

# ADJUSTABLE PRECISION ZENER SHUNT REGULATOR

## ZHT431

ISSUE 2 – FEBRUARY 1997

### DEVICE DESCRIPTION

The ZHT431 is a three terminal adjustable shunt regulator offering excellent temperature stability and output current handling capability up to 100mA. The device offers extended operating temperature range working from -55 to +125°C. The output voltage may be set to any chosen voltage between 2.5 and 20 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.

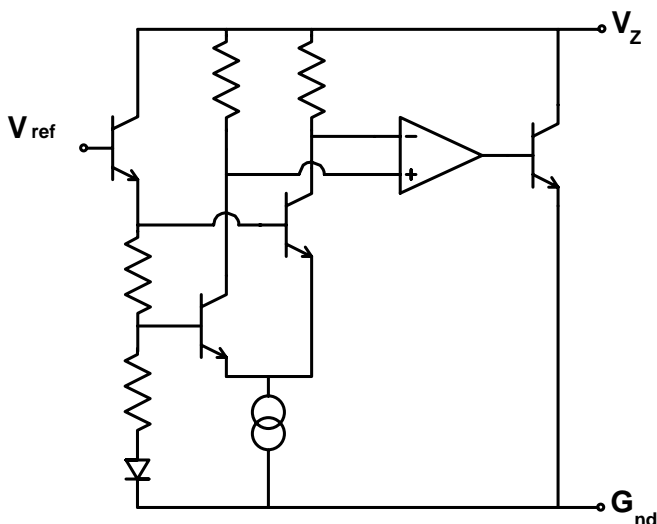
### FEATURES

- Surface mount SO8, SOT89, SOT223 and SOT23 packages
- TO92 package
- 2% and 1% tolerance
- Maximum temperature coefficient 67 ppm/°C
- Temperature compensated for operation over the full temperature range
- Programmable output voltage
- 50μA to 100mA current sink capability
- Low output noise
- Wide temperature range -55 to +125°C

### APPLICATIONS

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

### SCHEMATIC DIAGRAM



## ABSOLUTE MAXIMUM RATING

Cathode Voltage (V <sub>Z</sub> )	20V
Cathode Current	150mA
Operating Temperature	-55 to 125°C
Storage Temperature	-55 to 150°C

## Recommended Operating Conditions

	Min	Max
Cathode Voltage	V <sub>ref</sub>	20V
Cathode Current	50μA	100mA

## Power Dissipation (T<sub>amb</sub>=25°C)

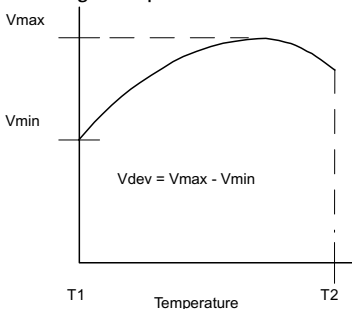
(T <sub>jmax</sub> = 150°C)	
SOT23	330mW
TO92	780mW
SOT223	2W
SO8	780mW
SOT89	1.5W

## ELECTRICAL CHARACTERISTICS TEST CONDITIONS (Unless otherwise stated):T<sub>amb</sub>=25°C

PARAMETER	SYMBOL	VALUE			UNITS	CONDITIONS
		MIN	TYP	MAX		
Reference Voltage	V <sub>ref</sub>	2.45	2.50	2.55	V	I <sub>L</sub> =10mA (Fig1), V <sub>Z</sub> =V <sub>ref</sub>
		2.475	2.50	2.525		
Deviation of Reference Input Voltage over Temperature	V <sub>dev</sub>		10	30	mV	I <sub>L</sub> =10mA, V <sub>Z</sub> =V <sub>ref</sub> T <sub>a</sub> =full range (Fig1)
Ratio of the change in Reference Voltage to the Change in Cathode Voltage	$\frac{\Delta V_{ref}}{\Delta V_Z}$		-1.85	-2.7	mV/V	V <sub>Z</sub> from V <sub>ref</sub> to 10V I <sub>Z</sub> =10mA (Fig2)
			-1.0	-2.0	mV/V	V <sub>Z</sub> from 10V to 20V I <sub>Z</sub> =10mA (Fig2)
Reference Input Current	I <sub>ref</sub>		0.12	1.0	μA	R1=10k, R2=O/C, I <sub>L</sub> =10mA (Fig2)
Deviation of Reference Input Current over Temperature	ΔI <sub>ref</sub>		0.04	0.2	μA	R1=10k, R2=O/C, I <sub>L</sub> =10mA T <sub>a</sub> =full range (Fig2)
Minimum Cathode Current for Regulation	I <sub>Zmin</sub>		35	50	μA	V <sub>Z</sub> =V <sub>ref</sub> (Fig1)
Off-state Current	I <sub>Zoff</sub>			0.1	μA	V <sub>Z</sub> =20V, V <sub>ref</sub> =0V(Fig3) †
Dynamic Output Impedance	R <sub>Z</sub>			0.75	Ω	V <sub>Z</sub> =V <sub>ref</sub> (Fig1), f=0Hz, I <sub>C</sub> =1mA to 100mA

Deviation of reference input voltage, V<sub>dev</sub>, 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<sub>ref</sub> is defined as:



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

The dynamic output impedance, R<sub>Z</sub>, is defined as:

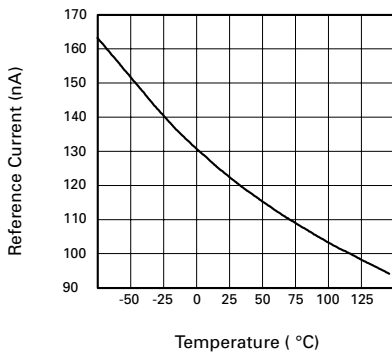
$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

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:

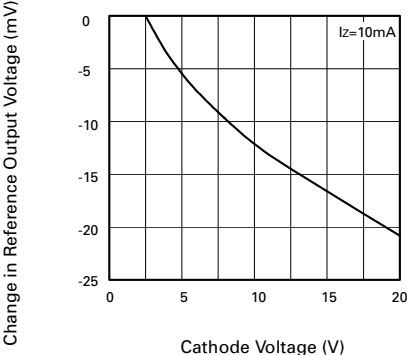
$$R' = R_Z \left(1 + \frac{R1}{R2}\right)$$

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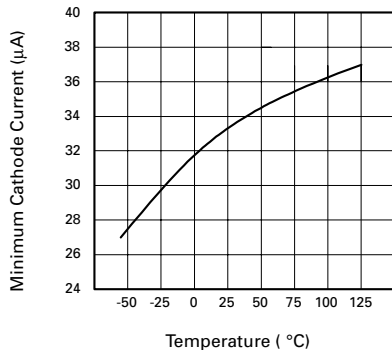
## TYPICAL CHARACTERISTICS



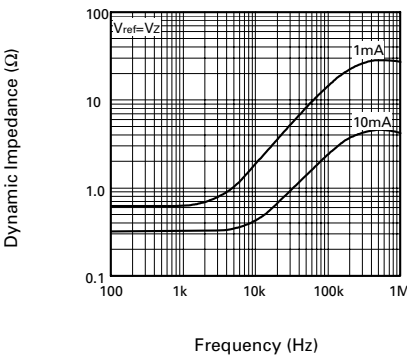
**$I_{ref}$  vs. Temperature**



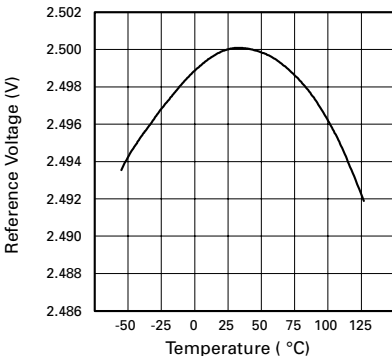
**Change in  $V_{ref}$  v Cathode Voltage**



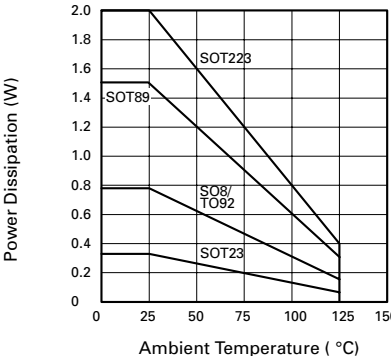
**$I_{zmin}$  vs. Temperature**



**Dynamic Impedance v Frequency**

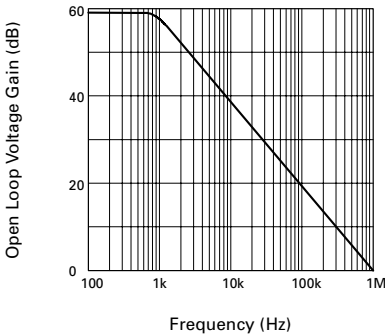


**$V_{ref}$  vs. Temperature**

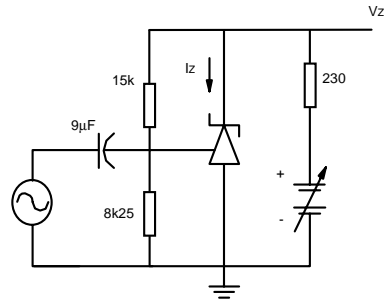


**Power Dissipation Derating**

## TYPICAL CHARACTERISTICS

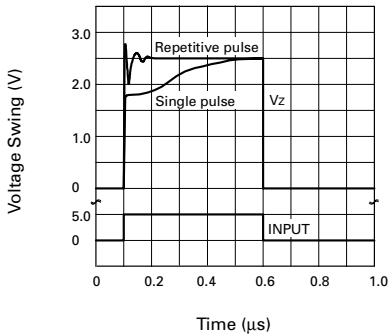


**Gain v Frequency**

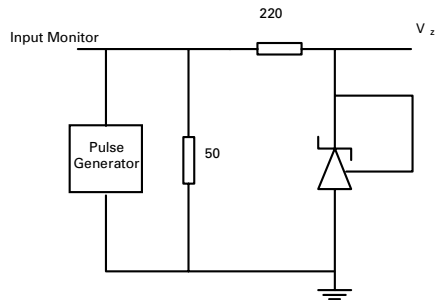


$I_Z = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

**Test Circuit for Open Loop Voltage Gain**

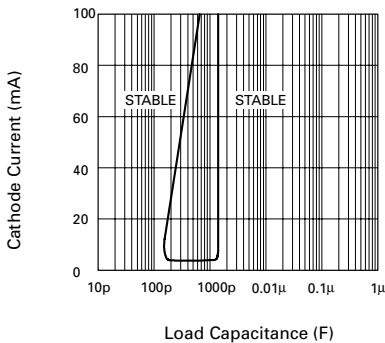


**Pulse Response**

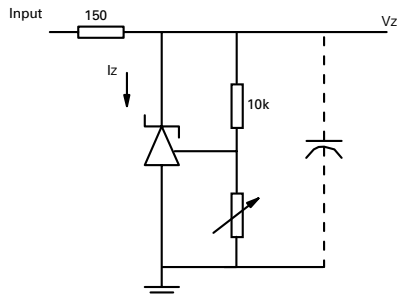


$T_A = 25^\circ\text{C}$

**Test Circuit for Pulse Response**



**Stability Boundary Conditions**



$V_{\text{ref}} < V_Z < 20$ ,  $I_Z = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

**Test Circuit for Stability Boundary Conditions**

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## DC TEST CIRCUITS

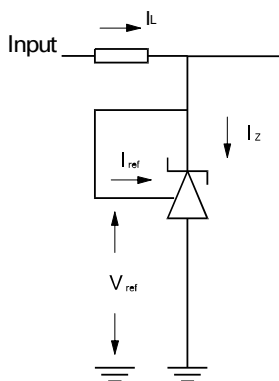


Fig 1 – Test Circuit for  $V_z = V_{ref}$

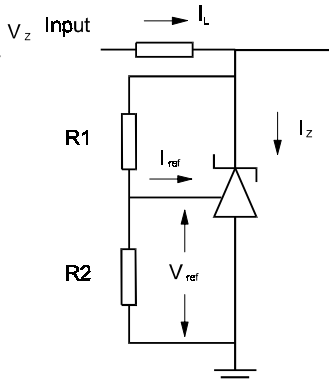


Fig 2 – Test Circuit for  $V_z > V_{ref}$

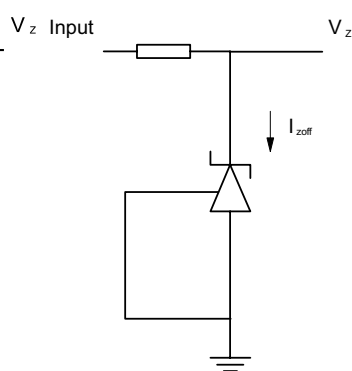
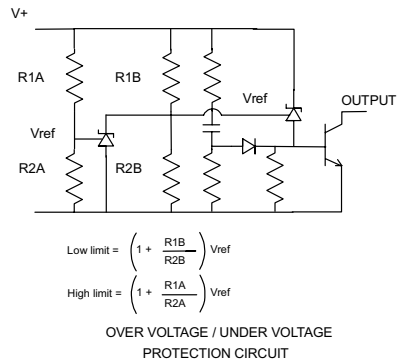
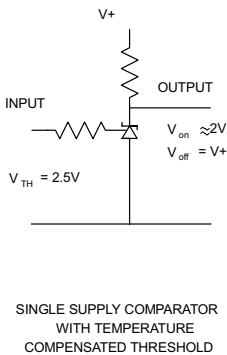
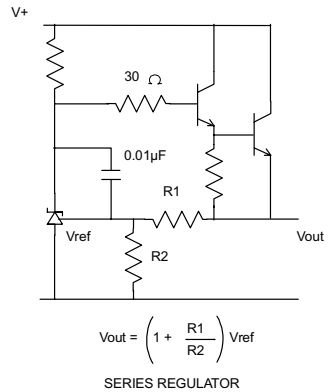
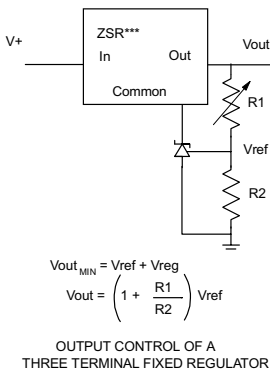
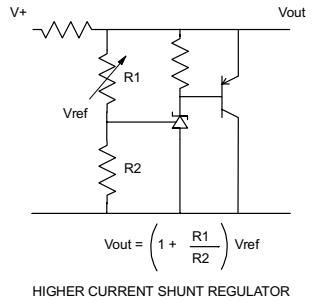
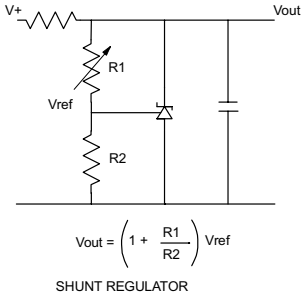


Fig 3 – Test Circuit for Off State current  $I_{zoff}$

### NOTE

† Since the "Off State" disables all internal circuitry including leakage control, operating in this mode at high temperature is not recommended.

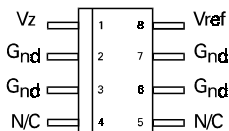
## APPLICATION CIRCUITS



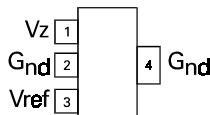
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## CONNECTION DIAGRAMS

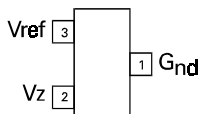
### SO8 Package Suffix – N8



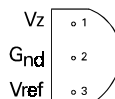
### SOT223 Package Suffix – G



### SOT23 Package Suffix – F



### TO92 Package Suffix – C



## ORDERING INFORMATION

PART No	TOL %	PACKAGE	PARTMARK
ZHT431N802	2	SO8	ZHT43102
ZHT431N801	1	SO8	ZHT43101
ZHT431G02	2	SOT223	ZHT43102
ZHT431G01	1	SOT223	ZHT43101
ZHT431F02	2	SOT23	43D
ZHT431F01	1	SOT23	43C
ZHT431C02	2	TO92	ZHT43102
ZHT431C01	1	TO92	ZHT43101
ZHT431Z02	2	SOT89	43F
ZHT431Z01	1	SOT89	43E

### SOT89 Package Suffix – Z

