

Low voltage adjustable shunt reference

Features

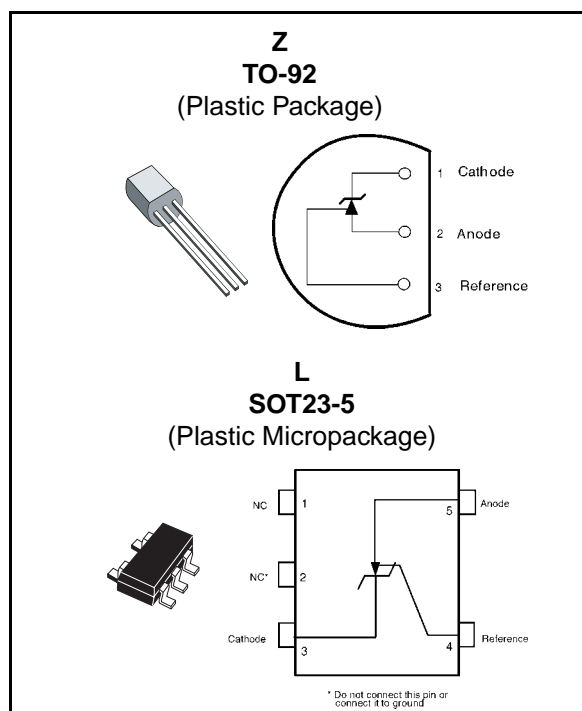
- Low voltage operation: 1.24 to 6V
- 2%, 1% and 0.5% voltage precision
- Wide operating range cathode current: 60 μ A to 30mA
- Low output impedance: 0.2 Ω
- Typically stable for any capacitive loads
- ESD protection:
 - Human body model: 2kV
 - Machine model: 200V
- 100ppm/ $^{\circ}$ C temperature 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.

Part number	Temperature range	Package	Packing	Marking	
TS431ILT	-40, + 125 $^{\circ}$ 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	3
2	Electrical characteristics	4
3	Package mechanical data	8
3.1	SOT23-5 package	9
3.2	TO-92 (tape & reel) package	10
3.3	TO92 (tape ammo pack) package	11
3.4	TO92 (bulk) package	12
4	Revision history	13

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. $T_{junction}=150^{\circ}\text{C}$, $T_{amb}=25^{\circ}\text{C}$ with
 $R_{THj-a}=200^{\circ}\text{C/W}$ for TO92 package and
 $R_{THj-a}=250^{\circ}\text{C/W}$ 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. $T_{amb} = 25^{\circ}\text{C}$ (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{ref}	Output voltage $V_{KA} = V_{ref}$ @ $I_K = 100\mu\text{A}$	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)} $I_K = 100\mu\text{A}$, $V_{KA} = V_{ref}$	$0 < T_{amb} < +70^{\circ}\text{C}$ $-40 < T_{amb} < +85^{\circ}\text{C}$ $-40 < T_{amb} < +105^{\circ}\text{C}$ $-40 < T_{amb} < +125^{\circ}\text{C}$			9 16 18 21	mV
$\frac{ \Delta V_{ref} }{ \Delta V_{KA} }$	Ratio of change in reference input voltage to change in cathode to anode voltage	$I_K = 10\text{mA}$ $V_{KA} = 6\text{V}$ to V_{ref}		1.8	2.7	mV/V
I_{ref}	Reference input current	$I_K = 10\text{mA}$		70	160	nA
ΔI_{ref}	Reference input current deviation over temperature range	$I_K=10\text{mA}$, $R_1=10\text{k}\Omega$ $R_2=\infty$ $-40 < T_{amb} < +85^{\circ}\text{C}$ $-40 < T_{amb} < +125^{\circ}\text{C}$		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	$V_{KA} = 6\text{V}$, $V_{ref} = 0$		0.001	0.1	μA
R_{KA}	Static impedance	$V_{KA} = V_{ref}$, $I_K = 0.1$ to 15mA		0.2	0.4	Ω

- Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.
- ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range.
 $\Delta V_{ref} = V_{ref \text{ max.}} - V_{ref \text{ min.}}$

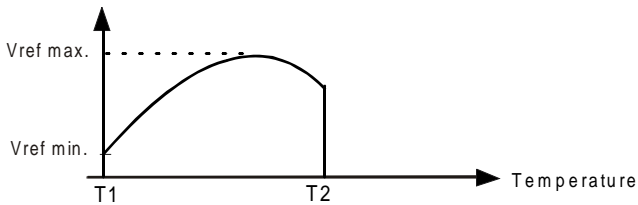


Figure 1. Reference voltage vs. temperature

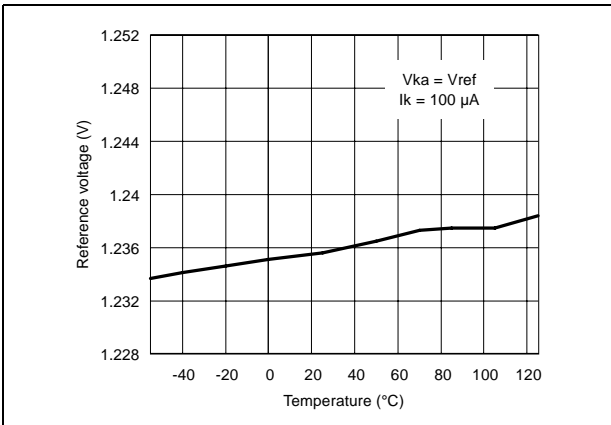


Figure 2. Test circuit for $V_{ka} = V_{ref}$

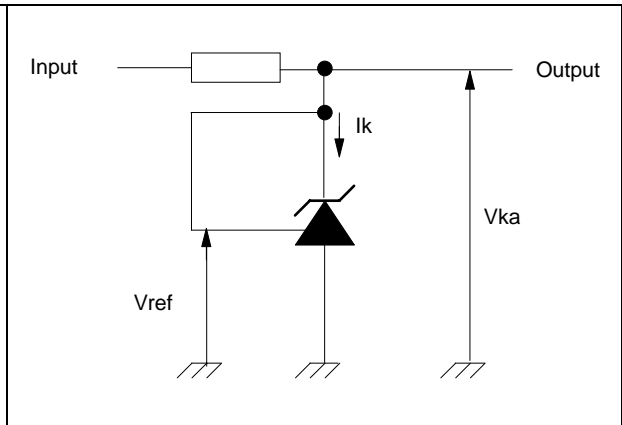


Figure 3. Cathode voltage vs. cathode current

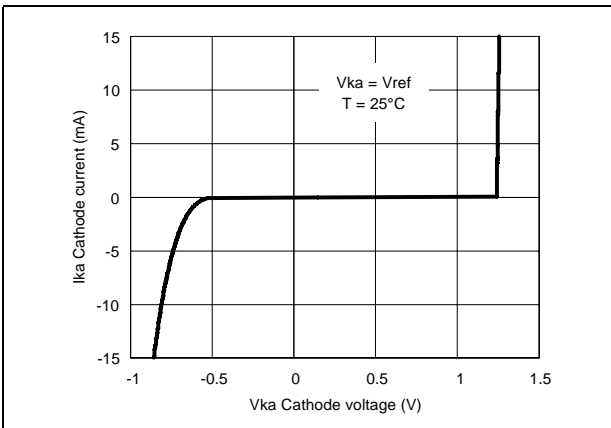


Figure 4. Cathode voltage vs. cathode current

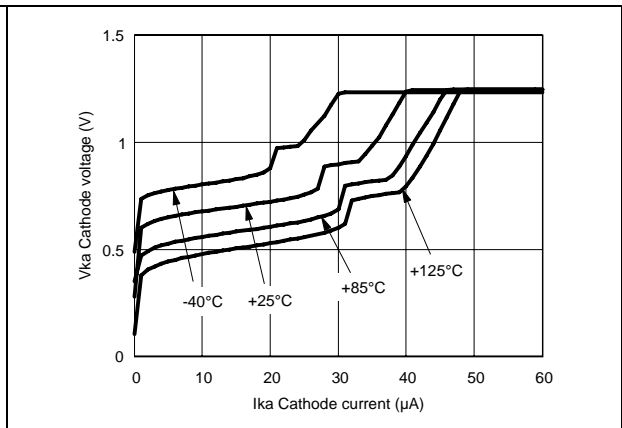


Figure 5. Reference input current vs. temperature

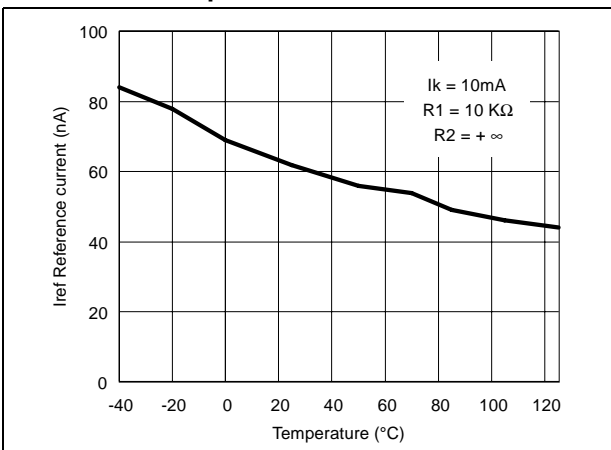


Figure 6. Static impedance vs. temperature

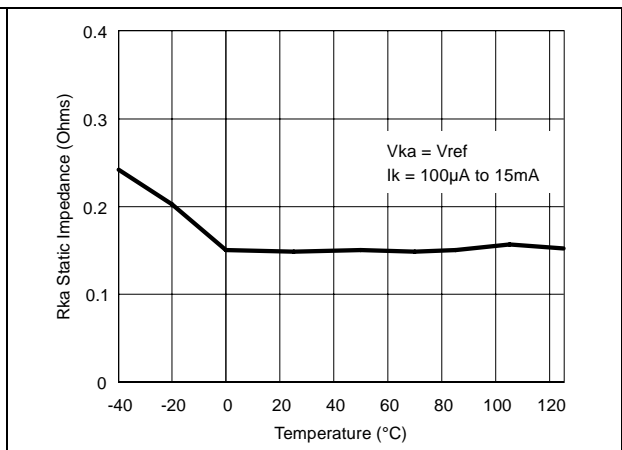


Figure 7. Off-state current vs. temperature

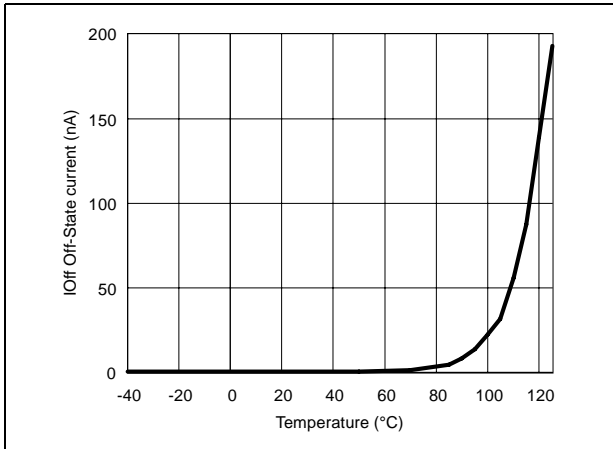


Figure 8. Test circuit for off-state current measurement

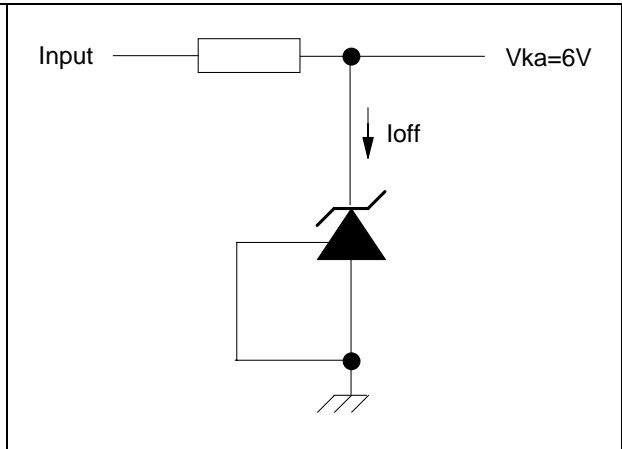


Figure 9. Ratio of change in reference input voltage to change in Vka voltage vs. temperature

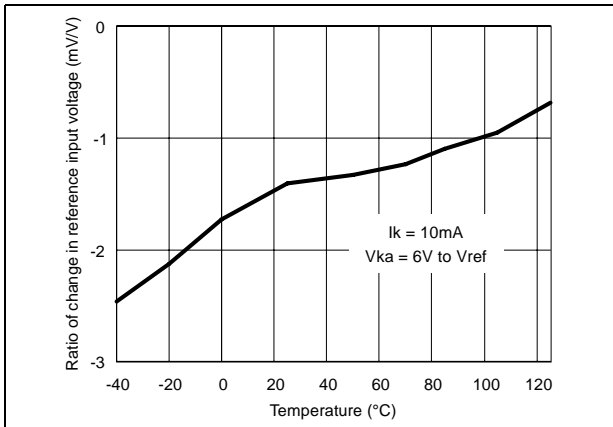


Figure 10. Test circuit for Vka > Vref

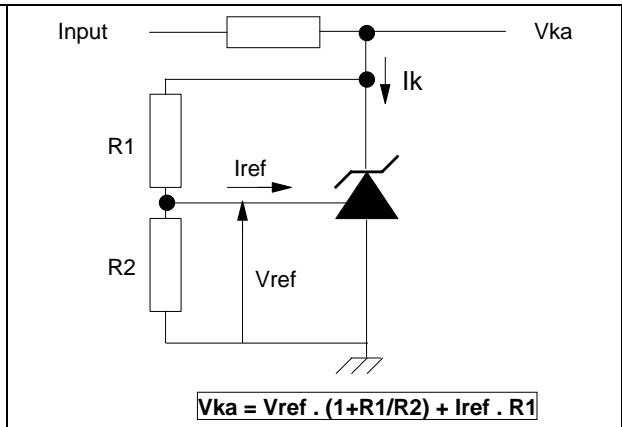


Figure 11. Phase and gain vs. frequency

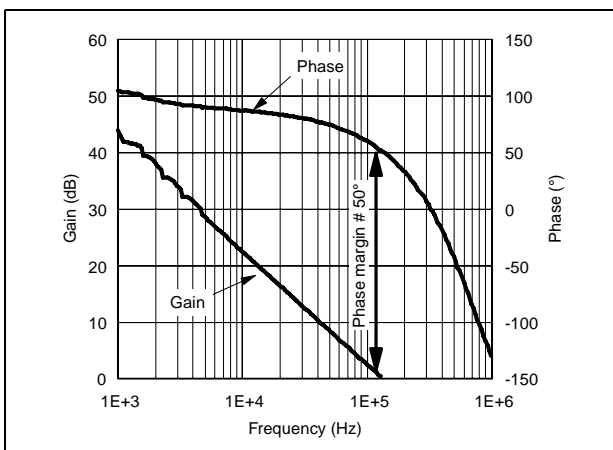


Figure 12. Test circuit for phase and gain measurement

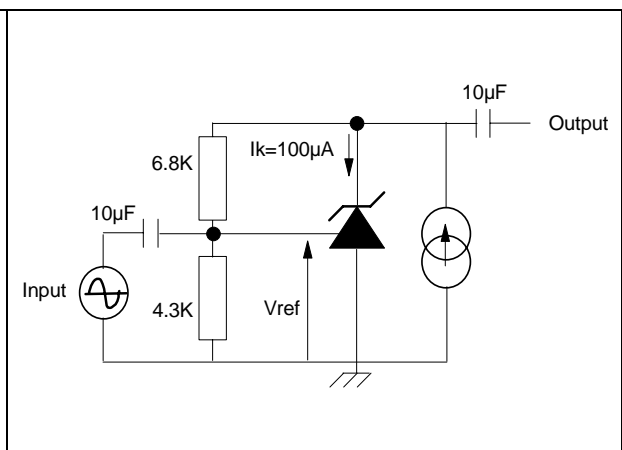


Figure 13. Pulse response at $I_k=100\mu A$

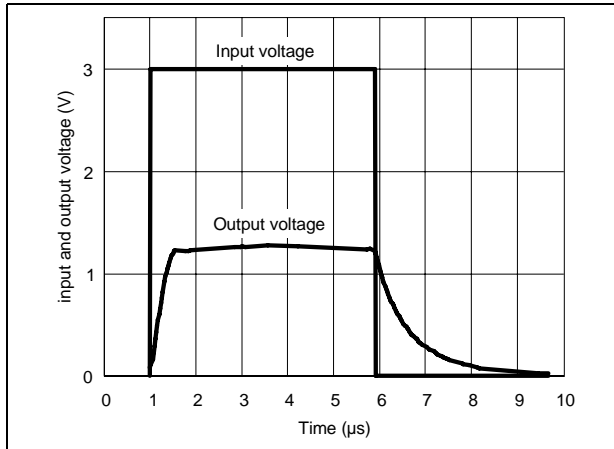


Figure 14. Test circuit for pulse response at $I_k=100\mu A$

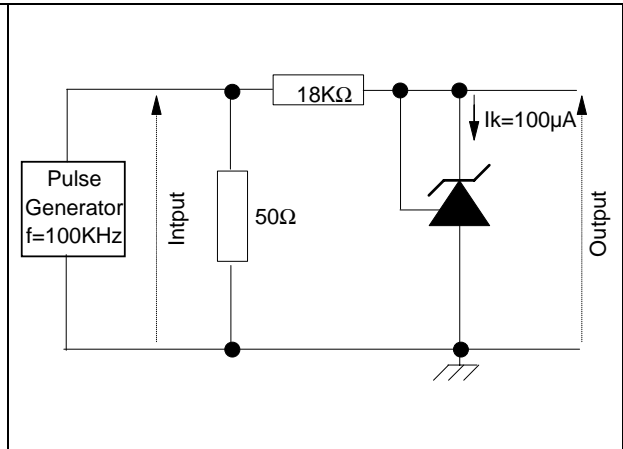


Figure 15. Pulse response at $I_k=1mA$

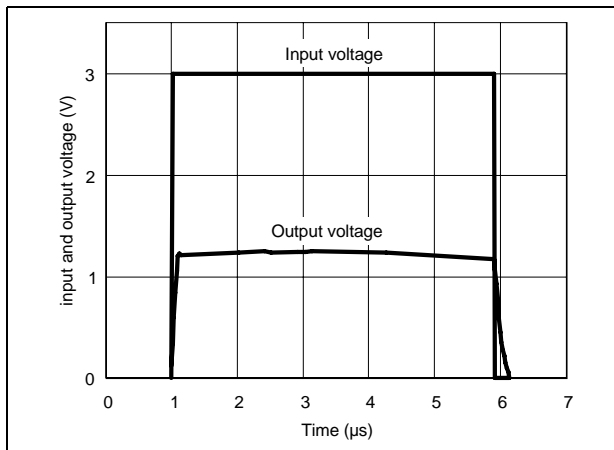


Figure 16. Test circuit for pulse response at $I_k=1mA$

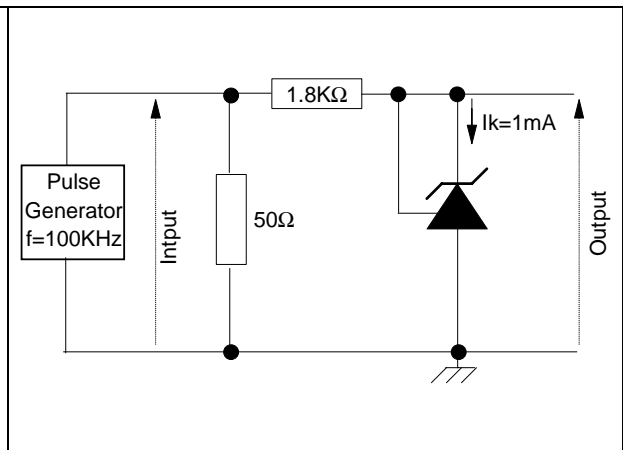
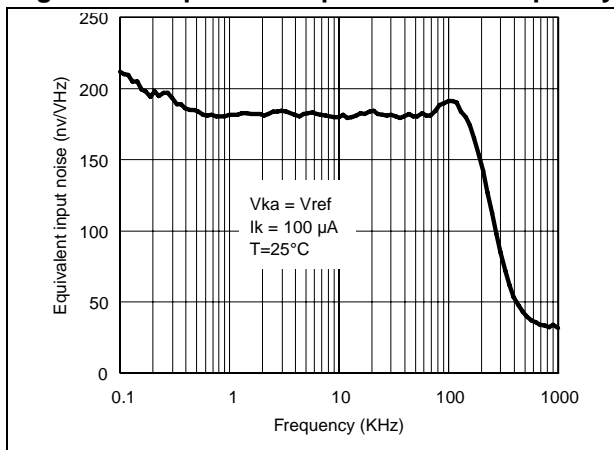


Figure 17. Equivalent input noise vs. frequency



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.

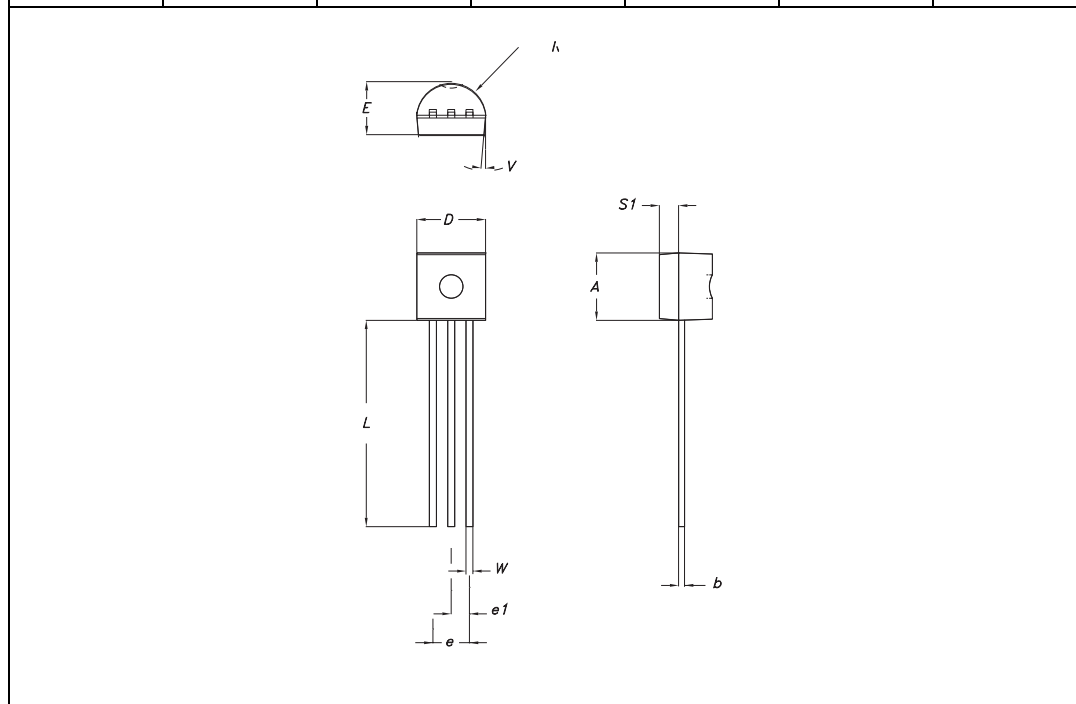
3.1 SOT23-5 package

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

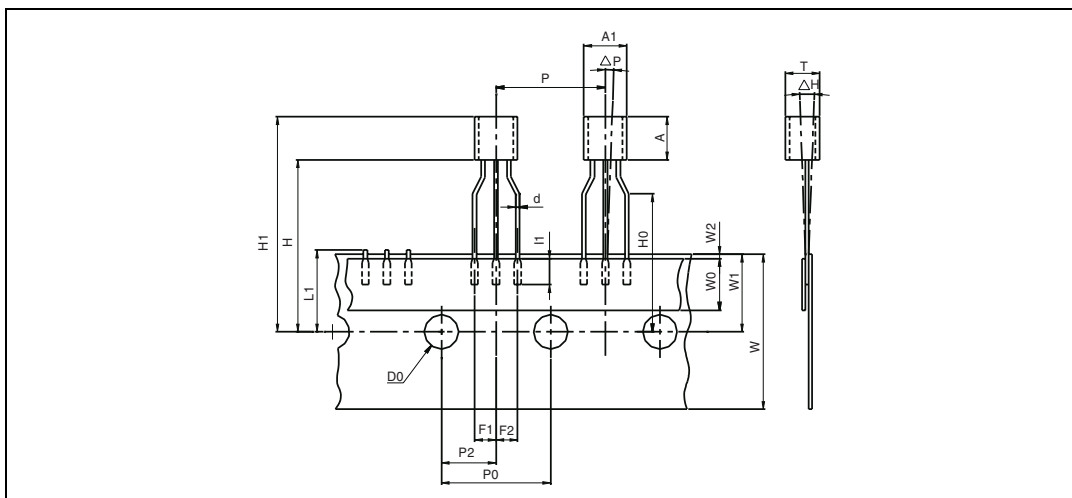
The technical drawings illustrate the SOT23-5 package geometry. The top view shows the package width (D) and lead spacing (e). The side view shows the package height (E) and lead length (L). The perspective view shows the package length (E1) and lead length (L). Dimension lines are labeled with A, A1, A2, b, D, E, E1, e, and L.

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

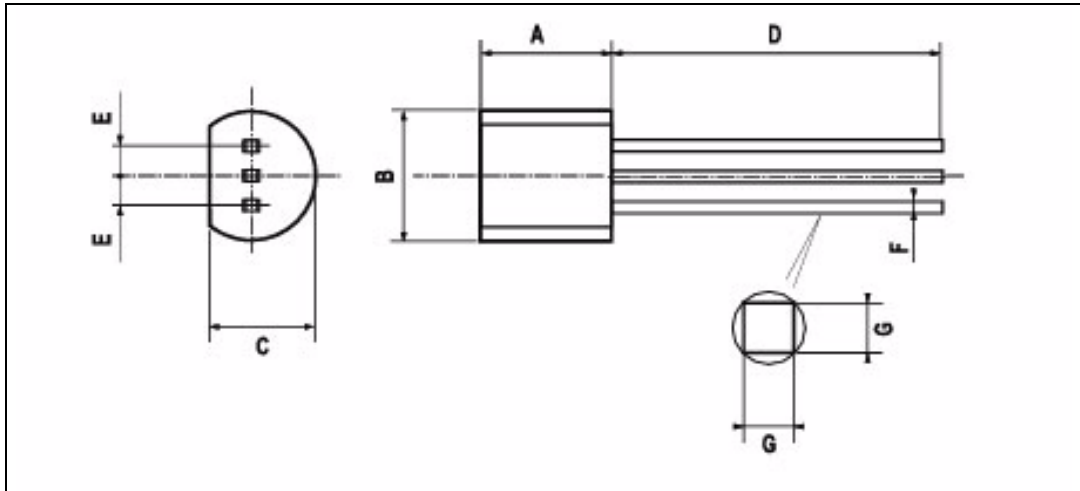


3.3 TO92 (tape ammo pack) package



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).

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2006 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com