



DATA SHEET

SKY65183-11: 2400 – 2700 MHz Transmit Variable Gain Amplifier Front-End Module

Applications

- LTE base stations
- WiMAX base stations and access points
- Zigbee® base stations

Features

- Transmit output power: >+20 dBm
- 6-bit digital step attenuator
- Programmable transmit power levels: 31.5 dB gain control range @ 0.5 dB step size
- High gain: 40 dB
- High OIP3: +40 dBm
- Single DC supply: 5 V
- Internal RF match and bias circuits
- Small footprint, MCM (28-pin, 6 x 6 mm) package (MSL3, 260 °C per JEDEC J-STD-020)

Description

Skyworks SKY65183-11 is a high dynamic range transmit Variable Gain Amplifier (VGA) Front-End Module (FEM) for Long-Term Evolution (LTE) and other applications that operate in the 2400 to 2700 MHz band.

The SKY65183-11 contains a Digital Step Attenuator (DSA) 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 two PAs enable high gain (>40 dB) and high linearity (>+40 dBm) at minimum attenuator settings.

The SKY65183-11 is provided in a 28-pin, 6 x 6 mm Multi-Chip Module (MCM) package, which allows for a highly manufacturable low cost solution. A block diagram of the SKY65183-11 is shown in Figure 1. The device package and pinout for the 28-pin MCM are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.



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.

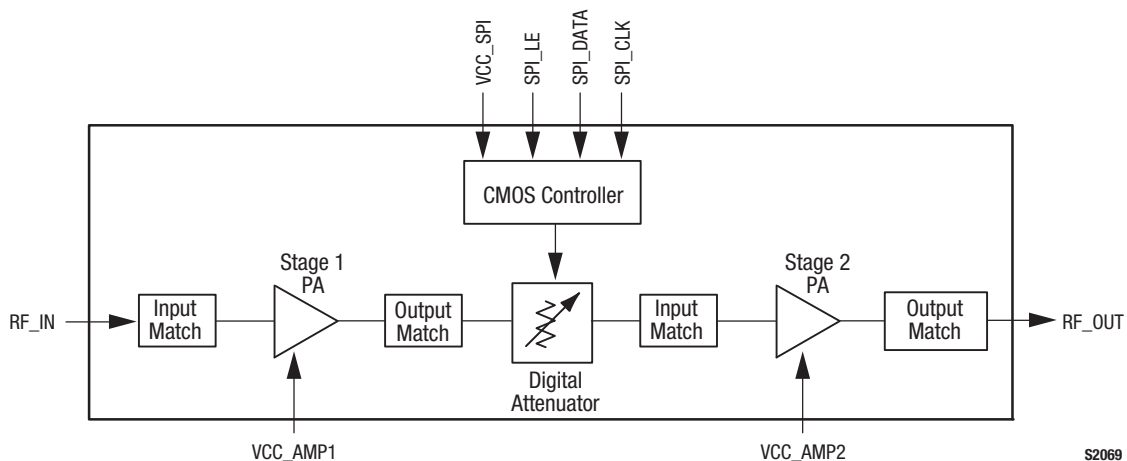


Figure 2. SKY65183-11 Block Diagram

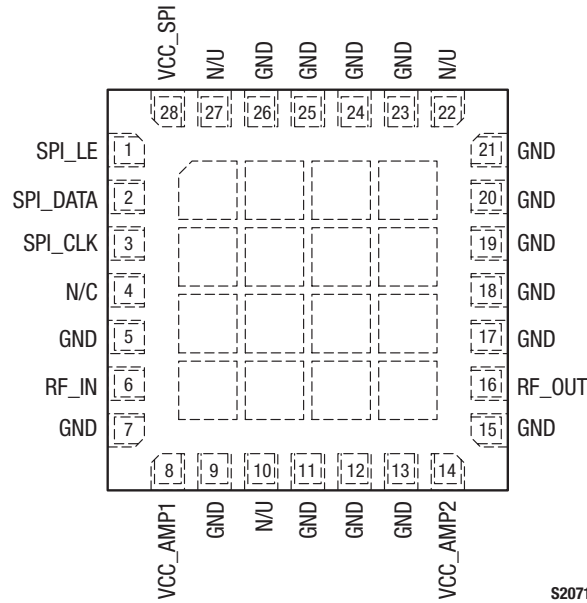


Figure 1. SKY65183-11 Pinout – 28-Pin MCM (Top View)

Table 1. SKY65183-11 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	SPI_LE	Serial latch enable input	15	GND	Ground
2	SPI_DATA	Serial data input	16	RF_OUT	RF output
3	SPI_CLK	Serial clock input	17	GND	Ground
4	N/C	No connect	18	GND	Ground
5	GND	Ground	19	GND	Ground
6	RF_IN	RF input	20	GND	Ground
7	GND	Ground	21	GND	Ground
8	VCC_AMP1	Supply voltage for amplifier 1	22	N/U	Not used (Note 1)
9	GND	Ground	23	GND	Ground
10	N/U	Not used (Note 1)	24	GND	Ground
11	GND	Ground	25	GND	Ground
12	GND	Ground	26	GND	Ground
13	GND	Ground	27	N/U	Not used (Note 1)
14	VCC_AMP2	Supply voltage for amplifier 2	28	VCC_SPI	Supply voltage for SPI and DSA

Note 1: Can be left floated or connected to ground.

Technical Description

The SKY65183-11 VGA FEM contains all of the needed RF matching and DC biasing circuits. The device is a two-stage, HBT InGaP device optimized for high linearity and high gain. These features make the device suitable for LTE and other applications operating in the 2400 to 2700 MHz 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 6-bit word. As shown in Figure 3, the 6-bit word contains logic for the attenuator setting. Each word contains the following sequence:

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

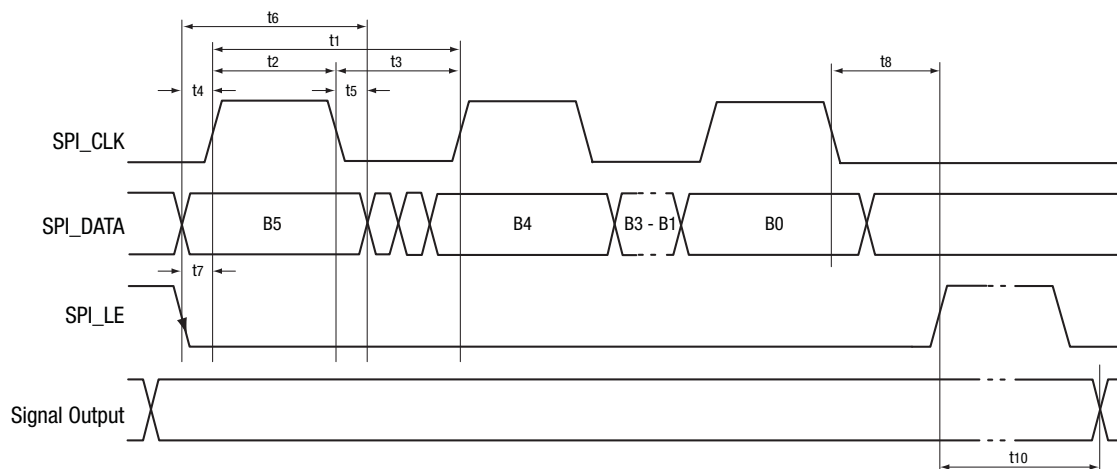
The minimum attenuation (0 dB) is achieved using the binary data sequence 111111b. Maximum attenuation (31.5 dB) corresponds to the binary data sequence 000000b (refer to Table 5).

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65183-11 are provided in Table 3. The recommended operating conditions are specified in Table 4 and electrical specifications are provided in Table 5.

Typical performance characteristics are shown in Figures 4 through 12.

The state of the SKY65183-11 is determined by the attenuation logic provided in Table 6.



S2076a

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. SKY65183-11 Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC_AMP1, VCC_AMP2	4.0	5.5	V
RF input power	P _{IN}		+5	dBm
RF output power	P _{OUT}		+31	dBm
Operating temperature	T _c	-40	+85	°C
Storage temperature	T _{ST}	-65	+150	°C
Junction temperature	T _J		+150	°C
Thermal resistance	J _C		25	°C/W

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. SKY65183-11 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Operating frequency range	f	2400		2700	MHz
Supply voltage	VCC_AMP1, VCC_AMP2, VCC_SPI	4.75	5.00	5.25	V
SPI control signals	SPI_LE, SPI_DATA, SPI_CLK	1.4		5.0	V
Operating temperature	T _A	-40	+25	+85	°C

Table 5. SKY65183-11 Electrical Specifications (Note 1)

(VCC_AMP1 = VCC_AMP2 = 5 V, Tc = +25 °C, f = 2550 MHz, Attenuation = 0 dB, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Small signal gain	IS21I	P _{IN} = -30 dBm, Minimum attenuation		40	42	dB
Gain variation over temperature		Minimum attenuation	-3		+3	dB
Attenuation			30.0	31.5		dB
Attenuation step			0.3	0.5	0.7	dB
Attenuation step error				0.1 ± 0.5%		dB
Output power for ACLR < -65 dBc		WCDMA test mode 1		+10		dBm
3 rd Order Output Intercept Point	OIP3	P _{OUT} = +10 dBm, frequency spacing = 10 MHz	+40	+41		dBm
1 dB Output Compression Point	OP1dB	Minimum attenuation	+27.0	+28.3		dBm
Noise Figure	NF	Minimum attenuation		3	5	dB
Input return loss	IS11I	P _{IN} = -30 dBm	10	15		dB
Output return loss	IS22I	P _{IN} = -30 dBm	10	15		dB
Gain flatness		Over 100 MHz		0.7		dB
Quiescent current	I _{CO}	No RF input		410	440	mA
Operating current	I _{CC}	P _{OUT} = +10 dBm		410	450	mA

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

Typical Performance Characteristics

(VCC_AMP1 = VCC_AMP2 = 5 V, Tc = +25 °C, f = 2550 MHz, Attenuation = 0 dB, Unless Otherwise Noted)

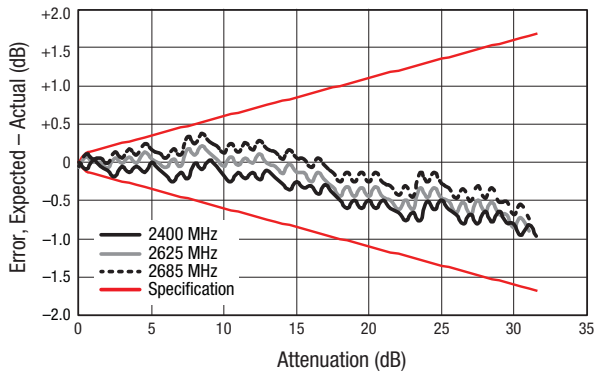


Figure 4. Cascaded Attenuation Accuracy vs Attenuation Setting (Spec = 0-.1 + 5%)

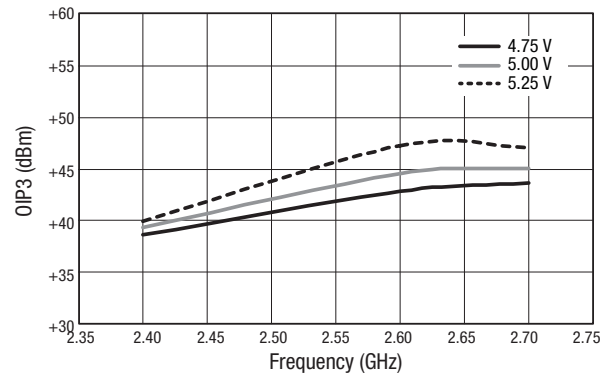


Figure 5. OIP3 vs Frequency Over Voltage

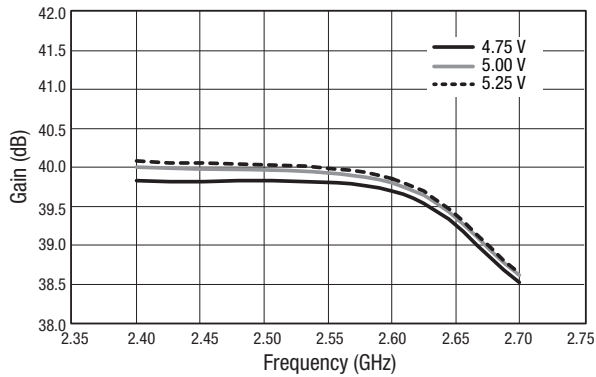


Figure 6. Gain vs Frequency Over Voltage

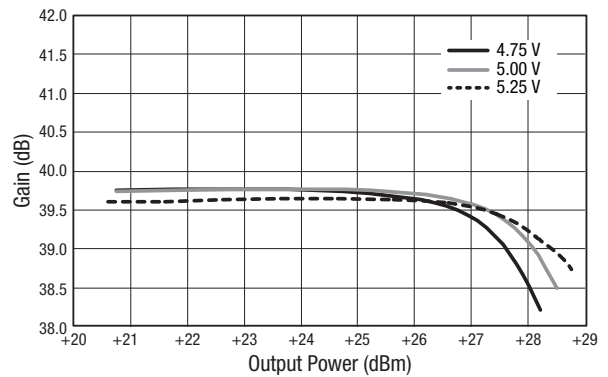


Figure 7. Gain vs Output Power Over Voltage

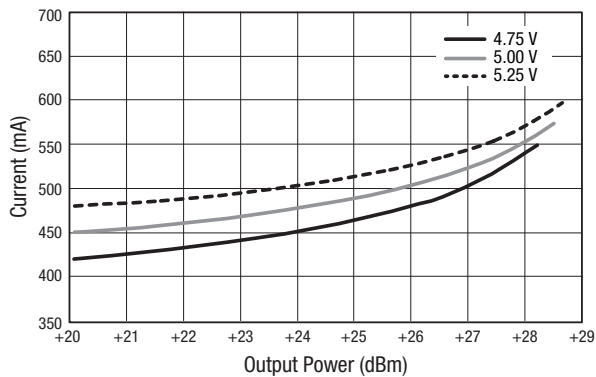


Figure 8. Current vs Output Power Over Voltage

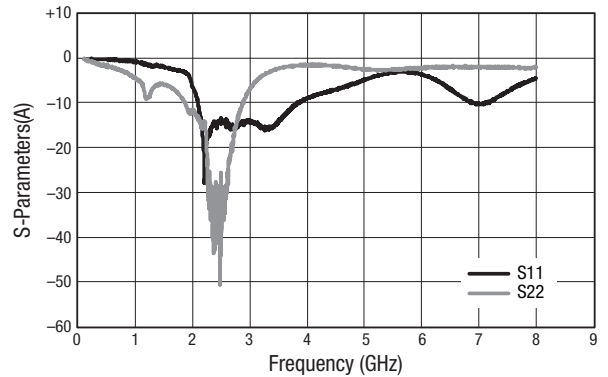


Figure 9. S-Parameters vs Frequency

Table 6. Attenuation Logic Truth Table

SPI Programming Word						Attenuation
B5 (MSB)	B4	B3	B2	B1	B0 (LSB)	Relative to Maximum Gain (dB)
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

Evaluation Board Description

The SKY65183-11 Evaluation Board is used to test the performance of the SKY65183-11 VGA FEM. A schematic diagram of the SKY65183-11 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 SKY65183-11 is provided in Figure 13. Package dimensions for the 28-pin MCM are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

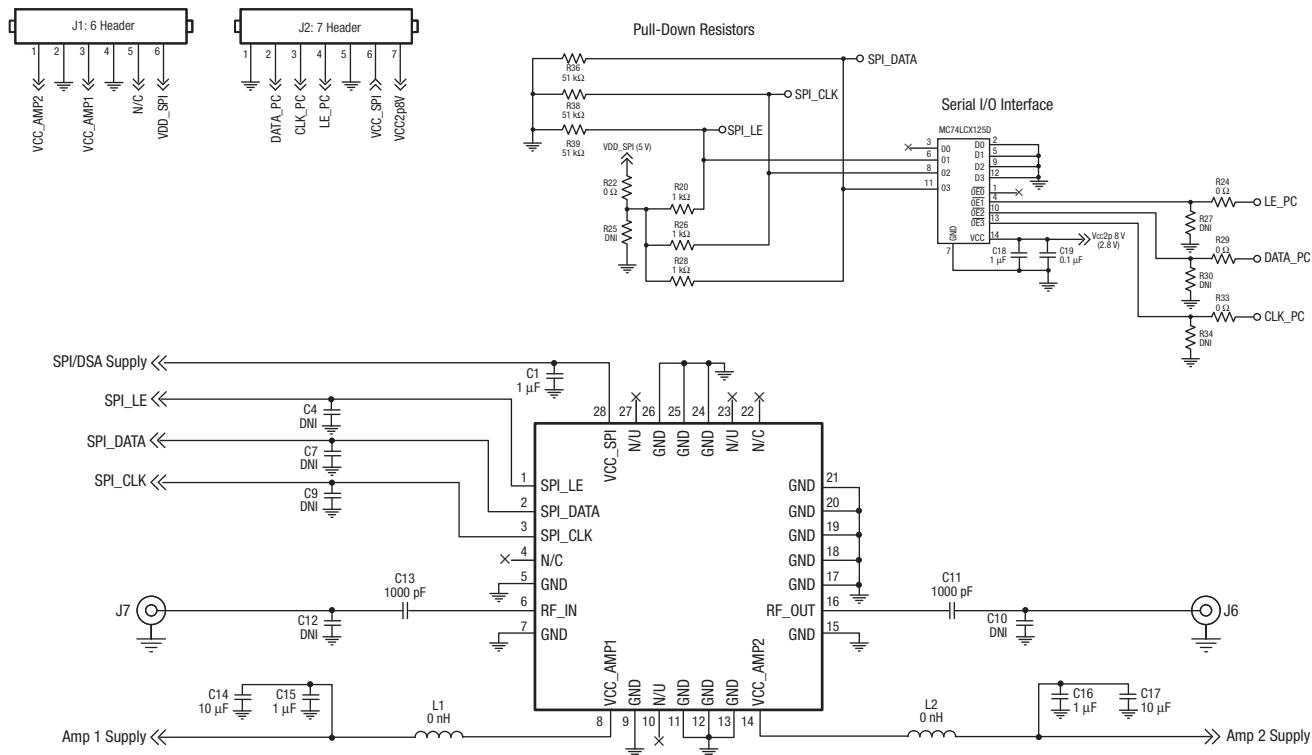
Package and Handling Information

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 SKY65183-11 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.

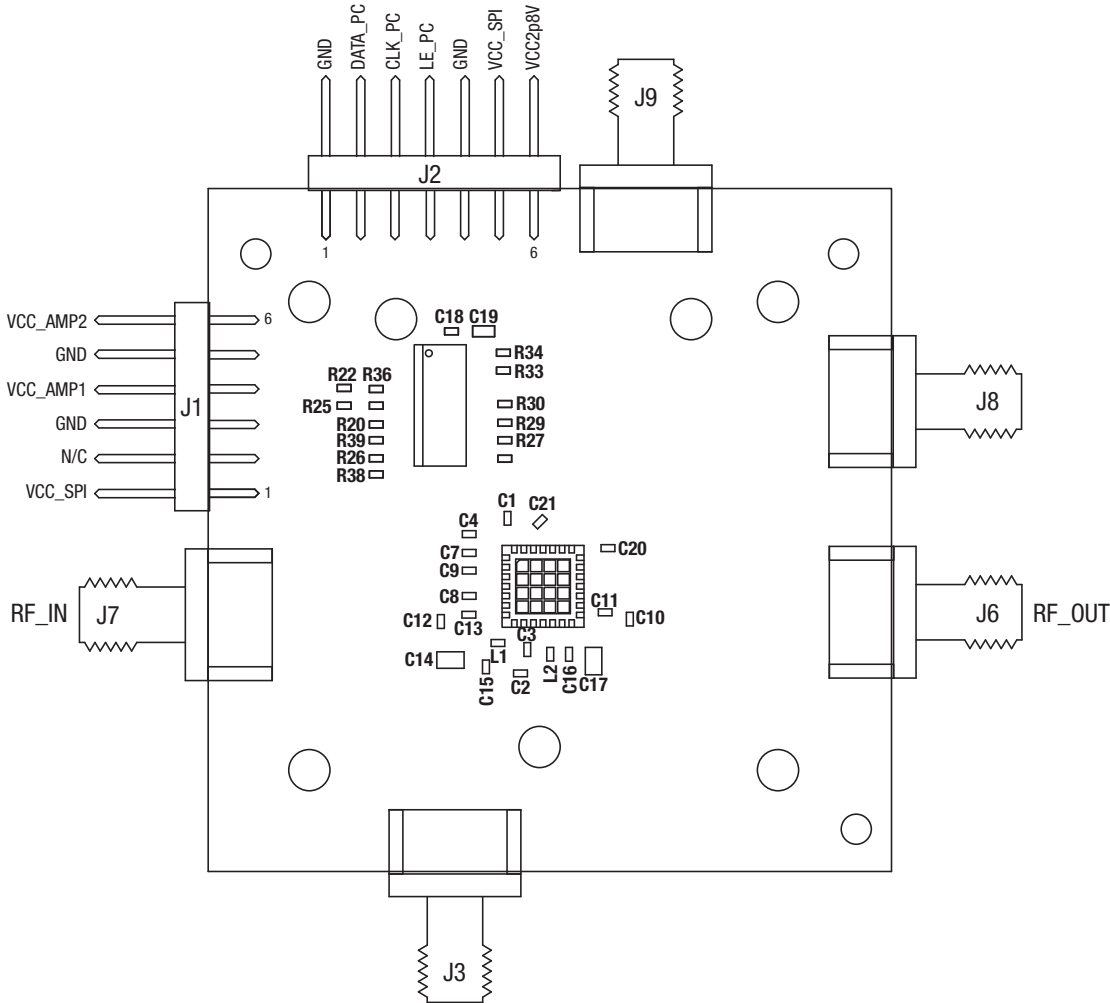
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

DATA SHEET • SKY65183-11 TRANSMIT VGA FEM



S2085

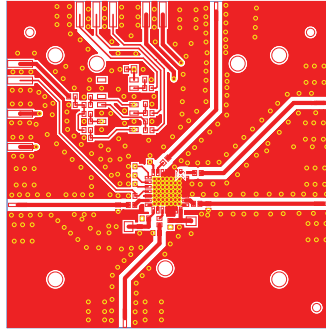
Figure 10. SKY65183-11 Application Schematic



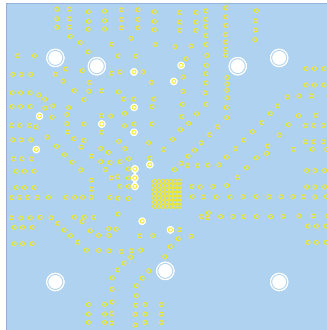
Note: J-connectors J3, J8, and J9 and not used.

S2083

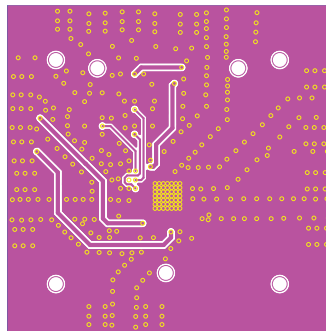
Figure 11. SKY65183-11 Evaluation Board Assembly Drawing



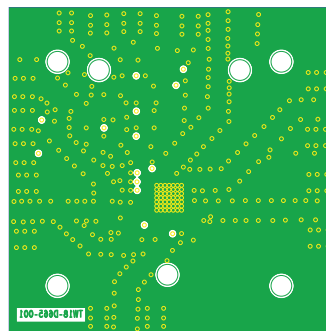
Layer 1: Top – Metal



Layer 2: Ground



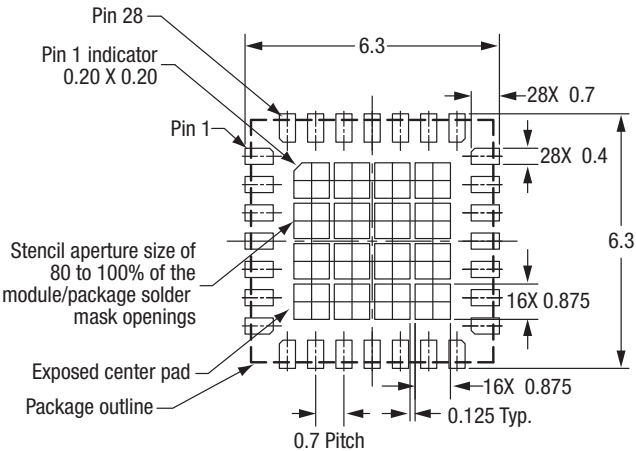
Layer 3: Power Plane



Layer 4: Solid Ground Plane

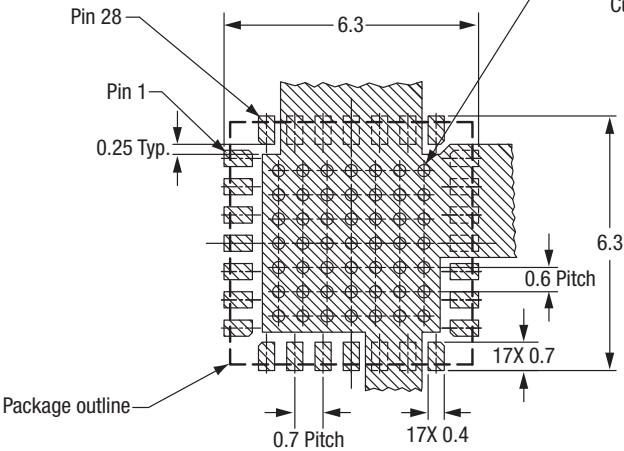
S2084

Figure 12. SKY65183-11 Evaluation Board Layer Detail

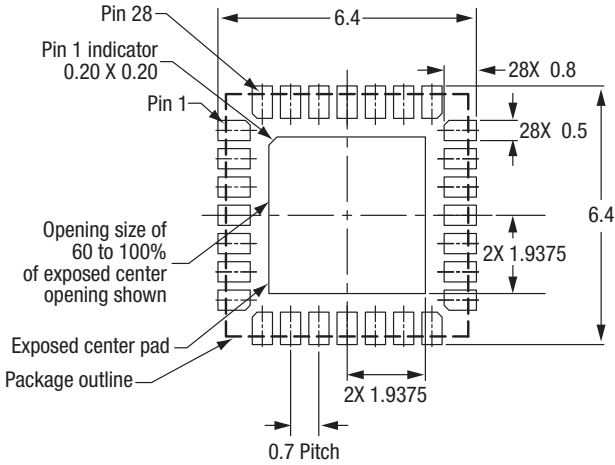


Stencil Aperture Top View

Thermal via array $\varnothing 0.3$ mm on 0.6 mm pitch will improve thermal performance.
 NOTE: thermal vias should be tented with solder mask, 30-35 μ m Cu plating recommended.



Metallization Top View

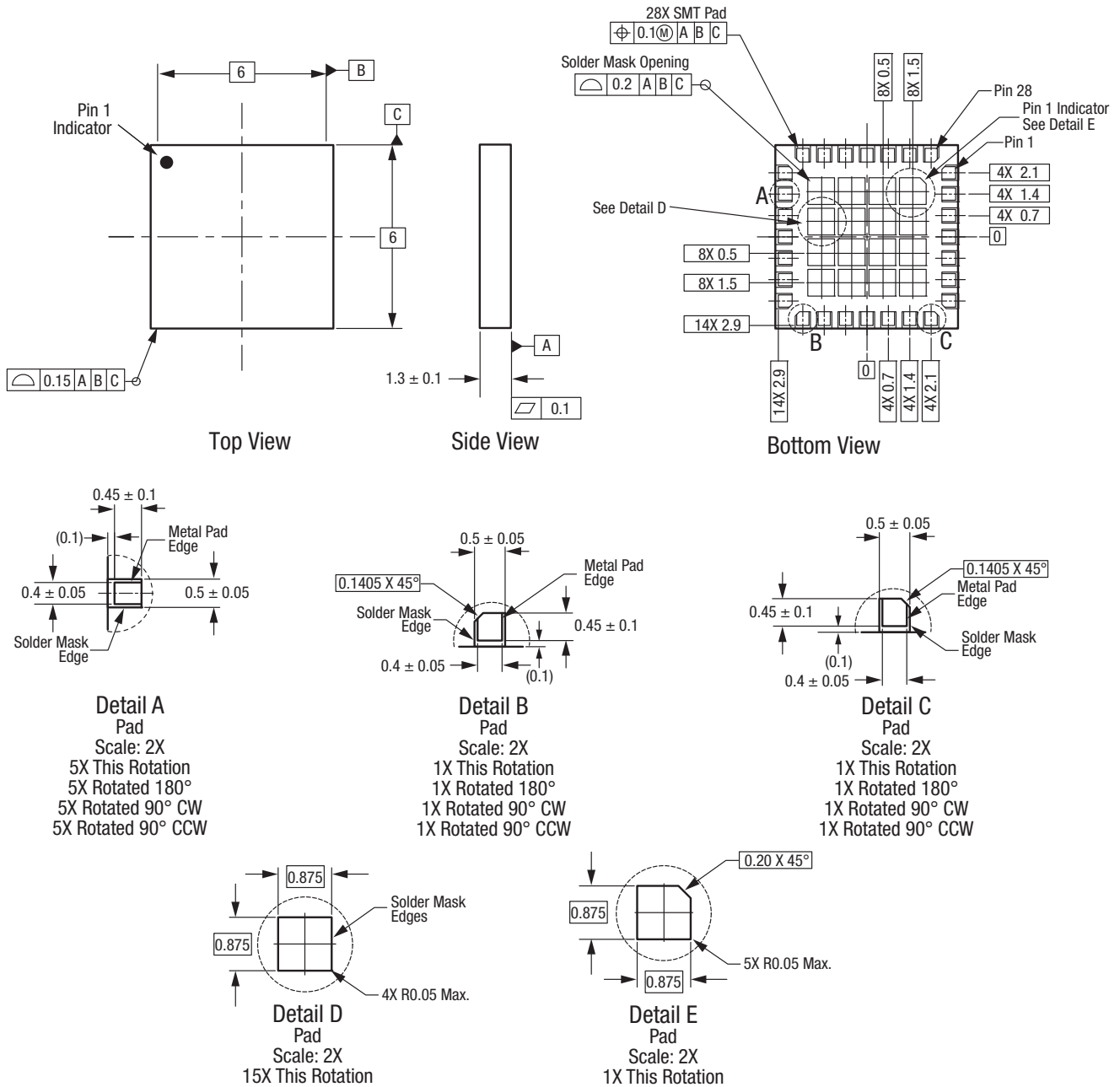


Solder Mask Opening Top View

All dimensions are in millimeters

S2919

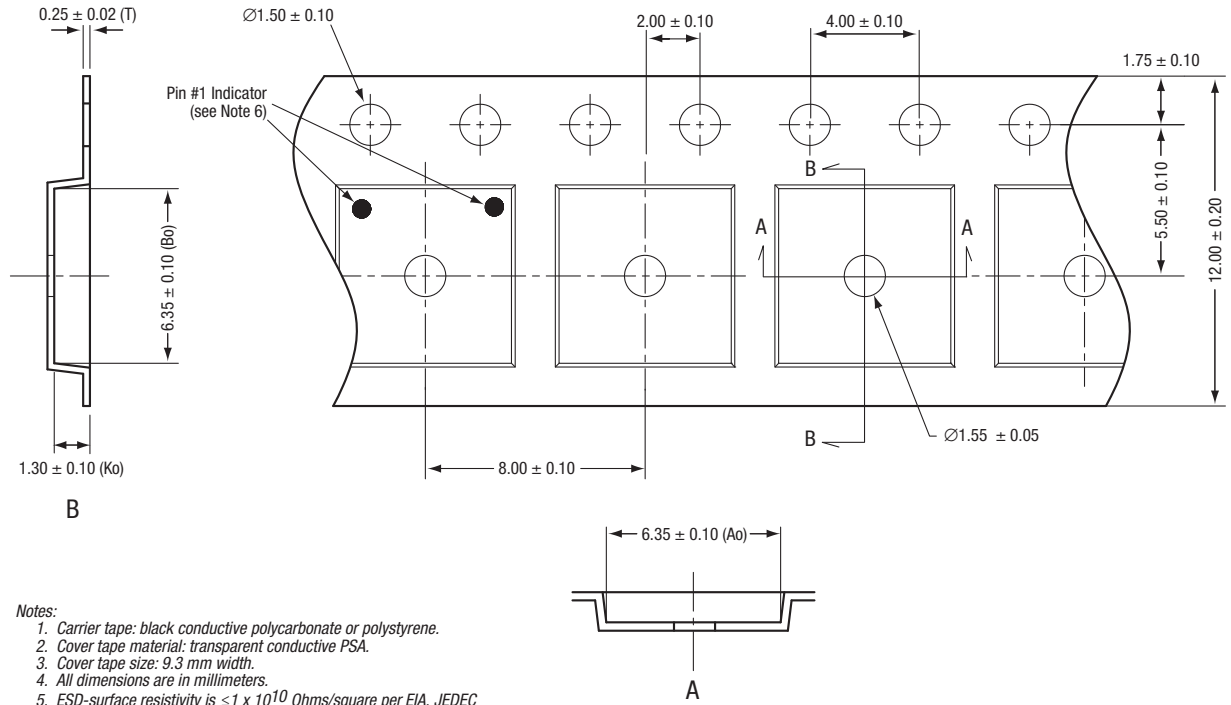
Figure 13. SKY65183-11 PCB Layout Footprint



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

S2070

Figure 14. SKY65183-11 28-Pin MCM Package Dimensions



- Notes:
1. Carrier tape: black conductive polycarbonate or polystyrene.
 2. Cover tape material: transparent conductive PSA.
 3. Cover tape size: 9.3 mm width.
 4. All dimensions are in millimeters.
 5. ESD-surface resistivity is $\leq 1 \times 10^{10}$ Ohms/square per EIA, JEDEC TNR Specification.
 6. Pin 1 orientation is in top left corner for the following Skyworks products:

SKY73022-21, -31
SKY73023-21, -31

For all other 6 x 6 mm MCM/RFLGA products, pin 1 orientation is in top right corner.

S1850

Figure 15. SKY65183-11 28-Pin MCM Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65183-11 VGA FEM	SKY65183-11	TW18-D665-001

Copyright © 2010, 2011, 2012 Skyworks Solutions, Inc. All Rights Reserved.

Information in this document is provided in connection with Skyworks Solutions, Inc. (“Skyworks”) products or services. These materials, including the information contained herein, are provided by Skyworks as a service to its customers and may be used for informational purposes only by the customer. Skyworks assumes no responsibility for errors or omissions in these materials or the information contained herein. Skyworks may change its documentation, products, services, specifications or product descriptions at any time, without notice. Skyworks makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Skyworks assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Skyworks products, information or materials, except as may be provided in Skyworks Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS AND INFORMATION ARE PROVIDED “AS IS” WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. SKYWORKS DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. SKYWORKS SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Skyworks products are not intended for use in medical, lifesaving or life-sustaining applications, or other equipment in which the failure of the Skyworks products could lead to personal injury, death, physical or environmental damage. Skyworks customers using or selling Skyworks products for use in such applications do so at their own risk and agree to fully indemnify Skyworks for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Skyworks products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Skyworks assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Skyworks products outside of stated published specifications or parameters.

Skyworks, the Skyworks symbol, and “Breakthrough Simplicity” are trademarks or registered trademarks of Skyworks Solutions, Inc., in the United States and other countries. Third-party brands and names are for identification purposes only, and are the property of their respective owners. Additional information, including relevant terms and conditions, posted at www.skyworksinc.com, are incorporated by reference.