

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

Features

- Extremely Low Supply Current (50 μ A, Typ.)
- Very Low Dropout Voltage
- 300mA Output Current
- 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 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	Package	Junction Temp. Range
TC1107-xxVOA	8-Pin SOIC	-40 $^{\circ}$ C to +125 $^{\circ}$ C
TC1107-xxVUA	8-Pin MSOP	-40 $^{\circ}$ C to +125 $^{\circ}$ C

NOTE: xx indicates output voltages

Available Output Voltages: 2.5, 2.8, 3.0, 3.3, 5.0.

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

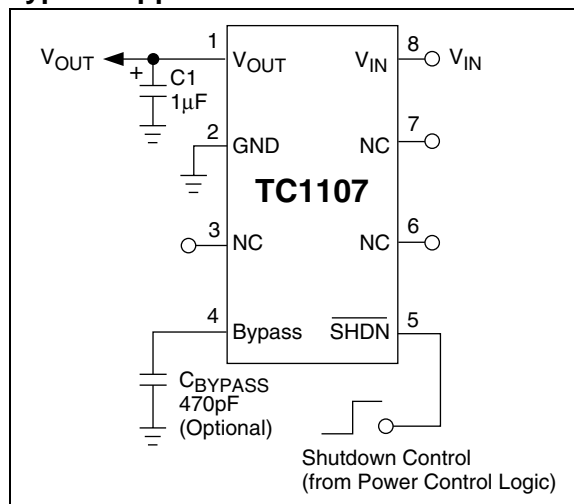
General Description

The TC1107 is a fixed output, high accuracy (typically $\pm 0.5\%$) CMOS upgrade for older (bipolar) low dropout regulators. Total supply current is typically 50 μ A at full load (20 to 60 times lower than in bipolar regulators).

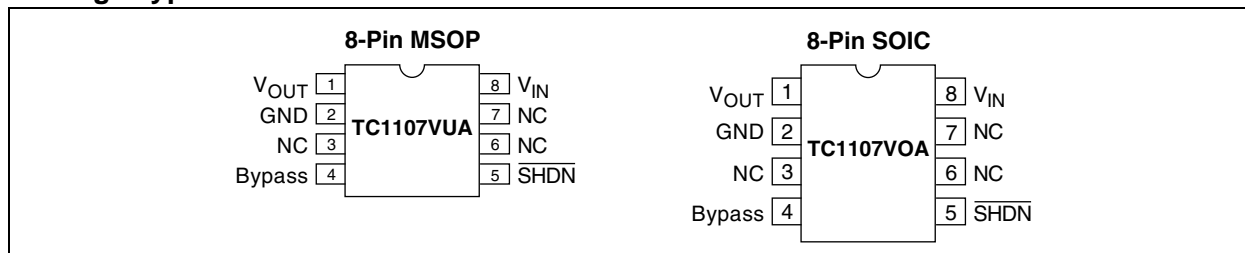
TC1107 key features include ultra low noise operation (plus optional Bypass input); very low dropout voltage (typically 240mV at full load), and fast response to step changes in load. Supply current is reduced to 0.05 μ A (typical) and V_{OUT} falls to zero when the shutdown input is low.

The TC1107 incorporates both over temperature and over current protection. The TC1107 is stable with an output capacitor of only 1 μ F and has a maximum output current of 300mA.

Typical Application



Package Type



TC1107

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Input Voltage	6.5V
Output Voltage.....	(V _{SS} - 0.3V) to (V _{IN} + 0.3V)
Power Dissipation.....	Internally Limited (Note 6)
Maximum Voltage on Any Pin	V _{IN} + 0.3V to -0.3V
Operating Temperature Range.....	-40°C < T _J < 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.

TC1107 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: V_{IN} = V_{OUT} + 1V, I_L = 0.1mA, C_L = 3.3μF, $\overline{\text{SHDN}} > V_{IH}$, T_A = 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 _{IN}	Input Operating Voltage	2.7	—	6.0	V	Note 7
I _{OUTMAX}	Maximum Output Current	300	—	—	mA	
V _{OUT}	Output Voltage	— V_R - 2.5%	V _R ± 0.5% —	— V_R + 2.5%	V	Note 1
ΔV _{OUT} /ΔT	V _{OUT} Temperature Coefficient	—	40	—	ppm/°C	Note 2
ΔV _{OUT} /ΔV _{IN}	Line Regulation	—	0.05	0.35	%	(V _R + 1V) ≤ V _{IN} ≤ 6V
ΔV _{OUT} /V _{OUT}	Load Regulation	—	1.1	2.0	%	I _L = 0.1mA to I _{OUTMAX}
V _{IN} -V _{OUT}	Dropout Voltage	—	20 80 270	30 160 480	mV	I _L = 0.1mA I _L = 100mA I _L = 300mA (Note 4)
I _{SS1}	Supply Current	—	50	90	μA	$\overline{\text{SHDN}} = V_{IH}$
I _{SS2}	Shutdown Supply Current	—	0.05	0.5	μA	$\overline{\text{SHDN}} = 0V$
PSRR	Power Supply Rejection Ratio	—	60	—	dB	F _{RE} ≤ 1kHz
I _{OUTsc}	Output Short Circuit Current	—	550	650	mA	V _{OUT} = 0V
ΔV _{OUT} /ΔP _D	Thermal Regulation	—	0.04	—	V/W	Note 5
eN	Output Noise	—	260	—	nV/√Hz	F = 1kHz, C _{OUT} = 1μF, R _{LOAD} = 50Ω
SHDN Input						
V _{IH}	$\overline{\text{SHDN}}$ Input High Threshold	45	—	—	%V _{IN}	
V _{IL}	$\overline{\text{SHDN}}$ Input Low Threshold	—	—	15	%V _{IN}	

- Note**
- 1: V_R is the regulator output voltage setting.
 - 2: TC V_{OUT} = $\frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
 - 3: 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.
 - 4: 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.
 - 5: 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_{LMAX} at V_{IN} = 6V for T = 10 msec.
 - 6: 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_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see Section 4.0 Thermal Considerations for more details.
 - 7: The minimum V_{IN} has to justify the conditions: V_{IN} ≥ V_R + V_{DROPOUT} and V_{IN} ≥ 2.7V for I_L = 0.1mA to I_{OUTMAX}.

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) (8-Pin MSOP)	Symbol	Description
1	V_{OUT}	Regulated voltage output.
2	GND	Ground terminal.
3	NC	No connect.
4	Bypass	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
5	$\overline{\text{SHDN}}$	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 0.05 μ A (typical).
6	NC	No connect.
7	NC	No connect.
8	V_{IN}	Unregulated supply input.

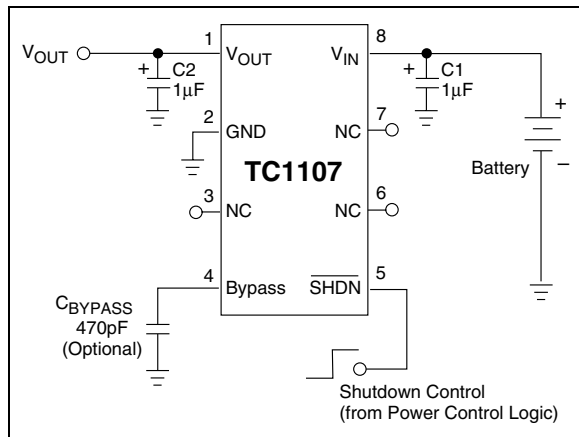
TC1107

3.0 DETAILED DESCRIPTION

The TC1107 is a precision regulator available in fixed voltages. Unlike bipolar regulators, the TC1107'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 0.05 μ A (typical), V_{OUT} falls to zero.

FIGURE 3-1: TYPICAL APPLICATION CIRCUIT



3.1 Output Capacitor

A 1 μ F (min) capacitor from V_{OUT} to ground is required. The output capacitor should have an effective series resistance greater than 0.1 Ω and less than 5.0 Ω . A 1 μ 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.

3.2 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.

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 (θ_{JA}). The 8-Pin SOIC package has a θ_{JA} of approximately 160°C/Watt, while the 8-Pin MSOP package has a θ_{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:

$$\begin{aligned} V_{INMAX} &= 3.0V + 10\% \\ V_{OUTMIN} &= 2.7V - 2.5\% \\ I_{LOADMAX} &= 250mA \\ T_{JMAX} &= 125^\circ C \\ T_{AMAX} &= 55^\circ C \\ &8\text{-Pin MSOP Package} \end{aligned}$$

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

Actual power dissipation:

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

Maximum allowable power dissipation:

$$\begin{aligned} P_{DMAX} &= \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}} \\ &= \frac{(125 - 55)}{220} \\ &= 318mW \end{aligned}$$

In this example, the TC1107 dissipates a maximum of 167mW; below the allowable limit of 318mW. In a similar manner, Equation 4-1 and Equation 4-2 can be used to calculate maximum current and/or input voltage limits.

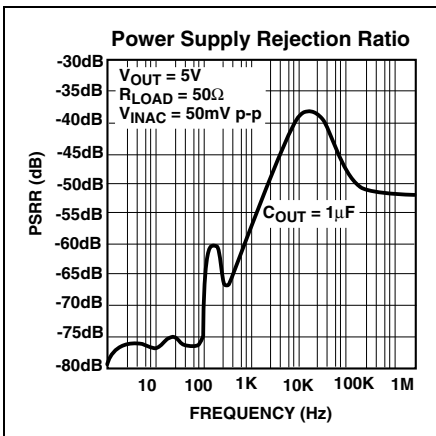
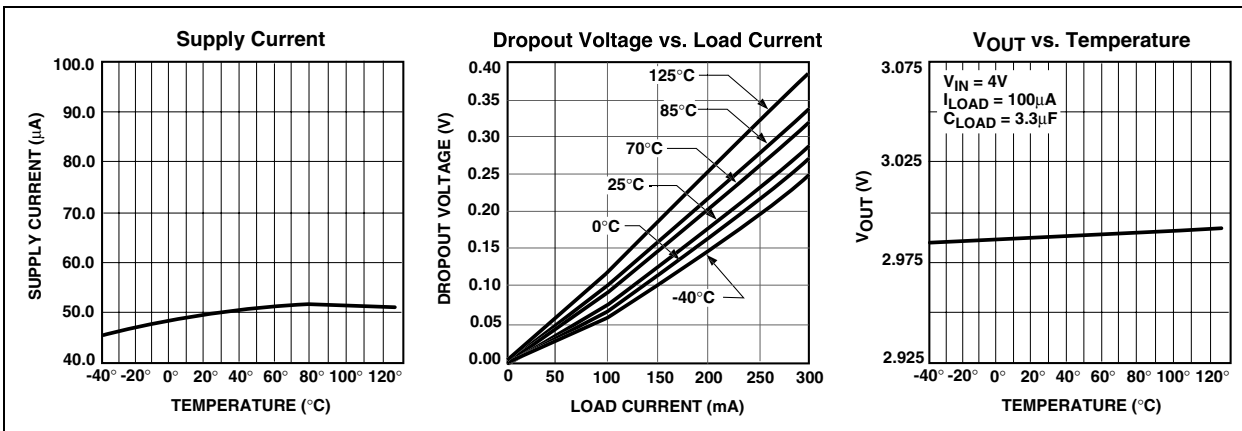
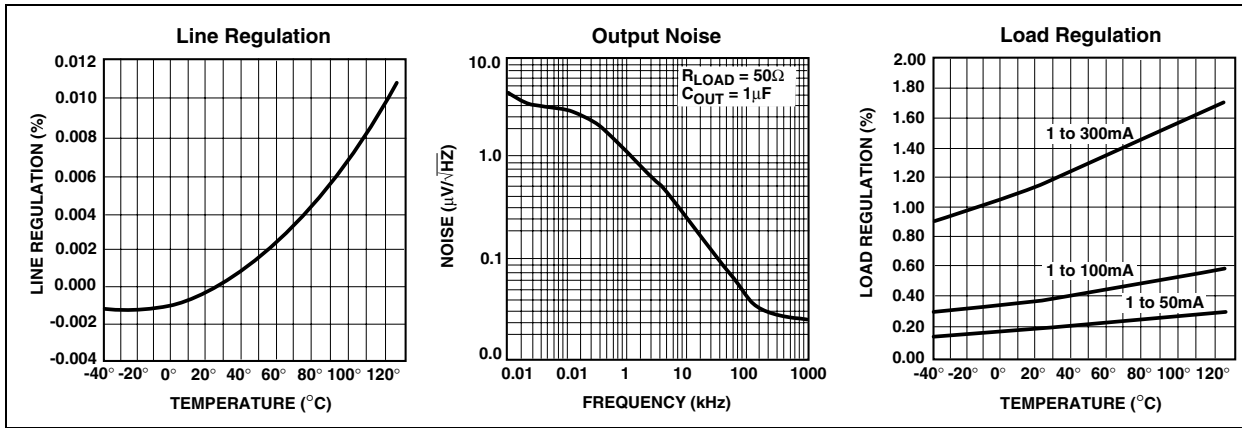
4.3 Layout Considerations

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 θ_{JA} and therefore increase the maximum allowable power dissipation limit.

TC1107

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.

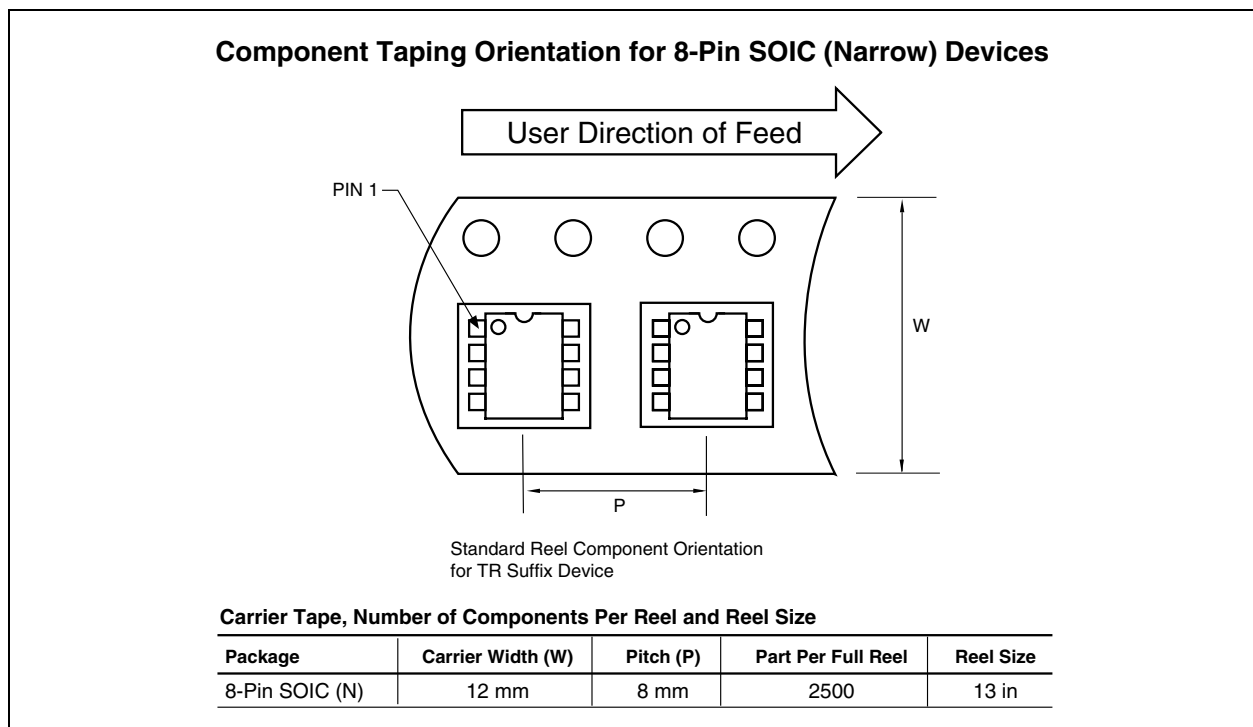
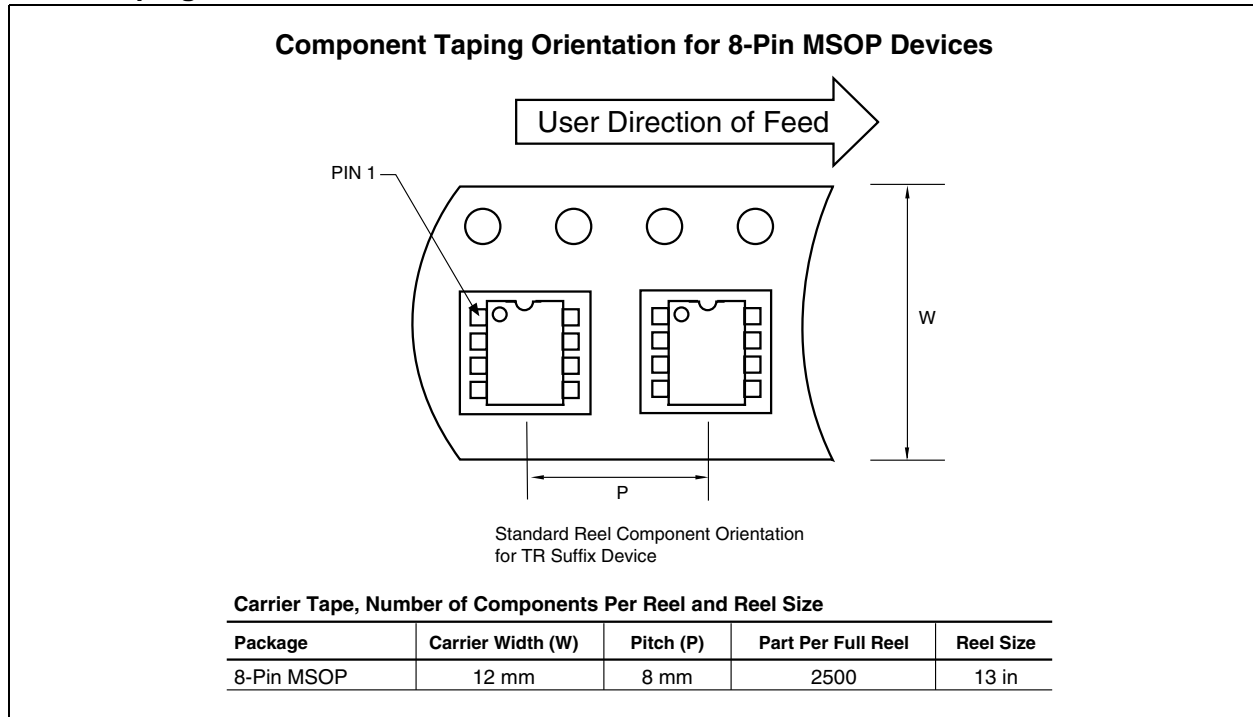


6.0 PACKAGING INFORMATION

6.1 Package Marking Information

Package marking data not available at this time.

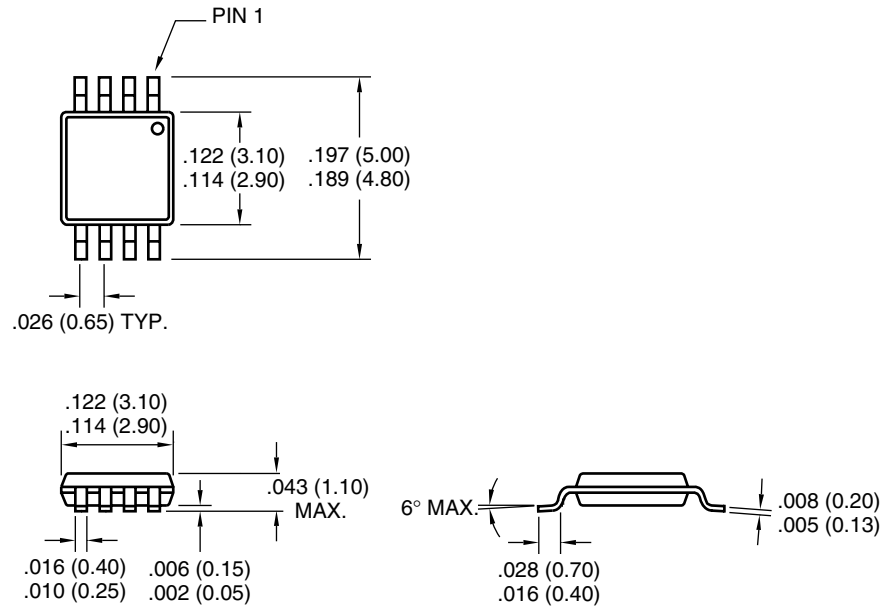
6.2 Taping Form



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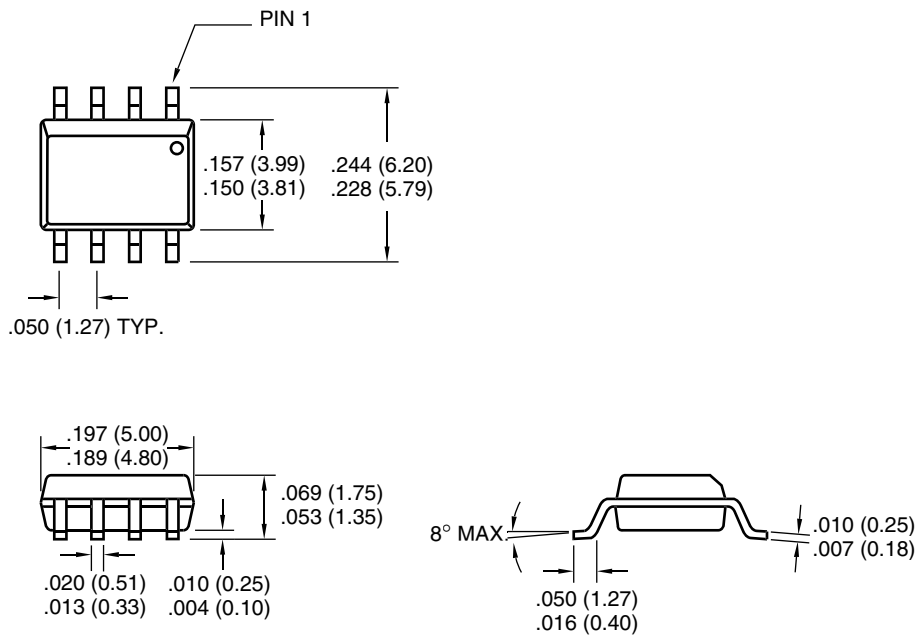
6.3 Package Dimensions

8-Pin MSOP



Dimensions: inches (mm)

8-Pin SOIC



Dimensions: inches (mm)

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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:

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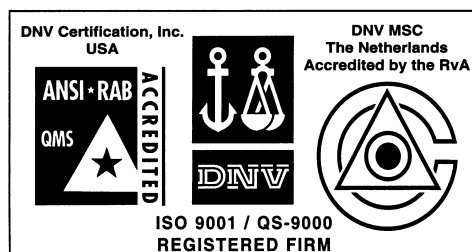
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Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

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'Shaugnessey 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
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France

Microchip Technology SARL
Parc d'Activite du Moulin de Massy
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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

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