Detection of interference from a distant PLT installation

1) Introduction

This note takes as examples two makes of PLT modems (otherwise called "Power Line Adaptors") that transmit high-speed data or video over domestic mains;

* The Comtrend PLAs. These are available as separate items or from BT as a part of the "BTVision" package. They transmit data in the frequency range 2 to 26.5MHz with notches to reduce emission in the amateur bands at 3.5, 7, 10,14, 18, 21, and 24 MHz.

*The Belkin Gigabit modems. These use TWO frequency bands.

- The first is from 2 to 28MHz. The amateur bands are notched as Comtrend with the addition of a notch for the 5.4 MHz allocation.
- The second is from 50 to 300MHz *without any notches*.

2) Technical Background

It is not easy to identify PLT emissions because for communications efficiency they are noise-like, and when monitored with an ordinary AM receiver they can easily be confused with other "noise" sources. Such other sources may include real natural noise and spurious emissions of other electrical and electronic products.
The article ***"Environmental effects of the widespread deployment of high speed Power Line Communication"*** published in The EMC Journal, March 2010, pp 29-37 and accessible at www.compliance-club.com and www.theemcjournal.com covers this subject in some detail, concentrating on the cumulative effects of large numbers of culprit modems.
The following notes should be read as an extension of that article into the specific problem of how to detect the PLT emissions from a ***single*** installation. In this instance there are identifyable characteristics that would be undetectable once averaged out across a large population of PLT sources.
For some types of PLA the interference generated varies with the data transmission load; For others it does not. There are recent reports that Comtrend have a new product that when idle generates less interference than did its predecessor.

3) Likely signal/noise ratio

3.1) The professional studies noted in the references within the above paper show lower PLT radiated emission levels at 3MHz than at 27MHz because of the lower "house antenna" gain. This may make it easier to detect PLT emission interference at the higher frequencies.

3.2) The ITU-documented typical noise levels are lower at 27MHz than they are at 3MHz Again, this may make it easier to detect interference from PLT emission at the higher frequencies.

3.3) Intended radio signals may handicap the positive identification of PLT interference. It may be helpful to choose a frequency that is above the MUF for the time-of-day. A directional receive antenna will also help.

3.4) At a distance from the source, interference signals fall off basically in accordance with the inverse square law. However, because of absorption of energy by buildings and the earth's surface, the "Ground wave" signal actually falls off with distance more quickly than does the "free space" signal. This effect is greater at higher frequencies, so that the PLT signal will fall off more rapidly with distance at the higher frequencies. This suggests that maybe 3MHz interference may be detectable at greater distance than that at 27MHz.

3.5) In summary, there will certainly be differences between different frequencies but with several effects coming into play it is uncertain how this will work out. Long distance detection of PLT interference will be easiest if the receiver is in an electrically-quiet environment.

4) Identifying Interferers

4.1) There are many videos of PLT emission to be found on Youtube.
See also http://www.archive.org/details/BtVisionPowerlineAdaptorInterferenceBpl-Thebtman.com

4.2) For an accessible single installation, the time-honoured method of turning the source off, and then on again, is obviously appropriate. However it should be noted that the boot-up time for modems may be quite long. For Comtrend, keying of the emission may be achieved thus or by pressing their "Standby" buttons. In either case allowance would need to be made for the start-up time of the modem. This is about 12 seconds. Alternatively the radiation characteristics of the mains wiring may be changed by connecting or disconnecting other items of domestic equipment. There seems to be no useful method of identification that is based on varying data flow since these modems emit at close-to-maximum level even in the absence of data flow.

4.3) Comtrend modems use the "UPA" OFDM modulation scheme. See **ref. [21]** of "Environmental effects of the widespread deployment of high speed Power Line Communication". They also present a wide-band interference source. An individual installation emits a clearly-identifiable spectrum signature at a specific instant in time **[see ref.22],** and if monitored on an AM receiver with sufficient bandwidth is demodulated to produce a rough note with a strong 1.3KHz component.

4.4) Belkin Gigabit modems are said to use the Homeplug protocol at HF with an additional high speed overlay that occupies the 50 to 300MHz spectrum even if the distance is too great for it to be used effectively. This modem is characterised by a "ticking" pulse emission at 25 pulses per second, locked to the local 50Hz electricity waveform. If data is being transmitted than this ticking is supplemented by additional "ticks" of similar amplitude that are not locked to the mains waveform.

4.5) Most PLT products have "notches" in their emission spectrum to reduce the level of interference to Amateur radio. These are typically 30dB deep (at least 5 S-points) and so an in-band / out-of-band comparison will provide a quick way to check if a strong source of interference is coming from a PLT installation. However it seems difficult to use these notches to uniquely identify a ***single*** distant PLT source.

4.6) An interesting challenge is that PLT interference is wideband – typically covering 2 to 26MHz overall. Deducting the notches the net bandwidth is 20.5MHz, ie 205 times 10KHz, so the total broadband power is 23dB higher than the 10KHz power. Simplistically this ought to allow detection at much greater range. But how?

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