SKY66113-11: 2.4 GHz Front-End Module Designed for Low Energy/802.15.4/Thread/Zigbee/Bluetooth® Applications

Applications

- In-home appliances
- Smart thermostats
- Sensors
- Beacons
- Gateways
- Wearable devices

Features

- Integrated LNA with 12 dB gain
- Integrated switch with receive LNA and transmit bypass function
- Low noise figure: 2 dB typical
- Single-ended transmit/receive interface
- Fast switch on/off time: < 2 µs
- Supply range: 1.7 V to 3.6 V
- Sleep mode current: < 1 µA typical
- No external bias resistor is required
- Small MCM (16-pin, 2.4 × 2.4 × 0.8 mm) package, NiPdAu-plated (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.
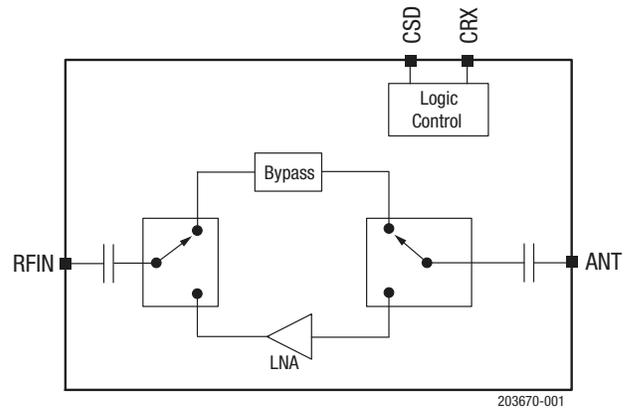

Figure 1. SKY66113-11 Block Diagram

Description

The SKY66113-11 is a high-performance, fully integrated RF front-end module (FEM) designed for Bluetooth® low energy, 802.15.4, Thread, and Zigbee technology applications.

The SKY66113-11 is designed for ease of use and maximum flexibility. The device integrates a high-gain, low-noise LNA, transmit bypass path, and digital controls compatible with 1.6 V to 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 1.7 V to 3.6 V that allows the SKY66113-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

A functional block diagram is shown in Figure 1. The SKY66113-11 is provided in a small, 16-pin, 2.4 × 2.4 mm Multi-Chip Module (MCM) package. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.
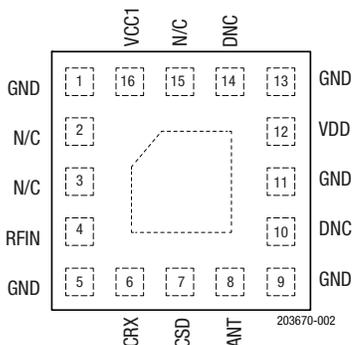
Figure 2. SKY66113-11 Pinout (Top View)

Table 1. SKY66113-11 Signal Descriptions[1]

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	9	GND	Ground
2	N/C	Not connected internally	10	DNC	Do not connect
3	N/C	Not connected internally	11	GND	Ground
4	RFIN	RF input power	12	VDD	Connect to positive supply
5	GND	Ground	13	GND	Ground
6	CRX	Connect to GPIO signal for mode control	14	DNC	Do not connect
7	CSD	Connect to GPIO signal for mode control	15	N/C	Not connected internally
8	ANT	Connect to 50 Ω antenna	16	VCC1	Connect to positive supply

[1] The paddle should be connected to ground.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66113-11 are provided in Table 2. The recommended operating conditions are specified in Table 3.

Electrical specifications are provided in Tables 4 and 5. The state of the SKY66113-11 is determined by the logic provided in Table 6.

Table 2. SKY66113-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC1} V_{DD}	-0.3 -0.3	+3.6 +3.6	V V
Control pin voltages	V_{CTL}	-0.3	+3.6	V
Input power at RFIN port	$P_{IN\_TR\_MAX}$		+20	dBm
Receive input power at ANT port	$P_{IN\_RX\_MAX}$		+15	dBm
Bypass input power at ANT port	$P_{IN\_BYP\_MAX}$		+20	dBm
Operating temperature	T_A	-40	+85	°C
Storage temperature	T_{STG}	-40	+85	°C
Electrostatic discharge: Human Body Model (HBM), Class 1C	ESD		 1500	 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.

CAUTION: *Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.*

Table 3. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage on VCC1 pin	V_{CC1}	1.7	3.0	3.6	V
Supply voltage on VDD pin	V_{DD}	1.7	3.0	3.6	V
Operating temperature	T_A	-40	+25	+85	°C

Table 4. SKY66113-11 Electrical Specifications[1]
(V$_{CC1}$ = V$_{DD}$ = 3.0 V, T$_A$ = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Total Rx mode supply current	I$_{CC\_RX}$			4	6	mA
Total bypass mode supply current	I$_{CC\_BYP}$			25		µA
Total sleep mode supply current	I$_{CC\_OFF}$	No RF			1	µA
Logic Characteristics						
Control voltage: High Low	V$_{IH}$ V$_{IL}$		1.6 0		V$_{DD}$ 0.3	V V
Control current: High Low	I$_{IH}$ I$_{IL}$				1.0 1.0	µA µA

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

Table 5. SKY66113-11 Electrical Specifications[1]
(V$_{CC1}$ = 1.8 or 3.0 V, V$_{DD}$ = 3.0 V, T$_A$ = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Receive Characteristics						
Frequency range	f		2400		2483	MHz
Receive gain	Gain$_{RX}$			12		dB
Receive noise figure	NF			2		dB
Third order input intercept point	IIP3			0		dBm
1 dB input compression point	IP1dB		-12	-8		dBm
Input return loss	S11	ANT1 or ANT2 ports		-10		dB
Output return loss	S22			-10		dB
Turn-on time	t$_{RISE}$	From 50% of CRX edge to 90% of final RF output power		0.8	2	µs
Turn-off time	t$_{FALL}$	From 50% of CRX edge to 10% of final RF output power		0.8	2	µs
Bypass Characteristics						
Frequency range	f		2400		2483	MHz
Bypass gain	Gain$_{BYP}$			-1.5		dB
Input return loss	S11			-10		dB
Output return loss	S22			-10		dB

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

Table 6. SKY66113-11 Mode Control Logic[1]

Mode	Description	CSD (Pin 7)	CRX (Pin 6)
0	All off (sleep mode) (Note 1)	0	
1	Receive LNA mode	1	1
2	Transmit bypass mode	1	0

[1] All controls must be at logic "0" to achieve the specified sleep current.

Application Schematic Description

A reference design schematic is provided in Figure 3. An Evaluation Board schematic diagram is shown in Figure 4.

A photograph of the Evaluation Board is shown in Figure 5. Table 7 provides the Bill of Materials (BOM) list for Evaluation Board components.
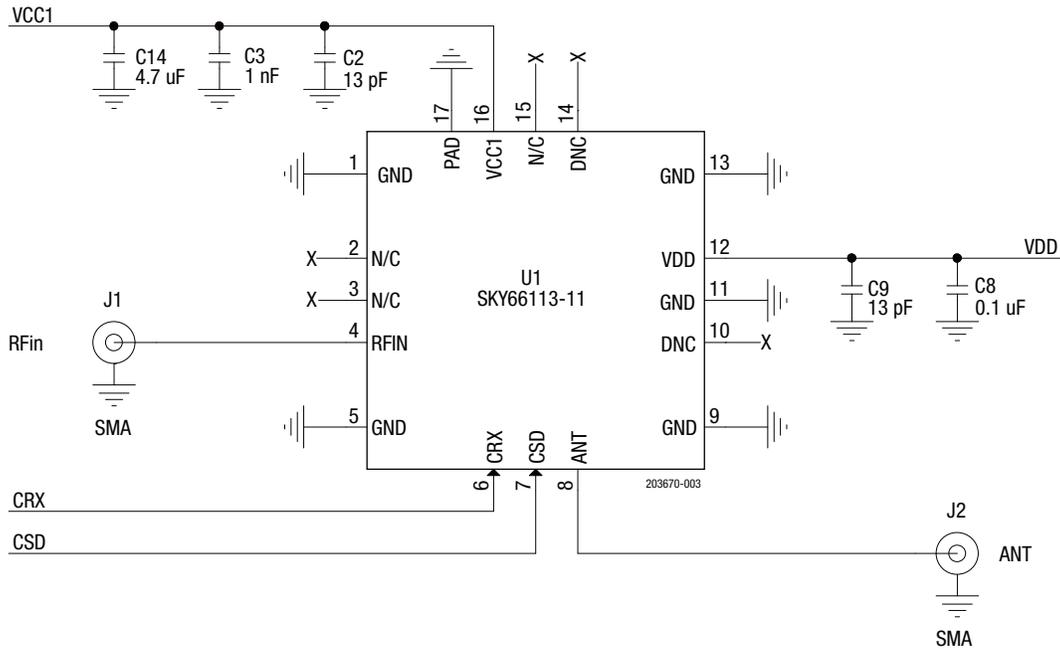
**Figure 3. SKY66113-11 Reference Design Schematic**
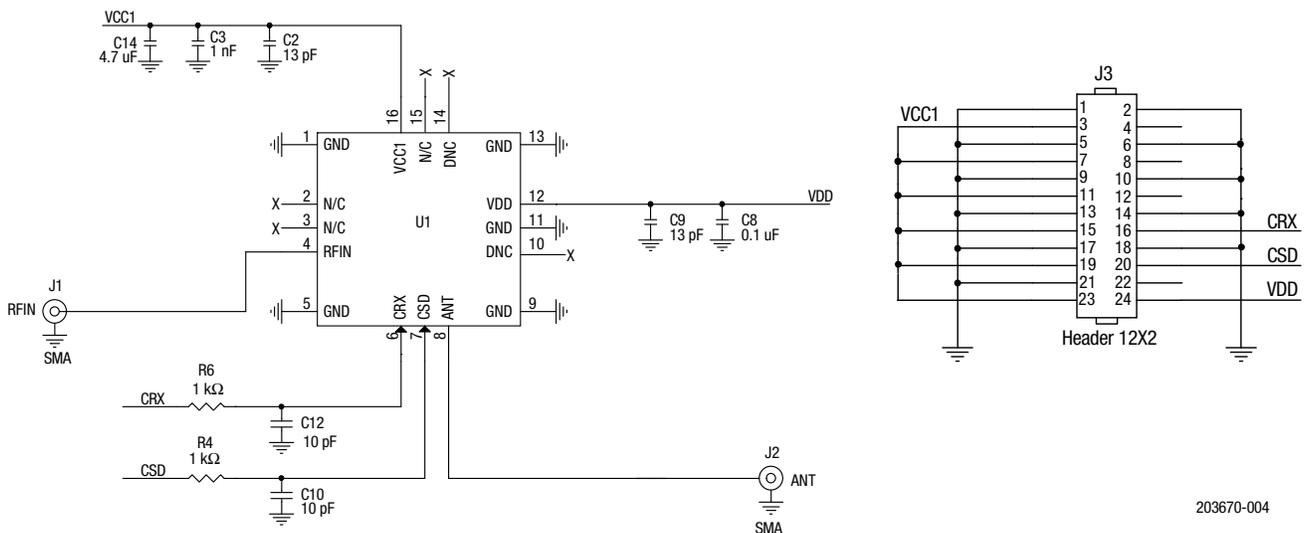
**Figure 4. SKY66113-11 Evaluation Board Schematic Diagram**
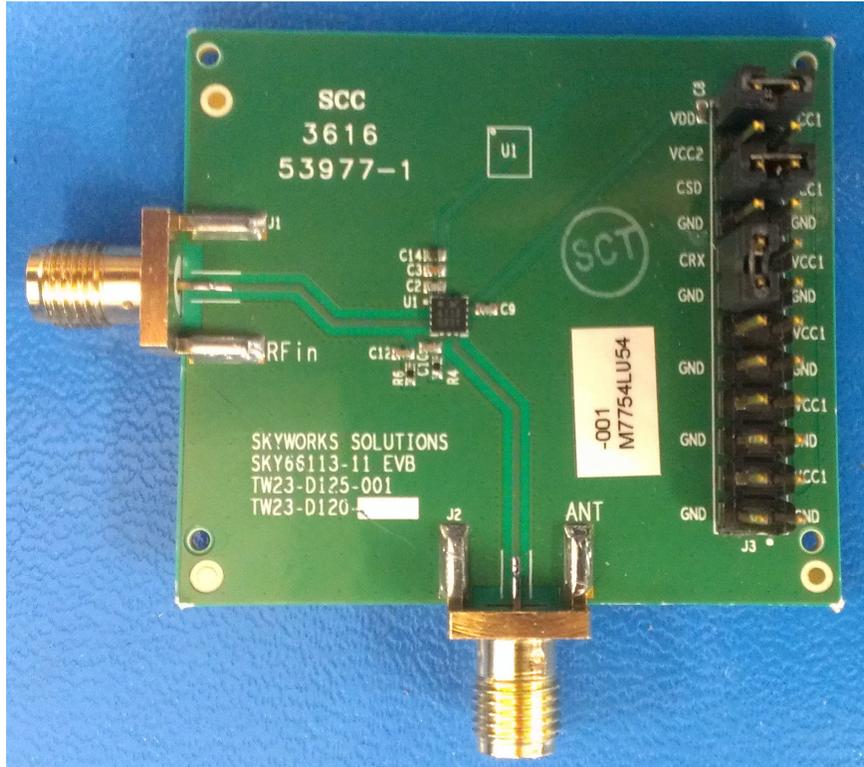
Figure 5. SKY66113-11 Evaluation Board

Table 7. SKY66113-11 Evaluation Board Bill of Materials (BOM)

Component	Value	Manufacturer	Mfr Part Number	Package	Description
C2, C9	13 pF	Murata	GRM1555C1H130JA01D	0402	Ceramic capacitor, 13 pF, 5%, C0G, 50 V, 0402
C3	1 nF	Various	Various	0402	Ceramic capacitor, 1000 pF, 10%, X7R, 50 V, 0402
C8	0.1 uF	Various	Various	0402	Ceramic capacitor, 0.1 uF, 10%, X7R, 16 V, 0402
C10, C12	10 pF	Various	Various	0402	Ceramic capacitor, 10 pF, 2%, C0G, 50 V, 0402
C14	4.7 uF	Various	Various	0402	Ceramic capacitor, 4.7 uF, 20%, X5R, 10 V, 0402
R6 R4	1 kΩ	Various	Various	0402	Resistor, 1000 ohm, 5%, 0.063 W, 0402
J1 J2		Johnson Components	142-0701-851	End launch	SMA end launch straight jack receptacle
J3		Samtec	TSW-112-07-G-D	100 mil	100 mil header

Package Dimensions

The PCB layout footprint for the SKY66113-11 is provided in Figure 6. The typical part marking is 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 SKY66113-11 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.
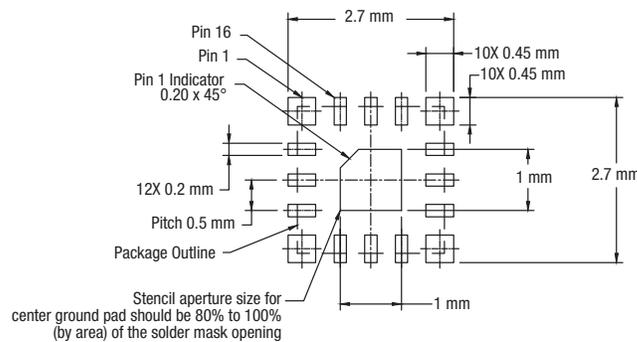
Stencil Aperture
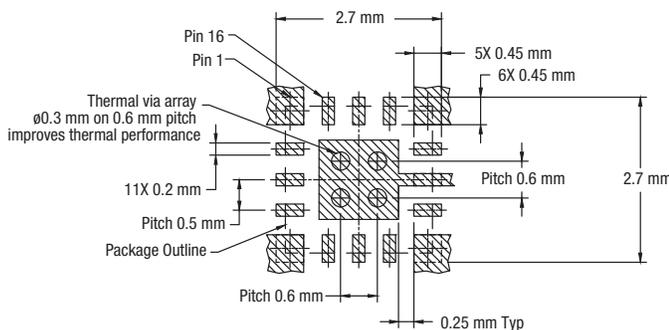
Metallization
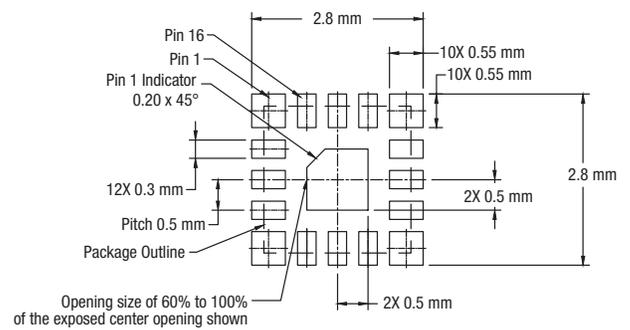
Solder Mask Opening

Notes:

1. All dimensions are in millimeters, unless otherwise specified.
2. Thermal vias should be resin filled and capped in accordance with IPC-4761 Type VII vias.
   Recommended Cu thickness is 30 to 35 µm.

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Figure 6. SKY66113-11 PCB Layout Footprint
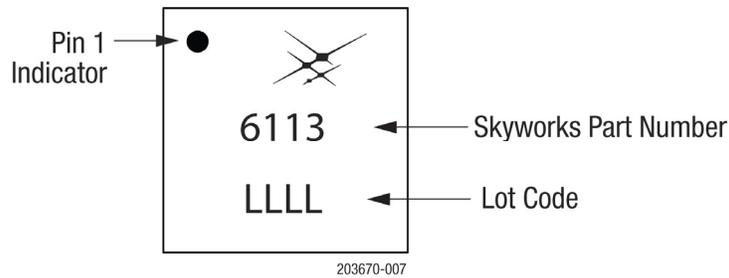
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Figure 7. SKY66113-11 Typical Part Marking
(Top View)

Top View

Side View

Bottom View

Detail A
2X Scale
3X This Rotation
3X Rotated 180°
3X Rotated 90° CW
3X Rotated 90° CCW

Detail B
2X Scale
1X This Rotation
1X Rotated 180°
1X Rotated 90° CW
1X Rotated 90° CCW

Detail C
1X Scale
1X This Rotation
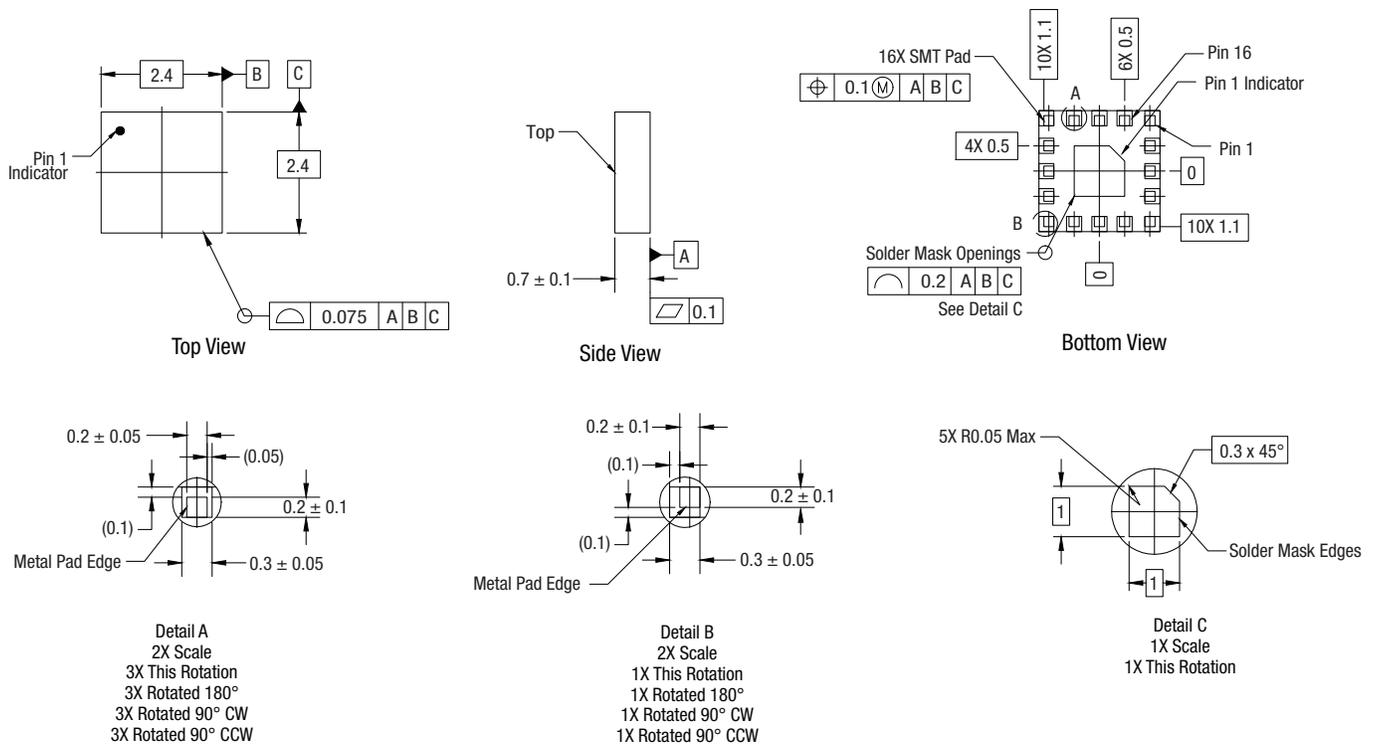
Notes:

1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.

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Figure 8. SKY66113-11 Package Dimensions

Detail B
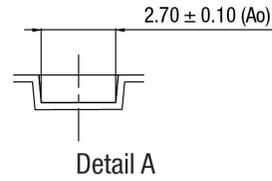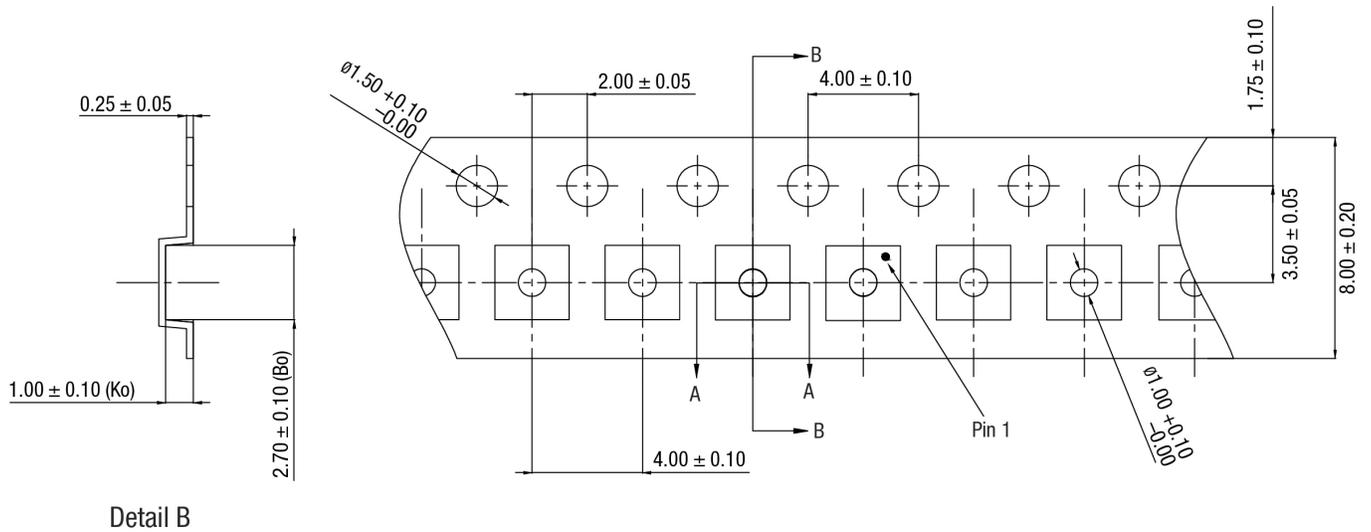
Notes:

1. Carrier tape must meet all requirements of Skyworks GP01-D232.
   procurement spec for tape and reel shipping.
2. Carrier tape shall be black conductive polystyrene.
3. Cover tape shall be transparent conductive material.
4. ESD-surface resistivity shall meet Skyworks GP01-D232.
5. 10-sprocket hole pitch cumulative tolerance: ±0.20 mm.
6. Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.
7. All measurements are in millimeters.

Detail A

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Figure 9. SKY66113-11 Tape and Reel Dimensions

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Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY66113-11	SKY66113-11: 2.4 GHz Front-End Module (FEM)	SKY66113-11EK1