

## 1.24V programmable shunt voltage reference

### Features

- Adjustable output voltage: 1.24 to 24V
- Several precision levels @ 25°C  
±2%, ±1%, ±0.5% and ±0.25%
- Sink current capability: 0.4 to 100mA
- Industrial temperature range: -40°C to +125°C
- Performance compatible with industry standard TL431

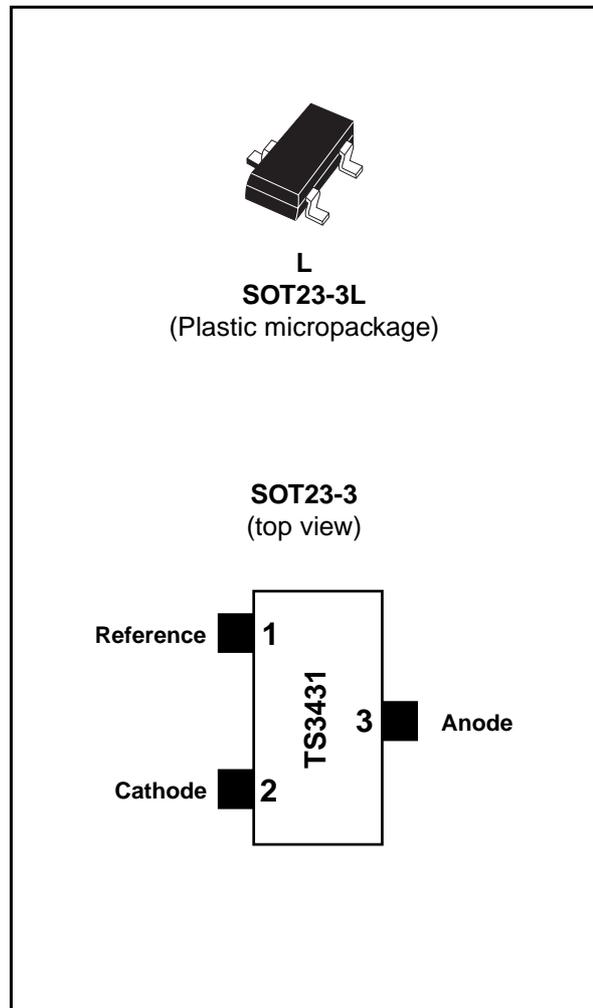
### Applications

- Computers
- Instrumentation
- Battery chargers
- Switch mode power supply
- Battery operated equipment

### Description

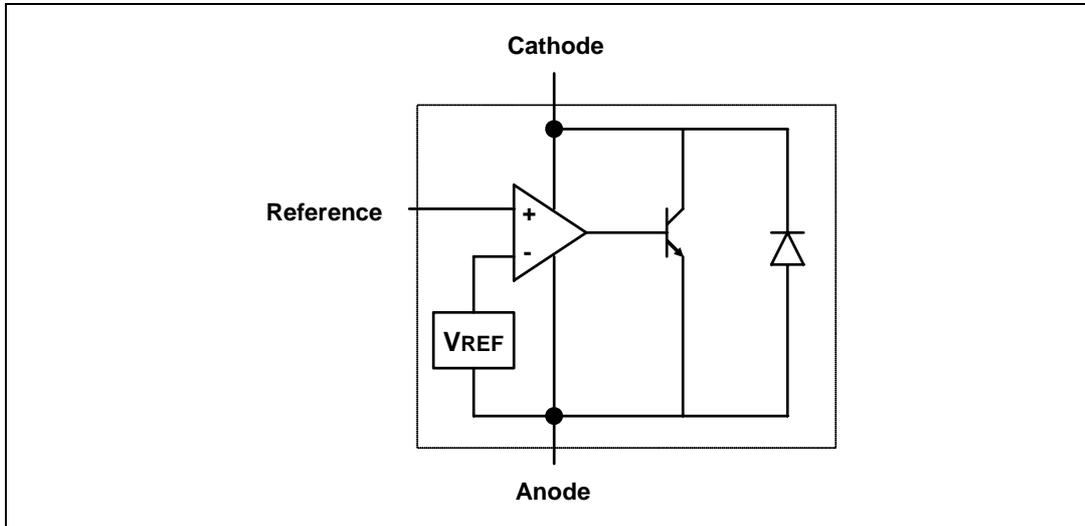
The TS3431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire operating temperature range (-40°C to +125°C). The output voltage can be set to any value between 1.24V and 24V with an external resistor bridge.

Available in SOT23-3 surface mount package, it can be used in application designs where space saving is critical.



# 1 Block diagram

Figure 1. Block diagram



# 2 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
$V_{KA}$	Cathode to anode voltage	25	V
$I_K$	Reverse breakdown current	-100 to +150	mA
$I_{REF}$	Reference current	-0.05 to 10	mA
$P_d$	Power dissipation <sup>(1)</sup> SOT23-3L	360	mW
$T_{stg}$	Storage temperature	-65 to +150	°C
ESD	Human body model (HBM)	2	kV
	Machine model (MM)	200	V
$T_{lead}$	Lead temperature (soldering, 10 seconds)	250	°C

1.  $P_d$  is calculated with  $T_{amb} = 25^\circ\text{C}$ ,  $T_j = 150^\circ\text{C}$ ,  $R_{thjc} = 110^\circ\text{C/W}$ ,  $R_{thja} = 340^\circ\text{C/W}$ .

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
$I_K$	Cathode operating current	0.5 to 100	mA
$V_K$	Cathode operating voltage	1.24 to 24	V
$T_{oper}$	Operating free air temperature range	-40 to +125	°C

### 3 Electrical characteristics

Table 3.  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)<sup>(1)</sup>

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_K$	Reference input voltage $I_K = 10\text{mA}$	TS3431 (2%)	1.215	1.24	1.265	V
		TS3431A (1%)	1.228		1.252	
		TS3431B (0.5%)	1.234		1.246	
		TS3431C (0.25%)	1.237		1.243	
$\Delta V_K$	Variation of reference input voltage over temperature	$0^{\circ}\text{C} < T < +70^{\circ}\text{C}$			10	mV
		$-40^{\circ}\text{C} < T < +105^{\circ}\text{C}$			18	
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			21	
$T_C$	Temperature coefficient	$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			100	ppm/ $^{\circ}\text{C}$
$I_{Kmin}$	Minimum operating current	$T = 25^{\circ}\text{C}$		0.35	0.4	mA
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			0.5	
$\frac{ \Delta V_{ref} }{ \Delta V_{ka} }$	Ratio of change in reference input voltage to change in cathode to anode voltage	$I_K=10\text{mA}$ $V_K= 24$ to $1.24\text{V}$		1.2	1.5	mV/V
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			2	
$I_{REF}$	Reference input current $I_K=10\text{mA}$ , $R1=10\text{K}\Omega$ , $R2=+\infty$	$T = 25^{\circ}\text{C}$		0.9	1.5	$\mu\text{A}$
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			2	
$\Delta I_{REF}$	Reference input current deviation $I_K=10\text{mA}$ , $R1=10\text{K}\Omega$ , $R2=+$	$0^{\circ}\text{C} < T < +70^{\circ}\text{C}$		0.5	1	$\mu\text{A}$
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$		0.9	1.5	
$I_{OFF}$	Off-state cathode current $V_K=24\text{V}$	$T = 25^{\circ}\text{C}$		35	500	nA
		$-40^{\circ}\text{C} < T < +105^{\circ}\text{C}$			1000	
		$-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$			2000	
$R_{KA}$	Reverse static impedance	$I_K = 1$ to $100\text{mA}$		0.2	0.4	W
$E_N$	Wideband noise	$I_K = 10\text{mA}$ $1\text{kHz} < f < 100\text{kHz}$		100		nV/ $\sqrt{\text{Hz}}$

1. Limits are 100% production tested at  $25^{\circ}\text{C}$ . Behavior at the temperature range limits is guaranteed through correlation and by design.

Figure 2. Reference voltage vs. temperature

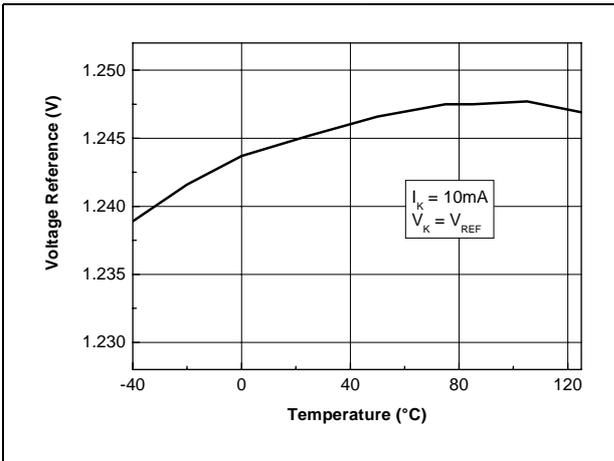


Figure 3. Test circuit for  $V_K = V_{REF}$

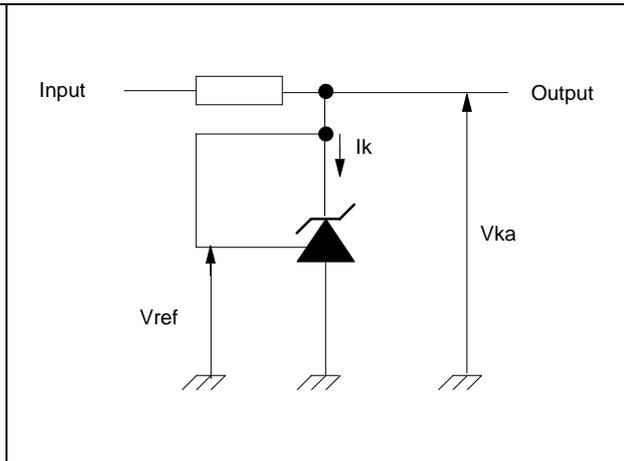


Figure 4. Cathode voltage vs cathode current

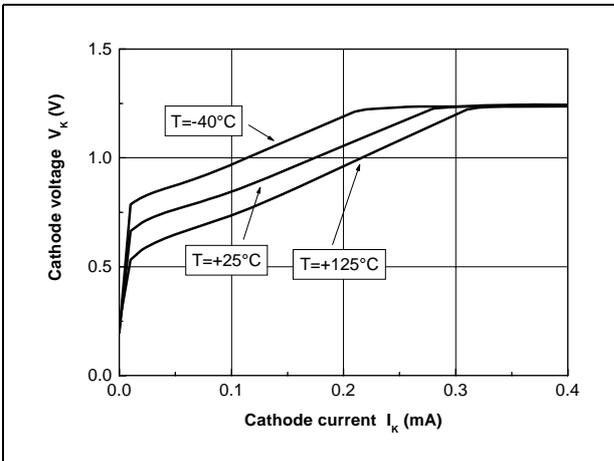


Figure 5. Minimum operating current vs temperature

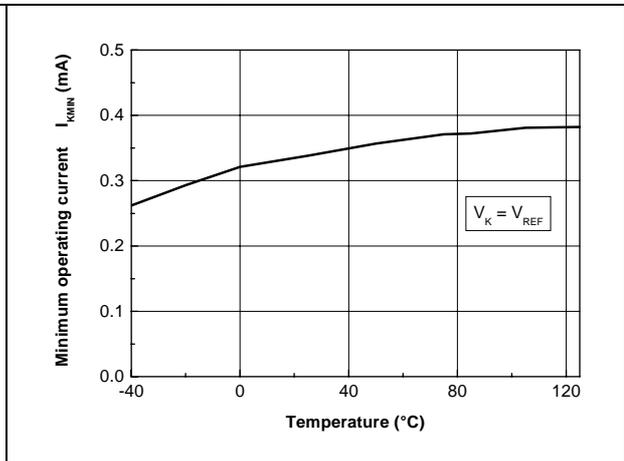


Figure 6. Reference input current vs temperature

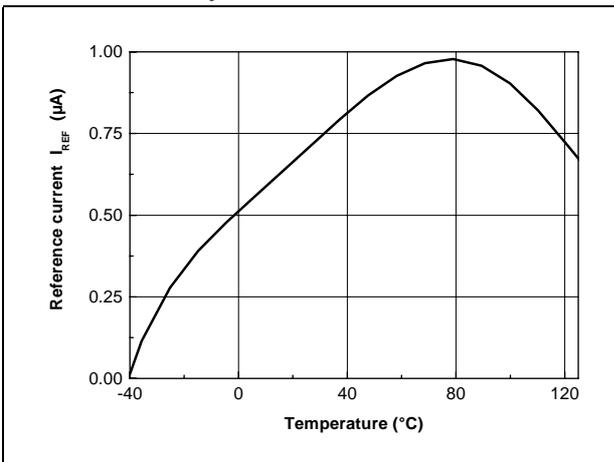


Figure 7. Dynamic impedance vs frequency

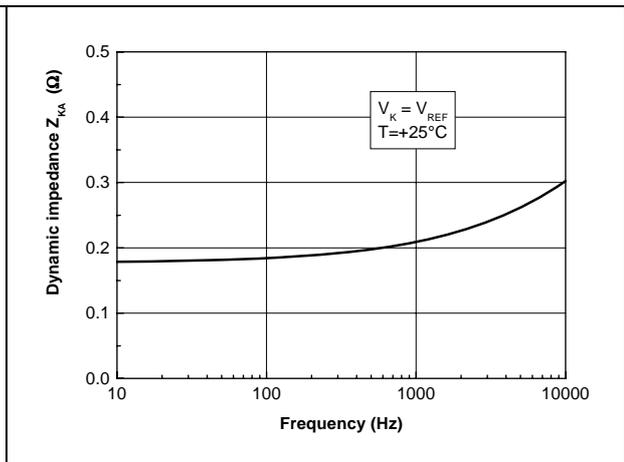


Figure 8. Off-state current vs temperature

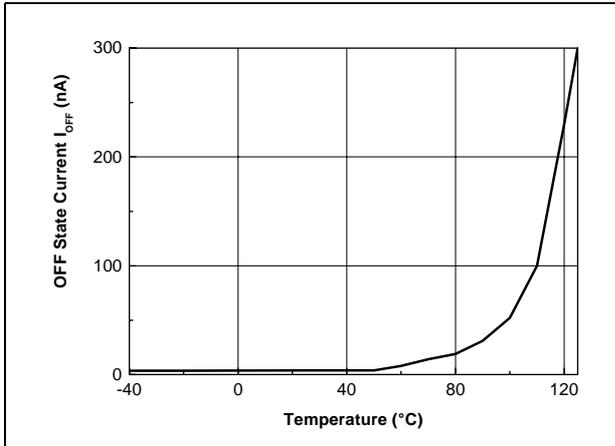


Figure 9. Test circuit for off-state current measurement

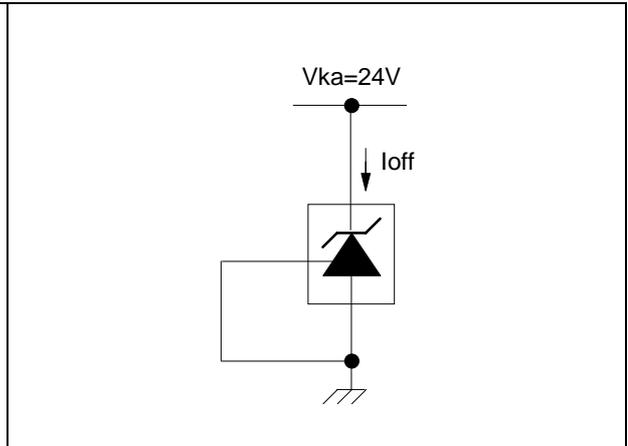


Figure 10. Ratio of change in reference input voltage to change in V<sub>KA</sub> voltage vs temperature

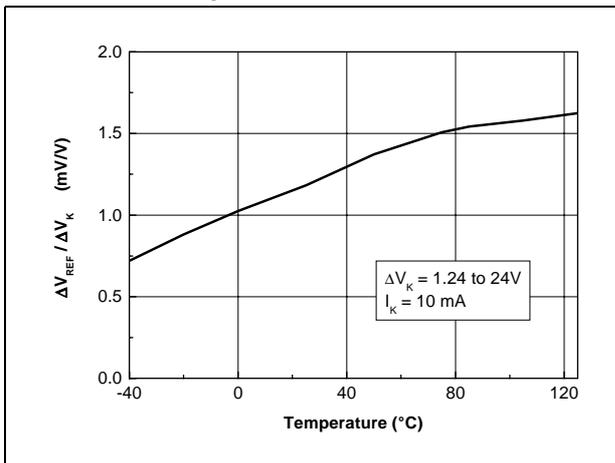


Figure 11. Test circuit for V<sub>K</sub> > V<sub>REF</sub>

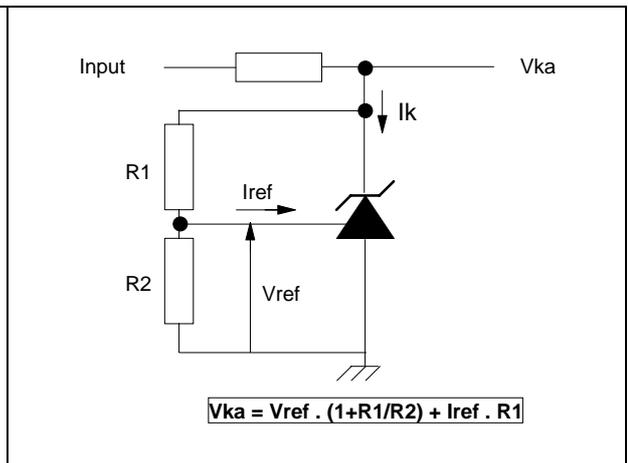


Figure 12. Pulse response at I<sub>K</sub>=1mA

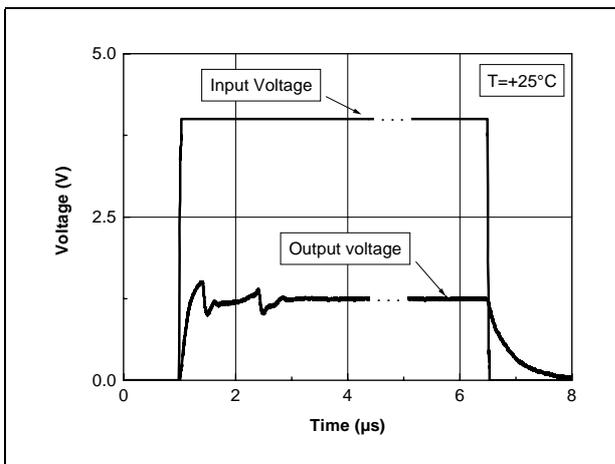


Figure 13. Test circuit for pulse response at I<sub>K</sub> = 1mA

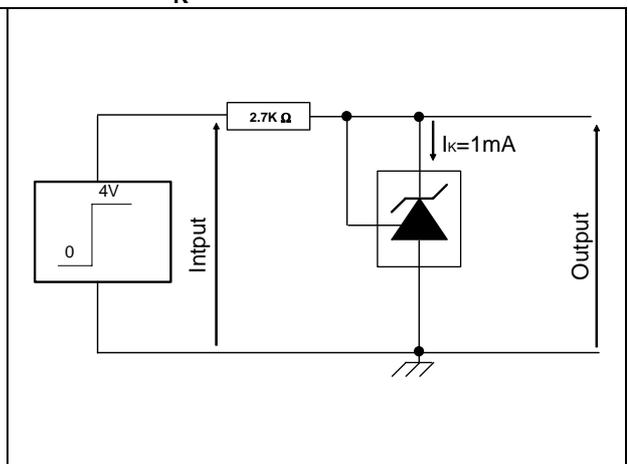


Figure 14. Pulse response at  $I_K = 10\text{mA}$

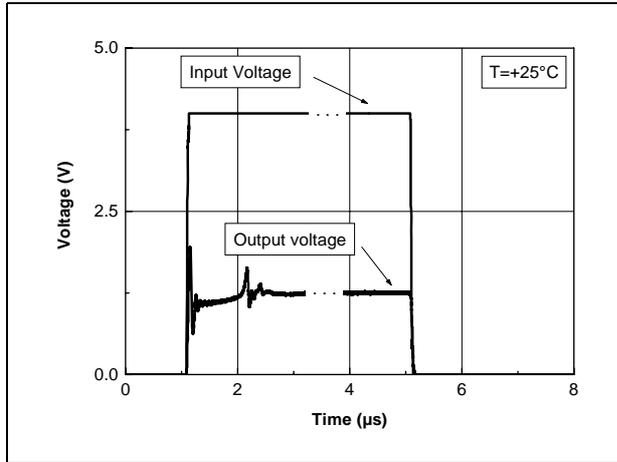


Figure 15. Test circuit for pulse response at  $I_K = 10\text{mA}$

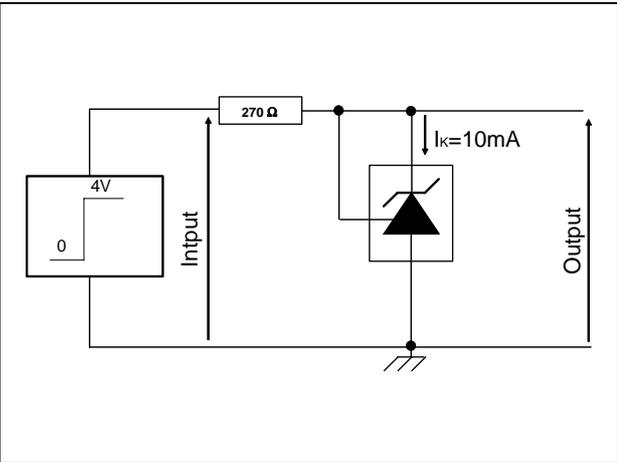


Figure 16. Phase and gain vs frequency

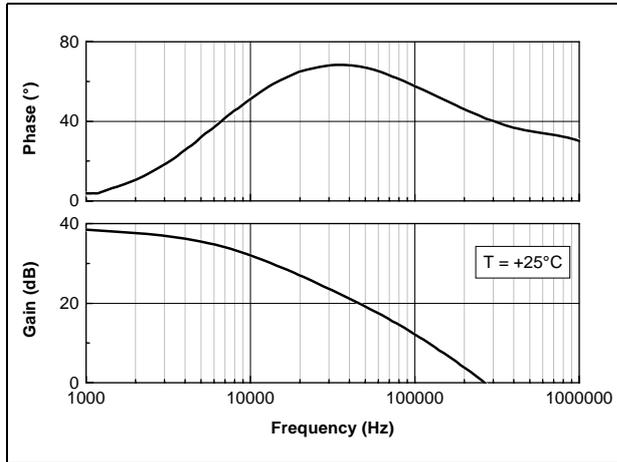


Figure 17. Equivalent input noise vs frequency

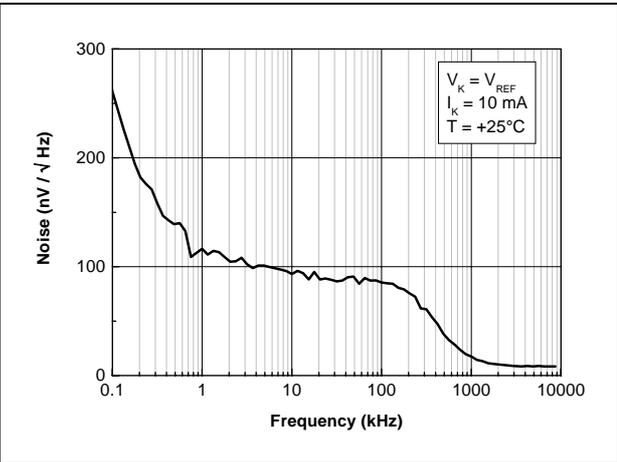
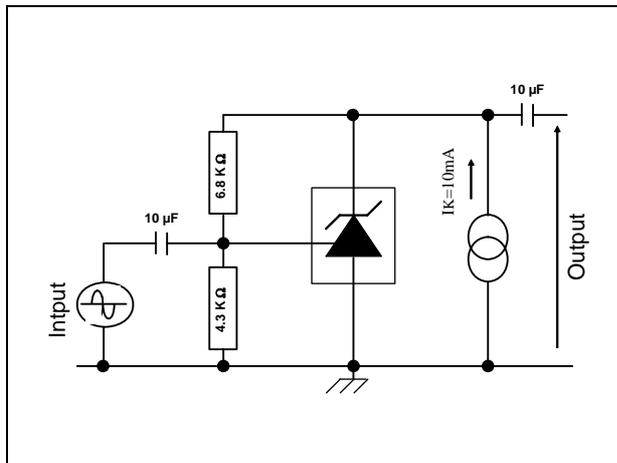


Figure 18. Test circuit for phase and gain measurement

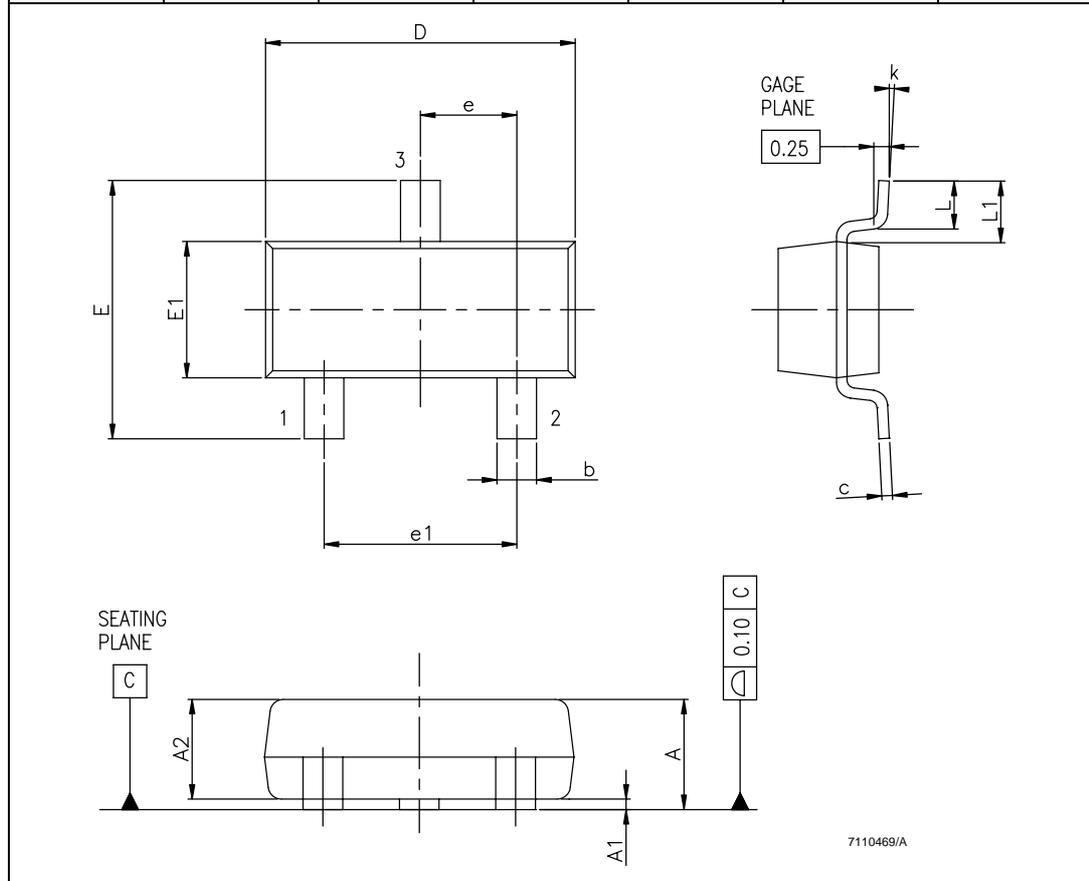


## 4 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

Figure 19. SOT23-3L package mechanical data

Ref.	Dimensions					
	Millimeters			Mils		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.890		1.120	35.05		44.12
A1	0.010		0.100	0.39		3.94
A2	0.880	0.950	1.020	34.65	37.41	40.17
b	0.300		0.500	11.81		19.69
C	0.080		0.200	3.15		7.88
D	2.800	2.900	3.040	110.26	114.17	119.72
E	2.100		2.64	82.70		103.96
E1	1.200	1.300	1.400	47.26	51.19	55.13
e		0.950			37.41	
e1		1.900			74.82	
L	0.400		0.600	15.75		23.63
L1		0.540			21.27	
k	0°		8°	0°		8°



## 5 Ordering information

Table 4. Order codes

Part number	Temperature range	Package	Packaging	Marking
TS3431ILT TS3431AILT TS3431BILT TS3431CILT	-40°C, +125°C	SOT23-3L	Tape & reel	L280 L281 L282 L283

## 6 Revision history

Date	Revision	Changes
1-Jan-2004	1	Initial release.
1-Dec-2004	2	Specific content changes as follows: – CI version added in <a href="#">Table 4: Order codes</a> . – $R_{thjc}$ information added in <a href="#">Table 1: Absolute maximum ratings (AMR)</a> . – Test condition added in electrical characteristics <a href="#">Table 3</a> .
26-Jun-2007	3	Removed TO-92 package information and associated order codes. Re-ordered electrical characteristics figures.

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2007 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

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