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 (Occupies Only Half the Space of an 8-Pin SOIC)**
- **Ultra Low Input Bias Current ..... Less than 100 pA**
- **Low Quiescent Current ..... 6 μA, Typ, Active ..... 0.1 μA in Shutdown Mode**
- **Operates Down to V_{DD} = 1.8V**
- **Rail-to-Rail Inputs and Outputs**
- **Programmable Hysteresis**

APPLICATIONS

- **Power Management Circuits**
- **Battery Operated Equipment**
- **Consumer Products**

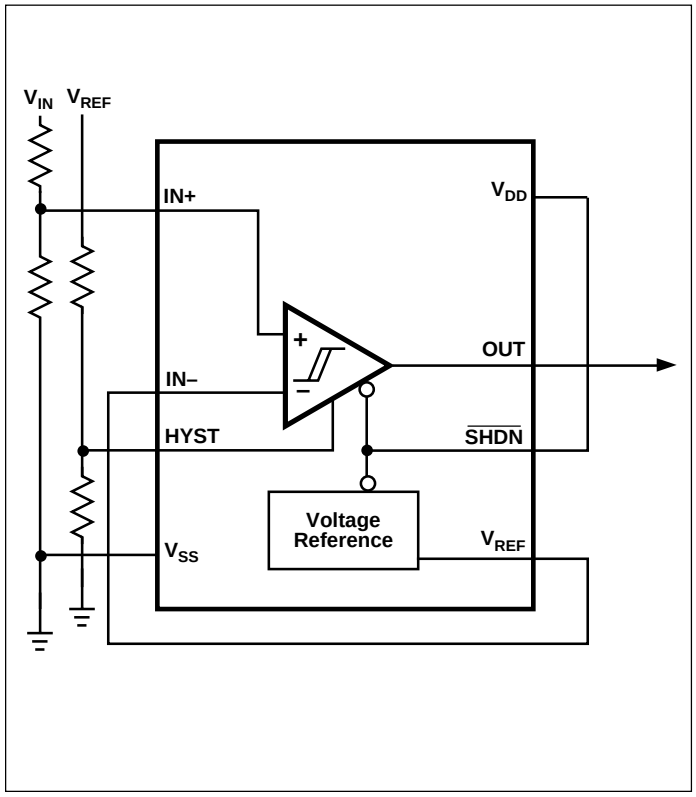
GENERAL DESCRIPTION

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 also is 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 guaranteed to V_{DD} = 1.8V. Typical active supply current is 6 μA. 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 0.1 μA (maximum) when taken low.

Packaged in a space-saving 8-Pin MSOP, the TC1031 is ideal for applications requiring high integration, small size, and low power.

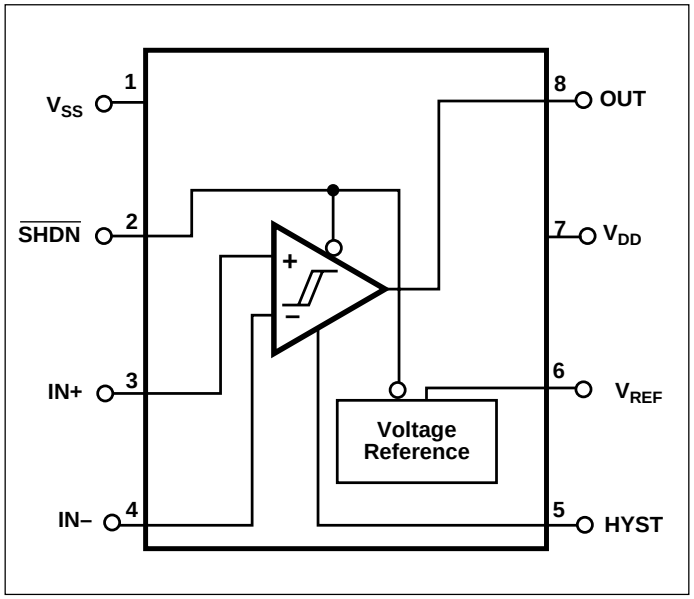
FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part No.	Package	Temp. Range
TC1031CEUA	8-Pin MSOP	– 40°C to +85°C

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6.0V
Voltage on Any Pin:
(With Respect to Supplies) .. (V_{SS} – 0.3V) to (V_{DD} +0.3V)
Operating Temperature Range: ..... – 40°C to + 85°C
Storage Temperature Range ..... – 55°C to +150°C
Lead Temperature (Soldering, 10 sec) ..... +260°C

* Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. 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 operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS: Minimum and maximum values apply for T_A = –40° to +85°C and V_{DD} = 1.8V to 5.5V, unless otherwise specified. Typical values apply at T_A = 25°C and V_{DD} = 3V.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage		1.8	—	5.5	V
I_Q	Supply Current, Operating	All outputs unloaded, $\overline{SHDN}$ = V_{DD}	—	6	10	µA
I_{SHDN}	Supply Current, Shutdown	$\overline{SHDN}$ = V_{SS}	—	—	0.1	µA
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	$\overline{SHDN}$ = V_{SS}	20	—	—	MΩ
C_{OUT} (SD)	Output Capacitance in Shutdown	$\overline{SHDN}$ = V_{SS}	—	—	5	pF
T_{SEL}	Select Time	V_{OUT} Valid from $\overline{SHDN}$ = V_{IH} R_L=10 KΩ to V_{SS}	—	20	—	µsec
T_{DESEL}	Deselect Time	V_{OUT} Invalid from $\overline{SHDN}$ = V_{IL} R_L=10 KΩ to V_{SS}	—	500	—	nsec
V_{ICMR}	Common-Mode Input Voltage Range		V_{SS} – 0.2	—	V_{DD} + 0.2	V
V_{OS}	Input Offset Voltage (Note 1)	V_{DD} = 3V, V_{CM} = 1.5V	–5	—	+5	mV
I_B	Input Bias Current	T_A = 25°C IN^+, IN^- = V_{DD} to V_{SS}	—	—	±100	pA
V_{OH}	Output High Voltage	R_L = 10 KΩ to V_{SS}	V_{DD} – 0.3	—	—	V
V_{OL}	Output Low Voltage	R_L = 10 KΩ to V_{DD}	—	—	0.3	V
CMRR	Common Mode Rejection Ratio	T_A = 25°C, V_{DD} = 5V V_{CM} = V_{DD} to V_{SS}	66	—	—	dB
PSRR	Power Supply Rejection Ratio	T_A = 25°C, V_{DD} = 1.8V to 5V V_{CM} = 1.2V	60	—	—	dB
I_{SRC}	Output Source Current	IN^+ = V_{DD}, IN^- = V_{SS} V_{DD} = 1.8V, Output Shorted to V_{SS}	1	—	—	mA
I_{SINK}	Output Sink Current	IN^+ = V_{SS}, IN^- = V_{DD} V_{DD} = 1.8V, Output Shorted to V_{DD}	2	—	—	mA
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	100mV Overdrive; C_L = 100pF	—	4	—	µsec
t_{PD2}	Response Time	10mV Overdrive; C_L = 100pF	—	6	—	µsec

ELECTRICAL CHARACTERISTICS: Typical values apply at T_A = 25°C and V_{DD} = 3V. 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	Test Conditions	Min	Typ	Max	Unit
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	$\overline{SHDN}$ = V_{SS}	20	—	—	MΩ
C_{OUT} (SD)	Output Capacitance in Shutdown	$\overline{SHDN}$ = V_{SS}	—	—	5	pF
T_{SEL}	Select Time	REF Valid from $\overline{SHDN}$ = V_{IH} R_L = 100KΩ to V_{SS}	—	200	—	µsec
T_{DESEL}	Deselect Time	REF Invalid from $\overline{SHDN}$ = V_{IL} R_L = 100KΩ to V_{SS}	—	10	—	µsec
$C_{L(REF)}$	Load Capacitance		—	—	100	pF
N_{VREF}	Voltage Noise	100 Hz to 100 KHz	—	20	—	μV_{RMS}
	Noise Density	1 KHz	—	1.0	—	$\mu V/\sqrt{Hz}$

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}.

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 6 µA (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.

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.

Voltage Reference

A 2.0 percent 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.

$\overline{SHDN}$ Input

$\overline{SHDN}$ at V_{IL} disables both the comparator and voltage reference and reduces the supply current to less than 0.1 µA. 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}.

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:

$$V_{HB} = 2 * V_{REF} * R1/(R1 + R2)$$ (See Figure 1)

and is symetrical 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.

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.

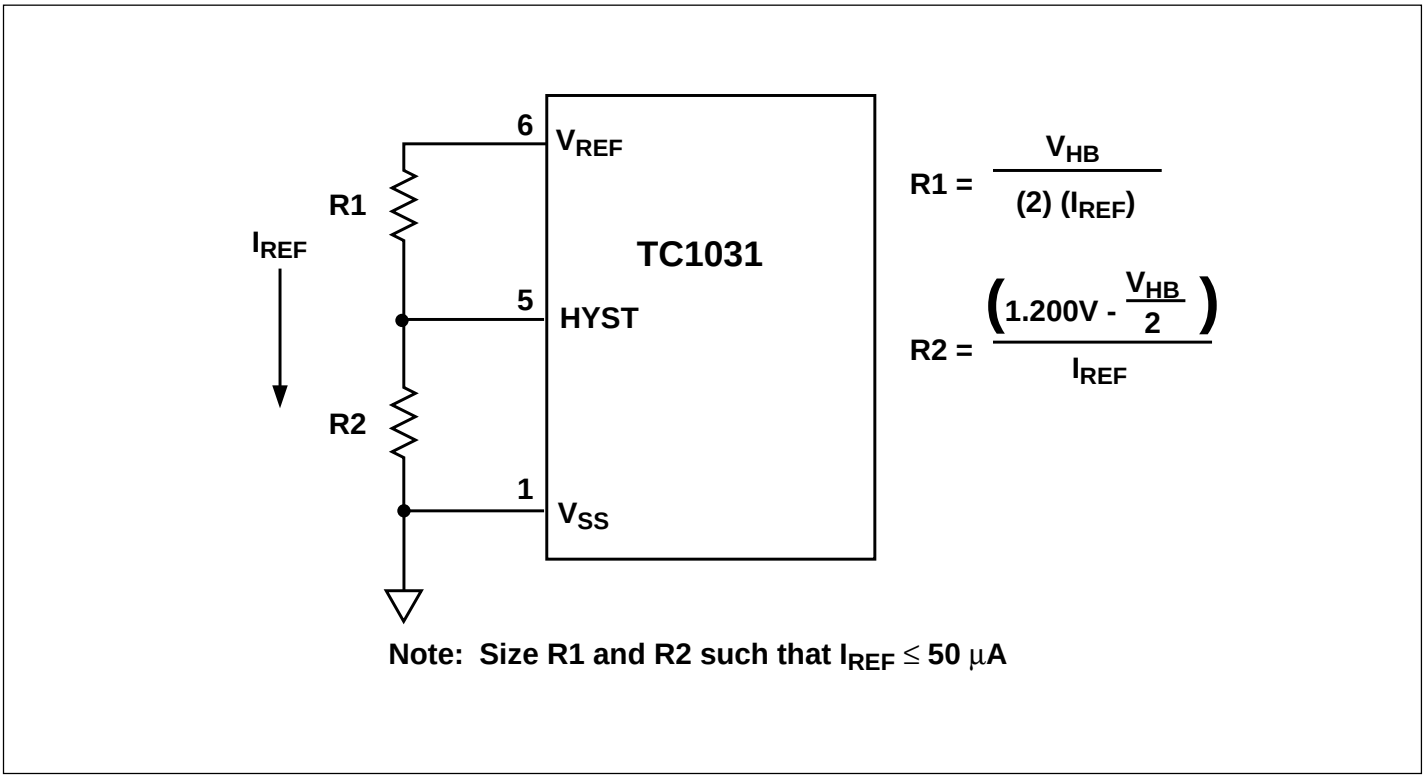
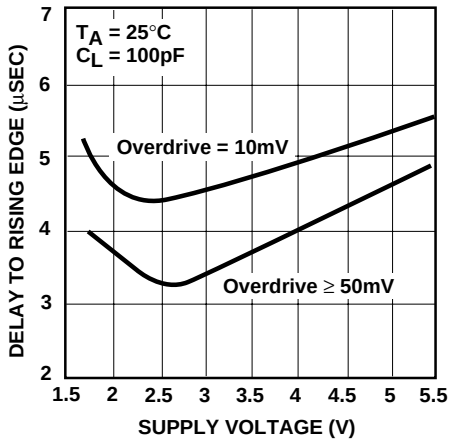


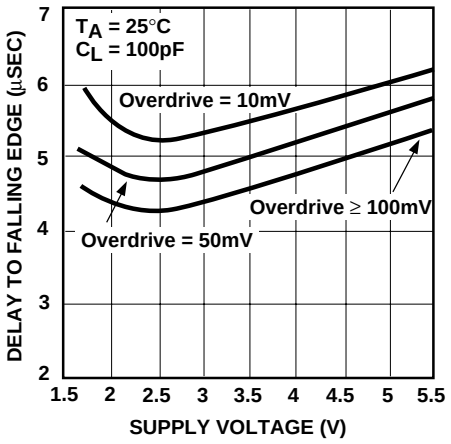
Figure 1. TC1031 Programmable Hysteresis

TYPICAL CHARACTERISTICS

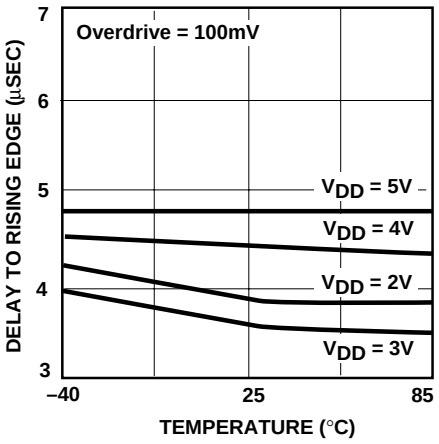
Comparator
Propagation Delay vs. Supply Voltage



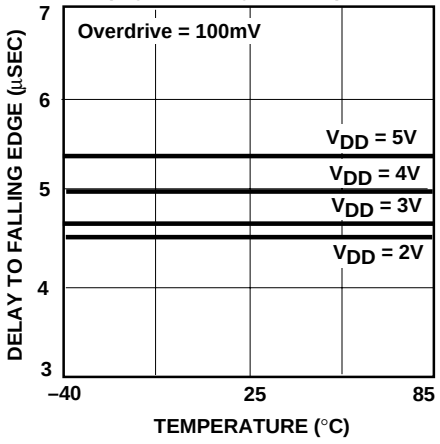
Comparator
Propagation Delay vs. Supply Voltage



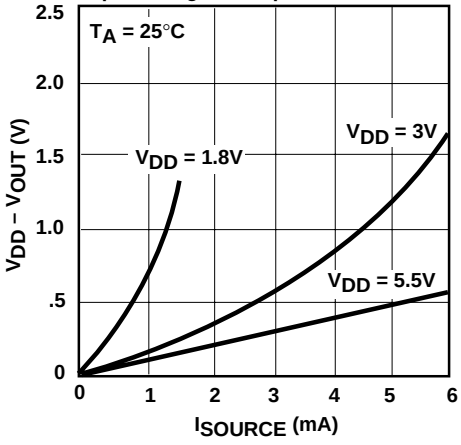
Comparator
Propagation Delay vs. Temperature



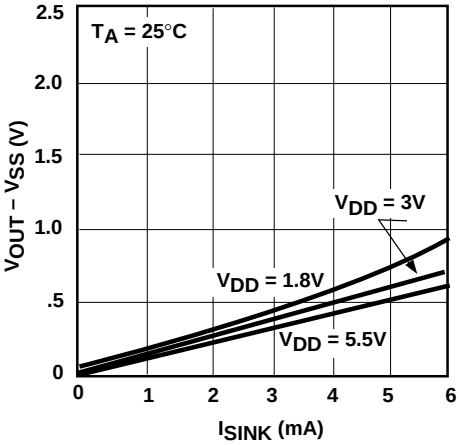
Comparator
Propagation Delay vs. Temperature



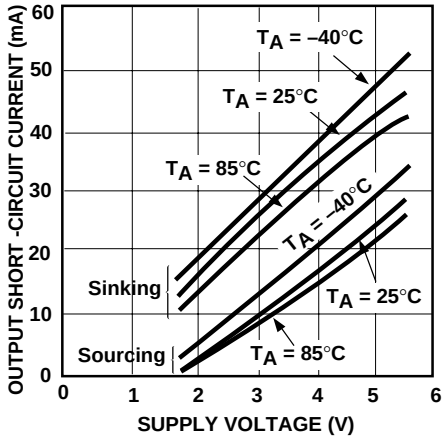
Comparator
Output Swing vs. Output Source Current



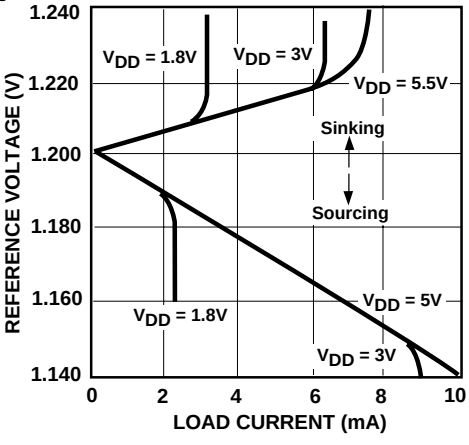
Comparator
Output Swing vs. Output Sink Current



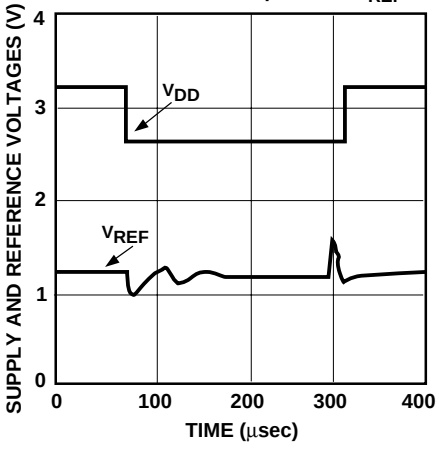
Comparator
Output Short-Circuit Current vs. Supply Voltage



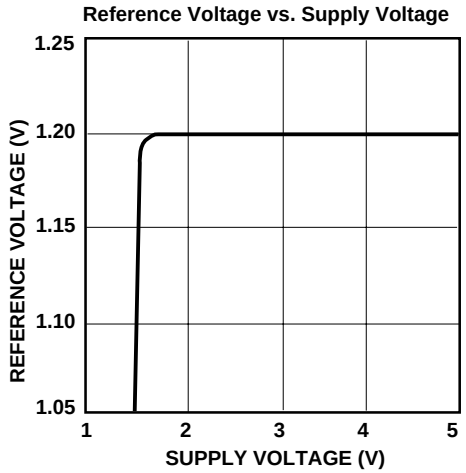
Reference Voltage vs. Load Current

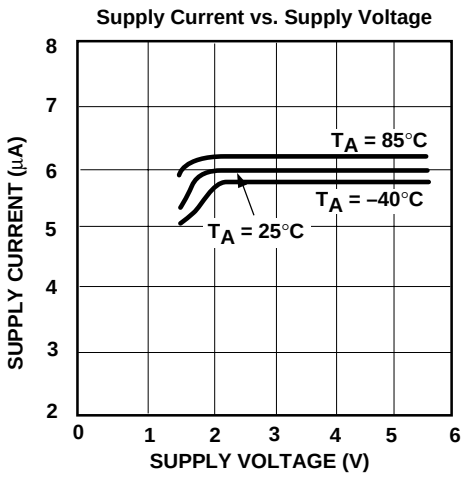


Line Transient Response of V_{REF}

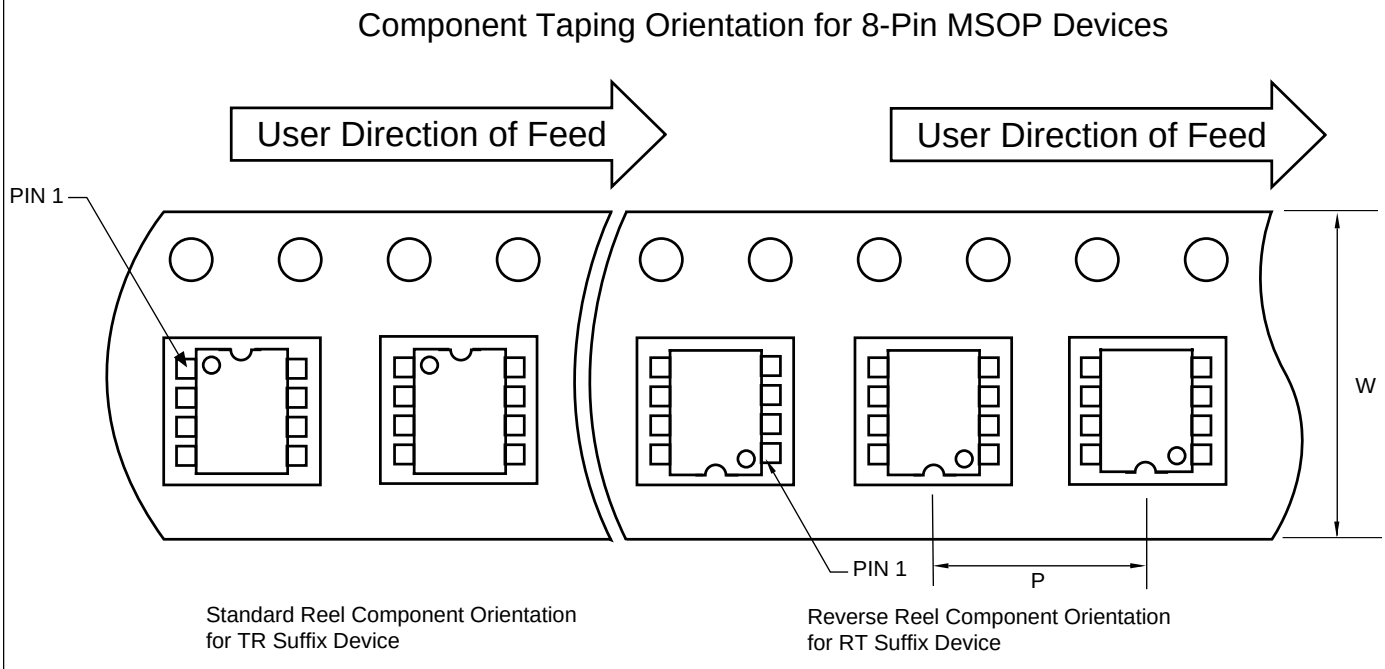


TYPICAL CHARACTERISTICS





TAPING FORM

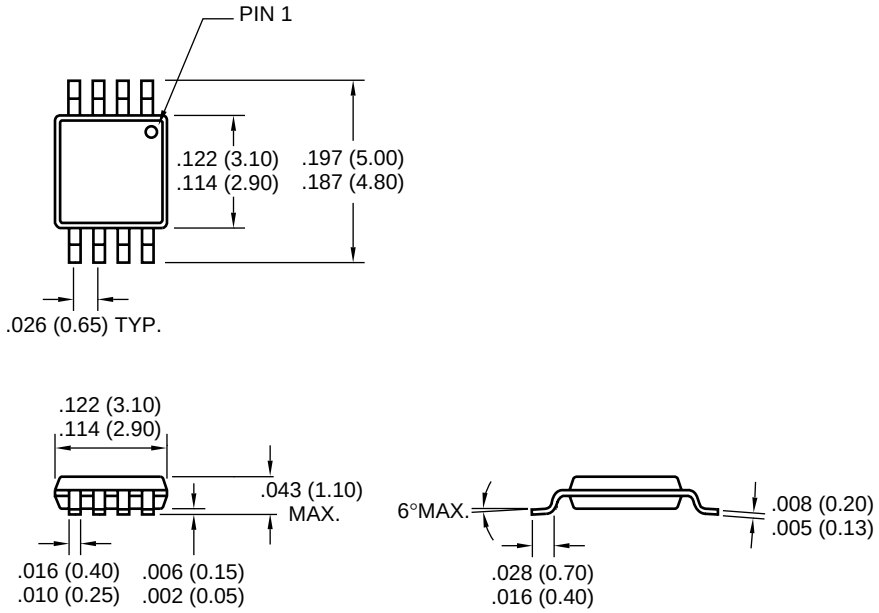


Carrier Tape, Number of Components Per Reel and Reel Size

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

PACKAGE DIMENSIONS

8-Pin MSOP



Dimensions: inches (mm)

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: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Austin
Analog Product Sales
8303 MoPac Expressway North
Suite A-201
Austin, TX 78759
Tel: 512-345-2030 Fax: 512-345-6085

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Boston
Analog Product Sales
Unit A-8-1 Millbrook Tarry Condominium
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Tel: 978-371-6400 Fax: 978-371-0050

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Dayton
Two Prestige Place, Suite 130
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

Mountain View
Analog Product Sales
1300 Terra Bella Avenue
Mountain View, CA 94043-1836
Tel: 650-968-9241 Fax: 650-967-1590

New York
150 Motor Parkway, Suite 202
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

China - Beijing
Microchip Technology Beijing Office
Unit 915
New China Hong Kong Manhattan Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Shanghai
Microchip Technology Shanghai Office
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

Hong Kong
Microchip Asia Pacific
RM 2101, 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, OíShaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Intl. Inc.
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
Tel: 82-2-554-7200 Fax: 82-2-558-5934

ASIA/PACIFIC (continued)

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

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

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

Denmark
Microchip Technology Denmark ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Arizona Microchip Technology SARL
Parc díActivite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Arizona Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Germany
Analog Product Sales
Lochhamer Strasse 13
D-82152 Martinsried, Germany
Tel: 49-89-895650-0 Fax: 49-89-895650-22

Italy
Arizona 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
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820