

EMI suppressor for VHF frequencies



Purpose, installation and usage

Introduction

Many installations of VHF airband radios result in problems when the transmitter is activated.

Typical problems include RF feedback in the intercom system or related interference, which may compromise the correct functioning of other electronic equipment such as GPS receivers or electronic instrumentation.

RF feedback in the intercom system may result in distorted transmissions, echo (bathroom sound), chirping (birdlike sounds) and annoying, loud tones during transmission.

Effects on electronic instrumentation can range from mild to severe, effecting LCD displays and creating measurement inaccuracies and other malfunctions.

In severe cases, RF feedback may destroy intercom systems and other electronics.

This document describes why this happens and what can be done about it.

The cause of RF feedback

RF feedback tends to occur mainly on smaller aircraft and is prevalent on ultralight aircraft. Tube and fabric and fiberglass aircraft are more affected compared to metal-skinned or carbon fibre aircraft.

RF feedback is becoming an increasing problem due to more powerful VHF transmitters becoming available.

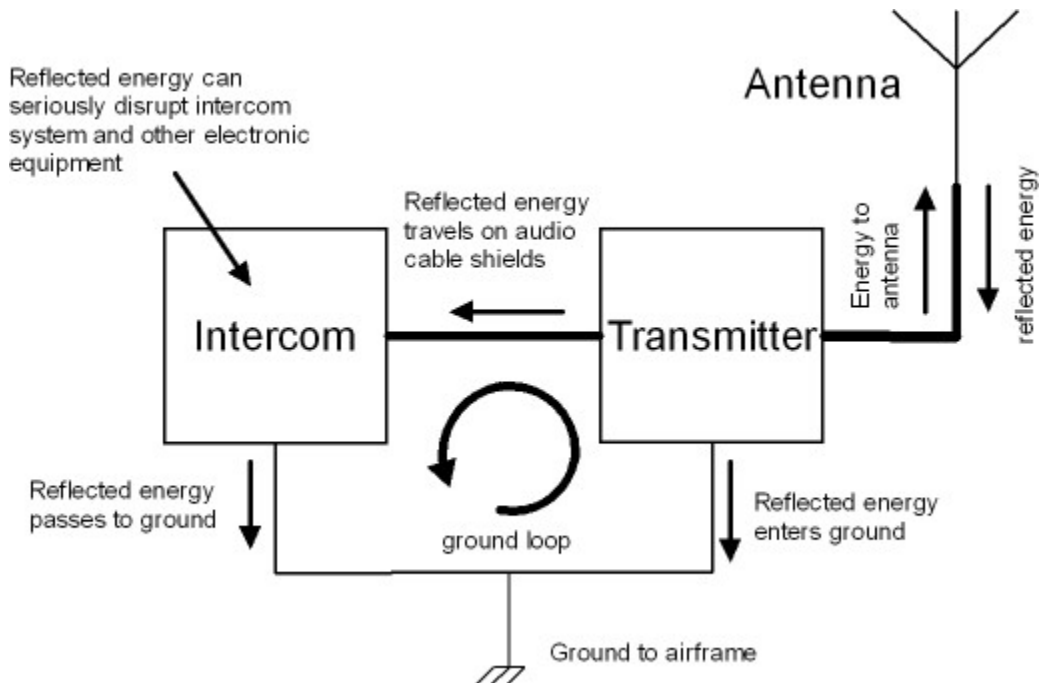
The fundamental cause of RF feedback is related to bad antenna matching. The VHF radio produces considerable amounts of peak RF power, which is routed via a 50-ohm RF cable to the antenna. Ideally, the antenna should absorb all of the energy and convert this to radiated energy.

However, in practice, this does not happen. Depending on the mismatch, a large amount of RF power is reflected back towards the VHF transmitter. This energy, which can be very considerable tends to travel on the outer shield of the 50-ohm RF cable and enters the ground (chassis) of the transmitter. From here it travels to the ground system of the aircraft via the transmitter's power supply.

Part of the energy will also travel to the intercom system via the audio cable leads, in particular the shielding and ground connection between the VHF transmitter and intercom system.

An RF ground loop is formed as shown in the following diagram:

VHF EMI suppressor



Why does the reflected RF affect other equipment?

Reflected RF energy enters equipment mainly via the ground connections common to these items. The RF energy may take the form of an A/C signal at the transmitting frequency (118-136 Mhz typical) and can reach levels of several tens of Volts depending on the output power of the radio and the level of antenna mismatch.

The frequency is much higher than regulated power supplies in electronic equipment can deal with and as a result power supplies in these items may seriously malfunction, sometimes destroying electronic circuitry.

Sensitive electronics such as audio amplifiers and microphone circuits in particular can be overwhelmed by the offending signal and cease to function correctly.

Why does filtering and shielding not work?

Typical RF filters, which tend to be employed in aircraft electronics, cannot perform due to the fact that the ground itself is contaminated. Shielding does not work either, as the problem is not caused by radiated signals. Shielding, when connected to ground, may even worsen the problem.

What can be done?

The most obvious solution is to improve the antenna matching as this will result in more of the RF energy being transmitted. On small aircraft, lack of ground planes or unsuitable antennas may present limits to how much improvement can be obtained.

Sometimes, on smaller aircraft, hand held radios are used with “rubber ducky” antennas. These present a very poor match.

Moving to reducing unavoidable reflections, two methods are known to work well. The first centers around connecting a quarter wave stub at the antenna connector on the radio. The quarter wave stub is connected to the shield of the antenna cable at the connector. The stub in case of the VHF radio would be a length of copper cable about 62 cm in length (1/4 wavelength).

The stub presents a short circuit to the reflected RF energy and the stub will help to convert the reflected power into radiated power.

The bad news is that this method is very unsuitable inside an aircraft. The proximity of a transmitting aerial in very close proximity to other electrical equipment may cause other problems.

The second method uses metal beads made from a specially formulated ferrite powder.

The ferrite RF suppressor

Ferrites in various forms have been used for many applications in RF electronics. These are produced in a wide variety of compositions, aimed at achieving a particular purpose.

MGL Avionics supplies ferrite beads aimed specifically at the frequency band of 100-150 Mhz with excellent characteristics.

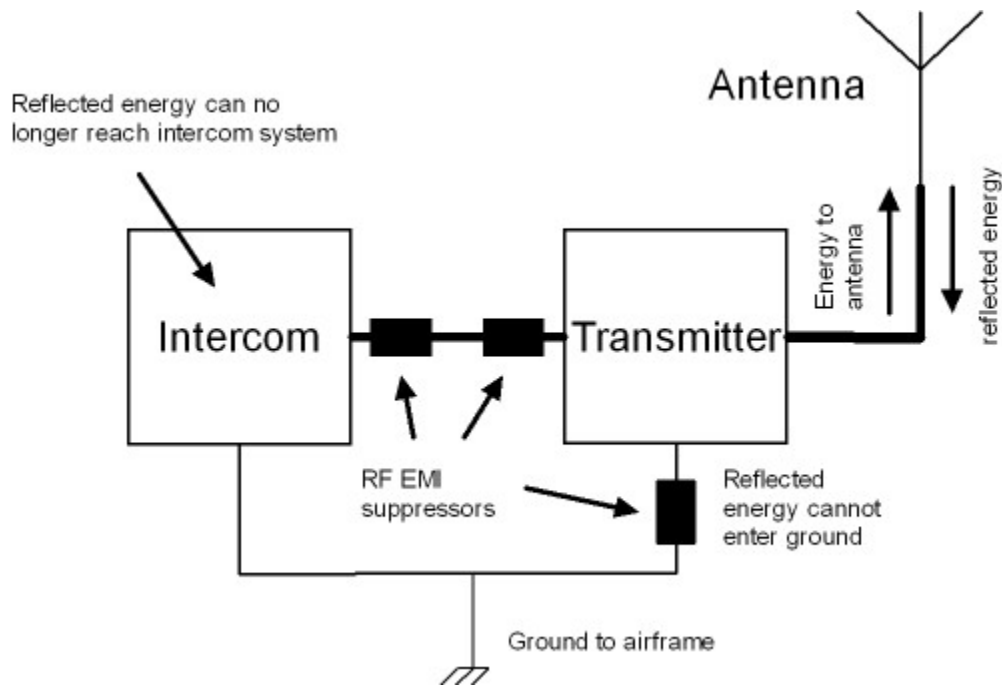
How do ferrite RF suppressors work?

The MGL Avionics RF suppressor increases the impedance of a cable at selected frequencies. This has the effect of effectively and greatly increasing the resistance of the cable at the offending frequency. As a result, RF energy at this frequency cannot travel along the cable and some of the RF energy is reflected back to the source. Some of the energy is absorbed by the ferrite itself.

How should the ferrite be installed?

It is normal to install several ferrites depending on the severity of the problem. A good installation will suppress the reflected RF energy close to the source (The VHF radio) and ferrites will be installed on all paths that the RF energy could take thus preventing reflected RF energy from contaminating the remainder of the electrical installation.

The following diagram shows a proven method that is effective even in severe cases:



In this case three ferrites are employed. Two are placed on the audio cables to the transmitter, one on each end, about 5 cm (two inches) from the ends of the cables.

A further ferrite is installed in the ground connection of the transmitter.

Sometimes it may be required to also use a ferrite in the power supply to the transmitter. This depends on the quality of the transmitters power supply filtering.

Note: be careful not to connect the radios chassis directly to the airframe ground.

Will any ferrite work?

No. Many ferrites will have little or no effect at all. Size counts as well as the material composition of the ferrite. The ferrite **MUST** be suitable for the VHF frequency range, which is far outside most ferrite applications, which tend to be used at much lower frequencies. The MGL Avionics ferrites are exactly matched to VHF frequencies using the highest-grade material available.