

Nanopower Precision Shunt Voltage Reference

FEATURES

- **Initial Voltage Accuracy: 0.05%**
- **Low Operating Current: 800nA**
- **Low Drift: 10ppm/°C Max**
- Less Than 1Ω Dynamic Impedance
- Available in 1.25V and 2.5V SO-8 Packages

APPLICATIONS

- Portable Meters
- Precision Regulators
- A/D and D/A Converters
- Calibrators

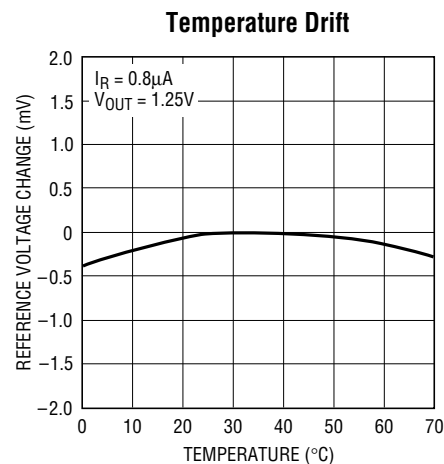
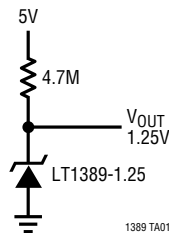
DESCRIPTION

The LT[®]1389 is a nanopower, precision shunt voltage reference. The bandgap reference uses trimmed precision thin-film resistors to achieve 0.05% initial voltage accuracy. An improved curvature correction technique guarantees 10ppm/°C maximum temperature drift. Advances in design, processing and packaging techniques guarantee 800nA operation and low temperature cycling hysteresis. The LT1389 does not require an output compensation capacitor, but is stable with capacitive loads. Low dynamic impedance makes the LT1389 reference easy to use from unregulated supplies.

The LT1389 reference can be used as a high performance upgrade to the LM185/LM385, LT1004, LT1034 and LT1634 where lowest power and guaranteed temperature drift is required.

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TYPICAL APPLICATION



ABSOLUTE MAXIMUM RATINGS

(Note 1)

Operating Current

1.25V 20mA

2.5V 20mA

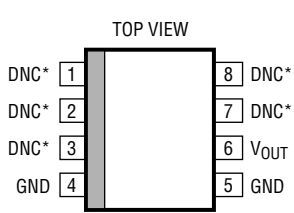
Forward Current 20mA

Operating Temperature Range 0°C to 70°C

Storage Temperature Range (Note 2) ... -65°C to 150°C

Lead Temperature (Soldering, 10 sec) 300°C

PACKAGE/ORDER INFORMATION

 S8 PACKAGE 8-LEAD PLASTIC SO $T_{JMAX} = 125^{\circ}\text{C}$, $\theta_{JA} = 190^{\circ}\text{C/W}$	ORDER PART NUMBER
	LT1389ACS8-1.25
	LT1389BCS8-1.25
	LT1389BCS8-2.5
S8 PART MARKING	
389A1	
389B1	
389B2	

*Connected internally. Do Not Connect external circuitry to these pins.
Consult factory for Industrial and Military grade parts.

AVAILABLE OPTIONS

TEMPERATURE	ACCURACY (%)	TEMPERATURE COEFFICIENT (ppm/°C)	PACKAGE TYPE	PART MARKING
			S8	S8
0°C to 70°C	0.05	10	LT1389ACS8-1.25	389A1
	0.05	20	LT1389BCS8-1.25	389B1
	0.05	20	LT1389BCS8-2.5	389B2

1.25V ELECTRICAL CHARACTERISTICS (Note 3)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1389ACS8/LT1389BCS8 ($I_R = 0.8\mu\text{A}$)	1.24937 -0.05	1.250	1.25062 0.05	V %
	LT1389ACS8 ($I_R = 0.8\mu\text{A}$)	1.24849 -0.12	1.250	1.25149 0.12	V %
	LT1389BCS8 ($I_R = 0.8\mu\text{A}$)	1.24762 -0.19	1.250	1.25237 0.19	V %
Reverse Breakdown Change with Current (Note 4)	$0.8\mu\text{A} \leq I_R \leq 200\mu\text{A}$		0.20 0.20	0.4 1.0	mV mV
	$200\mu\text{A} \leq I_R \leq 2\text{mA}$		0.3 0.3	1.0 2.0	mV mV
Minimum Operating Current				0.6	μA
Temperature Coefficient	LT1389ACS8 ($I_R = 0.8\mu\text{A}$)		4	10	ppm/°C
	LT1389BCS8 ($I_R = 0.8\mu\text{A}$)		4	20	ppm/°C
Reverse Dynamic Impedance (Note 5)	$0.8\mu\text{A} \leq I_R \leq 2\text{mA}$		0.25 0.25	0.7 1.5	Ω Ω
Low Frequency Noise (Note 6)	$I_R = 0.8\mu\text{A}$, $0.1\text{Hz} \leq f \leq 10\text{Hz}$		20		μV_{P-P}

2.5V ELECTRICAL CHARACTERISTICS (Note 3)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1389BCS8 ($I_R = 0.9\mu A$)	2.49875 –0.05	2.500	2.50125 0.05	V %
	LT1389BCS8 ($I_R = 0.9\mu A$)	2.49525 –0.19	2.500	2.50475 0.19	V %
Reverse Breakdown Change with Current (Note 4)	$0.9\mu A \leq I_R \leq 200\mu A$		0.2 0.2	0.5 1.5	mV mV
	$200\mu A \leq I_R \leq 2mA$		0.3 0.3	1.0 2.5	mV mV
Minimum Operating Current				0.7	μA
Temperature Coefficient	$I_R = 0.9\mu A$		8	20	ppm/°C
Reverse Dynamic Impedance (Note 5)	$0.9\mu A \leq I_R \leq 2mA$		0.25	0.75	Ω
			0.25	2	Ω
Low Frequency Noise (Note 6)	$I_R = 0.9\mu A, 0.1Hz \leq f \leq 10Hz$		40		μV_{P-P}

The ● denotes specifications which apply over the full operating temperature range.

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: If the part is stored outside of the specific operating temperature range, the output may shift due to hysteresis.

Note 3: ESD (Electrostatic Discharge) sensitive device. Use proper ESD handling precautions.

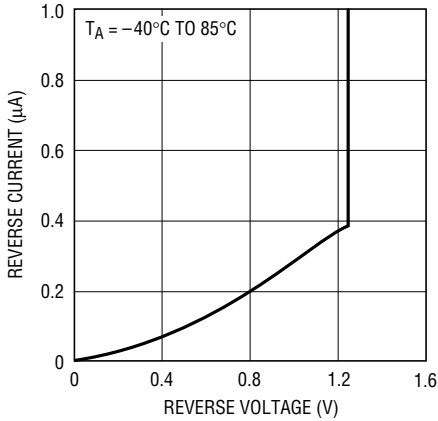
Note 4: Output requires 0.1 μF for operating current greater than 1mA.

Note 5: This parameter is guaranteed by “reverse breakdown change with current” test.

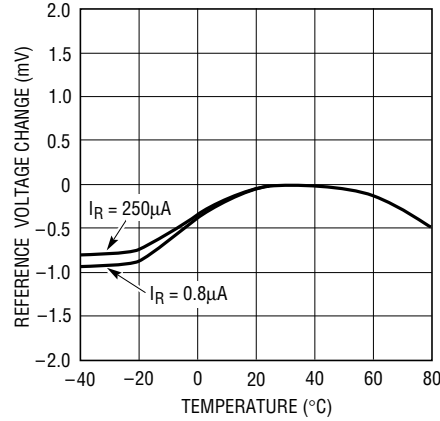
Note 6: Peak-to-peak noise is measured with a single highpass filter at 0.1Hz and 2-pole lowpass filter at 10Hz.

1.25V TYPICAL PERFORMANCE CHARACTERISTICS

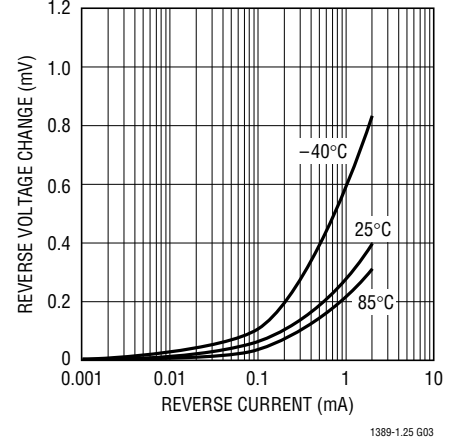
Reverse Characteristics



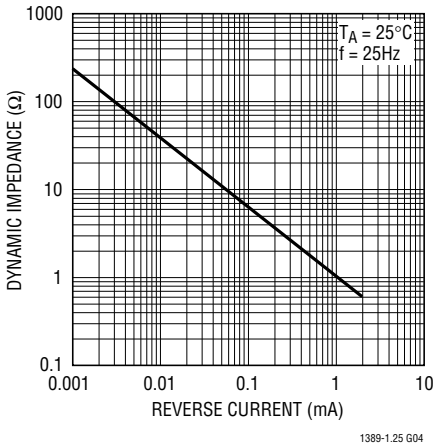
Temperature Drift



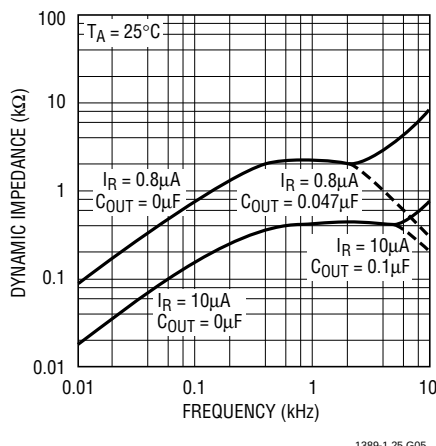
Reverse Voltage Change vs Current



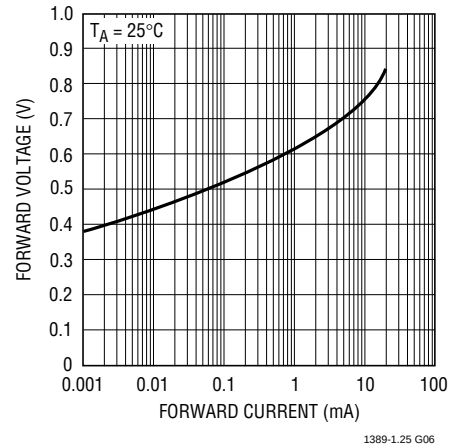
Reverse Dynamic Impedance



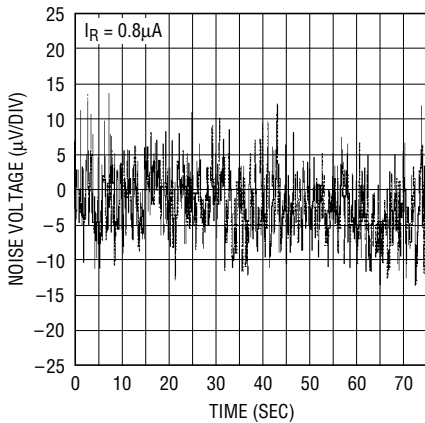
Dynamic Impedance vs Frequency



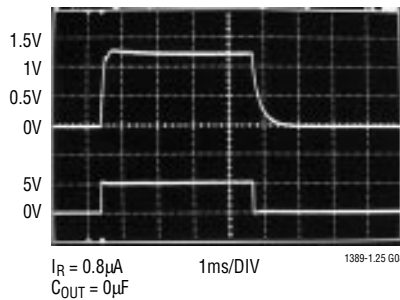
Forward Characteristics



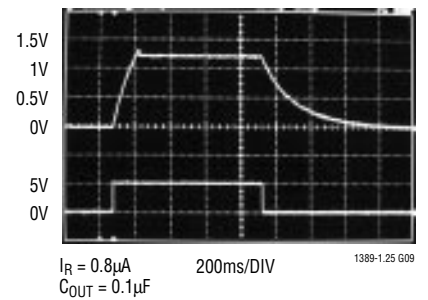
0.1Hz to 10Hz Noise



Response Time

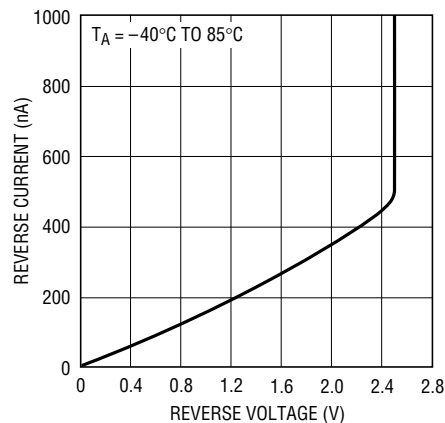


Response Time

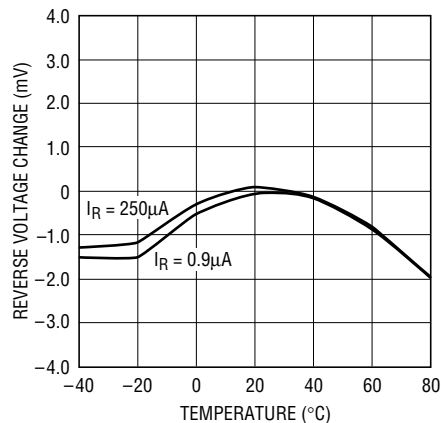


2.5V TYPICAL PERFORMANCE CHARACTERISTICS

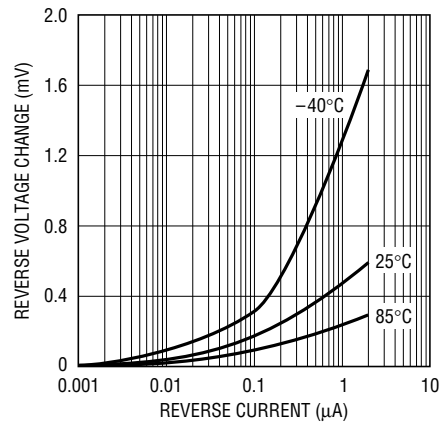
Reverse Characteristics



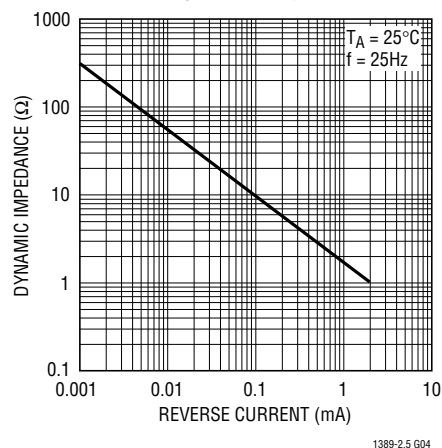
Temperature Drift



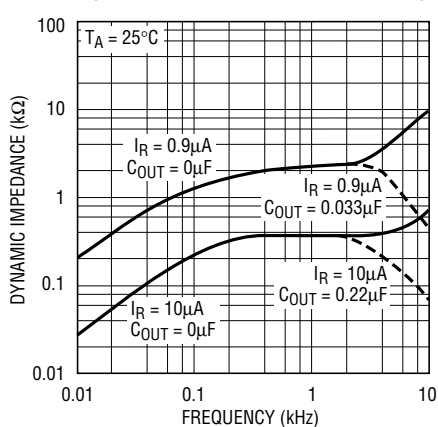
Reverse Voltage Change vs Current



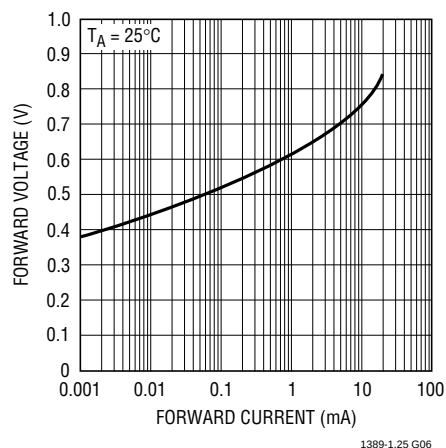
Reverse Dynamic Impedance



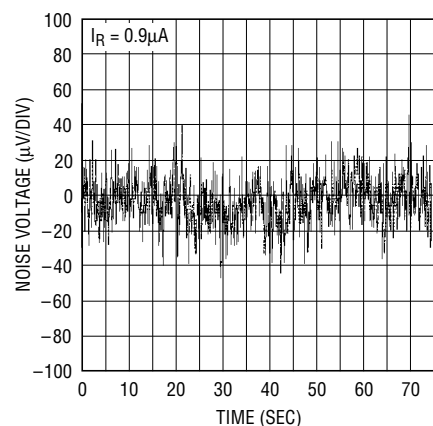
Dynamic Impedance vs Frequency



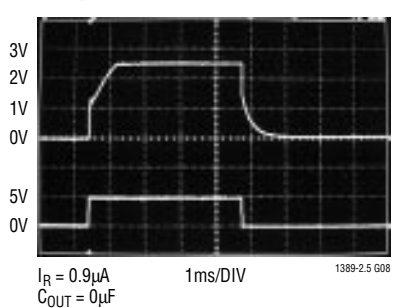
Forward Characteristics



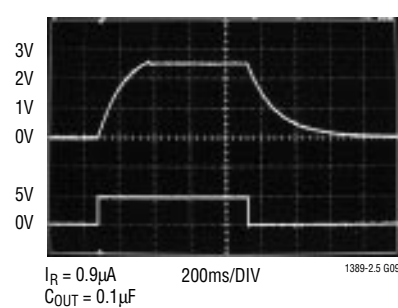
0.1Hz to 10Hz Noise



Response Time



Response Time



APPLICATIONS INFORMATION

The reverse characteristics of the LT1389 behave like a resistor in parallel with a Zener diode. This simple, well behaved characteristic is important to the proper operation of circuits like Figure 1. The adjustable output voltage reference depends upon positive feedback from the LT1495's output to start-up and regulate the bias current for the LT1389

Board leakage is a concern for a nanopower precision shunt voltage reference. The LT1389 requires attention to detail in board layout in order to maximize its performance. $1.5\text{G}\Omega$ of leakage between a DNC pin and a 5V supply will conduct 2.5nA which induces a 0.2% error in V_{OUT} . Board leakage can be minimized by encircling the DNC pins with a guard ring operated at a potential of V_{OUT} . By tying the guard ring to V_{OUT} as shown in Figure 2, leakage paths are eliminated.

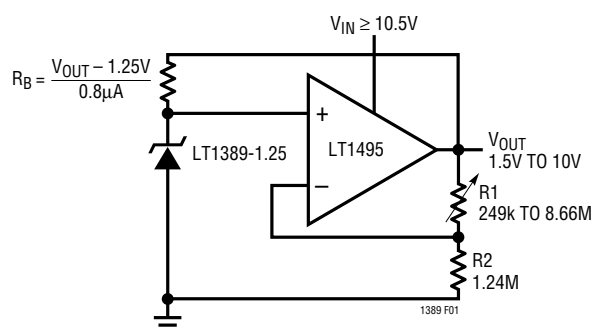


Figure 1. Adjustable Output Voltage Reference

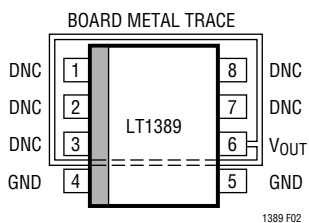
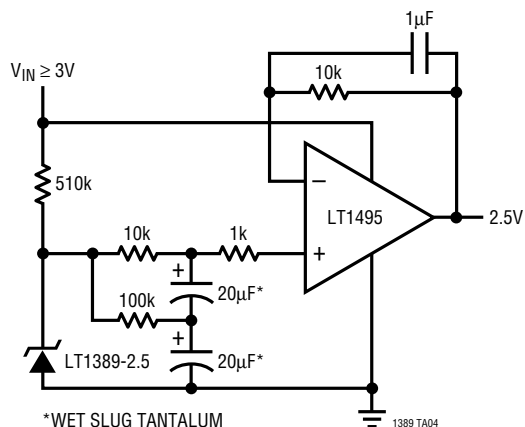


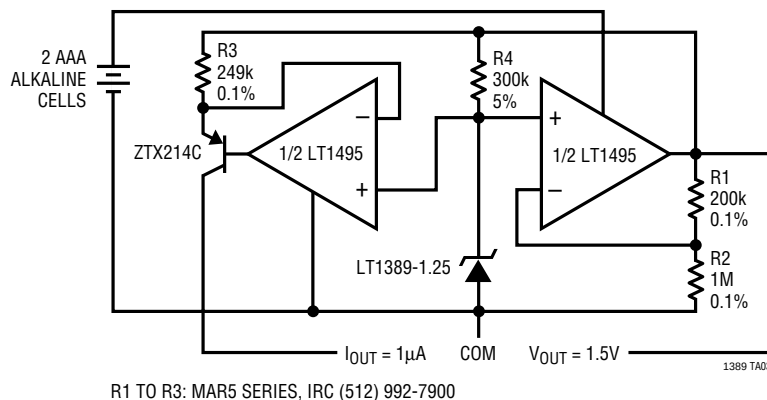
Figure 2. Guard Ring to Reduce Board Leakage

TYPICAL APPLICATIONS

2.5V Output, Low Noise Reference



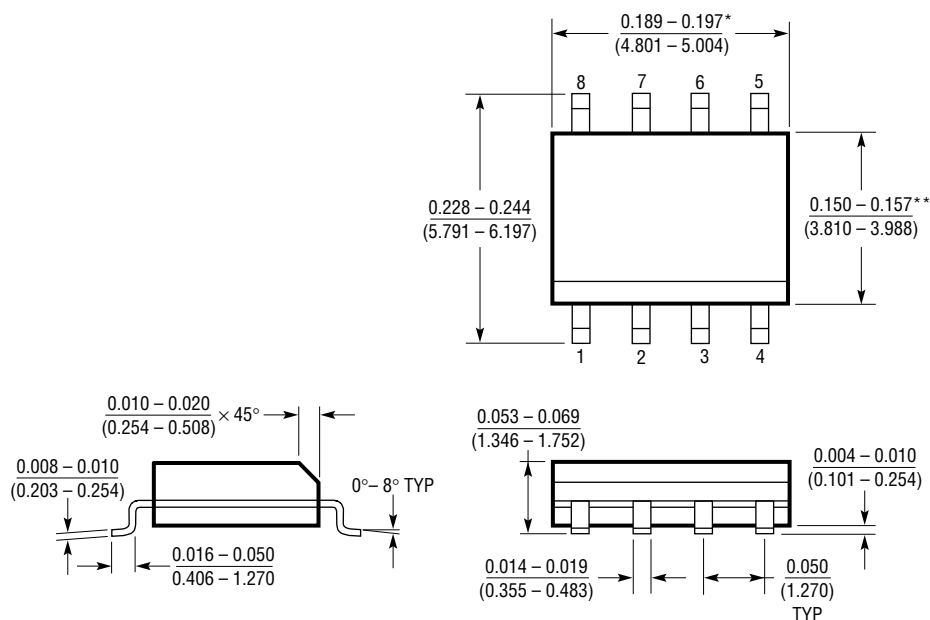
Micropower Voltage and Current Reference



PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S8 Package 8-Lead Plastic Small Outline (Narrow 0.150) (LTC DWG # 05-08-1610)



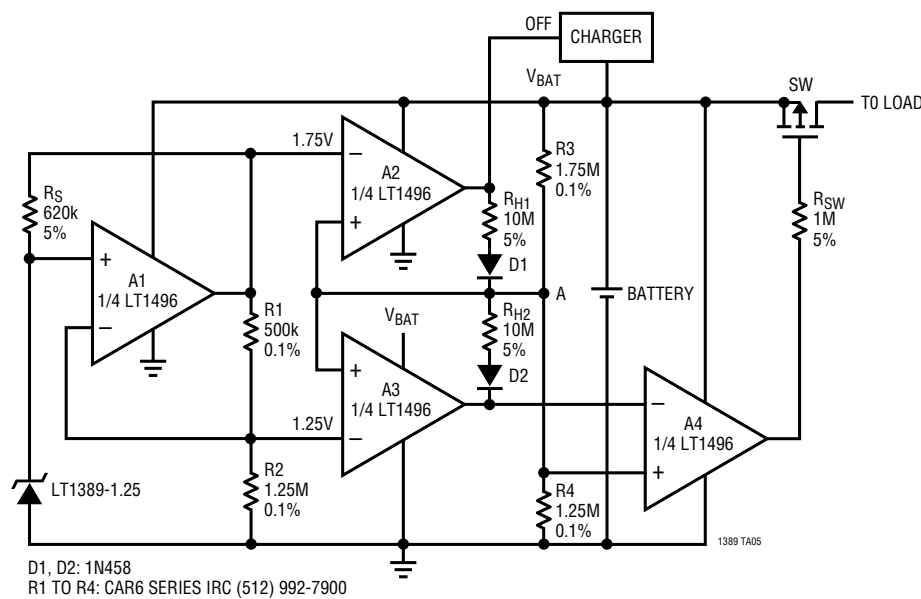
*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

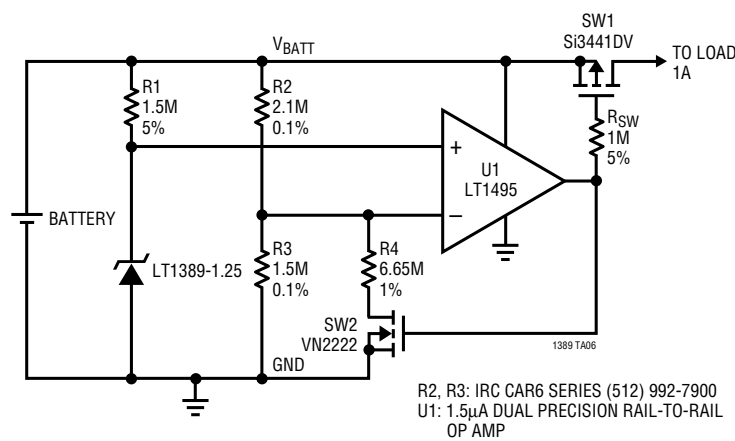
S08 0996

TYPICAL APPLICATIONS

Single Cell Li-Ion Battery Supervisory Circuit, $I_Q = 10\mu A$



Precision Undervoltage Lockout Circuit



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC®1440	Micropower Comparator with Reference	3.7μA Max Supply Current, 1% 1.182V Reference, MSOP, PDIP and SO-8 Packages
LT1460	Micropower Series Reference	0.075% Max, 10ppm/°C Max Drift, 2.5V, 5V and 10V Versions, MSOP, PDIP, SO-8, SOT-23 and TO-92 Packages
LT1495	1.5μA Precision Rail-to-Rail Dual Op Amp	1.5μA Max Supply Current, 100pA Max I_{OS}
LTC1540	Nanopower Comparator with Reference	600nA Max Supply Current, 2% 1.182V Reference, MSOP and SO-8 Packages
LT1634	Micropower Precision Shunt Voltage Reference	0.05% Max, 10ppm/°C Max Drift, 1.25V, 2.5V, 4.096V, 5V, 10μA Maximum Supply Current