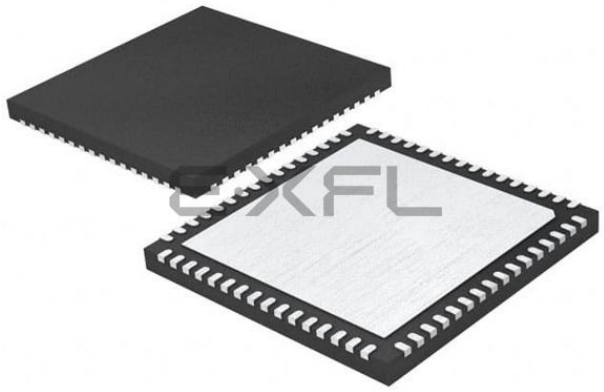
Microchip Technology - DSPIC33EV256GM106T-I/MR Datasheet



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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	70 MIPs
Connectivity	CANbus, I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, Motor Control PWM, POR, PWM, WDT
Number of I/O	53
Program Memory Size	256KB (85.5K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 36x10/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-VFQFN Exposed Pad
Supplier Device Package	64-VQFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ev256gm106t-i-mr

REGISTER 9-5: REFOCON: REFERENCE OSCILLATOR CONTROL REGISTER

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ROON	—	ROSSLP	ROSEL	RODIV3(1)	RODIV2(1)	RODIV1(1)	RODIV0(1)
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:			
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 ROON: Reference Oscillator Output Enable bit
1 = Reference oscillator output is enabled on the REFCLK pin(2)
0 = Reference oscillator output is disabled

bit 14 Unimplemented: Read as ‘0’

bit 13 ROSSLP: Reference Oscillator Run in Sleep bit
1 = Reference oscillator output continues to run in Sleep mode
0 = Reference oscillator output is disabled in Sleep mode

bit 12 ROSEL: Reference Oscillator Source Select bit
1 = Oscillator crystal is used as the reference clock
0 = System clock is used as the reference clock

bit 11-8 RODIV<3:0>: Reference Oscillator Divider bits(1)
1111 = Reference clock divided by 32,768
1110 = Reference clock divided by 16,384
1101 = Reference clock divided by 8,192
1100 = Reference clock divided by 4,096
1011 = Reference clock divided by 2,048
1010 = Reference clock divided by 1,024
1001 = Reference clock divided by 512
1000 = Reference clock divided by 256
0111 = Reference clock divided by 128
0110 = Reference clock divided by 64
0101 = Reference clock divided by 32
0100 = Reference clock divided by 16
0011 = Reference clock divided by 8
0010 = Reference clock divided by 4
0001 = Reference clock divided by 2
0000 = Reference clock

bit 7-0 Unimplemented: Read as ‘0’

Note 1: The reference oscillator output must be disabled (ROON = 0) before writing to these bits.
2: This pin is remappable. See Section 11.5 “Peripheral Pin Select (PPS)” for more information.

TABLE 11-1: SELECTABLE INPUT SOURCES (MAPS INPUT TO FUNCTION)

Input Name (1)	Function Name	Register	Configuration Bits
External Interrupt 1	INT1	RPINR0	INT1R<7:0>
External Interrupt 2	INT2	RPINR1	INT2R<7:0>
Timer2 External Clock	T2CK	RPINR3	T2CKR<7:0>
Input Capture 1	IC1	RPINR7	IC1R<7:0>
Input Capture 2	IC2	RPINR7	IC2R<7:0>
Input Capture 3	IC3	RPINR8	IC3R<7:0>
Input Capture 4	IC4	RPINR8	IC4R<7:0>
Output Compare Fault A	OCFA	RPINR11	OCFAR<7:0>
PWM Fault 1	FLT1	RPINR12	FLT1R<7:0>
PWM Fault 2	FLT2	RPINR12	FLT2R<7:0>
UART1 Receive	U1RX	RPINR18	U1RXR<7:0>
UART2 Receive	U2RX	RPINR19	U2RXR<7:0>
SPI2 Data Input	SDI2	RPINR22	SDI2R<7:0>
SPI2 Clock Input	SCK2	RPINR22	SCK2R<7:0>
SPI2 Slave Select	$\overline{SS2}$	RPINR23	SS2R<7:0>
CAN1 Receive	C1RX	RPINR26	C1RXR<7:0>
PWM Sync Input 1	SYNCI1	RPINR37	SYNCI1R<7:0>
PWM Dead-Time Compensation 1	DTCMP1	RPINR38	DTCMP1R<7:0>
PWM Dead-Time Compensation 2	DTCMP2	RPINR39	DTCMP2R<7:0>
PWM Dead-Time Compensation 3	DTCMP3	RPINR39	DTCMP3R<7:0>
SENT1 Input	SENT1R	RPINR44	SENT1R<7:0>
SENT2 Input	SENT2R	RPINR45	SENT2R<7:0>

Note 1: Unless otherwise noted, all inputs use the Schmitt Trigger input buffers.

REGISTER 17-15: FCLCONx: PWMx FAULT CURRENT-LIMIT CONTROL REGISTER (1)

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	CLSRC4	CLSRC3	CLSRC2	CLSRC1	CLSRC0	CLPOL(2)	CLMOD
bit 15							bit 8

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-0	R/W-0	R/W-0
FLTSRC4	FLTSRC3	FLTSRC2	FLTSRC1	FLTSRC0	FLTPOL(2)	FLTMOD1	FLTMOD0
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 14-10 CLSRC<4:0>: Current-Limit Control Signal Source Select for PWM Generator x bits
11111 = Fault 32
11110 = Reserved
•
•
•
01100 = Op Amp/Comparator 5
01011 = Comparator 4
01010 = Op Amp/Comparator 3
01001 = Op Amp/Comparator 2
01000 = Op Amp/Comparator 1
00111 = Fault 8
00110 = Fault 7
00101 = Fault 6
00100 = Fault 5
00011 = Fault 4
00010 = Fault 3
00001 = Fault 2
00000 = Fault 1 (default)

bit 9 CLPOL: Current-Limit Polarity for PWM Generator x bit(2)
1 = The selected current-limit source is active-low
0 = The selected current-limit source is active-high

bit 8 CLMOD: Current-Limit Mode Enable for PWM Generator x bit
1 = Current-Limit mode is enabled
0 = Current-Limit mode is disabled

Note 1: If the PWMLOCK Configuration bit (FDEVOPT<0>) is a '1', the FCLCONx register can only be written after the unlock sequence has been executed.

2: These bits should be changed only when PTEN = 0. Changing the clock selection during operation will yield unpredictable results.

18.2 SPI Control Registers

REGISTER 18-1: SPIxSTAT: SPIx STATUS AND CONTROL REGISTER

R/W-0	U-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0
SPIEN	—	SPISIDL	—	—	SPIBEC2	SPIBEC1	SPIBEC0
bit 15							bit 8

R/W-0	R/C-0, HS	R/W-0	R/W-0	R/W-0	R/W-0	R-0, HS, HC	R-0, HS, HC
SRMPT	SPIROV	SRXMPT	SISEL2	SISEL1	SISEL0	SPITBF	SPIRBF
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	C = Clearable bit

bit 15 SPIEN: SPIx Enable bit

1 = Enables the SPIx module and configures SCKx, SDOx, SDIx and $\overline{SSx}$ as serial port pins
0 = Disables the SPIx module

bit 14 Unimplemented: Read as ‘0’

bit 13 SPISIDL: SPIx Stop in Idle Mode bit

1 = Discontinues the SPIx module operation when the device enters Idle mode
0 = Continues the SPIx module operation in Idle mode

bit 12-11 Unimplemented: Read as ‘0’

bit 10-8 SPIBEC<2:0>: SPIx Buffer Element Count bits (valid in Enhanced Buffer mode)

Master mode:
Number of SPIx transfers are pending.

Slave mode:
Number of SPIx transfers are unread.

bit 7 SRMPT: SPIx Shift Register (SPIxSR) Empty bit (valid in Enhanced Buffer mode)

1 = The SPIx Shift register is empty and ready to send or receive the data
0 = The SPIx Shift register is not empty

bit 6 SPIROV: SPIx Receive Overflow Flag bit

1 = A new byte/word is completely received and discarded; the user application has not read the previous data in the SPIxBUF register
0 = Overflow has not occurred

bit 5 SRXMPT: SPIx Receive FIFO Empty bit (valid in Enhanced Buffer mode)

1 = RX FIFO is empty
0 = RX FIFO is not empty

bit 4-2 SISEL<2:0>: SPIx Buffer Interrupt Mode bits (valid in Enhanced Buffer mode)

111 = Interrupt when the SPIx transmit buffer is full (SPITBF bit is set)
110 = Interrupt when the last bit is shifted into SPIxSR, and as a result, the TX FIFO is empty
101 = Interrupt when the last bit is shifted out of SPIxSR and the transmit is complete
100 = Interrupt when one data is shifted into SPIxSR, and as a result, the TX FIFO has one open memory location
011 = Interrupt when the SPIx receive buffer is full (SPIRBF bit is set)
010 = Interrupt when the SPIx receive buffer is 3/4 or more full
001 = Interrupt when data is available in the SPIx receive buffer (SRMPT bit is set)
000 = Interrupt when the last data in the SPIx receive buffer is read, and as a result, the buffer is empty (SRXMPT bit is set)

REGISTER 19-2: I2CxCON2: I2Cx CONTROL REGISTER 2

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-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
—	PCIE	SCIE	BOEN	SDAHT	SBCDE	AHEN	DHEN
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 15-7 Unimplemented: Read as ‘0’

bit 6 PCIE: Stop Condition Interrupt Enable bit (I^2C Slave mode only).
1 = Enables interrupt on detection of Stop condition
0 = Stop detection interrupts are disabled

bit 5 SCIE: Start Condition Interrupt Enable bit (I^2C Slave mode only)
1 = Enables interrupt on detection of Start or Restart conditions
0 = Start detection interrupts are disabled

bit 4 BOEN: Buffer Overwrite Enable bit (I^2C Slave mode only)
1 = The I2CxRCV register bit is updated and an ACK is generated for a received address/data byte, ignoring the state of the I2COV bit only if the RBF bit = 0
0 = The I2CxRCV register bit is only updated when I2COV is clear

bit 3 SDAHT: SDAx Hold Time Selection bit
1 = Minimum of 300 ns hold time on SDAx after the falling edge of SCLx
0 = Minimum of 100 ns hold time on SDAx after the falling edge of SCLx

bit 2 SBCDE: Slave Mode Bus Collision Detect Enable bit (I^2C Slave mode only)
If, on the rising edge of SCLx, SDAx is sampled low when the module is outputting a high state, the BCL bit is set and the bus goes Idle. This Detection mode is only valid during data and ACK transmit sequences.
1 = Slave bus collision interrupts are enabled
0 = Slave bus collision interrupts are disabled

bit 1 AHEN: Address Hold Enable bit (I^2C Slave mode only)
1 = Following the 8^{th} falling edge of SCLx for a matching received address byte; the SCLREL bit (I2CxCON1<12>) will be cleared and the SCLx will be held low
0 = Address holding is disabled

bit 0 DHEN: Data Hold Enable bit (I^2C Slave mode only)
1 = Following the 8^{th} falling edge of SCLx for a received data byte; slave hardware clears the SCLREL bit (I2CxCON1<12>) and the SCLx is held low
0 = Data holding is disabled

20.3 Receive Mode

The module can be configured for receive operation by setting the RCVEN (SENTxCON1<11>) bit. The time between each falling edge is compared to SYNCMIN<15:0> (SENTxCON3<15:0>) and SYNCMAX<15:0> (SENTxCON2<15:0>), and if the measured time lies between the minimum and maximum limits, the module begins to receive data. The validated Sync time is captured in the SENTxSYNC register and the tick time is calculated. Subsequent falling edges are verified to be within the valid data width and the data is stored in the SENTxDATH/L register. An interrupt event is generated at the completion of the message and the user software should read the SENTx Data register before the reception of the next nibble. The equation for SYNCMIN<15:0> and SYNCMAX<15:0> is shown in Equation 20-3.

EQUATION 20-3: SYNCMIN<15:0> AND SYNCMAX<15:0> CALCULATIONS

$$T_{TICK} = T_{CLK} \bullet (TICKTIME<15:0> + 1)$$

$$FRAMETIME<15:0> = T_{TICK}/T_{FRAME}$$

$$SyncCount = 8 \times F_{RCV} \times T_{TICK}$$

$$SYNCMIN<15:0> = 0.8 \times SyncCount$$

$$SYNCMAX<15:0> = 1.2 \times SyncCount$$

$$FRAMETIME<15:0> \text{ t } 122 + 27N$$

$$FRAMETIME<15:0> \text{ t } 848 + 12N$$

Where:

T_{FRAME} = Total time of the message from ms

N = The number of data nibbles in message, 1-6

$F_{RCV} = F_{CY} \times$ prescaler

$T_{CLK} = F_{CY}$/Prescaler

For T_{TICK} = 3.0 µs and F_{CLK} = 4 MHz, SYNCMIN<15:0> = 76.

Note:	To ensure a Sync period can be identified, the value written to SYNCMIN<15:0> must be less than the value written to SYNCMAX<15:0>.

20.3.1 RECEIVE MODE CONFIGURATION

20.3.1.1 Initializing the SENTx Module:

Perform the following steps to initialize the module:

1. Write RCVEN (SENTxCON1<11>) = 1 for Receive mode.
2. Write NIBCNT<2:0> (SENTxCON1<2:0>) for the desired data frame length.
3. Write CRCEN (SENTxCON1<8>) for hardware or software CRC validation.
4. Write PPP (SENTxCON1<7>) = 1 if pause pulse is present.
5. Write SENTxCON2 with the value of SYNCMAXx (Nominal Sync Period + 20%).
6. Write SENTxCON3 with the value of SYNCMINx (Nominal Sync Period – 20%).
7. Enable interrupts and set interrupt priority.
8. Set the SNTEN (SENTxCON1<15>) bit to enable the module.

The data should be read from the SENTxDATH/L register after the completion of the CRC and before the next message frame's status nibble. The recommended method is to use the message frame completion interrupt trigger.

REGISTER 21-1: UxMODE: UART x MODE REGISTER (CONTINUED)

bit 5 ABAUD: Auto-Baud Enable bit
1 = Baud rate measurement on the next character is enabled – requires reception of a Sync field (55h) before other data; cleared in hardware upon completion
0 = Baud rate measurement is disabled or has completed

bit 4 URXINV: UARTx Receive Polarity Inversion bit
1 = UxRX Idle state is '0'
0 = UxRX Idle state is '1'

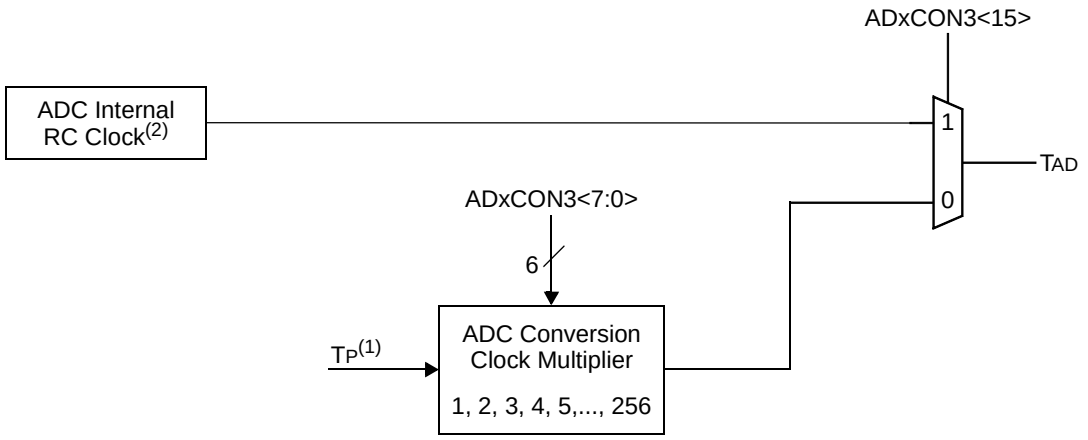
bit 3 BRGH: High Baud Rate Enable bit
1 = BRG generates 4 clocks per bit period (4x baud clock, High-Speed mode)
0 = BRG generates 16 clocks per bit period (16x baud clock, Standard mode)

bit 2-1 PDSEL<1:0>: Parity and Data Selection bits
11 = 9-bit data, no parity
10 = 8-bit data, odd parity
01 = 8-bit data, even parity
00 = 8-bit data, no parity

bit 0 STSEL: Stop Bit Selection bit
1 = Two Stop bits
0 = One Stop bit

Note 1: Refer to "Universal Asynchronous Receiver Transmitter (UART)" (DS70000582) in the "dsPIC33/PIC24 Family Reference Manual" for information on enabling the UART module for receive or transmit operation.
2: This feature is only available for the 16x BRG mode (BRGH = 0).
3: This feature is only available on 44-pin and 64-pin devices.
4: This feature is only available on 64-pin devices.

FIGURE 24-2: ADCx CONVERSION CLOCK PERIOD BLOCK DIAGRAM



Note 1: $T_P = 1/F_P$.

2: Refer to the ADC electrical specifications in Section 30.0 “Electrical Characteristics” for the exact RC clock value.

REGISTER 24-5: ADxCHS123: ADCx INPUT CHANNELS 1, 2, 3 SELECT REGISTER

U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	CH123SB2	CH123SB1	CH123NB1	CH123NB0	CH123SB0
bit 15							bit 8

U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	CH123SA2	CH123SA1	CH123NA1	CH123NA0	CH123SA0
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 12-11 CH123SB<2:1>: Channels 1, 2, 3 Positive Input Select for Sample B bits
- 1xx = CH1 positive input is AN0 (Op Amp 2), CH2 positive input is AN25 (Op Amp 5), CH3 positive input is AN6 (Op Amp 3)
- 011 = CH1 positive input is AN3 (Op Amp 1), CH2 positive input is AN0 (Op Amp 2), CH3 positive input is AN25 (Op Amp 5)
- 010 = CH1 positive input is AN3 (Op Amp 1), CH2 positive input is AN0 (Op Amp 2), CH3 positive input is AN6 (Op Amp 3)
- 001 = CH1 positive input is AN3, CH2 positive input is AN4, CH3 positive input is AN5
- 000 = CH1 positive input is AN0, CH2 positive input is AN1, CH3 positive input is AN2

bit 10-9 CH123NB<1:0>: Channels 1, 2, 3 Negative Input Select for Sample B bits
- 11 = CH1 negative input is AN9, CH2 negative input is AN10, CH3 negative input is AN11
- 10 = CH1 negative input is AN6, CH2 negative input is AN7, CH3 negative input is AN8
- 0x = CH1, CH2, CH3 negative inputs are VREFL

bit 8 CH123SB0: Channels 1, 2, 3 Positive Input Select for Sample B bit
See bits<12:11> for bit selections.

bit 7-5 Unimplemented: Read as ‘0’

bit 4-3 CH123SA<2:1>: Channels 1, 2, 3 Positive Input Select for Sample A bits
- 1xx = CH1 positive input is AN0 (Op Amp 2), CH2 positive input is AN25 (Op Amp 5), CH3 positive input is AN6 (Op Amp 3)
- 011 = CH1 positive input is AN3 (Op Amp 1), CH2 positive input is AN0 (Op Amp 2), CH3 positive input is AN25 (Op Amp 5)
- 010 = CH1 positive input is AN3 (Op Amp 1), CH2 positive input is AN0 (Op Amp 2), CH3 positive input is AN6 (Op Amp 3)
- 001 = CH1 positive input is AN3, CH2 positive input is AN4, CH3 positive input is AN5
- 000 = CH1 positive input is AN0, CH2 positive input is AN1, CH3 positive input is AN2

bit 2-1 CH123NA<1:0>: Channels 1, 2, 3 Negative Input Select for Sample A bits
- 11 = CH1 negative input is AN9, CH2 negative input is AN10, CH3 negative input is AN11
- 10 = CH1 negative input is AN6, CH2 negative input is AN7, CH3 negative input is AN8
- 0x = CH1, CH2, CH3 negative inputs are VREFL

bit 0 CH123SA0: Channels 1, 2, 3 Positive Input Select for Sample A bit
See bits<4:3> for bit selections.

26.0 COMPARATOR VOLTAGE REFERENCE

Note 1: This data sheet summarizes the features of the dsPIC33EVXXXGM00X/10X family of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to “Op Amp/Comparator” (DS70000357) in the “dsPIC33/PIC24 Family Reference Manual”, 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.

26.1 Configuring the Comparator Voltage Reference

The comparator voltage reference module is controlled through the CVRxCON registers (Register 26-1 and Register 26-2). The comparator voltage reference provides a range of output voltages with 128 distinct levels. The comparator reference supply voltage can come from either V_{DD} and V_{SS}, or the external $CV_{REF}+$ and AV_{SS} pins. The voltage source is selected by the CVRSS bit (CVRxCON<11>). The settling time of the comparator voltage reference must be considered when changing the CV_{REF} output.

TABLE 28-2: INSTRUCTION SET OVERVIEW (CONTINUED)

Base Instr #	Assembly Mnemonic	Assembly Syntax	Description	# of Words	# of Cycles	Status Flags Affected
53	MUL	MUL.SS Wb,Ws,Wnd	{Wnd + 1, Wnd} = signed(Wb) * signed(Ws)	1	1	None
		MUL.SS Wb,Ws,Acc	Accumulator = signed(Wb) * signed(Ws)	1	1	None
		MUL.SU Wb,Ws,Wnd	{Wnd + 1, Wnd} = signed(Wb) * unsigned(Ws)	1	1	None
		MUL.SU Wb,Ws,Acc	Accumulator = signed(Wb) * unsigned(Ws)	1	1	None
		MUL.SU Wb,#lit5,Acc	Accumulator = signed(Wb) * unsigned(lit5)	1	1	None
		MUL.US Wb,Ws,Wnd	{Wnd + 1, Wnd} = unsigned(Wb) * signed(Ws)	1	1	None
		MUL.US Wb,Ws,Acc	Accumulator = unsigned(Wb) * signed(Ws)	1	1	None
		MUL.UU Wb,Ws,Wnd	{Wnd + 1, Wnd} = unsigned(Wb) * unsigned(Ws)	1	1	None
		MUL.UU Wb,#lit5,Acc	Accumulator = unsigned(Wb) * unsigned(lit5)	1	1	None
		MUL.UU Wb,Ws,Acc	Accumulator = unsigned(Wb) * unsigned(Ws)	1	1	None
		MULW.SS Wb,Ws,Wnd	Wnd = signed(Wb) * signed(Ws)	1	1	None
		MULW.SU Wb,Ws,Wnd	Wnd = signed(Wb) * unsigned(Ws)	1	1	None
		MULW.US Wb,Ws,Wnd	Wnd = unsigned(Wb) * signed(Ws)	1	1	None
		MULW.UU Wb,Ws,Wnd	Wnd = unsigned(Wb) * unsigned(Ws)	1	1	None
		MUL.SU Wb,#lit5,Wnd	{Wnd + 1, Wnd} = signed(Wb) * unsigned(lit5)	1	1	None
		MUL.SU Wb,#lit5,Wnd	Wnd = signed(Wb) * unsigned(lit5)	1	1	None
		MUL.UU Wb,#lit5,Wnd	{Wnd + 1, Wnd} = unsigned(Wb) * unsigned(lit5)	1	1	None
		MUL.UU Wb,#lit5,Wnd	Wnd = unsigned(Wb) * unsigned(lit5)	1	1	None
		MUL f	W3:W2 = f * WREG	1	1	None
54	NEG	NEG Acc	Negate Accumulator	1	1	OA,OB,OAB, SA,SB,SAB
		NEG f	f = $\bar{f}$ + 1	1	1	C,DC,N,OV,Z
		NEG f,WREG	WREG = $\bar{f}$ + 1	1	1	C,DC,N,OV,Z
		NEG Ws,Wd	Wd = $\overline{Ws}$ + 1	1	1	C,DC,N,OV,Z
55	NOP	NOP	No Operation	1	1	None
		NOPR	No Operation	1	1	None
56	POP	POP f	Pop f from Top-of-Stack (TOS)	1	1	None
		POP Wdo	Pop from Top-of-Stack (TOS) to Wdo	1	1	None
		POP.D Wnd	Pop from Top-of-Stack (TOS) to W(nd):W(nd + 1)	1	2	None
		POP.S	Pop Shadow Registers	1	1	All
57	PUSH	PUSH f	Push f to Top-of-Stack (TOS)	1	1	None
		PUSH Wso	Push Wso to Top-of-Stack (TOS)	1	1	None
		PUSH.D Wns	Push W(ns):W(ns + 1) to Top-of-Stack (TOS)	1	2	None
		PUSH.S	Push Shadow Registers	1	1	None
58	PWRSAV	PWRSAV #lit1	Go into Sleep or Idle mode	1	1	WDTO,Sleep
59	RCALL	RCALL Expr	Relative Call	1	4	SFA
		RCALL Wn	Computed Call	1	4	SFA
60	REPEAT	REPEAT #lit15	Repeat Next Instruction lit15 + 1 times	1	1	None
		REPEAT Wn	Repeat Next Instruction (Wn) + 1 times	1	1	None
61	RESET	RESET	Software device Reset	1	1	None
62	RETFIE	RETFIE	Return from interrupt	1	6 (5)	SFA

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

TABLE 30-10: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions: 4.5V to 5.5V (unless otherwise stated) Operating temperature -40°C dTA d+85°C for Industrial -40°C dTA d+125°C for Extended				
Param No.	Symbol	Characteristic	Min.	Typ. (1)	Max.	Units	Conditions
DI10	VIL	Input Low Voltage I/O Pins	VSS	—	0.2 VDD	V	
DI20	VIH	Input High Voltage I/O Pins	0.75 VDD	—	5.5	V	
DI30	ICNPU	Change Notification Pull-up Current	200	375	600	PA	VDD = 5.0V, VPIN = VSS
DI31	ICNPD	Change Notification Pull-Down Current (7)	175	400	625	PA	VDD = 5.0V, VPIN = VDD
DI50	IIL	Input Leakage Current (2,3) I/O Pins	-100	—	100	nA	VSS dVPIN dVDD, pin at high-impedance
DI55		MCLR	-700	—	700	nA	VSS dVPIN dVDD
DI56		OSC1	-200	—	200	nA	VSS dVPIN dVDD, XT and HS modes
DI60a	IICL	Input Low Injection Current	0	—	-5(4,6)		All pins except VDD, VSS, AVDD, AVSS, MCLR, VCAP and RB7
DI60b	IICH	Input High Injection Current	0	—	+5(5,6)	mA	All pins except VDD, VSS, AVDD, AVSS, MCLR, VCAP, RB7 and all 5V tolerant pins(5)
DI60c	¦IICT	Total Input Injection Current (sum of all I/O and control pins)	-20(7)	—	+20(7)		Absolute instantaneous sum of all ± input injection currents from all I/O pins (| IICL |+ | IICH |) d ¦IICT

Note 1: Data in “Typ.” column is at 5.0V, +25°C unless otherwise stated.

2: The leakage current on the MCLR pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current can be measured at different input voltages.

3: Negative current is defined as current sourced by the pin.

4: VIL source < (VSS – 0.3). Characterized but not tested.

5: Digital 5V tolerant pins cannot tolerate any “positive” input injection current from input sources > 5.5V.

6: Non-zero injection currents can affect the ADC results by approximately 4-6 counts.

7: Any number and/or combination of I/O pins not excluded under IICL or IICH conditions are permitted, provided the mathematical “absolute instantaneous” sum of the input injection currents from all pins do not exceed the specified limit. Characterized but not tested.

TABLE 30-55: ADC MODULE SPECI FICATIONS (12-BIT MODE)

AC CHARACTERISTICS			Standard Operating Conditions (see Note 1): 4.5V to 5.5V (unless otherwise stated) Operating temperature -40°C dTA d+85°C for Industrial -40°C dTA d+125°C for Extended				
Param No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions
ADC Accuracy (12-Bit Mode)							
AD20a	Nr	Resolution	12 data bits			bits	
AD21a	INL	Integral Nonlinearity	-2	—	+2	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
AD22a	DNL	Differential Nonlinearity	! -1	—	< 1	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
AD23a	GERR	Gain Error	-10	4	10	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
AD24a	EOFF	Offset Error	-10	1.75	10	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
AD25a	—	Monotonicity(2)	—	—	—	—	Guaranteed
Dynamic Performance (12-Bit Mode)							
AD30a	THD	Total Harmonic Distortion	—	—	-75	dB	
AD31a	SINAD	Signal to Noise and Distortion	68.5	69.5	—	dB	
AD32a	SFDR	Spurious Free Dynamic Range	80	—	—	dB	
AD33a	FNYQ	Input Signal Bandwidth	—	—	250	kHz	
AD34a	ENOB	Effective Number of Bits	11.09	11.3	—	bits	

Note 1: Device is functional at VBORMIN < VDD < VDDMIN, but will have degraded performance. Device functionality is tested, but not characterized. Analog modules: ADC, op amp/comparator and comparator voltage reference, will have degraded performance. Refer to Parameter BO10 in Table 30-12 for the minimum and maximum BOR values.

2: The conversion result never decreases with an increase in the input voltage.

TABLE 31-17: OP AMP/COMPARATOR x SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions (see Note 3): 4.5V to 5.5V (unless otherwise stated) Operating temperature -40°C dTA d+150°C				
Param No.	Symbol	Characteristic	Min.	Typ. (1)	Max.	Units	Conditions
Comparator DC Characteristics							
HCM30	VOFFSET	Comparator Offset Voltage	-80	±60	80	mV	
HCM31	VHYST	Input Hysteresis Voltage	—	30	—	mV	
HCM34	VICM	Input Common-Mode Voltage	AVSS	—	AVDD	V	
Op Amp DC Characteristics (2)							
HCM40	VCMR	Common-Mode Input Voltage Range	AVSS	—	AVDD	V	
HCM42	VOFFSET	Op Amp Offset Voltage	-50	±6	50	mV	

Note 1: Data in “Typ.” column is at 5.0V, +25°C unless otherwise stated.

2: Resistances can vary by ±10% between op amps.

3: Device is functional at VBORMIN < VDD < VDDMIN, but will have degraded performance. Device functionality is tested, but is not characterized. Analog modules: ADC, op amp/comparator and comparator voltage reference, will have degraded performance. Refer to Parameter HBO10 in Table 31-10 for the minimum and maximum BOR values.

TABLE 31-18: ADC MODULE SPECI FICATIONS (12-BIT MODE)

AC CHARACTERISTICS			Standard Operating Conditions (see Note 1): 4.5V to 5.5V (unless otherwise stated) Operating temperature -40°C dTA d+150°C				
Param No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions
ADC Accuracy (12-Bit Mode)							
HAD20a	Nr	Resolution	12 data bits			bits	
HAD21a	INL	Integral Nonlinearity	-2	—	+2	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
HAD22a	DNL	Differential Nonlinearity	! -1	—	< 1	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
HAD23a	GERR	Gain Error	-10	4	10	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V
HAD24a	EOFF	Offset Error	-10	1.75	10	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5.5V

Note 1: Device is functional at VBORMIN < VDD < VDDMIN, but will have degraded performance. Device functionality is tested, but is not characterized. Analog modules: ADC, op amp/comparator and comparator voltage reference, will have degraded performance. Refer to Parameter BO10 in Table 30-12 for the minimum and maximum BOR values.

32.8 Pull-up and Pull-Down Current

FIGURE 32-27: TYPICAL PULL-UP CURRENT (V PIN = VSS) vs. TEMPERATURE

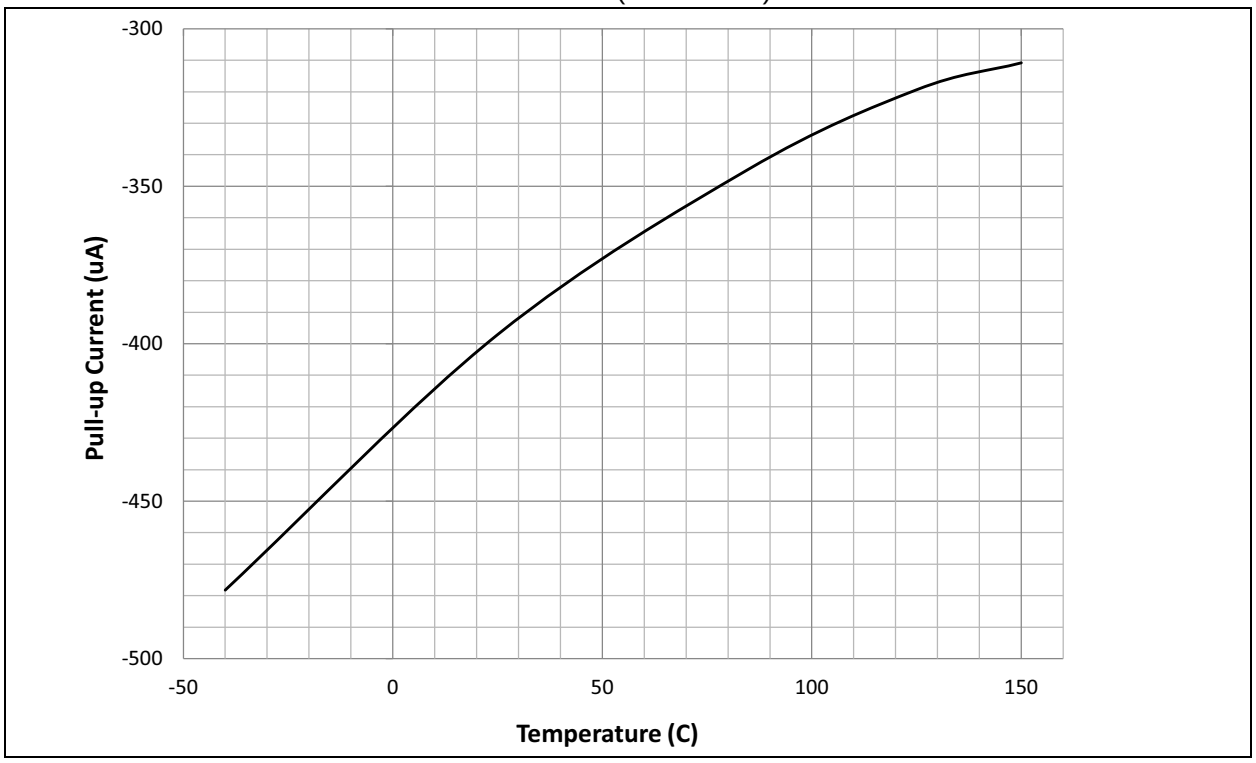
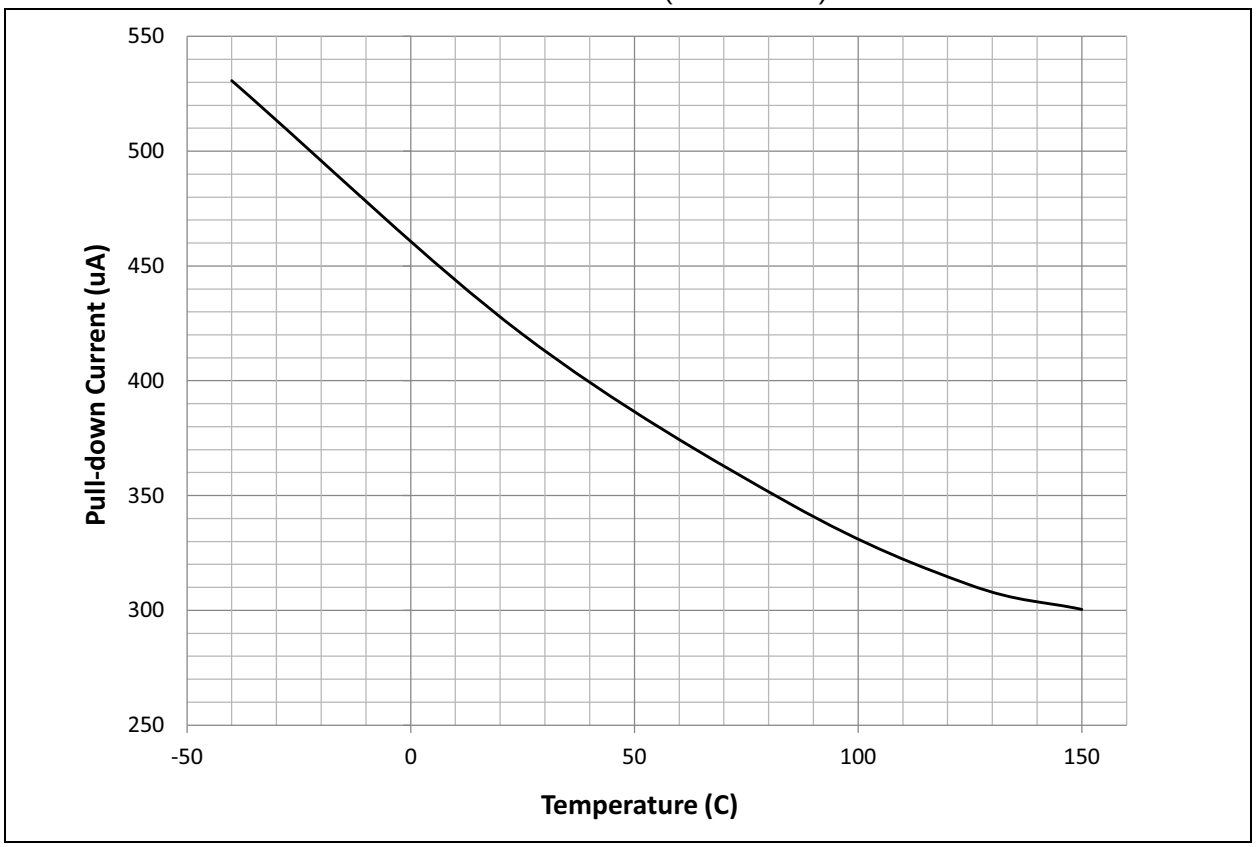


FIGURE 32-28: TYPICAL PULL-DOWN CURRENT (V PIN = 5.5V) vs. TEMPERATURE



33.0 CHARACTERISTICS FOR HIGH-TEMPERATURE DEVICES (+150°C)

33.1 IDD

FIGURE 33-1: TYPICAL/MAXIMUM I DD vs. F OSC (EC MODE 10 MHz TO 40 MHz, 5.5V MAX)

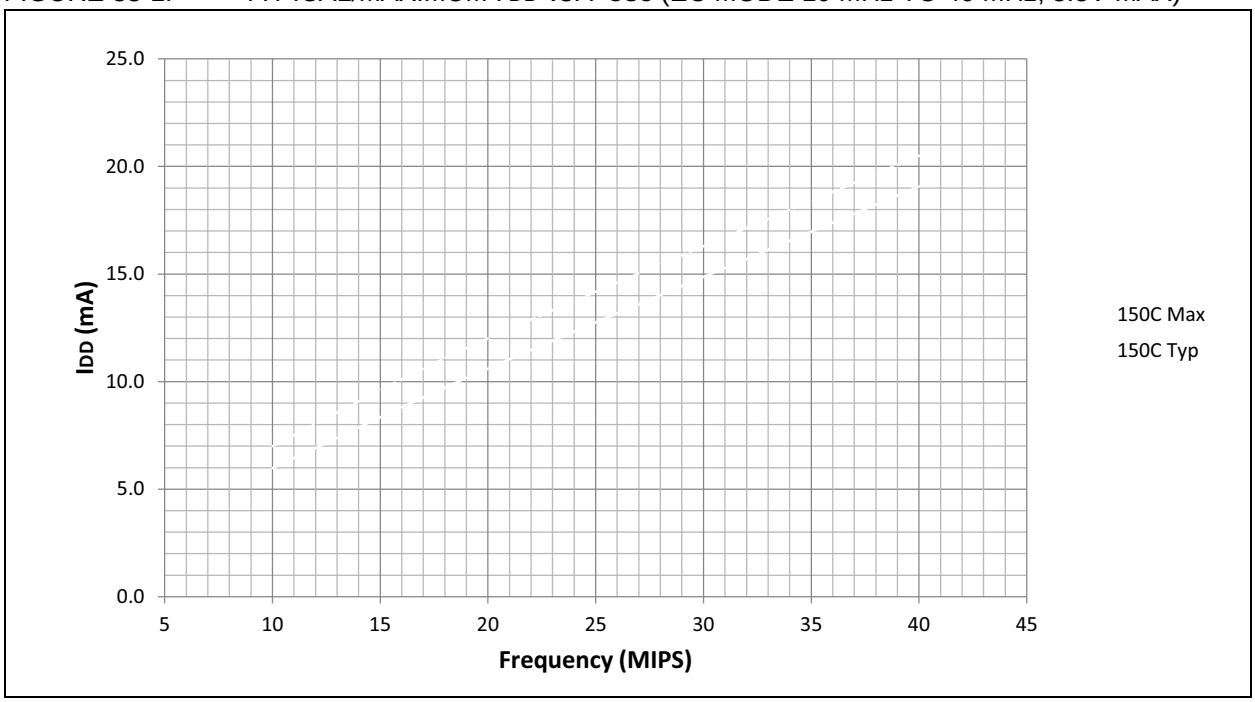


FIGURE 33-2: TYPICAL I DD vs. V DD (EC MODE, 10 MIPS)

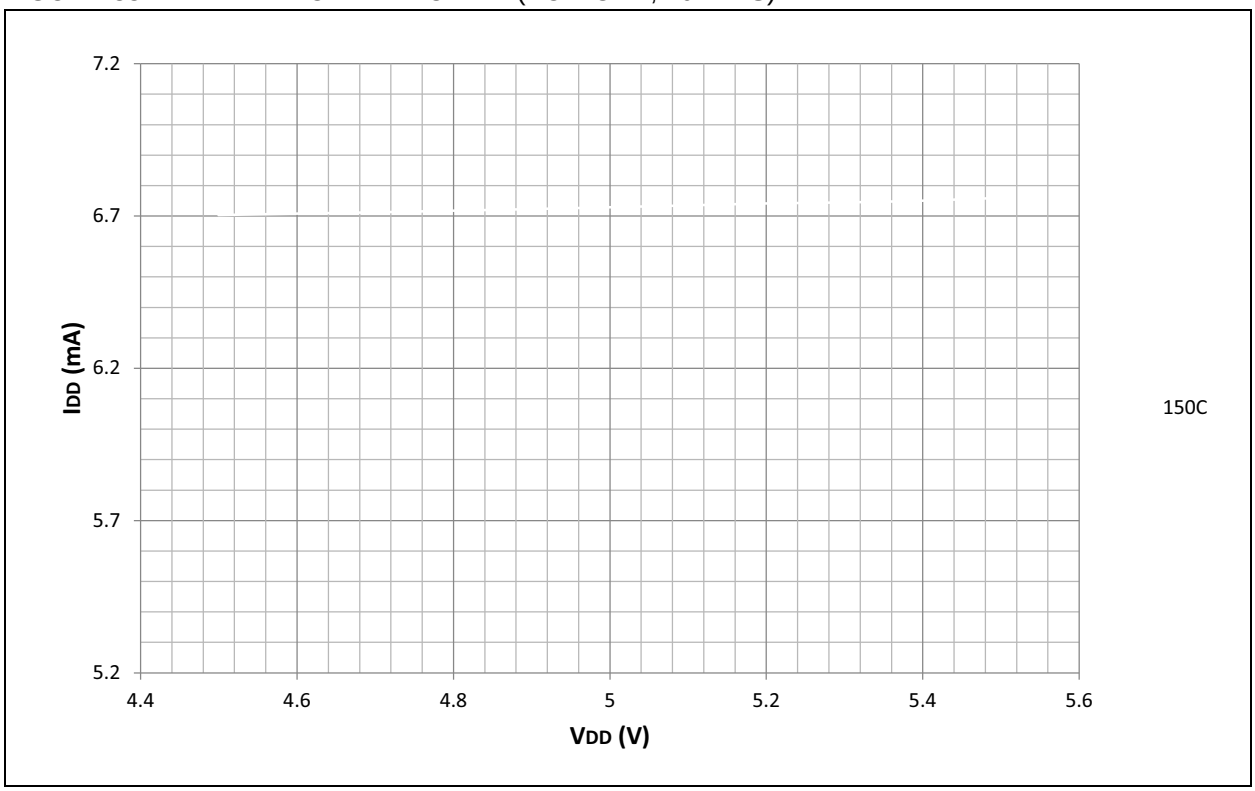
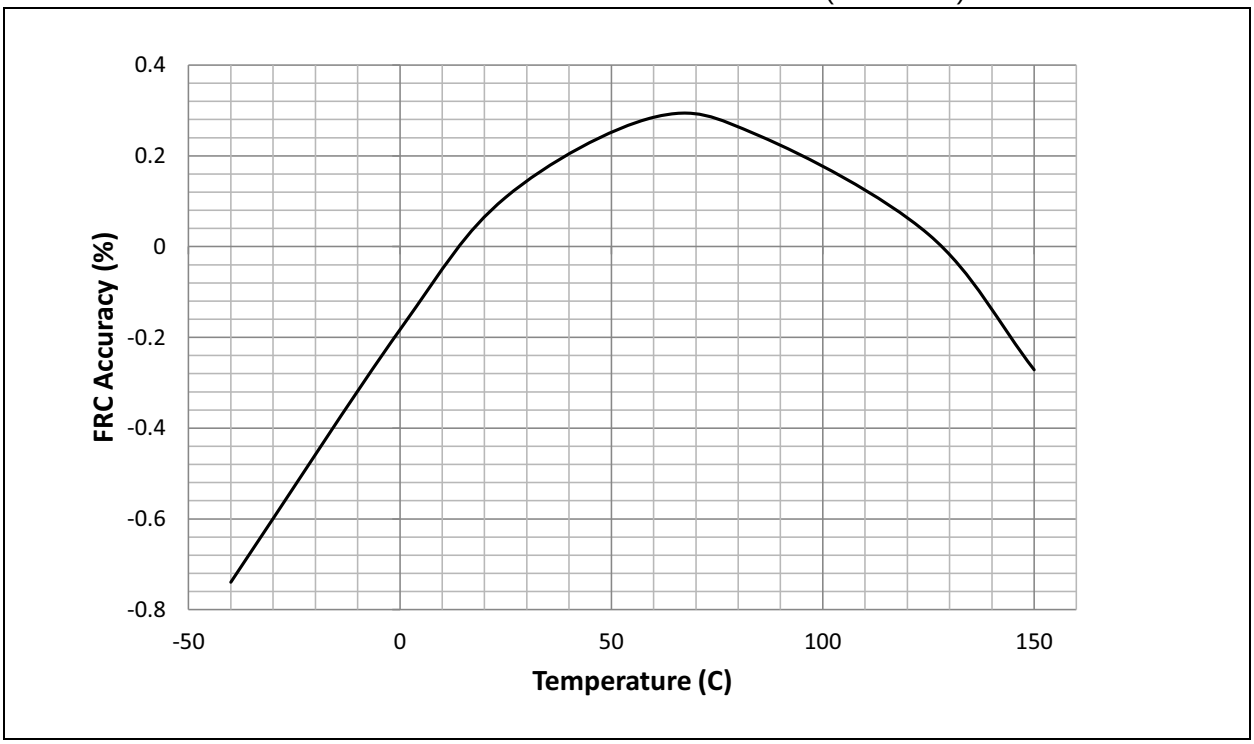
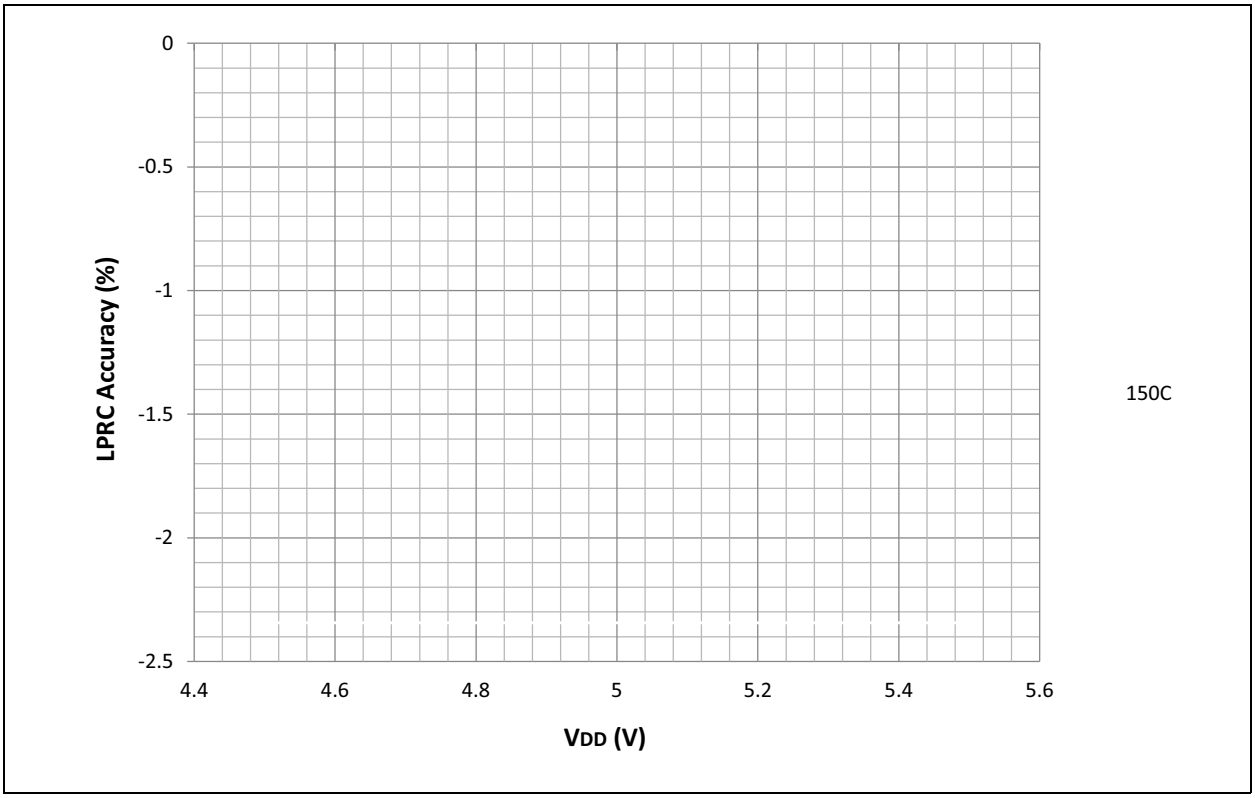


FIGURE 33-17: TYPICAL FRC ACCURACY vs. TEMPERATURE (5.5V V DD)



33.6 LPRC

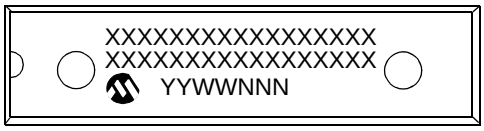
FIGURE 33-18: TYPICAL LPRC ACCURACY vs. V DD



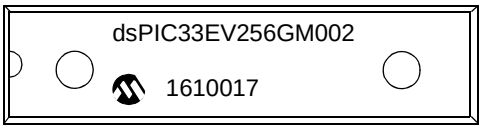
34.0 PACKAGING INFORMATION

34.1 Package Marking Information

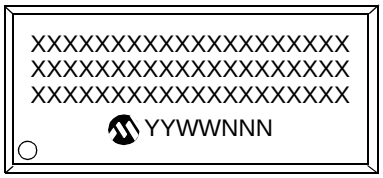
28-Lead SPDIP (.300”)



Example



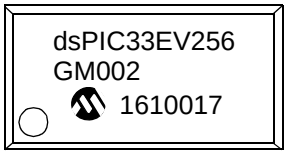
28-Lead SOIC (.300”)



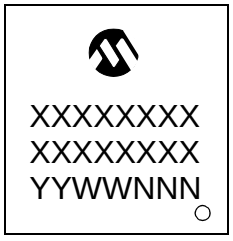
Example

28-Lead SSOP

Example



28-Lead QFN-S (6x6x0.9 mm)



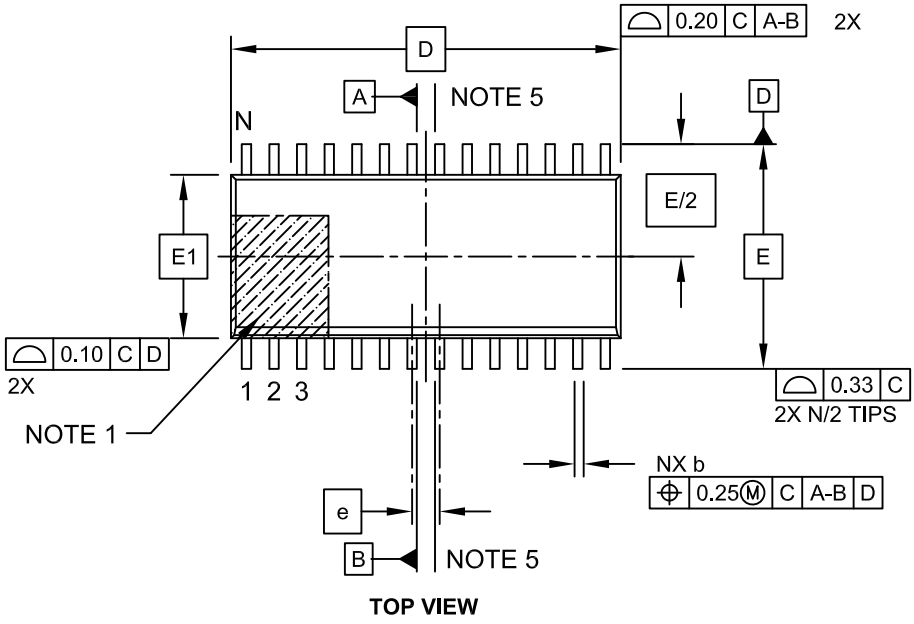
Example

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

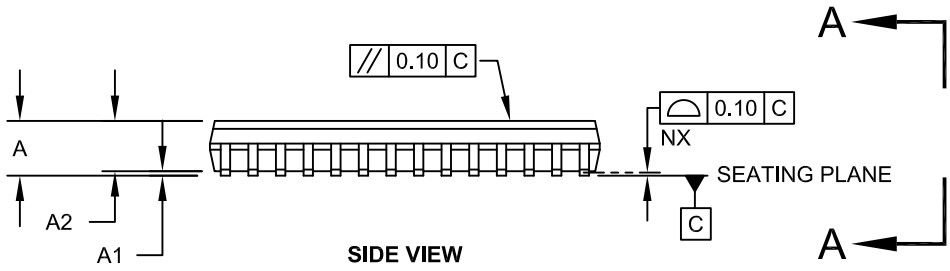
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

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

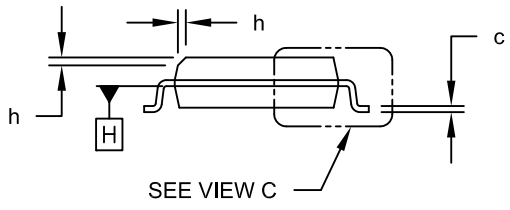
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW



VIEW A-A

Microchip Technology Drawing C04-052C Sheet 1 of 2

CxFMSKSEL1 (CANx Filters 7-0 Mask Selection 1) 269
CxFMSKSEL2 (CANx Filters 15-8 Mask Selection 2) 270
CxINTE (CANx Interrupt Enable) 261
CxINTF (CANx Interrupt Flag) 260
CxRXFnEID (CANx Acceptance Filter n Extended Identifier) 268
CxRXFnSID (CANx Acceptance Filter n Standard Identifier) 268
CxRXFUL1 (CANx Receive Buffer Full 1) 272
CxRXFUL2 (CANx Receive Buffer Full 2) 272
CxRXMnEID (CANx Acceptance Filter Mask n Extended Identifier) 271
CxRXMnSID (CANx Acceptance Filter Mask n Standard Identifier) 271
CxRXOVF1 (CANx Receive Buffer Overflow 1) 273
CxRXOVF2 (CANx Receive Buffer Overflow 2) 273
CxTRmnCON (CANx TX/RX Buffer mn Control) 274
CxVEC (CANx Interrupt Code) 257
DEVID (Device ID) 323
DEVREV (Device Revision) 323
DMALCA (DMA Last Channel Active Status) 120
DMAPPS (DMA Ping-Pong Status) 121
DMAPWC (DMA Peripheral Write Collision Status) 118
DMARQC (DMA Request Collision Status) 119
DMAxCNT (DMA Channel x Transfer Count) 116
DMAxCON (DMA Channel x Control) 112
DMAxPAD (DMA Channel x Peripheral Address) 116
DMAxREQ (DMA Channel x IRQ Select) 113
DMAxSTAH (DMA Channel x Start Address A, High) 114
DMAxSTAL (DMA Channel x Start Address A, Low) 114
DMAxSTBH (DMA Channel x Start Address B, High) 115
DMAxSTBL (DMA Channel x Start Address B, Low) 115
DMTCLR (Deadman Timer Clear) 183
DMTCNTH (Deadman Timer Count High) 185
DMTCNTL (Deadman Timer Count Low) 185
DMTCON (Deadman Timer Control) 182
DMTHOLDREG (DMT Hold) 188
DMTPRECLR (Deadman Timer Preclear) 182
DMTPSCNTH (DMT Post Configure Count Status High) 186
DMTPSCNTL (DMT Post Configure Count Status Low) 186
DMTPSINTVH (DMT Post Configure Interval Status High) 187
DMTPSINTVL (DMT Post Configure Interval Status Low) 187
DMTSTAT (Deadman Timer Status) 184
DSADRH (DMA Most Recent RAM High Address) 117
DSADRL (DMA Most Recent RAM Low Address) 117
DTRx (PWMx Dead-Time) 211
FCLCONx (PWMx Fault Current-Limit Control) 215
I2CxCON1 (I2Cx Control 1) 231
I2CxCON2 (I2Cx Control 2) 233
I2CxMSK (I2Cx Slave Mode Address Mask) 235
I2CxSTAT (I2Cx Status) 234
ICxCON1 (Input Capture x Control 1) 190
ICxCON2 (Input Capture x Control 2) 191
INTCON1 (Interrupt Control 1) 103
INTCON2 (Interrupt Control 2) 105
INTCON3 (Interrupt Control 3) 106
INTCON4 (Interrupt Control 4) 107
INTTREG (Interrupt Control and Status) 108
IOCONx (PWMx I/O Control) 213
LEBCONx (PWMx Leading-Edge Blanking Control) 217
LEBDLYx (PWMx Leading-Edge Blanking Delay) 218
MDC (PWMx Master Duty Cycle) 207
NVMADR (NVM Lower Address) 88
NVMADRU (NVM Upper Address) 88
NVMCON (NVM Control) 86
NVMKEY (NVM Key) 89
NVMSRCADRH (NVM Data Memory Upper Address) 90
NVMSRCADRL (NVM Data Memory Lower Address) 90
OCxCON1 (Output Compare x Control 1) 194
OCxCON2 (Output Compare x Control 2) 196
OSCCON (Oscillator Control) 126
OSCTUN (FRC Oscillator Tuning) 131
PDCx (PWMx Generator Duty Cycle) 210
PHASEx (PWMx Primary Phase-Shift) 210
PLLFBD (PLL Feedback Divisor) 130
PMD1 (Peripheral Module Disable Control 1) 136
PMD2 (Peripheral Module Disable Control 2) 137
PMD3 (Peripheral Module Disable Control 3) 138
PMD4 (Peripheral Module Disable Control 4) 138
PMD6 (Peripheral Module Disable Control 6) 139
PMD7 (Peripheral Module Disable Control 7) 140
PMD8 (Peripheral Module Disable Control 8) 141
PTCON (PWMx Time Base Control) 204
PTCON2 (PWMx Primary Master Clock Divider Select) 205
PTPER (PWMx Primary Master Time Base Period) 206
PWMCONx (PWMx Control) 208
RCON (Reset Control) 93
REFOCON (Reference Oscillator Control) 132
RPINR0 (Peripheral Pin Select Input 0) 153
RPINR1 (Peripheral Pin Select Input 1) 153
RPINR11 (Peripheral Pin Select Input 11) 157
RPINR12 (Peripheral Pin Select Input 12) 158
RPINR18 (Peripheral Pin Select Input 18) 159
RPINR19 (Peripheral Pin Select Input 19) 159
RPINR22 (Peripheral Pin Select Input 22) 160
RPINR23 (Peripheral Pin Select Input 23) 161
RPINR26 (Peripheral Pin Select Input 26) 161
RPINR3 (Peripheral Pin Select Input 3) 154
RPINR37 (Peripheral Pin Select Input 37) 162
RPINR38 (Peripheral Pin Select Input 38) 162
RPINR39 (Peripheral Pin Select Input 39) 163
RPINR44 (Peripheral Pin Select Input 44) 164
RPINR45 (Peripheral Pin Select Input 45) 164
RPINR7 (Peripheral Pin Select Input 7) 155
RPINR8 (Peripheral Pin Select Input 8) 156
RPOR0 (Peripheral Pin Select Output 0) 165
RPOR1 (Peripheral Pin Select Output 1) 165
RPOR10 (Peripheral Pin Select Output 10) 170