

**DATA SHEET**

# SKY12329-350LF: GaAs Digital Attenuator

## 5-Bit, 1 dB LSB 400 MHz–4 GHz

### Applications

- Transceiver transmit automatic level control or receive automatic gain control in WiMAX, GSM, CDMA, WCDMA, WLAN, Bluetooth®, Zigbee®, Land Mobile Radio Base stations or Terminal Equipment
- General purpose signal attenuation in telecommunications and instrumentation applications

### Features

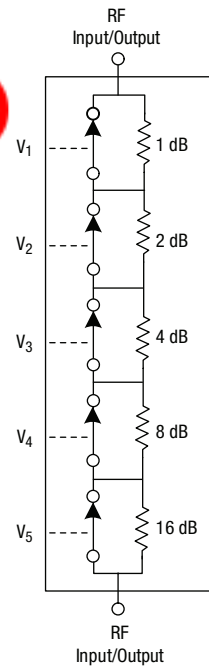
- Broadband: 400 MHz–4 GHz
- Attenuation range: 31 dB
- Least significant bit attenuation: 1 dB
- Low insertion loss: 1.2 dB @ 900 MHz
- Single positive control voltage: 2.7–5.5 V
- Low current consumption: <100  $\mu$ A @ 5 V
- Small QFN-16 3 x 3 mm package with exposed paddle
- Lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

### Description

The SKY12329-350LF is a monolithic GaAs, binary-weighted, 5-bit, single positive control voltage digital attenuator which operates from 400 MHz–4 GHz. The attenuator has a least significant bit (LSB) of 1 dB and total attenuation of 31 dB. The two RF ports are bilateral; each can be used as the RF input or the RF output. This attenuator requires an external supply voltage of 2.7–5.5 V.

The SKY12329-350LF is comprised of 5 fixed attenuators in cascade, each of which having a shunt bypass switch. Beginning at the LSB, which is 1 dB, 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, thereby

### Functional Block Diagram



bypassing that fixed attenuator stage, and a logic low opens the switch to force the input signal to that stage through the associated attenuator.

DC power consumption is very low, 100  $\mu$ A maximum with control voltage and supply voltage of 5 V. The switch can operate over the temperature range of -40 °C to +85 °C.

An evaluation board is available upon request.

**NEW** Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.



### Electrical Specifications

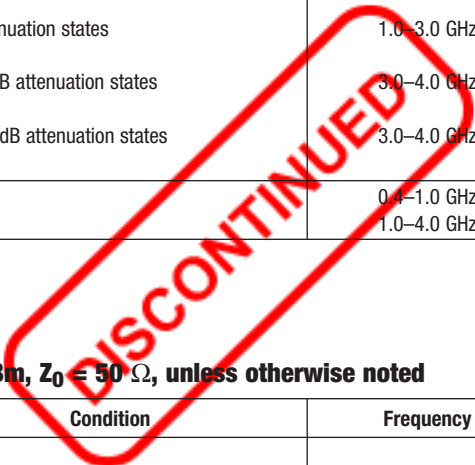
$V_{CTL} = 0\text{ V/5 V}$ ,  $T = 25\text{ °C}$ ,  $P_{INPUT} = 0\text{ dBm}$ ,  $Z_0 = 50\text{ }\Omega$ , unless otherwise noted

| Parameter            | Condition   | Frequency   | Min.  | Typ. | Max. | Unit |
|----------------------|---|-------------|---|------|------|------|
| Insertion loss       |   | 0.4–1.0 GHz |   | 1.2  | 1.6  | dB   |
|                      |   | 1.0–2.0 GHz |   | 1.5  | 1.9  | dB   |
|                      |   | 2.0–3.0 GHz |   | 1.8  | 2.2  | dB   |
|                      |   | 3.0–4.0 GHz |   | 2.7  | 3.1  | dB   |
| Attenuation range    |   |             |   | 31   |      | dB   |
| Attenuation accuracy | Attenuation referred to insertion loss.<br>All attenuation states | 0.4–1.0 GHz | $\pm (0.35 + 3\%$ of attenuation setting in dB) |      |      | dB   |
|                      | All attenuation states  | 1.0–3.0 GHz | $\pm (0.3 + 3\%$ of attenuation setting in dB)  |      |      | dB   |
|                      | 1–15 dB attenuation states  | 3.0–4.0 GHz | $\pm (0.5 + 5\%$ of attenuation setting in dB)  |      |      | dB   |
|                      | 16–31 dB attenuation states                                       | 3.0–4.0 GHz | $\pm (0.6 + 6\%$ of attenuation setting in dB)  |      |      | dB   |
| Return loss          |   | 0.4–1.0 GHz |   | 7    |      | dB   |
|                      |   | 1.0–4.0 GHz |   | 10   |      | dB   |

### Operating Characteristics

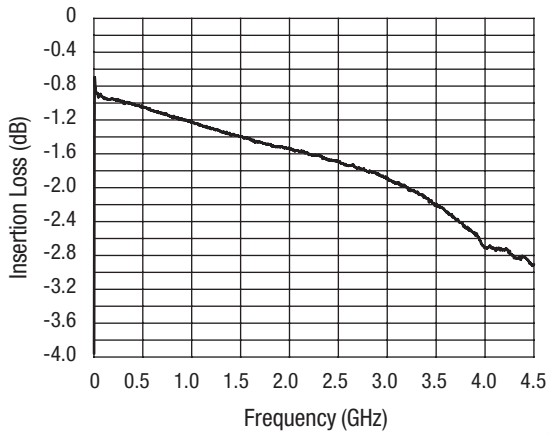
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| Parameter                                   | Condition   | Frequency | Min.             | Typ. | Max.             | Unit          |
|---|---|-----------|------------------|------|------------------|---------------|
| Switching characteristics                   | 50/90% or 10/90% RF   |           |                  | 150  |                  | ns            |
|   |   |           |                  |      |                  |               |
| Off/fall time                               | 50/10% or 90/10% RF   |           |                  | 500  |                  | ns            |
|   |   |           |                  |      |                  |               |
| Input power for 1 dB compression            | $V_{LOW} = 0\text{ V}$ , $V_{HIGH} = 3\text{ V}$<br>$V_{LOW} = 0\text{ V}$ , $V_{HIGH} = 5\text{ V}$  | 900 MHz   |                  | 29   |                  | dBm           |
|   |   | 900 MHz   |                  | 31   |                  | dBm           |
| Input third order intermodulation intercept | For two input tones. +5 dBm each tone<br>$V_{LOW} = 0\text{ V}$ , $V_{HIGH} = 3\text{ V}$<br>$V_{LOW} = 0\text{ V}$ , $V_{HIGH} = 5\text{ V}$ | 1–4 GHz   |                  | 39   |                  | dBm           |
|   |   | 1–4 GHz   |                  | 41   |                  | dBm           |
| Thermal resistance                          | Junction to package terminal  |           |                  | 45   |                  | °C/W          |
| Supply voltage                              |   |           | $V_{HIGH} - 0.2$ |      | $V_{HIGH} + 0.2$ | V             |
| Control voltage                             | High  |           | 2.7              |      | 5.5              | V             |
|   | Low   |           | -0.2             |      | 0.2              | V             |
| Control port current                        | $V_{CTL} = V_{HIGH}$  |           |                  | 15   | 100              | $\mu\text{A}$ |
|   | $V_{CTL} = V_{LOW}$   |           |                  | 5    | 20               | $\mu\text{A}$ |

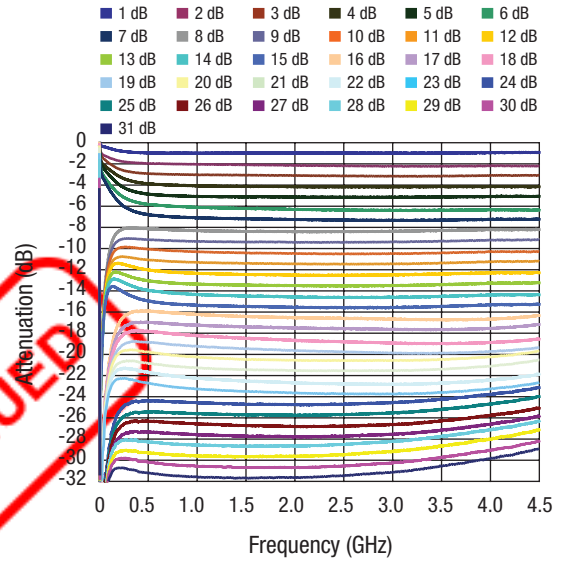


### Typical Performance Data

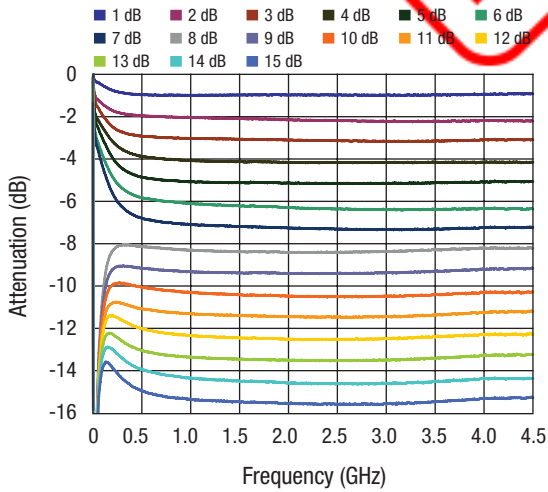
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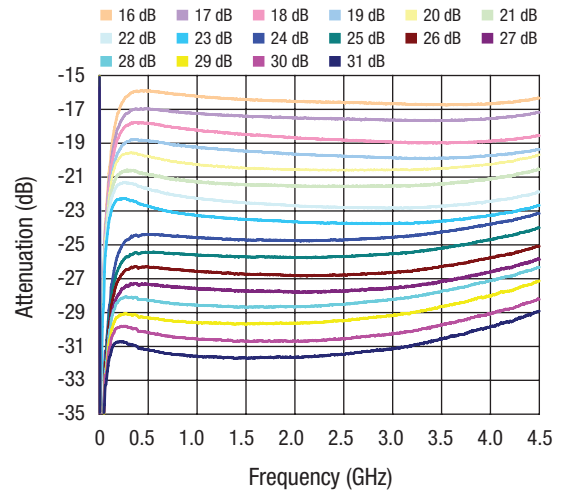
Insertion Loss vs. Frequency



Attenuation vs. Frequency<sup>1</sup>

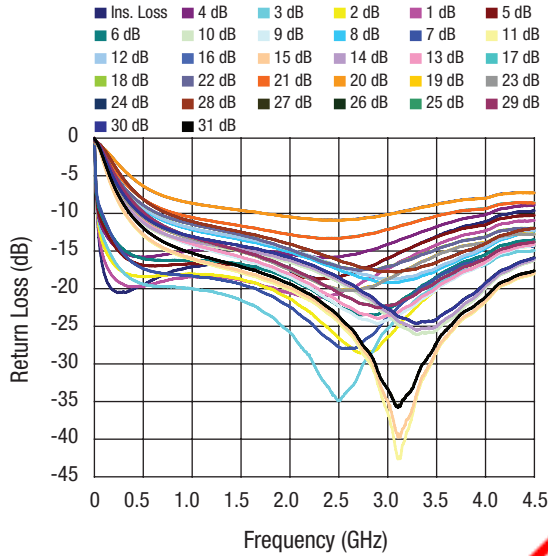


Attenuation vs. Frequency<sup>1</sup>  
1–15 dB

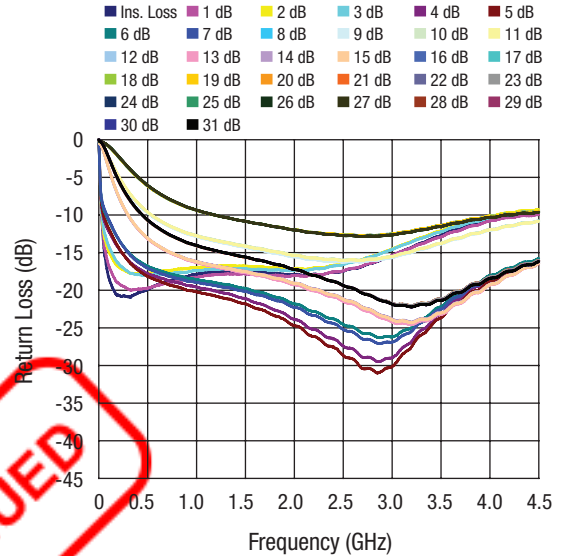


Attenuation vs. Frequency<sup>1</sup>  
16–31 dB

1. Attenuation normalized to insertion loss



Input Return Loss vs. Frequency



Output Return Loss vs. Frequency

**Truth Table**

| V <sub>1</sub>    | V <sub>2</sub>    | V <sub>3</sub>    | V <sub>4</sub>    | V <sub>5</sub>    | Attenuation              |
|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------------|
| V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | Reference insertion loss |
| V <sub>LOW</sub>  | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | 1 dB                     |
| V <sub>HIGH</sub> | V <sub>LOW</sub>  | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | 2 dB                     |
| V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>LOW</sub>  | V <sub>HIGH</sub> | V <sub>HIGH</sub> | 4 dB                     |
| V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>LOW</sub>  | V <sub>HIGH</sub> | 8 dB                     |
| V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>HIGH</sub> | V <sub>LOW</sub>  | 16 dB                    |
| V <sub>LOW</sub>  | V <sub>LOW</sub>  | V <sub>LOW</sub>  | V <sub>LOW</sub>  | V <sub>LOW</sub>  | 31 dB                    |

2.7 V ≤ V<sub>HIGH</sub> ≤ 5.5 V, V<sub>S</sub> = V<sub>HIGH</sub> ± 0.2 V, 0 ≤ V<sub>LOW</sub> ≤ 0.2 V.

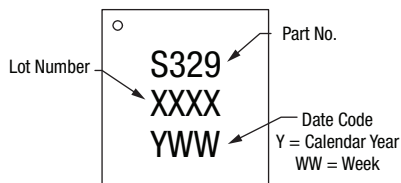
**Absolute Maximum Ratings**

| Characteristic              | Value   |
|-----------------------------|---|
| RF input power              | 33 dBm for f > 400 MHz,<br>V <sub>CTL</sub> = 0/8 V |
| Control voltage range       | -0.2 ≤ V <sub>C</sub> ≤ 8 V                         |
| Operating temperature range | -40 °C to +85 °C                                    |
| Storage temperature range   | -65 °C to +150 °C                                   |

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

**CAUTION:** Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.

**Part Marking**



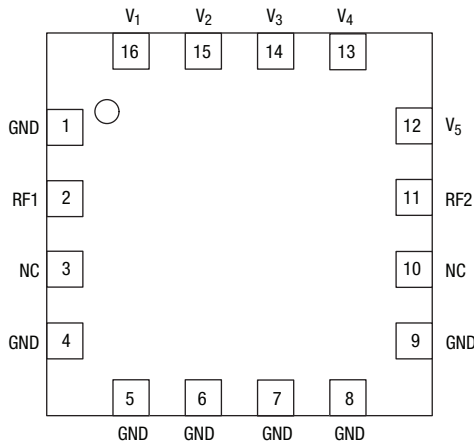
**Recommended Solder Reflow Profiles**

Refer to the [“Recommended Solder Reflow Profile”](#) Application Note.

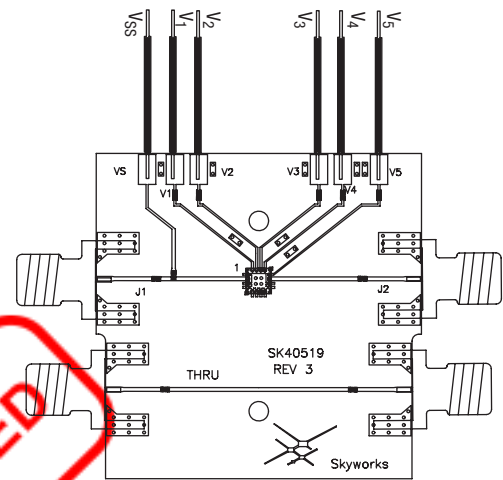
**Tape and Reel Information**

Refer to the [“Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation”](#) Application Note.

**Pin Out**



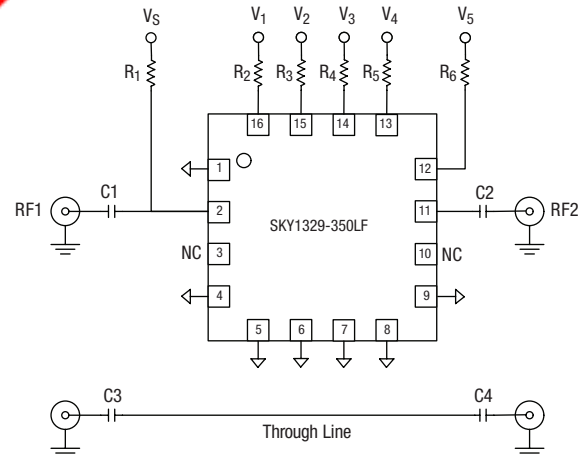
**SKY12329-350LF Evaluation Circuit PCB**



**Pin Descriptions**

| Pin Number | Pin Name       | Description  |
|------------|----------------|--|
| 1, 4-9     | GND            | Equipotential Point—Equipotential points for control voltages and RF circuits. Must be connected to PCB ground via lowest possible |
| 2          | RF1            | RF Input/Output—RF input or output port. A DC block is required for this port.   |
| 3, 10      | N/C            | No connection  |
| 11         | RF2            | RF Input/Output—RF input or output port. A DC block is required for this port.   |
| 12         | V <sub>5</sub> | Control Voltage—Control voltage input for 16 dB weighted bit (MSB)   |
| 13         | V <sub>4</sub> | Control Voltage—Control voltage input for 8 dB weighted bit  |
| 14         | V <sub>3</sub> | Control Voltage—Control voltage input for 4 dB weighted bit  |
| 15         | V <sub>2</sub> | Control Voltage—Control voltage input for 2 dB weighted bit  |
| 16         | V <sub>1</sub> | Control Voltage—Control voltage input for 1 dB weighted bit (LSB)  |

**SKY12329-350LF Evaluation Circuit**



**Evaluation Board**

The evaluation board for SKY12329-350LF allows the part to be fully exercised. The insertion loss of the transmission lines between J<sub>1</sub>–U<sub>1</sub> and U<sub>1</sub>–J<sub>2</sub> can be determined by measuring the performance of the calibration through line, which contains two DC block capacitors (560 pF) in identical positions to the DC blocks present in the main circuit.

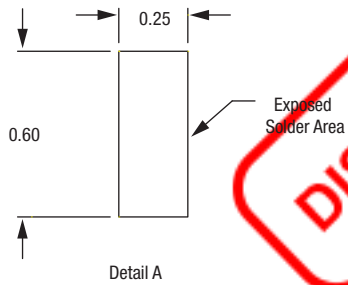
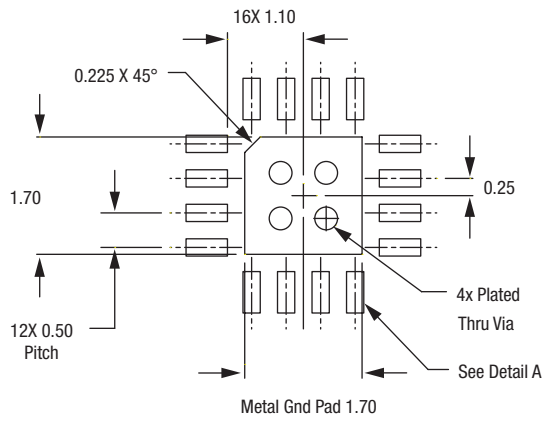
The state of the SKY12329-350LF is controlled by applying the appropriate logic level voltages to ports V<sub>1</sub> through V<sub>5</sub>, per the Truth Table

**Evaluation Board Components**

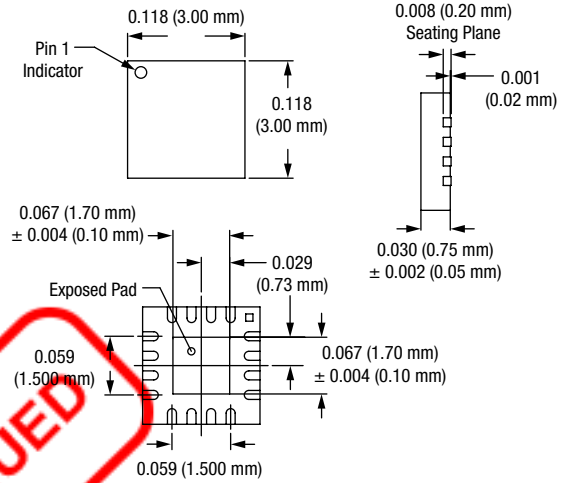
| Component                       | Description                            | Default           |
|---------------------------------|--|-------------------|
| C <sub>1</sub> –C <sub>4</sub>  | DC blocking capacitor                  | 560 pF, size 0402 |
| R <sub>1</sub>                  | RF block                               | 10k Ω, size 0402  |
| R <sub>2</sub> –R <sub>6</sub>  | Current limiting                       | 100 Ω             |
| U <sub>1</sub>                  | SKY12329-350LF GaAs digital attenuator |                   |
| J <sub>1</sub> , J <sub>2</sub> | SMA connectors                         |                   |

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**Land Pattern**



**-350 (QFN 3 x 3)**



**DISCONTINUED**



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