TC1029

Linear Building Block – Dual Low Power Op Amp

Features

- Optimized for Single Supply Operation
- Small Packages: 8-Pin MSOP, 8-Pin PDIP and 8-Pin SOIC
- Ultra Low Input Bias Current: Less than 100pA
- Low Quiescent Current: 12µA (Typ.)
- Rail-to-Rail Inputs and Outputs
- Operates Down to 1.8V

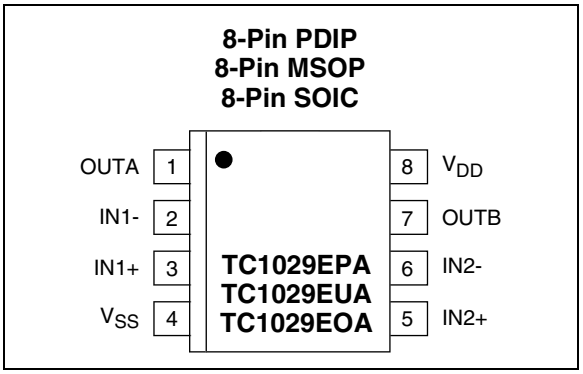
Applications

- Power Management Circuits
- Battery Operated Equipment
- Consumer Products

Device Selection Table

Part Number	Package	Temperature Range
TC1029EPA	8-Pin PDIP	-40°C to +85°C
TC1029EUA	8-Pin MSOP	-40°C to +85°C
TC1029EOA	8-Pin SOIC	-40°C to +85°C

Package Types



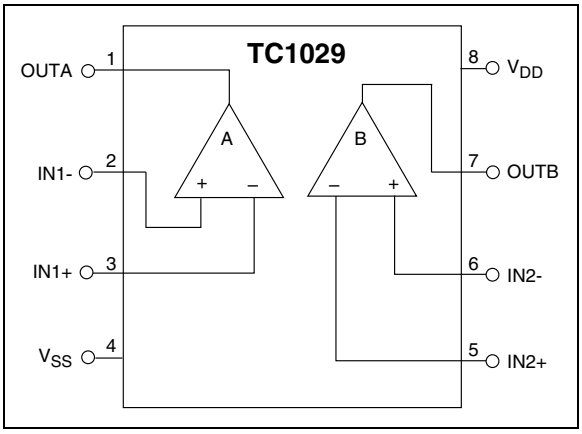
General Description

The TC1029 is a dual, CMOS operational amplifier designed for low-power applications. It is designed specifically for operation from a single supply, however, operation from dual supplies is also possible, and the power supply current drain is independent of the magnitude of the power supply voltage. The TC1029 operates from two 1.5V alkaline cells down to V_{DD} = 1.8V. Supply current is only typically 12µA, which significantly extends battery life.

Rail-to-rail inputs and outputs allow operation from low supply voltages while accommodating large input signals, yielding larger output signals.

Packaged in an 8-Pin MSOP, SOIC or DIP, the TC1029 is ideal for battery operated applications.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6.0V
Voltage on Any Pin ..... (V_{SS} – 0.5V) to (V_{DD} + 0.5V)
Junction Temperature.....+150°C
Operating Temperature Range.....-40°C to +85°C
Storage Temperature Range .....-55°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.

TC1029 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Typical values apply at 25°C and V_{DD} = 3.0V; T_A = -40° to +85°C, and V_{DD} = 1.8V to 5.5V, unless otherwise specified.

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{DD}	Supply Voltage	1.8	—	5.5	V	
I_Q	Supply Current, Operating	—	12	16	µA	All Outputs Open
A_{VOL}	Large Signal Voltage Gain	—	100	—	V/mV	R_L = 10kΩ, V_{DD} = 5V
V_{ICMR}	Common Mode Input Voltage Range	V_{SS} - 0.2	—	V_{DD} + 0.2	V	
V_{OS}	Input Offset Voltage		±100 ±0.3	±500 ±1.5	µV mV	V_{DD} = 3V, V_{CM} = 1.5V, T_A = 25°C, T_A = -40°C to 85°C
I_B	Input Bias Current	-100	50	100	pA	T_A = 25°C; V_{CM} = V_{DD} to V_{SS}
$V_{OS(DRIFT)}$	Input Offset Voltage Drift	—	±4	—	µV/°C	V_{DD} = 3V; V_{CM} = 1.5V
GBWP	Gain Bandwidth Product	—	90	—	kHz	V_{DD} = 1.8V to 5.5V; V_O = V_{DD} to V_{SS}
SR	Slew Rate	—	35	—	mV/µsec	C_L = 100pF; R_L = 1M to GND, Gain = 1 V_{IN} = V_{SS} to V_{DD}
V_{OUT}	Output Signal Swing	V_{SS} + 0.05	—	V_{DD} – 0.05	V	R_L = 10kΩ
CMRR	Common Mode Rejection Ratio	70	—	—	dB	T_A = 25°C; V_{DD} = 5V; V_{CM} = V_{DD} to V_{SS}
PSRR	Power Supply Rejection Ratio	80	—	—	dB	T_A = 25°C; V_{CM} = V_{SS}; V_{DD} = 1.8V to 5V
I_{SRC}	Output Source Current	3	—	—	mA	V_{IN} = V_{DD} Output Shorted to V_{SS} V_{DD} = 1.8V; Gain = 1
I_{SINK}	Output Sink Current	4	—	—	mA	V_{IN} = V_{SS}, Output Shorted to V_{DD} V_{DD} = 1.8V; Gain = 1
En	Input Noise Voltage	—	10	—	µVpp	0.1Hz to 10Hz
e_n	Input Noise Voltage Density	—	125	—	nV/$\sqrt{HZ}$	1kHz

2.0 PIN DESCRIPTION

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

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (8-Pin PDIP) (8-Pin MSOP) (8-Pin SOIC)	Symbol	Description
1	OUTA	Op amp output.
2	IN1-	Inverting op amp input.
3	IN1+	Non-inverting op amp input.
4	V_{SS}	Negative power supply.
5	IN2+	Non-inverting op amp input.
6	IN2-	Inverting op amp input.
7	OUTB	Op amp output.
8	V_{DD}	Positive power supply.

3.0 DETAILED DESCRIPTION

The TC1029 is one of a series of very low power, linear building block products for low voltage single supply operations. The TC1029 contains two rail to rail op amps which operate down to 1.8V with a maximum supply current of 16μA. The amplifier's input range extends beyond both supplies by 200mV and the outputs will swing to within several millivolts of the supplies, depending on the load current being driven.

The amplifier design is such that large signal gain, slew rate and bandwidth are largely independent of supply voltage. The low input bias current and offset voltage of the TC1029 make it suitable for precision applications.

4.0 TYPICAL APPLICATIONS

The TC1029 lends itself to a wide variety of applications, particularly in battery powered systems. It typically finds application in power management, processor supervisory and interface circuitry.

4.1 Voice Band Receive Filter

The majority of spectral energy for human voices is found to be in a 2.7kHz frequency band from 300Hz to 3kHz. To properly recover a voice signal in applications such as radios, cellular phones and voice pagers, a low power bandpass filter matched to the human voice spectrum can be implemented, using Microchip's CMOS op amps. Figure 4-1 shows a unity gain multi-pole Butterworth filter with ripple less than 0.15dB in the human voice band. The lower 3 dB cut-off frequency is 70Hz (single order response), while the upper cut-off frequency is 3.5kHz (fourth order response).

4.2 Supervisory Audio Tone (SAT) Filter for Cellular

Supervisory Audio Tones (SAT) provide a reliable transmission path between cellular subscriber units and base stations. The SAT tone functions much like the current/voltage used in land line telephone systems to indicate that a phone is off the hook. The SAT tone may be one of three frequencies: 5970, 6000 or 6030Hz. A loss of SAT implies that channel conditions are impaired and if SAT is interrupted for more than 5 seconds a cellular call is terminated.

Figure 4-2 shows high Q (30) second order SAT detection bandpass filter using Microchip's CMOS op amp architecture. This circuit nulls all frequencies except the three SAT tones of interest.

FIGURE 4-1: MULTI-POLE BUTTERWORTH VOICE BAND RECEIVE FILTER

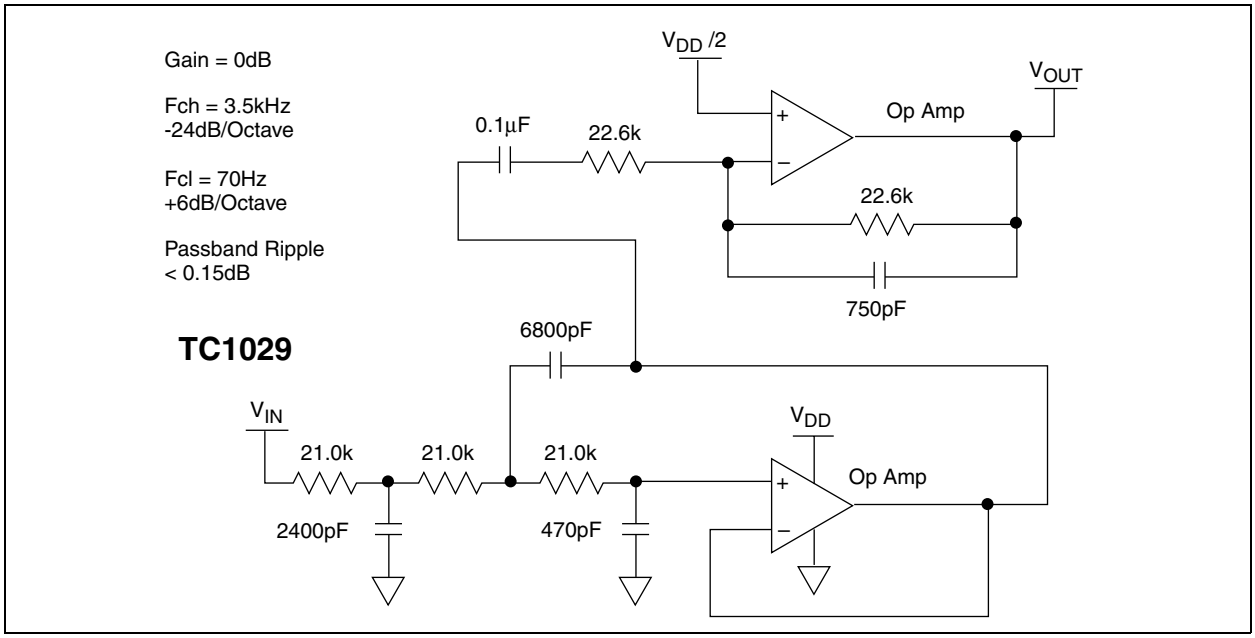
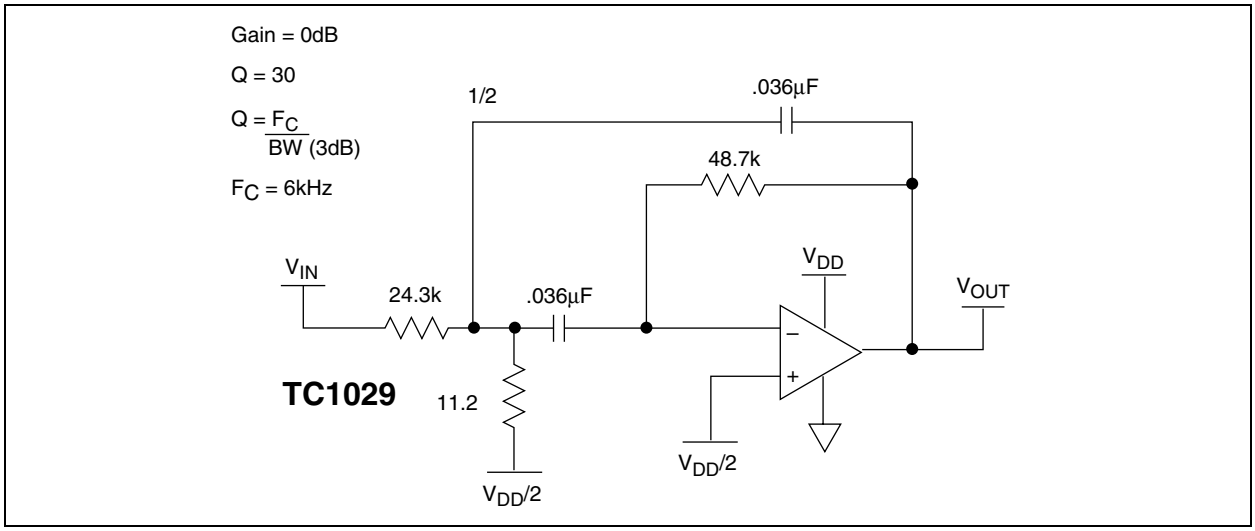


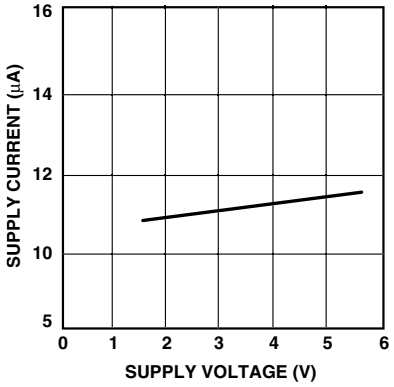
FIGURE 4-2: SECOND ORDER SAT BANDPASS FILTER



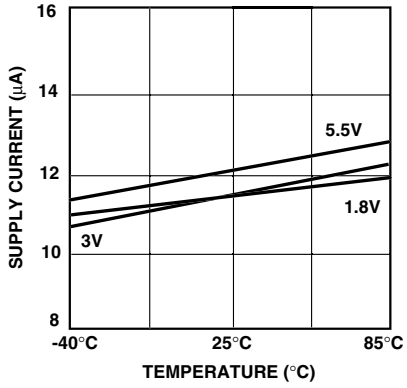
5.0 TYPICAL CHARACTERISTICS

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.

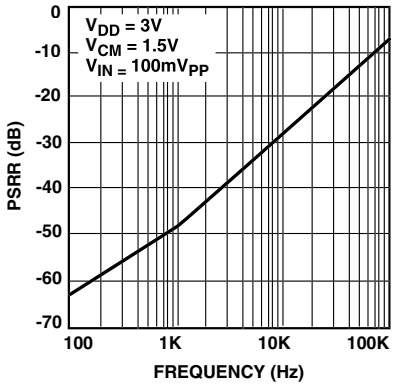
Op Amp Supply Voltage vs. Supply Current



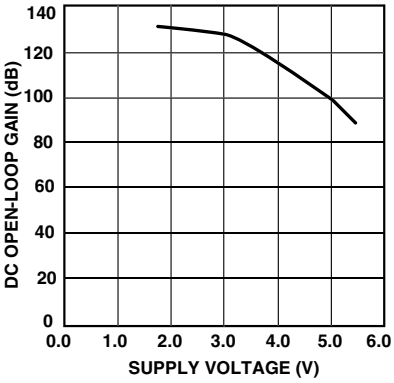
Op Amp Supply Current vs. Temperature



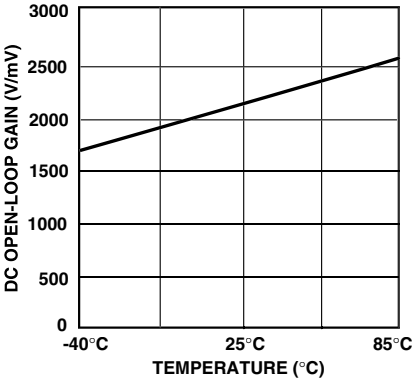
Op Amp Power Supply Rejection Ratio (PSRR) vs. Frequency



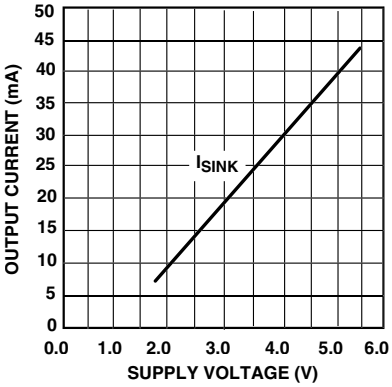
Op Amp DC Open-Loop Gain vs. Supply Voltage



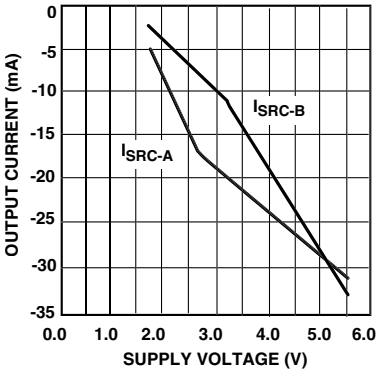
Op Amp DC Open-Loop Gain vs. Temperature



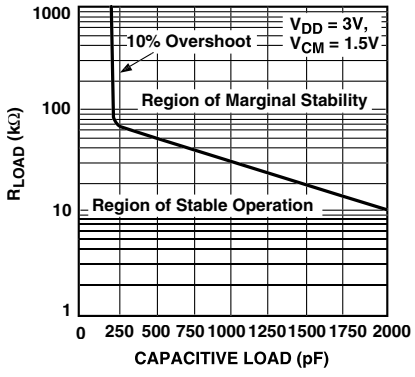
Op Amp Short-Circuit Current vs. Supply Voltage



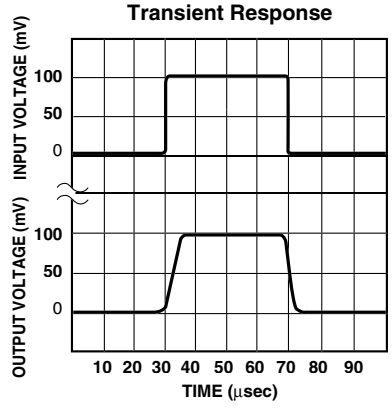
Op Amp Short-Circuit Current vs. Supply Voltage



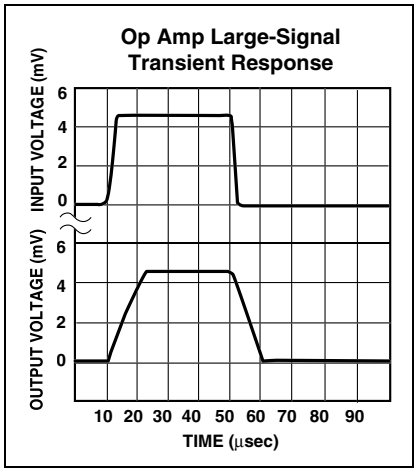
Op Amp Load Resistance vs. Load Capacitance



Op Amp Small-Signal Transient Response



5.0 TYPICAL CHARACTERISTICS (CONTINUED)



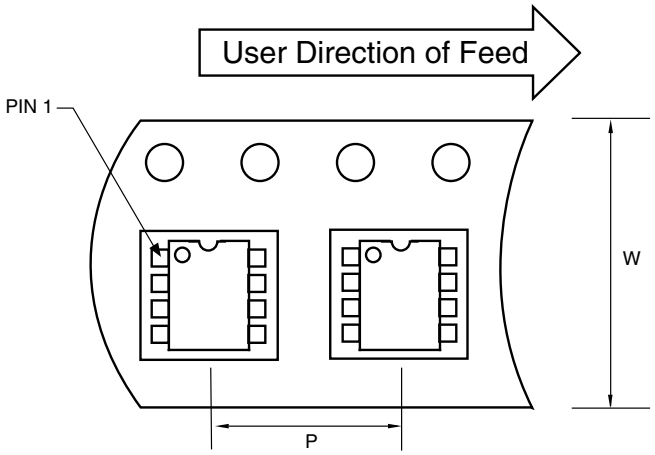
6.0 PACKAGING INFORMATION

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

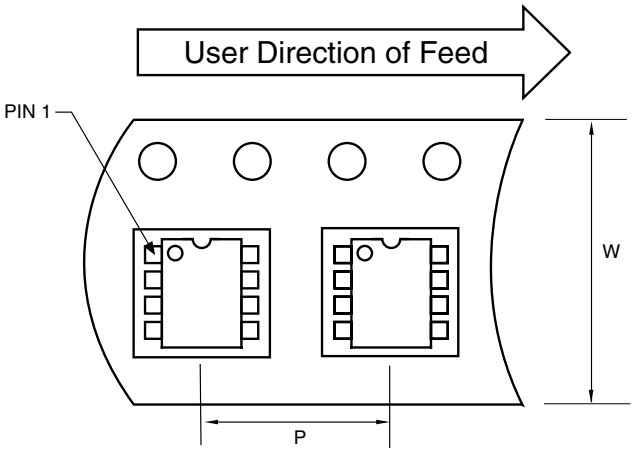


Standard Reel Component Orientation
for TR Suffix Device

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



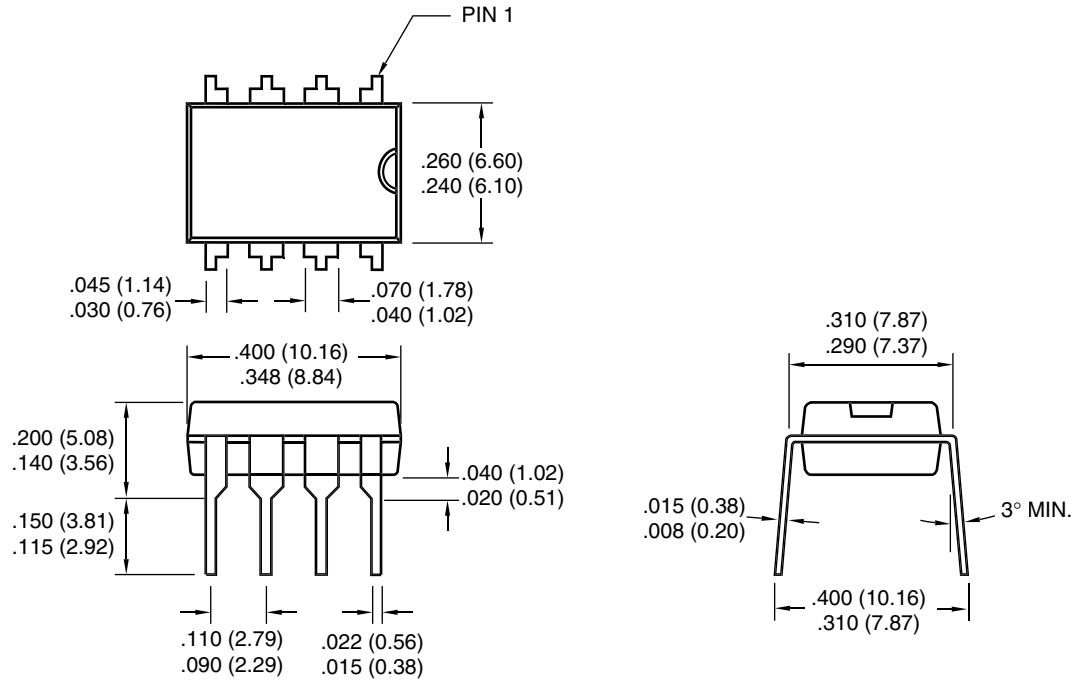
Standard Reel Component Orientation
for TR Suffix Device

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

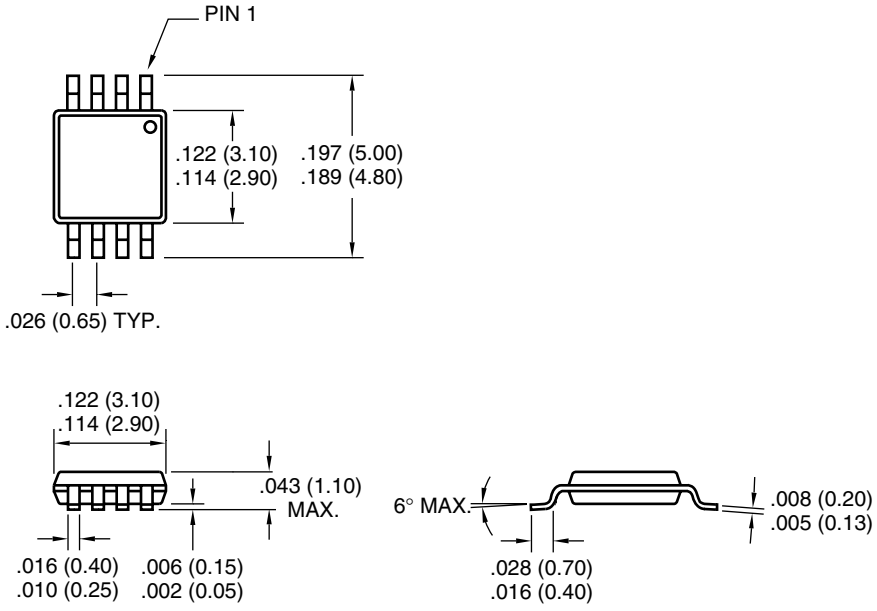
6.3 Package Dimensions

8-Pin Plastic DIP



Dimensions: inches (mm)

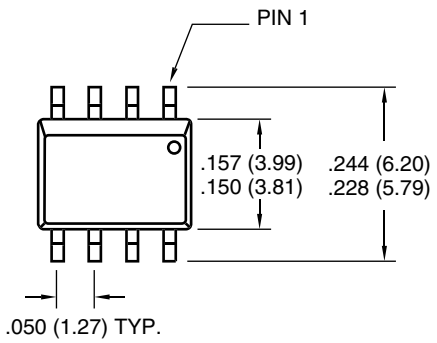
8-Pin MSOP

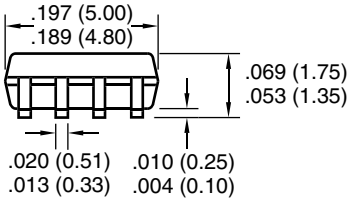


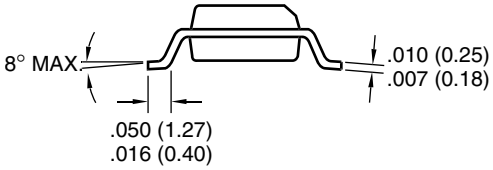
Dimensions: inches (mm)

6.3 Package Dimensions (Continued)

8-Pin SOIC







Dimensions: inches (mm)

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

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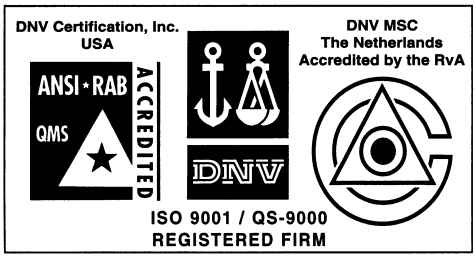
NOTES:



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