DATA SHEET

SKY12348-362LF: 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 V control voltage
- Small, QFN (16-pin, 3 x 3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

NEW

Skyworks Green™ products are RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, are halogen free according to IEC-61249-2-21, and contain <1,000 ppm antimony trioxide in polymeric materials.

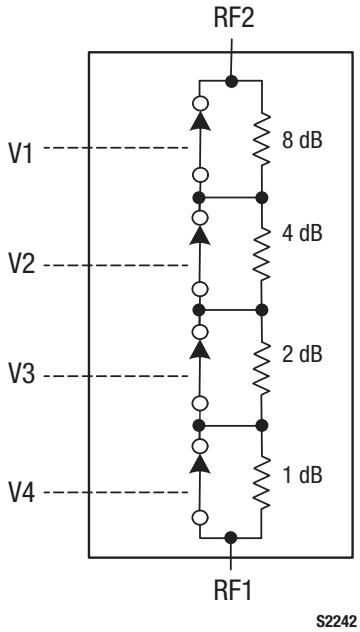


Figure 1. SKY12348-362LF Block Diagram

Description

The SKY12348-362LF 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 SKY12348-362LF 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.

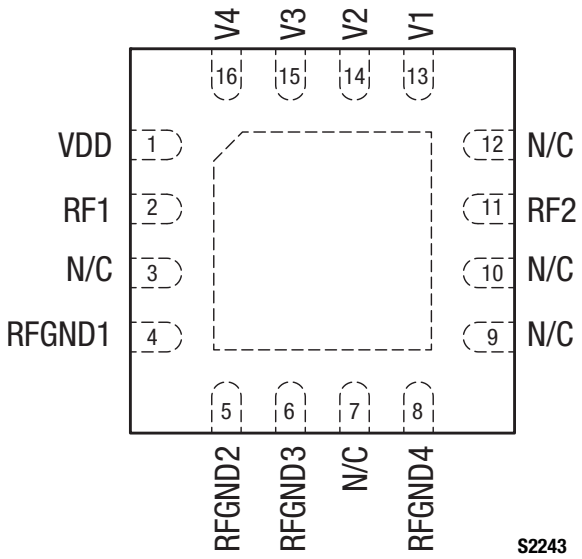


Figure 2. SKY12348-362LF Pinout – 16-Pin QFN (Top View)

Table 1. SKY12348-362LF 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 SKY12348-362LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY12348-362LF are illustrated in Figures 5 through 7.

The state of the SKY12348-362LF is determined by the logic provided in Table 4.

Table 2. SKY12348-362LF 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. SKY12348-362LF 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 [Z_O] = 50 Ω, , Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
RF Specifications						
Insertion loss	IL	@ 0.7 GHz @ 2.1 GHz @ 2.7 GHz		0.8 1.0 1.2	1.0 1.2 1.4	dB dB 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 2.1 GHz 2.7 GHz 2 dB bit: 0.7 GHz 2.1 GHz 2.7 GHz 4 dB bit: 0.7 GHz 2.1 GHz 2.7 GHz 8 dB bit: 0.7 GHz 2.1 GHz 2.7 GHz Max. attenuation (15 dB): 0.7 GHz 2.1 GHz 2.7 GHz	 0.8 0.8 0.8 1.8 1.8 1.8 3.8 3.8 3.8 7.8 7.8 7.5 14.8 14.4 13.8	 1 1 1 2 2 2 4 4 4 8 8 8 15 15 15	 1.2 1.2 1.3 2.2 2.3 2.4 4.3 4.4 4.4 8.4 8.2 8.2 15.5 15.5 15.3	 dB dB dB dB dB dB dB dB dB dB dB dB dB dB dB
0.1 dB Input Compression Point	IP0.1dB	V_{DD} = 3 V @ 1.8 GHz		+30		dBm
3rd 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. SKY12348-362LF Electrical Specifications (Note 1) (2 of 2)
(V_{DD} = 5 V, V_{CTL} = 5 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, , Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
DC Specifications						
Control voltage: Low High	V_{CTL}		 0 3.3		 0.8 V_{DD}	 V V
Supply voltage	V_{DD}		3.3	5.0	5.5	V
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 V, V_{CTL} = 5 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, , Unless Otherwise Noted)

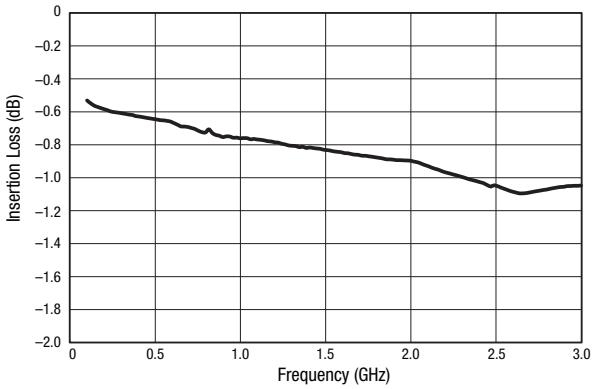


Figure 3. Insertion Loss vs Frequency @ 0 dB

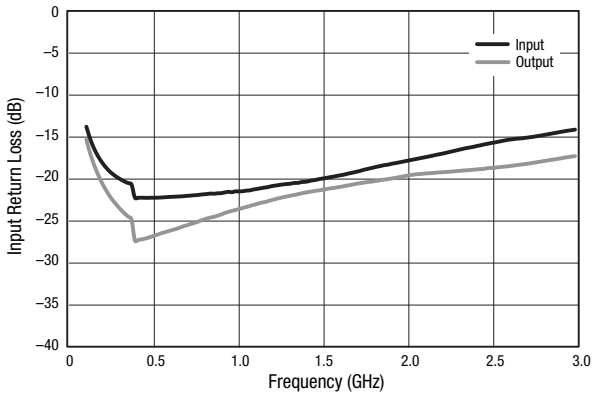


Figure 4. Input Return Loss vs Frequency

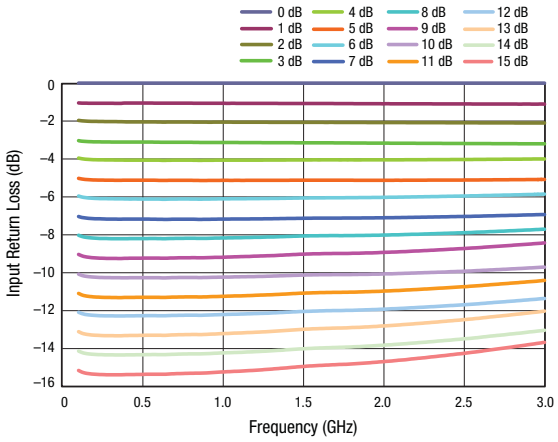


Figure 5. Normalized Attenuation vs Frequency

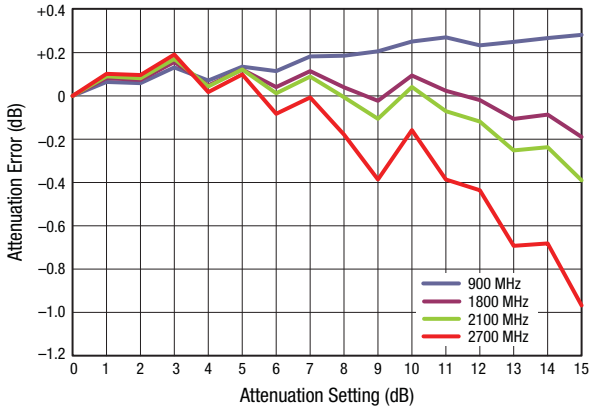


Figure 6. Attenuation Error vs Attenuation Setting

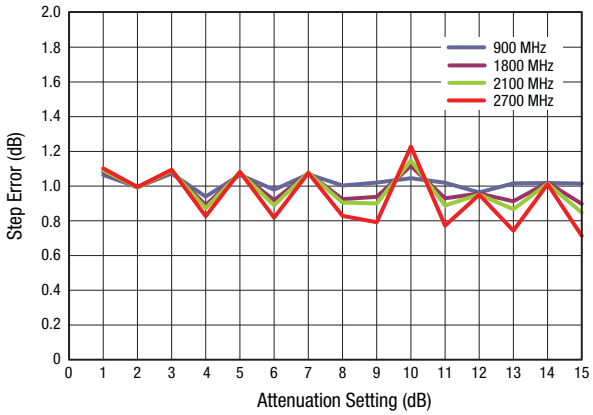


Figure 7. Step Error vs Attenuation Setting

Table 4. SKY12348-362LF 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
0.5 dB	1	1	1	1
1.0 dB	1	1	1	1
2.0 dB	1	1	1	0
4.0 dB	1	1	0	1
8.0 dB	1	0	1	1
16 dB	0	1	1	1
31.5 dB	0	0	0	0

Note: "1" = high control voltage: +2.0 to V_{DD}.
"0" = low control voltage: 0 to +0.8 V.

Evaluation Board Description

The SKY12348-362LF Evaluation Board is used to test the performance of the SKY12348-362LF 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 SKY12348-362LF 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 SKY12348-362LF 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.

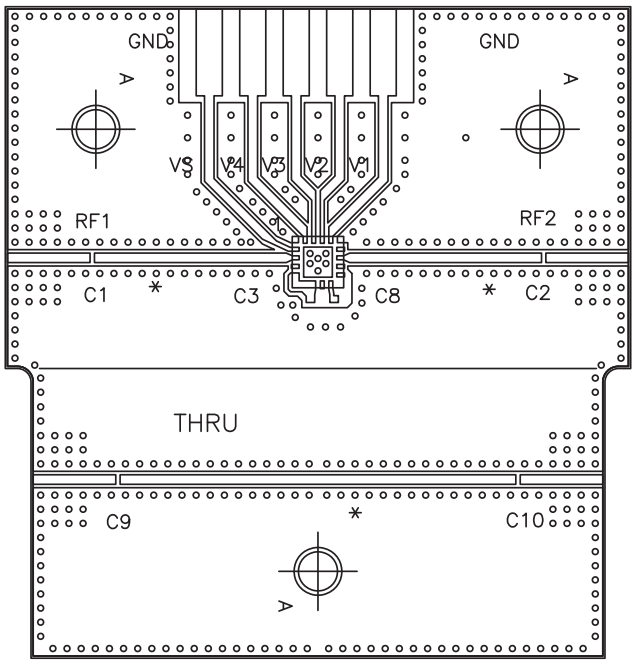


Figure 8. SKY12348-362LF Evaluation Board Assembly Diagram

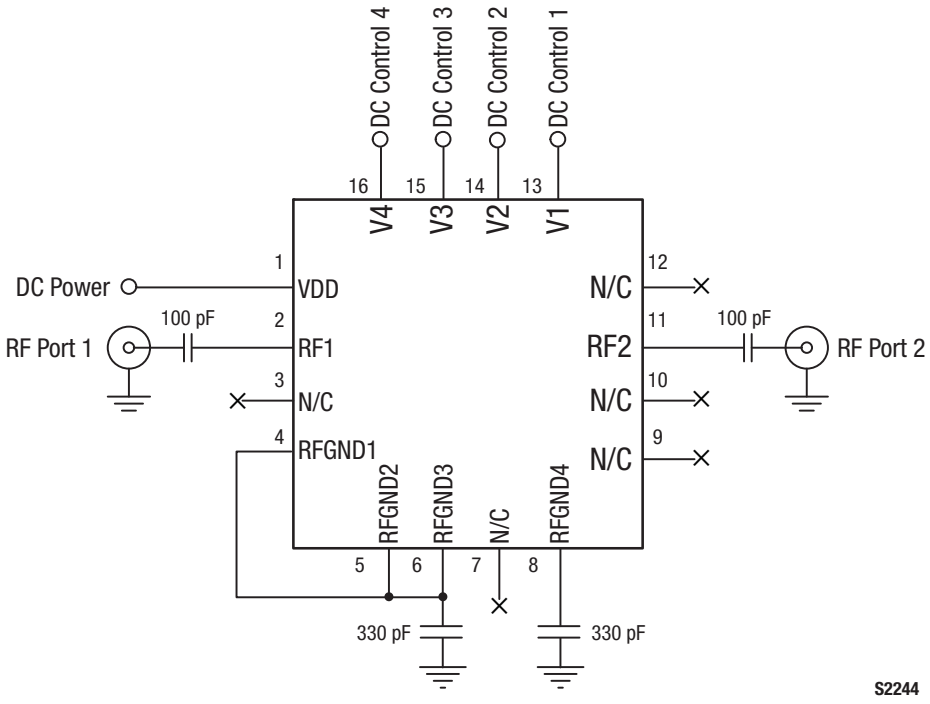
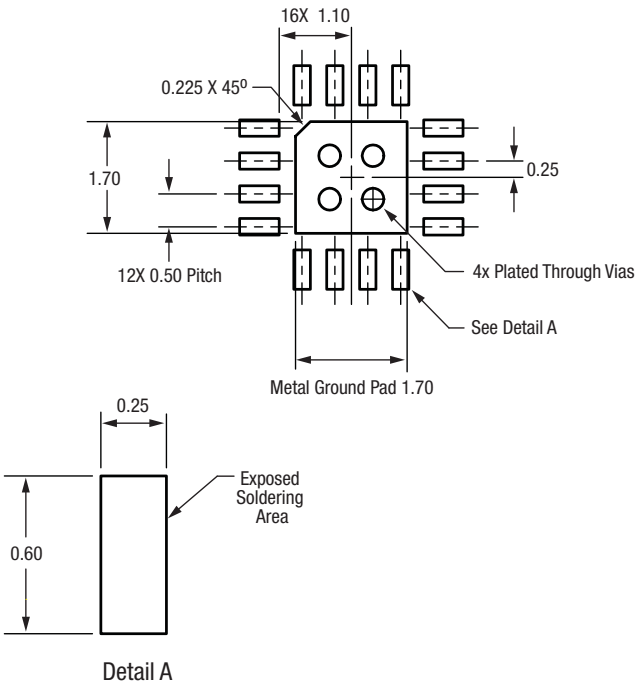


Figure 9. SKY12348-362LF Evaluation Board Schematic Diagram



All dimensions are in millimeters **S1691**

Figure 10. SKY12348-362LF PCB Layout Footprint

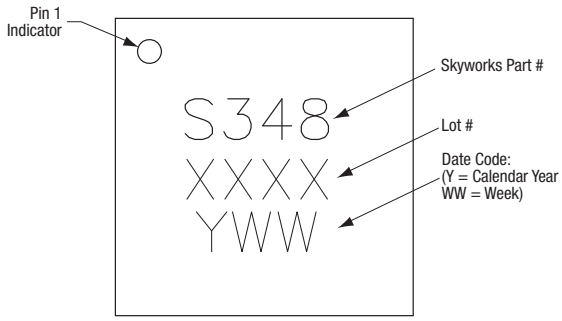
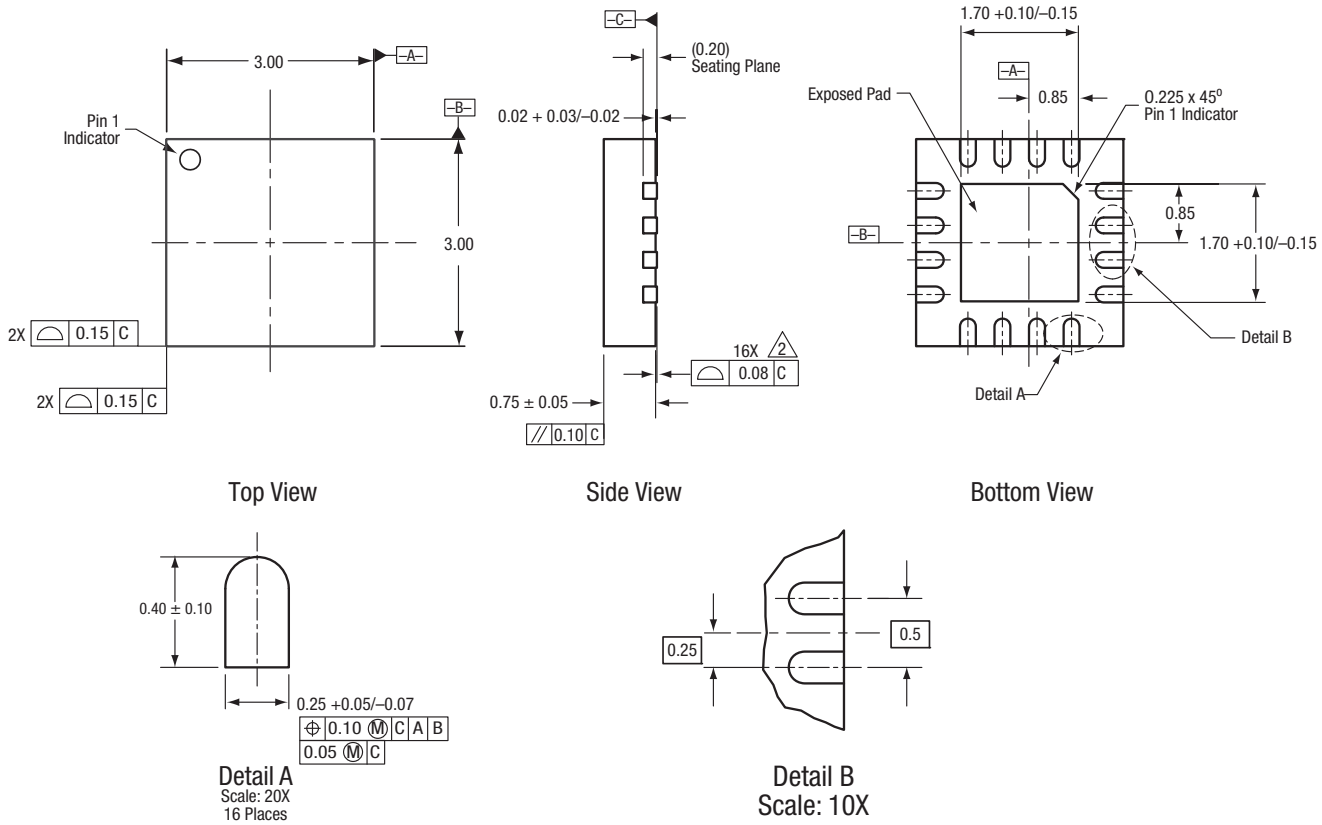


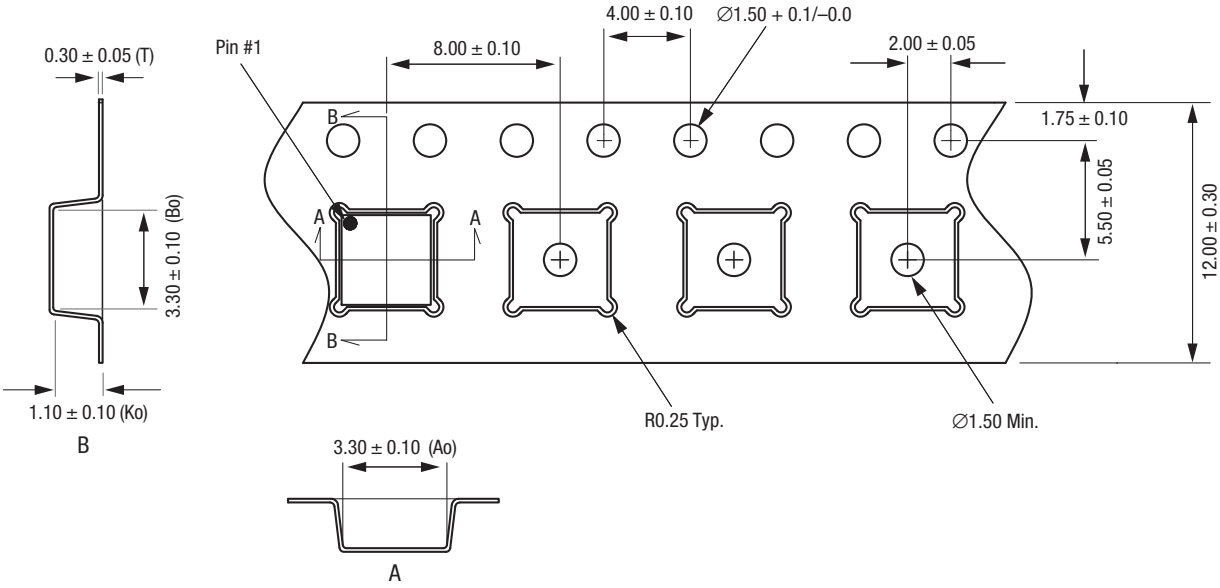
Figure 11. Typical Part Markings



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 SKY12348-362LF 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.*

S1698

Figure 13. SKY12348-362LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
SKY12348-362LF Digital Attenuator	SKY12348-362LF	SKY12348-362LF-EVB