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
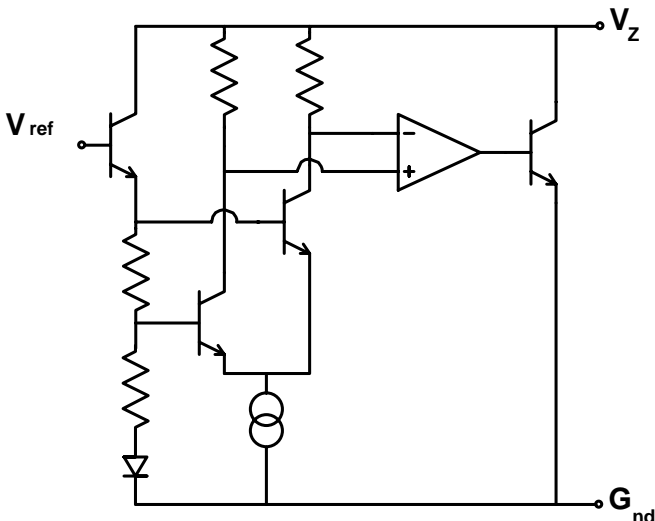
ABSOLUTE MAXIMUM RATING

Cathode Voltage (V$_Z$)	20V	**Power Dissipation (T$_{amb}$=25°C)**	
Cathode Current	150mA	(T$_{jmax}$ = 150°C)	
Operating Temperature	-55 to 125°C	SOT23	330mW
Storage Temperature	-55 to 150°C	TO92	780mW
Recommended Operating Conditions		SOT223	2W
	Min Max	SO8	780mW
Cathode Voltage	Vref 20V	SOT89	1.5W
Cathode Current	50µA 100mA		

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

PARAMETER	SYMBOL	VALUE			UNITS	CONDITIONS
		MIN	TYP	MAX		
Reference Voltage 2% 1%	V$_{ref}$	2.45 2.475	2.50 2.50	2.55 2.525	V	I$_L$=10mA (Fig1), V$_Z$=V$_{ref}$
Deviation of Reference Input Voltage over Temperature	V$_{dev}$		10	30	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	$\dfrac{\Delta V_{ref}}{\Delta V_Z}$		-1.85	-2.7	mV/V	V$_Z$ from V$_{ref}$ to 10V I$_Z$=10mA (Fig2)
			-1.0	-2.0	mV/V	V$_Z$ from 10V to 20V I$_Z$=10mA (Fig2)
Reference Input Current	I$_{ref}$		0.12	1.0	µA	R1=10k, R2=O/C, I$_L$=10mA (Fig2)
Deviation of Reference Input Current over Temperature	ΔI_{ref}		0.04	0.2	µA	R1=10k, R2=O/C, I$_L$=10mA T$_a$=full range (Fig2)
Minimum Cathode Current for Regulation	I$_{Zmin}$		35	50	µA	V$_Z$=V$_{ref}$ (Fig1)
Off-state Current	I$_{Zoff}$			0.1	µA	V$_Z$=20V, V$_{ref}$=0V(Fig3) †
Dynamic Output Impedance	R$_Z$			0.75	Ω	V$_Z$=V$_{ref}$ (Fig1), f=0Hz, I$_C$=1mA to 100mA

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:

Vmax

Vmin

Vdev = Vmax - Vmin

T1   Temperature   T2
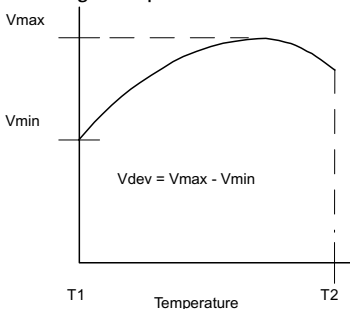
$$V_{ref}(ppm/°C) = \frac{V_{dev} \times 1000000}{V_{ref}(T1-T2)}$$
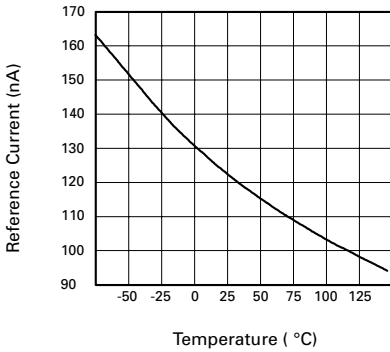
The dynamic output impedance, Rz, is defined as:

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

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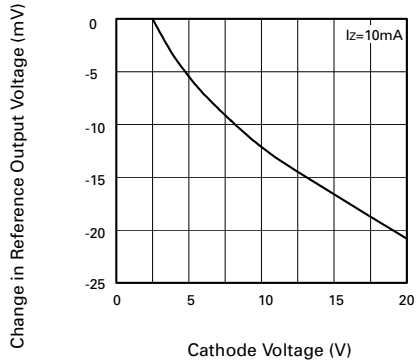
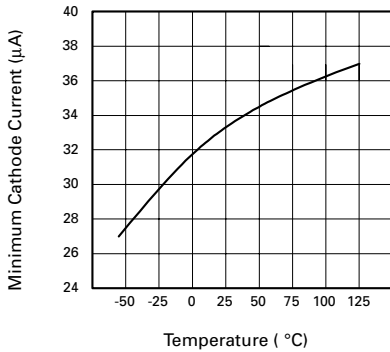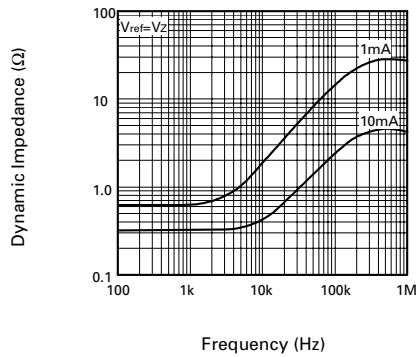$$R' = R_z\left(1 + \frac{R1}{R2}\right)$$

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TYPICAL CHARACTERISTICS

Iref vs. Temperature

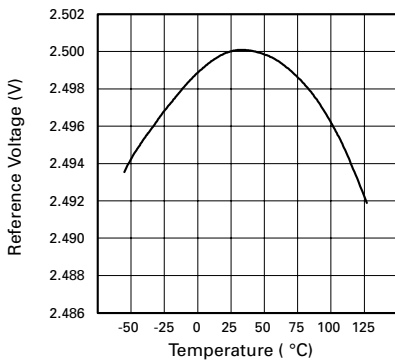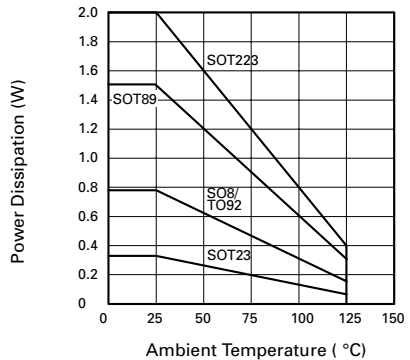**Change in Vref v Cathode Voltage**

Izmin vs. Temperature

Dynamic Impedance v Frequency

Vref vs. Temperature

Power Dissipation Derating

TYPICAL CHARACTERISTICS

Gain v Frequency

x-axis: Frequency (Hz), *y-axis:* Open Loop Voltage Gain (dB)

Test Circuit for Open Loop Voltage Gain

Iz = 10mA, TA = 25°C

Pulse Response

x-axis: Time (µs), *y-axis:* Voltage Swing (V)

Repetitive pulse
Single pulse
Vz
INPUT

Test Circuit for Pulse Response

TA = 25°C

Input Monitor
220
Vz
Pulse Generator
50

Stability Boundary Conditions

x-axis: Load Capacitance (F), *y-axis:* Cathode Current (mA)

STABLE   STABLE

Test Circuit for Stability Boundary Conditions

Input
150
Vz
Iz
10k

Vref < Vz < 20, Iz = 10mA, TA = 25°C

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DC TEST CIRCUITS

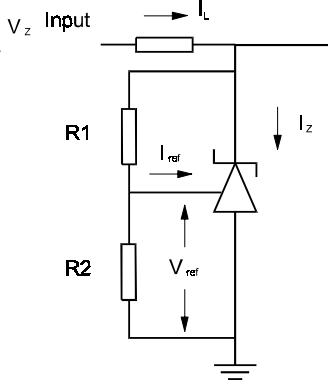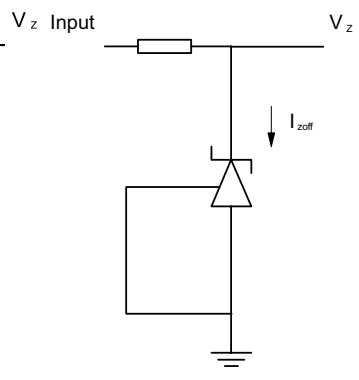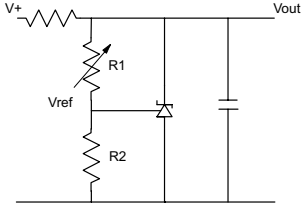Fig 1 – Test Circuit for $V_z=V_{ref}$ Fig 2 – Test Circuit for $V_z>V_{ref}$ Fig 3 – Test Circuit for Off State current †
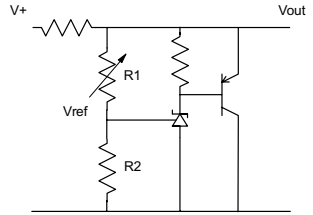
NOTE
†   Since the "Off State" disables all internal circuitry including leakage control, operating in this mode at high temperature is not recommended.
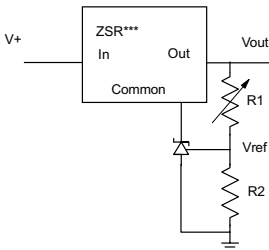
APPLICATION CIRCUITS

V+   Vout

R1

Vref

R2

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

SHUNT REGULATOR

V+   Vout

R1

Vref

R2

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

HIGHER CURRENT SHUNT REGULATOR

V+

ZSR***

In   Out   Vout

Common

R1

Vref

R2

$$Vout_{MIN} = Vref + Vreg$$
$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$
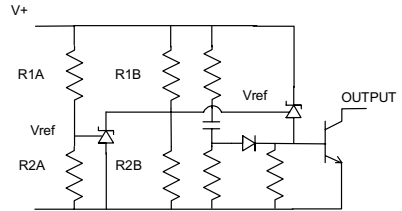
OUTPUT CONTROL OF A
THREE TERMINAL FIXED REGULATOR

V+

30 Ω

0.01µF

R1

Vref

R2
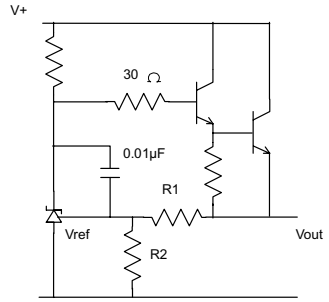
Vout

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

SERIES REGULATOR

V+

OUTPUT

INPUT

$V_{on} \approx 2V$

$V_{off} = V+$

$V_{TH} = 2.5V$
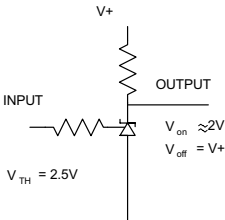
SINGLE SUPPLY COMPARATOR
WITH TEMPERATURE
COMPENSATED THRESHOLD

V+

R1A   R1B   Vref   OUTPUT

Vref

R2A   R2B

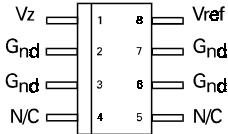$$\text{Low limit} = \left(1 + \frac{R1B}{R2B}\right) Vref$$

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

OVER VOLTAGE / UNDER VOLTAGE
PROTECTION CIRCUIT

ZHT431

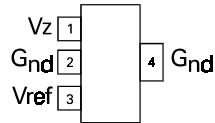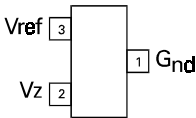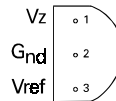## CONNECTION DIAGRAMS

SO8   Package Suffix – N8

Vz	1	8	Vref
Gnd	2	7	Gnd
Gnd	3	6	Gnd
N/C	4	5	N/C

Top View

SOT223   Package Suffix – G

Vz 1
Gnd 2   4 Gnd
Vref 3

*Top View –
Pin 4 floating or connected to pin 2*

SOT23   Package Suffix – F

Vref 3
1 Gnd
Vz 2

Top View

TO92   Package Suffix – C

Vz ○ 1
Gnd ○ 2
Vref ○ 3

Bottom View

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

Vref 1
Gnd 2   4 Gnd
Vz 3

*Top View –
Pin 4 floating or connected to pin 2*