Radiocommunication Study Groups

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North American Broadcasters Association (NABA)

PRELIMINARY DRAFT NEW REPORT ITU-R BS.[PROTECT-WIRED ABOVE 80 MHz]

Risk of interference from harmonics of PLT carrier frequencies in power networks with non-linear components

The North American Broadcasters Association (NABA, *www.nabanet.com*) is an association of broadcasters in Canada, Mexico, and the United States, and the NABA Technical Committee is its standing technical body. NABA is thus in a position to present the technical viewpoints of the most authoritative association of professional North American Broadcasters in television and sound programme production, post-production, and distribution for terrestrial, satellite, and cable broadcasting.

NABA is a Sector Member of ITU-R and a long-time participant in ITU-R Study Groups, Working Parties, Task Groups, Rapporteur Groups, etc. NABA numbers among its members Chairmen, Vice-Chairmen and members of the above groups. NABA also participates widely in the ITU work on radio, television and multimedia services and has a strong interest in spectrum management studies including spectrum engineering techniques, spectrum management fundamentals, spectrum monitoring, and inter-service sharing, interference and compatibility.

NABA notes that Working Party 6A initiated a working document towards a preliminary draft new Report entitled "Protection requirements of broadcasting systems operating above 80 MHz against interference from radiation caused by wired telecommunication systems." The document was attached to the Chairman's Report as Annex 13 to Document 6A/375. It is also noted that the Report contains the results of experimental measurements showing the extent of emissions from PLT devices. NABA also notes that at the last meeting of Working Party 1A in April 2010 that the International Amateur Radio Union (IARU) presented in Document 1A/266 further measurements of emissions from PLT devices.

Although the introduction of spectral notches into PLT systems may mitigate the interference potential to radiocommunication services from in-house PLT systems, the measurements resulting from these experiments have clearly demonstrated that the effects of non-linearity in other devices can have a major effect in significantly reducing the depths of the notches. The results of the measurements are included in the Annex for insertion as Section 9.4 of the Report.

ANNEX

9.4 Intermodulation effects on the depth of spectrum notches in PLT systems

The interference to radiocommunication services from PLT devices has led to the introduction of a mitigation technique known as spectral notching. The Recommendation ITU-T G.9960 entitled “Next generation home networking transceivers” provides details for limiting the power spectral density (PSD). Measurements made by the International Amateur Radio Union (IARU) have shown, however, that intermodulation effects in other equipments connected to the mains wiring can lead to a marked reduction in the effectiveness of this approach. This section describes the measurements and the impact of intermodulation.

9.4.1 Measurement technique

Two PLT devices were set up to communicate between them, with a line impedance stabilization network (LISN) feeding into a unit designated as ‘remote’: the 20 dB attenuation at RF simulates a remote PLT in another room. Hence the remote PLT only makes a small contribution to the measured emission. The devices are referred to as power line adaptors (PLA).

The local and remote PLAs are communicating but no data is being sent. Measurements were made at 400 spot frequencies with a 9 kHz measurement bandwidth and a quasi-peak (QP) detector. The results are shown in Fig. 1, with the EN55022 Class B QP at 60 dBµV limit shown for comparison.

Because of the frequency step size, the narrower notches such as 10 MHz, 18 MHz and 24 MHz amateur bands are not be shown with their full depth but all are at least 30 dB deep and some are over 40 dB deep at the centre.

A non-linear device using the circuit in Fig. 2 was connected to the mains. This is very similar to a number of small mains power supplies examined: there are variations in component values between various models.

FIGURE 1

The spectrum showing the spectral notches

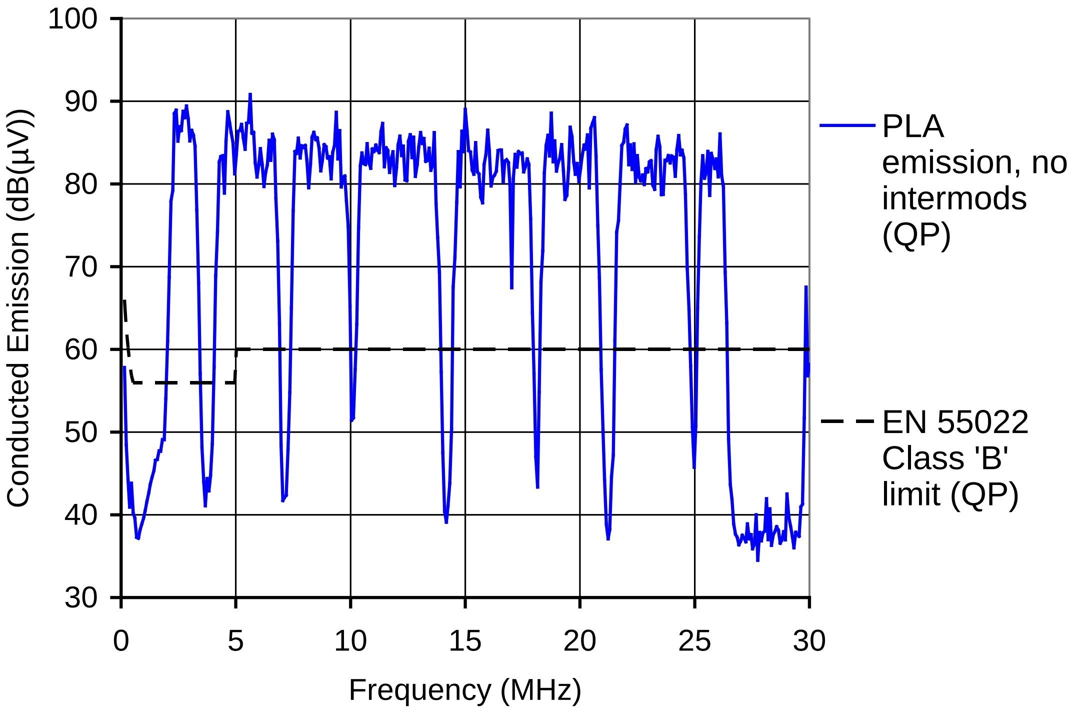
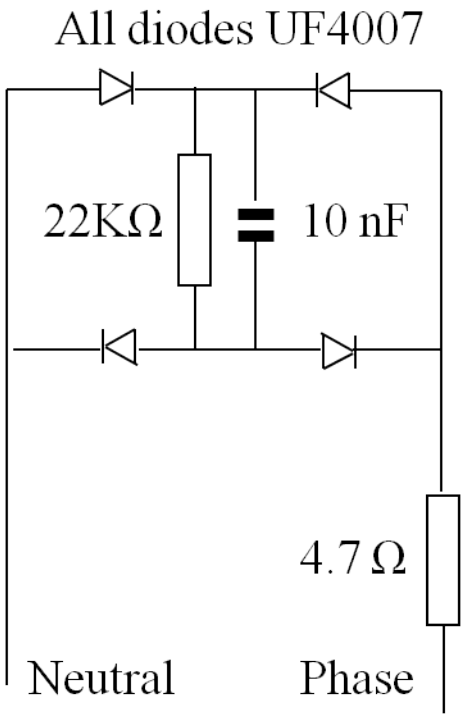


FIGURE 2

Simulated small power supply



9.4.2 Results

Figure 3 shows the effect of connecting the rectifier shown in Fig. 2 to an adjacent mains socket. It can be seen that the depth of the 3.5, 14, 18, 21, 24 and 28 MHz notches is reduced to about 20 dB. There is also a significant increase in out-of-band products with peak amplitude that is significantly higher than the QP level. The increase in emissions in the range 0.5-2 MHz includes the 1.8 MHz amateur band and the MF broadcast band. There are also increased emissions above 27 MHz that could affect the 28 MHz and 50 MHz amateur bands, although the emissions above 30 MHz are not shown in Fig. 3.

FIGURE 3

The effects of intermodulation on the notches

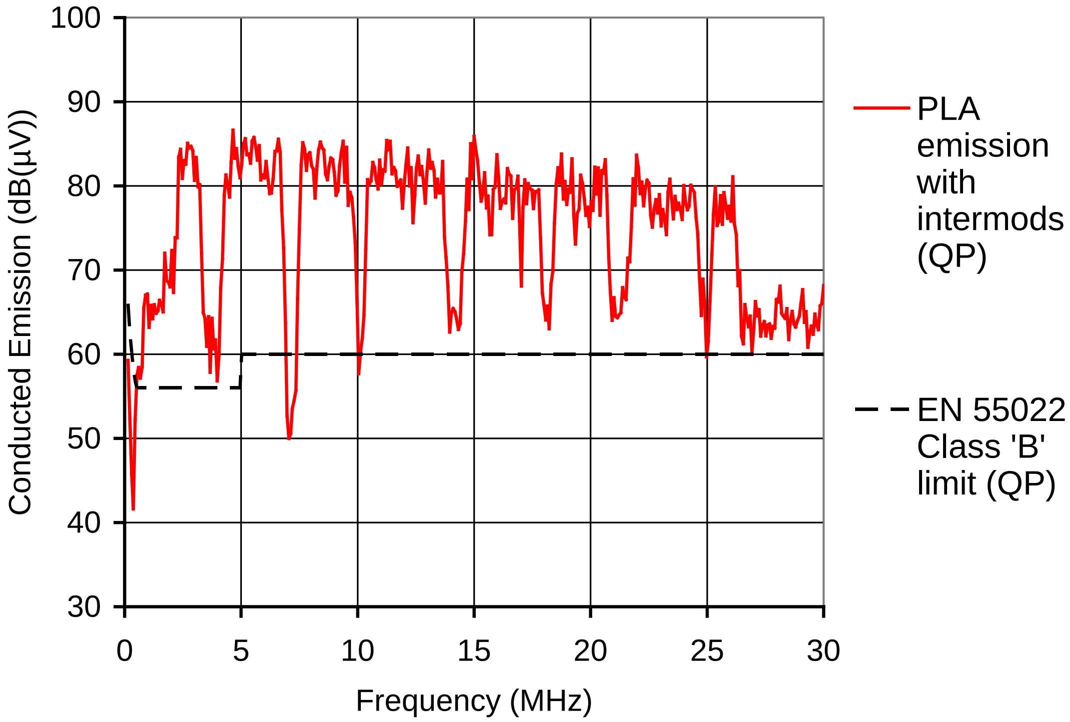
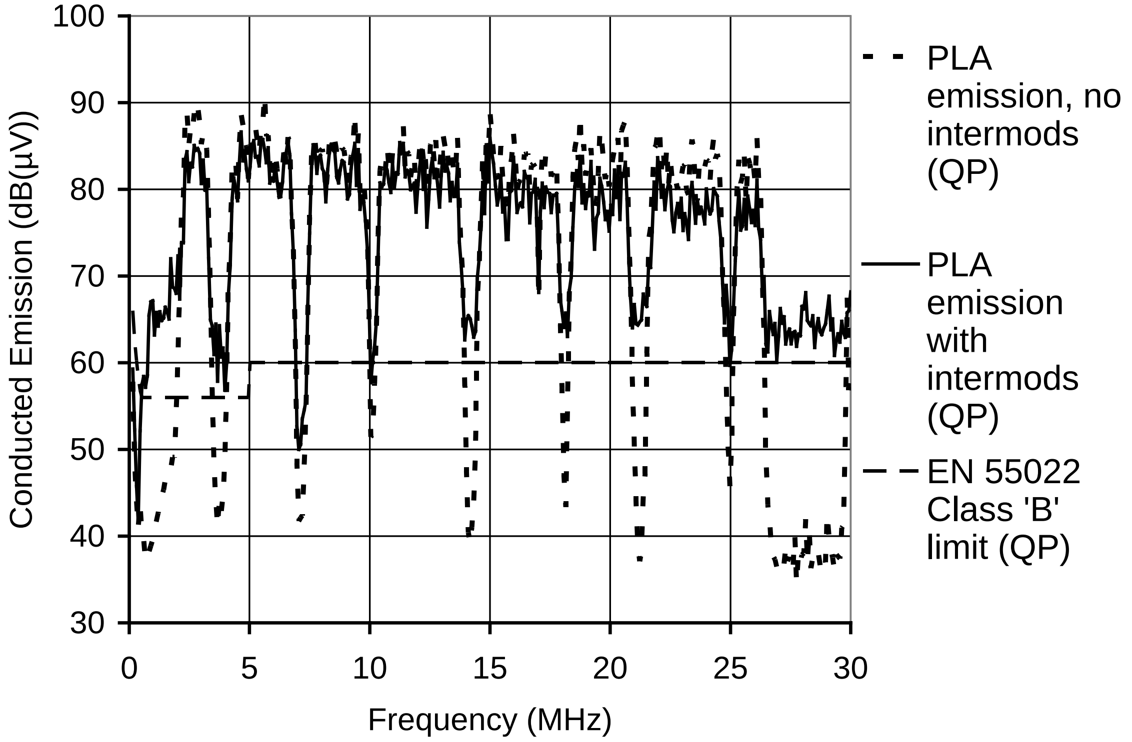


Figure 4 shows the composite plot of Fig. 2 and Fig. 3 overlaid.

A small plug-in switch-mode mains PSU was dismantled, and it was found that the rectifier part was similar to Fig. 1, apart from a larger smoothing capacitor and different diodes. The mains input is connected directly to the bridge rectifier via a 5.6 Ω resistor, and the RF interference filtering is after the rectifier. This means that RF signals from a nearby PLA can get straight into the bridge rectifier, and any intermodulation products and harmonics generated by the bridge rectifier can get straight out again, onto the mains.

FIGURE 4

Composite plot of Figs. 3 and 4 overlaid



Some tests were also performed with one PLA on its own. This may be a 'worst-case' situation where it is constantly calling while searching for another PLA but it may also be representative of the case where two PLAs are plugged in close together, as sometimes happens. In either case, the QP level of the intermodulation products is higher than the results shown in Fig. 3 (where a local PLA is communicating with a remote PLA). At a spot frequency of 14.182 MHz, inside the 14 MHz 'notch', the QP emission levels for one PLA on its own were as follows:

No rectifying load, 44 dBµV

With PSU on load, 60 dBµV

With PSU off load, 65 dBµV

With rectifier shown in Fig. 2, 73 dBµV.

The 14 MHz notch is quite deep and goes well below the EN55022 Class B limit of 60 dBµV QP but in this situation, it was found that the PSU on load can bring the level up to the limit. It was found that the same PSU disconnected from its PLA, i.e. unloaded, can generate intermodulation products that are about 5 dB over the limit. The PSU on its own is relatively quiet in the HF bands so the above emissions appear to be caused by the rectifier of the PSU generating intermodulation products from the PLA signals.

A charger for a mobile phone was also tested, and it also generated intermodulation products, particularly when off-load, although these were about 2 dB less than the PLA PSU when off-load. Clearly there are many different types of switch-mode power supply that can be plugged in to the mains and some of these may cause significantly more intermodulation than the two types mentioned above.

9.4.3 Conclusions

Although the introduction of spectral notches into PLT systems shows a very useful improvement in reducing the interference potential to radiocommunication services from in-house PLT systems, the measurements resulting from these experiments have demonstrated that the effects of non-linearity in other devices can have a major effect in significantly reducing the depths of the notches. Nevertheless, the notches still perform a valuable function even when intermodulation is present, but the effects of intermodulation can be best minimized by a reduction of the power levels applied to the mains distribution system.