



# Automotive EMC for Radio Amateurs



## Purpose of this leaflet

- (1) To advise radio amateurs on the installation of mobile amateur radio equipment in vehicles.
- (2) To provide information on the new syllabus section, 6.7 (EMC considerations for mobile installations) of the City and Guilds 7650 Radio Amateurs Examination (May 1998 onwards).

Before installing any radio transmitting equipment in a car, it is important to check the Owners' Handbook for any advice on installing mobile transmitters. If any such advice given by the manufacturer is not followed, this could invalidate the Warranty in the event of any failure of vehicle electronic equipment caused by high levels of RF. Furthermore, new UK regulations that came into effect on 1st October 2002 require radio equipment installed in certain cars to be 'e' marked.

## Location of Transceiver

The instruction manual provided with an amateur transceiver may contain a section on mobile installation. These instructions should be followed unless they conflict with the vehicle manufacturer's instructions.

A mobile transceiver should be located so that:

- \* The risk of injury to vehicle occupants in the event of an accident is minimised. If the fascia, glove pocket and/or parcel shelf is designed to collapse under impact, then the fitting of a transceiver should not prevent this from happening.
- \* All necessary controls are within easy reach of the driver (if the driver is the prime user) but not in such a way as to distract attention from the road.
- \* Hot or cold air does not blow directly onto the unit which should not be subjected to large temperature variations.
- \* It does not obstruct the inflation of an air bag (if fitted).

## Connection to 12 volt supply

The 12 volt supply to the transceiver should be via positive and negative cables which are connected directly to the battery terminals via the tags or clamps which connect to the battery pillars. It should not be plugged into a cigar lighter socket.

Both the positive and negative cables should be fitted with a fuse as close as possible to the battery. The fuse rating should be as recommended by the transceiver manufacturer. The reason for fitting a fuse to the negative cable is that under certain fault conditions, the return current for the starter motor could flow via the transceiver negative cable and the braid of the aerial feeder.

If a moulded twin core supply cable is not used, both the positive and negative supply cables should be twisted together along their length in order to reduce noise and interference induced by other wiring.

If it is necessary to control the 12V supply to the transceiver via the ignition switch, a relay should be fitted as shown in Fig. 1. Suitable relays are sold as 'Accessory Relays' by car accessory shops and may incorporate a fuse.

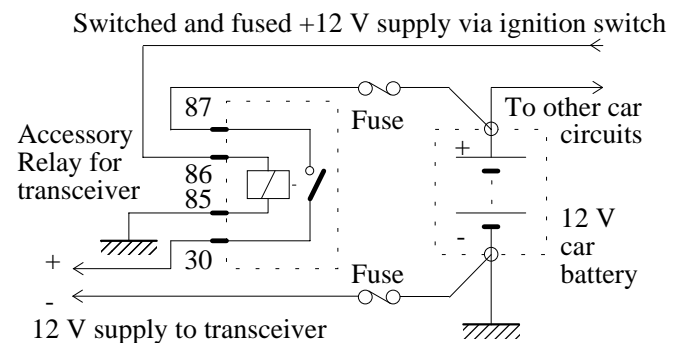


Fig 1

## Routing of DC supply cables

The transceiver DC supply cables should be routed so that;

- \* they avoid sharp edges or abrasion. Wherever a cable passes through a bulkhead, a grommet must be used.
- \* they are routed clear of vehicle wiring looms or electrical/electronic units particularly the Engine Control Unit (ECU) and ignition coil. This is to minimise possible interference to or from vehicle electrical or electronic systems.
- \* if they need to cross from one side of the car to the other, they are routed along the side and front of the engine compartment
- \* they are kept clear of fuel pipes, brake pipes, hot components or moving parts.
- \* they approach the battery so that if removed, they cannot accidentally be reconnected the wrong way round. This can be done by making one wire shorter than the other.

## **Antenna location and grounding**

If possible, a permanently mounted antenna should be used. The preferred location is in the centre of the roof, as this provides the most effective ground plane. Ideally, a hole should be drilled, as this provides the best grounding provided paint is removed inside the panel. If there is a sun roof, the antenna should be located approximately midway between the sunroof opening and the rear window. If an alternative method of mounting is used, for example a gutter mount or roof rack mount, it is important to ensure that the braid of the coaxial cable is well grounded to the vehicle body shell at the antenna mounting point. If this is not possible, the braid of the cable should be grounded as close as possible to the point of entry to the vehicle using a short, wide length of copper braid. Some cars have threaded inserts in the body shell above the doors; these are intended for fixing a roof rack but can also be used for mounting or grounding an antenna.

An alternative location for an antenna on a saloon car is in the centre of the rear boot lid. In this case, it is advisable to fit short copper grounding braids at least 12mm wide to ground the boot lid to the car body shell. The purpose of these is to ensure adequate RF grounding which the hinges alone may not provide.

Mounting a VHF antenna on the front or rear wing of a car is likely to give a distorted radiation pattern. If a wing mounted antenna is used, it should be located well away from electronic modules in the engine compartment to avoid subjecting such modules to excessively high field strengths which could cause malfunction.

On a vehicle with panels made of fibreglass or other non-conductive material, the antenna ground connection should be attached to a ground plane consisting of thin sheet metal fitted inside the panel. For maximum effectiveness at VHF, the antenna should be at least a quarter wavelength from any edge of the metal sheet.

If a magnetic mount antenna is the only option, it should be located as for a permanently mounted antenna. A magnetic mount antenna can be useful for test purposes to check for possible unwanted effects on vehicle electronics before fitting a permanent antenna.

"Glass mount" antennas are available for amateur UHF and possibly VHF mobile operation. Such antennas work by capacitive coupling through the glass and have no direct electrical connection to the radiating element. These are not recommended from an EMC point of view but if used, a glass mounted antenna should be located well clear of any heating elements in the glass to avoid coupling of RF signals into the vehicle's electrical system.

For a long HF mobile antenna, the rear bumper may be the only feasible location. If the bumper is non-conductive, the antenna ground connection should be

attached to the vehicle body shell via the shortest possible length of copper braid. If any tuning network is used with an antenna, this should be shielded and close to the antenna but clear of vehicle electronics and wiring.

## **Routing of antenna cables**

Good quality coaxial cable should be used with at least 95% shield coverage. Nevertheless, some RF may still be present on the outside of the cable due to imperfect shielding, antenna mismatch or poor antenna grounding. To minimise the possibility of unwanted interaction with vehicle electronic systems, the antenna cable should be routed well away from any vehicle wiring or electronic modules particularly the engine management system.

## **Testing**

After installing the transceiver and fitting and adjusting the antenna, it is advisable to perform some tests to check for possible effects of RF on vehicle electronic systems. With the vehicle stationary and the engine running the following should be checked while the transmitter is being operated at its maximum power:

- \* There is no apparent engine misfiring.
- \* No warning lights flicker or come on.
- \* The direction indicators flash at the normal rate.
- \* The windscreen wipers operate normally.
- \* There are no unwanted effects on other electronic systems, such as central locking or air bags.

If any unwanted effects occur, it will be necessary to relocate the antenna, reduce transmitter power or both.

It should be noted that not all possible adverse effects can be detected when the vehicle is stationary, for example, anti-lock braking, cruise control, automatic transmission, electric power assisted steering. It is therefore advisable to test drive the vehicle in a suitable location off the public highway. If any effect such as engine misfiring is noted when the transmitter is operated, transmission should cease immediately.

## **Further Reading**

MPT 1362 (1997 Edition), "Code of Practice for installation of mobile radio equipment in land based vehicles. Available from the Radiocommunications Agency of the DTI. <http://www.radio.gov.uk>

Leaflet "Radio Telephone/Mobile Radio Installation Guidelines" issued by General Motors Corp. (USA).

## **Footnote**

The Radio Society of Great Britain represents amateur radio in the UK. This leaflet was produced by: RSGB EMC Committee, c/o 3 Abbey Court, Priory Business Park, Bedford MK44 3WH