

## DATA SHEET

# SKY12322-86LF: 0.5-4.0 GHz Five-Bit Digital Attenuator (0.5 dB LSB)

## Applications

- Transceiver transmit automatic level control or receive automatic gain control in GSM, CDMA, WCDMA, WLAN, Bluetooth®, or Zigbee® land mobile radio base stations or terminal equipment
- General-purpose signal attenuation in telecommunications and instrumentation applications

## Features

- Broadband operation: 0.5 to 4.0 GHz
- Positive voltage operation: 2.7 to 5.5 V
- Low current consumption: <100  $\mu$ A @ 3 V
- LSB attenuation: 0.5 dB
- Attenuation range: 15.5 dB
- High IIP3: +45 dBm
- Low insertion loss: 1.2 dB @ 900 MHz
- Small, MSOP-10 (10-pin, 3 x 3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

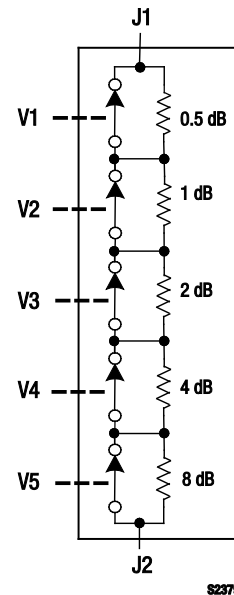


Skyworks Pb-free products are compliant with all applicable legislation. For additional information, refer to *Skyworks Definition of Lead (Pb)-Free*, document number SQ04-0073.

## Description

The SKY12322-86LF is a monolithic, GaAs binary-weighted five-bit single positive control voltage digital attenuator. The device operates from 0.5 to 4.0 GHz. DC power consumption is very low, typically 100  $\mu$ A maximum, with a control and supply voltage of 3 V.

The SKY12322-86LF has an LSB of 0.5 dB and total attenuation of 15.5 dB. The two RF ports are bilateral; each can be used as the RF input or the RF output. An external supply voltage of 2.7 to 5.5 V is required.

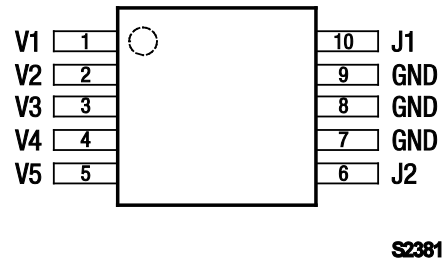


**Figure 1. SKY12322-86LF Block Diagram**

The SKY12322-86LF is comprised of five cascaded fixed attenuators, each of which has a shunt bypass switch. Beginning at the 0.5 dB LSB, each succeeding fixed attenuator produces twice the attenuation of the preceding stage.

The state of each bypass switch is controlled by the logic level voltage applied to the associated control voltage input. A logic high voltage closes the associated switch, which bypasses that fixed attenuator stage; a logic low opens the switch to force the input signal to that stage through the associated attenuator.

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. SKY12322-86LF Pinout – 10-Pin MSOP-10 (Top View)**

**Table 1. SKY12322-86LF Signal Descriptions**

Pin #	Name	Description	Pin #	Name	Description
1	V1	High impedance control voltage input for 0.5 dB weighted bit (LSB)	6	J2	RF input or output port, supply voltage input
2	V2	High impedance control voltage input for 1 dB weighted bit	7	GND	Ground
3	V3	High impedance control voltage input for 2 dB weighted bit	8	GND	Ground
4	V4	High impedance control voltage input for 4 dB weighted bit	9	GND	Ground
5	V5	High impedance control voltage input for 8 dB weighted bit (MSB)	10	J1	RF input or output port

**Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY12322-86LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY12322-86LF are illustrated in Figures 3 through 6.

The state of the SKY12322-86LF is determined by the logic provided in Table 4.

**Table 2. SKY12322-86LF Absolute Maximum Ratings**

Parameter	Symbol	Minimum	Typical	Maximum	Units
RF input power ( $V_{CTL} = 0/8\text{ V}$ )	$P_{IN}$	1 W for $f > 500\text{ MHz}$ 0.5 W for $f < 500\text{ MHz}$			
Supply voltage	$V_S$	3		8	V
Control voltage	$V_{CTL}$	-0.2		+8.0	V
Operating temperature	$T_{OP}$	-40		+85	°C
Storage temperature	$T_{STG}$	-65		+150	°C

**Note:** 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.

**CAUTION:** 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. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

**Table 3. SKY12322-86LF Electrical Specifications (Note 1)**

( $V_{CTL} = 0/3\text{ V}$ ,  $T_{OP} = +25\text{ °C}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\text{ }\Omega$ , Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Insertion loss	IL	0.5 to 1.0 GHz		1.4	2.0	dB
		1.0 to 2.0 GHz		1.5	2.5	dB
		2.0 to 3.0 GHz		2.3	3.0	dB
		3.0 to 4.0 GHz		3.0	3.5	dB
Attenuation range (Note 2)				15.5		dB
Attenuation accuracy (Note 2)		0.5 to 1.0 GHz	$\pm(0.2 + 3\%$ of attenuation setting)			dB
		1.0 to 3.0 GHz	$\pm(0.3 + 5\%$ of attenuation setting)			dB
		3.0 to 4.0 GHz	$\pm(0.5 + 5\%$ of attenuation setting)			dB
Return loss	RL	0.5 to 4.0 GHz	10	20		dB
Switching characteristics: Rise/fall time On/off time Video feedthrough		10/90% or 90/10% RF 50% $V_{CTL}$ to 90/10% RF $T_{RISE} = 1\text{ ns}$ , bandwidth = 500 MHz		150		ns
				300		ns
				70		mV
Input power for 1 dB compression	IP1dB	0.9 to 4.0 GHz: $V_{CTL} = 0\text{ to }3\text{ V}$ , $V_{CTL} = 0\text{ to }5\text{ V}$		+21 +27		dBm dBm
3 <sup>rd</sup> Order Input Intercept Point	IIP3	For two-tone input power, +5 dBm/tone, $\Delta f = 1\text{ MHz}$ , 0.9 to 4.0 GHz: $V_{CTL} = 0\text{ to }3\text{ V}$ , $V_{CTL} = 0\text{ to }5\text{ V}$		+45 +45		dBm dBm
Thermal resistance	$\Theta_{JC}$			25		°C/W
Supply voltage	$V_S$		2.8	3.0	8.0	V
Control voltage: Low High	$V_{CTL}$		-0.2 $V_S - 0.2$		+0.2	V
	$V_{LOW}$ $V_{HIGH}$				$V_S + 0.2$	V
Control current	$I_{CTL}$	$V_{CTL} = 0\text{ V}$			20	$\mu\text{A}$
		$V_{CTL} = 3\text{ V}$			100	$\mu\text{A}$
		$V_{CTL} = 5\text{ V}$			200	$\mu\text{A}$

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

**Note 2:** Attenuation referenced to insertion loss.

## Typical Performance Characteristics

( $V_S = 5\text{ V}$ ,  $V_{CTL} = 0\text{ to }3\text{ V}$ ,  $T_{OP} = +25\text{ }^{\circ}\text{C}$ ,  $C_{BLK} = 39\text{ pF}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\text{ }\Omega$ , , Unless Otherwise Noted)

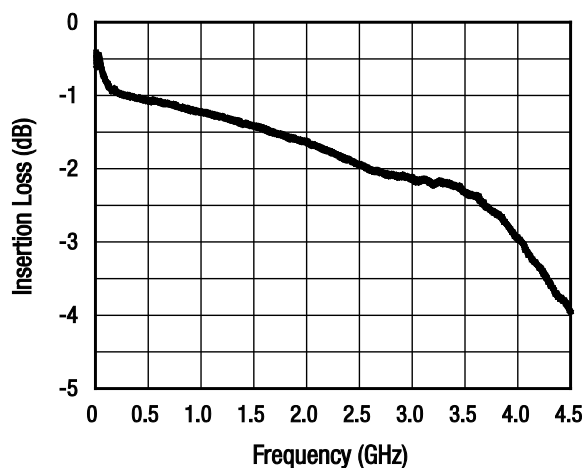


Figure 3. Insertion Loss vs Frequency

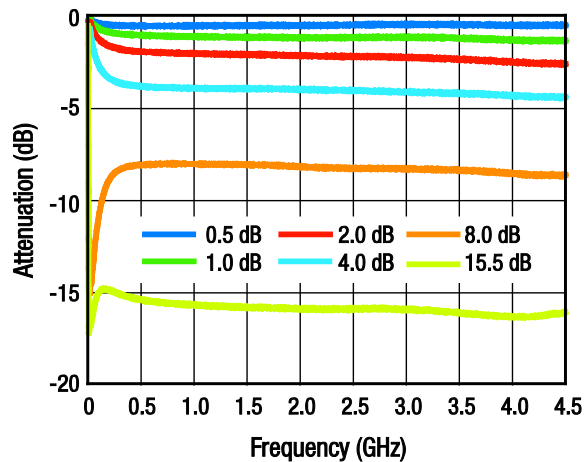


Figure 4. Attenuation vs Frequency  
(Normalized to Insertion Loss)

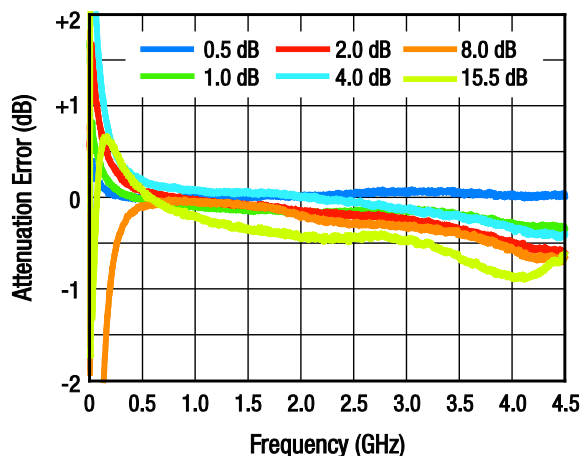


Figure 5. Attenuation vs Frequency  
(Normalized to Insertion Loss)

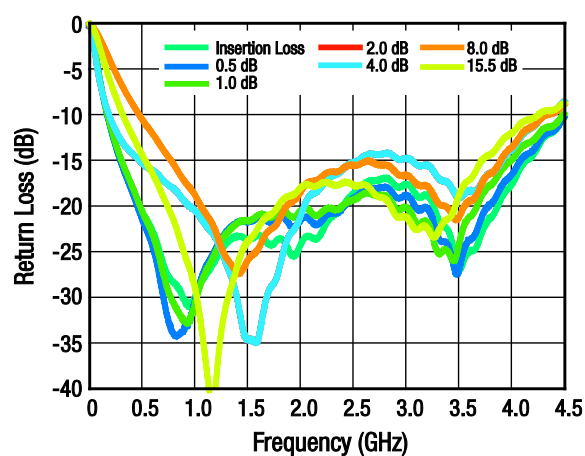


Figure 6. Insertion Loss vs Frequency

**Table 4. SKY12322-86LF Truth Table**

Nominal Attenuation	V1 (Pin 1)	V2 (Pin 2)	V3 (Pin 3)	V4 (Pin 4)	V5 (Pin 5)
Reference insertion loss	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>
0.5 dB	V <sub>LOW</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>
1.0 dB	V <sub>HIGH</sub>	V <sub>LOW</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>
2.0 dB	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>LOW</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>
4.0 dB	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>LOW</sub>	V <sub>HIGH</sub>
8.0 dB	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>HIGH</sub>	V <sub>LOW</sub>
15.5 dB	V <sub>LOW</sub>	V <sub>LOW</sub>	V <sub>LOW</sub>	V <sub>LOW</sub>	V <sub>LOW</sub>

**Note:** V<sub>HIGH</sub> = +3 V to 5 V. V<sub>LOW</sub> = 0 V to +0.2 V.

This Table shows the logic required for the major bits and full attenuation. Bit states need to be used in combination to set the sum of the bits selected.

## Evaluation Board Description

The SKY12322-86LF Evaluation Board is used to test the performance of the SKY12322-86LF digital attenuator. An assembly drawing for the Evaluation Board is shown in Figure 7 and an Evaluation Board schematic diagram is shown in Figure 8.

## Package Dimensions

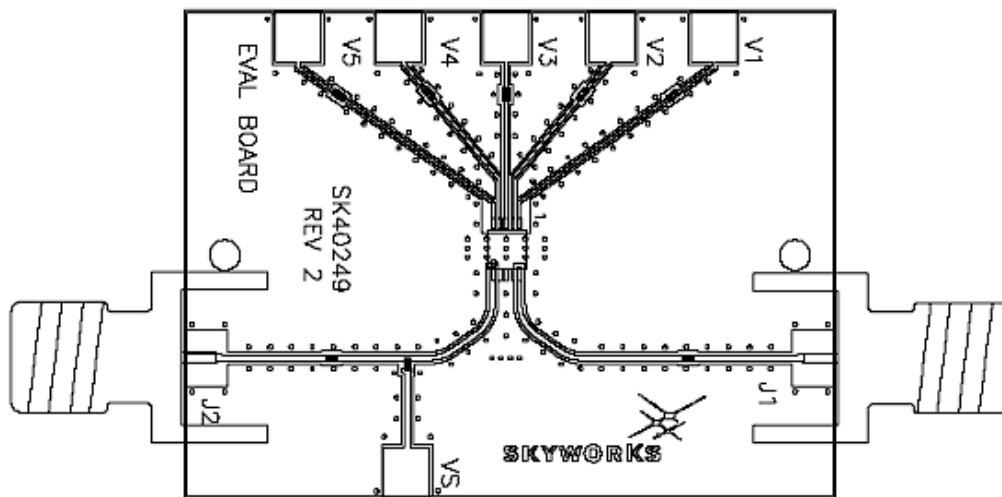
Package dimensions for the 10-pin MSOP-10 are shown in Figure 9, and tape and reel dimensions are provided in Figure 10.

## 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 SKY12322-86LF 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. SKY12322-86LF Evaluation Board Assembly Diagram**

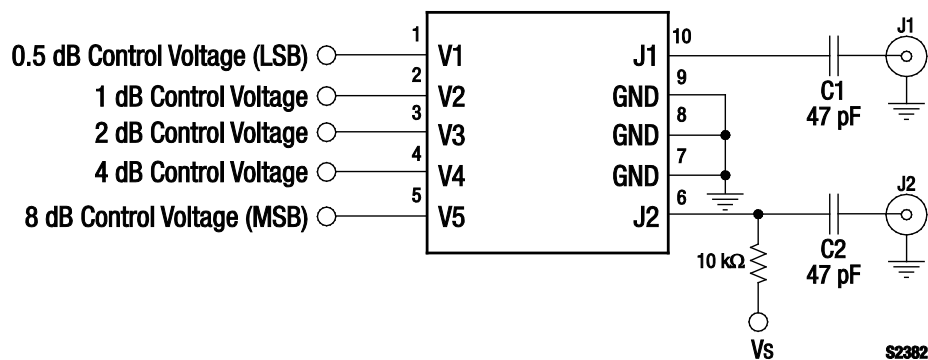


Figure 8. SKY12322-86LF Evaluation Board Schematic Diagram

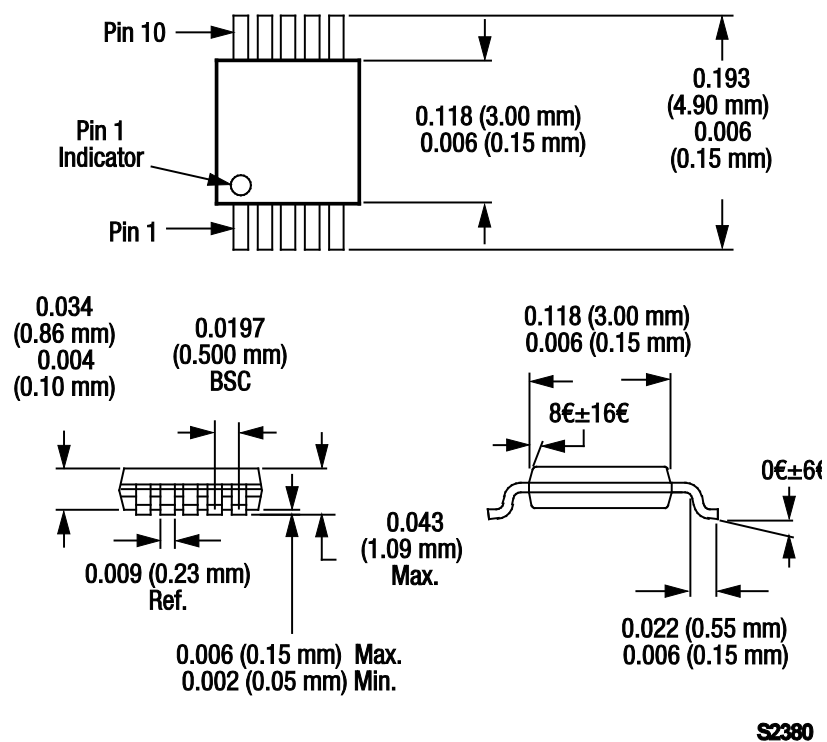
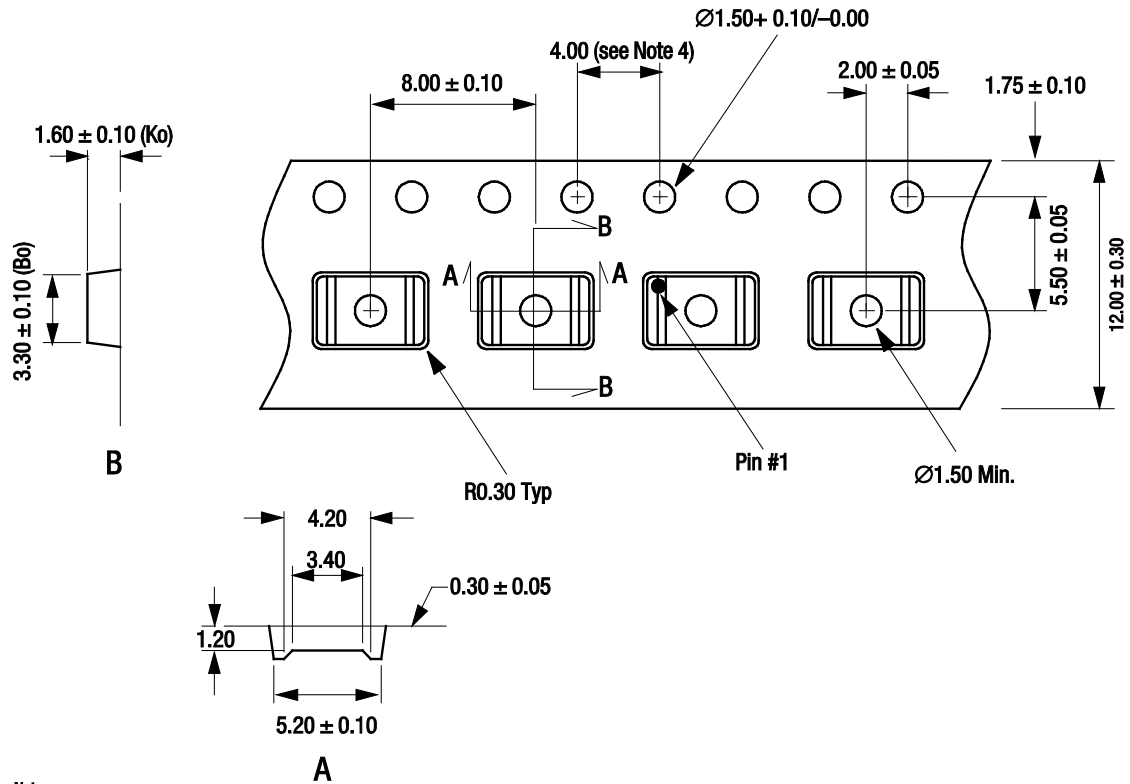


Figure 9. SKY12322-86LF 10-Pin MSOP-10 Package Dimensions



**Notes:**

1. Carrier tape: black conductive polystyrene.
2. Cover tape material: transparent conductive HSA.
3. Cover tape size: 9.2 mm width.
4. Ten sprocket hole pitch cumulative tolerance =  $\pm 0.20$  mm.
5. All measurements are in millimeters.
6. Standard reel size is 7 inches. Standard reel quantity is 3000 pcs.

**S2348**

**Figure 10. SKY12322-86LF Tape and Reel Dimensions**

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
SKY12322-86LF Digital Attenuator	SKY12322-86LF	SKY12322-86LF-EVB

Copyright © 2002-2006, 2011 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, the Skyworks symbol, and "Breakthrough Simplicity" are trademarks or registered trademarks of Skyworks Solutions, Inc., 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.