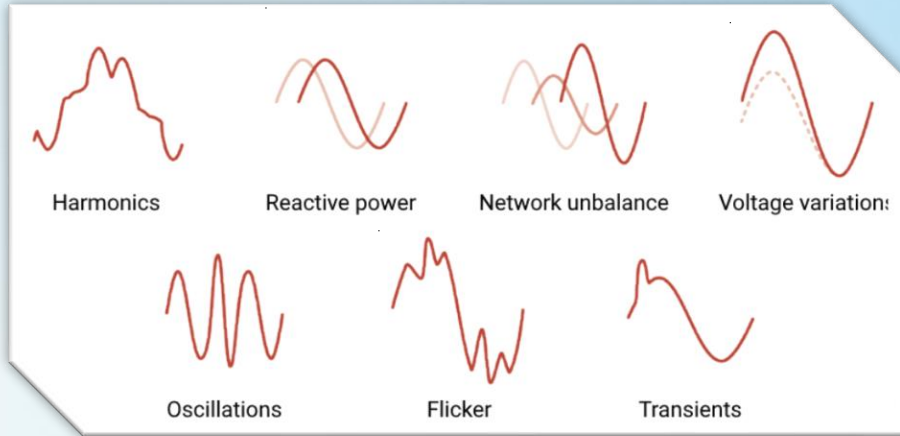


Power Quality: Risks & Mitigation



Introduction

Matthijs Mosselaar

Background: MSc. Electrical Power Engineering
Delft University of Technology

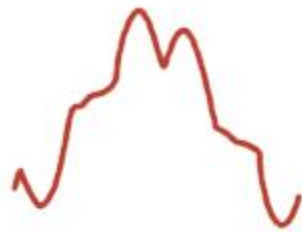
Occupation: (Electrical) Engineer

- Hybrid systems
- Technical Sales Support
- Modelling/Simulation
- Power Quality / EMC



Power Quality

What is it?



Harmonics



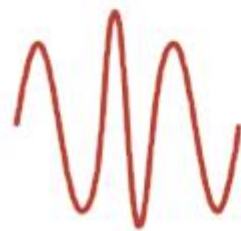
Reactive power



Network unbalance



Voltage variations



Oscillations



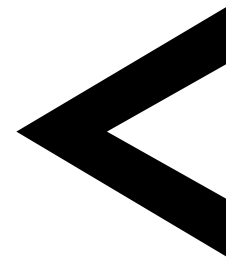
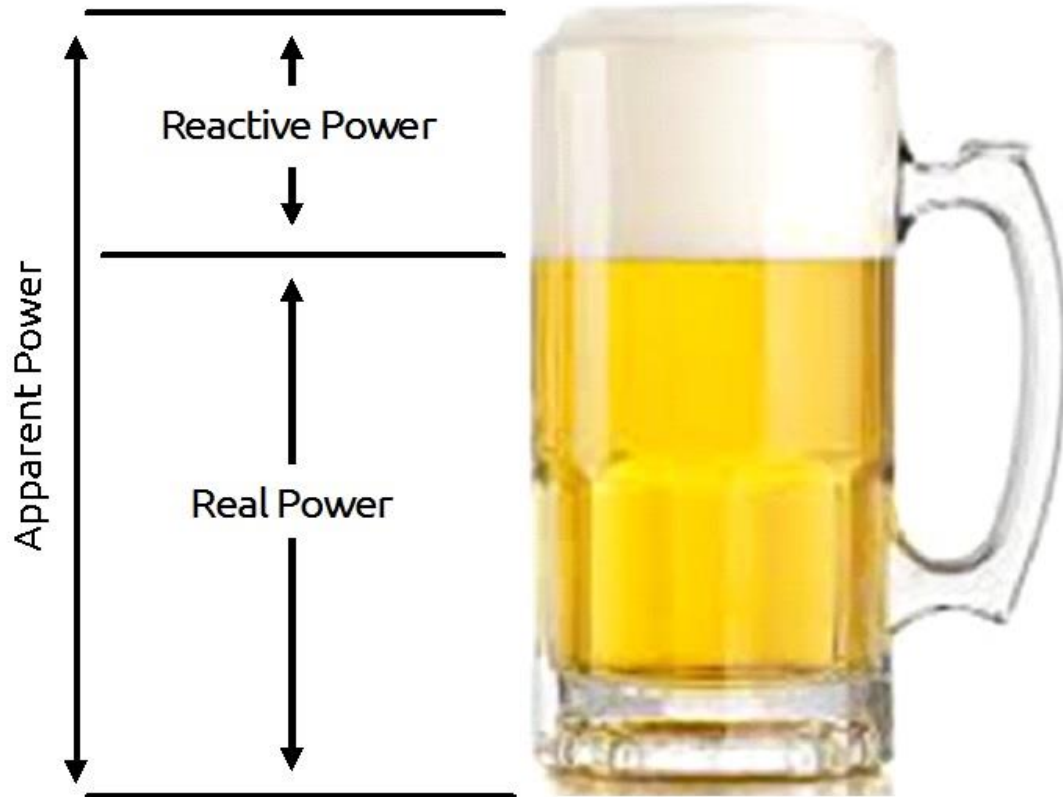
Flicker



Transients

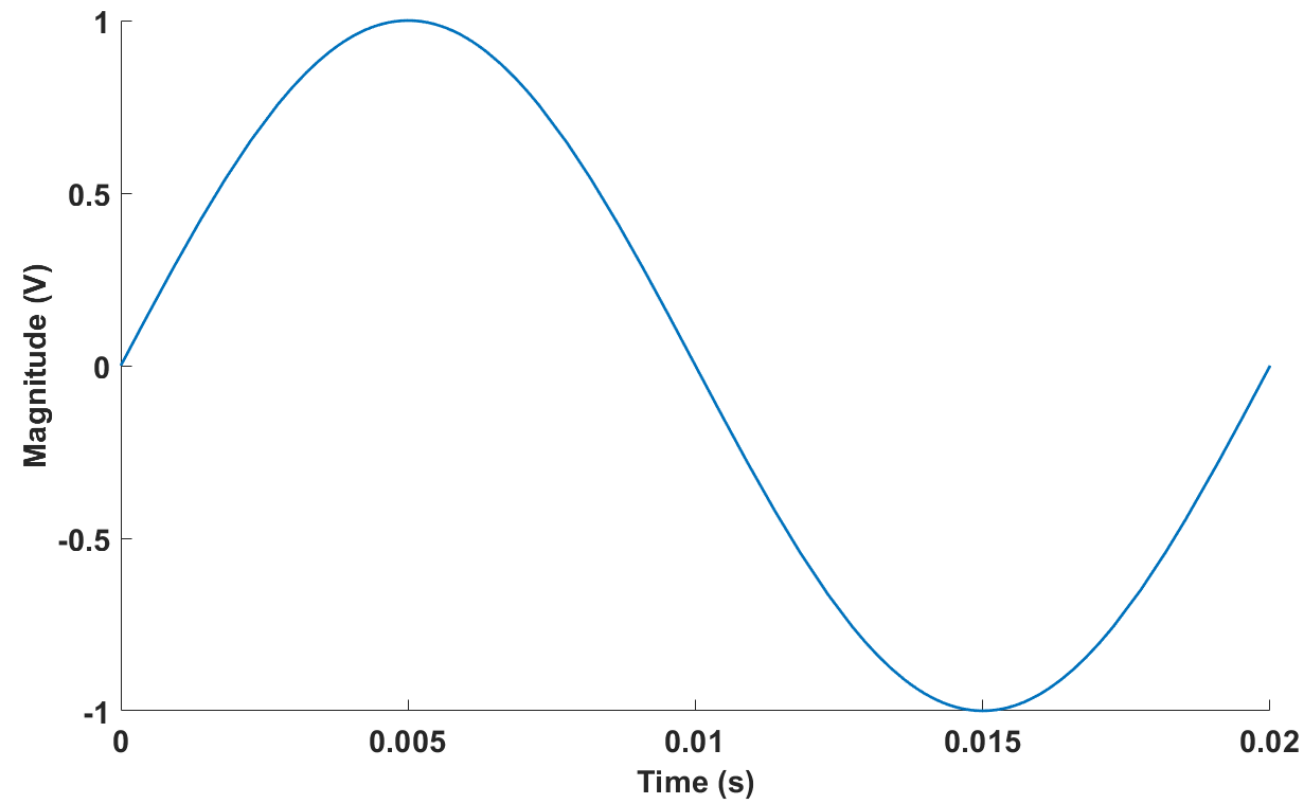
Power Quality

What is it?



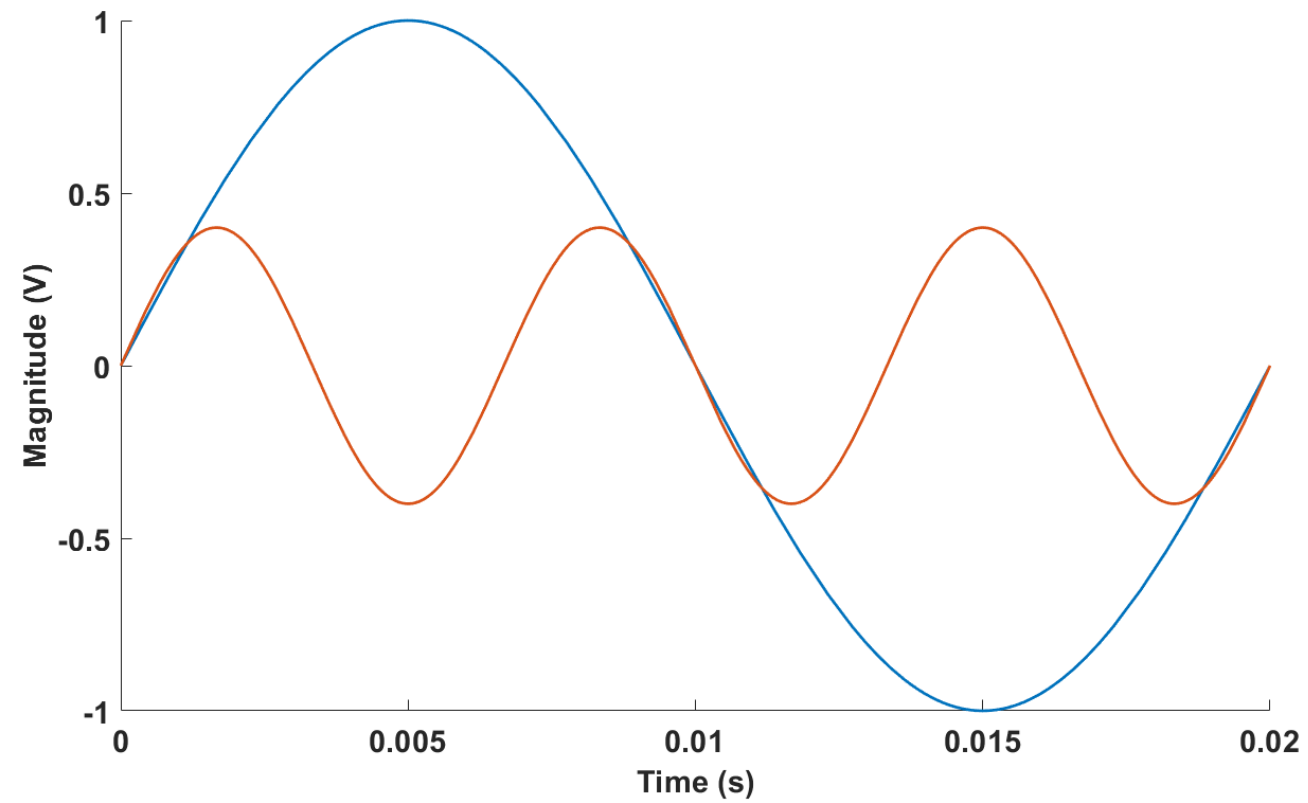
Harmonics

1st (base) harmonic



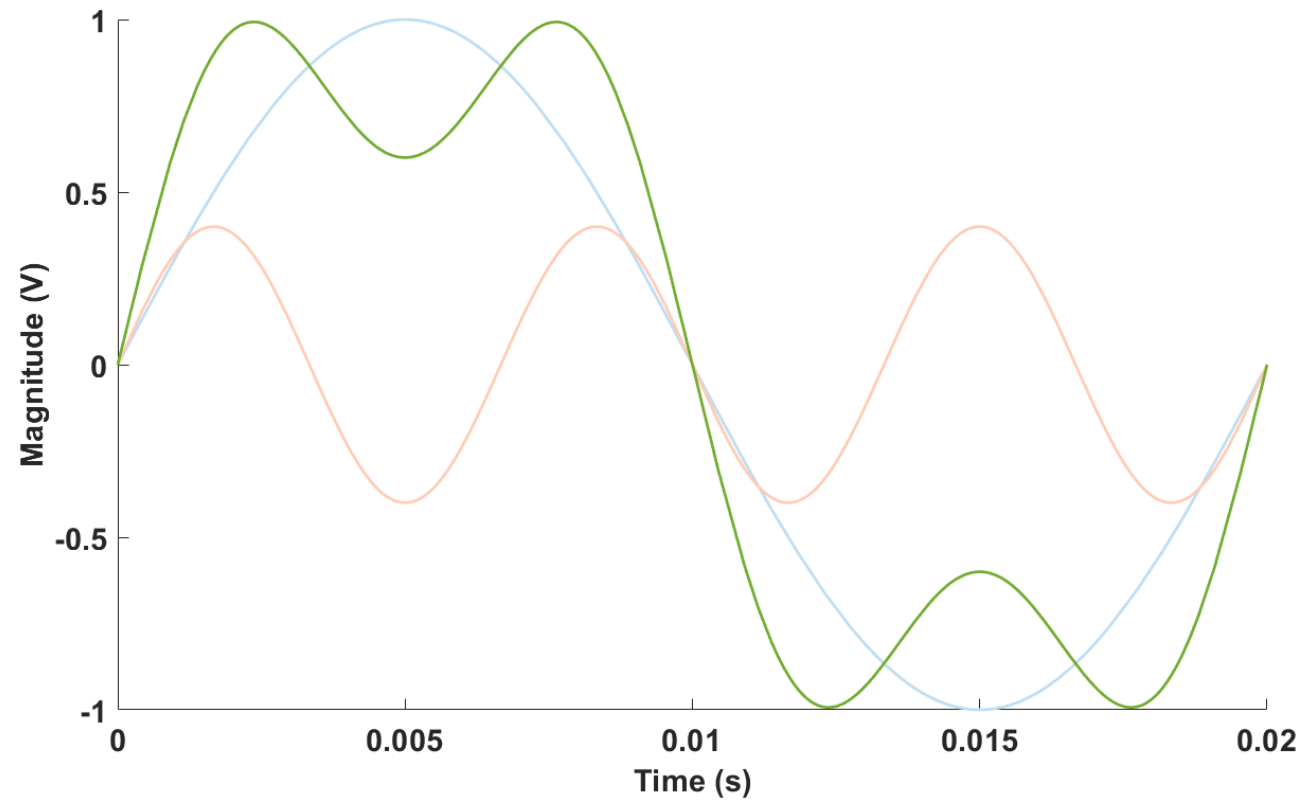
Harmonics

Introducing a 3rd harmonic

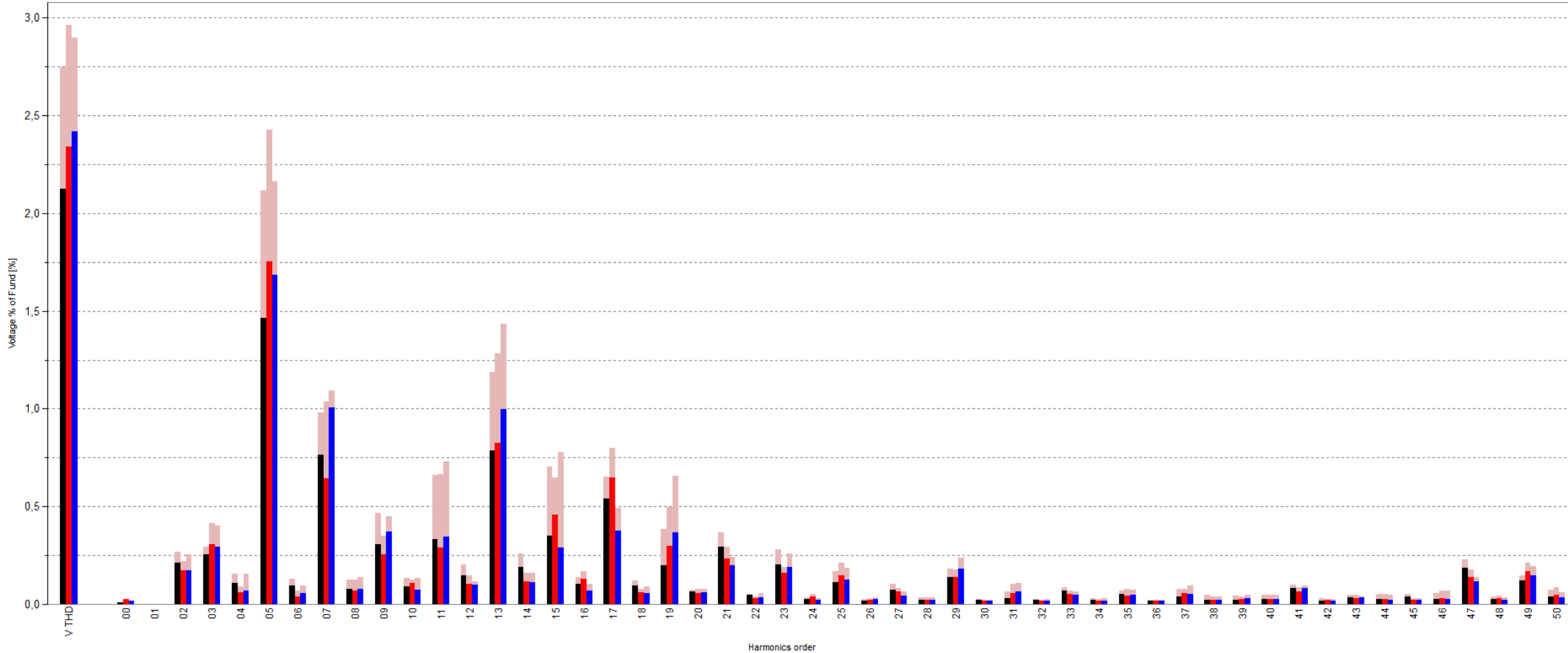


Harmonics

The result when summed up

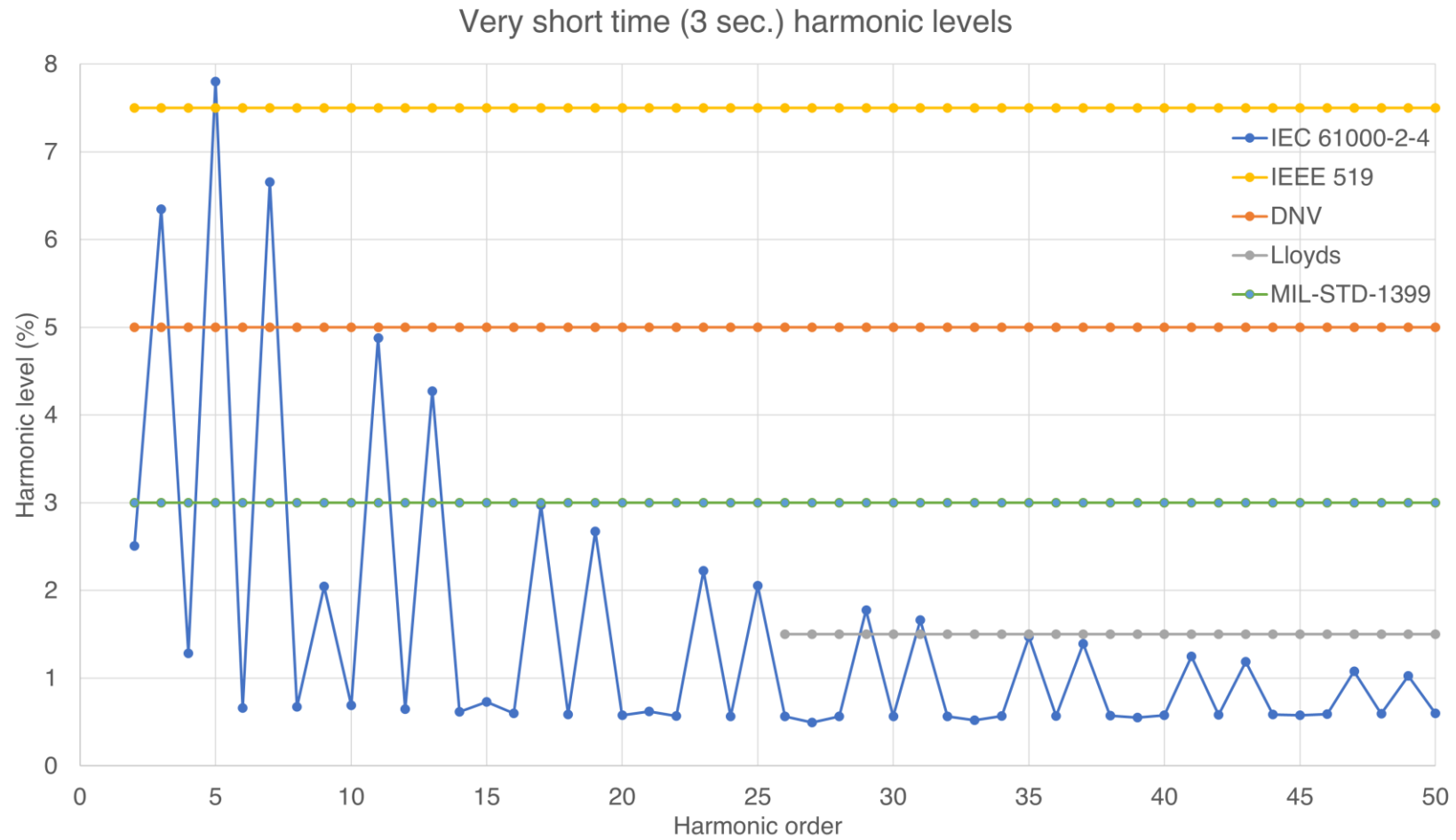


Harmonics



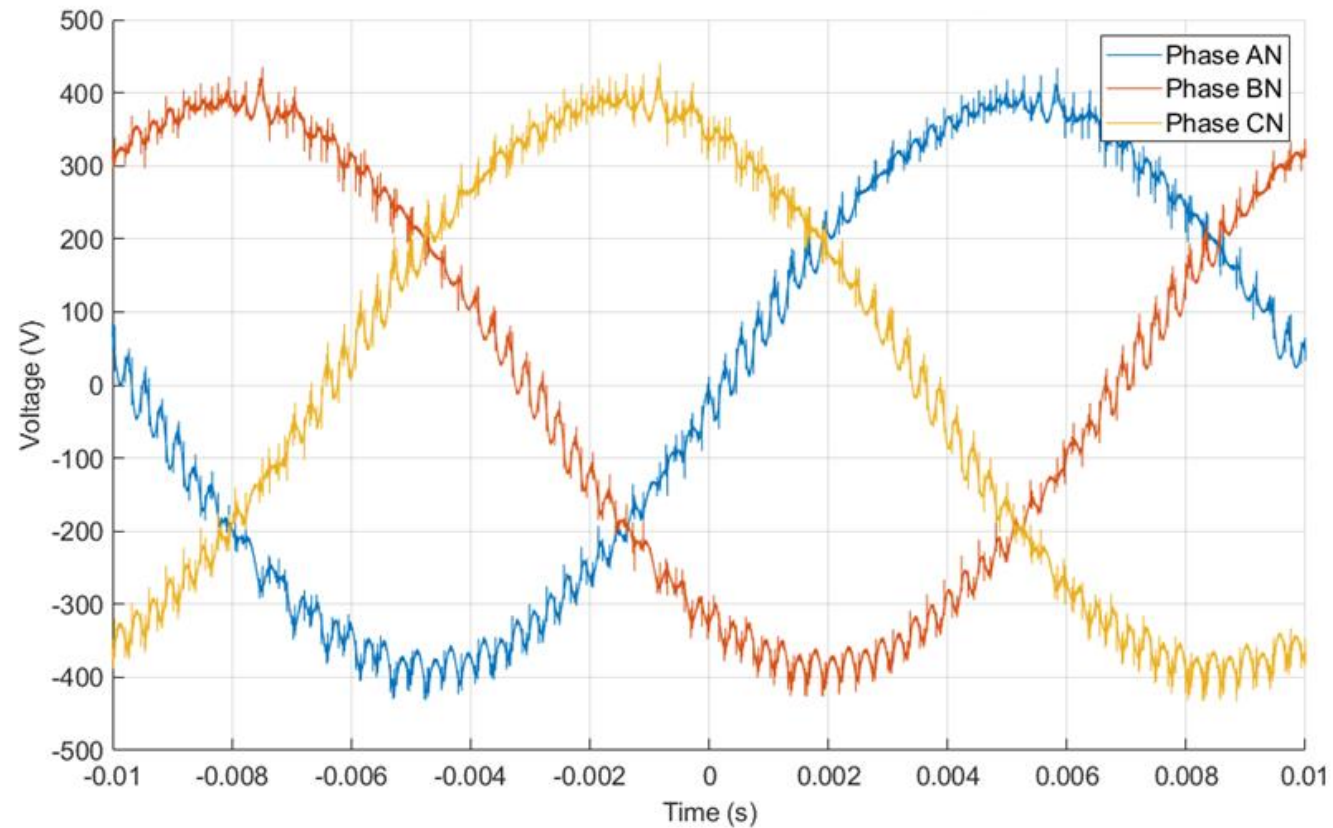
Harmonics

Limits



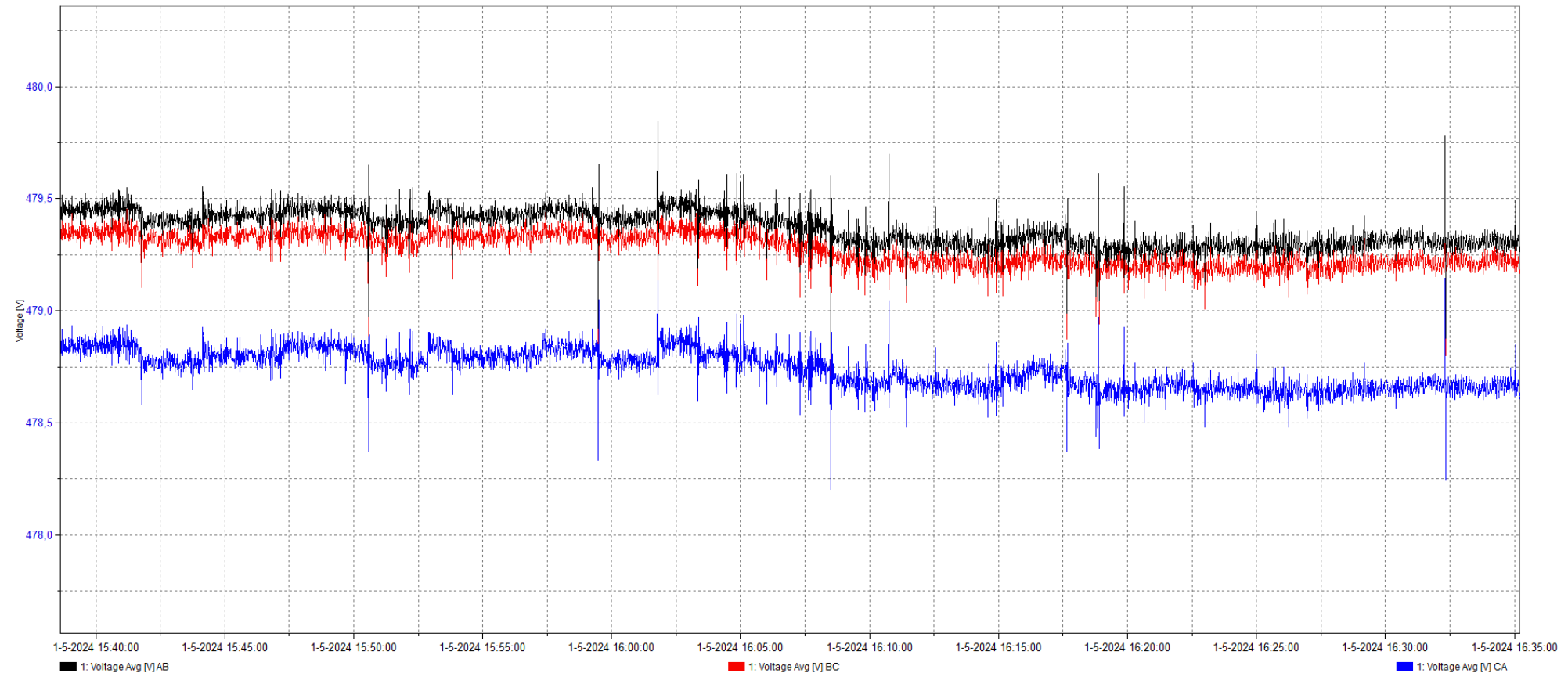
Filter design & Power Quality

A measurement result



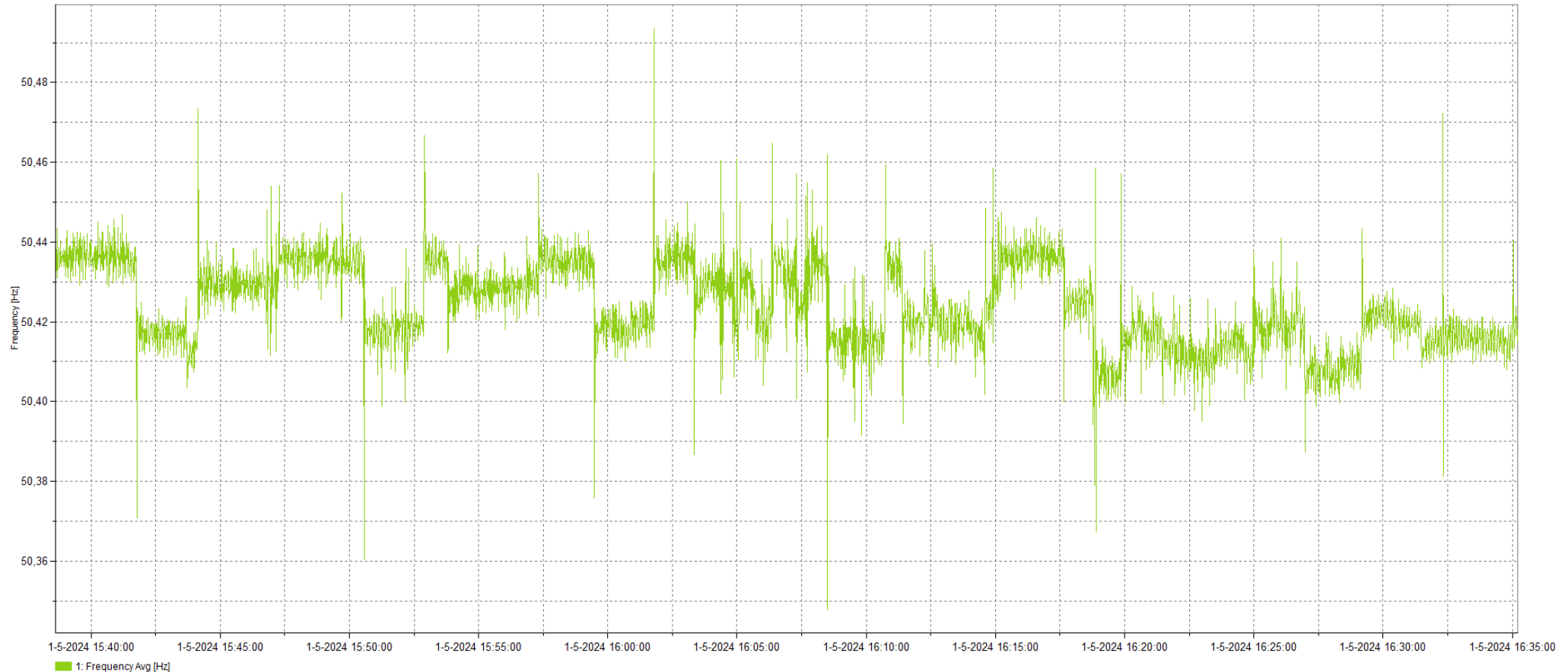
Filter design & Power Quality

A measurement result

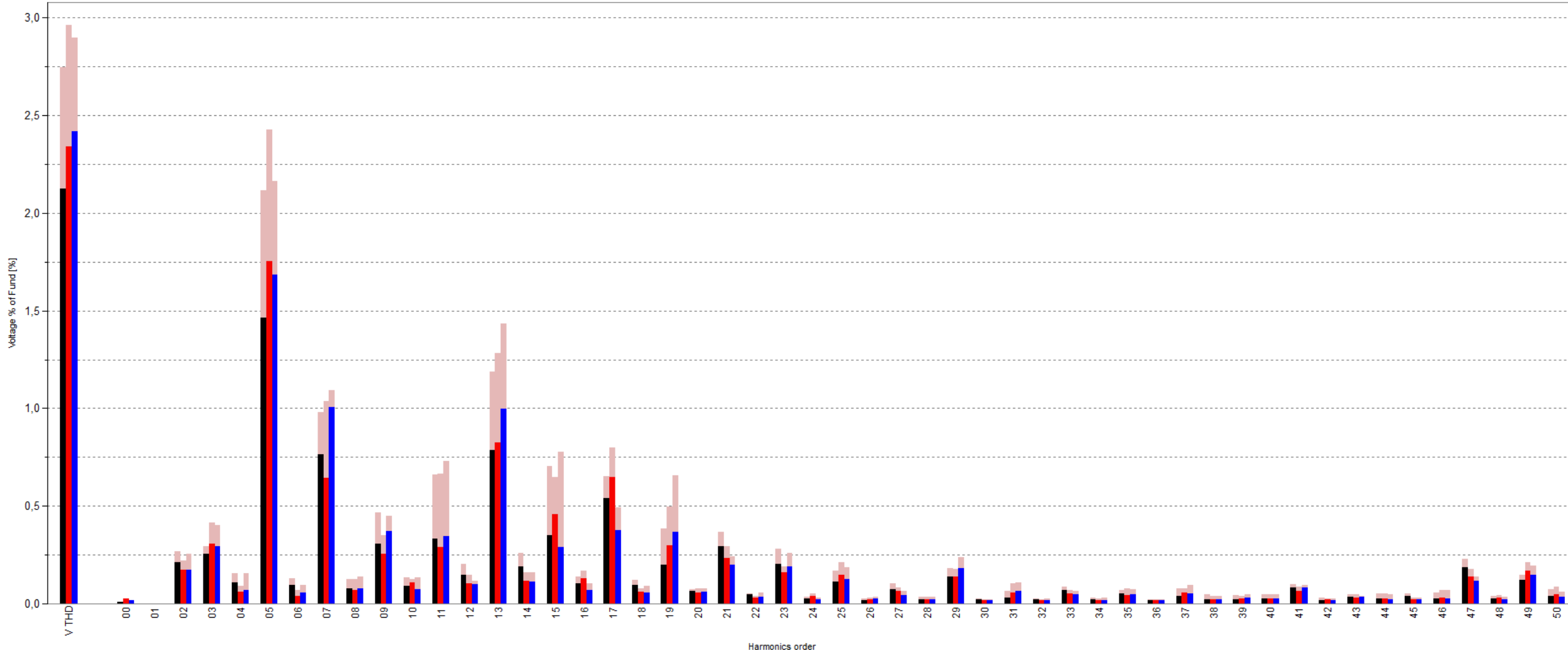


Filter design & Power Quality

A measurement result



Harmonics

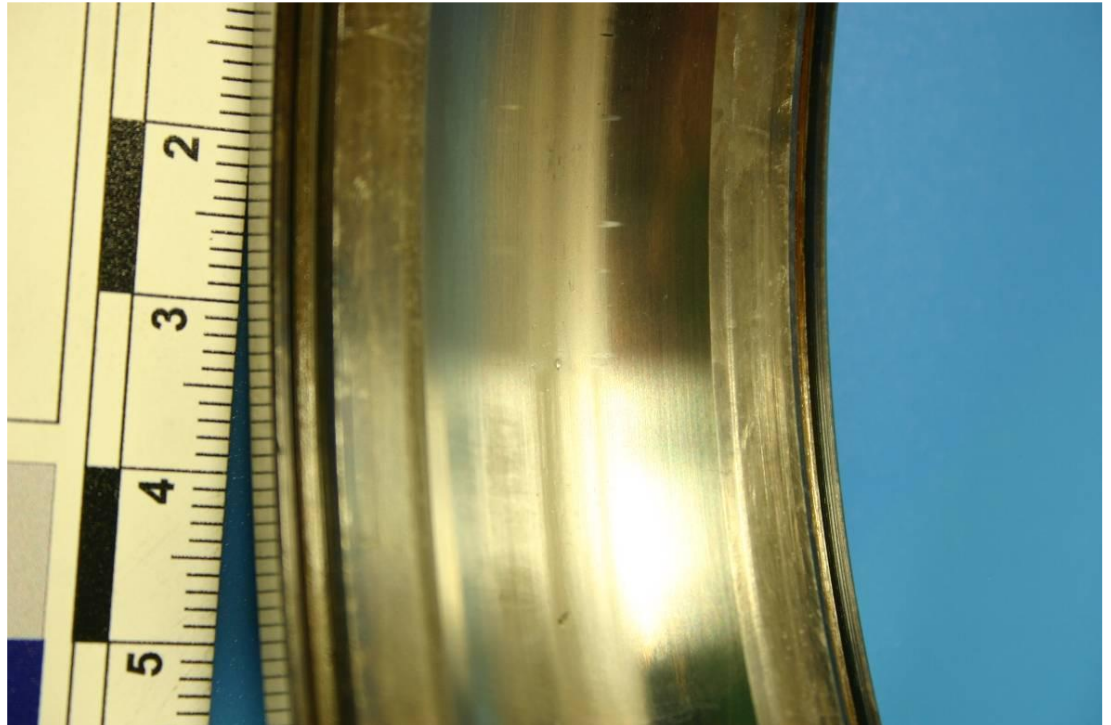


Filter design & Power Quality

Complaints

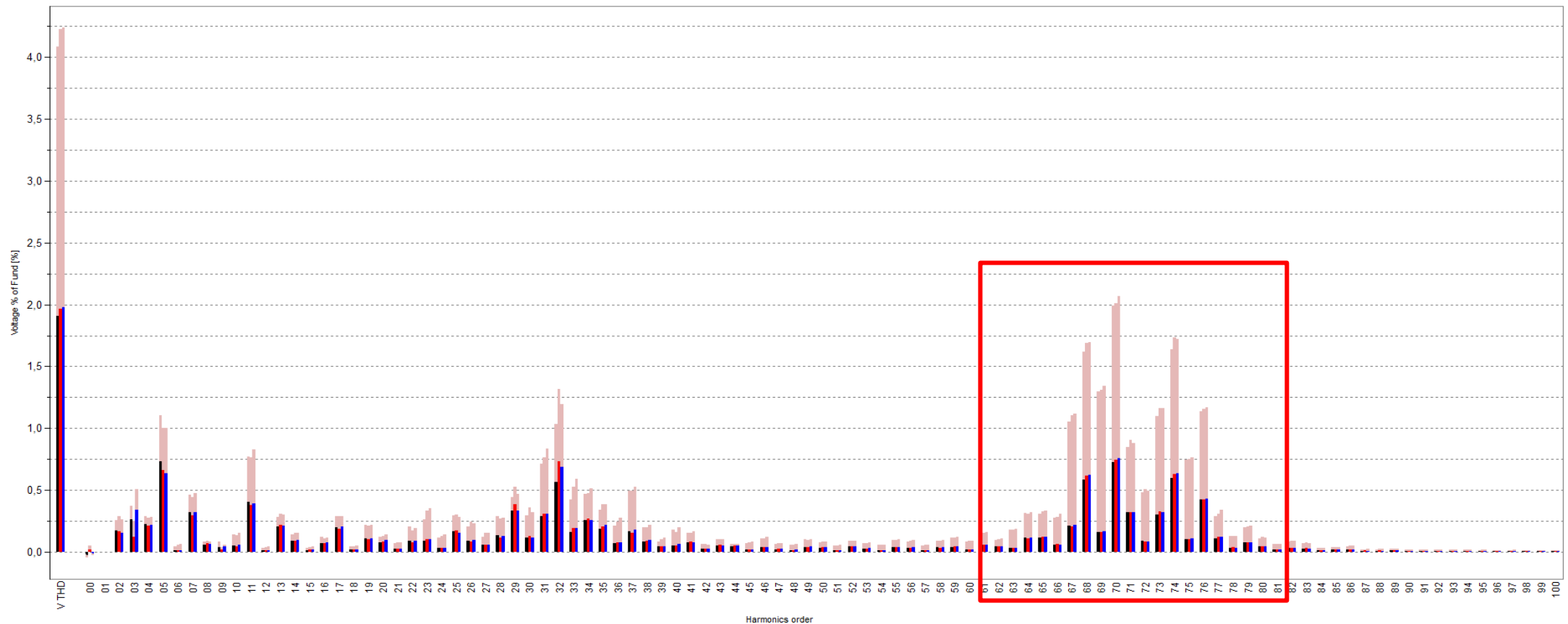
- High maintenance cost generator
 - Bearing replacement every 6 months
 - Isolation failure
- Often replace filter capacitors
- Often leakage on the filter inductances

- Baseline measurement before any upgrades



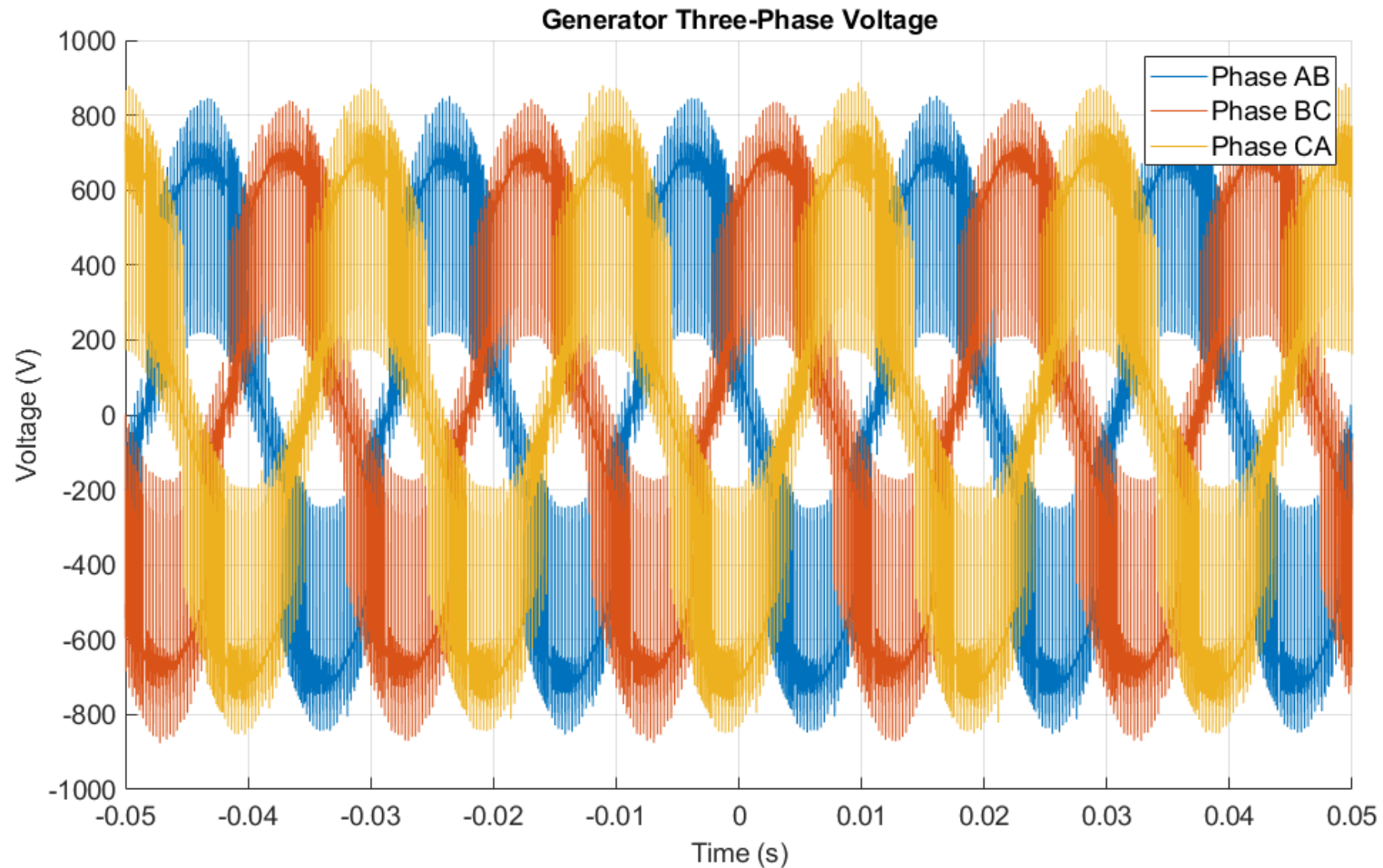
Filter design & Power Quality

Look further than 'the length of our nose'



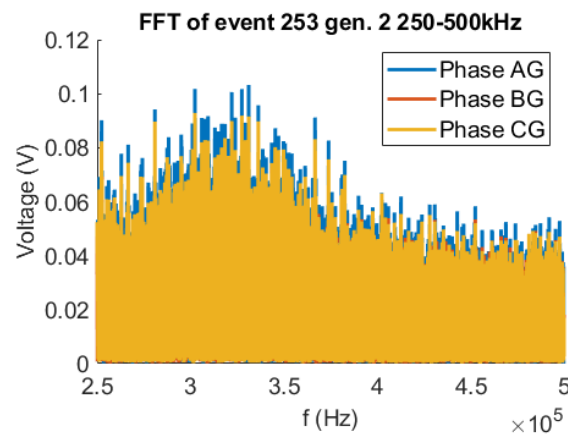
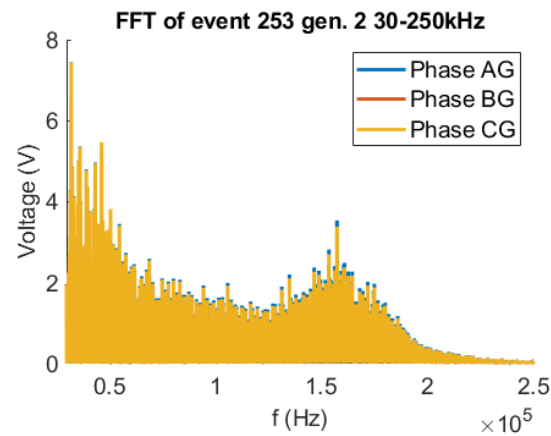
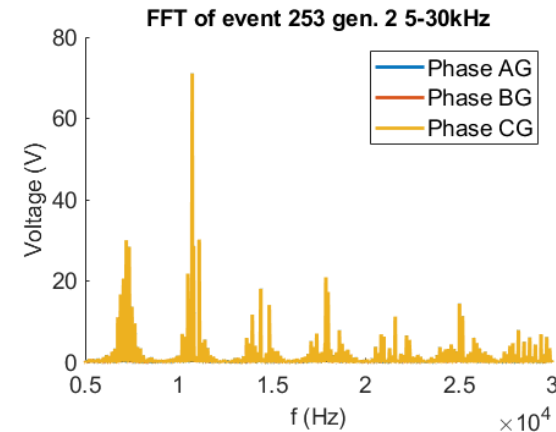
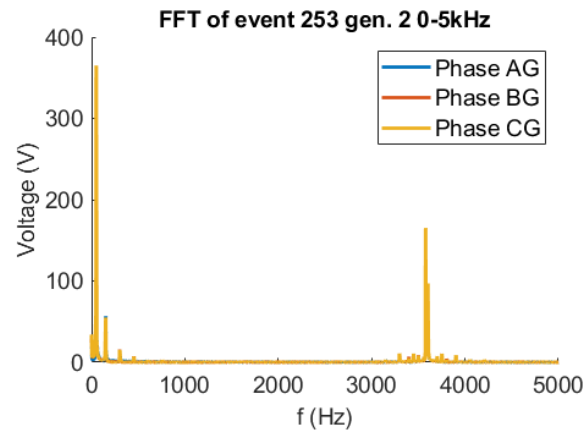
Filter design & Power Quality

Measuring phase-phase voltage

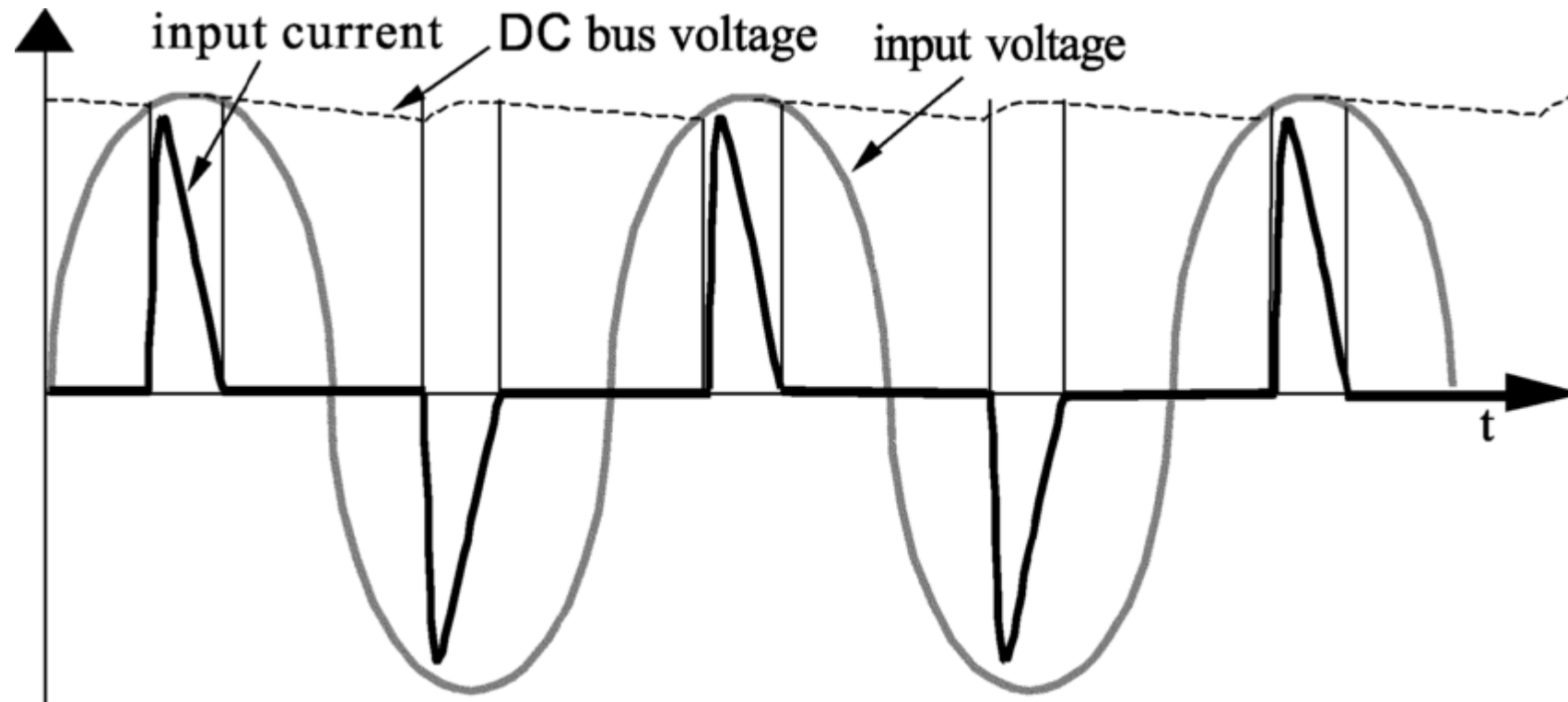


Filter design & Power Quality

Looking at higher frequencies



The effect of switching converters



$$\textit{Voltage} = \textit{current} \cdot \textit{impedance}$$

Filter design & Power Quality

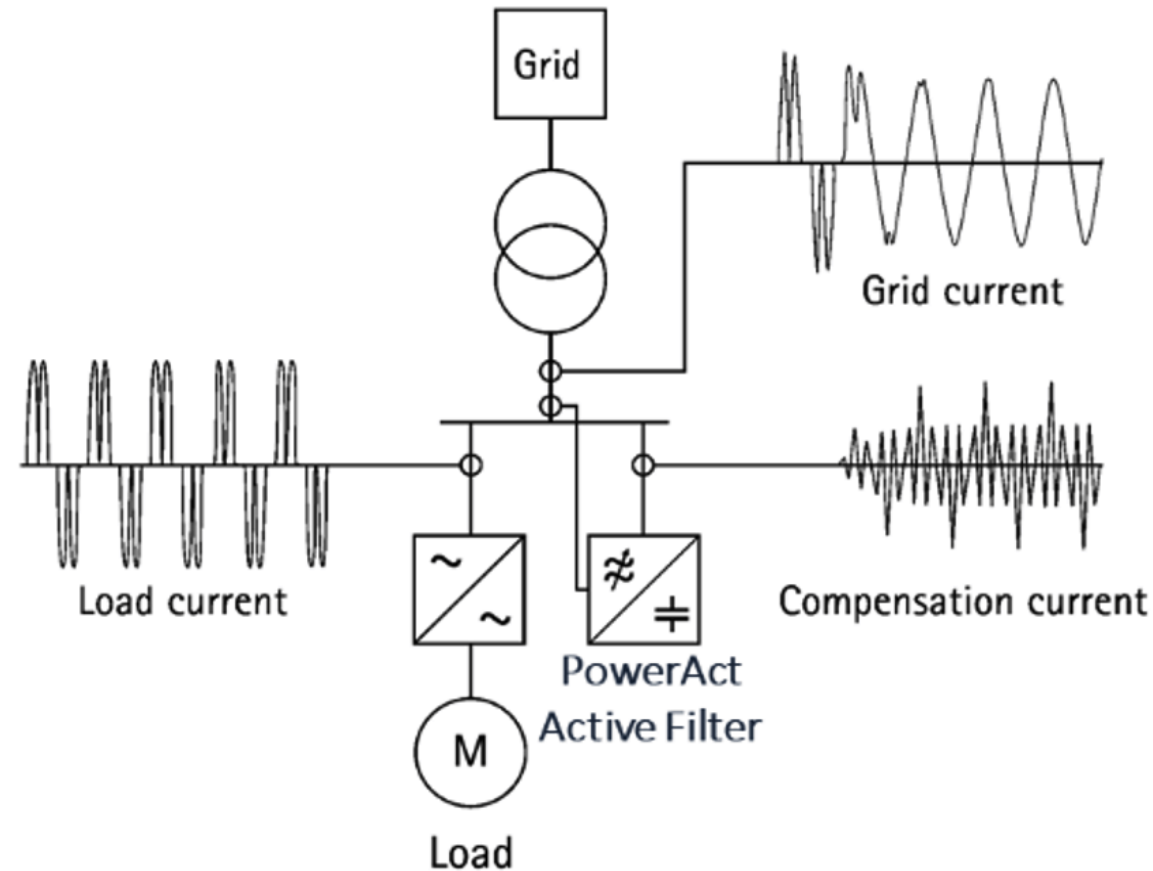
What can we do?

- Proper LCL filter
- High frequency (EMC) filter (30kHz – 300kHz)
- High frequency grounding
- Active Harmonic Filter (< 49th harmonic)



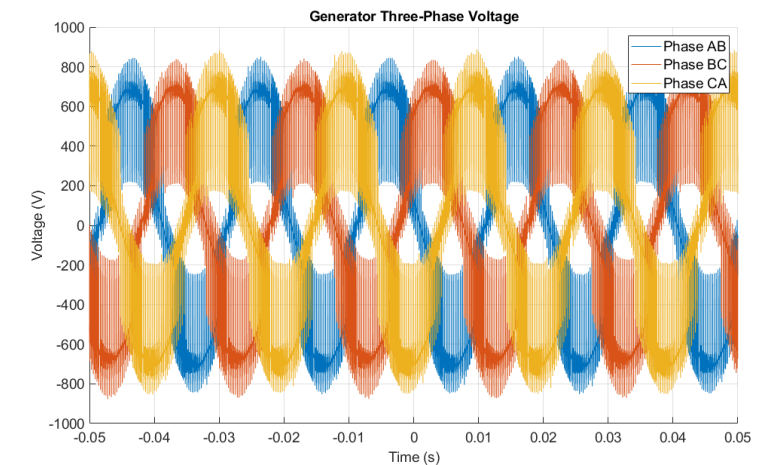
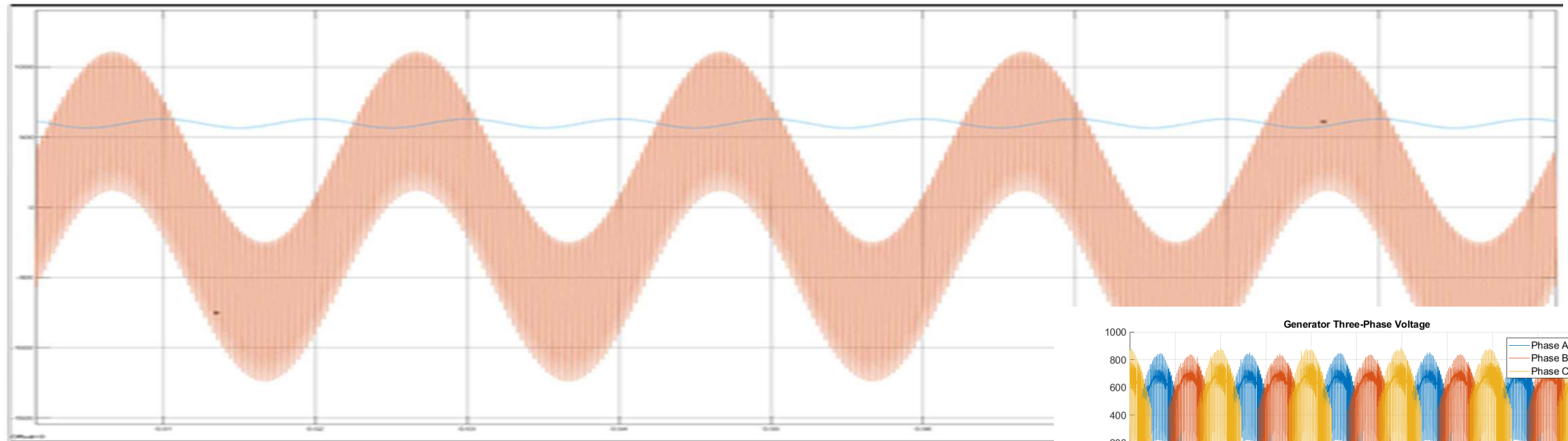
Filter design & Power Quality

Active Harmonic Filter



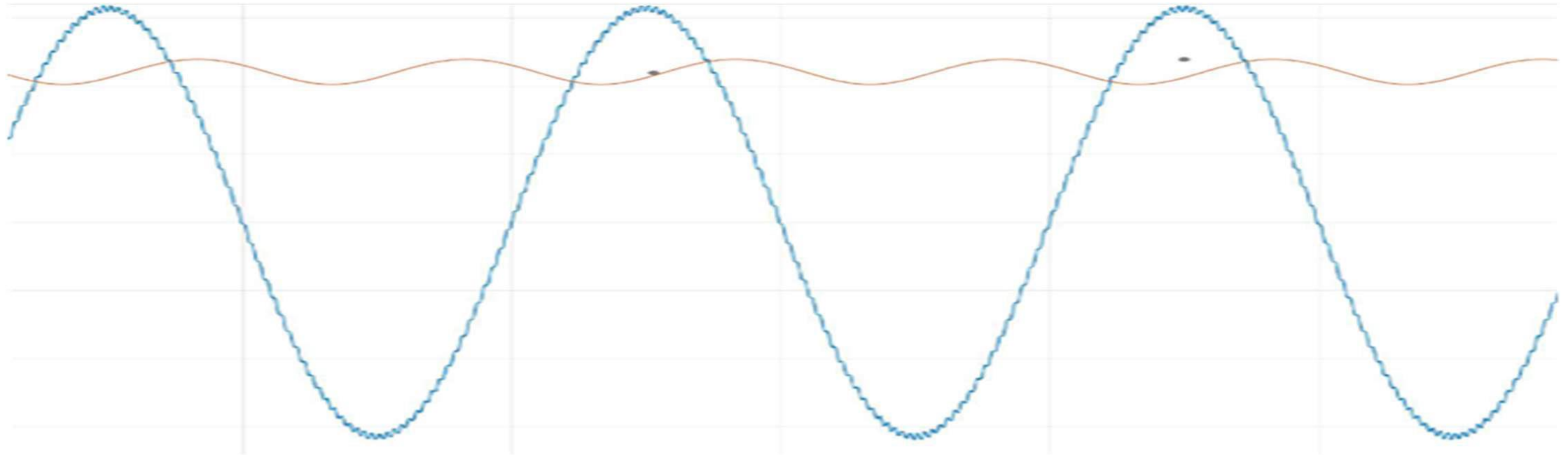
Filter design & Power Quality

Recreating the measured signal



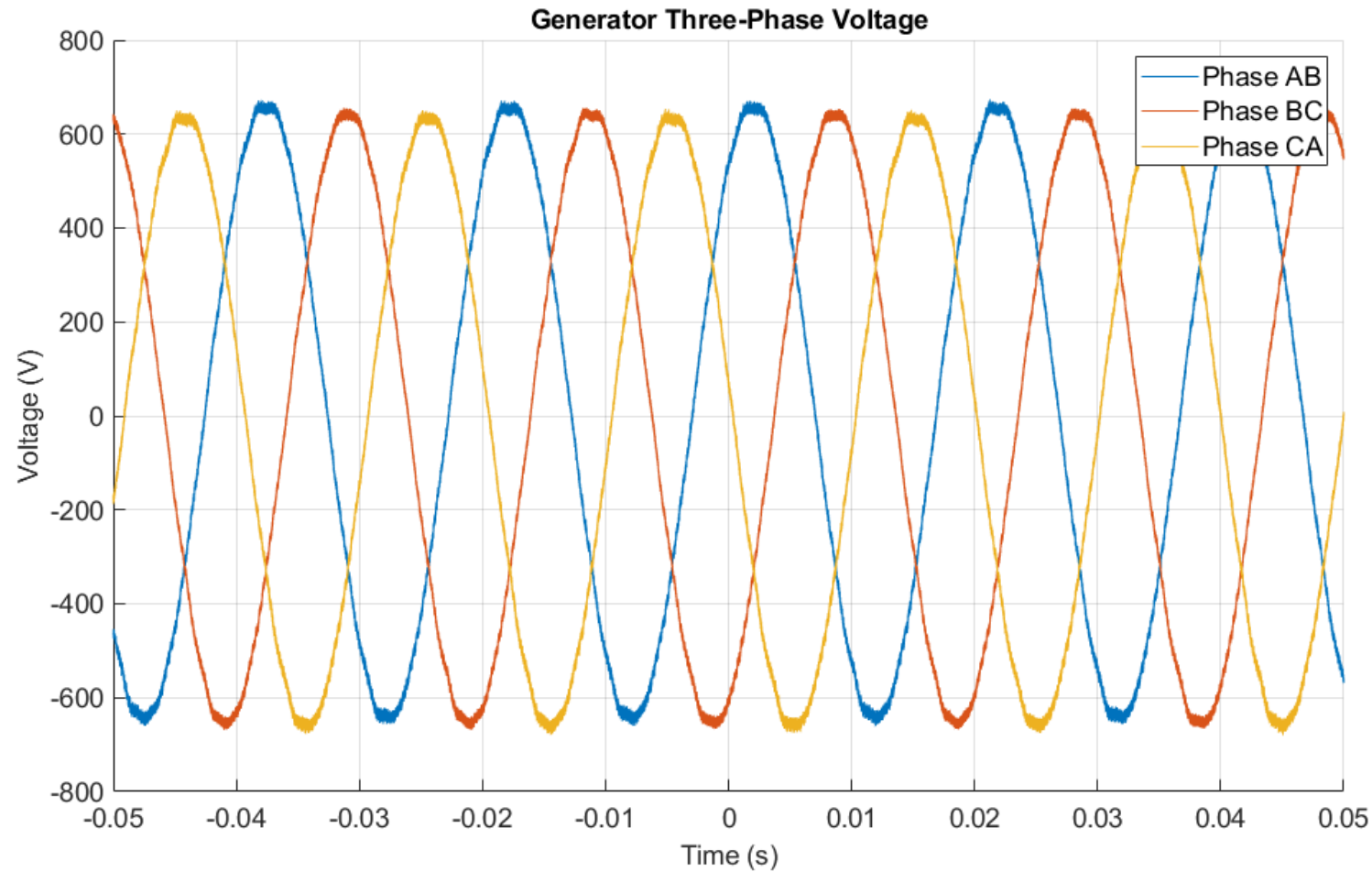
Filter design & Power Quality

After improving the filter in simulation environment



Filter design & Power Quality

After implementing the improved filter



Benefits

- Improved system performance
- Poor Power Quality = inefficiency
- Heat generated resulting in faster degradation
- Energy and fuel savings

Thank you!



WeConnect.