CM431A
LOW VOLTAGE ADJUSTABLE SHUNT REGULATOR

GENERAL DESCRIPTION

The CM431A 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 18V by using two external resistors. The CM431A offers low output impedance for improved load regulation with a typical output impedance of 200mΩ. Because of the active output circuitry, the CM431A 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.
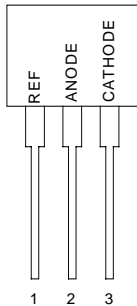
FEATURES

- ◆ Initial voltage reference accuracy of 1.0%.
- ◆ Sink current capability from 1mA to 100mA
- ◆ Typical output dynamic impedance less than 200mΩ;
- ◆ Adjustable output voltage from V_{REF} to 18V
- ◆ Available in SOT-23, SOT-89, TO-92, & SOP-8
- ◆ Low output noise
- ◆ Typical equivalent full range temperature coefficient of 30ppm/$^{\circ}$C
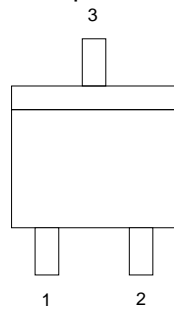
APPLICATIONS

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

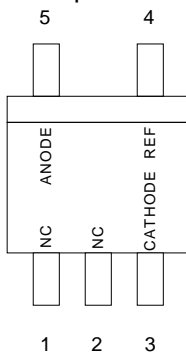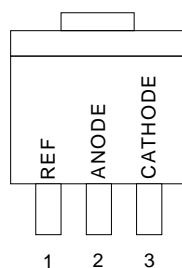## PIN CONFIGURATION

TO-92
Front View

SOT-23-3
Top View

	CM431AXCM233	CM431AXCM2R3
Pin 1	REF	CATHODE
Pin 2	CATHODE	REF
Pin 3	ANODE	ANODE

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

SOT-23-5
Top View

SOT-89
Top View

SOP-8
Top View
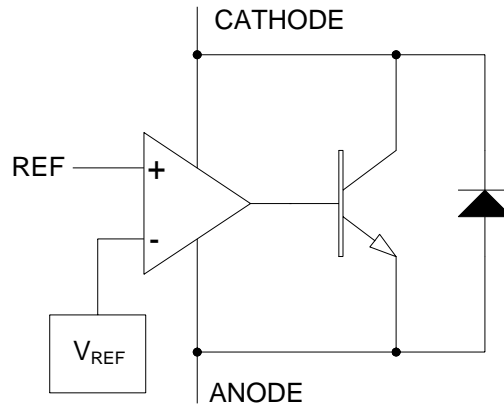
TYPICAL APPLICATION

Note: R_b should provide cathode current $\geq 1mA$

V+

$V_O = 5V$

R_b

R1
27.5K
0.1%

R2
27.5K
0.1%

5V Precision Regulator

BLOCK DIAGRAM

CATHODE

REF

V_{REF}

ANODE

ORDERING INFORMATION

PACKAGE	TOLERANCE			
	0.5%	1.0%	1.5%	T/R Quantity
SOT-23-3 [1]	CM431AACM233	CM431ABCM233	CM431AECM233	TR=3K
SOT-23-3 [1]	CM431AACM2R3	CM431ABCM2R3	CM431AECM2R3	TR=3K
SOT-23-5 [1]	CM431AACM235	CM431ABCM235	CM431AECM235	TR=3K
SOT-89 [1]	CM431AACM89	CM431ABCM89	CM431AECM89	TR=1K
TO-92 [2]	CM431AACN	CM431ABCN	CM431AECN	TA=2K
SOP-8	CM431AACS	CM431ABCS	CM431AECS	
SOT-23-3 [1]	CM431AGACM233*	CM431AGBCM233*	CM431AGECM233*	TR=3K
SOT-23-3 [1]	CM431AGACM2R3*	CM431AGBCM2R3*	CM431AGECM2R3*	TR=3K
SOT-23-5 [1]	CM431AGACM235*	CM431AGBCM235*	CM431AGECM235*	TR=3K
SOT-89 [1]	CM431AGACM89*	CM431AGBCM89*	CM431AGECM89*	TR=1K
TO-92 [2]	CM431AGACN*	CM431AGBCN*	CM431AGECN*	TA=2K
SOP-8	CM431AGACS*	CM431AGBCS*	CM431AGECS*	

Notes：

(1) Add suffix "TR"for Tape & Reel.

(2) Add suffix "TA"for Tape Ammo.

(3) ***Note:** Add suffix "G" for Pb Free Product

ABSOLUTE MAXIMUM RATINGS

Cathode to Anode Voltage (V_{KA}) (Note 2)	-0.3V to 18V
Continuous Cathode Current (I_K)	-100mA to 150mA
Reference Input Current (I_{REF})	-50uA to 10mA
Maximum junction temperature range, T_J	150 ^{o}C
Storage temperature range	-65 ^{o}C to 150 ^{o}C
Lead temperature (soldiering, 10 seconds)	260 ^{o}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	θ_{JA} (^{o}C/W)	Derating factor (mW/^{o}C) $T_A \geqq 25$ ^{o}C	$T_A \leqq 25$ ^{o}C Power rating(mW)	T_A=70 ^{o}C Power rating(mW)	T_A= 85 ^{o}C Power rating (mW)	T_A= 105 ^{o}C Power rating (mW)
SOP-8	165	6.06	757	485	394	272
TO-92	156	6.41	801	513	417	288
SOT-89	71(note)	14.1	1763	1128	916	635
SOT-23	285	3.5	438	280	228	158

Note :
1.　For SOT-89 package, Thermal Resistance-Junction to Tab (θ_{JT})　$= 35$ ^{o}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 θ_{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	^{o}C
Cathode current, I_K	1	100	mA
Cathode voltage, V_{KA}	0	16	V

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the operating ambient temperatures with T_A = 25°C.

Parameter	Symbol	Test Conditions	CM431A			Units
			Min	Typ	Max	
Reference Input Voltage	V_{REF}	I_K = 10mA, V_{KA} = V_{REF} ,0.5%	2.488	2.5	2.512	V
		I_K = 10mA, V_{KA} = V_{REF} ,1.0%	2.475	2.5	2.525	V
		I_K = 10mA, V_{KA} = V_{REF} ,1.5%	2.463	2.5	2.537	V
Reference Drift		I_K = 10mA, V_{KA} = V_{REF}, $0°C \leq T_A \leq 70°C$		4	17	mV
Voltage Ratio, Ref to Cathode (note 4)		I_K = 10mA, V_{KA} = 2.5V to 18V		-1.4	-2.7	mV/V
Reference Input Current	I_{REF}	I_K = 10mA, V_{KA} = V_{REF}		2	4	μA
		I_K = 10mA, V_{KA} = V_{REF}, $0°C \leq T_A \leq 70°C$			2.3	
Minimum Operating Current	I_{MIN}	V_{KA} = V_{REF}		0.4	1	mA
Off-State Cathode Current	I_{OFF}	V_{KA} = 18V, V_{REF} = 0V		0.1	1	μA
Dynamic Impedance	$|Z_{KA}|$	V_{KA} = V_{REF}, I_K = 1mA to 100mA, $f \leq 1kHz$		0.2	0.5	Ω

Note 3: These parameters are guaranteed by design

Note 4: $\dfrac{\triangle V_{REF}}{\triangle V_{KA}}$ Ratio of change in reference input voltage to the change in cathode voltage
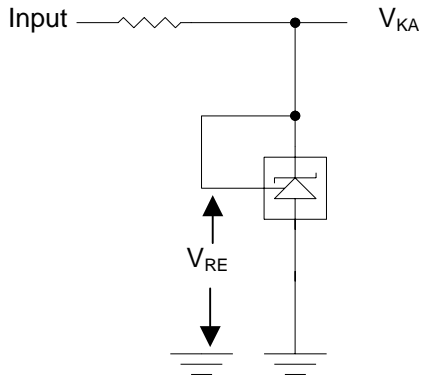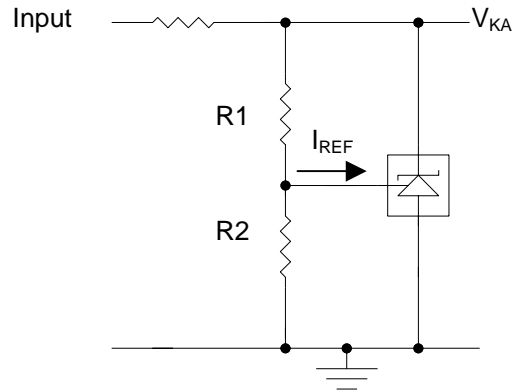
PARAMETER MEASUREMENT INFORMATION

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

$(1 + R1/R2) + I_{REF} \times R1$
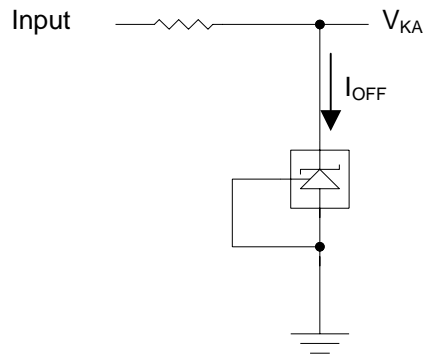
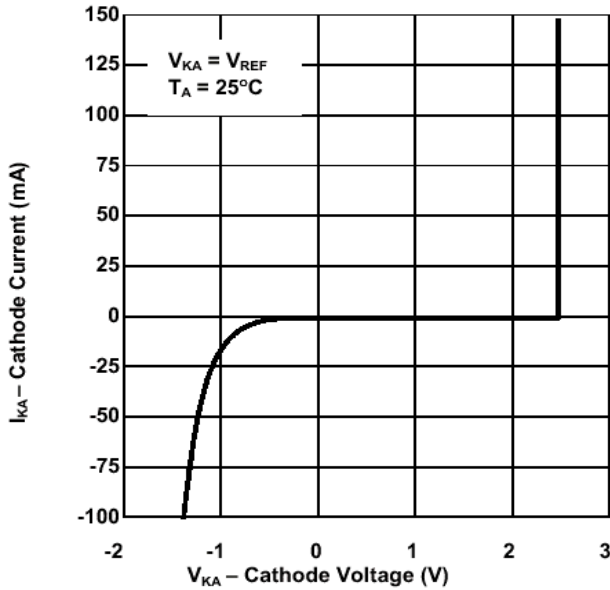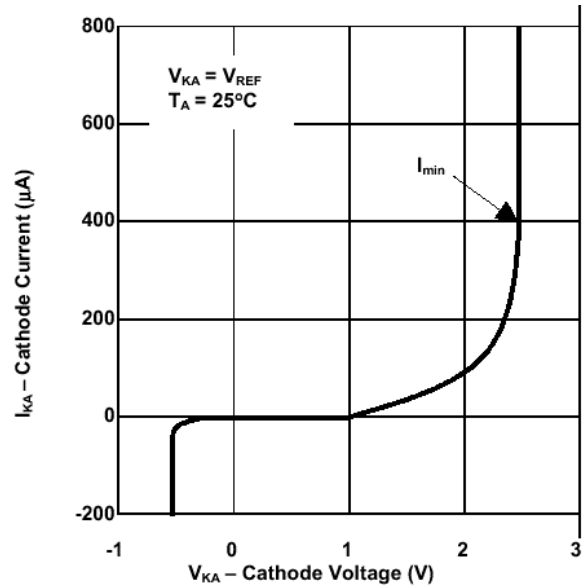**Figure 2.** Test Circuit for $V_{KA} > V_{REF}$

Figure 3. Test Circuit for I_{OFF}
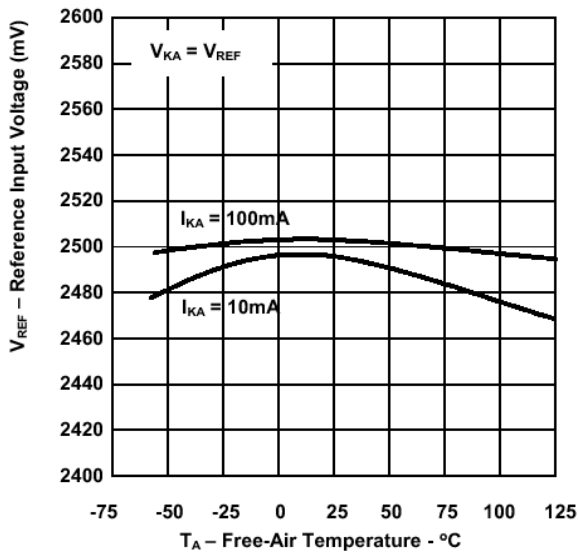
TYPICAL CHARACTERISTICS

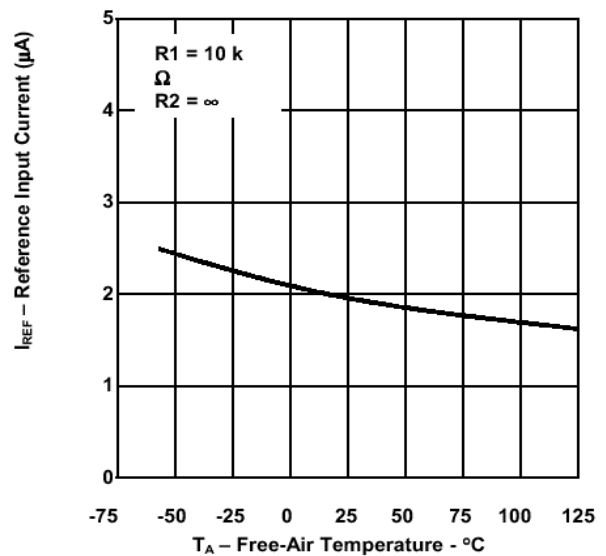**Cathode Current vs. Cathode Voltage**

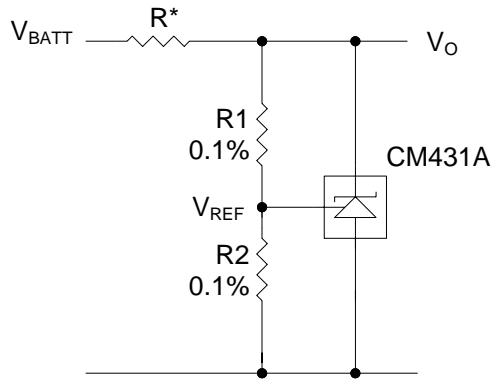**Cathode Current vs. Cathode Voltage**

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
CM431A of minimum V_{BATT}
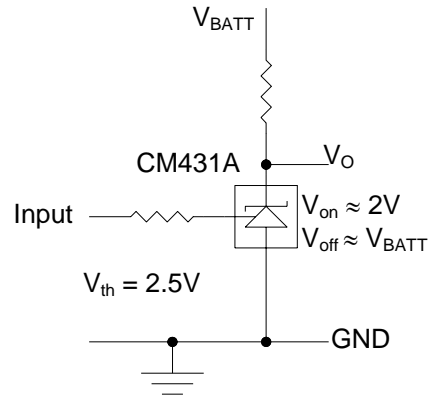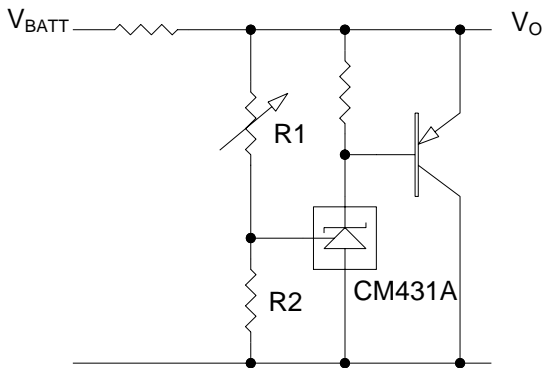
Figure 4. **Shunt Regulator**

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

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

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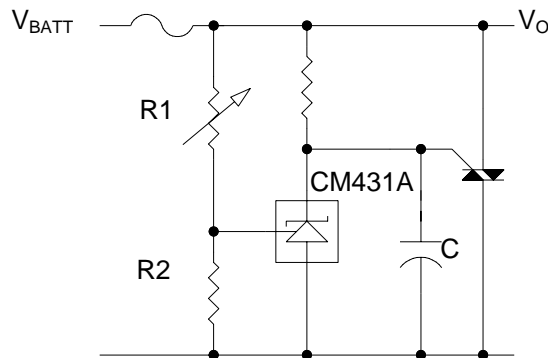

Figure 7. Crowbar Circuit
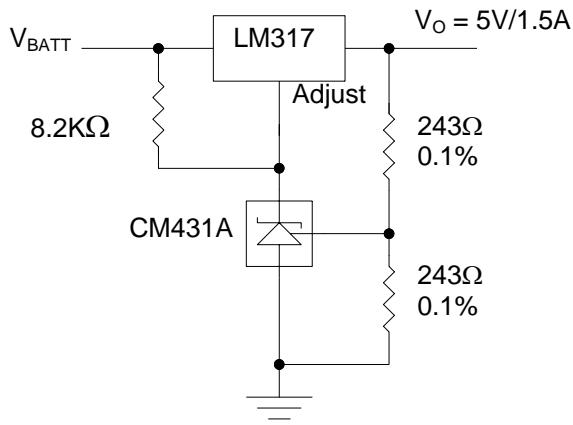
APPLICATION INFORMATION (continued)
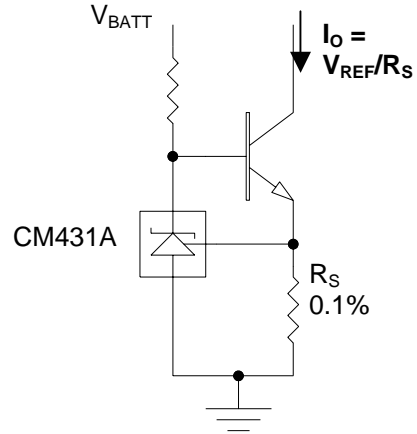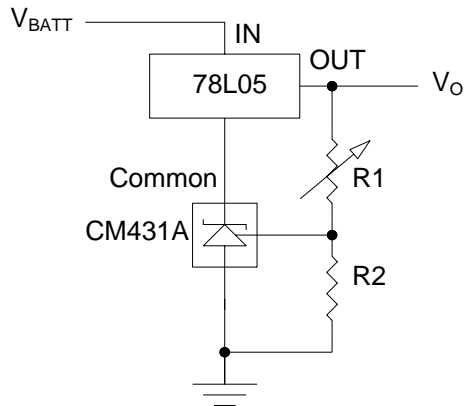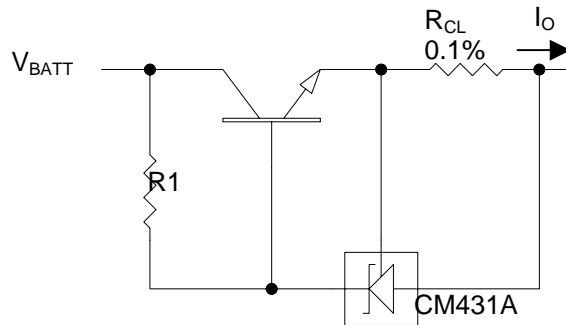

Figure 8.Precision 5V, 1.5A Regulator

Figure 9. Precision Constant Current Sink

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

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

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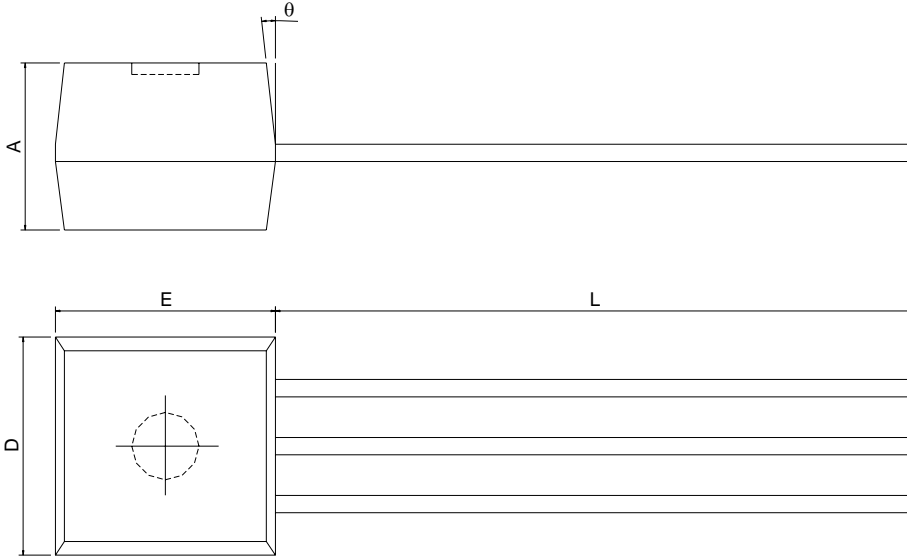Fixed Regulator

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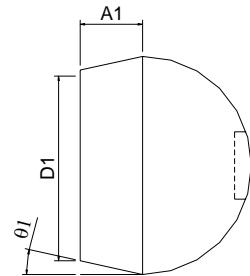
$R1 = V_{BATT}/((I_O/h_{FE}) + I_{KA})$

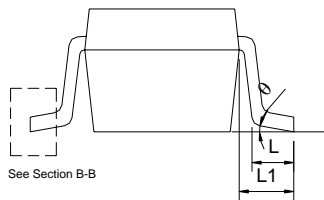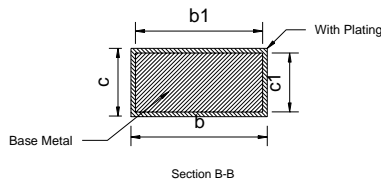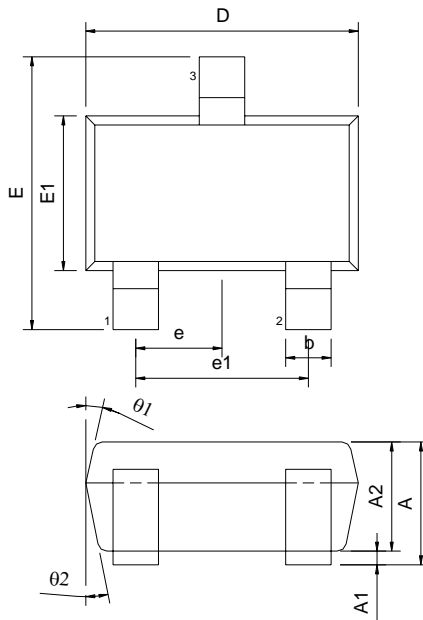**Figure 11**. Precision Current Limiter

PACKAGE DIMENSION

TO-92

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	3.45	3.56	3.66	0.136	0.140	0.144
A1	1.22	1.30	1.37	0.048	0.051	0.054
b	---	0.38	---	---	0.015	---
D	4.27	4.52	4.78	0.168	0.178	0.188
D1	4.14	4.29	4.45	0.163	0.169	0.175
E	4.32	4.57	4.83	0.170	0.180	0.190
L	12.98	13.49	14.00	0.511	0.531	0.551
e	---	1.27	---	---	0.050	---
θ	---	5°	---	---	5°	---
θ1	---	5°	---	---	5°	---

SOT-23-3

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.05	---	1.35	0.041	---	0.053
A1	0.05	---	0.15	0.002	---	0.006
A2	1.00	1.10	1.20	0.039	0.043	0.047
b	0.25	---	0.50	0.010	---	0.020
b1	0.25	0.40	0.45	0.010	0.016	0.018
c	0.08	---	0.20	0.003	---	0.008
c1	0.08	0.11	0.15	0.003	0.004	0.006
D	2.70	2.90	3.00	0.106	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
L	0.35	0.45	0.55	0.014	0.018	0.022
L1	0.60 REF			0.024 REF		
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
θ	0°	5°	10°	0°	5°	10°
θ1	3°	5°	7°	3°	5°	7°
θ2	6°	8°	10°	6°	8°	10°

PACKAGE DIMENSION (CONTINUED)

SOT-23-5

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.05	---	1.35	0.041	---	0.053
A1	0.05	---	0.15	0.002	---	0.006
A2	1.00	1.10	1.20	0.039	0.043	0.047
b	0.25	---	0.50	0.010	---	0.020
b1	0.25	0.40	0.45	0.010	0.016	0.018
c	0.08	---	0.20	0.003	---	0.008
c1	0.08	0.11	0.15	0.003	0.004	0.006
D	2.70	2.90	3.00	0.106	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
L	0.35	0.45	0.55	0.014	0.018	0.022
L1	0.60 REF			0.024 REF		
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
θ	0°	5°	10°	0°	5°	10°
θ1	3°	5°	7°	3°	5°	7°
θ2	6°	8°	10°	6°	8°	10°

SOT-89

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.80	---	1.20	0.031	---	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
H	3.94	---	4.25	0.155	---	0.167
E	2.40	2.50	2.60	0.094	0.098	0.102
e1	2.90	3.00	3.10	0.114	0.118	0.122
e	1.45	1.50	1.55	0.057	0.059	0.061

PACKAGE DIMENSION (CONTINUED)

8-PIN SOP (S08)

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A1	0.10	– – –	0.25	0.004	– – –	0.010
A2	1.40	– – –	1.55	0.055	– – –	0.061
b	0.30	– – –	0.51	0.012	– – –	0.020
C	0.15	– – –	0.26	0.006	– – –	0.010
D	4.60	– – –	5.06	0.169	– – –	0.199
E	5.79	– – –	6.20	0.228	– – –	0.244
E1	3.76	– – –	4.01	0.148	– – –	0.158
e	– – –	1.27	– – –	– – –	0.050	– – –
L	0.38	– – –	0.69	0.015	– – –	0.035
m	0.43	– – –	0.69	0.017	– – –	0.027
θ	0°	– – –	8°	0°	– – –	8°

NUMBERING SCHEME

Ordering Number: CM431A**XYZ (note1)**
Ordering Number: CM431A**GXYZ (note2)**

note1:
X : Suffix for Reference Voltage Tolerance (note 3)
Y : Suffix for Temperature Range (note 4)
Z : Suffix for Package Type (note 5)

note2:
G : Suffix for Pb Free Product
X : Suffix for Reference Voltage Tolerance (note 3)
Y : Suffix for Temperature Range (note 4)
Z : Suffix for Package Type (note 5)

note 3: see the Reference Voltage Tolerance Suffix Table

note 4:
Y= C: $0^{\circ}C \sim +105^{\circ}C$

note 5:
Z is single alphabet with or without digits
M233 : SOT-23-3 (TR only)
M2R3: SOT-23-3 (TR only) but pin assignment is different with M233
M235 : SOT-23-5 (TR only)
M89:SOT-89(TR only)
N:TO-92(TA only)
S:SOP-8(TR only)

Reference Voltage Tolerance Suffix Table

Tolerance	Suffix
0.5%	A
1%	B
1.5%	E

IMPORTANT NOTICE

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A few applications using integrated circuit products may involve potential risks of death, personal injury, or severe property or environmental damage. CMC integrated circuit products are not designed, intended, authorized, or warranted to be suitable for use in life-support applications, devices or systems or other critical applications. Use of CMC products in such applications is understood to be fully at the risk of the customer. In order to minimize risks associated with the customer's applications, the customer should provide adequate design and operating safeguards.