

TLV431A, TLV431B, SCV431A, SCV431B

Low Voltage Precision Adjustable Shunt Regulator

The TLV431A and B series are precision low voltage shunt regulators that are programmable over a wide voltage range of 1.24 V to 16 V. The TLV431A series features a guaranteed reference accuracy of $\pm 1.0\%$ at 25°C and $\pm 2.0\%$ over the entire industrial temperature range of -40°C to 85°C . For TLV431B series, the accuracy is even higher, it's $\pm 0.5\%$ and $\pm 1.0\%$ respectively. These devices exhibit a sharp low current turn-on characteristic with a low dynamic impedance of $0.20\ \Omega$ over an operating current range of $100\ \mu\text{A}$ to $20\ \text{mA}$. This combination of features makes this series an excellent replacement for zener diodes in numerous applications circuits that require a precise reference voltage. When combined with an optocoupler, the TLV431A/B can be used as an error amplifier for controlling the feedback loop in isolated low output voltage (3.0 V to 3.3 V) switching power supplies. These devices are available in economical TO-92-3 and micro size TSOP-5 and SOT-23-3 packages.

Features

- Programmable Output Voltage Range of 1.24 V to 16 V
- Voltage Reference Tolerance $\pm 1.0\%$ for A Series and $\pm 0.5\%$ for B Series
- Sharp Low Current Turn-On Characteristic
- Low Dynamic Output Impedance of $0.20\ \Omega$ from $100\ \mu\text{A}$ to $20\ \text{mA}$
- Wide Operating Current Range of $50\ \mu\text{A}$ to $20\ \text{mA}$
- Micro Miniature TSOP-5, SOT-23-3 and TO-92-3 Packages
- These are Pb-Free and Halide-Free Devices
- SCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

Applications

- Low Output Voltage (3.0 V to 3.3 V) Switching Power Supply Error Amplifier
- Adjustable Voltage or Current Linear and Switching Power Supplies
- Voltage Monitoring
- Current Source and Sink Circuits
- Analog and Digital Circuits Requiring Precision References
- Low Voltage Zener Diode Replacements

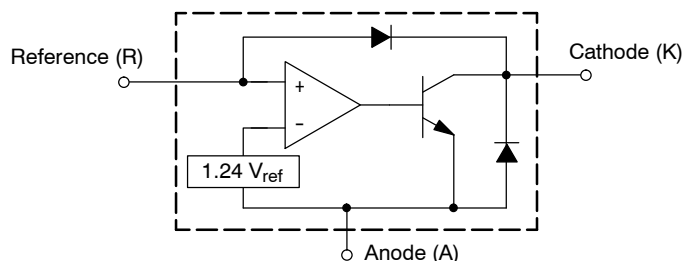


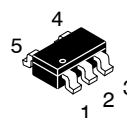
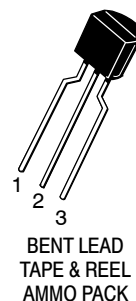
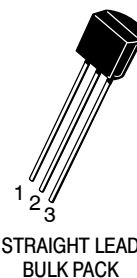
Figure 1. Representative Block Diagram



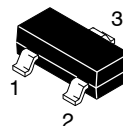
ON Semiconductor®

<http://onsemi.com>

TO-92
LP SUFFIX
CASE 29



TSOP-5
SN SUFFIX
CASE 483



SOT-23-3
SN1 SUFFIX
CASE 318

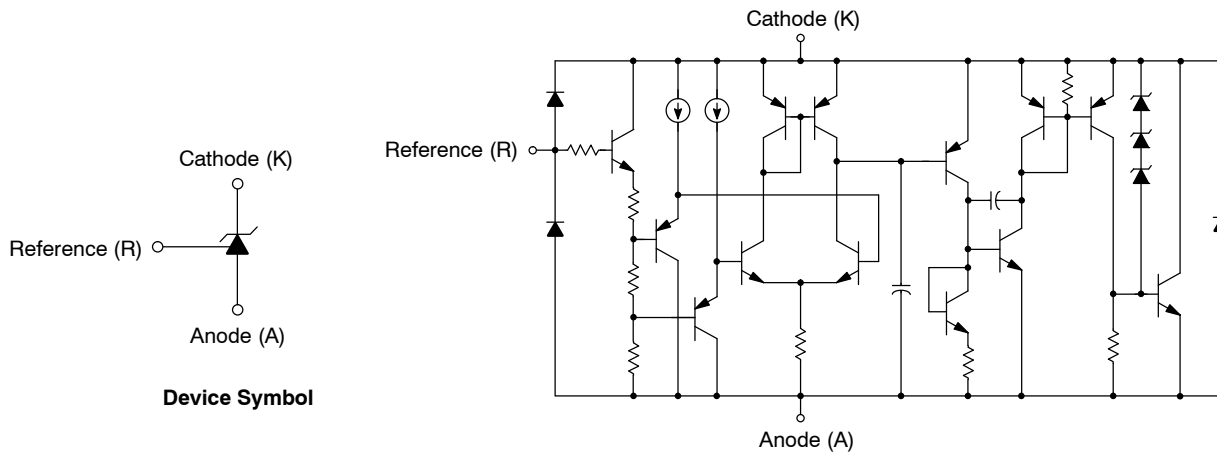
ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 11 of this data sheet.

DEVICE MARKING INFORMATION AND PIN CONNECTIONS

See general marking information in the device marking section on page 10 of this data sheet.

TLV431A, TLV431B, SCV431A, SCV431B



The device contains 13 active transistors.

Figure 2. Representative Device Symbol and Schematic Diagram

MAXIMUM RATINGS (Full operating ambient temperature range applies, unless otherwise noted)

Rating	Symbol	Value	Unit
Cathode to Anode Voltage	V_{KA}	18	V
Cathode Current Range, Continuous	I_K	-20 to 25	mA
Reference Input Current Range, Continuous	I_{ref}	-0.05 to 10	mA
Thermal Characteristics			$^{\circ}\text{C}/\text{W}$
LP Suffix Package, TO-92-3 Package	$R_{\theta JA}$	178	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JC}$	83	
SN Suffix Package, TSOP-5 Package	$R_{\theta JA}$	226	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	491	
SN1 Suffix Package, SOT-23-3 Package	$R_{\theta JA}$	491	
Thermal Resistance, Junction-to-Ambient			
Operating Junction Temperature	T_J	150	$^{\circ}\text{C}$
Operating Ambient Temperature Range	T_A	-40 to 85	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-65 to 150	$^{\circ}\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

NOTE: This device series contains ESD protection and exceeds the following tests: Human Body Model 2000 V per MIL-STD-883, Method 3015. Machine Model Method 200 V.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

RECOMMENDED OPERATING CONDITIONS

Condition	Symbol	Min	Max	Unit
Cathode to Anode Voltage	V_{KA}	V_{ref}	16	V
Cathode Current	I_K	0.1	20	mA

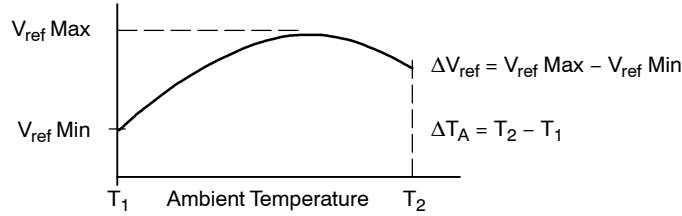
TLV431A, TLV431B, SCV431A, SCV431B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	TLV431A/SCV431A			TLV431B/SCV431B			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference Voltage (Figure 3) (V _{KA} = V _{ref} , I _K = 10 mA, T _A = 25°C) (T _A = T _{low} to T _{high} , Note 1)	V _{ref}	1.228 1.215	1.240 –	1.252 1.265	1.234 1.228	1.240 –	1.246 1.252	V
Reference Input Voltage Deviation Over Temperature (Figure 3) (V _{KA} = V _{ref} , I _K = 10 mA, T _A = T _{low} to T _{high} , Note 1)	ΔV _{ref}	–	7.2	20	–	7.2	20	mV
Ration of Reference Input Voltage Change to Cathode Voltage Change (Figure 4) (V _{KA} = V _{ref} to 16 V, I _K = 10 mA)	$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	–	–0.6	–1.5	–	–0.6	–1.5	$\frac{mV}{V}$
Reference Terminal Current (Figure 4) (I _K = 10 mA, R1 = 10 kΩ, R2 = open)	I _{ref}	–	0.15	0.3	–	0.15	0.3	μA
Reference Input Current Deviation Over Temperature (Figure 4) (I _K = 10 mA, R1 = 10 kΩ, R2 = open, Notes 1, 2)	ΔI _{ref}	–	0.04	0.08	–	0.04	0.08	μA
Minimum Cathode Current for Regulation (Figure 3)	I _{K(min)}	–	55	80	–	55	80	μA
Off-State Cathode Current (Figure 5) (V _{KA} = 6.0 V, V _{ref} = 0) (V _{KA} = 16 V, V _{ref} = 0)	I _{K(off)}	– –	0.01 0.012	0.04 0.05	– –	0.01 0.012	0.04 0.05	μA
Dynamic Impedance (Figure 3) (V _{KA} = V _{ref} , I _K = 0.1 mA to 20 mA, f ≤ 1.0 kHz, Note 3)	Z _{KA}	–	0.25	0.4	–	0.25	0.4	Ω

1. Ambient temperature range: T_{low} = –40°C, T_{high} = 85°C.

2. The deviation parameters ΔV_{ref} and ΔI_{ref} are defined as the difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.



The average temperature coefficient of the reference input voltage, αV_{ref} is defined as:

$$\alpha V_{ref} \left(\frac{ppm}{^{\circ}C} \right) = \frac{\left(\frac{\Delta V_{ref}}{V_{ref} (T_A = 25^{\circ}C)} \times 10^6 \right)}{\Delta T_A}$$

αV_{ref} can be positive or negative depending on whether V_{ref} Min or V_{ref} Max occurs at the lower ambient temperature, refer to Figure 8.

Example: ΔV_{ref} = 7.2 mV and the slope is positive,

$$V_{ref} @ 25^{\circ}C = 1.241 V$$

$$\Delta T_A = 125^{\circ}C$$

$$\alpha V_{ref} \left(\frac{ppm}{^{\circ}C} \right) = \frac{0.0072 \times 10^6}{1.241 \times 125} = 46 ppm/^{\circ}C$$

3. The dynamic impedance Z_{KA} is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device is operating with two external resistors, R1 and R2, (refer to Figure 4) the total dynamic impedance of the circuit is given by:

$$|Z_{KA}'| = |Z_{KA}| \times \left(1 + \frac{R1}{R2} \right)$$

TLV431A, TLV431B, SCV431A, SCV431B

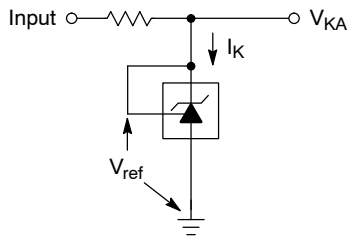


Figure 3. Test Circuit for $V_{KA} = V_{ref}$

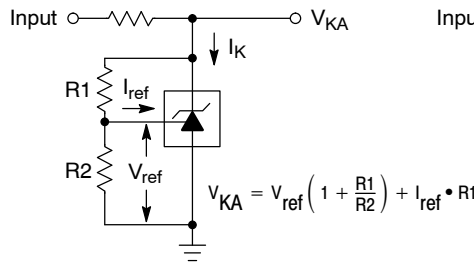


Figure 4. Test Circuit for $V_{KA} > V_{ref}$

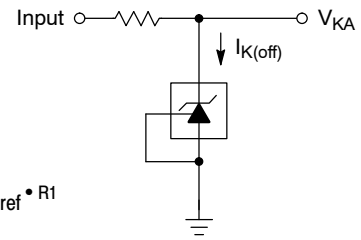


Figure 5. Test Circuit for $I_{K(off)}$

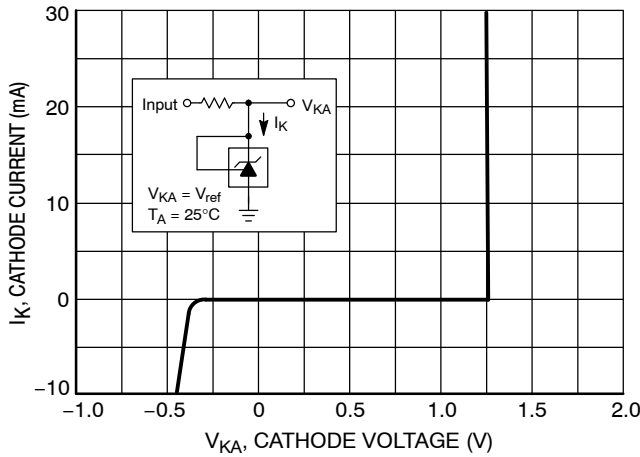


Figure 6. Cathode Current vs. Cathode Voltage

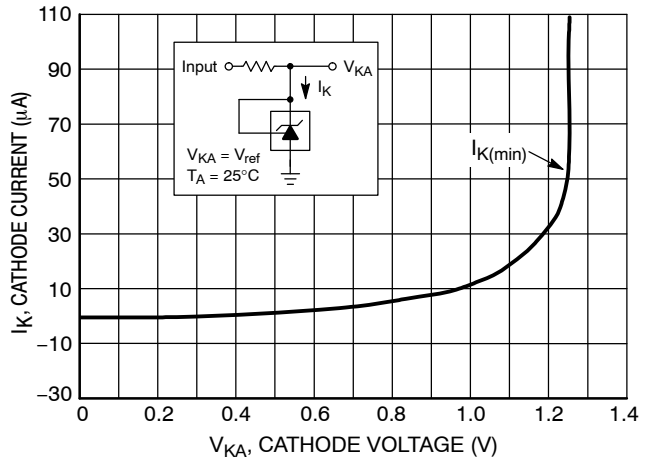


Figure 7. Cathode Current vs. Cathode Voltage

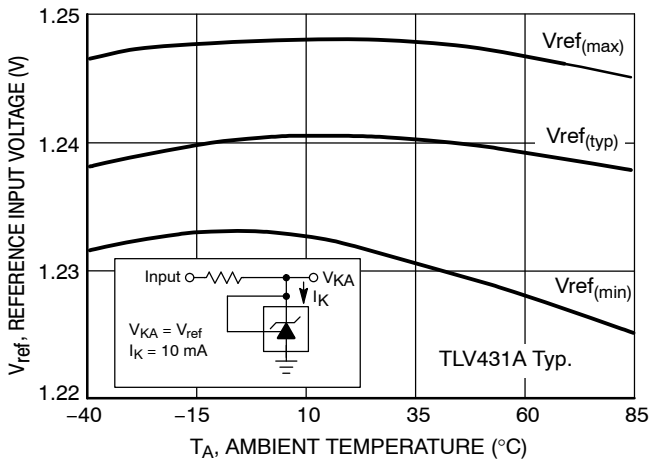


Figure 8. Reference Input Voltage versus Ambient Temperature

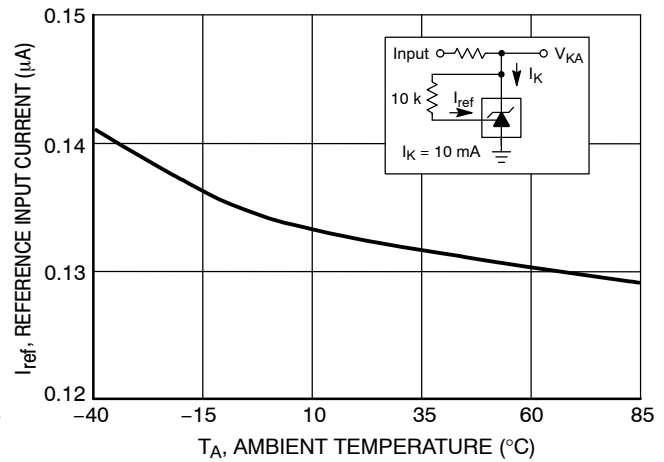


Figure 9. Reference Input Current versus Ambient Temperature

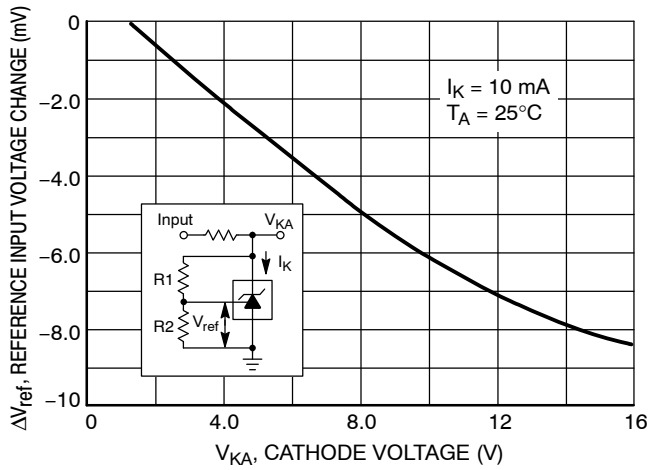


Figure 10. Reference Input Voltage Change versus Cathode Voltage

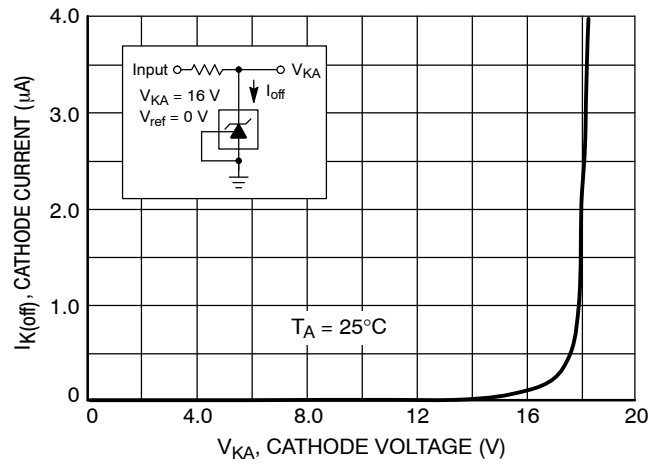


Figure 11. Off-State Cathode Current versus Cathode Voltage

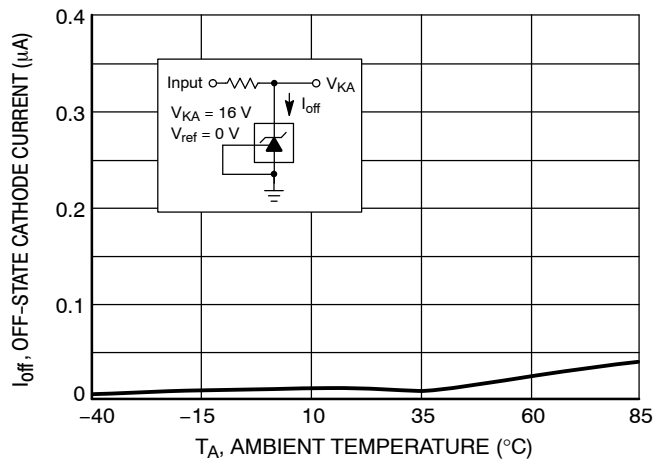


Figure 12. Off-State Cathode Current versus Ambient Temperature

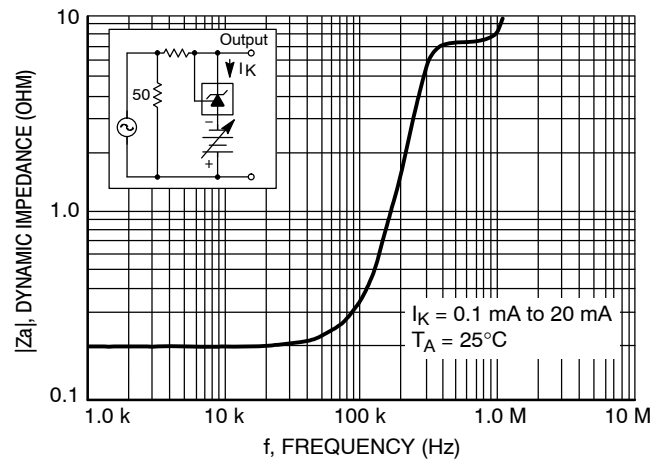


Figure 13. Dynamic Impedance versus Frequency

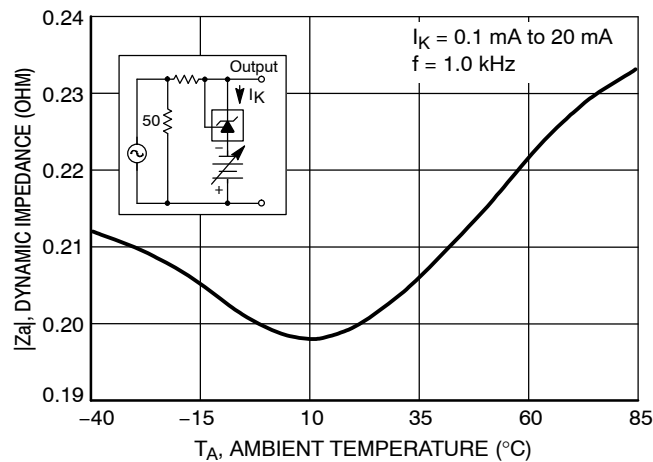


Figure 14. Dynamic Impedance versus Ambient Temperature

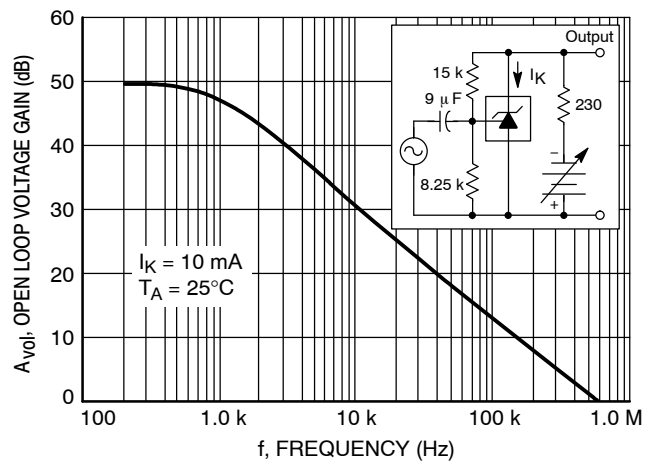


Figure 15. Open-Loop Voltage Gain versus Frequency

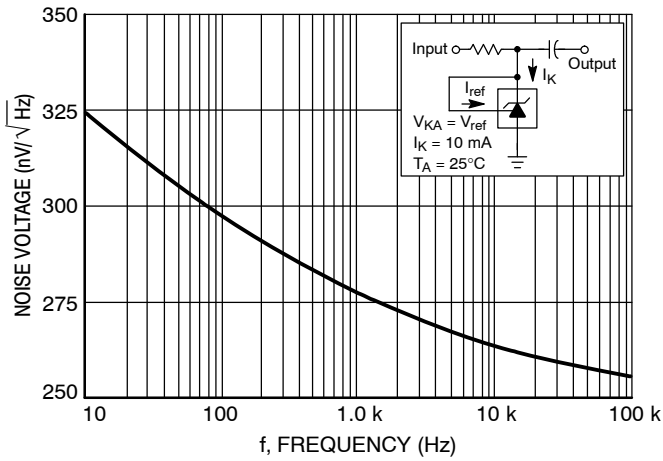


Figure 16. Spectral Noise Density

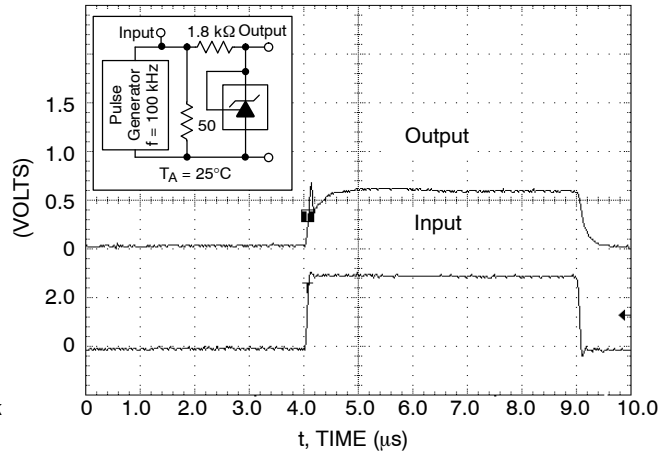


Figure 17. Pulse Response

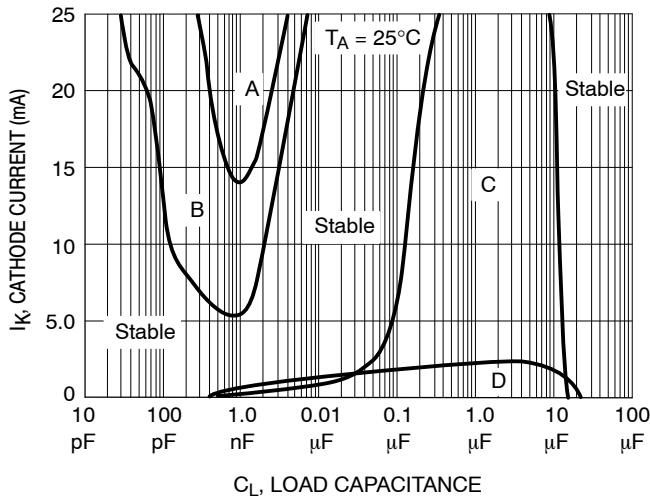
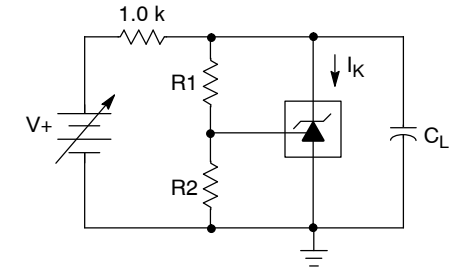


Figure 18. Stability Boundary Conditions



Unstable Regions	V_{KA} (V)	$R1$ (kΩ)	$R2$ (kΩ)
A, C	V_{ref}	0	∞
B, D	5.0	30.4	10

Figure 19. Test Circuit for Figure 18

Stability

Figures 18 and 19 show the stability boundaries and circuit configurations for the worst case conditions with the load capacitance mounted as close as possible to the device. The required load capacitance for stable operation can vary depending on the operating temperature and capacitor

equivalent series resistance (ESR). Ceramic or tantalum surface mount capacitors are recommended for both temperature and ESR. The application circuit stability should be verified over the anticipated operating current and temperature ranges.

TYPICAL APPLICATIONS

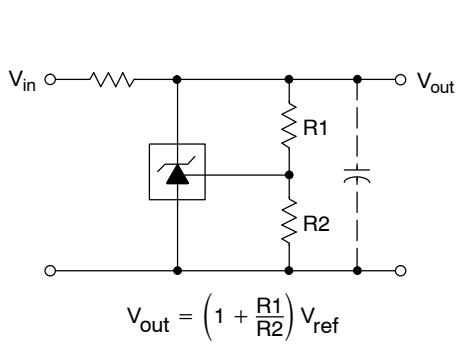


Figure 20. Shunt Regulator

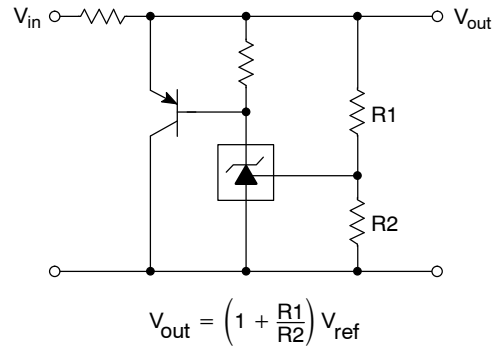


Figure 21. High Current Shunt Regulator

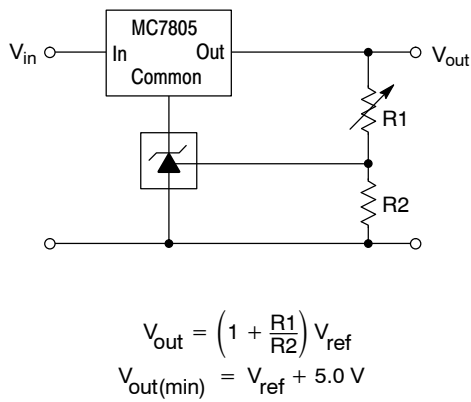


Figure 22. Output Control for a Three Terminal Fixed Regulator

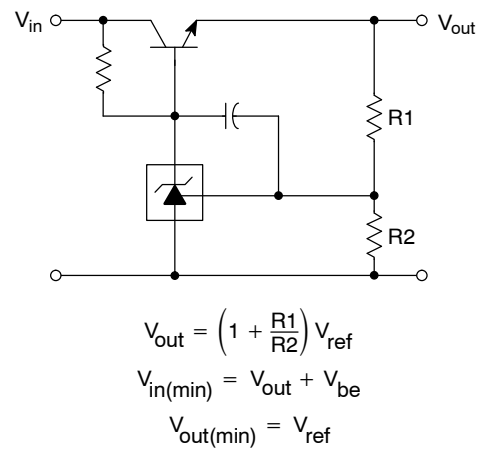


Figure 23. Series Pass Regulator

TLV431A, TLV431B, SCV431A, SCV431B

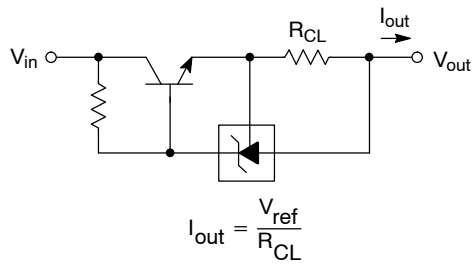


Figure 24. Constant Current Source

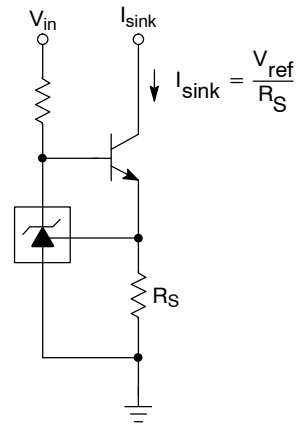


Figure 25. Constant Current Sink

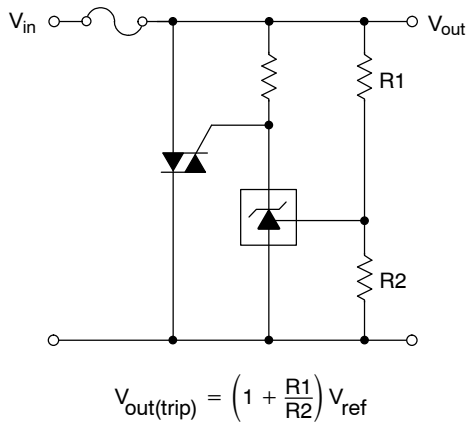


Figure 26. TRIAC Crowbar

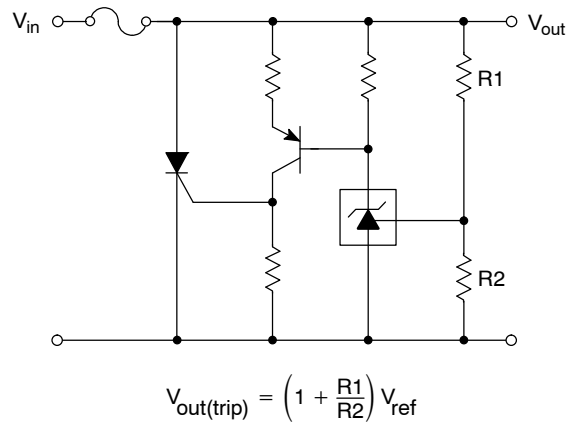
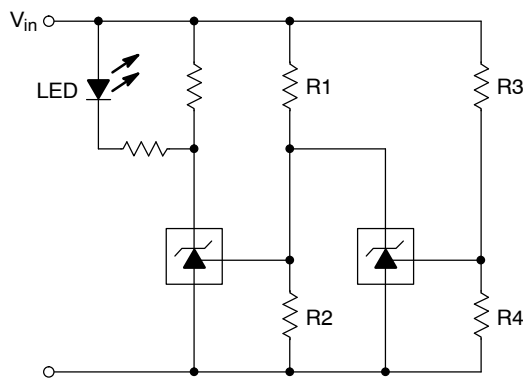


Figure 27. SCR Crowbar

TLV431A, TLV431B, SCV431A, SCV431B



L.E.D. indicator is 'ON' when V_{in} is between the upper and lower limits,

$$\text{Lower limit} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$\text{Upper limit} = \left(1 + \frac{R3}{R4}\right) V_{ref}$$

Figure 28. Voltage Monitor

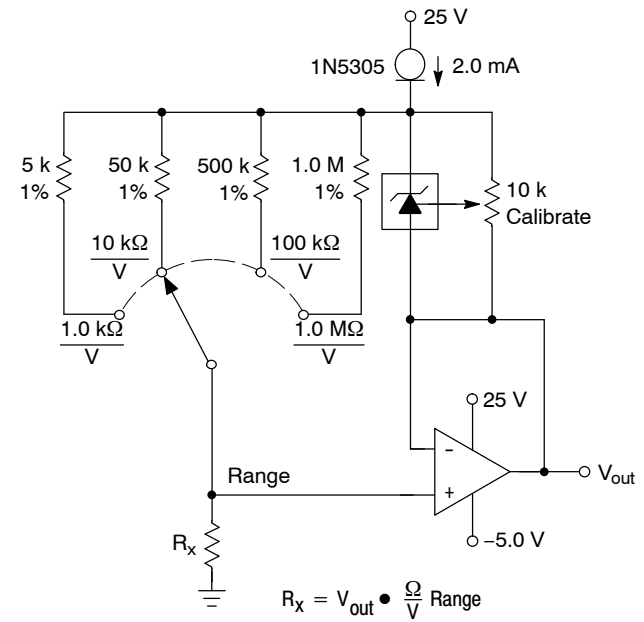
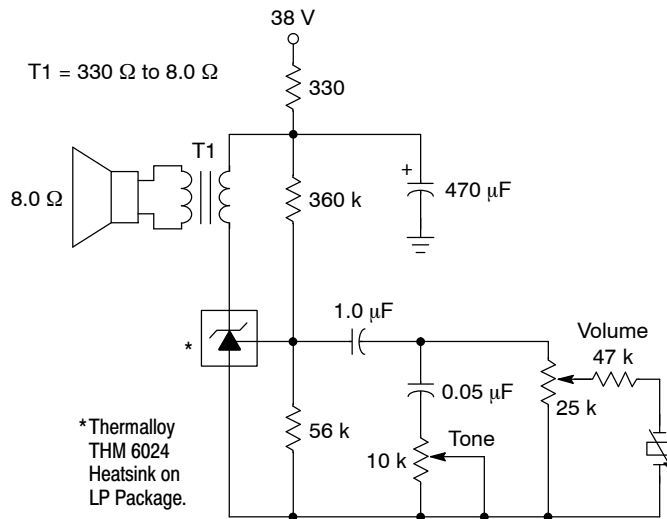


Figure 29. Linear Ohmmeter



*Thermalloy
THM 6024
Heatsink on
LP Package.

Figure 30. Simple 400 mW Phono Amplifier

The diagram illustrates a power supply circuit. It begins with an AC input connected to a full-bridge rectifier. The rectified output is filtered by a capacitor and then passes through a resistor before entering the primary of a transformer. The secondary of the transformer is connected to a diode, followed by a capacitor, which provides the DC output of 3.3 V. A feedback network consisting of resistors R1 (3.0 k) and R2 (1.8 k) is connected to the output and a feedback pin (V_{FB}) of a controller IC. The controller IC also has a current sense pin, a gate drive pin, and a V_{CC} pin. The gate drive pin is connected to the base of a MOSFET, which is in series with the transformer's primary. The MOSFET's source is connected to ground, and its drain is connected to the transformer's primary. The controller IC is also connected to ground through a network of resistors and capacitors.

The above circuit shows the TLV431A/B as a compensated amplifier controlling the feedback loop of an isolated output line powered switching regulator. The output voltage is programmed to 3.3 V by the resistors values selected for R1 and R2. The minimum output voltage that can be programmed with this circuit is 2.64 V, and is limited by the sum of the reference voltage (1.24 V) and the forward drop of the optocoupler light emitting diode (1.4 V). Capacitor C1 provides loop compensation.

XXX = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

TLV431A, TLV431B, SCV431A, SCV431B

ORDERING INFORMATION

Device	Device Code	Package	Shipping [†]
TLV431ALPG	ALP	TO-92-3 (Pb-Free)	6000/Box
TLV431ALPRAG	ALP	TO-92-3 (Pb-Free)	2000/Tape & Reel
TLV431ALPREG	ALP	TO-92-3 (Pb-Free)	2000/Tape & Reel
TLV431ALPRMG	ALP	TO-92-3 (Pb-Free)	2000/Ammo Pack
TLV431ALPRPG	ALP	TO-92-3 (Pb-Free)	2000/Ammo Pack
TLV431ASNT1G	RAA	TSOP-5 (Pb-Free, Halide-Free)	3000/Tape & Reel
TLV431ASN1T1G	RAF	SOT-23-3 (Pb-Free, Halide-Free)	3000/Tape & Reel
TLV431BLPG	BLP	TO-92-3 (Pb-Free)	6000/Box
TLV431BLPRAG	BLP	TO-92-3 (Pb-Free)	2000/Tape & Reel
TLV431BLPREG	BLP	TO-92-3 (Pb-Free)	2000/Tape & Reel
TLV431BLPRMG	BLP	TO-92-3 (Pb-Free)	2000/Ammo Pack
TLV431BLPRPG	BLP	TO-92-3 (Pb-Free)	2000/Ammo Pack
TLV431BSNT1G	RAH	TSOP-5 (Pb-Free, Halide-Free)	3000/Tape & Reel
TLV431BSN1T1G	RAG	SOT-23-3 (Pb-Free, Halide-Free)	3000/Tape & Reel
SCV431ASN1T1G*	RAE	SOT-23-3 (Pb-Free, Halide-Free)	3000/Tape & Reel
SCV431BSN1T1G*	RAC	SOT-23-3 (Pb-Free, Halide-Free)	3000/Tape & Reel

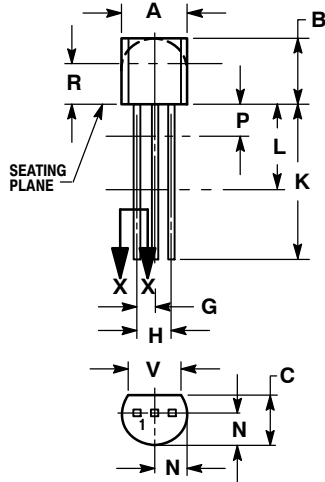
[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*SCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

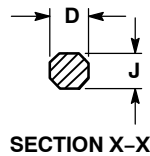
TLV431A, TLV431B, SCV431A, SCV431B

PACKAGE DIMENSIONS

TO-92 (TO-226)
LP SUFFIX
CASE 29-11
ISSUE AM



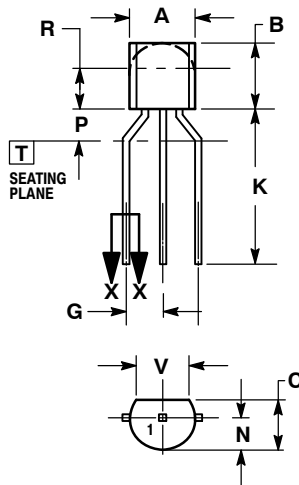
STRAIGHT LEAD
BULK PACK



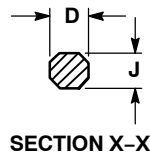
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



NOTES:

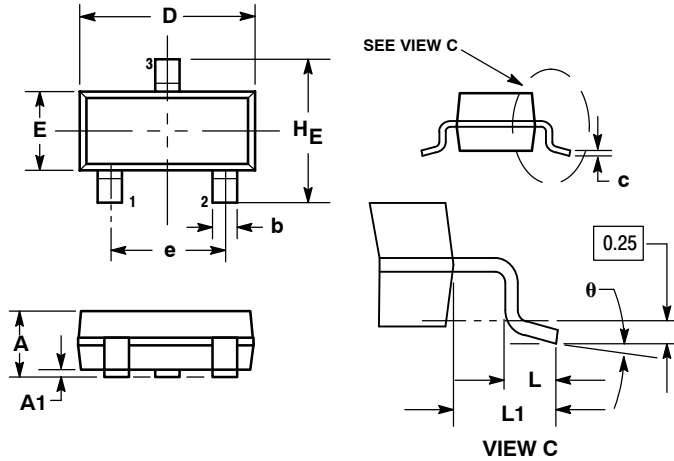
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS	
	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

TLV431A, TLV431B, SCV431A, SCV431B

PACKAGE DIMENSIONS

SOT-23-3
SN1 SUFFIX
CASE 318-08
ISSUE AN

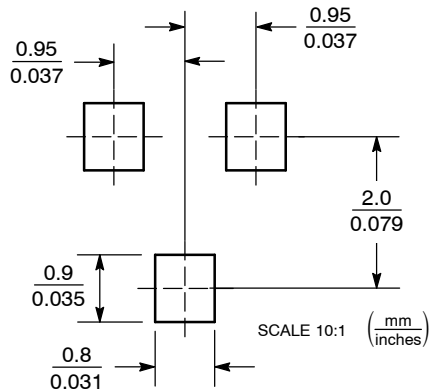


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318-01 THRU -07 AND -09 OBSOLETE, NEW STANDARD 318-08.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.89	1.00	1.11	0.035	0.040	0.044
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.37	0.44	0.50	0.015	0.018	0.020
c	0.09	0.13	0.18	0.003	0.005	0.007
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.081
L	0.10	0.20	0.30	0.004	0.008	0.012
L1	0.35	0.54	0.69	0.014	0.021	0.029
HE	2.10	2.40	2.64	0.083	0.094	0.104

SOLDERING FOOTPRINT*



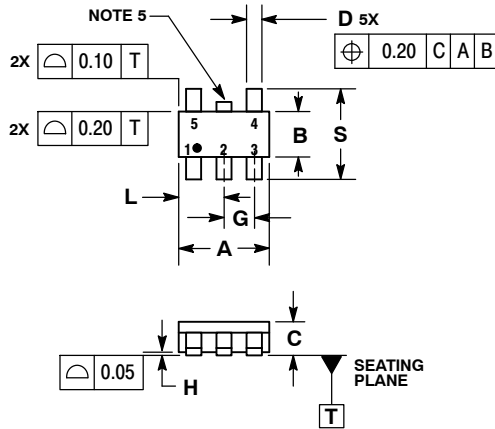
SOT-23-3

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

TLV431A, TLV431B, SCV431A, SCV431B

PACKAGE DIMENSIONS

TSOP-5
SN SUFFIX
CASE 483-02
ISSUE H

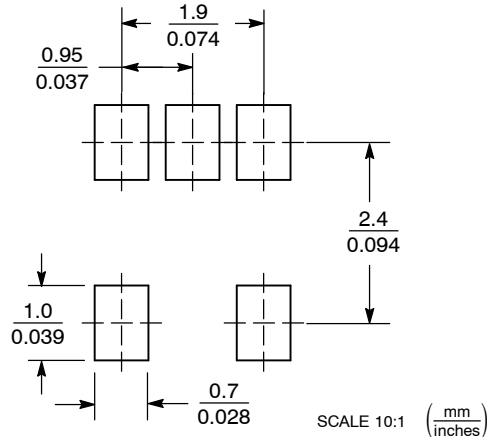


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

MILLIMETERS		
DIM	MIN	MAX
A	3.00 BSC	
B	1.50 BSC	
C	0.90	1.10
D	0.25	0.50
G	0.95 BSC	
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
L	1.25	1.55
M	0°	10°
S	2.50	3.00

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ON Semiconductor and are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marketing.pdf. SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC 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. "Typical" parameters which may be provided in SCILLC 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. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC 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 SCILLC was negligent regarding the design or manufacture of the part. SCILLC 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
P.O. Box 5163, Denver, Colorado 80217 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

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

Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local
Sales Representative