



MICROCHIP Indoor Air Quality Monitor UG

Indoor Air Quality Monitor User's Guide

Preface

**Important: Notice to customers**

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

Introduction

The Indoor Air Quality Monitor (AQM) is implemented using the AVR-IoT WG development board, sensors and MikroElektronika click boards™. The AVR-IoT WG development board is equipped with Microchip's ATmega4808 microcontroller (MCU), ATECC608A CryptoAuthentication™ secure element, and ATWINC1510 Wi-Fi® module.

The AQM monitors humidity and temperature levels of the indoor environment along with main airborne contaminants such as Particulate Matter (PM2.5), Carbon Dioxide (CO₂), and Total Volatile Organic Components (TVOC). The microcontroller processes these acquired readings and calculates the Air Quality Index (AQI) from the readings of the PM2.5 sensor. The AQI and other acquired air quality parameters are stored on the external EEPROM, displayed on the OLED, and uploaded to Google Cloud.

Recommended Reading

The following documents cover the AQM system documentation:

1. This user's guide covers the hardware setup, hardware connections, operating steps, LED indications, provisioning of the AVR-IoT WG development board's Wi-Fi module, and visualization of the AQM data over the cloud.
2. The application note [*“AN3403 - Indoor Air Quality Monitor: Concept and Implementation”*](#) describes the hardware and firmware overview of the AQM system and its power considerations.
3. The supplemented firmware creation guide [*“AN3417 - Indoor Air Quality Monitor: Firmware Creation Using Atmel START and MPLAB® Code Configurator \(MCC\)”*](#) covers the usage of the AVR-IoT stack for the AQM application. Additionally, it covers configuration details of microcontroller peripherals, and click boards using START and MCC.

It is recommended to read [*“AN3403 - Indoor Air Quality Monitor: Concept and Implementation”*](#) and [*“AN3417 - Indoor Air Quality Monitor: Firmware Creation Using Atmel START and MPLAB® Code Configurator \(MCC\)”*](#) application notes before reading this user's guide.

The AQM is developed over the AVR-IoT WG development board. Refer to the [*“AVR-IoT WG Development Board User Guide \(DS50002809\)”*](#) for more information.

Table of Contents

Preface.....	1
1. Application Demo.....	3
1.1. Hardware Setup.....	3
1.2. AQM Schematic.....	3
1.3. Firmware Configuration and Generation.....	4
1.4. Programming the MCU.....	5
1.5. Operating Steps.....	5
2. Revision History.....	10
The Microchip Website.....	11
Product Change Notification Service.....	11
Customer Support.....	11
Microchip Devices Code Protection Feature.....	11
Legal Notice.....	11
Trademarks.....	12
Quality Management System.....	12
Worldwide Sales and Service.....	13

1. Application Demo

1.1 Hardware Setup

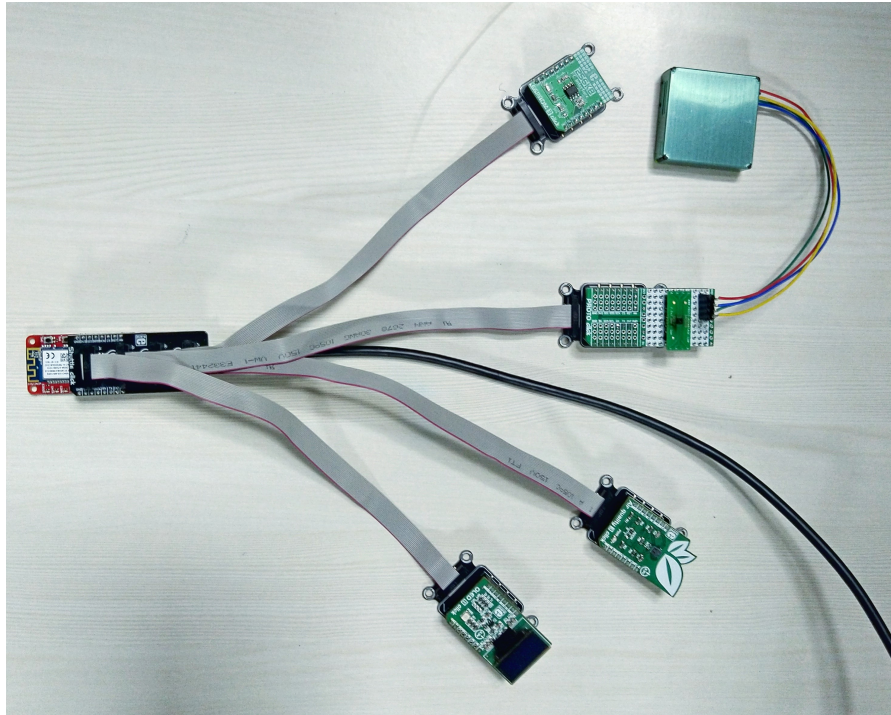
This section discusses the necessary connections required between the hardware units used for implementing the AQM system. The AVR-IoT WG development board has a single mikroBUS™ slot. Hence, a Shuttle click from MikroElektronika is used along with the mikroBUS shuttles and the FRC cables to connect the AVR-IoT WG development board with click boards.

The AQM hardware setup guidelines:

1. Mount a Shuttle click over the mikroBUS connector of the AVR-IoT WG development board.
2. The Shuttle click has four 16-pin male headers. Using the 16-pin female-female FRC cables, connect four mikroBUS shuttles to the Shuttle click, as shown in [Figure 1-1](#).
3. Mount the Air quality 3 click, the customized PROTO click (Humidity and PM sensor), the EEPROM 3 click, and the OLED B click over the mikroBUS shuttles.
4. Connect the USB cable to the AVR-IoT WG development board.

[Figure 1-1](#) shows the hardware setup of the AQM system.

Figure 1-1. AQM Setup



1.2 AQM Schematic

All the external clicks are connected to the single mikroBUS connector of the AVR-IoT WG development board.

[Figure 1-2](#) shows the AQM schematic details. Note that the Shuttle click is not shown in this figure. [Table 1-1](#) shows the pin mapping details of the mikroBUS slot of the AVR-IoT WG development board and other click boards.

Indoor Air Quality Monitor UG

Application Demo

Figure 1-2. AQM Schematic

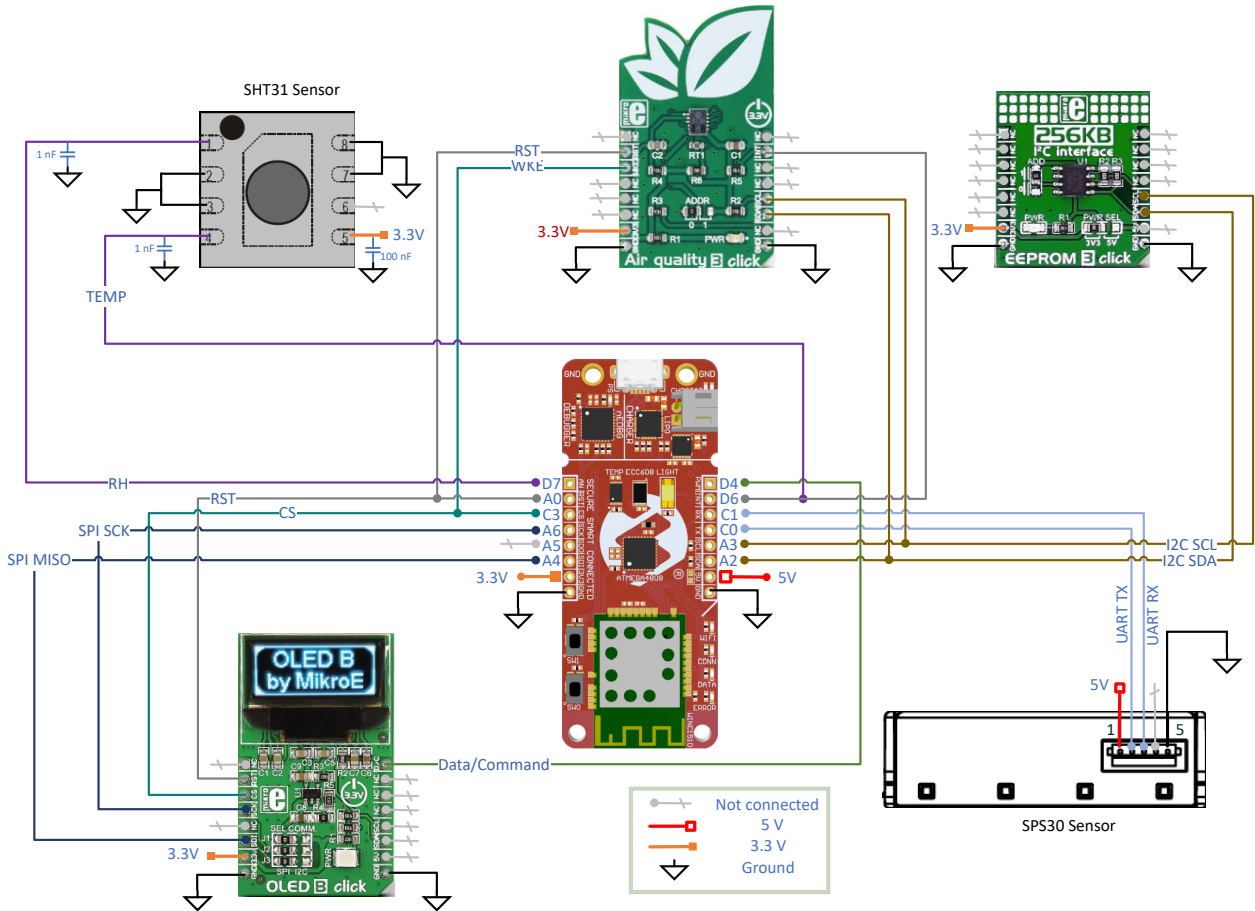


Table 1-1. Pin Connection Details

AQ 3	EEPRO M 3	SPS30 sensor	SHT31 ARP	OLED B	AVR- IoT	mikroBUS™				AVR- IoT	OLED B	SHT31 ARP	SPS30 sensor	EEPRO M 3	AQ 3
						Pin No.	Signal Name		Pin No.						
NC	NC	NC	RH	NC	D7	1	AN	PWM	16	D4	D/C	NC	NC	NC	NC
RST	NC	NC	NC	RST	A0	2	RST	INT	15	D6	NC	T	NC	NC	INT
WKE	NC	NC	NC	CS	C3	3	CS	RX	14	C1	NC	NC	TX	NC	NC
NC	NC	NC	NC	SCK	A6	4	SCK	TX	13	C0	NC	NC	RX	NC	NC
NC	NC	NC	NC	NC	A5	5	MISO	SCL	12	A3	SCL	NC	NC	SCL	SCL
NC	NC	NC	NC	SDI	A4	6	MOSI	SDA	11	A2	SDA	NC	NC	SDA	SDA
3.3V	3.3V	NC	VDD	3.3V	3.3V	7	3.3V	5V	10	5V	5V	NC	5V	5V	NC
GND	GND	GND	VSS	GND	GND	8	GND	GND	9	GND	GND	VSS	GND	GND	GND

1.3 Firmware Configuration and Generation

The firmware is available on GitHub, as below, and in the [Atmel START examples](#).



View Code Example on GitHub (Atmel Studio)
Click to browse repository



View Code Example on GitHub (MPLAB® X)

[Click to browse repository](#)

The application firmware can be generated using Atmel START or MCC.

For more details about the process to generate firmware using Atmel START or MCC frameworks, refer to [“AN3417 - Indoor Air Quality Monitor: Firmware Creation Using Atmel START and MPLAB® Code Configurator \(MCC\)”](#).

1.4 Programming the MCU

To program the application firmware on the microcontroller, refer to the [“AVR-IoT WG Development Board User Guide \(DS50002809\)”](#).

1.5 Operating Steps

After the completion of the required hardware connections and loading the application firmware onto the microcontroller, follow the steps below to operate the AQM demonstrator.

Prerequisites:

- Set the Wi-Fi router's SSID and password to default (SSID: MCHP.IOT, Password: microchip, NetworkType: WPA-PSK). For more details, refer to the [1.5.4 Provisioning of the AVR-IoT WG Board's Wi-Fi Module](#) section or to the [“AVR-IoT WG Development Board User Guide \(DS50002809\)”](#) to connect the AVR-IoT WG development board to the Wi-Fi router.

Steps:

- Power up the board by connecting the AVR-IoT WG development board to a host computer (PC) using the standard micro-USB cable.
- After power-on, the OLED displays the text 'AQM', as can be seen in [Figure 1-3](#).

Figure 1-3. Initial OLED Screen



- The LED array on the AVR-IoT WG development board flashes twice in the following order: Blue → Green → Yellow → Red.
- Thus, all the air quality parameters are sequentially displayed on the OLED, with an interval of approximately four seconds, as shown in [Figure 1-4](#).
Note: Press switch **SW0** to display the next parameter without waiting for four seconds of the predefined time.
- The OLED turns off after all the parameters are displayed.
Note: Press **SW0** to turn on the OLED display.

Indoor Air Quality Monitor UG

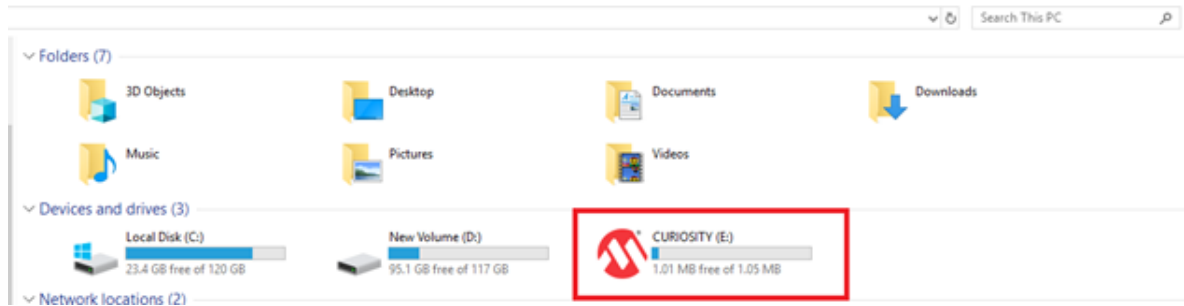
Application Demo

Figure 1-4. OLED Screens



6. Check the Blue and Green indication LEDs for successful Wi-Fi connection and cloud connection, respectively.
7. The Yellow LED flashes while the data are being uploaded to Google Cloud.
8. The Red LED turns on if there is an error in the connection.
Note: Instructions for troubleshooting connection errors and details of Wi-Fi module provisioning are explained later in this section.
9. The AVR-IoT WG development board will appear as a “Removable Storage Device” on the host PC, as shown in [Figure 1-5](#). Double click the **CURIOSITY** drive to open it.

Figure 1-5. Curiosity Drive



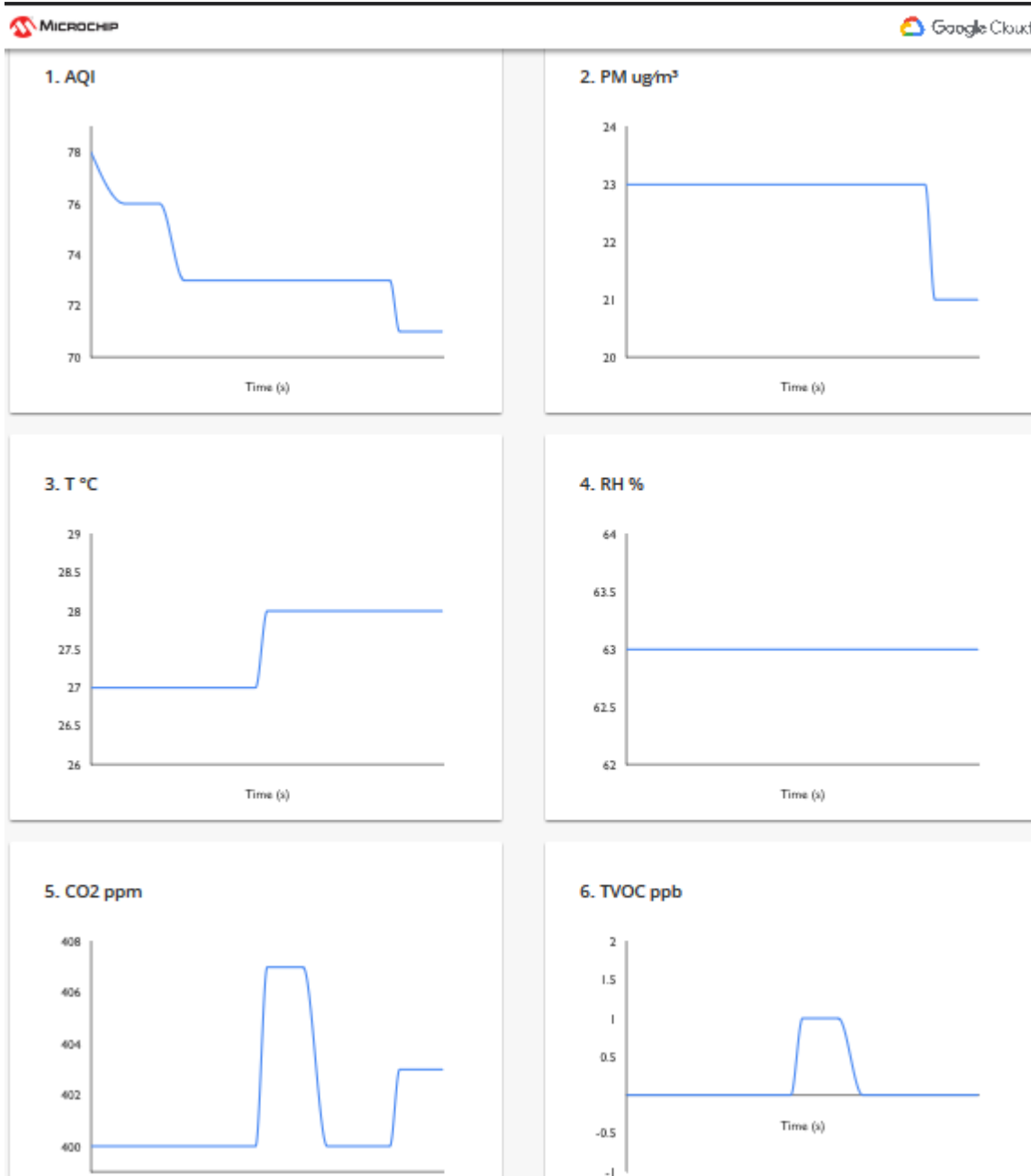
10. The CURIOSITY drive will contain multiple files. Double click the **CLICK-ME.HTM** file. It redirects the users to the dedicated AVR-IoT WG development board webpage. On this webpage, the graphs of the air quality parameters can be visualized. Refer to [1.5.1 Visualization of AQM Data](#) for more details.

1.5.1 Visualization of AQM Data

Once the board is connected to Google Cloud through the Wi-Fi interface, the AQM starts uploading data to the cloud. The Yellow LED flashes while the data are being uploaded. The avr-iot.com webpage shows the data gathered from various sensors in a graphical view, as shown in Figure 1-6.

Note: The order of the parameters shown in Figure 1-6 can be changed by modifying the order in the JSON object from the firmware.

Figure 1-6. Graphical Display of Air Quality Parameters on Webpage



1.5.2 Instructions for Troubleshooting the Connection Error

The Red LED turns on if there is an error in the connection.

This error can be caused by any of the following reasons:

1. The AVR-IoT WG development board's Wi-Fi module is not connected to the Wi-Fi router.
2. The AVR-IoT WG development board is not connected to Google Cloud.

1.5.3 Troubleshooting

1. Check whether the Wi-Fi router is available.
2. If available, check whether the AVR-IoT WG development board's Wi-Fi module is connected to the Wi-Fi router. If not, refer to [1.5.4 Provisioning of the AVR-IoT WG Board's Wi-Fi Module](#) section.
3. If the AVR-IoT WG development board's Wi-Fi module is connected to the Wi-Fi router and the error persists, check the Internet connectivity of the Wi-Fi router.

1.5.4 Provisioning of the AVR-IoT WG Board's Wi-Fi Module

First, connect the AVR-IoT WG development board to the host PC using a standard micro-USB cable. The board will appear as a Removable Storage Device on the host PC. Double click the **CURIOSITY** drive to open it.

The CURIOSITY drive must contain the following five files:

- `CLICK-ME.HTM` - redirects the user to the AVR-IoT web demo application
- `KIT-INFO.HTM` - redirects the user to a site containing information about the board
- `KIT-INFO.TXT` - a text file with details about the board, such as the serial number
- `PUBKEY.TXT` - a text file containing the public key used for data encryption
- `STATUS.TXT` - a text file containing the status of the board

Double click the `CLICK-ME.HTM` file to go to the dedicated webpage. On this page, the user can reconfigure the Wi-Fi credentials of the AVR-IoT WG development board. If the connection has not been established, the lower left-hand corner of the webpage shows a wireless network connection window where the user is supposed to enter the credentials for the Wi-Fi network (see [Figure 1-7](#)). The details provided in this figure are for reference only. The users can fill these fields with the SSID and password of their Wi-Fi network. For more information, refer to [1.5.3 Troubleshooting](#).

Figure 1-7. Entering Wi-Fi® Credentials

Wireless Network Login

MCHP.IOT

Your WiFi information is not transmitted anywhere—the config file is generated in your browser.

Network Type

☐ Open

☒ WPA/WPA2

☐ WEP

microchip

Hide password

Download Configuration

Note: The Wi-Fi network SSID and password are limited to 19 characters. Avoid using names or phrases that begin or end in spaces.

Indoor Air Quality Monitor UG

Application Demo

Once these details are entered, click the **Download Configuration** button. This will download the `WIFI.CFG` file on the host PC. From the `WIFI.CFG`'s download location, drag and drop the file to the CURIOSITY drive to update the Wi-Fi credentials of the AVR-IoT WG development board. The blue LED will light up to show a successful connection.

Note: Any information entered in the SSID and password fields will not be transmitted to the Microchip or Google servers over the web. Instead, the information is used locally (within the browser) to generate the `WIFI.CFG` file.

Note: As Standby sleep mode is implemented in this application, there may be a possibility that the microcontroller is in Standby sleep mode while the user is performing the above step (drag and drop `WIFI.CFG` file to the CURIOSITY drive). To ensure that the microcontroller is active, press switch **SW0**, which wakes up the microcontroller and then drag and drop the `WIFI.CFG` file to the CURIOSITY drive.

2. Revision History

Doc. Rev.	Date	Comments
A	03/2020	Initial document release

The Microchip Website

Microchip provides online support via our website at <http://www.microchip.com/>. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to <http://www.microchip.com/pcn> and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: <http://www.microchip.com/support>

Microchip Devices Code Protection Feature

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.

Legal Notice

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, TempTrackr, 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.

© 2020, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-5642-1

Quality Management System

For information regarding Microchip's Quality Management Systems, please visit <http://www.microchip.com/quality>.

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
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: http://www.microchip.com	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	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	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: 47-72884388 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