DATA SHEET

SKY66411-11: 2.4 GHz Front-End Module for Bluetooth®/Zigbee®/Thread Applications

Applications

- Medical wearable devices
- Wireless health monitoring
- Trackers
- Internet of Things (IoT) devices

Features

- Integrated PA with up to +10 dBm output power
- Integrated LNA (RX mode noise figure 2.3 dB typ.)
- Bypass path for TX/RX
- Single-ended transmit/receive interface
- Fast switch on/off time: < 1 µs
- VCC2 supply range: 1.7 V to 3.6 V
- Sleep mode current: < 1 µA typical
- Small 9-pin (1.32 mm x 1.32 mm x 0.381 mm) Chip Scale Package (CSP) (MSL1, 260 °C per JEDEC-J-STD-020)
- For RoHS and other product compliance information, see the Skyworks Certificate of Conformance.

Description

The SKY66411-11 is a high-performance, fully integrated RF front-end module (FEM) designed for Bluetooth® (including low energy), Zigbee®, and Thread applications.

The SKY66411-11 is designed for ease of use and maximum flexibility. The device provides a power amplifier, low-noise amplifier, low-loss bypass path, and transmit/receive switches.

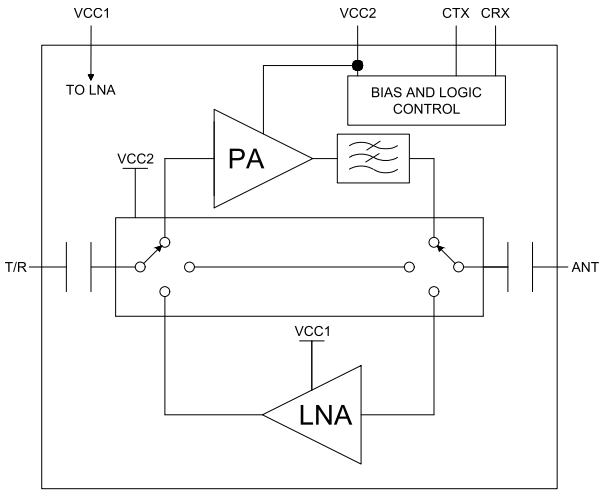


Figure 1. Functional Block Diagram

The PA and LNA operate over wide supply voltage ranges specified in Table 3, allowing the SKY66411-11 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. Signal pin assignments and pin descriptions are provided in Table 1.

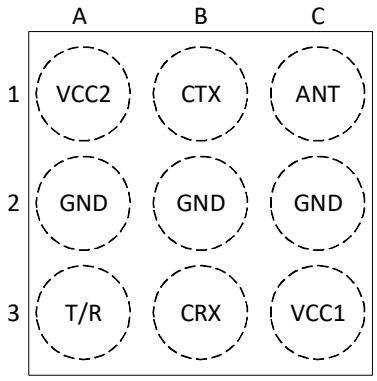


Figure 2. Pinout (Top View, Solder Bumps Down)

Table 1. Signal Descriptions

Pin	Name	Description	Pin	Name	Description
A1	VCC2	Positive power supply for switch and PA	B3	CRX	Receive mode control input
A2	GND	Ground	C1	ANT	Connect to 50 Ω antenna
A3	T/R	Connect to 50 Ω transceiver	C2	GND	Ground
B1	CTX	Transmit mode control input	C3	VCC1	Positive power supply for LNA
B2	GND	Ground			

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66411-11 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 is determined by the logic in Table 6.

Table 2. Absolute Maximum Ratings[1]

Parameter	Symbol	Min	Max	Units
Supply voltage	VCC1	–0.3	+3.6	V
	VCC2	–0.3	+4	
Control pin voltages	CTX, CRX	–0.3	VCC2	V
Transmit input power at T/R port	PIN_TX		+8	dBm
Receive input power at ANT ports[2]	PIN_RX		+15	dBm
Bypass input power at ANT ports[2]	PIN_BYP		+15	dBm
Voltage standing wave ratio	VSWR		10:1	
Electrostatic discharge: Human Body Model (HBM)	ESD		2000	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.
2. CW test signal

ESD Handling: *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	VCC1	1.1	1.2	2	V
Supply voltage on VCC2 pin	VCC2	1.7	2.4	3.6	V
Operating temperature	TA	–40	+25	+85	°C
Storage temperature	TSTG	–40		+125	°C

Table 4. DC Electrical Specifications[1]

(VCC1 = 1.2 V, VCC2 = 2.4 V, Logic Voltage Levels Low/High = 0V/VCC2, TA = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
DC Characteristics						
TX Mode						
VCC1 operating current	ICC1_TX	TX: POUT= 8 dBm		6.5		nA
		TX: POUT = 10 dBm, VCC1 = 1.2 V, VCC2 = 3.0 V		5.8		
VCC2 operating current	ICC2_TX	TX: POUT= 8 dBm		6.2	6.4	mA
		TX: POUT = 10 dBm, VCC1 = 1.2 V, VCC2 = 3.0 V		7.6	7.9	
CTX control current	ICTX_TX	TX		0.8		µA
CRX control current	ICRX_TX	TX		0.0		µA
VCC1 quiescent current	ICC1_TX_Q	TX: no RF		7.6		nA
VCC2 quiescent current	ICC2_TX_Q	TX: no RF		1.6		mA
CTX quiescent control current	ICTX_TX_Q	TX		0.8		µA
CRX quiescent control current	ICRX_TX_Q	TX		0.0		µA
RX Mode						
VCC1 operating current	ICC1_RX	RX		2.1	2.6	mA
VCC2 operating current	ICC2_RX	RX		0.4	0.4	mA
CTX control current	ICTX_RX	RX		0.1		µA
CRX control current	ICRX_RX	RX		0.6		µA
BYP Mode						
VCC1 operating current	ICC1_BYP	BYP		8.3		nA
VCC2 operating current	ICC2_BYP	BYP		11.0		nA
CTX control current	ICTX_BYP	BYP		0.8		µA
CRX control current	ICRX_BYP	BYP		0.6		µA
Sleep Mode						
VCC1 plus VCC2 sleep current	ICC_Sleep	Sleep: No RF VCC1 = 2.0 V, VCC2 = 3.6 V		0.1	1	µA
CTX control current	ICTX_Sleep	Sleep		0.1		µA
CRX control current	ICRX_Sleep	Sleep		0.0		µA
Control voltage, CTX, CRX						
High	VIH			1.05	VCC2	V
Low	VIL			0	0.3	V

1. Performance is assured only under the conditions listed in this table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.

Table 5. AC Electrical Specifications[1]

(VCC1 = 1.2 V, VCC2 = 2.4 V, TA = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Transmit Characteristics						
Frequency range	f		2400		2483.5	MHz
Power added efficiency	PAE	POUT = 8 dBm, VCC2 = 2.4 V POUT = 10 dBm, VCC2 = 3 V	38	40 38		%
Compression point	P1dB	VCC1 = 1.2 V, VCC2 = 2.4 V VCC1 = 1.2 V, VCC2 = 3.0 V		9 11		dBm
Output power	POUT	PIN = –2 dBm VCC1 = 1.2 V, VCC2 = 3.0 V PIN = –2 dBm		8 10		dBm
Gain variation over frequency	ΔG	POUT = 8 dBm	–0.5	0	0.5	dB
Input return loss	S11_TX	T/R port, PIN = –10 dBm		15		dB
Second harmonic	2fo	POUT = +8 dBm, CW VCC1 = 1.2 V, VCC2 = 3.0 V, POUT = +10 dBm, CW		–35 –35	–33	dBm
Third harmonic	3fo	POUT = +8 dBm, CW VCC1 = 1.2 V, VCC2 = 3.0 V, POUT = +10 dBm, CW		–35 –35	–33	dBm
ACLR (1 to 1.5 MHz)	ACLR	Offset frequency: –1.5 to –1 MHz, 1 to 1.5 MHz BDR, POUT = 8 dBm, f = 2440 MHz		–32	–29	dBc
ACLR (1.5 to 2.5 MHz)	ACLR	Offset frequency: –1.5 to –2.5 MHz, 1.5 to 2.5 MHz BDR, POUT = 8 dBm, f = 2440 MHz		–26	–23	dBm
ACLR (> 2.5 MHz)	ACLR	Offset frequency: < –2.5 MHz, > 2.5 MHz BDR, POUT = 8 dBm, f = 2440 MHz		–46	–43	dBm
Switching time (BYP/RX to TX)[2]	tBYP/RX_TX	50% control value(s) to 90% RF		1	2	µs
Turn-on time (SLEEP to TX)[2]	tSLEEP_TX	50% control value(s) to 90% RF		1	2	µs
Stability[2]	STAB	CW, PIN = 0 dBm, 0 GHz to 20 GHz, load VSWR = 6:1 (all non-harmonically related outputs)		–45	–42	dBm/MHz
Ruggedness[2]	RUG	CW, PIN = 0 dBm, load VSWR = 10:1	No permanent damage			
Receive Characteristics						
Frequency range	f		2400		2483.5	MHz
Receive gain	S21_RX		10.8	11.6		dB
Receive noise figure	NF			2.3		dB
Third order input intercept point	IIP3			–10		dBm
1 dB input compression point	IP1dB		–23	–20		dBm
ANT return loss	S11_RX	ANT port		12		dB
Switching time (BYP/TX to RX)[2]	tBYP/TX_RX	50% control value(s) to 90% RF		1	2	µs
Turn-on time (SLEEP to RX)[2]	tSLEEP_RX	50% control value(s) to 90% RF		1	2	µs

Table 5. AC Electrical Specifications[1] (Continued)

(VCC1 = 1.2 V, VCC2 = 2.4 V, TA = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Bypass Characteristics						
Frequency range	f		2400		2483.5	MHz
Bypass loss	S21_BYP			1.5	1.8	dB
ANT return loss	S11_BYP	ANT port	10	14		dB
T/R return loss	S22_BYP	T/R port	10	14		dB
Switching time (RX/TX to BYP)[2]	tRX/TX_BYP	50% control value(s) to 90% RF		1	2	µs
Turn-on time (SLEEP to BYP)[2]	tSLEEP_BYP	50% control value(s) to 90% RF		1	2	µs

1. Performance is assured only under the conditions listed in this table and is not assured over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.
2. Not tested in production. Fully characterized and assured by design.

Table 6. Mode Control Logic

State	CTX	CRX
Sleep	0	0
TX	1	0
RX	0	1
BYP	1	1

Evaluation Board Description

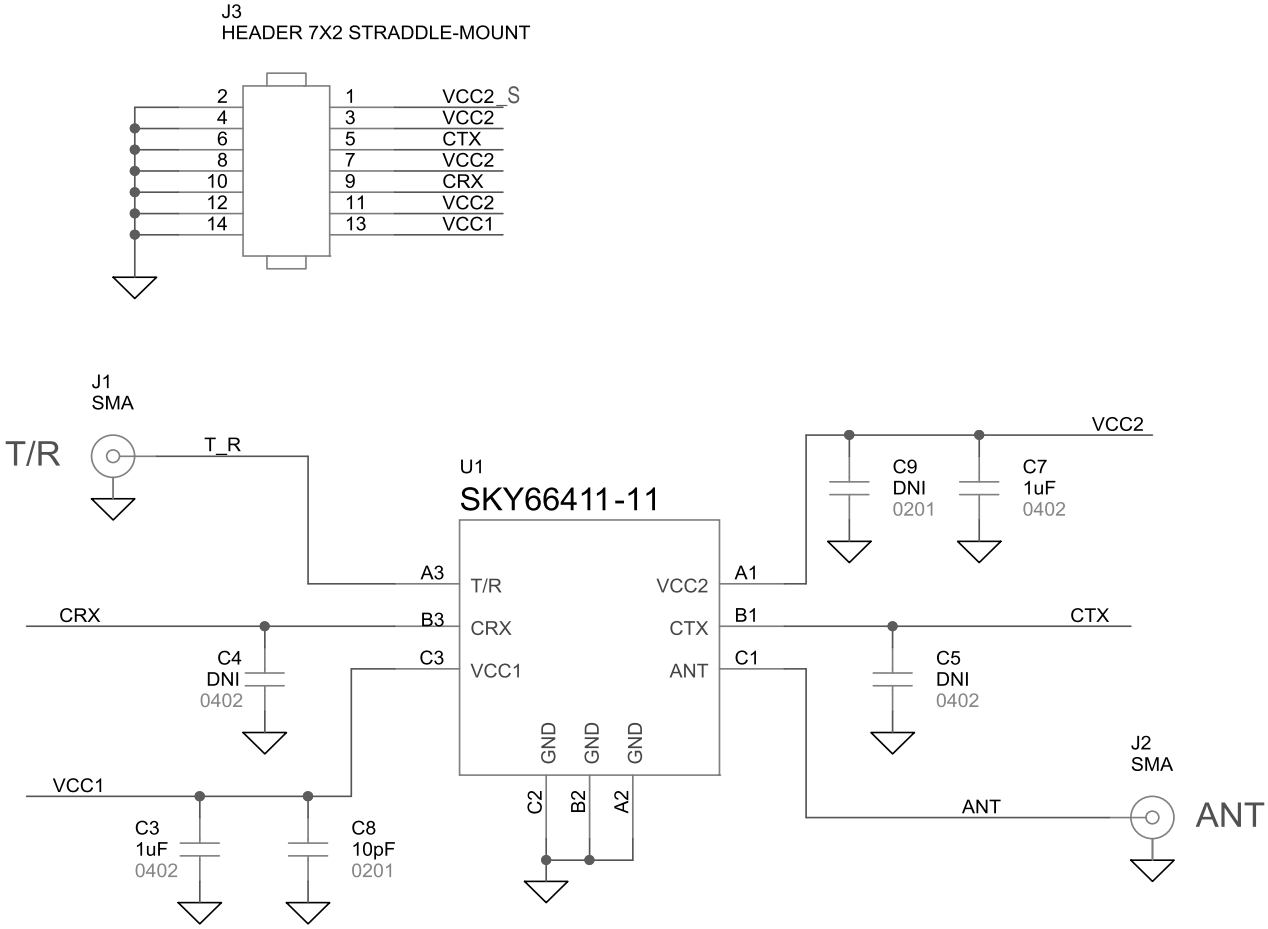


Figure 3. Evaluation Board Schematic Diagram

Table 7. Evaluation Board Bill of Materials

Item	Qty	Ref	Value	Manufacturer	Part Number	Package	Description
1	2	C3, C7	1 µF	Murata	GCM155C71A105KE38D	0402	Capacitor, ceramic, 1 µF, 10 V, X7S
2	2	C4, C5	DNI			0402	
3	1	C8	10 pF	Murata	GRM0335C1E100JD01	0201	Capacitor, ceramic, 10 pF, 25 V, C0G/NP0
4	1	C9	DNI			0201	
5	2	J1, J2	SMA	Multicomp/SPC	615R54-021 (R19-070-18-0032210MM)	SMA_END	SMA end launch straight jack, tab contact
6	1	J3	Header, 14 pos, 7 x 2	Samtec Inc.	TSW-107-07-G-D	0.100 (2.54 mm)	Header, vertical, 2.54 mm
7	1	PCB1	Z1824-A	Skyworks	Z1824-A		PCB
8	1	U1	SKY66411-11	Skyworks	SKY66411-11		2.4 GHz front-end module

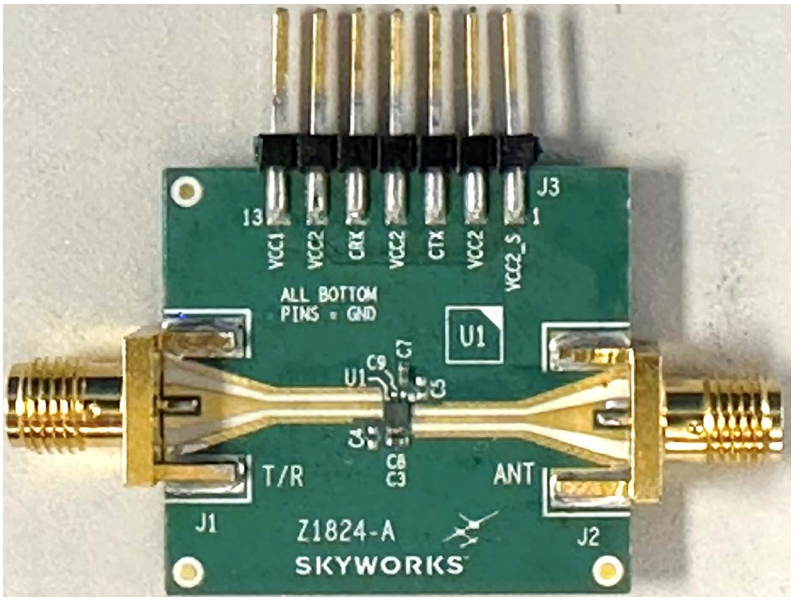


Figure 4. Evaluation Board Photograph

Package and Handling Information

The SKY66411-11 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, “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.

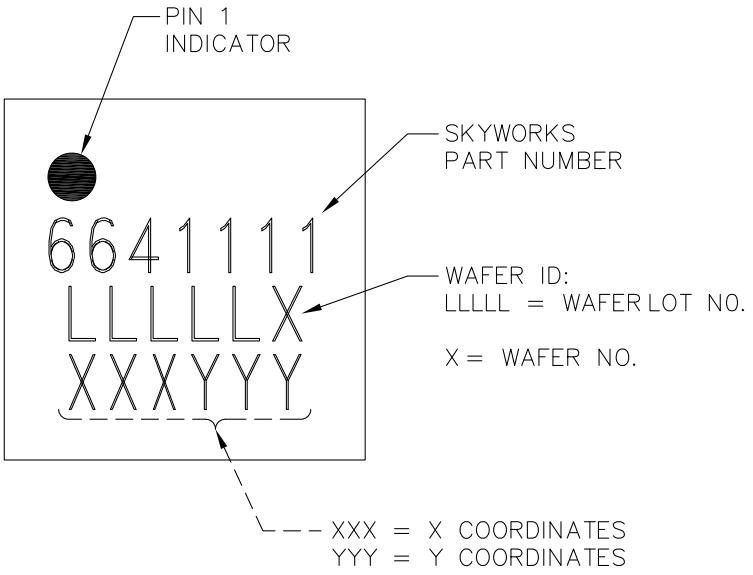
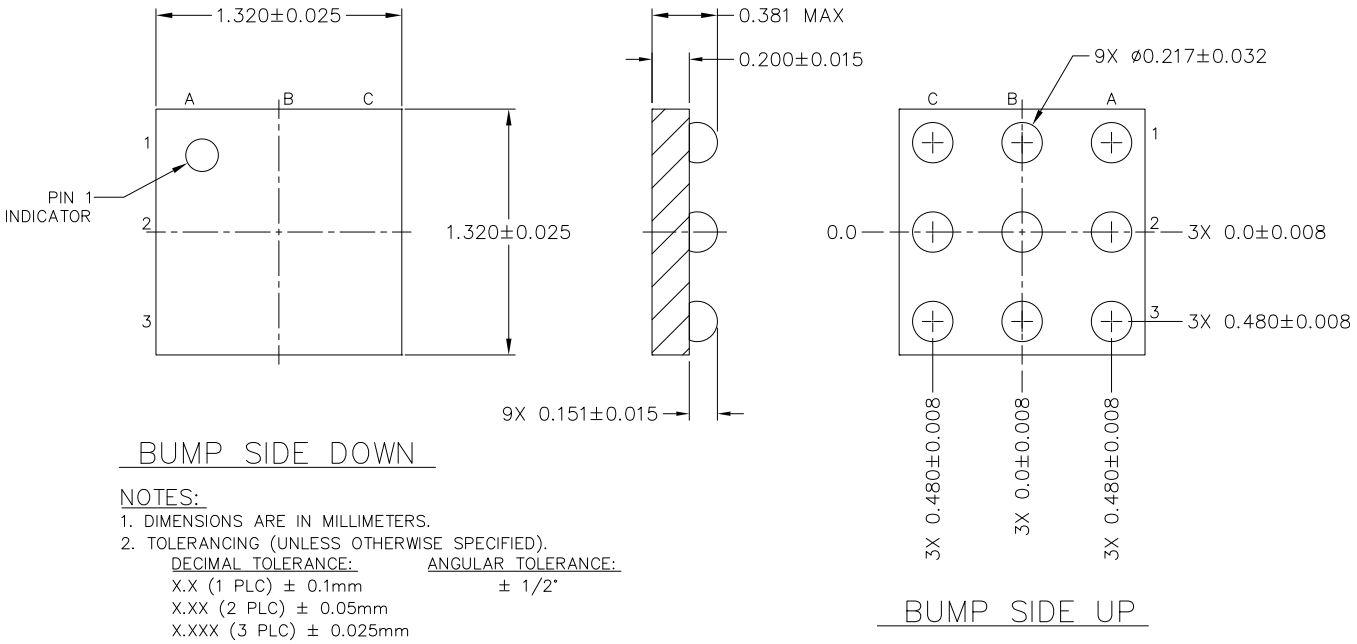


Figure 5. Typical Part Marking



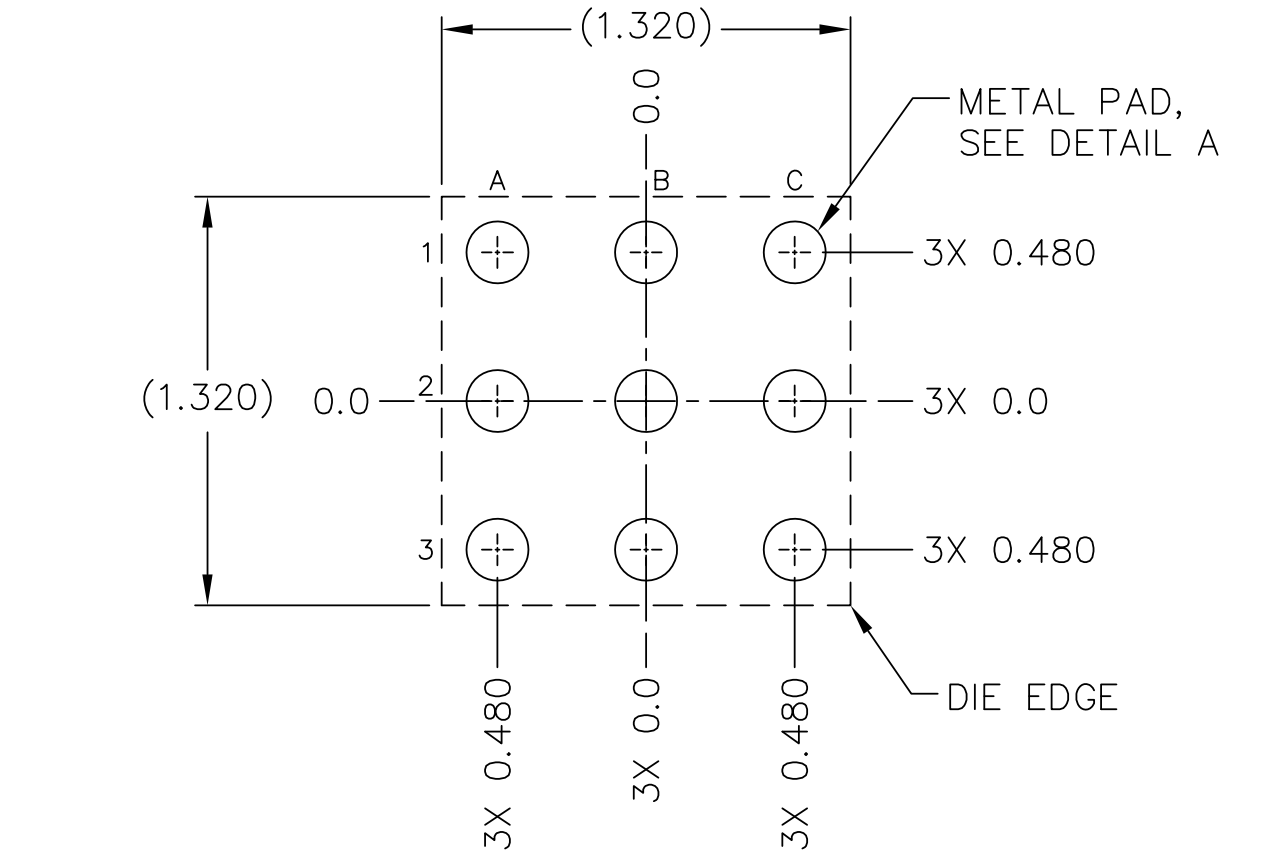
NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. TOLERANCING (UNLESS OTHERWISE SPECIFIED).

DECIMAL TOLERANCE:	ANGULAR TOLERANCE:
X.X (1 PLC) ± 0.1mm	± 1/2°
X.XX (2 PLC) ± 0.05mm	
X.XXX (3 PLC) ± 0.025mm	

BUMP TABLE

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
A1	VCC2	B1	CTX	C1	ANT
A2	GND	B2	GND	C2	GND
A3	TR	B3	CRX	C3	VCC1

Figure 6. Package Dimensions



TOP VIEW

(THRU WLCSP DIE, BUMP SIDE DOWN)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.
3. UNLESS SPECIFIED DIMENSIONS ARE SYMMETRICAL ABOUT CENTER LINES.
4. TOLERANCING (UNLESS OTHERWISE SPECIFIED).

DECIMAL TOLERANCE:
X.X (1 PLC) ± 0.1mm
X.XX (2 PLC) ± 0.05mm
X.XXX (3 PLC) ± 0.025mm

ANGULAR TOLERANCE:
± 1/2˚

DETAIL A
(2X SCALE)
9 PLCS

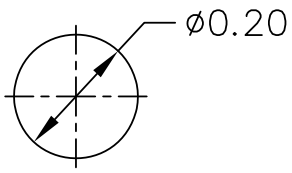
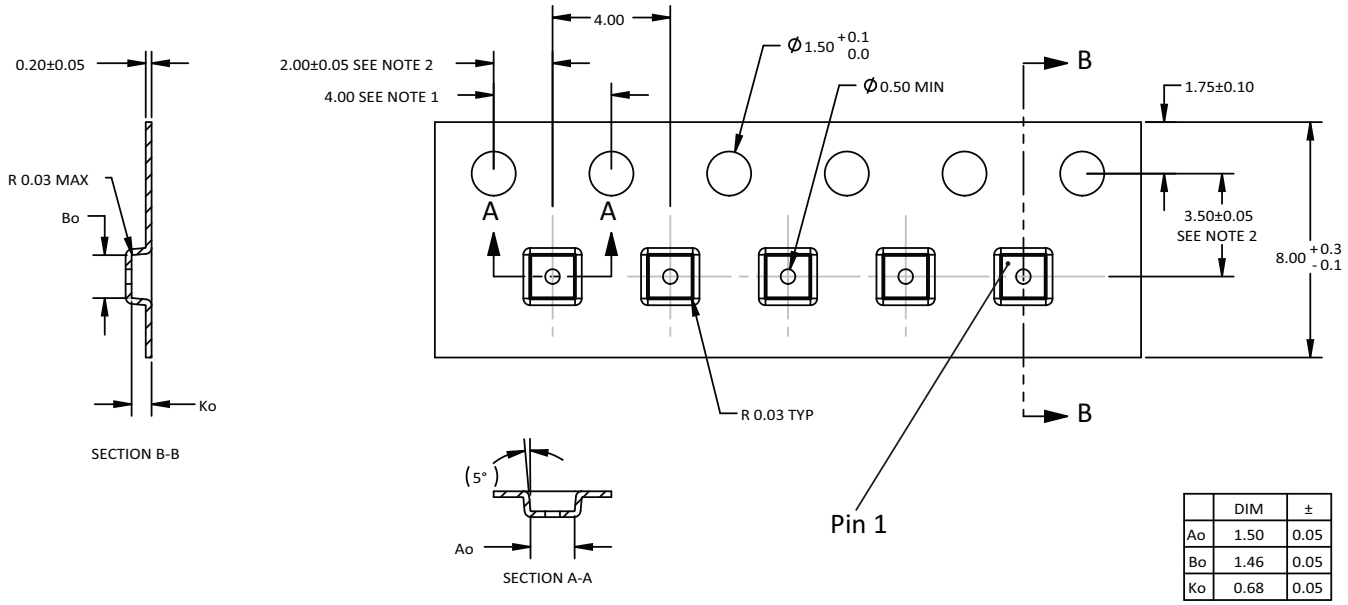


Figure 7. PCB Layout Footprint



	DIM	±
Ao	1.50	0.05
Bo	1.46	0.05
Ko	0.68	0.05

NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.
3. Ao AND Bo ARE MEASURED ON A PLANE AT A DISTANCE "R" ABOVE THE BOTTOM OF THE POCKET.

Figure 8. Tape and Reel Information

Ordering Information

Part Number	Description	Evaluation Board Part Number
SKY66411-11	2.4 GHz Front-End Module for Bluetooth®/Zigbee®/Thread Applications	SKY66411-11EK3