Adjustable Precision Shunt Regulator

General Description

The FE431 series ICs are three-terminal adjustable shunt regulators with guaranteed thermal stability over a full operation range. These ICs feature sharp turn-on characteristics, low temperature coefficient and low output impedance, which make them ideal substitutes for Zener diodes in applications such as switching power supply, charger and other adjustable regulators. The FE431 voltage type is 36V. The output voltage can be set to any value between and the corresponding maximum cathode voltage.
The FE431 precision reference is offered in three band gap tolerance: ±0.2%、±0.4%and±1.0%.

Features

- Programmable Precise Output Voltage from 2.5V to 36V
- Very Accurate Reference Voltage: Typical 0.15%
- High Stability under Capacitive Load
- Low Temperature Deviation: Typical 4.5mV
- Low Equivalent Full-range Temperature Coefficient with 20PPM/℃ Typical
- Low Dynamic Output Resistance: Typical 0.2Ω
- Sink Current Capacity from 1mA to 100 mA or from 0.25mA to100mA(FE431M)
- Low Output Noise

  Wide Operating Range of -40 to 85℃

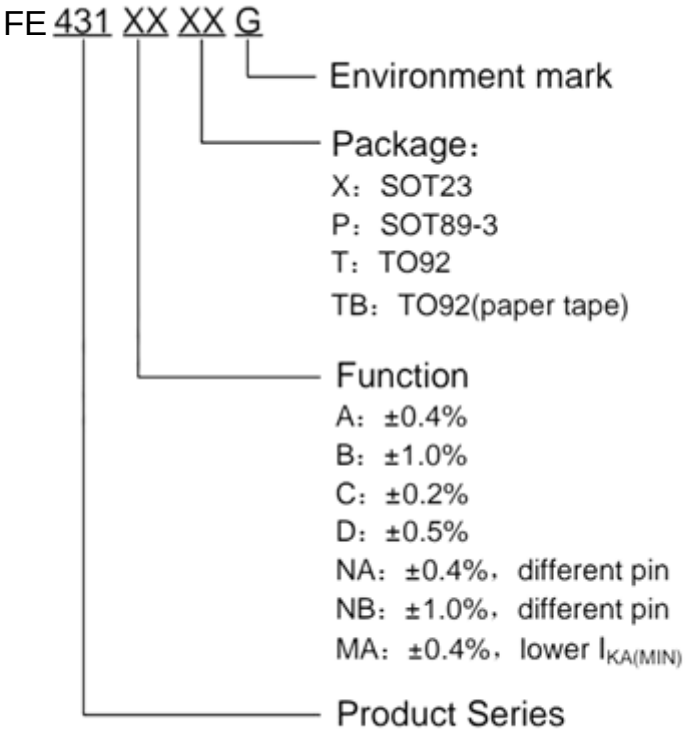
Typical Application

- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

Package

- 3-pin SOT23、TO92、SOT89-3

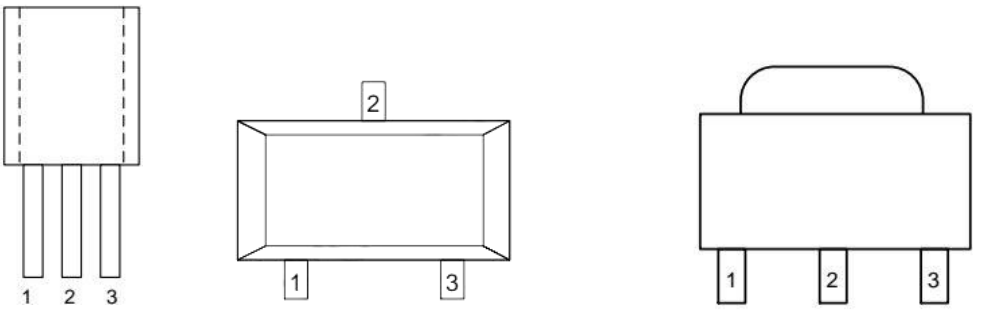
Selection Guide



product series	product description
FE431AXG	VREF=2.5V±0.4%; Package:SOT23
FE431BXG	VREF =2.5V±1.0%; Package: SOT23
FE431CXG	VREF=2.5V±0.2%; Package:SOT23
FE431DXG	VREF=2.55V±0.5%; Package: SOT23
FE431APG	VREF=2.5V±0.4%; Package: SOT89-3
FE431ATG	VREF=2.5V±0.4%; Package: TO92
FE431BTG	VREF=2.5V±1.0%; Package: TO92
FE431ATBG	VREF=2.5V±0.4%; Package: TO92;paper tape
FE431BTBG	VREF=2.5V±1.0%; Package: TO92;paper tape
FE431NAXG	VREF=2.5V±0.4%; Package: SOT23; Different pin
FE431NBXG	VREF=2.5V±1.0%; Package: SOT23; Different pin
FE431MAXG	VREF=2.5V±0.4%; Package:SOT23;Lower $I_{kA(MIN)}$

NOTE: If you need other voltage and package, please contact our sales staff 。

PIN Configuration

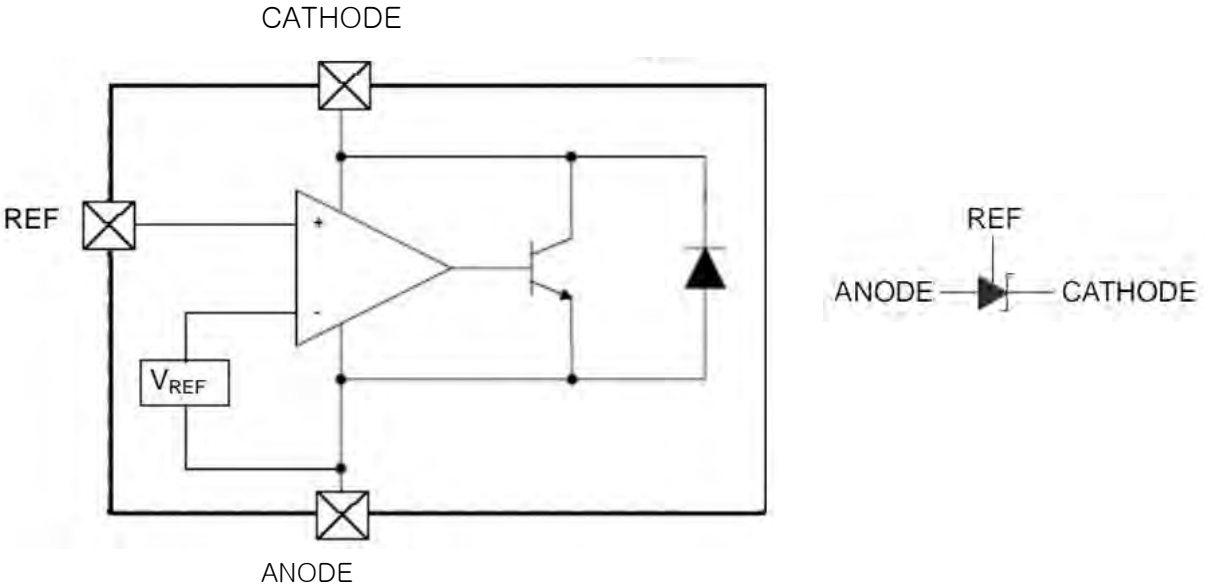


TO92 SOT23 SOT89-3

Pin Assignment

Pin Number		Symbol	Functions
FE431/FE431M	FE431N		
1	3	R	reference
2	2	A	anode
3	1	K	cathode

Block Diagram and symbol



Absolute Maximum Ratings

Parameter	Symbal	Rating	Unit
Cathode voltage	V_{KA}	36	V
Cathode current range (continuous)	I_{KA}	-100~+130	mA
Reference input current range	I_{REF}	10	mA
Power Dissipation	P_D	TO-92 Package:0.8	W
		SOT23 Package:0.4	
		SOT89-3 Package:1.25	
Junction temperature	T_J	-40~+150	℃
Storage Temperature range	T_{STG}	-55~+150	℃
Package thermal impedance (Junction to air)	θ_{JA}	TO-92 package:150	℃/W
		SOT23 package:330	
		SOT89-3 Package:100	

Note: Use this IC within the stated maximum ratings. Operation beyond these limits may cause degrading or permanent damage to the device.

Recommended Operating Conditions

Parameter		Symbol	Min	Max	Unit
Cathode Voltage		V_{KA}	V_{REF}	36	V
Cathode Current	FE431/FE431N	I_{KA}	1.0	100	mA
	FE431M		0.25	100	
Operating Ambient Temperature Range			-40	85	℃

Electrical Characteristics (T_A=25℃ ,unless otherwise noted)

Parameter		Symbol	Conditions		Min	Typ.	Max	Unit	Test circuit
Reference voltage	±0.2%	V_{REF}	$V_{KA}=V_{REF}, I_{KA}=10mA$		2.495	2.50	2.505	V	Fig.1
	± 0.4%				2.490	2.50	2.510		
	± 1.0%				2.475	2.50	2.525		
	± 0.5%				2.537	2.55	2.562		
Deviation of reference voltage over-temperature		ΔV_{REF}	$V_{KA}=V_{REF}$, $I_{KA}=10mA$	0 to 70 ℃	-	7	10	mV	Fig.1
				-40 to 150 ℃	-	25	30		
Dynamic impedance		$\lvert Z_{KA}\rvert$	$V_{KA}=V_{REF}, I_{KA}$=1 to 100mA, f≤ 1.0KHz		-	0.15	0.5	Ω	Fig.1
Minimum cathode current for regulation		I_{KA} (MIN)	$V_{KA}=V_{REF}$	FE431/FE431N	-	0.4	1.0	mA	Fig.1
				FE431M	-	0.22	0.25	mA	Fig.1
Ratio of change in		ΔV_{REF}	I_{KA}=10mA	ΔV_{KA}=10V to V_{REF}	-	-0.8	-2.5	mV/V	Fig.2

reference voltage to the change in cathode voltage			ΔV_{KA}=36V to 10V	-	-0.6	-1.5		
Reference current	I_{REF}	I_{KA}=10mA, R1=10KΩ, R2=x			0.7	3	μA	Fig.2
Deviation of reference over full temperature range	ΔI_{REF}	I_{KA}=10mA, R1=10K Ω, R2=x<, TA=40 to 150℃			0.1	1.2	μA	Fig.2
Off-state cathode current	I_{KA} (OFF)	V_{KA}=36V, V_{REF}=0			0.03	0.3	μA	Fig.3

Note:The dynamic impedance is defined as: $|Z_{KA}| = \triangle V_{KA} / \triangle I_{KA}$

Test Circuit

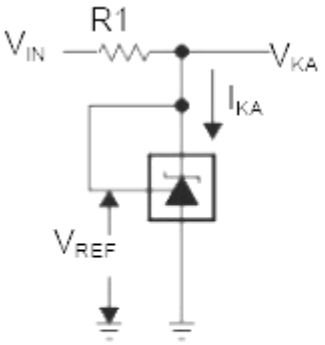
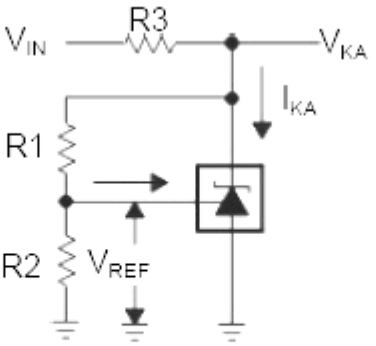


Fig.1: for $V_{KA} = V_{REF}$



$V_{KA} = V_{REF}(1+R1/R2) + I_{REF}R1$

Fig.2: for $V_{KA} > V_{REF}$

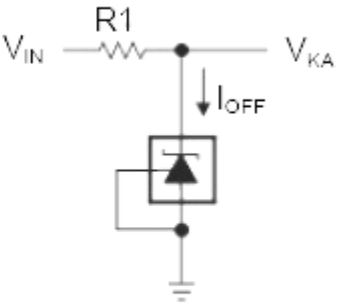
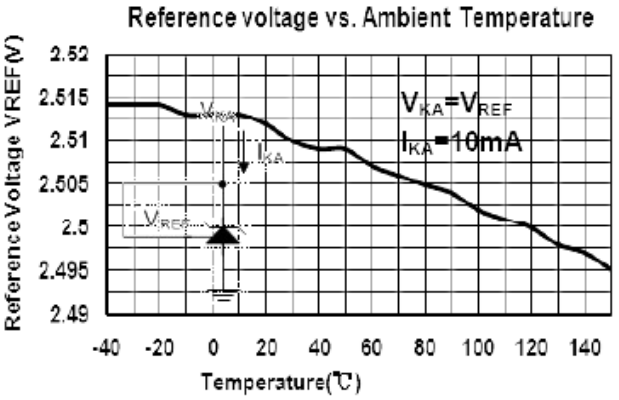
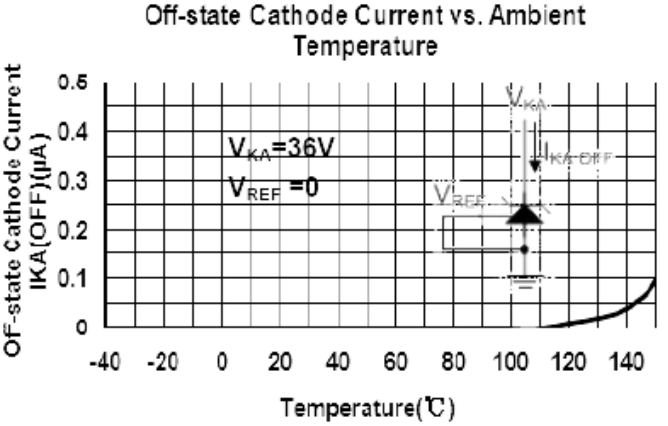


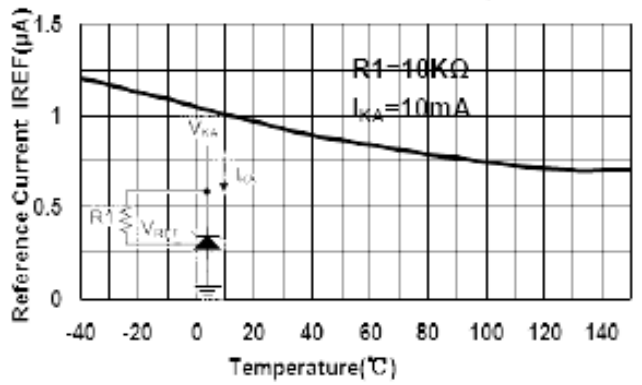
Fig.3: for I_{OFF}

Typical Performance Characteristics

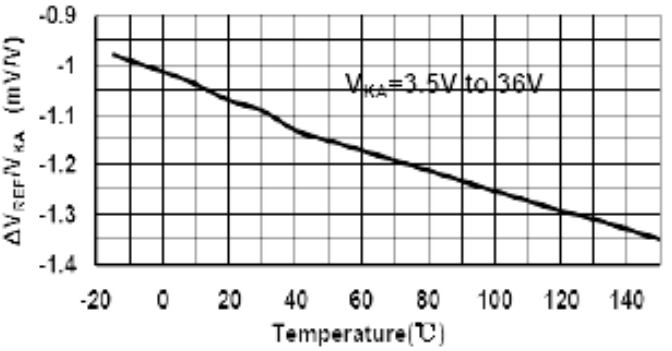




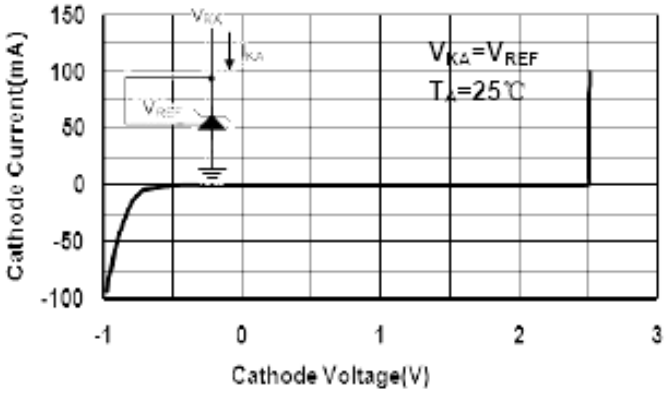
Reference Current vs. Ambient Temperature



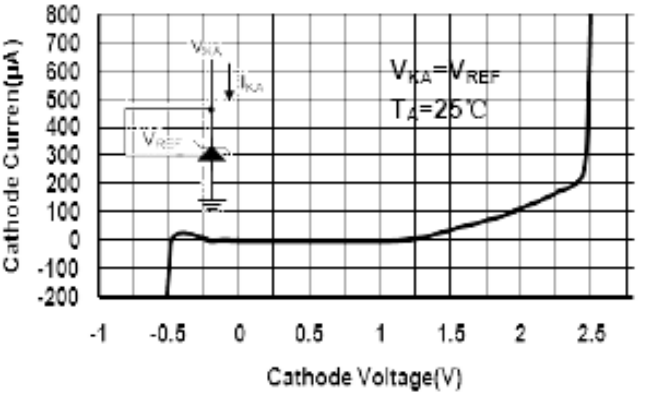
Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage



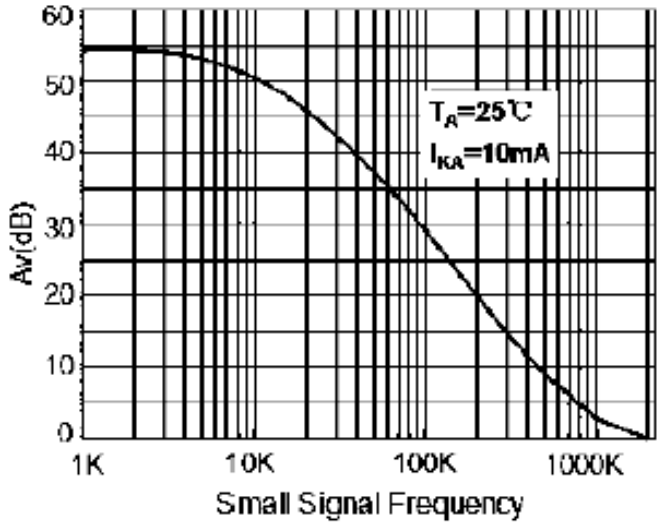
Cathode Current vs. Cathode Voltage

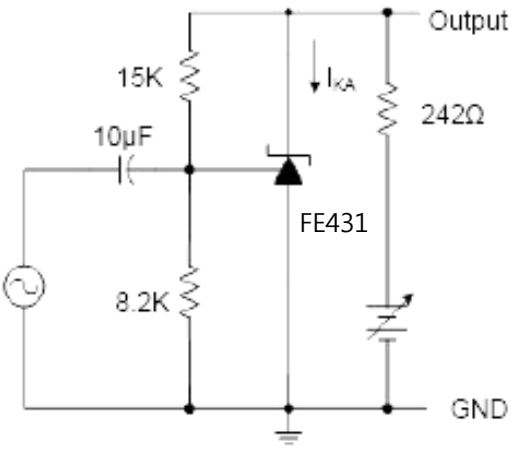


Cathode Current vs. Cathode Voltage

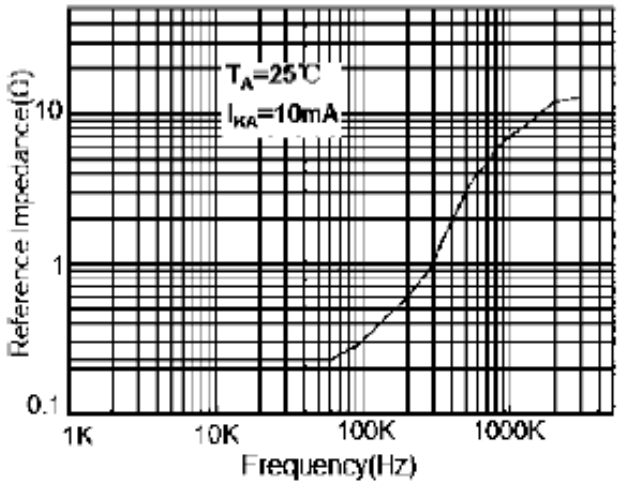


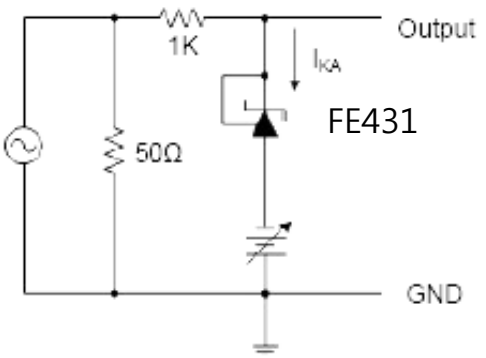
Small Signal Voltage Gain vs. Frequency



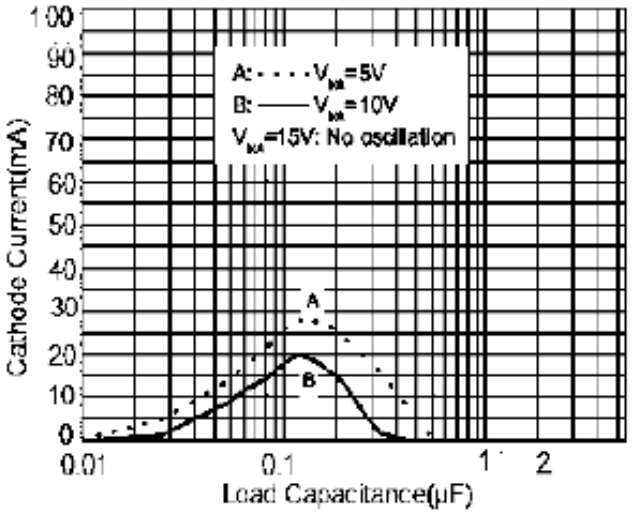


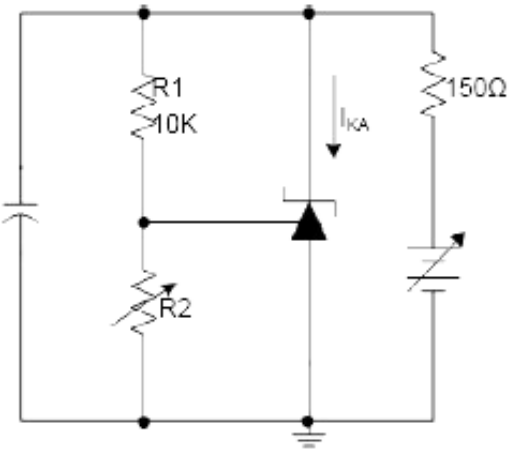
Reference Impedance vs. Frequency



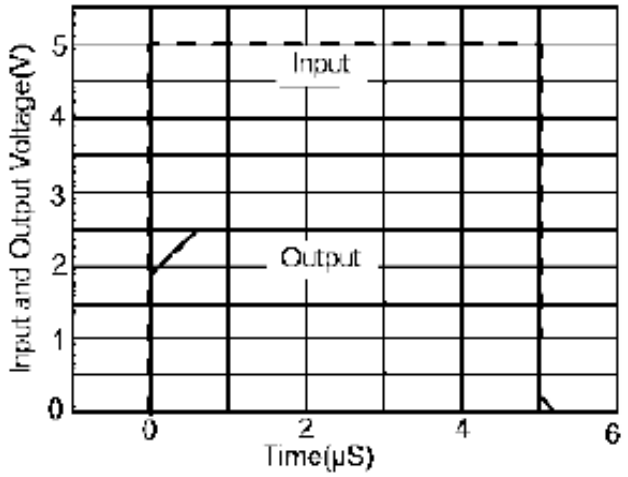


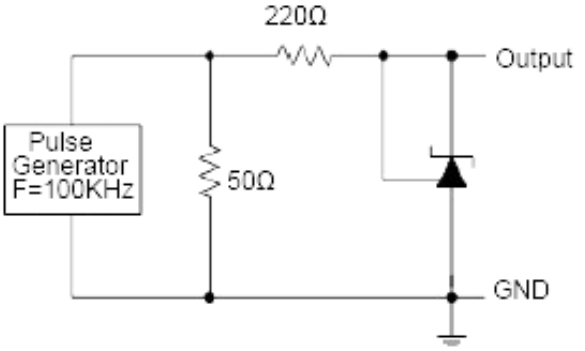
Stability Boundary Conditions vs. Load Capacitance



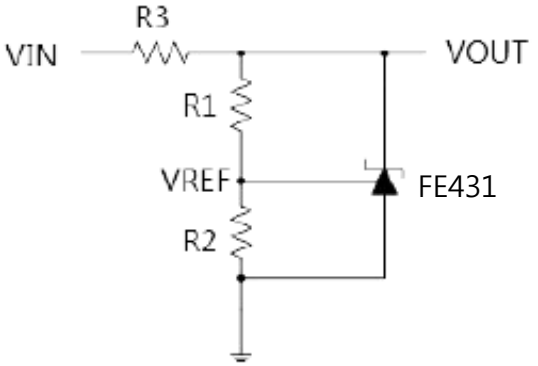


Pulse Response of Input and Output Voltage



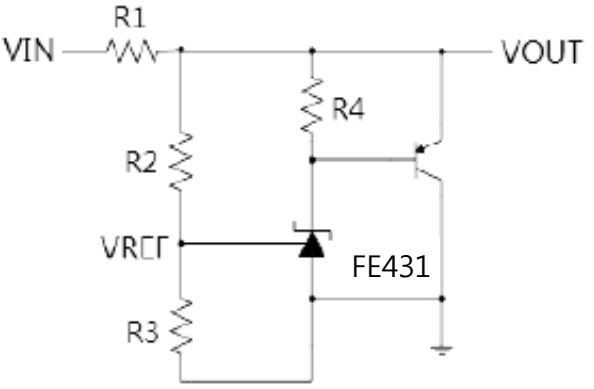


Typical Application



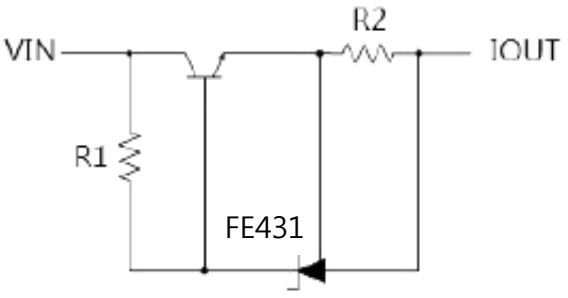
$V_O=(1+R1/R2)V_{REF}$

Fig.4: Shunt Regulator



$V_O=(1+R2/R3)V_{REF}$

Fig.5: High Current Shunt Regulator



$I_{OUT}=V_{REF}/R2+I_{KA}$

Fig.6: Current Source or Current Limit

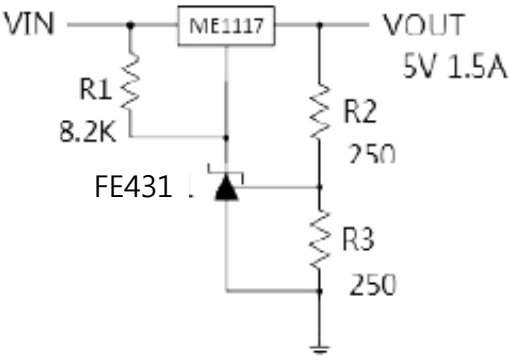
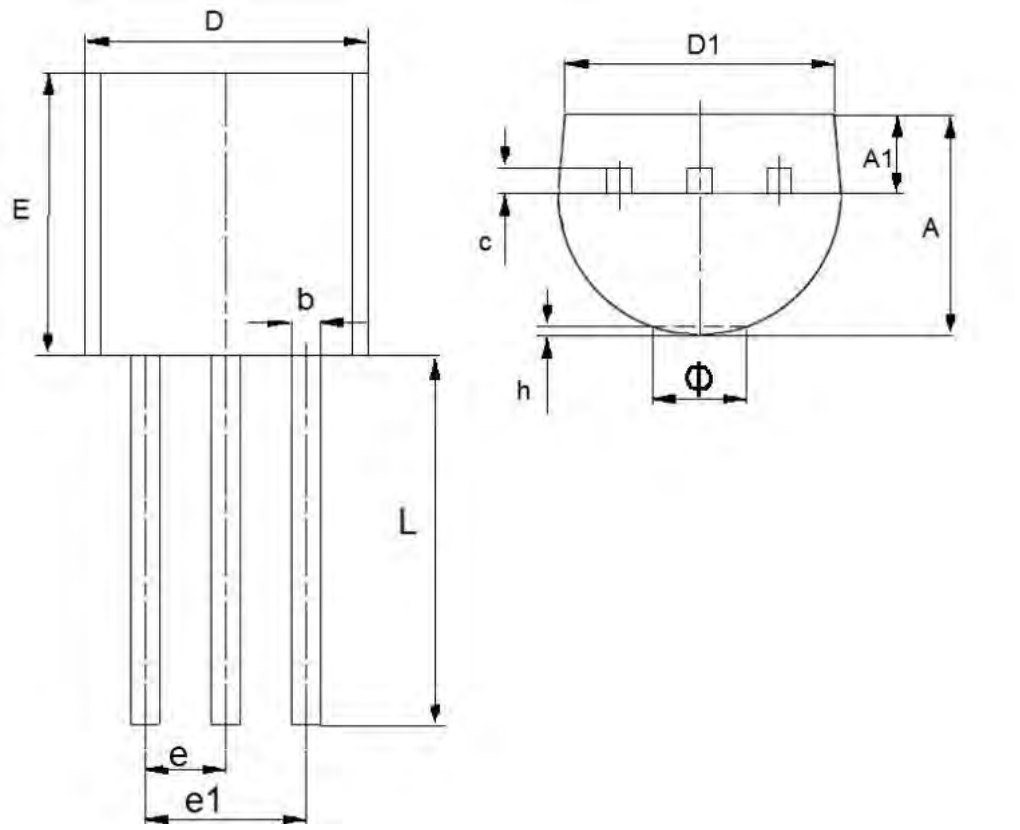


Fig.7: Precision 5V 1.5A Regulator

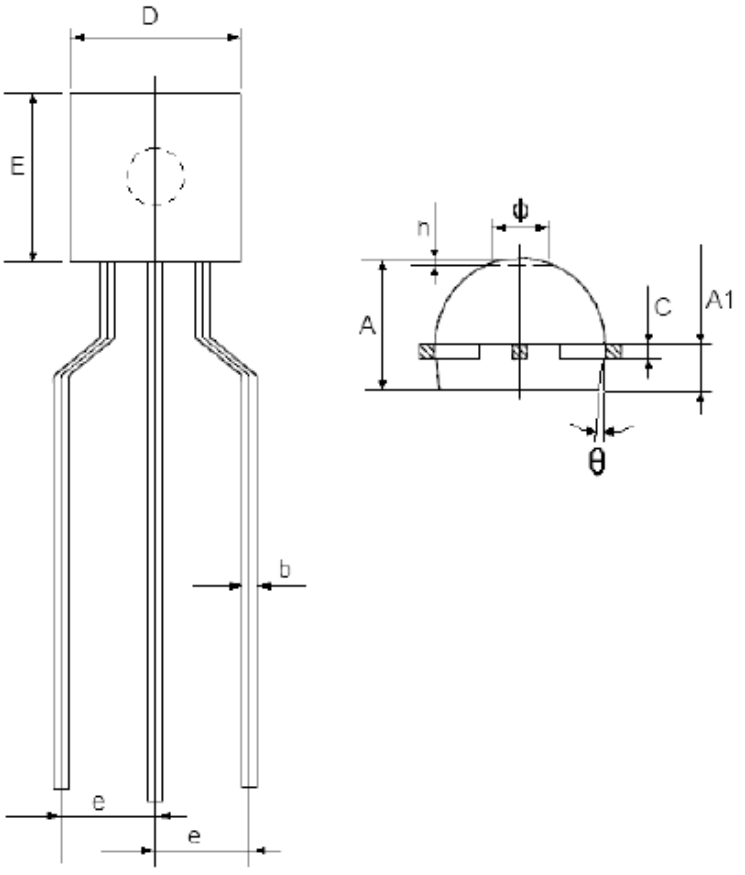
Packaging Type

· TO-92



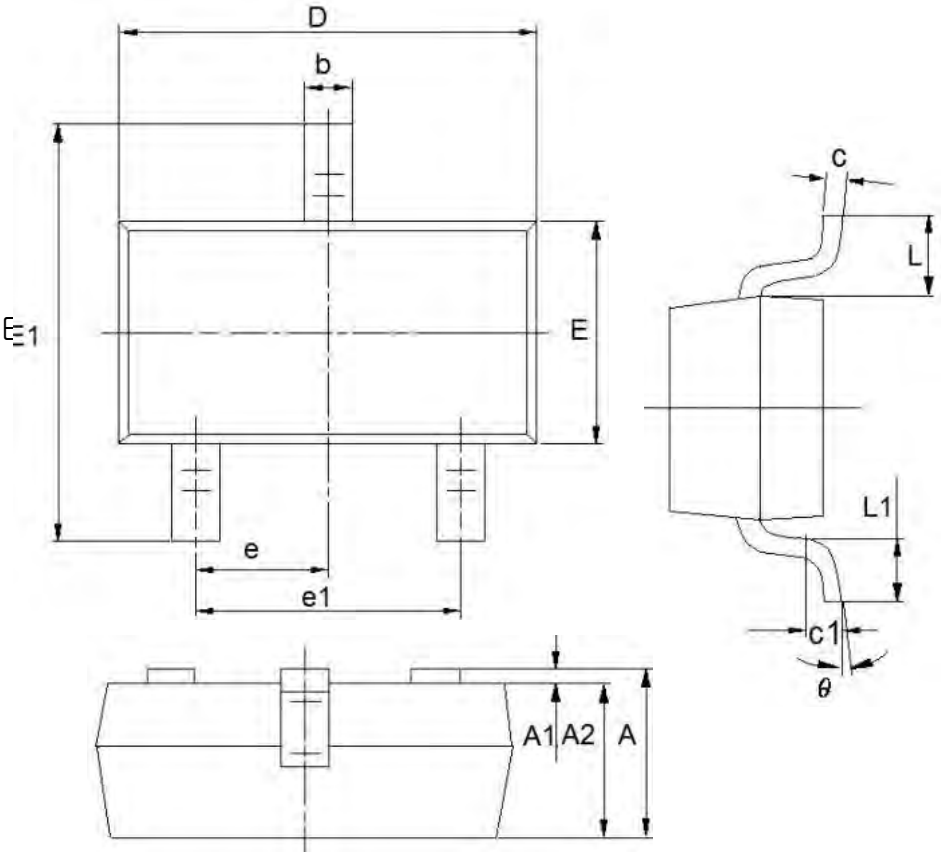
DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	3.3	3.7	0.1299	0.1457
A1	1.1	1.4	0.0433	0.0551
b	0.38	0.55	0.015	0.0217
C	0.36	0.51	0.0142	0.0201
D	4.3	4.7	0.1693	0.185
D1	3.43	—	0.135	—
E	4.3	4.7	0.1693	0.185
e	1.27TYP		0.05TYP	
e1	2.44	2.64	0.0961	0.1039
L	14.1	14.5	0.5551	0.5709
h	0	0.38	0	0.015
Φ	—	1.6	—	0.063

· TO-92 (Paper Tape)



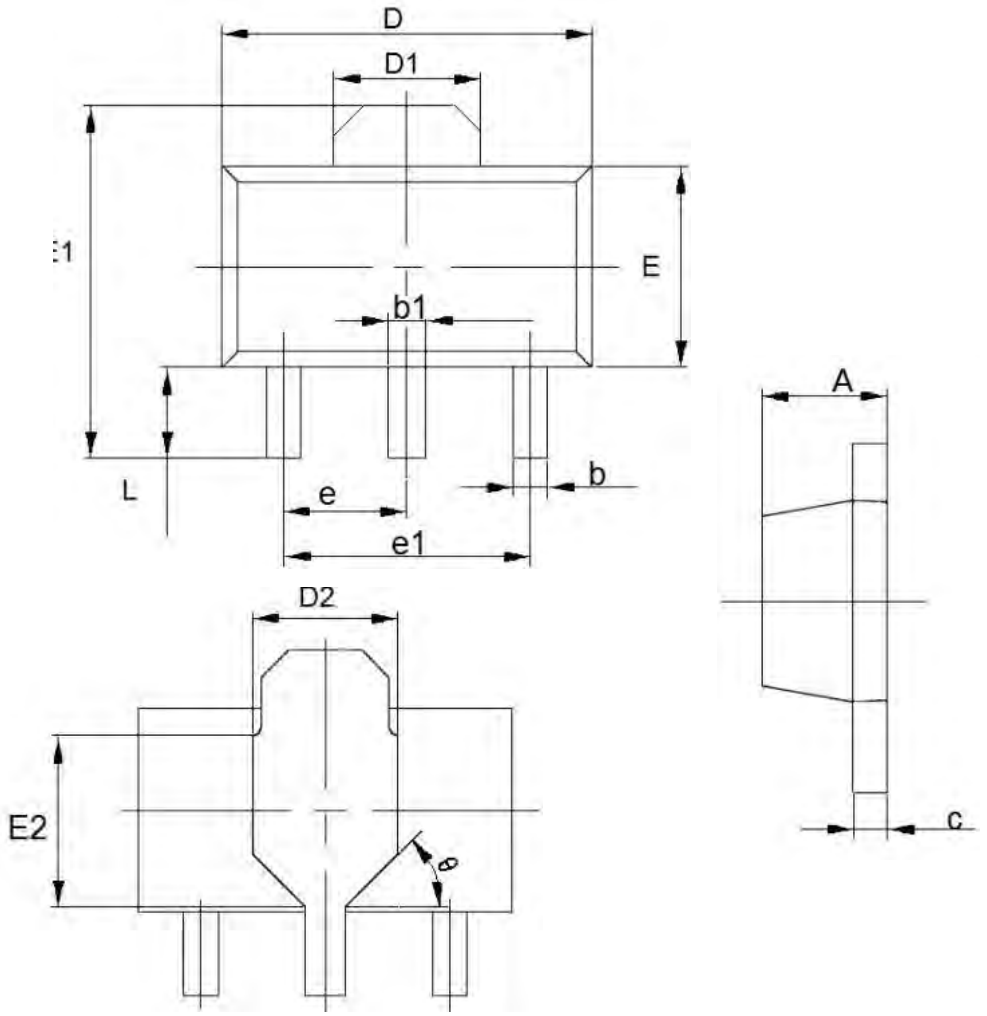
DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	3.4	3.7	0.1339	0.1457
A1	1.15	1.4	0.0453	0.0551
b	0.36	0.5	0.0142	0.0197
C	0.38		0.0150	
D	4.4	4.7	0.1732	0.1850
E	4.4	4.7	0.1732	0.1850
e	2.2	2.8	0.0866	0.1102
Φ	1.5		0.0591	
θ	5°		5°	
h	0.2		0.0079	

· SOT23



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.9	1.15	0.0354	0.0453
A1	0	0.14	0.0000	0.0055
A2	0.9	1.05	0.0354	0.0413
b	0.28	0.52	0.0110	0.0205
C	0.07	0.23	0.0028	0.0091
D	2.8	3.0	0.1102	0.1181
e1	1.8	2.0	0.0709	0.0787
E	1.2	1.4	0.0472	0.0551
E1	2.2	2.6	0.0866	0.1024
e	0.95(TYP)		0.0374(TYP)	
L	0.55(TYP)		0.0217(TYP)	
L1	0.25	0.55	0.0098	0.0217
θ	0	8°	0.0000	8°
c1	0.25(TYP)		0.0098(TYP)	

· SOT89-3



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.4	1.6	0.0551	0.0630
b	0.32	0.52	0.0126	0.0205
b1	0.4	0.58	0.0157	0.0228
C	0.35	0.45	0.0138	0.0177
D	4.4	4.6	0.1732	0.1811
D1	1.55(TYP)		0.061(TYP)	
D2	1.75(TYP)		0.0689(TYP)	
e1	3.0(TYP)		0.1181(TYP)	
E	2.3	2.6	0.0906	0.1023
E1	3.94	4.4	0.1551	0.1732
E2	1.9(TYP)		0.0748(TYP)	
e	1.5(TYP)		0.0591(TYP)	
L	0.8	1.2	0.0315	0.0472
θ	45°		45°	