

DATA SHEET

SKY85747-11: 5 GHz High-Power WLAN Front-End Module

Applications

- 802.11ax networking systems
- WLAN-enabled wireless video streaming systems

Features

- Integrated high-performance 5 GHz PA, LNA with bypass, and T/R switch
- Fully matched input and output
- Integrated logarithmic power detector and directional coupler
- Transmit gain: 34.5 dB
- Receive gain: 16 dB
- Supports 802.11ax output power: +18.5 dBm, -43 dB DEVM, MCS11
- Integrated, temperature- compensated log detector
- Highly sensitive, jammer-tolerant LNA
- Small LGA (24-pin, 3 x 5 mm) package (MSL4, 260 °C per JEDEC J-STD-020)



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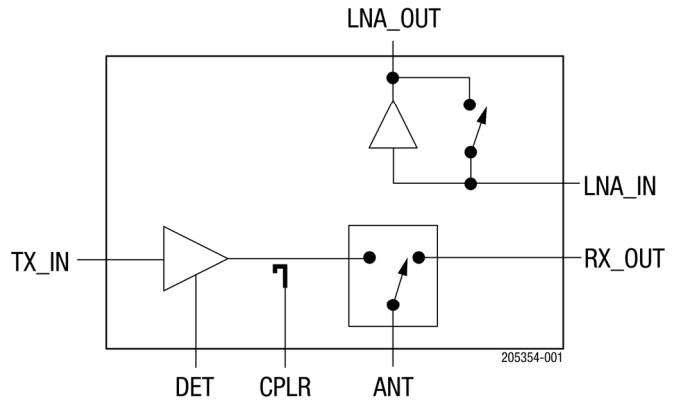


Figure 1. SKY85747-11 Block Diagram

Description

The SKY85747-11 is a highly integrated, 5 GHz front-end module (FEM) incorporating a transmit/receive (T/R) switch, a high-gain low-noise amplifier (LNA) with bypass, and a power amplifier (PA) intended for high-power 802.11ax applications and systems.

The LNA and PA disable functions ensure low leakage current in the off mode. An integrated logarithmic power detector is included to provide closed-loop power control over 20 dB of dynamic range.

The device is provided in a compact, 24-pin 3 x 5 mm Land Grid Array (LGA) package, which may reduce the front-end board space by more than 50 percent. 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.

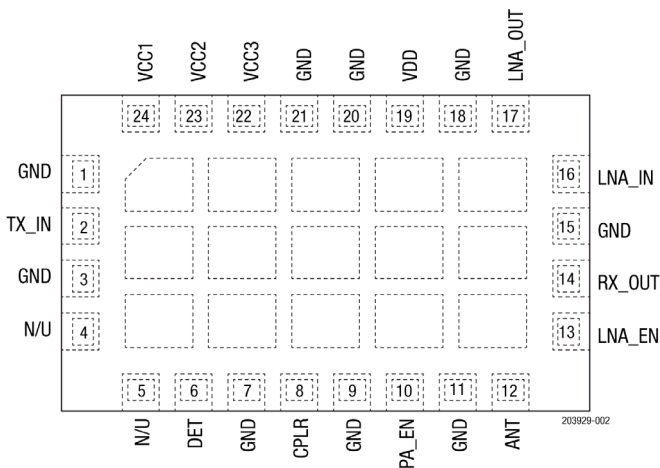


Figure 2. SKY85747-11 Pinout (Top View)

Table 1. SKY85747-11 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	13	LNA_EN	RX control pin
2	TX_IN	Transmit Input	14	RX_OUT	Switch RX output
3	GND	Ground	15	GND	Ground
4	N/U	Not used (recommend GND)	16	LNA_IN	LNA input
5	N/U	Not used (recommend GND)	17	LNA_OUT	LNA output
6	DET	Detector output	18	GND	Ground
7	GND	Ground	19	VDD	LNA supply voltage
8	CPLR	DPD coupler output	20	GND	Ground
9	GND	Ground	21	GND	Ground
10	PA_EN	TX control pin	22	VCC3	PA third stage supply voltage
11	GND	Ground	23	VCC2	PA second stage supply voltage
12	ANT	Antenna	24	VCC1	PA first stage supply voltage

Technical Description

The SKY85747-11 comprises a high-power 5 GHz PA, a 5 GHz LNA, and a low-loss broadband switch to provide the T/R switching function. The device is fully matched, and requires few external components for optimal performance, which makes it ideal for small portable or high stream-count applications. The FEM provides over +32 dB of transmit gain over the frequency band. The LNA supports active and bypass modes, which can operate in the presence of jammers by offering +10 dBm input third order intercept (IIP3). The power amplifier, low-noise amplifier, and T/R switch can be controlled as shown in Table 5.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY85747-11 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

The state of the SKY85747-11 is determined by the logic provided in Table 5.

Table 2. SKY85747-11 Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC1, VCC2, VCC3, and VDD	-0.3	+6.0	V
DC input on control pins (LNA_EN and PA_EN)	V _{IN}	-0.3	+3.6	V
Tx input power (50 Ω load)	T _{XIN}		+10	dBm
Tx supply current	T _{X_} I _{CC}		800	mA
Storage temperature	T _{ST}	-40	+150	°C
Junction temperature	T _J		160	°C
Electrostatic discharge: Human Body Model (HBM), Class 1C	ESD		1000	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. SKY85747-11 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	VCC1, VCC2, VCC3, and VDD	4.2	5.0	5.5	V
Control logic: High	V _{IH}	1.6		3.6	V
Low	V _{IL}	0		0.4	V
PA enable current	I _{ENABLE}		10	20	μA
LNA bias current	I _{DD}		25	35	mA
LNA_EN enable current				10	μA
Operating temperature	T _{OP}	-40		+85	°C

Table 4. SKY85747-11 Electrical Specifications¹ (1 of 2)
(VCC1 = VCC2 = VCC3 = VDD = 5.0 V, Top = 25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f	Main frequency band	5.15		5.925	GHz
Transmit Mode						
Gain	G G _{3.9}	At 3.9 GHz	32	34.5 -18	36.5 -13	dB dB
Gain flatness		Over any 80 MHz bandwidth			1	dB
Output power	P _{OUT}	11ax, MCS10/11, HE20-HE80, -47 dB DEVM 11ax, MCS10/11, HE20-HE80, -43 dB DEVM 11ac, MCS8/9, VHT20-VHT80, -35 dB DEVM 11n, MCS7, HT20-HT40, -30 dB DEVM MCS0, HT20, 2dB mask margin	+12 +16 +22 +23 +26	+17 +18.5 +23 +24.5 +27		dBm dBm dBm dBm dBm
Band edge power	O _{OB}	5180 MHz HT20, -47 dBm/MHz		+21		dBm
Current consumption		Modulated signal: @ quiescent @ +21 dBm @ +25 dBm @ +27 dBm Leakage, EN off		200 280 370 450 1	310 410 500 500	mA mA mA mA mA
2 nd harmonics	2fo	+27 dBm MCS0		-50	-45	dBm/MHz
3 rd harmonics	3fo	+27 dBm MCS0		-50	-45	dBm/MHz
Isolation		From ANT to RX in TX mode From TX to RX in TX mode		-45 -15		dB dB
Input return loss	S ₁₁		10			dB
Output return loss	S ₂₂		6			dB
Power detector output	V _{DET}	No RF @ +5 dBm @ +21 dBm @ +28 dBm	0.25 0.63 0.79	0.2 0.33 0.72 0.9	0.38 0.81 0.99	V V V V
Power detector slope	Slope	+5 dBm to +28 dBm	20	24		mV/dB
Power detector error	ERR _{DET}	+10 dBm < P _{OUT} < +28 dBm ΔP _{OUT} vs ideal V _{DET} , 5.15 GHz to 5.85 GHz: 50 Ω 2:1 VSWR			1.5 2	dBpk-pk dBpk-pk
Power detector output impedance	Z _{OUT_DET}	RF output = -30 dBm		200		Ω
Coupling factor	CPLG		-19	-17	-15.5	dB
Coupler directivity	Dir			17.5		dB
Stability	STAB	+27 dBm MCS0, 0.1 GHz to 20 GHz, load VSWR = 6:1	All non-harmonic related outputs < -45 dBm/MHz			
Ruggedness	Ru	TX_IN = +10 dBm, 10:1 mismatch, all phases	No permanent damage			

Table 4. SKY85747-11 Electrical Specifications¹ (2 of 2)
(VCC1 = VCC2 = VCC3 = VDD = 5.0 V, Top = 25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Receive Mode						
Gain	G	LNA active LNA bypass	14.5	16 -7		dB dB
1 dB input compression point	IP1dB	LNA active LNA bypass	-5	0 +19		dBm dBm
Gain step			19	21	24	dB
Gain flatness		Over any 80 MHz bandwidth	-0.25		+0.25	dB
Noise figure	NF	End to end		2.0	2.4	dB
Input return loss	S11	LNA active LNA bypass	9 9			dB dB
Output return loss	S22		6			dB
Third order input intercept point	IIP3	LNA active	+7	+11		dBm
Switching time	tsw	State 2 ↔ State 3 State 2 ↔ State 1		200 500	220	ns ns

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

Table 5. SKY85747-11 Logic

Mode	State	PA_EN (Pin 10)	LNA_EN (Pin 13)
TX to ANT	1	1	0
ANT to RX port (LNA mode)	2	0	1
Not supported	-	1	1
ANT to RX port (Bypass mode)	3	0	0

Evaluation Board Description

The SKY85747-11 Evaluation Board is used to test the performance of the SKY85747-11 FEM. A suggested application schematic diagram is shown in Figure 3. A photograph of the Evaluation Board is shown in Figure 4. Table 6 provides the Bill of Materials (BOM) list for the Evaluation Board components.

Evaluation Board Setup Procedure

1. Connect power supply ground to the J5 header, pin 1.
2. Apply 5 V to the J5 header, pin 2 and to the J6 header, pins 15, 17, 19, and 21 using jumpers (pin 15 to pin 16; pin 17 to pin 18; pin 19 to pin 20; and pin 21 to pin 22, respectively).
3. Select a path according to the information in Table 5 (L = 0 V, H = 3 V), either by placing jumpers at the J6 header, pins 9 and 13, or applying signals from a controller.
4. Detector output can be measured on the J6 header, pin 4.

Circuit Design Considerations

The following design considerations are general in nature and must be followed regardless of final use or configuration:

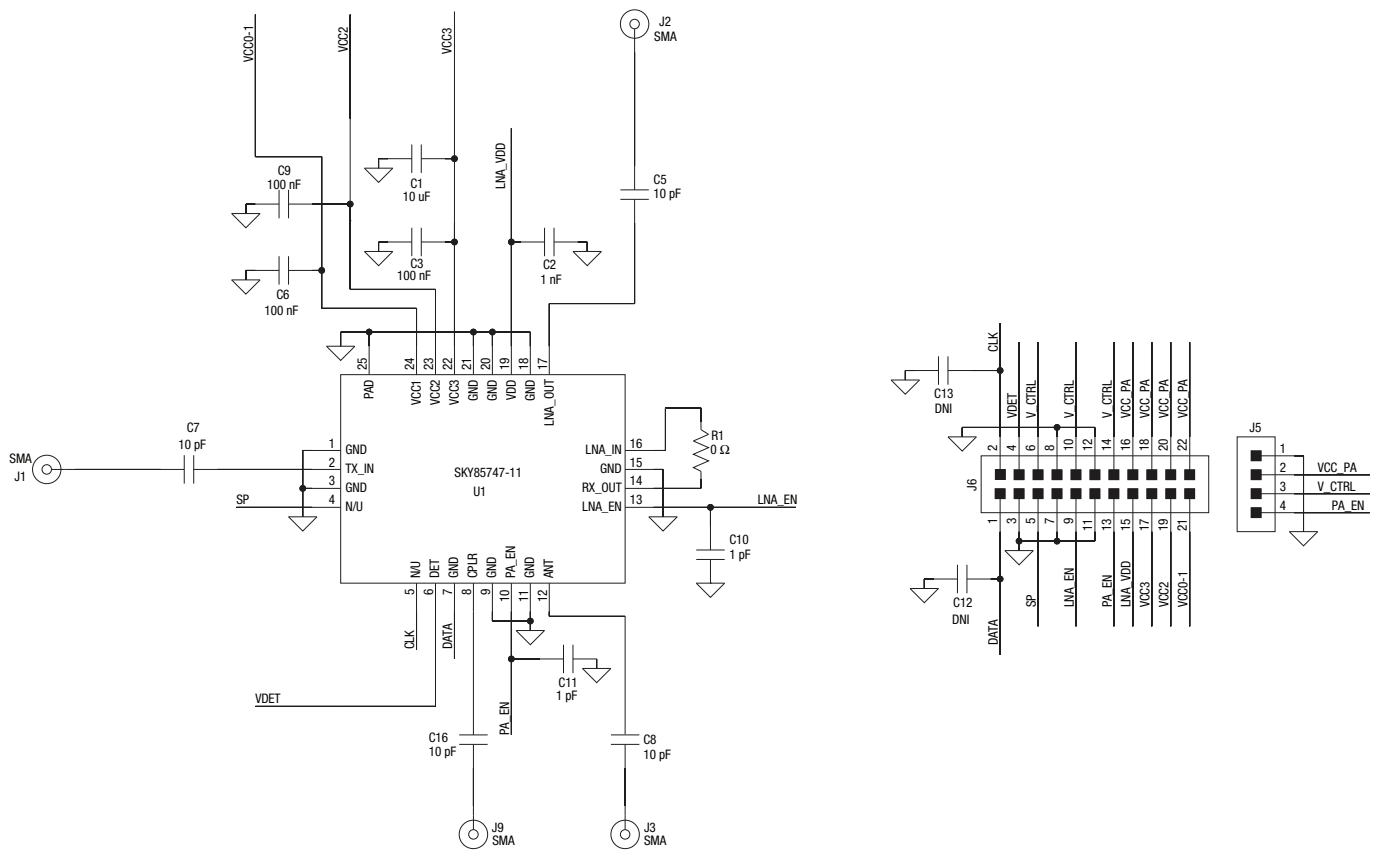
- Paths to ground should be made as short as possible.
- The ground pad of the SKY85747-11 has special electrical and thermal grounding requirements. This pad is the main thermal conduit for heat dissipation. Because the circuit board acts as the heat sink, it must shunt as much heat as possible from 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.

- TX_IN is DC shorted to GND. There is no DC leaking from the chip, but if there is DC on the line interfacing with the TX_IN pin, a 10 pF blocking capacitor is recommended.
- ANT, RX_OUT, and LNA_IN are DC blocked and do not require blocking capacitors.
- LNA_OUT is DC blocked but if there is > 1.5 V DC on the line connected to the LNA_OUT pin, a 10 pF blocking capacitor is recommended.

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

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

Figure 3. SKY85747-11 Application Schematic

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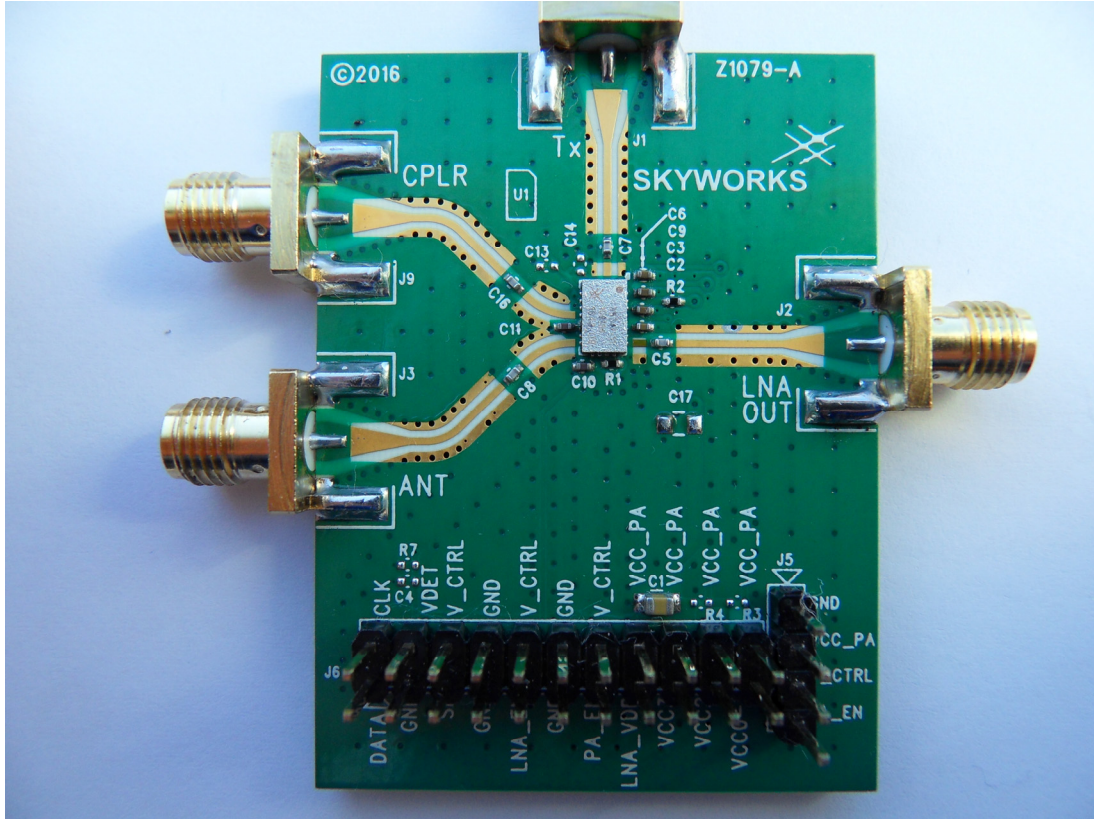


Figure 4. SKY85747-11 Evaluation Board

Table 6. SKY85747-11 Evaluation Board Bill of Materials

Component	Value	Size	Vendor	Part Number	Description
C1	10 uF	0805	Murata	GRM21BR71A106KE51L	Ceramic
C2	1 nF	0402	Murata	GRM1555C1H102JA01	Multilayer ceramic
C3, C6, C9	100 nF	0402	Murata	GRM155R71C104KA88D	Monolithic ceramic
C5, C7, C8	10 pF	0402	Murata	GRM1555C1H100JZ01	Multilayer ceramic
C10, C11	1 pF	0402	Murata	GRM1555C1H1ROCZ01	Multilayer ceramic
C16	10 pF	0402	Murata	GJM1555C1H100GB01	RF, high Q, low loss
R1, R2	0 Ω	0402	Panasonic	ERJ2GE0R00	Thick film chip resistor
U1	SKY85747-11	MCM3x5-24	Skyworks Solutions Inc.	SKY85747-11	5 GHz 11ax 5V FEM in 3x5 package with DPD coupler

Package Dimensions

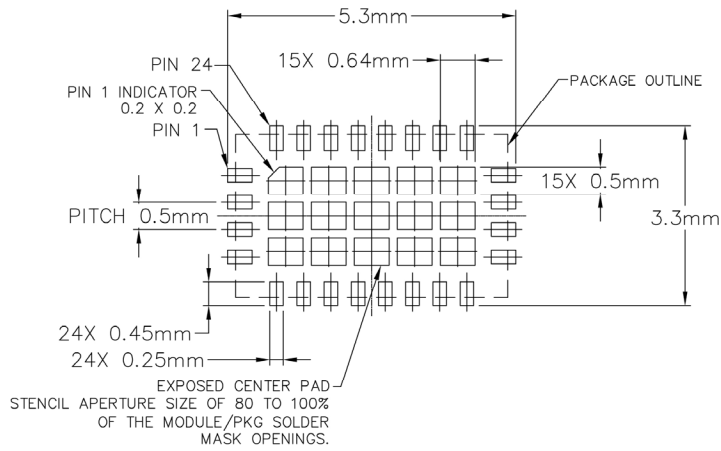
The PCB layout footprint for the SKY85747-11 is shown in Figure 5. Typical part markings are shown in Figure 6. Package dimensions for the are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

Package and Handling Information

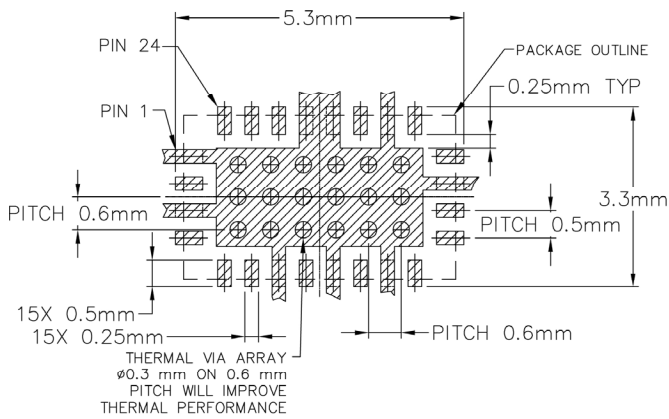
Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY85747-11 is rated to Moisture Sensitivity Level 4 (MSL4) 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.

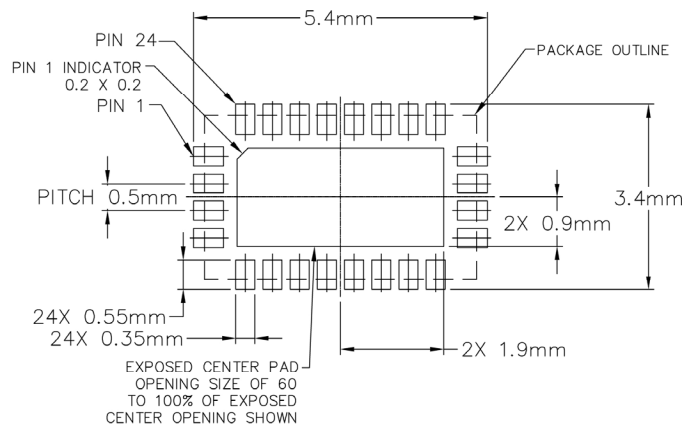
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



STENCIL APERTURE
Top View



METALLIZATION
Top View



SOLDER MASK OPENING
Top View

NOTE: THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

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Figure 5. SKY85747-11 PCB Layout Footprint
(Top View)

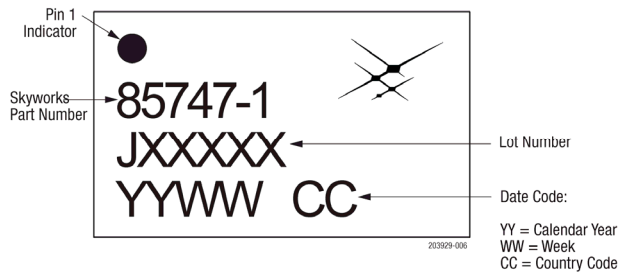
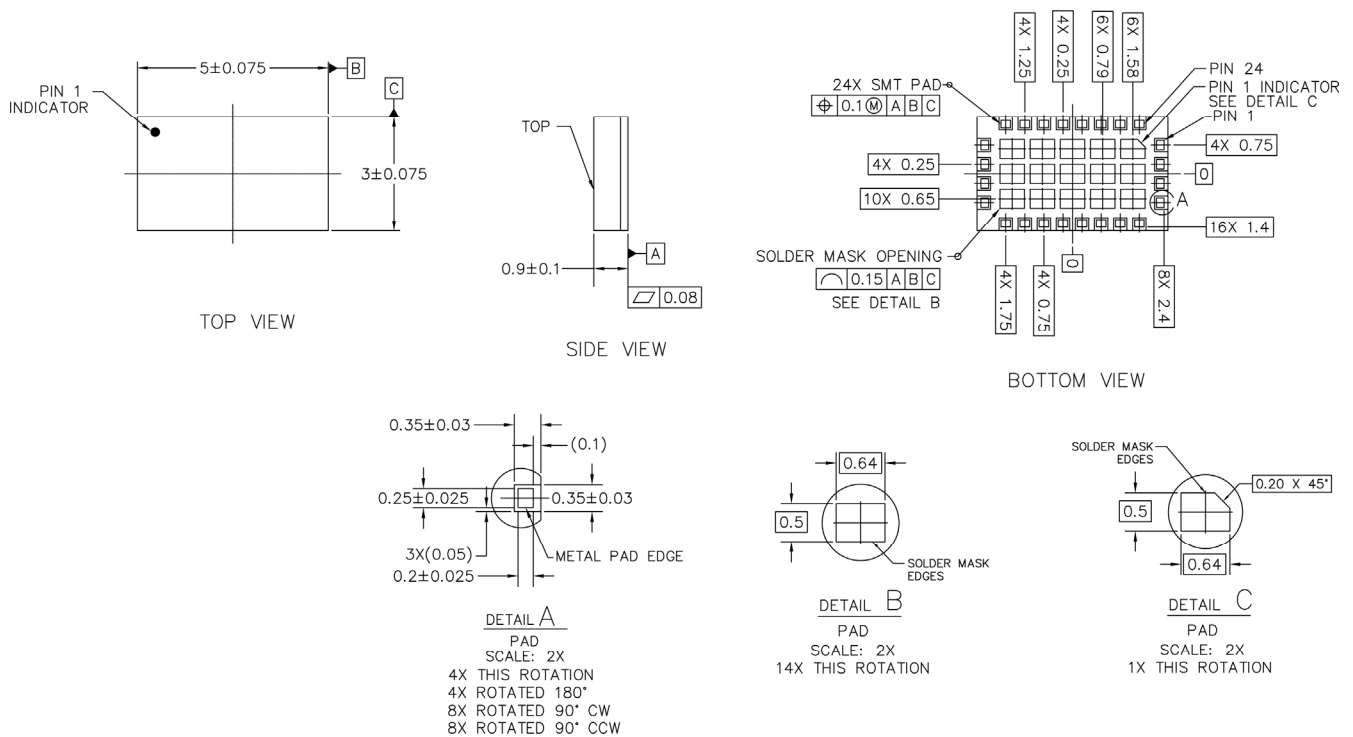


Figure 6. Typical Part Markings (Top View)



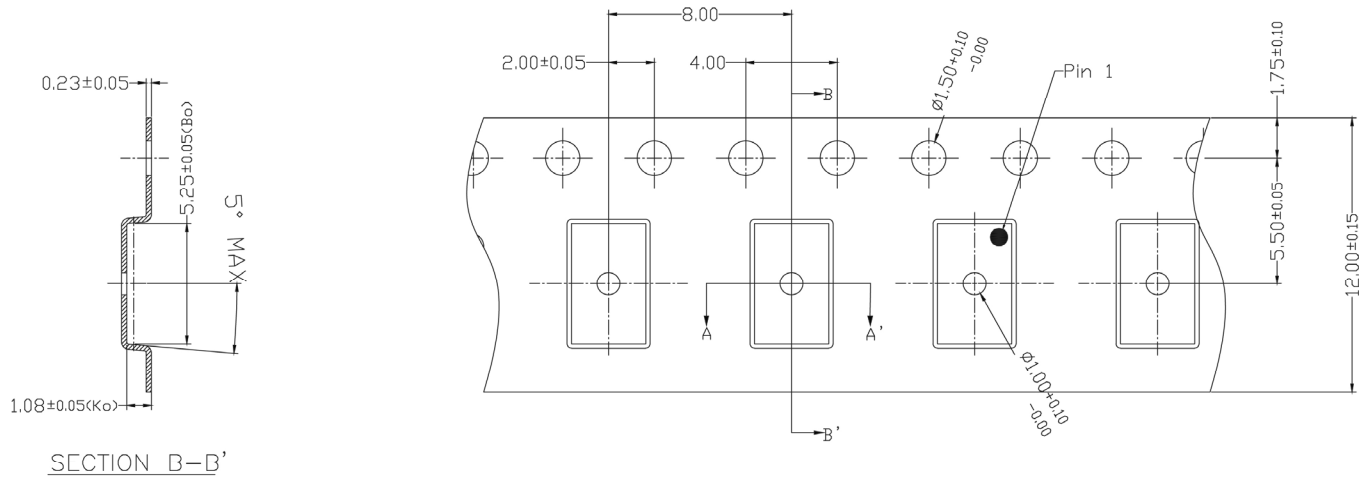
NOTES: UNLESS OTHERWISE SPECIFIED.

1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.
 2. DIMENSIONS ARE IN MILLIMETERS
- △ PRIMARY DATUM A AND SEATING PLANE ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
 - △ DIMENSION IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO PRIMARY DATUM A.

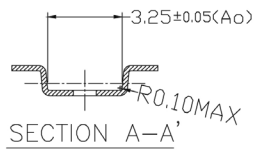
203929-007

Figure 7. SKY85747-11 Package Dimensions

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- NOTES:**
1. CARRIER TAPE MUST MEET ALL SKYWORKS REQUIREMENTS OF GP01-D233 PROCUREMENT SPEC FOR TAPE AND REEL
 2. CARRIER TAPE SHALL BE BLACK CONDUCTIVE POLYCARBONATE NON BAKEABLE.
 3. COVER TAPE SHALL BE TRANSPARENT CONDUCTIVE MATERIAL
 4. ESD-SURFACE RESISTIVITY SHALL MEET GP01-D233
 5. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE : ±0.20mm
 6. Ao & Bo MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
 7. ALL DIMENSIONS ARE IN MILLIMETERS.
 8. Co USA
 9. PIN 1 IS ONLY AS REFERENCE TRUE VALUE MUST BE ON AGILE PRODUCT MATERIAL RECORD



203929-008

Figure 8. SKY85747-11 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY85747-11	5 GHz High-Power WLAN Front-End Module	SKY85747-11EK1

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