

## 1.24 V programmable shunt voltage reference

Datasheet – production data

### Features

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

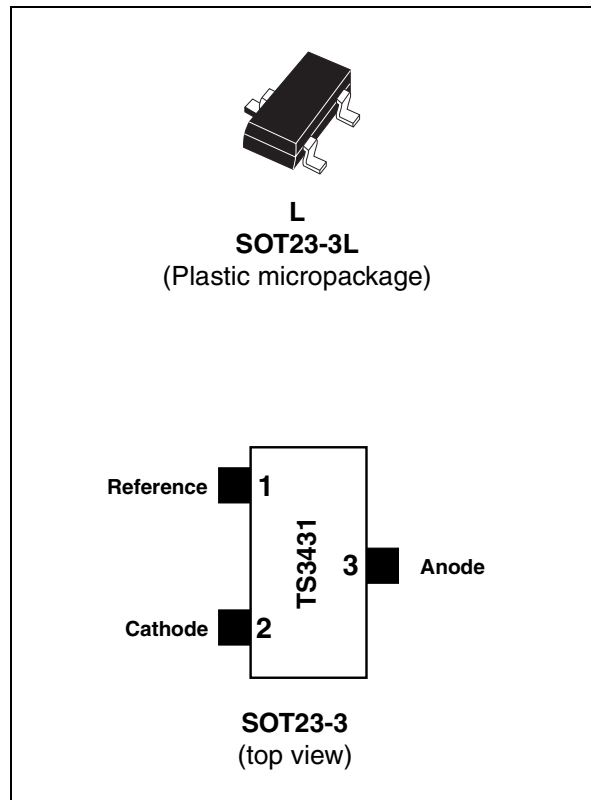
### Applications

- 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 1.24 V and 24 V with an external resistor bridge.

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



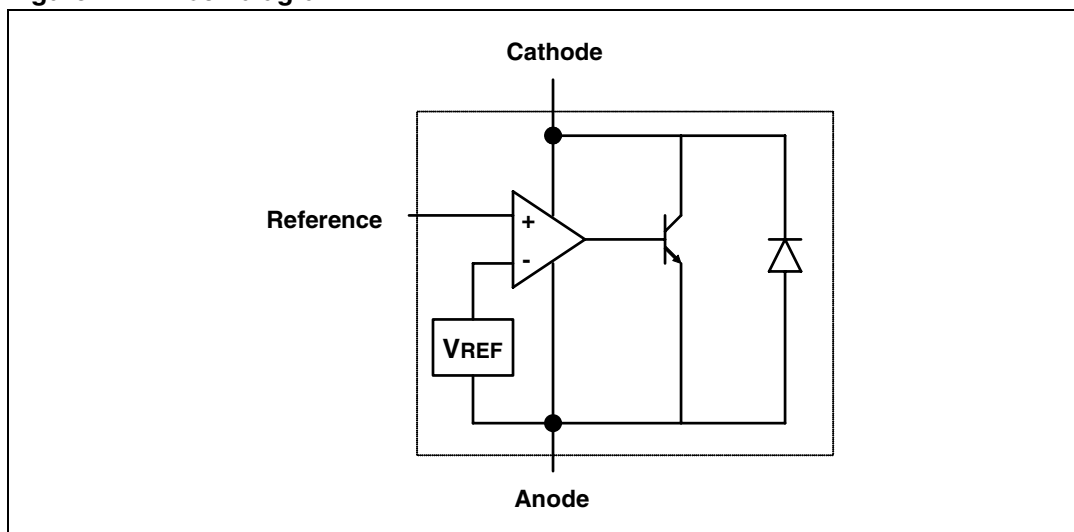
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# 1 Block diagram

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 $I_K = 10\text{ mA}$ , $V_{ka} = V_{ref}$	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, $V_{ka} = V_{ref}$	$0^{\circ}\text{C} < T < +70^{\circ}\text{C}$			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	$I_K=10\text{mA}$ $V_K= 24\text{ to }1.24\text{V}$		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	$I_K = 1\text{ to }100\text{mA}$		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

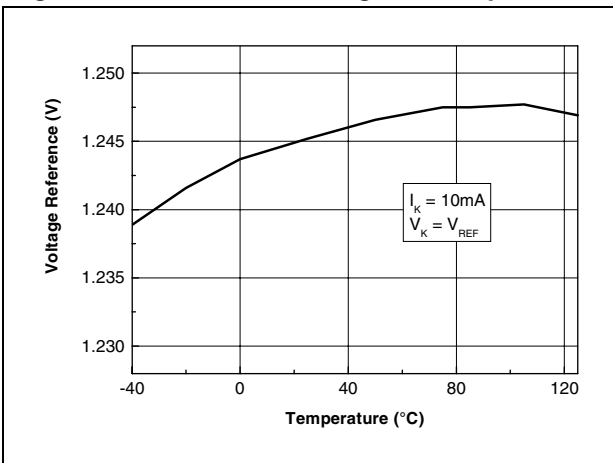


Figure 3. Test circuit for  $V_K = V_{REF}$

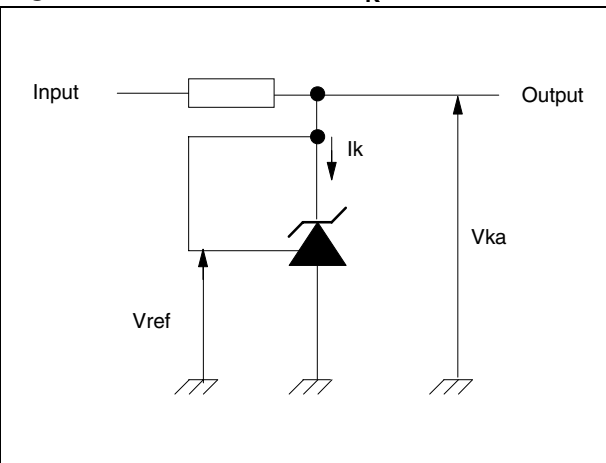


Figure 4. Cathode voltage vs. cathode current

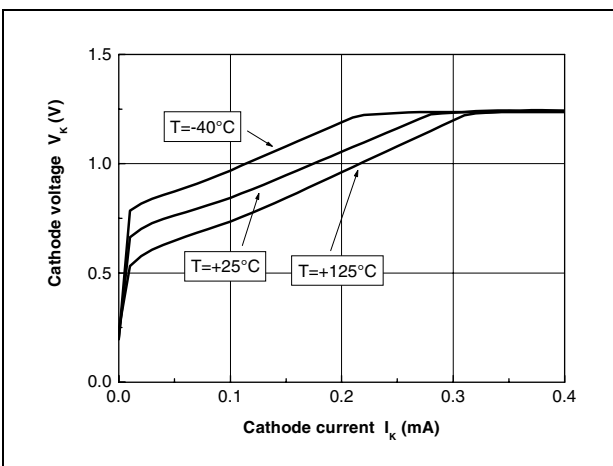


Figure 5. Minimum operating current vs. temperature

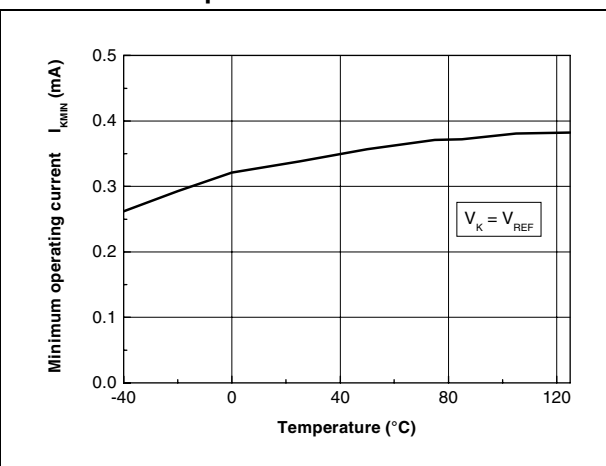


Figure 6. Reference input current vs. temperature

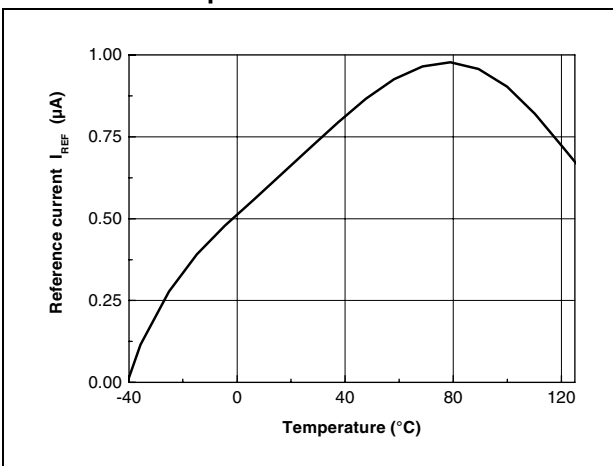


Figure 7. Dynamic impedance vs frequency

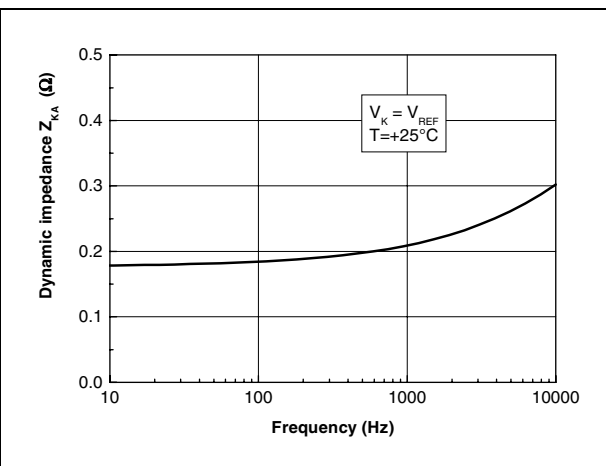


Figure 8. Off-state current vs temperature

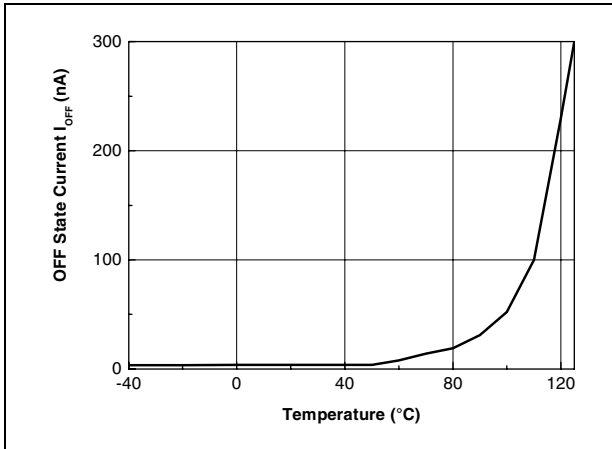


Figure 9. Test circuit for off-state current measurement

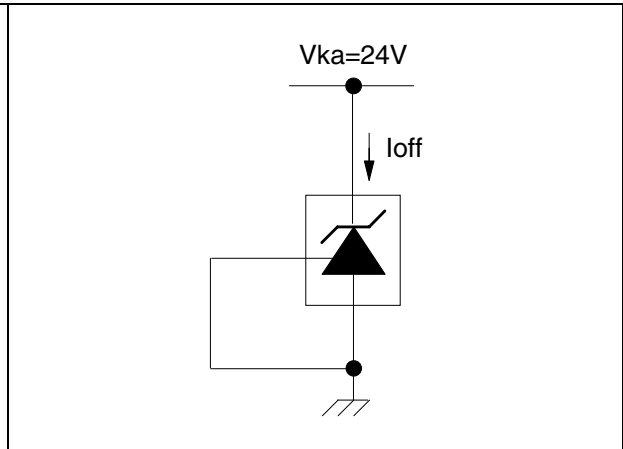


Figure 10. Ratio of change in reference input voltage to change in V<sub>KA</sub> voltage vs. temperature

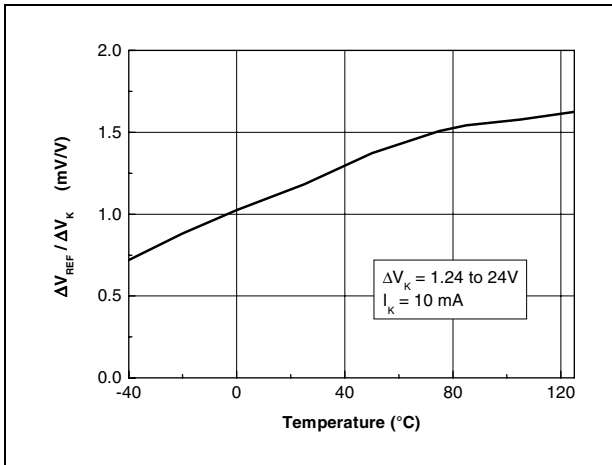


Figure 11. Test circuit for V<sub>K</sub> > V<sub>REF</sub>

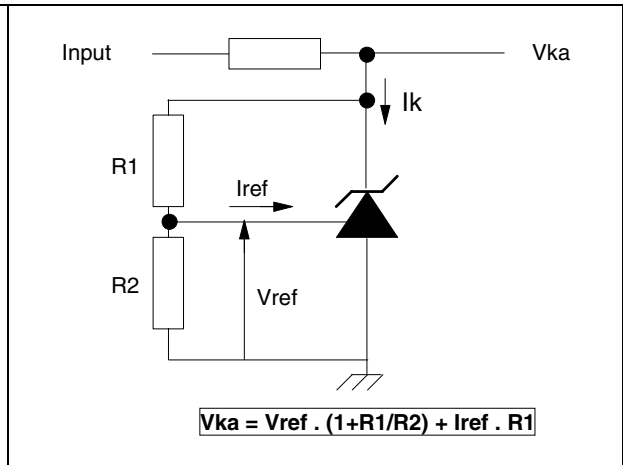


Figure 12. Pulse response at I<sub>K</sub>=1mA

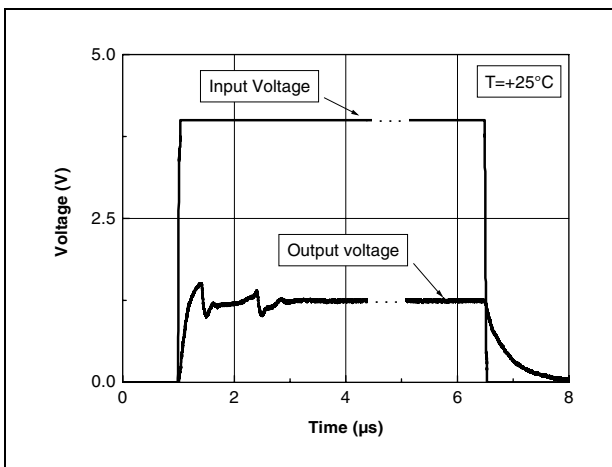


Figure 13. Test circuit for pulse response at I<sub>K</sub> = 1mA

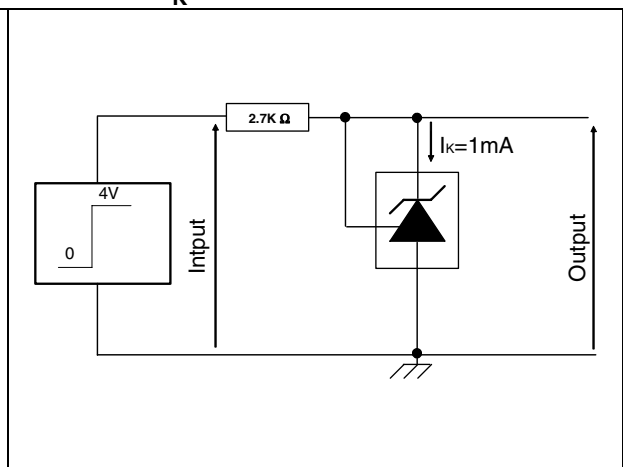


Figure 14. Pulse response at  $I_K = 10\text{mA}$

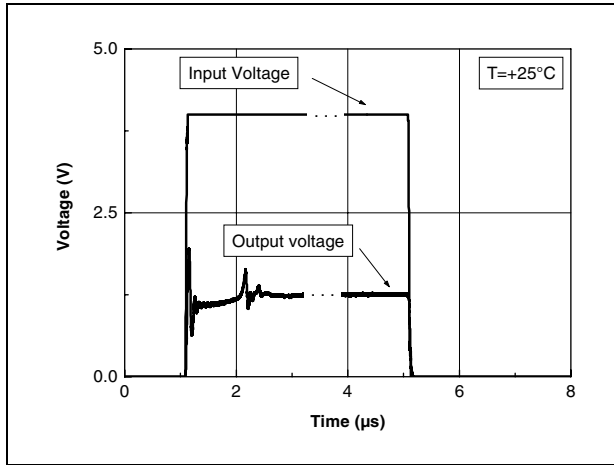


Figure 15. Test circuit for pulse response at  $I_K = 10\text{mA}$

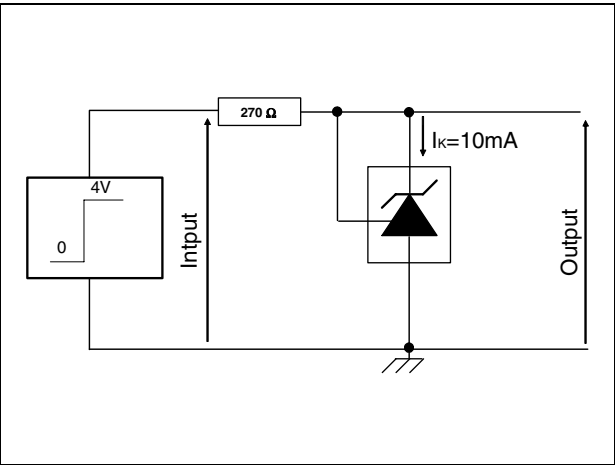


Figure 16. Phase and gain vs frequency

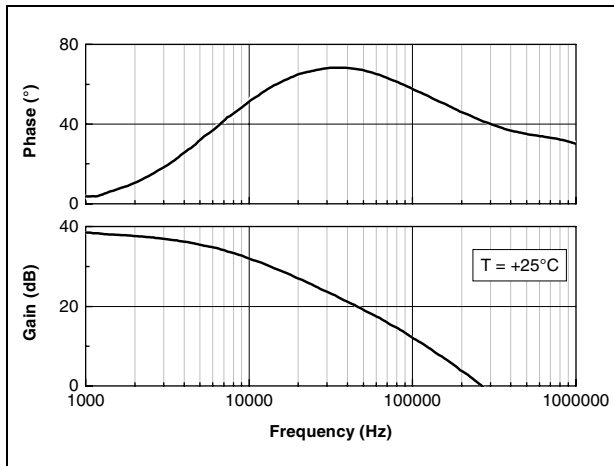


Figure 17. Equivalent input noise vs. frequency

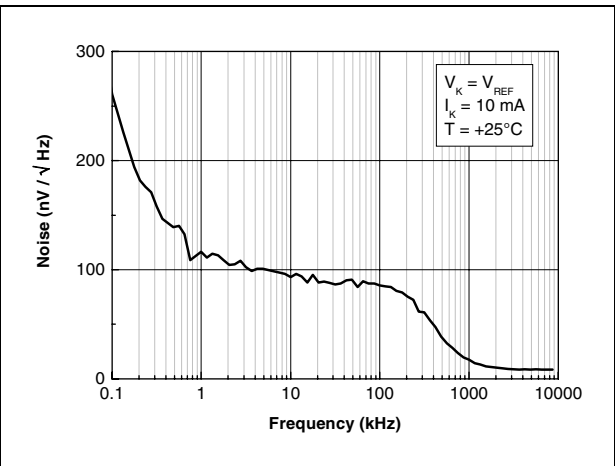
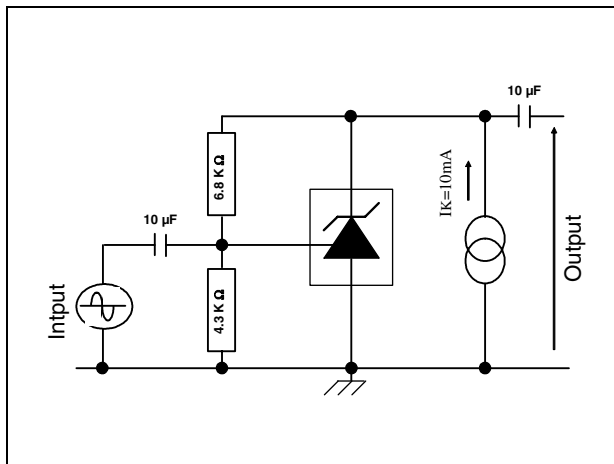


Figure 18. Test circuit for phase and gain measurement



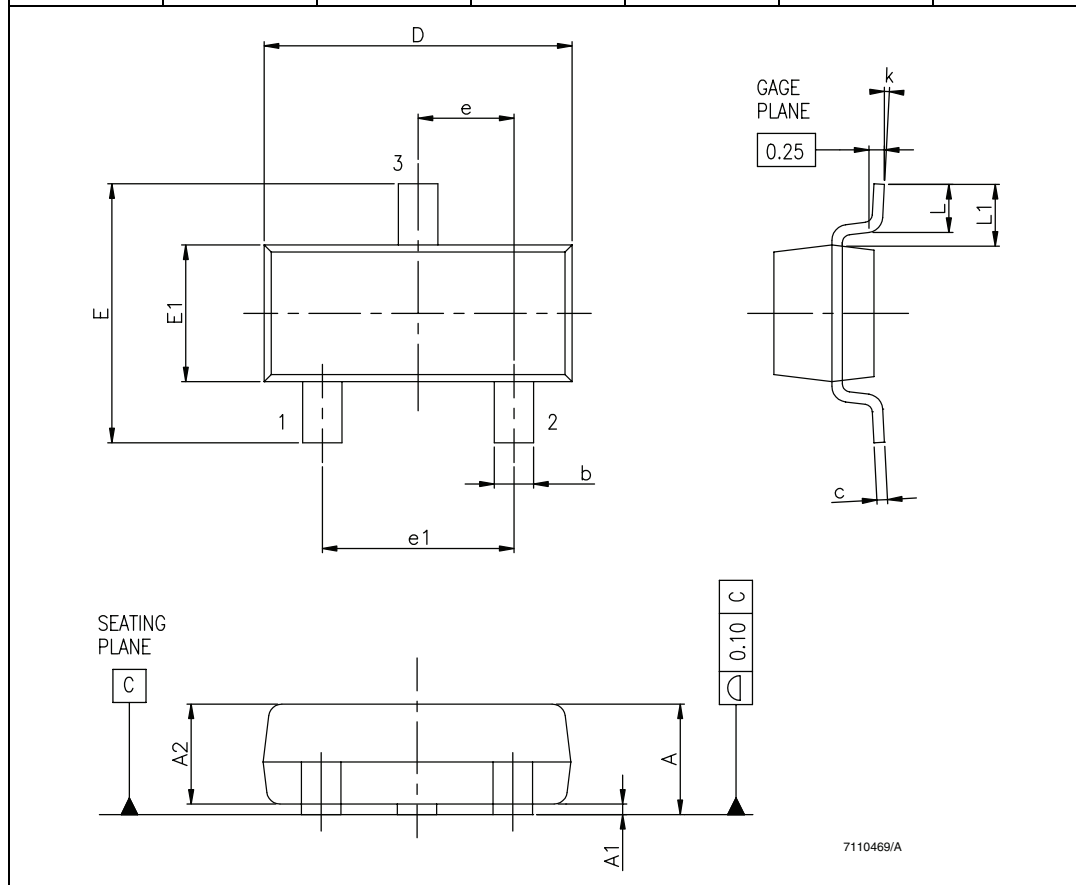


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Table 4. 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 5. Order codes

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

## 6 Revision history

**Table 6. Document revision history**

Date	Revision	Changes
1-Jan-2004	1	Initial release.
1-Dec-2004	2	Specific content changes as follows: <ul style="list-style-type: none"><li>– CI version added in <a href="#">Table 5: Order codes</a>.</li><li>– <math>R_{thjc}</math> information added in <a href="#">Table 1: Absolute maximum ratings (AMR)</a>.</li><li>– Test condition added in electrical characteristics <a href="#">Table 3</a>.</li></ul>
26-Jun-2007	3	Removed TO-92 package information and associated order codes. Re-ordered electrical characteristics figures.
30-Aug-2012	4	Added: $V_{ka} = V_{ref}$ parameter in <a href="#">Table 3 on page 5</a> .

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