

## LOW VOLTAGE ADJUSTABLE SHUNT REFERENCE

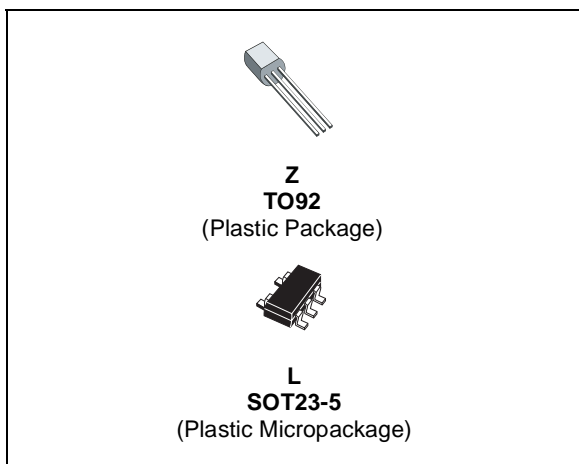
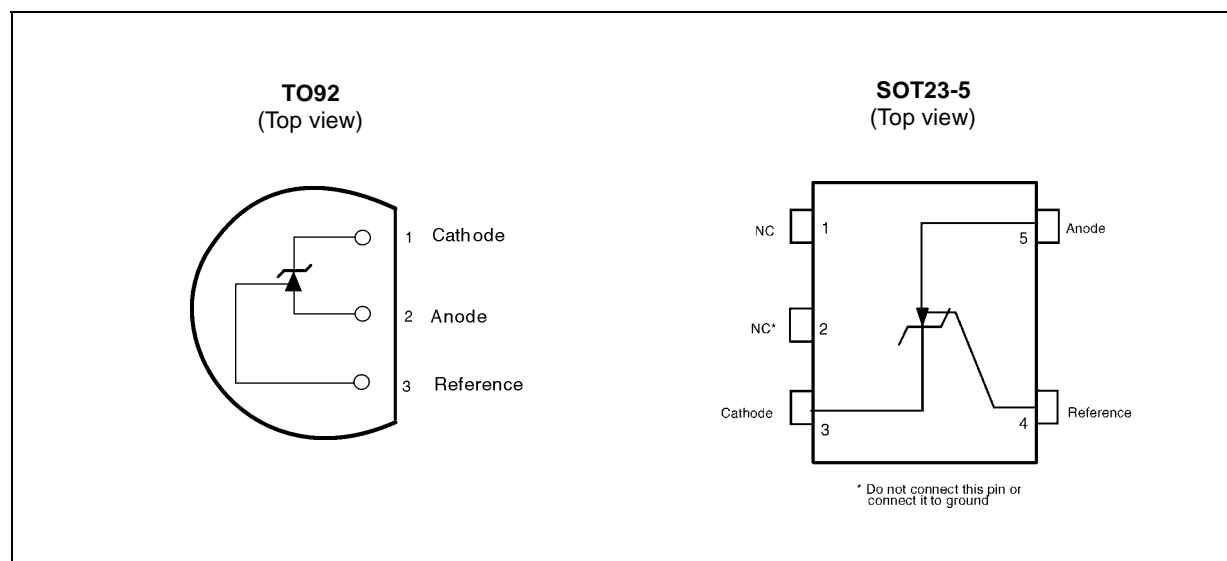
- **LOW VOLTAGE OPERATION : 1.24 TO 6V**
- **2%, 1% AND 0.5% VOLTAGE PRECISION**
- **WIDE OPERATING RANGE CATHODE CURRENT : 60 $\mu$ A TO 30mA**
- **LOW OUTPUT IMPEDANCE : 0.2 $\Omega$**
- **TYPICALLY STABLE FOR ANY CAPACITIVE LOADS**
- **ESD PROTECTION :**  
2kV (Human Body Model)  
200V (Machine Model)
- **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  $V_{ref}$  (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 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 <sup>1)</sup> TO92 package SOT23-5 package	625 500	mW
$T_{std}$	Storage Temperature Range	-65 to +150	°C

1.  $T_{junction}=150^{\circ}C$ ,  $T_{amb}=25^{\circ}C$  with  $R_{THj-a}=200^{\circ}C/W$  for TO92 package and  $R_{THj-a}=250^{\circ}C/W$  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**

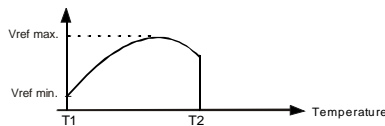
$T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{ref}$	Output Voltage $V_{KA} = V_{ref}$ @ $I_k = 100\mu A$	TS431 TS431A TS431B	1.215 1.228 1.234	1.240	1.265 1.252 1.246	V
$\Delta V_{ref}$	Output Voltage Change <sup>1) 2)</sup> $I_k = 100\mu A$ , $V_{KA} = V_{ref}$	$0 < T_{amb} < +70^{\circ}C$ $-40 < T_{amb} < +85^{\circ}C$ $-40 < T_{amb} < +105^{\circ}C$ $-40 < T_{amb} < +125^{\circ}C$			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	$I_k = 10mA$ $V_{KA} = 6V$ to $V_{ref}$		1.8	2.7	mV/V
$I_{ref}$	Reference Input Current	$I_k = 10mA$		70	160	nA
$\Delta I_{ref}$	Reference Input Current Deviation Over Temperature Range	$I_k=10mA$ $R_1=10k\Omega$ $R_2=\infty$ $-40 < T_{amb} < +85^{\circ}C$ $-40 < T_{amb} < +125^{\circ}C$		70 90	160 240	nA
$I_{min}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{ref}$		40	60	$\mu A$
$I_{off}$	Off-State Cathode Current	$V_{KA} = 6V$ , $V_{ref} = 0$		0.001	0.1	$\mu A$
$R_{KA}$	Static Impedance	$V_{KA} = V_{ref}$ , $I_k = 0.1$ to $15mA$		0.2	0.4	$\Omega$

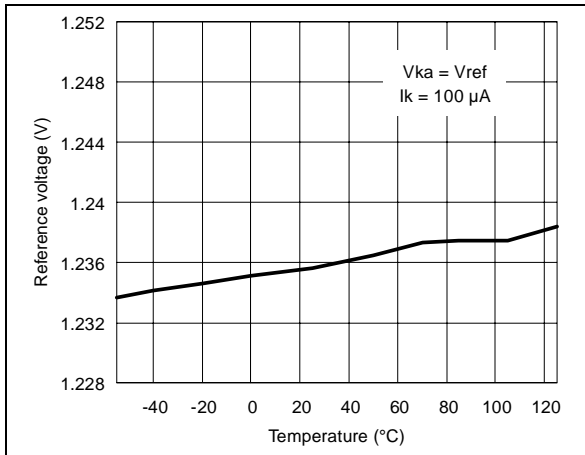
1. Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

2.  $\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.

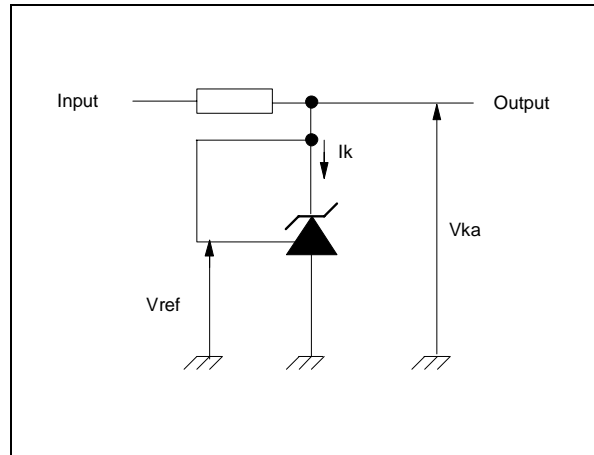
$\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min.}$



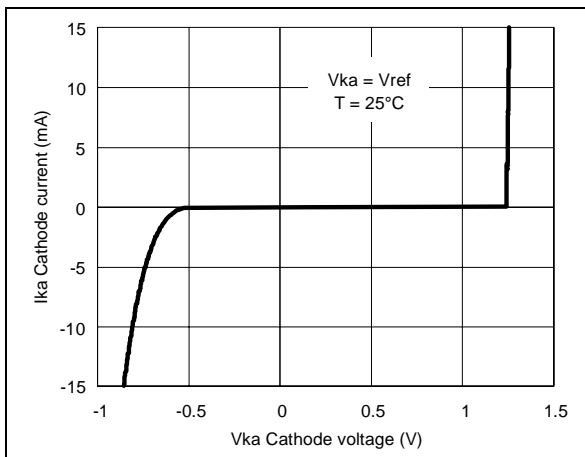
Reference voltage vs temperature



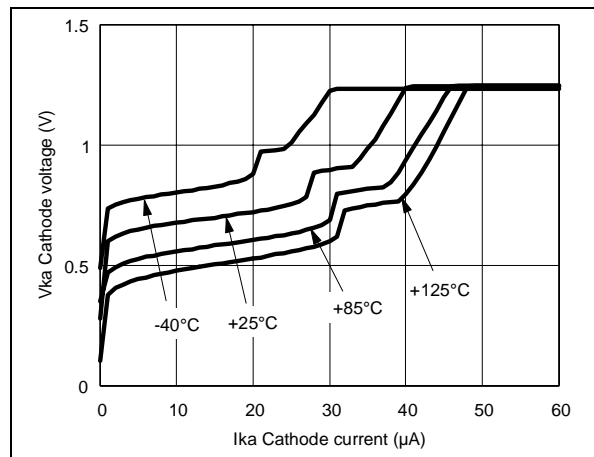
Test circuit for  $V_{ka} = V_{ref}$



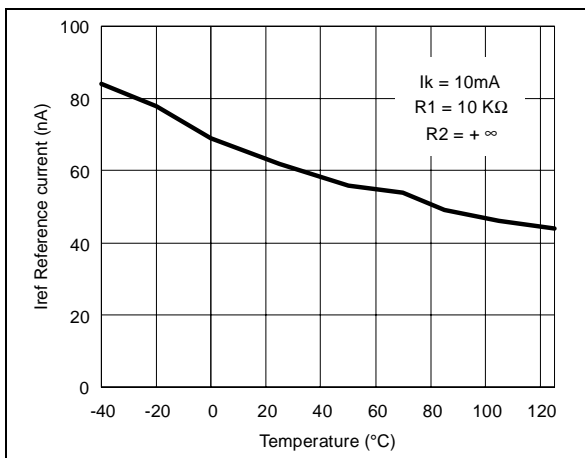
Cathode voltage vs cathode current



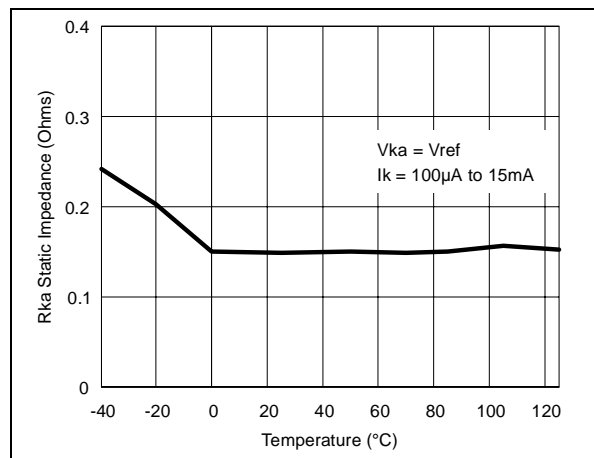
Cathode voltage vs cathode current



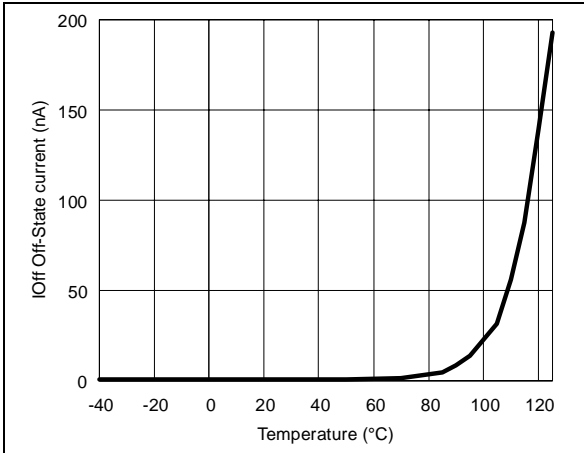
Reference input current vs temperature



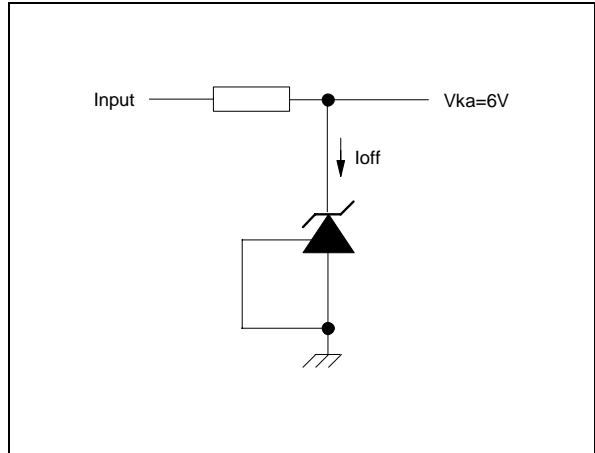
Static impedance vs temperature



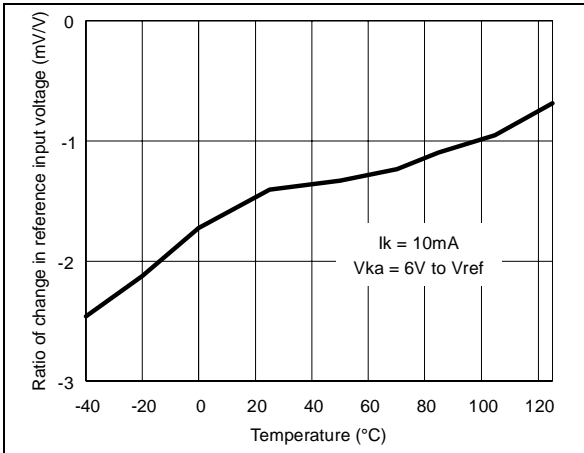
Off-State current vs temperature



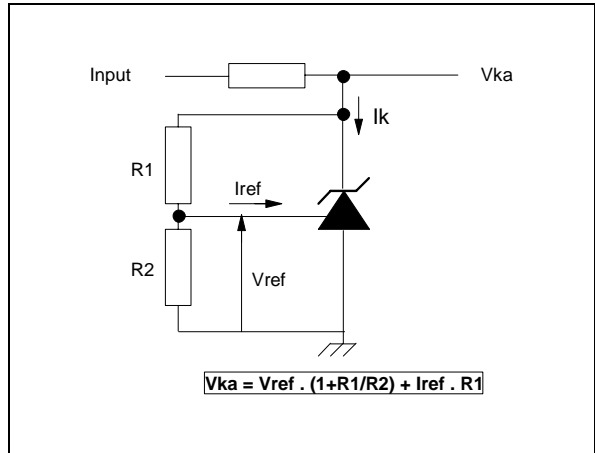
Test circuit for Off-State current measurement



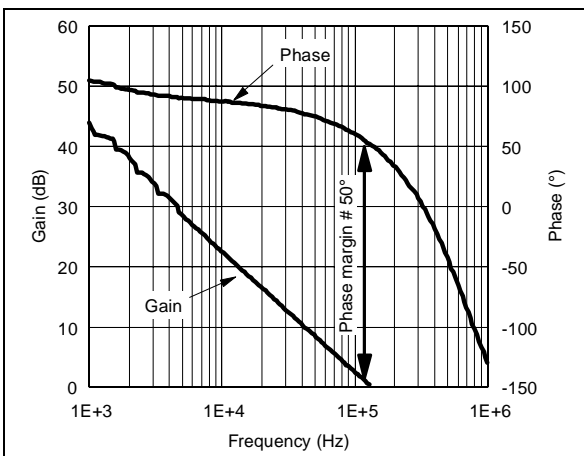
Ratio of change in reference input voltage to change in Vka voltage vs temperature



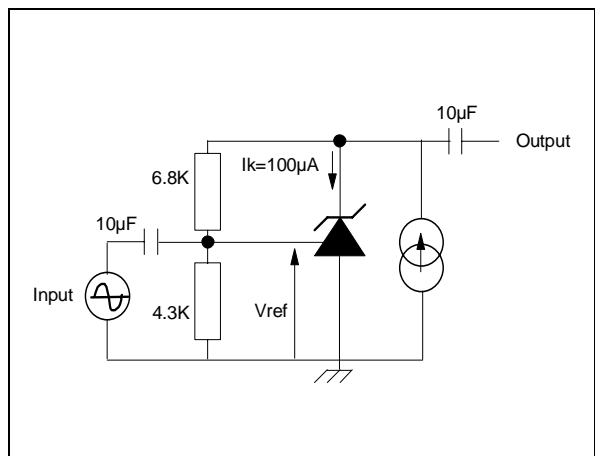
Test circuit for Vka > Vref



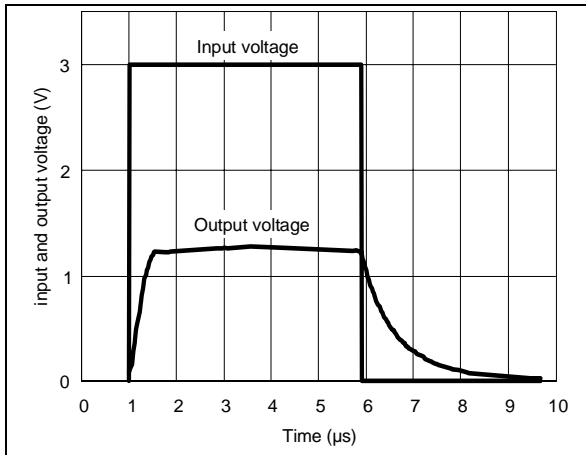
Phase and Gain vs frequency



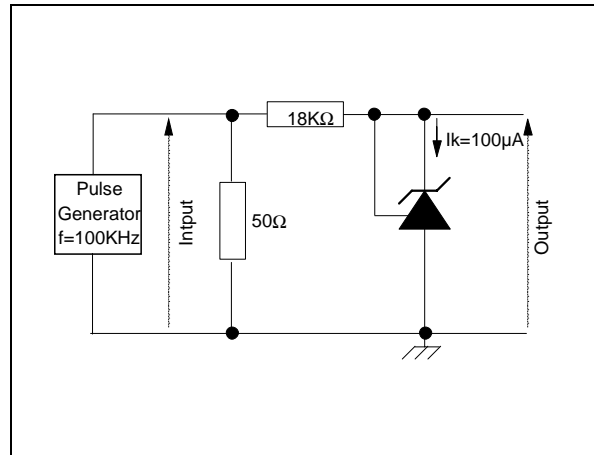
Test circuit for phase and gain measurement



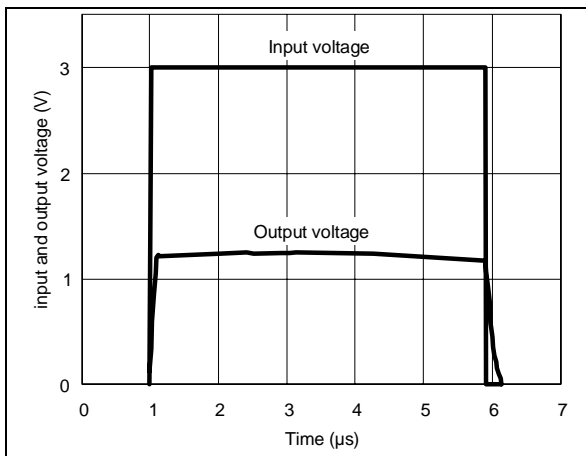
**Pulse response at  $I_k=100\mu\text{A}$**



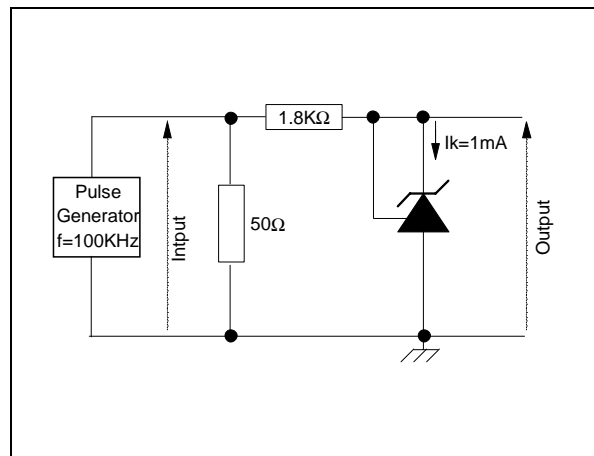
**Test circuit for pulse response at  $I_k = 100\mu\text{A}$**



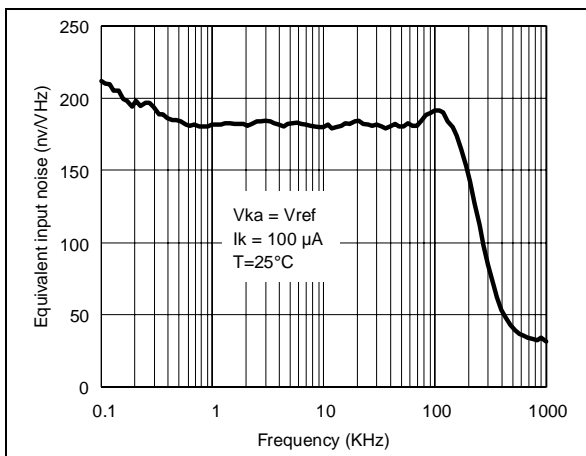
**Pulse response at  $I_k = 1\text{mA}$**



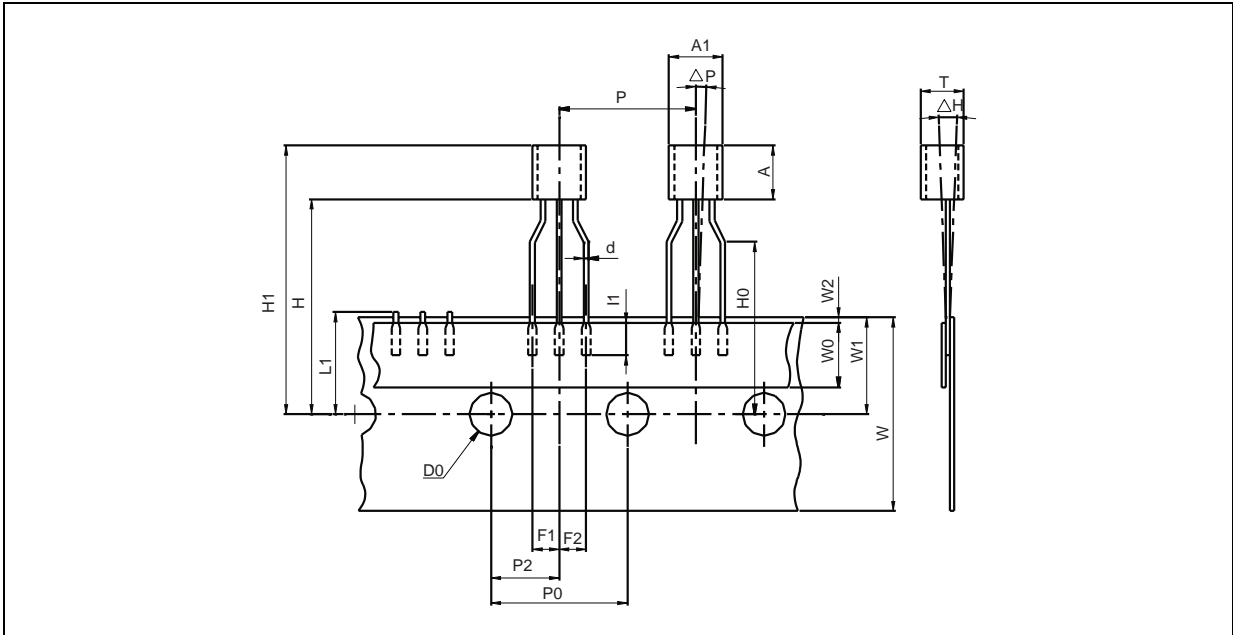
**Test circuit for pulse response at  $I_k = 1\text{mA}$**



**Equivalent input noise vs frequency**

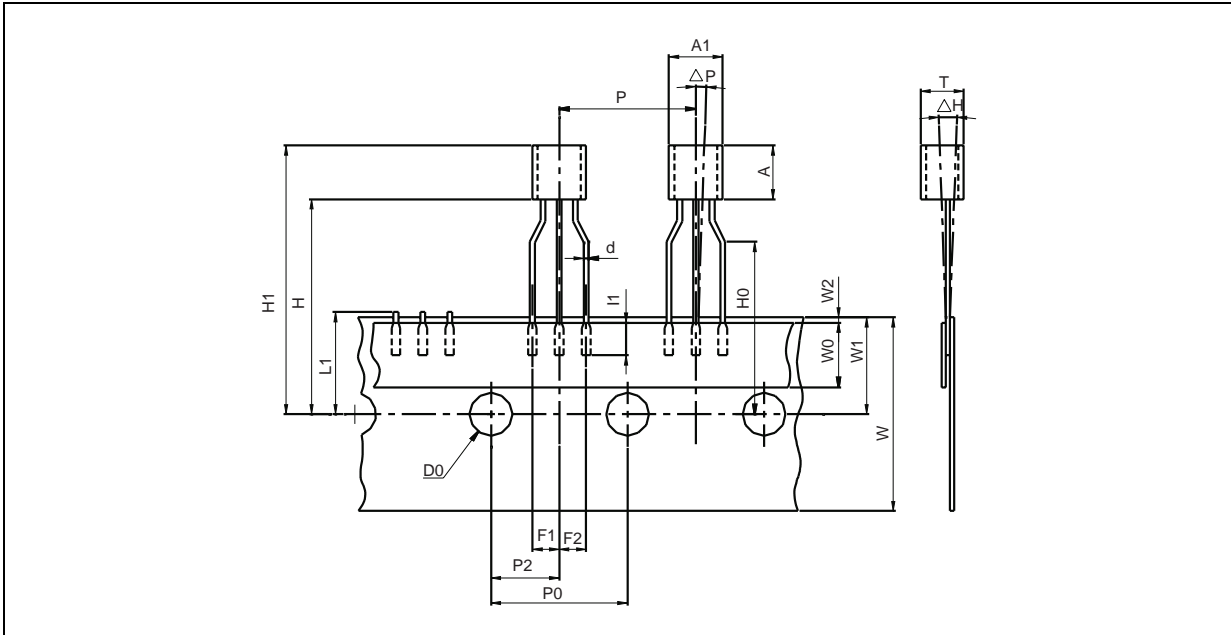


**PACKAGE MECHANICAL DATA**  
**3 PINS - PLASTIC PACKAGE TO92 (TAPE & REEL)**



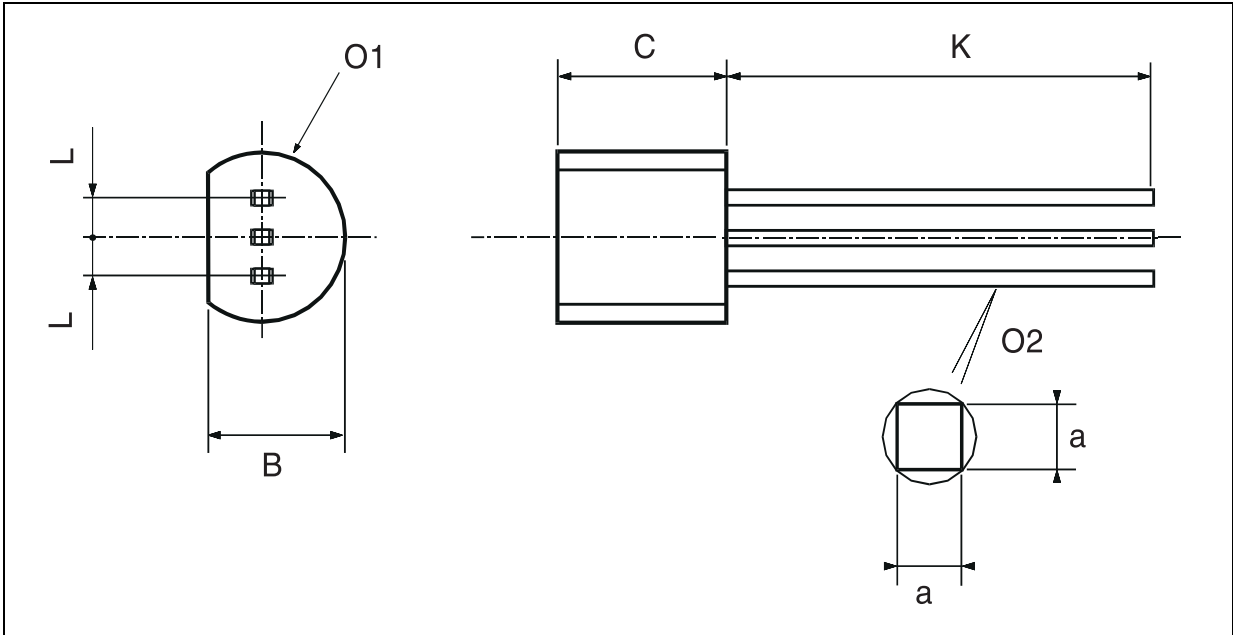
Dim.	Millimeters			Inches		
	Min	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0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

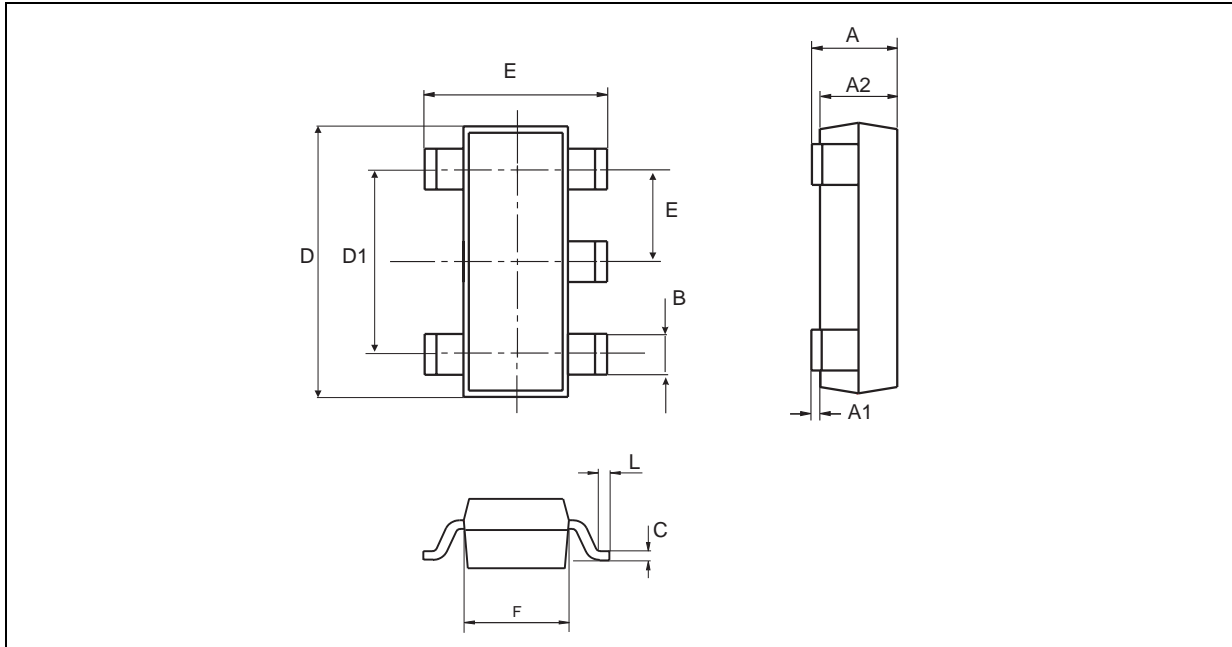
**PACKAGE MECHANICAL DATA**  
 3 PINS - PLASTIC PACKAGE TO92 (BULK)



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		



**PACKAGE MECHANICAL DATA**  
5 PINS - TINY PACKAGE (SOT23-5)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.3	0.5	0.60	0.012	0.014	0.024
K	0d		10d	0d		10d

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