AP64351QSP-EVM

AUTOMOTIVE-COMPLIANT, 40V, 3.5A SYNCHRONOUS BUCK WITH PROGRAMMABLE SOFT-START TIME

DESCRIPTION

The AP64351Q is an automotive-compliant, 3.5A, synchronous buck converter with a wide input voltage range of 3.8V to 40V. The device fully integrates a 75mΩ high-side power MOSFET and a 45mΩ low-side power MOSFET to provide high-efficiency step-down DC-DC conversion.

The AP64351Q device is easily used by minimizing the external component count due to its adoption of peak current mode control.

The AP64351Q design is optimized for Electromagnetic Interference (EMI) reduction. The device has a proprietary gate driver scheme to resist switching node ringing without sacrificing MOSFET turn-on and turn-off times, which reduces high-frequency radiated EMI noise caused by MOSFET switching. The AP64351Q also features Frequency Spread Spectrum (FSS) with a switching frequency jitter of ±6%, which reduces EMI by not allowing emitted energy to stay in any one frequency for a significant period of time.

The device is available in an SO-8EP package.

FEATURES

- AEC-Q100 Qualified with the Following Results
  - Device Temperature Grade 1: -40°C to +125°C TA Range
  - Device HBM ESD Classification Level H2
  - Device CDM ESD Classification Level C5
- VIN: 3.8V to 40V
- 3.5A Continuous Output Current
- 0.8V ±1% Reference Voltage
- 22µA Ultralow Quiescent Current (Pulse Frequency Modulation)
- 570kHz Switching Frequency
- Programmable Soft-Start Time
- Up to 85% Efficiency at 5mA Light Load
- Proprietary Gate Driver Design for Best EMI Reduction
- Frequency Spread Spectrum (FSS) to Reduce EMI
- Low-Dropout (LDO) Mode
- Precision Enable Threshold to Adjust UVLO
- Protection Circuitry
  - Undervoltage Lockout (UVLO)
  - Output Overvoltage Protection (OVP)
  - Cycle-by-Cycle Peak Current Limit
  - Thermal Shutdown
- Totally Lead-Free & Fully RoHS Compliant
- Halogen and Antimony Free. “Green” Device

APPLCATIONS

- 12V Automotive Power Systems
- Automotive Infotainment
- Automotive Instrument Clusters
- Automotive Telematics
- Advanced Driver Assistance Systems

TYPICAL APPLICATIONS CIRCUIT

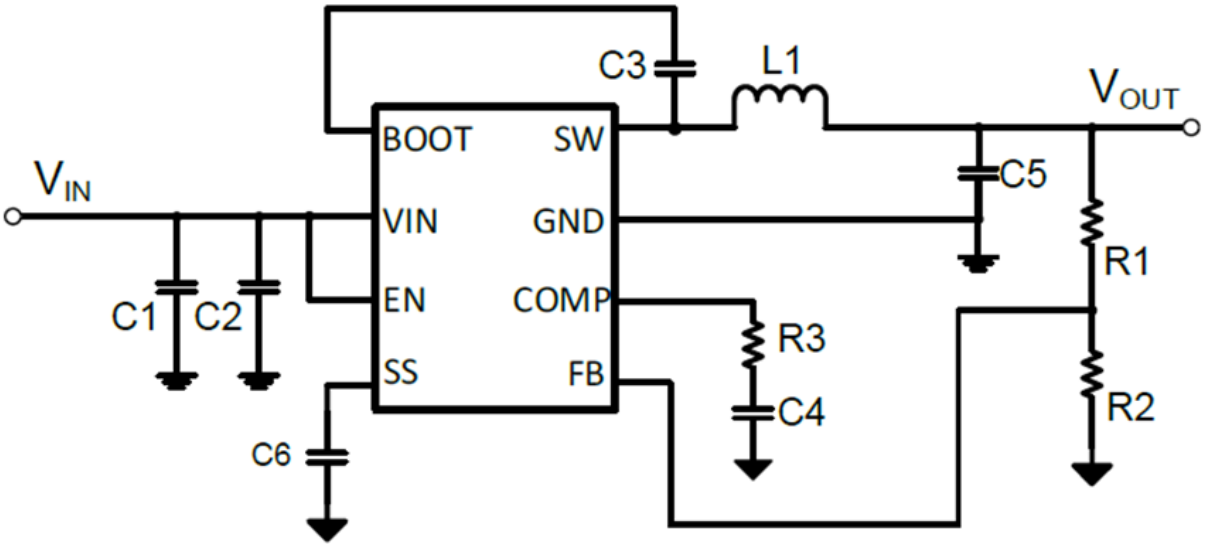

Figure 1. Typical Application Circuit

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
VIN	Supply Pin Voltage	-0.3 to +42.0 (DC)	V
		-0.3 to +45.0 (400ms)	
V_{BST}	Bootstrap Pin Voltage	V_{SW} - 0.3 to V_{SW} + 6.0	V
V_{EN}	Enable/UVLO Pin Voltage	-0.3 to +42.0	V
V_{SS}	Soft-Start Pin Voltage	-0.3 to +6.0	V
V_{FB}	Feedback Voltage	-0.3V to +6.0	V
V_{COMP}	Compensation Pin Voltage	-0.3 to +6.0	V
V_{SW}	Switch Node Voltage	-0.3 to VIN + 0.3 (DC)	V
		-2.5 to VIN + 2.0 (20ns)	
T_J	Junction Temperature	+160	°C
T_L	Lead Temperature	+260	°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
VIN	Supply Voltage	3.8	40	V
VOUT	Output Voltage	0.8	39	V
T_A	Operating Ambient Temperature Range	-40	+125	°C
T_J	Operating Junction Temperature Range	-40	+150	°C

EVALUATION BOARD

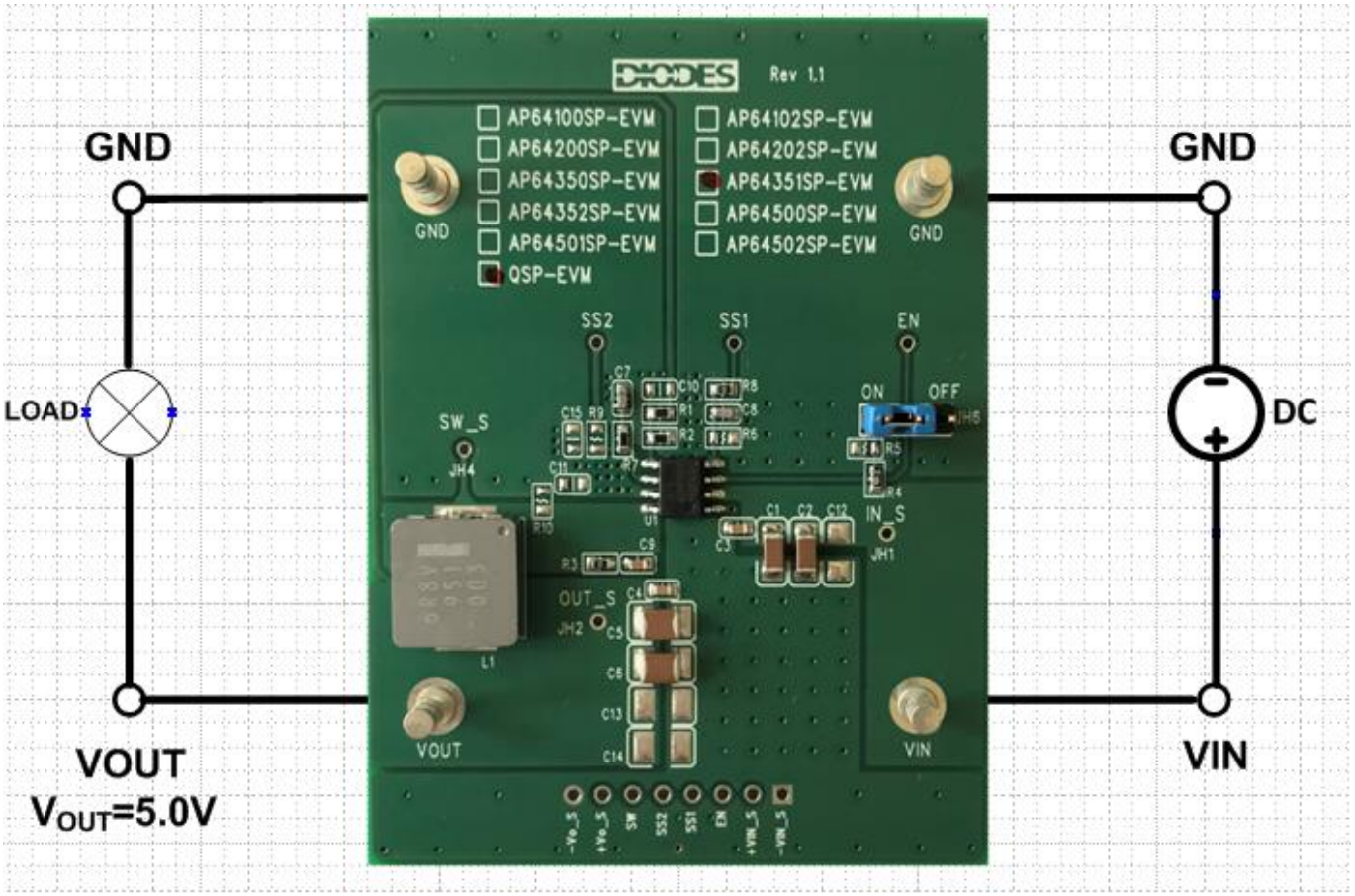

Figure 2. AP64351QSP-EVM

QUICK START GUIDE

The AP64351QSP-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP64351QSP, follow the procedure below:

1. Connect a power supply to the input terminals VIN and GND. Set VIN to 12V.
2. Connect the positive terminal of the electronic load to VOUT and negative terminal to GND.
3. For Enable, place a jumper at JH6 to “ON” position to connect EN pin to VIN through 100KΩ resistor to enable IC. Jump to “OFF” position to disable IC.
4. The evaluation board should now power up with a 5.0V output voltage.
5. Check for the proper output voltage of 5.0V (±1%) at the output terminals VOUT and GND. Measurement can also be done with a multimeter with the positive and negative leads between VOUT and GND.
6. Set the load to 3.5A through the electronic load. Check for the stable operation of the SW signal on the oscilloscope. Measure the switching frequency.

MEASUREMENT/PERFORMANCE GUIDELINES

1) When measuring the output voltage ripple, maintain the shortest possible ground lengths on the oscilloscope probe. Long ground leads can erroneously inject high frequency noise into the measured ripple.

2) For efficiency measurements, connect an ammeter in series with the input supply to measure the input current. Connect an electronic load to the output for output current.

SETTING OUTPUT VOLTAGE

Table 1 shows a list of recommended component selections for common output voltages.

VOUT	R1	R2	L1	R7	C7	C1, C2	C5, C6
1.2V	4.99KΩ	10KΩ	3.3µH	3.32KΩ	3.3nF	2x10µF	2x22µF
1.5V	8.66KΩ	10KΩ	3.3µH	4.22KΩ	3.3nF	2x10µF	2x22µF
1.8V	12.4KΩ	10KΩ	3.3µH	4.99KΩ	3.3nF	2x10µF	2x22µF
2.5V	21.5KΩ	10KΩ	4.7µH	6.98KΩ	3.3nF	2x10µF	2x22µF
3.3V	31.6KΩ	10KΩ	4.7µH	9.31KΩ	3.3nF	2x10µF	2x22µF
5.0V	52.3KΩ	10KΩ	6.8µH	14KΩ	3.3nF	2x10µF	2x22µF
12V	140KΩ	10KΩ	10µH	33.2KΩ	3.3nF	2x10µF	2x22µF

Table 1. Common Output Voltages

EVALUATION BOARD SCHEMATIC

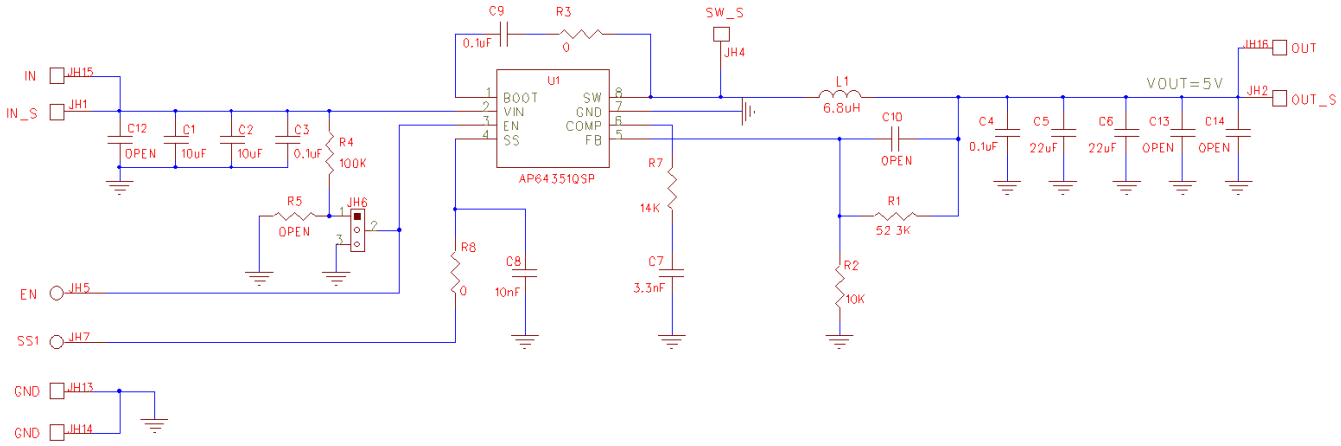

Figure 3. AP64351QSP-EVM Schematic

PCB TOP LAYOUT

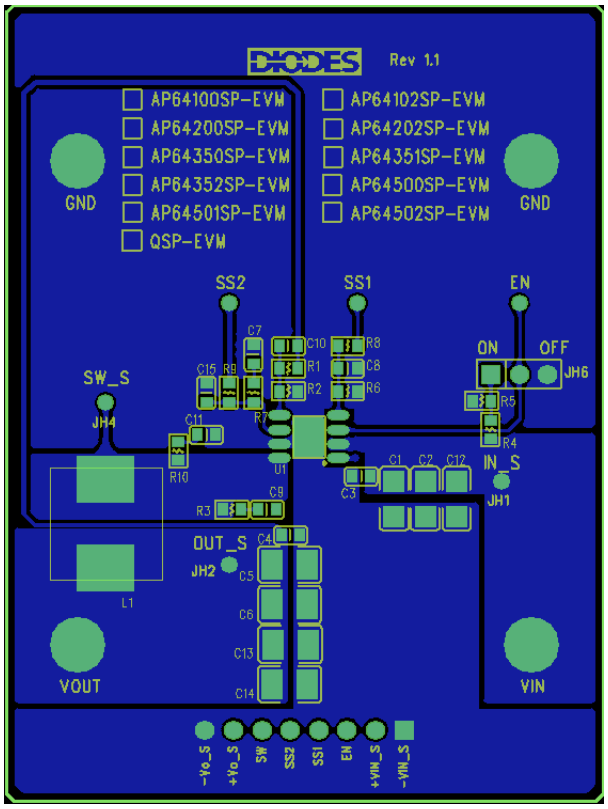

Figure 4. AP64351QSP-EVM – Top Layer

PCB BOTTOM LAYOUT

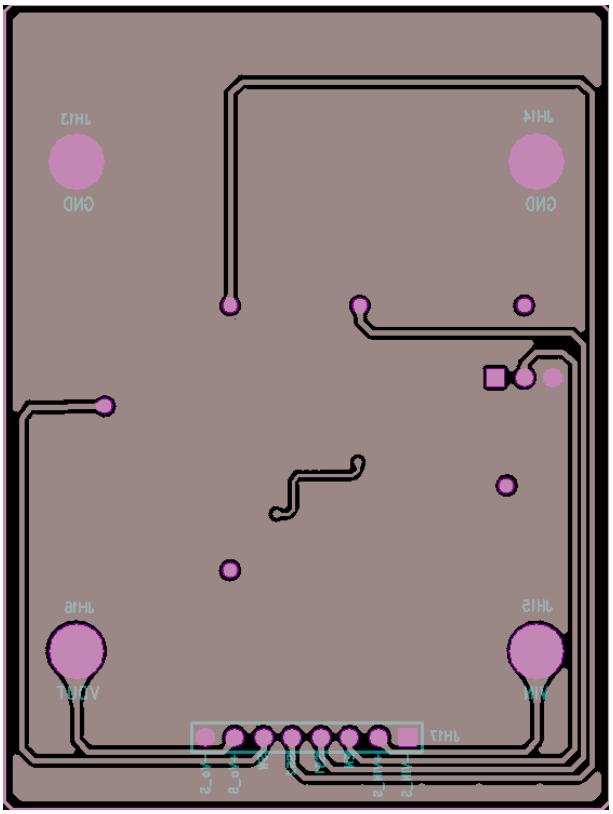

Figure 5. AP64351QSP-EVM – Bottom Layer

AUTOMOTIVE BILL OF MATERIALS for AP64351QSP-EVM @V_{OUT}=5V

Ref	Value	Description	Qty	Size	Vendor Name	Manufacturer PN
C1, C2	10µF	Ceramic Capacitor, 50V	2	1206	TDK	CGA5L1X7R1H106K160AC
C3, C4, C9	0.1µF	Ceramic Capacitor, 50V	3	0603	TDK	CGA3E3X8R1H104K080AB
C5, C6	22µF	Ceramic Capacitor, 16V	2	1210	TDK	CGA6P1X8L1C226M250AC
C7	3.3nF	Ceramic Capacitor, 50V	1	0603	TDK	CGA3E2NP01H332J080AA
C8	10nF	Ceramic Capacitor, 50V	1	0603	TDK	CGA3E2NP01H103J080AA
R1	52.3KΩ	SMD Resistor, 1%	1	0603	Panasonic	ERJ-3EKF5232V
R2	10KΩ	SMD Resistor, 1%	1	0603	Panasonic	ERJ-3EKF1002V
R3, R8	0Ω	RES SMD	2	0603	Panasonic	ERJ-3GEY0R00V
R4	100KΩ	RES SMD	1	0603	Panasonic	ERJ-3RBD104V
R7	14KΩ	RES SMD	1	0603	Panasonic	ERJ-3EKF1402V
L1	6.8µH	DCR=18.5mΩ, Ir=8.9A	1	10.0x10.7x 4mm	Panasonic	ETQP4M6R8KVC
JH6		PCB Header, 36 POS	1	1X3	Amphenol	78511-136HLF
JH13, JH14, JH15, JH16	1598	Terminal Turret Triple 0.094" L (Test Points)	4	Through-Hole	Keystone Electronics	1598-2
U1	AP64351Q	Sync DC-DC Buck Converter	1	SO-8EP	Diodes Inc	AP64351QSP

TYPICAL PERFORMANCE CHARACTERISTICS

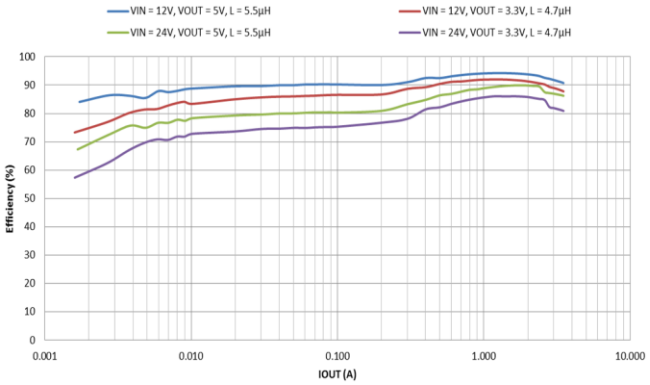

Figure 6. Efficiency vs. Output Current

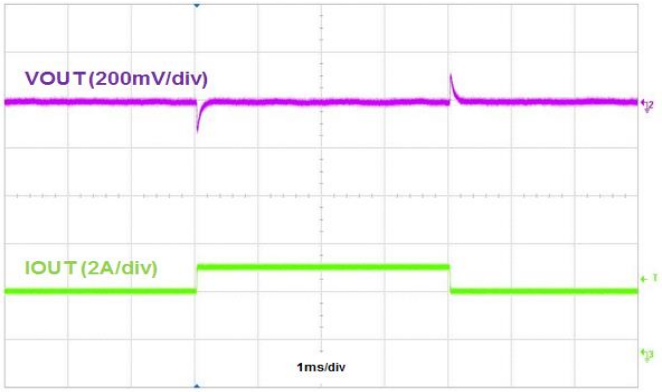

Figure 7. Load Transient 2A to 3.5A

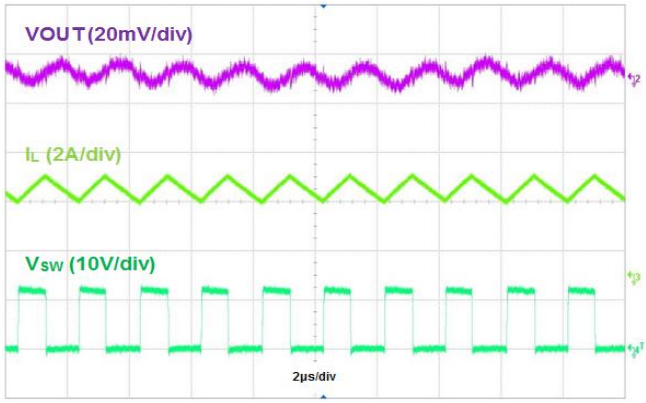

Figure 8. Output Voltage Ripple, IOUT=3.5A

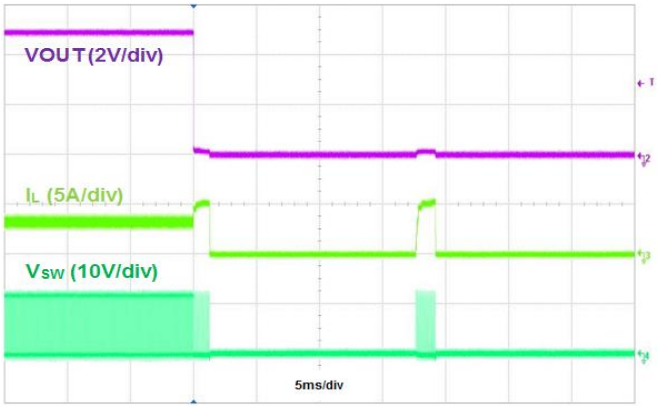

Figure 9. Output Short Protection, IOUT=3.5A

IMPORTANT NOTICE

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.

3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.

4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.

5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.

7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. 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.

8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.

9. This Notice may be periodically updated with the most recent version available at https://www.diodes.com/about/company/terms-and-conditions/important-notice

www.diodes.com