Vehicle contained HF radio

Lachlan Macallan

Introduction and Design

The purpose of this project was to implement an amateur radio into a vehicle. The current location of the radio is in a townhouse which is not conducive to good communication due to high electromagnetic interference from AC mains power inside the walls and ceiling, as well as a grounded roof with no practical way to mount an antenna.

Installing the radio in a personal vehicle is the chosen solution to this problem, it provides a large ground plane, mobility, a high-capacity battery with 12V output, which is within the input voltage tolerance of the radio and an integrated generator to charge the battery.

The desired wavelengths that the radio will operate are the 10m, 20m and 40m bands.

A 2.5m end fed antenna using the vehicle as a ground plane was decided as a good balance between practical installation and good electrical properties for the desired wavelengths. 2.5m being ¼, 1/8 and 1/16 of the desired bands. The antenna was to be a folding type mounted on the roof of the canopy so that the height of the vehicle was not increased when the antenna was stowed. The antenna was to maintain electrical separation between the vehicles ground.

The maximum current specification of the radio was 22 amps, 4mm V75 cable was chosen, protected by a 25A fuse.

AS/NZS:3008 Calculations:

Two single core cables installed in a wiring enclosure in air, V75;

Table 4, Column 16;

4mm = 31A

Derating for ambient air temperature in engine bay;

Table 27(1), Column 9;

50 C x V75 = 0.82

*31 * 0.82 = 25.42A*

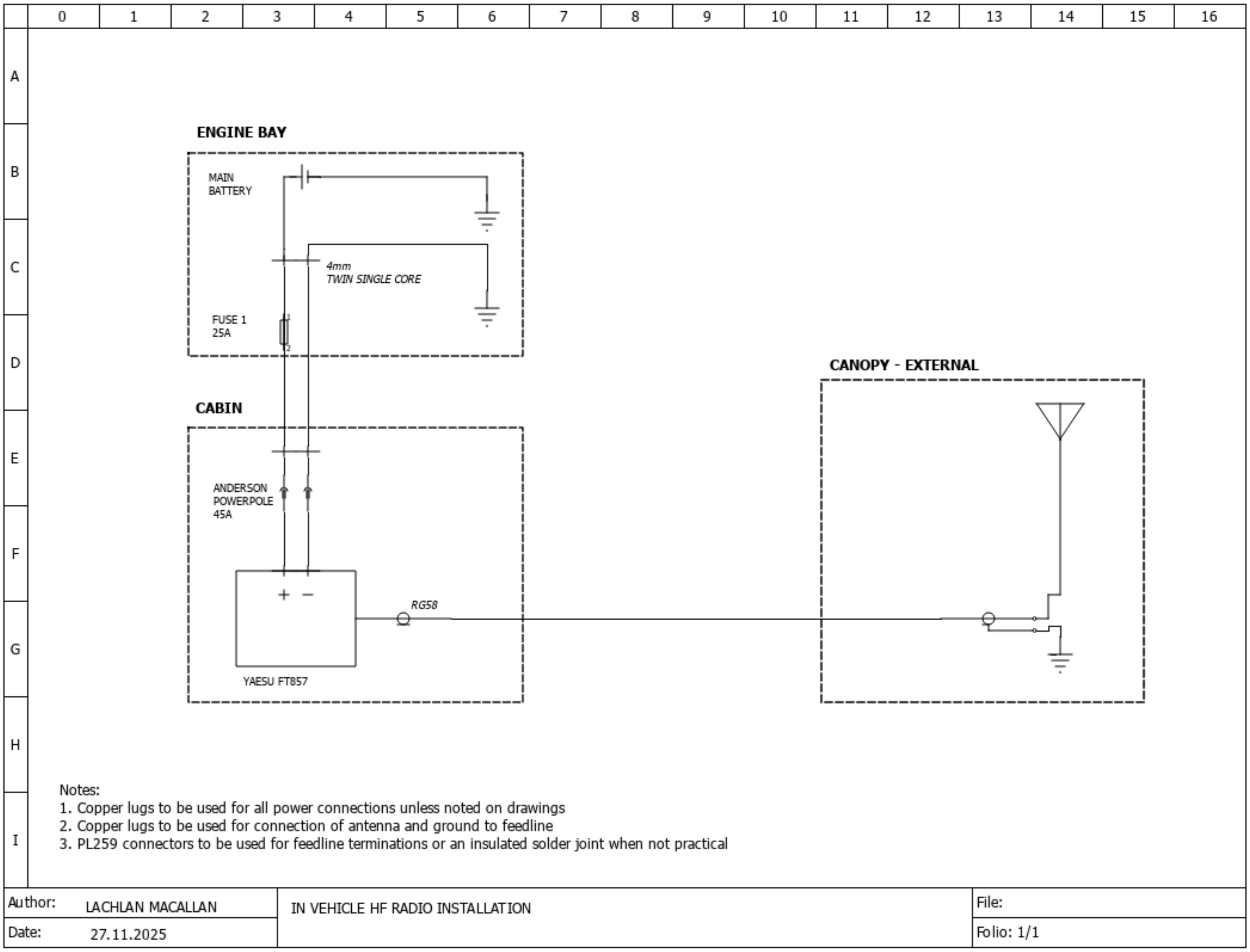
This satisfies AS/NZS:3000 clause 2.5.3.1 where

Ib (current carrying capacity of the cable) ≥ In (nominal current rating of the protection device) ≥ Iz (maximum demand of the circuit)

25.42A > 25A > 22A

RG58 was chosen as the feedline due to its flexibility, low price, ease to acquire and importantly its 50-ohm impedance matched the radios output impedance. An alternative option is RG213, which has lower attenuation for a higher price per meter.

Electrical drawing

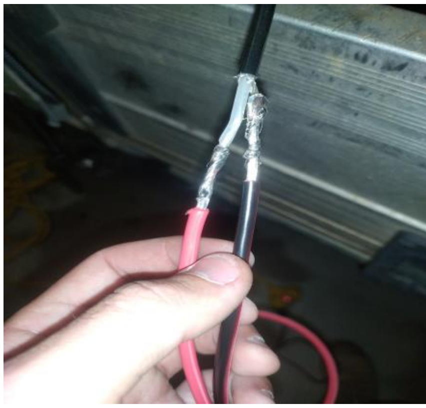


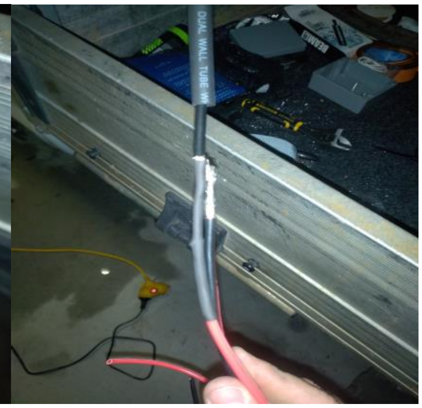
Installation

Insulating rubber was placed between the antenna and the conductive canopy, nylon bolts were used to fix it to the canopy to maintain electrical separation. The antenna consisted of a hinge attached to a folding metal pipe approximately 2.5m long. A cam strap securely fitted to the canopy was used to secure the antenna when stowed, when extended and lifted the antenna was held against the insulated ladder rack by a spare cam strap for operation, the spare cam strap is used to hold the antenna together when stowed.

The coaxial cable was installed in a protected manner underneath the interior vinyl, exiting the cabin through an IP rated gland.

The centre conductor and the sheath were broken out and soldered to copper cables, the joins were individually wrapped in heatshrink with an overall double walled heatshrink wrapped over both joins. This join was secured within the canopy. The sheath's respective cable was lugged and bolted to the canopy, the centre conductors cable was taken through the canopy via an IP rated gland and lugged and bolted to the base of the antenna. The radio side of the coax was terminated with a PL259 soldered plug.





The power cable was joined to a pre-terminated anderson power pole plug via a soldered connection, this connection had individual and overall heatshrink wrapping. The cable was installed securely behind the dash and routed through the firewall via the approved manufacturers' cable way.

In the engine bay the cable was protected with corrugated conduit and joined to an inline 25A fuse via crimp connections, from the fuse the negative was lugged and bolted to an existing ground connection while the positive conductor was lugged and bolted to the batteries positive terminal. The cable was secured with cable ties where appropriate.

Testing

Testing procedure was as follows, set the transmitter to the desired frequency, transmit and adjust the manual tuner (EAT-300A) until the optimum SWR was achieved, and the SWR was then recorded. The test was conducted in a field approximately 10 metres from the nearest sources of EM interference and metal structures that may affect signal transmission, namely low voltage powerlines.

A SWR of less than or equal to 2 is decided as a satisfactory performance.

The following settings were applied to the transmitter during this test:

Transmit power: 10 Watts

Modulation: Amplitude Modulation

Results

Band and test frequency	SWR	Tuner settings
10m, 28 MHz	1.7	Tx Cap: 0 Ant Cap: 0 Inductor: K
20m, 14.5 MHz	5	Tx Cap: 0 Ant Cap: 0 Inductor: J
40m, 7 MHz	5	Tx Cap: 8 Ant Cap: 0 Inductor: G

Analysis of these test results indicates satisfactory performance in the 10m band, however despite the use of a tuner we were unable to achieve good performance on the 20m or 40m bands.

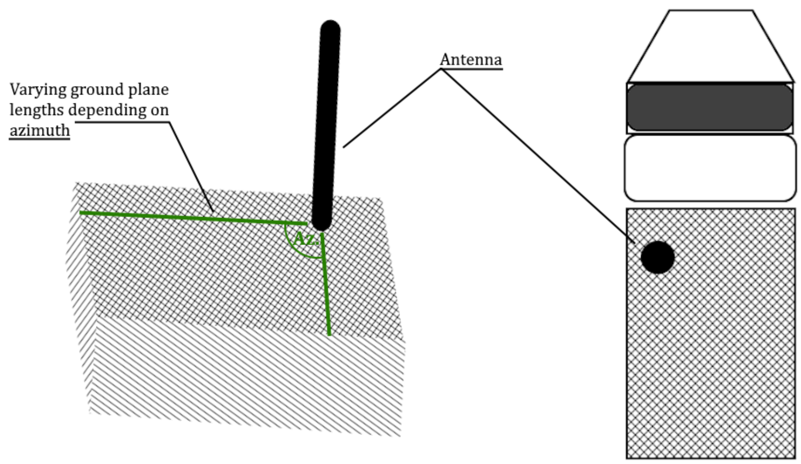
Lessons learned

Construction

During initial operation the dielectric of the PL259 fell out. This was because of poor soldering techniques. Too much heat applied and no solder on the centre conductor. This problem was rectified by re-terminating a new PL259 with the centre conductor exceeding the length of the centre pin. Only enough heat was applied to allow the solder to flow before the soldering iron was removed, the centre conductor was trimmed to length after soldering. This proved to be a reliable repair method.

Design

The placement of the antenna on the side of the roof has the benefit of ease of access, however it would negatively effect the directional gain characteristics since the ground plane will have a different cross-sectional area depending on the azimuth of a radio contact with respect to the vehicle.



.

Failure of the antenna to perform well on the 20m and 40m bands which were specified during the design brief indicates a failure in the design. It is likely that the antenna is too short for efficient propagation on those bands and will need to be extended in the future or we can investigate lengthening the electrical characteristics of the antenna through other means, further research required.