AUTOMOTIVE COMPLIANT ADJUSTABLE PRECISION SHUNT REGULATOR

Description

The ZTL431xQ and ZTL432xQ 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 ZTL432xQ has the same electrical specifications as the ZTL431xQ 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°C to +125°C as standard.

The ZTL431xQ and ZTL432xQ are qualified to AEC-Q100 Grade 1 and are Automotive Compliant supporting PPAPs.

Features

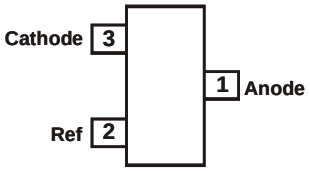
- Temperature Range: -40°C to +125°C
- Reference Voltage Tolerance at +25°C
  - 0.5%: B Grade
  - 1%: A Grade
- 0.2Ω Typical Output Impedance
- Sink Current Capability: 1mA to 100mA
- Adjustable Output Voltage: V_{REF} to 20V
- Green Molding in SOT23, SOT23F and SOT25
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **Qualified to AEC-Q100 Standards for High Reliability**
  - **AEC-Q100 Grade 1**
  - **PPAP Capable (Note 4)**

Applications

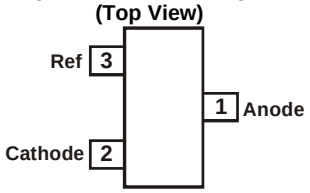
- Opto-Coupler Linearization
- Linear Regulators
- Improved Zener
- Variable Reference

Pin Assignments

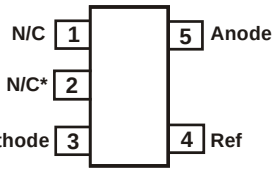
ZTL431xQF SOT23, ZTL431xQFF SOT23F
(Top View)



ZTL432xQF SOT23, ZTL432xQFF SOT23F
(Top View)

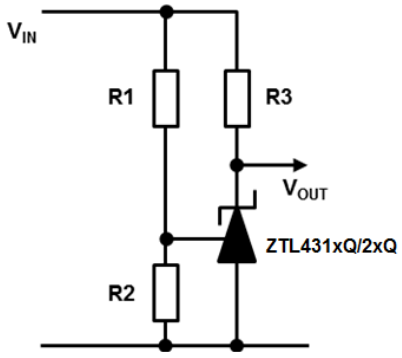


ZTL431xQE5 SOT25
(Top View)



*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.
4. Automotive Compliant products are AEC-Q100 qualified and are PPAP capable. Refer to http://www.diodes.com/quality/product_compliance_definitions/.

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	2	kV
MM	Machine Model	200	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 = +125°C
SOT23	380°C/W	260mW
SOT23F	138°C/W	720mW
SOT25	250°C/W	400mW

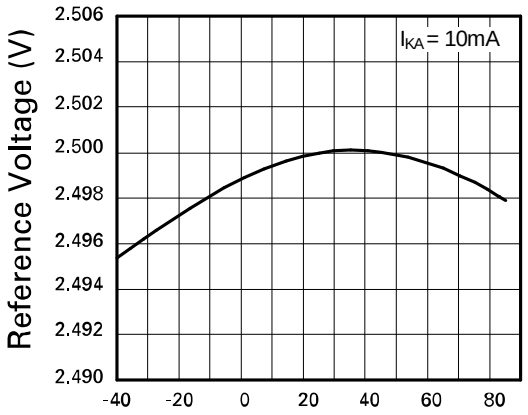
Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

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

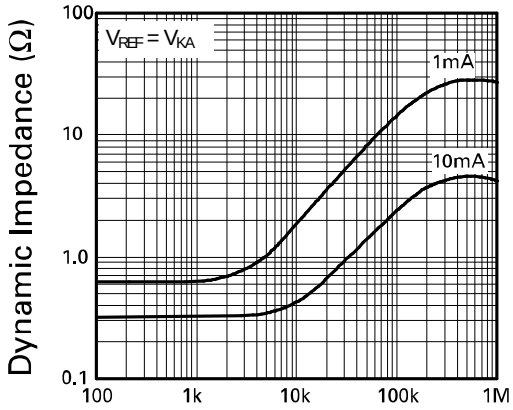
Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	V_{KA} = V_{REF} I_{KA} = 10mA	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 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

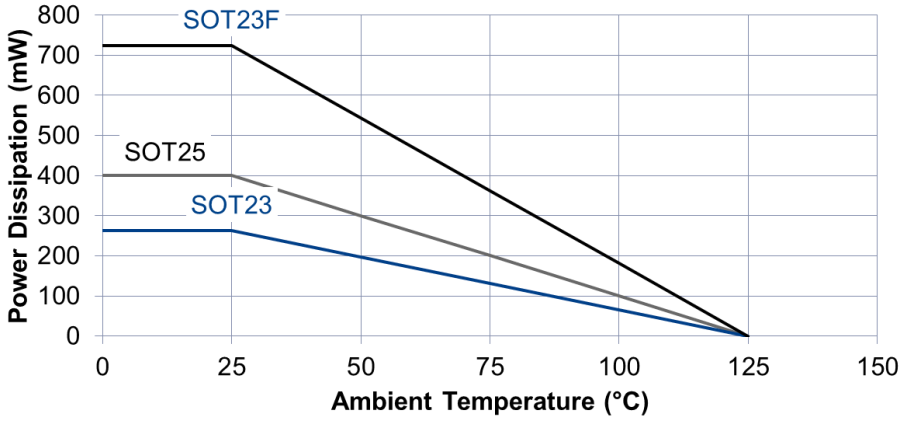
Typical Characteristics



Reference Voltage vs. Temperature

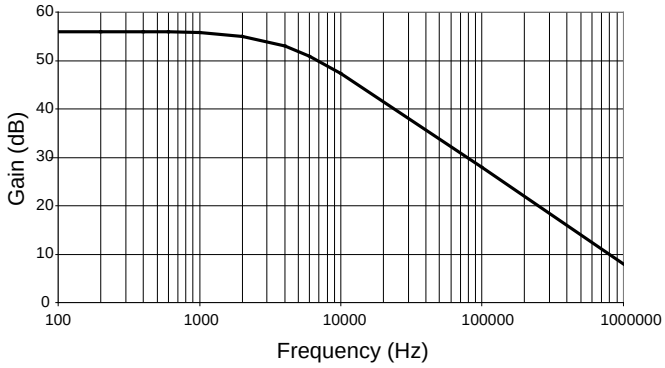


Dynamic Impedance vs. Frequency

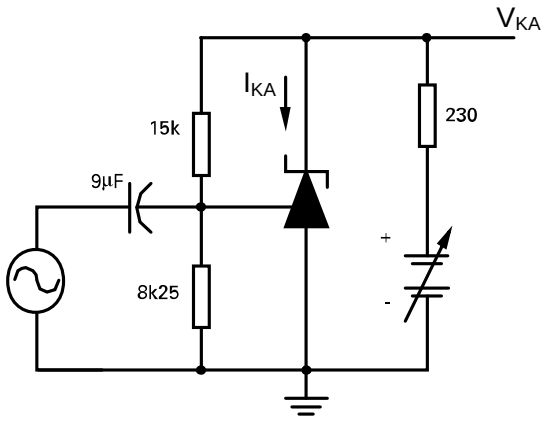


Power Dissipation Derating

Typical Characteristics (Continued)

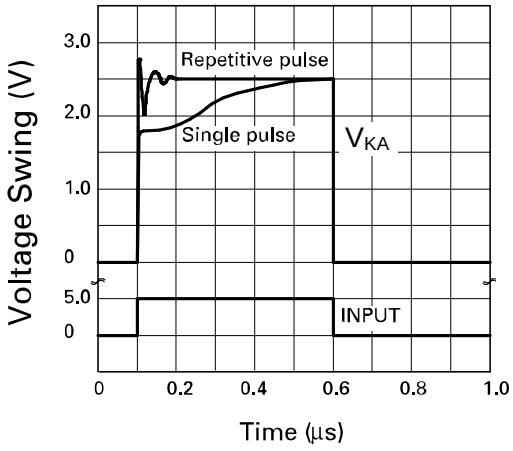


Gain vs. Frequency

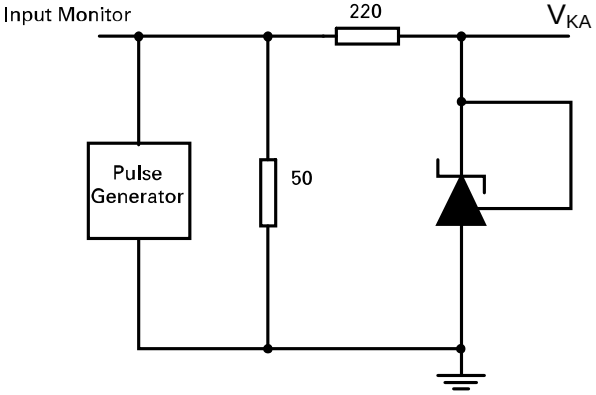


I_{KA} = 10mA, T_A = 25°C

Test Circuit for Open Loop Voltage Gain

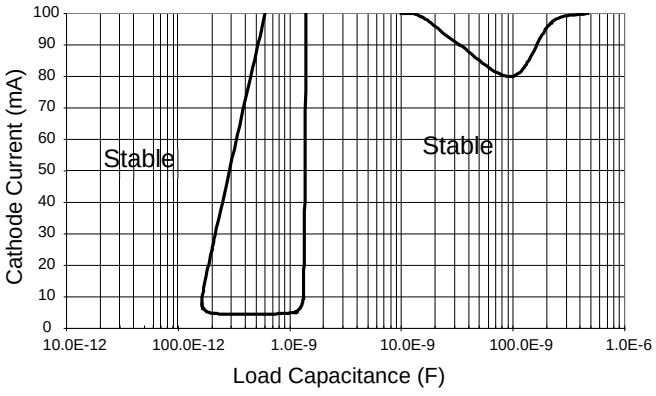


Pulse Response

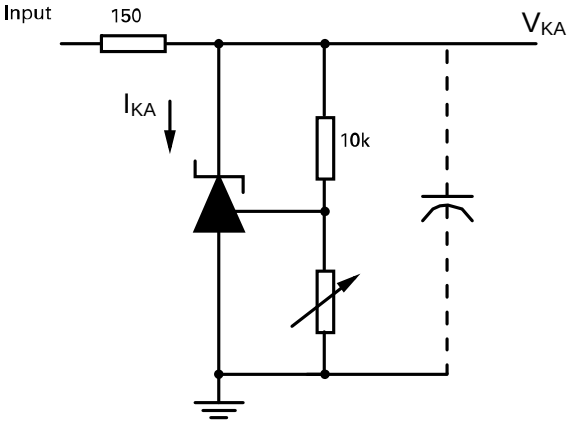


T_A = 25°C

Test Circuit for Pulse Response



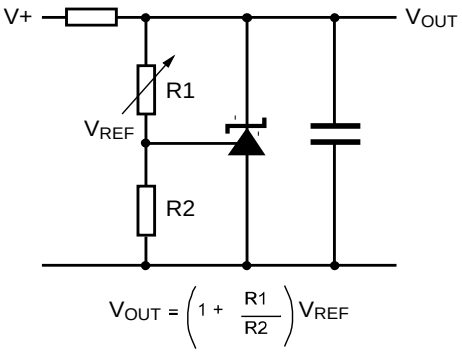
Stability Boundary Condition



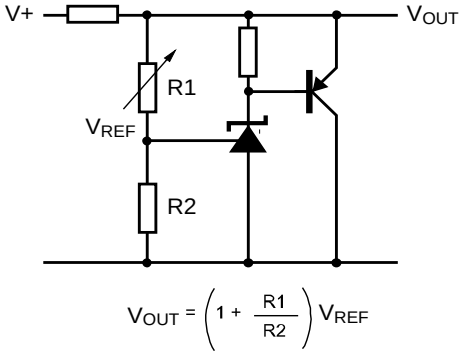
V_{REF} < V_{KA} < 20, I_{KA} = 10mA, T_A = 25°C

Test Circuit for Stabilty Boundary Conditions

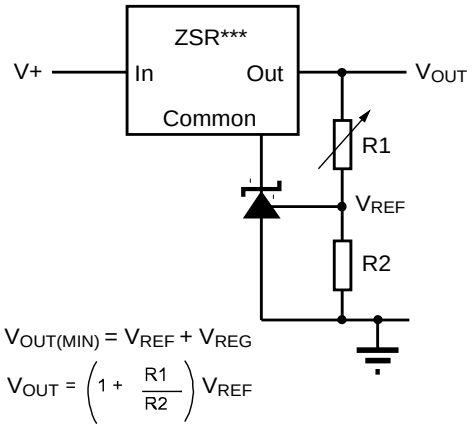
Application Circuits



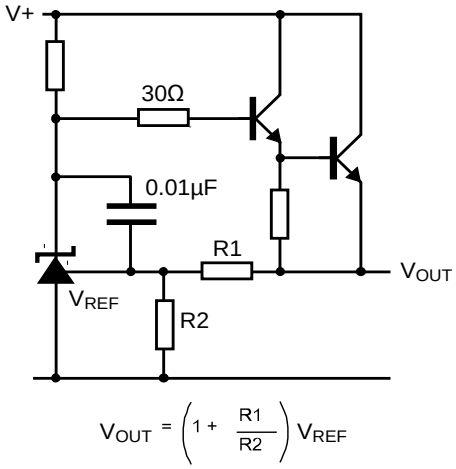
Shunt regulator



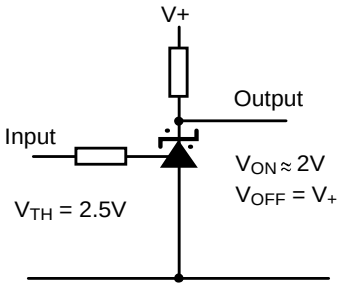
Higher current shunt regulator



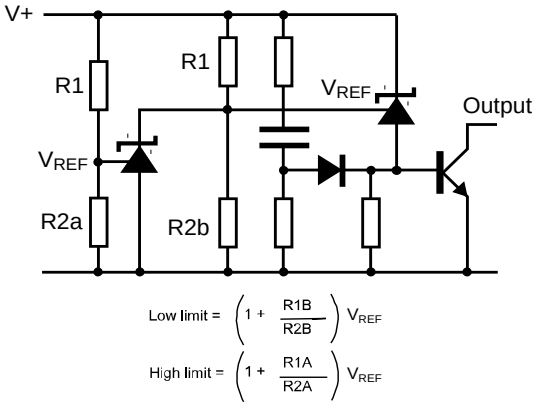
Output control of a three terminal fixed regulator



Series regulator



Single supply comparator with temperature compensated threshold



Over voltage / under voltage protection circuit

DC Test Circuits

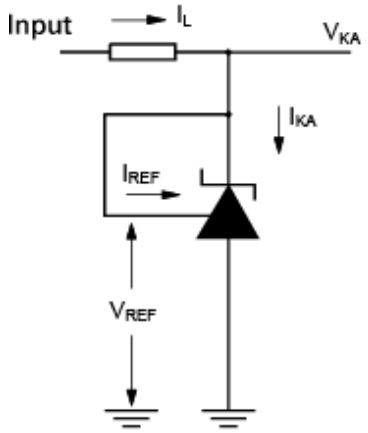


Figure 1. Test circuit for $V_{KA} = V_{REF}$

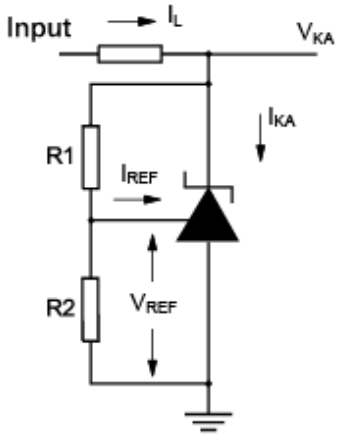


Figure 2. Test circuit for $V_{KA} > V_{REF}$

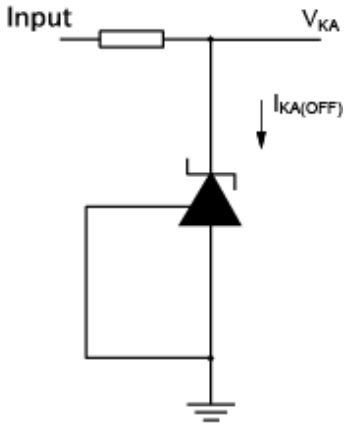


Figure 3. Test circuit for off state current

Notes

Deviation of reference input voltage, 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:

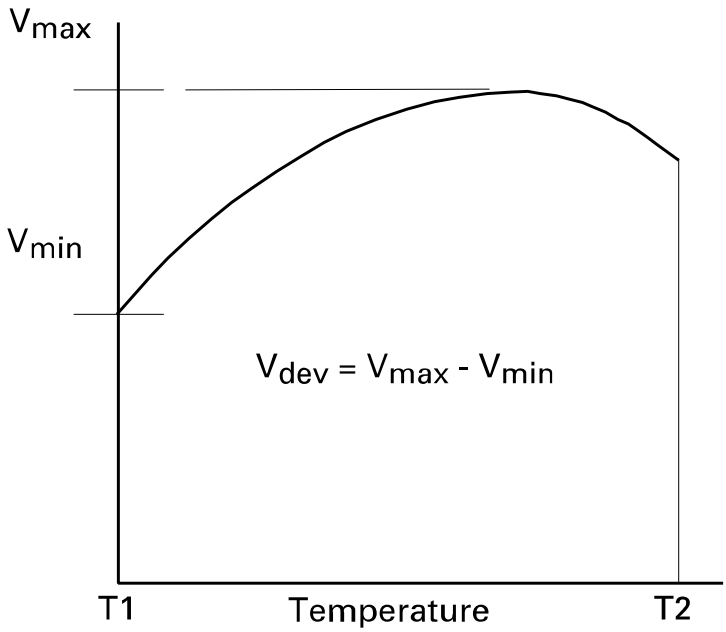
$$V_{REF}(ppm/°C) = \frac{V_{DEV} \times 1{,}000{,}000}{V_{REF}(T1-T2)}$$

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:

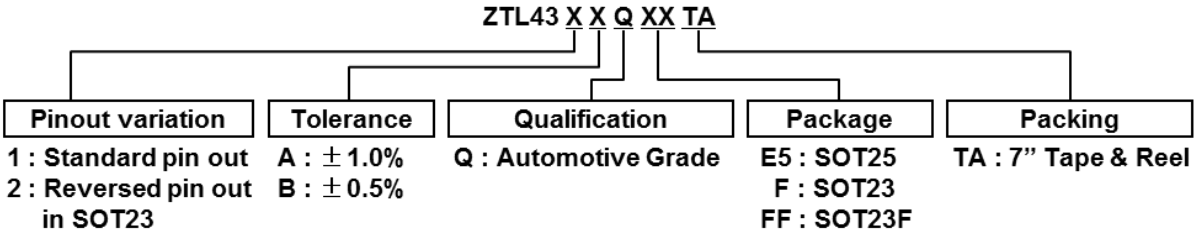
$$R'_Z = R_Z \left(1 + \frac{R1}{R2}\right)$$



Stability Boundary

The ZTL431xQ and ZTL432xQ 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

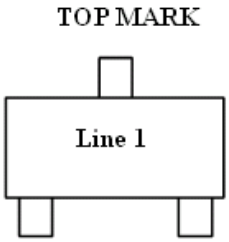


Tol.	Ordering Code	Package Code	Packaging (Note 5)	Part Mark	Reel Size	Tape Width (mm)	Quantity per Reel	Qualification (Note 6)
1%	ZTL431AQE5TA	E5	SOT25	31A	7", 180mm	8	3,000	Automotive Compliant
	ZTL431AQFFTA	FF	SOT23F	31A	7", 180mm	8	3,000	Automotive Compliant
	ZTL431AQFTA	F	SOT23	31A	7", 180mm	8	3,000	Automotive Compliant
	ZTL432AQFFTA	FF	SOT23F	32A	7", 180mm	8	3,000	Automotive Compliant
	ZTL432AQFTA	F	SOT23	32A	7", 180mm	8	3,000	Automotive Compliant
0.5%	ZTL431BQE5TA	E5	SOT25	31B	7", 180mm	8	3,000	Automotive Compliant
	ZTL431BQFFTA	FF	SOT23F	31B	7", 180mm	8	3,000	Automotive Compliant
	ZTL431BQFTA	F	SOT23	31B	7", 180mm	8	3,000	Automotive Compliant
	ZTL432BQFFTA	FF	SOT23F	32B	7", 180mm	8	3,000	Automotive Compliant
	ZTL432BQFTA	F	SOT23	32B	7", 180mm	8	3,000	Automotive Compliant

Notes: 5. Pad layout shown at http://www.diodes.com/package-outlines.html.
6. ZTL431xQ and ZTL432xQ are qualified to AEC-Q100 grade 1 and are classified as "Automotive Compliant" supporting PPAP documentation. 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/.
See ZTL431/ZTL432 datasheet for commercial qualified versions.

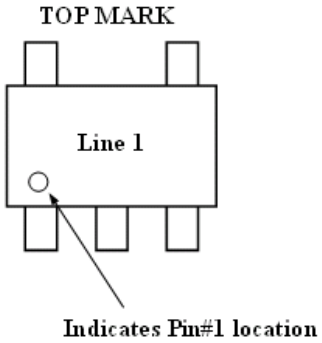
Package Marking Dimensions

SOT23 and SOT23F



Orderable	Part Mark
ZTL431AQFFTA	31A
ZTL431AQFTA	31A
ZTL432AQFFTA	32A
ZTL432AQFTA	32A
ZTL431BQFFTA	31B
ZTL431BQFTA	31B
ZTL432BQFFTA	32B
ZTL432BQFTA	32B

SOT25

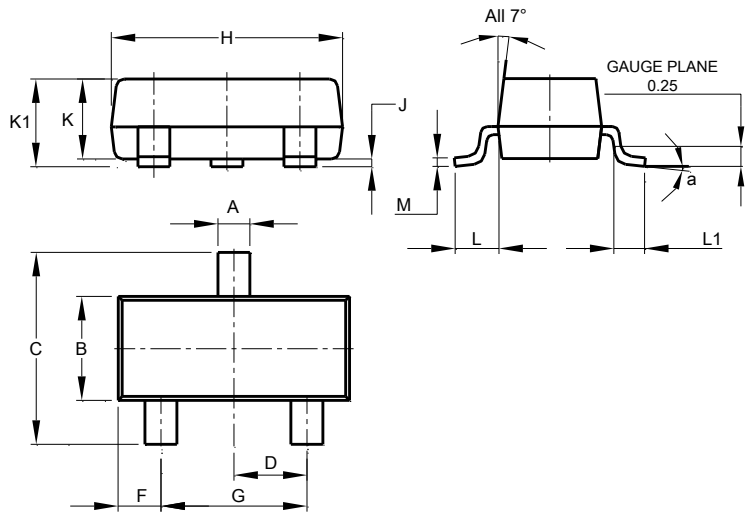


Orderable	Part Mark
ZTL431AQE5TA	31A
ZTL431BQE5TA	31B

Package Outline Dimensions

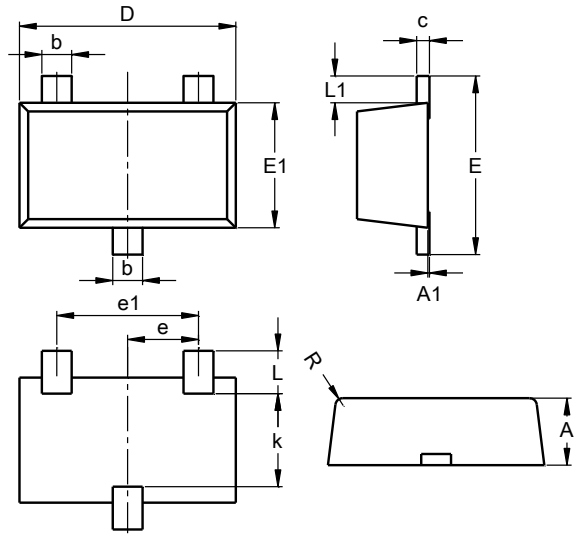
Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23



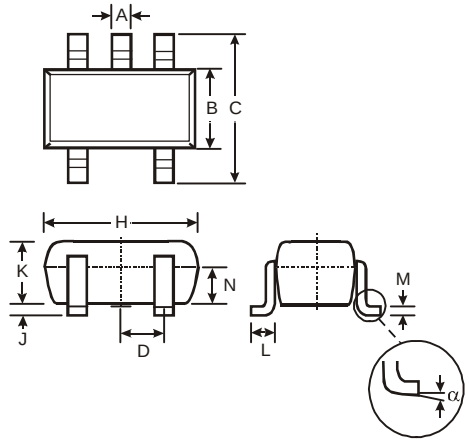
SOT23			
Dim	**Min**	**Max**	**Typ**
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.890	1.00	0.975
K1	0.903	1.10	1.025
L	0.45	0.61	0.55
L1	0.25	0.55	0.40
M	0.085	0.150	0.110
a	0°	8°	--
All Dimensions in mm			

SOT23F



SOT23F			
Dim	**Min**	**Max**	**Typ**
A	0.80	1.00	0.90
A1	0.00	0.10	0.01
b	0.35	0.50	0.44
c	0.10	0.20	0.16
D	2.80	3.00	2.90
e	0.95 REF		
e1	1.90 REF		
E	2.30	2.50	2.40
E1	1.50	1.70	1.65
k	1.20	-	-
L	0.30	0.65	0.50
L1	0.30	0.50	0.40
R	0.05	0.15	-
All Dimensions in mm			

SOT25

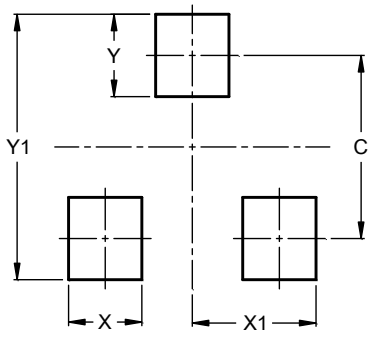


SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	-	-	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	-
All Dimensions in mm			

Suggested Pad Layout

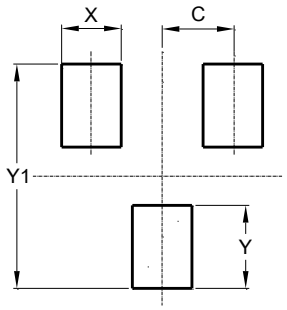
Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23



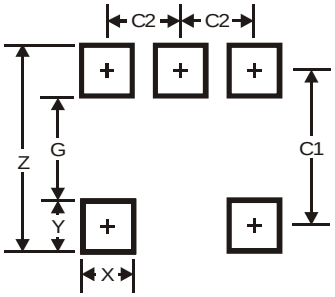
Dimensions	Value (in mm)
C	2.0
X	0.8
X1	1.35
Y	0.9
Y1	2.9

SOT23F



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

SOT25



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

Revision History

<table>
<tr><th>Date</th><th>Revision</th><th>Changes</th></tr>
<tr><td>August 2014</td><td>1-2</td><td>Initial release</td></tr>
<tr><td>July 2016</td><td>2-2</td><td>
Added further clarification of Automotive Grade and reference to Diodes' definition (Pages 1 and 7)

Amended generic part numbers from ZTL431Q/ZTL432Q to ZTL431xQ/ZTL432xQ (All pages Header)

Addition of SOT23F variants:
Pinout (page 1)
Thermal impedance (Pages 2 and 3)
Ordering information (page 7
<table>
<tr><th>Tol.</th><th>Ordering Code</th></tr>
<tr><td rowspan="2">1%</td><td>ZTL431AQFFTA</td></tr>
<tr><td>ZTL432AQFFTA</td></tr>
<tr><td rowspan="2">0.5%</td><td>ZTL431BQFFTA</td></tr>
<tr><td>ZTL432BQFFTA</td></tr>
</table>
Package dimensions (page 8) and landing pad info (page 9)

Correction of ESD ratings (Note 7) (Page 2):
<table>
<tr><td colspan="2">ESD Rating</td><td>Incorrect revision 1-2 specification</td><td>Corrected revision 2-2 specification</td><td>Unit</td></tr>
<tr><td>HBM</td><td>Human Body Model</td><td>4000</td><td>2000</td><td>V</td></tr>
<tr><td>MM</td><td>Machine Model</td><td>400</td><td>200</td><td>V</td></tr>
<tr><td>CDM</td><td>Charged Device Model</td><td>1000</td><td>1000</td><td>V</td></tr>
</table>
Note 7 The actual physical ESD withstand capability is unaltered.

Amendment of Recommended Maximum Power Dissipation based on revised maximum junction temperature of 125°C (Pages 2 and 3):
<table>
<tr><th rowspan="2">Package</th><th>Unchanged</th><th>Rev 1-2 specification</th><th>Rev 2-2 specification</th></tr>
<tr><th>θ_{JA}</th><th>P_{DIS}
T_A = +25°C, T_J = +150°C</th><th>P_{DIS}
T_A = +25°C, T_J = +125°C</th></tr>
<tr><td>SOT23</td><td>380°C/W</td><td>330mW</td><td>260mW</td></tr>
<tr><td>SOT23F</td><td>138°C/W</td><td></td><td>720mW</td></tr>
<tr><td>SOT25</td><td>250°C/W</td><td>500mW</td><td>400mW</td></tr>
</table>
</td></tr>
</table>

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