Alex McEachern – Power Standards Lab – Alameda, California, USA

2 kHz-150kHz:
A new power quality problem

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Power Standards Lab
Alameda, California

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Specialists in energy & power quality measurements

Embedded power instruments for semiconductor, medical, military, data centers

U.S., Asia, Europe, South America

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Specialist in high-technology power measurements

President, Power Standards Lab

Convenor of IEC 61000-4-30 (Power Quality Measurements), Chair of TF for 61000-4-11, 61000-4-34

Chairman/author of industry-specific and country-specific power standards – SEMI F47, Samsung, etc.

Chairman and co-author of many IEEE standards

Awarded 30+ U.S. Patents

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Why 10kHz – 150kHz? (2kHz – 150kHz?)

Frequencies below 10kHz – generally harmonics of 50/60 Hz
- Conducted emissions
- Well-understood problems

Frequencies above 150 kHz
- Radiated emissions, mostly
- Well regulated for emissions, immunity

BUT 10kHz – 150kHz – NO regulations!
Wild West!

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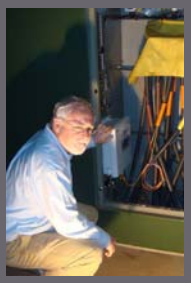
Sources and Problems in 10kHz – 150kHz range



Sources:
- Switching inverters in the 20kHz-100kHz range
  - Photovoltaic inverters
  - Wind turbine inverters
  - Fuel-cell inverters
  - Electric vehicle chargers
  - DC-AC converters generally, that are under price pressures

Problems:
"Smart meter" – incorrect readings
Interactions between controllers, lamp dimmers
Incorrect operation

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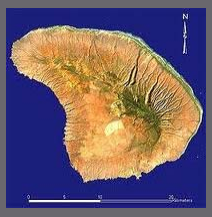
Example problem in 10kHz – 150kHz range (1)



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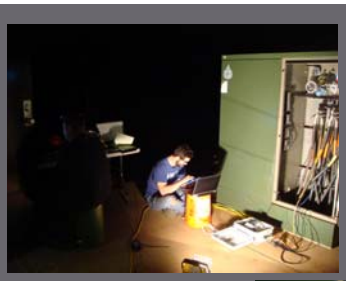
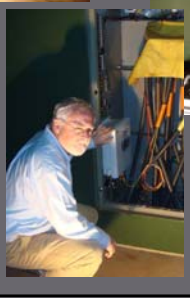
Example problem in 10kHz – 150kHz range (2)



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Questions about 10kHz – 150kHz range

Conducted or radiated? (nobody knows)

How big is the problem? (nobody knows)

Is amplitude or frequency modulation an issue? (nobody knows)

Answers (?): New measurement requirements in next Edition of IEC 61000-4-30 Power Quality Measurement Methods

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Two new IEC Standards for 10kHz – 150kHz range

Annex C
(informative)

Conducted disturbances in the 2 kHz – 150 kHz range

Background information about measurement and test methods for conducted disturbances in the 2 kHz – 150 kHz range can be found in IEC 61000-4-19 (currently circulating as 77A/783A/CD).

C.1 Measurement method

– Class A

On each channel, the measurement should be made through cascaded High Pass and Low Pass filters. The High Pass filter should have 4 poles, with a 3dB point at 1.5 kHz. The Low Pass filter should have 8 poles, with the 3dB point at 200 kHz.

Measurements should be taken at the output of the cascaded filters at equally spaced intervals such that 32 measurements are taken each 10/12 cycle interval.

NOTE There is no requirement for cross-channel synchronization.

Each measurement should consist of 512 samples taken at a sampling rate of 1.024 MHz.

The 512 samples should be processed with a Discrete Fourier Transform or equivalent, yielding 256 bins spaced at 2 kHz. The lowest bin, and the upper 101 bins, should be discarded. The magnitudes of the remaining 74 bins contain the emissions from 2 kHz to 150 kHz.

– Class B

The manufacturer should specify the measurement method.

C.2 Measurement range and measurement uncertainty

– Class A

The measurement range for each sample should be at least ±20V, with a resolution of 0.1V maximum. The uncertainty of each sample should be ±2% full-scale or better. The 1.024 MHz sampling rate should be ±1% or better. The 3 dB corner should be ±20% of the specified frequency. The pass-band of the filter between 2 kHz and 150 kHz should be flat, not deviating from the theoretical gain response by more than +/-3%.

– Class B

The manufacturer should specify the measurement uncertainty and the measuring range.

C.3 Aggregation

– Class A

At each 10/12 cycle interval, 32 sets of these 74 bins are available. At each 10/12 cycle interval, the minimum, average, and maximum value of the magnitude of these 74 bins should be reported. In addition, at each 10/12 cycle interval, a single maximum value of all 74 bins across all channels should be reported.

NOTE 3 The average value could be used, for example, to determine typical emissions. The maximum value could be used, for example, to determine worst-case emissions. The difference between the minimum and maximum values could be used, for example, to determine the presence of amplitude modulation. The single maximum value could be used, for example, to set worst-case limits.

– Class B

The manufacturer shall specify the aggregation method.

61000-4-30 - measurement

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-19: Testing and measurement techniques –
Test for immunity to conducted, differential mode disturbances
in the frequency range 2 kHz up to 150 kHz at a.c. ports

FOREWORD

61000-4-19 - immunity

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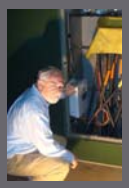
Conclusions: 10kHz-150kHz

New, fairly urgent problem

Closely related to distributed generation, Smart Grid

Not well understood yet

Measurement and immunity standards are being prepared



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