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 an 8-Pin MSOP (Occupies Only Half the Area of an 8-Pin SOIC)**
- **Ultra Low Input Bias Current ..... Less than 100 pA**
- **Low Quiescent Current ..... 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**

GENERAL DESCRIPTION

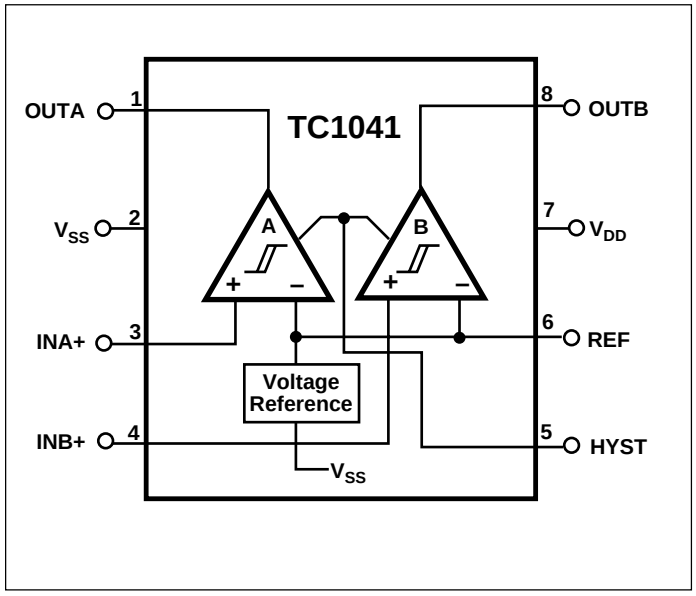
The TC1041 is a mixed-function device combining two comparators and a voltage reference in a single 8-pin package. The inverting inputs of both comparators are internally connected to the reference.

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 package size.

PIN CONFIGURATION (SOIC, MSOP)



ORDERING INFORMATION

Part No.	Package	Temp. Range
TC1041CEOA	8-Pin SOIC	– 40˚C to +85˚C
TC1041CEUA	8-Pin MSOP	– 40°C to +85°C

TC1041

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: 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	Test Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage		1.8	—	5.5	V
I_Q	Supply Current	All Outputs Open	—	10	16	µA
COMPARATORS						
V_{IR}	IN+ Voltage Range		V_{SS} – 0.2	—	V_{DD} + 0.2	V
V_{OS}	Input Offset Voltage	V_{DD} = 3V, T_A = 25°C T_A = –40°C to +85°C (Note 1)	–5 –5	— —	+5 +5	mV mV
I_B	Input Bias Current	T_A = 25°C $IN^+ = V_{DD}$ 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	60	—	—	dB
I_{SRC}	Output Source Current	$IN^+ = V_{DD}$ V_{DD} = 1.8V, Output Shorted to V_{SS}	1	—	—	mA
I_{SINK}	Output Sink Current	$IN^+ = V_{SS}$ 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
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
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 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.

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 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 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.

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.

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:

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

and is symmetrical around the normal (without hystereris) 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 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.

Precision Battery Monitor

Figure 2 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 of Figure 2 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 16 µA at 3V. Resistors R5 and R6 provide hysteresis of 116mV for both comparators.

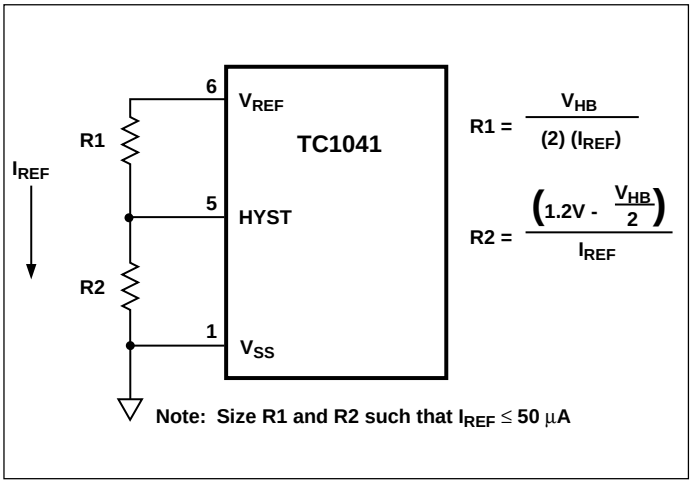


Figure 1. TC1041 Programmable Hysteresis

TC1041

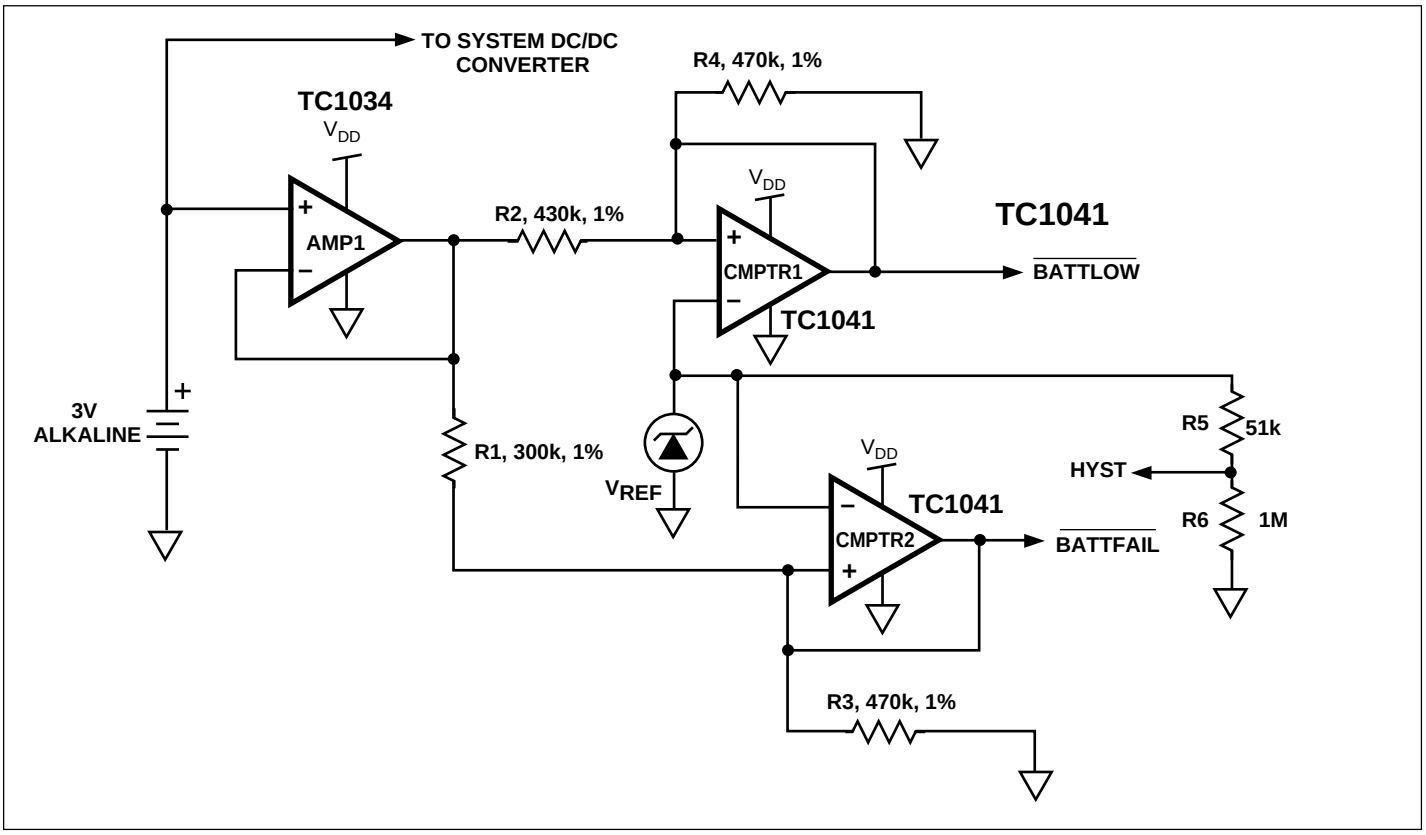
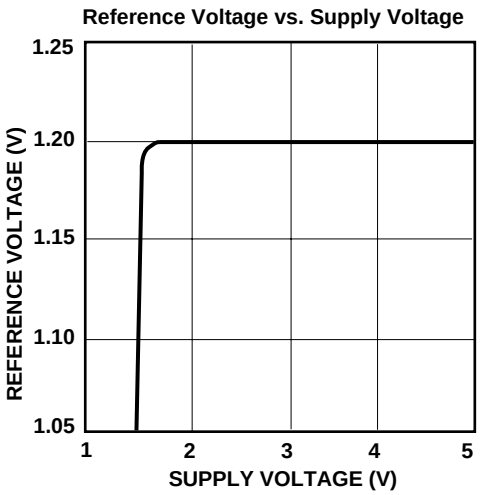
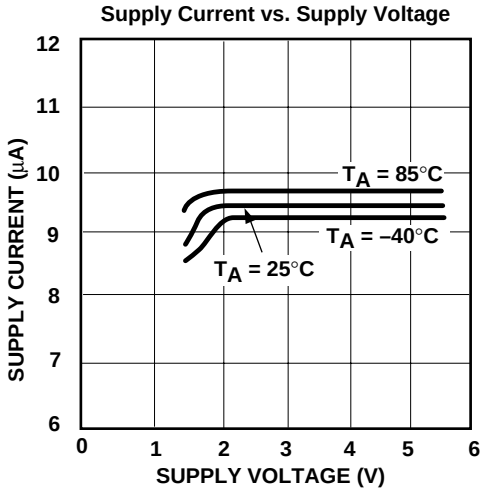


Figure 2. Precision Battery Monitor

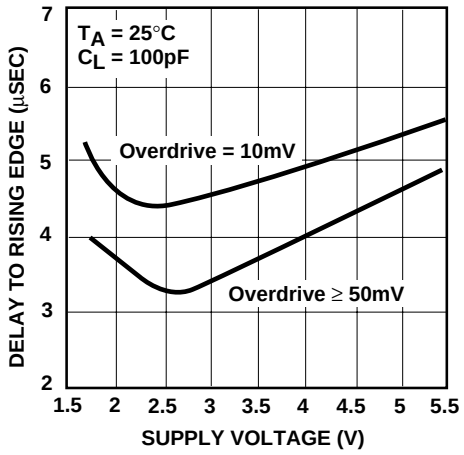
TYPICAL CHARACTERISTICS



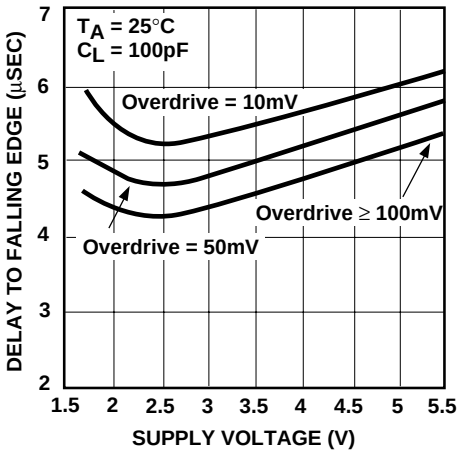


TYPICAL CHARACTERISTICS

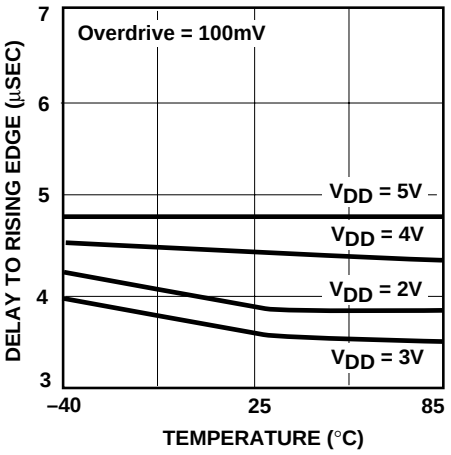
Comparator
Propagation Delay vs. Supply Voltage



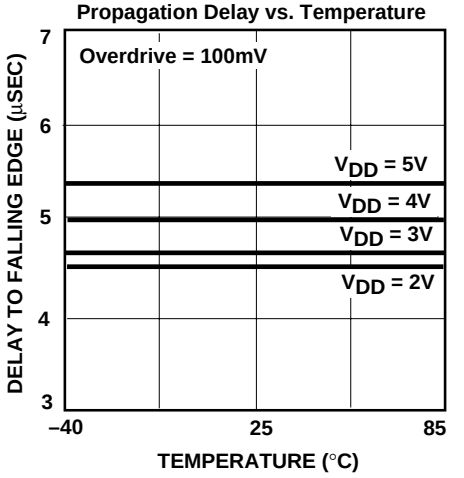
Comparator
Propagation Delay vs. Supply Voltage



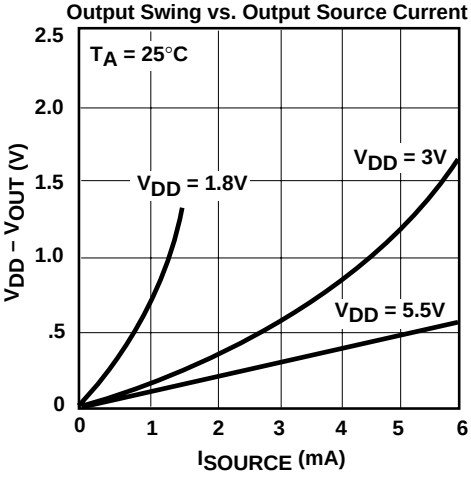
Comparator
Propagation Delay vs. Temperature



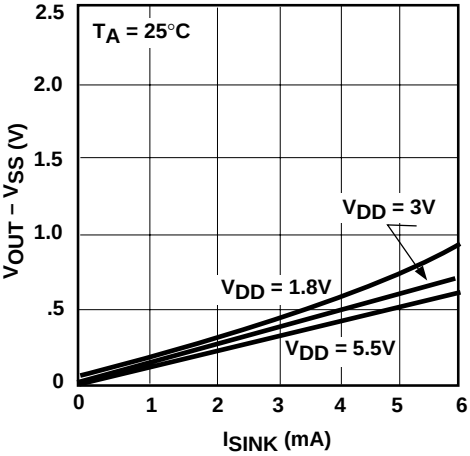
Comparator
Propagation Delay vs. Temperature



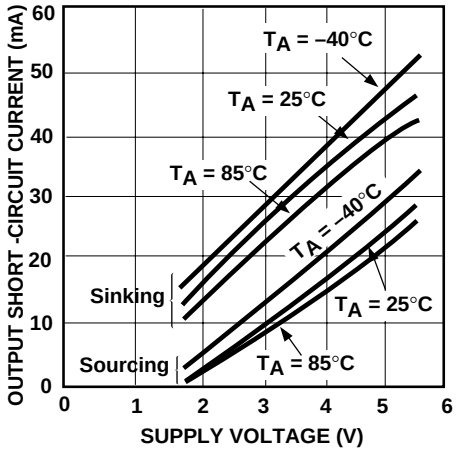
Comparator
Output Swing vs. Output Source Current



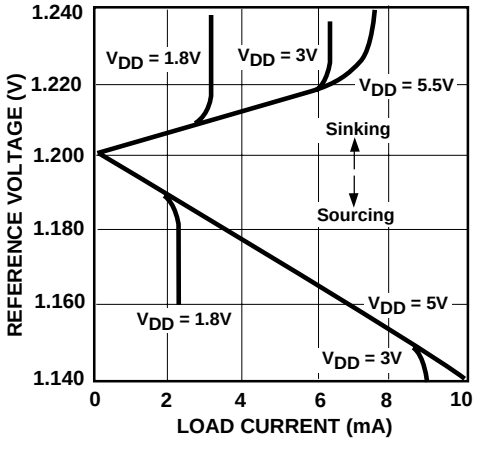
Comparator
Output Swing vs. Output Sink Current



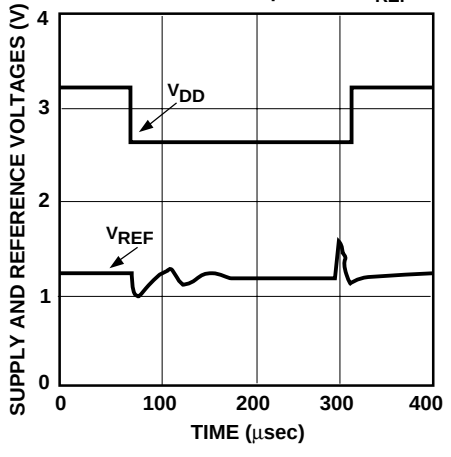
Comparator
Output Short-Circuit Current vs. Supply Voltage



Reference Voltage vs. Load Current



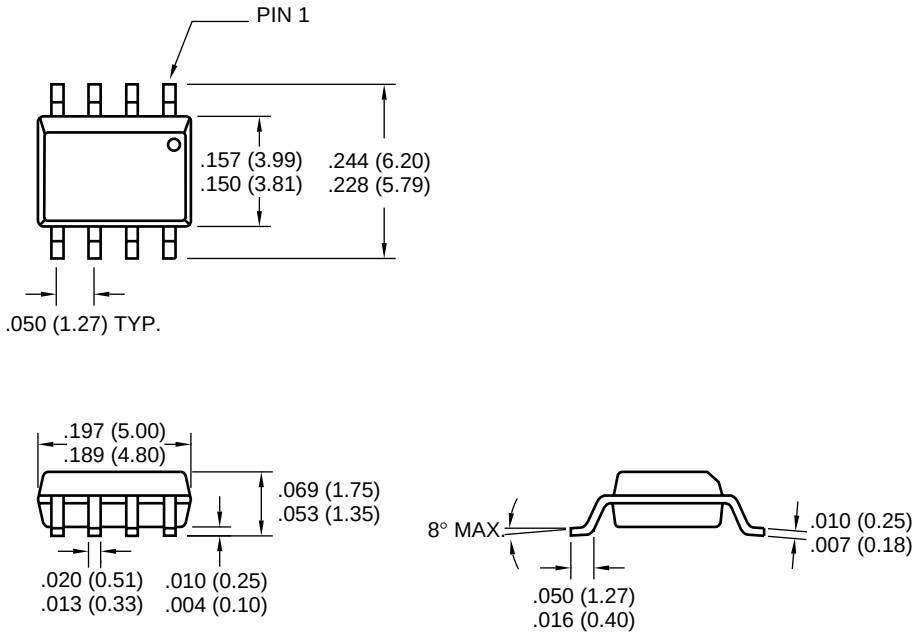
Line Transient Response of V_{REF}



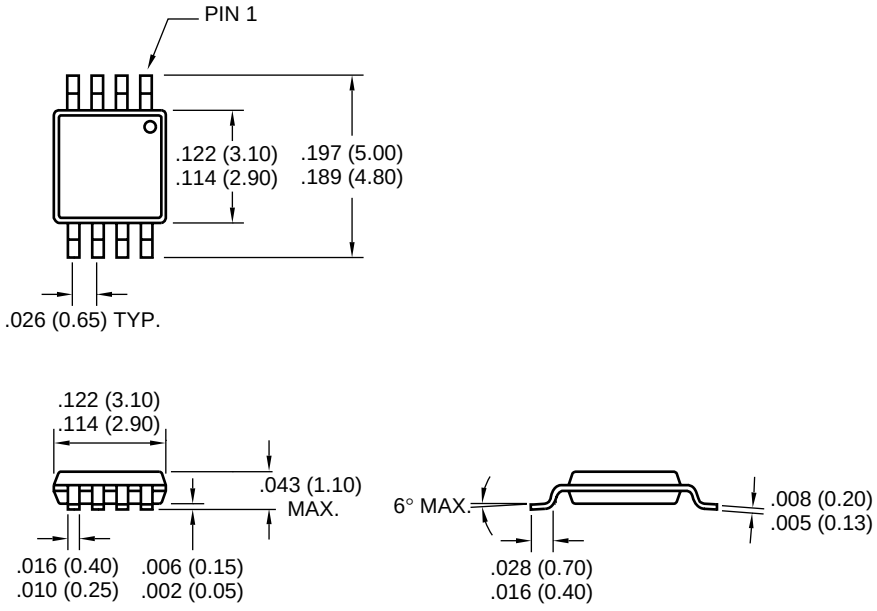
TC1041

PACKAGE DIMENSIONS

8-Pin SOIC (Narrow)



8-Pin MSOP



Dimensions: inches (mm)

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