

AVOIDING INTERFERENCE WITH 'HAND-HELD' & 'INSTALLED' LIGHT AIRCRAFT RADIOS - (Permit Aircraft)

By Mike Rudd

SOME HINTS ON BEATING MURPHY

There are growing numbers of aircraft using the very sophisticated and effective 'handheld' transceivers which may be seen as 'non-installed', and it is with these that these hints are mainly concerned, although they may apply equally to installed equipment.

Nothing that follows is by any means authoritative nor has it any 'official' blessing It is rather a collection of various experiences gathered in the course of battling with Murphy over a number of years which may prove useful to anyone trying to eliminate interference which is ruining his/her listening pleasure.

1. Types of Interference.

Usually, a handheld transceiver will be connected to a suitable external '1/4 Wave' aerial. If it is not the range will be much impaired, the likelihood of interference will be far greater, and the VOR function (if applicable) will be grossly inaccurate. Assuming an external aerial, interference falls into two main categories:

Radio Frequency Interference (RFI), which is unwanted noise or signals being transmitted by some other installation on board and being received on the tuned frequency. Most likely source will be the engine ignition system, or another radio set which may have 'un-clean' emissions, or strobes or Transponders.

Audio Frequency Interference (AFI), which is electrical 'noise' being generated at audible frequencies (ie in the human hearing range of about 100 to 15000 cycles per sec) which is managing to penetrate into some part of the transceiver's circuitry at a point downstream of the operating frequency (which is in the 108 to 137 Million cycles per sec). Commonest sources here are generators, gyro motors, audio 'feedback' (which may also come via the RFI route), static discharges due to poorly 'bonded' airframes and even cable 'crosstalk' where audio lines have been packed in a loom with unsuitable bedfellows.

2. Setting up for Diagnosis.

This is by far the most important task. Generally the problem will be audible in receive and may take various forms.

Begin by ensuring that the aerial, its coax lead and BNC connecting plug are properly connected, have no 'crackly' connections and no coiled up surplus coax tucked away. If excess aerial coax is coiled up, it will have a disastrous effect on the 'matching' of the aerial to the set and will certainly cause problems in transmit on some frequencies. It should be cut to convenient length with no more than reasonable slack. It is assumed that the aerial has a tuned 'counterpoise' by way of 'ground-plane plate' or 'helical' downgoing wirewound equivalent. This ensures that the set is presented with what it will see as a 'matched load' and will not suffer reflected un-emitted energy pulses which will lead to signal distortion or at best a seriously degraded receive and transmit performance.

Ensure that any headset patch lead connections are sound and that any remote PTT line and button are free from chafed insulation, poor connections etc.

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3. Diagnosis.

Start the aircraft engine, and switch on all the other instruments (gyros etc) that would be used in flight and of course switch on the transceiver. Back off the squelch control to allow background mush/white noise to be fully audible. Select a free frequency where no stations are transmitting (NEVER use 121.500). The 'mush' should be a loud slightly gritty hiss, but should not contain any whine, nor any continuous 'burp' nor steady crackle. If any is heard, vary the engine RPM to see if the pitch (note) of the noise alters in time with that change.

- a) If you have a sharp crackle which varies with engine speed, it is RFI coming from the HT leads in all probability.
- b) If you have a variable pitch whine, you are likely to have generator RFI or AFI or even both.
- c) If you have a lesser whine that does not change with engine RPM, it's likely to be the gyro blower motor or even the in-flight movie projector motor if you have one. The point is that the engine is blameless.
- d) If you have an occasional burst of crackles, which is more likely once the aircraft is airborne, then it is probably a build-up of skin friction generated static on an un-bonded section of the airframe which is arcing across a minute gap to the rest of the airframe whenever the charge is great enough to make mini-lightning ... and will sound very much like thunderstorms did especially on long wave Radio 4.

If you have none of these and the 'mush' is just mush, then check all the same items on a number of other free frequencies across the entire range of channels, eg, 118MHz, 120 MHz, 125MHz, 130MHz and say 135MHz. If all is still good it remains only to check transmissions. A helper with a handheld some 500 yards away is invaluable. Using non-sensitive (traffic free) frequencies only, make transmissions on a range of such frequencies.

If helper reports squeaks, 'raspberries', or obtrusive overlay of whine or continuous sharp crackle on your transmission, they may evidence one of the following:

- a) Squeaks and 'raspberries' are likely to be 'feedback' caused either by the aerial being so close to the headset leads in the cockpit that emitted signal is breaking into the lines and its audio content is getting onto the microphone lead and doing what so often occurs at the village fete when the microphone is too close to the public address speakers, or the raspberry may also be due to a low transceiver battery which cannot deliver enough power for transmitting. Most types of transceiver have a little illegible message which appears in the window to that effect. This would not apply to fixed installations powered from the aircraft supply.
- b) Whine or continuous crackle will be generator or HT leads adding their efforts riding pick-a-back on your carrier wave. This is only likely when the same problem has been encountered in receive.
- c) If helper reports a weak voice signal, but an apparently robust 'carrier' (ie when you press to transmit his mush is fully blanked out), then it is likely that the microphones in your chosen headsets are of the wrong type or ill-matched (impedance wise) to give sufficient 'audio drive' to put an adequate audio signal onto the carrier wave. In this event seek maker's advice and get correct/suitable headsets.

Before dealing with suggested remedies, it is worth mentioning that certain types of interference are more likely to occur if the transceiver is being wholly or additionally powered from the aircraft's on-board power supply. Such supplies are generally from the main battery, which is in

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turn kept charged from the generator or additional windings on a magneto. When the aircraft is first started, the main battery will be depleted and initially will absorb most of the 'roughness' coming from the generator & rectifier on the DC charge line. Once it is full up however, all the roughness will 'float' on the surface and will 'appear' on the line bringing power to the transceiver. It is not equipped to filter this 'noise' out, the characteristic whine will pervade both reception and transmission.

Suggested Remedies (at last ... but it helps to know the reasoning):

1. Generator or Gyro motor whine is most likely when using on-board power. The power line to the transceiver needs a filter. This is in the form of a wire wound 'choke' (obtainable from car radio installers) placed in series with the positive line, and an electrolytic capacitor in the region of 22,000 μ F (25Vdc Working V) connected across positive and negative lines.
2. HT lead continuous rpm related crackle is usually easy to cure by fitting screened plug leads. These should be grounded to the engine block at the distributor/magneto end and via the plug cap metal outercases at the plug end. This should stop the plug leads from 'radiating' over their length, which is about equivalent to a 'quarter wavelength' at our VHF band frequency ... so they can act as transmitting aerials quite efficiently! The spark pulse is a crude form of radio frequency transmission. Two stroke engines are particularly susceptible due to high rpm and vigorous spark. Marconi managed to get a simple spark to generate enough of an electromagnetic pulse to bridge the Atlantic!
3. Screening plug leads is not difficult, but requires access to some good quality tubular copper or tinned copper wire braid. This can be 'rescued' from large diameter Coax cable, by pulling out the centre conductor and insulator (dielectric) and then pulling off the outer PVC sheath, or may be obtained from electrical suppliers like Maplin or RS. You should also ensure that you are using the Bosch (1K) metal cased plug caps with automotive plugs and not the brown plastic NGK type (in the case of Rotax engines). You can then sleeve over each plug lead, soldering one braid end to each plug cap, and attaching a twisted tail at the coil end to the crank case by the shortest possible route. **MAKE ABSOLUTELY SURE THAT THERE ARE NO STRAY BRAID FILAMENTS LURKING IN OR CLOSE TO THE HT LEAD'S ENTRY INTO THE RUBBER BOOT ON THE COIL.**
4. Squeaks and raspberries have been dealt with. If the squeak varies in pitch (in transmit) when you wave the headset leads or the PTT line about, then either re-site the aerial further away, or look at replacing the headset leads with braided screened leads (many are not screened). Such screening must be grounded at the plug end. It may also prove necessary to have tiny 'de-coupling' capacitors fitted between the microphone 'live' line and ground and between the earphone leads at the sockets in the patching junction box. These cost only pennies (spec. 1nF) and have the effect of grounding down stray radio frequency signals on the lines, whilst not affecting the audio at all. A similar 1nF capacitor may also be needed across the remote PTT line where it joins the patch junction box, since it too can pick up stray RFI and convey it into the transceiver.
5. Static: This is a hard one to locate. Somewhere in the airframe, is an area exposed to airflow which has no good electrical contact with the remainder. When found, it will need a braid strap connecting it firmly to the rest of the airframe. Incidentally, the engine itself must of course have a stout braid connecting it to the rest of the airframe. If it does not, or if any other so-called grounded or negative items have no good connection one with another, then all attempts at curing interference may fail.

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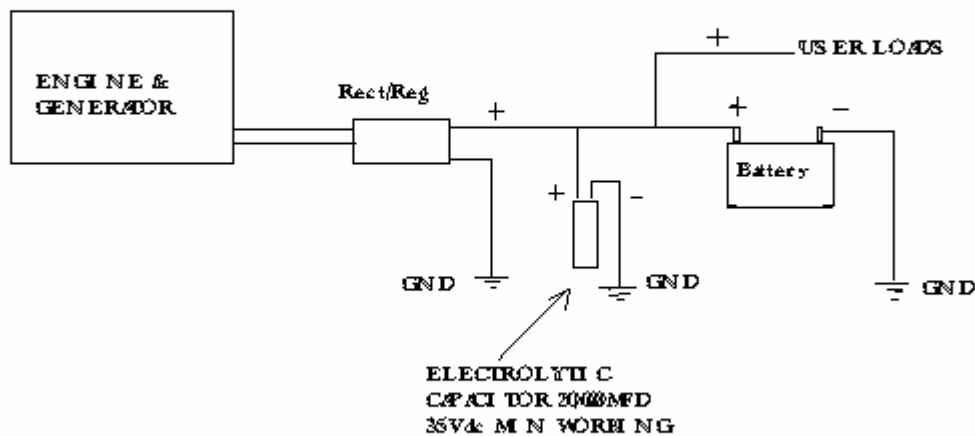
6. Aerials themselves: Most radio equipped aircraft are fitted with a "¼ wave groundplane" aerial (antenna). This may take the form of a smart encased dorsal fin or just a simple wire whip as the "driven" element, but on many installations there is evidence of complete ignorance about the "ground plane" side of the equation. Even some professional radio installers seem to think that if the braid of the feeder coax is firmly connected to the metal fuselage at the base of the aerial, then it will do the job. Wrong! At any given frequency the length of the driven element (sticking out bit) is calculated to be resonant as a ¼ wavelength (approx 22" or 550mm at mid VHF band). But the 'counterpoise' or other half must also be of similar dimension so as the present the transmitter/receiver with a "1/2 wavelength" total. The entire fuselage however presents no such thing, and completely unbalances the system, causing reflected, and hence un-radiated power to 'crawl' all over the airframe causing a variety of problems, not least interference and much degraded performance both in receive and transmit. At the base of the aerial, the braid should also be connected to a tuned groundplane either in the form of a downgoing insulated wire or number of wires measuring 5% less in length than the driven element. It can also be a helical 'rubber duck' which looks electrically like the same length or indeed a metal disc with a radius of same length, connected at its centre but insulated for the rest. It does not matter that the airframe is also connected because the oscillating pulses in the aerial will choose the resonant path both ways, just as a sound of fixed pitch in a room will cause only the string of resonant tuning in an idle piano to vibrate in 'sympathy'. So the aerial needs careful investigation. It can make a world of difference.

As a final reassurance try the following: Switch on receiver to a free channel, hear the mush, turn the squelch only just as far as absolutely necessary to kill the mush and note its position in O'clock terms, start the engine and rev as high as practical on the ground. Mush will break in again. Now turn the squelch again, only as far as needed to silence the mush once more. Now switch on any other ancillaries like the gyros etc. If mush re-appears, turn again only just enough to kill the mush. Now shut everything down and look to see how much additional squelch had to be introduced to eliminate the added mush from your machine. Typically it should not have needed more than '5 minutes' or so of added rotation. It should be noted that the use of squelch should always be the MINIMUM needed to kill mush, since any more just 'deafens' the receiver and shortens receive range.

Good luck and may Murphy perish!

Suggested 'Smoothing Circuit' to be added in the aircraft power supply which may help to absorb AFI from the generator or the rectifier regulator.

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NB: The Electrolytic Capacitor must have a working voltage of at least 35vDC. (for 12vDC systems)

The capacitance value needs to be 20,000MFD. This value is hard to source these days, so it can be made up of two 10,000MFD units connected in parallel (pos to pos and neg to neg). Maplin do have a suitable capacitor: Code: LE04E - Order Line: 0870 429 6000

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