# EMC

## More home powerline networking products tested.

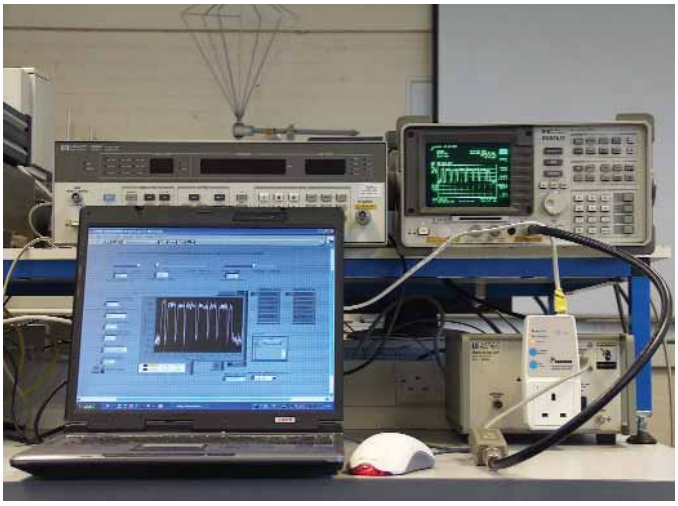

PHOTO 1: Laboratory testing of powerline networking adaptor.

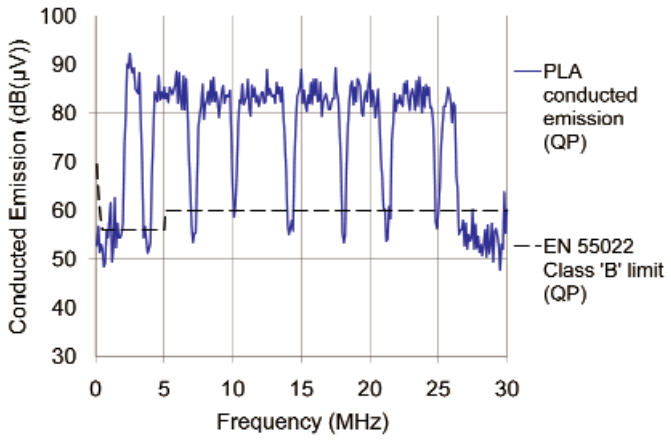


FIGURE 1: Conducted emission spectrum up to 30MHz from a single Comtrend PG902 powerline Ethernet adaptor.

**ROUTES TO EMC COMPLIANCE.** Products sold in the European Union need to be CE marked to indicate compliance with all applicable European directives. In the case of electronic products, this would normally include the EMC Directive. In May 2007, the European Commission (EC) Directorate General, Enterprise and Industry, published a *Guide for the EMC Directive 2004/108/EC*, which is intended to be a manual for all parties directly or indirectly affected by that Directive (See Websearch).

Complying with a harmonised European EMC standard is one way of demonstrating compliance with the protection requirements of the EMC Directive. An EMC Assessment (which replaces a Technical Construction File, TCF) is an alternative route to compliance. Section 3.2.3 of the above Guide states that, "A manufacturer may wish to declare the conformity of his apparatus directly to the protection requirements, without reference to harmonised standards, by making his own EMC assessment. This assessment needs to follow a technical methodology to ensure that the requirements of the EMC Directive are met. The manufacturer will need to provide clear evidence of compliance."

Whatever a manufacturer does in an EMC Assessment, compliance with the 'Essential Requirements' of the EMC Directive is mandatory. So what are these 'Essential Requirements'? An EC Directive is an instruction to member states to introduce legislation to transpose the Directive into national law. The relevant UK regulations are the EMC Regulations SI 2006 No 3418 (Websearch). The Essential Requirements of the UK EMC Regulations are in section 4, which states, "Equipment shall be designed and manufactured, having regard to the state of the art, so as to ensure that - (a) the electromagnetic disturbance it generates does not exceed a level above which radio and telecommunications equipment or other equipment cannot operate as intended; and…"

It appears that products such as powerline Ethernet adaptors cannot meet the existing Class A or Class B conducted emission limits of EN55022, the harmonised European standard for IT equipment, so manufacturers are using the EMC Assessment route instead. Some products have a Declaration of Conformity (DoC) that cites CISPR/I Committee Draft CIS/I/89/CD, a proposed amendment to CISPR 22 issued in November 2003 but subsequently rejected by the CISPR standards committee and withdrawn. Citing a *failed proposal* on a DoC seems somewhat questionable to say the least.

Nevertheless, such products still need to meet the 'Essential Requirements' of the EMC Regulations, as stated above. We have done some tests to see whether we think that they do.

**TESTING POWERLINE ETHERNET ADAPTORS.** The relevant EMC standards specify a conducted emission test method up to 30MHz based on the assumption that most of the RF interference below 30MHz gets out by being radiated by connected cables, such as power cables. It also makes an assumption of how much typical mains wiring converts conducted emissions into radiated emissions. This month's tests include both radiated and conducted tests.

The Comtrend DH10 Powerline Ethernet Adaptors (PLAs) tested in Dec 2008 EMC have been superseded by the PG902 model that is being used in new BT Vision installations. A PG902 device was tested, as shown in **Photo 1**. This is a pre-test sweep using pre-compliance test equipment and it only provides an approximate indication of the conducted emission spectrum and its level. The results are shown in **Figure 1**. The trace was produced using a 9kHz measurement bandwidth and a Quasi-Peak responding detector. The EN55022 Class B Quasi-peak (QP) limit line is shown for comparison.

The emissions from a pair of PLA devices would be slightly higher compared to Figure 1. By comparing the DH10 test results from December 2008 EMC with some test results posted on the UKQRM Yahoo Group (Websearch), it appears that the conducted emissions from a single PLA when tested by an accredited EMC test laboratory with a QP detector are approximately 6dB lower than those shown in December 2008 EMC. Figure 1 suggests that the QP conducted emissions may be at least 25dB above the EN55022 Class B QP limit. Nevertheless, it appears that compliance with EN55022 is not being claimed and that such devices are being CE marked using an EMC Assessment route.

The frequency range occupied by the DH10 model tested in December 2008 EMC is approximately 2.2 – 28MHz with 'notches' for the 3.5, 7, 10, 18, 21, 24 and 28MHz amateur bands but not the experimental 5MHz allocation. There is no notching for HF broadcasting or other HF radio users such as 27MHz CB, cordless mice and keyboards. The spectrum from the PG902 model shown in Figure 1 is similar to the DH10 except that the amplitude is slightly lower and the notch

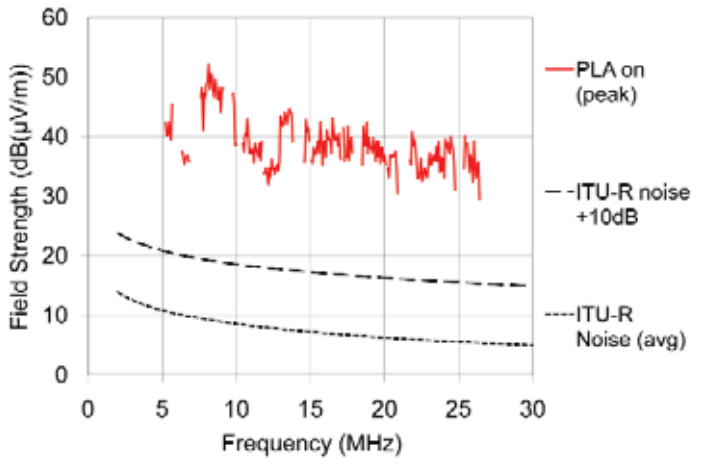


FIGURE 2: Radiated emission spectrum up to 30MHz from a pair of Comtrend PG902 powerline Ethernet adaptors at 10m.

PHOTO 2: Radiated emission measurements from PLAs installed in a house.

for the 28 – 29.7MHz amateur band has been extended down to 26.5MHz, which offers some protection to 27 – 30MHz.

The level of RF emissions from the PLAs did not change significantly between idle and sending data. The envelope of the emission is 100% AM at slightly over 1kHz, giving these devices a characteristic sound on an AM receiver that is subjectively much more obtrusive than the noise-like envelope from Homeplug PLA devices. This characteristic, combined with the continuous transmission, increases the potential for interference to HF radio services such as broadcasting.

**RADIATED EMISSION TESTS.** Two PG902 PLAs were plugged into mains sockets in the author's house. One was located on the ground floor near the TV set and the other was located upstairs on the first floor. **Photo 2** shows a Schaffner-Chase HLA 6120 broadband active H-field measuring loop antenna that was located 10m from the rear wall of the house. The output from the loop antenna was measured using an HP 8591EM EMC analyser to make swept measurements using 9kHz resolution bandwidth and a peak detector.

The test equipment was powered from a rechargeable 12V battery and an inverter to provide a fully isolated mains supply and avoid any conducted coupling path from the house mains supply to the measuring antenna and spectrum analyser.

**Figure 2** shows the field strength of the radiated emission measurements with the PLA devices on. The amplitude units are field strength in dB above 1$\mu$V/m. It also shows man-made atmospheric noise field strengths for residential areas according to ITU Recommendation ITU-R PI.372-6, 1994. As the ITU-R noise levels are average measurements, Figure 2 also shows an ITU-R residential man-made noise curve plus 10dB, as an approximation to the results when measured with a peak responding detector. Although the H-field or magnetic field strength was measured, the test results are presented as equivalent E-field (electric field) strength in dB$\mu$V/m, assuming 'far field' and 'free space' conditions. Figure 2 measurements were made late at night near mid winter when the maximum usable frequency (MUF) was below 12MHz. The red trace shows where sections of the PLA radiated emission spectrum are clearly identifiable above intentional signals such as broadcasting. The gaps are either where the PLA emissions are notched or where there were a significant number of broadcast signals.

From approximately 8 – 26MHz, broadband emissions from the PLAs are at a level of approximately 35 – 45dB$\mu$V/m, except in amateur bands that are notched. Below 10MHz, there are many ambient signals but spot frequency measurements made on frequencies that were relatively free of ambient signals showed that the field strength of the PLA emission was approx. 35 – 45dB$\mu$V/m, except in bands that are notched.

Further work is being done to measure how much the background noise level is increased when PLA devices are operating. Preliminary results at various relatively 'quiet' spot frequencies between 1.8 and 28MHz show that man-made atmospheric noise levels were broadly similar to the ITU-R noise levels and appear to be lower in some cases.

A 10m separation between a radio receiving antenna and the nearest point of the power wiring is relatively large and may be regarded as a 'best case' scenario. A 3m separation is more realistic although not always achievable and is likely to result in levels that are about 10dB higher than those shown in Figure 2.

If a separation of 10m can be achieved, then the notching of amateur radio bands appears to offer a reasonable amount of protection from interference, although the experimental 5MHz amateur allocation is not notched. Although the amateur band notching could not be turned off by the user in the PG902 PLAs tested, it appears that other types of PLA are available where users can disable the amateur band notching. If such devices are available in the UK, I would be very interested to receive details.

In the case of HF AM broadcasting, ITU-R recommendation BS 703 indicates a minimum protected field strength of 40dB$\mu$V/m and an RF signal to noise ratio (SNR) of 34dB. The measured levels shown in Figure 2 indicate that, under minimum broadcast field strength conditions, the RF SNR would be near zero in most broadcast bands. Even if the broadcast field strength is 10 – 20dB higher than the minimum, an SNR of 10 – 20dB yields a signal that is of little entertainment value, even with an optimistic separation distance of 10m.

DRM HF broadcasting uses transmitter powers that are typically 5 – 10dB lower than for AM. DRM test transmissions for the London area are currently taking place on 25.695MHz, in the '11 metre' band. Like the other HF broadcast bands, it is not protected by notching in the PLAs tested. The Crystal Palace DRM signal can normally be received at the author's QTH but when the PLAs are switched on, it is masked. If PLAs can prevent reception of this service and other HF broadcast services, how do they comply with the protection requirements of the EMC regulations? Readers can draw their own conclusions.

**WEBSEARCH**

European Commission Directorate General, Enterprise and Industry, 'Guide for the EMC Directive 2004/108/EC (21st May 2007)': http://ec.europa.eu/enterprise/electr_equipment/emc/guides/emcguide_may2007.pdf

EMC Regulations 2006, UK Statutory Instrument No. 3418: www.berr.gov.uk/whatwedo/sectors/sustainability/regulations/ecdirect/page12469.html and www.opsi.gov.uk/si/si2006/20063418.htm

UKQRM website against powerline Ethernet: www.ukqrm.org/

UKQRM Yahoo Group: http://groups.yahoo.com/group/ukqrm/