FAIRCHILD SEMICONDUCTOR®

December 2012

LM431A / LM431B / LM431C Programmable Shunt Regulator

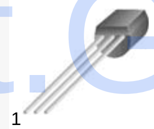
Features

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

Description

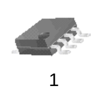
The LM431A / LM431B / LM431C are three terminal output adjustable regulators with thermal stability over the full operating temperature range. The output voltage can be set to any value between V_{REF} (approximately 2.5 V) and 36 V with two external resistors. These devices have a typical dynamic output impedance of 0.2 Ω. Active output circuit provides a sharp turn-on characteristic, making these devices excellent replacements for Zener diodes in many applications.

TO-92



1. Ref 2. Anode 3. Cathode

8-SOIC



1.Cathode 2.3.6.7.Anode
4.5.NC 8.Ref

Datasheet.Global

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Ordering Information

Part Number	Operating Temperature Range	Output Voltage Tolerance	Top Mark	Package	Packing Method
LM431CCZ	-25 ~ +85°C	0.5%	LM431CCZ	TO-92	Bulk
LM431CCMX			LM431CCM	8-SOIC	Tape and Reel
LM431BCZX		1%	LM431BCZ	TO-92	Tape and Reel
LM431BCZXA			LM431BCZ	TO-92	Ammo
LM431BCMX			LM431BCM	8-SOIC	Tape and Reel
LM431ACZ		2%	LM431ACZ	TO-92	Bulk
LM431ACZX			LM431ACZ	TO-92	Tape and Reel
LM431ACMX			LM431ACM	8-SOIC	Tape and Reel
LM431CIMX	-40 ~ +85°C	0.5%	LM431CIM	8-SOIC	Tape and Reel
LM431BIZX		1%	LM431BIZ	TO-92	Tape and Reel
LM431AIZ		2%	LM431AIZ	TO-92	Bulk
LM431AIMX			LM431AIM	8-SOIC	Tape and Reel

Block Diagram

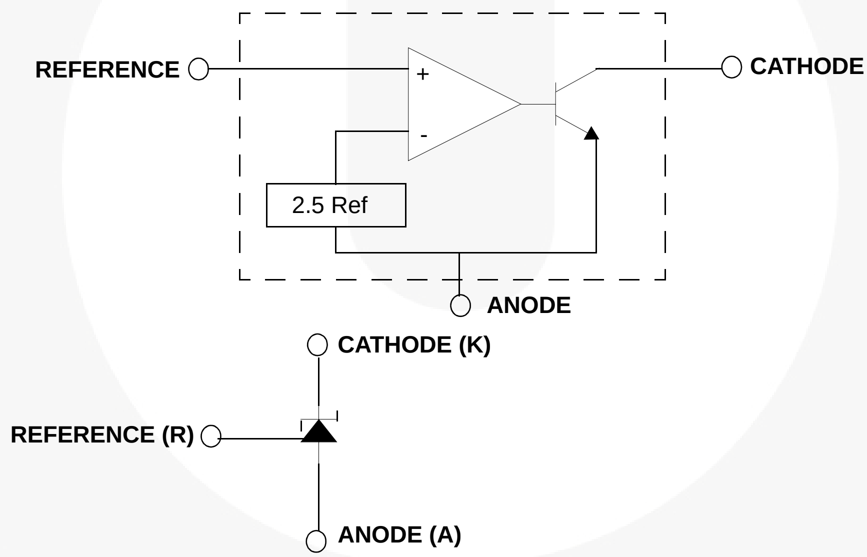


Figure 1. Block Diagram

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Value	Unit
V_{KA}	Cathode Voltage	37	V
I_{KA}	Cathode Current Range (Continuous)	-100 ~ +150	mA
I_{REF}	Reference Input Current Range	-0.05 ~ +10	mA
P_D	Power Dissipation M, Z Suffix Package	770	mW
T_{OPR}	Operating Temperature Range LM431xC	-25 ~ +85	°C
	Operating Temperature Range LM431xI	-40 ~ +85	°C
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature Range	-65 ~ +150	°C

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

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

Electrical Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Conditions		LM431A			LM431B			LM431C			Unit
				Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{REF}	Reference Input Voltage	$V_{KA} = V_{REF}$, I_{KA} = 10 mA		2.450	2.500	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V
$\Delta V_{REF}/\Delta T$	Deviation of Reference Input Voltage Over-Temperature	$V_{KA} = V_{REF}$, I_{KA} =10 mA $T_{MIN} \leq T_A \leq T_{MAX}$ (1)			4.5	17.0		4.5	17.0		4.5	17.0	mV
$\Delta V_{REF}/\Delta V_{KA}$	Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	I_{KA} = 10 mA	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	
I_{REF}	Reference Input Current	I_{KA} = 10 mA, R1 =10 kΩ, R2 = ∞			1.5	4		1.5	4		1.5	4	µA
$\Delta I_{REF}/\Delta T$	Deviation of Reference Input Current Over Full Temperature Range	I_{KA} = 10 mA, R1 = 10 kΩ, R2 = ∞ T_A = Full Range			0.4	1.2		0.4	1.2		0.4	1.2	µA
$I_{KA(MIN)}$	Minimum Cathode Cur-rent for Regulation	$V_{KA} = V_{REF}$			0.45	1.0		0.45	1.0		0.45	1.0	mA
$I_{KA(OFF)}$	Off - Stage Cathode Current	V_{KA} = 36 V, V_{REF} = 0			0.05	1.0		0.05	1.0		0.05	1.0	µA
Z_{KA}	Dynamic Impedance	$V_{KA} = V_{REF}$, I_{KA} =1 to 100 mA f ≥ 1.0 kHz			0.15	0.5		0.15	0.5		0.15	0.5	Ω

Notes:

1. LM431xC: T_{MIN} = -25°C, T_{MAX} = +85°C.
LM431xI: T_{MIN} = -40°C, T_{MAX} = +85°C.

Test Circuits

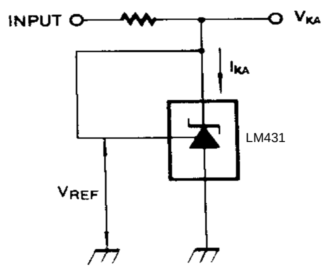


Figure 2. Test Circuit for $V_{KA} = V_{REF}$

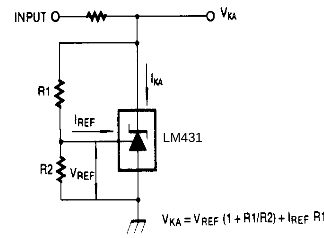


Figure 3. Test Circuit for $V_{KA} \geq V_{REF}$

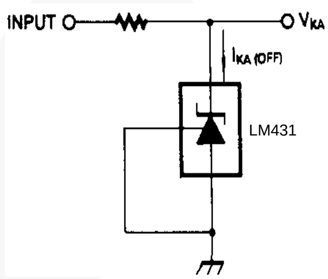


Figure 4. Test Circuit for $I_{KA(OFF)}$

Typical Performance Characteristics

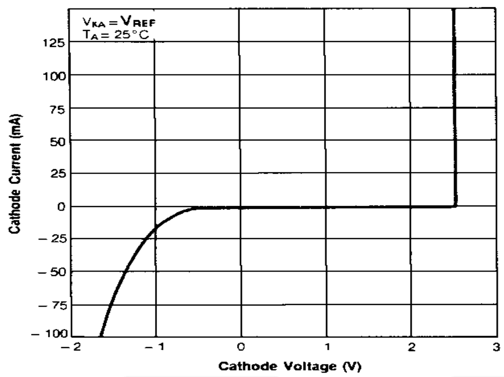


Figure 5. Cathode Current vs. Cathode Voltage

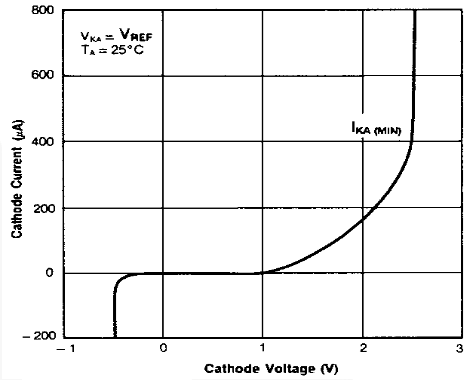


Figure 6. Cathode Current vs. Cathode Voltage

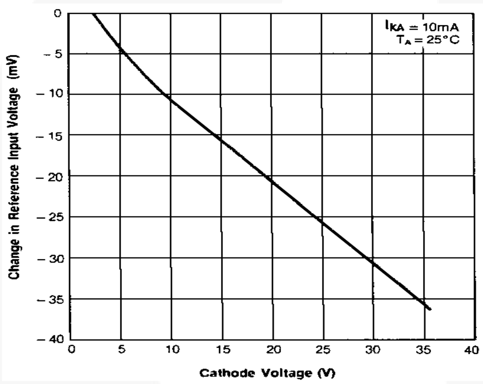


Figure 7. Change In Reference Input Voltage vs. Cathode Voltage

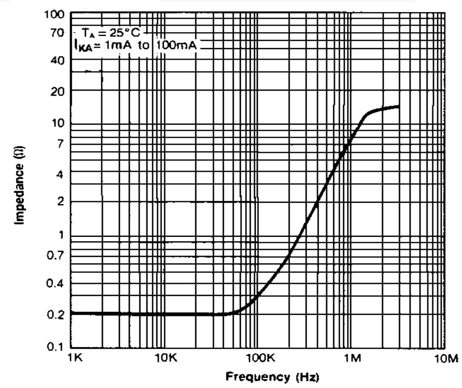


Figure 8. Dynamic Impedance Frequency

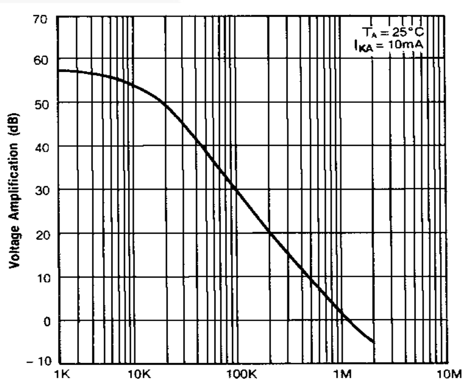


Figure 9. Small Signal Voltage Amplification vs. Frequency

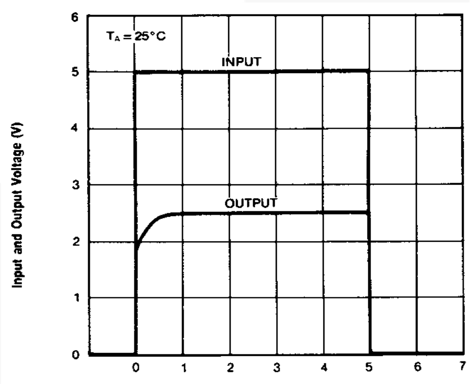


Figure 10. Pulse Response

Typical Performance Characteristics (Continued)

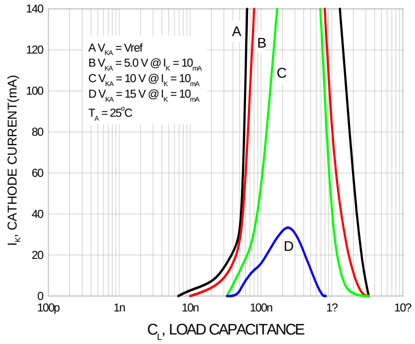


Figure11. Stability Boundary Conditions

Typical Application

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

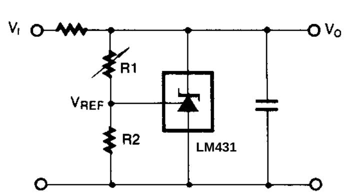


Figure 12. Shunt Regulator

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

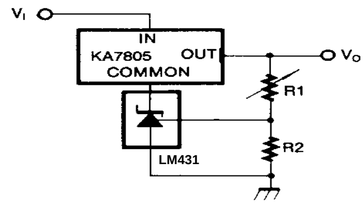


Figure 13. Output Control for Three-Terminal Fixed Regulator

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

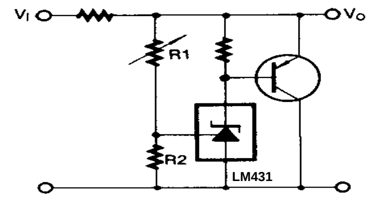


Figure 14. High-Current Shunt Regulator

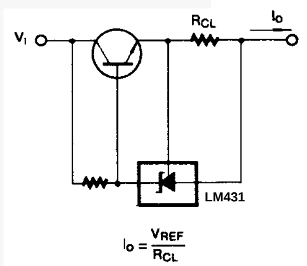


Figure 15. Current Limit or Current Source

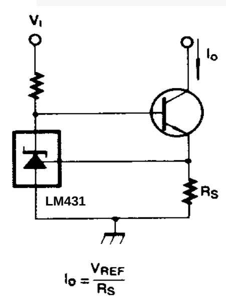
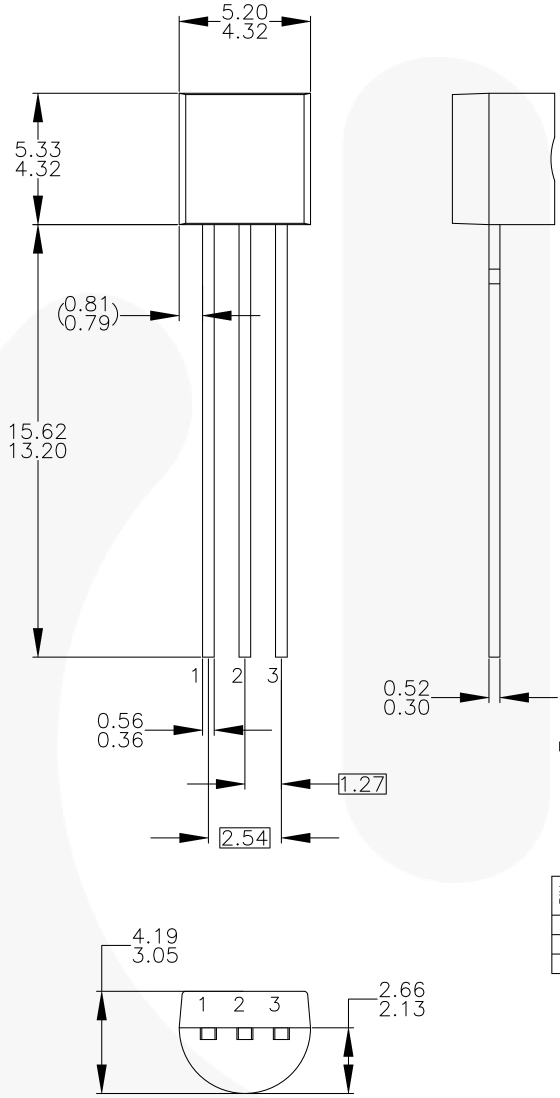


Figure 16. Constant-Current Sink

Physical Dimensions

TO-92 Bulk Type



NOTES: UNLESS OTHERWISE SPECIFIED

A) DRAWING WITH REFERENCE TO JEDEC TO−92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M−1994.
D) TO−92 (92,94,96,97,98) PIN CONFIGURATION:

PIN	92			94			96			97			98		
	P	F	M	P	F	M	B	F	M	P	F	M	P	F	M
1	E	S	S	E	S	S	B	D	G	C	G	D	C	G	D
2	B	D	G	C	G	D	E	S	S	B	D	G	E	S	S
3	C	G	D	B	D	G	C	G	D	E	S	S	B	D	G

LEGEND:

P − BIPOLAR   E − EMITTER   D − DRAIN
F − JFET   B − BASE   S − SOURCE
M − DMOS   C − COLLECTOR   G − GATE

E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN ”D” AND SOURCE ”S” ARE INTERCHANGEAGLE AT JFET ”F” OPTION.
F) DRAWING FILENAME: MKT−ZA03DREV3.

Figure 17. 3-Lead, TO-92, Molded, Standard Straight Lead

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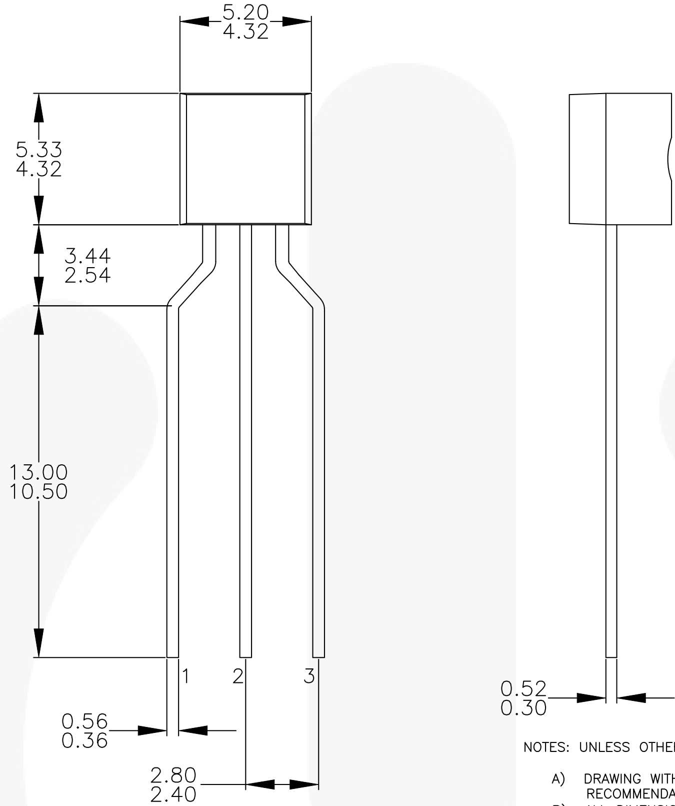
Physical Dimensions (Continued)

TO-92 Ammo Type, Tape and Reel Type

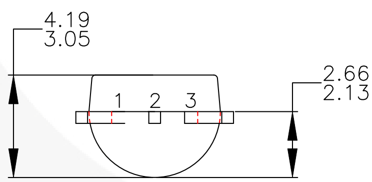


NOTES: UNLESS OTHERWISE SPECIFIED

A) DRAWING WITH REFERENCE TO JEDEC TO–92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M–1994.
D) TO–92 (92,94,96,97,98) PIN CONFIGURATION:

PIN	92			94			96			97			98		
	P	F	M	P	F	M	B	F	M	P	F	M	P	F	M
1	E	S	S	E	S	S	B	D	G	C	G	D	C	G	D
2	B	D	G	C	G	D	E	S	S	B	D	G	E	S	S
3	C	G	D	B	D	G	C	G	D	E	S	S	B	D	G

LEGEND:
P – BIPOLAR
F – JFET
M – DMOS
E – EMITTER
B – BASE
C – COLLECTOR
D – DRAIN
S – SOURCE
G – GATE



E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN "D" AND SOURCE "S" ARE INTERCHANGEAGLE AT JFET "F" OPTION.
F) DRAWING FILENAME: MKT–ZA03FREV2.

Figure 18. 3-Lead, TO-92, Molded, 0.200 in Line Spacing Lead Form

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Physical Dimensions (Continued)

8-SOIC

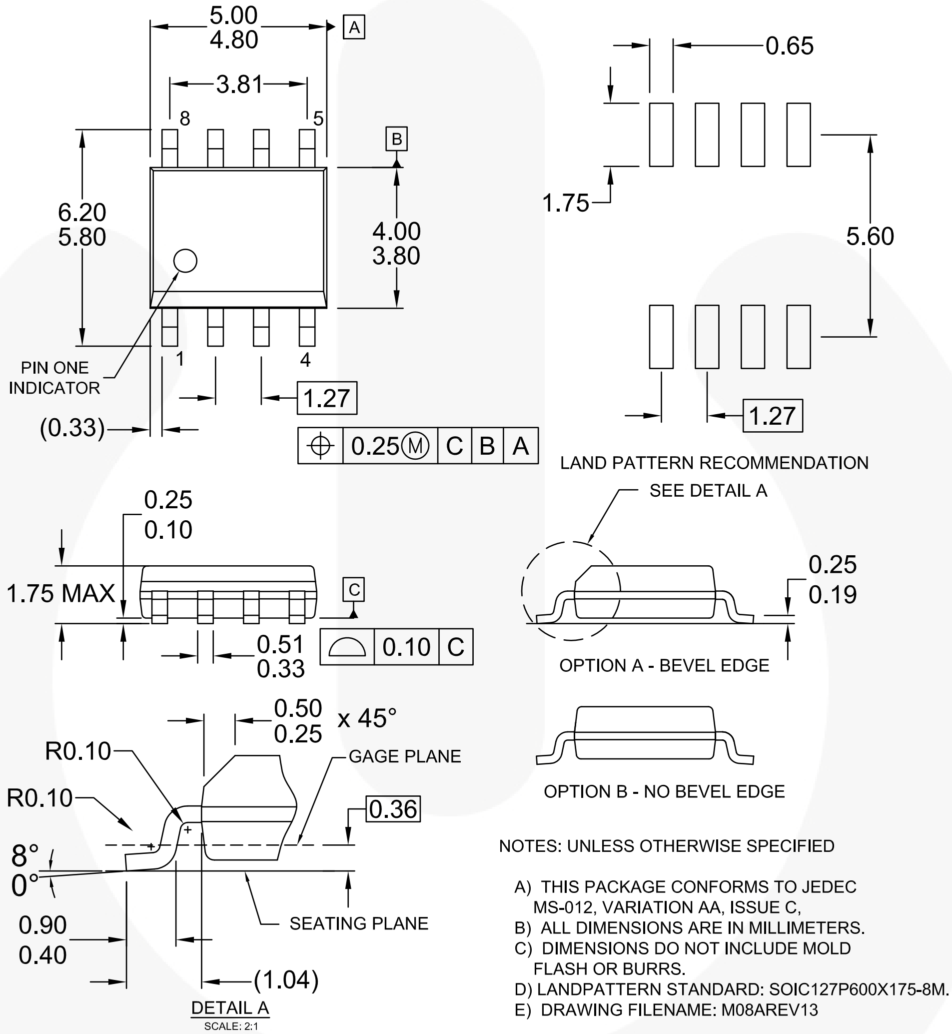

Figure 19. 8-Lead, SOIC, JEDEC MS 0-12, 0.150 inch Narrow Body

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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.
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