TC1031

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

Features

- Combines Comparator and Voltage Reference in a Single Package
- Optimized for Single Supply Operation
- Small Package: 8-Pin MSOP
- Ultra Low Input Bias Current: Less than 100pA
- Low Quiescent Current, Active: 6µA (Typ.), Shutdown Mode: 0.1µA (Typ.)
- Rail-to-Rail Inputs and Outputs
- Operates Down to V_{DD} = 1.8V
- Programmable Hysteresis

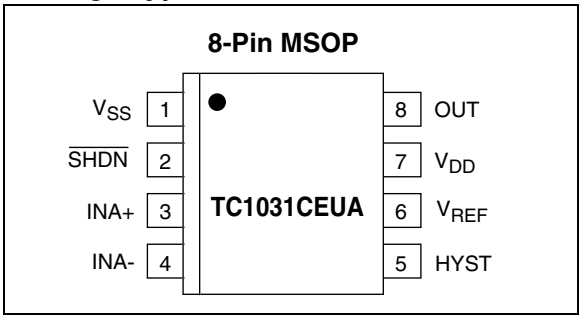
Applications

- Power Management Circuits
- Battery Operated Equipment
- Consumer Products

Device Selection Table

Part Number	Package	Temperature Range
TC1031CEUA	8-Pin MSOP	-40°C to +85°C

Package Type



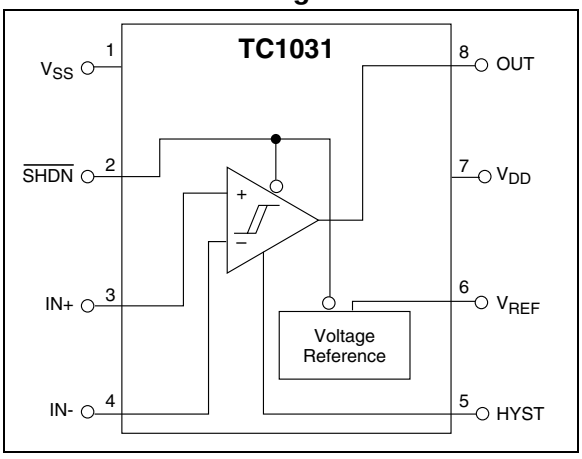
General Description

The TC1031 is a low-power comparator and voltage reference designed specifically for low-power applications. The TC1031 is designed for operation from a single supply, however operation from dual supplies is also possible. The power supply current drain is independent of the magnitude of the power supply voltage. The TC1031 can operate from two 1.5V alkaline cells, and operation is ensured to V_{DD} = 1.8V. Typical active supply current is 6µA. Rail-to-rail inputs and outputs allow operation from low supply voltages with large input and output signal swings.

The TC1031 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 input. A shutdown input, $\overline{SHDN}$, disables the comparator and voltage reference and reduces supply current to less than 0.1µA (maximum) when taken low.

The TC1031 is packaged in a space-saving 8-Pin MSOP, making it ideal for applications requiring high integration, small size and low power.

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.

TC1031 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	—	6	10	µA	All Outputs Open, $\overline{SHDN}$ = V_{DD}
I_{SHDN}	Supply Current, Shutdown	—	—	0.1	µA	$\overline{SHDN}$ = V_{SS}
Shutdown Input						
V_{IH}	Input High Threshold	80% V_{DD}	—	—	V	
V_{IL}	Input Low Threshold	—	—	20% V_{DD}	V	
I_{SI}	Shutdown Input Current	—	—	±100	nA	
Comparator						
R_{OUT} (SD)	Output Resistance in Shutdown	20	—	—	MΩ	$\overline{SHDN}$ = V_{SS}
C_{OUT} (SD)	Output Capacitance in Shutdown	—	—	5	pF	$\overline{SHDN}$ = V_{SS}
T_{SEL}	Select Time	—	20	—	µsec	V_{OUT} Valid from $\overline{SHDN}$ = V_{IH} R_L=10kΩ to V_{SS}
T_{DESEL}	Deselect Time	—	500	—	nsec	V_{OUT} Invalid from $\overline{SHDN}$ = V_{IL} R_L=10kΩ to V_{SS}
V_{ICMR}	Common-Mode Input Voltage Range	V_{SS} – 0.2	—	V_{DD} + 0.2	V	
V_{OS}	Input Offset Voltage **(Note 1)**	–5	—	+5	mV	V_{DD} = 3V, V_{CM} = 1.5V
I_B	Input Bias Current	—	—	±100	pA	T_A = 25°C IN+, 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 V_{CM} = 1.2V
I_{SRC}	Output Source Current	1	—	—	mA	IN+ = V_{DD}, IN- = V_{SS} V_{DD} = 1.8V, Output Shorted to V_{SS}
I_{SINK}	Output Sink Current	2	—	—	mA	IN+ = V_{SS}, IN- = V_{DD}, V_{DD} = 1.8V, Output Shorted to V_{DD}
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	100mV Overdrive; C_L = 100pF

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 asymmetry of the hysteresis thresholds around V_{REF}

TC1031 ELECTRICAL SPECIFICATIONS (CONTINUED)

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
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	
R_{OUT} (SD)	Output Resistance in Shutdown	20	—	—	MΩ	$\overline{SHDN} = V_{SS}$
C_{OUT} (SD)	Output Capacitance in Shutdown	—	—	5	pF	$\overline{SHDN} = V_{SS}$
T_{SEL}	Select Time	—	200	—	µsec	REF Valid from $\overline{SHDN} = V_{IH}$ R_L = 100kΩ to V_{SS}
T_{DESEL}	Deselect Time	—	10	—	µsec	REF Invalid from $\overline{SHDN} = V_{IL}$ R_L = 100kΩ
$C_{L(REF)}$	Load Capacitance	—	—	100	pF	
E_{VREF}	Voltage Noise	—	20	—	μV_{RMS}	100Hz to 100kHz
e_{VREF}	Noise Density	—	10	—	$\mu V/\sqrt{Hz}$	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 asymmetry of the hysteresis thresholds around V_{REF}

2.0 PIN DESCRIPTIONS

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

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (8-Pin MSOP)	Symbol	Description
1	V_{SS}	Negative power supply.
2	$\overline{SHDN}$	Shutdown input.
3	IN+	Comparator non-inverting input.
4	IN-	Comparator inverting input.
5	HYST	Adjustable hysteresis input.
6	V_{REF}	Voltage reference output.
7	V_{DD}	Positive power supply.
8	OUT	Comparator output.

3.0 DETAILED DESCRIPTION

The TC1031 is one of a series of very low-power, linear building block products targeted at low-voltage, single-supply applications. Minimum operating voltage for the device is 1.8V, and typical supply current is only 6µA (fully enabled). It combines one comparator and a voltage reference in a single package. The comparator and reference outputs are in a high-impedance state during shutdown.

3.1 Comparator

The TC1031 contains one comparator with programmable hysteresis. The range of the inputs extends 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 comparator exhibits a propagation delay and supply current which is largely independent of supply voltage. The low input bias current and offset voltage make it suitable for high impedance precision applications.

The comparator is disabled during shutdown and has high-impedance output.

3.2 Voltage Reference

A 2.0% tolerance, internally biased, 1.20V bandgap voltage reference is included in the TC1031. It has a push-pull output capable of sourcing and sinking at least 50µA. The voltage reference is disabled during shutdown, with a high-impedance output.

3.3 Shutdown Input

$\overline{SHDN}$ at V_{IL} disables both the comparator and voltage reference and reduces the supply current to less than 0.1µA. The $\overline{SHDN}$ input cannot be allowed to float; when not used, connect it to V_{DD}. The outputs are in a high impedance state when the TC1031 is disabled. The comparator's inputs and output can be driven from rail-to-rail by an external voltage when the TC1031 is disabled. No latchup will occur when the device is driven to its enabled state when $\overline{SHDN}$ is set to V_{IH}.

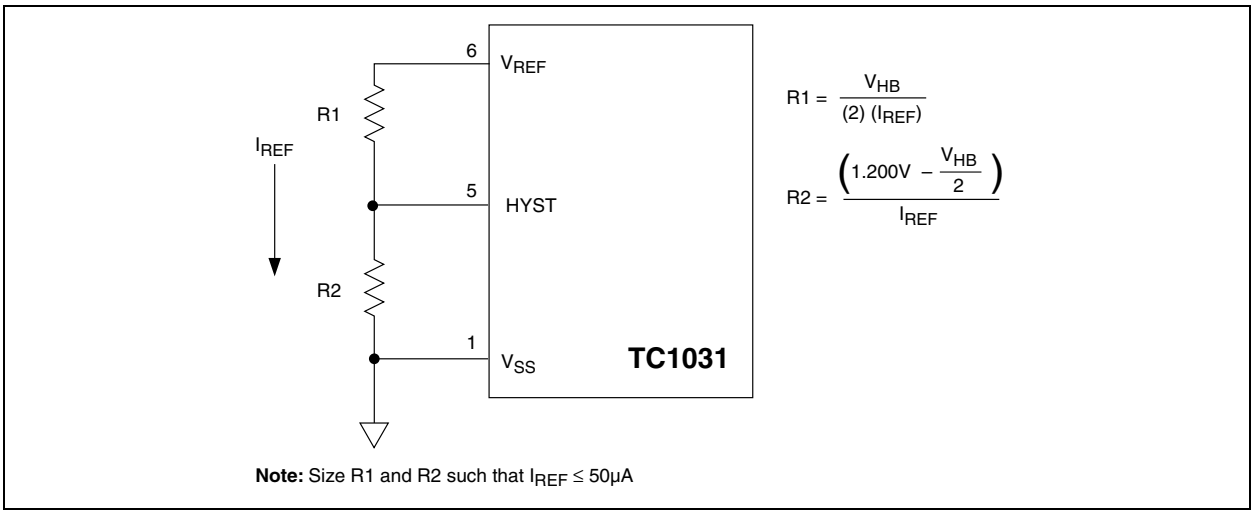
3.4 Programmable Hysteresis

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:

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

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: TC1031 PROGRAMMABLE HYSTERESIS



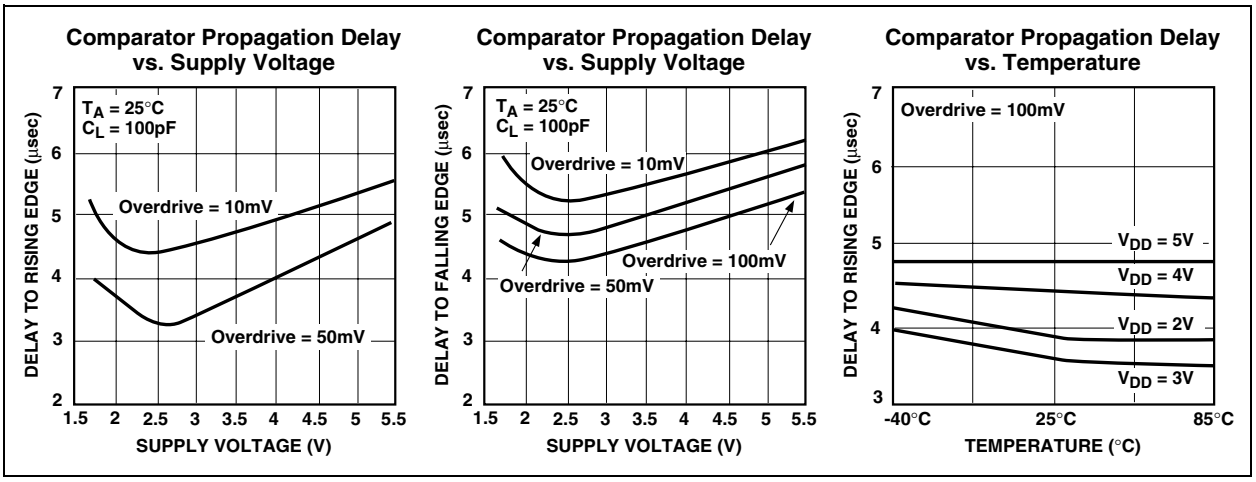
Note: Size R1 and R2 such that $I_{REF} \leq 50\mu A$

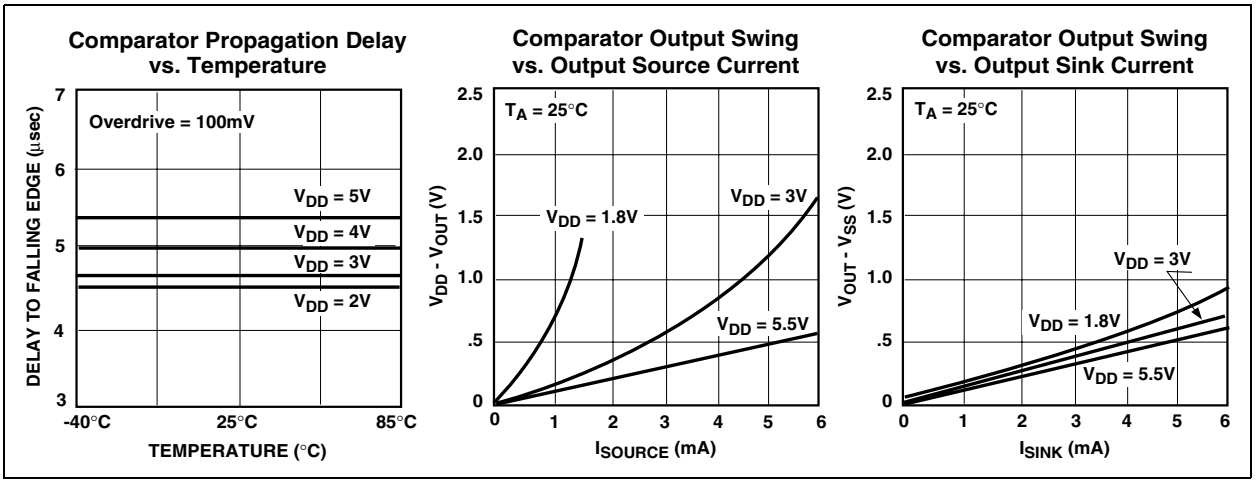
4.0 TYPICAL APPLICATIONS

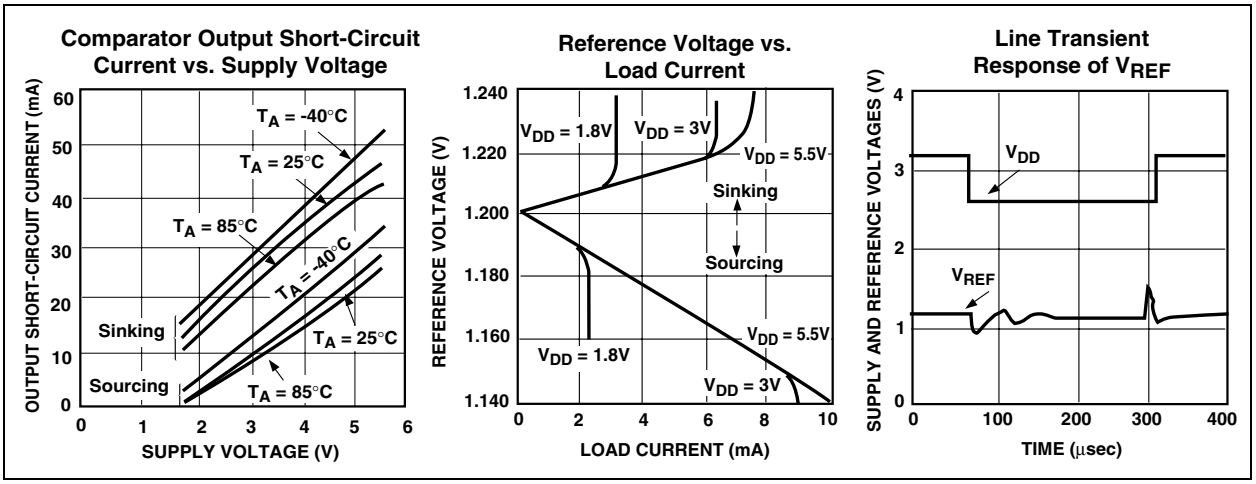
The TC1031 lends itself to a wide variety of applications, particularly in battery-powered systems. It typically finds application in power management, processor supervisory and interface circuitry.

5.0 TYPICAL CHARACTERISTICS

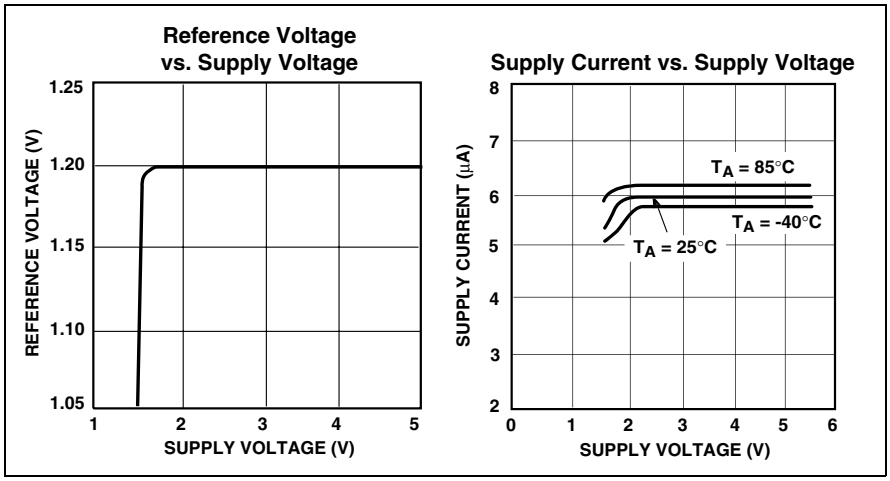
Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside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







5.0 TYPICAL CHARACTERISTICS (CONTINUED)



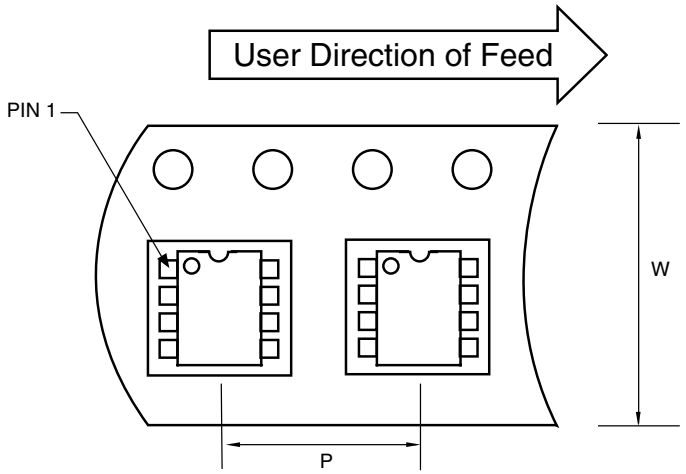
6.0 PACKAGING INFORMATION

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



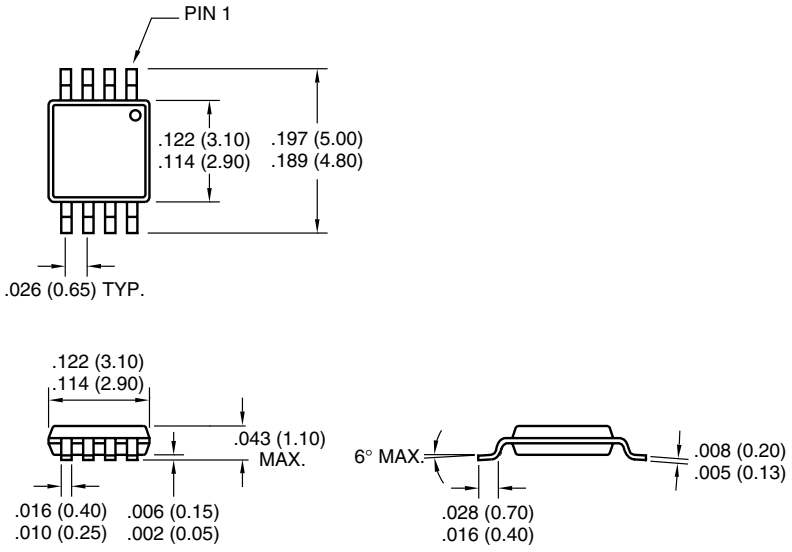
Standard Reel Component Orientation
for TR Suffix Device

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

6.3 Package Dimensions

8-Pin MSOP



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:

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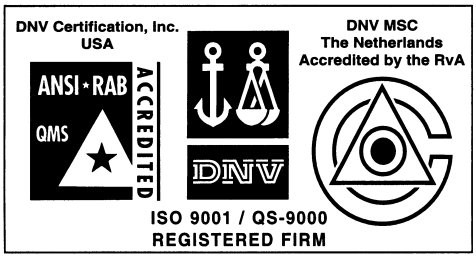

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