

ADJUSTABLE PRECISION ZENER SHUNT REGULATOR

ISSUE 3 DECEMBER 1997

ZR2431

DEVICE DESCRIPTION

The ZR2431 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 15 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 ZR2431 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.

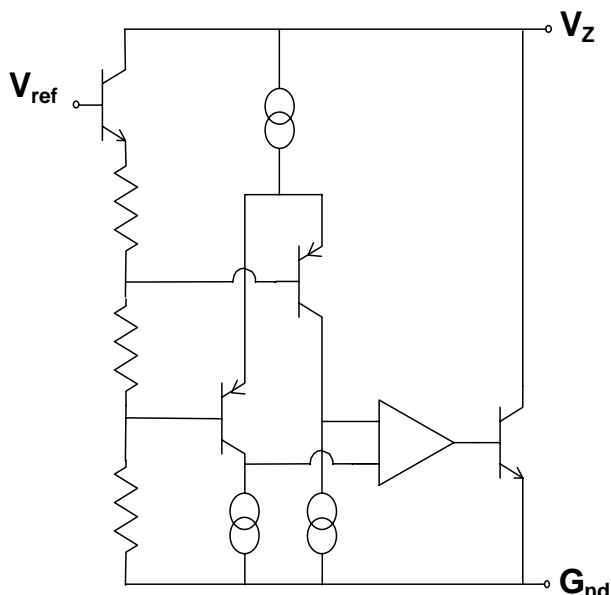
FEATURES

- Surface mount SOT23, SOT223, SOT89 and SO8 packages
- TO92 package
- 2.5% and 1% tolerance
- Maximum temperature coefficient 52 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



ZR2431

ABSOLUTE MAXIMUM RATING

| | |
|-----------------------------------|--------------|
| Cathode Voltage (V _Z) | 15V |
| Cathode Current | 50mA |
| Operating Temperature | -40 to 85°C |
| Storage Temperature | -55 to 125°C |

Recommended Operating Conditions

| | Min | Max |
|-----------------|------------------|------|
| Cathode Voltage | V _{REF} | 15V |
| Cathode Current | 100μA | 25mA |

Power Dissipation (T_{amb}=25°C,

T_{jmax}=150°C)

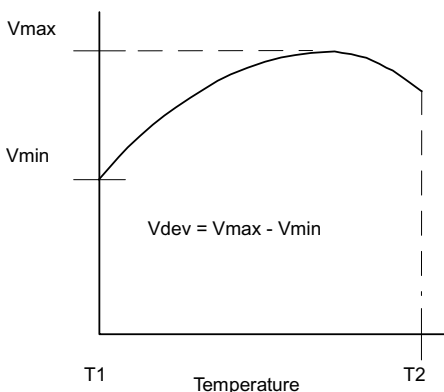
| | |
|--------|-------|
| SOT23 | 330mW |
| SOT223 | 2W |
| SO8 | 780mW |
| TO92 | 780mW |
| SOT89 | 1.5W |

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 | 1.24 | 1.271 | V | I _L =10mA (Fig1), V _Z =V _{ref} |
| | | 1.228 | 1.24 | 1.252 | | |
| 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 =15V, 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:

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

The dynamic output impedance, R_Z, is

$$\text{defined as: } R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

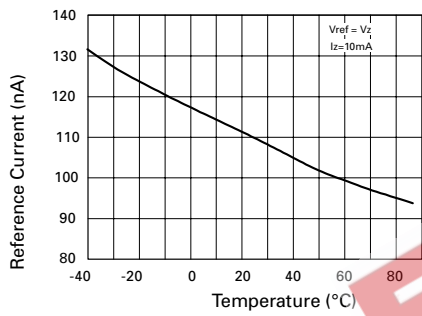
When the device is programmed with two external resistors, R₁ and R₂, (fig 2), the dynamic output impedance of the overall circuit, R', is defined as:

$$R' = R_Z \left(1 + \frac{R_1}{R_2}\right)$$

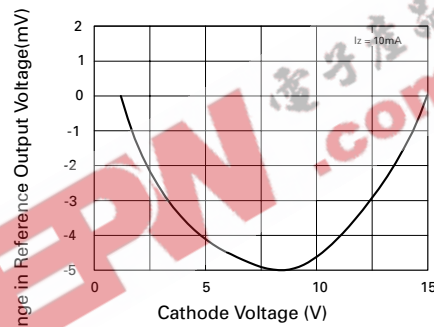
† With a capacitance of greater than 100pF between cathode and anode, minimum cathode current must be 0.2mA.

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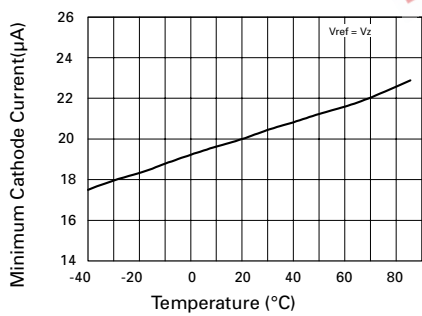
TYPICAL CHARACTERISTICS



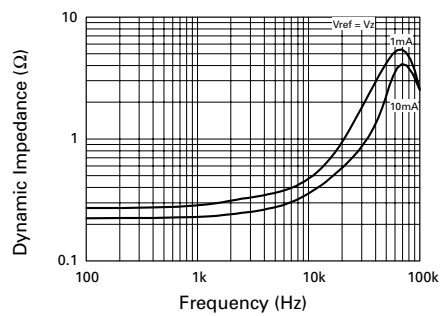
Reference Current v Temperature



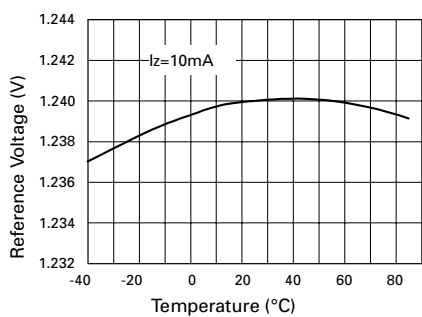
Change in Vref v Cathode Voltage



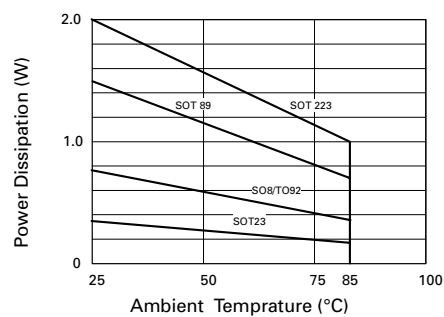
Cathode Current v Temperature



Dynamic Impedance v Frequency



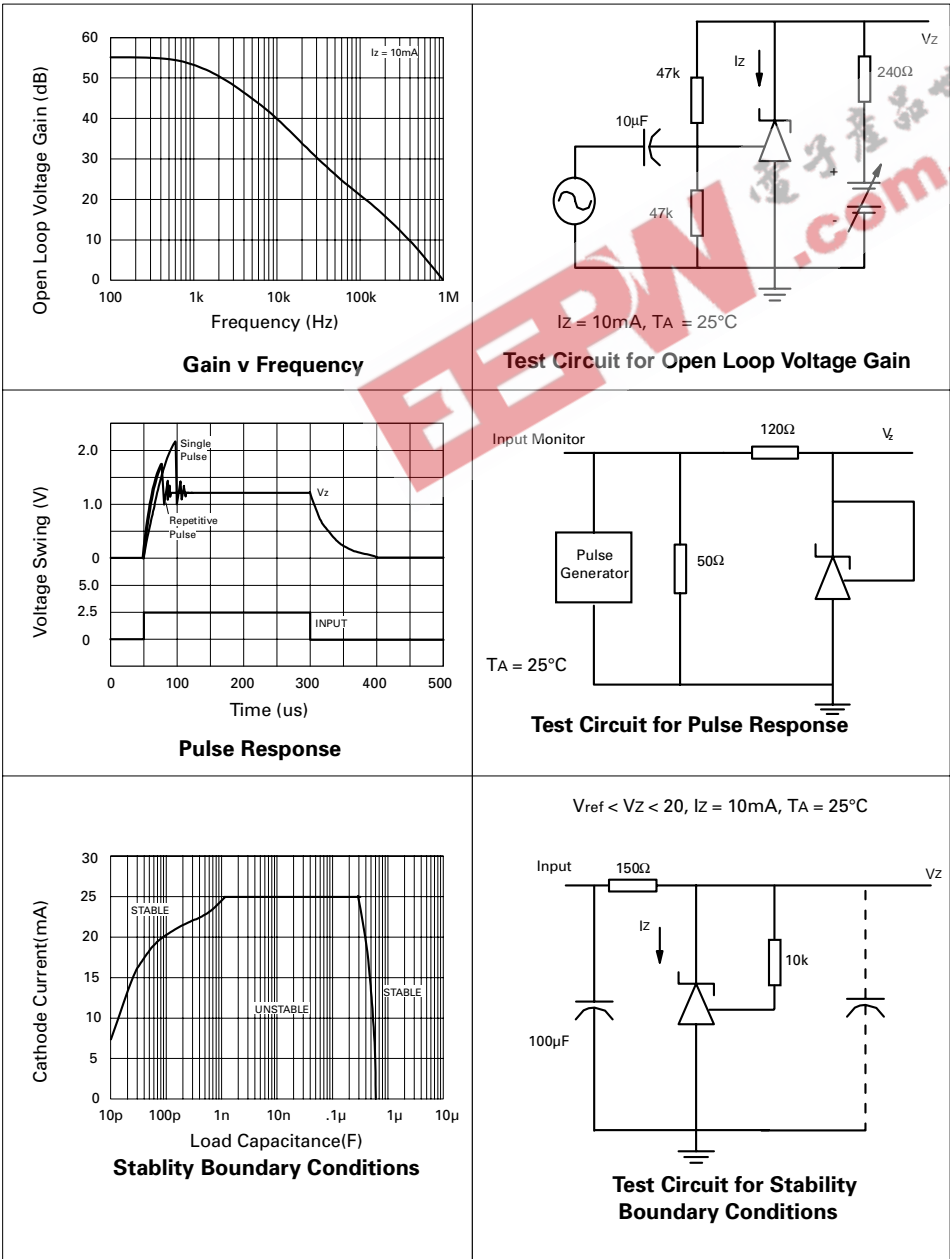
Reference Voltage v Temperature



Power Dissipation Derating

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TYPICAL CHARACTERISTICS



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DC TEST CIRCUITS

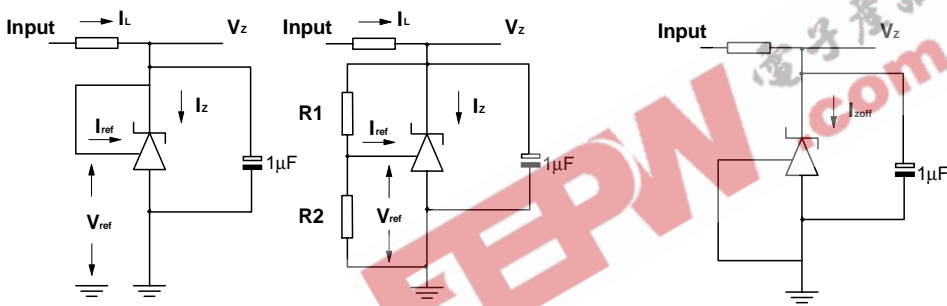
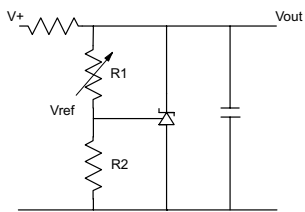


Fig 1 – Test Circuit for $V_z = V_{ref}$ Fig 2 – Test Circuit for $V_z > V_{ref}$

Fig 3 – Test Circuit for Off State current

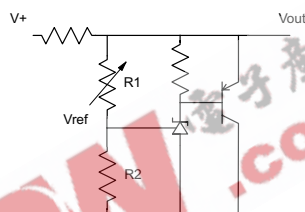
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APPLICATION CIRCUITS



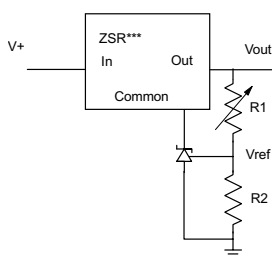
$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

SHUNT REGULATOR



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

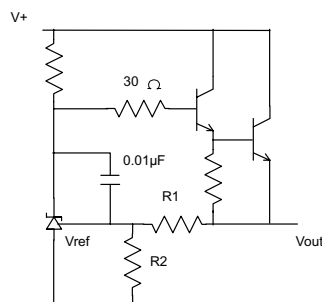
HIGHER CURRENT SHUNT REGULATOR



$$V_{out_MIN} = V_{ref} + V_{reg}$$

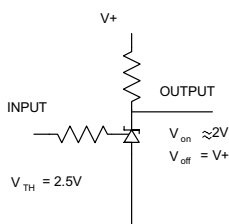
$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

OUTPUT CONTROL OF A THREE TERMINAL FIXED REGULATOR

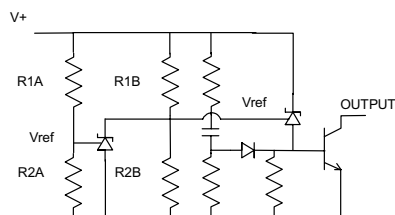


$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

SERIES REGULATOR



SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD



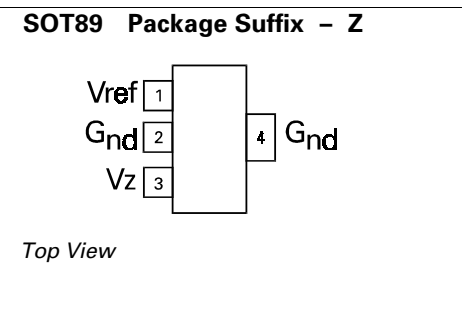
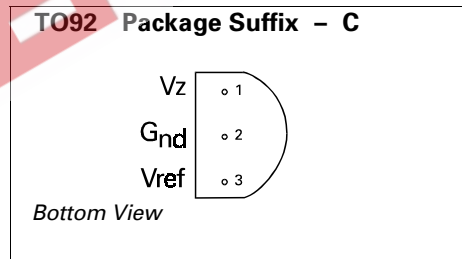
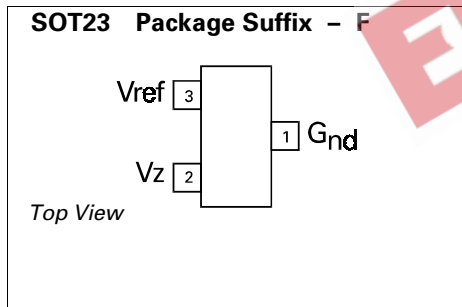
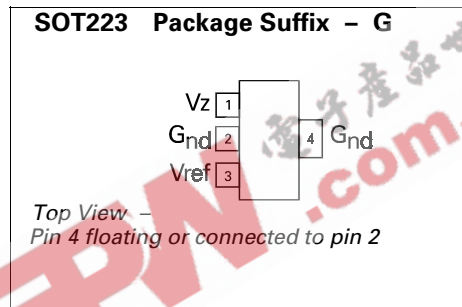
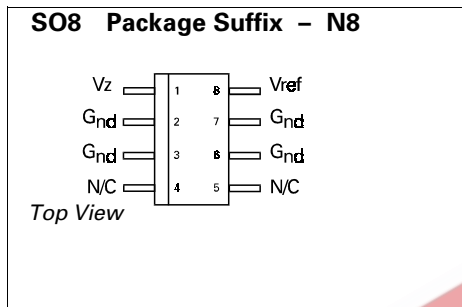
$$\text{Low limit} = \left(1 + \frac{R1B}{R2B}\right) V_{ref}$$

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

OVER VOLTAGE / UNDER VOLTAGE PROTECTION CIRCUIT

ZR2431

CONNECTION DIAGRAMS



ORDERING INFORMATION

| Part Number | Package | Tol % | Part Mark |
|-------------|---------|-------|-----------|
| ZR2431N802 | SO8 | 2.5 | ZR243102 |
| ZR2431N801 | SO8 | 1 | ZR243101 |
| ZR2431G02 | SOT223 | 2.5 | ZR243102 |
| ZR2431G01 | SOT223 | 1 | ZR243101 |
| ZR2431F02 | SOT23 | 2.5 | 24D |
| ZR2431F01 | SOT23 | 1 | 24E |
| ZR2431Z02 | SOT89 | 2.5 | 24D |
| ZR2431Z01 | SOT89 | 1 | 24E |
| ZR2431C02 | TO92 | 2.5 | ZR243102 |
| ZR2431C01 | TO92 | 1 | ZR243101 |