

## 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

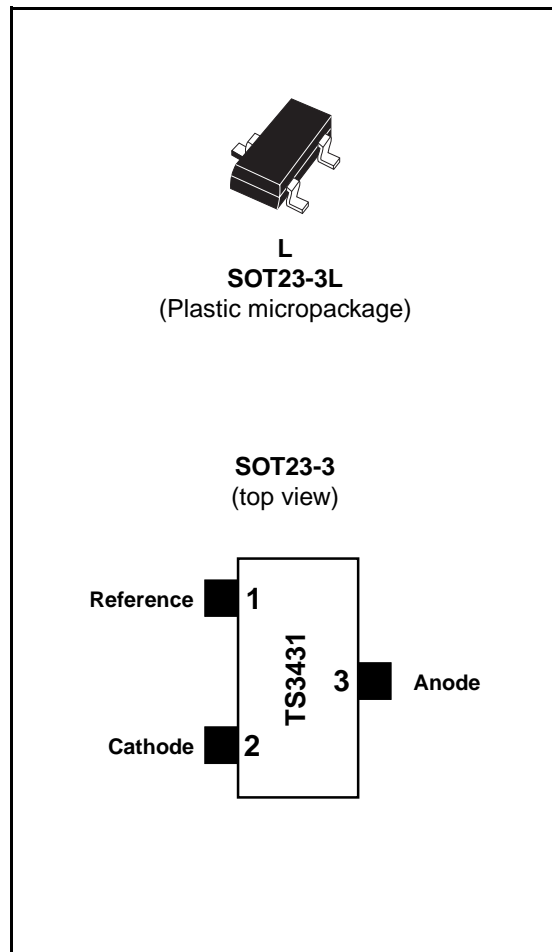
### Applications

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

### Description

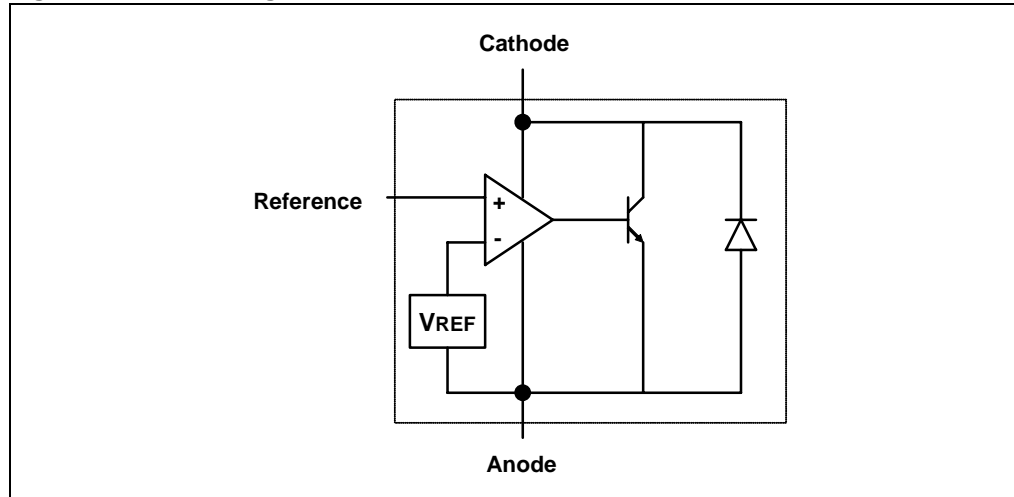
The TS3431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire operating temperature range (-40°C to +125°C). The output voltage can be set to any value between 1.24V and 24V with an external resistor bridge.

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		$\text{nV}/\sqrt{\text{Hz}}$

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  $V_K = V_{ref}$

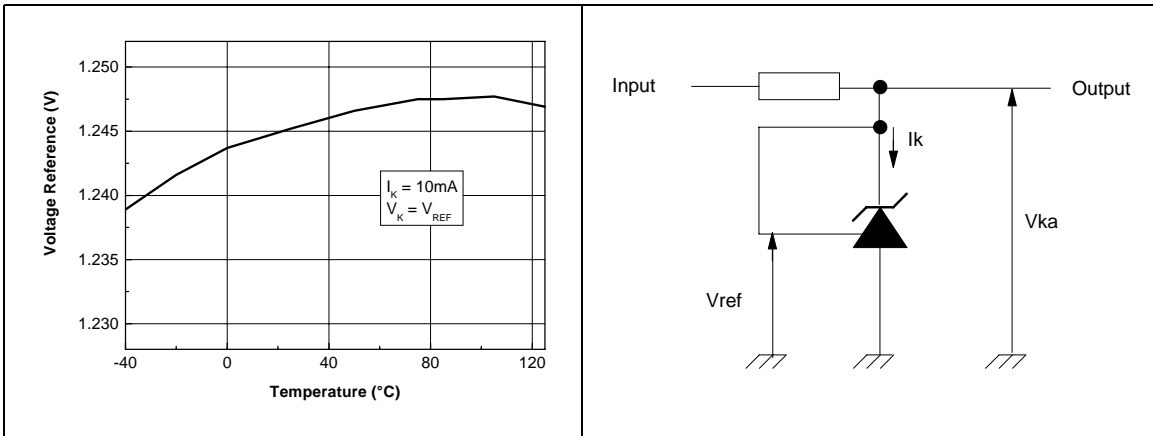


Figure 4. Cathode voltage vs cathode current Figure 5. Minimum operating current vs temperature

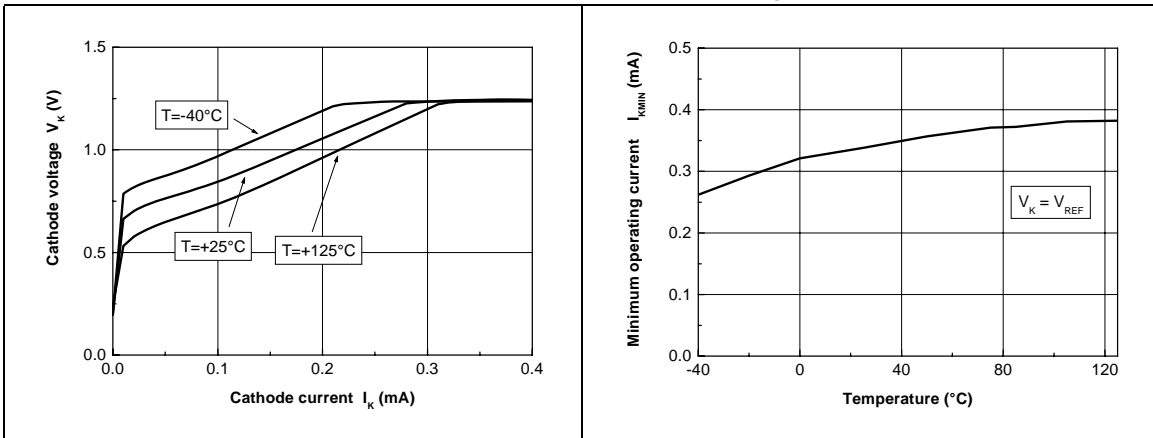


Figure 6. Reference input current vs temperature Figure 7. Dynamic impedance vs frequency

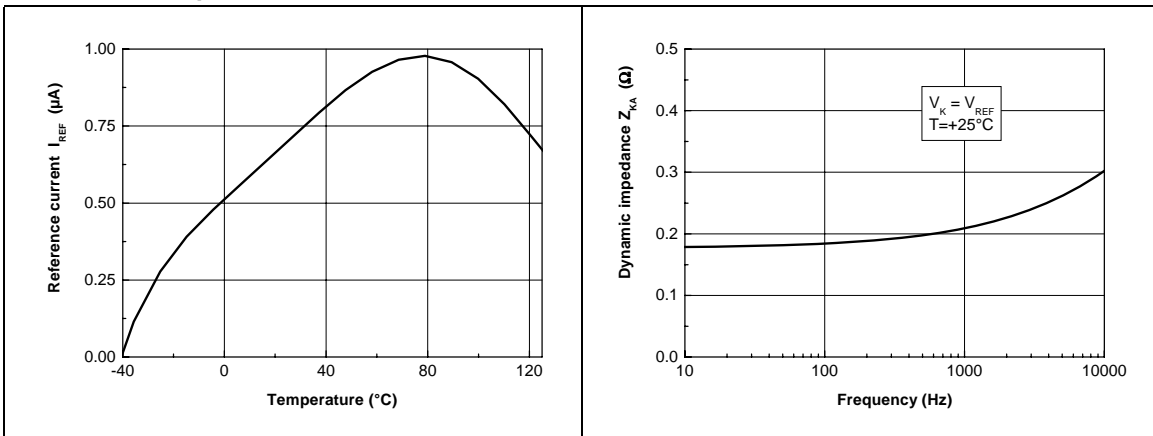


Figure 8. Off-state current vs temperature

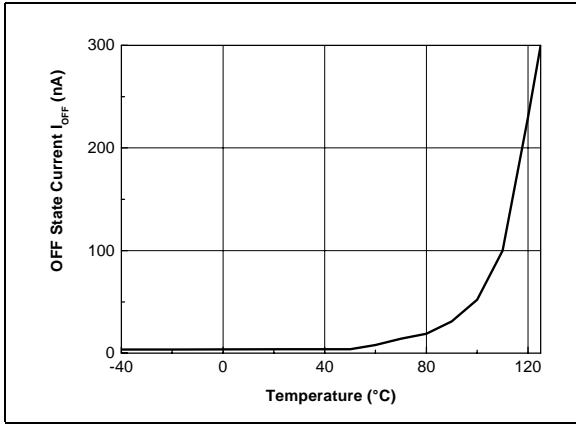


Figure 9. Test circuit for off-state current measurement

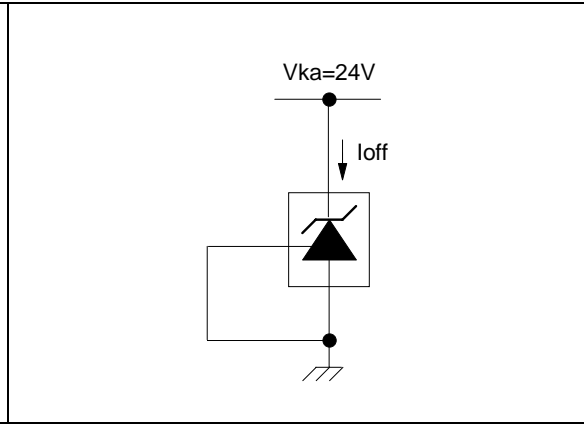


Figure 10. Ratio of change in reference input voltage to change in  $V_{KA}$  voltage vs temperature

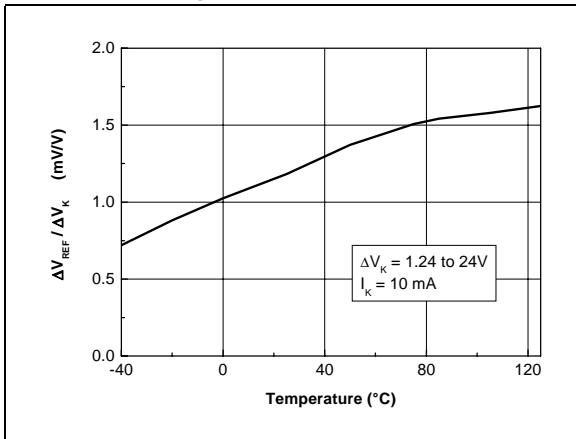


Figure 11. Test circuit for  $V_K > V_{REF}$

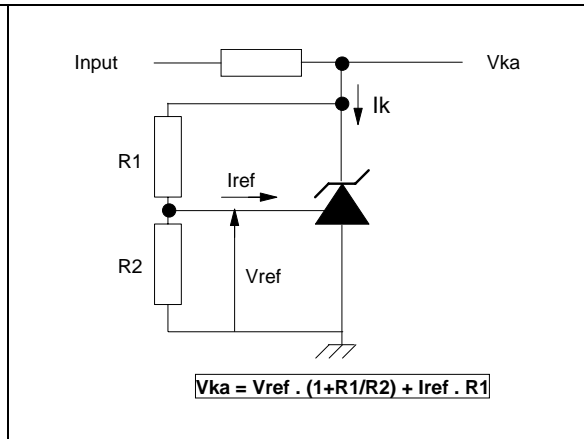


Figure 12. Pulse response at  $I_K=1mA$

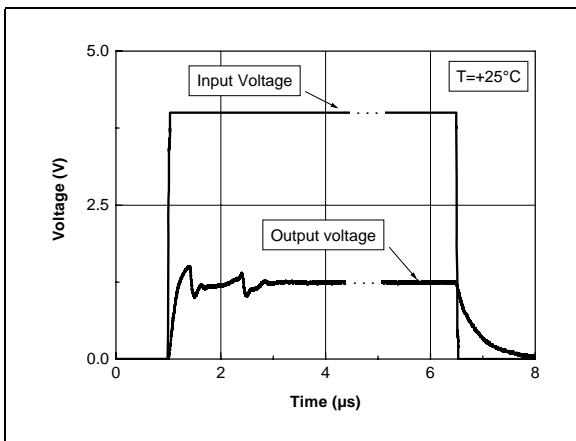


Figure 13. Test circuit for pulse response at  $I_K = 1mA$

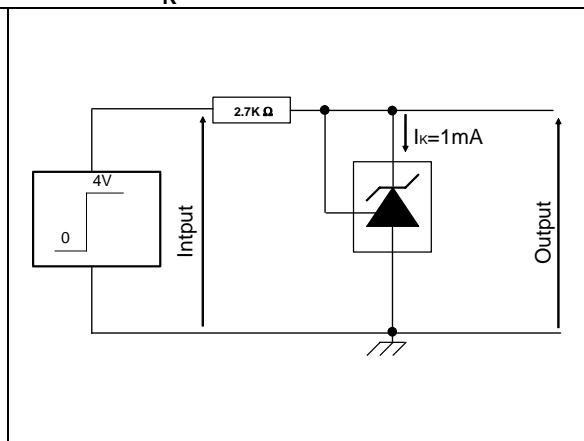


Figure 14. Pulse response at  $I_K = 10\text{mA}$

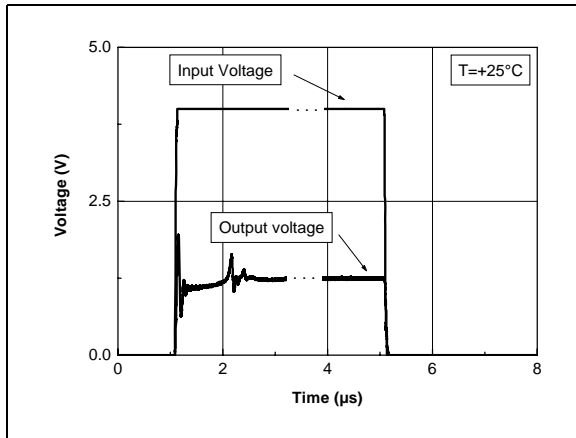


Figure 15. Test circuit for pulse response at  $I_K = 10\text{mA}$

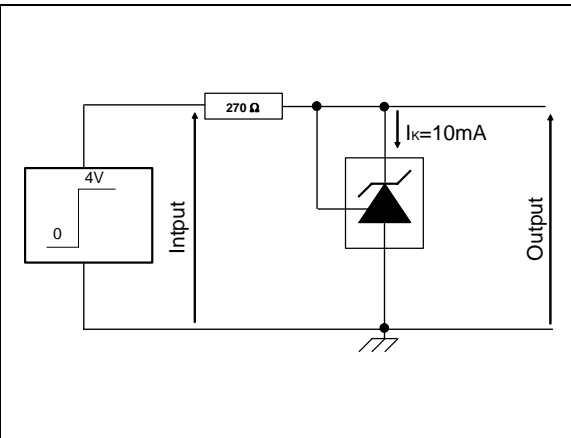


Figure 16. Phase and gain vs frequency

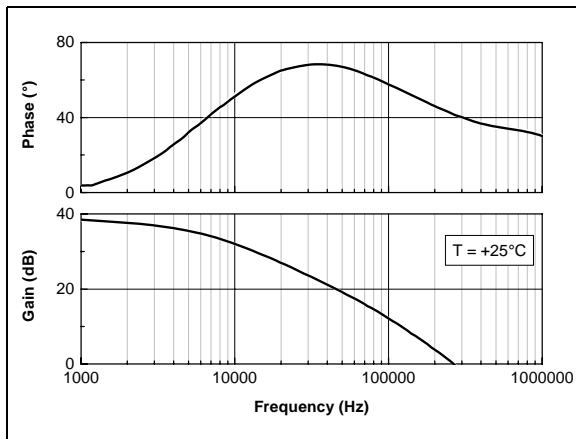


Figure 17. Equivalent input noise vs frequency

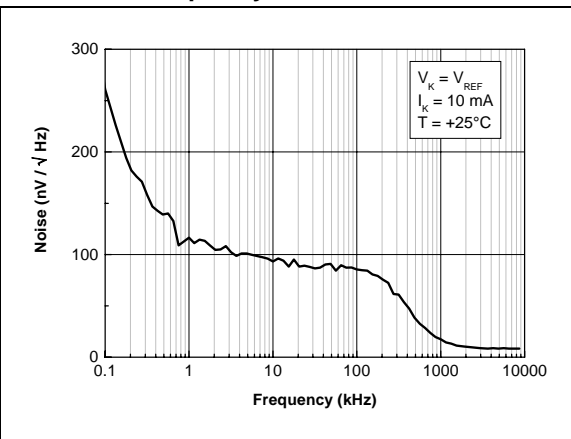
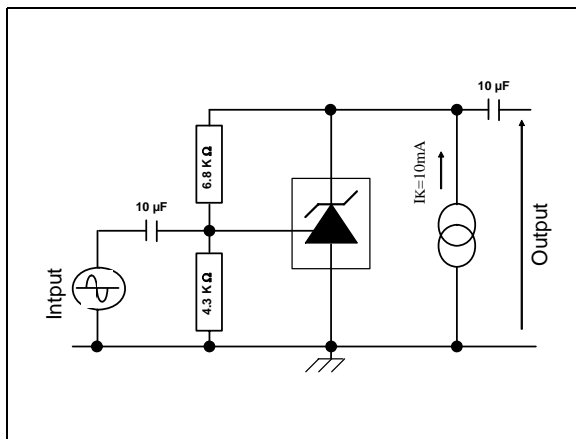


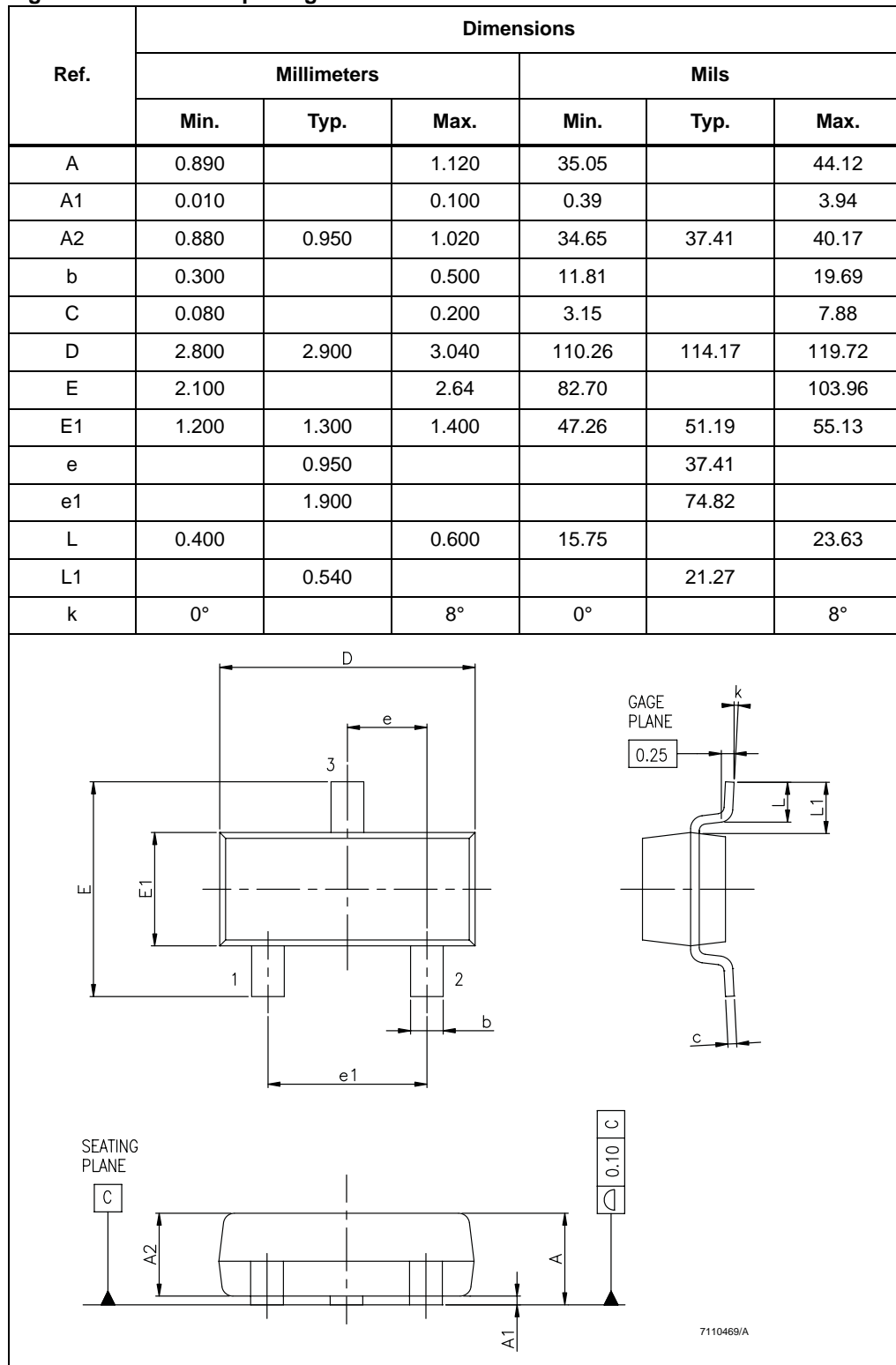
Figure 18. Test circuit for phase and gain measurement



## 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





## 5 Ordering information

Table 4. Order codes

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

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