

## Low Noise Amplifier with Bypass Switch for LTE High Band

### FEATURES

- Operating frequency 2300MHz to 2690MHz
- Noise figure(NF) =1.0dB
- High power gain =13.4dB
- Insertion Loss in bypass mode =4dB
- Gain mode IIP3ib =+5dBm
- Gain mode input 1dB-compression point=-2dBm
- Bypass mode input 1dB-compression point=+8dBm
- Supply voltage: 1.5V to 3.3V
- Gain mode current 9mA
- Bypass mode current <1uA
- Input and output DC decoupled
- Requires only one input matching inductor
- Integrated matching for the output
- FCDFN 1.1mmX0.7mmX0.37mm -6L package
- 2kV HBM ESD protection (including RFIN and RFOUT pin)

### GENERAL DESCRIPTION

- The AW15208HFDR is a Low Noise Amplifier with bypass designed for LTE receiver applications. The AW15208HFDR requires only one external input matching inductor, reduces assembly complexity and the PCB area, enabling a cost-effective solution.
- The AW15208HFDR achieves 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 AW15208HFDR an excellent choice for LTE LNA as it improves sensitivity with low noise figure and high gain, provides better immunity against jammer signals with high linearity, reduces filtering requirement of preceding stage and hence reduces the overall cost.
- The AW15208HFDR is available in a small lead-free, RoHS-Compliant, FCDFN 1.1mmX0.7mmX0.37 mm -6L package.

### APPLICATIONS

- Cell phones
- Tablets
- Other RF front-end modules

### TYPICAL APPLICATION CIRCUIT

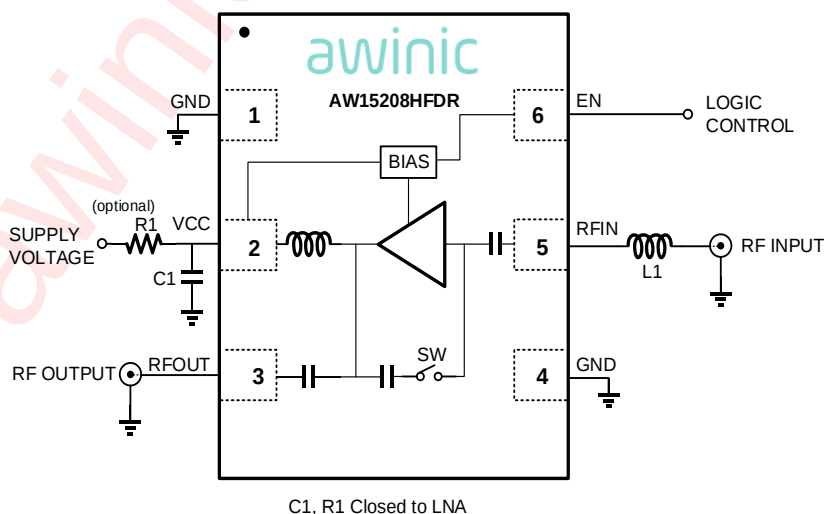


Figure 1 Typical Application Circuit of AW15208HFDR

## PIN CONFIGURATION AND TOP MARK

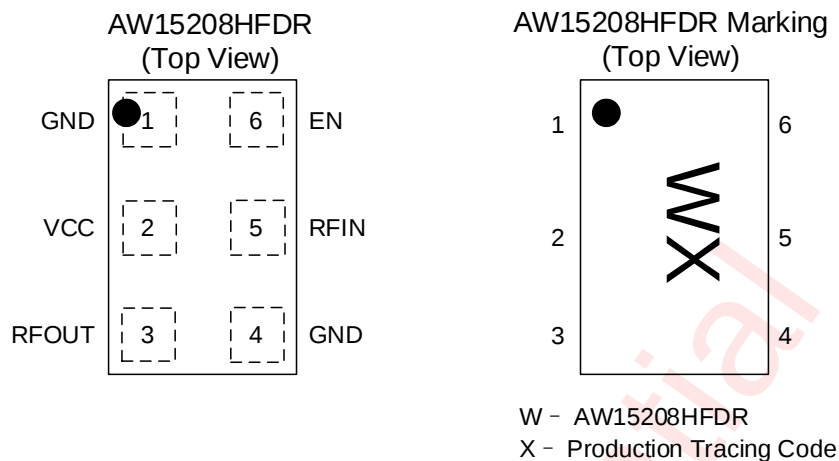


Figure 2 Pin Configuration and Top Mark

## PIN DEFINITION

| No. | NAME  | DESCRIPTION                                                                    |
|-----|-------|--------------------------------------------------------------------------------|
| 1   | GND   | Ground                                                                         |
| 2   | VCC   | Supply connection                                                              |
| 3   | RFOUT | RF output                                                                      |
| 4   | GND   | Ground                                                                         |
| 5   | RFIN  | RF input                                                                       |
| 6   | EN    | EN (high level) supports 1.8V/2.8V IO with internal 150Kohm pull-down resistor |

## FUNCTIONAL BLOCK DIAGRAM

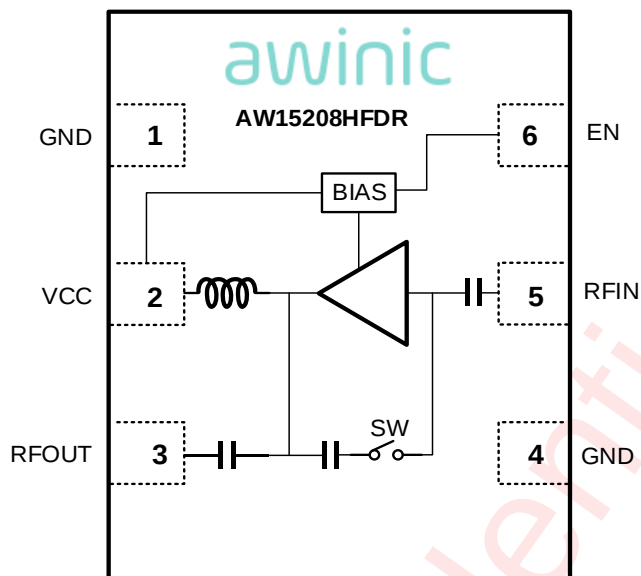


Figure 3 Functional Block Diagram

## ORDERING INFORMATION

| Part Number | Temperature | Package                      | Marking | Moisture Sensitivity Level | Environmental Information | Delivery Form                |
|-------------|-------------|------------------------------|---------|----------------------------|---------------------------|------------------------------|
| AW15208HFDR | -40℃~85℃    | FCDFN<br>1.1mmX<br>0.7mm -6L | W       | MSL1                       | ROHS+HF                   | 3000<br>units/Tape &<br>Reel |

**ABSOLUTE MAXIMUM RATINGS<sup>[1]</sup>**

| PARAMETERS                                     | RANGE                      |
|------------------------------------------------|----------------------------|
| Supply voltage VCC                             | -0.3V to 3.6V              |
| EN pin voltage                                 | -0.3V to 3.6V              |
| Supply maximum current ICC                     | 30mA                       |
| RF input power Pin                             | 25dBm                      |
| Maximum Junction temperature T <sub>JMAX</sub> | 150°C                      |
| Storage temperature T <sub>STG</sub>           | -65°C to 150°C             |
| Operating free-air temperature range           | -40°C to 85°C              |
| Lead temperature (Soldering 10 Seconds)        | 260°C                      |
| ESD <sup>[2]</sup>                             |                            |
| HBM                                            | ±2kV                       |
| CDM                                            | ±1kV                       |
| Latch-up                                       |                            |
| Standard: JEDEC STANDARD NO.78D NOVEMBER 2011  | +IT: +200mA<br>-IT: -200mA |

[1] Conditions out of those ranges listed in “absolute maximum ratings” may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in “recommended operating conditions”. Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

[2] The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: MIL-STD-883J Method 3015.9. The CDM test method: JEDEC EIA/JESD22-C101F.

**ELECTRICAL CHARACTERISTICS**

TA=+25°C , V<sub>CC</sub>=2.8V, EN=1.8V/2.8V, frequency=2300MHz to 2690MHz. Input matched to 50Ω using a 3.3nH<sup>[3]</sup> inductor in series. (unless otherwise noted).

| Symbol                              | Parameter                                            | Test Condition                                   | Min  | Typ  | Max  | Units |
|-------------------------------------|------------------------------------------------------|--------------------------------------------------|------|------|------|-------|
| <b>DC Electrical Characteristic</b> |                                                      |                                                  |      |      |      |       |
| VCC                                 | Supply Voltage                                       |                                                  | 1.5  | -    | 3.3  | V     |
| VEN                                 | Digital Input-Logic High                             |                                                  | 0.8  |      | 3.3  | V     |
|                                     | Digital Input-Logic Low                              |                                                  |      |      | 0.45 | V     |
| <b>Gain Mode</b>                    |                                                      |                                                  |      |      |      |       |
| ICC                                 | Supply Current                                       |                                                  |      | 9    | 12.5 | mA    |
| Gp                                  | Power Gain                                           | 2300MHz-2400MHz                                  | 12   | 13.6 | 14.5 | dB    |
|                                     |                                                      | 2400MHz-2496MHz                                  | 12   | 13.2 | 14.5 |       |
|                                     |                                                      | 2496MHz-2690MHz                                  | 12   | 12.8 | 14.5 |       |
|                                     |                                                      | f=2350MHz [4]                                    | 12   | 13.7 | 14.5 |       |
|                                     |                                                      | f=2655MHz [5]                                    | 12   | 13.0 | 14.5 |       |
| RLin                                | Input Return Loss                                    | f=2350MHz [4]                                    | 6    | 7    |      | dB    |
|                                     |                                                      | f=2655MHz [5]                                    | 6    | 9    |      |       |
| RLout                               | Output Return Loss                                   | f=2350MHz [4]                                    | 6    | 8    |      | dB    |
|                                     |                                                      | f=2655MHz [5]                                    | 6    | 7    |      |       |
| ISL                                 | Reverse Isolation                                    | f=2350MHz [4]                                    | 18   | 26   |      | dB    |
|                                     |                                                      | f=2655MHz [5]                                    | 18   | 26   |      |       |
| NF                                  | Noise Figure                                         | f=2350MHz [4][6]                                 |      | 1.0  | 1.4  | dB    |
|                                     |                                                      | f=2655MHz [5][6]                                 |      | 1.3  | 1.4  |       |
| IP1dB                               | In-band input 1dB-compression point                  | f=2350MHz [4]                                    | -6   | -3   |      | dBm   |
|                                     |                                                      | f=2655MHz [5]                                    | -6   | -1   |      |       |
| IIP3ib                              | In-band input 3 <sup>rd</sup> -order intercept point | f=2350MHz [4]                                    | -0.5 | 5    |      | dBm   |
|                                     |                                                      | f=2655MHz [5]                                    | -0.5 | 7.5  |      |       |
| ton                                 | turn-on time                                         | time from V <sub>EN</sub> ON to 90% of the gain  |      | 2    | 4    | μs    |
| toff                                | turn-off time                                        | time from V <sub>EN</sub> OFF to 10% of the gain |      | 1    | 2    | μs    |
| <b>Bypass Mode</b>                  |                                                      |                                                  |      |      |      |       |
| ICC                                 | Supply Current                                       | VEN<0.45V                                        |      |      | 1    | uA    |
| Gp                                  | Power Gain                                           | 2300MHz-2400MHz                                  | -4.5 | -3.8 |      | dB    |
|                                     |                                                      | 2400MHz-2496MHz                                  | -4.5 | -3.5 |      |       |
|                                     |                                                      | 2496MHz-2690MHz                                  | -4.5 | -3.5 |      |       |
|                                     |                                                      | f=2350MHz [4]                                    | -4.5 | -3.8 |      |       |
|                                     |                                                      | f=2655MHz [5]                                    | -4.5 | -3.5 |      |       |
| RLin                                | Input Return Loss                                    | f=2350MHz [4]                                    | 6    | 9    |      | dB    |
|                                     |                                                      | f=2655MHz [5]                                    | 6    | 9    |      |       |
| RLout                               | Output Return Loss                                   | f=2350MHz [4]                                    | 6    | 8.5  |      | dB    |

| Symbol | Parameter                                               | Test Condition | Min | Typ | Max | Units |
|--------|---------------------------------------------------------|----------------|-----|-----|-----|-------|
|        |                                                         | f=2655MHz [5]  | 6   | 7.5 |     |       |
| IP1dB  | In-band input<br>1dB-compression point                  | f=2350MHz [4]  | 2   | 7   |     | dBm   |
|        |                                                         | f=2655MHz [5]  | 2   | 8   |     |       |
|        |                                                         |                |     |     |     |       |
| IIP3ib | In-band input<br>3 <sup>rd</sup> -order intercept point | f=2350MHz [4]  | 6   | 8   |     | dBm   |
|        |                                                         | f=2655MHz [5]  | 6   | 8   |     |       |
|        |                                                         |                |     |     |     |       |

[3] High quality-factor 3.3nH inductor.

[4] E-UTRA operating band40(2300MHz to 2400MHz) , input power is -25dBm.

[5] E-UTRA operating band 7(2620MHz to 2690MHz) , input power is -25dBm.

[6] PCB losses are subtracted.

TA=+25°C , V<sub>CC</sub>=1.8V, EN=1.8V, frequency=2300MHz to 2690MHz. Input matched to 50Ω using a 3.3nH<sup>[3]</sup> inductor in series. (unless otherwise noted).

| Symbol                              | Parameter                                               | Test Condition                                   | Min  | Typ  | Max  | Units |
|-------------------------------------|---------------------------------------------------------|--------------------------------------------------|------|------|------|-------|
| <b>DC Electrical Characteristic</b> |                                                         |                                                  |      |      |      |       |
| VCC                                 | Supply Voltage                                          |                                                  | 1.5  | -    | 3.3  | V     |
| VEN                                 | Digital Input-Logic High                                |                                                  | 0.8  |      | 3.3  | V     |
|                                     | Digital Input-Logic Low                                 |                                                  |      |      | 0.45 | V     |
| <b>Gain Mode</b>                    |                                                         |                                                  |      |      |      |       |
| ICC                                 | Supply Current                                          |                                                  |      | 8.0  | 10   | mA    |
| Gp                                  | Power Gain                                              | 2300MHz-2400MHz                                  | 11.4 | 13.2 | 14   | dB    |
|                                     |                                                         | 2400MHz-2496MHz                                  | 11.4 | 12.8 | 14   |       |
|                                     |                                                         | 2496MHz-2690MHz                                  | 11.4 | 12.5 | 14   |       |
|                                     |                                                         | f=2350MHz [4]                                    | 11.4 | 13.2 | 14   |       |
|                                     |                                                         | f=2655MHz [5]                                    | 11.4 | 12.5 | 14   |       |
| RLin                                | Input Return Loss                                       | f=2350MHz [4]                                    | 6    | 7    |      | dB    |
|                                     |                                                         | f=2655MHz [5]                                    | 6    | 9    |      |       |
| RLout                               | Output Return Loss                                      | f=2350MHz [4]                                    | 6    | 8    |      | dB    |
|                                     |                                                         | f=2655MHz [5]                                    | 6    | 7    |      |       |
| ISL                                 | Reverse Isolation                                       | f=2350MHz [4]                                    | 18   | 26   |      | dB    |
|                                     |                                                         | f=2655MHz [5]                                    | 18   | 26   |      |       |
| NF                                  | Noise Figure                                            | f=2350MHz [4][6]                                 |      | 1.0  | 1.4  | dB    |
|                                     |                                                         | f=2655MHz [5][6]                                 |      | 1.3  | 1.4  |       |
| IP1dB                               | In-band input<br>1dB-compression point                  | f=2350MHz [4]                                    | -6   | -5.2 |      | dBm   |
|                                     |                                                         | f=2655MHz [5]                                    | -6   | -3.7 |      |       |
| IIP3ib                              | In-band input<br>3 <sup>rd</sup> -order intercept point | f=2350MHz [4]                                    | -0.5 | 3    |      | dBm   |
|                                     |                                                         | f=2655MHz [5]                                    | -0.5 | 5    |      |       |
| ton                                 | turn-on time                                            | time from VEN ON to 90% of the gain              |      | 2    | 4    | μs    |
| toff                                | turn-off time                                           | time from V <sub>EN</sub> OFF to 10% of the gain |      | 1    | 2    | μs    |
| <b>Bypass Mode</b>                  |                                                         |                                                  |      |      |      |       |
| ICC                                 | Supply Current                                          | V <sub>EN</sub> <0.45V                           |      |      | 1    | uA    |
| Gp                                  | Power Gain                                              | 2300MHz-2400MHz                                  | -4.8 | -4   |      | dB    |

| Symbol | Parameter                                               | Test Condition  | Min  | Typ  | Max | Units |
|--------|---------------------------------------------------------|-----------------|------|------|-----|-------|
|        |                                                         | 2400MHz-2496MHz | -4.8 | -3.8 |     |       |
|        |                                                         | 2496MHz-2690MHz | -4.8 | -3.8 |     |       |
|        |                                                         | f=2350MHz [4]   | -4.8 | -4   |     |       |
|        |                                                         | f=2655MHz [5]   | -4.8 | -3.8 |     |       |
| RLin   | Input Return Loss                                       | f=2350MHz [4]   | 6    | 8.5  |     | dB    |
|        |                                                         | f=2655MHz [5]   | 6    | 7.5  |     |       |
| RLout  | Output Return Loss                                      | f=2350MHz [4]   | 6    | 8.5  |     | dB    |
|        |                                                         | f=2655MHz [5]   | 6    | 7.5  |     |       |
| IP1dB  | In-band input<br>1dB-compression point                  | f=2350MHz [4]   | 2    | 5    |     | dBm   |
|        |                                                         | f=2655MHz [5]   | 2    | 5.5  |     |       |
| IIP3ib | In-band input<br>3 <sup>rd</sup> -order intercept point | f=2350MHz [4]   | 5    | 7    |     | dBm   |
|        |                                                         | f=2655MHz [5]   | 5    | 7    |     |       |

[3] High quality-factor 3.3nH inductor.

[4] E-UTRA operating band40(2300MHz to 2400MHz) , input power is -25dBm..

[5] E-UTRA operating band 7(2620MHz to 2690MHz) , input power is -25dBm.

[6] PCB losses are subtracted.

## MEASUREMENT DIAGRAM

### Test DC Characteristics(Current & Power Consumption)

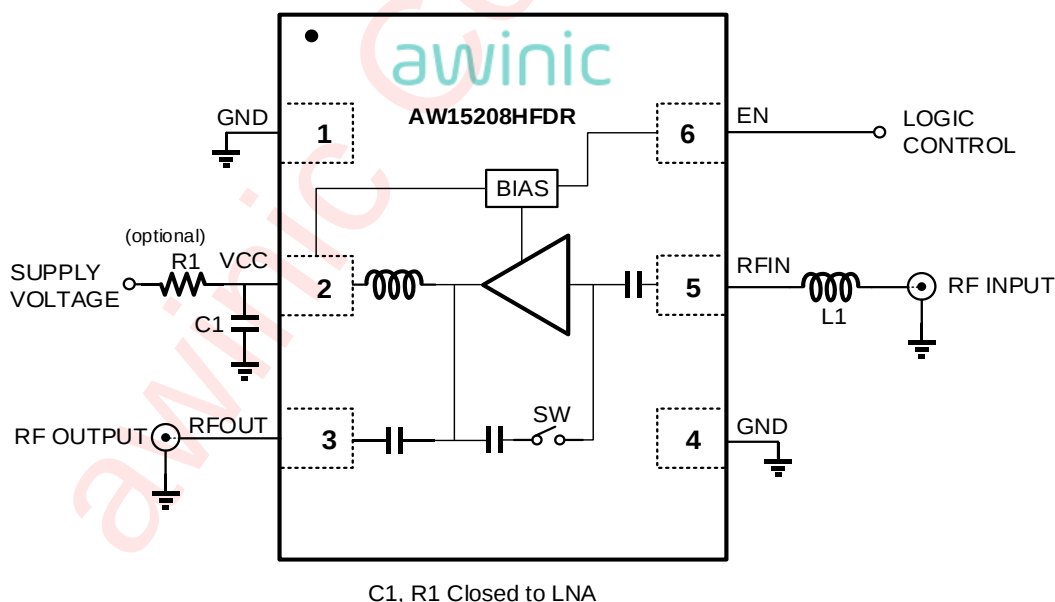
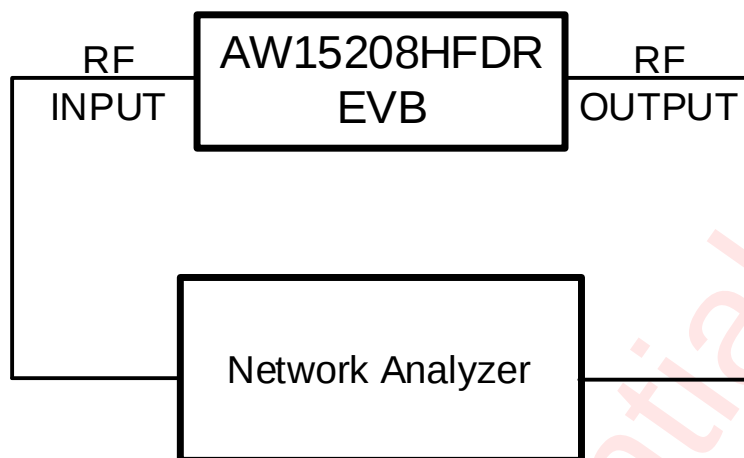
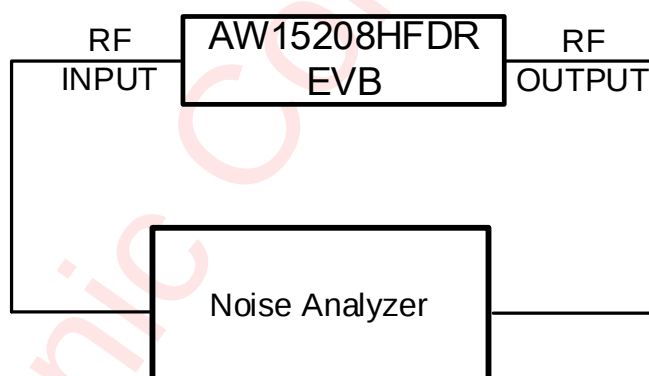
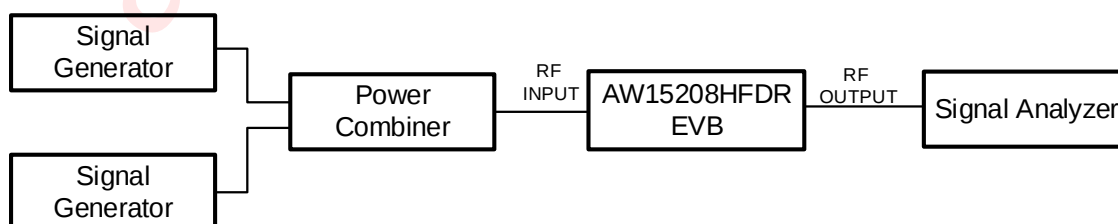


Figure 4 AW15208HFDR DC Test Diagram

**Test S-Parameter****Figure 5 AW15208HFDR S-parameter Measurement Diagram****Test Noise Figure****Figure 6 AW15208HFDR Noise Figure Measurement Diagram****Test IIP3****Figure 7 AW15208HFDR IIP3 Measurement Diagram**

## APPLICATION INFORMATION

### Choice of components

- The AW15208HFDR requires only one external inductor for input matching. If the device/phone manufacturers implement very good power supply filtering on their boards, the bypass capacitor mentioned in this application circuit may be optional. With the power supply decoupling capacitor, better performance would be received, like a little higher gain, etc. The value is optimized for the key performance, such as higher power gain, lower noise figure, and better return loss. Typical value of inductor is 3.3nH with high quality factor, and capacitor is 1nF. The typical application circuit can refer to Figure1.
- The output of AW15208HFDR is internally matched to 50 ohm and a DC blocking capacitor is integrated on-chip, thus no external component is required at the output.
- The AW15208HFDR should be placed close to the diversity antenna with the input-matching inductor. Use 50 ohm micro-strip lines to connect RF INPUT and RF OUTPUT. Bypass capacitor need be located close to the device. For long V<sub>CC</sub> lines, it may be necessary to add more decoupling capacitors. Proper grounding of the GND pins is very important.

Following tables show recommended inductor and capacitor values.

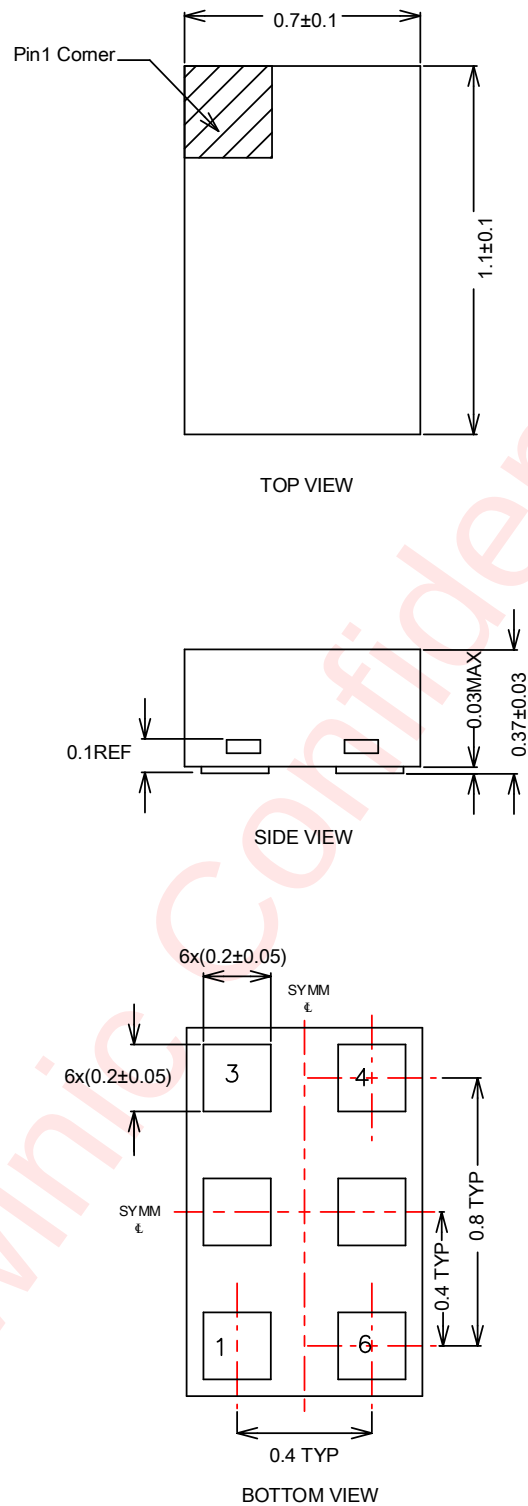
**Inductor Selection Table**

| Component | Part   | Typical(nH) | Q(min) | Frequency(MHz) | MFR    | Size |
|-----------|--------|-------------|--------|----------------|--------|------|
| L1        | LQW15A | 3.3         | 25     | 250            | Murata | 0402 |

**Capacitor Selection Table**

| Component | Part   | Typical(pF) | Voltage(V) | MFR    | Size |
|-----------|--------|-------------|------------|--------|------|
| C1        | GRM155 | 1000        | 50         | Murata | 0402 |

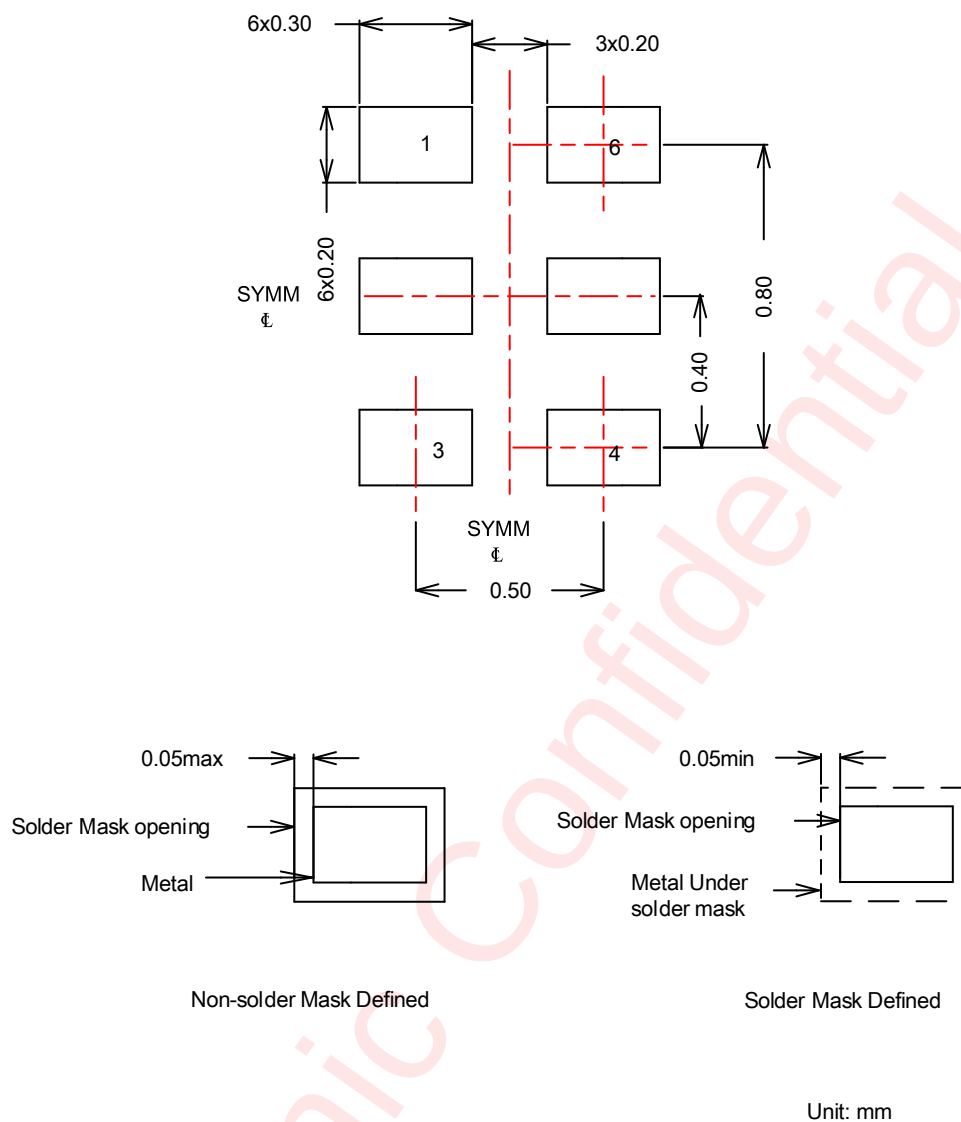
## PACKAGE DESCRIPTION



Unit : mm

Figure 8 Package Outline

## LAND PATTERN



### Figure 9 Land Pattern

## TAPE &amp; REEL DESCRIPTION

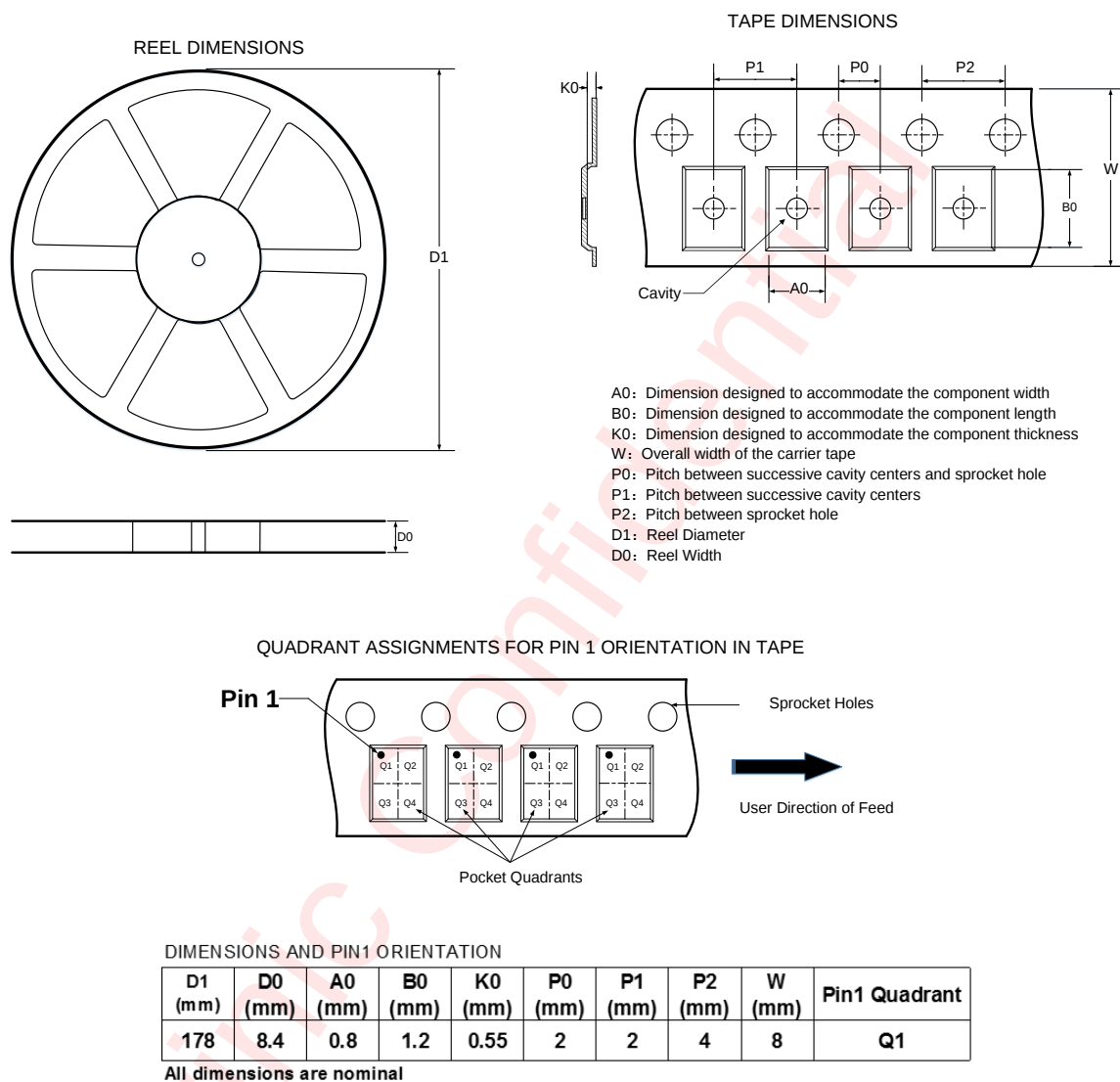


Figure 10 Tape &amp; Reel Description

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**REVISION HISTORY**

| Version | Date     | Change Record                     |
|---------|----------|-----------------------------------|
| V1.0    | Mar.2019 | Officially Released               |
| V1.1    | Oct.2019 | Update electrical characteristics |
| V1.2    | Oct.2019 | Update electrical characteristics |
| V1.3    | Nov.2019 | Update electrical characteristics |

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