

DATA SHEET

SKY65943-11: GNSS Low-Noise Amplifier Front-End Module with Integrated Pre-Filter and Post-Filter

Applications

- Wearables
- Action cameras
- Drones
- Personal navigation devices
- GNSS radio receivers

Features

- Small signal gain: 16 dB
- Out-of-band P1dB: +6 dBm
- Out-of-band rejection: +80 dBc, 1627 to 1660 MHz
- Low noise figure: 1.7 dB
- Low current consumption: 2.9 mA @ 1.8 V
- Input/output impedance internally matched to 50 Ω
- Single DC supply: 1.62 to 3.3 V
- Minimum number of external SMT devices required
- Small MCM (10-pin, 2.5 x 2.5 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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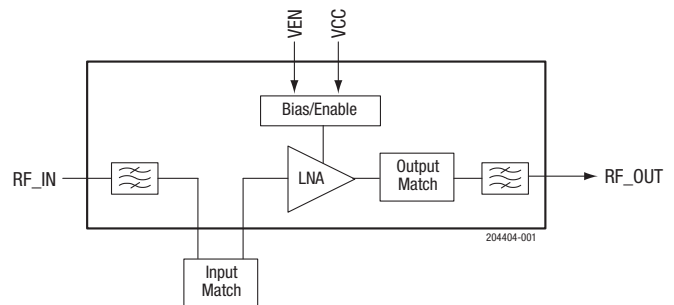


Figure 1. SKY65943-11 Block Diagram

Description

The SKY65943-11 is a front-end module (FEM) with an integrated low-noise amplifier (LNA) and pre-filter and post-filter designed for Global Navigation Satellite System (GNSS) receiver applications. The device provides high gain, excellent out-of-band rejection, and low noise figure. The pre-filter and post-filter provide low in-band insertion loss and excellent rejection for the cellular, PCS, and WLAN frequency bands. Output matching components are embedded inside the device. Only one external input matching inductor is required.

The SKY65943-11 is optimized to operate at 1559 to 1606 MHz, which makes it ideal for GPS / GLONASS / Galileo/Compass / QZSS radio receiver applications.

The SKY65943-11 uses surface-mount technology (SMT) in the form of a 2.5 x 2.5 mm Multi-Chip Module (MCM) package, which allows for a highly manufacturable and low-cost 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 provided in Table 1.

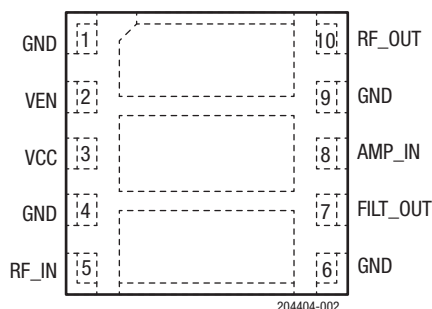


Figure 2. SKY65943-11 Pinout (Top View)

Table 1. SKY65943-11 Signal Descriptions

| Pin | Name | Description | Pin | Name | Description |
|-----|-------|------------------|-----|----------|---------------|
| 1 | GND | Ground | 6 | GND | Ground |
| 2 | VEN | LNA enable | 7 | FILT_OUT | Filter output |
| 3 | VCC | LNA power supply | 8 | AMP_IN | LNA input |
| 4 | GND | Ground | 9 | GND | Ground |
| 5 | RF_IN | RF input | 10 | RF_OUT | RF output |

Technical Description

LNA Enable

The VEN signal (pin 2) 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 SKY65943-11 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. SKY65943-11 Absolute Maximum Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|--------------------------------------------------------------|------------------|---------|---------|-------|
| RF input power | P _{IN} | | +10 | dBm |
| Supply voltage | V _{CC} | 0 | 3.4 | V |
| Storage temperature | T _{STG} | -55 | +150 | °C |
| Junction temperature | T _J | | +150 | °C |
| Electrostatic discharge: Human Body Model (HBM), Class 1A | ESD | | 250 | 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: *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. SKY65943-11 Recommended Operating Conditions

| Parameter | Symbol | Min | Typ | Max | Units |
|------------------|------------------------|-----------------------|------|-----------------|-------|
| Frequency | f | 1559 | 1575 | 1606 | MHz |
| Supply voltage | V _{CC} | 1.62 | | 3.3 | V |
| LNA enable: | | | | | |
| Enable (high) | LNA _{ENABLE} | V _{CC} - 0.3 | | V _{CC} | V |
| Disable (low) | LNA _{DISABLE} | | 0 | 0.3 | V |
| Case temperature | T _C | -40 | +25 | +85 | °C |

Table 4. SKY65943-11 Electrical Specifications¹
(V_{CC} = 1.8 V, V_{EN} = 1.8 V, f = 1575 MHz, T_c = +25 °C, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|-------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------|------|-------|-----|-------|
| Small signal gain | IS21I | P _{IN} = -30 dBm: | | | | |
| | | @ 1559 MHz | 12 | 15 | | dB |
| | | @ 1575 MHz | 13.5 | 15 | | dB |
| | | @ 1606 MHz | 12 | 15 | | dB |
| Noise figure | NF | @ 1559 MHz | | 2.2 | 2.6 | dB |
| | | @ 1575 MHz | | 1.7 | 2.0 | dB |
| | | @ 1606 MHz | | 2.0 | 2.4 | dB |
| In-band third order input intercept point | IIP3 | f ₁ = 1575 MHz @ P _{IN} = -30 dBm f ₂ = 1576 MHz @ P _{IN} = -30 dBm | | -7 | | dBm |
| In-band 1 dB input compression point | IP1dB | | | -13.5 | | dBm |
| Out-of-band 1dB input compression point | OOB_IP1dB | f _{OOB} = 1627 MHz, IP1dB@ f=1575 MHz | 6 | | | dBm |
| | | f _{OOB} = 1540 MHz, IP1dB@ f=1575 MHz | 6 | | | dBm |
| Reverse isolation | IS12I | P _{IN} = -30 dBm | 30 | 38 | | dB |
| Input return loss | IS11I | P _{IN} = -30 dBm | | 10 | | dB |
| Output return loss | IS22I | P _{IN} = -30 dBm | | 13 | | dB |
| Supply current | I _{CC} | No RF | | 2.9 | 4.0 | mA |
| Shutdown current | I _{LEAK} | No RF, V _{EN} = 0 V | | 0.1 | 1 | μA |
| Out-of-band rejection | OOB | P _{IN} = 0 dBm (in-band referred): | | | | |
| | | @ 10 to 300 MHz | | +80 | | dBc |
| | | @ 300 to 700 MHz | | +90 | | dBc |
| | | @ 700 to 1525 MHz | | +85 | | dBc |
| | | @ 1525 to 1540 MHz | | +60 | | dBc |
| | | @ 1627 to 1660 MHz | | +80 | | dBc |
| | | @ 1660 to 2500 MHz | | +75 | | dBc |
| @ 2500 to 6000 MHz | | +65 | | dBc | | |
| LNA turn-on time | t _{ON} | P _{IN} = -30 dBm, V _{CC} = 1.8 V, 50% of Venable to 90% final RF power | | 1 | 1.5 | μS |
| LNA turn-off time | t _{OFF} | P _{IN} = -30 dBm, V _{CC} = 1.8 V, 50% of Venable to 10% final RF power | | 0.1 | 0.2 | μS |

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

Table 5. SKY65943-11 Electrical Specifications¹
(V_{CC} = 2.8 V, V_{EN} = 2.8 V, f = 1575 MHz, T_c = +25 °C, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|-------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------|------|-------|-----|-------|
| Small signal gain | IS21I | P _{IN} = -30 dBm: | | | | |
| | | @ 1559 MHz | 13.5 | 16 | | dB |
| | | @ 1575 MHz | 14.5 | 16 | | dB |
| | | @ 1606 MHz | 13.0 | 15.5 | | dB |
| Noise figure | NF | @ 1559 MHz | | 2.2 | 2.6 | dB |
| | | @ 1575 MHz | | 1.7 | 2.0 | dB |
| | | @ 1606 MHz | | 2.0 | 2.4 | dB |
| In-band third order input intercept point | IIP3 | f ₁ = 1575 MHz @ P _{IN} = -30 dBm f ₂ = 1576 MHz @ P _{IN} = -30 dBm | | -7 | | dBm |
| In-band 1 dB input compression point | IP1dB | | | -13.0 | | dBm |
| Out-of-band 1dB input compression point | OOB_IP1dB | f _{OOB} = 1627 MHz, IP1dB@ f=1575 MHz | 6 | | | dBm |
| | | f _{OOB} = 1540 MHz, IP1dB@ f=1575 MHz | 6 | | | dBm |
| Reverse isolation | IS12I | P _{IN} = -30 dBm | | 40 | | dB |
| Input return loss | IS11I | P _{IN} = -30 dBm | | 12 | | dB |
| Output return loss | IS22I | P _{IN} = -30 dBm | | 18 | | dB |
| Supply current | ICC | No RF | | 3 | 4.5 | mA |
| Shutdown current | ILEAK | No RF, V _{EN} = 0 V | | 0.1 | 1 | µA |
| Out-of-band rejection | OOB | P _{IN} = 0 dBm (in-band referred): | | | | |
| | | @ 10 to 300 MHz | | +80 | | dBc |
| | | @ 300 to 700 MHz | | +90 | | dBc |
| | | @ 700 to 1525 MHz | | +85 | | dBc |
| | | @ 1525 to 1540 MHz | | +60 | | dBc |
| | | @ 1627 to 1660 MHz | | +80 | | dBc |
| @ 1660 to 2500 MHz | | +75 | | dBc | | |
| @ 2500 to 6000 MHz | | +65 | | dBc | | |
| LNA turn-on time | T _{ON} | P _{IN} = -30 dBm, V _{CC} = 2.8 V, 50% of Venable to 90% final RF power | | 1 | 1.5 | µS |
| LNA turn-off time | T _{OFF} | P _{IN} = -30 dBm, V _{CC} = 2.8 V, 50% of Venable to 10% final RF power | | 0.1 | 0.2 | µS |

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

Evaluation Board Description

The SKY65943-11 Evaluation Board is used to test the performance of the SKY65943-11 LNA. An assembly drawing for the Evaluation Board is shown in Figure 3. The Evaluation Board schematic diagram is shown in Figure 4. Table 6 provides the Bill of Materials (BOM) list for Evaluation Board components.

Package Dimensions

The PCB layout footprint for the SKY65943-11 is provided in Figure 5. Typical part markings are 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 SKY65943-11 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.

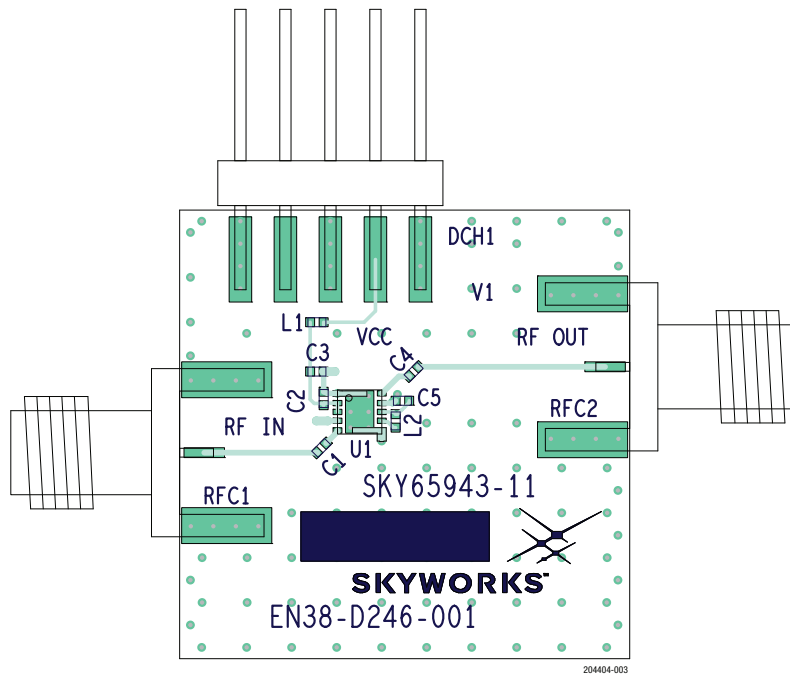


Figure 3. SKY65943-11 Evaluation Board Assembly Diagram

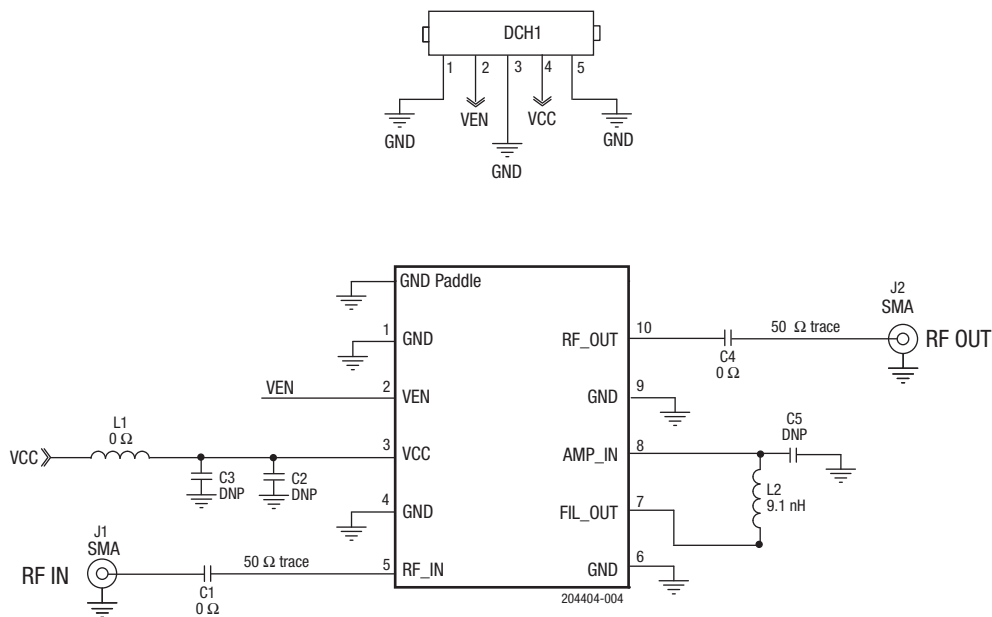
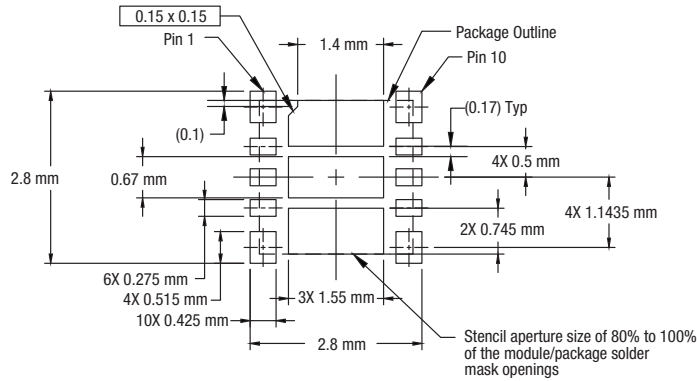


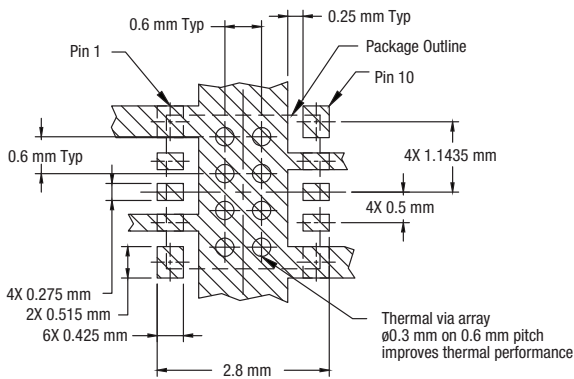
Figure 4. SKY65943-11 Evaluation Board Schematic

Table 6. SKY65943-11 Evaluation Board Bill of Materials

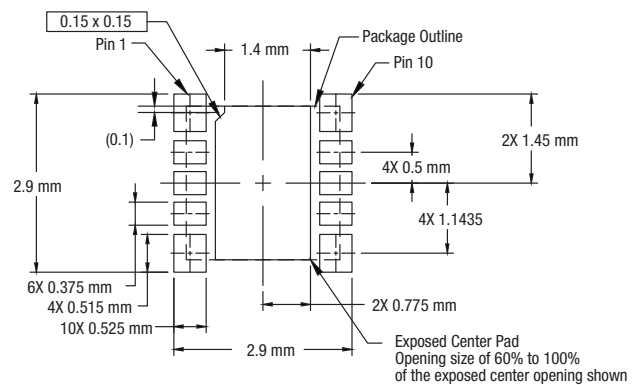
| Component | Size | Value | Manufacturer | Mfr Part Number |
|---------------|------|--------|--------------|-----------------|
| L1 (optional) | 0402 | 0 Ω | Panasonic | ERJ-2GE0R00X |
| L2 | 0402 | 9.1 nH | Murata | LQW15AN9N1J00D |
| C1, C4 | 0402 | 0 Ω | Panasonic | ERJ-2GE0R00X |
| C2, C3, C5 | 0402 | DNP | | DNP |



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 5. SKY65943-11 PCB Layout Footprint

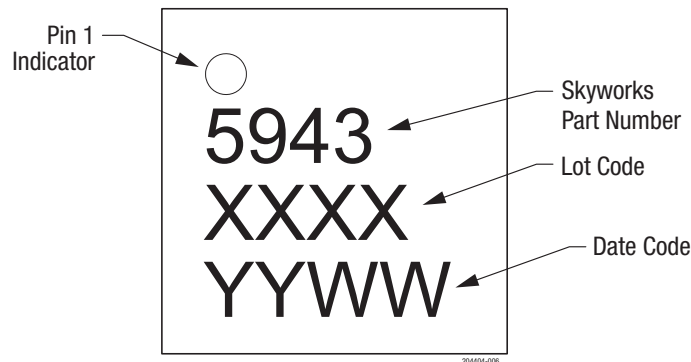
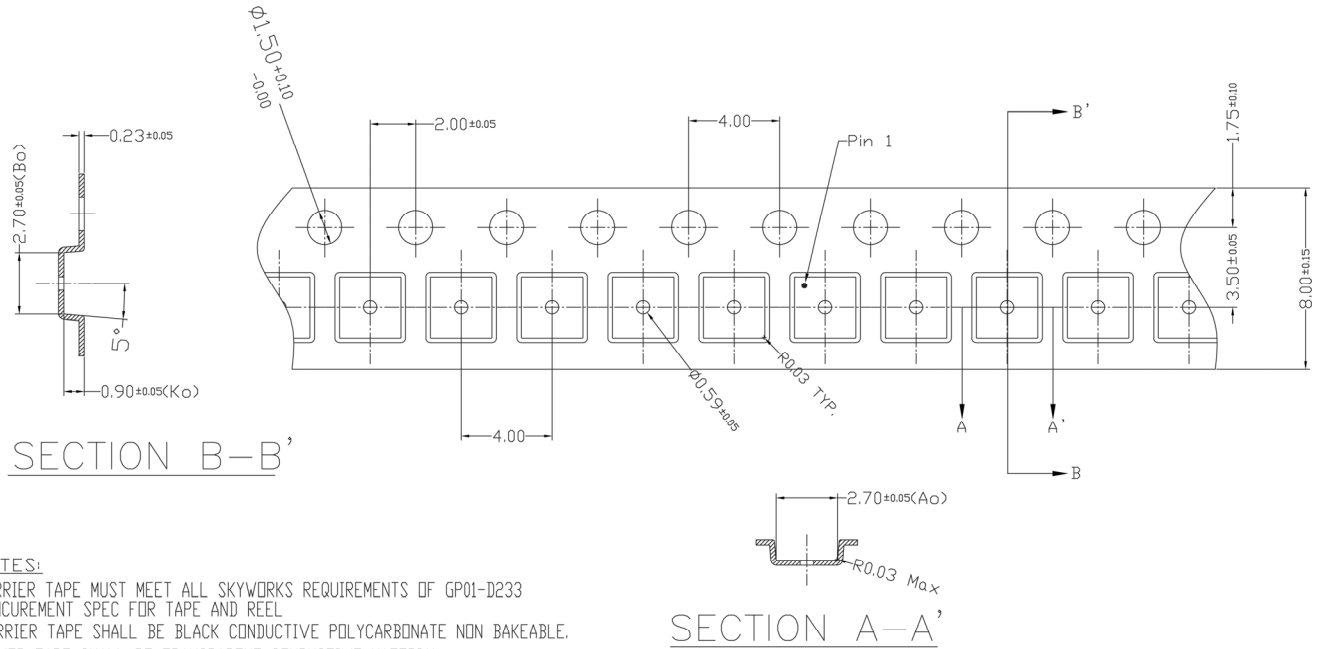


Figure 6. Typical Part Markings (Top View)

DATA SHEET • SKY65943-11: GNSS LOW-NOISE AMPLIFIER FEM WITH INTEGRATED PRE-FILTER AND POST-FILTER



- NOTES:**
1. CARRIER TAPE MUST MEET ALL SKYWORKS REQUIREMENTS OF GP01-D233 PROCUREMENT SPEC FOR TAPE AND REEL
 2. CARRIER TAPE SHALL BE BLACK CONDUCTIVE POLYCARBONATE NON BAKEABLE.
 3. COVER TAPE SHALL BE TRANSPARENT CONDUCTIVE MATERIAL
 4. ESD-SURFACE RESISTIVITY SHALL MEET GP01-D233
 5. 10 SPRUCKEL HOLE PITCH CUMULATIVE TOLERANCE : $\pm 0.20\text{mm}$
 6. Ao & Bo MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
 7. ALL DIMENSIONS ARE IN MILLIMETERS.

SECTION A-A'

Figure 8. SKY65943-11 Tape and Reel Dimensions

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Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|-------------|----------------------------------------------------------------------|------------------------------|
| SKY65943-11 | GNSS LNA Front-End Module with Integrated Pre-Filter and Post-Filter | SKY65943-11-EVB |

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