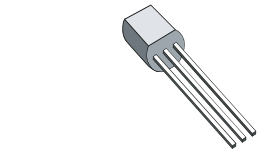
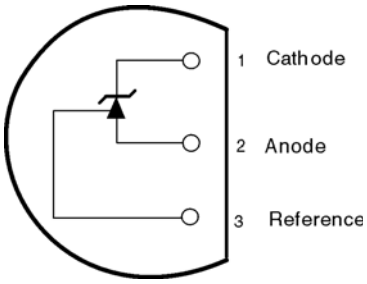
TS431

Low voltage adjustable shunt reference

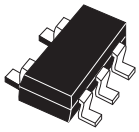
Datasheet - production data

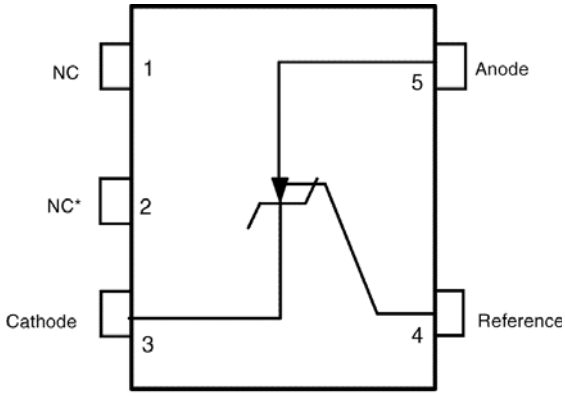
Z
TO92
(Plastic package)





L
SOT23-5
(Plastic micropackage)





Features

- Low voltage operation: 1.24 to 6 V
- 2 %, 1 % and 0.5 % voltage precision
- Wide operating range cathode current: 60 µA to 30 mA
- Low output impedance: 0.2 Ω
- Typically stable for any capacitive loads
- ESD protection:
  - Human body model: 2 kV
  - Machine model: 200 V
- 100 ppm/°C temperature coefficient
- Automotive grade version available

Description

The TS431 is a low-voltage, three-terminal, programmable shunt voltage reference. The output voltage can be set to any value between V_{ref} (1.24 V) and 6 V using two external resistors. The TS431 is able to operate at a lower voltage (1.24 V) and lower cathode current than the widely-used TL431 and TL1431 shunt voltage reference. When driving an optocoupler, the TS431 is particularly suitable for regulating 3.3 V switching power supplies.

This is information on a product in full production. www.st.com

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{KA}	Cathode to anode voltage	10	V
I_k	Continuous cathode current range	-20 to +40	mA
I_{ref}	Reference input current range	-0.05 to +3	mA
P_d	Power dissipation(1) TO92 package SOT23-5 package	 625 500	mW
T_{stg}	Storage temperature range	-65 to +150	°C

1. $T_{junction}$ = 150 °C, T_{amb} = 25 °C with
R_{thJA} = 200 °C/W for TO92 package and
R_{thJA} = 250 °C/W for SOT23-5L package

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{KA}	Cathode to anode voltage	1.24 to 6	V
I_k	Cathode current (1)	0.06 to 30	mA
T_{oper}	Operating free air temperature range	-40 to +125	°C

1. Please refer to *Section 3: Application information* for more details.

2 Electrical characteristics

Table 3. T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{ref}	Output voltage $V_{KA} = V_{ref}$ @ I_k = 100µA	TS431 TS431A TS431B	1.215 1.228 1.234	1.240	1.265 1.252 1.246	V
ΔV_{ref}	Output voltage change (1) (2) I_k = 100µA, $V_{KA} = V_{ref}$	0 < T_{amb} < +70°C -40 < T_{amb} < +85°C -40 < T_{amb} < +105°C -40 < T_{amb} < +125°C			9 16 18 21	mV
$\left\lvert\frac{\Delta Vref}{\Delta Vka}\right\rvert$	Ratio of change in reference input voltage to change in cathode to anode voltage	I_k = 10mA V_{KA} = 6V to V_{ref}		1.8	2.7	mV/V
I_{ref}	Reference input current	I_k = 10mA		70	160	nA
ΔI_{ref}	Reference input current deviation over temperature range	I_k=10mA, R_1=10kΩ, R_2=∞ -40 < T_{amb} < +85°C -40 < T_{amb} < +125°C		70 90	160 240	nA
I_{min}	Minimum cathode current for regulation	$V_{KA} = V_{ref}$		40	60	µA
I_{off}	Off-state cathode current	V_{KA} = 6V, V_{ref} = 0		0.001	0.1	µA
R_{KA}	Static impedance	$V_{KA} = V_{ref}$, I_k = 0.1 to 15mA		0.2	0.4	Ω

1. Limits are 100% production tested at 25°C. Behavior at the temperature range limits is guaranteed through correlation and by design.
2. See definition below.

2.1 Definition of output voltage change over temperature range

ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range.

$$\Delta V_{ref} = V_{ref\ max} - V_{ref\ min}$$

Figure 1. Output voltage change over temperature range

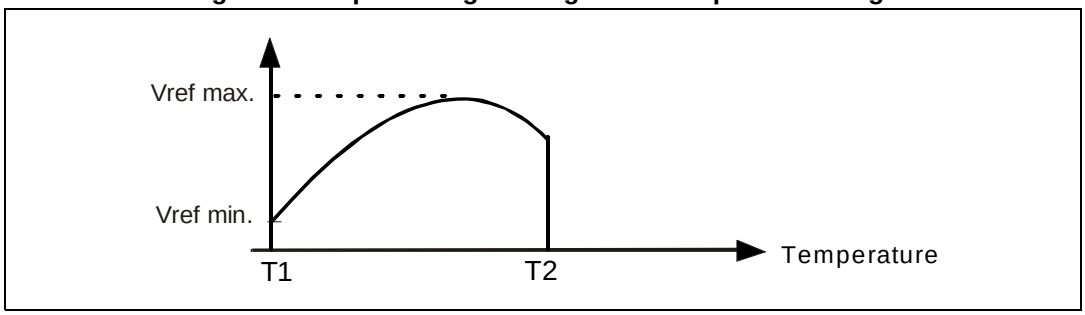


Figure 2. Reference voltage vs. temperature

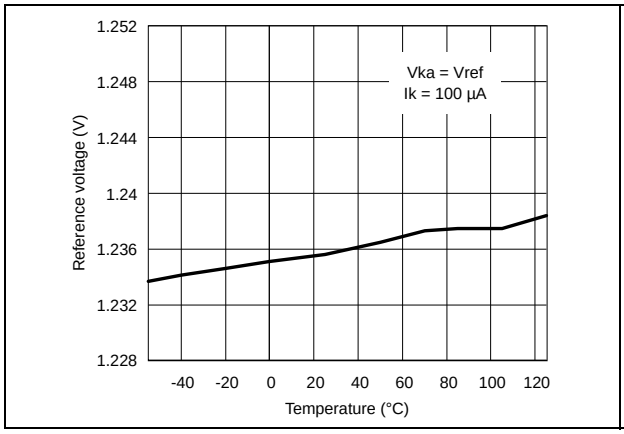


Figure 3. Test circuit for $V_{KA} = V_{ref}$

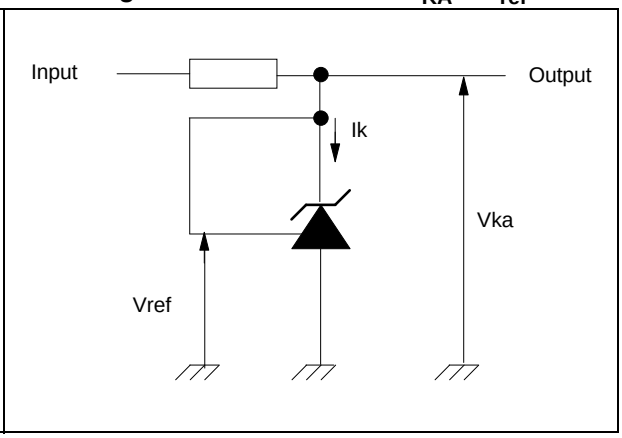


Figure 4. Cathode voltage vs. cathode current

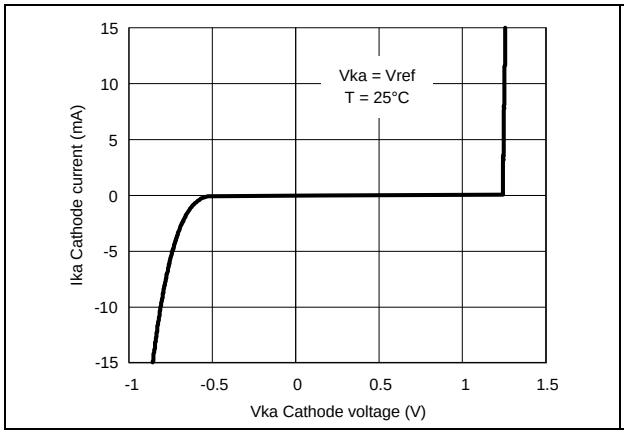


Figure 5. Cathode voltage vs. cathode current

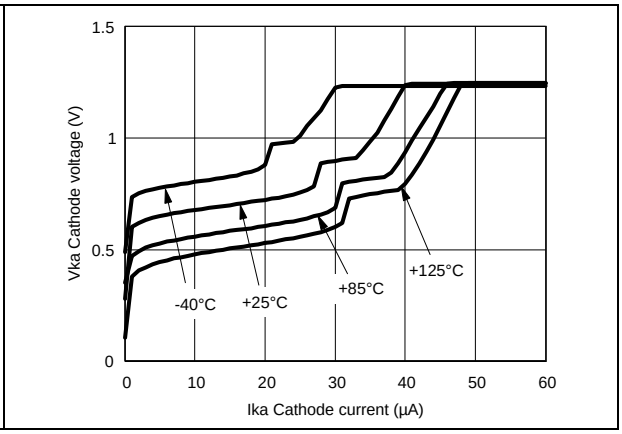


Figure 6. Reference input current vs. temperature

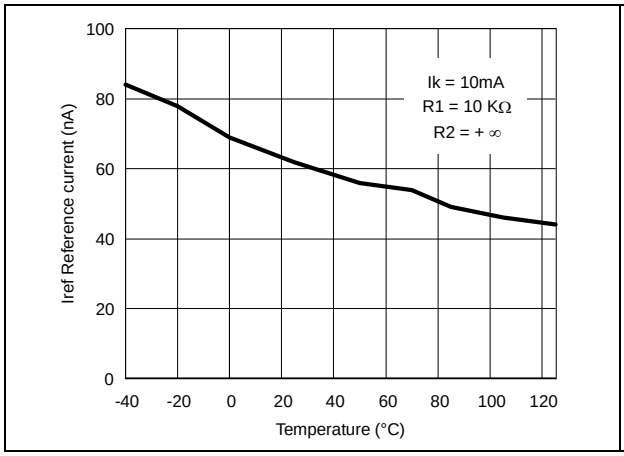


Figure 7. Static impedance vs. temperature

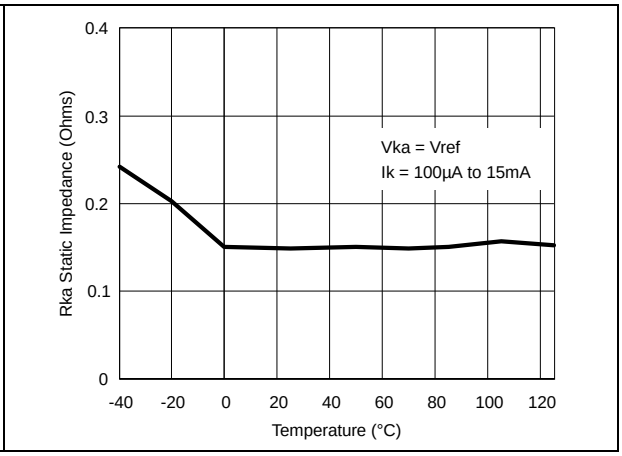


Figure 8. Off-state current vs. temperature

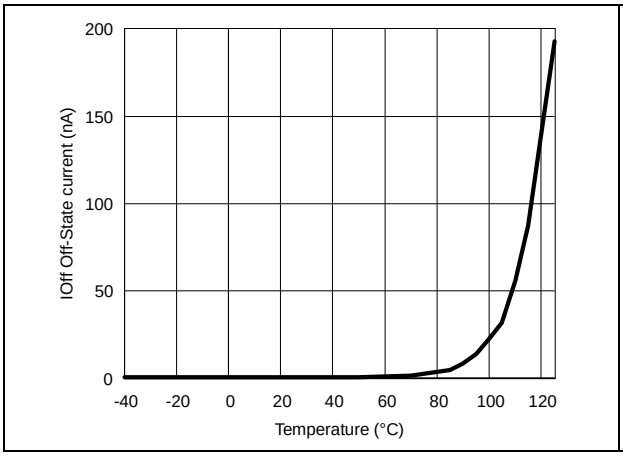


Figure 9. Test circuit for off-state current measurement

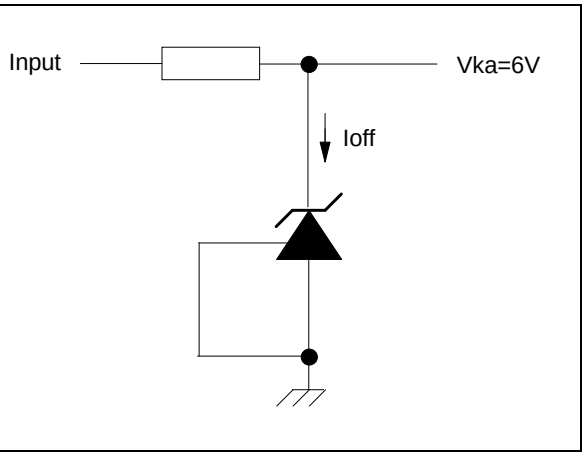


Figure 10. Ratio of change in reference input voltage to change in V_{KA} voltage vs. temperature

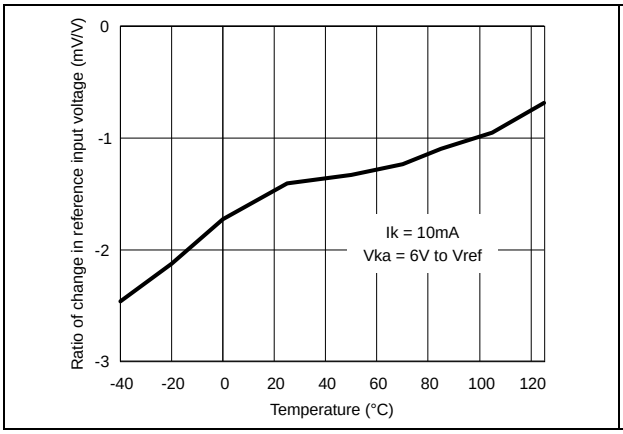


Figure 11. Test circuit for $V_{KA} > V_{ref}$

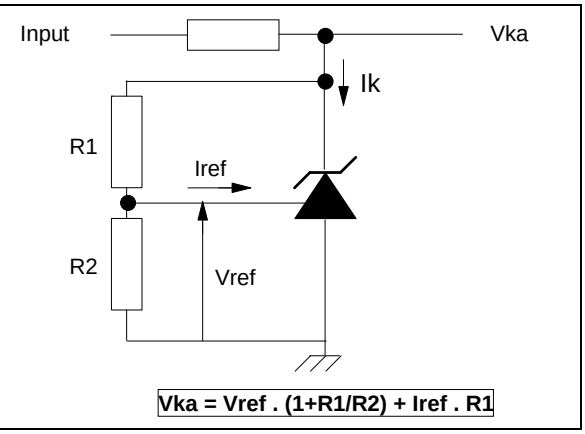


Figure 12. Phase and gain vs. frequency

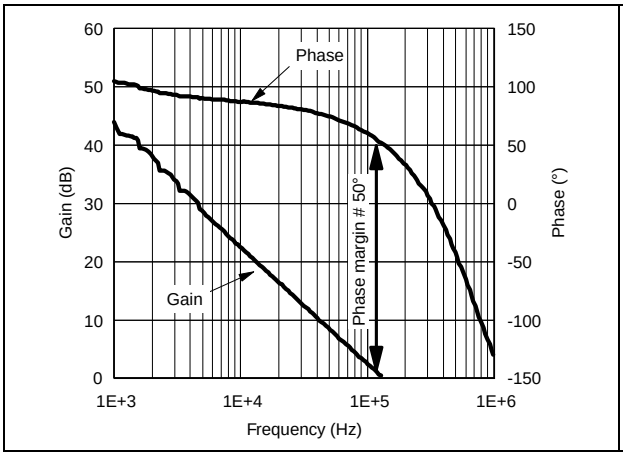


Figure 13. Test circuit for phase and gain measurement

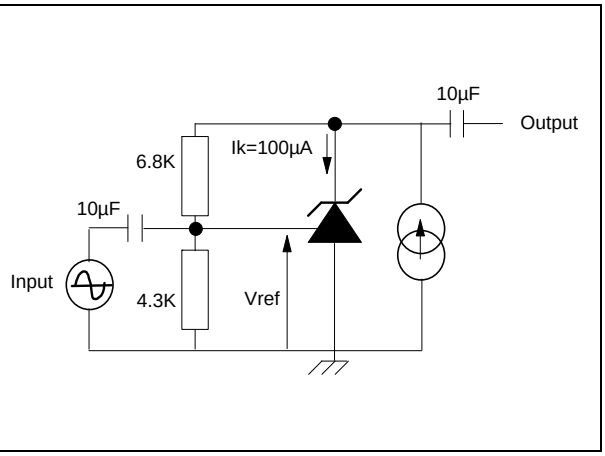


Figure 14. Pulse response at I_k = 100 µA

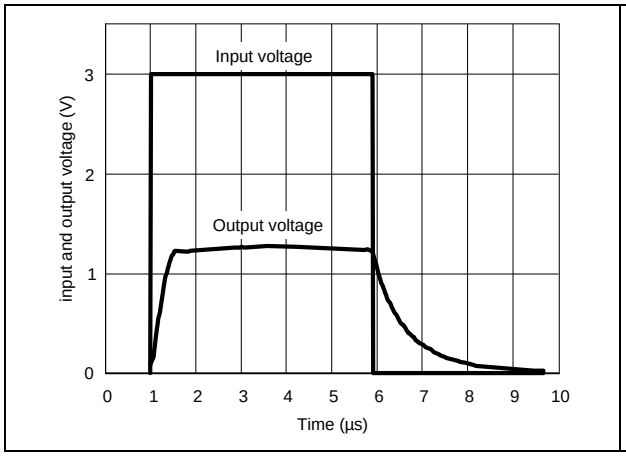


Figure 15. Test circuit for pulse response at I_k = 100 µA

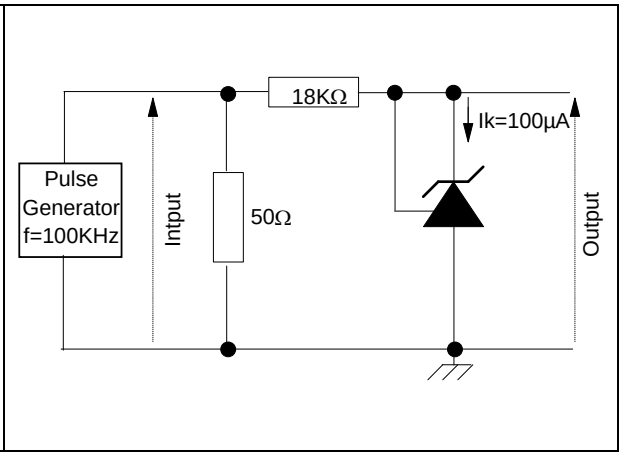


Figure 16. Pulse response at I_k = 1mA

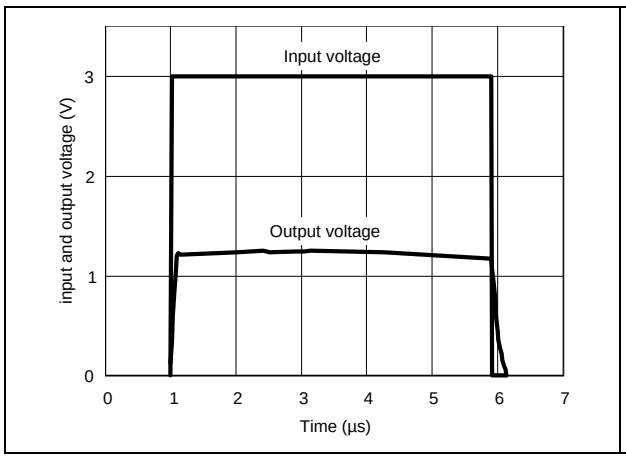


Figure 17. Test circuit for pulse response at I_k = 1 mA

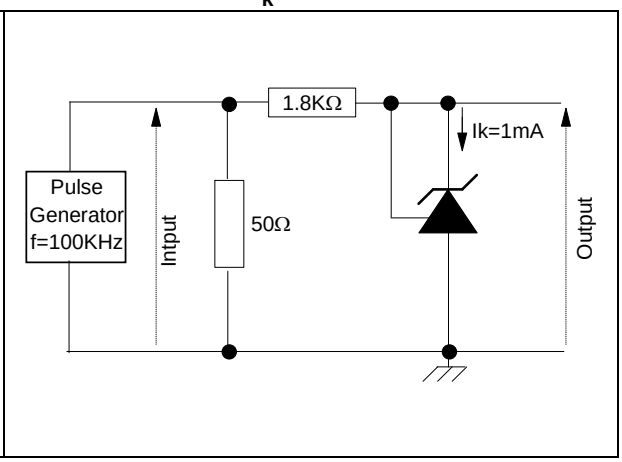
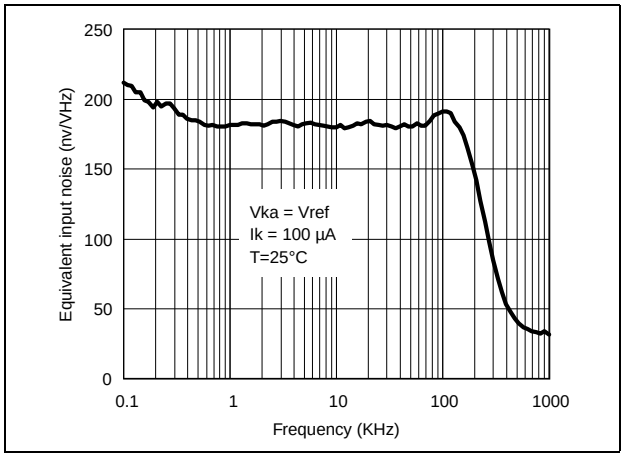


Figure 18. Equivalent input noise vs. frequency



3 Application information

The TS431 is a general-purpose low-power programmable shunt voltage reference, capable of operating with a cathode current as low as 60 µA and up to 30 mA.

The main static parameters of the TS431 voltage reference are specified in *Table 3*.

Since the TS431 is designed for general-purpose applications with a broad range of cathode currents, voltages and loads, when designing with the device in applications requiring fast dynamic response (turn-on/off and/or pulsed load conditions) it should be considered that upon application of power, the time required for the V_{KA} voltage to reach its final value within a specified error range depends on several factors, among which the temperature, cathode current and capacitive load inrush current are the most influential. The dynamic response of the device to fast turn-on/off, load and temperature changes is optimized when the cathode current is not in the lower end of the operating range (I_K > 500 µA).

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*. ECOPACK® is an ST trademark.

Table 4. SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	0.035		0.057
A1	0.00		0.15	0.00		0.006
A2	0.90		1.30	0.035		0.051
b	0.35		0.50	0.014		0.02
C	0.09		0.20	0.003		0.008
D	2.80		3.00	0.110		0.118
H	2.60		3.00	0.102		0.118
E	1.50		1.75	0.059		0.069
e		0.95			0.037	
e1		1.9			0.075	
L	0.35		0.55	0.014		0.022

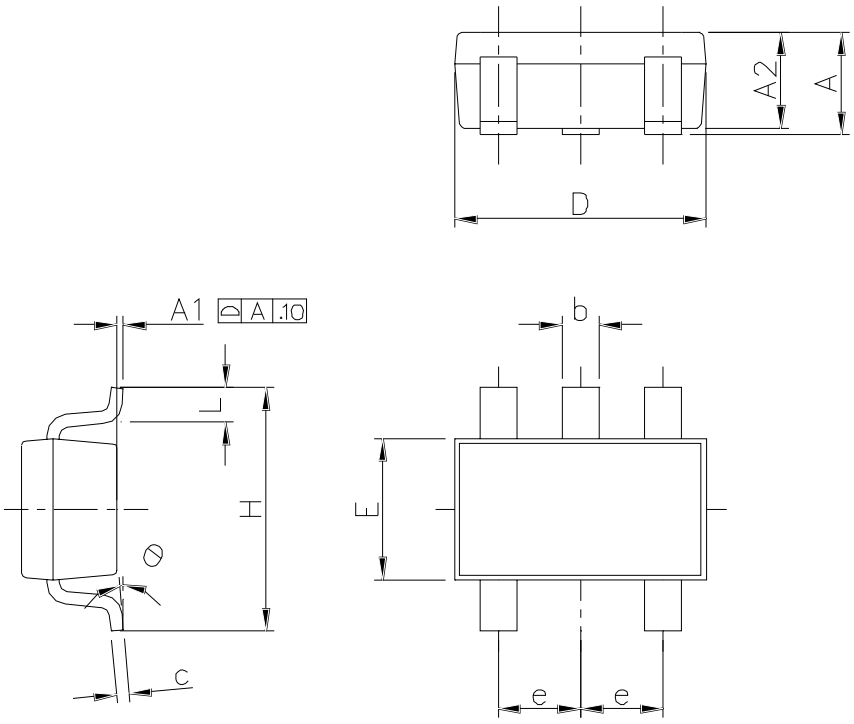
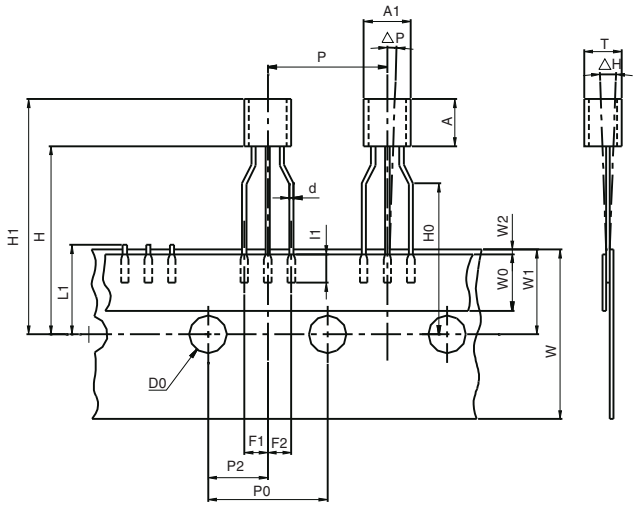
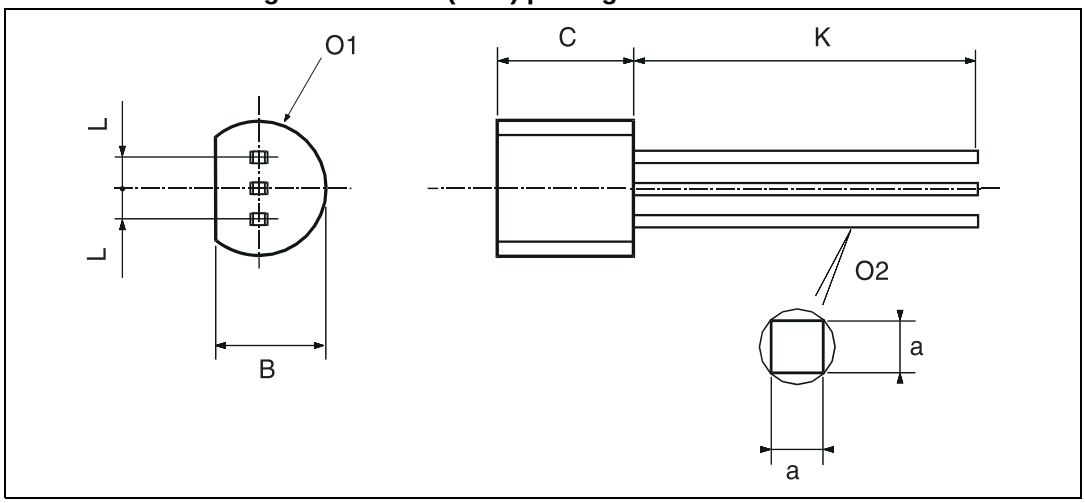


Figure 19. TO92 (tape ammopack and tape and reel) package data



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
I1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔP	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

Figure 20. TO92 (bulk) package mechanical data



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
L		1.27			0.05	
B	3.2	3.7	4.2	0.126	0.1457	0.1654
O1	4.45	5.00	5.2	0.1752	0.1969	0.2047
C	4.58	5.03	5.33	0.1803	0.198	0.2098
K	12.7			0.5		
O2	0.407	0.5	0.508	0.016	0.0197	0.02
a	0.35			0.0138		

5 Ordering information

Table 5. Order codes

Order codes	Temperature range	Packages	Packing	Marking
TS431ILT	-40°C, + 125°C	ΣOT23−5	Tape and reel	L272
TS431AILT				L271
TS431BILT				L270
TS431IYLT (1)		ΣOT23−5 (automotive grade level)		L274
TS431AIYLT (1)				L276
TS431BIYLT (1)				L273
TS431IZ/IZT/IZ-AP		TO92	Bulk (Z), Tape and reel (ZT) or Ammo pack (AP)	TS431I
TS431AIZ/AIZT/AIZ-AP				TS431AI
TS431BIZ/BIZT/BIZ-AP				TS431BI

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

6 Revision history

Table 6. Document revision history

Date	Revision	Changes
1-Sep-2003	1	Initial release.
1-Oct-2005	2	PPAP references inserted in the datasheet. See the order codes table. Minor changes to formatting and grammar.
2-Jan-2006	3	TS431AIYLT PPAP reference inserted. See the order codes table.
22-Sep-2006	4	Included footnote on automotive grade qualification to order codes table. Updated package information (changed mils to inches).
25-Apr-2007	5	Resized graphics on cover page. Moved definition of output voltage change from *Table 3* footnote to separate section below table. Corrected errors in SOT23-5 package mechanical data. Removed erroneous drawing for TO92 tape & reel package.
30-Aug-2007	6	Updated drawing for TO92 bulk package. Modified footnote related to automotive grade qualification in *Table 5: Order codes*, and re-ordered order codes.
27-Aug-2010	7	Modified note for package SOT23-5 on page 1.
15-Nov-2012	8	Modified note 1 *Table 5 on page 12*.
17-Dec-2012	9	Added note 1 *Table 2 on page 2* and *Section 3 on page 7*.
12-Mar-2013	10	Added features Automotive grade version available in cover page.

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