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Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	4MHz
Connectivity	-
Peripherals	Brown-out Detect/Reset, PWM, WDT
Number of I/O	13
Program Memory Size	3.5KB (2K x 14)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	128 x 8
Voltage - Supply (Vcc/Vdd)	2.5V ~ 5.5V
Data Converters	A/D 4x8b
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	20-SSOP (0.209", 5.30mm Width)
Supplier Device Package	20-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16lc715t-04i-ss

3.0 ARCHITECTURAL OVERVIEW

The high performance of the PIC16CXX family can be attributed to a number of architectural features commonly found in RISC microprocessors. To begin with, the PIC16CXX uses a Harvard architecture, in which, program and data are accessed from separate memories using separate buses. This improves bandwidth over traditional von Neumann architecture in which program and data are fetched from the same memory using the same bus. Separating program and data buses further allows instructions to be sized differently than the 8-bit wide data word. Instruction opcodes are 14-bits wide making it possible to have all single word instructions. A 14-bit wide program memory access bus fetches a 14-bit instruction in a single cycle. A two-stage pipeline overlaps fetch and execution of instructions (Example 3-1). Consequently, all instructions (35) execute in a single cycle (200 ns @ 20 MHz) except for program branches.

The table below lists program memory (EPROM) and data memory (RAM) for each PIC16C71X device.

Device	Program Memory	Data Memory
PIC16C710	512 x 14	36 x 8
PIC16C71	1K x 14	36 x 8
PIC16C711	1K x 14	68 x 8
PIC16C715	2K x 14	128 x 8

The PIC16CXX can directly or indirectly address its register files or data memory. All special function registers, including the program counter, are mapped in the data memory. The PIC16CXX has an orthogonal (symmetrical) instruction set that makes it possible to carry out any operation on any register using any addressing mode. This symmetrical nature and lack of 'special optimal situations' make programming with the PIC16CXX simple yet efficient. In addition, the learning curve is reduced significantly.

PIC16CXX devices contain an 8-bit ALU and working register. The ALU is a general purpose arithmetic unit. It performs arithmetic and Boolean functions between the data in the working register and any register file.

The ALU is 8-bits wide and capable of addition, subtraction, shift and logical operations. Unless otherwise mentioned, arithmetic operations are two's complement in nature. In two-operand instructions, typically one operand is the working register (W register). The other operand is a file register or an immediate constant. In single operand instructions, the operand is either the W register or a file register.

The W register is an 8-bit working register used for ALU operations. It is not an addressable register.

Depending on the instruction executed, the ALU may affect the values of the Carry (C), Digit Carry (DC), and Zero (Z) bits in the STATUS register. The C and DC bits operate as a borrow bit and a digit borrow out bit, respectively, in subtraction. See the SUBLW and SUBWF instructions for examples.

PIC16C71X

3.1 Clocking Scheme/Instruction Cycle

The clock input (from OSC1) is internally divided by four to generate four non-overlapping quadrature clocks namely Q1, Q2, Q3 and Q4. Internally, the program counter (PC) is incremented every Q1, the instruction is fetched from the program memory and latched into the instruction register in Q4. The instruction is decoded and executed during the following Q1 through Q4. The clocks and instruction execution flow is shown in Figure 3-2.

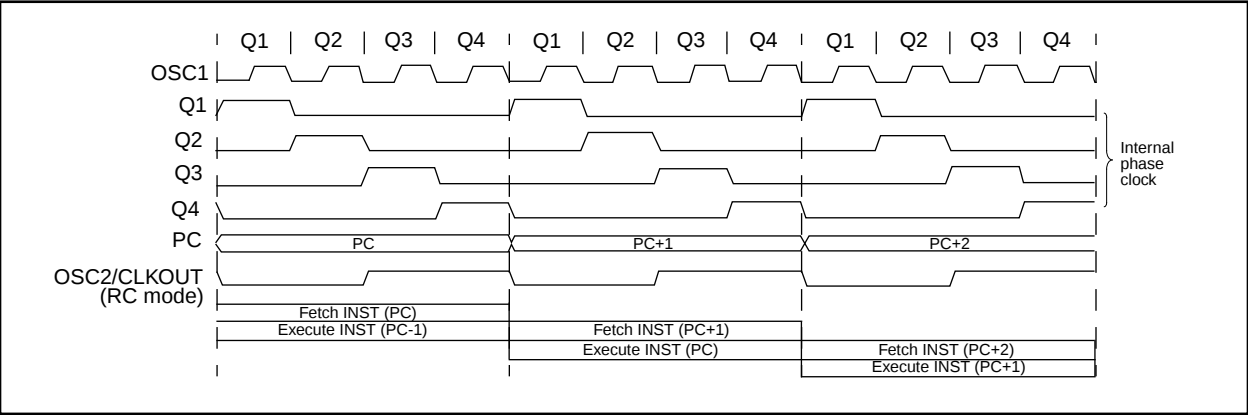
3.2 Instruction Flow/Pipelining

An "Instruction Cycle" consists of four Q cycles (Q1, Q2, Q3 and Q4). The instruction fetch and execute are pipelined such that fetch takes one instruction cycle while decode and execute takes another instruction cycle. However, due to the pipelining, each instruction effectively executes in one cycle. If an instruction causes the program counter to change (e.g. GOTO) then two cycles are required to complete the instruction (Example 3-1).

A fetch cycle begins with the program counter (PC) incrementing in Q1.

In the execution cycle, the fetched instruction is latched into the "Instruction Register" (IR) in cycle Q1. This instruction is then decoded and executed during the Q2, Q3, and Q4 cycles. Data memory is read during Q2 (operand read) and written during Q4 (destination write).

FIGURE 3-2: CLOCK/INSTRUCTION CYCLE



EXAMPLE 3-1: INSTRUCTION PIPELINE FLOW

	Tcy0	Tcy1	Tcy2	Tcy3	Tcy4	Tcy5
1. MOVLW 55h	Fetch 1	Execute 1				
2. MOVWF PORTB		Fetch 2	Execute 2			
3. CALL SUB_1			Fetch 3	Execute 3		
4. BSF PORTA, BIT3 (Forced NOP)				Fetch 4	Flush	
5. Instruction @ address SUB_1					Fetch SUB_1	Execute SUB_1

All instructions are single cycle, except for any program branches. These take two cycles since the fetch instruction is "flushed" from the pipeline while the new instruction is being fetched and then executed.

PIC16C71X

4.2.2.2 OPTION REGISTER

Applicable Devices	710	71	711	715
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The OPTION register is a readable and writable register which contains various control bits to configure the TMR0/WDT prescaler, the External INT Interrupt, TMR0, and the weak pull-ups on PORTB.

Note: To achieve a 1:1 prescaler assignment for the TMR0 register, assign the prescaler to the Watchdog Timer by setting bit PSA (OPTION<3>).

FIGURE 4-8: OPTION REGISTER (ADDRESS 81h, 181h)

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
RBP _U	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0
bit7							bit0

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

bit 7: **RBP_U**: PORTB Pull-up Enable bit
1 = PORTB pull-ups are disabled
0 = PORTB pull-ups are enabled by individual port latch values

bit 6: **INTEDG**: Interrupt Edge Select bit
1 = Interrupt on rising edge of RB0/INT pin
0 = Interrupt on falling edge of RB0/INT pin

bit 5: **T0CS**: TMR0 Clock Source Select bit
1 = Transition on RA4/T0CKI pin
0 = Internal instruction cycle clock (CLKOUT)

bit 4: **T0SE**: TMR0 Source Edge Select bit
1 = Increment on high-to-low transition on RA4/T0CKI pin
0 = Increment on low-to-high transition on RA4/T0CKI pin

bit 3: **PSA**: Prescaler Assignment bit
1 = Prescaler is assigned to the WDT
0 = Prescaler is assigned to the Timer0 module

bit 2-0: **PS2:PS0**: Prescaler Rate Select bits

Bit Value	TMR0 Rate	WDT Rate
000	1 : 2	1 : 1
001	1 : 4	1 : 2
010	1 : 8	1 : 4
011	1 : 16	1 : 8
100	1 : 32	1 : 16
101	1 : 64	1 : 32
110	1 : 128	1 : 64
111	1 : 256	1 : 128

TABLE 5-4: SUMMARY OF REGISTERS ASSOCIATED WITH PORTB

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other resets
06h, 106h	PORTB	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	xxxx xxxx	uuuu uuuu
86h, 186h	TRISB	PORTB Data Direction Register								1111 1111	1111 1111
81h, 181h	OPTION	$\overline{\text{RBPU}}$	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0	1111 1111	1111 1111

Legend: x = unknown, u = unchanged. Shaded cells are not used by PORTB.

PIC16C71X

FIGURE 7-2: ADCON0 REGISTER (ADDRESS 1Fh), PIC16C715

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0
ADCS1	ADCS0	—	CHS1	CHS0	GO/DONE	—	ADON
bit7							bit0

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

bit 7-6: **ADCS1:ADCS0:** A/D Conversion Clock Select bits
00 = Fosc/2
01 = Fosc/8
10 = Fosc/32
11 = FRC (clock derived from an RC oscillation)

bit 5: **Unused**

bit 6-3: **CHS1:CHS0:** Analog Channel Select bits
000 = channel 0, (RA0/AN0)
001 = channel 1, (RA1/AN1)
010 = channel 2, (RA2/AN2)
011 = channel 3, (RA3/AN3)
100 = channel 0, (RA0/AN0)
101 = channel 1, (RA1/AN1)
110 = channel 2, (RA2/AN2)
111 = channel 3, (RA3/AN3)

bit 2: **GO/DONE:** A/D Conversion Status bit
If ADON = 1
1 = A/D conversion in progress (setting this bit starts the A/D conversion)
0 = A/D conversion not in progress (This bit is automatically cleared by hardware when the A/D conversion is complete)

bit 1: **Unimplemented:** Read as '0'

bit 0: **ADON:** A/D On bit
1 = A/D converter module is operating
0 = A/D converter module is shutoff and consumes no operating current

FIGURE 7-3: ADCON1 REGISTER, PIC16C710/711 (ADDRESS 88h), PIC16C715 (ADDRESS 9Fh)

U-0	U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0
—	—	—	—	—	—	PCFG1	PCFG0
bit7							bit0

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

bit 7-2: **Unimplemented:** Read as '0'

bit 1-0: **PCFG1:PCFG0:** A/D Port Configuration Control bits

PCFG1:PCFG0	RA1 & RA0	RA2	RA3	VREF
00	A	A	A	VDD
01	A	A	VREF	RA3
10	A	D	D	VDD
11	D	D	D	VDD

A = Analog input
D = Digital I/O

8.4 Power-on Reset (POR), Power-up Timer (PWRT) and Oscillator Start-up Timer (OST), and Brown-out Reset (BOR)

8.4.1 POWER-ON RESET (POR)

Applicable Devices	710	71	711	715
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A Power-on Reset pulse is generated on-chip when V_{DD} rise is detected (in the range of 1.5V - 2.1V). To take advantage of the POR, just tie the $\overline{MCLR}$ pin directly (or through a resistor) to V_{DD} . This will eliminate external RC components usually needed to create a Power-on Reset. A maximum rise time for V_{DD} is specified. See Electrical Specifications for details.

When the device starts normal operation (exits the reset condition), device operating parameters (voltage, frequency, temperature, ...) must be met to ensure operation. If these conditions are not met, the device must be held in reset until the operating conditions are met. Brown-out Reset may be used to meet the startup conditions.

For additional information, refer to Application Note AN607, "Power-up Trouble Shooting."

8.4.2 POWER-UP TIMER (PWRT)

Applicable Devices	710	71	711	715
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The Power-up Timer provides a fixed 72 ms nominal time-out on power-up only, from the POR. The Power-up Timer operates on an internal RC oscillator. The chip is kept in reset as long as the PWRT is active. The PWRT's time delay allows V_{DD} to rise to an acceptable level. A configuration bit is provided to enable/disable the PWRT.

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

8.4.3 OSCILLATOR START-UP TIMER (OST)

Applicable Devices	710	71	711	715
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The Oscillator Start-up Timer (OST) provides 1024 oscillator cycle (from OSC1 input) delay after the PWRT delay is over. This ensures that the crystal oscillator or resonator has started and stabilized.

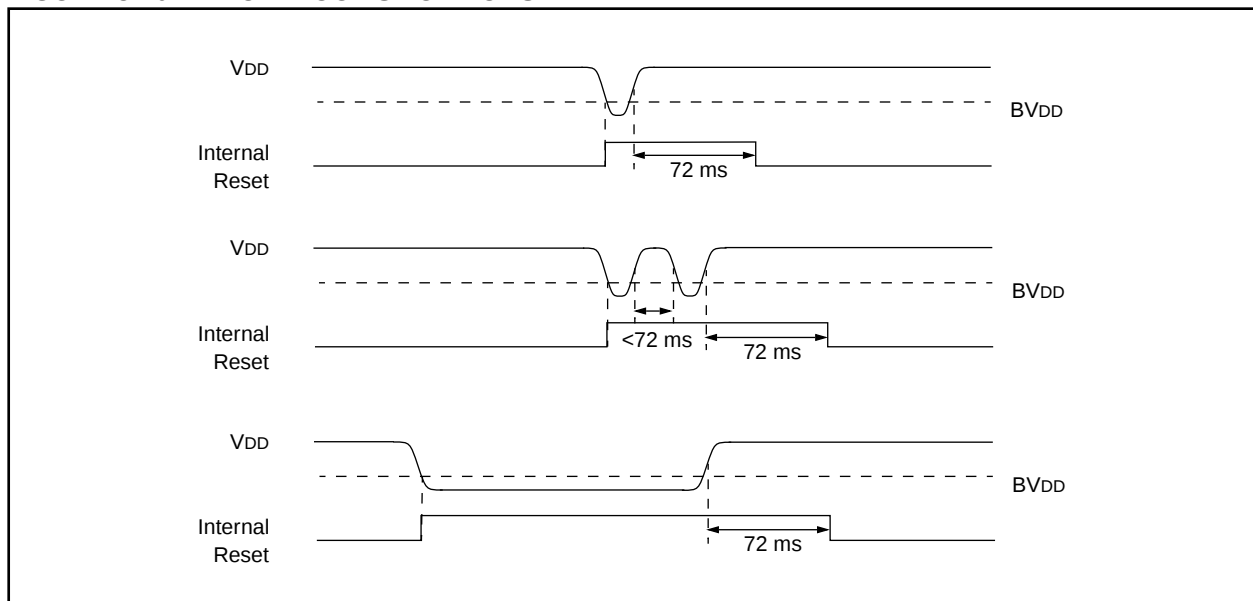
The OST time-out is invoked only for XT, LP and HS modes and only on Power-on Reset or wake-up from SLEEP.

8.4.4 BROWN-OUT RESET (BOR)

Applicable Devices	710	71	711	715
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A configuration bit, BODEN, can disable (if clear/programmed) or enable (if set) the Brown-out Reset circuitry. If V_{DD} falls below 4.0V (3.8V - 4.2V range) for greater than parameter #35, the brown-out situation will reset the chip. A reset may not occur if V_{DD} falls below 4.0V for less than parameter #35. The chip will remain in Brown-out Reset until V_{DD} rises above BV_{DD} . The Power-up Timer will now be invoked and will keep the chip in RESET an additional 72 ms. If V_{DD} drops below BV_{DD} while the Power-up Timer is running, the chip will go back into a Brown-out Reset and the Power-up Timer will be initialized. Once V_{DD} rises above BV_{DD} , the Power-up Timer will execute a 72 ms time delay. The Power-up Timer should always be enabled when Brown-out Reset is enabled. Figure 8-10 shows typical brown-out situations.

FIGURE 8-10: BROWN-OUT SITUATIONS



PIC16C71X

8.6 Context Saving During Interrupts

During an interrupt, only the return PC value is saved on the stack. Typically, users may wish to save key registers during an interrupt i.e., W register and STATUS register. This will have to be implemented in software.

Example 8-1 stores and restores the STATUS and W registers. The user register, STATUS_TEMP, must be defined in bank 0.

The example:

- a) Stores the W register.
- b) Stores the STATUS register in bank 0.
- c) Executes the ISR code.
- d) Restores the STATUS register (and bank select bit).
- e) Restores the W register.

EXAMPLE 8-1: SAVING STATUS AND W REGISTERS IN RAM

```
MOVWF    W_TEMP          ;Copy W to TEMP register, could be bank one or zero
SWAPF    STATUS,W         ;Swap status to be saved into W
MOVWF    STATUS_TEMP      ;Save status to bank zero STATUS_TEMP register
:
:(ISR)
:
SWAPF    STATUS_TEMP,W    ;Swap STATUS_TEMP register into W
                        ;(sets bank to original state)
MOVWF    STATUS           ;Move W into STATUS register
SWAPF    W_TEMP,F         ;Swap W_TEMP
SWAPF    W_TEMP,W         ;Swap W_TEMP into W
```

8.7 Watchdog Timer (WDT)

Applicable Devices	710	71	711	715
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The Watchdog Timer is as a free running on-chip RC oscillator which 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, a WDT time-out generates a device RESET (Watchdog Timer Reset). If the device is in SLEEP mode, a WDT time-out causes the device to wake-up and continue with normal operation (Watchdog Timer Wake-up). The WDT can be permanently disabled by clearing configuration bit WDTE (Section 8.1).

8.7.1 WDT PERIOD

The WDT has a nominal time-out period of 18 ms, (with no prescaler). The time-out periods vary with temperature, VDD and process variations from part to part (see DC specs). If longer time-out periods are desired, a prescaler with a division ratio of up to 1:128 can be

assigned to the WDT under software control by writing to the OPTION register. Thus, time-out periods up to 2.3 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 and generating a device RESET condition.

The $\overline{TO}$ bit in the STATUS register will be cleared upon a Watchdog Timer time-out.

8.7.2 WDT PROGRAMMING CONSIDERATIONS

It should also be taken into account that under worst case conditions (VDD = Min., Temperature = Max., and max. WDT prescaler) it may take several seconds before a WDT time-out occurs.

Note: When a CLRWDT instruction is executed and the prescaler is assigned to the WDT, the prescaler count will be cleared, but the prescaler assignment is not changed.

FIGURE 8-20: WATCHDOG TIMER BLOCK DIAGRAM

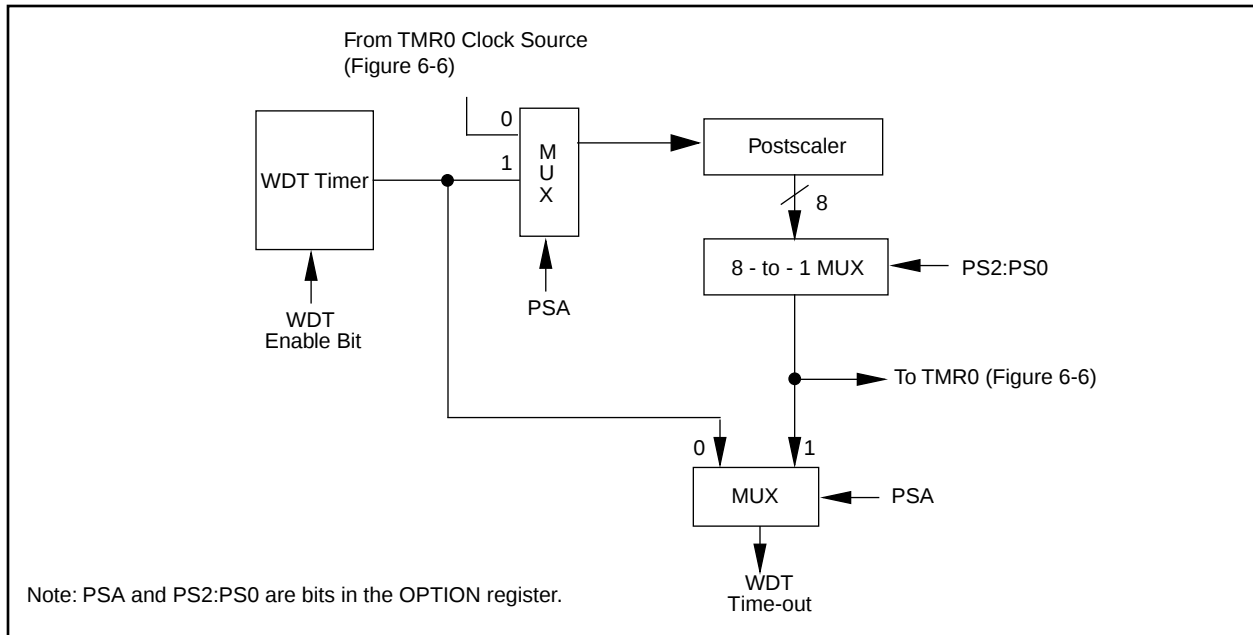


FIGURE 8-21: SUMMARY OF WATCHDOG TIMER REGISTERS

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2007h	Config. bits	(1)	BODEN ⁽¹⁾	CP1	CP0	PWRTE ⁽¹⁾	WDTE	FOSC1	FOSC0
81h,181h	OPTION	RBPU	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0

Legend: Shaded cells are not used by the Watchdog Timer.

Note 1: See Figure 8-1, Figure 8-2 and Figure 8-3 for operation of these bits.

9.0 INSTRUCTION SET SUMMARY

Each PIC16CXX instruction is a 14-bit word divided into an OPCODE which specifies the instruction type and one or more operands which further specify the operation of the instruction. The PIC16CXX instruction set summary in Table 9-2 lists **byte-oriented**, **bit-oriented**, and **literal and control** operations. Table 9-1 shows the opcode field descriptions.

For **byte-oriented** instructions, 'f' represents a file register designator and 'd' represents a destination designator. The file register designator specifies which file register is to be used by the instruction.

The destination designator specifies where the result of the operation is to be placed. If 'd' is zero, the result is placed in the W register. If 'd' is one, the result is placed in the file register specified in the instruction.

For **bit-oriented** instructions, 'b' represents a bit field designator which selects the number of the bit affected by the operation, while 'f' represents the number of the file in which the bit is located.

For **literal and control** operations, 'k' represents an eight or eleven bit constant or literal value.

TABLE 9-1: OPCODE FIELD DESCRIPTIONS

Field	Description
f	Register file address (0x00 to 0x7F)
w	Working register (accumulator)
b	Bit address within an 8-bit file register
k	Literal field, constant data or label
x	Don't care location (= 0 or 1) The assembler will generate code with x = 0. It is the recommended form of use for compatibility with all Microchip software tools.
d	Destination select; d = 0: store result in W, d = 1: store result in file register f. Default is d = 1
label	Label name
TOS	Top of Stack
PC	Program Counter
PCLATH	Program Counter High Latch
GIE	Global Interrupt Enable bit
WDT	Watchdog Timer/Counter
T $\overline{O}$	Time-out bit
P $\overline{D}$	Power-down bit
dest	Destination either the W register or the specified register file location
[]	Options
()	Contents
→	Assigned to
< >	Register bit field
∈	In the set of
<i>italics</i>	User defined term (font is courier)

The instruction set is highly orthogonal and is grouped into three basic categories:

- **Byte-oriented** operations
- **Bit-oriented** operations
- **Literal and control** operations

All instructions are executed within one single instruction cycle, unless a conditional test is true or the program counter is changed as a result of an instruction. In this case, the execution takes two instruction cycles with the second cycle executed as a NOP. One instruction cycle consists of four oscillator periods. Thus, for an oscillator frequency of 4 MHz, the normal instruction execution time is 1 μ s. If a conditional test is true or the program counter is changed as a result of an instruction, the instruction execution time is 2 μ s.

Table 9-2 lists the instructions recognized by the MPASM assembler.

Figure 9-1 shows the general formats that the instructions can have.

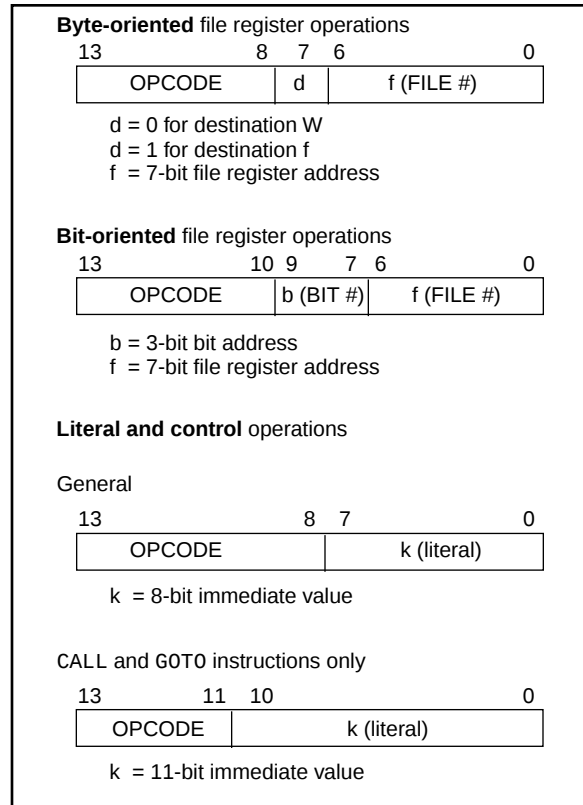
Note: To maintain upward compatibility with future PIC16CXX products, do not use the OPTION and TRIS instructions.

All examples use the following format to represent a hexadecimal number:

0xhh

where h signifies a hexadecimal digit.

FIGURE 9-1: GENERAL FORMAT FOR INSTRUCTIONS



PIC16C71X

TABLE 9-2: PIC16CXX INSTRUCTION SET

Mnemonic, Operands	Description	Cycles	14-Bit Opcode				Status Affected	Notes	
			MSb		LSb				
BYTE-ORIENTED FILE REGISTER OPERATIONS									
ADDWF	f, d	Add W and f	1	00	0111	dfff	ffff	C,DC,Z	1,2
ANDWF	f, d	AND W with f	1	00	0101	dfff	ffff	Z	1,2
CLRF	f	Clear f	1	00	0001	1fff	ffff	Z	2
CLRWF	-	Clear W	1	00	0001	0xxx	xxxx	Z	
COMF	f, d	Complement f	1	00	1001	dfff	ffff	Z	1,2
DECF	f, d	Decrement f	1	00	0011	dfff	ffff	Z	1,2
DECFSZ	f, d	Decrement f, Skip if 0	1(2)	00	1011	dfff	ffff		1,2,3
INCF	f, d	Increment f	1	00	1010	dfff	ffff	Z	1,2
INCFSZ	f, d	Increment f, Skip if 0	1(2)	00	1111	dfff	ffff		1,2,3
IORWF	f, d	Inclusive OR W with f	1	00	0100	dfff	ffff	Z	1,2
MOVF	f, d	Move f	1	00	1000	dfff	ffff	Z	1,2
MOVWF	f	Move W to f	1	00	0000	1fff	ffff		
NOP	-	No Operation	1	00	0000	0xx0	0000		
RLF	f, d	Rotate Left f through Carry	1	00	1101	dfff	ffff	C	1,2
RRF	f, d	Rotate Right f through Carry	1	00	1100	dfff	ffff	C	1,2
SUBWF	f, d	Subtract W from f	1	00	0010	dfff	ffff	C,DC,Z	1,2
SWAPF	f, d	Swap nibbles in f	1	00	1110	dfff	ffff		1,2
XORWF	f, d	Exclusive OR W with f	1	00	0110	dfff	ffff	Z	1,2
BIT-ORIENTED FILE REGISTER OPERATIONS									
BCF	f, b	Bit Clear f	1	01	00bb	bfff	ffff		1,2
BSF	f, b	Bit Set f	1	01	01bb	bfff	ffff		1,2
BTFSC	f, b	Bit Test f, Skip if Clear	1 (2)	01	10bb	bfff	ffff		3
BTFSS	f, b	Bit Test f, Skip if Set	1 (2)	01	11bb	bfff	ffff		3
LITERAL AND CONTROL OPERATIONS									
ADDLW	k	Add literal and W	1	11	111x	kkkk	kkkk	C,DC,Z	
ANDLW	k	AND literal with W	1	11	1001	kkkk	kkkk	Z	
CALL	k	Call subroutine	2	10	0kkk	kkkk	kkkk		
CLRWDT	-	Clear Watchdog Timer	1	00	0000	0110	0100	$\overline{TO}, \overline{PD}$	
GOTO	k	Go to address	2	10	1kkk	kkkk	kkkk		
IORLW	k	Inclusive OR literal with W	1	11	1000	kkkk	kkkk	Z	
MOVLW	k	Move literal to W	1	11	00xx	kkkk	kkkk		
RETFIE	-	Return from interrupt	2	00	0000	0000	1001		
RETLW	k	Return with literal in W	2	11	01xx	kkkk	kkkk		
RETURN	-	Return from Subroutine	2	00	0000	0000	1000		
SLEEP	-	Go into standby mode	1	00	0000	0110	0011	$\overline{TO}, \overline{PD}$	
SUBLW	k	Subtract W from literal	1	11	110x	kkkk	kkkk	C,DC,Z	
XORLW	k	Exclusive OR literal with W	1	11	1010	kkkk	kkkk	Z	

- Note 1: When an I/O register is modified as a function of itself (e.g., `MOVF PORTB, 1`), the value used will be that value present on the pins themselves. For example, if the data latch is '1' for a pin configured as input and is driven low by an external device, the data will be written back with a '0'.
- 2: If this instruction is executed on the TMR0 register (and, where applicable, d = 1), the prescaler will be cleared if assigned to the Timer0 Module.
- 3: If Program Counter (PC) is modified or a conditional test is true, the instruction requires two cycles. The second cycle is executed as a NOP.

MPASM has the following features to assist in developing software for specific use applications.

- Provides translation of Assembler source code to object code for all Microchip microcontrollers.
- Macro assembly capability.
- Produces all the files (Object, Listing, Symbol, and special) required for symbolic debug with Microchip's emulator systems.
- Supports Hex (default), Decimal and Octal source and listing formats.

MPASM provides a rich directive language to support programming of the PIC16/17. Directives are helpful in making the development of your assemble source code shorter and more maintainable.

10.11 Software Simulator (MPLAB-SIM)

The MPLAB-SIM Software Simulator allows code development in a PC host environment. It allows the user to simulate the PIC16/17 series microcontrollers on an instruction level. On any given instruction, the user may examine or modify any of the data areas or provide external stimulus to any of the pins. The input/output radix can be set by the user and the execution can be performed in; single step, execute until break, or in a trace mode.

MPLAB-SIM fully supports symbolic debugging using MPLAB-C and MPASM. The Software Simulator offers the low cost flexibility to develop and debug code outside of the laboratory environment making it an excellent multi-project software development tool.

10.12 C Compiler (MPLAB-C)

The MPLAB-C Code Development System is a complete 'C' compiler and integrated development environment for Microchip's PIC16/17 family of microcontrollers. The compiler provides powerful integration capabilities and ease of use not found with other compilers.

For easier source level debugging, the compiler provides symbol information that is compatible with the MPLAB IDE memory display.

10.13 Fuzzy Logic Development System (fuzzyTECH-MP)

fuzzyTECH-MP fuzzy logic development tool is available in two versions - a low cost introductory version, MP Explorer, for designers to gain a comprehensive working knowledge of fuzzy logic system design; and a full-featured version, *fuzzyTECH-MP*, edition for implementing more complex systems.

Both versions include Microchip's *fuzzyLAB™* demonstration board for hands-on experience with fuzzy logic systems implementation.

10.14 MP-DriveWay™ – Application Code Generator

MP-DriveWay is an easy-to-use Windows-based Application Code Generator. With MP-DriveWay you can visually configure all the peripherals in a PIC16/17 device and, with a click of the mouse, generate all the initialization and many functional code modules in C language. The output is fully compatible with Microchip's MPLAB-C C compiler. The code produced is highly modular and allows easy integration of your own code. MP-DriveWay is intelligent enough to maintain your code through subsequent code generation.

10.15 SEEVAL® Evaluation and Programming System

The SEEVAL SEEPROM Designer's Kit supports all Microchip 2-wire and 3-wire Serial EEPROMs. The kit includes everything necessary to read, write, erase or program special features of any Microchip SEEPROM product including Smart Serials™ and secure serials. The Total Endurance™ Disk is included to aid in trade-off analysis and reliability calculations. The total kit can significantly reduce time-to-market and result in an optimized system.

10.16 KEELOQ® Evaluation and Programming Tools

KEELOQ evaluation and programming tools support Microchips HCS Secure Data Products. The HCS evaluation kit includes an LCD display to show changing codes, a decoder to decode transmissions, and a programming interface to program test transmitters.

11.5 Timing Diagrams and Specifications

FIGURE 11-2: EXTERNAL CLOCK TIMING

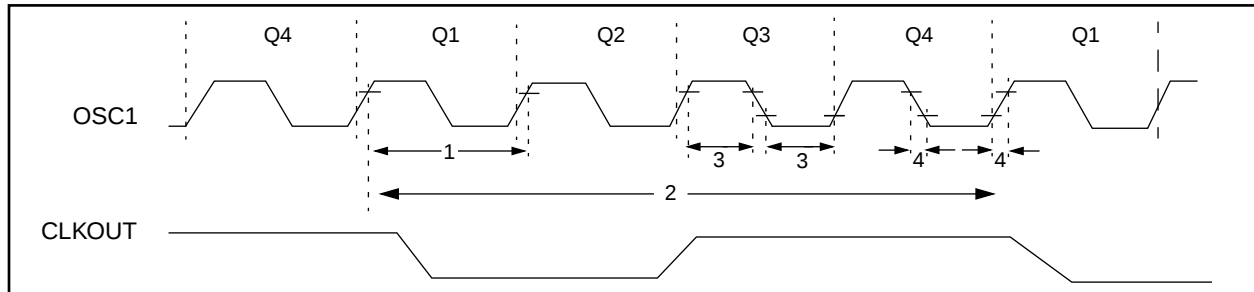


TABLE 11-2: EXTERNAL CLOCK TIMING REQUIREMENTS

Parameter No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
1	Fosc	External CLKIN Frequency (Note 1)	DC	—	4	MHz	XT osc mode
			DC	—	4	MHz	HS osc mode (-04)
			DC	—	10	MHz	HS osc mode (-10)
			DC	—	20	MHz	HS osc mode (-20)
			DC	—	200	kHz	LP osc mode
	Tosc	Oscillator Frequency (Note 1)	DC	—	4	MHz	RC osc mode
			0.1	—	4	MHz	XT osc mode
			4	—	20	MHz	HS osc mode
			5	—	200	kHz	LP osc mode
	Tosc	External CLKIN Period (Note 1)	250	—	—	ns	XT osc mode
			250	—	—	ns	HS osc mode (-04)
			100	—	—	ns	HS osc mode (-10)
			50	—	—	ns	HS osc mode (-20)
			5	—	—	μs	LP osc mode
		Oscillator Period (Note 1)	250	—	—	ns	RC osc mode
			250	—	10,000	ns	XT osc mode
			250	—	250	ns	HS osc mode (-04)
2	Tcy	Instruction Cycle Time (Note 1)	200	—	DC	ns	Tcy = 4/Fosc
3	TosL, TosH	External Clock in (OSC1) High or Low Time	50	—	—	ns	XT oscillator
			2.5	—	—	μs	LP oscillator
			10	—	—	ns	HS oscillator
4	TosR, TosF	External Clock in (OSC1) Rise or Fall Time	—	—	25	ns	XT oscillator
			—	—	50	ns	LP oscillator
			—	—	15	ns	HS oscillator

† 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 the OSC1/CLKIN pin. When an external clock input is used, the "Max." cycle time limit is "DC" (no clock) for all devices. OSC2 is disconnected (has no loading) for the PIC16C710/711.

FIGURE 12-25: TYPICAL I_{DD} vs. FREQUENCY
(LP MODE, 25°C)

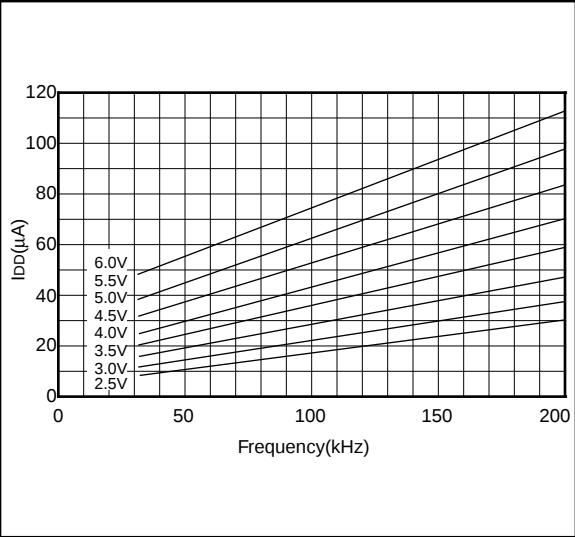


FIGURE 12-27: TYPICAL I_{DD} vs. FREQUENCY
(XT MODE, 25°C)

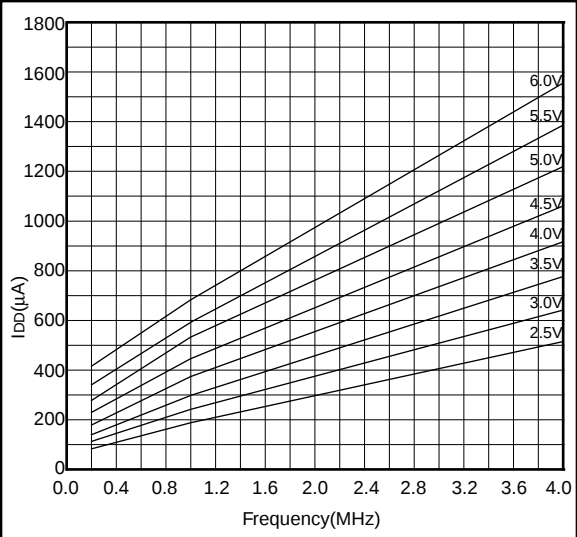


FIGURE 12-26: MAXIMUM I_{DD} vs.
FREQUENCY
(LP MODE, 85°C TO -40°C)

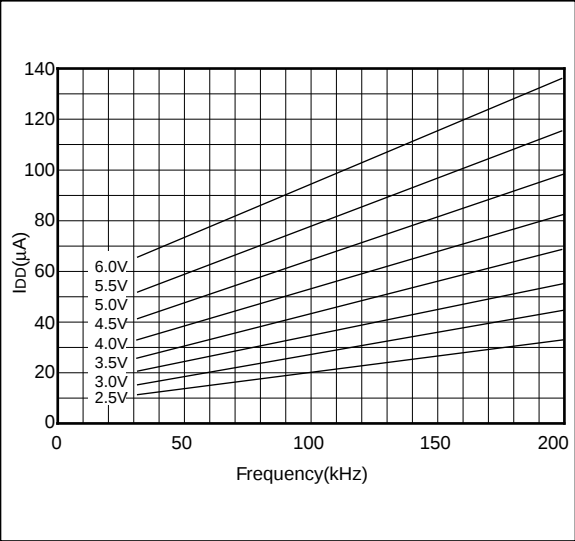


FIGURE 12-28: MAXIMUM I_{DD} vs.
FREQUENCY
(XT MODE, -40°C TO 85°C)

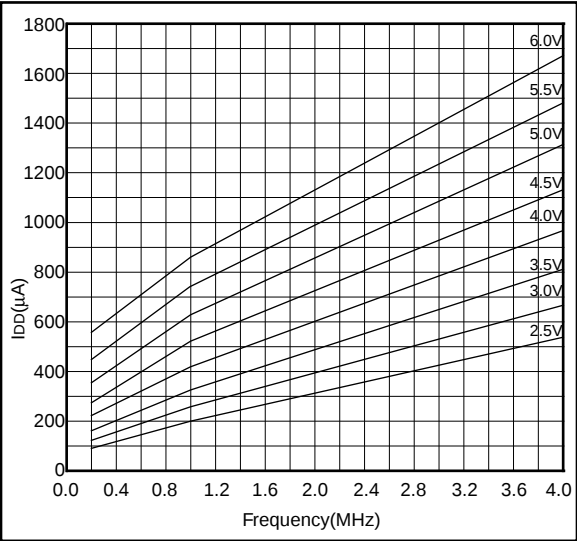


FIGURE 13-3: CLKOUT AND I/O TIMING

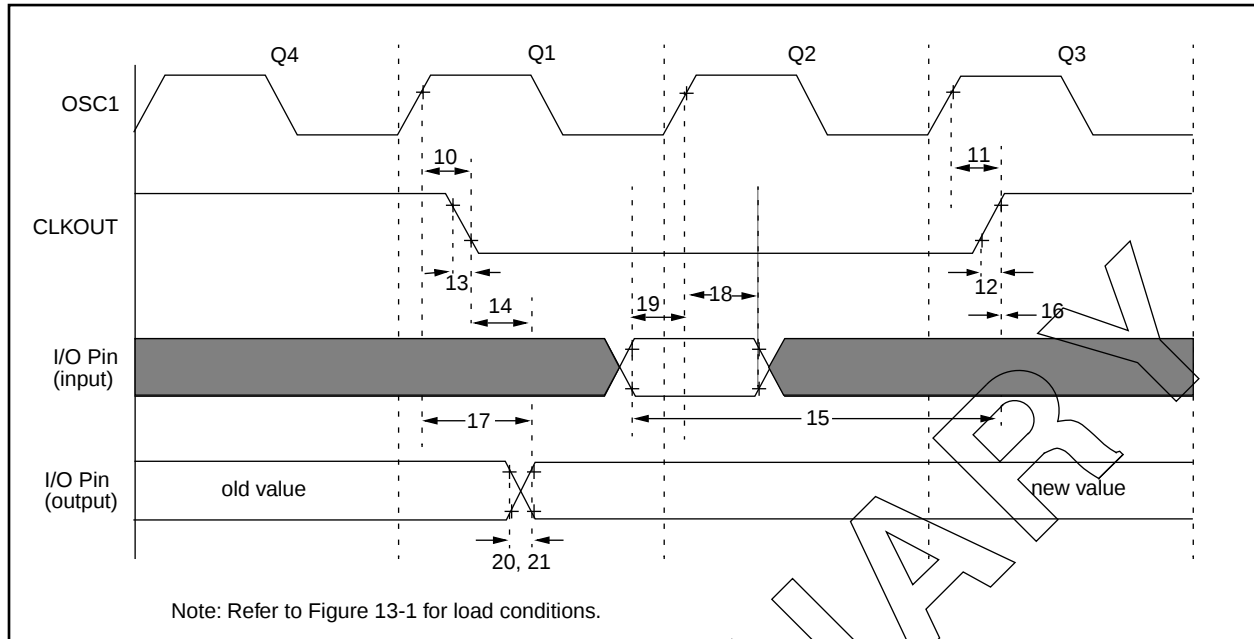


TABLE 13-3: CLKOUT AND I/O TIMING REQUIREMENTS

Parameter No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
10*	Tosh2ckL	OSC1↑ to CLKOUT↓	—	15	30	ns	Note 1
11*	Tosh2ckH	OSC1↑ to CLKOUT↑	—	15	30	ns	Note 1
12*	TckR	CLKOUT rise time	—	5	15	ns	Note 1
13*	TckF	CLKOUT fall time	—	5	15	ns	Note 1
14*	TckL2ioV	CLKOUT ↓ to Port out valid	—	—	0.5T _{CY} + 20	ns	Note 1
15*	TioV2ckH	Port in valid before CLKOUT ↑	0.25T _{CY} + 25	—	—	ns	Note 1
16*	TckH2ioI	Port in hold after CLKOUT ↑	0	—	—	ns	Note 1
17*	Tosh2ioV	OSC1↑ (Q1 cycle) to Port out valid	—	—	80 - 100	ns	
18*	Tosh2ioI	OSC1↑ (Q2 cycle) to Port input invalid (I/O in hold time)	TBD	—	—	ns	
19*	TioV2osH	Port input valid to OSC1↑ (I/O in setup time)	TBD	—	—	ns	
20*	TioR	Port output rise time	—	10	25	ns	
			—	—	60	ns	
21*	TioF	Port output fall time	—	10	25	ns	
			—	—	60	ns	
22††*	Tinp	INT pin high or low time	20	—	—	ns	
23††*	Ttrp	RB7:RB4 change INT high or low time	20	—	—	ns	

* 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 asynchronous events not related to any internal clock edges.

Note 1: Measurements are taken in RC Mode where CLKOUT output is 4 x T_{osc}.

PIC16C71X

Applicable Devices 710 71 711 715

FIGURE 14-3: TYPICAL I_{PD} vs. V_{DD} @ 25°C (WDT ENABLED, RC MODE)

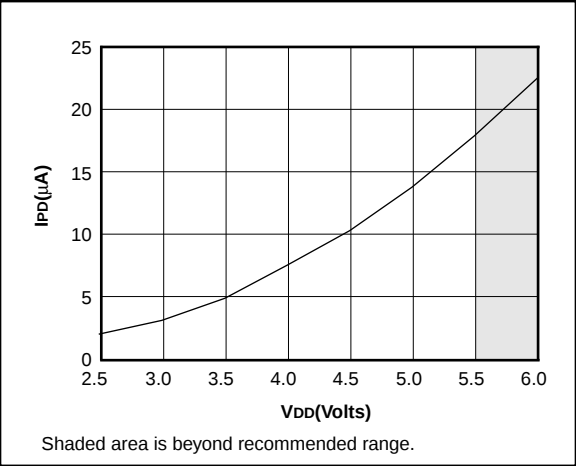


FIGURE 14-4: MAXIMUM I_{PD} vs. V_{DD} (WDT ENABLED, RC MODE)

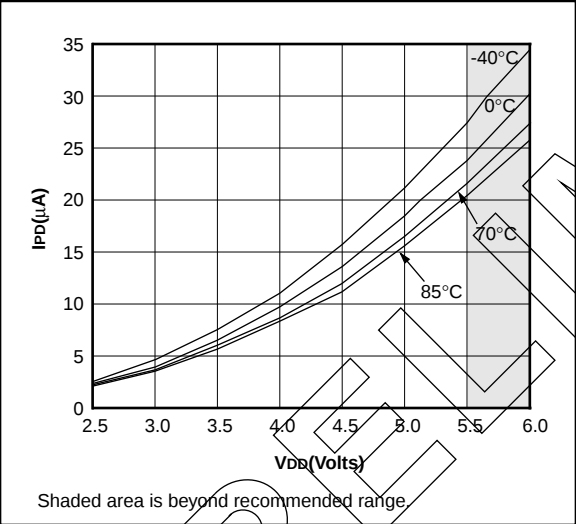


FIGURE 14-5: TYPICAL RC OSCILLATOR FREQUENCY vs. V_{DD}

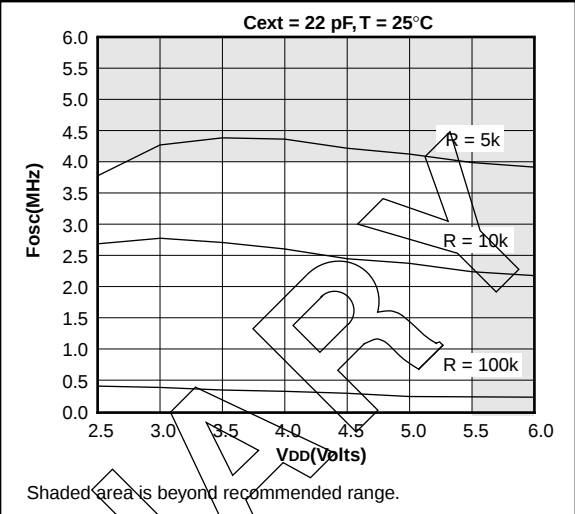


FIGURE 14-6: TYPICAL RC OSCILLATOR FREQUENCY vs. V_{DD}

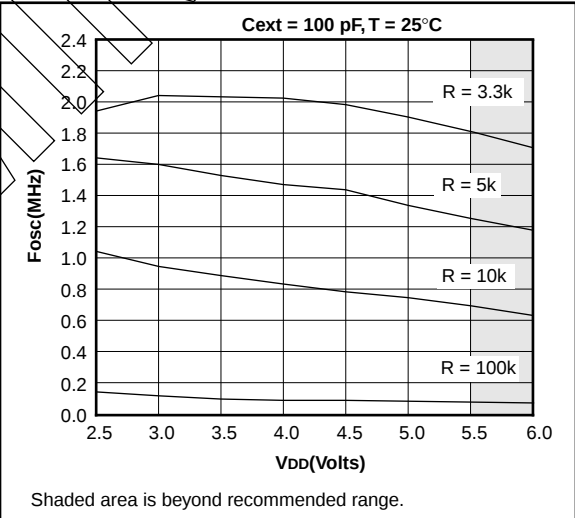


FIGURE 14-7: TYPICAL RC OSCILLATOR FREQUENCY vs. V_{DD}

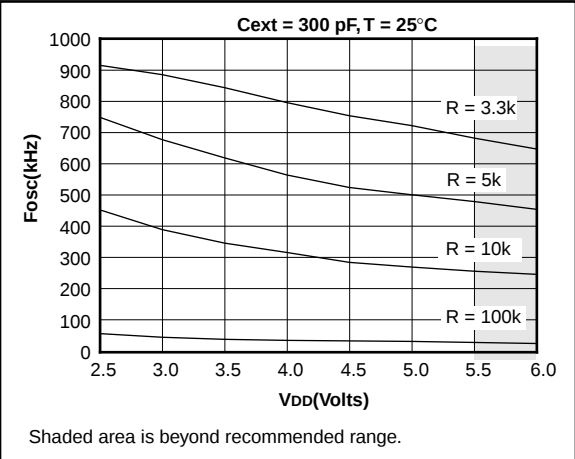


FIGURE 14-18: TYPICAL I_{DD} vs. CAPACITANCE @ 500 kHz (RC MODE)

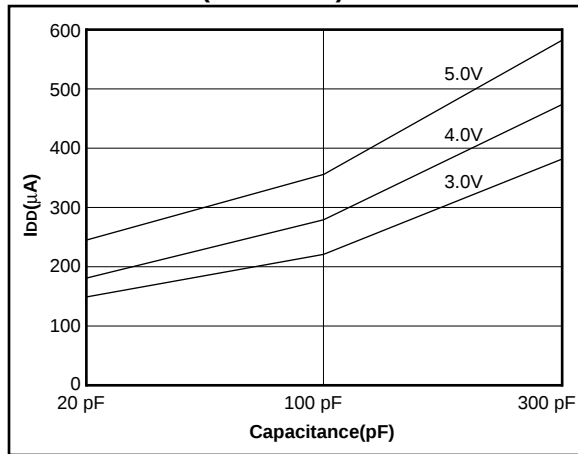


TABLE 14-1: RC OSCILLATOR FREQUENCIES

Cext	Rext	Average	
		Fosc @ 5V, 25°C	
22 pF	5k	4.12 MHz	± 1.4%
	10k	2.35 MHz	± 1.4%
	100k	268 kHz	± 1.1%
100 pF	3.3k	1.80 MHz	± 1.0%
	5k	1.27 MHz	± 1.0%
	10k	688 kHz	± 1.2%
	100k	77.2 kHz	± 1.0%
300 pF	3.3k	707 kHz	± 1.4%
	5k	501 kHz	± 1.2%
	10k	269 kHz	± 1.6%
	100k	28.3 kHz	± 1.1%

The percentage variation indicated here is part to part variation due to normal process distribution. The variation indicated is ± 3 standard deviation from average value for $V_{DD} = 5V$.

FIGURE 14-19: TRANSCONDUCTANCE(gm) OF HS OSCILLATOR vs. V_{DD}

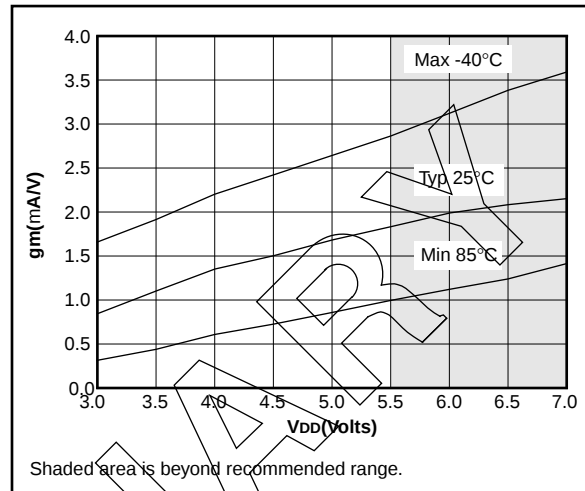


FIGURE 14-20: TRANSCONDUCTANCE(gm) OF LP OSCILLATOR vs. V_{DD}

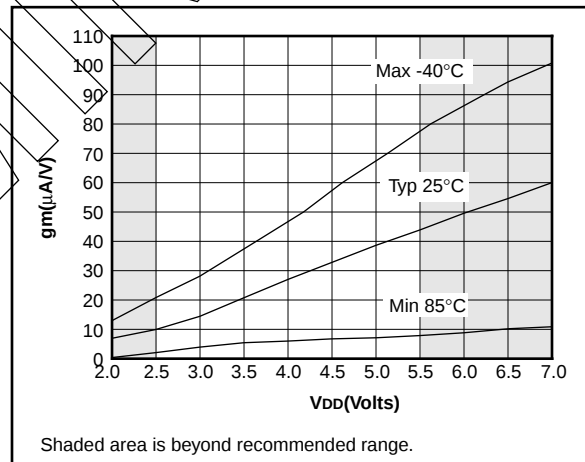
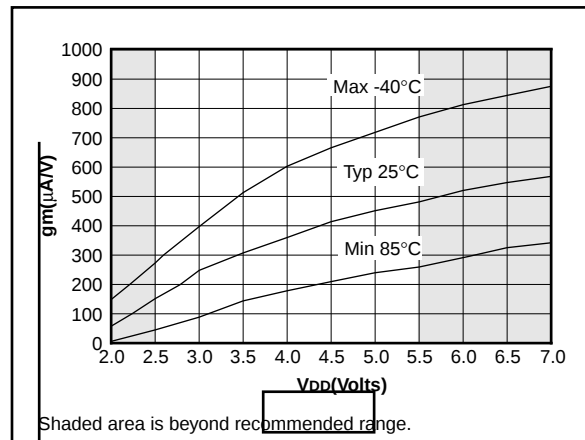


FIGURE 14-21: TRANSCONDUCTANCE(gm) OF XT OSCILLATOR vs. V_{DD}



15.0 ELECTRICAL CHARACTERISTICS FOR PIC16C71

Absolute Maximum Ratings †

Ambient temperature under bias	-55 to +125°C
Storage temperature	-65°C to +150°C
Voltage on any pin with respect to Vss (except VDD, $\overline{\text{MCLR}}$, and RA4).....	-0.3V to (VDD + 0.3V)
Voltage on VDD with respect to Vss	-0.3 to +7.5V
Voltage on $\overline{\text{MCLR}}$ with respect to Vss (Note 2).....	0 to +14V
Voltage on RA4 with respect to Vss	0 to +14V
Total power dissipation (Note 1).....	800 mW
Maximum current out of Vss pin	150 mA
Maximum current into VDD pin	100 mA
Input clamp current, I _{IK} (V _I < 0 or V _I > VDD).....	± 20 mA
Output clamp current, I _{OK} (V _O < 0 or V _O > VDD)	± 20 mA
Maximum output current sunk by any I/O pin.....	25 mA
Maximum output current sourced by any I/O pin	20 mA
Maximum current sunk by PORTA	80 mA
Maximum current sourced by PORTA	50 mA
Maximum current sunk by PORTB.....	150 mA
Maximum current sourced by PORTB.....	100 mA

Note 1: Power dissipation is calculated as follows: $P_{dis} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum (V_{OL} \times I_{OL})$

Note 2: Voltage spikes below Vss at the $\overline{\text{MCLR}}$ pin, inducing currents greater than 80 mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a “low” level to the $\overline{\text{MCLR}}$ pin rather than pulling this pin directly to Vss.

† NOTICE: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

TABLE 15-1: CROSS REFERENCE OF DEVICE SPECS FOR OSCILLATOR CONFIGURATIONS AND FREQUENCIES OF OPERATION (COMMERCIAL DEVICES)

OSC	PIC16C71-04	PIC16C71-20	PIC16LC71-04	JW Devices
RC	VDD: 4.0V to 6.0V IDD: 3.3 mA max. at 5.5V IPD: 14 µA max. at 4V Freq: 4 MHz max.	VDD: 4.5V to 5.5V IDD: 1.8 mA typ. at 5.5V IPD: 1.0 µA typ. at 4V Freq: 4 MHz max.	VDD: 3.0V to 6.0V IDD: 1.4 mA typ. at 3.0V IPD: 0.6 µA typ. at 3V Freq: 4 MHz max.	VDD: 4.0V to 6.0V IDD: 3.3 mA max. at 5.5V IPD: 14 µA max. at 4V Freq: 4 MHz max.
XT	VDD: 4.0V to 6.0V IDD: 3.3 mA max. at 5.5V IPD: 14 µA max. at 4V Freq: 4 MHz max.	VDD: 4.5V to 5.5V IDD: 1.8 mA typ. at 5.5V IPD: 1.0 µA typ. at 4V Freq: 4 MHz max.	VDD: 3.0V to 6.0V IDD: 1.4 mA typ. at 3.0V IPD: 0.6 µA typ. at 3V Freq: 4 MHz max.	VDD: 4.0V to 6.0V IDD: 3.3 mA max. at 5.5V IPD: 14 µA max. at 4V Freq: 4 MHz max.
HS	VDD: 4.5V to 5.5V IDD: 13.5 mA typ. at 5.5V IPD: 1.0 µA typ. at 4.5V Freq: 4 MHz max.	VDD: 4.5V to 5.5V IDD: 30 mA max. at 5.5V IPD: 1.0 µA typ. at 4.5V Freq: 20 MHz max.	Not recommended for use in HS mode	VDD: 4.5V to 5.5V IDD: 30 mA max. at 5.5V IPD: 1.0 µA typ. at 4.5V Freq: 20 MHz max.
LP	VDD: 4.0V to 6.0V IDD: 15 µA typ. at 32 kHz, 4.0V IPD: 0.6 µA typ. at 4.0V Freq: 200 kHz max.	Not recommended for use in LP mode	VDD: 3.0V to 6.0V IDD: 32 µA max. at 32 kHz, 3.0V IPD: 9 µA max. at 3.0V Freq: 200 kHz max.	VDD: 3.0V to 6.0V IDD: 32 µA max. at 32 kHz, 3.0V IPD: 9 µA max. at 3.0V Freq: 200 kHz max.

The shaded sections indicate oscillator selections which are tested for functionality, but not for MIN/MAX specifications. It is recommended that the user select the device type that ensures the specifications required.

PIC16C71X

I

I/O Ports	
PORTA	25
PORTB	27
Section	25
I/O Programming Considerations	30
ICEPIC Low-Cost PIC16CXXX In-Circuit Emulator	85
In-Circuit Serial Programming	47, 67
INDF Register	14, 16, 24
Indirect Addressing	24
Instruction Cycle	10
Instruction Flow/Pipelining	10
Instruction Format	69
Instruction Set	
ADDLW	71
ADDWF	71
ANDLW	71
ANDWF	71
BCF	72
BSF	72
BTFSC	72
BTFSS	73
CALL	73
CLRF	74
CLRW	74
CLRWDI	74
COMF	75
DECF	75
DECFSZ	75
GOTO	76
INCF	76
INCFSZ	77
IORLW	77
IORWF	78
MOVF	78
MOVLW	78
MOVWF	78
NOP	79
OPTION	79
RETFIE	79
RETLW	80
RETURN	80
RLF	81
RRF	81
SLEEP	82
SUBLW	82
SUBWF	83
SWAPF	83
TRIS	83
XORLW	84
XORWF	84
Section	69
Summary Table	70
INT Interrupt	63
INTCON Register	19
INTE bit	19
INTEDG bit	18, 63
Internal Sampling Switch (Rss) Impedance	40
Interrupts	47
A/D	61
External	61
PORTB Change	61
PortB Change	63
RB7:RB4 Port Change	27
Section	61
TMR0	63

TMR0 Overflow	61
INTF bit	19
IRP bit	17

K

KeeLoq® Evaluation and Programming Tools	87
--	----

L

Loading of PC	23
LP	54

M

MCLR	52, 56
Memory	
Data Memory	12
Program Memory	11
Register File Maps	
PIC16C71	12
PIC16C710	12
PIC16C711	13
PIC16C715	13
MP-DriveWay™ - Application Code Generator	87
MPEEN bit	22, 48
MPLAB™ C	87
MPLAB™ Integrated Development Environment	
Software	86

O

OPCODE	69
OPTION Register	18
Orthogonal	7
OSC selection	47
Oscillator	
HS	49, 54
LP	49, 54
RC	49
XT	49, 54
Oscillator Configurations	49
Oscillator Start-up Timer (OST)	53

P

Packaging	
18-Lead Cerdip w/Window	155
18-Lead PDIP	156
18-Lead SOIC	157
20-Lead SSOP	158
Paging, Program Memory	23
PCL Register	14, 15, 16, 23
PCLATH	57, 58
PCLATH Register	14, 15, 16, 23
PCON Register	22, 54
PD bit	17, 52, 55
PER bit	22
PIC16C71	147
AC Characteristics	147
PICDEM-1 Low-Cost PIC16/17 Demo Board	86
PICDEM-2 Low-Cost PIC16CXX Demo Board	86
PICDEM-3 Low-Cost PIC16CXXX Demo Board	86
PICMASTER® In-Circuit Emulator	85
PICSTART® Plus Entry Level Development System	85
PIE1 Register	20
Pin Functions	
MCLR/VPP	9
OSC1/CLKIN	9
OSC2/CLKOUT	9
RA0/AN0	9
RA1/AN1	9

LIST OF TABLES

Table 1-1:	PIC16C71X Family of Devices.....	4	Table 11-6:	A/D Converter Characteristics: PIC16C710/711-04 (Commercial, Industrial, Extended) PIC16C710/711-10 (Commercial, Industrial, Extended) PIC16C710/711-20 (Commercial, Industrial, Extended) PIC16LC710/711-04 (Commercial, Industrial, Extended)	99
Table 3-1:	PIC16C710/71/711/715 Pinout Description	9	Table 11-7:	A/D Conversion Requirements	100
Table 4-1:	PIC16C710/71/711 Special Function Register Summary	14	Table 12-1:	RC Oscillator Frequencies.....	107
Table 4-2:	PIC16C715 Special Function Register Summary.....	15	Table 12-2:	Capacitor Selection for Crystal Oscillators	108
Table 5-1:	PORTA Functions	26	Table 13-1:	Cross Reference of Device Specs for Oscillator Configurations and Frequencies of Operation (Commercial Devices)	112
Table 5-2:	Summary of Registers Associated with PORTA.....	26	Table 13-2:	Clock Timing Requirements.....	118
Table 5-3:	PORTB Functions	28	Table 13-3:	CLKOUT and I/O Timing Requirements .	119
Table 5-4:	Summary of Registers Associated with PORTB.....	29	Table 13-4:	Reset, Watchdog Timer, Oscillator Start-up Timer, Power-up Timer, and Brown-out Reset Requirements.....	120
Table 6-1:	Registers Associated with Timer0.....	35	Table 13-5:	Timer0 Clock Requirements	121
Table 7-1:	TAD vs. Device Operating Frequencies, PIC16C71.....	41	Table 13-6:	A/D Converter Characteristics: PIC16C715-04 (Commercial, Industrial, Extended) PIC16C715-10 (Commercial, Industrial, Extended) PIC16C715-20 (Commercial, Industrial, Extended)	122
Table 7-2:	TAD vs. Device Operating Frequencies, PIC16C710/711, PIC16C715	41	Table 13-7:	A/D Converter Characteristics: PIC16LC715-04 (Commercial, Industrial)	123
Table 7-3:	Registers/Bits Associated with A/D, PIC16C710/71/711.....	46	Table 13-8:	A/D Conversion Requirements	124
Table 7-4:	Registers/Bits Associated with A/D, PIC16C715.....	46	Table 14-1:	RC Oscillator Frequencies.....	131
Table 8-1:	Ceramic Resonators, PIC16C71.....	49	Table 14-2:	Capacitor Selection for Crystal Oscillators	132
Table 8-2:	Capacitor Selection For Crystal Oscillator, PIC16C71.....	49	Table 15-1:	Cross Reference of Device Specs for Oscillator Configurations and Frequencies of Operation (Commercial Devices)	135
Table 8-3:	Ceramic Resonators, PIC16C710/711/715.....	50	Table 15-2:	External Clock Timing Requirements	141
Table 8-4:	Capacitor Selection for Crystal Oscillator, PIC16C710/711/715.....	50	Table 15-3:	CLKOUT and I/O Timing Requirements .	142
Table 8-5:	Time-out in Various Situations, PIC16C71.....	54	Table 15-4:	Reset, Watchdog Timer, Oscillator Start-up Timer and Power-up Timer Requirements	143
Table 8-6:	Time-out in Various Situations, PIC16C710/711/715.....	54	Table 15-5:	Timer0 External Clock Requirements	144
Table 8-7:	Status Bits and Their Significance, PIC16C71.....	55	Table 15-6:	A/D Converter Characteristics	145
Table 8-8:	Status Bits and Their Significance, PIC16C710/711.....	55	Table 15-7:	A/D Conversion Requirements	146
Table 8-9:	Status Bits and Their Significance, PIC16C715.....	55	Table 16-1:	RC Oscillator Frequencies.....	148
Table 8-10:	Reset Condition for Special Registers, PIC16C710/71/711.....	56			
Table 8-11:	Reset Condition for Special Registers, PIC16C715.....	56			
Table 8-12:	Initialization Conditions For All Registers, PIC16C710/71/711.....	57			
Table 8-13:	Initialization Conditions for All Registers, PIC16C715.....	58			
Table 9-1:	Opcode Field Descriptions	69			
Table 9-2:	PIC16CXX Instruction Set.....	70			
Table 10-1:	Development Tools From Microchip	88			
Table 11-1:	Cross Reference of Device Specs for Oscillator Configurations and Frequencies of Operation (Commercial Devices).....	89			
Table 11-2:	External Clock Timing Requirements.....	95			
Table 11-3:	CLKOUT and I/O Timing Requirements....	96			
Table 11-4:	Reset, Watchdog Timer, Oscillator Start-up Timer, Power-up Timer, and Brown-out Reset Requirements	97			
Table 11-5:	Timer0 External Clock Requirements	98			

PIC16C71X PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery refer to the factory or the listed sales office.

PART NO.	-XX	X	/XX	XXX		Examples
					Pattern:	QTP, SQTP, Code or Special Requirements
					Package:	JW = Windowed Cerdip SO = SOIC SP = Skinny plastic dip P = PDIP SS = SSOP
					Temperature Range:	- = 0°C to +70°C I = -40°C to +85°C E = -40°C to +125°C
					Frequency Range:	04 = 200 kHz (PIC16C7X-04) 04 = 4 MHz 10 = 10 MHz 20 = 20 MHz
					Device	PIC16C7X :V _{DD} range 4.0V to 6.0V PIC16C7XT :V _{DD} range 4.0V to 6.0V (Tape/Reel) PIC16LC7X :V _{DD} range 2.5V to 6.0V PIC16LC7XT :V _{DD} range 2.5V to 6.0V (Tape/Reel)

* JW Devices are UV erasable and can be programmed to any device configuration. JW Devices meet the electrical requirement of each oscillator type (including LC devices).

Sales and Support

Products supported by a preliminary Data Sheet may possibly have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office (see below)
2. The Microchip Corporate Literature Center U.S. FAX: (602) 786-7277
3. The Microchip's Bulletin Board, via your local CompuServe number (CompuServe membership NOT required).

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

For latest version information and upgrade kits for Microchip Development Tools, please call 1-800-755-2345 or 1-602-786-7302.