SKYWORKS®

SKY55951-11: Sky 5® GNSS L1 + L5 Dual-Frequency Low-Noise Amplifier Front-End Module with Post-Filter

Applications

- 4G/5G cellular IoT modules
- Smartwatches
- Personal trackers
- Vehicle trackers
- Personal navigation devices
- Handheld computers
- Wi-Fi 6E enterprise access points

Features

- Dedicated L1 and L5 receive paths
- Small signal gain: 17 dB typical
- Low current consumption:
  L1 = 1 mA, L5 = 1.9 mA @ 1.8 V
- Integrated input and output matching on L1 and L5 paths
- Integrated B13 notch on L1 path
- Single, wide DC supply range: 1.5 to 3.3 V
- Small MCM package
  20-pin, 2.0 x 1.6 x 0.7 (nominal) mm
  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.
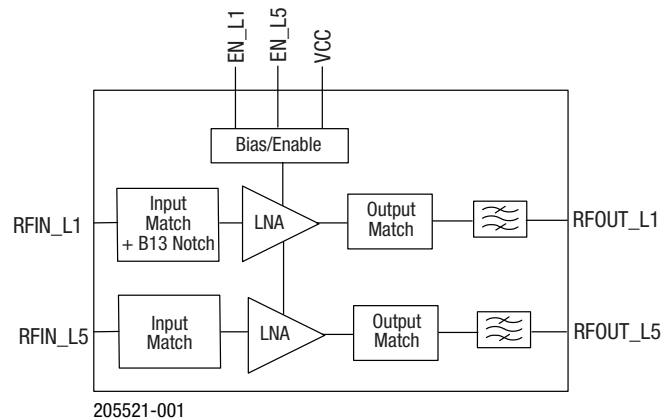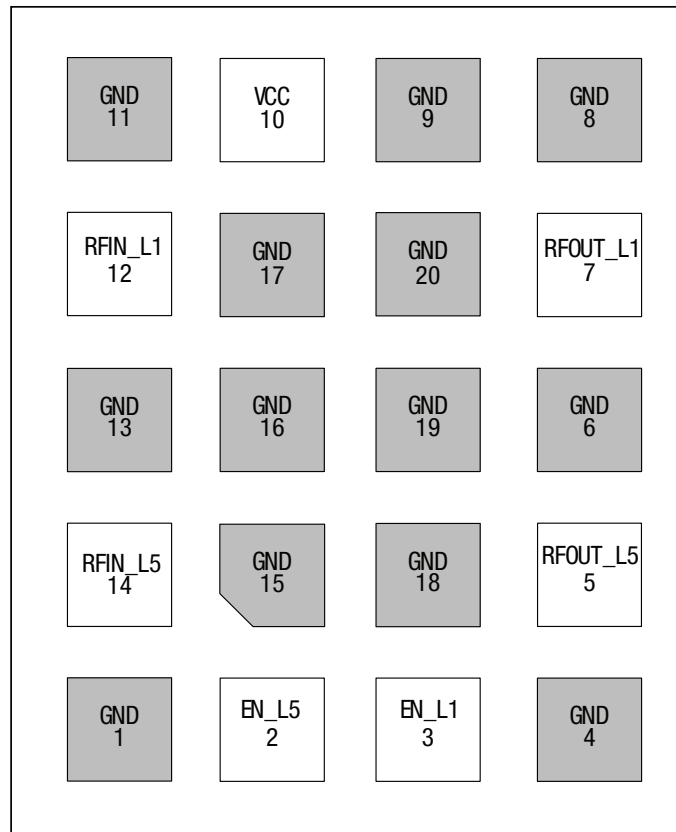

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Figure 1. SKY85347-11 Block Diagram

Description

The SKY55951-11 front-end module (FEM) features an integrated L1 low-noise amplifier (LNA) and post-filter along with an L5 LNA and post-filter designed for Global Navigation Satellite System (GNSS) receiver applications. Part of our Sky5® portfolio, the SKY55951-11 provides high gain, low current consumption, and integrated input and output matching for L1 and L5, all in a compact package.

The L1 path also features an integrated B13 notch filter, providing excellent suppression (-50 dBm) of cellular low-band second harmonic signals impacting GPS L1 reception. The post-filtering on the L5 path also provides high (> 45 dBc) out-of-band rejection for interference below 1 GHz. The SKY55951-11 uses surface-mount technology (SMT) in a Multi-Chip Module (MCM), a proven and highly manufacturable solution.

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 shown in Table 1.

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1

April 17, 2023

205521-002

Figure 2. SKY55951-11 Pinout (Top View)

Table 1. SKY55951-11 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	11	GND	Ground
2	EN_L5	L5 enable	12	RFIN_L1	L1 RF input
3	EN_L1	L1 enable	13	GND	Ground
4	GND	Ground	14	RFIN_L5	L5 RF input
5	RFOUT_L5	L5 RF output	15	GND	Ground
6	GND	Ground	16	GND	Ground
7	RFOUT_L1	L1 RF output	17	GND	Ground
8	GND	Ground	18	GND	Ground
9	GND	Ground	19	GND	Ground
10	VCC	Supply	20	GND	Ground

Technical Description

LNA Enable

The VEN signal (pin 3) enables or disables the LNA. A logic high signal powers on the LNA and a logic low signal powers off the device.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY55951-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 and 5.

Table 2. SKY55951-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
RF input power	P_{IN}		+10	dBm
Supply voltage	V_{CC}	0	3.6	V
Storage temperature	T_{STG}	-40	+85	C
Junction temperature	T_J		+85	°C
Electrostatic discharge: Charged-Device Model (CDM), Class 3 Human Body Model (HBM), Class 1A	ESD		1000 500	V 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. SKY55951-11Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Frequency range	f_L1 f_L5	1559 1164	1575 1176	1606 1189	MHz MHz
Supply voltage	V_{CC}	1.5	1.8	3.3	V
LNA enable: Enable (high) Disable (low)	LNA_{ENABLE} $LNA_{DISABLE}$	1.5	1.8 0	V_{CC} 0.3	V V
Case operating temperature	T_C	-40	+25	+85	°C

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3   **April 17, 2023**

Table 4. SKY55951-11 Electrical Specifications[1]
(VCC = 1.8 V, VEN = 1.8 V, f_L1 = 1575 MHz, Tc = +25°C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Small signal gain f = 1561 MHz f = 1575 MHz f = 1602 MHz	|S21|	P_{IN} = -40 dBm	14.5 14.5 14.5	16.5 17 16.5	19.5 19.5 19.5	dB db dB
Noise figure f = 1561 MHz f = 1575 MHz f = 1602 MHz	NF			1.4 1.4 1.5	2.2 2.2 2.2	dB dB dB
In-band third order input intercept point	IIP3	f1 = 1575 MHz @ P_{IN} = -40 dBm f2 = 1576 MHz @ P_{IN} = -40 dBm		-21		dBm
1 dB input compression point (in-band)	IP1dB			-29		dBm
Reverse isolation	|S12|	P_{IN} = -40 dBm		30		dB
Input return loss	|S11|	P_{IN} = -40 dBm		8		dB
Output return loss	|S22|	P_{IN} = -40 dBm		15		dB
Group delay	GDlay			22		nS
Supply current	Icc	No RF		1.0	2	mA
Shutdown current	Ileak	No RF, V_{EN} = 0 V		0.01	1	uA
Logic current	ILogic	VCC 1.8 V, EN_L1 = 1.8 V VCC 1.8 V, EN_L1 = 0 V		0.01 0.01	1 1	uA uA
Out-of-band rejection	OOB	P_{IN} = 0 dBm, in-band referred: @ 777 to 798 MHz @ 806 to 928 MHz @ 1710 to 1980 MHz @ 2400 to 2500 MHz @ 5160 to 5560 MHz		93 87 70 77 69		dBc dBc dBc dBc dBc
B13 2nd harmonic	B13$_{2fo}$	P_{IN} = -10 dBm @ 787.76 MHz measured @ 1575.52 MHz output referred		-53		dBm
Stability factor	K-Factor		1	2.3		k
LNA turn-on time	t$_{ON}$	P_{IN} = -40 dBm, V_{CC} = 1.8 V, 50% of V_{ENABLE} to 90% final RF power		1		us
LNA turn-off time	t$_{OFF}$	P_{IN} = -40 dBm, V_{CC} = 1.8 V, 50% of V_{ENABLE} to 10% final RF power		0.06		us

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

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Table 5. SKY55951-11 Electrical Specifications[1]
(VCC = 1.8 V, VEN = 1.8 V, f_L5 = 1176 MHz, Tc = +25°C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Small signal gain: f = 1164 MHz f = 1176 MHz f = 1189 MHz	|S21|	P_IN = -40 dBm	14 14 14	17.5 17.5 17.5	20.5 20.5 20.5	dB dB dB
Noise figure: f = 1164 MHz f = 1176 MHz f = 1189 MHz	NF			1.1 1.1 1.1	1.7 1.7 1.7	dB dB dB
In-band third order input intercept point	IIP3	f1 = 1176 MHz @ P_IN = -40 dBm f2 = 1177 MHz @ P_IN = -40 dBm		-18		dBm
1 dB input compression point (in-band)	IP1dB			-13.8		dBm
Reverse isolation	|S12|	P_IN = -40 dBm		47		dB
Input return loss	|S11|	P_IN = -40 dBm		7		dB
Output return loss	|S22|	P_IN = -40 dBm		18		dB
Group delay	GDlay			15		nS
Supply current	Icc	No RF		2	3	mA
Shutdown current	Ileak	No RF, VEN = 0 V		0.01	1	uA
Logic current	ILogic	VCC 1.8 V, EN_L5 = 1.8 V VCC 1.8 V, EN_L5 = 0 V		0.01 0.01	1 1	uA uA
Out-of-band rejection	OOB	P_IN = 0 dBm, in-band referred: @ 777 to 960 MHz @ 1427 to 1463 MHz @ 1710 to 1980 MHz @ 2400 to 2500 MHz @ 5160 to 5560 MHz		48 33 56 48 52		dBc dBc dBc dBc dBc
Stability factor	K-Factor		1	13		k
LNA turn-on time	tON	P_IN = -40 dBm, VCC = 1.8 V, 50% of VENABLE to 90% final RF power		1.2		us
LNA turn-off time	tOFF	P_IN = -40 dBm, VCC = 1.8 V, 50% of VENABLE to 10% final RF power		0.1		us

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

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5 April 17, 2023

Evaluation Board

An Evaluation Board is used to test the performance of the SKY55951-11. A schematic of the Evaluation Board is provided in Figure 3. An assembly diagram of the Evaluation Board is shown in Figure 4. Table 6 provides the Evaluation Board Bill of Materials.
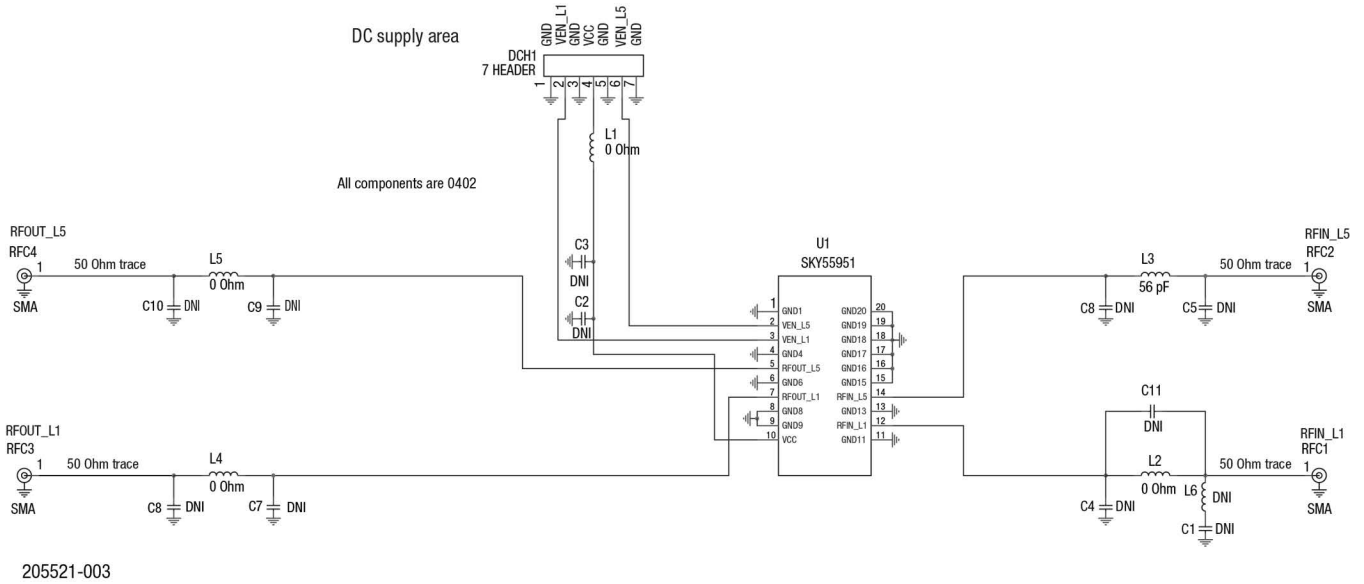

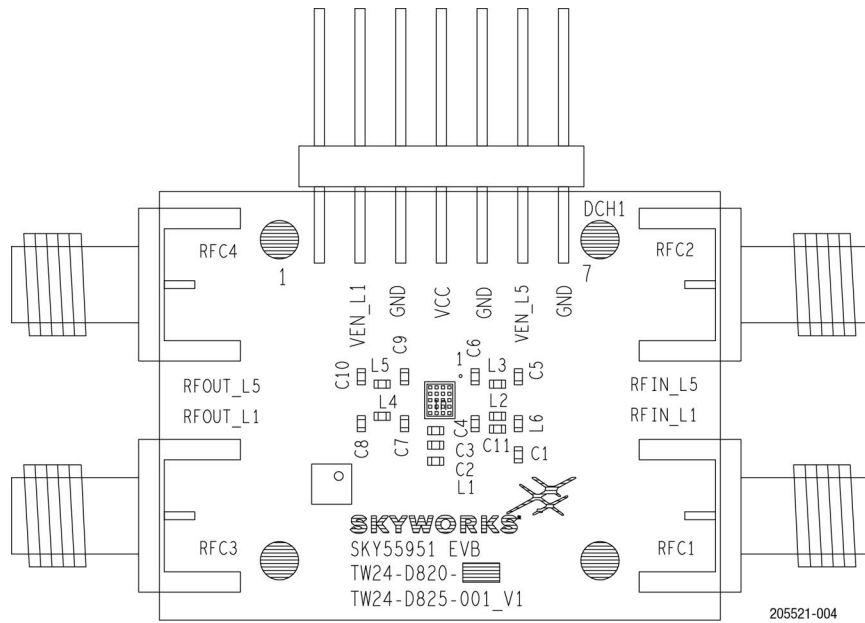**Figure 3. SKY55951-11 Evaluation Board Schematic**

Figure 4. SKY55951-11 Evaluation Board Assembly Diagram

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6   April 17, 2023

Table 6. SKY55951-11 Evaluation Board Bill of Materials

Component	PCB Number	PCB Variant	Size	Description
L1, L2, L4, L5[1]	5424R27-134		0402	Resistor, 0 ohm, 5%, 0.063 W
RFC1, RFC2, RFC3, RFC4	615R54-021			SMA .062 edge connector (EF Johnson)
DCH1	615R31-005			7 HEADER_13_HDR_2540P_1X7_SMT_I
U1	SKY55951			SKY55951-11
C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, L6	Do not install			
L3	GRM1555C1H560JZ01		0402	Ceramic capacitor, 56 pF, Murata
	TW24-D825-001	V1		PCB, SKY55951-11 Sky 5® GNSS L1 + L5 FEM

1. 56 pF DC block required at RFIN_L5 pin

Package Dimensions

The PCB layout footprint for the SKY55951-11 is provided in Figure 5. The typical part marking is 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

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 SKY55951-11 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 & 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.

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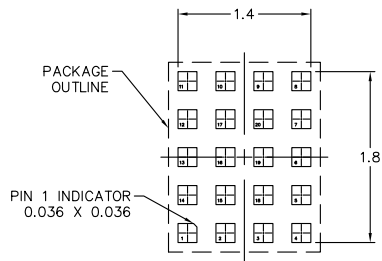
STENCIL APERTURE
TOP VIEW
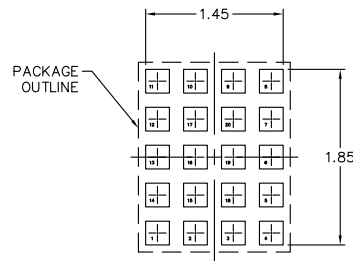
SOLDER MASK OPENING
TOP VIEW

METALLIZATION
TOP VIEW

THE CROSSHATCHED AREA REPRESENTS THE MERGER OF THE GROUND PADS. ALL I/O GROUND PADS SHOULD HAVE AT LEAST ONE VIA CONNECTING TO INTERNAL GROUND PLANES FOR OPTIMUM ELECTRICAL PERFORMANCE.

SMT PAD DETAIL
PAD
SCALE: 4X
1X THIS ROTATION

SMT PAD DETAIL
PAD
SCALE: 4X
19X THIS ROTATION
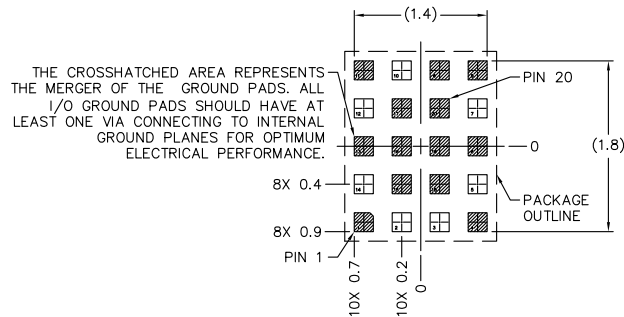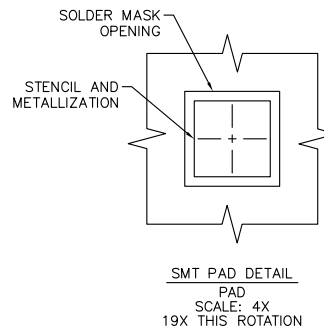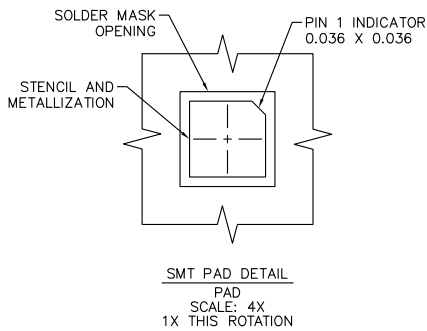
NOTES:
1. DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE SPECIFIED.
2. THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

205521-005

Figure 5. SKY55951-11 PCB Layout Footprint

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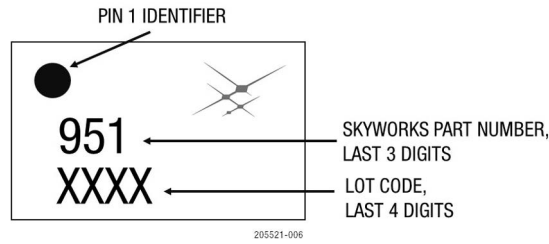
Figure 6. SKY55951-11 Typical Part Marking
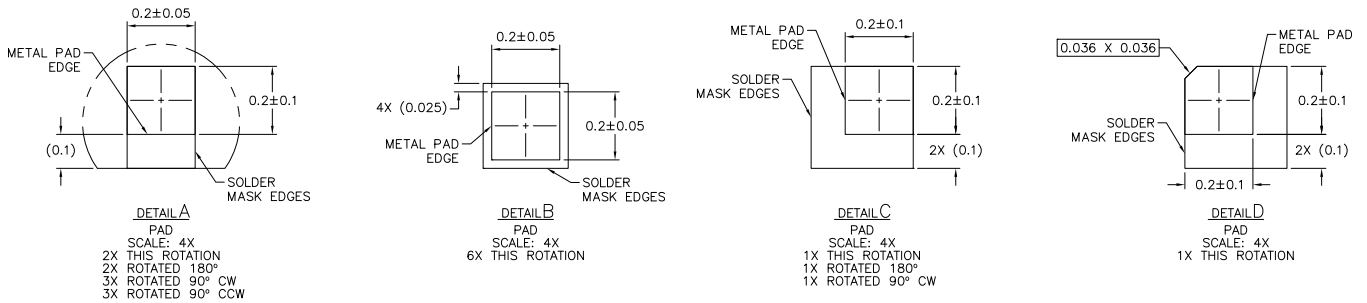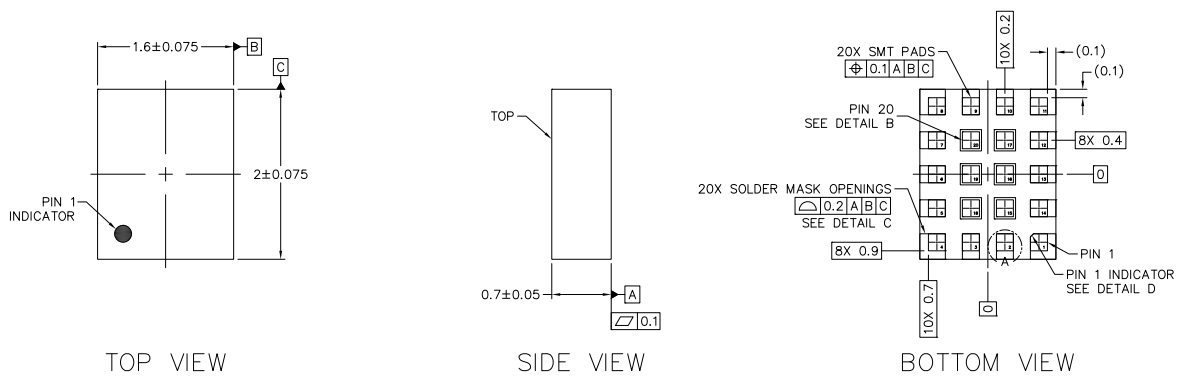
NOTES: UNLESS OTHERWISE SPECIFIED.
1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M—1994.
2. DIMENSIONS ARE IN MILLIMETERS
3. PAD DEFINITIONS PER DETAILS ON DRAWING.

205521-007

Figure 7. SKY55951-11 Package Dimensions

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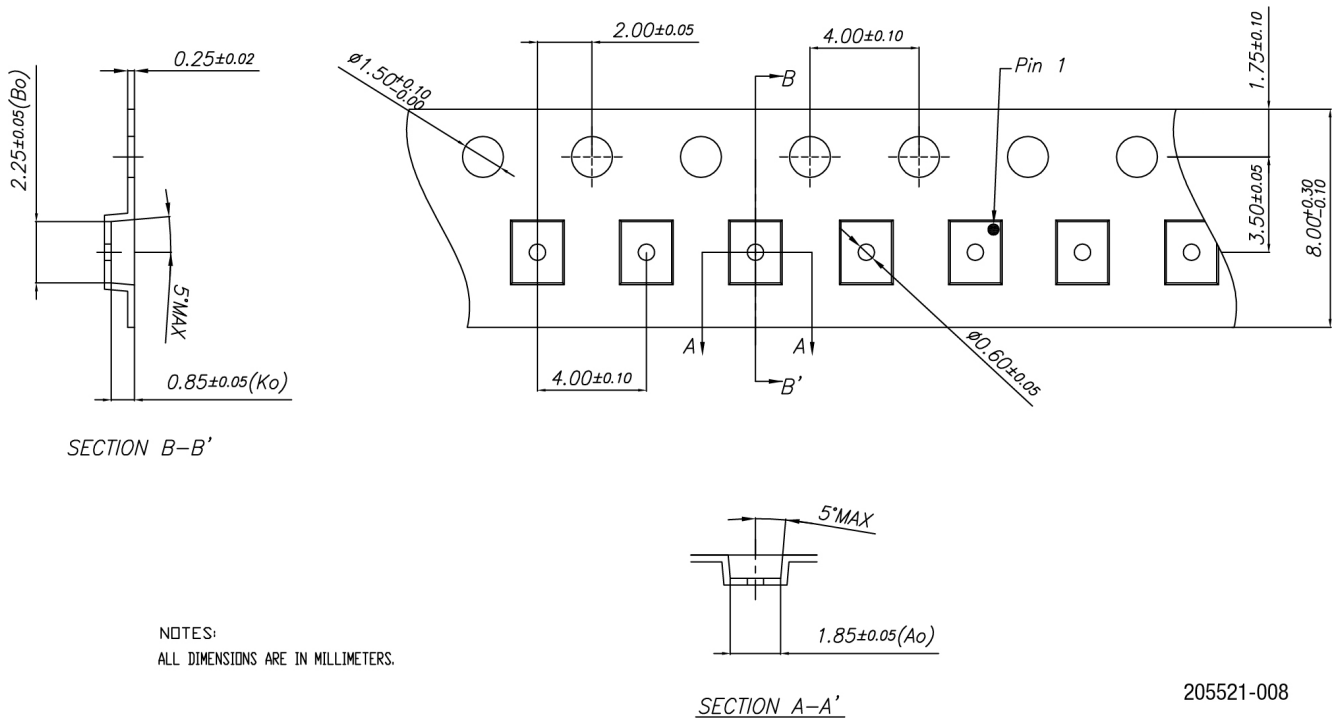
Figure 8. SKY55951-11 Tape and Reel Dimensions

NOTES:
ALL DIMENSIONS ARE IN MILLIMETERS.

205521-008

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10   April 17, 2023

Ordering Information

Part Number	Part Description	Evaluation Board Part Number
SKY55951-11	GNSS L1 + L5 Dual-Frequency Low-Noise Amplifier Front-End Module with Post-Filter	SKY85347-11EK1

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