DATA SHEET

SKY66114-11: 2.4 GHz Front-End Module for Bluetooth® Low Energy /802.15.4/Thread/ZigBee®

Applications

- In-home appliances
- Smart thermostats
- IoT gateways
- Smart lighting
- Sensors
- Range extender

Features

- Integrated PA with up to +23 dBm output power
- Integrated LNA with 12 dB gain
- Integrated switch selects between PA, LNA, and bypass functions
- Low noise figure: 2 dB typical
- Single-ended transmit/receive interface
- Fast switch on/off time: < 800 ns
- Supply range: 1.8 V to 3.6 V
- Sleep mode current: < 1 µA typical
- No external bias resistor is required
- Small MCM (16-pin, 2.4 mm × 2.4 mm × 0.7 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.

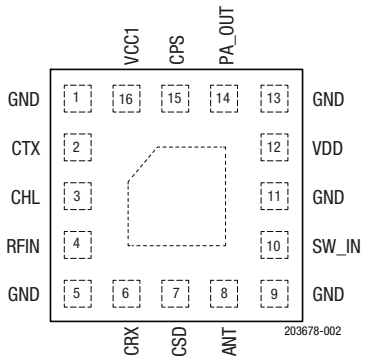


Figure 2. SKY66114-11 Pinout (Top View)

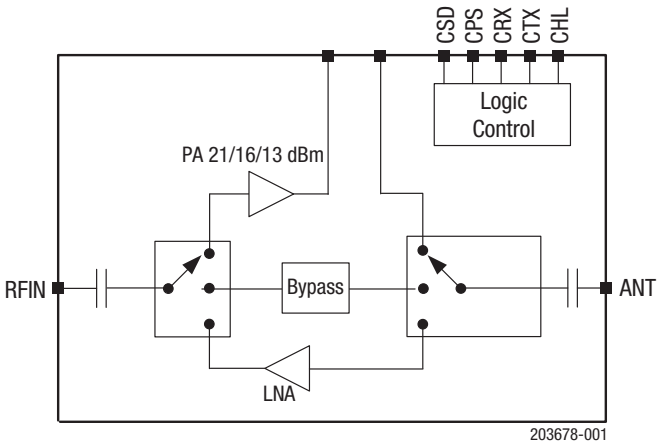


Figure 1. SKY66114-11 Block Diagram

Description

The SKY66114-11 is a high-performance, fully integrated RF front-end module (FEM) designed for Bluetooth Low Energy, 802.15.4, Thread, and ZigBee applications.

The SKY66114-11 is designed for ease of use and maximum flexibility. The device integrates a high-efficiency saturated PA, high-gain LNA, T/R and bypass switches, 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 1.8 V to 3.6 V that allows the SKY66114-11 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 SKY66114-11 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.

Table 1. SKY66114-11 Signal Descriptions[1]

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	9	GND	Ground
2	CTX	Connect to GPIO signal for mode control (see Table 6)	10	SW_IN	Transmit arm of T/R switch, nominal impedance 50 Ω
3	CHL	Connect to GPIO signal for mode control (see Table 6)	11	GND	Ground
4	RFIN	RF input power, connect to 50 Ω RF source	12	VDD	Connect to positive supply
5	GND	Ground	13	GND	Ground
6	CRX	Connect to GPIO signal for mode control (see Table 6)	14	PA_OUT	Output of final PA stage; connect to output matching network (OMN) and VCC2 supply.
7	CSD	Connect to GPIO signal for mode control (see Table 6)	15	CPS	Connect to GPIO signal for mode control (see Table 6)
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 SKY66114-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 and 5.

The state of the SKY66114-11 is determined by the logic provided in Table 6.

Table 2. SKY66114-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC1} V_{CC2} V_{DD}	-0.3 -0.3 -0.3	+3.6 +3.6 +3.6	V V V
Control pin voltages	V_{CTL}	-0.3	+3.6	V
Transmit output power at ANT port into 50 Ω load	$P_{OUT\_TX\_MAX}$		+22.5	dBm
Input power at RFIN port	$P_{IN\_TR\_MAX}$		+5	dBm
Receive input power at ANT port[2]	$P_{IN\_RX\_MAX}$		+15	dBm
Bypass input power at ANT port[2]	$P_{IN\_BYP\_MAX}$		+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			
Pin 14 (PA_OUT)			500	V
All other pins			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**: 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. 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 PA_OUT pin	V_{CC2}	1.2	3.0	3.6	V
Supply voltage on VDD pin	V_{DD}	1.7[1]	3.0	3.6	V
Operating temperature	T_A	-40	+25	+85	°C

[1] Performance at VDD < 2.5 V will be slightly degraded compared to VDD = 2.5 V or more.

Table 4. SKY66114-11 Electrical Specifications[1]
(V_{CC1} = 1.8 V, V_{CC2} = 3.0 V, V_{DD} = 3.0 V, T_A = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Total supply current (transmit mode)	I_{CC_TX}	P_{OUT} = +22 dBm[2] P_{OUT} = +20 dBm[3] P_{OUT} = +16 dBm[4] P_{OUT} = +13 dBm[5]		125 90 60 45		mA mA mA mA
Total supply current (receive mode)	I_{CC_RX}			4	6	mA
Total supply current (bypass mode)	I_{CC_BYP}			65		µA
Sleep supply current	I_{CC_OFF}	No RF			1	µA
Quiescent current	I_{CCQ_TX}	High-power mode[2] Low-power mode[3] Low-power mode[4]		20 15 15		mA mA mA
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.

[2] V_{CC1} = 1.8 V, V_{CC2} = 3.0 V, P_{IN} = -1 dBm.

[3] V_{CC1} = 1.8 V, V_{CC2} = 3.0 V, P_{IN} = -4 dBm.

[4] V_{CC1} = 1.8 V, V_{CC2} = 1.8 V, P_{IN} = -3 dBm.

[5] V_{CC1} = 1.8 V, V_{CC2} = 1.2 V, P_{IN} = -4 dBm.

Table 5. SKY66114-11 Electrical Specifications[1]
(V_{CC1} = 1.8 V, V_{CC2} = 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
Transmit Characteristics						
Frequency range	f		2400		2483	MHz
Output power at ANT port	P_{OUT}	V_{CC1}= 1.8 V, V_{CC2}= 3.0 V, P_{IN} = -1 dBm V_{CC1}= 1.8 V, V_{CC2}= 3.0 V, P_{IN} = -4 dBm V_{CC1}= 1.8 V, V_{CC2}= 1.8 V, P_{IN} = -3 dBm V_{CC1}= 1.8 V, V_{CC2}= 1.2 V, P_{IN} = -4 dBm		+22 +20 +16 +13		dBm dBm dBm dBm
Saturated gain, high-power mode	$Gain_{SAT}$			24		dB
Saturated output power variation	ΔP_{OUT}	Across all ZigBee channels			1	dBp-p
2nd and 3rd harmonics	2fo, 3fo	P_{OUT} = +20 dBm, IEEE 802.15.4 source			-42	dBm/MHz
Input return loss	S11			-10		dB
Turn-on time	t_{RISE}	From 50% of CTX edge to 90% of final RF output power		1		us
Turn-off time	t_{FALL}	From 50% of CTX edge to 10% of final RF output power		100		ns
Stability	STAB	CW, Pin = 0 dBm, 0.1 GHz to 20 GHz, load VSWR = 6:1	All non-harmonically related outputs < -42 dBm/MHz			
Ruggedness	RUG	CW, Pin = 0 dBm, load VSWR = 10:1	No permanent damage			
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		-14	-8		dBm
Input return loss	S11	ANT port		-10		dB
Output return loss	S22			-10		dB
Turn-on time	t_{RISE}	From 50% of CTX edge to 90% of final RF output power		2		µs
Turn-off time	t_{FALL}	From 50% of CTX edge to 10% of final RF output power		100		ns
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. SKY66114-11 Mode Control Logic[1]
(V_{CC1} = 1.8 V, V_{CC2} = 3.0 V, V_{DD} = 3.0 V, T_A = +25 °C)

Mode	Description	CSD (Pin 7)	CPS (Pin 15)	CRX (Pin 6)	CTX (Pin 2)	CHL (Pin 3)
0	All off (sleep mode)1	0	x	x	x	x
1	Receive LNA mode	1	0	1	0	x
2	Transmit high-power mode	1	0	x	1	1
3	Transmit low-power mode	1	0	x	1	0
4	Receive bypass mode	1	1	1	0	x
5	Transmit bypass mode	1	1	x	1	x
6	All off (sleep mode)	1	x	0	0	x

[1] All controls must be at logic "0" to achieve the specified sleep current.
[2] X = Don't care.

Application Schematic Description

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

The Evaluation Board Bill of Materials (BOM) is listed in Table 7. The reference layout layers are shown in Figure 5.

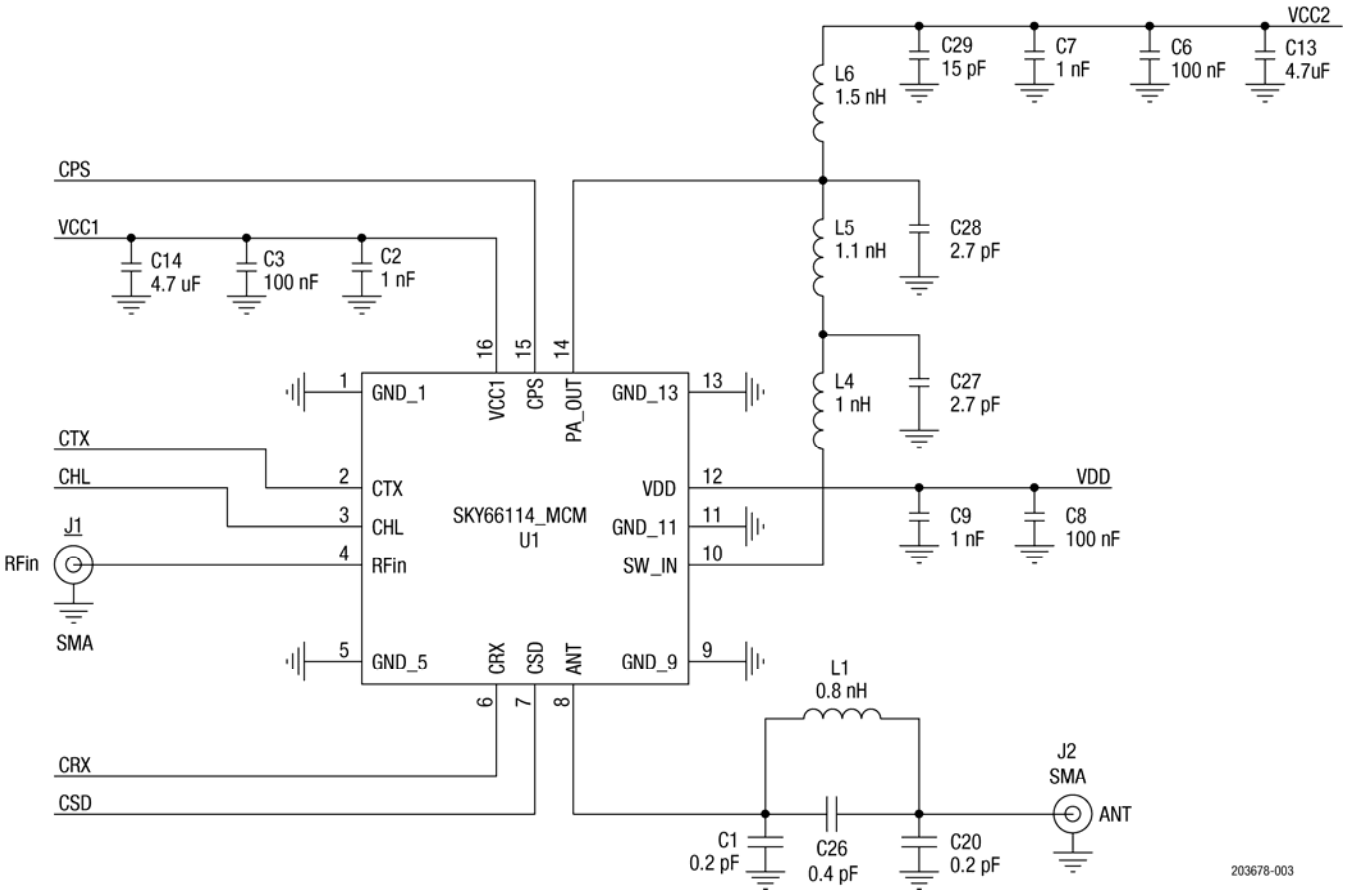


Figure 3. SKY66114-11 Reference Design Schematic

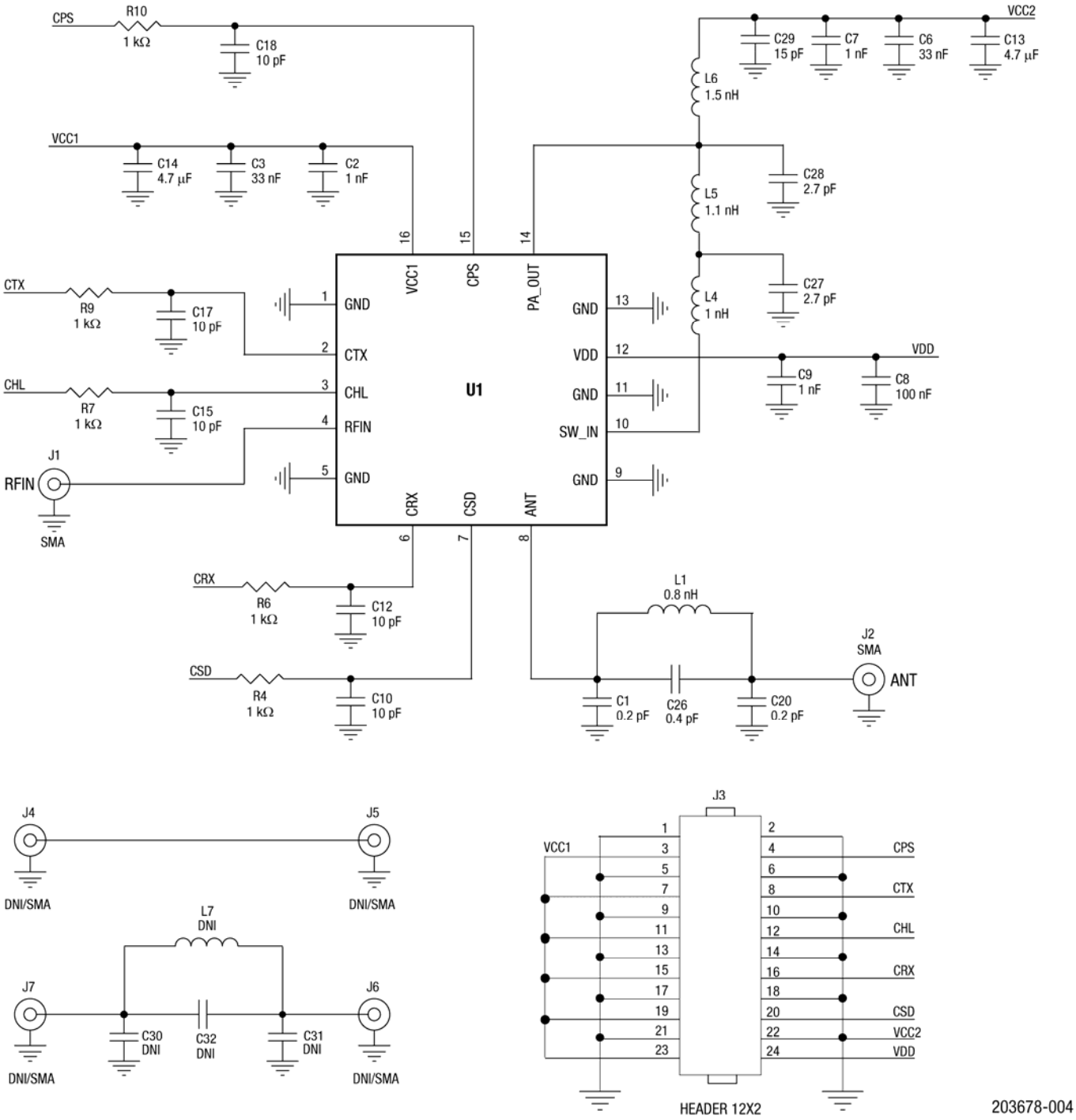
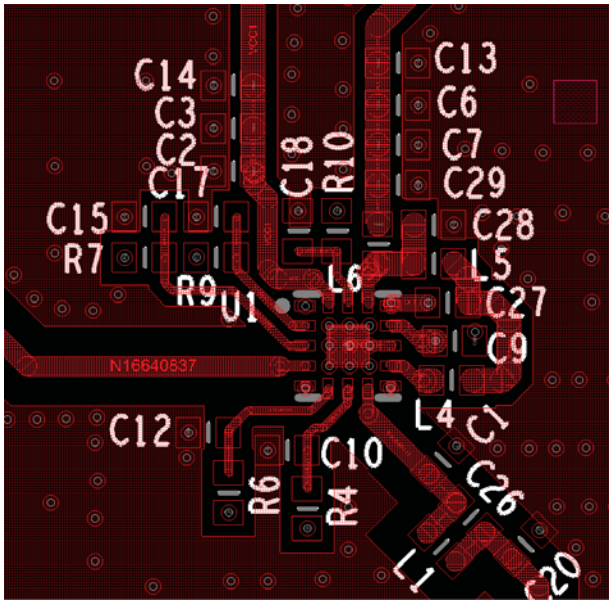


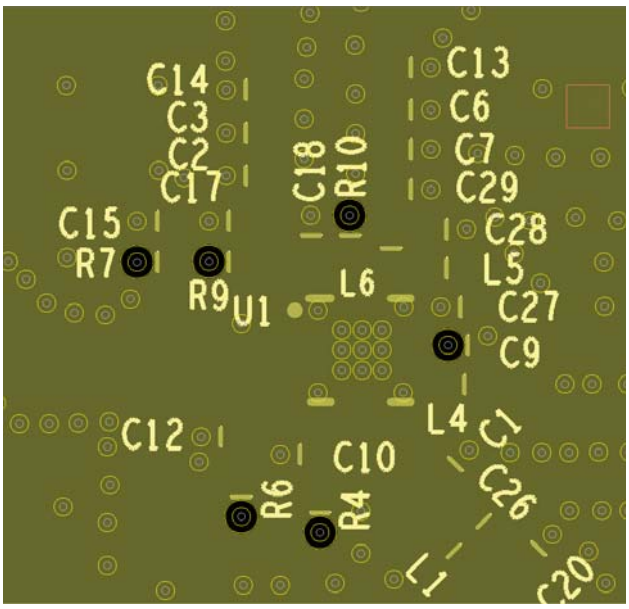
Figure 4. SKY66114-11 Evaluation Board Schematic Diagram

Table 7. SKY66114-11 Evaluation Board Bill of Materials (BOM)

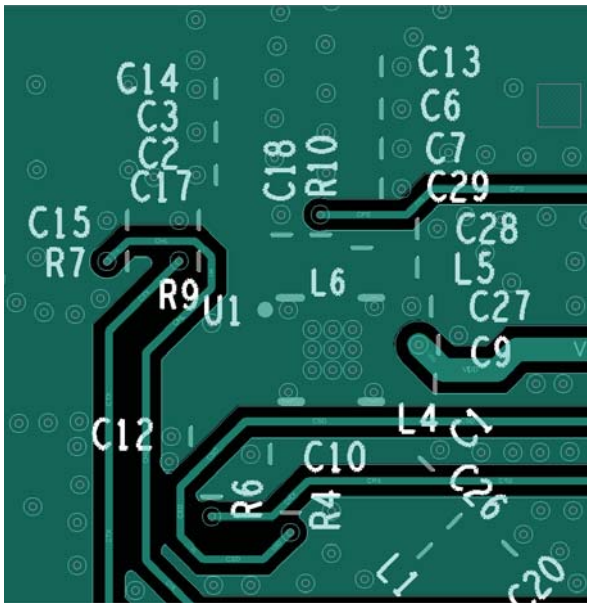
Component	Value	Size	Manufacturer	Mfr Part Number	Description
C1, C20	0.2 pF	0402	Murata	GJM1555C1HR20BB01D	Ceramic capacitor, 0.2 pF, High-Q, 50 V, C0G
C2, C7, C9	1000 pF	0402	Murata	GRM1555C1H102JA01D	Ceramic capacitor, 1000 pF, 50 V, 5%, C0G
C3, C6	33000 pF	0402	Murata	GRM155R71C333KA01D	Ceramic capacitor, 33000 pF, 16 V, 10%, X7R
C8	0.1 µF	0402	Murata	GRM155R71C104KA88J	Ceramic capacitor, 0.1 µF, 16 V, 10%, X7R
C10, C12, C15, C17, C18	10 pF	0402	Murata	GRM1555C1H100JA01D	Ceramic capacitor, 10 pF, 50 V, 5%, C0G
C13, C14	4.7 µF	0402	Samsung	CL05A475MP5NRNC	Ceramic capacitor, 4.7 µF, 10V, 20%, X5R
C26	0.4 pF	0402	Murata	GJM1555C1HR40BB01D	Ceramic capacitor, 0.4 pF, High-Q, 50 V, C0G
C27, C28	2.7 pF	0402	Murata	GJM1555C1H2R7BB01D	Ceramic capacitor, 2.7 pF, High-Q, 50 V, C0G
C29	15 pF	0402	Murata	GRM1555C1H150JA01D	Ceramic capacitor, 15 pF, 50 V, 5%, C0G
L1	0.8 nH	0402	TDK	MHQ1005P0N8BT000	High-Q multilayer inductor
L4	1 nH	0402	TDK	MHQ1005P1N0BT000	High-Q multilayer inductor
L5	1.1 nH	0402	TDK	MHQ1005P1N1BT000	High-Q multilayer inductor
L6	1.5 nH	0402	TDK	MHQ1005P1N5BT000	High-Q multilayer inductor
R10, R9, R7, R6, R4	1000 Ω	0402	Samsung	RC1005J102CS	Resistor, 1000 Ω, 5%, 0402
L7, C30, C31, C32	DNI				



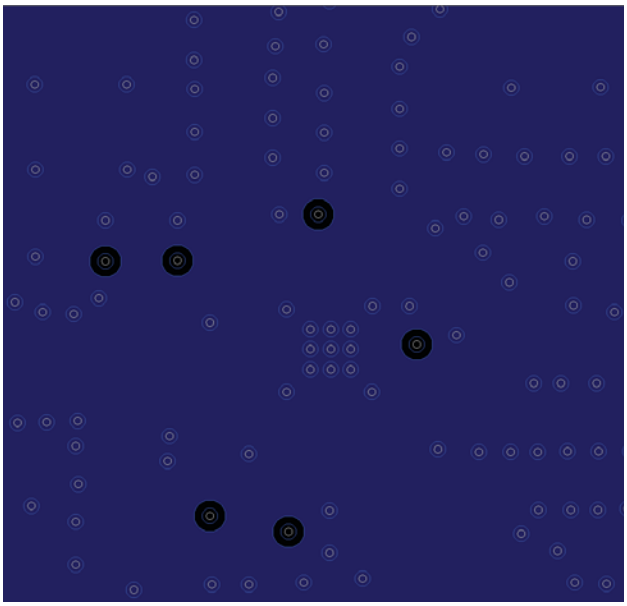
Reference Layout Layer 1



Reference Layout Layer 2



Reference Layout Layer 3



Reference Layout Layer 4

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Figure 5. Reference Layout Layers

Package Dimensions

The PCB layout footprint for the SKY66114-11 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 SKY66114-11 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.

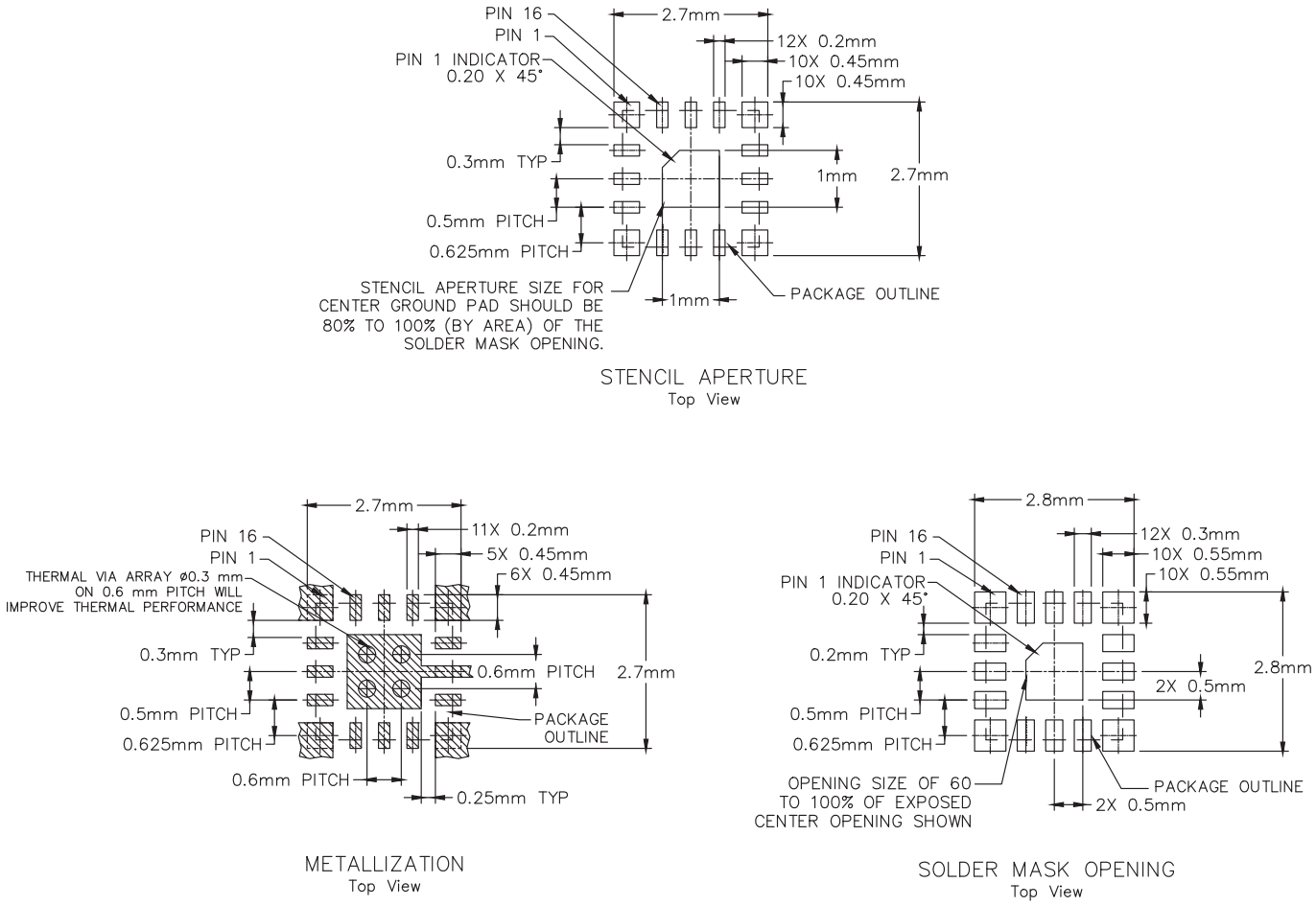


Figure 6. SKY66114-11 PCB Layout Footprint

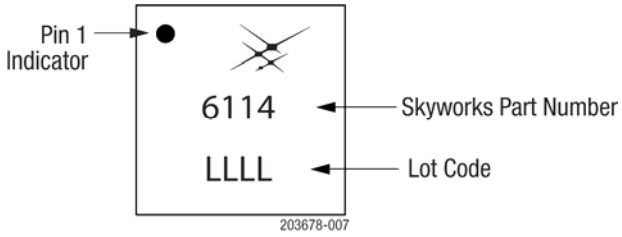
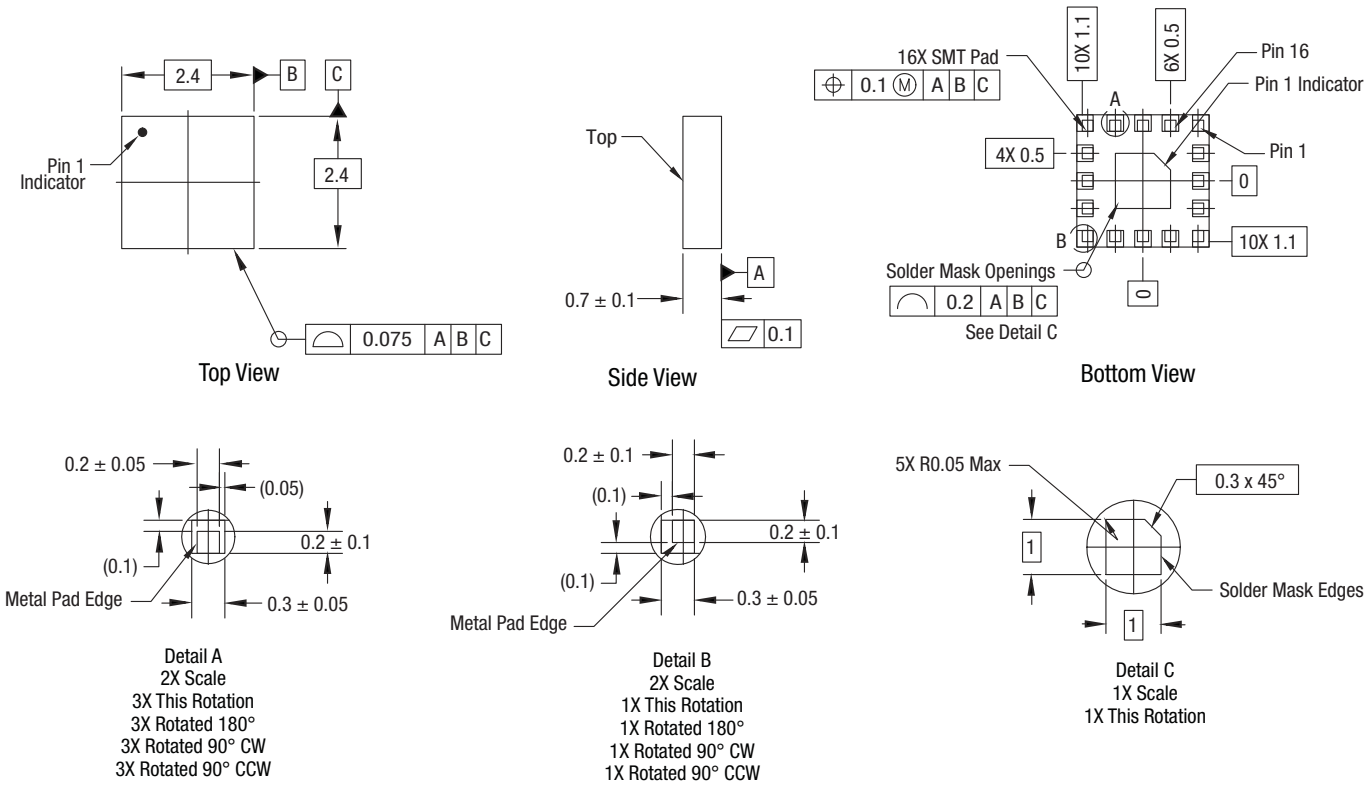


Figure 7. SKY66114-11 Typical Part Marking (Top View)



Notes:

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

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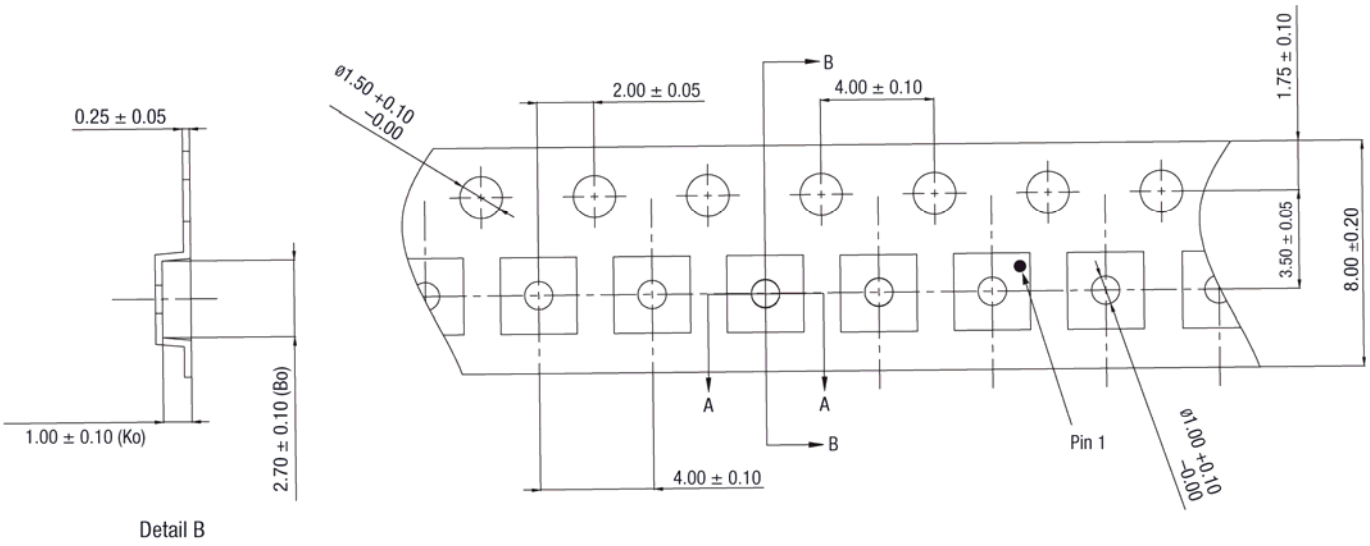
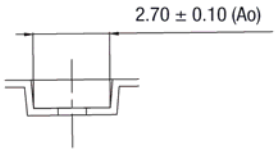
Figure 8. SKY66114-11 Package Dimensions





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Notes:

1. *Carrier tape must meet all Skyworks requirements of GP01-D232 procurement spec for tape and reel.*
2. *Carrier tape material: Black conductive polystyrene.*
3. *Cover tape material: Transparent conductive.*
4. *ESD surface resistivity shall meet 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 dimensions are in millimeters.*

Figure 9. SKY66114-11 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY66114-11	2.4 GHz FEM for Bluetooth Low Energy/802.15.4/Thread/ZigBee	SKY66114-11EK1

LifeElectronics
Живое партнерство

ООО «ЛайфЭлектроникс» **“LifeElectronics” LLC**

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