

# ZTL431, ZTL432

## Cost effective adjustable precision shunt regulator

### Description

The ZTL431 and ZTL432 are three terminal adjustable shunt regulators offering excellent temperature stability and output current handling capability up to 100mA. The output voltage may be set to any chosen voltage between 2.5 and 20 volts by selection of two external divider resistors.

The ZTL432 has the same electrical specifications as the ZTL431 but has a different pin out in SOT23 (F-suffix) and SOT23F (FF-suffix).

Both variants are available in 2 grades with initial tolerances of 1% and 0.5% for the A and B grades respectively.

The devices can be used as a replacement for zener diodes in many applications requiring an improvement in zener performance.

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

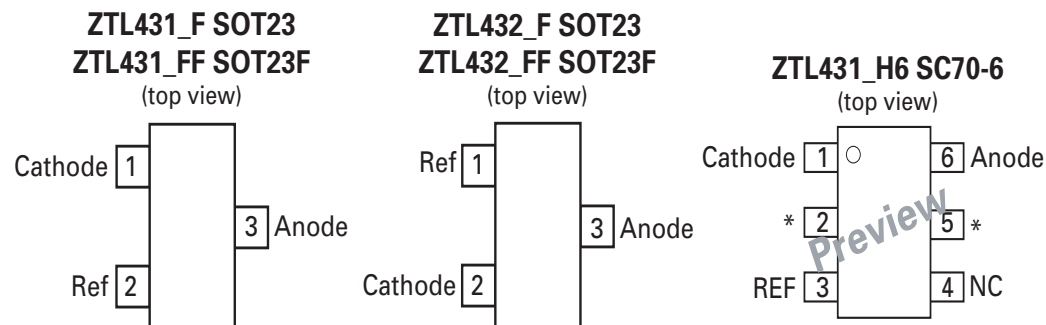
### Features

- Temperature range ..... -40 to 125°C
- Reference voltage tolerance at 25°C
  - 0.5% ..... B grade
  - 1% ..... A grade
- Low output noise
- 0.2 typical output impedance
- Sink current capability ..... 1mA to 100mA
- Adjustable output voltage .....  $V_{REF}$  to 20V

### Applications

- Opto-coupler linearization
- Linear regulators
- Improved zener
- Variable reference

### Pin connections



# ZTL431, ZTL432

## Ordering information

| Tol. | Order code  | Pack    | Part mark | Status*  | Reel Size  | Tape width (mm) | Quantity per reel |
|------|-------------|---------|-----------|----------|------------|-----------------|-------------------|
| 1%   | ZTL431ACSTZ | TO92    | ZTL431A   | Active   | Concertina | N/A             | 1500              |
|      | ZTL431AE5TA | SOT23-5 | 31A       | Preview* | 7", 180mm  | 8               | 3000              |
|      | ZTL431AFFTA | SOT23F  | 31A       | Active   | 7", 180mm  | 8               | 3000              |
|      | ZTL431AFTA  | SOT23   | 31A       | Active   | 7", 180mm  | 8               | 3000              |
|      | ZTL431AH6TA | SC70-6  | 31A       | Preview* | 7", 180mm  | 8               | 3000              |
|      | ZTL431AZTA  | SOT89   | 31A       | Preview* | 7", 180mm  | 12              | 1000              |
|      | ZTL432AFFTA | SOT23F  | 32A       | Active   | 7", 180mm  | 8               | 3000              |
|      | ZTL432AFTA  | SOT23   | 32A       | Active   | 7", 180mm  | 8               | 3000              |
| 0.5% | ZTL431BCSTZ | TO92    | ZTL431B   | Preview* | Concertina | N/A             | 1500              |
|      | ZTL431BE5TA | SOT23-5 | 31B       | Preview* | 7", 180mm  | 8               | 3000              |
|      | ZTL431BFFTA | SOT23F  | 31B       | Preview* | 7", 180mm  | 8               | 3000              |
|      | ZTL431BFTA  | SOT23   | 31B       | Active   | 7", 180mm  | 8               | 3000              |
|      | ZTL431BH6TA | SC70-6  | 31B       | Preview* | 7", 180mm  | 8               | 3000              |
|      | ZTL431BZTA  | SOT89   | 31B       | Preview* | 7", 180mm  | 12              | 1000              |
|      | ZTL432BFFTA | SOT23F  | 32B       | Active   | 7", 180mm  | 8               | 3000              |
|      | ZTL432BFTA  | SOT23   | 32B       | Active   | 7", 180mm  | 8               | 3000              |

### NOTES:

\* For availability of pre-production status devices contact your local Zetex representative

## Absolute maximum ratings

Cathode voltage ( $V_{KA}$ ) ..... 20V

Continuous cathode current ( $I_{KA}$ ) ..... 150mA

Reference input current range ( $I_{REF}$ )..... -50  $\mu$ A to 10mA

Operating junction temperature ..... -40 to 150°C

Storage temperature ..... -55 to 150°C

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.

## Package thermal data

| Package | $\Theta_{JA}$ | $P_{DIS}$<br>$T_A = 25^\circ\text{C}, T_J = 150^\circ\text{C}$ |
|---------|---------------|--|
| TO92    | 160°C/W       | 780mW  |
| SOT23   | 380°C/W       | 330mW  |
| SOT23F  | 138°C/W       | 900mW  |
| SOT23-5 | 250°C/W       | 500mW  |
| SOT89   | 125°C/W       | 1000mW   |

# ZTL431, ZTL432

## Recommended operating conditions

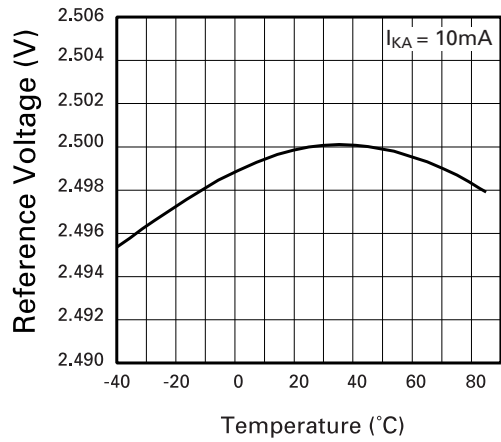
|          |                                     | Min       | Max | Units |
|----------|-------------------------------------|-----------|-----|-------|
| $V_{KA}$ | Cathode voltage                     | $V_{ref}$ | 20  | V     |
| $I_{KA}$ | Cathode current                     | 1         | 100 | mA    |
| $T_A$    | Operating ambient temperature range | -40       | 125 | °C    |

## Electrical characteristics

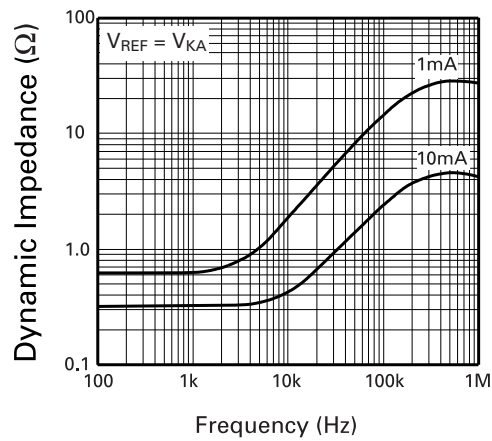
Electrical characteristics over recommended operating conditions,  $T_A = 25^\circ\text{C}$ , unless otherwise stated.

| Symbol                                 | Parameter   | Conditions  | Min.                                    | Typ. | Max.  | Units         |
|--|---|---|---|------|-------|---------------|
| $V_{REF}$                              | Reference voltage   | $V_{KA} = V_{REF}$<br>$I_{KA} = 10\text{mA}$                            | ZTL43_A<br>2.475                        | 2.5  | 2.525 | V             |
|  |   |   | ZTL43_B<br>2.487                        | 2.5  | 2.513 |               |
| $V_{DEV}$                              | Deviation of reference voltage over full temperature range            | $V_{KA} = V_{REF}$<br>$I_{KA} = 10\text{mA}$                            | $T_A = 0\text{ to }70^\circ$            | 6    | 16    | mV            |
|  |   |   | $T_A = -40\text{ to }85^\circ\text{C}$  | 14   | 34    |               |
|  |   |   | $T_A = -40\text{ to }125^\circ\text{C}$ | 14   | 34    |               |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of change in reference voltage to the change in cathode voltage | $I_{KA} = 10\text{mA}$  | $V_{KA} = V_{REF}\text{ to }10$         | -1.4 | -2.7  | mV/V          |
|  |   |   | $V_{KA} = 10\text{V to }20\text{V}$     | -1.0 | -2.0  |               |
| $I_{REF}$                              | Reference input current   | $I_{KA} = 10\text{mA}$ , $R_1 = 10\text{k}\Omega$<br>$R_2 = \text{OC}$  |   | 2    | 4     | $\mu\text{A}$ |
| $\Delta I_{REF}$                       | $I_{REF}$ deviation over full temperature range                       | $I_{KA} = 10\text{mA}$<br>$R_1 = 10\text{k}\Omega$<br>$R_2 = \text{OC}$ | $T_A = 0\text{ to }70^\circ\text{C}$    | 0.8  | 1.2   | $\mu\text{A}$ |
|  |   |   | $T_A = -40\text{ to }85^\circ\text{C}$  | 0.8  | 2.5   |               |
|  |   |   | $T_A = -40\text{ to }125^\circ\text{C}$ | 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   | $\mu\text{A}$ |
| $R_Z$                                  | Dynamic output impedance  | $V_{KA} = V_{REF}$ $f = 0\text{Hz}$                                     |   | 0.2  | 0.5   | $\Omega$      |

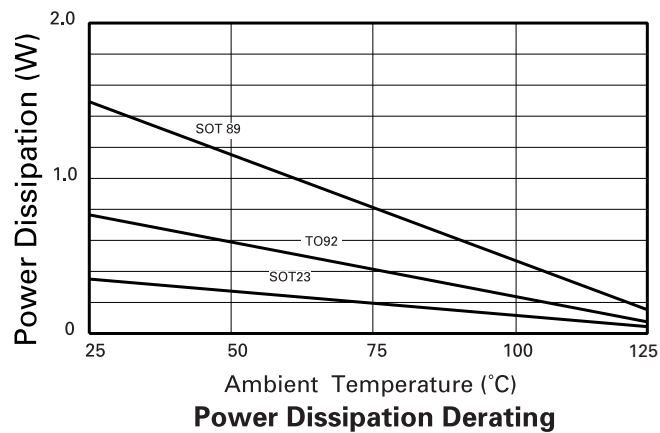
## Typical characteristics



Reference Voltage v Temperature



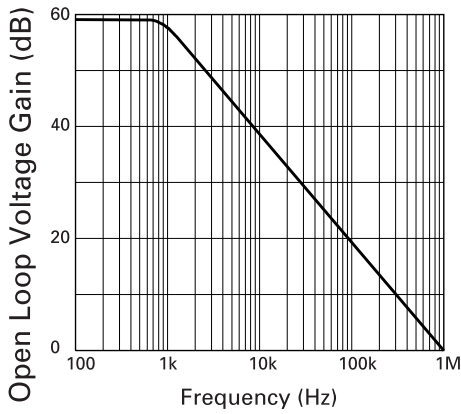
Dynamic Impedance v Frequency



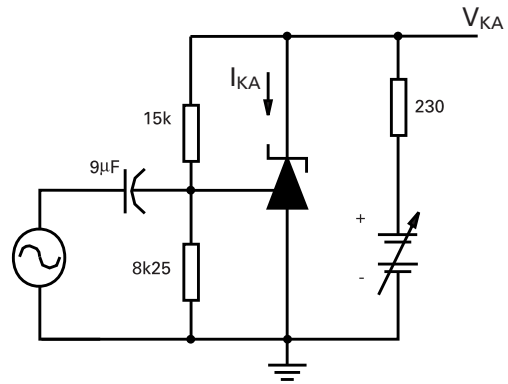
Power Dissipation Derating

# ZTL431, ZTL432

## Typical characteristics

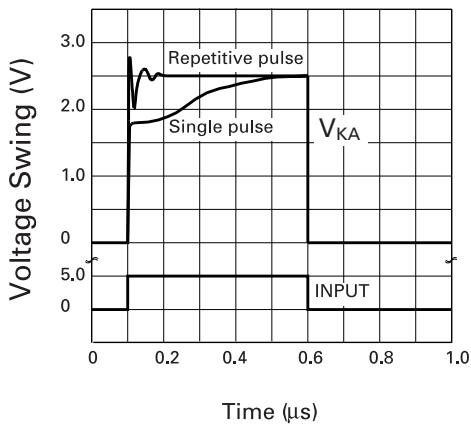


**Gain v Frequency**

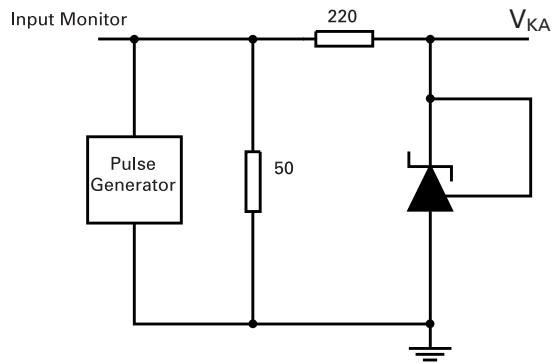


$I_{KA} = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

**Test Circuit for Open Loop Voltage Gain**

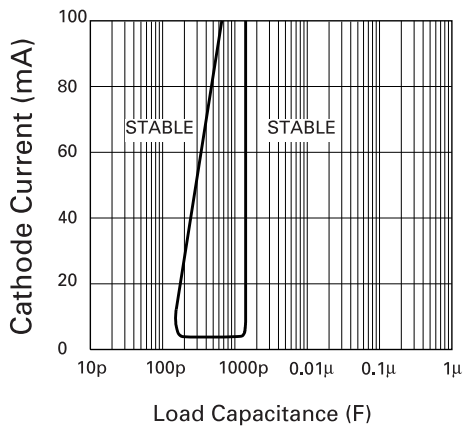


**Pulse Response**

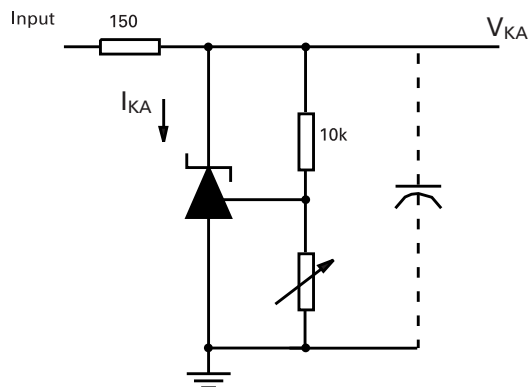


$T_A = 25^\circ\text{C}$

**Test Circuit for Pulse Response**



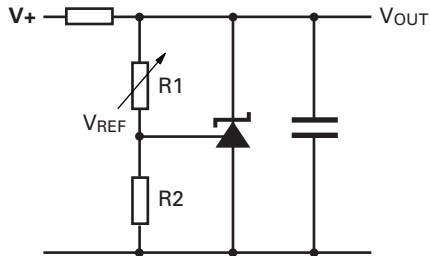
**Stability Boundary Conditions**



$V_{REF} < V_{KA} < 20$ ,  $I_{KA} = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

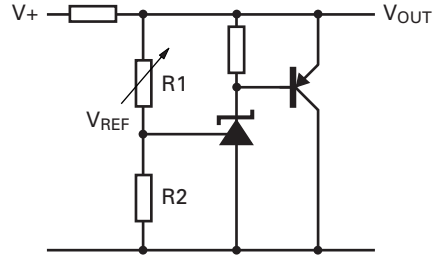
**Test Circuit for Stability Boundary Conditions**

## Application circuits



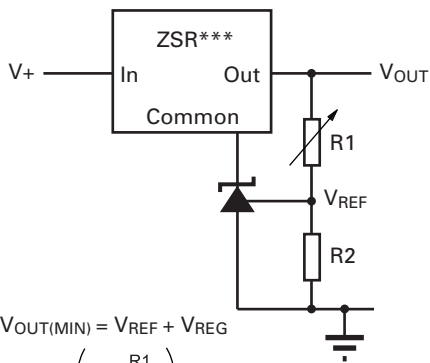
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**Shunt regulator**



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

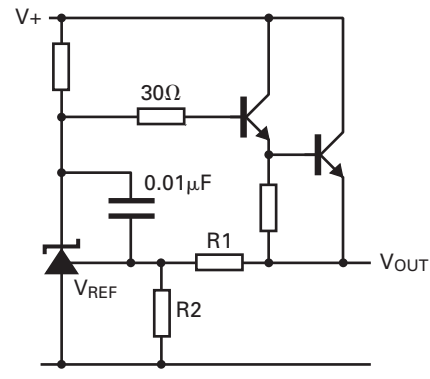
**Higher current shunt regulator**



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

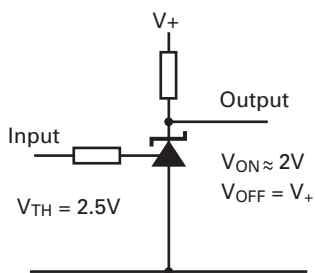
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**Output control of a three terminal fixed regulator**

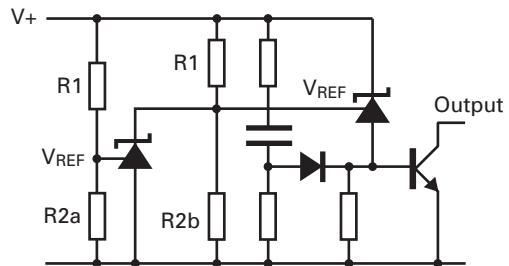


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**Series regulator**



**Single supply comparator with temperature compensated threshold**

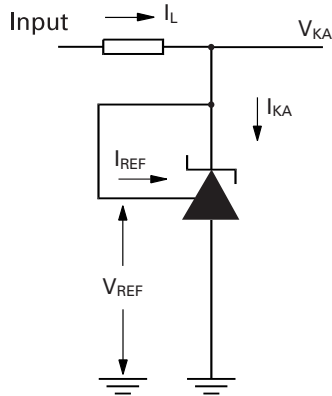


$$\text{Low limit} = \left(1 + \frac{R1B}{R2B}\right) V_{REF}$$

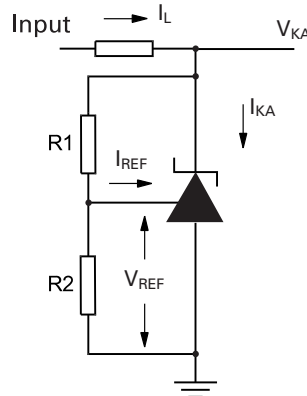
$$\text{High limit} = \left(1 + \frac{R1A}{R2A}\right) V_{REF}$$

**Over voltage / under voltage protection circuit**

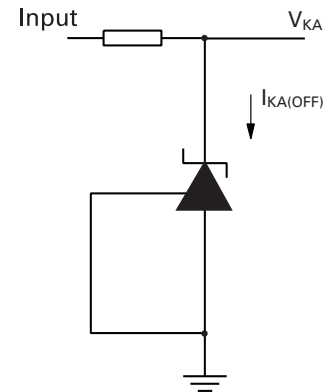
## DC test circuits



**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:

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

The dynamic output impedance,  $R_z$ , is defined as:

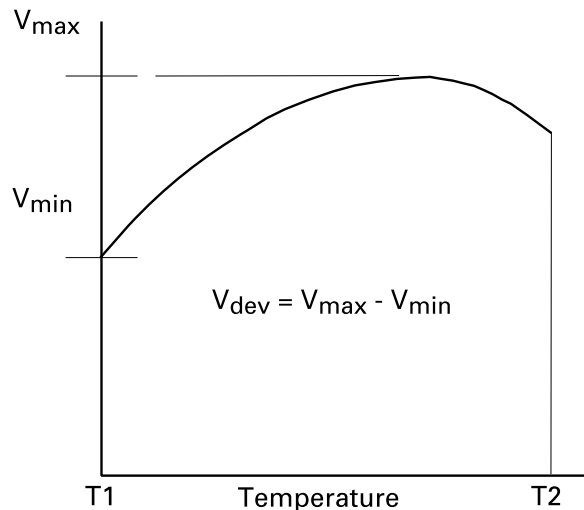
$$R_z = \frac{\Delta V_z}{\Delta I_z}$$

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

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

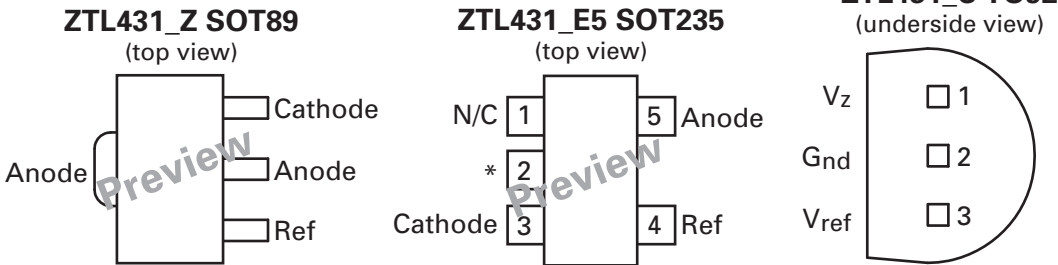
## Stability boundary

The ZTL431 and ZTL432 are stable with a range of capacitive loads. A zone of instability exists as demonstrated in the typical characteristic graph on page 5. The graph shows typical conditions. To ensure reliable stability a capacitor of 4.7nF or greater is recommended between anode and cathode.



# ZTL431, ZTL432

## Pin connections - preview status devices

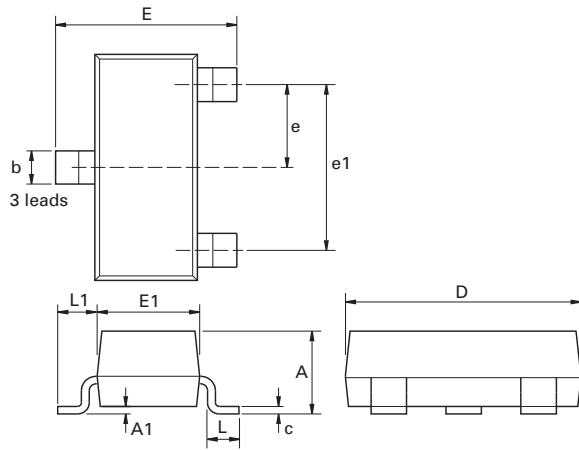


\* Pin 2 should be left floating or connected to pin 5



# ZTL431, ZTL432

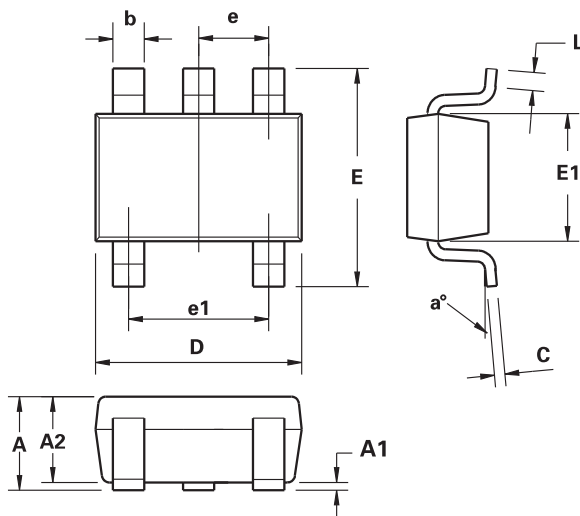
## Packaging details - SOT23



| Dim. | Millimeters |       | Inches     |       | Dim. | Millimeters |      | Inches    |       |
|------|-------------|-------|------------|-------|------|-------------|------|-----------|-------|
|      | Min.        | Max.  | Min.       | Max.  |      | Min.        | Max. | Max.      | Max.  |
| A    | -           | 1.12  | -          | 0.044 | e1   | 1.90 NOM    |      | 0.075 NOM |       |
| A1   | 0.01        | 0.10  | 0.0004     | 0.004 | E    | 2.10        | 2.64 | 0.083     | 0.104 |
| b    | 0.30        | 0.50  | 0.012      | 0.020 | E1   | 1.20        | 1.40 | 0.047     | 0.055 |
| C    | 0.085       | 0.120 | 0.003      | 0.008 | L    | 0.25        | 0.62 | 0.018     | 0.024 |
| D    | 2.80        | 3.04  | 0.110      | 0.120 | L1   | 0.45        | 0.62 | 0.018     | 0.024 |
| e    | 0.95 NOM    |       | 0.0375 NOM |       | -    | -           | -    | -         | -     |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

## Packaging details - SOT23-5

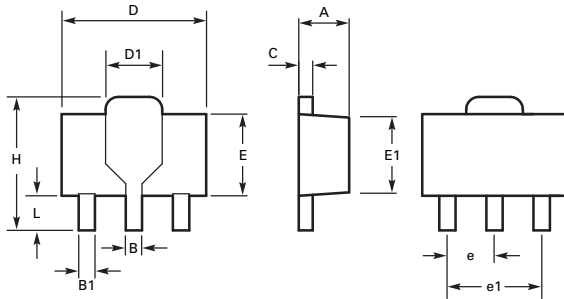


| Dim. | Millimeters |      | Inches     |        |
|------|-------------|------|------------|--------|
|      | Min.        | Max. | Min.       | Max.   |
| A    | 0.90        | 1.45 | 0.0354     | 0.0570 |
| A1   | 0.00        | 0.15 | 0.00       | 0.0059 |
| A2   | 0.90        | 1.30 | 0.0354     | 0.0511 |
| b    | 0.20        | 0.50 | 0.0078     | 0.0196 |
| C    | 0.09        | 0.26 | 0.0035     | 0.0102 |
| D    | 2.70        | 3.10 | 0.1062     | 0.1220 |
| E    | 2.20        | 3.20 | 0.0866     | 0.1181 |
| E1   | 1.30        | 1.80 | 0.0511     | 0.0708 |
| e    | 0.95 REF    |      | 0.0374 REF |        |
| e1   | 1.90 REF    |      | 0.0748 REF |        |
| L    | 0.10        | 0.60 | 0.0039     | 0.0236 |
| a°   | 0°          | 30°  | 0°         | 30°    |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

# ZTL431, ZTL432

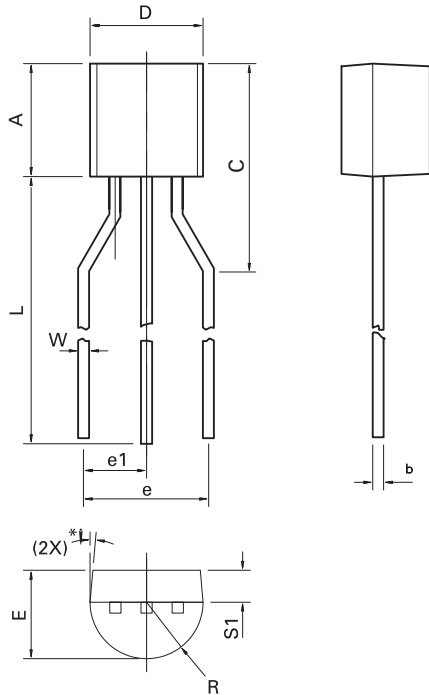
## Package details - SOT89



| Dim. | Millimeters |      | Inches |       | Dim. | Millimeters |      | Inches    |       |
|------|-------------|------|--------|-------|------|-------------|------|-----------|-------|
|      | Min.        | Max. | Min.   | Max.  |      | Min.        | Max. | Min.      | Max.  |
| A    | 1.40        | 1.60 | 0.550  | 0.630 | E1   | 2.13        | 2.29 | 0.084     | 0.090 |
| B    | 0.44        | 0.56 | 0.017  | 0.022 | e    | 1.50 BSC    |      | 0.059 BSC |       |
| B1   | 0.36        | 0.48 | 0.014  | 0.019 | e1   | 3.00 BSC    |      | 0.118 BSC |       |
| C    | 0.35        | 0.44 | 0.014  | 0.019 | H    | 3.94        | 4.25 | 0.155     | 0.167 |
| D    | 4.40        | 4.60 | 0.173  | 0.181 | L    | 0.89        | 1.20 | 0.155     | 0.167 |
| E    | 2.29        | 2.60 | 0.090  | 0.102 |      | -           | -    | -         | -     |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

## Package details - TO92

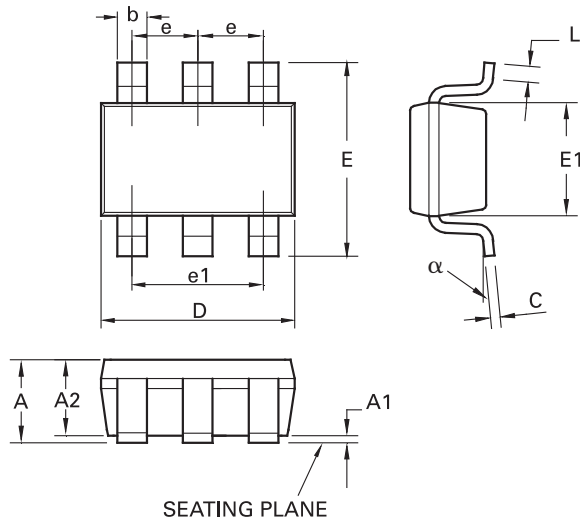


| Dim. | Millimeters |       | Inches |       |
|------|-------------|-------|--------|-------|
|      | Min.        | Max.  | Min.   | Max.  |
| A    | 4.32        | 4.95  | 0.170  | 0.195 |
| b    | 0.36        | 0.51  | 0.014  | 0.020 |
| C    | 2.50        | 3.50  | 0.099  | 0.138 |
| E    | 3.30        | 3.94  | 0.130  | 0.155 |
| e    | 4.88        | 5.88  | 0.192  | 0.232 |
| e1   | 2.44        | 2.94  | 0.096  | 0.116 |
| L    | 12.70       | 15.49 | 0.500  | 0.610 |
| R    | 2.16        | 2.41  | 0.085  | 0.095 |
| S1   | 1.14        | 1.52  | 0.045  | 0.060 |
| W    | 0.41        | 0.56  | 0.016  | 0.022 |
| D    | 4.45        | 4.95  | 0.175  | 0.195 |
| *°   | 4°          | 6°    | 4°     | 6°    |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

# ZTL431, ZTL432

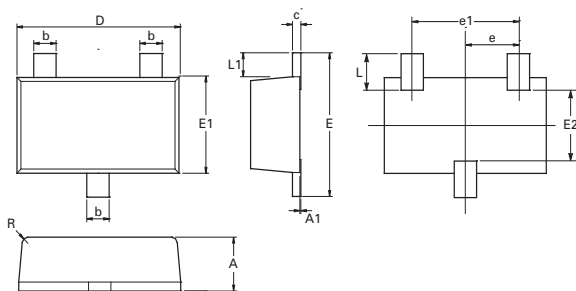
## Package details - SC70-6



| Dim. | Millimeters |      | Inches     |        | Dim. | Millimeters |      | Inches     |        |
|------|-------------|------|------------|--------|------|-------------|------|------------|--------|
|      | Min.        | Max. | Min.       | Max.   |      | Min.        | Max. | Max.       | Max.   |
| A    | 0.80        | 1.10 | 0.0315     | 0.0433 | E    | 2.10 BSC    |      | 0.0826 BSC |        |
| A1   | -           | 0.10 | -          | 0.0039 | E1   | 1.25        | 1.35 | 0.0492     | 0.0531 |
| A2   | 0.80        | 1.00 | 0.0315     | 0.0394 | e    | 0.65 BSC    |      | 0.0255 BSC |        |
| b    | 0.15        | 0.30 | 0.006      | 0.0118 | e1   | 1.30 BSC    |      | 0.0511 BSC |        |
| C    | 0.08        | 0.25 | 0.0031     | 0.0098 | L    | 0.26        | 0.46 | 0.0102     | 0.0181 |
| D    | 2.00 BSC    |      | 0.0787 BSC |        | α    | 0°          | 8°   | 0°         | 8°     |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

## Package details SOT23F



| Dim. | Millimeters |      | Inches     |        | Dim. | Millimeters |      | Inches |        |
|------|-------------|------|------------|--------|------|-------------|------|--------|--------|
|      | Min.        | Max. | Min.       | Max.   |      | Min.        | Max. | Max.   | Max.   |
| A    | 0.80        | 1.00 | 0.031      | 0.0394 | E    | 2.30        | 2.50 | 0.0906 | 0.0984 |
| A1   | -           | 0.10 | 0.00       | 0.0043 | E1   | 1.50        | 1.70 | 0.0590 | 0.0669 |
| A2   | 0.06        | 0.16 | 0.0024     | 0.0006 | E2   | 1.10        | 1.26 | 0.0433 | 0.0496 |
| b    | 0.39        | 0.41 | 0.0153     | 0.0161 | L    | 0.48        | 0.68 | 0.0189 | 0.0268 |
| c    | 0.11        | 0.20 | 0.0043     | 0.0079 | L1   | 0.39        | 0.41 | 0.0153 | 0.0161 |
| D    | 2.80        | 3.00 | 0.1102     | 0.1181 | R    | 0.05        | 0.15 | 0.0019 | 0.0059 |
| e    | 0.95 ref    |      | 0.0374 ref |        | O    | 0°          | 12°  | 0°     | 12°    |
| e1   | 1.90 ref    |      | 0.7480 ref |        | -    | -           | -    | -      | -      |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

# ZTL431, ZTL432

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## Definitions

### Product change

Zetex Semiconductors reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

### Applications disclaimer

The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Zetex with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Zetex does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

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A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body

or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labelling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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### Quality of product

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### ESD (Electrostatic discharge)

Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

### Green compliance

Zetex Semiconductors is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.

All Zetex components are compliant with the RoHS directive, and through this it is supporting its customers in their compliance with WEEE and ELV directives.

### Product status key:

|                                   |  |
|-----------------------------------|--|
| "Preview"                         | Future device intended for production at some point. Samples may be available  |
| "Active"                          | Product status recommended for new designs                                     |
| "Last time buy (LTB)"             | Device will be discontinued and last time buy period and delivery is in effect |
| "Not recommended for new designs" | Device is still in production to support existing designs and production       |
| "Obsolete"                        | Production has been discontinued   |

### Datasheet status key:

|                       |   |
|-----------------------|---|
| "Draft version"       | This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.  |
| "Provisional version" | This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice. |
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