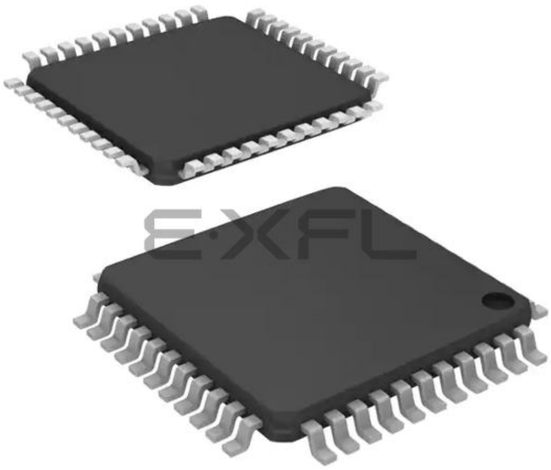

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	PIC
Core Size	16-Bit
Speed	60 MIPs
Connectivity	I²C, IrDA, LINbus, QEI, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, Motor Control PWM, 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 ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	44-TQFP
Supplier Device Package	44-TQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic24ep512mc204t-e-pt

TABLE 4-4: INTERRUPT CONTROLLER REGISTER MAP FOR PIC24EPXXXMC20X 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
IPC35	0886	—	JTAGIP<2:0>			—	ICDIP<2:0>			—	—	—	—	—	—	—	—	4400
IPC36	0888	—	PTG0IP<2:0>			—	PTGWDTIP<2:0>			—	PTGSTEPIP<2:0>			—	—	—	—	4440
IPC37	088A	—	—	—	—	—	PTG3IP<2:0>			—	PTG2IP<2:0>			—	PTG1IP<2:0>			0444
INTCON1	08C0	NSTDIS	OVAERR	OVBERR	—	—	—	—	—	—	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.

7.3 Interrupt Resources

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

Note:	In the event you are not able to access the product page using the link above, enter this URL in your browser: http://www.microchip.com/wwwproducts/Devices.aspx?dDocName=en555464

7.3.1 KEY RESOURCES

- **"Interrupts"** (DS70600) in the *"dsPIC33/PIC24 Family Reference Manual"*
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All Related *"dsPIC33/PIC24 Family Reference Manual"* Sections
- Development Tools

7.4 Interrupt Control and Status Registers

dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X devices implement the following registers for the interrupt controller:

- INTCON1
- INTCON2
- INTCON3
- INTCON4
- INTTREG

7.4.1 INTCON1 THROUGH INTCON4

Global interrupt control functions are controlled from INTCON1, INTCON2, INTCON3 and INTCON4.

INTCON1 contains the Interrupt Nesting Disable bit (NSTDIS), as well as the control and status flags for the processor trap sources.

The INTCON2 register controls external interrupt request signal behavior and also contains the Global Interrupt Enable bit (GIE).

INTCON3 contains the status flags for the DMA and DO stack overflow status trap sources.

The INTCON4 register contains the software generated hard trap status bit (SGHT).

7.4.2 IFSx

The IFSx registers maintain all of the interrupt request flags. Each source of interrupt has a status bit, which is set by the respective peripherals or external signal and is cleared via software.

7.4.3 IECx

The IECx registers maintain all of the interrupt enable bits. These control bits are used to individually enable interrupts from the peripherals or external signals.

7.4.4 IPCx

The IPCx registers are used to set the Interrupt Priority Level (IPL) for each source of interrupt. Each user interrupt source can be assigned to one of eight priority levels.

7.4.5 INTTREG

The INTTREG register contains the associated interrupt vector number and the new CPU Interrupt Priority Level, which are latched into the Vector Number bits (VECNUM<7:0>) and Interrupt Priority Level bits (ILR<3:0>) fields in the INTTREG register. The new Interrupt Priority Level is the priority of the pending interrupt.

The interrupt sources are assigned to the IFSx, IECx and IPCx registers in the same sequence as they are listed in Table 7-1. For example, the INT0 (External Interrupt 0) is shown as having Vector Number 8 and a natural order priority of 0. Thus, the INT0IF bit is found in IFS0<0>, the INT0IE bit in IEC0<0> and the INT0IP bits in the first position of IPC0 (IPC0<2:0>).

7.4.6 STATUS/CONTROL REGISTERS

Although these registers are not specifically part of the interrupt control hardware, two of the CPU Control registers contain bits that control interrupt functionality. For more information on these registers refer to **"CPU"** (DS70359) in the *"dsPIC33/PIC24 Family Reference Manual"*.

- The CPU STATUS Register, SR, contains the IPL<2:0> bits (SR<7:5>). These bits indicate the current CPU Interrupt Priority Level. The user software can change the current CPU Interrupt Priority Level by writing to the IPLx bits.
- The CORCON register contains the IPL3 bit which, together with IPL<2:0>, also indicates the current CPU priority level. IPL3 is a read-only bit so that trap events cannot be masked by the user software.

All Interrupt registers are described in Register 7-3 through Register 7-7 in the following pages.

REGISTER 7-5: INTCON3: INTERRUPT CONTROL REGISTER 3

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

U-0	U-0	R/W-0	R/W-0	U-0	U-0	U-0	U-0
—	—	DAE	DOOVR	—	—	—	—
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 15-6 **Unimplemented:** Read as ‘0’

bit 5 **DAE:** DMA Address Error Soft Trap Status bit
1 = DMA address error soft trap has occurred
0 = DMA address error soft trap has not occurred

bit 4 **DOOVR:** DO Stack Overflow Soft Trap Status bit
1 = DO stack overflow soft trap has occurred
0 = DO stack overflow soft trap has not occurred

bit 3-0 **Unimplemented:** Read as ‘0’

REGISTER 7-6: INTCON4: INTERRUPT CONTROL REGISTER 4

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

U-0	U-0	U-0	U-0	U-0	U-0	U-0	R/W-0
—	—	—	—	—	—	—	SGHT
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 15-1 **Unimplemented:** Read as ‘0’

bit 0 **SGHT:** Software Generated Hard Trap Status bit
1 = Software generated hard trap has occurred
0 = Software generated hard trap has not occurred

REGISTER 11-13: RPINR23: PERIPHERAL PIN SELECT INPUT REGISTER 23

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
—	SS2R<6:0>						
bit 7							bit 0

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

bit 15-7 **Unimplemented:** Read as ‘0’

bit 6-0 **SS2R<6:0>:** Assign SPI2 Slave Select ($\overline{SS2}$) to the Corresponding RPn Pin bits (see Table 11-2 for input pin selection numbers)

1111001 = Input tied to RPI121
.
.
.
0000001 = Input tied to CMP1
0000000 = Input tied to Vss

REGISTER 11-14: RPINR26: PERIPHERAL PIN SELECT INPUT REGISTER 26 (dsPIC33EPXXXGP/MC50X DEVICES ONLY)

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
—	C1RXR<6:0>						
bit 7							bit 0

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

bit 15-7 **Unimplemented:** Read as ‘0’

bit 6-0 **C1RXR<6:0>:** Assign CAN1 RX Input (CRX1) to the Corresponding RPn Pin bits (see Table 11-2 for input pin selection numbers)

1111001 = Input tied to RPI121
.
.
.
0000001 = Input tied to CMP1
0000000 = Input tied to Vss

REGISTER 11-15: RPINR37: PERIPHERAL PIN SELECT INPUT REGISTER 37 (dsPIC33EPXXXMC20X/50X AND PIC24EPXXXMC20X DEVICES ONLY)

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	SYNCI1R<6:0>						
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 **Unimplemented:** Read as ‘0’

bit 14-8 **SYNCI1R<6:0>:** Assign PWM Synchronization Input 1 to the Corresponding RPn Pin bits (see Table 11-2 for input pin selection numbers)

1111001 = Input tied to RPI121
.
.
.
0000001 = Input tied to CMP1
0000000 = Input tied to VSS

bit 7-0 **Unimplemented:** Read as ‘0’

12.0 TIMER1

Note 1: This data sheet summarizes the features of the dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **"Timers"** (DS70362) 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.

The Timer1 module is a 16-bit timer that can operate as a free-running interval timer/counter.

The Timer1 module has the following unique features over other timers:

- Can be operated in Asynchronous Counter mode from an external clock source
- The external clock input (T1CK) can optionally be synchronized to the internal device clock and the clock synchronization is performed after the prescaler

A block diagram of Timer1 is shown in Figure 12-1.

The Timer1 module can operate in one of the following modes:

- Timer mode
- Gated Timer mode
- Synchronous Counter mode
- Asynchronous Counter mode

In Timer and Gated Timer modes, the input clock is derived from the internal instruction cycle clock (FCY). In Synchronous and Asynchronous Counter modes, the input clock is derived from the external clock input at the T1CK pin.

The Timer modes are determined by the following bits:

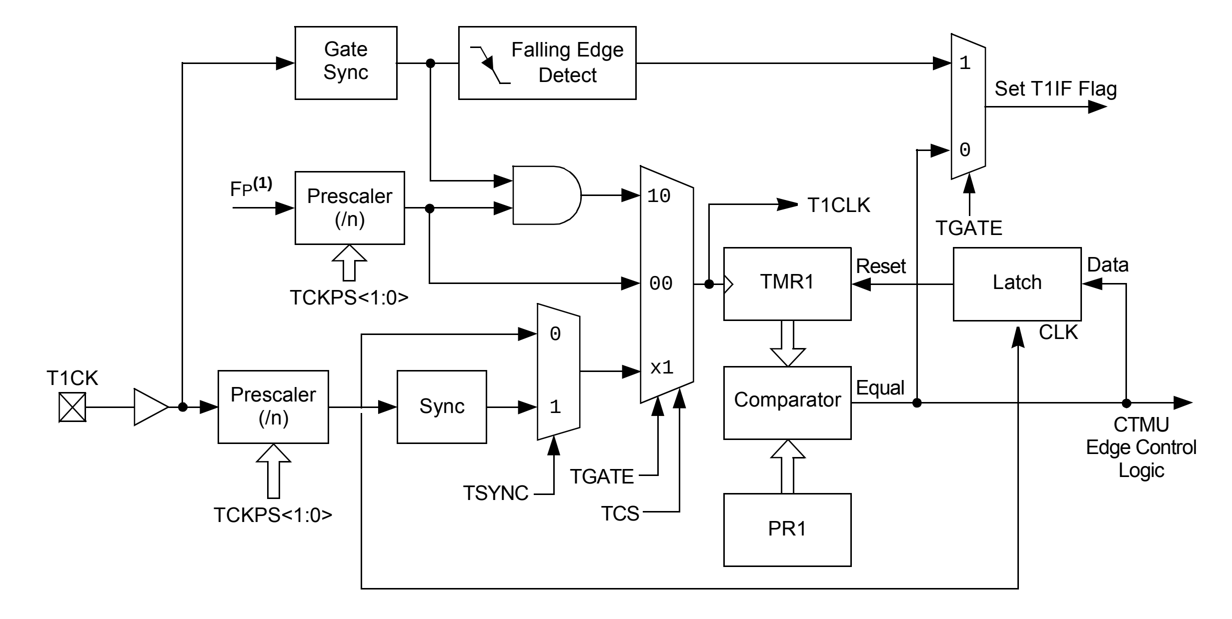
- Timer Clock Source Control bit (TCS): T1CON<1>
- Timer Synchronization Control bit (TSYNC): T1CON<2>
- Timer Gate Control bit (TGATE): T1CON<6>

Timer control bit setting for different operating modes are given in the Table 12-1.

TABLE 12-1: TIMER MODE SETTINGS

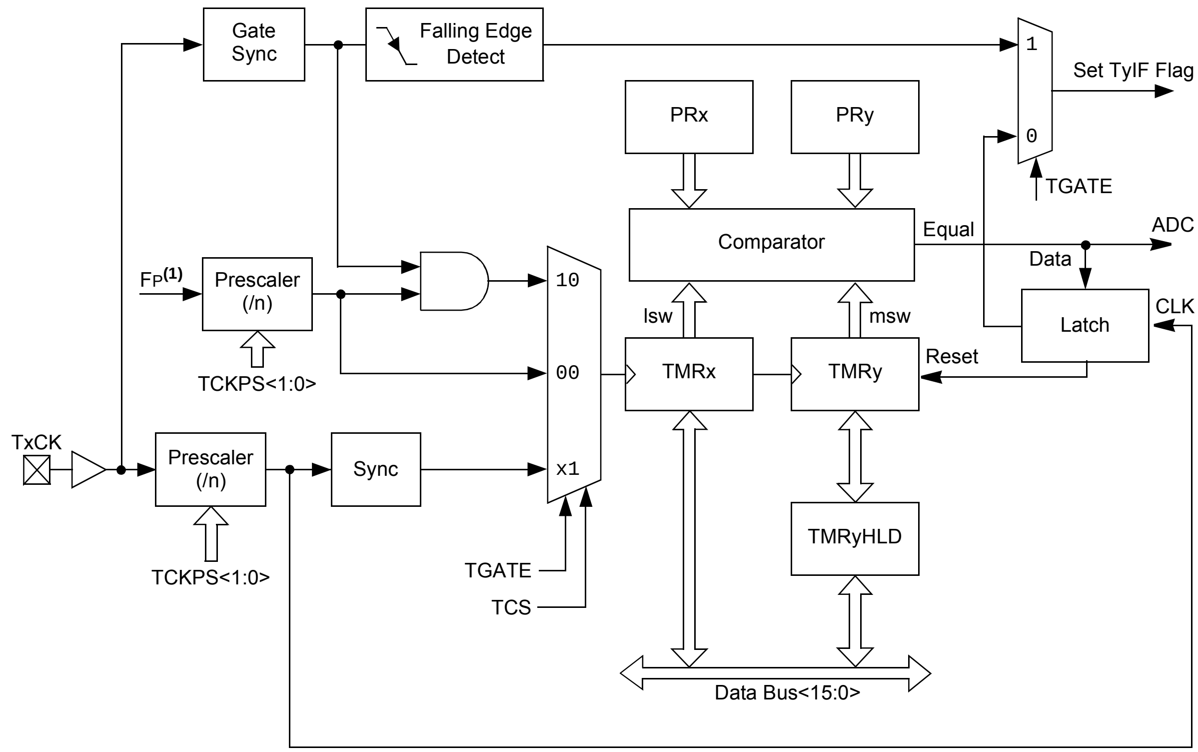
Mode	TCS	TGATE	TSYNC
Timer	0	0	x
Gated Timer	0	1	x
Synchronous Counter	1	x	1
Asynchronous Counter	1	x	0

FIGURE 12-1: 16-BIT TIMER1 MODULE BLOCK DIAGRAM



Note 1: FP is the peripheral clock.

FIGURE 13-3: TYPE B/TYPE C TIMER PAIR BLOCK DIAGRAM (32-BIT TIMER)



Note 1: The ADC trigger is available on the TMR3:TMR2 andTMR5:TMR4 32-bit timer pairs.
2: Timerx is a Type B timer (x = 2 and 4).
3: Timery is a Type C timer (y = 3 and 5).

13.1 Timerx/y Resources

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

Note:	In the event you are not able to access the product page using the link above, enter this URL in your browser: http://www.microchip.com/wwwproducts/Devices.aspx?dDocName=en555464

13.1.1 KEY RESOURCES

- **"Timers"** (DS70362) in the *"dsPIC33/PIC24 Family Reference Manual"*
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All Related *"dsPIC33/PIC24 Family Reference Manual"* Sections
- Development Tools

REGISTER 16-2: PTCON2: PWMx PRIMARY MASTER CLOCK DIVIDER SELECT REGISTER 2

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

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	PCLKDIV2(1)	PCLKDIV1(1)	PCLKDIV0(1)
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 15-3 **Unimplemented:** Read as ‘0’

bit 2-0 **PCLKDIV<2:0>:** PWMx Input Clock Prescaler (Divider) Select bits(1)

111 = Reserved
110 = Divide-by-64
101 = Divide-by-32
100 = Divide-by-16
011 = Divide-by-8
010 = Divide-by-4
001 = Divide-by-2
000 = Divide-by-1, maximum PWMx timing resolution (power-on default)

Note 1: These bits should be changed only when PTEN = 0. Changing the clock selection during operation will yield unpredictable results.

REGISTER 19-2: I2CxSTAT: I2Cx STATUS REGISTER (CONTINUED)

bit 3	**S:** Start bit 1 = Indicates that a Start (or Repeated Start) bit has been detected last 0 = Start bit was not detected last Hardware is set or clear when a Start, Repeated Start or Stop is detected.
bit 2	**R_W:** Read/Write Information bit (when operating as I^2C slave) 1 = Read – Indicates data transfer is output from the slave 0 = Write – Indicates data transfer is input to the slave Hardware is set or clear after reception of an I^2C device address byte.
bit 1	**RBF:** Receive Buffer Full Status bit 1 = Receive is complete, I2CxRCV is full 0 = Receive is not complete, I2CxRCV is empty Hardware is set when I2CxRCV is written with a received byte. Hardware is clear when software reads I2CxRCV.
bit 0	**TBF:** Transmit Buffer Full Status bit 1 = Transmit in progress, I2CxTRN is full 0 = Transmit is complete, I2CxTRN is empty Hardware is set when software writes to I2CxTRN. Hardware is clear at completion of a data transmission.

REGISTER 20-2: UxSTA: UARTx STATUS AND CONTROL REGISTER

R/W-0	R/W-0	R/W-0	U-0	R/W-0, HC	R/W-0	R-0	R-1
UTXISEL1	UTXINV	UTXISEL0	—	UTXBRK	UTXEN(1)	UTXBF	TRMT
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R-1	R-0	R-0	R/C-0	R-0
URXISEL1	URXISEL0	ADDEN	RIDLE	PERR	FERR	OERR	URXDA
bit 7							bit 0

Legend:	HC = Hardware Clearable bit	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 15,13 **UTXISEL<1:0>:** UARTx Transmission Interrupt Mode Selection bits
11 = Reserved; do not use
10 = Interrupt when a character is transferred to the Transmit Shift Register (TSR) and as a result, the transmit buffer becomes empty
01 = Interrupt when the last character is shifted out of the Transmit Shift Register; all transmit operations are completed
00 = Interrupt when a character is transferred to the Transmit Shift Register (this implies there is at least one character open in the transmit buffer)

bit 14 **UTXINV:** UARTx Transmit Polarity Inversion bit
If IREN = 0:
1 = UxTX Idle state is ‘0’
0 = UxTX Idle state is ‘1’
If IREN = 1:
1 = IrDA encoded, UxTX Idle state is ‘1’
0 = IrDA encoded, UxTX Idle state is ‘0’

bit 12 **Unimplemented:** Read as ‘0’

bit 11 **UTXBRK:** UARTx Transmit Break bit
1 = Sends Sync Break on next transmission – Start bit, followed by twelve ‘0’ bits, followed by Stop bit; cleared by hardware upon completion
0 = Sync Break transmission is disabled or completed

bit 10 **UTXEN:** UARTx Transmit Enable bit(1)
1 = Transmit is enabled, UxTX pin is controlled by UARTx
0 = Transmit is disabled, any pending transmission is aborted and buffer is reset; UxTX pin is controlled by the PORT

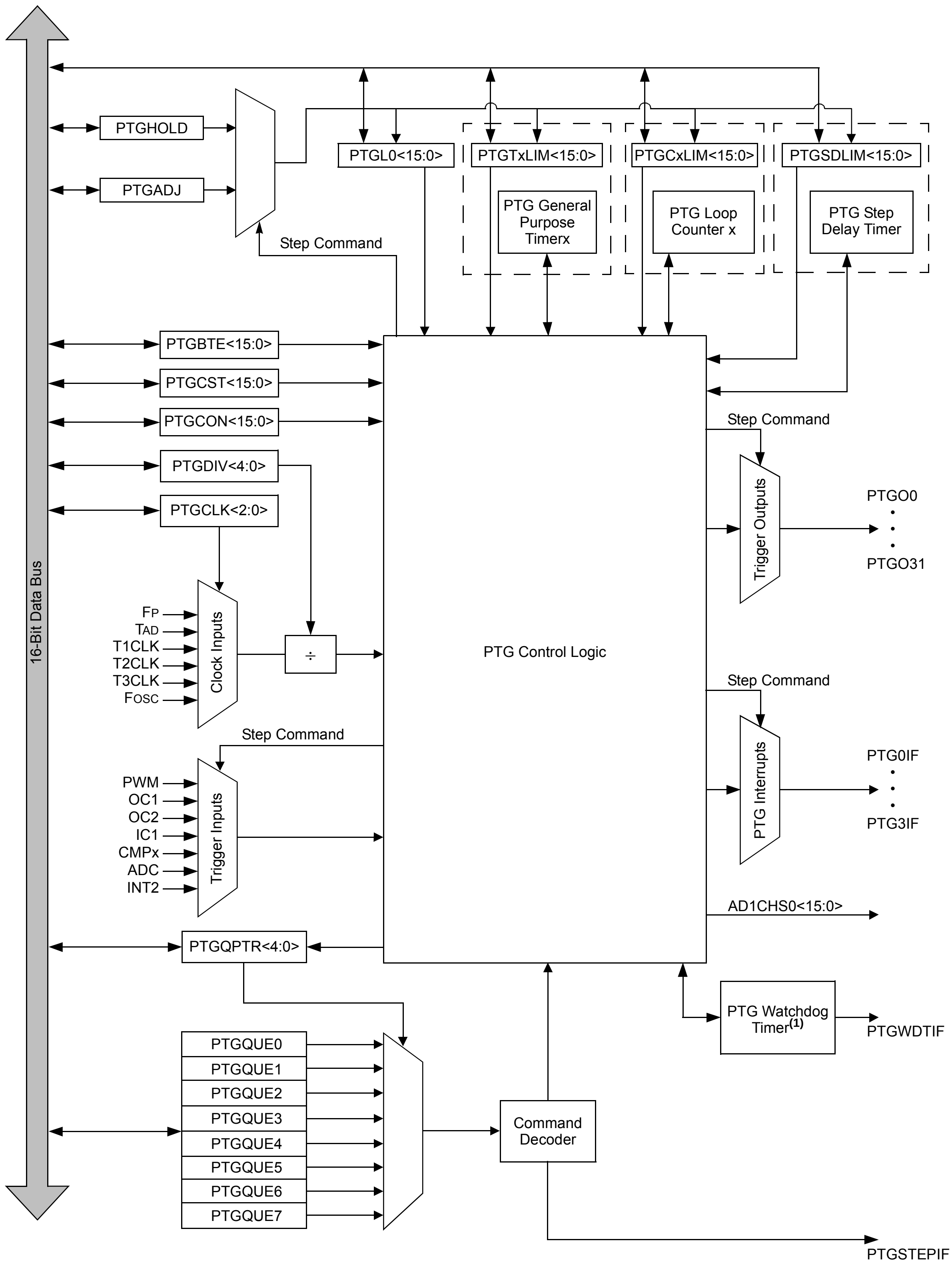
bit 9 **UTXBF:** UARTx Transmit Buffer Full Status bit (read-only)
1 = Transmit buffer is full
0 = Transmit buffer is not full, at least one more character can be written

bit 8 **TRMT:** Transmit Shift Register Empty bit (read-only)
1 = Transmit Shift Register is empty and transmit buffer is empty (the last transmission has completed)
0 = Transmit Shift Register is not empty, a transmission is in progress or queued

bit 7-6 **URXISEL<1:0>:** UARTx Receive Interrupt Mode Selection bits
11 = Interrupt is set on UxRSR transfer, making the receive buffer full (i.e., has 4 data characters)
10 = Interrupt is set on UxRSR transfer, making the receive buffer 3/4 full (i.e., has 3 data characters)
0x = Interrupt is set when any character is received and transferred from the UxRSR to the receive buffer; receive buffer has one or more characters

Note 1: Refer to the **“UART”** (DS70582) section in the *“dsPIC33/PIC24 Family Reference Manual”* for information on enabling the UARTx module for transmit operation.

FIGURE 24-1: PTG BLOCK DIAGRAM



Note 1: This is a dedicated Watchdog Timer for the PTG module and is independent of the device Watchdog Timer.

REGISTER 25-4: CMxMSKSRC: COMPARATOR x MASK SOURCE SELECT CONTROL REGISTER

U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	RW-0
—	—	—	—	SELSRCC3	SELSRCC2	SELSRCC1	SELSRCC0
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
SELSRCB3	SELSRCB2	SELSRCB1	SELSRCB0	SELSRCA3	SELSRCA2	SELSRCA1	SELSRCA0
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 15-12 **Unimplemented:** Read as ‘0’

bit 11-8 **SELSRCC<3:0>:** Mask C Input Select bits

1111 = FLT4
1110 = FLT2
1101 = PTGO19
1100 = PTGO18
1011 = Reserved
1010 = Reserved
1001 = Reserved
1000 = Reserved
0111 = Reserved
0110 = Reserved
0101 = PWM3H
0100 = PWM3L
0011 = PWM2H
0010 = PWM2L
0001 = PWM1H
0000 = PWM1L

bit 7-4 **SELSRCB<3:0>:** Mask B Input Select bits

1111 = FLT4
1110 = FLT2
1101 = PTGO19
1100 = PTGO18
1011 = Reserved
1010 = Reserved
1001 = Reserved
1000 = Reserved
0111 = Reserved
0110 = Reserved
0101 = PWM3H
0100 = PWM3L
0011 = PWM2H
0010 = PWM2L
0001 = PWM1H
0000 = PWM1L

26.0 PROGRAMMABLE CYCLIC REDUNDANCY CHECK (CRC) GENERATOR

> **Note 1:** This data sheet summarizes the features of the dsPIC33EPXXXGP50X, dsPIC33EPXXXMC20X/50X and PIC24EPXXXGP/MC20X families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **"Programmable Cyclic Redundancy Check (CRC)"** (DS70346) of 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.

The programmable CRC generator offers the following features:

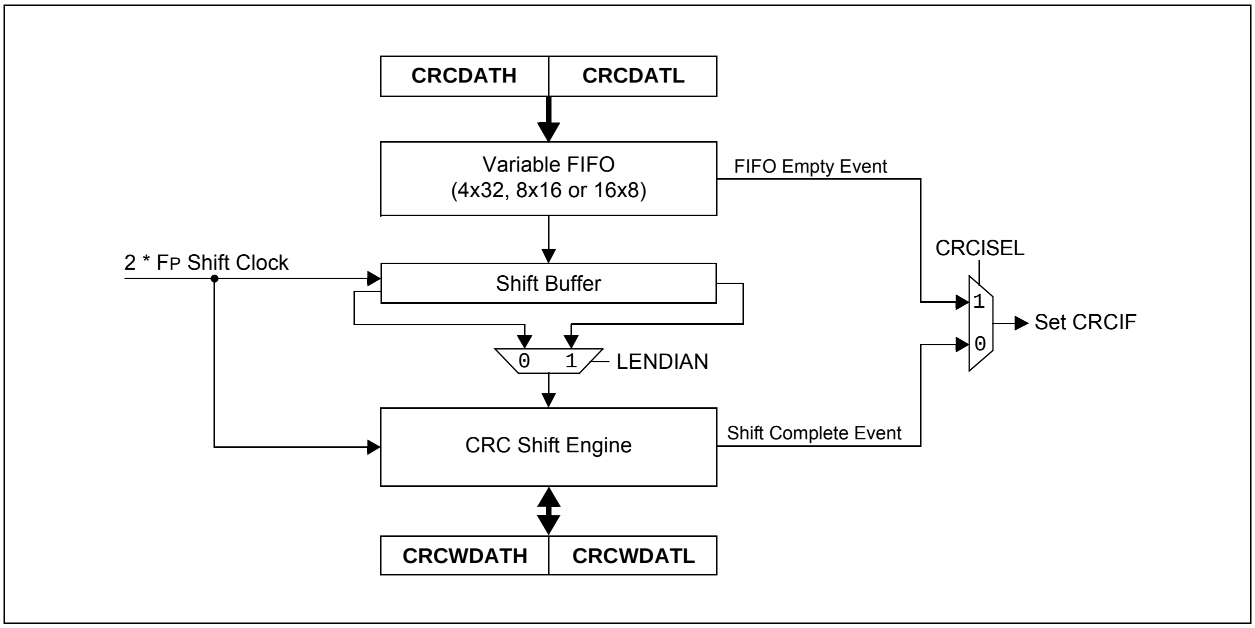
- User-programmable (up to 32nd order) polynomial CRC equation
- Interrupt output
- Data FIFO

The programmable CRC generator provides a hardware implemented method of quickly generating checksums for various networking and security applications. It offers the following features:

- User-programmable CRC polynomial equation, up to 32 bits
- Programmable shift direction (little or big-endian)
- Independent data and polynomial lengths
- Configurable interrupt output
- Data FIFO

A simplified block diagram of the CRC generator is shown in Figure 26-1. A simple version of the CRC shift engine is shown in Figure 26-2.

FIGURE 26-1: CRC BLOCK DIAGRAM



NOTES:

TABLE 30-14: DC CHARACTERISTICS: PROGRAM MEMORY

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				
Param No.	**Symbol**	**Characteristic**	**Min.**	**Typ.(1)**	**Max.**	**Units**	**Conditions**
		Program Flash Memory					
D130	EP	Cell Endurance	10,000	—	—	E/W	-40°C to +125°C
D131	VPR	VDD for Read	3.0	—	3.6	V	
D132b	VPEW	VDD for Self-Timed Write	3.0	—	3.6	V	
D134	TRETD	Characteristic Retention	20	—	—	Year	Provided no other specifications are violated, -40°C to +125°C
D135	IDDP	Supply Current during Programming(2)	—	10	—	mA	
D136	IPEAK	Instantaneous Peak Current During Start-up	—	—	150	mA	
D137a	TPE	Page Erase Time	17.7	—	22.9	ms	TPE = 146893 FRC cycles, TA = +85°C (See **Note 3)**
D137b	TPE	Page Erase Time	17.5	—	23.1	ms	TPE = 146893 FRC cycles, TA = +125°C (See **Note 3)**
D138a	TWW	Word Write Cycle Time	41.7	—	53.8	µs	TWW = 346 FRC cycles, TA = +85°C (See **Note 3)**
D138b	TWW	Word Write Cycle Time	41.2	—	54.4	µs	TWW = 346 FRC cycles, TA = +125°C (See **Note 3)**

Note 1: Data in “Typical” column is at 3.3V, +25°C unless otherwise stated.

2: Parameter characterized but not tested in manufacturing.

3: Other conditions: FRC = 7.37 MHz, TUN<5:0> = 011111 (for Minimum), TUN<5:0> = 100000 (for Maximum). This parameter depends on the FRC accuracy (see Table 30-19) and the value of the FRC Oscillator Tuning register (see Register 9-4). For complete details on calculating the Minimum and Maximum time, see **Section 5.3 “Programming Operations”**.

FIGURE 30-11: TIMERQ (QEI MODULE) EXTERNAL CLOCK TIMING CHARACTERISTICS (dsPIC33EPXXXMC20X/50X AND PIC24EPXXXMC20X DEVICES ONLY)

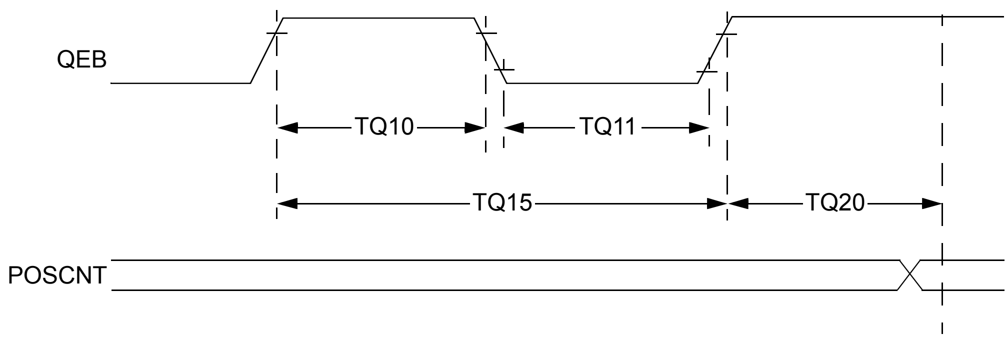


TABLE 30-30: QEI MODULE EXTERNAL CLOCK TIMING REQUIREMENTS (dsPIC33EPXXXMC20X/50X AND PIC24EPXXXMC20X DEVICES ONLY)

AC CHARACTERISTICS				Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic[(1)]**		**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
TQ10	TtQH	TQCK High Time	Synchronous, with prescaler	Greater of 12.5 + 25 or (0.5 TCY/N) + 25	—	—	ns	Must also meet Parameter TQ15
TQ11	TtQL	TQCK Low Time	Synchronous, with prescaler	Greater of 12.5 + 25 or (0.5 TCY/N) + 25	—	—	ns	Must also meet Parameter TQ15
TQ15	TtQP	TQCP Input Period	Synchronous, with prescaler	Greater of 25 + 50 or (1 TCY/N) + 50	—	—	ns	
TQ20	TCKEXTMRL	Delay from External TQCK Clock Edge to Timer Increment		—	1	TCY	—	

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

FIGURE 30-21: SPI2 SLAVE MODE (FULL-DUPLEX, CKE = 0, CKP = 0, SMP = 0) TIMING CHARACTERISTICS

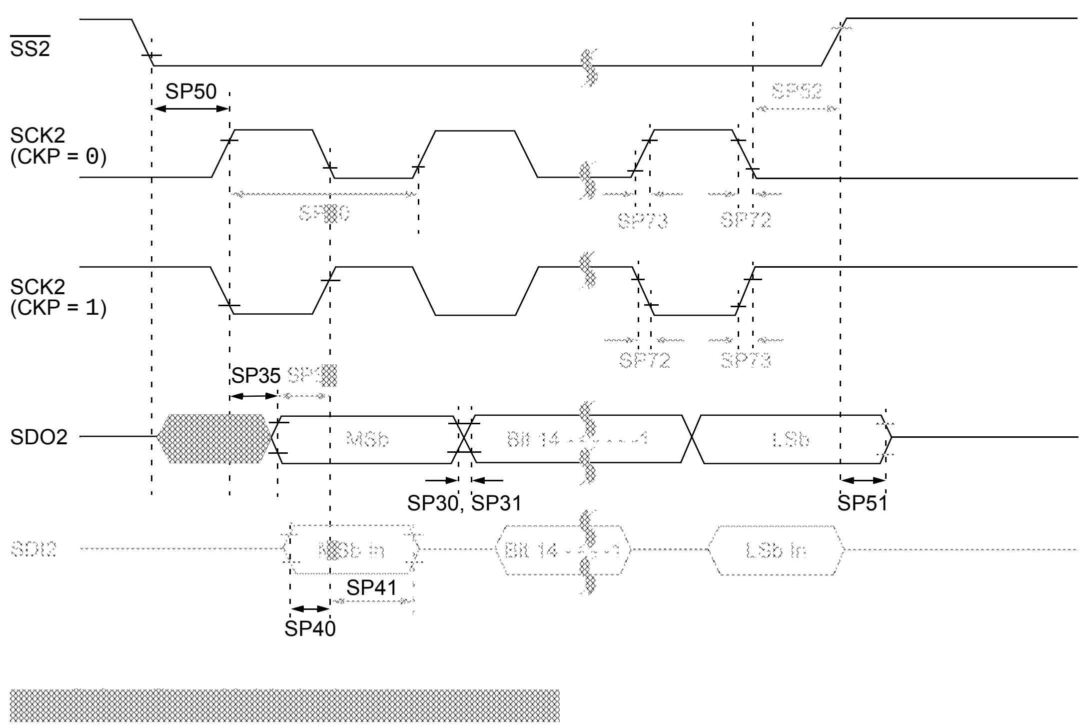
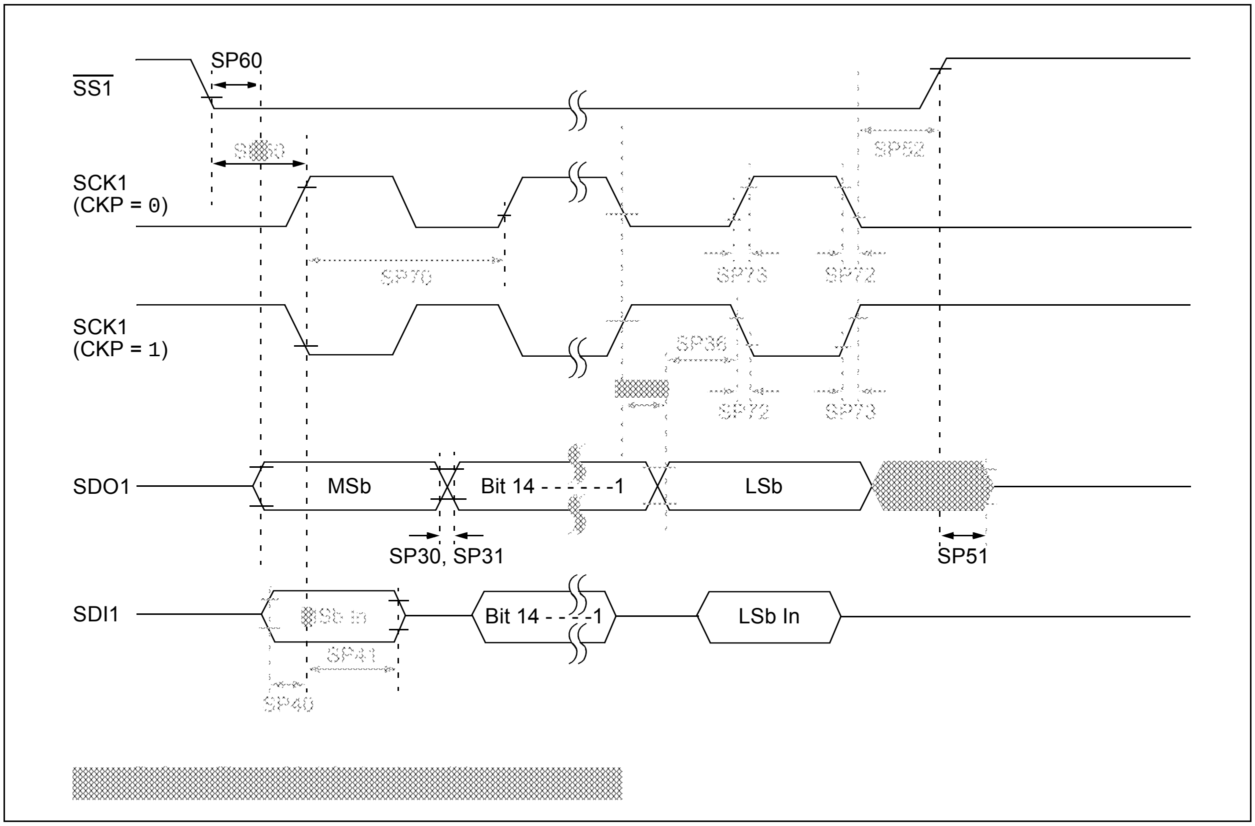


FIGURE 30-27: SPI1 SLAVE MODE (FULL-DUPLEX, CKE = 1, CKP = 1, SMP = 0) TIMING CHARACTERISTICS



32.0 DC AND AC DEVICE CHARACTERISTICS GRAPHS

Note:	The graphs provided following this note are a statistical summary based on a limited number of samples and are provided for design guidance purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore, outside the warranted range.

FIGURE 32-1: VOH – 4x DRIVER PINS

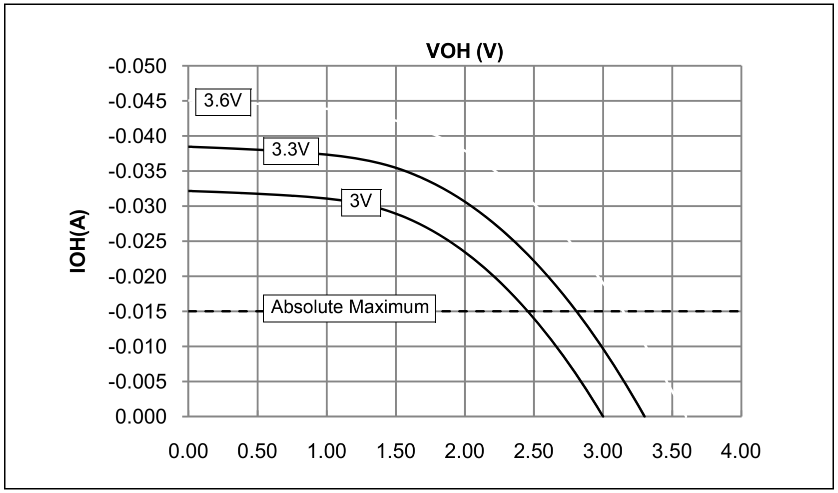


FIGURE 32-2: VOH – 8x DRIVER PINS

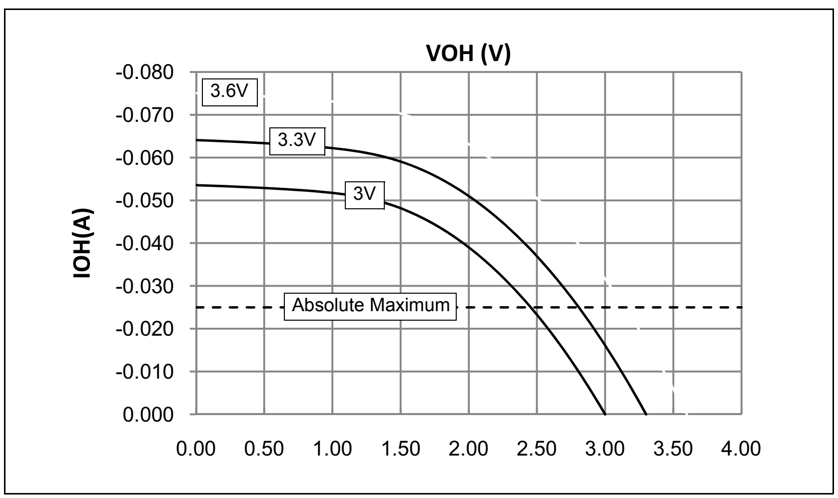


FIGURE 32-3: VOL – 4x DRIVER PINS

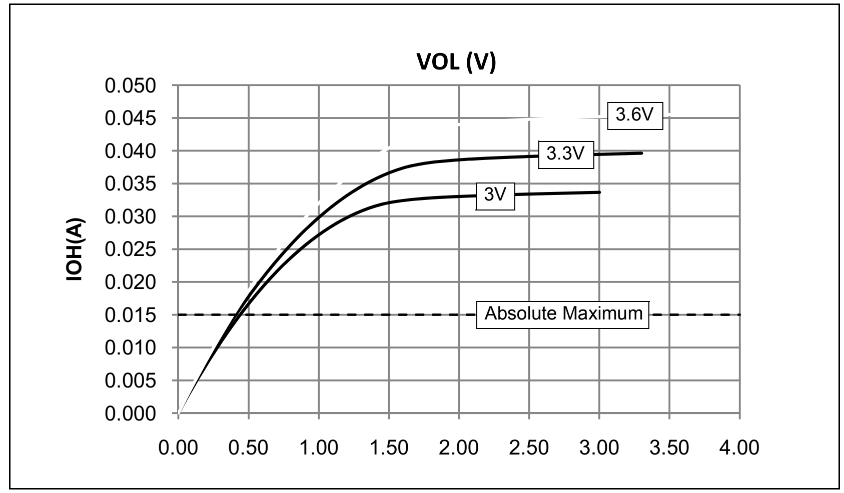
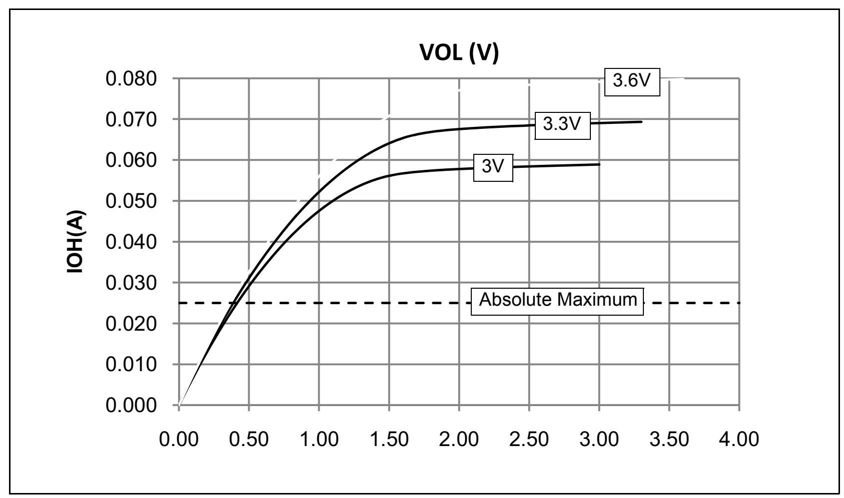


FIGURE 32-4: VOL – 8x DRIVER PINS



NOTES: