SKY12324-73LF: 0.5-4.0 GHz Two-Bit Digital Attenuator (4 dB LSB)

Applications

- Cellular telephone base stations
- Test instrumentation
- Wireless data level control circuits

Features

- Four dB LSB steps to 12 dB
- Single, positive control voltage per bit
- Low insertion loss
- Small SOT-6 package (MSL1, 260 °C per JEDEC J-STD-020)

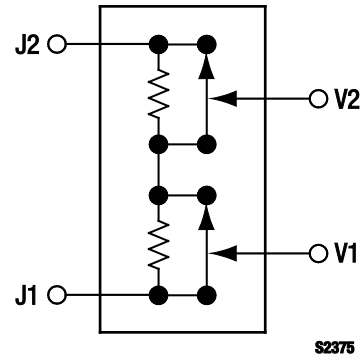**NEW** Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Figure 1. SKY12324-73LF Block Diagram

Description

The SKY12324-73LF is a two-bit GaAs pHEMT digital attenuator in a low-cost SOT-6 package. The two attenuation bits, 4 and 8 dB, can be independently switched into or out of the signal path according to the magnitudes of the control voltages applied to the two high impedance control voltage inputs. The RF ports are internally matched to 50 Ω and are fully bilateral.

The SKY12324-73LF is ideally suited for use in applications where excellent attenuation accuracy, low insertion loss, and excellent intermodulation distortion performance are required.

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.
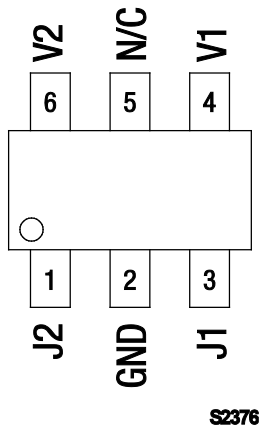

Figure 2. SKY12324-73LF Pinout – 6-Pin SOT-6 (Top View)

Table 1. SKY12324-73LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	J2	RF port. Must be DC blocked.	4	V1	DC control voltage. High input impedance control port for the 8 dB bit. The high control voltage applied to this pin must be within 0.2 V of the supply voltage applied to pin 3 or the part may be permanently damaged. The low control voltage is 0 V nominal.
2	GND	RF ground. Must be AC-coupled to ground.	5	N/C	No connect
3	J1	RF port. Must be DC blocked.	6	V2	DC control voltage. High input impedance control port for the 4 dB bit. The high control voltage applied to this pin must be within 0.2 V of the supply voltage applied to pin 3 or the part may be permanently damaged. The low control voltage is 0 V nominal.

Table 2. SKY12324-73LF Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
RF input power (V_{CTL} = 0/8 V)	P_{IN}		+31	dBm
Supply voltage	V_S		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.*

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY12324-73LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY12324-73LF are illustrated in Figures 3 through 8.

The state of the SKY12324-73LF is determined by the logic provided in Table 4.

Skyworks Solutions, Inc. • Phone [781] 376-3000 • Fax [781] 376-3100 • sales@skyworksinc.com • www.skyworksinc.com

2   February 22, 2011 • Skyworks Proprietary Information • Products and Product Information are Subject to Change Without Notice • 200219E

Table 3. SKY12324-73LF Electrical Specifications (Note 1)
(V_{CTL} = 0/3 V, V_S = 3 V, T_{OP} = +25 °C, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition (Note 2)	Min	Typical	Max	Units
Insertion loss	IL	0.5 to 1.0 GHz		0.9	1.0	dB
		1.0 to 2.0 GHz		1.0	1.2	dB
		2.0 to 2.5 GHz		1.2	1.3	dB
		2.5 to 3.0 GHz		1.3	1.4	dB
		3.0 to 4.0 GHz		2.0	2.1	dB
Attenuation range				12		dB
Attenuation accuracy (Note 3)		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		$\pm$ (0.4 + 5% of attenuation setting)		dB
Return loss (insertion loss state)	RL	0.5 to 3.0 GHz	15	20		dB
		3.0 to 4.0 GHz	12	15		dB
Return loss (attenuation state)	RL	0.5 to 3.0 GHz	12	18		dB
		3.0 to 4.0 GHz	12	15		dB
Switching characteristics:						
Rise/fall		10/90% or 90/10% RF		40		ns
On/off		50% V_{CTL} to 90/10% RF		100		ns
Video feedthrough		T_{RISE} = 1 ns, bandwidth = 500 MHz		50		mV
1 dB Input Compression Point	IP1dB	900 MHz, V_S = 3 V		+30		dBm
3rd Order Input Intercept Point	IIP3	For two-tone input, P_{IN} = +15 dBm/tone:				
		1.0 GHz		+46		dBm
		3.0 GHz		+44		dBm
Supply voltage	V_S		3		5	V
Control voltage	V_{CTL}	V_{CTL} = V_{LOW}	0		0.2	V
		V_{CTL} = V_{HIGH}	V_S − 0.2		V_S + 0.2	V
Control current	I_{CTL}	V_{CTL} = V_{LOW}		10	20	μA
		V_{CTL} = V_{HIGH} = 3 V		50	100	μA
		V_{CTL} = V_{HIGH} = 5 V		100	200	μA

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

Table 4. SKY12324-73LF Truth Table

Attenuation, J1 to J2	V1 (Pin 4, 4 dB)	V2 (Pin 6, 8 dB)
Insertion loss	V_{HIGH}	V_{HIGH}
4 dB	V_{HIGH}	V_{LOW}
8 dB	V_{LOW}	V_{HIGH}
12 dB	V_{LOW}	V_{LOW}

Note: V_{HIGH} = +3 V to +5 V; V_{LOW} = V_S ± 0.2 V
All other conditions not recommended.

Typical Performance Characteristics

(V$_{CTL}$ = 0/3 V, V$_S$ = 3 V, T$_{OP}$ = +25 °C, Characteristic Impedance [Z$_0$] = 50 Ω, Unless Otherwise Noted)
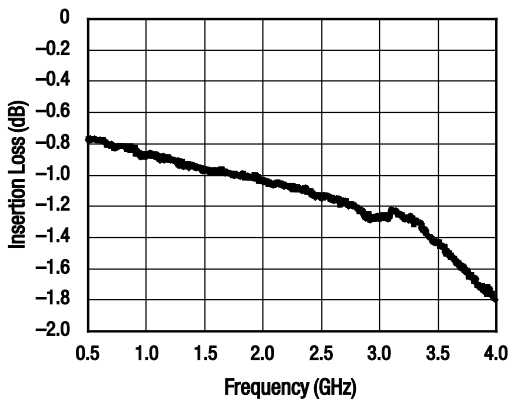

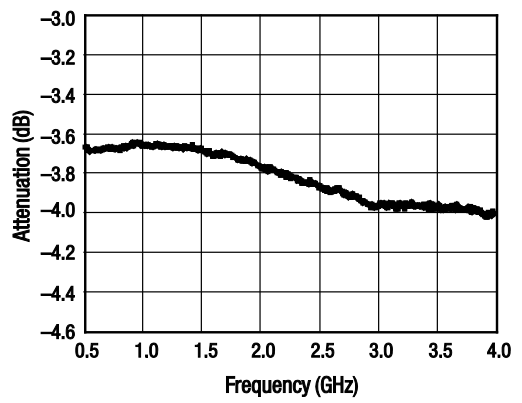Figure 3. Insertion Loss vs Frequency
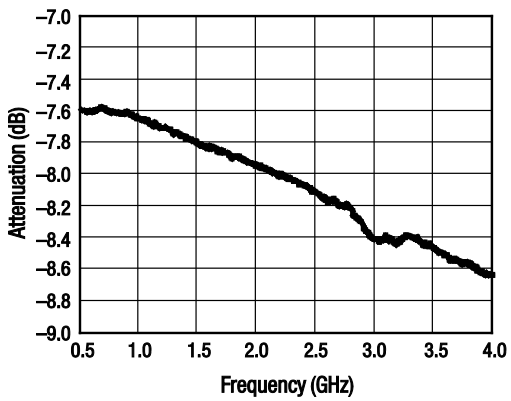

Figure 4. 4 dB Attenuation vs Frequency
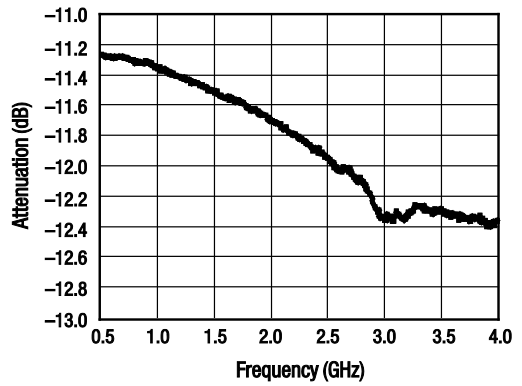

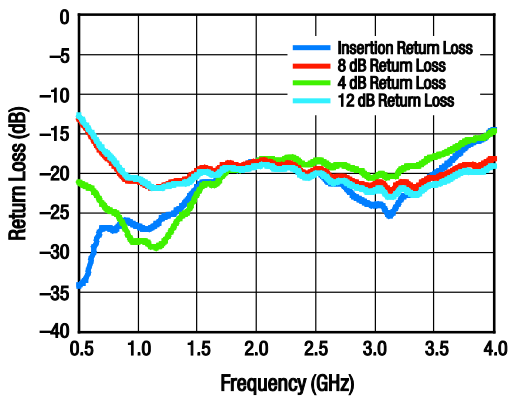Figure 5. 8 dB Attenuation vs Frequency

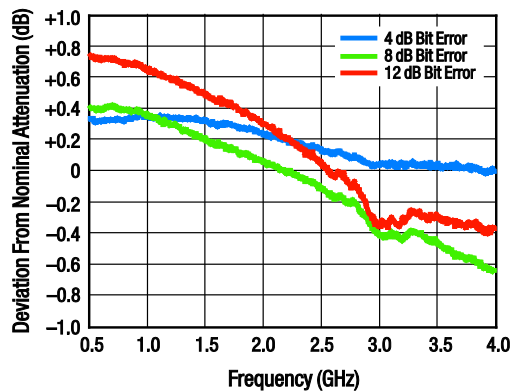Figure 6. 12 Bit Attenuation vs Frequency

Figure 7. Return Loss vs Frequency

Figure 8. Attenuation Accuracy vs Frequency

Evaluation Board Description

The SKY12324-73LF Evaluation Board is used to test the performance of the SKY12324-73LF digital attenuator. An assembly drawing for the Evaluation Board is shown in Figure 9. A schematic diagram is shown in Figure 10.

Package Dimensions

The PCB layout footprint for the SKY12324-73LF is provided in Figure 11. Figure 12 shows the package dimensions for the 6-pin SOT-6, 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 SKY12324-73LF 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.
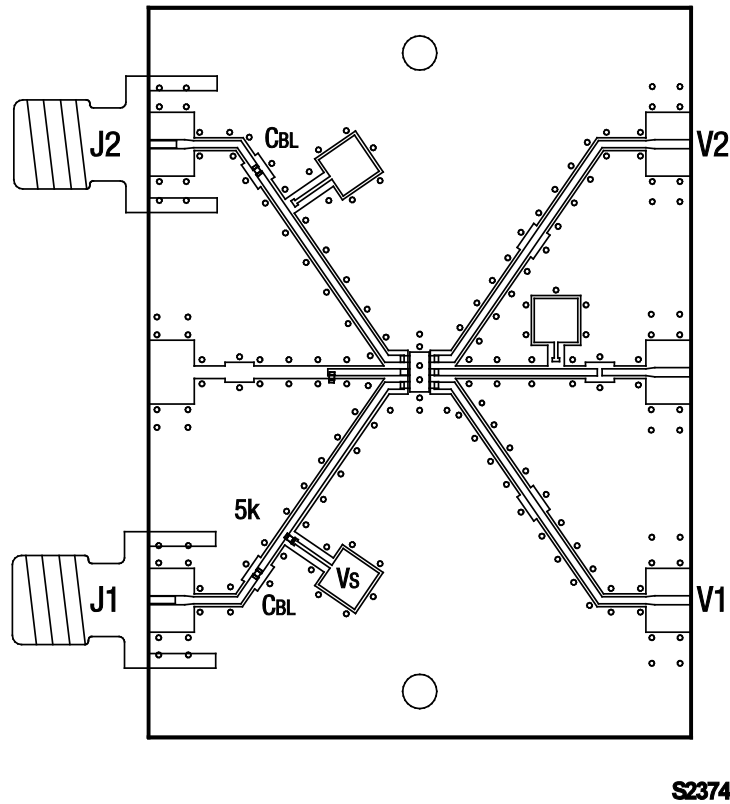
Figure 9. SKY12324-73LF Evaluation Board Assembly Diagram
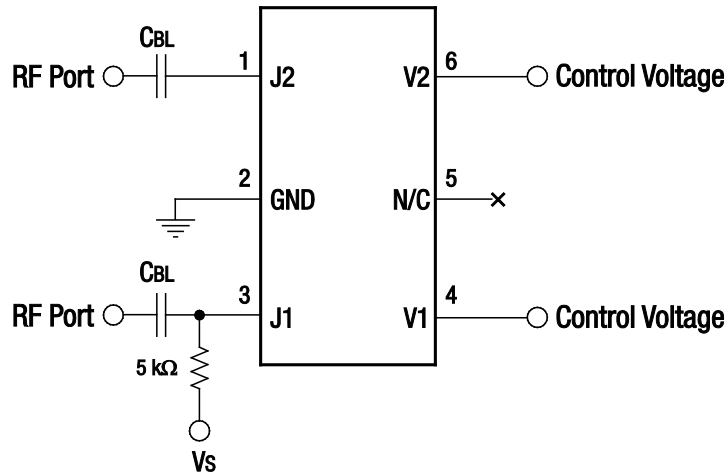
Note: C_{BL} = 47 pF for frequencies >500 MHz operation.   S2377

Figure 10. SKY12324-73LF Evaluation Board Schematic Diagram
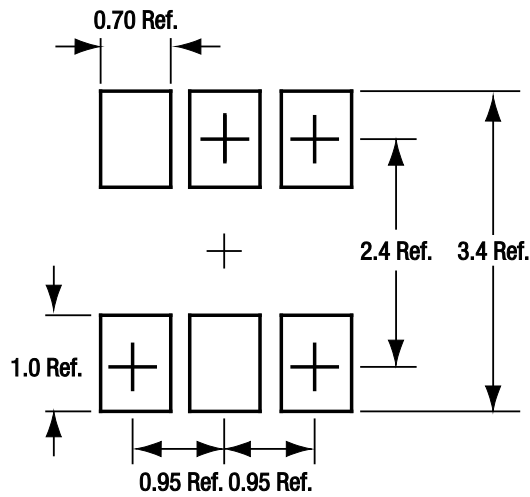
All measurements in millimeters   S2378

Figure 11. PCB Layout Footprint for the SKY12324-73LF

0.074
(1.90 mm) Ref.

Pin 6

0.126 (3.20 mm)
0.087 (2.20 mm)

Pin 1
Indicator

0.071 (1.80 mm)
0.052 (1.30 mm)

Pin 1

0.020 (0.51 mm)
0.014 (0.350 mm)

0.037 (0.95 mm) Ref.

0.057 (1.45 mm)
0.035 (0.90 mm)

0.006
(0.15 mm)
0.000
(0.00 mm)

0.012
(0.30 mm)
Typ.

5.0! 1!

0.014
(0.26 mm)
0.004
(0.10 mm)

5.0! 1!

0.122 (3.10 mm)
0.106 (2.70 mm)

0.022 (0.61 mm)
0.004 (0.10 mm)

Dimensions are in inches (millimeters shown in parentheses)

S2349
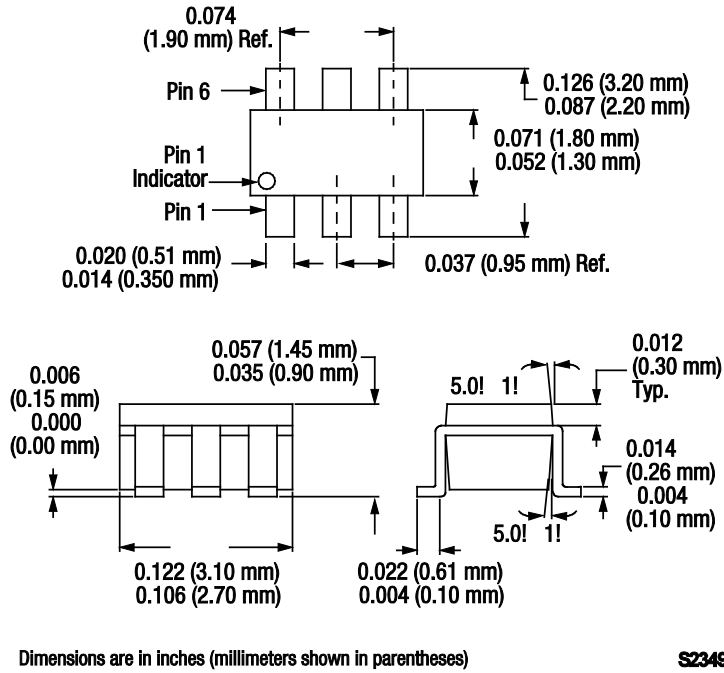
Figure 12. SKY12324-73LF 6-Pin SOT-6 Package Dimensions

∅1.50+ 0.10/−0.00

4.00 ± 0.10

4.00 (see Note 4)

2.00 ± 0.05

1.75 ± 0.10

Pin #1

1.40 ± 0.10 (Ko)

B

3.20 ± 0.10 (Bo)

A

A

3.50 ± 0.05

8.00 +0.30/−0.10

B

B

∅1.00 Min.

0.20 ± 0.03

R0.30 Typ

3.15 ± 0.10 (Ao)

A
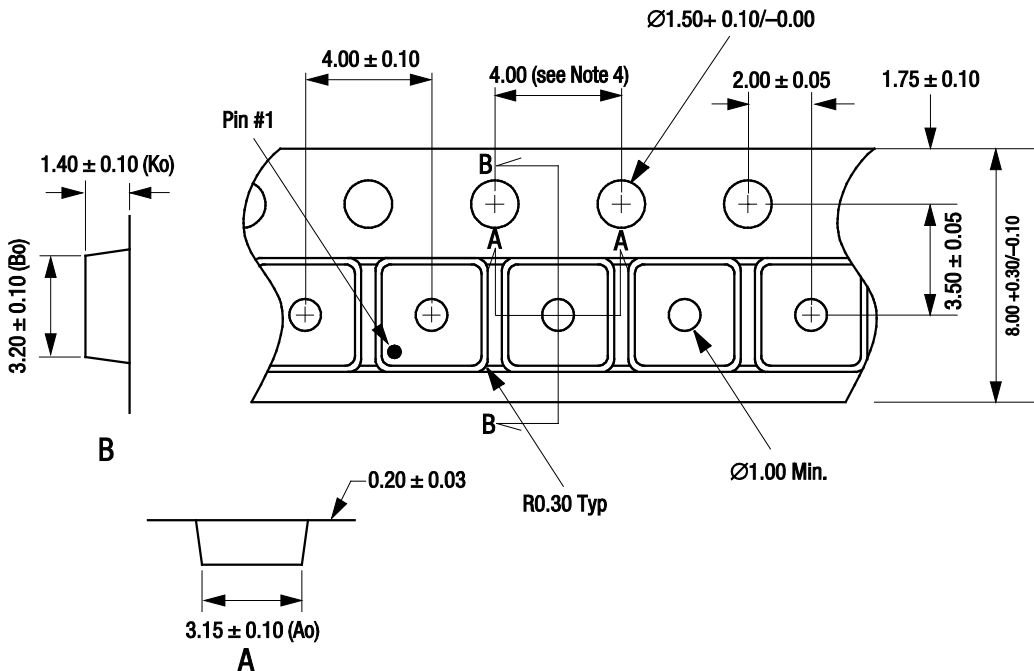
Notes:
1. Carrier tape: black conductive polystyrene.
2. Cover tape material: transparent conductive HSA.
3. Cover tape size: 5.40 mm width.
4. Ten sprocket hole pitch cumulative tolerance = ±0.20 mm.
5. All measurements are in millimeters.
6. Standard reel size is 7 inches. Standard reel quantity is 3000 pcs.

S1681

Figure 13. SKY12324-73LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
SKY12324-73LF Two-Bit Digital Attenuator	SKY12324-73LF	SKY12324-73LF-EVB