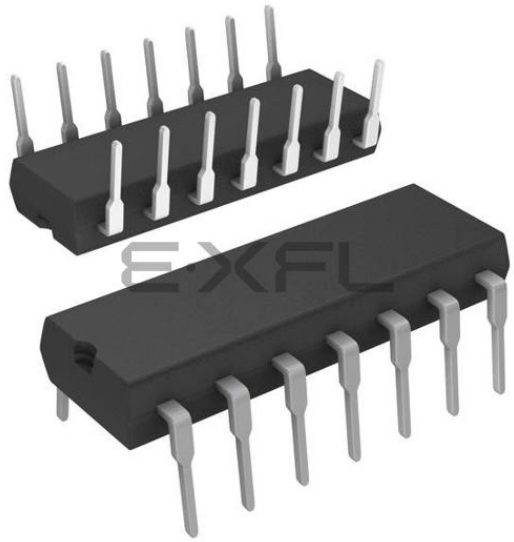

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	-
Peripherals	POR, WDT
Number of I/O	11
Program Memory Size	1.5KB (1K x 12)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	72 x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Through Hole
Package / Case	14-DIP (0.300", 7.62mm)
Supplier Device Package	14-PDIP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16c505-20-p

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 μs) 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).

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.

2.0 PIC16C505 DEVICE VARIETIES

A variety of packaging options are available. Depending on application and production requirements, the proper device option can be selected using the information in this section. When placing orders, please use the PIC16C505 Product Identification System at the back of this data sheet to specify the correct part number.

2.1 One-Time-Programmable (OTP) Devices

The availability of OTP devices is especially useful for customers who need the flexibility of frequent code updates or small volume applications.

The OTP devices, packaged in plastic packages, permit the user to program them once. In addition to the program memory, the configuration bits must also be programmed.

2.2 Quick-Turnaround-Production (QTP) Devices

Microchip offers a QTP Programming Service for factory production orders. This service is made available for users who choose not to program medium to high quantity units and whose code patterns have stabilized. The devices are identical to the OTP devices but with all EPROM locations and fuse options already programmed by the factory. Certain code and prototype verification procedures do apply before production shipments are available. Please contact your local Microchip Technology sales office for more details.

2.3 Serialized Quick-Turnaround Production (SQTP^{SM}) Devices

Microchip offers a unique programming service, where a few user-defined locations in each device are programmed with different serial numbers. The serial numbers may be random, pseudo-random or sequential.

Serial programming allows each device to have a unique number, which can serve as an entry-code, password or ID number.

4.5 OSCCAL Register

The Oscillator Calibration (OSCCAL) register is used to calibrate the internal 4 MHz oscillator. It contains six bits for calibration

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.

After you move in the calibration constant, do not change the value. See Section 7.2.5

REGISTER 4-3: OSCCAL REGISTER (ADDRESS 05h) PIC16C505

R/W-1	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	U-0
CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	—	—
bit7							bit0

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

bit 7-2: **CAL<5:0>:** Calibration

bit 1-0: Unimplemented read as '0'

6.0 TIMER0 MODULE AND TMR0 REGISTER

The Timer0 module has the following features:

- 8-bit timer/counter register, TMR0
  - Readable and writable
- 8-bit software programmable prescaler
- Internal or external clock select
  - Edge select for external clock

Figure 6-1 is a simplified block diagram of the Timer0 module.

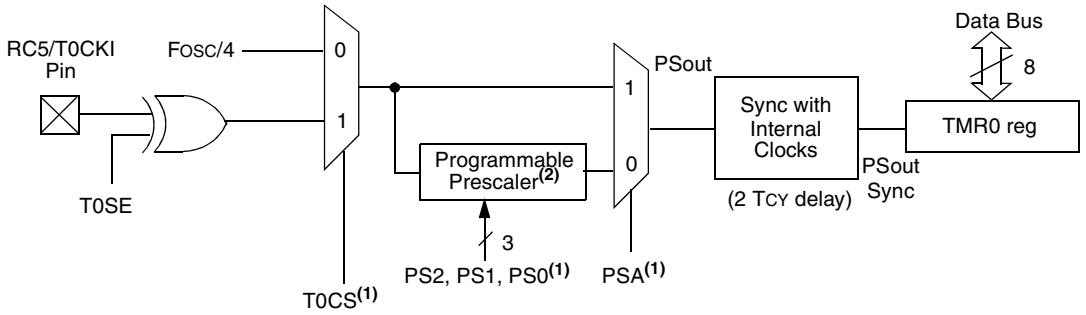
Timer mode is selected by clearing the T0CS bit (OPTION<5>). In timer mode, the Timer0 module will increment every instruction cycle (without prescaler). If TMR0 register is written, the increment is inhibited for the following two cycles (Figure 6-2 and Figure 6-3). The user can work around this by writing an adjusted value to the TMR0 register.

Counter mode is selected by setting the T0CS bit (OPTION<5>). In this mode, Timer0 will increment either on every rising or falling edge of pin T0CKI. The T0SE bit (OPTION<4>) determines the source edge. Clearing the T0SE bit selects the rising edge. Restrictions on the external clock input are discussed in detail in Section 6.1.

The prescaler may be used by either the Timer0 module or the Watchdog Timer, but not both. The prescaler assignment is controlled in software by the control bit PSA (OPTION<3>). Clearing the PSA bit will assign the prescaler to Timer0. The prescaler is not readable or writable. When the prescaler is assigned to the Timer0 module, prescale values of 1:2, 1:4,..., 1:256 are selectable. Section 6.2 details the operation of the prescaler.

A summary of registers associated with the Timer0 module is found in Table 6-1.

FIGURE 6-1: TIMER0 BLOCK DIAGRAM



Note 1: Bits T0CS, T0SE, PSA, PS2, PS1 and PS0 are located in the OPTION register.
2: The prescaler is shared with the Watchdog Timer (Figure 6-5).

6.1 Using Timer0 with an External Clock

When an external clock input is used for Timer0, it must meet certain requirements. The external clock requirement is due to internal phase clock (TOSC) synchronization. Also, there is a delay in the actual incrementing of Timer0 after synchronization.

6.1.1 EXTERNAL CLOCK SYNCHRONIZATION

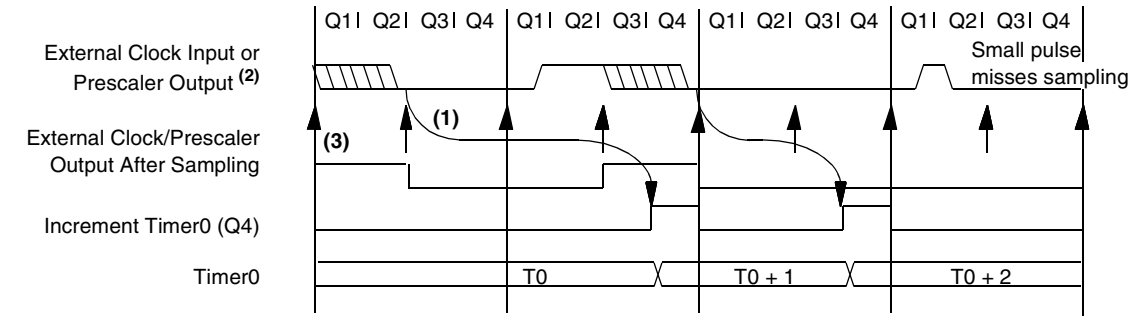
When no prescaler is used, the external clock input is the same as the prescaler output. The synchronization of T0CKI with the internal phase clocks is accomplished by sampling the prescaler output on the Q2 and Q4 cycles of the internal phase clocks (Figure 6-4). Therefore, it is necessary for T0CKI to be high for at least 2TOSC (and a small RC delay of 20 ns) and low for at least 2TOSC (and a small RC delay of 20 ns). Refer to the electrical specification of the desired device.

When a prescaler is used, the external clock input is divided by the asynchronous ripple counter-type prescaler, so that the prescaler output is symmetrical. For the external clock to meet the sampling requirement, the ripple counter must be taken into account. Therefore, it is necessary for T0CKI to have a period of at least 4TOSC (and a small RC delay of 40 ns) divided by the prescaler value. The only requirement on T0CKI high and low time is that they do not violate the minimum pulse width requirement of 10 ns. Refer to parameters 40, 41 and 42 in the electrical specification of the desired device.

6.1.2 TIMER0 INCREMENT DELAY

Since the prescaler output is synchronized with the internal clocks, there is a small delay from the time the external clock edge occurs to the time the Timer0 module is actually incremented. Figure 6-4 shows the delay from the external clock edge to the timer incrementing.

FIGURE 6-4: TIMER0 TIMING WITH EXTERNAL CLOCK



Note 1: Delay from clock input change to Timer0 increment is 3Tosc to 7Tosc. (Duration of Q = Tosc). Therefore, the error in measuring the interval between two edges on Timer0 input = ± 4Tosc max.
2: External clock if no prescaler selected; prescaler output otherwise.
3: The arrows indicate the points in time where sampling occurs.

7.0 SPECIAL FEATURES OF THE CPU

What sets a microcontroller apart from other processors are special circuits to deal with the needs of real-time applications. The PIC16C505 microcontroller has a host of such features intended to maximize system reliability, minimize cost through elimination of external components, provide power saving operating modes and offer code protection. These features are:

- Oscillator selection
- Reset
  - Power-On Reset (POR)
  - Device Reset Timer (DRT)
  - Wake-up from SLEEP on pin change
- Watchdog Timer (WDT)
- SLEEP
- Code protection
- ID locations
- In-circuit Serial Programming
- Clock Out

The PIC16C505 has a Watchdog Timer, which can be shut off only through configuration bit WDTE. It runs off of its own RC oscillator for added reliability. If using HS, XT or LP selectable oscillator options, there is always an 18 ms (nominal) delay provided by the Device Reset Timer (DRT), intended to keep the chip in reset until the crystal oscillator is stable. If using INTRC or EXTRC, there is an 18 ms delay only on V_{DD} power-up. With this timer on-chip, most applications need no external reset circuitry.

The SLEEP mode is designed to offer a very low current power-down mode. The user can wake-up from SLEEP through a change on input pins or through a Watchdog Timer time-out. Several oscillator options are also made available to allow the part to fit the application, including an internal 4 MHz oscillator. The EXTRC oscillator option saves system cost while the LP crystal option saves power. A set of configuration bits are used to select various options.

7.1 Configuration Bits

The PIC16C505 configuration word consists of 12 bits. Configuration bits can be programmed to select various device configurations. Three bits are for the selection of the oscillator type, one bit is the Watchdog Timer enable bit, and one bit is the $\overline{MCLR}$ enable bit. Seven bits are for code protection (Register 7-1).

REGISTER 7-1: CONFIGURATION WORD FOR PIC16C505

CP	CP	CP	CP	CP	CP	MCLRE	CP	WDTE	FOSC2	FOSC1	FOSC0
bit11	10	9	8	7	6	5	4	3	2	1	bit0

Register: CONFIG
Address(2): 0FFFh

bit 11-6, 4: **CP Code Protection bits** (1)(2)(3)

bit 5: **MCLRE:** RB3/$\overline{MCLR}$ pin function select
1 = RB3/$\overline{MCLR}$ pin function is $\overline{MCLR}$
0 = RB3/$\overline{MCLR}$ pin function is digital I/O, $\overline{MCLR}$ internally tied to V_{DD}

bit 3: **WDTE:** Watchdog timer enable bit
1 = WDT enabled
0 = WDT disabled

bit 2-0: **FOSC<1:0>:** Oscillator Selection bits
111 = external RC oscillator/CLKOUT function on RB4/OSC2/CLKOUT pin
110 = external RC oscillator/RB4 function on RB4/OSC2/CLKOUT pin
101 = internal RC oscillator/CLKOUT function on RB4/OSC2/CLKOUT pin
100 = internal RC oscillator/RB4 function on RB4/OSC2/CLKOUT pin
011 = invalid selection
010 = HS oscillator
001 = XT oscillator
000 = LP oscillator

Note 1: 03FFh is always uncode protected on the PIC16C505. This location contains the MOVLWxx calibration instruction for the INTRC.
2: Refer to the PIC16C505 Programming Specifications to determine how to access the configuration word. This register is not user addressable during device operation.
3: All code protect bits must be written to the same value.

7.7 Time-Out Sequence, Power Down, and Wake-up from SLEEP Status Bits ($\overline{TO}$/$\overline{PD}$/RBWUF)

The $\overline{TO}$, $\overline{PD}$, and RBWUF bits in the STATUS register can be tested to determine if a RESET condition has been caused by a power-up condition, a $\overline{MCLR}$ or Watchdog Timer (WDT) reset.

TABLE 7-7: $\overline{TO}$/$\overline{PD}$/RBWUF STATUS AFTER RESET

RBWUF	$\overline{TO}$	$\overline{PD}$	RESET caused by
0	0	0	WDT wake-up from SLEEP
0	0	u	WDT time-out (not from SLEEP)
0	1	0	$\overline{MCLR}$ wake-up from SLEEP
0	1	1	Power-up
0	u	u	$\overline{MCLR}$ not during SLEEP
1	1	0	Wake-up from SLEEP on pin change

Legend: u = unchanged

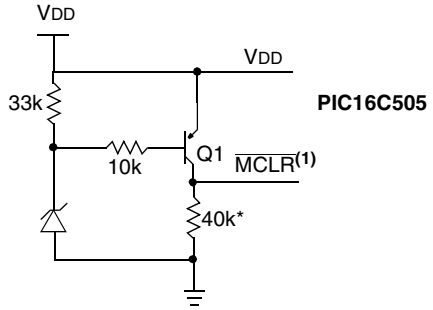
Note 1: The $\overline{TO}$, $\overline{PD}$, and RBWUF bits maintain their status (u) until a reset occurs. A low-pulse on the $\overline{MCLR}$ input does not change the $\overline{TO}$, $\overline{PD}$, and RBWUF status bits.

7.8 Reset on Brown-Out

A brown-out is a condition where device power (V_{DD}) dips below its minimum value, but not to zero, and then recovers. The device should be reset in the event of a brown-out.

To reset PIC16C505 devices when a brown-out occurs, external brown-out protection circuits may be built, as shown in Figure 7-12 and Figure 7-13.

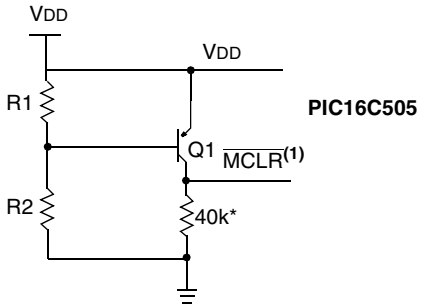
FIGURE 7-12: BROWN-OUT PROTECTION CIRCUIT 1



This circuit will activate reset when V_{DD} goes below Vz + 0.7V (where Vz = Zener voltage).

Note 1: Pin must be confirmed as $\overline{MCLR}$.

FIGURE 7-13: BROWN-OUT PROTECTION CIRCUIT 2

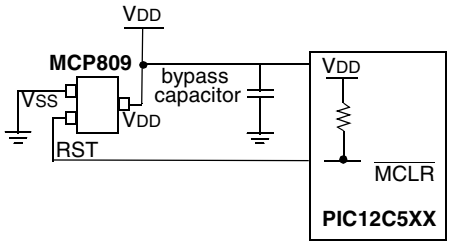


This brown-out circuit is less expensive, although less accurate. Transistor Q1 turns off when V_{DD} is below a certain level such that:

$$V_{DD} \bullet \frac{R1}{R1 + R2} = 0.7V$$

Note 1: Pin must be confirmed as $\overline{MCLR}$.

FIGURE 7-14: BROWN-OUT PROTECTION CIRCUIT 3



This brown-out protection circuit employs Microchip Technology's MCP809 microcontroller supervisor. There are 7 different trip point selections to accommodate 5V to 3V systems.

7.12 In-Circuit Serial Programming

The PIC16C505 microcontrollers can be serially programmed while in the end application circuit. This is simply done with two lines for clock and data, and three other lines for power, ground, and the programming voltage. This allows customers to manufacture boards with unprogrammed devices, and then program the microcontroller just before shipping the product. This also allows the most recent firmware or a custom firmware to be programmed.

The device is placed into a program/verify mode by holding the RB1 and RB0 pins low while raising the $\overline{MCLR}$ (V_{PP}) pin from V_{IL} to V_{IHH} (see programming specification). RB1 becomes the programming clock and RB0 becomes the programming data. Both RB1 and RB0 are Schmitt Trigger inputs in this mode.

After reset, a 6-bit command is then supplied to the device. Depending on the command, 14 bits of program data are then supplied to or from the device, depending if the command was a load or a read. For complete details of serial programming, please refer to the PIC16C505 Programming Specifications.

A typical in-circuit serial programming connection is shown in Figure 7-15.

FIGURE 7-15: TYPICAL IN-CIRCUIT SERIAL PROGRAMMING CONNECTION

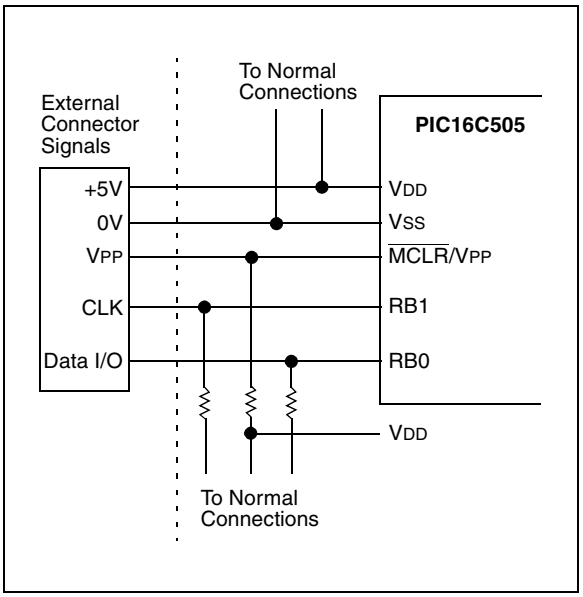


TABLE 8-2: INSTRUCTION SET SUMMARY

Mnemonic, Operands		Description	Cycles	12-Bit Opcode MSb	LSb	Status Affected	Notes
ADDWF	**f,d**	Add W and f	1	0001 11df ffff		C,DC,Z	1,2,4
ANDWF	**f,d**	AND W with f	1	0001 01df ffff		Z	2,4
CLRF	**f**	Clear f	1	0000 011f ffff		Z	4
CLRW	**–**	Clear W	1	0000 0100 0000		Z	
COMF	**f, d**	Complement f	1	0010 01df ffff		Z	
DECF	**f, d**	Decrement f	1	0000 11df ffff		Z	2,4
DECFSZ	**f, d**	Decrement f, Skip if 0	1(2)	0010 11df ffff		None	2,4
INCF	**f, d**	Increment f	1	0010 10df ffff		Z	2,4
INCFSZ	**f, d**	Increment f, Skip if 0	1(2)	0011 11df ffff		None	2,4
IORWF	**f, d**	Inclusive OR W with f	1	0001 00df ffff		Z	2,4
MOVF	**f, d**	Move f	1	0010 00df ffff		Z	2,4
MOVWF	**f**	Move W to f	1	0000 001f ffff		None	1,4
NOP	**–**	No Operation	1	0000 0000 0000		None	
RLF	**f, d**	Rotate left f through Carry	1	0011 01df ffff		C	2,4
RRF	**f, d**	Rotate right f through Carry	1	0011 00df ffff		C	2,4
SUBWF	**f, d**	Subtract W from f	1	0000 10df ffff		C,DC,Z	1,2,4
SWAPF	**f, d**	Swap f	1	0011 10df ffff		None	2,4
XORWF	**f, d**	Exclusive OR W with f	1	0001 10df ffff		Z	2,4
BIT-ORIENTED FILE REGISTER OPERATIONS							
BCF	**f, b**	Bit Clear f	1	0100 bbbf ffff		None	2,4
BSF	**f, b**	Bit Set f	1	0101 bbbf ffff		None	2,4
BTFSC	**f, b**	Bit Test f, Skip if Clear	1 (2)	0110 bbbf ffff		None	
BTFSS	**f, b**	Bit Test f, Skip if Set	1 (2)	0111 bbbf ffff		None	
LITERAL AND CONTROL OPERATIONS							
ANDLW	**k**	AND literal with W	1	1110 kkkk kkkk		Z	
CALL	**k**	Call subroutine	2	1001 kkkk kkkk		None	1
CLRWDT	**k**	Clear Watchdog Timer	1	0000 0000 0100		$\overline{TO}$, $\overline{PD}$	
GOTO	**k**	Unconditional branch	2	101k kkkk kkkk		None	
IORLW	**k**	Inclusive OR Literal with W	1	1101 kkkk kkkk		Z	
MOVLW	**k**	Move Literal to W	1	1100 kkkk kkkk		None	
OPTION	**–**	Load OPTION register	1	0000 0000 0010		None	
RETLW	**k**	Return, place Literal in W	2	1000 kkkk kkkk		None	
SLEEP	**–**	Go into standby mode	1	0000 0000 0011		$\overline{TO}$, $\overline{PD}$	
TRIS	**f**	Load TRIS register	1	0000 0000 0fff		None	3
XORLW	**k**	Exclusive OR Literal to W	1	1111 kkkk kkkk		Z	

Note 1: The 9th bit of the program counter will be forced to a '0' by any instruction that writes to the PC except for GOTO. (Section 4.6)

2: 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'.

3: The instruction TRIS f, where f = 6 causes the contents of the W register to be written to the tristate latches of PORTB. A '1' forces the pin to a hi-impedance state and disables the output buffers.

4: If this instruction is executed on the TMR0 register (and, where applicable, d = 1), the prescaler will be cleared (if assigned to TMR0).

MOVWF **Move W to f**

Syntax: [*label*] MOVWF f

Operands: $0 \le f \le 31$

Operation: (W) → (f)

Status Affected: None

Encoding:

0000	001f	ffff

Description: Move data from the W register to register 'f'.

Words: 1

Cycles: 1

Example:
```
MOVWF   TEMP_REG
```
Before Instruction
TEMP_REG = 0xFF
W = 0x4F
After Instruction
TEMP_REG = 0x4F
W = 0x4F

NOP **No Operation**

Syntax: [*label*] NOP

Operands: None

Operation: No operation

Status Affected: None

Encoding:

0000	0000	0000

Description: No operation.

Words: 1

Cycles: 1

Example:
```
NOP
```

OPTION **Load OPTION Register**

Syntax: [*label*] OPTION

Operands: None

Operation: (W) → OPTION

Status Affected: None

Encoding:

0000	0000	0010

Description: The content of the W register is loaded into the OPTION register.

Words: 1

Cycles: 1

Example
```
OPTION
```
Before Instruction
W = 0x07
After Instruction
OPTION = 0x07

RETLW **Return with Literal in W**

Syntax: [*label*] RETLW k

Operands: $0 \le k \le 255$

Operation: k → (W);
TOS → PC

Status Affected: None

Encoding:

1000	kkkk	kkkk

Description: The W register is loaded with the eight bit literal 'k'. The program counter is loaded from the top of the stack (the return address). This is a two cycle instruction.

Words: 1

Cycles: 2

Example:
```
        CALL TABLE ;W contains
                   ;table offset
                   ;value.
        •          ;W now has table
        •          ;value.
        •
TABLE   ADDWF PC   ;W = offset
        RETLW k1   ;Begin table
        RETLW k2   ;
        •
        •
        •
        RETLW kn   ; End of table
```
Before Instruction
W = 0x07
After Instruction
W = value of k8

10.1 DC CHARACTERISTICS: PIC16C505-04 (Commercial, Industrial, Extended) PIC16C505-20(Commercial, Industrial, Extended)

DC Characteristics Power Supply Pins			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)				
Parm. No.	**Characteristic**	**Sym**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
D001	Supply Voltage	VDD	3.0		5.5	V	See Figure 10-1 through Figure 10-3
D002	RAM Data Retention Voltage(2)	VDR	—	1.5*	—	V	Device in SLEEP mode
D003	VDD Start Voltage to ensure Power-on Reset	VPOR	—	VSS	—	V	See section on Power-on Reset for details
D004	VDD Rise Rate to ensure Power-on Reset	SVDD	0.05*	—	—	V/ms	See section on Power-on Reset for details
D010	Supply Current(3)	IDD	— — — — — —	0.8 0.6 3 4 4.5 19	1.4 1.0 7 12 16 27	mA mA mA mA mA µA	FOSC = 4MHz, VDD = 5.5V, WDT disabled (Note 4)* FOSC = 4MHz, VDD = 3.0V, WDT disabled (Note 4) FOSC = 10MHz, VDD = 3.0V, WDT disabled (Note 6) FOSC = 20MHz, VDD = 4.5V, WDT disabled FOSC = 20MHz, VDD = 5.5V, WDT disabled* FOSC = 32kHz, VDD = 3.0V, WDT disabled (Note 6)
D020	Power-Down Current (5)	IPD	— — — —	0.25 0.4 3 5	4 5.5 8 14	µA µA µA µA	VDD = 3.0V (Note 6) VDD = 4.5V* (Note 6) VDD = 5.5V, Industrial VDD = 5.5V, Extended Temp.
D022	WDT Current(5)	ΔIWDT	—	2.2	5	µA	VDD = 3.0V (Note 6)
1A	LP Oscillator Operating Frequency RC Oscillator Operating Frequency XT Oscillator Operating Frequency HS Oscillator Operating Frequency	Fosc	0 0 0 0	— — — —	200 4 4 20	kHz MHz MHz MHz	All temperatures All temperatures All temperatures All temperatures

* These parameters are characterized but not tested.

Note 1: Data in the Typical ("Typ") column is based on characterization results at 25°C. This data is for design guidance only and is not tested.

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

3: The supply current is mainly a function of the operating voltage and frequency. Other factors such as bus loading, oscillator type, bus rate, internal code execution pattern and temperature also have an impact on the current consumption.

a) The test conditions for all IDD measurements in active operation mode are: OSC1 = external square wave, from rail-to-rail; all I/O pins tristated, pulled to VSS, T0CKI = VDD, $\overline{MCLR}$ = VDD; WDT enabled/disabled as specified.

b) For standby current measurements, the conditions are the same, except that the device is in SLEEP mode.

4: Does not include current through Rext. The current through the resistor can be estimated by the formula: IR = VDD/2Rext (mA) with Rext in kOhm.

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

6: Commercial temperature range only.

DC 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 as described in DC spec Section 10.1 and Section 10.3.				
Param No.	**Characteristic**	**Sym**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
	Output High Voltage						
D090	I/O ports/CLKOUT (Note 3)	VOH	VDD - 0.7	—	—	V	IOH = -3.0 mA, VDD = 4.5V, –40°C to +85°C
D090A			VDD - 0.7	—	—	V	IOH = -2.5 mA, VDD = 4.5V, –40°C to +125°C
D092	OSC2		VDD - 0.7	—	—	V	IOH = -1.3 mA, VDD = 4.5V, –40°C to +85°C
D092A			VDD - 0.7	—	—	V	IOH = -1.0 mA, VDD = 4.5V, –40°C to +125°C
	Capacitive Loading Specs on Output Pins						
D100	OSC2 pin	COSC2	—	—	15	pF	In XT, HS and LP modes when external clock is used to drive OSC1.
D101	All I/O pins and OSC2	CIO	—	—	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 $\overline{MCLR}$ 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/$\overline{MCLR}$ configured as external $\overline{MCLR}$ and GP3/$\overline{MCLR}$ configured as input with internal pull-up enabled.

6: This spec. applies when GP3/$\overline{MCLR}$ is configured as an input with pull-up disabled. The leakage current of the $\overline{MCLR}$ circuit is higher than the standard I/O logic.

10.5 Timing Diagrams and Specifications

FIGURE 10-5: EXTERNAL CLOCK TIMING - PIC16C505

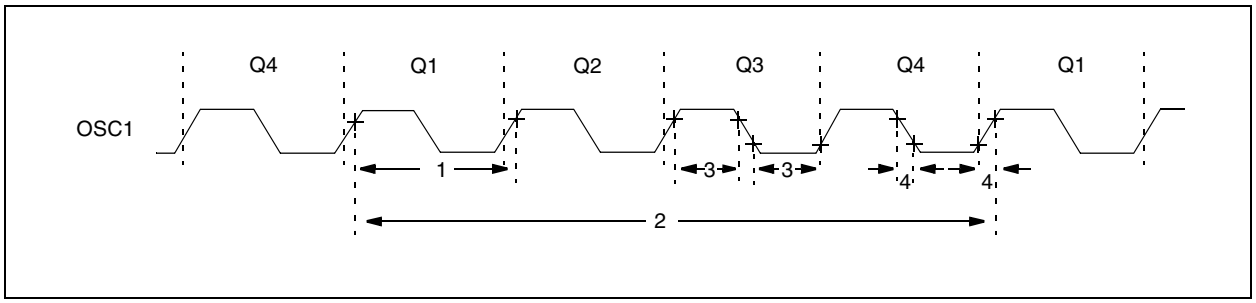


TABLE 10-2: EXTERNAL CLOCK TIMING REQUIREMENTS - PIC16C505

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						
Parameter No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
1A	FOSC	External CLKIN Frequency(2)	DC	—	4	MHz	XT osc mode
			DC	—	4	MHz	HS osc mode (PIC16C505-04)
			DC	—	20	MHz	HS osc mode (PIC16C505-20)
			DC	—	200	kHz	LP osc mode
		Oscillator Frequency(2)	DC	—	4	MHz	EXTRC osc mode
			0.1	—	4	MHz	XT osc mode
			4	—	4	MHz	HS osc mode (PIC16C505-04)
			DC	—	200	kHz	LP osc mode
1	TOSC	External CLKIN Period(2)	250	—	—	ns	XT osc mode
			50	—	—	ns	HS osc mode (PIC16C505-20)
				—	—	µs	LP osc mode
		Oscillator Period(2)	250	—	—	ns	EXTRC osc mode
			250	—	10,000	ns	XT osc mode
			250	—	250	ns	HS ocs mode (PIC16C505-04)
			50	—	250	ns	HS ocs mode (PIC16C505-20)
			5	—	—	µs	LP osc mode
2	TCY	Instruction Cycle Time	—	4/FOSC	DC	ns	
			200	—		ns	

* 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.

2: 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.
When an external clock input is used, the "max" cycle time limit is "DC" (no clock) for all devices.

TABLE 10-2: EXTERNAL CLOCK TIMING REQUIREMENTS - PIC16C505 (CONTINUED)

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

Parameter No.	Sym	Characteristic	Min	Typ(1)	Max	Units	Conditions
3	TosL, TosH	Clock in (OSC1) Low or High Time	50*	—	—	ns	XT oscillator
			2*	—	—	µs	LP oscillator
			10			ns	HS oscillator
4	TosR, TosF	Clock in (OSC1) Rise or Fall Time	—	—	25*	ns	XT oscillator
			—	—	50*	ns	LP oscillator
			—	—	15	ns	HS oscillator

* 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.

2: 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.
When an external clock input is used, the "max" cycle time limit is "DC" (no clock) for all devices.

TABLE 10-3: CALIBRATED INTERNAL RC FREQUENCIES - 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

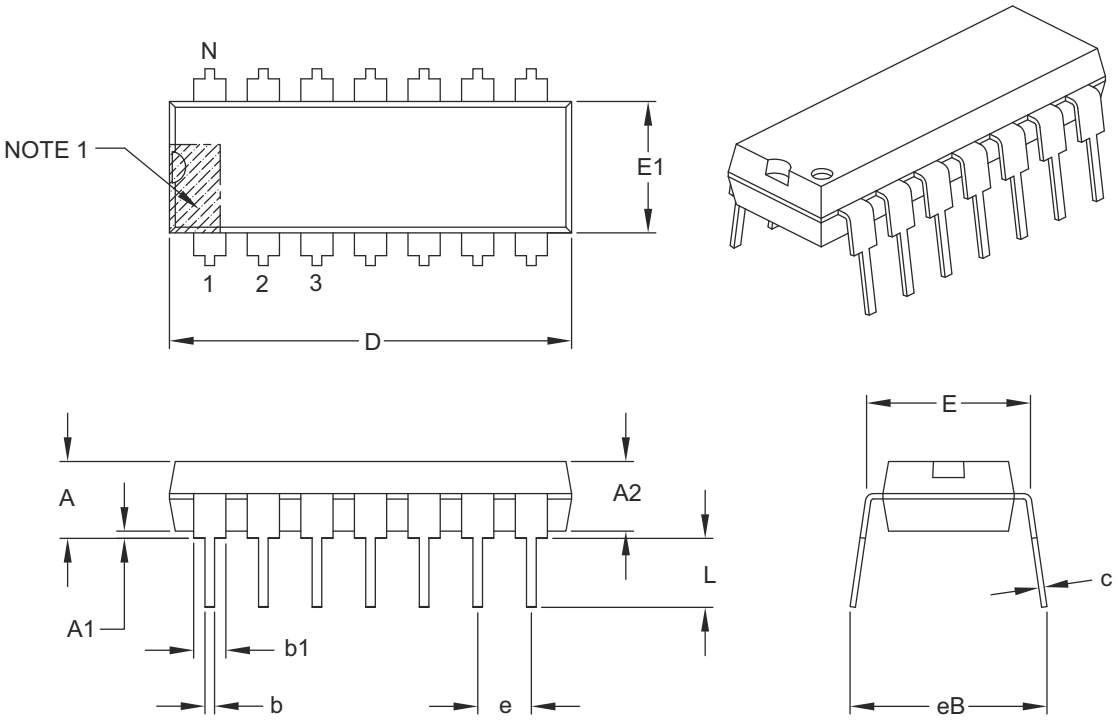
Parameter No.	Sym	Characteristic	Min*	Typ(1)	Max*	Units	Conditions
		Internal Calibrated RC Frequency	3.65	4.00	4.28	MHz	VDD = 5.0V
		Internal Calibrated RC Frequency	3.55	4.00	4.31	MHz	VDD = 2.5V

* 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 Dual In-Line (P) – 300 mil Body [PDIP]

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



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		.100 BSC	
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.735	.750	.775
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

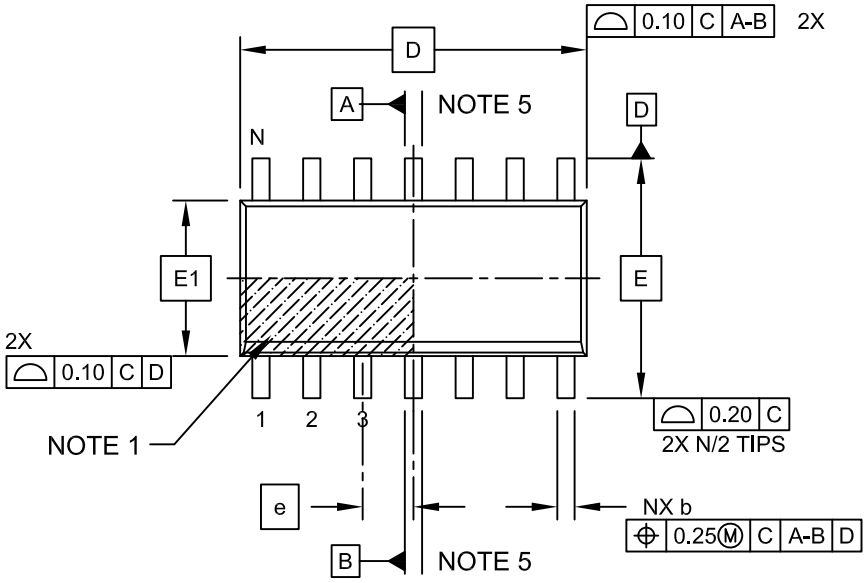
1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

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

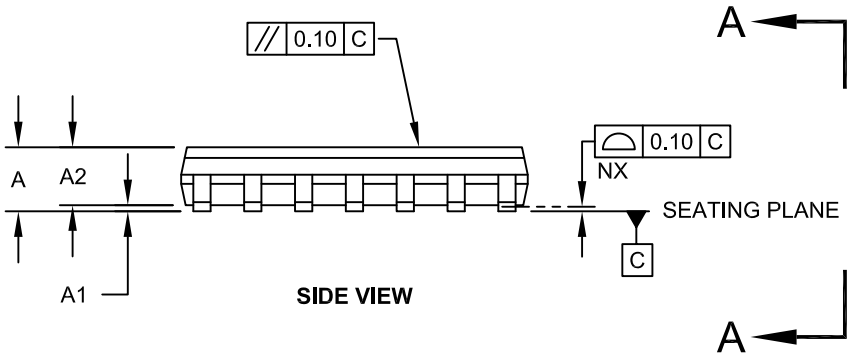
Microchip Technology Drawing C04-005B

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

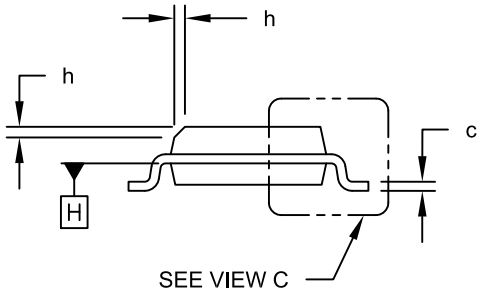
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

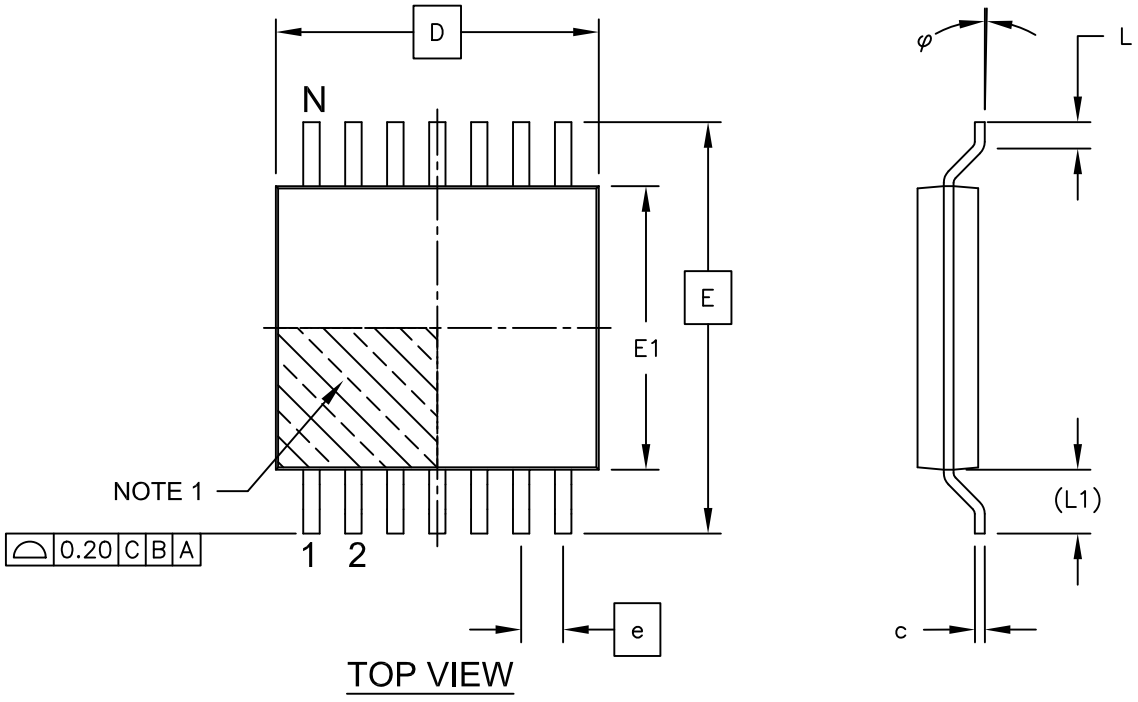


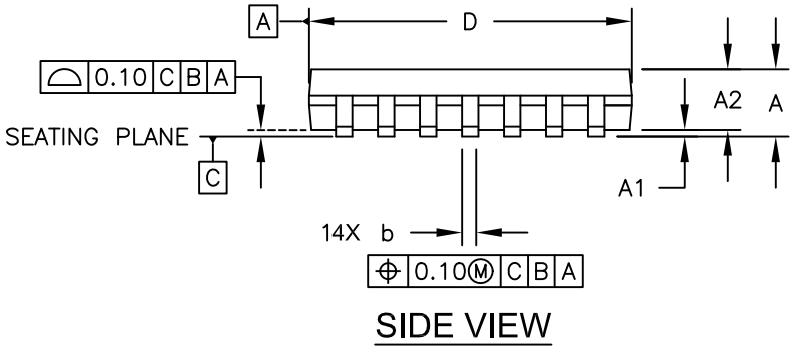
VIEW A-A

Microchip Technology Drawing No. C04-065C Sheet 1 of 2

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





Microchip Technology Drawing C04-087C Sheet 1 of 2

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

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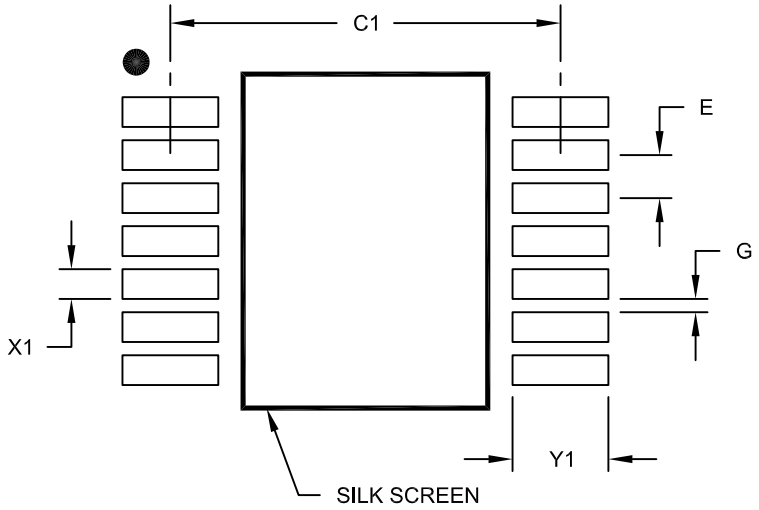

RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.65 BSC	
Contact Pad Spacing	C1		5.90	
Contact Pad Width (X14)	X1			0.45
Contact Pad Length (X14)	Y1			1.45
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2087A

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