

DATA SHEET

# SKY12339-350LF: 0.4-3.0 GHz 5-Bit Digital Attenuator (1 dB LSB)

## Applications

- WiMAX, GSM, CDMA, WCDMA, WLAN, Bluetooth®, Zigbee®, and mobile radio base stations or terminal equipment
- Telecommunications and instrumentation

## Features

- Broadband operation: 0.4 to 3.0 GHz
- Attenuation: 31 dB
- LSB attenuation: 1 dB
- Low insertion loss: 1.2 dB @ 900 MHz
- Positive voltage operation: 4.5 to 5.5 V
- Low current consumption: 1.5 mA typical @ 5 V
- Small, QFN (16-pin, 3 x 3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

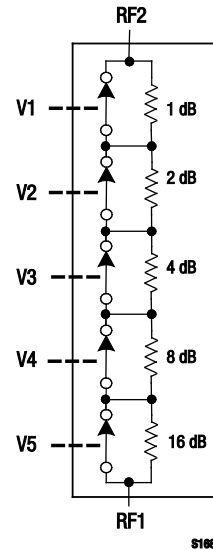


Figure 1. SKY12339-350LF Block Diagram



**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.

## Description

The SKY12339-350LF is a monolithic, GaAs binary-weighted five-bit single positive control voltage digital attenuator. The device operates from 0.4 to 3.0 GHz. DC power consumption is very low, typically 1.5 mA, with a supply voltage of 5 V.

The SKY12339-350LF has an 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. An external supply voltage of 4.5 to 5.5 V is required.

The SKY12339-350LF is comprised of five cascaded fixed attenuators, each of which has a shunt bypass switch. Beginning at the 1 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.

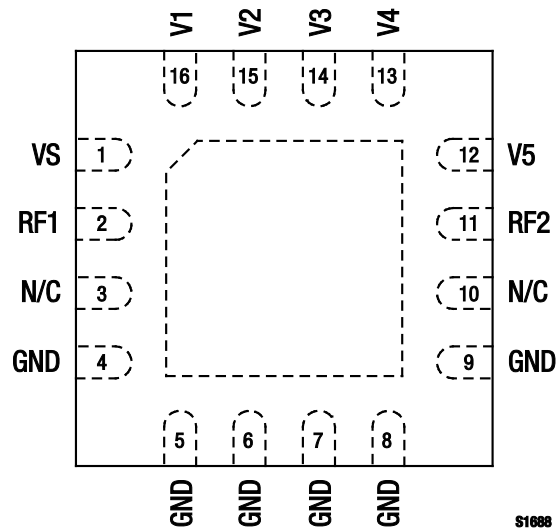


Figure 2. SKY12339-350LF Pinout – 16-Pin QFN (Top View)

Table 1. SKY12339-350LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	VS	Supply voltage	9	GND	Ground
2	RF1	RF input/output. A DC block is required.	10	N/C	No connection
3	N/C	No connection	11	RF2	RF input/output. A DC block is required.
4	GND	Ground	12	V5	Control voltage input for 16 dB weighted bit
5	GND	Ground	13	V4	Control voltage input for 8 dB weighted bit
6	GND	Ground	14	V3	Control voltage input for 4 dB weighted bit
7	GND	Ground	15	V2	Control voltage input for 2 dB weighted bit
8	GND	Ground	16	V1	Control voltage input for 1 dB weighted bit

Note: Exposed paddle must be grounded.

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY12339-350LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY12339-350LF are illustrated in Figures 3 through 9.

The state of the SKY12339-350LF is determined by the logic provided in Table 4.

**Table 2. SKY12339-350LF Absolute Maximum Ratings**

Parameter	Symbol	Minimum	Typical	Maximum	Units
RF input power: @ 3 V @ 5 V	P <sub>IN</sub>		+31 +33		dBm dBm
Supply voltage	V <sub>S</sub>	4.5		5.5	V
Control voltage	V <sub>CTL</sub>	-0.2		V <sub>S</sub>	V
Operating temperature	T <sub>OP</sub>	-40		+85	°C
Storage temperature	T <sub>STG</sub>	-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. SKY12339-350LF Electrical Specifications (Note 1)**

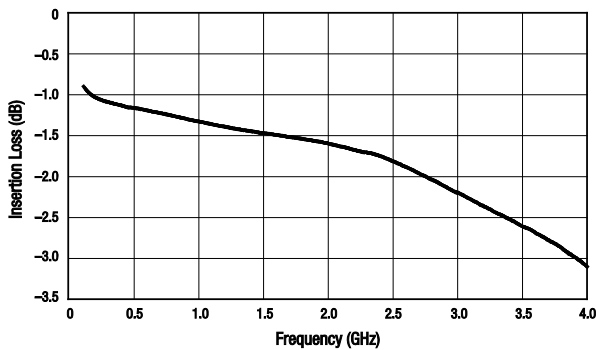
(V<sub>S</sub> = 5 V, V<sub>CTL</sub> = 0 to 3 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Insertion loss	IL	0.4 to 1.0 GHz		1.2	1.6	dB
		1.0 to 2.0 GHz		1.5	1.9	dB
		2.0 to 3.0 GHz		2.0	2.6	dB
Attenuation range			31			dB
Attenuation accuracy		Attenuation referred to insertion loss, all attenuation states				
		0.4 to 1.0 GHz		±(0.35 + 3% of attenuation setting)		dB
		1.0 to 2.0 GHz		±(0.30 + 3% of attenuation setting)		dB
		2.0 to 3.0 GHz (1-16 dB)		±(0.30 + 3% of attenuation setting)		dB
2.0 to 3.0 GHz (17-31 dB)		±(0.30 + 6% of attenuation setting)		dB		
Return loss	IS11I, IS22I	Worst case for all attenuation states				
		0.4 to 1.0 GHz		7		dB
1.0 to 3.0 GHz		7			dB	
Switching characteristics: On/rise time Off/fall time		50/90% or 10/90% RF		50		ns
		50/10% or 90/10% RF		20		ns
Input power for 0.1 dB compression	IPO.1dB	@ 1800 MHz		+25		dBm
3 <sup>rd</sup> Order Input Intercept Point	IIP3	Worst case for all attenuation states. For two-tone input power, +5 dBm/tone, 1800 MHz spacing		+39		dBm
Supply voltage	V <sub>S</sub>		4.5	5.0	5.5	V
Supply current	I <sub>S</sub>	V <sub>CTL</sub> = low		1.5		mA
		V <sub>CTL</sub> = high		1.0		mA
Control voltage: High Low	V <sub>CTL</sub>		2.7		V <sub>S</sub>	V
			-0.2		+0.2	V
Control port current	I <sub>CTL</sub>	V <sub>CTL</sub> = low		15	100	μA
		V <sub>CTL</sub> = high		5	20	μA

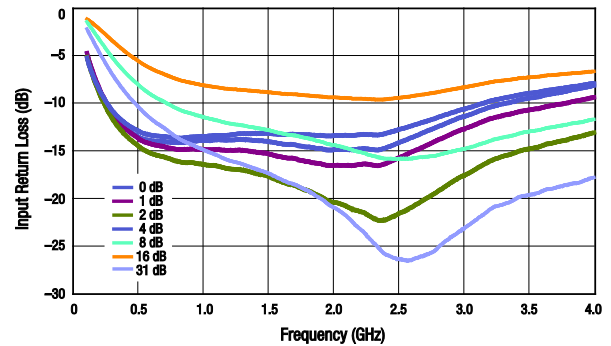
**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

### Typical Performance Characteristics

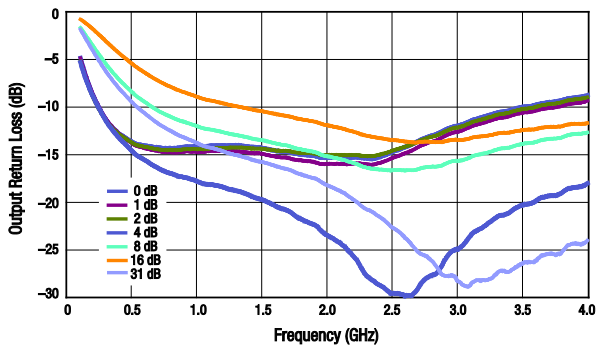
( $V_S = 5\text{ V}$ ,  $V_{CTL} = 0\text{ to }3\text{ V}$ ,  $T_{OP} = +25\text{ }^\circ\text{C}$ ,  $C_{BLK} = 39\text{ pF}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\text{ }\Omega$ , , Unless Otherwise Noted)



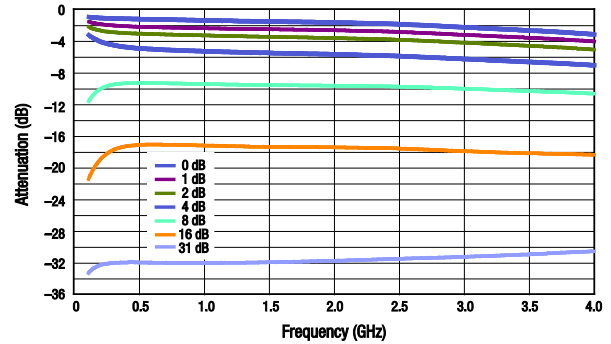
**Figure 3. Insertion Loss vs Frequency (0 dB State)**



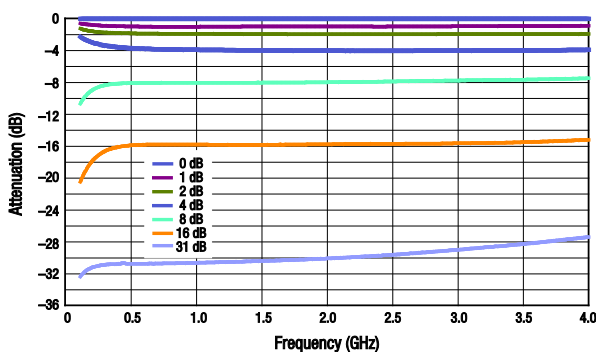
**Figure 4. Input Return Loss vs Frequency**



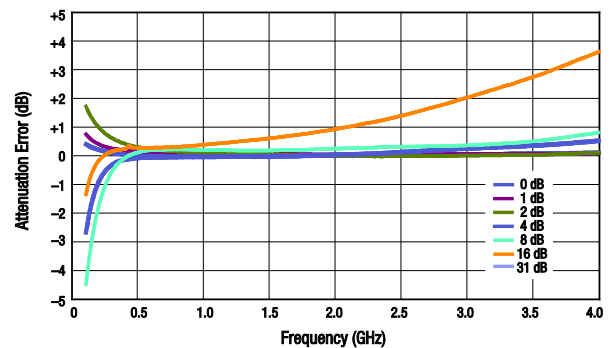
**Figure 5. Output Return Loss vs Frequency**



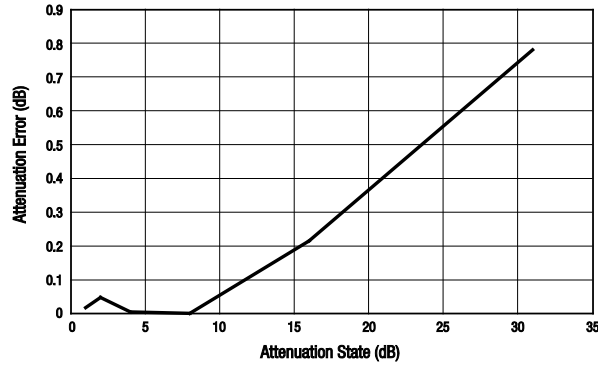
**Figure 6. Attenuation vs Frequency**



**Figure 7. Attenuation vs Frequency, Normalized to 0 dB State**



**Figure 8. Attenuation Error vs Frequency**



**Figure 9. Attenuation Error vs Attenuation State, (f = 1.8 GHz)**

**Table 4. SKY12339-350LF Truth Table**

RF1/RF2 (Pins 2 & 11) Attenuation	V1 (Pin 16)	V2 (Pin 15)	V3 (Pin 14)	V4 (Pin 13)	V5 (Pin 12)
Insertion loss	1	1	1	1	1
1.0 dB	0	1	1	1	1
2.0 dB	1	0	1	1	1
4.0 dB	1	1	0	1	1
8.0 dB	1	1	1	0	1
16 dB	1	1	1	1	0
31 dB	0	0	0	0	0

**Note:** "1" = +2.7 V to Vs. "0" = -0.2 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 SKY12339-350LF Evaluation Board is used to test the performance of the SKY12339-350LF digital attenuator. An assembly drawing for the Evaluation Board is shown in Figure 10 and an Evaluation Board schematic diagram is shown in Figure 11. Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components.

### Package Dimensions

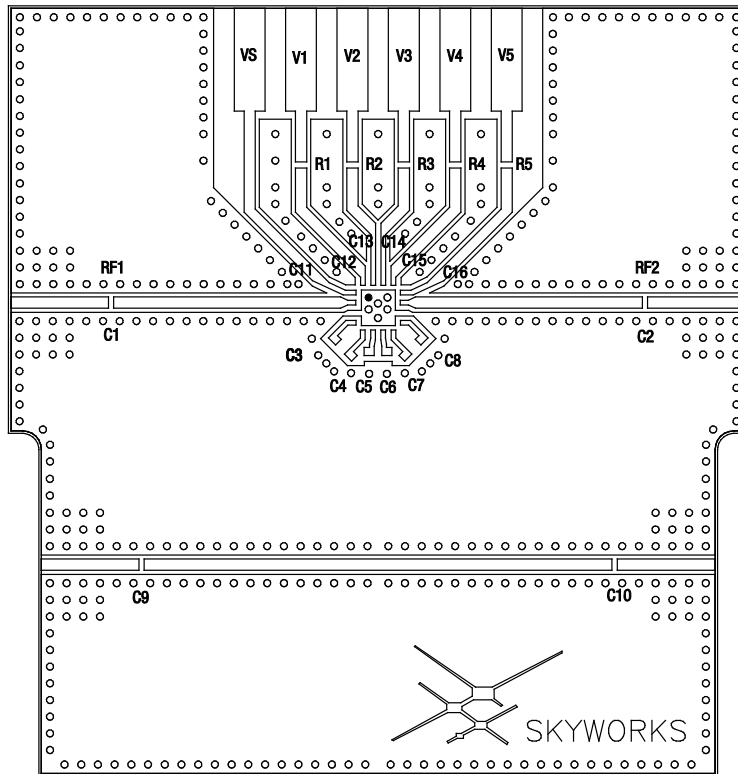
The PCB layout footprint for the SKY12339-350LF is shown in Figure 12. Typical case markings are noted in Figure 13. Package dimensions for the 16-pin QFN are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

### 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 SKY12339-350LF 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.



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Figure 10. SKY12339-350LF Evaluation Board Assembly Diagram

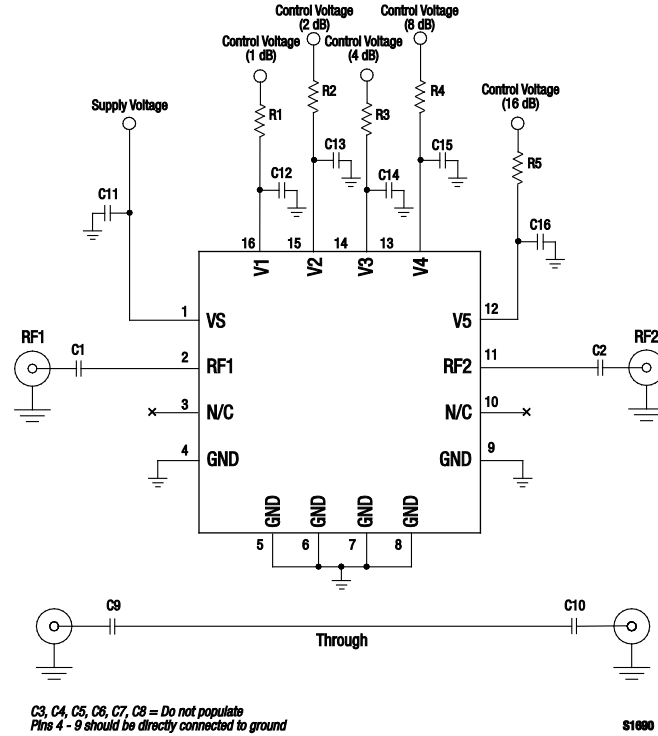
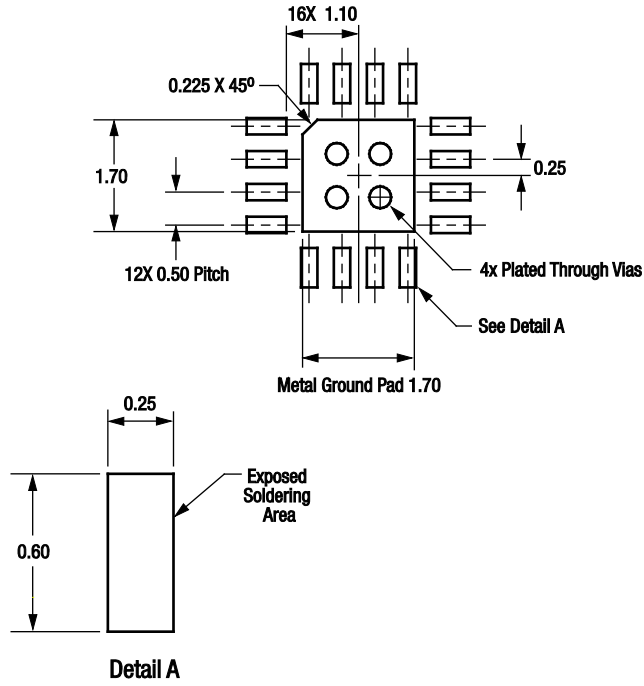


Figure 11. SKY12339-350LF Evaluation Board Schematic Diagram

Table 5. SKY12339-350LF Evaluation Board Bill of Materials

Component	Value	Size	Manufacturer/Part Series
C1, C2	39 pF	0402	Murata GRM
C9	39 pF	0402	Murata GRM
C10	39 pF	0402	Murata GRM
C11	39 pF	0402	Murata GRM
C12	39 pF	0402	Murata GRM
C13	39 pF	0402	Murata GRM
C14	39 pF	0402	Murata GRM
C15	39 pF	0402	Murata GRM
C16	39 pF	0402	Murata GRM
R1	0 Ω	0402	Panasonic
R2	0 Ω	0402	Panasonic
R3	0 Ω	0402	Panasonic
R4	0 Ω	0402	Panasonic
R5	0 Ω	0402	Panasonic
J1 SMA PCB adaptor	–	0402	–
J2 SMA PCB adaptor	–	0402	–



All dimensions are in millimeters

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Figure 12. SKY12339-350LF PCB Layout Footprint

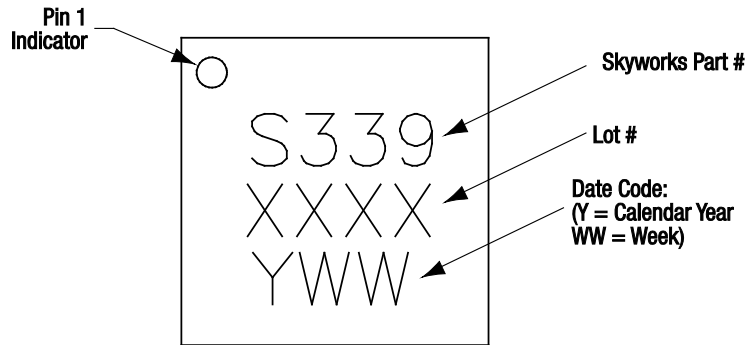
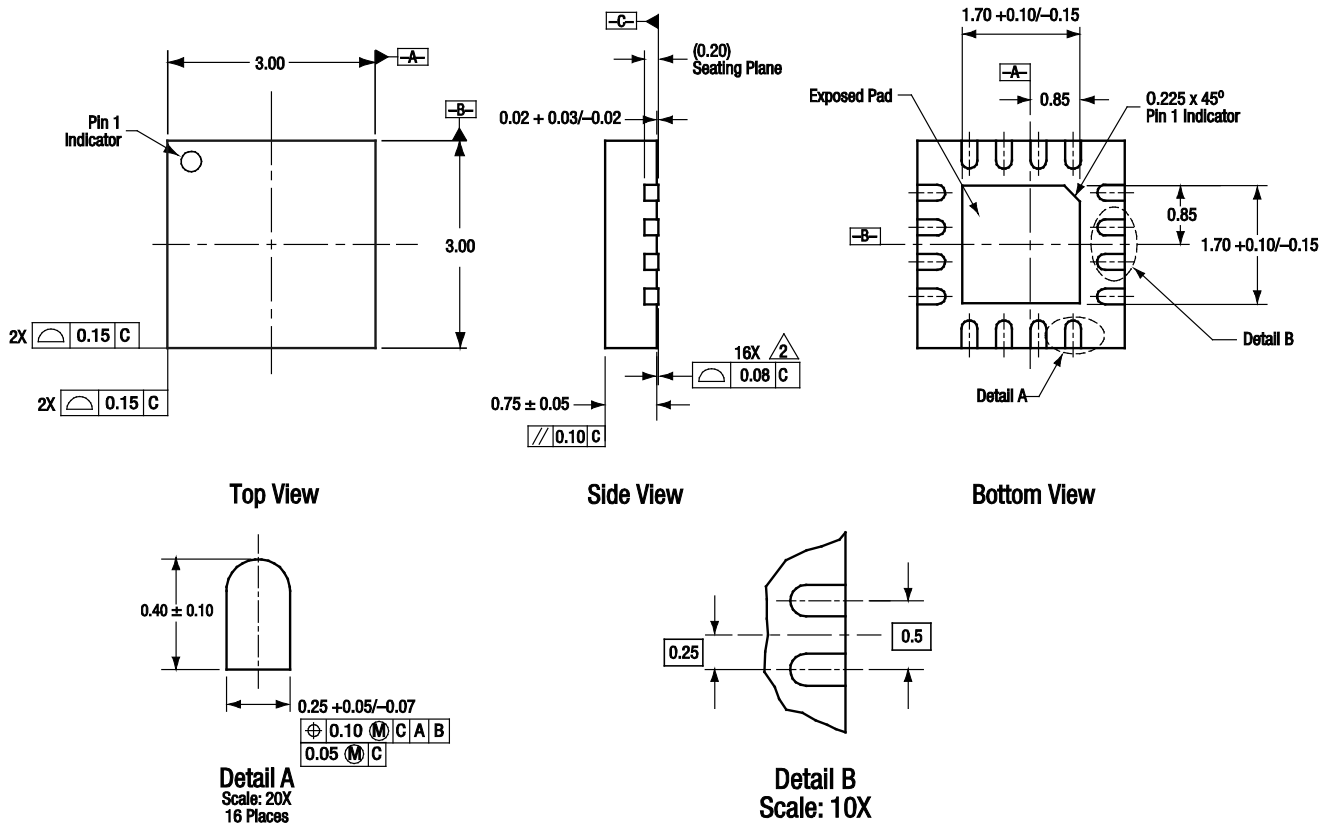


Figure 13. Typical Part Markings

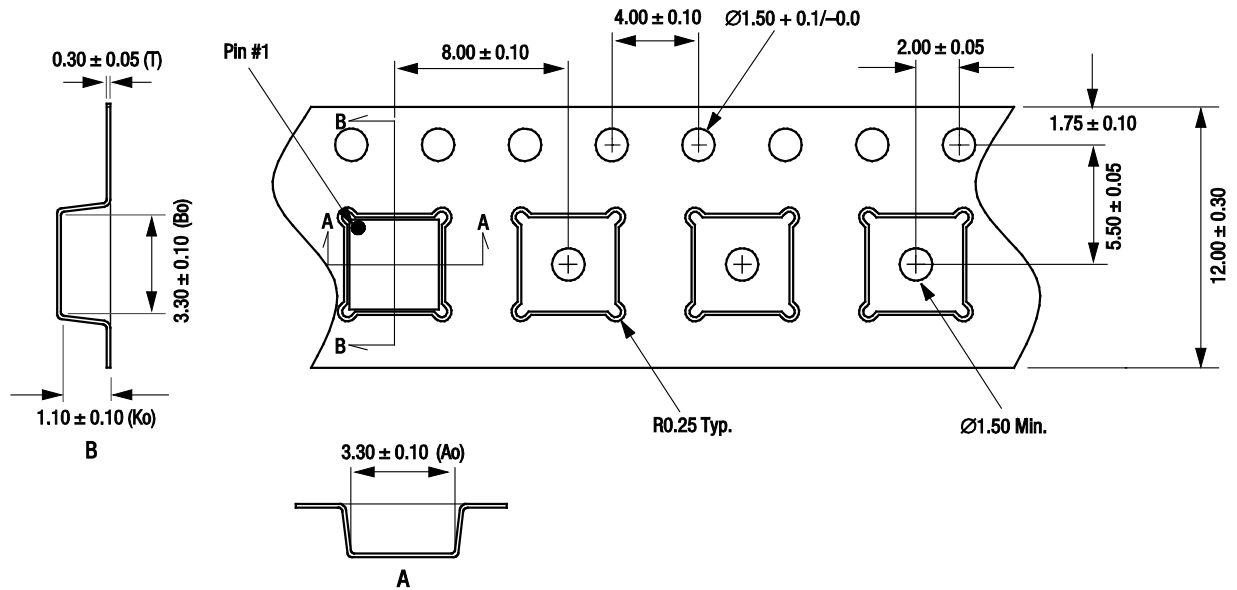




All measurements are in millimeters.  
 Dimensioning and tolerancing according to ASME Y14.5M-1994.  
 Coplanarity applies to the exposed heat sink slug as well as the terminals.  
 Plating requirement per source control drawing (SCD) 2504.

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Figure 14. SKY12339-350LF 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.

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Figure 15. SKY12339-350LF Tape and Reel Dimensions

**Ordering Information**

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers
SKY12339-350LF Digital Attenuator	SKY12339-350LF	SKY12339-350LF-EVB

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