

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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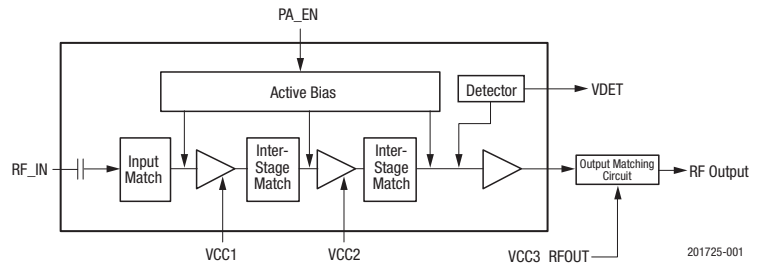


Figure 1. SKY65900-11 Block Diagram

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.

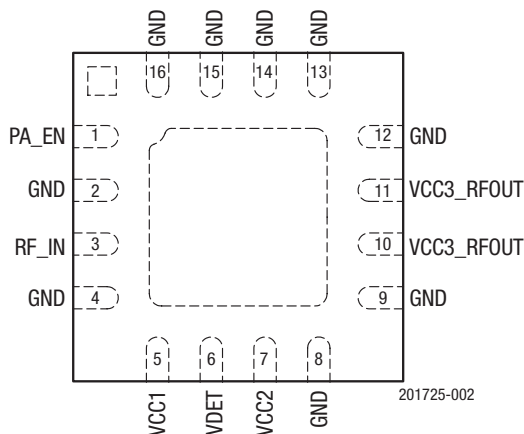


Figure 2. SKY65900-11 Pinout (Top View)

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)

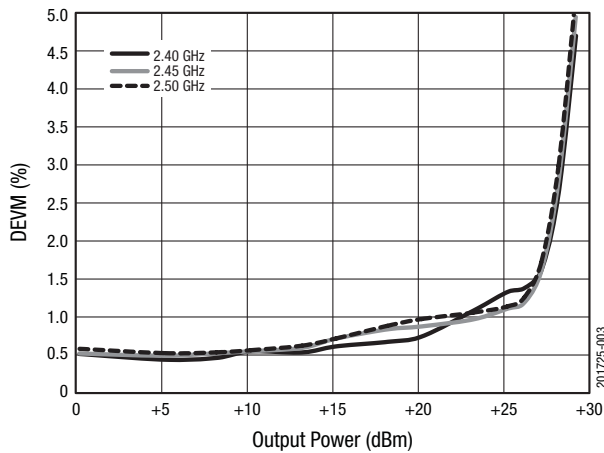


Figure 3. DEVM vs Output Power Over Frequency
(Vcc = +5 V)

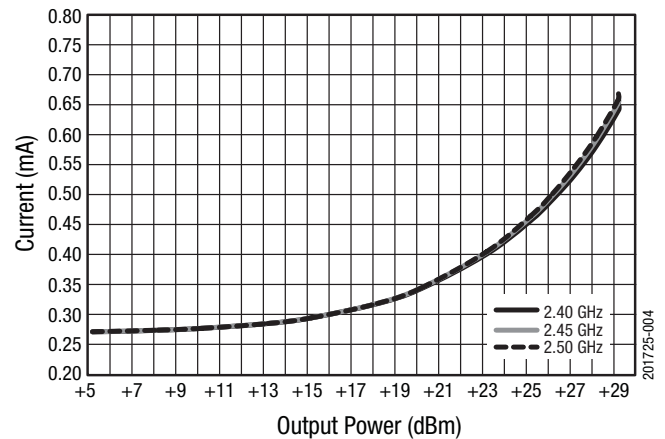


Figure 4. Current vs Output Power Over Frequency
(CW, Vcc = +5 V)

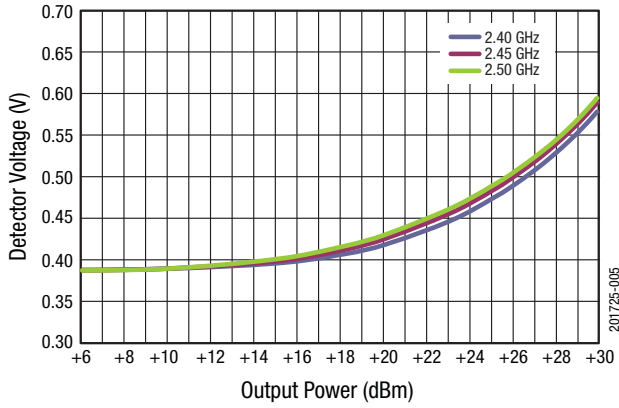


Figure 5. Detector Voltage vs Output Power Over Frequency (CW, Vcc = +5 V)

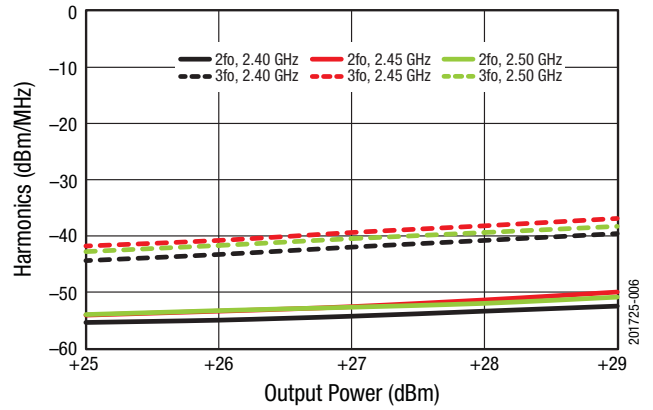


Figure 6. Second and Third Harmonic Levels vs Output Power (CW, +5 V)

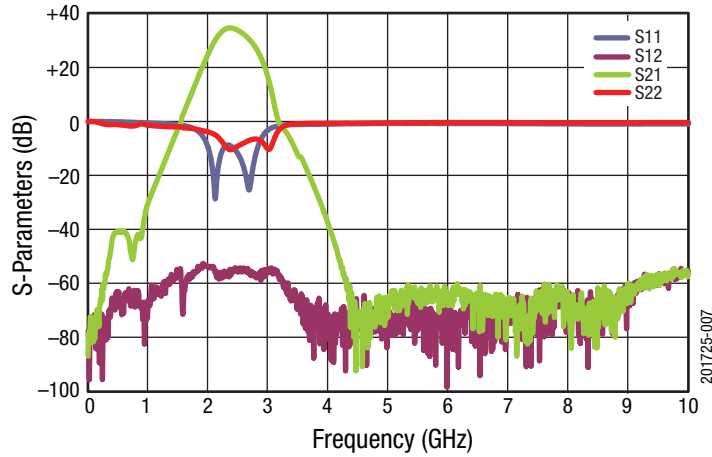


Figure 7. Small Signal Parameters vs Frequency (@ 5 V)

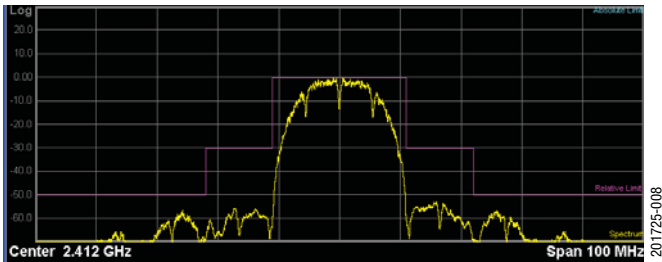


Figure 8. CCK Mask Compliance (@ 2.412 GHz, +30 dBm, +5 V)

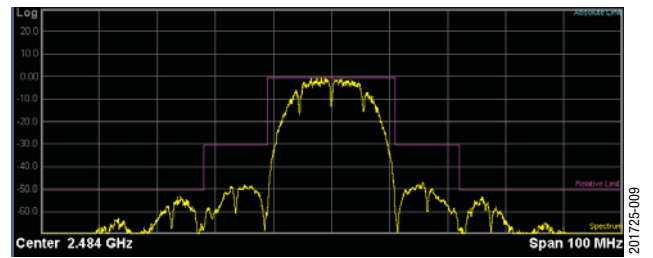


Figure 9. CCK Mask Compliance (@2.484 GHz, +30 dBm, +5 V)

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.*

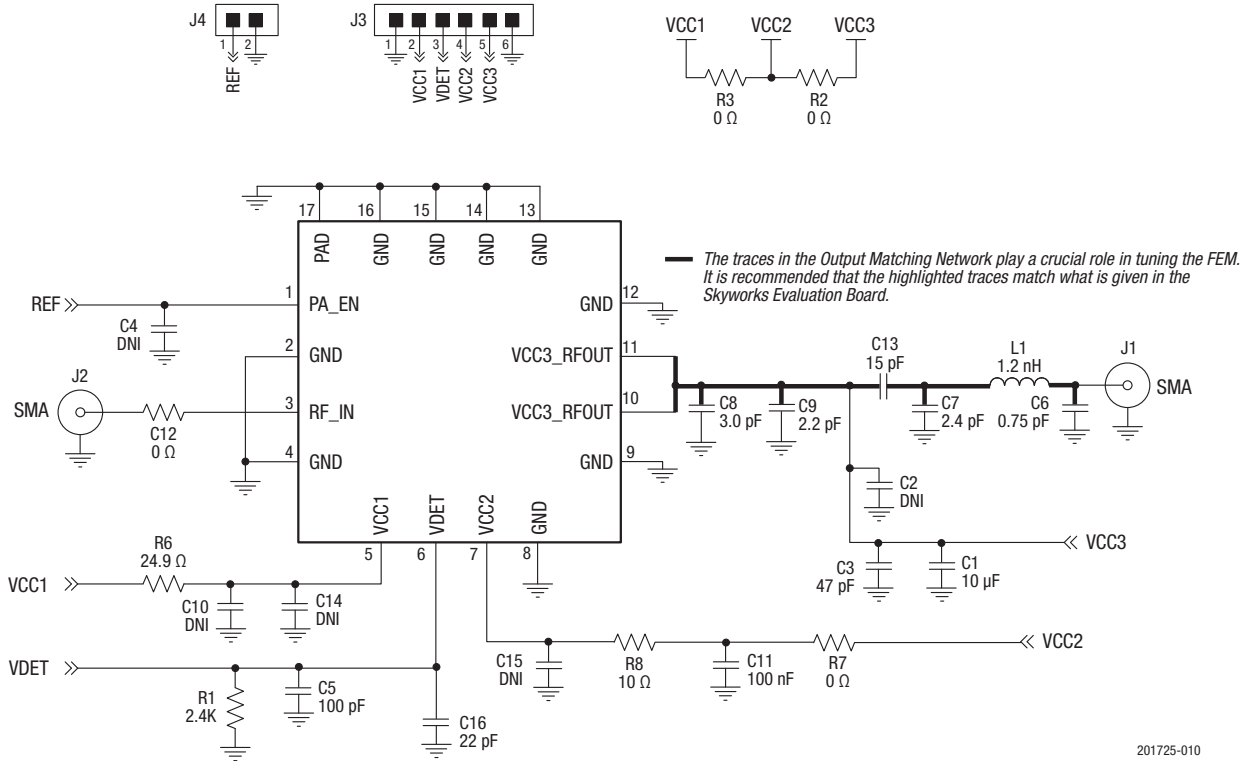


Figure 10. SKY65900-11 Typical Application Schematic

Table 5. SKY65900-11 Evaluation Board Bill of Materials

| Component | Size | Value | Manufacturer | Mfr Part Number | Description |
|-----------------------|------------|---------|--------------------|--------------------|---|
| C1 | 0603 | 10 μF | 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 kΩ | 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 |

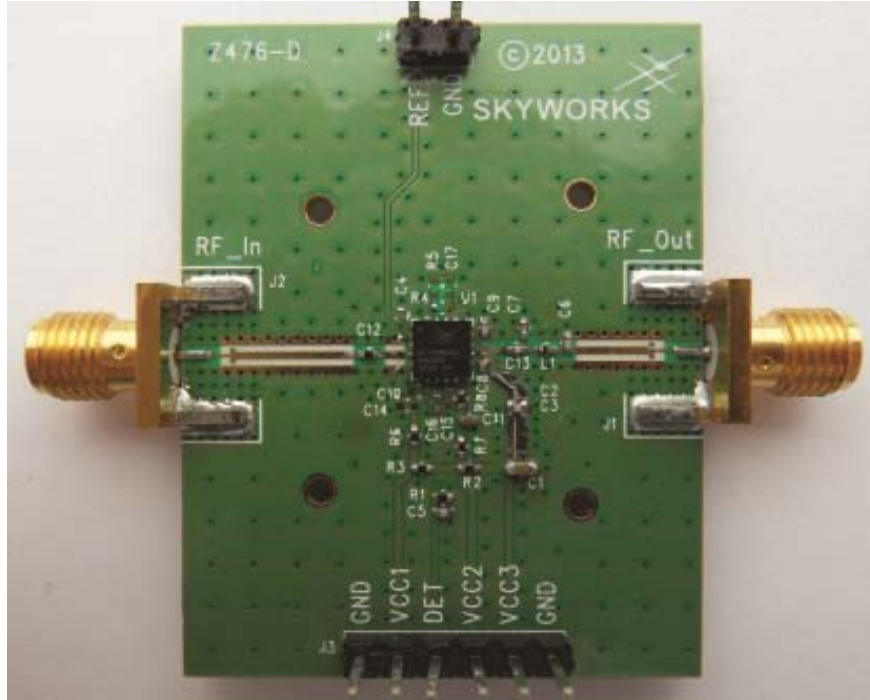


Figure 11. SKY65900-11 Evaluation Board

Package Dimensions

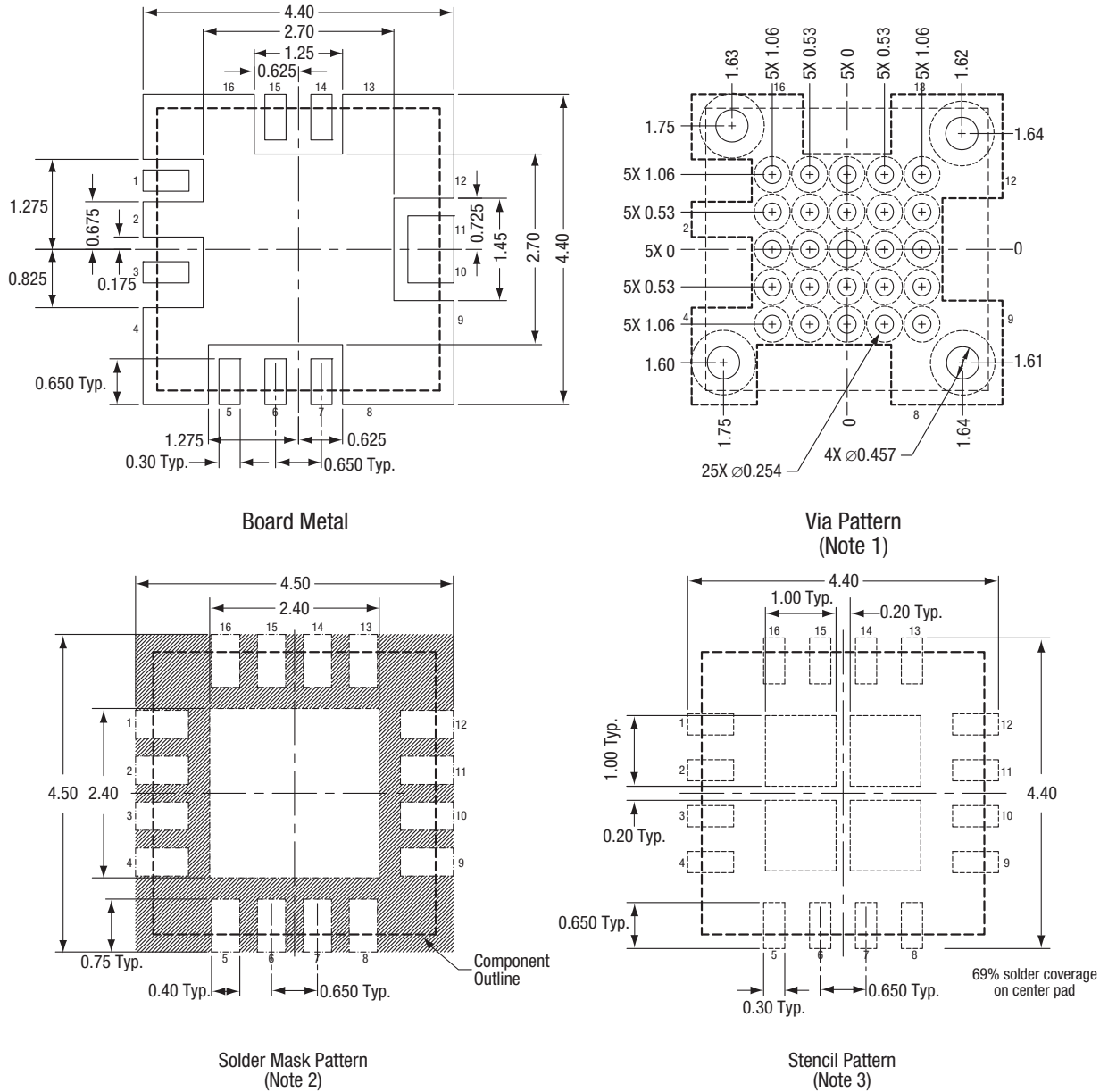
The PCB layout footprint for the SKY65900-11 is shown in Figure 12. Typical part markings are shown in Figure 13. Package dimensions are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

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

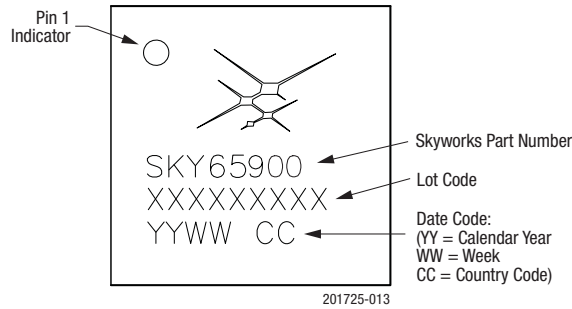
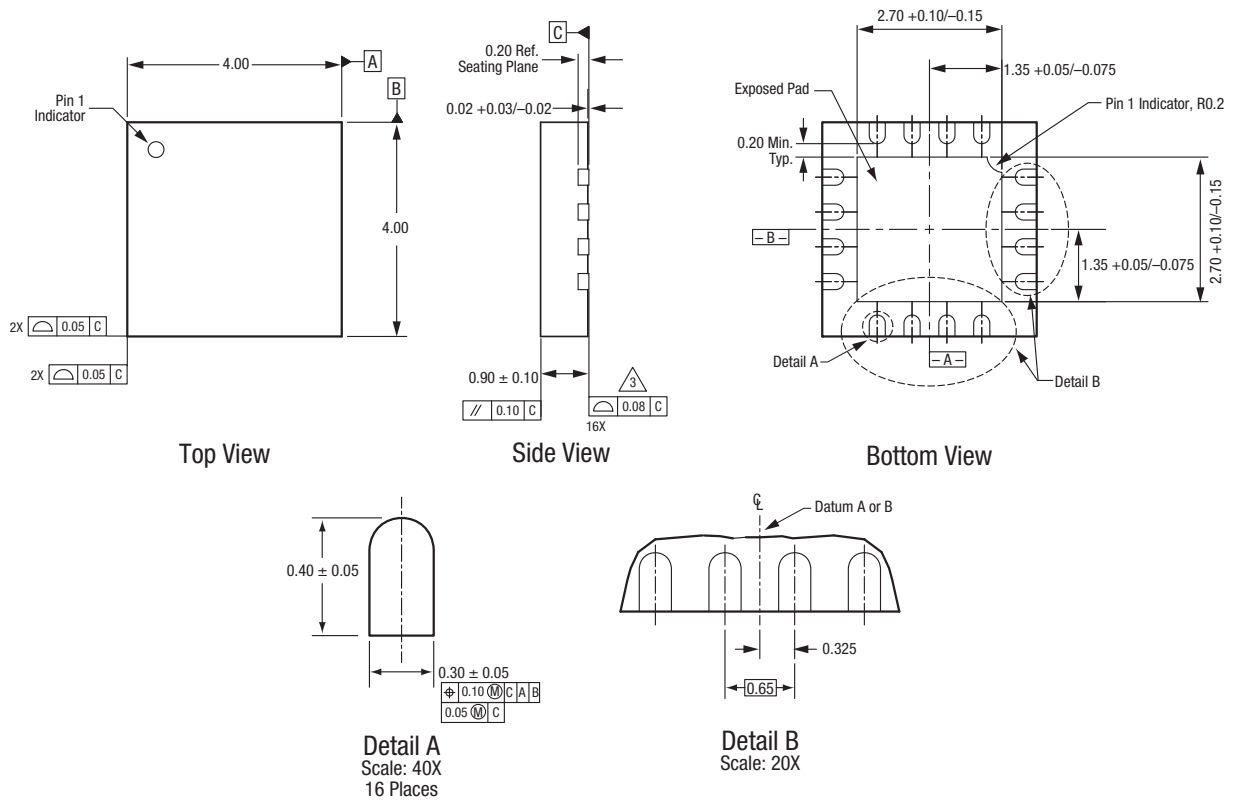


Figure 13. SKY65900-11 Typical Part Markings



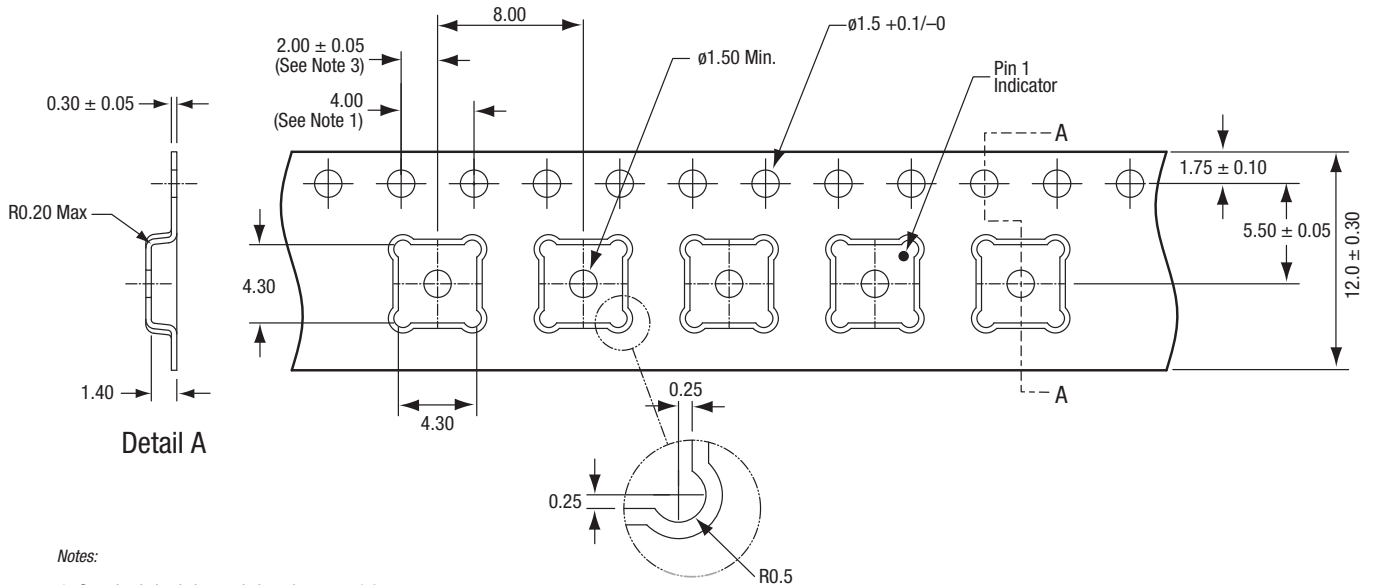
Notes:

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.

201725-014

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.

201725-015

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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