

# SKY65009: 250 – 2500 MHz Linear Power Amplifier Driver

## Applications

- UHF television
- TETRA radio
- GSM450, GSM480, and GSM750
- AMPS, PCS, DCS, 2.5G, 3G
- ISM band transmitters
- Fixed WCS
- 802.11b/g WLANs

## Features

- Wideband frequency range: 250 to 2500 MHz
- High linearity: OIP3 > +44 dBm, P1dB > +25 dBm
- High efficiency: PAE 42%
- High gain: 20 dB
- Single DC supply, +3 V or +5 V
- On-chip bias circuit
- MCM (3-pin, 4 x 4 mm) or SOT-89 (4-pin 2.4 x 4.5 mm) Pb-free package (MSL3, 250 °C per JEDEC J-STD-0-20)

**NEW**

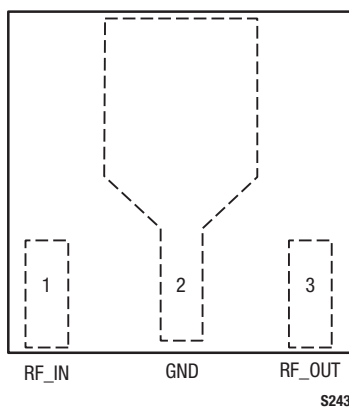
Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances) compliant packaging.



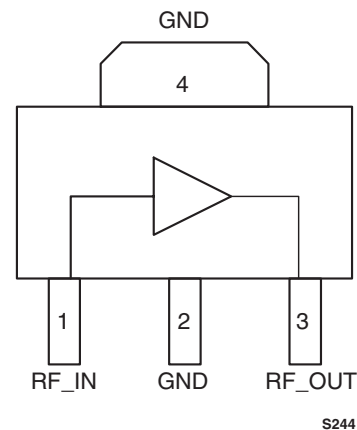
## Description

Skyworks SKY65009 is a high performance, ultra-wideband Power Amplifier (PA) driver with superior output power, linearity, and efficiency. The high linearity and superior Adjacent Channel Power Rejection/Adjacent Channel Leakage Ratio (ACPR/ACLR) performance make the SKY65009 ideal for use in the driver stage of infrastructure transmit chains.

The SKY65009 is fabricated with Skyworks high reliability Heterojunction Bipolar Transistor (HBT) process. The device uses low-cost Surface-Mount Technology (SMT) in the form of a 3-pin, 4 x 4 mm Multi-Chip Module (MCM) package (-21 option) or an optional 2.4 x 4.5 mm Small Outline Transistor (SOT) package (-70LF option). The device packages and pinouts are shown in Figures 1 and 2. A functional block diagram is provided in Figure 3.

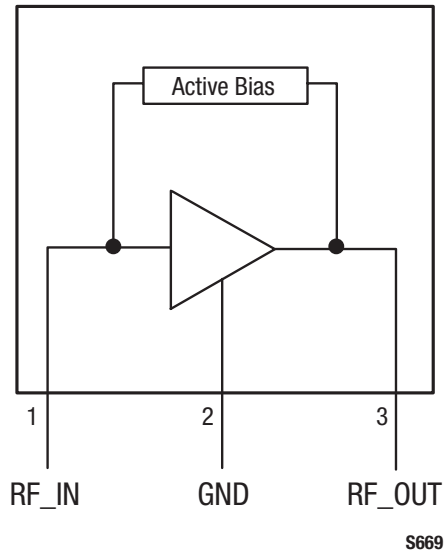


**Figure 1. SKY65009-21 Pinout – 3-Pin MCM Package (Top View)**



**Figure 2. SKY65009-70LF Pinout – 4-Pin SOT-89 Package (Top View)**

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**Figure 3. SKY65009 Block Diagram**

**Electrical and Mechanical Specifications**

Signal pin assignments and functional pin descriptions for the SKY65009 are provided in Table 1. The absolute maximum ratings are provided in Table 2, and the recommended operating conditions in Table 3. Electrical characteristics for the SKY65009 are provided in Table 4.

Typical performance characteristics of the SKY65009 are illustrated in Figures 4 through 10. Package, and tape and reel dimensions for the 3-pin MCM are shown in Figures 14 and 15, respectively. Package, and tape and reel dimensions for the 4-pin SOT-89 are shown in Figures 16 and 17, respectively.

**Package and Handling Information**

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. 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 SKY65009 is rated to Moisture Sensitivity Level 3 (MSL3) at 250 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design and SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.

**Electrostatic Discharge (ESD) Sensitivity**

The SKY65009 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

**Table 1. SKY65009 Signal Descriptions**

Pin #	Name	Description
1	RF_IN	RF input
2	GND	Ground
3	RF_OUT	RF output
4 (SOT-89 package only)	GND	Ground

**Table 2. SKY65009 Absolute Maximum Ratings**  
( $T_A = +25\text{ }^\circ\text{C}$ , unless otherwise noted)

Parameter	Symbol	Min	Typical	Max	Units
Supply voltage	VCC			6	V
RF output power	P <sub>OUT</sub>			+26	dBm
Supply current	I <sub>CC</sub>			300	mA
Power dissipation	P <sub>D</sub>			1.1	W
Operating case temperature	T <sub>C</sub>	-40		+85	°C
Storage temperature	T <sub>ST</sub>	-55		+125	°C
Junction temperature	T <sub>J</sub>			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 values.

**Table 3. SKY65009 Recommended Operating Conditions**

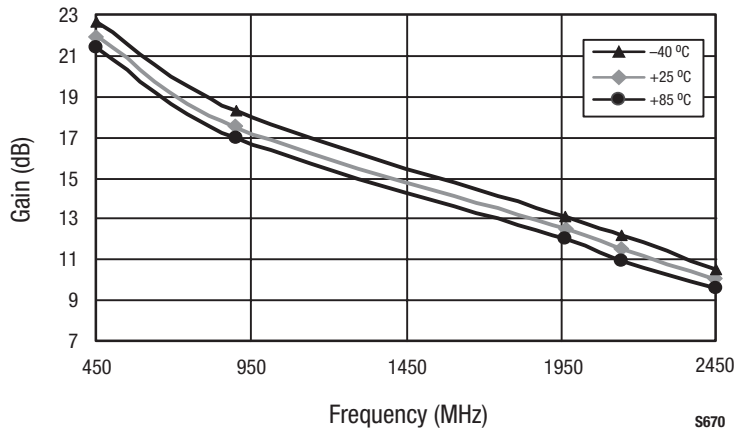
Parameter	Symbol	Min	Typical	Max	Units
Supply voltage	VCC		5	5.5	V
Frequency range	F	250		2500	MHz
Junction temperature	T <sub>J</sub>			140	°C

**Table 4. SKY65009 Electrical Characteristics (1 of 2)**  
(70LF option characterized, VCC = 5.0 V, T<sub>C</sub> = 25 °C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
<b>Test Frequency = 450 MHz</b>						
Small signal gain	G	CW		22		dB
Output power @ 1 dB compression	P <sub>1dB</sub>	CW		26.5		dBm
Output 3rd Order Intercept Point	OIP3	Two tones, each @ +18 dBm/output tone		36		dBm
<b>Test Frequency = 900 MHz</b>						
Small signal gain	G	CW		17		dB
Output power @ 1 dB compression	P <sub>1dB</sub>	CW		25		dBm
Output 3rd Order Intercept Point	OIP3	Two tones, each @ +15 dBm/output tone		41		dBm
P <sub>OUT</sub> @ ACPR = -45 dBc, 750 kHz offset	P <sub>OUT</sub>	IS-95, 9 forward channels		19.5		dBm
<b>Test Frequency = 1960 MHz (OIP3 Match)</b>						
Small signal gain	G	CW	10.5	12.0	13.5	dB
Output power @ 1 dB compression	P <sub>1dB</sub>	CW	23.5	27		dBm
Output 3rd Order Intercept Point	OIP3	Two tones, each @ +11 dBm/output tone	38	43		dBm
Noise Figure	NF			4	5.5	dB
Power-added efficiency	PAE	CW, P <sub>OUT</sub> = P <sub>1dB</sub>	37	45		%
Quiescent current	I <sub>Q</sub>	No RF input		110	135	mA

**Table 4. SKY65009-70LF Electrical Characteristics (2 of 2)**  
**(70LF option characterized, VCC = 5.0 V, Tc = 25 °C, unless otherwise noted)**

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
<b>Test Frequency = 1960 MHz (ACPR Match)</b>						
Output power @ 1 dB compression	P <sub>1dB</sub>	CW		27		dBm
P <sub>OUT</sub> @ ACPR = -45 dBc, 885 kHz offset	P <sub>OUT</sub>	IS-95, 9 forward channels		23		dBm
<b>Test Frequency = 2140 MHz</b>						
Small signal gain	G	CW		12		dB
Output power @ 1 dB compression	P <sub>1dB</sub>	CW		27		dBm
Output 3rd Order Intercept Point	OIP3	Two tones, each @ +11 dBm/output tone		44		dBm
P <sub>OUT</sub> @ ACLR = -45 dBc, 5 MHz offset	P <sub>OUT</sub>	3G WCDMA: downlink test model #1 with 64 DPCH		19		dBm
<b>Test Frequency = 2450 MHz</b>						
Small signal gain	G	CW		10		dB
Output power @ 1 dB compression	P <sub>1dB</sub>	CW		26.5		dBm
Output 3rd Order Intercept Point	OIP3	Two tones, each @ +11 dBm/output tone		42		dBm
Power-added efficiency	PAE	CW, P <sub>OUT</sub> = +28 dBm		42		%
P <sub>OUT</sub> @ IEEE 802.11b	P <sub>OUT-b</sub>	CCK, 11 Mbps		25.5		dBm
P <sub>OUT</sub> @ IEEE 802.11g	P <sub>OUT-g</sub>	OFDM, 54 Mbps		24		dBm



**Figure 4. Typical Small Signal Gain vs Frequency Over Temperature**

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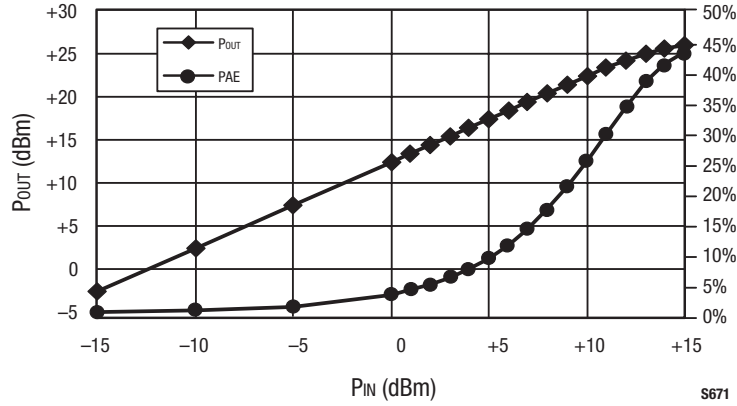


Figure 5. Typical Small Signal Gain and PAE (1960 MHz OIP3 Match)

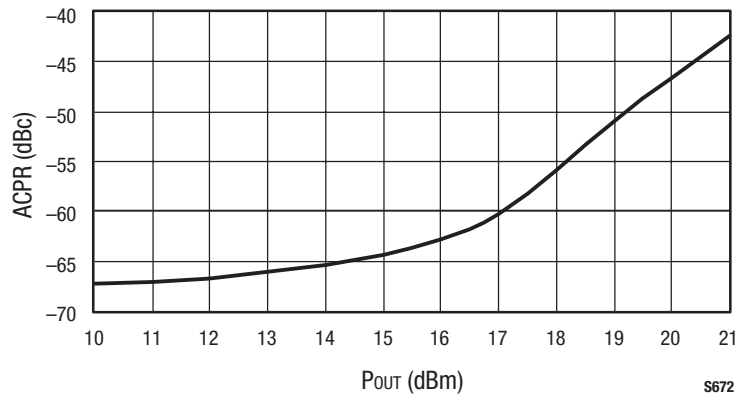


Figure 6. Typical ACPR vs Pout @ 900 MHz (IS-95 Signal With 9 Forward Channels)

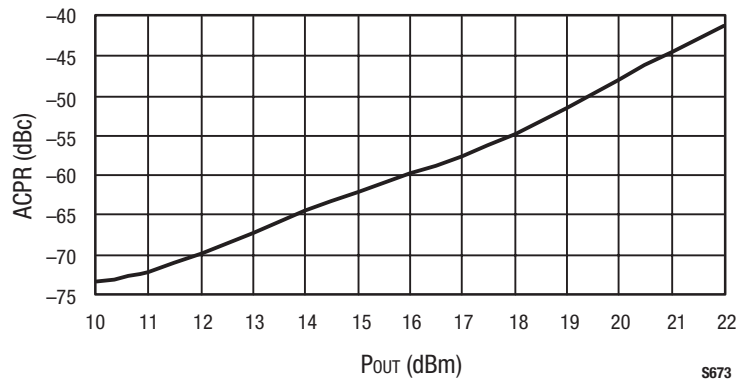
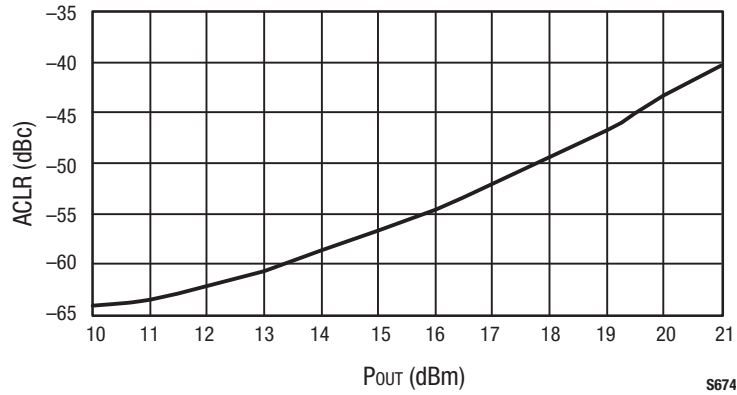
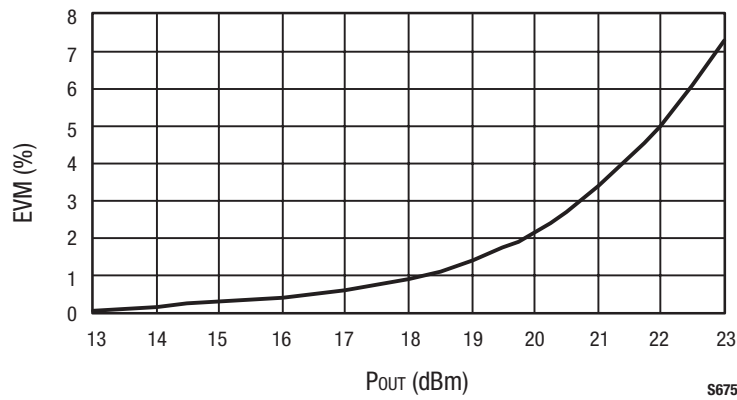


Figure 7. Typical ACPR vs Pout @ 1960 MHz (IS-95 Signal With 9 Forward Channels)

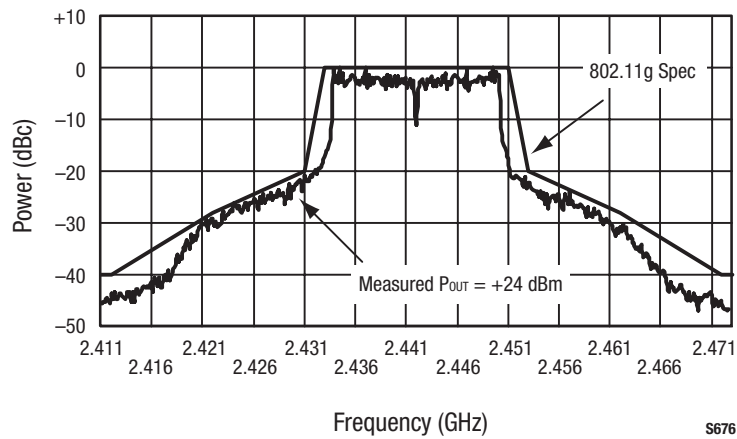
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**Figure 8. Typical ACLR vs Pout @ 2140 MHz  
(3G WCDMA Test Model #1 With 64 Forward Channels)**



**Figure 9. Typical EVM vs Pout @ 2450 MHz  
(802.11g 64QAM @ 54 Mbps Input Signal)**



**Figure 10. Spectral Response  
(802.11g 64QAM @ 54 Mbps Input Signal)**

## Evaluation Board Description

The Skyworks SKY65009 Evaluation Board is used to test the performance of the SKY65009 power amplifier driver. An assembly drawing for the Evaluation Board is shown in Figure 11 and the layer detail is provided in Figure 12.

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### Circuit Design Configurations

The following design considerations are general in nature and must be followed regardless of final use or configuration.

1. Paths to ground should be made as short as possible.
2. The ground pad of the SKY65009 power amplifier has special electrical and thermal grounding requirements. This pad is the main thermal conduit for heat dissipation. Since the circuit board acts as the heat sink, it must shunt as much heat as possible from the amplifier. As such, design the connection to the ground pad to dissipate the maximum wattage produced to the circuit board. Multiple vias to the grounding layer are required.

**NOTE:** Junction temperature ( $T_j$ ) of the device increases with a poor connection to the slug and ground. This reduces the lifetime of the device.

A suggested matching circuit is shown in Figure 13 with component values listed in Table 5 (SKY65009-21) and Table 6 (SKY65009-70LF).

### Testing Procedure

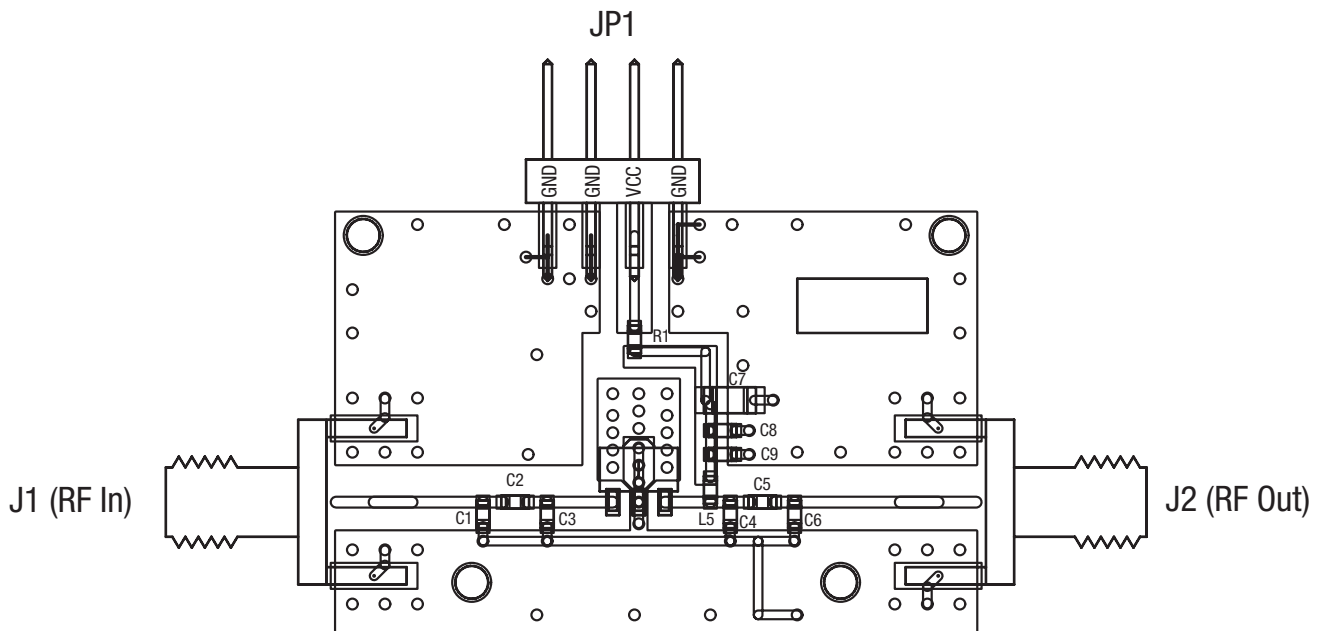
Use the following procedure to set up the SKY65009 Evaluation Board for testing:

1. Connect a 5 V supply to VCC. If available, enable the current limiting function of the power supply to 240 mA.
2. Connect a signal generator to the RF signal input port. Set it to the desired RF frequency at a power level of  $-15$  dBm or less to the Evaluation Board but do NOT enable the RF signal.
3. Connect a spectrum analyzer to the RF signal output port.
4. Enable the power supply.
5. Enable the RF signal.
6. Take measurements.

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**CAUTION:** If any of the output signals exceed the rated maximum values, the SKY65009 Evaluation Board can be permanently damaged.

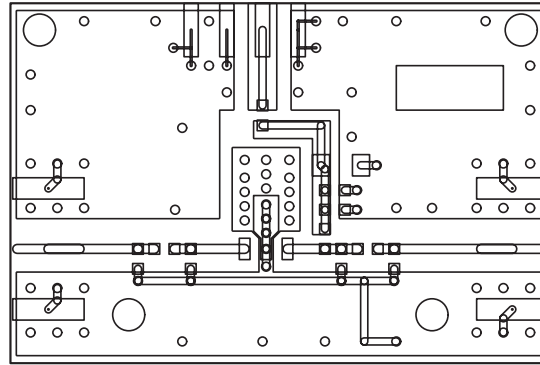
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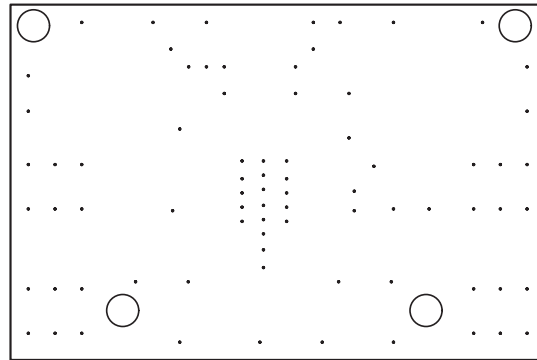
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Figure 11. Evaluation Board Assembly Drawing

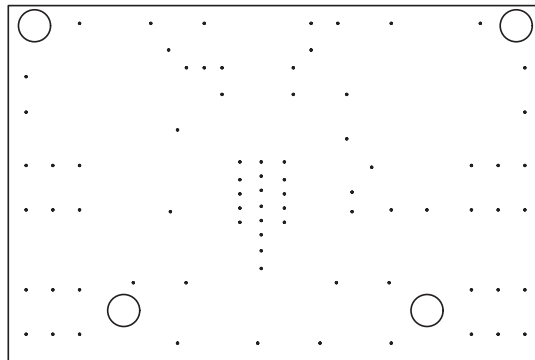
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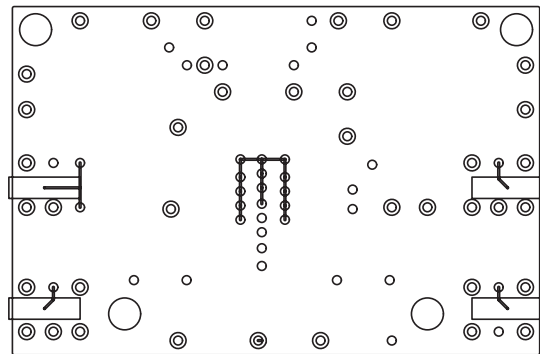
Layer 1: Top - Metal



Layer 2: Ground



Layer 3: Ground



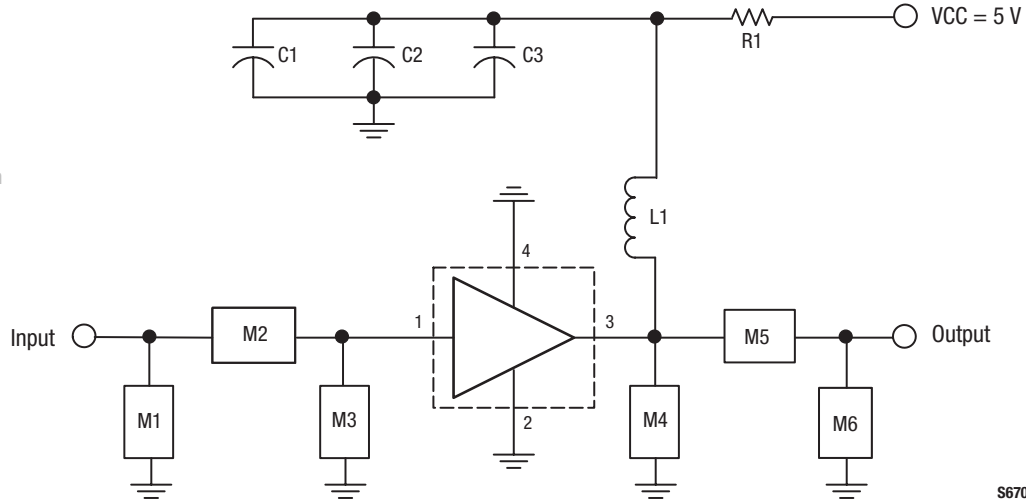
Layer 4: Solid Ground Plane

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Figure 12. Evaluation Board Layer Detail



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**Figure 13. SKY65009 Evaluation Board Schematic  
(Refer to Tables 6 and 7 for Component Values)**

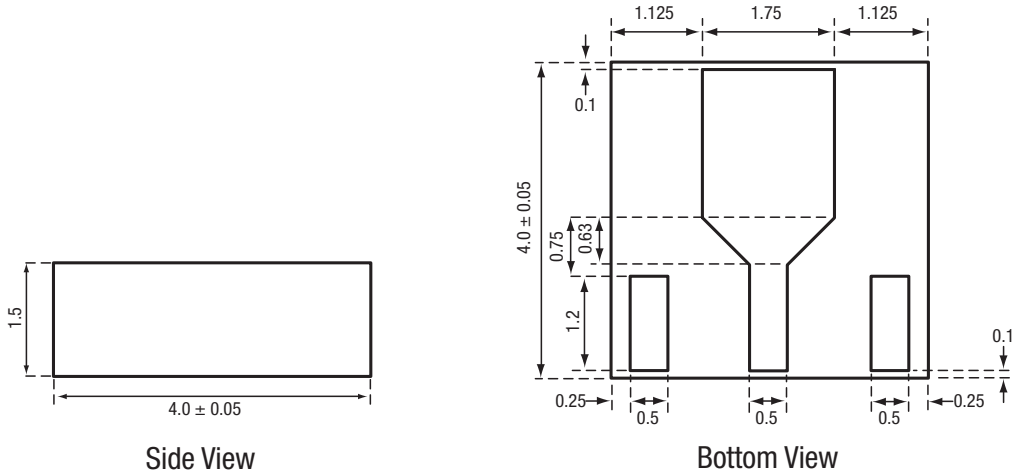
**Table 5. SKY65009-21 Evaluation Board Component Values vs Frequency**

Component	Evaluation Board Frequency (MHz)					
	450	900	1960 (OIP3)	1960 (ACPR)	2140	2450
R1	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω
C1	0.1 μF	0.1 μF	0.1 μF	0.1 μF	0.1 μF	0.1 μF
C2	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF
C3	120 pF	68 pF	18 pF	18 pF	18 pF	18 pF
L1	100 nH	39 nH	27 nH	27 nH	27 nH	27 nH
M1	12 nH	8.2 nH	DNC	DNC	DNC	DNC
M2	12 pF	3.9 pF	4.7 pF	4.7 pF	4.7 pF	4.7 pF
M3	15 pF	DNC	1.0 pF	1.5 pF	1.5 pF	1.0 pF
M4	DNC	DNC	0.5 pF	0.5 pF	0.5 pF	DNC
M5	82 pF	56 pF	2.2 pF	10 pF	10 pF	10 pF
M6	6.8 pF	3.3 pF	3.3 nH	DNC	DNC	DNC

**Table 6. SKY65009-70LF Evaluation Board Component Values vs Frequency**

Component	Evaluation Board Frequency (MHz)					
	450	900	1960 (OIP3)	1960 (ACPR)	2140	2450
R1	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω
C1	1 μF	1 μF	1 μF	1 μF	1 μF	1 μF
C2	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF
C3	68 pF	68 pF	18 pF	18 pF	18 pF	15 pF
L1	47 nH	47 nH	27 nH	22 nH	22 nH	22 nH
M1	8.2 nH	8.2 nH	1.8 pF	1.2 pF	1.2 pF	1 pF
M2	12 pF	4.7 pF	2.7 pF	2.2 pF	2.2 pF	1.2 pF
M3	6.8 pF	4.7 pF	DNC	DNC	DNC	DNC
M4	DNC	DNC	1.2 pF	1.2 pF	1.2 pF	DNC
M5	12 pF	6.8 pF	5.6 pF	3.3 pF	3.3 pF	2.2 pF
M6	27 nH	12 nH	1.0 pF	0.5 pF	0.5 pF	1.2 pF

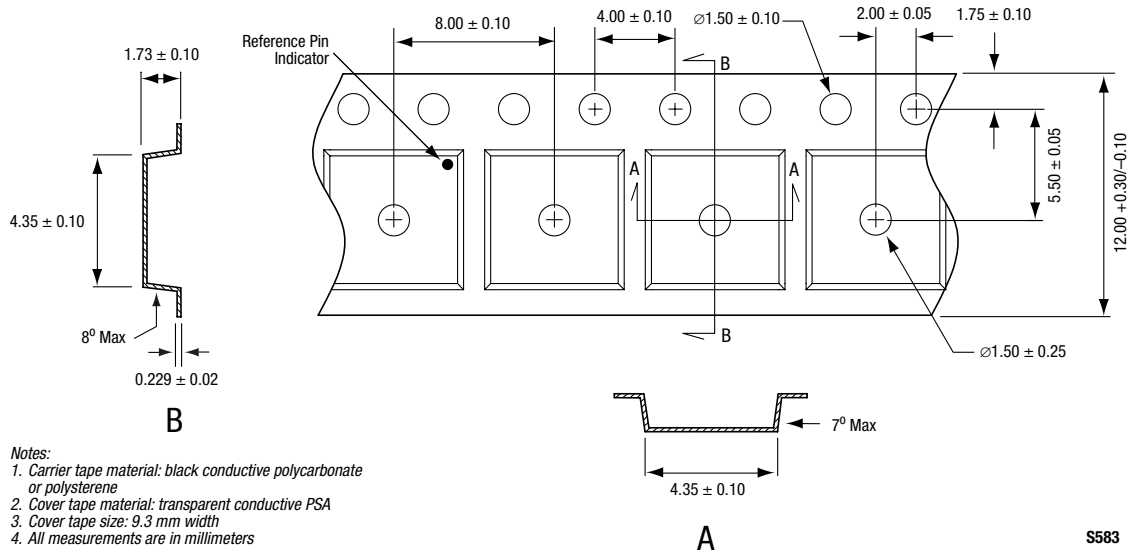
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All measurements are in millimeters

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Figure 14. SKY65009-21 MCM Package Dimensions



Notes:

1. Carrier tape material: black conductive polycarbonate or polystyrene
2. Cover tape material: transparent conductive PSA
3. Cover tape size: 9.3 mm width
4. All measurements are in millimeters

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Figure 15. SKY65009-21 MCM Tape and Reel Dimensions



## Ordering Information

Model Name	Ordering Part Number	Evaluation Kit Part Number
SKY65009 250-2500 MHz Linear PA Driver	SKY65009-21 (MCM Pb-free package)	TW13-D281 (450 MHz) TW13-D282 (900 MHz) TW13-D283 (1960 MHz – OIP3) TW13-D284 (1960 MHz – ACPR) TW13-D285 (2140 MHz) TW13-D286 (2450 MHz)
	SKY65009-70LF (SOT-89 Pb-free package)	TW13-D281-101 (450 MHz) TW13-D282-101 (900 MHz) TW13-D283-101 (1960 MHz – OIP3) TW13-D284-101 (1960 MHz – ACPR) TW13-D285-101 (2140 MHz) TW13-D286-101 (2450 MHz)

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