



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 μ A, Typ, Active 0.1 μ A 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

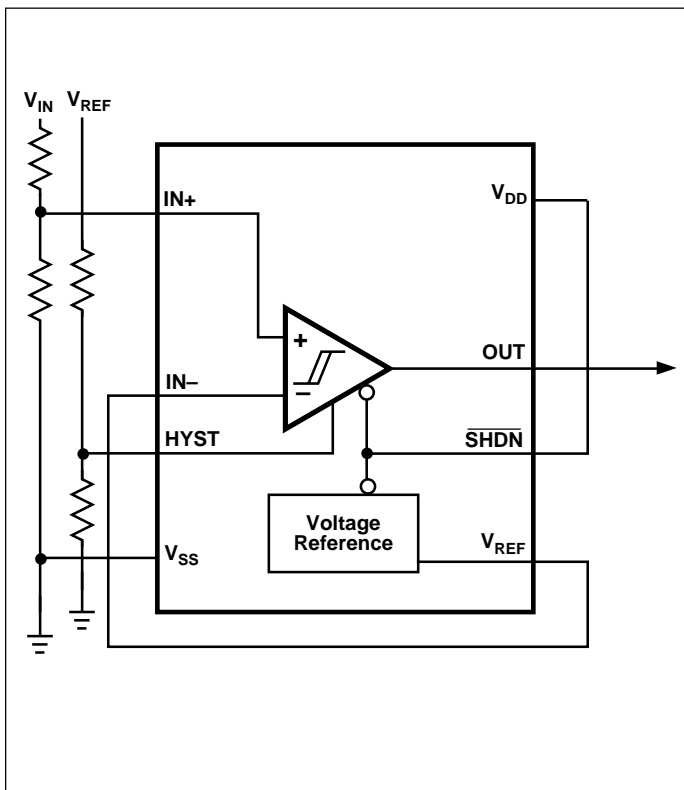
GENERAL DESCRIPTION

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 μ A. 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 μ A (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.

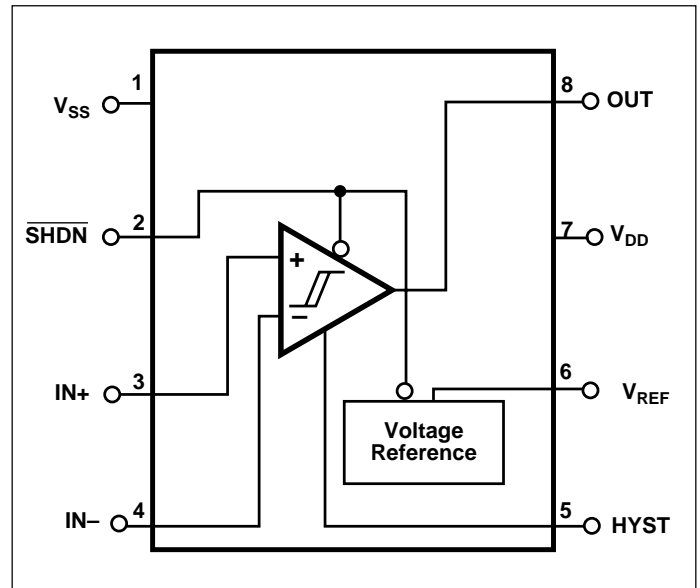
FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

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

PIN CONFIGURATION



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TC1031

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: $-40^{\circ}C$ to $+85^{\circ}C$
Storage Temperature Range $-55^{\circ}C$ to $+150^{\circ}C$
Lead Temperature (Soldering, 10 sec) $+260^{\circ}C$

* 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 $T_A = -40^{\circ}$ to $+85^{\circ}C$ and $V_{DD} = 1.8V$ to $5.5V$, unless otherwise specified. Typical values apply at $T_A = 25^{\circ}C$ 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	—	—	$M\Omega$
$C_{OUT(SD)}$	Output Capacitance in Shutdown	$\overline{SHDN} = V_{SS}$	—	—	5	pF
T_{SEL}	Select Time	V_{OUT} Valid from $\overline{SHDN} = V_{IH}$ $R_L = 10 K\Omega$ to V_{SS}	—	20	—	μsec
T_{DESEL}	Deselect Time	V_{OUT} Invalid from $\overline{SHDN} = V_{IL}$ $R_L = 10 K\Omega$ 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	$T_A = 25^{\circ}C$ IN^+ , $IN^- = V_{DD}$ to V_{SS}	—	—	± 100	pA
V_{OH}	Output High Voltage	$R_L = 10 K\Omega$ to V_{SS}	$V_{DD} - 0.3$	—	—	V
V_{OL}	Output Low Voltage	$R_L = 10 K\Omega$ to V_{DD}	—	—	0.3	V
CMRR	Common Mode Rejection Ratio	$T_A = 25^{\circ}C$, $V_{DD} = 5V$ $V_{CM} = V_{DD}$ to V_{SS}	66	—	—	dB
PSRR	Power Supply Rejection Ratio	$T_A = 25^{\circ}C$, $V_{DD} = 1.8V$ 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

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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	$\overline{\text{SHDN}} = V_{SS}$	20	—	—	$\text{M}\Omega$
$C_{OUT(SD)}$	Output Capacitance in Shutdown	$\overline{\text{SHDN}} = V_{SS}$	—	—	5	pF
T_{SEL}	Select Time	REF Valid from $\overline{\text{SHDN}} = V_{IH}$ $R_L = 100\text{K}\Omega$ to V_{SS}	—	200	—	μsec
T_{DESEL}	Deselect Time	REF Invalid from $\overline{\text{SHDN}} = V_{IL}$ $R_L = 100\text{K}\Omega$ 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	—	$\mu\text{V}/\sqrt{\text{Hz}}$

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 asymmetry 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 50 μA . The voltage reference is disabled during shutdown, with a high-impedance output.

$\overline{\text{SHDN}}$ Input

$\overline{\text{SHDN}}$ at V_{IL} disables both the comparator and voltage reference and reduces the supply current to less than 0.1 μA . The $\overline{\text{SHDN}}$ 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 latching will occur when the device is driven to its enabled state when $\overline{\text{SHDN}}$ 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:

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

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

TC1031

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.

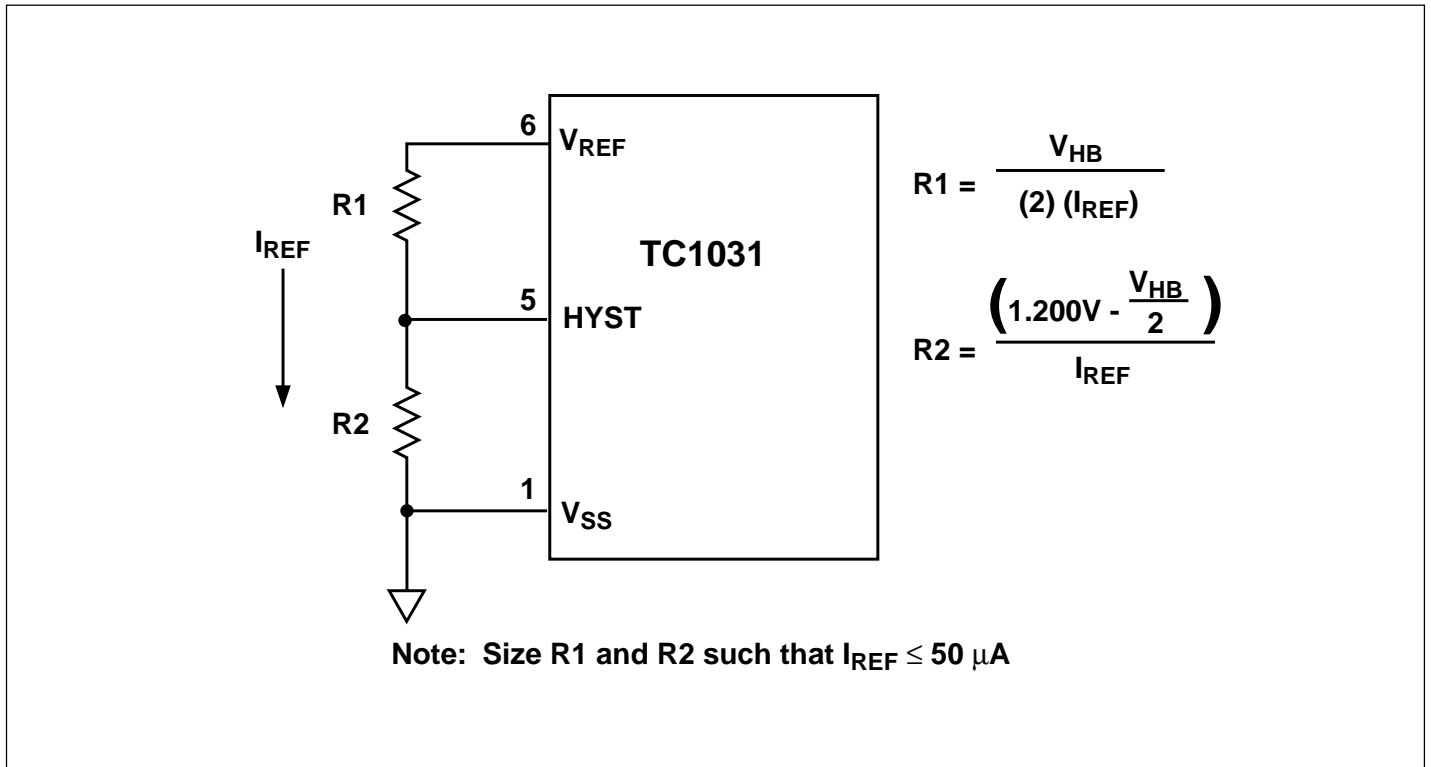
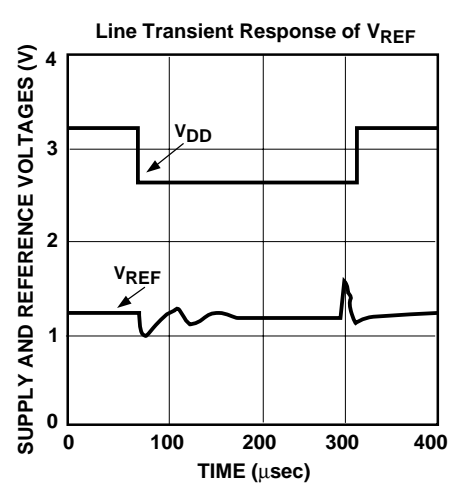
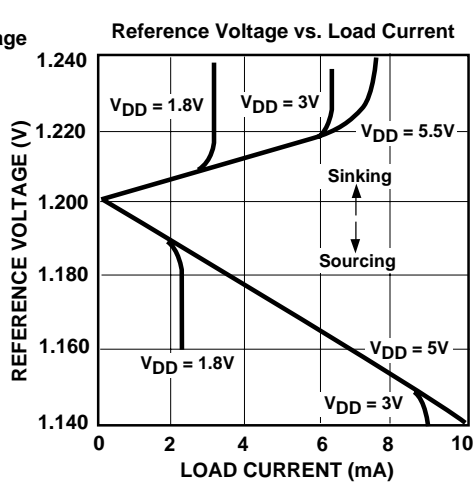
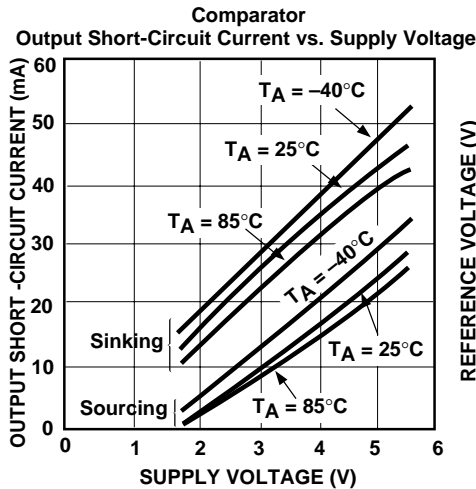
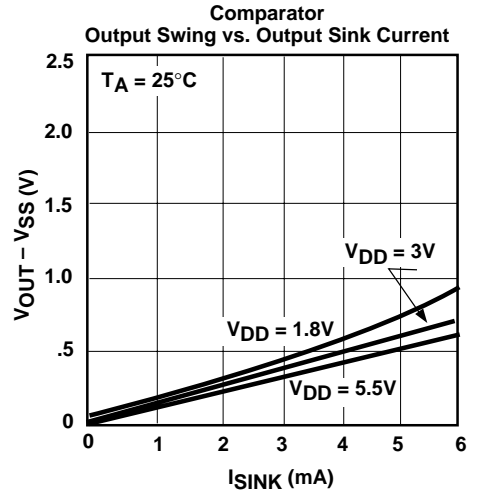
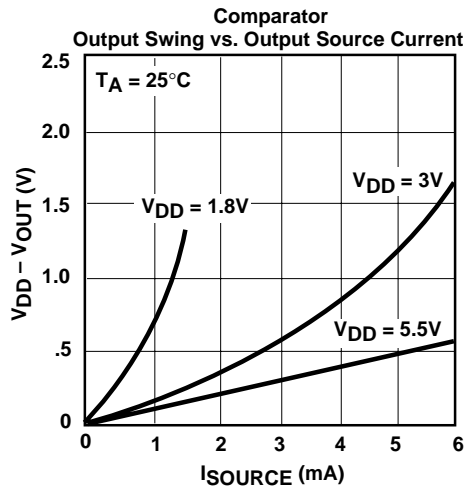
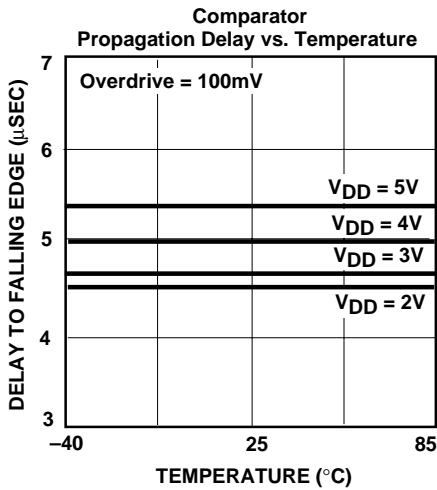
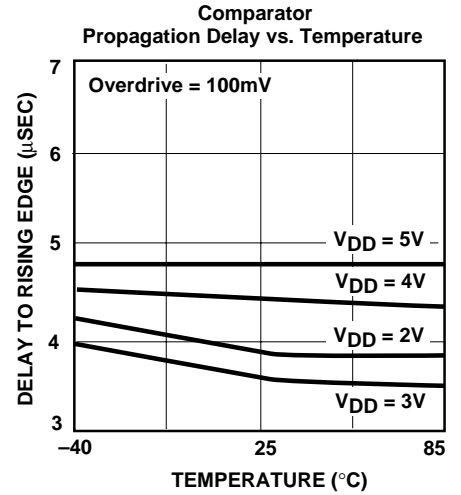
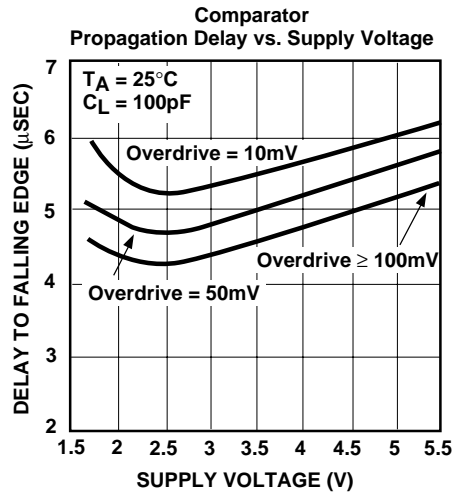
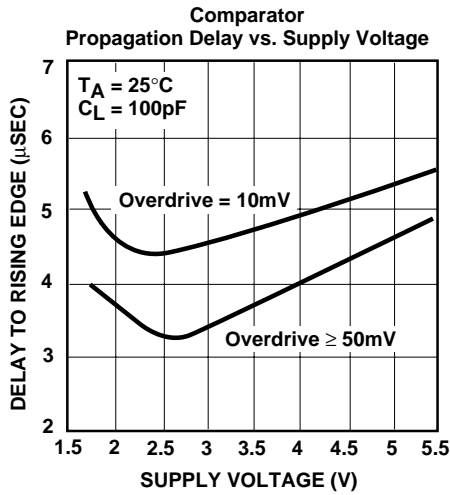


Figure 1. TC1031 Programmable Hysteresis

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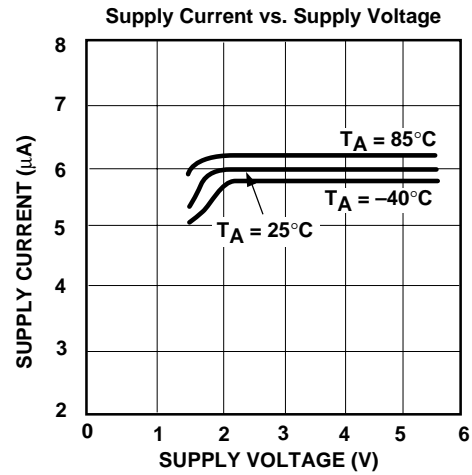
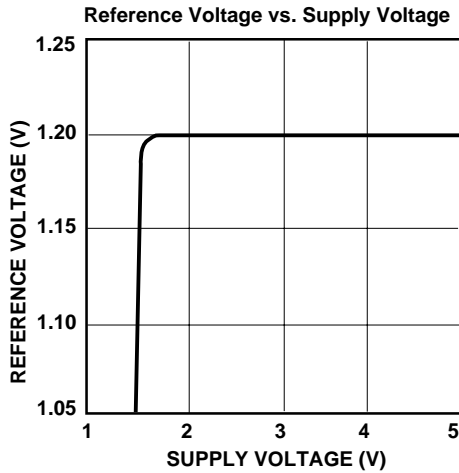
TYPICAL CHARACTERISTICS



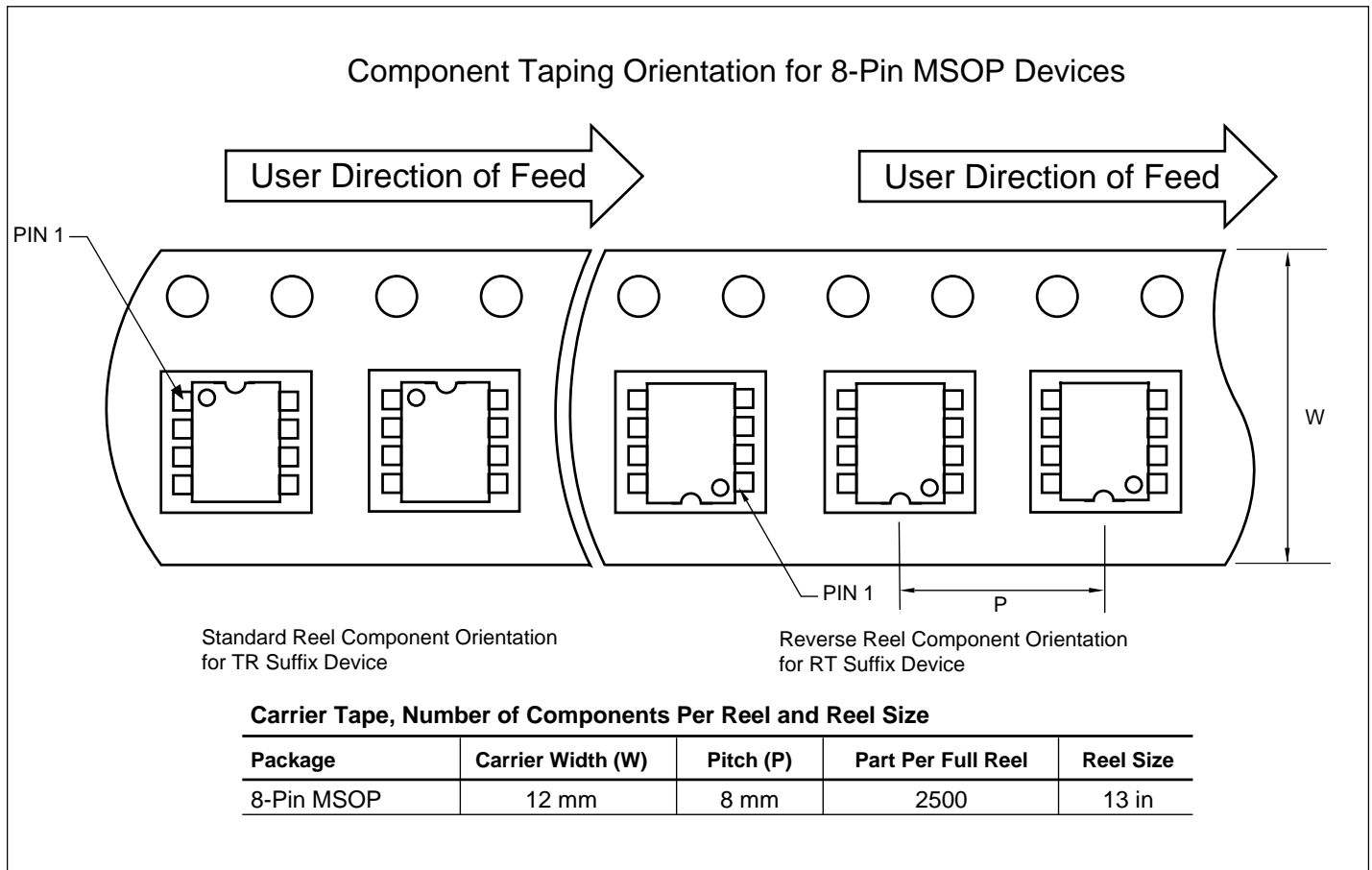
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TYPICAL CHARACTERISTICS



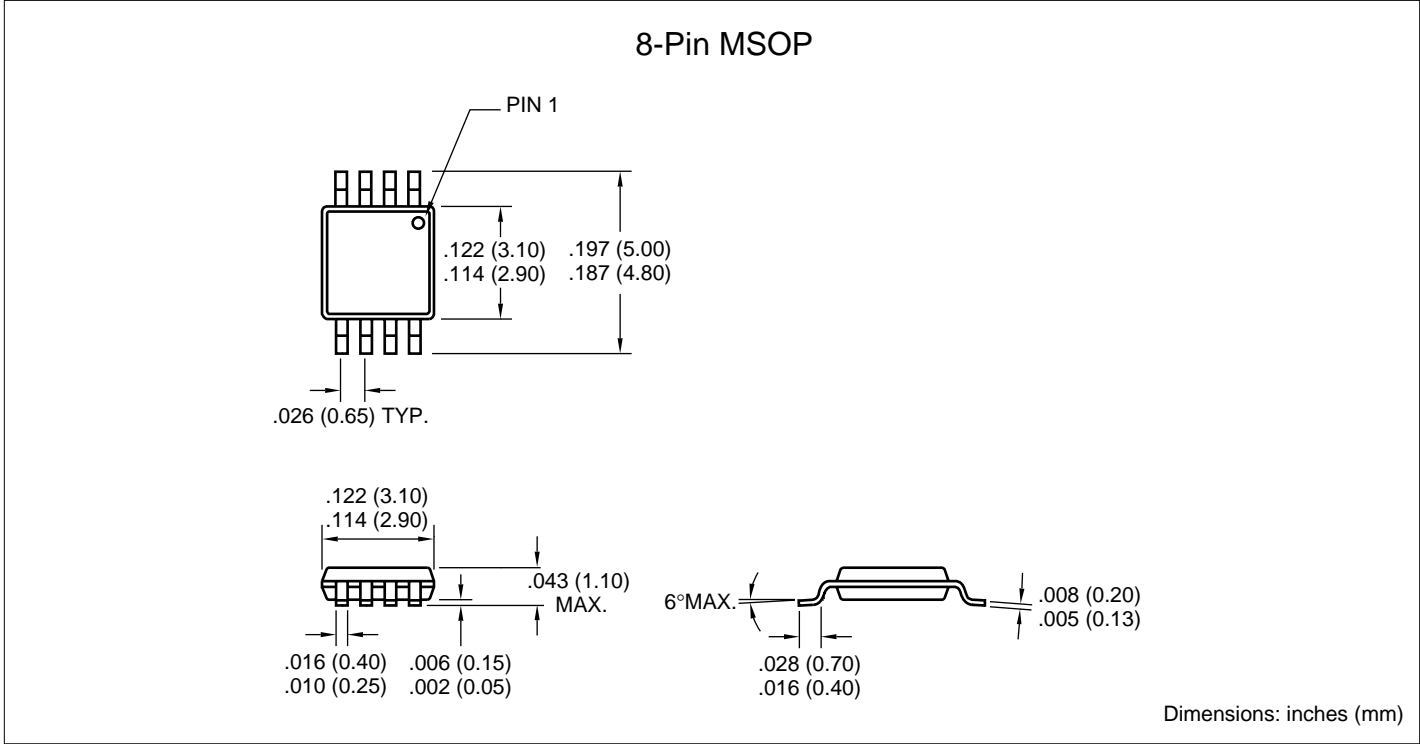
TAPING FORM



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

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PACKAGE DIMENSIONS





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