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

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.

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

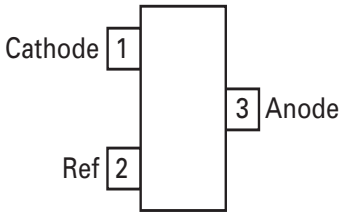
- Temperature range ..... -40 to 125°C
- Reference voltage tolerance at 25°C
  - 0.5% ..... B grade
  - 1% ..... A grade
- Low output noise
- 0.2 typical output impedance
- Sink current capability ..... 1mA to 100mA
- Adjustable output voltage..... $V_{REF}$ to 20V

## Applications

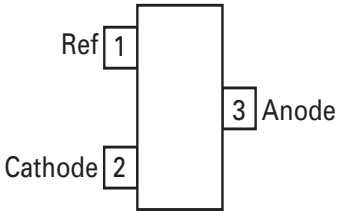
- Opto-coupler linearization
- Linear regulators
- Improved zener
- Variable reference

## Pin connections

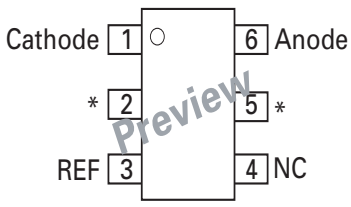
**ZTL431_F SOT23**
**ZTL431_FF SOT23F**
(top view)




**ZTL432_F SOT23**
**ZTL432_FF SOT23F**
(top view)




**ZTL431_H6 SC70-6**
(top view)



## 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 µA 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 | $\Theta_{JA}$ | $P_{DIS}$ $T_A$ =25°C, $T_J$ = 150°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 |

## Recommended operating conditions

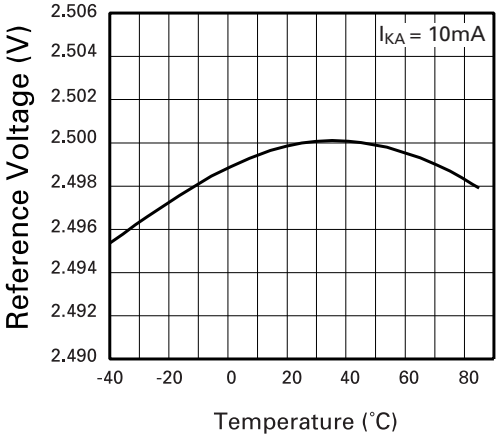
| | | Min | Max | Units |
|---|---|---|---|---|
| $V_{KA}$ | Cathode voltage | $V_{ref}$ | 20 | V |
| $I_{KA}$ | Cathode current | 1 | 100 | mA |
| $T_A$ | Operating ambient temperature range | -40 | 125 | °C |

## Electrical characteristics

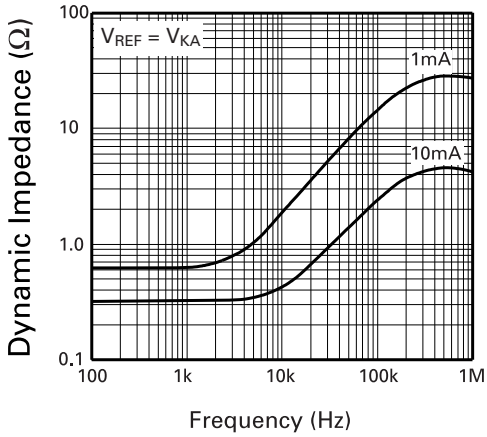
Electrical characteristics over recommended operating conditions, $T_A$ = 25°C, unless otherwise stated.

| Symbol | Parameter | Conditions | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| $V_{REF}$ | Reference voltage | $V_{KA} = V_{REF}$<br>$I_{KA}$ = 10mA | ZTL43_A | 2.475 | 2.5 | 2.525 | V |
| | | | ZTL43_B | 2.487 | 2.5 | 2.513 | |
| $V_{DEV}$ | Deviation of reference voltage over full temperature range | $V_{KA} = V_{REF}$<br>$I_{KA}$ = 10 mA | $T_A$ = 0 to 70° | | 6 | 16 | mV |
| | | | $T_A$ = -40 to 85°C | | 14 | 34 | |
| | | | $T_A$ = -40 to 125°C | | 14 | 34 | |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of change in reference voltage to the change in cathode voltage | $I_{KA}$ = 10mA | $V_{KA} = V_{REF}$ to 10 | | -1.4 | -2.7 | mV/V |
| | | | $V_{KA}$ = 10V to 20V | | -1.0 | -2.0 | |
| $I_{REF}$ | Reference input current | $I_{KA}$ = 10mA, R1 = 10kΩ<br>$R_2$ = OC | | | 2 | 4 | µA |
| $\Delta I_{REF}$ | $I_{REF}$ deviation over full temperature range | $I_{KA}$ = 10mA<br>$R_1$ = 10kΩ<br>$R_2$ = OC | $T_A$ = 0 to 70°C | | 0.8 | 1.2 | µA |
| | | | $T_A$ = -40 to 85°C | | 0.8 | 2.5 | |
| | | | $T_A$ = -40 to 125°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 | $V_{KA}$ = 20V, $V_{REF}$ = 0V | | | 0.1 | 0.5 | µA |
| $R_Z$ | Dynamic output impedance | $V_{KA} = V_{REF}$, f = 0Hz | | | 0.2 | 0.5 | Ω |

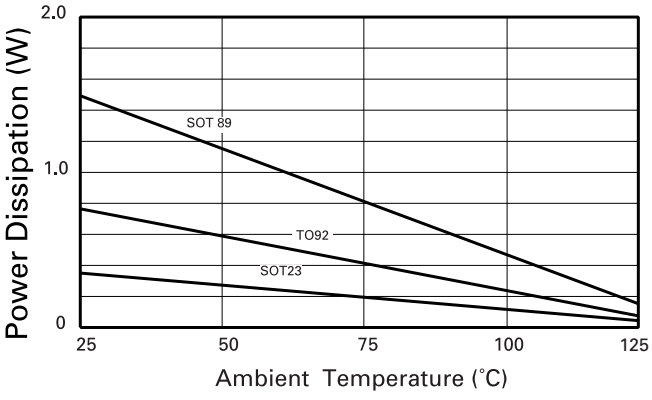
## Typical characteristics




**Reference Voltage v Temperature**

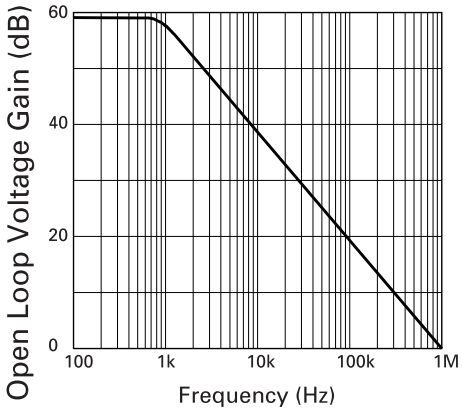



**Dynamic Impedance v Frequency**

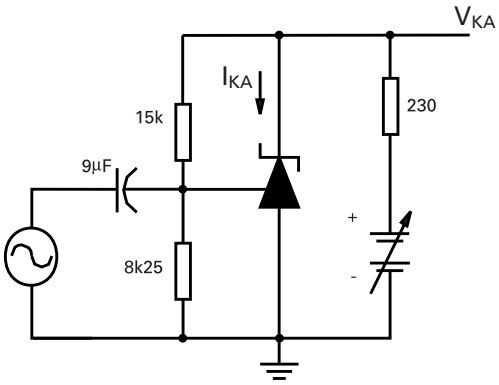



**Power Dissipation Derating**

## Typical characteristics

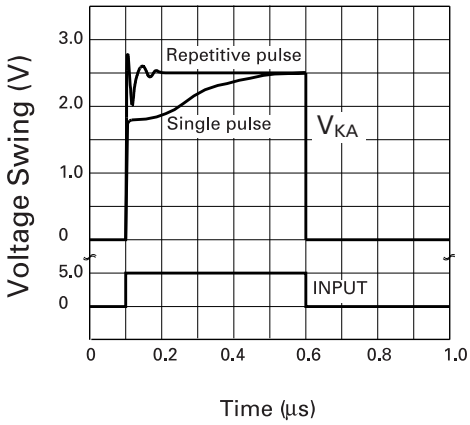



**Gain v Frequency**

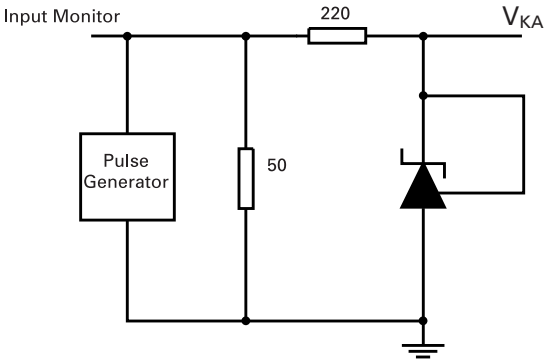



$I_{KA}$ = 10mA, $T_A$ = 25°C

**Test Circuit for Open Loop Voltage Gain**

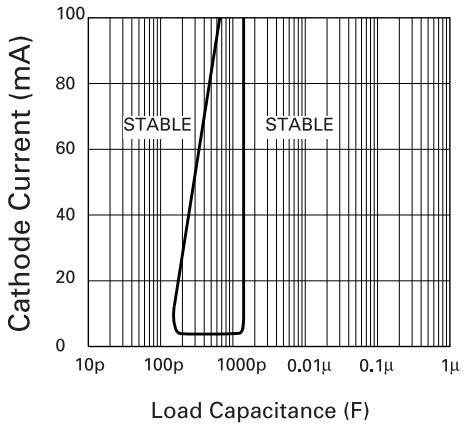



**Pulse Response**

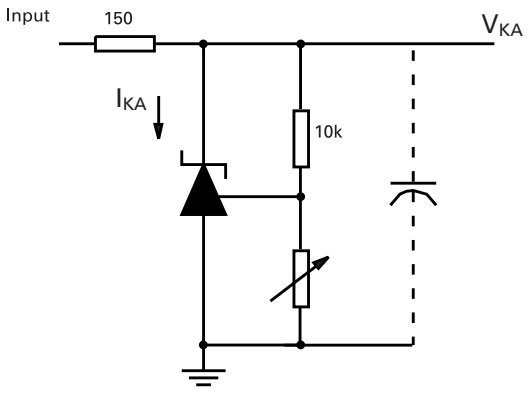



$T_A$ = 25°C

**Test Circuit for Pulse Response**



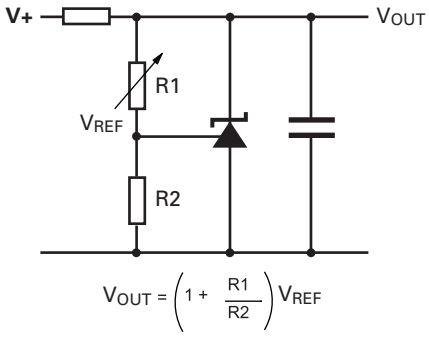

**Stability Boundary Conditions**



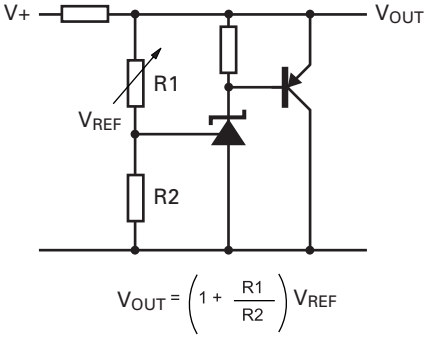

$V_{REF} < V_{KA} < 20$, $I_{KA}$ = 10mA, $T_A$ = 25°C

**Test Circuit for Stability Boundary Conditions**

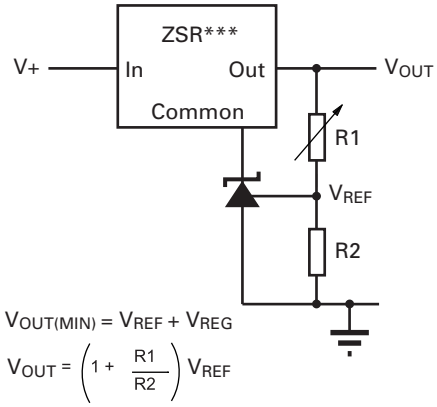
## Application cicuits



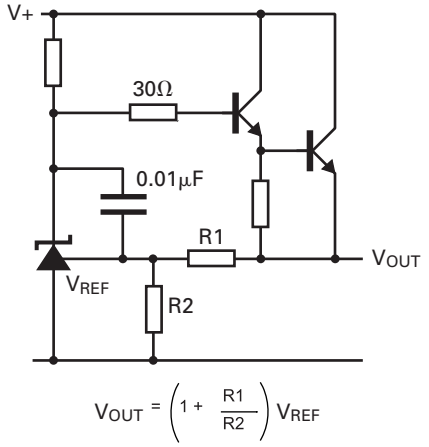

**Shunt regulator**



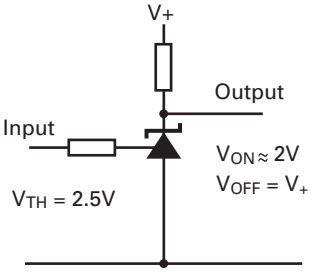

**Higher current shunt regulator**



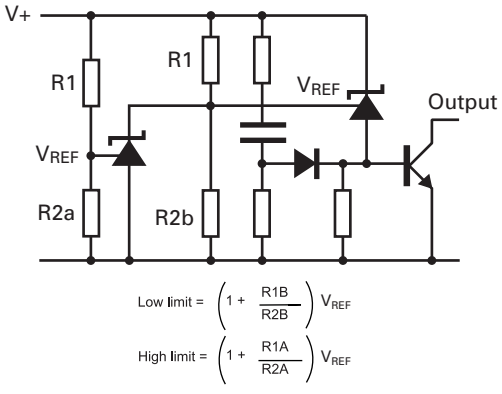

**Output control of a three terminal fixed regulator**




**Series regulator**




**Single supply comparator with temperature compensated threshold**




**Over voltage / under voltage protection circuit**

## DC test circuits

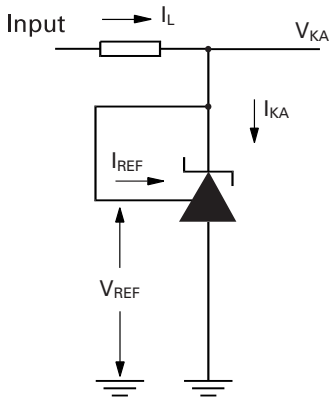



**Figure 1** Test circuit for $V_{KA} = V_{REF}$

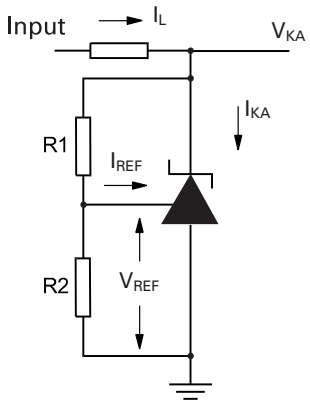



**Figure 2** Test circuit for $V_{KA} > V_{REF}$

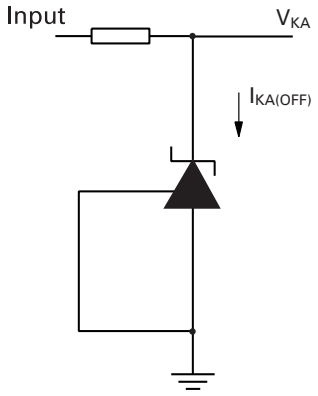



**Figure 3** Test circuit for off state current

## Notes

Deviation of reference input voltage, Vdev, 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:

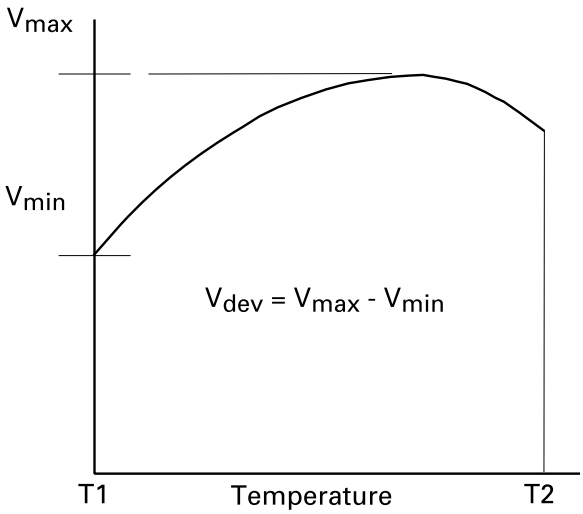
$$V_{REF}(ppm°C) = \frac{V_{DEV} \times 1,000,000}{V_{REF}(T1 - T2)}$$

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:

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

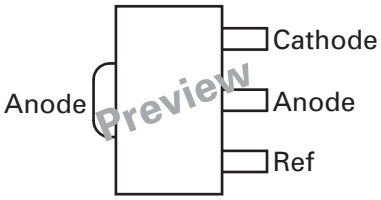



## Stability boundary

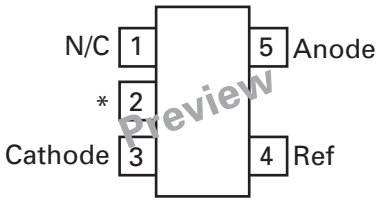
The ZTL431 and ZTL432 are stable with a range of capacitive loads. A zone of instability exists as demonstrated in the typical characteristic graph on page 5. The graph shows typical conditions. To ensure reliable stability a capacitor of 4.7nF or greater is recommended between anode and cathode.

## Pin connections - preview status devices

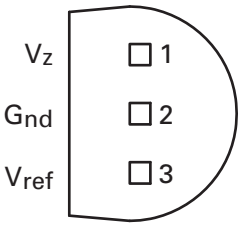
**ZTL431_Z SOT89**
(top view)




**ZTL431_E5 SOT235**
(top view)

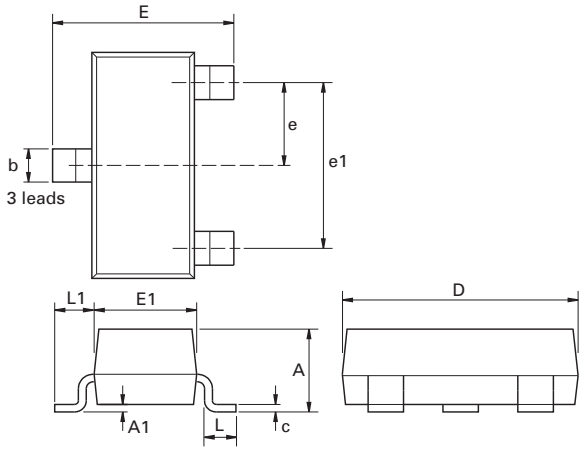



**ZTL431_C TO92**
(underside view)




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

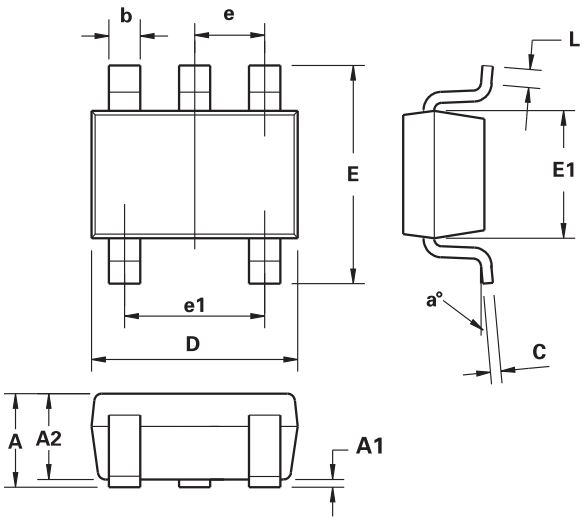
## Packaging details - SOT23




| 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

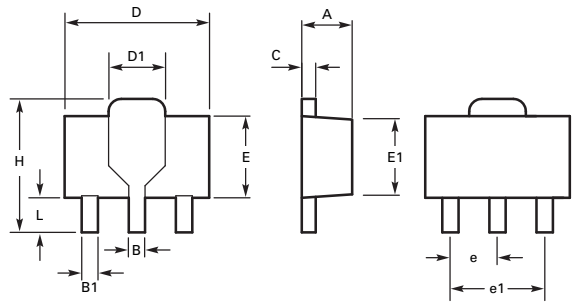
## Packaging details - SOT23-5




| 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

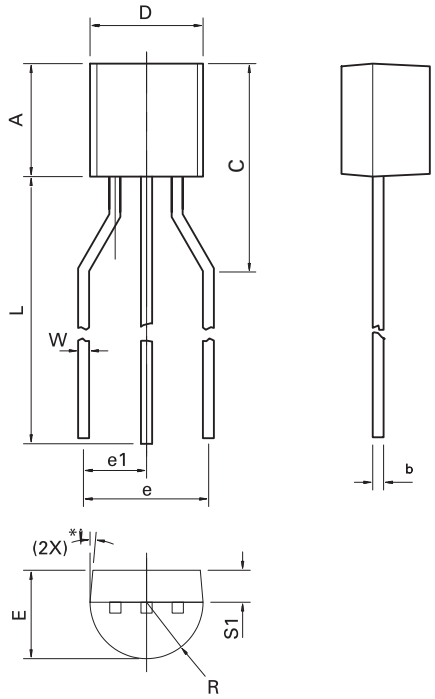
## Package details - SOT89




| 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

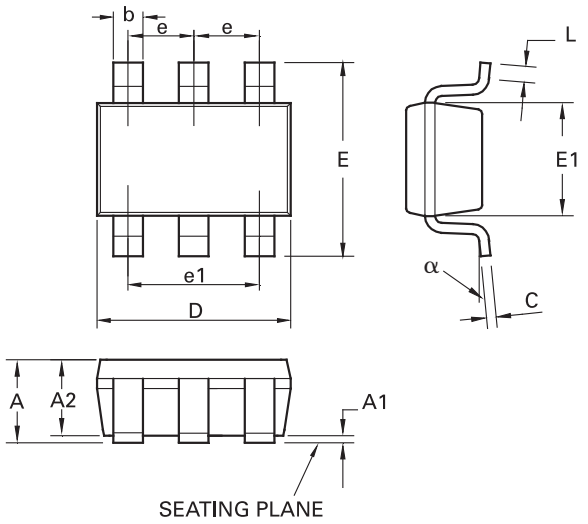
## Package details - TO92




| 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

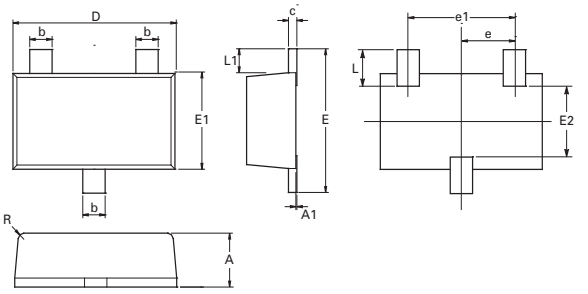
## Package details - SC70-6




| 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

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| | |
|---|---|
| "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:**

| | |
|---|---|
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| Europe | Americas | Asia Pacific | Corporate Headquarters |
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| Zetex GmbH<br>Kustermann-park<br>Balanstraße 59<br>D-81541 München<br>Germany | Zetex Inc<br>700 Veterans Memorial Highway<br>Hauppauge, NY 11788<br>USA | Zetex (Asia Ltd)<br>3701-04 Metroplaza Tower 1<br>Hing Fong Road, Kwai Fong<br>Hong Kong | Zetex Semiconductors plc<br>Zetex Technology Park, Chadderton<br>Oldham, OL9 9LL<br>United Kingdom |
| Telefon: (49) 89 45 49 49 0<br>Fax: (49) 89 45 49 49 49<br>europe.sales@zetex.com | Telephone: (1) 631 360 2222<br>Fax: (1) 631 360 8222<br>usa.sales@zetex.com | Telephone: (852) 26100 611<br>Fax: (852) 24250 494<br>asia.sales@zetex.com | Telephone: (44) 161 622 4444<br>Fax: (44) 161 622 4446<br>hq@zetex.com |