AUTOMOTIVE GRADE ADJUSTABLE PRECISION SHUNT REGULATOR

Description

The ZTL431Q and ZTL432Q 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 ZTL432Q has the same electrical specifications as the ZTL431Q but has a different pin out in SOT23 (F-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°C to +125°C as standard.

The ZTL431Q and ZTL432Q have been qualified to AEC-Q100 Grade 1 and are Automotive Grade supporting PPAPs

Features

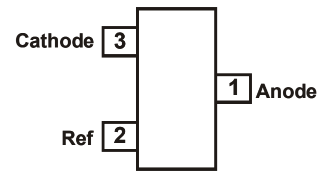
- Temperature Range .... -40°C to +125°C
- Reference Voltage Tolerance at +25°C
  - 0.5%......................................B grade
  - 1% ....A grade
- 0.2Ω typical output impedance
- Sink Current Capability…….. 1mA to 100mA
- Adjustable Output Voltage……V_{REF} to 20V
- Green Molding in SOT23 and SOT25
  - Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
  - Halogen and Antimony Free. “Green” Device (Note 3)
- **Automotive Grade**
  - Qualified to AEC-Q100 Grade 1
  - Supports PPAP documents

Applications

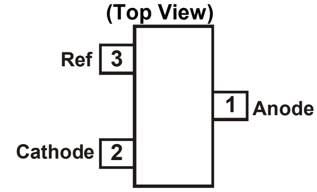
- Opto-Coupler Linearization
- Linear Regulators
- Improved Zener
- Variable Reference

Pin Assignments

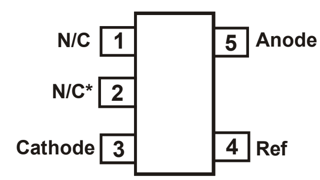
ZTL431_QF SOT23, ZTL431_FF SOT23F
(Top View)



ZTL432_QF SOT23, ZTL432_FF SOT23F
(Top View)

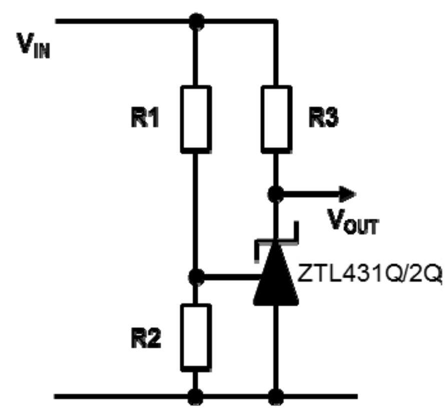


ZTL431_QE5 SOT25
(Top View)



*must be left floating or connected to pin 5

Typical Application



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 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.

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})		-50µA to +10mA	—
Operating Junction Temperature		-40 to +150	°C
Storage Temperature		-55 to +150	°C
ESD Susceptibility			
HBM	Human Body Model	4	kV
MM	Machine Model	400	V
CDM	Charged Device Model	1	kV

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at conditions between maximum recommended operating conditions and absolute maximum ratings is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

(Semiconductor devices are ESD sensitive and may 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°C, T_J = +150°C
SOT23	380°C/W	330mW
SOT25	250°C/W	500mW

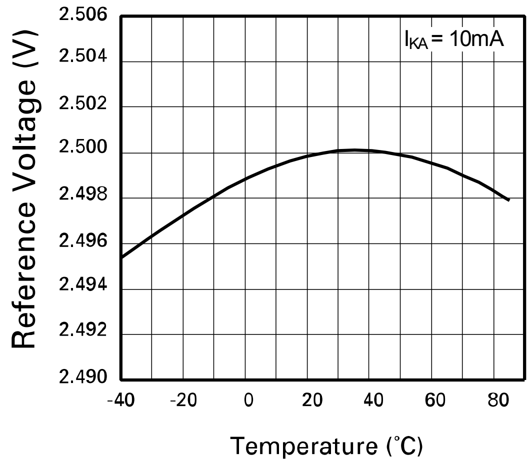
Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

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	°C

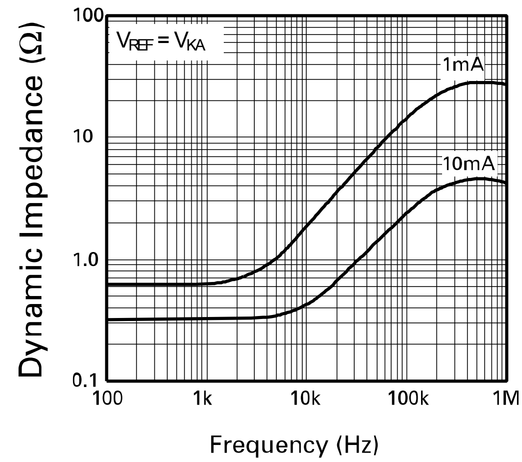
Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	V_{KA} = V_{REF} I_{KA} = 10mA	ZTL43_QA	2.475	2.5	2.525	V
			ZTL43_QB	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°	—	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, R_2 = OC		—	2	4	µA
ΔI_{REF}	I_{REF} Deviation Over Full Temperature Range	I_{KA} = 10mA R_1 = 10kΩ 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

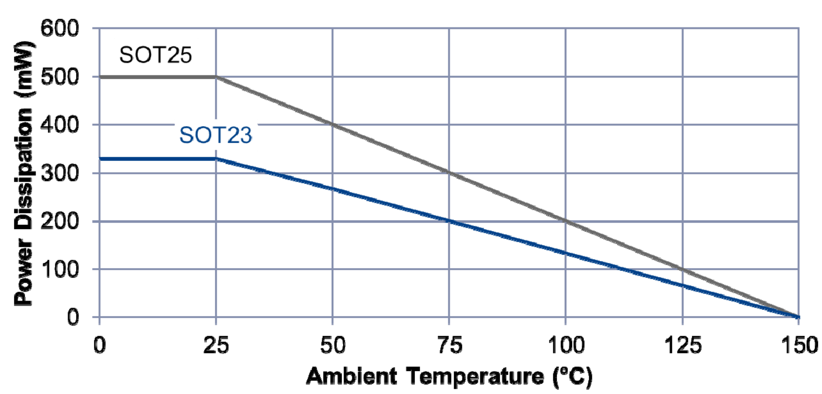
Typical Characteristics



Reference Voltage vs. Temperature

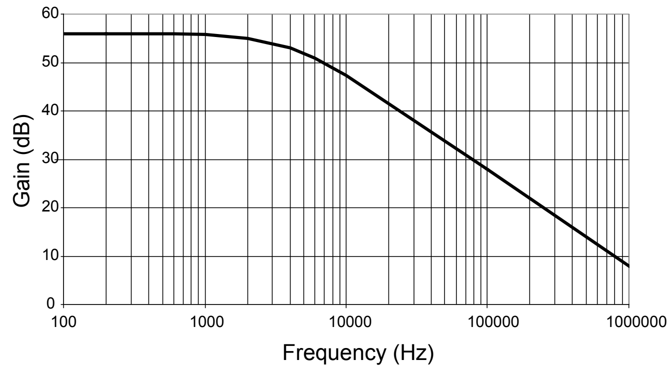


Dynamic Impedance vs. Frequency

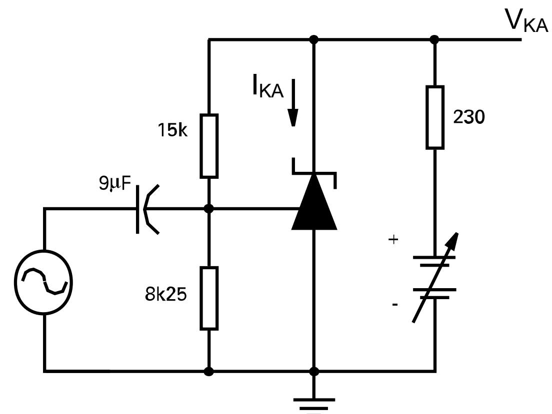


Power Dissipation Derating

Typical Characteristics (cont.)

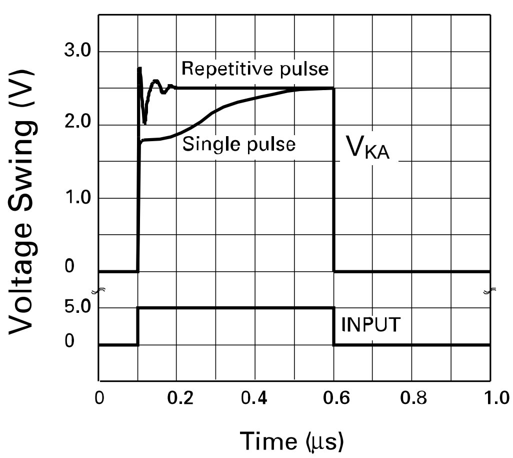


Gain vs. Frequency

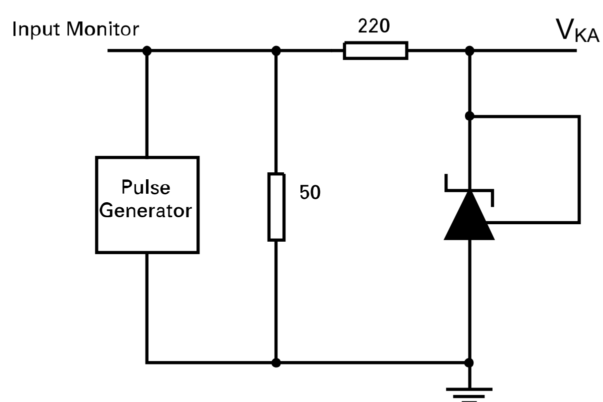


I_{KA} = 10mA, T_A = 25°C

Test Circuit for Open Loop Voltage Gain

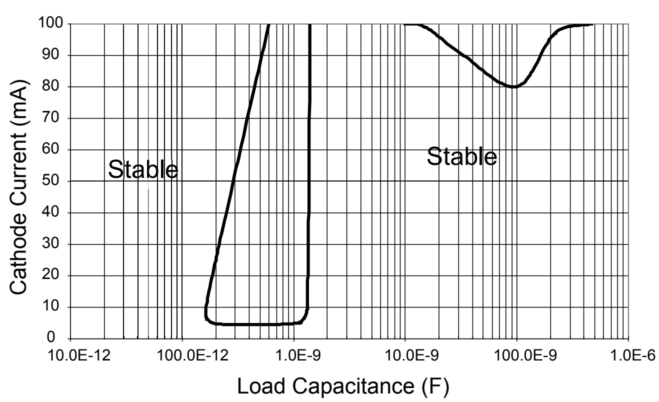


Pulse Response

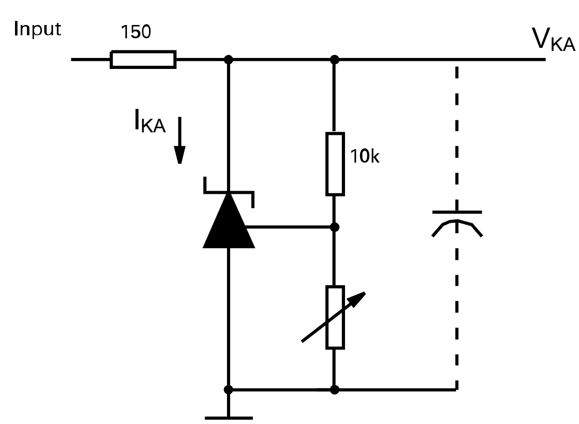


T_A = 25°C

Test Circuit for Pulse Response



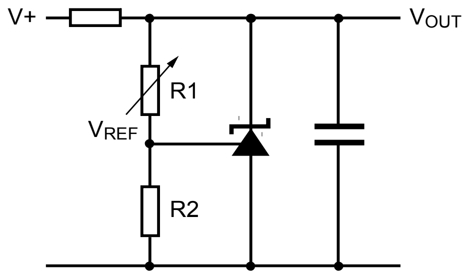
Stability Boundary Condition



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

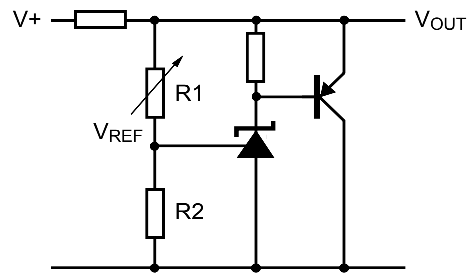
Test Circuit for Stabilty Boundary Conditions

Application Circuits



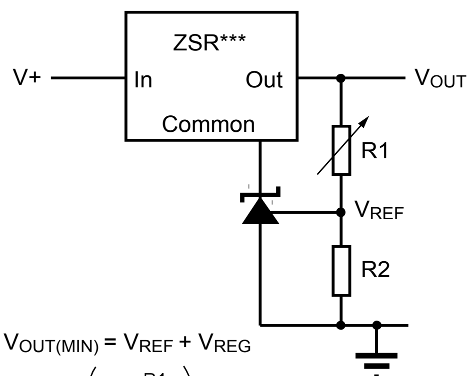
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Shunt regulator



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

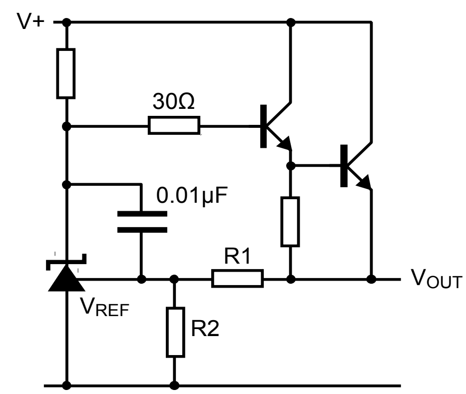
Higher current shunt regulator



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

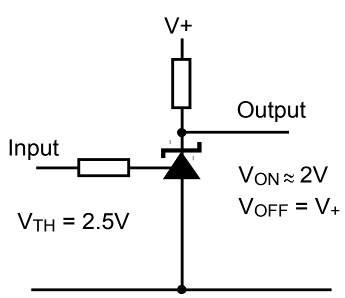
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Output control of a three terminal fixed regulator

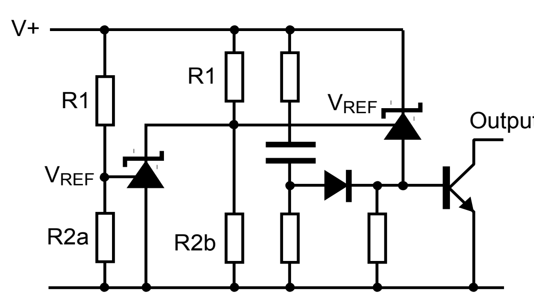


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

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

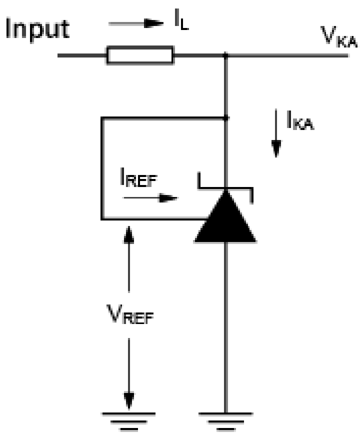


Figure 1. Test circuit for $V_{KA} = V_{REF}$

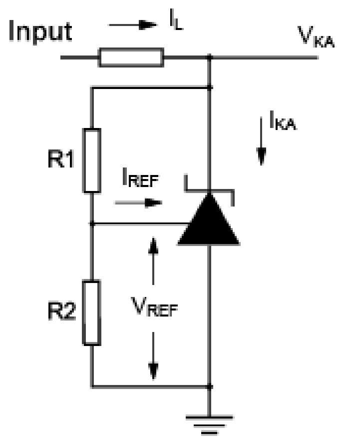


Figure 2. Test circuit for $V_{KA} > V_{REF}$

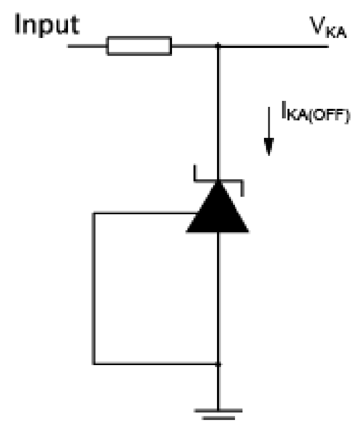


Figure 3. Test circuit for off state current

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:

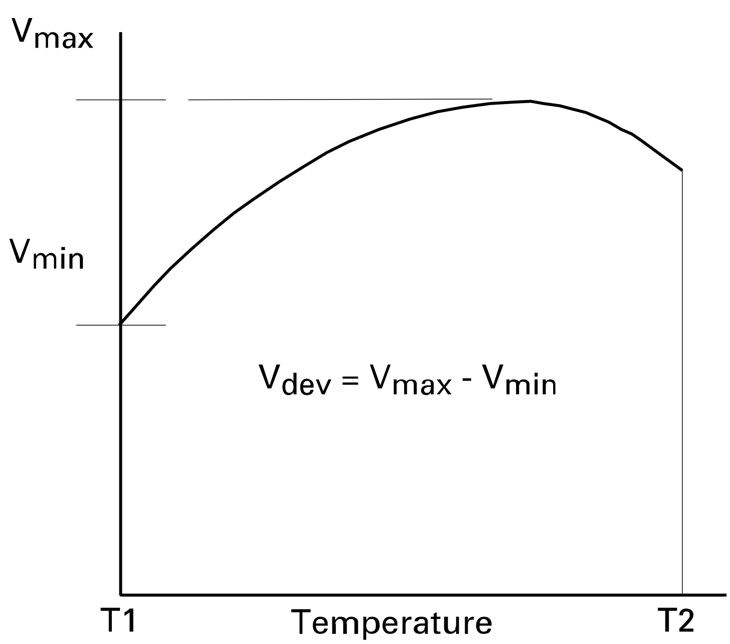
$$V_{REF}(ppm/°C) = \frac{V_{DEV} \times 1{,}000{,}000}{V_{REF}(T1-T2)}$$

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:

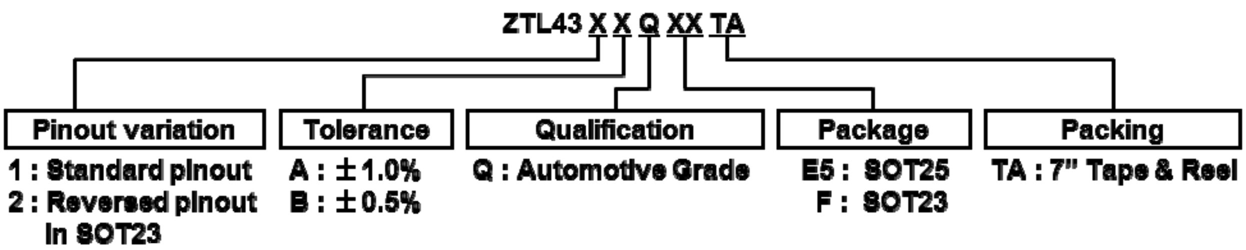
$$R'_Z = R_Z \left(1 + \frac{R1}{R2}\right)$$



Stability Boundary

The ZTL431Q and ZTL432Q 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



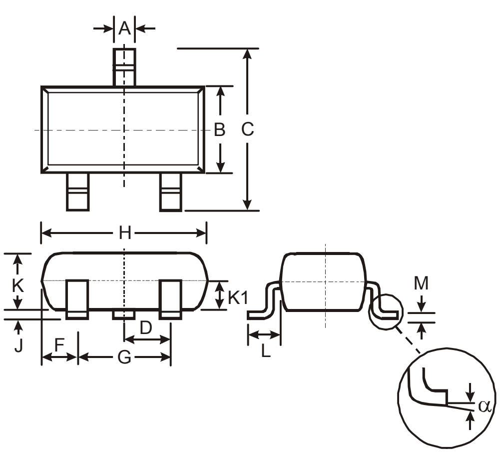
Tol.	Ordering Code	Pack	Part Mark	Status*	Reel Size	Tape Width (mm)	Quantity per Reel
1%	ZTL431AQE5TA	SOT25	31A	Active	7”, 180mm	8	3000
	ZTL431AQFTA	SOT23	31A	Active	7”, 180mm	8	3000
	ZTL432AQFTA	SOT23	32A	Active	7”, 180mm	8	3000
0.5%	ZTL431BQE5TA	SOT25	31B	Active	7”, 180mm	8	3000
	ZTL431BQFTA	SOT23	31B	Active	7”, 180mm	8	3000
	ZTL432BQFTA	SOT23	32B	Active	7”, 180mm	8	3000

Note: 4. Automotive Grade products are AEC-Q100 qualified and are PPAP capable. Automotive, AEC-Q100 and standard products are electrically and thermally the same, except where specified.
For more information, please refer to http://www.diodes.com/quality/product_compliance_definitions/.

Package Outline Dimensions

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

SOT23

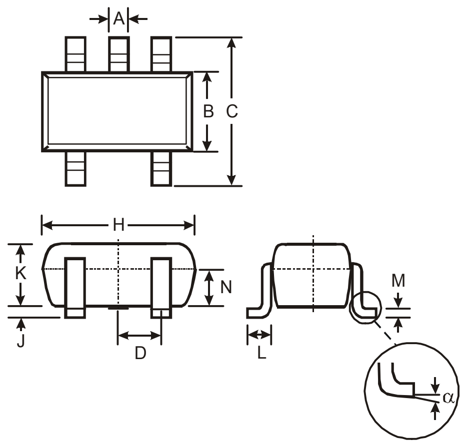


SOT23			
Dim	**Min**	**Max**	**Typ**
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.903	1.10	1.00
K1	-	-	0.400
L	0.45	0.61	0.55
M	0.085	0.18	0.11
α	0°	8°	-
All Dimensions in mm			

Package Outline Dimensions (cont.)

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

SOT25

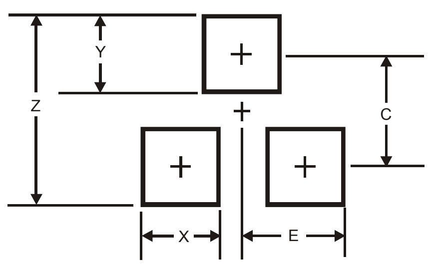


SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	—	—	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	—
All Dimensions in mm			

Suggested Pad Layout

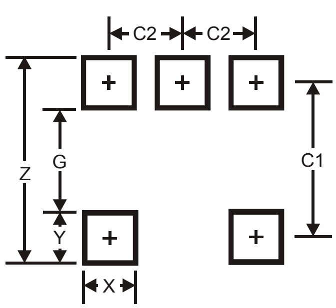
Please see AP02001 at http://www.diodes.com/datasheets/ap02001.pdf for the latest version.

SOT23



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

SOT25



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