ADJUSTABLE PRECISION ZENER SHUNT REGULATOR

ZR431L

Issue 1 - NOVEMBER 1998

DEVICE DESCRIPTION

The ZR431L is a three terminal adjustable shunt regulator offering excellent temperature stability and output current handling capability up to 25mA. The output voltage may be set to any chosen voltage between 1.24 and 10 volts by selection of two external divider resistors.

The devices can be used as a replacement for zener diodes in many applications requiring an improvement in zener performance.

The ZR431L is particularly used in the feedback control loop of switch mode power supplies. In this application the device 1.24 volt reference enables the generation of low voltage supplies, typically 3.3 volts or 3 volts.

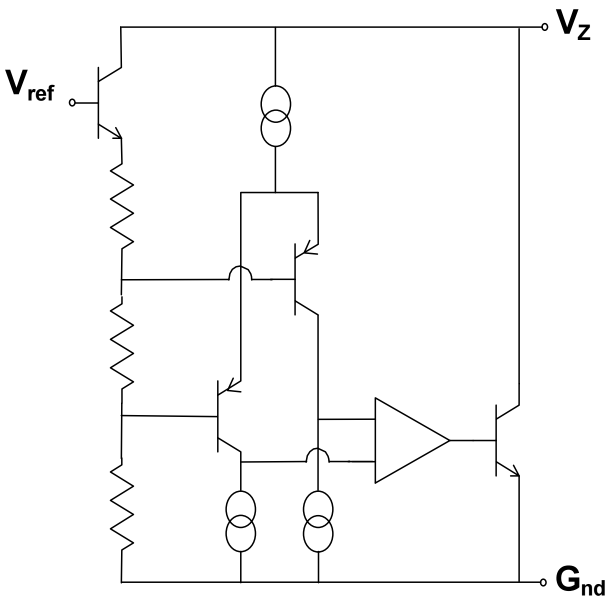
FEATURES

- Surface mount SOT23 package
- TO92 package
- 2.5% and 1% tolerance
- Maximum temperature coefficient 50 ppm/°C
- Temperature compensated for operation over the full temperature range
- Programmable output voltage
- 100µA to 25mA current sink capability
- Low output noise

APPLICATIONS

- Shunt regulator
- Series regulator
- Voltage monitor
- Over voltage/ under voltage protection
- Switch mode power supplies

SCHEMATIC DIAGRAM



ZR431L

ABSOLUTE MAXIMUM RATING

Cathode Voltage (V_Z)	10V
Cathode Current	50mA
Operating Temperature	-40 to 85°C
Storage Temperature	-55 to 125°C

Recommended Operating Conditions

	Min	Max
Cathode Voltage	V_{REF}	10V
Cathode Current	100μA	25mA

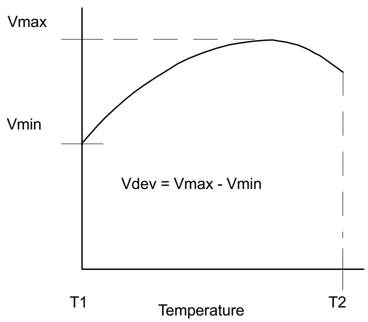
Power Dissipation (T_{amb}=25°C, T_{jmax}=150°C)

SOT23	330mW
TO92	600mW

ELECTRICAL CHARACTERISTICS TEST CONDITIONS (Unless otherwise stated):T_{amb}=25°C

PARAMETER	SYMBOL	VALUE			UNITS	CONDITIONS
		MIN	TYP	MAX		
Reference Voltage 2.5% 1.0%	V_{ref}	1.209 1.228	1.24 1.24	1.271 1.252	V	I_L=10mA (Fig1), V_Z=V_{ref}
Deviation of Reference Input Voltage over Temperature	V_{dev}		4.0	8.0	mV	I_L=10mA, V_Z=V_{ref} T_a=full range (Fig1)
Ratio of the change in Reference Voltage to the Change in Cathode Voltage	$\frac{\Delta V_{ref}}{\Delta V_Z}$		0.5	2.0	mV/V	V_Z from V_{ref} to 10V I_Z=10mA (Fig2)
Reference Input Current	I_{ref}	0.02	0.11	0.4	μA	R1=10k, R2=O/C, I_L=10mA (Fig2)
Deviation of Reference Input Current over Temperature	ΔI_{ref}		0.02	0.2	μA	R1=10k, R2=O/C, I_L=10mA T_a=full range (Fig2)
Minimum Cathode Current for Regulation	I_{Zmin}		30	100	μA	
Off-state Current	I_{Zoff}		10	30	μA	V_Z=10V, V_{ref} =0V (Fig3)
Dynamic Output Impedance	R_Z		0.25	2	Ω	V_Z=V_{ref} (Fig1), f=0Hz, I_L=10mA

Deviation of reference input voltage, V_{dev}, is defined as the maximum variation of the reference input voltage over the full temperature range.



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

$$V_{ref}\,(ppm/^\circ C) = \frac{V_{dev}\ x\ 1000000}{V_{ref}\,(T1 - T2)}$$

The dynamic output impedance, Rz, is defined as:

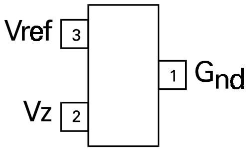
$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

When the device is programmed with two external resistors, R1 and R2, (fig 2) , the dynamic output impedance of the overall circuit, R’, is defined as:

$$R' = R_z\,(1 + \frac{R1}{R2})$$

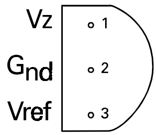
CONNECTION DIAGRAMS

SOT23 Package Suffix – F



Top View

TO92 Package Suffix – C

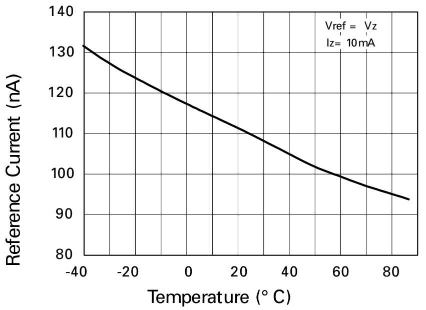


Bottom View

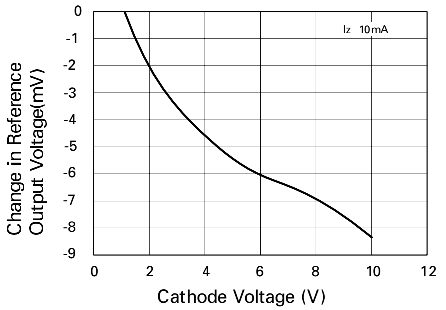
ORDERING INFORMATION

Part Number	Package	Tol %	Part Mark
ZR431LF02	SOT23	2.5	43L
ZR431LF01	SOT23	1	43M
ZR431LC02	TO92	2.5	ZR431L02
ZR431LC01	TO92	1	ZR431L01

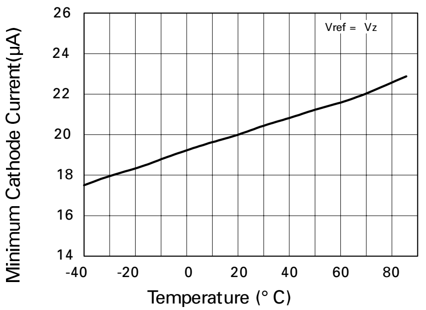
TYPICAL CHARACTERISTICS



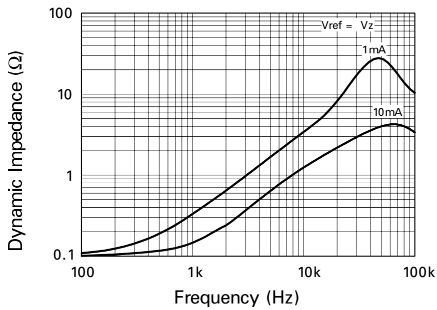
Reference Current v Temperature



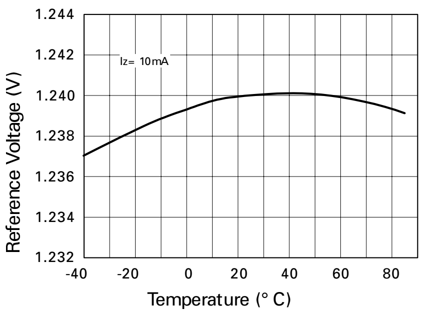
Change in V_{ref} v Cathode Voltage



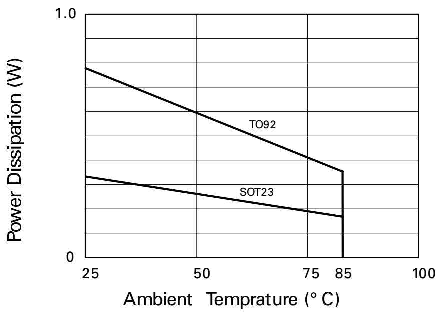
Cathode Current v Temperature



Dynamic Impedance v Frequency



Reference Voltage v Temperature



Power Dissipation Derating

DC TEST CIRCUITS

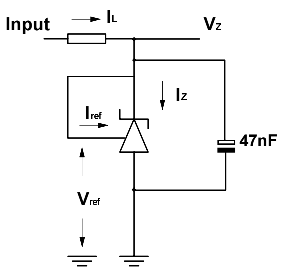


Fig 1 – Test Circuit for $V_z = V_{ref}$

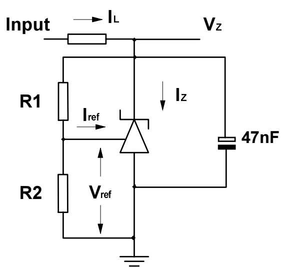


Fig 2 – Test Circuit for $V_z > V_{ref}$

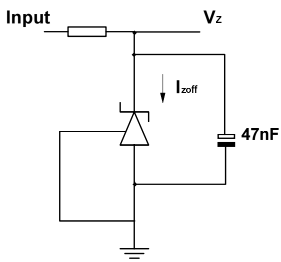
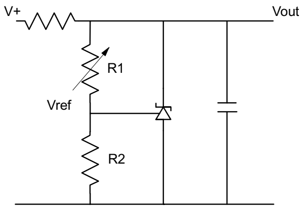


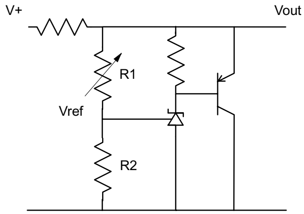
Fig 3 – Test Circuit for Off State current

APPLICATION CIRCUITS



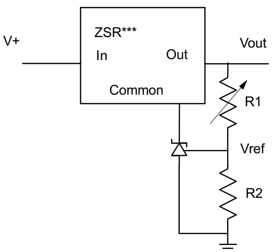
$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

SHUNT REGULATOR



$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

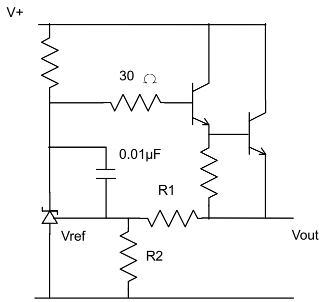
HIGHER CURRENT SHUNT REGULATOR



$$Vout_{MIN} = Vref + Vreg$$

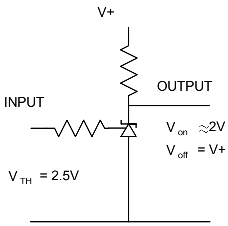
$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

OUTPUT CONTROL OF A
THREE TERMINAL FIXED REGULATOR

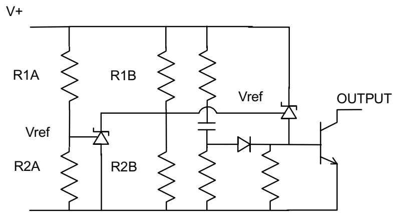


$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

SERIES REGULATOR



SINGLE SUPPLY COMPARATOR
WITH TEMPERATURE
COMPENSATED THRESHOLD

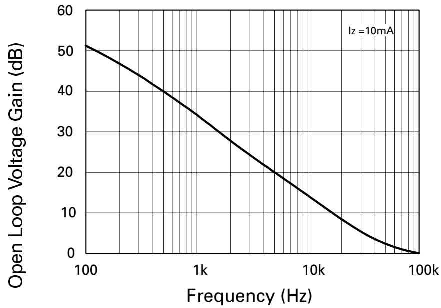


$$\text{Low limit} = \left(1 + \frac{R1B}{R2B}\right) Vref$$

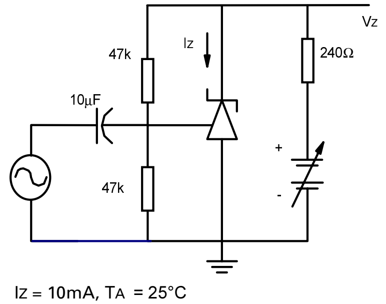
$$\text{High limit} = \left(1 + \frac{R1A}{R2A}\right) Vref$$

OVER VOLTAGE / UNDER VOLTAGE
PROTECTION CIRCUIT

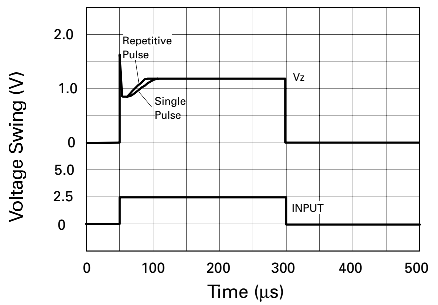
TYPICAL CHARACTERISTICS



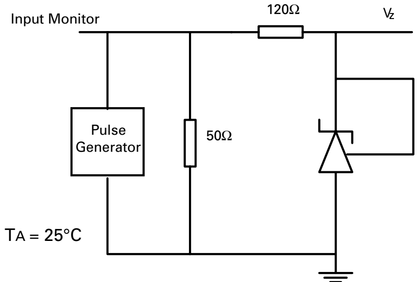
Gain v Frequency



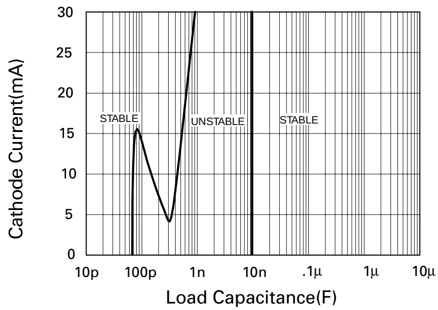
Test Circuit for Open Loop Voltage Gain



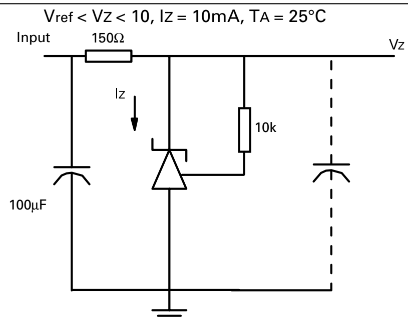
Pulse Response



Test Circuit for Pulse Response



Stability Boundary Conditions



Test Circuit for Stability Boundary Conditions