TL431

Adjustable Precision Shunt Regulations

Features

- Programmable Precise Output Voltage from 2.5V to 36V
- High Stability under Capacitive Load
- Low Temperature Deviation: 5mV Typical
- Low Equivalent Full-range Temperature Coefficient
- With 40PPM/℃ Typical
- Sink Current Capacity from 1mA to 100 mA
- Low Output Noise
- Wide Operating Range of -40 to 125 ℃
- Lead-Free Packages, Available in "Green" Molding Compound:SOT-23, SOT-23-5, TO-92, SOT-89
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.

2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.

3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Applications

- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

General Description

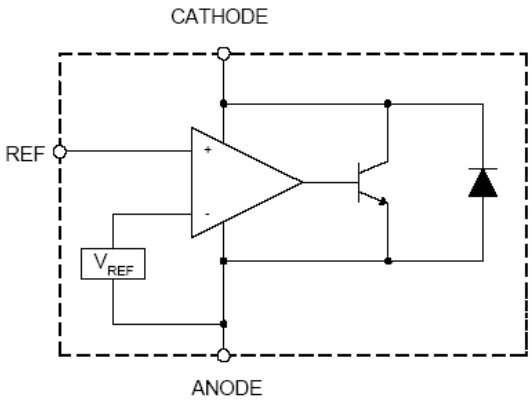
The TL431 is a three-terminal adjustable shunt regulator with guaranteed thermal stability over a full operation range. It features sharp turn-on characteristics, low temperature coefficient and low output impedance, which make it ideal substitute for Zener diode in applications such as switching power supply, charger and other adjustable regulators.

The output voltage of TL431 can be set to any value between Vref (2.5V) and the corresponding maximum cathode voltage (36V).

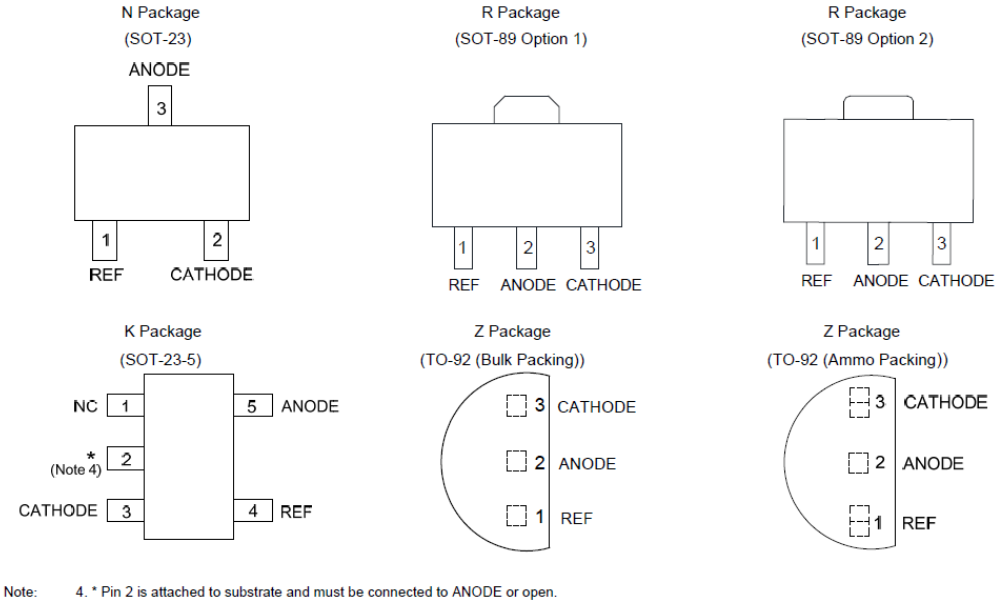
The TL431 precision reference is offered in two voltage tolerance: 0.5% and 1%.

This IC is available in 4 Packages: TO-92(bulk or ammo packing), SOT-23, SOT-23-5 and SOT-89.

Block Diagram



Pin Assignment



Note: 4. * Pin 2 is attached to substrate and must be connected to ANODE or open.

Figure 2. Pin Configuration of TL431

Absolute Maximum Ratings (Note 5)

Symbol	Parameter	Rating		Unit
V_{KA}	Cathode Voltage	40		V
I_{KA}	Cathode Current Range (Continuous)	-100 to 150		mA
I_{REF}	Reference Input Current Range	10		mA
P_D	Power Dissipation	Z, R Package	770	mW
		N, K Package	370	
T_J	Junction Temperature	+150		°C
T_{STG}	Storage Temperature Range	-65 to +150		°C
ESD	ESD (Human Body Model)	2000		V

Note 5: Stresses greater than 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 beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

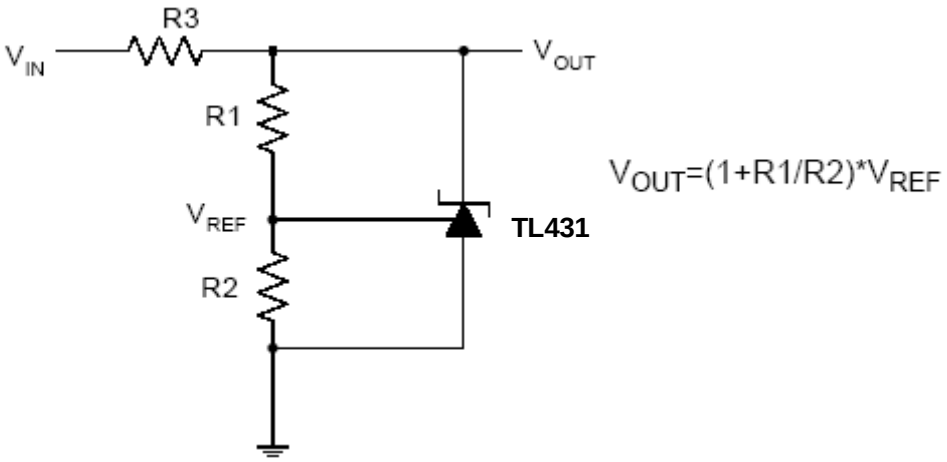
Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{KA}	Cathode Voltage	V_{REF}	36	V
I_{KA}	Cathode Current	1.0	100	mA
T_A	Operating Ambient Temperature Range	-40	+125	°C

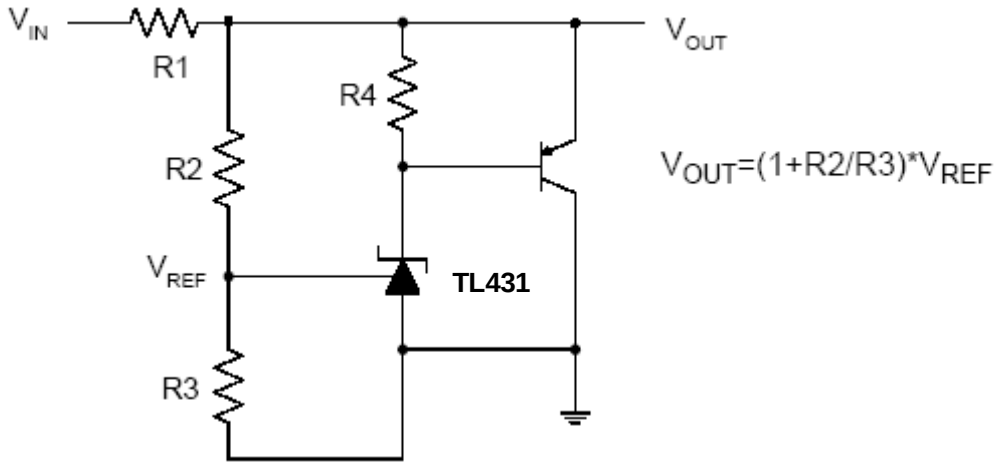
Electrical Characteristics (Operating Conditions: T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Test Circuit	Conditions		Min	Typ	Max	Unit
V_{REF}	Reference Voltage	0.5%	4	V_{KA}= V_{REF}, I_{KA}= 10mA		2.483	2.495	2.507	V
		1.0%				2.470	2.495	2.520	
ΔV_{REF}	Deviation of Reference Voltage Over Full Temperature Range		4	V_{KA}= V_{REF}, I_{KA}= 10mA	0 to +70°C	–	5	20	mV
					-40 to +85°C	–	5	26	
					-40 to +125°C	–	5	40	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change ineference Voltage to the Change in Cathode Voltage		5	I_{KA}= 10mA	ΔV_{KA}= 10V to V_{REF}	–	-1.0	-2.7	mV/V
					ΔV_{KA}= 36V to 10V	–	-0.5	-2.0	
I_{REF}	Reference Current		5	I_{KA}= 10mA, R1 = 10KΩ, R2 = ∞		–	0.7	4	μA
ΔI_{REF}	Deviation of Reference Current Over Full Temperature Range		5	I_{KA}= 10mA, R1 = 10KΩ, R2 = ∞, T_A= -40 to +125°C		–	0.4	1.2	μA
I_{KA} (Min)	Minimum Cathode Current for Regulation		4	V_{KA}= V_{REF}		–	0.4	1.0	mA
I_{KA} (Off)	Off-state Cathode Current		6	V_{KA}= 36V, V_{REF}= 0		–	0.05	1.0	μA
Z_{KA}	Dynamic Impedance		4	V_{KA}= V_{REF}, I_{KA}= 1 to 100mA, f ≤ 1.0KHz		–	0.2	0.5	Ω
θ_{JC}	Thermal Resistance		–	SOT-23		–	135.9	–	°C/W
				SOT-23-5		–	135.9	–	
				TO-92		–	81.9	–	
				SOT-89		–	29.8	–	

Typical Applications Circuit

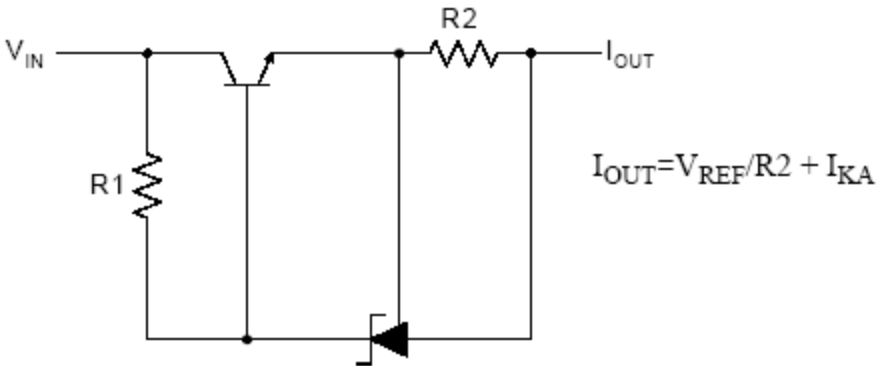


Shunt Regulator

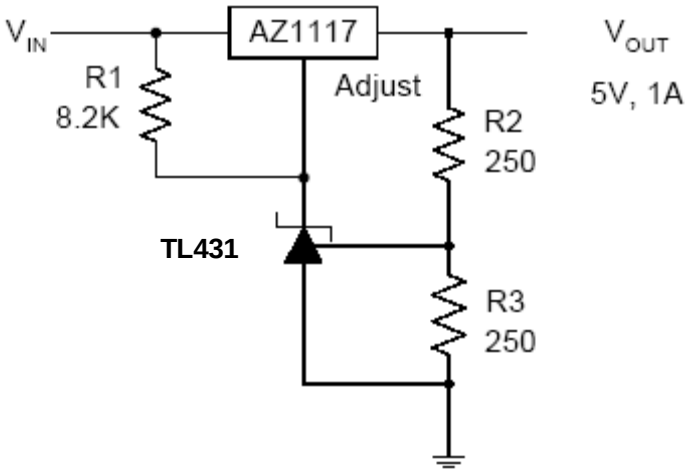


High Current Shunt Regulator

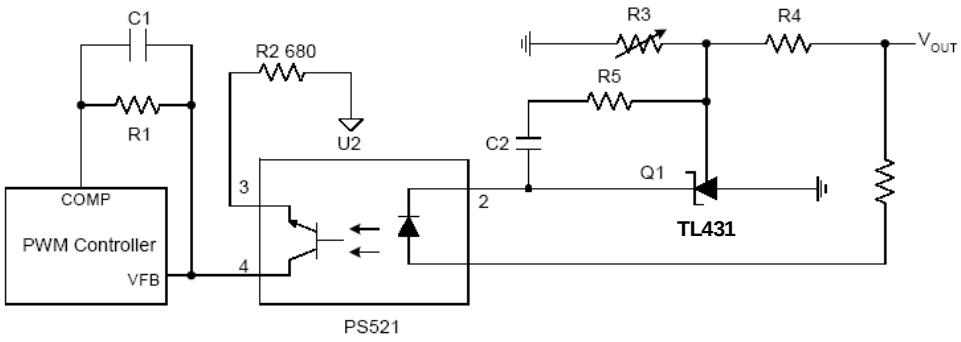
Typical Applications Circuit (Cont.)



Current Source or Current Limit

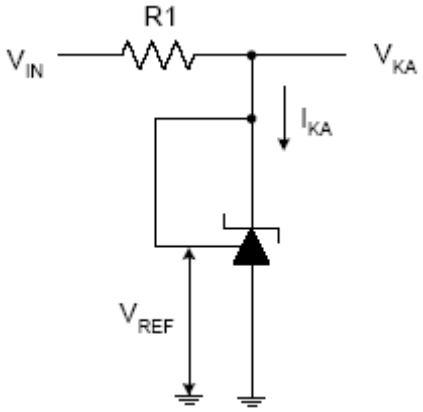


Precision 5V 1A Regulator

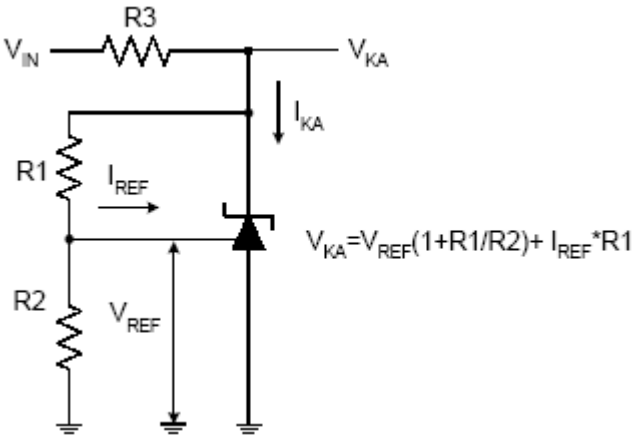


PWM Converter with Reference

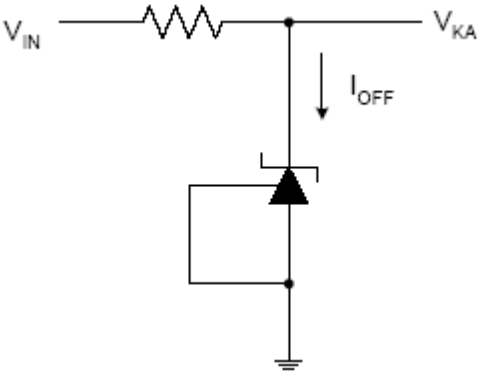
Electrical Characteristics (Cont.)



Test Circuit 4 for $V_{KA} = V_{REF}$



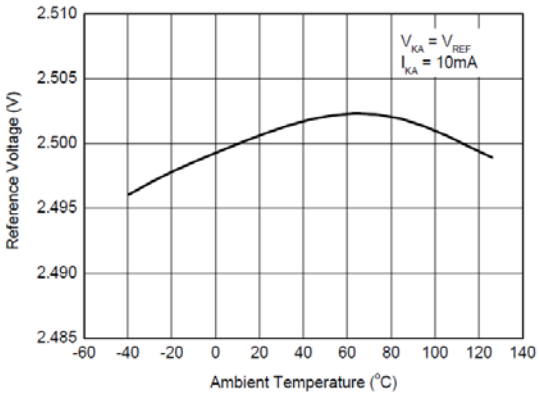
Test Circuit 5 for $V_{KA} > V_{REF}$



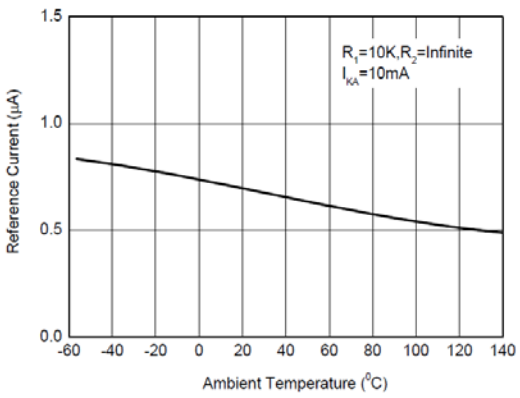
Test Circuit 6 for I_{OFF}

Performance Characteristics

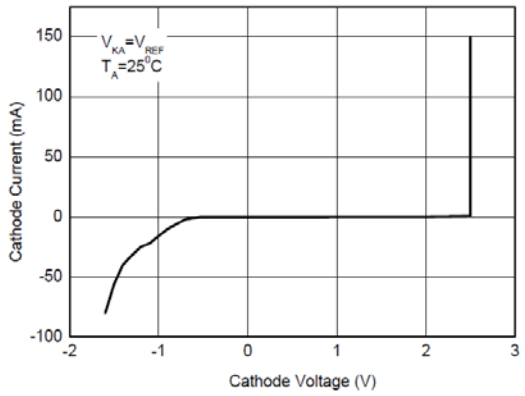
Reference Voltage vs. Ambient Temperature



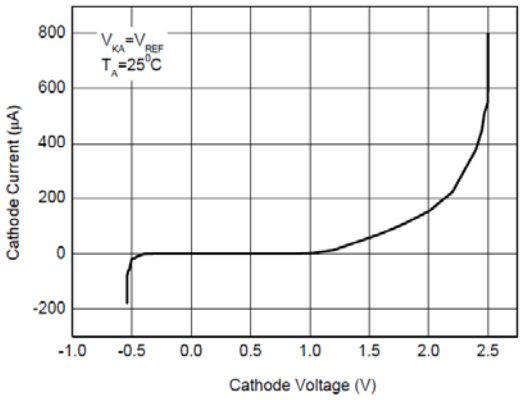
Reference Current vs. Ambient Temperature



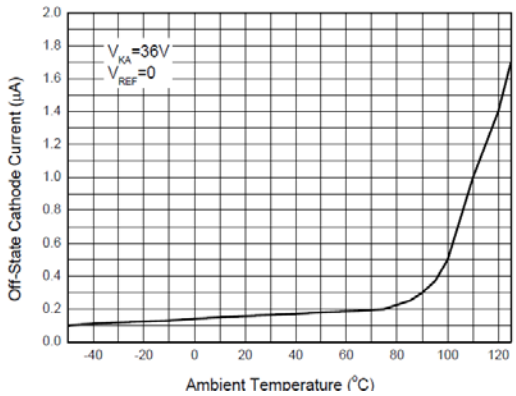
Cathode Current vs. Cathode Voltage



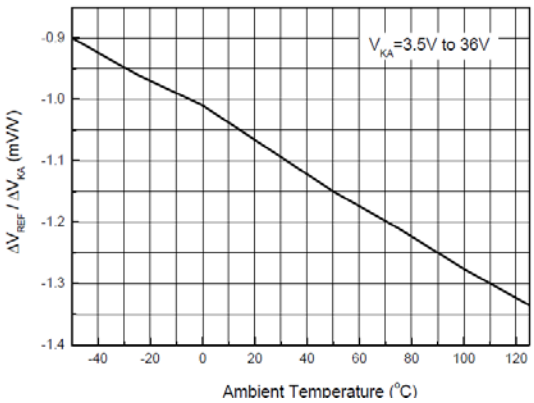
Cathode Current vs. Cathode Voltage



Off-State Cathode Current vs. Ambient Temperature

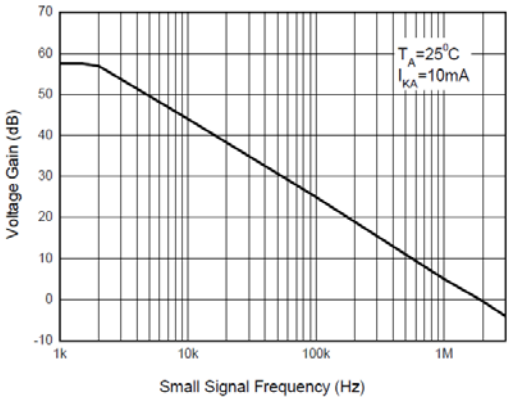


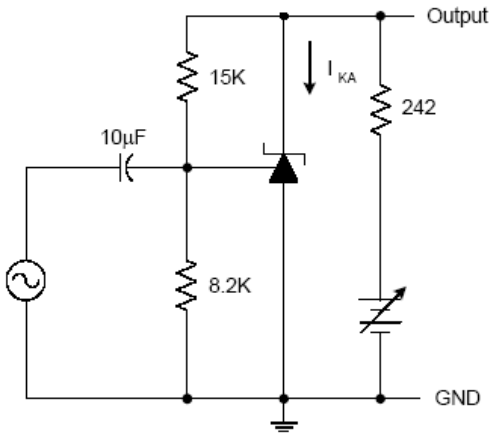
Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage



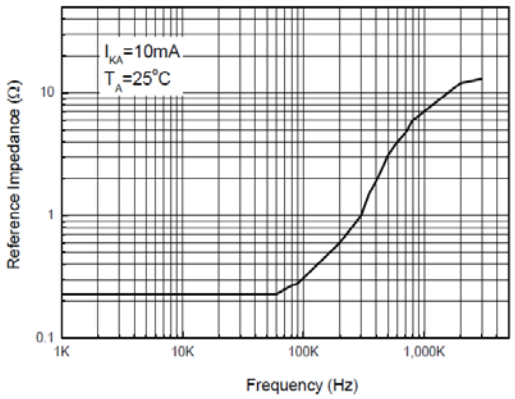
Performance Characteristics (Cont.)

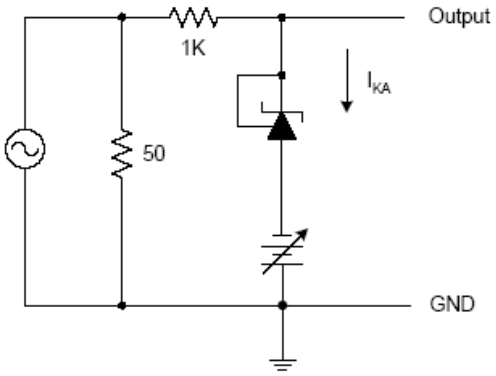
Small Signal Voltage Gain vs. Frequency



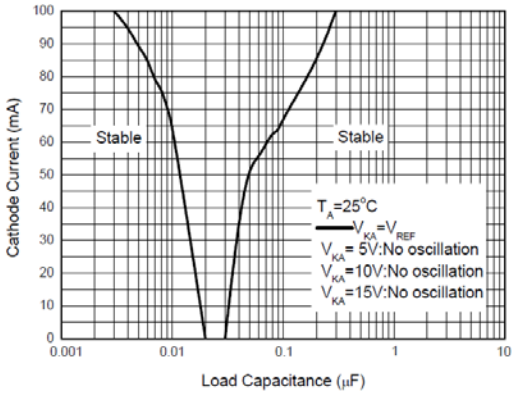


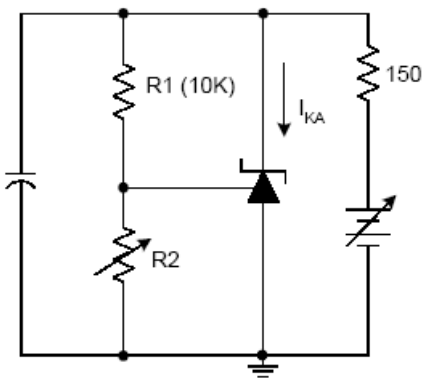
Reference Impedance vs. Frequenc





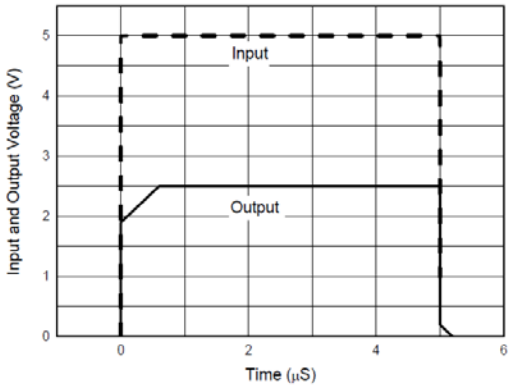
Stability Boundary Conditions vs. Load Capacitance

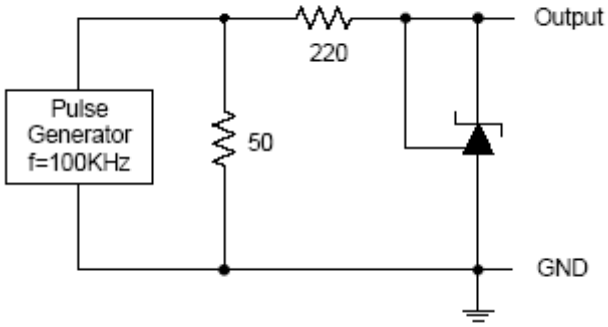




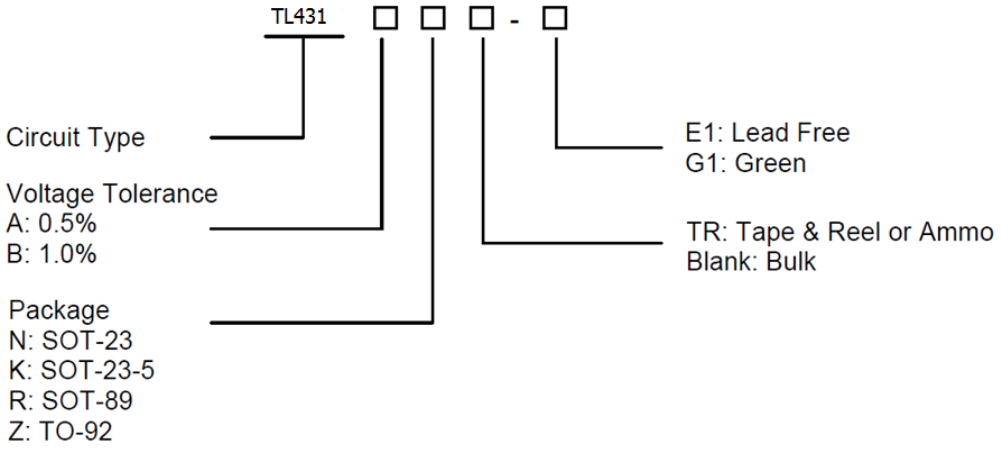
Performance Characteristics (Cont.)

Pulse Response of Input and Output Voltage





Ordering Information

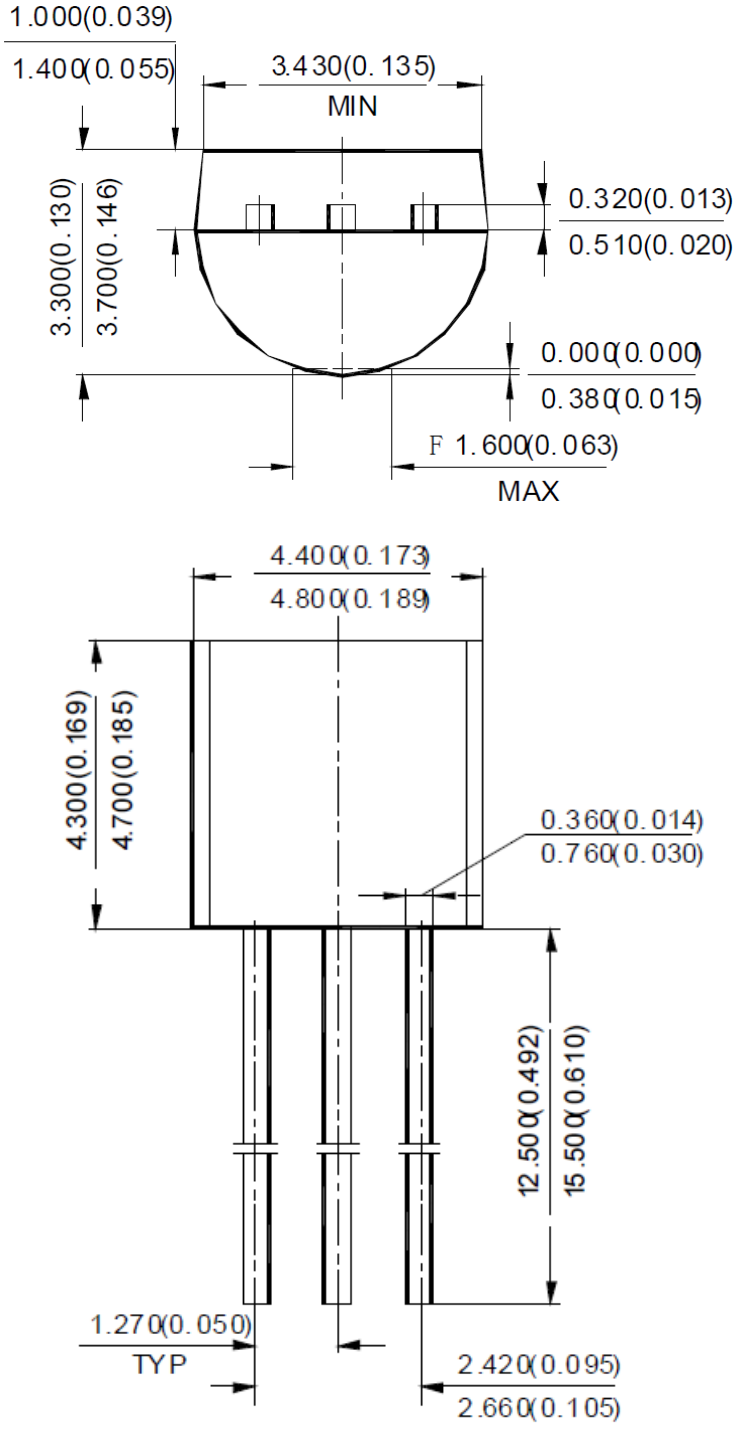


Package	Temperature Range	Voltage Tolerance	Part Number		Marking ID		Packing Type
			Lead Free	Green	Lead Free	Green	
SOT-23	-40 to +125°C	0.5%	TL431ANTR-E1	TL431ANTR-G1	EB5	GB5	Tape & Reel
		1.0%	TL431BNTR-E1	TL431BNTR-G1	EB6	GB6	Tape & Reel
SOT-23-5	-40 to +125°C	0.5%	TL431AKTR-E1	TL431AKTR-G1	E6H	G6H	Tape & Reel
		1.0%	TL431BKTR-E1	TL431BKTR-G1	E6I	G6I	Tape & Reel
TO-92	-40 to +125°C	0.5%	TL431AZ-E1	TL431AZ-G1	TL431AZ-E1	TL431AZ-G	Bulk
		0.5%	TL431AZTR-E1	TL431AZTR-G1	TL431AZ-E1	TL431AZ-G1	Ammo
		1.0%	TL431BZ-E1	TL431BZ-G1	TL431BZ-E1	TL431BZ-G1	Bulk
		1.0%	TL431BZTR-E1	TL431BZTR-G1	TL431BZ-E1	TL431BZ-G1	Ammo
SOT-89	-40 to +125°C	0.5%	TL431ARTR-E1	TL431ARTR-G1	E43G	G43G	Tape & Reel
		1.0%	TL431BRTR-E1	TL431BRTR-G1	E43H	G43H	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.

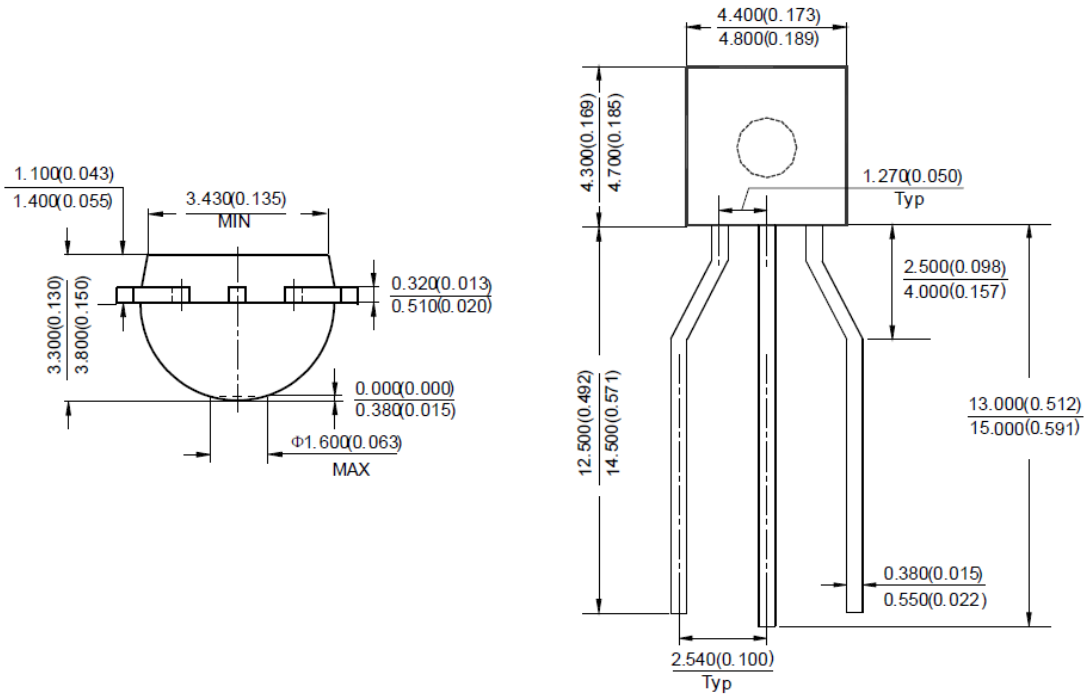
Package Outline Dimensions (All dimensions in mm(inch).)

TO-92 (Bulk Packing)



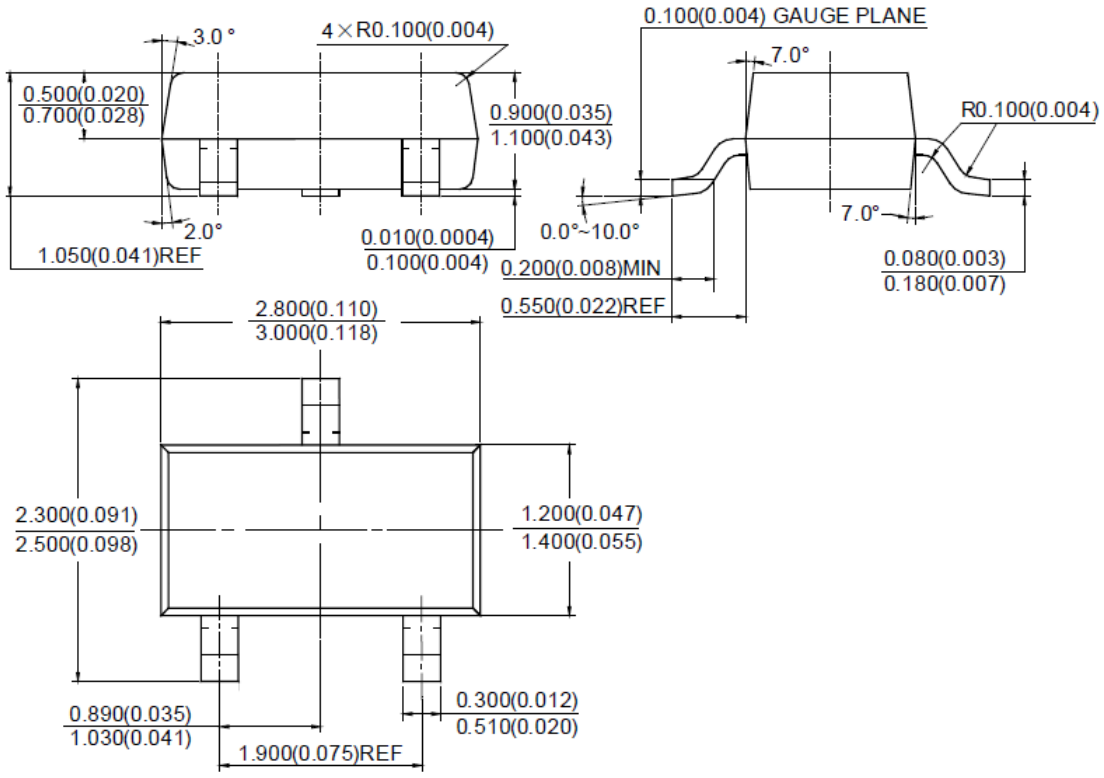
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

TO-92 (Ammo Packing)



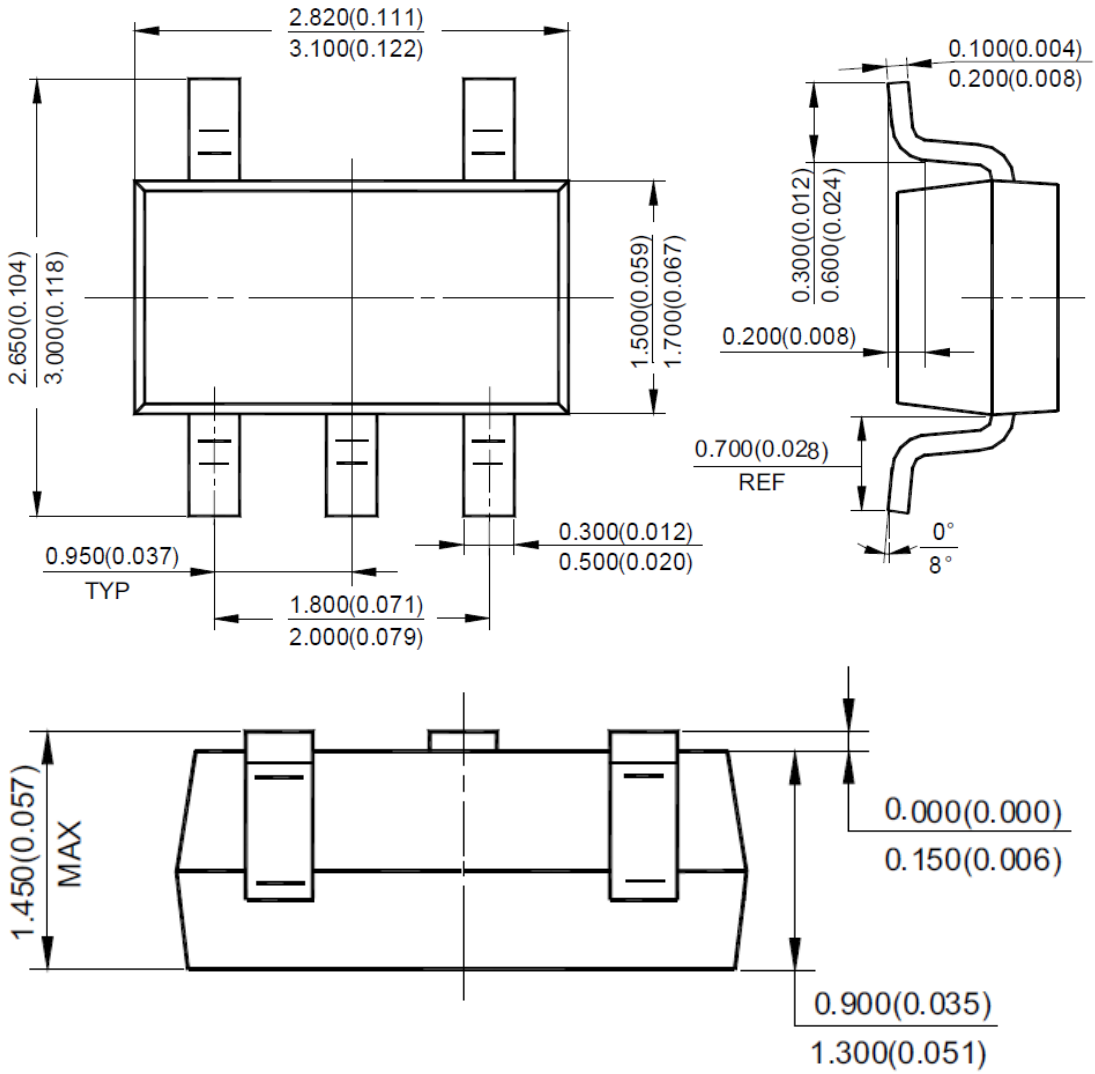
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-23



Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-23-5



Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-89

