

SKY12348-350LF: 0.1-3.0 GHz Four-Bit Digital Attenuator (1 dB LSB)

Applications

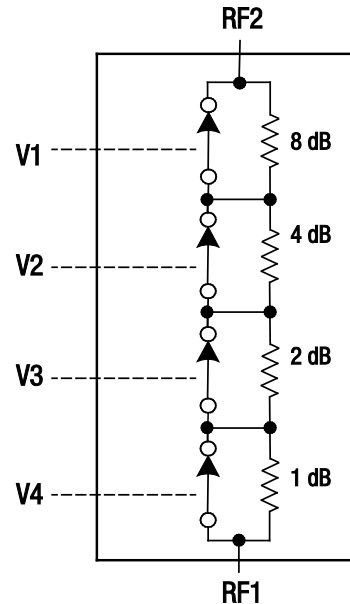
- Cellular, 3G/4G, WiMAX, and LTE Infrastructures
- RF and IF systems

Features

- Broadband operation: 0.1 to 3.0 GHz
- Attenuation: 15 dB with 1 dB LSB
- +5 V supply voltage and +3.3 V control voltage
- Small, QFN (16-pin, 3 x 3 mm) 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.



S2242

Figure 1. SKY12348-350LF Block Diagram

Description

The SKY12348-350LF is a GaAs pHEMT four-bit broadband digital attenuator with a 1 dB Least Significant Bit (LSB). The attenuator features low insertion loss, excellent attenuation accuracy, a 15 dB attenuation range, and high linearity performance. The SKY12348-350LF is an ideal choice for a wide variety of cellular 3G and 4G infrastructure applications.

Attenuation is controlled by four DC control pins (V1, V2, V3, and V4). Depending on the control bias, the attenuation state between the RF1 and RF2 pins can vary between a low insertion loss state or up to 15 dB.

The device is provided in a 3 x 3 mm, 16-pin Quad Flat No-Lead (QFN) package. 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.

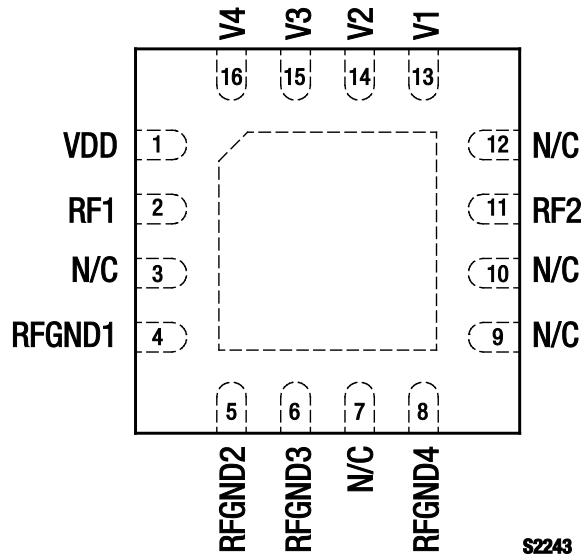


Figure 2. SKY12348-350LF Pinout – 16-Pin QFN (Top View)

Table 1. SKY12348-350LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	VDD	DC power supply	9	N/C	No connection. Can be grounded without affecting performance.
2	RF1	RF input/output to digital attenuator	10	N/C	No connection. Can be grounded without affecting performance.
3	N/C	No connection. Can be grounded without affecting performance.	11	RF2	RF input/output to digital attenuator
4	RFGND1	Connect through external capacitor to ground. Capacitor value determines lower frequency operation of attenuator.	12	N/C	No connection. Can be grounded without affecting performance.
5	RFGND2	Connect through external capacitor to ground. Capacitor value determines lower frequency operation of attenuator.	13	V1	DC control pin. See Table 4.
6	RFGND3	Connect through external capacitor to ground. Capacitor value determines lower frequency operation of attenuator.	14	V2	DC control pin. See Table 4.
7	N/C	No connection. Can be grounded without affecting performance.	15	V3	DC control pin. See Table 4.
8	RFGND4	Connect through external capacitor to ground. Capacitor value determines lower frequency operation of attenuator.	16	V4	DC control pin. See Table 4.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY12348-350LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY12348-350LF are illustrated in Figures 5 through 7.

The state of the SKY12348-350LF is determined by the logic provided in Table 4.

Table 2. SKY12348-350LF Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V _{DD}	3.3	6.0	V
Control voltage	V _{CTL}	0	V _{DD}	V
RF input power	P _{IN}		+30	dBm
Operating temperature	T _{OP}	-40	+85	°C
Storage temperature	T _{STG}	-40	+125	°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. SKY12348-350LF Electrical Specifications (Note 1) (1 of 2)

(V_{DD} = 5 V, V_{CTL} = 5 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z₀] = 50 Ω, , Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units	
RF Specifications							
Insertion loss	IL	@ 0.7 GHz		0.8	1.0	dB	
		@ 2.1 GHz		1.0	1.2	dB	
		@ 2.7 GHz		1.2	1.4	dB	
Attenuation range		0.1 to 3.0 GHz	1		15	dB	
Return loss	RL	0.1 to 3.0 GHz		15		dB	
Attenuation accuracy	Attn	1 dB bit:					
		0.7 GHz	0.8	1	1.2	dB	
		2.1 GHz	0.8	1	1.2	dB	
		2.7 GHz	0.8	1	1.3	dB	
		2 dB bit:					
		0.7 GHz	1.8	2	2.2	dB	
		2.1 GHz	1.8	2	2.3	dB	
		2.7 GHz	1.8	2	2.4	dB	
		4 dB bit:					
		0.7 GHz	3.8	4	4.3	dB	
		2.1 GHz	3.8	4	4.4	dB	
		2.7 GHz	3.8	4	4.4	dB	
		8 dB bit:					
		0.7 GHz	7.8	8	8.4	dB	
		2.1 GHz	7.8	8	8.2	dB	
2.7 GHz	7.5	8	8.2	dB			
Max. attenuation (15 dB):							
0.7 GHz	14.8	15	15.5	dB			
2.1 GHz	14.4	15	15.5	dB			
2.7 GHz	13.8	15	15.3	dB			
0.1 dB Input Compression Point	IPO.1dB	V _{DD} = 3 V @ 1.8 GHz		+30		dBm	
3 rd Order Input Intercept Point	IIP3	P _{IN} = +10 dBm/tone @ 1.8 GHz, V _{DD} = 3 V, ΔF = 1 MHz, worst case in 16 states		+45		dBm	

Table 3. SKY12348-350LF Electrical Specifications (Note 1) (2 of 2)

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

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
DC Specifications						
Control voltage:	V_{CTL}		0		0.8	V
			3.3		V_{DD}	V
Supply voltage	V_{DD}		3.3	5.0	5.5	V
Supply current	I_{DD}	$V_{DD} = 5\text{ V}$		75		μA
Control current	I_{CTL}	$V_{DD} = 3.3\text{ V}$		5		μA
Switching Speed Specifications						
On/rise		50% control or 90% RF to 10% RF		200		ns
Off/fall		50% control or 10% RF to 90% RF		180		ns

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

Typical Performance Characteristics

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

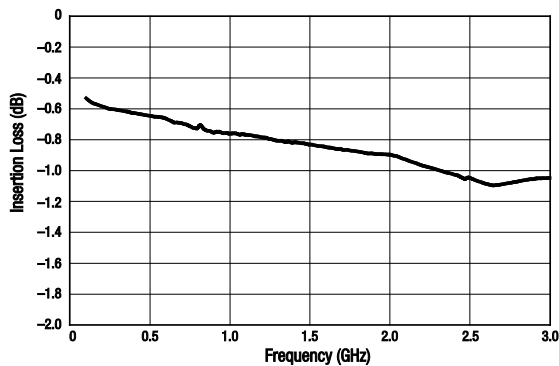


Figure 3. Insertion Loss vs Frequency @ 0 dB

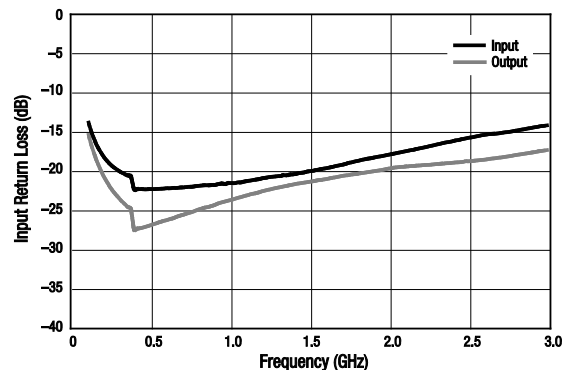


Figure 4. Input Return Loss vs Frequency

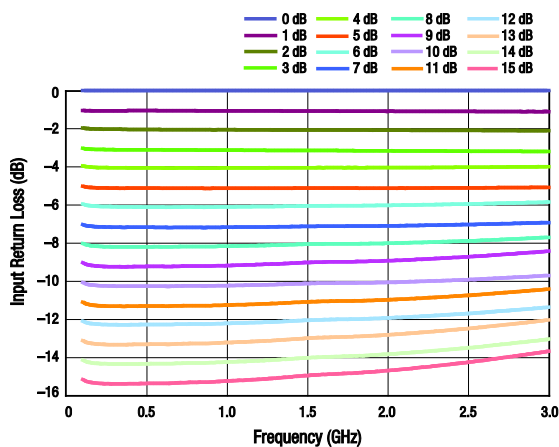


Figure 5. Normalized Attenuation vs Frequency

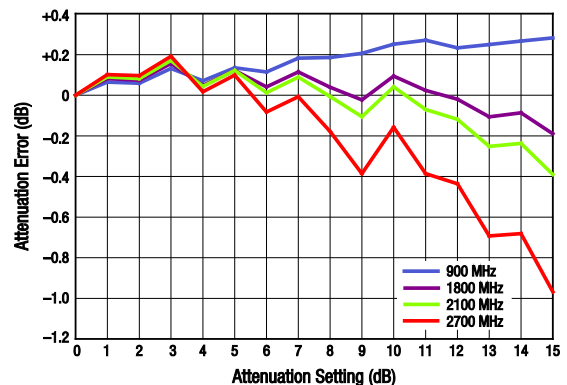


Figure 6. Attenuation Error vs Attenuation Setting

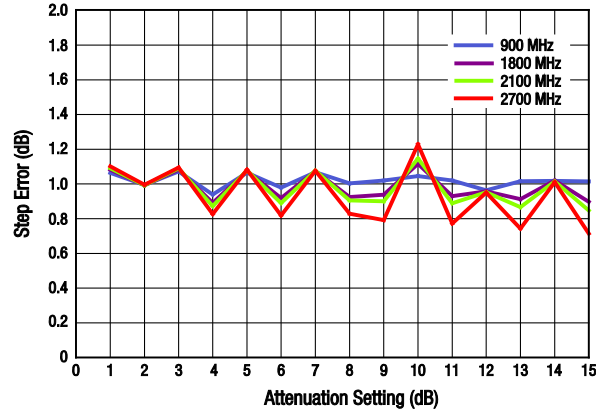


Figure 7. Step Error vs Attenuation Setting

Table 4. SKY12348-350LF Truth Table

RF1/RF2 (Pins 2 & 11) Attenuation	V4 (Pin 16)	V3 (Pin15)	V2 (Pin 14)	V1 (Pin 13)
Insertion loss	1	1	1	1
1 dB	0	1	1	1
2 dB	1	0	1	1
4 dB	1	1	0	1
8 dB	1	1	1	0
15 dB	0	0	0	0

Notes: "1" = high control voltage: +3.3 to V_{DD}.
 "0" = low control voltage: 0 to +0.8 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 SKY12348-350LF Evaluation Board is used to test the performance of the SKY12348-350LF digital attenuator. An assembly drawing for the Evaluation Board is shown in Figure 8 and an Evaluation Board schematic diagram is shown in Figure 9.

Package Dimensions

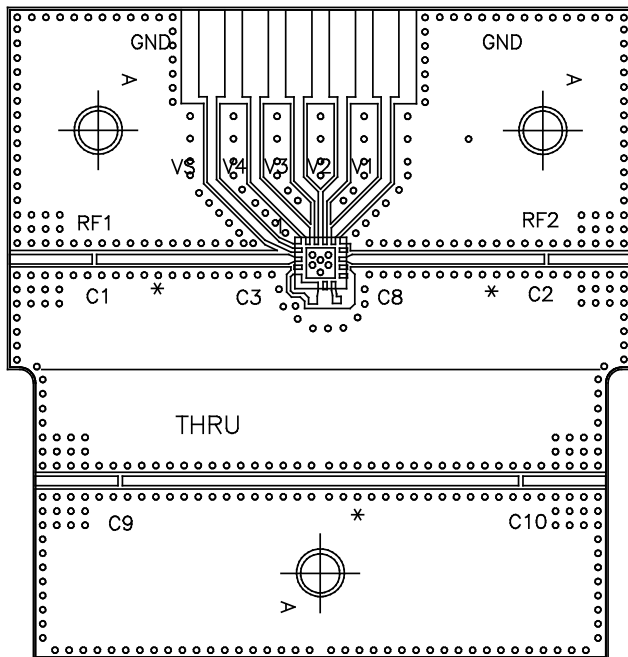
The PCB layout footprint for the SKY12348-350LF is shown in Figure 10. Typical case markings are noted in Figure 11. Package dimensions for the 16-pin QFN are shown in Figure 12, and tape and reel dimensions are provided in Figure 13.

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.

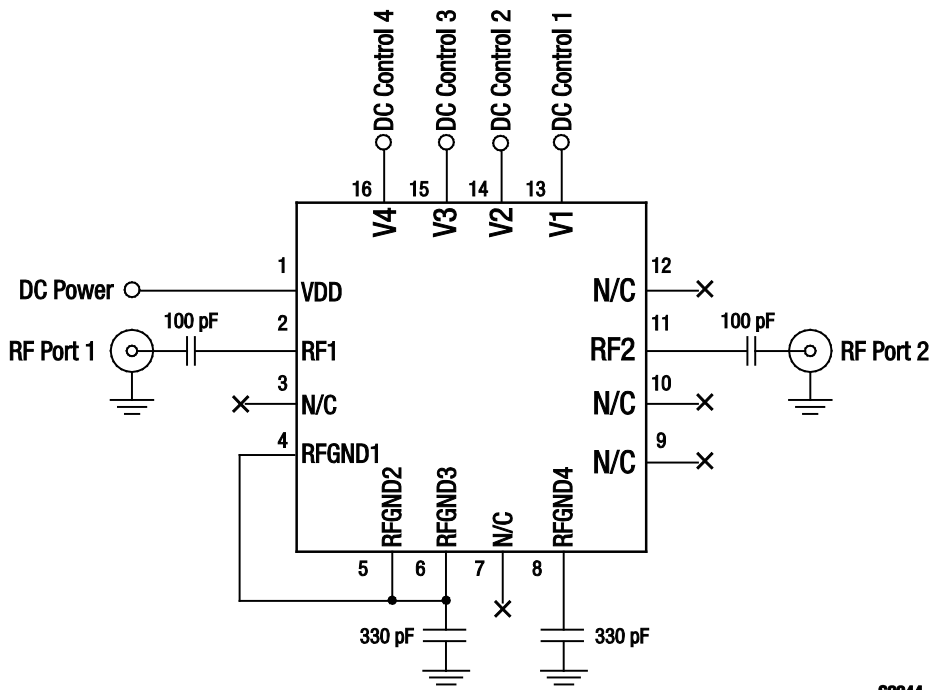
THE SKY12348-350LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

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.



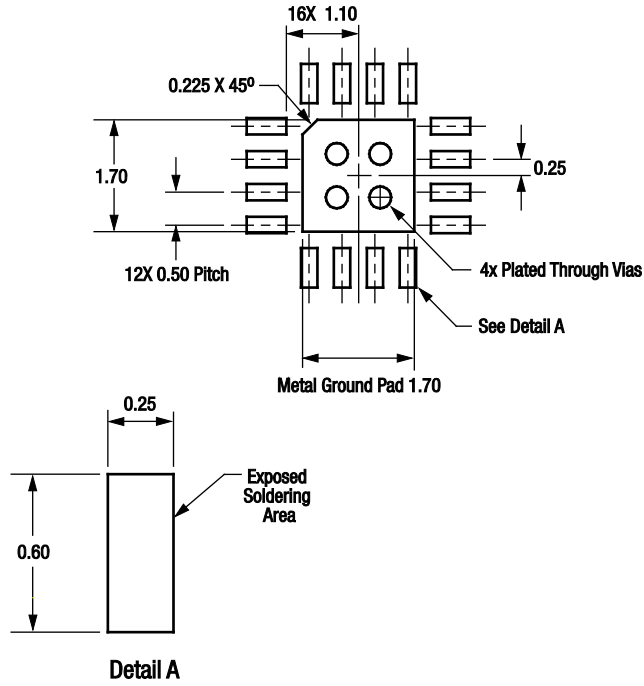
S2245

Figure 8. SKY12348-350LF Evaluation Board Assembly Diagram



S2244

Figure 9. SKY12348-350LF Evaluation Board Schematic Diagram



All dimensions are in millimeters

S1681

Figure 10. SKY12348-350LF PCB Layout Footprint

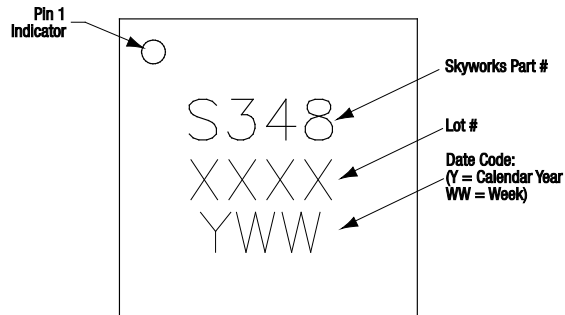
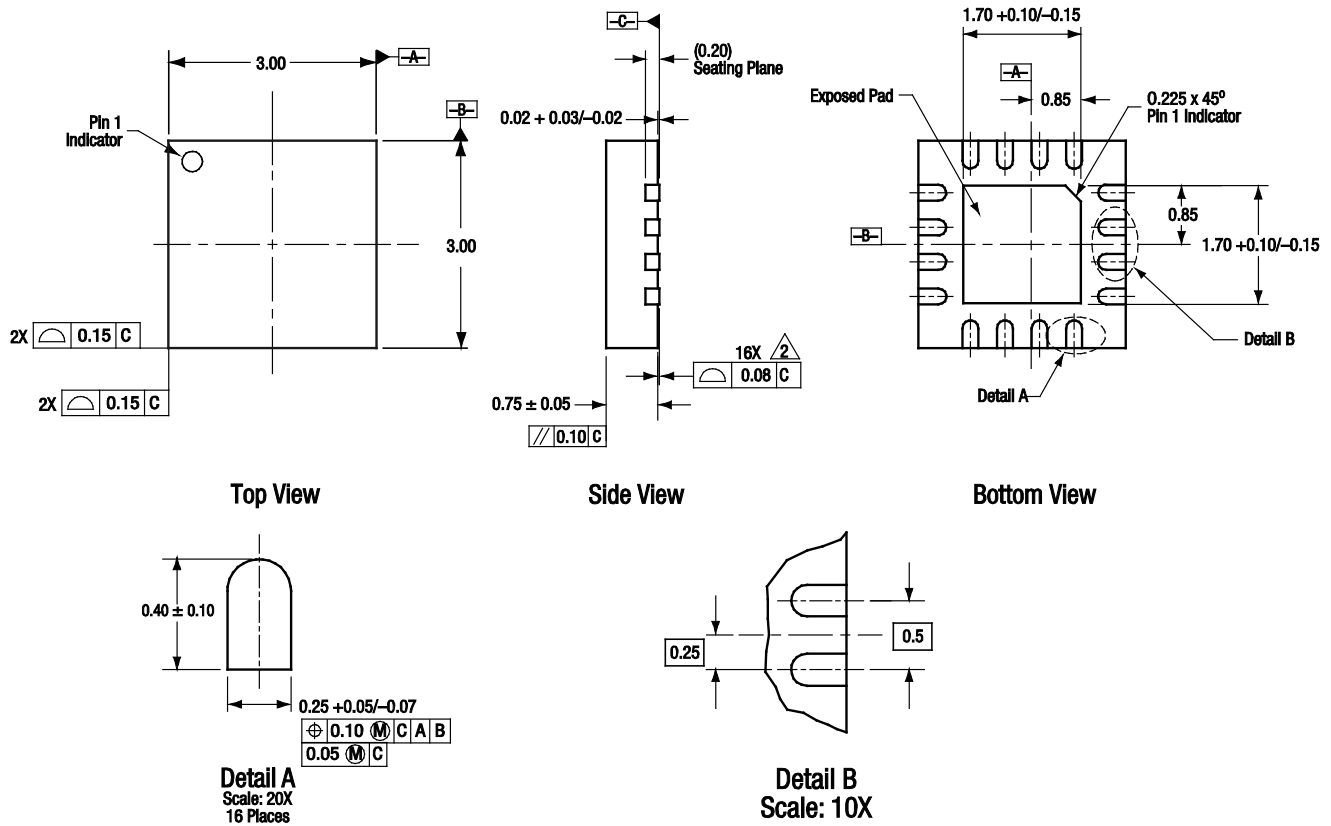


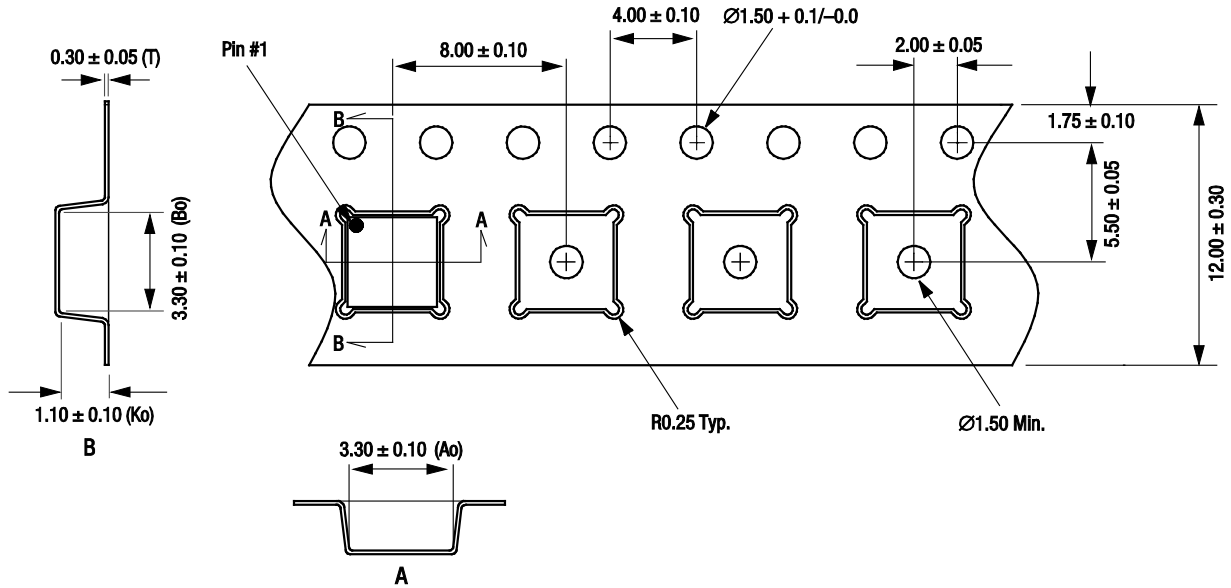
Figure 11. Typical Part Markings



All measurements are in millimeters.
 Dimensioning and tolerancing according to ASME Y14.5M-1994.
 Coplanarity applies to the exposed heat sink slug as well as the terminals.
 Plating requirement per source control drawing (SCD) 2504.

S1692

Figure 12 SKY12348-350LF 16-Pin QFN Package Dimensions



- Notes:
1. Carrier tape: black conductive polystyrene, non-bakeable material.
 2. Cover tape material: transparent conductive HSA.
 3. Cover tape size: 9.20 mm width.
 4. All measurements are in millimeters.

S1688

Figure 13. SKY12348-350LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
SKY12348-350LF Digital Attenuator	SKY12348-350LF	SKY12348-350LF-EVB

Copyright © 2010, 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, are incorporated by reference.