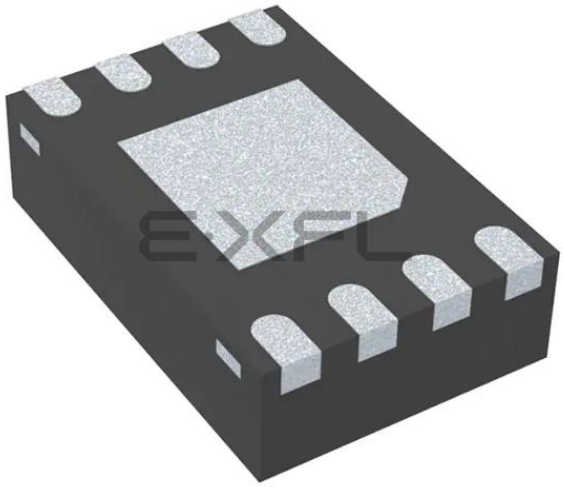

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	8MHz
Connectivity	-
Peripherals	POR, WDT
Number of I/O	5
Program Memory Size	1.5KB (1K x 12)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	41 x 8
Voltage - Supply (Vcc/Vdd)	2V ~ 5.5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	8-VFDFN Exposed Pad
Supplier Device Package	8-DFN (2x3)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic12f519-i-mc

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NOTES:

NOTES:

3.1 Clocking Scheme/Instruction Cycle

The clock input (OSC1/CLKIN pin) is internally divided by four to generate four non-overlapping quadrature clocks, namely Q1, Q2, Q3 and Q4. Internally, the PC is incremented every Q1 and the instruction is fetched from program memory and latched into the instruction register in Q4. It is decoded and executed during the following Q1 through Q4. The clocks and instruction execution flow is shown in Figure 3-2 and Example 3-1.

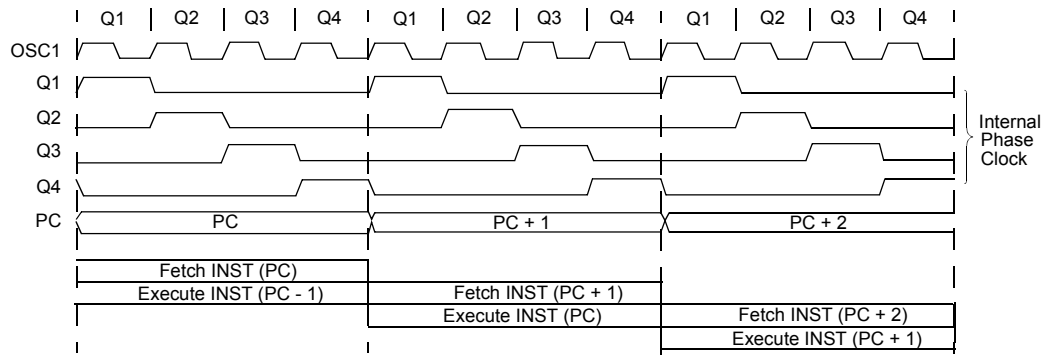
3.2 Instruction Flow/Pipelining

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

A fetch cycle begins with the PC incrementing in Q1.

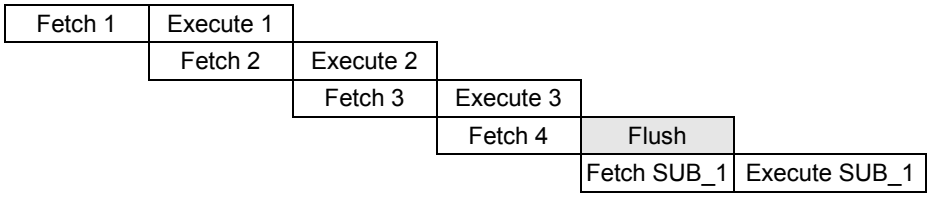
In the execution cycle, the fetched instruction is latched into the Instruction Register (IR) in cycle Q1. This instruction is then decoded and executed during the Q2, Q3 and Q4 cycles. Data memory is read during Q2 (operand read) and written during Q4 (destination write).

FIGURE 3-2: CLOCK/INSTRUCTION CYCLE



EXAMPLE 3-1: INSTRUCTION PIPELINE FLOW

```
1. MOVLW 03H
2. MOVWF GPIO
3. CALL  SUB_1
4. BSF  GPIO, 1
```



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

TABLE 4-1: SPECIAL FUNCTION REGISTER SUMMARY

Addr	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-on Reset
N/A	TRISGPIO	—	—	TRISGPIO5	TRISGPIO4	TRISGPIO3	TRISGPIO2	TRISGPIO1	TRISGPIO0	--11 1111
N/A	OPTION	Contains Control Bits to Configure Timer0 and Timer0/WDT Prescaler								1111 1111
00h	INDF	Uses Contents of FSR to Address Data Memory (not a physical register)								xxxx xxxx
01h	TMR0	Timer0 Module Register								xxxx xxxx
02h(1)	PCL	Low Order 8 bits of PC								1111 1111
03h	STATUS	GPWUF	—	PA0	$\overline{TO}$	$\overline{PD}$	Z	DC	C	0-01 1xxx
04h	FSR	Indirect Data Memory Address Pointer								110x xxxx
05h	OSCCAL	CAL6	CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	—	1111 111-
06h	GPIO	—	—	GP5	GP4	GP3	GP2	GP1	GP0	--xx xxxx
21h	EECON	—	—	—	FREE	WRERR	WREN	WR	RD	---0 x000
25h	EEDATA	EEDATA7	EEDATA6	EEDATA5	EEDATA4	EEDATA3	EEDATA2	EEDATA1	EEDATA0	xxxx xxxx
26h	EEADR	—	—	EEADR5	EEADR4	EEADR3	EEADR2	EEADR1	EEADR0	--xx xxxx

Legend: x = unknown, u = unchanged, – = unimplemented, read as '0' (if applicable). Shaded cells = unimplemented or unused

Note 1: The upper byte of the Program Counter is not directly accessible. See **Section 4.6 "Program Counter"** for an explanation of how to access these bits.

4.3 STATUS register

This register contains the arithmetic status of the ALU, the Reset status and the page preselect bit.

The STATUS register can be the destination for any instruction, as with any other register. If the STATUS register is the destination for an instruction that affects the Z, DC or C bits, then the write to these three bits is disabled. These bits are set or cleared according to the device logic. Furthermore, the $\overline{TO}$ and $\overline{PD}$ bits are not writable. Therefore, the result of an instruction with the STATUS register as destination may be different than intended.

For example, CLRF STATUS, will clear the upper three bits and set the Z bit. This leaves the STATUS register as '000u u1uu' (where u = unchanged).

Therefore, it is recommended that only BCF, BSF and MOVWF instructions be used to alter the STATUS register. These instructions do not affect the Z, DC or C bits from the STATUS register. For other instructions which do affect Status bits, see **Section 9.0 "Instruction Set Summary"**.

REGISTER 4-1: STATUS: STATUS REGISTER

R/W-0	U-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
GPWUF	—	PA0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **GPWUF**: Wake-up From Sleep on Pin Change bit
1 = Reset due to wake-up from Sleep on pin change
0 = After power-up or other Reset

bit 6 **Unimplemented:** Read as '0'

bit 5 **PA0**: Program Page Preselect bit
1 = Page 1 (000h-1FFh)
0 = Page 0 (200h-3FFh)

bit 4 **$\overline{TO}$**: Time-out bit
1 = After power-up, CLRWDT instruction, or SLEEP instruction
0 = A WDT time-out occurred

bit 3 **$\overline{PD}$**: Power-down bit
1 = After power-up or by the CLRWDT instruction
0 = By execution of the SLEEP instruction

bit 2 **Z**: Zero bit
1 = The result of an arithmetic or logic operation is zero
0 = The result of an arithmetic or logic operation is not zero

bit 1 **DC**: Digit carry/$\overline{borrow}$ bit (for ADDWF and SUBWF instructions)
ADDWF:
1 = A carry from the 4th low-order bit of the result occurred
0 = A carry from the 4th low-order bit of the result did not occur
SUBWF:
1 = A borrow from the 4th low-order bit of the result did not occur
0 = A borrow from the 4th low-order bit of the result occurred

bit 0 **C**: Carry/$\overline{borrow}$ bit (for ADDWF, SUBWF and RRF, RLF instructions)

ADDWF:	SUBWF:	RRF or RLF:
1 = A carry occurred	1 = A borrow did not occur	Load bit with LSb or MSb, respectively
0 = A carry did not occur	0 = A borrow occurred	

4.4 OPTION Register

The OPTION register is a 8-bit wide, write-only register, which contains various control bits to configure the Timer0/WDT prescaler and Timer0.

By executing the OPTION instruction, the contents of the W register will be transferred to the OPTION register. A Reset sets the OPTION<7:0> bits.

Note:	If the T0SC bit is set to '1', it will override the TRIS function on the T0CKI pin.

REGISTER 4-2: OPTION: OPTION REGISTER

W-1	W-1	W-1	W-1	W-1	W-1	W-1	W-1
$\overline{\text{GPWU}}$	$\overline{\text{GPPU}}$	T0CS	T0SE	PSA	PS2	PS1	PS0
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	x = Bit is unknown
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared

bit 7 **$\overline{\text{GPWU}}$:** Enable Wake-up On Pin Change bit
1 = Disabled
0 = Enabled

bit 6 **$\overline{\text{GPPU}}$:** Enable Weak Pull-ups bit
1 = Disabled
0 = Enabled

bit 5 **T0CS:** Timer0 Clock Source Select bit
1 = Transition on T0CKI pin
0 = Internal instruction cycle clock (CLKOUT)

bit 4 **T0SE:** Timer0 Source Edge Select bit
1 = Increment on high-to-low transition on T0CKI pin
0 = Increment on low-to-high transition on T0CKI pin

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

bit 2-0 **PS<2:0>:** Prescaler Rate Select bits

Bit Value	Timer0 Rate	WDT Rate
000	1 : 2	1 : 1
001	1 : 4	1 : 2
010	1 : 8	1 : 4
011	1 : 16	1 : 8
100	1 : 32	1 : 16
101	1 : 64	1 : 32
110	1 : 128	1 : 64
111	1 : 256	1 : 128

8.2.3 EXTERNAL CRYSTAL OSCILLATOR CIRCUIT

Either a prepackaged oscillator or a simple oscillator circuit with TTL gates can be used as an external crystal oscillator circuit. Prepackaged oscillators provide a wide operating range and better stability. A well-designed crystal oscillator will provide good performance with TTL gates. Two types of crystal oscillator circuits can be used: one with parallel resonance, or one with series resonance.

Figure 8-3 shows implementation of a parallel resonant oscillator circuit. The circuit is designed to use the fundamental frequency of the crystal. The 74AS04 inverter performs the 180-degree phase shift that a parallel oscillator requires. The 4.7 kΩ resistor provides the negative feedback for stability. The 10 kΩ potentiometers bias the 74AS04 in the linear region. This circuit could be used for external oscillator designs.

FIGURE 8-3: EXTERNAL PARALLEL RESONANT CRYSTAL OSCILLATOR CIRCUIT

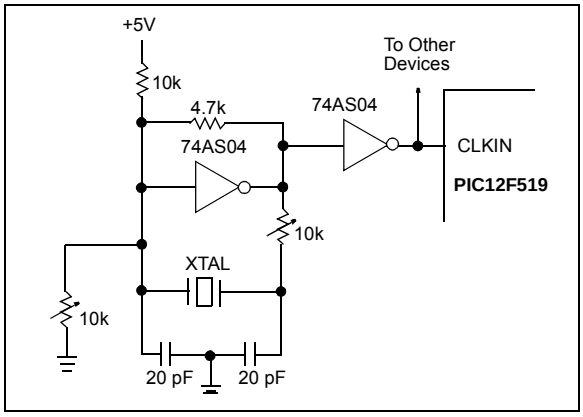
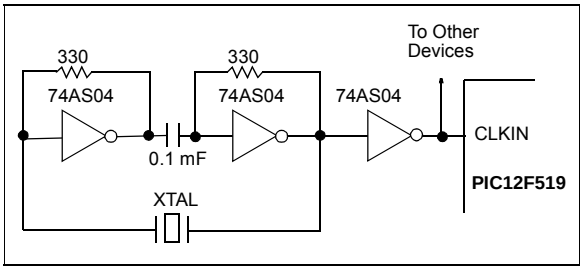


Figure 8-4 shows a series resonant oscillator circuit. This circuit is also designed to use the fundamental frequency of the crystal. The inverter performs a 180-degree phase shift in a series resonant oscillator circuit. The 330Ω resistors provide the negative feedback to bias the inverters in their linear region.

FIGURE 8-4: EXTERNAL SERIES RESONANT CRYSTAL OSCILLATOR CIRCUIT



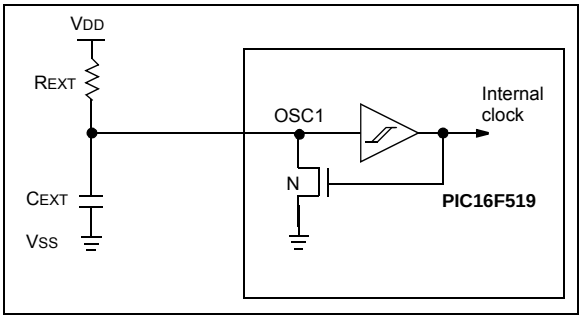
8.2.4 EXTERNAL RC OSCILLATOR

For timing insensitive applications, the RC circuit option offers additional cost savings. The RC oscillator frequency is a function of the supply voltage, the resistor (REXT) and capacitor (CEXT) values, and the operating temperature. In addition to this, the oscillator frequency will vary from unit-to-unit due to normal process parameter variation. Furthermore, the difference in lead frame capacitance between package types will also affect the oscillation frequency, especially for low CEXT values. The user also needs to take into account variation due to tolerance of external R and C components used.

Figure 8-5 shows how the R/C combination is connected to the PIC12F519 device. For REXT values below 3.0 kΩ, the oscillator operation may become unstable, or stop completely. For very high REXT values (e.g., 1 MΩ), the oscillator becomes sensitive to noise, humidity and leakage. It is recommended keeping REXT between 5.0 kΩ and 100 kΩ.

Although the oscillator will operate with no external capacitor (CEXT = 0 pF), it is recommended using values above 20 pF for noise and stability reasons. With no or small external capacitance, the oscillation frequency can vary dramatically due to changes in external capacitances, such as PCB trace capacitance or package lead frame capacitance. See Figure 11-1 and Figure 11-2.

FIGURE 8-5: EXTERNAL RC OSCILLATOR MODE



8.2.5 INTERNAL 4/8 MHz RC OSCILLATOR

The internal RC oscillator provides a fixed 4/8 MHz (nominal) system clock at VDD = 3.5V and 25°C, (see **Section 11.0 "Electrical Characteristics"** for information on variation over voltage and temperature).

In addition, a calibration instruction is programmed into the last address of memory, which contains the calibration value for the internal RC oscillator. This location is always non-code protected, regardless of the code-protect settings. This value is programmed as a `MOVLW XX` instruction where XX is the calibration value, and is placed at the Reset vector. This will load the W register with the calibration value upon Reset and the

TABLE 8-4: RESET CONDITION FOR SPECIAL REGISTERS

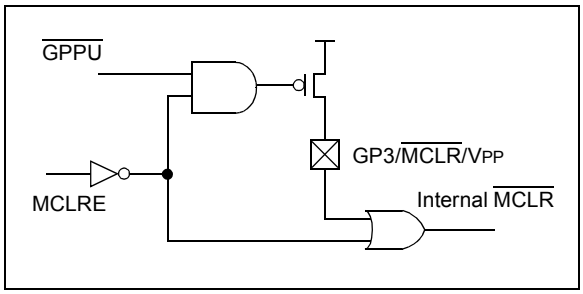
	STATUS Addr: 03h
Power-on Reset	0-01 1xxx
$\overline{MCLR}$ Reset during normal operation	0-0u uuuu
$\overline{MCLR}$ Reset during Sleep	0-01 0uuu
WDT Reset during Sleep	0-00 0uuu
WDT Reset normal operation	0-00 uuuu
Wake-up from Sleep on pin change	1-01 0uuu

Legend: u = unchanged, x = unknown

8.3.1 $\overline{MCLR}$ ENABLE

This Configuration bit, when unprogrammed (left in the '1' state), enables the external $\overline{MCLR}$ function. When programmed, the $\overline{MCLR}$ function is tied to the internal VDD and the pin is assigned to be a I/O. See Figure 8-6.

FIGURE 8-6: $\overline{MCLR}$ SELECT



8.4 Power-on Reset (POR)

The PIC12F519 device incorporates an on-chip Power-on Reset (POR) circuitry, which provides an internal chip Reset for most power-up situations.

The on-chip POR circuit holds the chip in Reset until VDD has reached a high enough level for proper operation. To take advantage of the internal POR, program the GP3/$\overline{MCLR}$/VPP pin as $\overline{MCLR}$ and tie through a resistor to VDD, or program the pin as GP3, in which case, an internal weak pull-up resistor is implemented using a transistor (refer to Table 11-4 for the pull-up resistor ranges). This will eliminate external RC components usually needed to create a Power-on Reset. A maximum rise time for VDD is specified. See **Section 11.0 "Electrical Characteristics"** for details.

When the devices start normal operation (exit the Reset condition), device operating parameters (voltage, frequency, temperature,...) must be met to ensure operation. If these conditions are not met, the devices must be held in Reset until the operating parameters are met.

A simplified block diagram of the on-chip Power-on Reset circuit is shown in Figure 8-7.

The Power-on Reset circuit and the Device Reset Timer (see **Section 8.5 "Device Reset Timer (DRT)"**) circuit are closely related. On power-up, the Reset latch is set and the DRT is reset. The DRT timer begins counting once it detects $\overline{MCLR}$ to be high. After the time-out period, which is typically 18 ms or 1 ms, it will reset the Reset latch and thus end the on-chip Reset signal.

A power-up example where $\overline{MCLR}$ is held low is shown in Figure 8-8. VDD is allowed to rise and stabilize before bringing $\overline{MCLR}$ high. The chip will actually come out of Reset TDRT after $\overline{MCLR}$ goes high.

In Figure 8-9, the on-chip Power-on Reset feature is being used ($\overline{MCLR}$ and VDD are tied together or the pin is programmed to be GP3). The VDD is stable before the Start-up timer times out and there is no problem in getting a proper Reset. However, Figure 8-10 depicts a problem situation where VDD rises too slowly. The time between when the DRT senses that $\overline{MCLR}$ is high and when $\overline{MCLR}$ and VDD actually reach their full value, is too long. In this situation, when the start-up timer times out, VDD has not reached the VDD (min) value and the chip may not function correctly. For such situations, we recommend that external RC circuits be used to achieve longer POR delay times (Figure 8-9).

Note:	When the devices start normal operation (exit the Reset condition), device operating parameters (voltage, frequency, temperature, etc.) must be met to ensure operation. If these conditions are not met, the device must be held in Reset until the operating conditions are met.

For additional information, refer to Application Note AN522, "*Power-Up Considerations*" (DS00522)

8.9 Program Verification/Code Protection

If the code protection bits have not been programmed, the on-chip program and data memory can be read out for verification purposes.

The first 64 locations and the last location (OSCCAL) can be read, regardless of the setting of the program memory's code protection bit. If the code protect bit specific to the FLASH data memory is programmed, then none of the contents of this memory region can be verified externally.

8.10 ID Locations

Four memory locations are designated as ID locations where users 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. The upper bits should be programmed as 0s.

8.11 In-Circuit Serial Programming™

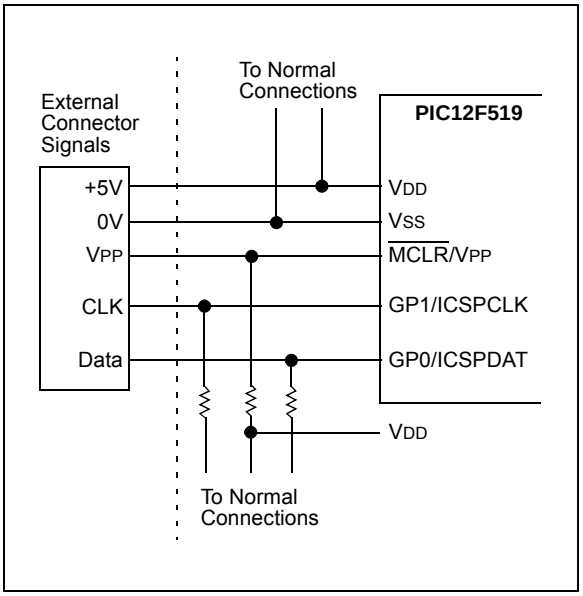
The PIC12F519 device can be serially programmed while in the end application circuit. This is simply done with two lines for clock and data, and three other lines for power, ground and the programming voltage. This allows users to manufacture boards with unprogrammed PIC12F519 device and then program the PIC12F519 device just before shipping the product. This also allows the most recent firmware, or a custom firmware, to be programmed.

The PIC12F519 device is placed into a Program/Verify mode by holding the GP1 and GP0 pins low while raising the $\overline{MCLR}$ (V_{PP}) pin from V_{IL} to V_{IHH} (see programming specification). The GP1 pin becomes the programming clock, and the GP0 pin becomes the programming data. Both GP1 and GP0 pins are Schmitt Trigger inputs in this mode.

After Reset, a 6-bit command is then supplied to the device. Depending on the command, 14 bits of program data are then supplied to or from the device, depending if the command was a Load or a Read. For complete details of serial programming, please refer to the "*PIC12F519 Memory Programming Specification*," (DS41316).

A typical In-Circuit Serial Programming connection is shown in Figure 8-12.

FIGURE 8-12: TYPICAL IN-CIRCUIT SERIAL PROGRAMMING CONNECTION



ADDWF	Add W and f
Syntax:	[*label*] ADDWF f,d
Operands:	$0 \le f \le 31$ $d \in [0,1]$
Operation:	(W) + (f) → (dest)
Status Affected:	C, DC, Z
Description:	Add the contents of the W register and register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

ANDLW	AND literal with W
Syntax:	[*label*] ANDLW k
Operands:	$0 \le k \le 255$
Operation:	(W).AND. (k) → (W)
Status Affected:	Z
Description:	The contents of the W register are AND'ed with the eight-bit literal 'k'. The result is placed in the W register.

ANDWF	AND W with f
Syntax:	[*label*] ANDWF f,d
Operands:	$0 \le f \le 31$ $d \in [0,1]$
Operation:	(W) .AND. (f) → (dest)
Status Affected:	Z
Description:	The contents of the W register are AND'ed with register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

BCF	Bit Clear f
Syntax:	[*label*] BCF f,b
Operands:	$0 \le f \le 31$ $0 \le b \le 7$
Operation:	0 → (f<b>)
Status Affected:	None
Description:	Bit 'b' in register 'f' is cleared.

BSF	Bit Set f
Syntax:	[*label*] BSF f,b
Operands:	$0 \le f \le 31$ $0 \le b \le 7$
Operation:	1 → (f<b>)
Status Affected:	None
Description:	Bit 'b' in register 'f' is set.

BTFSC	Bit Test f, Skip if Clear
Syntax:	[*label*] BTFSC f,b
Operands:	$0 \le f \le 31$ $0 \le b \le 7$
Operation:	skip if (f<b>) = 0
Status Affected:	None
Description:	If bit 'b' in register 'f' is '0', then the next instruction is skipped. If bit 'b' is '0', then the next instruction fetched during the current instruction execution is discarded, and a NOP is executed instead, making this a two-cycle instruction.

TRIS	Load TRIS Register
Syntax:	[*label*] TRIS f
Operands:	f = 6
Operation:	(W) → TRIS register f
Status Affected:	None
Description:	TRIS register 'f' (f = 6 or 7) is loaded with the contents of the W register.

XORLW	Exclusive OR literal with W
Syntax:	[*label*] XORLW k
Operands:	0 ≤ k ≤ 255
Operation:	(W) .XOR. k → (W)
Status Affected:	Z
Description:	The contents of the W register are XOR'ed with the eight-bit literal 'k'. The result is placed in the W register.

XORWF	Exclusive OR W with f
Syntax:	[*label*] XORWF f,d
Operands:	0 ≤ f ≤ 31 d ∈ [0,1]
Operation:	(W) .XOR. (f) → (dest)
Status Affected:	Z
Description:	Exclusive OR the contents of the W register with register 'f'. If 'd' is '0', the result is stored in the W register. If 'd' is '1', the result is stored back in register 'f'.

10.7 MPLAB ICE 2000 High-Performance In-Circuit Emulator

The MPLAB ICE 2000 In-Circuit Emulator is intended to provide the product development engineer with a complete microcontroller design tool set for PIC microcontrollers. Software control of the MPLAB ICE 2000 In-Circuit Emulator is advanced by the MPLAB Integrated Development Environment, which allows editing, building, downloading and source debugging from a single environment.

The MPLAB ICE 2000 is a full-featured emulator system with enhanced trace, trigger and data monitoring features. Interchangeable processor modules allow the system to be easily reconfigured for emulation of different processors. The architecture of the MPLAB ICE 2000 In-Circuit Emulator allows expansion to support new PIC microcontrollers.

The MPLAB ICE 2000 In-Circuit Emulator system has been designed as a real-time emulation system with advanced features that are typically found on more expensive development tools. The PC platform and Microsoft® Windows® 32-bit operating system were chosen to best make these features available in a simple, unified application.

10.8 MPLAB REAL ICE In-Circuit Emulator System

MPLAB REAL ICE In-Circuit Emulator System is Microchip's next generation high-speed emulator for Microchip Flash DSC® and MCU devices. It debugs and programs PIC® and dsPIC® Flash microcontrollers with the easy-to-use, powerful graphical user interface of the MPLAB Integrated Development Environment (IDE), included with each kit.

The MPLAB REAL ICE probe is connected to the design engineer's PC using a high-speed USB 2.0 interface and is connected to the target with either a connector compatible with the popular MPLAB ICD 2 system (RJ11) or with the new high speed, noise tolerant, low-voltage differential signal (LVDS) interconnection (CAT5).

MPLAB REAL ICE is field upgradeable through future firmware downloads in MPLAB IDE. In upcoming releases of MPLAB IDE, new devices will be supported, and new features will be added, such as software breakpoints and assembly code trace. MPLAB REAL ICE offers significant advantages over competitive emulators including low-cost, full-speed emulation, real-time variable watches, trace analysis, complex breakpoints, a ruggedized probe interface and long (up to three meters) interconnection cables.

10.9 MPLAB ICD 2 In-Circuit Debugger

Microchip's In-Circuit Debugger, MPLAB ICD 2, is a powerful, low-cost, run-time development tool, connecting to the host PC via an RS-232 or high-speed USB interface. This tool is based on the Flash PIC MCUs and can be used to develop for these and other PIC MCUs and dsPIC DSCs. The MPLAB ICD 2 utilizes the in-circuit debugging capability built into the Flash devices. This feature, along with Microchip's In-Circuit Serial Programming™ (ICSP™) protocol, offers cost-effective, in-circuit Flash debugging from the graphical user interface of the MPLAB Integrated Development Environment. This enables a designer to develop and debug source code by setting breakpoints, single stepping and watching variables, and CPU status and peripheral registers. Running at full speed enables testing hardware and applications in real time. MPLAB ICD 2 also serves as a development programmer for selected PIC devices.

10.10 MPLAB PM3 Device Programmer

The MPLAB PM3 Device Programmer is a universal, CE compliant device programmer with programmable voltage verification at V_{DDMIN} and V_{DDMAX} for maximum reliability. It features a large LCD display (128 x 64) for menus and error messages and a modular, detachable socket assembly to support various package types. The ICSP™ cable assembly is included as a standard item. In Stand-Alone mode, the MPLAB PM3 Device Programmer can read, verify and program PIC devices without a PC connection. It can also set code protection in this mode. The MPLAB PM3 connects to the host PC via an RS-232 or USB cable. The MPLAB PM3 has high-speed communications and optimized algorithms for quick programming of large memory devices and incorporates an SD/MMC card for file storage and secure data applications.

11.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings(†)

Ambient temperature under bias ..... -40°C to +125°C
Storage temperature ..... -65°C to +150°C
Voltage on V_{DD} with respect to V_{SS} ..... 0 to +6.5V
Voltage on $\overline{MCLR}$ with respect to V_{SS} ..... 0 to +13.5V
Voltage on all other pins with respect to V_{SS} ..... -0.3V to (V_{DD} + 0.3V)
Total power dissipation(1) ..... 700 mW
Max. current out of V_{SS} pin ..... 200 mA
Max. current into V_{DD} pin ..... 150 mA
Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD}) ..... ±20 mA
Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DD}) ..... ±20 mA
Max. output current sunk by any I/O pin ..... 25 mA
Max. output current sourced by any I/O pin ..... 25 mA
Max. output current sourced by I/O port ..... 75 mA
Max. output current sunk by I/O port ..... 75 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 "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

12.0 DC AND AC CHARACTERISTICS GRAPHS AND CHARTS

The graphs and tables provided in this section are for **design guidance** and are **not tested**.

In some graphs or tables, the data presented are **outside specified operating range** (i.e., outside specified VDD range). This is for **information only** and devices are ensured to operate properly only within the specified range.

Note:	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 + 3σ) or (mean - 3σ) respectively, where σ is a standard deviation, over each temperature range.

FIGURE 12-1: TYPICAL IDD vs. FOSC OVER VDD (XT, EXTRC mode)

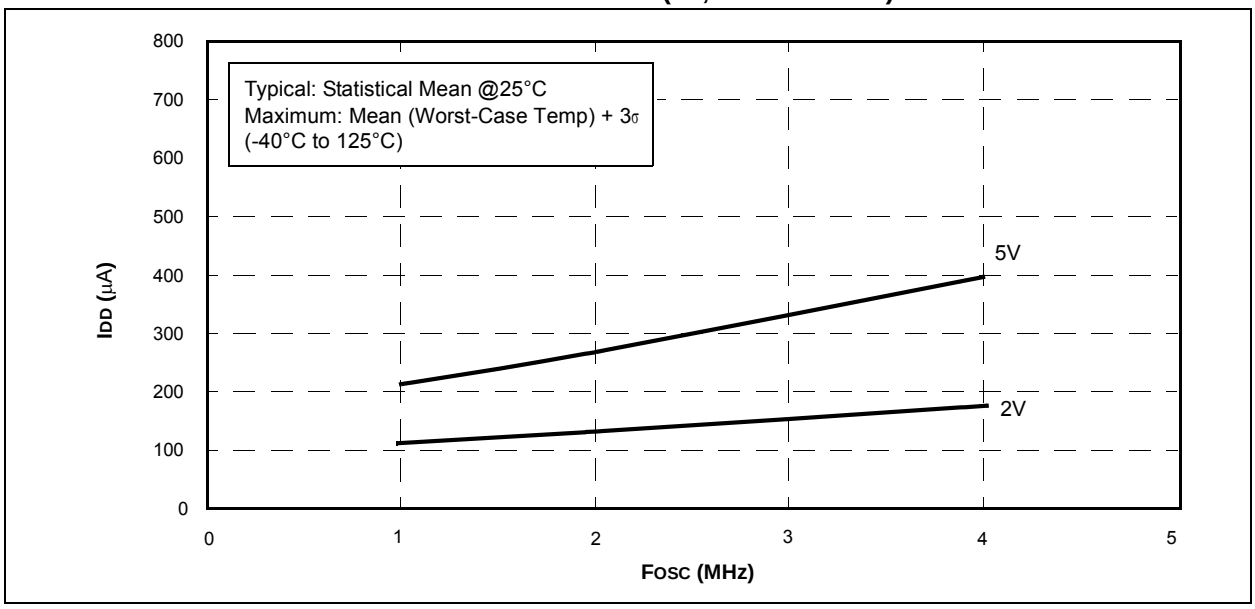
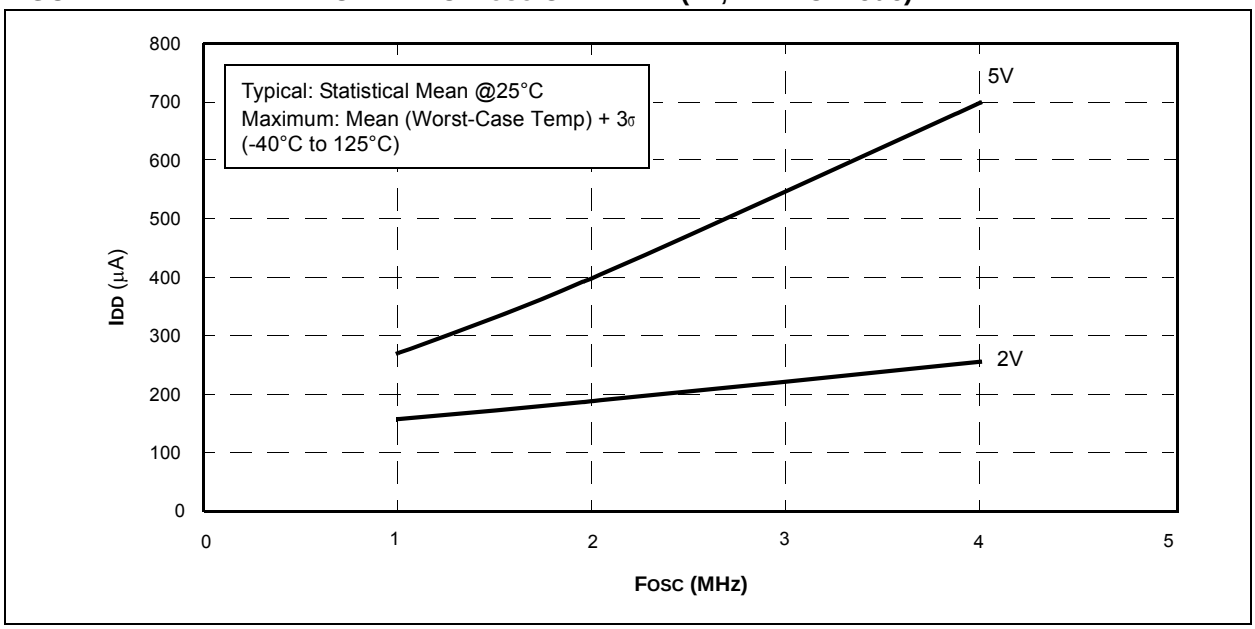


FIGURE 12-2: MAXIMUM IDD vs. FOSC OVER VDD (XT, EXTRC mode)

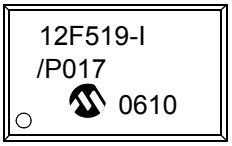


13.0 PACKAGING INFORMATION

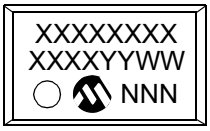
13.1 Package Marking Information

8-Lead PDIP

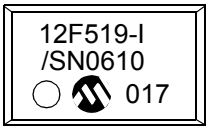
Example



8-Lead SOIC (3.90 mm)



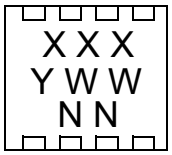
Example



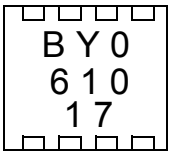
8-Lead MSOP

Example

8-Lead 2x3 DFN*



Example



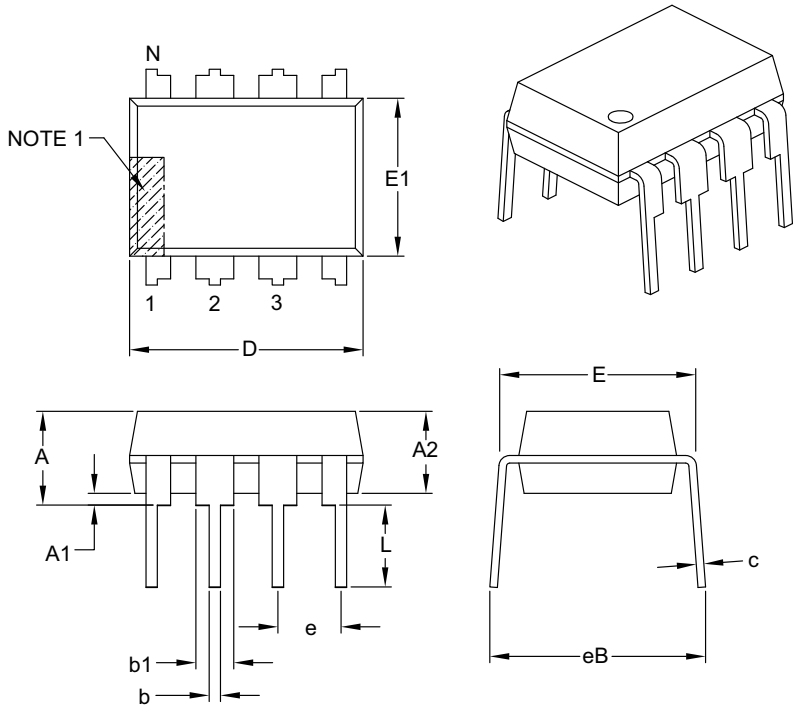
Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

***** Standard PIC® device marking consists of Microchip part number, year code, week code, and traceability code. For PIC device marking beyond this, certain price adders apply. Please check with your Microchip Sales Office. For QTP devices, any special marking adders are included in QTP price.

8-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

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



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		.100 BSC	
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.348	.365	.400
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.040	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

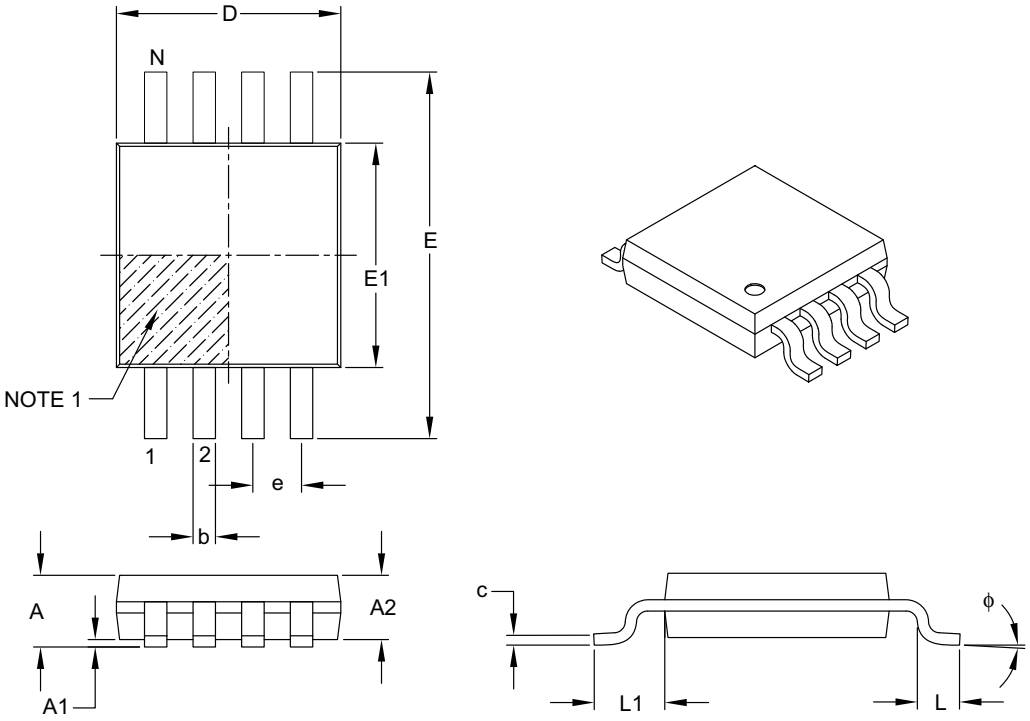
1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

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

Microchip Technology Drawing C04-018B

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.65 BSC	
Overall Height	A	–	–	1.10
Molded Package Thickness	A2	0.75	0.85	0.95
Standoff	A1	0.00	–	0.15
Overall Width	E		4.90 BSC	
Molded Package Width	E1		3.00 BSC	
Overall Length	D		3.00 BSC	
Foot Length	L	0.40	0.60	0.80
Footprint	L1		0.95 REF	
Foot Angle	ϕ	0°	–	8°
Lead Thickness	c	0.08	–	0.23
Lead Width	b	0.22	–	0.40

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M.

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

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-111B

APPENDIX A: REVISION HISTORY

Revision A (May 2007)

Original release of this document.

Revision B (September 2008)

Added DC and AC Characteristics graphs; Updated Electrical Characteristics section; Updated Package Drawings and made general edits.

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