Paris Session 2022

The Harmonic Loci-Based Control Design

B4 – DC Systems and Power Electronics
PS1-4 Harmonics and Filtering and Interference in HVDC Applications

Question: 1.7

- Are there methodologies and approaches to analyse the possible harmonic interactions and predict the scenarios with harmonic interaction?

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1st part of the question:

Are there methodologies and approaches to analyse the possible harmonic interactions?

A: **Yes:** Common methods are:

- Impedance based stability analysis
- Modal Analysis
- Electromagnetic transient (EMT) simulations

2nd part of the question:

and predict the scenarios with harmonic interaction (issues) ?

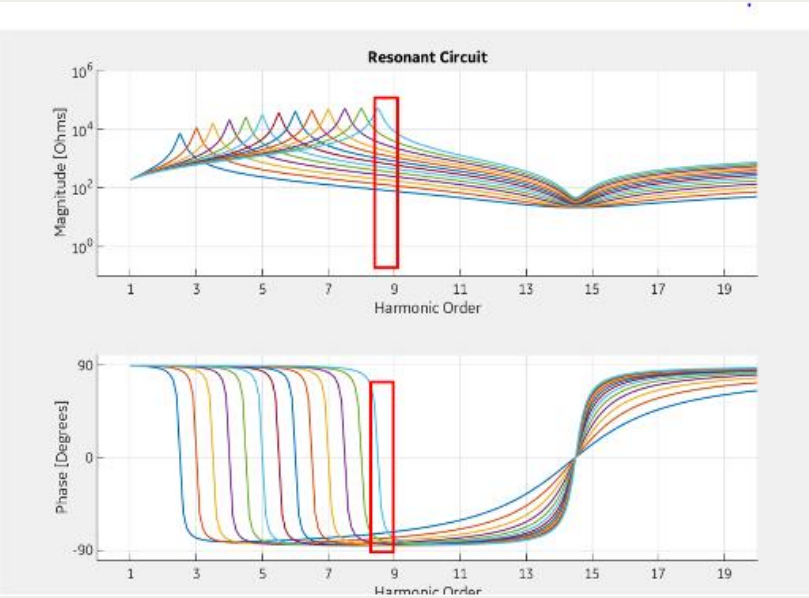
A: **Yes but** only for the scenarios that are known in detailed.

It is practically impossible to know all harmonic scenarios of complex AC networks.

So final combined answer is: **No…but** the complete answer is in our past experience.

50 years ago,

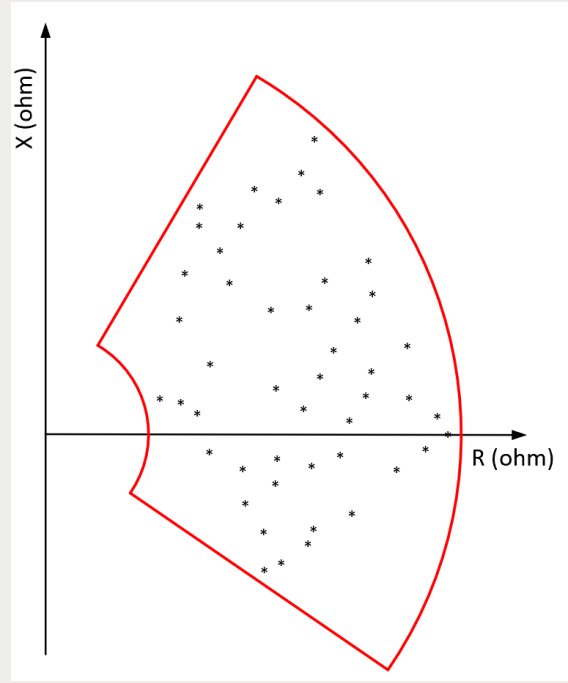
HVDC LCC solved the harmonic network uncertainty for the design of of AC passive filters. It used the Loci network representation.



Loci representation
is a mapping process
for a range of frequencies
(red rectangle)

|Z| v freq
φ v freq

X v R



Today,

MMC VSC can use the same process for both Performance and Harmonic Stability

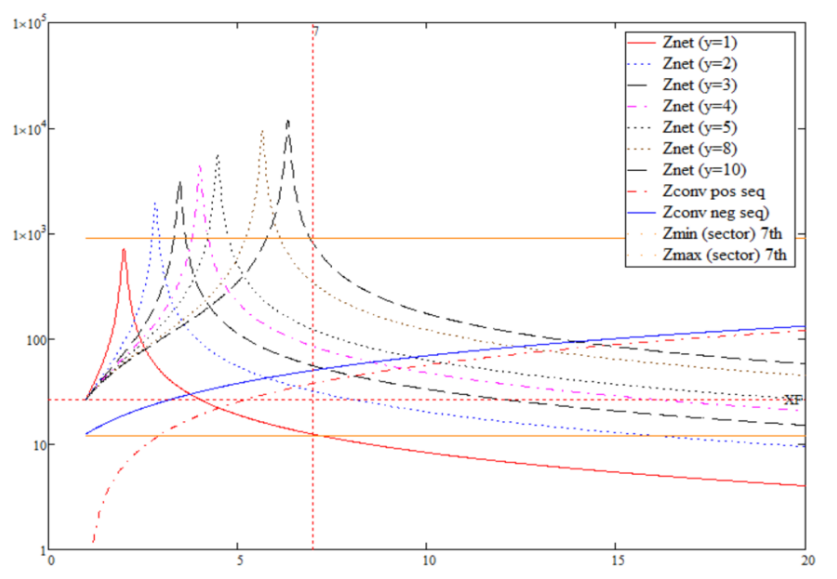
Another issue:

Testability of MMC HVDC controls in time domain in the harmonic range.

Problem is similar : Difficult to define representative circuits for time domain simulations.

Solution:

Use of simple multiple Synthetic AC network models based on Loci.



Detailed information of the complete methodology is given in paper CIGRE 2022 paper: ID 10112

"The Harmonic Loci-Based Control Design: Practical Methods in Frequency and Time Domain for a Consistent Design of VSC HVDC Harmonic Active Solution"