Antenna Design Note

Rev. Antenna_Design_Note_V1.8

Date: 2016-06-01

Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:

Quectel Wireless Solutions Co., Ltd.
Office 501, Building 13, No.99, Tianzhou Road, Shanghai, China, 200233
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local office. For more information, please visit:
http://www.quectel.com/support/salesupport.aspx

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/techsupport.aspx
Or email to: Support@quectel.com

GENERAL NOTES

QUECTEL OFFERS THE INFORMATION AS A SERVICE TO ITS CUSTOMERS. THE INFORMATION PROVIDED IS BASED UPON CUSTOMERS' REQUIREMENTS. QUECTEL MAKES EVERY EFFORT TO ENSURE THE QUALITY OF THE INFORMATION IT MAKES AVAILABLE. QUECTEL DOES NOT MAKE ANY WARRANTY AS TO THE INFORMATION CONTAINED HEREIN, AND DOES NOT ACCEPT ANY LIABILITY FOR ANY INJURY, LOSS OR DAMAGE OF ANY KIND INCURRED BY USE OF OR RELIANCE UPON THE INFORMATION. THE INFORMATION SUPPLIED HEREIN IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

COPYRIGHT

About the Document

History

Revision	Date	Author	Description
1.0	2012-06-09	David WEI	Initial
1.1	2012-06-15	David WEI	Modified Figure 1
1.2	2012-08-01	David WEI	Added contact information for antenna manufacturers: Antenova and Pulse Electronics
1.3	2012-11-21	David WEI	Added contact information for GLONASS antenna manufacturer INPAQ
1.4	2013-07-10	David WEI	1. Added ceramic chip antenna 2. Updated contact information
1.5	2014-11-21	Jackie WANG	Added the antenna performance and LDS antenna
1.6	2015-04-11	Jackie WANG	Added applicable modules
1.7	2016-01-06	Mark ZHANG	1. Added external PCB antenna 2. Added contact information for antenna manufacturer SAINTENNA and JINGHONG
1.8	2016-06-01	Mark ZHANG	1. Updated the contact information of antenna manufacturer JESONCOM 2. Updated the address and contact information of antenna manufacturer Antenova

Contents

1 Recommended Component Placement of Main PCB

This document is applicable to all Quectel modules.

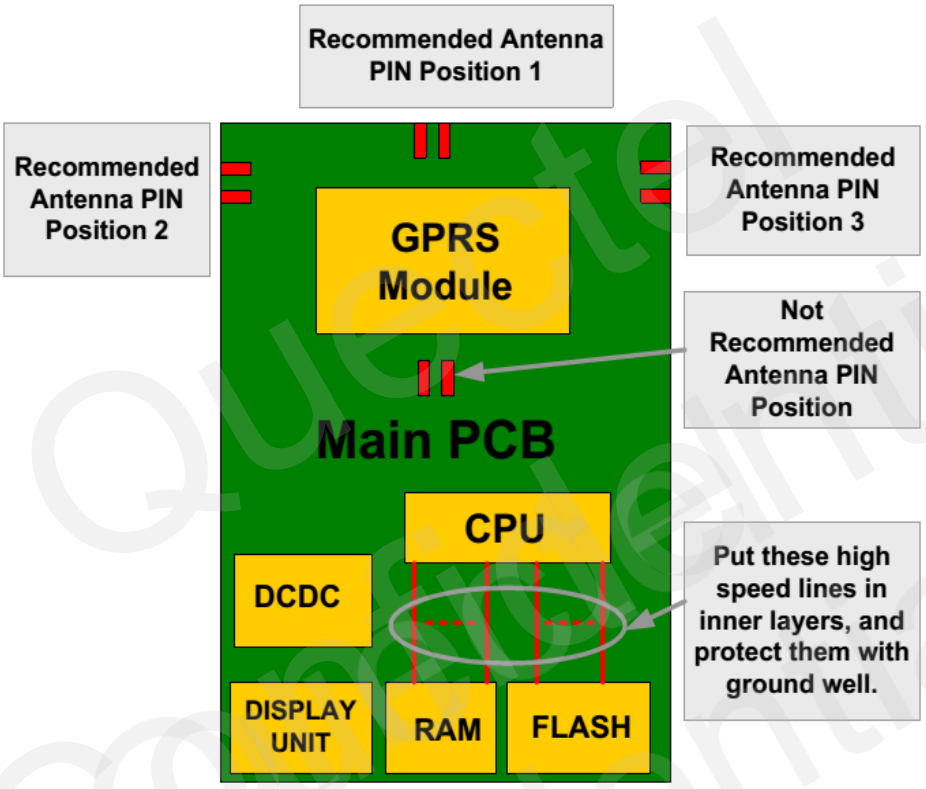


Figure 1: Ideal Component Placement

Notes:
1. It is suggested to keep the RF ports on the outer side of PCB when displaying the module.
2. Put antenna pin at the edge of the main PCB, not in the center.
3. Keep antenna as far away from CPU\FLASH\DCDC\DISPLAY FPC as possible. It is preferred to place the antenna in the different side of CPU\FLASH\DCDC\DISPLAY CONNECTOR.
4. Keep the high speed lines between CPU and DISPLAY as short as possible, put these lines in inner layers and protect them with ground as well as possible. Add some EMI filters in the lines if necessary
5. Put CPU\FLASH\DCDC\DISPLAY ZIF in shield case.

2 Basic Parameters and Requirements of Antenna

2.1. Basic Parameters of Antenna

Gain (dBi): The ratio of “power of antenna” and “power of isotropic radiation from an ideal current source” in maximum transmitting direction with the same input power. “dBi” is widely used as the unit of antenna gain.

Gain (dBd):
The ratio of “power of antenna” and “power of half wave dipole antenna” in maximum transmitting direction with the same input power. One formula indicating relationship between dBi and dBd is given as below:
dBi=2.15+dBd

Directivity: The ratio of “power of antenna” and “power of isotropic radiation from an ideal current source” in maximum transmitting direction with the same radiated power.

Efficiency: The ratio of the antenna radiation power and antenna input power.

APIP (Antenna Port Input Power): The input power to antenna.

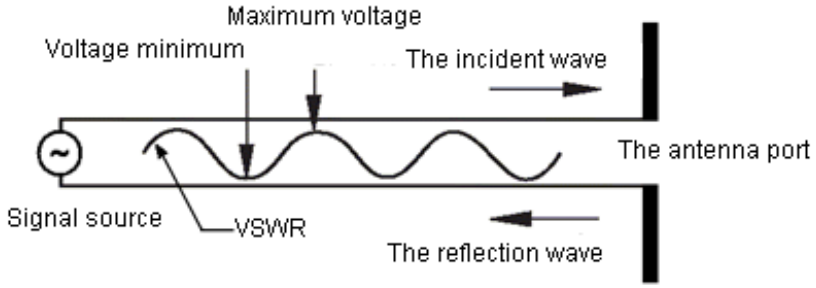
EIRP (Effective Isotropic Radiated Power): Compared to isotropic antenna, it is the power obtained in maximum transmitting direction. Its formula is:
EIRP=P*G (Here P is radiation power, G is antenna gain indicated in dBi.)

PEIRP (Peak Effective Isotropic Radiated Power): The peak value of EIRP.

ERP (Effective Radiated Power): Comparing to half wave dipole antenna, it is the power obtained in maximum transmitting direction. Its formula is:
EIRP=P*G (Here P is radiation power, G is antenna gain indicated in dBd.)

VSWR (Voltage Standing Wave Ratio):

$$VSWR = \frac{Vmax}{Vmin} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$



Voltage standing wave ratio return loss is commonly used in engineering RL (S11), corresponding relationship is shown as the following table:

The correspondng formula: $RL = -20\lg\frac{V+1}{V-1}(dB)$

VSWR(K)	1.20	1.25	1.30	1.35	1.40	1.50	2.00
Return loss (dB)	-21.00	-19.00	-17.60	-16.60	-15.60	-14.00	-9.50

2.2. Basic Requirements of Antenna

Table 1: Basic Requirements of Antenna

Type	Requirements
Frequency Range	According to the operating band of device
VSWR	≤ 3
Gain (dBi)	≥1
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical linear polarization (GSM/WCDMA CDMA2000 TD-SCDMA/LTE) Right hand circular polarization (GPS)

3 Embedded 2G/3G/4G Antenna

3.1. PIFA Antenna with FPC Form

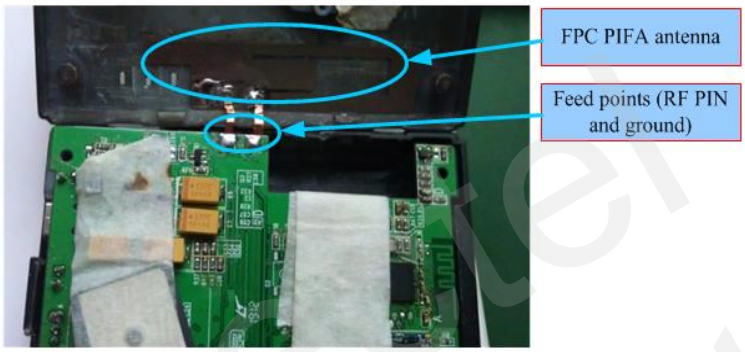


Figure 2: Example of FPC PIFA Antenna with Welding Pads and Feed Points

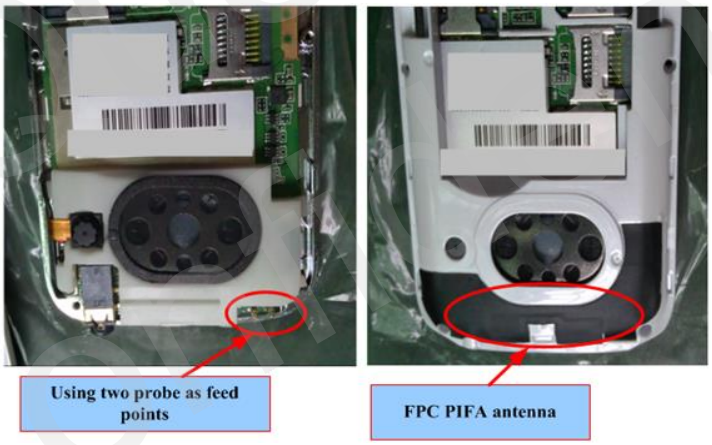


Figure 3: Example of FPC PIFA Antenna with Spring Probes as Feed Points

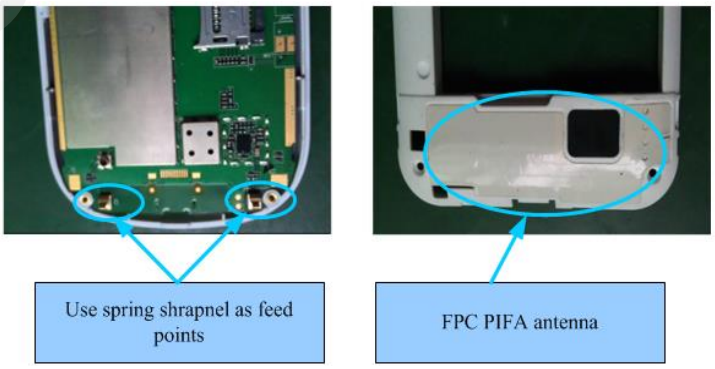


Figure 4: FPC PIFA Antenna with Spring Shrapnel as Feed Points

Notes:
1. FPC PIFA antenna can be pasted in the casing, which can save space especially for PDA and vehicle device.
2. Keep the distance between antenna and main PCB at least 5 millimeters.
3. Ground copper is required under antenna area in the main PCB.
4. Feed points can be designed as spring probes, shrapnel, welding pads. For more reliability, some melted plastic leg can be designed inside the device casing.

3.2. PIFA Antenna with Plastic Bracket

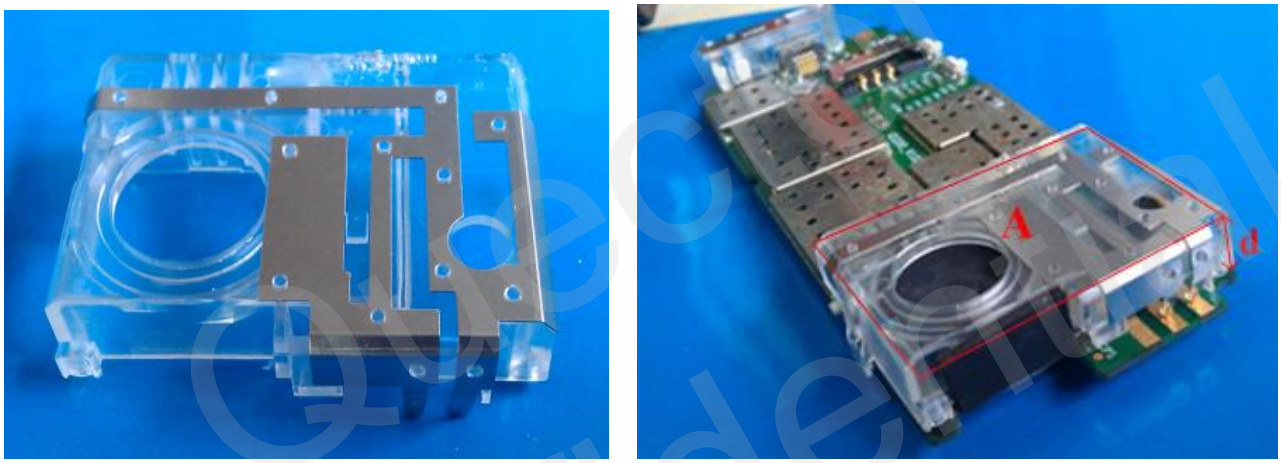


Figure 5: PIFA Antenna with Plastic Bracket

Notes:
1. This kind of antenna needs 2 or 3 pins, one is for RF pin and the other (two) is for ground.
2. Ground copper is required under antenna area in the main PCB.
3. For dual band, antenna projected area "A" is no less than 500 square millimeters, the height "d" is no less than 7mm.
4. For quad band, antenna projected area "A" is no less than 600 square millimeters, the height "d" is no less than 9mm.

3.3. Monopole Antenna

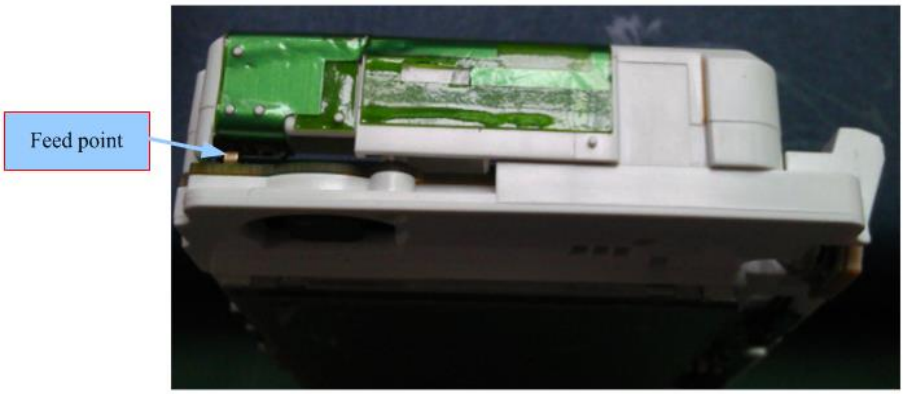


Figure 6: Example of FPC Monopole Antenna

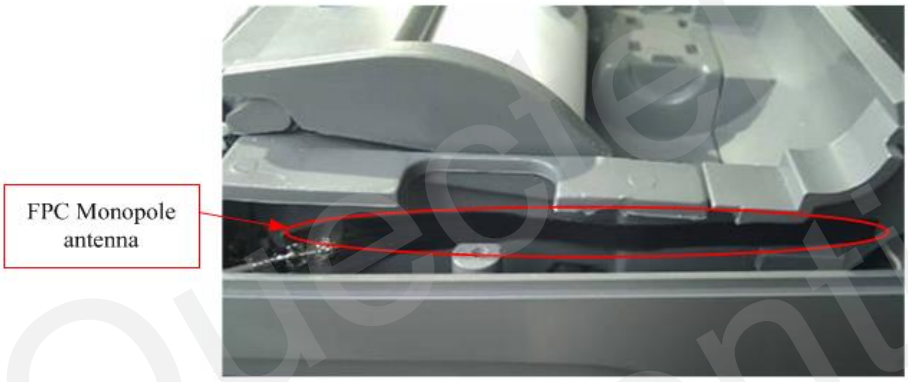


Figure 7: Example of FPC Monopole Antenna Pasted inside the Casing

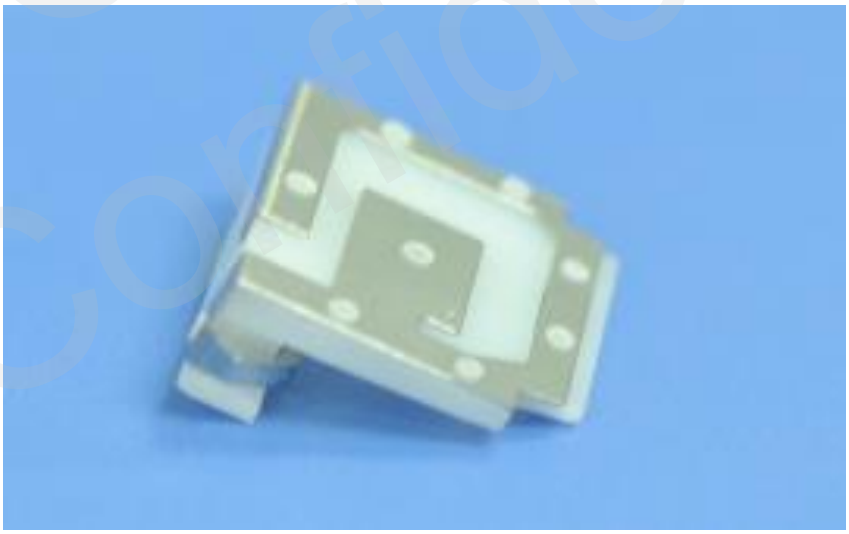


Figure 8: Monopole Antenna with Plastic Bracket

Notes:
1. This kind of antenna only has one feed point.
2. A certain clearance area in all layers under antenna of host PCB is required.
3. For dual band antenna, the height of the bracket is more than 6mm and the clearance area in PCB

should be more than 360 square millimeters. For quad band, the height and clearance area should be 8mm and 400 square millimeters respectively.

3.4. FPC Dipole Antenna

Figure 9: Example of Dipole Antenna with FPC Form

Note:

The distance between inner edge of antenna and main PCB ground (marked as “d”) should be more than 8 millimeters.

3.5. PCB Antenna

Figure 10: Example of PCB Antenna

Figure 11: Example of Practical Applications of PCB Antenna

Notes:

1. This kind of antenna can be fixed to plastic box and does not need any host PCB area. It will be better if the antenna is mounted in suitable notch.
2. There should be no metal material around antenna.
3. Antenna can be connected by RF connector or welding pad.

3.6. Chip Antenna

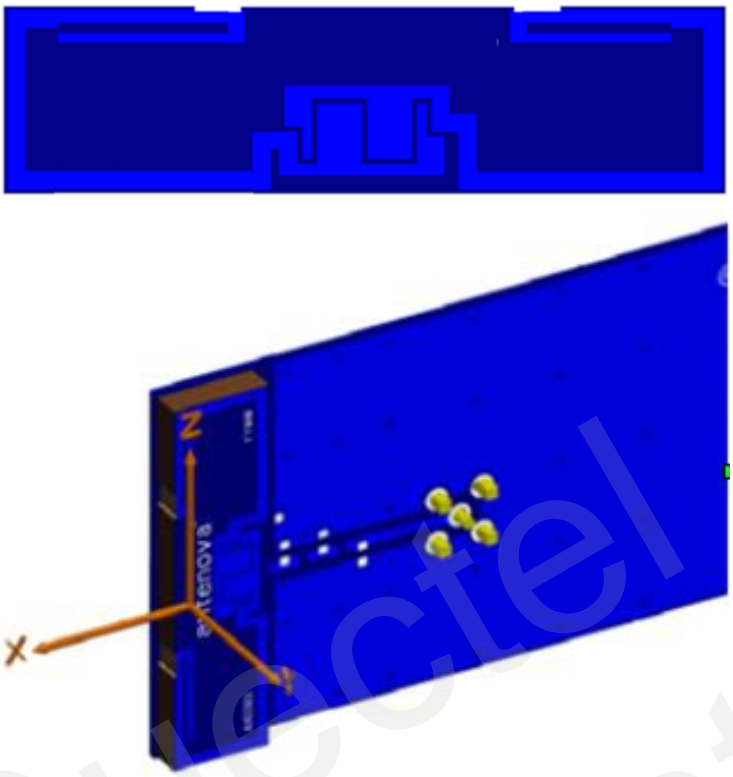


Figure 12: Example of Ceramic Chip Antenna

Notes:
1. This kind of antenna needs enough main PCB size.
2. There should be no metal material under antenna.
3. This kind of antenna should be placed on the edge of main PCB and can be packaged in SMT type.

3.7. Laser Direct Structure Antenna

Figure 13: Example of Laser Direct Structure Antenna

Notes:
1. The performance of the antenna is stable and has good consistency and high precision. Manufacturing cycle is short. There is no need of circuit graphics mould. And it is the green product as well.
2. The antenna is radiated on the mobile phone shell to prevent the interference of mobile phone internal components, thus the signal is stable.
3. It is easier to make the device smaller and thinner.
4. The cost of LDS antenna is higher than common type because of the complex production process.

4 External 2G/3G/4G Antenna

4.1. Dipole Antenna

Figure 14: Example of Dipole Antenna

Notes:
1. The height between antenna and main metal board "h" should be more than 8 centimeters.
2. The length of cable should be as short as possible. The shield copper wire net of the cable should be as dense as possible. The quantity for surround copper lines used to shield signal should be no less than 32.

4.2. Monopole Antenna

Figure 15: Example of Practical Monopole Antennas

Notes:
1. There should be no other metal pole 200 millimeters around the antenna.
2. VSWR for stubby antenna should be less than 4, and VSWR for vehicle with long cable should be less than 2.
3. The length of cable should be as short as possible. The quantity for surround copper lines used to shield signal should be no less than 32.

4.3. PCB Antenna

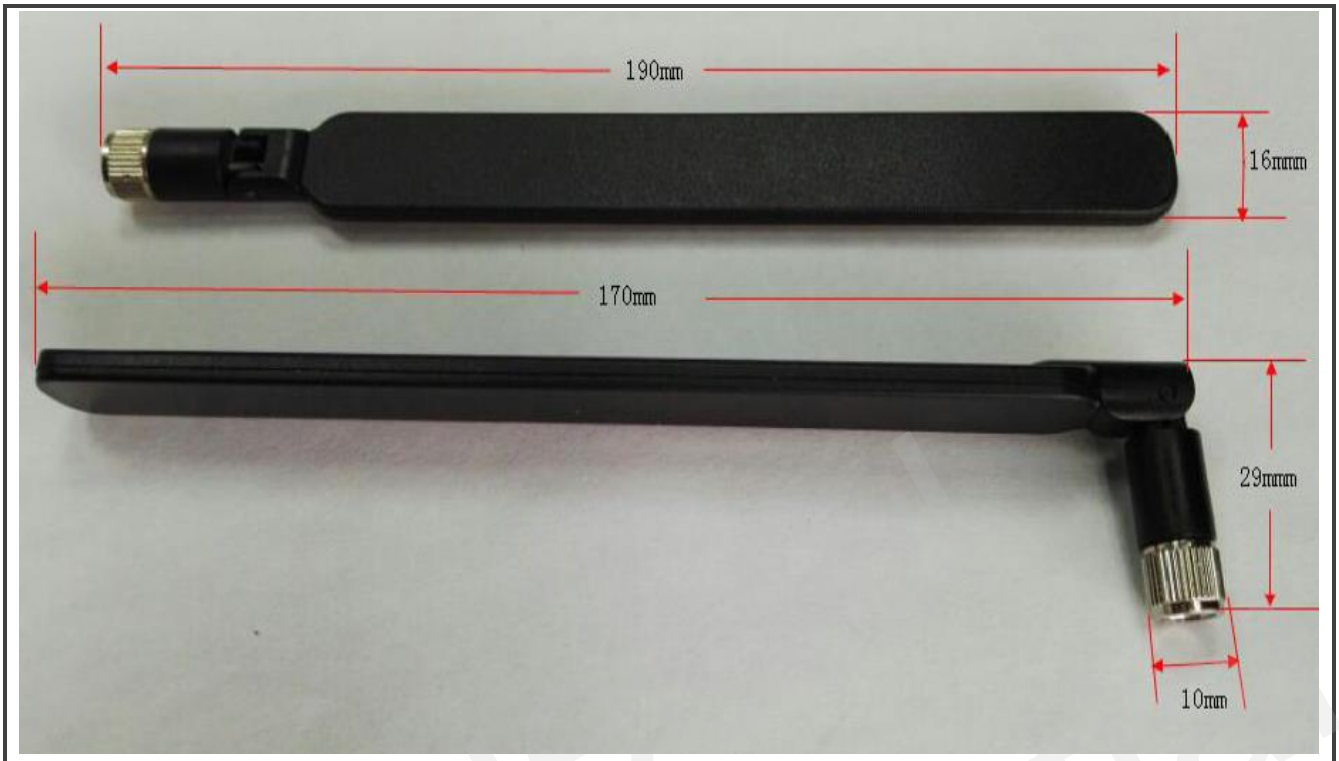


Figure 16: Example of PCB Antenna

Notes：
1. The performance of the external antenna is stable and superior.
3. Keep antenna perpendicular to the ground and avoid being surrounded by metal objects.
4. As two branches of LTE antenna, the main antenna is responsible for sending and receiving signals and the diversity antenna is only responsible for receiving signals. Diversity antenna mainly resists multipath fading and fast fading. Considering the receive gain of diversity antenna is much worse than main antenna, the gain of diversity antenna should be controlled under 3dBi.
5. Attention should be paid to the relative position between main antenna and diversity antenna, the overall performance would be better when isolation is less than 10dB between antennas in view of distance and polarization isolation.
6. The multi-antenna technology (MIMO) has the ability to transmit high-speed data and resist interference in the future.