

EMC between communication circuits and power systems in the frequency range 2-150 kHz

Dave Thomas

University of Nottingham

03/05/2016

IEC TC13 Focus group (Nov 2014 ACEC meeting)



EMI Focus Group – Requirements for a Solution

- **To note** the given specific EMC problems in the frequency range 2-150 kHz, with power electronic as well as mains communicating equipment as main players but having relevance for EMC with a broader range of electrical equipment
- **To support** the necessary standardization work with EU funding of additional research
- **To check** the relevance of the specific EMC problem related to the frequency range 2-150 kHz for a future improvement of the definition of electromagnetic disturbances and with that of EMC

e: EMI Focus Group

03/05/2016



The University of
Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

ITU Study group 5 Question 9/5

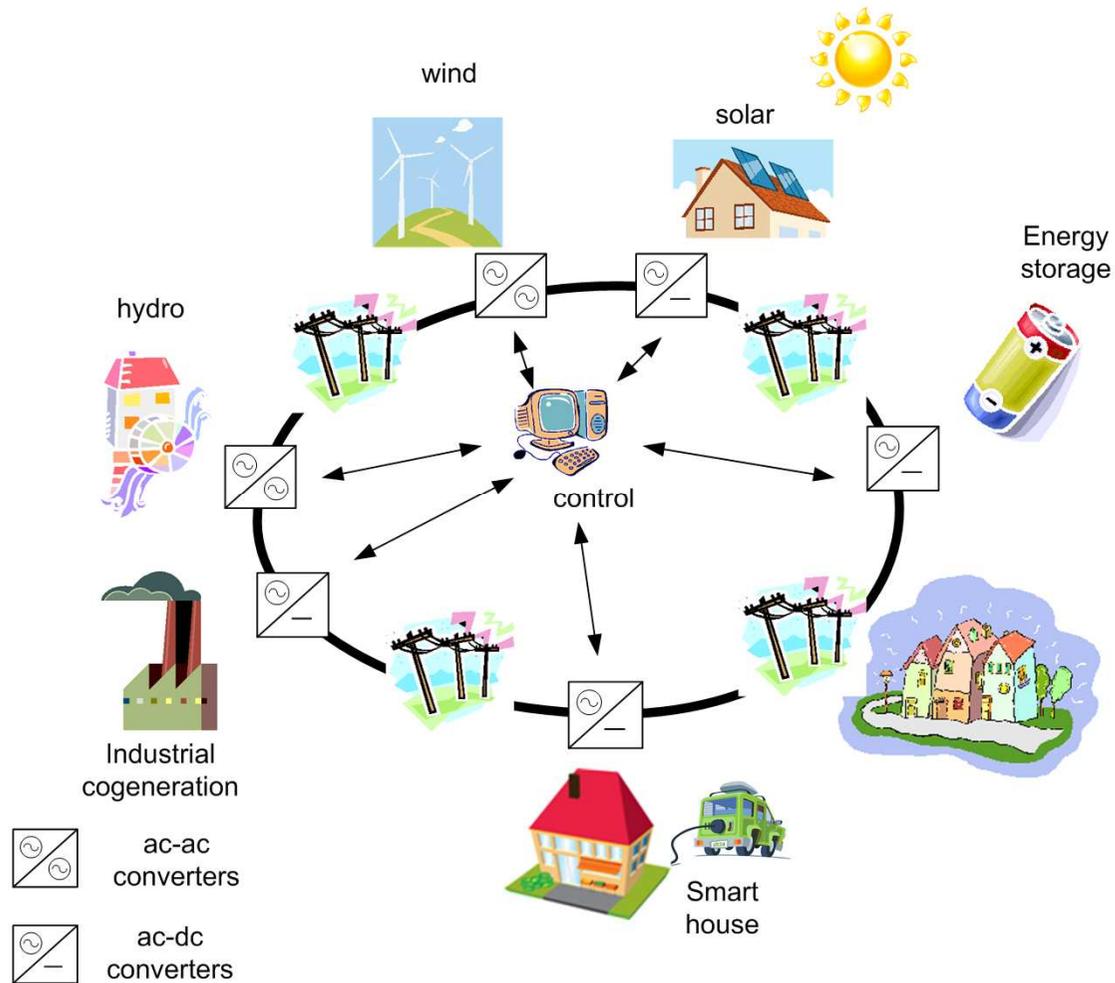
Study period 2013-2016

Review of C143 Rev1

This contribution reported the reason and necessity to establish appropriate EMC requirement below 150 kHz. After the discussion, the meeting got these conclusions:

For basic requirements, such as: limit of AC port below 150 kHz and test facilities, for example AMN, these requirements should be studied by IEC TC77 or CISPR. SG5 Q9 hopes NTT could continue to collect enough cases or evidences involved EM disturbance below 150 kHz in the AC port. WP2 Q9 could prepare and send Liaisons to IEC to speed this study when the opportunity is coming.

The smart grid

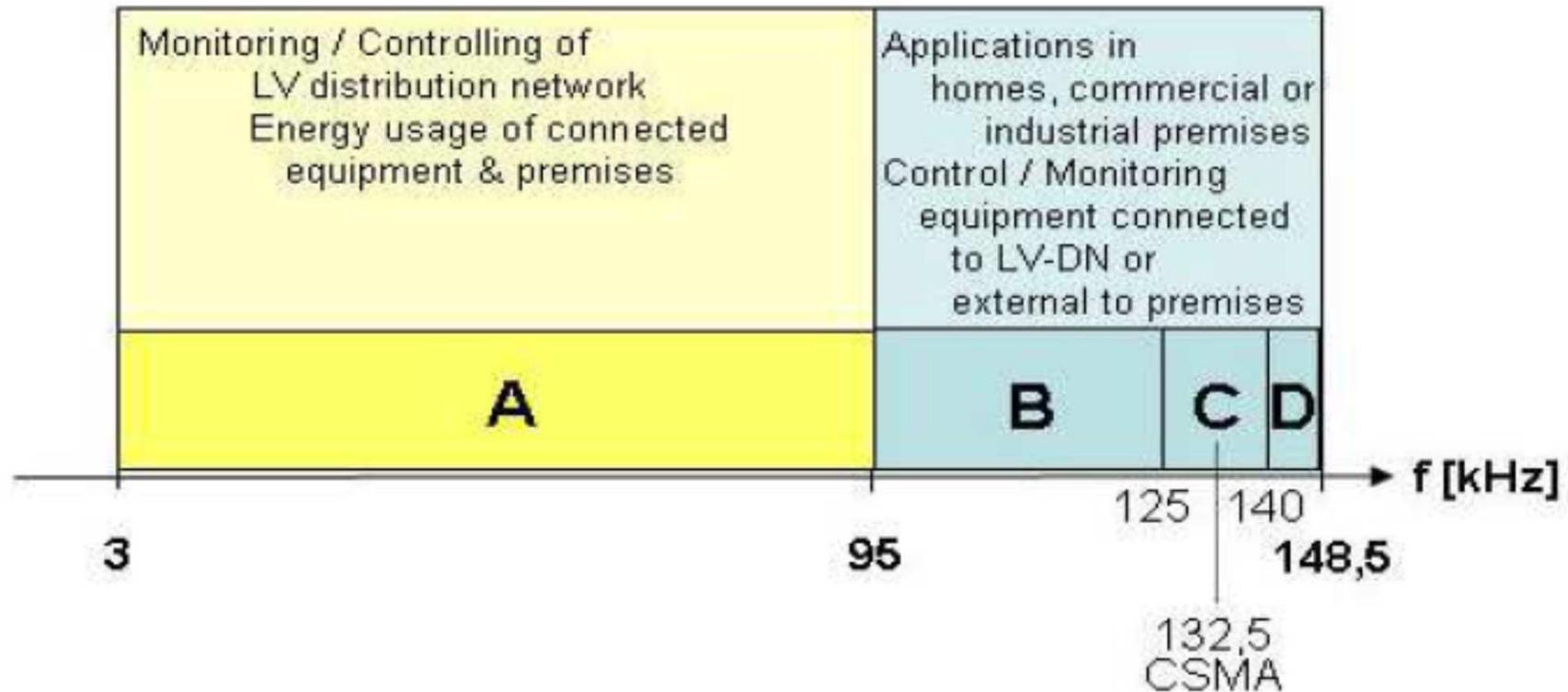


03/05/2016

Physical phenomena

- EMI in the frequency range 9-150 kHz is mostly due to the conducted emissions from power electronics and unintentional conducted or induced components from Mains Communications Systems (MCS). Depending on the current rating, modern power converters can have switching frequencies from a few kHz to tens of kHz, the harmonics of which give rise to significant emissions in this frequency range

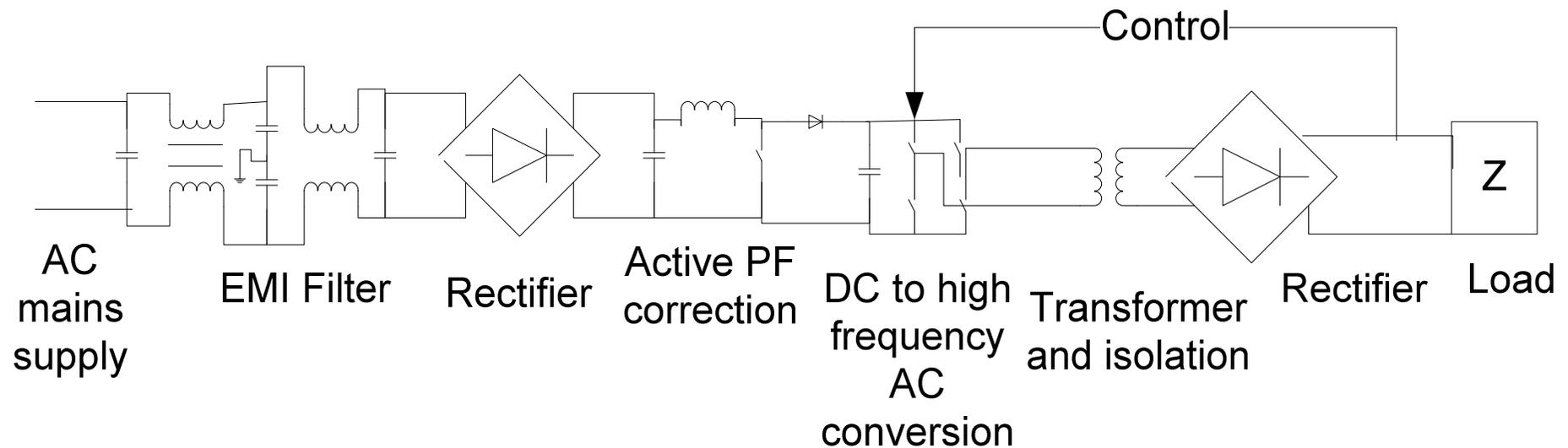
Frequency allocation EN 50065-1



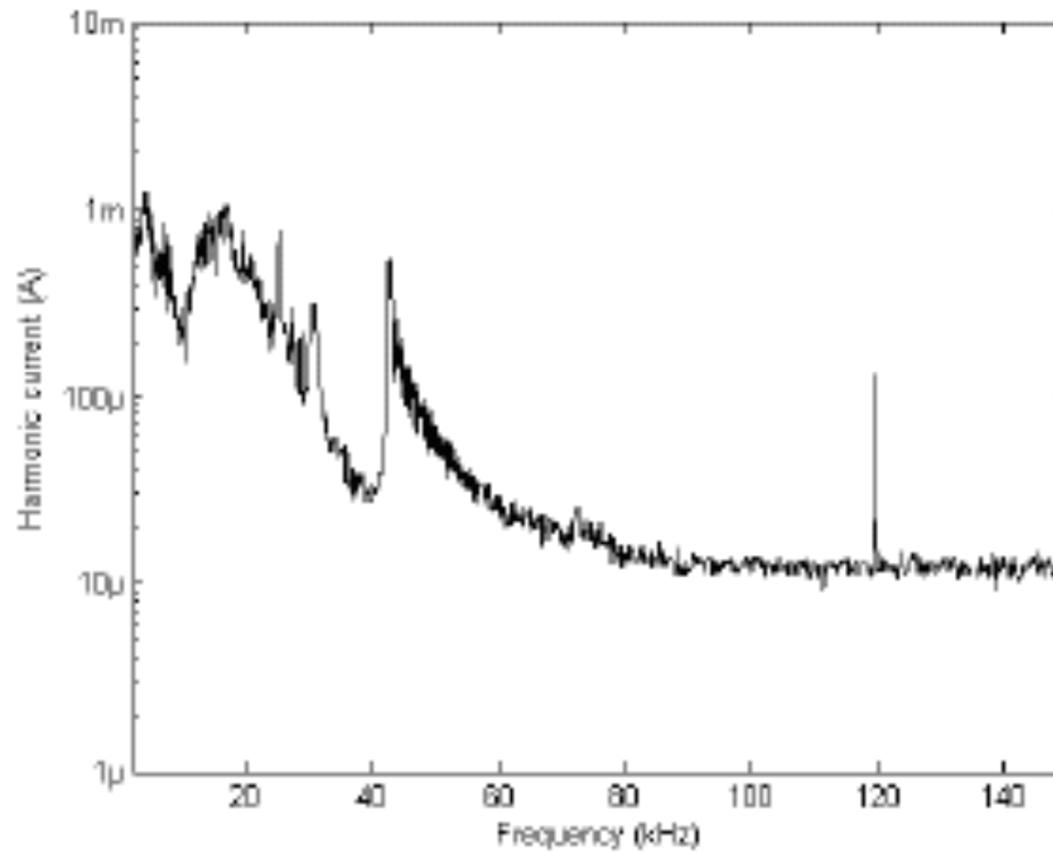
Emission sources 9-150 kHz

Type	Example Equipment
Inverters	PV installations and variable speed drives (e.g. lifts, heating system pumps, ventilation system fans)
Switch-mode power supplies	PCs, consumer electronics, home entertainment (TV, DVD etc.), uninterruptable power supplies , ICT equipment and charging devices.
Lighting equipment	Fluorescent lamps, compact fluorescent lamps and LEDs
Household equipment	Induction cooking hobs, washing machines, electric shaver
Portable mains operated tools	Drills, hedge cutters, lawn mowers and power drills etc.
Smart meters	PLC transmission (AMR-PLC)

Fluorescent lights

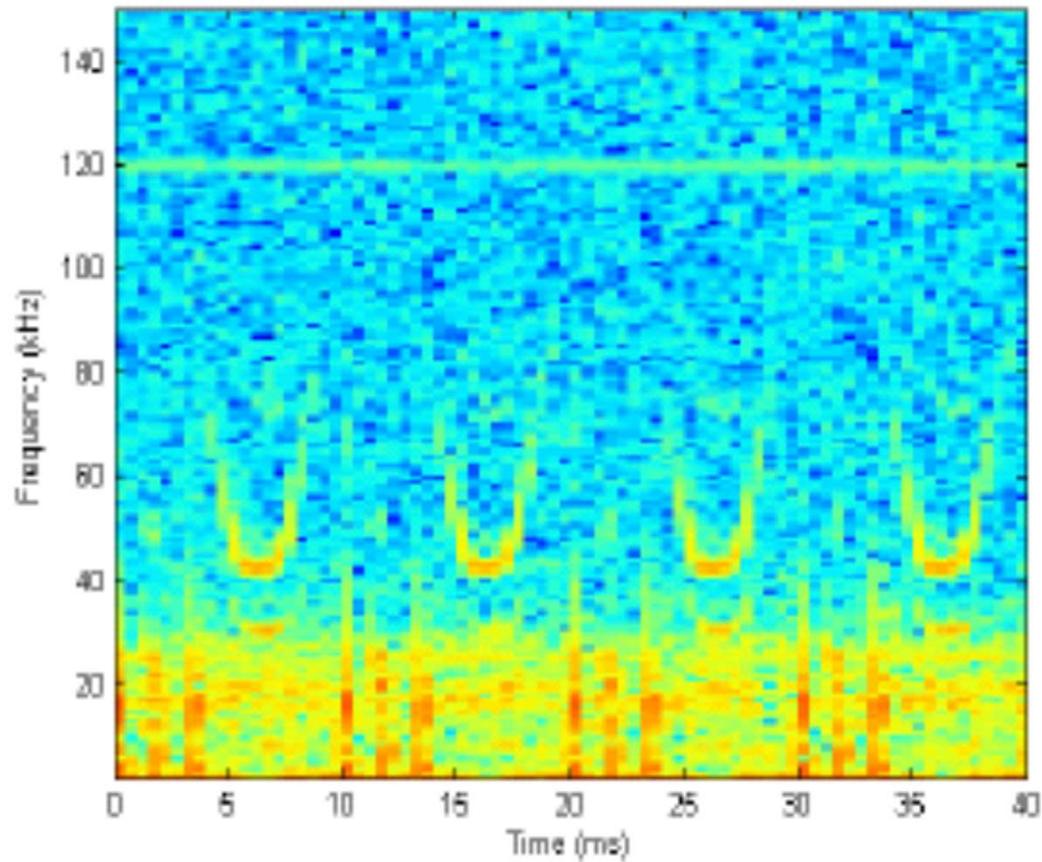


Fluorescent light spectra



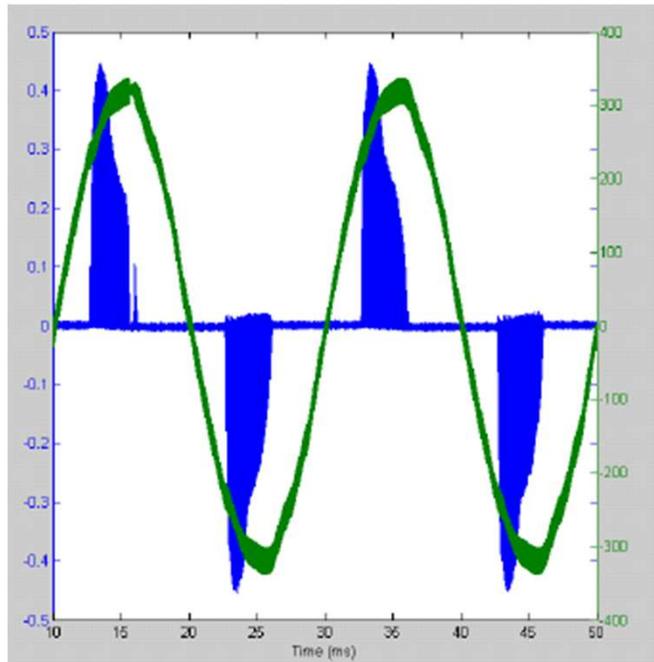
03/05/2016

STFT from a single lamp

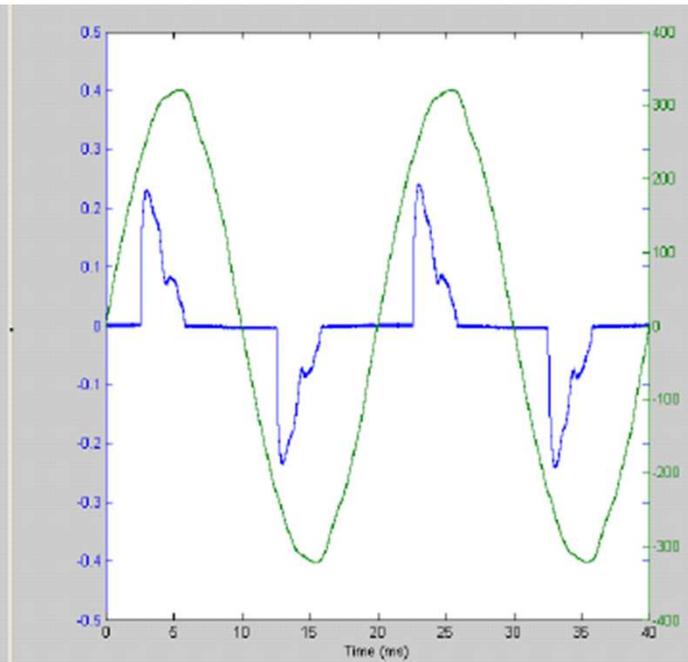


03/05/2016

CFL and PLC

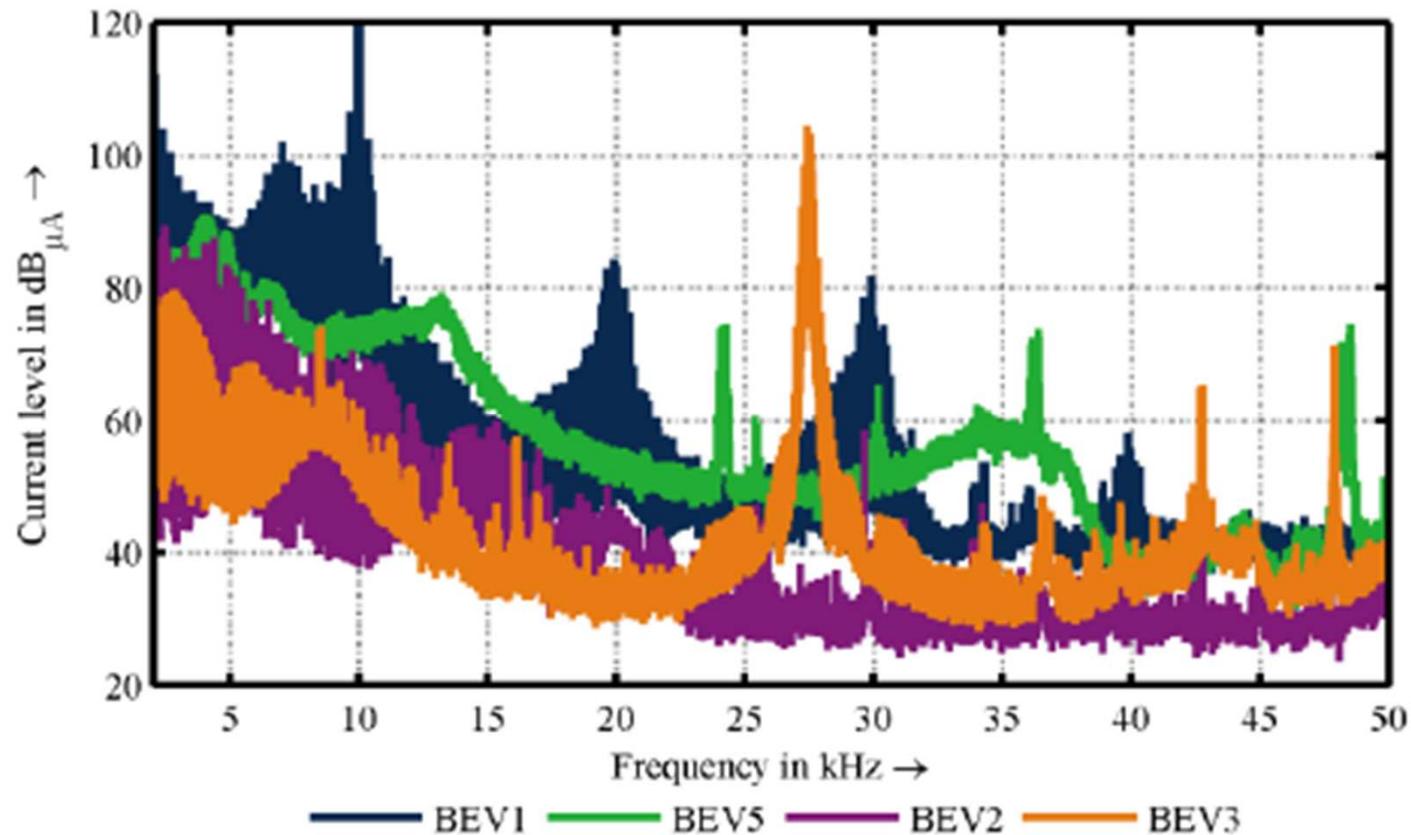


Voltage and current with PLC



Voltage and current without PLC

Charging of Battery Electric Vehicle



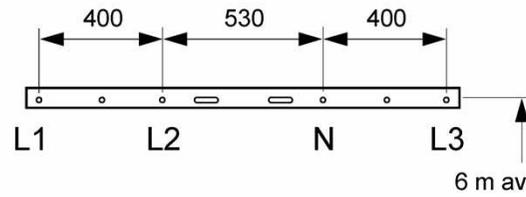
03/05/2016

Effects

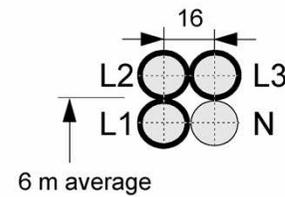
Equipment	Type of failure
Power meters both solid state meters and meters with PLC data transmission (AMR-PLC)	Displaying incorrect reading or failure to communicate
Electronic control (e.g. touch dimmer lamps, alarm systems, traffic control systems, street lighting, coffee machines, ceramic hobs)	Unintentional switching or malfunction
Communications systems (e.g. Ethernet, ISDN-, ADSL-modems, LAN, IP network branch exchange, routers)	Loss of link or CRC error
Telephone systems including inductive train radio systems	Audible noise
Earth leakage circuit breakers	False or nuisance tripping
Contactless magnetic card readers, credit card terminals	Malfunction of reading function
Notebooks	Disturbed cursor position (37 kHz)
Broadcast standard time signal systems (e.g. DCF77, Japanese system)	Electronic clocks being fast (up to 15 mins. Per day)
TV and radio receivers	Audible noise (up to 20 kHz)
Amateur Radio	Disturbed reception of distant transmitters

Modelling

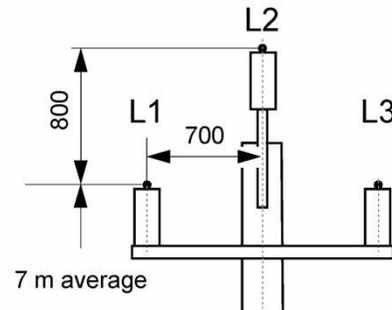
0.4 kV flat arrangement with bare conductors of 95 mm²



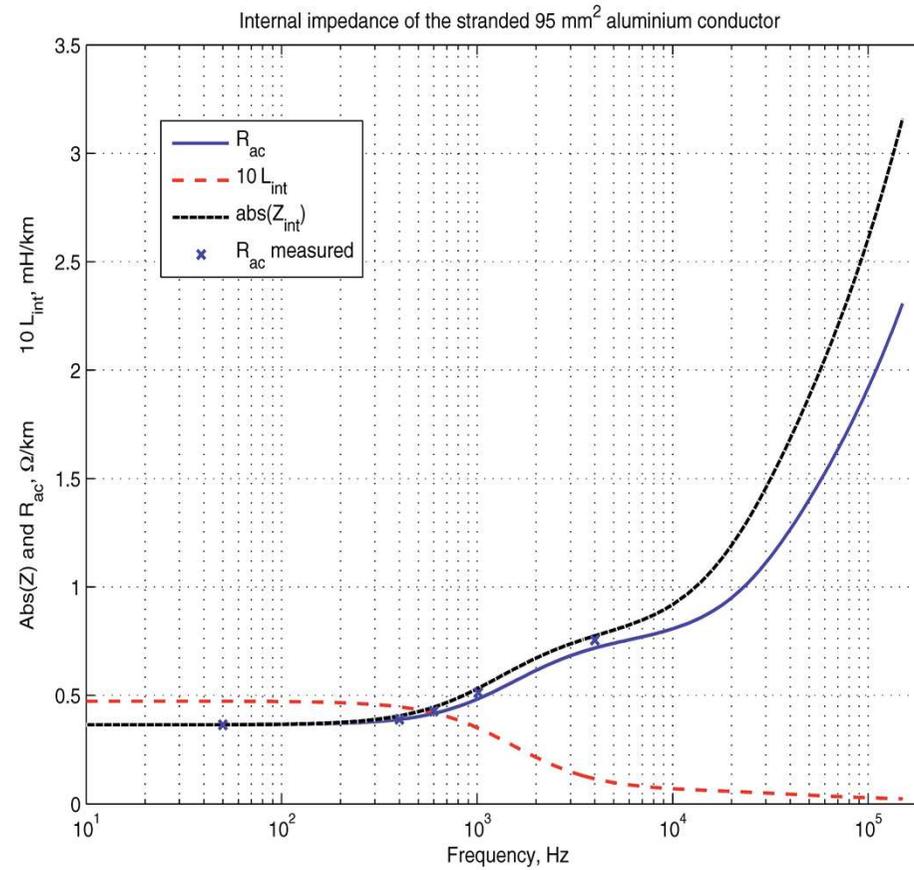
0.4 kV compact arrangement with insulated phase and bare N conductors of 95 mm²



20 kV arrangement with bare conductors of 95 mm²:



Modelling



Modelling

Work is on going to review available models and where possible compare with measurements

Conclusions

- Changing use of power supplies and new technologies
- Increased distortion in the frequency range 9-150kHz
- Both conducted and radiated paths
- Only a few problems reported at present
- New compatible standards are required
- More research required
- This is a topical problem in power systems and linked to the implementation of the smart city

References

- Larsson, A & Bollen, M 2010, 'Measurement result from 1 to 48 fluorescent lamps in the frequency range 2 to 150 kHz', 14th International Conference on Harmonics and Quality of Power (ICHQP), IEEE, Piscataway, NJ
- S Schöttke, J Meyer, P Schegner, S Bachmann, "Emission in the Frequency Range of 2kHz to 150kHz Caused by Electrical Vehicle Charging" EMC Europe 2014 paper 620
- S Schöttke, S Rademacher, J Meyer and P Schegner, " Transfer Characteristic of a MV/LV Transformer in the Frequency Range between 2 kHz and 150 kHz" EMC Europe 2015, pp 114-118
- L Ran, S Gokani, J Clare, K J Bradley and C Christopoulos "Conducted electromagnetic emissions in induction motor drive systems Part 1" IEEE Transactions on Power Electronic, Vol. 13 No. 4, July 1998, pp757-767
- CENELEC SC205A Study Report "Study report on electromagnetic interference between electrical equipment / systems in the frequency range below 150 kHz" ED. 2 Sept 2014 CLC/Fpr TR 50627:2014