DATA SHEET

SKY65004: 250–2700 MHz Linear Power Amplifier Driver

Applications

- UHF TV broadcasts
- TETRA radios
- GSM450, GSM480, GSM750 handsets
- AMPS, PCS, DCS, 2.5G, 3G handsets
- ISM band transmitters
- WCS fixed wireless
- 802.11b/g WLANs

Features

- Wideband frequency range: 250–2700 MHz
- High linearity: OIP3 > 40 dBm and $P_{1\ dB}$ > 24 dBm
- High efficiency: PAE 48%
- High gain: 20 dB
- Single DC supply, 3 V or 5 V
- Available lead (Pb)-free MCM (3-pin, 4 x 4 mm) package (SKY65004-21)

Description

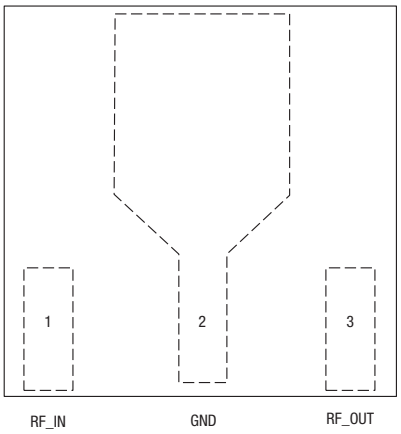
Skyworks SKY65004 is a high performance, ultra-wideband amplifier with superior output power, linearity, and efficiency. The device is fabricated using Skyworks high reliability Aluminum Gallium Arsenide (AlGaAs) Heterojunction Bipolar Transistor (HBT) technology.

The SKY65004 achieves a high linearity and superior Adjacent Channel Power Rejection/Adjacent Channel Leakage Ratio (ACPR/ACLR) performance. This makes it ideal for use in the driver stage of infrastucture transmit chains for Trans-European Trunked Radio (TETRA) transceivers, multi-band (GSM, AMPS, PCS, DCS) handsets, and many other wireless applications.

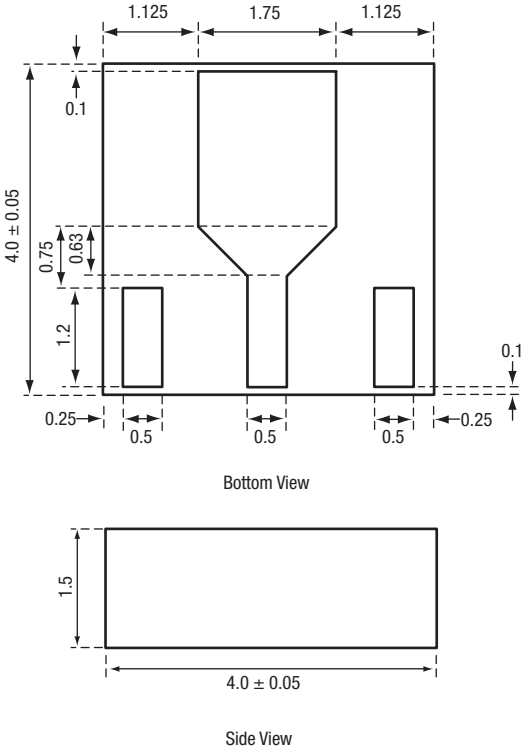
The SKY65004 uses a lead (Pb)-free 3-pin, 4 x 4 mm Multi-Chip Module (MCM) package.

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

Pinout – 3-Pin MCM Package (Top View)



Package Dimensions (3-Pin MCM)



All measurements are in millimeters

Electrical Characteristics

V_{CC} = 5 V, T_C = 25 °C, unless otherwise noted

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Test Frequency = 450 MHz						
Small signal gain	G	CW		27		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW		24		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power		42		dBm
Test Frequency = 900 MHz						
Small signal gain	G	CW		22		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW		24		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power		42		dBm
Noise figure	NF			4		dB
Output power @ ACPR = -45 dBc, 750 kHz offset	P_{OUT}	IS-95. Nine forward channels		18		dBm
Test Frequency = 1960 MHz						
Small signal gain	G	CW	14.5	16		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW	23	25		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power	39	42		dBm
Noise figure	NF			5.5	6.5	dB
Power added efficiency	PAE	CW @ $P_{OUT} = P_{1\ dB}$	42	48		%
Supply current	I_S			125	145	mA
Output power @ ACPR = -45 dBc, 885 kHz offset	P_{OUT}	IS-95. Nine forward channels	17	19		dBm
Test Frequency = 2140 MHz						
Small signal gain	G	CW		15		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW		25		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power		42		dBm
Output power @ ACLR = -45 dBc, 5 MHz offset	P_{OUT}	WCDMA. Test model #1; 64 DPCH		17		dBm
Test Frequency = 2450 MHz						
Small signal gain	G	CW		14.5		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW		25		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power		42		dBm
Noise figure	NF			5		dB
Power added efficiency	PAE	CW, P_{OUT} = 26 dBm		50		%
Test Frequency = 2600 MHz						
Small signal gain	G	CW		14		dB
Output power @ 1 dB compression	$P_{1\ dB}$	CW		25		dBm
Output 3rd order intercept point	OIP3	Two tones, each @ 7 dBm output power		41		dBm

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.

For details on attachment techniques, precautions, and handling procedures recommended by Skyworks, please refer to Skyworks Application Note, PCB Design and SMT Assembly/ Rework Guidelines for MCM-L Packages, document number 101752. Additional information on standard SMT reflow profiles can also be found in the JEDEC Standard J-STD-020.

Electrostatic Discharge (ESD) Sensitivity

The SKY65028-70LF is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

Pin Descriptions

Pin #	Name	Description
1	RF_In	RF input
2	GND	Ground
3	RF_Out	RF output
4	GND	Ground

Absolute Maximum Ratings

Characteristic	Value
RF input power (P_{IN})	15 dBm max.
RF output power (P_{OUT})	27 dBm
Supply voltage (V_{CC})	6 V
Supply current (I_{CC})	160 mA
Power dissipation (P_D)	1.2 W
Operating case temperature (T_C)	-40 °C to +85 °C
Storage temperature (T_{ST})	-55 °C to +125 °C
Junction temperature (T_J)	150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty. Each absolute maximum rating listed is an individual parameter. Biasing and driving the amplifier with more than one absolute maximum rating listed may result in permanent damage to the device. Exposure to maximum rating conditions for extended periods may reduce device reliability.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		5		V
Frequency range	F	250		2700	MHz
Junction temperature	T_J			140	°C
Thermal resistance	Θ_{JC}		36		°C/W

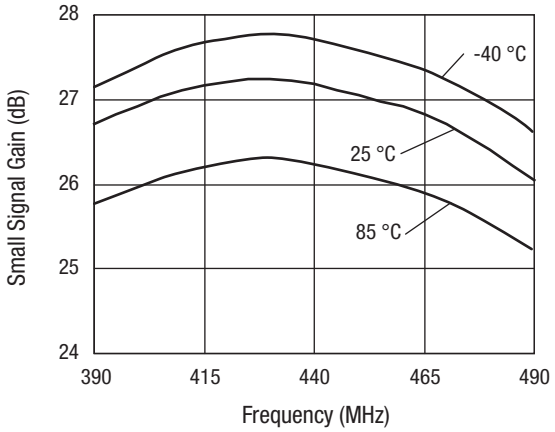
Theory of Operation

The SKY65004 is comprised of a single amplifier stage. All matching structures are external to the amplifier to accommodate a wide frequency range of tuning over the 250–2700 MHz band. The part has excellent linearity at low power levels and high efficiency at $P_{1\ dB}$. Utilizing the matching and bias circuits shown the evaluation board schematic, the part can be tuned for a specific frequency band and operate single positive supply voltage of typically 3–5 V.

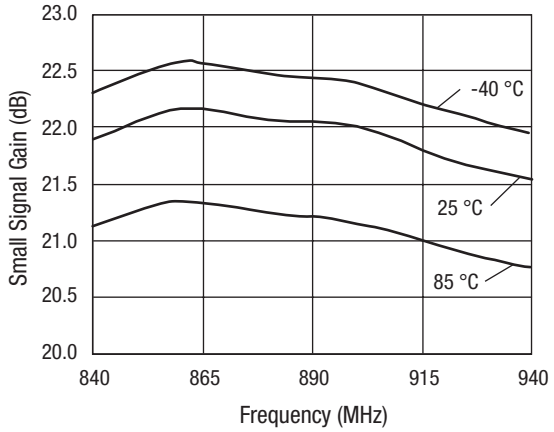
The amplifier collector voltage is supplied through an RF choke to the output. The reference voltage is supplied through a separate RF choke to the amplifier input. A voltage divider (R2/R3) sets the proper bias level to the input. Capacitors C7, C8 and C9 provide DC bias decoupling for V_{CC}. In some applications, if a series DC blocking cap is not part of the input or output RF matching circuits, a blocking cap of 100 pF, should be included to provide DC blocking to the RF ports.

Typical Performance Data

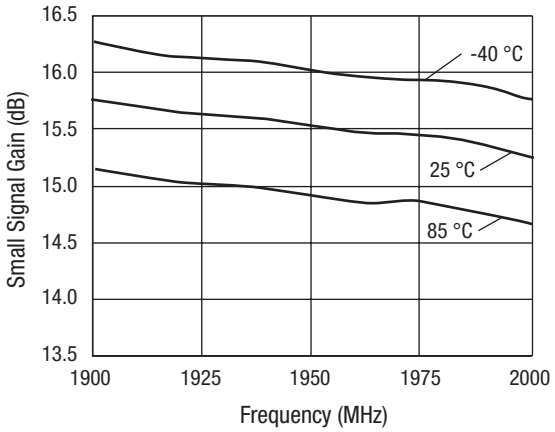
V_{CC} = 5 V, T_C = 25 °C, unless otherwise noted



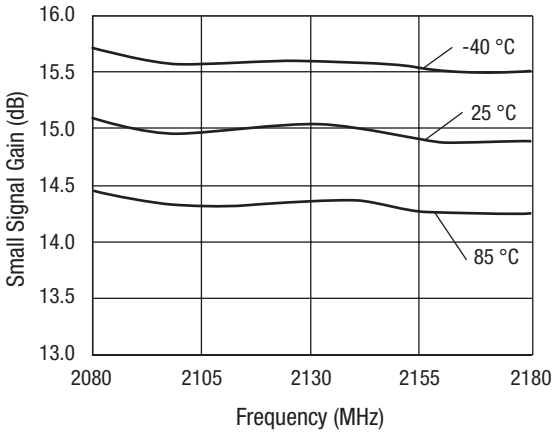
Typical Small Signal Gain From 390–490 MHz Over Temperature



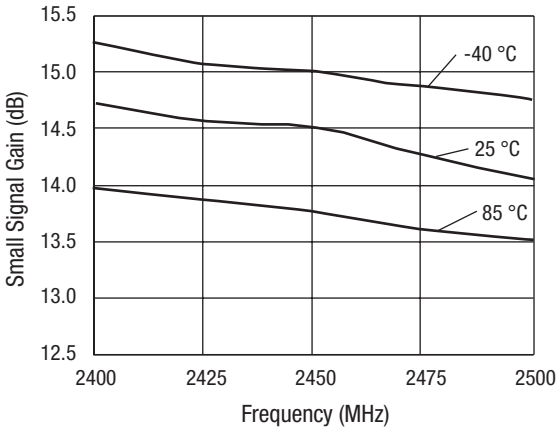
Typical Small Signal Gain From 840–940 MHz Over Temperature



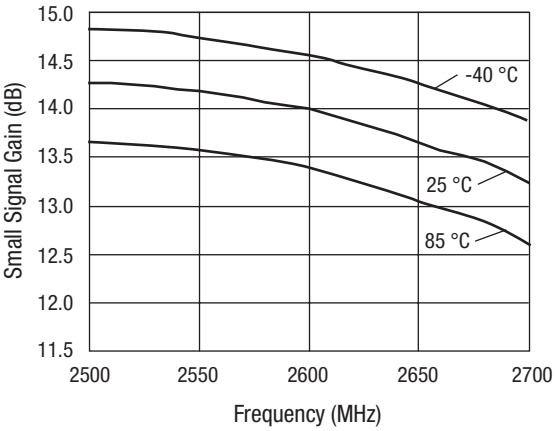
Typical Small Signal Gain From 1900–2000 MHz Over Temperature



Typical Small Signal Gain From 2080–2180 MHz Over Temperature



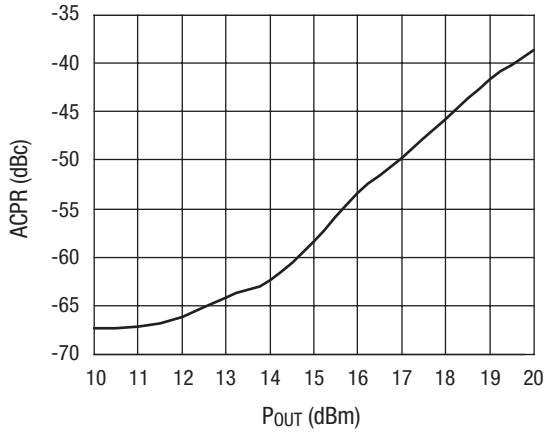
Typical Small Signal Gain From 2400–2500 MHz Over Temperature



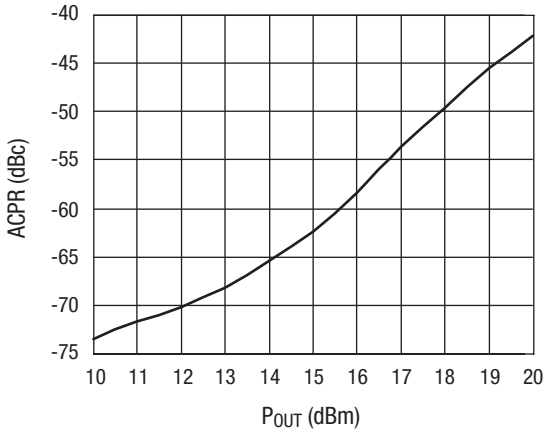
Typical Small Signal Gain From 2500–2700 MHz Over Temperature

Typical Performance Data

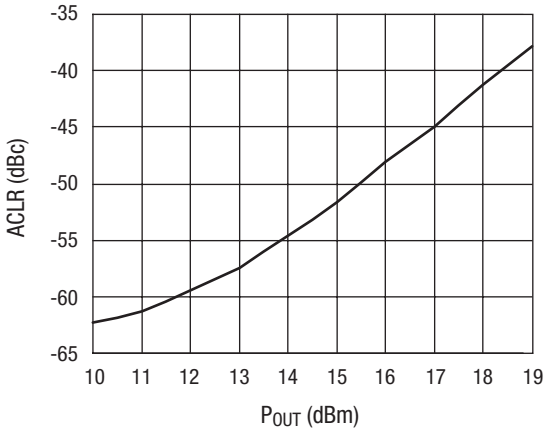
V_{CC} = 5 V, T_C = 25 °C, unless otherwise noted



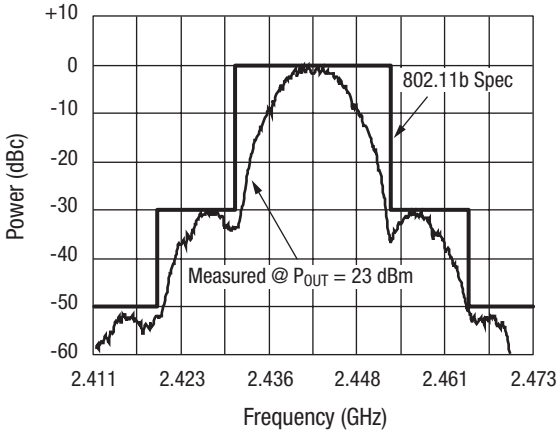
Typical ACPR vs. P_{OUT} @ 900 MHz, 750 kHz Offset, IS-95



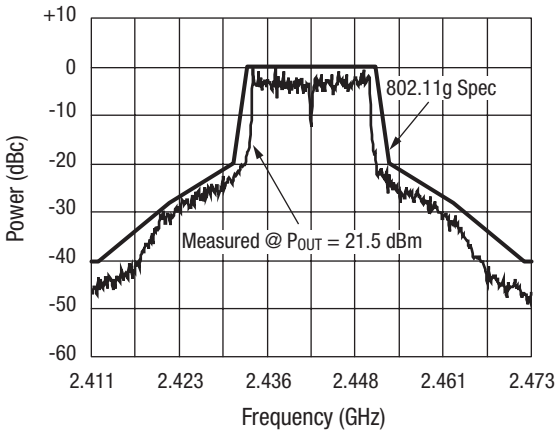
Typical ACPR vs. P_{OUT} @ 1960 MHz, 885 kHz Offset, IS-95



Typical ACPR vs. P_{OUT} @ 2140 MHz, 5 MHz Offset, WCDMA



Spectral Response with 802.11b Signal (CCK @ 11 Mbps, V_{CC} = 3.3 V)



Spectral Response with 802.11g Signal (64 QAM @ 54 Mbps, V_{CC} = 3.3 V)

Evaluation Board Description

The Skyworks SKY65004 Evaluation Board is used to test the performance of the SKY65004 power amplifier driver.

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 SKY65004 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.*

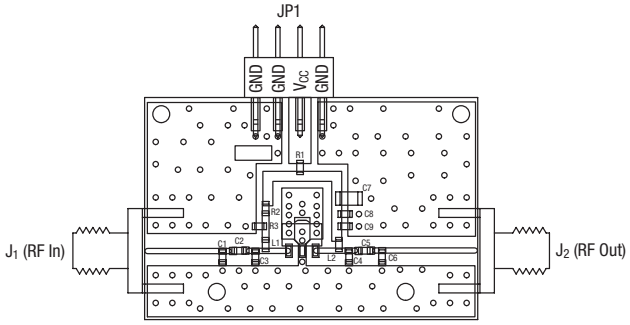
Testing Procedure

Use the following procedure to set up the SKY65004 Evaluation Board for testing:

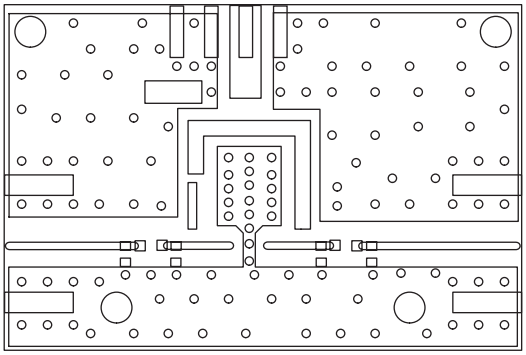
1. Connect a 5.0 V supply to V_{CC}. If available, enable the current limiting function of the power supply to 240 mA.
2. Connect a signal generator to the RF signal input port. Set it to the desired RF frequency at a power level of -15 dBm or less to the evaluation board but do NOT enable the RF signal.
3. Connect a spectrum analyzer to the RF signal output port.
4. Enable the power supply.
5. Enable the RF signal.
6. Take measurements.

CAUTION: *If any of the output signals exceed the rated maximum values, the SKY65004 evaluation board can be permanently damaged.*

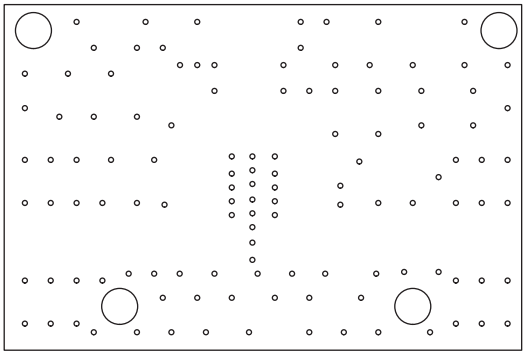
Evaluation Board Assembly



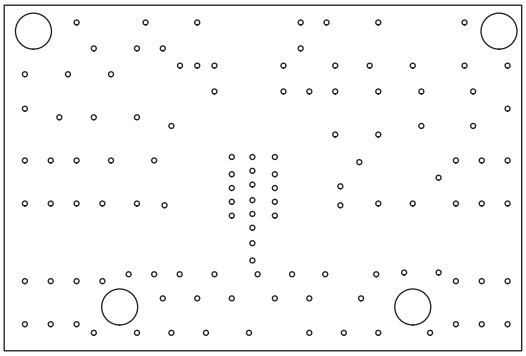
Evaluation Board Layer Detail



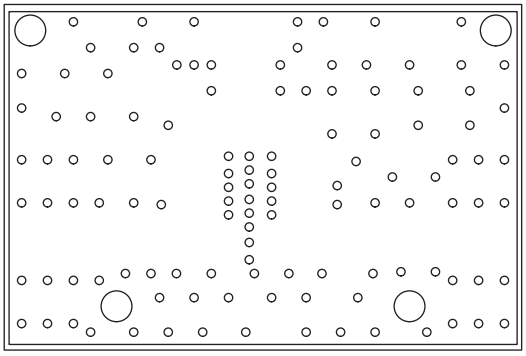
Layer 1: Top - Metal



Layer 2: Ground

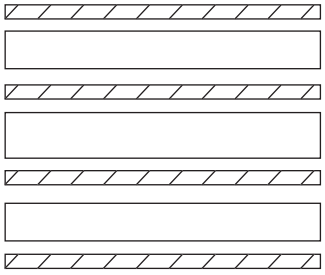


Layer 3: Ground



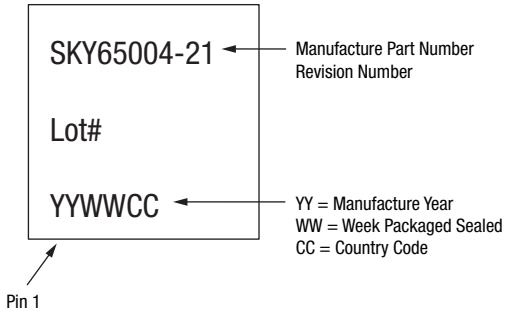
Layer 4: Solid Ground Plane

Evaluation Board Stack-Up

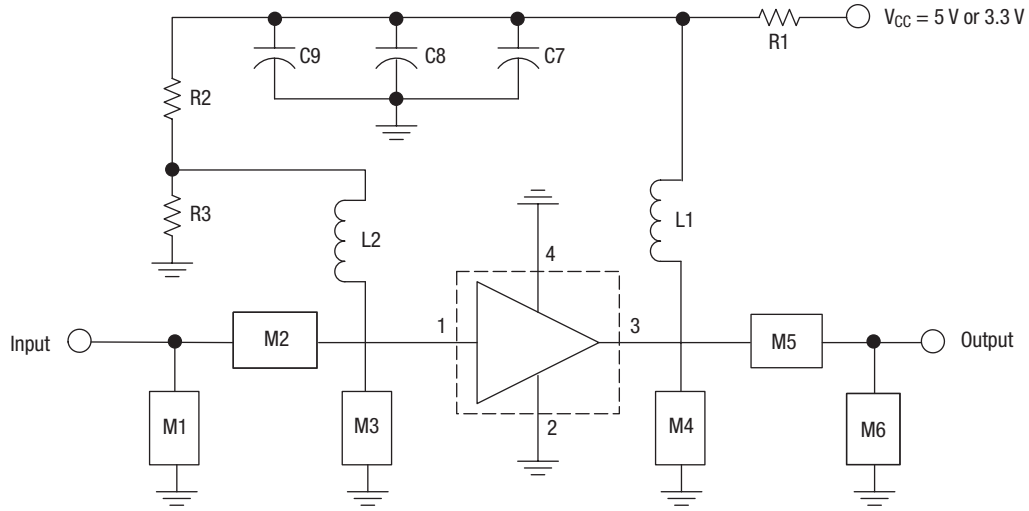


Cross Section	Name	Thickness (mils)	Material	ε_r
	L1	1.4	Cu	–
	Lam1	12	Rogers 4003-12	3.38
	L2_GND	1.4	Cu, 1 oz.	–
	Lam2	4	FR4-4	4.35
	L3_GND	1.4	Cu, 1 oz.	–
	Lam3	12	FR4-12	4.35
	L4	1.4	Cu, 1 oz.	–

Branding Specifications



Evaluation Board Schematic



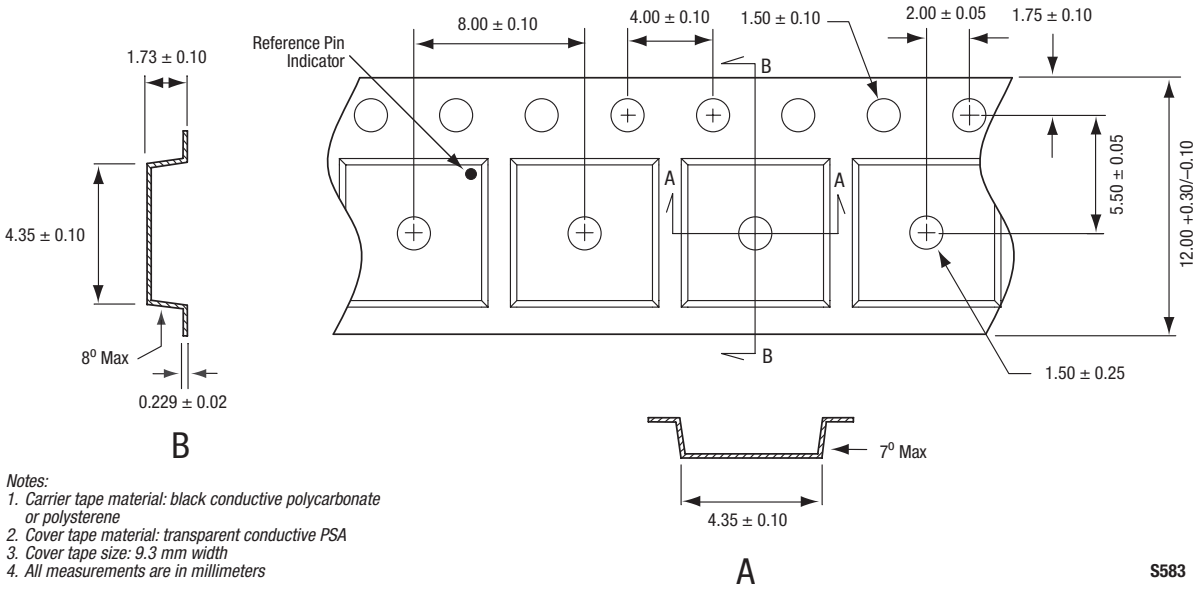
Refer to Evaluation Board Component Values vs. Frequency Table for component values.

Evaluation Board Component Values vs. Frequency

Component	Evaluation Board Frequency (MHz)						
	450	900	1960	2140	2450	2450	2600
	V_{CC} = 5 V					V_{CC} = 3.3 V	V_{CC} = 5 V
R1	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω
R2	390 Ω	390 Ω	390 Ω	390 Ω	390 Ω	220 Ω	390 Ω
R3	180 Ω	180 Ω	180 Ω	180 Ω	180 Ω	200 Ω	180 Ω
C7	0.1 µF	0.1 µF	0.1 µF	0.1 µF	0.1 µF	0.1 µF	0.1 µF
C8	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF
C9	68 pF	68 pF	18 pF	18 pF	18 pF	18 pF	18 pF
L1	39 nH	39 nH	27 nH	27 nH	27 nH	27 nH	27 nH
L2	39 nH	39 nH	27 nH	27 nH	27 nH	27 nH	27 nH
M1	6.8 nH	6.8 nH	5.6 nH	6.8 nH	0.5 pF	0.5 pF	0.5 pF
M2	15 pF	6.8 pF	1 pF	1 pF	1 pF	1 pF	1 pF
M3	DNI	10 pF	1 pF	0.5 pF	DNI	DNI	DNI
M4	DNI	DNI	DNI	2.7 pF	DNI	DNI	DNI
M5	330 pF	8.2 pF	22 pF	2.7 pF	20 pF	20 pF	20 pF
M6	56 nH	8.2 nH	0.5 pF	2.2 nH	0.5 pF	0.5 pF	0.5 pF

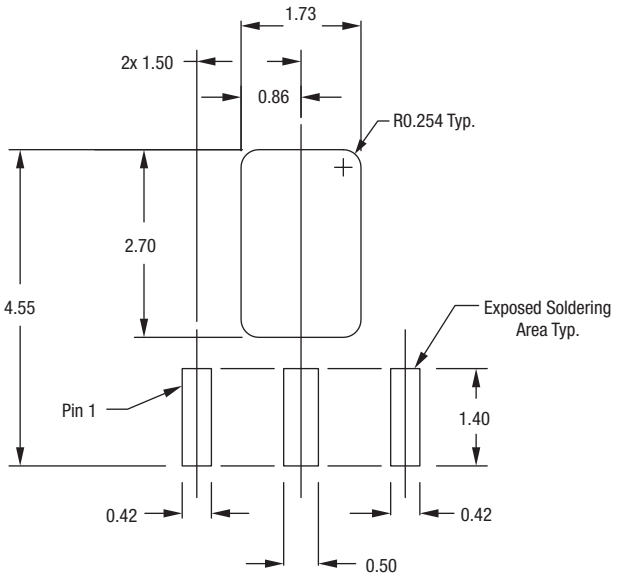
DNI: Do Not Install.

Tape and Reel Dimensions



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

Recommended Footprint



Ordering Information

Model Name	Ordering Part Number	Evaluation Kit Part Number
SKY65004 250-2700 MHz Linear PA Driver (3-pin MCM package)	SKY65004-21 (Pb-free package)	TW13-D391-011 (450 MHz)
		TW13-D391-021 (900 MHz)
		TW13-D391-031 (1960 MHz)
		TW13-D391-041 (2140 MHz)
		TW13-D391-061 (2450 MHz, V_{CC} = 3.3 V)
		TW13-D391-071 (2450 MHz, V_{CC} = 5 V)
		TW13-D391-081 (2600 MHz)