Power line modem communication as a backbone for smart grids

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Why and how

- PLM (**Power line Modem**) or DLC (Distribution Line Carrier) = communication for ‘Smart Grid’
- In ‘Smart Grid’ = Automatic Meter Reading (**AMR**) or Automatic Meter Management (**AMM**)
- **Alternatives** to PLM and pros and cons:
  - **Wireless**: **GPRS**, .. (☹ extra service provider + reception, ☺ installation cost)
  - **Wired**: **CATV**, **PSTN** (☹ extra service provider + installation cost, ☺ reliability)

State of art

- **EN50065-1 (for power line modems)**:
  - **9-90 kHz**: reserved for the power utilities
  - **140 -148.5 kHz**: free commercial use = narrowband = several systems on the market today
  - strong limits148.5-500 kHz were introduced to recude interference with LW radio?
  - 122dBµV with 50Ω//(50µH+5Ω) LISN
- **EN 55022 (EMC-ICT):**
  - **> 150 kHz** and **limits** are **much lower** (e.g. < 80 dBµV)
  - used by broadband PLM systems on the market: 5-30 MHz (short distance, domestic ICT)
  - 5-30 MHz on the street > interference with e.g. world receivers

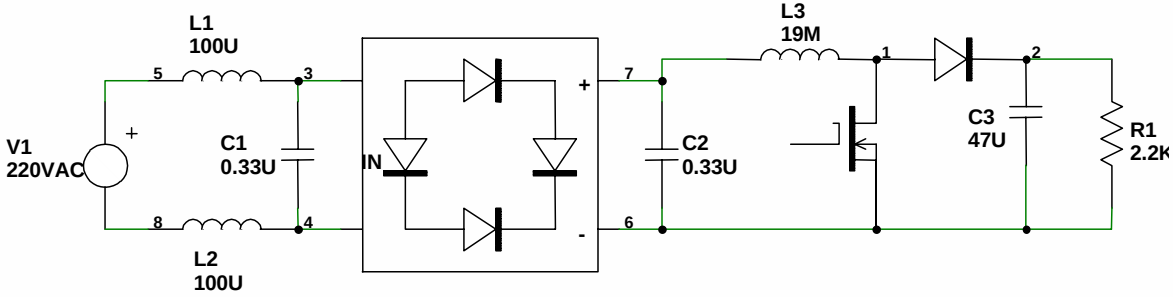
PLM challenges

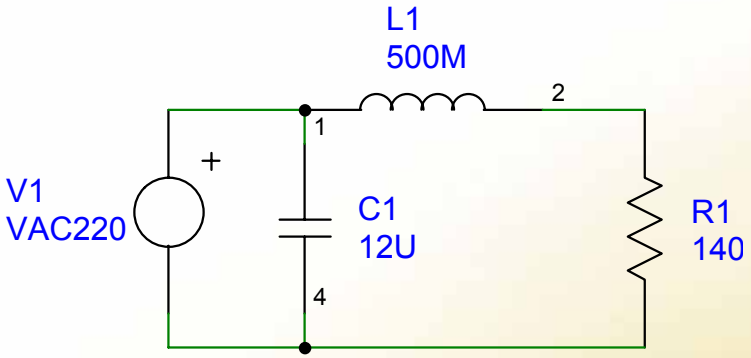
- **Low signal interference** > only lighting (EN 55015) and PLM (EN50065-1) have line conducted **noise** emission limits <150 kHz but ICT&TV (a.o.) have not!
- **Low signal attenuation** > line **impedance** in the grid varies typically between 1 and 100 Ω and there are no limits on HF impedance (test standard LISN = 50 Ω).

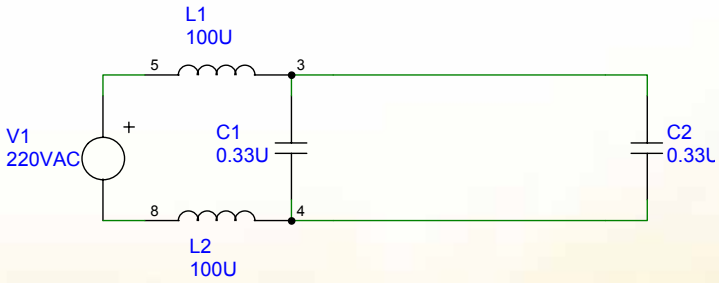
Example 1: how to solve

- source: PLM control for dimming street lighting
- Electronic ballasts were tailored for maximum synergy
- switching frequency 90-100 kHz
- high ballast input impedance
- The proper choice of EMI filter limits the conducted noise and has high input impedance
- It worked! (succesfully applied by Verdeyen and Tyco)

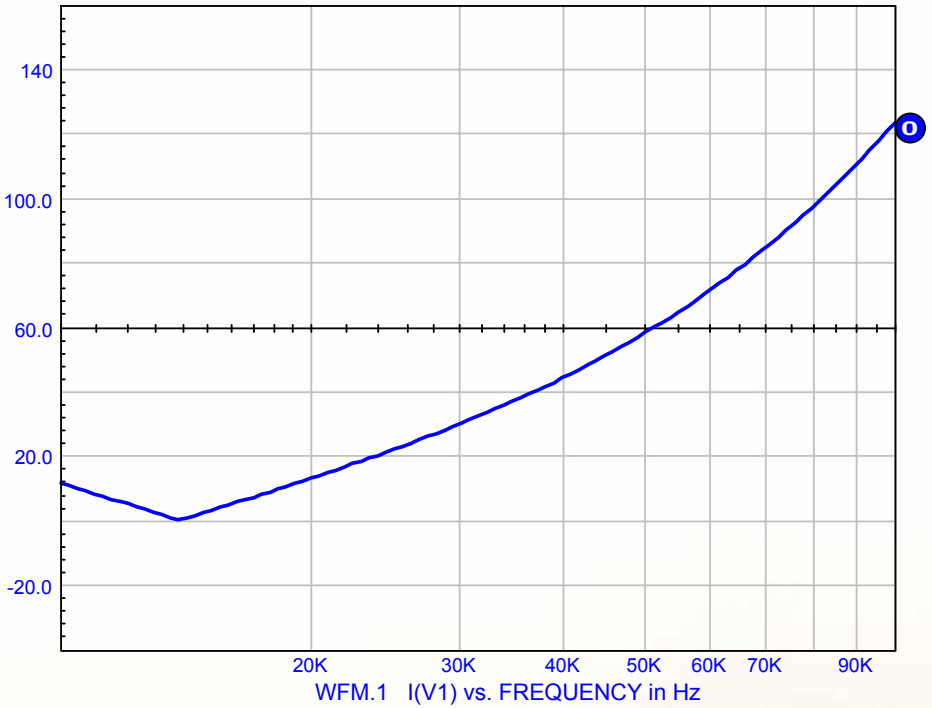
Circuit Diagram for Active Boost Rectifier (synchronous)70 Watt HPS lamp + AC equivalent (left) versus Magnetic (right)

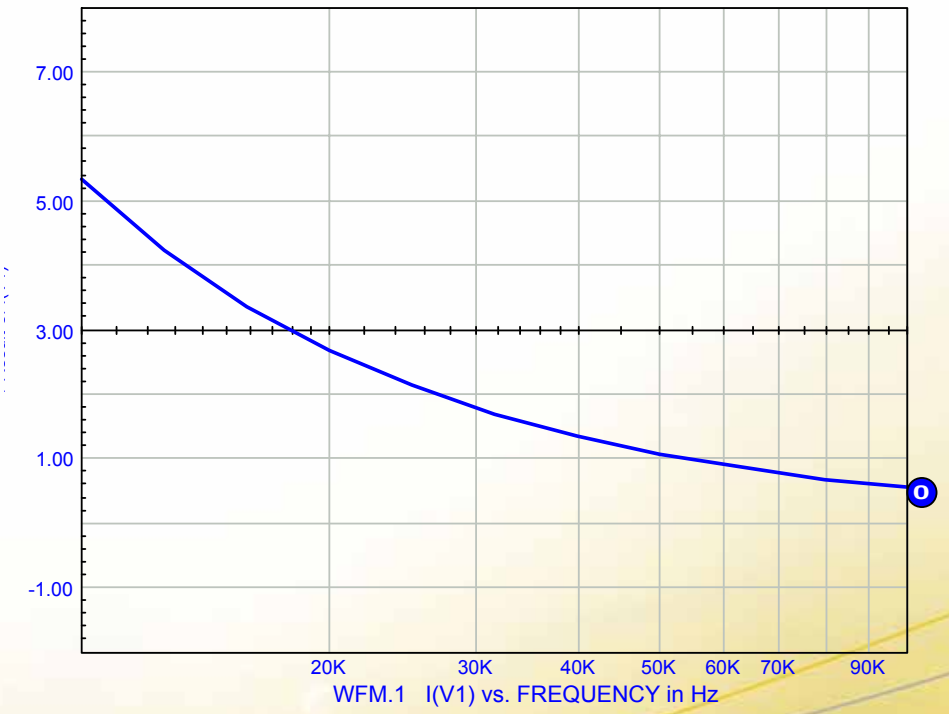






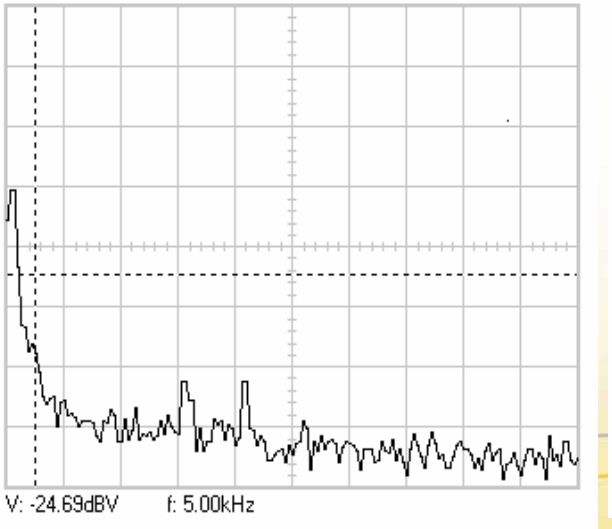
Input impedance electronic ballast (left) versus magnetic (right)

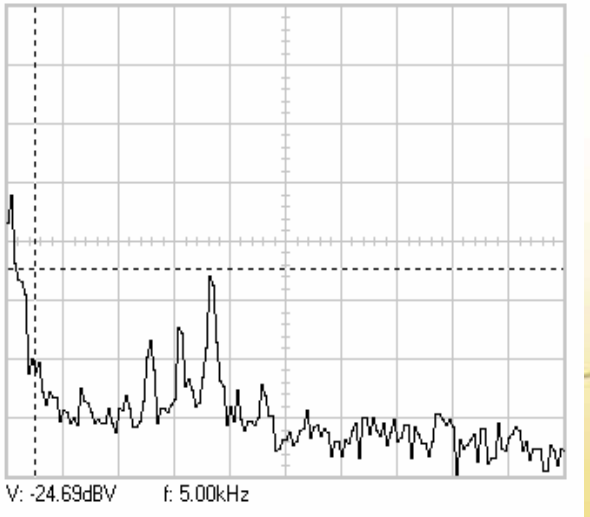




Example 2: Evaluation of a holiday park for AMM with PLM

- Frequency hopping tested (26 kHz, 31 kHz, 37 kHz, 42 kHz, 47 kHz, 52 kHz)
- The signal was to weak due to a power factor compensation capacitor bank installed and taking noise into account
- It could have been solved (extra filtering) but cost was to high





Conclusions

- **Recommendations** are:
  - **Limit network noise** (TV, PC, ..) < 150 kHz, currently only applicable for lighting equipment!
  - **Extend bandwitdth** > 150 KHz + forget LW radio
  - Introduce lower **limits for input impedance** (TV, PC,..)
  - + upgraded analog and digital modem technology
- Note: alternative PLM solutions exists for grids with *defined* (e.g. street lighting) grids (e.g. Vitolink I, www.vitolink.com) ≠ *distribution* grid
- Thank you!