

**AP4310A**

**DUAL OP AMP AND VOLTAGE REFERENCE**

**Description**

The AP4310A is a monolithic IC specifically designed to regulate the output current and voltage levels of switching battery chargers and power supplies

The device contains two Op Amps and a 2.5V precision shunt voltage reference. Op Amp 1 is designed for voltage control with its non-inverting input internally connected to the output of the shunt regulator. Op Amp 2 is for current control with both inputs uncommitted. The IC offers the power converter designer a control solution that features increased precision with a corresponding reduction in system complexity and cost.

The AP4310A is available in SO-8 package.

**Features**

**OP Amp**

- Input Offset Voltage: 0.5mV
- Supply Current: 75µA per OP Amp at 5.0V Supply Voltage
- Unity Gain Bandwidth: 1MHz
- Output Voltage Swing: 0 to  $V_{CC}-1.5V$
- Power Supply Range: 3 to 36V

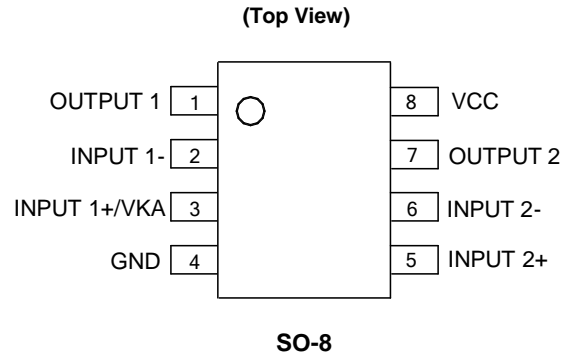
**Voltage Reference**

- Fixed Output Voltage Reference: 2.5V
- Reference Voltage Tolerance :±0.4%
- Sink Current Capability: 0.05 to 80mA
- Typical Output Impedance: 0.2Ω

- **Totally Lead-free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.  
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.  
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

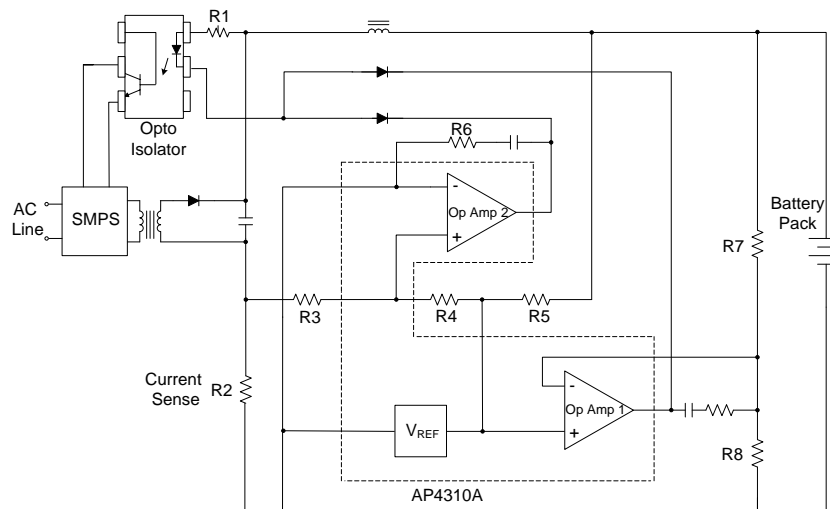
**Pin Assignments**



**Applications**

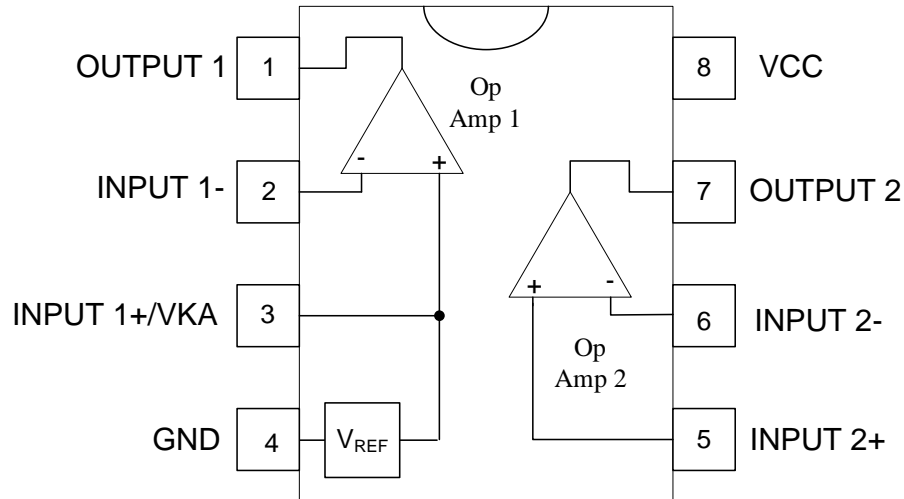
- Battery Charger
- Switching Power Supply

**Typical Applications Circuit**



Application of AP4310A in a Constant Current and Constant Voltage Charger

**Functional Block Diagram**



**Absolute Maximum Ratings** (Note 4)

Symbol	Parameter	Rating	Unit
$V_{CC}$	Power Supply Voltage (VCC to GND)	40	V
$V_{IN}$	Op Amp1 and 2 Input Voltage Range (Pins 2, 5, 6)	-0.3 to $V_{CC}+0.3$	V
$V_{ID}$	Op Amp 2 Input Differential Voltage (Pins 5, 6)	40	V
$I_k$	Voltage Reference Cathode Current (Pin 3)	100	mA
$P_D$	Power Dissipation ( $T_A = +25^{\circ}C$ )	500	mW
$T_J$	Operating Junction Temperature	+150	$^{\circ}C$
$T_{STG}$	Storage Temperature Range	-65 to +150	$^{\circ}C$
$T_{LEAD}$	Lead Temperature (Soldering 10sec)	+260	$^{\circ}C$
ESD	ESD (Human Body Model)	$\geq 2000$	V

Note 4: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

**Recommended Operating Conditions**

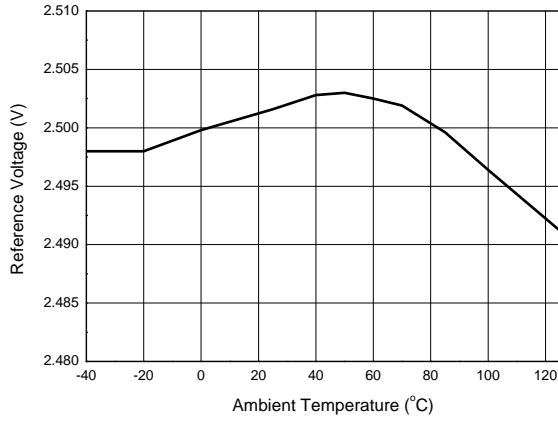
Parameter	Min	Max	Unit
Supply Voltage	3	36	V
Ambient Temperature	-40	+105	$^{\circ}C$

**Electrical Characteristics** (@ $V_{CC}=5V$ ,  $T_A=+25^\circ C$ , unless otherwise specified.)

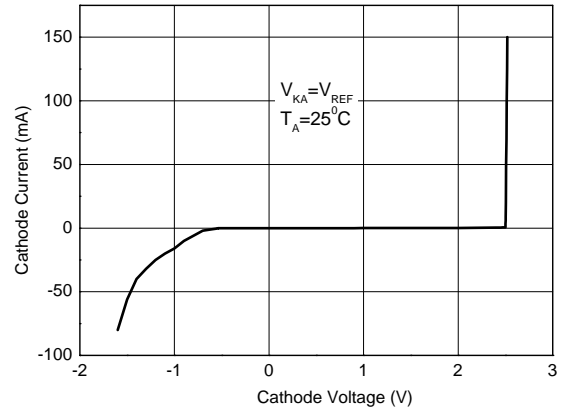
Parameters		Conditions	Min	Typ	Max	Unit	
Total Supply Current, excluding Current in Voltage Reference		$V_{CC}=5V$ , no load, $-40^\circ C \leq T_A \leq +105^\circ C$	-	0.15	0.25	mA	
		$V_{CC}=30V$ , no load, $-40^\circ C \leq T_A \leq +105^\circ C$	-	0.20	0.30		
<b>Voltage Reference Section</b>							
Reference Voltage		$I_K=10mA$	$T_A = +25^\circ C$	2.49	2.50	2.51	V
			$-40^\circ C \leq T_A \leq +105^\circ C$	2.48	2.50	2.52	
Reference Voltage Deviation over Full Temperature Range		$I_K=10mA$ , $T_A = -40^\circ C$ to $+105^\circ C$	-	5	24	mV	
Minimum Cathode Current for Regulation		-	-	0.01	0.05	mA	
Dynamic Impedance		$I_K=1mA$ to $80mA$ , $f < 1kHz$	-	0.2	0.5	$\Omega$	
<b>Op Amp 1 Section</b> ( $V_{CC} = 5V$ , $V_O = 1.4V$ , $T_A = +25^\circ C$ , unless otherwise noted.)							
Input Offset Voltage		$T_A = +25^\circ C$	-	0.5	3	mV	
		$T_A = -40^\circ C$ to $+105^\circ C$	-	-	5		
Input Offset Voltage Temperature Drift		$T_A = -40^\circ C$ to $+105^\circ C$	-	7	-	$\mu V/^\circ C$	
Input Bias Current (Inverting Input Only)		$T_A = +25^\circ C$	-	20	150	nA	
Large Signal Voltage Gain		$V_{CC} = 15V$ , $R_L = 2k\Omega$ , $V_O = 1.4V$ to $11.4V$	85	100	-	dB	
Power Supply Rejection Ratio		$V_{CC} = 5V$ to $30V$	70	90	-	dB	
Output Current	Source	$V_{CC} = 15V$ , $V_{ID} = 1V$ , $V_O = 2V$	20	40	-	mA	
	Sink	$V_{CC} = 15V$ , $V_{ID} = -1V$ , $V_O = 2V$	5	20	-		
Output Voltage Swing (High)		$V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = 1V$	27	28	-	V	
Output Voltage Swing (Low)		$V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = -1V$	-	17	100	mV	
Slew Rate		$V_{CC} = 18V$ , $R_L = 2k\Omega$ , $A_V = 1$ , $V_{IN} = 0.5V$ to $2V$ , $C_L = 100pF$	0.2	0.5	-	$V/\mu s$	
Unity Gain Bandwidth		$V_{CC} = 30V$ , $R_L = 2k\Omega$ , $C_L = 100pF$	0.7	1.0	-	MHz	
<b>Op Amp 2 Section</b> ( $V_{CC} = 5V$ , $V_O = 1.4V$ , $T_A = +25^\circ C$ , unless otherwise noted.)							
Input Offset Voltage		$T_A = +25^\circ C$	-	0.5	3	mV	
		$T_A = -40^\circ C$ to $+105^\circ C$	-	-	5		
Input Offset Voltage Temperature Drift		$T_A = -40^\circ C$ to $+105^\circ C$	-	7	-	$\mu V/^\circ C$	
Input Offset Current		$T_A = +25^\circ C$	-	2	30	nA	
Input Bias Current		$T_A = +25^\circ C$	-	20	150	nA	
Input Voltage Range		$V_{CC} = 0$ to $36V$	0	-	$V_{CC}-1.5$	V	
Common Mode Rejection Ratio		$T_A = +25^\circ C$ , $V_{CM} = 0$ to $3.5V$	70	85	-	dB	
Large Signal Voltage Gain		$V_{CC} = 15V$ , $R_L = 2k\Omega$ , $V_O = 1.4V$ to $11.4V$	85	100	-	dB	
Power Supply Rejection Ratio		$V_{CC} = 5V$ to $30V$	70	90	-	dB	
Output Current	Source	$V_{CC} = 15V$ , $V_{ID} = 1V$ , $V_O = 2V$	20	40	-	mA	
	Sink	$V_{CC} = 15V$ , $V_{ID} = -1V$ , $V_O = 2V$	5	20	-		
Output Voltage Swing (High)		$V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = 1V$	27	28	-	V	
Output Voltage Swing (Low)		$V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = -1V$	-	17	100	mV	
Slew Rate		$V_{CC} = 18V$ , $R_L = 2k\Omega$ , $A_V = 1$ , $V_{IN} = 0.5V$ to $2V$ , $C_L = 100pF$	0.2	0.5	-	$V/\mu s$	
Unity Gain Bandwidth		$V_{CC} = 30V$ , $R_L = 2k\Omega$ , $C_L = 100pF$	0.7	1.0	-	MHz	

**Performance Characteristics**

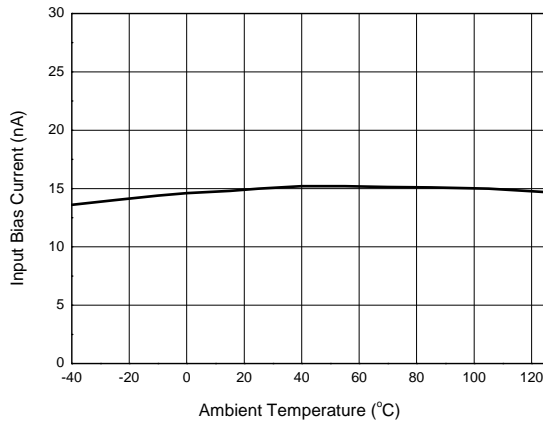
**Reference Voltage vs. Ambient Temperature**



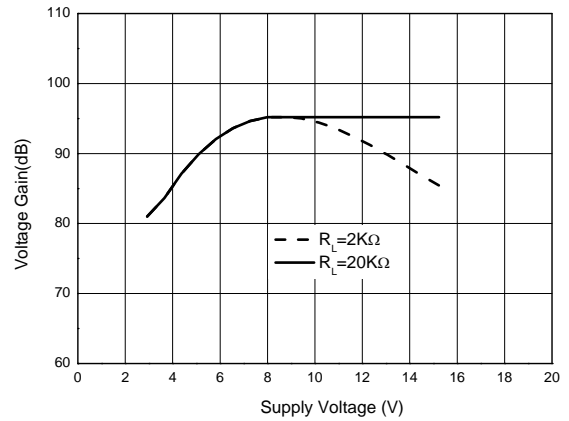
**Cathode Current vs. Cathode Voltage**



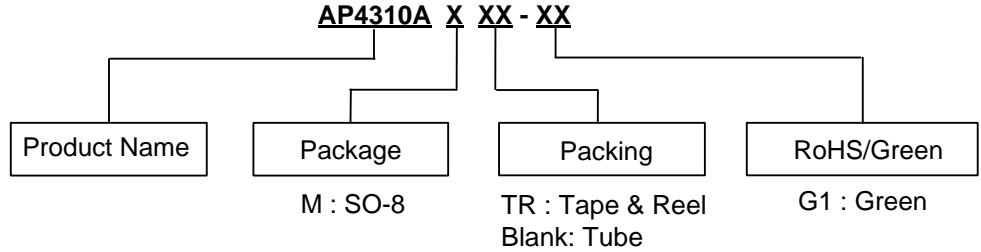
**Input Bias Current vs. Ambient Temperature**



**Op Amp Voltage Gain**



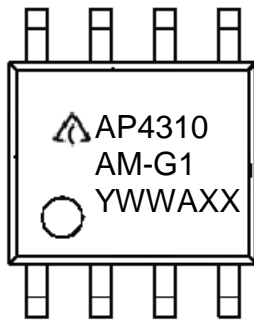
**Ordering Information**



Package	Temperature Range	Reference Voltage	Voltage Tolerance	Part Number	Marking ID	Packing
SO-8	-40 to +105°C	2.5V	±0.4%	AP4310AM-G1	AP4310AM-G1	100/Tube
				AP4310AMTR-G1	AP4310AM-G1	4000/Tape & Reel

**Marking Information**

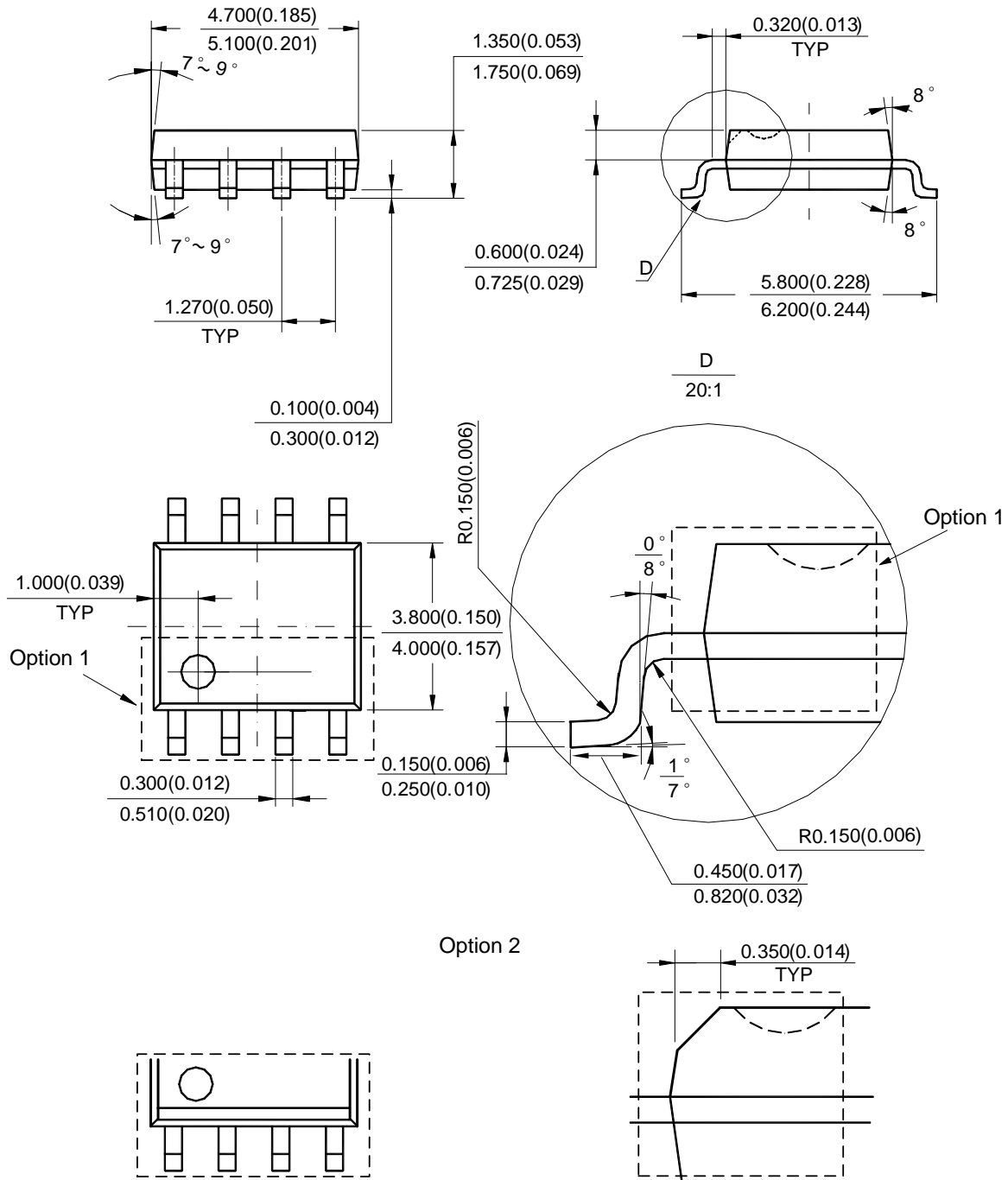
(Top View)



First and Second Lines: Logo and Marking ID  
 Third Line: Date Code  
 Y: Year  
 WW: Work Week of Molding  
 A: Assembly House Code  
 XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch No.

**Package Outline Dimensions** (All dimensions in mm (inch).)

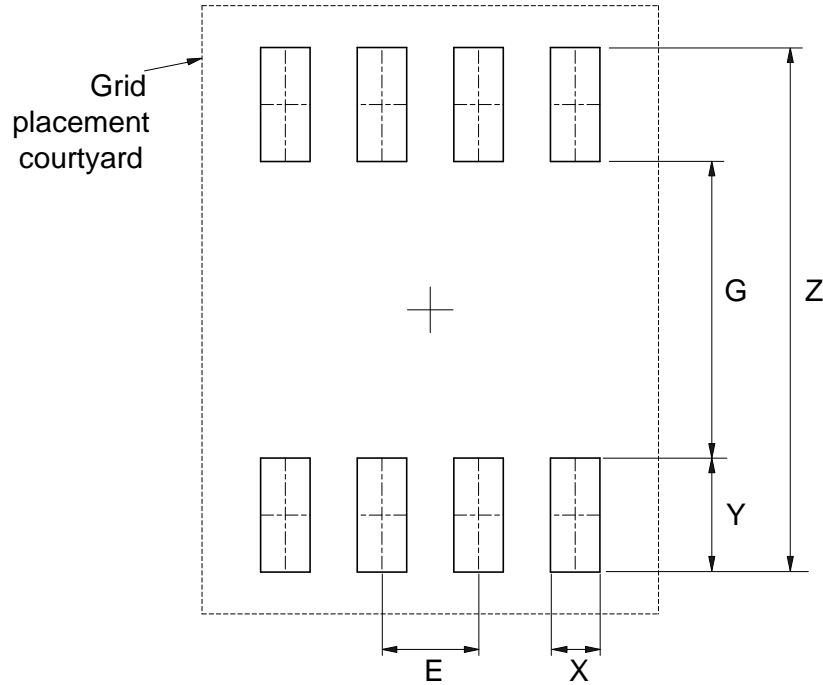
(1) Package Type: SO-8



Note: Eject hole, oriented hole and mold mark is optional.

**Suggested Pad Layout**

(1) Package Type: SO-8



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	1.270/0.050

**IMPORTANT NOTICE**

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel. Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

**LIFE SUPPORT**

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2014, Diodes Incorporated

[www.diodes.com](http://www.diodes.com)