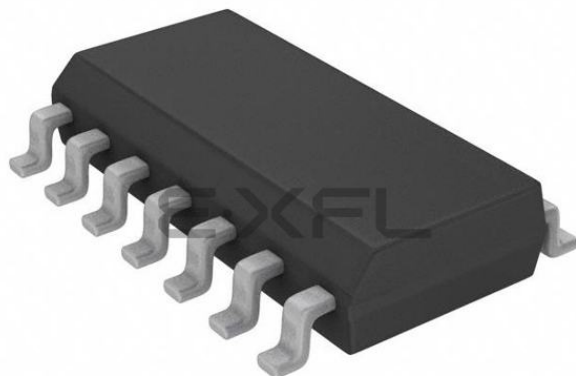




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Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	4MHz
Connectivity	-
Peripherals	POR, WDT
Number of I/O	12
Program Memory Size	1.5KB (1K x 12)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	72 x 8
Voltage - Supply (Vcc/Vdd)	2.5V ~ 5.5V
Data Converters	-
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	14-SOIC (0.154", 3.90mm Width)
Supplier Device Package	14-SOIC
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16lc505t-04i-sl

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1.0 GENERAL DESCRIPTION

The PIC16C505 from Microchip Technology is a low-cost, high-performance, 8-bit, fully static, EPROM/ROM-based CMOS microcontroller. It employs a RISC architecture with only 33 single word/single cycle instructions. All instructions are single cycle (200 μ s) except for program branches, which take two cycles. The PIC16C505 delivers performance an order of magnitude higher than its competitors in the same price category. The 12-bit wide instructions are highly symmetrical resulting in a typical 2:1 code compression over other 8-bit microcontrollers in its class. The easy to use and easy to remember instruction set reduces development time significantly.

The PIC16C505 product is equipped with special features that reduce system cost and power requirements. The Power-On Reset (POR) and Device Reset Timer (DRT) eliminate the need for external reset circuitry. There are five oscillator configurations to choose from, including INTRC internal oscillator mode and the power-saving LP (Low Power) oscillator mode. Power saving SLEEP mode, Watchdog Timer and code protection features improve system cost, power and reliability.

The PIC16C505 is available in the cost-effective One-Time-Programmable (OTP) version, which is suitable for production in any volume. The customer can take full advantage of Microchip's price leadership in OTP microcontrollers, while benefiting from the OTP's flexibility.

The PIC16C505 product is supported by a full-featured macro assembler, a software simulator, an in-circuit emulator, a 'C' compiler, a low-cost development programmer and a full featured programmer. All the tools are supported on IBM® PC and compatible machines.

1.1 Applications

The PIC16C505 fits in applications ranging from personal care appliances and security systems to low-power remote transmitters/receivers. The EPROM technology makes customizing application programs (transmitter codes, appliance settings, receiver frequencies, etc.) extremely fast and convenient. The small footprint packages, for through hole or surface mounting, make this microcontroller perfect for applications with space limitations. Low-cost, low-power, high-performance, ease of use and I/O flexibility make the PIC16C505 very versatile even in areas where no microcontroller use has been considered before (e.g., timer functions, replacement of "glue" logic and PLD's in larger systems, and coprocessor applications).

PIC16C505

TABLE 1-1: PIC16C505 DEVICE

		PIC16C505
Clock	Maximum Frequency of Operation (MHz)	20
Memory	EPROM Program Memory	1024
	Data Memory (bytes)	72
Peripherals	Timer Module(s)	TMR0
	Wake-up from SLEEP on pin change	Yes
Features	I/O Pins	11
	Input Pins	1
	Internal Pull-ups	Yes
	In-Circuit Serial Programming	Yes
	Number of Instructions	33
	Packages	14-pin DIP, SOIC, TSSOP

The PIC16C505 device has Power-on Reset, selectable Watchdog Timer, selectable code protect, high I/O current capability and precision internal oscillator.

The PIC16C505 device uses serial programming with data pin RB0 and clock pin RB1.

PIC16C505

NOTES:

3.0 ARCHITECTURAL OVERVIEW

The high performance of the PIC16C505 can be attributed to a number of architectural features commonly found in RISC microprocessors. To begin with, the PIC16C505 uses a Harvard architecture in which program and data are accessed on separate buses. This improves bandwidth over traditional von Neumann architecture where program and data are fetched on the same bus. Separating program and data memory further allows instructions to be sized differently than the 8-bit wide data word. Instruction opcodes are 12 bits wide, making it possible to have all single word instructions. A 12-bit wide program memory access bus fetches a 12-bit instruction in a single cycle. A two-stage pipeline overlaps fetch and execution of instructions. Consequently, all instructions (33) execute in a single cycle (200ns @ 20MHz) except for program branches.

The Table below lists program memory (EPROM) and data memory (RAM) for the PIC16C505.

Device	Memory	
	Program	Data
PIC16C505	1024 x 12	72 x 8

The PIC16C505 can directly or indirectly address its register files and data memory. All special function registers, including the program counter, are mapped in the data memory. The PIC16C505 has a highly 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 PIC16C505 simple yet efficient. In addition, the learning curve is reduced significantly.

The PIC16C505 device contains an 8-bit ALU and working register. The ALU is a general purpose arithmetic unit. It performs arithmetic and Boolean functions between 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, one operand is typically the W (working) register. The other operand is either 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 and digit borrow out bit, respectively, in subtraction. See the SUBWF and ADDWF instructions for examples.

A simplified block diagram is shown in Figure 3-1, with the corresponding device pins described in Table 3-1.

4.6 Program Counter

As a program instruction is executed, the Program Counter (PC) will contain the address of the next program instruction to be executed. The PC value is increased by one every instruction cycle, unless an instruction changes the PC.

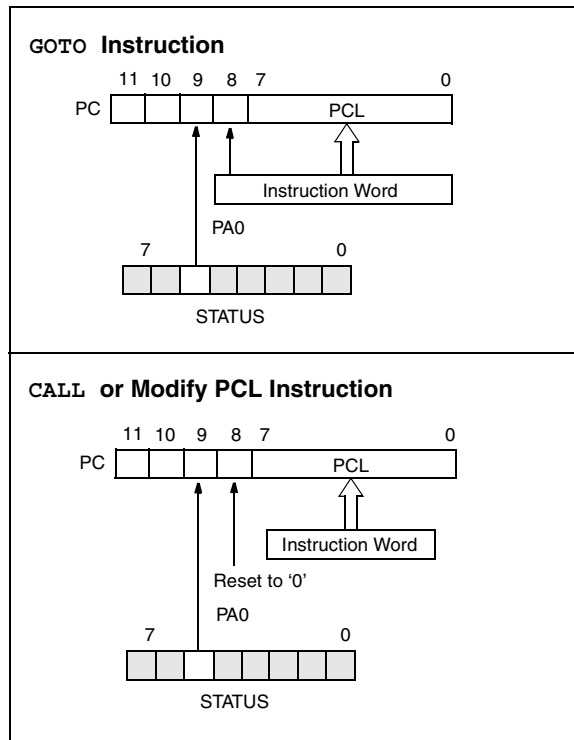
For a **GOTO** instruction, bits 8:0 of the PC are provided by the **GOTO** instruction word. The PC Latch (PCL) is mapped to PC<7:0>. Bit 5 of the STATUS register provides page information to bit 9 of the PC (Figure 4-3).

For a **CALL** instruction, or any instruction where the PCL is the destination, bits 7:0 of the PC again are provided by the instruction word. However, PC<8> does not come from the instruction word, but is always cleared (Figure 4-3).

Instructions where the PCL is the destination, or Modify PCL instructions, include **MOVWF PC**, **ADDWF PC**, and **BSF PC, 5**.

Note: Because PC<8> is cleared in the **CALL** instruction or any Modify PCL instruction, all subroutine calls or computed jumps are limited to the first 256 locations of any program memory page (512 words long).

FIGURE 4-3: LOADING OF PC BRANCH INSTRUCTIONS - PIC16C505



4.6.1 EFFECTS OF RESET

The Program Counter is set upon a **RESET**, which means that the PC addresses the last location in the last page (i.e., the oscillator calibration instruction.) After executing **MOVLW XX**, the PC will roll over to location 00h and begin executing user code.

The STATUS register page preselect bits are cleared upon a **RESET**, which means that page 0 is pre-selected.

Therefore, upon a **RESET**, a **GOTO** instruction will automatically cause the program to jump to page 0 until the value of the page bits is altered.

4.7 Stack

PIC16C505 devices have a 12-bit wide hardware push/pop stack.

A **CALL** instruction will push the current value of stack 1 into stack 2 and then push the current program counter value, incremented by one, into stack level 1. If more than two sequential **CALL**'s are executed, only the most recent two return addresses are stored.

A **RETLW** instruction will pop the contents of stack level 1 into the program counter and then copy stack level 2 contents into level 1. If more than two sequential **RETLW**'s are executed, the stack will be filled with the address previously stored in level 2. Note that the W register will be loaded with the literal value specified in the instruction. This is particularly useful for the implementation of data look-up tables within the program memory.

Note 1: There are no STATUS bits to indicate stack overflows or stack underflow conditions.

Note 2: There are no instructions mnemonics called **PUSH** or **POP**. These are actions that occur from the execution of the **CALL**, **RETLW**, and instructions.

PIC16C505

NOTES:

7.2.5 INTERNAL 4 MHz RC OSCILLATOR

The internal RC oscillator provides a fixed 4 MHz (nominal) system clock at $V_{DD} = 5V$ and $25^{\circ}C$, see Electrical Specifications section for information on variation over voltage and temperature.

In addition, a calibration instruction is programmed into the last address of memory, which contains the calibration value for the internal RC oscillator. This location is always protected, regardless of the code protect settings. This value is programmed as a `MOVLW XX` instruction where XX is the calibration value, and is placed at the reset vector. This will load the W register with the calibration value upon reset and the PC will then roll over to the users program at address 0x000. The user then has the option of writing the value to the OSCCAL Register (05h) or ignoring it.

OSCCAL, when written to with the calibration value, will “trim” the internal oscillator to remove process variation from the oscillator frequency.

Note: Please note that erasing the device will also erase the pre-programmed internal calibration value for the internal oscillator. The calibration value must be read prior to erasing the part so it can be reprogrammed correctly later.

For the PIC16C505, only bits <7:2> of OSCCAL are implemented.

7.3 RESET

The device differentiates between various kinds of reset:

- a) Power on reset (POR)
- b) $\overline{MCLR}$ reset during normal operation
- c) $\overline{MCLR}$ reset during SLEEP
- d) WDT time-out reset during normal operation
- e) WDT time-out reset during SLEEP
- f) Wake-up from SLEEP on pin change

Some registers are not reset in any way, they are unknown on POR and unchanged in any other reset. Most other registers are reset to “reset state” on power-on reset (POR), $\overline{MCLR}$, WDT or wake-up on pin change reset during normal operation. They are not affected by a WDT reset during SLEEP or $\overline{MCLR}$ reset during SLEEP, since these resets are viewed as resumption of normal operation. The exceptions to this are TO, PD and RBWUF bits. They are set or cleared differently in different reset situations. These bits are used in software to determine the nature of reset. See Table 7-3 for a full description of reset states of all registers.

FIGURE 7-7: SIMPLIFIED BLOCK DIAGRAM OF ON-CHIP RESET CIRCUIT

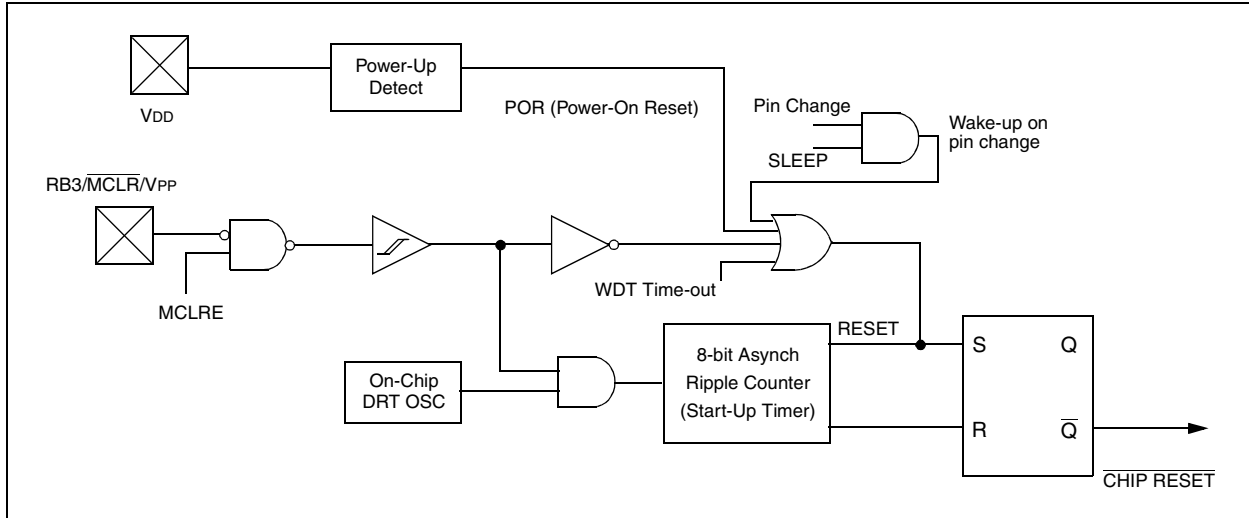


FIGURE 7-8: TIME-OUT SEQUENCE ON POWER-UP ($\overline{\text{MCLR}}$ PULLED LOW)

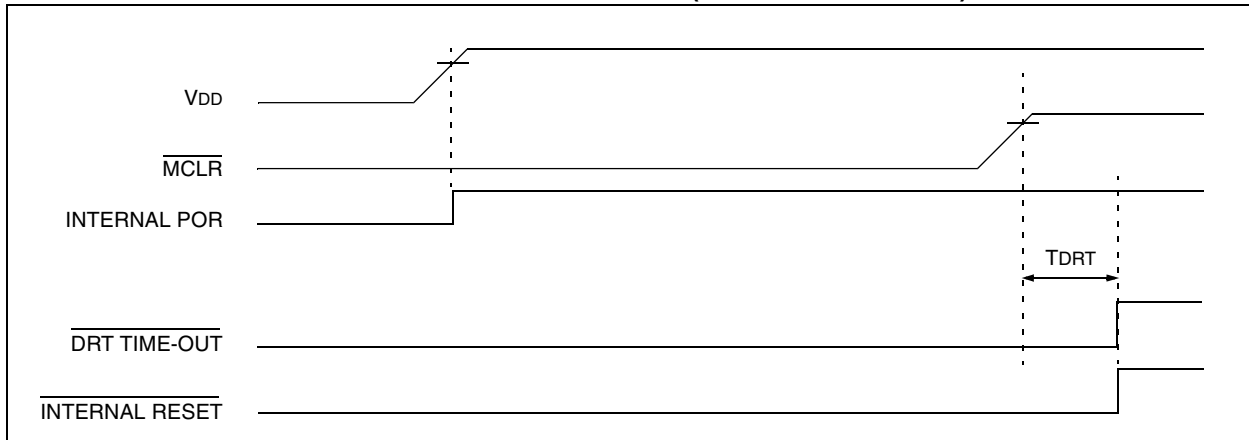
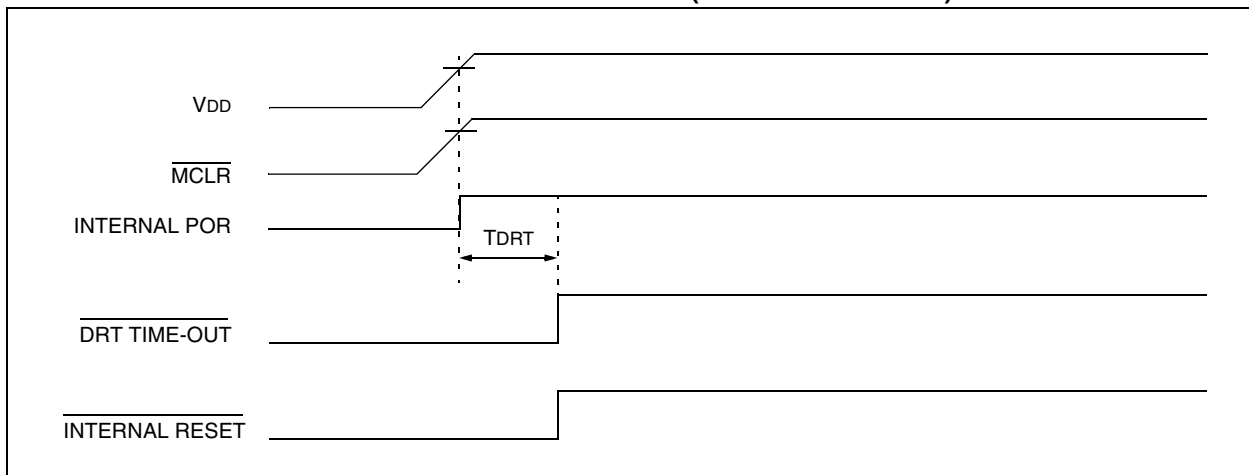


FIGURE 7-9: TIME-OUT SEQUENCE ON POWER-UP ($\overline{\text{MCLR}}$ TIED TO VDD): FAST VDD RISE TIME



7.9 Power-Down Mode (SLEEP)

A device may be powered down (SLEEP) and later powered up (Wake-up from SLEEP).

7.9.1 SLEEP

The Power-Down mode is entered by executing a SLEEP instruction.

If enabled, the Watchdog Timer will be cleared but keeps running, the $\overline{TO}$ bit (STATUS<4>) is set, the $\overline{PD}$ bit (STATUS<3>) is cleared and the oscillator driver is turned off. The I/O ports maintain the status they had before the SLEEP instruction was executed (driving high, driving low or hi-impedance).

It should be noted that a RESET generated by a WDT time-out does not drive the $\overline{MCLR}$ pin low.

For lowest current consumption while powered down, the T0CKI input should be at VDD or VSS and the RB3/ $\overline{MCLR}$ /VPP pin must be at a logic high level (VIHMC) if $\overline{MCLR}$ is enabled.

7.9.2 WAKE-UP FROM SLEEP

The device can wake-up from SLEEP through one of the following events:

1. An external reset input on RB3/ $\overline{MCLR}$ /VPP pin, when configured as $\overline{MCLR}$.
2. A Watchdog Timer time-out reset (if WDT was enabled).
3. A change on input pin RB0, RB1, RB3 or RB4 when wake-up on change is enabled.

These events cause a device reset. The $\overline{TO}$, $\overline{PD}$, and RBWUF bits can be used to determine the cause of device reset. The $\overline{TO}$ bit is cleared if a WDT time-out occurred (and caused wake-up). The $\overline{PD}$ bit, which is set on power-up, is cleared when SLEEP is invoked. The RBWUF bit indicates a change in state while in SLEEP at pins RB0, RB1, RB3 or RB4 (since the last file or bit operation on RB port).

Caution: Right before entering SLEEP, read the input pins. When in SLEEP, wake up occurs when the values at the pins change from the state they were in at the last reading. If a wake-up on change occurs and the pins are not read before reentering SLEEP, a wake-up will occur immediately even if no pins change while in SLEEP mode.

The WDT is cleared when the device wakes from sleep, regardless of the wake-up source.

7.10 Program Verification/Code Protection

If the code protection bit has not been programmed, the on-chip program memory can be read out for verification purposes.

The first 64 locations and the last location (OSCCAL) can be read, regardless of the code protection bit setting.

7.11 ID Locations

Four memory locations are designated as ID locations where the user can store checksum or other code-identification numbers. These locations are not accessible during normal execution, but are readable and writable during program/verify.

Use only the lower 4 bits of the ID locations and always program the upper 8 bits as '0's.

ADDWF Add W and f

Syntax: [*label*] ADDWF f,d

Operands: $0 \leq f \leq 31$
 $d \in [0,1]$

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

Status Affected: C, DC, Z

Encoding:

0001	11df	ffff
------	------	------

Description: Add the contents of the W register and 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'.

Words: 1

Cycles: 1

Example: ADDWF FSR, 0

Before Instruction

W = 0x17
 FSR = 0xC2

After Instruction

W = 0xD9
 FSR = 0xC2

ANDWF AND W with f

Syntax: [*label*] ANDWF f,d

Operands: $0 \leq f \leq 31$
 $d \in [0,1]$

Operation: $(W) .\text{AND.} (f) \rightarrow (\text{dest})$

Status Affected: Z

Encoding:

0001	01df	ffff
------	------	------

Description: The contents of the W register are AND'ed 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'.

Words: 1

Cycles: 1

Example: ANDWF FSR, 1

Before Instruction

W = 0x17
 FSR = 0xC2

After Instruction

W = 0x17
 FSR = 0x02

ANDLW And literal with W

Syntax: [*label*] ANDLW k

Operands: $0 \leq k \leq 255$

Operation: $(W) .\text{AND.} (k) \rightarrow (W)$

Status Affected: Z

Encoding:

1110	kkkk	kkkk
------	------	------

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

Words: 1

Cycles: 1

Example: ANDLW 0x5F

Before Instruction

W = 0xA3

After Instruction

W = 0x03

BCF Bit Clear f

Syntax: [*label*] BCF f,b

Operands: $0 \leq f \leq 31$
 $0 \leq b \leq 7$

Operation: $0 \rightarrow (f)$

Status Affected: None

Encoding:

0100	bbbf	ffff
------	------	------

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

Words: 1

Cycles: 1

Example: BCF FLAG_REG, 7

Before Instruction

FLAG_REG = 0xC7

After Instruction

FLAG_REG = 0x47

IORLW Inclusive OR literal with W

Syntax: [*label*] IORLW *k*

Operands: $0 \leq k \leq 255$

Operation: (W) .OR. (*k*) → (W)

Status Affected: Z

Encoding:

1101	kkkk	kkkk
------	------	------

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

Words: 1

Cycles: 1

Example: IORLW 0x35

Before Instruction
W = 0x9A

After Instruction
W = 0xBF
Z = 0

IORWF Inclusive OR W with f

Syntax: [*label*] IORWF *f*,*d*

Operands: $0 \leq f \leq 31$
 $d \in [0,1]$

Operation: (W).OR. (*f*) → (*dest*)

Status Affected: Z

Encoding:

0001	00df	ffff
------	------	------

Description: Inclusive OR the W register with register 'f'. If 'd' is 0, the result is placed in the W register. If 'd' is 1, the result is placed back in register 'f'.

Words: 1

Cycles: 1

Example: IORWF RESULT, 0

Before Instruction
RESULT = 0x13
W = 0x91

After Instruction
RESULT = 0x13
W = 0x93
Z = 0

MOVF Move f

Syntax: [*label*] MOVF *f*,*d*

Operands: $0 \leq f \leq 31$
 $d \in [0,1]$

Operation: (*f*) → (*dest*)

Status Affected: Z

Encoding:

0010	00df	ffff
------	------	------

Description: The contents of register 'f' are moved to destination 'd'. If 'd' is 0, destination is the W register. If 'd' is 1, the destination is file register 'f'. 'd' = 1 is useful as a test of a file register since status flag Z is affected.

Words: 1

Cycles: 1

Example: MOVF FSR, 0

After Instruction
W = value in FSR register

MOVLW Move Literal to W

Syntax: [*label*] MOVLW *k*

Operands: $0 \leq k \leq 255$

Operation: *k* → (W)

Status Affected: None

Encoding:

1100	kkkk	kkkk
------	------	------

Description: The eight bit literal 'k' is loaded into the W register. The don't cares will assembled as 0s.

Words: 1

Cycles: 1

Example: MOVLW 0x5A

After Instruction
W = 0x5A

Standard Operating Conditions (unless otherwise specified) Operating temperature $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ (commercial) $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ (industrial) $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ (extended) Operating voltage V_{DD} range as described in DC spec Section 10.1 and Section 10.3.							
DC CHARACTERISTICS							
Param No.	Characteristic	Sym	Min	Typ†	Max	Units	Conditions
D090	Output High Voltage I/O ports/CLKOUT (Note 3)	V_{OH}	$V_{DD} - 0.7$	—	—	V	$I_{OH} = -3.0\text{ mA}$, $V_{DD} = 4.5\text{V}$, -40°C to $+85^{\circ}\text{C}$ $I_{OH} = -2.5\text{ mA}$, $V_{DD} = 4.5\text{V}$, -40°C to $+125^{\circ}\text{C}$ $I_{OH} = -1.3\text{ mA}$, $V_{DD} = 4.5\text{V}$, -40°C to $+85^{\circ}\text{C}$ $I_{OH} = -1.0\text{ mA}$, $V_{DD} = 4.5\text{V}$, -40°C to $+125^{\circ}\text{C}$
D090A			$V_{DD} - 0.7$	—	—	V	
D092	OSC2		$V_{DD} - 0.7$	—	—	V	
D092A			$V_{DD} - 0.7$	—	—	V	
D100	Capacitive Loading Specs on Output Pins OSC2 pin	C_{OSC2}	—	—	15	pF	In XT, HS and LP modes when external clock is used to drive OSC1.
D101	All I/O pins and OSC2	C_{IO}	—	—	50	pF	

† 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:** In EXTRC oscillator configuration, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the PIC16C505 be driven with external clock in RC mode.
- 2:** The leakage current on the $\overline{\text{MCLR}}$ 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:** Does not include GP3. For GP3 see parameters D061 and D061A.
- 5:** This spec. applies to GP3/ $\overline{\text{MCLR}}$ configured as external $\overline{\text{MCLR}}$ and GP3/ $\overline{\text{MCLR}}$ configured as input with internal pull-up enabled.
- 6:** This spec. applies when GP3/ $\overline{\text{MCLR}}$ is configured as an input with pull-up disabled. The leakage current of the $\overline{\text{MCLR}}$ circuit is higher than the standard I/O logic.

PIC16C505

FIGURE 10-8: TIMER0 CLOCK TIMINGS - PIC16C505

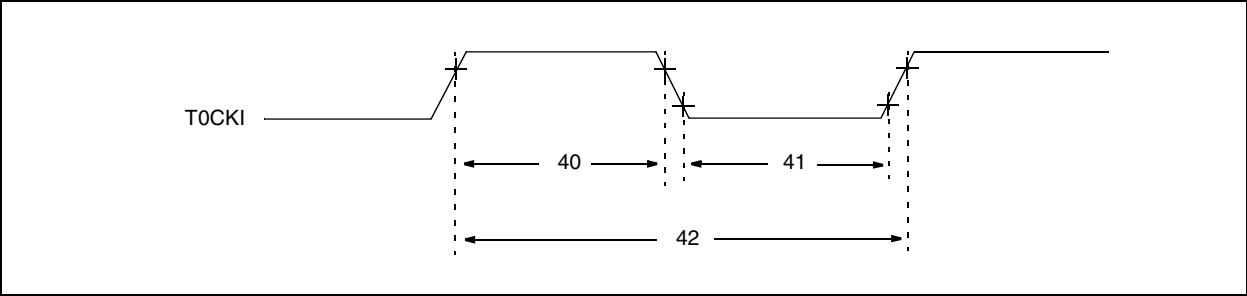


TABLE 10-7: TIMER0 CLOCK REQUIREMENTS - PIC16C505

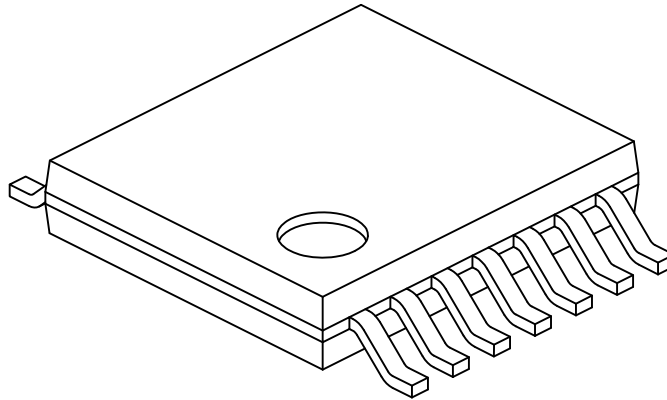
AC Characteristics				Standard Operating Conditions (unless otherwise specified)				
				Operating Temperature 0°C ≤ TA ≤ +70°C (commercial) -40°C ≤ TA ≤ +85°C (industrial) -40°C ≤ TA ≤ +125°C (extended) Operating Voltage VDD range is described in Section 10.1.				
Parm No.	Sym	Characteristic		Min	Typ ⁽¹⁾	Max	Units	Conditions
40	Tt0H	T0CKI High Pulse Width	No Prescaler	0.5 TCY + 20*	—	—	ns	
			With Prescaler	10*	—	—	ns	
41	Tt0L	T0CKI Low Pulse Width	No Prescaler	0.5 TCY + 20*	—	—	ns	
			With Prescaler	10*	—	—	ns	
42	Tt0P	T0CKI Period		20 or TCY + 40* N	—	—	ns	Whichever is greater. N = Prescale Value (1, 2, 4,..., 256)

* These parameters are characterized but not tested.

Note 1: Data in the Typical ("Typ") column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

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



Dimension	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Pins	N	14		
Pitch	e	0.65 BSC		
Overall Height	A	-	-	1.20
Molded Package Thickness	A2	0.80	1.00	1.05
Standoff	A1	0.05	-	0.15
Overall Width	E	6.40 BSC		
Molded Package Width	E1	4.30	4.40	4.50
Molded Package Length	D	4.90	5.00	5.10
Foot Length	L	0.45	0.60	0.75
Footprint	(L1)	1.00 REF		
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.09	-	0.20
Lead Width	b	0.19	-	0.30

Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
- Dimensioning and tolerancing per ASME Y14.5M
 - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
 - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-087C Sheet 2 of 2

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