DATA SHEET

SKY66110-11: Low-Power, Low Energy Front-End Module for Bluetooth® Range Extension Applications

Applications

- Range extender
- Wearable technology
- Beacons
- Sensors
- Home automation
- Internet of Things (IoT) devices

Features

- Low power consumption: 10 mA @ +10 dBm
- Output: +10 dBm
- Supply operation: 1.8 to 5 V
- Low sleep current: < 1 µA
- RX bypass
- Small MCM (20-pin, 3.3 x 3.0 x 0.8 mm) 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.

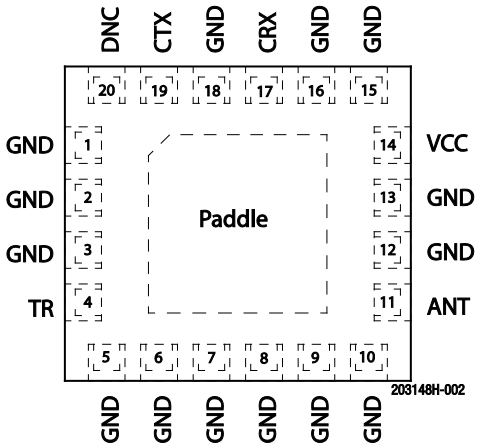


Figure 2. SKY66110-11 Pinout (Top View)

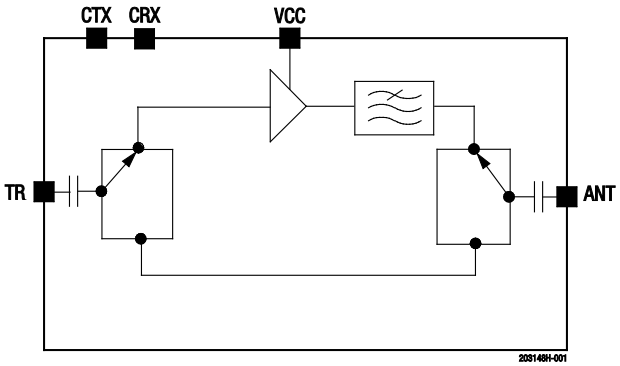


Figure 1. SKY66110-11 Functional Block Diagram

Description

The SKY66110-11 is a highly integrated front-end module (FEM) designed for devices that support Bluetooth® range extension applications (including low energy) operating in the 2.4 to 2.485 GHz range.

The device is provided in a 3.3 x 3.0 x 0.8 mm 20-pin MCM package. A functional block diagram is shown in Figure 1. Pin assignments are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

Table 1. SKY66110-11 Signal Descriptions[1]

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	11	ANT	Antenna port
2	GND	Ground	12	GND	Ground
3	GND	Ground	13	GND	Ground
4	TR	Common receive/transmit port	14	VCC	Positive power supply
5	GND	Ground	15	GND	Ground
6	GND	Ground	16	GND	Ground
7	GND	Ground	17	CRX	RX control signal
8	GND	Ground	18	GND	Ground
9	GND	Ground	19	CTX	Tx control signal and amplifier bias voltage
10	GND	Ground	20	DNC	Do not connect

[1] The paddle should be connected to ground. See Figure 6.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66110-11 are provided in Table 2. The recommended operating conditions are specified in Table 3.

Electrical specifications are provided in Tables 4 through 8.

Table 2. SKY66110-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC}		5.5	V
Control voltages	V_{CTX}, V_{CRX}		5.0	V
RF Input power	P_{IN}		+20	dBm
Voltage standing wave ratio	VSWR		10:1	
Operating temperature	T_A	-40	+85	°C
Storage temperature	T_{STG}	-65	+150	°C
Electrostatic discharge: Human Body Model (HBM), Class 0	ESD		150	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. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Frequency	f	2.4		2.485	GHz
Supply voltage	V_{CC}	1.8	3	5.0	V
Control voltages	V_{CTX}, V_{CRX}	1.7	3	V_{CC}	V
Operating temperature	T_A		25		°C

Table 4. SKY66110-11 Electrical Specifications: DC Characteristics[1]
(V_{CC} = 3.3 V, V_{CTX} = 1.8 V, T_A = +25 °C, R5 = 0 kΩ, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
RX current (bypass)	I_{CQ_RX}	RX mode		1		µA
TX quiescent current[2]	I_{CQ_TX}	TX mode		6		mA
TX operating current[2]	I_{OP_TX}	TX mode (P_{IN} = -1 dBm): V_{CC} = 1.8 V V_{CC} = 3.0 V V_{CC} = 3.3 V V_{CC} = 5.0 V		 8.5 10 10.5 11		 mA mA mA mA
TX bias current (CTX pin)	I_{BIAS_TX}			550		µA
Sleep current[3]	I_{CC_OFF}	Sleep mode		0.1	1	µA

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

[2] For total current, I_{BIAS_TX} should be added to the values.

[3] V_{CTX} = 0 V.

Table 5. SKY66110-11 Electrical Specifications Transmit Characteristics[1]
(V_{CC} = 3.3 V, V_{CTX} = 1.8 V, T_A = +25 °C, P_{IN} = -1 dBm, R5 = 0 kΩ, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Output power	P_{OUT}	V_{CC} = 1.8 V V_{CC} = 3.0 V V_{CC} = 3.3 V V_{CC} = 5.0 V		+8 +10 +10.3 +10.8		dBm dBm dBm dBm
Saturated gain[2]	G_SAT	P_{IN} = -1 dBm		11		dB
Gain slope	G_{SLOPE}	Over frequency range		0.7	1	dB
Input return loss	S11			-14		dB
Output return loss	S22			-10		dB
Insertion loss (sleep mode) [2]	$S21_SLEEP$			-15	-12	dB
Third order input intercept point[2]	IIP3	@ 2.44 GHz, Δ f = ± 1 MHz, P_{IN} = -14 dBm/tone		+5		dBm
Third order output intercept point[2]	OIP3	@ 2.44 GHz, Δ f = ± 1 MHz, P_{IN} = -14 dBm/tone		+16		dBm
1 dB input compression point	IP1dB			-1		dBm
1 dB output compression point	OP1dB			+10		dBm
2nd to 10th harmonics[2]	2fo to 10fo				-30	dBm/MHz
RX to TX transition time[2]	t_{SWITCH}	10% to 90% RF 50% V_{CTX} to 90% RF		500		ns
TX power on time[2]	t_{ON}	10% to 90% RF 50% V_{CTX} to 90% RF		500		ns
TX power off time[2]	t_{OFF}	90% to 10% RF 50% V_{CTX} to 10% RF		150		ns

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

[2] Guaranteed by characterization.

Table 6. SKY66110-11 Electrical Specifications: Receive Characteristics[1]
(V_{CC} = 3.3 V, V_{CRX} = 1.8 V, V_{CTX} = 0 V, T_A = +25 °C, P_{IN} = -20 dBm, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Insertion loss	S21			0.9		dB
Isolation	S12	TX Mode (P_{IN} = -20 dBm)		25		dB
Input return loss	S11			-15		dB
Output return loss	S22			-15		dB
TX to RX transition time[2]	t_{SWITCH}	10% to 90% RF 50% V_{CRX} to 90% RF		500		ns
RX power on time[2]	t_{ON}	10% to 90% RF 50% V_{CRX} to 90% RF		150		ns
RX power off time[2]	t_{OFF}	90% to 10% RF 50% V_{CRX} to 10% RF		150		ns

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

[2] Guaranteed by characterization.

Table 7. SKY66110-11 Electrical Characteristics: Logic Characteristics (T_A = +25 °C)

Parameter	Symbol	Minimum	Maximum	Units
Voltage logic high[1]	V_{HIGH}	1.8	5	V
Voltage logic low	V_{LOW}	0	0.2	V

[1] Difference between logic high voltages for V_{CRX} and V_{CTX} should not exceed 0.2 V.

Table 8. SKY66110-11 Mode Logic Truth Table

Mode	CTX	CRX
Sleep mode	0	0
Receive (RX) mode	0	1
Transmit (TX) mode	1	0
Non-permissible state[1]	1	1

[1] This state will enable both the TX and RX paths. It is not permitted to operate in this state.

Evaluation Board Description

The SKY66110-11 Evaluation Board is used to test the performance of the SKY66110-11 front-end module. The board is optimized for evaluation, experimentation, and investigation with an 802.15.4 signal source. The design and layout can be quickly and easily transferred into a production design.

An Evaluation Board schematic diagram is provided in Figure 3. A reference design schematic is provided in Figure 4. Table 9 provides the Bill of Materials (BOM) list for Evaluation Board components. A photograph of the Evaluation Board is shown in Figure 5.

Evaluation Board Setup Procedure

Connect Supply

1. Connect J1 and J4 to 50 Ω instruments. Terminate all unused ports (if applicable) with 50 Ω.
2. Connect the supply ground to Pins 1, 4, and 6 of J2.
3. Connect 3.3 V to pin 7 of J2.
4. Connect 1.8 V to one of the logic pins (pin 3 or pin 5) on J2 to select RX or TX mode. Connect the other logic pin to ground. Refer to Table 8 for mode control settings.

Measure Performance

TX

Monitor the 2.4 GHz amplifier performance by applying an RF signal to connector J4 (TR) and verify the output power on connector J1 (ANT).

RX

Monitor the 2.4 GHz switch performance by applying an RF signal to connector J1 (ANT) and verify the output signal on connector J4 (TR).

CAUTION: *Be careful not to overdrive the switch by applying too much RF on the input to the device. A starting input power of -20 dBm is suitable.*

Package Dimensions

The PCB layout footprint for the SKY66110-11 is provided 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 SKY66110-11 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.

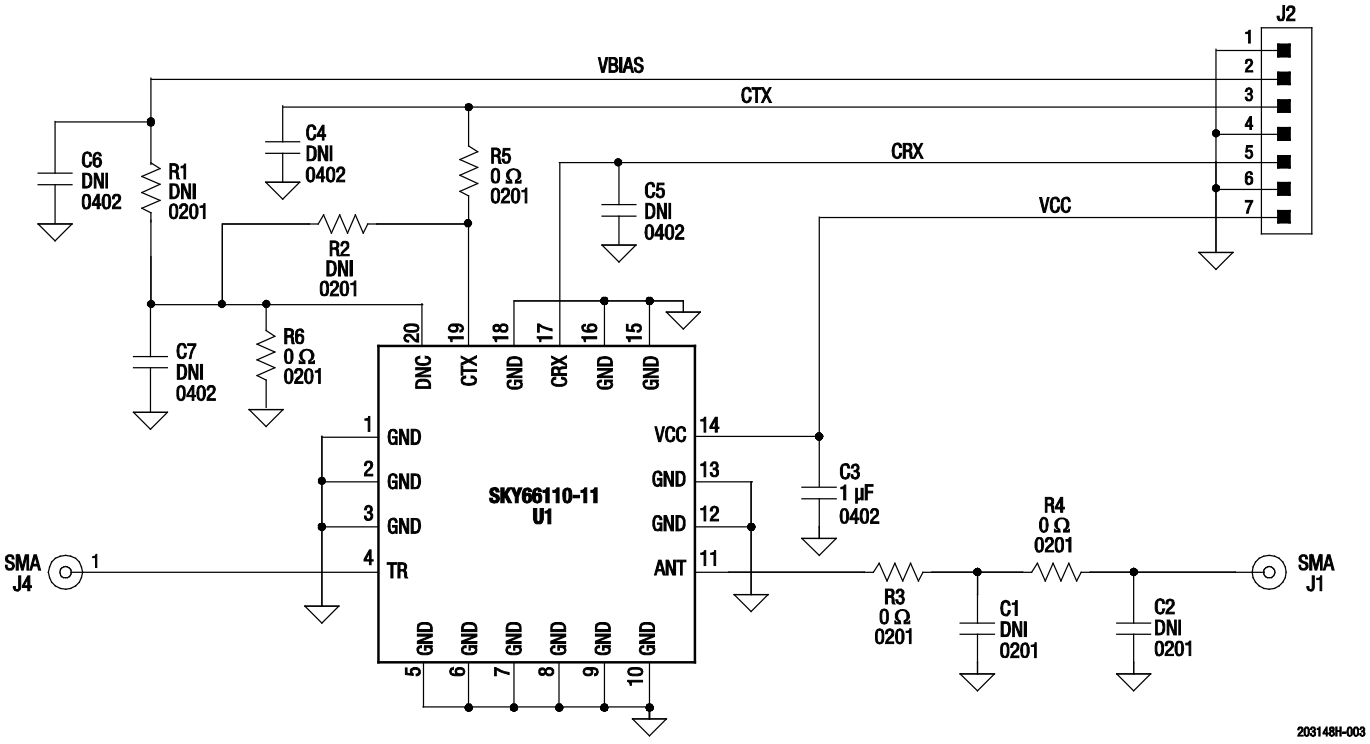


Figure 3. SKY66110-11 Evaluation Board Schematic

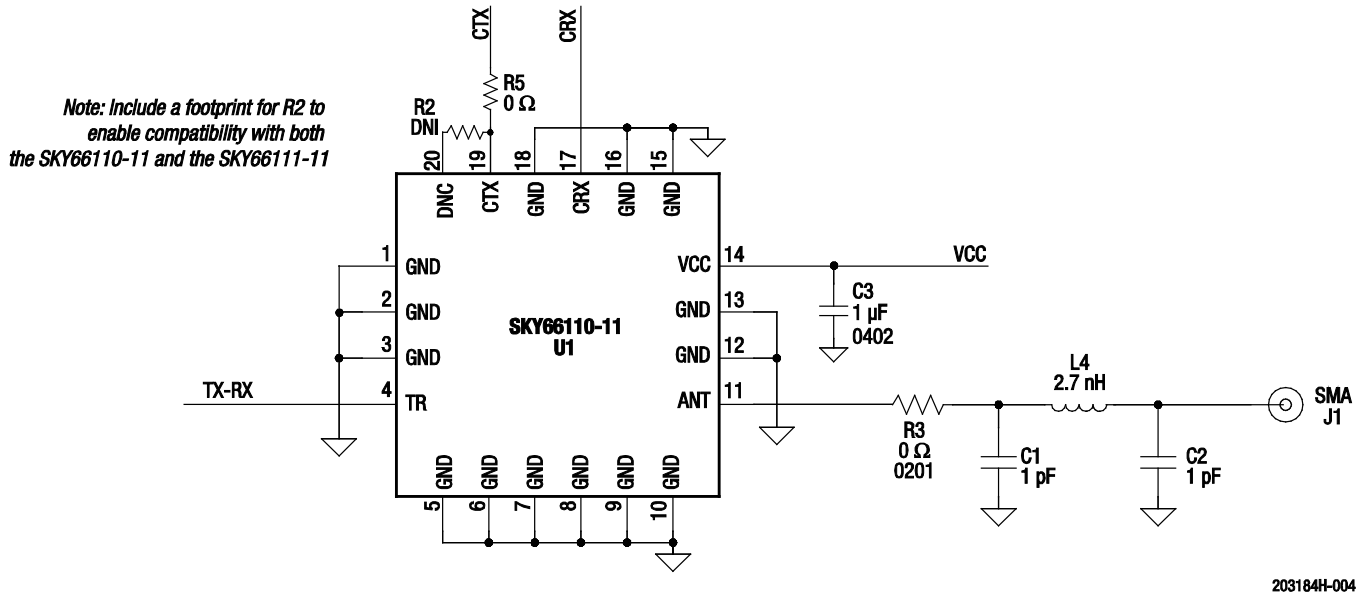


Figure 4. SKY66110-11 Reference Design Schematic

Table 9. SKY66110-11 Evaluation Board Bill of Materials (BOM)

Component	Value	Size	Manufacturer	Mfr Part Number	Characteristics
C1, C2	DNI	0201			
C3	1 uF	0402			Capacitor
C4, C5, C6	DNI	0402			
J1, J4	SMA	end launch	Johnson Components	142-0701-851	SMA end launch straight jack receptacle - tab contact
J2	7X1	100 mil	Samtec	TSW-107-07-G-S	100mil header
PCB1	Z720-B		Skyworks Solutions Inc.	Z720-B	PCB
R1, R2	DNI	0201			Do not install
R3, R4, R5, R6	0 Ω	0201	Panasonic	ERJ1GE0R00	Thick film chip resistor
U1	SKY66110-11	MCM50P300X330-20	Skyworks Solutions Inc.	SKY66110-11	Low-power Bluetooth® applications low energy FEM

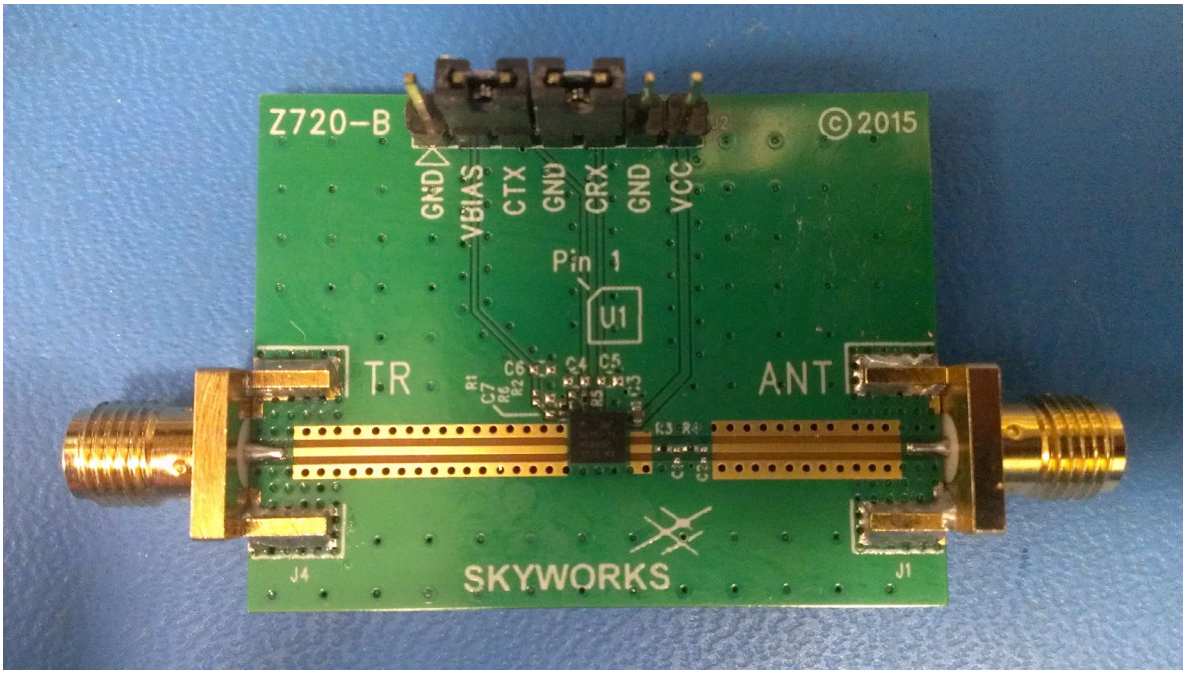
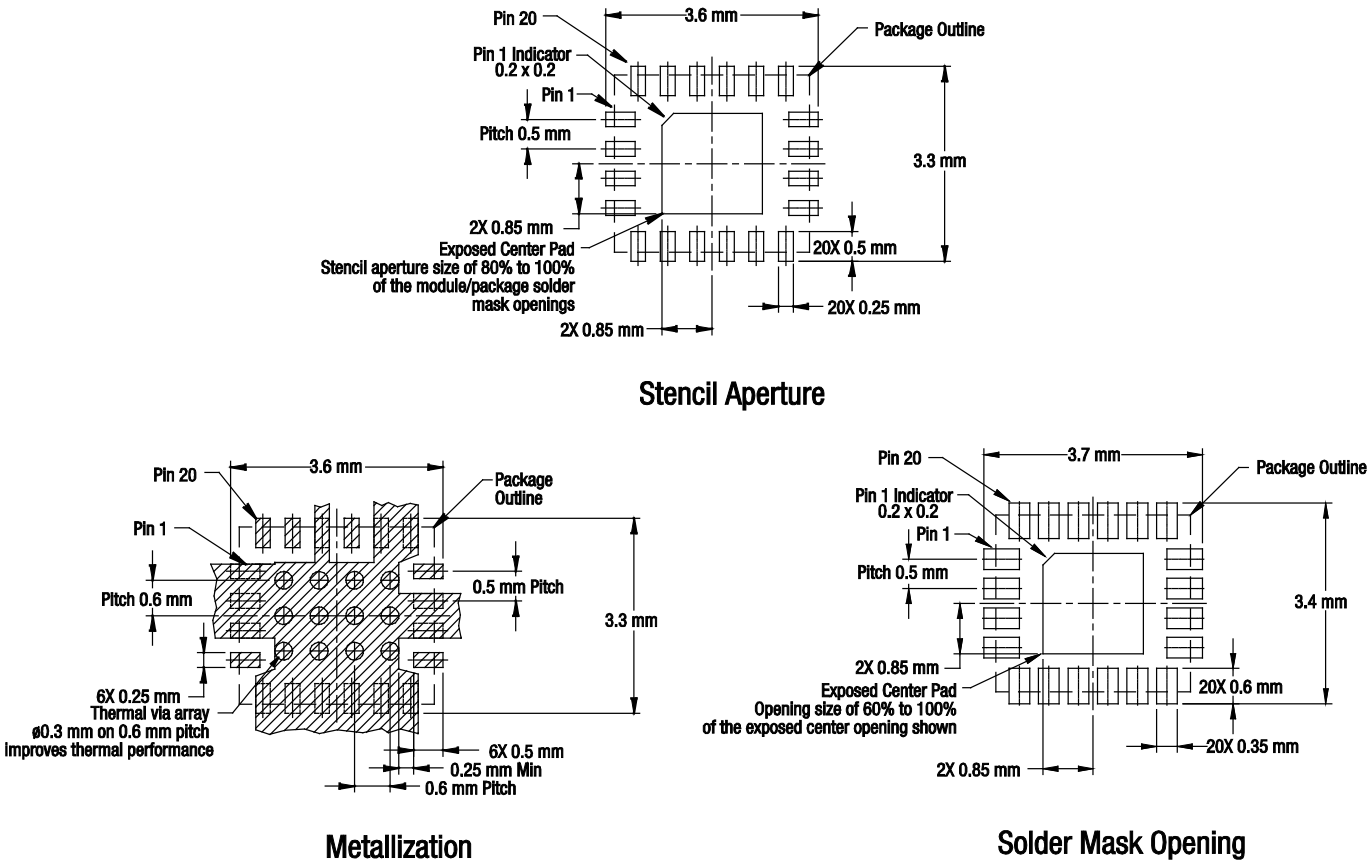


Figure 5. SKY66110-11 Evaluation Board



Notes:

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

203184H-006

Figure 6. PCB Layout Footprint

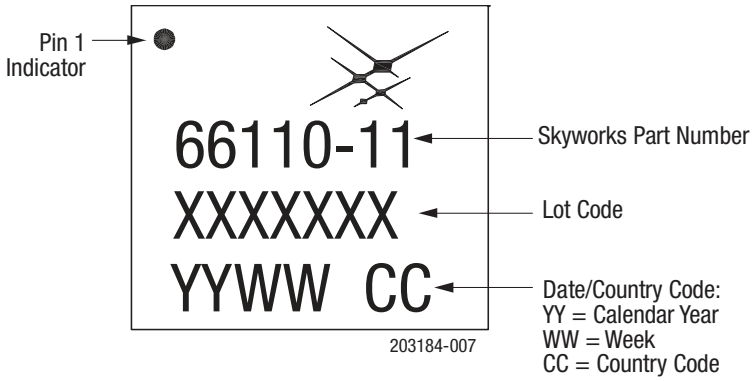


Figure 7. Typical Part Marking

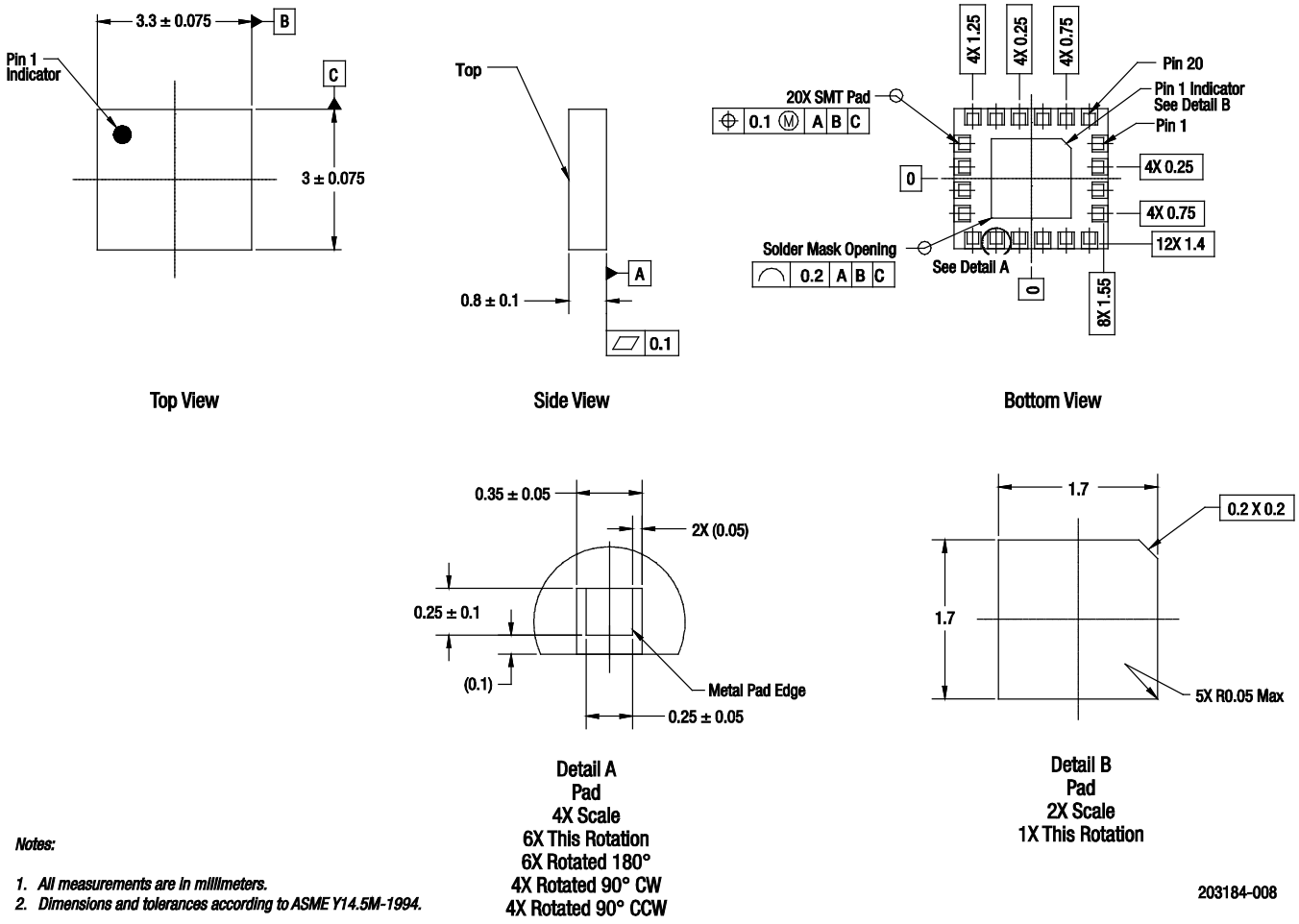
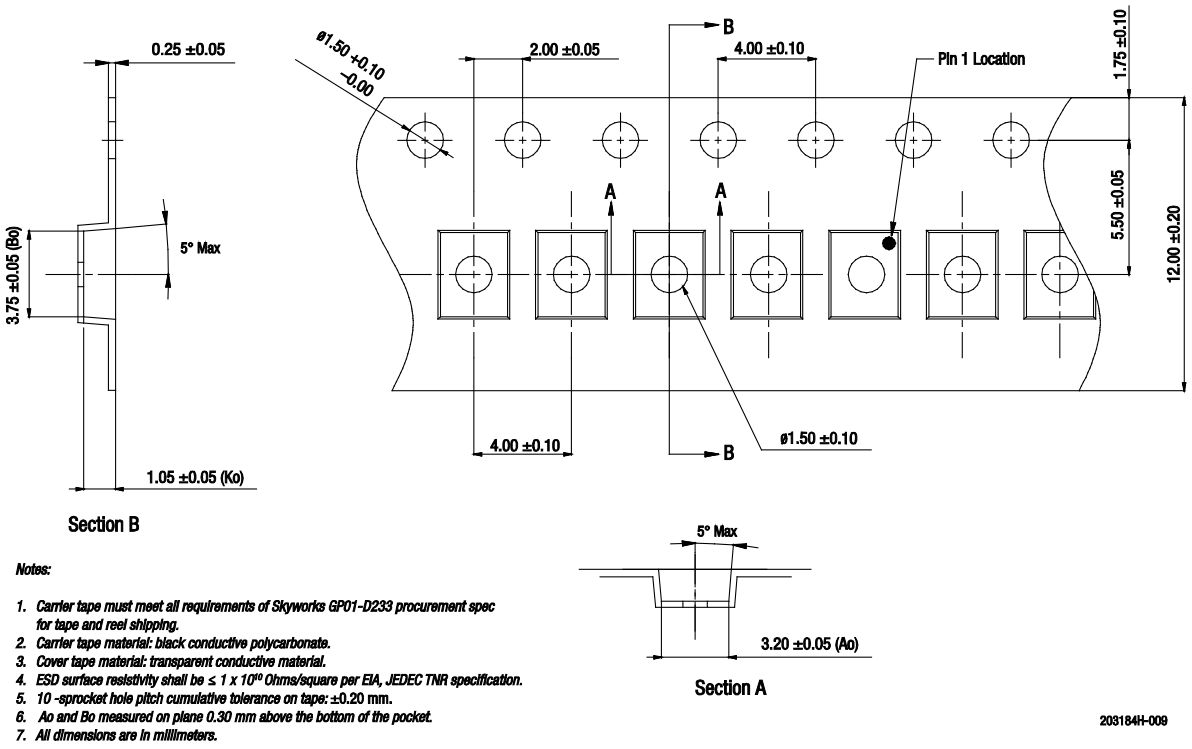


Figure 8. SKY66110 Package Dimensions



Notes:

1. *Carrier tape must meet all requirements of Skyworks GP01-D233 procurement spec for tape and reel shipping.*
2. *Carrier tape material: black conductive polycarbonate.*
3. *Cover tape material: transparent conductive material.*
4. *ESD surface resistivity shall be ≤ 1 x 10^{10} Ohms/square per EIA, JEDEC TNR specification.*
5. *10 -sprocket hole pitch cumulative tolerance on tape: ±0.20 mm.*
6. *Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.*
7. *All dimensions are in millimeters.*

Figure 9. SKY66110-11 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY66110-11	Low-power, low energy front-end module for Bluetooth® range extension applications	SKY66110-11-EK1

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