DATA SHEET

# SKY66189-11: 1930 to 1995 MHz Linear Power Amplifier

## Applications

- 3G/4G LTE Bands 2 and 25 small cell
- Active distributed antenna system
- Cellular repeaters
- Driver amplifier

## Features

- High gain: 40 dB (unconditionally stable)
- High linearity: +23 dBm with -50 dBc ACLR @ 85 °C (WCDMA Test Model 1 with 64 DPCH)
- RF input and output internally matched to 50 ohms
- Excellent output return loss: < -20 dB
- Integrated active bias: performance compensated over temp
- PA On/Off function: 3.5 us switching time
- Integrated coupler for output power monitoring
- Single supply voltage: 3.3 V
- Pin-to-pin compatible PA family supporting all 3GPP bands
- Small 5 x 5 mm, 28-pin package (MSL3, 260 °C per JEDEC J-STD-020)

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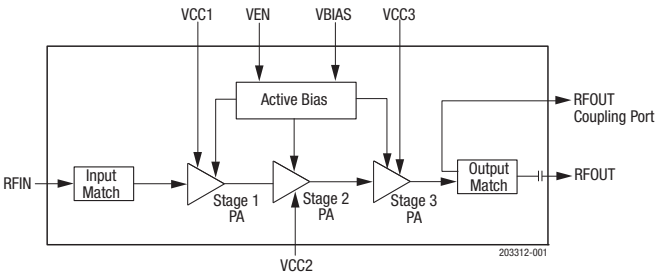



**Figure 1. SKY66189-11 Linear PA Block Diagram**

## Description

The SKY66189-11 is a high-linearity power amplifier (PA) with fully matched input/output and high gain. The compact 5 x 5 mm PA is designed for FDD 3G/4G LTE small cell base stations operating from 1930 to 1995 MHz. The active biasing circuitry is integrated to compensate PA performance over temperature, voltage, and process variation as well as an internal coupler for power monitoring.

The SKY66189-11 requires minimal external components and is part of a high-linearity, pin-to-pin compatible PA family supporting all 3GPP bands.

A block diagram of the SKY66189-11 is shown in Figure 1. The device package and pinout for the 28-pin device are shown in Figure 2. Table 1 lists the pin-to-pin compatible parts in the PA family. Signal pin assignments and functional pin descriptions are described in Table 2.

**Table 1. Pin-to-Pin Compatible PA Family**

| Part Number | Frequency (MHz) | LTE Band |
|---|---|---|
| SKY66181-11 | 1805 to 1880 | 3 |
| SKY66184-11 | 2110 to 2170 | 1, 4, and 10 |
| SKY66185-11 | 851 to 894 | 5, 6, 18, 19, 26, and 27 |
| SKY66186-11 | 728 to 768 | 12, 13, 14, and 17 |
| SKY66187-11 | 2620 to 2690 | 7 |
| SKY66188-11 | 758 to 803 | 28 |
| SKY66189-11 | 1930 to 1995 | 2 and 25 |

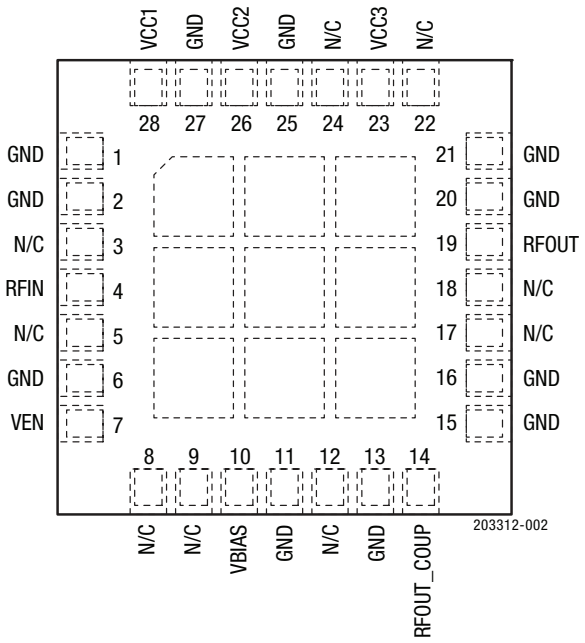



**Figure 2. SKY66189-11 Pinout (Top View)**

**Table 2. SKY66189-11 Signal Descriptions**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | GND | Ground | 15 | GND | Ground |
| 2 | GND | Ground | 16 | GND | Ground |
| 3 | N/C | No internal connection | 17 | N/C | No internal connection |
| 4 | RFIN | RF input | 18 | N/C | No internal connection |
| 5 | N/C | No internal connection | 19 | RFOUT | RF output |
| 6 | GND | Ground | 20 | GND | Ground |
| 7 | VEN | Enable (active low) | 21 | GND | Ground |
| 8 | N/C | No internal connection | 22 | N/C | No internal connection |
| 9 | N/C | No internal connection | 23 | VCC3 | Output stage supply voltage |
| 10 | VBIAS | Bias voltage | 24 | N/C | No internal connection |
| 11 | GND | Ground | 25 | GND | Ground |
| 12 | N/C | No internal connection | 26 | VCC2 | Stage 2 PA supply voltage |
| 13 | GND | Ground | 27 | GND | Ground |
| 14 | RFOUT_COUP | RF output coupling port | 28 | VCC1 | Input stage supply voltage |

## Technical Description

The SKY66189-11 PA contains all of the needed RF matching and DC biasing circuits. This three-stage device is optimized for high linearity and power efficiency. These features make the device suitable for wideband applications where PA linearity and power consumption are of critical importance (e.g., small cell and infrastructure applications).

The device is designed for standard WCDMA and LTE modulated signals. Under these stringent test conditions, the device exhibits excellent spectral purity and power efficiency.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66189-11 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 3 through 14.

**Table 3. SKY66189-11 Absolute Maximum Ratings[1]**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| Supply voltage (VCC) | $V_{CC}$ | 0 | +4.0 | V |
| Total supply current | $I_{CC}$ | | 1800 | mA |
| Logic control input voltage (VEN) | $V_{EN}$ | -0.5 | 3.6 | V |
| RF input | $RFIN_{MAX}$ | | +5 | dBm |
| Case operating temperature[2] | $T_C$ | -40 | +98 | °C |
| Storage temperature | $T_{STG}$ | -55 | +150 | °C |
| Junction temperature | $T_J$ | | +150 | °C |
| Thermal resistance | $\theta_{JC}$ | | 21.7 | °C/W |
| Power dissipation | $P_D$ | | 1.6 | W |
| Ruggedness @ $P_{OUT}$ = +23 dBm (WCMDA TM1 signal, all phases) | | | 10:1 VSWR | |
| Electrostatic discharge: | ESD | | | |
| Charged Device Model (CDM), Class 4 | | | 500 | V |
| Human Body Model (HBM), Class 1C | | | 150 | 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.

2 Case operating temperature ($T_C$) refers to the temperature of the bottom ground pad.

***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 4. SKY66189-11 Recommended Operating Conditions**

| Parameter | Symbol | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Frequency range | f | 1930 | | 1995 | MHz |
| Supply voltage (VCC1, VCC2, VCC3) [1] | $V_{CC}$ | 3.0 | 3.3 | 3.6 | V |
| PA enable control voltage (active low): | | | | | |
| Disable | $V_{ENH}$ | 2.5 | | 3.6 | V |
| Enable | $V_{ENL}$ | 0 | | 0.6 | V |
| PA enable current (@ PAEN = 3.6 V) | $I_{EN}$ | | | < 1 | mA |
| Case operating temperature | $T_C$ | 0 | +40 | +85 | °C |

1 Voltage levels measured at the pads of the package. The Evaluation Board supply voltage levels may be different.

**Table 5. SKY66189-11 Electrical Specifications [1]**
**($V_{CC}$ = +3.3 V, $T_C$ = +25 °C, f = 1960 MHz, Characteristic Impedance [Z0] = 50 ohms, $V_{EN}$ = 0 V, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Gain | G@23dBm | CW, $P_{OUT}$ = +23 dBm | 38 | 40 | | dB |
| Input return loss | \|S11\| | CW, $P_{IN}$ = –30 dBm | 8 | 10 | | dB |
| Output return loss: | \|S22\| | CW, $P_{IN}$ = –30 dBm: | | | | |
| In-band | | In-band frequency: 1930 and 1995 MHz | 17 | 20 | | dB |
| Out-of-band | | Out-of-band frequency: 1850 and 2070 MHz | 12 | 16 | | dB |
| Quiescent current | $I_{CQ}$ | No RF | | 370 | 430 | mA |
| Operating current | $I_{CC}$ | CW, $P_{OUT}$ = +23 dBm | | 660 | 730 | mA |
| Power-down current:[2] | $I_{PD}$ | VEN = 2.5 V | | 0.1 | 0.5 | mA |
| Harmonics: | | | | | | |
| 2fo @ +23 dBm | 2fo | | | -50 | -42 | dBc |
| 3fo @ +23 dBm | 3fo | | | -60 | -48 | dBc |
| Adjacent channel leakage ratio | ACLR | 5 MHz offset, WCDMA test model 1, with 64 DPCH, 8.5 dB PAR, $P_{OUT}$ = +23 dBm | | -50 | -46.5 | dBc |
| Output 1 dB compression point | OP1dB | CW (Gain compression less than 1dB reference to G@23dBm) | +30 | +31 | | dBm |
| Power-added efficiency | PAE | CW @ $P_{OUT}$ = +23 dBm | 8.0 | 10 | | % |
| Output coupling factor | CPLOUT | $P_{OUT}$ = +23 dBm, CW | 20.5 | 22.5 | 24.5 | dB |

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

2 Verified by characterization.

## Typical Performance Characteristics

**(VCC = +3.3 V, TC = +25 °C, f = 1960 MHz, Characteristic Impedance [Z0] = 50 ohms, VEN = 0 V, Unless Otherwise Noted)**

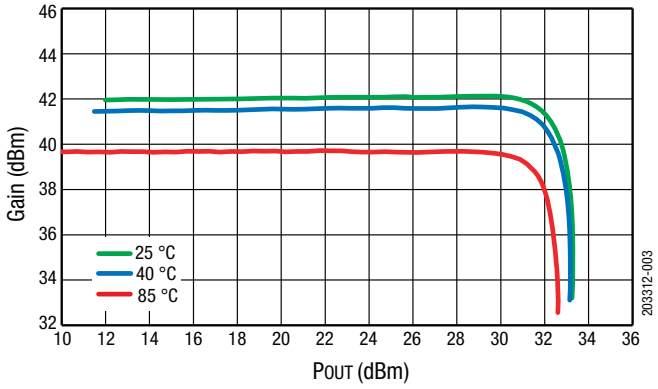



**Figure 3. Gain vs Output Power Across Temperature**

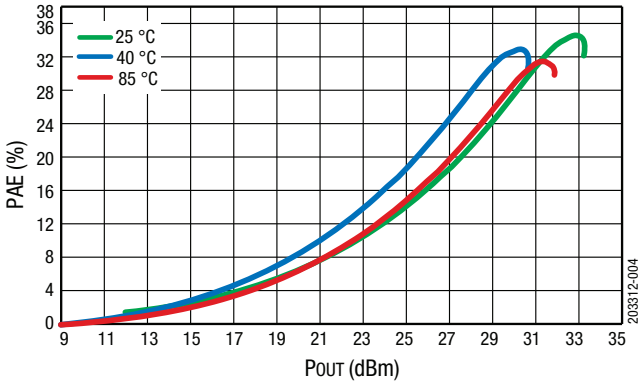



**Figure 4. PAE vs POUT Across Temperature**

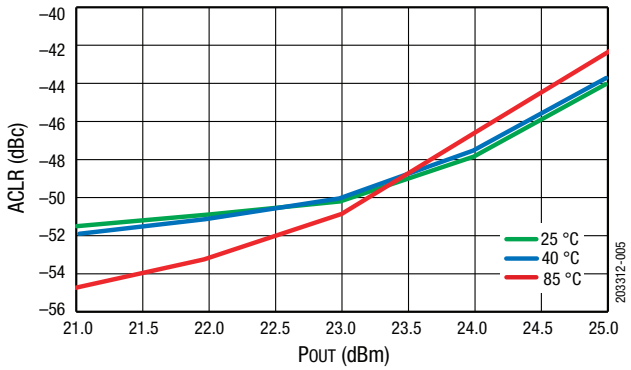



**Figure 5. ACLR vs Output Power Across Temperature**

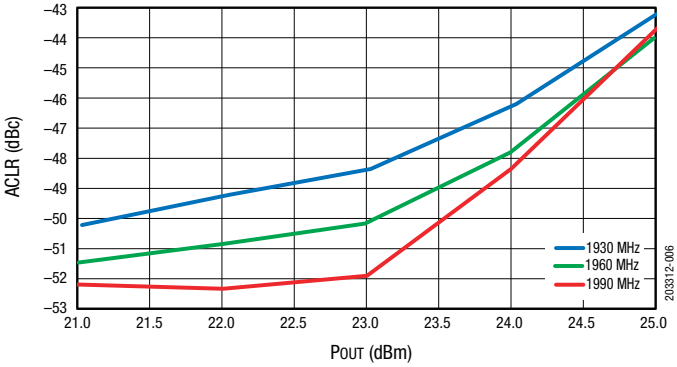



**Figure 6. ACLR (5 MHz) vs POUT Across Frequency**

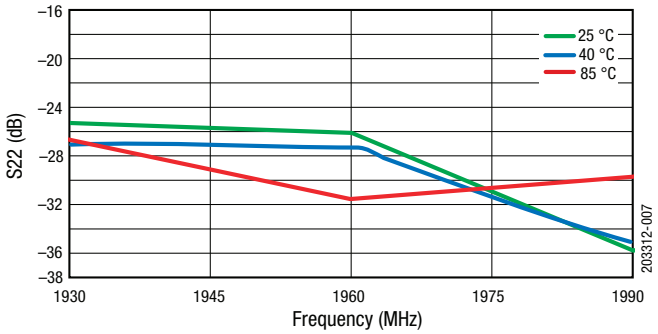



**Figure 7. S22 vs Frequency Across Temperature**

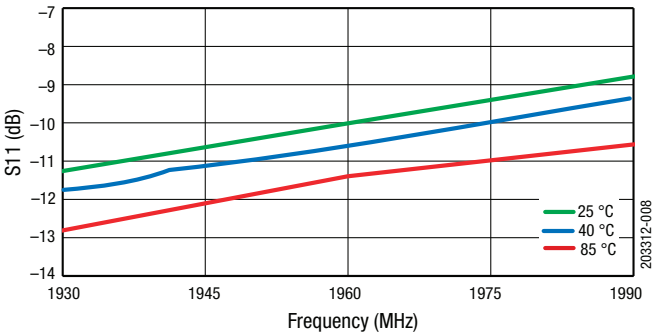



**Figure 8. S11 vs Frequency Across Temperature**

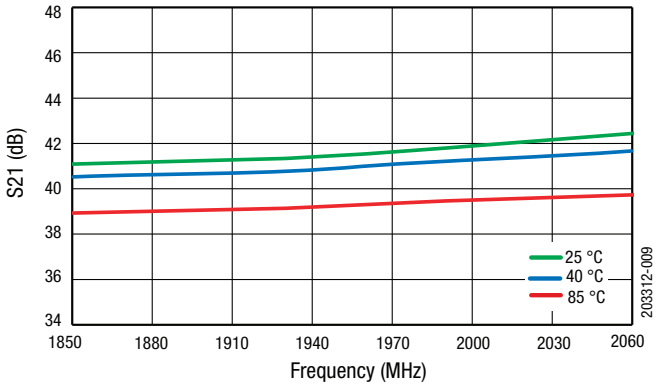



**Figure 9. S21 vs Frequency Across Temperature**

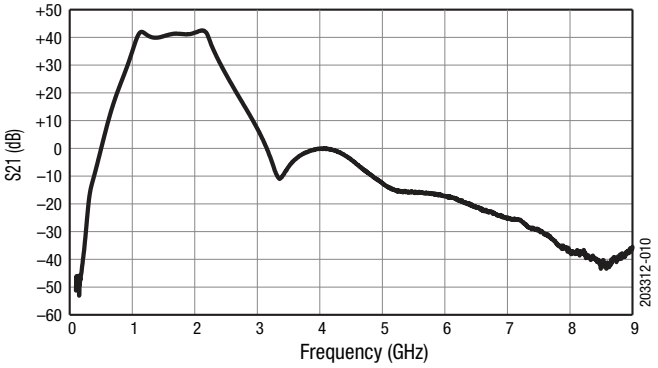



**Figure 10. S21 vs Frequency**

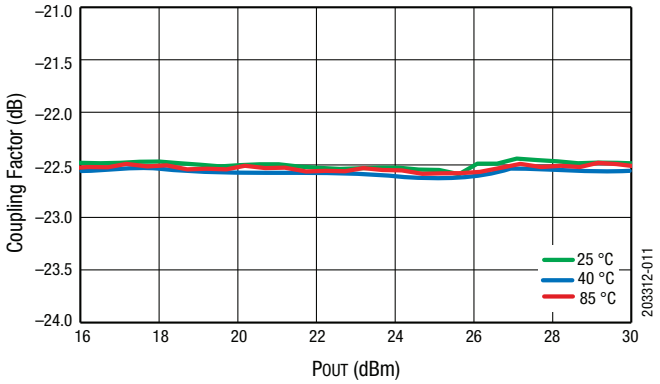



**Figure 11. Coupling Factor vs POUT Across Temperature (1960 MHz, 3.3 V)**

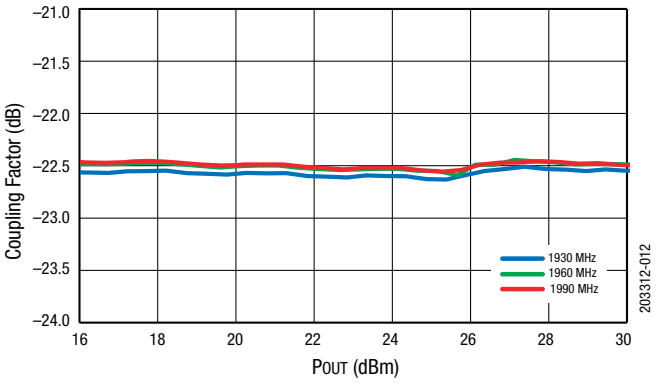



**Figure 12. Coupling Factor vs POUT Across Frequency (3.3 V, 25 °C)**

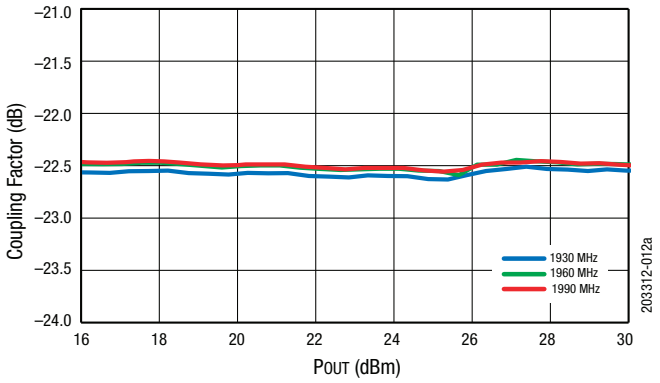



**Figure 13. 2nd Harmonic @ +23 dBm vs. Frequency Across Temperature**

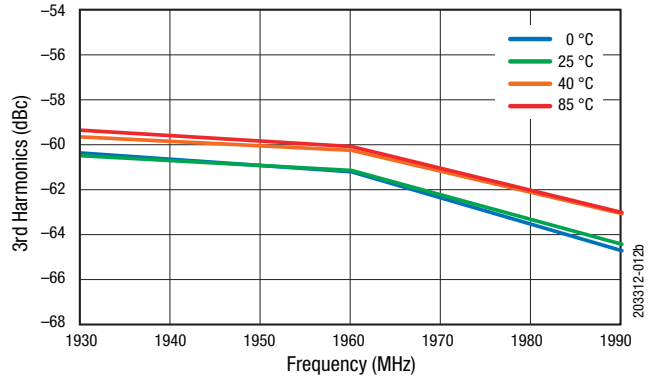



**Figure 14. 3rd Harmonic @ +23 dBm vs. Frequency Across Temperature**

## Evaluation Board Description

The SKY66189-11 Evaluation Board is used to test the performance of the SKY66189-11 PA. A typical application schematic diagram is shown in Figure 15. A Bill of Materials for the SKY66189-11 Evaluation Board is listed in Table 6. An assembly drawing for the Evaluation Board is shown in Figure 16. The board layer detail is shown in Figure 17. The layer detail physical characteristics are shown in Figure 18.

## 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.

**GND (pins 1, 2, 6, 11, 13, 15, 16, 20, 21, 25, and 27).** 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.

**VBIAS (pin 10).** The bias supply voltage for each stage, nominally set to +3.3 V.

**RFOUT (pin 19).** Amplifier RF output pin (Z0 = 50 ohms). The module includes an onboard internal DC blocking capacitor. All impedance matching is provided internal to the module.

**VCC1, VCC2, and VCC3 (pins 28, 26, and 23, respectively).** Supply voltage for each stage collector bias is nominally set to 3.3 V. Bypass and decoupling capacitors C1, C2, C3, C4, C5, and C6 should be placed in the approximate location shown on the evaluation board assembly drawing, although exact placement is not critical.

**RFIN (pin 4).** Amplifier RF input pin (Z0 = 50 ohms). All impedance matching is provided internal to the module.

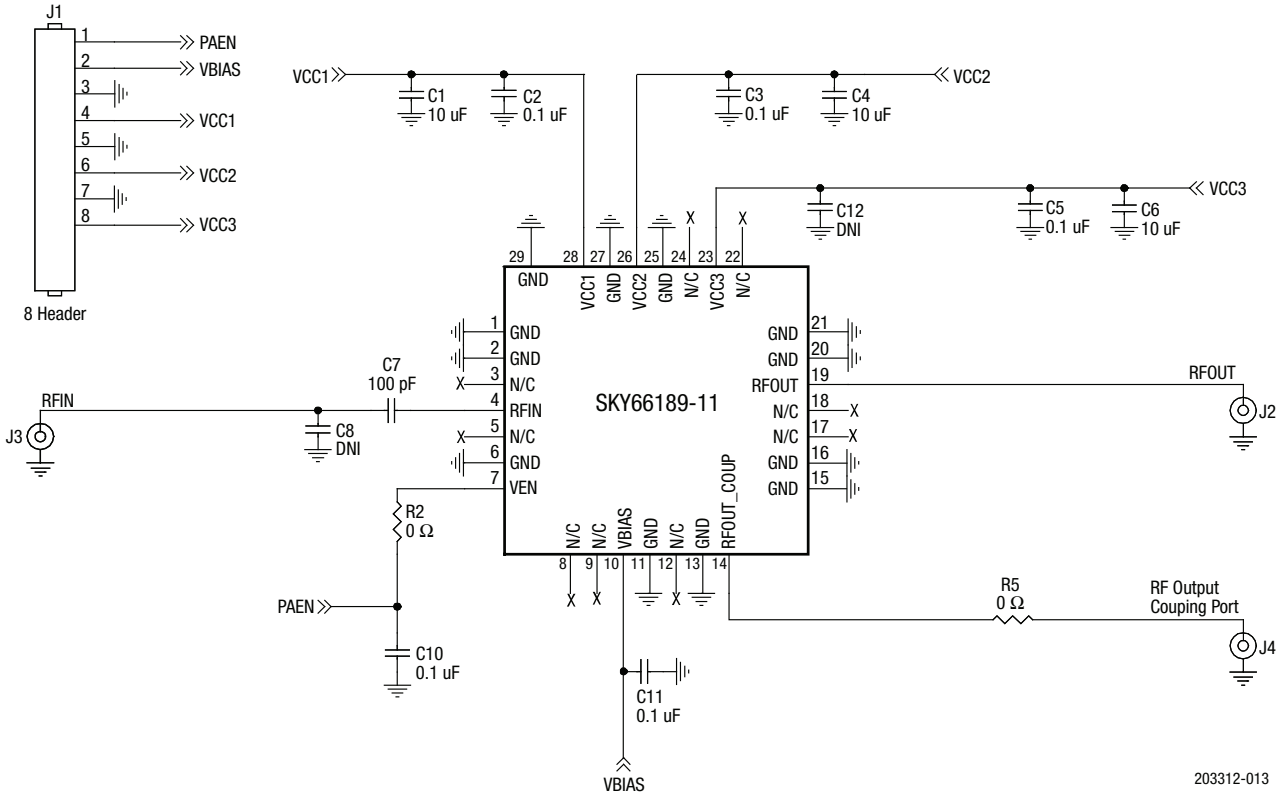
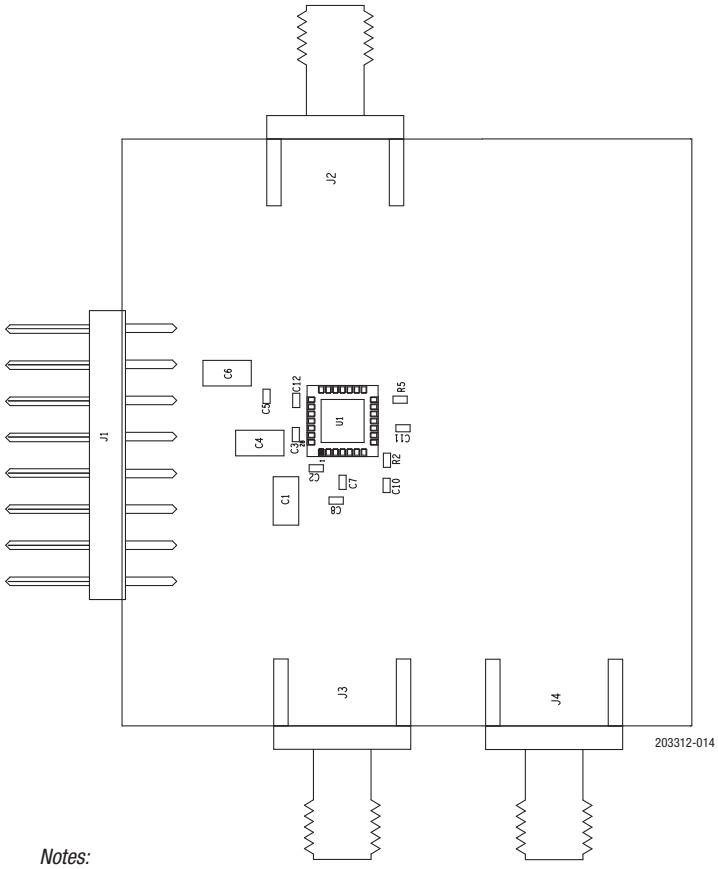



**Figure 15. SKY66189-11 Application Schematic**

**Table 6. SKY66189-11 Evaluation Board Bill of Materials (BoM)**

| Quantity | Component | Size | Part Number | Description |
|---|---|---|---|---|
| 3 | C1, C4, C6 | 1206 | C1206X7R160-106KNE | Capacitor, 10 uF, 16 V, ±10%, X7R |
| 5 | C2, C3, C5, C10, C11 | 0402 | GRM155R71C104KA88 | Ceramic capacitor, 0.1 uF, 10%, X7R, 16 V |
| 1 | C7 | 0402 | GRM1555C1H101JZ01J | Capacitor, 100 pF, 50 V, 5%, COG/NPO |
| 2 | C8, C12 | | DNI | DNI |
| 2 | R2, R5 | 0402 | ERJ2GE0R00 | Resistor, 0 ohm jumper, 0.063 W |
| 1 | | PCB | TW22-D115-003 | SKY66189 |




*Notes:*

*The C3 and C4 components are not required.*
*Some of the other components shown are optional.*

**Figure 16. SKY66189-11 Evaluation Board Assembly Diagram**

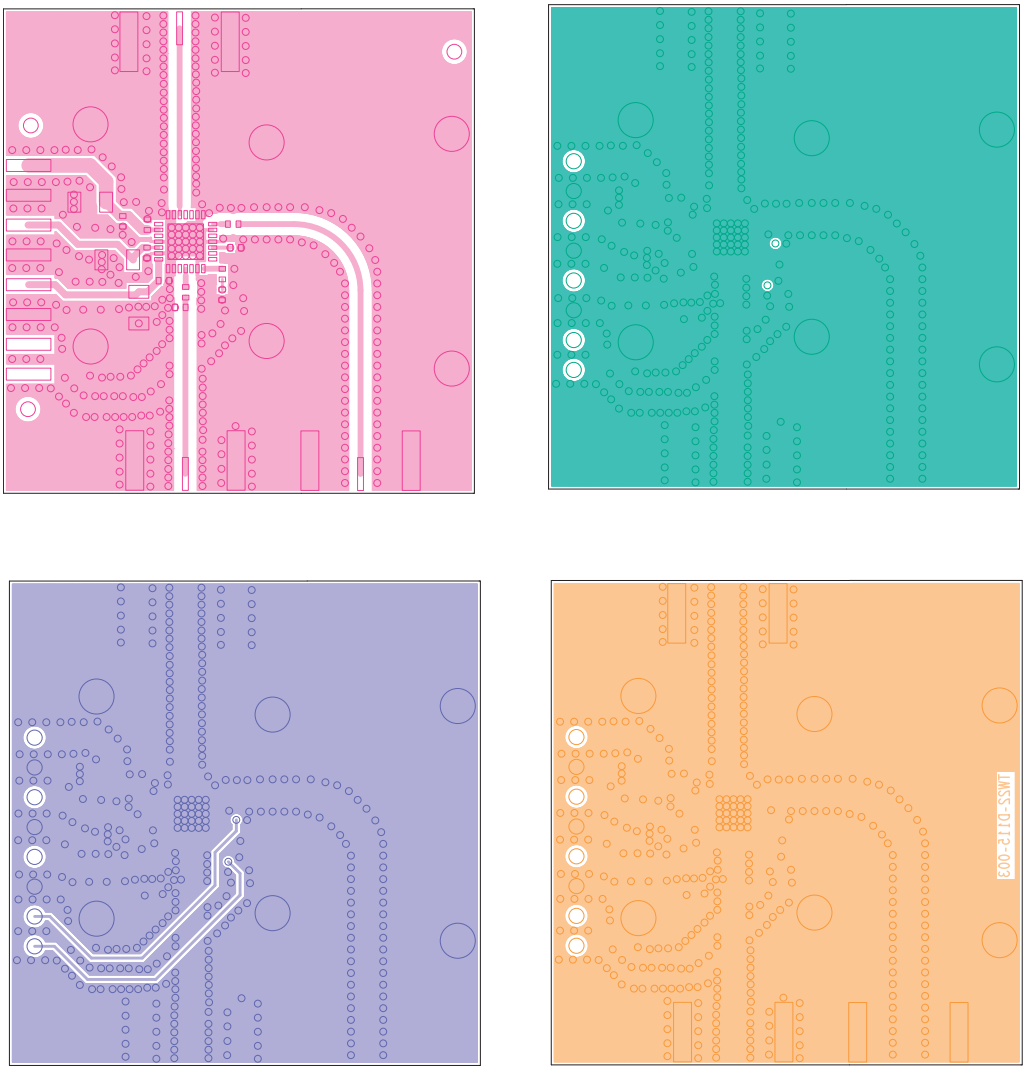



**Figure 17. SKY66189-11 Board Layer Detail**

| 50 Ω | Cross Section | Name | Thickness (mm) | Material |
|---|---|---|---|---|
| W = 0.500 | | TMask | 0.010 | Solder Resist |
| | | L1 | 0.035 | Cu – 1 oz |
| | | Dielectric | 0.250 | Rogers 4350B |
| | | L2 | 0.035 | Cu – 1 oz |
| | | Dielectric | 0.500 | FR4 |
| | | L3 | 0.035 | Cu – 1 oz |
| | | Dielectric | 0.250 | FR4 |
| | | L4 | 0.035 | Cu – 1 oz |
| | | BMask | 0.010 | Solder Resist |

203312-013

**Figure 18. SKY66189-11 Layer Detail Physical Characteristics**

## Package Dimensions

The typical part marking is shown in Figure 19. Figure 20 shows the PCB layout footprint. Figure 21 shows the package dimensions, and Figure 22 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 SKY66189-11 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 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.

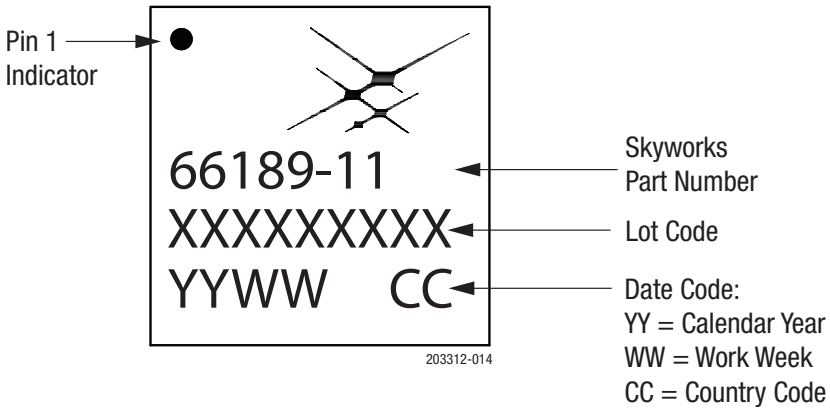
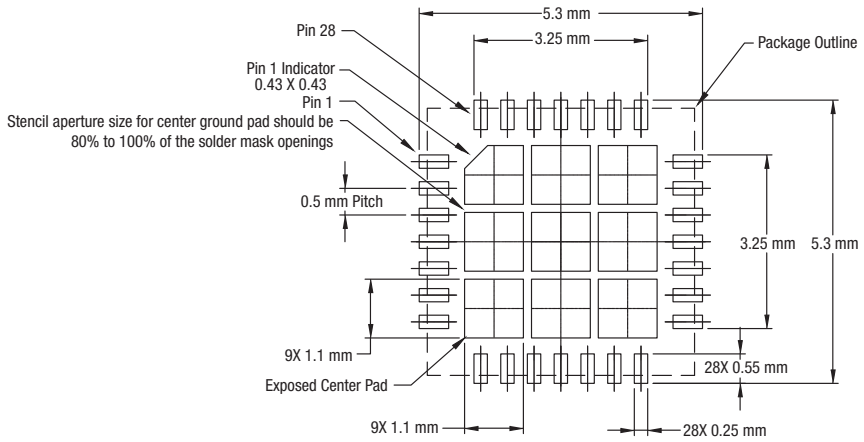
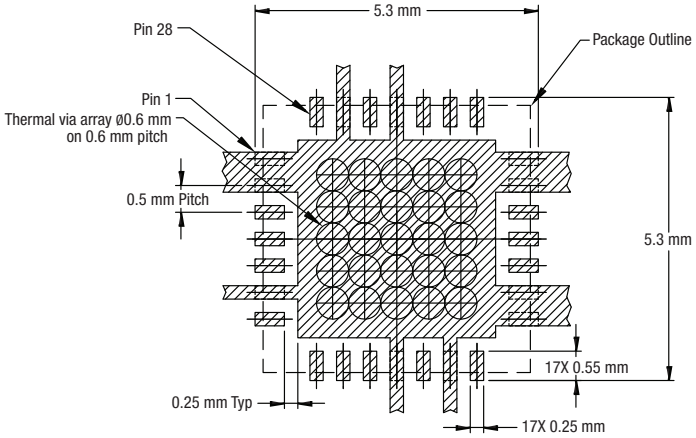


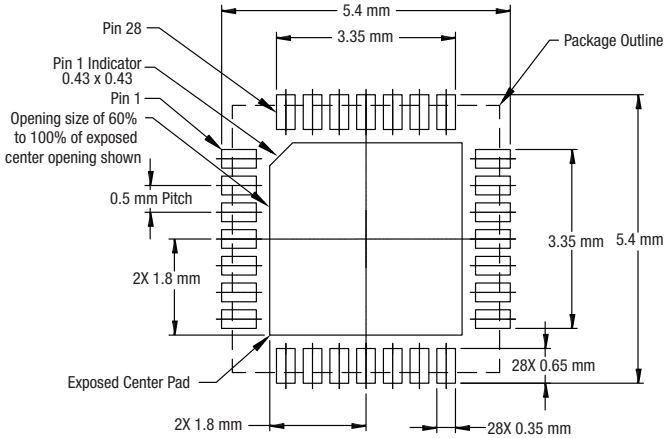

**Figure 19. Typical Part Marking**




Stencil Aperture
Top View




Metallization
Top View




Solder Mask Opening
Top View

*Notes:*

1. *Thermal vias should be resin filled and capped in accordance with IPC–4761 type VII vias.*
2. *Recommended Cu thickness is 30 to 35 µm.*

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**Figure 20. SKY66189-11 PCB Layout Footprint**

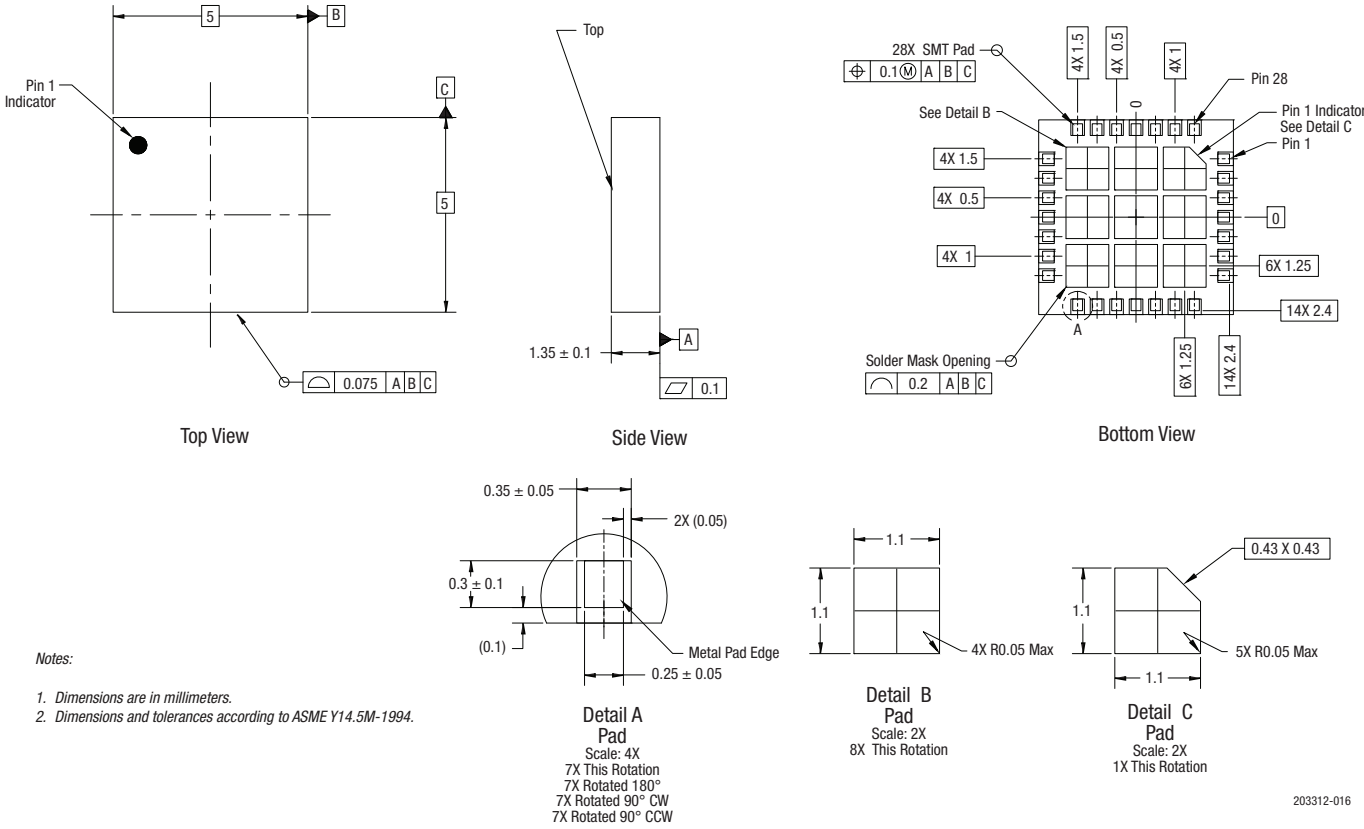
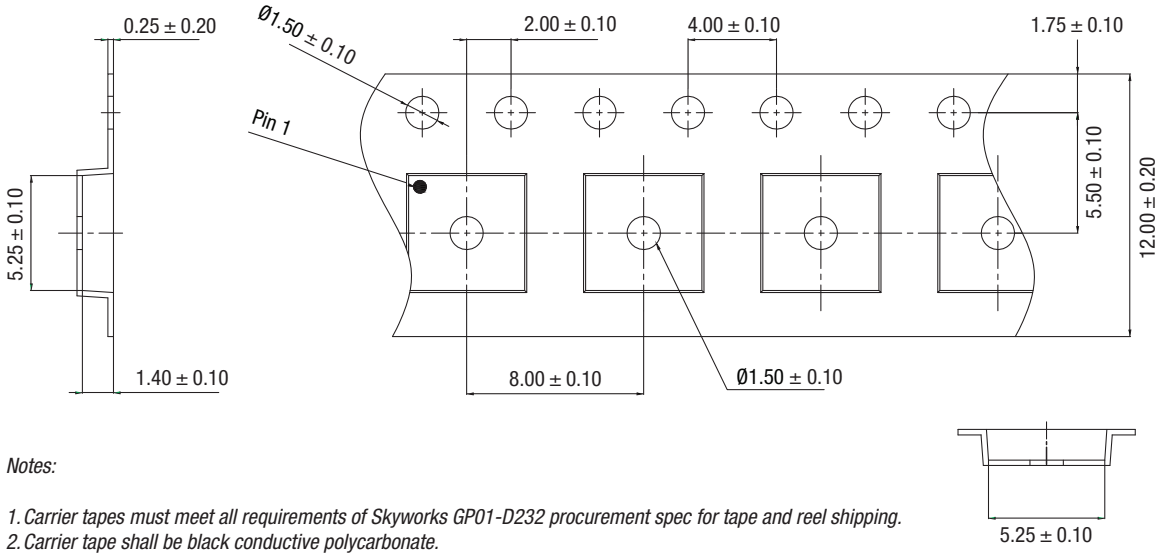



**Figure 21. SKY66189-11 Package Dimensions**




*Notes:*

*1. Carrier tapes must meet all requirements of Skyworks GP01-D232 procurement spec for tape and reel shipping.*
*2. Carrier tape shall be black conductive polycarbonate.*
*3. Cover tape shall be transparent conductive material.*
*4. ESD-surface resistivity shall be ≤ $1 \times 10^{10}$ Ω/square per EJA, JEDEC TNR specification.*
*5. All measurements are in millimeters.*

203312-017

**Figure 22. SKY66189-11 Tape and Reel Dimensions**

## Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|---|---|---|
| SKY66189-11 | 1930 to 1995 MHz Linear Power Amplifier | SKY66189-11-EK1 |

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