NOT RECOMMENDED FOR NEW DESIGN
USE AP431SHA(B)N1TR-G1 FOR ZXRE250B(A)SA-7
USE AP431SHA(B)NTR-G1FOR ZXRE252B(A)SA-7

ZXRE250 / ZXRE252

Lead-free Green

VERY LOW CATHODE CURRENT ADJUSTABLE PRECISION SHUNT REGULATOR

Description

The ZXRE250 and ZXRE252 are three-terminal adjustable shunt regulators that offer excellent temperature stability and output current handling capability up to 100mA. The output voltage may be set to any chosen voltage between 2.5V and 36V by selection of two external divider resistors.

ZXRE250 has the same electrical specifications as the industry standard '431 except it features a very-low minimum cathode current for regulation. The typical value of 40µA makes the parts ideal for very low-power applications.

The devices can be used as a replacement for zener diodes in many applications requiring an improvement in zener performance. The ZXRE250/2 is available in two grades with initial tolerances of 1% and 0.5% for the A and B grades respectively.

Features

- Minimum Cathode Current for Regulation: 40µA (typ)
- Temperature Range: -40°C to +125°C
- Reference Voltage Tolerance at +25°C
  - ZXRE250A: 2.495V ± 1.0%
  - ZXRE250B: 2.495V ± 0.5%
- Low Output Noise
- 0.2Ω Typical Output Impedance
- Sink Current Capability: 0.065mA to 100mA
- Adjustable Output Voltage: V_{REF} to 36V
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

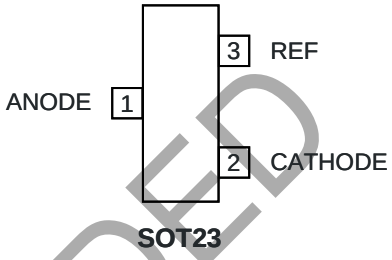
Applications

- Optocoupler Linearisers
- Shunt Regulators
- Improved Zener
- Variable Reference

Pin Assignments

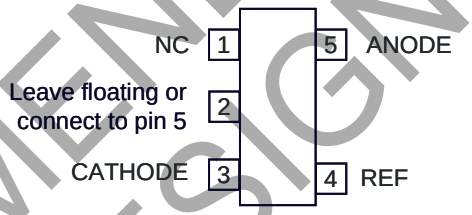
ZXRE250

(Top View)



SOT23

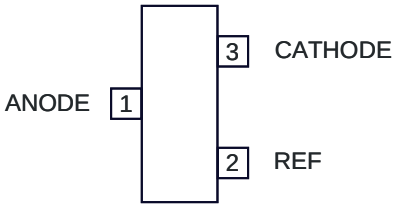
(Top View)



SOT25

ZXRE252

(Top View)



SOT23

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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.

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Absolute Maximum Ratings (Note 4) (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Rating	Unit
V_{KA}	Cathode Voltage		40	V
I_{KA}	Continuous Cathode Current		150	mA
I_{REF}	Reference Input Current		-0.050 to +10	mA
T_J	Operating Junction Temperature		+150	°C
T_{ST}	Storage Temperature		-55 to +150	°C
P_D	Power Dissipation (Notes 5 & 6)	SOT23	330	mW
		SOT25	500	mW

Notes:
4. Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability. Unless otherwise stated voltages specified are relative to the ANODE pin.
5. T_J, max = +150°C
6. Ratings apply to ambient temperature at +25°C.

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V_{KA}	Cathode Voltage	V_{REF}	36	V
I_{KA}	Cathode Current	0.065	100	mA
T_A	Operating Ambient Temperature	-40	+125	°C

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
V_{REF}	Reference Voltage	$V_{KA} = V_{REF}$, I_{KA} = 10mA	ZXRE250A	2.470	2.495	2.520	V
			ZXRE250B	2.482	2.495	2.507	V
V_{DEV}	Deviation of Reference Voltage Over Full Temperature Range (Note 7)	$V_{KA} = V_{REF}$, I_{KA} = 10mA	T_A = 0 to +70°C	—	6	16	mV
			T_A = -40 to +85°C	—	14	34	mV
			T_A = -40 to +125°C	—	14	34	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_{KA} = 10mA	V_{KA} = 10V to V_{REF}	—	-1.4	-2.7	mV/V
			V_{KA} = 36V to 10V	—	-1	-2	mV/V
I_{REF}	Reference Input Current	I_{KA} = 10mA, R1 = 10KΩ, R2 = ∞		—	1	4	µA
ΔI_{REF}	I_{REF} Deviation Over Full Temperature Range (Note 7)	I_{KA} = 10mA, R1 = 10KΩ, R2 = ∞	T_A = 0 to +70°C	—	0.8	1.2	µA
			T_A = -40 to +85°C	—	0.8	2.5	µA
			T_A = -40 to +125°C	—	0.8	2.5	µA
$I_{KA(MIN)}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{REF}$		—	40	65	µA
$I_{KA(OFF)}$	Off-State Current	V_{KA} = 36V, V_{REF} = 0V		—	0.05	0.5	µA
$\lvert Z_{KA} \rvert$	Dynamic Output Impedance (Note 8)	$V_{KA} = V_{REF}$, f = 0Hz		—	0.2	0.5	Ω
Θ_{JA}	Thermal Resistance Junction to Ambient	SOT23		—	380	—	°C/W
		SOT25		—	250	—	°C/W

Notes:
7. Deviation of V_{DEV}, and ΔI_{REF} are defined as the maximum variation of the values over the full temperature range.
8. Derivation of Z_{KA} on following page.

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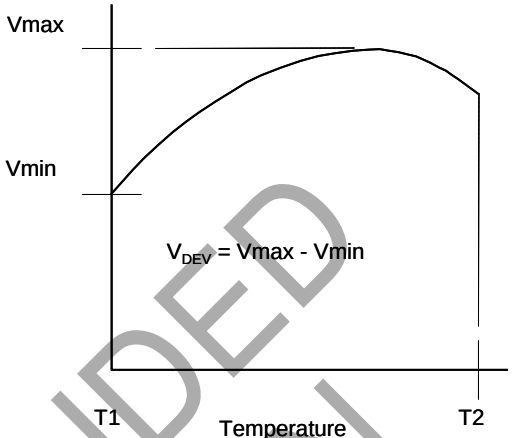
Electrical Characteristics (continued) (@T_A = +25°C, unless otherwise specified.)

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

$$|\alpha V_{REF}| = \frac{\left(\frac{V_{DEV}}{V_{REF} @ 25^oC}\right) X\ 10^6}{T2 - T1} \text{ ppm/}^oC$$



Where:
T2 - T1 = full temperature change.

αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Note : 8. The dynamic output impedance, R_Z, is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

When the device is programmed with two external resistors R1 and R2, the dynamic output impedance of the overall circuit, is defined as:

$$|Z'| = \frac{\Delta V}{\Delta I} \approx |Z_{KA}| \left(1 + \frac{R1}{R2}\right)$$

Test Circuits

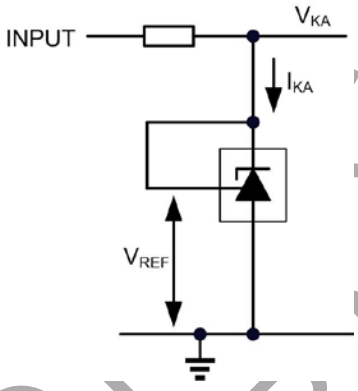


Figure 1 Test Circuit for $V_{KA} = V_{REF}$

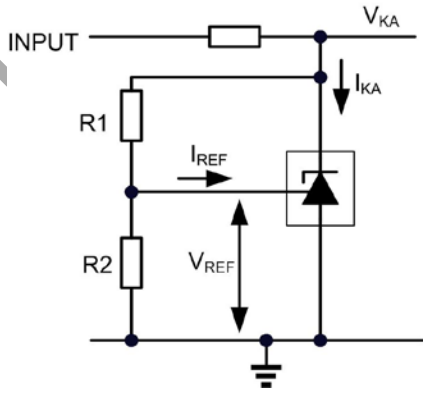


Figure 2 Test Circuit for $V_{KA} > V_{REF}$

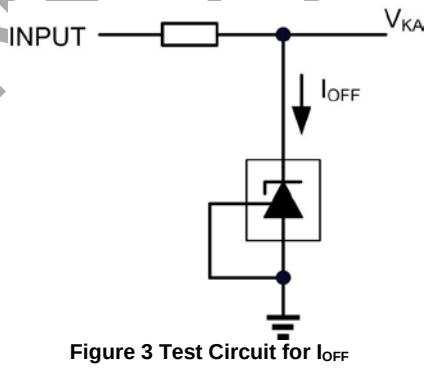


Figure 3 Test Circuit for I_{OFF}

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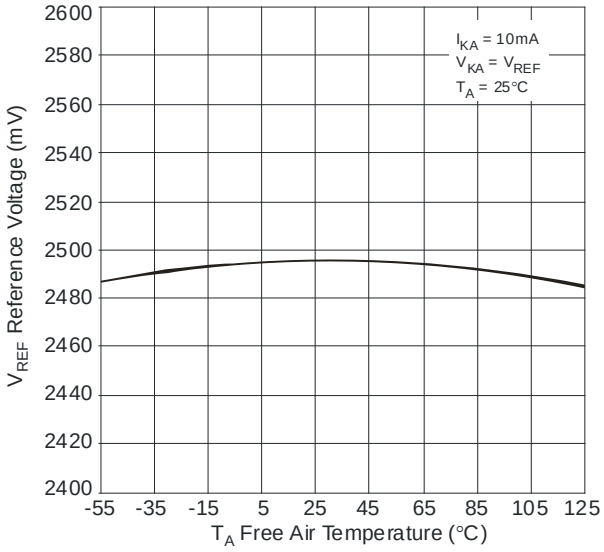
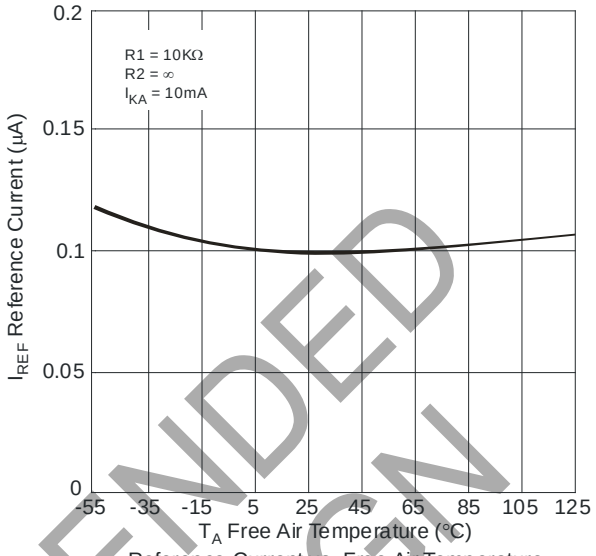
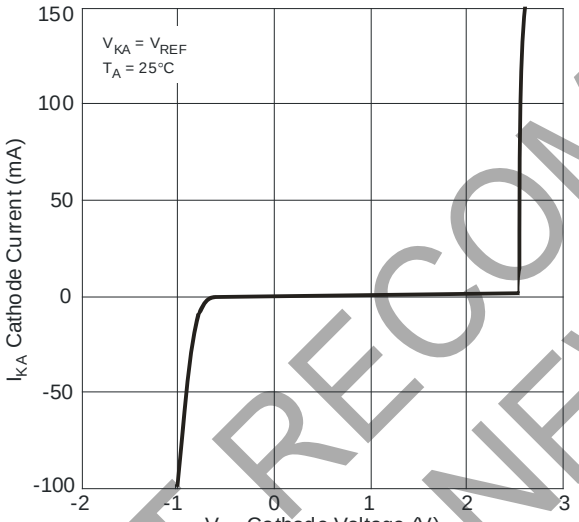
Typical Performance Characteristics



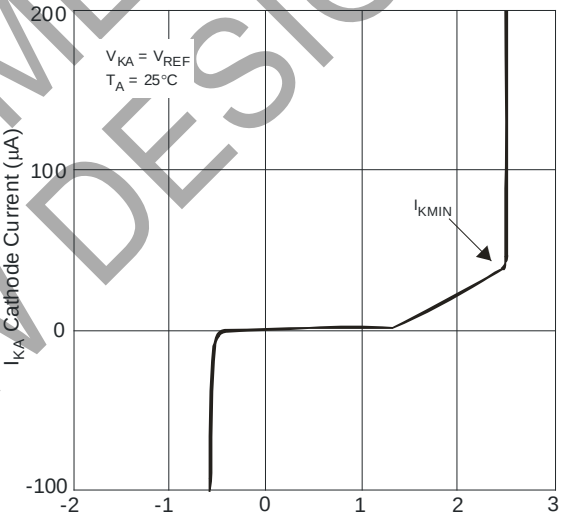
Reference Voltage vs. Free Air Temperature



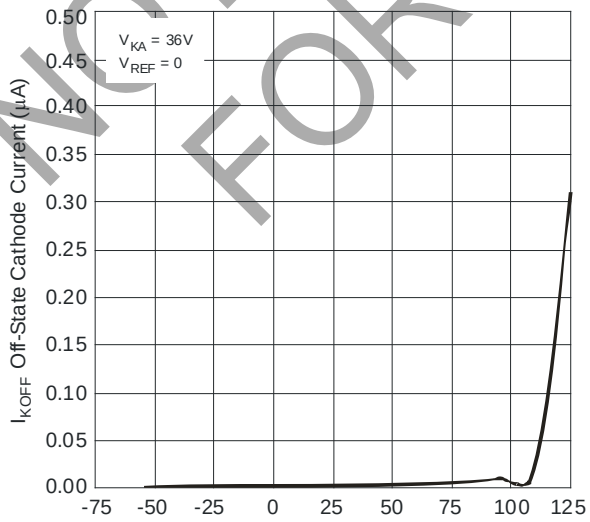
Reference Current vs. Free Air Temperature



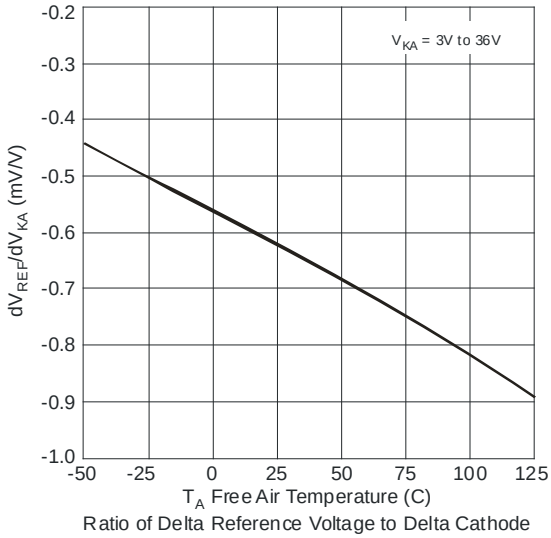
Cathode Current vs. Cathode Voltage



Cathode Current vs. Cathode Voltage



Off-State Cathode Current vs. Free Air Temperature



Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Free Air Temperature

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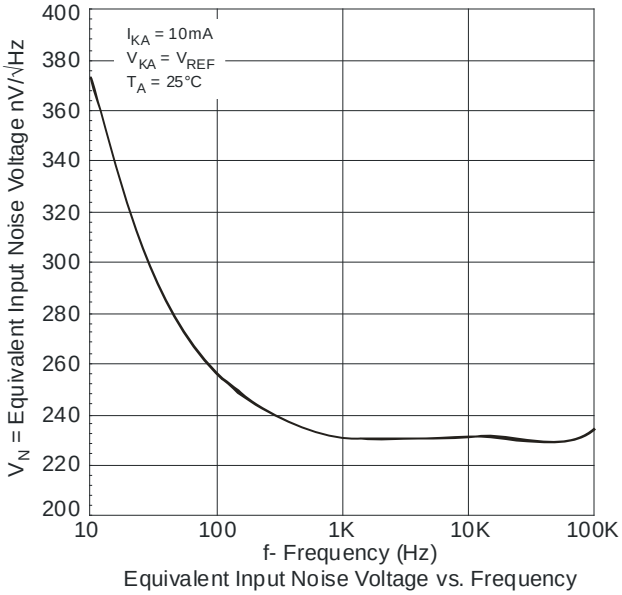
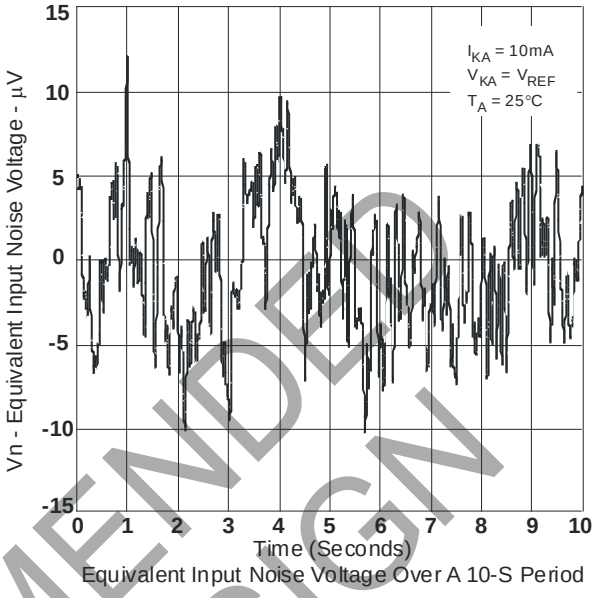
Typical Performance Characteristics (Continued)



Equivalent Input Noise Voltage vs. Frequency



Equivalent Input Noise Voltage Over A 10-S Period

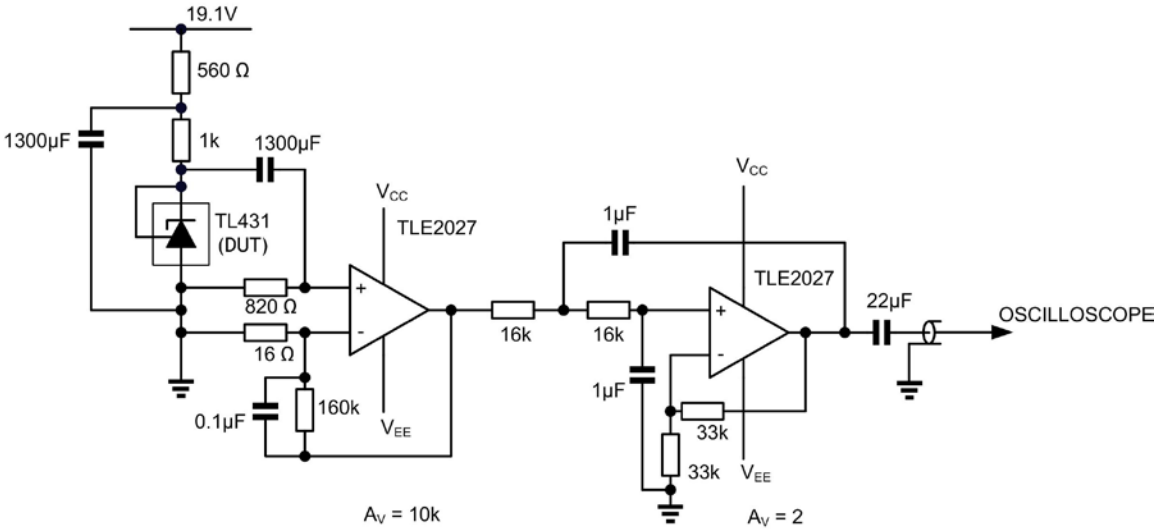


Figure 4 Test Circuit for Noise Input Voltage

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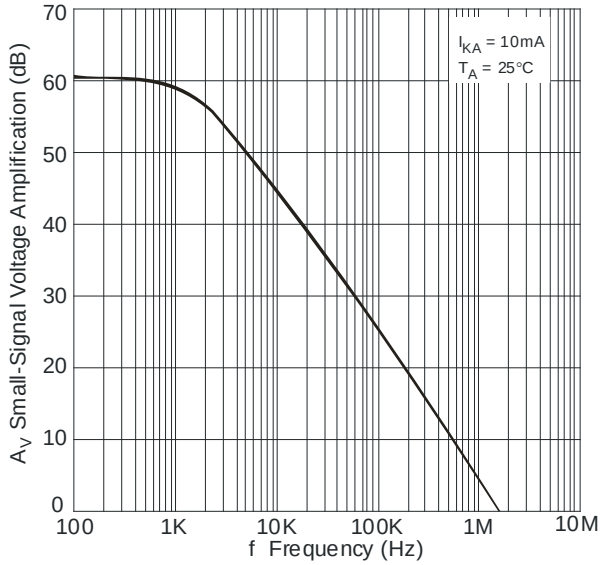
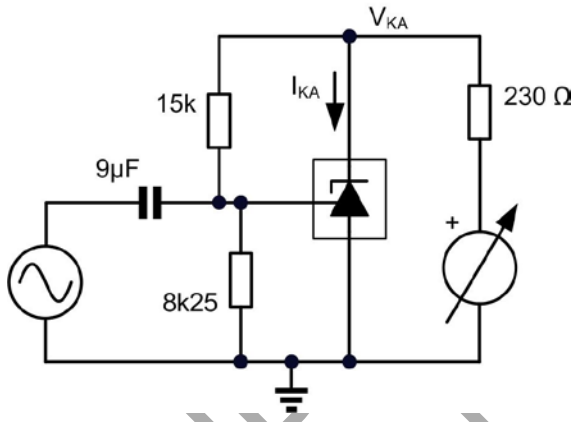
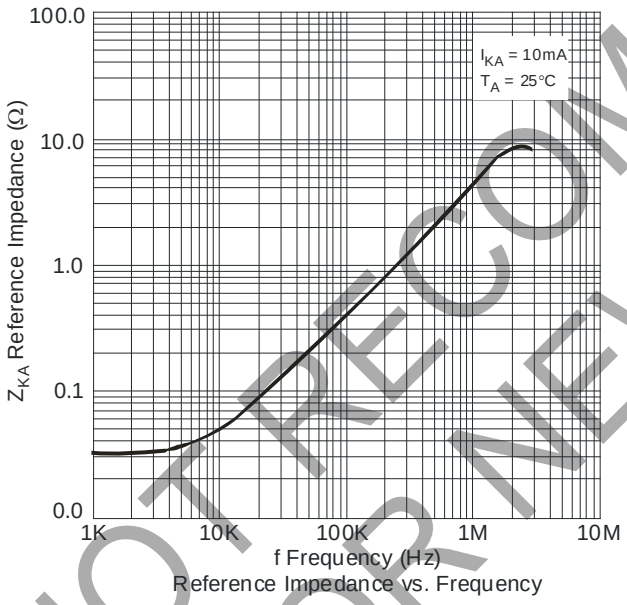
Typical Performance Characteristics (Cont.)



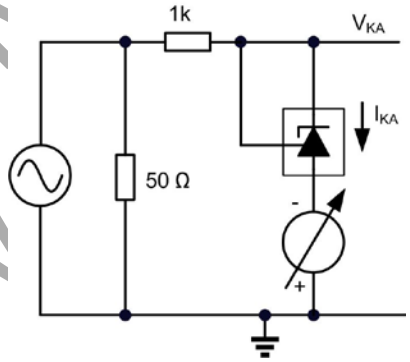
Small-Signal Voltage Amplification vs. Frequency



Test Circuit for Voltage Amplification



Reference Impedance vs. Frequency



Test Circuit for Reference Impedance

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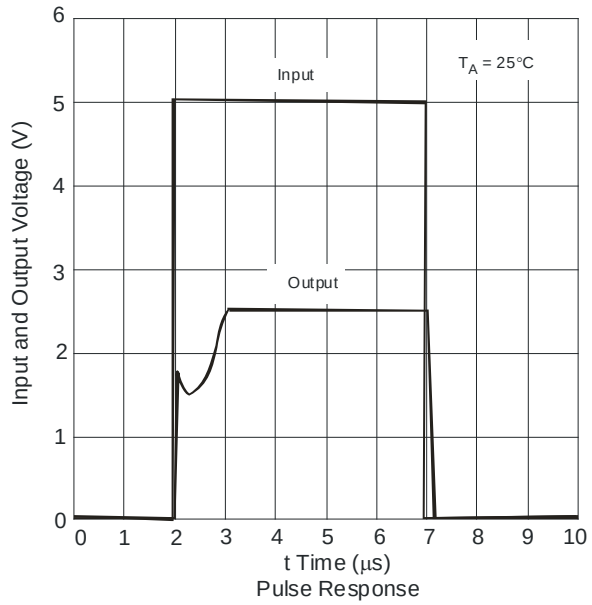
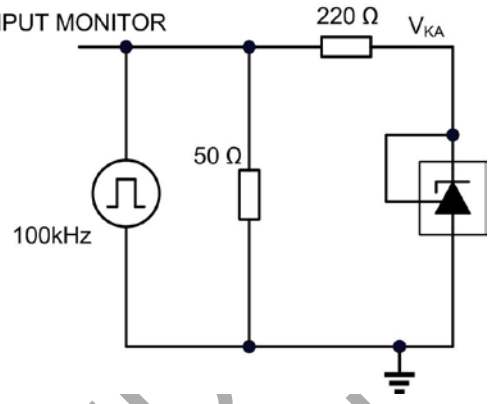
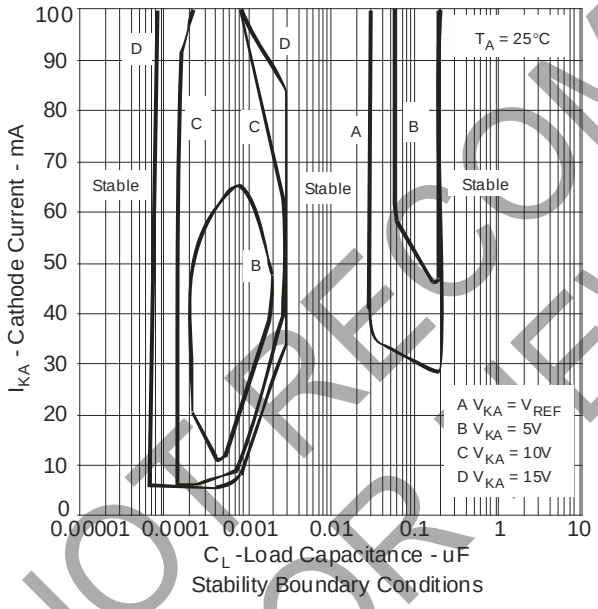
Typical Performance Characteristics (Cont.)



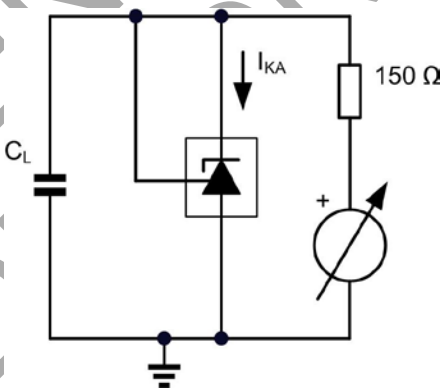
Pulse Response



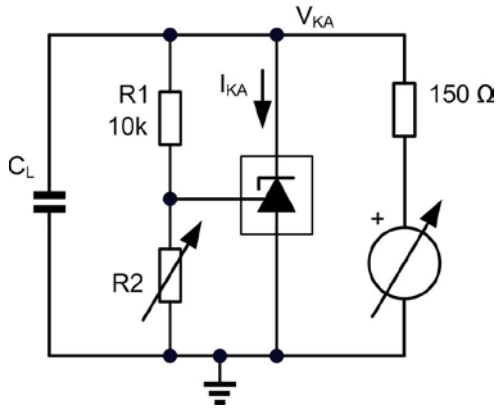
Test Circuit for Pulse Response



Stability Boundary Conditions



Test Circuit for Curve A



Test Circuit for Curves B, C, D

The device is stable under all conditions with a load capacitance not exceeding 50pF. The device is stable under all conditions with a load capacitance between 5nF and 20nF. The device is stable under all conditions with a load capacitance exceeding 300nF. With a cathode current not exceeding 5mA, the device is stable with any load capacitance.

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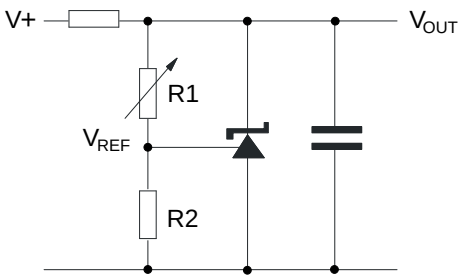
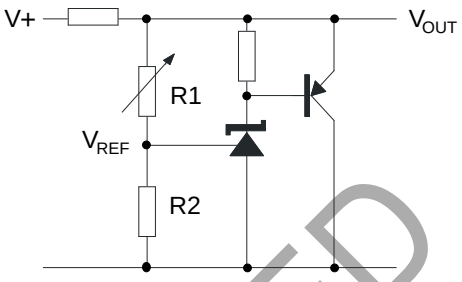
Application Information



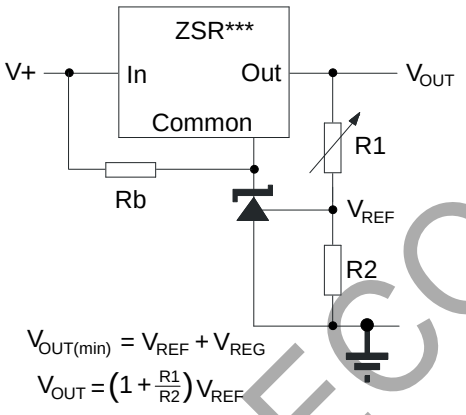
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Shunt Regulator



$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Higher Current Shunt Regulator

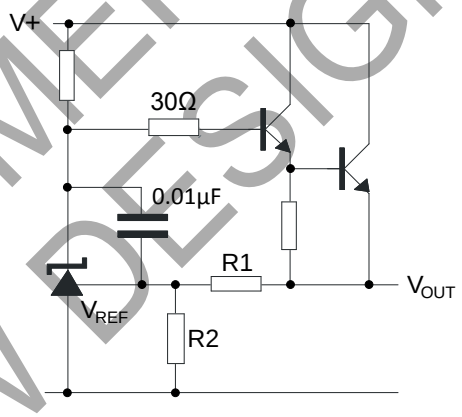


$$V_{OUT(min)} = V_{REF} + V_{REG}$$

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

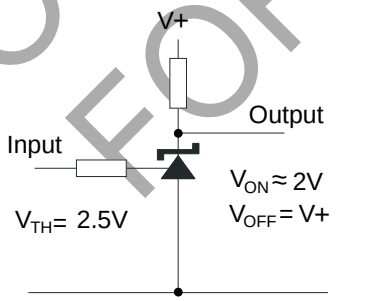
Rb - Optional to provide minimum cathode current

Output Control of a Three Terminal Fixed Regulator

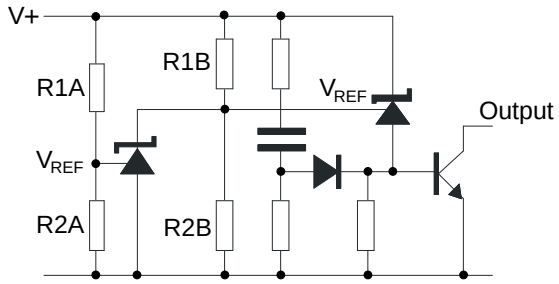


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Series Regulator



Single Supply Comparator with Temperature Compensated Threshold



$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right) V_{REF}$$

$$\text{High Limit} = \left(1 + \frac{R1A}{R2A}\right) V_{REF}$$

Over Voltage / Under Voltage Protection Circuit

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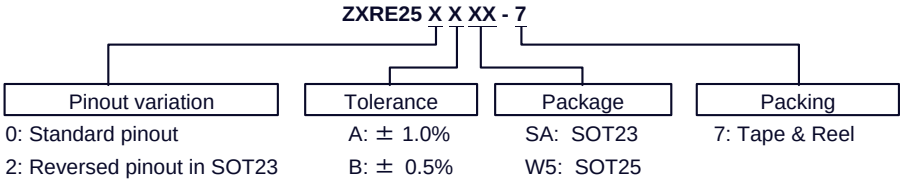
Ordering Information



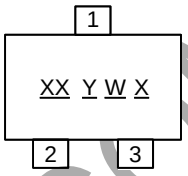
Part Number (Note 9)	Package Code	Packaging	7" Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
ZXRE250A(B)SA-7	SA	SOT23	3,000/Tape & Reel	-7	NA	NA
ZXRE250A(B)W5-7	W5	SOT25	3,000/Tape & Reel	-7	NA	NA
ZXRE252A(B)SA-7	SA	SOT23	3,000/Tape & Reel	-7	NA	NA

Note: 9. Suffix (B) denotes ZXRE250B (0.5% tolerance) device.

Marking Information

(1) SOT23

(Top View)

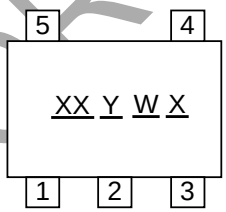


XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green

Device	Package	Identification Code
ZXRE250ASA	SOT23	DA
ZXRE250BSA	SOT23	DB
ZXRE252ASA	SOT23	FA
ZXRE252BSA	SOT23	FB

(2) SOT25

(Top View)



XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green

Device	Package	Identification Code
ZXRE250AW5	SOT25	DA
ZXRE250BW5	SOT25	DB

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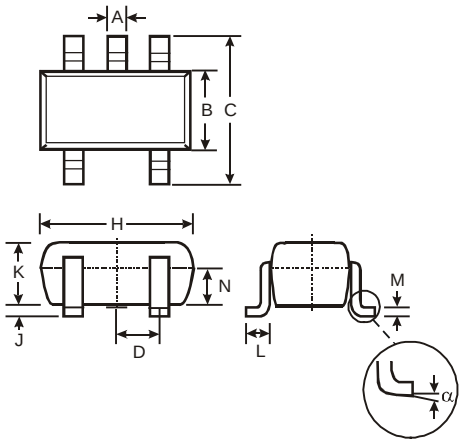
Package Outline Dimensions

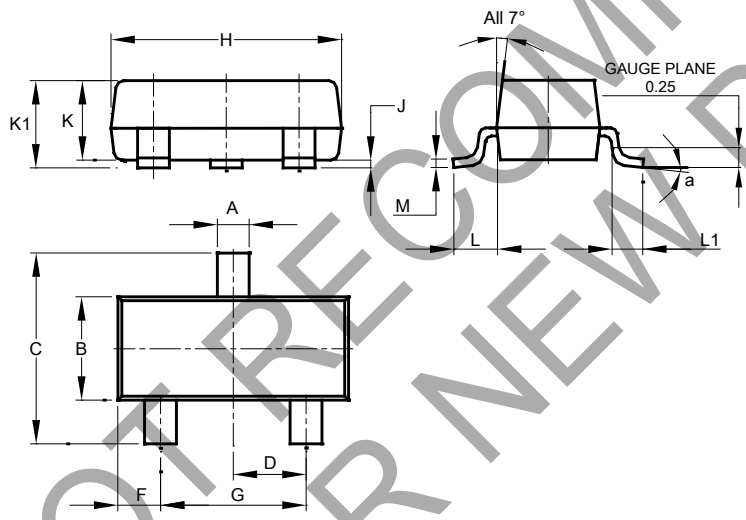
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT25



SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	-	-	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	-
All Dimensions in mm			

(2) Package Type: SOT23



SOT23			
Dim	**Min**	**Max**	**Typ**
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.890	1.00	0.975
K1	0.903	1.10	1.025
L	0.45	0.61	0.55
L1	0.25	0.55	0.40
M	0.085	0.150	0.110
a	0°	8°	--
All Dimensions in mm			

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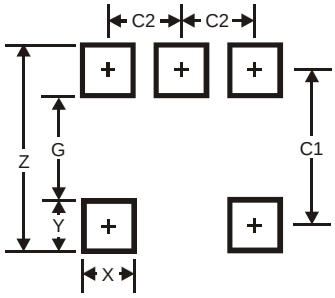
Suggested Pad Layout

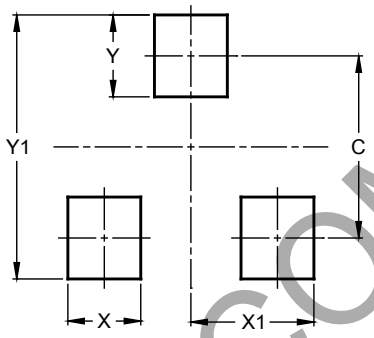
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT25



Dimensions	Value
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

(2) Package Types: SOT23



Dimensions	Value (in mm)
C	2.0
X	0.8
X1	1.35
Y	0.9
Y1	2.9

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