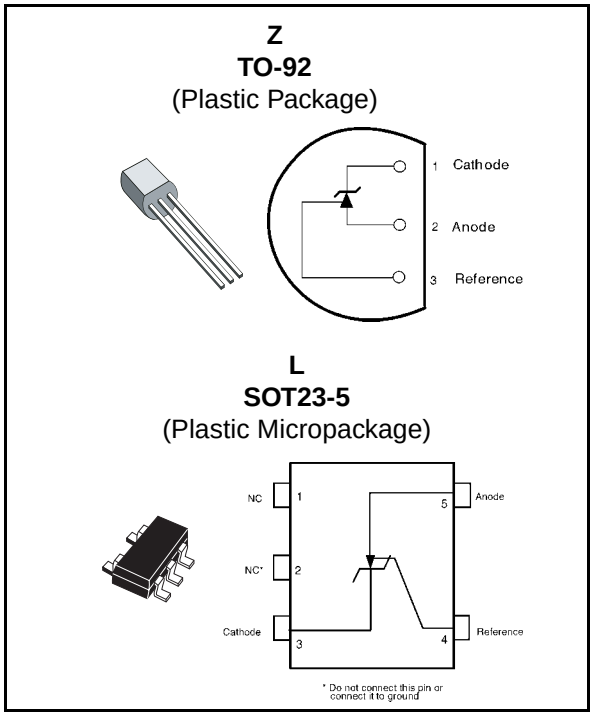
TS431

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



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

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.

Part number	Temperature range	Package	Packing	Marking
TS431ILT	-40, + 125°C	SOT23-5	Tape & reel	L272
TS431AILT				L271
TS431AIYLT(1)		SOT23-5 (automotive grade level)		L276
TS431BILT		SOT23-5		L270
TS431BIYLT(1)		SOT23-5 (automotive grade level)		L273
TS431IYLT(1)		SOT23-5 (automotive grade level)		L274
TS431IZ/IZT/IZ-AP		TO-92	Bulk (Z), Tape & reel (ZT) or Ammo pack (AP)	TS431I
TS431AIZ/AIZT/AIZ-AP				TS431AI
TS431BIZ/BIZT/BIZ-AP				TS431BI

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

Contents

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_{std}	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. Limits over temperature are guaranteed through correlation and by design.
2. ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range. $\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min.}$

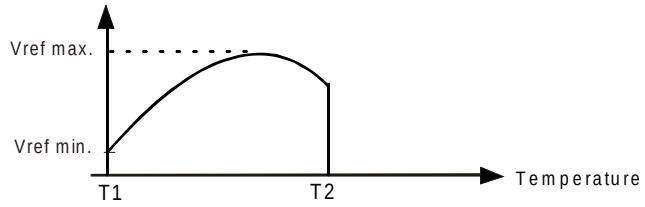


Figure 1. Reference voltage vs. temperature

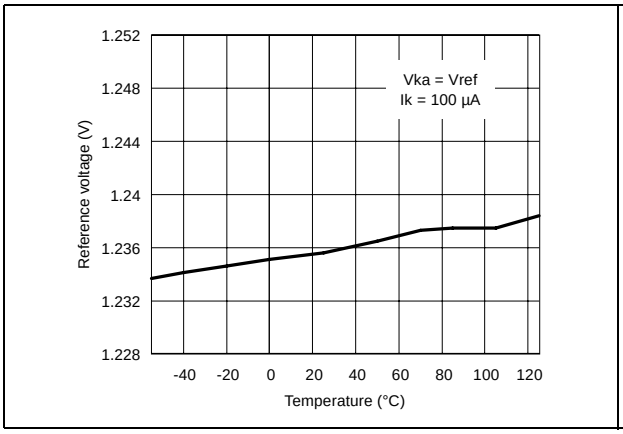


Figure 2. Test circuit for Vka = Vref

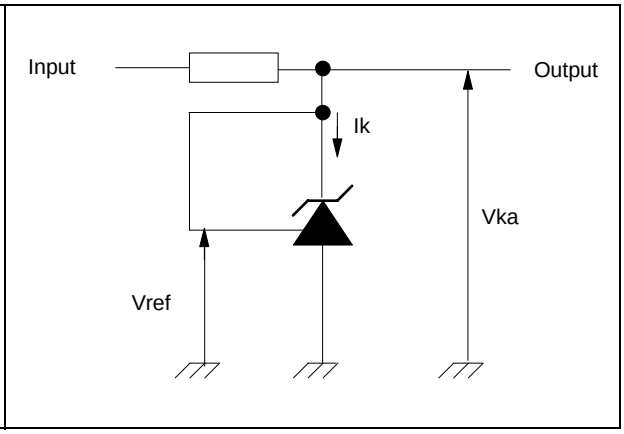


Figure 3. Cathode voltage vs. cathode current

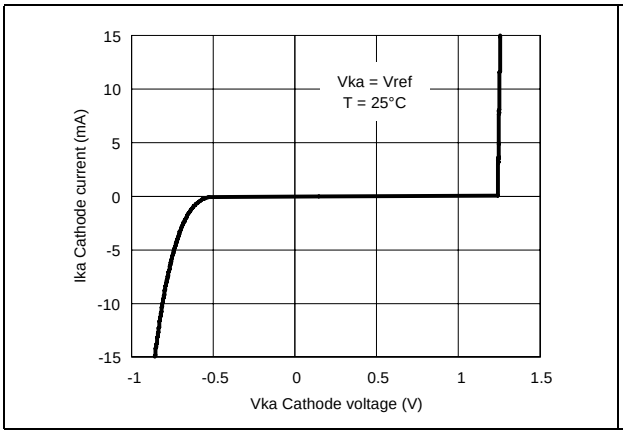


Figure 4. Cathode voltage vs. cathode current

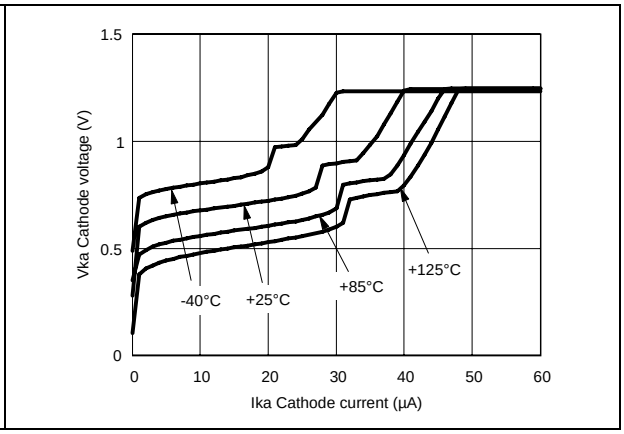


Figure 5. Reference input current vs. temperature

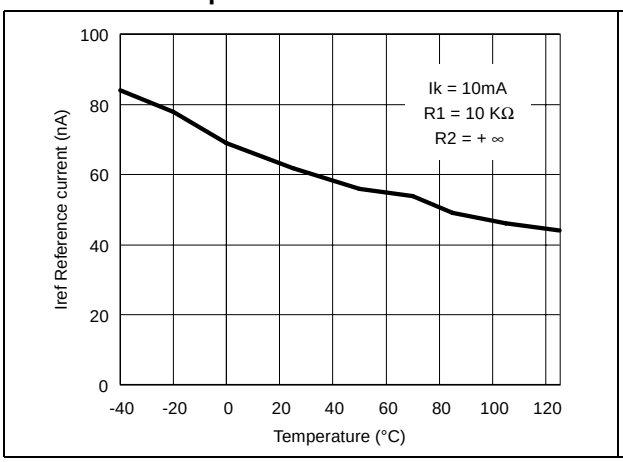


Figure 6. Static impedance vs. temperature

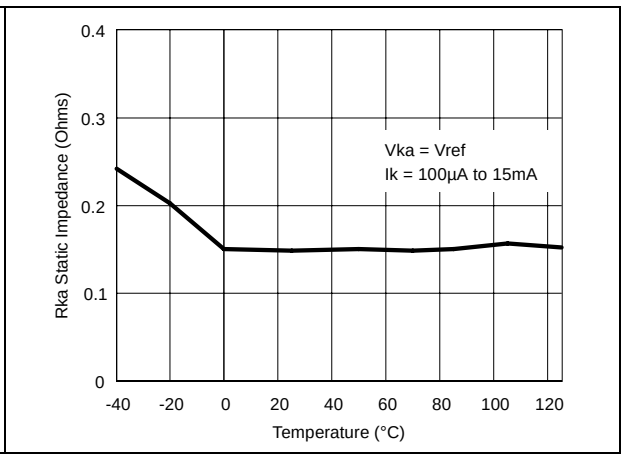


Figure 7. Off-state current vs. temperature

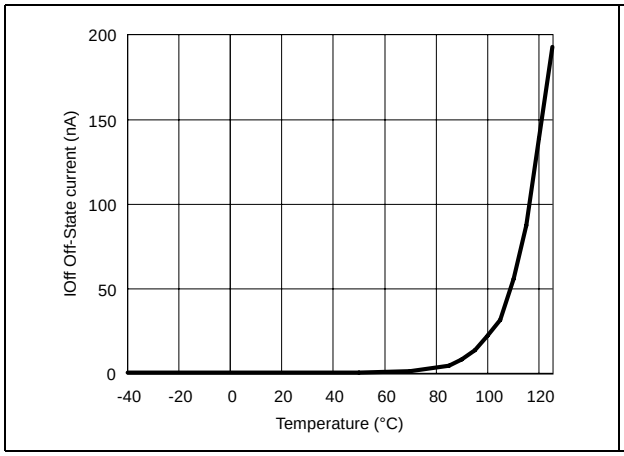


Figure 8. Test circuit for off-state current measurement

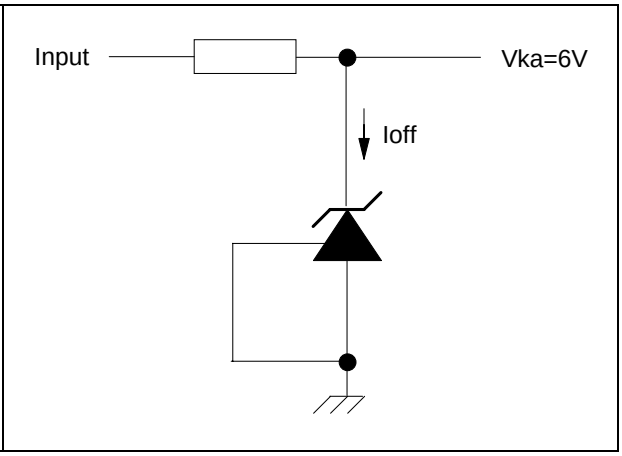


Figure 9. Ratio of change in reference input voltage to change in Vka voltage vs. temperature

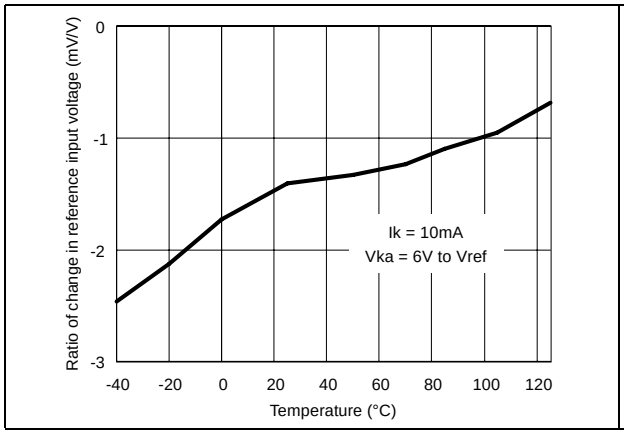


Figure 10. Test circuit for Vka > Vref

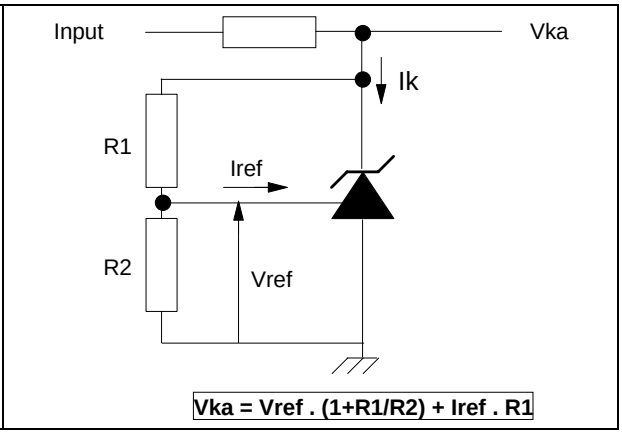


Figure 11. Phase and gain vs. frequency

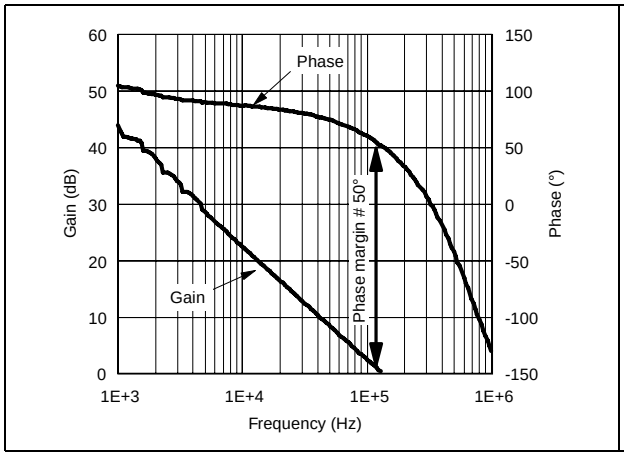


Figure 12. Test circuit for phase and gain measurement

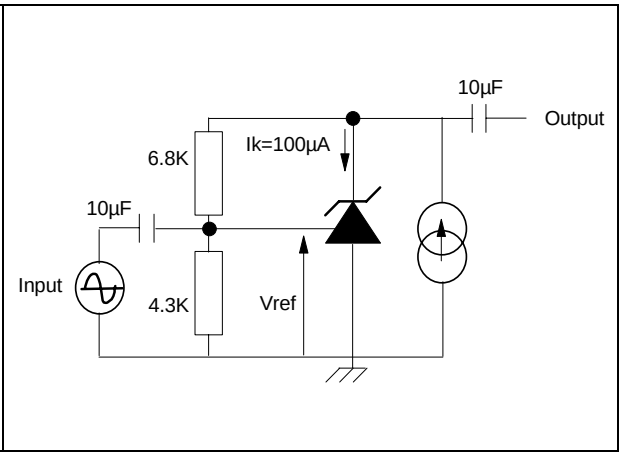


Figure 13. Pulse response at Ik=100µA

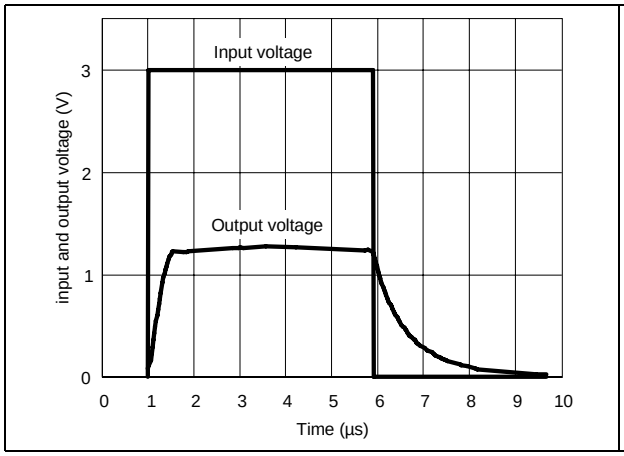


Figure 14. Test circuit for pulse response at Ik=100µA

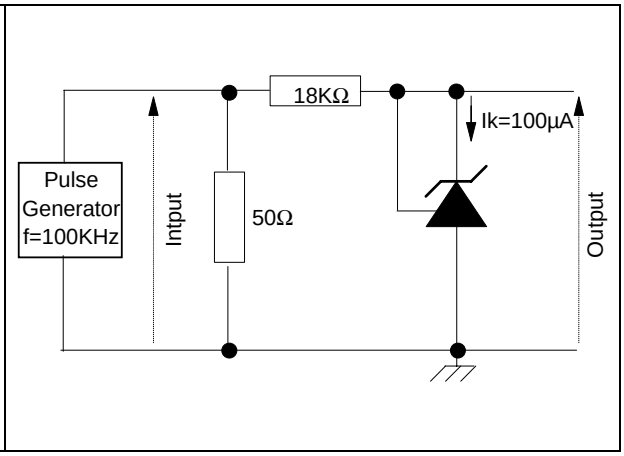


Figure 15. Pulse response at Ik=1mA

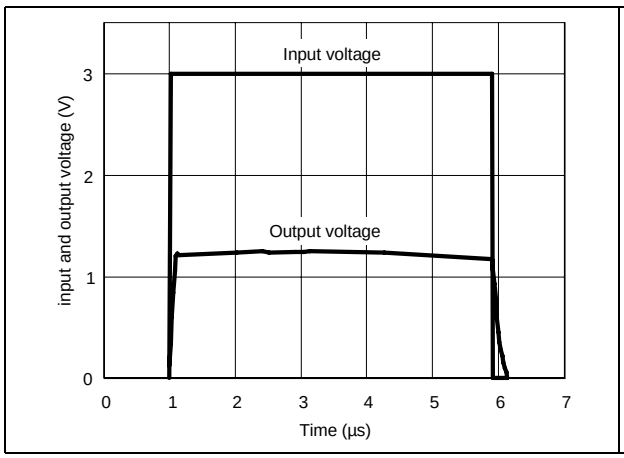


Figure 16. Test circuit for pulse response at Ik=1mA

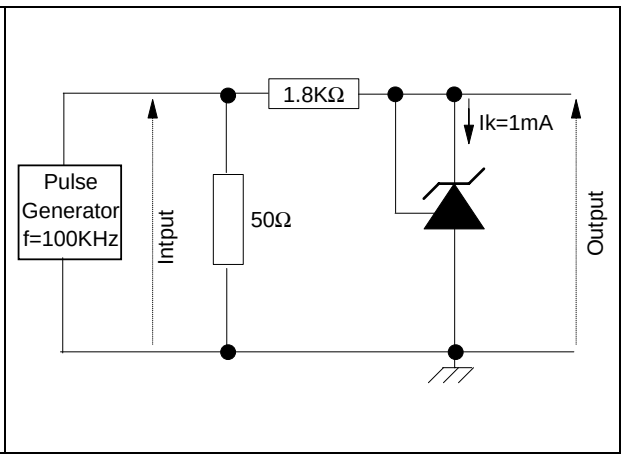
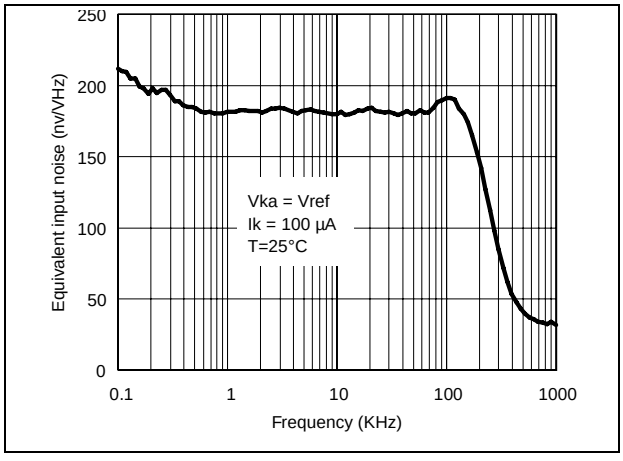


Figure 17. Equivalent input noise vs. frequency

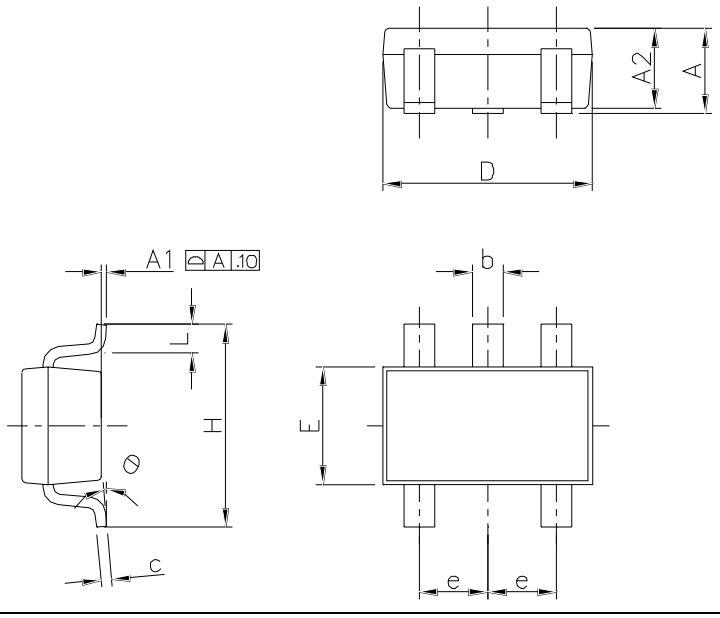


3 Package mechanical data

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.

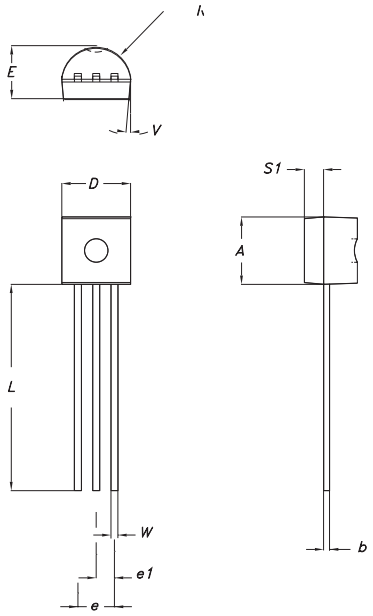
3.1 SOT23-5 package

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
E	2.60		3.00	0.102		0.118
E1	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

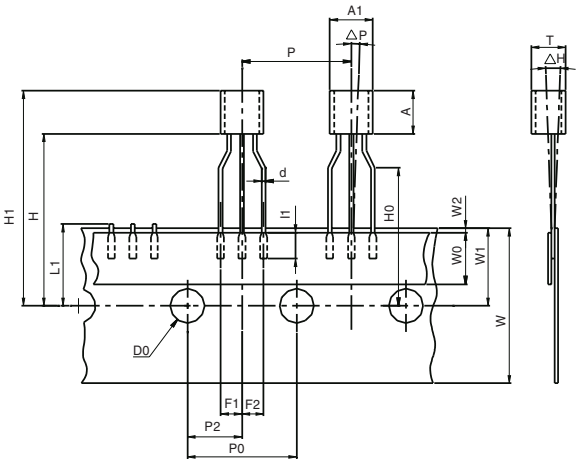


3.2 TO-92 (tape & reel) package

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.32		4.95	0.170		0.195
b	0.36		0.51	0.014		0.020
D	4.45		4.95	0.175		0.195
E	3.30		3.94	0.130		0.155
e	2.41		2.67	0.095		0.105
e1	1.14		1.40	0.045		0.055
L	12.7		15.49	0.500		0.610
R	2.16		2.41	0.085		0.095
S1	0.92		1.52	0.036		0.060
W	0.41		0.56	0.016		0.022

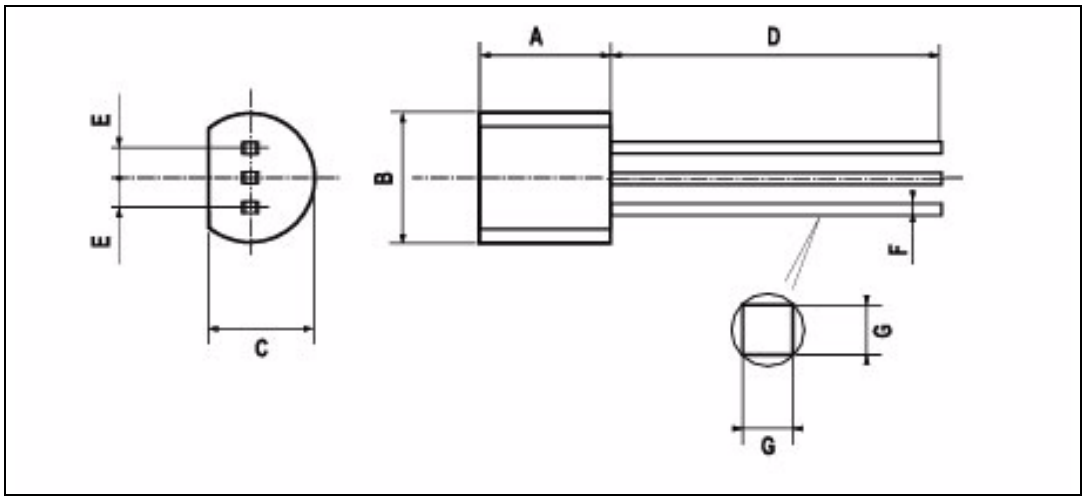


3.3 TO92 (tape ammo pack) package



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

3.4 TO92 (bulk) package



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 Revision history

Table 4. 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 on the cover page. Minor changes to formatting and grammar.
2-Jan-2006	3	TS431AIYLT PPAP reference inserted. See the order codes table on the cover page.
22-Sep-2006	4	Included footnote on automotive grade qualification to order code table on cover page. Updated package information (changed mils to inches).

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