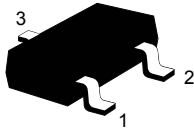
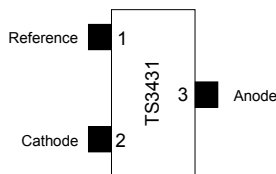


## 1.24 V adjustable shunt voltage reference



SOT23-3L  
(Plastic micropackage)



SOT23-3L  
(top view)

### 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 + 105 °C
- Performance compatible with industry standard TL431

### Applications

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

### Description

The **TS3431** is an adjustable 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.

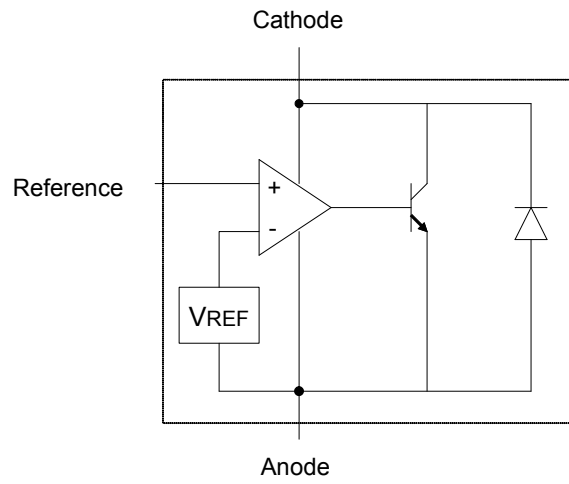
Available in SOT23-3 surface mount package, it can be used in application designs where space saving is critical.

Maturity status link

[TS3431](#)

# 1 Diagram

Figure 1. Block diagram



## 2 Maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{ka}$	Cathode to anode voltage	25	V
$I_K$	Reverse breakdown current	-100 to +150	mA
$I_{REF}$	Reference input current range	0.05 to +10	mA
$P_d$	Power dissipation SOT23-3L <sup>(1)</sup> .	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  $T_{amb} = 25\text{ °C}$ ,  $T_j = 150\text{ °C}$ ,  $R_{thjc} = 110\text{ °C/W}$ ,  $R_{thja} = 340\text{ °C/W}$

**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 + 105	°C

### 3 Electrical characteristics

Limits are 100% production tested at 25 °C. Behavior at the temperature range limits is guaranteed through correlation and by design.  $T_{amb} = 25\text{ °C}$  (unless otherwise specified).

**Table 3. Electrical characteristics**

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, $V_{ka} = V_{ref}$	$0\text{ °C} < T < +70\text{ °C}$			10	mV
		$-40\text{ °C} < T < +105\text{ °C}$			18	
		$-40\text{ °C} < T < +125\text{ °C}$			21	
$T_C$	Temperature coefficient	$-40\text{ °C} < T < +125\text{ °C}$			100	ppm/°C
$I_{Kmin}$	Minimum operating current	$T = 25\text{ °C}$		0.35	0.4	mA
		$-40\text{ °C} < T < +125\text{ °C}$			0.5	
$\left  \frac{\Delta V_{ref}}{\Delta V_{ka}} \right $	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
		$-40\text{ °C} < T < +125\text{ °C}$			2	
$I_{REF}$	Reference input current $I_K = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = +\infty$	$T = 25\text{ °C}$		1.5	2.0	$\mu\text{A}$
		$-40\text{ °C} < T < +125\text{ °C}$			2.5	
$\Delta I_{REF}$	Reference input current deviation $I_K = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = +\infty$	$0\text{ °C} < T < +70\text{ °C}$		0.5	1	$\mu\text{A}$
		$-40\text{ °C} < T < +125\text{ °C}$		0.9	1.5	
$I_{OFF}$	Off-state cathode current $V_K = 24\text{ V}$	$T = 25\text{ °C}$		35	500	nA
		$-40\text{ °C} < T < +105\text{ °C}$			1000	
		$-40\text{ °C} < T < +125\text{ °C}$			2000	
$R_{KA}$	Reverse static impedance	$I_K = 1\text{ to }100\text{ mA}$		0.2	0.4	$\Omega$
EN	Wideband noise	$I_K = 10\text{ mA}$ $1\text{ kHz} < f < 100\text{ kHz}$		100		nV/ $\sqrt{\text{Hz}}$

### 3.1 Performance characteristics

Figure 2. Reference voltage vs. temperature

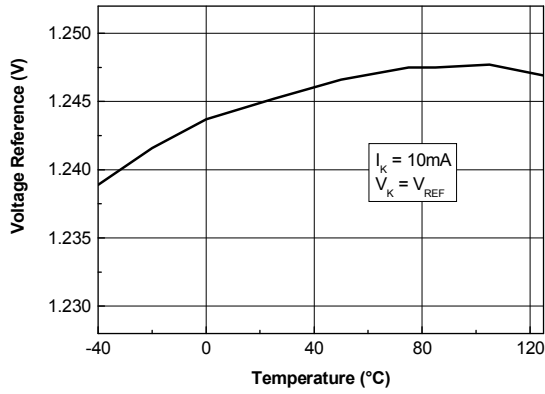


Figure 3. Test circuit for  $V_K = V_{ref}$

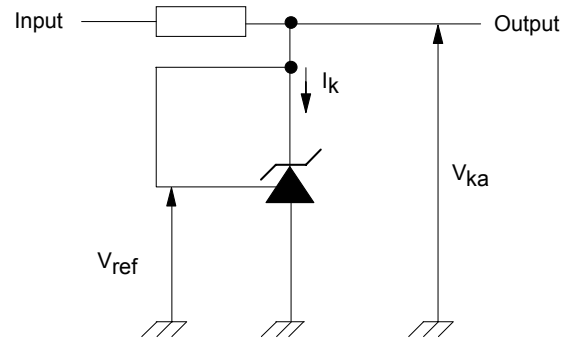


Figure 4. Cathode voltage vs. cathode current

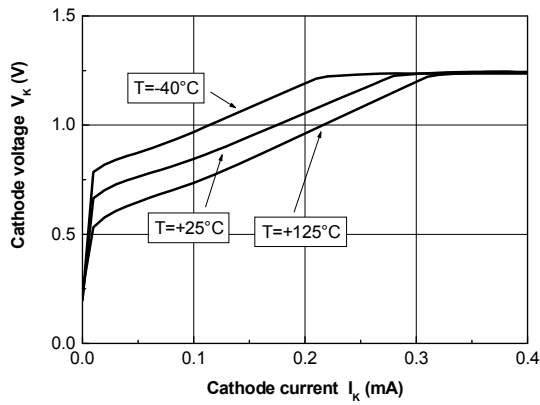


Figure 5. Minimum operating current vs. temperature

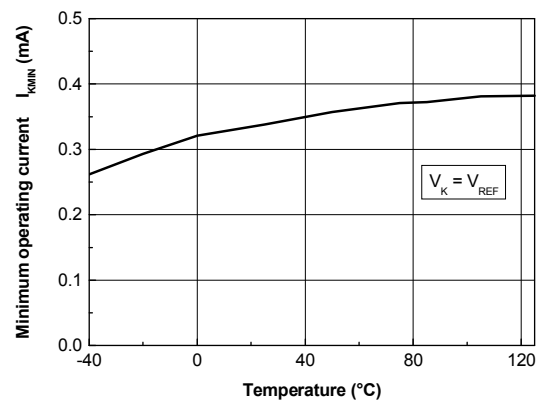


Figure 6. Reference input current vs. temperature

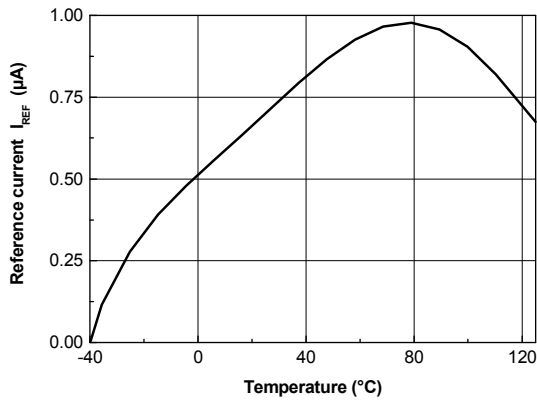


Figure 7. Dynamic impedance vs. frequency

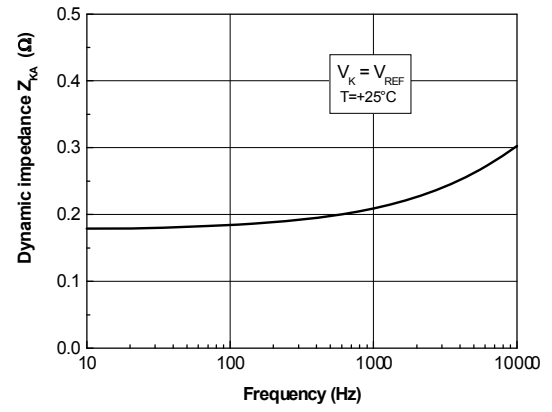


Figure 8. Off-state current vs. temperature

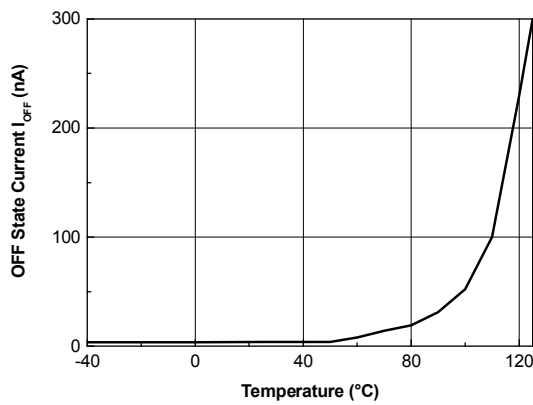
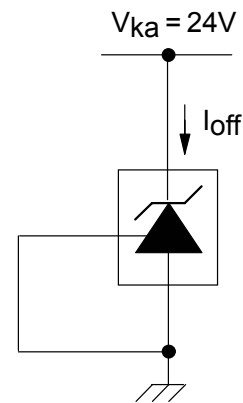
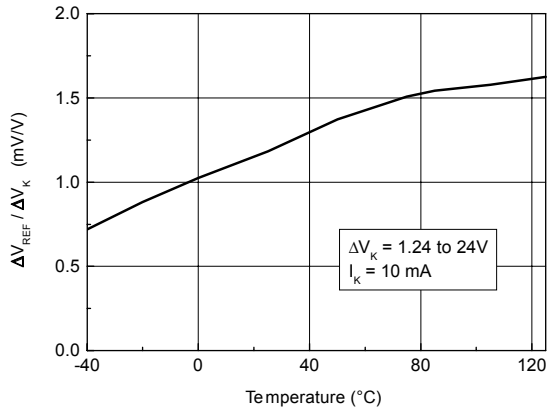


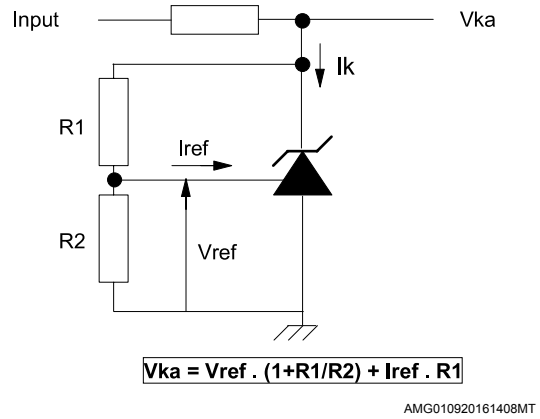
Figure 9. Test circuit for off-state current measurement



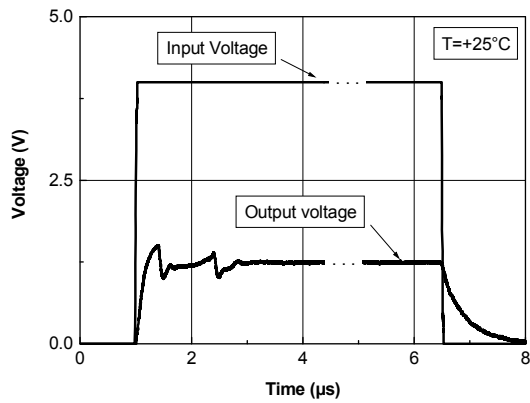
**Figure 10. Ratio of change in reference input voltage to change in  $V_{KA}$  voltage vs. temperature**



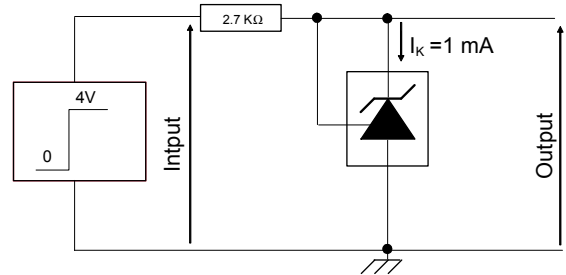
**Figure 11. Test circuit for  $V_K > V_{REF}$**



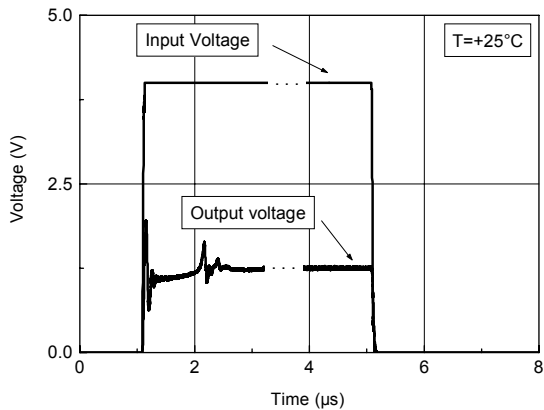
**Figure 12. Pulse response at  $I_K = 1$  mA**



**Figure 13. Test circuit for pulse response at  $I_K = 10$  mA**



**Figure 14. Pulse response at  $I_K = 10$  mA**



**Figure 15. Test circuit for pulse response at  $I_K = 10$  mA**

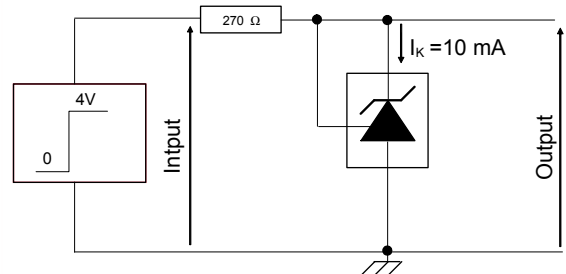


Figure 16. Phase and gain vs. frequency

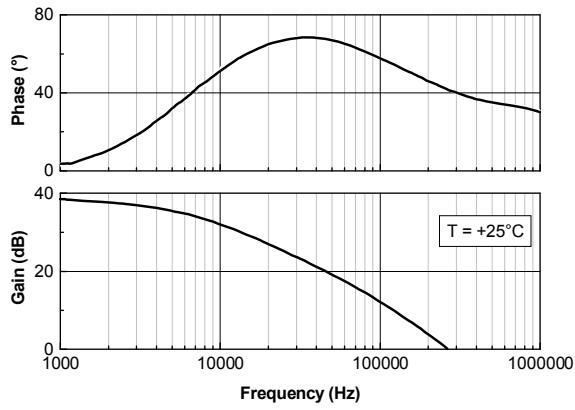


Figure 17. Equivalent input noise vs. frequency

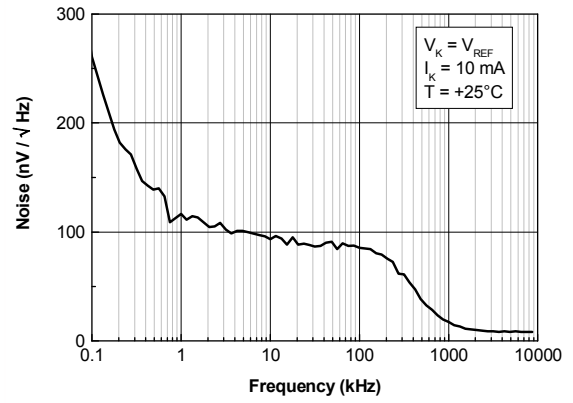
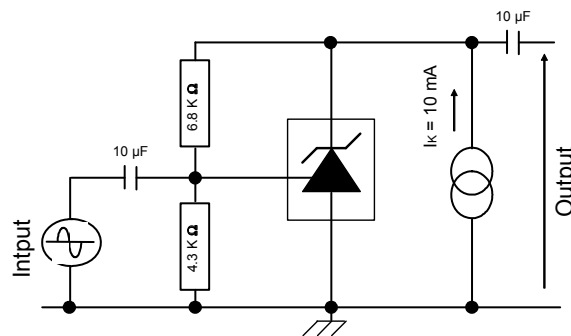


Figure 18. Test circuit for phase and gain measurement





## 4 Package information

---

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

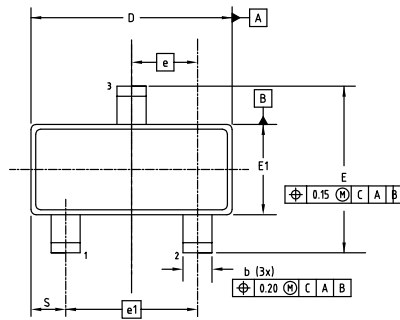
## 4.1 SOT23-3L package information

Figure 19. SOT23-3L package outline

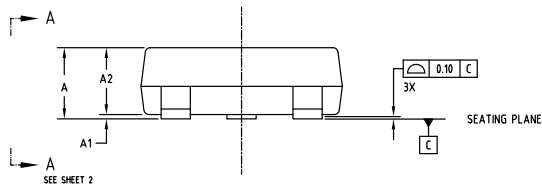
PLANT CODE : 9992

SOT23 3L PITCH 0.95

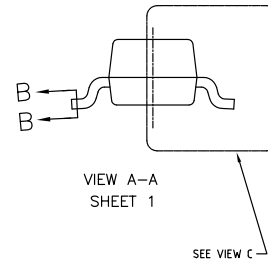
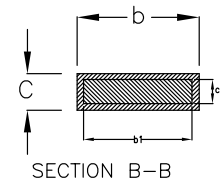
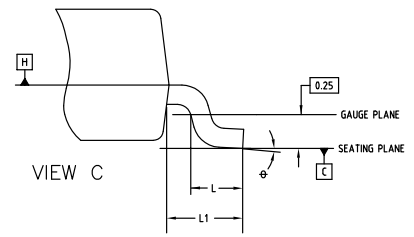
TOP VIEW



SIDE VIEW



SECTION VIEWS



7110469 rev 4.0

Table 4. SOT23-3L package mechanical data

Ref.	Dimensions		
	Min.	Typ.	Max.
A	0.89		1.12
A1	0.013		0.10
A2	0.88	0.95	1.02
b	0.37		0.50 <sup>(1)</sup>
b1	0.37	0.40	0.45 <sup>(1)</sup>
c	0.085		0.18 <sup>(2)</sup>
c1	0.085		0.16
D	2.80	2.90	3.04 <sup>(3)</sup>
E	2.10		3.04
E1	1.20	1.30	1.40 <sup>(3)</sup>
e	0.95BSC		
e1		1.90BSC	
*L <sup>(4)</sup>	0.28	0.38	0.48
L1		0.55REF	
R	0.05		
R1	0.05		
Θ	0°		8°
s	0.45		0.60

1. These dimensions apply to the flat section of the lead between 0.08 mm and 0.15 mm from the lead tip.
2. The max. value of "c" (terminal thickness) increases to 0.19 mm when Cu base leads are electroplated with Sn or SnPb.
3. Dimension D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.25 mm per side. Dimension E1 does not include interlead flash or protrusion. Interlead flash or protrusion shall not exceed 0.25 mm per side.
4. All dimensions comply with JEDEC T0-236-AB unless otherwise marked with designator " \* ".

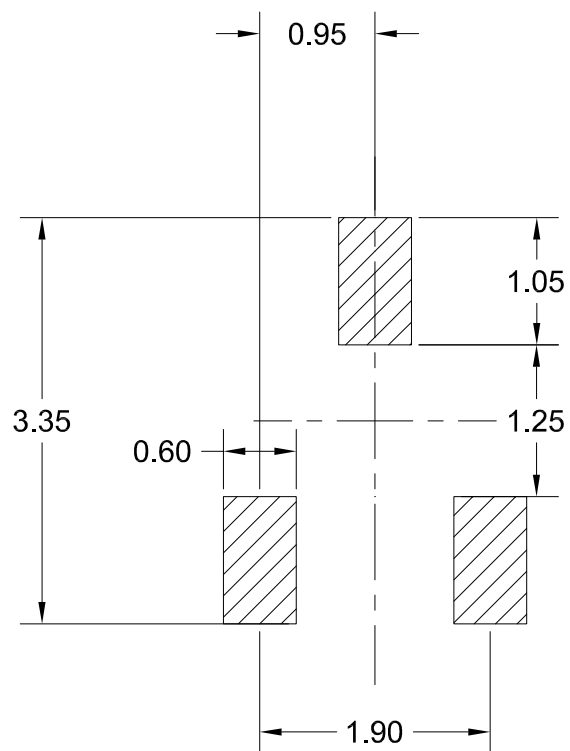
Note: Standard for thermally enhanced plastic small outline transistor. Dimension and tolerance conform to ASME Y14.5M-1994. All dimensions are in millimeters. All angles are in degrees.

Figure 20. SOT23-3L recommended footprint

FOOTPRINT SUGGESTED

PLANT CODE : 9992

SOT23 3L PITCH 0.95



## 5 Device summary

**Table 5. Order code**

Order code	Temperature range	Package	Packing	Marking
TS3431ILT	-40 to + 105 °C	SOT23-3L	Tape and reel	L280
TS3431AILT				L281
TS3431BILT				L282
TS3431CILT				L283

## 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: – CI version added in Table 5: Order code. – Rthjc information added in Table 1: Absolute maximum ratings (AMR). – Test condition added in electrical characteristics Table 3.
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 Table 3 on page 5.
04-Dec-2017	5	Updated the title and Section 4.1: SOT23-3L package information. Minor text changes.
27-Jun-2018	6	Updated: Figure 10. Ratio of change in reference input voltage to change in $V_{KA}$ voltage vs. temperature and Figure 11. Test circuit for $V_K > V_{REF}$ .
29-May-2019	7	Updated: $I_{REF}$ values in <a href="#">Section 3 Electrical characteristics</a> .

---

## Contents

<b>1</b>	<b>Diagram</b> .....	<b>2</b>
<b>2</b>	<b>Maximum ratings</b> .....	<b>3</b>
<b>3</b>	<b>Electrical characteristics</b> .....	<b>4</b>
<b>3.1</b>	<b>Performance characteristics</b> .....	<b>4</b>
<b>4</b>	<b>Package information</b> .....	<b>9</b>
<b>4.1</b>	<b>SOT23-3L package information</b> .....	<b>10</b>
<b>5</b>	<b>Device summary</b> .....	<b>13</b>
	<b>Revision history</b> .....	<b>14</b>

## List of tables

<b>Table 1.</b>	Absolute maximum ratings . . . . .	3
<b>Table 2.</b>	Operating conditions . . . . .	3
<b>Table 3.</b>	Electrical characteristics . . . . .	4
<b>Table 4.</b>	SOT23-3L package mechanical data . . . . .	11
<b>Table 5.</b>	Order code . . . . .	13
<b>Table 6.</b>	Document revision history . . . . .	14



## List of figures

Figure 1.	Block diagram . . . . .	2
Figure 2.	Reference voltage vs. temperature . . . . .	5
Figure 3.	Test circuit for $V_K = V_{ref}$ . . . . .	5
Figure 4.	Cathode voltage vs. cathode current . . . . .	5
Figure 5.	Minimum operating current vs. temperature . . . . .	5
Figure 6.	Reference input current vs. temperature . . . . .	6
Figure 7.	Dynamic impedance vs. frequency . . . . .	6
Figure 8.	Off-state current vs. temperature . . . . .	6
Figure 9.	Test circuit for off-state current measurement . . . . .	6
Figure 10.	Ratio of change in reference input voltage to change in $V_{KA}$ voltage vs. temperature . . . . .	7
Figure 11.	Test circuit for $V_K > V_{REF}$ . . . . .	7
Figure 12.	Pulse response at $I_K = 1$ mA. . . . .	7
Figure 13.	Test circuit for pulse response at $I_K = 10$ mA. . . . .	7
Figure 14.	Pulse response at $I_K = 10$ mA. . . . .	7
Figure 15.	Test circuit for pulse response at $I_K = 10$ mA. . . . .	7
Figure 16.	Phase and gain vs. frequency. . . . .	8
Figure 17.	Equivalent input noise vs. frequency . . . . .	8
Figure 18.	Test circuit for phase and gain measurement . . . . .	8
Figure 19.	SOT23-3L package outline. . . . .	10
Figure 20.	SOT23-3L recommended footprint . . . . .	12