PCB Antenna with Cable Integration Application Note

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1. BASICS

A PCB antenna with cable is a very flexible and economical solution widely used in the wireless industry.

Usually used of FR4 PCB fibre-glass resin material or flexible PCB (polyimide), a trace is printed on the substrate to get the desired antenna topology. Various antenna types such as monopoles, dipoles and printed F antennas can be made.

This design application note is intended to help the antenna integrator understand the relevant parameters affecting the antenna performance. Taoglas recommends that the integrator strictly follow the guidelines in this application note, upon your device prototype completion Taoglas can provide further optimization by custom tuning and testing service of the antenna in your device. (see Note 15 on Page 6 for further info on Tuning)

2. APPLICATIONS

A PCB antenna with cable is suitable for mobile applications or areas where internal antennas are required or where not much space or volume is available. Taoglas PCB antennas come in single-band or multi-band solutions. Starting from 450MHz up to 6 GHz.

3. SIZE

The larger the antenna surface area (or volume), in general the higher the performance in terms of gain and radiation characteristics.

	AMPS	GSM	PCS	DCS
Band	824-896	880-960	1850-1990	1710-1880
VSWR	4.76	2.20	2.28	1.89
Minimum Return Loss	-3.71	-8.49	-8.18	-10.17

3.1	Communication System	AMPS	GSM	DCS	PCS
3.2	Frequency Band	850 MHz	900 MHz	1800 MHz	1900 MHz
3.3	VSWR	1.92	1.65	1.92	1.40
3.4	Return Loss	-10 dB	-12.24 dB	- 10.01 dB	-15.55 dB

4. SHAPE AND THICKNESS

A PCB antenna can be made into any 2D shape for ease of fit into a product. Holes can be made in the antenna for screws.

FR4 standard thickness is 0.8mm. Thicknesses of 1.6mm or other custom thicknesses of the laminate are available for custom projects.

Flexible PCB antennas are super low profile 0.5mm

5. GROUND PLANE EFFECTS

Dipole antennas can be classed as being largely ground-plane independent in terms of performance. Planar antennas such as F-Type interact with the ground-plane more. In general we wish for 20mm clearance from the main ground-plane for reasons of efficiency.

6. IMPEDANCE

RF circuits in mobile devices should be designed for a 50 Ohm characteristic impedance at the source (RF module), transmission line (PCB trace or coax cable) and load (antenna). In practice sometimes the characteristic impedance of the circuit is not 50 Ohms at different transmitting and receiving bands. This necessitates the antenna impedance to be changed to match the actual characteristic impedance of the circuit. For a cellular antenna this is most effective when tuning the antenna at over the air active testing stage when the device is turned on and using the TRP and TIS numbers as guide to find the best impedance match for the antenna. Care must be taken at the same time to check any harmonics in the system are not over the limit of regulatory compliance.

7. BANDWIDTH

Bandwidth is defined as the frequency band below -10dB return loss.

Taoglas PCB antennas in general are rated at a minimum of -7.5dB return loss for the targeted application bands (for example GSM 850/900/1800/1900). A return loss of below -10dB is targeted for the centre of the bands. -5dB return loss at edge of bands where it rolls off.

8. VSWR

In principle the target is to be below 2.0, ideally below 1.5. In practice in multi-band and challenging environments it may go to 3.0.

9. GAIN

The gain of the antenna is closely linked to the surface area or volume of the antenna. The larger the surface area or volume of the antenna the higher the gain. Care must be taken that clearances of minimum 4mm are kept from other metal components in the device or metalized substances which will absorb or reflect the electro-magnetic radiation, substantially reducing the gain. The larger the clearance, the better the radiation characteristics of the antenna. We recommend 20mm or more for best gain and radiation efficiency.

10. EFFICIENCY

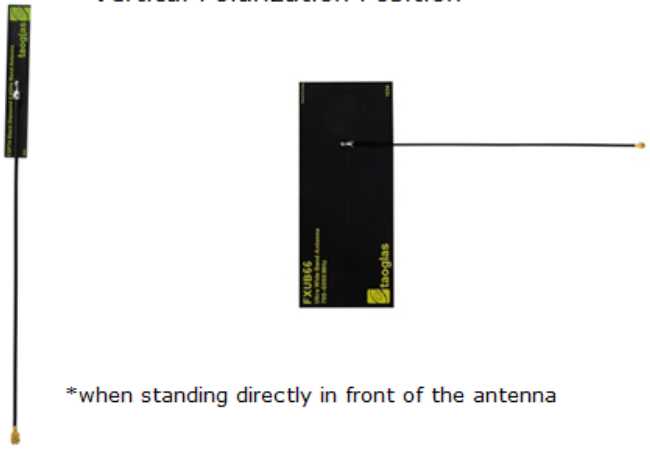
Efficiency is a good overall measurement of an omni-directional antenna for mobile communication systems such as GSM and WLAN. A PCB antenna can be designed to have high efficiency (>30% to 50%+) if the antenna surface area is large enough. It is more difficult to achieve high efficiency for more than two bands or in very compact form factor housings. Efficiency of the antenna directly relates to the TRP/TIS results of a device in OTA testing if the module has a 50 Ohm impedance.

11. POLARIZATION

Polarization describes the orientation of the wave oscillation. All our cellular and broadband antennas are linearly polarized to most efficiently match with the signals broadcast and the antennas mounted on cellular base-stations and from hot-spots Whether it is horizontally or vertically polarized depends just depends on how it is mounted from your frame of reference. Standing directly in front of the antenna the linear polarization is horizontal if the antenna is placed in a horizontal position and vertical if the antennas are placed in a vertical position. In practice the radiation emitted and received by internal antennas will be to some degree cross-polarized due to reflections from the environment and scattering in the atmosphere.

Horizontal Polarization Position*

Vertical Polarization Position*



*when standing directly in front of the antenna

12. ADVANTAGES of PCB antennas with cable

- Minimum footprint.
- Light
- Design Flexibility – size, shape, cable, connector all fully customizable with no tooling cost
- Quick turn-around time on new designs – 2 weeks to prototypes
- Multi-band frequencies easily accommodated
- Economical pricing

13. MOUNTING

Taoglas PCB antennas can be mounted in many different ways. Ideally the PCB antenna is mounted close to the outer housing of the device to allow it to radiate outwards and receive signals without obstruction from internal components in the device. The antenna can be slid into a slot, screwed down, or affixed with double-sided adhesive. Cable exit can be moved to different locations on the antenna. Generally the orientation of the antenna is not critical, as long as clearance to metal components is kept.

14. ENVIRONMENTAL CONSIDERATIONS

Close proximity to components or housing affects the electrical performance of all antennas. When placed on a non-conductive area of the board, in most cases ideally there should be clearance of 20mm in all directions from the board/housing for maximum efficiency. A reduction in the efficiency of the antenna efficiency and shift in tuned frequency will be observed if these clearances are not adhered to. Proximity effects will also have an adverse effect on the radiation pattern of the antenna. Device housings should never be metal or have metal materials

15. TUNING

The frequencies of PCB antennas with cable are easily shifted when close to other components or even if the cable is bent more than 30 degrees. This phenomenon is called “detuning”.

This is why Taoglas always offers a tuning service to it’s customers at prototype integration phase. We “tune” the antenna frequency back to the right bands for the application at our lab. Samples are sent back to the customer within 2 weeks of receiving the device along with a test report showing antenna performance Return Loss/VSWR, Gain and Radiation Characteristics, in the customer device. Please contact us for costing for this service. sales@taoglas.com

Further services such as optimizing the RF performance of the whole device to enable the product to pass network approvals, regulatory compliance or specific performance targets are offered as well.

16. ISOLATION

Isolation is a measure of coupling between two different antennas. For example in a CDMA diversity antenna plan the target is to get -10dB isolation between the main and the auxiliary antenna. Greater isolation can be achieved by using different polarizations on the two antennas. For example the main antenna has horizontal linear polarization and the auxiliary antenna has vertical linear polarization. In practice this is difficult for omni-directional internal cellular antennas as there is cross-polarization of the waves occurring. So the normal solution is to keep the distance from both antennas as far away as possible.

The two antennas cables should not cross over or come close to the other’s antenna.

Testing is carried by sending a signal in one antenna and measuring the power of the signal at the other antenna. There should be a 10dB or more difference between the transmit and the receive signal. The easiest method is to keep moving the two antennas farther from each other until the target isolation is achieved.

17. CABLE & CONNECTOR

1.13mm diameter micro coax cable is preferred in most cellular antenna projects as most economical solution. Cable loss is not a big factor if cable length is kept below 150mm.

The cable needs good grounding. If the body of the cable is near the ground of the device the cable should be as near as possible to the device ground.

The cable should not be looped because it will cause frequency shifts and also create magnetic field which will interact with the main antenna magnetic field.

The cable should be kept away from emitting components such as LCD driver chip or CPU.

It is preferred to use connectors on the cables for higher reliability in connection over solder. Most economical connector solution is IPEX line of connectors which is compatible with Hirose industry standards U.FL and W.FL. Taoglas offers any cable and connector solution for the integrator. Taoglas also offers the on-board mating connector and cable jumpers.