

DATA SHEET

# SKY16603-632LF: High-Linearity Dual PIN Diode Limiter 0.6 to 6.0 GHz

## Applications

- 5G massive MIMO infrastructure
- Receiver protection
- Test instrumentation

## Features

- Optimized for 0.6 to 6.0 GHz operation
- Low limiting threshold (+8 dBm typical)
- Low insertion loss
- Excellent IIP3 and low IM distortion
- Integrated dual PIN limiter diodes and DC blocks
- DFN (2-pin, 2.3 x 2.3 mm) Pb-free package, (MSL1, 260°C per JEDEC J-STD-020)



Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.

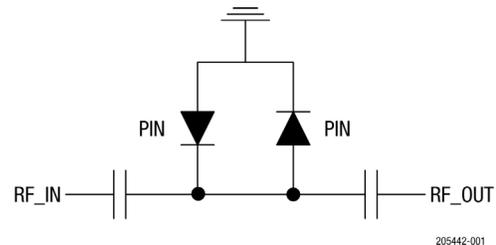


Figure 1. SKY16603-632LF Block Diagram

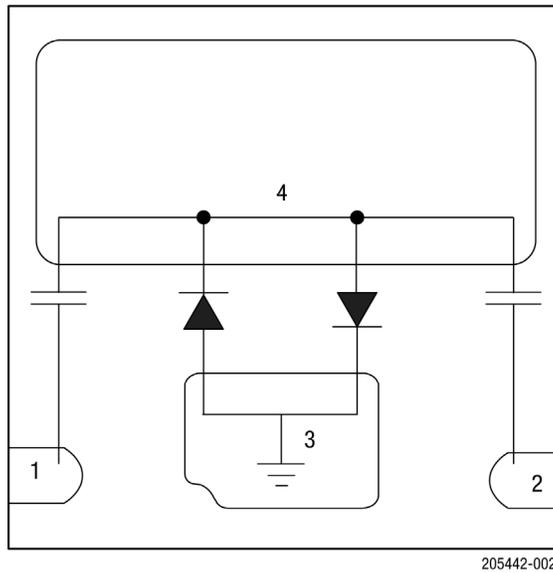
## Description

The SKY16603-632LF is a fully integrated dual PIN diode high-linearity limiter module in a surface-mount package. It is designed for use as a passive receiver protector in wireless or other RF systems for frequencies up to 6 GHz. It features a low limiting threshold, low-insertion loss, excellent IIP3, and low IM distortion in a Dual Flat No Lead (DFN) package.

The SKY16603-632LF module is comprised of dual PIN limiter diodes and two DC blocking caps at the RF ports in a 2-lead DFN. The small package design reduces printed circuit board area.

The module can operate over the operating temperature range of -40°C to +105°C.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.



**Figure 2. SKY16603-632LF Pinout (Top View)**

**Table 1. SKY16603-632LF Signal Descriptions**

Pin	Name	Description
1	RF_IN	RF input, AC coupled
2	RF_OUT	RF output, AC coupled
3	GND	Must be connected to chassis ground
4	PAD	Exposed pad ( <b>must be isolated from ground</b> )

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY16603-632LF are provided in Table 2. Electrical specifications are provided in Table 3. The SKY16603-632LF schematic is shown in Figure 3, and typical performance characteristics are illustrated in Figures 4 and 5.

Figure 6 shows the power derating curve for the limiter. The temperature is referenced to the bottom of the DFN package.

**Table 2. SKY16603-632LF Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Minimum	Maximum	Unit
CW power dissipation at T <sub>CASE</sub> = 120°C	P <sub>DIS</sub>		1	W
Storage temperature	T <sub>STG</sub>	-65	150	°C
Operating temperature	T <sub>OP</sub>	-40	105	°C
Electrostatic discharge:	ESD			
Charged-Device Model (CDM), Class 4			1000	V
Human Body Model (HBM), Class 1B			250	V
Machine Model (MM), Class A			150	V

<sup>1</sup> Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

**ESD HANDLING:** *Although this device is designed to be as robust as possible, electrostatic discharge (ESD) can damage this device. This device must be protected at all times from ESD when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

**Table 3. SKY16603-632LF Electrical Specifications**

(T<sub>OP</sub> = 25°C, Z<sub>o</sub> = 50 Ω, as Measured in Skyworks Evaluation Board Optimized for Operation at 0.6 to 6.0 GHz, Unless Otherwise Noted)

Parameter	Symbol	Condition	Frequency	Min	Typ	Max	Units
Reverse voltage	V <sub>R</sub>					20	V
Forward current	I <sub>F</sub>					50	mA
Insertion loss	I <sub>L</sub>	P <sub>IN</sub> = 0 dBm	2.6 GHz		0.3	0.5	dB
Return loss	R <sub>L</sub>	P <sub>IN</sub> = 0 dBm	2.6 GHz		22		dB
Threshold level	T <sub>L</sub>	P1dB	2.6 GHz		8		dBm
Maximum saturated CW input power <sup>1</sup>	P <sub>IN_MAX</sub>	T <sub>c</sub> = 120 °C	2.6 GHz		35		dBm
Flat leakage power <sup>2</sup>	F <sub>L</sub>	P <sub>IN</sub> = +15 dBm	2.6 GHz	5.5	9		dBm
Input third order intercept point	IIP3	Two CW tones, P <sub>IN</sub> = -5 dBm per tone, spacing = 10 MHz	2.6 GHz	25	29		dBm
Recovery time <sup>3</sup>	t <sub>r</sub>		2.6 GHz		1		ns
Thermal resistance	θ <sub>JC</sub>	Junction-to-case (T <sub>c</sub> = 120 °C)			52		°C/W

<sup>1</sup> Saturated CW input power is defined as the point where the diode series resistance does not change with the rectified current. As the input power increases past this point, output power will increase until the diode reaches its maximum power limit.

<sup>2</sup> Flat leakage power is defined as the power level after the limiter has fully turned on and the output pulse reaches a constant level.

<sup>3</sup> Recovery time represents the transition time from the high-loss to low-loss state following the removal of high-power input. RF pulse modulation: 1 μs pulse width and 0.1% duty factor.

### Theory of Operation

A limiter prevents overload by allowing RF signals that are below a certain threshold to pass through, but larger signals exceeding the threshold are increasingly attenuated. The SKY16603-632LF has a lower threshold level compared to a traditional self-bias limiter circuit with an inductor for a ground return.

The device accomplishes this by incorporating a pair of specially optimized PIN limiter diodes. The two internal DC input/output capacitors provide DC blocking needed for most applications.

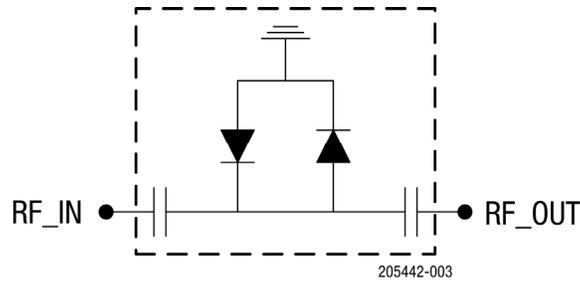
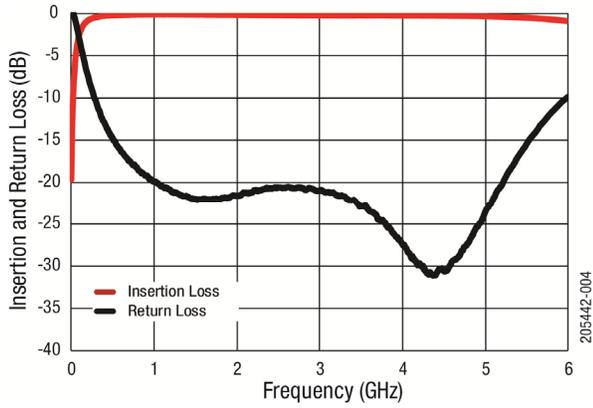
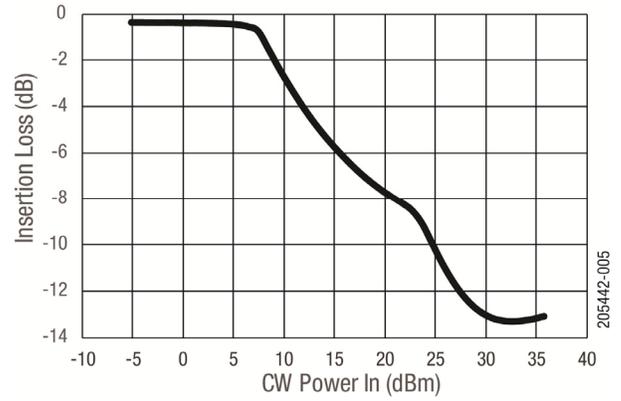


Figure 3. SKY16603-632LF Schematic

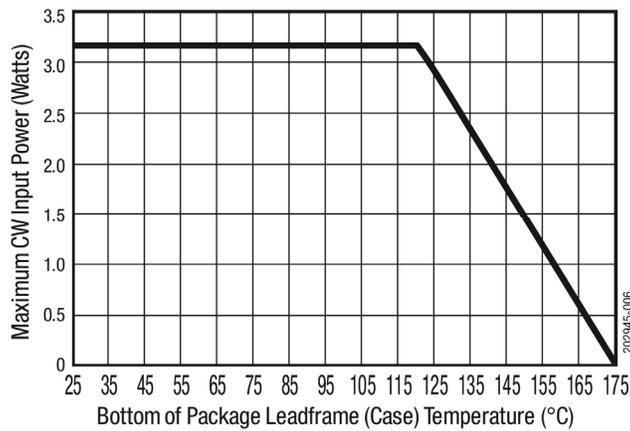
**Typical Performance Characteristics**  
 (T<sub>OP</sub>=25 °C, Characteristic Impedance = 50 Ω)



**Figure 4. Small Signal Performance**



**Figure 5. Insertion Loss vs CW Power In (f = 2.6 GHz)**



**Figure 6. Power Derating Curve (Pd = 1 W @ 120 °C) vs Package Leadframe (Case) Temperature**

### Evaluation Board Description

The SKY16603-632LF Evaluation Boards are used to test the performance of the limiter. An assembly drawing for the Evaluation Board is shown in Figure 7. The Evaluation Board layer detail is provided in Figure 8.

### Package Dimensions

The PCB layout footprint for the SKY16603-632LF is shown in Figure 9. Typical part markings are noted in Figure 10. Package dimensions are shown in Figure 11, and tape and reel dimensions are provided in Figure 12.

### Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY16603-632LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, Solder Reflow Information, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

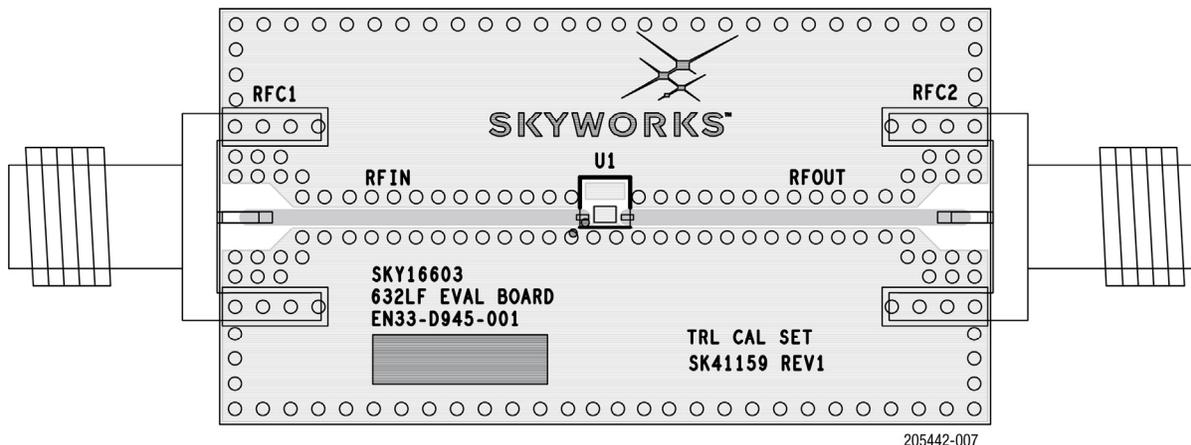


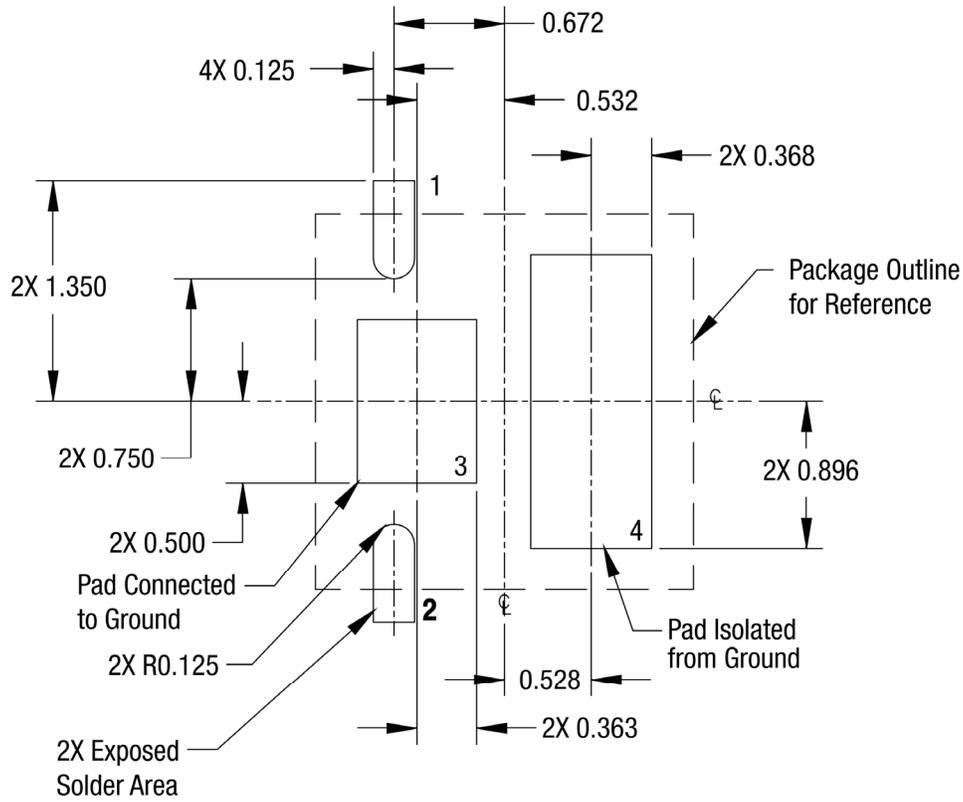
Figure 7. SKY16603-632LF Evaluation Board Assembly Diagram

Cross Section	Name	Thickness (in)	Material
	Top Solder mask		
	L1	(0.0028)	Cu foil
	Laminated	0.012 ± 0.0006	Rogers R04003C Core
	L2	(0.0014)	Cu foil
	Laminated	(Note 1)	FR4 Prepreg
	L3	(0.0014)	Cu foil
	Laminated	0.010 ± 0.0006	FR4 Core
	L4	(0.0028)	Cu foil
	Bottom Solder mask		

Note 1: Adjust this thickness to meet total thickness goal of 0.062 ± 0.005 inches.

205442-008

Figure 8. Board Layer Detail Physical Characteristics



All dimensions are in millimeters

205442-010

Figure 9. SKY16603-632LF PCB Layout Footprint

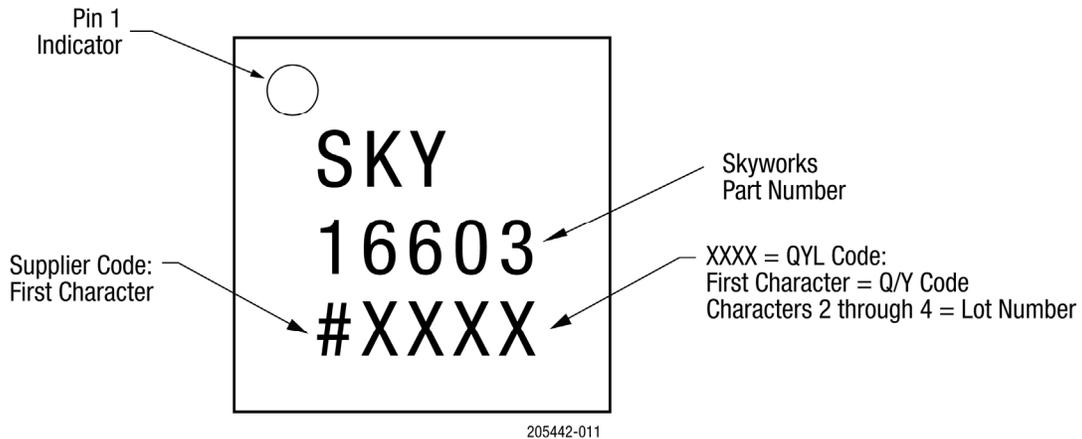
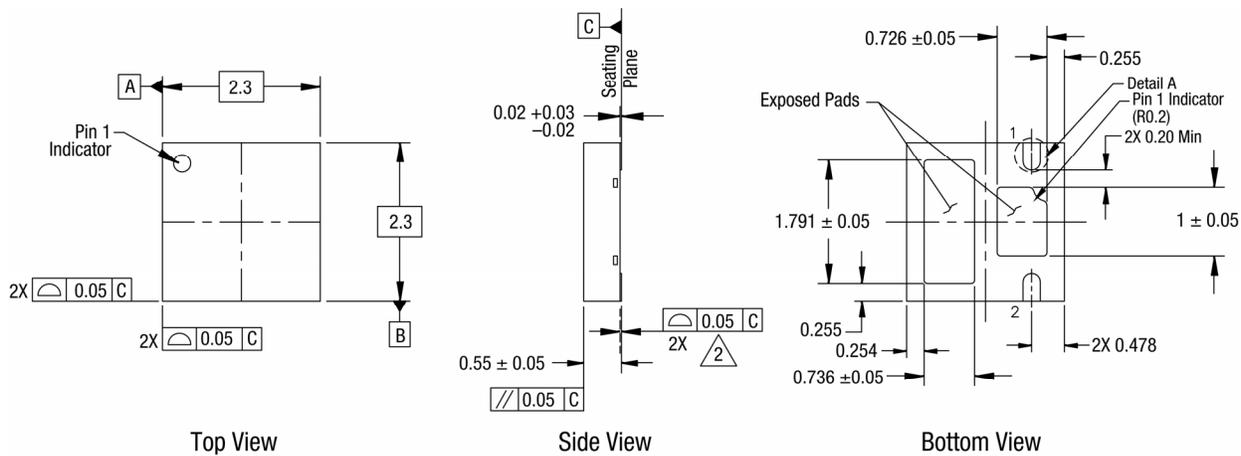


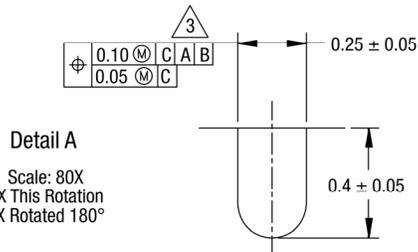
Figure 10. SKY16603-632LF Typical Part Markings

**DATA SHEET • SKY16603-632LF: HIGH-LINEARITY DUAL PIN DIODE LIMITER 0.6 TO 6.0 GHz**



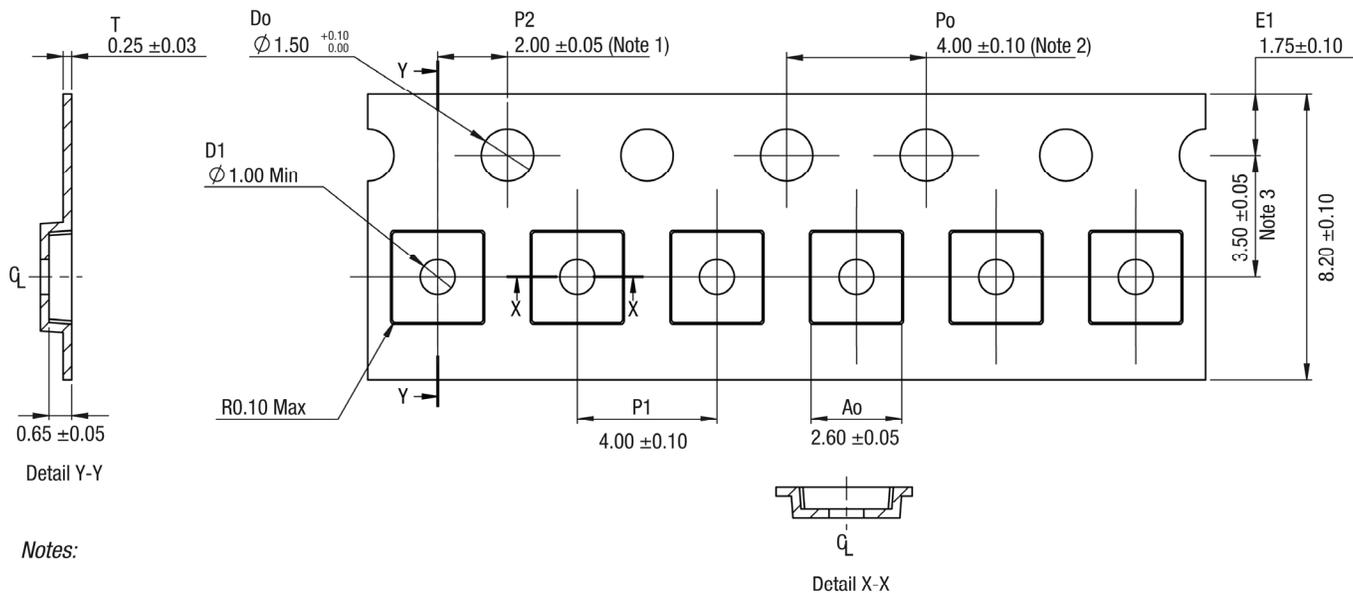
**Notes:**

1. Dimensions and tolerances according to ASME Y14.5M-1994.
2. Coplanarity applies to the exposed heat sink slug as well as the terminals.
3. Dimension applies to metallized terminal. If the terminal has a radius on its end, the width dimension should not be measured in that area.
4. Plating requirement per source control drawing (SCD) 2504.
5. All measurements are in millimeters.



205442-012

**Figure 11. SKY16603-632LF Package Dimensions**



**Notes:**

1. Measured from centerline of sprocket hole to centerline of pocket.
2. Cumulative tolerance of 10 sprocket holes is ±0.20.
3. Measured from centerline of sprocket hole to centerline of pocket.
4. Other material available.
5. All dimensions in millimeters unless otherwise stated.

205442-013

**Figure 12. SKY16603-632LF Tape and Reel Dimensions**

## Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY16603-632LF	High-Linearity Dual PIN Diode Limiter 0.6 to 6.0 GHz	SKY16603-632EK1
SK41159	Calibration Board	TRL CAL SET

Copyright © 2019-2020 Skyworks Solutions, Inc. All Rights Reserved.

Information in this document is provided in connection with Skyworks Solutions, Inc. ("Skyworks") products or services. These materials, including the information contained herein, are provided by Skyworks as a service to its customers and may be used for informational purposes only by the customer. Skyworks assumes no responsibility for errors or omissions in these materials or the information contained herein. Skyworks may change its documentation, products, services, specifications or product descriptions at any time, without notice. Skyworks makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Skyworks assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Skyworks products, information or materials, except as may be provided in Skyworks Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. SKYWORKS DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. SKYWORKS SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Skyworks products are not intended for use in medical, lifesaving or life-sustaining applications, or other equipment in which the failure of the Skyworks products could lead to personal injury, death, physical or environmental damage. Skyworks customers using or selling Skyworks products for use in such applications do so at their own risk and agree to fully indemnify Skyworks for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Skyworks products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Skyworks assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Skyworks products outside of stated published specifications or parameters.

Skyworks and the Skyworks symbol are trademarks or registered trademarks of Skyworks Solutions, Inc. or its subsidiaries in the United States and other countries. Third-party brands and names are for identification purposes only, and are the property of their respective owners. Additional information, including relevant terms and conditions, posted at [www.skyworksinc.com](http://www.skyworksinc.com), are incorporated by reference.

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Skyworks:](#)

[SKY16603-632EK1](#) [SKY16603-632LF](#)