Is Now Part of

ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

FAIRCHILD SEMICONDUCTOR®

June 2013

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

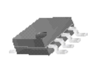
Description

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

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

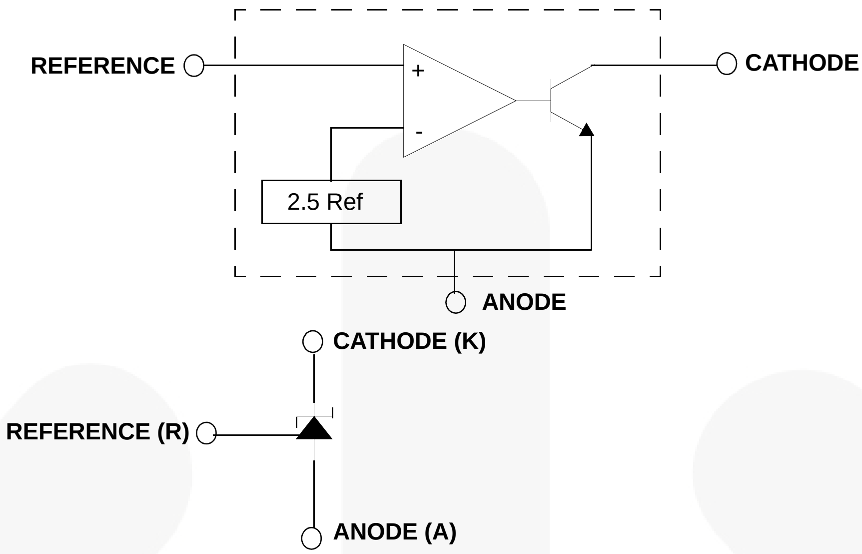


Figure 1. Block Diagram

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 TO-92, 8-SOIC Packages	770	mW
$R_{\theta jA}$	Thermal Resistance, Junction to Ambient TO-92, 8-SOIC Packages	160	°C/W
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.	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 $T_{MIN} \le T_A \le T_{MAX}$ (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	4.0		1.5	4.0		1.5	4.0	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	1.00		0.45	1.00		0.45	1.00	mA
$I_{KA(OFF)}$	Off - Stage Cathode Current	V_{KA} = 36 V, V_{REF} = 0			0.05	1.00		0.05	1.00		0.05	1.00	µA
Z_{KA}	Dynamic Impedance	$V_{KA} = V_{REF}$, I_{KA} =1 to 100 mA f ≥ 1.0 kHz			0.15	0.50		0.15	0.50		0.15	0.50	Ω

Note:

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

Test Circuits

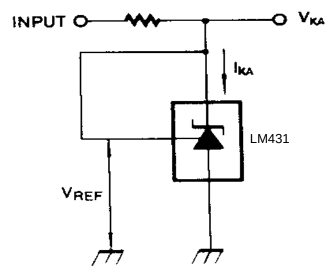


Figure 2. Test Circuit for $V_{KA} = V_{REF}$

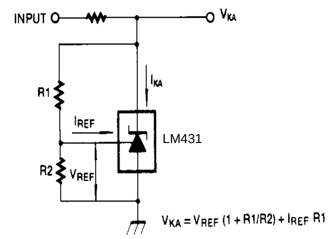


Figure 3. Test Circuit for $V_{KA} \geq V_{REF}$

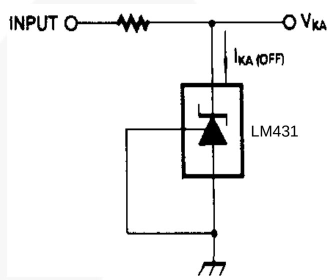


Figure 4. Test Circuit for $I_{KA(OFF)}$

Typical Performance Characteristics

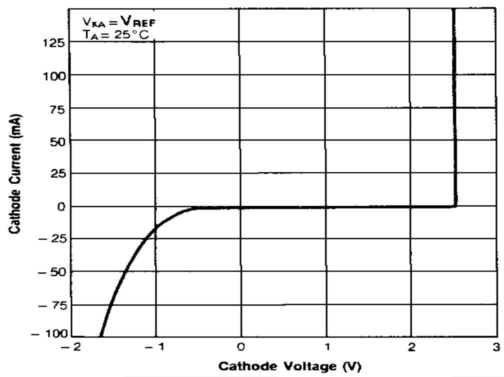


Figure 5. Cathode Current vs. Cathode Voltage

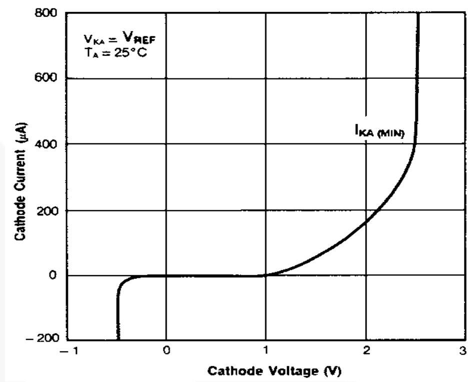


Figure 6. Cathode Current vs. Cathode Voltage

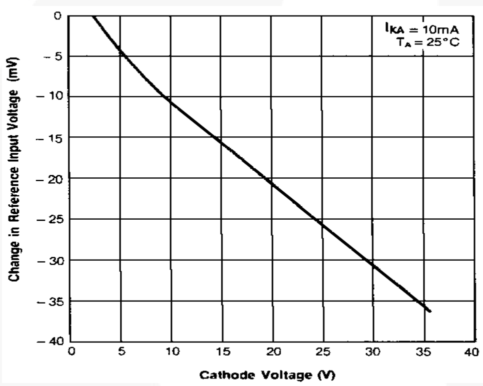


Figure 7. Change In Reference Input Voltage vs. Cathode Voltage

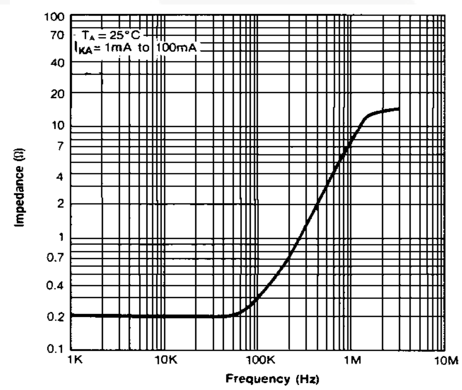


Figure 8. Dynamic Impedance Frequency

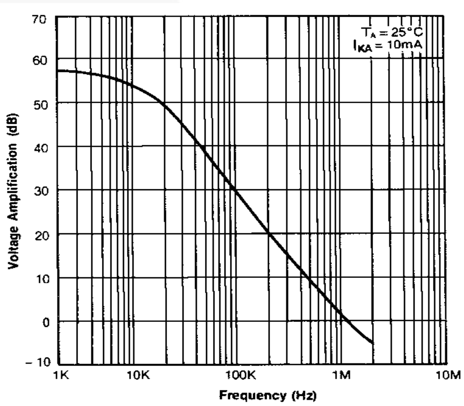


Figure 9. Small Signal Voltage Amplification vs. Frequency

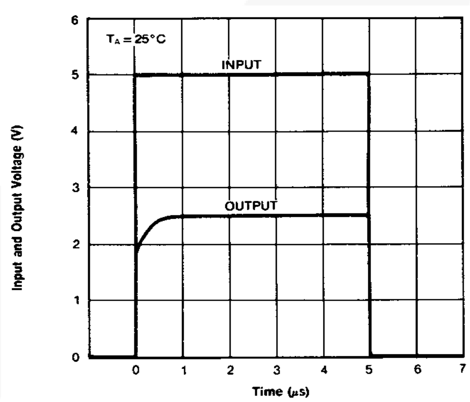


Figure 10. Pulse Response

Typical Performance Characteristics (Continued)

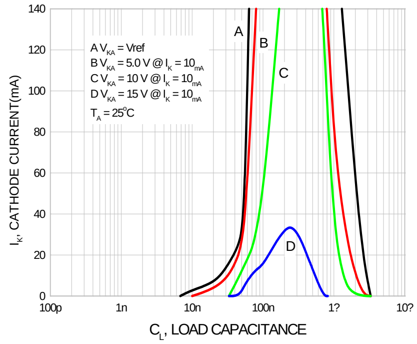


Figure11. Stability Boundary Conditions

Typical Application

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

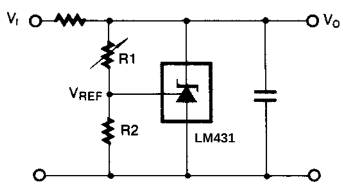


Figure 12. Shunt Regulator

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

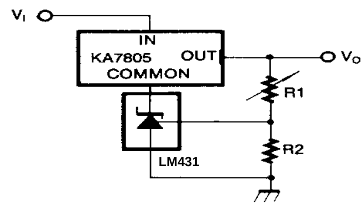


Figure 13. Output Control for Three-Terminal Fixed Regulator

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

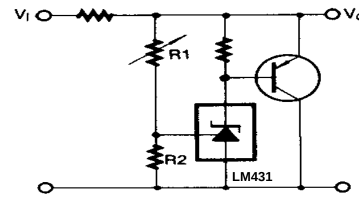


Figure 14. High-Current Shunt Regulator

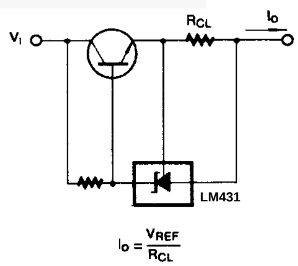


Figure 15. Current Limit or Current Source

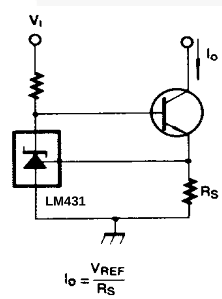


Figure 16. Constant-Current Sink

Physical Dimensions

TO-92 Bulk Type

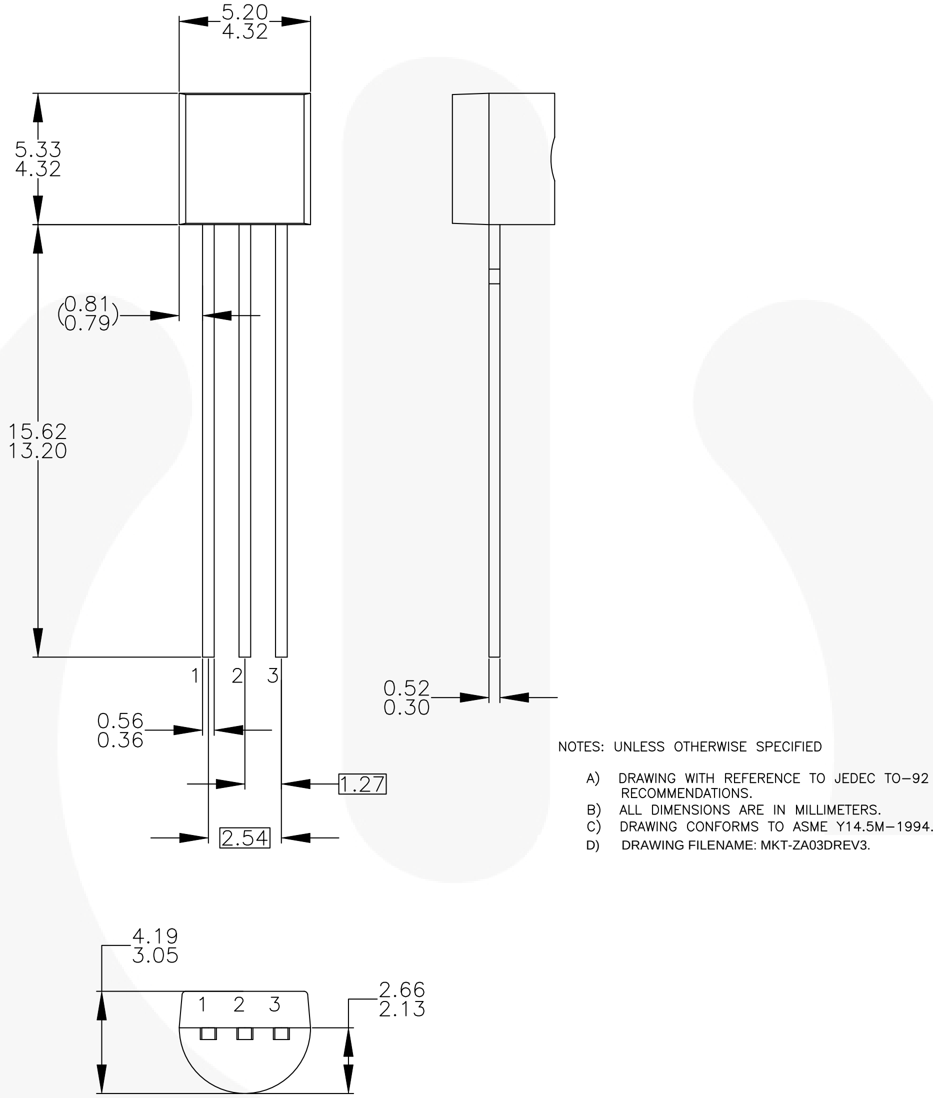


Figure 17. 3-Lead, TO-92, Molded, Standard Straight Lead

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/packaging/.

Physical Dimensions (Continued)

TO-92 Ammo Type, Tape and Reel Type

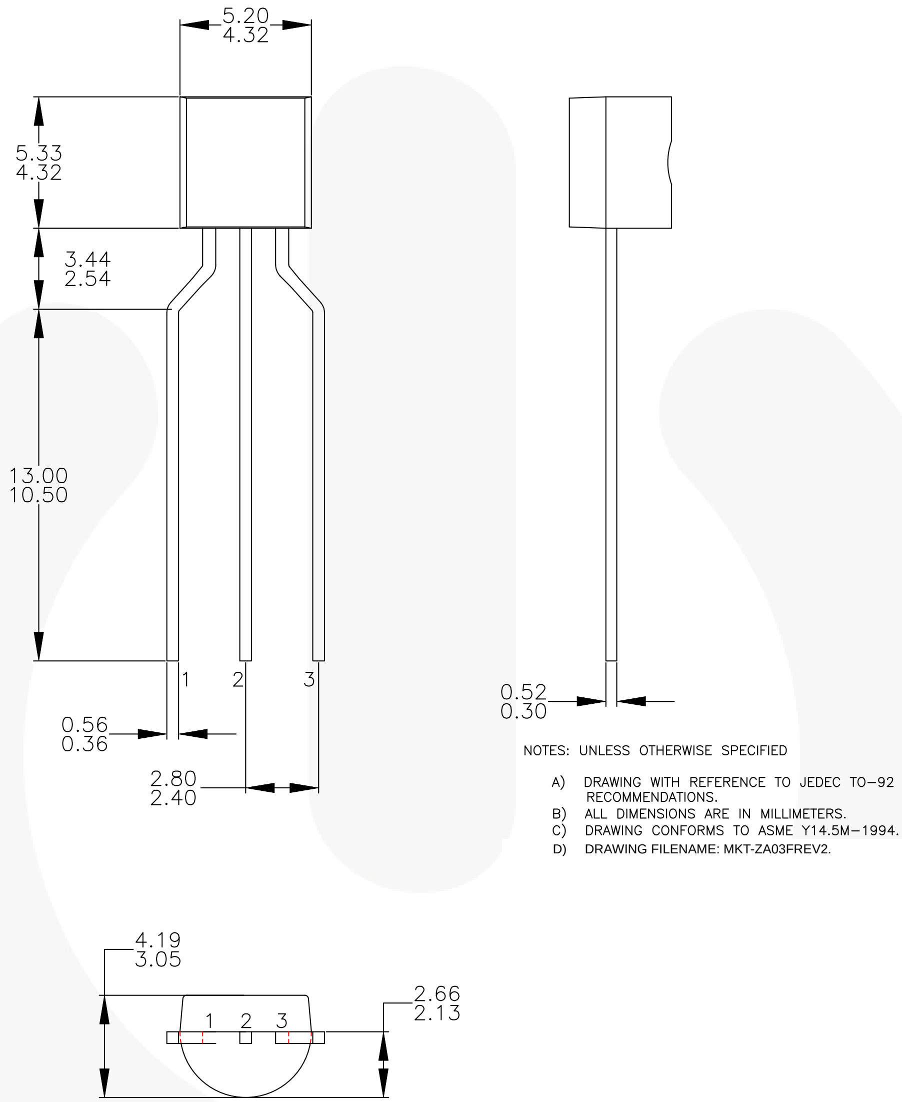


Figure 18. 3-Lead, TO-92, Molded, 0.200 in Line Spacing Lead Form

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/packaging/.

For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/products/discrete/pdf/to92_tr.pdf.

Physical Dimensions (Continued)

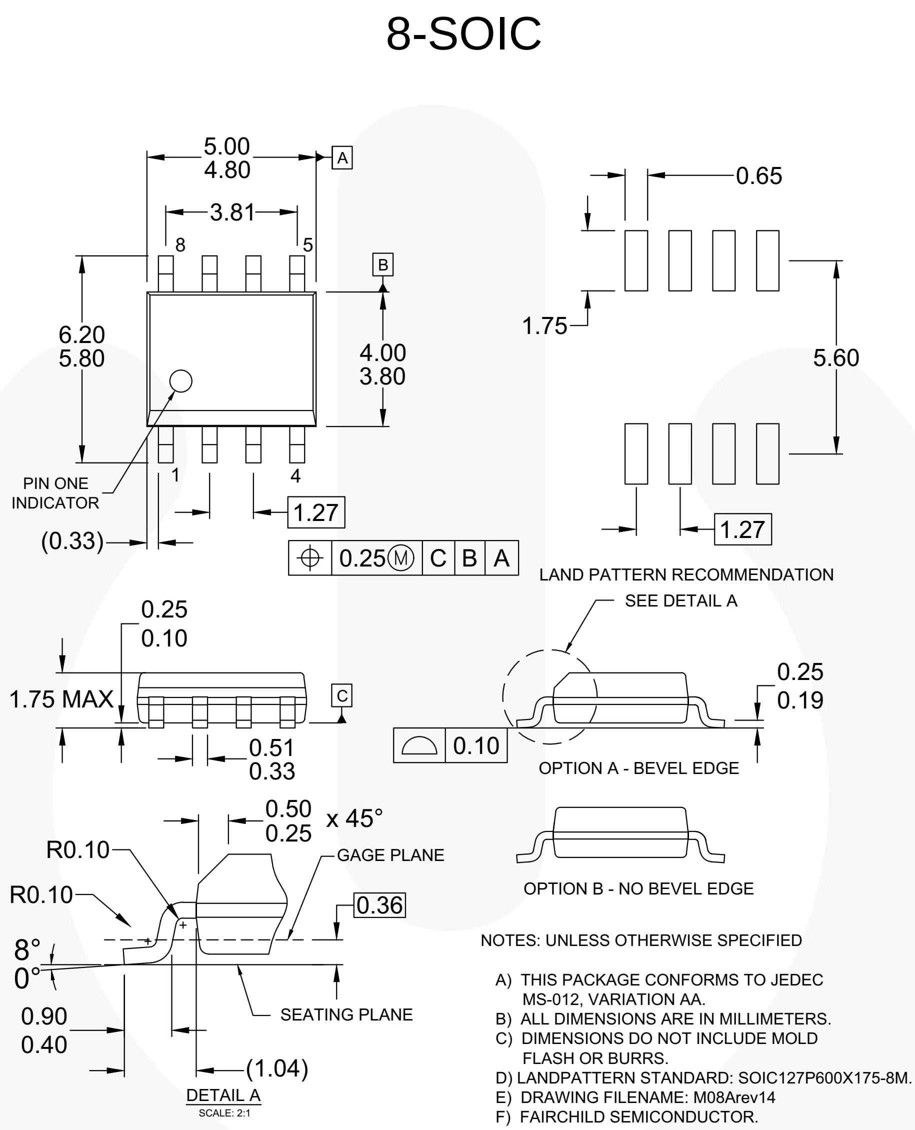


Figure 19. 8-Lead, SOIC, JEDEC MS 0-12, 0.150 inch Narrow Body

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/packaging/.

For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/products/discrete/pdf/soic8_tr.pdf.

TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

2Cool™
AccuPower™
AX-CAP®*
BitSiC™
Build it Now™
CorePLUS™
CorePOWER™
CROSSVOLT™
CTL™
Current Transfer Logic™
DEUXPEED®
Dual Cool™
EcoSPARK®
EfficientMax™
ESBC™
®
Fairchild®
Fairchild Semiconductor®
FACT Quiet Series™
FACT®
FAST®
FastvCore™
FETBench™
FPS™
F-PFS™
FRFET®
Global Power Resource℠
GreenBridge™
Green FPS™
Green FPS™ e-Series™
G*max*™
GTO™
IntelliMAX™
ISOPLANAR™
Making Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
mWSaver™
OptoHiT™
OPTOLOGIC®
OPTOPLANAR®
®
PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™
™
Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS®
SyncFET™
Sync-Lock™
SYSTEM GENERAL®*
TinyBoost™
TinyBuck™
TinyCalc™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
TinyWire™
TranSiC™
TriFault Detect™
TRUECURRENT®*
μSerDes™
SerDes™
UHC®
Ultra FRFET™
UniFET™
VCX™
VisualMax™
VoltagePlus™
XS™

* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
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.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

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. I64