

DATA SHEET

# SKY85308-11: 2.4 GHz, 256 QAM WLAN/Bluetooth® Front-End Module

## Applications

- WiFi-enabled smartphones, tablets, and mobile/portable devices
- System-in-Package (SIP) modules for embedded systems

## Features

- Integrated high-performance 2.4 GHz PA, harmonic filter, LNA with bypass, and T/R switch
- Fully matched input and output
- Low-loss LNA bypass for BT coexistence
- Integrated positive slope logarithmic power detector with high impedance
- Transmit gain: 28 dB
- Receive gain: 14 dB
- Output power:
  - +18.5 dBm, MCS9, HT40
  - +19.5 dBm, MCS7, HT40
  - +22.5 dBm, 802.11b mask compliant
- Small QFN (16-pin, 2.3 x 2.3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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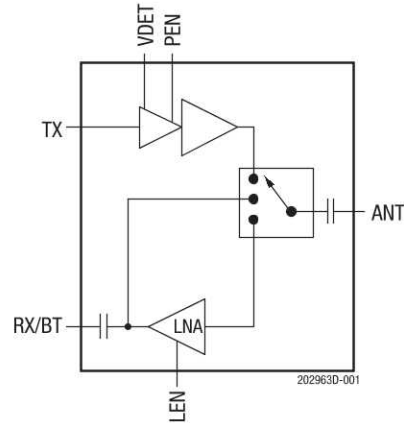


Figure 1. SKY85308-11 Block Diagram

## Description

The SKY85308-11 is a complete 802.11b/g/n/ac WLAN RF front-end module (FEM) with a Bluetooth port. The device provides all the functionality of a fully matched power amplifier (PA), power detector, harmonic filter, and low-noise amplifier (LNA).

The SKY85308-11 provides a complete 2.4 GHz WLAN RF solution from the output of the transceiver to the antenna, and from the antenna to the input of the transceiver. The LNA increases the receive sensitivity of embedded solutions to improve range or to overcome the insertion loss of cellular filters (often included for mobile applications).

The SKY85308-11 also includes a transmitter logarithmic power detector with 20 dB of dynamic range, and a digital enable control for transmitter power ramp on/off control.

The device is provided in an ultra-compact, 16-pin 2.3 x 2.3 mm Quad Flat No-Lead (QFN) package. 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.

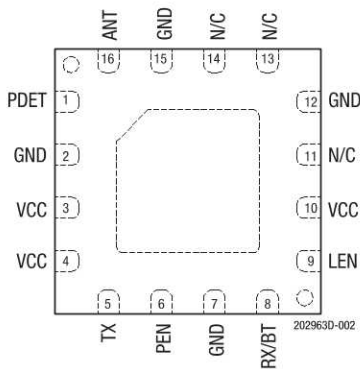


Figure 2. SKY85308-11 Pinout (Top View)

**Table 1. SKY85308-11 Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	PDET	Power detector output voltage	9	LEN	LNA enable control input
2	GND	Ground	10	VCC	LNA positive supply voltage
3	VCC	PA positive supply voltage	11	N/C	No connection
4	VCC	PA positive supply voltage	12	GND	Ground
5	TX	RF transmit PA input	13	N/C	No connection
6	PEN	PA enable control input	14	N/C	No connection
7	GND	Ground	15	GND	Ground
8	RX/BT	RX receive output/BT	16	ANT	Antenna

### Technical Description

The SKY85308-11 is comprised of a high-efficiency 2.4 GHz PA, 2.4 GHz LNA, and 2.4 GHz switch. The device is fully matched, and requires few external components for optimal performance, which makes it ideal for small portable/mobile applications. The FEM provides a typical gain of 31 dB. The LNA supports an enable/disable mode and bypass mode for power savings when not in receive mode. The PA can be shut off using the PEN signal (pin 6).

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY85308-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 through 9.

The state of the SKY85308-11 is determined by the logic provided in Table 10.

**Table 2. SKY85308-11 Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC1, VCC2	-0.3	+3.6	V
DC input on control pins	V <sub>IN</sub>	-0.3	+3.6	V
Transmit input power (ANT terminated in 50 Ω match)	P <sub>IN</sub>		+5	dBm
Operating temperature	T <sub>A</sub>	-40	+85	°C
Storage temperature	T <sub>ST</sub>	-40	+140	°C
Electrostatic discharge: Human Body Model (HBM)	ESD		500	V

<sup>1</sup> 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.

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**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.*

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**Table 3. SKY85308-11 Recommended Operating Conditions**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage relative to GND = 0 V	VCC1, VCC2	3.0	3.3	3.6	V
Operating temperature	T <sub>A</sub>	-40	+25	+85	°C

**Table 4. SKY85308-11 Electrical Specifications: DC Characteristics<sup>1</sup>**  
(VCC1 = VCC2 = 3.3 V, T<sub>A</sub> = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Total supply current, high-power mode	I <sub>CC</sub>	High-power mode: P <sub>OUT</sub> = +18 dBm P <sub>OUT</sub> = +17 dBm		210 210	230 230	mA mA
Quiescent current	I <sub>CCQ</sub>	No RF:high-power mode		140		mA
LNA supply current	I <sub>CC_LNA</sub>	LNA enabled		9.5		mA
LNA bypass supply current	I <sub>CC_LNA_BYP</sub>	LEN = PEN = 0 V		1.5		μA

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.**Table 5. SKY85308-11 Electrical Specifications: Transmit Characteristics<sup>1</sup>**  
(VCC1 = VCC2 = 3.3 V, State 1, T<sub>A</sub> = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2.4		2.5	GHz
Output power	P <sub>OUT</sub>	MCS7, EVM = -30 dB MCS9, EVM = -35 dB	+18 +17	+19.5 +18.5		dBm dBm
Spectral mask	SM	Output power meeting spectral mask		+22.5		dBm
Small signal gain	IS211	High-power mode	26	28	31	dB
Gain flatness	Δ S21	Across band			+2	dB
2 <sup>nd</sup> harmonics	2f <sub>o</sub>	P <sub>OUT</sub> = +22.5 dBm, 1 Mbps, 802.11b			-30	dBm/MHz
3 <sup>rd</sup> harmonics	3f <sub>o</sub>	P <sub>OUT</sub> = +22.5 dBm, 1 Mbps, 802.11b			-32	dBm/MHz
Delay and rise/fall time	t <sub>DR</sub> , t <sub>DF</sub>	50% of V <sub>PEN</sub> edge and 90/10% of final output power level			400	ns
Input return loss	IS111	@ TX port		10		dB
Output return loss	IS221	@ ANT port		15		dB
Stability	Stab	CW, P <sub>IN</sub> = +10 dBm, 0.1 GHz to 20 GHz, load VSWR = 6:1	All non-harmonically related outputs less than -43 dBm/MHz			
Ruggedness	RGGD	CW, P <sub>IN</sub> = +10 dBm, 0.1 GHz to 20 GHz, load VSWR = 10:1	No permanent damage or performance degradation			

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

**Table 6. SKY85308-11 Electrical Specifications: Receive Bypass/Bluetooth Characteristics<sup>1</sup>**  
**(VCC1 = VCC2 = 3.3 V, State 4, T<sub>A</sub> = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2.4		2.5	GHz
Receive bypass/BT insertion loss	IL	LNA bypass, Bluetooth TX/RX		2		dB
Receive bypass/BT port return loss	S11	At Pin 8		-8		dB

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

**Table 7. SKY85308-11 Electrical Specifications: Receive Characteristics<sup>1</sup>**  
**(VCC1 = VCC2 = 3.3 V, State 3, T<sub>A</sub> = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2.4		2.5	GHz
Small signal gain	S21	LNA enabled	12	14		dB
Noise figure	NF			2.2		dB
Third order input intercept point	IIP3	LAN enabled		+3		dBm
1dB compression	P1dB			-7		dBm
Input return loss	IS111			10		dB
Output return loss	IS221			10		dB
Enable time	T <sub>EN</sub>	10% to 90% of RX RF power from time that LEN is at 50%			300	ns
Switch isolation	ISO	ANT to RX, State 1	40			dB

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

**Table 8. SKY85308-11 Electrical Specifications: Power Detector Characteristics<sup>1</sup>**  
**(VCC1 = VCC2 = 3.3 V, State 1 or State 2, T<sub>A</sub> = 25 °C, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2.4		2.5	GHz
Power detector range	PDR	CW, measured @ ANT	0		+25	dBm
Output impedance	PDZ <sub>LOAD</sub>			2.5		kΩ
Output voltage	PDV	P <sub>OUT</sub> = No RF, measured into 1 MΩ P <sub>OUT</sub> = +18 dBm, CW, measured into 1 MΩ P <sub>OUT</sub> = +23 dBm, CW, measured into 1 MΩ	0.720 0.83	0.19 0.76 0.88	0.82 0.97	V V V
Power detector bandwidth	PD <sub>BW</sub>			1		MHz

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

**Table 9. SKY85308-11 Electrical Specifications: Control Logic Characteristics<sup>1</sup>**  
**(VCC1 = VCC2 = 3.3 V, T<sub>A</sub> = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Control voltage:						
High	V <sub>IH</sub>		1.8		3.6	V
Low	V <sub>IL</sub>		0		0.2	V
Input current, high	I <sub>IH</sub>	All pins			5	μA
Input current, low	I <sub>IL</sub>	All pins			1	μA

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

**Table 10. SKY85308-11 Control Logic<sup>1</sup>**

State	Function	PEN	LEN
1	PA On	1	0
2	LNA active	0	1
3	LNA bypass, Bluetooth TX/RX	0	0
4	Not active	1	1



## Evaluation Board Description

The SKY85308-11 Evaluation Board is used to test the performance of the SKY85308-11 FEM. A suggested application schematic diagram is shown in Figure 3. Table 11 lists the Bill of Materials (BOM). A diagram of the Evaluation Board is shown in Figure 4.

## Evaluation Board Setup Procedure

1. Connect system ground to pin 2 of connector J7.
2. Apply 3.3 V to pin 1 of connector J7 and pin 13 of connector J6.
3. Test the RF paths as described by the control logic in Table 10.
4. Connect a digital multi-meter to pin 6 of connector J6 to monitor the power detector voltage.
5. Monitor the ANT-to-RX performance by applying an RF signal to J3 (ANT) and measuring the response from the J2 (RX) connector output.
6. Monitor the transmit performance is by applying an RF signal to connector J1 (TX) and monitoring the output power on the antenna port connector J3 (ANT).

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**CAUTION:** Care should be taken not to overdrive the amplifier by applying too much RF on the device input.

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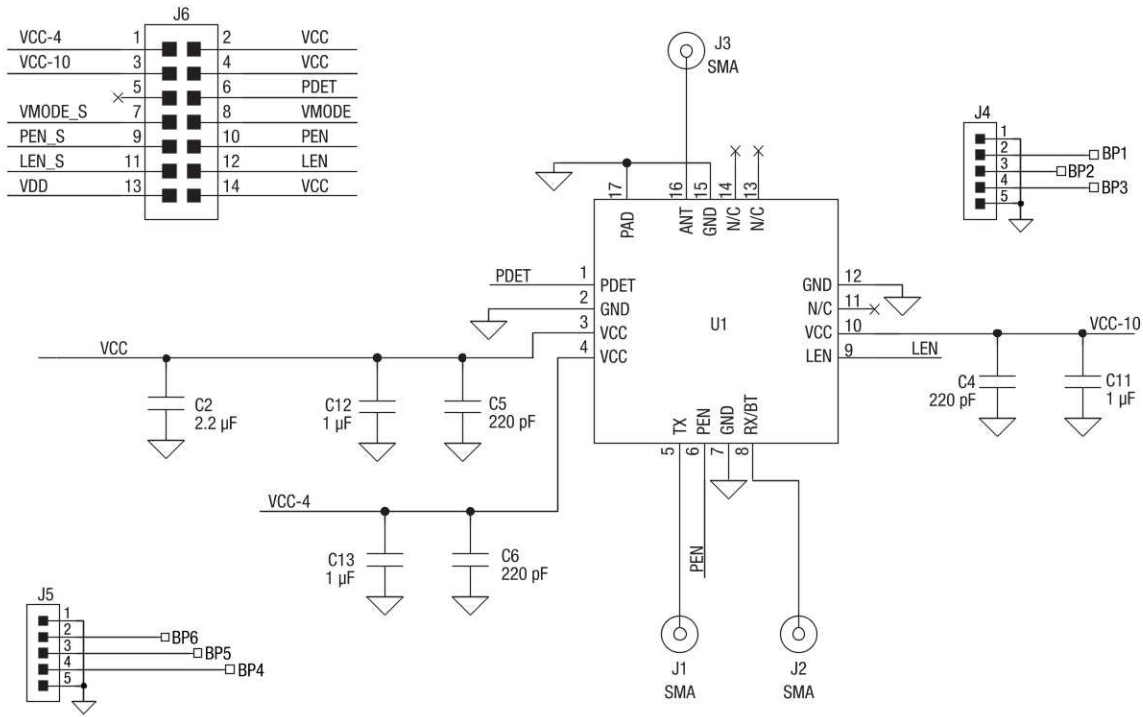
## Circuit Design Considerations

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 SKY85308-11 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.

**NOTE:** A poor connection between the ground pad and ground increases junction temperature ( $T_j$ ), which reduces the life of the device.

- Optimum performance is guaranteed by following the application schematic, Bill of Materials (BOM), and Gerber files.
- The exposed die pad under the chip provides thermal and RF ground to the device. It is recommended that the maximum allowable number of vias be used to connect the PDB top metal (where the die is soldered) to internal ground plane(s) of the PCB.
- The RX/BT and ANT ports are AC-coupled and do not require DC blocking capacitors. The TX port (pin 5) has an on-chip inductor to ground followed by a DC blocking capacitor between the inductor and the die. Therefore, there is no DC present on this port.
- If the TX port is connected to an external component with DC present, a 10 PF (component C9) general-purpose blocking capacitor is recommended. If the TX port is connected to an external component without DC present, the 10 pF capacitor can be removed.
- The 10 pF decoupling capacitors, C3 and C4, should be on the primary side of the board at a minimum manufacturable distance from the FEM.
- The component placement of the rest of the components not mentioned in this section is not critical.



Note: 0 Ω resistors and DNI components are not shown in this schematic.

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Figure 3. SKY85308-11 Application Schematic

Table 11. Bill of Materials (BOM) for the SKY85308-11 Evaluation Board

Description	Value	Manufacturer	Mfr Part Number	Package	Description
BP1, BP2, BP3, BP4, BP5, BP6		Skyworks Solutions	printed element	0.25 mm X 0.25 mm	Bonding pad
C1, C2	2.2 uF	Murata	GRM188R71A225KE15D	0603	Monolithic ceramic
C11, C12, C13	1 uF	TDK Corporation	C1005X5R1A105K	0402	Multilayer ceramic
C4, C5, C6	220 pF	Murata	GRM033R71C221KD01	0201	Multilayer ceramic
J4, J5	5X1	Samtec	TSW-105-07-G-S	100 mil	100 mil header
PCB1	Z606-A	Skyworks Solutions	Z606-A		PCB
U1	SKY85308-11	Skyworks Solutions	SKY85308-11	QFN 2.3x2.3-16	2 GHz 802.11ac 17 dBm FEM

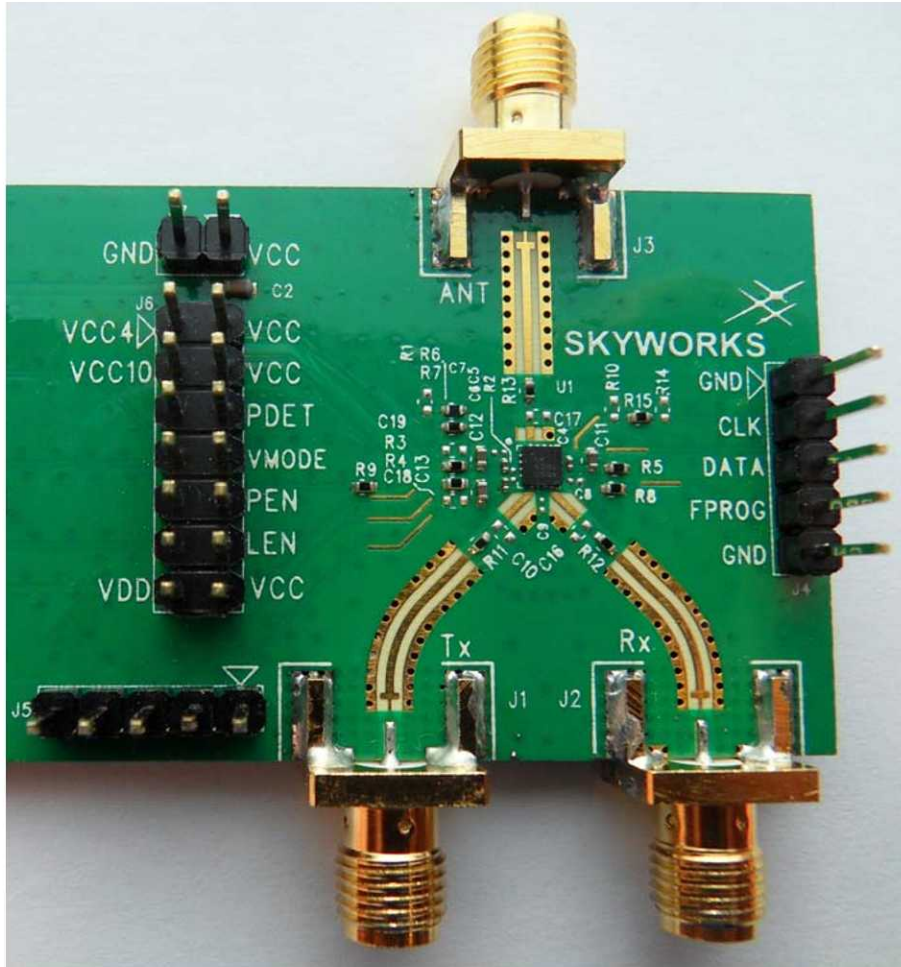


Figure 4. SKY85308-11 Evaluation Board Assembly



## Package Dimensions

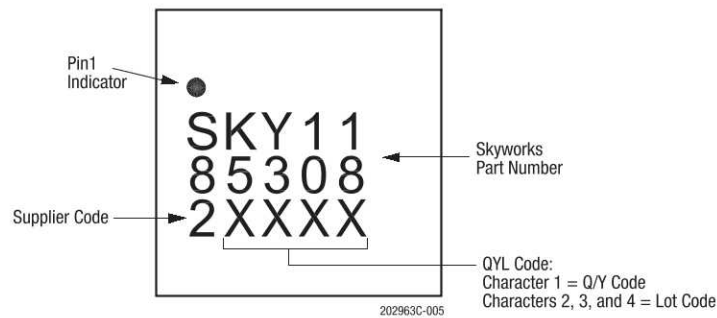
A typical part marking diagram is provided in Figure 5. The PCB board layout footprint for the SKY85308-11 is shown in Figure 6. Package dimensions are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

## Package and Handling Information

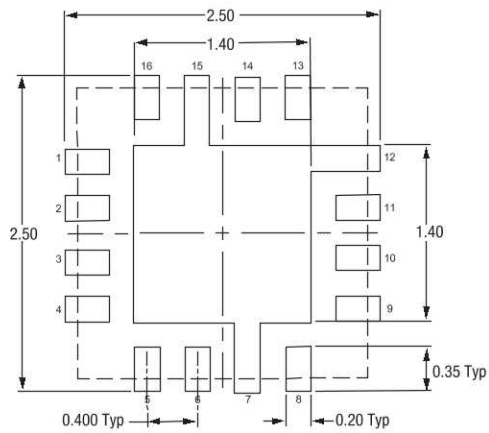
Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY85308-11 is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

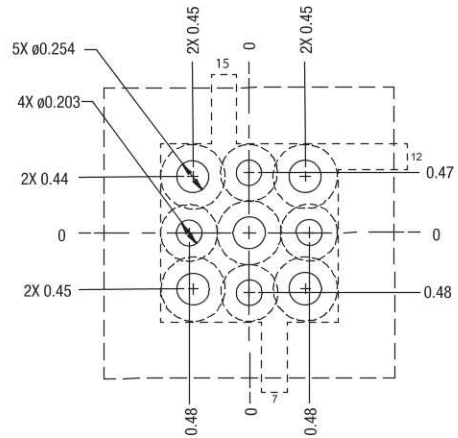
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



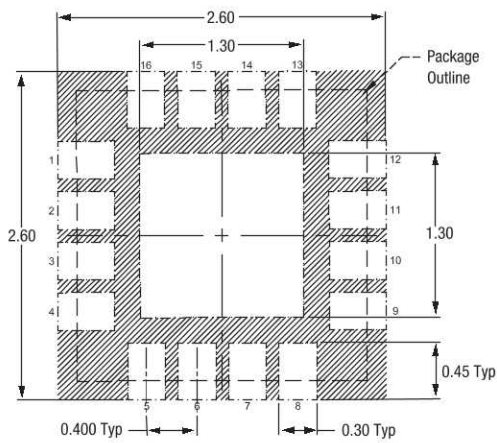
**Figure 5. Typical Part Marking (Top View)**



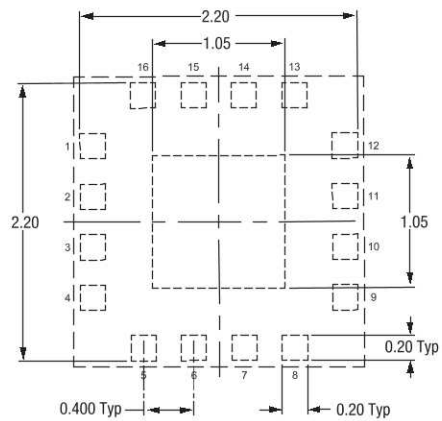
Board Metal



Via Pattern  
(Note 1)



Solder Mask Pattern  
(Note 2)



Stencil Pattern  
(Note 3)

65% Solder Coverage  
on Center Pad

Notes:

1. Via hole recommendations:  
0.025 mm Cu via wall plating (minimum), via holes to be filled with conductive paste and plated over.
2. Solder mask recommendations:  
Contact board fabricator for recommended solder mask offset and tolerance.
3. Stencil recommendations:  
0.10 mm stencil thickness, laser cut apertures, trapezoidal walls and rounded corners offer better paste release.
4. Dimensions and tolerances according to ASME Y14.5M-1994.
5. Unless specified, dimensions are symmetrical about center lines.
6. All dimensions are in millimeters.

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Figure 6. SKY85308-11 PCB Layout Footprint

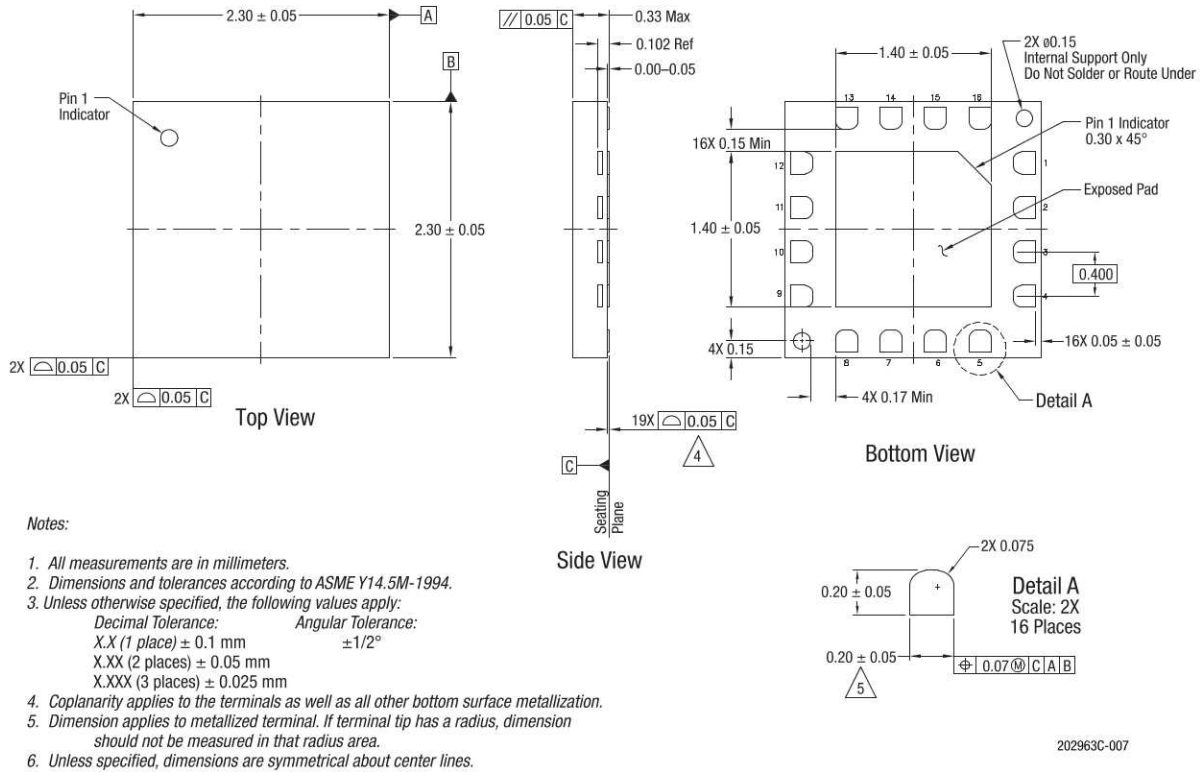


Figure 7. SKY85308-11 Package Dimensions

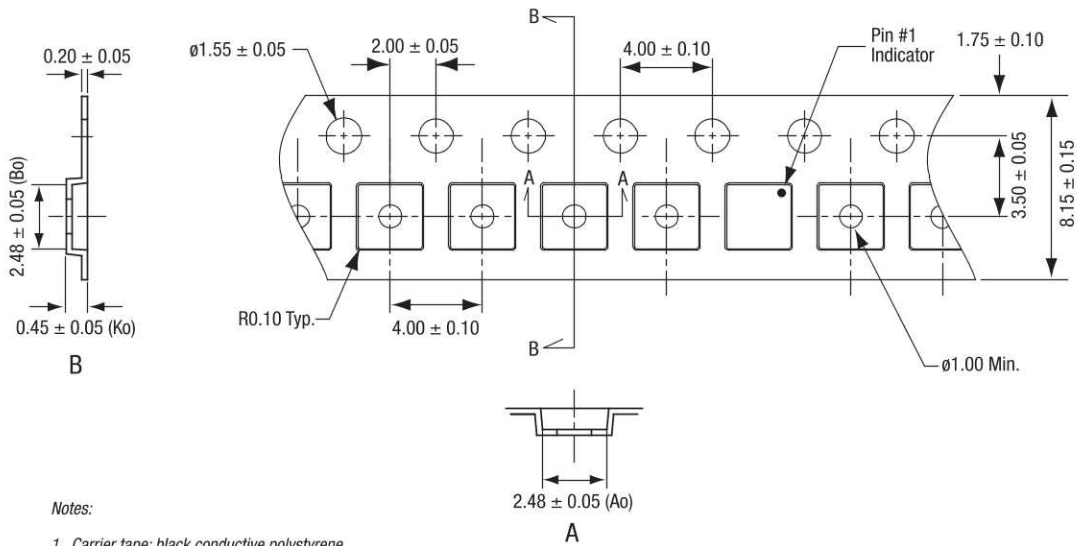


Figure 8. SKY85308-11 Tape and Reel Dimensions

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY85308-11: 2.4 GHz Front-End Module	SKY85308-11	SKY85308-11-EVB

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