Microair Avionics Pty Ltd
ABN 92 091 040 032

P O Box 5532
Airport Drive
Bundaberg West
Queensland 4670
Australia

Phone: 07 4155 3048
+61 7 4155 3048

Fax: 07 4155 3049
+61 7 4155 3049

Email: support@microair.com.au
Web: www.microair.com.au

VHF Aerial Installation FAQ

Installation of a VHF aerial on many light aircraft can be problematic due to the lack of suitable mounting locations and effective RF grounding / screening surfaces.

A substandard aerial installation can result in:

- Damage to the transceiver's transmitter.
- Poor transmit and/or receive performance.
- Interference to other instruments when transmitting.
- Feedback (howling or screeching) on transmit.

Microair does not do installations and recommends qualified professionals are used for the installation of our products. The following guide is offered as informative only.

Q: *What type of coax cable should I use?*

A:

- The coax must be 50ohm, not 75ohm as used for TV aerial installations. The same applies for the BNC connectors. *Caution: They look the same!*
- Choose a quality cable. The amount of copper in the screen is all important; never use cable with a foil screen. RG58 is O.K for short runs, RG400 is better all-round, particularly for longer runs. Low loss versions are available which usually have a foam core instead of a solid plastic core. These are more easily crushed or kinked so take care to protect the cable.
- The coax should never be joined using anything other than RF coaxial connectors.
- Coax has a minimum bending radius that must be observed.

Q: *Do all aerials need a ground plane?*

A: Most commonly available "¼ wave whip" aerials need a ground plane.
G.I (ground independent) aerials are specifically designed not to need a ground plane.
Dipoles (aerials with 2 elements) must not have ground planes.
Always consult the aerial manufacturer's documentation.

Q: *When is a "Ground Independent" aerial a good choice?*

A: If you have a fibreglass, wood or cloth skinned aircraft, a "GI" aerial is a reasonable choice. A "GI" aerial solves the problem of fitting a good aerial ground plane to a non-metal skinned plane. Not recommended for carbon-fibre or metal skinned airframes.

Q: ***My aircraft is carbon-fibre; do I still need a ground plane?***

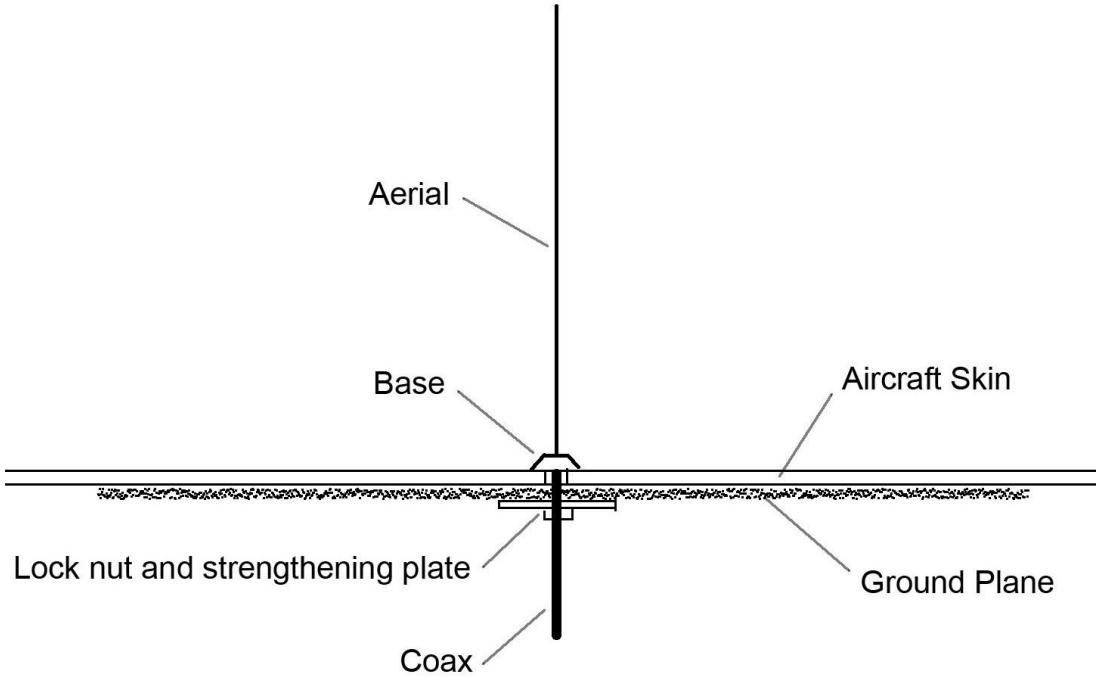
A: Although carbon-fibre is conductive and a good RF screen, the encapsulating epoxy resin prevents a reliable electrical connection to the carbon fibre. It is recommended that a ground plane consisting of a fine metal mesh is glued to the inner surface of the carbon fibre. Leave bare metal around the aerial hole for a good earth connection. (*See below*)

Q: ***My aircraft is fibreglass, cloth or wood, how do I make a ground plane?***

A: Use flat bar, sheet-metal or mesh to create a ground plane. Choose a metal that will not cause corrosion problems. The materials do not need to be heavy gauge. Aluminium adhesive tape is not recommended as the aerial base fixing will quickly cut through it.
Bend the metal to the contour of inner skin and glue or fix into place centred on the proposed aerial mounting point. Keep the mounting point area free from paint and glue, it must make a good electrical contact with the base.
Do not inadvertently insulate the base earth from the ground plane with sealing gaskets.

The “ideal” ground plane is a disc (solid or mesh) with a radius roughly equivalent to the length of the aerial or greater. The ground plane surface may deviate from horizontal by up to 45 degrees (away from the aerial) without adversely affecting performance. An amount of drop away from the aerial can actually be beneficial. An absolute minimal functional ground plane consists of a horizontal cross formed by 4 metal elements at 90 degrees to each other. The length of each element should be the length of the aerial or longer. One or both axis may be opportunistically formed by part of a metal frame.

A typical ¼ wave whip installation:



Q: ***Where should I mount the aerial?***

A:
- Ideally, away from nearby vertical metalwork in line with the aerial. Space at least 1.5 x length of the aerial away from other vertical metal surfaces. If positioned near significant metal obstructions, blind spots (shading) will occur.
- As far away from instrumentation as possible. Also run the coax well away from other electrical wiring.
- The aerial should be within 30 degrees from vertical.
- Centred on a large metal surface where possible.
- Keep away from engine to reduce ignition and alternator interference.
- Consult the aircraft manufacturer for advice.

Q: ***What happens if I don't have a good ground plane?***

A: You may experience poor radio performance on both transmit and receive:
- Reception or transmission may appear to be dependent on direction – can't talk to other aircraft but no problems with ground communication or vice-versa. In the total absence of a ground plane, the radiation pattern from the aerial will not be a uniform 360 degrees, typically it will tend to point out from the end of the aerial with poor communication in all other directions.
- Transmitting causes feedback (howling, screeching) or instruments go crazy. RF energy is being reflected back down the coax outer screen, radiating the energy into all nearby wiring and electronics.
- Susceptibility to locally generated electrical interference – ignition, alternator, electric motor and strobe noise.
- Transmitter damage may occur.

Q: ***How do I check an aerial installation?***

A: This requires a piece of test equipment called a VSWR meter and the knowledge of how to use it. It is inserted in line with the coax cable and measures the ratio of RF energy travelling to the aerial and the amount reflected back. A VSWR ratio of 2:1 or lower across the band is acceptable. A high VSWR reading indicates problems but does not identify the source of the problem. Check earthing points for cleanliness and corrosion, connectors and coax cable for crushed sections and that the aerial is actually cut to the right length. The lowest VSWR reading should occur around 127MHz (centre of band).

A 50ohm "RF Dummy Load" is a useful addition to isolate faults further. It can be placed directly onto the radio's BNC connector to remove the entire aerial installation from the equation or used in conjunction with the VSWR meter at the far end of the coax to check the coax integrity. A VSWR reading of very close to 1:1 should be made and the forward power reading should not indicate a substantial loss compared to a reading at the radio end of the coax.

Q: ***What do "ferrite" suppressors achieve?***

A: When all else fails, a large clamp-on ferrite suppressor can be placed around the coax cable to reduce the amount of RF energy radiating back along the coax outer screen. The suppressor is best positioned hard up against the aerial connection but some experimentation may be required. These may also be clamped around other wiring to reduce RF interference entering or exiting other sensitive electronic devices.

Example of a clamp-on ferrite suppressor:

Q: ***What should be earthed?***

A:
- A thick earth strap between engine, chassis and battery is essential. If a "bus" system is used to distribute power, make sure the –ve bus is also strapped straight to the chassis and battery.
- The transceiver power supply ground (–ve) wire should be wired directly to the chassis using as short a wire as possible (if chassis is earthed and nearby) or directly back to the –ve bus or battery –ve terminal.
- If the aerial ground plane is isolated from earth, do not run an earth wire to it. The ground plane will be earthed back to the radio via the coax outer screen. Multiple points of earthing can cause unforeseen problems due to "ground loops".
- In some situations, it may be necessary to isolate headphone jacks from metalwork by using insulating washers. This prevents problems that may be caused by multiple earth points.

Q: ***I have more than one aerial, how far apart should they be?***

A:
- As far apart as reasonably practical.
- Consider putting UHF aerials on the underside away from a top mounted VHF aerial. This will also aid communication with the ground.
- The shortest aerial should be spaced at least 1.5 times its length away from a longer aerial.

Q: ***What types of aerials are available?***

A: Aviation band VHF Comm Aerials generally fall into 3 groups:

1. **1/4 wave whips.**
    - These require ground planes.
    - Typical length is 22 inch (including base).
    - Some are “electrically” shortened by using “loading coils”. A small loss of performance results.
    - Some have a fibreglass outer housing for aerodynamics and rigidity.
    - Some are swept back or bent to aid clearance (particularly for underbelly mounting).
    - Coax is connected to the end of the aerial.

A variety of ¼ wave whips:

The “Rubber Ducky” is a ¼ wave whip that is shortened to the extreme. Its relative performance is poor but has a role to play in handhelds or where short range communication is all that is required.

2. 1/2 wave dipoles

- These must not have ground planes and are suitable only for non-carbon fibre, non-metal frames i.e. cloth, wood or fibreglass.
- Typically mounted in the tail.
- Typical length is 43 inch.
- Dipoles outperform 1/4 wave whips.
- Many ground independent aerials are dipoles with one half formed solely by a loading coil. Performance drops back to a typical 1/4 wave whip but no ground plane is required.
- Coax is connected to the centre of the aerial.

A ½ wave dipole:

Example of a G.I Aerial:

3. **5/8 wave whip**
    - Most often used as Base station or ground crew aerials.
    - Too long for aircraft fitting.
    - These offer performance similar to dipoles.
    - Typical length is 48 inch.
    - Some are “electrically” shortened by using “loading coils”.
    - Most are ground independent.
    - Coax is connected to the end of the aerial.

Example of a 5/8 whip for vehicle use:

Additional Notes:

Some whips (both 1/4 and 5/8) are sold “pre-cut” to length for correct tuning. Others are sold “over-length” and require to be cut down to size for correct tuning. The aerial must be cut in place as its length is affected by the ground plane - don’t copy the length of someone else’s aerial. This requires an understanding of the use of a VSWR meter and is usually done at mid-band i.e. 127MHz. The shorter the aerial, the higher the tuned frequency. ***“You can’t put back what you chop off!”***

Never transmit without an aerial (or dummy load) connected. Transmitter damage may occur.

Many aerials will measure as short circuited between connection points – this is quite normal and does not always indicate a fault.

Aerials behave the same in both transmit and receive directions, only the symptoms change. Transmit problems due to the aerial installation will have an accompanying set of receive problems. These reciprocal problems often go unnoticed until the problem is rectified.

Relative aerial performance is correctly quoted as “gain” in dB (decibels) in relation to an “isotropic radiator” which is a theoretical point source of radiation.

The maximum gain of a 1/4 wave whip is 3dB but is typically 2.5dB or less.
The maximum gain of a 1/2 wave dipole is 6dB but is typically 5.6dB or less.
The maximum gain of a 5/8 wave whip is 5.5dB but is typically 5dB or less.
A rubber ducky will typically have a (negative) gain of -1dB or less.

Every 3dB is an effective doubling in performance.