FAIRCHILD SEMICONDUCTOR®

June 2012

LM431SA/LM431SB/LM431SC
Programmable Shunt Regulator

Features

- Programmable Output Voltage to 36 Volts
- Low Dynamic Output Impedance 0.2Ω Typical
- Sink Current Capability of 1.0 to 100mA
- Equivalent Full-Range Temperature Coefficient of 50ppm/°C Typical
- Temperature Compensated for Operation Over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response

Description

The LM431SA/LM431SB/LM431SC are three terminal output adjustable regulators with thermal stability over operating temperature range. The output voltage can be set any value between V_{REF} (approximately 2.5 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of 0.2Ω. Active output circuit provides a sharp turn-on characteristic, making these devices excellent replacement for Zener Diodes in many applications.

SOT-89

1. Ref 2. Anode 3. Cathode

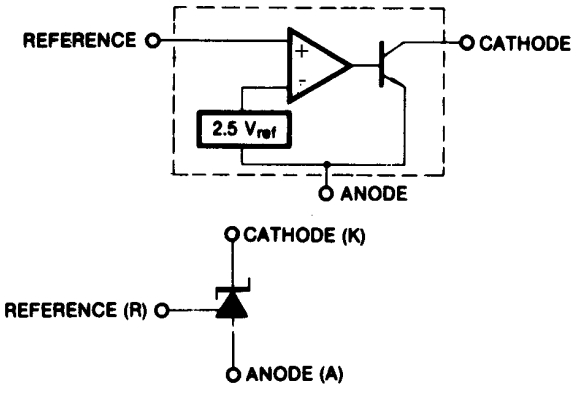
SOT-23F

1. Cathode 2. Ref 3. Anode

SOT-23

M32 - 1. Ref 2. Cathode 3. Anode
M3 - 1. Cathode 2. Ref 3. Anode

Internal Block Diagram



Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified.)

Parameter	Symbol	Value	Unit
Cathode Voltage	V_{KA}	37	V
Cathode current Range (Continuous)	I_{KA}	-100 ~ +150	mA
Reference Input Current Range	I_{REF}	-0.05 ~ +10	mA
Thermal Resistance Junction-Air (Note1,2) ML Suffix Package (SOT-89) MF Suffix Package (SOT-23F) M32, M3 Suffix Package (SOT-23)	$R_{\theta JA}$	 220 350 400	°C/W
Power Dissipation (Note3,4) ML Suffix Package (SOT-89) MF Suffix Package (SOT-23F) M32, M3 Suffix Package (SOT-23)	P_D	 560 350 310	mW
Junction Temperature	T_J	150	°C
Operating Temperature Range	T_{OPR}	-25 ~ +85	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Note:

1. Thermal resistance test board
   Size: 76.2mm * 114.3mm * 1.6mm (1S0P)
   JEDEC Standard: JESD51-3, JESD51-7
2. Assume no ambient airflow.
3. T_{JMAX} = 150°C, Ratings apply to ambient temperature at 25°C
4. Power dissipation calculation: $P_D = (T_J - T_A)/R_{\theta JA}$

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Cathode Voltage	V_{KA}	V_{REF}	-	36	V
Cathode Current	I_{KA}	1.0	-	100	mA

Electrical Characteristics

(T_A = +25°C, unless otherwise specified)

Parameter	Symbol	Conditions		LM431SA			LM431SB			LM431SC			Unit
				Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Input Voltage	V_{REF}	$V_{KA}=V_{REF}$, I_{KA}=10mA		2.450	2.500	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V
Deviation of Reference Input Voltage Over-Temperature	$\Delta V_{REF}/\Delta T$	$V_{KA}=V_{REF}$, I_{KA}=10mA $T_{MIN} \le T_A \le T_{MAX}$	SOT-89 SOT-23F	-	4.5	17	-	4.5	17	-	4.5	17	mV
			SOT-23	-	6.6	24	-	6.6	24	-	6.6	24	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_{KA} =10mA	ΔV_{KA}=10V -V_{REF}	-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
			ΔV_{KA}=36V -10V	-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0	
Reference Input Current	I_{REF}	I_{KA}=10mA, R_1=10KΩ,R_2=∞		-	1.5	4	-	1.5	4	-	1.5	4	μA
Deviation of Reference Input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	I_{KA}=10mA, R_1=10KΩ, R_2=∞, T_A =Full Range	SOT-89 SOT-23F	-	0.4	1.2	-	0.4	1.2	-	0.4	1.2	μA
			SOT-23	-	0.8	2.0	-	0.8	2.0	-	0.8	2.0	μA
Minimum Cathode Current for Regulation	$I_{KA(MIN)}$	$V_{KA}=V_{REF}$		-	0.45	1.0	-	0.45	1.0	-	0.45	1.0	mA
Off -Stage Cathode Current	$I_{KA(OFF)}$	V_{KA}=36V, V_{REF}=0		-	0.05	1.0	-	0.05	1.0	-	0.05	1.0	μA
Dynamic Impedance	Z_{KA}	$V_{KA}=V_{REF}$, I_{KA}=1 to 100mA , f ≥1.0kHz		-	0.15	0.5	-	0.15	0.5	-	0.15	0.5	Ω

Note1

T_{MIN} = -25°C, T_{MAX} = +85°C

Test Circuits

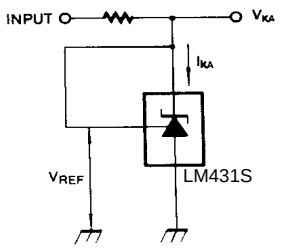


Figure 1. Test Circuit for $V_{KA}=V_{REF}$

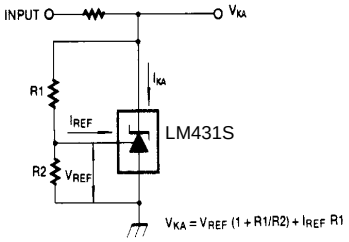


Figure 2. Test Circuit for $V_{KA} \geq V_{REF}$

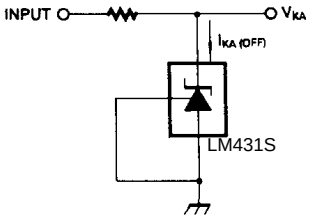


Figure 3. Test Circuit for $I_{KA(OFF)}$

Typical Performance Characteristics

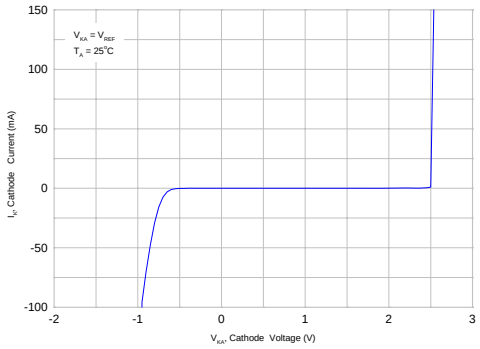


Figure 4. Cathode Current vs. Cathode Voltage

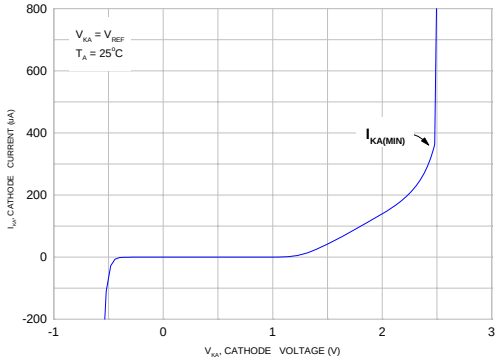


Figure 5. Cathode Current vs. Cathode Voltage

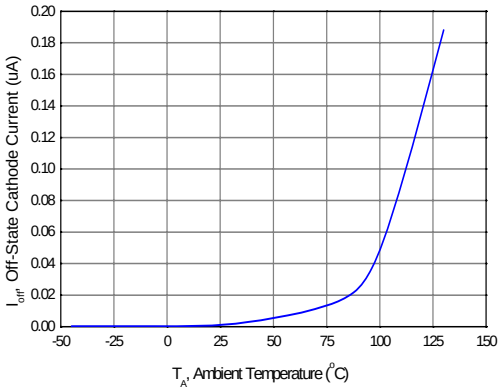


Figure 6. OFF-State Cathode Current vs. Ambient Temperature

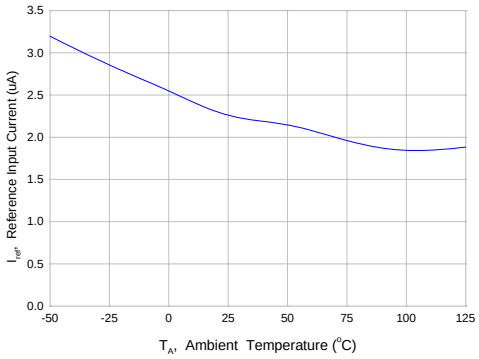


Figure 7. Reference Input Current vs. Ambient Temperature

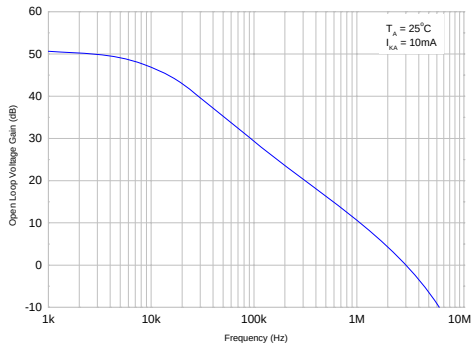


Figure 8. Small Signal Voltage Amplification vs. Frequency

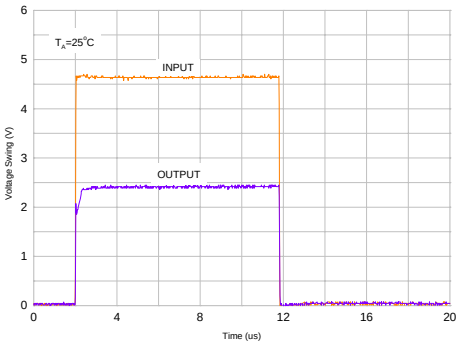


Figure 9. Pulse Response

Typical Performance Characteristics (Continued)

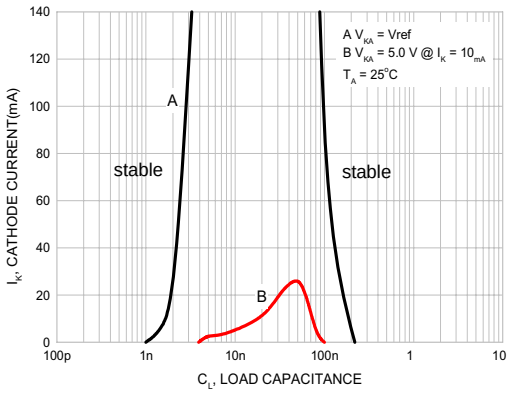


Figure 10. Stability Boundary Conditions

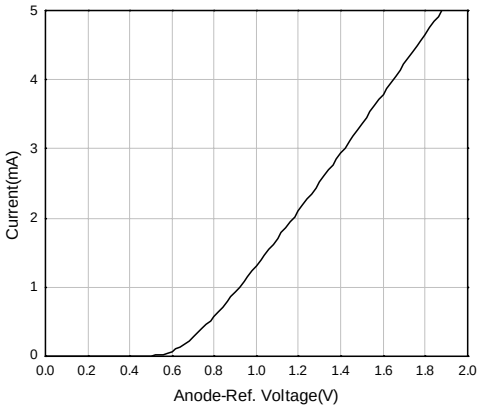


Figure 11. Anode-Reference Diode Curve

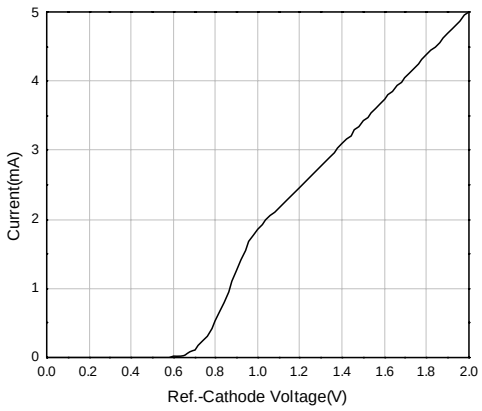


Figure 12. Reference-Cathode Diode Curve

Typical Application

$$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{ref}$$

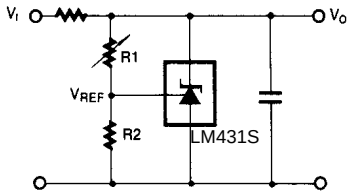


Figure 13. Shunt Regulator

$$V_O = V_{ref}\left(1 + \frac{R_1}{R_2}\right)$$

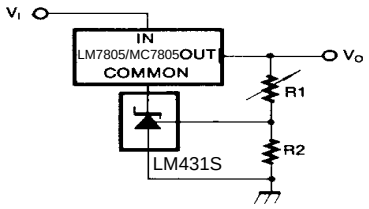


Figure 14. Output Control for Three-Terminal Fixed Regulator

$$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{ref}$$

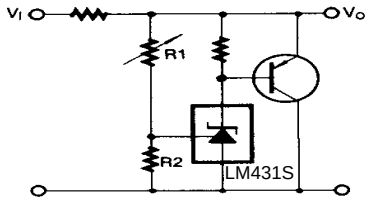


Figure 15. High Current Shunt Regulator

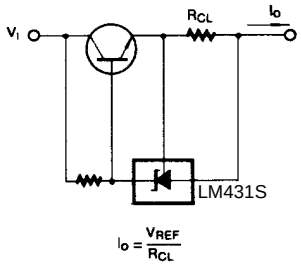


Figure 16. Current Limit or Current Source

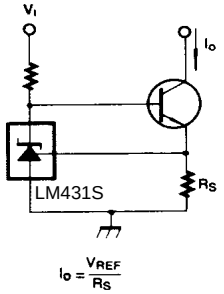


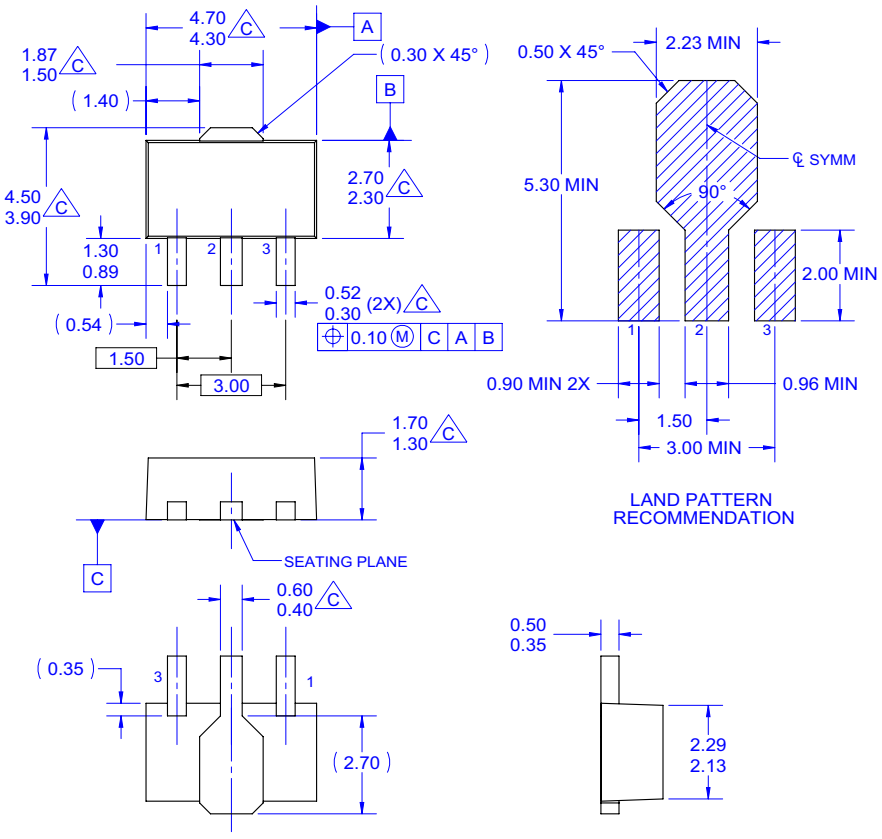
Figure 17. Constant-Current Sink

Mechanical Dimensions

Package

Dimensions in millimeters

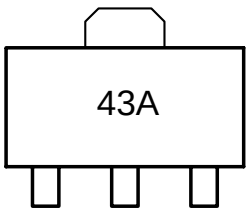
SOT-89



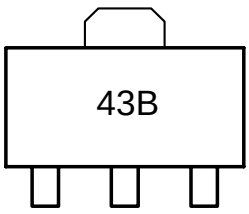
NOTES: UNLESS OTHERWISE SPECIFIED.

A. REFERENCE TO JEDEC TO-243 VARIATION AA.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C DOES NOT COMPLY JEDEC STANDARD VALUE.
D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSION.
E. DIMENSION AND TOLERANCE AS PER ASME Y14.5-1994.
F. DRAWING FILE NAME: MA03CREV2

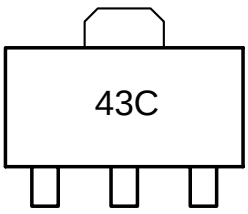
Marking



2% tolerance



1% tolerance



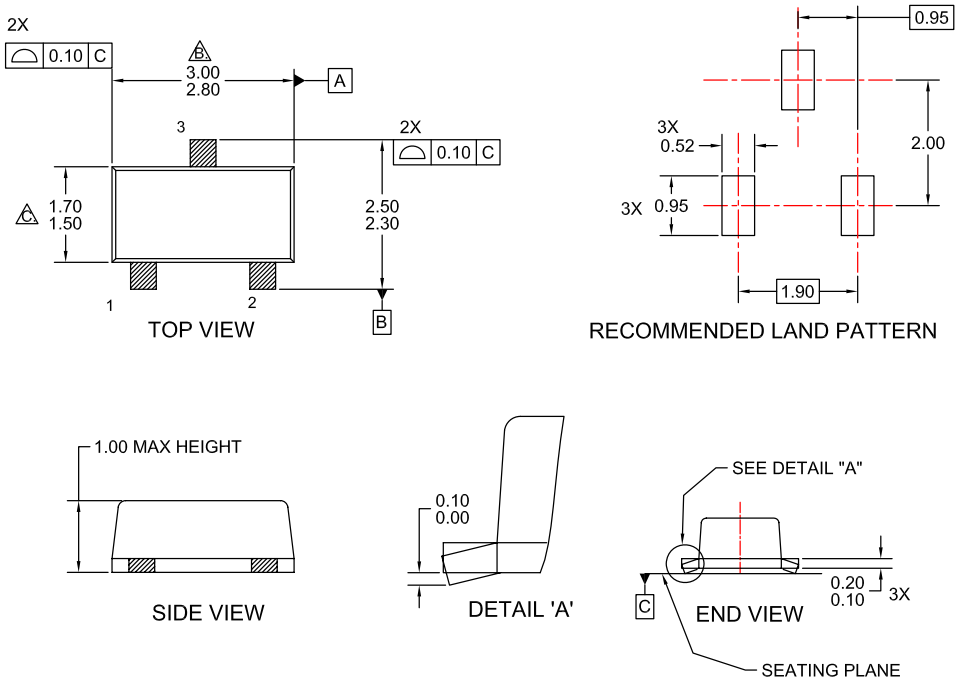
0.5% tolerance

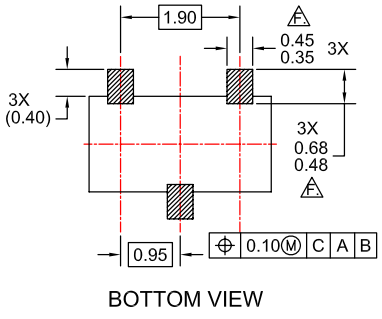
Mechanical Dimensions (Continued)

Package

Dimensions in millimeters

SOT-23F





NOTES:

A. ALL DIMENSIONS ARE IN MILLIMETERS.

B. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15mm PER END.

C. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.15mm PER SIDE.

D. DIMENSIONS B AND C ARE DETERMINED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.

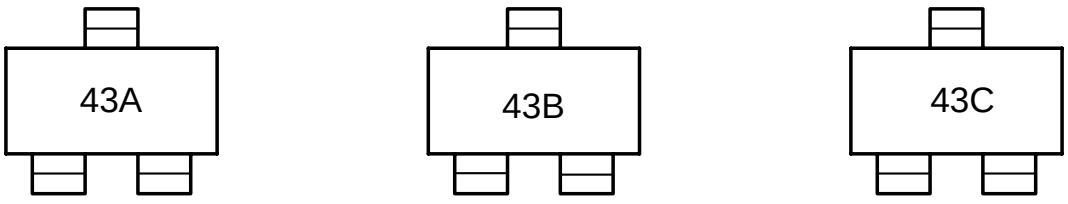
E. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.

F. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08mm AND 0.15mm FROM THE LEAD TIP.

G. LANDPATTERN RECOMMENDATION PER IPC SOTFL95P240X100-4N (ADAPTED TO 3LD)

H. DRAWING FILE NUMBER AND REVISION: MKT-MA03EREV1.DWG

Marking



2% tolerance

1% tolerance

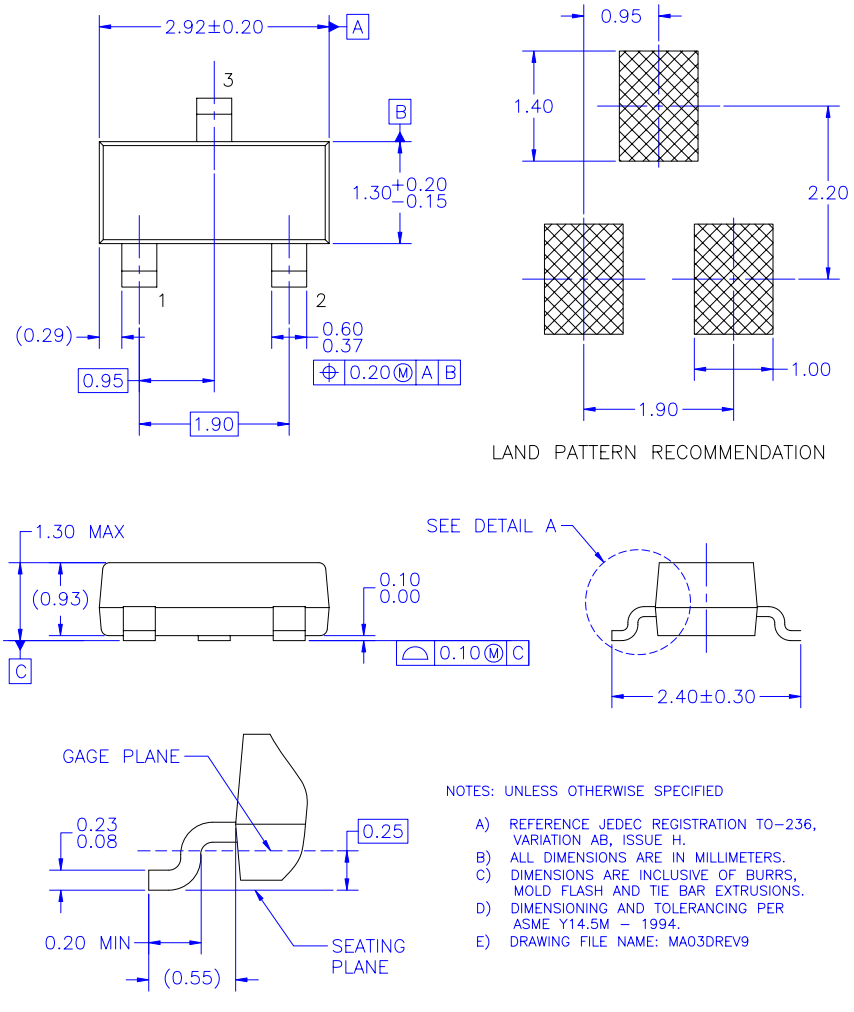
0.5% tolerance

Mechanical Dimensions (Continued)

Package

Dimensions in millimeters

SOT-23



NOTES: UNLESS OTHERWISE SPECIFIED

A) REFERENCE JEDEC REGISTRATION TO-236, VARIATION AB, ISSUE H.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS ARE INCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.
D) DIMENSIONING AND TOLERANCING PER ASME Y14.5M – 1994.
E) DRAWING FILE NAME: MA03DREV9

Marking

Ordering Information

Product Number	Output Voltage Tolerance	Operating Temperature	Package	Packing Method
LM431SCCMLX	0.5%	-25 ~ +85°C	SOT-89	Tape and Reel
LM431SCCMFX			SOT-23F	
LM431SCCM32X			SOT-23	
LM431SCCM3X			SOT-23	
LM431SBCMLX	1%		SOT-89	
LM431SBCMFX			SOT-23F	
LM431SBCM32X			SOT-23	
LM431SBCM3X			SOT-23	
LM431SACMLX	2%		SOT-89	
LM431SACMFX			SOT-23F	
LM431SACM32X			SOT-23	
LM431SACM3X			SOT-23	

Note : X suffix means " Tape and Reel " packing.

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EfficientMax™
ESBC™
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Fairchild®
Fairchild Semiconductor®
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FAST®
FastvCore™
FETBench™
FlashWriter®*
FPS™
F-PFS™
FRFET®
Global Power Resource℠
GreenBridge™
Green FPS™
Green FPS™ e-Series™
Gmax™
GTO™
IntelliMAX™
ISOPLANAR™
Making Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
Motion-SPM™
mWSaver™
OptoHiT™
OPTOLOGIC®
OPTOPLANAR®
®
PowerTrench®
PowerXS™
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QFET®
QS™
Quiet Series™
RapidConfigure™
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SmartMax™
SMART START™
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SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I61