

LOW VOLTAGE ADJUSTABLE SHUNT REFERENCE

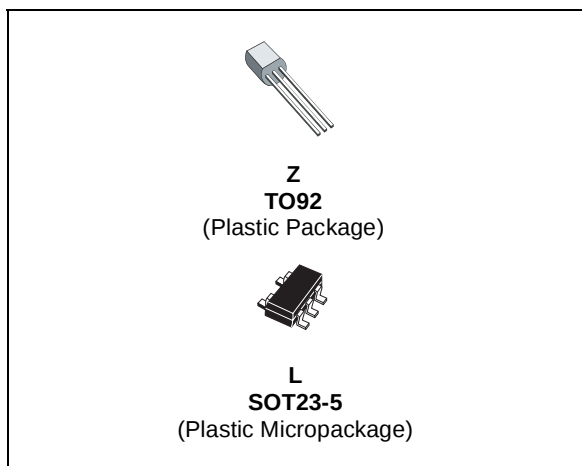
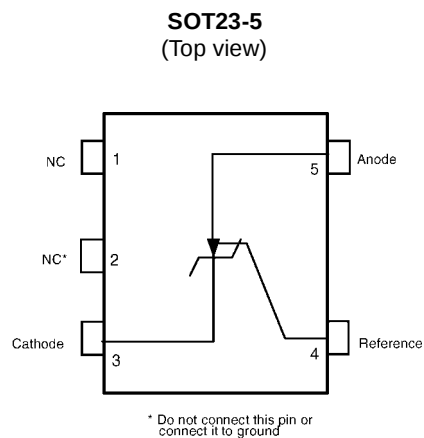
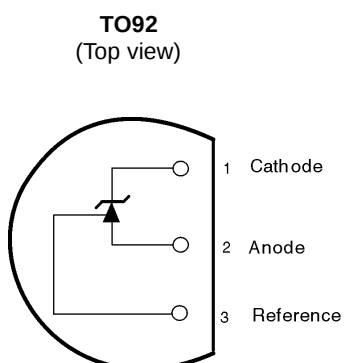
- **LOW VOLTAGE OPERATION : 1.24 TO 6V**
- **2%, 1% AND 0.5% VOLTAGE PRECISION**
- **WIDE OPERATING RANGE CATHODE CURRENT : 60 μ A TO 30mA**
- **LOW OUTPUT IMPEDANCE : 0.2 Ω**
- **TYPICALLY STABLE FOR ANY CAPACITIVE LOADS**
- **ESD PROTECTION :
2kV (Human Body Model)
200V (Machine Model)**
- **100ppm/ $^{\circ}$ C TEMPERATURE COEFFICIENT**

DESCRIPTION

The TS431 is a low voltage three terminals programmable shunt Voltage Reference. The output voltage can be set to any value between Vref (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 widespread TL431 and TL1431 shunt voltage reference.

When driving an optocoupler, the TS431 is particularly interesting to regulate 3.3V switching power supplies.

PIN CONNECTIONS (top view)



ORDER CODE

Part Number	Temperature Range	Package		SOT-23 Marking
		Z	L	
TS431I	-40 $^{\circ}$ C, +125 $^{\circ}$ C	•	•	L272
TS431AI		•	•	L271
TS431BI		•	•	L270

Z = TO92 Plastic package - also available in Bulk (Z), Tape & Reel (ZT) and Ammo Pack (AP)
LT = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

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

OPERATING CONDITIONS

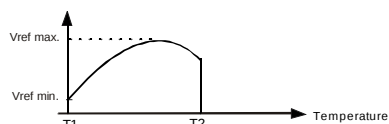
Symbol	Parameter	Value	Unit
V_{KA}	Cathode to Anode Voltage	1.24 to 6	V
I_K	Cathode Current	0.06 to 30	mA
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C

ELECTRICAL CHARACTERISTICS

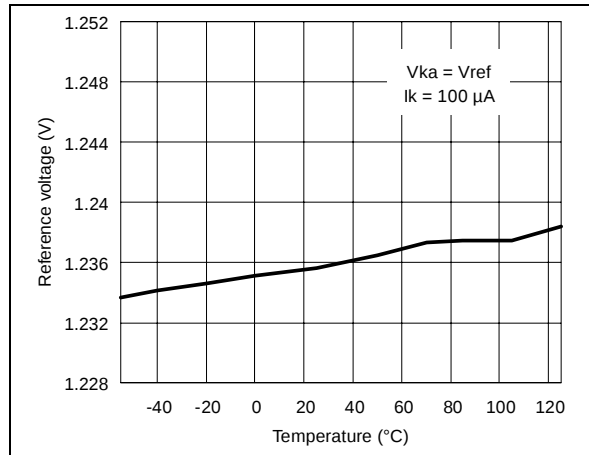
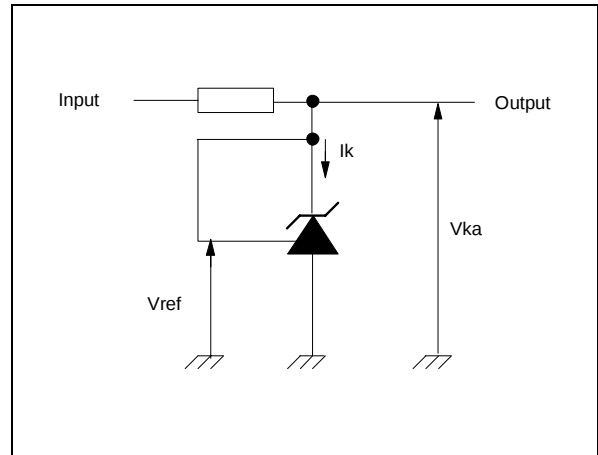
$T_{amb} = 25^{\circ}\text{C}$ (unless otherwise specified)

Symbol	Parameter	Test Condition	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
$\left \frac{\Delta V_{ref}}{\Delta V_{KA}} \right $	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage	$I_K = 10\text{mA}$ $V_{KA} = 6\text{V to } V_{ref}$		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

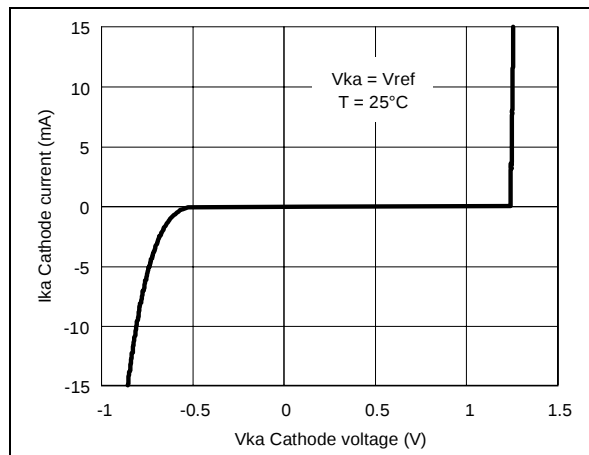
1. Limits are 100% production tested at 25°C . Limits over temperature are guaranteed through correlation and by design.
 2. ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range.
 $\Delta V_{ref} = V_{ref \text{ max.}} - V_{ref \text{ min.}}$



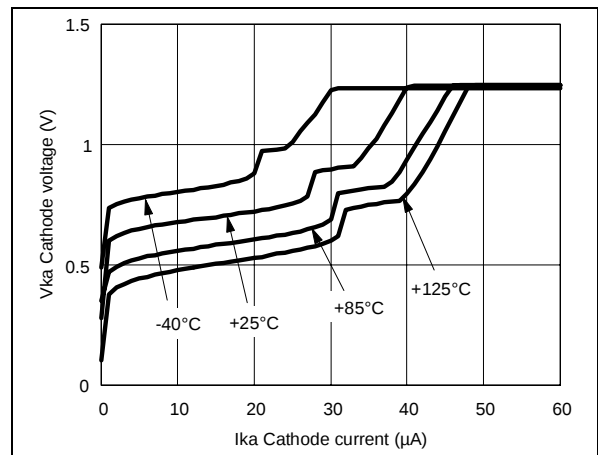
Reference voltage vs temperature

Test circuit for $V_{ka} = V_{ref}$ 

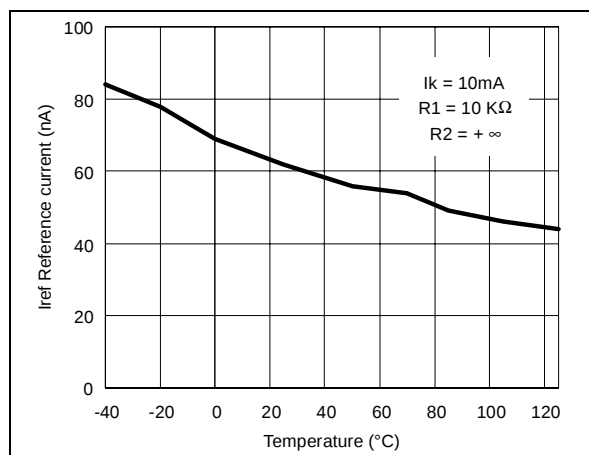
Cathode voltage vs cathode current



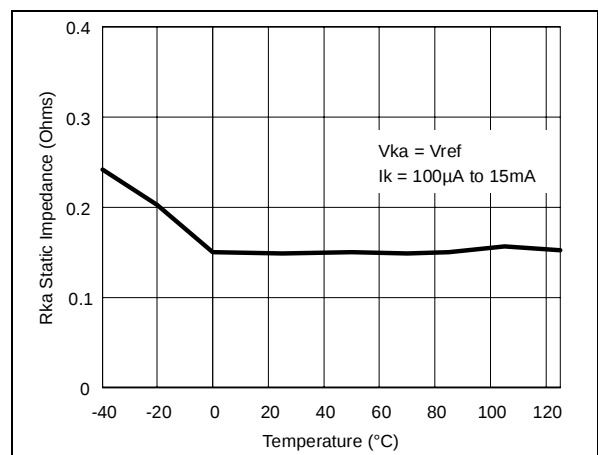
Cathode voltage vs cathode current



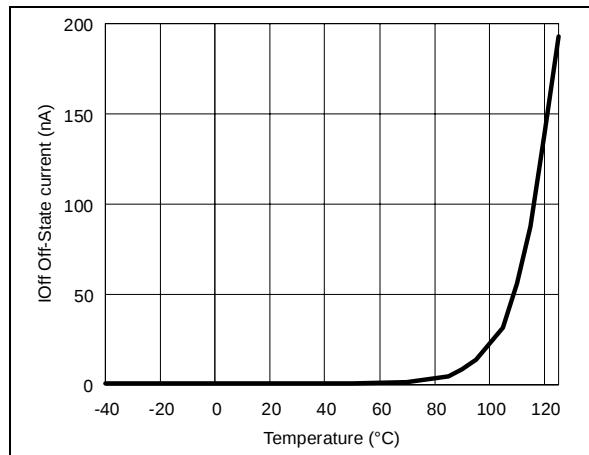
Reference input current vs temperature



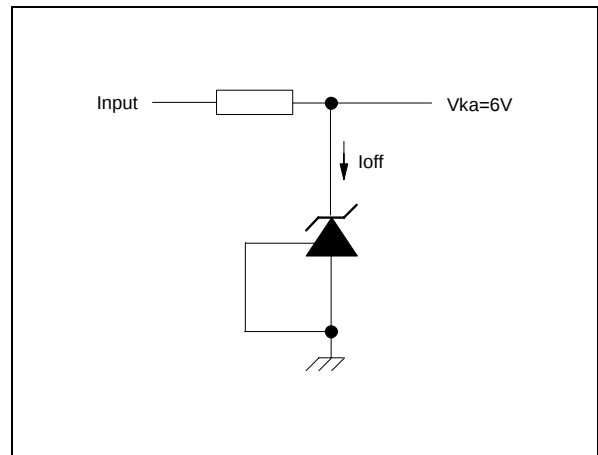
Static impedance vs temperature



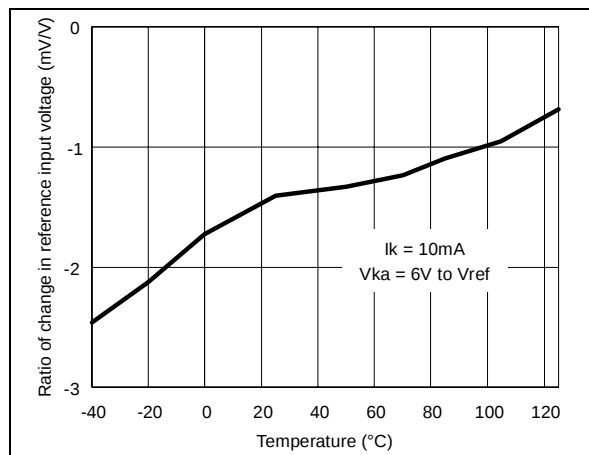
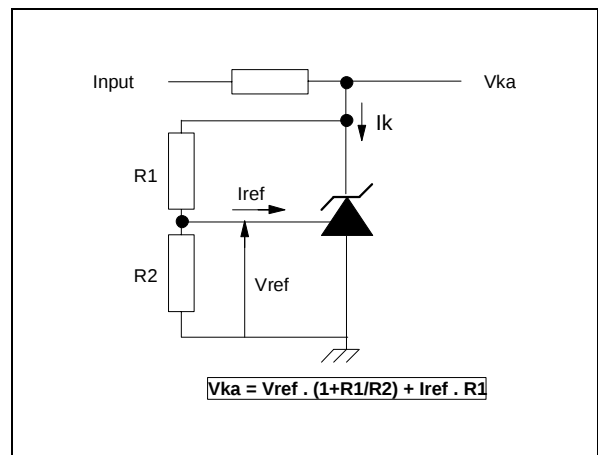
Off-State current vs temperature



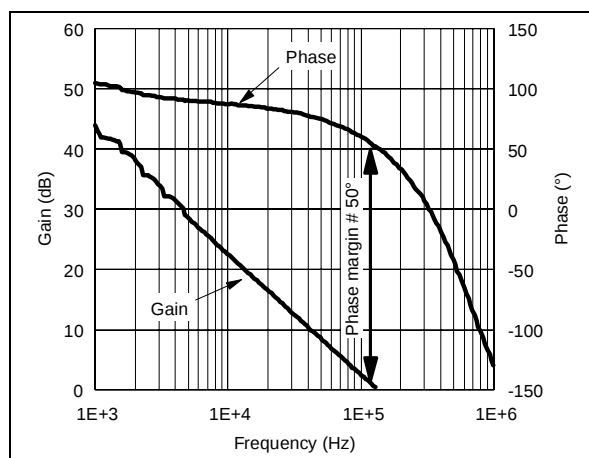
Test circuit for Off-State current measurement



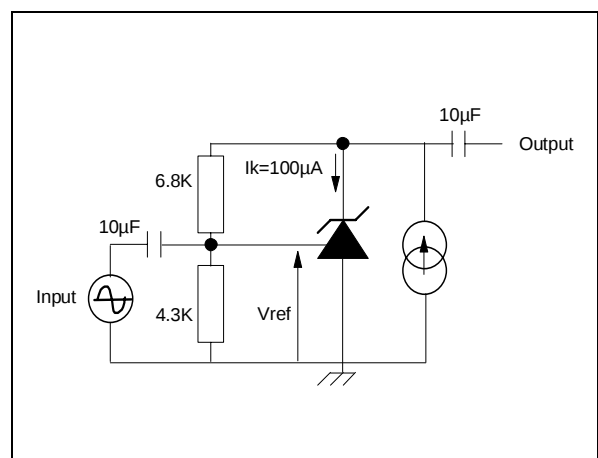
Ratio of change in reference input voltage to change in Vka voltage vs temperature

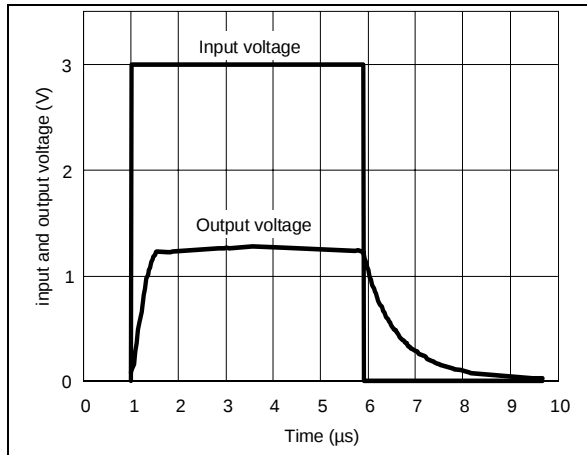
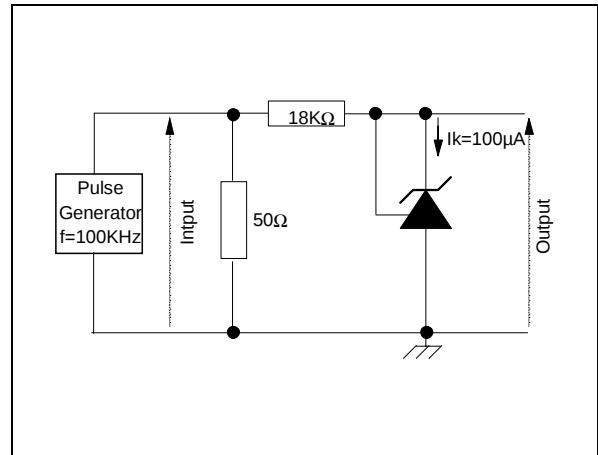
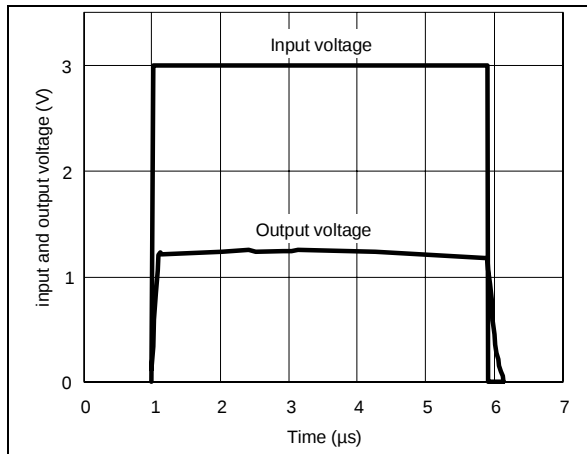
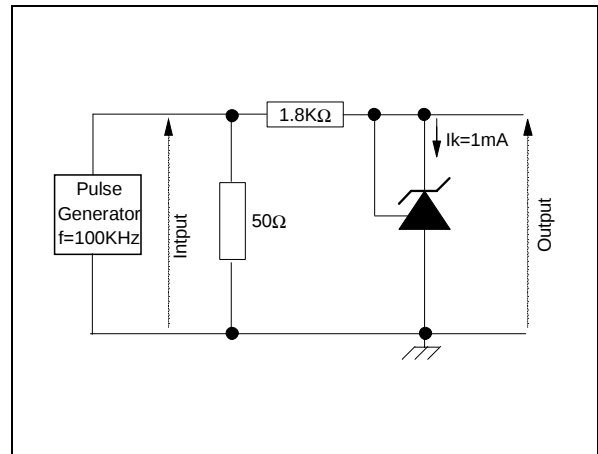
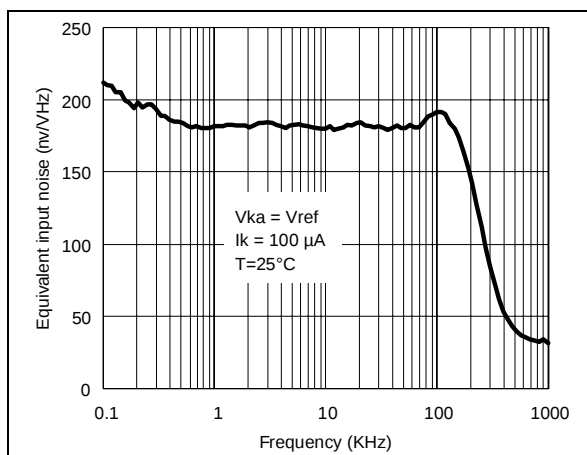
Test circuit for $V_{ka} > V_{ref}$ 

Phase and Gain vs frequency



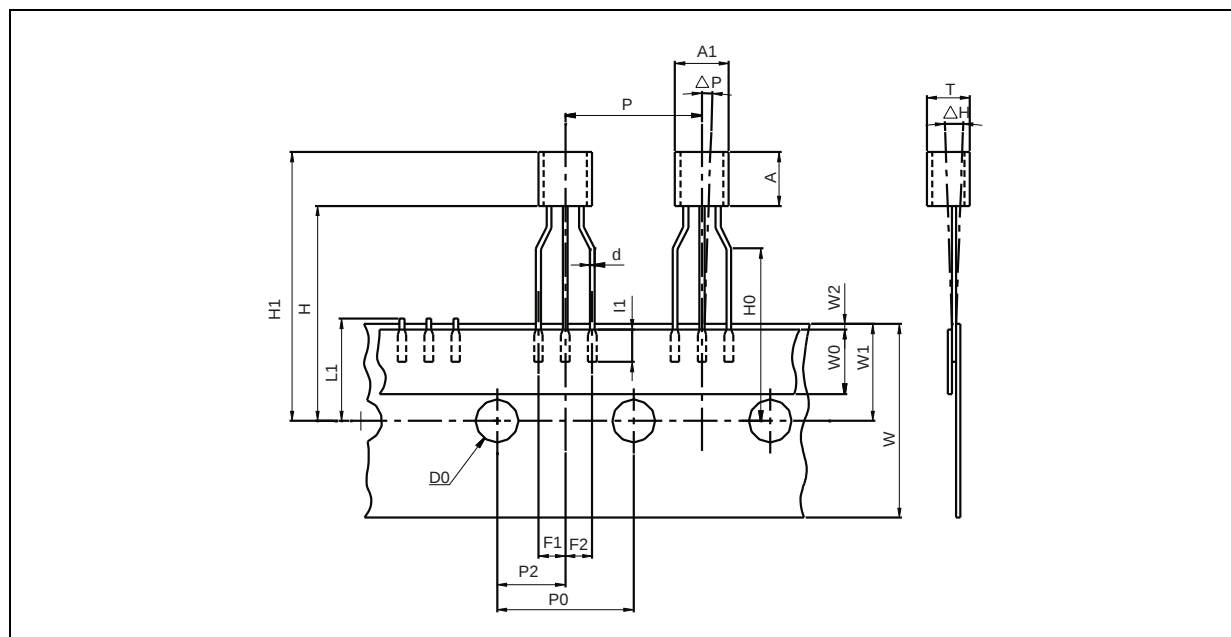
Test circuit for phase and gain measurement



Pulse response at $I_k=100\mu\text{A}$ **Test circuit for pulse response at $I_k = 100\mu\text{A}$** **Pulse response at $I_k = 1\text{mA}$** **Test circuit for pulse response at $I_k = 1\text{mA}$** **Equivalent input noise vs frequency**

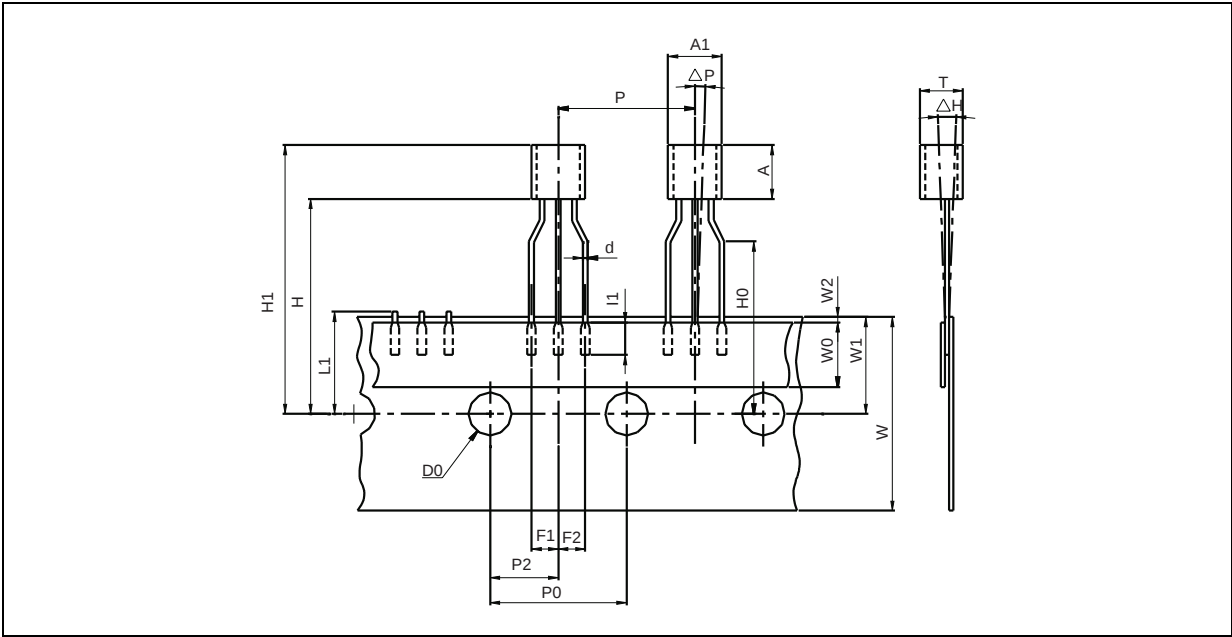
PACKAGE MECHANICAL DATA

3 PINS - PLASTIC PACKAGE TO92 (TAPE & REEL)



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	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
P0	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

PACKAGE MECHANICAL DATA
3 PINS - PLASTIC PACKAGE TO92 (TAPE AMMO PACK)



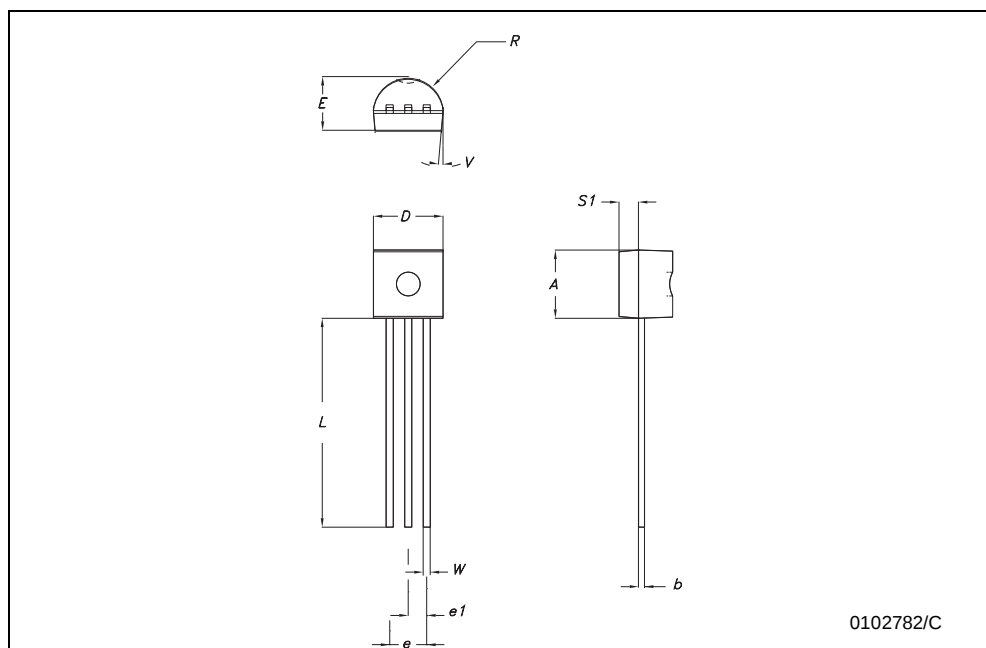
Dim.	Millimeters			Inches		
	Min	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	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

PACKAGE MECHANICAL DATA

3 PINS - PLASTIC PACKAGE TO92 (BULK)

TO-92 MECHANICAL DATA

DIM.	mm.			mils		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.32		4.95	170.1		194.9
b	0.36		0.51	14.2		20.1
D	4.45		4.95	175.2		194.9
E	3.30		3.94	129.9		155.1
e	2.41		2.67	94.9		105.1
e1	1.14		1.40	44.9		55.1
L	12.7		15.49	500.0		609.8
R	2.16		2.41	85.0		94.9
S1	0.92		1.52	36.2		59.8
W	0.41		0.56	16.1		22.0



PACKAGE MECHANICAL DATA

SOT23-5L MECHANICAL DATA						
DIM.	mm.			mils		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.0		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0.95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6

The diagram shows two views of the SOT23-5L package. The left view is a side profile showing dimensions A (total width), A1 (lead thickness), A2 (lead length), b (lead width), C (lead thickness at base), and L (lead height). The right view is a top-down perspective showing dimensions D (package width), E (package height), E1 (package height to lead top), e (pitch between leads), and e1 (total width between lead centers).

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