Precision Adjustable Shunt Reference

TL431

FEATURES

- **Trimmed 1% Bandgap Reference**
- **Nominal Temperature Range Extended to 105^{o}C**
- **Temperature-Compensated: 30ppm/^{o}C**
- **Internal Amplifier with 150mA Capability**
- **Low Output Noise**
- **Low Frequency Dynamic Output Impedance**

DESCRIPTION

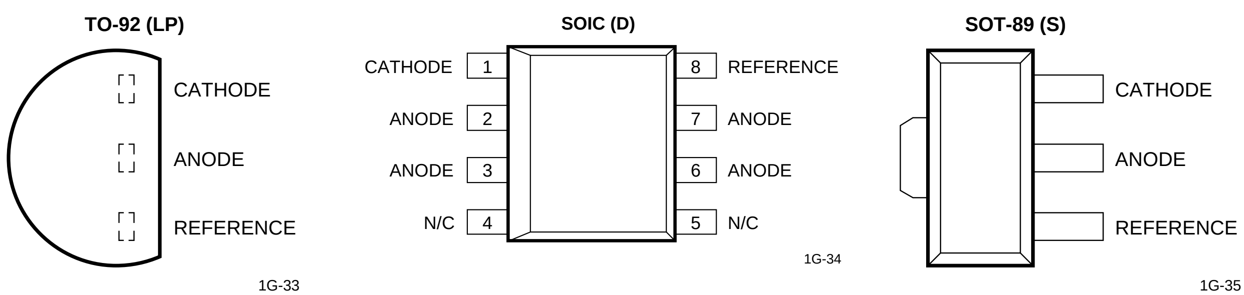
The TL431 is an adjustable shunt regulator designed to act as an open-loop error amplifier with a 2.5V temperature compensated reference. Its highly accurate 1% bandgap reference is perfect for applications requiring stability and accuracy over temperature and life.

Sharp turn-on characteristics and a low temperature coefficient make the TL431 an excellent replacement for many zener diode applications, programmable to any value greater than 2.5V and up to 36V by using two external resistors. As a combination error amplifier and reference, it can be used to manage control loops such as switching power supplies.

ORDERING INFORMATION

Part	Package	Temperature Range
TL431LP	TO-92	0 to 105^{o}C
TL431D	8-Pin Plastc SOIC	0 to 105^{o}C
TL431S	SOT-89	0 to 105^{o}C

PIN CONFIGURATION (Top View)



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ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
V_{KA}	Cathode-Anode Reverse Breakdown	37	V
I_{AK}	Anode-Cathode Forward Current	1	A
I_{KA}	Operating Cathode Current	250	mA
I_{REF}	Reference Input Current	10	mA
P_D	Continuous Power at 25°C TO-92 8L SOIC SOT-89	 775 750 1000	 mW mW mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	–65 to 150	°C
T_L	Lead Temperature, Soldering 10 Seconds	300	°C

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

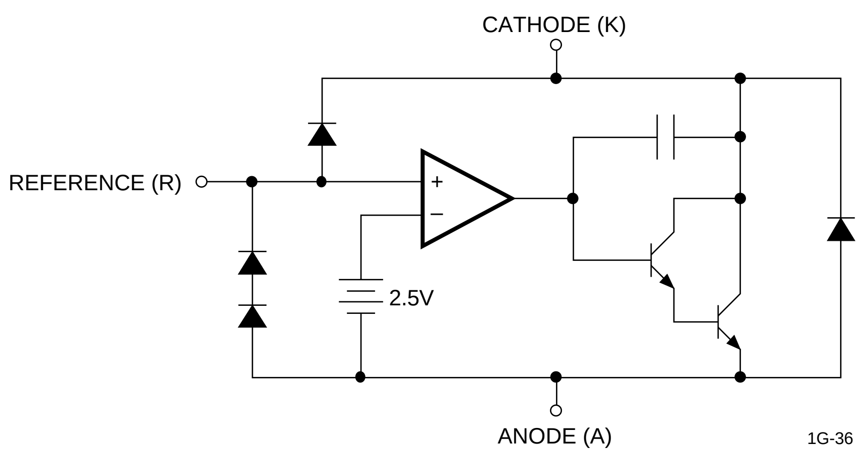
RECOMMENDED CONDITIONS

SYMBOL	PARAMETER	RATING	UNIT
V_{KA}	Cathode Voltage	V_{REF} to 20	V
I_K	Cathode Current	10	mA

TYPICAL THERMAL RESISTANCE

PACKAGE	θ_{JA}	θ_{JC}	TYPICAL DERATING
TO-92	160°C/W	80°C/W	6.3mW/°C
SOIC	175°C/W	45°C/W	5.7mW/°C
SOT-89	110°C/W	8°C/W	9.1mW/°C

FUNCTIONAL BLOCK DIAGRAM

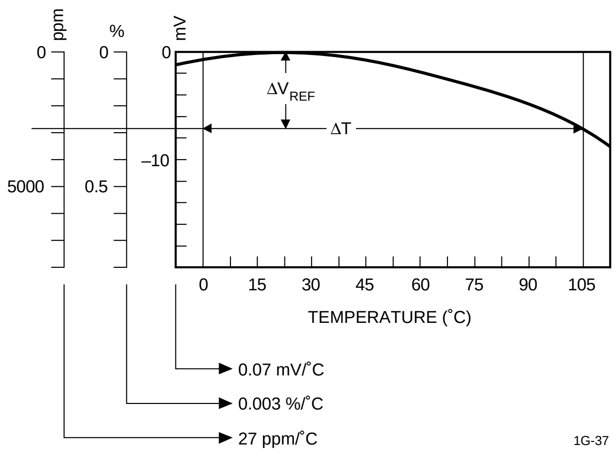


ELECTRICAL CHARACTERISTICS

Electrical Characteristics are guaranteed over full junction temperature range (0 to 105°C). Ambient temperature must be derated based on power dissipation and package thermal characteristics. The conditions are: $V_{KA} = V_{REF}$ and $I_K = 10mA$ unless otherwise stated.

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CIRCUIT	TEST CONDITION
V_{REF}	Reference Voltage	2.470	2.495	2.520	V	1	$T_A = 25°C$
		2.449		2.541	V	1	Over Temp.
TC	ΔV_{REF} with Temp.*		0.07	0.20	mV/°C	1	
$\frac{\Delta V_{REF}}{\Delta V_K}$	Ratio of Change in V_{REF} to Cathode Voltage	–2.7	–1.0		mV/V	2	V_{REF} to 10V
		–2	–0.4	0.3			10V to 36V
I_{REF}	Reference Input Current		0.7	4	µA	2	
ΔI_{REF}	I_{REF} Temp Deviation		0.4	1.2	µA	2	Over Temp.
$I_{K(MIN)}$	Min I_K for Regulation		0.4	1	mA	1	
$I_{K(OFF)}$	Off State Leakage		0.04	250	nA	3	$V_{REF} = 0V$, $V_{KA} = 36V$
Z_{KA}	Dynamic Output Impedance		0.15	0.5	Ω	1	$f \leq 1kHz$, $I_K = 1$ to 150mA

*CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

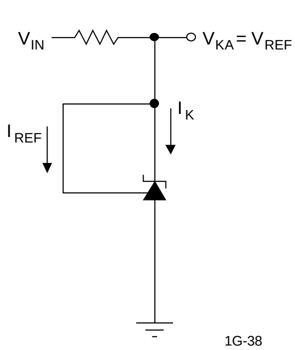


- $$\text{TC in mV/°C} = \frac{\Delta V_{REF}\ (mV)}{\Delta T_A}$$

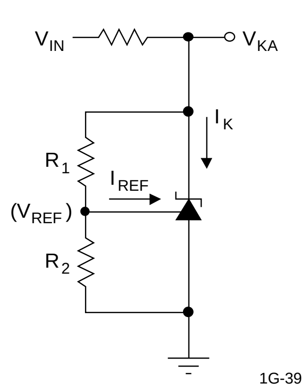
- $$\text{TC in \%/°C} = \frac{\left(\frac{\Delta V_{REF}}{V_{REF} \text{ at } 25°C}\right) \times 100}{\Delta T_A}$$

- $$\text{TC in ppm/°C} = \frac{\left(\frac{\Delta V_{REF}}{V_{REF} \text{ at } 25°C}\right) \times 10^6}{\Delta T_A}$$

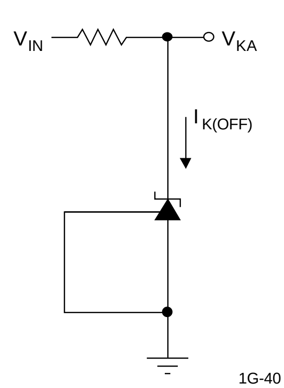
TEST CIRCUITS



TEST CIRCUIT 1



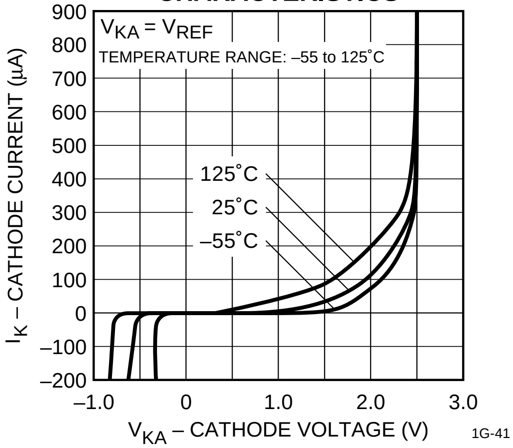
TEST CIRCUIT 2



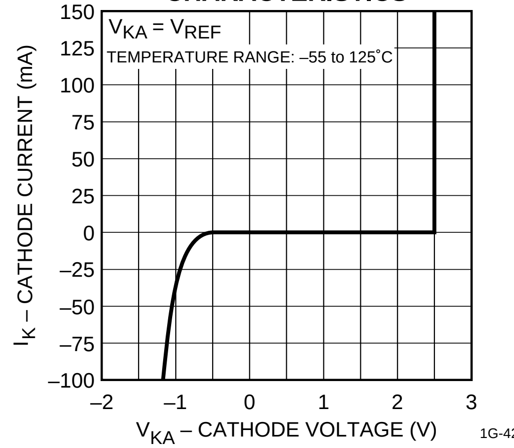
TEST CIRCUIT 3

TYPICAL PERFORMANCE CURVES

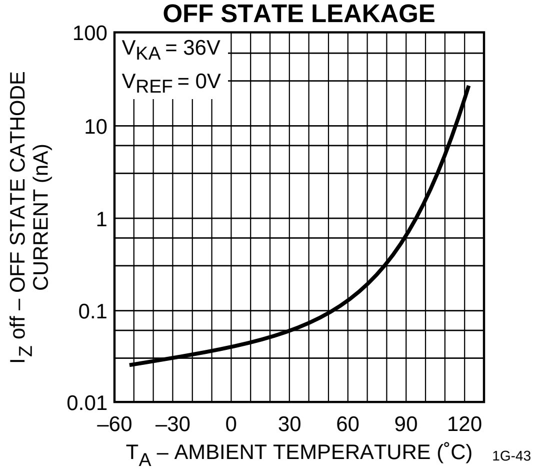
LOW CURRENT OPERATING CHARACTERISTICS



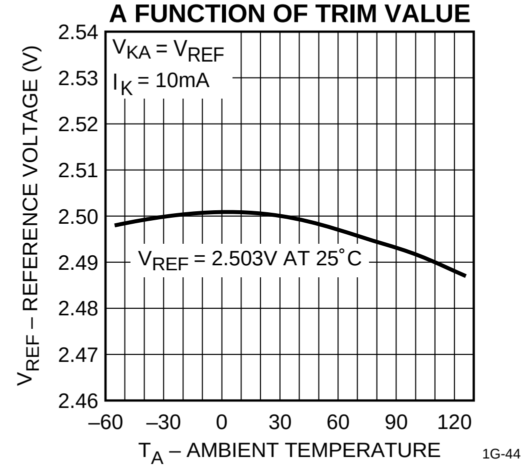
HIGH CURRENT OPERATING CHARACTERISTICS



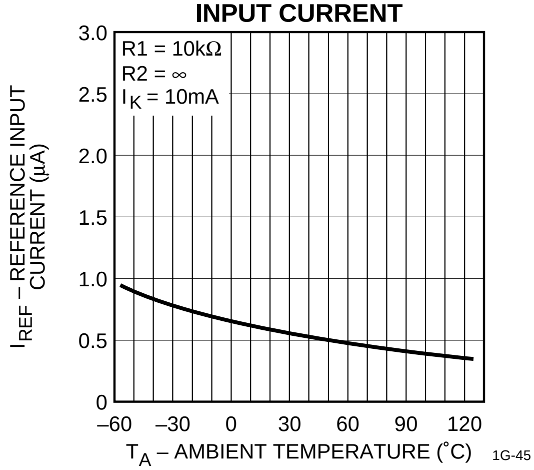
OFF STATE LEAKAGE



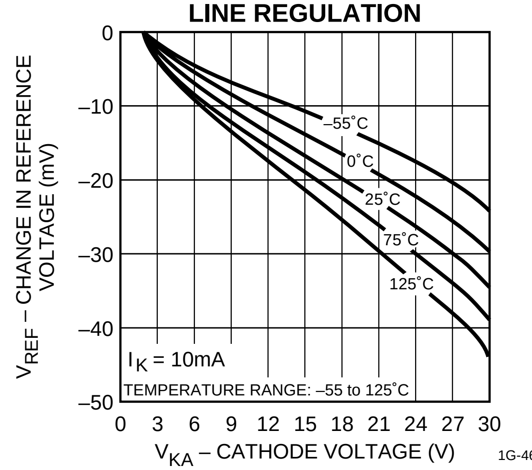
TEMPERATURE COEFFICIENT AS A FUNCTION OF TRIM VALUE



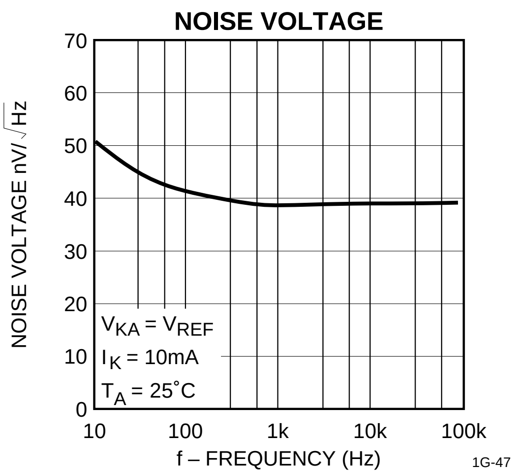
REFERENCE INPUT CURRENT

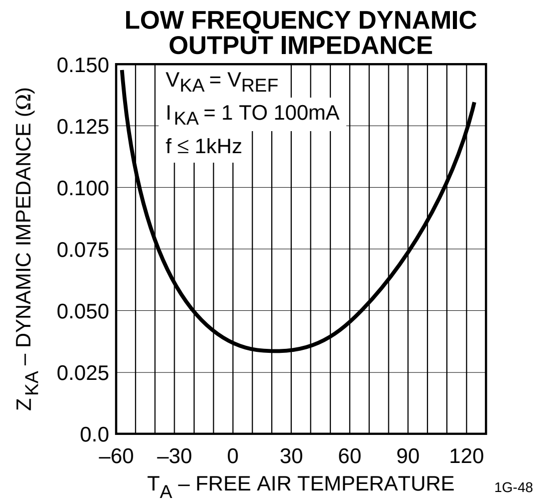


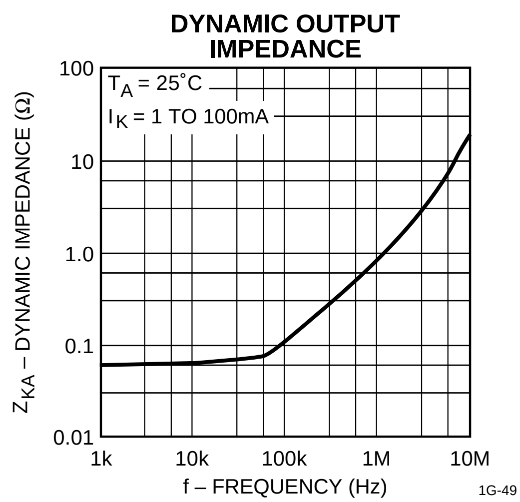
REFERENCE VOLTAGE LINE REGULATION

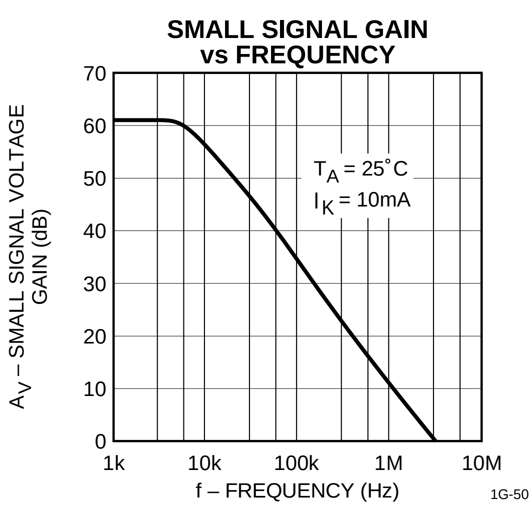


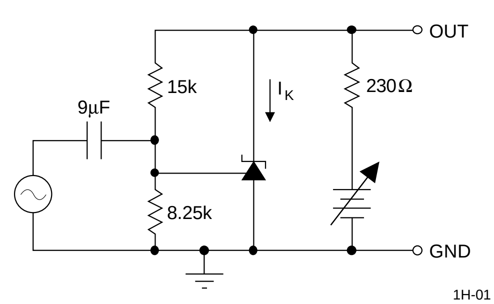
TYPICAL PERFORMANCE CURVES (continued)











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TYPICAL PERFORMANCE CURVES (continued)