

# DATA SHEET

# SKY12355-337LF: 0.35 to 4.0 GHz Two-Bit Digital Attenuator

# **Applications**

- Cellular infrastructure
- Wireless receivers

# **Features**

- Positive voltage operation with integrated decoder
- Broadband operation: 0.35 to 4.0 GHz
- Attenuation: 18 dB with 6 dB LSB
- Low insertion loss: 0.6 dB @ 2 GHz
- Absorptive in 50  $\Omega$  systems
- Small QFN (12-pin, 3 x 3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

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 For additional information, refer to *Skyworks Definition of Green<sup>™</sup>*, document number SQ04–0074.







Figure 1. SKY12355-337LF Block Diagram

### **Description**

The SKY12355-337LF is a GaAs pHEMT two-bit digital attenuator I/C. The device is provided in a 3 x 3 mm, 12-pin Quad Flat No-Lead (QFN) package.

The SKY12355-337LF is particularly suited for low-cost commercial applications for which high attenuation accuracy, low insertion loss, and low intermodulation products 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.

Pin	Name	Description	Pin	Name	Description	
1	GND	Ground	7	N/C	No connection required. May be connected to ground with no change in performance.	
2	RF1	RF port. Must be DC blocked.	8	RF2	RF port. Must be DC blocked.	
3	N/C	No connection required. May be connected to ground with no change in performance.	9	GND	Ground	
4	N/C	No connection required. May be connected to ground with no change in performance.	10	VCTL2	DC control voltage. Controls 12 dB attenuation state. Refer to Table 4.	
5	N/C	No connection required. May be connected to ground with no change in performance.	11	VCTL1	DC control voltage. Controls 6 dB attenuation state. Refer to Table 4.	
6	N/C	No connection required. May be connected to ground with no change in performance.	12	VDD	DC power supply.	
<sup>1</sup> Exposed pad must be grounded.						

### Table 1. SKY12355-337LF Signal Descriptions<sup>1</sup>

### **Functional Description**

This attenuator has a least significant bit (LSB) of 6 dB and a most significant bit (MSB) of 12 dB for a total of 18 dB available attenuation. Pins 10 and 11 (VCTL2 and VCTL1) control the state of the 6 dB and 12 dB attenuation bits, respectively. For each bit, a logic high enables the attenuation state while a logic low enables a low insertion loss state.

### **Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY12355-337LF are provided in Table 2. Electrical specifications are provided in Table 3.

The state of the SKY12355-337LF is determined by the logic provided in Table 4. The VCTL1 and VCTL2 signals control the 6 dB and 12 dB attenuation bits, respectively. For each bit, a logic high enables the attenuation state, while a logic low enables the insertion loss state.

Typical performance characteristics are illustrated in Figures 3 to 6.

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	Vdd			5.5	V
Control voltage	VCTL1, VCTL2			Vdd + 0.1	V
RF input power @ 3 V	Pin			+28	dBm
RF input power:					
$\begin{array}{l} \text{Tcase} \leq +85 \ ^{\circ}\text{C} \\ \text{Tcase} = +105 \ ^{\circ}\text{C} \end{array}$	Pin Pin_105C			+28 +21	dBm dBm
Operating temperature	Тор	-40		+105	°C
Storage temperature	Тѕтс	-65		+150	°C
Junction temperature	TJC	-65		+150	°C
Electrostatic discharge:	ESD				
Charged-Device Model (Class 4) Human Body Model (Class 1A) Machine Model (Class A)				1000 250 100	V V V

### Table 2. SKY12355-337LF Absolute Maximum Ratings<sup>1</sup>

<sup>1</sup> 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.

**ESD HANDLING**: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.

### Table 3. SKY12355-337LF Electrical Specifications<sup>1</sup> (1 of 2)

# (V<sub>DD</sub> = 3 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 $\Omega$ , C1 and C2 = 1000 pF, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Insertion loss	IL	350 to 500 MHz		0.45	0.80	dB
		500 MHz to 2 GHz		0.65	0.80	dB
		2 GHz to 3 GHz		0.65	0.90	dB
		3 GHz to 4 GHz		0.75	1.00	dB
Attenuation accuracy (normalized to	Att	@ 6 dB:				
insertion loss)		350 MHz to 500 MHz	5.7	6.0	6.3	dB
		500 MHz to 2 GHz	5.9	6.2	6.5	dB
		2 GHz to 3 GHz	6.1	6.4	6.7	dB
		3 GHz to 4 GHz	6.1	6.4	6.7	dB
		@ 12 dB:				
		350 MHz to 500 MHz	11.9	12.2	12.5	dB
		500 MHz to 2 GHz	12.0	12.3	12.6	dB
		2 GHz to 3 GHz	11.9	12.2	12.5	dB
		3 GHz to 4 GHz	11.8	12.1	12.4	dB
		@ 18 dB:				
		350 MHz to 500 MHz	17.9	18.3	18.7	dB
		500 MHz to 2 GHz	18.3	18.6	18.9	dB
		2 GHz to 3 GHz	18.3	18.6	18.9	dB
		3 GHz to 4 GHz	18.3	18.6	18.9	dB

 Table 3. SKY12355-337LF Electrical Specifications<sup>1</sup> (2 of 2)

(VDD = 3 V, VCTL = 0 to 3 V, TOP = +25 °C, PIN = 0 dBm, Characteristic Impedance [Zo] = 50  $\Omega$ , C1 and C2 = 1000 pF, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Мах	Units
Return loss	IS11I	350 to 500 MHz 500 MHz to 2 GHz 2 GHz to 3 GHz 3 GHz to 4 GHz	10 14 12 12	20 22 19		dB dB dB dB
Switching characteristics: Rise/fall time		10% RF to 90% RF or 90% RF to 10% RF	12	8		ns
On/off time		50% Vcт∟ to 90% RF or 50% Vcт∟ to 10% RF		37		ns
Attenuation amplitude settling		500 ns to 5 ms			0.25	dB
Phase settling (by design)		500 ns to 5 ms	-2		+2	deg
1 dB input compression point	IP1dB	VCTL = 3 V, 500 MHz to 4 GHz, insertion state		+28		dBm
0.1 dB input compression point	IP0.1dB	VCTL = 3 V, 500 MHz to 4 GHz, all states		+19		dBm
Third order input intercept point	IIP3	Tone spacing = 20 MHz, power/tone = +18 dBm, VDD = VCTL1 = VCTL2 = 3.3 V, 500 MHz to 4 GHz:				
		Insertion loss state	+48	+50		dBm
		All attenuation states	+44	+47		dBm
Supply voltage	Vdd		3		5	V
Control voltage		Vdd Vctl = low Vctl = high	3 0 0.7 × Vdd		5 0.3 × Vdd Vdd	V V V
Control current		$V_{CTL} = Iow and V_{CTL} = high$		10		μΑ
Supply current	lod			20	50	μA

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

### Table 4. SKY12355-337LF Truth Table

State	VDD	VCTL1	VCTL2
Insertion loss	High	Low	Low
6 dB	High	High	Low
12 dB	High	Low	High
18 dB	High	High	High

<sup>1</sup> High =  $0.7 \times VDD$  to VDD

Low = 0 to  $0.3 \times VDD$ 

Any state other than described in this table places the attenuator into an undefined state.

## **Typical Performance Characteristics**

(VDD = 3 V, VCTL = 0 to 3 V, TOP = +25 °C, PIN = 0 dBm, Characteristic Impedance [Zo] = 50  $\Omega$ , C1 and C2 = 1000 pF, Unless Otherwise Noted)



**Figure 3. Insertion Loss vs Frequency** 



Figure 5. Attenuation Error vs Frequency (Normalized to Insertion Loss)



Figure 4. Attenuation vs Frequency (Normalized to Insertion Loss)



**Figure 6. Return Loss vs Frequency** 

## **Evaluation Board Description**

The SKY12355-337LF Evaluation Board is used to test the performance of the SKY12355-337LF digital attenuator. An Evaluation Board schematic diagram is shown in Figure 7. Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components. An assembly drawing for the Evaluation Board is shown in Figure 8.

### **Package Dimensions**

The PCB layout footprint for the SKY12355-337LF is shown in Figure 9. Typical part markings are noted in Figure 10. Package dimensions are shown in Figure 11, and tape and reel dimensions are provided in Figure 12.

## **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 SKY12355-337LF 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 7. SKY12355-337LF Evaluation Board Schematic Diagram

Component	Value	Size	Manufacturer/Part Series
C1, C2	1000 pF	0402	Murata GRM Series

<sup>1</sup> Blocking capacitors are required on both RF ports for proper functionality. Value of DC blocking capacitor determines lower frequency operation.



Figure 8. SKY12355-337LF Evaluation Board Assembly Diagram



Figure 9. SKY12355-337LF PCB Layout Footprint



from the terminal tip. Do not measure at radius area.

Figure 11. SKY12355-337LF Package Dimensions

202281-011





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### **Ordering Information**

Model Name	Manufacturing Part Number	Evaluation Board Part Numbers	
SKY12355-337LF: Digital Attenuator	SKY12355-337LF	SKY12355-337LF-EK1	

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