DATA SHEET

# SKY66104-11: 1787 to 1930 MHz High-Power RF Front-End Module

## Applications

- Cordless phone wireless headsets
- Cordless phone base station/handsets
- Unified communications systems

## Features

- Integrated PA with up to +25 dBm output power
- Single-ended, 50 Ω transmit/receive RF interfaces
- Fast turn-on/turn-off time: < 5 µs
- Supply operation: 3.0 V to 4.5 V
- Sleep mode current: < 5 µA
- Small footprint MCM (24-pin, 4 x 4 mm) package (MSL3, 260 °C per JEDEC J-STD-020)

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## Description

The SKY66104-11 is a high performance, highly integrated RF Front-End Module (FEM) designed for Digitally Enhanced Cordless Telecommunication (DECT) applications operating in the 1880 MHz to 1930 MHz frequency band, and extended applications for the 1787 MHz to 1792 MHz band.

The SKY66104-11 is designed for ease of use and maximum flexibility, with fully matched 50 Ω inputs and outputs, and digital controls compatible with 1.4 V to 3 V CMOS levels. An external Output Matching Network (OMN) between the PA output and the antenna switch provides ultimate flexibility in DECT applications.

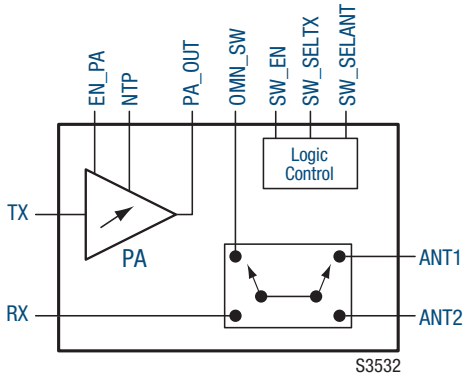



**Figure 1. SKY66104-11 FEM Block Diagram**

A Normal Transmit Power (NTP) input is used to control power between –10 dBm and +25 dBm. NTP is a voltage-operated control with a very high input impedance (>100 kΩ) and a range of 0 V to 1.8 V.

The RF blocks operate over a wide supply voltage range from 3.0 V to 4.5 V, which allows the SKY66104-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

The SKY66104-11 is packaged in a 24-pin, 4 x 4 mm Multi-Chip Module (MCM), which allows for a highly manufacturable low-cost solution.

A functional block diagram of the SKY66104-11 is shown in Figure 1. The 24-pin MCM package and pinout are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

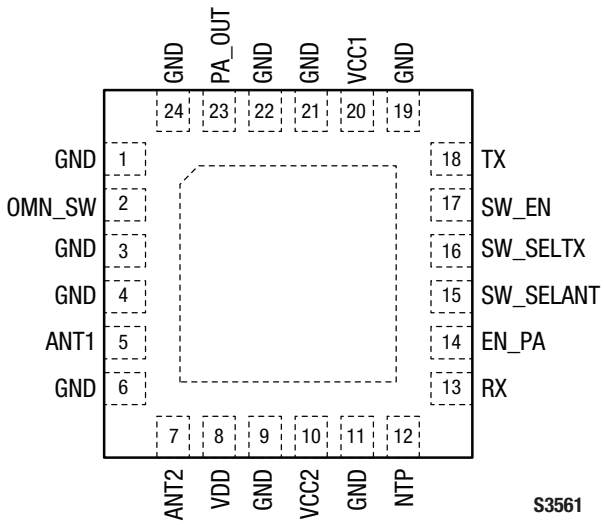



**Figure 2. SKY66104-11 Pinout – 24-Pin MCM (Top View)**

**Table 1. SKY66104-11 Signal Descriptions**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | GND | Ground | 13 | RX | Receive output port (from switch) |
| 2 | OMN_SW | Transmit post-OMN input to switch | 14 | EN_PA | PA enable |
| 3 | GND | Ground | 15 | SW_SELANT | Switch logic control, ANT1/ANT2 select |
| 4 | GND | Ground | 16 | SW_SELTX | Switch logic control, TX/RX select |
| 5 | ANT1 | Antenna 1 port | 17 | SW_EN | Switch logic control, switch enable |
| 6 | GND | Ground | 18 | TX | Transmit input port (to PA) |
| 7 | ANT2 | Antenna 2 port | 19 | GND | Ground |
| 8 | VDD | Supply, switch | 20 | VCC1 | Supply, PA bias |
| 9 | GND | Ground | 21 | GND | Ground |
| 10 | VCC2 | Supply, PA collector and NTP controller | 22 | GND | Ground |
| 11 | GND | Ground | 23 | PA_OUT | PA output port (to external OMN) |
| 12 | NTP | Normal Transmit Power adjustment | 24 | GND | Ground |

## Technical Description

The SKY66104-11 contains all of the needed RF matching and DC biasing circuits. The PA is a two-stage, HBT InGaP device optimized for high linearity and power efficiency. The PA output power is controlled by a silicon device.

These features make the device suitable for wideband digital applications where PA linearity and power consumption are of critical importance.

The device is designed for standard DECT applications. Under these stringent test conditions, the device exhibits excellent spectral purity and power efficiency.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66104-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 through 7.

The state of the SKY66104-11 is determined by the logic provided in Table 8. Mode control configurations are noted in Table 9.

A plot of output power versus NTP is shown in Figure 3.

**Table 2. SKY66104-11 Absolute Maximum Ratings (Note 1)**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| Supply voltage (VCC1, VCC2, VDD) | $V_{PS}$ | –0.3 | +4.8 | V |
| Logic control voltages | $V_{IH}$, $V_{IL}$ | –0.3 | +3.3 | V |
| Transmit RF input power (at TX port) | $P_{IN_TX}$ | | +10 | dBm |
| Receive RF input power (at ANT1 or ANT2 ports) | $P_{IN_RX}$ | | +20 | dBm |
| Voltage standing wave ratio | VSWR | | 6:1 | – |
| Operating case temperature (Note 2) | $T_C$ | –40 | +85 | °C |
| Storage temperature | $T_{STG}$ | –55 | +150 | °C |
| Electrostatic discharge:<br>Human Body Model (HBM), Class 1A | ESD | | <br>250 | <br>V |

**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 typical value as provided in Tables 3, 4, and 5. Exceeding any of the limits listed here may result in permanent damage to the device.

**Note 2**: Nominal junction-to-case thermal resistance is 80°C/W.

***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 3. SKY66104-11 Recommended Operating Conditions**

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Operating case temperature (Note 1) | $T_C$ | –40 | +25 | +80 | °C |
| RF supply voltage (Note 2) | VCC1, VCC2 | 3.0 | 3.6 | 4.5 | V |
| Switch supply voltage (Note 2) | VDD | 3.0 | 3.6 | 4.5 | V |

**Note 1**: Specified case temperature is measured at the MCM ground pad interface.

**Note 2**: Power supply pins VCC1, VCC2, and VDD are independent supplies and are not internally tied together.

**Table 4. SKY66104-11 DC Electrical Specifications (Note 1)**
**(VCC1/2 = +3.6 V, VDD = 3.6 V, $T_C$ = +25 °C, $P_{IN}$ = 0 dBm, as Measured on the SKY66104-11 Evaluation Board (De-Embedded to Device), Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Total supply current in Transmit Mode (Note 2) | $I_{PS(TX24)}$ | $P_{OUT}$ = +24 dBm | | 171 | | mA |
| | $I_{PS(TX15)}$ | $P_{OUT}$ = +15 dBm | | 83 | | mA |
| | $I_{PS(TX10)}$ | $P_{OUT}$ = +10 dBm | | 58 | | mA |
| Total supply current in Receive Mode (Note 2) (Note 3) | $I_{PS(RX)}$ | | | 60 | | µA |
| Total supply current in Sleep Mode (Note 2) (Note 3) | $I_{PS(OFF)}$ | | | 4.1 | | µA |
| NTP input current in Transmit Mode (Note 3) | $I_{NTP_IN}$ | | | 9.5 | | µA |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table. Receive (RX), Transmit (TX), and Sleep Mode configurations are defined in Table 9. Typical performance shown is for Engineering Sample 2 (ES2).

**Note 2:** $I_{PS} = I_{CC1} + I_{CC2} + I_{DD}$. These are expected total power supply currents for indicated $P_{OUT}$ at ANT1/2 ports.

**Note 3**: NTP = 0 V.

**Table 5. SKY66104-11 Transmit Mode Electrical Specifications (Note 1) (Note 2)**
**(VCC1/2 = +3.6 V, VDD = 3.6 V, $T_C$ = +25 °C, $P_{IN}$ = 0 dBm, as Measured on the SKY66104-11 Evaluation Board (De-Embedded to Device), All Used and Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Frequency range (Note 3) | f | | 1880 | | 1930 | MHz |
| Output power at ANT1/2 ports (Note 4) | $P_{OUT}$ | NTP ≥ 1.55 V<br>NTP ≤ 0.3 V | | +24<br>+0 | | dBm<br>dBm |
| Output power variation over temperature (Note 4) (Note 5) | $P_{OUT_TV}$ | $T_C$ = –40 °C to +85 °C, relative to the value at 25 °C | –2 | –0.9/+0.8 | +2 | dB |
| NTP input voltage (Note 4) | NTP | $P_{OUT}$ = +15 dB<br>$P_{OUT}$ = +10 dB | | 0.7<br>0.5 | | V<br>V |
| Small signal gain | S21 | $P_{IN}$ = –25 dBm, NTP = 1.8 V | | +27 | | dB |
| TX-RX port isolation | $S21_{TX-RX}$ | Pin 13 relative to pin 18 | | 5 | | dB |
| Ant–RX port isolation | $S21_{ANT-RX}$ | Pin 13 relative to pin 5 or 7 | | 29 | | dB |
| Input return loss | S11 | @ TX port | | –12 | –7 | dB |
| Output return loss | S22 | | | –12 | –8 | dB |
| 1 dB output compression point (Note 6) | OP1dB | NTP = 1.8 V | | +24 | | dBm |
| 2nd and 3rd harmonics | 2fo, 3fo | NTP = 1.8 V, CW | | –50 | –30 | dBc |
| Higher harmonics (Note 5) | 4fo to 10 fo | NTP = 1.8 V, CW | | –50 | –40 | dBc |
| Turn-on time (Note 5) | $t_{ON}$ | From 50% of rising logic control to 90% of final RF output power | | 1.6 | 5 | µs |
| Turn-off time (Note 5) | $t_{OFF}$ | From 50% of falling logic control to 10% of final RF output power | | 0.3 | 5 | µs |
| Stability (Note 5) | Stab | NTP = 1.8 V, CW<br>f = 0.1 GHz to 20 GHz, load VSWR = 6:1 | All non-harmonically related outputs < –40 dBm | | | |
| Ruggedness (Note 5) | RU | NTP = 1.8 V, CW<br>load VSWR = 6:1 | No permanent damage | | | |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table. Production testing is performed at 1905 MHz. Transmit (TX) Mode configuration is defined in Table 9. Typical performance shown is for Engineering Sample 2 (ES2).

**Note 2:** With specified matching network between pins PA_OUT and OMN_SW. $P_{OUT}$ measured at ANT1/ANT2 ports.

**Note 3:** f = 1787 MHz to 1880 MHz at reduced performance with $P_{OUT}$ = +20 dBm.

**Note 4:** NTP is an analog input control. See Figure 3 for typical characteristics.

**Note 5**: Not tested in production. Fully characterized and guaranteed by design.

**Note 6:** Starting point for test is $P_{IN}$ = –13 dBm.

**Table 6. SKY66104-11 Receive Mode Electrical Specifications (Note 1)**
**(VCC1/2 = +3.6 V, VDD = 3.6 V, Tc = +25 °C, ANT1 and ANT2 Ports, as Measured on the SKY66104-11 Evaluation Board (De-Embedded to Device), All Used and Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Frequency range (Note 2) | f | | 1880 | | 1930 | MHz |
| Receive loss | $R_{X_LOSS}$ | | | 0.8 | | dB |
| ANT1/2 port input return loss | $S11_{ANT1/2}$ | | | –12 | –8 | dB |
| RX port output return loss | $S22_{RX}$ | | | –12 | –8 | dB |
| Turn-on time (Note 3) | $t_{ON}$ | From 50% of falling logic control to 90% of final RF output power | | 1.6 | 5 | µs |
| Turn-off time (Note 3) | $t_{OFF}$ | From 50% of rising logic control to 10% of final RF output power | | 0.3 | 5 | µs |

**Note 1**: Performance is guaranteed only under the conditions listed in this table. Production testing is performed at 1905 MHz. Receive (RX) Mode configuration is defined in Table 9.

**Note 2**: f = 1787 MHz to 1792 MHz at reduced performance.

**Note 3**: Not tested in production. Fully characterized and guaranteed by design.

**Table 7. SKY66104-11 Diversity Antenna Electrical Specifications (Note 1)**
**(VCC1/2 = +3.6 V, VDD = 3.6 V, Tc = +25 °C, as Measured on the SKY66104-11 Evaluation Board (De-Embedded to Device), All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Isolation, ANT1 to ANT2 | $ISOL_{ANTSW}$ | Transmit (TX) Mode | | 29 | | dB |
| Isolation, ANT(x) to RX | $ISOL_{ANT-RX}$ | Transmit (TX) Mode | | 29 | | dB |
| ANT1 to ANT2 switching time in Transmit Mode (Note 2) | $t_{ANT1_ANT2(TX)}$ | Transmit (TX) Mode | | 1.6 | 5 | µs |
| ANT1 to ANT2 switching time in Receive Mode (Note 2) | $t_{ANT1_ANT2(RX)}$ | Receive (RX) Mode | | 0.3 | 5 | µs |

**Note 1**: Performance is guaranteed only under the conditions listed in this Table. Receive (RX) Mode and Transmit (TX) Mode configurations are defined in Table 9.

**Note 2**: Not tested in production. Fully characterized and guaranteed by design.

**Table 8. SKY66104-11 Electrical Specifications: Control Logic Characteristics (Note 1)**
**(Tc = +25 °C, as Measured on the SKY66104-11 Evaluation Board (De-Embedded to Device), Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Control voltage: | | | | | | |
| High | $V_{IH}$ | | 1.4 | 1.7 | 3.3 | V |
| Low | $V_{IL}$ | | 0 | | 0.3 | V |
| Input current: | | | | | | |
| High (Note 2) | $I_{IH}$ | | | 24 | | µA |
| Low (Note 3) | $I_{IL}$ | | | 0 | | µA |

**Note 1:** Performance is guaranteed only under the conditions listed in this table. Control logic input signals are: SW_EN, SW_SELTX, and SW_SELANT.

**Note 2**: With required internal pull-down of 72 kΩ, typical $I_{IH}$ condition is $V_{IH}$ = 1.7 V.

**Note 3**: Typical $I_{IL}$ condition is $V_{IL}$ = 0 V.

**Table 9. SKY66104-11 Mode Control Logic (Note 1)**

| Mode | EN_PA (Note 2) (Pin 14) | SW_SELANT (Pin 15) | SW_SELTX (Pin 16) | SW_EN (Pin 17) | Total Current |
|---|---|---|---|---|---|
| TX → ANT1 | 1 | 1 | 1 | 1 | 72 mA |
| TX → ANT2 | 1 | 0 | 1 | 1 | 72 mA |
| RX → ANT1 (Note 3) | 0 | 1 | 0 | 1 | 60 µA |
| RX → ANT2 (Note 3) | 0 | 0 | 0 | 1 | 60 µA |
| Sleep (Note 3) (Note 4) | 0 | 0 | 0 | 0 | 4.1 µA |

**Note 1**: Logic levels "0" and "1" are compliant with $V_{IL}$ and $V_{IH}$, respectively, as specified in Table 8.

**Note 2**: EN_PA is exclusively used to power up/down the PA. This signal is not involved with configuring the switches. The EN_PA states shown in this table are what is needed to achieve the desired receive and transmit functionality and performance.

**Note 3**: The transmit PA is turned off in this mode for minimum power consumption.

**Note 4**: NTP at 0 V.

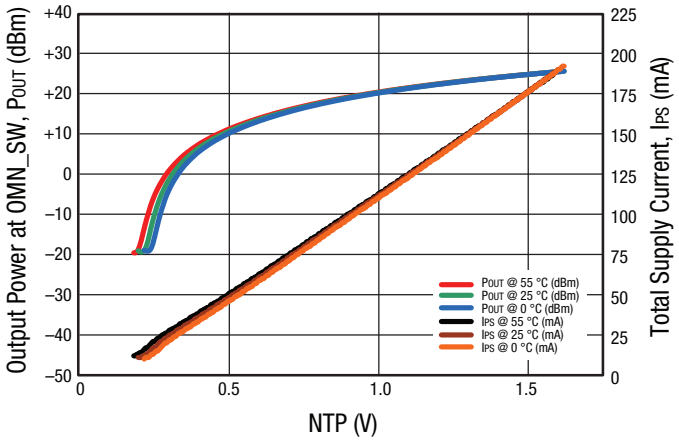



**Figure 3. SKY66104-11 NTP Control vs Output Power (TX Mode, $V_{PS}$ = 3.6 V, f = 1905 MHz, $P_{IN}$ = 0 dBm)**

## Evaluation Board Description

The SKY66104-11 Evaluation Board is used to test the performance of the SKY66104-11 FEM. A typical application schematic diagram is provided in Figure 4. An assembly drawing for the Evaluation Board is shown in Figure 5. An Evaluation Board schematic is shown in Figure 6, and the layer detail is provided in Figure 7.

## Package Dimensions

Typical part markings are shown in Figure 8. The PCB layout footprint for the SKY66104-11 is provided in Figure 9. Figure 10 shows the package dimensions for the 24-pin MCM, and Figure 11 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 SKY66104-11 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.

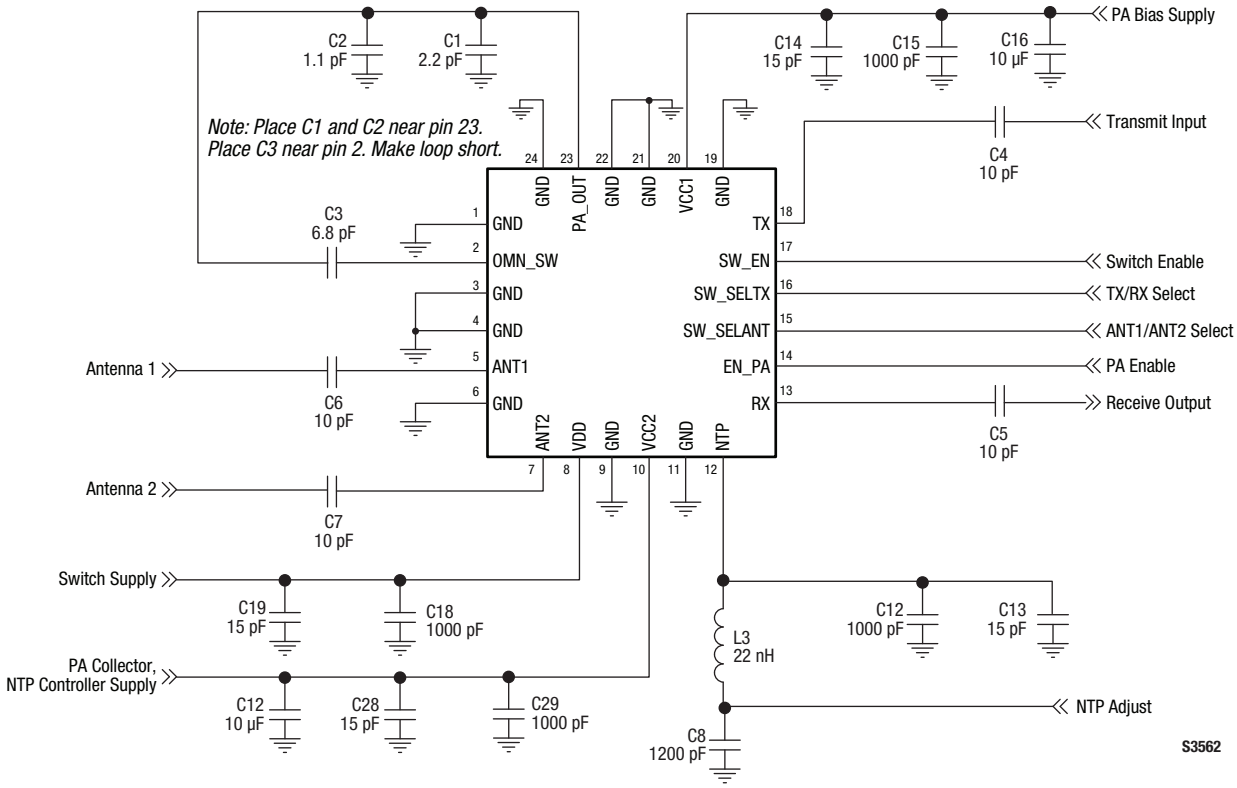



**Figure 4. SKY66104-11 Typical Application Schematic**

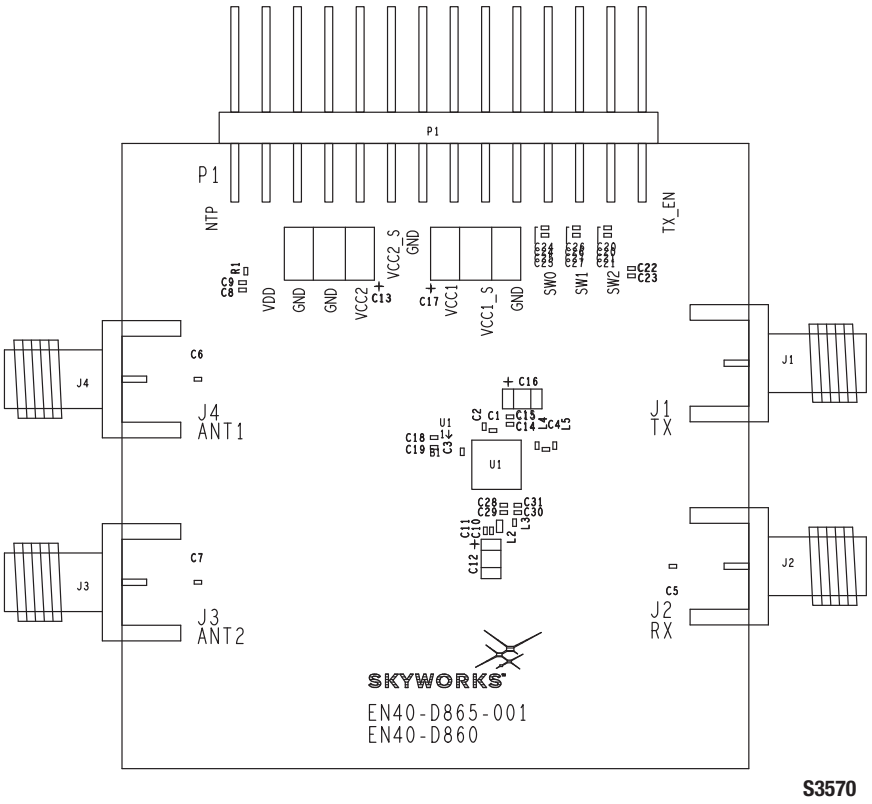
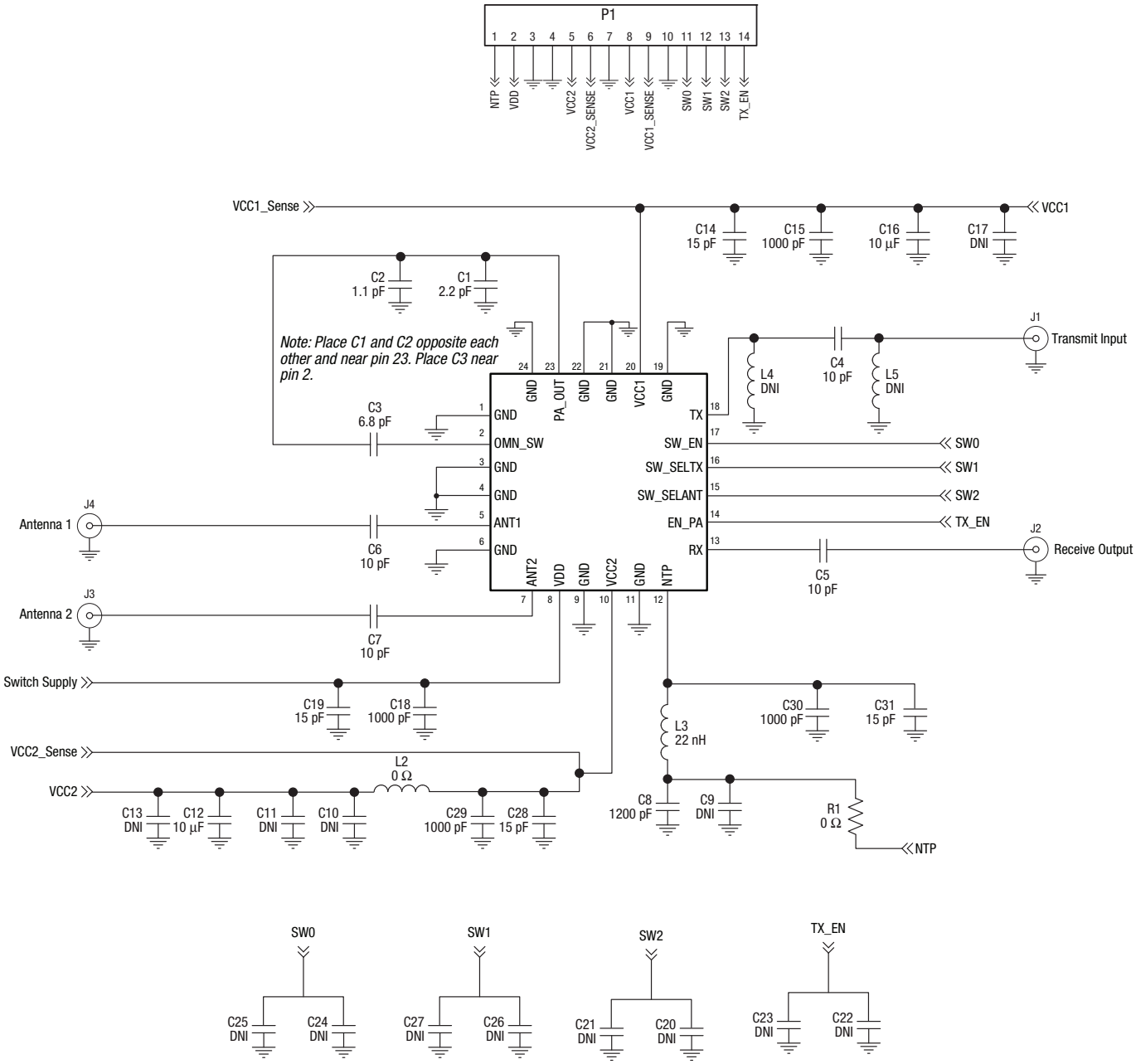



**Figure 5. SKY66104-11 Evaluation Board Assembly Drawing**




*Note: Some component labels may be different than the corresponding component symbol shown here. Component values, however, are accurate as of the date of this Data Sheet.*

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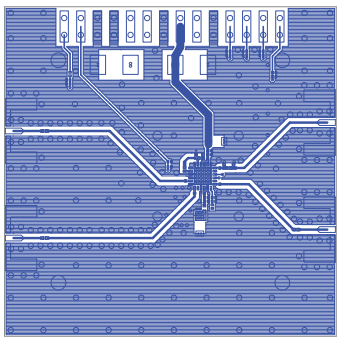
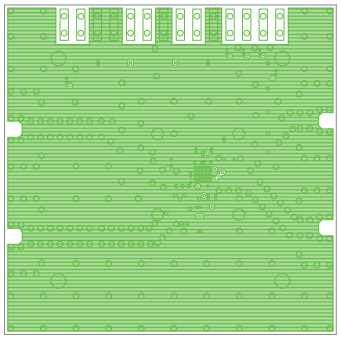
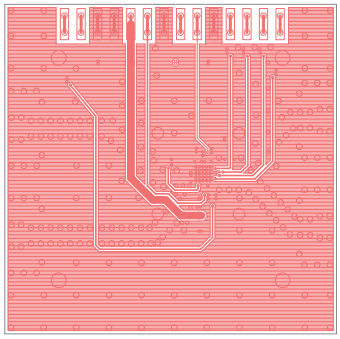
**Figure 6. SKY66104-11 Evaluation Board Schematic**



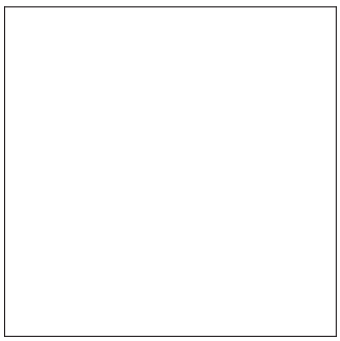
Layer 1: Top Layer



Layer 2: Ground Plane



Layer 3: VCC Layer



Layer 4: Bottom Layer

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**Figure 7. Evaluation Board Layer Detail**

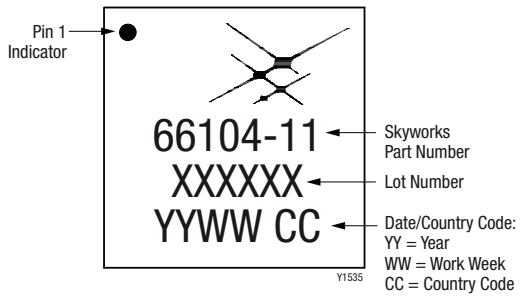



**Figure 8. Typical Part Markings (Top View)**

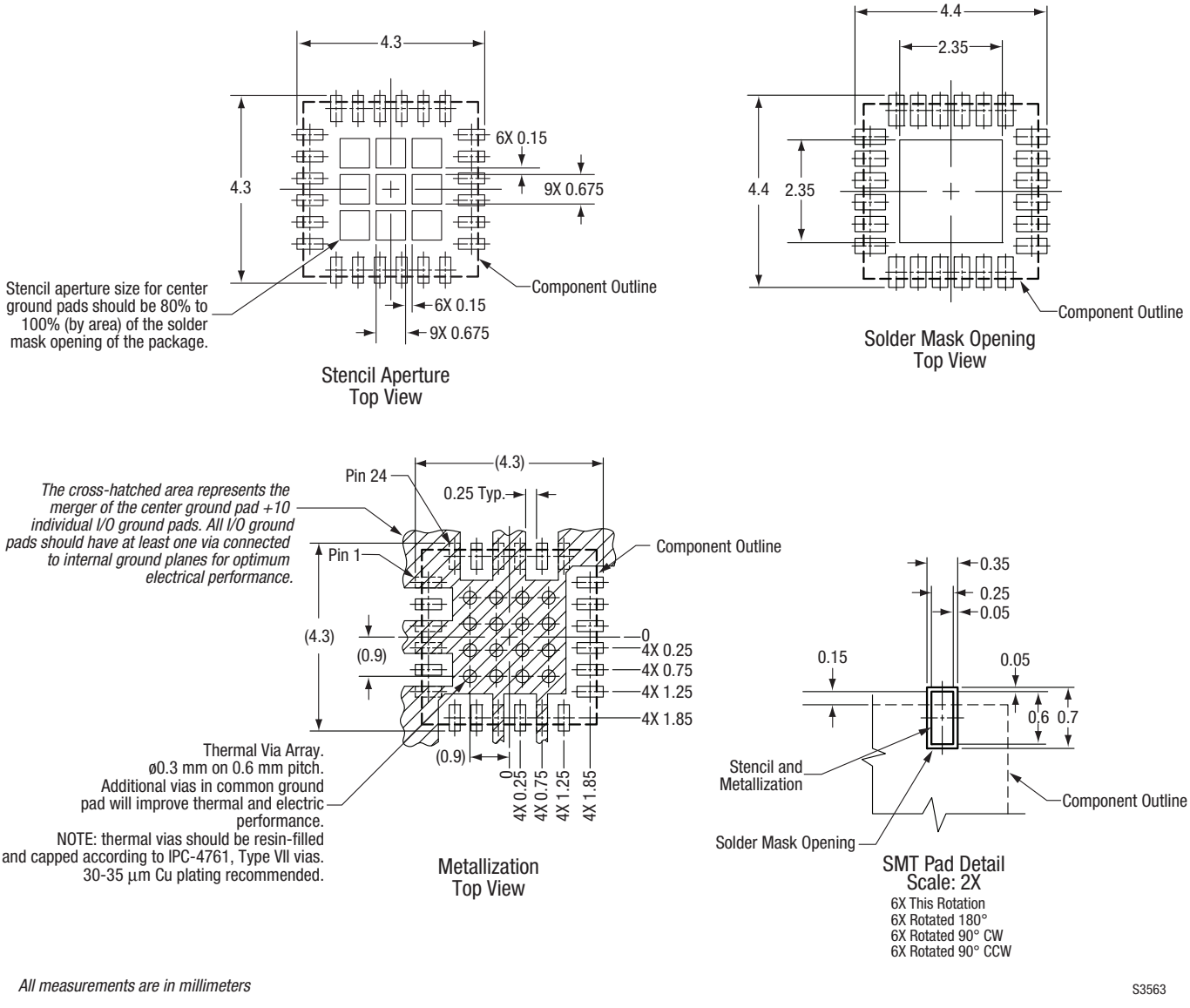
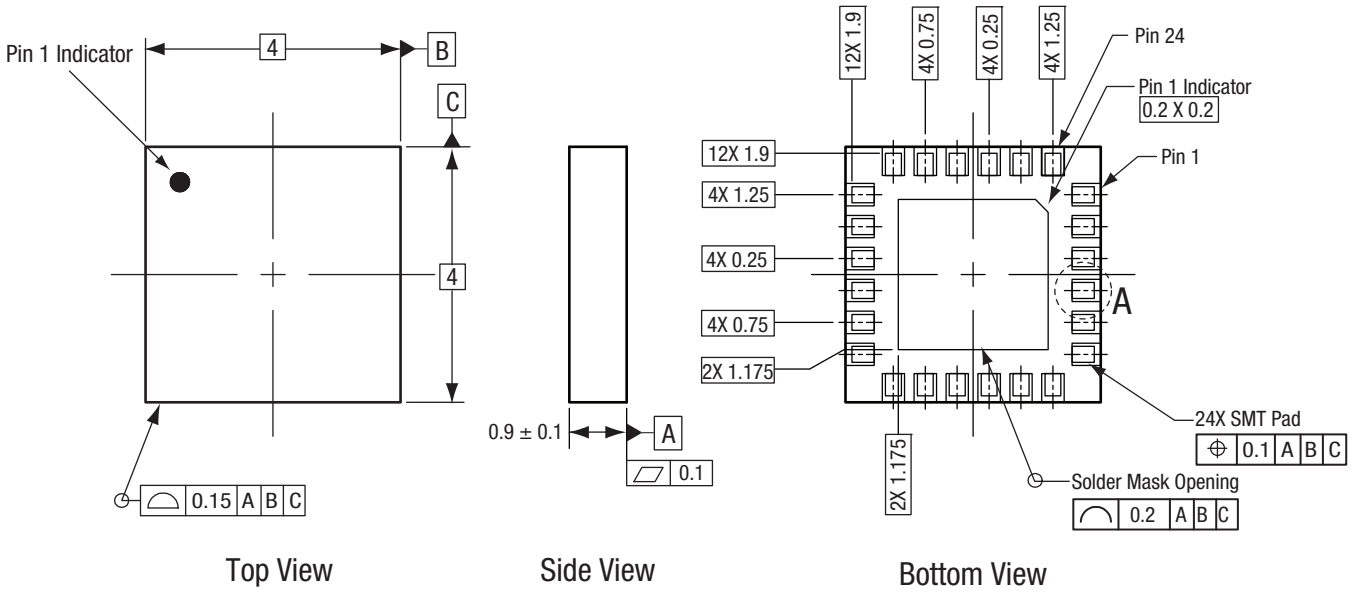
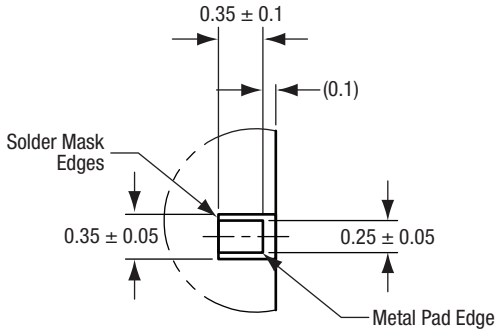



**Figure 9. SKY66104-11 PCB Layout Footprint**



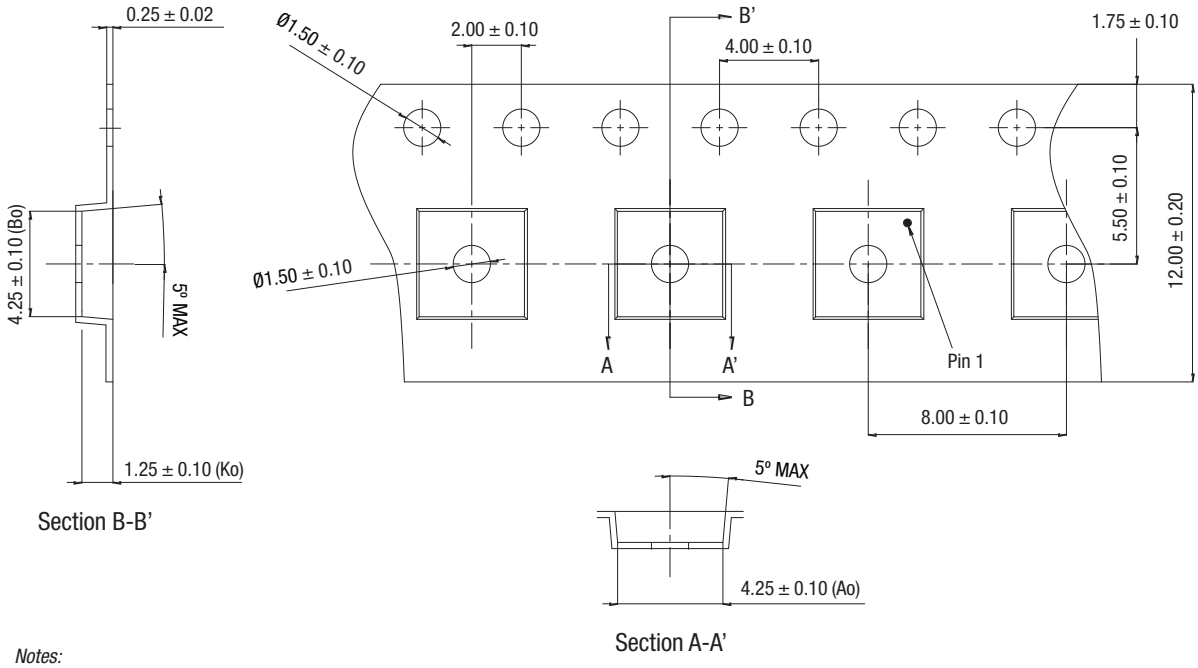

Detail A
SMT Pad
Scale: 2X
6X This Rotation
6X Rotated 180°
6X Rotated 90° CW
6X Rotated 90° CCW

*All measurements are in millimeters*

*Dimensioning and tolerancing according to ASME Y14.5M-1994*

**S3560**

**Figure 10. SKY66104-11 24-Pin MCM Package Dimensions**




*Notes:*
*1. All measurements are in millimeters.*
*2. Carrier tape must meet all requirements of Skyworks GP01-D232 procurement Spec for tape and reel shipping.*
*3. Carrier tape shall be black conductive polycarbonate.*
*4. Cover tape shall be transparent conductive material.*
*5. ESD-surface resistivity shall meet GP01-D232.*
*6. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm.*
*7. Ao and Bo measured on plane 0.30 mm above the bottom of the procket.*
*8. Part No. : KS-1208-440-PC. (Please indicate on purchase order)*

ts269

**Figure 11. SKY66104-11 Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY66104-11: RF Front-End Module | SKY66104-11 | SKY66104-11-EK1 |

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