EMC

Vehicle EMC and Ultra Wideband radio systems

VEHICLE EMC. Modern cars typically have several electronic systems that could cause a safety hazard in the event of abnormal operation due to RF field strengths that exceed the level of immunity to which they have been tested. These include the engine control unit (ECU), anti-lock braking system (ABS), electro-hydraulic power steering (EPS) and secondary restraint system (SRS) or airbags. Vehicle type approval tests include tests for RF immunity but the frequencies, power levels and suitable antenna positions that have been included in the vehicle type approval vary greatly between different makes and models of cars. It pays to check this before buying a car if you intend to install a radio transceiver. Some models of car are only approved for installation of mobile phones or CB radios but others can also have HF/VHF/UHF amateur radio transceivers installed up to a specified RF power limit.

For new models of vehicles that obtained type approval after July 2006, manufacturers are obliged to provide publicly available information about the correct installation of after-market mobile radio equipment whose frequency, power level and suitable antenna positions have been included in the vehicle type approval. In practice, this information is also available for many vehicles that were type-approved before July 2006. This information may be available in the vehicle handbook, on the motor manufacturer's website or from a dealer. Some motor manufactures also issue their own general mobile radio installation guidelines (see Websearch).

FCS 1362 (formerly known as MPT1362) is the Code of Practice for installation of mobile radio and related ancillary equipment in land based vehicles. The code sets out industry best practice for the installation of mobile phones, radios, sat nav, telematics and other in-vehicle two way transmitting equipment. The document was first published by the Radiocommunications Agency in 1987 and has undergone various revisions since then. The latest version was published in May 2008 by the Federation of Communication Services (FCS). FCS is the Trade Association for businesses delivering communications products and services to customers in the UK by radio, mobile, fixed and IP telephony. FCS1362 is a 55-page document that is recommended reading for any radio amateurs who intend to install a radio transmitter in a vehicle.

FCS1362 states, "Unless otherwise indicated by the vehicle manufacturer, a dedicated power supply cable should be used for a mobile installation. The power supply cable should only be fused in the positive power line with the fuse located as close as possible to the battery or power source.

"In the case of negative earth return vehicles, the negative power line should be connected to the vehicle body as close as practical to the point where the battery-to-body connection is made. Do not connect the negative power lead directly to the battery."

The last point has caused some confusion as some amateur radio sources used to recommend connecting both the positive and negative 12V supply wires from the transceiver directly to the battery terminals. This idea of this was to minimise the area of the loop formed by the transceiver power cables in order to reduce induced interference from the car's electrical system. Nevertheless, if this is done there is a risk that if the main chassis connection for the car battery negative lead becomes loose, corroded or disconnected, starter motor current would flow to the vehicle ground via the transceiver negative supply wire and the coaxial cable to a grounded antenna, causing the transceiver wiring to overheat. For this reason, a fuse in both the positive and negative cables was recommended. As explained previously however, the current UK Code of Practice in FCS1362 states that the negative power lead from the transceiver should not be connected directly to the car battery terminal but to the vehicle body near the battery ground connection. This arrangement is shown in **Figure 1**.

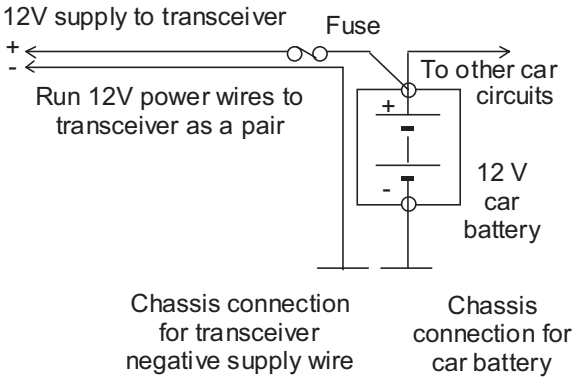

FIGURE 1: Recommended way of connecting a dedicated/ permanent 12V supply for a transceiver in a vehicle.

ULTRA WIDEBAND RADIO. Ultra-Wideband (UWB) is a technique for radio transmission that spreads the transmitted RF signal over a large bandwidth and shares spectrum with other radio users. Applications include short-range high data rate wireless links together with longer range, low data rate applications and also radar systems for penetrating walls or the ground.

UWB was originally called 'pulse radio'. Instead of transmitting sine wave carrier signals, it transmits very short duration pulses with very fast rise and fall times. ITU-R now defines UWB systems as those that occupy a bandwidth of at least 500MHz or at least 20% of the centre frequency, whichever is less. UWB systems can now use two fundamentally different modulation techniques, either pulse or multi-carrier such as orthogonal frequency-division multiplexing (OFDM). Systems that meet the UWB regulations in a particular country can operate on a licence-exempt basis.

UWB operates across radio spectrum that is already allocated to other services, such as mobile phone networks and some amateur bands (mainly microwave). It raises the apparent background noise level in the radio frequency bands where it operates so there are regulations that aim to ensure that the amount of increase is insignificant. In February 2007 the European Commission adopted the UWB Decision and Ofcom introduced UK regulations in 2007 to implement the UWB Decision. During the consultation phase for the 2007 regulations, a joint response was submitted by the Radio Society of Great Britain, UK Microwave Group and AMSAT-UK relating to weak signal services including the Amateur Service, particularly in the 3.40 - 3.41GHz part of the 9cm amateur band.

In July 2009, Ofcom published the proposed Wireless Telegraphy (Ultra-Wideband Equipment) (Exemption) Regulations 2009 (see Websearch), which would also revoke two previous UWB regulations from 2007. Ofcom UWB regulations exempt UWB equipment from the need for a transmitting licence where,

"it does not cause or contribute to Undue Interference and it only emits transmissions at the specified limits in certain frequency bands." The proposed 2009 regulations would increase the 'generic limits' for UWB transmission power in the frequency range 2.7GHz - 3.8GHz and would make other changes to encourage operation above 6GHz. They would relax the current prohibition against attaching UWB equipment to automotive and railway vehicles and would also allow the operation of UWB Building Material Analysis devices that can scan walls for embedded wires, pipes, etc.

In some frequency ranges, further increases in power levels of up to 30dB are permitted if interference mitigation measures are used. These measures include Detect and Avoid (DAA) that can be used in the range 3.1 - 4.2GHz and 8.5 - 9GHz. UWB equipment using DAA detects any other radio systems operating in the area and selects a frequency and transmission level at which to operate. Clearly, DAA cannot detect another radio system nearby that is receiving but not transmitting.

UWB power limits below 1.6GHz are specified but no minimum frequency is specified. As UWB systems are defined as occupying a bandwidth of at least 500MHz or 20% of the centre frequency, whichever is less, licence-exempt UWB systems could in principle operate in the HF, VHF, UHF or SHF bands provided they comply with the regulations for transmitted power density. Nevertheless, due to the relatively low limit for transmitted power below 1.6GHz, UWB systems operating in the HF band seem unlikely due to the higher atmospheric noise levels at HF compared to VHF and UHF. Nevertheless, a UWB system operating nearby may be significant for users of the 5.7, 3.4, 2.3 and possibly 1.3GHz amateur bands.

3.5MHz QRM. Gordon, G3DNF wonders whether he is the only one who has endured 'dreadful QRM' on the 3.5MHz band this year. He reports that, for several months, the band has been practically unusable, with a background noise level such that the only hope of reading the strongest CW during daylight hours was to switch in the attenuator, whereas it used to be such a quiet band to operate. The QRM affects a broad sector of the spectrum, from the top of the MW broadcast band around 1.5MHz up to 4.2MHz, with fairly sharp cut-off at both ends of the range. It sounds like a harsh hiss in CW mode, rather like the hash created by some switch-mode PSUs such as 'wall-wart' plug-in transformers. In AM mode, it is heard as a harsh hum of about 100Hz with an underlying variable component of higher frequency.

At first, Gordon thought that the cause was a neighbour's 'wall-wart' but he soon found that it affected his entire neighbourhood. Driving around within a 2 mile radius with the car radio tuned to 1.611MHz showed that there were 'hot spots'. When he used a portable MW radio in these hot spots, it gave strong directional bearings but these bearings proved to be 'orphans', as none of them intersected and they faded out as he moved out of the hot spots. Gordon's QTH is located in one of the 'hot spots'. He interprets this behaviour as evidence that there may be more than one source.

The QRM was present 24/7 but occasionally reduced at night and on rare occasions it was absent for a time at weekends. One Sunday morning, he logged the QRM at S9+10dB and off the scale on AM mode but by the evening, it had vanished. To his astonishment and delight it has not yet reappeared. Gordon has now put a portable direction finding frame aerial together for 1.8MHz. This has confirmed the absence of the main signal, though there remains a faint remnant on a different bearing. Gordon asks for any thoughts or information on this strange business.

First, Gordon did the right thing by listening on different modes. Interference sources often sound very different in CW or SSB mode compared to AM mode, due to different type of detector. The normal AM 'envelope detector' often gives more clues about the nature of the source. Any source that produces a 100Hz buzz on AM that is synchronous to the mains could be something like a switch-mode power supply for a computer, some sort of plug-in 'wall wart' power supply or mobile phone charger, an 'electronic transformer' for 12V halogen spotlights or even a low energy lamp. None of the above devices should produce interference at the sort of levels that G3DNF mentions but it only needs one such device with no RF interference filtering components to create the sort of 'hot spot' that he describes. If you have an oscilloscope it is worth checking whether a buzz is actually 100Hz and whether it is synchronised to the mains. Display the audio output of the receiver on an oscilloscope and select 'Line' (mains) triggering mode. If the oscilloscope trace stays completely still, the signal is locked to the mains but if it drifts quickly or slowly then the signal is more likely to be from some source that is not locked to the mains, for example the frame rate of a TV or a computer monitor.

Radio direction finding of interference sources at 1.8 or 3.5MHz can be difficult as RF signals can travel tens or hundreds of metres along underground or overhead power cables or telephone cables so it can be difficult to get any meaningful results, as G3DNF found. Driving along the road with a portable MF or HF receiver in the car can help to locate the source as it may give a clear peak as you pass the place where the source is located.

RSGB EMC Committee will be at EMC UK – THE place to rub shoulders with EMC professionals.

EMC UK. 13 and 14 October sees the 6th EMC UK event at Newbury Racecourse. This is arguably the biggest and best EMC event in the UK, and is definitely where the cream of the country's EMC professionals go to rub shoulders.

This year, for the first time, the EMC Committee will be representing the RSGB at this premier event. Apart from all the normal run of the mill EMC issues, you can be sure that PLT will be very high on the agenda. This is another example of where an RSGB committee of unpaid volunteers is doing sterling work among the people who matter.

Unlike many of these top-flight professional events, admission is free and open to anyone with an interest in EMC matters. In addition to the exhibition, there is a lecture programme organised by the Institution of Engineering and Technology (IET), although this and the accompanying training programme are chargeable and must be booked in advance.

For full details of the event, including the training/lecture programme details and booking information, go to www.emcuk.co.uk. You also need to go to that website to register for your free tickets. If you've any interest in EMC, then this is an event not to be missed.

WEBSEARCH

Federation of Communication Services, FCS 1362, Code of Practice for installation of mobile radio and related ancillary equipment in land based vehicles. www.fcs.org.uk/FITAS/FCS1362.aspx or www.fcs.org.uk/IndustryCodesOfPractice.aspx for list of documents.

General Motors Corporation, Radio Telephone/Mobile Radio Installation guidelines (January 2002 Issue) http://service.gm.com/techlineinfo/radio.html

Ford Motor Company Mobile Radio Installation Guidelines (1998 edition). www.fordemc.com/docs/download/Mobile_Radio_Guide.pdf

Notice of Ofcom's proposal to make the Wireless Telegraphy (Ultra-Wideband Equipment) (Exemption) Regulations 2009 www.ofcom.org.uk/consult/condocs/regs2009/regs2009condoc.pdf