TS431

Low voltage adjustable shunt reference

Features

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

Description

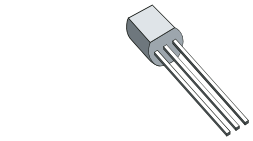
The TS431 is a low-voltage, three-terminal, programmable shunt voltage reference.

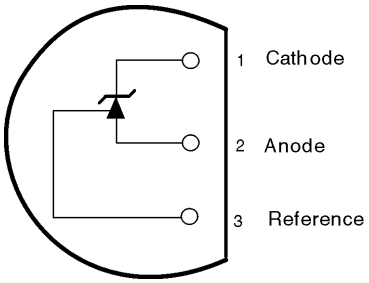
The output voltage can be set to any value between V_{ref} (1.24V) and 6V with two external resistors.

The TS431 is able to operate at a lower voltage (1.24V) and lower cathode current than the widely used TL431 and TL1431 shunt voltage reference.

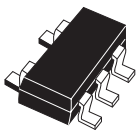
When driving an optocoupler, the TS431 is particularly useful for regulating 3.3V switching power supplies.

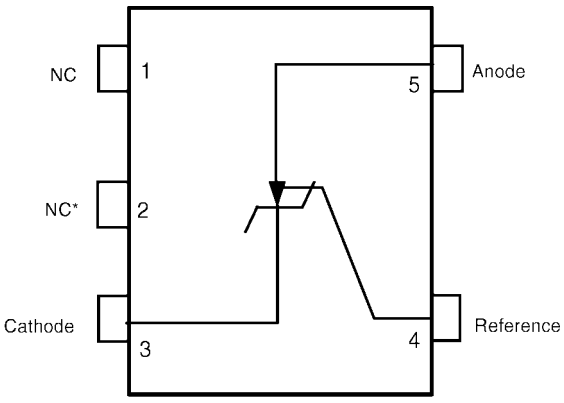
Z
TO92
(Plastic package)





L
SOT23-5
(Plastic micropackage)





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_{THj-a}=200°C/W for TO92 package and R_{THj-a}=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	0.06 to 30	mA
T_{oper}	Operating free air temperature range	-40 to +125	°C

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.

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

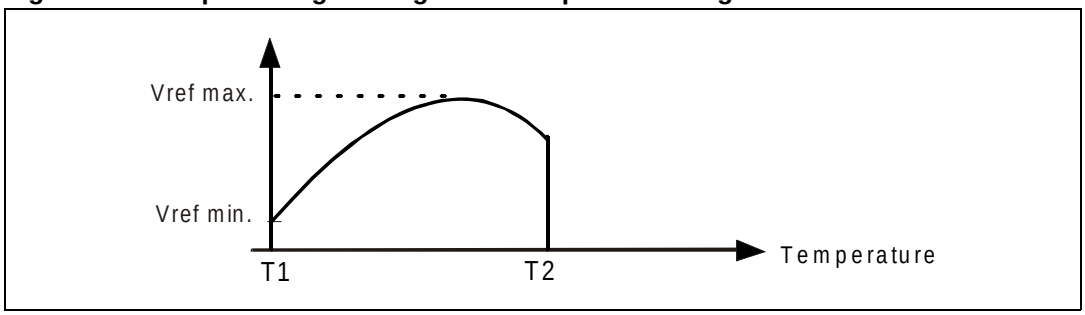


Figure 2. Reference voltage vs. temperature

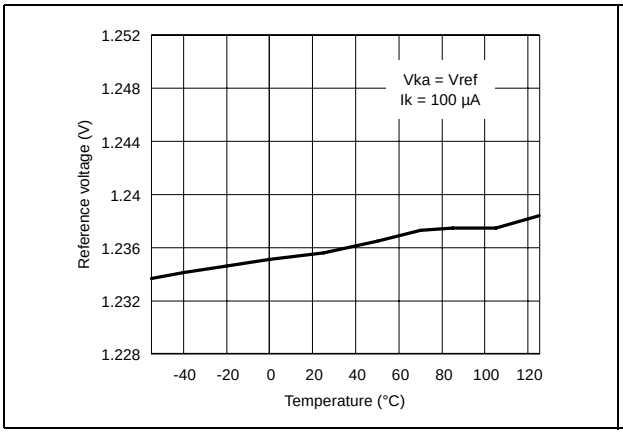


Figure 3. Test circuit for $V_{KA} = V_{ref}$

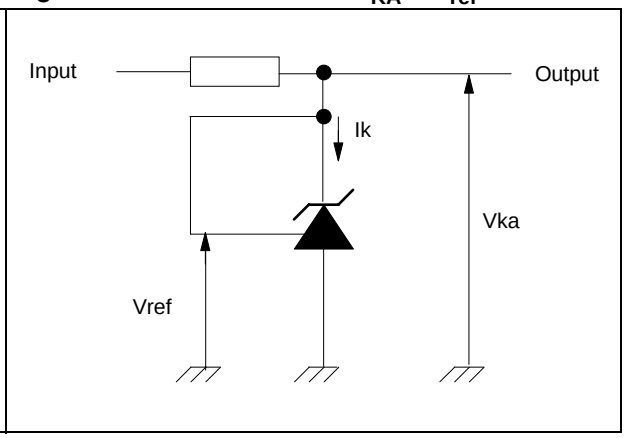


Figure 4. Cathode voltage vs. cathode current

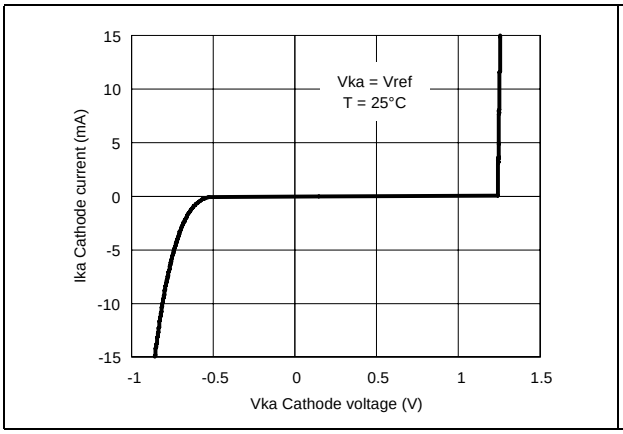


Figure 5. Cathode voltage vs. cathode current

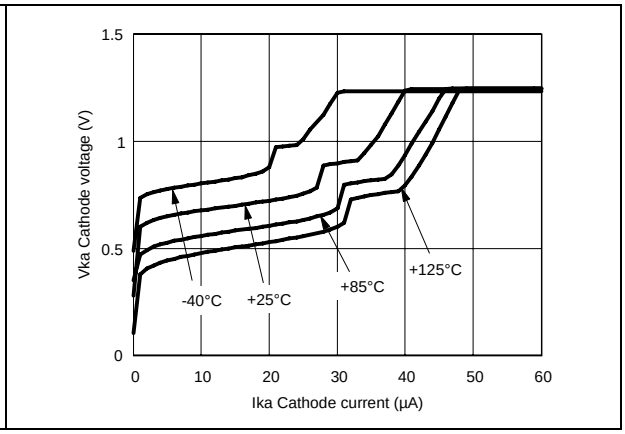


Figure 6. Reference input current vs. temperature

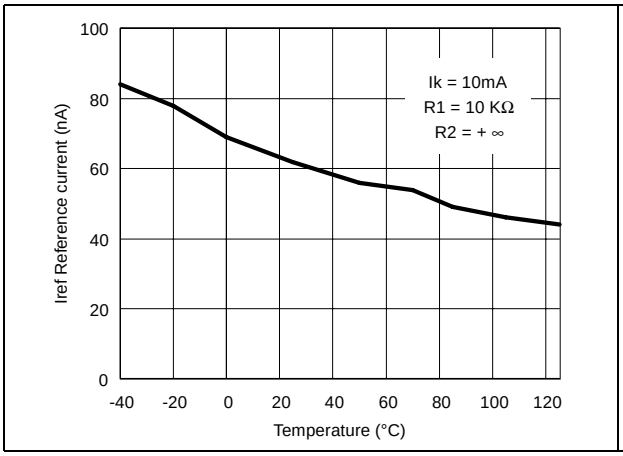


Figure 7. Static impedance vs. temperature

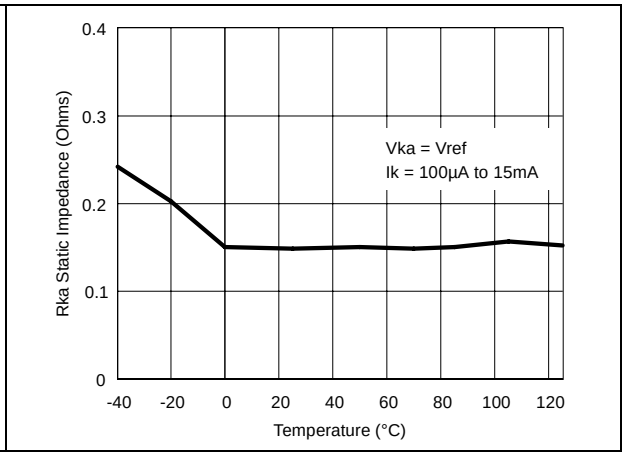


Figure 8. Off-state current vs. temperature

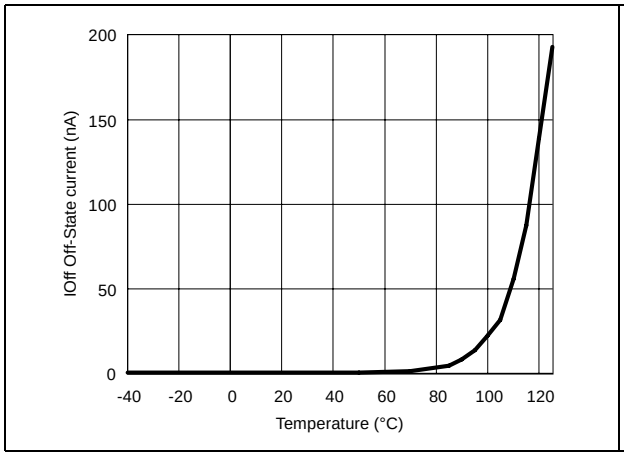


Figure 9. Test circuit for off-state current measurement

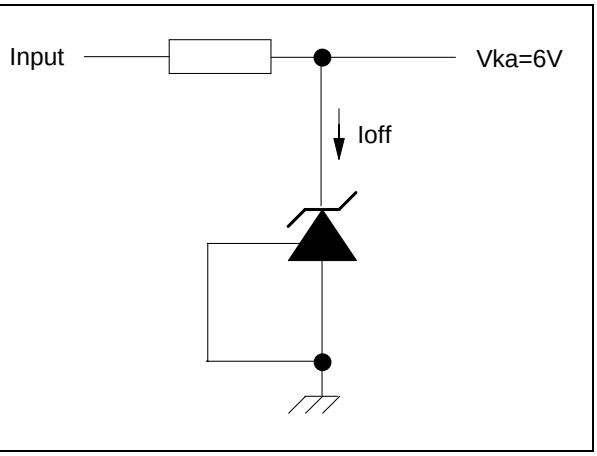


Figure 10. Ratio of change in reference input voltage to change in V_{KA} voltage vs. temperature

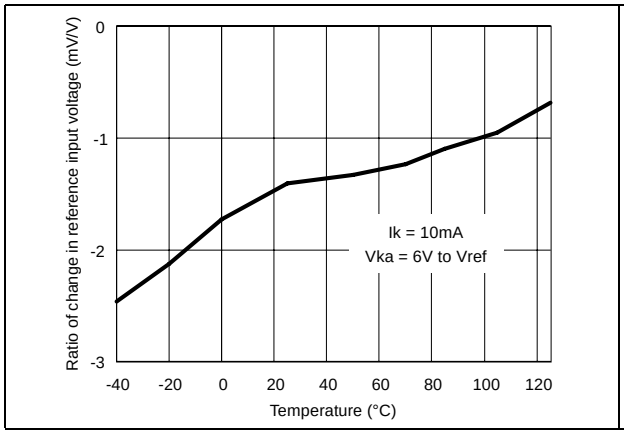


Figure 11. Test circuit for $V_{KA} > V_{ref}$

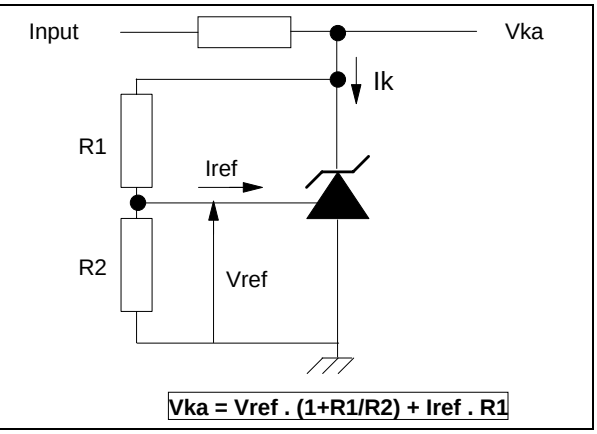


Figure 12. Phase and gain vs. frequency

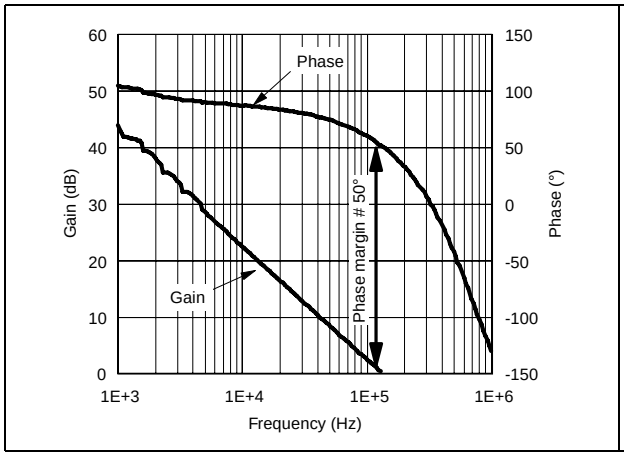


Figure 13. Test circuit for phase and gain measurement

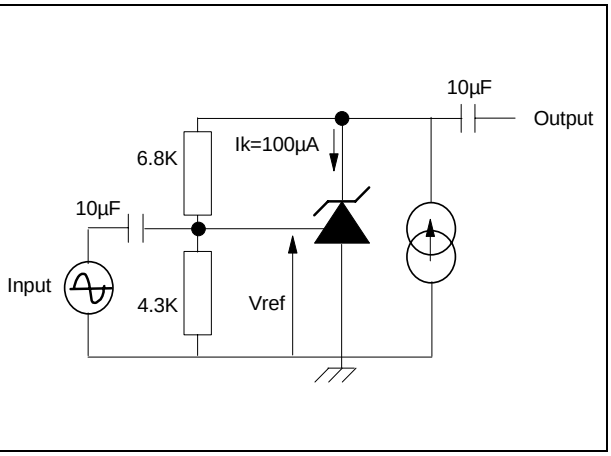


Figure 14. Pulse response at I_k=100µA

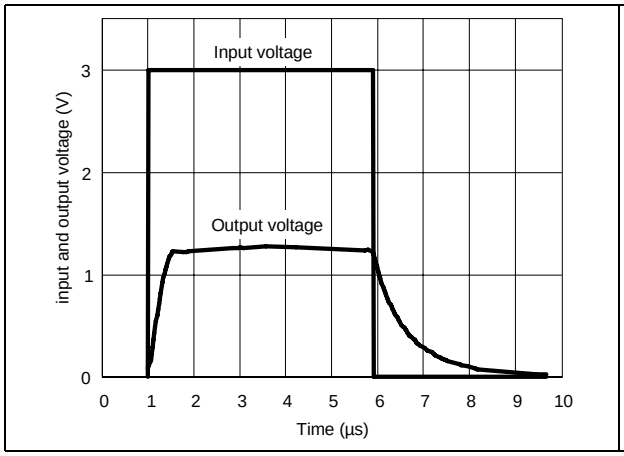


Figure 15. Test circuit for pulse response at I_k=100µA

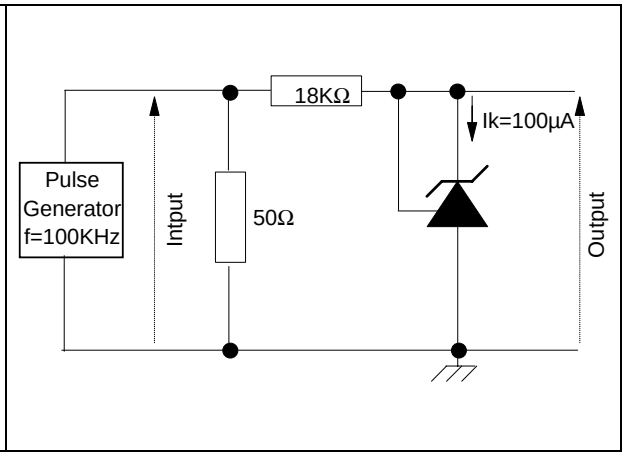


Figure 16. Pulse response at I_k=1mA

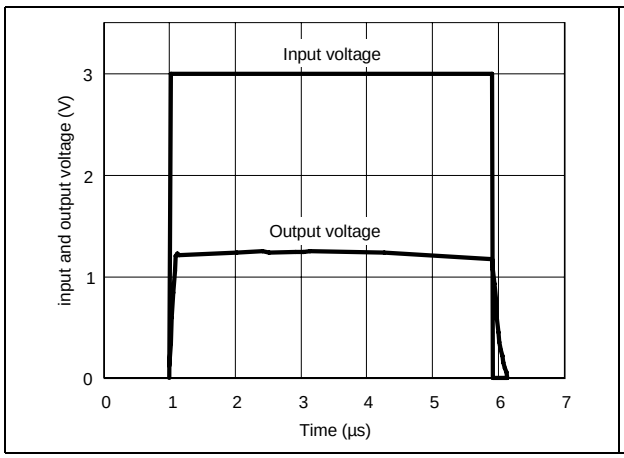


Figure 17. Test circuit for pulse response at I_k=1mA

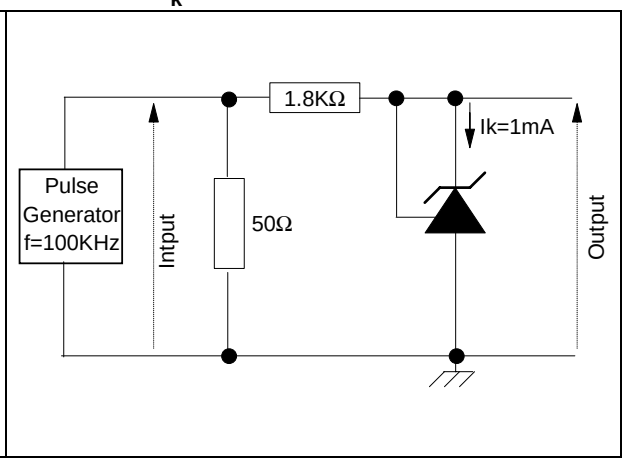
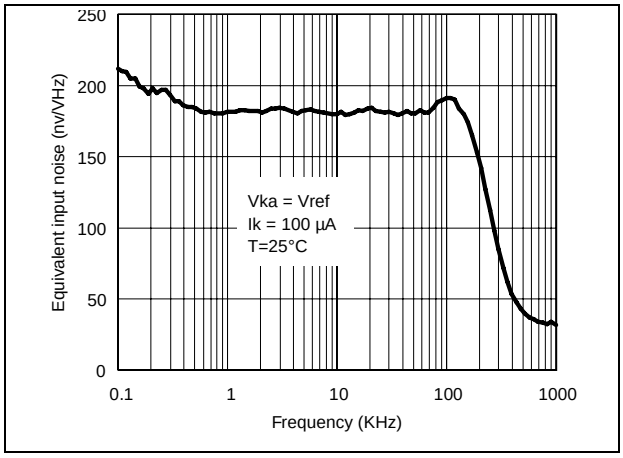


Figure 18. Equivalent input noise vs. frequency

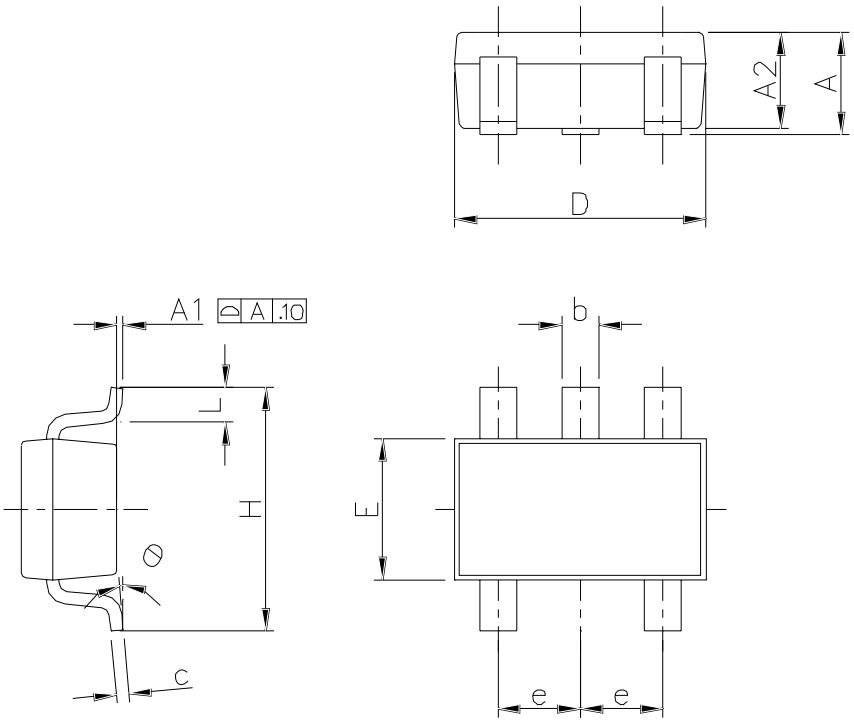


3 Package information

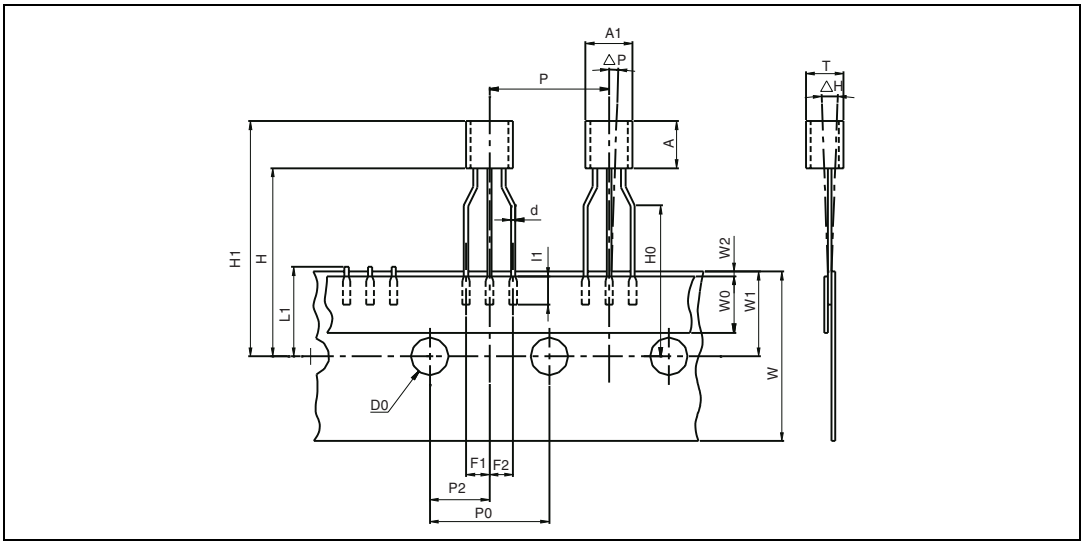
In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. 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.

3.1 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

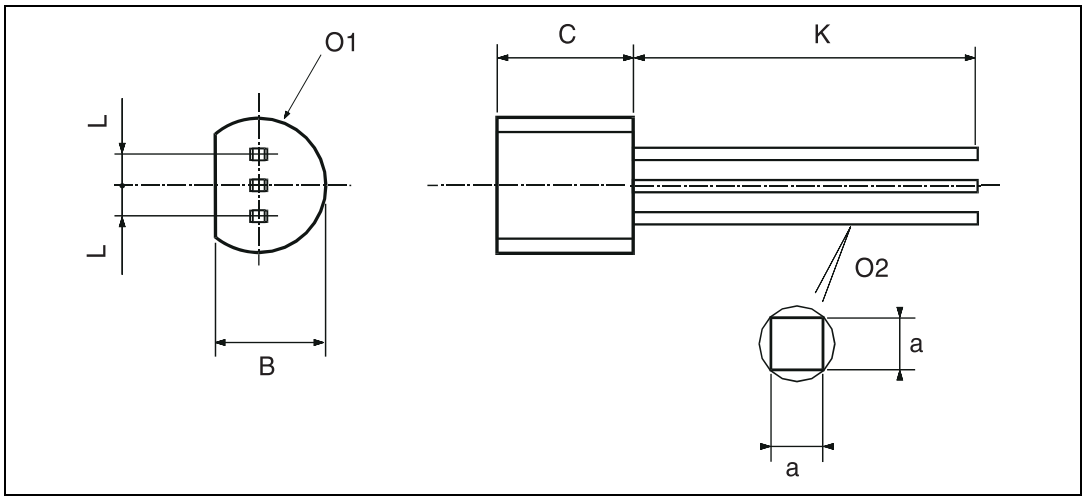


3.2 TO92 (tape ammo pack and tape & reel) package data



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

3.3 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		

4 Ordering information

Table 4. Order codes

Part number	Temperature range	Package	Packing	Marking
TS431ILT	-40°C, + 125°C	SOT23-5	Tape & reel	L272
TS431AILT				L271
TS431BILT				L270
TS431IYLT(1)		SOT23-5 (automotive grade level)		L274
TS431AIYLT(1)				L276
TS431BIYLT(1)				L273
TS431IZ/IZT/IZ-AP		TO92	Bulk (Z), Tape & 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 are on-going.

5 Revision history

Table 5. 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 4: Order codes*, and re-ordered order codes.

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