



dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304 Family Silicon Errata and Data Sheet Clarification

The dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304 family devices that you have received conform functionally to the current Device Data Sheet (DS70290J), except for the anomalies described in this document.

The silicon issues discussed in the following pages are for silicon revisions with the Device and Revision IDs listed in [Table 1](#). The silicon issues are summarized in [Table 2](#).

The errata described in this document will be addressed in future revisions of the dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304 silicon.

Note: This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated in the last column of [Table 2](#) apply to the current silicon revision (**A6**).

Data Sheet clarifications and corrections start on [page 10](#), following the discussion of silicon issues.

The silicon revision level can be identified using the current version of MPLAB® IDE and Microchip's programmers, debuggers and emulation tools, which are available at the Microchip corporate web site (www.microchip.com).

For example, to identify the silicon revision level using MPLAB IDE in conjunction with MPLAB ICD 3 or PICkit™ 3:

1. Using the appropriate interface, connect the device to the MPLAB ICD 3 programmer/debugger or PICkit 3.
2. From the main menu in MPLAB IDE, select *Configure>Select Device*, and then select the target part number in the dialog box.
3. Select the MPLAB hardware tool (*Debugger>Select Tool*).
4. Perform a "Connect" operation to the device (*Debugger>Connect*). Depending on the development tool used, the part number *and* Device Revision ID value appear in the **Output** window.

Note: If you are unable to extract the silicon revision level, please contact your local Microchip sales office for assistance.

The Device and Revision ID values for the various dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304 silicon revisions are shown in [Table 1](#).

TABLE 1: SILICON DEVREV VALUES

Part Number	Device ID ⁽¹⁾	Revision ID for Silicon Revision ⁽²⁾				
		A2	A3	A4	A5	A6
dsPIC33FJ32GP202	0x0F0D	0x3001	0x3002	0x3004	0x3005	0x3006
dsPIC33FJ32GP204	0x0F0F					
dsPIC33FJ16GP304	0x0F07					

- Note 1:** The Device and Revision IDs (DEVID and DEVREV) are located at the last two implemented addresses in program memory.
- 2:** Refer to the "dsPIC33F/PIC24H Flash Programming Specification" (DS70152) for detailed information on Device and Revision IDs for your specific device.

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

TABLE 2: SILICON ISSUE SUMMARY

Module	Feature	Item Number	Issue Summary	Affected Revisions ⁽¹⁾				
				A2	A3	A4	A5	A6
JTAG	Flash Programming	1.	JTAG programming does not work.	X	X	X	X	X
UART	High-Speed Mode	2.	The auto-baud feature may not calculate the correct baud rate when the Baud Rate Generator (BRG) is set up for 4x mode.	X	X	X	X	X
UART	Auto-Baud	3.	With the auto-baud feature selected, the Sync Break character (0x55) may be loaded into the FIFO as data.	X	X	X	X	X
UART	Auto-Baud	4.	The auto-baud feature measures baud rate inaccurately for certain baud rate and clock speed combinations.	X	X	X	X	X
UART	Auto-Baud	5.	When an auto-baud is detected, the receive interrupt may occur twice.	X	X	X	X	X
UART	IR Mode	6.	The 16x baud clock signal on the BCLK pin is present only when the module is transmitting.	X	X	X	X	X
UART	High-Speed Mode	7.	When the UART is in 4x mode (BRGH = 1) and using two Stop bits (STSEL = 1), it may sample the first Stop bit instead of the second one.	X	X	X	X	X
SPI	SCKx Pins	8.	The SPIxCON1 DISSCK bit does not influence port functionality.	X	X	X	X	X
I ² C™	SFR Writes	9.	The BCL bit in I2CxSTAT can be cleared only with 16-bit operation and can be corrupted with 1-bit or 8-bit operations on I2CxSTAT.	X	X	X	X	X
I ² C	10-Bit Addressing	10.	When the I ² C module is configured for 10-bit addressing using the same address bits (A10 and A9) as other I ² C devices, A10 and A9 bits may not work as expected.	X	X	X	X	X
Product Identification	Extended Temperature	11.	Revision A2 devices marked as Extended temperature range (E) devices support only Industrial temperature range (I).	X				
UART	Interrupts	12.	The UART error interrupt may not occur, or may occur at an incorrect time, if multiple errors occur during a short period of time.	X	X	X	X	X
UART	IR Mode	13.	When the UART module is operating in 8-bit mode (PDSEL<1:0> = 0x) and using the IrDA® encoder/decoder (IREN = 1), the module incorrectly transmits a data payload of 80h as 00h.	X	X	X	X	X
Internal Voltage Regulator	Sleep Mode	14.	When the VREGS bit (RCON<8>) is set to a logic '0', device may reset and higher Sleep current may be observed.	X	X	X	X	X
PSV Operations	—	15.	An address error trap occurs in certain addressing modes when accessing the first four bytes of any PSV page.	X	X	X	X	X
I ² C	10-Bit Addressing	16.	When the I ² C module is configured as a 10-bit slave with an address of 0x02, the I2CxRCV register content for the lower address byte is 0x01 rather than 0x02.	X	X	X	X	X

Note 1: Only those issues indicated in the last column apply to the current silicon revision.

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

TABLE 2: SILICON ISSUE SUMMARY (CONTINUED)

Module	Feature	Item Number	Issue Summary	Affected Revisions ⁽¹⁾				
				A2	A3	A4	A5	A6
I ² C	—	17.	With the I ² C module enabled, the PORT bits and external interrupt input functions (if any) associated with SCLx and SDAx pins will not reflect the actual digital logic levels on the pins.	X	X	X	X	X
I ² C	10-Bit Addressing	18.	The 10-bit slave does not set the RBF flag or load the I2CxRCV register on address match if the Least Significant bits (LSBs) of the address are the same as the 7-bit reserved addresses.	X	X	X	X	X
I ² C	—	19.	After the ACKSTAT bit is set when receiving a NACK, it may be cleared by the reception of a Start or Stop bit.	X	X	X	X	X
CPU	EXCH Instruction	20.	The EXCH instruction does not execute correctly.	X	X	X	X	X
PGEC3/ PGED3 Programming Pins	Device Programming	21.	When using the PGEC3/PGED3 pins for device programming, the programming time may be slower as compared to other available PGECx/PGEDx pin pairs.	X	X	X	X	X
UART	Break Character Generation	22.	The UART module will not generate back-to-back Break characters.	X	X	X	X	X
ADC	Current Consumption in Sleep Mode	23.	If the ADC module is in an enabled state when the device enters Sleep mode, the power-down current (I _{PD}) of the device may exceed the device data sheet specifications.	X	X	X	X	X
All	150°C Operation	24.	These revisions of silicon only support 140°C operation instead of 150°C for high-temperature operating temperature.	X	X	X	X	
CPU	Interrupt Disable	25.	When a previous DISI instruction is active (i.e., the DISICNT register is non-zero), and the value of the DISICNT register is updated manually, the DISICNT register freezes and disables interrupts permanently.	X	X	X	X	X
CPU	div.sd	26.	When using the div.sd instruction, the Overflow bit is not getting set when an overflow occurs.	X	X	X	X	X
UART	TX Interrupt	27.	A Transmit (TX) interrupt may occur before the data transmission is complete.	X	X	X	X	X
JTAG	Flash Programming	28.	JTAG Flash programming is not supported.	X	X	X	X	X

Note 1: Only those issues indicated in the last column apply to the current silicon revision.

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

Silicon Errata Issues

Note: This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated by the shaded column in the following tables apply to the current silicon revision (A6).

1. Module: JTAG

JTAG programming does not work.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

2. Module: UART

The auto-baud feature may not calculate the correct baud rate when the High Baud Rate Enable bit, BRGH, is set. With the BRGH bit set, the baud rate calculation used is the same as BRG = 0.

Work around

If the auto-baud feature is needed, use the Low Baud Rate mode by clearing the BRGH bit.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

3. Module: UART

With the auto-baud feature selected, the Sync Break character (0x55) may be loaded into the FIFO as data.

Work around

To prevent the Sync Break character from being loaded into the FIFO, load the UxBRG register with either 0x0000 or 0xFFFF prior to enabling the auto-baud feature (ABAUD = 1).

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

4. Module: UART

The auto-baud feature may miscalculate for certain baud rate and clock speed combinations, resulting in a BRG value that is greater than or less than the expected value by 1. This may result in reception or transmission failures.

Work around

Test the auto-baud rate at various clock speed and baud rate combinations that would be used in an application. If an inaccurate BRG value is generated, manually correct the baud rate in user software.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

5. Module: UART

When an auto-baud is detected, the receive interrupt may occur twice. The first interrupt occurs at the beginning of the Start bit and the second after reception of the Sync field character.

Work around

If an extra interrupt is detected, ignore the additional interrupt.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

6. Module: UART

When the UART is configured for IR interface operations (UxMODE<9:8> = 11), the 16x baud clock signal on the BCLK pin is present only when the module is transmitting. The pin is idle at all other times.

Work around

Configure one of the output compare modules to generate the required baud clock signal when the UART is receiving data or in an Idle state.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

7. Module: UART

When the UART is in 4x mode (BRGH = 1) and using two Stop bits (STSEL = 1), it may sample the first Stop bit instead of the second one.

This issue does not affect the other UART configurations.

Work around

Use the 16x baud rate option (BRGH = 0) and adjust the baud rate accordingly.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

8. Module: SPI

When the SPI module is enabled, setting the DISSCK bit in the SPIxCON1 register does not allow the user application to use the SCK pin as a General Purpose I/O pin.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

9. Module: I²C™

The BCL bit in I2CxSTAT can be cleared only with 16-bit operation and can be corrupted with 1-bit or 8-bit operations on I2CxSTAT.

Work around

Use 16-bit operations to clear BCL.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

10. Module: I²C

If there are two I²C devices on the bus, one of them is acting as the Master receiver and the other as the Slave transmitter. Suppose that both devices are configured for 10-bit addressing mode, and have the same value in the A10 and A9 bits of their addresses. When the Slave select address is sent from the Master, both the Master and Slave Acknowledges it. When the Master sends out the read operation, both the Master and the Slave enter into Read mode and both of them transmit the data. The resultant data will be the ANDing of the two transmissions.

Work around

Use different addresses, including the higher two bits (A10 and A9), for different modules.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

11. Module: Product Identification

Revision A2 devices marked as Extended temperature range (E) devices, support only Industrial temperature range (I).

Work around

Use Revision A3 or newer devices marked as Extended temperature range (E) devices.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X							

12. Module: UART

The UART error interrupt may not occur, or may occur at an incorrect time, if multiple errors occur during a short period of time.

Work around

Read the error flags in the UxSTA register whenever a byte is received to verify the error status. In most cases, these bits will be correct, even if the UART error interrupt fails to occur.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

13. Module: UART

When the UART is operating in 8-bit mode (PDSEL<1:0> = 0x) and using the IrDA encoder/decoder (IREN = 1), the module incorrectly transmits a data payload of 80h as 00h.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

14. Module: Internal Voltage Regulator

When the VREGS bit (RCON<8>) is set to a logic '0', the device may reset and a higher Sleep current may be observed.

Work around

Ensure VREGS bit (RCON<8>) is set to a logic '1' for device Sleep mode operation.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

15. Module: PSV Operations

An address error trap occurs in certain addressing modes when accessing the first four bytes of a PSV page. This occurs only when using the following addressing modes:

- MOV.D
- Register Indirect Addressing (Word or Byte mode) with pre/post-decrement

Work around

Do not perform PSV accesses to any of the first four bytes using the above addressing modes. For applications using the C language, MPLAB C30 Version 3.11 or higher provides the following command-line switch that implements a work around for the erratum.

```
-merrata=psv_trap
```

Refer to the `readme.txt` file in the MPLAB C30 v3.11 toolsuite for further details.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

16. Module: I²C

When the I²C module is configured as a 10-bit slave with an address of 0x02, the I2CxRCV register content for the lower address byte is 0x01 rather than 0x02; however, the module Acknowledges both address bytes.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

17. Module: I²C

With the I²C module enabled, the PORT bits and external interrupt input functions (if any) associated with the SCLx and SDAx pins do not reflect the actual digital logic levels on the pins.

Work around

If the SDAx and/or SCLx pins need to be polled, these pins should be connected to other port pins in order to be read correctly. This issue *does not* affect the operation of the I²C module.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

18. Module: I²C

In 10-Bit Addressing mode, some address matches do not set the RBF flag or load the I2Cx Receive register, I2CxRCV, if the lower address byte matches the reserved addresses. In particular, these include all addresses with the form 'xx0000xxxx' and 'xx1111xxxx', with the following exceptions:

- '001111000x'
- '011111001x'
- '101111010x'
- '111111011x'

Work around

Ensure that the lower address byte in 10-Bit Addressing mode does not match any 7-bit reserved addresses.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

19. Module: I²C

When the I²C module is operating in either Master or Slave mode, after the ACKSTAT bit is set when receiving a NACK, it may be cleared by the reception of a Start or Stop bit.

Work around

Store the value of the ACKSTAT bit immediately after receiving a NACK.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

20. Module: CPU

The EXCH instruction does not execute correctly.

Work around

If writing source code in assembly, the recommended work around is to replace:

```
EXCH Wsource, Wdestination
```

with:

```
PUSH Wdestination
MOV Wsource, Wdestination
POP Wsource
```

If using the MPLAB C30 C compiler, specify the compiler option: `-merrata=exch` (*Project > Build Options > Projects > MPLAB C30 > Use Alternate Settings*).

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

21. Module: PGEC3/PGED3 Programming Pins

When using the PGEC3/PGED3 pins for device programming, the programming time may be slower as compared to other available PGECx/PGEDx pin pairs because the Enhanced ICSP programming algorithm cannot be executed on this pin pair.

Refer to the “*dsPIC33F/PIC24H Flash Programming Specification*” (DS70152) for additional information on this limitation.

Work around

Use alternate PGECx/PGEDx programming pin pairs.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

22. Module: UART

The UART module will not generate consecutive Break characters. Trying to perform a back-to-back Break character transmission will cause the UART module to transmit the dummy character used to generate the first Break character instead of transmitting the second Break character. Break characters are generated correctly if they are followed by non-Break character transmission.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

23. Module: ADC

If the ADC module is in an enabled state when the device enters Sleep mode as a result of executing a `PWRSVAV #0` instruction, the device power-down current (IPD) may exceed the specifications listed in the device data sheet. This may happen even if the ADC module is disabled by clearing the ADON bit prior to entering Sleep mode.

Work arounds

Work around 1:

In order to remain within the IPD specifications listed in the device data sheet, the user software must completely disable the ADC module by setting the ADC module disable bit in the corresponding Peripheral Module Disable register (PMDx), prior to executing a `PWRSVAV #0` instruction.

Note: The ADC module must be re-initialized by the user application before resuming ADC operation.

Work around 2:

If the ADC module was previously initialized and enabled before entering Sleep, execute the lines of code provided in [Example 1](#).

Note: Unlike **Work around 1**, the user application does not need to re-initialize the ADC module; however, it is necessary to re-enable the ADC module by setting the ADON bit after waking from Sleep.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

EXAMPLE 1:

```
AD1CON1bits.ADON = 0;           //Disable the ADC module
__asm__ volatile ("REPEAT #50"); //Wait 50 Tcy
__asm__ volatile ("NOP");       //Repeat NOP 51 times
Sleep();                        // Execute PWRSVAV #0 and go to Sleep
```


dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

24. Module: All

The affected silicon revisions listed below are not warranted for operation at 150°C.

Work around

Use only the affected revisions of silicon for high-temperature operating range, from -40°C to +140°C.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X				

25. Module: CPU

When a previous `DISI` instruction is active (i.e., the `DISCNT` register is non-zero), and the value of the `DISCNT` register is updated manually, the `DISCNT` register freezes and disables interrupts permanently.

Work around

Avoid updating the `DISCNT` register manually. Instead, use the `DISI #n` instruction with the required value for 'n'.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

26. Module: CPU

When using the Signed 32-by-16-bit Division instruction, `div.sd`, the Overflow bit does not always get set when an overflow occurs.

Work around

Test for and handle overflow conditions outside of the `div.sd` instruction.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

27. Module: UART

When using `UTXISEL<1:0> = 01` (interrupt when the last character is shifted out of the Transmit Shift Register) and the final character is being shifted out through the Transmit Shift Register, the Transmit (TX) interrupt may occur before the final bit is shifted out.

Work arounds

If it is critical that the interrupt processing occur only when all transmit operations are complete. Hold off the interrupt routine processing by adding a loop at the beginning of the routine that polls the Transmit Shift Register Empty bit (TRMT) before processing the rest of the interrupt.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

28. Module: JTAG

JTAG Flash programming is not supported.

Work around

None.

Affected Silicon Revisions

A2	A3	A4	A5	A6			
X	X	X	X	X			

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

Data Sheet Clarifications

The following typographic corrections and clarifications are to be noted for the latest version of the device data sheet (DS70290J):

Note: Corrections are shown in **bold**. Where possible, the original bold text formatting has been removed for clarity.

1. Module: Electrical Characteristics

The specifications for F21a in [Table 22-19](#) have been updated as shown in **bold** below.

TABLE 22-19: INTERNAL RC ACCURACY

AC 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.	Characteristic	Min	Typ	Max	Units	Conditions	
	LPRC @ 32.768 kHz ^(1,2)						
F21a	LPRC	-20	±10	+20	%	$-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$	V _{DD} = 3.0-3.6V
F21b	LPRC	-40	—	+40	%	$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	V _{DD} = 3.0-3.6V

Note 1: Change of LPRC frequency as V_{DD} changes.

Note 2: LPRC impacts the Watchdog Timer Time-out Period (TWDT1). See Section 19.4 “Watchdog Timer (WDT)” for more information.

APPENDIX A: REVISION HISTORY

Rev A Document (4/2009)

Initial release of this document; issued for revision A2, A3, A4 and A5 silicon.

Includes silicon issues 1 ([JTAG](#)), 2-7 ([UART](#)), 8 ([SPI](#)), 9-10 ([I²C™](#)), 11 ([Product Identification](#)), 12-13 ([UART](#)), 14 ([Internal Voltage Regulator](#)), 15 ([PSV Operations](#)), 16-19 ([I²C](#)) and 20 ([CPU](#)).

This document replaces the following errata document: DS80337, “*dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304 Rev. A2/A3/A4 Silicon Errata*”

Rev B Document (8/2009)

Added silicon issues 21 ([PGEC3/PGED3 Programming Pins](#)) and 22 ([UART](#)).

Rev C Document (6/2010)

Updated silicon issue 20 ([CPU](#)).

Added silicon issue 23 ([ADC](#)) and data sheet clarification 1 ([DC Characteristics: I/O Pin Input Specifications](#)).

Rev D Document (10/2010)

Updated the work around in silicon issue 23 ([ADC](#)).

Added silicon issue 24 ([All](#)).

Rev E Document (12/2010)

Added silicon revision A6 references throughout the document.

Rev F Document (3/2011)

Updated data sheet revision from “F” to “G” and removed data sheet clarification issue 1.

Rev G Document (11/2011)

Added silicon issues 25 ([CPU](#)), 26 ([CPU](#)), 27 ([UART](#)), and 28 ([JTAG](#)).

Rev H Document (12/2013)

Added data sheet clarification 1 ([Electrical Characteristics](#)).

dsPIC33FJ32GP202/204 and dsPIC33FJ16GP304

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC³² logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MTP, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.


Analog-for-the-Digital Age, Application Maestro, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniclient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICtail, REAL ICE, rLAB, Select Mode, SQI, Serial Quad I/O, Total Endurance, TSHARC, UniWinDriver, WiperLock, ZENA and Z-Scale are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

GestIC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2011-2013, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

ISBN: 978-1-62077-802-9

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949 ==



MICROCHIP

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hangzhou
Tel: 86-571-2819-3187
Fax: 86-571-2819-3189

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880-3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Pforzheim
Tel: 49-7231-424750

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

10/28/13