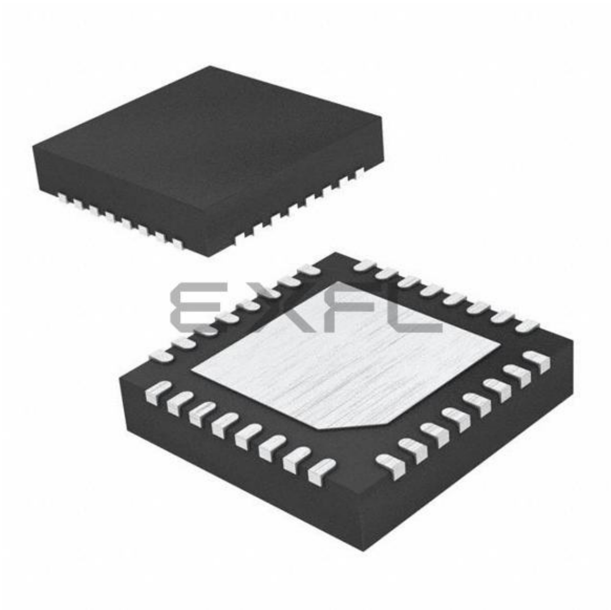




## What is "Embedded - Microcontrollers"?

"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 | 40 MIPs |
| Connectivity | CANbus, I²C, IrDA, LINbus, SPI, UART/USART |
| Peripherals | Brown-out Detect/Reset, DCI, DMA, I²S, POR, PWM, WDT |
| Number of I/O | 21 |
| Program Memory Size | 64KB (64K x 8) |
| Program Memory Type | FLASH |
| EEPROM Size | - |
| RAM Size | 16K x 8 |
| Voltage - Supply (Vcc/Vdd) | 3V ~ 3.6V |
| Data Converters | A/D 10x10b/12b; D/A 2x16b |
| 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/dspic33fj64gp802-i-mm |

## 4.0 MEMORY ORGANIZATION

> **Note:** This data sheet summarizes the features of the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **Section 4. "Program Memory"** (DS70203) of the *"dsPIC33F/PIC24H Family Reference Manual"*, which is available from the Microchip website (www.microchip.com).

The dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 architecture features separate program and data memory spaces and buses. This architecture also allows the direct access of program memory from the data space during code execution.

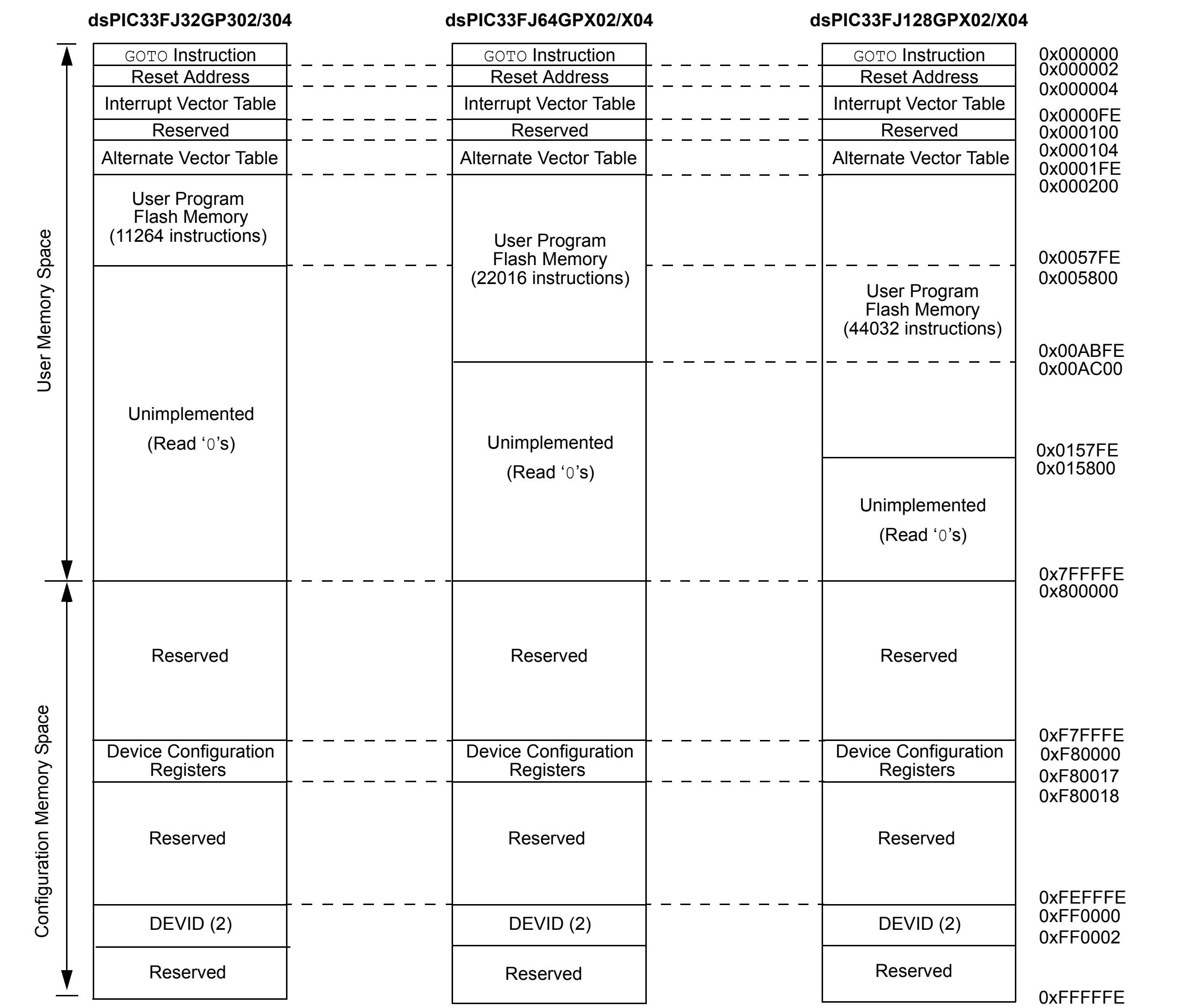
## 4.1 Program Address Space

The program address memory space of the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 devices is 4M instructions. The space is addressable by a 24-bit value derived either from the 23-bit Program Counter (PC) during program execution, or from table operation or data space remapping as described in **Section 4.8 "Interfacing Program and Data Memory Spaces"**.

User application access to the program memory space is restricted to the lower half of the address range (0x000000 to 0x7FFFFF). The exception is the use of `TBLRD`/`TBLWT` operations, which use TBLPAG<7> to permit access to the Configuration bits and Device ID sections of the configuration memory space.

The memory map for the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 devices is shown in Figure 4-1.

**FIGURE 4-1: PROGRAM MEMORY MAP FOR dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, AND dsPIC33FJ128GPX02/X04 DEVICES**




**Note:** Memory areas are not shown to scale.

**REGISTER 7-25: IPC11: INTERRUPT PRIORITY CONTROL REGISTER 11**

| U-0 | U-0 | U-0 | U-0 | U-0 | R/W-1 | R/W-0 | R/W-0 |
|---|---|---|---|---|---|---|---|
| — | — | — | — | — | DMA4IP<2:0> | | |
| bit 15 | | | | | | | bit 8 |

| U-0 | R/W-1 | R/W-0 | R/W-0 | U-0 | U-0 | U-0 | U-0 |
|---|---|---|---|---|---|---|---|
| — | PMPIP<2:0> | | | — | — | — | — |
| 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 10-8 **DMA4IP<2:0>:** DMA Channel 4 Data Transfer Complete Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

bit 7 **Unimplemented:** Read as ‘0’

bit 6-4 **PMPIP<2:0>:** Parallel Master Port Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

### REGISTER 7-31: INTTREG: INTERRUPT CONTROL AND STATUS REGISTER

| U-0 | U-0 | U-0 | U-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| — | — | — | — | ILR<3:0> | | | |
| bit 15 | | | | | | | bit 8 |

| U-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| — | VECNUM<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 15-12 **Unimplemented:** Read as ‘0’

bit 11-8 **ILR<3:0>:** New CPU Interrupt Priority Level bits
1111 = CPU Interrupt Priority Level is 15
•
•
•
0001 = CPU Interrupt Priority Level is 1
0000 = CPU Interrupt Priority Level is 0

bit 7 **Unimplemented:** Read as ‘0’

bit 6-0 **VECNUM<6:0>:** Vector Number of Pending Interrupt bits
0111111 = Interrupt Vector pending is number 135
•
•
•
0000001 = Interrupt Vector pending is number 9
0000000 = Interrupt Vector pending is number 8

The DMA controller features eight identical data transfer channels.

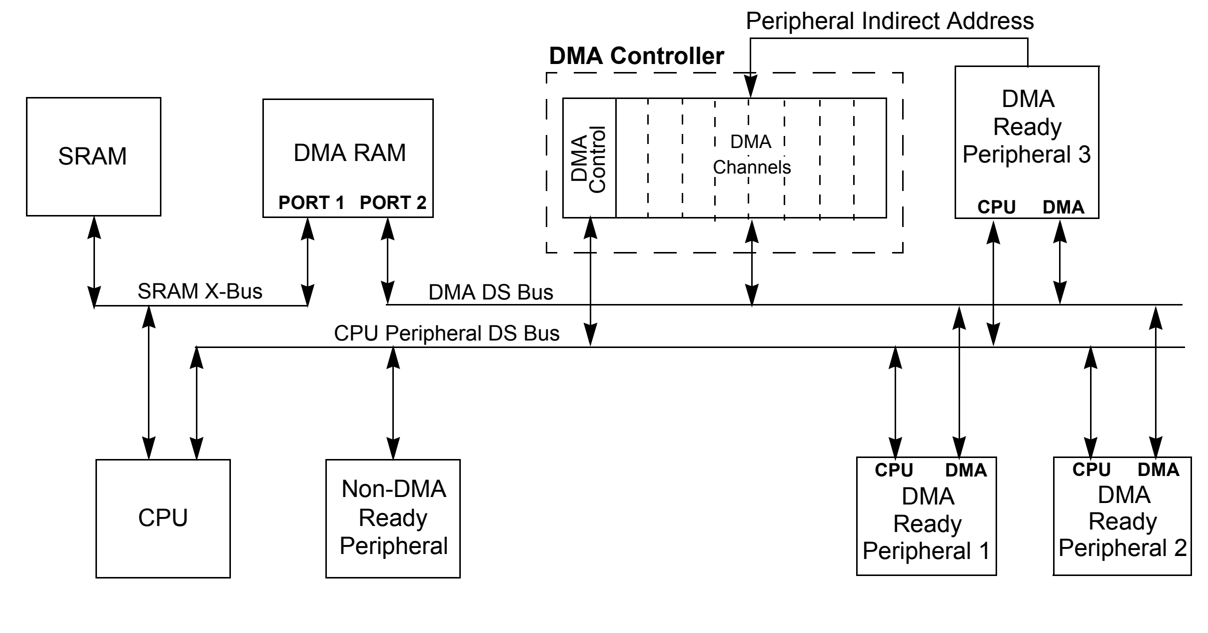
Each channel has its own set of control and status registers. Each DMA channel can be configured to copy data either from buffers stored in dual port DMA RAM to peripheral SFRs, or from peripheral SFRs to buffers in DMA RAM.

The DMA controller supports the following features:

- Eight 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 DPSRAM start addresses after each block transfer complete)
- DMA request for each channel can be selected from any supported interrupt source
- Debug support features

For each DMA channel, a DMA interrupt request is generated when a block transfer is complete. Alternatively, an interrupt can be generated when half of the block has been filled.

**FIGURE 8-1: TOP LEVEL SYSTEM ARCHITECTURE USING A DEDICATED TRANSACTION BUS**




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

## 8.3 DMA Control Registers

### REGISTER 8-1: DMAxCON: DMA CHANNEL x CONTROL REGISTER

| R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | U-0 | U-0 | U-0 |
|---|---|---|---|---|---|---|---|
| CHEN | SIZE | DIR | HALF | NULLW | — | — | — |
| bit 15 | | | | | | | bit 8 |

| U-0 | U-0 | R/W-0 | R/W-0 | U-0 | U-0 | R/W-0 | R/W-0 |
|---|---|---|---|---|---|---|---|
| — | — | AMODE<1:0> | | — | — | MODE<1:0> | |
| 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 **CHEN:** Channel Enable bit
1 = Channel enabled
0 = Channel disabled

bit 14 **SIZE:** Data Transfer Size bit
1 = Byte
0 = Word

bit 13 **DIR**: Transfer Direction bit (source/destination bus select)
1 = Read from DMA RAM address, write to peripheral address
0 = Read from peripheral address, write to DMA RAM address

bit 12 **HALF:** Early Block Transfer Complete Interrupt Select bit
1 = Initiate block transfer complete interrupt when half of the data has been moved
0 = Initiate block transfer complete interrupt when all of the data has been moved

bit 11 **NULLW:** Null Data Peripheral Write Mode Select bit
1 = Null data write to peripheral in addition to DMA RAM write (DIR bit must also be clear)
0 = Normal operation

bit 10-6 **Unimplemented:** Read as ‘0’

bit 5-4 **AMODE<1:0>:** DMA Channel Operating Mode Select bits
11 = Reserved (acts as Peripheral Indirect Addressing mode)
10 = Peripheral Indirect Addressing mode
01 = Register Indirect without Post-Increment mode
00 = Register Indirect with Post-Increment mode

bit 3-2 **Unimplemented:** Read as ‘0’

bit 1-0 **MODE<1:0>:** DMA Channel Operating Mode Select bits
11 = One-Shot, Ping-Pong modes enabled (one block transfer from/to each DMA RAM buffer)
10 = Continuous, Ping-Pong modes enabled
01 = One-Shot, Ping-Pong modes disabled
00 = Continuous, Ping-Pong modes disabled

**REGISTER 8-9: DSADR: MOST RECENT DMA RAM ADDRESS**

| R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| DSADR<15:8> | | | | | | | |
| bit 15 | | | | | | | bit 8 |

| R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| DSADR<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 **DSADR<15:0>:** Most Recent DMA RAM Address Accessed by DMA Controller bits

## 9.1 CPU Clocking System

The dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 devices provide seven system clock options:

- Fast RC (FRC) Oscillator
- FRC Oscillator with Phase-Locked Loop (PLL)
- Primary (XT, HS or EC) Oscillator
- Primary Oscillator with PLL
- Secondary (LP) Oscillator
- Low-Power RC (LPRC) Oscillator
- FRC Oscillator with postscaler

### 9.1.1 SYSTEM CLOCK SOURCES

The Fast RC (FRC) internal oscillator runs at a nominal frequency of 7.37 MHz. User software can tune the FRC frequency. User software can optionally specify a factor (ranging from 1:2 to 1:256) by which the FRC clock frequency is divided. This factor is selected using the FRCDIV<2:0> bits (CLKDIV<10:8>).

The primary oscillator can use one of the following as its clock source:

- Crystal (XT): Crystals and ceramic resonators in the range of 3 MHz to 10 MHz. The crystal is connected to the OSC1 and OSC2 pins.
- High-Speed Crystal (HS): Crystals in the range of 10 MHz to 40 MHz. The crystal is connected to the OSC1 and OSC2 pins.
- External Clock (EC): External clock signal is directly applied to the OSC1 pin.

The secondary (LP) oscillator is designed for low power and uses a 32.768 kHz crystal or ceramic resonator. The LP oscillator uses the SOSCI and SOSCO pins.

The Low-Power RC (LPRC) internal osclllator runs at a nominal frequency of 32.768 kHz. It is also used as a reference clock by the Watchdog Timer (WDT) and Fail-Safe Clock Monitor (FSCM).

The clock signals generated by the FRC and primary oscillators can be optionally applied to an on-chip PLL to provide a wide range of output frequencies for device operation. PLL configuration is described in **Section 9.1.4 “PLL Configuration”**.

The FRC frequency depends on the FRC accuracy (see Table 30-19) and the value of the FRC Oscillator Tuning register (see Register 9-4).

### 9.1.2 SYSTEM CLOCK SELECTION

The oscillator source used at a device Power-on Reset event is selected using Configuration bit settings. The oscillator Configuration bit settings are located in the Configuration registers in the program memory. (Refer to **Section 27.1 “Configuration Bits”** for further details.) The Initial Oscillator Selection Configuration bits, FNOSC<2:0> (FOSCSEL<2:0>), and the Primary Oscillator Mode Select Configuration bits, POSCMD<1:0> (FOSC<1:0>), select the oscillator source that is used at a Power-on Reset. The FRC primary oscillator is the default (unprogrammed) selection.

The Configuration bits allow users to choose among 12 different clock modes, shown in Table 9-1.

The output of the oscillator (or the output of the PLL if a PLL mode has been selected) FOSC is divided by 2 to generate the device instruction clock (FCY) and peripheral clock time base (FP). FCY defines the operating speed of the device, and speeds up to 40 MHz are supported by the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 architecture.

Instruction execution speed or device operating frequency, FCY, is given by:

**EQUATION 9-1: DEVICE OPERATING FREQUENCY**

$$F_{CY} = \frac{F_{OSC}}{2}$$

### 9.1.3 AUXILIARY OSCILLATOR

The Auxiliary Oscillator (AOSC) can be used for peripherals that need to operate at a frequency unrelated to the system clock such as a Digital-to-Analog Converter (DAC).

The Auxiliary Oscillator can use one of the following as its clock source:

- Crystal (XT): Crystal and ceramic resonators in the range of 3 MHz to 10 MHz. The crystal is connected to the SOCI and SOSCO pins.
- High-Speed Crystal (HS): Crystals in the range of 10 to 40 MHz. The crystal is connected to the SOSCI and SOSCO pins.
- External Clock (EC): External clock signal up to 64 MHz. The external clock signal is directly applied to SOSCI pin.

## 11.7 I/O Helpful Tips

1. In some cases, certain pins as defined in **TABLE 30-9: "DC Characteristics: I/O Pin Input Specifications"** under "Injection Current", have internal protection diodes to VDD and VSS. The term "Injection Current" is also referred to as "Clamp Current". On designated pins, with sufficient external current limiting precautions by the user, I/O pin input voltages are allowed to be greater or less than the data sheet absolute maximum ratings with nominal VDD with respect to the VSS and VDD supplies. Note that when the user application forward biases either of the high or low side internal input clamp diodes, that the resulting current being injected into the device that is clamped internally by the VDD and VSS power rails, may affect the ADC accuracy by four to six counts.
2. I/O pins that are shared with any analog input pin, (i.e., ANx), are always analog pins by default after any reset. Consequently, any pin(s) configured as an analog input pin, automatically disables the digital input pin buffer. As such, any attempt to read a digital input pin will always return a '0' regardless of the digital logic level on the pin if the analog pin is configured. To use a pin as a digital I/O pin on a shared ANx pin, the user application needs to configure the analog pin configuration registers in the ADC module, (i.e., ADxPCFGL, AD1PCFGH), by setting the appropriate bit that corresponds to that I/O port pin to a '1'. On devices with more than one ADC, both analog pin configurations for both ADC modules must be configured as a digital I/O pin for that pin to function as a digital I/O pin.

| **Note:** | Although it is not possible to use a digital input pin when its analog function is enabled, it is possible to use the digital I/O output function, TRISx = 0x0, while the analog function is also enabled. However, this is not recommended, particularly if the analog input is connected to an external analog voltage source, which would create signal contention between the analog signal and the output pin driver. |
|---|---|

3. Most I/O pins have multiple functions. Referring to the device pin diagrams in the data sheet, the priorities of the functions allocated to any pins are indicated by reading the pin name from left-to-right. The left most function name takes precedence over any function to its right in the naming convention. For example: AN16/T2CK/T7CK/RC1. This indicates that AN16 is the highest priority in this example and will supersede all other functions to its right in the list. Those other functions to its right, even if enabled, would not work as long as any other function to its left was enabled. This rule applies to all of the functions listed for a given pin.
4. Each CN pin has a configurable internal weak pull-up resistor. The pull-ups act as a current source connected to the pin, and eliminates the need for external resistors in certain applications. The internal pull-up is to ~(VDD-0.8) not VDD. This is still above the minimum VIH of CMOS and TTL devices.
5. When driving LEDs directly, the I/O pin can source or sink more current than what is specified in the VOH/IOH and VOL/IOL DC characteristic specification. The respective IOH and IOL current rating only applies to maintaining the corresponding output at or above the VOH and at or below the VOL levels. However, for LEDs unlike digital inputs of an externally connected device, they are not governed by the same minimum VIH/VIL levels. An I/O pin output can safely sink or source any current less than that listed in the absolute maximum rating section of the data sheet. For example:

   VOH = 2.4v @ IOH = -8 mA and VDD = 3.3V

   The maximum output current sourced by any 8 mA I/O pin = 12 mA.

   LED source current < 12 mA is technically permitted. Refer to the VOH/IOH graphs in **Section 30.0 "Electrical Characteristics"** for additional information.

## 11.8 I/O Resources

Many useful resources related to I/O 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=en532311 |
|---|---|

### 11.8.1 KEY RESOURCES

- **Section 10. "I/O Ports"** (DS70193)
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All related dsPIC33F/PIC24H Family Reference Manuals Sections
- Development Tools

NOTES:

## 17.2 $I^2C$ Resources

Many useful resources related to $I^2C$ 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=en532311

### 17.2.1 KEY RESOURCES

- **Section 11. "Inter-Integrated Circuit™ ($I^2C$™)"** (DS70195)
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All related dsPIC33F/PIC24H Family Reference Manuals Sections
- Development Tools

## 17.3 $I^2C$ Registers

I2CxCON and I2CxSTAT are control and status registers, respectively. The I2CxCON register is readable and writable. The lower six bits of I2CxSTAT are read-only. The remaining bits of the I2CSTAT are read/write:

- I2CxRSR is the shift register used for shifting data internal to the module and the user application has no access to it.
- I2CxRCV is the receive buffer and the register to which data bytes are written, or from which data bytes are read.
- I2CxTRN is the transmit register to which bytes are written during a transmit operation.
- The I2CxADD register holds the slave address.
- A status bit, ADD10, indicates 10-bit Address mode.
- The I2CxBRG acts as the Baud Rate Generator (BRG) reload value.

In receive operations, I2CxRSR and I2CxRCV together form a double-buffered receiver. When I2CxRSR receives a complete byte, it is transferred to I2CxRCV, and an interrupt pulse is generated.

**REGISTER 19-5: CiFIFO: ECAN™ FIFO STATUS REGISTER**

| U-0 | U-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| — | — | FBP<5:0> | | | | | |
| bit 15 | | | | | | | bit 8 |

| U-0 | U-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |
|---|---|---|---|---|---|---|---|
| — | — | FNRB<5:0> | | | | | |
| bit 7 | | | | | | | bit 0 |

| **Legend:** | C = Writable bit, but only ‘0’ can be written to clear the 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 15-14 **Unimplemented:** Read as ‘0’

bit 13-8 **FBP<5:0>:** FIFO Buffer Pointer bits
011111 = RB31 buffer
011110 = RB30 buffer
•
•
•
000001 = TRB1 buffer
000000 = TRB0 buffer

bit 7-6 **Unimplemented:** Read as ‘0’

bit 5-0 **FNRB<5:0>:** FIFO Next Read Buffer Pointer bits
011111 = RB31 buffer
011110 = RB30 buffer
•
•
•
000001 = TRB1 buffer
000000 = TRB0 buffer

## 23.1 Comparator Resources

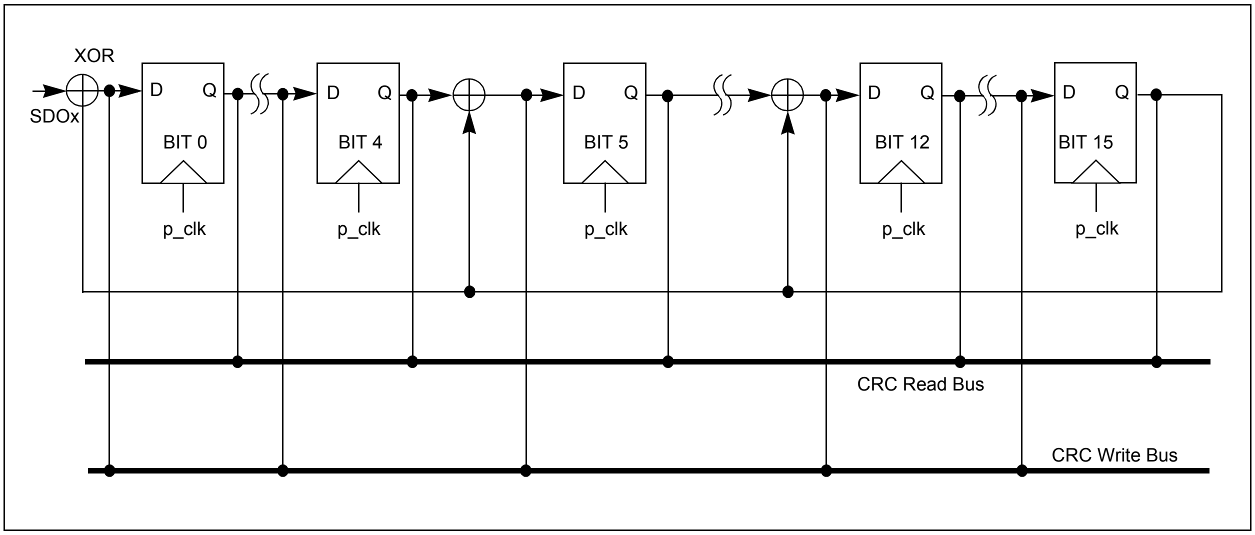
Many useful resources related to Comparators are provided on the main product page of the Microchip web site for the devices listed in this data sheet. This product page, which can be accessed using this link, contains the latest updates and additional information.

> **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=en532311

### 23.1.1 KEY RESOURCES

- **Section 34. "Comparator"** (DS70212)
- Code Samples
- Application Notes
- Software Libraries
- Webinars
- All related dsPIC33F/PIC24H Family Reference Manuals Sections
- Development Tools

**FIGURE 25-2: CRC GENERATOR RECONFIGURED FOR $x^{16} + x^{12} + x^5 + 1$**




## 25.2 User Interface

### 25.2.1 DATA INTERFACE

To start serial shifting, a '1' must be written to the CRCGO bit.

The module incorporates a FIFO that is 8 deep when PLEN (PLEN<3:0>) > 7, and 16 deep, otherwise. The data for which the CRC is to be calculated must first be written into the FIFO. The smallest data element that can be written into the FIFO is one byte. For example, if PLEN = 5, then the size of the data is PLEN + 1 = 6. The data must be written as follows:

```
data[5:0] = crc_input[5:0]
data[7:6] = 'bxx
```

Once data is written into the CRCWDAT MSb (as defined by PLEN), the value of VWORD (VWORD<4:0>) increments by one. The serial shifter starts shifting data into the CRC engine when CRCGO = 1 and VWORD > 0. When the MSb is shifted out, VWORD decrements by one. The serial shifter continues shifting until the VWORD reaches 0. Therefore, for a given value of PLEN, it will take (PLEN + 1) * VWORD number of clock cycles to complete the CRC calculations.

When VWORD reaches 8 (or 16), the CRCFUL bit will be set. When VWORD reaches 0, the CRCMPT bit will be set.

To continually feed data into the CRC engine, the recommended mode of operation is to initially "prime" the FIFO with a sufficient number of words so no interrupt is generated before the next word can be written. Once that is done, start the CRC by setting the CRCGO bit to '1'. From that point onward, the VWORD<4:0> bits should be polled. If they read less than 8 or 16, another word can be written into the FIFO.

To empty words already written into a FIFO, the CRCGO bit must be set to '1' and the CRC shifter allowed to run until the CRCMPT bit is set.

Also, to get the correct CRC reading, it will be necessary to wait for the CRCMPT bit to go high before reading the CRCWDAT register.

If a word is written when the CRCFUL bit is set, the VWORD Pointer will roll over to 0. The hardware will then behave as if the FIFO is empty. However, the condition to generate an interrupt will not be met; therefore, no interrupt will be generated (See **Section 25.2.2 "Interrupt Operation"**).

At least one instruction cycle must pass after a write to CRCWDAT before a read of the VWORD bits is done.

### 25.2.2 INTERRUPT OPERATION

When the VWORD<4:0> bits make a transition from a value of '1' to '0', an interrupt will be generated.

## 25.3 Operation in Power-Saving Modes

### 25.3.1 SLEEP MODE

If Sleep mode is entered while the module is operating, the module will be suspended in its current state until clock execution resumes.

### 25.3.2 IDLE MODE

To continue full module operation in Idle mode, the CSIDL bit must be cleared prior to entry into the mode.

If CSIDL = 1, the module will behave the same way as it does in Sleep mode; pending interrupt events will be passed on, even though the module clocks are not available.

## 27.0 SPECIAL FEATURES

> **Note 1:** This data sheet summarizes the features of the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to the *"dsPIC33F/PIC24H Family Reference Manual"*. Please see the Microchip web site (www.microchip.com) for the latest dsPIC33F/PIC24H Family Reference Manual sections.
>
> **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.

dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 devices include several features intended to maximize application flexibility and reliability, and minimize cost through elimination of external components. These are:

- Flexible configuration
- Watchdog Timer (WDT)
- Code Protection and CodeGuard™ Security
- JTAG Boundary Scan Interface
- In-Circuit Serial Programming™ (ICSP™)
- In-Circuit emulation

### 27.1 Configuration Bits

The dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 devices provide nonvolatile memory implementation for device configuration bits. Refer to **Section 25. "Device Configuration"** (DS70194), in the *"dsPIC33F/PIC24H Family Reference Manual"* for more information on this implementation.

The Configuration bits can be programmed (read as '0'), or left unprogrammed (read as '1'), to select various device configurations. These bits are mapped starting at program memory location 0xF80000.

The individual Configuration bit descriptions for the Configuration registers are shown in Table 27-2.

Note that address 0xF80000 is beyond the user program memory space. It belongs to the configuration memory space (0x800000-0xFFFFFF), which can only be accessed using table reads and table writes.

The Device Configuration register map is shown in Table 27-1.

**TABLE 27-1: DEVICE CONFIGURATION REGISTER MAP**

| Address | Name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|
| 0xF80000 | FBS | RBS<1:0> | | — | — | BSS<2:0> | | | BWRP |
| 0xF80002 | FSS(1) | RSS<1:0> | | — | — | SSS<2:0> | | | SWRP |
| 0xF80004 | FGS | — | — | — | — | — | GSS<1:0> | | GWRP |
| 0xF80006 | FOSCSEL | IESO | — | — | — | | FNOSC<2:0> | | |
| 0xF80008 | FOSC | FCKSM<1:0> | | IOL1WAY | — | — | OSCIOFNC | POSCMD<1:0> | |
| 0xF8000A | FWDT | FWDTEN | WINDIS | — | WDTPRE | WDTPOST<3:0> | | | |
| 0xF8000C | FPOR | Reserved(2) | | | ALTI2C | — | FPWRT<2:0> | | |
| 0xF8000E | FICD | Reserved(3) | | JTAGEN | — | — | — | ICS<1:0> | |
| 0xF80010 | FUID0 | User Unit ID Byte 0 | | | | | | | |
| 0xF80012 | FUID1 | User Unit ID Byte 1 | | | | | | | |
| 0xF80014 | FUID2 | User Unit ID Byte 2 | | | | | | | |
| 0xF80016 | FUID3 | User Unit ID Byte 3 | | | | | | | |

**Legend:** — = unimplemented bit, read as '0'.

**Note 1:** This Configuration register is not available and reads as 0xFF on dsPIC33FJ32GP302/304 devices.

**2:** These bits are reserved and always read as '1'.

**3:** These bits are reserved for use by development tools and must be programmed as '1'.

## 28.0 INSTRUCTION SET SUMMARY

> **Note:** This data sheet summarizes the features of the dsPIC33FJ32GP302/304, dsPIC33FJ64GPX02/X04, and dsPIC33FJ128GPX02/X04 families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to the *"dsPIC33F/PIC24H Family Reference Manual"*. Please see the Microchip web site (www.microchip.com) for the latest reference manual sections.

The dsPIC33F instruction set is identical to that of the dsPIC30F.

Most instructions are a single program memory word (24 bits). Only three instructions require two program memory locations.

Each single-word instruction is a 24-bit word, divided into an 8-bit opcode, which specifies the instruction type and one or more operands, which further specify the operation of the instruction.

The instruction set is highly orthogonal and is grouped into five basic categories:

- Word or byte-oriented operations
- Bit-oriented operations
- Literal operations
- DSP operations
- Control operations

Table 28-1 shows the general symbols used in describing the instructions.

The dsPIC33F instruction set summary in Table 28-2 lists all the instructions, along with the status flags affected by each instruction.

Most word or byte-oriented W register instructions (including barrel shift instructions) have three operands:

- The first source operand, which is typically a register 'Wb' without any address modifier
- The second source operand, which is typically a register 'Ws' with or without an address modifier
- The destination of the result, which is typically a register 'Wd' with or without an address modifier

However, word or byte-oriented file register instructions have two operands:

- The file register specified by the value 'f'
- The destination, which could be either the file register 'f' or the W0 register, which is denoted as 'WREG'

Most bit-oriented instructions (including simple rotate/shift instructions) have two operands:

- The W register (with or without an address modifier) or file register (specified by the value of 'Ws' or 'f')
- The bit in the W register or file register (specified by a literal value or indirectly by the contents of register 'Wb')

The literal instructions that involve data movement can use some of the following operands:

- A literal value to be loaded into a W register or file register (specified by 'k')
- The W register or file register where the literal value is to be loaded (specified by 'Wb' or 'f')

However, literal instructions that involve arithmetic or logical operations use some of the following operands:

- The first source operand, which is a register 'Wb' without any address modifier
- The second source operand, which is a literal value
- The destination of the result (only if not the same as the first source operand), which is typically a register 'Wd' with or without an address modifier

The `MAC` class of DSP instructions can use some of the following operands:

- The accumulator (A or B) to be used (required operand)
- The W registers to be used as the two operands
- The X and Y address space prefetch operations
- The X and Y address space prefetch destinations
- The accumulator write back destination

The other DSP instructions do not involve any multiplication and can include:

- The accumulator to be used (required)
- The source or destination operand (designated as Wso or Wdo, respectively) with or without an address modifier
- The amount of shift specified by a W register 'Wn' or a literal value

The control instructions can use some of the following operands:

- A program memory address
- The mode of the table read and table write instructions

**TABLE 31-12: SPIx MODULE SLAVE MODE (CKE = 0) TIMING REQUIREMENTS**

| AC CHARACTERISTICS | | Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated)<br>Operating temperature -40°C ≤TA ≤+150°C for High Temperature | | | | | |
|---|---|---|---|---|---|---|---|
| Param No. | Symbol | Characteristic[1] | Min | Typ | Max | Units | Conditions |
| HSP35 | TscH2doV,<br>TscL2doV | SDOx Data Output Valid after SCKx Edge | — | — | 35 | ns | — |
| HSP40 | TdiV2scH,<br>TdiV2scL | Setup Time of SDIx Data Input to SCKx Edge | 25 | — | — | ns | — |
| HSP41 | TscH2diL,<br>TscL2diL | Hold Time of SDIx Data Input to SCKx Edge | 25 | — | — | ns | — |
| HSP51 | TssH2doZ | $\overline{SSx}$ ↑ to SDOx Output High-Impedance | 15 | — | 55 | ns | See **Note 2** |

**Note 1:** These parameters are characterized but not tested in manufacturing.
**2:** Assumes 50 pF load on all SPIx pins.

**TABLE 31-13: SPIx MODULE SLAVE MODE (CKE = 1) TIMING REQUIREMENTS**

| AC CHARACTERISTICS | | Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated)<br>Operating temperature -40°C ≤TA ≤+150°C for High Temperature | | | | | |
|---|---|---|---|---|---|---|---|
| Param No. | Symbol | Characteristic[1] | Min | Typ | Max | Units | Conditions |
| HSP35 | TscH2doV,<br>TscL2doV | SDOx Data Output Valid after SCKx Edge | — | — | 35 | ns | — |
| HSP40 | TdiV2scH,<br>TdiV2scL | Setup Time of SDIx Data Input to SCKx Edge | 25 | — | — | ns | — |
| HSP41 | TscH2diL,<br>TscL2diL | Hold Time of SDIx Data Input to SCKx Edge | 25 | — | — | ns | — |
| HSP51 | TssH2doZ | $\overline{SSx}$ ↑ to SDOx Output High-Impedance | 15 | — | 55 | ns | See **Note 2** |
| HSP60 | TssL2doV | SDOx Data Output Valid after $\overline{SSx}$ Edge | — | — | 55 | ns | — |

**Note 1:** These parameters are characterized but not tested in manufacturing.
**2:** Assumes 50 pF load on all SPIx pins.

**NOTES:**

**FIGURE 32-13: TYPICAL FRC FREQUENCY @ VDD = 3.3V**

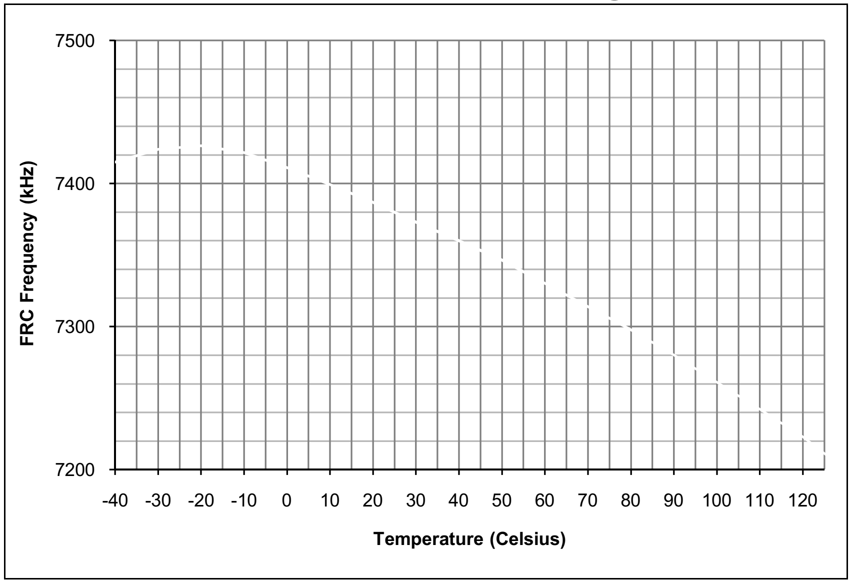
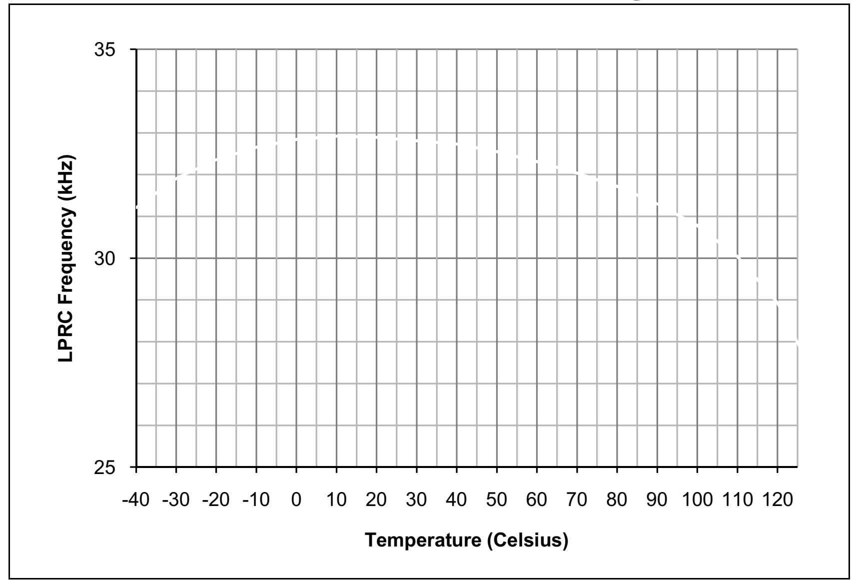
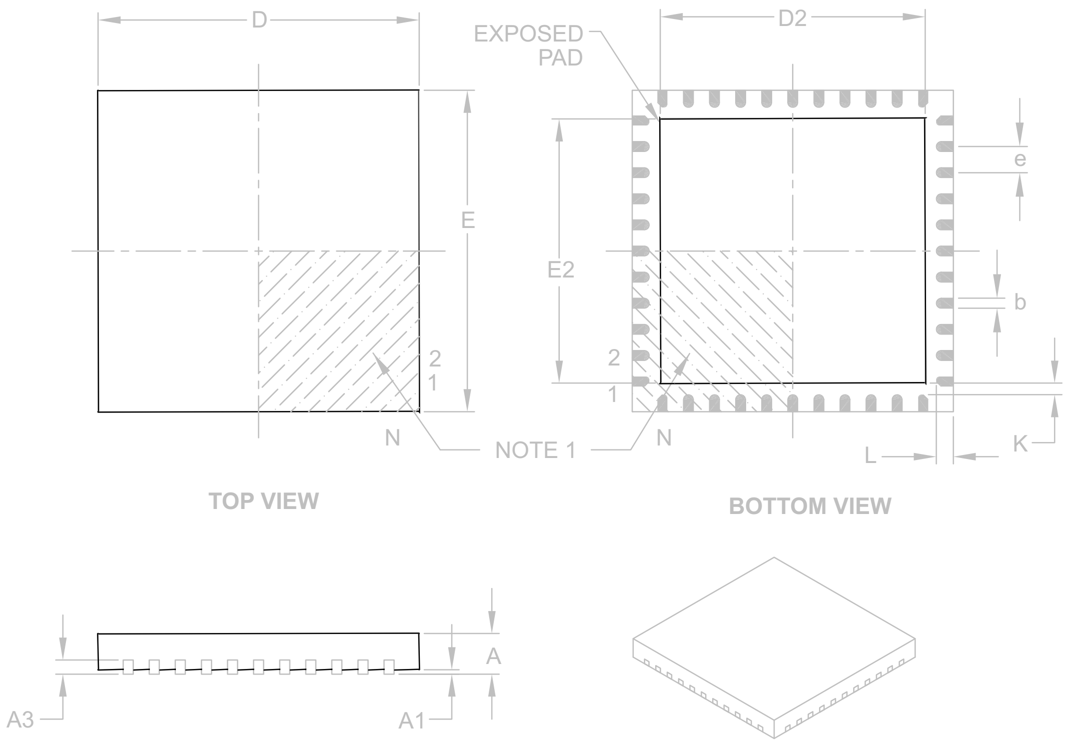



**FIGURE 32-14: TYPICAL LPRC FREQUENCY @ VDD = 3.3V**



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

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




| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Pins | N | 44 | | |
| Pitch | e | 0.65 BSC | | |
| Overall Height | A | 0.80 | 0.90 | 1.00 |
| Standoff | A1 | 0.00 | 0.02 | 0.05 |
| Contact Thickness | A3 | 0.20 REF | | |
| Overall Width | E | 8.00 BSC | | |
| Exposed Pad Width | E2 | 6.30 | 6.45 | 6.80 |
| Overall Length | D | 8.00 BSC | | |
| Exposed Pad Length | D2 | 6.30 | 6.45 | 6.80 |
| Contact Width | b | 0.25 | 0.30 | 0.38 |
| Contact Length | L | 0.30 | 0.40 | 0.50 |
| Contact-to-Exposed Pad | K | 0.20 | – | – |

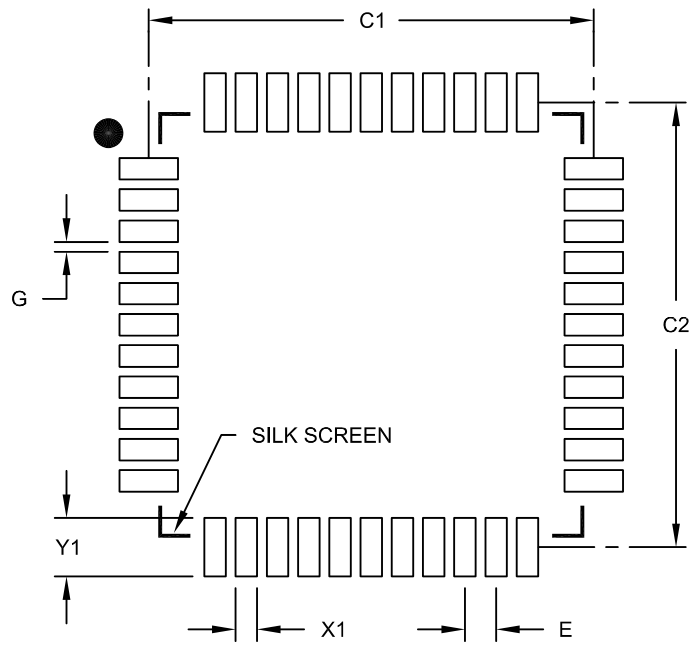
**Notes:**

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 C04-103B

44-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 | | 0.80 BSC | |
| Contact Pad Spacing | C1 | | 11.40 | |
| Contact Pad Spacing | C2 | | 11.40 | |
| Contact Pad Width (X44) | X1 | | | 0.55 |
| Contact Pad Length (X44) | Y1 | | | 1.50 |
| Distance Between Pads | G | 0.25 | | |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2076B