

## 300mA CMOS LDO with Shutdown and $V_{REF}$ Bypass

### Features

- Very Low Ground Current for Longer Battery Life
- Very Low Dropout Voltage
- 300mA Output Circuit
- High Output Voltage Accuracy
- Standard or Custom Output Voltages
- Power Saving Shutdown Mode
- Bypass Input for Ultra Quiet Operation
- Over Current and Over Temperature Protection
- Space-Saving MSOP Package

### Applications

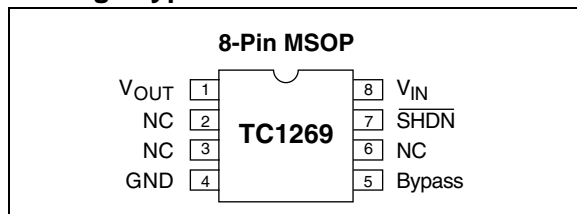
- Battery Operated Systems
- Portable Computers
- Medical Instruments
- Instrumentation
- Cellular/GSM/PHS Phones
- Linear Post-Regulator for SMPS
- Pagers
- Digital Cameras

### Device Selection Table

Part Number	Output* Voltage (V)	Package	Junction Temp. Range
TC1269-2.5VUA	2.5	8-Pin MSOP	-40°C to +125°C
TC1269-2.8VUA	2.8	8-Pin MSOP	-40°C to +125°C
TC1269-3.0VUA	3.0	8-Pin MSOP	-40°C to +125°C
TC1269-3.3VUA	3.3	8-Pin MSOP	-40°C to +125°C
TC1269-5.0VUA	5.0	8-Pin MSOP	-40°C to +125°C

\*Other output voltages are available. Please contact Microchip Technology Inc. for details.

### Package Type



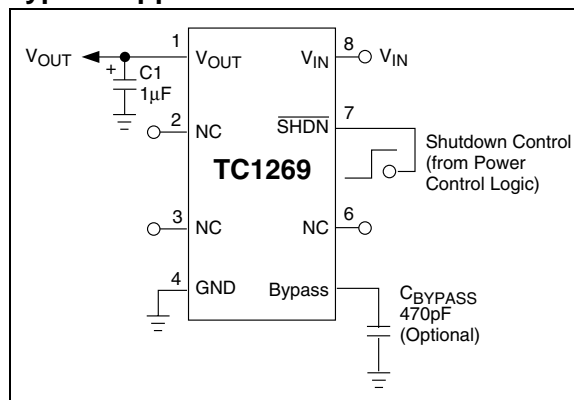
### General Description

The TC1269 is a fixed output, high accuracy (typically  $\pm 0.5\%$ ) CMOS upgrade for older (bipolar) low dropout regulators. Total supply current is typically  $50\mu A$  at full load (20 to 60 times lower than in bipolar regulators).

TC1269 key features include ultra low noise operation (plus optional Bypass input); very low dropout voltage (typically  $240mV$  at full load), and fast response to step changes in load. Supply current is reduced to  $0.05\mu A$  (typical) and  $V_{OUT}$  falls to zero when the shutdown input is low.

The TC1269 incorporates both over temperature and over current protection. The TC1269 is stable with an output capacitor of only  $1\mu F$  and has a maximum output current of  $300mA$ .

### Typical Application



# TC1269

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Input Voltage .....	6.5V
Output Voltage.....	(V <sub>SS</sub> - 0.3) to (V <sub>IN</sub> + 0.3V)
Maximum Voltage on Any Pin .....	V <sub>IN</sub> + 0.3V to -0.3V
Power Dissipation.....	Internally Limited ( <b>Note 6</b> )
Operating Temperature .....	-40°C < T <sub>J</sub> < +125°C
Storage Temperature.....	-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.

### TC1269 ELECTRICAL SPECIFICATIONS

<b>Electrical Characteristics:</b> V <sub>IN</sub> = V <sub>OUT</sub> + 1V, I <sub>L</sub> = 0.1μA, C <sub>L</sub> = 3.3μF, $\overline{\text{SHDN}} > V_{IH}$ , T <sub>A</sub> = 25°C, unless otherwise noted. <b>Boldface</b> type specifications apply for junction temperatures of -40°C to +125°C.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V <sub>IN</sub>	Input Operating Voltage	—	—	<b>6.0</b>	V	
I <sub>OUTMAX</sub>	Maximum Output Current	<b>300</b>	—	—	mA	
V <sub>OUT</sub>	Output Voltage	— <b>V<sub>R</sub> - 2.5%</b>	V <sub>R</sub> ±0.5% —	— <b>V<sub>R</sub> + 2.5%</b>	V	<b>Note 1</b>
ΔV <sub>OUT</sub> /ΔT	V <sub>OUT</sub> Temperature Coefficient	—	<b>40</b>	—	ppm/°C	<b>Note 2</b>
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	—	0.05	<b>0.35</b>	%	(V <sub>R</sub> + 1V) ≤ V <sub>IN</sub> ≤ 6V
ΔV <sub>OUT</sub> /V <sub>OUT</sub>	Load Regulation	—	0.5	<b>2.0</b>	%	I <sub>L</sub> = 0.1mA to I <sub>OUTMAX</sub>
V <sub>IN</sub> -V <sub>OUT</sub>	Dropout Voltage	—	20 80 240	<b>30</b> <b>160</b> <b>480</b>	mV	I <sub>L</sub> = 0.1mA I <sub>L</sub> = 100mA I <sub>L</sub> = 300mA ( <b>Note 4</b> )
I <sub>SS1</sub>	Supply Current	—	50	<b>90</b>	μA	$\overline{\text{SHDN}} = V_{IH}$
I <sub>SS2</sub>	Shutdown Supply Current	—	0.05	<b>0.5</b>	μA	$\overline{\text{SHDN}} = 0V$
PSRR	Power Supply Rejection Ratio	—	50	—	dB	F <sub>RE</sub> ≤ 120Hz
I <sub>OUTSC</sub>	Output Short Circuit Current	—	550	650	mA	V <sub>OUT</sub> = 0V
ΔV <sub>OUT</sub> /ΔP <sub>D</sub>	Thermal Regulation	—	0.04	—	V/W	<b>Note 5</b>
eN	Output Noise	—	260	—	nV/√Hz	F = 1kHz, C <sub>OUT</sub> = 1μF, R <sub>LOAD</sub> = 50Ω
<b>SHDN Input</b>						
V <sub>IH</sub>	$\overline{\text{SHDN}}$ Input High Threshold	<b>45</b>	—	—	%V <sub>IN</sub>	
V <sub>IL</sub>	$\overline{\text{SHDN}}$ Input Low Threshold	—	—	<b>15</b>	%V <sub>IN</sub>	

**Note 1:** V<sub>R</sub> is the regulator output voltage setting.

$$\text{2: } T_C V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$$

- Regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 0.1mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
- Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at a 1V differential.
- Thermal Regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I<sub>LMAX</sub> at V<sub>IN</sub> = 6V for T = 10 msec.
- The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction-to-air (i.e., T<sub>A</sub>, T<sub>J</sub>, θ<sub>JA</sub>). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see Section 4.0 Thermal Considerations for more details.

## 2.0 PIN DESCRIPTIONS

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

**TABLE 2-1: PIN FUNCTION TABLE**

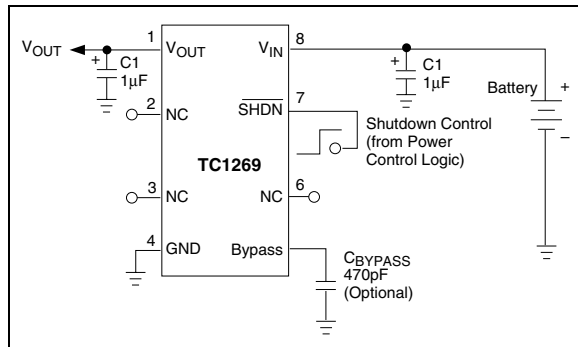
Pin No. (8-Pin SOIC)	Symbol	Description
1	$V_{OUT}$	Regulated voltage output.
2	NC	No connect.
3	NC	No connect.
4	GND	Ground terminal.
5	Bypass	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
6	NC	No connect.
7	$\overline{SHDN}$	Shutdown control input. The regulator is fully enabled when a logic high is applied to this input. The regulator is fully enabled when a logic high is applied to this input. The regulator enters shutdown when a logic low is applied to this input. During shutdown, output voltage falls to zero and supply current is reduced to 0.05 $\mu$ A (typical).
8	$V_{IN}$	Unregulated supply input.

## 3.0 DETAILED DESCRIPTION

The TC1269 is a precision regulator available in fixed voltages. Unlike the bipolar regulators, the TC1269 supply current does not increase with load current. In addition,  $V_{OUT}$  remains stable and within regulation over the entire 0mA to  $I_{OUTMAX}$  operating load current range, (an important consideration in RTC and CMOS RAM battery backup applications).

Figure 3-1 shows a typical application circuit. The regulator is enabled any time the shutdown input (SHDN) is at or above  $V_{IH}$ , and shutdown (disabled) when SHDN is at or below  $V_{IL}$ . SHDN may be controlled by a CMOS logic gate, or I/O port of a microcontroller. If the SHDN input is not required, it should be connected directly to the input supply. While in shutdown, supply current decreases to 0.05 $\mu$ A (typical),  $V_{OUT}$  falls to zero.

**FIGURE 3-1: TYPICAL APPLICATION CIRCUIT**



## 3.1 Bypass Input

A 470pF capacitor connected from the Bypass input to ground reduces noise present on the internal reference, which in turn significantly reduces output noise. If output noise is not a concern, this input may be left unconnected. Larger capacitor values may be used, but results in a longer time period to rated output voltage when power is initially applied.

## 3.2 Output Capacitor

A 1 $\mu$ F (min) capacitor from  $V_{OUT}$  to ground is recommended. The output capacitor should have an effective series resistance greater than 0.1 $\Omega$  and less than 5.0 $\Omega$ , and a resonant frequency above 1MHz. A 1 $\mu$ F capacitor should be connected from  $V_{IN}$  to GND if there is more than 10 inches of wire between the regulator and the AC filter capacitor, or if a battery is used as the power source. Aluminum electrolytic or tantalum capacitor types can be used. (Since many aluminum electrolytic capacitors freeze at approximately -30 $^{\circ}$ C, solid tantalums are recommended for applications operating below -25 $^{\circ}$ C.) When operating from sources other than batteries, supply-noise rejection and transient response can be improved by increasing the value of the input and output capacitors and employing passive filtering techniques.

## 4.0 THERMAL CONSIDERATIONS

### 4.1 Thermal Shutdown

Integrated thermal protection circuitry shuts the regulator off when die temperature exceeds 150°C. The regulator remains off until the die temperature drops to approximately 140°C.

### 4.2 Power Dissipation

The amount of power the regulator dissipates is primarily a function of input and output voltage, and output current. The following equation is used to calculate worst case actual power dissipation:

#### EQUATION 4-1:

$$P_D \approx (V_{INMAX} - V_{OUTMIN}) I_{LOADMAX}$$

Where:

$P_D$  = Worst case actual power dissipation  
 $V_{INMAX}$  = Maximum voltage on  $V_{IN}$   
 $V_{OUTMIN}$  = Minimum regulator output voltage  
 $I_{LOADMAX}$  = Maximum output (load) current

The maximum allowable power dissipation (Equation 4-2) is a function of the maximum ambient temperature ( $T_{AMAX}$ ), the maximum allowable die temperature ( $T_{JMAX}$ ) and the thermal resistance from junction-to-air ( $\theta_{JA}$ ).

#### EQUATION 4-2:

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$

Where all terms are previously defined.

Equation 4-1 can be used in conjunction with Equation 4-2 to ensure regulator thermal operation is within limits. For example:

Given:

$$\begin{aligned} V_{INMAX} &= 3.0V \pm 10\% \\ V_{OUTMIN} &= 2.7V - 2.5\% \\ I_{LOAD} &= 250mA \\ T_{AMAX} &= 55^\circ C \end{aligned}$$

Find: 1. Actual power dissipation  
 2. Maximum allowable dissipation

Actual power dissipation:

$$\begin{aligned} P_D &\approx (V_{INMAX} - V_{OUTMIN}) I_{LOADMAX} \\ &= [(3.0 \times 1.1) - (2.7 \times .975)] 250 \times 10^{-3} \\ &= 167mW \end{aligned}$$

Maximum allowable power dissipation:

$$\begin{aligned} P_{DMAX} &= \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}} \\ &= \frac{(125 - 55)}{200} \\ &= 350mW \end{aligned}$$

In this example, the TC1269 dissipates a maximum of 167mW; below the allowable limit of 350mW. In a similar manner, Equation 4-1 and Equation 4-2 can be used to calculate maximum current and/or input voltage limits.

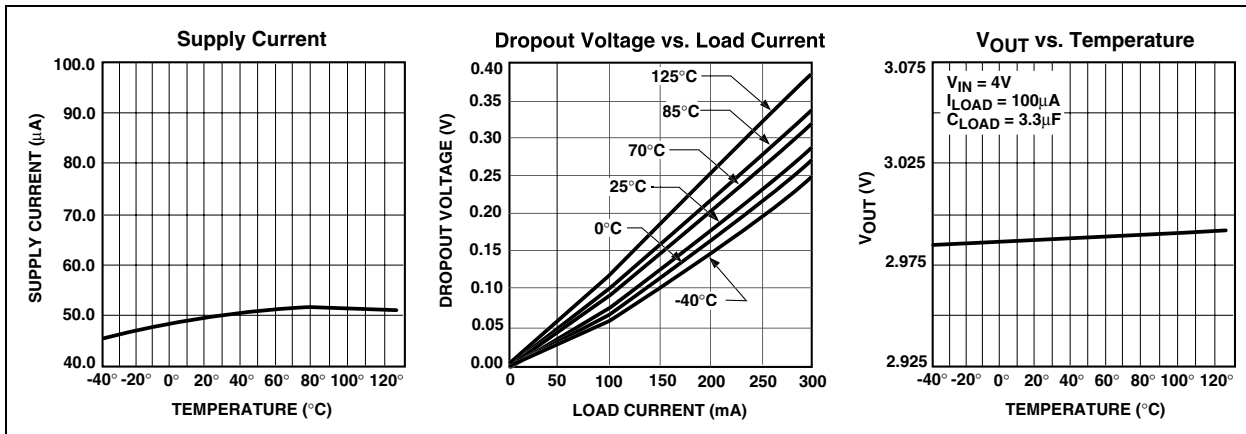
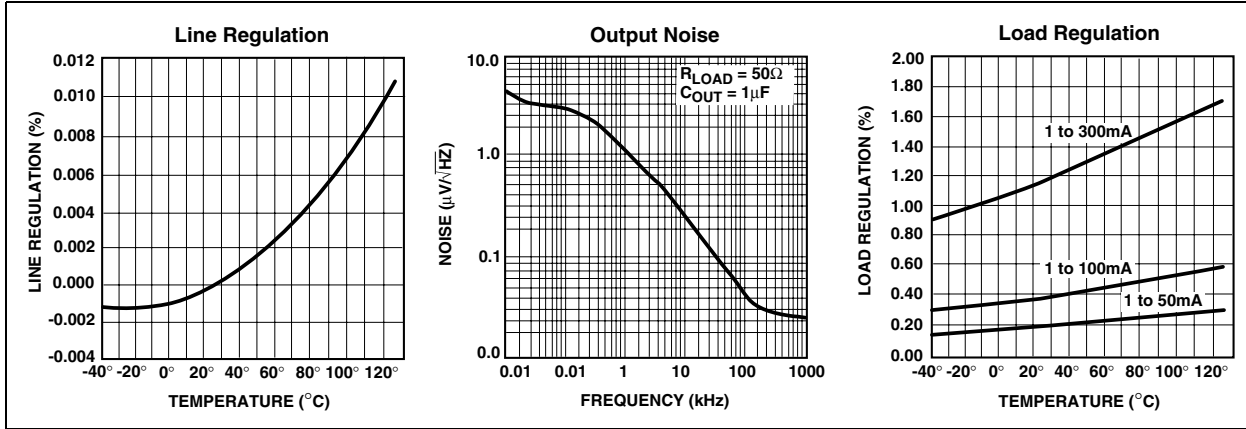
### 4.3 Layout Considerations

The primary path of heat conduction out of the package is via the package leads. Therefore, layouts having a ground plane, wide traces at the pads, and wide power supply bus lines combine to lower  $\theta_{JA}$  and, therefore, increase the maximum allowable power dissipation limit.

# TC1269

## 5.0 TYPICAL CHARACTERISTICS

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

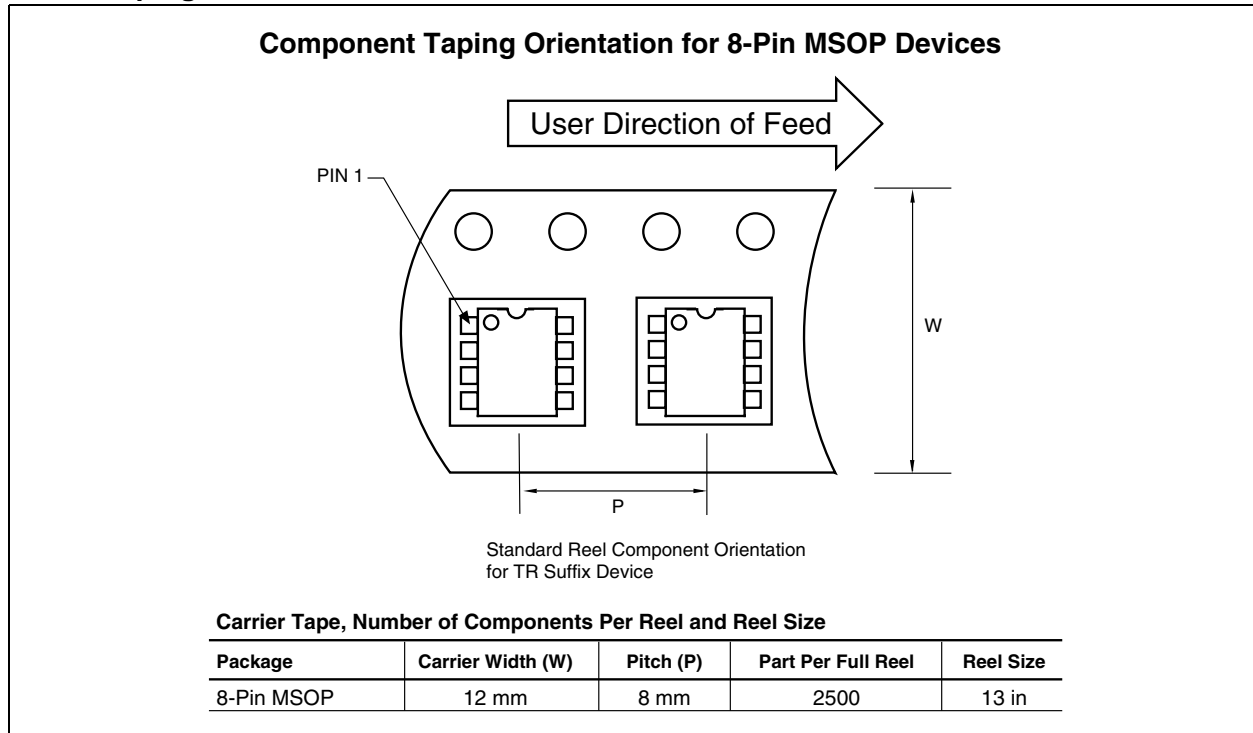


## 6.0 PACKAGING INFORMATION

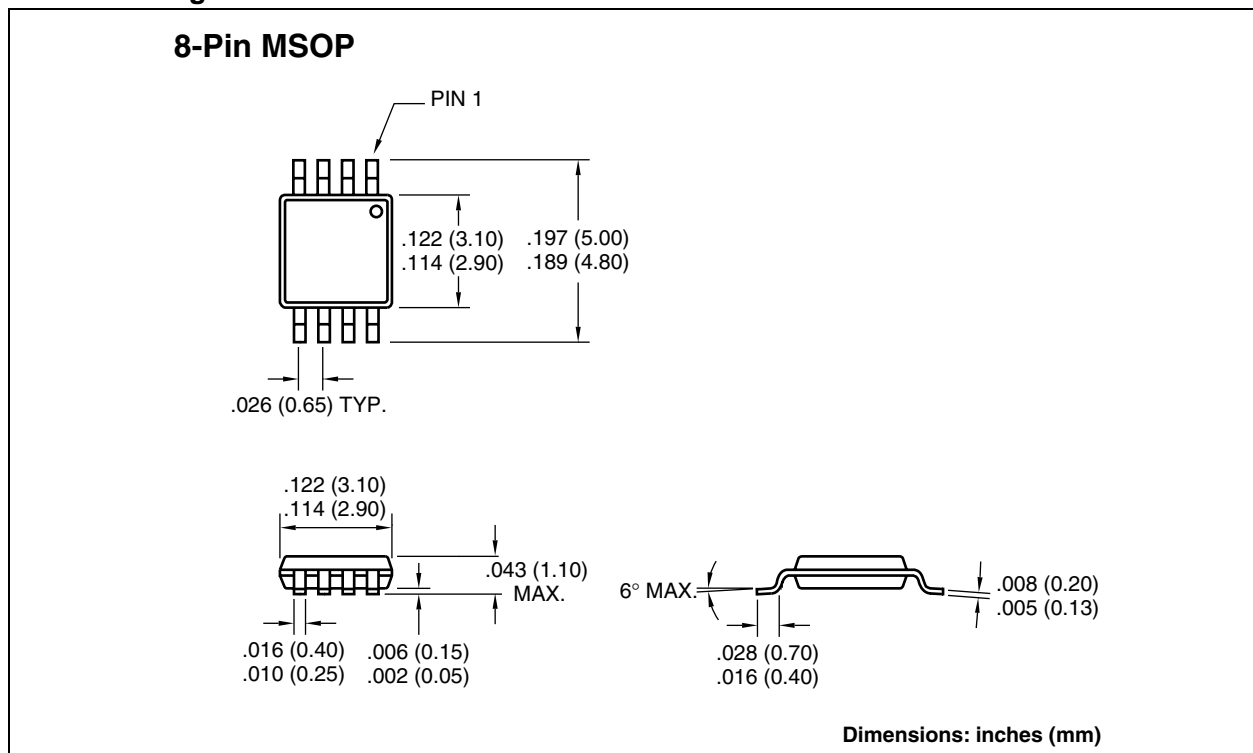
### 6.1 Package Marking Information

Package marking data not available at this time.

### 6.2 Taping Form



### 6.3 Package Dimensions



# TC1269

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NOTES:



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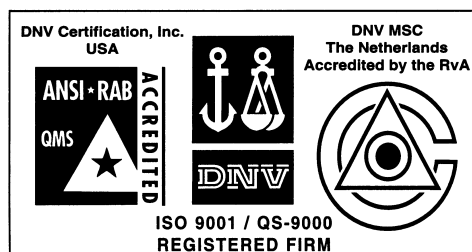
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Epping 2121, NSW  
Australia  
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Microchip Technology Consulting (Shanghai)  
Co., Ltd., Beijing Liaison Office  
Unit 915  
Bei Hai Wan Tai Bldg.  
No. 6 Chaoyangmen Beidajie  
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Tel: 86-10-85282100 Fax: 86-10-85282104

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Renminnan Lu  
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#### China - Hong Kong SAR

Microchip Technology Hongkong Ltd.  
Unit 901-6, Tower 2, Metroplaza  
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India Liaison Office  
Divyasree Chambers  
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Microchip Technology Korea  
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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  
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Milan, Italy  
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Microchip Ltd.  
505 Eskdale Road  
Winnersh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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