



Is Now Part of



**ON Semiconductor®**

To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (\_), the underscore (\_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (\_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at [www.onsemi.com](http://www.onsemi.com). Please email any questions regarding the system integration to [Fairchild\\_questions@onsemi.com](mailto:Fairchild_questions@onsemi.com).

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.



June 2015

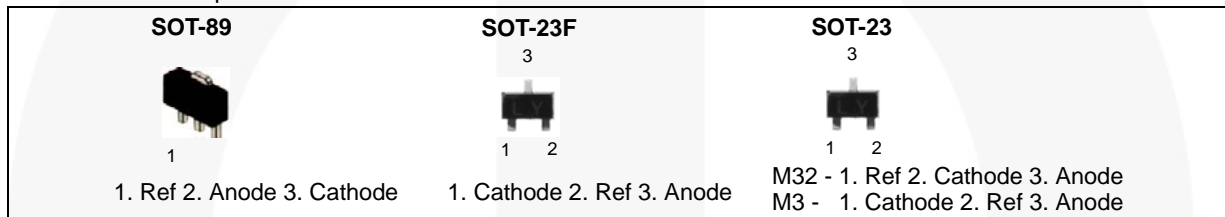
# LM431SA / LM431SB / LM431SC Programmable Shunt Regulator

## 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 LM431SA / LM431SB / LM431SC are three-terminal the output adjustable regulators with thermal stability over operating temperature range. The output voltage can be set 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 replacement for zener diodes in many applications.



## Ordering Information

Product Number	Output Voltage Tolerance	Operating Temperature	Top Mark <sup>(1)</sup>	Package	Packing Method
LM431SACMFX	2%	-25 to +85°C	43A	SOT-23F 3L	Tape and Reel
LM431SACM3X			43L	SOT-23 3L	
LM431SACM32X			43G	SOT-23 3L	
LM431SBCMLX	1%		43B	SOT-89 3L	
LM431SBCMFX			43B	SOT-23F 3L	
LM431SBCM3X			43M	SOT-23 3L	
LM431SBCM32X	0.5%		43H	SOT-23 3L	
LM431SCCMLX			43C	SOT-89 3L	
LM431SCCMFX			43C	SOT-23F 3L	
LM431SCCM3X			43N	SOT-23 3L	
LM431SCCM32X	43J		SOT-23 3L		
LM431SAIMFX	2%		-40 to +85°C	43AI	

### Note:

1. SOT-23 and SOT-23F have basically four-character marking except LM431SAIMFX.

(3 letters for device code + 1 letter for date code)

SOT-23F date code is composed of 1 digit numeric or alphabetic week code adding bar-type year code.

> Week code: Change in every two weeks

> Year code (additional bar): Rotate in three year cycle

Week	01-02	03-04	05-06	07-08	09-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26
Code	1	2	3	4	5	6	7	8	9	A	D	E	F
Week	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52
Code	H	J	K	L	N	O	P	R	S	T	U	V	X

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Code	□	□	□	□	□	□	□	□	□	□	□

## Block Diagram

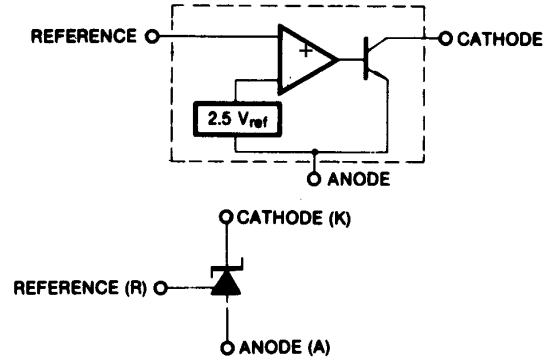


Figure 1. Block Diagram

## 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  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Value	Unit
$V_{KA}$	Cathode Voltage	37	V
$I_{KA}$	Cathode current Range (Continuous)	-100 to +150	mA
$I_{REF}$	Reference Input Current Range	-0.05 to +10.00	mA
$R_{\theta JA}$	Thermal Resistance Junction-Air <sup>(2,3)</sup>	ML Suffix Package (SOT-89)	220
		MF Suffix Package (SOT-23F)	350
		M32, M3 Suffix Package (SOT-23)	400
$P_D$	Power Dissipation <sup>(4,5)</sup>	ML Suffix Package (SOT-89)	560
		MF Suffix Package (SOT-23F)	350
		M32, M3 Suffix Package (SOT-23)	310
$T_J$	Junction Temperature	150	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature Range	All products except LM431SAIMFX	-25 to +85
		LM431SAIMFX	-40 to +85
$T_{STG}$	Storage Temperature Range	-65 to +150	$^\circ\text{C}$

### Notes:

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

## 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	100	mA

## Electrical Characteristics<sup>(6)</sup>

Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Conditions	LM431SA			LM431SB			LM431SC			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{REF}$	Reference Input Voltage	$V_{KA} = V_{REF}$ , $I_{KA} = 10\text{ mA}$	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	$V_{KA} = V_{REF}$ , $I_{KA} = 10\text{ mA}$ , $T_{MIN} \leq T_A \leq T_{MAX}$	SOT-89 SOT-23F		4.5	17.0		4.5	17.0		4.5	17.0	mV
			SOT-23		6.6	24		6.6	24		6.6	24	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$I_{KA} = 10\text{ mA}$	$\Delta V_{KA} = 10\text{ V} - V_{REF}$		-1.0	-2.7		-1.0	-2.7		-1.0	-2.7	mV/V
			$\Delta V_{KA} = 36\text{ V} - 10\text{ V}$		-0.5	-2.0		-0.5	-2.0		-0.5	-2.0	
$I_{REF}$	Reference Input Current	$I_{KA} = 10\text{ mA}$ , $R_1 = 10\text{ K}\Omega$ , $R_2 = \infty$		1.5	4.0		1.5	4.0		1.5	4.0	$\mu\text{A}$	
$\Delta I_{REF} / \Delta T$	Deviation of Reference Input Current Over Full Temperature Range	$I_{KA} = 10\text{ mA}$ , $R_1 = 10\text{ K}\Omega$ , $R_2 = \infty$ , $T_A = \text{Full Range}$	SOT-89 SOT-23F		0.4	1.2		0.4	1.2		0.4	1.2	$\mu\text{A}$
			SOT-23		0.8	2.0		0.8	2.0		0.8	2.0	$\mu\text{A}$
$I_{KA(MIN)}$	Minimum Cathode Current 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	$V_{KA} = 36\text{ V}$ , $V_{REF} = 0$		0.05	1.00		0.05	1.00		0.05	1.00	$\mu\text{A}$	
$Z_{KA}$	Dynamic Impedance	$V_{KA} = V_{REF}$ , $I_{KA} = 1\text{ to }100\text{ mA}$ , $f \geq 1.0\text{ kHz}$		0.15	0.50		0.15	0.50		0.15	0.50	$\Omega$	

### Note:

6.  $T_{MIN} = -25^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$ .

**Electrical Characteristics**<sup>(7, 8)</sup> (Continued)

 Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

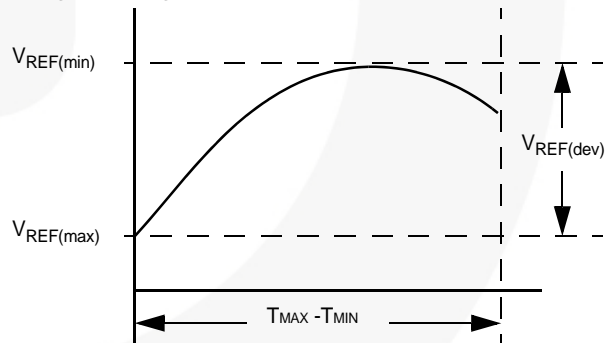
Symbol	Parameter	Conditions	LM431SAI			Unit
			Min.	Typ.	Max.	
$V_{REF}$	Reference Input Voltage	$V_{KA} = V_{REF}, I_{KA} = 10\text{ mA}$	2.450	2.500	2.550	V
$V_{REF(dev)}$	Deviation of Reference Input Voltage Over-Temperature	$V_{KA} = V_{REF}, I_{KA} = 10\text{ mA}, T_{MIN} \leq T_A \leq T_{MAX}$		5	20	mV
$\Delta V_{REF}/\Delta V_{KA}$	Ratio of Change in Reference Input Voltage to Change in Cathode Voltage	$I_{KA} = 10\text{ mA}$	$\Delta V_{KA} = 10\text{ V} - V_{REF}$	-1.0	-2.7	mV/V
			$\Delta V_{KA} = 36\text{ V} - 10\text{ V}$	-0.5	-2.0	
$I_{REF}$	Reference Input Current	$I_{KA} = 10\text{ mA}, R_1 = 10\text{ K}\Omega, R_2 = \infty$		1.5	4.0	$\mu\text{A}$
$I_{REF(dev)}$	Deviation of Reference Input Current Over Full Temperature Range	$I_{KA} = 10\text{ mA}, R_1 = 10\text{ K}\Omega, R_2 = \infty, T_{MIN} \leq T_A \leq T_{MAX}$		0.8	2.0	$\mu\text{A}$
$I_{KA(MIN)}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{REF}$		0.45	1.00	mA
$I_{KA(OFF)}$	Off -Stage Cathode Current	$V_{KA} = 36\text{ V}, V_{REF} = 0$		0.05	1.00	$\mu\text{A}$
$Z_{KA}$	Dynamic Impedance	$V_{KA} = V_{REF}, I_{KA} = 1\text{ to }100\text{ mA}, f \geq 1.0\text{ kHz}$		0.15	0.50	$\Omega$

**Notes:**

 7.  $T_{MIN} = -40^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$ .

 8. The deviation parameters  $V_{REF(dev)}$  and  $I_{REF(dev)}$  are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage,  $\alpha V_{REF}$ , is defined as:

$$|\alpha V_{REF}| \left( \frac{\text{ppm}}{^\circ\text{C}} \right) = \frac{\left( \frac{V_{REF(dev)}}{V_{REF(at 25^\circ\text{C})}} \right) \cdot 10^6}{T_{MAX} - T_{MIN}}$$


 where  $T_{MAX} - T_{MIN}$  is the rated operating free-air temperature range of the device.

 $\alpha V_{REF}$  can be positive or negative, depending on whether minimum  $V_{REF}$  or maximum  $V_{REF}$ , respectively, occurs at the lower temperature.

 Example:  $V_{REF(dev)} = 4.5\text{ mV}$ ,  $V_{REF} = 2500\text{ mV}$  at  $25^\circ\text{C}$ ,  $T_{MAX} - T_{MIN} = 125^\circ\text{C}$  for LM431SAI.

$$|\alpha V_{REF}| = \frac{\left( \frac{4.5\text{ mV}}{2500\text{ mV}} \right) \cdot 10^6}{125^\circ\text{C}} = 14.4\text{ ppm}/^\circ\text{C}$$

 Because minimum  $V_{REF}$  occurs at the lower temperature, the coefficient is positive.

## Test Circuits

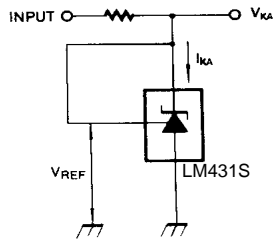


Figure 2. Test Circuit for  $V_{KA} = V_{REF}$

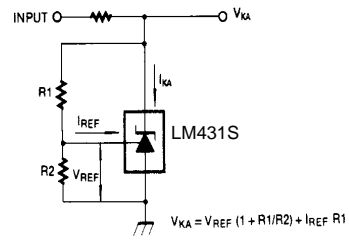


Figure 3. Test Circuit for  $V_{KA} \geq V_{REF}$

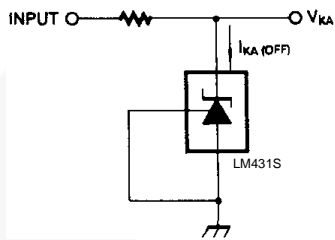


Figure 4. Test Circuit for  $I_{KA(OFF)}$

## Typical Applications

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

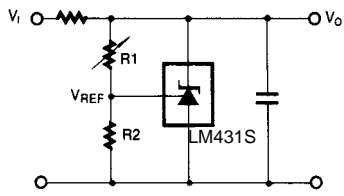


Figure 5. Shunt Regulator

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

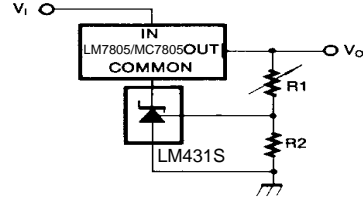


Figure 6. Output Control for Three-Terminal Fixed Regulator

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

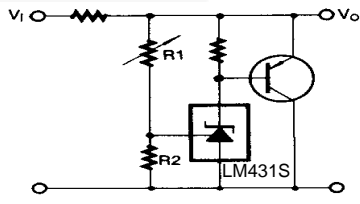


Figure 7. High Current Shunt Regulator

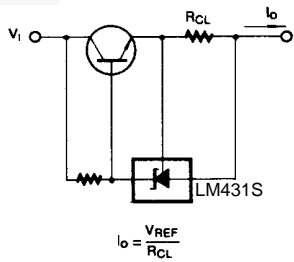


Figure 8. Current Limit or Current Source

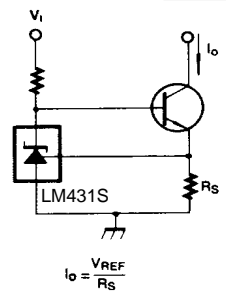


Figure 9. Constant-Current Sink

## Typical Performance Characteristics

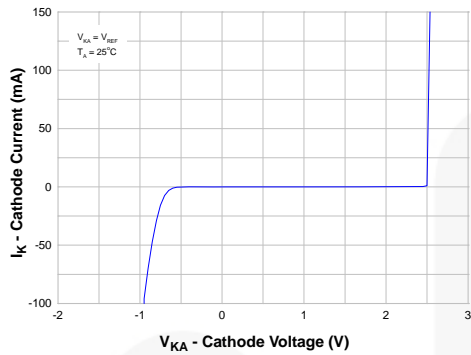


Figure 10. Cathode Current vs. Cathode Voltage

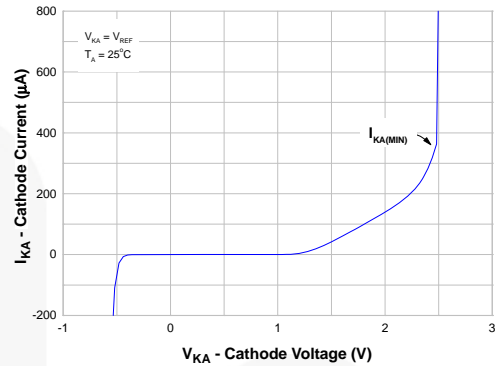


Figure 11. Cathode Current vs. Cathode Voltage

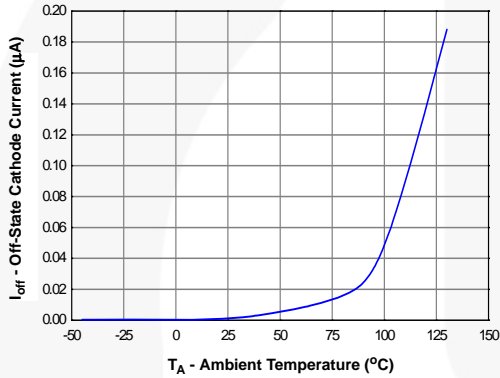


Figure 12. OFF-State Cathode Current vs. Ambient Temperature

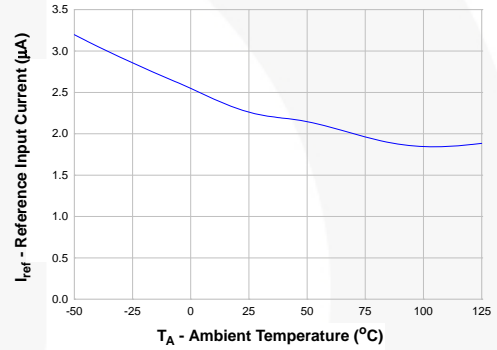


Figure 13. Reference Input Current vs. Ambient Temperature

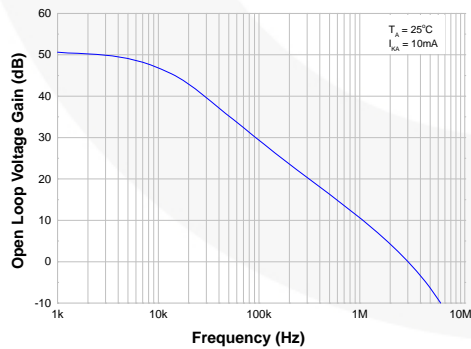


Figure 14. Frequency vs. Small Signal Voltage Amplification

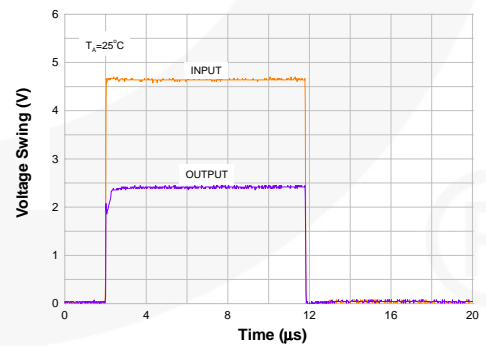


Figure 15. Pulse Response



Typical Performance Characteristics (Continued)

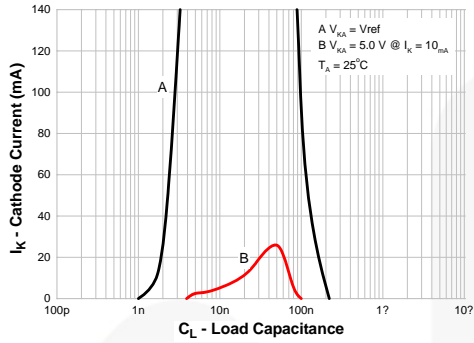


Figure 16. Stability Boundary Conditions

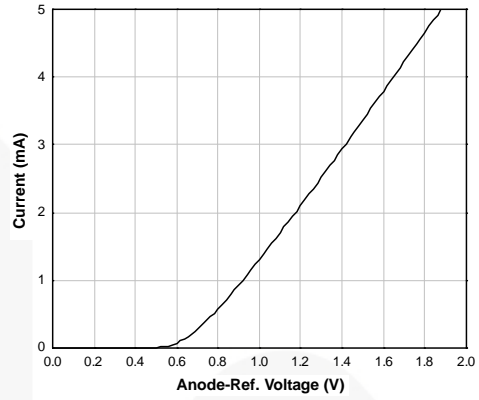


Figure 17. Anode-Reference Diode Curve

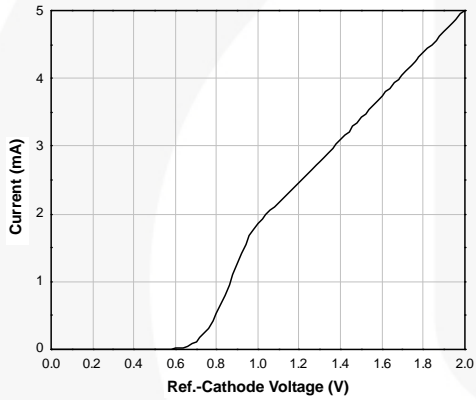


Figure 18. Reference-Cathode Diode Curve

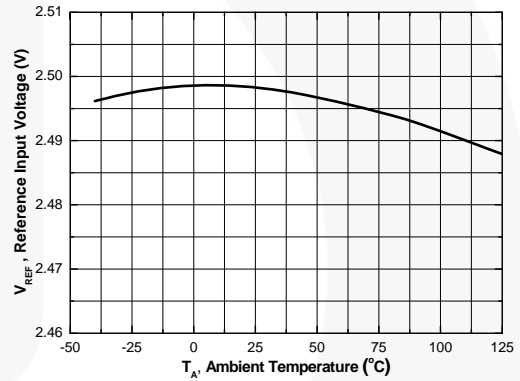
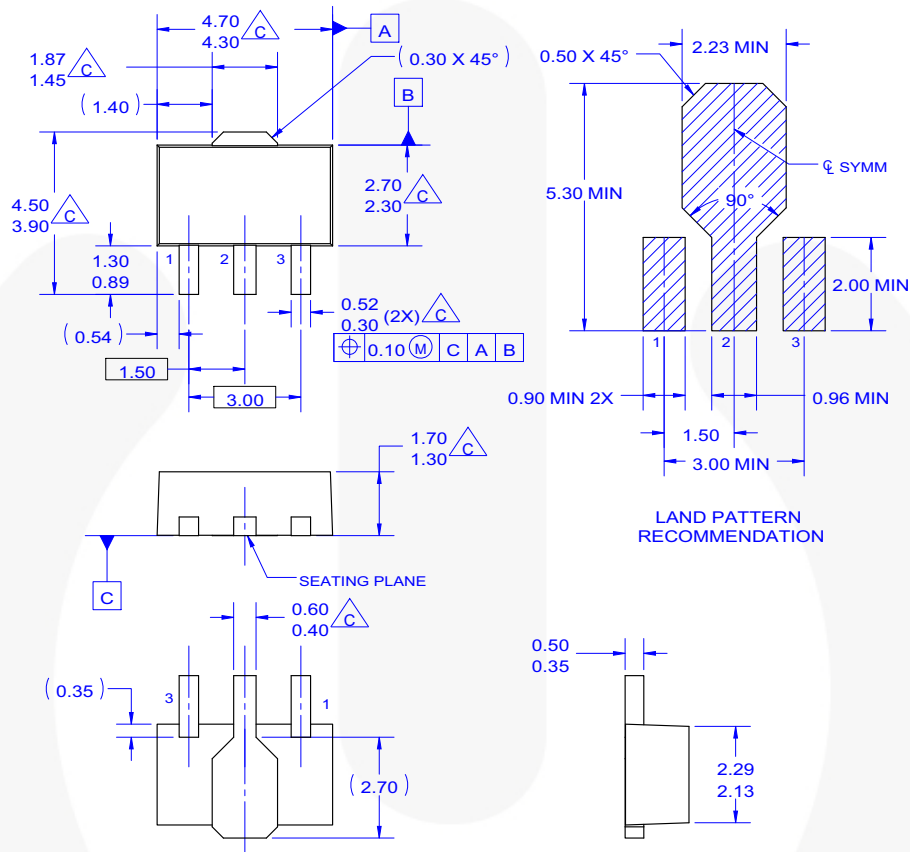


Figure 19. Reference Input Voltage vs. Ambient Temperature

Physical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED.

A. REFERENCE TO JEDEC TO-243 VARIATION AA.  
 B. ALL DIMENSIONS ARE IN MILLIMETERS.

$\triangle C$  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: MA03CREV3

Figure 20. 3-LEAD, SOT-89, JEDEC TO-243, OPTION AA



Physical Dimensions (Continued)

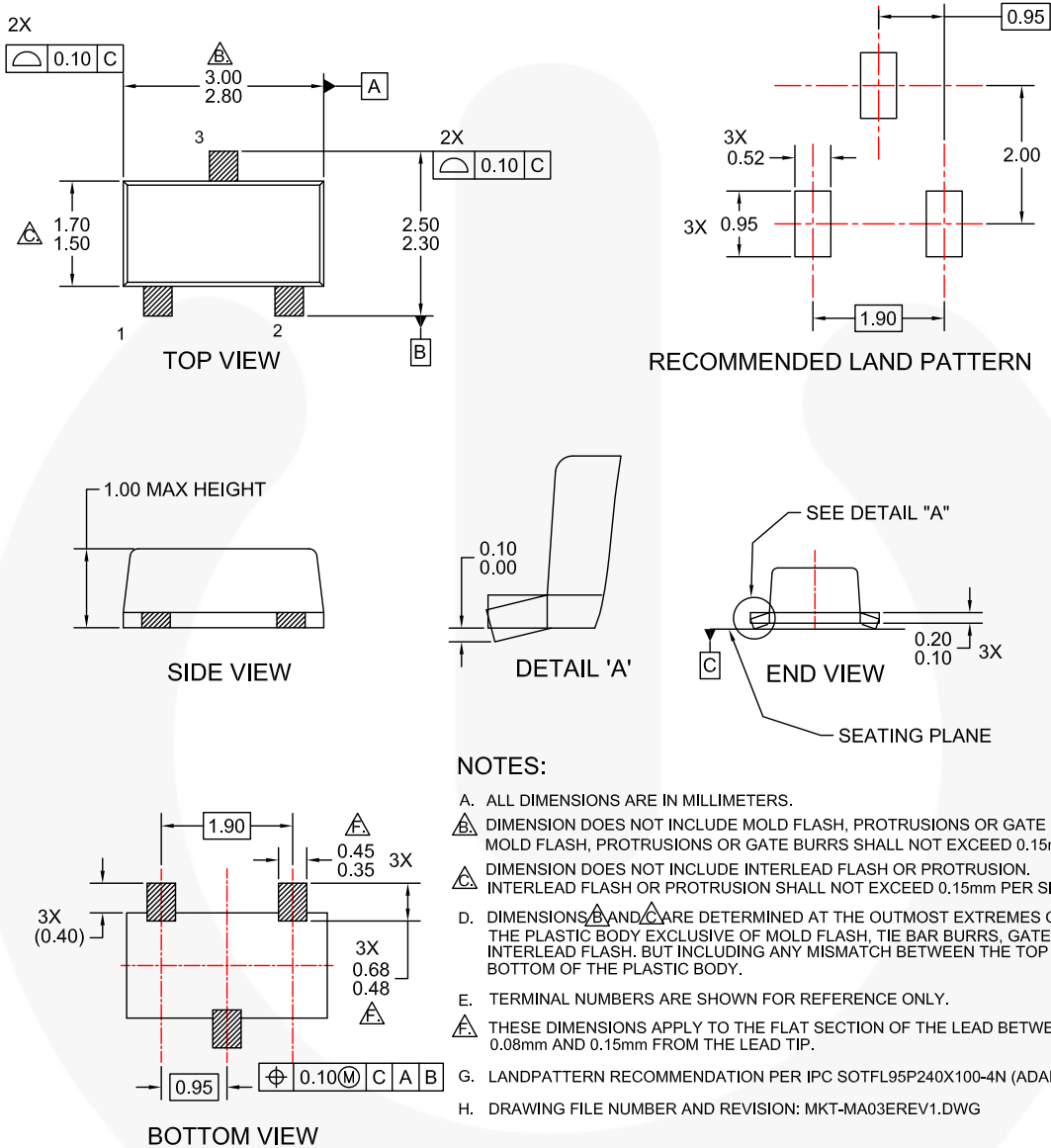



Figure 21. 3-LEAD, SOT23F, FLAT LEAD, LOW PROFILE







## 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.

AccuPower™  
 AttitudeEngine™  
 Awinda®  
 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<sup>SM</sup>  
 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™  
 MotionGrid®  
 MT<sup>®</sup>  
 MTx<sup>®</sup>  
 MVN<sup>®</sup>  
 mWSaver®  
 OptoHiT™  
 OPTOLOGIC®

OPTOPLANAR®  
  
 Power Supply WebDesigner™  
 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™  
  
 UHC®  
 Ultra FRFET™  
 UniFET™  
 VCX™  
 VisualMax™  
 VoltagePlus™  
 XS™  
 Xsens™  
 仙童™

\* 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. TO OBTAIN THE LATEST, MOST UP-TO-DATE DATASHEET AND PRODUCT INFORMATION, VISIT OUR WEBSITE AT <http://www.fairchildsemi.com>. 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](http://www.fairchildsemi.com), under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeit 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. 174

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local  
Sales Representative