

## GENERAL DESCRIPTION

The CM431 is a three-terminal adjustable shunt voltage regulator with specified thermal stability and pin-to-pin compatible with the earlier 431 series. The output voltage can be adjusted to any value between  $V_{REF}$  and 36V by using two external resistors. The CM431 offers low output impedance for improved load regulation with a typical output impedance of 200m $\Omega$ . Because of the active output circuitry, the CM431 can replace the zener diodes in applications such as switching power supplies, OVP crowbar circuits, references for A/D, D/A converters with improved turn-on characteristics.

## FEATURES

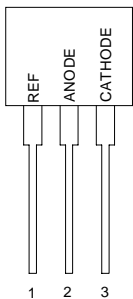
- ◆ Initial voltage reference accuracy of 1.0%.
- ◆ Sink current capability from 1mA to 100mA
- ◆ Typical output dynamic impedance less than 200m $\Omega$ ;
- ◆ Adjustable output voltage from  $V_{REF}$  to 36V
- ◆ Available in SOT-23, SOT-89, TO-92, & SOP-8
- ◆ Low output noise
- ◆ Typical equivalent full range temperature coefficient of 30ppm/ $^{\circ}$ C

## APPLICATIONS

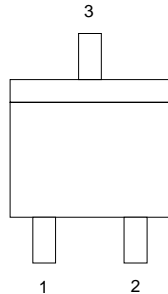
- ◆ Voltage Reference
- ◆ Precision shunt regulator
- ◆ High current shunt regulator
- ◆ PWM down converter with reference
- ◆ Voltage monitor

## PIN CONFIGURATION

TO-92  
Front View



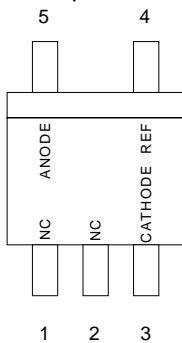
SOT-23-3  
Top View



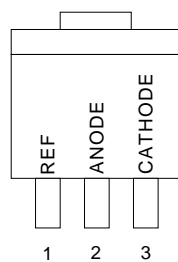
	CM431XCM233	CM431XCM2R3
Pin 1	REF	CATHODE
Pin 2	CATHODE	REF
Pin 3	ANODE	ANODE

Suffix "X": Grade "A", "B", "C", or "D"

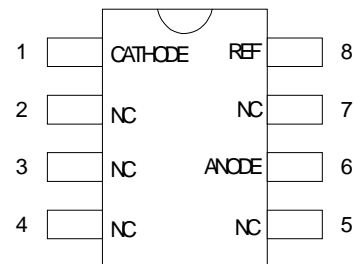
SOT-23-5  
Top View

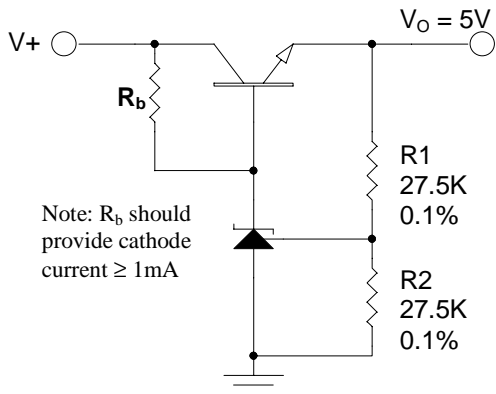
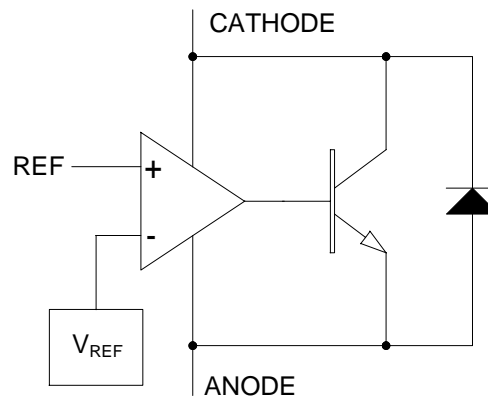


SOT-89  
Top View



SOP-8  
Top View



**TYPICAL APPLICATION**

**5V Precision Regulator**
**BLOCK DIAGRAM**

**ORDERING INFORMATION**

PACKAGE	TOLERANCE			T/R Quantity
	0.5%	0.7%	1.0%	
SOT-23 <sup>(1)</sup>	CM431ACM233	CM431DCM233	CM431BCM233	TR=3K
SOT-23 <sup>(1)</sup>	CM431ACM2R3	CM431DCM2R3	CM431BCM2R3	TR=3K
SOT-89 <sup>(1)</sup>	CM431ACM89	CM431DCM89	CM431BCM89	TR=1K
TO-92 <sup>(2)</sup>	CM431ACN	CM431DCN	CM431BCN	TA=2K
SOP-8	CM431ACS	CM431DCS	CM431BCS	

Notes :

- (1) Add suffix "TR" for Tape & Reel.
- (2) Add suffix "TA" for Tape Ammo.

**ABSOLUTE MAXIMUM RATINGS**

Cathode to Anode Voltage ( $V_{KA}$ ) (Note 2)	-0.3V to 37V
Continuous Cathode Current ( $I_K$ )	-100mA to 150mA
Reference Input Current ( $I_{REF}$ )	-50uA to 10mA
Maximum junction temperature range, $T_J$	150°C
Storage temperature range	-65°C to 150°C
Lead temperature (soldering, 10 seconds)	260°C

Note 1: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

Note 2: Voltage values are with respect to the anode terminal unless otherwise noted.

**POWER DISSIPATION TABLE**

Package	$\theta_{JA}$ (°C/W)	Derating factor ( mW/°C ) $T_A \geq 25^\circ\text{C}$	$T_A \leq 25^\circ\text{C}$ Power rating(mW)	$T_A=70^\circ\text{C}$ Power rating(mW)	$T_A= 85^\circ\text{C}$ Power rating (mW)
SOP-8	165	6.06	757	485	394
TO-92	156	6.41	801	513	417
SOT-89	71(note)	14.1	1763	1128	916
SOT-23	285	3.5	438	280	228

Note :

1. For SOT-89 package, Thermal Resistance-Junction to Tab ( $\theta_{JT}$ ) = 35°C/W.  $T_J = T_{TAB} + (P_D \times \theta_{JT})$

2.  $\theta_{JA}$ : Thermal Resistance-Junction to Ambient

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ .

The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/PC-board system.

All of the above assume no ambient airflow.

**RECOMMENDED OPERATING CONDITIONS**

	Min	Max	Units
Operating free air temperature range, $T_A$	0	105	°C
Cathode current, $I_K$	1	100	mA
Cathode voltage, $V_{KA}$	0	36	V

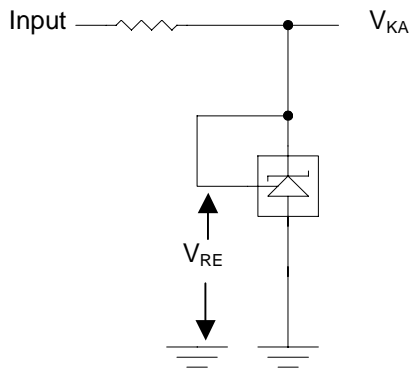
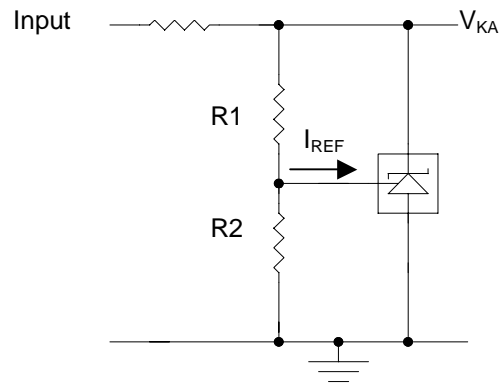
**ELECTRICAL CHARACTERISTICS**

 Unless otherwise specified, these specifications apply over the operating ambient temperatures with  $T_A = 25^\circ\text{C}$ .

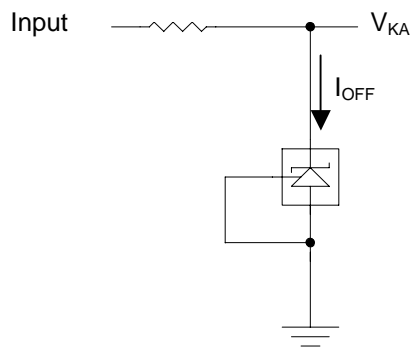
Parameter	Symbol	Test Conditions	CM431			Units
			Min	Typ	Max	
Reference Input Voltage	$V_{REF}$	$I_K = 10\text{mA}, V_{KA} = V_{REF}, 0.5\%$	2.482	2.495	2.507	V
		$I_K = 10\text{mA}, V_{KA} = V_{REF}, 0.7\%$	2.478	2.495	2.512	V
		$I_K = 10\text{mA}, V_{KA} = V_{REF}, 1.0\%$	2.470	2.495	2.520	V
Reference Drift		$I_K = 10\text{mA}, V_{KA} = V_{REF}, 0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$		4	17	mV
Voltage Ratio, Ref to Cathode (note 4)		$I_K = 10\text{mA}, V_{KA} = 2.5\text{V to } 36\text{V}$		-1.4	-2.7	mV/V
Reference Input Current	$I_{REF}$	$I_K = 10\text{mA}, V_{KA} = V_{REF}$		2	4	$\mu\text{A}$
		$I_K = 10\text{mA}, V_{KA} = V_{REF}, 0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$			2.3	
Minimum Operating Current	$I_{MIN}$	$V_{KA} = V_{REF}$		0.4	1	mA
Off-State Cathode Current	$I_{OFF}$	$V_{KA} = 36\text{V}, V_{REF} = 0\text{V}$		0.1	1	$\mu\text{A}$
Dynamic Impedance	$ Z_{KA} $	$V_{KA} = V_{REF}, I_K = 1\text{mA to } 100\text{mA}, f \leq 1\text{kHz}$		0.2	0.5	$\Omega$

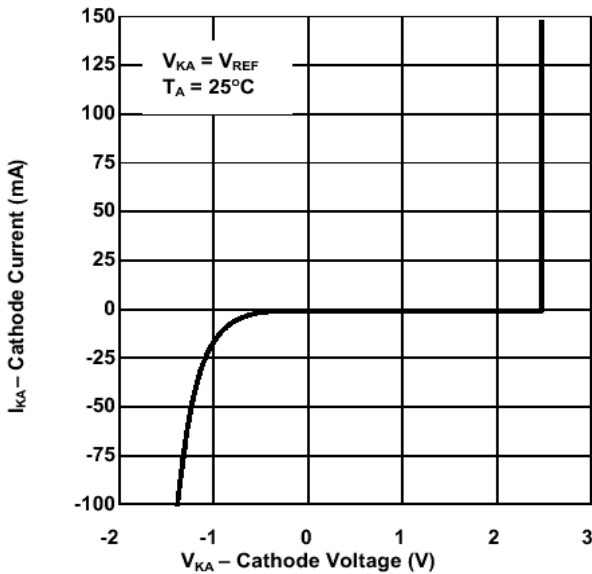
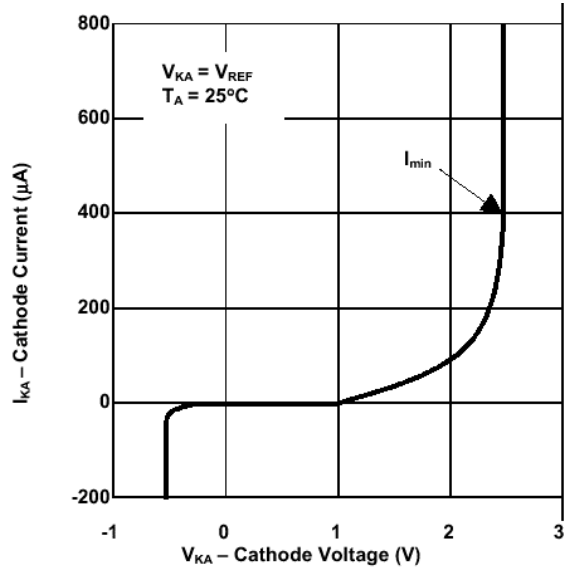
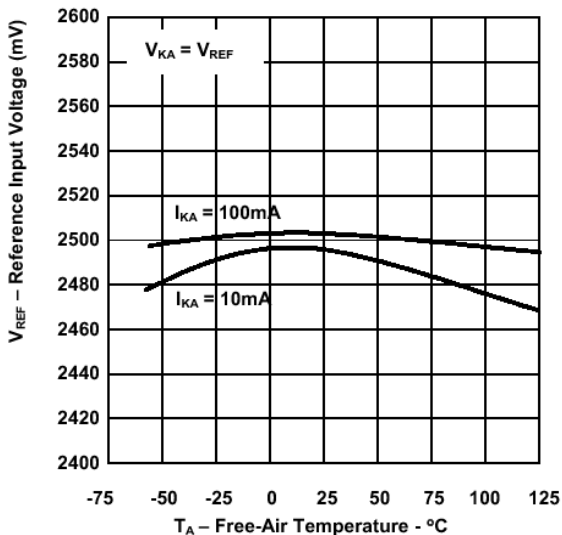
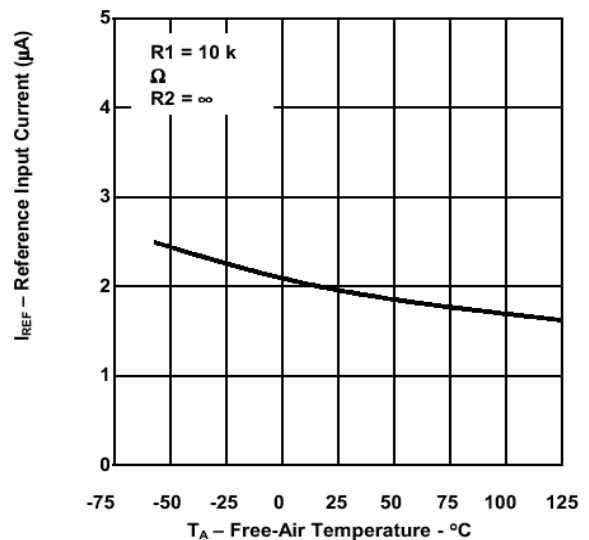
Note 3: These parameters are guaranteed by design

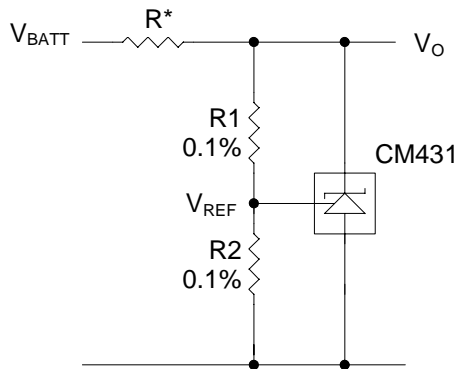
 Note 4:  $\frac{\Delta V_{REF}}{\Delta V_{KA}}$  Ratio of change in reference input voltage to the change in cathode voltage

**PARAMETER MEASUREMENT INFORMATION**

**Figure 1.** Test Circuit for  $V_{KA} = V_{REF}$ 


$$(1 + R1/R2) + I_{REF} \times R1$$

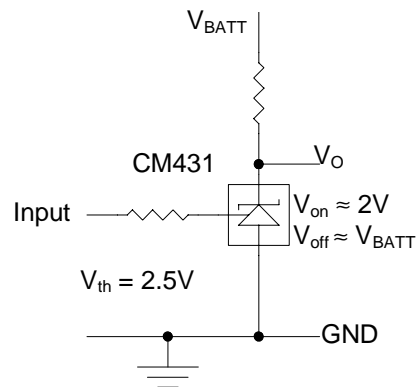
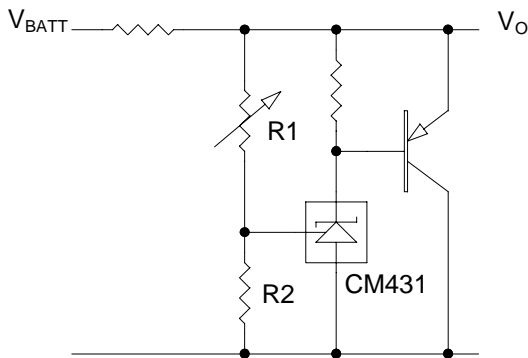
**Figure 2.** Test Circuit for  $V_{KA} > V_{REF}$ 

**Figure 3.** Test Circuit for  $I_{OFF}$

**TYPICAL CHARACTERISTICS**
**Cathode Current vs. Cathode Voltage**

**Cathode Current vs. Cathode Voltage**

**Ref. Input Voltage vs. Free-Air Temperature**

**Ref. Input Current vs. Free-Air Temperature**


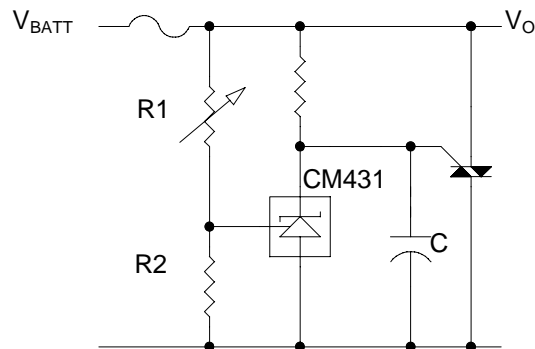
**APPLICATION INFORMATION**


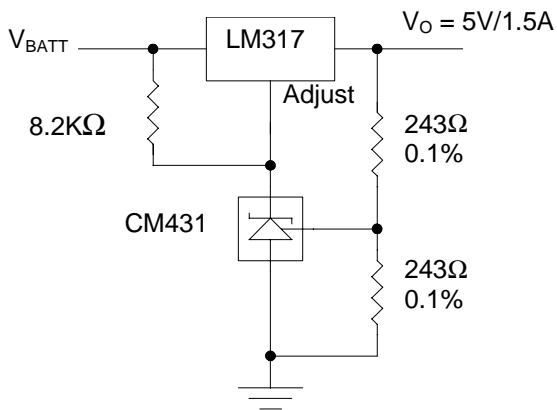
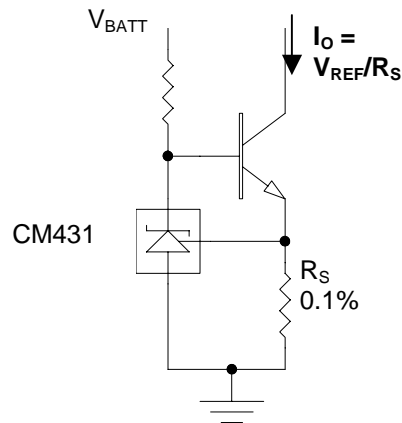
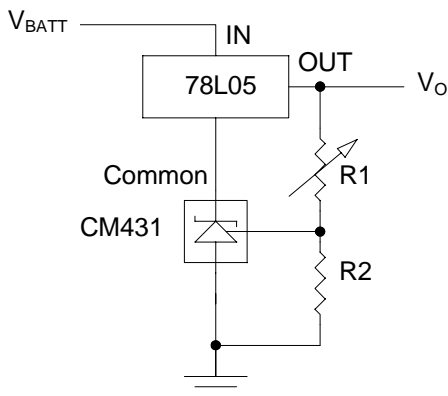
$$V_O = (1 + R1/R2) \times V_{REF}$$

Note: R should provide 1mA cathode current to the CM431 of minimum  $V_{BATT}$

**Figure 4. Shunt Regulator**

**Figure 5. Single-Supply Comparator With Temperature compensated threshold.**


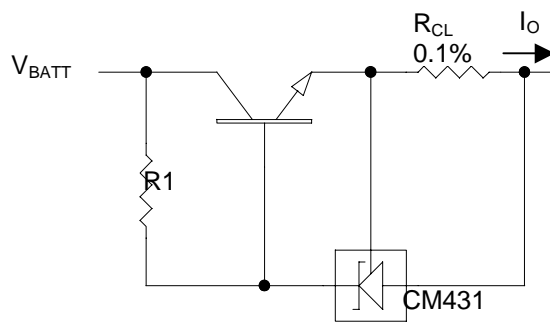
$$V_O = (1 + R1/R2) \times V_{REF}$$

**Figure 6. High-Current Shunt Regulator**

**Figure 7. Crowbar Circuit**

**APPLICATION INFORMATION (continued)**

**Figure 8.** Precision 5V, 1.5A Regulator

**Figure 9.** Precision Constant Current Sink


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

$$\text{Min } V_O = V_{REF} + 5V$$

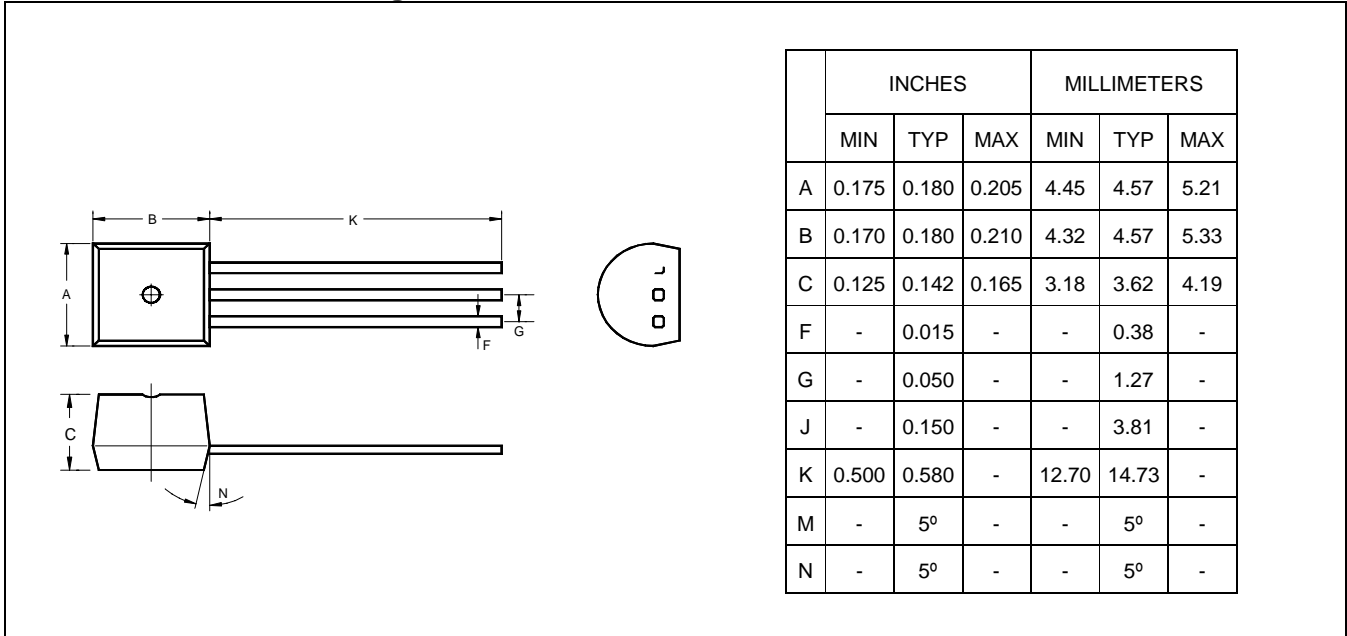
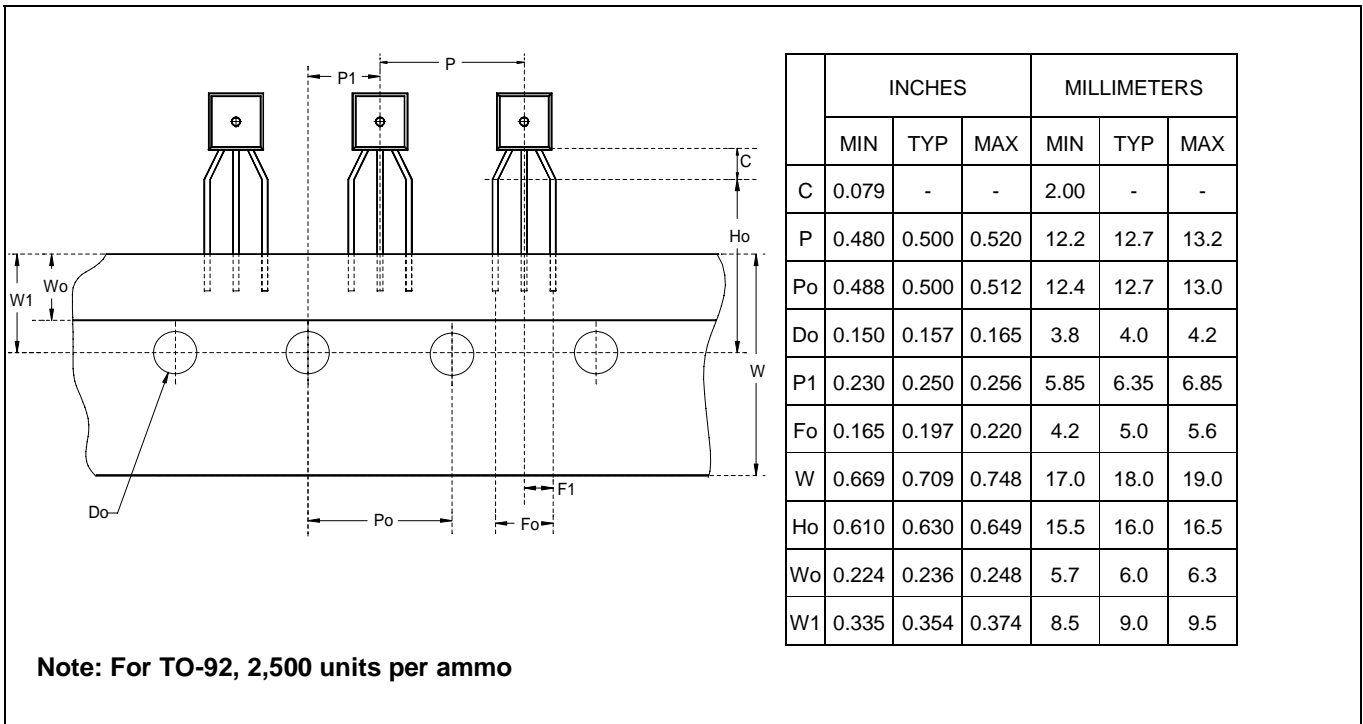
**Figure 10.** Output Control of a Three-Terminal Fixed Regulator


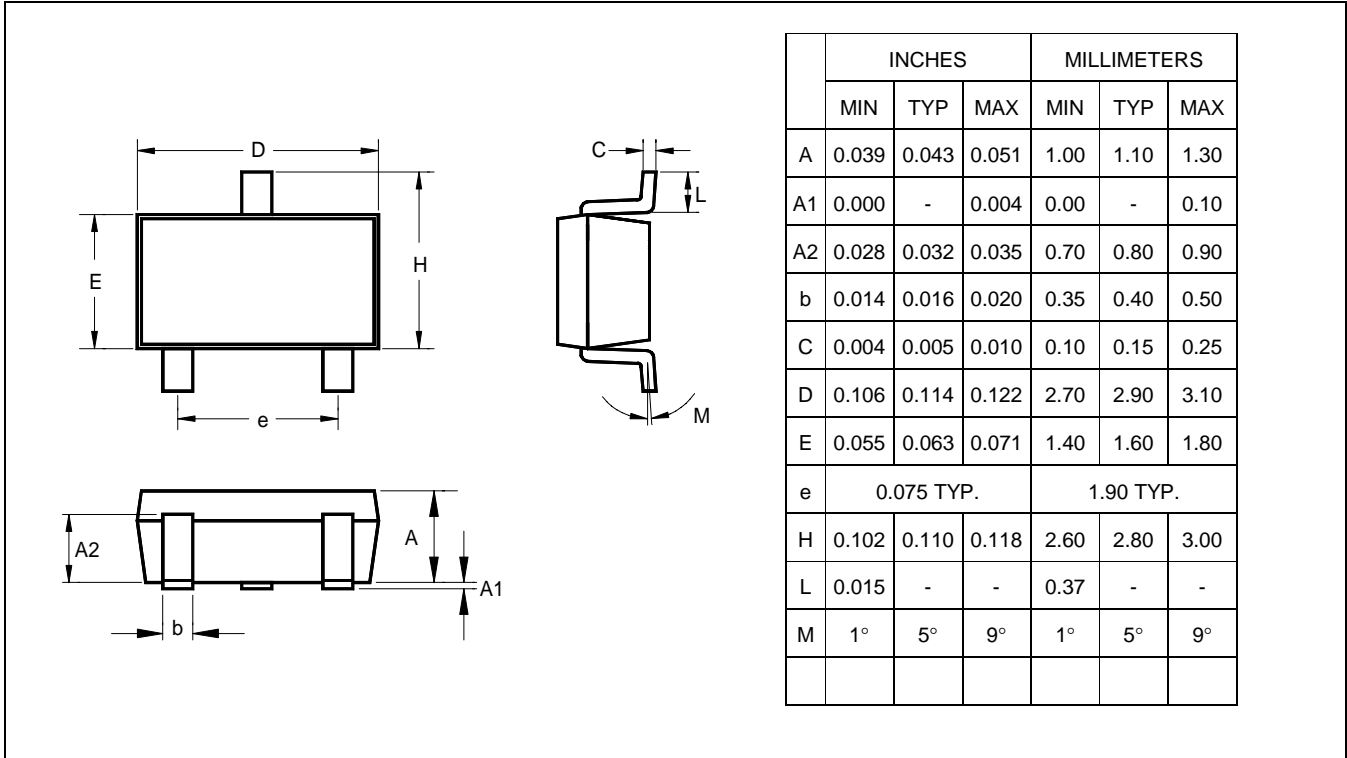
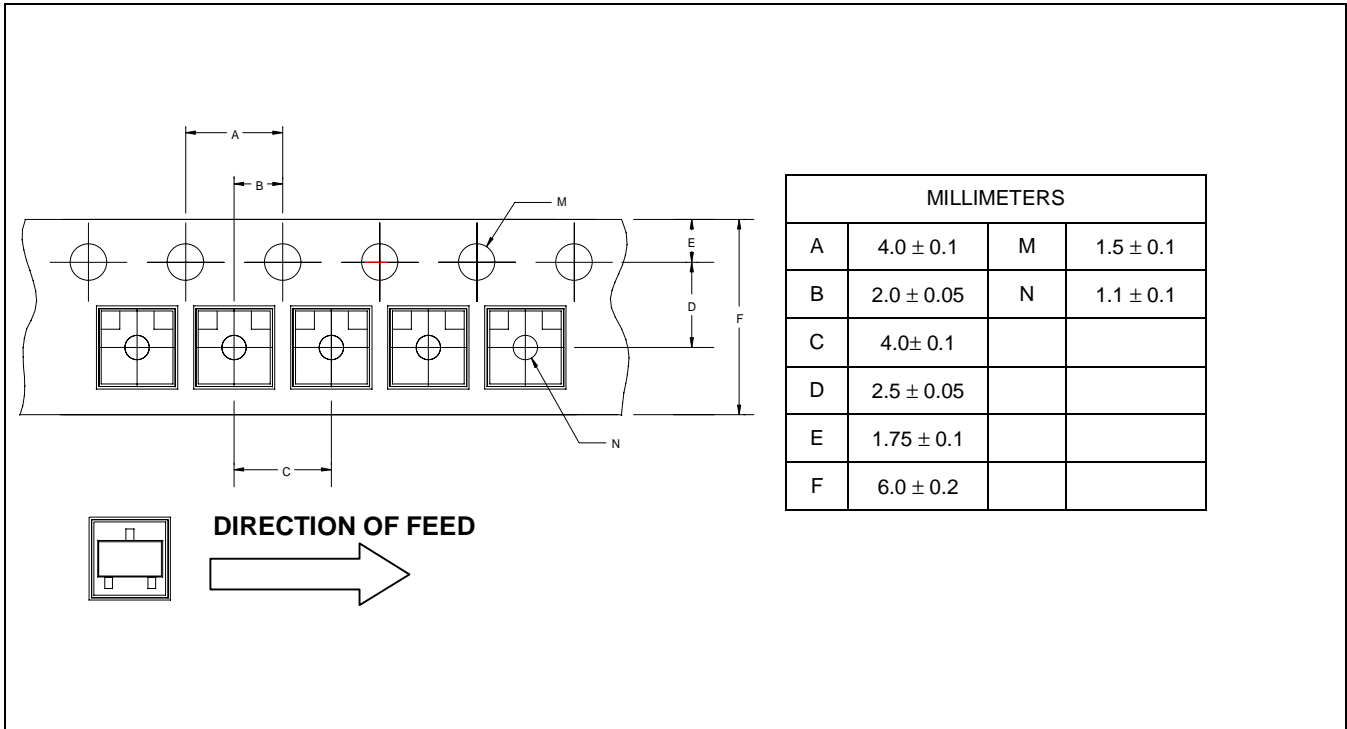
$$I_{OUT} = (V_{REF}/R_{CL}) + I_{KA}$$

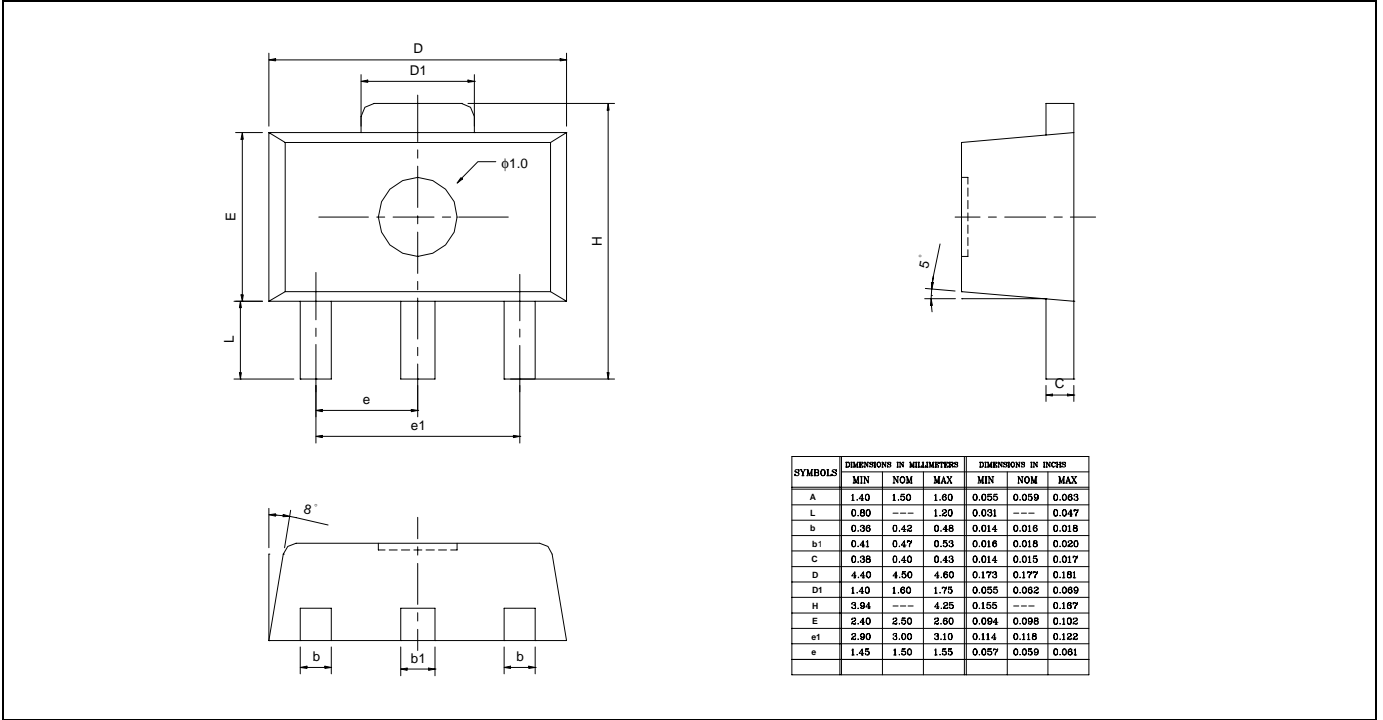
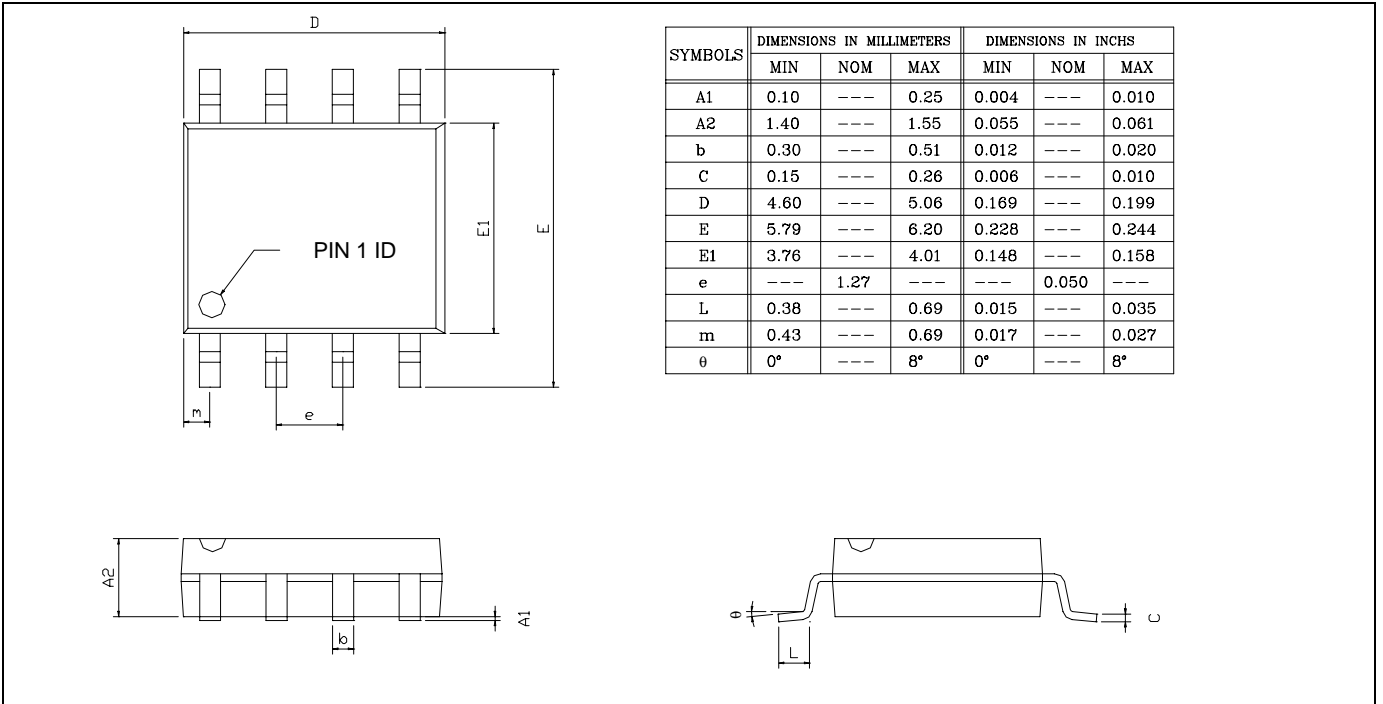
$$R1 = V_{BATT}/((I_O/h_{FE}) + I_{KA})$$

**Figure 11.** Precision Current Limiter



**3-Pin Plastic TO-92 Package Dimension**

**3-Pin Plastic TO-92 Carrier Dimensions**


**Surface Mount SOT-23**

**Surface Mount SOT-23 Carrier Dimensions**


**SOT-89 Package Dimension**

**8-Pin Plastic S.O.I.C.**


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