

Proposal current emission limits 2-150 kHz Challenges, developments, findings

Nice to meet you!

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Overview

- Supraharmonics
- Measurement challenges
- Developments / findings 2-150 kHz
 - Findings on network impedance
 - Improved impedance calculation method
 - New voltage compatibility standard
- Derivation / proposal current emission limits 2-150 kHz

Supraharmonics

2-150 kHz conducted distortions

Sources:

Electric vehicles, PV inverters, LED lamps, Variable frequency drives, small converters

Caused interference:

Reduced lifetime of capacitors, tripping/blinding of RCDs, flickering of LED lamps, audible noise, misoperation or failure of equipment, failure of cable terminations

Prevent by:

Use of EMC filters, setting limits, measuring and understanding

Image source: The Propagation and Interaction of Supraharmonics from Electric Vehicle Chargers in a Low-Voltage Grid (Slangen et al., 2020)

Supraharmonics

What do we need to know?

- Emission of a device (EV/FCS)
- Summation of components
- The propagation of distortions
- The effect on the voltage
- The effects on other equipment \rightarrow All?
- Interaction
- $\rightarrow I_{SH}$ $\rightarrow Z_{SH}, I_{SH}$ $\rightarrow Z_{SH}, I_{SH}$ $\rightarrow U_{SH}$

 \rightarrow All?

 $\mathbf{Z}_{\mathrm{SH}=}$ \mathbf{U}_{SH} / \mathbf{I}_{SH}

Measurement challenges 2-150 kHz

Measurement challenges 2-150 kHz

- Voltage *and* current!
- Lab vs. Field
- Bandwidth
- Resolution
- Method?

Emission measurement outcomes

\rightarrow In session 3 at 13h30

Session 3			
13.30	Tim Slangen, TU/e	SH-emission DC-chargers and interaction	
14.00	Thomas Gerrits, Heliox	Multi-MW charging systems	
14.30	Ernst Wierenga, Stedin	Implementation in grid calculation tools	
15.00	drinks		

Developments / findings 2-150 kHz

Network impedance for 9 to 150 kHz

- CISPR-16-1-2 reference impedance
- IEC 60725 short-circuit impedance (Ssc)
- Method by Stiegler / TU Dresden combines these two; Scaled CISPR impedance
- Verified by measurements **Erhan / TU Eindhoven** and Stiegler / TU Dresden

Based on:

 Erhan, V., Slangen, T., Cuk, V., Cobben, J. F. G., & van Wijk, T. (2022). Measurement and Analysis of the Low Voltage Network Impedance in the Supraharmonic Range. In 2022 20th International Conference on Harmonics & Quality of Power (ICHQP): Proceedings "Power Quality in the Energy Transition" https://doi.org/10.1109/ICHQP53011.2022.9808479

Elaadni TU/e

V. Erhan (2022, TU Eindhoven)

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EV charging plaza

PoC/Houses

Impedance $[\Omega]$ Phase [°] -50 With load Without load -100Frequency [kHz]

House 2: with and without loads

CISPR and Scaled-CISPR (Stiegler method) for different Ssc values from practice

CISPR and Scaled-CISPR (Stiegler method) for different Ssc values from practice

- 99th percentile of Stiegler measurements gives a maximum of 25 MVA: lowest impedance
- CISPR overestimates the network impedance by **up to a factor 5**: highest impedance
- The **DUT might emit more current distortion** when the network impedance is lower
- Hence, testing with **CISPR** spec LISN/AMN is not a representative network impedance
- Recommendation: test also with lower network impedances than CISPR
- Ideally: test with different network impedances representing different Ssc values

Recent developments / findings 2-150 kHz

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Voltage compatibility levels defined in IEC 61000-2-2

- Amendment 1 and 2: 40th harmonic up to 30 kHz
- New amendment A2:2019: 30 to 150 kHz!

Compatibility?

NEN-EN-IEC 61000 series

Voltage compatibility 2-150 kHz

Separate definitions for 2-9, 9-30, 30-50 and 50-150 kHz

$$V[V] = 10^{(V[dB\mu V] - 120)/20}$$

dBuV	V
129.5	3.0
120	1.0
100	0.1
85	0.02

Derivation / proposal current emission limits 2-150 kHz

- Based on the new voltage compatibility standard and the recent findings on network impedance, a possible range for future emission limits is derived
- These values are also in line with recommendations from the Elaad Testlab
- For the values below the derived emission range, no interferences are known, but this is not a guarantee
- Recommendation: use the derived emission limits, as future standards might come with similar values
- However, no rights can be derived from the proposed / derived emission limit values.

Derived emission limit range

Band based on CISPR and scaled-CISPR, up to Ssc = 25 MVA

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Further readings: <u>https://research.tue.nl/nl/persons/tim-mh-slangen/publications/</u>