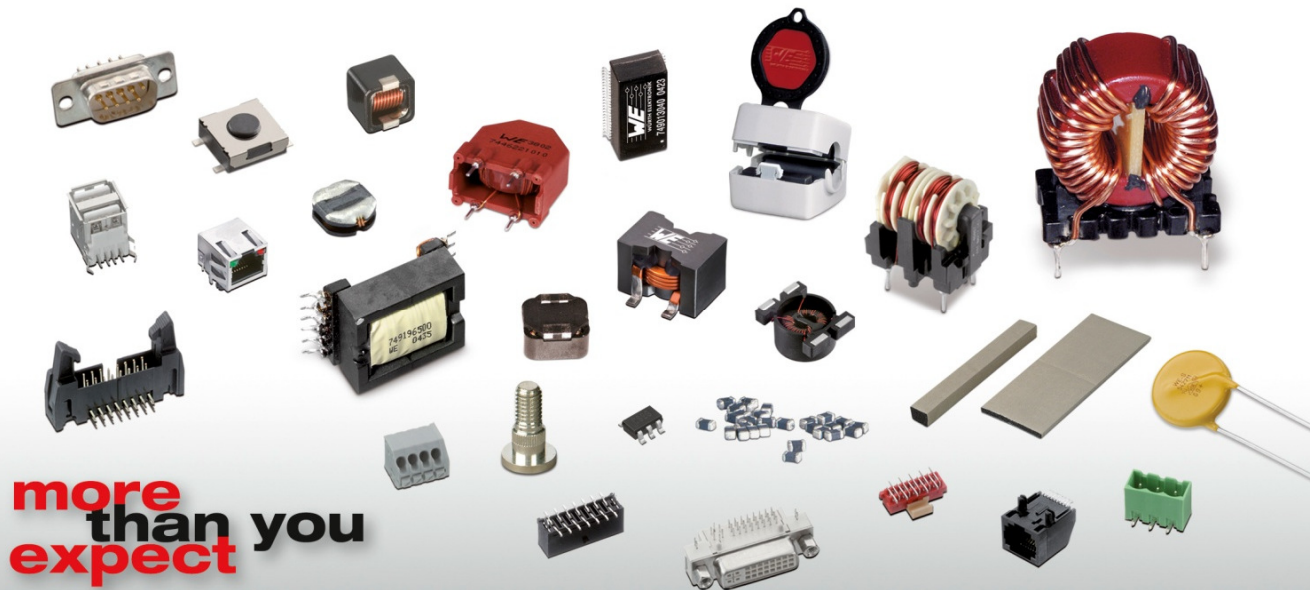
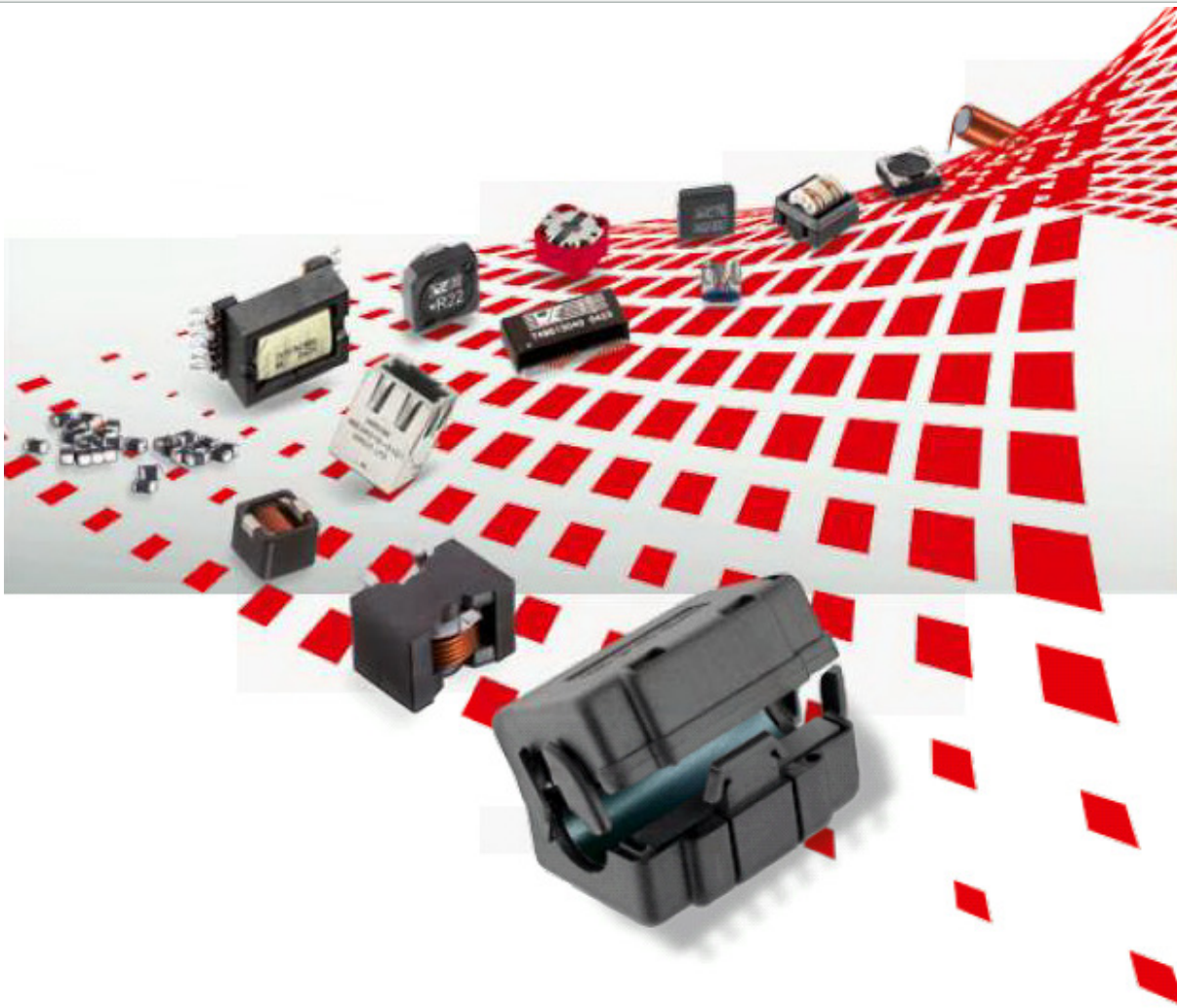


Filtering on Wires Cable Ferrites, Usage & Comparison



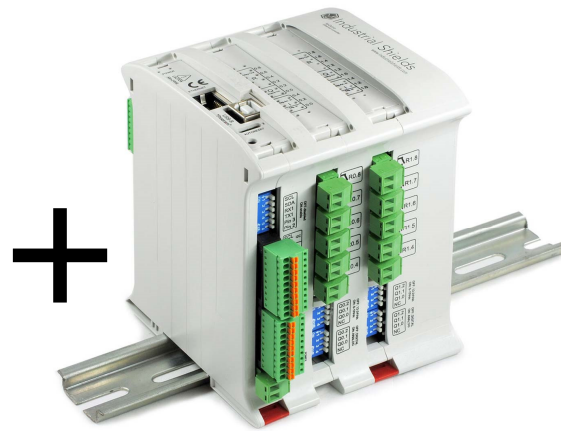
Alex Snijder
Field Application Engineer
Würth Elektronik Nederland B.V.

Agenda



- **Electromagnetic Compatibility (EMC)**
- **Application of Cable Ferrites**
- **Impedance of a Ferrite**
- **Different Core materials**
- **Behaviour of a ferrite**

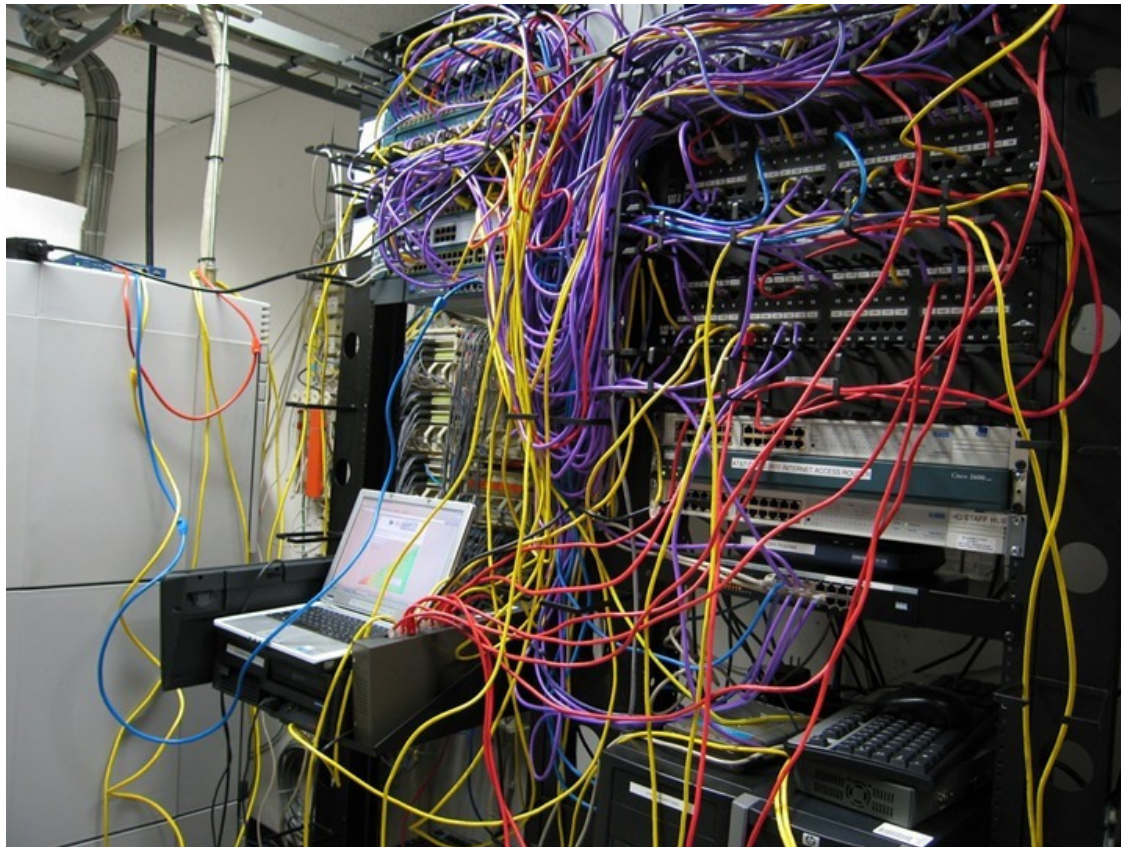
Electromagnetic Compatibility (EMC)



+ ≠ CE

CE + CE ≠ CE

Electromagnetic Compatibilty (EMC)

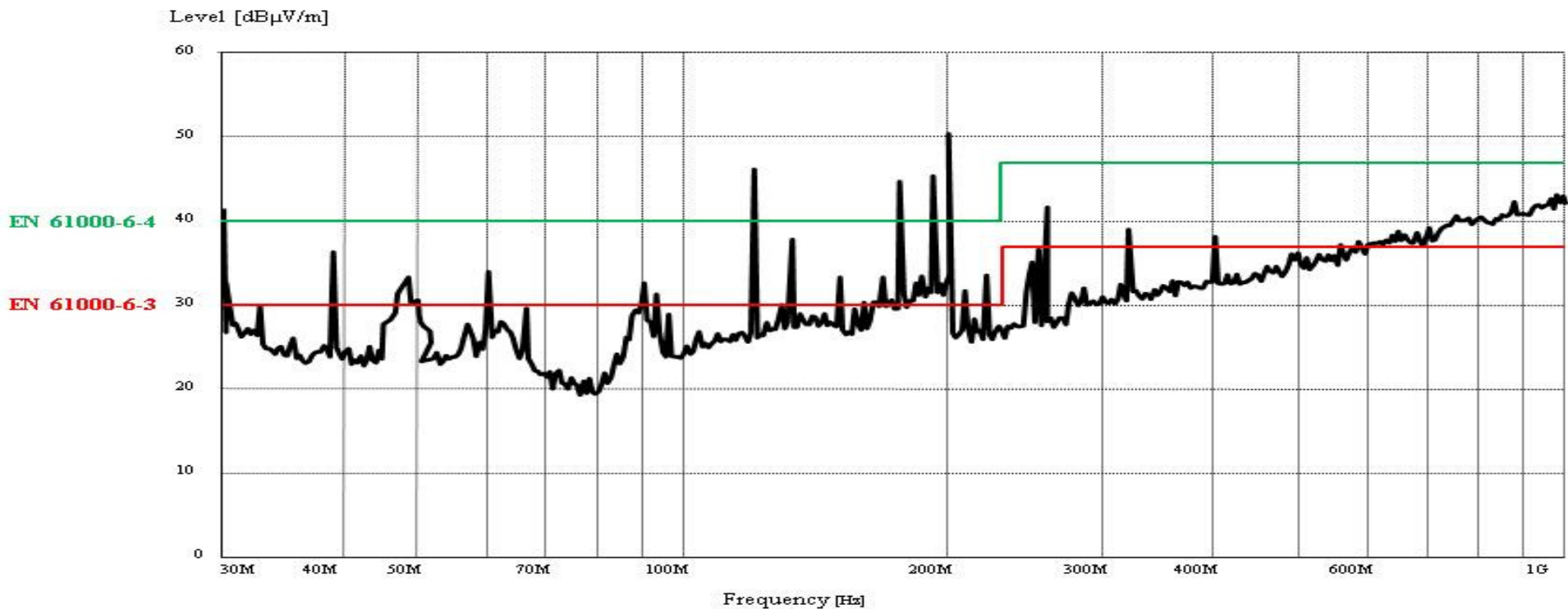


Electromagnetic Compatibility (EMC)

- **Standard: IEC 61000-1-1 (International Standard)**
- **Definition:**
 - Ability of electronic devices and systems to operate correct without influencing other devices or being disturbed by surrounding noises
- **Conclusion:**
 - All devices have to follow the defined limits of EMC

Electromagnetic Compatibility (EMC)

- EN61000-6-4 industry standard
- EN61000-6-3 consumer area



Application of Cable Ferrites

■ Usage for:

- Interference suppression
- Conductive and radiated emissions
- Common and differential mode noise



■ Benefits:

- Fast solution to ensure delivery
- No redesign of the printed circuit needed
- No influence to the data signal

■ Application Areas:

- Computer, Industry, Consumer products, Telecommunication...

■ Conclusion:

- Cable ferrites are used to eliminate EMI-Problems!

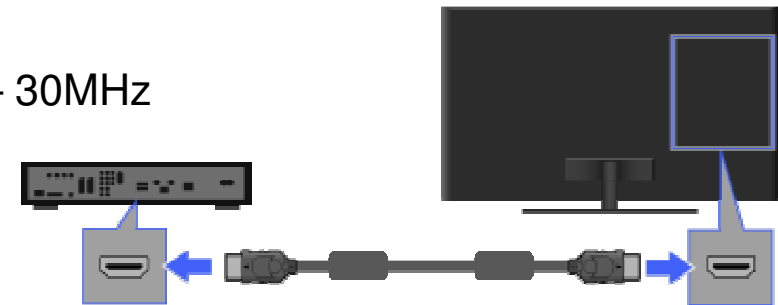
Kinds of Interferences

■ Origin of an Interference:

- Change of Voltage and Current in the disturbing source

■ Conductive Interferences:

- Standard definition: Test at EMC Lab from 150kHz – 30MHz
- For Differential Mode disturbances



■ Radiated Interferences:

- Standard definition: Test at EMC Lab from 30MHz – 2GHz
- For Common Mode disturbances



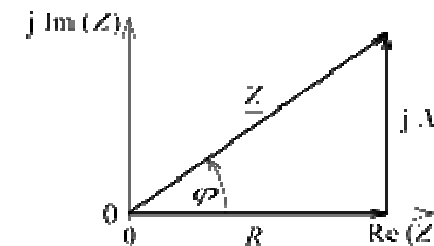
■ Conclusion:

- Depending on the frequency we have different kind of interferences

Impedance of a Ferrite

General Information

- Impedance is also called AC resistance and is a complex function over frequency
- The Modulus of complex impedance is $Z = \sqrt{R^2 + X^2}$
 - It is the complex addition of resistance and reactance



Dependent Factors

$$Z = \sqrt{R^2 + X^2}$$

R

X

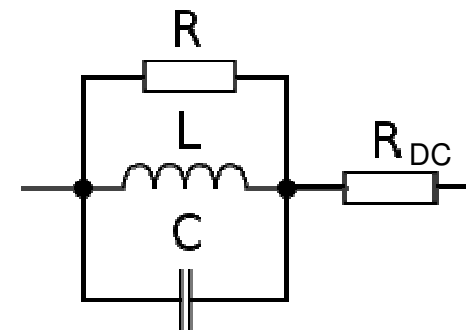
Resistance

- Ferrite Core
- Cable
- Measuring Instrument

Reactance

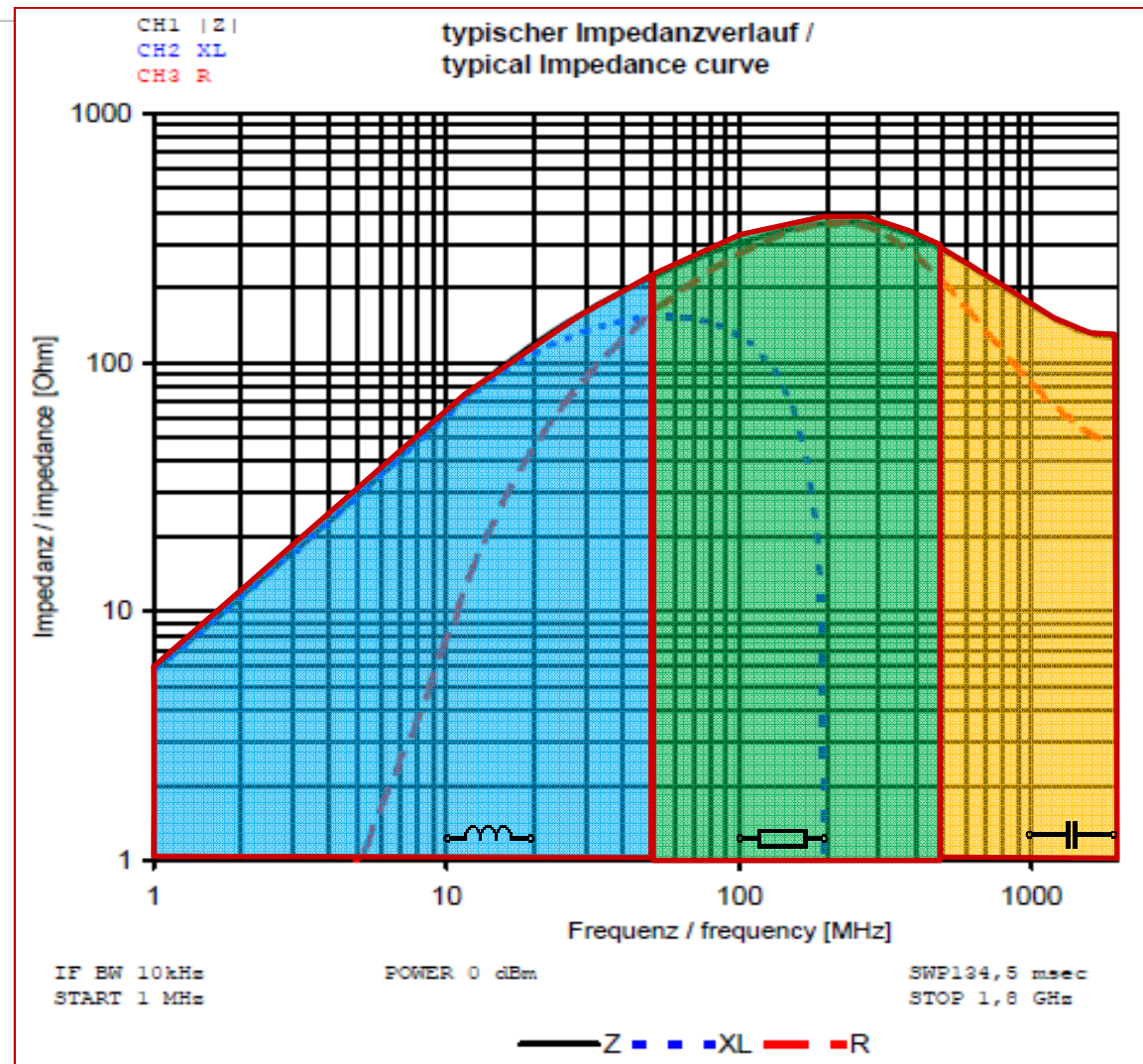
- Inductive Losses
- Capacitive Losses

Equivalent Circuit of a cable ferrite



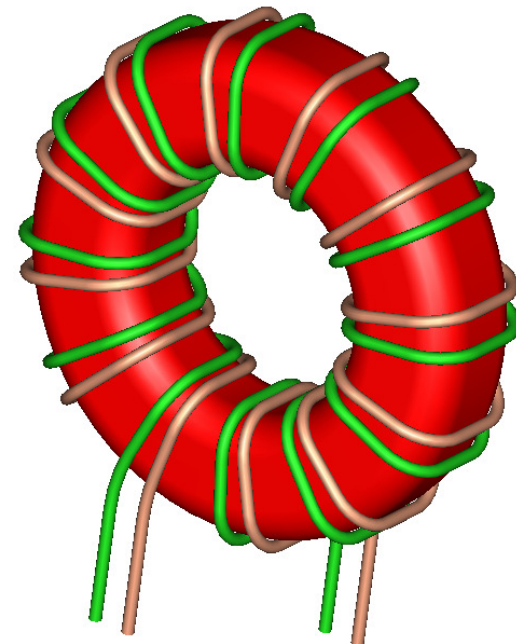
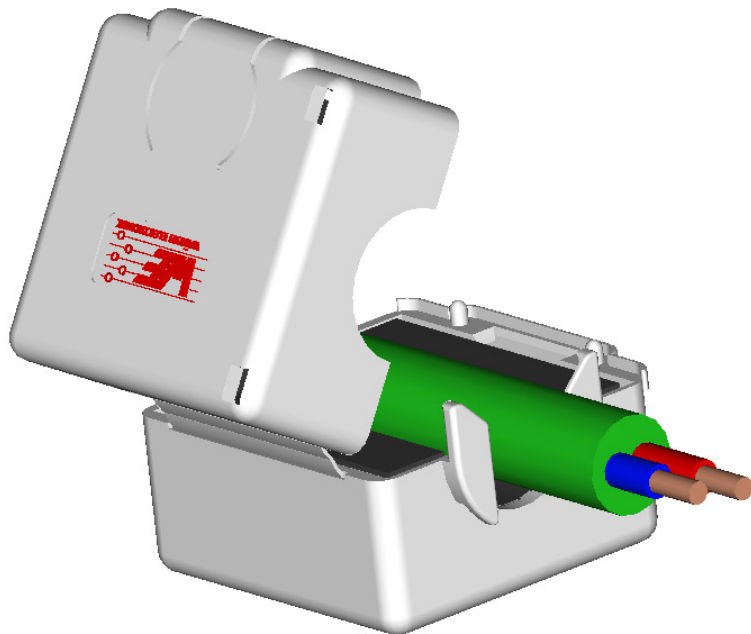
Impedance Curve

- **Resistance**
 - Absorbes disturbance energie
- **Inductive Reactance**
 - Stores energy (for a short time)
- **Capacitance**
 - AC passes, DC is blocked
- **SRF**
 - $XL=XC$



Cable Ferrite functioning

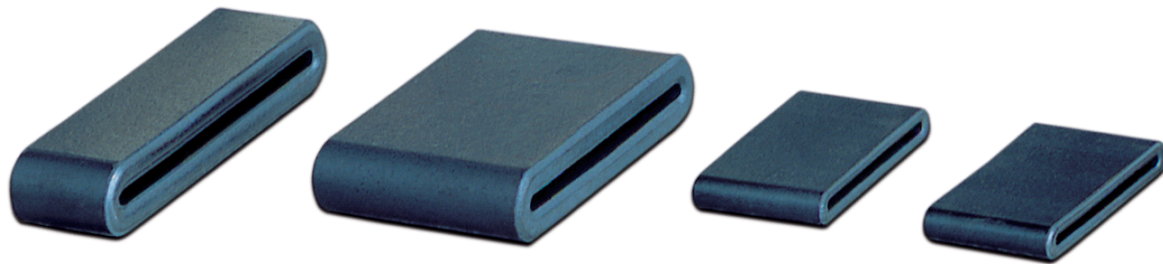
- A Cable Ferrite is comparable to a common mode choke with bifilar winding



- Both are absorbing common mode interferences
- For detecting differential mode interferences you can put the cable ferrite over one wire

Solid Cores

- Planned EMI Suppression
- Smaller Dimensions
- Cost effective



WE-Flat

WE-AFB



WE-TOF

Snap Ferrites (STAR-Series)

- **Subsequent EMI Suppression**
- **Key Technology**
 - Patented
 - Inner security lock
 - No unauthorized removing
- **Fixation of the cable**
- **Cable Clamping Protection**



Star-Ring

Star-Bueno

Star-Flat

Star-Tec

Star-Fix

Star-Fix LFS

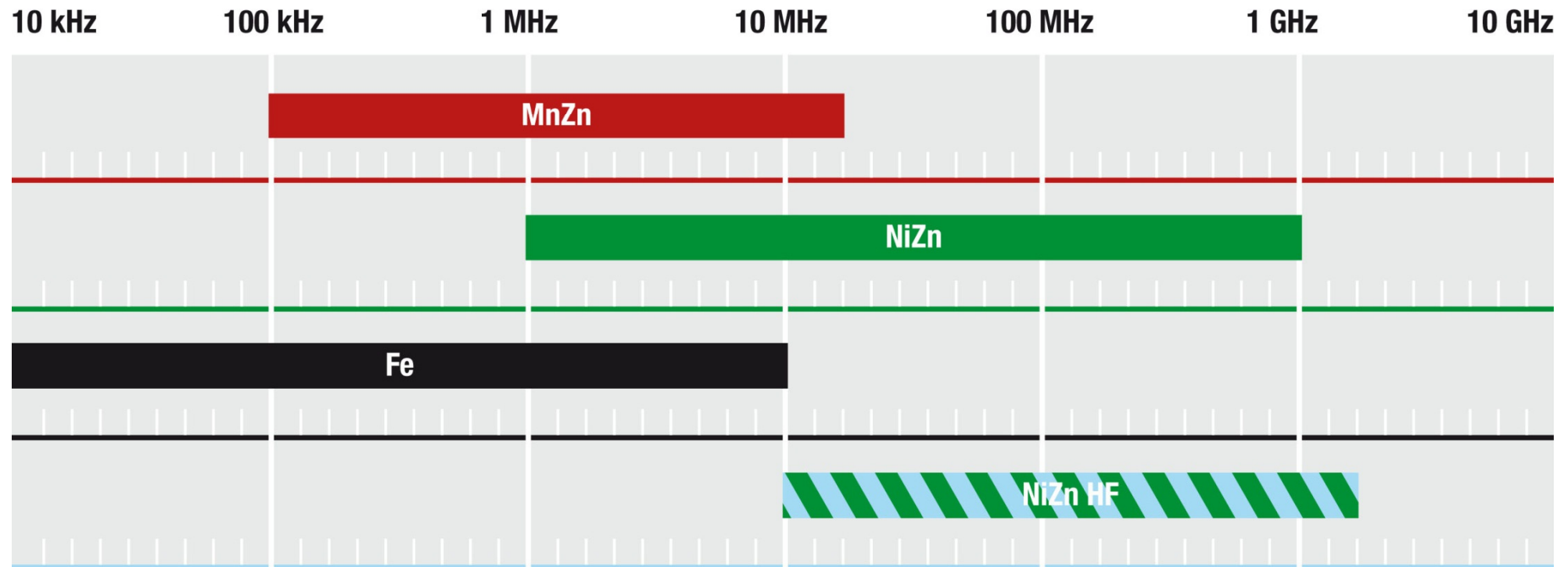
Star-Gap

Key

Different Core materials

Step 1: Check the frequency range

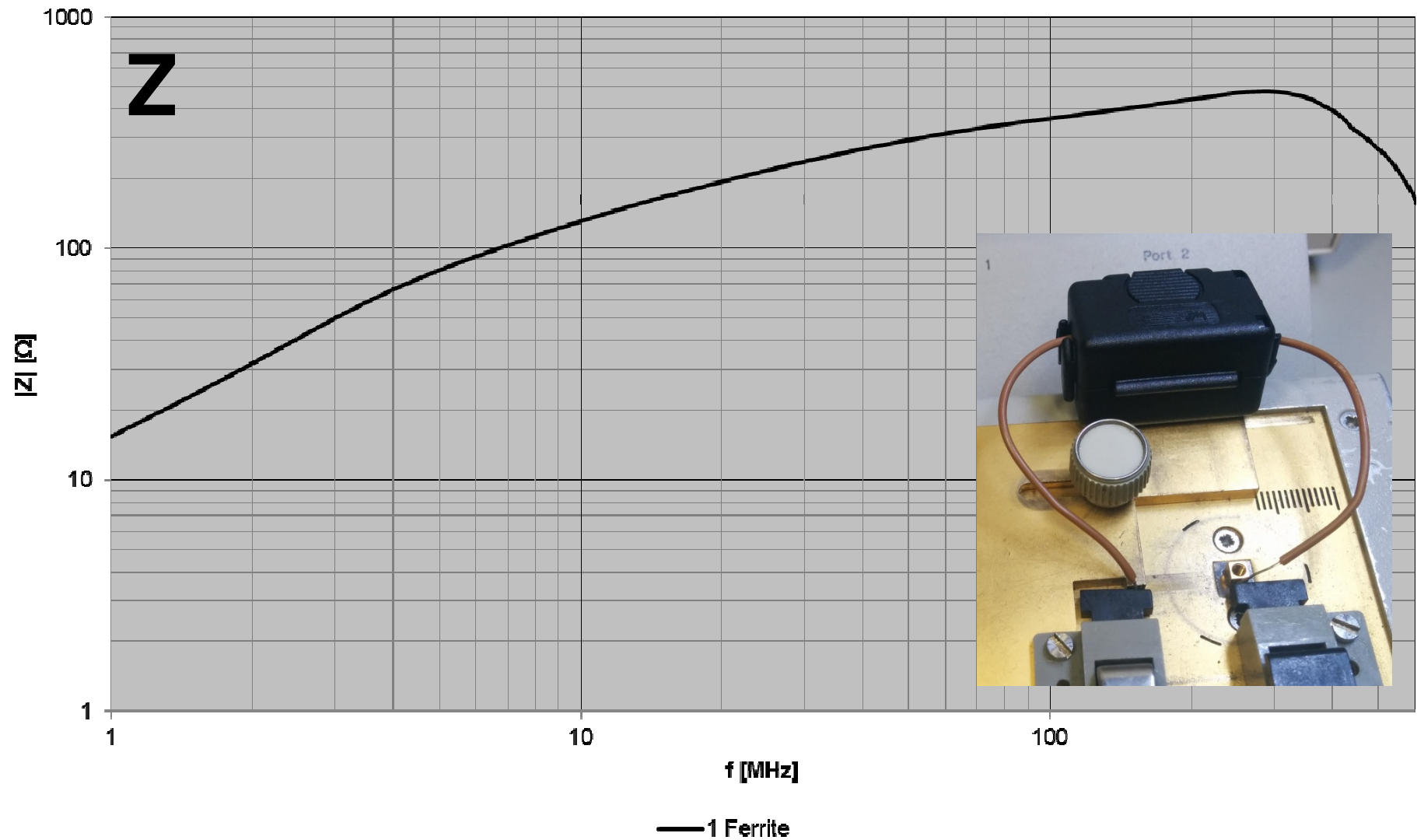
Frequency Range



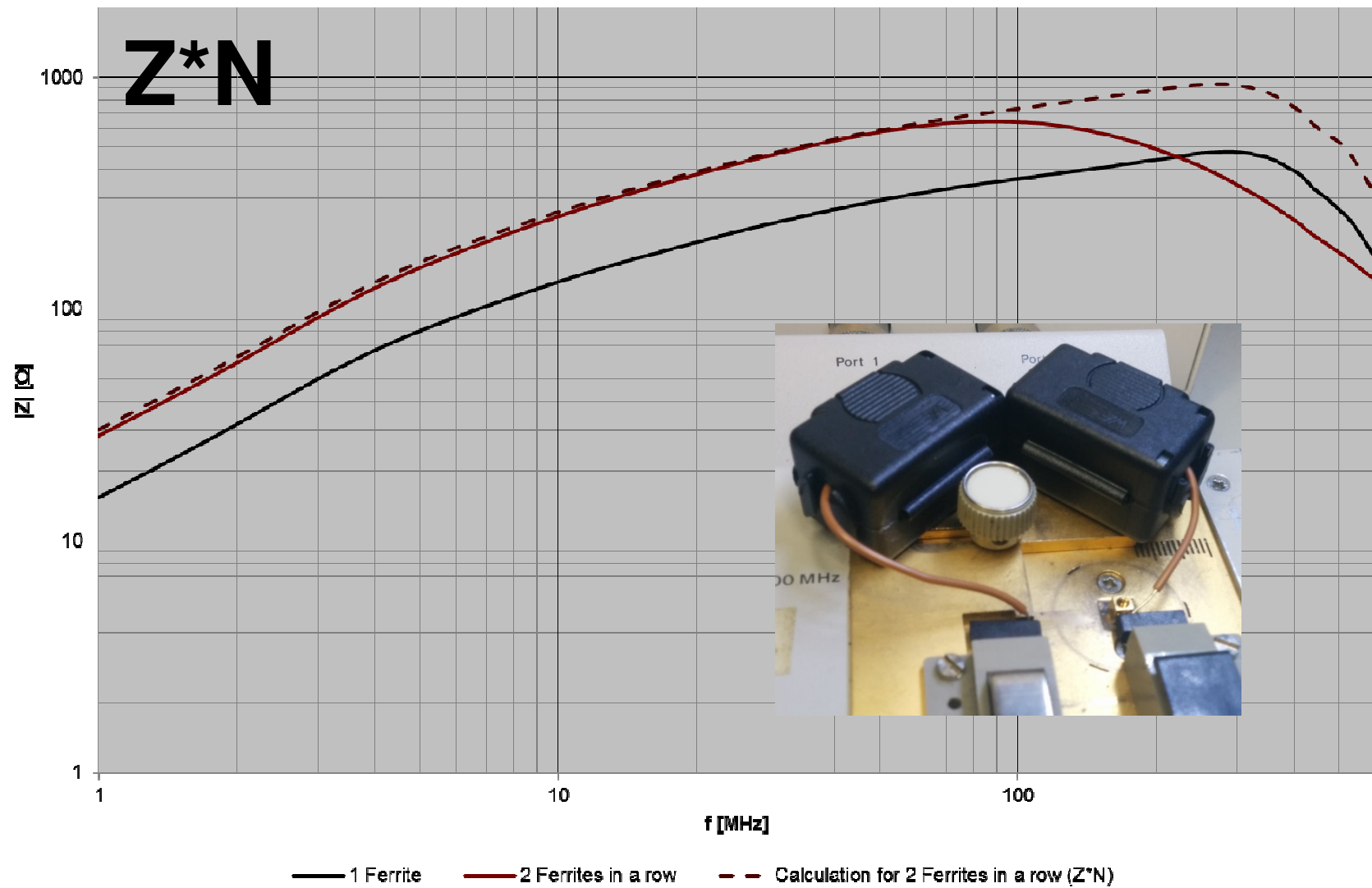
Behaviour of a ferrite (NiZn (74271733) and MnZn (74272733))

- 1 Ferrite on Cable
- 2 Ferrites in row
- 2 turns on 1 Ferrite

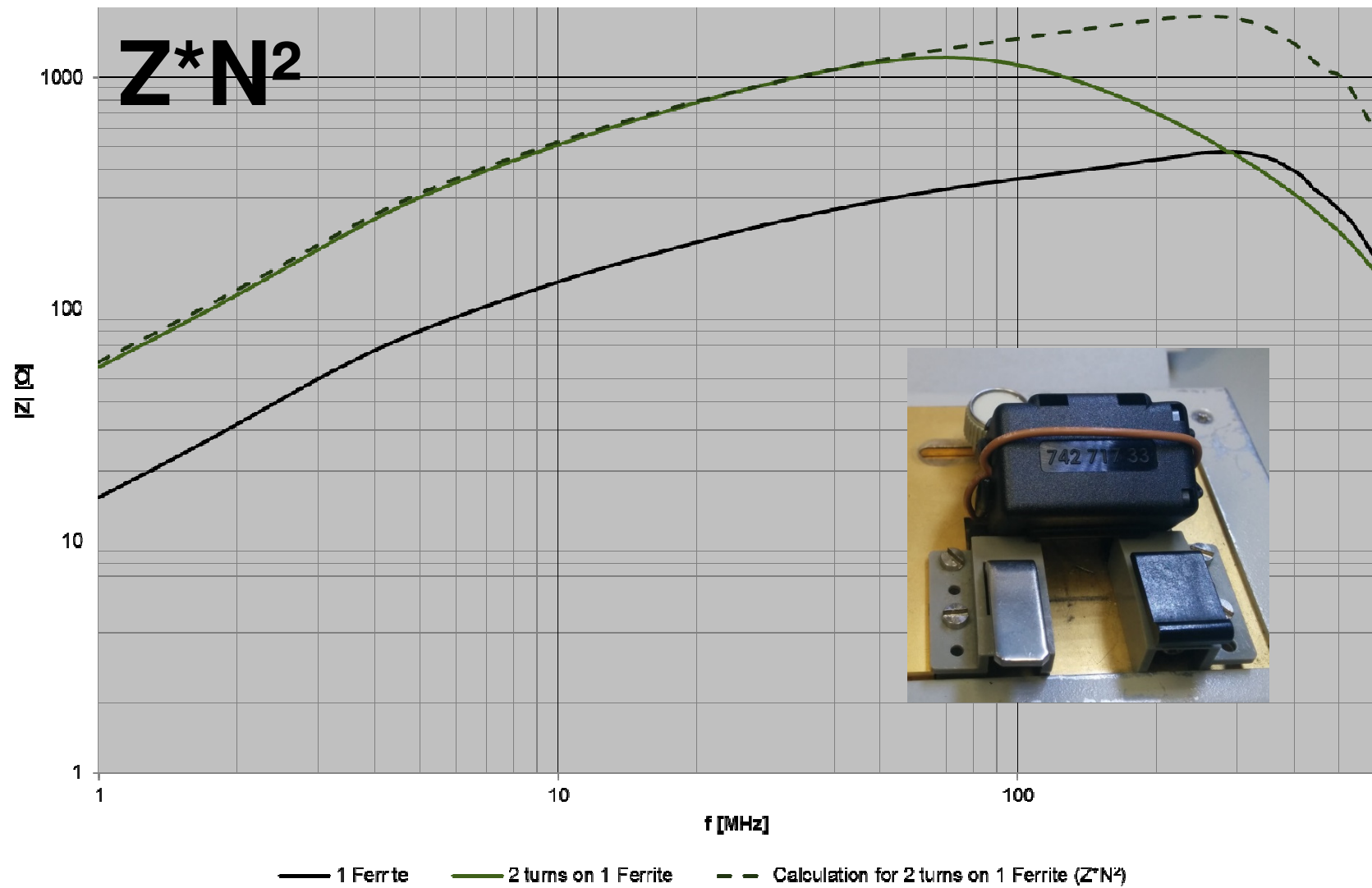
NiZn Ferrite 74271733 – 1 Ferrite



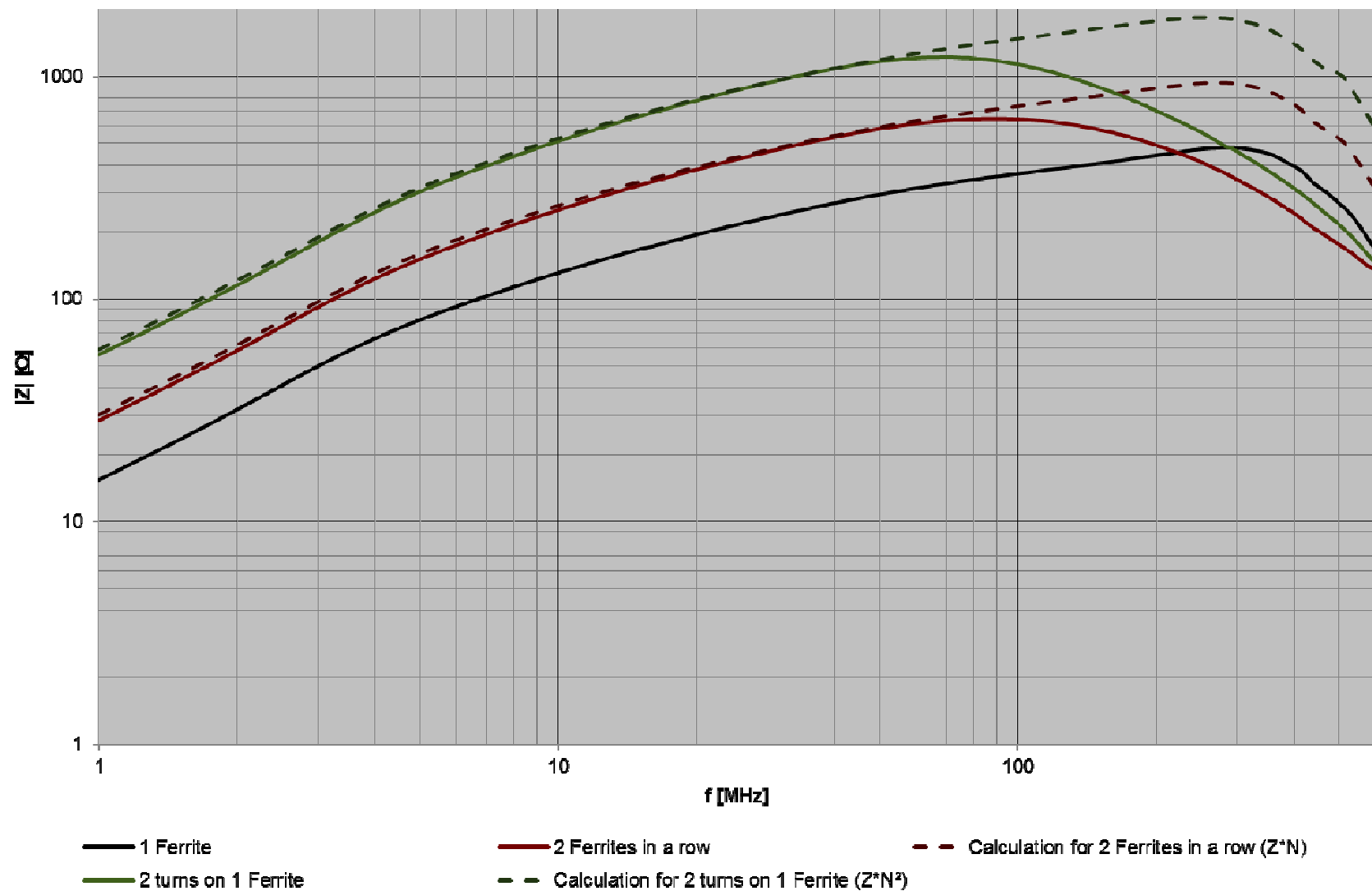
NiZn Ferrite 74271733 – 2 Ferrites in a row



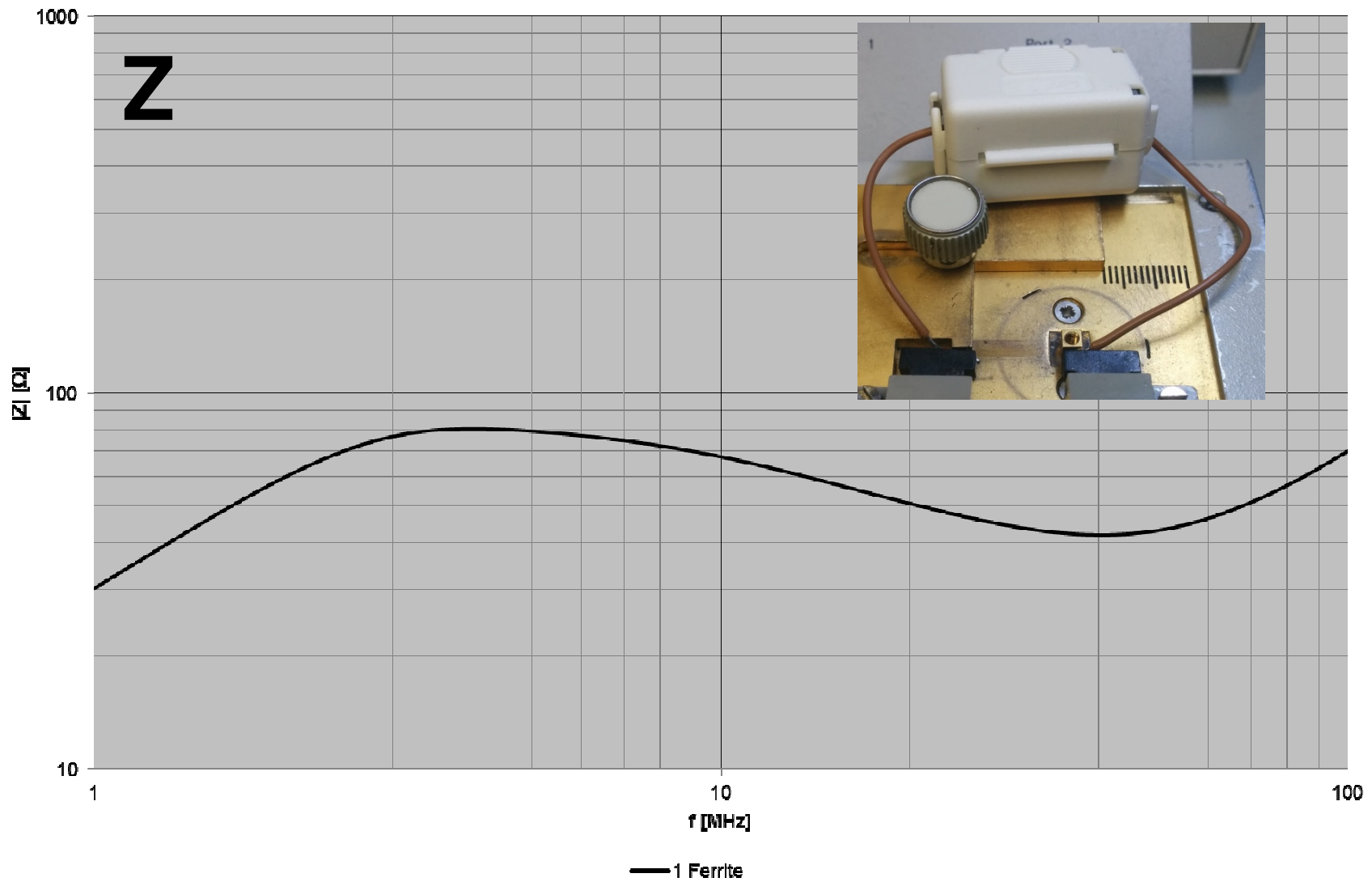
NiZn Ferrite 74271733 – 2 turns on 1 Ferrite



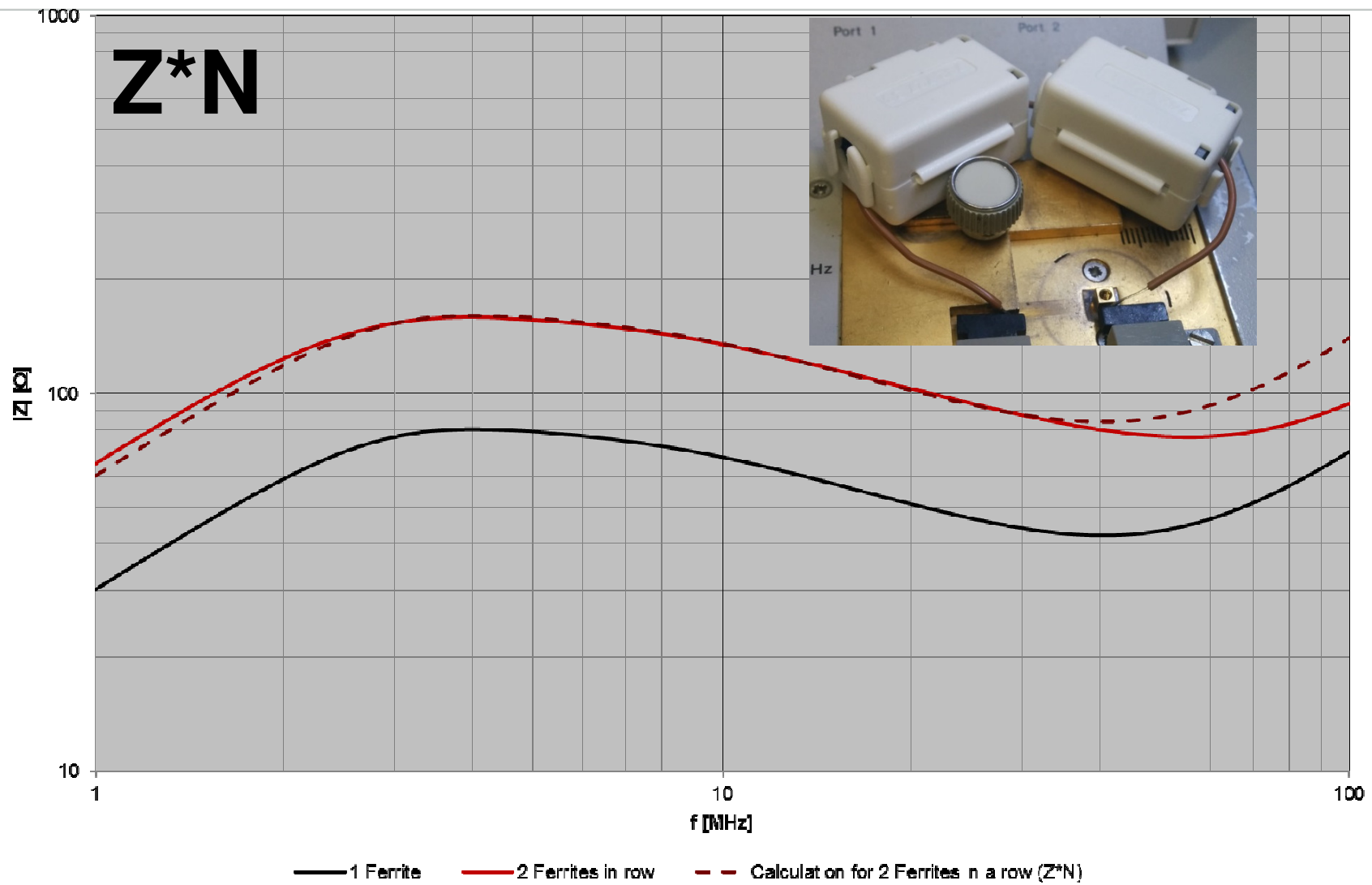
Measurement of NiZn Ferrite – overview



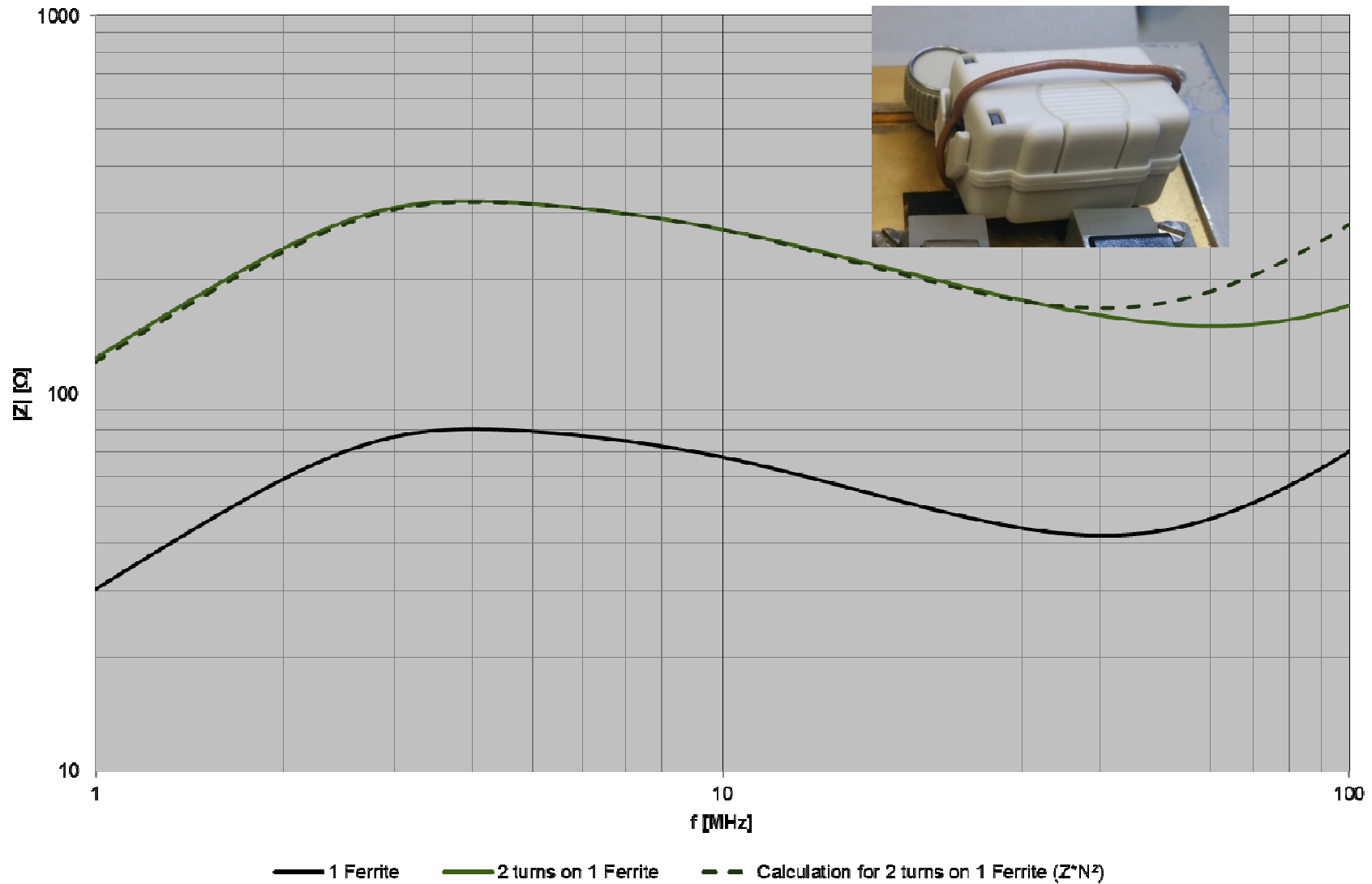
MnZn Ferrite 74272733 – 1 Ferrite



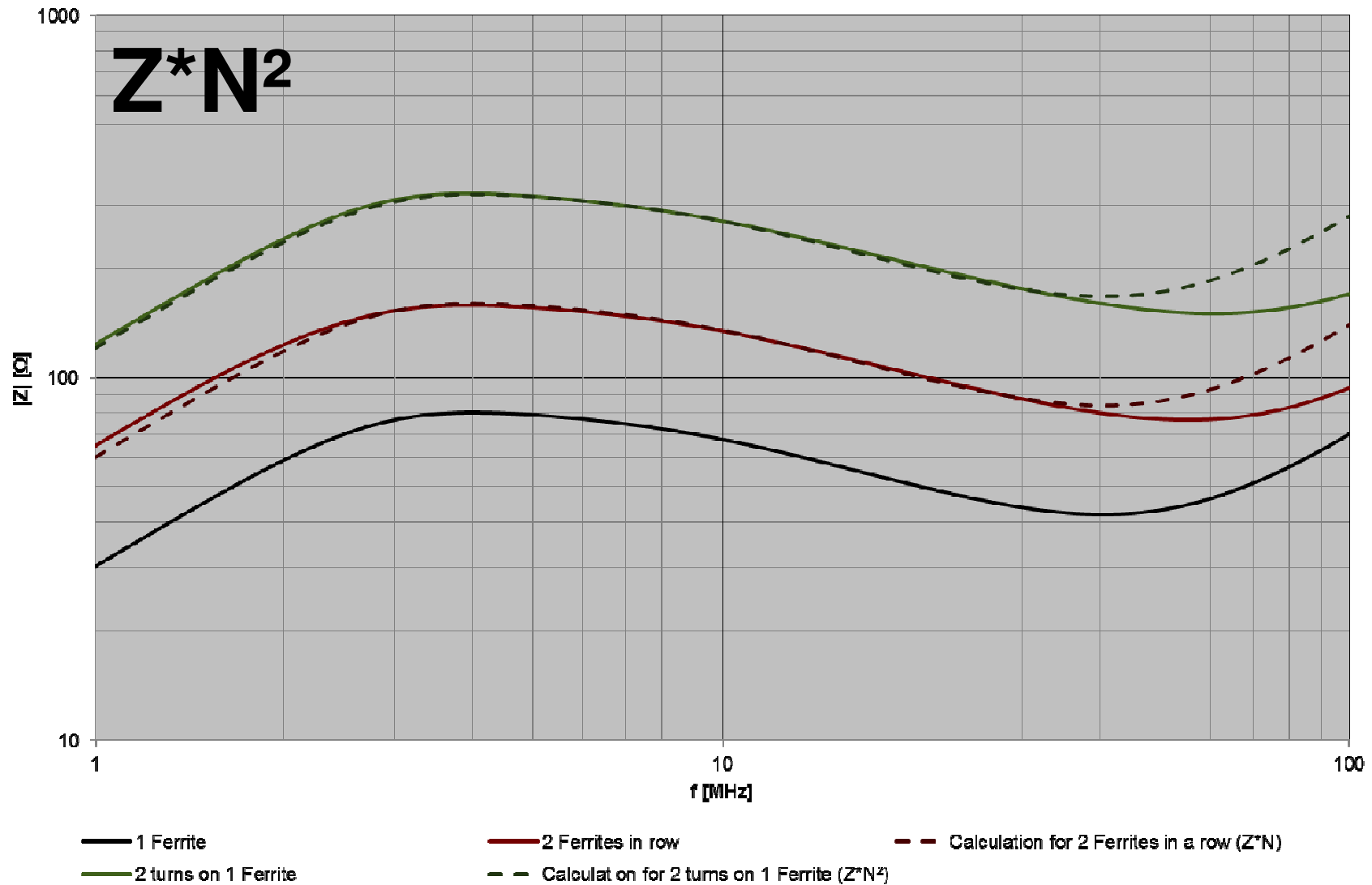
MnZn Ferrite 74272733 – 2 Ferrites in row



MnZn Ferrite 74272733 – 1 Ferrite 2 turns



MnZn Ferrite 74272733 – Comparison



Summarize

- CE certified equipment combined can't be considered as an new CE certified machine
- Ferrites can solve issues in both lower frequencies (MnZn) and high frequencies (NiZn)
- Ferrites will also increase immunity of the application
- Adding more turns and/or ferrites on a cable has a complex result

Trilogy of Magnetics

- Now published as 4th edition

- Three sections:

 - Magnetic basics

 - Components

 - Application notes

 - Filtering

 - DC/DC PSU design



Toolbox for engineers & purchasers



Software

- › Magnetic Builder
- › WEBENCH® Designer
- › Component Selector
- › LTspice Simulator



Search Tools

- › Application Guide
- › Product Finder - One Click Selection Guide
- › RF Product Finder
- › Product Matrix
- › Product & Application Overview Passive Components
- › Product & Application Overview Electromechanical Components
- › Crossreference
- › IC Reference Designs
- › Search Engine for Passive Components
- › Search Engine for Electromechanical Components



Libraries

- › Eagle library for Passive & Electromechanical Components
- › Altium Designer
- › S-Parameter
- › 3D Files for Passive Components (.igs .stp .wrl)
- › 3D Files for Connectors & Switches (.igs .stp .wrl)
- › LTspice library of WE components



e-learning

- › Product Training
- › Application Notes

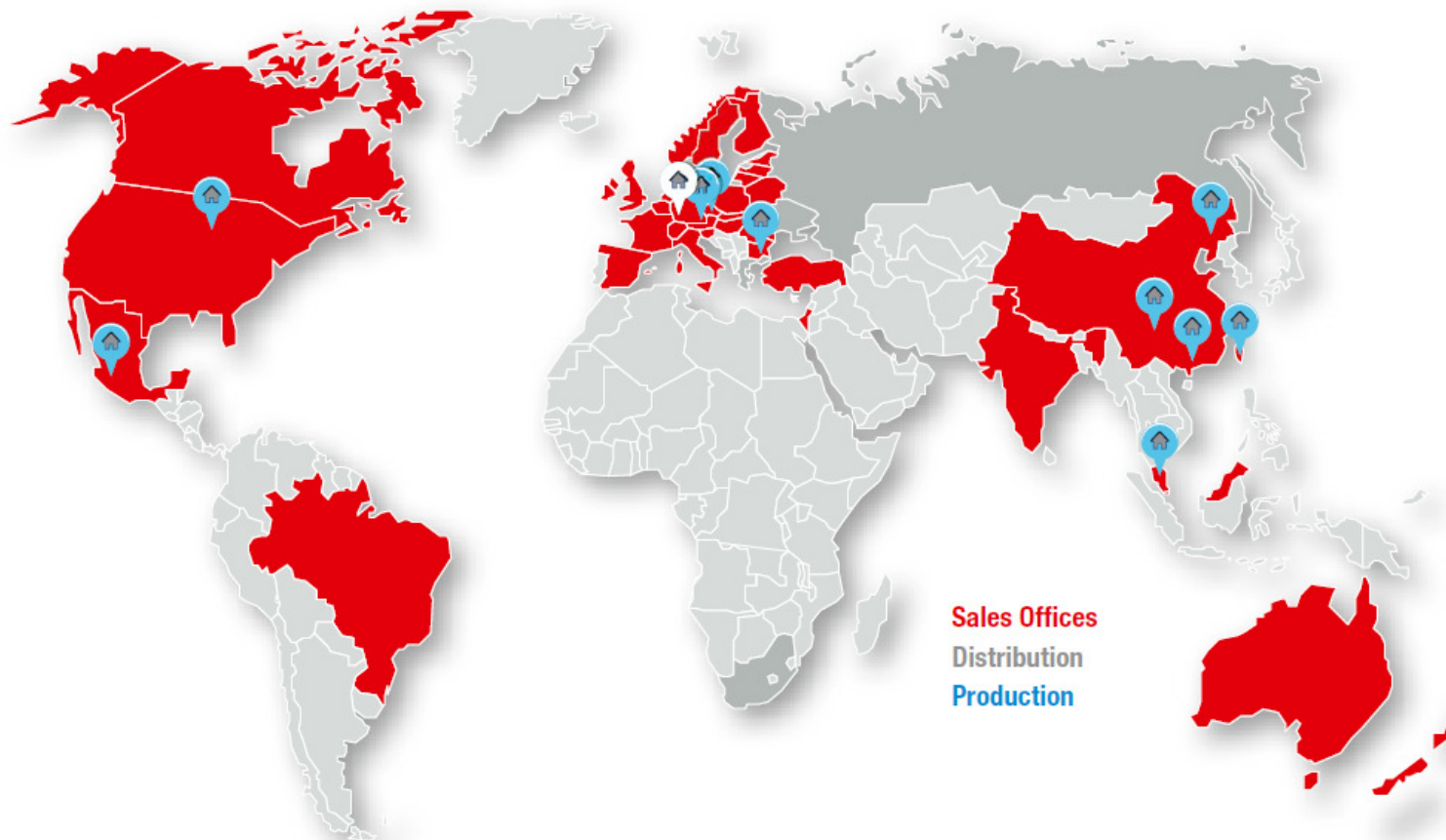


Lab rack & Design kits

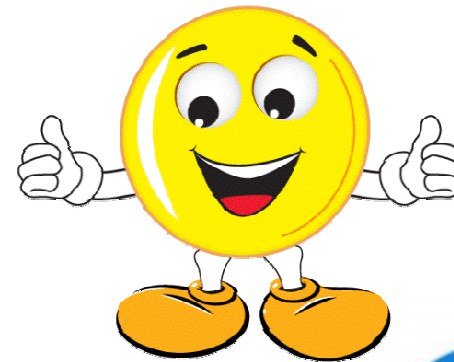


Globally available. Locally present.

Würth Elektronik is present with production plants and a worldwide technical sales force in all important markets of the world.



THANK YOU



Any Questions?

