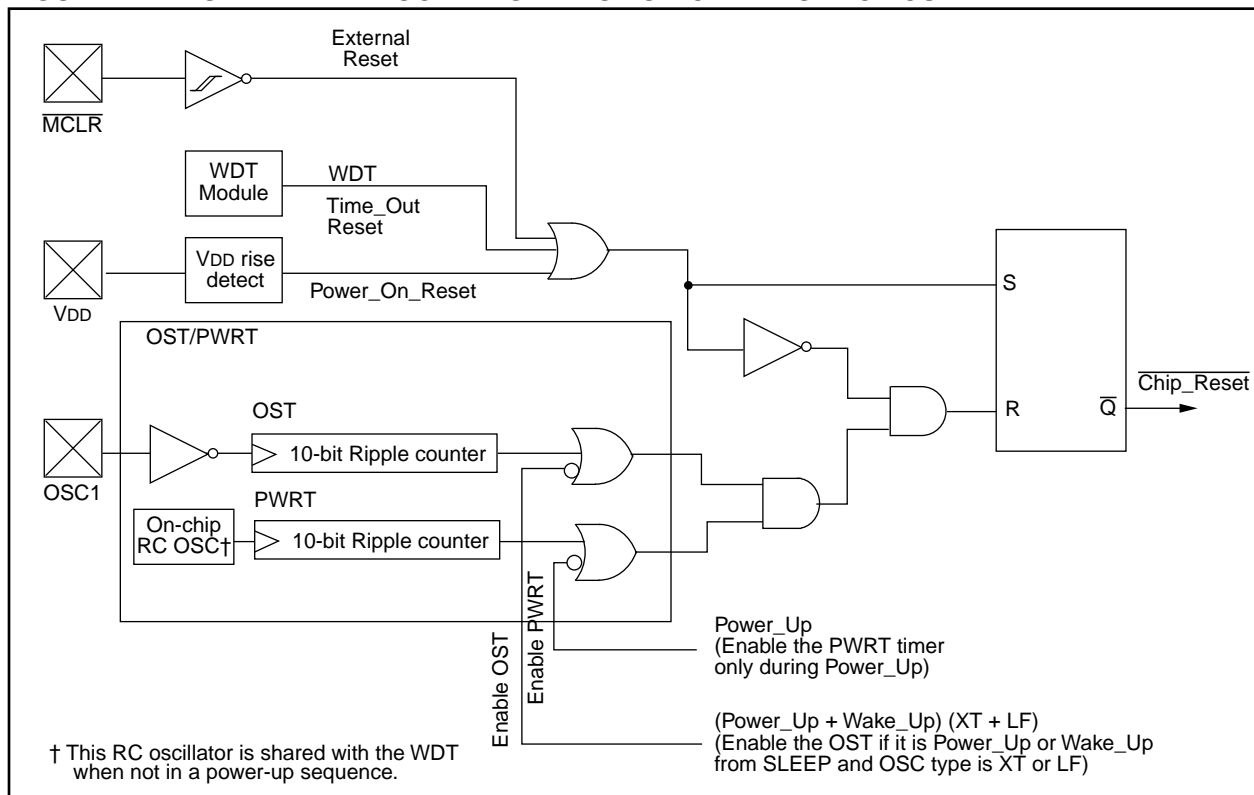


FIGURE 4-2: TIME-OUT SEQUENCE ON POWER-UP ($\overline{\text{MCLR}}$ TIED TO V_{DD})

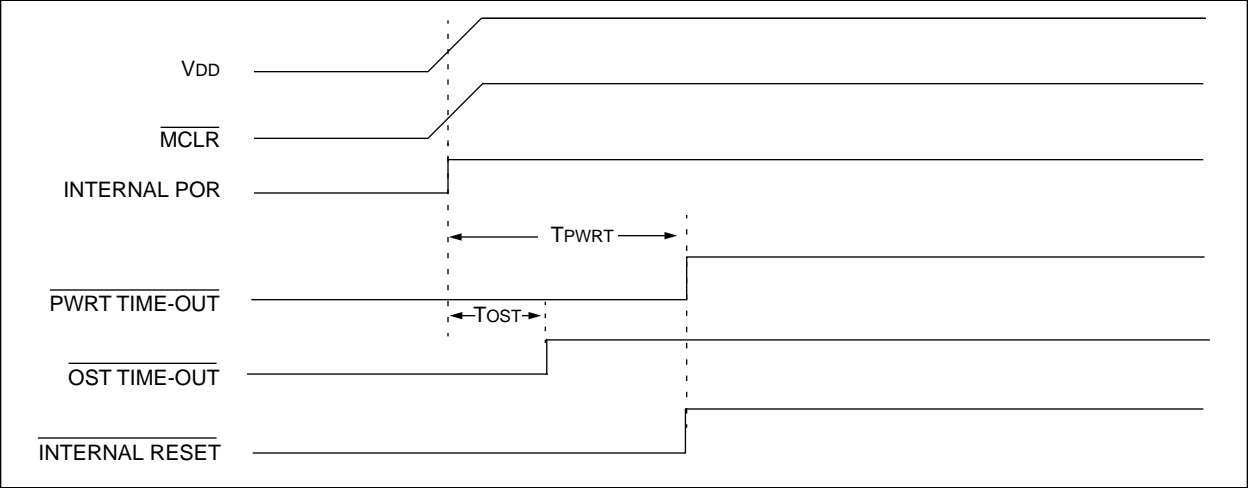


FIGURE 4-3: TIME-OUT SEQUENCE ON POWER-UP ($\overline{\text{MCLR}}$ NOT TIED TO V_{DD})

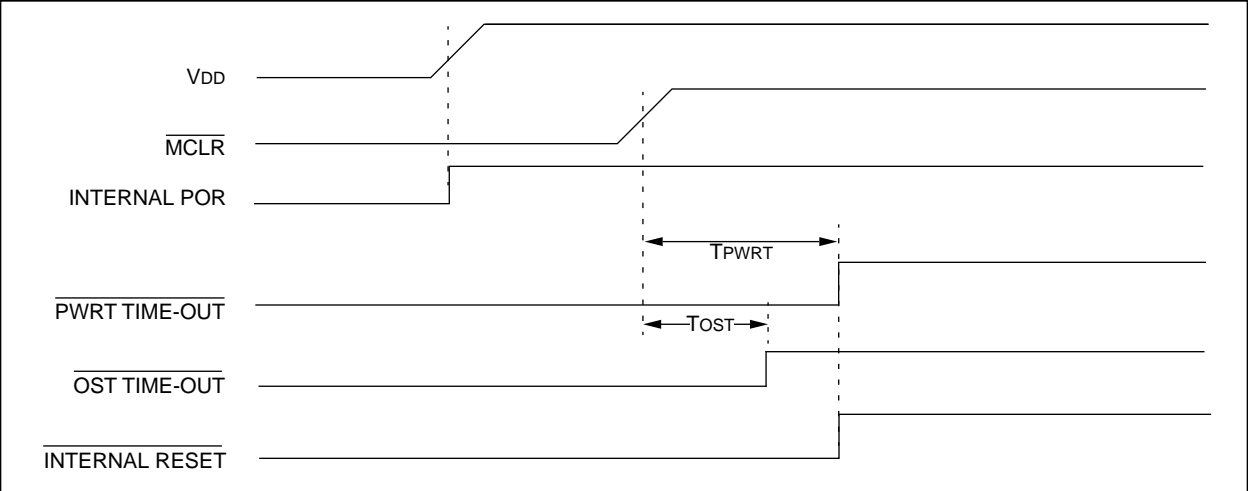
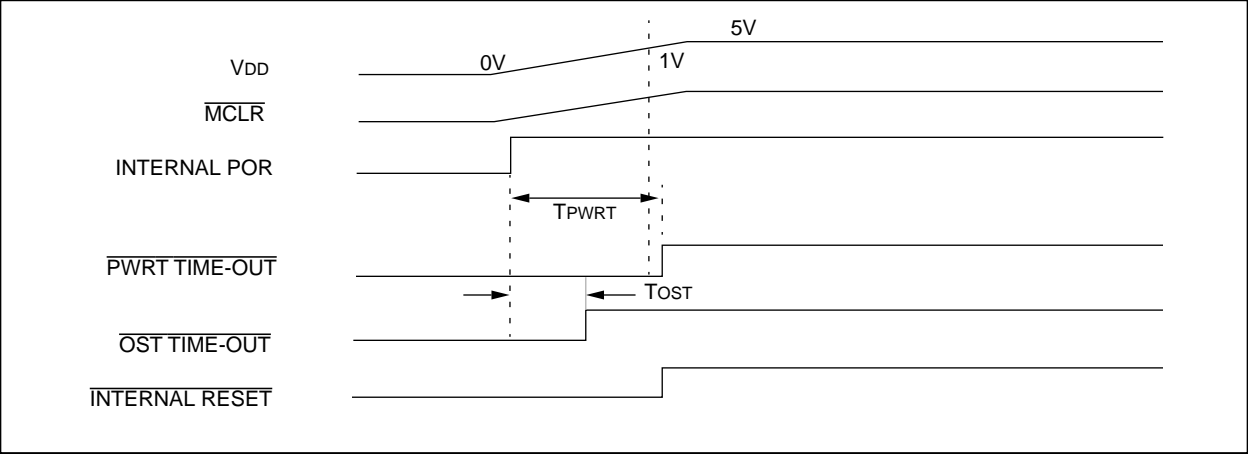


FIGURE 4-4: SLOW RISE TIME ($\overline{\text{MCLR}}$ TIED TO V_{DD})



5.0 INTERRUPTS

The PIC17C4X devices have 11 sources of interrupt:

- External interrupt from the RA0/INT pin
- Change on RB7:RB0 pins
- TMR0 Overflow
- TMR1 Overflow
- TMR2 Overflow
- TMR3 Overflow
- USART Transmit buffer empty
- USART Receive buffer full
- Capture1
- Capture2
- T0CKI edge occurred

There are four registers used in the control and status of interrupts. These are:

- CPUSTA
- INTSTA
- PIE
- PIR

The CPUSTA register contains the GLINTD bit. This is the Global Interrupt Disable bit. When this bit is set, all interrupts are disabled. This bit is part of the controller core functionality and is described in the Memory Organization section.

When an interrupt is responded to, the GLINTD bit is automatically set to disable any further interrupt, the return address is pushed onto the stack and the PC is loaded with the interrupt vector address. There are four interrupt vectors. Each vector address is for a specific interrupt source (except the peripheral interrupts which have the same vector address). These sources are:

- External interrupt from the RA0/INT pin
- TMR0 Overflow
- T0CKI edge occurred
- Any peripheral interrupt

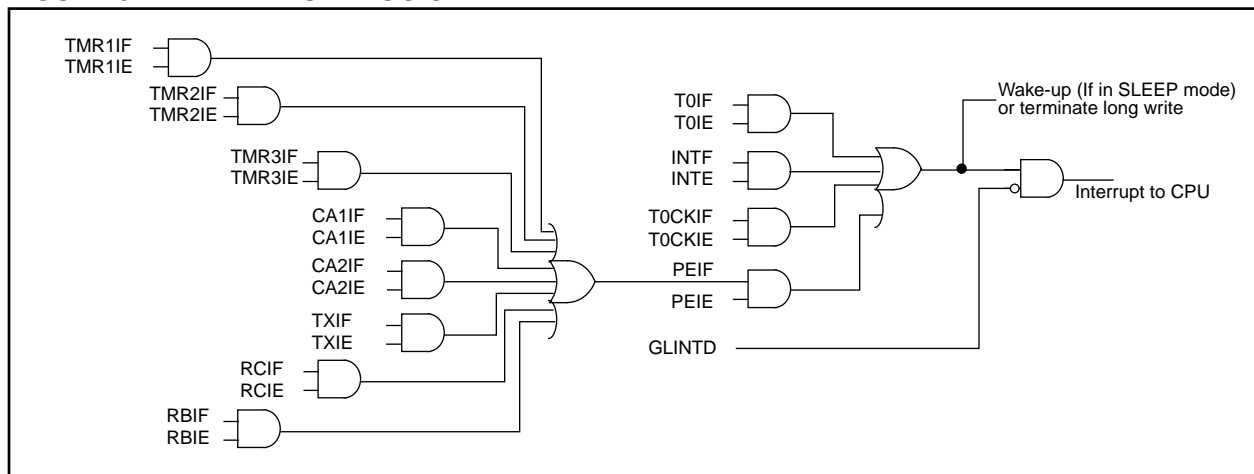
When program execution vectors to one of these interrupt vector addresses (except for the peripheral interrupt address), the interrupt flag bit is automatically cleared. Vectoring to the peripheral interrupt vector address does not automatically clear the source of the interrupt. In the peripheral interrupt service routine, the source(s) of the interrupt can be determined by testing the interrupt flag bits. The interrupt flag bit(s) must be cleared in software before re-enabling interrupts to avoid infinite interrupt requests.

All of the individual interrupt flag bits will be set regardless of the status of their corresponding mask bit or the GLINTD bit.

For external interrupt events, there will be an interrupt latency. For two cycle instructions, the latency could be one instruction cycle longer.

The “return from interrupt” instruction, `RETFIE`, can be used to mark the end of the interrupt service routine. When this instruction is executed, the stack is “POPed”, and the GLINTD bit is cleared (to re-enable interrupts).

FIGURE 5-1: INTERRUPT LOGIC



5.2 Peripheral Interrupt Enable Register (PIE)

This register contains the individual flag bits for the Peripheral interrupts.

FIGURE 5-3: PIE REGISTER (ADDRESS: 17h, BANK 1)

R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0
RBIE	TMR3IE	TMR2IE	TMR1IE	CA2IE	CA1IE	TXIE	RCIE
bit7							bit0
<p>bit 7: RBIE: PORTB Interrupt on Change Enable bit 1 = Enable PORTB interrupt on change 0 = Disable PORTB interrupt on change</p> <p>bit 6: TMR3IE: Timer3 Interrupt Enable bit 1 = Enable Timer3 interrupt 0 = Disable Timer3 interrupt</p> <p>bit 5: TMR2IE: Timer2 Interrupt Enable bit 1 = Enable Timer2 interrupt 0 = Disable Timer2 interrupt</p> <p>bit 4: TMR1IE: Timer1 Interrupt Enable bit 1 = Enable Timer1 interrupt 0 = Disable Timer1 interrupt</p> <p>bit 3: CA2IE: Capture2 Interrupt Enable bit 1 = Enable Capture interrupt on RB1/CAP2 pin 0 = Disable Capture interrupt on RB1/CAP2 pin</p> <p>bit 2: CA1IE: Capture1 Interrupt Enable bit 1 = Enable Capture interrupt on RB2/CAP1 pin 0 = Disable Capture interrupt on RB2/CAP1 pin</p> <p>bit 1: TXIE: USART Transmit Interrupt Enable bit 1 = Enable Transmit buffer empty interrupt 0 = Disable Transmit buffer empty interrupt</p> <p>bit 0: RCIE: USART Receive Interrupt Enable bit 1 = Enable Receive buffer full interrupt 0 = Disable Receive buffer full interrupt</p>							

R = Readable bit
W = Writable bit
-n = Value at POR reset

PIC17C4X

TABLE 6-1: MODE MEMORY ACCESS

Operating Mode	Internal Program Memory	Configuration Bits, Test Memory, Boot ROM
Microprocessor	No Access	No Access
Microcontroller	Access	Access
Extended Microcontroller	Access	No Access
Protected Microcontroller	Access	Access

The PIC17C4X can operate in modes where the program memory is off-chip. They are the microprocessor and extended microcontroller modes. The microprocessor mode is the default for an unprogrammed device.

Regardless of the processor mode, data memory is always on-chip.

FIGURE 6-2: MEMORY MAP IN DIFFERENT MODES

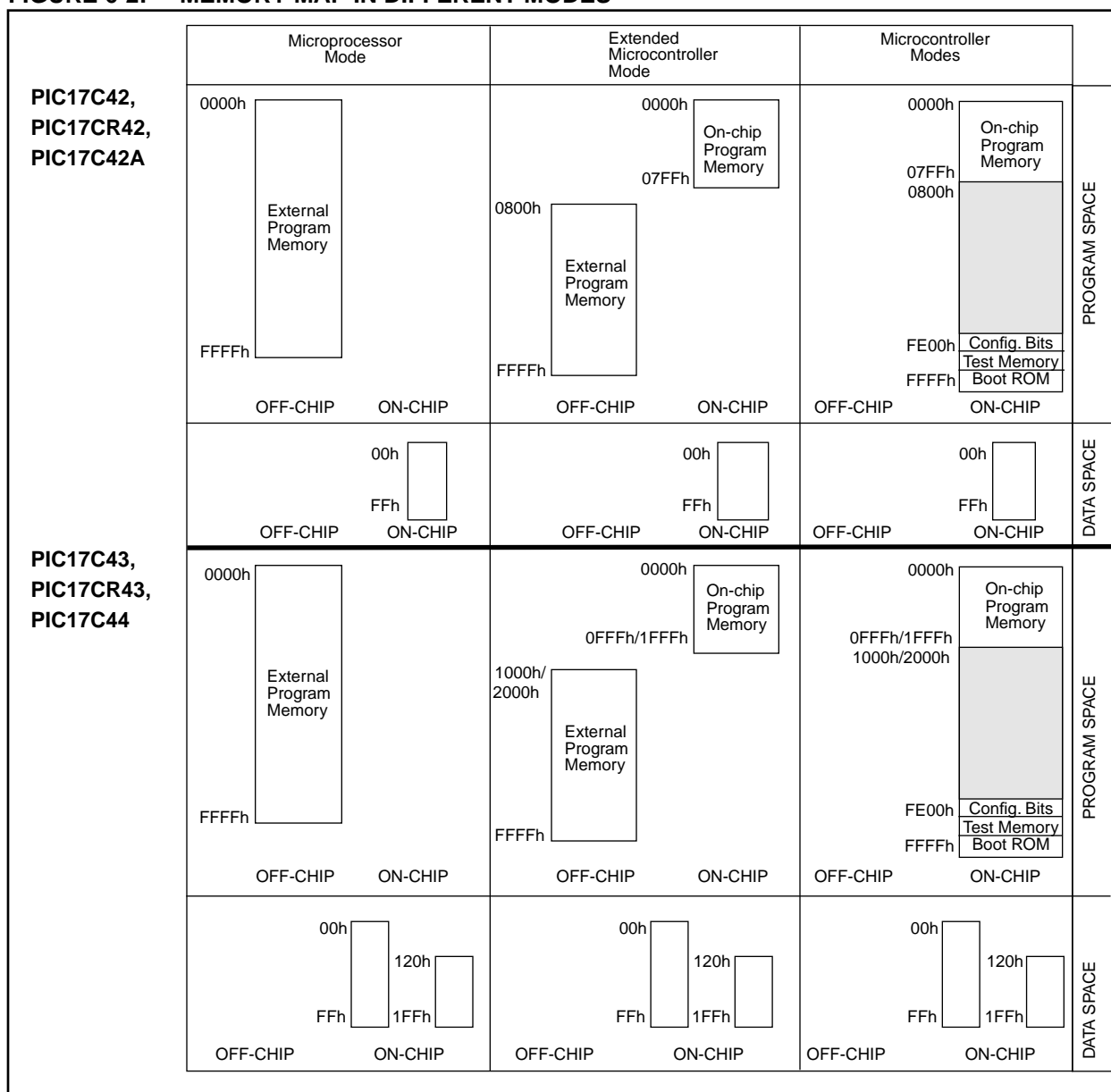


TABLE 6-3: SPECIAL FUNCTION REGISTERS

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-on Reset	Value on all other resets (3)
Unbanked											
00h	INDF0	Uses contents of FSR0 to address data memory (not a physical register)								---- --	---- --
01h	FSR0	Indirect data memory address pointer 0								xxxx xxxx	uuuu uuuu
02h	PCL	Low order 8-bits of PC								0000 0000	0000 0000
03h ⁽¹⁾	PCLATH	Holding register for upper 8-bits of PC								0000 0000	uuuu uuuu
04h	ALUSTA	FS3	FS2	FS1	FS0	OV	Z	DC	C	1111 xxxx	1111 uuuu
05h	T0STA	INTEDG	T0SE	T0CS	PS3	PS2	PS1	PS0	—	0000 000-	0000 000-
06h ⁽²⁾	CPUSTA	—	—	STKAV	GLINTD	T0	PD	—	—	--11 11--	--11 qq--
07h	INTSTA	PEIF	T0CKIF	T0IF	INTF	PEIE	T0CKIE	T0IE	INTE	0000 0000	0000 0000
08h	INDF1	Uses contents of FSR1 to address data memory (not a physical register)								---- --	---- --
09h	FSR1	Indirect data memory address pointer 1								xxxx xxxx	uuuu uuuu
0Ah	WREG	Working register								xxxx xxxx	uuuu uuuu
0Bh	TMR0L	TMR0 register; low byte								xxxx xxxx	uuuu uuuu
0Ch	TMR0H	TMR0 register; high byte								xxxx xxxx	uuuu uuuu
0Dh	TBLPTRL	Low byte of program memory table pointer								(4)	(4)
0Eh	TBLPTRH	High byte of program memory table pointer								(4)	(4)
0Fh	BSR	Bank select register								0000 0000	0000 0000
Bank 0											
10h	PORTA	RBP0	—	RA5	RA4	RA3	RA2	RA1/T0CKI	RA0/INT	0-xx xxxx	0-uu uuuu
11h	DDRB	Data direction register for PORTB								1111 1111	1111 1111
12h	PORTB	PORTB data latch								xxxx xxxx	uuuu uuuu
13h	RCSTA	SPEN	RX9	SREN	CREN	—	FERR	OERR	RX9D	0000 -00x	0000 -00u
14h	RCREG	Serial port receive register								xxxx xxxx	uuuu uuuu
15h	TXSTA	CSRC	TX9	TXEN	SYNC	—	—	TRMT	TX9D	0000 --1x	0000 --1u
16h	TXREG	Serial port transmit register								xxxx xxxx	uuuu uuuu
17h	SPBRG	Baud rate generator register								xxxx xxxx	uuuu uuuu
Bank 1											
10h	DDRC	Data direction register for PORTC								1111 1111	1111 1111
11h	PORTC	RC7/AD7	RC6/AD6	RC5/AD5	RC4/AD4	RC3/AD3	RC2/AD2	RC1/AD1	RC0/AD0	xxxx xxxx	uuuu uuuu
12h	DDRD	Data direction register for PORTD								1111 1111	1111 1111
13h	PORTD	RD7/AD15	RD6/AD14	RD5/AD13	RD4/AD12	RD3/AD11	RD2/AD10	RD1/AD9	RD0/AD8	xxxx xxxx	uuuu uuuu
14h	DDRE	Data direction register for PORTE								---- -111	---- -111
15h	PORTE	—	—	—	—	—	RE2/W _R	RE1/O _E	RE0/ALE	---- -xxx	---- -uuu
16h	PIR	RBIF	TMR3IF	TMR2IF	TMR1IF	CA2IF	CA1IF	TXIF	RCIF	0000 0010	0000 0010
17h	PIE	RBIE	TMR3IE	TMR2IE	TMR1IE	CA2IE	CA1IE	TXIE	RCIE	0000 0000	0000 0000

Legend: x = unknown, u = unchanged, - = unimplemented read as '0', q - value depends on condition. Shaded cells are unimplemented, read as '0'.

Note 1: The upper byte of the program counter is not directly accessible. PCLATH is a holding register for PC<15:8> whose contents are updated from or transferred to the upper byte of the program counter.

2: The T0 and PD status bits in CPUSTA are not affected by a MCLR reset.

3: Other (non power-up) resets include: external reset through MCLR and the Watchdog Timer Reset.

4: The following values are for both TBLPTRL and TBLPTRH:

All PIC17C4X devices (Power-on Reset 0000 0000) and (All other resets 0000 0000)
except the PIC17C42 (Power-on Reset xxxx xxxx) and (All other resets uuuu uuuu)

5: The PRODL and PRODH registers are not implemented on the PIC17C42.

6.2.2.1 ALU STATUS REGISTER (ALUSTA)

The ALUSTA register contains the status bits of the Arithmetic and Logic Unit and the mode control bits for the indirect addressing register.

As with all the other registers, the ALUSTA register can be the destination for any instruction. If the ALUSTA 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. Therefore, the result of an instruction with the ALUSTA register as destination may be different than intended.

For example, `CLRF ALUSTA` will clear the upper four bits and set the Z bit. This leaves the ALUSTA register as 0000u1uu (where u = unchanged).

It is recommended, therefore, that only `BCF`, `BSF`, `SWAPF` and `MOVWF` instructions be used to alter the ALUSTA register because these instructions do not affect any status bit. To see how other instructions affect the status bits, see the "Instruction Set Summary."

Note 1: The C and DC bits operate as a borrow out bit in subtraction. See the `SUBLW` and `SUBWF` instructions for examples.

Note 2: The overflow bit will be set if the 2's complement result exceeds +127 or is less than -128.

Arithmetic and Logic Unit (ALU) is capable of carrying out arithmetic or logical operations on two operands or a single operand. All single operand instructions operate either on the WREG register or a file register. For two operand instructions, one of the operands is the WREG register and the other one is either a file register or an 8-bit immediate constant.

FIGURE 6-7: ALUSTA REGISTER (ADDRESS: 04h, UNBANKED)

R/W - 1	R/W - 1	R/W - 1	R/W - 1	R/W - x	R/W - x	R/W - x	R/W - x
FS3	FS2	FS1	FS0	OV	Z	DC	C
bit7							bit0
<p>bit 7-6: FS3:FS2: FSR1 Mode Select bits 00 = Post auto-decrement FSR1 value 01 = Post auto-increment FSR1 value 1x = FSR1 value does not change</p> <p>bit 5-4: FS1:FS0: FSR0 Mode Select bits 00 = Post auto-decrement FSR0 value 01 = Post auto-increment FSR0 value 1x = FSR0 value does not change</p> <p>bit 3: OV: Overflow bit This bit is used for signed arithmetic (2's complement). It indicates an overflow of the 7-bit magnitude, which causes the sign bit (bit7) to change state. 1 = Overflow occurred for signed arithmetic, (in this arithmetic operation) 0 = No overflow occurred</p> <p>bit 2: Z: Zero bit 1 = The result of an arithmetic or logic operation is zero 0 = The results of an arithmetic or logic operation is not zero</p> <p>bit 1: DC: Digit carry/borrow bit For <code>ADDWF</code> and <code>ADDLW</code> instructions. 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 Note: For borrow the polarity is reversed.</p> <p>bit 0: C: carry/borrow bit For <code>ADDWF</code> and <code>ADDLW</code> instructions. 1 = A carry-out from the most significant bit of the result occurred Note that a subtraction is executed by adding the two's complement of the second operand. For rotate (<code>RRCF</code>, <code>RLCF</code>) instructions, this bit is loaded with either the high or low order bit of the source register. 0 = No carry-out from the most significant bit of the result Note: For borrow the polarity is reversed.</p>							

R = Readable bit
 W = Writable bit
 -n = Value at POR reset
 (x = unknown)

7.0 TABLE READS AND TABLE WRITES

The PIC17C4X has four instructions that allow the processor to move data from the data memory space to the program memory space, and vice versa. Since the program memory space is 16-bits wide and the data memory space is 8-bits wide, two operations are required to move 16-bit values to/from the data memory.

The `TLWT t,f` and `TABLWT t,i,f` instructions are used to write data from the data memory space to the program memory space. The `TLRD t,f` and `TABLRD t,i,f` instructions are used to write data from the program memory space to the data memory space.

The program memory can be internal or external. For the program memory access to be external, the device needs to be operating in extended microcontroller or microprocessor mode.

Figure 7-1 through Figure 7-4 show the operation of these four instructions.

FIGURE 7-1: TLWT INSTRUCTION OPERATION

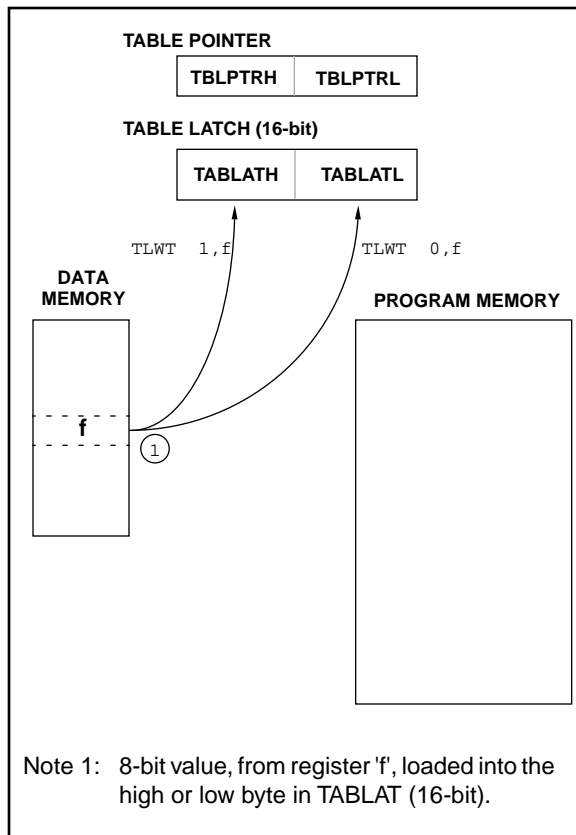
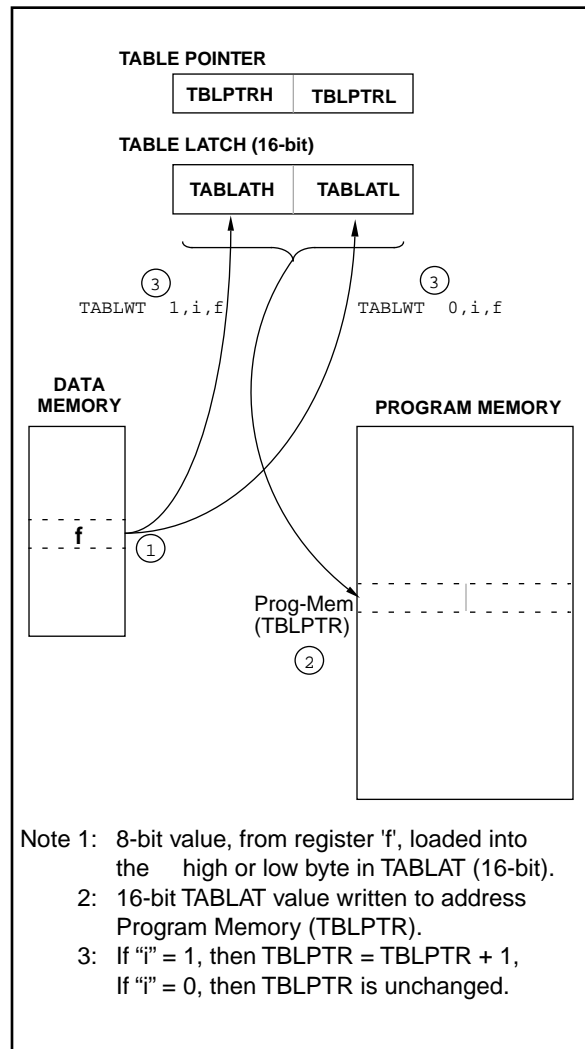


FIGURE 7-2: TABLWT INSTRUCTION OPERATION



11.0 TIMER0

The Timer0 module consists of a 16-bit timer/counter, TMR0. The high byte is TMR0H and the low byte is TMR0L. A software programmable 8-bit prescaler makes an effective 24-bit overflow timer. The clock source is also software programmable as either the internal instruction clock or the RA1/T0CKI pin. The control bits for this module are in register T0STA (Figure 11-1).

FIGURE 11-1: T0STA REGISTER (ADDRESS: 05h, UNBANKED)

R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	R/W - 0	U - 0
INTEDG	T0SE	T0CS	PS3	PS2	PS1	PS0	—
bit7							bit0

R = Readable bit
W = Writable bit
U = Unimplemented, Read as '0'
-n = Value at POR reset

bit 7: **INTEDG:** RA0/INT Pin Interrupt Edge Select bit
This bit selects the edge upon which the interrupt is detected
1 = Rising edge of RA0/INT pin generates interrupt
0 = Falling edge of RA0/INT pin generates interrupt

bit 6: **T0SE:** Timer0 Clock Input Edge Select bit
This bit selects the edge upon which TMR0 will increment
When T0CS = 0
1 = Rising edge of RA1/T0CKI pin increments TMR0 and/or generates a T0CKIF interrupt
0 = Falling edge of RA1/T0CKI pin increments TMR0 and/or generates a T0CKIF interrupt
When T0CS = 1
Don't care

bit 5: **T0CS:** Timer0 Clock Source Select bit
This bit selects the clock source for TMR0.
1 = Internal instruction clock cycle (Tcy)
0 = T0CKI pin

bit 4-1: **PS3:PS0:** Timer0 Prescale Selection bits
These bits select the prescale value for TMR0.

PS3:PS0	Prescale Value
0000	1:1
0001	1:2
0010	1:4
0011	1:8
0100	1:16
0101	1:32
0110	1:64
0111	1:128
1xxx	1:256

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

FIGURE 14-3: CRYSTAL OPERATION, OVERTONE CRYSTALS (XT OSC CONFIGURATION)

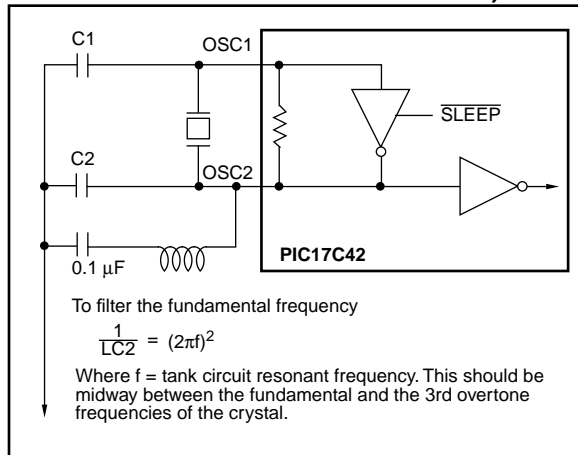


TABLE 14-2: CAPACITOR SELECTION FOR CERAMIC RESONATORS

Oscillator Type	Resonator Frequency	Capacitor Range C1 = C2
LF	455 kHz	15 - 68 pF
	2.0 MHz	10 - 33 pF
XT	4.0 MHz	22 - 68 pF
	8.0 MHz	33 - 100 pF
	16.0 MHz	33 - 100 pF

Higher capacitance increases the stability of the oscillator but also increases the start-up time. These values are for design guidance only. Since each resonator has its own characteristics, the user should consult the resonator manufacturer for appropriate values of external components.

Resonators Used:

455 kHz	Panasonic EFO-A455K04B	± 0.3%
2.0 MHz	Murata Erie CSA2.00MG	± 0.5%
4.0 MHz	Murata Erie CSA4.00MG	± 0.5%
8.0 MHz	Murata Erie CSA8.00MT	± 0.5%
16.0 MHz	Murata Erie CSA16.00MX	± 0.5%

Resonators used did not have built-in capacitors.

TABLE 14-3: CAPACITOR SELECTION FOR CRYSTAL OSCILLATOR

Osc Type	Freq	C1	C2
LF	32 kHz ⁽¹⁾	100-150 pF	100-150 pF
	1 MHz	10-33 pF	10-33 pF
	2 MHz	10-33 pF	10-33 pF
XT	2 MHz	47-100 pF	47-100 pF
	4 MHz	15-68 pF	15-68 pF
	8 MHz ⁽²⁾	15-47 pF	15-47 pF
	16 MHz	TBD	TBD
	25 MHz	15-47 pF	15-47 pF
	32 MHz ⁽³⁾	0 ⁽³⁾	0 ⁽³⁾

Higher capacitance increases the stability of the oscillator but also increases the start-up time and the oscillator current. These values are for design guidance only. Rs may be required in XT mode to avoid overdriving the crystals with low drive level specification. Since each crystal has its own characteristics, the user should consult the crystal manufacturer for appropriate values for external components.

Note 1: For VDD > 4.5V, C1 = C2 ≈ 30 pF is recommended.

2: Rs of 330Ω is required for a capacitor combination of 15/15 pF.

3: Only the capacitance of the board was present.

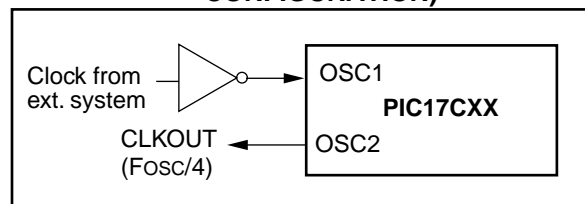
Crystals Used:

32.768 kHz	Epson C-001R32.768K-A	± 20 PPM
1.0 MHz	ECS-10-13-1	± 50 PPM
2.0 MHz	ECS-20-20-1	± 50 PPM
4.0 MHz	ECS-40-20-1	± 50 PPM
8.0 MHz	ECS ECS-80-S-4 ECS-80-18-1	± 50 PPM
16.0 MHz	ECS-160-20-1	TBD
25 MHz	CTS CTS25M	± 50 PPM
32 MHz	CRYSTEK HF-2	± 50 PPM

14.2.3 EXTERNAL CLOCK OSCILLATOR

In the EC oscillator mode, the OSC1 input can be driven by CMOS drivers. In this mode, the OSC1/CLKIN pin is hi-impedance and the OSC2/CLKOUT pin is the CLKOUT output (4 TOSC).

FIGURE 14-4: EXTERNAL CLOCK INPUT OPERATION (EC OSC CONFIGURATION)



14.3 Watchdog Timer (WDT)

The Watchdog Timer's function is to recover from software malfunction. The WDT uses an internal free running on-chip RC oscillator for its clock source. This does not require any external components. This RC oscillator is separate from the RC oscillator of the OSC1/CLKIN pin. That means that the WDT will run, even if the clock on the OSC1/CLKIN and OSC2/CLKOUT pins of the device has been stopped, for example, by execution of a `SLEEP` instruction. During normal operation and SLEEP mode, a WDT time-out generates a device RESET. The WDT can be permanently disabled by programming the configuration bits WDTPS1:WDTPS0 as '00' (Section 14.1).

Under normal operation, the WDT must be cleared on a regular interval. This time is less the minimum WDT overflow time. Not clearing the WDT in this time frame will cause the WDT to overflow and reset the device.

14.3.1 WDT PERIOD

The WDT has a nominal time-out period of 12 ms, (with postscaler = 1). The time-out periods vary with temperature, V_{DD} and process variations from part to part (see DC specs). If longer time-out periods are desired, a postscaler with a division ratio of up to 1:256 can be assigned to the WDT. Thus, typical time-out periods up to 3.0 seconds can be realized.

The `CLRWDT` and `SLEEP` instructions clear the WDT and the postscaler (if assigned to the WDT) and prevent it from timing out thus generating a device RESET condition.

The \overline{TO} bit in the CPUSTA register will be cleared upon a WDT time-out.

14.3.2 CLEARING THE WDT AND POSTSCALER

The WDT and postscaler are cleared when:

- The device is in the reset state
- A `SLEEP` instruction is executed
- A `CLRWDT` instruction is executed
- Wake-up from SLEEP by an interrupt

The WDT counter/postscaler will start counting on the first edge after the device exits the reset state.

14.3.3 WDT PROGRAMMING CONSIDERATIONS

It should also be taken in account that under worst case conditions (V_{DD} = Min., Temperature = Max., max. WDT postscaler) it may take several seconds before a WDT time-out occurs.

The WDT and postscaler is the Power-up Timer during the Power-on Reset sequence.

14.3.4 WDT AS NORMAL TIMER

When the WDT is selected as a normal timer, the clock source is the device clock. Neither the WDT nor the postscaler are directly readable or writable. The overflow time is 65536 T_{OSC} cycles. On overflow, the \overline{TO} bit is cleared (device is not reset). The `CLRWDT` instruction can be used to set the \overline{TO} bit. This allows the WDT to be a simple overflow timer. When in sleep, the WDT does not increment.

ADDLW

ADD Literal to WREG

Syntax: [*label*] ADDLW k

Operands: $0 \leq k \leq 255$

Operation: (WREG) + k → (WREG)

Status Affected: OV, C, DC, Z

Encoding:

1011	0001	kkkk	kkkk
------	------	------	------

Description: The contents of WREG are added to the 8-bit literal 'k' and the result is placed in WREG.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Execute	Write to WREG

Example: ADDLW 0x15

Before Instruction
WREG = 0x10

After Instruction
WREG = 0x25

ADDWF

ADD WREG to f

Syntax: [*label*] ADDWF f,d

Operands: $0 \leq f \leq 255$
 $d \in [0,1]$

Operation: (WREG) + (f) → (dest)

Status Affected: OV, C, DC, Z

Encoding:

0000	111d	ffff	ffff
------	------	------	------

Description: Add WREG to register 'f'. If 'd' is 0 the result is stored in WREG. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write to destination

Example: ADDWF REG, 0

Before Instruction
WREG = 0x17
REG = 0xC2

After Instruction
WREG = 0xD9
REG = 0xC2

ANDWF

AND WREG with f

Syntax:

[/label] ANDWF f,d

Operands:

$0 \leq f \leq 255$

$d \in [0,1]$

Operation:

(WREG) .AND. (f) → (dest)

Status Affected:

Z

Encoding:

0000	101d	ffff	ffff
------	------	------	------

Description:

The contents of WREG are AND'ed with register 'f'. If 'd' is 0 the result is stored in WREG. If 'd' is 1 the result is stored back in register 'f'.

Words:

1

Cycles:

1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write to destination

Example: ANDWF REG, 1

Before Instruction

 WREG = 0x17

 REG = 0xC2

After Instruction

 WREG = 0x17

 REG = 0x02

BCF

Bit Clear f

Syntax:

[/label] BCF f,b

Operands:

$0 \leq f \leq 255$

$0 \leq b \leq 7$

Operation:

$0 \rightarrow (f)$

Status Affected:

None

Encoding:

1000	1bbb	ffff	ffff
------	------	------	------

Description:

Bit 'b' in register 'f' is cleared.

Words:

1

Cycles:

1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write register 'f'

Example: BCF FLAG_REG, 7

Before Instruction

 FLAG_REG = 0xC7

After Instruction

 FLAG_REG = 0x47

INCF Increment f

Syntax: [*label*] INCF f,d

Operands: $0 \leq f \leq 255$
 $d \in [0,1]$

Operation: $(f) + 1 \rightarrow (\text{dest})$

Status Affected: OV, C, DC, Z

Encoding:

0001	010d	ffff	ffff
------	------	------	------

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in WREG. If 'd' is 1 the result is placed back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write to destination

Example: INCF CNT, 1

Before Instruction

CNT = 0xFF
 Z = 0
 C = ?

After Instruction

CNT = 0x00
 Z = 1
 C = 1

INCFSZ Increment f, skip if 0

Syntax: [*label*] INCFSZ f,d

Operands: $0 \leq f \leq 255$
 $d \in [0,1]$

Operation: $(f) + 1 \rightarrow (\text{dest})$
 skip if result = 0

Status Affected: None

Encoding:

0001	111d	ffff	ffff
------	------	------	------

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in WREG. If 'd' is 1 the result is placed back in register 'f'.

If the result is 0, the next instruction, which is already fetched, is discarded, and an NOP is executed instead making it a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write to destination

If skip:

Q1	Q2	Q3	Q4
Forced NOP	NOP	Execute	NOP

Example: HERE INCFSZ CNT, 1
 NZERO :
 ZERO :

Before Instruction

PC = Address (HERE)

After Instruction

CNT = CNT + 1
 If CNT = 0;
 PC = Address (ZERO)
 If CNT \neq 0;
 PC = Address (NZERO)

NEGW

Negate W

Syntax:

[*label*] NEGW f,s

Operands:

$0 \leq F \leq 255$

$s \in [0,1]$

Operation:

$\overline{WREG} + 1 \rightarrow (f);$

$\overline{WREG} + 1 \rightarrow s$

Status Affected:

OV, C, DC, Z

Encoding:

0010	110s	ffff	ffff
------	------	------	------

Description:

WREG is negated using two's complement. If 's' is 0 the result is placed in WREG and data memory location 'f'. If 's' is 1 the result is placed only in data memory location 'f'.

Words:

1

Cycles:

1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Execute	Write register 'f' and other specified register

Example: NEGW REG,0

Before Instruction
WREG = 0011 1010 [0x3A],
REG = 1010 1011 [0xAB]

After Instruction
WREG = 1100 0111 [0xC6]
REG = 1100 0111 [0xC6]

NOP

No Operation

Syntax:

[*label*] NOP

Operands:

None

Operation:

No operation

Status Affected:

None

Encoding:

0000	0000	0000	0000
------	------	------	------

Description:

No operation.

Words:

1

Cycles:

1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	NOP	Execute	NOP

Example:

None.

Standard Operating Conditions (unless otherwise stated)							
DC CHARACTERISTICS							
Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial and $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for commercial							
Operating voltage V_{DD} range as described in Section 17.1							
Parameter No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
D080 D081	VOL	Output Low Voltage I/O ports (except RA2 and RA3) with TTL buffer	– –	– –	0.1V _{DD} 0.4	V V	IOL = 4 mA IOL = 6 mA, V _{DD} = 4.5V Note 6
D082 D083		RA2 and RA3 OSC2/CLKOUT (RC and EC osc modes)	– –	– –	3.0 0.4	V V	IOL = 60.0 mA, V _{DD} = 5.5V IOL = 2 mA, V _{DD} = 4.5V
D090 D091	VOH	Output High Voltage (Note 3) I/O ports (except RA2 and RA3) with TTL buffer	0.9V _{DD} 2.4	– –	– –	V V	IOH = -2 mA IOH = -6.0 mA, V _{DD} = 4.5V Note 6
D092 D093		RA2 and RA3 OSC2/CLKOUT (RC and EC osc modes)	– 2.4	– –	12 –	V V	Pulled-up to externally applied voltage IOH = -5 mA, V _{DD} = 4.5V
D100	Cosc2	Capacitive Loading Specs on Output Pins OSC2 pin	–	–	25 ††	pF	In EC or RC osc modes when OSC2 pin is outputting CLKOUT. External clock is used to drive OSC1.
D101	CIO	All I/O pins and OSC2 (in RC mode)	–	–	50 ††	pF	
D102	CAD	System Interface Bus (PORTC, PORTD and PORTE)	–	–	100 ††	pF	In Microprocessor or Extended Microcontroller mode

* 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.

‡ These parameters are for design guidance only and are not tested, nor characterized.

†† Design guidance to attain the AC timing specifications. These loads are not tested.

Note 1: In RC oscillator configuration, the OSC1 pin is a Schmitt Trigger input. It is not recommended that the PIC17CXX devices be driven with external clock in RC mode.

2: The leakage current on the 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.

3: Negative current is defined as coming out of the pin.

4: These specifications are for the programming of the on-chip program memory EPROM through the use of the table write instructions. The complete programming specifications can be found in: PIC17CXX Programming Specifications (Literature number DS30139).

5: The MCLR/Vpp pin may be kept in this range at times other than programming, but this is not recommended.

6: For TTL buffers, the better of the two specifications may be used.

PIC17C4X

Applicable Devices 42 R42 42A 43 R43 44

FIGURE 18-9: TYPICAL I_{PD} vs. V_{DD} WATCHDOG DISABLED 25°C

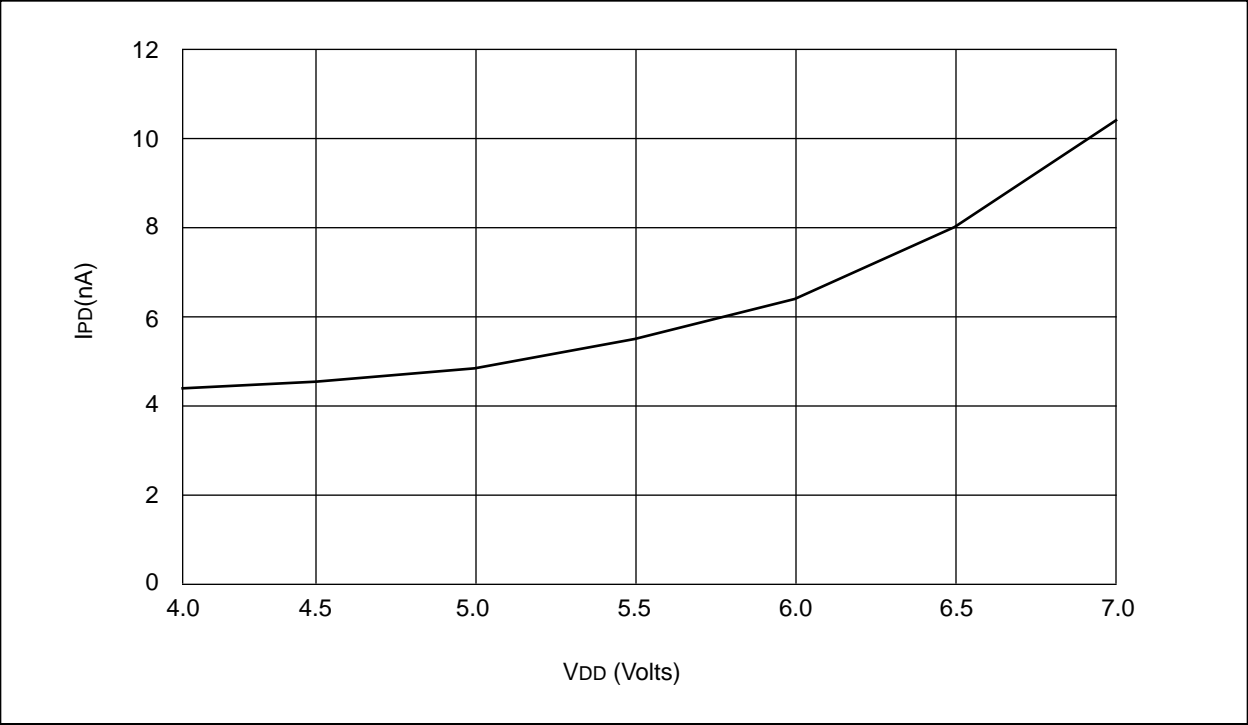
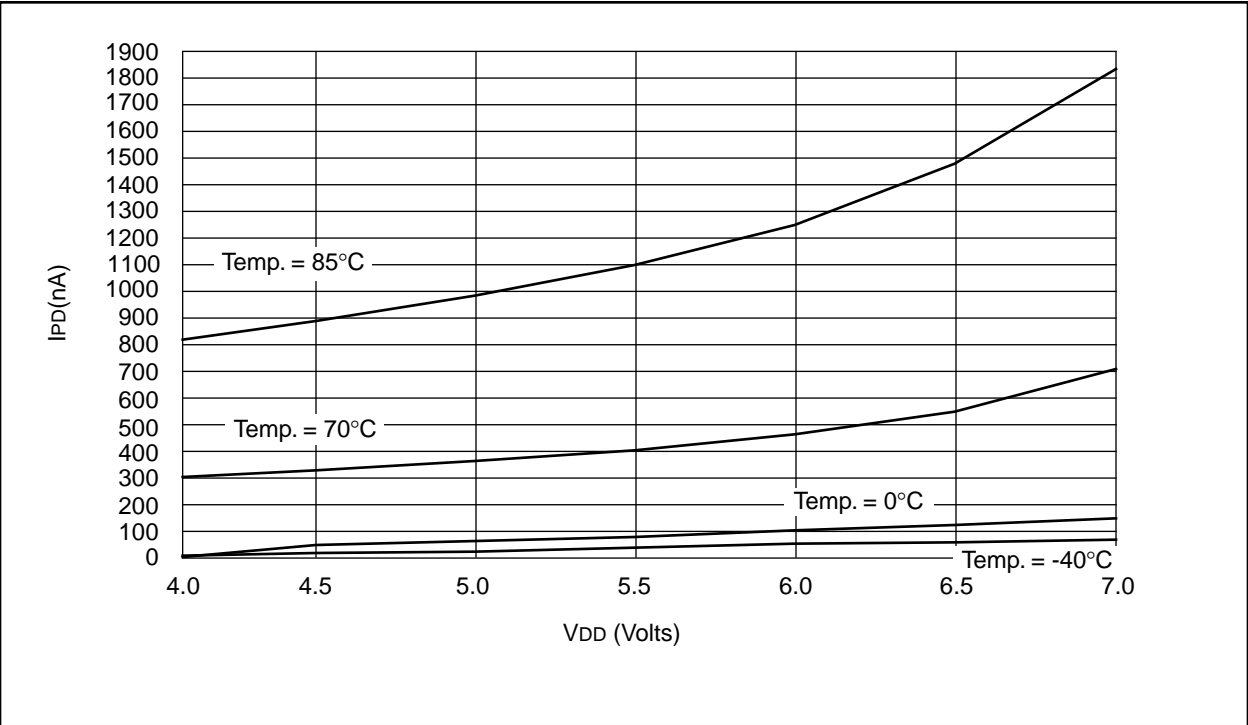


FIGURE 18-10: MAXIMUM I_{PD} vs. V_{DD} WATCHDOG DISABLED



PIC17C4X

Applicable Devices 42 R42 42A 43 R43 44

FIGURE 18-13: WDT TIMER TIME-OUT PERIOD vs. VDD

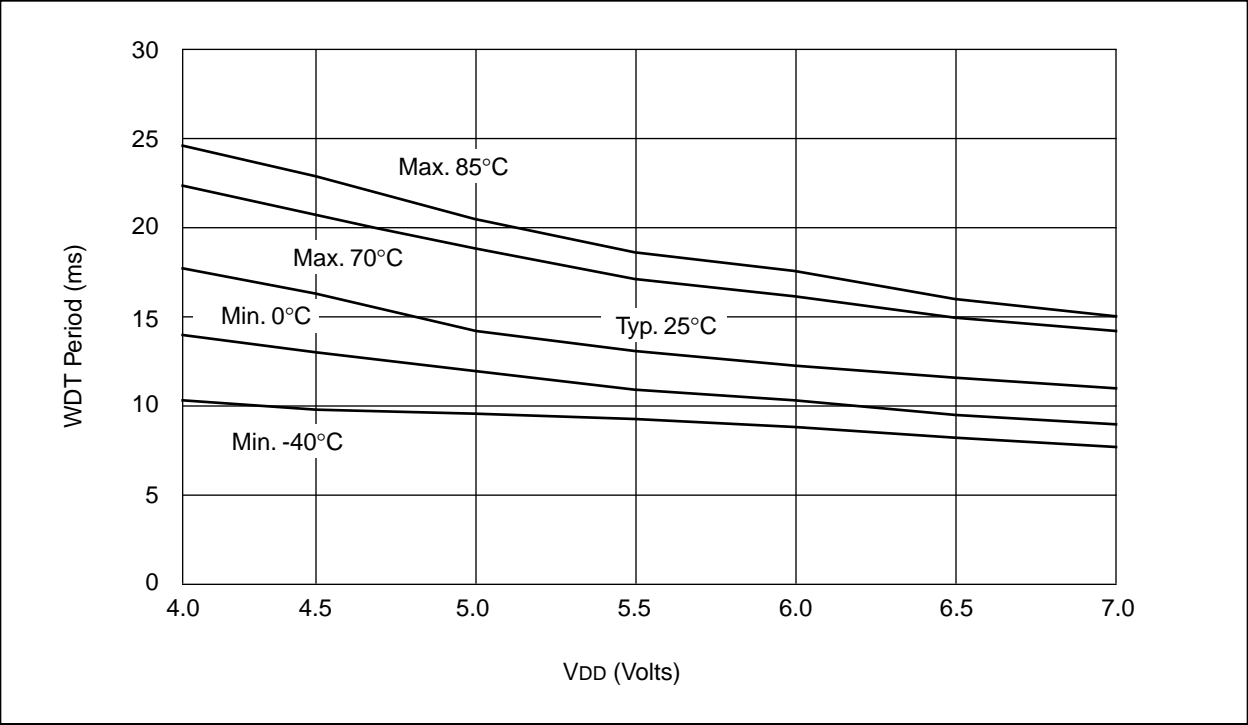


FIGURE 18-14: IOH vs. VOH, VDD = 3V

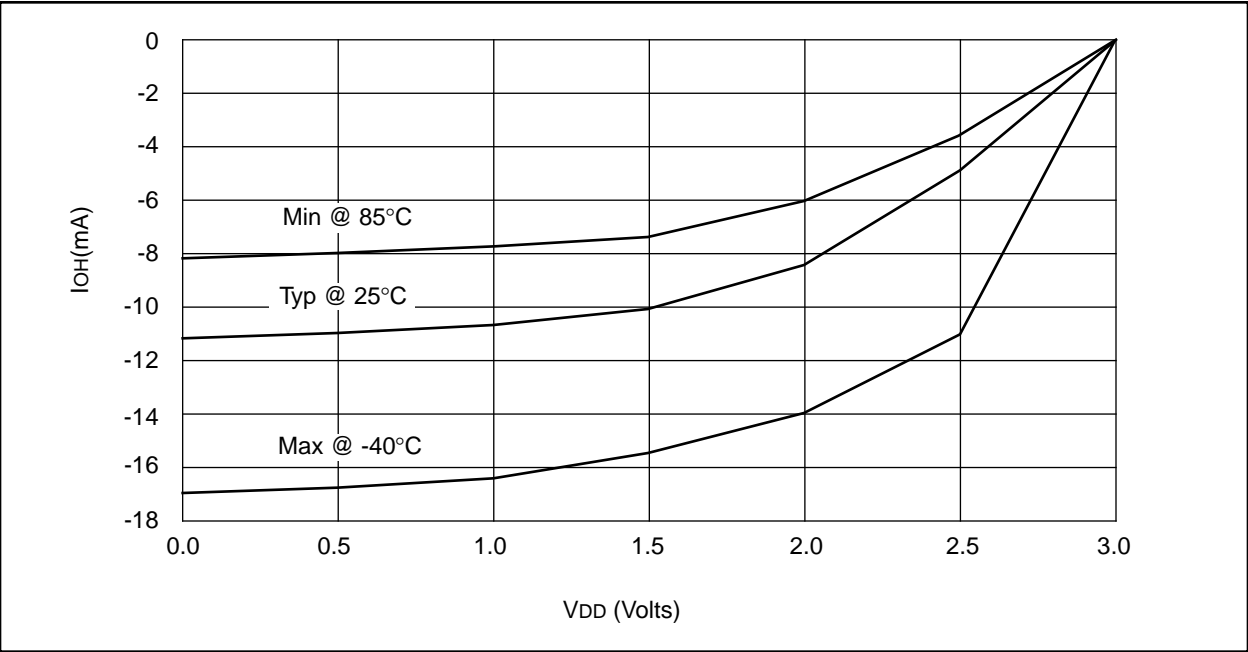


FIGURE 20-4: TYPICAL RC OSCILLATOR FREQUENCY vs. V_{DD}

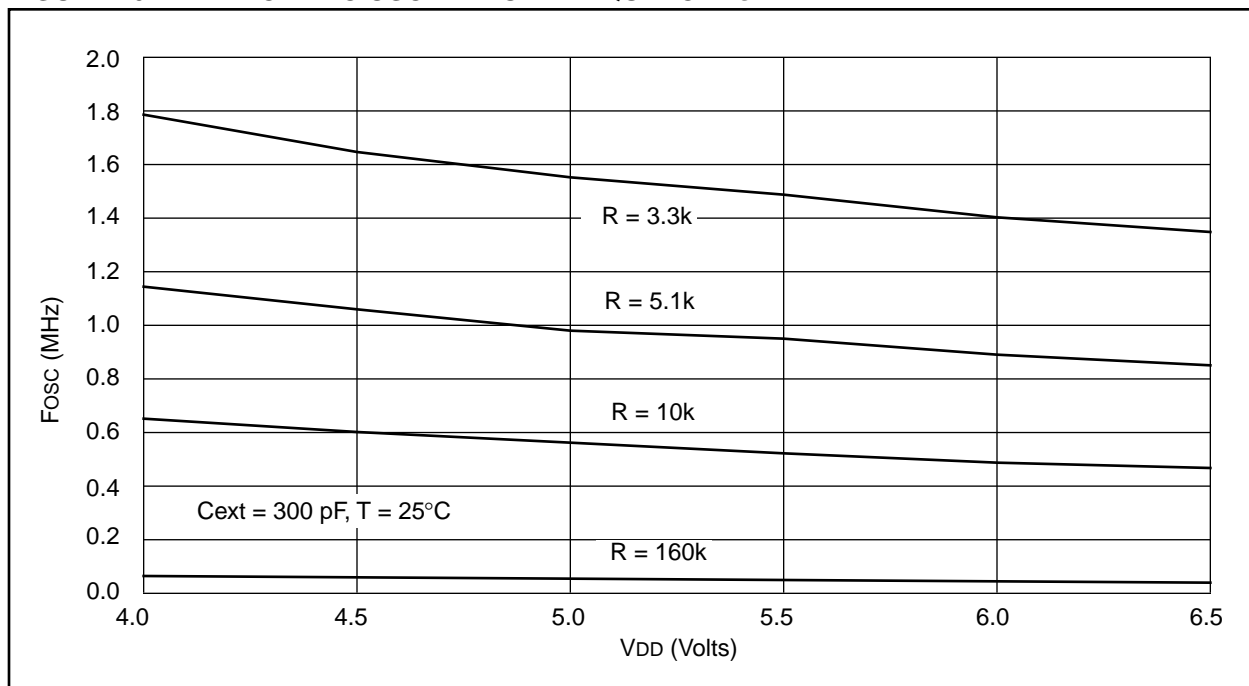


TABLE 20-2: RC OSCILLATOR FREQUENCIES

Cext	Rext	Average	
		Fosc @ 5V, 25°C	
22 pF	10k	3.33 MHz	± 12%
	100k	353 kHz	± 13%
100 pF	3.3k	3.54 MHz	± 10%
	5.1k	2.43 MHz	± 14%
	10k	1.30 MHz	± 17%
	100k	129 kHz	± 10%
300 pF	3.3k	1.54 MHz	± 14%
	5.1k	980 kHz	± 12%
	10k	564 kHz	± 16%
	160k	35 kHz	± 18%

APPENDIX A: MODIFICATIONS

The following is the list of modifications over the PIC16CXX microcontroller family:

1. Instruction word length is increased to 16-bit. This allows larger page sizes both in program memory (8 Kwords versus 2 Kwords) and register file (256 bytes versus 128 bytes).
2. Four modes of operation: microcontroller, protected microcontroller, extended microcontroller, and microprocessor.
3. 22 new instructions. The `MOVF`, `TRIS` and `OPTION` instructions have been removed.
4. 4 new instructions for transferring data between data memory and program memory. This can be used to "self program" the EPROM program memory.
5. Single cycle data memory to data memory transfers possible (`MOVFP` and `MOVFP` instructions). These instructions do not affect the Working register (WREG).
6. W register (WREG) is now directly addressable.
7. A PC high latch register (PCLATH) is extended to 8-bits. The PCLATCH register is now both readable and writable.
8. Data memory paging is redefined slightly.
9. DDR registers replaces function of TRIS registers.
10. Multiple Interrupt vectors added. This can decrease the latency for servicing the interrupt.
11. Stack size is increased to 16 deep.
12. BSR register for data memory paging.
13. Wake up from SLEEP operates slightly differently.
14. The Oscillator Start-Up Timer (OST) and Power-Up Timer (PWRT) operate in parallel and not in series.
15. PORTB interrupt on change feature works on all eight port pins.
16. TMR0 is 16-bit plus 8-bit prescaler.
17. Second indirect addressing register added (FSR1 and FSR2). Configuration bits can select the FSR registers to auto-increment, auto-decrement, remain unchanged after an indirect address.
18. Hardware multiplier added (8 x 8 → 16-bit) (PIC17C43 and PIC17C44 only).
19. Peripheral modules operate slightly differently.
20. Oscillator modes slightly redefined.
21. Control/Status bits and registers have been placed in different registers and the control bit for globally enabling interrupts has inverse polarity.
22. Addition of a test mode pin.
23. In-circuit serial programming is not implemented.

APPENDIX B: COMPATIBILITY

To convert code written for PIC16CXX to PIC17CXX, the user should take the following steps:

1. Remove any `TRIS` and `OPTION` instructions, and implement the equivalent code.
2. Separate the interrupt service routine into its four vectors.
3. Replace:

```
MOVF    REG1, W
```

 with:

```
MOVFP   REG1, WREG
```
4. Replace:

```
MOVF    REG1, W
```

```
MOVWF   REG2
```

 with:

```
MOVFP   REG1, REG2 ; Addr(REG1)<20h
```

 or

```
MOVFP   REG1, REG2 ; Addr(REG2)<20h
```

Note: If REG1 and REG2 are both at addresses greater than 20h, two instructions are required.

```
MOVFP   REG1, WREG ;
MOVFP   WREG, REG2 ;
```

5. Ensure that all bit names and register names are updated to new data memory map location.
6. Verify data memory banking.
7. Verify mode of operation for indirect addressing.
8. Verify peripheral routines for compatibility.
9. Weak pull-ups are enabled on reset.

To convert code from the PIC17C42 to all the other PIC17C4X devices, the user should take the following steps.

1. If the hardware multiply is to be used, ensure that any variables at address 18h and 19h are moved to another address.
2. Ensure that the upper nibble of the BSR was not written with a non-zero value. This may cause unexpected operation since the RAM bank is no longer 0.
3. The disabling of global interrupts has been enhanced so there is no additional testing of the GLINTD bit after a `BSF CPUSTA, GLINTD` instruction.