

DATA SHEET

SKY65900-11: 2.4 to 2.5 GHz +28 dBm WLAN Power Amplifier

Applications

- IEEE 802.11 b/g/n WLANs
- ISM band transmitters
- Wireless access point, routers, gateways

Features

- DEVM = 3% for P_{OUT} = +28 dBm @ 5 V
- High gain = 34 dB @ 5 V
- Internal active-bias circuits
- Internal on/off control circuit
- Internal load-insensitive power detector
- Small QFN (16-pin, 4 x 4 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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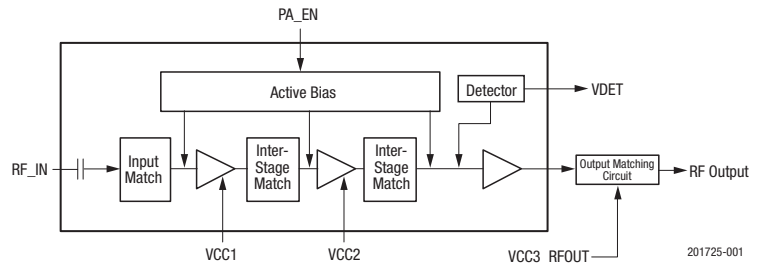


Figure 1. SKY65900-11 Block Diagram

Description

The SKY65900-11 is a Microwave Monolithic Integrated Circuit (MMIC) Power Amplifier (PA) with superior output power, linearity, and efficiency. These features make the SKY65900-11 ideal for Wireless Local Area Network (WLAN) applications. The high linearity (low EVM) and high efficiency of this device make it ideal for use in the transmit chain of WLAN access points or modems.

The SKY65900-11 is fabricated using Skyworks high reliability Heterojunction Bipolar Transistor (HBT) InGaP process, which allows for single supply operation while maintaining high efficiency and good linearity. The device is internally matched at the RF input and mounted in a 16-pin, 4 x 4 mm Quad Flat No-Lead (QFN) surface-mount technology (SMT) package, which allows for a highly manufacturable low-cost solution.

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.

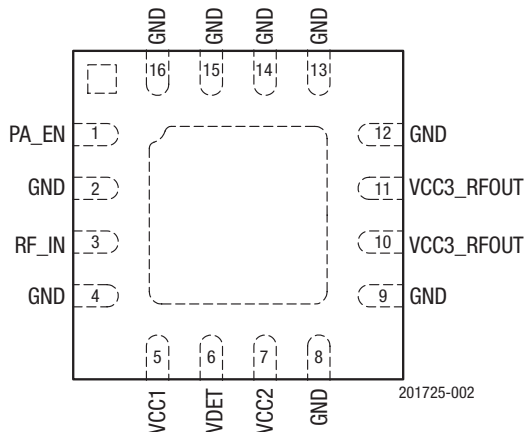


Figure 2. SKY65900-11 Pinout (Top View)

Table 1. SKY65900-11 Signal Descriptions¹

Pin	Name	Description	Pin	Name	Description
1	PA_EN	Digital enable	9	GND	Ground
2	GND	Ground	10	VCC3_RFOUT	Stage three collector voltage and RF output
3	RF_IN	RF input	11	VCC3_RFOUT	Stage three collector voltage and RF output
4	GND	Ground	12	GND	Ground
5	VCC1	Stage 1 collector voltage	13	GND	Ground
6	VDET	Detector voltage	14	GND	Ground
7	VCC2	Stage 2 collector voltage	15	GND	Ground
8	GND	Ground	16	GND	Ground

¹ The center ground pad must have a low inductance and low thermal resistance connection to the printed circuit board ground plane.

Functional Description

The SKY65900-11 is a three-stage, HBT InGaP device optimized for high linearity and power efficiency. An in-module active bias circuit is included within the device for all three amplifier stages, which provides excellent gain tracking over temperature and voltage variations.

Each stage is supplied using the VCC1 (pin 5), VCC2 (pin 7), and VCC3_RFOUT (pins 10 and 11). The Evaluation Board includes shunt decoupling capacitors on these pins to suppress any possible bias effect on the RF signal at low frequencies.

The SKY65900-11 includes an internal PA enable control pin (pin 1) for fast RF on/off control. Zero volts turns off the PA while 1.8 to 3.6 V enables the PA. The device also provides an output power detector voltage, VDET, at pin 6.

Pin 3 is the RF input, and pins 10 and 11 are the RF outputs. External DC blocking or RF matching is required on the RF output. Grounding is through several ground pins and the package center ground.

These features make the device suitable for wideband digital applications where PA linearity and power consumption are of critical importance (e.g., WLANs). The device has been characterized with the highest specified data rates for 802.11b (11 Mbps) and 802.11g (54 Mbps). Under these stringent test conditions, the device exhibits excellent spectral purity and power efficiency.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65900-11 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

Typical performance characteristics for the SKY65900-11 are illustrated in Figures 3 through 9.

Table 2. SKY65900-11 Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
RF output power	P _{OUT}		+30	dBm
Supply voltage (VCC1, VCC2, VCC3_RFOUT)	V _{CC}	4.5	6.0	V
Total supply current @ P _{OUT} = +30 dBm	I _{CC}		1	A
Thermal resistance	Θ _{JC}		14.7	°C/W
Junction temperature	T _J		+170	°C
Case temperature	T _C	-40	+110	°C
Storage temperature	T _{STG}	-55	+125	°C
Electrostatic discharge: Human Body Model (HBM), Class 1B			500	V

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.

ESD HANDLING: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.

Table 3. SKY65900-11 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
RF output power	P _{OUT}		+28		dBm
Supply voltage (VCC1, VCC2, VCC3)	V _{CC}	4.50	5.00	5.25	V
PA enable		1.8	3.3	3.6	V
Operating frequency	f	2400		2500	MHz
Case temperature	T _C	-40	+25	+85	°C

Table 4. SKY65900-11 Electrical Specifications: 5.0 V Performance¹ (1 of 2)

(VCC1 = VCC2 = VCC3_RFOUT = 5 V, PA_EN = 3.3 V, T_C = 25 °C, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Continuous Wave Input Signal						
Quiescent current	I _{CCA}	@ 5 V		275		mA
Operational current	I _{CC}	P _{OUT} = +28 dBm, 5 V, 1 Mbps		600	660	mA
1 dB output compression point	OP1dB	@ 5 V		+34		dBm
Small signal gain	IS21I	@ 5 V		34		dB
Gain variation across band		2.4 to 2.5 GHz		1.0		dB
Input return loss	IS11I			10		dB
Output return loss	IS22I			10		dB

Table 4. SKY65900-11 Electrical Specifications: 5.0 V Performance¹ (2 of 2)
(VCC1 = VCC2 = VCC3_RFOUT = 5 V, PA_EN = 3.3 V, Tc = 25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Continuous Wave Input Signal (continued)						
Detector voltage	V _{DET}	P _{OUT} = +28 dBm		0.57		V
2 nd harmonic	2fo	P _{OUT} = +28 dBm, CW, 5 V			-45	dBm/MHz
3 rd harmonic	3fo	P _{OUT} = +28 dBm, CW, 5 V			-38	dBm/MHz
Orthogonal Frequency Division Multiplexing Input Signal, 64 QAM, 54 Mbps						
Output power, EVM compliant	P _{OUT}	3% EVM, 802.11g, 802.11n, MCS7, HT20, HT40	+26	+28		dBm
Output power, mask compliant	P _{OUT}	Compliant to CCK spectral mask, +5 V	+29	+30		dBm
Ruggedness	RU	P _{IN} ≤ +2 dBm, 6:1 VSWR	No change			
Band edge compliant	BE	Channel 1 and Channel 11, HT20, MCS7	+19	+22		dBm

¹ Performance is guaranteed only under the conditions listed in this table.

Typical Performance Characteristics

(VCC1 = VCC2 = VCC3_RFOUT = 5 V, PA_EN = 3.3 V, Tc = 25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

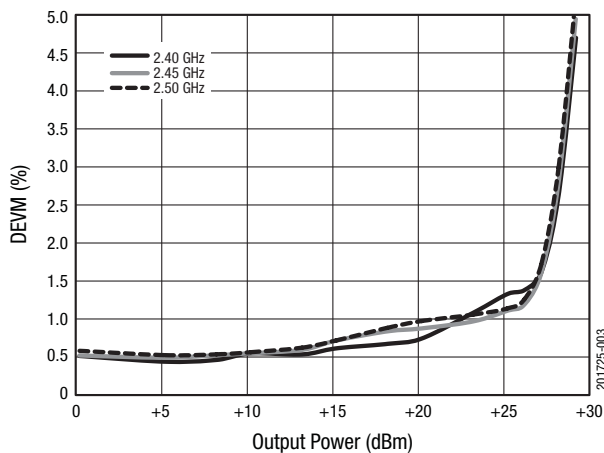


Figure 3. DEVM vs Output Power Over Frequency
(Vcc = +5 V)

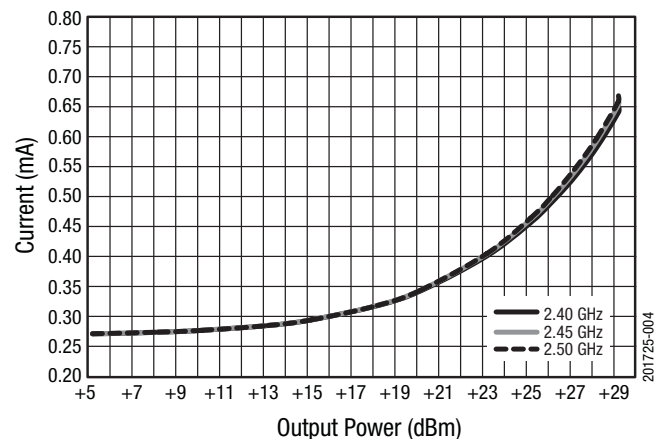


Figure 4. Current vs Output Power Over Frequency
(CW, Vcc = +5 V)

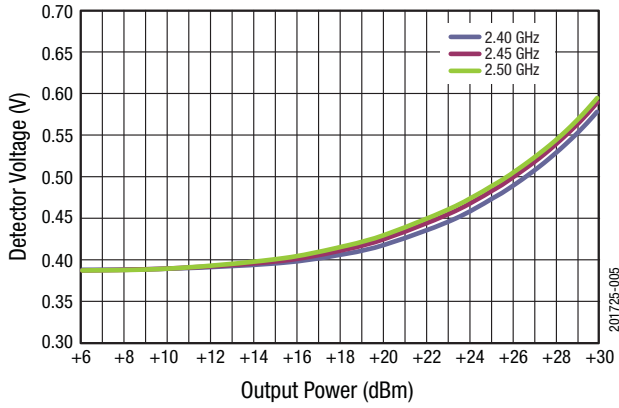


Figure 5. Detector Voltage vs Output Power Over Frequency (CW, Vcc = +5 V)

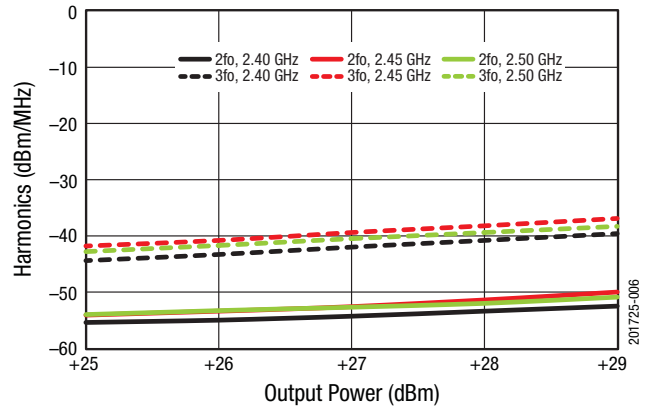


Figure 6. Second and Third Harmonic Levels vs Output Power (CW, +5 V)

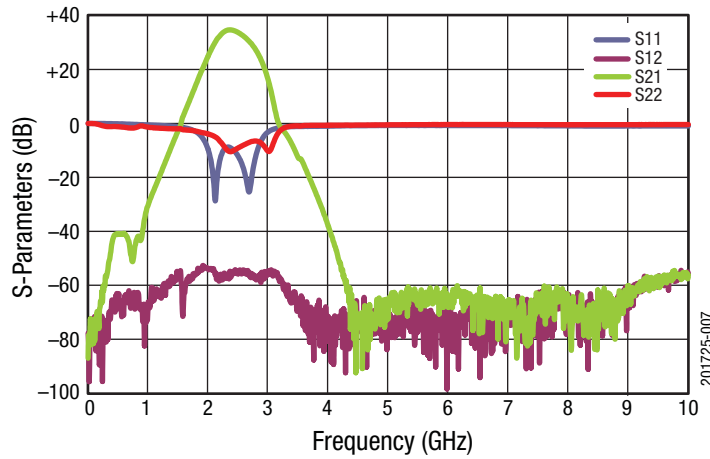


Figure 7. Small Signal Parameters vs Frequency (@ 5 V)

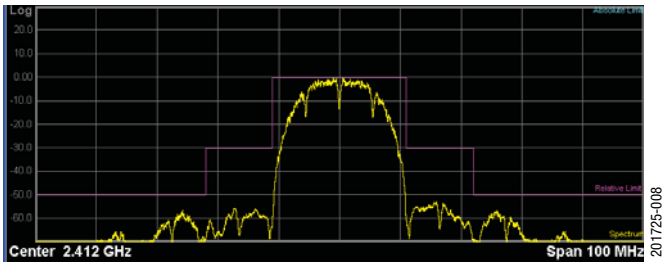


Figure 8. CCK Mask Compliance (@ 2.412 GHz, +30 dBm, +5 V)

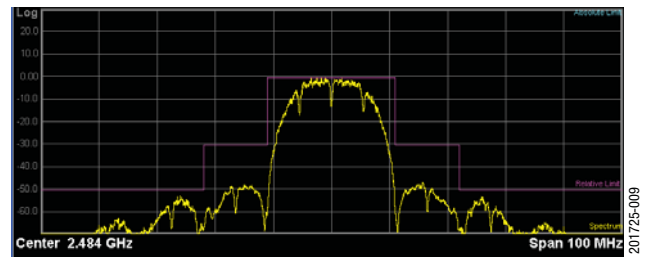


Figure 9. CCK Mask Compliance (@2.484 GHz, +30 dBm, +5 V)

Evaluation Board Description

The SKY65900-11 Evaluation Board is used to test the performance of the SKY65900-11 PA. A typical application schematic diagram is provided in Figure 10.

Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components. A photograph of the Evaluation Board is shown in Figure 11.

Evaluation Board Test Procedure

1. Connect GND to all ground pins.
2. Connect a power supply to the VCC1, VCC2, and the two VCC3_RFOUT pins.
3. If desired, connect a voltage meter to the VDET pin.
4. Connect a +3.3 V supply to PA_EN pin.
5. Connect a signal generator to the RF signal input port. Set it to the desired RF frequency at a power level of –30 dBm or less to the Evaluation Board. DO NOT enable the RF signal.
6. Connect a spectrum analyzer to the RF signal output port.
7. Enable the power supply.
8. Enable the RF signal.
9. Take measurements.

CAUTION: *If the input signal exceeds the rated power, the SKY65900-11 Evaluation Board can be permanently damaged.*

NOTE: *It is important to adjust the VCC voltage source so that the target supply voltage (+5) is measured at the board. The high collector currents will drop the collector voltage significantly if long leads are used. Adjust the bias voltage to compensate.*

Circuit Design Considerations

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

- Paths to ground should be made as short as possible.
- The ground pad of the SKY65900-11 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.

For further information, refer to the Skyworks Application Note, *PCB Design Guidelines for High Power Dissipation Packages*, document number 201211.

- Bypass capacitors should be used on the DC supply lines. An RF inductor is required on the VCC supply line to block RF signals from the DC supply. Refer to the schematic drawing in Figure 10 for further details.
- The RF lines should be well separated from each other with solid ground in between traces to maximize input-to-output isolation.

NOTE: *A poor connection between the ground pad and ground increases junction temperature (T_j), which reduces the life of the device.*

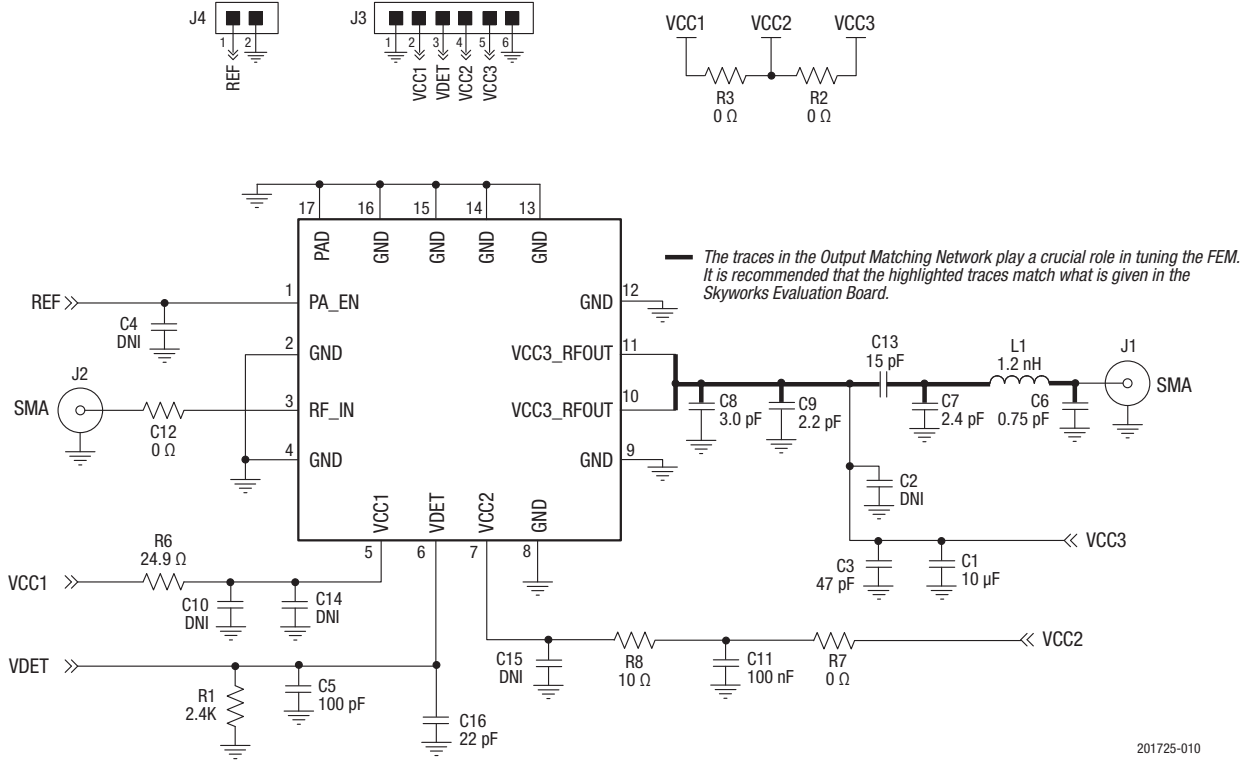


Figure 10. SKY65900-11 Typical Application Schematic

Table 5. SKY65900-11 Evaluation Board Bill of Materials

Component	Size	Value	Manufacturer	Mfr Part Number	Description
C1	0603	10 μ F	Murata	GRM188R60J106ME47	Multilayer ceramic
C2, C4, C10, C14, C15	0402	DNI	DNI	DNI	–
C3	0402	47 pF	Murata	GRM1555C1H470JZ01	Multilayer ceramic
C5	0402	100 pF	Murata	GRM1555C1H101JZ01	Multilayer ceramic
C6	0402	0.75 pF	Murata	GJM1555C1HR75BB01	RF, high Q, low loss
C7	0402	2.4 pF	Murata	GJM1555C1H2R4CB01	RF, high Q, low loss
C8	0402	3.0 pF	Murata	GJM1555C1H3R0CB01	RF, high Q, low loss
C9	0402	2.2 pF	Murata	GJM1555C1H2R2CB01	RF, high Q, low loss
C12, R2, R3, R7	0402	0 Ω	Panasonic	ERJ2GEJ0R0	Thick film chip resistor
C13	0402	15 pF	Murata	GJM1555C1H150JB01	RF, high Q, low loss
C11	0402	100 nF	Murata	GRM155R71C104KA88D	Monolithic ceramic
J1, J2	End launch	–	Johnson Components	142-0701-851	SMA end launch, straight jack receptacle, tab contact
J3	100 mil	–	Samtec	TSW-106-07-G-S	100 mil header, 6X1
J4	100 mil	–	Samtec	TSW-102-07-G-S	100 mil header, 2X1
L1	0402	1.2 nH	Murata	LQG15HN1N2S02D	High frequency multilayer
R1	0402	2.4 k Ω	Panasonic	ERJ2GEJ242	Thick film chip resistor
R6	0402	24.9 Ω	Panasonic	ERJ2RKF24R9	Thick film chip resistor
R8	0402	10 Ω	Panasonic	ERJ2GEJ100	Thick film chip resistor

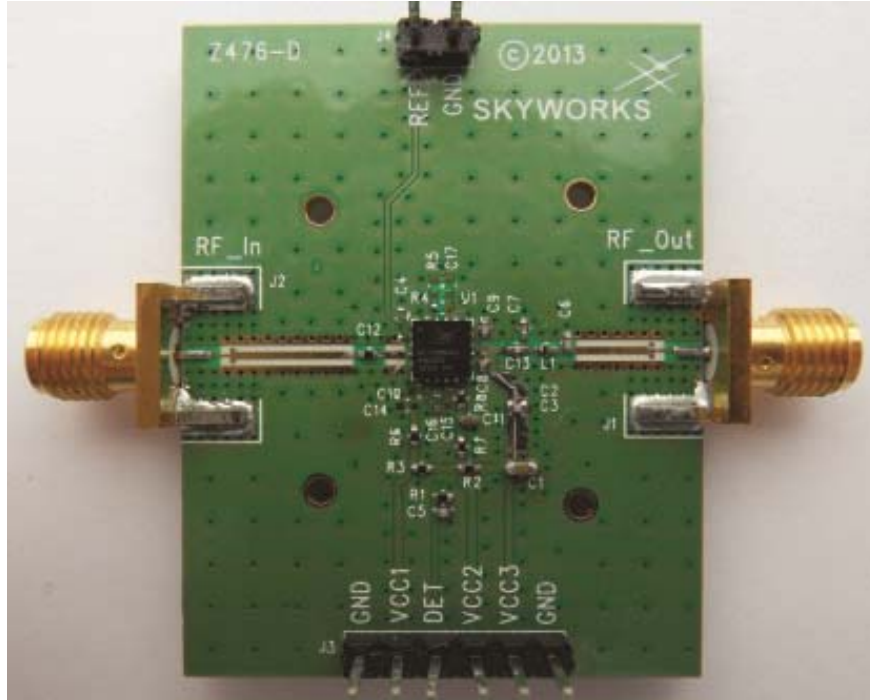


Figure 11. SKY65900-11 Evaluation Board

Package Dimensions

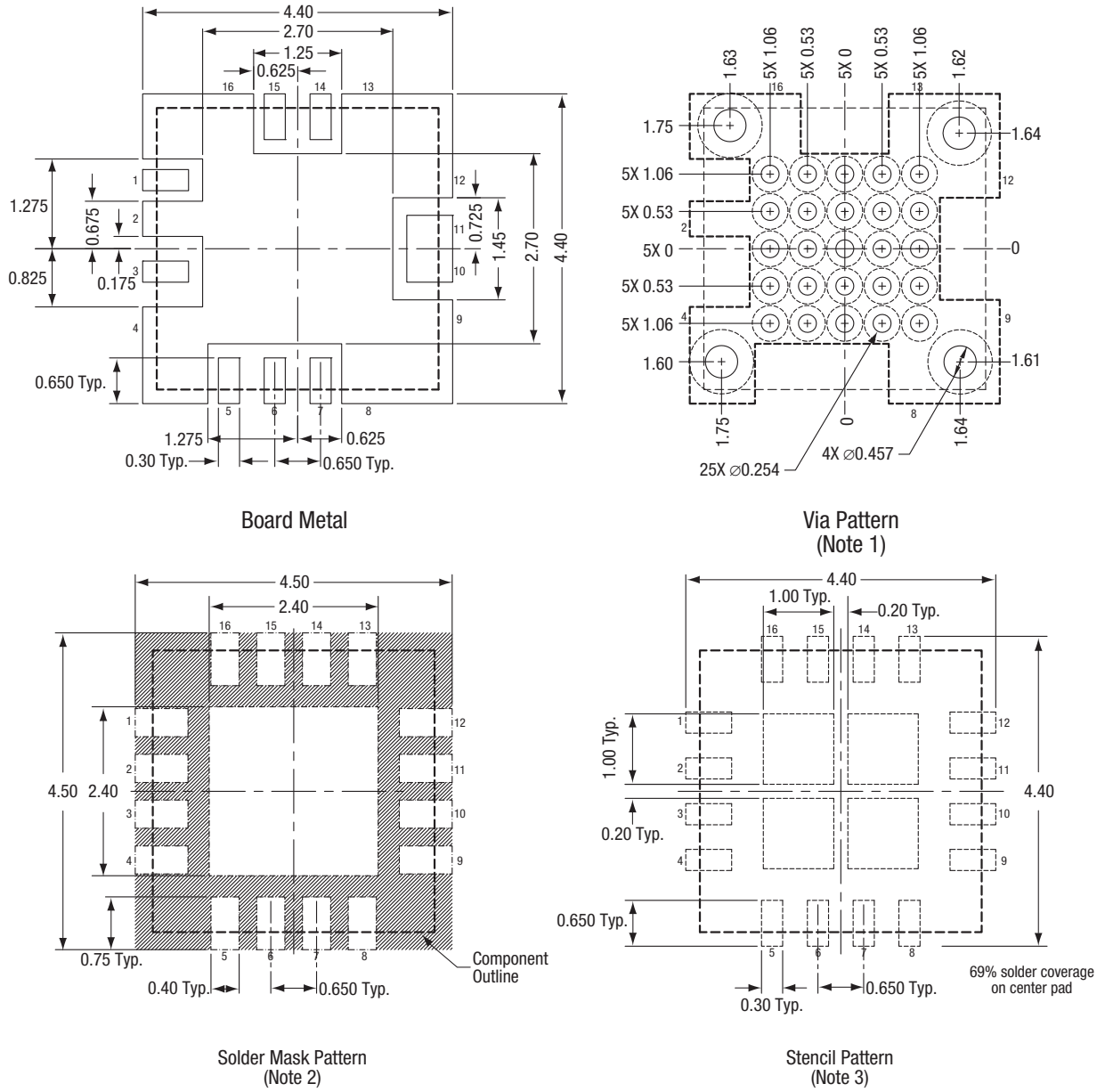
The PCB layout footprint for the SKY65900-11 is shown in Figure 12. Typical part markings are shown in Figure 13. Package dimensions are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

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 SKY65900-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering.

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.



Notes:

1. Via hole recommendations:
0.025 mm Cu via wall plating (minimum), solder mask on the far side should tent or plug via holes.
2. Solder mask recommendations:
Contact board fabricator for recommended solder mask offset and tolerance.
3. Stencil recommendations:
0.125 mm stencil thickness, laser cut apertures, trapezoidal walls and rounded corners offer better paste release.

Dimensions and tolerances according to ASME Y14.5M-1994. Unless specified, dimensions are symmetrical about center lines. All dimensions are in millimeters.

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Figure 12. SKY65900-11 PCB Layout Footprint

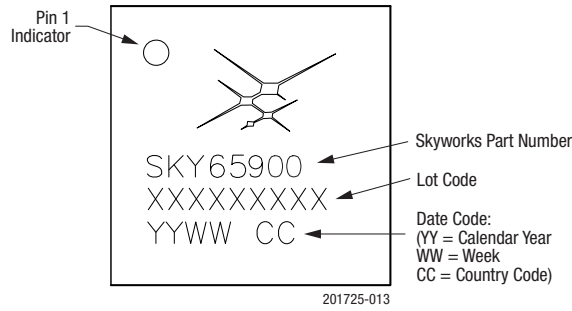
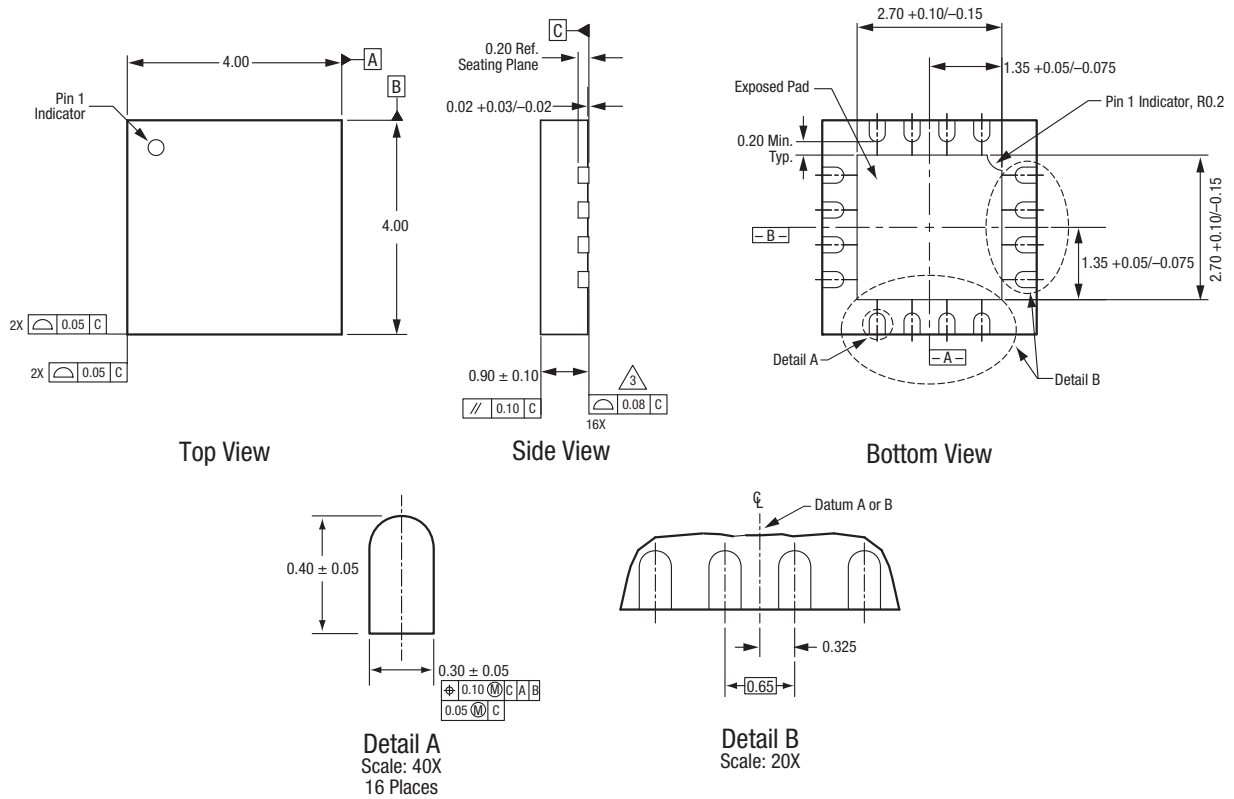


Figure 13. SKY65900-11 Typical Part Markings



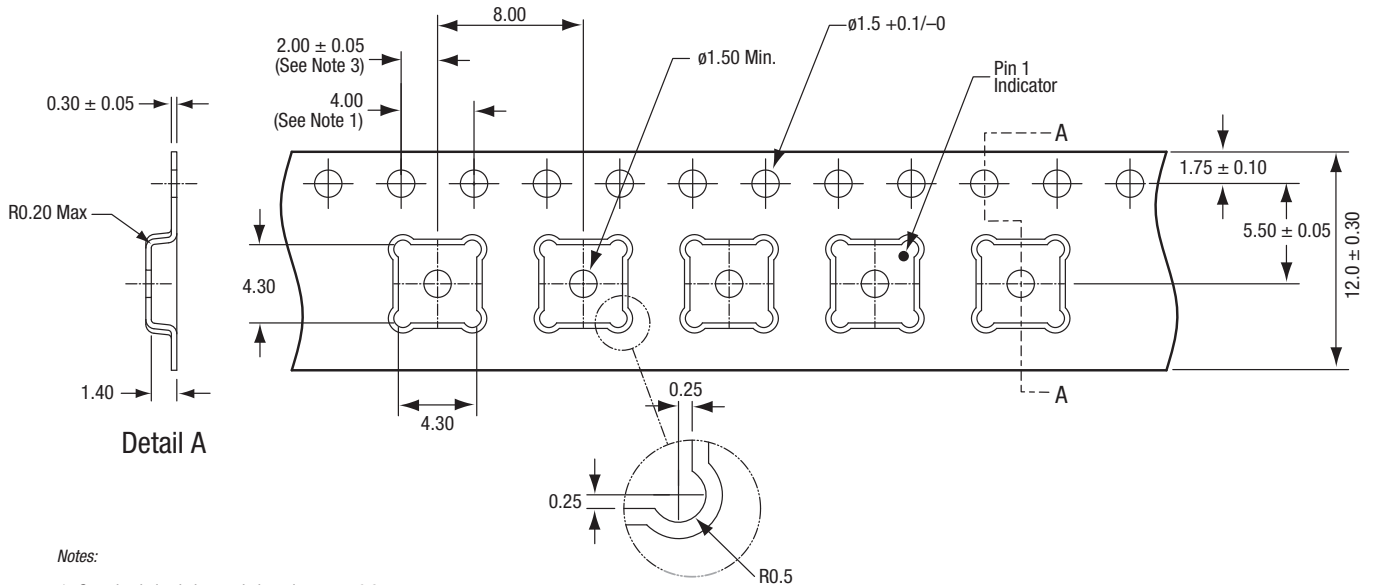
Notes:

1. All measurements are in millimeters.
2. Dimensioning and tolerancing according to ASME Y14.5M-1994.
3. Unilateral coplanarity zone applies to the exposed heat sink slug as well as the terminals.

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Figure 14. SKY65900-11 Package Dimensions

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Notes:

1. Sprocket hole pitch cumulative tolerance: ± 0.2 .
2. Carrier tape: black conductive polystyrene.
3. Pocket position relative to sprocket hole, measure as true position of pocket, not pocket hole.
4. Cover tape material: transparent conductive PSA, 9.20 mm wide.
5. All dimensions are in millimeters.

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Figure 15. SKY65900-11 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65900-11: WLAN Power Amplifier	SKY65900-11	SKY65900-11-EVB

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