



## Product Change Notification - SYST-14IQPA658

---

**Date:**

17 Jun 2019

**Product Category:**

8-bit Microcontrollers

**Affected CPNs:****Notification subject:**

ERRATA - PIC16(L)F19155/56/75/76/85/86 Family Silicon Errata and Data Sheet Clarification

**Notification text:**

SYST-14IQPA658

Microchip has released a new DeviceDoc for the PIC16(L)F19155/56/75/76/85/86 Family Silicon Errata and Data Sheet Clarification of devices. If you are using one of these devices please read the document located at [PIC16\(L\)F19155/56/75/76/85/86 Family Silicon Errata and Data Sheet Clarification](#).

**Notification Status:** Final

**Description of Change:**

1) Data Sheet Clarifications: Removed all modules (Data Sheet updated).

**Impacts to Data Sheet:** None

**Reason for Change:** To Improve Productivity

**Change Implementation Status:** Complete

**Date Document Changes Effective:** 17 June 2019

**NOTE:** Please be advised that this is a change to the document only the product has not been changed.

**Markings to Distinguish Revised from Unrevised Devices:** N/A

**Attachment(s):**

[PIC16\(L\)F19155/56/75/76/85/86 Family Silicon Errata and Data Sheet Clarification](#)

Please contact your local [Microchip sales office](#) with questions or concerns regarding this notification.

**Terms and Conditions:**

If you wish to receive Microchip PCNs via email please register for our PCN email service at our [PCN home page](#) select register then fill in the required fields. You will find instructions about registering for Microchips PCN email service in the [PCN FAQ](#) section.

If you wish to change your PCN profile, including opt out, please go to the [PCN home page](#) select login and sign into your myMicrochip account. Select a profile option from the left navigation bar and make the applicable selections.

Affected Catalog Part Numbers (CPN)

PIC16F19155-E/MV  
PIC16F19155-E/SO  
PIC16F19155-E/SP  
PIC16F19155-E/SS  
PIC16F19155-I/MV  
PIC16F19155-I/SO  
PIC16F19155-I/SP  
PIC16F19155-I/SS  
PIC16F19155T-I/MV  
PIC16F19155T-I/SO  
PIC16F19155T-I/SS  
PIC16F19156-E/MV  
PIC16F19156-E/SO  
PIC16F19156-E/SP  
PIC16F19156-E/SS  
PIC16F19156-I/MV  
PIC16F19156-I/SO  
PIC16F19156-I/SP  
PIC16F19156-I/SS  
PIC16F19156T-I/MV  
PIC16F19156T-I/SO  
PIC16F19156T-I/SS  
PIC16F19175-E/MV  
PIC16F19175-E/P  
PIC16F19175-E/PT  
PIC16F19175-I/MV  
PIC16F19175-I/P  
PIC16F19175-I/PT  
PIC16F19175T-I/MV  
PIC16F19175T-I/PT  
PIC16F19176-E/MV  
PIC16F19176-E/P  
PIC16F19176-E/PT  
PIC16F19176-I/MV  
PIC16F19176-I/P  
PIC16F19176-I/PT  
PIC16F19176T-I/MV  
PIC16F19176T-I/PT  
PIC16F19185-E/MV  
PIC16F19185-E/PT  
PIC16F19185-I/MV  
PIC16F19185-I/PT  
PIC16F19185T-I/MV  
PIC16F19185T-I/PT  
PIC16F19186-E/MV  
PIC16F19186-E/PT

PIC16F19186-I/MV  
PIC16F19186-I/PT  
PIC16F19186T-I/MV  
PIC16F19186T-I/PT  
PIC16LF19155-E/MV  
PIC16LF19155-E/SO  
PIC16LF19155-E/SP  
PIC16LF19155-E/SS  
PIC16LF19155-I/MV  
PIC16LF19155-I/SO  
PIC16LF19155-I/SP  
PIC16LF19155-I/SS  
PIC16LF19155T-I/MV  
PIC16LF19155T-I/SO  
PIC16LF19155T-I/SS  
PIC16LF19156-E/MV  
PIC16LF19156-E/SO  
PIC16LF19156-E/SP  
PIC16LF19156-E/SS  
PIC16LF19156-I/MV  
PIC16LF19156-I/SO  
PIC16LF19156-I/SP  
PIC16LF19156-I/SS  
PIC16LF19156T-I/MV  
PIC16LF19156T-I/SO  
PIC16LF19156T-I/SS  
PIC16LF19175-E/MV  
PIC16LF19175-E/P  
PIC16LF19175-E/PT  
PIC16LF19175-I/MV  
PIC16LF19175-I/P  
PIC16LF19175-I/PT  
PIC16LF19175T-I/MV  
PIC16LF19175T-I/PT  
PIC16LF19176-E/MV  
PIC16LF19176-E/P  
PIC16LF19176-E/PT  
PIC16LF19176-I/MV  
PIC16LF19176-I/P  
PIC16LF19176-I/PT  
PIC16LF19176T-I/MV  
PIC16LF19176T-I/PT  
PIC16LF19185-E/MV  
PIC16LF19185-E/PT  
PIC16LF19185-I/MV  
PIC16LF19185-I/PT  
PIC16LF19185T-I/MV  
PIC16LF19185T-I/PT  
PIC16LF19186-E/MV

PIC16LF19186-E/PT  
PIC16LF19186-I/MV  
PIC16LF19186-I/PT  
PIC16LF19186-I/PTC01  
PIC16LF19186T-I/MV  
PIC16LF19186T-I/PT  
PIC16LF19186T-I/PTC01



# PIC16(L)F19155/56/75/76/85/86

## PIC16(L)F19155/56/75/76/85/86 Family Silicon Errata and Data Sheet Clarification

The PIC16(L)F19155/56/75/76/85/86 family devices that you have received conform functionally to the current Device Data Sheet (DS40001923B), 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 PIC16(L)F19155/56/75/76/85/86 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 (**A3**).

Data Sheet clarifications and corrections start on [page 6](#), 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 website ([www.microchip.com](http://www.microchip.com)).

For example, to identify the silicon revision level using MPLAB IDE in conjunction with a hardware debugger:

1. Using the appropriate interface, connect the device to the hardware debugger.
2. Open an MPLAB IDE project.
3. Configure the MPLAB IDE project for the appropriate device and hardware debugger.
4. Based on the version of MPLAB IDE you are using, do one of the following:
  - a) For MPLAB IDE 8, select **Programmer > Reconnect**.
  - b) For MPLAB X IDE, select **Window > Dashboard** and click the **Refresh Debug Tool Status** icon (  ).
5. 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 DEVREV values for the various PIC16(L)F19155/56/75/76/85/86 silicon revisions are shown in [Table 1](#).

**TABLE 1: SILICON DEVREV VALUES**

Part Number	Device ID <sup>(1)</sup>	Revision ID for Silicon Revision <sup>(2)</sup>	
		A1	A3
PIC16F19155	3096h	2001h	2003h
PIC16LF19155	3097h	2001h	2003h
PIC16F19156	3098h	2001h	2003h
PIC16LF19156	3099h	2001h	2003h
PIC16F19175	309Ah	2001h	2003h
PIC16LF19175	309Bh	2001h	2003h
PIC16F19176	309Ch	2001h	2003h
PIC16LF19176	309Dh	2001h	2003h
PIC16F19185	30BAh	2001h	2003h
PIC16LF19185	30BBh	2001h	2003h
PIC16F19186	30BCh	2001h	2003h
PIC16LF19186	30BDh	2001h	2003h

- Note 1:** The Device and Revision IDs is located at the respective addresses 8006h and 8005h of configuration memory space.
- 2:** Refer to the "PIC16(L)F191XX Memory Programming Specification" (DS40001880) for detailed information on Device and Revision IDs for your specific device.

# PIC16(L)F19155/56/75/76/85/86

**TABLE 2: SILICON ISSUE SUMMARY**

Module	Feature	Item Number	Summary	Affected Revisions	
				A1	A3
Analog-to-Digital Converter with Computation (ADC <sup>2</sup> )	ADC <sup>2</sup> with Fixed Voltage Reference (FVR)	1.1	Using the FVR as the ADC positive voltage reference can cause missing codes.	X	
	ADC <sup>2</sup> with Guard Ring Outputs	1.2	The Guard Ring Output feature is not implemented.	X	
	ADC <sup>2</sup> FRC Clock Sleep Mode	1.3	If in Sleep and ADRC is used, the oscillator continues to run after conversion.	X	
	ADC <sup>2</sup> FRC Clock ADGO Delay	1.4	When using FRC as clock source, there is a delay of 1 instruction cycle.	X	
	ADC <sup>2</sup> Conversion	1.5	At the very beginning of the ADC conversion, the input signal may briefly be pulled to ground.	X	
Reset and VBAT	VBAT with ULPBOR	2.1	Higher current with ULPBOR active.	X	
Liquid Crystal Display (LCD) Controller	Internal VLCD3 Measurement	3.1	Non-stable readings.	X	
	1/2 MUX, 1/2 Bias with External Resistor Ladder	3.2	1/2 MUX, 1/2 Bias with External Resistor Ladder is not operational.	X	
Comparator (CMP)	C2 Low-Power Clocked Comparator	4.1	Unstable output.	X	X
Windowed Watchdog Timer (WWDT)	Watchdog Timer Clock Source	5.1	WWDT only operates from the LFINTOSC clock source.	X	
Real-Time Clock and Calendar (RTCC)	RTCC Alarm	6.1	An alarm will not occur if the lower nibble of ALRMLSEC <3:0> is configured to 0x0.	X	
Electrical Specifications	SMBus V <sub>IL</sub> Level	7.1	The maximum V <sub>IL</sub> level changes when V <sub>DD</sub> is below 4.0V.	X	
	Fixed Voltage Reference (FVR) Accuracy	7.2	Fixed Voltage Reference (FVR) output tolerance may be higher than specified at temperatures below -20°C.	X	X
	Nonvolatile Memory (NVM) for LF Devices	7.3	Performing a row erase through the NVMREG access may not execute as expected when V <sub>DD</sub> is lowered.	X	X
	Min V <sub>DD</sub> Specification	7.4	V <sub>DDMIN</sub> specifications are changed for LF devices only.	X	X
Device Information Area (DIA)	Fixed Voltage Reference Data	8.1	FVR Reference Data may be missing	X	

## 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 (**A3**).

### 1. Module: Analog-to-Digital Converter with Computation (ADC<sup>2</sup>)

#### 1.1 ADC<sup>2</sup> with Fixed Voltage Reference (FVR)

Using the FVR as the positive voltage reference (VREF+) for the ADC, can cause an increase in missing codes.

##### Work around

Method 1: Increase the bit conversion time, known as TAD, to 8 μs or higher.

Method 2: Use VDD as the positive voltage reference to the ADC.

##### Affected Silicon Revisions

A1	A3						
X							

#### 1.2 ADC<sup>2</sup> with Guard Ring Outputs

The two guard ring drive outputs ADGRDA and ADGRDB are not implemented on these devices.

##### Work around

None.

##### Affected Silicon Revisions

A1	A3						
X							

#### 1.3 ADC<sup>2</sup> FRC Clock Sleep Mode

If the part is in Sleep and the ADCRC oscillator is used as the clock source to the ADC, the oscillator continues to run after the conversion is complete. This will increase the current consumption in Sleep mode. The oscillator will stop after the device exits Sleep mode and resumes normal code execution.

##### Work around

None.

##### Affected Silicon Revisions

A1	A3						
X							

#### 1.4 ADC<sup>2</sup> FRC Clock ADGO Delay

When using the FRC as the clock source for ADC<sup>2</sup>, there is a delay of one instruction cycle between the user setting the ADGO bit and being able to read it. This can lead to a false conversion complete scenario (i.e., ADGO being cleared), depending if the user code has a bit clear test (BTFC) instruction on the ADGO bit, immediately after setting the ADGO bit. See Code Example below.

```
BSF  ADCON0,ADGO ;Start conversion
BTFCADCON0,ADGO ;Is conversion
                        done?
GOTO $-1           ;No, test again
```

The BTFC will pass the very first time in this situation.

##### Work around

Add a NOP instruction after setting the ADGO bit and before testing the bit for completion of conversion. See Code Example below:

```
BSF  ADCON0,ADGO ;Start conversion
NOP
BTFCADCON0,ADGO ;Is conversion
                        done?
GOTO $-1           ;No, test again
```

##### Affected Silicon Revisions

A1	A3						
X							

#### 1.5 ADC<sup>2</sup> Conversion

At the very beginning of the ADC conversion, the input signal may briefly be pulled to ground, which in turn may take some charge out of the internal sample and hold capacitor. The problem is more pronounced on inputs with an impedance greater than 1K ohm.

This issue will be seen when sampling the following internal channel inputs: FVR, DAC, and Temperature Indicator and when sampling external sources on an analog pin, including the CVD.

##### Work around

When sampling the internal channel inputs, FVR, DAC, and Temperature Indicator, increase the minimum TAD time to 4 μs to increase accuracy.

# PIC16(L)F19155/56/75/76/85/86

When sampling an external source through an analog pin, keep the input impedance below 1K ohm.

When using the ADC as an internal reference for the CVD module, there is no work around.

## Affected Silicon Revisions

A1	A3						
X							

## 2. Module: Reset and VBAT

### 2.1 VBAT with ULPBOR

In order to avoid high IBAT currents of 10  $\mu$ A or greater, when utilizing VBAT to provide battery backup the ULPBOR should not be activated. When the part is used in this fashion, VDD should also be either off (0 volts) or >1.5V.

#### Work around

Do not use VBAT along with ULPBOR.

## Affected Silicon Revisions

A1	A3						
X							

## 3. Module: Liquid Crystal Display (LCD) Controller

### 3.1 Internal VLCD3 Measurement

The 1/4 scale tap point provided on the LP Resistor Ladder for use together with the ADC does not provide stable readings to support monitoring of the LCD pump output level.

#### Work around

Measure the VLCD3 via an external ADC.

## Affected Silicon Revisions

A1	A3						
X							

### 3.2 1/2 MUX, 1/2 Bias with External Resistor Ladder

The 1/2 MUX, 1/2 bias with External Resistor Ladder mode of operation is non-functional.

#### Work around

For 1/2 MUX, 1/2 Bias mode operation use the internal LP, MP or HP ladder.

## Affected Silicon Revisions

A1	A3						
X							

## 4. Module: Comparator (CMP)

### 4.1 C2 Low-Power Clocked Comparator

The output of the Low-Power Clocked Comparator (CMP2) is unstable and is not recommended for use.

#### Work around

None.

## Affected Silicon Revisions

A1	A3						
X	X						

## 5. Module: Windowed Watchdog Timer (WWDT)

### 5.1 Watchdog Timer Clock Source

When the WDTCS <2:0> bits of the WDTCON1 register are set to either the MFINTOSC (b'001') or the SOSC (b'010') clock source, the WWDT does not operate.

#### Work around

Use the LFINTOSC (b'000') as the clock source for the WWDT.

## Affected Silicon Revisions

A1	A3						
X							

## 6. Module: Real-Time Clock and Calendar (RTCC)

### 6.1 Real-Time Clock and Calendar (RTCC) Alarm

When using the RTCC alarm function in any mode other than AMASK<3:0> = 0b0000 or AMASK<3:0> = 0b0001, an alarm will not occur if the lower nibble of the ALRMSEC register, ALRMLSEC <3:0>, is configured to 0x0.

#### Work around

If an alarm is desired when the lower nibble of the SECONDS register = 0x0, configure ALRMLSEC<3:0> = 0xA.

## Affected Silicon Revisions

A1	A3						
X							



# PIC16(L)F19155/56/75/76/85/86

## 7. Module: Electrical Specifications

### 7.1 SMBus V<sub>IL</sub> Level

When the V<sub>DD</sub> voltage level supplied to the device is 4.0V and above, the maximum SMBus voltage level for the V<sub>IL</sub> parameter is 0.8V. When V<sub>DD</sub> drops below 4.0V, the maximum SMBus voltage level for V<sub>IL</sub> drops to 0.7V.

#### Work around

None.

#### Affected Silicon Revisions

A1	A3						
X							

### 7.2 Fixed Voltage Reference (FVR) Accuracy

At temperatures below -20°C, the output voltage for the FVR may be greater than the levels specified in the data sheet. This will apply to all three gain amplifier settings (1X, 2X, 4X). The affected parameter numbers found in the data sheet are: FVR01 (1X gain setting), FVR02 (2X gain setting), and FVR03 (4X gain setting).

#### Work around

At temperatures above -20°C, the stated tolerances in the data sheet remain in effect. Operate the FVR only at temperatures above -20°C.

#### Affected Silicon Revisions

A1	A3						
X	X						

### 7.3 Nonvolatile Memory (NVM) for LF Devices

Performing a row erase through the NVMREG access on LF devices may not execute as expected when V<sub>DD</sub> is lowered from >3.3V down to <2.0V before or during the row erase, while also operating between +25°C and -40°C.

#### Work around

None.

#### Affected Silicon Revisions

A1	A3						
X	X						

### 7.4 Min V<sub>DD</sub> Specification for LF Devices

V<sub>DDMIN</sub> for LF devices is 2.0V.

#### Work around

None.

#### Affected Silicon Revisions

A1	A3						
X	X						

## 8. Module: Device Information Area (DIA)

### 8.1 Fixed Voltage Reference Data

Devices marked with date code 1846 and older, may or may not have the measured FVR reference data stored in DIA address locations 8118h through 811Dh. Devices marked with date code 1847 and newer are not affected.

#### Work around

None.

#### Affected Silicon Revisions

A1	A3						
X							

# PIC16(L)F19155/56/75/76/85/86

---

## Data Sheet Clarifications

The following typographic corrections and clarifications are to be noted for the latest version of the device data sheet (DS40001923B):

<p><b>Note:</b> Corrections are shown in <b>bold</b>. Where possible, the original bold text formatting has been removed for clarity.</p>
---

None.

## APPENDIX A: DOCUMENT REVISION HISTORY

### Rev F Document (06/2019)

Data Sheet Clarifications: Removed all modules (Data Sheet updated).

### Rev E Document (04/2019)

Added silicon rev. A3.

Removed Module 1.5: ADC<sup>2</sup> Channel Switching.

Added Module 8: Device Information Area (DIA).

Data Sheet Clarifications: Added Module 1.2: TAD Parameters. Updated Section 3: Capture/Compare/PWM Modules.

### Rev D Document (09/2018)

Added Module 1.3 ADC<sup>2</sup> FRC Clock Sleep Mode.  
Added Module 1.4 ADC<sup>2</sup> FRC Clock ADGO Delay.  
Added Module 1.5 ADC<sup>2</sup> Channel Switching. Added Module 1.6 ADC<sup>2</sup> Conversion. Added Module 3.2 1/2 MUX, 1/2 Bias with External Resistor Ladder. Added 5.1 Watchdog Timer Clock Source. Added Module 6: Real-Time Clock and Calendar (RTCC) and 6.1 RTCC Alarm. Updated Table 2.

### Rev C Document (05/2018)

Added silicon issue 5.4: Min V<sub>DD</sub> Specification for LF devices.

Data Sheet Clarifications: Added Module 1: Analog-to-Digital with Computation (ADC<sup>2</sup>) and Module 2: Real-Time Clock and Calendar (RTCC).

### Rev B Document (11/2017)

Added silicon issue 5.3: Nonvolatile Memory (NVM) for LF devices.

### Rev A Document (06/2017)

Initial release of this document; issued for revision A1. Includes silicon issues 1.1 (ADC<sup>2</sup>), 2.1 (VBAT), 3.1 (LCD), 4.1 (CMP), Electrical Specifications: 5.1 SMBus, 5.2 Program Flash Memory, and 5.3 FVR.

---

---

**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 unless otherwise stated.

### Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Klear, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TempTracker, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, Vite, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA 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.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark 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.

© 2017-2019, Microchip Technology Incorporated, All Rights Reserved.

ISBN: 978-1-5224-4640-8

For information regarding Microchip's Quality Management Systems, please visit [www.microchip.com/quality](http://www.microchip.com/quality).



# 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](http://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

#### 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  
Tel: 317-536-2380

#### Los Angeles

Mission Viejo, CA  
Tel: 949-462-9523  
Fax: 949-462-9608  
Tel: 951-273-7800

#### Raleigh, NC

Tel: 919-844-7510

#### New York, NY

Tel: 631-435-6000

#### San Jose, CA

Tel: 408-735-9110  
Tel: 408-436-4270

#### Canada - Toronto

Tel: 905-695-1980  
Fax: 905-695-2078

### ASIA/PACIFIC

**Australia - Sydney**  
Tel: 61-2-9868-6733

**China - Beijing**  
Tel: 86-10-8569-7000

**China - Chengdu**  
Tel: 86-28-8665-5511

**China - Chongqing**  
Tel: 86-23-8980-9588

**China - Dongguan**  
Tel: 86-769-8702-9880

**China - Guangzhou**  
Tel: 86-20-8755-8029

**China - Hangzhou**  
Tel: 86-571-8792-8115

**China - Hong Kong SAR**  
Tel: 852-2943-5100

**China - Nanjing**  
Tel: 86-25-8473-2460

**China - Qingdao**  
Tel: 86-532-8502-7355

**China - Shanghai**  
Tel: 86-21-3326-8000

**China - Shenyang**  
Tel: 86-24-2334-2829

**China - Shenzhen**  
Tel: 86-755-8864-2200

**China - Suzhou**  
Tel: 86-186-6233-1526

**China - Wuhan**  
Tel: 86-27-5980-5300

**China - Xian**  
Tel: 86-29-8833-7252

**China - Xiamen**  
Tel: 86-592-2388138

**China - Zhuhai**  
Tel: 86-756-3210040

### ASIA/PACIFIC

**India - Bangalore**  
Tel: 91-80-3090-4444

**India - New Delhi**  
Tel: 91-11-4160-8631

**India - Pune**  
Tel: 91-20-4121-0141

**Japan - Osaka**  
Tel: 81-6-6152-7160

**Japan - Tokyo**  
Tel: 81-3-6880-3770

**Korea - Daegu**  
Tel: 82-53-744-4301

**Korea - Seoul**  
Tel: 82-2-554-7200

**Malaysia - Kuala Lumpur**  
Tel: 60-3-7651-7906

**Malaysia - Penang**  
Tel: 60-4-227-8870

**Philippines - Manila**  
Tel: 63-2-634-9065

**Singapore**  
Tel: 65-6334-8870

**Taiwan - Hsin Chu**  
Tel: 886-3-577-8366

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

**Taiwan - Taipei**  
Tel: 886-2-2508-8600

**Thailand - Bangkok**  
Tel: 66-2-694-1351

**Vietnam - Ho Chi Minh**  
Tel: 84-28-5448-2100

### EUROPE

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

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

**Finland - Espoo**  
Tel: 358-9-4520-820

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

**Germany - Garching**  
Tel: 49-8931-9700

**Germany - Haan**  
Tel: 49-2129-3766400

**Germany - Heilbronn**  
Tel: 49-7131-72400

**Germany - Karlsruhe**  
Tel: 49-721-625370

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

**Germany - Rosenheim**  
Tel: 49-8031-354-560

**Israel - Ra'anana**  
Tel: 972-9-744-7705

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

**Italy - Padova**  
Tel: 39-049-7625286

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

**Norway - Trondheim**  
Tel: 47-7288-4388

**Poland - Warsaw**  
Tel: 48-22-3325737

**Romania - Bucharest**  
Tel: 40-21-407-87-50

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

**Sweden - Gothenberg**  
Tel: 46-31-704-60-40

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

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