What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details

Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	70 MIPs
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	21
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 12x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C
Mounting Type	Surface Mount
Package / Case	28-VQFN Exposed Pad
Supplier Device Package	28-QFN-S (6x6)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ep32gs202t-i-mm

4.2.1 PROGRAM MEMORY ORGANIZATION

The program memory space is organized in word-addressable blocks. Although it is treated as 24 bits wide, it is more appropriate to think of each address of the program memory as a lower and upper word, with the upper byte of the upper word being unimplemented. The lower word always has an even address, while the upper word has an odd address (Figure 4-3).
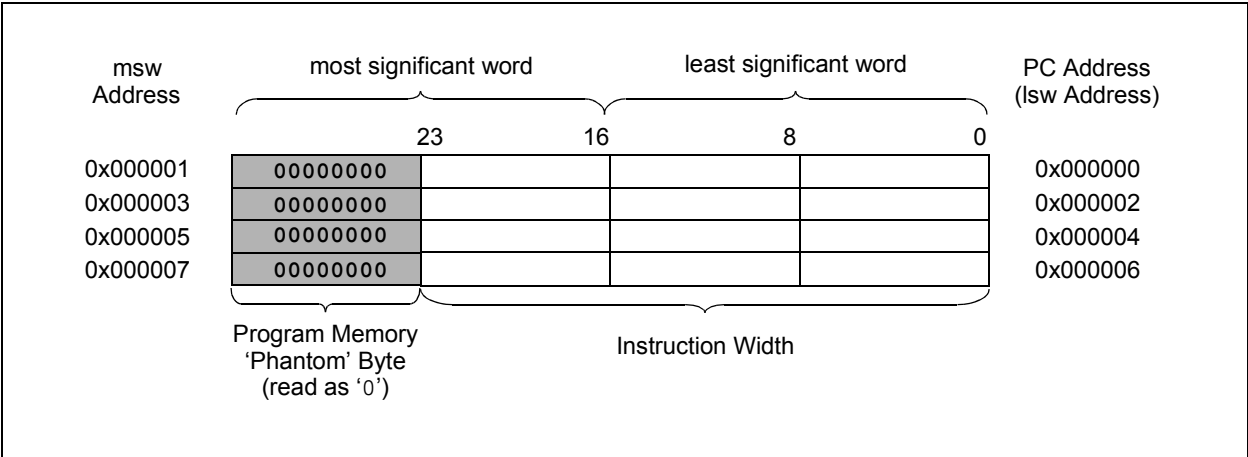
Program memory addresses are always word-aligned on the lower word, and addresses are incremented, or decremented, by two during code execution. This arrangement provides compatibility with data memory space addressing and makes data in the program memory space accessible.

4.2.2 INTERRUPT AND TRAP VECTORS

All dsPIC33EPXXGS202 family devices reserve the addresses between 0x000000 and 0x000200 for hard-coded program execution vectors. A hardware Reset vector is provided to redirect code execution from the default value of the PC on device Reset to the actual start of code. A GOTO instruction is programmed by the user application at address, 0x000000, of Flash memory, with the actual address for the start of code at address, 0x000002, of Flash memory.

A more detailed discussion of the Interrupt Vector Tables (IVTs) is provided in **Section 7.1 "Interrupt Vector Table"**.

FIGURE 4-3: **PROGRAM MEMORY ORGANIZATION**

4.5.1 PAGED MEMORY SCHEME

The dsPIC33EPXXGS202 architecture extends the available Data Space through a paging scheme, which allows the available Data Space to be accessed using MOV instructions in a linear fashion for pre- and post-modified Effective Addresses (EAs). The upper half of the base Data Space address is used in conjunction with the Data Space Read Page (DSRPAG) register to form the Program Space Visibility (PSV) address.

The Data Space Read Page (DSRPAG) register is located in the SFR space. Construction of the PSV address is shown in Figure 4-5. When DSRPAG<9> = 1 and the base address bit, EA<15> = 1, the DSRPAG<8:0> bits are concatenated onto EA<14:0> to form the 24-bit PSV read address.

The paged memory scheme provides access to multiple 32-Kbyte windows in the PSV memory. The Data Space Read Page register (DSRPAG), in combination with the upper half of the Data Space address, can provide up to 8 Mbytes of PSV address space. The paged data memory space is shown in Figure 4-6.

The Program Space (PS) can be accessed with a DSRPAG of 0x200 or greater. Only reads from PS are supported using the DSRPAG.

FIGURE 4-5: PROGRAM SPACE VISIBILITY (PSV) READ ADDRESS GENERATION

Note: DS read access when DSRPAG = 0x000 will force an address error trap.
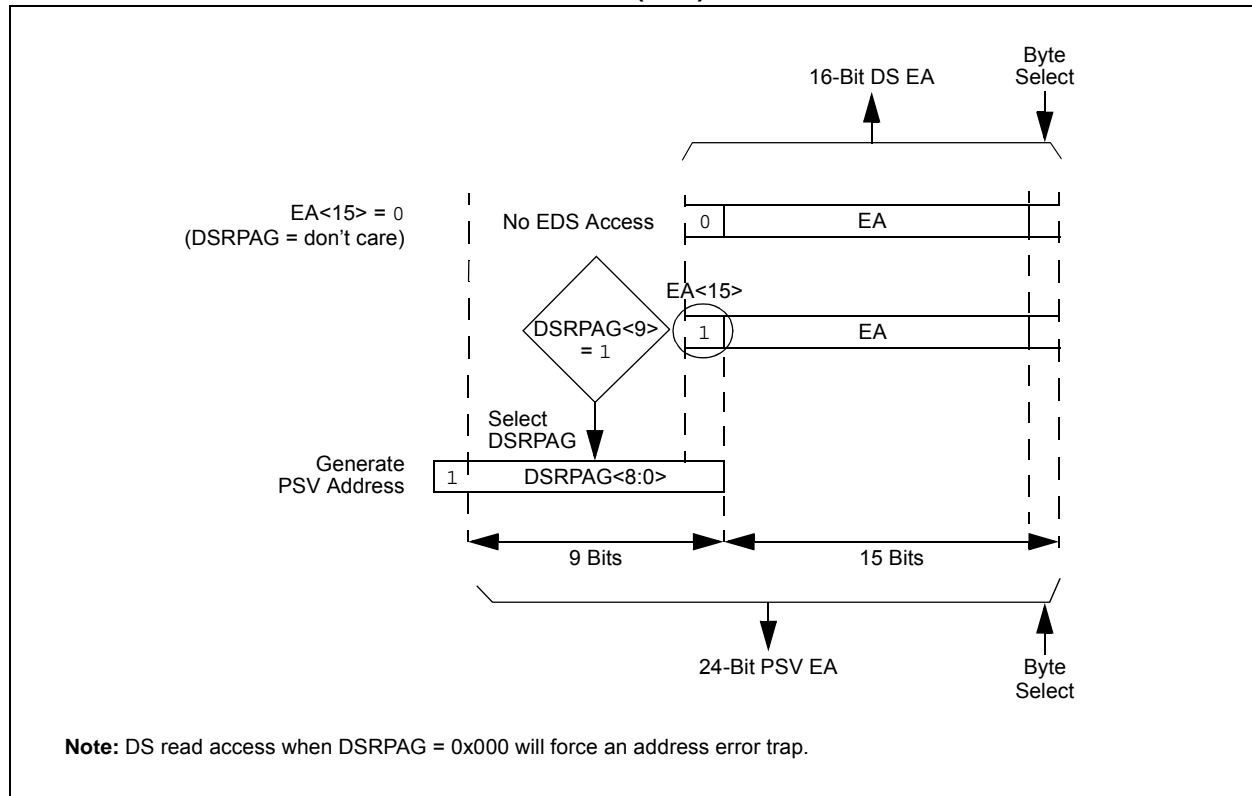
NOTES:

REGISTER 7-1: **SR: CPU STATUS REGISTER**[1]

R/W-0	R/W-0	R/W-0	R/W-0	R/C-0	R/C-0	R-0	R/W-0
OA	OB	SA	SB	OAB	SAB	DA	DC
bit 15							bit 8

R/W-0[3]	R/W-0[3]	R/W-0[3]	R-0	R/W-0	R/W-0	R/W-0	R/W-0
IPL2[2]	IPL1[2]	IPL0[2]	RA	N	OV	Z	C
bit 7							bit 0

Legend:	C = Clearable bit		
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 7-5   **IPL<2:0>:** CPU Interrupt Priority Level Status bits[2,3]

111 = CPU Interrupt Priority Level is 7 (15); user interrupts are disabled
110 = CPU Interrupt Priority Level is 6 (14)
101 = CPU Interrupt Priority Level is 5 (13)
100 = CPU Interrupt Priority Level is 4 (12)
011 = CPU Interrupt Priority Level is 3 (11)
010 = CPU Interrupt Priority Level is 2 (10)
001 = CPU Interrupt Priority Level is 1 (9)
000 = CPU Interrupt Priority Level is 0 (8)

Note 1: For complete register details, see Register 3-1.

2: The IPL<2:0> bits are concatenated with the IPL<3> bit (CORCON<3>) to form the CPU Interrupt Priority Level. The value in parentheses indicates the IPL, if IPL<3> = 1. User interrupts are disabled when IPL<3> = 1.

3: The IPL<2:0> Status bits are read-only when the NSTDIS bit (INTCON1<15>) = 1.

TABLE 8-1: CONFIGURATION BIT VALUES FOR CLOCK SELECTION

Oscillator Mode	Oscillator Source	POSCMD<1:0>	FNOSC<2:0>	See Notes
Fast RC Oscillator with Divide-by-N (FRCDIVN)	Internal	xx	111	**1, 2**
Fast RC Oscillator with Divide-by-16	Internal	xx	110	**1**
Low-Power RC Oscillator (LPRC)	Internal	xx	101	**1**
Primary Oscillator (HS) with PLL (HSPLL)	Primary	10	011	
Primary Oscillator (XT) with PLL (XTPLL)	Primary	01	011	
Primary Oscillator (EC) with PLL (ECPLL)	Primary	00	011	**1**
Primary Oscillator (HS)	Primary	10	010	
Primary Oscillator (XT)	Primary	01	010	
Primary Oscillator (EC)	Primary	00	010	**1**
Fast RC Oscillator (FRC) with Divide-by-N and PLL (FRCPLL)	Internal	xx	001	**1**
Fast RC Oscillator (FRC)	Internal	xx	000	**1**

Note 1: OSC2 pin function is determined by the OSCIOFNC Configuration bit.

2: This is the default oscillator mode for an unprogrammed (erased) device.

8.2 Auxiliary Clock Generation

The auxiliary clock generation is used for peripherals that need to operate at a frequency unrelated to the system clock, such as PWM or ADC.

The primary oscillator and internal FRC oscillator sources can be used with an Auxiliary PLL (APLL) to obtain the auxiliary clock. The Auxiliary PLL has a fixed 16x multiplication factor.

The auxiliary clock has the following configuration restrictions:

- For proper PWM operation, auxiliary clock generation must be configured for 120 MHz (see Parameter OS56 in **Section 25.0 "Electrical Characteristics"**). If a slower frequency is desired, the PWM Input Clock Prescaler (Divider) Select bits (PCLKDIV<2:0>) should be used.

- To achieve 1.04 ns PWM resolution, the auxiliary clock must use the 16x Auxiliary PLL (APLL). All other clock sources will have a minimum PWM resolution of 8 ns.

- If the primary PLL is used as a source for the auxiliary clock, the primary PLL should be configured up to a maximum operation of 30 MIPS or less.

8.3 Oscillator Resources

Many useful resources are provided on the main product page of the Microchip web site for the devices listed in this data sheet. This product page contains the latest updates and additional information.

8.3.1 KEY RESOURCES

- **"Oscillator Module"** (DS70005131) in the "*dsPIC33/PIC24 Family Reference Manual"*
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All Related *"dsPIC33/PIC24 Family Reference Manual"* Sections
- Development Tools

REGISTER 8-1: OSCCON: OSCILLATOR CONTROL REGISTER[1] (CONTINUED)

bit 4   **Unimplemented:** Read as '0'

bit 3   **CF:** Clock Fail Detect bit[3]

                    1 = FSCM has detected a clock failure
                    0 = FSCM has not detected a clock failure

bit 2-1   **Unimplemented:** Read as '0'

bit 0   **OSWEN:** Oscillator Switch Enable bit

                    1 = Requests oscillator switch to selection specified by the NOSC<2:0> bits
                    0 = Oscillator switch is complete

Note 1: Writes to this register require an unlock sequence.

       2: Direct clock switches between any Primary Oscillator mode with PLL and FRCPLL mode are not permitted. This applies to clock switches in either direction. In these instances, the application must switch to FRC mode as a transitional clock source between the two PLL modes.

       3: This bit should only be cleared in software. Setting the bit in software (= 1) will have the same effect as an actual oscillator failure and trigger an oscillator failure trap.

NOTES:

REGISTER 10-8: **RPINR13: PERIPHERAL PIN SELECT INPUT REGISTER 13**

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
FLT4R7	FLT4R6	FLT4R5	FLT4R4	FLT4R3	FLT4R2	FLT4R1	FLT4R0
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
FLT3R7	FLT3R6	FLT3R5	FLT3R4	FLT3R3	FLT3R2	FLT3R1	FLT3R0
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 15-8 **FLT4R<7:0>:** Assign PWM Fault 4 (FLT4) to the Corresponding RPn Pin bits

`10110101` = Input tied to RP181
`10110100` = Input tied to RP180
•
•
•
`00000001` = Input tied to RP1
`00000000` = Input tied to Vss

bit 7-0 **FLT3R<7:0>:** Assign PWM Fault 3 (FLT3) to the Corresponding RPn Pin bits

`10110101` = Input tied to RP181
`10110100` = Input tied to RP180
•
•
•
`00000001` = Input tied to RP1
`00000000` = Input tied to Vss

REGISTER 10-13:   RPINR38: PERIPHERAL PIN SELECT INPUT REGISTER 38

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
SYNCI2R<7:0>							
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 15-8 **Unimplemented:** Read as '0'

bit 7-0 **SYNCI2R<7:0>:** Assign PWM Synchronization Input 2 to the Corresponding RPn Pin bits

10110101 = Input tied to RP181
10110100 = Input tied to RP180
•
•
•
00000001 = Input tied to RP1
00000000 = Input tied to Vss

REGISTER 15-5: STCON: PWM SECONDARY MASTER TIME BASE CONTROL REGISTER

U-0	U-0	U-0	HS/HC-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	SESTAT	SEIEN	EIPU[(1)]	SYNCPOL	SYNCOEN
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
SYNCEN	SYNCSRC2	SYNCSRC1	SYNCSRC0	SEVTPS3	SEVTPS2	SEVTPS1	SEVTPS0
bit 7							bit 0

Legend:		
	HS = Hardware Settable bit	HC = Hardware Clearable bit
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 15-13   **Unimplemented:** Read as '0'

bit 12   **SESTAT:** Special Event Interrupt Status bit

1 = Secondary special event interrupt is pending
0 = Secondary special event interrupt is not pending

bit 11   **SEIEN:** Special Event Interrupt Enable bit

1 = Secondary special event interrupt is enabled
0 = Secondary special event interrupt is disabled

bit 10   **EIPU:** Enable Immediate Period Updates bit[(1)]

1 = Active Secondary Period register is updated immediately
0 = Active Secondary Period register updates occur on PWM cycle boundaries

bit 9   **SYNCPOL:** Synchronize Input and Output Polarity bit

1 = SYNCIx/SYNCO2 polarity is inverted (active-low)
0 = SYNCIx/SYNCO2 polarity is active-high

bit 8   **SYNCOEN:** Secondary Master Time Base Synchronization Enable bit

1 = SYNCO2 output is enabled.
0 = SYNCO2 output is disabled

bit 7   **SYNCEN:** External Secondary Master Time Base Synchronization Enable bit

1 = External synchronization of secondary time base is enabled
0 = External synchronization of secondary time base is disabled

bit 6-4   **SYNCSRC<2:0>:** Secondary Time Base Sync Source Selection bits

111 = Reserved
101 = Reserved
100 = Reserved
011 = Reserved
010 = Reserved
001 = SYNCI2
000 = SYNCI1

bit 3-0   **SEVTPS<3:0>:** PWM Secondary Special Event Trigger Output Postscaler Select bits

1111 = 1:16 Postscale
0001 = 1:2 Postscale
•
•
•
0000 = 1:1 Postscale

Note 1: This bit only applies to the secondary master time base period.

REGISTER 15-16: SPHASEx: PWMx SECONDARY PHASE-SHIFT REGISTER[1,2]

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
			SPHASEx<15:8>				
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
			SPHASEx<7:0>				
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 15-0 **SPHASEx<15:0>:** Secondary Phase Offset for PWMxL Output Pin bits
(used in Independent PWM mode only)

Note 1: If PWMCONx<9> = 0, the following applies based on the mode of operation:
- Complementary, Redundant and Push-Pull Output mode (IOCONx<11:10> = 00, 01 or 10); SPHASEx<15:0> = Not used
- True Independent Output mode (IOCONx<11:10> = 11), SPHASEx<15:0> = Phase-shift value for PWMxL only

2: If PWMCONx<9> = 1, the following applies based on the mode of operation:
- Complementary, Redundant and Push-Pull Output mode (IOCONx<11:10> = 00, 01 or 10); SPHASEx<15:0> = Not used
- True Independent Output mode (IOCONx<11:10> = 11); SPHASEx<15:0> = Independent time base period value for PWMxL only
- When the PHASEx/SPHASEx registers provide the local period, the valid range of values is 0x0010-0xFFF8

REGISTER 19-13: ADLVLTRGL: ADC LEVEL-SENSITIVE TRIGGER CONTROL REGISTER LOW

U-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
—	LVLEN14	—	—	LVLEN<11:8>			
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
LVLEN<7:0>							
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 15 **Unimplemented:** Read as '0'

bit 14 **LVLEN14:** Level Trigger 14 Enable bit
1 = Input Channel 14 trigger is level-sensitive
0 = Input Channel 14 trigger is edge-sensitive

bit 13-12 **Unimplemented:** Read as '0'

bit 11-0 **LVLEN<11:0>:** Level Trigger x Enable bits
1 = Input Channel x trigger is level-sensitive
0 = Input Channel x trigger is edge-sensitive

REGISTER 19-16: ADMOD0L: ADC INPUT MODE CONTROL REGISTER 0 LOW

U-0	R/W-0	U-0	R/W-0	U-0	R/W-0	U-0	R/W-0
—	SIGN7	—	SIGN6	—	SIGN5	—	SIGN4
bit 15							bit 8

U-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	SIGN3	—	SIGN2	DIFF1	SIGN1	DIFF0	SIGN0
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 (odd)15-5   **Unimplemented:** Read as '0'

bit (3,1)   **DIFF<x>:** Pseudo-Differential Mode for Corresponding Analog Inputs bits
1 = Channel is pseudo-differential
0 = Channel is single-ended

bit (even)   **SIGNx:** Output Data Sign for Corresponding Analog Inputs bits
1 = Channel output data is signed
0 = Channel output data is unsigned

REGISTER 19-17: ADMOD0H: ADC INPUT MODE CONTROL REGISTER 0 HIGH

U-0	U-0	U-0	R/W-0	U-0	R/W-0	U-0	R/W-0
—	—	—	SIGN14	—	SIGN13	—	SIGN12
bit 15							bit 8

U-0	R/W-0	U-0	R/W-0	U-0	R/W-0	U-0	R/W-0
—	SIGN11	—	SIGN10	—	SIGN9	—	SIGN8
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 15-13   **Unimplemented:** Read as '0'

bit (odd)   **Unimplemented:** Read as '0'

bit (even)   **SIGN<x>:** Output Data Sign for Corresponding Analog Inputs bits
1 = Channel output data is signed
0 = Channel output data is unsigned

REGISTER 19-23: ADCAL1H: ADC CALIBRATION REGISTER 1 HIGH

R/W-0, HS	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
CSHRRDY	—	—	—	CSHRSKIP	CSHRDIFF	CSHREN	CSHRRUN
bit 15							bit 8

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 7							bit 0

Legend:		HS = Hardware Settable bit	
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 15 **CSHRRDY:** Shared ADC Core Calibration Status Flag bit

1 = Shared ADC core calibration is finished
0 = Shared ADC core calibration is in progress

bit 14-12 **Unimplemented:** Read as '0'

bit 11 **CSHRSKIP:** Shared ADC Core Calibration Bypass bit

1 = After power-up, the shared ADC core will not be calibrated
0 = After power-up, the shared ADC core will be calibrated

bit 10 **CSHRDIFF:** Shared ADC Core Pseudo-Differential Input Mode Calibration bit

1 = Shared ADC core will be calibrated in Pseudo-Differential Input mode
0 = Shared ADC core will be calibrated in Single-Ended Input mode

bit 9 **CSHREN:** Shared ADC Core Calibration Enable bit

1 = Shared ADC core calibration bits (CSHRRDY, CSHRSKIP, CSHRDIFF and CSHRRUN) can be accessed by software
0 = Shared ADC core calibration bits are disabled

bit 8 **CSHRRUN:** Shared ADC Core Calibration Start bit

1 = If this bit is set by software, the shared ADC core calibration cycle is started; this bit is cleared automatically by hardware
0 = Software can start the next calibration cycle

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

TABLE 22-1: CONFIGURATION REGISTER MAP

Name	Address	Device Memory Size (Kbytes)	Bits 23-16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
FSEC	002B80	16	—	AIVTDIS	—	—	—	CSS <2:0>			CWRP	GSS <1:0>		GWRP	—	BSEN	BSS <1:0>		BWRP
	005780	32																	
FBSLIM	002B90	16	—	—	—	—	BSLIM <12:0>												
	005790	32																	
FSIGN	002B94	16	—	Reserved[2]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	005794	32																	
FOSCSEL	002B98	16	—	—	—	—	—	—	—	—	—	IESO	—	—	—	—	FNOSC<2:0>		
	005798	32																	
FOSC	002B9C	16	—	—	—	—	—	—	—	—	PLLKEN	FCKSM<1:0>		IOL1WAY	—	—	OSCIOFNC	POSCMD<1:0>	
	00579C	32																	
FWDT	002BA0	16	—	—	—	—	—	WDTWIN<1:0>		—	—	WINDIS	WDTEN<1:0>		WDTPRE	WDTPOST <3:0>			
	0057A0	32																	
FPOR	002BA4	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Reserved[1]
	0057A4	32																	
FICD	002BA8	16	—	—	—	—	—	—	—	—	—	Reserved[1]	—	JTAGEN	—	—	—	ICS <1:0>	
	0057A8	32																	
FDEVOPT	002BAC	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Reserved[1]	—	PWMLOCK
	0057AC	32																	
FALTREG	002BB0	16	—	—	—	—	—	—	—	—	—	—	CTXT2 <2:0>			—	CTXT1 <2:0>		
	0057B0	32																	

Note 1: These bits are reserved and must be programmed as '1'.

  2: This bit is reserved and must be programmed as '0'.

24.6 MPLAB X SIM Software Simulator

The MPLAB X SIM Software Simulator allows code development in a PC-hosted environment by simulating the PIC MCUs and dsPIC DSCs on an instruction level. On any given instruction, the data areas can be examined or modified and stimuli can be applied from a comprehensive stimulus controller. Registers can be logged to files for further run-time analysis. The trace buffer and logic analyzer display extend the power of the simulator to record and track program execution, actions on I/O, most peripherals and internal registers.

The MPLAB X SIM Software Simulator fully supports symbolic debugging using the MPLAB XC Compilers, and the MPASM and MPLAB Assemblers. The software simulator offers the flexibility to develop and debug code outside of the hardware laboratory environment, making it an excellent, economical software development tool.

24.7 MPLAB REAL ICE In-Circuit Emulator System

The 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 all 8, 16 and 32-bit MCU, and DSC devices with the easy-to-use, powerful graphical user interface of the MPLAB X IDE.

The emulator 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 in-circuit debugger systems (RJ-11) or with the new high-speed, noise tolerant, Low-Voltage Differential Signal (LVDS) interconnection (CAT5).

The emulator is field upgradable through future firmware downloads in MPLAB X IDE. MPLAB REAL ICE offers significant advantages over competitive emulators including full-speed emulation, run-time variable watches, trace analysis, complex breakpoints, logic probes, a ruggedized probe interface and long (up to three meters) interconnection cables.

24.8 MPLAB ICD 3 In-Circuit Debugger System

The MPLAB ICD 3 In-Circuit Debugger System is Microchip's most cost-effective, high-speed hardware debugger/programmer for Microchip Flash DSC and MCU devices. It debugs and programs PIC Flash microcontrollers and dsPIC DSCs with the powerful, yet easy-to-use graphical user interface of the MPLAB IDE.

The MPLAB ICD 3 In-Circuit Debugger probe is connected to the design engineer's PC using a high-speed USB 2.0 interface and is connected to the target with a connector compatible with the MPLAB ICD 2 or MPLAB REAL ICE systems (RJ-11). MPLAB ICD 3 supports all MPLAB ICD 2 headers.

24.9 PICkit 3 In-Circuit Debugger/ Programmer

The MPLAB PICkit 3 allows debugging and programming of PIC and dsPIC Flash microcontrollers at a most affordable price point using the powerful graphical user interface of the MPLAB IDE. The MPLAB PICkit 3 is connected to the design engineer's PC using a full-speed USB interface and can be connected to the target via a Microchip debug (RJ-11) connector (compatible with MPLAB ICD 3 and MPLAB REAL ICE). The connector uses two device I/O pins and the Reset line to implement in-circuit debugging and In-Circuit Serial Programming™ (ICSP™).

24.10 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 MMC card for file storage and data applications.

FIGURE 25-6: INPUT CAPTURE 1 (IC1) TIMING CHARACTERISTICS

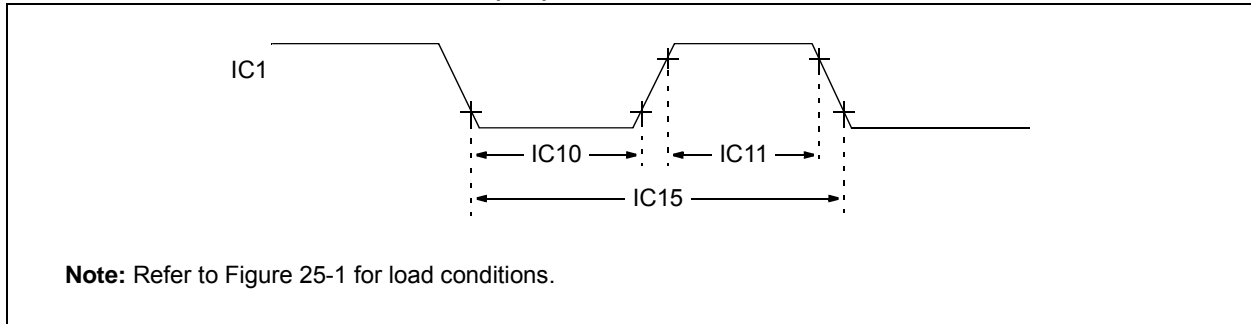**Note:** Refer to Figure 25-1 for load conditions.

TABLE 25-27: INPUT CAPTURE 1 MODULE TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +125°C for Extended				
Param. No.	Symbol	Characteristics[1]	Min.	Max.	Units	Conditions	
IC10	T_{CCL}	IC1 Input Low Time	Greater of: 12.5 + 25 or (0.5 T_{CY}/N) + 25	—	ns	Must also meet Parameter IC15	N = Prescale Value (1, 4, 16)
IC11	T_{CCH}	IC1 Input High Time	Greater of: 12.5 + 25 or (0.5 T_{CY}/N) + 25	—	ns	Must also meet Parameter IC15	
IC15	T_{CCP}	IC1 Input Period	Greater of: 25 + 50 or (1 T_{CY}/N) + 50	—	ns		

Note 1: These parameters are characterized but not tested in manufacturing.

TABLE 25-40: I2C1 BUS DATA TIMING REQUIREMENTS (SLAVE MODE)

AC CHARACTERISTICS				Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended			
Param No.	Symbol	Characteristic[3]		Min.	Max.	Units	Conditions
IS10	$T_{LO:SCL}$	Clock Low Time	100 kHz mode	4.7	—	μs	
			400 kHz mode	1.3	—	μs	
			1 MHz mode[1]	0.5	—	μs	
IS11	$T_{HI:SCL}$	Clock High Time	100 kHz mode	4.0	—	μs	Device must operate at a minimum of 1.5 MHz
			400 kHz mode	0.6	—	μs	Device must operate at a minimum of 10 MHz
			1 MHz mode[1]	0.5	—	μs	
IS20	$T_{F:SCL}$	SDA1 and SCL1 Fall Time	100 kHz mode	—	300	ns	C_B is specified to be from 10 to 400 pF
			400 kHz mode	20 + 0.1 C_B	300	ns	
			1 MHz mode[1]	—	100	ns	
IS21	$T_{R:SCL}$	SDA1 and SCL1 Rise Time	100 kHz mode	—	1000	ns	C_B is specified to be from 10 to 400 pF
			400 kHz mode	20 + 0.1 C_B	300	ns	
			1 MHz mode[1]	—	300	ns	
IS25	$T_{SU:DAT}$	Data Input Setup Time	100 kHz mode	250	—	ns	
			400 kHz mode	100	—	ns	
			1 MHz mode[1]	100	—	ns	
IS26	$T_{HD:DAT}$	Data Input Hold Time	100 kHz mode	0	—	μs	
			400 kHz mode	0	0.9	μs	
			1 MHz mode[1]	0	0.3	μs	
IS30	$T_{SU:STA}$	Start Condition Setup Time	100 kHz mode	4.7	—	μs	Only relevant for Repeated Start condition
			400 kHz mode	0.6	—	μs	
			1 MHz mode[1]	0.25	—	μs	
IS31	$T_{HD:STA}$	Start Condition Hold Time	100 kHz mode	4.0	—	μs	After this period, the first clock pulse is generated
			400 kHz mode	0.6	—	μs	
			1 MHz mode[1]	0.25	—	μs	
IS33	$T_{SU:STO}$	Stop Condition Setup Time	100 kHz mode	4.7	—	μs	
			400 kHz mode	0.6	—	μs	
			1 MHz mode[1]	0.6	—	μs	
IS34	$T_{HD:STO}$	Stop Condition Hold Time	100 kHz mode	4	—	μs	
			400 kHz mode	0.6	—	μs	
			1 MHz mode[1]	0.25		μs	
IS40	$T_{AA:SCL}$	Output Valid from Clock	100 kHz mode	0	3500	ns	
			400 kHz mode	0	1000	ns	
			1 MHz mode[1]	0	350	ns	
IS45	$T_{BF:SDA}$	Bus Free Time	100 kHz mode	4.7	—	μs	Time the bus must be free before a new transmission can start
			400 kHz mode	1.3	—	μs	
			1 MHz mode[1]	0.5	—	μs	
IS50	C_B	Bus Capacitive Loading		—	400	pF	
IS51	T_{PGD}	Pulse Gobbler Delay		65	390	ns	(Note 2)

**Note 1:** Maximum Pin Capacitance = 10 pF for all I2C1 pins (for 1 MHz mode only).

2: Typical value for this parameter is 130 ns.

3: These parameters are characterized but not tested in manufacturing.

28-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

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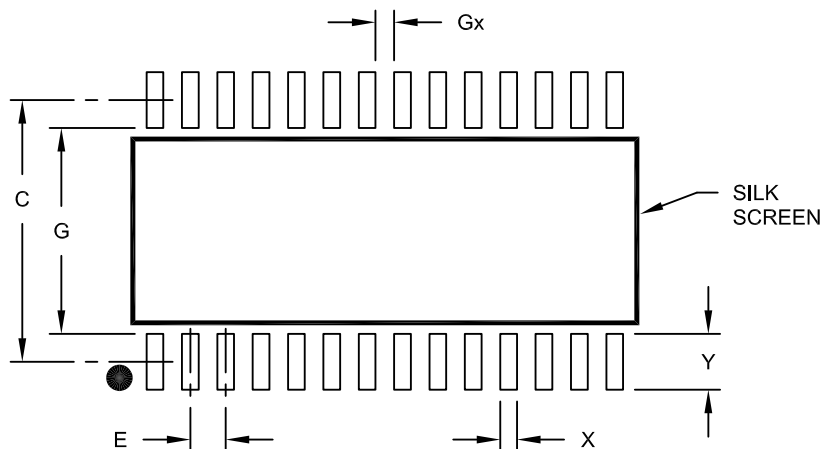
RECOMMENDED LAND PATTERN

	Units		MILLIMETERS	
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		9.40	
Contact Pad Width (X28)	X			0.60
Contact Pad Length (X28)	Y			2.00
Distance Between Pads	Gx	0.67		
Distance Between Pads	G	7.40		

Notes:
1. Dimensioning and tolerancing per ASME Y14.5M
    BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2052A

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/
support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

07/14/15