Power Quality Webinar

Supraharmonics – the rise of HF emissions

POWERSIDE™

October 2022

Presentation Outline

1. changes in today's electrical grid

2. what are supraharmonics?
3. where do they come from; how do they propagate?
4. how can supraharmonics cause damage?

5. how can supra-harmonics be detected?
6. Future for supra-harmonics measurements

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Global zero-emission objectives drive changes to the grid

Acceleration of DER deployment around the world

Huge push to Electrify Transportation (EVs)

*…..put the United States on a path to achieve net-zero emissions, economy-wide, by no later than **2050**.*

*"by **2035 100%** of new cars and light trucks sold in California will be zero-emission vehicles"*

*"EU agrees new cars must be emissions-free after **2035**…."*

*"The Canadian Net-Zero Emissions Accountability Act, which became law on June 29, 2021, enshrines in legislation Canada's commitment to achieve net-zero emissions by **2050**"*

Electrify Transportation

Global Warming

Decarbonize the grid

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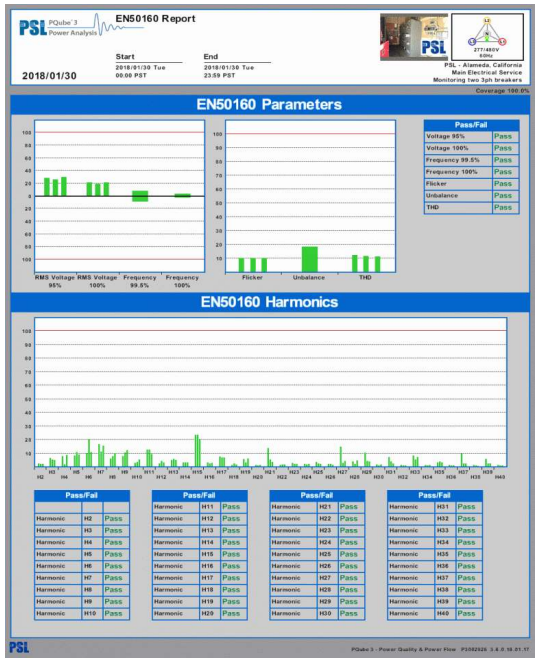
What do we observe ?



PQube3 embedded EN50150 compliance report

- Growing penetration of Solar generation , MV, LV , domestic
- IEC and IEEE standards define methods to measure those phenomena (e.g. IEEE 519, IEC 61000-4-30)
- For the last few years, unexplained problems with equipment and field/lab investigations have uncovered a new type of phenomenon: Supraharmonics

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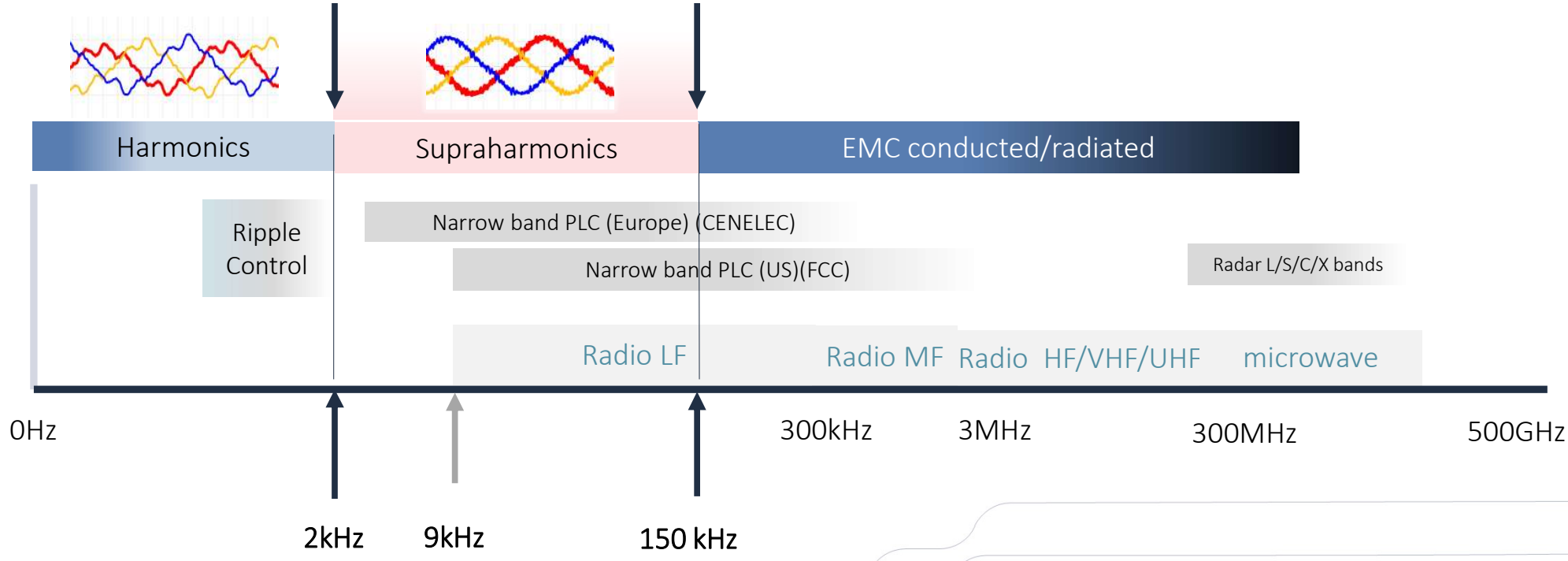
2 kHz ~ 150 kHz range Conducted Emissions “supraharmonics”



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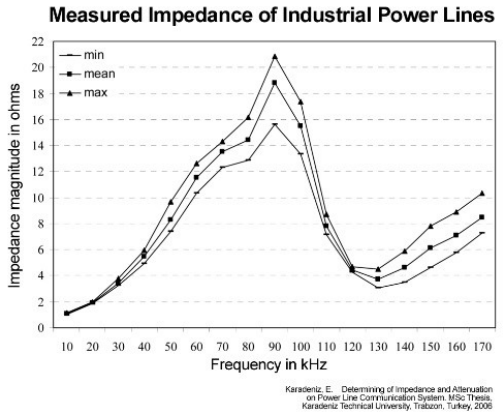
How do 2kHz~150kHz emissions propagate?

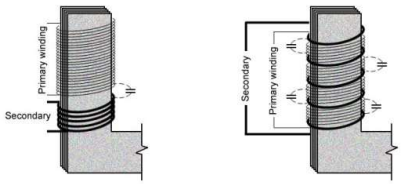
Through power lines, underground cables, building wiring…

The grid is designed to carry 50/60 Hz power from one location to another.

By accident, it also carries 2kHz-150kHz fairly efficiently.

Transformer design for efficiency also allows conducted emissions to leak through





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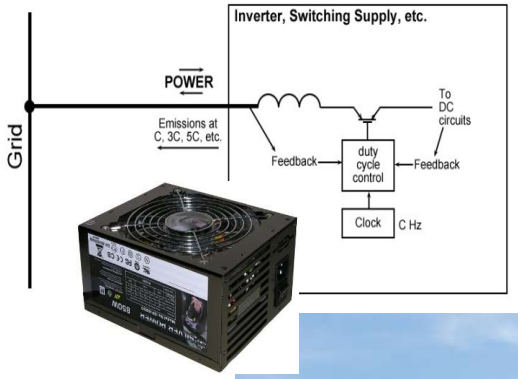
Where do they come from?

Power electronics – switching devices

Emissions at switching frequency and multiples of the frequency

Inverters

- Solar (PV) farms
- Wind farms
- Fuel cells
- BESS (Battery Energy storage systems)
- UPS
- EV chargers
- Variable Frequency Drives (VFD)



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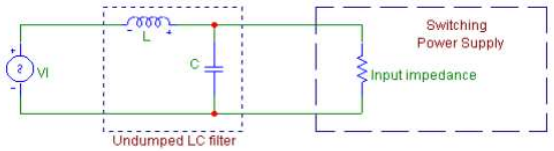
Damage caused by undetected Supraharmonics

- Equipment power supplies overheat, accelerated ageing, component fire ..(excessive currents in capacitors)
- Measurement errors (smart meters..)
- PLC communications jammed
- Electronic controllers (e.g. LED lighting control)
- Audible effects
- …

Why?

Capacitor impedance $= \frac{1}{2\pi F C}$



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Measuring Supraharmonics with PQube3

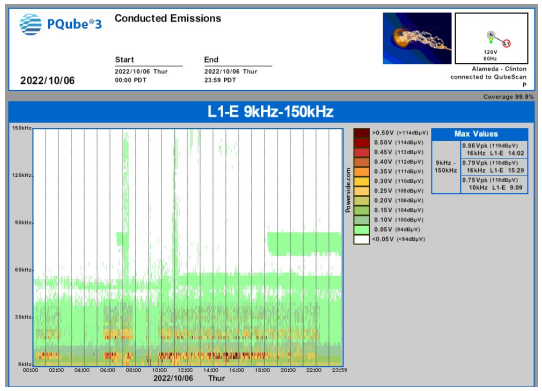
<u>Continuous Recordings:</u>

> 2 kHz ~ 9 kHz range (200 Hz resolution)

> 8 kHz ~ 150 kHz range (2kHz resolution)

> 1 min interval, average & max values

PQube3 generates daily a heat map (GIF) & ascii data files)



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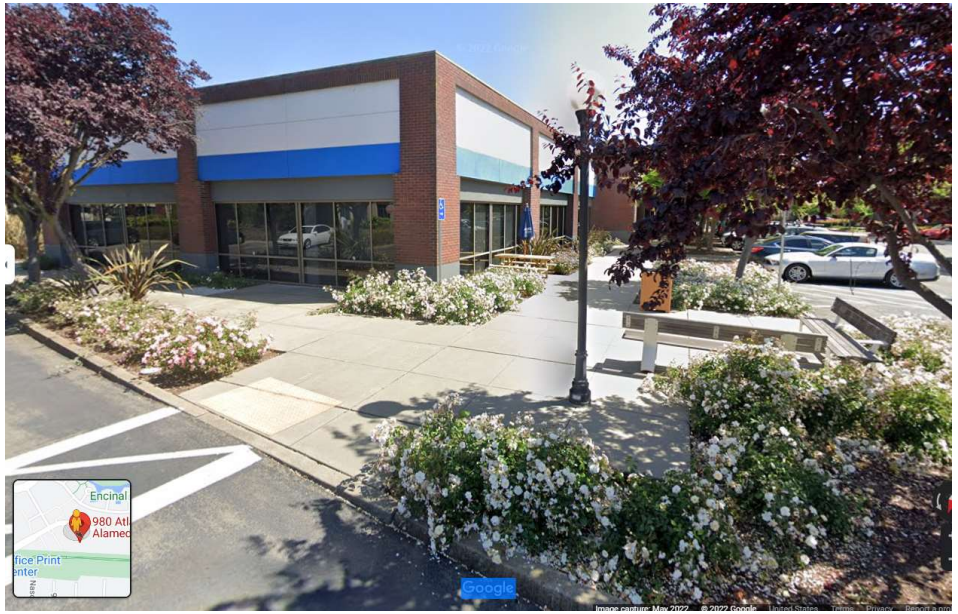
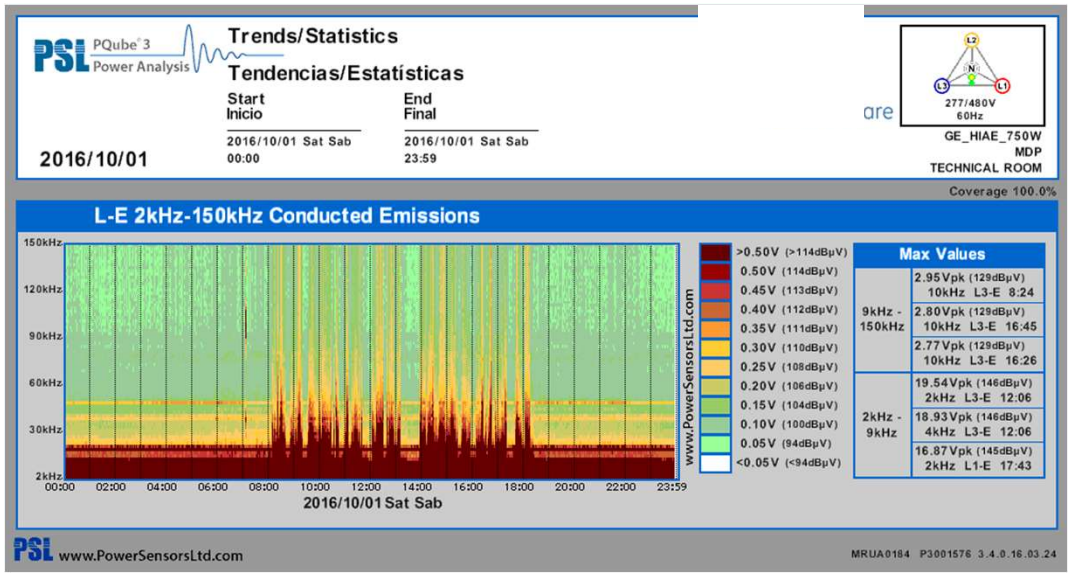
Powerside building main electrical entrance (LV) Alameda, Ca

- Live access to PQube3



MRI Technical Room – Hospital (Brazil)



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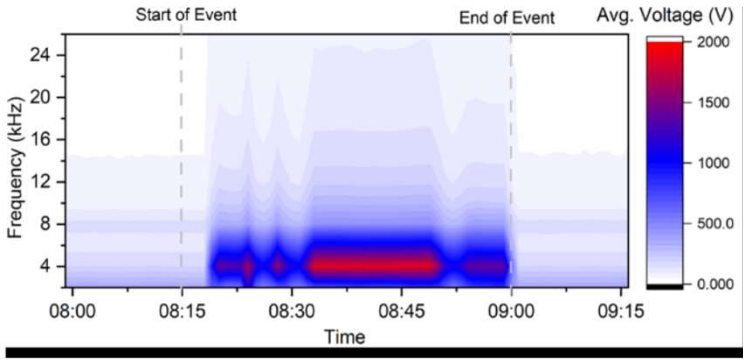
Supraharmonics in Medium Voltage grids: interface to microgrid with DERs

- Needs adequate sensor technology!
  High frequency bandwidth, accuracy ..
- CVD based sensors from G&W



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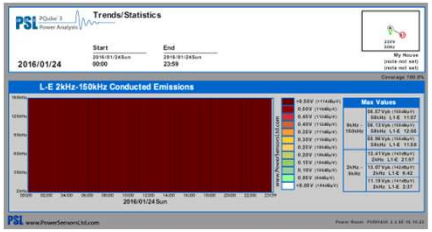
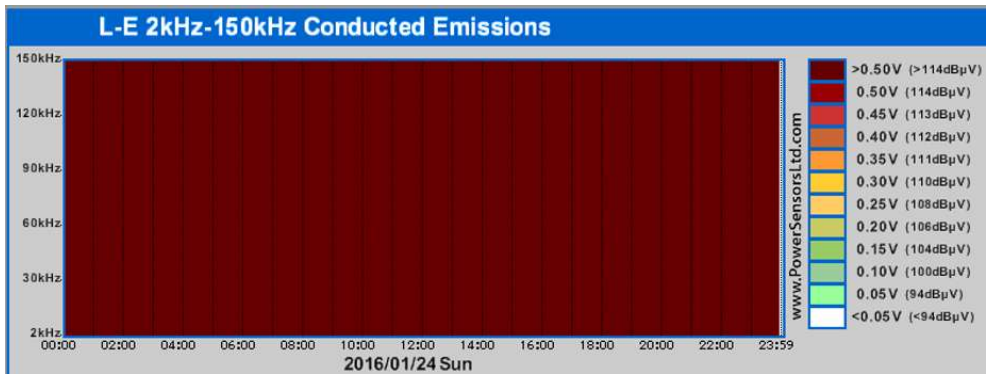
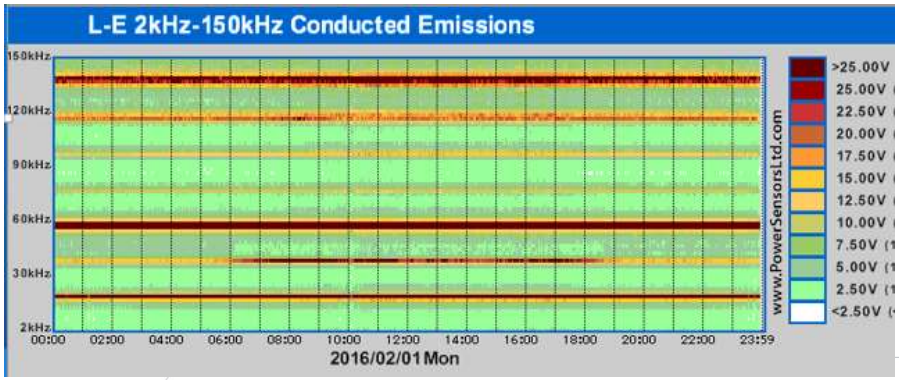
Supraharmonics at solar generation sites



Emission “heat map” sensitivity was adapted





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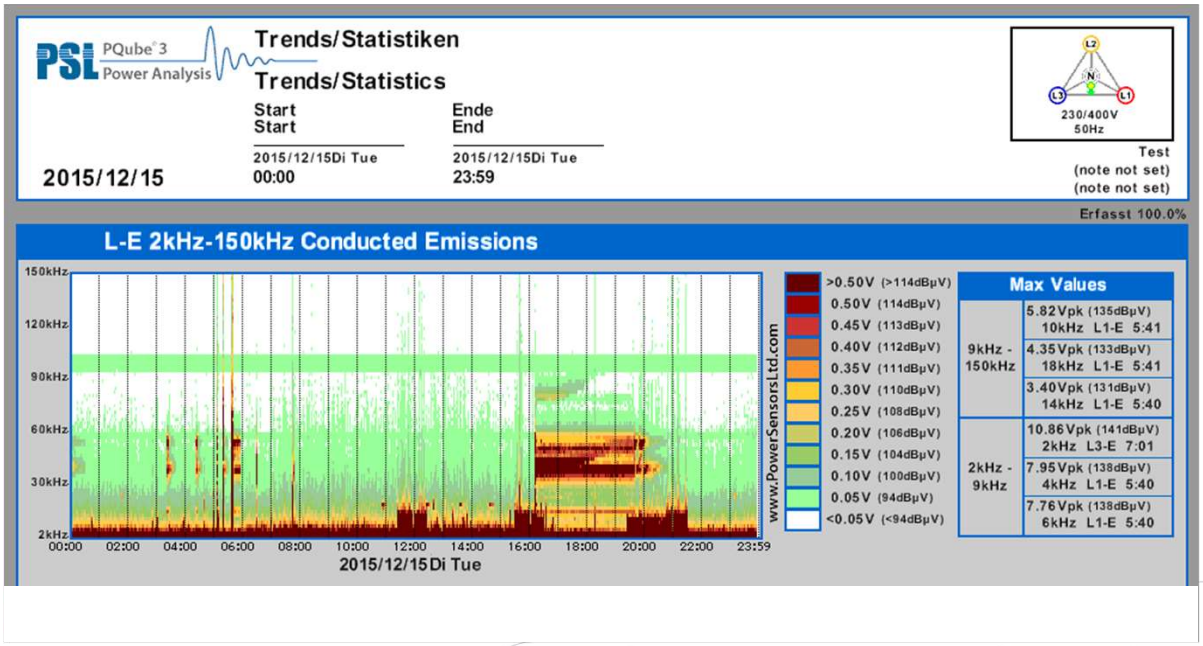
Supraharmonics and Electrical Vehicles

- Time of occurrence helps correlation with offending sources
- We will see a dramatic increase in EV charging infrastructure
- Bigger charge point stations…
- More chargers, more switching devices ….



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Future of supraharmonics measurement methods: Power Quality method Standard : IEC 61000-4-30

Economic tradeoff between method completeness and instrument price

Edition 3

(published 2015)

Present method applies well for steady-state HF emissions…

For fluctuating emissions, the method may show limitations capturing

Edition 4

(future pub. 2024)

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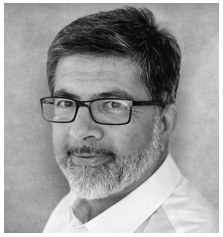
Summary

New technologies with power electronics, inverters in particular, and their deployment in the grid brings huge benefits but also challenges

The Supraharmonics conducted emissions levels will get worse due to the accelerated deployment of power electronics in or at the edge of the grid.

Power Analyzers, such as PQube3 can detect, quantify and help diagnose or prevent failures that traditional power quality instrument cannot see.



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