AN2468

AT06015: Production Programming of Microchip AVR® and SAM Microcontrollers

Description

This application note covers both the AVR® and SAM microcontrollers, but not the PIC® microcontrollers.

Microchip AVR and SAM microcontrollers are Flash-based, and the program memory, therefore, needs to be programmed with a firmware image for the end-product to operate as desired. During *development*, it is recommended to use the combined programming and debugging tools from Microchip, which integrate directly in the Atmel Studio IDE. However, for *production programming*, it is recommended to use third-party programming tools that are intended for industrial environments. Another option is to order the microcontrollers pre-programmed from Microchip or from a programming house.

Features

- Microchip programming solutions
- Third-party programming solutions
- Programming services

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1. Microchip Development and Programming Tools

To identify the correct programming and debugging tool for a microcontroller from Microchip: Go to the microcontroller product page and from the quick access links above the product name, click the Development Tools icon (see the figure below). This will show a list of development tools for the product. The **SAM-ICE™** supports programming and debugging of all Microchip SAM microcontrollers. The SAM devices can also be programmed through the **SAM-BA®** bootloader (various interface options). The **Atmel-ICE** is a programming and debugging tool that supports all of the Microchip AVR microcontroller products and Microchip SAM microcontrollers. AVR microcontrollers can also be programmed using the **AVRISP mkII**. However, note that the **AVRISP mkII** does not support debugging.

Note: The above-mentioned programming tools are not recommended for production programming as they are designed for development environments. SAM-BA can be considered as an exception, as it does not depend on a physical tool, but the software only.

SAM-ICE: http://www.microchip.com/developmenttools/productdetails.aspx?partno=at91sam-ice

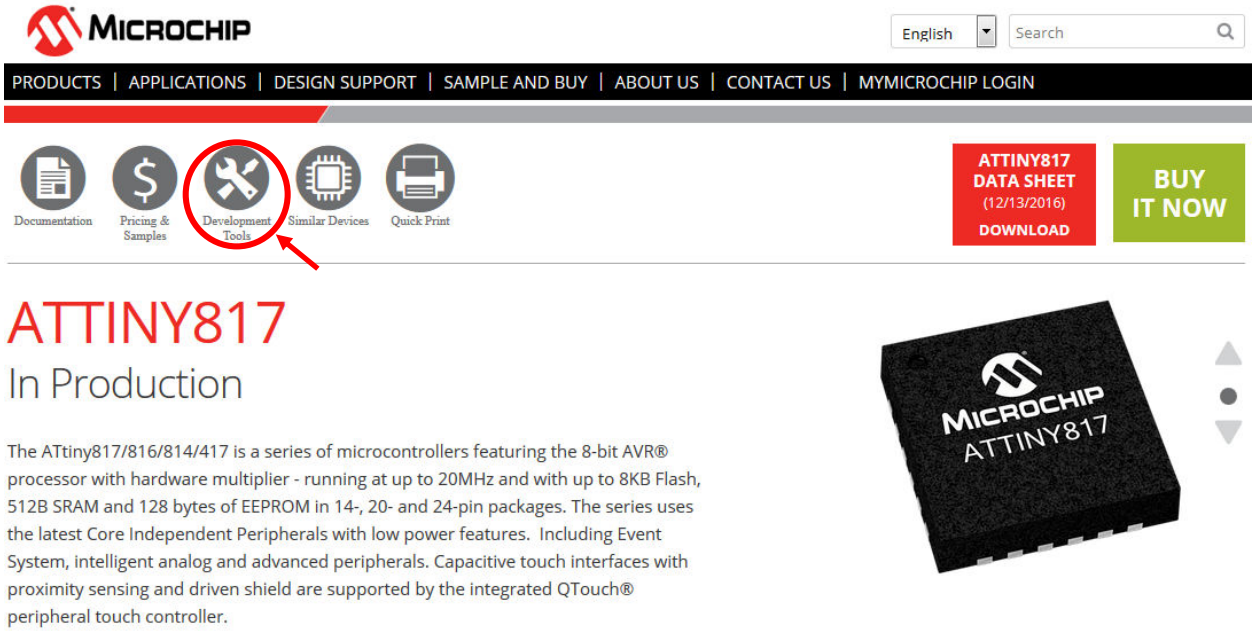
SAM-BA programming: http://www.microchip.com/developmenttools/productdetails.aspx?partno=atmel+sam-ba+in-system+programmer

AVRISP mkII: http://www.microchip.com/developmenttools/productdetails.aspx?partno=atavrisp2

Atmel-ICE: http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=atatmel-ice

Atmel-ICE for **AVR®** Programming In Mass Production: http://ww1.microchip.com/downloads/en/AppNotes/00002466A.pdf

Figure 1-1. Development Tools Icon



2. Pre-Programmed Microcontrollers

Microchip and many Microchip distributors offer pre-programmed microcontrollers. In this case, the binary image is provided to Microchip or the distributor. This solution is obviously less flexible if changes are made frequently to the pre-programmed firmware and does have MOQ implications, but can have advantages related to reduced production time for the end-product.

To request pre-programming of Microchip microcontrollers contact MicrochipDirect, your local Microchip sales office, or your distributor.

MicrochipDirect: https://www.microchipdirect.com/programming/

3. Third-Party Programming Tools

For production programming, and e.g. to perform in-system calibration or parameter customization for the end-product it is recommended to use professional third-party programming tools.

The list of third-party programming tools in the following table includes programming solutions for use in both development and production. Gang programmers in this context refer to single- and multi-site programmers, where devices are inserted into the programming fixture to be programmed. This in contrast to In-system programming where the device to program is mounted on the PCB while being programmed. Both kinds of programmers can thus be used in production environments, while in-system programmers are usually preferred for development purposes.

Table 3-1. Third-Party Vendors of Programming Tools in Alphabetic Order

Company Name	ARM® Support	AVR Support	Programmer Intended for	Gang	In-system
Advantech Equipment Corp. Taiwan ROC http://www.aec.com.tw/	Yes	Yes	Production (and development)	Yes	No
ASIX s.r.o. Czech Republic http://tools.asix.net/index.htm	Yes	Yes	Development and production	No	Yes
BPM Microsystems USA http://www.bpmmicro.com/	Information missing: contact vendor				
Data I/O Corp. USA http://dataio.com	Yes	Yes	Production and development	Yes	No
Dataman Ltd. UK www.dataman.com	Yes	Yes	Production (and development)	Yes	Yes
EETools, Inc. USA www.eetools.com	Information missing: contact vendor				
ELNEC s.r.o. Slovak Republic http://www.elnec.com/	Yes	Yes	Production (and development)	Yes	Yes
Equinox Technologies United Kingdom	Yes	Yes	Production, field-service, and development	Yes	Yes

Company Name	ARM® Support	AVR Support	Programmer Intended for	Gang	In-system
http://www.equinox-tech.com/					
Hi-Lo System Research Co. Ltd. Taiwan ROC http://www.hilosystems.com.tw/	Yes	Yes	Production (and development)	Yes	No
Leap Electronic Co., Ltd. Taiwan ROC http://www.leap.com.tw/	Yes	Yes	Production (and development)	Yes	No
MikroElektronika Serbia http://www.mikroe.com/	No	Yes	Development	No	Yes
Opteeq Technologies China http://www.opteeq.com/en/	Yes	Yes	Production (and development)	Yes	Yes
Phyton, Inc. USA http://www.phyton.com	Yes	Yes	Production and development	Yes	Yes
Ronetix GmbH Austria http://www.ronetix.at/	Yes	Yes	Production and development	No	Yes
RPM Systems Corporation USA http://www.rpmsys.com/	Yes	Yes	Production and development	Yes	Yes
SMH Technologies Italy http://www.smh-tech.com	Yes	Yes	Production and development	Yes	Yes
System General Corporation Taiwan ROC http://www.sg.com.tw	Yes	Yes	Production (and development)	Yes	No
Xeltek Inc. USA http://www.xeltek.com/	Yes	Yes	Production and development	Yes	Yes

A general list of third-party vendors for Microchip products can be found at the pages below (not limited to programming tools). It is recommended to refer to this list for the most recent information about third-party tools.

4. Introduction of Listed Third-Party Programming Offerings

The descriptions below are provided by the third-party vendors listed in the previous section's table and contain additional information related to the programming products and the services these vendors offer. The third-party vendors are listed in alphabetic order.

Note: The descriptions below do not reflect any recommendations by Microchip.

4.1 Advantech Equipment

The **Labtool-48UXP** is a universal programmer for development and low volume production. It supports most of the Microchip AVR 8-bit MCUs, up to 64 pins, in various packages including PLCC, SOIC, TSSOP, SOT23, TQFP, QFN, and QFP. In addition, through adapters with up to 64 pins, it also supports the Microchip ARM7TDMI MCU in 64/48 pins in TQFP package, as well as the complete line of Microchip 8951-C1 and 51-C12 MCU.

The **Labtool-848XP** is a production gang programmer for high density NOR Flash and Flash-based MCU's with EEPROM. It supports parts of the AVR 8-bit family as well as the 89C51-1C and -2C MCU from Microchip. The **Labtool-848UXP** can also be customized with additional chip support upon customer request. In addition, if the default chip support is not sufficient, Advantech Equipment can be contacted to add the chip support with custom software.

Labtool-48UXP universal programmer: http://www.aec.com.tw/lt-48uxp.htm

Labtool-848XP gang programmer: http://www.aec.com.tw/lt-848xp.htm

4.2 ASIX

ASIX s.r.o. founded in 1991 has entered the development tools business in the mid-90s. Since 2004 ASIX has been offering an In-System USB programmer, **PRESTO**, which supports many Microchip devices including AVR, '51, and ARM7TDMI MCUs, as well as serial EEPROM and Flash memories. In 2012, ASIX introduced a **FORTE** programmer, which offers more features and higher speed. Both programmers are primarily intended for development and service purposes, but many of them are also used for small and medium volume production (up to a couple of thousand units/day), typically with multiple programmers working in production lines. User-friendly and highly configurable software, called **UP**, supports production programming (serial number generator, remote control from command-line, Windows® messages, DLL library, etc.). Updates of **UP** and other software tools for **PRESTO** and **FORTE** are freely available. ASIX offers fast and effective technical support including new device implementation by a customer's request.

Company web page: http://www.asix.net/

4.3 BP Microsystems

No description available.

4.4 Data I/O

Data I/O is the world's leading provider of manual and automated device programming systems for Flash, Microcontroller, and Logic devices. They serve electronics manufacturers around the world including

OEM, ODM, EMS, and programming centers. Programming systems and value-added software solutions enable our customers to:

- Streamline programming - with their production processes
- Meet their specific quality requirements
- Ensure that the devices are programmed at maximum speed and with the highest quality

Data I/O creates best-in-class production solutions including:

PSV7000 Automated high-speed automated handler: www.dataio.com/PSV7000

RoadRunner3 Inline automated just-in-time programmer: http://www.dataio.com/Solutions/RoadRunner-Family

FlashPAK III manual programmer: http://www.dataio.com/Solutions/FlashPAK-Family

4.5 Dataman

With over 30 years of experience, Dataman is a world-leading provider of device programmers.

Dataman designs and sells products that stand out from the crowd and continue to provide market-leading solutions. Dataman offers a comprehensive range of programming solutions suitable for every requirement from design and development to large-scale production.

Dataman currently supports over 80,000 devices (Nov. 2013), with updates every 3 - 4 weeks adding 200 - 300 new chips. Support can be added for missing devices quickly and typically free of charge. Their universal programmers come as standard with a 3-year warranty, free life-time technical support, and software updates.

4.6 EE Tools, Inc.

In 1992, EE Tools, Inc. started manufacturing a line of low-cost device programmers with an emphasis on MOS programming. EE Tools later developed a series of bipolar memory and logic programmers to complement the earlier products, and have since then grown to become one of the most well-known universal device programmer manufacturers worldwide. From their headquarter in San Jose, through a network of distributors around the globe, they are able to stay on top of the expanding device programmer market and provide customers with the best performance products and support. All products are backed with full technical support and free software updates for the product's lifetime.

Stand-alone and Production Programmer: **MultiMax-8G+**

PC-driven Production Programmer via USB Interface: **ProMax-4G**

PC-driven Development Programmer via USB Interface: **TopMax2**, **ChipMax2**

EPROM Eraser: **Model 10**, **Chip-20**

EPROM Emulator via USB Interface: **EEROM-8U**

4.7 Elnec

Elnec is a leading provider of solutions for programming memories, microcontrollers, and other programmable devices in Europe. Elnec is committed to set a new standard in the industry by providing universal, highly reliable, and cost-effective programming solutions for devices in any package, whether

programmed in a socket or through ISP on a circuit board. Elnec offers programming adapters; more than 800 models of universal, specialized, and BGA adapters.

Their product range includes support for Microchip AVR 8-bit, AVR 32-bit, ARM-based, and 8051 microcontroller: Production programmers with multi-site concurrent programming for high volume manufacturers, and Universal programmers with single-site programming for developers and low volume manufacturers.

Production programmers: http://www.elnec.com/products/production-programmers/

Universal programmers: http://www.elnec.com/products/universal-programmers/

Programming adapters: http://www.elnec.com/products/programming-adapters/

4.8 Equinox Technologies

Equinox Technologies offers a comprehensive range of development, field-service, and production programming tools, which support In-System Programming (ISP) of Microchip AVR and ARM microcontrollers. The **EPSILON5-MK4** and **FS2009USB** portable programmers operate in standalone mode and are therefore ideally suited to low-throughput production programming and field-service applications. The **ISPnano - Series 3/Series 4 GANG and MUX** families of ISP programmers offer scalable, high-speed production programming solutions from 1 to 32 channels (gang mode) and 2 - 256 channels (multiplexed mode). All programmers offer comprehensive ESD and over-voltage protection.

EPSILON5-MKIV - Portable standalone ISP programmer: http://www.equinox-tech.com/products/details.asp?ID=1575

FS2009USB - Portable standalone ISP programmer: http://www.equinox-tech.com/products/details.asp?ID=1561

ISPnano Series 4 - Production ISP programmer: http://www.equinox-tech.com/products/details.asp?ID=1538

ISPnano-MUX 2/4/8 - Multiplexed ISP programmer: http://www.equinox-tech.com/products/details.asp?ID=1498

4.9 Hi-Lo Systems

HI-LO has been devoted to providing device programmers and programming/testing solutions, with reliable quality at a reasonable price for over 30 years. Their product range covers engineering, production programmers, automated device programming systems, and 3D lead/marking inspection systems. HI-LO is one of the market leaders regarding to Device Programming Equipment and Programming services in Pan Asia. (Hong Kong, Taiwan, China, Japan, etc.)

Hi-Lo Systems product pages: www.hilosystems.com.tw/en

4.10 Leap Electronic Co., Ltd.

Leap Electronic is deeply involved in the field of IC testing and programming equipment, supplying many series of products such as programmers, automation systems, and logic analyzers. The range of programmers varies from universal to gang programmers, all of which can support both AVR and ARM. Moreover, Leap Electronic also has the capability of providing programming services. Four branches are established in China, in order to provide customers well-organized and professional services. Email: overseas1@leap.com.tw.

Leaper-56 (Single-site programmers): https://sites.google.com/site/leapleaptronixen/programmer_series/LEAPER-56

Leaper-456 (Development programmers): https://sites.google.com/site/leapleaptronixen/programmer_series/LP-456?pageUrlChanged=LP-456

AH-160 (Gang programmer series): https://sites.google.com/site/leapleaptronixen/automated_system/ah-160

AH-480 (Gang programmer series): https://sites.google.com/site/leapleaptronixen/automated_system/ah-480

4.11 MikroElektronika

mikroProg™ for AVR is a fast USB programmer supporting numerous AVR microcontrollers. It is supported with **mikroC**, **mikroBasic**, and **mikroPascal** compilers for AVR, but may also be used as a standalone programming tool. Outstanding performance, easy operation, and low price are its top features. Elegant minimalistic design, clean matte white plastic finish, and color indicator LEDs make **mikroProg** for AVR the first of its kind.

mikroProg for AVR web page: http://www.mikroe.com/mikroprog/avr/

mikroElektronika AVR compilers: https://www.mikroe.com/compilers/compilers-avr

4.12 Opteeq Technologies

Opteeq S-Series is an ultra-fast, industrial grade, in-system programmer. It universally supports different types of programming interfaces and silicon architectures. Thanks to its compact size and software library, **S-Series** can be easily integrated into other production equipment, e.g., functional or circuit testing machines, testing fixtures, etc. Additionally, **S-Series** can also be used as a desk-top programmer. To satisfy various output volumes, **S-Series** offers models with 1, 4, or 8 physical programming channels. Its capability to work stable and protection of target circuit makes the S-Series an excellent choice for mass production of automotive, industrial, and consumer electronics.

Opteeq Technologies product page: http://www.opteeq.com/en/product.html

4.13 Phyton, Inc.

Phyton **ChipProg** line of device programmers for both development and production include single-site, gang parallel, and in-system programmers. They provide extremely fast flash programming for Microchip SAM D20, SAM3, SAM4, AVR, C51, and AT89LP microcontrollers, memory devices, and PLDs. Multiple Phyton programmers can be controlled from one computer for concurrent programming, from a friendly GUI, remotely from ATE via DLL, or in command line mode. The **ChipProg** software features script language and other tools for programming automation, allowing the writing of serial numbers and signatures into the chips. Adapters are available (BGA, QFN, QFP, TSOP, SOIC, PLCC, etc.).

ChipProg-ISP web page: http://phyton.com/categories/product/chipprog-isp

ChipProg-G41 web page: http://phyton.com/categories/product/chipprog-g41

ChipProg-481 web page: http://phyton.com/categories/product/chipprog-481

Device Finder web page: http://phyton.com/device-search

4.14 Ronetix

Ronetix is an Austrian manufacturer of high-quality software tool-kits, debug probes, and programmers for wide-range CPUs and cores. Ronetix's JTAG Flash programmer **PEEDI** is a production and development solution for high-speed programming onboard and on-chip Flash devices on all ARM and AVR based MCUs.

- Programming of over 1000 NOR flash chips, NAND Flash, OneNAND Flash
- Programming of Data Flash, SPI Flash devices
- Programming of a JFFS2 image to a NAND Flash
- Working in standalone mode in the production line (with an MMC/SD card)
- Multi-core programming; upgrade to **PEEDI** JTAG Emulator

For more information, see: http://www.ronetix.at/flash-programmer.html

4.15 RPM Systems

RPM System Corporation with ***MPQ*** Four-port In-circuit Gang Programmers provide programming support with:

- One image on up to four devices in parallel
- Up to 16 MPQ's can be interconnected to provide programming of up to 64 devices in parallel
- Up to four separate program images can be stored on the programmer, allowing optional stand-alone operation, and making programming fast and efficient
- Stand-alone, ATE-controlled, or PC-controlled operation
- Device Serialization feature allows automatic serialization of programmed devices
- Secure Image Management feature provides code security and allows restrictions on the number of parts programmed from each image
- Support for Microchip AVR, AVR32, and ARM devices
- Support for SPI, PDI, TPI, JTAG, and SWD Microchip programming interfaces
- More information at http://www.rpmsys.com/products.htm

4.16 SMH Technologies

SMH Technologies is a global, independent, high-tech company leader in Silicon Device In-System Programming and related services for the electronic boards manufacturing industry. **FlashRunner** series, the company's professional Silicon Device In-System Programming platform, is the result of the decennial experience in micro-code encoding for 8-, 16-, and 32-bit processors. **FlashRunner** helps customers enhance quality, save time, and optimize manufacturing cycles. SMH continuously improve their offer by releasing new programming algorithms weekly. Thanks to **FlashRunner** flexible and modular design, the same algorithms are to be used on all of the models.

FlashRunner I series: A range of high-performance In-System Programmers for Flash-based microcontrollers and serial memories. Targets production environments and works in full standalone mode or controlled by a host system.

FlashRunner Quattro is a high-integration in-system gang programmer, based on the FlashRunner technology, designed for programming multi-PCB panel assemblies.

FlashRunner FRPXIA3 is a PXI module for Gang In System Programming. First in the world programming solution for PXI system, and has full hardware and software ATE integration and multi-target parallel programming channels.

4.17 System General

In response to increasing customer demands for programming IC devices, System General provides total solutions in terms of manual and automated equipment primarily used for mass production. Currently System General supports more than 22,000 IC's from major IC manufacturers, including the Microchip AVR and ARM-based families. The supported IC list can be found in one of the links below. As for automated solutions, the **AP710** is intended for handling small and fragile CSP packages and serves as the universal programming platform, while the **AP720** is optimized for high volume production, carrying four nozzles and is able to run with four programmers simultaneously. In addition, programming solutions support eMMC/NAND/NOR/MCU and CPLD devices and software updates are free of charge throughout the product life of the programming equipment!

System General Products: http://www.sg.com.tw/instruGP/product_E.asp

System General Chip List: http://www.sg.com.tw/instruGP/search_E.asp

4.18 Xeltec Inc.

Xeltek Inc. offers professional high-speed programming solutions for in-system production programming of AVR microcontrollers. **SuperPro IS01** is intended for small to medium scale production. **SuperPro IS03** and **SuperPro XPS01** are for large-scale production and multiple **SuperPro IS03** units can be set up to program multiple microcontrollers in parallel, to save production time. All programming tools are controlled through the **SuperPro software**, and some can also be controlled by command line and LabVIEW. The **SuperPro software** has multilingual support including English, Chinese, German, French, and other languages.

SuperPro IS01 web page: http://www.xeltek.com/isp-programmers/in-system-programmers-superpro-is01/

SuperPro IS03 web page: http://www.xeltek.com/isp-programmers/superpro-is03-in-system-isp-programmer/

SuperPro XPS01 web page: http://www.xeltek.com/isp-programmers/superpro-xps01-isp-production-workstation/

SuperPro software web page: http://www.xeltek.com/SuperPro-Software-Download-Center/

5. Programming Houses

Programming services are also available from distributors. Contact your distributor for more information about programming services.

Table 5-1. Other Programming Houses in Alphabetic Order (not limited to)

Company Name	Products Supported	Other Services
A&J Programming USA http://www.ajprogram.com/	AVR, ARM	Ink and laser marking, coplanarity check and inspection, dry pack.
Falcon Denshi K.K. Japan http://www.falcon-denshi.co.jp/en	SAM3, SAM4, SAMA5, SAM9	
Hi-Lo Electronics AB Sweden www.hilo.nu	AVR, ARM	Laser and ink marking. Repacking according to the customer's needs.
Hi-Lo System Research Co. Ltd. Taipei, Taiwan http://www.hilosystems.com.tw/en/	AVR, ARM	Programming of NAND, Nor flash, etc.
MINATO HOLDINGS INC. Japan http://www.minato.co.jp/en	SAM3, SAM4	
Prochild International Incorporated Korea http://www.prochild.com	AVR, ARM	
Program Automation, Inc. USA http://www.progauto.com/	AVR, ARM	Programming of memories and FPGA.
Xeltek Co., Ltd. China http://www.xeltek.com.cn/	AT89C51, AVR, SAM7, SAM3, SAM4, SAM D20	Programming of PLD, GAL.

6. How to Register as a Third-Party Design Partner

Microchip's Worldwide Design Partner network provides a channel between our authorized Design Partners and customers in need of technical expertise and cost-effective solutions in a timely manner. If you are interested in joining, e.g. registering programming tools for Microchip microcontroller products, send us an email: designpartners@microchip.com. See also our Design Partner Program web page for more information.

7. Revision History

Doc. Rev.	Date	Comments
B	12/2017	1. In Chapter 1 - "Atmel-ICE for AVR..." is added. 2. Some minor editorial updates
A	06/2017	1. Converted to Microchip format and replaced the Atmel document number 42215. 2. Opteec added. 3. New documentation template.
42215D	10/2016	A complete update with several changes in the application note
42215C	01/2015	SMH details added
42215B	01/2014	EE Tools, Dataman, and Segger added
42215A	11/2013	Initial document release

The Microchip Web Site

Microchip provides online support via our web site at http://www.microchip.com/. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **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 (FAQ), technical support requests, online discussion groups, Microchip consultant 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

Customer Change Notification Service

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

To register, access the Microchip web site at http://www.microchip.com/. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site 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

Trademarks

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Quality Management System Certified by DNV

ISO/TS 16949

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.

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