

DATA SHEET

SKY65174-21: 2.4 to 2.5 GHz WLAN Power Amplifier Module

Applications

- IEEE 802.11 b/g/n WLAN systems
- ISM band transmitters
- Wireless access points, routers, gateways

Features

- PA linear output power: +27 dBm @ <2.5% EVM
- High gain: 35 dB
- Input/Output internally matched to 50 Ω
- Internal, active bias circuits
- MCM (10-pin, 4 x 4 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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Description

The SKY65174-21 is a highly integrated power amplifier module (PAM) intended for high performance wireless local area network (WLAN) requiring up to +27 dBm linear output power.

The SKY65174-21 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 PAM is packaged in a 10-pin, 4 x 4 mm Multi-Chip Module (MCM) together with power detector, biasing, and input/output matching components. This architecture makes the SKY65174-21 a highly integrated solution requiring a minimum number of external components.

A functional block diagram of the SKY65174-21 is shown in Figure 1. The 10-pin MCM package and pinout are provided in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

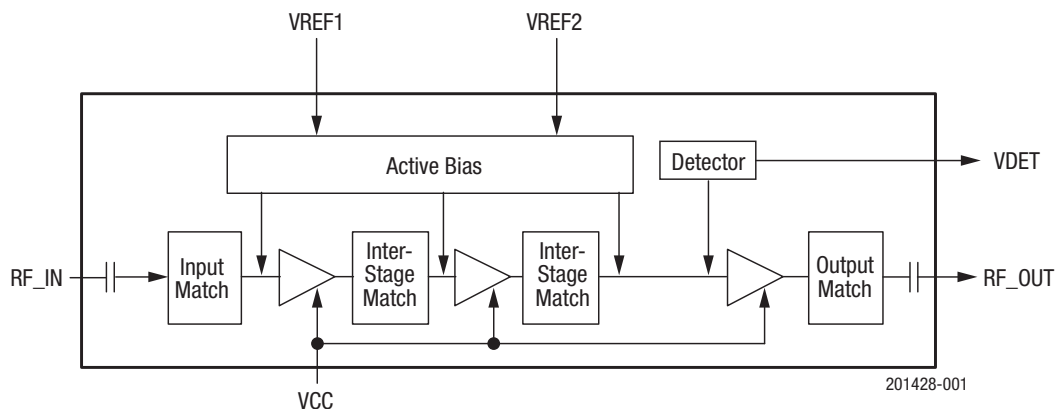


Figure 1. SKY65174-21 Block Diagram

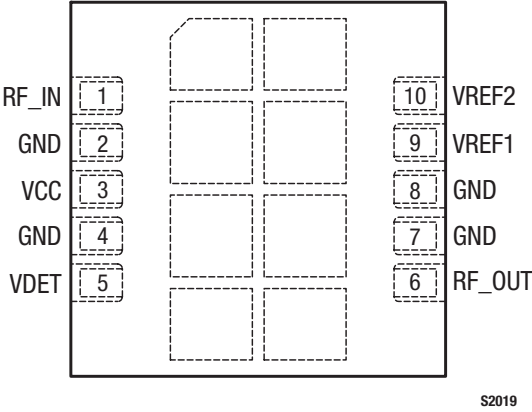


Figure 2. SKY65174-21 Pinout (Top View)

Table 1. SKY65174-21 Signal Descriptions

| Pin | Name | Description | I/O | Signal Type |
|-----|--------|-----------------------|-----|-------------|
| 1 | RF_IN | RF transmitter input | I | RF |
| 2 | GND | Ground | - | - |
| 3 | VCC | Supply voltage | I | Supply 5 V |
| 4 | GND | Ground | - | - |
| 5 | VDET | Power detector output | O | Analog |
| 6 | RF_OUT | RF transmitter output | O | RF |
| 7 | GND | Ground | - | - |
| 8 | GND | Ground | - | - |
| 9 | VREF1 | Reference voltage 1 | I | 2.85 V |
| 10 | VREF2 | Reference voltage 2 | I | 2.85 V |

Technical Description

The SKY65174-21 meets the stringent WLAN spectral masks for Orthogonal Frequency Division Multiplexing (OFDM) composite signals. The high linearity of the PA enables an Error Vector Magnitude (EVM) of less than 3% at output power levels of +27 dBm.

The power detector achieves a dynamic range greater than 25 dB. The PAM is stable up to an 6:1 voltage standing-wave ratio (VSWR).

The SKY65174-21 PAM supports a battery voltage range of 3.3 V up to 5.5 V.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65174-21 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 (Vcc = 5 V) and 5 (Vcc = 3.3 V).

Typical performance characteristics of the SKY65174-21 are illustrated in Figures 3 to 8.

Table 2. SKY65174-21 Absolute Maximum Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|---------------------------------|------------------|---------|---------|-------|
| RF output power (CW) | P _{OUT} | | +30 | dBm |
| Supply voltage | V _{CC} | | 5.5 | V |
| Reference voltages ² | VREF1, VREF2 | | 3.1 | V |
| Total supply current | I _{CC} | | 1000 | mA |
| Power dissipation | P _D | | 2.9 | W |
| Thermal resistance | Θ _{JC} | | 28 | °C/W |
| Storage temperature | T _{STG} | -55 | +125 | °C |
| Operating temperature | T _A | -40 | +85 | °C |
| Junction temperature | T _J | | +150 | °C |

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.

² Measured at the package pins.

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. SKY65174-21 Recommended Operating Conditions

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|------------------------------------|-------------------|---------|---------|---------|-------|
| Operating frequency | f | 2412 | | 2483 | MHz |
| Supply voltage (high voltage mode) | V _{CC} | 4.5 | 5.0 | 5.5 | V |
| Supply voltage (low voltage mode) | V _{CC} | 3.0 | 3.3 | 3.6 | V |
| RF output power | P _{OUT} | | +27 | | dBm |
| Reference voltages ¹ | VREF1, VREF2 | 2.75 | 2.85 | 2.95 | V |
| Reference current 1 | I _{REF1} | | 11 | 12 | mA |
| Reference current 2 | I _{REF2} | | 1 | 2 | mA |
| Total supply current (CW signal) | I _{CC} | | 600 | | mA |
| Operating temperature | T _A | -35 | +25 | +85 | °C |

¹ Measured at the package pins.

Table 4. SKY65174-21 Electrical Specifications¹**(V_{CC} = +5 V, VREF1 = VREF2 = 3.1 V, T_A = +25 °C, f = 2.442 GHz, CW, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|--|------------------|--|-------|----------|----------|------------|
| Continuous Wave (CW) Input | | | | | | |
| Quiescent current | I _{CO} | | | 275 | 300 | mA |
| Operational current | I _{CC} | P _{OUT} = +27 dBm | | 700 | 800 | mA |
| 1 dB output compression point | OP1dB | | +31.0 | +34.5 | | dBm |
| Noise figure | NF | | | 7 | | dB |
| Small signal gain | IS21I | | 34.0 | 34.5 | 35.0 | dB |
| Gain variation | ΔS21 | P _{IN} = -25 dBm, f = 2.4 to 2.5 GHz | | | 1 | dB |
| Input return loss | IS11I | | 15 | | | dB |
| Detector voltage | V _{DET} | 802.11g, P _{OUT} = +27 dBm | | 0.75 | 0.80 | V |
| 2 nd harmonic distortion | 2fo | P _{OUT} = +27 dBm | | | -50 | dBc |
| 3 rd harmonic distortion | 3fo | P _{OUT} = +27 dBm | | | -60 | dBc |
| PA enable time | | VREF1 toggled, VREF2 = 2.85 V | | 200 | | ns |
| IEEE 802.11g OFDM Input Signal, 64 QAM, 54 Mbps | | | | | | |
| Output power | P _{OUT} | EVM = 2.5% EVM = 3.0% | | - +27 | +27 - | dBm dBm |

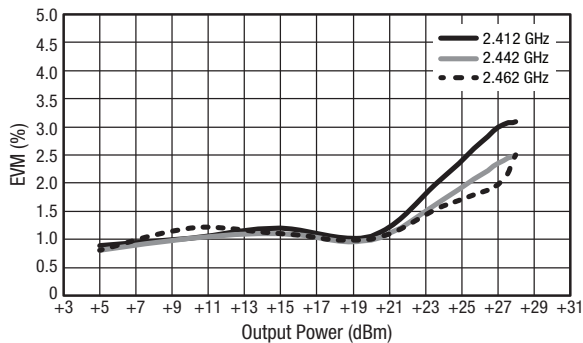
¹ Performance is guaranteed only under the conditions listed in this table.**Table 5. SKY65174-21 Electrical Specifications¹****(V_{CC} = +3.3 V, VREF1 = VREF2 = 2.85 V, T_A = +25 °C, f = 2.442 GHz, CW, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|--|------------------|----------------------------|-----|---------|-----|-------|
| Continuous Wave (CW) Input | | | | | | |
| Quiescent current | I _{CO} | | | 230 | | mA |
| Operational current | I _{CC} | P _{OUT} = +24 dBm | | 520 | | mA |
| 1 dB output compression point | OP1dB | | | +31 | | dBm |
| Small signal gain | IS21I | | | 33 | | dB |
| IEEE 802.11g OFDM Input Signal, 64 QAM, 54 Mbps | | | | | | |
| Output power | P _{OUT} | EVM = 2.5% | | +24 | | dBm |

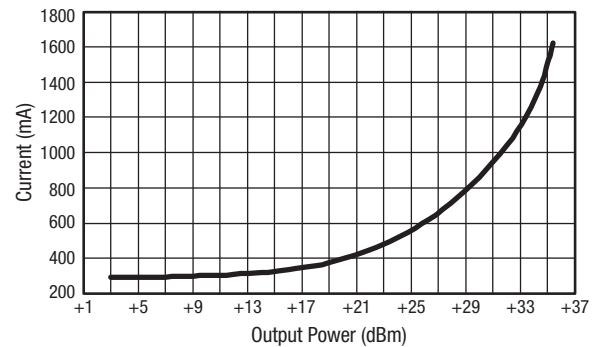
¹ Performance is guaranteed only under the conditions listed in this table.

Typical Performance Characteristics

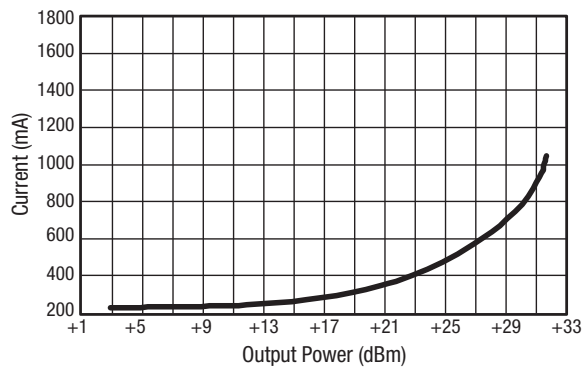
($V_{CC} = +5\text{ V}$, $V_{REF1} = V_{REF2} = 3.1\text{ V}$, $T_A = +25\text{ }^{\circ}\text{C}$, $f = 2.442\text{ GHz}$, Unless Otherwise Noted)



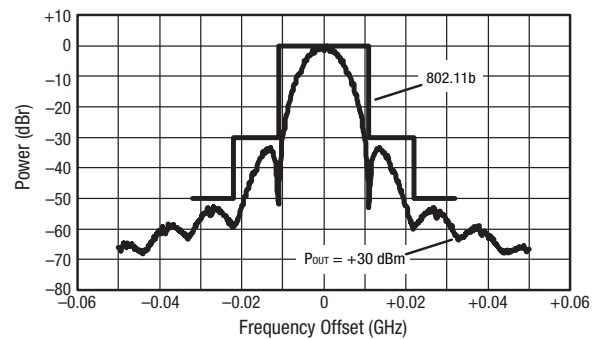
**Figure 3. EVM vs Output Power Over Frequency
(64 QAM, 54 Mbps, OFDM)**



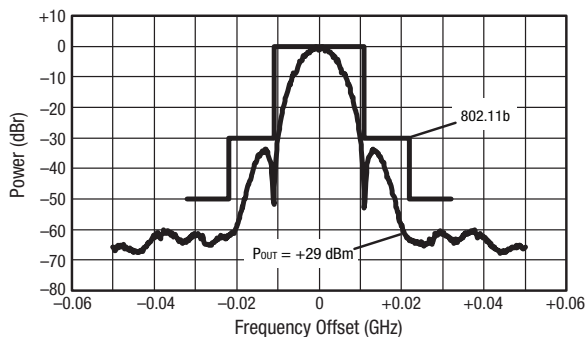
**Figure 4. Current vs Output Power
(CW)**



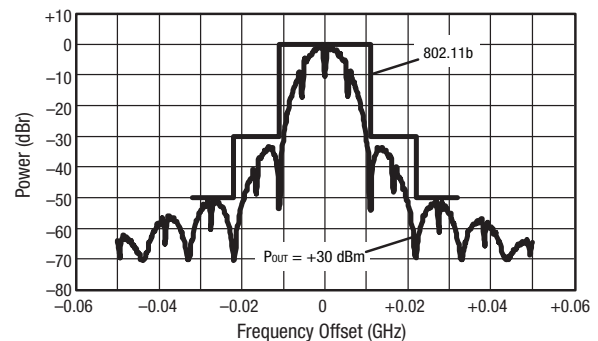
**Figure 5. Current vs Output Power
(CW, $V_{CC} = 3.3\text{ V}$)**



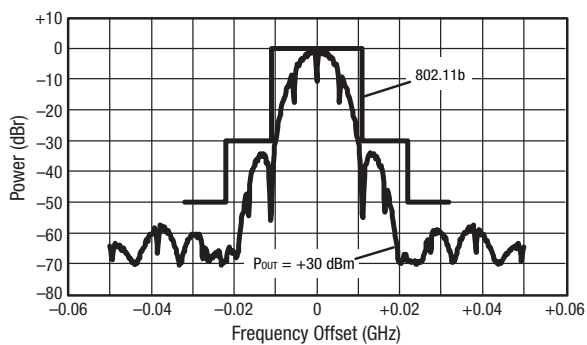
**Figure 6. Spectral Mask
(11 Mbps)**



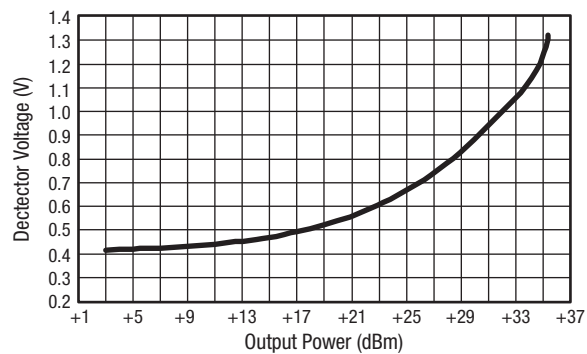
**Figure 7. Spectral Mask
(11 Mbps, $V_{CC} = 3.3\text{ V}$)**



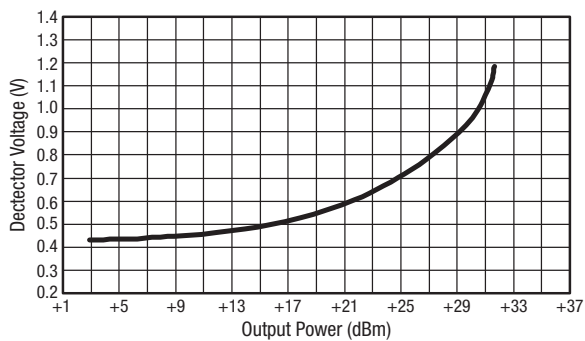
**Figure 8. Spectral Mask
(1 Mbps)**



**Figure 9. Spectral Mask
(1 Mbps, Vcc = 3.3 V)**



**Figure 10. Detector Voltage vs Output Power
(CW)**



**Figure 11. Detector Voltage vs Output Power
(CW, Vcc = 3.3 V)**

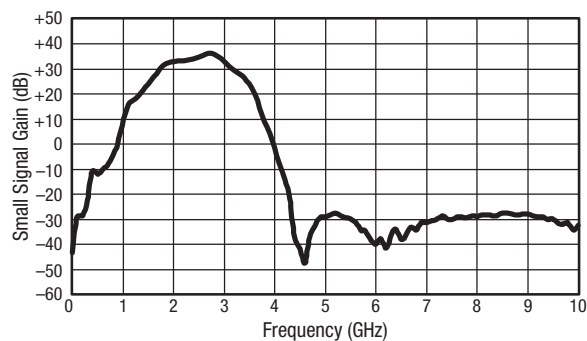


Figure 12. Small Signal Gain vs Frequency

Evaluation Board Description

The SKY65174-21 Evaluation Board is used to test the performance of the SKY65174-21 PAM. Application schematic diagrams are provided in Figures 13 (for applications using phase and amplitude tracking) and 14 (for applications that do not use amplitude tracking). A photograph of the Evaluation Board is shown in Figure 15.

Application Circuit Notes

Center Ground. It is extremely important to sufficiently ground the bottom ground pad of the device for both thermal and stability reasons. Multiple small vias are acceptable and work well under the device if solder migration is an issue.

RF_IN (pin 1). The module includes an on board internal DC blocking capacitor for this pin signal ($Z_0 = 50 \Omega$). All impedance matching is provided internal to the module.

GND (pins 2, 4, 7, and 8). Attach all ground pins to the RF ground plane with the largest diameter and lowest inductance via that the layout allows. Multiple small vias are acceptable and work well under the device if solder migration is an issue.

VCC (pin 3). The supply voltage for all three stages is typically set to +5 V. Component C2 is a bypass capacitor, and C16 is a decoupling capacitor and energy storage component.

VDET (pin 5). The interstage detector output voltage signal is connected to component C9, which has a filtering function. This value can be adjusted or completely removed to speed up the detector response. Component R1 provides a load to the detector and acts as a biasing resistor.

RF_OUT (pin 6). The module includes an on board internal DC blocking capacitor for this pin signal ($Z_0 = 50 \Omega$). All impedance matching is provided internal to the module.

VREF1 (pin 9) and VREF2 (pin 10). Bias reference voltage for the PA. These signals can be operated from 2.75 V to 3.00 V (measured at the device pins). Additional filters may be implemented on VREF1 to enhance dynamic linearity performance. The filter is composed of a series 40Ω resistor in parallel with a series 90Ω resistor and $0.1 \mu\text{F}$ capacitor. VREF1 and VREF2 may be used as PA enable pins and can be pulled down to 0 V to disable the PA.

Circuit Design Configurations

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 SKY65174-21 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 more details, 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 line (VCC). Refer to the schematic drawings in Figures 13 and 14 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 slug and ground increases junction temperature (T_J), which reduces the lifetime of the device.

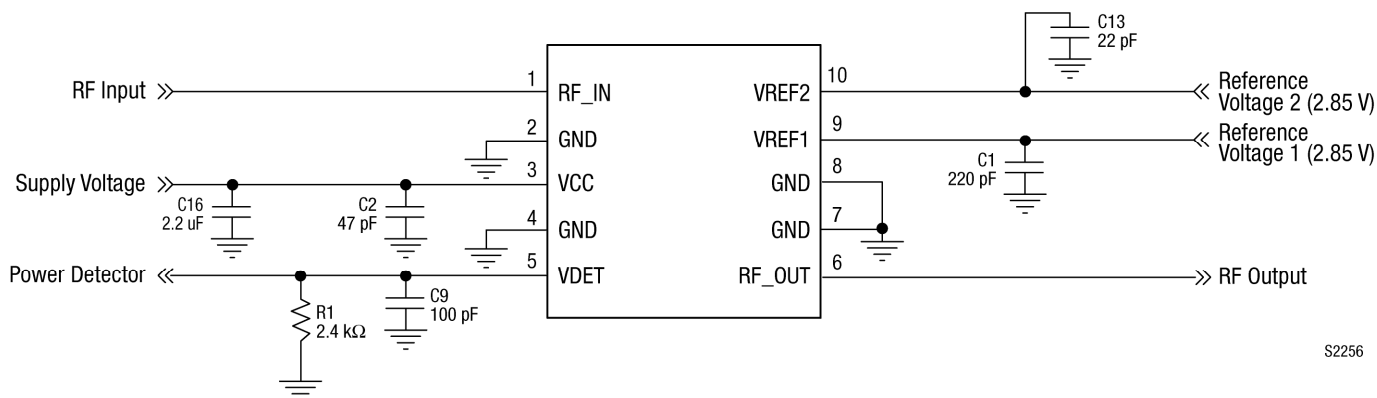


Figure 13. SKY65174-21 Application Schematic for Both 3.3 V and 5 V Operation

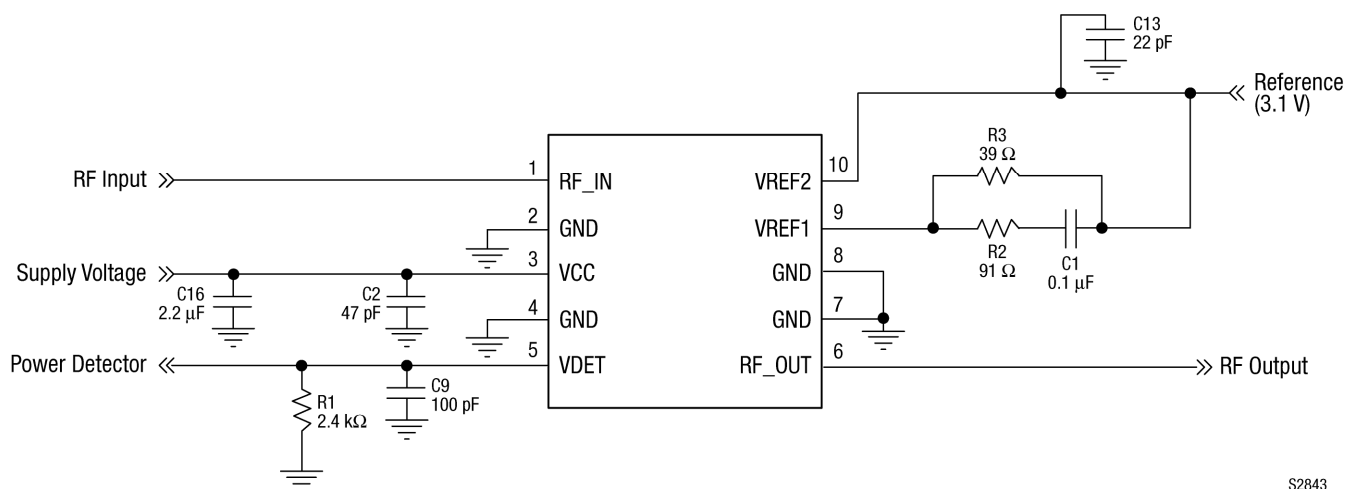


Figure 14. SKY65174-21 Application Schematic for Applications That Do Not Implement Amplitude Tracking

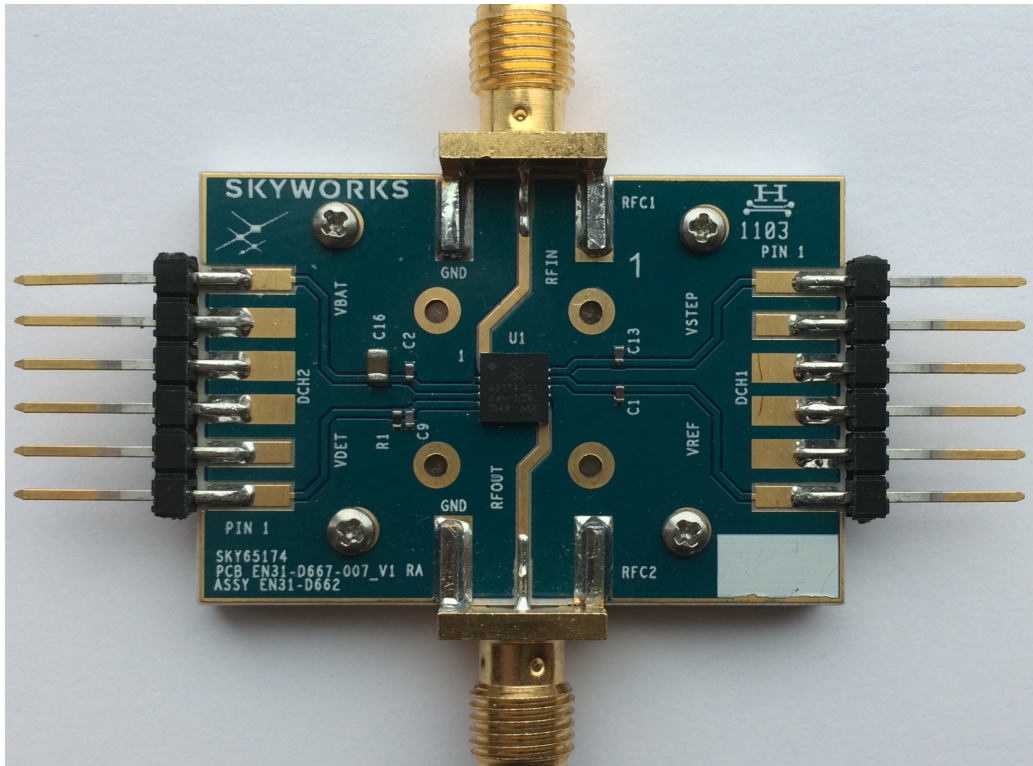


Figure 15. SKY65174-21 Evaluation Board

Package Dimensions

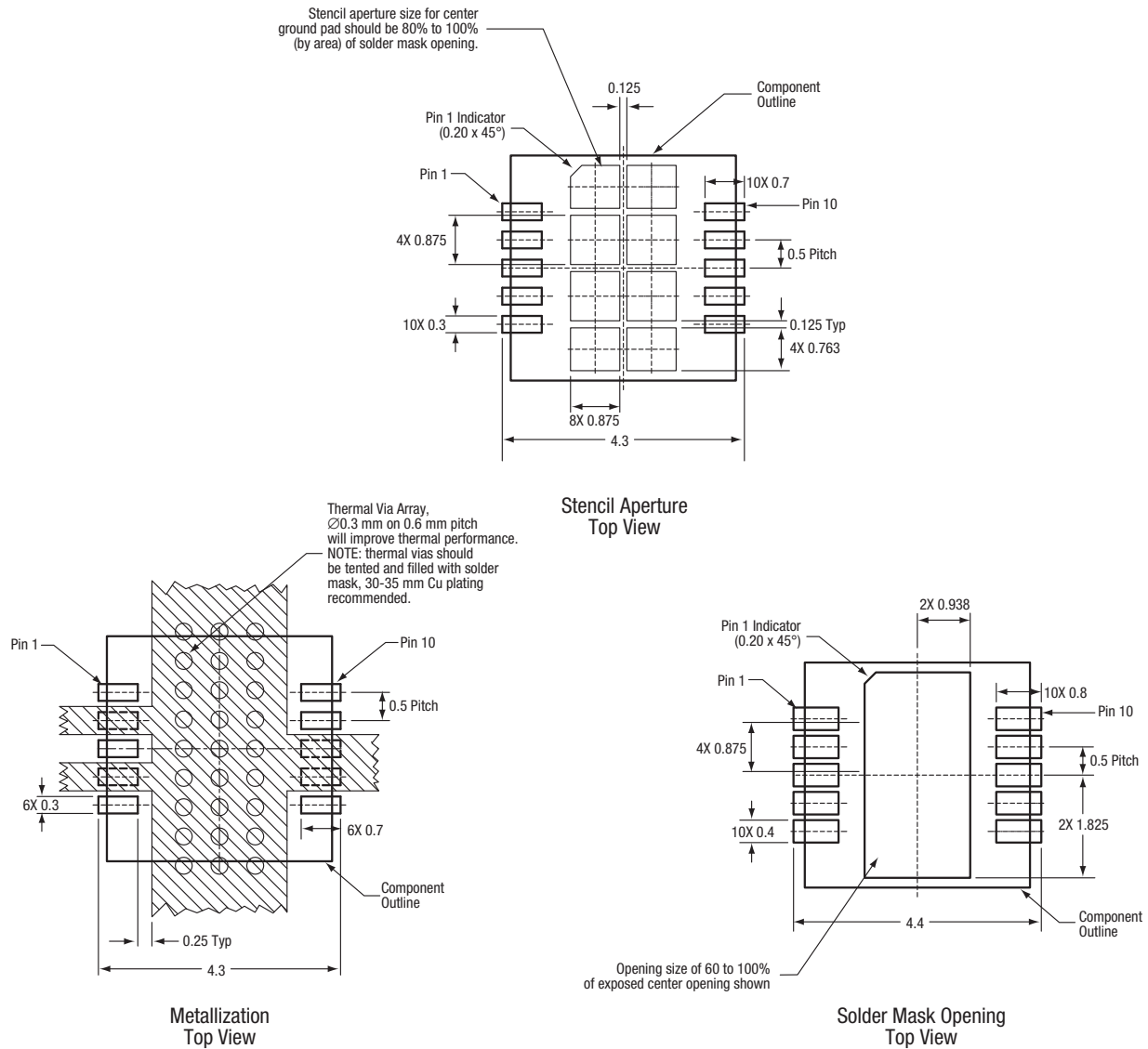
The PCB layout footprint for the SKY65174-21 is provided in Figure 16. Typical part markings are shown in Figure 17. Figure 18 shows the package dimensions for the 10-pin MCM, and Figure 19 provides the tape and reel dimensions.

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 SKY65174-21 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 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.

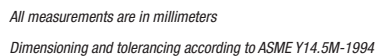


All dimensions are in millimeters

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Figure 16. SKY65174-21 PCB Layout Footprint

Figure 1: Mechanical drawing of the PCB showing Top, Side, and Bottom views. The Top View shows a square pad with dimensions 4x4, a Pin 1 Indicator, and a Solder Mask Opening (SMO) of 0.15. The Side View shows the pad thickness of 0.85 ± 0.1 and a width of 0.1. The Bottom View shows the pad layout with dimensions 10x1.9, 8x0.5, and 4x1.4438, and a Pin 1 Indicator.



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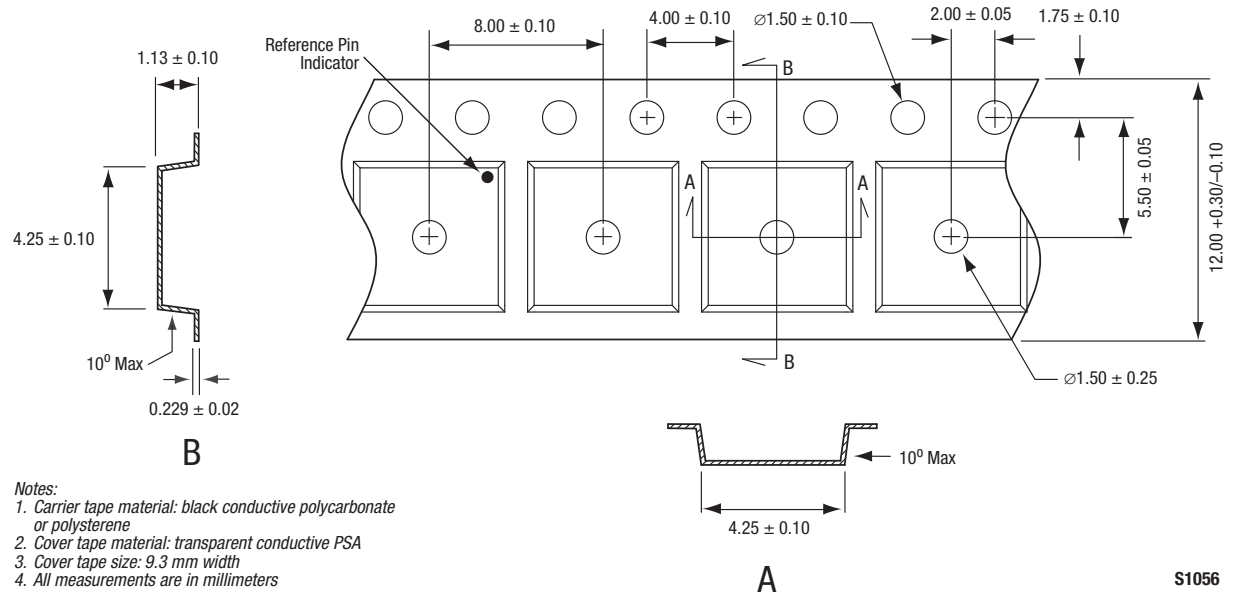


Figure 19. SKY65174-21 Tape and Reel Dimensions

Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|-------------|--|------------------------------|
| SKY65174-21 | 2.4 to 2.5 GHz WLAN Power Amplifier Module | SKY65174-21-EVB |

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