# Ultra-Low Noise Amplifier for Global Navigation Satellite Systems (GNSS)

## FEATURES

- Reduce RF environment Interference with patented Smart-Linearity-Technology (SLT);
- Ultra low noise figure(NF)=0.55dB;
- High power gain=18dB;
- High linearity IIP3oob=0dBm;
- High input 1dB-compression point=-9.5dBm;
- GPS L1 requires only one input matching inductor;
- RF output internally matched to 50 ohm for GPS L1;
- Supply voltage: 1.5V to 3.3V;
- Operating frequencies: 1550~1615MHz; 1164~1215MHz;
- FCDFN-6L package:1.1mmX0.7mmX0.37mm
- 2000V HBM ESD protection (including RFIN and RFOUT pin)

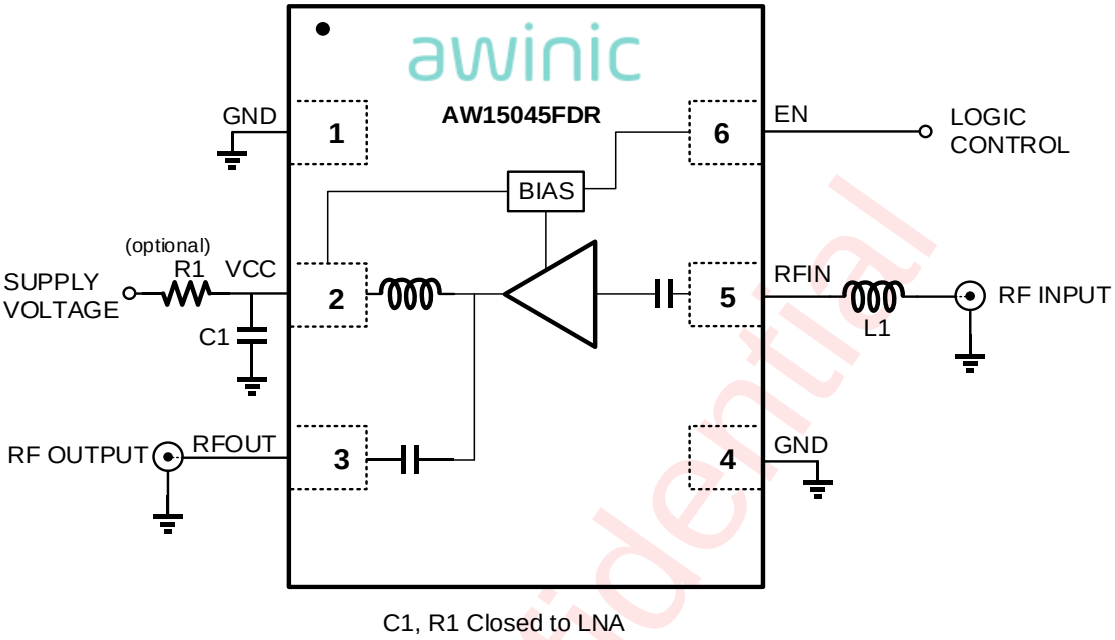
## APPLICATIONS

- Smart Phones, Feature Phones;
- Tablet PCs;
- Personal Navigation Devices;
- Digital Still Cameras, Digital Video Cameras;
- RF Front End modules;
- Complete GPS chipset modules;
- Theft protection(laptop, ATM);

## GENERAL DESCRIPTION

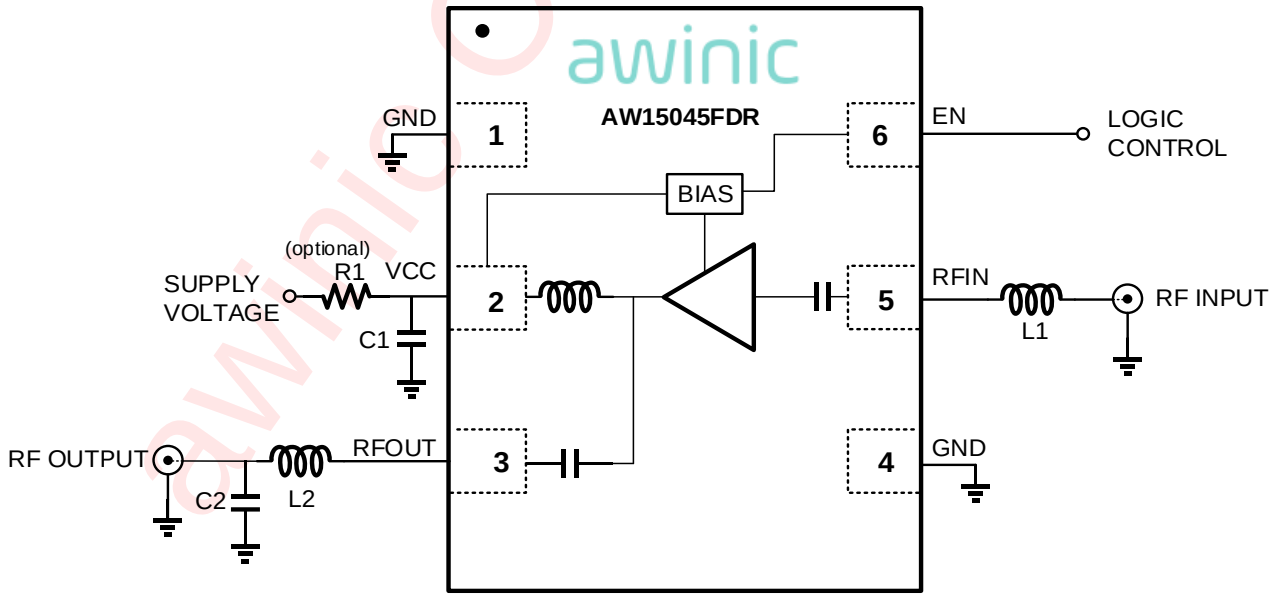
- The AW15045FDR is a Low Noise Amplifier designed for Global Navigation Satellite Systems (GNSS) as GPS, Beidou, GLONASS, Galileo and Compass. With on-chip DC blocking capacitors at RFIN and RFOUT, The AW15045FDR can be close to the antenna, requires only one external input matching inductor, and reduces assembly complexity and the PCB area, enabling a cost-effective solution.
- The AW15045FDR with patented Smart Linearity Technology (SLT) achieves ultra-low noise figure, high linearity, high gain, over a wide range of supply voltages from 1.5V up to 3.3V. All these features make AW15045FDR an excellent choice for GNSS LNA as it improves sensitivity with low noise figure and high gain, provide better immunity against out-of-band jammer signals with high linearity, reduces filtering requirement of preceding stage and hence reduces the overall cost of the GNSS receiver.
- The AW15045FDR is available in a small lead-free, RoHS-Compliant, 1.1mm x 0.7mm x 0.37mm 6-pin FCDFN package.

## TYPICAL APPLICATION CIRCUIT




C1, R1 Closed to LNA

**Figure 1(a) Typical Application Circuit of AW15045FDR for GPS L1**




C1, R1 Closed to LNA

**Figure 1(b) Typical Application Circuit of AW15045FDR for GPS L5**

# RECOMMENDED COMPONENTS LIST

Table1 and talble2 list the recommended components types and values.

Table1: list of inductor for GPS L1

| Component | Part Number | Inductance (nH) | Q(min) | Q Test Frequency (MHz) | Supplier | Size |
|---|---|---|---|---|---|---|
| L1 | LQW15A | 10 | 25 | 250 | Murata | 0402 |
| L1 | SDWL1005C | 10 | 24 | 250 | Sunlord | 0402 |
| | | | | | | |
| Component | Part Number | Capacitance (pF) | Rated Voltage (V) | | Supplier | Size |
| C1 | GRM155 | 1000 | 50 | | Murata | 0402 |

Table2: list of inductor for GPS L5

| Component | Part Number | Inductance (nH) | Q(min) | Q Test Frequency (MHz) | Supplier | Size |
|---|---|---|---|---|---|---|
| L1 | LQW15A | 20 | 25 | 250 | Murata | 0402 |
| L2 | LQW15A | 12 | 25 | 250 | Murata | 0402 |
| | | | | | | |
| Component | Part Number | Capacitance (pF) | Rated Voltage (V) | | Supplier | Size |
| C1 | GRM155 | 1000 | 50 | | Murata | 0402 |
| C2 | GRM155 | 5.6 | 50 | | Murata | 0402 |

## PIN CONFIGURATION AND TOP MARK

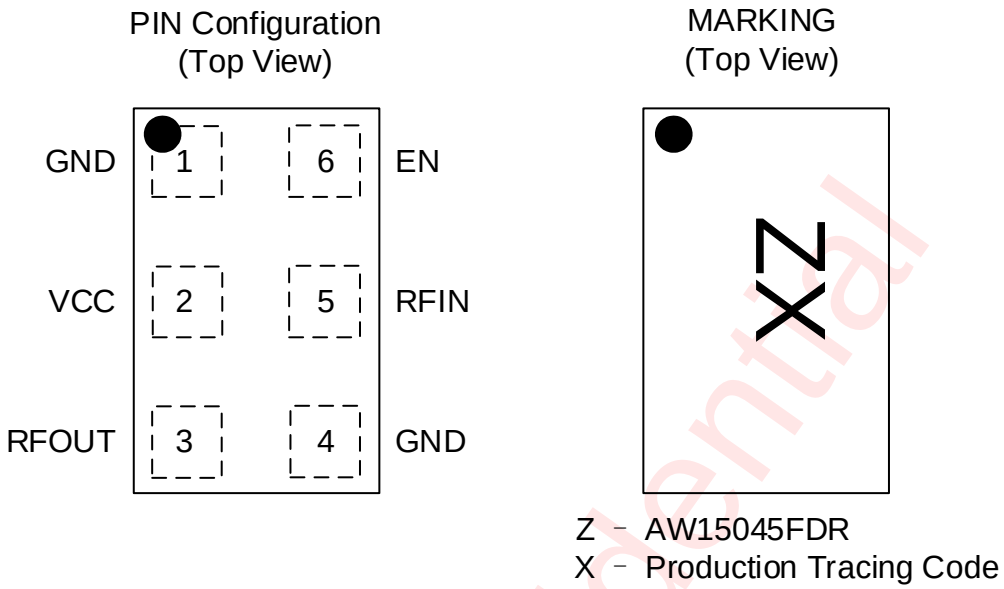



**Figure 2 Pin Configuration and Top Mark**

## PIN DEFINITION

| No. | NAME | DESCRIPTION |
|---|---|---|
| 1 | GND | Ground |
| 2 | VCC | DC Supply |
| 3 | RFOUT | LNA output |
| 4 | GND | Ground |
| 5 | RFIN | LNA input |
| 6 | EN | Logic control |

## FUNCTIONAL BLOCK DIAGRAM

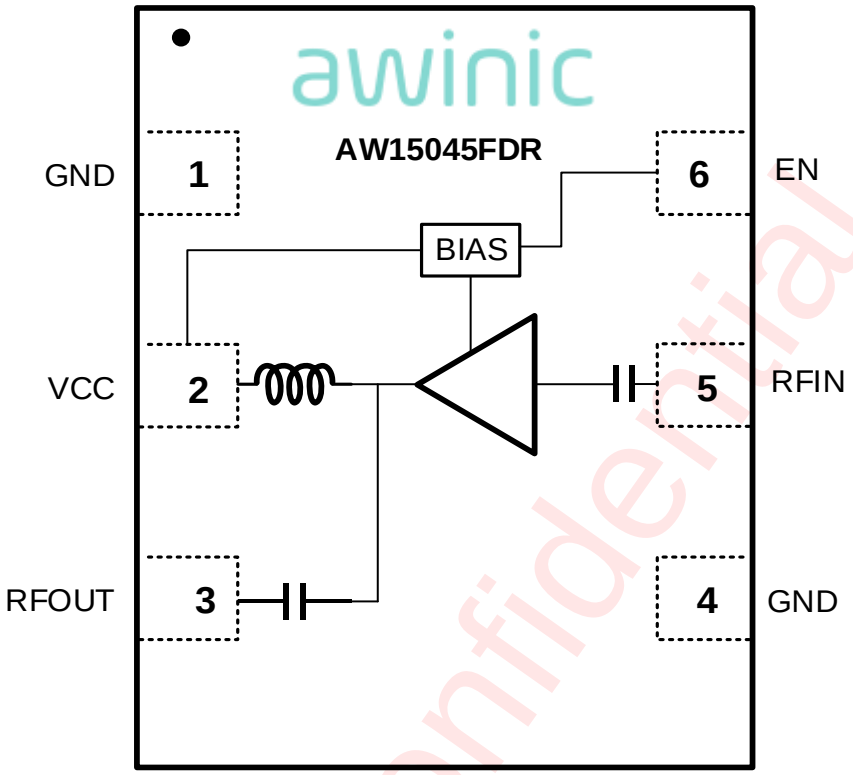



**Figure 3 Functional Block Diagram**

## ORDERING INFORMATION

| Part Number | Temperature | Package | Marking | Moisture Sensitivity Level | Environmental Information | Delivery Form |
|---|---|---|---|---|---|---|
| AW15045FDR | -40°C ~ 85°C | FCDFN 1.1mmx0.7mm-6L | Z | MSL1 | ROHS+HF | 3000 units/ Tape and Reel |

## ABSOLUTE MAXIMUM RATINGS[1]

| PARAMETERS | Symbol | Values | | | |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Supply Voltage at pin VCC | $V_{CC}$ | -0.3 | - | 3.6 | V |
| Voltage at pin EN [2] | $V_{EN}$ | -0.3 | - | 3.6 | V |
| Current into pin VCC | $I_{CC}$ | - | - | 30 | mA |
| RF input power [3] | $P_{IN}$ | - | - | 15 | dBm |
| Package thermal resistance | $\theta_{JA}$ | - | 148 | - | ℃/W |
| Junction temperature | $T_J$ | - | - | 150 | ℃ |
| Storage temperature range | $T_{STG}$ | -65 | - | 150 | ℃ |
| Ambient temperature range | $T_{amb}$ | -40 | - | 85 | ℃ |
| Solder temperature(10s) | | - | 260 | - | ℃ |
| ESD range | | | | | |
| HBM [4] | | ±2000 | | | V |
| CDM [4] | | ±1000 | | | V |
| Latch-up | | | | | |
| Standard: JEDEC EIA/JESD78E | | +IT: +400<br>-IT: -400 | | | mA<br>mA |

***Note1**: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.*

*These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.*

***Note2:** Warning: due to internal ESD diode protection, the applied DC voltage should not exceed 5.0V in order to avoid excess current.*

***Note3**: The RF input and RF output are AC coupled through internal DC blocking capacitor.*

***Note4**: HBM standard: MIL-STD-883H Method 3015.9. CDM standard: JEDEC EIA/JESD22-C101F.*

## ELECTRICAL CHARACTERISTICS

(AW15045FDR EVB; Typical values are at VCC=2.8V and TA=+25°C, f=1550-1615MHz, unless otherwise noted)

| PARAMETER | | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **DC ELECTRICAL CHARACTERISTICS** | | | | | | |
| $V_{CC}$ | Supply Voltage | | 1.5 | - | 3.3 | V |
| $I_{SD}$ | Shut-Down Current | EN=Low | | | 1 | μA |
| $I_{CC}$ | Supply Current | EN=High | | 6.0 | 8.0 | mA |
| $V_{EN}$ | Digital Input-Logic High | | 0.80 | | 3.3 | V |
| $V_{EN}$ | Digital Input-Logic Low | | | | 0.45 | V |
| $I_{EN}$ | Digital Input-Logic High | | | | 15 | μA |
| **AC ELECTRICAL CHARACTERISTICS** | | | | | | |
| Gp | Power Gain | | 15.5 | 18.0 | 19.5 | dB |
| $RL_{in}$ | Input Return Loss | | 6.0 | 9.0 | | dB |
| $RL_{out}$ | Output Return Loss | | 6.0 | 14.0 | | dB |
| ISL | Reverse Isolation | | 20.0 | 30.0 | | dB |
| NF | Noise Figure[2] | Zs=50 ohm;<br>No jammer | | 0.55 | 1.0 | dB |
| Kf | Stability factor | f=20MHz…10GHz | 1 | | | |
| IP1dB | Inband input<br>1dB-compression point | f=1575.42MHz | -13.0 | -9.5 | | dBm |
| $IIP3_{ib}$ | Inband input<br>$3^{rd}$-order intercept point | f1=1575.42MHz;<br>f2=1576.42MHz;<br>Pin=-30dBm; | -5.0 | -3.0 | | dBm |
| $IIP3_{oob}$ | Out-of-band input<br>$3^{rd}$-order intercept point | f1=1712.7MHz;<br>f2=1850MHz;<br>Pin=-30dBm; | -5.0 | 0.0 | | dBm |
| $t_{on}$ | turn-on time | time from $V_{EN}$ ON to 90% of the final gain | | 2.2 | 3.0 | μs |
| $t_{off}$ | turn-off time | time from $V_{EN}$ OFF to 10% of the gain | | 1.7 | 3.0 | μs |

***Note1**: input matched to 50 ohm using a high quality-factor 10nH inductor.*

***Note2**: 0.08dB PCB losses are subtracted.*

(AW15045FDR EVB; Typical values are at VCC=1.8V and TA=+25°C, f=1550-1615MHz, unless otherwise noted)

| PARAMETER | | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **DC ELECTRICAL CHARACTERISTICS** | | | | | | |
| $V_{CC}$ | Supply Voltage | | 1.5 | - | 3.3 | V |
| $I_{SD}$ | Shut-Down Current | EN=Low | | | 1 | μA |
| $I_{CC}$ | Supply Current | EN=High | | 6.0 | 8.0 | mA |
| $V_{EN}$ | Digital Input-Logic High | | 0.80 | | 3.3 | V |
| $V_{EN}$ | Digital Input-Logic Low | | | | 0.45 | V |
| $I_{EN}$ | Digital Input-Logic High | | | | 15 | μA |
| **AC ELECTRICAL CHARACTERISTICS** | | | | | | |
| Gp | Power Gain | | 15.5 | 17.7 | 19.5 | dB |
| $RL_{in}$ | Input Return Loss | | 6.0 | 8.5 | | dB |
| $RL_{out}$ | Output Return Loss | | 6.0 | 14.0 | | dB |
| ISL | Reverse Isolation | | 20.0 | 30.0 | | dB |
| NF | Noise Figure[2] | Zs=50 ohm;<br>No jammer | | 0.55 | 1.0 | dB |
| Kf | Stability factor | f=20MHz…10GHz | 1 | | | |
| IP1dB | Inband input<br>1dB-compression point | f=1575.42MHz | -13.0 | -10.0 | | dBm |
| $IIP3_{ib}$ | Inband input<br>$3^{rd}$-order intercept point | f1=1575.42MHz;<br>f2=1576.42MHz;<br>Pin=-30dBm; | -7.0 | -4.0 | | dBm |
| $IIP3_{oob}$ | Out-of-band input<br>$3^{rd}$-order intercept point | f1=1712.7MHz;<br>f2=1850MHz;<br>Pin=-30dBm; | -5.0 | -0.8 | | dBm |
| $t_{on}$ | turn-on time | time from $V_{EN}$ ON to 90% of the final gain | | 2.2 | 3.0 | μs |
| $t_{off}$ | turn-off time | time from $V_{EN}$ OFF to 10% of the gain | | 1.7 | 3.0 | μs |

***Note1**: input matched to 50 ohm using a high quality-factor 10nH inductor.*

***Note2**: 0.08dB PCB losses are subtracted.*

(AW15045FDR EVB; Typical values are at VCC=2.8V and TA=+25°C, f=1164-1215MHz, unless otherwise noted)

| PARAMETER | | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **DC ELECTRICAL CHARACTERISTICS** | | | | | | |
| $V_{CC}$ | Supply Voltage | | 1.5 | - | 3.3 | V |
| $I_{SD}$ | Shut-Down Current | EN=Low | | | 1 | μA |
| $I_{CC}$ | Supply Current | EN=High | | 6.0 | 8.0 | mA |
| $V_{EN}$ | Digital Input-Logic High | | 0.80 | | 3.3 | V |
| $V_{EN}$ | Digital Input-Logic Low | | | | 0.45 | V |
| $I_{EN}$ | Digital Input-Logic High | | | | 15 | μA |
| **AC ELECTRICAL CHARACTERISTICS** | | | | | | |
| Gp | Power Gain | | 15.5 | 17.7 | 19.5 | dB |
| $RL_{in}$ | Input Return Loss | | 8.0 | 12.0 | | dB |
| $RL_{out}$ | Output Return Loss | | 6.0 | 14.0 | | dB |
| ISL | Reverse Isolation | | 20.0 | 40.0 | | dB |
| NF | Noise Figure[2] | Zs=50 ohm;<br>No jammer | | 0.5 | 1.0 | dB |
| Kf | Stability factor | f=20MHz…10GHz | 1 | | | |
| IP1dB | Inband input<br>1dB-compression point | f=1176.45MHz | -15.0 | -13.3 | | dBm |
| $IIP3_{ib}$ | Inband input<br>3rd-order intercept point | f1=1176.45MHz;<br>f2=1177.45MHz;<br>Pin=-30dBm; | -6.0 | -4.0 | | dBm |
| $IIP3_{oob}$ | Out-of-band input<br>3rd-order intercept point | f1=1800MHz;<br>f2=2400MHz;<br>Pin=-30dBm; | -3 | 8.7 | | dBm |
| $t_{on}$ | turn-on time | time from $V_{EN}$ ON to 90% of the final gain | | 2.2 | 3.0 | μs |
| $t_{off}$ | turn-off time | time from $V_{EN}$ OFF to 10% of the gain | | 1.7 | 3.0 | μs |

***Note1**: input matched to 50 ohm using a high quality-factor 20nH inductor. Output matching using 12nH inductor and 5.6pF capacitor.*
***Note2**: 0.08dB PCB losses are subtracted.*

(AW15045FDR EVB; Typical values are at VCC=1.8V and TA=+25°C, f=1164-1215MHz, unless otherwise noted)

| PARAMETER | | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **DC ELECTRICAL CHARACTERISTICS** | | | | | | |
| $V_{CC}$ | Supply Voltage | | 1.5 | - | 3.3 | V |
| $I_{SD}$ | Shut-Down Current | EN=Low | | | 1 | μA |
| $I_{CC}$ | Supply Current | EN=High | | 6.0 | 8.0 | mA |
| $V_{EN}$ | Digital Input-Logic High | | 0.80 | | 3.3 | V |
| $V_{EN}$ | Digital Input-Logic Low | | | | 0.45 | V |
| $I_{EN}$ | Digital Input-Logic High | | | | 15 | μA |
| **AC ELECTRICAL CHARACTERISTICS** | | | | | | |
| Gp | Power Gain | | 15.5 | 17.5 | 19.5 | dB |
| $RL_{in}$ | Input Return Loss | | 8.0 | 12.0 | | dB |
| $RL_{out}$ | Output Return Loss | | 6.0 | 14.0 | | dB |
| ISL | Reverse Isolation | | 20.0 | 40.0 | | dB |
| NF | Noise Figure[2] | Zs=50 ohm;<br>No jammer | | 0.5 | 1.0 | dB |
| Kf | Stability factor | f=20MHz…10GHz | 1 | | | |
| IP1dB | Inband input<br>1dB-compression point | f=1176.45MHz | -17.0 | -14.0 | | dBm |
| IIP3ib | Inband input<br>3rd-order intercept point | f1=1176.45MHz;<br>f2=1177.45MHz;<br>Pin=-30dBm; | -10.0 | -5.0 | | dBm |
| IIP3oob | Out-of-band input<br>3rd-order intercept point | f1=1800MHz;<br>f2=2400MHz;<br>Pin=-30dBm; | -3 | 8.7 | | dBm |
| $t_{on}$ | turn-on time | time from $V_{EN}$ ON to 90% of the final gain | | 2.2 | 3.0 | μs |
| $t_{off}$ | turn-off time | time from $V_{EN}$ OFF to 10% of the gain | | 1.7 | 3.0 | μs |

***Note1**: input matched to 50 ohm using a high quality-factor 20nH inductor. Output matching using 12nH inductor and 5.6pF capacitor.*
***Note2**: 0.08dB PCB losses are subtracted.*

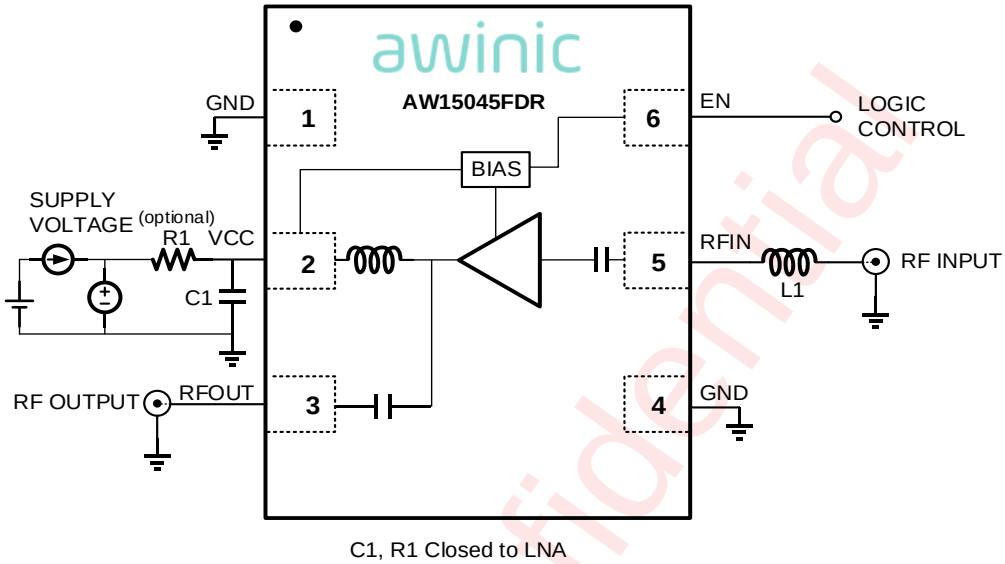


# TEST CIRCUITS

## DC Characteristics

The following is the test bench for power supply, pin voltage, supply current, standby current




C1, R1 Closed to LNA

**Figure 4 Test Circuits**

## S Parameter

The following is the test bench for input return loss, output return loss, reverse isolation, forward gain, and 1dB gain compression.

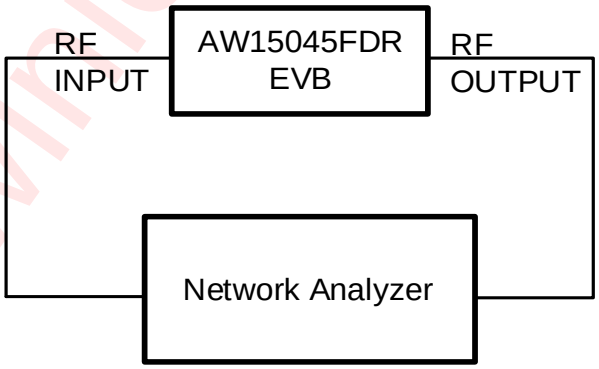



**Figure 5 S Parameter Test Bench**

## Noise Figure

The following is the test bench for noise figure, power gain.

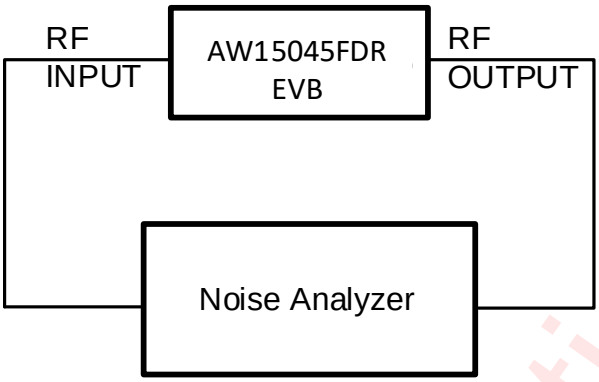



**Figure 6 Noise Figure Test Bench**

## Intermodulation distortion

The following is the test bench for third-order intercept point and second-order intercept point.

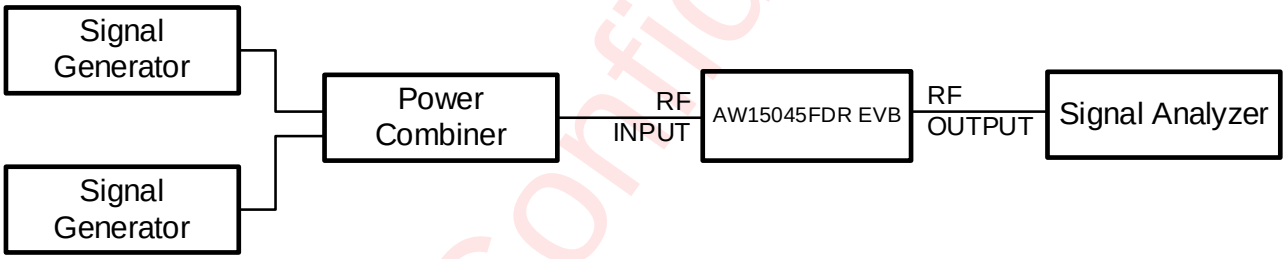
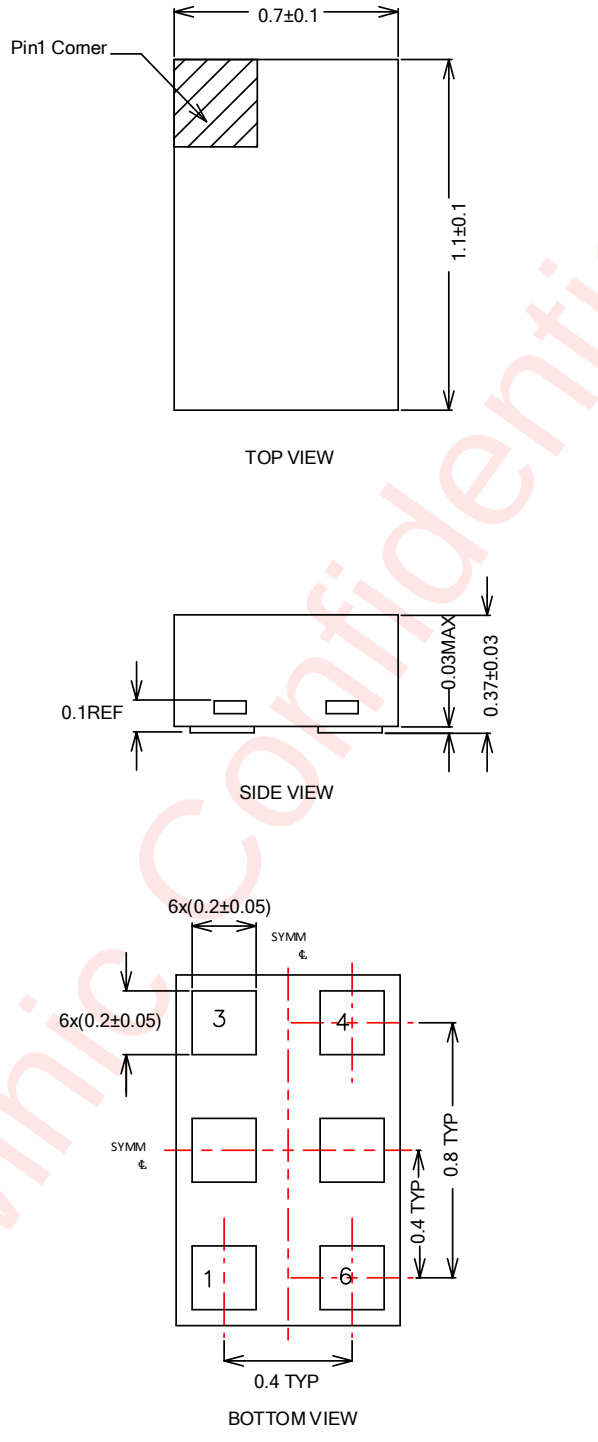



**Figure 7 IIP3 Test Bench**

# PACKAGE DESCRIPTION




Unit: mm

**Figure 8 Package Outline**

## LAND PATTERN

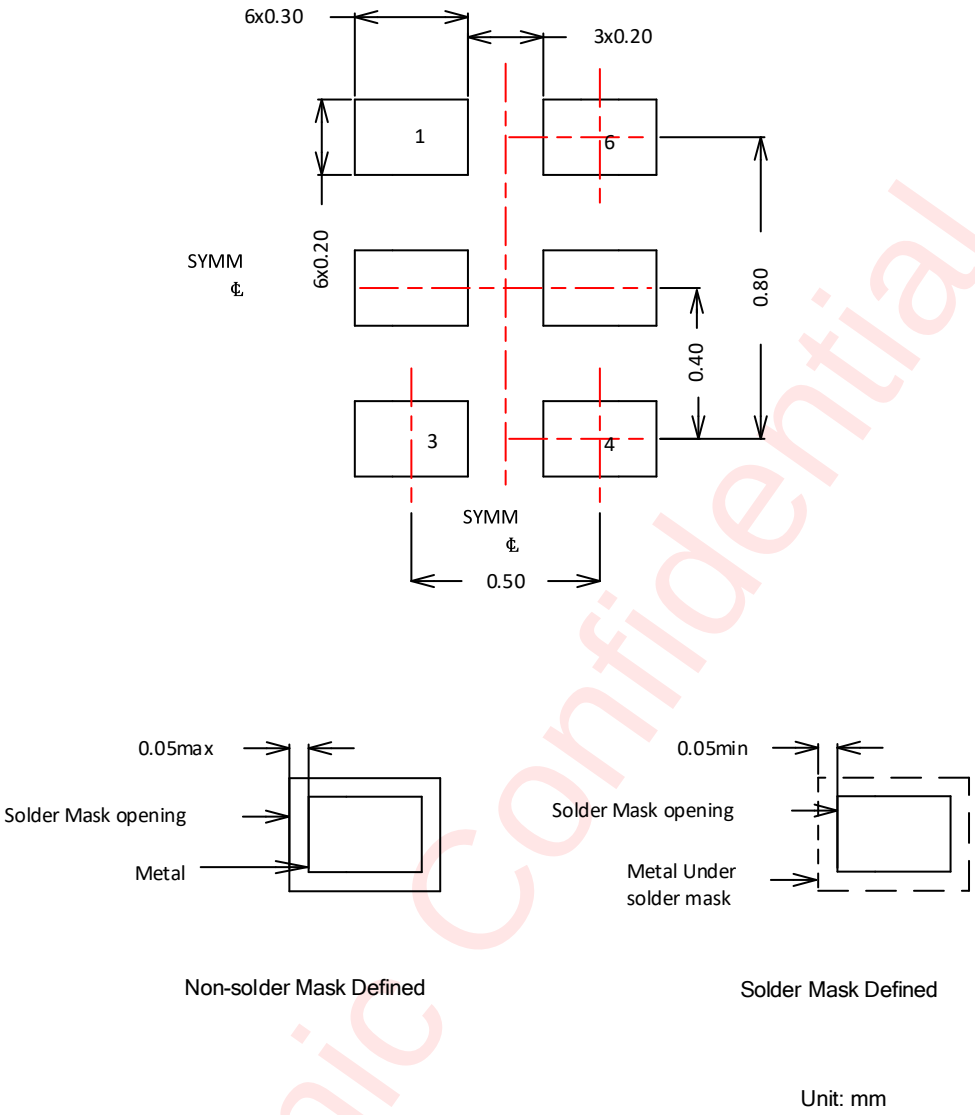
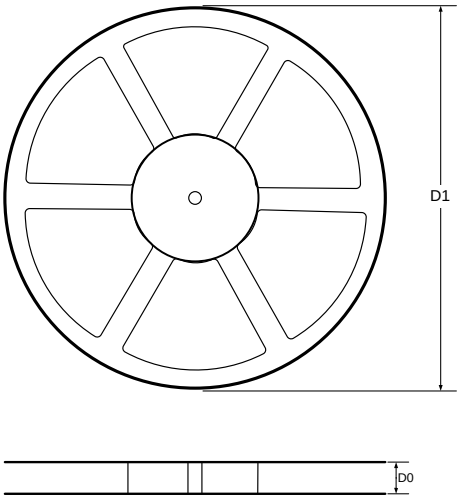


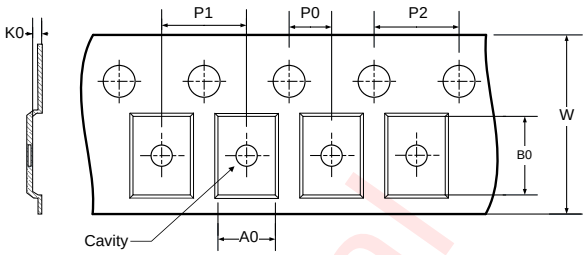

**Figure 9 Land Pattern**

# TAPE & REEL DESCRIPTION

REEL DIMENSIONS

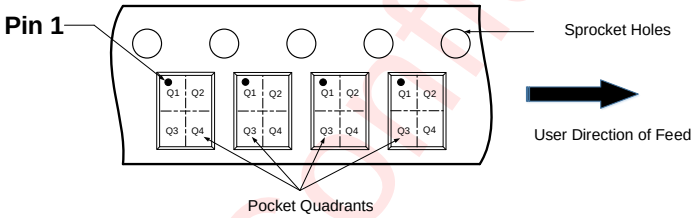



TAPE DIMENSIONS




A0：Dimension designed to accommodate the component width
B0：Dimension designed to accommodate the component length
K0：Dimension designed to accommodate the component thickness
W：Overall width of the carrier tape
P0：Pitch between successive cavity centers and sprocket hole
P1：Pitch between successive cavity centers
P2：Pitch between sprocket hole
D1：Reel Diameter
D0：Reel Width

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE




DIMENSIONS AND PIN1 ORIENTATION

| D1 (mm) | D0 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|
| 178 | 8.4 | 0.8 | 1.2 | 0.55 | 2 | 2 | 4 | 8 | Q1 |

**All dimensions are nominal**

**Figure 10 Tape & Reel Description**

# REVISION HISTORY

| Version | Date | Change Record |
|---|---|---|
| V1.0 | Jun. 2019 | Officially Released |
| V1.1 | Nov. 2019 | Updated Electrical Characteristics |
| V1.2 | Jan. 2020 | Updated Electrical Characteristics |
| V1.3 | Apr. 2020 | Updated Document Pattern |
| V1.4 | Aug. 2020 | Updated Electrical Characteristics |
| V1.5 | Aug. 2020 | Updated Electrical Characteristics |
| V1.6 | Apr. 2021 | Updated Electrical Characteristics |
| V1.7 | Jul. 2021 | Updated Electrical Characteristics |
| V1.8 | Nov. 2021 | Change the spec of L1 and L5; Change the spec of gain and $RL_{out}$ in L5 |

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