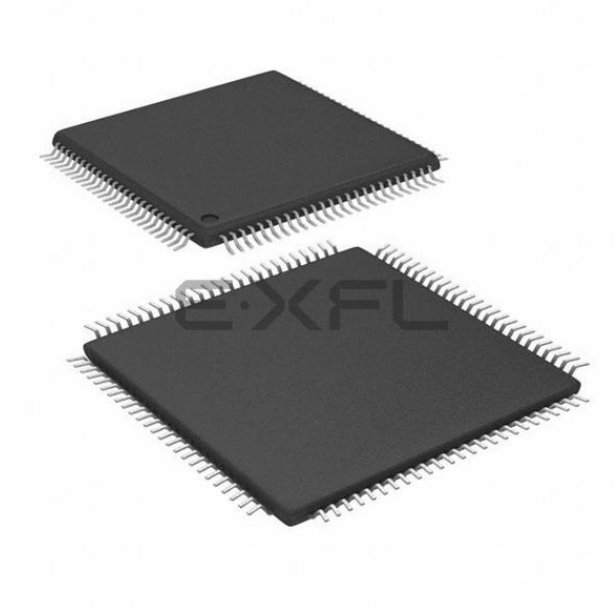
Microchip Technology - DSPIC33EP256GM310-E/PT Datasheet



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"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.

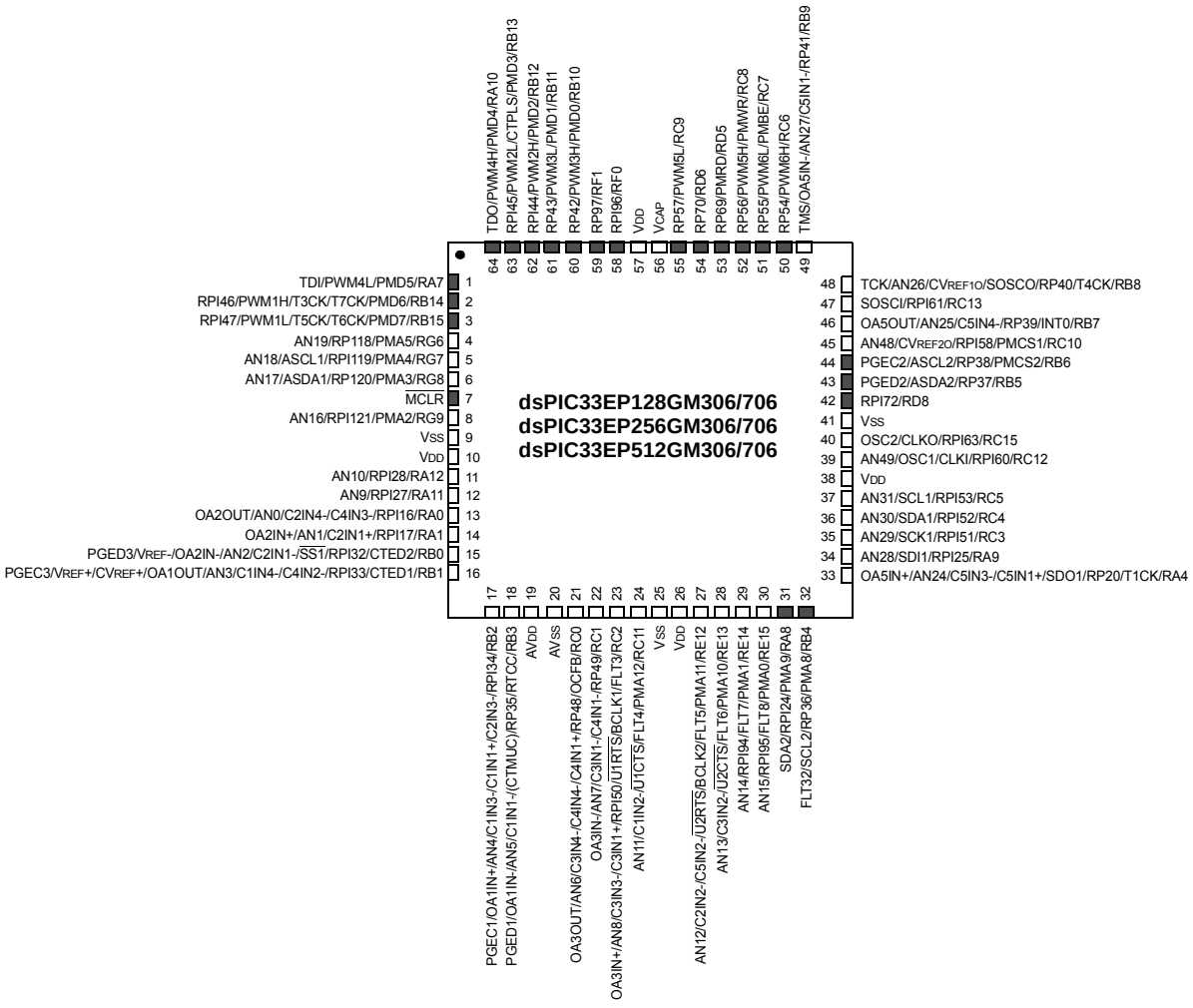
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	60 MIPs
Connectivity	I²C, IrDA, LINbus, QEI, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, I²S, Motor Control PWM, POR, PWM, WDT
Number of I/O	85
Program Memory Size	256KB (85.5K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 49x10b/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	100-TQFP
Supplier Device Package	100-TQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ep256gm310-e-pt

Pin Diagrams (Continued)

64-Pin QFN(1,2,3,4)

■ = Pins are up to 5V tolerant



Note 1: The RPn/RPIn pins can be used by any remappable peripheral with some limitation. See **Section 11.4 "Peripheral Pin Select (PPS)"** for available peripherals and for information on limitations.

2: Every I/O port pin (RAx-RGx) can be used as a Change Notification pin (CNAx-CNGx). See **Section 11.0 "I/O Ports"** for more information.

3: This pin is not available as an input when OPMODE (CMxCON<10>) = 1.

4: The metal pad at the bottom of the device is not connected to any pins and is recommended to be connected to VSS externally.

FIGURE 2-7: INTERLEAVED PFC

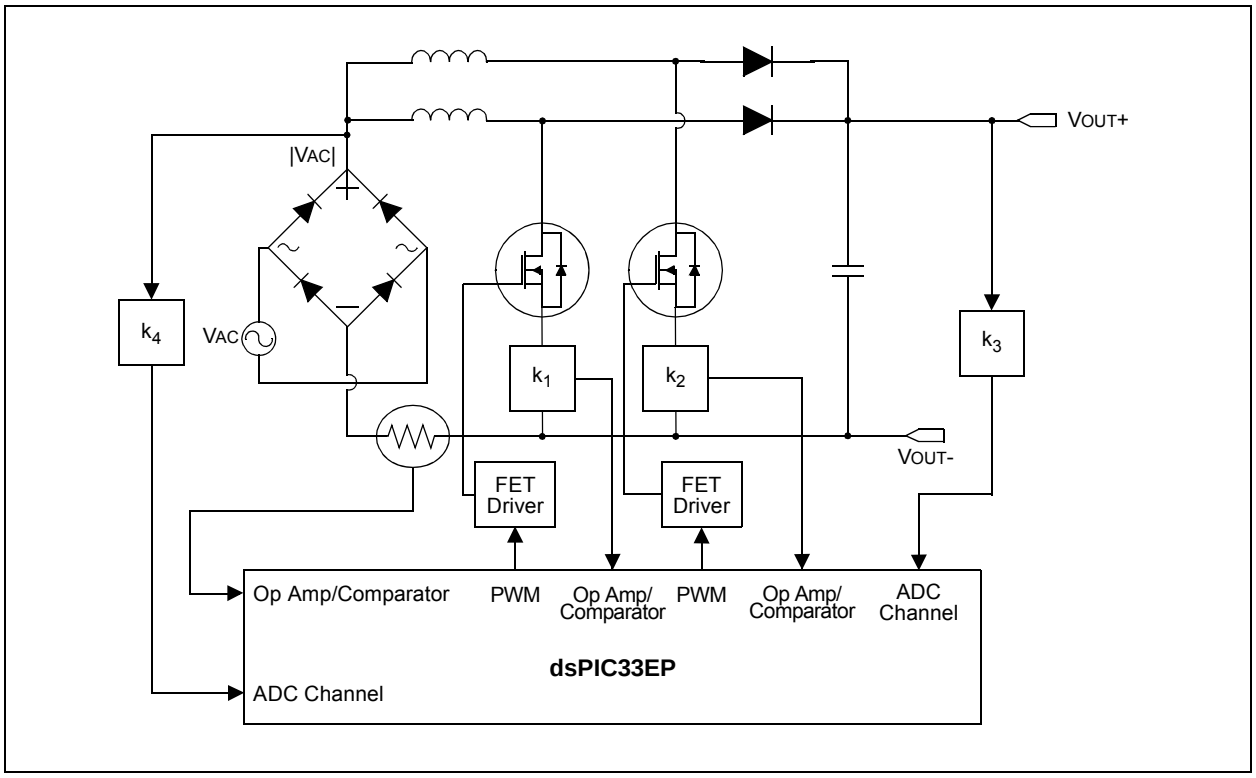
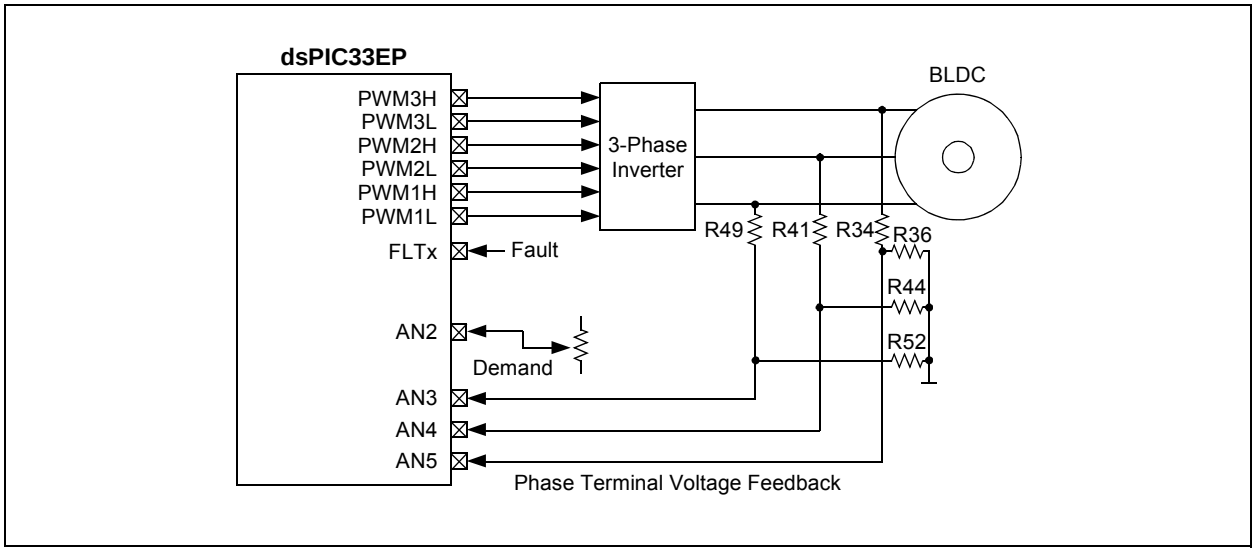


FIGURE 2-8: BEMF VOLTAGE MEASURED USING THE ADC MODULE



3.0 CPU

Note 1: This data sheet summarizes the features of the dsPIC33EPXXXGM3XX/6XX/7XX family of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to the "*dsPIC33/PIC24 Family Reference Manual*", **"CPU"** (DS70359), which is available from the Microchip web site (www.microchip.com).

2: Some registers and associated bits described in this section may not be available on all devices. Refer to **Section 4.0 "Memory Organization"** in this data sheet for device-specific register and bit information.

The CPU has a 16-bit (data) modified Harvard architecture with an enhanced instruction set, including significant support for digital signal processing. The CPU has a 24-bit instruction word, with a variable length opcode field. The Program Counter (PC) is 23 bits wide and addresses up to 4M x 24 bits of user program memory space.

An instruction prefetch mechanism helps maintain throughput and provides predictable execution. Most instructions execute in a single-cycle, effective execution rate, with the exception of instructions that change the program flow, the double-word move (`MOV.D`) instruction, PSV accesses and the table instructions. Overhead-free program loop constructs are supported using the `DO` and `REPEAT` instructions, both of which are interruptible at any point.

3.1 Registers

The dsPIC33EPXXXGM3XX/6XX/7XX devices have sixteen 16-bit Working registers in the programmer's model. Each of the Working registers can act as a data, address or address offset register. The 16th Working register (W15) operates as a Software Stack Pointer for interrupts and calls.

3.2 Instruction Set

The device instruction set has two classes of instructions: the MCU class of instructions and the DSP class of instructions. These two instruction classes are seamlessly integrated into the architecture and execute from a single execution unit. The instruction set includes many addressing modes and was designed for optimum C compiler efficiency.

3.3 Data Space Addressing

The Base Data Space can be addressed as 4K words or 8 Kbytes and is split into two blocks, referred to as X and Y data memory. Each memory block has its own independent Address Generation Unit (AGU). The MCU class of instructions operate solely through the X memory AGU, which accesses the entire memory map as one linear Data Space. On dsPIC33EP devices, certain DSP instructions operate through the X and Y AGUs to support dual operand reads, which splits the data address space into two parts. The X and Y Data Space boundary is device-specific.

The upper 32 Kbytes of the Data Space memory map can optionally be mapped into Program Space at any 16K program word boundary. The program-to-Data Space mapping feature, known as Program Space Visibility (PSV), lets any instruction access Program Space as if it were Data Space. Moreover, the Base Data Space address is used in conjunction with a Data Space Read or Write Page register (DSRPAG or DSWPAG) to form an Extended Data Space (EDS) address. The EDS can be addressed as 8M words or 16 Mbytes. Refer to **"Data Memory"** (DS70595) and **"Program Memory"** (DS70613) in the *"dsPIC33/PIC24 Family Reference Manual"* for more details on EDS, PSV and table accesses.

On dsPIC33EP devices, overhead-free circular buffers (Modulo Addressing) are supported in both X and Y address spaces. The Modulo Addressing removes the software boundary checking overhead for DSP algorithms. The X AGU circular addressing can be used with any of the MCU class of instructions. The X AGU also supports Bit-Reversed Addressing to greatly simplify input or output data reordering for radix-2 FFT algorithms.

3.4 Addressing Modes

The CPU supports these addressing modes:

- Inherent (no operand)
- Relative
- Literal
- Memory Direct
- Register Direct
- Register Indirect

Each instruction is associated with a predefined addressing mode group, depending upon its functional requirements. As many as six addressing modes are supported for each instruction.

REGISTER 3-1: SR: CPU STATUS REGISTER (CONTINUED)

bit 7-5 **IPL<2:0>:** CPU Interrupt Priority Level Status bits(1,2)

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)

bit 4 **RA:** REPEAT Loop Active bit

1 = REPEAT loop is in progress
0 = REPEAT loop is not in progress

bit 3 **N:** MCU ALU Negative bit

1 = Result was negative
0 = Result was non-negative (zero or positive)

bit 2 **OV:** MCU ALU Overflow bit

This bit is used for signed arithmetic (2's complement). It indicates an overflow of the magnitude that causes the sign bit to change state.
1 = Overflow occurred for signed arithmetic (in this arithmetic operation)
0 = No overflow occurred

bit 1 **Z:** MCU ALU Zero bit

1 = An operation that affects the Z bit has set it at some time in the past
0 = The most recent operation that affects the Z bit has cleared it (i.e., a non-zero result)

bit 0 **C:** MCU ALU Carry/$\overline{\text{Borrow}}$ bit

1 = A carry-out from the Most Significant bit (MSb) of the result occurred
0 = No carry-out from the Most Significant bit of the result occurred

Note 1: 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.

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

3: A data write to the SR register can modify the SA and SB bits by either a data write to SA and SB or by clearing the SAB bit. To avoid a possible SA or SB bit write race condition, the SA and SB bits should not be modified using bit operations.

REGISTER 11-22: RPINR28: PERIPHERAL PIN SELECT INPUT REGISTER 28

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	U4CTSR<6:0>						
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	U4RXR<6:0>						
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 14-8 **U4CTSR<6:0>:** Assign UART4 Clear-to-Send ($\overline{\text{U4CTS}}$) to the Corresponding RPn/RPIn Pin bits (see Table 11-2 for input pin selection numbers)

1111111 = Input tied to RP124
•
•
•
0000001 = Input tied to CMP1
0000000 = Input tied to Vss

bit 7 **Unimplemented:** Read as ‘0’

bit 6-0 **U4RXR<6:0>:** Assign UART4 Receive (U4RX) to the Corresponding RPn/RPIn Pin bits (see Table 11-2 for input pin selection numbers)

1111111 = Input tied to RP124
•
•
•
0000001 = Input tied to CMP1
0000000 = Input tied to Vss

REGISTER 16-1: PTCON: PWMx TIME BASE CONTROL REGISTER (CONTINUED)

bit 6-4 **SYNCSRC<2:0>:** Synchronous Source Selection bits(1)

111 = Reserved
•
•
•
100 = Reserved
011 = PTGO17(2)
010 = PTGO16(2)
001 = Reserved
000 = SYNCI1

bit 3-0 **SEVTPS<3:0>:** PWMx Special Event Trigger Output Postscaler Select bits(1)

1111 = 1:16 Postscaler generates Special Event Trigger on every sixteenth compare match event
•
•
•
0001 = 1:2 Postscaler generates Special Event Trigger on every second compare match event
0000 = 1:1 Postscaler generates Special Event Trigger on every compare match event

Note 1: These bits should be changed only when PTEN = 0. In addition, when using the SYNCI1 feature, the user application must program the Period register with a value that is slightly larger than the expected period of the external synchronization input signal.

2: See **Section 25.0 "Peripheral Trigger Generator (PTG) Module"** for information on this selection.

REGISTER 16-11: PWMCONx: PWMx CONTROL REGISTER

HS/HC-0	HS/HC-0	HS/HC-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
FLTSTAT(1)	CLSTAT(1)	TRGSTAT	FLTIEN	CLIEN	TRGIEN	ITB(2)	MDCS(2)
bit 15							bit 8

R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
DTC1	DTC0	DTCP(3)	—	MTBS	CAM(2,4)	XPRES(5)	IUE(2)
bit 7							bit 0

Legend:	HC = Hardware Clearable bit	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 **FLTSTAT:** Fault Interrupt Status bit(1)
1 = Fault interrupt is pending
0 = No Fault interrupt is pending
This bit is cleared by setting: FLTIEN = 0.

bit 14 **CLSTAT:** Current-Limit Interrupt Status bit(1)
1 = Current-limit interrupt is pending
0 = No current-limit interrupt is pending
This bit is cleared by setting: CLIEN = 0.

bit 13 **TRGSTAT:** Trigger Interrupt Status bit
1 = Trigger interrupt is pending
0 = No trigger interrupt is pending
This bit is cleared by setting: TRGIEN = 0.

bit 12 **FLTIEN:** Fault Interrupt Enable bit
1 = Fault interrupt is enabled
0 = Fault interrupt is disabled and the FLTSTAT bit is cleared

bit 11 **CLIEN:** Current-Limit Interrupt Enable bit
1 = Current-limit interrupt is enabled
0 = Current-limit interrupt is disabled and the CLSTAT bit is cleared

bit 10 **TRGIEN:** Trigger Interrupt Enable bit
1 = A trigger event generates an interrupt request
0 = Trigger event interrupts are disabled and the TRGSTAT bit is cleared

bit 9 **ITB:** Independent Time Base Mode bit(2)
1 = PHASEx register provides the time base period for this PWMx generator
0 = PTPER register provides timing for this PWMx generator

bit 8 **MDCS:** Master Duty Cycle Register Select bit(2)
1 = MDC register provides duty cycle information for this PWMx generator
0 = PDCx register provides duty cycle information for this PWMx generator

Note 1: Software must clear the interrupt status here and in the corresponding IFSx bit in the interrupt controller.
2: These bits should not be changed after the PWMx is enabled (PTEN = 1).
3: DTC<1:0> = 11 for DTCP to be effective; otherwise, DTCP is ignored.
4: The Independent Time Base (ITB = 1) mode must be enabled to use Center-Aligned mode. If ITB = 0, the CAM bit is ignored.
5: To operate in External Period Reset mode, the ITB bit must be '1' and the CLMOD bit in the FCLCONx register must be '0'.

REGISTER 18-3: SPIxCON2: SPIx CONTROL REGISTER 2

R/W-0	R/W-0	R/W-0	U-0	U-0	U-0	U-0	U-0
FRMEN	SPIFSD	FRMPOL	—	—	—	—	—
bit 15							bit 8

U-0	U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0
—	—	—	—	—	—	FRMDLY	SPIBEN
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 **FRMEN:** Framed SPIx Support bit
1 = Framed SPIx support is enabled ($\overline{SS}$x pin is used as the Frame Sync pulse input/output)
0 = Framed SPIx support is disabled

bit 14 **SPIFSD:** SPIx Frame Sync Pulse Direction Control bit
1 = Frame Sync pulse input (slave)
0 = Frame Sync pulse output (master)

bit 13 **FRMPOL:** Frame Sync Pulse Polarity bit
1 = Frame Sync pulse is active-high
0 = Frame Sync pulse is active-low

bit 12-2 **Unimplemented:** Read as ‘0’

bit 1 **FRMDLY:** Frame Sync Pulse Edge Select bit
1 = Frame Sync pulse coincides with first bit clock
0 = Frame Sync pulse precedes first bit clock

bit 0 **SPIBEN:** SPIx Enhanced Buffer Enable bit
1 = Enhanced Buffer is enabled
0 = Enhanced Buffer is disabled (Standard mode)

REGISTER 27-3: ALCFGRPT: ALARM CONFIGURATION REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ALRMEN	CHIME	AMASK3	AMASK2	AMASK1	AMASK0	ALRMPTR1	ALRMPTR0
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
ARPT7	ARPT6	ARPT5	ARPT4	ARPT3	ARPT2	ARPT1	ARPT0
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 **ALRMEN:** Alarm Enable bit

1 = Alarm is enabled (cleared automatically after an alarm event whenever ARPT<7:0> = 0x00 and CHIME = 0)
0 = Alarm is disabled

bit 14 **CHIME:** Chime Enable bit

1 = Chime is enabled; ARPT<7:0> bits are allowed to roll over from 0x00 to 0xFF
0 = Chime is disabled; ARPT<7:0> bits stop once they reach 0x00

bit 13-10 **AMASK<3:0>:** Alarm Mask Configuration bits

0000 = Every half second
0001 = Every second
0010 = Every 10 seconds
0011 = Every minute
0100 = Every 10 minutes
0101 = Every hour
0110 = Once a day
0111 = Once a week
1000 = Once a month
1001 = Once a year (except when configured for February 29th, once every 4 years)
101x = Reserved – do not use
11xx = Reserved – do not use

bit 9-8 **ALRMPTR<1:0>:** Alarm Value Register Window Pointer bits

Points to the corresponding Alarm Value registers when reading the ALRMVAL register. The ALRMPTR<1:0> value decrements on every read or write of ALRMVAL until it reaches '00'.

bit 7-0 **ARPT<7:0>:** Alarm Repeat Counter Value bits

11111111 = Alarm will repeat 255 more times
•
•
•
00000000 = Alarm will not repeat

The counter decrements on any alarm event. The counter is prevented from rolling over from 0x00 to 0xFF unless CHIME = 1.

28.1 PMP Control Registers

REGISTER 28-1: PMCON: PARALLEL MASTER PORT CONTROL REGISTER(3)

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PMPEN	—	PSIDL	ADRMUX1	ADRMUX0	PTBEEN	PTWREN	PTRDEN
bit 15							bit 8

R/W-0	R/W-0	R/W-0(1)	R/W-0(1)	R/W-0(1)	R/W-0	R/W-0	R/W-0
CSF1	CSF0	ALP	CS2P	CS1P	BEP	WRSP	RDSP
bit 7							bit 0

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

bit 15 **PMPEN:** Parallel Master Port Enable bit
1 = PMP module is enabled
0 = PMP module is disabled, no off-chip access is performed

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

bit 13 **PSIDL:** PMP Stop in Idle Mode bit
1 = Discontinues module operation when device enters Idle mode
0 = Continues module operation in Idle mode

bit 12-11 **ADRMUX<1:0>:** Address/Data Multiplexing Selection bits
11 = Reserved
10 = All 16 bits of address are multiplexed on PMD<7:0> pins
01 = Lower eight bits of address are multiplexed on PMD<7:0> pins, upper eight bits are on PMA<15:8>
00 = Address and data appear on separate pins

bit 10 **PTBEEN:** Byte Enable Port Enable bit (16-Bit Master mode)
1 = PMBE port is enabled
0 = PMBE port is disabled

bit 9 **PTWREN:** Write Enable Strobe Port Enable bit
1 = PMWR/PMENB port is enabled
0 = PMWR/PMENB port is disabled

bit 8 **PTRDEN:** Read/Write Strobe Port Enable bit
1 = PMRD/$\overline{\text{PMWR}}$ port is enabled
0 = PMRD/$\overline{\text{PMWR}}$ port is disabled

bit 7-6 **CSF<1:0>:** Chip Select Function bits
11 = Reserved
10 = PMCS1 and PMCS2 function as Chip Select
01 = PMCS2 functions as Chip Select, PMCS1 functions as Address Bit 14
00 = PMCS1 and PMCS2 function as Address Bits 15 and 14

bit 5 **ALP:** Address Latch Polarity bit(1)
1 = Active-high ($\overline{\text{PMALL}}$ and $\overline{\text{PMALH}}$)
0 = Active-low (PMALL and PMALH)

bit 4 **CS2P:** Chip Select 1 Polarity bit(1)
1 = Active-high ($\overline{\text{PMCS2}}$)
0 = Active-low (PMCS2)

Note 1: These bits have no effect when their corresponding pins are used as address lines.
2: PMCS1 applies to Master mode and PMCS applies to Slave mode.
3: This register is not available on 44-pin devices.

REGISTER 28-3: PMADDR: PARALLEL MASTER PORT ADDRESS REGISTER (MASTER MODES ONLY)(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
CS2	CS1	ADDR13	ADDR12	ADDR11	ADDR10	ADDR9	ADDR8
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
ADDR7	ADDR6	ADDR5	ADDR4	ADDR3	ADDR2	ADDR1	ADDR0
bit 7							bit 0

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

bit 15 **CS2:** Chip Select 2 bit
If PMCON<7:6> = 10 or 01:
1 = Chip Select 2 is active
0 = Chip Select 2 is inactive
If PMCON<7:6> = 11 or 00:
Bit functions as ADDR15.

bit 14 **CS1:** Chip Select 1 bit
If PMCON<7:6> = 10:
1 = Chip Select 1 is active
0 = Chip Select 1 is inactive
If PMCON<7:6> = 11 or 0x:
Bit functions as ADDR14.

bit 13-0 **ADDR<13:0>:** Destination Address bits

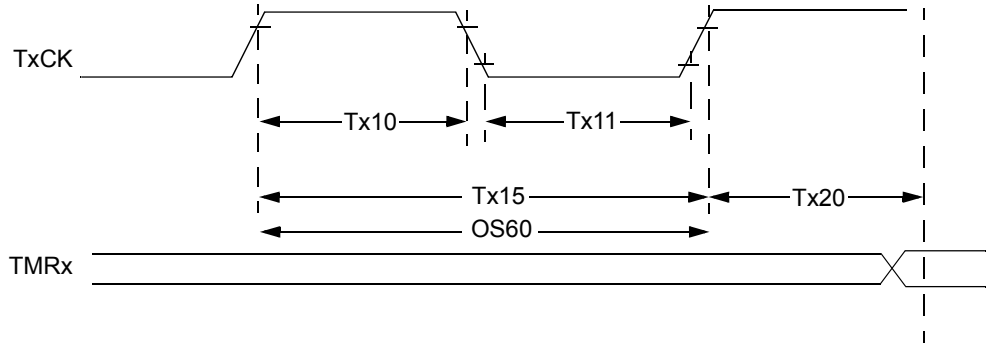
Note 1: In Enhanced Slave mode, PMADDR functions as PMDOUT1, one of the two Data Buffer registers.
2: This register is not available on 44-pin devices.

TABLE 31-2: INSTRUCTION SET OVERVIEW (CONTINUED)

Base Instr #	Assembly Mnemonic	Assembly Syntax	Description	# of Words	# of Cycles	Status Flags Affected
8	BSW	BSW.C Ws,Wb	Write C bit to Ws<Wb>	1	1	None
		BSW.Z Ws,Wb	Write Z bit to Ws<Wb>	1	1	None
9	BTG	BTG f,#bit4	Bit Toggle f	1	1	None
		BTG Ws,#bit4	Bit Toggle Ws	1	1	None
10	BTSC	BTSC f,#bit4	Bit Test f, Skip if Clear	1	1 (2 or 3)	None
		BTSC Ws,#bit4	Bit Test Ws, Skip if Clear	1	1 (2 or 3)	None
11	BTSS	BTSS f,#bit4	Bit Test f, Skip if Set	1	1 (2 or 3)	None
		BTSS Ws,#bit4	Bit Test Ws, Skip if Set	1	1 (2 or 3)	None
12	BTST	BTST f,#bit4	Bit Test f	1	1	Z
		BTST.C Ws,#bit4	Bit Test Ws to C	1	1	C
		BTST.Z Ws,#bit4	Bit Test Ws to Z	1	1	Z
		BTST.C Ws,Wb	Bit Test Ws<Wb> to C	1	1	C
		BTST.Z Ws,Wb	Bit Test Ws<Wb> to Z	1	1	Z
13	BTSTS	BTSTS f,#bit4	Bit Test then Set f	1	1	Z
		BTSTS.C Ws,#bit4	Bit Test Ws to C, then Set	1	1	C
		BTSTS.Z Ws,#bit4	Bit Test Ws to Z, then Set	1	1	Z
14	CALL	CALL lit23	Call subroutine	2	4	SFA
		CALL Wn	Call indirect subroutine	1	4	SFA
		CALL.L Wn	Call indirect subroutine (long address)	1	4	SFA
15	CLR	CLR f	f = 0x0000	1	1	None
		CLR WREG	WREG = 0x0000	1	1	None
		CLR Ws	Ws = 0x0000	1	1	None
		CLR Acc,Wx,Wxd,Wy,Wyd,AWB	Clear Accumulator	1	1	OA,OB,SA, SB
16	CLRWDT	CLRWDT	Clear Watchdog Timer	1	1	WDTO,Sleep
17	COM	COM f	$f = \overline{f}$	1	1	N,Z
		COM f,WREG	$WREG = \overline{f}$	1	1	N,Z
		COM Ws,Wd	$Wd = \overline{Ws}$	1	1	N,Z
18	CP	CP f	Compare f with WREG	1	1	C,DC,N,OV,Z
		CP Wb,#lit8	Compare Wb with lit8	1	1	C,DC,N,OV,Z
		CP Wb,Ws	Compare Wb with Ws (Wb – Ws)	1	1	C,DC,N,OV,Z
19	CP0	CP0 f	Compare f with 0x0000	1	1	C,DC,N,OV,Z
		CP0 Ws	Compare Ws with 0x0000	1	1	C,DC,N,OV,Z
20	CPB	CPB f	Compare f with WREG, with Borrow	1	1	C,DC,N,OV,Z
		CPB Wb,#lit8	Compare Wb with lit8, with Borrow	1	1	C,DC,N,OV,Z
		CPB Wb,Ws	Compare Wb with Ws, with Borrow ($Wb – Ws – \overline{C}$)	1	1	C,DC,N,OV,Z
21	CPSEQ	CPSEQ Wb,Wn	Compare Wb with Wn, skip if =	1	1 (2 or 3)	None
	CPBEQ	CPBEQ Wb,Wn,Expr	Compare Wb with Wn, branch if =	1	1 (5)	None
22	CPSGT	CPSGT Wb,Wn	Compare Wb with Wn, skip if >	1	1 (2 or 3)	None
	CPBGT	CPBGT Wb,Wn,Expr	Compare Wb with Wn, branch if >	1	1 (5)	None
23	CPSLT	CPSLT Wb,Wn	Compare Wb with Wn, skip if <	1	1 (2 or 3)	None
	CPBLT	CPBLT Wb,Wn,Expr	Compare Wb with Wn, branch if <	1	1 (5)	None
24	CPSNE	CPSNE Wb,Wn	Compare Wb with Wn, skip if ≠	1	1 (2 or 3)	None
	CPBNE	CPBNE Wb,Wn,Expr	Compare Wb with Wn, branch if ≠	1	1 (5)	None

Note: Read and Read-Modify-Write (e.g., bit operations and logical operations) on non-CPU SFRs incur an additional instruction cycle.

FIGURE 33-6: TIMER1-TIMER5 EXTERNAL CLOCK TIMING CHARACTERISTICS



Note: Refer to Figure 33-1 for load conditions.

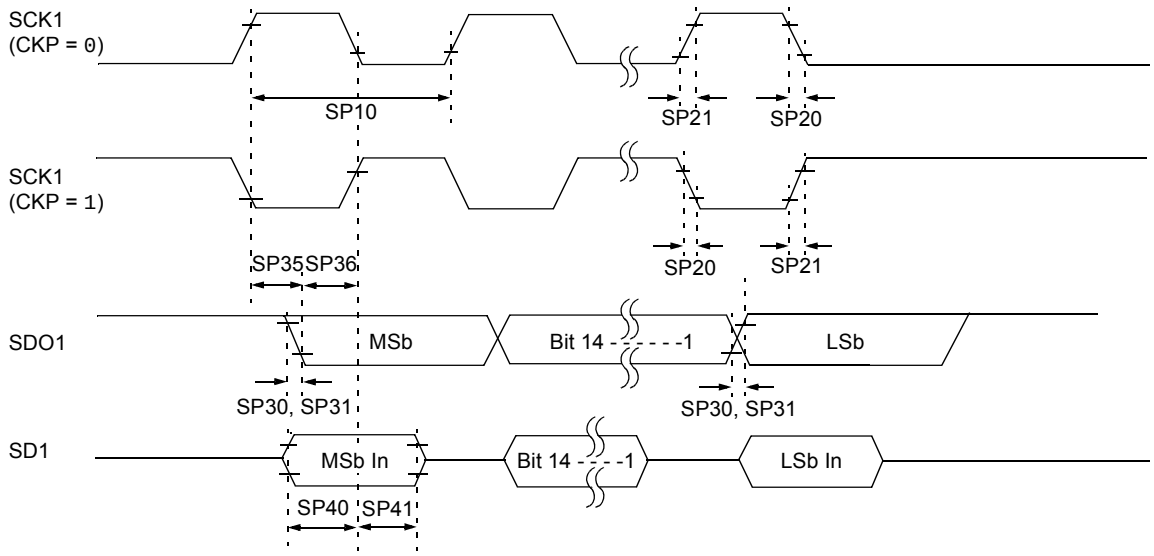
TABLE 33-22: TIMER1 EXTERNAL CLOCK TIMING REQUIREMENTS(1)

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(2)**		**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
TA10	TTXH	T1CK High Time	Synchronous mode	Greater of: 20 or (TCY + 20)/N	—	—	ns	Must also meet Parameter TA15, N = Prescaler value (1, 8, 64, 256)
			Asynchronous	35	—	—	ns	
TA11	TTXL	T1CK Low Time	Synchronous mode	Greater of: 20 or (TCY + 20)/N	—	—	ns	Must also meet Parameter TA15, N = Prescaler value (1, 8, 64, 256)
			Asynchronous	10	—	—	ns	
TA15	TTXP	T1CK Input Period	Synchronous mode	Greater of: 40 or (2 TCY + 40)/N	—	—	ns	N = Prescaler value (1, 8, 64, 256)
OS60	Ft1	T1CK Oscillator Input Frequency Range (oscillator enabled by setting TCS (T1CON<1>) bit)		DC	—	50	kHz	
TA20	TCKEXTMRL	Delay from External T1CK Clock Edge to Timer Increment		0.75 TCY + 40	—	1.75 TCY + 40	ns	

Note 1: Timer1 is a Type A.

2: These parameters are characterized, but are not tested in manufacturing.

FIGURE 33-26: SPI1 MASTER MODE (FULL-DUPLEX, CKE = 0, CKP = x, SMP = 1) TIMING CHARACTERISTICS



Note: Refer to Figure 33-1 for load conditions.

TABLE 33-43: SPI1 MASTER MODE (FULL-DUPLEX, CKE = 0, CKP = x, SMP = 1) TIMING REQUIREMENTS

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.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
SP10	FscP	Maximum SCK1 Frequency	—	—	25	MHz	-40ºC to +125ºC **(Note 3)**
SP20	TscF	SCK1 Output Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP21	TscR	SCK1 Output Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP30	TdoF	SDO1 Data Output Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP31	TdoR	SDO1 Data Output Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP35	TscH2doV, TscL2doV	SDO1 Data Output Valid after SCK1 Edge	—	6	20	ns	
SP36	TdoV2scH, TdoV2scL	SDO1 Data Output Setup to First SCK1 Edge	20	—	—	ns	
SP40	TdiV2scH, TdiV2scL	Setup Time of SDI1 Data Input to SCK1 Edge	20	—	—	ns	
SP41	TscH2diL, TscL2diL	Hold Time of SDI1 Data Input to SCK1 Edge	20	—	—	ns	

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

2: Data in “Typical” column is at 3.3V, +25°C unless otherwise stated.

3: The minimum clock period for SCK1 is 100 ns. The clock generated in Master mode must not violate this specification.

4: Assumes 50 pF load on all SPI1 pins.

TABLE 33-46: SPI1 SLAVE MODE (FULL-DUPLEX, CKE = 0, CKP = 1, SMP = 0) TIMING REQUIREMENTS

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.	**Symbol**	**Characteristic(1)**	**Min.**	**Typ.(2)**	**Max.**	**Units**	**Conditions**
SP70	FscP	Maximum SCK1 Input Frequency	—	—	25	MHz	**(Note 3)**
SP72	TscF	SCK1 Input Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP73	TscR	SCK1 Input Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP30	TdoF	SDO1 Data Output Fall Time	—	—	—	ns	See Parameter DO32 **(Note 4)**
SP31	TdoR	SDO1 Data Output Rise Time	—	—	—	ns	See Parameter DO31 **(Note 4)**
SP35	TscH2doV, TscL2doV	SDO1 Data Output Valid after SCK1 Edge	—	6	20	ns	
SP36	TdoV2scH, TdoV2scL	SDO1 Data Output Setup to First SCK1 Edge	20	—	—	ns	
SP40	TdiV2scH, TdiV2scL	Setup Time of SDI1 Data Input to SCK1 Edge	20	—	—	ns	
SP41	TscH2diL, TscL2diL	Hold Time of SDI1 Data Input to SCK1 Edge	15	—	—	ns	
SP50	TssL2scH, TssL2scL	$\overline{SS1}$ ↓ to SCK1 ↑ or SCK1 ↓ Input	120	—	—	ns	
SP51	TssH2doZ	$\overline{SS1}$ ↑ to SDO1 Output High-Impedance	10	—	50	ns	**(Note 4)**
SP52	TscH2ssH, TscL2ssH	$\overline{SS1}$ ↑ after SCK1 Edge	1.5 TCY + 40	—	—	ns	**(Note 4)**

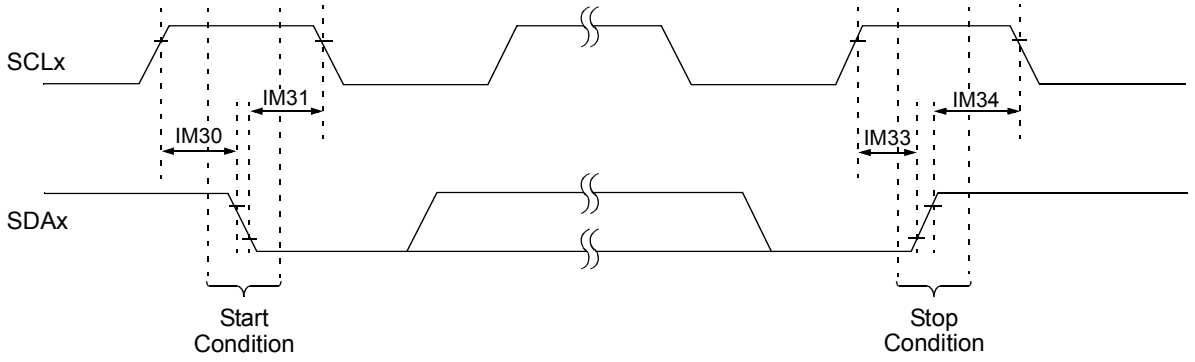
Note 1: These parameters are characterized, but are not tested in manufacturing.

2: Data in "Typical" column is at 3.3V, +25°C unless otherwise stated.

3: The minimum clock period for SCK1 is 66.7 ns. Therefore, the SCK1 clock generated by the master must not violate this specification.

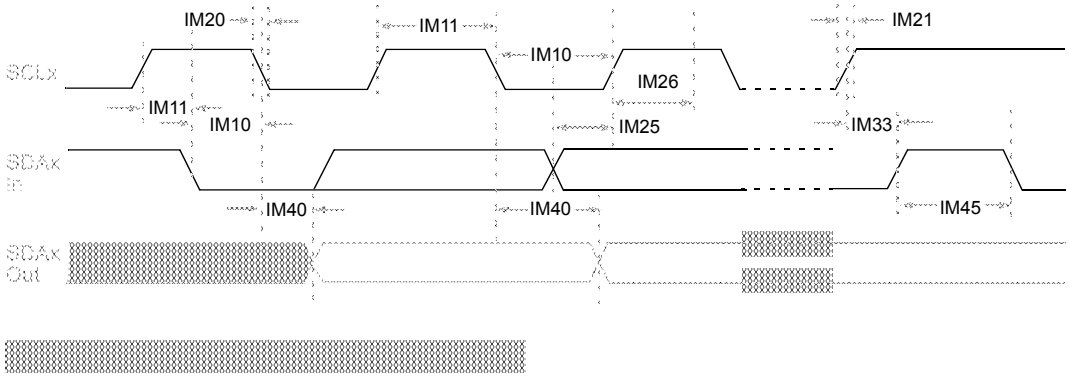
4: Assumes 50 pF load on all SPI1 pins.

FIGURE 33-31: I2Cx BUS START/STOP BITS TIMING CHARACTERISTICS (MASTER MODE)



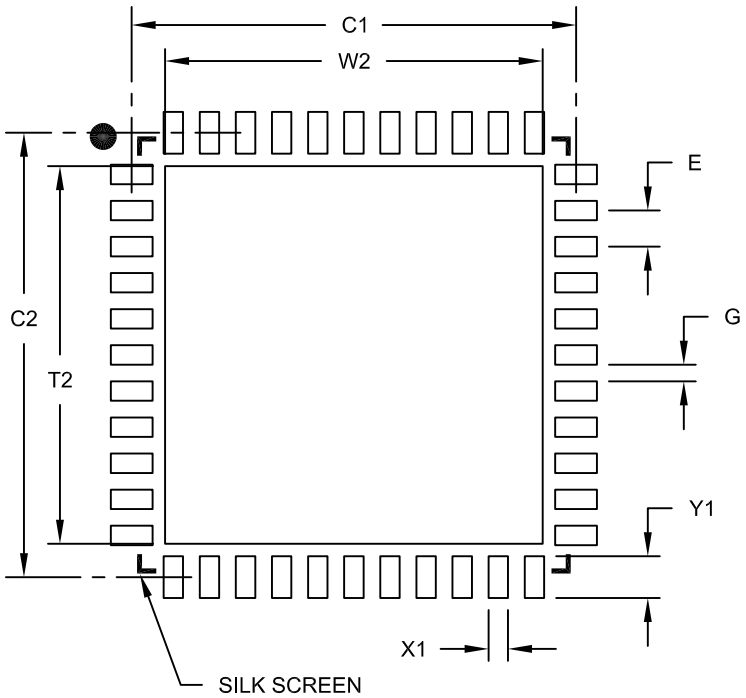
Note: Refer to Figure 33-1 for load conditions.

FIGURE 33-32: I2Cx BUS DATA TIMING CHARACTERISTICS (MASTER MODE)



44-Lead Plastic Quad Flat, No Lead Package (ML) - 8x8 mm Body [QFN]

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		0.65 BSC	
Optional Center Pad Width	W2			6.60
Optional Center Pad Length	T2			6.60
Contact Pad Spacing	C1		8.00	
Contact Pad Spacing	C2		8.00	
Contact Pad Width (X44)	X1			0.35
Contact Pad Length (X44)	Y1			0.85
Distance Between Pads	G	0.25		

Notes:

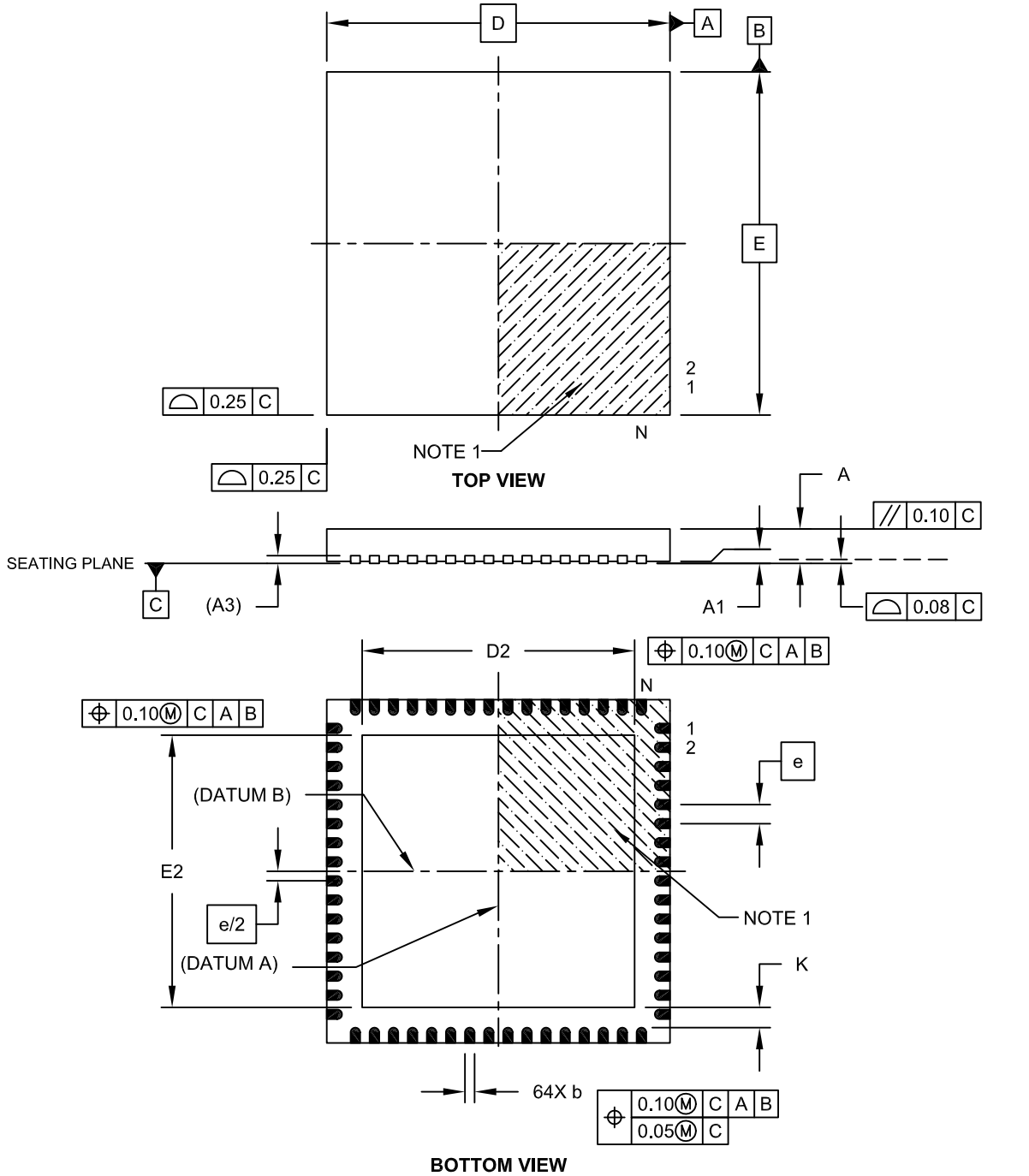
1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2103B

64-Lead Plastic Quad Flat, No Lead Package (MR) – 9x9x0.9 mm Body [QFN]
With 7.15 x 7.15 Exposed Pad

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

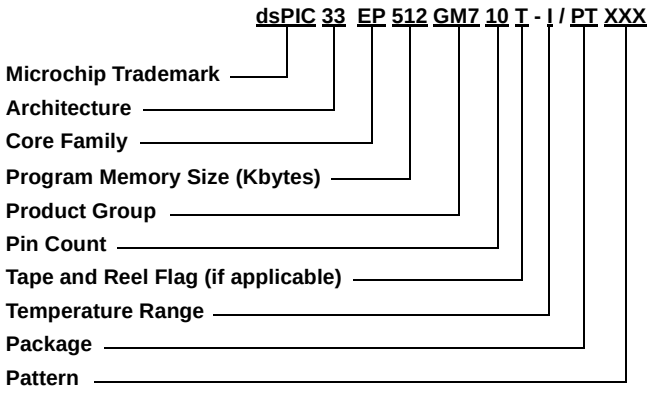


Microchip Technology Drawing C04-149C Sheet 1 of 2

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.



Architecture:	33	=	16-Bit Digital Signal Controller
Family:	EP	=	Enhanced Performance
Product Group:	GM7	=	General Purpose plus Motor Control Family
Pin Count:	04	=	44-pin
	06	=	64-pin
	10	=	100/124-pin
Temperature Range:	I	=	-40°C to +85°C (Industrial)
	E	=	-40°C to +125°C (Extended)
Package:	BG	=	Plastic Thin Profile Ball Grid Array - (121-pin) 10x10 mm body (TFBGA)
	ML	=	Plastic Quad, No Lead Package - (44-pin) 8x8 mm body (QFN)
	MR	=	Plastic Quad, No Lead Package - (64-pin) 9x9 mm body (QFN)
	PT	=	Plastic Thin Quad Flatpack - (44-pin) 10x10 mm body (TQFP)
	PT	=	Plastic Thin Quad Flatpack - (64-pin) 10x10 mm body (TQFP)
	PT	=	Thin Quad Flatpack - (100-pin) 12x12x1 mm body (TQFP)
	PF	=	Thin Quad Flatpack - (100-pin) 14x14x1 mm body (TQFP)

Example:

dsPIC33EP512GM710-I/PT:
dsPIC33, Enhanced Performance, 512-Kbyte program memory, 100-pin, Industrial temperature, TQFP package.