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### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Active                                                                                                                                                        |
| Core Processor             | PIC                                                                                                                                                           |
| Core Size                  | 8-Bit                                                                                                                                                         |
| Speed                      | 40MHz                                                                                                                                                         |
| Connectivity               | -                                                                                                                                                             |
| Peripherals                | POR, WDT                                                                                                                                                      |
| Number of I/O              | 20                                                                                                                                                            |
| Program Memory Size        | 3KB (2K x 12)                                                                                                                                                 |
| Program Memory Type        | OTP                                                                                                                                                           |
| EEPROM Size                | -                                                                                                                                                             |
| RAM Size                   | 72 x 8                                                                                                                                                        |
| Voltage - Supply (Vcc/Vdd) | 2.5V ~ 6.25V                                                                                                                                                  |
| Data Converters            | -                                                                                                                                                             |
| Oscillator Type            | External                                                                                                                                                      |
| Operating Temperature      | 0°C ~ 70°C (TA)                                                                                                                                               |
| Mounting Type              | Through Hole                                                                                                                                                  |
| Package / Case             | 28-DIP (0.600", 15.24mm)                                                                                                                                      |
| Supplier Device Package    | 28-PDIP                                                                                                                                                       |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/microchip-technology/pic16c57-lp-p">https://www.e-xfl.com/product-detail/microchip-technology/pic16c57-lp-p</a> |

# PIC16C5X

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## 6.5.1 PAGING CONSIDERATIONS – PIC16C56/CR56, PIC16C57/CR57 AND PIC16C58/CR58

If the Program Counter is pointing to the last address of a selected memory page, when it increments it will cause the program to continue in the next higher page. However, the page preselect bits in the STATUS Register will not be updated. Therefore, the next `GOTO`, `CALL` or modify PCL instruction will send the program to the page specified by the page preselect bits (PA0 or PA<1:0>).

For example, a `NOP` at location 1FFh (page 0) increments the PC to 200h (page 1). A `GOTO xxx` at 200h will return the program to address xxh on page 0 (assuming that PA<1:0> are clear).

To prevent this, the page preselect bits must be updated under program control.

## 6.5.2 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 RESET vector).

The STATUS Register page preselect bits are cleared upon a RESET, which means that page 0 is preselected.

Therefore, upon a RESET, a `GOTO` instruction at the RESET vector location will automatically cause the program to jump to page 0.

## 6.6 Stack

PIC16C5X devices have a 10-bit or 11-bit wide, two-level 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.

For the `RETLW` instruction, the PC is loaded with the Top of Stack (TOS) contents. All of the devices covered in this data sheet have a two-level stack. The stack has the same bit width as the device PC, therefore, paging is not an issue when returning from a subroutine.

6.7 Indirect Data Addressing; INDF and FSR Registers

The INDF Register is not a physical register. Addressing INDF actually addresses the register whose address is contained in the FSR Register (FSR is a *pointer*). This is indirect addressing.

EXAMPLE 6-1: INDIRECT ADDRESSING

- Register file 08 contains the value 10h
  - Register file 09 contains the value 0Ah
  - Load the value 08 into the FSR Register
  - A read of the INDF Register will return the value of 10h
  - Increment the value of the FSR Register by one (FSR = 09h)
  - A read of the INDF register now will return the value of 0Ah.
- Reading INDF itself indirectly (FSR = 0) will produce 00h. Writing to the INDF Register indirectly results in a no-operation (although STATUS bits may be affected).
- A simple program to clear RAM locations 10h-1Fh using indirect addressing is shown in Example 6-2.

EXAMPLE 6-2: HOW TO CLEAR RAM USING INDIRECT ADDRESSING

```
MOVLW H'10' ;initialize pointer
MOVWF FSR ; to RAM
NEXT      CLRF INDF ;clear INDF Register
          INCF FSR,F ;inc pointer
          BTFSC FSR,4 ;all done?
          GOTO NEXT ;NO, clear next
          : ;YES, continue
CONTINUE
```

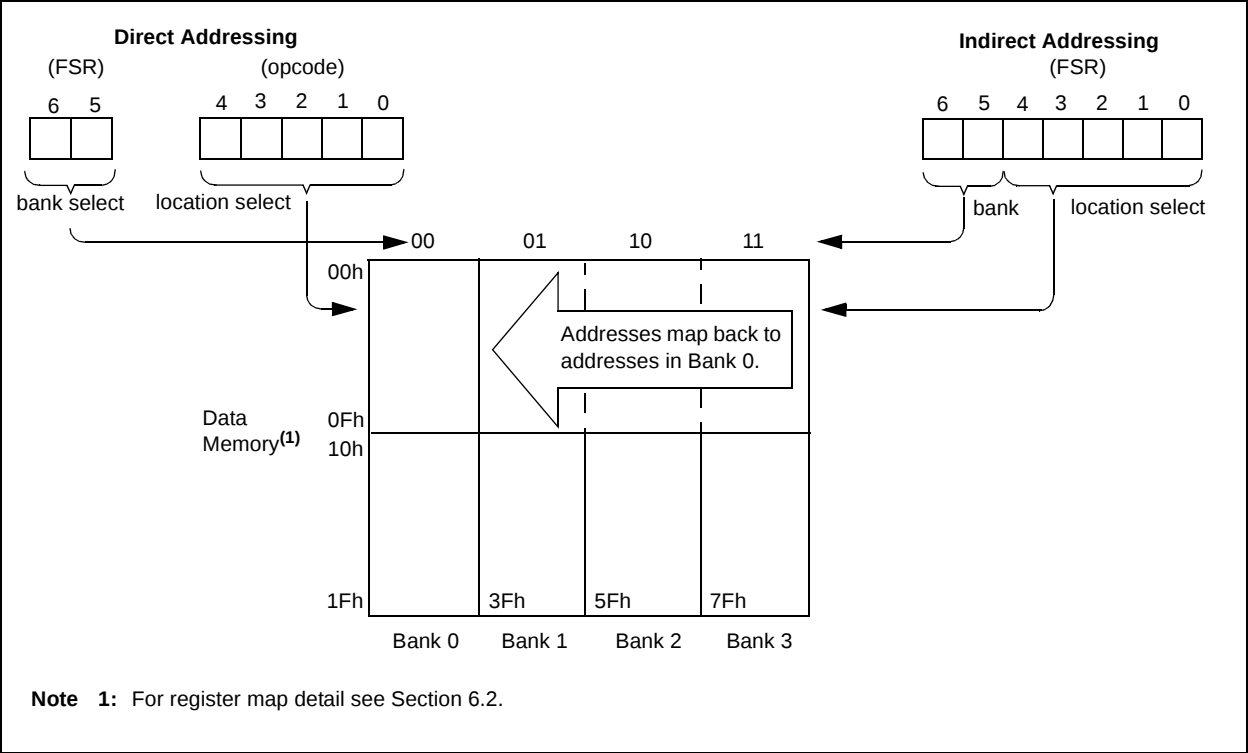
The FSR is either a 5-bit (PIC16C54, PIC16CR54, PIC16C55, PIC16C56, PIC16CR56) or 7-bit (PIC16C57, PIC16CR57, PIC16C58, PIC16CR58) wide register. It is used in conjunction with the INDF Register to indirectly address the data memory area.

The FSR<4:0> bits are used to select data memory addresses 00h to 1Fh.

**PIC16C54, PIC16CR54, PIC16C55, PIC16C56, PIC16CR56:** These do not use banking. FSR<6:5> bits are unimplemented and read as '1's.

**PIC16C57, PIC16CR57, PIC16C58, PIC16CR58:** FSR<6:5> are the bank select bits and are used to select the bank to be addressed (00 = bank 0, 01 = bank 1, 10 = bank 2, 11 = bank 3).

FIGURE 6-10: DIRECT/INDIRECT ADDRESSING



## 9.3 Power-Down Mode (SLEEP)

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

### 9.3.1 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 MCLR/VPP pin low.

For lowest current consumption while powered down, the T0CKI input should be at VDD or VSS and the MCLR/VPP pin must be at a logic high level (MCLR = VIH).

### 9.3.2 WAKE-UP FROM SLEEP

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

1. An external RESET input on  $\overline{MCLR/VPP}$  pin.
2. A Watchdog Timer Time-out Reset (if WDT was enabled).

Both of these events cause a device RESET. The  $\overline{TO}$  and  $\overline{PD}$  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 WDT is cleared when the device wakes from SLEEP, regardless of the wake-up source.

## 9.4 Program Verification/Code Protection

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

**Note:** Microchip does not recommend code protecting windowed devices.

## 9.5 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 '1's.

**Note:** Microchip will assign a unique pattern number for QTP and SQTP requests and for ROM devices. This pattern number will be unique and traceable to the submitted code.

| CALL                     |                                                                                                                                                                                                                                               | Subroutine Call |  |  |  |      |      |      |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--|--|--|------|------|------|
| Syntax:                  | [ <i>label</i> ] CALL k                                                                                                                                                                                                                       |                 |  |  |  |      |      |      |
| Operands:                | 0 ≤ k ≤ 255                                                                                                                                                                                                                                   |                 |  |  |  |      |      |      |
| Operation:               | (PC) + 1 → TOS;<br>k → PC<7:0>;<br>(STATUS<6:5>) → PC<10:9>;<br>0 → PC<8>                                                                                                                                                                     |                 |  |  |  |      |      |      |
| Status Affected:         | None                                                                                                                                                                                                                                          |                 |  |  |  |      |      |      |
| Encoding:                | <table border="1"><tr><td>1001</td><td>kkkk</td><td>kkkk</td></tr></table>                                                                                                                                                                    |                 |  |  |  | 1001 | kkkk | kkkk |
| 1001                     | kkkk                                                                                                                                                                                                                                          | kkkk            |  |  |  |      |      |      |
| Description:             | Subroutine call. First, return address (PC+1) is pushed onto the stack. The eight bit immediate address is loaded into PC bits <7:0>. The upper bits PC<10:9> are loaded from STATUS<6:5>, PC<8> is cleared. CALL is a two-cycle instruction. |                 |  |  |  |      |      |      |
| Words:                   | 1                                                                                                                                                                                                                                             |                 |  |  |  |      |      |      |
| Cycles:                  | 2                                                                                                                                                                                                                                             |                 |  |  |  |      |      |      |
| Example:                 | HERE CALL THERE                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |
| Before Instruction       |                                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |
| PC = address (HERE)      |                                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |
| After Instruction        |                                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |
| PC = address (THERE)     |                                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |
| TOS = address (HERE + 1) |                                                                                                                                                                                                                                               |                 |  |  |  |      |      |      |

| CLRF               |                                                                            | Clear f |      |      |      |      |
|--------------------|----------------------------------------------------------------------------|---------|------|------|------|------|
| Syntax:            | [ <i>label</i> ] CLRF    f                                                 |         |      |      |      |      |
| Operands:          | $0 \leq f \leq 31$                                                         |         |      |      |      |      |
| Operation:         | 00h $\rightarrow$ (f);<br>1 $\rightarrow$ Z                                |         |      |      |      |      |
| Status Affected:   | Z                                                                          |         |      |      |      |      |
| Encoding:          | <table border="1"><tr><td>0000</td><td>011f</td><td>ffff</td></tr></table> |         |      | 0000 | 011f | ffff |
| 0000               | 011f                                                                       | ffff    |      |      |      |      |
| Description:       | The contents of register 'f' are cleared and the Z bit is set.             |         |      |      |      |      |
| Words:             | 1                                                                          |         |      |      |      |      |
| Cycles:            | 1                                                                          |         |      |      |      |      |
| Example:           | CLRF        FLAG_REG                                                       |         |      |      |      |      |
| Before Instruction |                                                                            |         |      |      |      |      |
| FLAG_REG           |                                                                            | =       | 0x5A |      |      |      |
| After Instruction  |                                                                            |         |      |      |      |      |
| FLAG_REG           |                                                                            | =       | 0x00 |      |      |      |
| Z                  |                                                                            | =       | 1    |      |      |      |

| CLR W              |                                                                            | Clear W |  |      |      |      |
|--------------------|----------------------------------------------------------------------------|---------|--|------|------|------|
| Syntax:            | [ <i>label</i> ] CLRW                                                      |         |  |      |      |      |
| Operands:          | None                                                                       |         |  |      |      |      |
| Operation:         | 00h → (W);<br>1 → Z                                                        |         |  |      |      |      |
| Status Affected:   | Z                                                                          |         |  |      |      |      |
| Encoding:          | <table border="1"><tr><td>0000</td><td>0100</td><td>0000</td></tr></table> |         |  | 0000 | 0100 | 0000 |
| 0000               | 0100                                                                       | 0000    |  |      |      |      |
| Description:       | The W register is cleared. Zero bit (Z) is set.                            |         |  |      |      |      |
| Words:             | 1                                                                          |         |  |      |      |      |
| Cycles:            | 1                                                                          |         |  |      |      |      |
| Example:           | CLR W                                                                      |         |  |      |      |      |
| Before Instruction |                                                                            |         |  |      |      |      |
| W = 0x5A           |                                                                            |         |  |      |      |      |
| After Instruction  |                                                                            |         |  |      |      |      |
| W = 0x00           |                                                                            |         |  |      |      |      |
| Z = 1              |                                                                            |         |  |      |      |      |

| CLRWDT                 | Clear Watchdog Timer                                                                                                                                                                                |      |      |      |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|
| Syntax:                | [ <i>label</i> ] CLRWDT                                                                                                                                                                             |      |      |      |
| Operands:              | None                                                                                                                                                                                                |      |      |      |
| Operation:             | 00h → WDT;<br>0 → $\overline{\text{WDT}}$ prescaler (if assigned);<br>1 → $\overline{\text{TO}}$ ;<br>1 → $\overline{\text{PD}}$                                                                    |      |      |      |
| Status Affected:       | $\overline{\text{TO}}$ , $\overline{\text{PD}}$                                                                                                                                                     |      |      |      |
| Encoding:              | <table border="1"><tr><td>0000</td><td>0000</td><td>0100</td></tr></table>                                                                                                                          | 0000 | 0000 | 0100 |
| 0000                   | 0000                                                                                                                                                                                                | 0100 |      |      |
| Description:           | The CLRWDT instruction resets the WDT. It also resets the prescaler, if the prescaler is assigned to the WDT and not Timer0. Status bits $\overline{\text{TO}}$ and $\overline{\text{PD}}$ are set. |      |      |      |
| Words:                 | 1                                                                                                                                                                                                   |      |      |      |
| Cycles:                | 1                                                                                                                                                                                                   |      |      |      |
| Example:               | CLRWDT                                                                                                                                                                                              |      |      |      |
| Before Instruction     |                                                                                                                                                                                                     |      |      |      |
| WDT counter            | = ?                                                                                                                                                                                                 |      |      |      |
| After Instruction      |                                                                                                                                                                                                     |      |      |      |
| WDT counter            | = 0x00                                                                                                                                                                                              |      |      |      |
| WDT prescaler          | = 0                                                                                                                                                                                                 |      |      |      |
| $\overline{\text{TO}}$ | = 1                                                                                                                                                                                                 |      |      |      |
| $\overline{\text{PD}}$ | = 1                                                                                                                                                                                                 |      |      |      |

# PIC16C5X

## COMF Complement f

**Syntax:** `[label] COMF f,d`

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

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

**Status Affected:** Z

**Encoding:**

|      |      |      |
|------|------|------|
| 0010 | 01df | ffff |
|------|------|------|

**Description:** The contents of register 'f' are complemented. 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:** `COMF REG1, 0`

Before Instruction  
 REG1 = 0x13  
 After Instruction  
 REG1 = 0x13  
 W = 0xEC

## DECF Decrement f

**Syntax:** `[label] DECF f,d`

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

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

**Status Affected:** Z

**Encoding:**

|      |      |      |
|------|------|------|
| 0000 | 11df | ffff |
|------|------|------|

**Description:** Decrement register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

**Words:** 1

**Cycles:** 1

**Example:** `DECF CNT, 1`

Before Instruction  
 CNT = 0x01  
 Z = 0  
 After Instruction  
 CNT = 0x00  
 Z = 1

## DECFSZ Decrement f, Skip if 0

**Syntax:** `[label] DECFSZ f,d`

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

**Operation:**  $(f) - 1 \rightarrow d$ ; skip if result = 0

**Status Affected:** None

**Encoding:**

|      |      |      |
|------|------|------|
| 0010 | 11df | ffff |
|------|------|------|

**Description:** The contents of register 'f' are decremented. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'. If the result is 0, the next instruction, which is already fetched, is discarded and a NOP is executed instead making it a two-cycle instruction.

**Words:** 1

**Cycles:** 1(2)

**Example:** `HERE DECFSZ CNT, 1  
 GOTO LOOP  
 CONTINUE`

Before Instruction  
 PC = address (HERE)  
 After Instruction  
 CNT = CNT - 1;  
 if CNT = 0,  
 PC = address (CONTINUE);  
 if CNT  $\neq$  0,  
 PC = address (HERE+1)

# PIC16C5X

## 12.5 DC Characteristics: PIC16C54/55/56/57-RCE, XTE, 10E, HSE, LPE (Extended)

| DC CHARACTERISTICS |           |                                               | Standard Operating Conditions (unless otherwise specified)                                  |      |               |               |                                                                                                                |
|--------------------|-----------|-----------------------------------------------|---------------------------------------------------------------------------------------------|------|---------------|---------------|----------------------------------------------------------------------------------------------------------------|
|                    |           |                                               | Operating Temperature $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended |      |               |               |                                                                                                                |
| Param No.          | Symbol    | Characteristic                                | Min                                                                                         | Typ† | Max           | Units         | Conditions                                                                                                     |
| D030               | $V_{IL}$  | <b>Input Low Voltage</b>                      |                                                                                             |      |               |               |                                                                                                                |
|                    |           | I/O ports                                     | $V_{SS}$                                                                                    | —    | $0.15 V_{DD}$ | V             | Pin at hi-impedance                                                                                            |
|                    |           | MCLR (Schmitt Trigger)                        | $V_{SS}$                                                                                    | —    | $0.15 V_{DD}$ | V             |                                                                                                                |
|                    |           | T0CKI (Schmitt Trigger)                       | $V_{SS}$                                                                                    | —    | $0.15 V_{DD}$ | V             |                                                                                                                |
|                    |           | OSC1 (Schmitt Trigger)                        | $V_{SS}$                                                                                    | —    | $0.15 V_{DD}$ | V             | PIC16C5X-RC only <sup>(3)</sup>                                                                                |
|                    |           | OSC1 (Schmitt Trigger)                        | $V_{SS}$                                                                                    | —    | $0.3 V_{DD}$  | V             | PIC16C5X-XT, 10, HS, LP                                                                                        |
| D040               | $V_{IH}$  | <b>Input High Voltage</b>                     |                                                                                             |      |               |               |                                                                                                                |
|                    |           | I/O ports                                     | $0.45 V_{DD}$                                                                               | —    | $V_{DD}$      | V             | For all $V_{DD}$ <sup>(4)</sup>                                                                                |
|                    |           | I/O ports                                     | 2.0                                                                                         | —    | $V_{DD}$      | V             | $4.0\text{V} < V_{DD} \leq 5.5\text{V}$ <sup>(4)</sup>                                                         |
|                    |           | I/O ports                                     | $0.36 V_{DD}$                                                                               | —    | $V_{DD}$      | V             | $V_{DD} > 5.5\text{V}$                                                                                         |
|                    |           | MCLR (Schmitt Trigger)                        | $0.85 V_{DD}$                                                                               | —    | $V_{DD}$      | V             |                                                                                                                |
|                    |           | T0CKI (Schmitt Trigger)                       | $0.85 V_{DD}$                                                                               | —    | $V_{DD}$      | V             |                                                                                                                |
|                    |           | OSC1 (Schmitt Trigger)                        | $0.85 V_{DD}$                                                                               | —    | $V_{DD}$      | V             | PIC16C5X-RC only <sup>(3)</sup>                                                                                |
|                    |           | OSC1 (Schmitt Trigger)                        | $0.7 V_{DD}$                                                                                | —    | $V_{DD}$      | V             | PIC16C5X-XT, 10, HS, LP                                                                                        |
| D050               | $V_{HYS}$ | <b>Hysteresis of Schmitt Trigger inputs</b>   | $0.15 V_{DD}^*$                                                                             | —    | —             | V             |                                                                                                                |
| D060               | $I_{IL}$  | <b>Input Leakage Current</b> <sup>(1,2)</sup> |                                                                                             |      |               |               |                                                                                                                |
|                    |           | I/O ports                                     | –1                                                                                          | 0.5  | +1            | $\mu\text{A}$ | <b>For <math>V_{DD} \leq 5.5\text{V}</math>:</b><br>$V_{SS} \leq V_{PIN} \leq V_{DD}$ ,<br>pin at hi-impedance |
|                    |           | MCLR                                          | –5                                                                                          | —    | —             | $\mu\text{A}$ | $V_{PIN} = V_{SS} + 0.25\text{V}$                                                                              |
|                    |           | MCLR                                          | —                                                                                           | 0.5  | +5            | $\mu\text{A}$ | $V_{PIN} = V_{DD}$                                                                                             |
|                    |           | T0CKI                                         | –3                                                                                          | 0.5  | +3            | $\mu\text{A}$ | $V_{SS} \leq V_{PIN} \leq V_{DD}$                                                                              |
|                    |           | OSC1                                          | –3                                                                                          | 0.5  | +3            | $\mu\text{A}$ | $V_{SS} \leq V_{PIN} \leq V_{DD}$ ,<br>PIC16C5X-XT, 10, HS, LP                                                 |
| D080               | $V_{OL}$  | <b>Output Low Voltage</b>                     |                                                                                             |      |               |               |                                                                                                                |
|                    |           | I/O ports                                     | —                                                                                           | —    | 0.6           | V             | $I_{OL} = 8.7\text{ mA}$ , $V_{DD} = 4.5\text{V}$                                                              |
|                    |           | OSC2/CLKOUT                                   | —                                                                                           | —    | 0.6           | V             | $I_{OL} = 1.6\text{ mA}$ , $V_{DD} = 4.5\text{V}$ ,<br>PIC16C5X-RC                                             |
| D090               | $V_{OH}$  | <b>Output High Voltage</b> <sup>(2)</sup>     |                                                                                             |      |               |               |                                                                                                                |
|                    |           | I/O ports                                     | $V_{DD} - 0.7$                                                                              | —    | —             | V             | $I_{OH} = -5.4\text{ mA}$ , $V_{DD} = 4.5\text{V}$                                                             |
|                    |           | OSC2/CLKOUT                                   | $V_{DD} - 0.7$                                                                              | —    | —             | V             | $I_{OH} = -1.0\text{ mA}$ , $V_{DD} = 4.5\text{V}$ ,<br>PIC16C5X-RC                                            |

\* These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is based on characterization results at  $25^{\circ}\text{C}$ . This data is for design guidance only and is not tested.

**Note 1:** The leakage current on the  $\overline{\text{MCLR}}/\text{VPP}$  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 voltage.

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

**3:** For PIC16C5X-RC devices, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the PIC16C5X be driven with external clock in RC mode.

**4:** The user may use the better of the two specifications.

**TABLE 12-1: EXTERNAL CLOCK TIMING REQUIREMENTS - PIC16C54/55/56/57**

| <b>Standard Operating Conditions (unless otherwise specified)</b><br><b>AC Characteristics</b> Operating Temperature $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for commercial<br>$-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial<br>$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended |               |                                       |      |        |        |       |                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------------|------|--------|--------|-------|------------------------|
| Param No.                                                                                                                                                                                                                                                                                                                                    | Symbol        | Characteristic                        | Min  | Typ†   | Max    | Units | Conditions             |
| 1                                                                                                                                                                                                                                                                                                                                            | Tosc          | External CLKIN Period <sup>(1)</sup>  | 250  | —      | —      | ns    | XT osc mode            |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 100  | —      | —      | ns    | 10 MHz mode            |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 50   | —      | —      | ns    | HS osc mode (Comm/Ind) |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 62.5 | —      | —      | ns    | HS osc mode (Ext)      |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 25   | —      | —      | μs    | LP osc mode            |
|                                                                                                                                                                                                                                                                                                                                              |               | Oscillator Period <sup>(1)</sup>      | 250  | —      | —      | ns    | RC osc mode            |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 250  | —      | 10,000 | ns    | XT osc mode            |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 100  | —      | 250    | ns    | 10 MHz mode            |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 50   | —      | 250    | ns    | HS osc mode (Comm/Ind) |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 62.5 | —      | 250    | ns    | HS osc mode (Ext)      |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 25   | —      | —      | μs    | LP osc mode            |
| 2                                                                                                                                                                                                                                                                                                                                            | Tcy           | Instruction Cycle Time <sup>(2)</sup> | —    | 4/Fosc | —      | —     |                        |
| 3                                                                                                                                                                                                                                                                                                                                            | TosL,<br>TosH | Clock in (OSC1) Low or High Time      | 85*  | —      | —      | ns    | XT oscillator          |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 20*  | —      | —      | ns    | HS oscillator          |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | 2.0* | —      | —      | μs    | LP oscillator          |
| 4                                                                                                                                                                                                                                                                                                                                            | TosR,<br>TosF | Clock in (OSC1) Rise or Fall Time     | —    | —      | 25*    | ns    | XT oscillator          |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | —    | —      | 25*    | ns    | HS oscillator          |
|                                                                                                                                                                                                                                                                                                                                              |               |                                       | —    | —      | 50*    | ns    | LP oscillator          |

\* These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is at 5.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

**Note 1:** 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.

**2:** Instruction cycle period (Tcy) equals four times the input oscillator time base period.

## 13.3 DC Characteristics: PIC16CR54A-04, 10, 20, PIC16LCR54A-04 (Commercial) PIC16CR54A-04I, 10I, 20I, PIC16LCR54A-04I (Industrial)

| DC CHARACTERISTICS |                  |                                                                                                                                            | Standard Operating Conditions (unless otherwise specified)<br>Operating Temperature 0°C ≤ TA ≤ +70°C for commercial<br>-40°C ≤ TA ≤ +85°C for industrial |                             |                                                                                                                     |                            |                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Param No.          | Symbol           | Characteristic                                                                                                                             | Min                                                                                                                                                      | Typ†                        | Max                                                                                                                 | Units                      | Conditions                                                                                                                                                                                                                                                                                                                                      |
| D030               | V <sub>IL</sub>  | <b>Input Low Voltage</b><br>I/O ports<br>MCLR (Schmitt Trigger)<br>T0CKI (Schmitt Trigger)<br>OSC1 (Schmitt Trigger)<br>OSC1               | V <sub>SS</sub><br>V <sub>SS</sub><br>V <sub>SS</sub><br>V <sub>SS</sub><br>V <sub>SS</sub>                                                              | —<br>—<br>—<br>—<br>—       | 0.2 V <sub>DD</sub><br>0.15 V <sub>DD</sub><br>0.15 V <sub>DD</sub><br>0.15 V <sub>DD</sub><br>0.15 V <sub>DD</sub> | V<br>V<br>V<br>V<br>V      | Pin at hi-impedance<br><br><br>RC mode only <sup>(3)</sup><br>XT, HS and LP modes                                                                                                                                                                                                                                                               |
| D040               | V <sub>IH</sub>  | <b>Input High Voltage</b><br>I/O ports<br>I/O ports<br>MCLR (Schmitt Trigger)<br>T0CKI (Schmitt Trigger)<br>OSC1 (Schmitt Trigger)<br>OSC1 | 2.0<br>0.6 V <sub>DD</sub><br>0.85 V <sub>DD</sub><br>0.85 V <sub>DD</sub><br>0.85 V <sub>DD</sub><br>0.85 V <sub>DD</sub>                               | —<br>—<br>—<br>—<br>—<br>—  | V <sub>DD</sub><br>V <sub>DD</sub><br>V <sub>DD</sub><br>V <sub>DD</sub><br>V <sub>DD</sub><br>V <sub>DD</sub>      | V<br>V<br>V<br>V<br>V<br>V | V <sub>DD</sub> = 3.0V to 5.5V <sup>(4)</sup><br>Full V <sub>DD</sub> range <sup>(4)</sup><br><br>RC mode only <sup>(3)</sup><br>XT, HS and LP modes                                                                                                                                                                                            |
| D050               | V <sub>HYS</sub> | <b>Hysteresis of Schmitt Trigger inputs</b>                                                                                                | 0.15 V <sub>DD</sub> *                                                                                                                                   | —                           | —                                                                                                                   | V                          |                                                                                                                                                                                                                                                                                                                                                 |
| D060               | I <sub>IL</sub>  | <b>Input Leakage Current<sup>(1,2)</sup></b><br>I/O ports<br><br>MCLR<br>MCLR<br>T0CKI<br>OSC1                                             | -1.0<br>-5.0<br>—<br>-3.0<br>-3.0                                                                                                                        | —<br>—<br>0.5<br>0.5<br>0.5 | +1.0<br>—<br>+5.0<br>+3.0<br>+3.0                                                                                   | μA<br>μA<br>μA<br>μA<br>μA | <b>For V<sub>DD</sub> ≤ 5.5V:</b><br>V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub> ,<br>pin at hi-impedance<br>V <sub>PIN</sub> = V <sub>SS</sub> + 0.25V<br>V <sub>PIN</sub> = V <sub>DD</sub><br>V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub><br>V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub> ,<br>XT, HS and LP modes |
| D080               | V <sub>OL</sub>  | <b>Output Low Voltage</b><br>I/O ports<br>OSC2/CLKOUT                                                                                      | —<br>—                                                                                                                                                   | —<br>—                      | 0.5<br>0.5                                                                                                          | V<br>V                     | I <sub>OL</sub> = 10 mA, V <sub>DD</sub> = 6.0V<br>I <sub>OL</sub> = 1.9 mA, V <sub>DD</sub> = 6.0V,<br>RC mode only                                                                                                                                                                                                                            |
| D090               | V <sub>OH</sub>  | <b>Output High Voltage<sup>(2)</sup></b><br>I/O ports<br>OSC2/CLKOUT                                                                       | V <sub>DD</sub> - 0.5<br>V <sub>DD</sub> - 0.5                                                                                                           | —<br>—                      | —<br>—                                                                                                              | V<br>V                     | I <sub>OH</sub> = -4.0 mA, V <sub>DD</sub> = 6.0V<br>I <sub>OH</sub> = -0.8 mA, V <sub>DD</sub> = 6.0V,<br>RC mode only                                                                                                                                                                                                                         |

\* These parameters are characterized but not tested.

† 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.

**Note 1:** The leakage current on the MCLR/VPP 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 voltage.

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

**3:** For the RC mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the PIC16C5X be driven with external clock in RC mode.

**4:** The user may use the better of the two specifications.

# PIC16C5X

## 13.4 DC Characteristics: PIC16CR54A-04E, 10E, 20E (Extended)

| DC CHARACTERISTICS |           |                                                                                                                                                         | Standard Operating Conditions (unless otherwise specified)                                               |                                 |                                                                                  |                                                                                   |                                                                                                                                                                                                                                                                              |
|--------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    |           |                                                                                                                                                         | Operating Temperature $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended              |                                 |                                                                                  |                                                                                   |                                                                                                                                                                                                                                                                              |
| Param No.          | Symbol    | Characteristic                                                                                                                                          | Min                                                                                                      | Typ†                            | Max                                                                              | Units                                                                             | Conditions                                                                                                                                                                                                                                                                   |
| D030               | $V_{IL}$  | <b>Input Low Voltage</b><br>I/O ports<br>MCLR (Schmitt Trigger)<br>T0CKI (Schmitt Trigger)<br>OSC1 (Schmitt Trigger)<br>OSC1                            | $V_{SS}$<br>$V_{SS}$<br>$V_{SS}$<br>$V_{SS}$<br>$V_{SS}$                                                 | —<br>—<br>—<br>—<br>—           | $0.15 V_{DD}$<br>$0.15 V_{DD}$<br>$0.15 V_{DD}$<br>$0.15 V_{DD}$<br>$0.3 V_{DD}$ | V<br>V<br>V<br>V<br>V                                                             | Pin at hi-impedance<br><br><br>RC mode only <sup>(3)</sup><br>XT, HS and LP modes                                                                                                                                                                                            |
| D040               | $V_{IH}$  | <b>Input High Voltage</b><br>I/O ports<br>I/O ports<br>I/O ports<br>MCLR (Schmitt Trigger)<br>T0CKI (Schmitt Trigger)<br>OSC1 (Schmitt Trigger)<br>OSC1 | $0.45 V_{DD}$<br>2.0<br>$0.36 V_{DD}$<br>$0.85 V_{DD}$<br>$0.85 V_{DD}$<br>$0.85 V_{DD}$<br>$0.7 V_{DD}$ | —<br>—<br>—<br>—<br>—<br>—<br>— | $V_{DD}$<br>$V_{DD}$<br>$V_{DD}$<br>$V_{DD}$<br>$V_{DD}$<br>$V_{DD}$<br>$V_{DD}$ | V<br>V<br>V<br>V<br>V<br>V<br>V                                                   | For all $V_{DD}$ <sup>(4)</sup><br>$4.0\text{V} < V_{DD} \leq 5.5\text{V}$ <sup>(4)</sup><br>$V_{DD} > 5.5\text{V}$<br><br>RC mode only <sup>(3)</sup><br>XT, HS and LP modes                                                                                                |
| D050               | $V_{HYS}$ | <b>Hysteresis of Schmitt Trigger inputs</b>                                                                                                             | $0.15 V_{DD}^*$                                                                                          | —                               | —                                                                                | V                                                                                 |                                                                                                                                                                                                                                                                              |
| D060               | $I_{IL}$  | <b>Input Leakage Current</b> <sup>(1,2)</sup><br>I/O ports<br><br>MCLR<br>MCLR<br>T0CKI<br>OSC1                                                         | −1.0<br>−5.0<br>—<br>−3.0<br>−3.0                                                                        | 0.5<br>—<br>0.5<br>0.5<br>0.5   | +1.0<br>—<br>+5.0<br>+3.0<br>+3.0                                                | $\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$ | <b>For <math>V_{DD} \leq 5.5\text{V}</math>:</b><br>$V_{SS} \leq V_{PIN} \leq V_{DD}$ ,<br>pin at hi-impedance<br>$V_{PIN} = V_{SS} + 0.25\text{V}$<br>$V_{PIN} = V_{DD}$<br>$V_{SS} \leq V_{PIN} \leq V_{DD}$<br>$V_{SS} \leq V_{PIN} \leq V_{DD}$ ,<br>XT, HS and LP modes |
| D080               | $V_{OL}$  | <b>Output Low Voltage</b><br>I/O ports<br>OSC2/CLKOUT                                                                                                   | —<br>—                                                                                                   | —<br>—                          | 0.6<br>0.6                                                                       | V<br>V                                                                            | $I_{OL} = 8.7\text{ mA}$ , $V_{DD} = 4.5\text{V}$<br>$I_{OL} = 1.6\text{ mA}$ , $V_{DD} = 4.5\text{V}$ ,<br>RC mode only                                                                                                                                                     |
| D090               | $V_{OH}$  | <b>Output High Voltage</b> <sup>(2)</sup><br>I/O ports<br>OSC2/CLKOUT                                                                                   | $V_{DD} - 0.7$<br>$V_{DD} - 0.7$                                                                         | —<br>—                          | —<br>—                                                                           | V<br>V                                                                            | $I_{OH} = -5.4\text{ mA}$ , $V_{DD} = 4.5\text{V}$<br>$I_{OH} = -1.0\text{ mA}$ , $V_{DD} = 4.5\text{V}$ ,<br>RC mode only                                                                                                                                                   |

\* These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is based on characterization results at  $25^{\circ}\text{C}$ . This data is for design guidance only and is not tested.

**Note 1:** The leakage current on the MCLR/VPP 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 voltage.

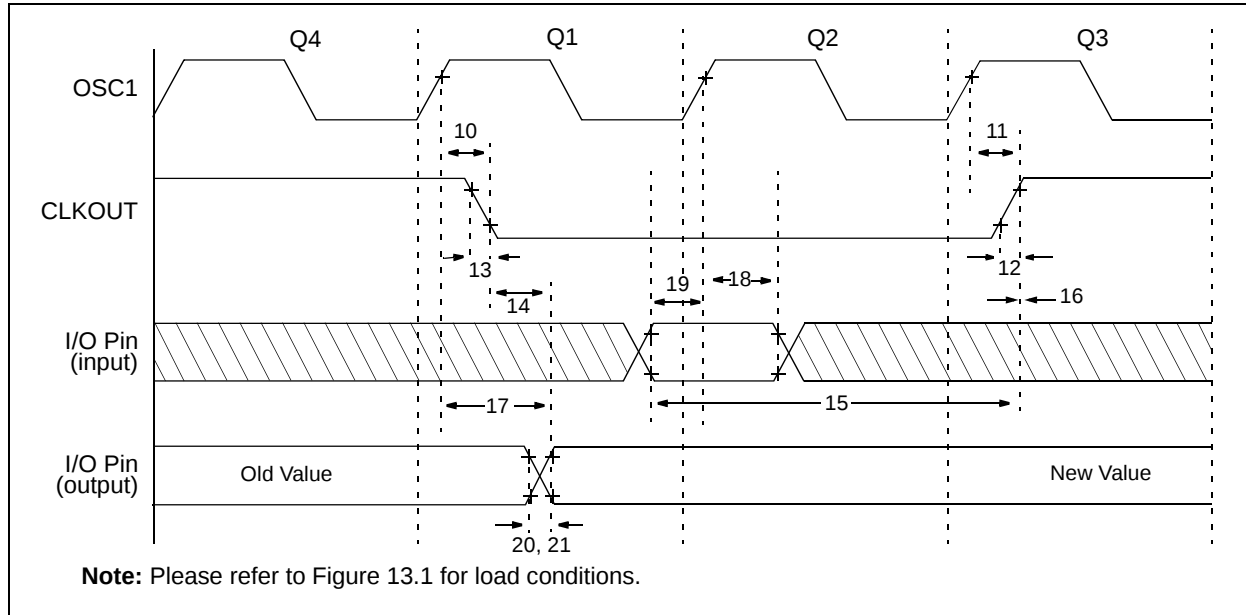
**2:** Negative current is defined as coming out of the pin.

**3:** For the RC mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the PIC16C5X be driven with external clock in RC mode.

**4:** The user may use the better of the two specifications.

# PIC16C5X

**FIGURE 13-3: CLKOUT AND I/O TIMING - PIC16CR54A**



**TABLE 13-2: CLKOUT AND I/O TIMING REQUIREMENTS - PIC16CR54A**

| AC Characteristics |          | Standard Operating Conditions (unless otherwise specified)<br>Operating Temperature $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for commercial<br>$-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial<br>$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended |              |      |      |       |
|--------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------|------|-------|
| Param No.          | Symbol   | Characteristic                                                                                                                                                                                                                                                                                              | Min          | Typ† | Max  | Units |
| 10                 | TosH2ckL | OSC1↑ to CLKOUT↓ <sup>(1)</sup>                                                                                                                                                                                                                                                                             | —            | 15   | 30** | ns    |
| 11                 | TosH2ckH | OSC1↑ to CLKOUT↑ <sup>(1)</sup>                                                                                                                                                                                                                                                                             | —            | 15   | 30** | ns    |
| 12                 | TckR     | CLKOUT rise time <sup>(1)</sup>                                                                                                                                                                                                                                                                             | —            | 5.0  | 15** | ns    |
| 13                 | TckF     | CLKOUT fall time <sup>(1)</sup>                                                                                                                                                                                                                                                                             | —            | 5.0  | 15** | ns    |
| 14                 | TckL2ioV | CLKOUT↓ to Port out valid <sup>(1)</sup>                                                                                                                                                                                                                                                                    | —            | —    | 40** | ns    |
| 15                 | TioV2ckH | Port in valid before CLKOUT↑ <sup>(1)</sup>                                                                                                                                                                                                                                                                 | 0.25 TCY+30* | —    | —    | ns    |
| 16                 | TckH2ioI | Port in hold after CLKOUT↑ <sup>(1)</sup>                                                                                                                                                                                                                                                                   | 0*           | —    | —    | ns    |
| 17                 | TosH2ioV | OSC1↑ (Q1 cycle) to Port out valid <sup>(2)</sup>                                                                                                                                                                                                                                                           | —            | —    | 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 <sup>(2)</sup>                                                                                                                                                                                                                                                                        | —            | 10   | 25** | ns    |
| 21                 | TioF     | Port output fall time <sup>(2)</sup>                                                                                                                                                                                                                                                                        | —            | 10   | 25** | ns    |

\* These parameters are characterized but not tested.

\*\* These parameters are design targets and are not tested. No characterization data available at this time.

† 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.

**Note 1:** Measurements are taken in RC Mode where CLKOUT output is 4 x Tosc.

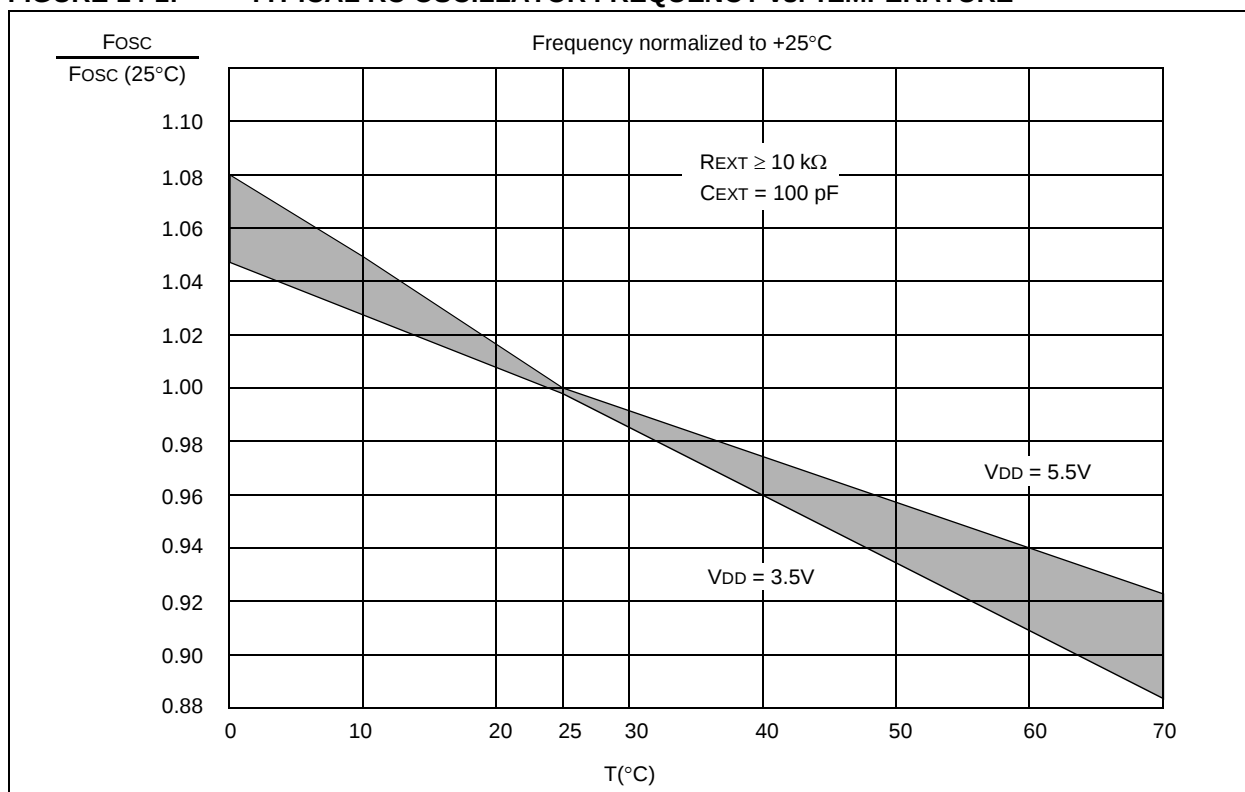
**2:** Please refer to Figure 13.1 for load conditions.

## 14.0 DEVICE CHARACTERIZATION - PIC16C54A

The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

“Typical” represents the mean of the distribution at 25°C. “Maximum” or “minimum” represents (mean + 3 $\sigma$ ) or (mean – 3 $\sigma$ ) respectively, where  $\sigma$  is a standard deviation, over the whole temperature range.

**FIGURE 14-1: TYPICAL RC OSCILLATOR FREQUENCY vs. TEMPERATURE**



**TABLE 14-1: RC OSCILLATOR FREQUENCIES**

| $C_{EXT}$ | $R_{EXT}$ | Average<br>$F_{osc}$ @ 5 V, 25°C |       |
|-----------|-----------|----------------------------------|-------|
| 20 pF     | 3.3K      | 5 MHz                            | ± 27% |
|           | 5K        | 3.8 MHz                          | ± 21% |
|           | 10K       | 2.2 MHz                          | ± 21% |
|           | 100K      | 262 kHz                          | ± 31% |
| 100 pF    | 3.3K      | 1.6 MHz                          | ± 13% |
|           | 5K        | 1.2 MHz                          | ± 13% |
|           | 10K       | 684 kHz                          | ± 18% |
|           | 100K      | 71 kHz                           | ± 25% |
| 300 pF    | 3.3K      | 660 kHz                          | ± 10% |
|           | 5.0K      | 484 kHz                          | ± 14% |
|           | 10K       | 267 kHz                          | ± 15% |
|           | 100K      | 29 kHz                           | ± 19% |

The frequencies are measured on DIP packages.

The percentage variation indicated here is part-to-part variation due to normal process distribution. The variation indicated is  $\pm 3$  standard deviations from the average value for  $V_{DD} = 5\text{V}$ .

FIGURE 14-19: PORTA, B AND C I<sub>OH</sub> vs. V<sub>OH</sub>, V<sub>DD</sub> = 3 V

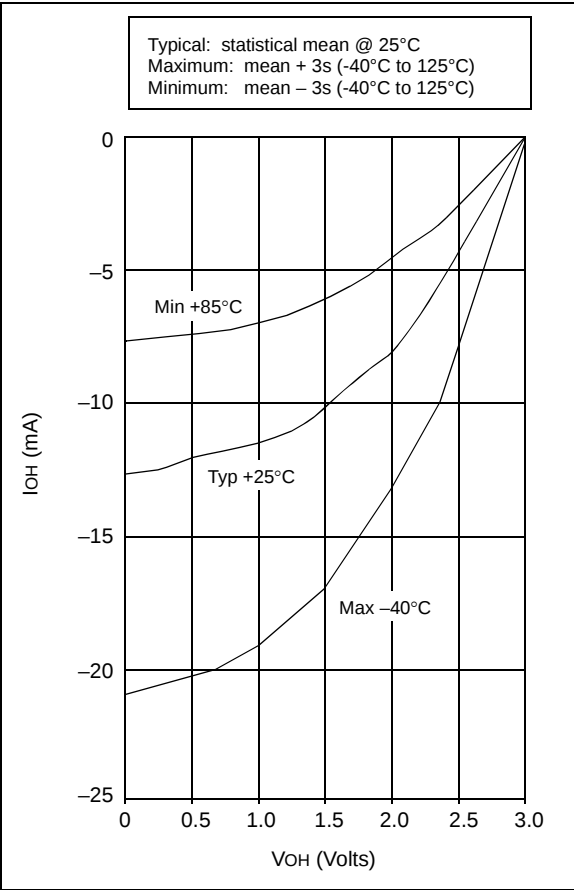
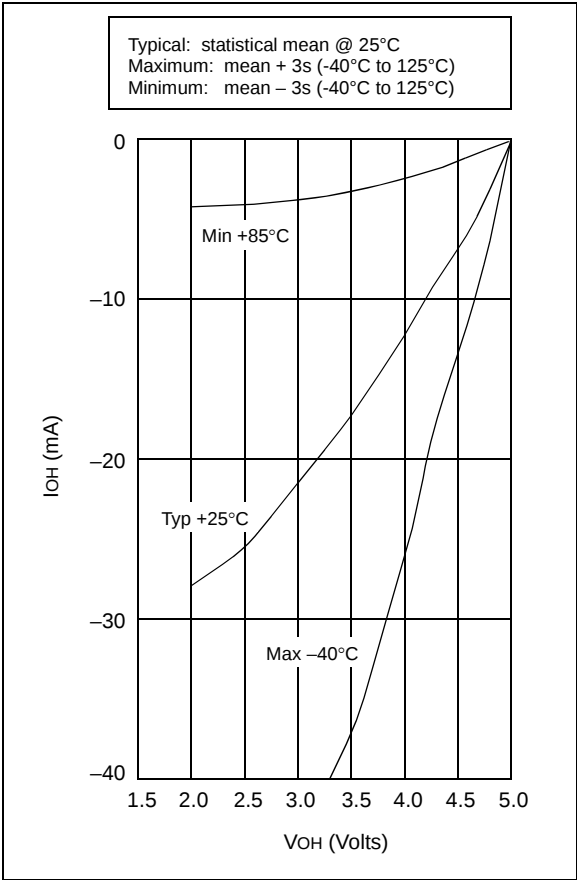


FIGURE 14-20: PORTA, B AND C I<sub>OH</sub> vs. V<sub>OH</sub>, V<sub>DD</sub> = 5 V



## 15.0 ELECTRICAL CHARACTERISTICS - PIC16C54A

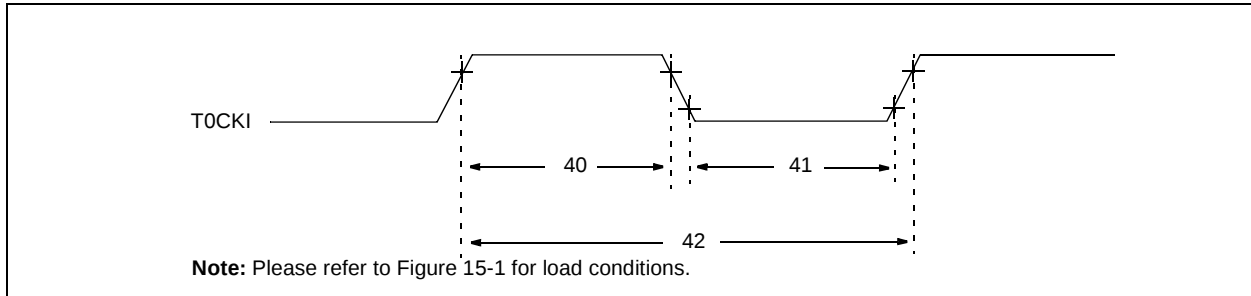
### Absolute Maximum Ratings<sup>(†)</sup>

|                                                                                                       |                                   |
|-------------------------------------------------------------------------------------------------------|-----------------------------------|
| Ambient temperature under bias .....                                                                  | –55°C to +125°C                   |
| Storage temperature .....                                                                             | –65°C to +150°C                   |
| Voltage on V <sub>DD</sub> with respect to V <sub>SS</sub> .....                                      | 0 to +7.5V                        |
| Voltage on MCLR with respect to V <sub>SS</sub> .....                                                 | 0 to +14V                         |
| Voltage on all other pins with respect to V <sub>SS</sub> .....                                       | –0.6V to (V <sub>DD</sub> + 0.6V) |
| Total power dissipation <sup>(1)</sup> .....                                                          | 800 mW                            |
| Max. current out of V <sub>SS</sub> pin .....                                                         | 150 mA                            |
| Max. current into V <sub>DD</sub> pin .....                                                           | 100 mA                            |
| Max. current into an input pin (T <sub>0</sub> CKI only) .....                                        | ±500 µA                           |
| Input clamp current, I <sub>IK</sub> (V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>DD</sub> ) .....  | ±20 mA                            |
| Output clamp current, I <sub>OK</sub> (V <sub>O</sub> < 0 or V <sub>O</sub> > V <sub>DD</sub> ) ..... | ±20 mA                            |
| Max. output current sunk by any I/O pin .....                                                         | 25 mA                             |
| Max. output current sourced by any I/O pin .....                                                      | 20 mA                             |
| Max. output current sourced by a single I/O port (PORTA or B) .....                                   | 50 mA                             |
| Max. output current sunk by a single I/O port (PORTA or B) .....                                      | 50 mA                             |

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

† NOTICE: Stresses above those listed under "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.

**FIGURE 15-5: TIMER0 CLOCK TIMINGS - PIC16C54A**



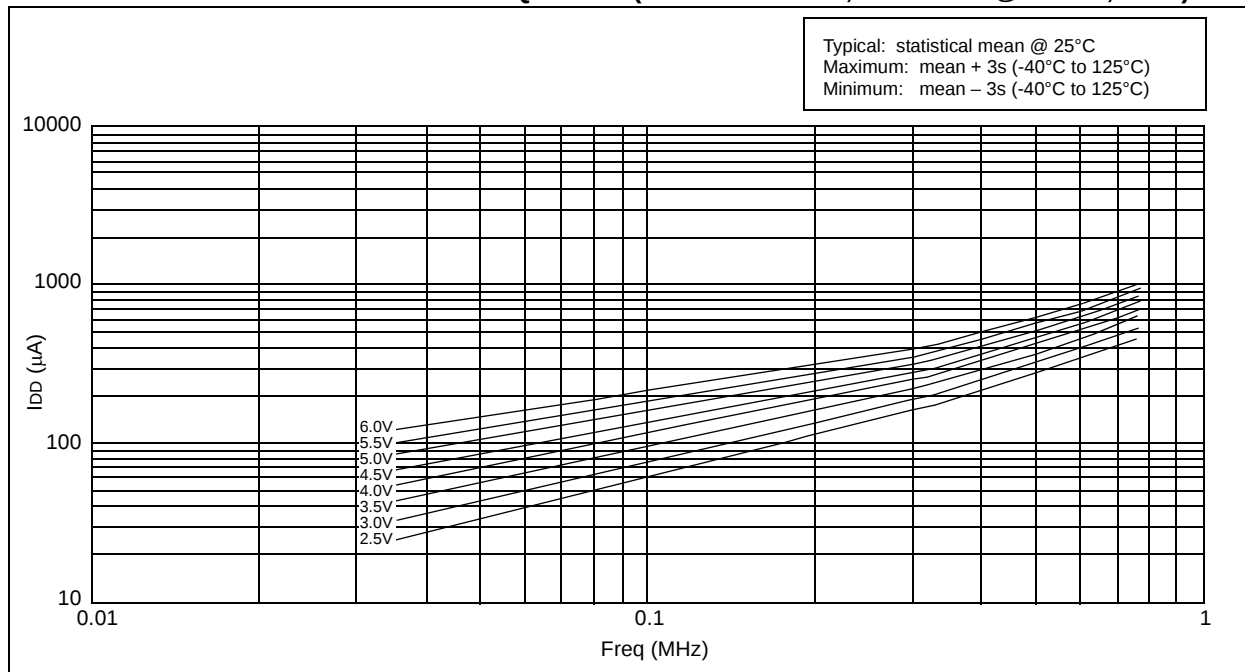
**TABLE 15-4: TIMER0 CLOCK REQUIREMENTS - PIC16C54A**

| <b>Standard Operating Conditions (unless otherwise specified)</b><br>Operating Temperature $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for commercial<br>$-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial<br>$-20^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for industrial - PIC16LV54A-02I<br>$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for extended |        |                        |                                   |      |     |       |                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------|-----------------------------------|------|-----|-------|-------------------------------------------------------------------|
| <b>AC Characteristics</b>                                                                                                                                                                                                                                                                                                                                                                                     |        |                        |                                   |      |     |       |                                                                   |
| Param No.                                                                                                                                                                                                                                                                                                                                                                                                     | Symbol | Characteristic         | Min                               | Typ† | Max | Units | Conditions                                                        |
| 40                                                                                                                                                                                                                                                                                                                                                                                                            | Tt0H   | T0CKI High Pulse Width |                                   |      |     |       |                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                               |        | - No Prescaler         | $0.5 T_{CY} + 20^*$               | —    | —   | ns    |                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                               |        | - With Prescaler       | $10^*$                            | —    | —   | ns    |                                                                   |
| 41                                                                                                                                                                                                                                                                                                                                                                                                            | Tt0L   | T0CKI Low Pulse Width  |                                   |      |     |       |                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                               |        | - No Prescaler         | $0.5 T_{CY} + 20^*$               | —    | —   | ns    |                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                               |        | - With Prescaler       | $10^*$                            | —    | —   | ns    |                                                                   |
| 42                                                                                                                                                                                                                                                                                                                                                                                                            | Tt0P   | T0CKI Period           | $20$ or $\frac{T_{CY} + 40^*}{N}$ | —    | —   | ns    | Whichever is greater.<br>N = Prescale Value<br>(1, 2, 4,..., 256) |

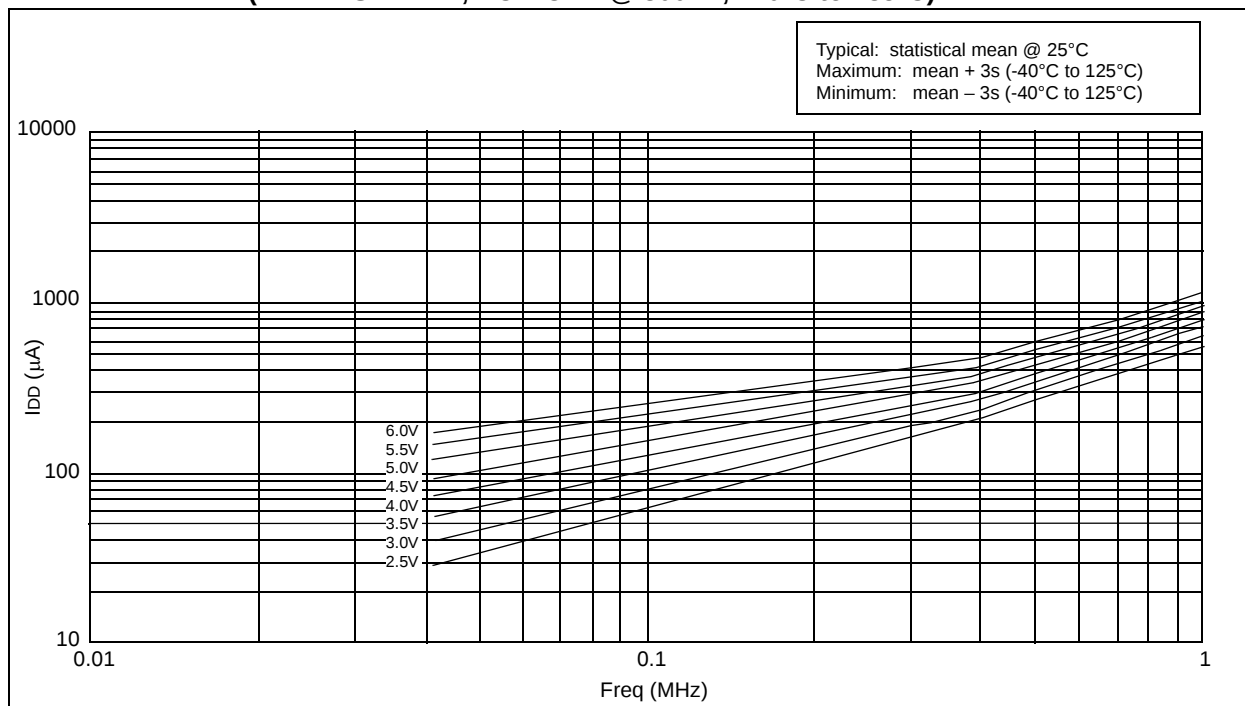
\* These parameters are characterized but not tested.

† 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.

**FIGURE 16-14: TYPICAL  $I_{DD}$  vs. FREQUENCY (WDT DISABLED, RC MODE @ 300 pF, 25°C)**



**FIGURE 16-15: MAXIMUM  $I_{DD}$  vs. FREQUENCY (WDT DISABLED, RC MODE @ 300 pF, -40°C to +85°C)**



## 17.1 DC Characteristics: PIC16C54C/C55A/C56A/C57C/C58B-04, 20 (Commercial, Industrial) PIC16LC54C/LC55A/LC56A/LC57C/LC58B-04 (Commercial, Industrial) PIC16CR54C/CR56A/CR57C/CR58B-04, 20 (Commercial, Industrial) PIC16LCR54C/LCR56A/LCR57C/LCR58B-04 (Commercial, Industrial)

| <b>PIC16LC5X</b><br><b>PIC16LCR5X</b><br>(Commercial, Industrial) |        | <b>Standard Operating Conditions (unless otherwise specified)</b><br>Operating Temperature      0°C ≤ TA ≤ +70°C for commercial<br>–40°C ≤ TA ≤ +85°C for industrial |     |      |      |       |                                                |
|-------------------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|-------|------------------------------------------------|
| <b>PIC16C5X</b><br><b>PIC16CR5X</b><br>(Commercial, Industrial)   |        | <b>Standard Operating Conditions (unless otherwise specified)</b><br>Operating Temperature      0°C ≤ TA ≤ +70°C for commercial<br>–40°C ≤ TA ≤ +85°C for industrial |     |      |      |       |                                                |
| Param No.                                                         | Symbol | Characteristic/Device                                                                                                                                                | Min | Typ† | Max  | Units | Conditions                                     |
| D010                                                              | IDD    | <b>Supply Current<sup>(2,3)</sup></b>                                                                                                                                |     |      |      |       |                                                |
|                                                                   |        | PIC16LC5X                                                                                                                                                            | —   | 0.5  | 2.4  | mA    | FOSC = 4.0 MHz, VDD = 5.5V, XT and RC modes    |
|                                                                   |        |                                                                                                                                                                      | —   | 11   | 27   | μA    | FOSC = 32 kHz, VDD = 2.5V, LP mode, Commercial |
|                                                                   |        |                                                                                                                                                                      | —   | 14   | 35   | μA    | FOSC = 32 kHz, VDD = 2.5V, LP mode, Industrial |
| D010A                                                             |        | PIC16C5X                                                                                                                                                             | —   | 1.8  | 2.4  | mA    | FOSC = 4 MHz, VDD = 5.5V, XT and RC modes      |
|                                                                   |        |                                                                                                                                                                      | —   | 2.6  | 3.6* | mA    | FOSC = 10 MHz, VDD = 3.0V, HS mode             |
|                                                                   |        |                                                                                                                                                                      | —   | 4.5  | 16   | mA    | FOSC = 20 MHz, VDD = 5.5V, HS mode             |
|                                                                   |        |                                                                                                                                                                      | —   | 14   | 32   | μA    | FOSC = 32 kHz, VDD = 3.0V, LP mode, Commercial |
|                                                                   |        |                                                                                                                                                                      | —   | 17   | 40   | μA    | FOSC = 32 kHz, VDD = 3.0V, LP mode, Industrial |

Legend: Rows with standard voltage device data only are shaded for improved readability.

\* These parameters are characterized but not tested.

† Data in "Typ" column is at 5V, 25°C, unless otherwise stated. These parameters are for design guidance only, and are not tested.

**Note 1:** This is the limit to which VDD can be lowered in SLEEP mode without losing RAM data.

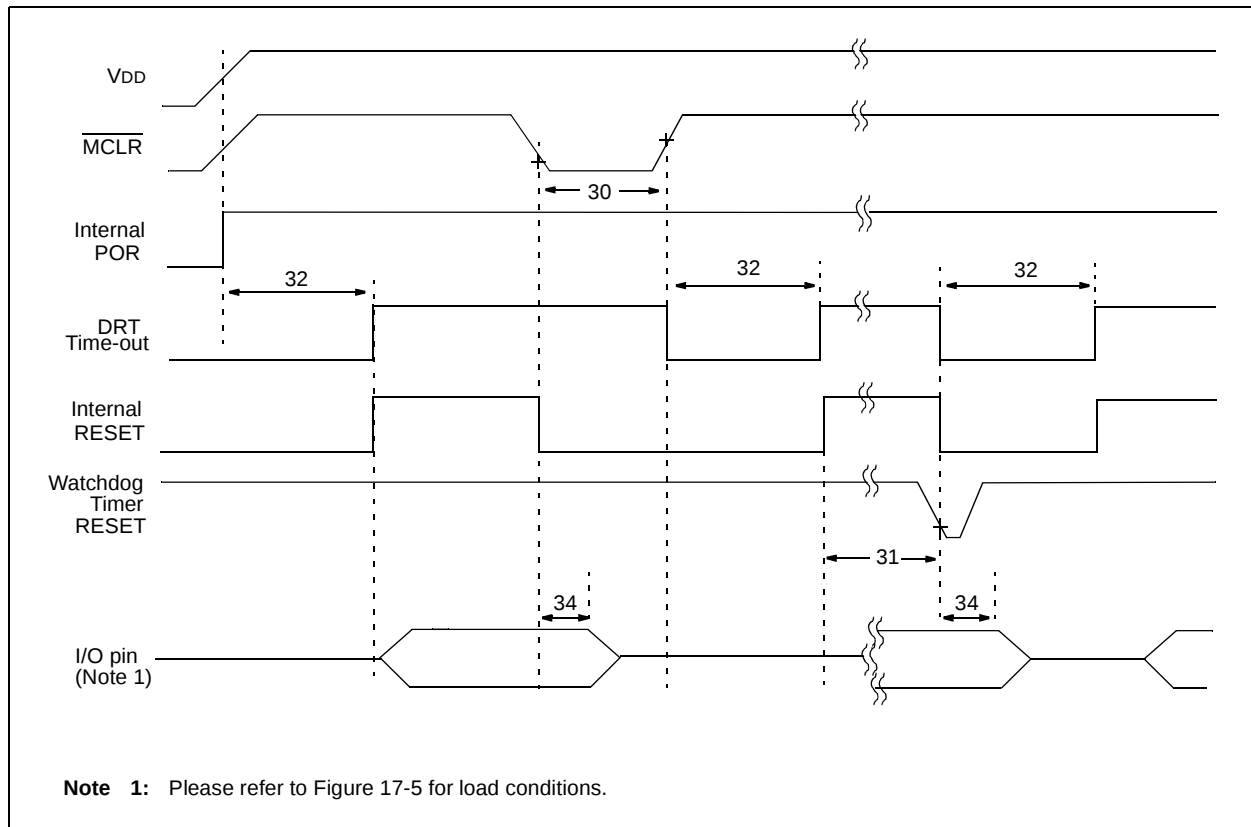
**2:** The supply current is mainly a function of the operating voltage and frequency. Other factors such as bus loading, oscillator type, bus rate, internal code execution pattern and temperature also have an impact on the current consumption.

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, 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. The power-down current in SLEEP mode does not depend on the oscillator type.

**3:** Does not include current through REXT. The current through the resistor can be estimated by the formula:  
 $I_R = V_{DD}/2R_{EXT}$  (mA) with REXT in kΩ.

**FIGURE 17-8: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER TIMING - PIC16C5X, PIC16CR5X**



**TABLE 17-3: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER - PIC16C5X, PIC16CR5X**

| Standard Operating Conditions (unless otherwise specified) |        |                                               |       |      |       |       |                   |
|------------------------------------------------------------|--------|-----------------------------------------------|-------|------|-------|-------|-------------------|
| AC Characteristics                                         |        | Operating Temperature                         |       |      |       |       |                   |
|                                                            |        | 0°C ≤ TA ≤ +70°C for commercial               |       |      |       |       |                   |
|                                                            |        | -40°C ≤ TA ≤ +85°C for industrial             |       |      |       |       |                   |
|                                                            |        | -40°C ≤ TA ≤ +125°C for extended              |       |      |       |       |                   |
| Param No.                                                  | Symbol | Characteristic                                | Min   | Typ† | Max   | Units | Conditions        |
| 30                                                         | Tmcl   | MCLR Pulse Width (low)                        | 1000* | —    | —     | ns    | VDD = 5.0V        |
| 31                                                         | Twdt   | Watchdog Timer Time-out Period (No Prescaler) | 9.0*  | 18*  | 30*   | ms    | VDD = 5.0V (Comm) |
| 32                                                         | TDRT   | Device Reset Timer Period                     | 9.0*  | 18*  | 30*   | ms    | VDD = 5.0V (Comm) |
| 34                                                         | Tioz   | I/O Hi-impedance from MCLR Low                | 100*  | 300* | 1000* | ns    |                   |

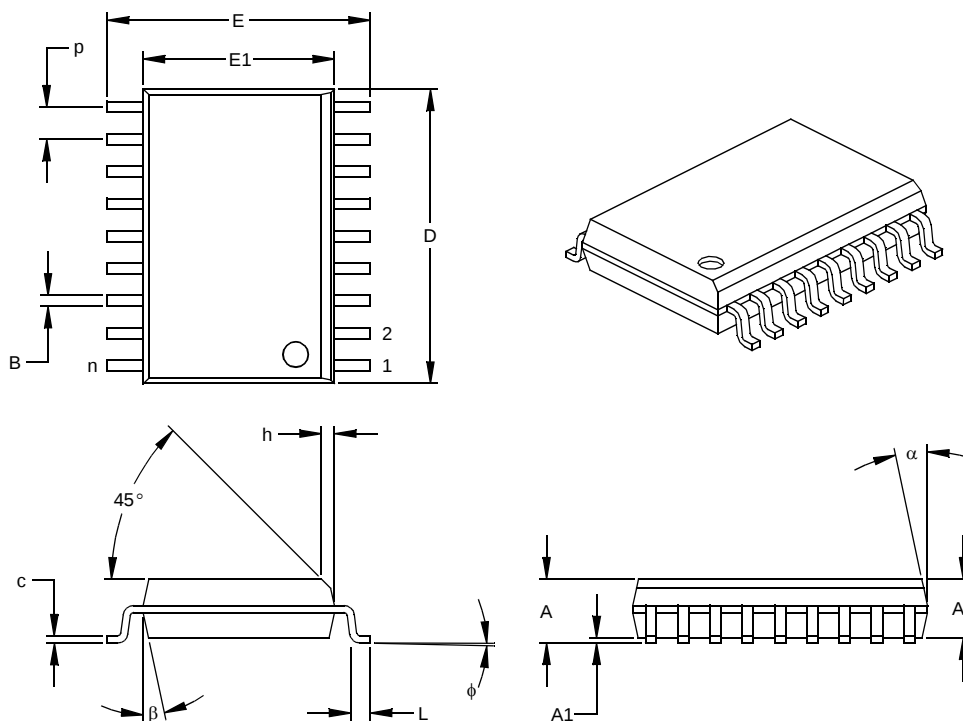
\* These parameters are characterized but not tested.

† 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.

# PIC16C5X

## 18-Lead Plastic Small Outline (SO) – Wide, 300 mil (SOIC)

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



| Units                    |    | INCHES* |      |      | MILLIMETERS |       |       |
|--------------------------|----|---------|------|------|-------------|-------|-------|
| Dimension Limits         |    | MIN     | NOM  | MAX  | MIN         | NOM   | MAX   |
| Number of Pins           | n  |         | 18   |      |             | 18    |       |
| Pitch                    | p  |         | .050 |      |             | 1.27  |       |
| Overall Height           | A  | .093    | .099 | .104 | 2.36        | 2.50  | 2.64  |
| Molded Package Thickness | A2 | .088    | .091 | .094 | 2.24        | 2.31  | 2.39  |
| Standoff §               | A1 | .004    | .008 | .012 | 0.10        | 0.20  | 0.30  |
| Overall Width            | E  | .394    | .407 | .420 | 10.01       | 10.34 | 10.67 |
| Molded Package Width     | E1 | .291    | .295 | .299 | 7.39        | 7.49  | 7.59  |
| Overall Length           | D  | .446    | .454 | .462 | 11.33       | 11.53 | 11.73 |
| Chamfer Distance         | h  | .010    | .020 | .029 | 0.25        | 0.50  | 0.74  |
| Foot Length              | L  | .016    | .033 | .050 | 0.41        | 0.84  | 1.27  |
| Foot Angle               | φ  | 0       | 4    | 8    | 0           | 4     | 8     |
| Lead Thickness           | c  | .009    | .011 | .012 | 0.23        | 0.27  | 0.30  |
| Lead Width               | B  | .014    | .017 | .020 | 0.36        | 0.42  | 0.51  |
| Mold Draft Angle Top     | α  | 0       | 12   | 15   | 0           | 12    | 15    |
| Mold Draft Angle Bottom  | β  | 0       | 12   | 15   | 0           | 12    | 15    |

\* Controlling Parameter

§ Significant Characteristic

Notes:

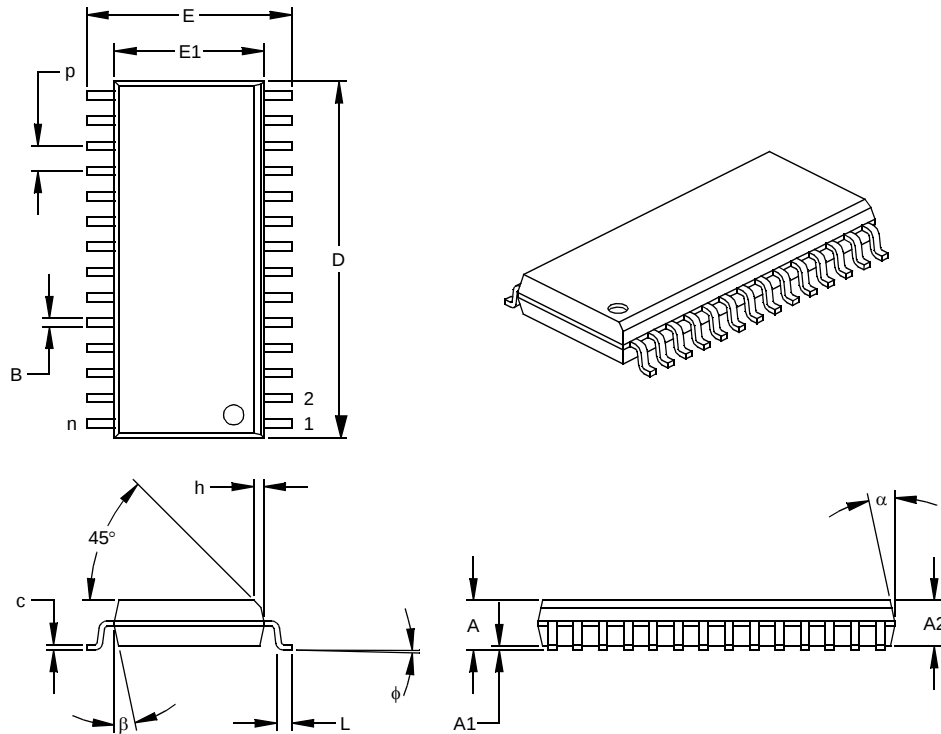
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-013

Drawing No. C04-051

## 28-Lead Plastic Small Outline (SO) – Wide, 300 mil (SOIC)

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



| Units                    |    | INCHES* |      |      | MILLIMETERS |       |       |
|--------------------------|----|---------|------|------|-------------|-------|-------|
| Dimension Limits         |    | MIN     | NOM  | MAX  | MIN         | NOM   | MAX   |
| Number of Pins           | n  |         | 28   |      |             | 28    |       |
| Pitch                    | p  |         | .050 |      |             | 1.27  |       |
| Overall Height           | A  | .093    | .099 | .104 | 2.36        | 2.50  | 2.64  |
| Molded Package Thickness | A2 | .088    | .091 | .094 | 2.24        | 2.31  | 2.39  |
| Standoff §               | A1 | .004    | .008 | .012 | 0.10        | 0.20  | 0.30  |
| Overall Width            | E  | .394    | .407 | .420 | 10.01       | 10.34 | 10.67 |
| Molded Package Width     | E1 | .288    | .295 | .299 | 7.32        | 7.49  | 7.59  |
| Overall Length           | D  | .695    | .704 | .712 | 17.65       | 17.87 | 18.08 |
| Chamfer Distance         | h  | .010    | .020 | .029 | 0.25        | 0.50  | 0.74  |
| Foot Length              | L  | .016    | .033 | .050 | 0.41        | 0.84  | 1.27  |
| Foot Angle Top           | φ  | 0       | 4    | 8    | 0           | 4     | 8     |
| Lead Thickness           | c  | .009    | .011 | .013 | 0.23        | 0.28  | 0.33  |
| Lead Width               | B  | .014    | .017 | .020 | 0.36        | 0.42  | 0.51  |
| Mold Draft Angle Top     | α  | 0       | 12   | 15   | 0           | 12    | 15    |
| Mold Draft Angle Bottom  | β  | 0       | 12   | 15   | 0           | 12    | 15    |

\* Controlling Parameter  
§ Significant Characteristic

**Notes:**

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-013

Drawing No. C04-052

## 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     |
|-------------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|
| Device                              |   | Frequency Range/OSC Type                                                                                                                                                                                                                                                                                                           | Temperature Range                                                                                                                                                                                                                                                                                                                                                                                                                                | Package | Pattern |
| Device                              |   | PIC16C54<br>PIC16C54A<br>PIC16CR54A<br>PIC16C54C<br>PIC16CR54C<br>PIC16C55<br>PIC16C55A<br>PIC16C56<br>PIC16C56A<br>PIC16CR56A<br>PIC16C57<br>PIC16C57C<br>PIC16CR57C<br>PIC16C58B<br>PIC16CR58B                                                                                                                                   | PIC16C54T <sup>(2)</sup><br>PIC16C54AT <sup>(2)</sup><br>PIC16CR54AT <sup>(2)</sup><br>PIC16C54CT <sup>(2)</sup><br>PIC16CR54CT <sup>(2)</sup><br>PIC16C55T <sup>(2)</sup><br>PIC16C55AT <sup>(2)</sup><br>PIC16C56T <sup>(2)</sup><br>PIC16C56AT <sup>(2)</sup><br>PIC16CR56AT <sup>(2)</sup><br>PIC16C57T <sup>(2)</sup><br>PIC16C57CT <sup>(2)</sup><br>PIC16CR57CT <sup>(2)</sup><br>PIC16C58BT <sup>(2)</sup><br>PIC16CR58BT <sup>(2)</sup> |         |         |
| Frequency Range/<br>Oscillator Type |   | RC Resistor Capacitor<br>LP Low Power Crystal<br>XT Standard Crystal/Resonator<br>HS High Speed Crystal<br>02 200 KHz (LP) or 2 MHz (XT and RC)<br>04 200 KHz (LP) or 4 MHz (XT and RC)<br>10 10 MHz (HS only)<br>20 20 MHz (HS only)<br>40 40 MHz (HS only)<br>b <sup>(4)</sup> No oscillator type for JW packages <sup>(3)</sup> |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
|                                     |   | *RC/LP/XT/HS are for 16C54/55/56/57 devices only<br>-02 is available for 16LV54A only<br>-04/10/20 options are available for all other devices<br>-40 is available for 16C54C/55A/56A/57C/58B devices only                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
| Temperature Range                   |   | b <sup>(4)</sup> = 0°C to +70°C<br>I = -40°C to +85°C<br>E = -40°C to +125°C                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
| Package                             |   | S = Die in Waffle Pack<br>JW = 28-pin 600 mil/18-pin 300 mil windowed CER-DIP <sup>(3)</sup><br>P = 28-pin 600 mil/18-pin 300 mil PDIP<br>SO = 300 mil SOIC<br>SS = 209 mil SSOP<br>SP = 28-pin 300 mil Skinny PDIP                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
|                                     |   | *See Section 21 for additional package information.                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
| Pattern                             |   | QTP, SQTP, ROM code (factory specified) or Special Requirements. Blank for OTP and Windowed devices.                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |

### Examples:

- PIC16C55A - 04/P 301 = Commercial Temp., PDIP package, 4 MHz, standard V<sub>DD</sub> limits, QTP pattern #301
- PIC16LC54C - 04I/SO Industrial Temp., SOIC package, 200 kHz, extended V<sub>DD</sub> limits
- PIC16C57 - RC/SP = RC Oscillator, commercial temp, skinny PDIP package, 4 MHz, standard V<sub>DD</sub> limits
- PIC16C58BT -40/SS 123 = commercial temp, SSOP package in tape and reel, 4 MHz, extended V<sub>DD</sub> limits, ROM pattern #123

- Note 1:** C = normal voltage range  
LC = extended
- 2:** T = in tape and reel - SOIC and SSOP packages only
- 3:** JW Devices are UV erasable and can be programmed to any device configuration. JW Devices meet the electrical requirements of each oscillator type, including LC devices.
- 4:** b = Blank

## Sales and Support

### Data Sheets

Products supported by a preliminary Data Sheet may 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:

- Your local Microchip sales office
- The Microchip Worldwide Site ([www.microchip.com](http://www.microchip.com))