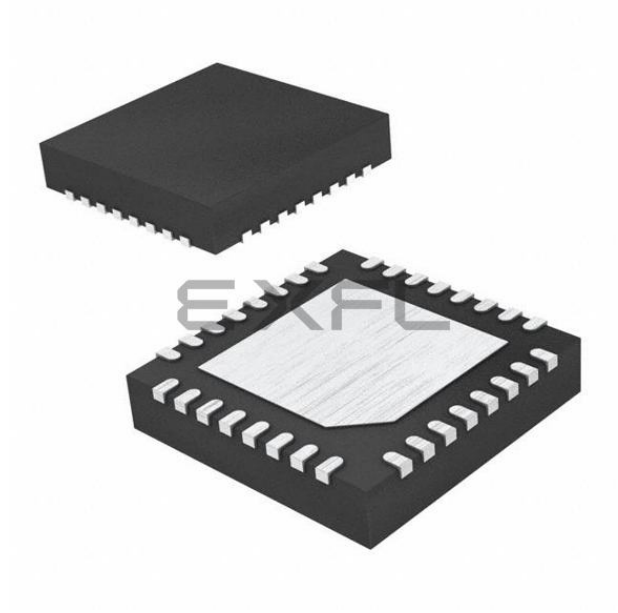
Microchip Technology - DSPIC33EV64GM102-I/MM Datasheet



Welcome to E-XFL.COM

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	CANbus, I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, Motor Control PWM, POR, PWM, WDT
Number of I/O	21
Program Memory Size	64KB (22K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	8K x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 11x10/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
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/dspic33ev64gm102-i-mm

FIGURE 3-2: PROGRAMMER'S MODEL

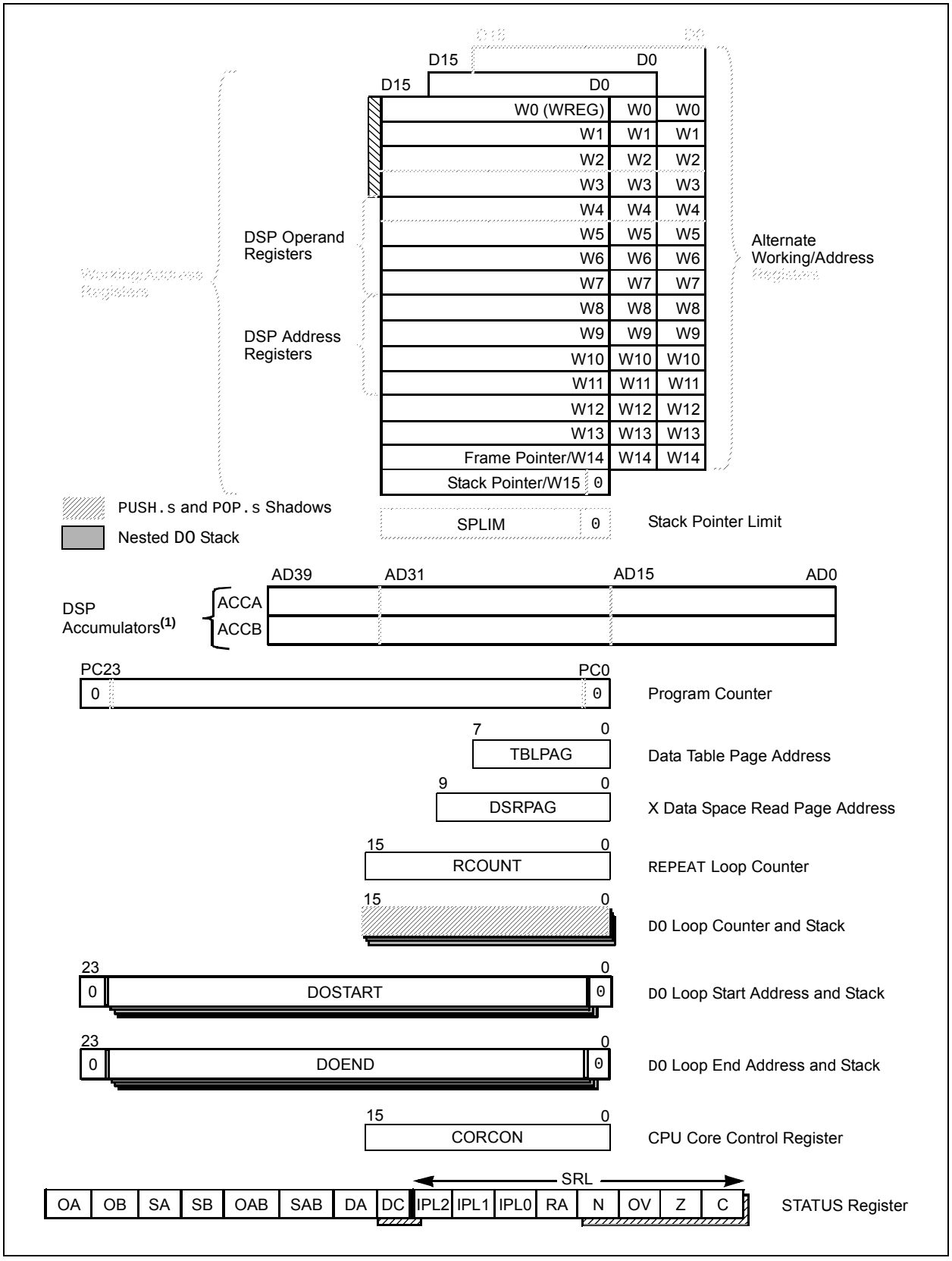


TABLE 4-11: CAN1 REGISTER MAP WHEN WIN (C1CTRL<0>) = 1 FOR dsPIC33EVXXXGM10X DEVICES

SFR Name	Addr.	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	All Resets
	0400-041E	See definition when WIN = x																
C1BUFPNT1	0420	F3BP3	F3BP2	F3BP1	F3BP0	F2BP3	F2BP2	F2BP1	F2BP0	F1BP3	F1BP2	F1BP1	F1BP0	F0BP3	F0BP2	F0BP1	F0BP0	0000
C1BUFPNT2	0422	F7BP3	F7BP2	F7BP1	F7BP0	F6BP3	F6BP2	F6BP1	F6BP0	F5BP3	F5BP2	F5BP1	F5BP0	F4BP3	F4BP2	F4BP1	F4BP0	0000
C1BUFPNT3	0424	F11BP3	F11BP2	F11BP1	F11BP0	F10BP3	F10BP2	F10BP1	F10BP0	F9BP3	F9BP2	F9BP1	F9BP0	F8BP3	F8BP2	F8BP1	F8BP0	0000
C1BUFPNT4	0426	F15BP3	F15BP2	F15BP1	F15BP0	F14BP3	F14BP2	F14BP1	F14BP0	F13BP3	F13BP2	F13BP1	F13BP0	F12BP3	F12BP2	F12BP1	F12BP0	0000
C1RXM0SID	0430	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	MIDE	—	EID17	EID16	xxxx
C1RXM0EID	0432	EID<15:0>																xxxx
C1RXM1SID	0434	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	MIDE	—	EID17	EID16	xxxx
C1RXM1EID	0436	EID<15:0>																xxxx
C1RXM2SID	0438	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	MIDE	—	EID17	EID16	xxxx
C1RXM2EID	043A	EID<15:0>																xxxx
C1RXF0SID	0440	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF0EID	0442	EID<15:0>																xxxx
C1RXF1SID	0444	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF1EID	0446	EID<15:0>																xxxx
C1RXF2SID	0448	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF2EID	044A	EID<15:0>																xxxx
C1RXF3SID	044C	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF3EID	044E	EID<15:0>																xxxx
C1RXF4SID	0450	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF4EID	0452	EID<15:0>																xxxx
C1RXF5SID	0454	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF5EID	0456	EID<15:0>																xxxx
C1RXF6SID	0458	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF6EID	045A	EID<15:0>																xxxx
C1RXF7SID	045C	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF7EID	045E	EID<15:0>																xxxx
C1RXF8SID	0460	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF8EID	0462	EID<15:0>																xxxx
C1RXF9SID	0464	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF9EID	0466	EID<15:0>																xxxx
C1RXF10SID	0468	SID10	SID9	SID8	SID7	SID6	SID5	SID4	SID3	SID2	SID1	SID0	—	EXIDE	—	EID17	EID16	xxxx
C1RXF10EID	046A	EID<15:0>																xxxx

Legend: x = unknown value on Reset; — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-26: DMAC REGISTER MAP

SFR Name	Addr.	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	All Resets
DMA0CON	0B00	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE1	AMODE0	—	—	MODE1	MODE0	0000
DMA0REQ	0B02	FORCE	—	—	—	—	—	—	—	IRQSEL7	IRQSEL6	IRQSEL5	IRQSEL4	IRQSEL3	IRQSEL2	IRQSEL1	IRQSEL0	00FF
DMA0STAL	0B04	STA<15:0>																0000
DMA0STAH	0B06	—	—	—	—	—	—	—	—	STA<23:16>								0000
DMA0STBL	0B08	STB<15:0>																0000
DMA0STBH	0B0A	—	—	—	—	—	—	—	—	STB<23:16>								0000
DMA0PAD	0B0C	PAD<15:0>																0000
DMA0CNT	0B0E	—	—	CNT<13:0>														0000
DMA1CON	0B10	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE1	AMODE0	—	—	MODE1	MODE0	0000
DMA1REQ	0B12	FORCE	—	—	—	—	—	—	—	IRQSEL7	IRQSEL6	IRQSEL5	IRQSEL4	IRQSEL3	IRQSEL2	IRQSEL1	IRQSEL0	00FF
DMA1STAL	0B14	STA<15:0>																0000
DMA1STAH	0B16	—	—	—	—	—	—	—	—	STA<23:16>								0000
DMA1STBL	0B18	STB<15:0>																0000
DMA1STBH	0B1A	—	—	—	—	—	—	—	—	STB<23:16>								0000
DMA1PAD	0B1C	PAD<15:0>																0000
DMA1CNT	0B1E	—	—	CNT<13:0>														0000
DMA2CON	0B20	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE1	AMODE0	—	—	MODE1	MODE0	0000
DMA2REQ	0B22	FORCE	—	—	—	—	—	—	—	IRQSEL7	IRQSEL6	IRQSEL5	IRQSEL4	IRQSEL3	IRQSEL2	IRQSEL1	IRQSEL0	00FF
DMA2STAL	0B24	STA<15:0>																0000
DMA2STAH	0B26	—	—	—	—	—	—	—	—	STA<23:16>								0000
DMA2STBL	0B28	STB<15:0>																0000
DMA2STBH	0B2A	—	—	—	—	—	—	—	—	STB<23:16>								0000
DMA2PAD	0B2C	PAD<15:0>																0000
DMA2CNT	0B2E	—	—	CNT<13:0>														0000
DMA3CON	0B30	CHEN	SIZE	DIR	HALF	NULLW	—	—	—	—	—	AMODE1	AMODE0	—	—	MODE1	MODE0	0000
DMA3REQ	0B32	FORCE	—	—	—	—	—	—	—	IRQSEL7	IRQSEL6	IRQSEL5	IRQSEL4	IRQSEL3	IRQSEL2	IRQSEL1	IRQSEL0	00FF
DMA3STAL	0B34	STA<15:0>																0000
DMA3STAH	0B36	—	—	—	—	—	—	—	—	STA<23:16>								0000
DMA3STBL	0B38	STB<15:0>																0000
DMA3STBH	0B3A	—	—	—	—	—	—	—	—	STB<23:16>								0000
DMA3PAD	0B3C	PAD<15:0>																0000
DMA3CNT	0B3E	—	—	CNT<13:0>														0000
DMAPWC	0BF0	—	—	—	—	—	—	—	—	—	—	—	—	PWCOL<3:0>				0000
DMARQC	0BF2	—	—	—	—	—	—	—	—	—	—	—	—	RQCOL<3:0>				0000
DMAPPS	0BF4	—	—	—	—	—	—	—	—	—	—	—	—	PPST<3:0>				0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

FIGURE 4-16: BIT-REVERSED ADDRESSING EXAMPLE

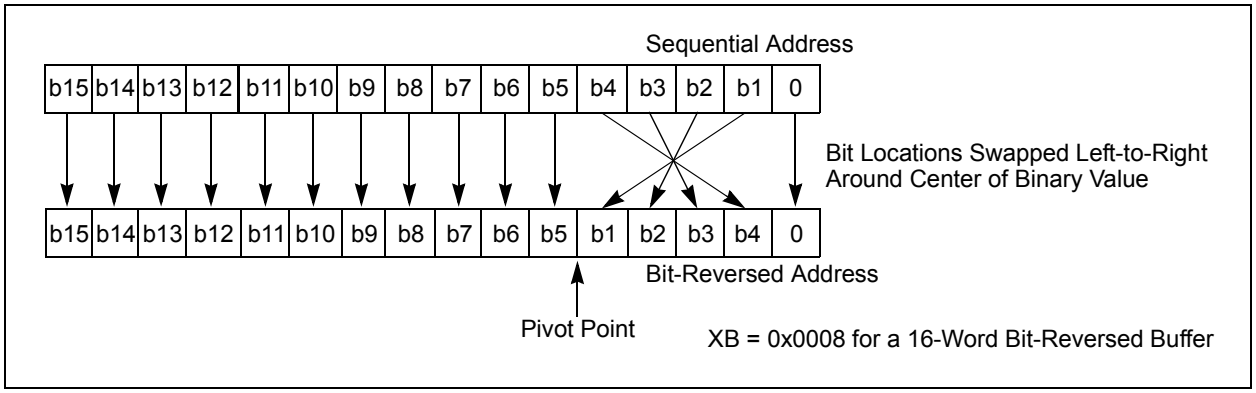
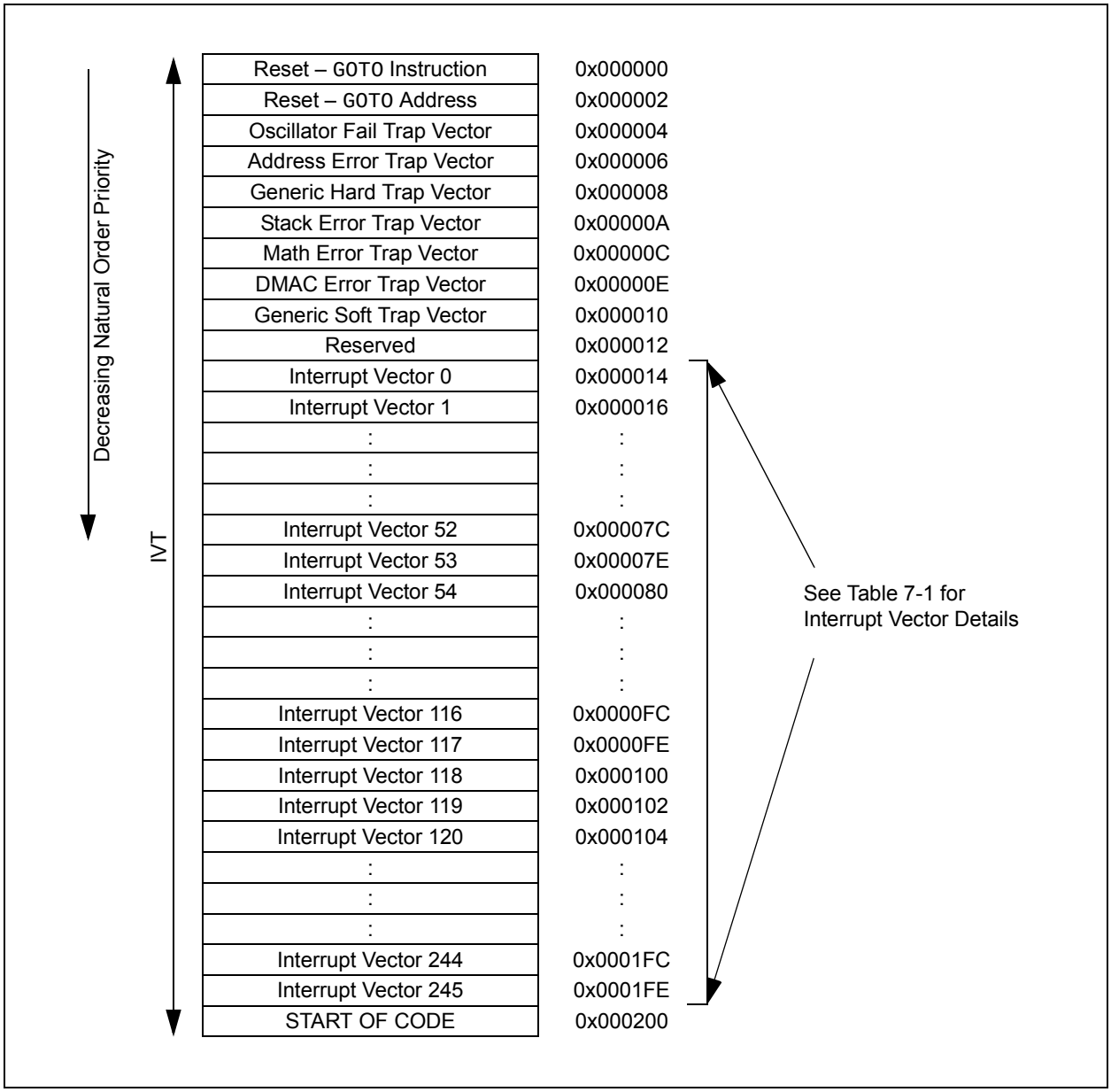


TABLE 4-46: BIT-REVERSED ADDRESSING SEQUENCE (16-ENTRY)

Normal Address					Bit-Reversed Address				
A3	**A2**	**A1**	**A0**	**Decimal**	**A3**	**A2**	**A1**	**A0**	**Decimal**
0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	0	0	0	8
0	0	1	0	2	0	1	0	0	4
0	0	1	1	3	1	1	0	0	12
0	1	0	0	4	0	0	1	0	2
0	1	0	1	5	1	0	1	0	10
0	1	1	0	6	0	1	1	0	6
0	1	1	1	7	1	1	1	0	14
1	0	0	0	8	0	0	0	1	1
1	0	0	1	9	1	0	0	1	9
1	0	1	0	10	0	1	0	1	5
1	0	1	1	11	1	1	0	1	13
1	1	0	0	12	0	0	1	1	3
1	1	0	1	13	1	0	1	1	11
1	1	1	0	14	0	1	1	1	7
1	1	1	1	15	1	1	1	1	15

FIGURE 7-2: dsPIC33EVXXXGM00X/10X FAMILY INTERRUPT VECTOR TABLE



REGISTER 7-2: CORCON: CORE CONTROL REGISTER(1)

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R-0	R-0	R-0
VAR	—	US1	US0	EDT	DL2	DL1	DL0
bit 15							bit 8

R/W-0	R/W-0	R/W-1	R/W-0	R/C-0	R-0	R/W-0	R/W-0
SATA	SATB	SATDW	ACCSAT	IPL3(2)	SFA	RND	IF
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

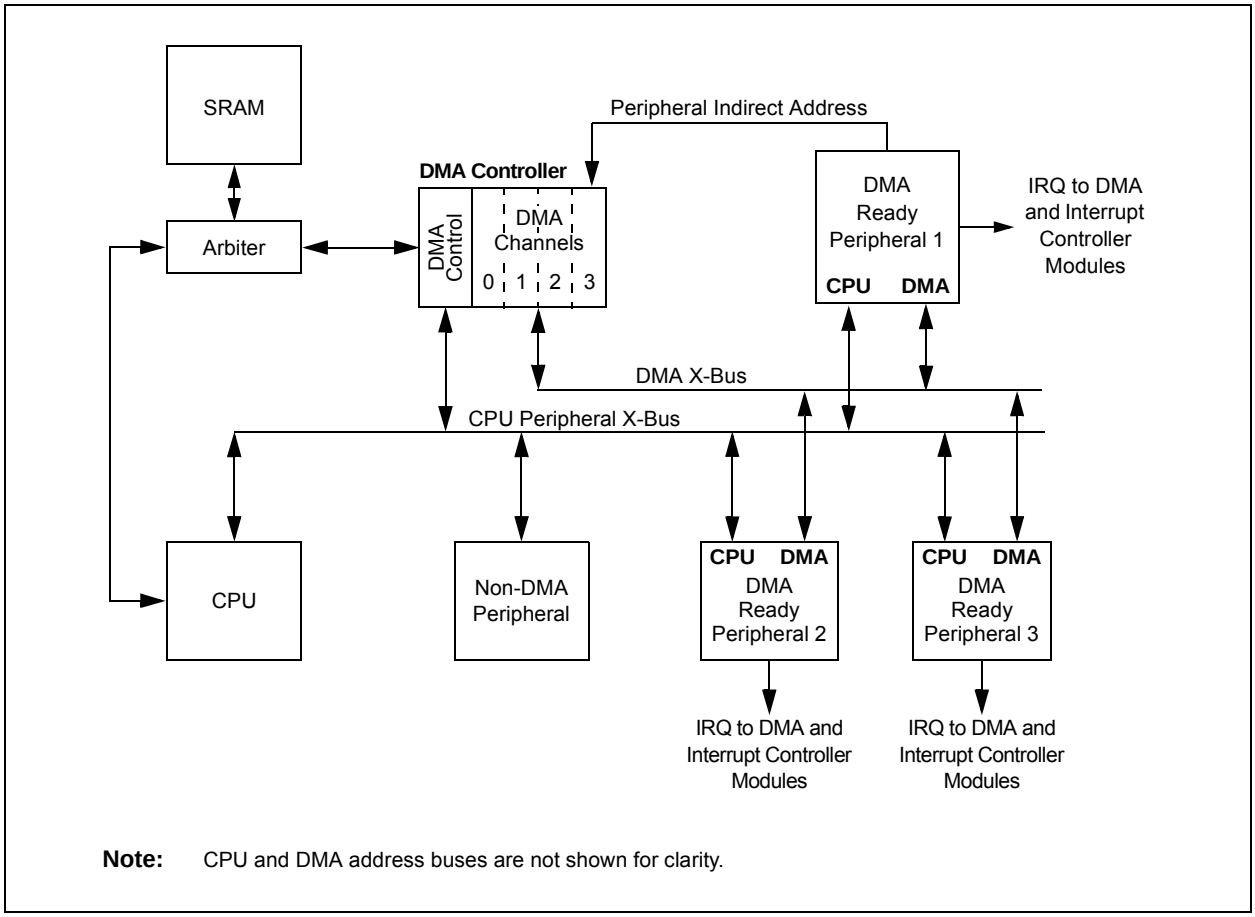
bit 15 **VAR:** Variable Exception Processing Latency Control bit
1 = Variable exception processing latency is enabled
0 = Fixed exception processing latency is enabled

bit 3 **IPL3:** CPU Interrupt Priority Level Status bit 3(2)
1 = CPU Interrupt Priority Level is greater than 7
0 = CPU Interrupt Priority Level is 7 or less

Note 1: For complete register details, see Register 3-2.
2: The IPL3 bit is concatenated with the IPL<2:0> bits (SR<7:5>) to form the CPU Interrupt Priority Level.

Figure 8-2 illustrates the DMA Controller block diagram.

FIGURE 8-2: DMA CONTROLLER BLOCK DIAGRAM



Note: CPU and DMA address buses are not shown for clarity.

8.1 DMAC Controller Registers

Each DMAC Channel x (where x = 0 to 3) contains the following registers:

- 16-Bit DMA Channel x Control Register (DMAxCON)
- 16-Bit DMA Channel x IRQ Select Register (DMAxREQ)
- 32-Bit DMA Channel x Start Address Register A High/Low (DMAxSTAH/L)
- 32-Bit DMA Channel x Start Address Register B High/Low (DMAxSTBH/L)
- 16-Bit DMA Channel x Peripheral Address Register (DMAxPAD)
- 14-Bit DMA Channel x Transfer Count Register (DMAxCNT)

Additional status registers (DMAPWC, DMARQC, DMAPPS, DMALCA and DSADRH/L) are common to all DMAC channels. These status registers provide information on write and request collisions, as well as on last address and channel access information.

The DMA Interrupt Flags (DMAxIF) are located in an IFSx register in the interrupt controller. The corresponding DMA Interrupt Enable bits (DMAxIE) are located in an IECx register in the interrupt controller and the corresponding DMA Interrupt Priority bits (DMAxIP) are located in an IPCx register in the interrupt controller.

11.4 Slew Rate Selection

The slew rate selection feature allows the device to have control over the slew rate selection on the required I/O pin which supports this feature. For this purpose, for each I/O port, there are two registers: SR1x and SR0x, which configure the selection of the slew rate. The register outputs are directly connected to the associated I/O pins, which support the slew rate selection function. The SR1x register specifies the MSb and the SR0x register provides the LSb of the 2-bit field that selects the desired slew rate. For example, slew rate selections for PORTA are as follows:

EXAMPLE 11-2: SLEW RATE SELECTIONS FOR PORTA

```
SR1Ax, SR0Ax = 00 = Fastest Slew rate
SR1Ax, SR0Ax = 01 = 4x slower Slew rate
SR1Ax, SR0Ax = 10 = 8x slower Slew rate
SR1Ax, SR0Ax = 11 = 16x slower Slew rate
```

11.5 Peripheral Pin Select (PPS)

A major challenge in general purpose devices is providing the largest possible set of peripheral features while minimizing the conflict of features on I/O pins. The challenge is even greater on low pin count devices. In an application where more than one peripheral needs to be assigned to a single pin, inconvenient work arounds in application code, or a complete redesign, may be the only option.

The Peripheral Pin Select (PPS) configuration provides an alternative to these choices by enabling peripheral set selection and their placement on a wide range of I/O pins. By increasing the pinout options available on a particular device, users can better tailor the device to their entire application, rather than trimming the application to fit the device.

The PPS configuration feature operates over a fixed subset of digital I/O pins. Users may independently map the input and/or output of most digital peripherals to any one of these I/O pins. Hardware safeguards are included that prevent accidental or spurious changes to the peripheral mapping after it has been established.

11.5.1 AVAILABLE PINS

The number of available pins is dependent on the particular device and its pin count. Pins that support the PPS feature include the designation, “RPn” or “RPIn”, in their full pin designation, where “n” is the remappable pin number. “RP” is used to designate pins that support both remappable input and output functions, while “RPI” indicates pins that support remappable input functions only.

11.5.2 AVAILABLE PERIPHERALS

The peripherals managed by the PPS are all digital only peripherals. These include general serial communications (UART and SPI), general purpose timer clock inputs, timer related peripherals (input capture and output compare) and Interrupt-on-Change (IOC) inputs.

In comparison, some digital only peripheral modules are never included in the PPS feature, because the peripheral’s function requires special I/O circuitry on a specific port and cannot be easily connected to multiple pins. These modules include I^2C and the PWM. A similar requirement excludes all modules with analog inputs, such as the ADC Converter.

A key difference between the remappable and non-remappable peripherals is that the remappable peripherals are not associated with a default I/O pin. The peripheral must always be assigned to a specific I/O pin before it can be used. In contrast, the non-remappable peripherals are always available on a default pin, assuming that the peripheral is active and not conflicting with another peripheral.

When a remappable peripheral is active on a given I/O pin, it takes priority over all the other digital I/O and digital communication peripherals associated with the pin. Priority is given regardless of the type of peripheral that is mapped. Remappable peripherals never take priority over any analog functions associated with the pin.

11.5.3 CONTROLLING PERIPHERAL PIN SELECT

The PPS features are controlled through two sets of SFRs: one to map the peripheral inputs and the other to map the outputs. Because they are separately controlled, a particular peripheral’s input and output (if the peripheral has both) can be placed on any selectable function pin without constraint.

The association of a peripheral to a peripheral-selectable pin is handled in two different ways, depending on whether an input or output is being mapped.

11.5.4 INPUT MAPPING

The inputs of the PPS options are mapped on the basis of the peripheral. That is, a control register associated with a peripheral dictates the pin it will be mapped to. The RPINRx registers are used to configure peripheral input mapping (see Table 11-1 and Register 11-1 through Register 11-17). Each register contains sets of 8-bit fields, with each set associated with one of the remappable peripherals. Programming a given peripheral’s bit field with an appropriate 8-bit value maps the RPn pin with the corresponding value to that peripheral. For any given device, the valid range of values for any bit field corresponds to the maximum number of Peripheral Pin Selects supported by the device.

REGISTER 14-11: DMTHOLDREG: DMT HOLD REGISTER(1)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
UPRCNT<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
UPRCNT<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 **UPRCNT<15:0>:** Value of the DMTCNTH register when DMTCNTL and DMTCNTH were Last Read bits

Note 1: The DMTHOLDREG register is initialized to '0' on Reset, and is only loaded when the DMTCNTL and DMTCNTH registers are read.

REGISTER 15-2: ICxCON2: INPUT CAPTURE x CONTROL REGISTER 2 (CONTINUED)

bit 4-0 **SYNCSEL<4:0>:** Input Source Select for Synchronization and Trigger Operation bits(4)

11111 = Reserved
11110 = Reserved
11101 = Reserved
11100 = CTMU trigger is the source for the capture timer synchronization
11011 = ADC1 interrupt is the source for the capture timer synchronization(5)
11010 = Analog Comparator 3 is the source for the capture timer synchronization(5)
11001 = Analog Comparator 2 is the source for the capture timer synchronization(5)
11000 = Analog Comparator 1 is the source for the capture timer synchronization(5)
10111 = Analog Comparator 5 is the source for the capture timer synchronization(5)
10110 = Analog Comparator 4 is the source for the capture timer synchronization(5)
10101 = Reserved
10100 = Reserved
10011 = Input Capture 4 interrupt is the source for the capture timer synchronization
10010 = Input Capture 3 interrupt is the source for the capture timer synchronization
10001 = Input Capture 2 interrupt is the source for the capture timer synchronization
10000 = Input Capture 1 interrupt is the source for the capture timer synchronization
01111 = GP Timer5 is the source for the capture timer synchronization
01110 = GP Timer4 is the source for the capture timer synchronization
01101 = GP Timer3 is the source for the capture timer synchronization
01100 = GP Timer2 is the source for the capture timer synchronization
01011 = GP Timer1 is the source for the capture timer synchronization
01010 = Reserved
01001 = Reserved
01000 = Input Capture 4 is the source for the capture timer synchronization(6)
00111 = Input Capture 3 is the source for the capture timer synchronization(6)
00110 = Input Capture 2 is the source for the capture timer synchronization(6)
00101 = Input Capture 1 is the source for the capture timer synchronization(6)
00100 = Output Compare 4 is the source for the capture timer synchronization
00011 = Output Compare 3 is the source for the capture timer synchronization
00010 = Output Compare 2 is the source for the capture timer synchronization
00001 = Output Compare 1 is the source for the capture timer synchronization
00000 = Reserved

Note 1: The IC32 bit in both the odd and even ICx must be set to enable Cascade mode.
2: The input source is selected by the SYNCSEL<4:0> bits of the ICxCON2 register.
3: This bit is set by the selected input source (selected by the SYNCSEL<4:0> bits); it can be read, set and cleared in software.
4: Do not use the ICx module as its own sync or trigger source.
5: This option should only be selected as a trigger source and not as a synchronization source.
6: When the source ICx timer rolls over, then in the next clock cycle, trigger or synchronization occurs.

17.3 PWMx Control Registers

REGISTER 17-1: PTCON: PWMx TIME BASE CONTROL REGISTER

R/W-0	U-0	R/W-0	HS-0, HC	R/W-0	R/W-0	R/W-0	R/W-0
PTEN	—	PTSIDL	SESTAT	SEIEN	EIPU(1)	SYNCPOL(1)	SYNCOEN(1)
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(1)	SYNCSRC2(1)	SYNCSRC1(1)	SYNCSRC0(1)	SEVTPS3(1)	SEVTPS2(1)	SEVTPS1(1)	SEVTPS0(1)
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 **PTEN:** PWMx Module Enable bit
1 = PWMx module is enabled
0 = PWMx module is disabled

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

bit 13 **PTSIDL:** PWMx Time Base Stop in Idle Mode bit
1 = PWMx time base halts in CPU Idle mode
0 = PWMx time base runs in CPU Idle mode

bit 12 **SESTAT:** Special Event Interrupt Status bit
1 = Special event interrupt is pending
0 = Special event interrupt is not pending

bit 11 **SEIEN:** Special Event Interrupt Enable bit
1 = Special event interrupt is enabled
0 = Special event interrupt is disabled

bit 10 **EIPU:** Enable Immediate Period Updates bit(1)
1 = Active Period register is updated immediately
0 = Active Period register updates occur on PWMx cycle boundaries

bit 9 **SYNCPOL:** Synchronize Input and Output Polarity bit(1)
1 = SYNCI1/SYNCO1 polarity is inverted (active-low)
0 = SYNCI1/SYNCO1 is active-high

bit 8 **SYNCOEN:** Primary Time Base Sync Enable bit(1)
1 = SYNCO1 output is enabled
0 = SYNCO1 output is disabled

bit 7 **SYNCEN:** External Time Base Synchronization Enable bit(1)
1 = External synchronization of primary time base is enabled
0 = External synchronization of primary time base is disabled

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.

REGISTER 18-1: SPIxSTAT: SPIx STATUS AND CONTROL REGISTER (CONTINUED)

bit 1 **SPITBF:** SPIx Transmit Buffer Full Status bit

1 = Transmit has not yet started, the SPIxTXB bit is full
0 = Transmit has started, the SPIxTXB bit is empty

Standard Buffer mode:
Automatically set in hardware when the core writes to the SPIxBUF location, loading SPIxTXB. Automatically cleared in hardware when the SPIx module transfers data from SPIxTXB to SPIxSR.

Enhanced Buffer mode:
Automatically set in the hardware when the CPU writes to the SPIxBUF location, loading the last available buffer location. Automatically cleared in hardware when a buffer location is available for a CPU write operation.

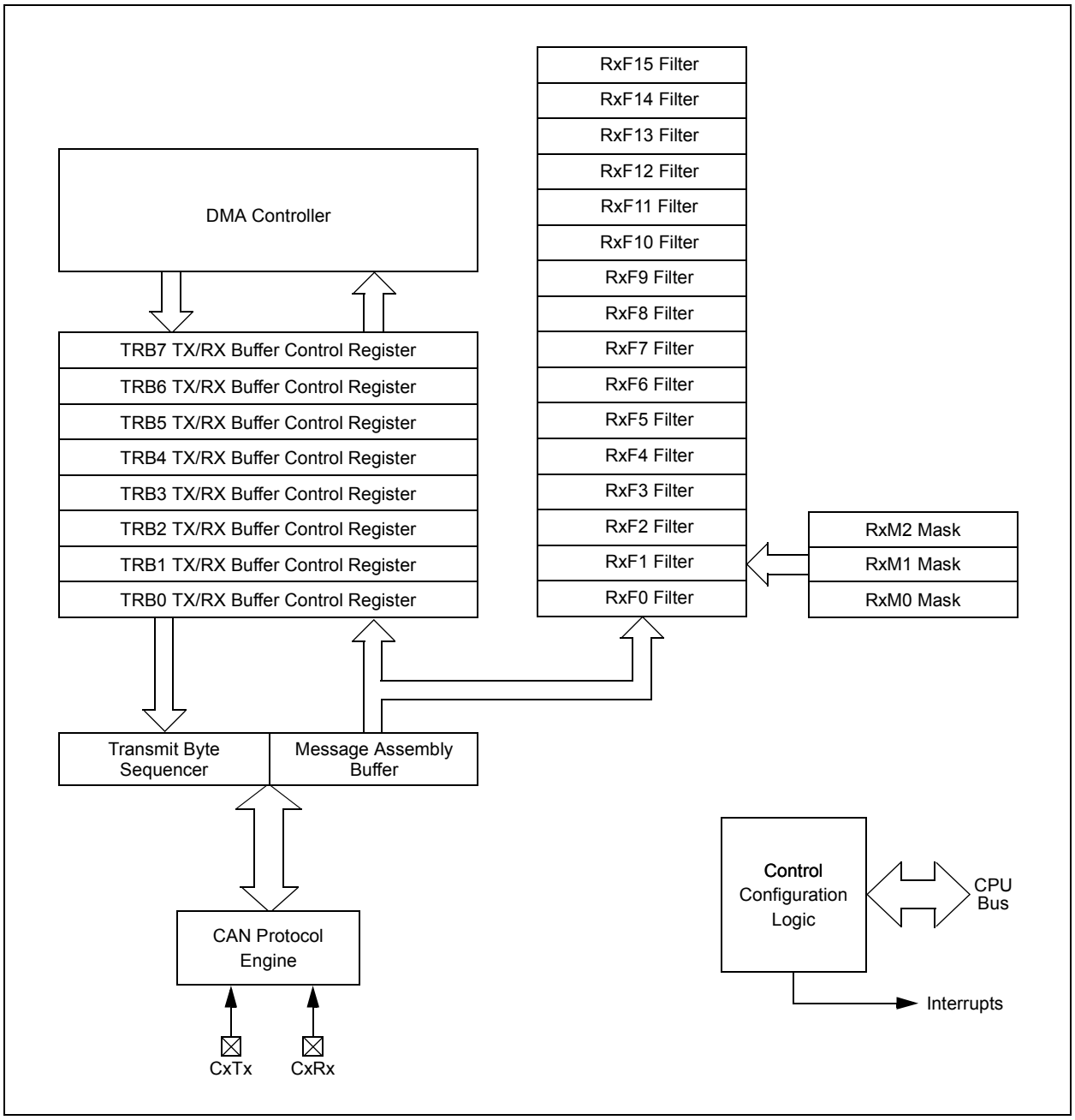
bit 0 **SPIRBF:** SPIx Receive Buffer Full Status bit

1 = Receive is complete, the SPIxRXB bit is full
0 = Receive is incomplete, the SPIxRXB bit is empty

Standard Buffer mode:
Automatically set in the hardware when SPIx transfers data from SPIxSR to SPIxRXB. Automatically cleared in hardware when the core reads the SPIxBUF location, reading SPIxRXB.

Enhanced Buffer mode:
Automatically set in hardware when SPIx transfers data from SPIxSR to the buffer, filling the last unread buffer location. Automatically cleared in hardware when a buffer location is available for a transfer from SPIxSR.

FIGURE 22-1: CANx MODULE BLOCK DIAGRAM



22.2 Modes of Operation

The CANx module can operate in one of several operation modes selected by the user. These modes include:

- Initialization mode
- Disable mode
- Normal Operation mode
- Listen Only mode
- Listen All Messages mode
- Loopback mode

Modes are requested by setting the REQOP<2:0> bits (CxCTRL1<10:8>). Entry into a mode is Acknowledged by monitoring the OPMODE<2:0> bits (CxCTRL1<7:5>). The module does not change the mode and the OPMODEx bits until a change in mode is acceptable, generally during bus Idle time, which is defined as at least 11 consecutive recessive bits.

TABLE 27-1: CONFIGURATION WORD REGISTER MAP (CONTINUED)

File 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
FDMTINTVL	0057AC	32	—	DMTIVT<15:0>															
	00ABAC	64																	
	0157AC	128																	
	02ABAC	256																	
FDMTINTVH	0057B0	32	—	DMTIVT<31:16>															
	00ABB0	64																	
	0157B0	128																	
	02ABB0	256																	
FDMTCNTL	0057B4	32	—	DMTCNT<15:0>															
	00ABB4	64																	
	0157B4	128																	
	02ABB4	256																	
FDMTCNTH	0057B8	32	—	DMTCNT<31:16>															
	00AB8	64																	
	0157B8	128																	
	02ABB8	256																	
FDMT	0057BC	32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	DMTEN
	00ABBC	64																	
	0157BC	128																	
	02ABBC	256																	
FDEVOPT	0057C0	32	—	—	—	—	—	—	—	—	—	—	—	—	—	ALTI2C1	Reserved(2)	—	PWMLOCK
	00ABC0	64																	
	0157C0	128																	
	02ABC0	256																	
FALTREG	0057C4	32	—	—	—	—	—	—	—	—	—	—	CTXT2<2:0>			—	CTXT1<2:0>		
	00ABC4	64																	
	0157C4	128																	
	02ABC4	256																	

Legend: — = unimplemented, read as '1'.

Note 1: This bit is reserved and must be programmed as '0'.

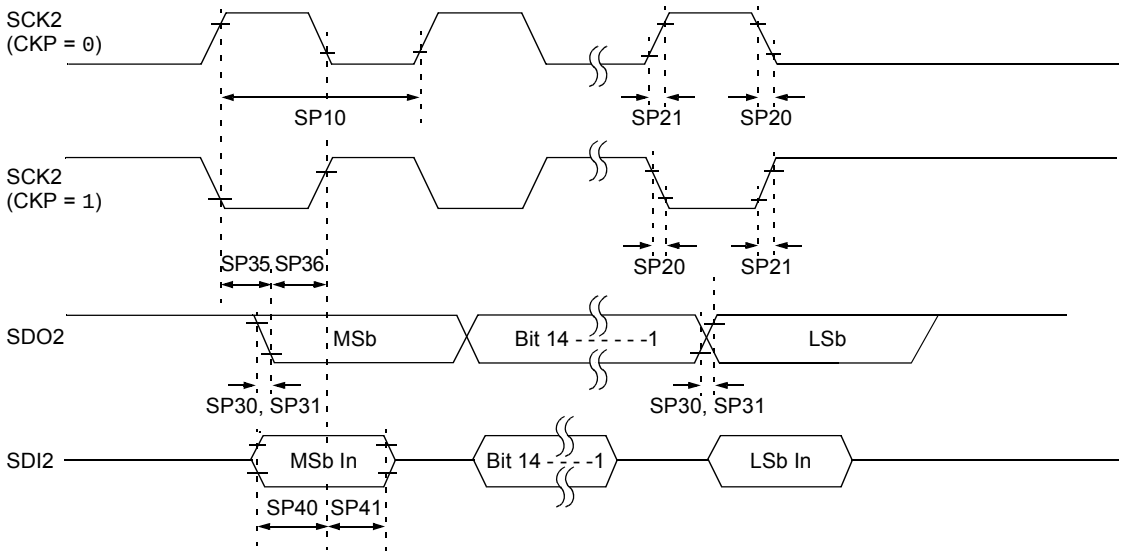
2: This bit is reserved and must be programmed as '1'.

TABLE 28-2: INSTRUCTION SET OVERVIEW (CONTINUED)

Base Instr #	Assembly Mnemonic	Assembly Syntax		Description	# of Words	# of Cycles	Status Flags Affected
46	MAC	MAC	Wm*Wn,Acc,Wx,Wxd,Wy,Wyd,AWB	Multiply and Accumulate	1	1	OA,OB,OAB, SA,SB,SAB
		MAC	Wm*Wm,Acc,Wx,Wxd,Wy,Wyd	Square and Accumulate	1	1	OA,OB,OAB, SA,SB,SAB
47	MOV	MOV	f,Wn	Move f to Wn	1	1	None
		MOV	f	Move f to f	1	1	None
		MOV	f,WREG	Move f to WREG	1	1	None
		MOV	#lit16,Wn	Move 16-bit literal to Wn	1	1	None
		MOV.b	#lit8,Wn	Move 8-bit literal to Wn	1	1	None
		MOV	Wn,f	Move Wn to f	1	1	None
		MOV	Wso,Wdo	Move Ws to Wd	1	1	None
		MOV	WREG,f	Move WREG to f	1	1	None
		MOV.D	Wns,Wd	Move Double from W(ns):W(ns + 1) to Wd	1	2	None
		MOV.D	Ws,Wnd	Move Double from Ws to W(nd + 1):W(nd)	1	2	None
48	MOVPAG	MOVPAG	#lit10,DSRPAG	Move 10-bit literal to DSRPAG	1	1	None
		MOVPAG	#lit9,DSWPAG	Move 9-bit literal to DSWPAG	1	1	None
		MOVPAG	#lit8,TBLPAG	Move 8-bit literal to TBLPAG	1	1	None
		MOVPAGW	Ws, DSRPAG	Move Ws<9:0> to DSRPAG	1	1	None
		MOVPAGW	Ws, DSWPAG	Move Ws<8:0> to DSWPAG	1	1	None
		MOVPAGW	Ws, TBLPAG	Move Ws<7:0> to TBLPAG	1	1	None
49	MOVSAC	MOVSAC	Acc,Wx,Wxd,Wy,Wyd,AWB	Prefetch and store accumulator	1	1	None
50	MPY	MPY	Wm*Wn,Acc,Wx,Wxd,Wy,Wyd	Multiply Wm by Wn to Accumulator	1	1	OA,OB,OAB, SA,SB,SAB
		MPY	Wm*Wm,Acc,Wx,Wxd,Wy,Wyd	Square Wm to Accumulator	1	1	OA,OB,OAB, SA,SB,SAB
51	MPY.N	MPY.N	Wm*Wn,Acc,Wx,Wxd,Wy,Wyd	-(Multiply Wm by Wn) to Accumulator	1	1	None
52	MSC	MSC	Wm*Wm,Acc,Wx,Wxd,Wy,Wyd,AWB	Multiply and Subtract from Accumulator	1	1	OA,OB,OAB, SA,SB,SAB

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

FIGURE 30-15: SPI2 MASTER MODE (FULL-DUPLEX, CKE = 0, CKP = x, SMP = 1) TIMING CHARACTERISTICS



Note: Refer to Figure 30-1 for load conditions.

TABLE 30-33: SPI2 MASTER MODE (FULL-DUPLEX, CKE = 0, CKP = x, SMP = 1) TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 4.5V to 5.5V (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 SCK2 Frequency	—	—	9	MHz	-40ºC to +125ºC and see **Note 3**
SP20	TscF	SCK2 Output Fall Time	—	—	—	ns	See Parameter DO32 and **Note 4**
SP21	TscR	SCK2 Output Rise Time	—	—	—	ns	See Parameter DO31 and **Note 4**
SP30	TdoF	SDO2 Data Output Fall Time	—	—	—	ns	See Parameter DO32 and **Note 4**
SP31	TdoR	SDO2 Data Output Rise Time	—	—	—	ns	See Parameter DO31 and **Note 4**
SP35	TscH2doV, TscL2doV	SDO2 Data Output Valid after SCK2 Edge	—	6	20	ns	
SP36	TdoV2scH, TdoV2scL	SDO2 Data Output Setup to First SCK2 Edge	30	—	—	ns	
SP40	TdiV2scH, TdiV2scL	Setup Time of SDI2 Data Input to SCK2 Edge	30	—	—	ns	
SP41	TscH2diL, TscL2diL	Hold Time of SDI2 Data Input to SCK2 Edge	30	—	—	ns	

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

2: Data in "Typ." column is at 5.0V, +25°C unless otherwise stated.

3: The minimum clock period for SCK2 is 111 ns. The clock generated in Master mode must not violate this specification.

4: Assumes 50 pF load on all SPI2 pins.

31.1 High-Temperature DC Characteristics

TABLE 31-1: OPERATING MIPS vs. VOLTAGE

Characteristic	VDD Range (in Volts)	Temperature Range (in °C)	Max MIPS
			dsPIC33EVXXXGM00X/10X Family
HDC5	4.5V to 5.5V(1,2)	-40°C to +150°C	40

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

2: When BOR is enabled, the device will work from 4.7V to 5.5V.

TABLE 31-2: THERMAL OPERATING CONDITIONS

Rating	Symbol	Min	Typ	Max	Unit
High-Temperature Devices					
Operating Junction Temperature Range	TJ	-40	—	+155	°C
Operating Ambient Temperature Range	TA	-40	—	+150	°C
Power Dissipation: Internal Chip Power Dissipation: PINT = VDD x (IDD – Σ IOH) I/O Pin Power Dissipation: I/O = Σ ({VDD – VOH} x IOH) + Σ (VOL x IOL)	PD	PINT + PI/O			W
Maximum Allowed Power Dissipation	PDMAX	(TJ – TA)/θJA			W

TABLE 31-3: DC TEMPERATURE AND VOLTAGE SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions (see Note 3): 4.5V to 5.5V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +150°C for High Temperature				
Param No.	Symbol	Characteristic	Min.	Typ.(1)	Max.	Units	Conditions
Operating Voltage							
HDC10	VDD	**Supply Voltage(3)**	VBOR	—	5.5	V	
HDC12	VDR	**RAM Data Retention Voltage(2)**	1.8	—	—	V	
HDC16	VPOR	**VDD Start Voltage** to Ensure Internal Power-on Reset Signal	—	—	VSS	V	
HDC17	SVDD	**VDD Rise Rate** to Ensure Internal Power-on Reset Signal	1.0	—	—	V/ms	0V-5.0V in 5 ms
HDC18	VCORE	**VDD Core** Internal Regulator Voltage	1.62	1.8	1.98	V	Voltage is dependent on load, temperature and VDD

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

2: This is the limit to which VDD may be lowered without losing RAM data.

3: VDD voltage must remain at VSS for a minimum of 200 μs to ensure POR.

FIGURE 32-11: TYPICAL IIDLE vs. VDD (EC MODE, 60 MIPS)

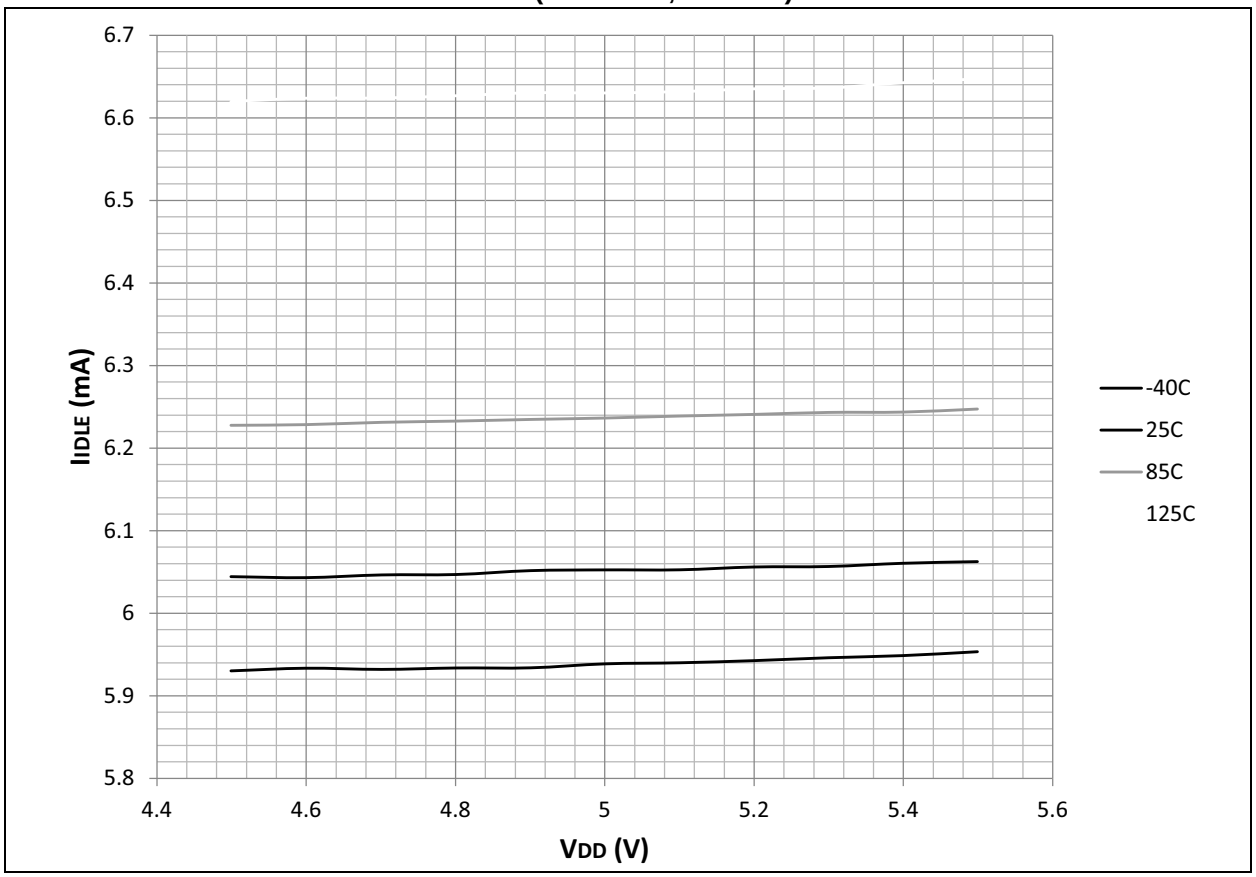
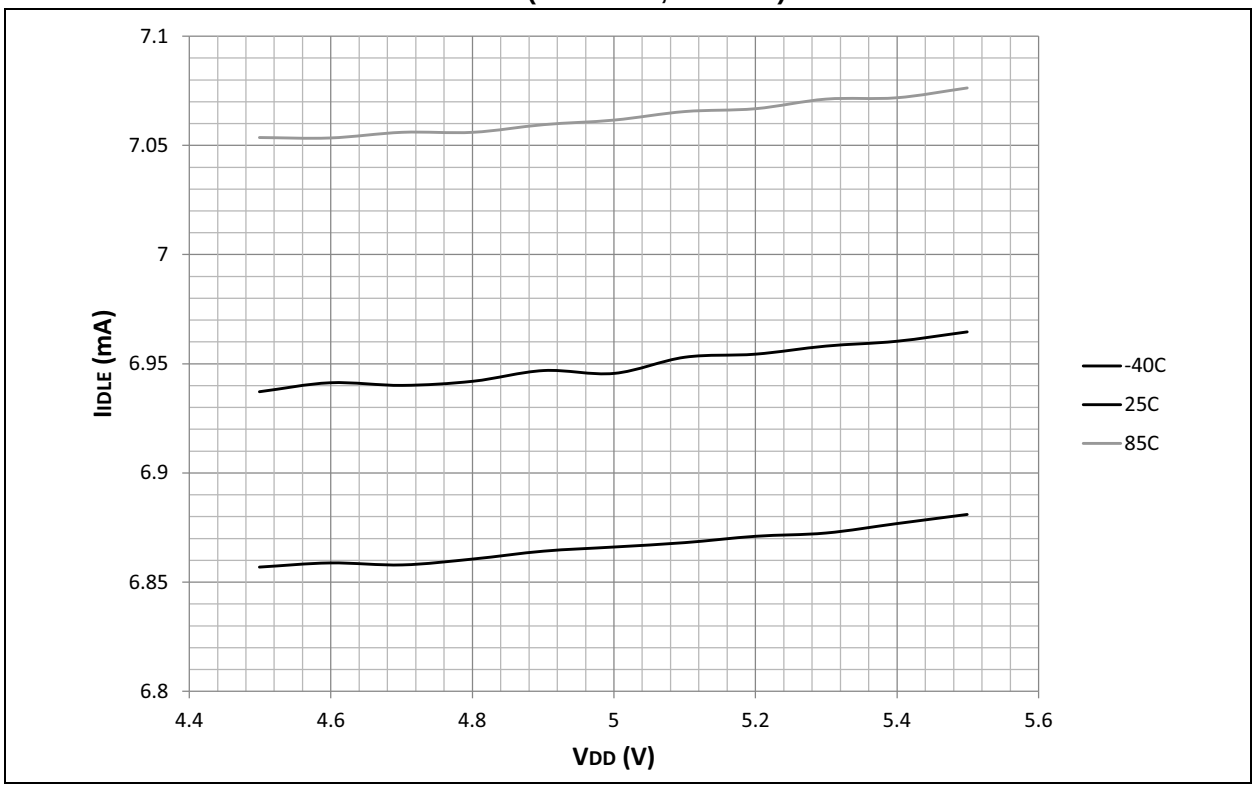
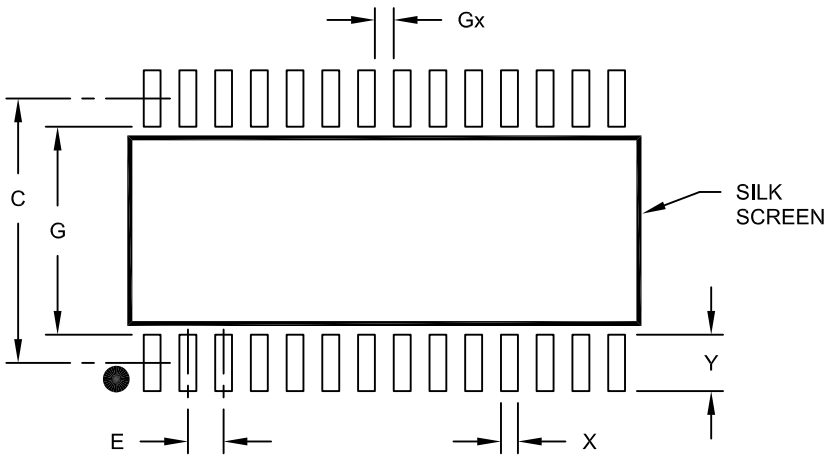


FIGURE 32-12: TYPICAL IIDLE vs. VDD (EC MODE, 70 MIPS)



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:

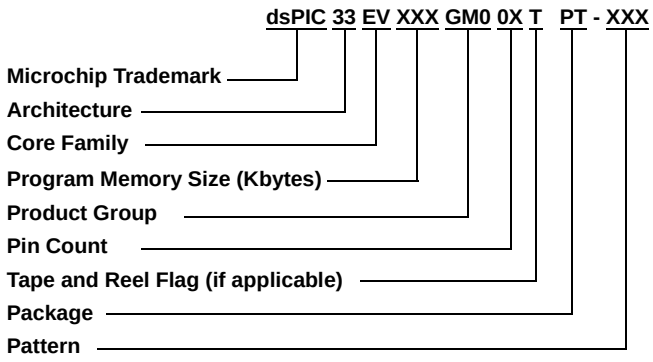
1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2052A

PRODUCT IDENTIFICATION SYSTEM

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



Example:

dsPIC33EV256GM006-I/PT:
dsPIC33, Enhanced Voltage,
256-Kbyte Program Memory, 64-Pin,
Industrial Temperature, TQFP Package.

Architecture:	33	=	16-Bit Digital Signal Controller
Family:	EV	=	Enhanced Voltage
Product Group:	GM	=	General Purpose plus Motor Control Family
Pin Count:	02	=	28-Pin
	04	=	44-Pin
	06	=	64-Pin
Temperature Range	I	=	-40°C to +85°C (Industrial)
	E	=	-40°C to +125°C (Extended)
	H	=	-40°C to +150°C (High)
Package:	MM	=	Plastic Quad Flat, No Lead Package – (28-pin) 6x6x0.9 mm body (QFN-S)
	SO	=	Plastic Small Outline – (28-pin) 7.50 mm body (SOIC)
	SS	=	Plastic Shrink Small Outline – (28-pin) 5.30 mm body (SSOP)
	SP	=	Skinny Plastic Dual In-Line – (28-pin) 300 mil body (SPDIP)
	ML	=	Plastic Quad Flat, No Lead Package – (44-pin) 8x8 mm body (QFN)
	MR	=	Plastic Quad Flat, No Lead Package – (64-pin) 9x9x0.9 mm body (QFN)
	PT	=	Plastic Thin Quad Flatpack – (44-pin) 10x10x1 mm body (TQFP)
	PT	=	Plastic Thin Quad Flatpack – (64-pin) 10x10x1 mm body (TQFP)