MPE PRE-COMPLIANCE TESTING CAPABILITY

MPE offers diagnostic pre-compliance testing to help make the most cost-effective choice of filter solution to meet EMC specification requirements.
Filters and shielding or screening will usually need to be fitted to motors and equipment to enable compliance with EMC specifications.

Conducted Emissions Testing
Conducted emissions testing is most accurately carried out in MPE's screened room by powering equipment from either batteries for low voltage dc equipment or from the mains. The equipment is powered via LISNs which provide a defined impedance from the power source. The noise emissions can either be made as voltage measurements in dBµV by taking a signal from a connection on the LISN or in dBµA by connecting a current clamp around the power cable.
Many items of equipment can be measured in this way to either military or commercial specifications. Military specifications are more stringent and require greater dynamic range and slightly different measurement bandwidths from commercial specifications and although pre-compliance testing cannot guarantee full compliance as it provides a quick and comparatively cheap indication of potential problems and options to introduce a solution with a high degree of confidence before full compliance testing is carried out.
This technique is suitable for many items of equipment depending on size, power rating loading requirements etc, but low voltage equipment running on 12Vdc or 24Vdc with a short term current rating of up to 100A can normally be measured although not always under load conditions. Mains operated equipment up to 30A can also be measured.

Specifications for military use which can be used are Def Stan 59-411 or Mil Std 461
For commercial use there are numerous specifications but these are generally less onerous than the military specifications and so can usually be accommodated
Where it is not possible to test equipment in the screened room, limited testing can be carried out in situ by using current probes clamped onto power lines although the measurements obtained can only be used as a guide, as they will be subject to ambient noise and non standard source impedance.

Radiated Emissions Testing

It is less practical to carry out pre-compliance radiated testing because of the need to have calibrated antennas for each frequency range which slows the process. It is also necessary to carry out such testing in a screened room to negate the effects of ambient noise. Pre-compliance radiated testing is therefore usually only used as a guide and is conducted using sniffer probes to identify problem areas which can then be investigated using other techniques such as conducted tests or visual investigation of mounting shielding, earthing, etc.

Military Vehicle Equipment Testing

In the case of military vehicles, the vehicle will ultimately need to be tested for radiated emissions, and particular emphasis will be placed on emissions in the HF frequency band where many military radios operate. The radiated noise can be caused by direct radiation e.g. sparking from motor or generator brushes, microprocessors, smps circuitry, or it can be caused by secondary radiation from cables and harnesses carrying noisy signals down cables connected to these devices.

The first step towards identifying problems is to carry out a baseline noise measurement. This is normally a radiated test carried out with the vehicle in a screened room with the engine running and all equipment operating. The radiated noise picked up is plotted over the specified frequency range and compared against the specification limit. For military vehicles in the UK, the usual and most stringent limit is specified in Def Stan 59-411 Land Class A. This is specified where vehicles are fitted for radio and need minimal interference. Slightly less stringent are Def Stan 59-411 Land Class B and Mil Std 461 requirements.

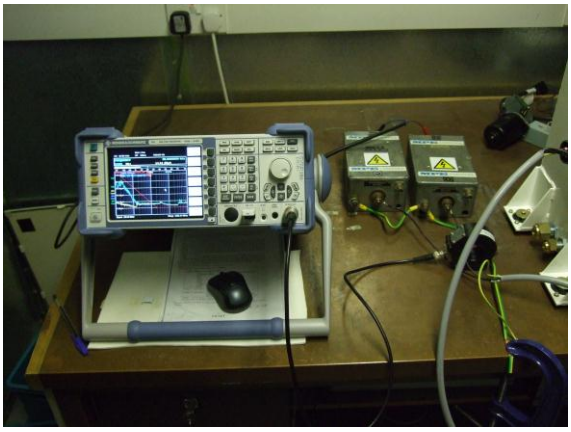
Having established a baseline noise level and compared it with the specification requirement to identify out-of-specification areas, it is necessary to identify the causes of regions of non-compliance. In a full vehicle test this is most easily achieved by switching off one item of electrical equipment at a time and carrying out another frequency sweep. This is often carried out over a narrower frequency band to save time. This process can identify the causes of electrical noise but takes time and will not necessarily identify the radiation mode i.e. is the noise being radiated directly from the equipment or from its connected cable harness, or is the noise travelling down cables and appearing elsewhere.

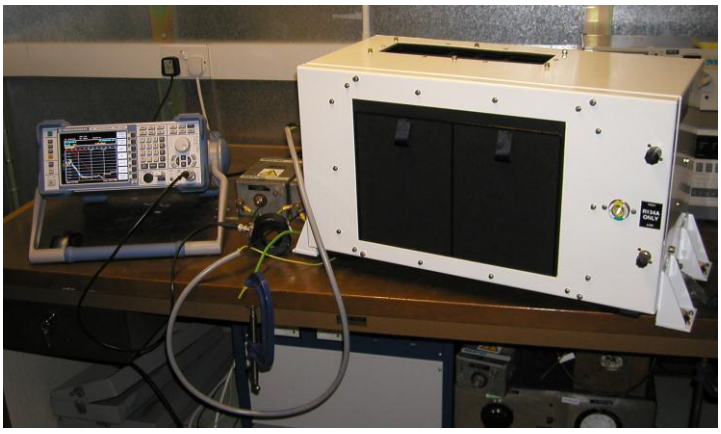
Because these baseline tests have to be carried out in a screened room, it is not practical to carry out a baseline noise measurement with a pre-compliance tester. However a portable pre-compliance tester with sniffer probe can usefully help to identify where localised radiation is emanating from either from the vehicle in the screened room or, with less accuracy because of background noise, from a vehicle in a ‘quiet’ location.

Having identified the sources of electrical noise, individual items of equipment can be addressed both from a screening point of view to reduce direct radiation, and from a filter solution in terms of filtering out conducted noise which can subsequently re-radiate further along the cable harness. The direct radiated noise problem can be investigated with a pre-compliance tester and sniffer probe directly on the vehicle or by powering up the equipment in isolation in a screened room. An assessment based on experience will be needed to propose a suitable level of screening to achieve compliance.

Bench Testing of Individual Equipment

Alternatively, the conducted emissions of an item of equipment can be investigated in isolation in a screened room and a suitable filter circuit identified to reduce conducted emissions. The equipment such as a motors, fans, air conditioning condensers and evaporators, power supplies etc. are normally powered from a car battery via a LISN and the conducted noise can either be measured as a voltage directly from the LISN in dBµV, or more normally using current probes measuring in dBµA, as required by DEF STAN 59-411. A suitable filter can then be connected into the circuit and the improvement in performance measured. The filter can be optimised to suit the frequency range of the noise, the magnitude of the noise and the mode of the noise, symmetrical or asymmetrical (differential or common mode). It is important to note that the screening and mounting of the filter, as well as appropriate parts of the equipment, is important to ensure that the filter is not by-passed due to radiated coupling.

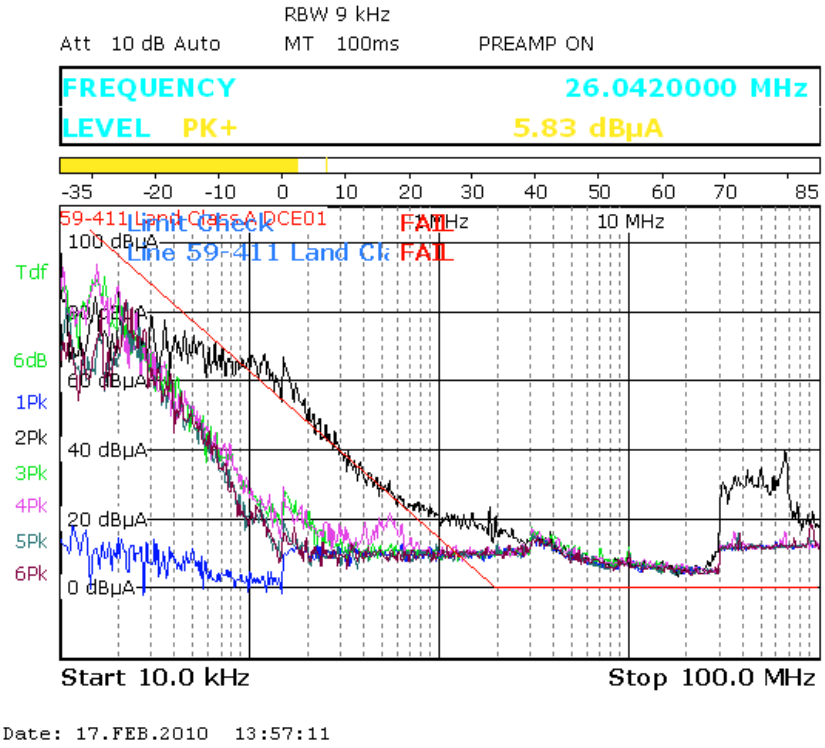




Conducted measurements are made to DEF STAN 59-411 conducted emissions limits DCE01. It is unlikely that a pre-compliance test receiver will have sufficient sensitivity to provide an accurate noise measurement over the full frequency range to DEF STAN 59-411 Land Class A as the limits are extremely low. However, if the noise measurements turn out to be within the noise floor of the receiver (which could be within say 10dB of the specification) then there is a good chance that the equipment will be compliant.

By experience, if the equipment meets the conducted emissions requirement when bench tested, there is a high likelihood that it will pass the final radiated requirement when fitted to the vehicle. This of course assumes that any direct radiation from the equipment has also been addressed. It is clearly important that each item of equipment mounted on the vehicle is compliant in its own right as the overall compliance of the vehicle will be limited by the weakest link on the vehicle.

Typical expected results from bench testing:



Red line	Def Stan 59-411 Land Class A limit
Black trace	Unfiltered equipment noise (baseline) – out of specification at various frequencies
Blue line	Instrument noise level
Other colours	Various filtered measurements – all compliant until limited by instrument noise at just over 1MHz – but good chance of being ok as no big spikes above noise

Note that instrument noise level is not quite sufficient (by about 10dB) to measure the most sensitive area of land class A above about 1MHz – This is one of the compromises of pre-compliance testing – it is ok for land class B and Mil Std 461, and commercial specifications which are not so demanding. However, if there were serious problems in this area, we would expect to see significant spikes above the noise level which would be measured.

Pre-Compliance vs Full Compliance

Full Compliance to Def-Stan 59-411

It is important to remember that full compliance to specifications such as Def Stan 59-411 for a vehicle must be carried out with the correct tuned antennas at the correct positions in an anechoic screened room, using advanced and expensive test kit. Each frequency scan takes about 2 hours, for each antenna position, so the test could take several days, and there will be a cost and time associated with this. This is the only way to guarantee full compliance of the vehicle. However if a vehicle is submitted for a full compliance test and needs lots of remedial work, this can be very expensive, and pre-compliance testing in advance can provide confidence that the vehicle will be close to being compliant before it is submitted for full testing and thus reduce costs.

MPE pre-compliance Offering

MPE offer a testing service as an aid to identify the correct filter solution for individual items of equipment. This helps to provide an indicative check on whether equipment is likely to pass full tests and if not, help to provide a filter solution before the costs of full testing are incurred.

Benefits of Pre- compliance

A. Vehicle tests

Quick
Low cost
Quick diagnostic analysis of e.g. a vehicle can identify potential problem areas such as motors which may be radiating. This can be qualitatively established using electric and magnetic sniffer probes and clamp on current probes for more precise measurements where accessibility is possible.
Can get indication of which items of fitted electrical equipment are likely to cause problems
Can get rough idea of magnitude of noise to provide indication of performance of filter needed.
Can get rough idea of frequency range of noise to identify type of filter circuit needed

B. Equipment Tests

A more accurate quantitative measurement can be made by testing individual items of equipment back in the screened room at MPE using conducted measurements.
Conducted emissions measurements are conducted in the same way as for full compliance tests but with less precision and less sensitivity.
Still not fully compliant but much closer than radiated tests.

Compromises of Pre-compliance

1. Can't perform serious or quantitative radiated measurements without having vehicle in screened room with correct antennas at correct positions
2. To carry out quick measurements can't achieve the measurement dwell times or the frequency step sizes
3. May not use the exact bandwidths required but will only be minor differences
4. May not measure over full frequency range but will measure the normally problematic frequencies within 9kHz – 6GHz
5. May not have quite low enough ambient noise floor but should give a good indication
6. Impractical to use correct antennas due to speed and different antennas needed each with special calibration for each frequency range

Typical Pre-Compliance Plan for Military Vehicle

1. With engine running use electric field & magnetic field sniffer probes plus rod antenna for radiated tests
    a. Test with magnetic sniffer probe 10kHz to 200kHz
    b. Test with electric sniffer probe for frequency 9kHz to 6GHz
    c. Test with 2m vertical rod antenna in HF band from 1.6MHz to 30MHz
2. Try spectrum analyser mode as well as receiver mode
3. Use sniffer probes over harnesses & around typical interference sources like all motors, engine management etc
4. Switch motors on & off to help identify sources
5. Log frequencies, sources, magnitudes of noise
6. If practical, clamp current probe on individual cables to get more accurate conducted measurement
7. Where possible remove identified noisy equipments or get separate equipment and test in screened room for conducted noise using LISN's etc

Typical Pre-Compliance Plan for Equipment from Military Vehicle in Screened Room

1. Power up equipment from car batteries via LISN's
2. Measure conducted interference with current probe to DCE01
3. Based on conducted measurements:
    a. If noise problems at frequencies above 1MHz then will need f/t capacitors
    b. Try fitting feedthrough capacitors on power cables as simplest solution
    c. Re-test conducted interference & see if now generally compliant.
    d. If not try:
        i. Bigger capacitors
        ii. Coupled choke
        iii. Discrete chokes
        iv. Capicitors between lines
        v. Multi stage circuit eg pi filter
    e. Address low freq (<10MHz) first as higher freqs will need proper mounting & screening so will take longer
    f. If discrete chokes give better result than coupled then interference more likely to be predominantly differential mode
    g. Establish suitable mounting & packaging arrangement for filter components based on parts needed and frequency range.
4. Investigate radiated emissions as 1a and 1b in vehicle tests above
5. Visually look for poor EMC design issues likely to cause radiated problems or leaks

Produce testing template and improve it as experience is gained
Keep log of test results to build up a history for experience for future comparisons