KN431/KNF431

Programmable Voltage Reference

Description

The KN431 series are 3-terminal precision shunt regulators that are programmable over a wide voltage range of 2.495V to 36V with ±0.3%, ±0.5%, ±1.0% tolerance. The KN431 series have a low dynamic impedance of 0.15Ω. These features make the KN431 series an excellent replacement for zener diodes in numerous applications circuits that require a precision reference voltage.

Features

Programmable output voltage from 2.495V to 36V

Voltage reference tolerance : ±0.3%, ±0.5%, ±1.0%

Cathode current capability of 1mA to 100mA

ESD ratings : 2000V (HBM), 200V (MM)

Pin Assignment

(Top View)

PKG : SOT-89

Apply Device : KN431xF

(Top View)

PKG : SOT-23

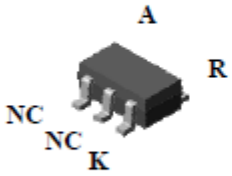
Apply Device : KN431xS

(Top View)

PKG : SOT-23

Apply Device : KNF431xS

(Top View)



PKG : SOT-25

Apply Device : KN431xN

(Marking Side View)

PKG : TO-92

Apply Device : KN431x

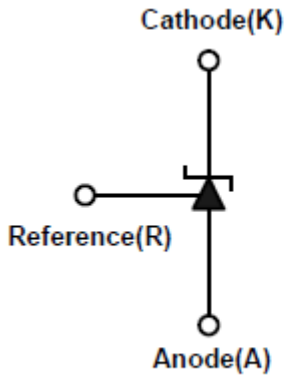
(Marking Side View)

PKG : TO-92M

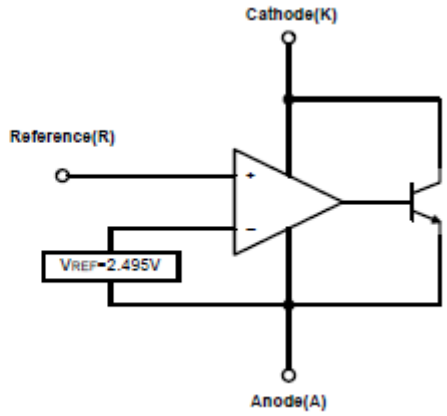
Apply Device : KN431xM

[K : Cathode, A: Anode, R : Reference]

Symbol



Functional block diagram



Ordering Information

Vref Tolerance	PKG Type	Device Name	Marking
±1%	TO-92	KN431A	KN431 A•
	TO-92M	KN431AM	KN431 A•
	SOT-23	KN431AS[1)]	4GA□[3)]△•
	SOT-23	KNF431AS[2)]	4KA□[3)]△•
	SOT-25	KN431AN	N4A□[3)] •
	SOT-89	KN431AF	KN431A•
±0.5%	TO-92	KN431B	KN431 B•
	TO-92M	KN431BM	KN431B•
	SOT-23	KN431BS[1)]	4GB□[3)]△•
	SOT-23	KNF431BS[2)]	4KB□[3)]△•
	SOT-25	KN431BN	N4B□[3)] •
	SOT-89	KN431BF	KN431B•
±0.3%	SOT-23	KN431CS[1)]	4GC□[3)]△•
	SOT-23	KNF431CS[2)]	4KC□[3)]△•

1) KN431xS Pin Connection : (1) Cathode, (2) Reference, (3) Anode

2) KNF431xS Pin Connection : (1) Reference, (2) Cathode, (3) Anode

3) □ : Year & Week Code

4) △ : Machine Code [SOT-23 PKG.]

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Absolute maximum ratings

[Ta=25℃]

Characteristic		Symbol	Rating	Unit
Cathode to Anode voltage		V_{KA}	37	V
Cathode current Range (Continuous)		I_K	-100~150	mA
Reference input current Range		I_{ref}	-0.05~10	mA
Power Dissipation	SOT-23	P_D(Note1)	350	mW
	SOT-25	P_D(Note1)	400	
	SOT-89	P_D(Note1)	500	
	TO-92	P_D(Note2)	700	
	TO-92M	P_D(Note2)	400	
Junction Temperature		T_J	150	℃
Operating temperature range		T_{opr}	-40 ~ +85	℃
Storage temperature range		T_{stg}	-55 ~ +150	℃

Note 1 : Mounted on a glass epoxy PCB board (25.4 × 25.4mm).T_A=25℃

Note 2 : T_A=25℃

Recommended operating conditions

Characteristic	Symbol	Rating		Unit
		Min.	Max.	
Cathode to Anode voltage	V_{KA}	V_{ref}	36	V
Cathode current	I_K	1	100	mA

Electrical Characteristics (Ta=25℃, unless otherwise noted.)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
Reference voltage (Fig.1)	V_{ref}	$V_{KA}=V_{ref}$, I_K=10mA	KN431C	2.487	2.495	2.503	V
			KN431B	2.482		2.508	
			KN431A	2.482		2.520	
Reference input voltage deviation over temperature (Fig.1, Note1,2)	$\triangle V_{ref}$	$V_{KA}=V_{ref}$, I_K=10mA @ -40°C ≤ Ta ≤ 85°C		-	7	30	mV
Ratio of delta reference input voltage to delta cathode voltage (Fig.2)	$\frac{\triangle V_{ref}}{\triangle V_{KA}}$	I_K=10mA $V_{ref} \leq V_{KA} \leq 36V$		-	-1.0	-2.7	mV/V
Reference current (Fig.2)	I_{ref}	I_K=10mA, R1=10KΩ, R2=∞		-	1.8	4.0	μA
Reference input current deviation over temperature (Fig.2, Note 1,2)	$\triangle I_{ref}$	I_K=10mA, R1=10KΩ, R2=∞ @ -40°C ≤ Ta ≤ 85°C		-	0.4	2.5	μA
Minimum cathode current for regulation	$I_{K(MIN)}$	$V_{KA}=V_{ref}$		-	0.35	1.0	mA
Off-state cathode current (Fig.3)	$I_{K(off)}$	V_{KA}=36V, V_{ref}=0V		-	2.7	1000	nA
Dynamic impedance (Fig.1, Note3)	Z_{KA}	$V_{KA}=V_{ref}$, f ≤ 1.0KHz 1.0mA ≤ I_K ≤ 100mA		-	0.15	0.5	Ω

Fig. 1 Test circuit for $V_{KA}=V_{ref}$

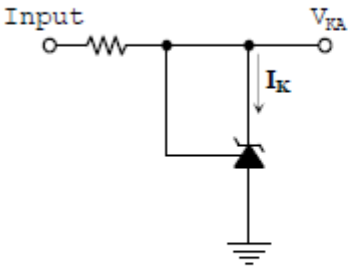


Fig. 2 Test circuit for $V_{KA}>V_{ref}$

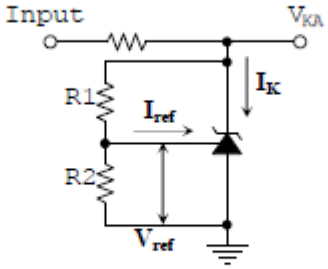
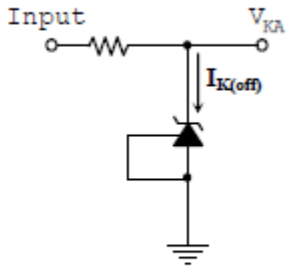


Fig. 3 Test circuit for $I_{K(off)}$

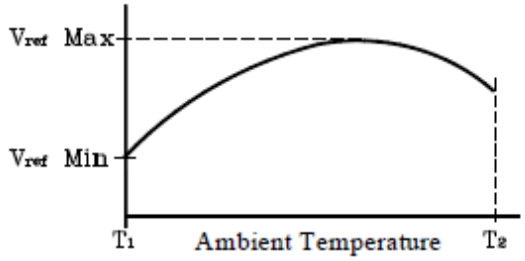


$$V_{KA} = V_{ref} \times (1 + \frac{R_1}{R_2}) + I_{ref} \times R_1$$

Note.

1. Ambient temperature range: T_{LOW} = -40℃, T_{High} = 85℃

2. The deviation parameters $\triangle V_{ref}$ and $\triangle I_{ref}$ are defined as the difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.



$\Delta V_{ref} = V_{ref}\,Max - V_{ref}\,Min$

$\Delta Ta = T_2 - T_1$

The average temperature coefficient of the reference input voltage, αV_{ref} is defined as:

$$\alpha V_{ref}(\frac{ppm}{℃}) = \frac{(\frac{\Delta V_{ref}}{V_{ref}(T_a = 25℃)} \times 10^6)}{\Delta T_a}$$

Example : $\triangle V_{ref}$ = 30mV and the slope is positive,

$\triangle V_{ref}$ @ 25℃ = 2.495V

$\triangle Ta$ = 70℃

$$\alpha V_{ref}(\frac{ppm}{℃}) = \frac{(\frac{0.03}{2.495}) \times 10^6}{70} = 171 ppm/℃$$

3. The dynamic impedance Z_{KA} is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device is operating with two external resistors, R1 and R2, (refer to Fig.2) the total dynamic impedance of the circuit is given by:

$$|Z_{KA}'| = |Z_{KA}| \times (1 + \frac{R_1}{R_2})$$

Electrical Characteristic Curves

Fig.4 V_{ref} vs T_A

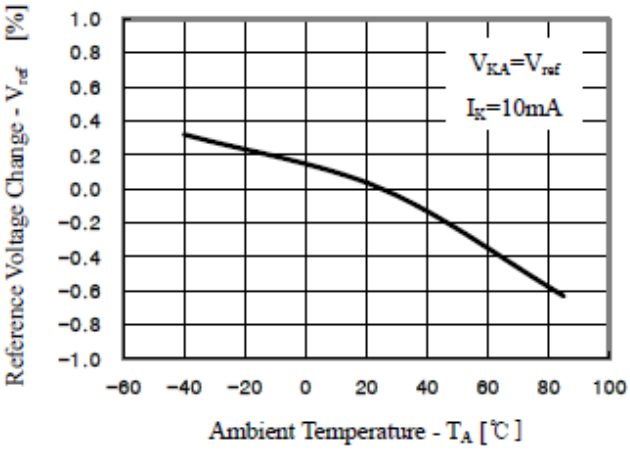


Fig.5 I_{ref} vs T_A

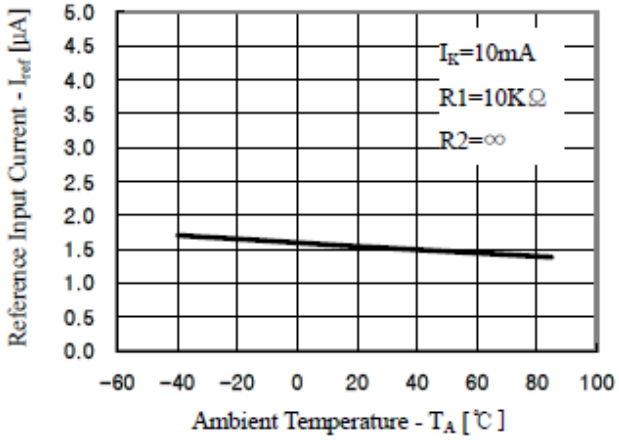


Fig.6 I_{KA} vs V_{KA}

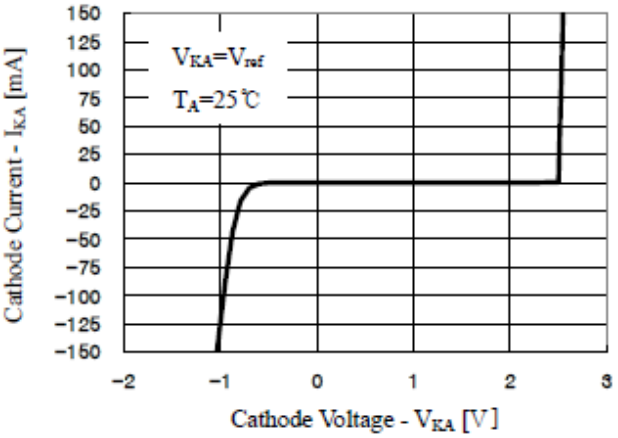


Fig.7 I_{KA} vs V_{KA}

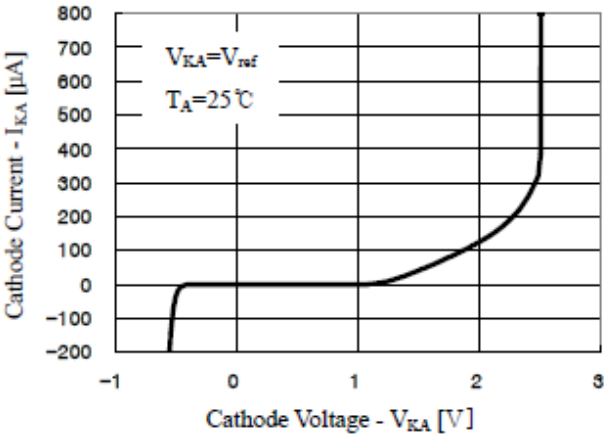


Fig.8 I_{off} vs T_A

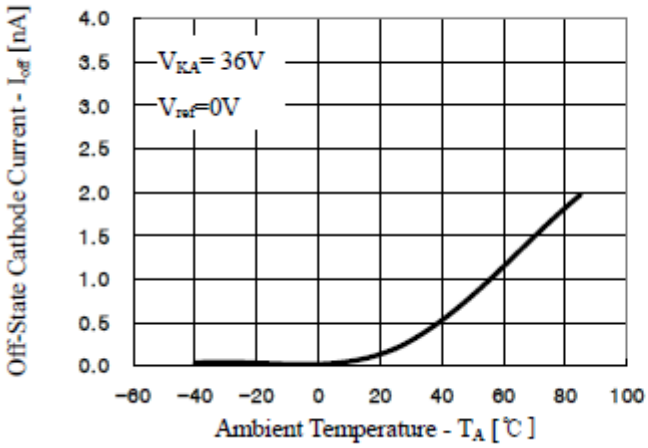
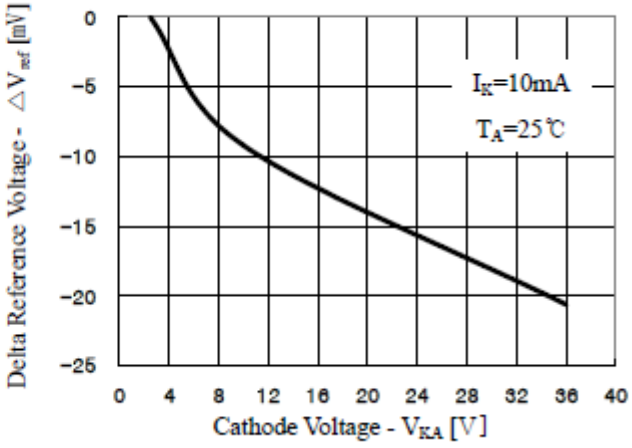
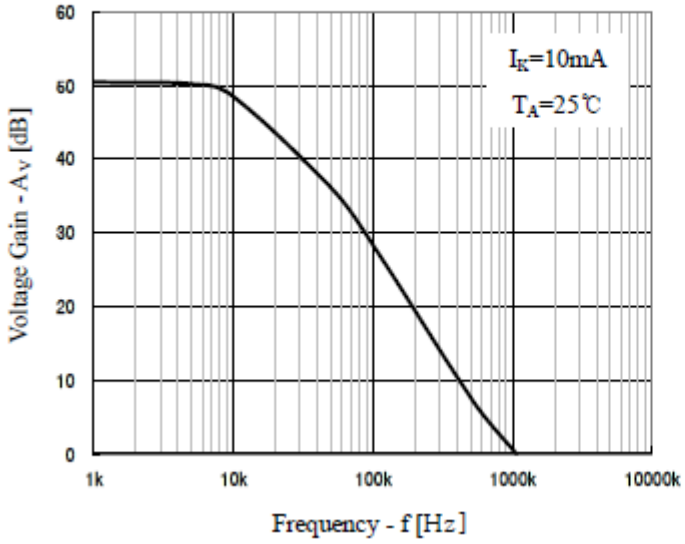


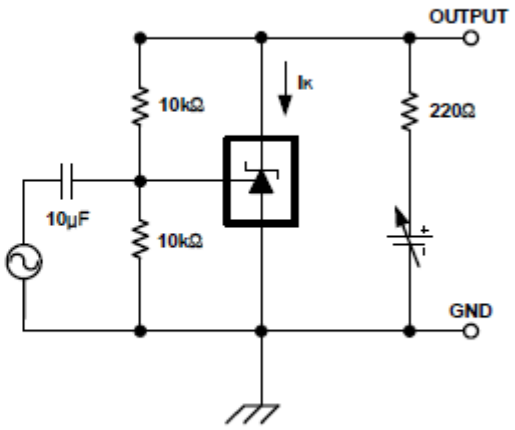
Fig.9 $\triangle V_{ref}$ vs V_{KA}



Electrical Characteristic Curves

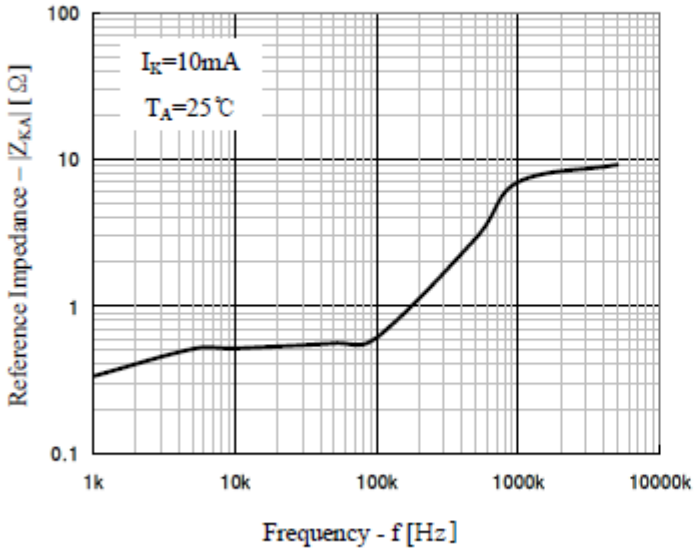
Fig.10 A_V vs f

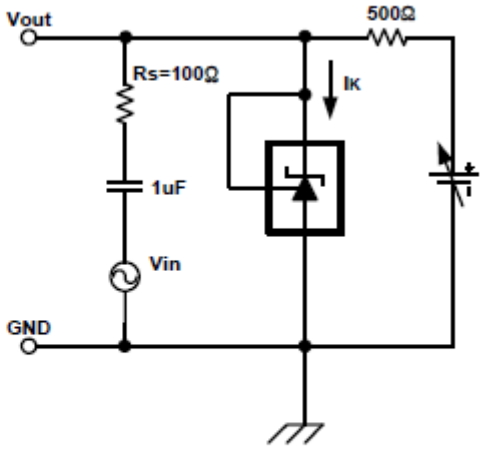




Voltage Gain Test Circuit

Fig.11 $|Z_{KA}|$ vs f

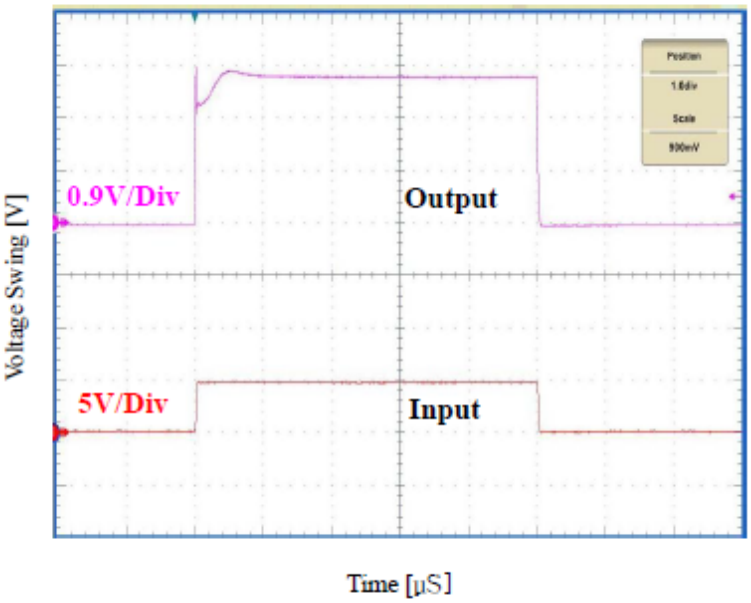


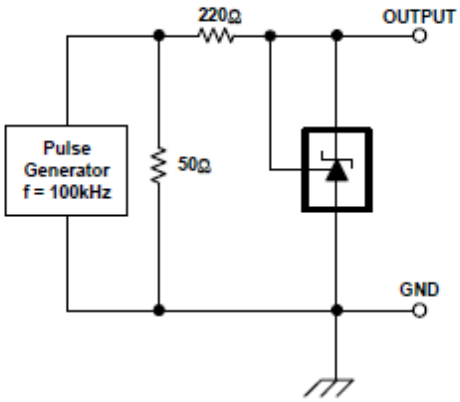


ZKA = Vout/Vin x Rs

Dynamic Impedance Test Circuit

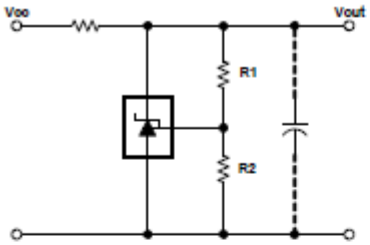
Fig.12 Pulse Response





Pulse Response Test Circuit

Typical Application



$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

Fig14. Shunt Regulator

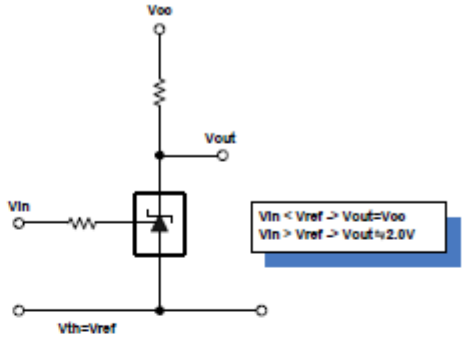
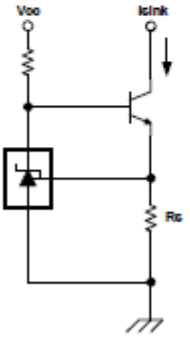
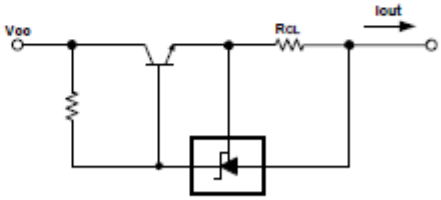


Fig15. Single-Supply Comparator with Temperature-Compensated Threshold



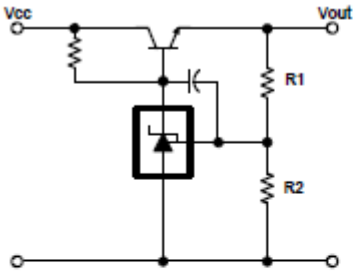
$Isink = Vref / Rs$

Fig16. Constant Current Sink



$Iout = Vref / R_{CL}$

Fig17. Constant Current Source

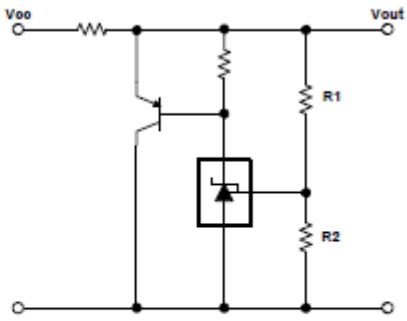


$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

$Vin(min) = Vout + Vbe$

$Vout(min) = Vref + Vbe$

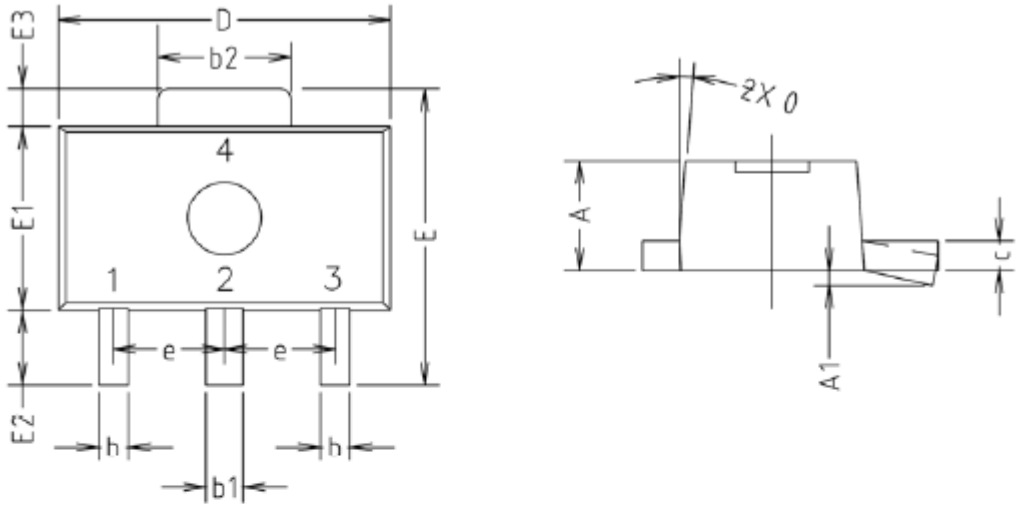
Fig18. Series Pass Regulator



$$Vout = \left(1 + \frac{R1}{R2}\right) Vref$$

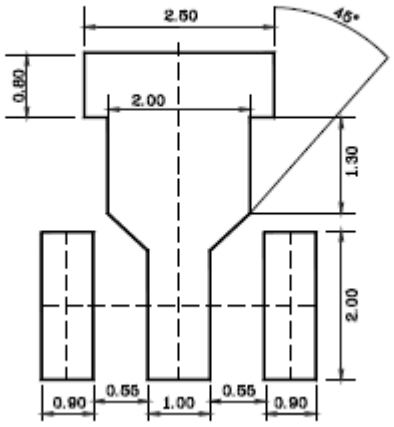
Fig19. High Currnet Shunt Regulator

SOT-89 Outline Dimension (Unit: mm)

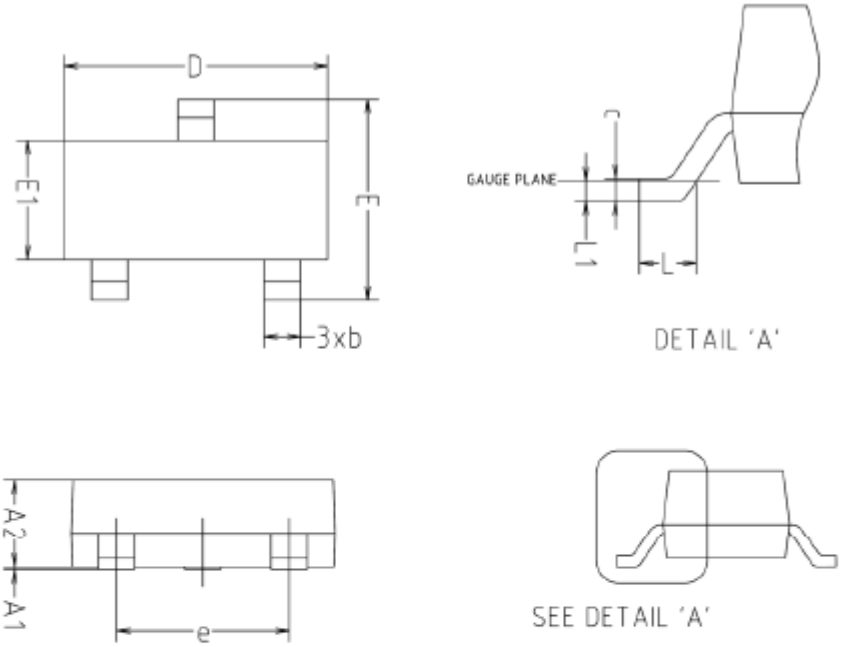


SYMBOL	MILLIMETERS			NOTE
	MINIMUM	NOMINAL	MAXIMUM	
A	1.40	1.50	1.60	
A1	0.00	–	0.10	
b	0.38	0.42	0.48	
b1	0.48	0.52	0.58	
b2	1.79	1.82	1.87	
c	0.40	0.42	0.46	
D	4.40	4.50	4.70	
E	3.70	4.00	4.30	
E1	2.40	2.50	2.70	
E2	0.80	1.00	1.20	
E3	0.40	0.50	0.60	
e	1.50 TYP.			
θ	4° TYP.			

※ Recommend PCB solder land (Unit: mm)

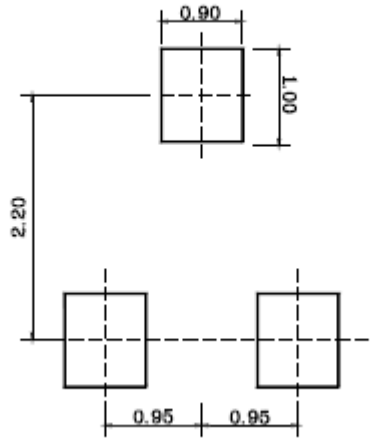


SOT-23 Outline Dimension (Unit: mm)

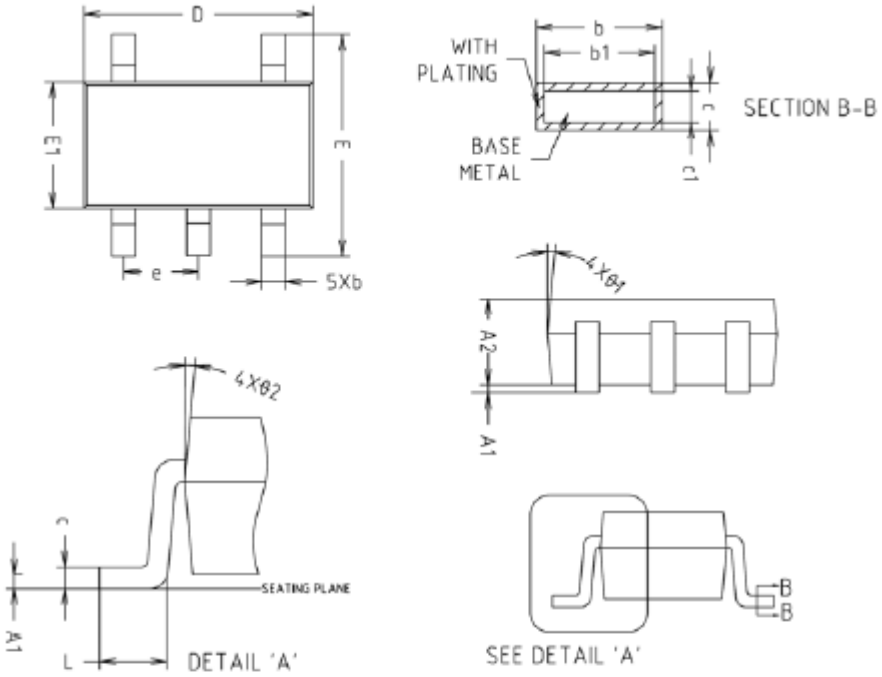


SYMBOL	MILLIMETERS			NOTE
	MINIMUM	NOMINAL	MAXIMUM	
A1	0.00	-	0.10	
A2	0.82	-	1.02	
b	0.39	0.42	0.45	
c	0.09	0.12	0.15	
D	2.80	2.90	3.00	
E	2.20	2.40	2.60	
E1	1.20	1.30	1.40	
e	1.90BSC			
L	0.20	-	-	
L1	0.12BSC			

※ Recommend PCB solder land (Unit: mm)

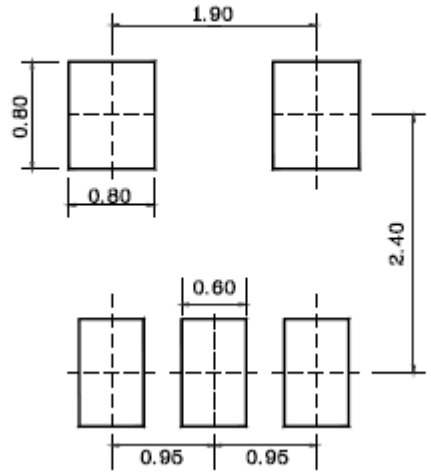


SOT-25 Outline Dimension (Unit: mm)

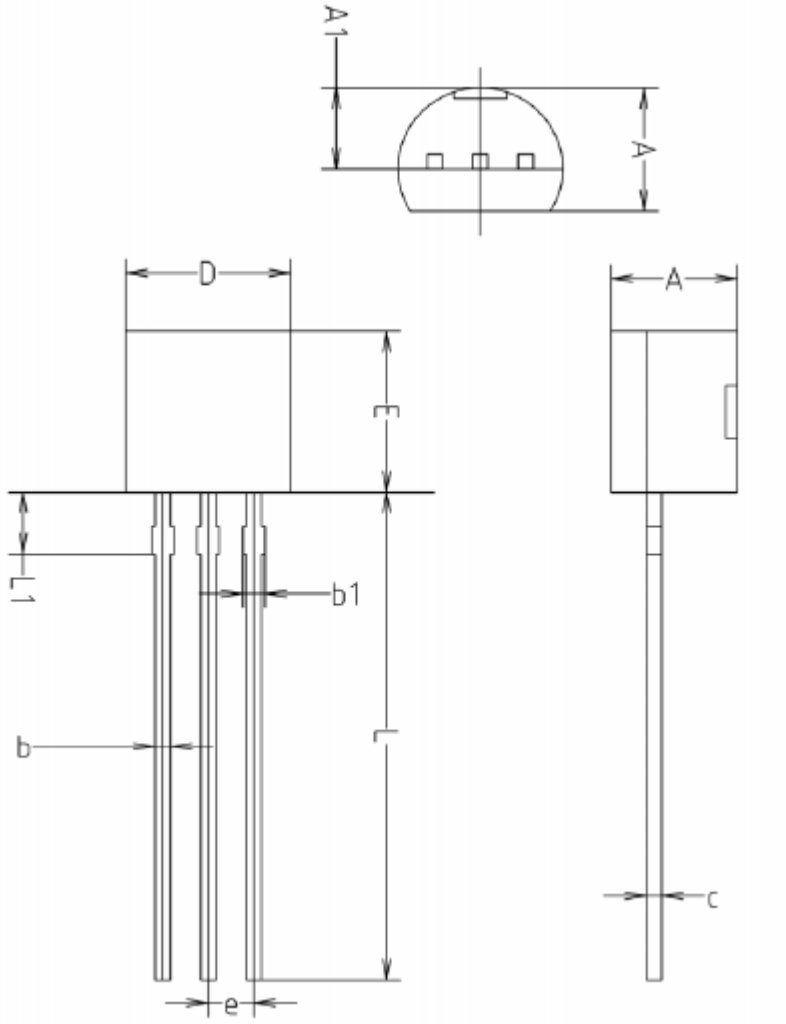


SYMBOL	MILLIMETERS			NOTE
	MINIMUM	NOMINAL	MAXIMUM	
A1	0.000	0.050	0.100	
A2	1.000	1.100	1.200	
b	-	0.400	0.450	
b1	-	0.375	0.425	
c	0.110	0.150	0.190	
c1	0.085	0.125	0.165	
D	2.800	2.900	3.000	
E	2.600	2.800	3.000	
E1	1.500	1.600	1.700	
e	0.930	0.950	0.970	
L	0.400	-	-	
θ1	5° REF			
θ2	5° REF			

※ Recommend PCB solder land (Unit: mm)

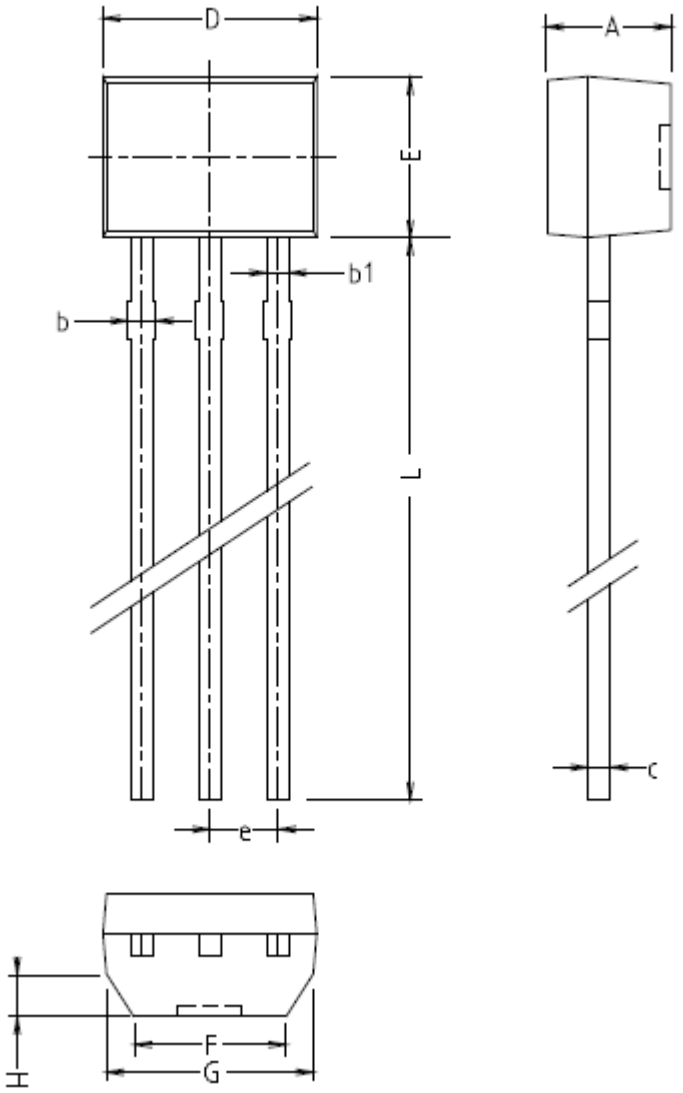


TO-92 Outline Dimension (Unit: mm)



SYMBOL	MILLMETERS(mm)		
	MINIMUM	NOMINAL	MAXIMUM
A	3.40	3.50	3.66
A1	2.46	2.51	2.59
b	0.39	0.44	0.53
b1	0.39	–	0.63
c	0.35	0.42	0.47
D	4.48	4.60	4.70
E	4.48	4.60	4.70
e	1.17	1.27	1.37
L	13.70	14.00	14.77
L1	1.55	1.70	2.15

TO-92M Outline Dimension (Unit: mm)



SYMBOL	MILLMETERS(mm)		
	MINIMUM	NOMINAL	MAXIMUM
A	2.20	2.30	2.40
b	–	0.50	–
b1	–	0.44	–
c	–	0.42	–
D	3.90	4.00	4.10
E	2.90	3.00	3.10
e	–	1.27	–
L	–	14.50	15.00
F	2.80	2.85	2.90
G	3.80	–	–
H	–	0.70	–

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