

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

### Features

- Extremely Low Supply Current (50 $\mu$ A, Typ.)
- Very Low Dropout Voltage
- 300mA Output Current
- Adjustable Output Voltages
- Power Saving Shutdown Mode
- Bypass Input for Ultra Quiet Operation
- Over Current and Over Temperature Protection
- Space-Saving MSOP Package Option

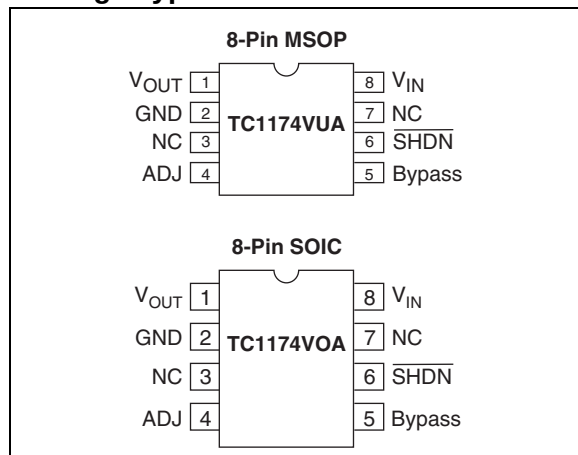
### Applications

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

### Device Selection Table

| Part Number | Output Voltage (V) | Package    | Junction Temp. Range |
|-------------|--------------------|------------|----------------------|
| TC1174VOA   | Adjustable         | 8-Pin SOIC | -40°C to +125°C      |
| TC1174VUA   | Adjustable         | 8-Pin MSOP | -40°C to +125°C      |

### Package Type



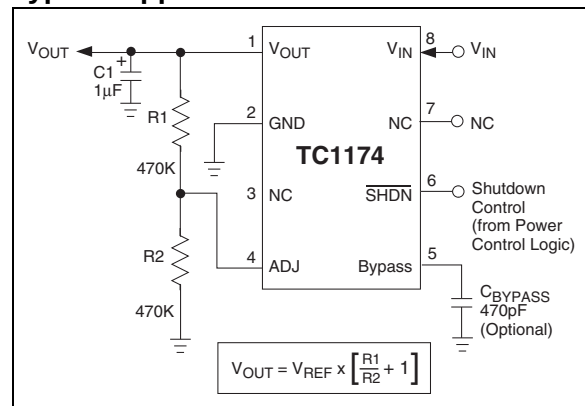
### General Description

The TC1174 is an adjustable output CMOS low dropout regulator. Total supply current is typically 50 $\mu$ A at full load (20 to 60 times lower than in bipolar regulators).

TC1174 key features include ultra low noise operation (plus optional Bypass input); very low dropout voltage (typically 270mV at full load) and internal feed-forward compensation for 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 TC1174 incorporates both over temperature and over current protection. The TC1174 is stable with an output capacitor of only 1 $\mu$ F and has a maximum output current of 300mA.

### Typical Application



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

|                                  |                                                      |
|----------------------------------|------------------------------------------------------|
| Input Voltage .....              | 6.5V                                                 |
| Output Voltage.....              | (V <sub>SS</sub> – 0.3V) to (V <sub>IN</sub> + 0.3V) |
| Power Dissipation.....           | Internally Limited ( <b>Note 5</b> )                 |
| Maximum Voltage on Any Pin ..... | V <sub>IN</sub> +0.3V to -0.3V                       |
| Operating Temperature Range..... | -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.

### TC1174 ELECTRICAL SPECIFICATIONS

**Electrical Characteristics:** V<sub>IN</sub> = V<sub>OUT</sub> + 1V, I<sub>L</sub> = 0.1μA, C<sub>L</sub> = 3.3μF, SHDN > V<sub>IH</sub>, T<sub>A</sub> = 25°C, unless otherwise noted. **Boldface** 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>2.7</b>   | —               | <b>6.0</b>                            | V                | <b>Note 6</b>                                                                                |
| I <sub>OUTMAX</sub>                 | Maximum Output Current                   | <b>300</b>   | —               | —                                     | mA               |                                                                                              |
| V <sub>REF</sub>                    | Reference Voltage                        | <b>1.165</b> | 1.20            | <b>1.235</b>                          | V                |                                                                                              |
| ΔV <sub>OUT</sub> /ΔT               | V <sub>OUT</sub> Temperature Coefficient | —            | <b>40</b>       | —                                     | ppm/°C           | <b>Note 1</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> /I <sub>OUT</sub> | Load Regulation                          | —            | 1.1             | <b>2.0</b>                            | %                | I <sub>L</sub> = 0.1mA to I <sub>OUTMAX</sub> ( <b>Note 2</b> )                              |
| V <sub>IN</sub> -V <sub>OUT</sub>   | Dropout Voltage                          | —            | 20<br>80<br>270 | <b>30</b><br><b>160</b><br><b>480</b> | mV               | I <sub>L</sub> = 0.1mA<br>I <sub>L</sub> = 100mA<br>I <sub>L</sub> = 300mA ( <b>Note 3</b> ) |
| I <sub>SS1</sub>                    | Supply Current                           | —            | 50              | <b>90</b>                             | μA               | SHDN = V <sub>IH</sub>                                                                       |
| I <sub>SS2</sub>                    | Shutdown Supply Current                  | —            | 0.05            | 0.5                                   | μA               | SHDN = 0V                                                                                    |
| PSRR                                | Power Supply Rejection Ratio             | —            | 60              | —                                     | dB               | F <sub>RE</sub> = 1kHz                                                                       |
| 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 4</b>                                                                                |
| eN                                  | Output Noise                             | —            | 260             | —                                     | nV/√Hz           | F = 10kHz, I <sub>L</sub> = I <sub>OUTMAX</sub><br>470pF from Bypass to GND                  |
| <b>SHDN Input</b>                   |                                          |              |                 |                                       |                  |                                                                                              |
| V <sub>IH</sub>                     | SHDN Input High Threshold                | <b>45</b>    | —               | —                                     | %V <sub>IN</sub> |                                                                                              |
| V <sub>IL</sub>                     | SHDN Input Low Threshold                 | —            | —               | <b>15</b>                             | %V <sub>IN</sub> |                                                                                              |
| <b>ADJ Input</b>                    |                                          |              |                 |                                       |                  |                                                                                              |
| I <sub>ADJ</sub>                    | Adjustable Input Leakage Current         | —            | 50              | —                                     | pA               |                                                                                              |

$$1: TC V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$$

- 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.
- The minimum V<sub>IN</sub> has to justify the conditions: V<sub>IN</sub> ≥ V<sub>R</sub> + V<sub>DROPOUT</sub> and V<sub>IN</sub> ≥ 2.7V for I<sub>L</sub> = 0.1mA to I<sub>OUTMAX</sub>.

## 2.0 PIN DESCRIPTIONS

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

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

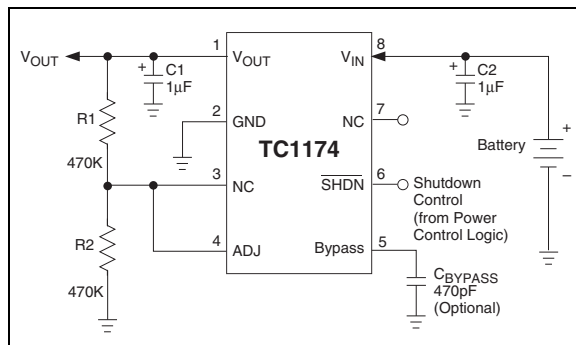
| Pin No.<br>(8-Pin SOIC)<br>(8-Pin MSOP) | Symbol           | Description                                                                                                                                                                                                                                                                  |
|-----------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                       | V <sub>OUT</sub> | Regulated voltage output.                                                                                                                                                                                                                                                    |
| 2                                       | GND              | Ground terminal.                                                                                                                                                                                                                                                             |
| 3                                       | NC               | No connect.                                                                                                                                                                                                                                                                  |
| 4                                       | ADJ              | Output voltage adjust terminal. Output voltage setting is programmed with a resistor divider from V <sub>OUT</sub> to this input. A capacitor may also be added to this input to reduce output noise.                                                                        |
| 5                                       | Bypass           | Reference bypass input. Connecting a 470pF to this input further reduces output noise.                                                                                                                                                                                       |
| 6                                       | SHDN             | Shutdown control 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 0.05μA (typical). |
| 7                                       | NC               | No connect.                                                                                                                                                                                                                                                                  |
| 8                                       | V <sub>IN</sub>  | Unregulated supply input.                                                                                                                                                                                                                                                    |

## 3.0 DETAILED DESCRIPTION

The TC1174 is an adjustable low drop-out regulator. Unlike bipolar regulators, the TC1174's 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 back-up 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 0.05µA (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 1µF (min) capacitor from  $V_{OUT}$  to ground is required. The output capacitor should have an effective series resistance greater than 0.1Ω and less than 5.0Ω. A 1µF 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°C, solid tantalums are recommended for applications operating below -25°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.

## 3.3 Adjust Input

The output voltage setting is determined by the values of R1 and R2 (Figure 3-1). The ohmic values of these resistors should be between 470K and 3M to minimize bleeder current.

The output voltage setting is calculated using the following equation.

**EQUATION 3-1:**

$$V_{OUT} = V_{REF} \times \left[ \frac{R1}{R2} + 1 \right]$$

The voltage adjustment range of the TC1174 is from  $V_{REF}$  to  $(V_{IN} - 0.05V)$ .

## 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 ( $\theta_{JA}$ ). The 8-Pin SOIC package has a  $\theta_{JA}$  of approximately 160°C/Watt, while the 8-Pin MSOP package has a  $\theta_{JA}$  of approximately 200°C/Watt.

#### 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:

$$\begin{aligned} V_{INMAX} &= 3.0V + 10\% \\ V_{OUTMIN} &= 2.7V - 0.5\% \\ I_{LOADMAX} &= 250mA \\ T_{JMAX} &= 125^\circ C \\ T_{AMAX} &= 55^\circ C \\ &\text{8-Pin MSOP Package} \end{aligned}$$

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

Actual power dissipation:

$$\begin{aligned} P_D &\approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX} \\ &= [(3.0 \times 1.1) - (2.7 \times .995)]250 \times 10^{-3} \\ &= 155mW \end{aligned}$$

Maximum allowable power dissipation:

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

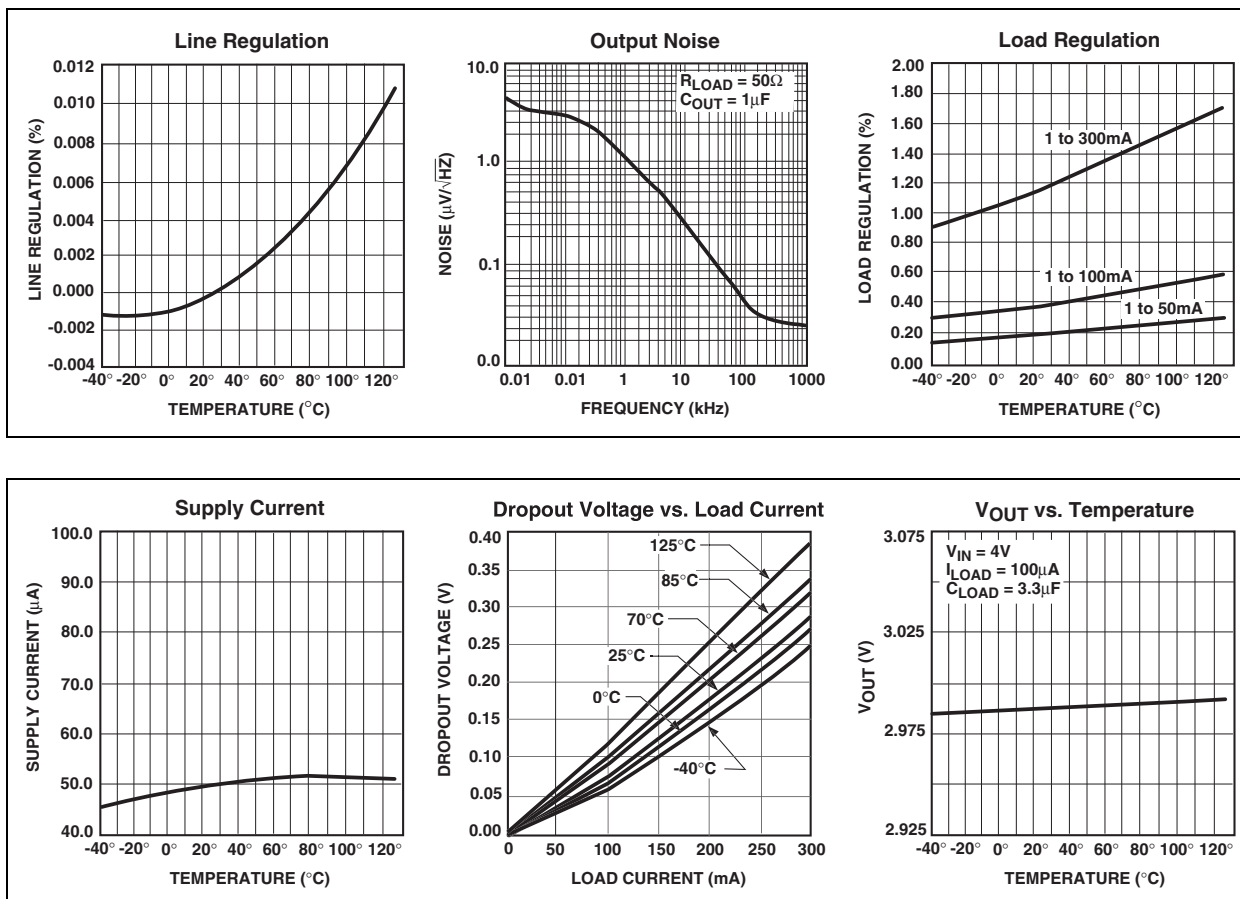
In this example, the TC1174 dissipates a maximum of 155mW; below the allowable limit of 350mW. In a similar manner, Equation 4-1 and Equation 4-2 can be used to calculate maximum current and/or input voltage limits. For example, the maximum allowable  $V_{IN}$  is found by substituting the maximum allowable power dissipation of 350mW into Equation 4-1, from which  $V_{INMAX} = 4.1V$ .

### 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.

## 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.



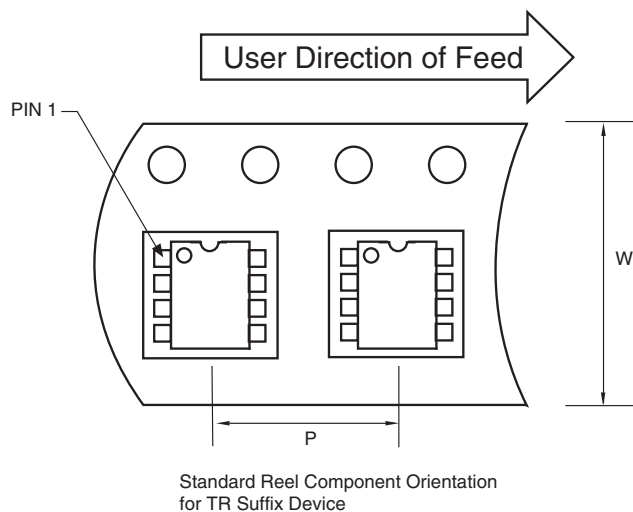
## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

Package marking data not available at this time.

### 6.2 Taping Form

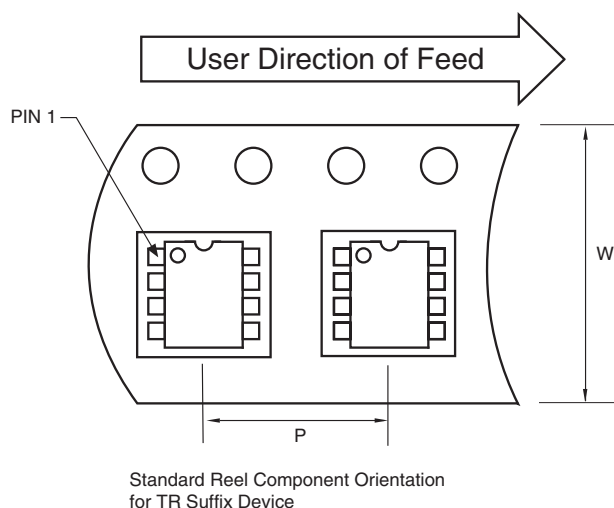
#### Component Taping Orientation for 8-Pin MSOP Devices



Carrier Tape, Number of Components Per Reel and Reel Size

| Package    | Carrier Width (W) | Pitch (P) | Part Per Full Reel | Reel Size |
|------------|-------------------|-----------|--------------------|-----------|
| 8-Pin MSOP | 12 mm             | 8 mm      | 2500               | 13 in     |

#### Component Taping Orientation for 8-Pin SOIC (Narrow) Devices



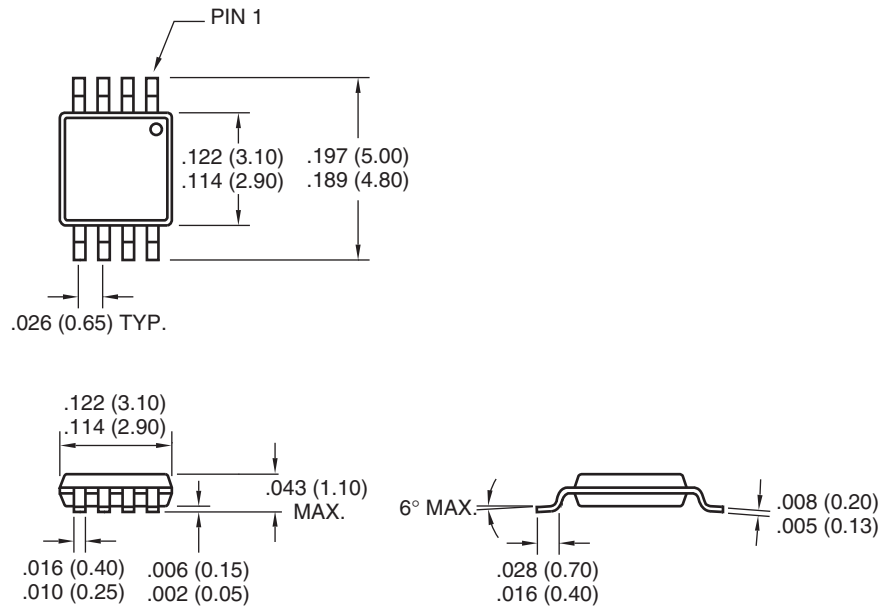
Carrier Tape, Number of Components Per Reel and Reel Size

| Package        | Carrier Width (W) | Pitch (P) | Part Per Full Reel | Reel Size |
|----------------|-------------------|-----------|--------------------|-----------|
| 8-Pin SOIC (N) | 12 mm             | 8 mm      | 2500               | 13 in     |

## 6.3 Package Dimensions

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

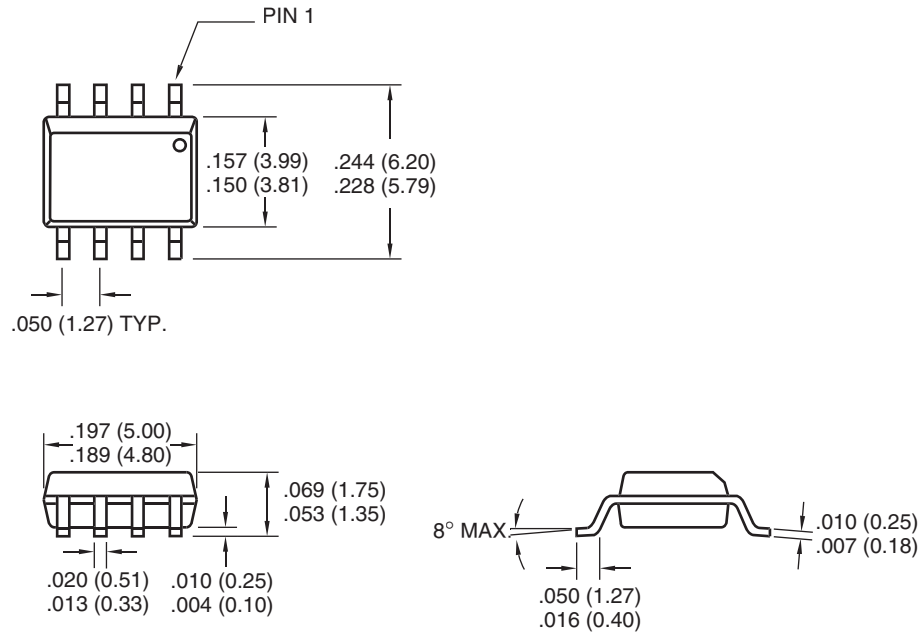
### 8-Pin MSOP



Dimensions: inches (mm)

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

## 8-Pin SOIC



Dimensions: inches (mm)

## REVISION HISTORY

### Revision C (November 2012)

Added a note to each package outline drawing.

## 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 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.

NOTES:

---

**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.

---

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.

#### **Trademarks**

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, KEELoQ, KEELoQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC<sup>32</sup> logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MTP, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

Analog-for-the-Digital Age, Application Maestro, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniclient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICTail, REAL ICE, rLAB, Select Mode, SQI, Serial Quad I/O, Total Endurance, TSHARC, UniWinDriver, WiperLock, ZENA and Z-Scale 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.

GestIC and ULPP are registered trademarks 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.

© 2002-2012, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.



Printed on recycled paper.

ISBN: 9781620767344

**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.*



## 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:  
<http://www.microchip.com/support>  
Web Address:  
[www.microchip.com](http://www.microchip.com)

**Atlanta**  
Duluth, GA  
Tel: 678-957-9614  
Fax: 678-957-1455

**Boston**  
Westborough, MA  
Tel: 774-760-0087  
Fax: 774-760-0088

**Chicago**  
Itasca, IL  
Tel: 630-285-0071  
Fax: 630-285-0075

**Cleveland**  
Independence, OH  
Tel: 216-447-0464  
Fax: 216-447-0643

**Dallas**  
Addison, TX  
Tel: 972-818-7423  
Fax: 972-818-2924

**Detroit**  
Farmington Hills, MI  
Tel: 248-538-2250  
Fax: 248-538-2260

**Indianapolis**  
Noblesville, IN  
Tel: 317-773-8323  
Fax: 317-773-5453

**Los Angeles**  
Mission Viejo, CA  
Tel: 949-462-9523  
Fax: 949-462-9608

**Santa Clara**  
Santa Clara, CA  
Tel: 408-961-6444  
Fax: 408-961-6445

**Toronto**  
Mississauga, Ontario,  
Canada  
Tel: 905-673-0699  
Fax: 905-673-6509

### ASIA/PACIFIC

**Asia Pacific Office**  
Suites 3707-14, 37th Floor  
Tower 6, The Gateway  
Harbour City, Kowloon  
Hong Kong  
Tel: 852-2401-1200  
Fax: 852-2401-3431

**Australia - Sydney**  
Tel: 61-2-9868-6733  
Fax: 61-2-9868-6755

**China - Beijing**  
Tel: 86-10-8569-7000  
Fax: 86-10-8528-2104

**China - Chengdu**  
Tel: 86-28-8665-5511  
Fax: 86-28-8665-7889

**China - Chongqing**  
Tel: 86-23-8980-9588  
Fax: 86-23-8980-9500

**China - Hangzhou**  
Tel: 86-571-2819-3187  
Fax: 86-571-2819-3189

**China - Hong Kong SAR**  
Tel: 852-2401-1200  
Fax: 852-2401-3431

**China - Nanjing**  
Tel: 86-25-8473-2460  
Fax: 86-25-8473-2470

**China - Qingdao**  
Tel: 86-532-8502-7355  
Fax: 86-532-8502-7205

**China - Shanghai**  
Tel: 86-21-5407-5533  
Fax: 86-21-5407-5066

**China - Shenyang**  
Tel: 86-24-2334-2829  
Fax: 86-24-2334-2393

**China - Shenzhen**  
Tel: 86-755-8203-2660  
Fax: 86-755-8203-1760

**China - Wuhan**  
Tel: 86-27-5980-5300  
Fax: 86-27-5980-5118

**China - Xian**  
Tel: 86-29-8833-7252  
Fax: 86-29-8833-7256

**China - Xiamen**  
Tel: 86-592-2388138  
Fax: 86-592-2388130

**China - Zhuhai**  
Tel: 86-756-3210040  
Fax: 86-756-3210049

### ASIA/PACIFIC

**India - Bangalore**  
Tel: 91-80-3090-4444  
Fax: 91-80-3090-4123

**India - New Delhi**  
Tel: 91-11-4160-8631  
Fax: 91-11-4160-8632

**India - Pune**  
Tel: 91-20-2566-1512  
Fax: 91-20-2566-1513

**Japan - Osaka**  
Tel: 81-66-152-7160  
Fax: 81-66-152-9310

**Japan - Yokohama**  
Tel: 81-45-471- 6166  
Fax: 81-45-471-6122

**Korea - Daegu**  
Tel: 82-53-744-4301  
Fax: 82-53-744-4302

**Korea - Seoul**  
Tel: 82-2-554-7200  
Fax: 82-2-558-5932 or  
82-2-558-5934

**Malaysia - Kuala Lumpur**  
Tel: 60-3-6201-9857  
Fax: 60-3-6201-9859

**Malaysia - Penang**  
Tel: 60-4-227-8870  
Fax: 60-4-227-4068

**Philippines - Manila**  
Tel: 63-2-634-9065  
Fax: 63-2-634-9069

**Singapore**  
Tel: 65-6334-8870  
Fax: 65-6334-8850

**Taiwan - Hsin Chu**  
Tel: 886-3-5778-366  
Fax: 886-3-5770-955

**Taiwan - Kaohsiung**  
Tel: 886-7-213-7828  
Fax: 886-7-330-9305

**Taiwan - Taipei**  
Tel: 886-2-2508-8600  
Fax: 886-2-2508-0102

**Thailand - Bangkok**  
Tel: 66-2-694-1351  
Fax: 66-2-694-1350

### EUROPE

**Austria - Wels**  
Tel: 43-7242-2244-39  
Fax: 43-7242-2244-393

**Denmark - Copenhagen**  
Tel: 45-4450-2828  
Fax: 45-4485-2829

**France - Paris**  
Tel: 33-1-69-53-63-20  
Fax: 33-1-69-30-90-79

**Germany - Munich**  
Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

**Italy - Milan**  
Tel: 39-0331-742611  
Fax: 39-0331-466781

**Netherlands - Drunen**  
Tel: 31-416-690399  
Fax: 31-416-690340

**Spain - Madrid**  
Tel: 34-91-708-08-90  
Fax: 34-91-708-08-91

**UK - Wokingham**  
Tel: 44-118-921-5869  
Fax: 44-118-921-5820

10/26/12