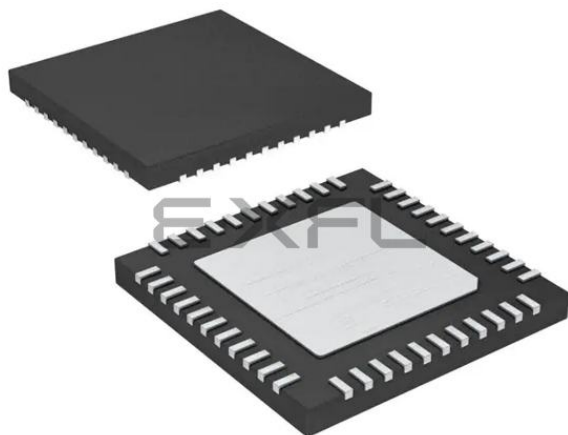




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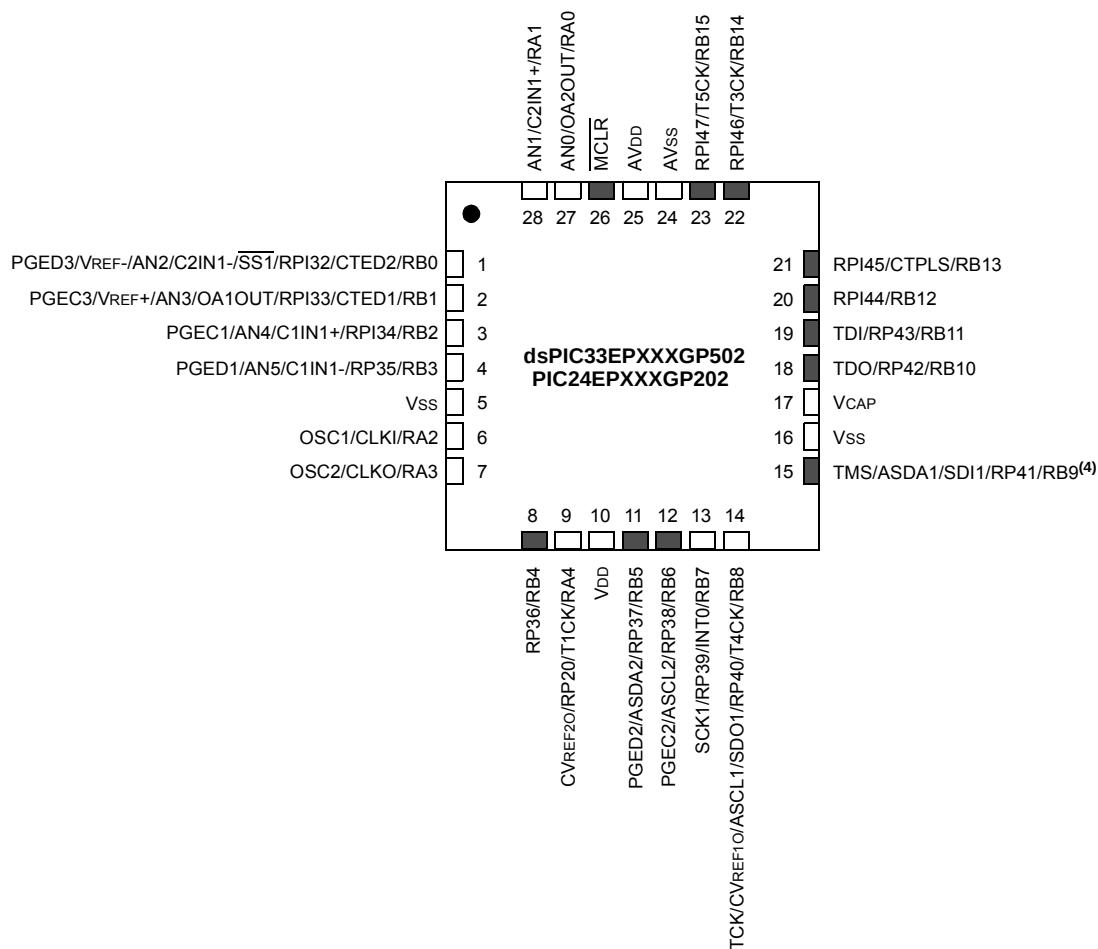
Details

Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	70 MIPS
Connectivity	CANbus, I ² C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	35
Program Memory Size	512KB (170K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	24K x 16
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 9x10b/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	44-VQFN Exposed Pad
Supplier Device Package	44-QFN (8x8)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33ep512gp504-i-ml

Pin Diagrams (Continued)

28-Pin QFN-S^(1,2,3)

■ = 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.
- Note 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.
- Note 3:** The metal pad at the bottom of the device is not connected to any pins and is recommended to be connected to Vss externally.
- Note 4:** There is an internal pull-up resistor connected to the TMS pin when the JTAG interface is active. See the JTAGEN bit field in Table 27-2.

FIGURE 4-16: DATA MEMORY MAP FOR PIC24EP512GP/MC20X/50X DEVICES

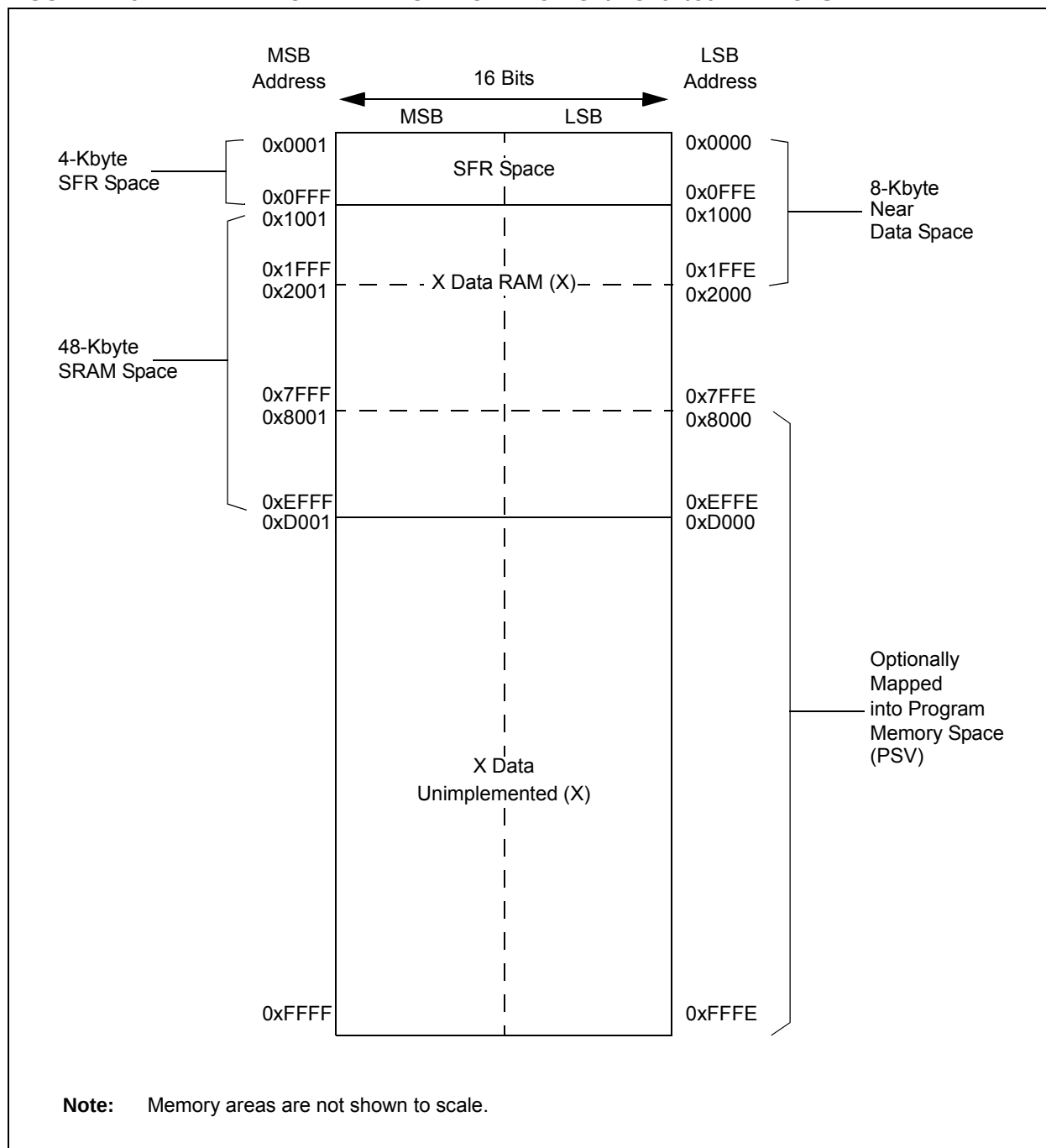


TABLE 4-5: INTERRUPT CONTROLLER REGISTER MAP FOR dsPIC33EPXXXGP50X DEVICES ONLY

File 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
IFS0	0800	—	DMA1IF	AD1IF	U1TXIF	U1RXIF	SPI1IF	SPI1EIF	T3IF	T2IF	OC2IF	IC2IF	DMA0IF	T1IF	OC1IF	IC1IF	INT0IF	0000
IFS1	0802	U2TXIF	U2RXIF	INT2IF	T5IF	T4IF	OC4IF	OC3IF	DMA2IF	—	—	—	INT1IF	CNIF	CMIF	MI2C1IF	SI2C1IF	0000
IFS2	0804	—	—	—	—	—	—	—	—	—	IC4IF	IC3IF	DMA3IF	C1IF	C1RXIF	SPI2IF	SPI2EIF	0000
IFS3	0806	—	—	—	—	—	—	—	—	—	—	—	—	—	MI2C2IF	SI2C2IF	—	0000
IFS4	0808	—	—	CTMUIF	—	—	—	—	—	—	C1TXIF	—	—	CRCIF	U2EIF	U1EIF	—	0000
IFS6	080C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IF	0000
IFS8	0810	JTAGIF	ICDIF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IFS9	0812	—	—	—	—	—	—	—	—	—	PTG3IF	PTG2IF	PTG1IF	PTG0IF	PTGWDTIF	PTGSTIEIF	—	0000
IEC0	0820	—	DMA1IE	AD1IE	U1TXIE	U1RXIE	SPI1IE	SPI1EIE	T3IE	T2IE	OC2IE	IC2IE	DMA0IE	T1IE	OC1IE	IC1IE	INT0IE	0000
IEC1	0822	U2TXIE	U2RXIE	INT2IE	T5IE	T4IE	OC4IE	OC3IE	DMA2IE	—	—	—	INT1IE	CNIE	CMIE	MI2C1IE	SI2C1IE	0000
IEC2	0824	—	—	—	—	—	—	—	—	—	IC4IE	IC3IE	DMA3IE	C1IE	C1RXIE	SPI2IE	SPI2EIE	0000
IEC3	0826	—	—	—	—	—	—	—	—	—	—	—	—	—	MI2C2IE	SI2C2IE	—	0000
IEC4	0828	—	—	CTMUIE	—	—	—	—	—	—	C1TXIE	—	—	CRCIE	U2EIE	U1EIE	—	0000
IEC8	0830	JTAGIE	ICDIE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IEC9	0832	—	—	—	—	—	—	—	—	—	PTG3IE	PTG2IE	PTG1IE	PTG0IE	PTGWDTIE	PTGSTIEIE	—	0000
IPC0	0840	—	T1IP<2:0>			—	OC1IP<2:0>			—	IC1IP<2:0>			—	INT0IP<2:0>			4444
IPC1	0842	—	T2IP<2:0>			—	OC2IP<2:0>			—	IC2IP<2:0>			—	DMA0IP<2:0>			4444
IPC2	0844	—	U1RXIP<2:0>			—	SPI1IP<2:0>			—	SPI1EIP<2:0>			—	T3IP<2:0>			4444
IPC3	0846	—	—	—	—	—	DMA1IP<2:0>			—	AD1IP<2:0>			—	U1TXIP<2:0>			0444
IPC4	0848	—	CNIP<2:0>			—	CMIP<2:0>			—	MI2C1IP<2:0>			—	SI2C1IP<2:0>			4444
IPC5	084A	—	—	—	—	—	—	—	—	—	—	—	—	—	INT1IP<2:0>			0004
IPC6	084C	—	T4IP<2:0>			—	OC4IP<2:0>			—	OC3IP<2:0>			—	DMA2IP<2:0>			4444
IPC7	084E	—	U2TXIP<2:0>			—	U2RXIP<2:0>			—	INT2IP<2:0>			—	T5IP<2:0>			4444
IPC8	0850	—	C1IP<2:0>			—	C1RXIP<2:0>			—	SPI2IP<2:0>			—	SPI2EIP<2:0>			4444
IPC9	0852	—	—	—	—	—	IC4IP<2:0>			—	IC3IP<2:0>			—	DMA3IP<2:0>			0444
IPC11	0856	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IPC12	0858	—	—	—	—	—	MI2C2IP<2:0>			—	SI2C2IP<2:0>			—	—	—	—	0440
IPC16	0860	—	CRCIP<2:0>			—	U2EIP<2:0>			—	U1EIP<2:0>			—	—	—	—	4440
IPC17	0862	—	—	—	—	—	C1TXIP<2:0>			—	—	—	—	—	—	—	—	0400
IPC19	0866	—	—	—	—	—	—	—	—	—	CTMUIP<2:0>			—	—	—	—	0040
IPC35	0886	—	JTAGIP<2:0>			—	ICDIP<2:0>			—	—	—	—	—	—	—	—	4400
IPC36	0888	—	PTG0IP<2:0>			—	PTGWDIP<2:0>			—	PTGSTIEIP<2:0>			—	—	—	—	4440
IPC37	088A	—	—	—	—	—	PTG3IP<2:0>			—	PTG2IP<2:0>			—	PTG1IP<2:0>			0444

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

TABLE 4-5: INTERRUPT CONTROLLER REGISTER MAP FOR dsPIC33EPXXXGP50X DEVICES ONLY (CONTINUED)

File 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
INTCON1	08C0	NSTDIS	OVAERR	OVBERR	COVAERR	COVBERR	OVATE	OVBT	COVTE	SFTACERR	DIV0ERR	DMACERR	MATHERR	ADDRERR	STKERR	OSCFAIL	—	0000
INTCON2	08C2	GIE	DISI	SWTRAP	—	—	—	—	—	—	—	—	—	—	INT2EP	INT1EP	INT0EP	8000
INTCON3	08C4	—	—	—	—	—	—	—	—	—	—	DAE	DOOVR	—	—	—	—	0000
INTCON4	08C6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	SGHT	0000
INTTREG	08C8	—	—	—	—	ILR<3:0>				VECNUM<7:0>								0000

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

TABLE 4-6: INTERRUPT CONTROLLER REGISTER MAP FOR dsPIC33EPXXXMC20X DEVICES ONLY

File 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
IFS0	0800	—	DMA1IF	AD1IF	U1TXIF	U1RXIF	SPI1IF	SPI1EIF	T3IF	T2IF	OC2IF	IC2IF	DMA0IF	T1IF	OC1IF	IC1IF	INT0IF	0000
IFS1	0802	U2TXIF	U2RXIF	INT2IF	T5IF	T4IF	OC4IF	OC3IF	DMA2IF	—	—	—	INT1IF	CNIF	CMIF	MI2C1IF	SI2C1IF	0000
IFS2	0804	—	—	—	—	—	—	—	—	—	IC4IF	IC3IF	DMA3IF	—	—	SPI2IF	SPI2EIF	0000
IFS3	0806	—	—	—	—	—	QE11IF	PSEMIF	—	—	—	—	—	—	MI2C2IF	SI2C2IF	—	0000
IFS4	0808	—	—	CTMUIF	—	—	—	—	—	—	—	—	—	CRCIF	U2EIF	U1EIF	—	0000
IFS5	080A	PWM2IF	PWM1IF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IFS6	080C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IF	0000
IFS8	0810	JTAGIF	ICDIF	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IFS9	0812	—	—	—	—	—	—	—	—	—	PTG3IF	PTG2IF	PTG1IF	PTG0IF	PTGWDTIF	PTGSTIEIF	—	0000
IEC0	0820	—	DMA1IE	AD1IE	U1TXIE	U1RXIE	SPI1IE	SPI1EIE	T3IE	T2IE	OC2IE	IC2IE	DMA0IE	T1IE	OC1IE	IC1IE	INT0IE	0000
IEC1	0822	U2TXIE	U2RXIE	INT2IE	T5IE	T4IE	OC4IE	OC3IE	DMA2IE	—	—	—	INT1IE	CNIE	CMIE	MI2C1IE	SI2C1IE	0000
IEC2	0824	—	—	—	—	—	—	—	—	—	IC4IE	IC3IE	DMA3IE	—	—	SPI2IE	SPI2EIE	0000
IEC3	0826	—	—	—	—	—	QE11IE	PSEMIE	—	—	—	—	—	—	MI2C2IE	SI2C2IE	—	0000
IEC4	0828	—	—	CTMUIE	—	—	—	—	—	—	—	—	—	CRCIE	U2EIE	U1EIE	—	0000
IEC5	082A	PWM2IE	PWM1IE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IEC6	082C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IE	0000
IEC8	0830	JTAGIE	ICDIE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
IEC9	0832	—	—	—	—	—	—	—	—	—	PTG3IE	PTG2IE	PTG1IE	PTG0IE	PTGWDTIE	PTGSTIEIE	—	0000
IPC0	0840	—	T1IP<2:0>			—	OC1IP<2:0>			—	IC1IP<2:0>			—	INT0IP<2:0>			4444
IPC1	0842	—	T2IP<2:0>			—	OC2IP<2:0>			—	IC2IP<2:0>			—	DMA0IP<2:0>			4444
IPC2	0844	—	U1RXIP<2:0>			—	SPI1IP<2:0>			—	SPI1EIP<2:0>			—	T3IP<2:0>			4444
IPC3	0846	—	—	—	—	—	DMA1IP<2:0>			—	AD1IP<2:0>			—	U1TXIP<2:0>			0444
IPC4	0848	—	CNIP<2:0>			—	CMIP<2:0>			—	MI2C1IP<2:0>			—	SI2C1IP<2:0>			4444
IPC5	084A	—	—	—	—	—	—	—	—	—	—	—	—	—	INT1IP<2:0>			0004
IPC6	084C	—	T4IP<2:0>			—	OC4IP<2:0>			—	OC3IP<2:0>			—	DMA2IP<2:0>			4444
IPC7	084E	—	U2TXIP<2:0>			—	U2RXIP<2:0>			—	INT2IP<2:0>			—	T5IP<2:0>			4444
IPC8	0850	—	—	—	—	—	C1RXIP<2:0>			—	SPI2IP<2:0>			—	SPI2EIP<2:0>			0444
IPC9	0852	—	—	—	—	—	IC4IP<2:0>			—	IC3IP<2:0>			—	DMA3IP<2:0>			0444
IPC12	0858	—	—	—	—	—	MI2C2IP<2:0>			—	SI2C2IP<2:0>			—	—	—	—	0440
IPC14	085C	—	—	—	—	—	QE11IP<2:0>			—	PSEMIP<2:0>			—	—	—	—	0440
IPC16	0860	—	CRCIP<2:0>			—	U2EIP<2:0>			—	U1EIP<2:0>			—	—	—	—	4440
IPC19	0866	—	—	—	—	—	—	—	—	—	CTMUIP<2:0>			—	—	—	—	0040
IPC23	086E	—	PWM2IP<2:0>			—	PWM1IP<2:0>			—	—	—	—	—	—	—	—	4400
IPC24	0870	—	—	—	—	—	—	—	—	—	—	—	—	—	PWM3IP<2:0>			0004

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

TABLE 4-10: OUTPUT COMPARE 1 THROUGH OUTPUT COMPARE 4 REGISTER MAP

File 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
OC1CON1	0900	—	—	OCSIDL	OCTSEL<2:0>			—	ENFLTB	ENFLTA	—	OCFLTB	OCFLTA	TRIGMODE	OCM<2:0>			0000
OC1CON2	0902	FLTMD	FLTOUT	FLTTRIEN	OCINV	—	—	—	OC32	OCTRIG	TRIGSTAT	OCTRIS	SYNCSEL<4:0>					000C
OC1RS	0904	Output Compare 1 Secondary Register																xxxx
OC1R	0906	Output Compare 1 Register																xxxx
OC1TMR	0908	Timer Value 1 Register																xxxx
OC2CON1	090A	—	—	OCSIDL	OCTSEL<2:0>			—	ENFLTB	ENFLTA	—	OCFLTB	OCFLTA	TRIGMODE	OCM<2:0>			0000
OC2CON2	090C	FLTMD	FLTOUT	FLTTRIEN	OCINV	—	—	—	OC32	OCTRIG	TRIGSTAT	OCTRIS	SYNCSEL<4:0>					000C
OC2RS	090E	Output Compare 2 Secondary Register																xxxx
OC2R	0910	Output Compare 2 Register																xxxx
OC2TMR	0912	Timer Value 2 Register																xxxx
OC3CON1	0914	—	—	OCSIDL	OCTSEL<2:0>			—	ENFLTB	ENFLTA	—	OCFLTB	OCFLTA	TRIGMODE	OCM<2:0>			0000
OC3CON2	0916	FLTMD	FLTOUT	FLTTRIEN	OCINV	—	—	—	OC32	OCTRIG	TRIGSTAT	OCTRIS	SYNCSEL<4:0>					000C
OC3RS	0918	Output Compare 3 Secondary Register																xxxx
OC3R	091A	Output Compare 3 Register																xxxx
OC3TMR	091C	Timer Value 3 Register																xxxx
OC4CON1	091E	—	—	OCSIDL	OCTSEL<2:0>			—	ENFLTB	ENFLTA	—	OCFLTB	OCFLTA	TRIGMODE	OCM<2:0>			0000
OC4CON2	0920	FLTMD	FLTOUT	FLTTRIEN	OCINV	—	—	—	OC32	OCTRIG	TRIGSTAT	OCTRIS	SYNCSEL<4:0>					000C
OC4RS	0922	Output Compare 4 Secondary Register																xxxx
OC4R	0924	Output Compare 4 Register																xxxx
OC4TMR	0926	Timer Value 4 Register																xxxx

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

TABLE 4-16: QE1 REGISTER MAP FOR dsPIC33EPXXXMC20X/50X AND PIC24EPXXXMC20X DEVICES ONLY

File 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
QE1CON	01C0	QE1EN	—	QE1SIDL	PIMOD<2:0>			IMV<1:0>		—	INTDIV<2:0>			CNTPOL	GATEN	CCM<1:0>		0000
QE1IOC	01C2	QCAPEN	FLTREN	QFDIV<2:0>			OUTFNC<1:0>		SWPAB	HOMPOL	IDXPOL	QEBPOL	QEAPOL	HOME	INDEX	QEB	QEA	000x
QE1STAT	01C4	—	—	PCHEQIRQ	PCHEQIEN	PCLEQIRQ	PCLEQIEN	POSOVIRQ	POSOVIEN	PCIIRQ	PCIEN	VELOVIRQ	VELOVIEN	HOMIRQ	HOMIEN	IDXIRQ	IDXIEN	0000
POS1CNTL	01C6	POSCNT<15:0>																0000
POS1CNTH	01C8	POSCNT<31:16>																0000
POS1HLD	01CA	POSHLD<15:0>																0000
VEL1CNT	01CC	VELCNT<15:0>																0000
INT1TMRL	01CE	INTTMR<15:0>																0000
INT1TMRH	01D0	INTTMR<31:16>																0000
INT1HLDL	01D2	INTHLD<15:0>																0000
INT1HLDH	01D4	INTHLD<31:16>																0000
INDX1CNTL	01D6	INDXCNT<15:0>																0000
INDX1CNTH	01D8	INDXCNT<31:16>																0000
INDX1HLD	01DA	INDXHLD<15:0>																0000
QE1GECL	01DC	QEIGEC<15:0>																0000
QE1ICL	01DC	QEIIC<15:0>																0000
QE1GECH	01DE	QEIGEC<31:16>																0000
QE1ICH	01DE	QEIIC<31:16>																0000
QE1LECL	01E0	QEILEC<15:0>																0000
QE1LECH	01E2	QEILEC<31:16>																0000

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

TABLE 4-39: PMD REGISTER MAP FOR dsPIC33EPXXXGP50X DEVICES ONLY

File 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
PMD1	0760	T5MD	T4MD	T3MD	T2MD	T1MD	—	—	—	I2C1MD	U2MD	U1MD	SPI2MD	SPI1MD	—	C1MD	AD1MD	0000
PMD2	0762	—	—	—	—	IC4MD	IC3MD	IC2MD	IC1MD	—	—	—	—	OC4MD	OC3MD	OC2MD	OC1MD	0000
PMD3	0764	—	—	—	—	—	CMPMD	—	—	CRCMD	—	—	—	—	—	I2C2MD	—	0000
PMD4	0766	—	—	—	—	—	—	—	—	—	—	—	—	REFOMD	CTMUMD	—	—	0000
PMD6	076A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
PMD7	076C	—	—	—	—	—	—	—	—	—	—	—	DMA0MD	PTGMD	—	—	—	0000
													DMA1MD					
													DMA2MD					
													DMA3MD					

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

TABLE 4-40: PMD REGISTER MAP FOR dsPIC33EPXXXMC50X DEVICES ONLY

File 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
PMD1	0760	T5MD	T4MD	T3MD	T2MD	T1MD	QE1MD	PWMMD	—	I2C1MD	U2MD	U1MD	SPI2MD	SPI1MD	—	C1MD	AD1MD	0000
PMD2	0762	—	—	—	—	IC4MD	IC3MD	IC2MD	IC1MD	—	—	—	—	OC4MD	OC3MD	OC2MD	OC1MD	0000
PMD3	0764	—	—	—	—	—	CMPMD	—	—	CRCMD	—	—	—	—	—	I2C2MD	—	0000
PMD4	0766	—	—	—	—	—	—	—	—	—	—	—	—	REFOMD	CTMUMD	—	—	0000
PMD6	076A	—	—	—	—	—	PWM3MD	PWM2MD	PWM1MD	—	—	—	—	—	—	—	—	0000
PMD7	076C	—	—	—	—	—	—	—	—	—	—	—	DMA0MD	PTGMD	—	—	—	0000
													DMA1MD					
													DMA2MD					
													DMA3MD					

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

In addition, DMA transfers can be triggered by timers as well as external interrupts. Each DMA channel is unidirectional. Two DMA channels must be allocated to read and write to a peripheral. If more than one channel receives a request to transfer data, a simple fixed priority scheme based on channel number, dictates which channel completes the transfer and which channel, or channels, are left pending. Each DMA channel moves a block of data, after which, it generates an interrupt to the CPU to indicate that the block is available for processing.

The DMA Controller provides these functional capabilities:

- Four DMA channels
- Register Indirect with Post-Increment Addressing mode
- Register Indirect without Post-Increment Addressing mode

- Peripheral Indirect Addressing mode (peripheral generates destination address)
- CPU interrupt after half or full block transfer complete
- Byte or word transfers
- Fixed priority channel arbitration
- Manual (software) or automatic (peripheral DMA requests) transfer initiation
- One-Shot or Auto-Repeat Block Transfer modes
- Ping-Pong mode (automatic switch between two SRAM start addresses after each block transfer is complete)
- DMA request for each channel can be selected from any supported interrupt source
- Debug support features

The peripherals that can utilize DMA are listed in Table 8-1.

TABLE 8-1: DMA CHANNEL TO PERIPHERAL ASSOCIATIONS

Peripheral to DMA Association	DMAxREQ Register IRQSEL<7:0> Bits	DMAxPAD Register (Values to Read from Peripheral)	DMAxPAD Register (Values to Write to Peripheral)
INT0 – External Interrupt 0	00000000	—	—
IC1 – Input Capture 1	00000001	0x0144 (IC1BUF)	—
IC2 – Input Capture 2	00000101	0x014C (IC2BUF)	—
IC3 – Input Capture 3	00100101	0x0154 (IC3BUF)	—
IC4 – Input Capture 4	00100110	0x015C (IC4BUF)	—
OC1 – Output Compare 1	00000010	—	0x0906 (OC1R) 0x0904 (OC1RS)
OC2 – Output Compare 2	00000110	—	0x0910 (OC2R) 0x090E (OC2RS)
OC3 – Output Compare 3	00011001	—	0x091A (OC3R) 0x0918 (OC3RS)
OC4 – Output Compare 4	00011010	—	0x0924 (OC4R) 0x0922 (OC4RS)
TMR2 – Timer2	00000111	—	—
TMR3 – Timer3	00001000	—	—
TMR4 – Timer4	00011011	—	—
TMR5 – Timer5	00011100	—	—
SPI1 Transfer Done	00001010	0x0248 (SPI1BUF)	0x0248 (SPI1BUF)
SPI2 Transfer Done	00100001	0x0268 (SPI2BUF)	0x0268 (SPI2BUF)
UART1RX – UART1 Receiver	00001011	0x0226 (U1RXREG)	—
UART1TX – UART1 Transmitter	00001100	—	0x0224 (U1TXREG)
UART2RX – UART2 Receiver	00011110	0x0236 (U2RXREG)	—
UART2TX – UART2 Transmitter	00011111	—	0x0234 (U2TXREG)
ECAN1 – RX Data Ready	00100010	0x0440 (C1RXD)	—
ECAN1 – TX Data Request	01000110	—	0x0442 (C1TXD)
ADC1 – ADC1 Convert Done	00001101	0x0300 (ADC1BUF0)	—

REGISTER 10-5: PMD6: PERIPHERAL MODULE DISABLE CONTROL REGISTER 6

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	PWM3MD ⁽¹⁾	PWM2MD ⁽¹⁾	PWM1MD ⁽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 15-11 **Unimplemented:** Read as '0'

bit 10 **PWM3MD:** PWM3 Module Disable bit⁽¹⁾

1 = PWM3 module is disabled

0 = PWM3 module is enabled

bit 9 **PWM2MD:** PWM2 Module Disable bit⁽¹⁾

1 = PWM2 module is disabled

0 = PWM2 module is enabled

bit 8 **PWM1MD:** PWM1 Module Disable bit⁽¹⁾

1 = PWM1 module is disabled

0 = PWM1 module is enabled

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

Note 1: This bit is available on dsPIC33EPXXXMC50X/20X and PIC24EPXXXMC20X devices only.

NOTES:

REGISTER 17-15: QE1GEC: QE1 GREATER THAN OR EQUAL COMPARE HIGH WORD 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
QEIGEC<31:24>							
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
QEIGEC<23:16>							
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 **QEIGEC<31:16>**: High Word Used to Form 32-Bit Greater Than or Equal Compare Register (QE1GEC) bits

REGISTER 17-16: QE1GECL: QE1 GREATER THAN OR EQUAL COMPARE LOW WORD 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
QEIGEC<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
QEIGEC<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 **QEIGEC<15:0>**: Low Word Used to Form 32-Bit Greater Than or Equal Compare Register (QE1GEC) bits

29.0 DEVELOPMENT SUPPORT

The PIC® microcontrollers (MCU) and dsPIC® digital signal controllers (DSC) are supported with a full range of software and hardware development tools:

- Integrated Development Environment
 - MPLAB® X IDE Software
- Compilers/Assemblers/Linkers
 - MPLAB XC Compiler
 - MPASM™ Assembler
 - MPLINK™ Object Linker/
MPLIB™ Object Librarian
 - MPLAB Assembler/Linker/Librarian for
Various Device Families
- Simulators
 - MPLAB X SIM Software Simulator
- Emulators
 - MPLAB REAL ICE™ In-Circuit Emulator
- In-Circuit Debuggers/Programmers
 - MPLAB ICD 3
 - PICKit™ 3
- Device Programmers
 - MPLAB PM3 Device Programmer
- Low-Cost Demonstration/Development Boards,
Evaluation Kits and Starter Kits
- Third-party development tools

29.1 MPLAB X Integrated Development Environment Software

The MPLAB X IDE is a single, unified graphical user interface for Microchip and third-party software, and hardware development tool that runs on Windows®, Linux and Mac OS® X. Based on the NetBeans IDE, MPLAB X IDE is an entirely new IDE with a host of free software components and plug-ins for high-performance application development and debugging. Moving between tools and upgrading from software simulators to hardware debugging and programming tools is simple with the seamless user interface.

With complete project management, visual call graphs, a configurable watch window and a feature-rich editor that includes code completion and context menus, MPLAB X IDE is flexible and friendly enough for new users. With the ability to support multiple tools on multiple projects with simultaneous debugging, MPLAB X IDE is also suitable for the needs of experienced users.

Feature-Rich Editor:

- Color syntax highlighting
- Smart code completion makes suggestions and provides hints as you type
- Automatic code formatting based on user-defined rules
- Live parsing

User-Friendly, Customizable Interface:

- Fully customizable interface: toolbars, toolbar buttons, windows, window placement, etc.
- Call graph window

Project-Based Workspaces:

- Multiple projects
- Multiple tools
- Multiple configurations
- Simultaneous debugging sessions

File History and Bug Tracking:

- Local file history feature
- Built-in support for Bugzilla issue tracker

TABLE 30-6: DC CHARACTERISTICS: OPERATING CURRENT (I_{DD})

DC 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			
Parameter No.	Typ.	Max.	Units	Conditions		
Operating Current (IDD) ⁽¹⁾						
DC20d	9	15	mA	-40°C	3.3V	10 MIPS
DC20a	9	15	mA	+25°C		
DC20b	9	15	mA	+85°C		
DC20c	9	15	mA	+125°C		
DC22d	16	25	mA	-40°C	3.3V	20 MIPS
DC22a	16	25	mA	+25°C		
DC22b	16	25	mA	+85°C		
DC22c	16	25	mA	+125°C		
DC24d	27	40	mA	-40°C	3.3V	40 MIPS
DC24a	27	40	mA	+25°C		
DC24b	27	40	mA	+85°C		
DC24c	27	40	mA	+125°C		
DC25d	36	55	mA	-40°C	3.3V	60 MIPS
DC25a	36	55	mA	+25°C		
DC25b	36	55	mA	+85°C		
DC25c	36	55	mA	+125°C		
DC26d	41	60	mA	-40°C	3.3V	70 MIPS
DC26a	41	60	mA	+25°C		
DC26b	41	60	mA	+85°C		

Note 1: I_{DD} is primarily a function of the operating voltage and frequency. Other factors, such as I/O pin loading and switching rate, oscillator type, internal code execution pattern and temperature, also have an impact on the current consumption. The test conditions for all I_{DD} measurements are as follows:

- Oscillator is configured in EC mode with PLL, OSC1 is driven with external square wave from rail-to-rail (EC clock overshoot/undershoot < 250 mV required)
- CLK0 is configured as an I/O input pin in the Configuration Word
- All I/O pins are configured as inputs and pulled to V_{SS}
- $\overline{\text{MCLR}} = V_{DD}$, WDT and FSCM are disabled
- CPU, SRAM, program memory and data memory are operational
- No peripheral modules are operating; however, every peripheral is being clocked (all PMDx bits are zeroed)
- CPU is executing `while(1){NOP();}` statement
- JTAG is disabled

TABLE 30-11: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS (CONTINUED)

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ for Extended				
Param No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions
DI60a	I _{ICL}	Input Low Injection Current	0	—	-5 ^(4,7)	mA	All pins except V _{DD} , V _{SS} , AV _{DD} , AV _{SS} , MCLR, VCAP and RB7
DI60b	I _{ICH}	Input High Injection Current	0	—	+5 ^(5,6,7)	mA	All pins except V _{DD} , V _{SS} , AV _{DD} , AV _{SS} , MCLR, VCAP, RB7 and all 5V tolerant pins ⁽⁶⁾
DI60c	ΣI_{ICT}	Total Input Injection Current (sum of all I/O and control pins)	-20 ⁽⁸⁾	—	+20 ⁽⁸⁾	mA	Absolute instantaneous sum of all $\pm$ input injection currents from all I/O pins ($ I_{ICL} + I_{ICH} $) $\leq \Sigma I_{ICT}$

- Note 1:** 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.
- 2:** Negative current is defined as current sourced by the pin.
- 3:** See the “Pin Diagrams” section for the 5V tolerant I/O pins.
- 4:** V_{IL} source < (V_{SS} – 0.3). Characterized but not tested.
- 5:** Non-5V tolerant pins V_{IH} source > (V_{DD} + 0.3), 5V tolerant pins V_{IH} source > 5.5V. Characterized but not tested.
- 6:** Digital 5V tolerant pins cannot tolerate any “positive” input injection current from input sources > 5.5V.
- 7:** Non-zero injection currents can affect the ADC results by approximately 4-6 counts.
- 8:** Any number and/or combination of I/O pins not excluded under I_{ICL} or I_{ICH} 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 30-48: SPI1 SLAVE MODE (FULL-DUPLEX, CKE = 0, CKP = 0, 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	—	—	11	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	30	—	—	ns	
SP40	TdiV2scH, TdiV2scL	Setup Time of SDI1 Data Input to SCK1 Edge	30	—	—	ns	
SP41	Tsch2diL, TscL2diL	Hold Time of SDI1 Data Input to SCK1 Edge	30	—	—	ns	
SP50	TssL2scH, TssL2scL	$\overline{SS1} \downarrow$ to SCK1 $\uparrow$ or SCK1 $\downarrow$ Input	120	—	—	ns	
SP51	TssH2doZ	$\overline{SS1} \uparrow$ to SDO1 Output High-Impedance	10	—	50	ns	(Note 4)
SP52	Tsch2ssH, TscL2ssH	$\overline{SS1} \uparrow$ 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 91 ns. Therefore, the SCK1 clock generated by the master must not violate this specification.

4: Assumes 50 pF load on all SPI1 pins.

TABLE 30-59: ADC MODULE SPECIFICATIONS (10-BIT MODE)

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) ⁽¹⁾ Operating temperature -40°C ≤ T _A ≤ +85°C for Industrial -40°C ≤ T _A ≤ +125°C for Extended				
Param No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions
ADC Accuracy (10-Bit Mode)							
AD20b	Nr	Resolution	10 Data Bits			bits	
AD21b	INL	Integral Nonlinearity	-0.625	—	0.625	LSb	-40°C ≤ T _A ≤ +85°C (Note 2)
			-1.5	—	1.5	LSb	+85°C < T _A ≤ +125°C (Note 2)
AD22b	DNL	Differential Nonlinearity	-0.25	—	0.25	LSb	-40°C ≤ T _A ≤ +85°C (Note 2)
			-0.25	—	0.25	LSb	+85°C < T _A ≤ +125°C (Note 2)
AD23b	GERR	Gain Error	-2.5	—	2.5	LSb	-40°C ≤ T _A ≤ +85°C (Note 2)
			-2.5	—	2.5	LSb	+85°C < T _A ≤ +125°C (Note 2)
AD24b	EOFF	Offset Error	-1.25	—	1.25	LSb	-40°C ≤ T _A ≤ +85°C (Note 2)
			-1.25	—	1.25	LSb	+85°C < T _A ≤ +125°C (Note 2)
AD25b	—	Monotonicity	—	—	—	—	Guaranteed
Dynamic Performance (10-Bit Mode)							
AD30b	THD	Total Harmonic Distortion ⁽³⁾	—	64	—	dB	
AD31b	SINAD	Signal to Noise and Distortion ⁽³⁾	—	57	—	dB	
AD32b	SFDR	Spurious Free Dynamic Range ⁽³⁾	—	72	—	dB	
AD33b	FNYQ	Input Signal Bandwidth ⁽³⁾	—	550	—	kHz	
AD34b	ENOB	Effective Number of Bits ⁽³⁾	—	9.4	—	bits	

Note 1: Device is functional at V_{BORMIN} < V_{DD} < V_{DDMIN}, but will have degraded performance. Device functionality is tested, but not characterized. Analog modules (ADC, op amp/comparator and comparator voltage reference) may have degraded performance. Refer to Parameter BO10 in Table 30-13 for the minimum and maximum BOR values.

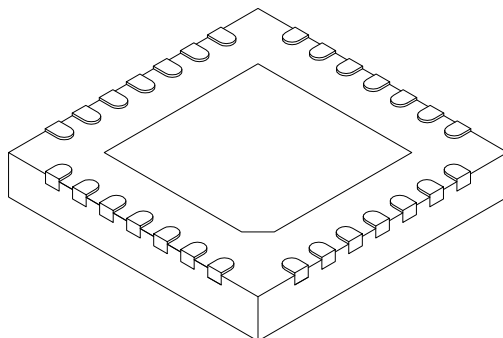
2: For all accuracy specifications, V_{INL} = AV_{SS} = V_{REFL} = 0V and AV_{DD} = V_{REFH} = 3.6V.

3: Parameters are characterized but not tested in manufacturing.

NOTES:

28-Lead Plastic Quad Flat, No Lead Package (MM) - 6x6x0.9mm Body [QFN-S] With 0.40 mm Terminal Length

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	28		
Pitch	e	0.65 BSC		
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3	0.20 REF		
Overall Width	E	6.00 BSC		
Exposed Pad Width	E2	3.65	3.70	4.70
Overall Length	D	6.00 BSC		
Exposed Pad Length	D2	3.65	3.70	4.70
Terminal Width	b	0.23	0.30	0.35
Terminal Length	L	0.30	0.40	0.50
Terminal-to-Exposed Pad	K	0.20	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

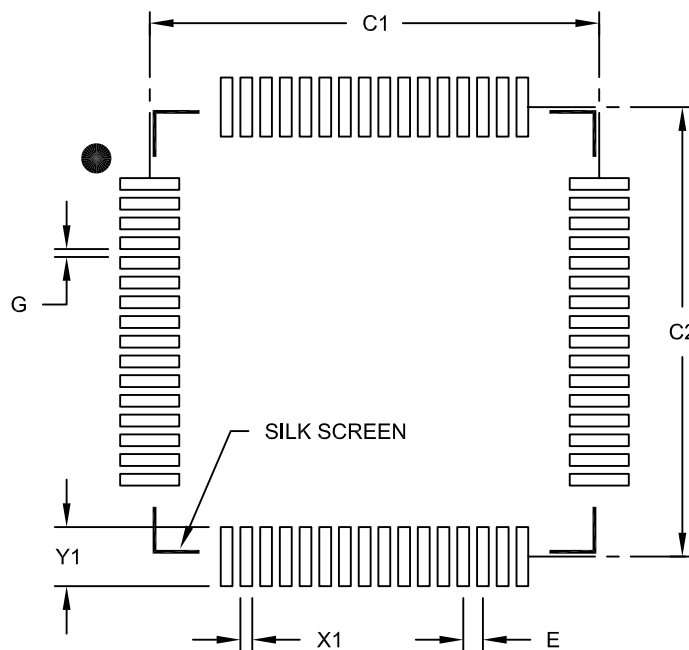
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-124C Sheet 2 of 2

64-Lead Plastic Thin Quad Flatpack (PT) 10x10x1 mm Body, 2.00 mm Footprint [TQFP]

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	0.50 BSC		
Contact Pad Spacing	C1		11.40	
Contact Pad Spacing	C2		11.40	
Contact Pad Width (X64)	X1			0.30
Contact Pad Length (X64)	Y1			1.50
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2085B