

TRIUNE PRODUCTS

Features

- Low Offset
- High Voltage Input
- Supply voltage: 4V-42V
- Low Temperature Drift
- Low input bias current
- Pedestal Voltage for offset compensation
- Available in 8-pin SOT-23 package
- Product is lead-free, Halogen Free, RoHS / WEEE compliant

Applications

- Multi-standard compliant and non-compliant wireless chargers for:
 - Cell Phones and Smartphones
 - Qi-Compliant Wireless Charging Transmitters
 - Tablets and eReaders
- Notebook Computers
- Telecom Equipment
- Power Management
- Battery Chargers
- Welding Equipment

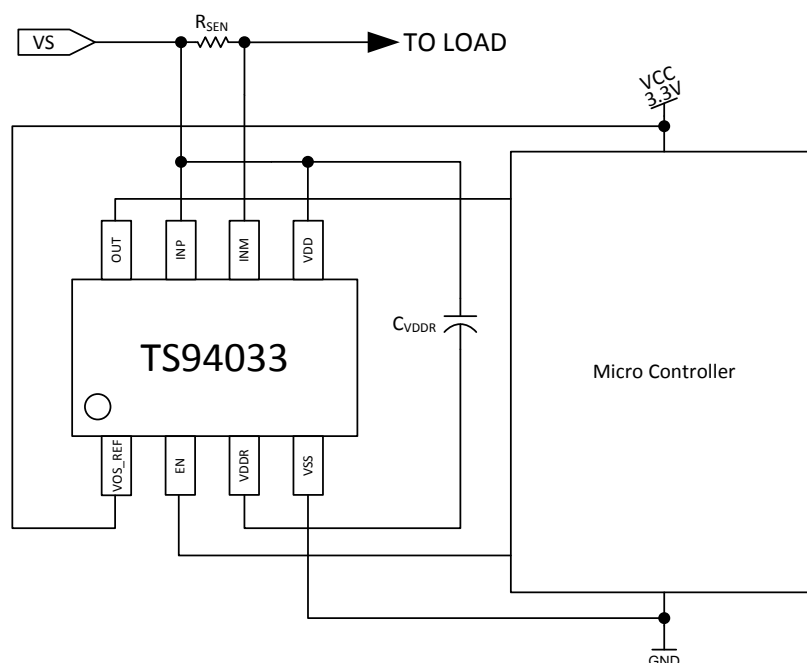
Description

The TS94033 is a low power, low offset high-side current sense amplifier. It utilizes a chopper-stabilized configuration to provide high gain-bandwidth while reducing input offset and 1/f noise. The sense amplifiers offer high voltage inputs and a 0 to 3.3V output. The supply voltage range of 4V to 42V can accommodate a wide variety of applications.

A zero-current output offset is set by providing a bias voltage on the VOS_REF pin. This allows the ability to sense limited negative currents, improves transient response time, and provides a method to detect faults in the current sense system.

The TS94033 operational amplifier is optimal for bridge drive applications where accurate current sensing is needed.

Typical Application Circuit



Pin Description

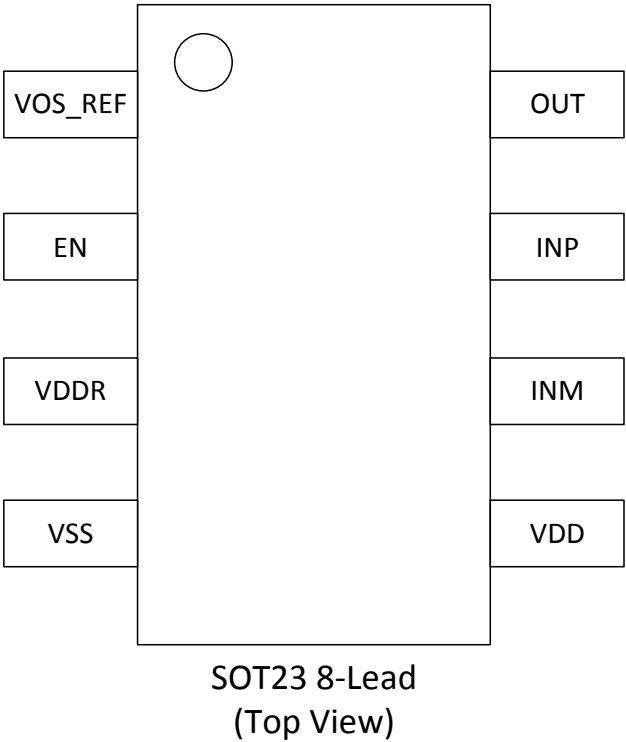


Figure 1: TS94033 Pin Configuration

Pin Number	Pin Name	I/O/P	Description
1	VOS_REF	I	Zero-Current Output Offset Reference
2	EN	I	Enable Input
3	VDDR	O	Supply-Referenced Regulated Voltage Output
4	VSS	P	Power Supply Return, VOS_REF and OUT Signal Reference Voltage (ground)
5	VDD	P	Power Supply Input, Sense Amplifier Input Common-Mode Signal Reference
6	INM	I	Sense Amplifier Inverting Input
7	INP	I	Sense Amplifier Non-Inverting Input
8	OUT	O	Sense Amplifier Output

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_S	Supply Voltage, VDD – VSS	4	42	V
V_{OS_REF}	Output Offset Reference, (VOS_REF – VSS)	0	3.3	V
V_{IN}	Differential Input Voltage, (VINP – VINM)	-4	66	mV
V_{CM}	Input Common-Mode Range, ($V_{DD} - 0.5 * (VINP + VINM)$)	VDD-2	VDD+0.3	V
V_{IH-EN}	High Level Input Voltage, EN Pin	2.4	5.5	V
V_{IL-EN}	Low Level Input Voltage, EN Pin	0	0.4	V
C_L	OUT Pin Load Capacitance		100	nF

Electrical Characteristics

Typical: $T_J = 25^\circ\text{C}$, $V_{DD} = 12\text{V}$

Min and max: $T_J = -40^\circ\text{C}$ to 125°C , $V_{DD} = 4\text{V} \sim 42\text{V}$

Unless otherwise noted $V_{SS} = 0\text{V}$, $V_{CM} = V_{DD}$, INP - INM = 0V, $V_{OS_REF} = 3.3\text{V}$

Symbol	Parameter	Condition	Min	Typ	Max	Unit
I_{QDD}	Quiescent Current	From VDD		140	315	μA
I_{QVCM}	Quiescent Current	Through INP/INM		28		μA
I_{Q-OFF}	Quiescent Current	From VDD, EN = 0V, $V_{OS_REF}=0$		1.1	8.6	μA
I_{IL-EN}	Input Low Leakage, EN Pin	$V_{EN} = 0\text{V}$		1.1		μA
I_B	Input Bias Current	$V_{OS_REF} = 0\text{V}$		2.1		μA
ΔV_{DDR}	Sense-Amp Supply Voltage	$\Delta V_{DDR} = V_{DD} - V_{DDR}$ $C_{VDDR} = 100\text{nF}$		4.4		V
T_{ON-EN}	Turn-On Time ⁽¹⁾	EN driven from 0V to 3.3V, OUT settled to 90% of final value		600		μs
PSRR	Power Supply Rejection Ratio ¹	100 kHz		-70		dB
LR	Line Regulation	4– 42V step applied on V_{DD}		-83		dB
SR	Slew Rate	$C_L=100\text{nF}$		10		mV/ μs
$ I_{sc} $	Short-Circuit Current, Sourcing or Sinking	OUT shorted to VDD or VSS		1	1.7	mA
V_{OUT}	Voltage Output swing		3.3		3.6	V
CMRR	Common-Mode Rejection Ratio ⁽¹⁾	$-2\text{V} < V_{CM} < 0.4\text{V}$		-110		dB
Gain	Gain	OUT / V_{IN}	48.5	49.25	50	V/V
V_{OS}	Output-Referred Offset Voltage	$V_{OS_REF} = 3.3\text{V}$	155	215	280	mV
Gain _{TC}	Gain Temperature Coefficient ⁽¹⁾	$[(\Delta\text{Gain}/50) / \Delta T] * 10^6$	-60	-20	10	ppm/ $^\circ\text{C}$
V_{OS-TC}	Output Offset Temperature Coefficient ⁽¹⁾		-50		50	$\mu\text{V}/^\circ\text{C}$
Gain _{VOS}	Offset Reference Gain	V_{OS} / V_{OS_REF}		0.06515		V/V
BW	-3 dB Bandwidth ⁽¹⁾	No load		4		kHz

Notes:

(1) This parameter is not tested in production.

Typical Characteristics

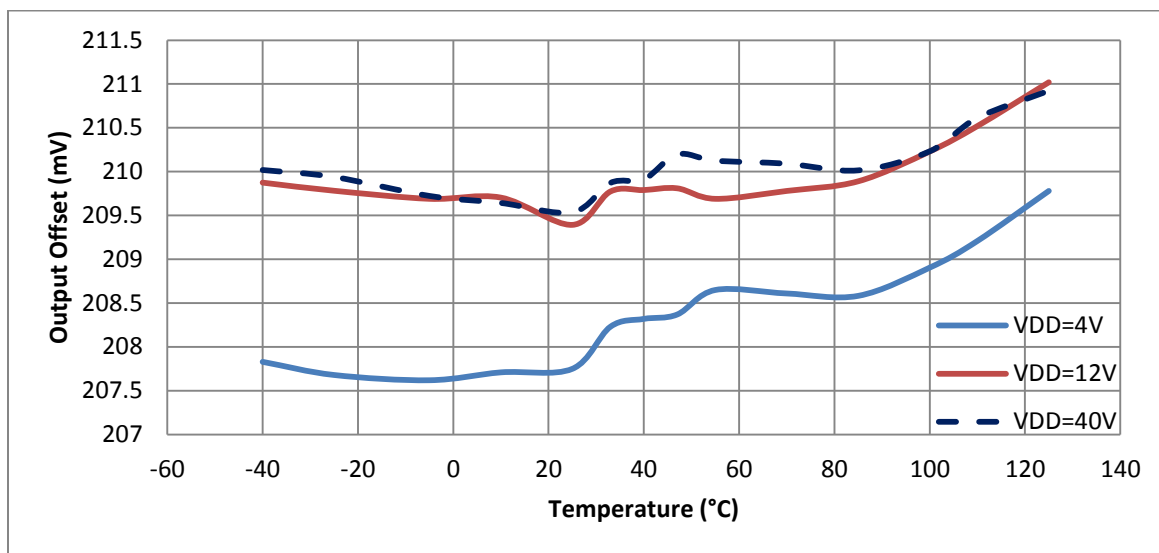


Figure 3: Offset Voltage vs Temperature

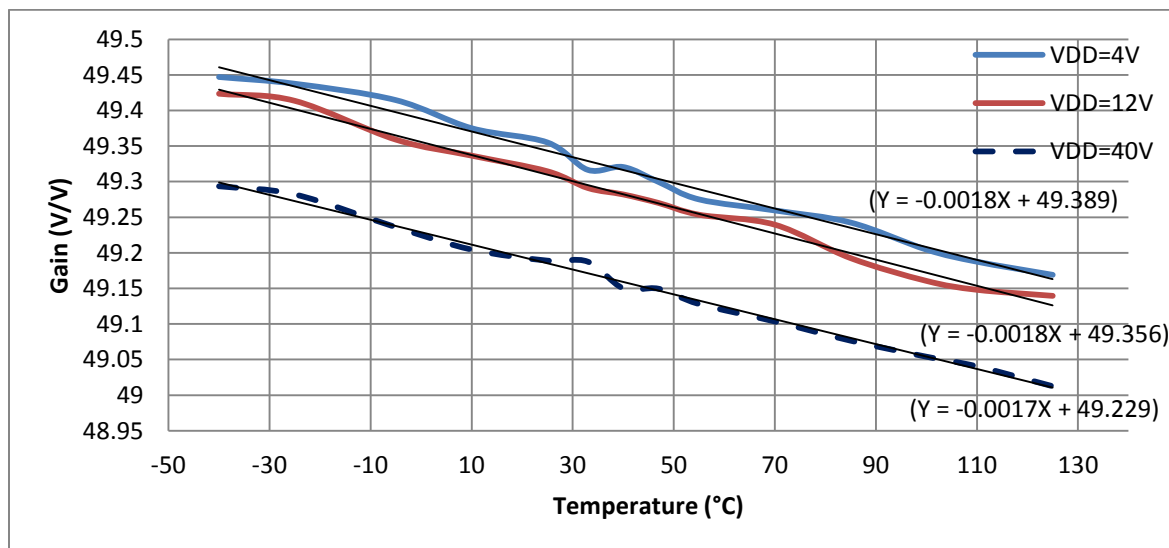


Figure 4: Gain vs Temperature

Operational Modes

The TS94033 is a low power, low offset high-side chopper-stabilized current sense amplifier. The amplifier is supplied on the high-side from the VDD pin and a sub-regulated supply that is generated at the VDDR pin. It is necessary for good supply rejection to have a bypass capacitor, C_{VDDR} closely-coupled between the VDD and VDDR pins.

The INP and INM pins are used to sense the voltage drop across a current-sensing resistor. Though it is usually the case that the INP pin would be connected to the VDD pin, the common-mode voltage can extend above and below VDD as specified by the V_{CM} parameter.

The EN pin may be used to set the device into a low-quiescent current mode when asserted low.

A zero-current output offset is set by providing a bias voltage on the VOS_REF pin. The zero-current offset voltage can be determined by the following relation:

$$V_{OS} = 0.065152 * V_{OS_REF}$$

The output voltage at the VOUT pin is referenced to the VSS pin. The VSS pin should be closely coupled to the circuit monitoring this voltage. The VOS_REF should be bypassed to this VSS as well.

Application Schematic

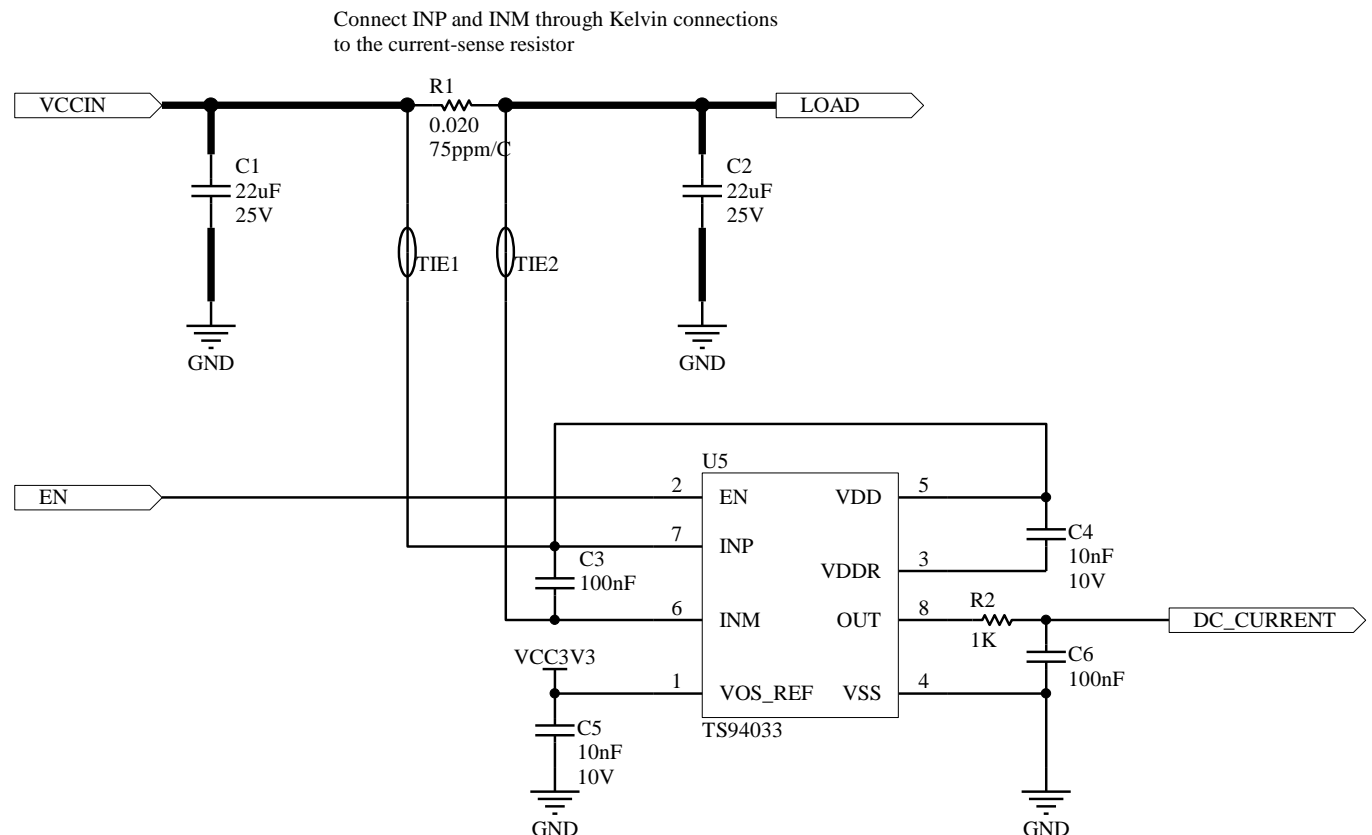
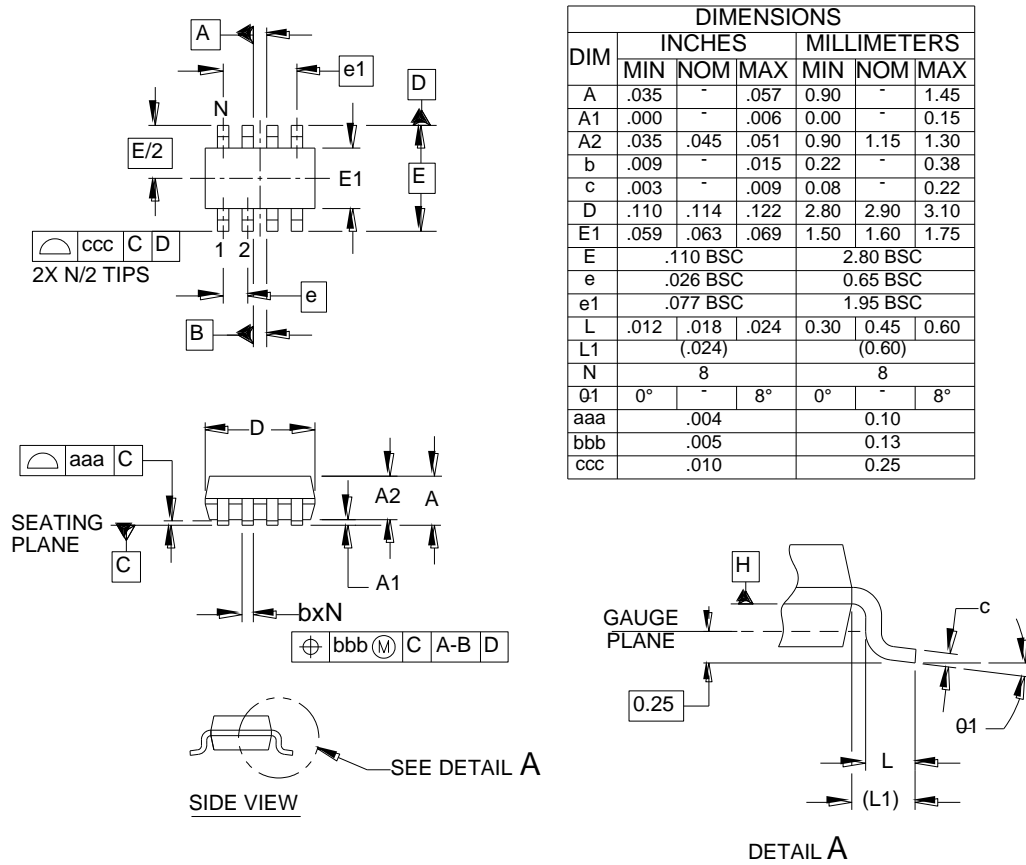


Figure 5: Standard Configuration

Package Information

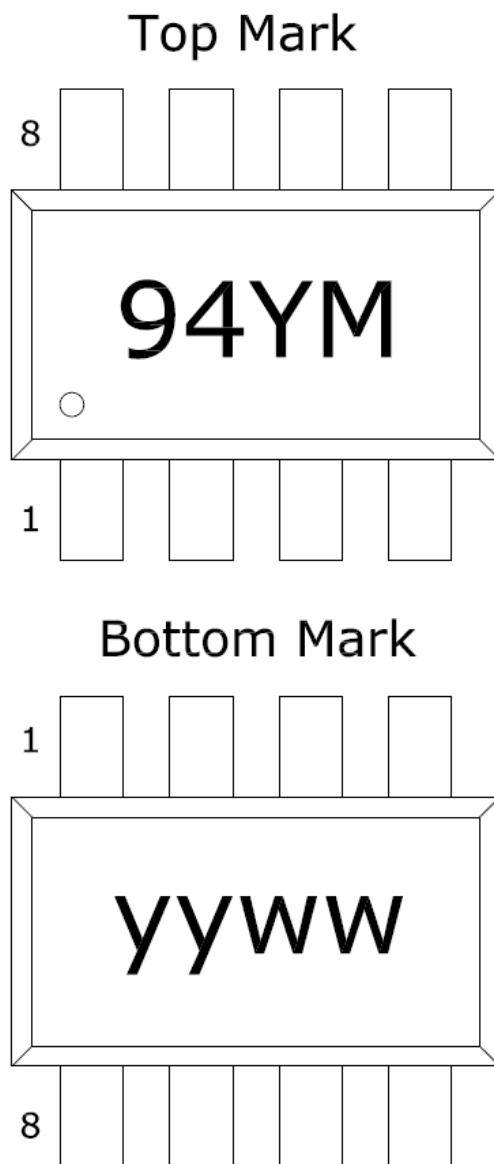


NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
4. REFERENCE JEDEC STD MO-178, VARIATION BA.

Figure 6: Package Outline Drawing

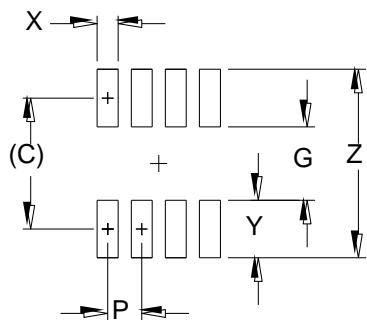
Package Information (continued)



Top Mark:
94YM = Product Marking

Bottom Mark:
yy = year
ww = week

Figure 7: Device Symbolization



DIMENSIONS		
DIM	INCHES	MILLIMETERS
C	(.098)	(2.50)
G	.055	1.40
P	.026	0.65
X	.016	0.40
Y	.043	1.10
Z	.142	3.60

NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Figure 8: Recommended Board Layout Land Pattern

Ordering Information

Device Part Number	Description	8-pin SOT-23 Package
TS94033SKTRC	Current Sense Amplifier	Tape & Reel (3000 parts/reel)



IMPORTANT NOTICE

Information relating to this product and the application or design described herein is believed to be reliable, however such information is provided as a guide only and Semtech assumes no liability for any errors in this document, or for the application or design described herein. Semtech reserves the right to make changes to the product or this document at any time without notice. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. Semtech warrants performance of its products to the specifications applicable at the time of sale, and all sales are made in accordance with Semtech's standard terms and conditions of sale.

SEMTECH PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS, OR IN NUCLEAR APPLICATIONS IN WHICH THE FAILURE COULD BE REASONABLY EXPECTED TO RESULT IN PERSONAL INJURY, LOSS OF LIFE OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. INCLUSION OF SEMTECH PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE UNDERTAKEN SOLELY AT THE CUSTOMER'S OWN RISK. Should a customer purchase or use Semtech products for any such unauthorized application, the customer shall indemnify and hold Semtech and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs damages and attorney fees which could arise.

The Semtech name and logo are registered trademarks of the Semtech Corporation. All other trademarks and trade names mentioned may be marks and names of Semtech or their respective companies. Semtech reserves the right to make changes to, or discontinue any products described in this document without further notice. Semtech makes no warranty, representation or guarantee, express or implied, regarding the suitability of its products for any particular purpose. All rights reserved.

© Semtech 2016

Contact Information

Semtech Corporation
200 Flynn Road, Camarillo, CA 93012
Phone: (805) 498-2111, Fax: (805) 498-3804
www.semtech.com