PRELIMINARY DATA SHEET

SKY65185: 1.7 – 2.7 GHz Dual-Channel, Variable Gain Amplifier Front-End Module

Applications

- Cellular, 3G and LTE infrastructure
- Microwave radio
- Repeaters
- High performance radio links

Features

- Frequency range: 1.7 to 2.7 GHz
- Dual channel
- 6-bit digital step attenuator for each channel
- 31.5 dB control range with 0.5 dB step size
- Single DC supply: +5 V
- Internal RF match and bias circuits
- Small footprint, MCM (32-pin, 7 x 7 mm) package (MSL3, 260 °C per JEDEC J-STD-020)

Skyworks Pb-free products are compliant with all applicable legislation. For additional information, refer to *Skyworks Definition of Lead (Pb)-Free*, document number SQ04-0073.

Description

Skyworks SKY65185 is a high dynamic range receive Variable Gain Amplifier (VGA) Front-End Module (FEM) for 3G and LTE infrastructures and other applications that operate in the 1.7 to 2.7 GHz band.

The SKY65185 contains two Digital Step Attenuators (DSAs) and two Power Amplifiers (PAs). The DSA is a 6-bit attenuator with an 0.5 dB step size that provides 31.5 dB of total attenuation. The DSA is controlled using an on-chip Serial Peripheral Interface (SPI) logic circuit.

The SKY65185 is provided in a 32-pin, 7 x 7 mm Multi-Chip Module (MCM) package, which allows for a highly manufacturable low cost solution. The device package and pinout for the 32-pin MCM are shown in Figure 1. A block diagram of the SKY65185 is shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

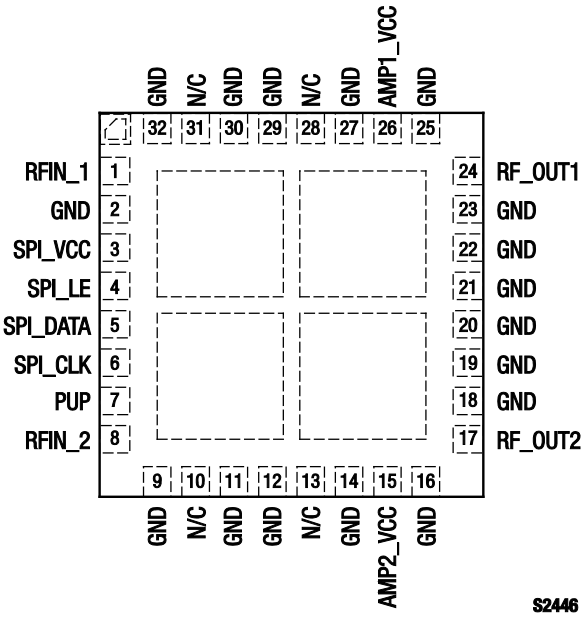


Figure 1. SKY65185 Pinout – 32-Pin MCM (Top View)

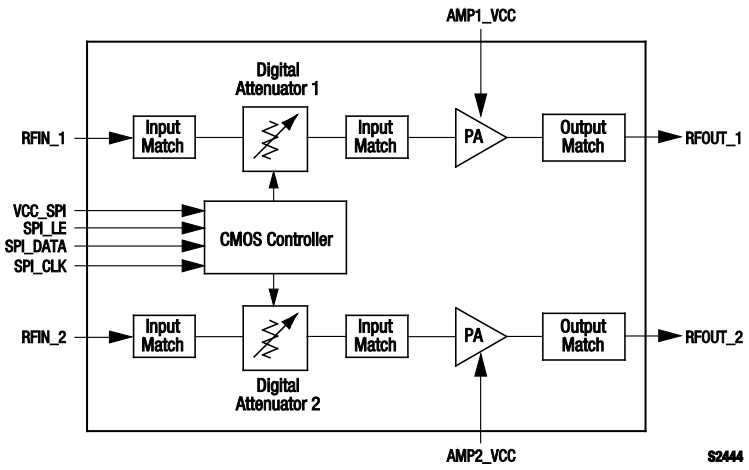


Figure 2. SKY65185 Block Diagram

Table 1. SKY65185 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RF_IN1	RF input 1	17	RF_OUT2	RF output 2
2	GND	Ground	18	GND	Ground
3	SPI_VCC	Supply voltage for SPI	19	GND	Ground
4	SPI_LE	Serial latch enable input	20	GND	Ground
5	SPI_DATA	Serial data input	21	GND	Ground
6	SPI_CLK	Serial clock input	22	GND	Ground
7	PUP	Power-up states	23	GND	Ground
8	RF_IN2	RF input 2	24	RF_OUT1	RF output 1
9	GND	Ground	25	GND	Ground
10	N/C	No connection	26	AMP1_VCC	Supply voltage for amplifier 1
11	GND	Ground	27	GND	Ground
12	GND	Ground	28	N/C	No connection
13	N/C	No connection	29	GND	Ground
14	GND	Ground	30	GND	Ground
15	AMP2_VCC	Supply voltage for amplfier 2	31	N/C	No connection
16	GND	Ground	32	GND	Ground

Technical Description

The SKY65185 VGA FEM contains all of the needed RF matching and DC biasing circuits. The device is a dual-channel,digitally controlled VGA that features high linearity and a low Noise Figure (NF). These features make the device suitable for 3G infrastructures and other applications operating in the 1.7 to 2.7 GHz frequency range.

Serial I/O Control Interface

The three-wire serial bus consists of the SPI_CLK, SPI_LE, and SPI_DATA control signals. The serial bus timing is shown in Figure 3. Timing parameters are defined in Table 2. The serial data is sent MSB first and should be sampled with the rising edge of the serial clock (SPI_CLK). The rising edge of the latch enable (SPI_LE) signal should be used to capture the data into holding registers.

Serial data is formatted as a 12-bit word. As shown in Figure 3, the 12-bit word contains logic for both attenuators. Each word contains the following sequence:

Attenuator 1:

Bit[11]: attenuation = 16 dB

Bit[10]: attenuation = 8 dB

Bit[9]: attenuation = 4 dB

Bit[8]: attenuation = 2 dB

Bit[7]: attenuation = 1 dB

Bit[6]: attenuation = 0.5 dB

Attenuator 2:

Bit[5]: attenuation = 16 dB

Bit[4]: attenuation = 8 dB

Bit[3]: attenuation = 4 dB

Bit[2]: attenuation = 2 dB

Bit[1]: attenuation = 1 dB

Bit[0]: attenuation = 0.5 dB

The minimum attenuation (0 dB) for each attenuator is achieved using the binary data sequence 111111b. Maximum attenuation (31.5 dB) corresponds to the binary data sequence 000000b (refer to Tables 5 and 6).

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65185 are provided in Table 3. Electrical specifications are provided in Table 4.

Typical performance characteristics are shown in Figures 4 through 9.

Table 5 provides RF performance specifications at key operating frequencies. The state of the SKY65185 is determined by the attenuation logic provided in Table 6 (DSA 1) and Table 7 (DSA 2), and the power-up logic provided in Table 8.

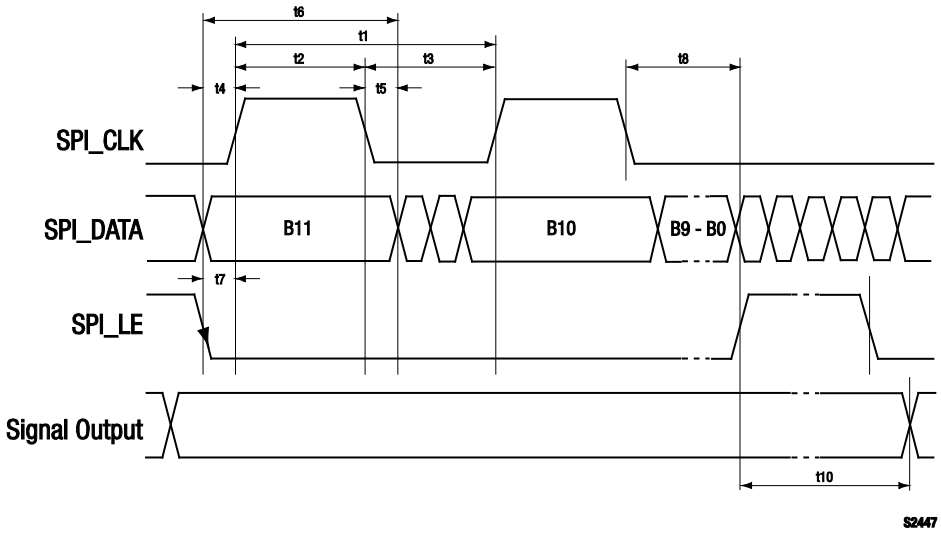


Figure 3. Serial Input Timing Diagram

Table 2. Serial Input Timing Parameters

Parameter	Value	Description
t1	25 MHz maximum	Clock frequency
t2	20 ns minimum	CLK high
t3	20 ns minimum	CLK low
t4	5 ns minimum	DATA to CLK setup time
t5	5 ns minimum	DATA to CLK hold time
t6	30 ns minimum	DATA valid
t7	5 ns minimum	LE to CLK setup time
t8	5 ns minimum	CLK to LE setup time
t9	10 ns minimum	LE pulse width
t10	20 ns minimum	Output set

Table 3. SKY65185 Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	AMP1_VCC, AMP2_VCC	4.0	5.5	V
RF input power	P_{IN}		+14	dBm
Operating temperature	T_C	–40	+85	°C
Storage temperature	T_{ST}	–65	+150	°C
Junction temperature	T_J		+150	°C

Note 1: 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 4. SKY65185 Electrical Specifications (1 of 2) (Note 1)
(V_{CC} = 5 V, T_C = +25 °C, f = 2100 MHz, Attenuation = 0 dB, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Operating frequency range	f		1.7		2.7	GHz
Small signal gain	$\|S_{21}\|$	Minimum attenuation		15		dB
Gain variation over temperature		Minimum attenuation	–0.5		+0.5	dB
Attenuation				31.5		dB
Attenuation step				0.5		dB
Attenuation step error				0.1 ± 5%		dB
3rd Order Output Intercept Point	OIP3	Output power = 0 dBm, frequency spacing = 10 MHz	+37	+41		dBm
1 dB Output Compression Point	OP1dB	Minimum attenuation		+26		dBm

Table 4. SKY65185 Electrical Specifications (2 of 2) (Note 1)
(Vcc = 5 V, Tc = +25 °C, f = 2100 MHz, Attenuation = 0 dB, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Noise Figure	NF	Minimum attenuation		4.5		dB
Input return loss	|S11|		10	13		dB
Output return loss	|S22|		10	12		dB
Gain flatness		Over 100 MHz		0.5		dB
Supply voltage	AMP1_VCC, AMP2_VCC		4.75	5.00	5.50	V
Quiescent current	I_Q	No RF input		165		mA
Channel isolation		RF_IN1 to RF_OUT2, RF_IN2 to RF_OUT1		43		dB

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

Typical Performance Characteristics

(Vcc = 5 V, Tc = +25 °C, Unless Otherwise Noted)

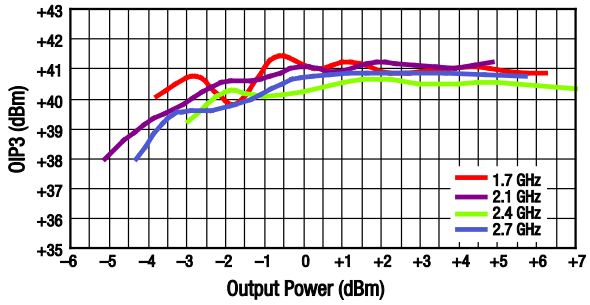


Figure 4. OIP3 vs Output Power Over Frequency

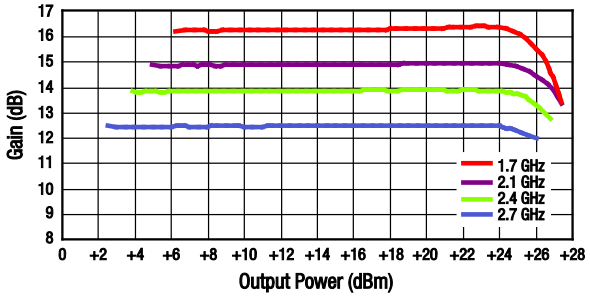


Figure 5. Gain vs Output Power Over Frequency

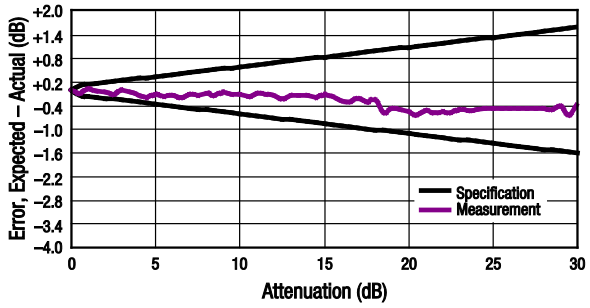


Figure 6. Attenuation Accuracy vs Attenuation Setting @ 1700 MHz

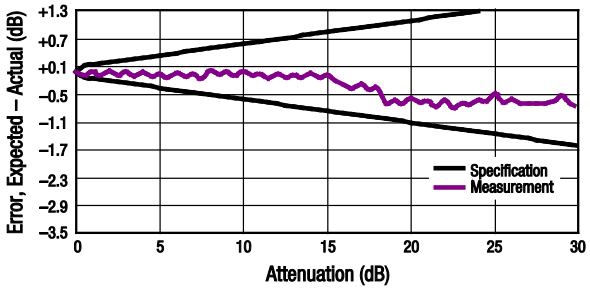


Figure 7. Attenuation Accuracy vs Attenuation Setting @ 2100 MHz

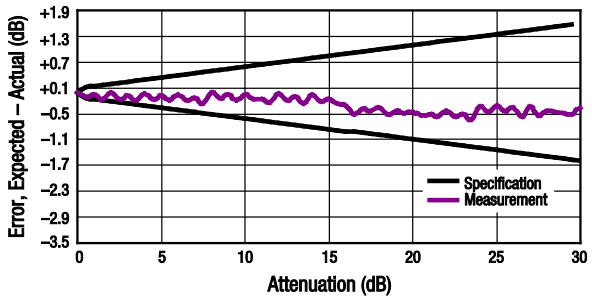


Figure 8. Attenuation Accuracy vs Attenuation Setting @ 2400 MHz

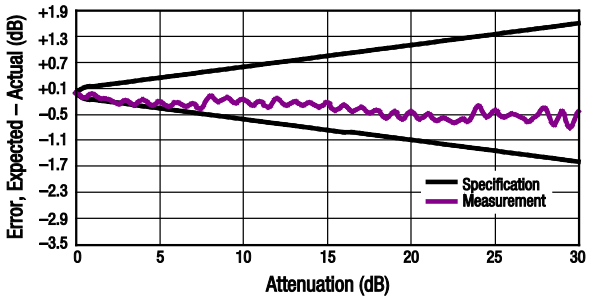


Figure 9. Attenuation Accuracy vs Attenuation Setting @ 2700 MHz

Table 5. Typical RF Performance at Key Operating Frequencies

Parameter	Symbol	Operating Frequency (MHz)	Min	Typical	Max	Units
Small signal gain	|S21|	1700 2100 2400 2700		16.2 15.0 14.0 12.5		dB dB dB dB
1 dB Output Compression Point	OP1dB	1700 2100 2400 2700		+26.3 +26.9 +26.7 +26.5		dBm dBm dBm dBm
3rd Order Output Intercept Point (output power = 0 dBm, 10 MHz spacing)	OIP3	1700 2100 2400 2700		+40.7 +41.0 +40.2 +40.5		dBm dBm dBm dBm
Noise Figure	NF	1700 2100 2400 2700		4.4 4.4 4.7 5.1		dB dB dB dB

Table 6. Attenuation Logic Truth Table (DSA 1)

Attenuator Control Word (Channel 1)						Attenuation Relative to Maximum Gain (dB)
B11 (MSB)	B10	B9	B8	B7	B6 (LSB)	
1	1	1	1	1	1	0
1	1	1	1	1	0	0.5
1	1	1	1	0	1	1.0
1	1	1	0	1	1	2.0
1	1	0	1	1	1	4.0
1	0	1	1	1	1	8.0
0	1	1	1	1	1	16.0
0	0	0	0	0	0	31.5

Table 7. Attenuation Logic Truth Table (DSA 2)

Attenuator Control Word (Channel 2)						Attenuation Relative to Maximum Gain (dB)
B5 (MSB)	B4	B3	B2	B1	B0 (LSB)	
1	1	1	1	1	1	0
1	1	1	1	1	0	0.5
1	1	1	1	0	1	1.0
1	1	1	0	1	1	2.0
1	1	0	1	1	1	4.0
1	0	1	1	1	1	8.0
0	1	1	1	1	1	16.0
0	0	0	0	0	0	31.5

Table 8. Power-Up (PUP) Logic Truth Table

SPI_LE (Pin 1)	PUP (Pin 4)	Power-Up Relative to Maximum Gain (dB)
0	0	0
0	1	31.5
1	x	31.5 to approx. 0

Evaluation Board Description

The SKY65185 Evaluation Board is used to test the performance of the SKY65185 VGA FEM. A schematic diagram of the SKY65185 Evaluation Board is shown in Figure 10. An assembly drawing for the Evaluation Board is shown in Figure 11 and the layer detail is provided in Figure 12.

Package Dimensions

The PCB layout footprint for the SKY65185 is provided in Figure 13. Package dimensions for the 32-pin MCM are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

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 SKY65185 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 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.

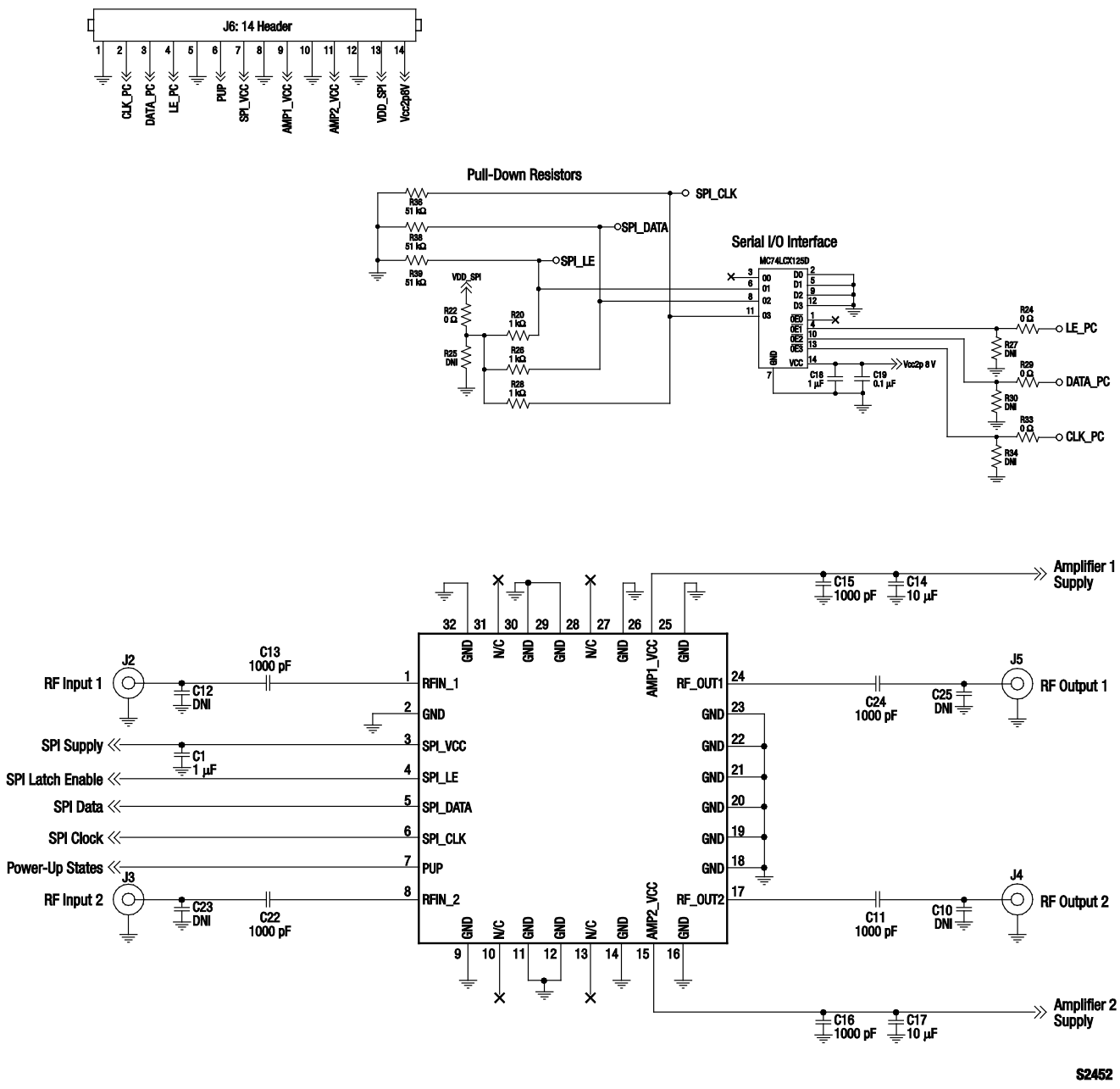


Figure 10. SKY65185 Evaluation Board Schematic

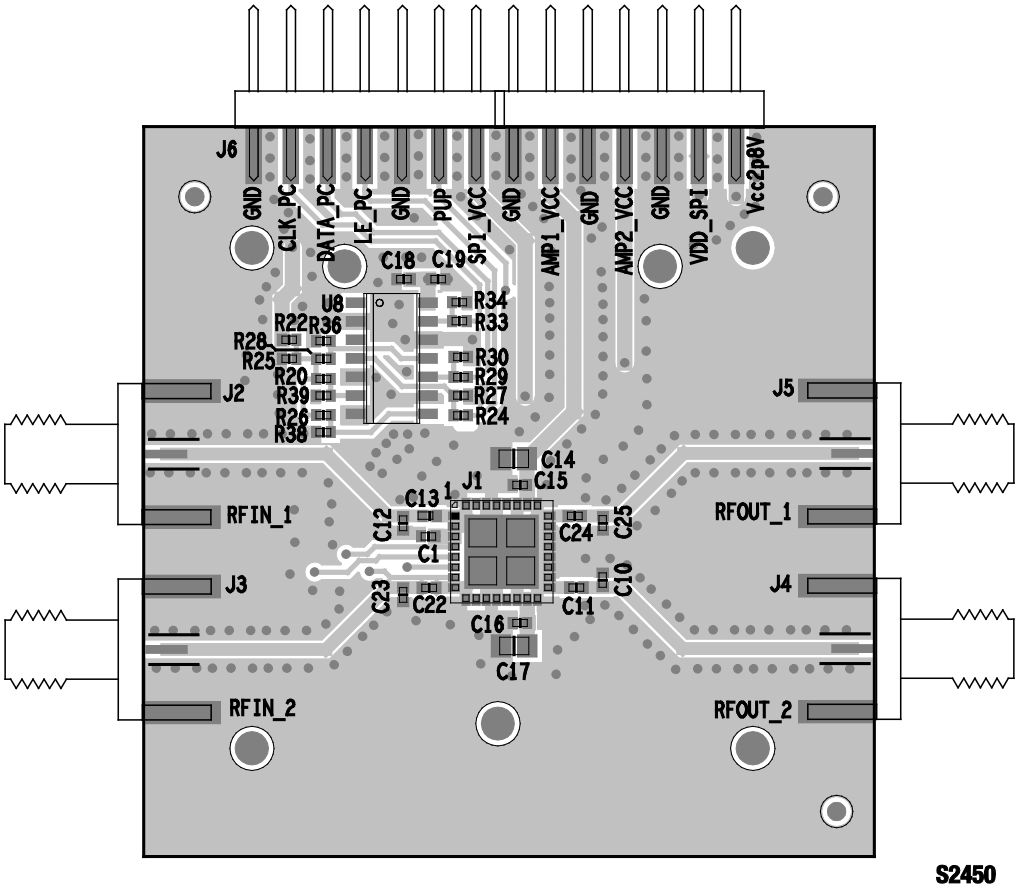
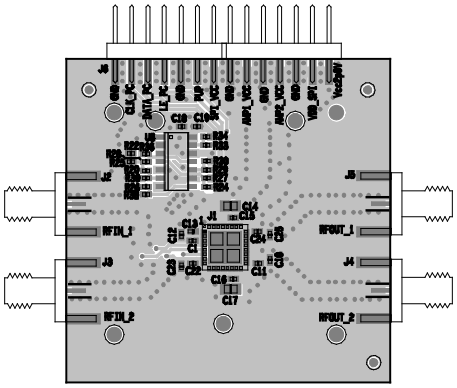
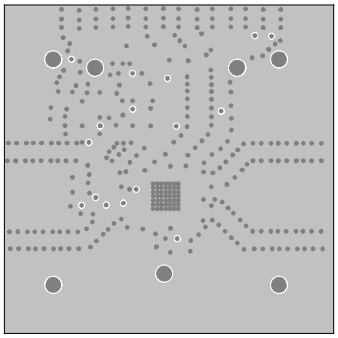


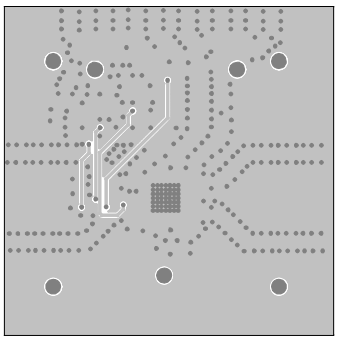
Figure 11. SKY65185 Evaluation Board Assembly Drawing



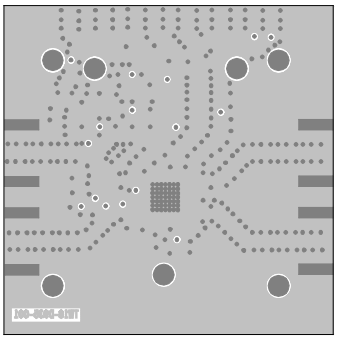
Layer 1: Top – Metal



Layer 2: Ground Plane



Layer 3: Signal Traces



Layer 4: Bottom Ground Plane

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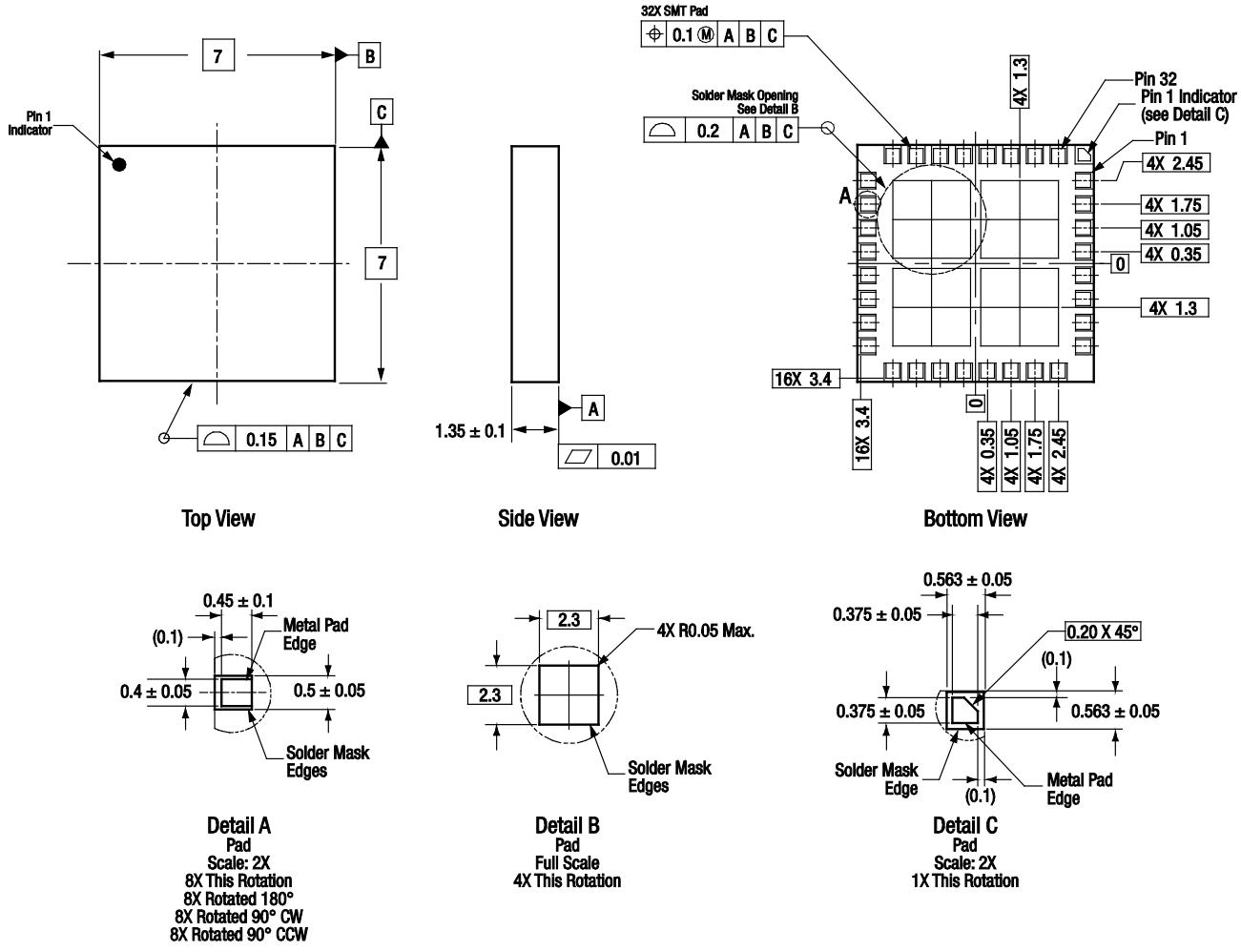
Figure 12. SKY65185 Evaluation Board Layer Detail

*** TBD ***

Figure 13. SKY65185 PCB Layout Footprint



All measurements are in millimeters
Dimensioning and tolerancing according to ASME Y14.5M-1994
Pads are metal-defined

S2554

Figure 14. SKY65185 32-Pin MCM Package Dimensions

*** TBD ***

Figure 15. SKY65185 32-Pin MCM Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65185 Dual-Channel VGA FEM	SKY65185	TW18-D930-001