

Description

The ZTL431AQ, ZTL431BQ, ZTL432AQ, and ZTL432BQ are three terminal adjustable shunt regulators that offer excellent temperature stability and output current handling capability up to 100mA. The output voltage can be set to any chosen voltage between 2.5V and 20V by the selection of two external divider resistors.

The ZTL432AQ and ZTL432BQ have the same electrical specifications as the ZTL431AQ and ZTL431BQ but have a different pin out in SOT23 (F-suffix).

The ZTL431AQ, ZTL431BQ, ZTL432AQ, and ZTL432BQ are available in two grades with initial tolerances of 1% and 0.5% for the A and B grades respectively.

These devices are functionally equivalent to the TL431/TL432 except for maximum operation voltage, and they have an ambient temperature range of -40°C to +125°C as standard.

Features

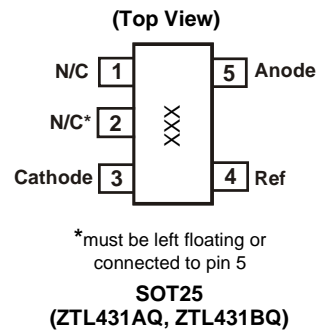
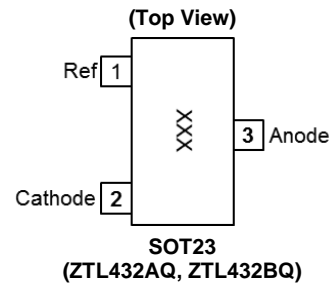
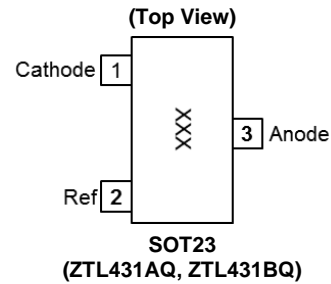
- Temperature Range: -40°C to +125°C
- Reference Voltage Tolerance at +25°C
 - 0.5%: B Grade
 - 1%: A Grade
- 0.2Ω Typical Output Impedance
- Sink Current Capability: 1mA to 100mA
- Adjustable Output Voltage: V_{REF} to 20V
- Green Molding in SOT23 and SOT25
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The ZTL431AQ, ZTL431BQ, ZTL432AQ and ZTL432BQ are suitable for automotive applications requiring specific change control; these parts are AEC-Q100 qualified, PPAP capable, and manufactured in IATF16949 certified facilities.**
<https://www.diodes.com/quality/product-definitions/>

Applications

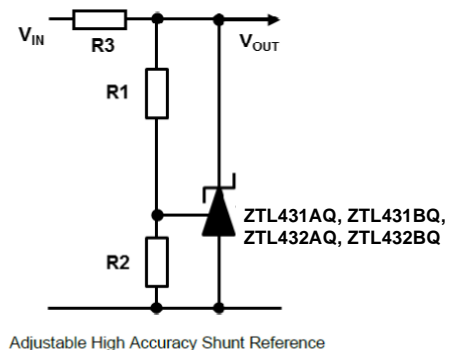
- Optocoupler linearization
- Linear regulators
- Improved Zener
- Variable references

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.

Pin Assignments



Typical Application



Absolute Maximum Ratings (Voltages specified are relative to the Anode pin unless otherwise stated.)

| Parameter | | Rating | Unit |
|---|----------------------|----------------------|--------------|
| Cathode Voltage (V_{KA}) | | 20 | V |
| Continuous Cathode Current (I_{KA}) | | 150 | mA |
| Reference Input Current Range (I_{REF}) | | -50 μ A to +10mA | — |
| Operating Junction Temperature | | -40 to +150 | $^{\circ}$ C |
| Storage Temperature | | -55 to +150 | $^{\circ}$ C |
| ESD Susceptibility | | | |
| HBM | Human Body Model | 2 | kV |
| MM | Machine Model | 200 | V |
| CDM | Charged Device Model | 1 | kV |

Caution: Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

(Semiconductor devices are ESD sensitive and can be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.)

Package Thermal Data

| Package | θ_{JA} | P_{DIS} $T_A = +25^{\circ}\text{C}, T_J = +125^{\circ}\text{C}$ |
|---------|--------------------|--|
| SOT23 | 380 $^{\circ}$ C/W | 260mW |
| SOT25 | 250 $^{\circ}$ C/W | 400mW |

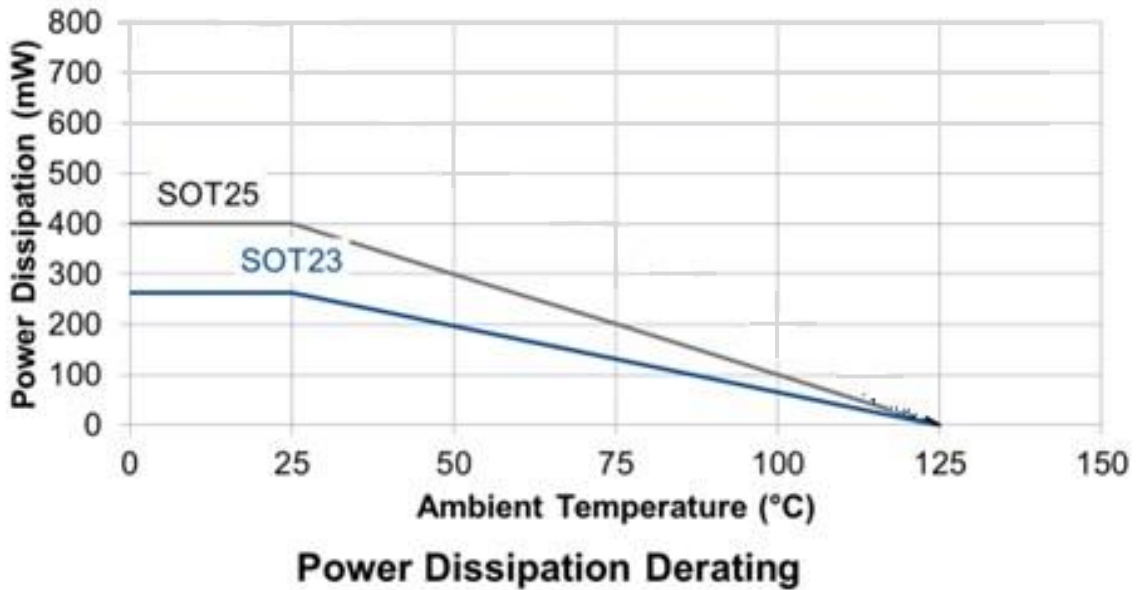
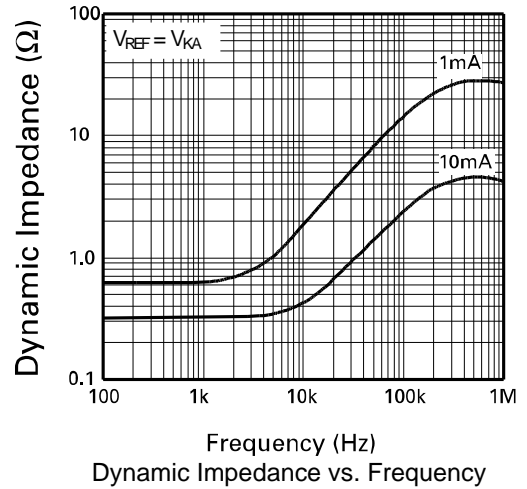
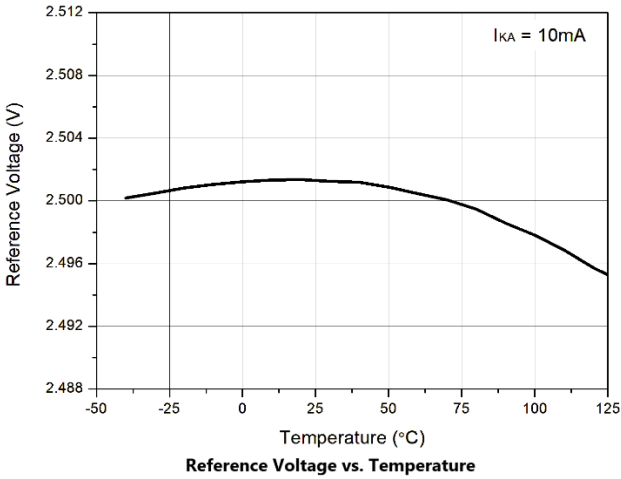
Recommended Operating Conditions (@ $T_A = +25^{\circ}\text{C}$, unless otherwise specified.)

| Symbol | Parameter | Min | Max | Unit |
|----------|-------------------------------------|-----------|------|--------------|
| V_{KA} | Cathode Voltage | V_{REF} | 20 | V |
| I_{KA} | Cathode Current | 1 | 100 | mA |
| T_A | Operating Ambient Temperature Range | -40 | +125 | $^{\circ}$ C |

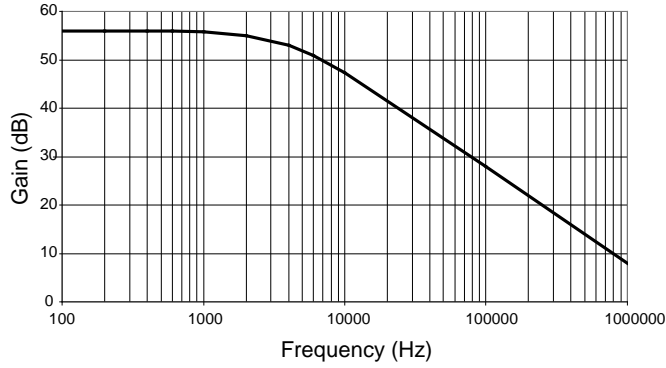
Electrical Characteristics (@ $T_A = +25^{\circ}\text{C}$, unless otherwise specified.)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---|---|--|------|-------|----------|
| V_{REF} | Reference Voltage | $V_{KA} = V_{REF}$ $I_{KA} = 10\text{mA}$ | A - grade 2.475 | 2.5 | 2.525 | V |
| | | | B - grade 2.487 | 2.5 | 2.513 | |
| V_{DEV} | Deviation of Reference Voltage over Full Temperature Range | $V_{KA} = V_{REF}$ $I_{KA} = 10\text{mA}$ | $T_A = 0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ — | 6 | 16 | mV |
| | | | $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ — | 14 | 34 | |
| | | | $T_A = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ — | 14 | 34 | |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of Change in Reference Voltage to the Change in Cathode Voltage | $I_{KA} = 10\text{mA}$ | $V_{KA} = V_{REF}$ to 10V — | -1.4 | -2.7 | mV/V |
| | | | $V_{KA} = 10\text{V}$ to 20V — | -1.0 | -2.0 | |
| I_{REF} | Reference Input Current | $I_{KA} = 10\text{mA}, R_1 = 10\text{k}\Omega, R_2 = \text{open}$ | — | 2 | 4 | μ A |
| ΔI_{REF} | I_{REF} Deviation over Full Temperature Range | $I_{KA} = 10\text{mA}$ $R_1 = 10\text{k}\Omega$ $R_2 = \text{open}$ | $T_A = 0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ — | 0.8 | 1.2 | μ A |
| | | | $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ — | 0.8 | 2.5 | |
| | | | $T_A = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ — | 0.8 | 2.5 | |
| $I_{KA(MIN)}$ | Minimum Cathode Current for Regulation | $V_{KA} = V_{REF}$ | — | 0.4 | 0.6 | mA |
| $I_{KA(OFF)}$ | Off-State Current | $V_{KA} = 20\text{V}$ $V_{REF} = 0\text{V}$ | — | 0.1 | 0.5 | μ A |
| R_Z | Dynamic Output Impedance | $V_{KA} = V_{REF}$ $f = 0\text{Hz}$ | — | 0.2 | 0.5 | Ω |

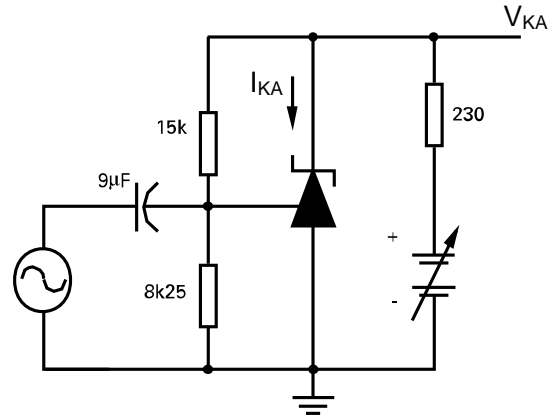
Typical Characteristics



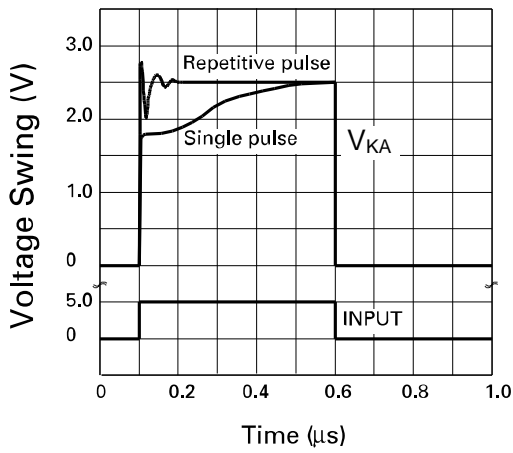
Typical Characteristics (continued)



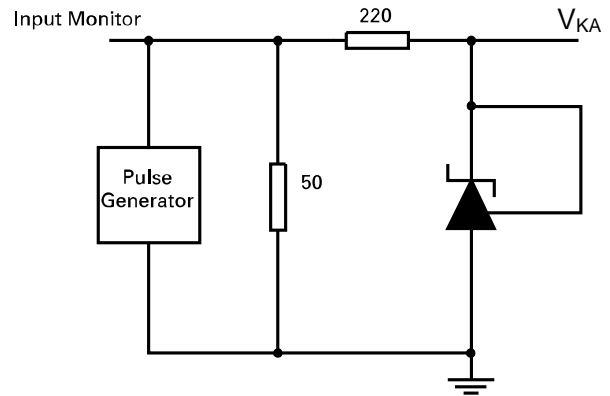
Gain vs. Frequency



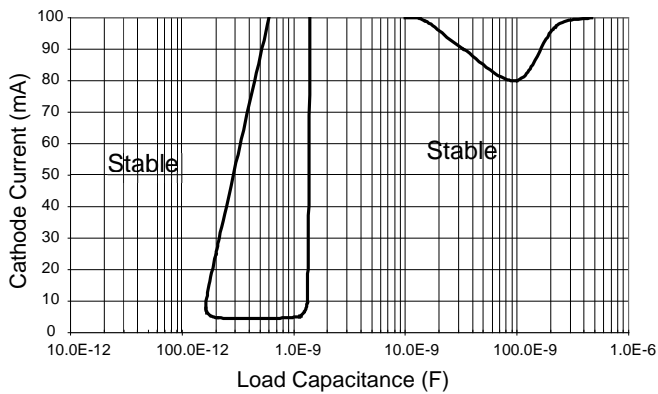
$I_{KA} = 10\text{mA}$, $T_A = 25^\circ\text{C}$
Test Circuit for Open Loop Voltage Gain



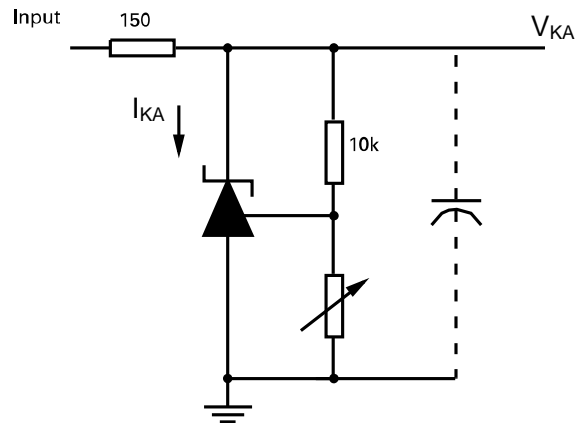
Pulse Response



$T_A = 25^\circ\text{C}$
Test Circuit for Pulse Response

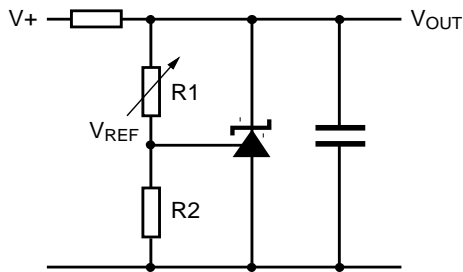


Stability Boundary Condition



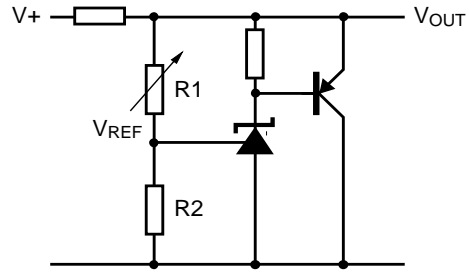
$V_{REF} < V_{KA} < 20\text{V}$, $I_{KA} = 10\text{mA}$, $T_A = +25^\circ\text{C}$
Test Circuit for Stability Boundary Conditions

Application Circuits



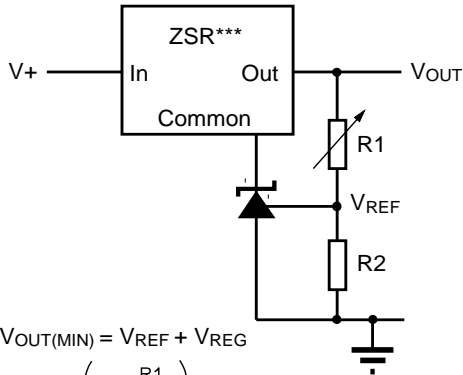
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Shunt regulator



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

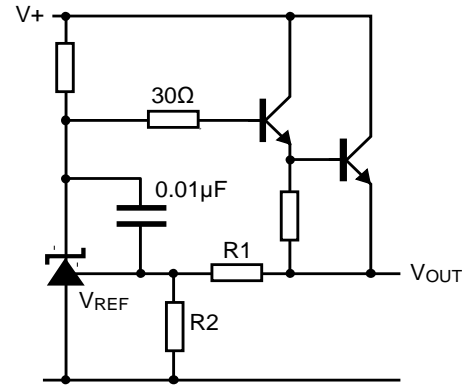
Higher current shunt regulator



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

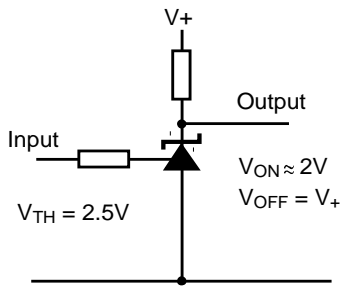
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Output control of a three terminal fixed regulator

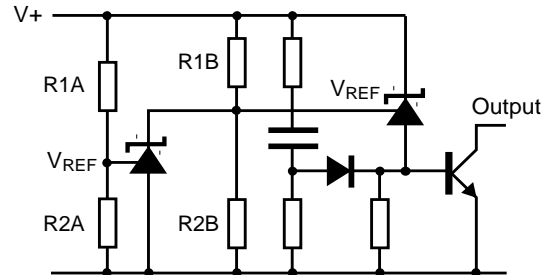


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Series regulator



Single supply comparator with temperature compensated threshold



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

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

Overvoltage/undervoltage protection circuit

DC Test Circuits

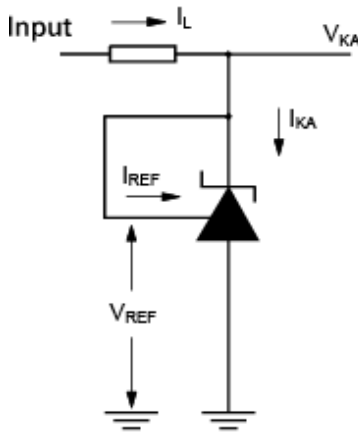


Figure 1. Test circuit for $V_{KA} = V_{REF}$

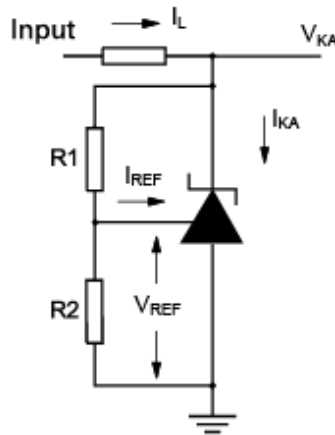


Figure 2. Test circuit for $V_{KA} > V_{REF}$

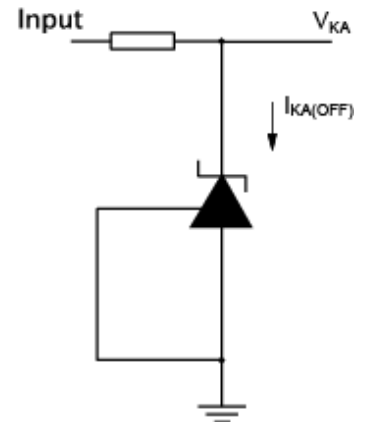


Figure 3. Test circuit for off state current

Notes

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:

$$V_{REF}(ppm/^{\circ}C) = \frac{V_{DEV} \times 1,000,000}{V_{REF}(T1-T2)}$$

The dynamic output impedance, R_z , is defined as:

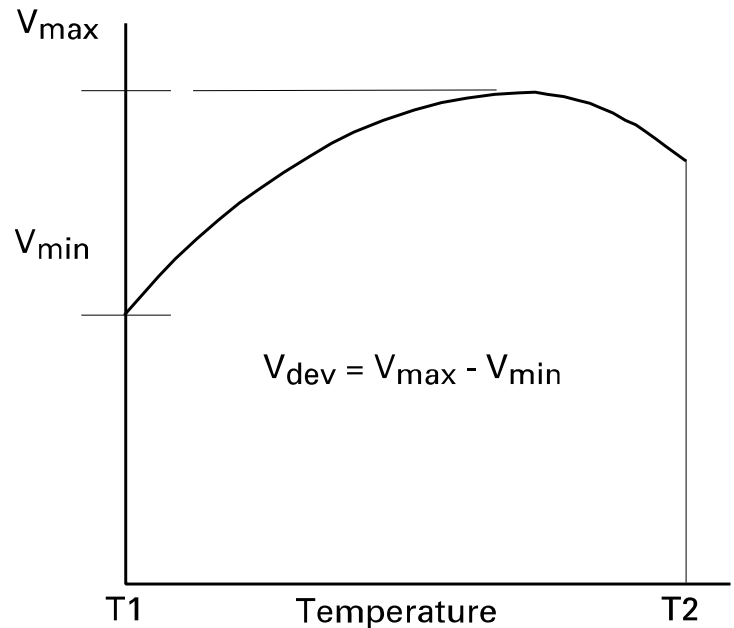
$$R_z = \frac{\Delta V_z}{\Delta I_z}$$

When the device is programmed with two external resistors, R_1 and R_2 , (Figure 2), the dynamic output impedance of the overall circuit, R'_z , is defined as:

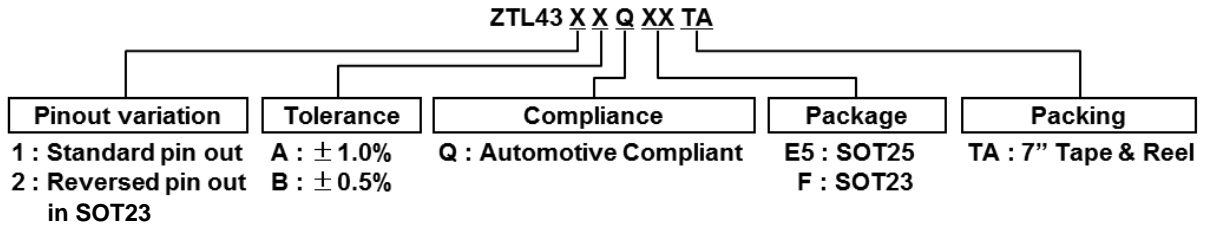
$$R'_z = R_z \left(1 + \frac{R_1}{R_2} \right)$$

Stability Boundary

The ZTL431AQ, ZTL431BQ, ZTL432AQ, and ZTL432BQ are stable with a range of capacitive loads. A zone of instability exists as demonstrated in the typical characteristic graph on page 4. The graph shows typical conditions. To ensure reliable stability, a capacitor of 4.7nF or greater is recommended between anode and cathode.



Ordering Information

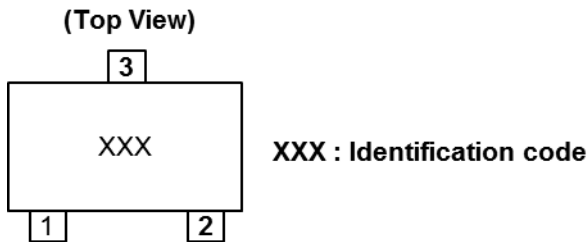


| Tol. | Orderable Part Number | Package Code | Package (Note 4) | Identification Code | Reel Size | Tape Width (mm) | Packing | |
|------|-----------------------|--------------|------------------|---------------------|-----------|-----------------|---------|-------------|
| | | | | | | | Qty. | Carrier |
| 1% | ZTL431AQE5TA | E5 | SOT25 | 31A | 7", 180mm | 8 | 3,000 | Tape & Reel |
| | ZTL431AQFTA | F | SOT23 | 31A | 7", 180mm | 8 | 3,000 | Tape & Reel |
| | ZTL432AQFTA | F | SOT23 | 32A | 7", 180mm | 8 | 3,000 | Tape & Reel |
| 0.5% | ZTL431BQE5TA | E5 | SOT25 | 31B | 7", 180mm | 8 | 3,000 | Tape & Reel |
| | ZTL431BQFTA | F | SOT23 | 31B | 7", 180mm | 8 | 3,000 | Tape & Reel |
| | ZTL432BQFTA | F | SOT23 | 32B | 7", 180mm | 8 | 3,000 | Tape & Reel |

Note: 4. Pad layout as shown in Diodes Incorporated's package outline PDFs, which can be found on our website at <http://www.diodes.com/package-outlines.html>.

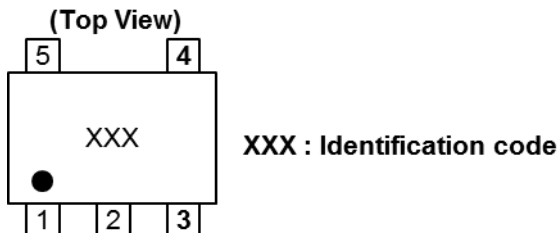
Marking Information

(1) SOT23



| Orderable Part Number | Identification Code |
|-----------------------|---------------------|
| ZTL431AQFTA | 31A |
| ZTL432AQFTA | 32A |
| ZTL431BQFTA | 31B |
| ZTL432BQFTA | 32B |

(2) SOT25

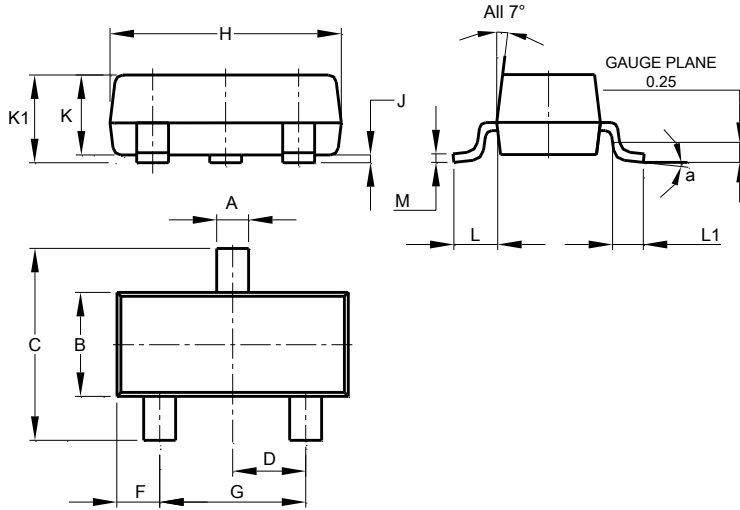


| Orderable Part Number | Identification Code |
|-----------------------|---------------------|
| ZTL431AQE5TA | 31A |
| ZTL431BQE5TA | 31B |

Package Outline Dimensions

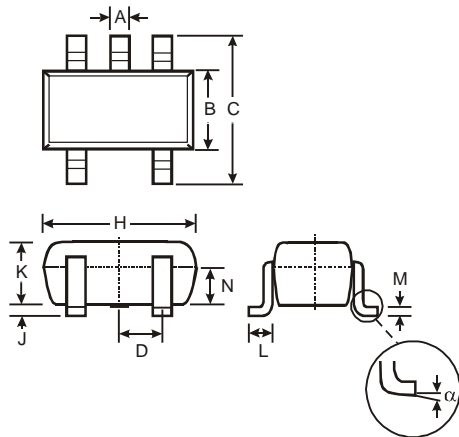
Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) 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 | | | |

(2) Package Type: SOT25

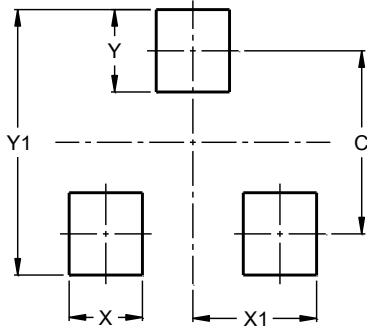


| SOT25 | | | |
|----------------------|-------|------|------|
| Dim | Min | Max | Typ |
| A | 0.35 | 0.50 | 0.38 |
| B | 1.50 | 1.70 | 1.60 |
| C | 2.70 | 3.00 | 2.80 |
| D | - | - | 0.95 |
| H | 2.90 | 3.10 | 3.00 |
| J | 0.013 | 0.10 | 0.05 |
| K | 1.00 | 1.30 | 1.10 |
| L | 0.35 | 0.55 | 0.40 |
|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

Suggested Pad Layout

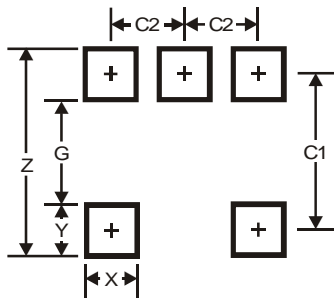
Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) Package Type: SOT23



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

(2) Package Type: SOT25



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

Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish — Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (e3)
- Weight:
 - SOT23: 0.009 grams (Approximate)
 - SOT25: 0.0153 grams (Approximate)

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