

## ECONOMONITOR™ – 3-Pin System Supervisor with Power Supply Monitor and Watchdog

### Features

- Incorporates the Functionality of the Industry Standard TC1232 (Processor Monitor, Watchdog and Manual Override RESET Controller) into a Small, Lower Cost Package
- Guards Against Unstable Processor Operation Resulting from Power "Brown-Out"
- Automatically Halts and Restarts an Out-of-Control Microprocessor
- Output can be Wire-ORed, or Hooked to Manual RESET Push-button Switch
- Space-Saving 3-Pin TO-92 or SOT-223 Package

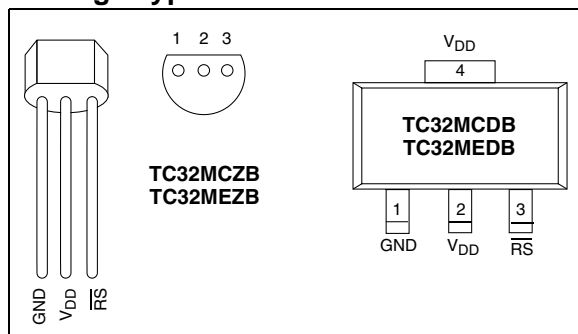
### Applications

- All Microprocessor-Based Systems
- Battery Powered Computers and Controllers
- Automotive Systems
- Intelligent Instruments
- Critical Processor Monitoring
- Embedded Controllers

### Device Selection Table

Part Number	Package	Temp. Range
TC32MCDB	SOT-223	0°C to +70°C
TC32MCZB	TO-92	0°C to +70°C
TC32MEDB	SOT-223	-40°C to +85°C
TC32MEZB	TO-92	-40°C to +85°C

### Package Type



### General Description

The TC32M is a fully-integrated processor supervisor in a 3-pin package. It provides three important functions to safeguard processor sanity: precision power on/off RESET control, watchdog timer and external RESET override.

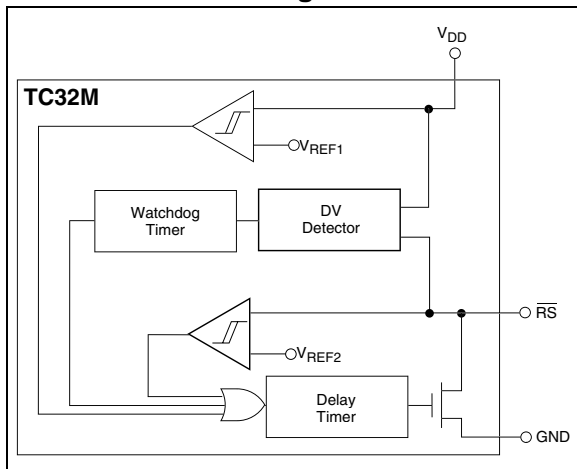
On power-up, the TC32M holds the processor in the reset state for a minimum of 500msec after  $V_{DD}$  is within tolerance to ensure a stable system start-up. Microprocessor sanity is monitored by the on-board watchdog circuit. The microprocessor must provide a high-to-low level shift (through an external resistor divider) on the RS pin of the TC32M. Should the processor fail to supply this signal within the specified timeout period (typically 700msec), an out-of-control processor is indicated and the TC32M issues a processor reset as a result.

The output of the TC32M can be wire-ORed with a push-button switch (or electronic signal) to override the TC32M and unconditionally reset the processor. When connected to a push-button switch, the TC32M provides contact debounce.

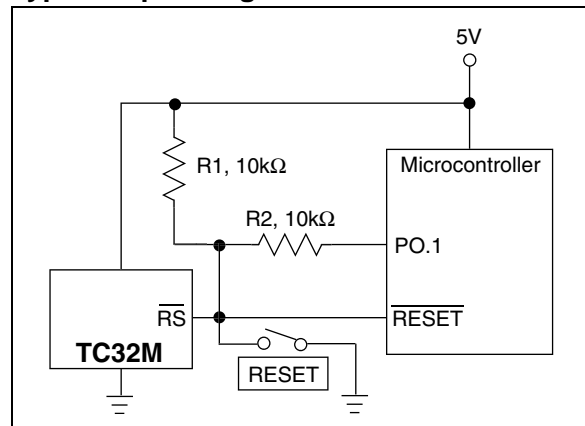
The TC32M is packaged in a space-saving TO-92 or SOT-223 package. It provides all of the functionality of the industry standard TC1232 in a smaller, lower cost configuration.

# TC32M

## Functional Block Diagram



## Typical Operating Circuit



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Supply Voltage ( $V_{DD}$  to GND) ..... +6.0V  
 Input Voltage Any Pin..... (GND – 0.3V) to ( $V_{DD}$  +0.3V)  
 Operating Temperature Range  
     TC32MC Package..... 0°C to +70°C  
     TC32ME Package..... -40°C to +85°C  
 Storage Temperature Range ..... -65°C to +150°C

\*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

### TC32M ELECTRICAL SPECIFICATIONS

Recommended DC Operating Conditions: $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$V_{DD}$	Supply Voltage	4.5	—	5.5	V	
$V_{IH}$	$\overline{RS}$ Input HIGH Level for PB	2.0	—	—	V	
$V_{IL}$	$\overline{RS}$ Input LOW Level for PB	—	—	0.3	V	
DC Electrical Characteristics: $V_{DD} = 4.5\text{V}$ to $5.5\text{V}$ , $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$I_{IL}$	$\overline{RS}$ Input Leakage	-1	—	+1	$\mu\text{A}$	
$I_{OL}$	$\overline{RS}$ Output Current	2.0	10	—	mA	$V_{OL} = 0.4\text{V}$
$I_{CC}$	Operating Current	—	50	200	$\mu\text{A}$	Note 1
$V_{STH}$	$\overline{RS}$ Strobe HIGH Level	( $V_{DD} - 0.5\text{V}$ )	—	—	V	Figure 3-1
$V_{STL}$	$\overline{RS}$ Strobe LOW Level	2.00	—	( $V_{DD} - 1.5\text{V}$ )	V	Figure 3-1
$V_{RST}$	RESET Threshold	4.25	—	4.50	V	$V_{DD}$ Falling (Note 2, Figure 3-3)
Capacitance Electrical Characteristics: $T_A = 25^{\circ}\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$C_{IN}$	Input Capacitance	—	—	5	pF	
$C_{OUT}$	Output Capacitance	—	—	7	pF	
AC Electrical Characteristics: $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{DD} = 5\text{V} \pm 10\%$ , unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$t_{RST}$	RESET Active Time	500	700	900	msec	Figure 3-2
$t_{ST}$	$\overline{RS}$ Strobe Pulse Width	500	—	—	nsec	Figure 3-1
$t_{TD}$	Watchdog Timeout Period	500	700	900	msec	Figure 3-1
$t_{RPD}$	$V_{DD}$ Detect to $\overline{RS}$ LOW	—	—	—	nsec	Figure 3-3

Note 1: No output load.  
 Note 2: All voltages referenced to ground.

# TC32M

## 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (SOT-223, TO-92)	Symbol	Description
1	GND	Ground.
2	$V_{DD}$	The +5V power supply input.
3	$\overline{RS}$	<p>RESET/STROBE (Bidirectional). The open drain goes active if:</p> <ol style="list-style-type: none"><li>1. <math>V_{DD}</math> falls below 4.5V nominal.</li><li>2. If pulled low by an external electronic signal or switch closure.</li><li>3. If the watchdog is not strobed within the minimum watchdog timeout period.</li><li>4. During power-up and power-down.</li></ol> <p>In the input mode, <math>\overline{RS}</math> connects to a voltage level shift network (typically a resistor divider to <math>V_{DD}</math>.) The watchdog timer is reset when processor causes a voltage level <math>\leq V_{STL}</math> to be applied to <math>\overline{RS}</math>.</p>
4	$V_{DD}$	The +5V power supply input (SOT-223 only).

## 3.0 DETAILED DESCRIPTION

The TC32M provides three important functions to safeguard stable processor operation: precision processor monitor, watchdog sanity timer and external override reset control.

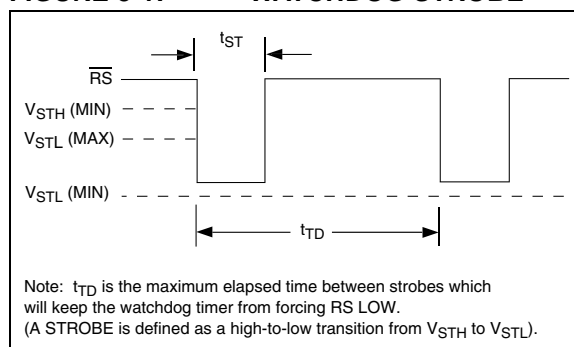
### 3.1 Processor Monitor

The  $\overline{RS}$  pin is immediately driven low any time  $V_{DD}$  is below the nominal threshold voltage. As a result, this pin is LOW when power is initially applied, holding the processor in its reset state.  $\overline{RS}$  remains low for a minimum of 500msec after  $V_{DD}$  is within tolerance to allow the power supply and processor to stabilize.

### 3.2 Watchdog Timer

The processor drives the  $\overline{RS}$  pin with an input/output (I/O) line in series with a resistor voltage divider to  $V_{DD}$ . Pulling the bottom resistor of this divider low results in an internal voltage change (*strobe*) sufficient to reset the watchdog timer, but above the  $V_{IL}$  input threshold of the processor  $\overline{RESET}$  pin. The processor must continuously apply strobes in this manner within a set period to verify proper software execution. A momentary reset (500msec minimum) is generated by the TC32M if a hardware or software failure keeps  $\overline{RS}$  from being strobed within the watchdog timeout period. This action typically initiates the processor's power-up routine. If the interruption persists, new reset pulses are generated each timeout period until  $\overline{RS}$  is strobed. This timeout period is typically 700msec.

FIGURE 3-1: WATCHDOG STROBE



The software routine that drives the  $\overline{RS}$  strobe must be in a section of the program that executes frequently enough so the time between toggles is less than one watchdog timeout period. The strobe signal can be derived from microprocessor address, data and/or control signals. Typical circuit examples are shown in Figure 3-4.

### 3.3 Resistor Value Selection

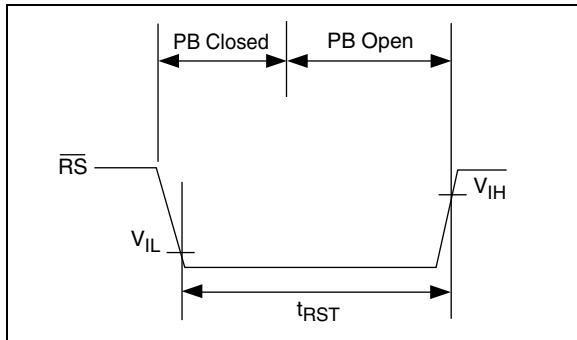
The values of  $R1$  and  $R2$  must be chosen to ensure a valid low strobe level ( $V_{STL}$ ) on  $\overline{RS}$  when the processor I/O line is low. The use of 10k $\Omega$ ,  $\pm 5\%$  tolerance resistors are recommended. These values result in a nominal strobe level of 2.5 on  $\overline{RS}$  (min/max of 2.13V/3.08V, assuming  $V_{DD} = 5.0V \pm 10\%$ ). Other resistor values can be used, so long as the additive tolerances of the power supply and resistor values result in a strobe that falls within  $V_{STH}$  and  $V_{STL}$  under all additive tolerance conditions.

# TC32M

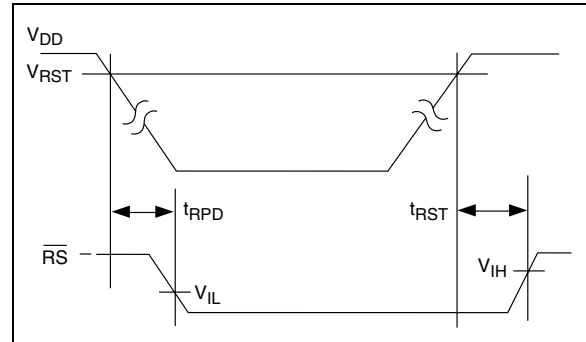
## 3.4 External Override Reset Control

A built-in debounce circuit allows a push-button switch (PB) or other electronic signal to be wire-ORed to this pin as an external RESET override control. The external  $\overline{\text{RESET}}$  is required to be an active low signal. Internally, this input is timed to provide a minimum  $\overline{\text{RESET}}$  pulse width of 500msec. Reference Figure 3-2.

**FIGURE 3-2:  $\overline{\text{RS}}$  PULLED LOW BY PUSH-BUTTON RESET**



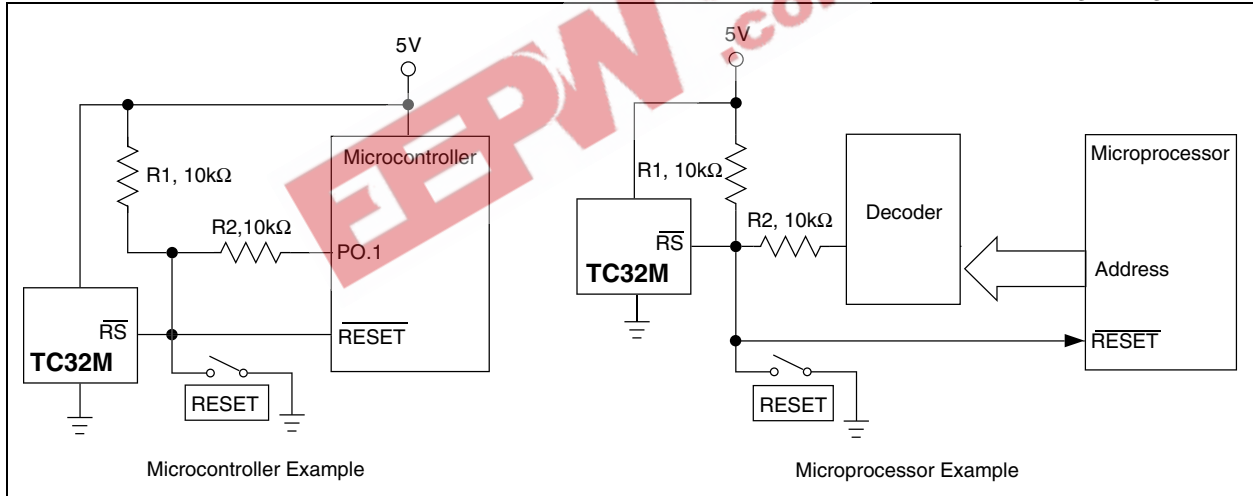
**FIGURE 3-3: POWER UP/DOWN RESET TIMING**



## 3.5 Supply Monitor Noise Sensitivity

The TC32M is optimized for fast response to negative-going changes in  $V_{DD}$ . Systems with an inordinate amount of electrical noise on  $V_{DD}$  (such as systems using relays), may require a 0.01 $\mu\text{F}$  bypass capacitor to reduce detection sensitivity. This capacitor should be installed as close to the TC32M as possible to keep the capacitor lead length short.

**FIGURE 3-4: TC32M HARDWARE CONNECTIONS (R1, R2 CHOSEN TO MEET  $V_{STH}$ ,  $V_{STL}$ )**



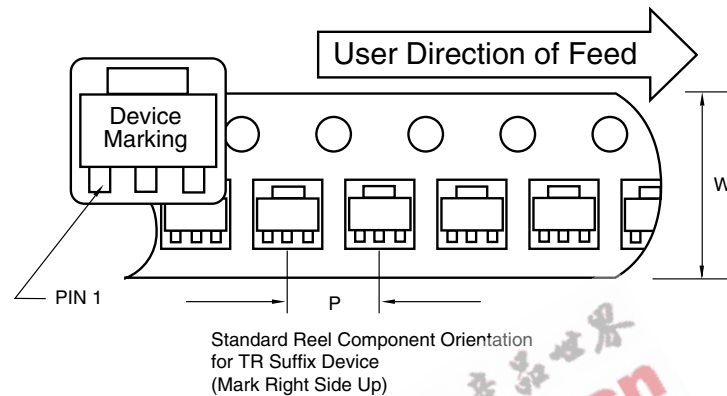
## 4.0 PACKAGING INFORMATION

### 4.1 Package Marking Information

Package marking data not available at this time.

### 4.2 Taping Form

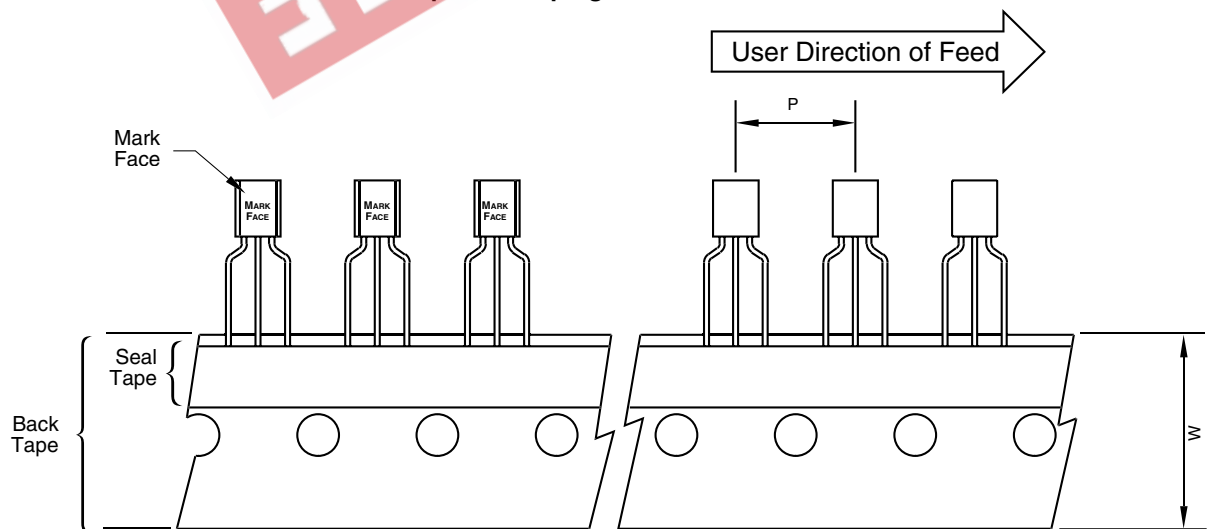
#### Component Taping Orientation for 3-Pin SOT-223 Devices



Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
3-Pin SOT-223	12 mm	8 mm	4000	13 in

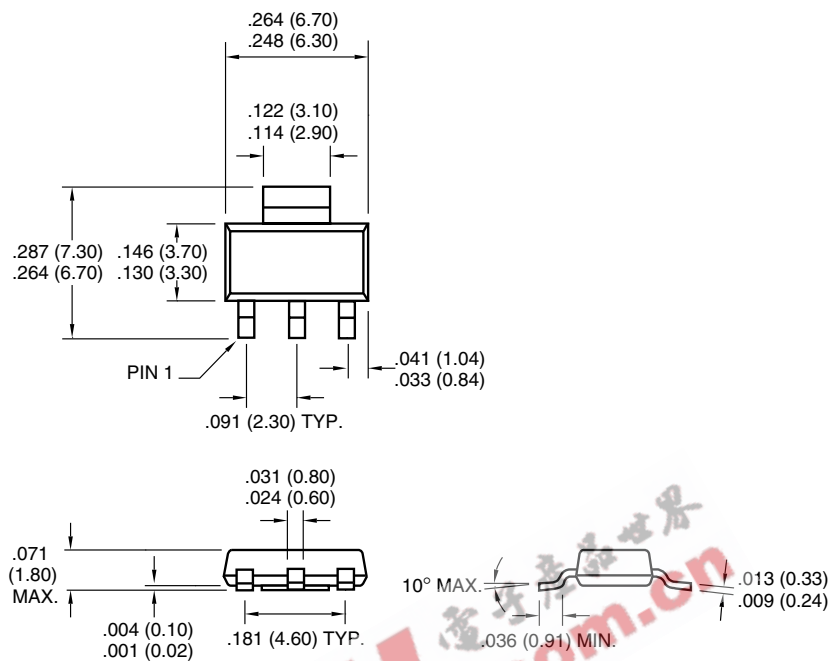
#### Component Taping Orientation for 3-Pin TO-92



# TC32M

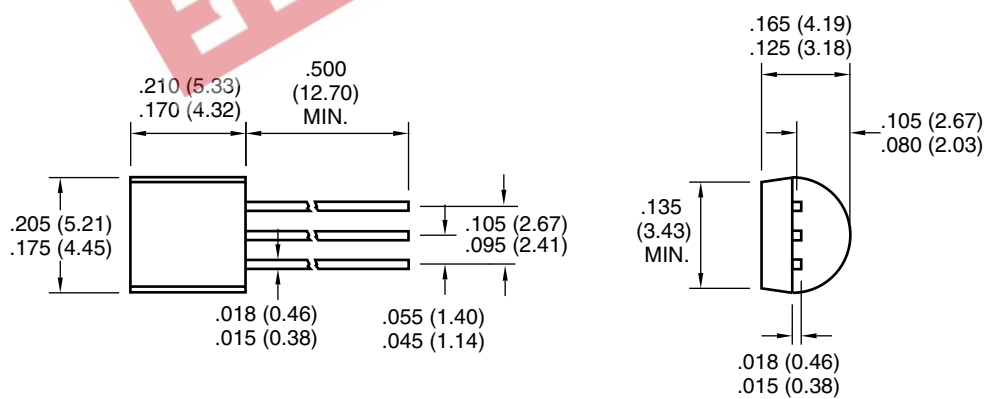
## 4.3 Package Dimensions

### 3-Pin SOT-223



Dimensions: inches (mm)

### TO-92-3



Dimensions: inches (mm)



## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<b>PART CODE</b>	<b>TC32M</b>	<b>X</b>	<b>XX</b>
<b>Temperature:</b>			
C: Commercial (0°C to +70°C)			
E: Extended (-40°C to +85°C)			
<b>Package Type:</b>			
ZB: 3-Pin TO-92			
DB: 3-Pin SOT223			
DB713: 3-Pin Tape & Reel SOT223			

## Sales and Support

### Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site ([www.microchip.com](http://www.microchip.com))

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

### New Customer Notification System

Register on our web site ([www.microchip.com/cn](http://www.microchip.com/cn)) to receive the most current information on our products.

# TC32M

---

NOTES:

EEPW 电子產品世界  
.com.cn

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

## Trademarks


The Microchip name and logo, the Microchip logo, FilterLab, KEELoQ, microID, MPLAB, PIC, PICmicro, PICMASTER, PICSTART, PRO MATE, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

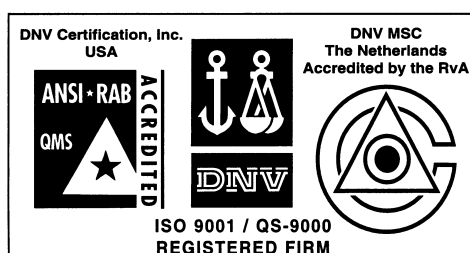
dsPIC, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, microPort, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, MXDEV, MXLAB, PICC, PICDEM, PICDEM.net, rfPIC, Select Mode and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A.

Serialized Quick Turn Programming (SQTP) is a service mark of Microchip Technology Incorporated in the U.S.A.

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

© 2002, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.



*Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999 and Mountain View, California in March 2002. The Company's quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELoQ® code hopping devices, Serial EEPROMs, microperipherals, non-volatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001 certified.*



## 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: 480-792-7627  
Web Address: <http://www.microchip.com>

#### Rocky Mountain

2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 480-792-7966 Fax: 480-792-7456

#### Atlanta

500 Sugar Mill Road, Suite 200B  
Atlanta, GA 30350  
Tel: 770-640-0034 Fax: 770-640-0307

#### Boston

2 Lan Drive, Suite 120  
Westford, MA 01886  
Tel: 978-692-3848 Fax: 978-692-3821

#### Chicago

333 Pierce Road, Suite 180  
Itasca, IL 60143  
Tel: 630-285-0071 Fax: 630-285-0075

#### Dallas

4570 Westgrove Drive, Suite 160  
Addison, TX 75001  
Tel: 972-818-7423 Fax: 972-818-2924

#### Detroit

Tri-Atria Office Building  
32255 Northwestern Highway, Suite 190  
Farmington Hills, MI 48334  
Tel: 248-538-2250 Fax: 248-538-2260

#### Kokomo

2767 S. Albright Road  
Kokomo, Indiana 46902  
Tel: 765-864-8360 Fax: 765-864-8387

#### Los Angeles

18201 Von Karman, Suite 1090  
Irvine, CA 92612  
Tel: 949-263-1888 Fax: 949-263-1338

#### New York

150 Motor Parkway, Suite 202  
Hauppauge, NY 11788  
Tel: 631-273-5305 Fax: 631-273-5335

#### San Jose

Microchip Technology Inc.  
2107 North First Street, Suite 590  
San Jose, CA 95131  
Tel: 408-436-7950 Fax: 408-436-7955

#### Toronto

6285 Northam Drive, Suite 108  
Mississauga, Ontario L4V 1X5, Canada  
Tel: 905-673-0699 Fax: 905-673-6509

### ASIA/PACIFIC

#### Australia

Microchip Technology Australia Pty Ltd  
Suite 22, 41 Rawson Street  
Epping 2121, NSW  
Australia  
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

#### China - Beijing

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Beijing Liaison Office  
Unit 915  
Bei Hai Wan Tai Bldg.  
No. 6 Chaoyangmen Beidajie  
Beijing, 100027, No. China  
Tel: 86-10-85282100 Fax: 86-10-85282104

#### China - Chengdu

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Chengdu Liaison Office  
Rm. 2401, 24th Floor,  
Ming Xing Financial Tower  
No. 88 TIDU Street  
Chengdu 610016, China  
Tel: 86-28-86766200 Fax: 86-28-86766599

#### China - Fuzhou

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Fuzhou Liaison Office  
Unit 28F, World Trade Plaza  
No. 71 Wusi Road  
Fuzhou 350001, China  
Tel: 86-591-7503506 Fax: 86-591-7503521

#### China - Shanghai

Microchip Technology Consulting (Shanghai)  
Co., Ltd.  
Room 701, Bldg. B  
Far East International Plaza  
No. 317 Xian Xia Road  
Shanghai, 200051  
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

#### China - Shenzhen

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Shenzhen Liaison Office  
Rm. 1315, 13/F, Shenzhen Kerry Centre,  
Renminnan Lu  
Shenzhen 518001, China  
Tel: 86-755-2350361 Fax: 86-755-2366086

#### China - Hong Kong SAR

Microchip Technology Hongkong Ltd.  
Unit 901-6, Tower 2, Metroplaza  
223 Hing Fong Road  
Kwai Fong, N.T., Hong Kong  
Tel: 852-2401-1200 Fax: 852-2401-3431

#### India

Microchip Technology Inc.  
India Liaison Office  
Divyasree Chambers  
1 Floor, Wing A (A3/A4)  
No. 11, O'Shaughnessy Road  
Bangalore, 560 025, India  
Tel: 91-80-2290061 Fax: 91-80-2290062

### Japan

Microchip Technology Japan K.K.  
Benex S-1 6F  
3-18-20, Shinyokohama  
Kohoku-Ku, Yokohama-shi  
Kanagawa, 222-0033, Japan  
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

### Korea

Microchip Technology Korea  
168-1, Youngbo Bldg. 3 Floor  
Samsung-Dong, Kangnam-Ku  
Seoul, Korea 135-882  
Tel: 82-2-554-7200 Fax: 82-2-558-5934

### Singapore

Microchip Technology Singapore Pte Ltd.  
200 Middle Road  
#07-02 Prime Centre  
Singapore, 188980  
Tel: 65-6334-8870 Fax: 65-6334-8850

### Taiwan

Microchip Technology Taiwan  
11F-3, No. 207  
Tung Hua North Road  
Taipei, 105, Taiwan  
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

### EUROPE

#### Denmark

Microchip Technology Nordic ApS  
Regus Business Centre  
Lautrup høj 1-3  
Ballerup DK-2750 Denmark  
Tel: 45 4420 9895 Fax: 45 4420 9910

#### France

Microchip Technology SARL  
Parc d'Activite du Moulin de Massy  
43 Rue du Saule Trapu  
Batiment A - 1er Etage  
91300 Massy, France  
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

#### Germany

Microchip Technology GmbH  
Gustav-Heinemann Ring 125  
D-81739 Munich, Germany  
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

#### Italy

Microchip Technology SRL  
Centro Direzionale Colleoni  
Palazzo Taurus 1 V. Le Colleoni 1  
20041 Agrate Brianza  
Milan, Italy  
Tel: 39-039-65791-1 Fax: 39-039-6899883

#### United Kingdom

Microchip Ltd.  
505 Eskdale Road  
Winnersh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44 118 921 5869 Fax: 44-118 921-5820

05/01/02