DATA SHEET

SKY85743-31: 5 GHz High-Power WLAN Front-End Module

Applications

- Indoor and outdoor 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
- Transmit gain: 34 dB typical
- Supports 802.11ax: output power:
  - +21 dBm, -43 dB DEVM, MCS11
  - +22 dBm, -40 dB DEVM, MCS11
  - +24 dBm, -35 dB DEVM, MCS9
- Conformally shielded part
- Integrated, temperature-compensated log detector
- Highly sensitive, jammer-tolerant (> +10 dBm IIP3), high-gain (16 dB) LNA
- Small (24-pin, 3 x 5 mm) conformally shielded package (MSL3, 260 °C per JEDEC J-STD-020)

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04–0074.

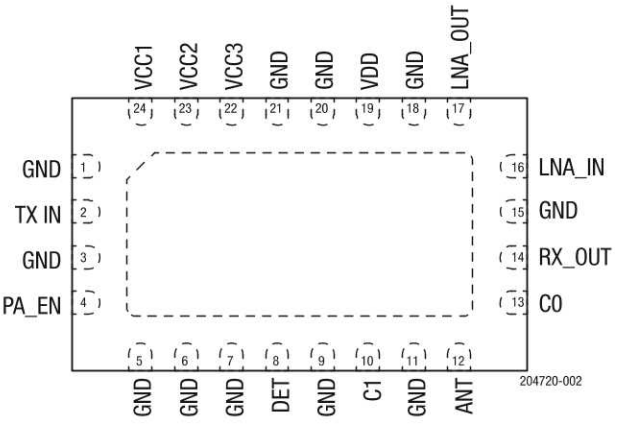


Figure 2. SKY85743-31 Pinout (Top View)

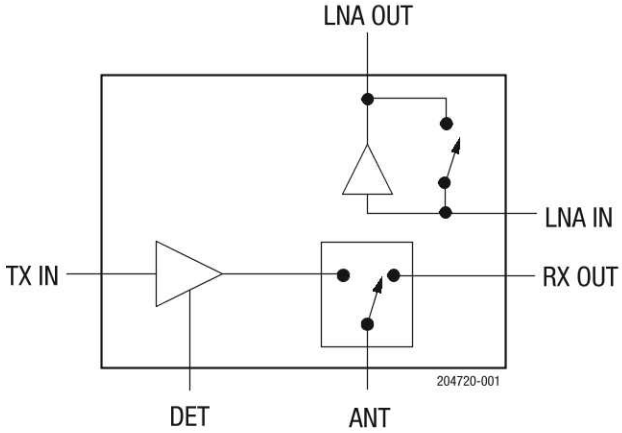


Figure 1. SKY85743-31 Block Diagram

Description

The SKY85743-31 is a highly integrated, 5 GHz front-end module (FEM) incorporating a 5 GHz single-pole, double-throw (SPDT) transmit/receive (T/R) switch, a 5 GHz high-gain low-noise amplifier (LNA) with bypass, and a 5 GHz 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 conformally shielded 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.

Table 1. SKY85743-31 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	13	C0	Control pin 0
2	TX_IN	Transmit Input	14	RX_OUT	Switch RX ouput
3	GND	Ground	15	GND	Ground
4	PA_EN	PA enable	16	LNA_IN	LNA input
5	GND	Ground	17	LNA_OUT	LNA output
6	GND	Ground	18	GND	Ground
7	GND	Ground	19	VDD	LNA supply voltage
8	DET	Detector output	20	GND	Ground
9	GND	Ground	21	GND	Ground
10	C1	Control pin 1	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 SKY85743-31 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 log detector provides accurate closed-loop power control over 20 dB of dynamic range. 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 SKY85743-31 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 SKY85743-31 is determined by the logic provided in Table 5.

Table 2. SKY85743-31 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC1, VCC2, VCC3, and VDD	-0.3	+6.0	V
DC input on control pins (C0, C1, and PA_EN)	V_{IN}	-0.3	+3.6	V
Input power (50 Ω load)	P_{IN}		+10	dBm
Supply current	I_{CC}		800	mA
Storage temperature	T_{ST}	-40	+150	°C
Junction temperature	T_J		160	°C
Thermal resistance	θ_{JC}		34	°C/W
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. SKY85743-31 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 Low	 V_{IH} V_{IL}	 1.6 0		 3.6 0.4	 V V
PA enable current	I_{ENABLE}		10	20	µA
LNA bias current	I_{DD}			40	mA
C0, C1 enable current				10	µA
Operating temperature	T_{OP}	-40		+85	°C

Table 4. SKY85743-31 Electrical Specifications[1] (1 of 2)
(V_{CC1} = V_{CC2} = V_{CC3} = V_{DD} = 5.0 V, T_{OP} = 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 $G_{3.9}$	@ P_{IN} = -25 dBm At 3.9 GHz	32	34 -13	 -8	dB dB
Gain flatness		Over any 80 MHz bandwidth	-0.5		+0.5	dB
Output power	P_{OUT}	Amplitude tracking off: MCS11, HT20 – HT80, -43 dB DEVM MCS11, HT160, -43 dB DEVM[2] MCS11, HT20 – HT80, -40 dB DEVM MCS11, HT160, -40 dB DEVM[2] MCS9, HT20 – HT80, -35 dB DEVM MCS9, HT160, -35 dB DEVM[2] MCS7, HT20 – HT80, -30 dB DEVM MCS0, HT20, mask with 3 dB margin	 +18 +15 +20 +18 +22 +20 +23 +25	 +21 +19 +22 +21 +24 +23 +25 +27		 dBm dBm dBm dBm dBm dBm dBm dBm
Current consumption		Modulated signal: @ quiescent @ +21 dBm @ +25 dBm @ +27 dBm Leakage, EN off		 190 270 360 410 1	 200 300 400 455 1.3	 mA mA mA mA mA
2nd harmonics	2fo	+27 dBm MCS0		-50	-43	dBm/MHz
3rd harmonics	3fo	+27 dBm MCS0		-50	-43	dBm/MHz
All non-harmonic spurious		+27 dBm OFDM, VSWR = 6:1, 6 Mbps			-45	dBm/MHz
Isolation		From ANT to LNA_OUT TX mode (switch leakage + LNA S21 when off) From RX_OUT to LNA_IN in RX mode[3]		-45 -45	-39 -40	dB dB
Input return loss	|S11|		9			dB
Output return loss	|S22|		8			dB
Power detector output	V_{DET1}	@+5 dBm CW, 5150 to 5350 MHz	0.2	0.3	0.42	V
		@+5 dBm CW, 5470 to 5725 MHz	0.22	0.31	0.43	V
		@+5 dBm CW, 5725 to 5925 MHz	0.22	0.33	0.44	V
	V_{DET2}	@+10 dBm CW, 5150 to 5350 MHz	0.33	0.43	0.55	V
		@+10 dBm CW, 5470 to 5725 MHz	0.34	0.44	0.56	V
		@+10 dBm CW, 5725 to 5925 MHz	0.36	0.46	0.58	V
	V_{DET3}	@+21 dBm CW, 5150 to 5350 MHz	0.61	0.7	0.84	V
		@+21 dBm CW, 5470 to 5725 MHz	0.63	0.72	0.85	V
		@+21 dBm CW, 5725 to 5925 MHz	0.65	0.74	0.89	V
	V_{DET4}	@+28 dBm CW, 5150 to 5350 MHz	0.78	0.87	1.03	V
		@+28 dBm CW, 5470 to 5725 MHz	0.80	0.89	1.05	V
		@+28 dBm CW, 5725 to 5925 MHz	0.82	0.92	1.07	V

Table 4. SKY85743-31 Electrical Specifications[1] (2 of 2)
(V_{CC1} = V_{CC2} = V_{DD} = 5.0 V, T_{OP} = 25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Transmit Mode (continued)						
Power detector slope	Slope	+10 dBm to +28 dBm, 5150 to 5350 MHz	+21	+25.6		mV/dB
		+10 dBm to +28 dBm, 5470 to 5725 MHz	+21	+26		mV/dB
		+10 dBm to +28 dBm, 5725 to 5925 MHz	+21	+26.3		mV/dB
Power detector error	ERR_{DET}	Reference an idealized detector response from +10 dBm to +28 dBm			3	dB pk-pk
Power detector output impedance	Z_{OUT_DET}	RF output = -30 dBm		100	220	Ω
Ruggedness	Ru	TX_IN = +10 dBm, 10:1 mismatch, all phases	No permanent damage			
Receive Mode						
Gain	G		14.5	16		dB
1 dB input compression point	IP1dB	LNA active LNA bypass	-5 +20	0 +22	 +24	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	9		dB
Third order input intercept point	IIP3	LNA active	+8	+12		dBm
Switching time	t_{SW}	LNA ↔ bypass RX ↔ TX		190 400	200 500	ns ns
Receive Bypass Mode						
Insertion loss	S21			6	9	dB

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

[2] Guaranteed by characterization.

[3] To obtain the best RX_OUT to LNA_IN isolation, refer to the section "Circuit Design Considerations."

Table 5. SKY85743-31 Logic

Mode	State	PEN	C0	C1
TX to ANT	1	1	0	1
RX LNA to ANT	2	0	1	0
RX bypass to ANT	3	0	1	1
All off	4	0	0	0
All other states	Not supported			

Evaluation Board Description

The SKY85743-31 Evaluation Board is used to test the performance of the SKY85743-31 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 J6 header, pin 2 and the J5 header, pin 1.
2. Place jumpers between:
   - J6 header, pin 11 and J4 header, pin 6
   - J6 header, pin 15 and J4 header, pin 8
   - J6 header, pin 17 and J4 header, pin 9
   - J6 header, pin 19 and J4 header, pin 10
3. Apply 5 V to the J5 header, pins 2 and 3.
4. Select a path according to the information in Table 5 by applying control voltage (L = 0 V, H = 3.3 V) to PA_EN (J6 header, pin 13), C0 (J6 header, pin 9), and C1 (J6 header, pin 7).
5. Detector output can be measured on the J4 header, pin 1.

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 SKY85743-31 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.
- Special consideration should be taken for the layout when an external RX filter is used between RX_OUT and LNA_IN. To provide the best in-band isolation between RX_OUT and LNA_IN, the recommended layout is shown in Figure 5. The ground copper with through-hole vias is recommended between RX_OUT and LNA_IN before these signals are connected to the external filter. The filter's input and output pins should also be isolated by the solid ground in between. In addition to the above approach, more isolation can be achieved by routing RX_OUT trace on one layer and LNA_IN trace on another layer and with ground layer in between.

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

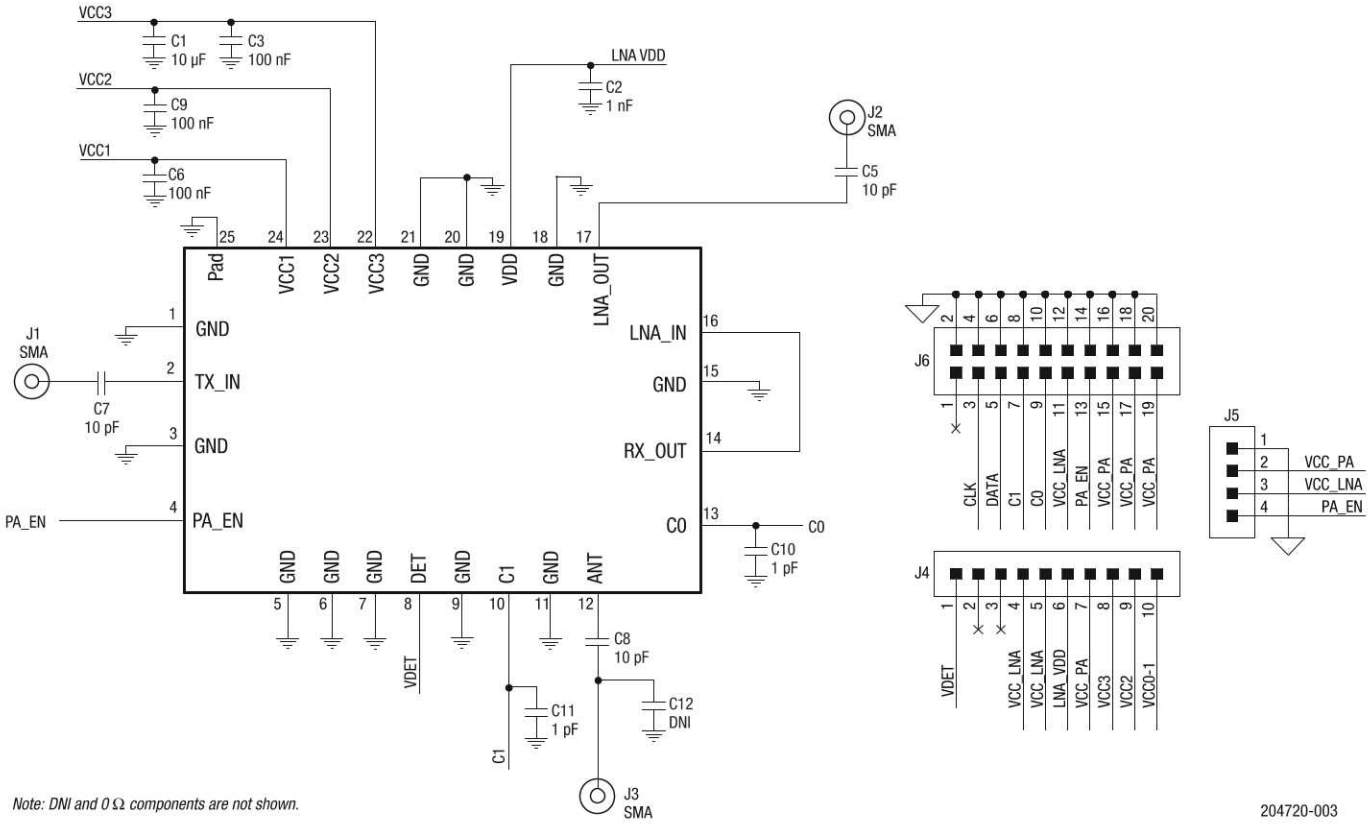


Figure 3. SKY85743-31 Application Schematic

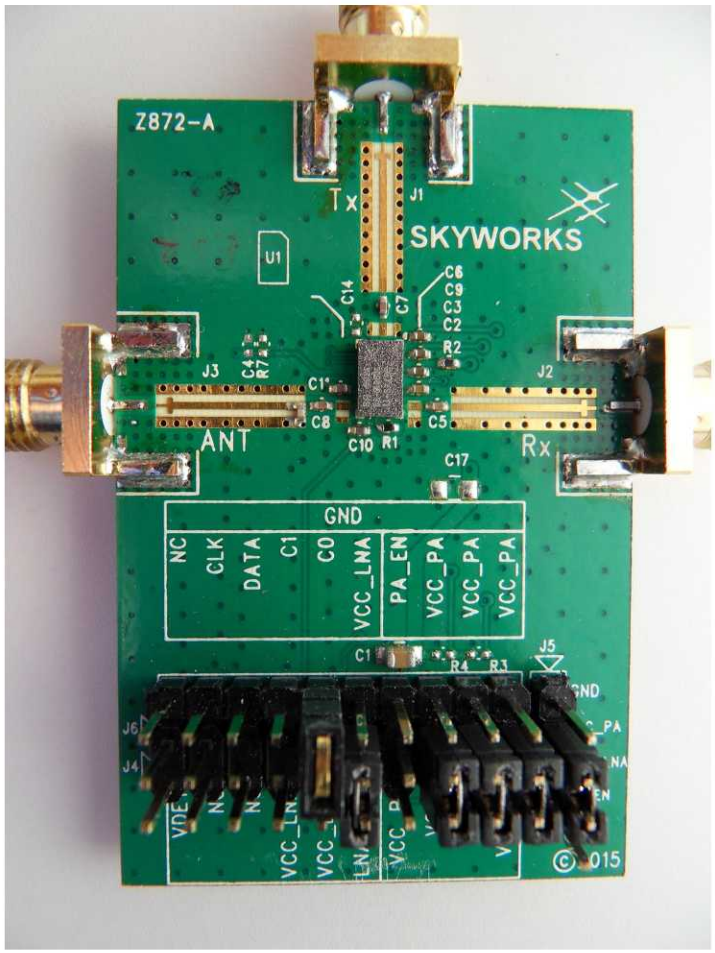
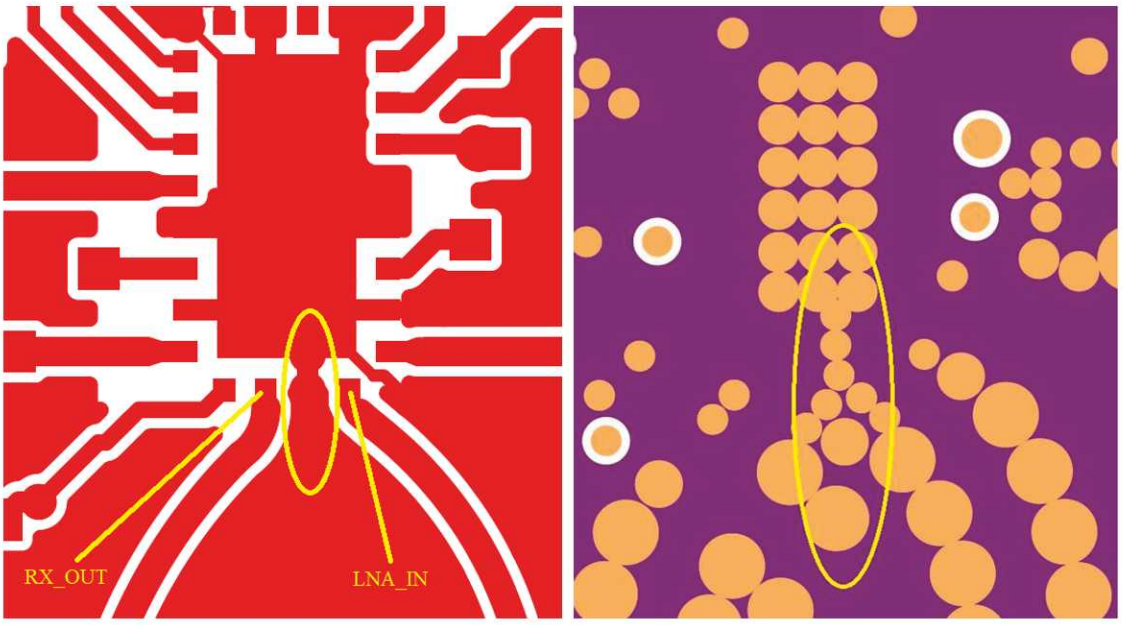


Figure 4. SKY85743-31 Evaluation Board

Table 6. SKY85743-31 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	GRM1555C1H1R0CZ01	Multilayer ceramic
C12	DNI				



Top Layer Ground Copper between RX_OUT and LNA_IN

Ground vias between RX_OUT and LNA_IN

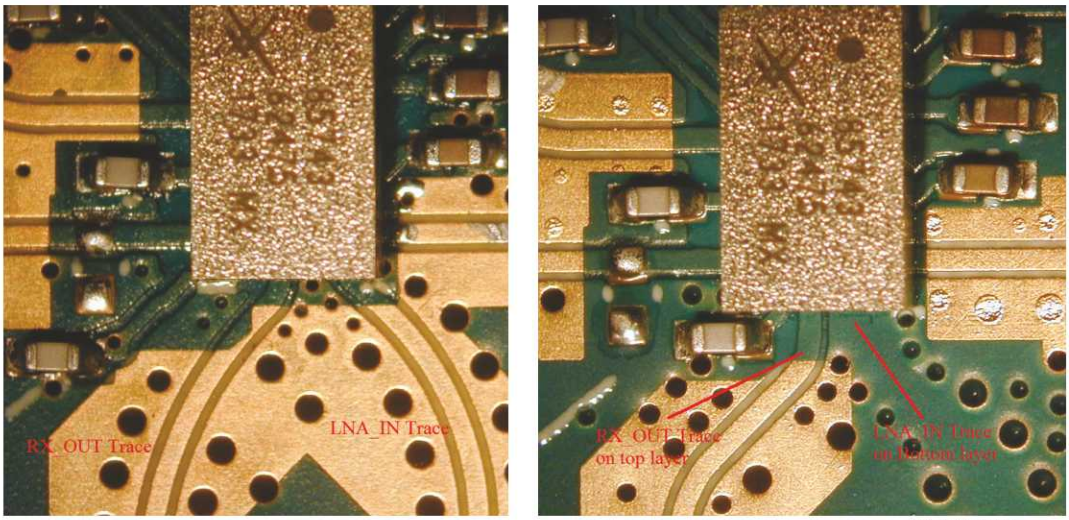


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Figure 5. SKY85743-31 Layout to Improve the Isolation between RX_OUT and LNA_IN

Package Dimensions

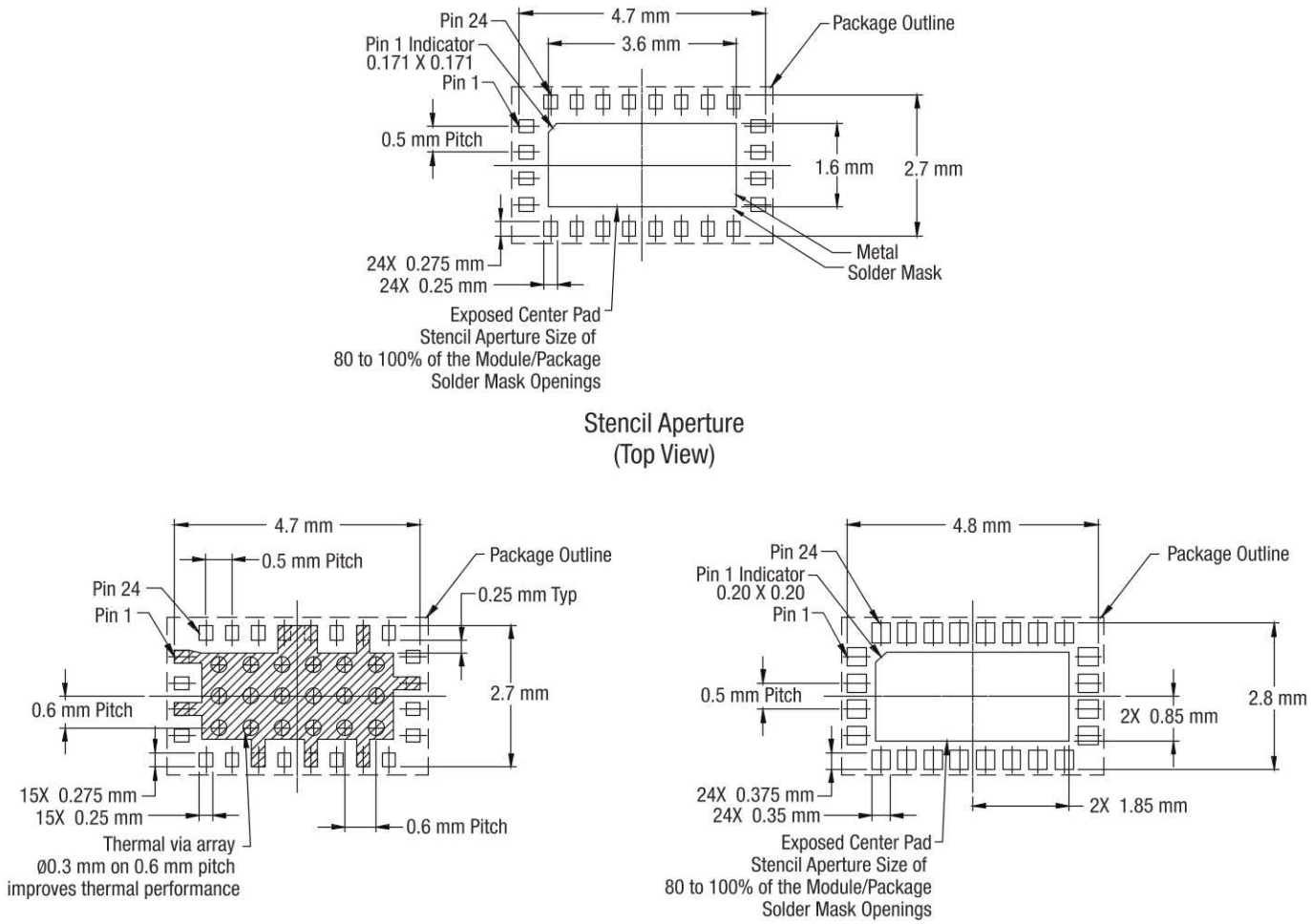
The PCB layout footprint for the SKY85743-31 is shown in Figure 6. Typical part markings are shown in Figure 7. Package dimensions are shown in Figure 8, and tape and reel dimensions are provided in Figure 9.

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 SKY85743-31 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, *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.



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 6. SKY85743-31 PCB Layout Footprint (Top View)

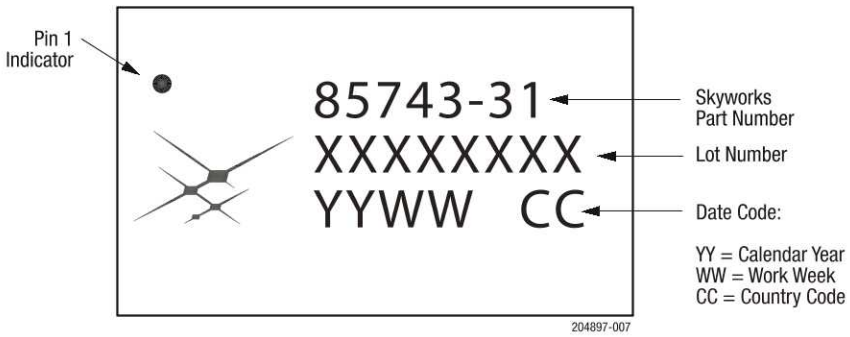
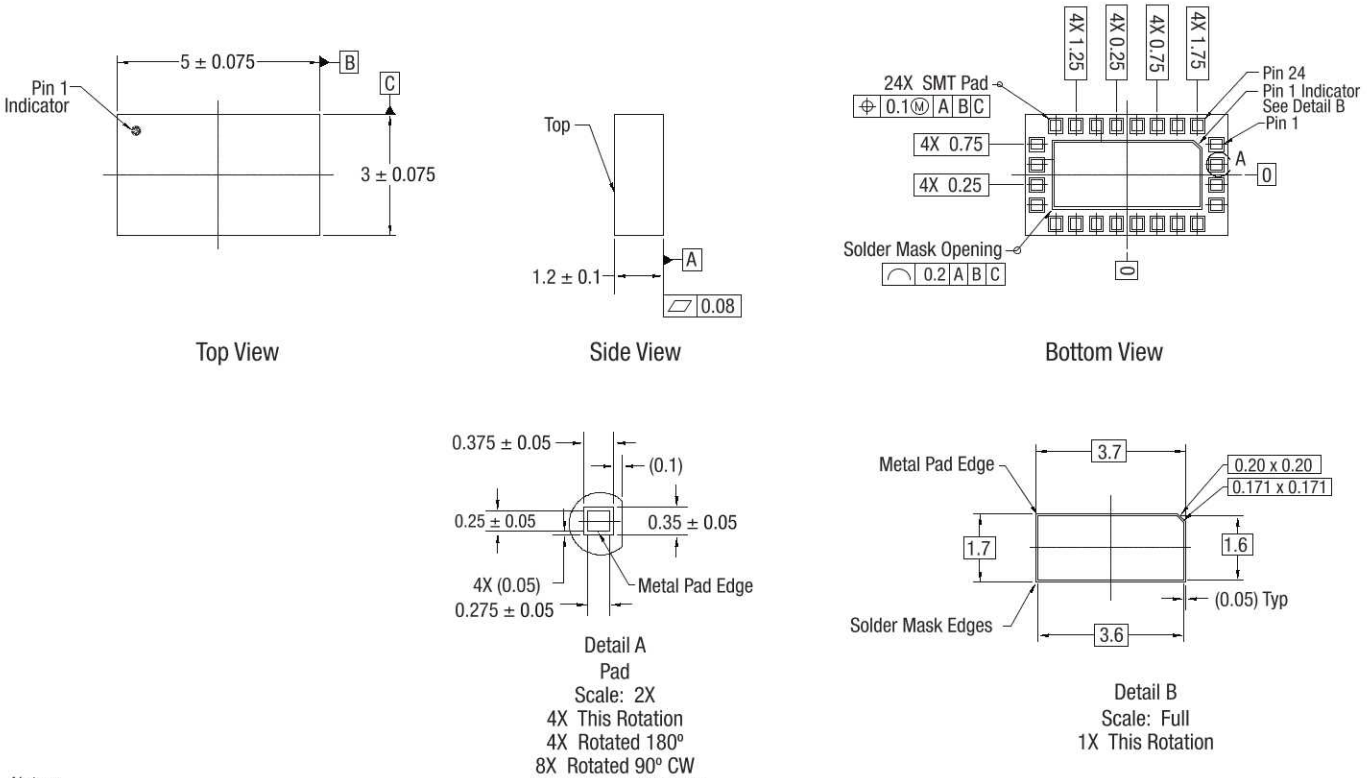


Figure 7. Typical Part Markings (Top View)



Notes:

1. *Dimensions and tolerances in accordance with ASME Y14.5M-1994.*
2. *All measurements are in millimeters.*
3. *Primary datum A and seating plane are defined by spherical crowns of the solder balls.*
4. *Dimension is measured at the maximum solder ball diameter, parallel to primary datum A.*

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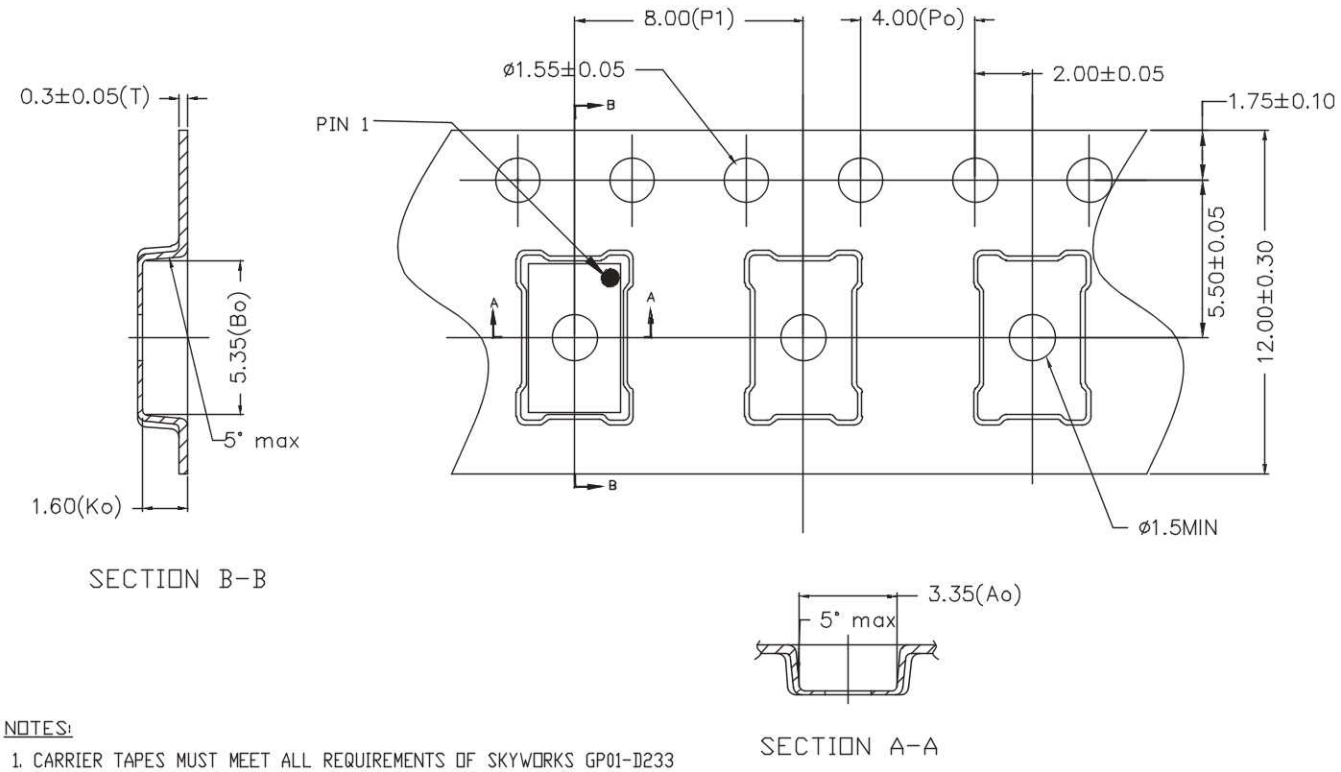
Figure 8. SKY85743-31 Package Dimensions



NOTES:

1. CARRIER TAPES MUST MEET ALL REQUIREMENTS OF SKYWORKS GP01-D233 PROCUREMENT SPEC FOR TAPE and REEL SHIPPING.
2. CARRIER TAPE SHALL BE BLACK CONDUCTIVE POLYSTYRENE OR POLYCARBONATE.
3. COVER TAPE SHALL BE TRANSPARENT CONDUCTIVE MATERIAL.
4. ESD-SURFACE RESISTIVITY SHALL MEET GP01-D233 RESISTIVITY SPECS
5. Po/P1, 10 PITCHES CUMULATIVE TOLERANCE ON TAPE: ±0.20mm
6. Ao & Bo MEASUREMENT POINT TO BE 0.30 FROM BOTTOM POCKET.
7. ALL DIMENSIONS ARE IN MILLIMETERS.

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Figure 9. SKY85743-31 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY85743-31	5 GHz WLAN Front-End Module	SKY85743-31EK1