TLV431A, TLV431B

Low Voltage Precision Adjustable Shunt Regulator

The TLV431A and B series are precision low voltage shunt regulators that are programmable over a wide voltage range of 1.24 V to 16 V. The TLV431A series features a guaranteed reference accuracy of ±1.0% at 25°C and ±2.0% over the entire industrial temperature range of −40°C to 85°C. For TLV431B series, the accuracy is even higher, it's ±0.5% and ±1.0% respectively. These devices exhibit a sharp low current turn−on characteristic with a low dynamic impedance of 0.20 Ω over an operating current range of 100 μA to 20 mA. This combination of features makes this series an excellent replacement for zener diodes in numerous applications circuits that require a precise reference voltage. When combined with an optocoupler, the TLV431A/B can be used as an error amplifier for controlling the feedback loop in isolated low output voltage (3.0 V to 3.3 V) switching power supplies. These devices are available in economical TO−92−3 and micro size TSOP−5 and SOT−23−3 packages.

Features

- Programmable Output Voltage Range of 1.24 V to 16 V
- Voltage Reference Tolerance ±1.0% for A Series and ±0.5% for B Series
- Sharp Low Current Turn−On Characteristic
- Low Dynamic Output Impedance of 0.20 Ω from 100 μA to 20 mA
- Wide Operating Current Range of 50 μA to 20 mA
- Micro Miniature TSOP−5, SOT−23−3 and TO−92−3 Packages
- Pb−Free Packages are Available

Applications

- Low Output Voltage (3.0 V to 3.3 V) Switching Power Supply Error Amplifier
- Adjustable Voltage or Current Linear and Switching Power Supplies
- Voltage Monitoring
- Current Source and Sink Circuits
- Analog and Digital Circuits Requiring Precision References
- Low Voltage Zener Diode Replacements

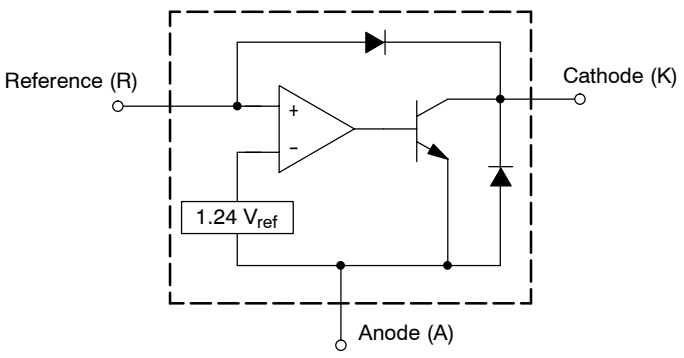

Figure 1. Representative Block Diagram

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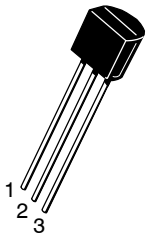
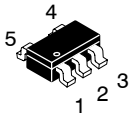
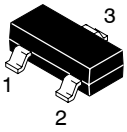


TO−92−3−3
LP SUFFIX
CASE 29



TSOP−5
SN SUFFIX
CASE 483



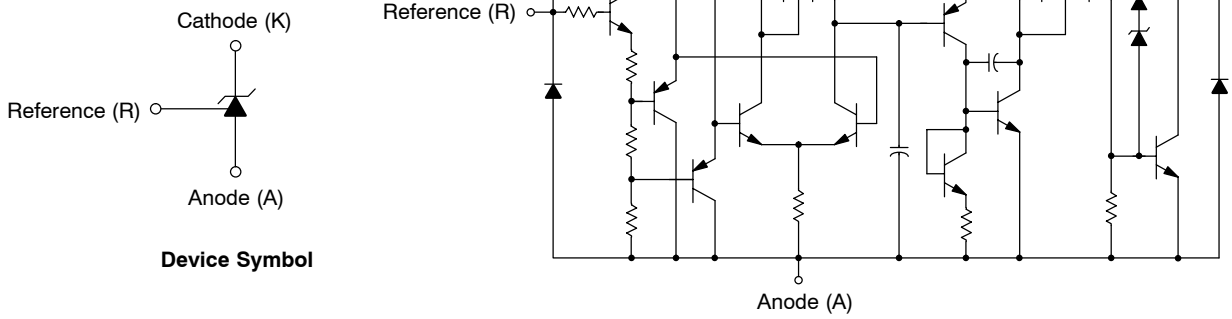
SOT−23−3
SN1 SUFFIX
CASE 318

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 11 of this data sheet.

DEVICE MARKING INFORMATION AND PIN CONNECTIONS

See general marking information in the device marking section on page 11 of this data sheet.



The device contains 13 active transistors.

Figure 2. Representative Device Symbol and Schematic Diagram

MAXIMUM RATINGS (Full operating ambient temperature range applies, unless otherwise noted)

Rating	Symbol	Value	Unit
Cathode to Anode Voltage	V_{KA}	18	V
Cathode Current Range, Continuous	I_K	−20 to 25	mA
Reference Input Current Range, Continuous	I_{ref}	− 0.05 to 10	mA
Thermal Characteristics			°C/W
LP Suffix Package, TO−92−3 Package			
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	178	
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83	
SN Suffix Package, TSOP−5 Package			
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	226	
SN1 Suffix Package, SOT−23−3 Package			
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	491	
Operating Junction Temperature	T_J	150	°C
Operating Ambient Temperature Range	T_A	− 40 to 85	°C
Storage Temperature Range	T_{stg}	− 65 to 150	°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

NOTE: This device series contains ESD protection and exceeds the following tests: Human Body Model 2000 V per MIL−STD−883, Method 3015. Machine Model Method 200 V.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

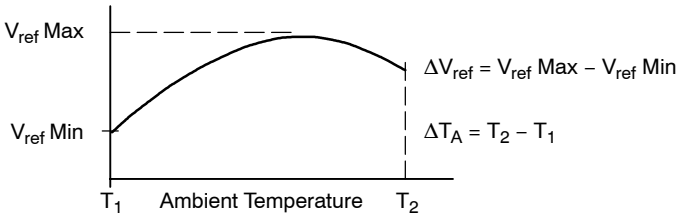
RECOMMENDED OPERATING CONDITIONS

Condition	Symbol	Min	Max	Unit
Cathode to Anode Voltage	V_{KA}	V_{ref}	16	V
Cathode Current	I_K	0.1	20	mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	TLV431A			TLV431B			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference Voltage (Figure 3) (V_{KA} = V_{ref}, I_K = 10 mA, T_A = 25°C) (T_A = T_{low} to T_{high}, Note 1)	V_{ref}	 1.228 1.215	 1.240 –	 1.252 1.265	 1.234 1.228	 1.240 –	 1.246 1.252	V
Reference Input Voltage Deviation Over Temperature (Figure 3) (V_{KA} = V_{ref}, I_K= 10 mA, T_A = T_{low} to T_{high}, Note 1)	ΔV_{ref}	–	7.2	20	–	7.2	20	mV
Ration of Reference Input Voltage Change to Cathode Voltage Change (Figure 4) (V_{KA} = V_{ref} to 16 V, I_K= 10 mA)	$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	–	–0.6	–1.5	–	–0.6	–1.5	$\frac{mV}{V}$
Reference Terminal Current (Figure 4) (I_K = 10 mA, R1 = 10 kΩ, R2 = open)	I_{ref}	–	0.15	0.3	–	0.15	0.3	μA
Reference Input Current Deviation Over Temperature (Figure 4) (I_K = 10 mA, R1 = 10 kΩ, R2 = open, Notes 1, 2)	ΔI_{ref}	–	0.04	0.08	–	0.04	0.08	μA
Minimum Cathode Current for Regulation (Figure 3)	$I_{K(min)}$	–	55	80	–	55	80	μA
Off−State Cathode Current (Figure 5) (V_{KA} = 6.0 V, V_{ref} = 0) (V_{KA} = 16 V, V_{ref} = 0)	$I_{K(off)}$	 – –	 0.01 0.012	 0.04 0.05	 – –	 0.01 0.012	 0.04 0.05	μA
Dynamic Impedance (Figure 3) (V_{KA} = V_{ref}, I_K =0.1 mA to 20 mA, f ≤ 1.0 kHz, Note 3)	$\lvert Z_{KA}\rvert$	–	0.25	0.4	–	0.25	0.4	Ω

1. Ambient temperature range: T_{low} = −40°C, T_{high} = 85°C.
2. The deviation parameters ΔV_{ref} and ΔI_{ref} are defined as the difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.



The average temperature coefficient of the reference input voltage, αV_{ref} is defined as:

$$\alpha V_{ref}\left(\frac{ppm}{°C}\right) = \frac{\left(\frac{(\Delta V_{ref})}{V_{ref}\ (T_A = 25°C)} \times 10^6\right)}{\Delta T_A}$$

αV_{ref} can be positive or negative depending on whether V_{ref} Min or V_{ref} Max occurs at the lower ambient temperature, refer to Figure 8.

Example: ΔV_{ref} = 7.2 mV and the slope is positive,
V_{ref} @ 25°C = 1.241 V
ΔT_A = 125°C

$$\alpha V_{ref}\left(\frac{ppm}{°C}\right) = \frac{\frac{0.0072}{1.241} \times 10^6}{125} = 46\ ppm/°C$$

3. The dynamic impedance Z_{KA} is defined as:

$$\lvert Z_{KA}\rvert = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device is operating with two external resistors, R1 and R2, (refer to Figure 4) the total dynamic impedance of the circuit is given by:

$$\lvert Z_{KA}'\rvert = \lvert Z_{KA}\rvert \times \left(1 + \frac{R1}{R2}\right)$$