

DATA SHEET

SKY66101-11: 902 to 928 MHz High-Power RF Front-End Module

Applications

- Range extender
- Smart meters
- In-home appliances
- Smart thermostats

Features

- Integrated PA with +30 dBm output power
- Integrated LNA with programmable bypass
- Low noise figure: 2.5 dB, typical
- Single-ended 50 Ω transmit RF interface
- Differential 100 Ω receive RF interface
- Fast turn-on/turn-off time: <1 μs
- Supply voltage: 2.0 V to 4.8 V
- Sleep mode current: < 1 μA
- Small MCM (36-pin, 6 x 6 x 0.9 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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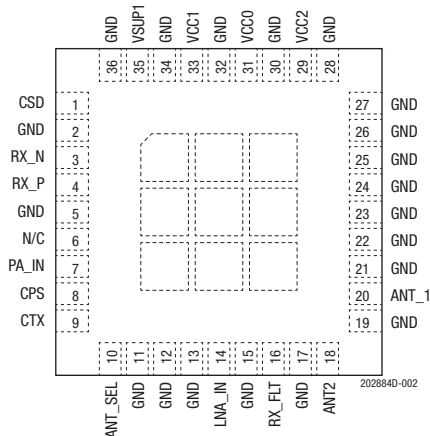


Figure 2. SKY66101-11 Pinout (Top View)

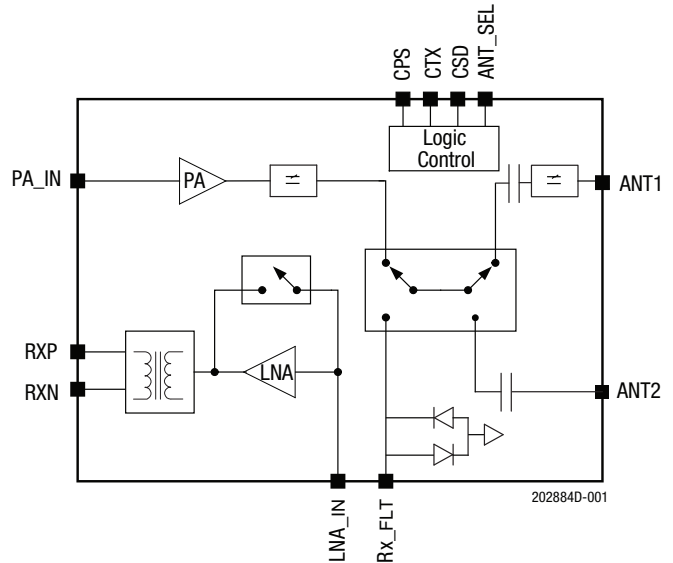


Figure 1. SKY66101-11 Functional Block Diagram

Description

The SKY66101-11 is a high-performance, highly integrated RF front-end module (FEM) designed for high-power Industrial, Scientific, Medical (ISM) band applications operating in the 902 to 928 MHz frequency range.

The SKY66101-11 is designed for ease of use and maximum flexibility with fully matched, 50 Ω power amplifier (PA) input and output, and digital controls compatible with 1.6 to 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 2.0 to 4.8 V that allows the SKY66101-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

The SKY66101-11 is packaged in a 36-pin, 6 x 6 x 0.9 mm Multi-Chip Module (MCM), which allows for a highly manufacturable low-cost solution.

A functional block diagram of the SKY66101-11 is shown in Figure 1. The 36-pin MCM package and pinout are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

Table 1. SKY66101-11 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	CSD	Standby control (see Table 9)	19	GND	Ground
2	GND	Ground	20	ANT1	Antenna 1 (integrated harmonic filtering)
3	RX_N	Receive RF output, negative polarity (100 Ω differential)	21	GND	Ground
4	RX-P	Receive RF output, positive polarity (100 Ω differential)	22	GND	Ground
5	GND	Ground	23	GND	Ground
6	N/C	No connection	24	GND	Ground
7	PA_IN	PA input	25	GND	Ground
8	CPS	LNA gain control (see Table 9)	26	GND	Ground
9	CTX	Transmit/receive control (see Table 9)	27	GND	Ground
10	ANT_SEL	Antenna select control (see Table 9)	28	GND	Ground
11	GND	Ground	29	VCC2	PA voltage supply
12	GND	Ground	30	GND	Ground
13	GND	Ground	31	VCC0	Decoupling capacitor
14	LNA_IN	LNA input	32	GND	Ground
15	GND	Ground	33	VCC1	PA voltage supply
16	RX_FLT	Receive signal from antennas	34	GND	Ground
17	GND	Ground	35	VSUP1	PA voltage supply
18	ANT2	Antenna 2 (no integrated harmonic filtering)	36	GND	Ground

Technical Description

The SKY66101-11 consists of a complete T/R chain with T/R switches contained in the module. An SP3T switch selects between receive, transmit, and transmit bypass paths. The module has a shutdown mode to minimize power consumption.

Three digital input control pins (CSD, CPS, and CTX) are used to select between shutdown, T/R, or transmit bypass mode, respectively. A fourth digital control pin (ANT_SEL) is used to select between antenna ports 1 and 2.

The bypass mode can also be configured to power-down the PA and remove it from the RF path using an internal single-pole, single-throw (SPST) switch.

The transmit path contains a PA optimized for saturated performance. The PA can be passed through an external impedance matching network and harmonic filter before being fed through the SP3T switch. External inductors for each of the two PA stages provide maximum application flexibility.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66101-11 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 through 8.

The state of the SKY66101-11 is determined by the logic provided in Table 9.

Table 2. SKY66101-11 Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage (no RF)	VCC	-0.3	+5.5	V
Control pin (CSD, CPS, CTX, and ANT_SEL) voltages		-0.3	+3.6	V
Operating temperature	TA	-40	+85	°C
Storage temperature	TSTG	-40	+125	°C
Transmit RF input power	PIN_TX_MAX		+10	dBm
Receive RF input power @ ANT1 or ANT2 ports	PIN_RX_MAX		+15	dBm
Voltage Standing Wave Ratio @ ANT1 or ANT2 ports	VSWR		10:1	-
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class 2			250	V
Human Body Model (HBM), Class 1C			1000	V
Machine Model (MM), Class A			50	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. SKY66101-11 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	VCC	2.0	3.6	4.8	V
Operating temperature	TA	-40	+25	+85	°C
Transmit duty cycle				50	%

Table 4. SKY66101-11 DC Electrical Specifications¹
(V_{CC} = +3.6 V, T_A = +25 °C, as Measured on the SKY66101-11 Evaluation Board [De-Embedded to Device], Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Total supply current, transmit mode ²	ICC_TX30	POUT = +30 dBm		670		mA
	ICC_TX27	POUT = +27 dBm		475		mA
	ICC_TX24	POUT = +24 dBm		340		mA
Total supply current, receive mode	ICC_RX			6		mA
Total supply current, receive bypass mode	ICC_RXB				250	µA
Quiescent current	ICQ_TX	No RF		50		mA
Sleep supply current	ICC_OFF	No RF		0.05	1.00	µA

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

² ICC_TX27 and ICC_TX24 are not production tested.

Table 5. SKY66101-11 Receive Mode Electrical Specifications¹
(V_{CC} = +3.6 V, T_A = +25 °C, as Measured on the Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted. Input Ports: ANT1 or ANT2, Output Port: RX_N/RX_P, 0 Ω Connected between the RX_FLT and LNA_IN Pins in lieu of External Filters)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		902		928	MHz
Gain	RX_GAIN	900 to 930 MHz		16		dB
Noise Figure ²	NF			2.5		dB
Third order input intercept point ²	IIP3		-5	-2		dBm
1 dB input compression point	IP1dB		-12	-9		dBm
Gain in receive bypass mode	G_RXB		-4.5	-3		dB
1 dB input compression point in receive bypass mode ²	IP1dB_RXB		+9			dBm
Antenna port return loss	S11	900 to 930 MHz, into 50 Ω, ANT1 and ANT2 ports		-12	-8	dB
Turn-on time ²	ton	From 50% of CTX edge to 90% of final RF output power			1	µs
Turn-off time ²	toff	From 50% of CTX edge to 10% of final RF output power			1	µs

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

² Not production tested.

Table 6. SKY66101-11 Transmit Mode Electrical Specifications¹
(V_{CC} = +3.6 V, T_A = +25 °C, P_{OUT} = +30 dBm, as Measured on the Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted. Input Port: PA_IN, Output Ports: ANT1 and ANT2)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		902		928	MHz
Output power @ ANT1 port ²	P _{OUT}	V _{CC} = 4.0 V V _{CC} = 3.6 V V _{CC} = 3.0 V		+31 +30 +28		dBm dBm dBm
Small signal gain	S ₂₁	@ 902 to 928 MHz		33		dB
Output return loss	S ₂₂	50 Ω, ANT1 and ANT2 ports		-10	-7	dB
2 nd harmonic	2fo	P _{OUT} = +30 dBm, CW into 50 Ω, ANT1 and ANT2 ports			-22	dBc
3 rd to 10 th harmonic ³	3fo to 10fo	P _{OUT} = +30 dBm, CW: ANT1 ANT2			-72 -45	dBc dBc
Turn-on time ⁴	t _{ON}	From 50% of CTX edge to 90% of final RF output power			1	μs
Turn-off time ⁴	t _{OFF}	From 50% of CTX edge to 10% of final RF output power			1	μs
Stability ⁴	Stab	@ 0.1 to 20 GHz, CW, P _{OUT} = +30 dBm, load VSWR = 6:1	All non-harmonically related outputs < -43 dBm			
Ruggedness ⁴	RU	CW, P _{OUT} = +30 dBm into 50 Ω load, VSWR = 10:1	No permanent damage			

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

² Production tested at V_{CC} = 3.6 V only.

³ Only the 2nd to 5th harmonics at ANT1 are production tested. The 6th to 10th harmonics are characterized only.

⁴ Not production tested.

Table 7. SKY66101-11 Diversity Antenna Electrical Specifications¹
(V_{CC} = +3.6 V, T_A = +25 °C, f = 900 MHz to 930 MHz, as Measured on the 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 between ANT1 and ANT2 ports	ISO_ANTSW			28		dB
Insertion loss from ANT1 to RX_FLT port (Note 2)	RX_ANT1			1.0		dB
Insertion loss from ANT2 to RX_FLT port (Note 2)	RX_ANT2			1.0		dB
ANT1 to ANT2 switching time, transmit mode (Note 2)	T _{ANT1-ANT2_TX}			800		ns
ANT1 to ANT2 switching time, receive mode (Note 2)	T _{ANT1-ANT2_RX}			400		ns

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

² Not production tested.

Table 8. SKY66101-11 Electrical Specifications: Control Logic Characteristics¹
(T_A = +25 °C, as Measured on the SKY66101-11 Evaluation Board [De-Embedded to Device], Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Control voltage: ²						
High	V _{IH}		1.6		3.6	V
Low	V _{IL}		0		0.3	V
Input current: ²						
High	I _{IH}				1	μA
Low	I _{IL}				1	μA

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

² Not production tested.

Table 9. SKY66101-11 Mode Control Logic¹

Mode	CPS (Pin 8)	CSD (Pin 1)	CTX (Pin 9)	ANT_SEL (Pin 10)
Sleep (all off)	0	0	0	X
Receive bypass	0	1	0	X
Receive LNA mode	1	1	0	X
Transmit	X	1	1	X
ANT1 port enabled	X	X	X	0
ANT2 port enabled	X	X	X	1

¹ "1" = 1.6 to 3.6 V, "0" = 0 to 0.3 V, "X" = don't care.

Evaluation Board Description

The SKY66101-11 Evaluation Board is used to test the performance of the SKY66101-11 front-end module. An Evaluation Board schematic diagram is provided in Figure 3.

An assembly drawing for the Evaluation Board is shown in Figure 4, and the layer detail information is provided in Figure 5.

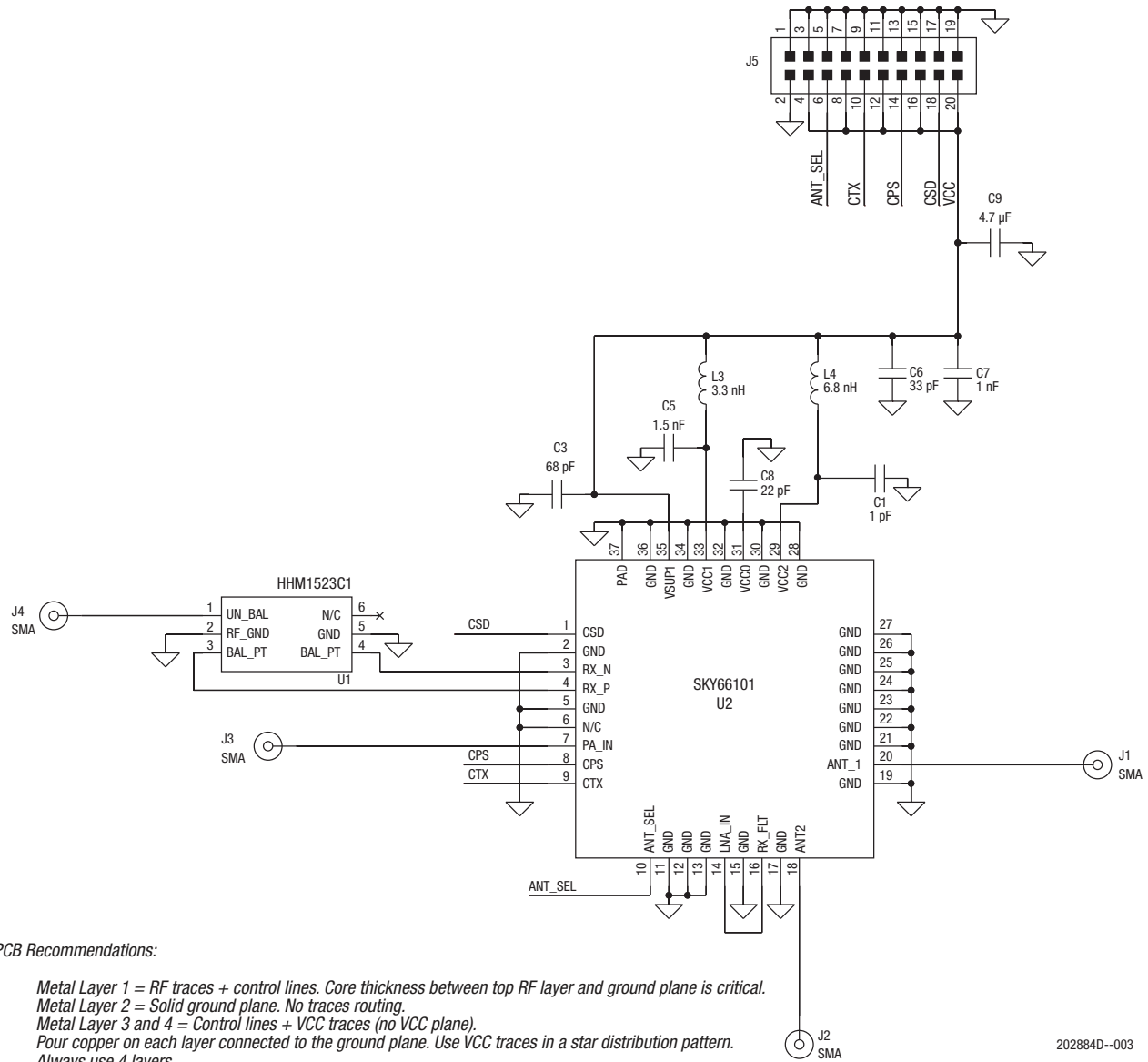


Figure 3. SKY66101-11 Evaluation Board Schematic

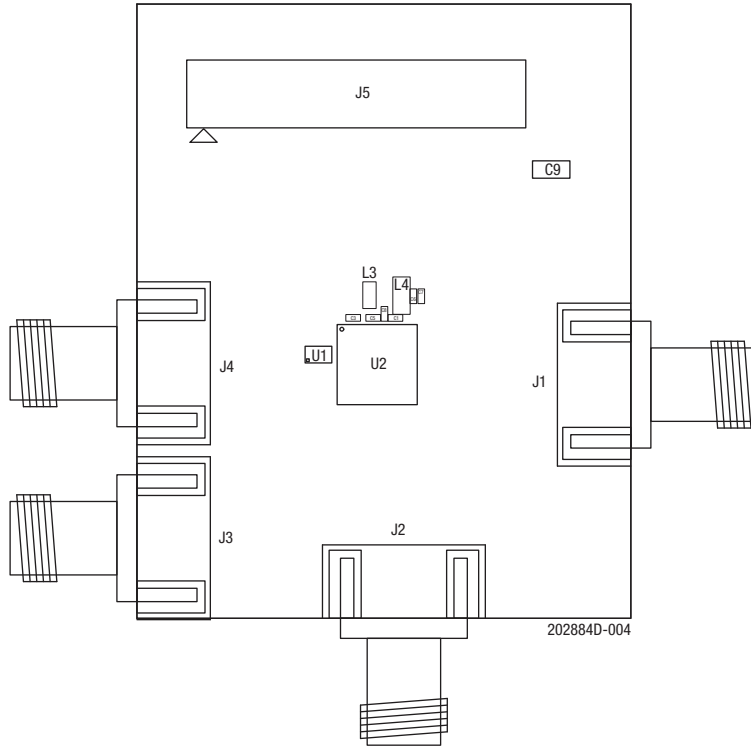
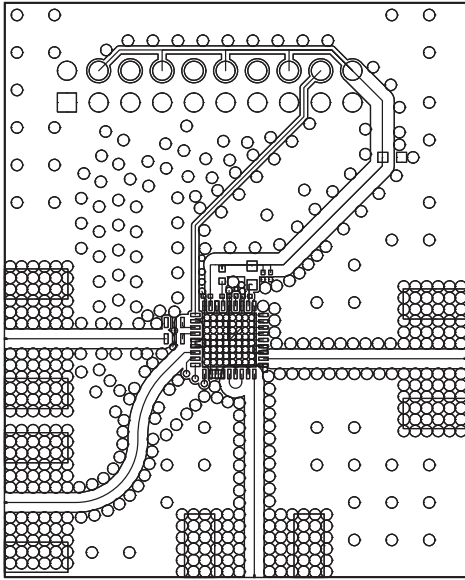
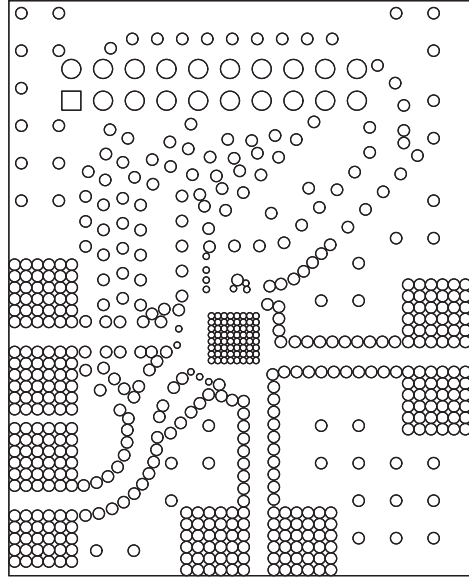


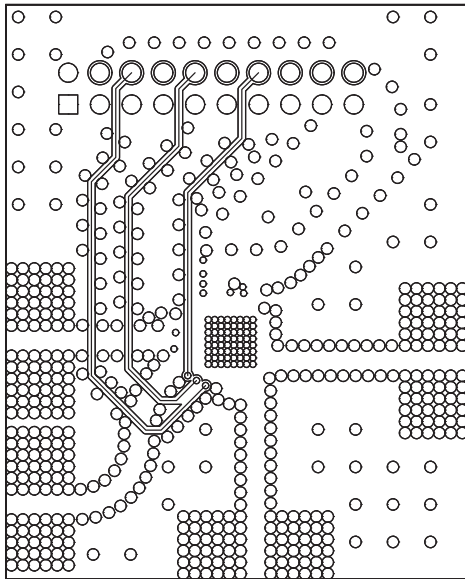
Figure 4. SKY66101-11 Evaluation Board Assembly Drawing



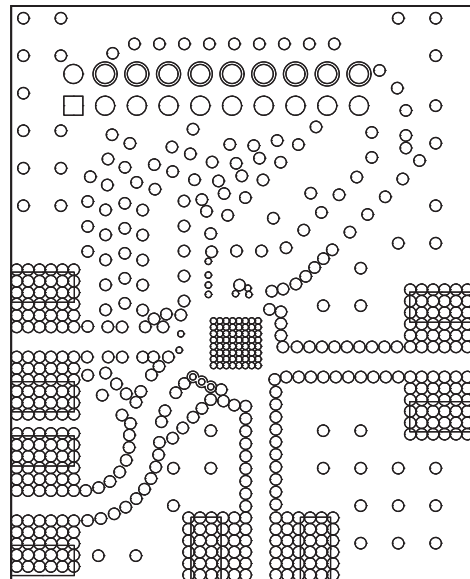
Top Layer



Layer Two



Layer Three



Bottom Layer

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Figure 5. SKY66101-11 Evaluation Board Layer Details

Package Dimensions

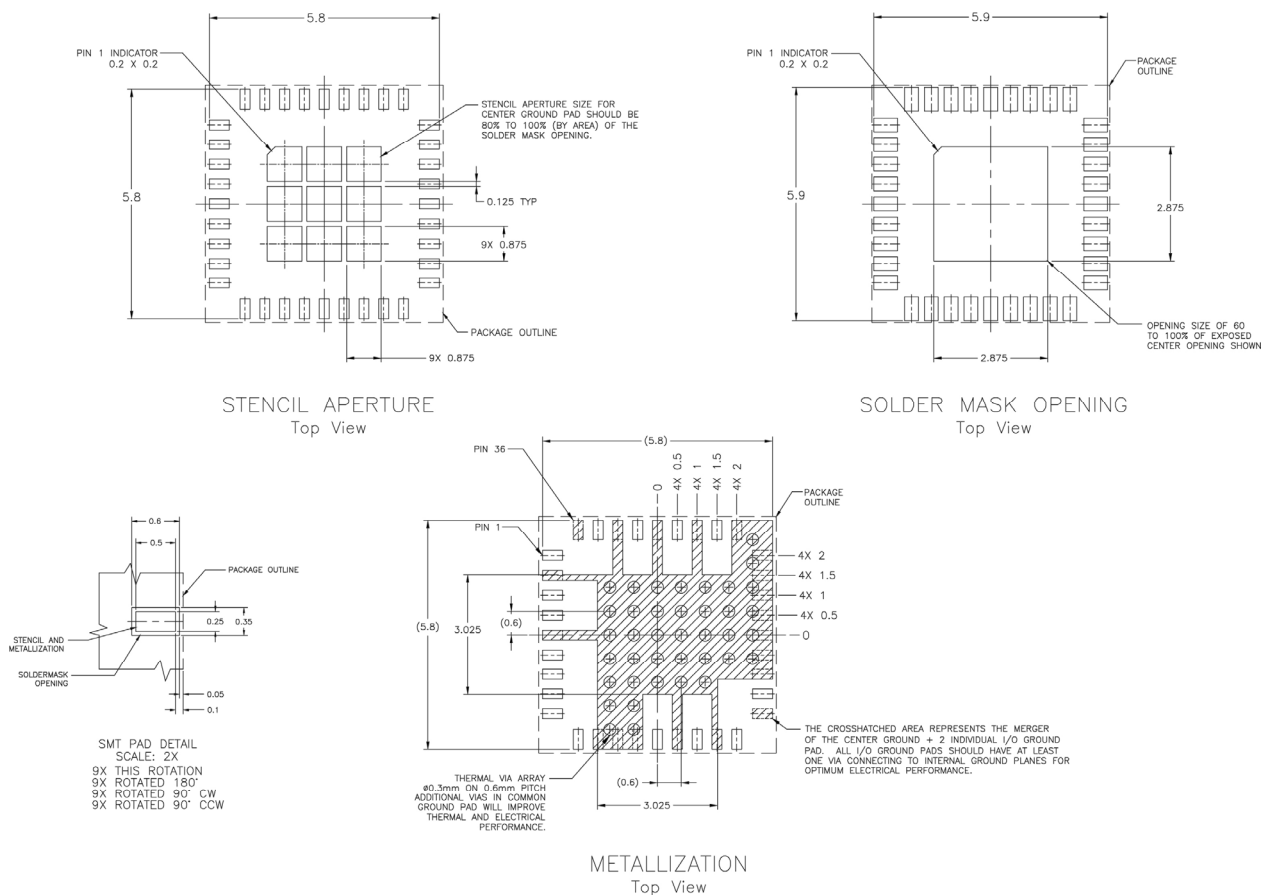
The PCB layout footprint is shown in Figure 6. Figure 7 shows the package dimensions, and Figure 8 provides the tape and reel dimensions.

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.

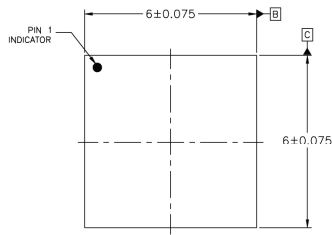
The SKY66101-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design and SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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.

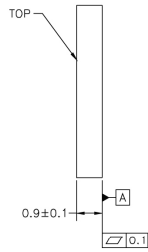


- NOTES:
1. DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE SPECIFIED.
 2. THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

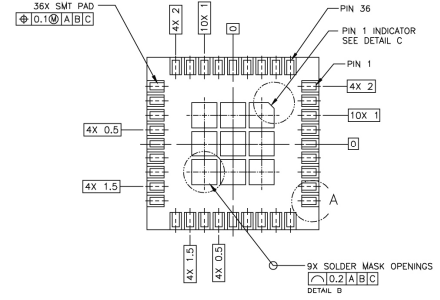
Figure 6. SKY66101-11 PCB Layout Footprint



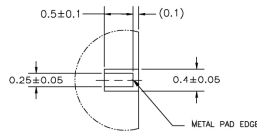
TOP VIEW



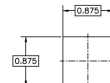
SIDE VIEW



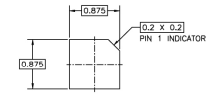
BOTTOM VIEW



DETAIL A
PAD
SCALE: 2X
9X THIS ROTATION
9X ROTATED 180°
9X ROTATED 90° CW
9X ROTATED 90° CCW



DETAIL B
PAD
SCALE: 2X
8X THIS ROTATION



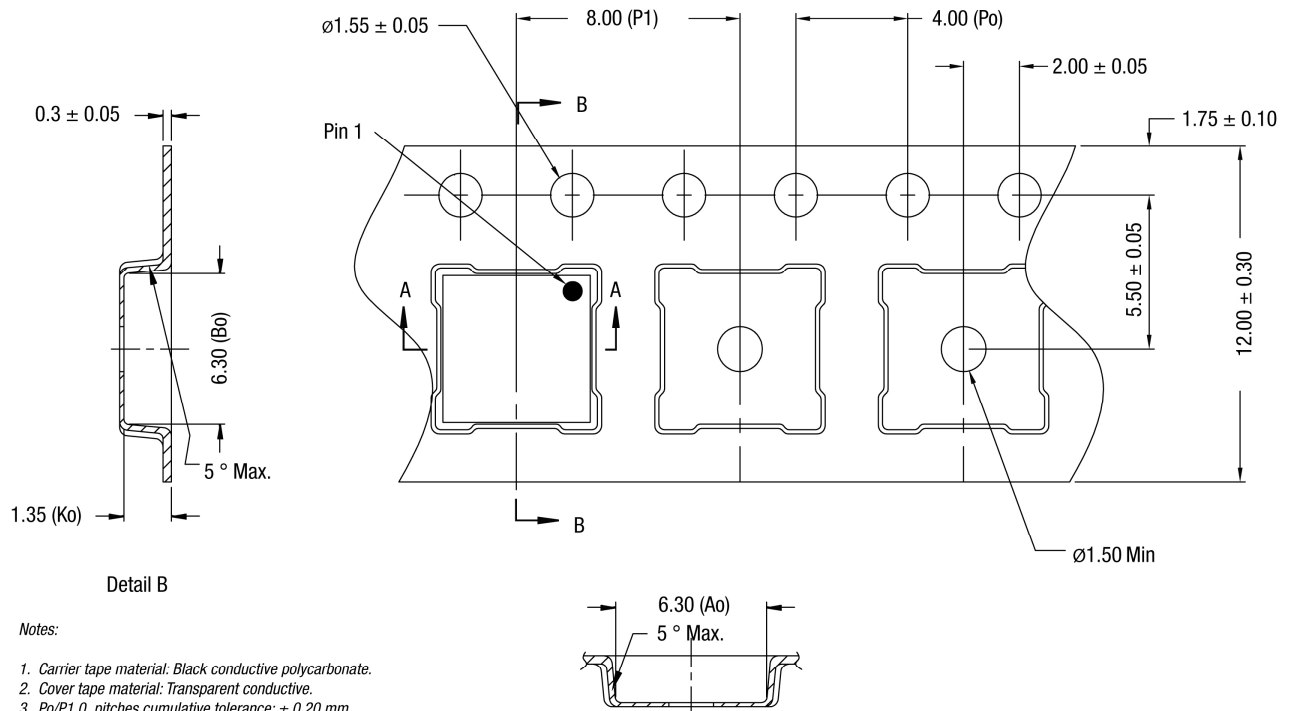
DETAIL C
PAD
SCALE: 2X
1X THIS ROTATION

NOTES: UNLESS OTHERWISE SPECIFIED.

1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.
2. DIMENSIONS ARE IN MILLIMETERS
3. PAD DEFINITIONS PER DETAILS ON DRAWING.

202884-007

Figure 7. SKY66101-11 Package Dimensions



Notes:

1. Carrier tape material: Black conductive polycarbonate.
2. Cover tape material: Transparent conductive.
3. Po/P1 0 pitches cumulative tolerance: ± 0.20 mm.
5. Ao and Bo measured on plane 0.30 mm from bottom pocket.
6. All dimensions are in millimeters.

202884-008

Figure 8. SKY66101-11 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY66101-11	High-Power RF Front-End Module	SKY66101-11-EK1

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