

PRELIMINARY DATA SHEET

SKY65172: 400-2700 MHz Variable Gain Amplifier

Applications

- GSM/EDGE, CDMA2000, WCDMA, LTE, TD-SCDMA cellular base station systems
- Repeaters
- WLL and ISM band transmitters
- Other wireless communication systems

Features

- Wideband frequency range: 400 to 2700 MHz
- Two variable attenuators: one analog with 25 dB continuous range; one digital with 31.5 dB range in 0.5 dB steps
- On-die serial to parallel interface converter
- High linearity OIP3: cascaded +38 dBm
- Gain: 26.5 dB
- Single DC supply: +5 V
- On-chip active bias circuits
- Small, low-cost MCM (48-pin, 7 x 7 mm) SMT package (MSL3, 260 °C per JEDEC J-STD-020)

Description

Skyworks SKY65172 is a high performance, wideband Variable Gain Amplifier (VGA) with two Power Amplifiers (PAs), a Voltage Controlled Attenuator (VCA), and a Digital Step Attenuator (DSA) integrated into a small form factor module. The input and output stages are independently accessible for maximum flexibility.

The output of the first PA (AMP1) is externally matched to the input of the VCA. The output of the VCA is externally matched to the input of the second PA (AMP2). The output of the second PA is externally matched to the input of the DSA.

The SKY65172 VGA uses low-cost Surface Mount Technology (SMT) in the form of a compact, 7 x 7 mm 48-pin Multi-Chip Module (MCM). 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.

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

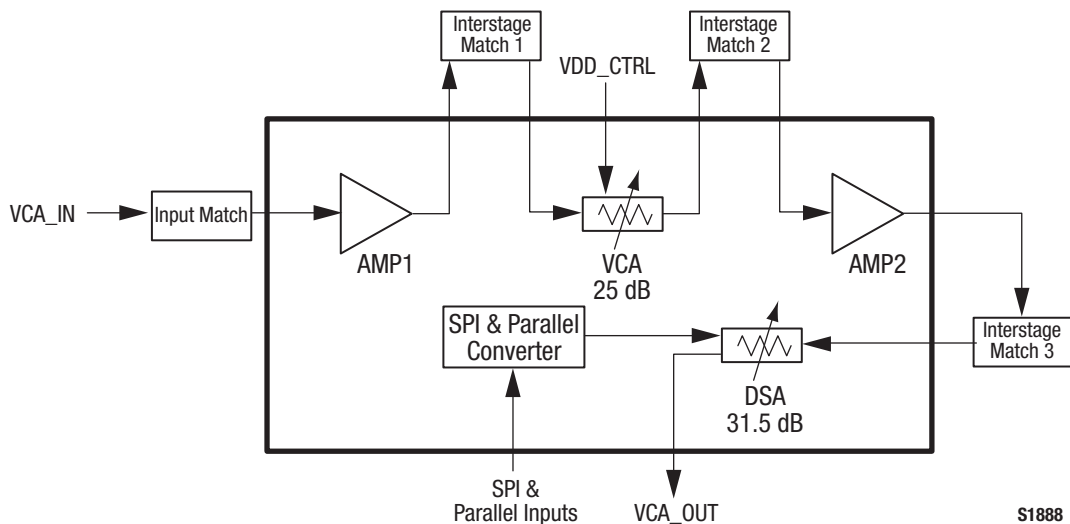


Figure 1. SKY65172 Block Diagram

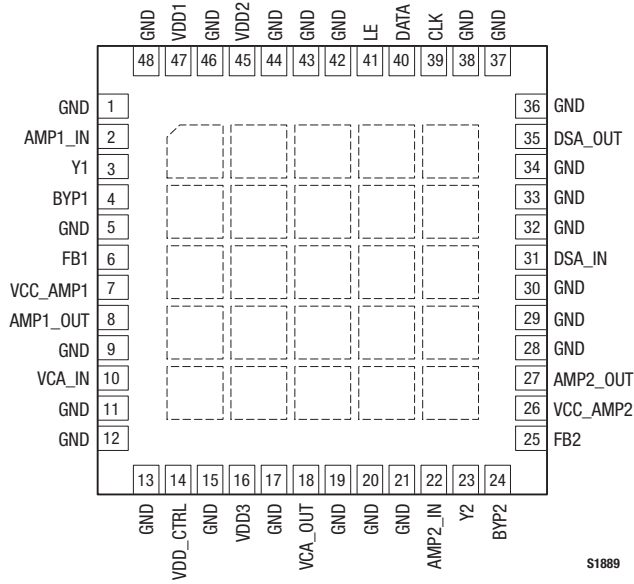


Figure 2. SKY65172 Pinout – 48-Pin MCM (Top View)

Table 1. SKY65172 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	GND	Ground	25	FB2	AMP2 bias control
2	AMP1_IN	AMP1 RF input	26	VCC_AMP2	AMP2 supply voltage
3	Y1	AMP1 bias node	27	AMP2_OUT	AMP2 RF output
4	BYP1	AMP1 bypass	28	GND	Ground
5	GND	Ground	29	GND	Ground
6	FB1	AMP1 bias control	30	GND	Ground
7	VCC_AMP1	AMP1 supply voltage	31	DSA_IN	DSA RF input
8	AMP1_OUT	AMP1 RF output	32	GND	Ground
9	GND	Ground	33	GND	Ground
10	VCA_IN	VCA RF input	34	GND	Ground
11	GND	Ground	35	DSA_OUT	DSA RF output
12	GND	Ground	36	GND	Ground
13	GND	Ground	37	GND	Ground
14	VDD_CTRL	VCA control voltage	38	GND	Ground
15	GND	Ground	39	CLK	SPI clock
16	VDD3	VCA supply voltage	40	DATA	SPI data
17	GND	Ground	41	LE	SPI latch enable
18	VCA_OUT	VCA RF output	42	GND	Ground
19	GND	Ground	43	GND	Ground
20	GND	Ground	44	GND	Ground
21	GND	Ground	45	VDD2	DSA supply voltage
22	AMP2_IN	AMP2 RF input	46	GND	Ground
23	Y2	AMP2 bias node	47	VDD1	SPI supply voltage
24	BYP2	AMP2 bypass	48	GND	Ground

Functional Description

Control and Programming

The serial I/O control interface consists of the CLK, LE, and DATA control signals. A three-wire serial bus is used to program the 6-bit digital attenuator. The attenuation logic is shown in Table 2. The resolution or minimum step is 0.5 dB. The serial input timing diagram is shown in Figure 3.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65172 are provided in Table 3. The recommended operating conditions are specified in Table 4 and electrical specifications are provided in Table 5.

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 SKY65172 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & 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.

Table 2. Digital Attenuator Logic

Attenuation Value (dB)	Bits					
	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0
0.5	0	0	0	0	0	1
1.0	0	0	0	0	1	0
2.0	0	0	0	1	0	0
4.0	0	0	1	0	0	0
8.0	0	1	0	0	0	0
16.0	1	0	0	0	0	0
31.5	1	1	1	1	1	1

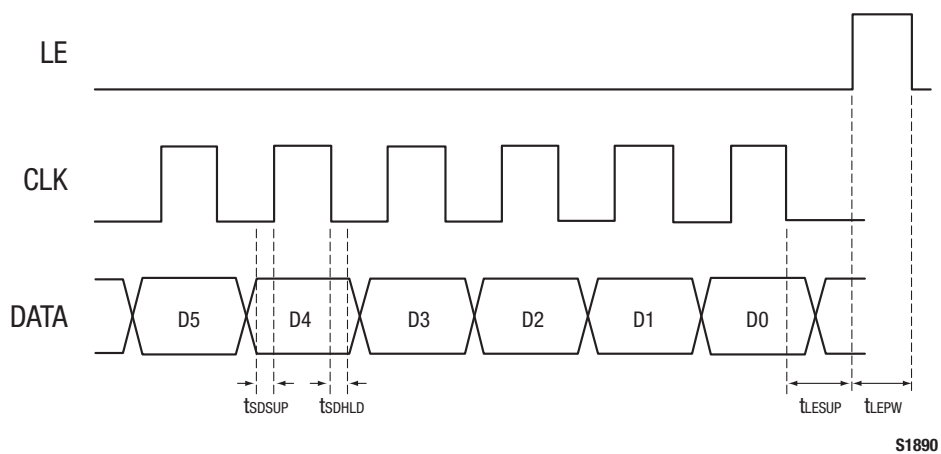


Figure 3. SKY65172 Serial Input Timing Diagram

Table 3. SKY65172 Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V _{CC}	4.75	5.25	V
Supply current	I _{CC}		*** TBD ***	mA
Input power	P _{IN}		*** TBD ***	dBm
Operating case temperature	T _C	-40	+85	°C
Storage case temperature	T _{STG}	-40	+125	°C
Junction temperature	T _J		+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.

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 4. SKY65172 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	V _{CC}	4.75	5.00	5.25	V
Frequency range	f	400		2700	MHz
Operating case temperature	T _C	-40		+85	°C

Table 5. SKY65172 Electrical Specifications (1 of 3) (Note 1)
(V_{CC} = 4.75 to 5.25 V, T_C = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
General						
Frequency range	f		400		2700	MHz
Return loss	RL		-10	-15		dB
Supply current	I _{CC}			340		mA
Isolation		AMP1 out to VCA out		45		dB
		AMP1 out to DSA out		60		dB
		AMP2 out to DSA out		55		dB
AMP1 Input to AMP1 Output						
Noise Figure	NF _{AMP1}	0.4 to 1.0 GHz		6		dB
		1.4 to 2.2 GHz		5		dB
		2.2 to 2.7 GHz		5		dB
Gain	G _{AMP1}	0.4 to 1.0 GHz		16.0		dB
		1.4 to 2.2 GHz		15.5		dB
		2.2 to 2.7 GHz		15.0		dB
Gain flatness (with every 200 MHz in each frequency band)	G _{FLAT_AMP1}	0.4 to 1.0 GHz		1		dB
		1.4 to 2.2 GHz		1		dB
		2.2 to 2.7 GHz		1		dB

Table 5. SKY65172 Electrical Specifications (2 of 3) (Note 1)
(V_{CC} = 4.75 to 5.25 V, T_c = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
AMP1 Input to AMP1 Output (Continued)						
Gain variation over temperature	G _{TEMP_AMP1}	-40 °C ~ +25 °C		+0.02		dB/°C
		+25 °C ~ +85 °C		-0.02		dB/°C
1 dB Output Compression Point	OP1dBAMP1	0.4 to 1.0 GHz		+24.5		dBm
		1.4 to 2.2 GHz		+24.5		dBm
		2.2 to 2.7 GHz		+24.5		dBm
3 rd Order Output Intercept Point	OIP3AMP1	0.4 to 1.0 GHz		+41.0		dBm
		1.4 to 2.2 GHz		+41.0		dBm
		2.2 to 2.7 GHz		+40.5		dBm
VCA Input to VCA Output						
Insertion loss	IL _{VCA}			2.5		dB
VCA gain control range	G _{RANGE_VCA}			25		dB
Control voltage range	V _{CTRL_VCA}		0.5		4.5	V
Attenuation slope	Slope _{VCA}			40		dB/V
1 dB Input Compression Point	IP1dBVCA			+25		dBm
3 rd Order Input Intercept Point	IIP3VCA	P _{IN} = +2 dBm, f = 10 MHz		+41		dBm
AMP2 Input to AMP2 Output						
Noise Figure	NF _{AMP2}	0.4 to 1.0 GHz		6.0		dB
		1.4 to 2.2 GHz		5.0		dB
		2.2 to 2.7 GHz		5.0		dB
Gain	G _{AMP2}	0.4 to 1.0 GHz		16.0		dB
		1.4 to 2.2 GHz		15.5		dB
		2.2 to 2.7 GHz		15.0		dB
Gain flatness (with every 200 MHz in each frequency band)	G _{FLAT_AMP2}	0.4 to 1.0 GHz		1		dB
		1.4 to 2.2 GHz		1		dB
		2.2 to 2.7 GHz		1		dB
Gain variation over temperature	G _{TEMP_AMP2}	-40 °C ~ +25 °C		+0.035		dB/°C
		+25 °C ~ +85 °C		-0.050		dB/°C
1 dB Output Compression Point	OP1dBAMP2	0.4 to 1.0 GHz		+24.5		dBm
		1.4 to 2.2 GHz		+24.5		dBm
		2.2 to 2.7 GHz		+24.5		dBm
3 rd Order Output Intercept Point	OIP3AMP2	0.4 to 1.0 GHz		+41.0		dBm
		1.4 to 2.2 GHz		+41.0		dBm
		2.2 to 2.7 GHz		+40.5		dBm
DSA Input to DSA Output						
Insertion loss	IL _{DSA}	0.4 to 1.0 GHz		1.5		dB
		1.4 to 2.2 GHz		1.8		dB
		2.2 to 2.7 GHz		2.0		dB
DSA gain control range	G _{RANGE_DSA}			31.5		dB

Table 5. SKY65172 Electrical Specifications (3 of 3) (Note 1)
(V_{CC} = 4.75 to 5.25 V, T_c = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
DSA Input to DSA Output (Continued)						
DSA step size	G _{STEP}			0.5		dB
Attenuation accuracy				±(0.3 + 5% × atten)		dB
1 dB Input Compression Point	IP1dB _{DSA}			+28		dBm
3 rd Order Input Intercept Point	IIP3 _{DSA}			+48		dBm
Switching speed (50% control to 0.5 dB of attenuation value)				1		μs
Switching control frequency					25	kHz
Serial Interface						
SPI clock speed	Clk				10	MHz
Clock high time	t _{CLK_H}		30			ns
Clock low time	t _{CLK_L}		30			ns
Clock-to-load-enable set-up time	t _{LESUP}		10			ns
Load-enable pulse width	t _{LEPW}		10			ns
Data setup to clock rise	t _{SDSUP}		10			ns
Data hold from clock rise	t _{SDHLD}		10			ns
Input low voltage	V _{IL}				0.9	V
Input high voltage	V _{IH}		2.1			V

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

Evaluation Board Description

The SKY65172 Evaluation Board is used to test the performance of the SKY65172 VGA. The Evaluation Board schematic diagram is shown in Figure 4. An assembly drawing for the Evaluation Board is shown in Figure 5 and the layer detail is provided in Figure 6.

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 SKY65172 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 device. Therefore, design the connection to the ground pad to dissipate the maximum wattage produced by the circuit board. Multiple vias to the grounding layer are required.
3. Skyworks recommends including external bypass capacitors on the VCC voltage inputs of the device.

Testing Procedure

Use the following procedure to set up the SKY65172 Evaluation Board for VGA testing:

1. *** TBD ***

Package Dimensions

Figure 7 shows the package dimensions for the 48-pin MCM and Figure 8 provides the tape and reel dimensions.

*** TBD ***

Figure 4. SKY65172 Evaluation Board Schematic

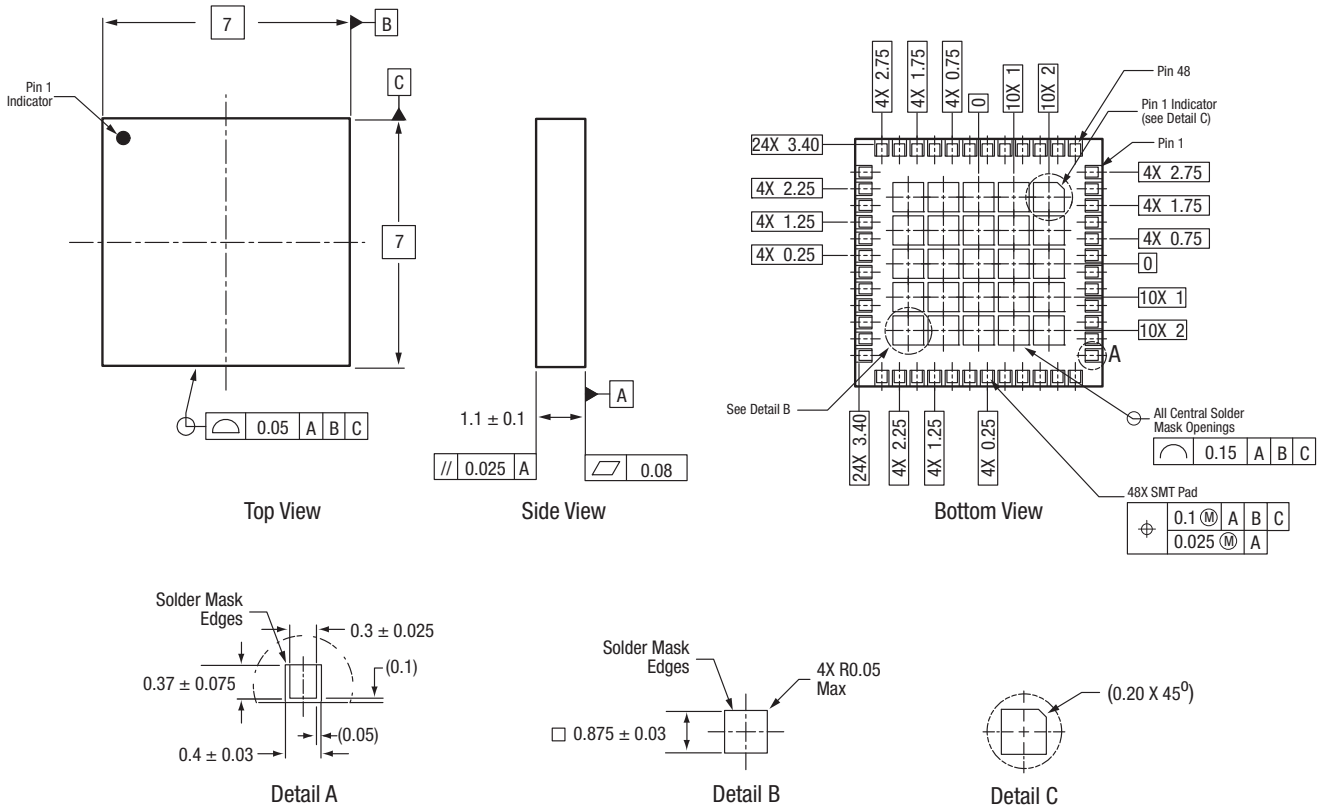
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Figure 5. SKY65172 Evaluation Board Assembly Drawing

***** TBD *****

Figure 6. SKY65172 Evaluation Board Layer Detail

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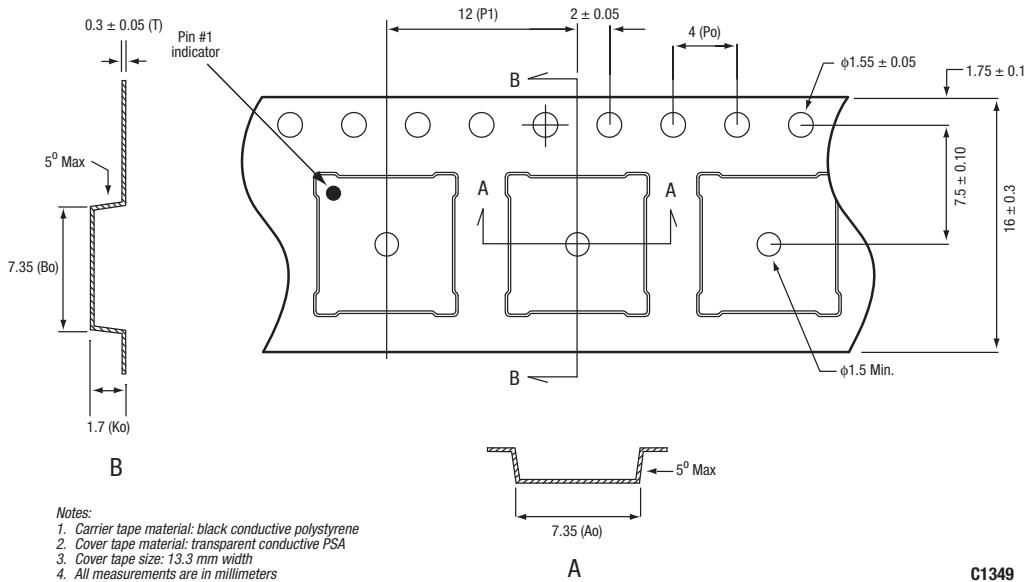


All measurements are in millimeters

Dimensioning and tolerancing according to ASME Y14.5M-1994

S1312a

Figure 7. SKY65172 48-Pin MCM Package Dimensions



- Notes:
1. Carrier tape material: black conductive polystyrene
 2. Cover tape material: transparent conductive PSA
 3. Cover tape size: 13.3 mm width
 4. All measurements are in millimeters

C1349

Figure 8. SKY65172 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number
SKY65172 400-2700 MHz Variable Gain Amplifier	SKY65172	*** TBD ***

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