TC1041

Linear Building Block – Dual Low Power Comparator and Voltage Reference with Programmable Hysteresis

Features

- Combines Two Comparators and a Voltage Reference in a Single Package
- Optimized for Single Supply Operation
- Available in Two Small Packages: 8-Pin SOIC or 8-Pin MSOP
- Ultra Low Input Bias Current: Less than 100pA
- Low Quiescent Current, Operating: 10µA (Typ.)
- Rail-to-Rail Inputs and Outputs
- Operates Down to V_{DD} = 1.8V
- Programmable Hysteresis

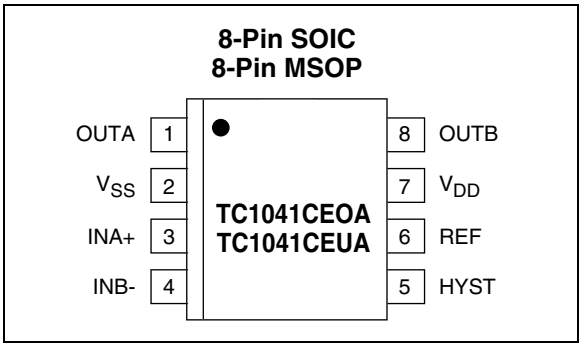
Applications

- Power Supply Circuits
- Battery Operated Equipment
- Consumer Products
- Replacements for Discrete Components

Device Selection Table

Part Number	Package	Temperature Range
TC1041CEOA	8-Pin SOIC	-40°C to +85°C
TC1041CEUA	8-Pin MSOP	-40°C to +85°C

Package Types



General Description

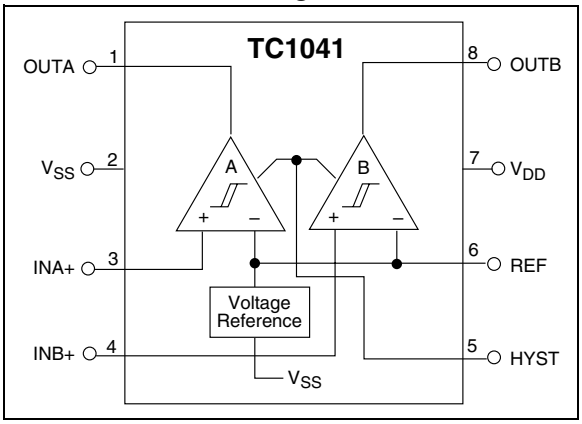
The TC1041 is a mixed-function device combining two comparators and a voltage reference in a single 8-pin package. The inverting inputs of both comparators are internally connected to the reference.

This increased integration allows the user to replace two packages, which saves space, lowers supply current and increases system performance. The TC1041 operates from two 1.5V alkaline cells down to V_{DD} = 1.8V. It requires only 10µA typical supply current which significantly extends battery life. The TC1041 provides a simple method for adding user-adjustable hysteresis without feedback or complex external circuitry. Hysteresis is adjusted with a simple resistor divider on the HYST pin.

Rail-to-rail inputs and outputs allow operation from low supply voltages with large input and output signal swings.

Packaged in an 8-Pin SOIC or 8-Pin MSOP, the TC1041 is ideal for applications requiring low power and small packages.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6.0V
Voltage on Any Pin ..... (V_{SS} – 0.3V) to (V_{DD} + 0.3V)
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.

TC1041 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Typical values apply at 25°C and V_{DD} = 3.0V. Minimum and maximum values apply for 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	—	10	15	µA	All Outputs Open
Comparators						
V_{IR}	IN+ Voltage Range	V_{SS} – 0.2	—	V_{DD} + 0.2	V	
V_{OS}	Input Offset Voltage	-5 -5	—	+5 +5	mV mV	V_{DD} = 3V, T_A = 25°C T_A = -40°C to 85°C **(Note 1)**
I_B	Input Bias Current	—	—	±100	pA	T_A = 25°C, IN+ = V_{DD} to V_{SS}
V_{OH}	Output High Voltage	V_{DD} – 0.3	—	—	V	R_L = 10kΩ to V_{SS}
V_{OL}	Output Low Voltage	—	—	0.3	V	R_L = 10kΩ to V_{DD}
CMRR	Common Mode Rejection Ratio	66	—	—	dB	T_A = 25°C, V_{DD} = 5V V_{CM} = V_{DD} to V_{SS}
PSRR	Power Supply Rejection Ratio	60	—	—	dB	T_A = 25°C V_{DD} = 1.8V to 5V
I_{SRC}	Output Source Current	1	—	—	mA	IN+ = V_{DD}, Output Shorted to V_{SS} V_{DD} = 1.8V
I_{SINK}	Output Sink Current	2	—	—	mA	IN+ = V_{SS}, Output Shorted to V_{DD} V_{DD} = 1.8V
V_{HYST}	Voltage Range at HYST Pin	V_{REF} – 0.08	—	V_{REF}	V	
I_{HYST}	Hysteresis Input Current	—	—	±100	nA	
t_{PD1}	Response Time	—	4	—	µsec	100mV Overdrive, C_L = 100pF
t_{PD2}	Response Time	—	6	—	µsec	10mV Overdrive, C_L = 100pF
Voltage Reference						
V_{REF}	Reference Voltage	1.176	1.200	1.224	V	
$I_{REF(SOURCE)}$	Source Current	50	—	—	µA	
$I_{REF(SINK)}$	Sink Current	50	—	—	µA	
$C_{L(REF)}$	Load Capacitance	—	—	100	pF	
E_{VREF}	Noise Voltage	—	20	—	μV_{RMS}	100Hz to 100kHz
e_{VREF}	Noise Voltage Density	—	1.0	—	$\mu V/\sqrt{Hz}$	1kHz

Note 1: V_{OS} is measured as (V_{UT} + V_{LT} – 2V_{REF})/2 where V_{UT} is the upper hysteresis threshold and V_{LT} is the lower hysteresis threshold with V_{REF} – V_{HYST} set to 10mV. This represents the assymetry of the hysteresis thresholds around V_{REF}.

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 SOIC) (8-Pin MSOP)	Symbol	Description
1	OUTA	Comparator output.
2	V_{SS}	Negative power supply.
3	INA+	Non-inverting input to Comparator A.
4	INB-	Non-Inverting input to Comparator B.
5	HYST	Adjustable hysteresis input.
6	REF	Voltage reference output.
7	V_{DD}	Positive power supply.
8	OUTB	Comparator output.

3.0 DETAILED DESCRIPTION

The TC1041 is one of a series of very low power, linear building block products targeted at low voltage operation. The TC1041 contains two comparators and a voltage reference and operates at a minimum supply voltage of 1.8V with a typical current consumption of 10µA. Both comparators have programmable hysteresis.

3.1 Comparator

The TC1041 contains two comparators with programmable hysteresis. The inverting inputs of the comparators are connected to the output of the voltage reference, while the range of the non-inverting inputs extend beyond both supply voltages by 200mV. The comparator outputs will swing to within several millivolts of the supplies depending on the load current being driven.

The comparators exhibit a propagation delay and supply current which are largely independent of supply voltage. The low input bias current and offset voltage make them suitable for high impedance precision applications.

3.2 Voltage Reference

A 2.0 percent tolerance, internally biased, 1.20V bandgap voltage reference is included in the TC1041. It has a push-pull output capable of sourcing and sinking at least 50µA.

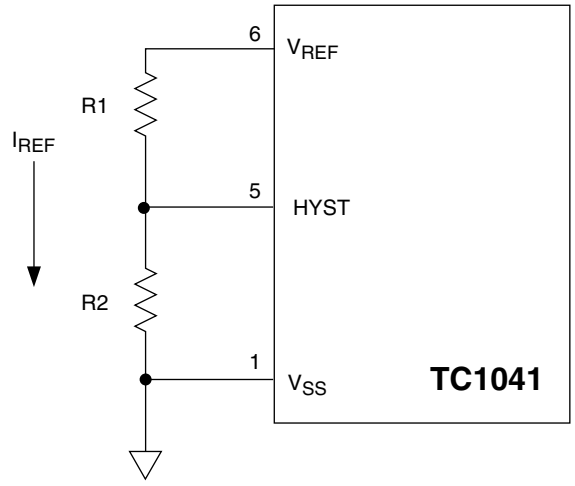
3.3 Programmable Hysteresis

Hysteresis is added to the comparators by connecting a resistor, R1, between the V_{REF} and HYST pins and another resistor, R2, between the HYST pin and V_{SS}. For no hysteresis, V_{REF} should be directly connected to HYST. The hysteresis, V_{HB}, is equal to twice the voltage difference between the V_{REF} and HYST pins where:

$$V_{HB} = 2V_{REF}\ R1/(R1 + R2) \quad \text{(See Figure 3-1)}$$

and is symmetrical around the normal (without hysterersis) threshold of the comparator. The maximum voltage allowed between the V_{REF} and H_{YST} pins is 80mV, giving a maximum hysteresis of 160mV.

FIGURE 3-1: TC1041 PROGRAMMABLE HYSTERESIS



$$R1 = \frac{V_{HB}}{(2)\ (I_{REF})}$$

$$R2 = \frac{\left(1.2V - \frac{V_{HB}}{2}\right)}{I_{REF}}$$

Note: Size R1 and R2 such that $I_{REF} \leq 50\mu A$

4.0 TYPICAL APPLICATIONS

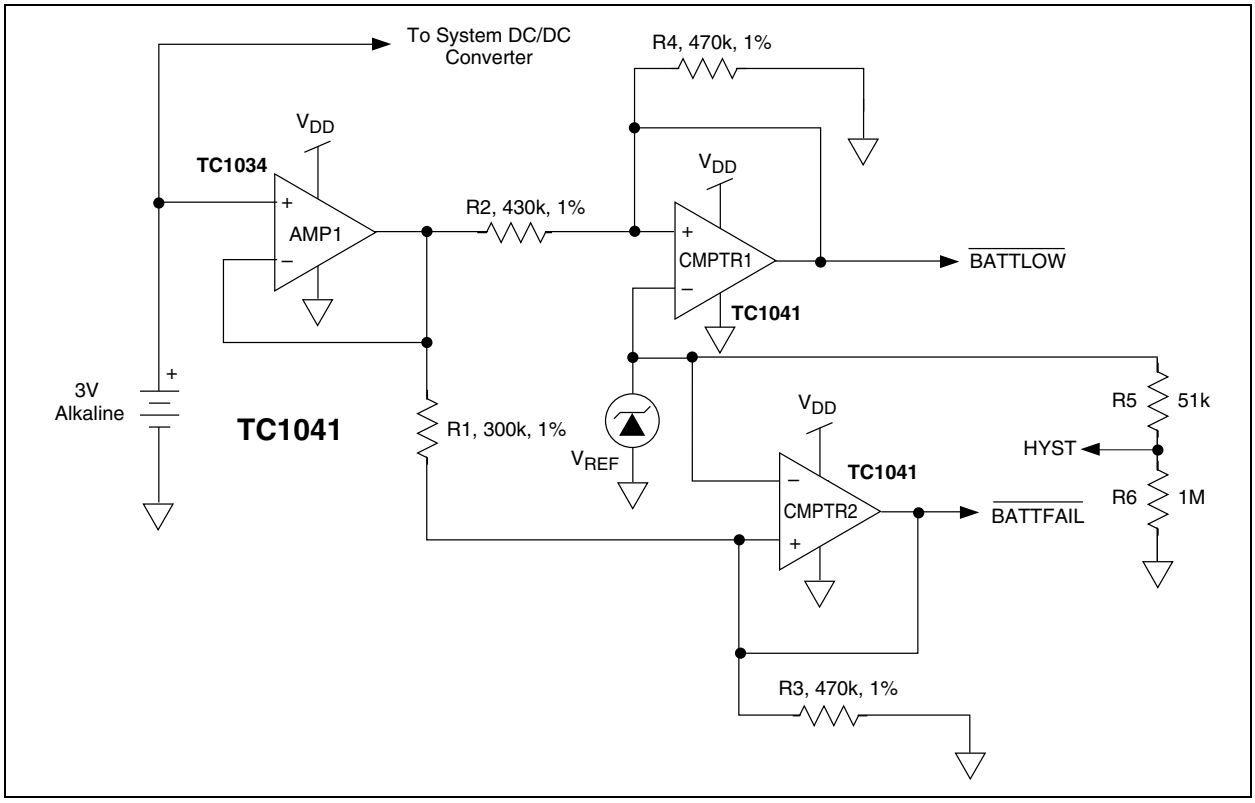
The TC1041 lends itself to a wide variety of applications, particularly in battery powered systems. It typically finds application in power management, processor supervisory and interface circuitry.

4.1 Precision Battery Monitor

Figure 4-1 is a precision battery low/battery dead monitoring circuit. Typically, the battery low output warns the user that a battery dead condition is imminent. Battery dead typically initiates a forced shutdown to prevent operation at low internal supply voltages (which can cause unstable system operation).

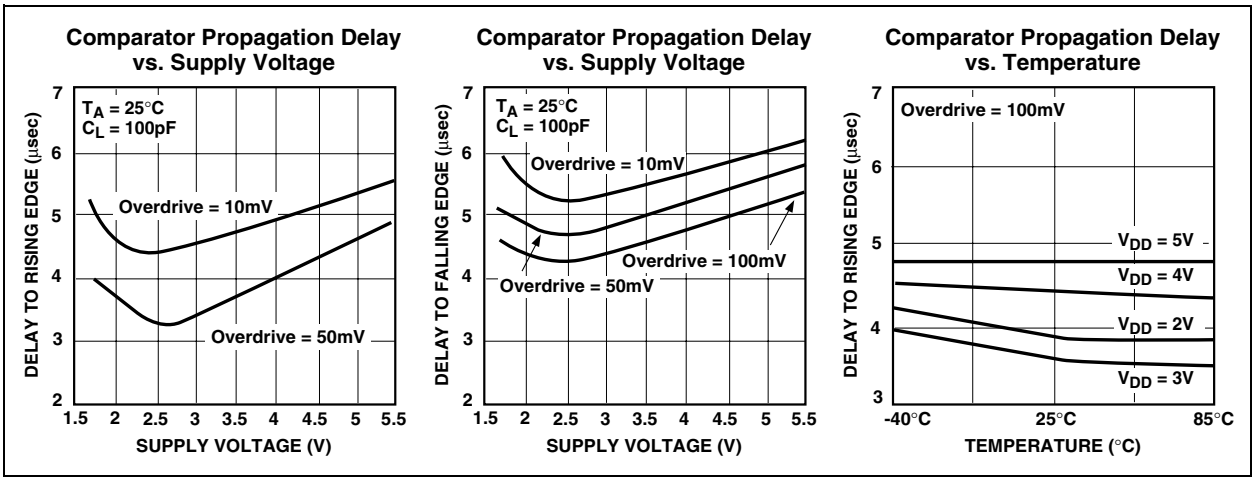
The circuit in Figure 4-1 uses a TC1034, a TC1041 and only six external resistors. AMP 1 is a simple buffer while CMPTR1 and CMPTR2 provide precision voltage detection using V_{REF} as a reference. Resistors R2 and R4 set the detection threshold for $\overline{\text{BATT LOW}}$ while Resistors R1 and R3 set the detection threshold for $\overline{\text{BATT FAIL}}$. The component values shown assert $\overline{\text{BATT LOW}}$ at 2.2V (typical) and $\overline{\text{BATT FAIL}}$ at 2.0V (typical). Total current consumed by this circuit is typically 16µA at 3V. Resistors R5 and R6 provide hysteresis of 116mV for both comparators.

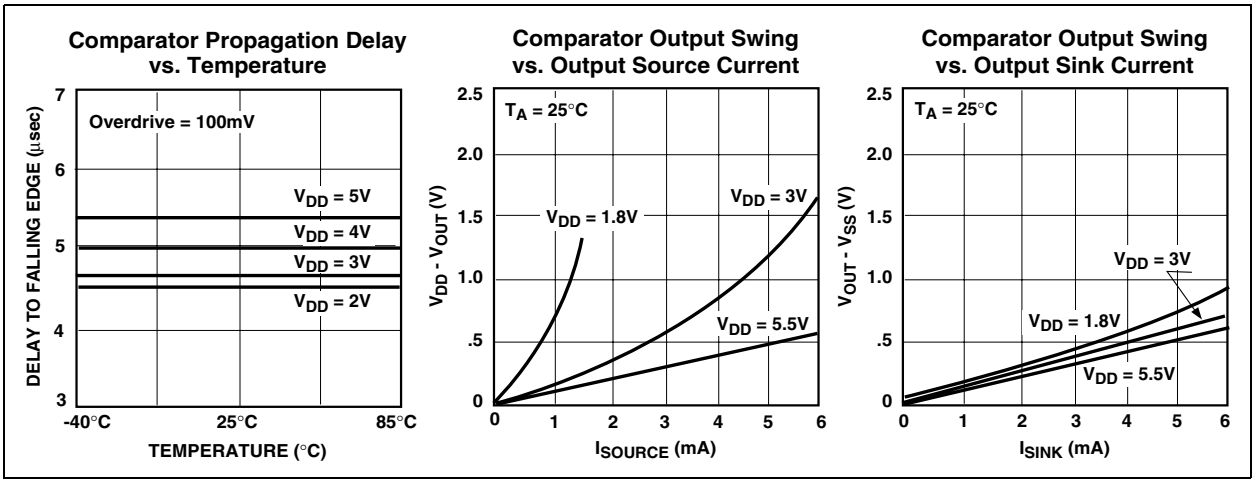
FIGURE 4-1: PRECISION BATTERY MONITOR

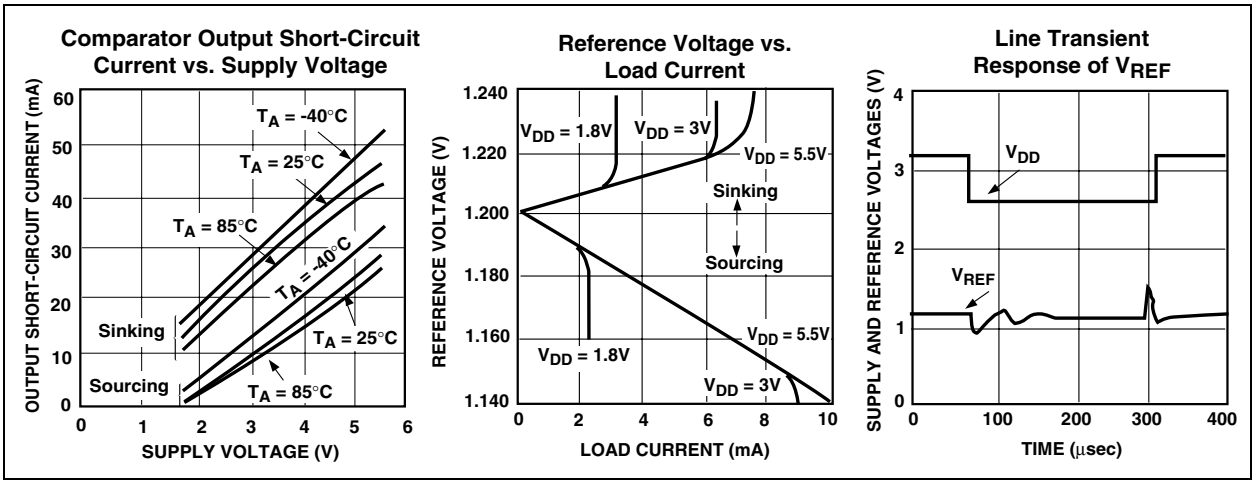


5.0 TYPICAL CHARACTERISTICS

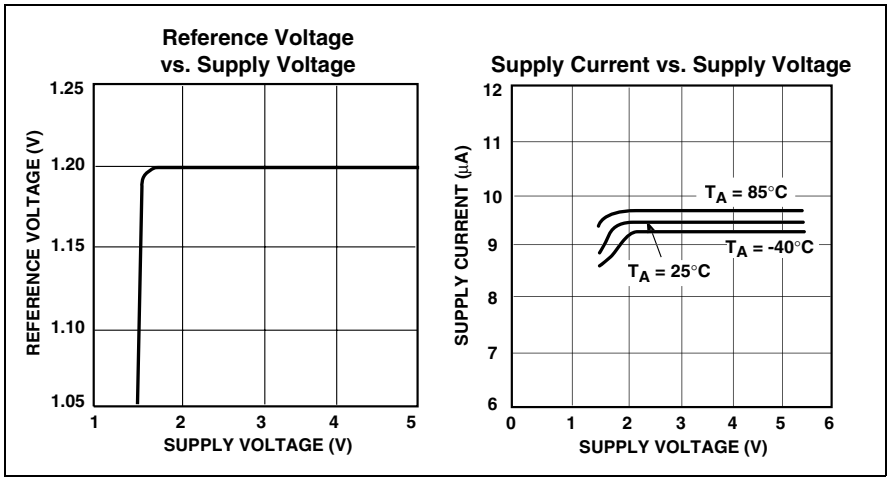
Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside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







5.0 TYPICAL CHARACTERISTICS (CONTINUED)



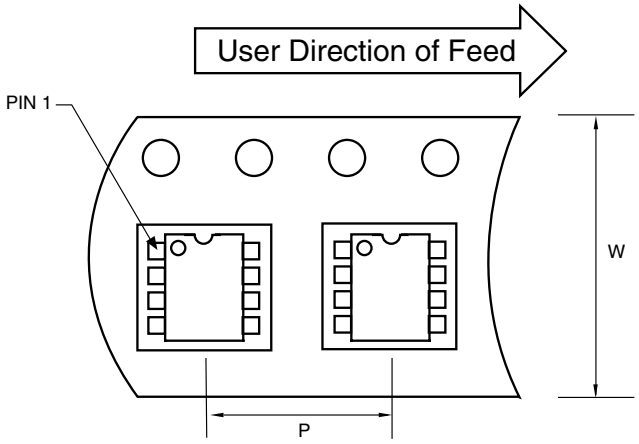
6.0 PACKAGING INFORMATION

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

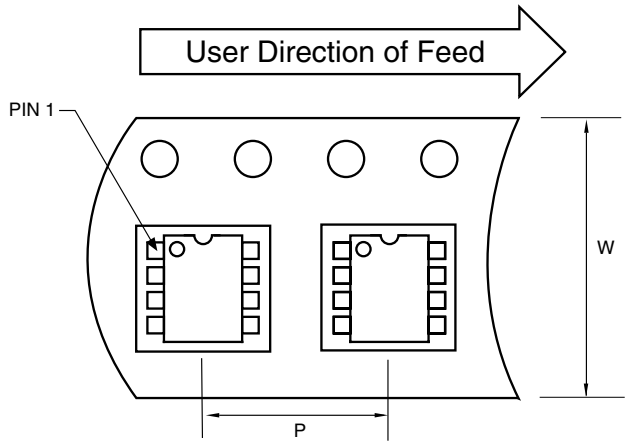


Standard Reel Component Orientation
for TR Suffix Device

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



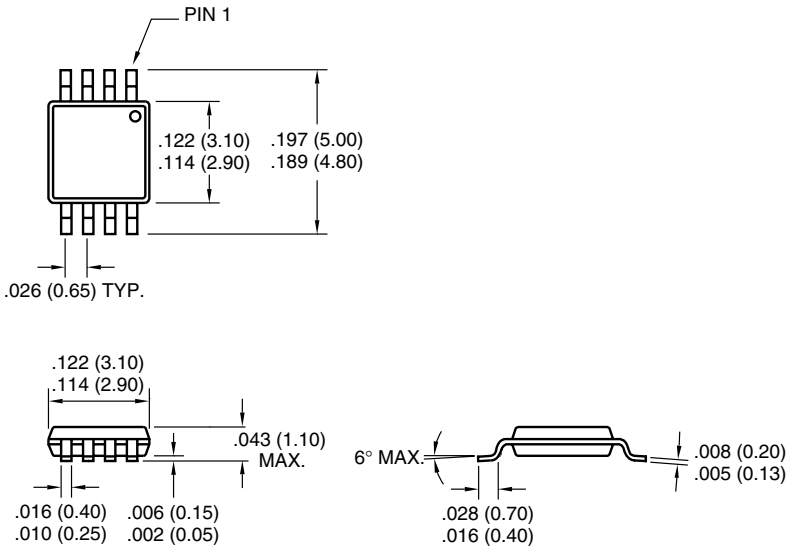
Standard Reel Component Orientation
for TR Suffix Device

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

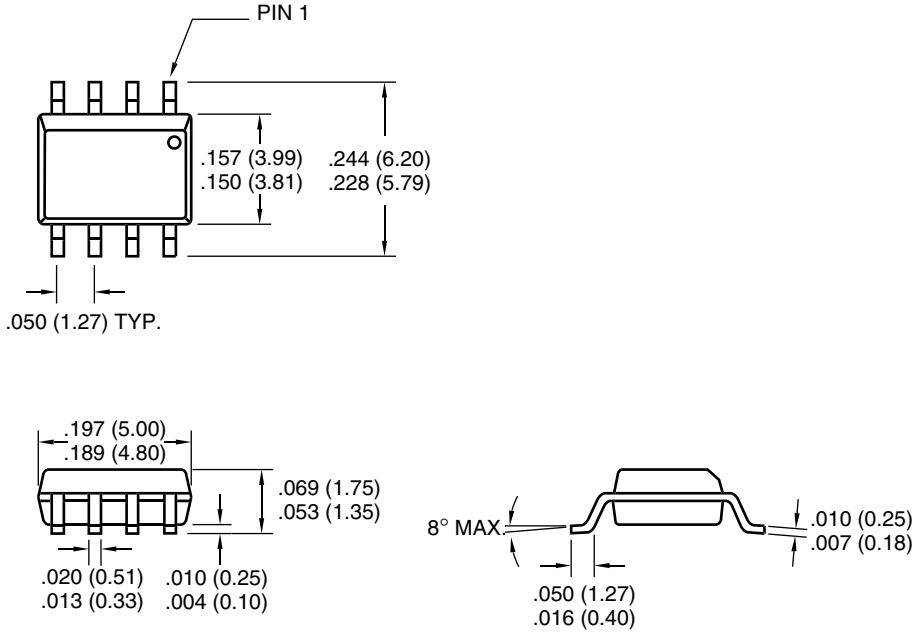
6.3 Package Dimensions

8-Pin MSOP



Dimensions: inches (mm)

8-Pin SOIC



Dimensions: inches (mm)

NOTES:

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:

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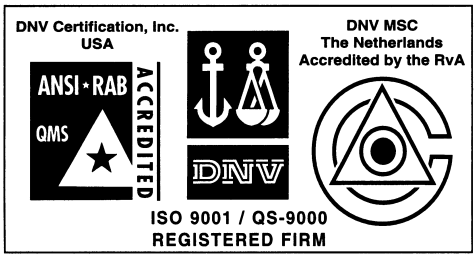

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