

**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 two 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°C to +125°C as standard.

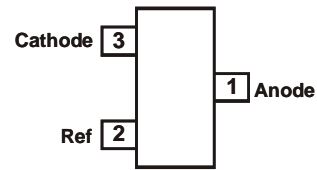
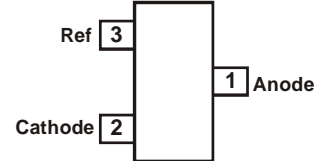
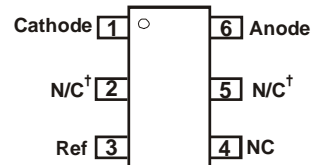
**Features**

- 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
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

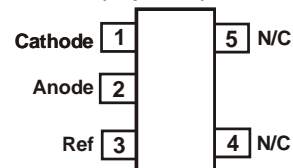
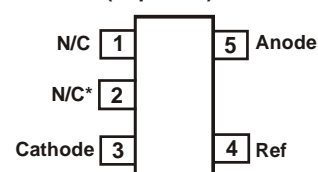
**Applications**

- Opto-Coupler Linearization
- Linear Regulators
- Improved Zener
- Variable Reference

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) 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**
**ZTL431\_F SOT23, ZTL431\_FF SOT23F  
(Top View)**

**ZTL432\_F SOT23, ZTL432\_FF SOT23F  
(Top View)**

**ZTL431\_H6, SOT363  
(Top View)**


†Connected internally to substrate; should be left floating or connected to Anode

**ZTL431ASE5 SOT25  
(Top View)**

**ZTL431\_E5 SOT25  
(Top View)**


\*must be left floating or connected to pin 5

**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 $\mu$ A to +10mA	-
Operating Junction Temperature	-40 to +150	$^{\circ}$ C
Storage Temperature	-55 to +150	$^{\circ}$ C

Operation above the absolute maximum rating may cause device failure.  
 Operation at the absolute maximum ratings, for extended periods, may reduce device reliability.

**Package Thermal Data**

Package	$\theta_{JA}$	$P_{DIS}$ $T_A = +25^{\circ}$ C, $T_J = +150^{\circ}$ C
SOT23	380 $^{\circ}$ C/W	330mW
SOT23F	138 $^{\circ}$ C/W	900mW
SOT25	250 $^{\circ}$ C/W	500mW
SOT363	380 $^{\circ}$ C/W	330mW

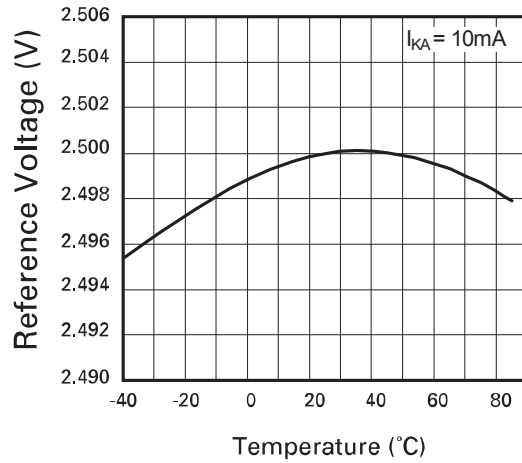
**Recommended Operating Conditions** (@ $T_A = +25^{\circ}$ C, unless otherwise specified.)

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

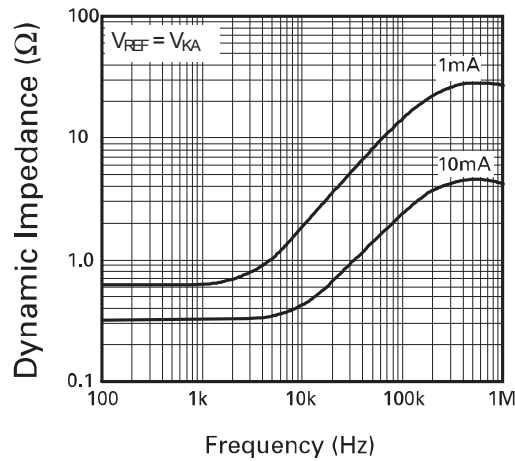
**Electrical Characteristics** (@ $T_A = +25^{\circ}$ C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
$V_{REF}$	Reference Voltage	$V_{KA} = V_{REF}$ $I_{KA} = 10$ mA	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	$V_{KA} = V_{REF}$ $I_{KA} = 10$ mA	$T_A = 0$ to $+70^{\circ}$	-	6	16	mV
			$T_A = -40$ to $+85^{\circ}$ C	-	14	34	
			$T_A = -40$ to $+125^{\circ}$ C	-	14	34	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change In Reference Voltage To the Change In Cathode Voltage	$I_{KA} = 10$ mA	$V_{KA} = V_{REF}$ to 10	-	-1.4	-2.7	mV/V
			$V_{KA} = 10$ V to 20V	-	-1.0	-2.0	
$I_{REF}$	Reference Input Current	$I_{KA} = 10$ mA, $R_1 = 10$ k $\Omega$ , $R_2 = OC$	-	2	4	$\mu$ A	
$\Delta I_{REF}$	$I_{REF}$ Deviation Over Full Temperature Range	$I_{KA} = 10$ mA $R_1 = 10$ k $\Omega$ $R_2 = OC$	$T_A = 0$ to $+70^{\circ}$ C	-	0.8	1.2	$\mu$ A
			$T_A = -40$ to $+85^{\circ}$ C	-	0.8	2.5	
			$T_A = -40$ to $+125^{\circ}$ 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	$V_{KA} = 20$ V, $V_{REF} = 0$ V	-	0.1	0.5	$\mu$ A	
$R_Z$	Dynamic Output Impedance	$V_{KA} = V_{REF}$ , $f = 0$ Hz	-	0.2	0.5	$\Omega$	

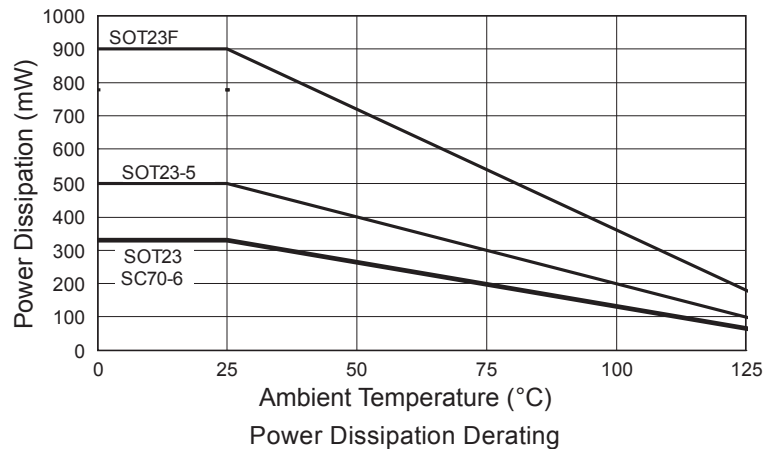
**Typical Characteristics**



Reference Voltage vs. Temperature

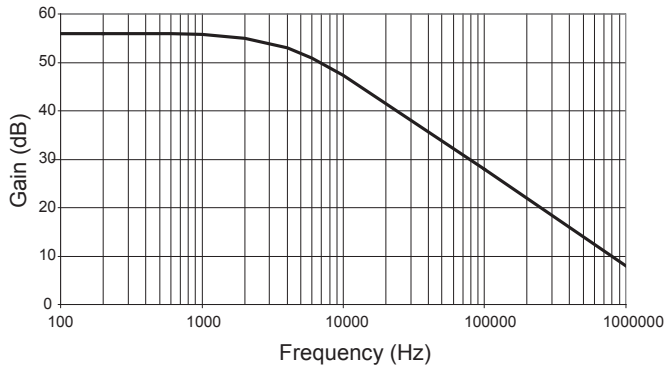


Dynamic Impedance vs. Frequency

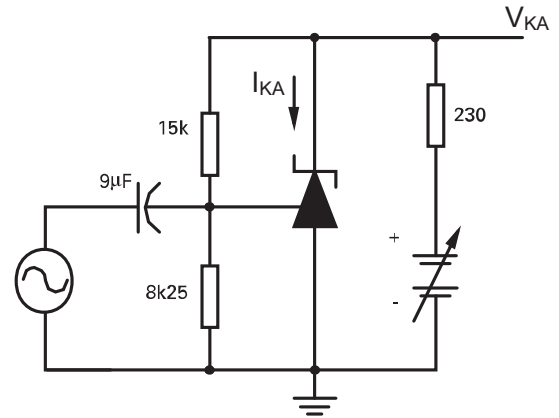


Power Dissipation Derating

**Typical Characteristics** (continued)

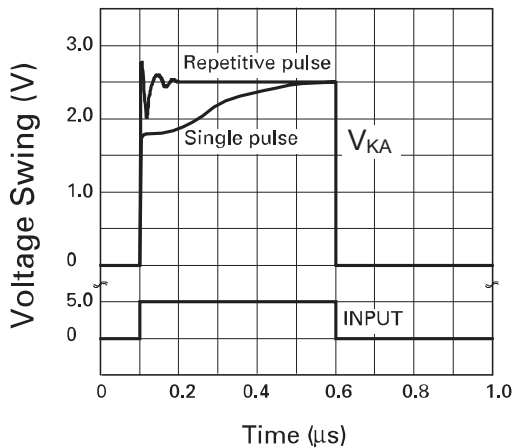


Gain vs. Frequency

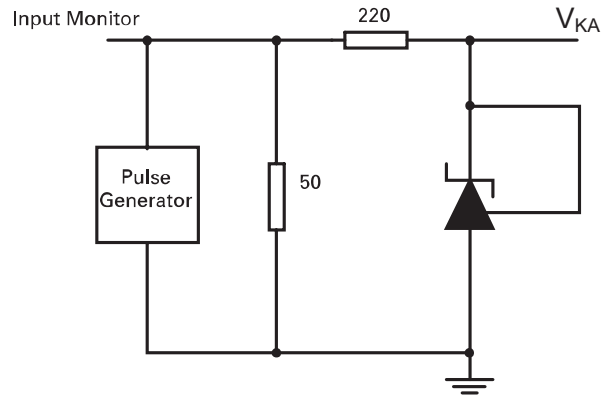


$I_{KA} = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

Test Circuit for Open Loop Voltage Gain

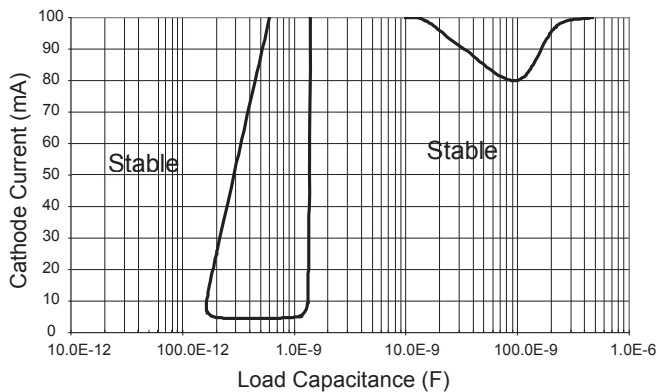


Pulse Response

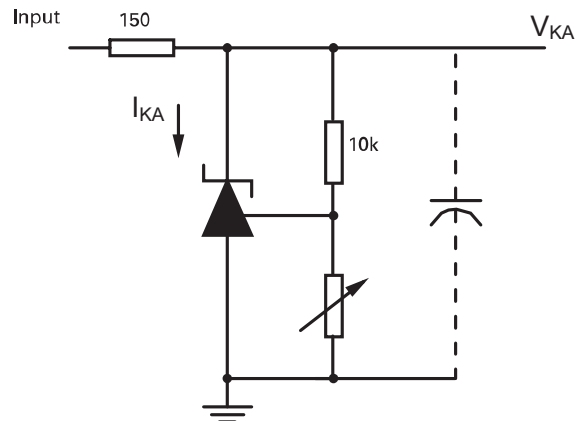


$T_A = 25^\circ\text{C}$

Test Circuit for Pulse Response



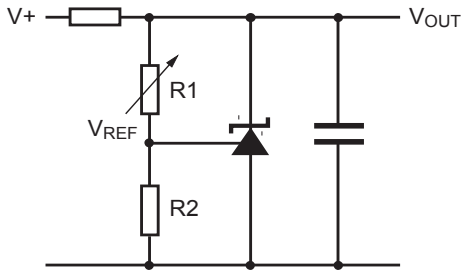
Stability Boundary Condition



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

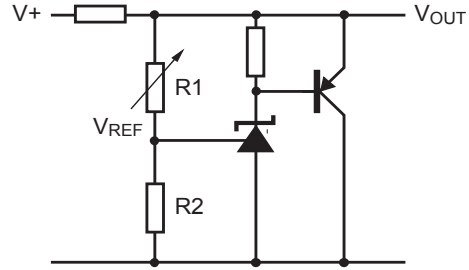
Test Circuit for Stability Boundary Conditions

**Application Circuits**



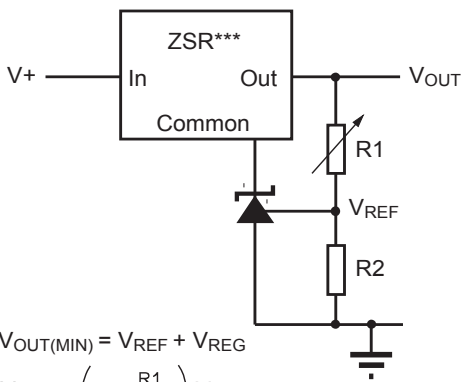
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Shunt regulator



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

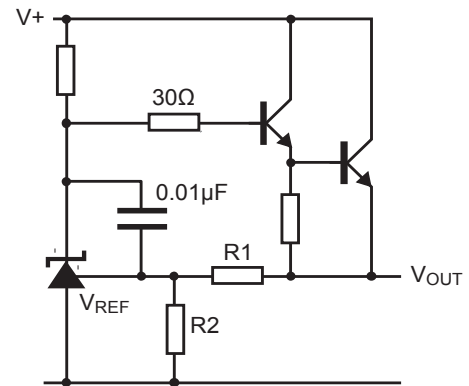
Higher current shunt regulator



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

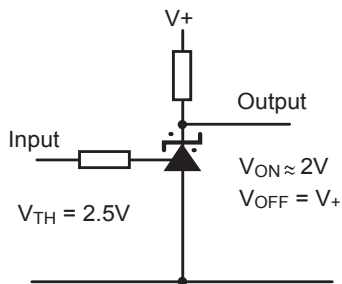
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Output control of a three terminal fixed regulator

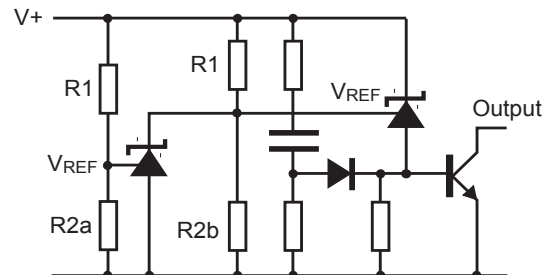


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

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**

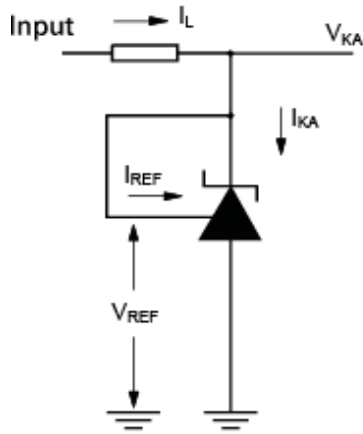


Figure 1. Test circuit for  $V_{KA} = V_{REF}$

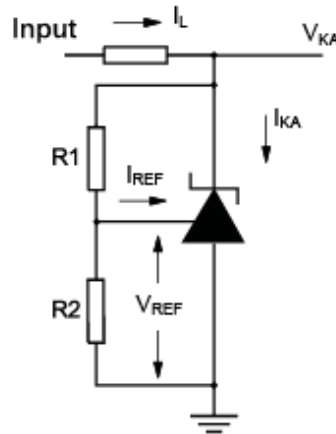


Figure 2. Test circuit for  $V_{KA} > V_{REF}$

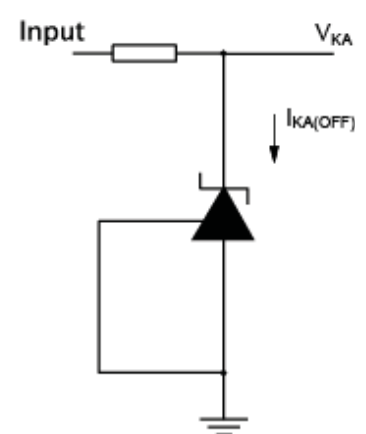


Figure 3. Test circuit for off state current

**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:

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

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

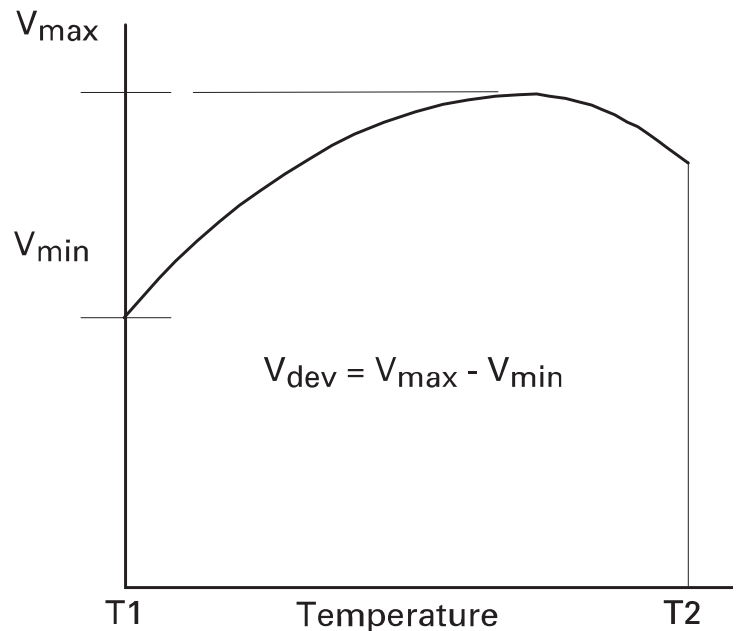
$$R_z = \frac{\Delta V_z}{\Delta I_z}$$

When the device is programmed with two external resistors,  $R1$  and  $R2$ , (Figure 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 4. The graph shows typical conditions. To ensure reliable stability, a capacitor of 4.7nF or greater is recommended between anode and cathode.



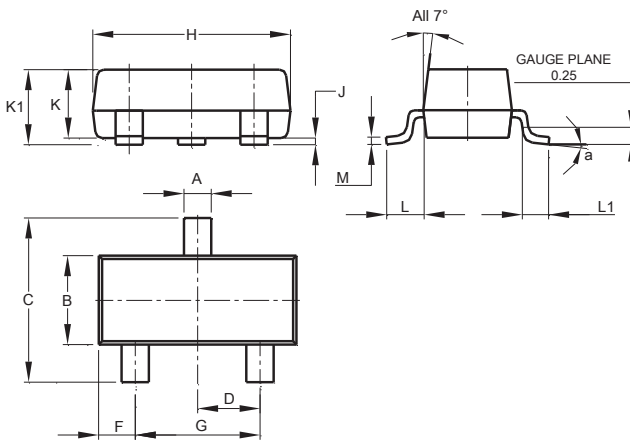
**Ordering Information**

Tol.	Ordering Code	Pack	Part Mark	Status*	Reel Size	Tape Width (mm)	Quantity per Reel
1%	ZTL431AE5TA	SOT25	31A	Active	7", 180mm	8	3,000
	ZTL431AFFTA	SOT23F	31A	Active	7", 180mm	8	3,000
	ZTL431AFTA	SOT23	31A	Active	7", 180mm	8	3,000
	ZTL431AH6TA	SOT363	31A	Active	7", 180mm	8	3,000
	ZTL431ASE5TA	SOT25	S2A	Active	7", 180mm	8	3,000
	ZTL432AFFTA	SOT23F	32A	Active	7", 180mm	8	3,000
	ZTL432AFTA	SOT23	32A	Active	7", 180mm	8	3,000
0.5%	ZTL431BE5TA	SOT25	31B	Active	7", 180mm	8	3,000
	ZTL431BFFTA	SOT23F	31B	Active	7", 180mm	8	3,000
	ZTL431BFTA	SOT23	31B	Active	7", 180mm	8	3,000
	ZTL431BH6TA	SOT363	31B	Active	7", 180mm	8	3,000
	ZTL432BFFTA	SOT23F	32B	Active	7", 180mm	8	3,000
	ZTL432BFTA	SOT23	32B	Active	7", 180mm	8	3,000

**Package Outline Dimensions**

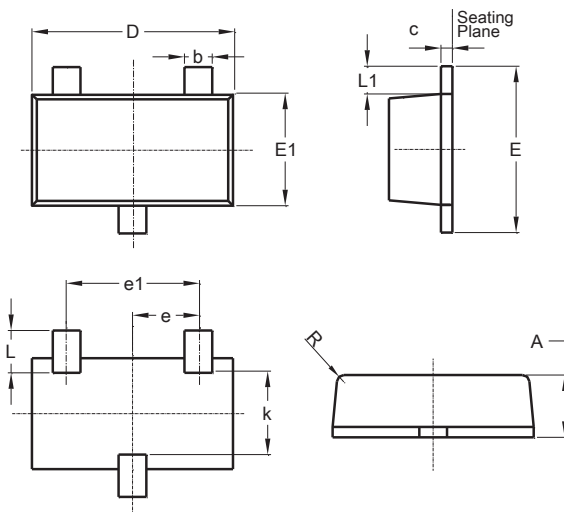
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

**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	8°		
All Dimensions in mm			

**SOT23F**

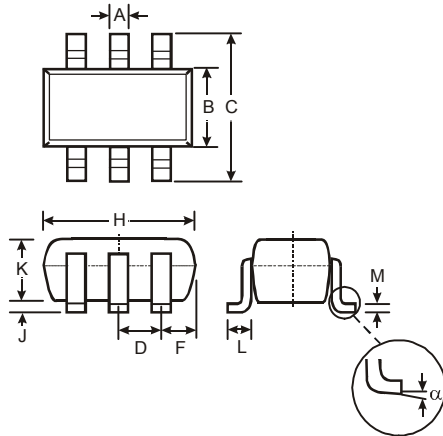


SOT23F			
Dim	Min	Max	Typ
A	0.80	1.00	0.90
b	0.35	0.45	0.40
c	0.06	0.16	0.11
D	2.80	3.00	2.90
e	-	-	0.95
e1	-	-	1.90
E	2.30	2.50	2.40
E1	1.50	1.70	1.60
k	1.10	1.26	1.18
L	0.48	0.68	0.58
L1	0.39	0.41	0.40
R	0.05	0.15	0.10
All Dimensions in mm			

**Package Outline Dimensions** (continued)

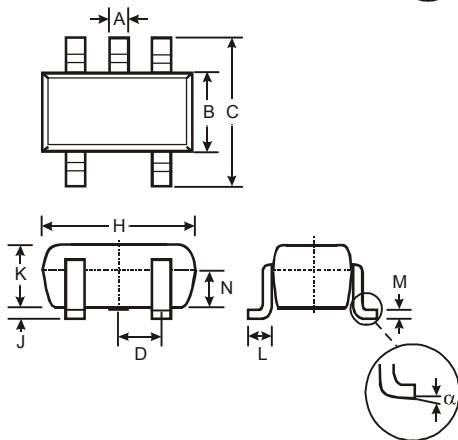
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

**SOT363**



SOT363			
Dim	Min	Max	Typ
A	0.10	0.30	0.25
B	1.15	1.35	1.30
C	2.00	2.20	2.10
D	0.65 Typ		
F	0.40	0.45	0.425
H	1.80	2.20	2.15
J	0	0.10	0.05
K	0.90	1.00	1.00
L	0.25	0.40	0.30
M	0.10	0.22	0.11
α	0°	8°	-
All Dimensions in mm			

**SOT25**

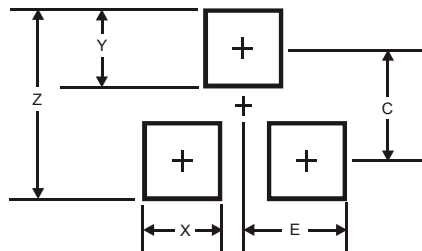


SOT25			
Dim	Min	Max	Typ
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	—	—	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	—
All Dimensions in mm			

**Suggested Pad Layout**

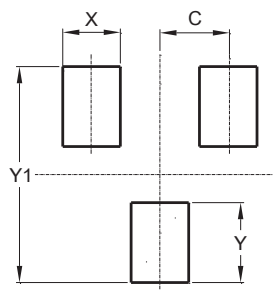
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

**SOT23**



Dimensions	Value (in mm)
Z	2.9
X	0.8
Y	0.9
C	2.0
E	1.35

**SOT23F**



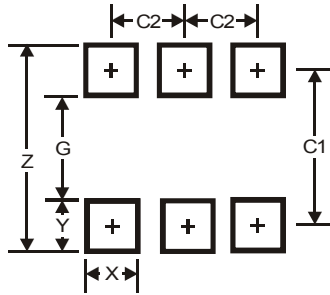
Dimensions	Value (in mm)
C	0.95
X	0.80
Y	1.110
Y1	3.000



**Suggested Pad Layout** (continued)

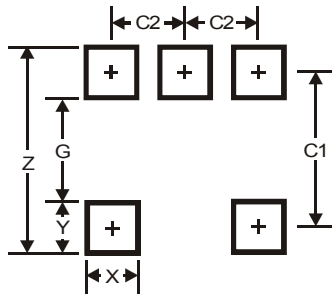
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

**SOT363**



Dimensions	Value (in mm)
Z	2.5
G	1.3
X	0.42
Y	0.6
C1	1.9
C2	0.65

**SOT25**



Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

#### **IMPORTANT NOTICE**

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

#### **LIFE SUPPORT**

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

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 labeling 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.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2015, Diodes Incorporated

[www.diodes.com](http://www.diodes.com)