

## 4K (512 x 8) CMOS EEPROM

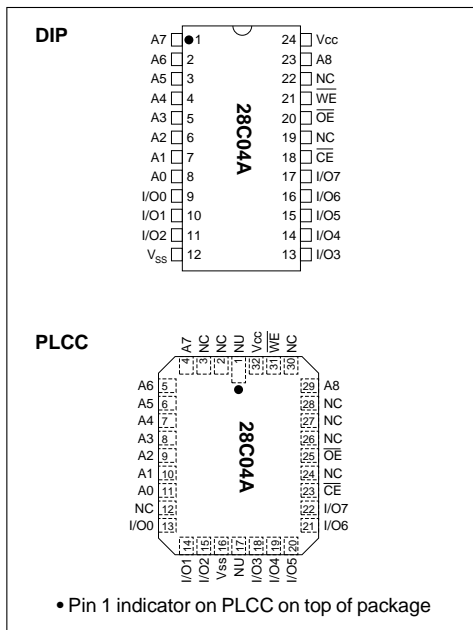
### FEATURES

- Fast Read Access Time—150 ns
- CMOS Technology for Low Power Dissipation
  - 30 mA Active
  - 100  $\mu$ A Standby
- Fast Byte Write Time—200  $\mu$ s or 1 ms
- Data Retention >200 years
- Endurance - Minimum  $10^4$  Erase/Write Cycles
  - Automatic Write Operation
  - Internal Control Timer
  - Auto-Clear Before Write Operation
  - On-Chip Address and Data Latches
- Data Polling
- Chip Clear Operation
- Enhanced Data Protection
  - Vcc Detector
  - Pulse Filter
  - Write Inhibit
- 5-Volt-Only Operation
- Organized 512x8 JEDEC standard pinout
  - 24-pin Dual-In-Line Package
  - 32-pin PLCC Package
- Available for Extended Temperature Ranges:
  - Commercial: 0°C to +70°C
  - Industrial: -40°C to +85°C

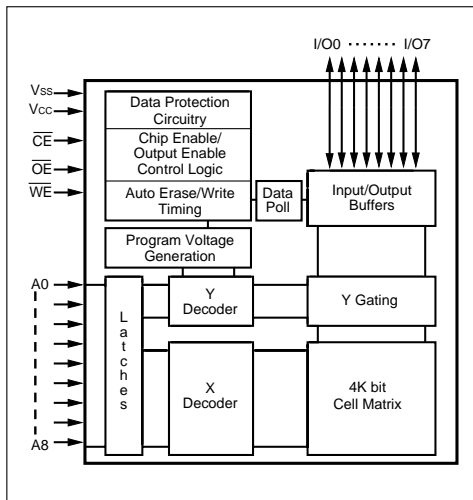
### DESCRIPTION

The Microchip Technology Inc. 28C04A is a CMOS 4K non-volatile electrically Erasable and Programmable Read Only Memory (EEPROM). The 28C04A is accessed like a static RAM for the read or write cycles without the need of external components. During a "byte write", the address and data are latched internally, freeing the microprocessor address and data bus for other operations. Following the initiation of write cycle, the device will go to a busy state and automatically clear and write the latched data using an internal control timer. To determine when a write cycle is complete, the 28C04A uses Data polling. Data polling allows the user to read the location last written to when the write operation is complete. CMOS design and processing enables this part to be used in systems where reduced power consumption and reliability are required. A complete family of packages is offered to provide the utmost flexibility in applications.

### PACKAGE TYPES



### BLOCK DIAGRAM



**1.0 ELECTRICAL CHARACTERISTICS****1.1 MAXIMUM RATINGS\***

V<sub>CC</sub> and input voltages w.r.t. V<sub>SS</sub>..... -0.6V to + 6.25V  
 Voltage on  $\overline{OE}$  w.r.t. V<sub>SS</sub> ..... -0.6V to +13.5V  
 Output Voltage w.r.t. V<sub>SS</sub>..... -0.6V to V<sub>CC</sub>+0.6V  
 Storage temperature ..... -65°C to +125°C  
 Ambient temp. with power applied..... -50°C to +95°C

**\*Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**TABLE 1-1: PIN FUNCTION TABLE**

Name	Function
A0 - A8	Address Inputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
V <sub>CC</sub>	+5V Power Supply
V <sub>SS</sub>	Ground
NC	No Connect; No Internal Connection
NU	Not Used; No External Connection is Allowed

**TABLE 1-2: READ/WRITE OPERATION DC CHARACTERISTICS**

V <sub>CC</sub> = +5V ±10% Commercial (C): T <sub>amb</sub> = 0°C to +70°C Industrial (I): T <sub>amb</sub> = -40°C to +85°C						
Parameter	Status	Symbol	Min	Max	Units	Conditions
Input Voltages	Logic '1' Logic '0'	V <sub>IH</sub> V <sub>IL</sub>	2.0 -0.1	V <sub>CC</sub> +1 0.8	V V	
Input Leakage		I <sub>LI</sub>	-10	10	μA	V <sub>IN</sub> = -0.1V to V <sub>CC</sub> +1
Input Capacitance		C <sub>IN</sub>		10	pF	V <sub>IN</sub> = 0V; T <sub>amb</sub> = 25°C; f = 1 MHz
Output Voltages	Logic '1' Logic '0'	V <sub>OH</sub> V <sub>OL</sub>	2.4	0.45	V V	I <sub>OH</sub> = -400 μA I <sub>OL</sub> = 2.1 mA
Output Leakage		I <sub>LO</sub>	-10	10	μA	V <sub>OUT</sub> = -0.1V TO V <sub>CC</sub> + 0.1V
Output Capacitance		C <sub>OUT</sub>		12	pF	V <sub>IN</sub> = 0V; T <sub>AMB</sub> = 25°C; f = 1 MHz
Power Supply Current, Active	TTL input	I <sub>CC</sub>		30	mA	f = 5 MHz (Note 1) V <sub>CC</sub> = 5.5V
Power Supply Current, Standby	TTL input TTL input CMOS input	I <sub>CC</sub> (S) <sub>TTL</sub> I <sub>CC</sub> (S) <sub>TTL</sub> I <sub>CC</sub> (S) <sub>CMOS</sub>		2 3 100	mA mA μA	$\overline{CE}$ = V <sub>IH</sub> (0°C to +70°C) $\overline{CE}$ = V <sub>IH</sub> (-40°C to +85°C) $\overline{CE}$ = V <sub>CC</sub> -0.3 to V <sub>CC</sub> +1 $\overline{OE}$ = V <sub>CC</sub> All inputs equal V <sub>CC</sub> or V <sub>SS</sub>

Note 1: AC power supply current above 5 MHz; 1 mA/MHz.

TABLE 1-3: READ OPERATION AC CHARACTERISTICS

		AC Testing Waveform:		V <sub>IH</sub> = 2.4V; V <sub>IL</sub> = 0.45V; V <sub>OH</sub> = 2.0V; V <sub>OL</sub> = 0.8V					
		Output Load:		1 TTL Load + 100 pF					
		Input Rise and Fall Times:		20 ns					
		Ambient Temperature:		Commercial (C): Tamb = 0°C to +70°C		Industrial (I): Tamb = -40°C to +85°C			
Parameter	Sym	28C04A-15		28C04A-20		28C04A-25		Units	Conditions
		Min	Max	Min	Max	Min	Max		
Address to Output Delay	t <sub>ACC</sub>		150		200		250	ns	$\overline{OE} = \overline{CE} = V_{IL}$
$\overline{CE}$ to Output Delay	t <sub>CE</sub>		150		200		250	ns	$\overline{OE} = V_{IL}$
$\overline{OE}$ to Output Delay	t <sub>OE</sub>		70		80		100	ns	$\overline{CE} = V_{IL}$
$\overline{CE}$ to $\overline{OE}$ High Output Float	t <sub>OFF</sub>	0	50	0	55	0	70	ns	
Output Hold from Address, $\overline{CE}$ or $\overline{OE}$ , whichever occurs first	t <sub>OH</sub>	0		0		0		ns	
Endurance	—	1M	—	1M	—	1M	—	cycles	25°C, V <sub>CC</sub> = 5.0V, Block Mode (Note)

Note: This parameter is not tested but guaranteed by characterization. For endurance estimates in a specific application, please consult the Total Endurance Model which can be obtained on our BBS or website.

FIGURE 1-1: READ WAVEFORMS

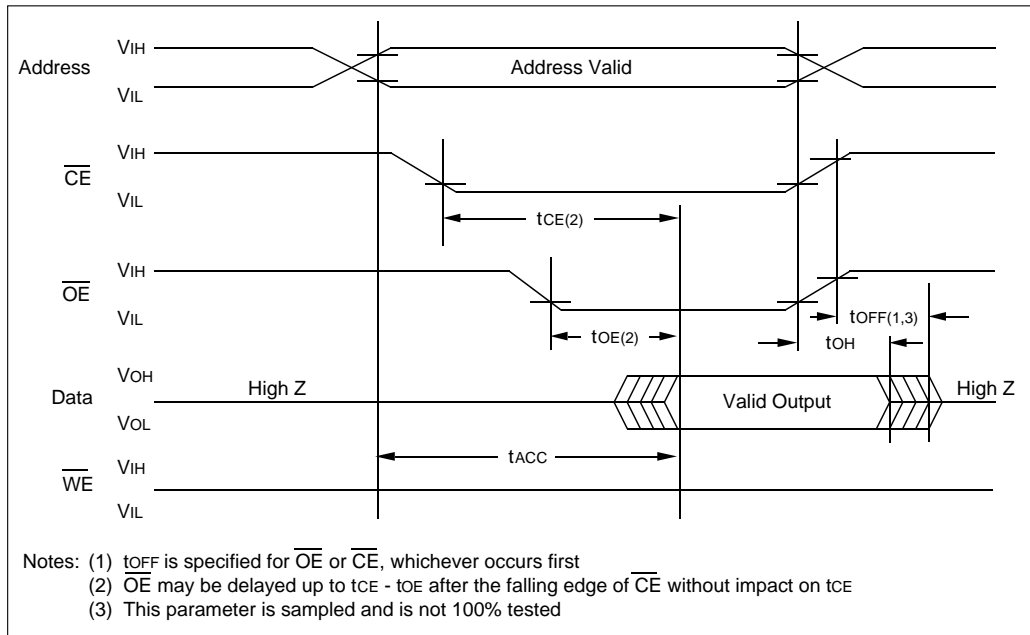
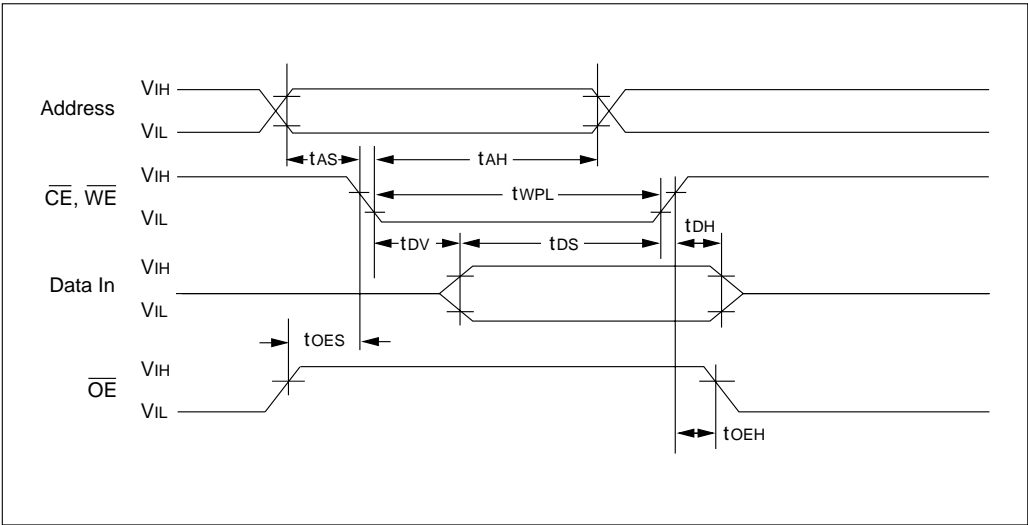


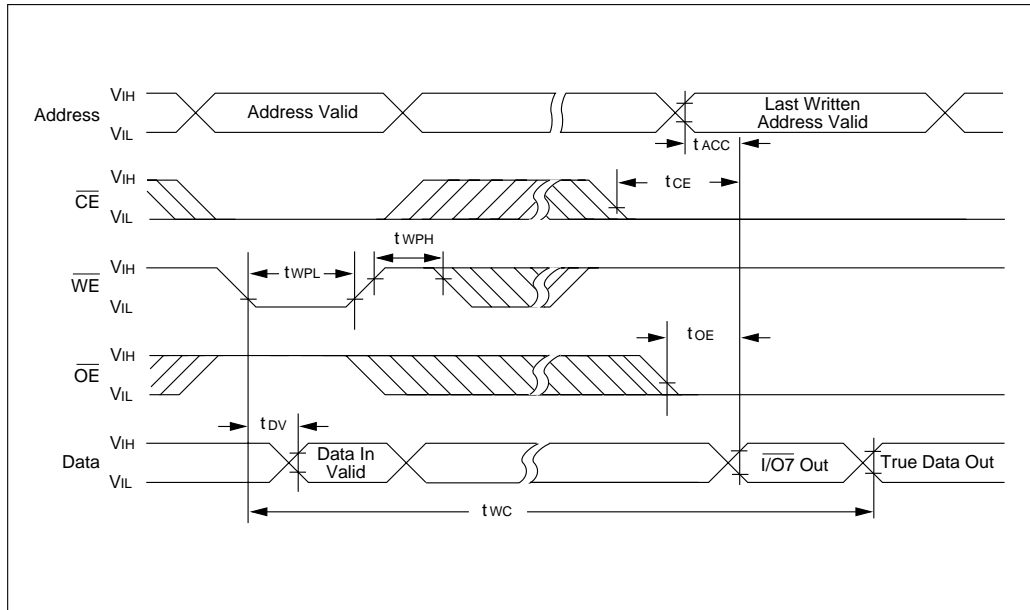
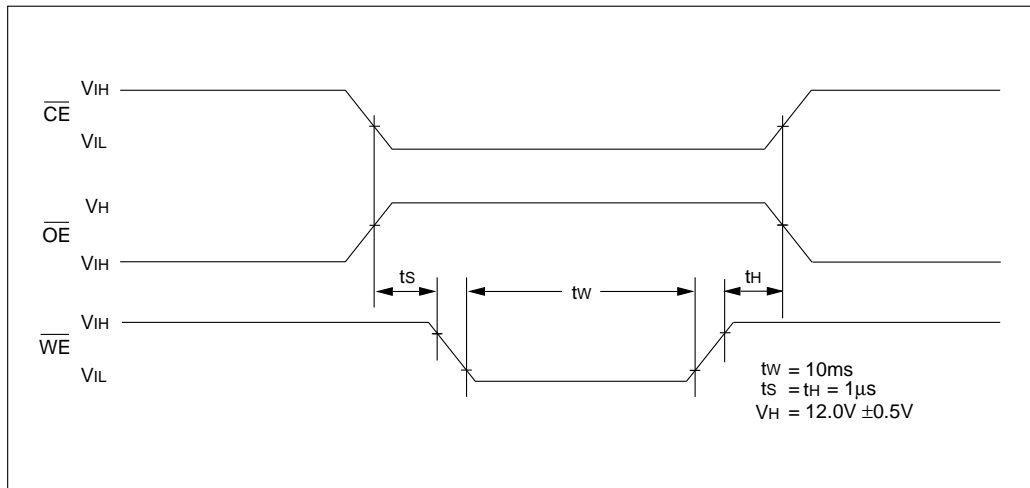
TABLE 1-4:     BYTE WRITE AC CHARACTERISTICS

		AC Testing Waveform: Output Load: Input Rise/Fall Times: Ambient Temperature:		VIH = 2.4V; VIL = 0.45V; VOH = 2.0V; VOL = 0.8V 1 TTL Load + 100 pF 20 nsec Commercial (C): Tamb= 0°C to 70°C Industrial (I): Tamb= -40°C to 85°C	
Parameter	Symbol	Min	Max	Units	Remarks
Address Set-Up Time	tAS	10		ns	
Address Hold Time	tAH	50		ns	
Data Set-Up Time	tDS	50		ns	
Data Hold Time	tDH	10		ns	
Write Pulse Width	twPL	100		ns	Note 1
Write Pulse High Time	twPH	50		ns	
OE Hold Time	toEH	10		ns	
OE Set-Up Time	toES	10		ns	
Data Valid Time	tDV		1000	ns	Note 2
Write Cycle Time (28C04A)	twC		1	ms	0.5 ms typical
Write Cycle Time (28C04AF)	twC		200	µs	100 µs typical

- Note 1: A write cycle can be initiated by  $\overline{CE}$  or  $\overline{WE}$  going low, whichever occurs last. The data is latched on the positive edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever occurs first.
- 2: Data must be valid within 1000ns max. after a write cycle is initiated and must be stable at least until tDH after the positive edge of  $\overline{WE}$  or  $\overline{CE}$ , whichever occurs first.

FIGURE 1-2:     PROGRAMMING WAVEFORMS



**FIGURE 1-3: DATA POLLING WAVEFORMS****FIGURE 1-4: CHIP CLEAR WAVEFORMS**

## 2.0 DEVICE OPERATION

The Microchip Technology Inc. 28C04A has four basic modes of operation—read, standby, write inhibit, and byte write—as outlined in the following table.

Operation Mode	CE	IE	WE	I/O
Read	L	L	H	DOUT
Standby	H	X	X	High Z
Write Inhibit	H	X	X	High Z
Write Inhibit	X	L	X	High Z
Write Inhibit	X	X	H	High Z
Byte Write	L	H	L	DIN
Byte Clear	Automatic Before Each "Write"			

X = Any TTL level.

### 2.1 Read Mode

The 28C04A has two control functions, both of which must be logically satisfied in order to obtain data at the outputs. Chip enable ( $\overline{CE}$ ) is the power control and should be used for device selection. Output Enable ( $\overline{OE}$ ) is the output control and is used to gate data to the output pins independent of device selection. Assuming that addresses are stable, address access time ( $t_{ACC}$ ) is equal to the delay from  $\overline{CE}$  to output ( $t_{CE}$ ). Data is available at the output  $t_{OE}$  after the falling edge of  $\overline{OE}$ , assuming that  $\overline{CE}$  has been low and addresses have been stable for at least  $t_{ACC}-t_{OE}$ .

### 2.2 Standby Mode

The 28C04A is placed in the standby mode by applying a high signal to the  $\overline{CE}$  input. When in the standby mode, the outputs are in a high impedance state, independent of the  $\overline{OE}$  input.

### 2.3 Data Protection

In order to ensure data integrity, especially during critical power-up and power-down transitions, the following enhanced data protection circuits are incorporated:

First, an internal  $V_{CC}$  detect (3.3 volts typical) will inhibit the initiation of non-volatile programming operation when  $V_{CC}$  is less than the  $V_{CC}$  detect circuit trip.

Second, there is a  $\overline{WE}$  filtering circuit that prevents  $\overline{WE}$  pulses of less than 10 ns duration from initiating a write cycle.

Third, holding  $\overline{WE}$  or  $\overline{CE}$  high or  $\overline{OE}$  low, inhibits a write cycle during power-on and power-off ( $V_{CC}$ ).

## 2.4 Write Mode

The 28C04A has a write cycle similar to that of a Static RAM. The write cycle is completely self-timed and initiated by a low going pulse on the  $\overline{WE}$  pin. On the falling edge of  $\overline{WE}$ , the address information is latched. On rising edge, the data and the control pins ( $\overline{CE}$  and  $\overline{OE}$ ) are latched.

## 2.5 Data Polling

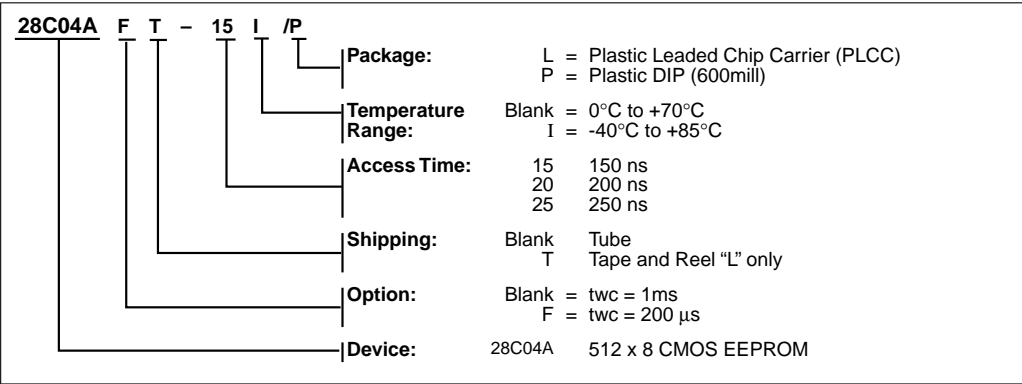
The 28C04A features Data polling to signal the completion of a byte write cycle. During a write cycle, an attempted read of the last byte written results in the data complement of I/O7 (I/O0 to I/O6 are indeterminate). After completion of the write cycle, true data is available. Data polling allows a simple read/compare operation to determine the status of the chip eliminating the need for external hardware.

## 2.6 Chip Clear

All data may be cleared to 1's in a chip clear cycle by raising  $\overline{OE}$  to 12 volts and bringing the  $\overline{WE}$  and  $\overline{CE}$  low. This procedure clears all data.

28C04A Product Identification System

To order or to obtain information, e.g., on pricing or delivery, please use the listed part numbers, and refer to the factory or the listed sales offices.





**MICROCHIP**

## WORLDWIDE SALES AND SERVICE

### AMERICAS

#### Corporate Office

Microchip Technology Inc.  
2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 602-786-7200 Fax: 602-786-7277  
Technical Support: 602 786-7627  
Web: <http://www.microchip.com>

#### Atlanta

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

#### Boston

Microchip Technology Inc.  
5 Mount Royal Avenue  
Marlborough, MA 01752  
Tel: 508-480-9990 Fax: 508-480-8575

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

#### Dallas

Microchip Technology Inc.  
14651 Dallas Parkway, Suite 816  
Dallas, TX 75240-8809  
Tel: 972-991-7177 Fax: 972-991-8588

#### Dayton

Microchip Technology Inc.  
Two Prestige Place, Suite 150  
Miamisburg, OH 45342  
Tel: 937-291-1654 Fax: 937-291-9175

#### Detroit

Microchip Technology Inc.  
42705 Grand River, Suite 201  
Novi, MI 48375-1727  
Tel: 248-374-1888 Fax: 248-374-2878

#### Los Angeles

Microchip Technology Inc.  
18201 Von Karman, Suite 1090  
Irvine, CA 92612  
Tel: 714-263-1888 Fax: 714-263-1338

#### New York

Microchip Technology Inc.  
150 Motor Parkway, Suite 202  
Hauppauge, NY 11788  
Tel: 516-273-5305 Fax: 516-273-5335

#### San Jose

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

### AMERICAS (continued)

#### Toronto

Microchip Technology Inc.  
5925 Airport Road, Suite 200  
Mississauga, Ontario L4V 1W1, Canada  
Tel: 905-405-6279 Fax: 905-405-6253

### ASIA/PACIFIC

#### Hong Kong

Microchip Asia Pacific  
RM 3801B, Tower Two  
Metroplaza  
223 Hing Fong Road  
Kwai Fong, N.T., Hong Kong  
Tel: 852-2-401-1200 Fax: 852-2-401-3431

#### India

Microchip Technology Inc.  
India Liaison Office  
No. 6, Legacy, Convent Road  
Bangalore 560 025, India  
Tel: 91-80-229-0061 Fax: 91-80-229-0062

#### Japan

Microchip Technology Intl. Inc.  
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  
Tel: 82-2-554-7200 Fax: 82-2-558-5934

#### Shanghai

Microchip Technology  
RM 406 Shanghai Golden Bridge Bldg.  
2077 Yan'an Road West, Hong Qiao District  
Shanghai, PRC 200335  
Tel: 86-21-6275-5700 Fax: 86 21-6275-5060

### ASIA/PACIFIC (continued)

#### Singapore

Microchip Technology Singapore Pte Ltd.  
200 Middle Road  
#07-02 Prime Centre  
Singapore 188980  
Tel: 65-334-8870 Fax: 65-334-8850

#### Taiwan, R.O.C

Microchip Technology Taiwan  
10F-1C 207  
Tung Hua North Road  
Taipei, Taiwan, ROC  
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

### EUROPE

#### United Kingdom

Arizona Microchip Technology Ltd.  
505 Eskdale Road  
Winnesh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44-1189-21-5858 Fax: 44-1189-21-5835

#### France

Arizona Microchip Technology SARL  
Zone Industrielle de la Bonde  
2 Rue du Buisson aux Fraises  
91300 Massy, France  
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

#### Germany

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

#### Italy

Arizona Microchip Technology SRL  
Centro Direzionale Colleoni  
Palazzo Taurus 1 V. Le Colleoni 1  
20041 Agrate Brianza  
Milan, Italy  
Tel: 39-39-6899939 Fax: 39-39-6899883

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*Microchip received ISO 9001 Quality System certification for its worldwide headquarters, design, and wafer fabrication facilities in January, 1997. Our field-programmable PICmicro™ 8-bit MCUs, Serial EEPROMs, related specialty memory products and development systems conform to the stringent quality standards of the International Standard Organization (ISO).*

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