Power Line Communication (PLC): Measurements and Filtering the Signals

OnFILTER' products help in design, installation and mitigating problems in power line communication (PLC).

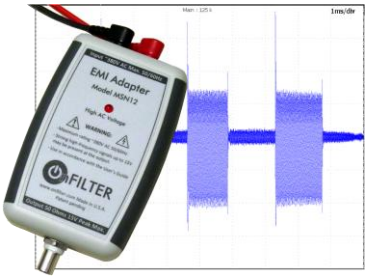

Figure 1. OnFILTER' Power Line EMI Adapter MSN12

Background

Power line communication (PLC) is both ubiquitous and invisible. You won't find antennae masts and, normally, you wouldn't even suspect that communication via power lines is taking place. Yet, it is at work in many places and is expanding. Power lines and ground provide unique wide-spread ready infrastructure for electrical signals that is not blocked by shielding and does not occupy precious airwave frequency bands. PLC provides great convenience for communication but is not free from its challenges.

What is Power Line Communication (PLC)?

Communication over power lines is done by superimposing modulated high-frequency signal on power lines in one location and separating and demodulating it at the destination. PLC can be very simple and basic, or it can be quite complex. There is a number of standards for PLC that span from basic control to high-speed networking. Figure 2 lists some of existing PLC standards with more in works. This table relates to narrowband communication while there are also standards for broadband communication with extends up to 250MHz with much higher data rate. The names associated with PLC include Smart Grid, HomePlug, HomePNA, LonWorks, HomeGrid and a number of others. PLC is a growing business - it offers advantages of communication without need for additional wires while technically not being wireless and not having a need for the wireless bandwidth.

Table 3. Specifications of narrowband PLC standards

Standard	Technology	Frequency band	Bit rate (kbps)
G3-PLC	OFDM	36-90.6kHz	5.6-45
PRIME	OFDM	42-89kHz	21.4-128.6
IEEE P1901.2	OFDM	9-500kHz	Coming Soon
ANSI/EIA 709.1,.2	BPSK	86, 131kHz	3.6-5.4
KNX	S-FSK	125-140kHz	1.2
IEC61334	S-FSK	CENELEC-A	2.4

Figure 2. Some of narrowband PLC standards
Source: Cypress Semiconductor

Figure 3 illustrates how the high-frequency signal is superimposed on AC mains in a ubiquitous X10 control PLC. Here small bursts of high frequency signal (in this case 120kHz) are injected into 120VAC 60Hz mains' line. On the receiving end this signal is being separated from the mains and processed.

OnFILTER' products help with several aspects of power line communication: design, installation, troubleshooting and interference.

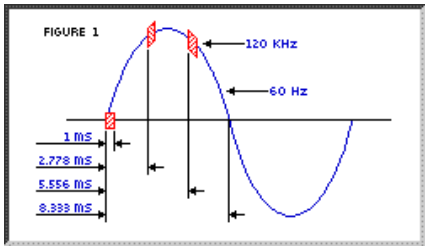

Figure 3. Example of PLC: X10
Source: SmartHomeUSA

OnFILTER' Power Line EMI Adapters "see" PLC Signals

Measurement of high-frequency signals on power lines is important for analysis of PLC - not only for observing and measurement of PLC signal itself, but also of interference signals on power lines that can cause problems for PLC. One of the challenges in analysis of power line communication is separation of high-frequency signal from high voltage of AC mains so that instruments, such as oscilloscopes, spectrum analyzers and others, can safely observe and measure PLC signals. OnFILTER' power line EMI Adapters MSN01 and MSN12 are designed specifically for this task. They completely block 50/60Hz voltage and pass through only high-frequency signals providing complete galvanic separation from high voltage on mains and true balanced input. Frequency response of EMI Adapters (10kHz to 30MHz) makes them perfectly suited for use with narrow-band PLC and with some of broadband PLC.

This enables easy and safe measurements, diagnostics and troubleshooting of power line communication in any environment. Figure 4 shows the same X10 signal extracted from 120VAC power line and shown on the screen of an oscilloscope with different time bases for analysis.

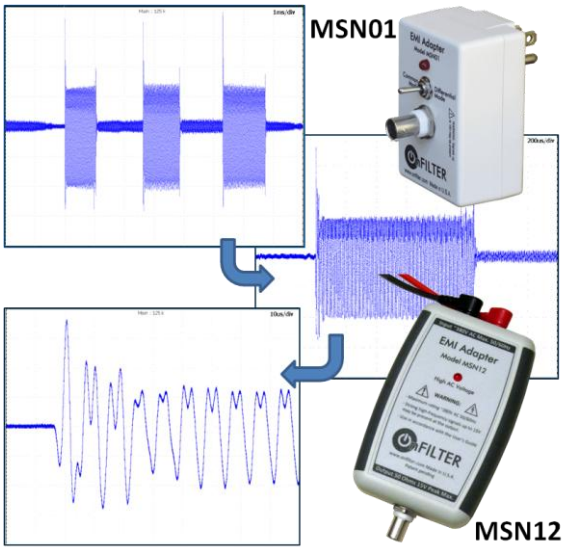

Figure 4. Observing PLC waveforms with help of OnFILTER' power line EMI adapters

OnFILTER' Power Line EMI Adapters

OnFILTER manufactures two types of power line EMI adapters - plug-in (MSN01) and hand-held (MSN12). MSN01 offers convenience of use (simple plug-in) and ability to measure either differential (live-to-neutral) or common mode (live + neutral to ground) high-frequency signals. MSN01 is available with U.S. plug - for international outlets use widely available plug adapters.

For measuring of signals on power lines where connecting to the outlet is not an option (such as in power distribution boxes and in other locations) use hand-held adapter MSN12. It comes with test leads that can be connected to different points. MSN12 is designed for up to 380VAC applications. Both adapters have 50 Ohms standard output and come complete with the cables.

PLC Signal Collision and Interference

What happens when there is more than one similar PLC systems on the same power network? It often ends up in signal collision and malfunction. Power line EMI filters resolve this problem by blocking PLC signals from the power sections where they don't belong. OnFILTER' CleanSweep® AC power line filters perform very well in this application. They also can protect PLC in a section of power line by blocking it from external interference. Figure 5 shows how PLC signals are suppressed by CleanSweep® EMI filter allowing for interference-free and secure operation. As an illustration, Figure 6 shows performance or a regular multi-stage EMI filter with equivalent ratings. As seen, regular filters don't do much for reducing high frequency signals on power lines. For details on how CleanSweep EMI filters achieve such performance see OnFILTER Advantage app. note in our Library.

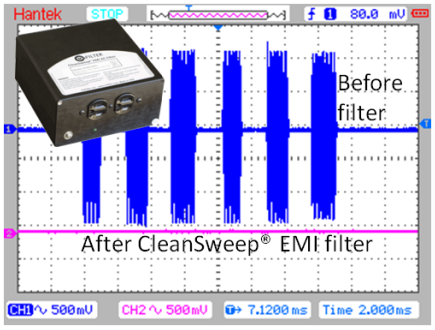

Figure 5. CleanSweep® EMI filters block PLC signals

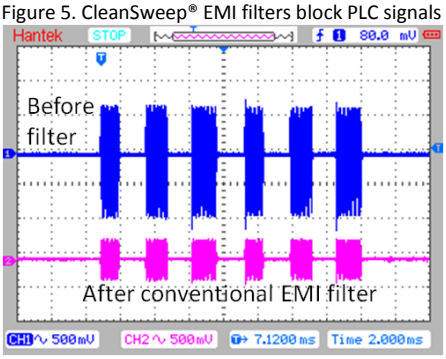

Figure 6. Conventional multistage EMI filters cannot block PLC signals

Conclusion

OnFILTER' offers several solutions to help designers, installers and users of power line communication. Please visit www.onfilter.com for more detailed information. Contact us at info@onfilter.com with any questions.

Figure 7. CleanSweep® family of plug-and-play power line AC EMI Filters - available in many international configurations