

DATA SHEET

SKY85329-11: 2.4 GHz, 802.11n WLAN Front-End Module

Applications

- 802.11n set-top boxes, networking, and personal computer systems
- PC cards, PCMCIA cards, mini-cards, and half mini-cards
- WLAN enabled wireless video systems

Features

- Integrated high-performance 2.4 GHz PA, LNA with bypass and T/R switch
- Fully-matched input and output
- LNA with integrated bypass mode
- Integrated positive slope power detector
- Transmit gain: 32.5 dB
- Receive gain: 16.5 dB
- Small QFN (16-pin, 2.5 x 2.5 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

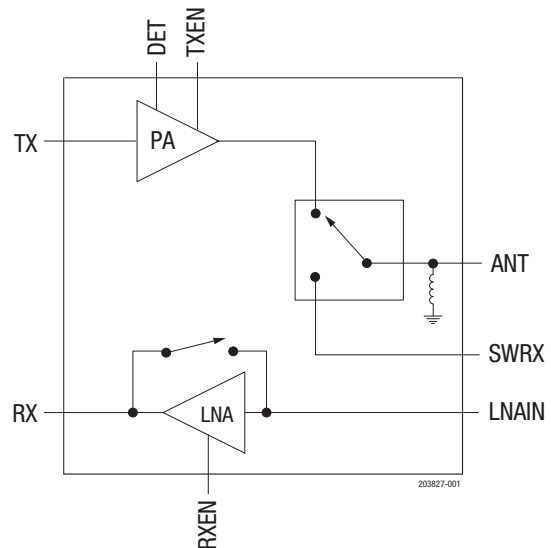


Figure 1. SKY85329-11 Block Diagram



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.

Description

The SKY85329-11 is a complete 802.11b/g/n WLAN RF front-end module (FEM). The device provides all the functionality of a fully matched power amplifier (PA), power detector, low-noise amplifier (LNA), and single-pole, dual-throw (SPDT) switch.

The SKY85329-11 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 SKY85329-11 also includes a transmitter 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 2.5 x 2.5 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.

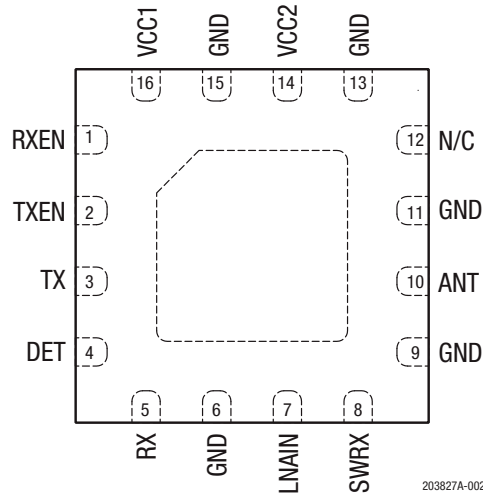


Figure 2. SKY85329-11 Pinout (Top View)

Table 1. SKY85329-11 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	RXEN	LNA enable control input	9	GND	Ground
2	TXEN	PA enable control input	10	ANT	Antenna
3	TX	RF transmit PA input	11	GND	Ground
4	DET	Power detector output voltage	12	N/C	No connection
5	RX	RF receive LNA output	13	GND	Ground
6	GND	Ground	14	VCC2	PA positive supply voltage
7	LNAIN	2.4 GHz LNA input signal	15	GND	Ground
8	SWRX	2.4 GHz switch RX output	16	VCC1	PA positive supply voltage

Technical Description

The SKY85329-11 is comprised of a high-efficiency 2.4 GHz PA, 2.4 GHz LNA, and 2.4 GHz SPDT switch. The device is partially matched, and requires few external components for optimal performance, which makes it ideal for access point and set-top-box applications. The FEM provides a typical gain of 32.5 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 TXEN signal (pin 2).

The low-loss SPDT switch provides the T/R switching function on the SKY85329-11.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY85329-11 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 through 11.

The state of the SKY85329-11 is determined by the logic provided in Table 12.

Table 2. SKY85329-11 Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC1, VCC2	-0.3	+6	V
DC input on control pins	VIN	-0.3	+3.6	V
Transmit input power (Wi-Fi OFDM signal, ANT terminated into 50 Ω)	PINTX		+10	dBm
Receive input power (Wi-Fi OFDM signal)	PINRX		+15	dBm
Maximum junction temperature	TJ		+150	°C
Storage temperature	TST	-40	+150	°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: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.

Table 3. SKY85329-11 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage relative to GND = 0 V	VCC1, VCC2	3.0	5.0	5.5	V
Operating temperature	TOP	-40	+25	+85	°C

Table 4. SKY85329-11 Electrical Specifications: DC Characteristics^{1,2}
(VCC1 = VCC2 = 5.0 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Total supply current	ICC	P _{OUT} = +25 dBm		260	300	mA
		P _{OUT} = +22 dBm		190	240	mA
Current off	ICC_OFF	No RF, TXEN = RXEN = 0 V		4	12	μA
Quiescent current	ICQ	No RF		100	130	mA
LNA supply current	ICC_LNA	RXEN = 3.3 V		6	9	mA
LNA bypass supply current	ICC_LNA_BYP	RXEN = TXEN = 0 V		4	6	μA

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

² The Vcc = 5 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 5. SKY85329-11 Electrical Specifications: DC Characteristics^{1,2}
(VCC1 = VCC2 = 3.3 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Total supply current	I _{CC}	P _{OUT} = +18 dBm P _{OUT} = +21 dBm		140 175	180 215	mA mA
Current off	I _{CC_OFF}	No RF, TXEN = RXEN = 0 V		1	9	μA
Quiescent current	I _{CO}	No RF		100	130	mA
LNA supply current	I _{CC_LNA}	RXEN = 3.3 V		9	12	mA
LNA bypass supply current	I _{CC_LNA_BYP}	RXEN = TXEN = 0 V		4	6	μA

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

² The V_{CC} = 3.3 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 6. SKY85329-11 Electrical Specifications: Transmit Characteristics¹
(VCC1 = VCC2 = 5.0 V, TXEN = 3.3 V, RXEN = 0 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		2.4		2.5	GHz
Output power ²	P _{OUT}	V _{CC} = 5.0 V: DEV _M = 3% (-30 dB), MCS7, HT40 CCK, mask compliant	+21 +23	+22 +25		dBm dBm
Small signal gain ²	IS ₂₁	V _{CC} = 5.0 V	31	32.5	35	dB
Small signal gain variation	ΔS ₂₁				±0.5	dB
2 nd harmonics	2f _o	P _{OUT} = +25 dBm, 1 Mbps, 802.11b			-47.2	dBm/MHz
3 rd harmonics	3f _o	P _{OUT} = +25 dBm, 1 Mbps, 802.11b			-47.2	dBm/MHz
Delay and rise/fall time	t _{DR} , t _{DF}	50% of V _{TXEN} edge and 90/10% of final output power level			400	ns
Input return loss	IS ₁₁	@ TX port	8	12		dB
Stability	Stab	CW, P _{IN} = -5 dBm, 0.1 GHz to 20 GHz, load VSWR = 6:1	All non-harmonically related outputs less than -43 dBm/MHz			
Ruggedness	RUG	CW, P _{IN} = +5 dBm, 0.1 GHz to 20 GHz, load VSWR = 10:1	No permanent damage or performance degradation			

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

² The V_{CC} = 5 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 7. SKY85329-11 Electrical Specifications: Transmit Characteristics¹
(VCC1 = VCC2 = 3.3 V, TXEN = 3.3 V, RXEN = 0 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		2.4		2.5	GHz
Output power ²	P _{OUT}	V _{CC} = 3.3 V: DEVM = 3% (-30 dB), MCS7, HT40 CCK, mask compliant	+17 +20	+18 +21		dBm dBm
Small signal gain ²	IS211	V _{CC} = 5.0 V	30	32	34	dB
Small signal gain variation	ΔS21				±0.5	dB
2 nd harmonics	2fo	P _{OUT} = +25 dBm, 1 Mbps, 802.11b			-47.2	dBm/MHz
3 rd harmonics	3fo	P _{OUT} = +25 dBm, 1 Mbps, 802.11b			-47.2	dBm/MHz
Delay and rise/fall time	t _{DR} , t _{DF}	50% of V _{TXEN} edge and 90/10% of final output power level			400	ns
Input return loss	IS111	@ TX port	8	12		dB
Stability	Stab	CW, P _{IN} = -5 dBm, 0.1 GHz to 20 GHz, load VSWR = 6:1	All non-harmonically related outputs less than -43 dBm/MHz			
Ruggedness	RUG	CW, P _{IN} = +5 dBm, 0.1 GHz to 20 GHz, load VSWR = 10:1	No permanent damage or performance degradation			

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

² The V_{CC} = 3.3 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 8. SKY85329-11 Electrical Specifications: Receive Characteristics¹
(VCC1 = VCC2 = 5.0 V or 3.3 V, RXEN = 3.3 V, TXEN = 0 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		2.4		2.5	GHz
Small signal gain	IS211	LNA enabled Bypass mode	+15.0 -6	+16.5 -4.5	+18 -3	dB dB
Noise figure @ 5 V	NF	From ANT to RX pins		2.1	2.4	dB
Third order input intercept point	IIP3	LNA enabled Bypass mode	+2 +25	+4 +28		dBm dBm
Input return loss	IS111	RXEN = 3.3 V RXEN = 0 V	9 9	12 12		dB dB
Output return loss	IS221		10	12		dB
Enable time	T _{EN}	10% to 90% of RX RF power from time that RXEN is at 50%			400	ns
ANT–RX isolation	I _{SO}	RXEN = 0 V, TXEN = 3.3 V	40	48		dB

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

² The V_{CC} = 5 V or 3.3 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 9. SKY85329-11 Electrical Specifications: Power Detector Characteristics^{1,2}
(VCC1 = VCC2 = 5.0 V, TXEN = 3.3 V, RXEN = 0 V, TA = 25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		2.4		2.5	GHz
Power detector range	PDR	CW, measured @ ANT	0		+26	dBm
Output impedance	PDZ _{LOAD}			1.2	3	kΩ
Output voltage	PDV	P _{OUT} = No RF, measured into 1 MΩ	0.17	0.21	0.29	V
		P _{OUT} = +21 dBm, CW, measured into 1 MΩ	0.57	0.65	0.73	V
		P _{OUT} = +26 dBm, CW, measured into 1 MΩ	0.95	1.0	1.15	V
Power detector bandwidth	PD _{BW}			3	6	MHz

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

² The V_{CC} = 5 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 10. SKY85329-11 Electrical Specifications: Power Detector Characteristics^{1,2}
(VCC1 = VCC2 = 3.3 V, TXEN = 3.3 V, RXEN = 0 V, TA = 25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f		2.4		2.5	GHz
Power detector range	PDR	CW, measured @ ANT	0		+22	dBm
Output impedance	PDZ _{LOAD}			1.2	3	kΩ
Output voltage	PDV	P _{OUT} = No RF, measured into 1 MΩ	0.17	0.21	0.29	V
		P _{OUT} = +17 dBm, CW, measured into 1 MΩ	0.38	0.4	0.53	V
		P _{OUT} = +22 dBm, CW, measured into 1 MΩ	0.67	0.75	0.83	V
Power detector bandwidth	PD _{BW}			3	6	MHz

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

² The V_{CC} = 3.3 V specifications apply only when the device is connected in the application circuit shown in Figure 3.

Table 11. SKY85329-11 Electrical Specifications: Control Logic Characteristics¹
(VCC1 = VCC2 = 5.0 V, TA = 25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Control voltage:	V _{IH} V _{IL}		2.7		3.6	V
			0		0.4	V
Input current, high	I _{IH}	TXEN = RXEN			100	μA
Input current, low	I _{IL}	TXEN = RXEN			12.5	μA

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

Table 12. SKY85329-11 Control Logic¹

Mode	RXEN	TXEN
LNA enable	1	0
LNA bypass	0	0
Transmit	0	1

¹ "1" = +3.3 V, "0" = 0 V. Any other state than described in this table places the switch into an undefined state. An undefined state will not damage the device.

Evaluation Board Description

The SKY85329-11 Evaluation Board is used to test the performance of the SKY85329-11 FEM. The EK1 (5.0 V operation) application schematic diagrams are shown in Figure 3. A photograph of the Evaluation Board is shown in Figure 4. Component values for the SKY85329-11 Evaluation Board are listed in Table 13.

Evaluation Board Setup Procedure

1. Connect the system ground to pin 13 of connector J4.
2. Apply 5.0 V or 3.3 V to pin 14 of connector J4.
3. Refer to the Control Logic table in Table 9 to set the device in the desired mode of operation:
 - 1 = $V_{IH} = 3.3\text{ V}$
 - 0 = $V_{IL} = 0\text{ V}$
4. Connect a multimeter or oscilloscope to VDET on pin 2 of connector J4 to monitor the power detector voltage.
5. Monitor the transmit performance by applying an RF signal to the connector J3 (TX) and measuring the output power at the antenna port connector J1 (ANT).

CAUTION: Care should be taken not to overdrive the amplifier by applying too much RF on the input to the device. A suitable starting input power is -20 dBm .

6. Monitor the receive performance by applying an RF signal to the antenna port connector J1 (ANT) and measuring the output power at the receive port connector J2 (RX).

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 SKY85329-11 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.

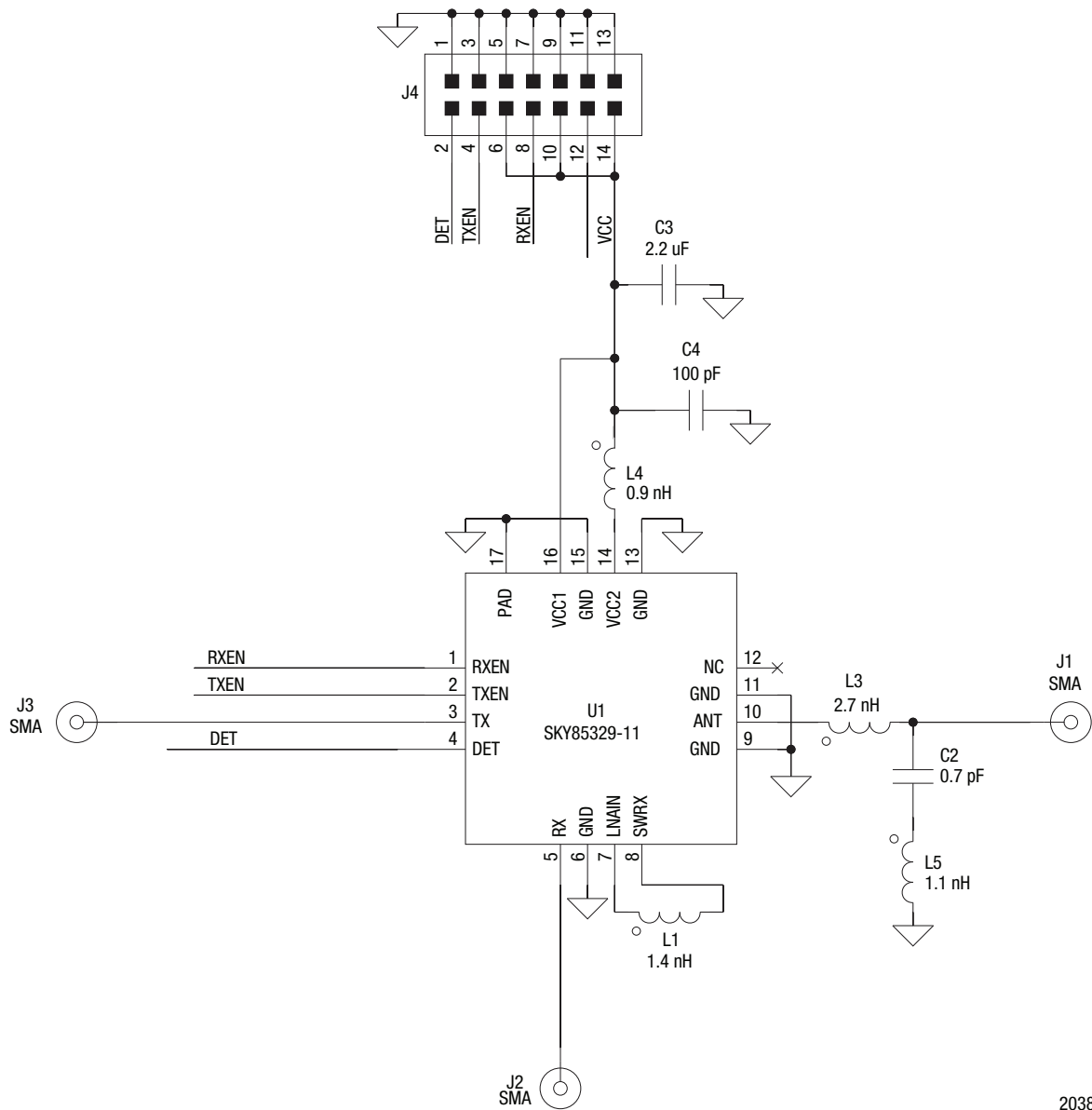
NOTE: A poor connection between the ground pad and ground increases junction temperature (T_J), which reduces the life of the device.

- There is no DC present on any RF port.
- The ANT pin has a shunt inductor to GND and has to be DC blocked if connected to an external source with $> 2.5\text{ V}$ DC present.
- If the TX, RX, LNA IN or SW RX are connected to an external source with $> 2.5\text{ V}$ DC present, a 10 pF general-purpose blocking capacitor is recommended.
- L1, L3, L4, L5, C2 and C4 are critical. Follow the recommended layout and part number recommendations.
- The placement of the rest of the components not mentioned in this section is not critical.

Evaluation Board Losses

The board losses from the RF connectors of the Evaluation Board to the pins of the SKY85329-11 are:

ANT: 0.22 dB
 BT: 0.22 dB
 RX: 0.29 dB
 TX: 0.35 dB



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Figure 3. SKY85329-11 EKI Application Schematic Operating at 5.0 V or 3.3 V

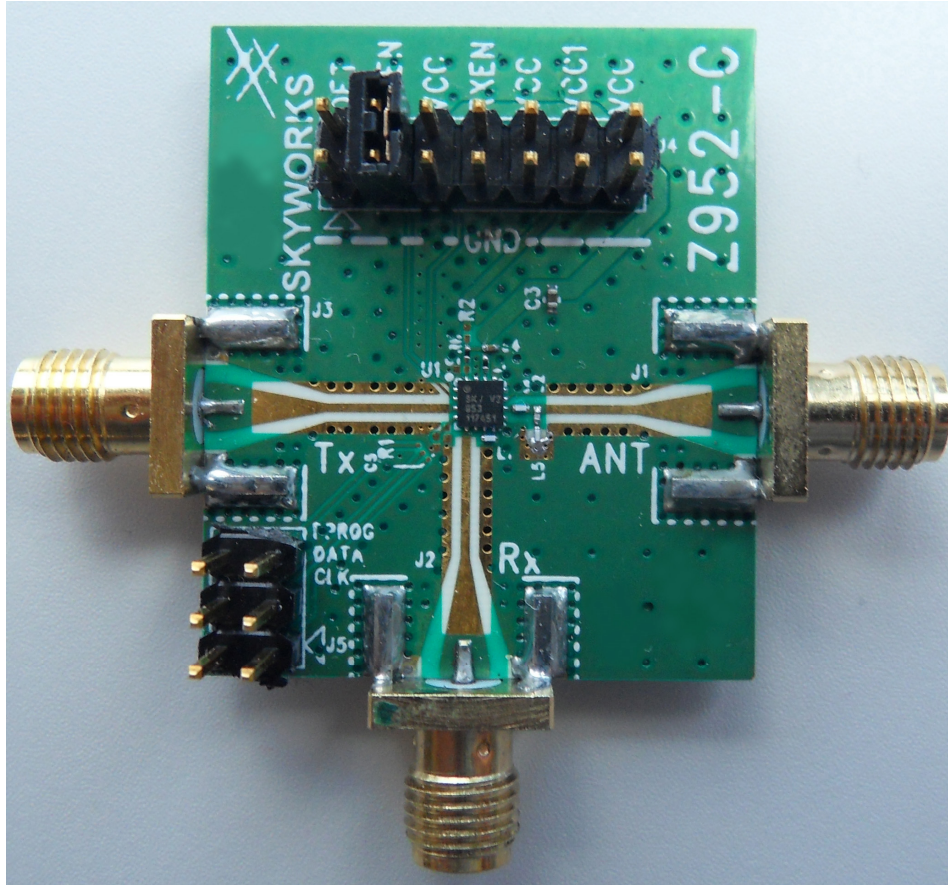


Figure 4. SKY85329-11 Evaluation Board Photograph

Table 13. SKY85329-11 Evaluation Board Bill of Materials

Component	Value	Manufacturer	Mfr Part Number	Package	Description
C2	0.7 pF	Murata	GRM0335C1HR70WA01	0201	Multilayer ceramic
L4	0.9 nH	Murata	LQP03TN0N9B02	0201	Chip coils for high frequency film type
R8	0 Ω	Panasonic	ERJ1GE0R00	0201	Thick film chip resistor
L5	1.1 nH	Murata	LQP03TN1N1B02	0201	Chip coils for high frequency film type
L1	1.4 nH	Murata	LQP03TN1N4B02	0201	Chip coils for high frequency film type
C3	2.2 uF	Murata	GRM155R61A225KE95	0402	Multilayer ceramic
L3	2.7 nH	Murata	LQP03TN2N7B02	0201	Chip coils for high frequency film type
C4	100 pF	Murata	GRM0335C1H101JA01	0201	Multilayer ceramic
U1	SKY85329-11	Skyworks Solutions Inc.	SKY85329-11	QFN2.5x2.5-16	2.4 GHz 256 QAM PA+SW+LNA FEM

Package Dimensions

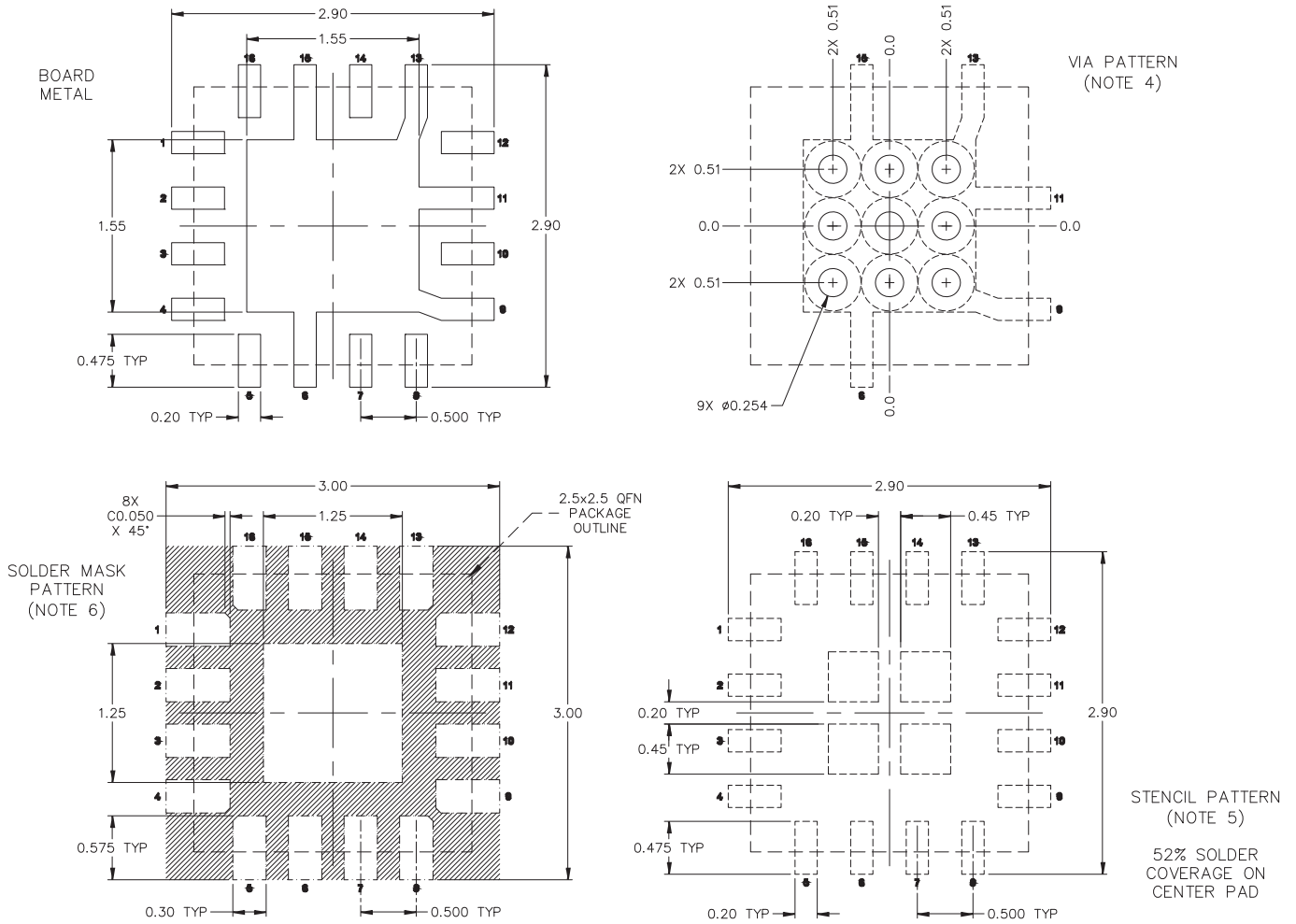
The PCB board layout footprint for the SKY85329-11 is shown in Figure 5. Typical part markings are shown in Figure 6. Package dimensions are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

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 SKY85329-11 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.



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. UNLESS SPECIFIED DIMENSIONS ARE SYMMETRICAL ABOUT CENTER LINES.
4. VIA HOLE RECOMMENDATIONS:
0.025mm Cu VIA WALL PLATING (MINIMUM),
VIA HOLE TO BE FILLED WITH CONDUCTIVE PASTE AND PLATED OVER.
5. STENCIL RECOMMENDATIONS: 0.10mm STENCIL THICKNESS, LASER CUT APERTURES, TRAPEZODIAL WALLS AND ROUNDED CORNERS WILL OFFER BETTER PASTE RELEASE.
6. SOLDER MASK RECOMMENDATIONS: CONTACT BOARD FABRICTOR FOR RECOMMENDED SOLDER MASK OFFSET AND TOLERANCE.

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Figure 5. SKY85329-11 PCB Layout Footprint

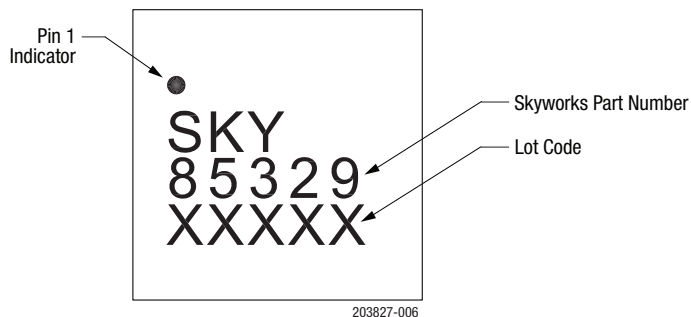


Figure 6. Typical Part Marking

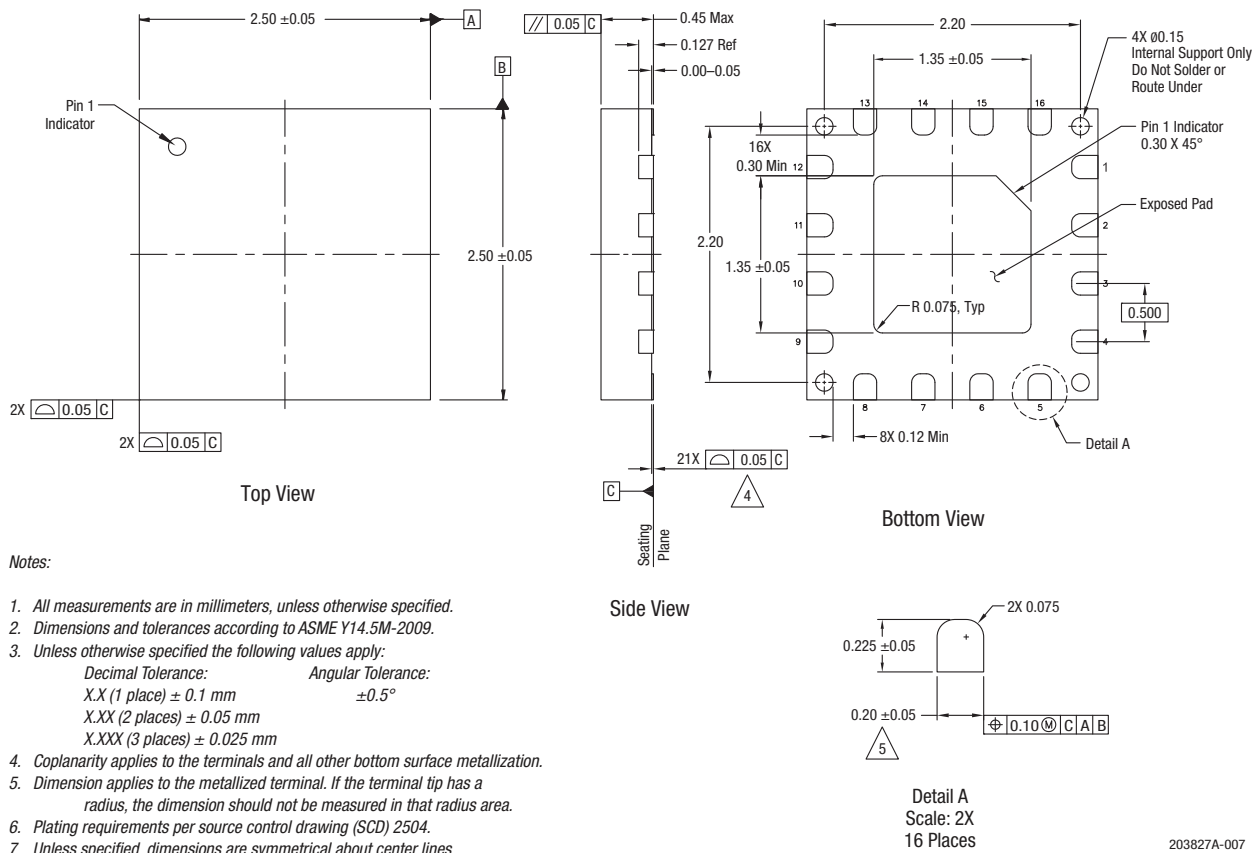
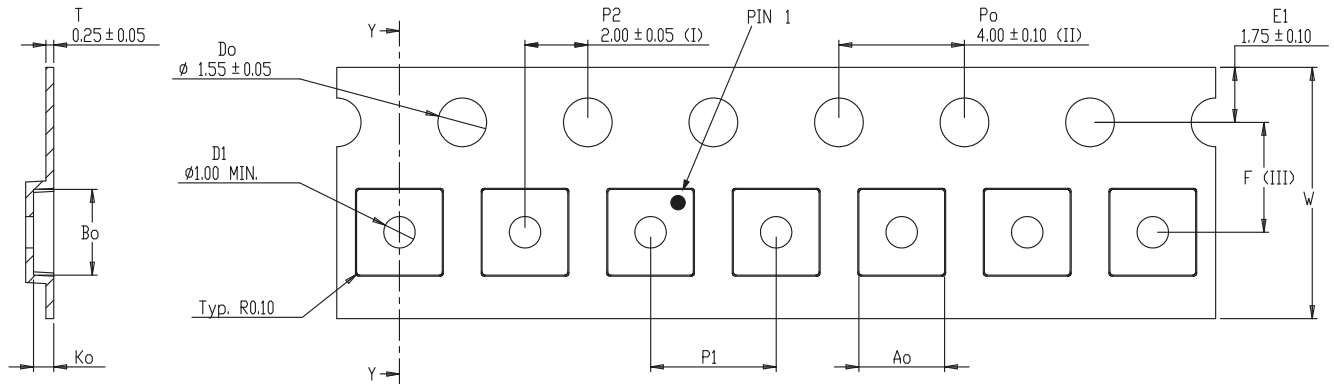


Figure 7. SKY85329-11 Package Dimensions

Notes:

1. All measurements are in millimeters, unless otherwise specified.
2. Dimensions and tolerances according to ASME Y14.5M-2009.
3. Unless otherwise specified the following values apply:
 Decimal Tolerance: Angular Tolerance:
 X.X (1 place) ± 0.1 mm ±0.5°
 X.XX (2 places) ± 0.05 mm
 X.XXX (3 places) ± 0.025 mm
4. Coplanarity applies to the terminals and all other bottom surface metallization.
5. Dimension applies to the metallized terminal. If the terminal tip has a radius, the dimension should not be measured in that radius area.
6. Plating requirements per source control drawing (SCD) 2504.
7. Unless specified, dimensions are symmetrical about center lines.

203827A-007



SECTION Y-Y
SCALE 6.5 : 1

- (I) Measured from centreline of sprocket hole to centreline of pocket.
- (II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
- (III) Measured from centreline of sprocket hole to centreline of pocket.
- (IV) Other material available.

Ao	2.73	+/- 0.05
Bo	2.73	+/- 0.05
Ko	0.65	+/- 0.05
F	3.50	+/- 0.05
P1	4.00	+/- 0.10
W	8.20	+0.10/-0.05

203827-008

Figure 8. SKY85329-11 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY85329-11	2.4 GHz Front-End Module	SKY85329-11EK1

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