DIY MAGNETIC NEAR FIELD PROBE & NANOCRYSTALLINE SHIELDING

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AGENDA

Contents

** Some presentation images have clickable web links*

- **DIY Magnetic Near Field Probe (NFP)**
  - Workshop overview.
  - Theory.
  - Tools and materials.
  - Procedure.
- **Testing**
  - Setup and measurements.
  - Reduce the noise with some shielding sheets.
  - PCB Troubleshooting Tips.
- **Nanocrystalline**
  - WE-FNCS.
- **WE Shielding Portfolio**

DIY MAGNETIC NEAR FIELD PROBE (NFP)

DIY MAGNETIC NEAR FIELD PROBE

Workshop Overview

- Everyone can make their own DIY Near Field Probe (NFP).
- Components and tools are provided.
- We have a test setup, where participants can try their DIY NFP if it is working.
- First 5 participants who can finish and properly detect the expected noise waveform will win prizes.

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DIY MAGNETIC NEAR FIELD PROBE

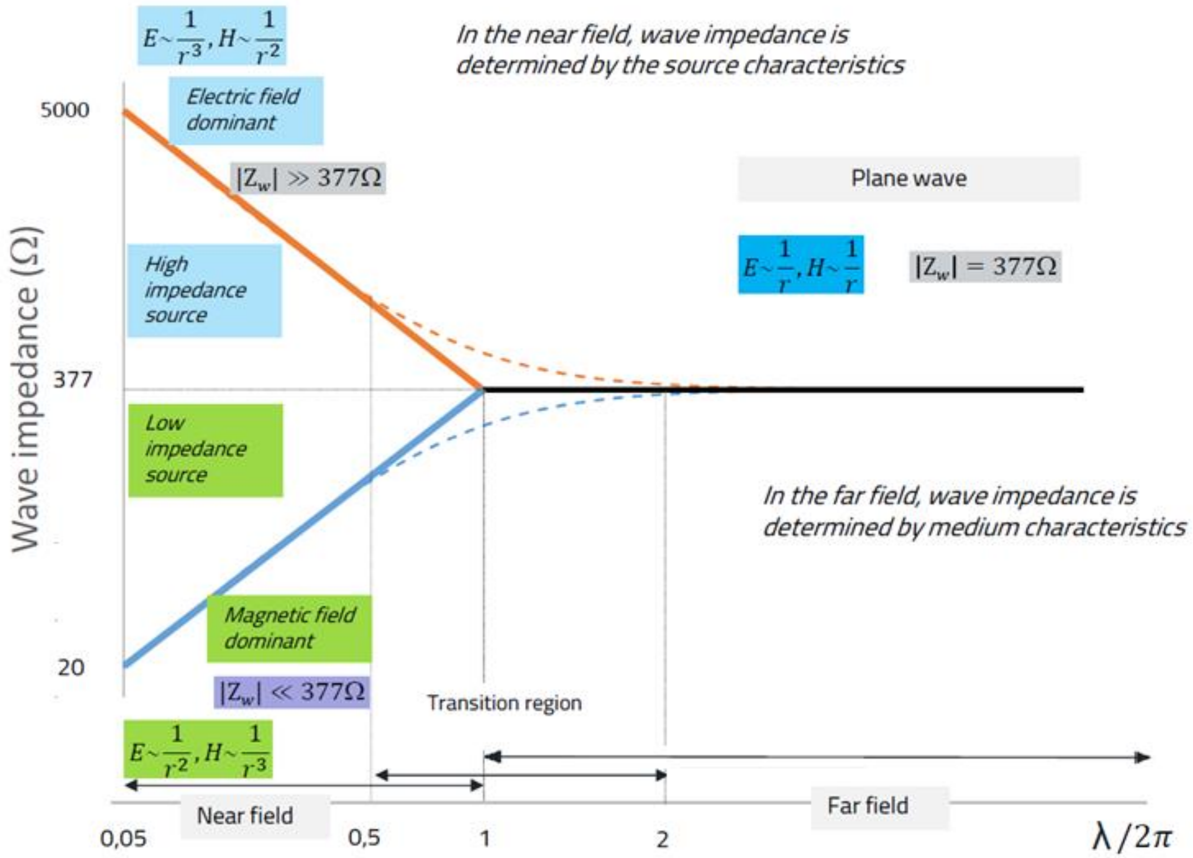
Theory

- Near Field Probes (NFP) are used to sniff out potential EMI issue on your PCB and circuits.
- The Magnetic Near Field Probe respond primary to magnetic field as opposed to an Electric Near Field Probe, which response to electric field.
- Magnetic NFP responds to changing current which creates the magnetic field. Electric NFP responds to switching voltages which creates electric field.
- The magnetic NFP will be shielded by the outer coaxial cable metal covering to minimize picking up of electric field.
- Magnetic NFP is sensitive to the orientation of how the loop is placed in reference to the plane. It responds to the current in the same plane as the loop.

DIY MAGNETIC NEAR FIELD PROBE

Theory

- As the name implies, the Magnetic Near Field Probe works in the near field as opposed to the far field.



https://interferencetechnology.com/classical-shielding-theory-vs-near-field-measurements/

Wave Impedance = $Z_W = \frac{E}{H}$

Far Field $= \sqrt{(\mu_0/\varepsilon_0)} = 377\Omega$

$\mu_0 \approx 12.566 \times 10^{-7}$ H/m is the magnetic constant, also known as the permeability of free space,

$\varepsilon_0 \approx 8.854 \times 10^{-12}$ F/m is the electric constant, also known as the permittivity of free space,

Near Field:

Source Impedance:

$Z_W > 377\Omega$ -> Large voltage changes, small current change
-> Pick up by electric near field probe

$Z_W < 377\Omega$ -> Large current changes, small voltage changes
-> Pick up by magnetic near field probe

DIY MAGNETIC NEAR FIELD PROBE

Materials

- SMA straight plug coaxial cable – 65503503530507 or alike
- Heat shrink tube - 71204811 to cover exposed conductive areas.
- Optional materials:
  - Cable ferrite – WE-SAFB series like 74270023
  - Heat shrink tube with bigger diameter like 71232011
  - PVC insulating tape

DIY MAGNETIC NEAR FIELD PROBE

Tools

DIY MAGNETIC NEAR FIELD PROBE

Tools

DIY MAGNETIC NEAR FIELD PROBE

Procedure

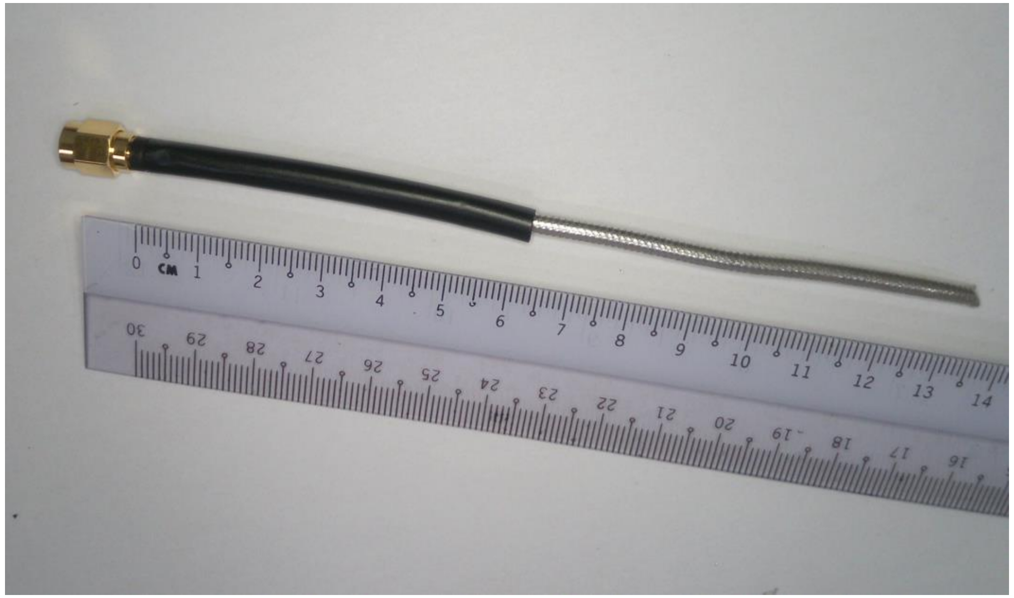
Get the SMA cable connector and cut it having **at least 13-15 cm**. Only one side is needed.

Cut around 6cm of Heat Shrink tube (71204811)

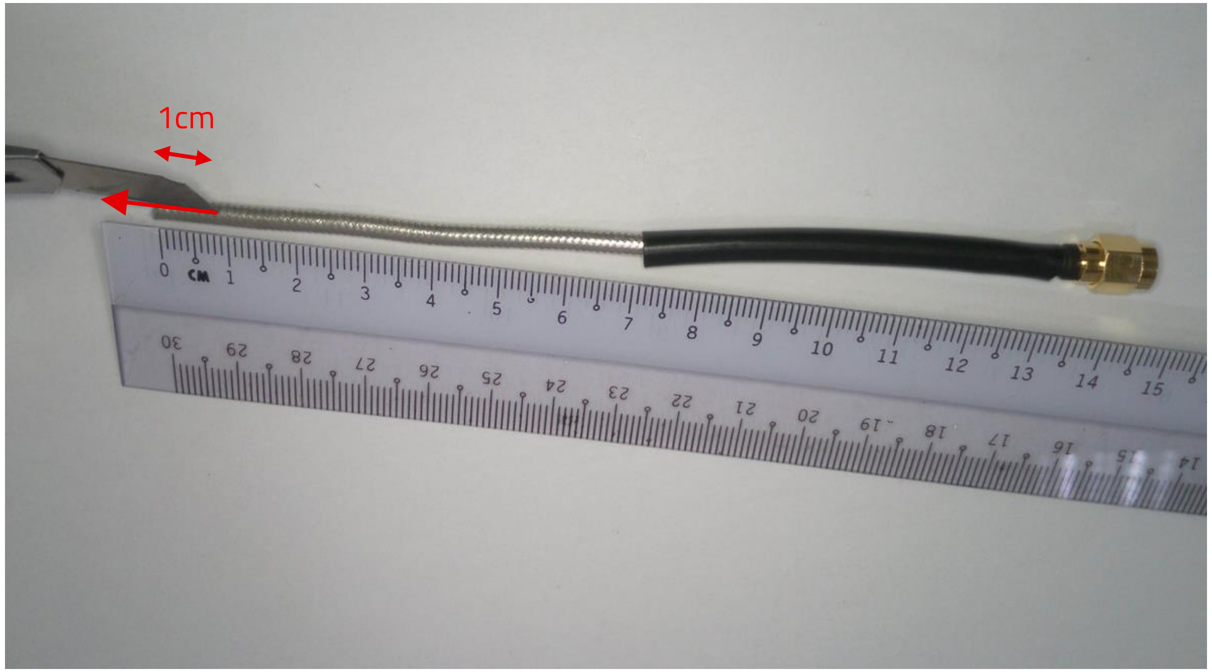
DIY MAGNETIC NEAR FIELD PROBE

Procedure

Put the 6cm heat shrink tube (71204811) through the cable as shown below.



Cut around 1 cm along the outer shielding at the cable tip at both side.

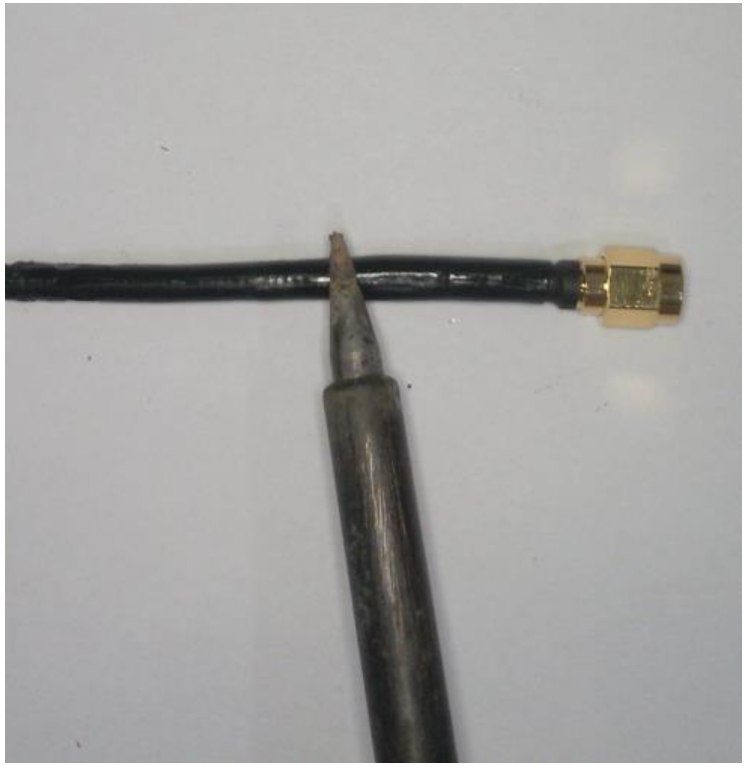


Note: Do not cut too deep into the plastic insulation.
Just cut enough to peel back the outer metal shielding.

DIY MAGNETIC NEAR FIELD PROBE

Procedure

Shrink down the heat shrink tube with a solder iron.



DIY MAGNETIC NEAR FIELD PROBE

Procedure

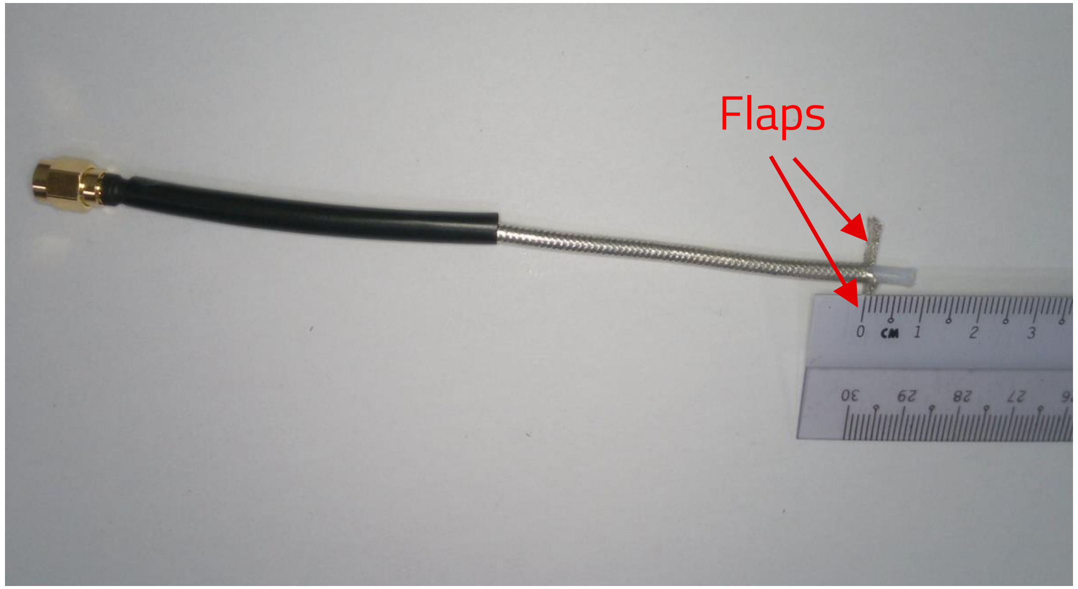
Slip in the 3 cable ferrites as shown below

Adding cable ferrite(s) to a near field probe serves to reduce high-frequency noise coupling directly into the cable.

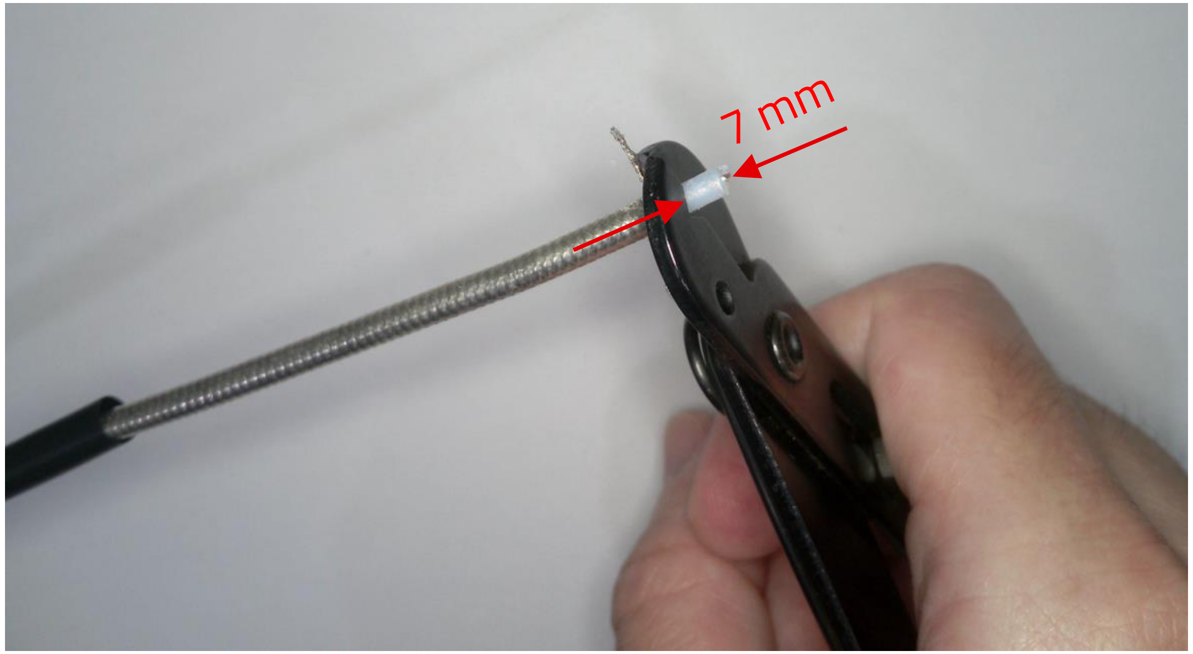
DIY MAGNETIC NEAR FIELD PROBE

Procedure

Peel back both side of the outer metal shielding as shown by 1cm from the end tip to form 2 flaps.



Strip the plastic insulation off (around 7mm) at the end tip of the cable as shown below to expose the inner core wire.



DIY MAGNETIC NEAR FIELD PROBE

Procedure

Exposed core wire (around 7mm) after stripping off the plastic insulation.

Bend the exposed core wire with a plier and flatten it against the cable.

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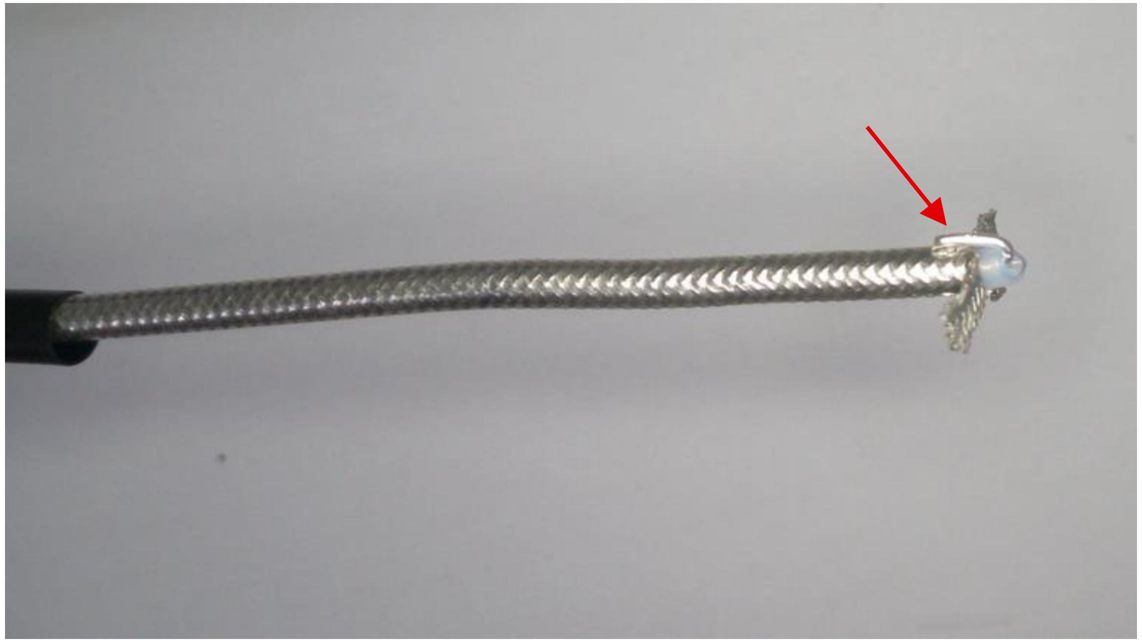
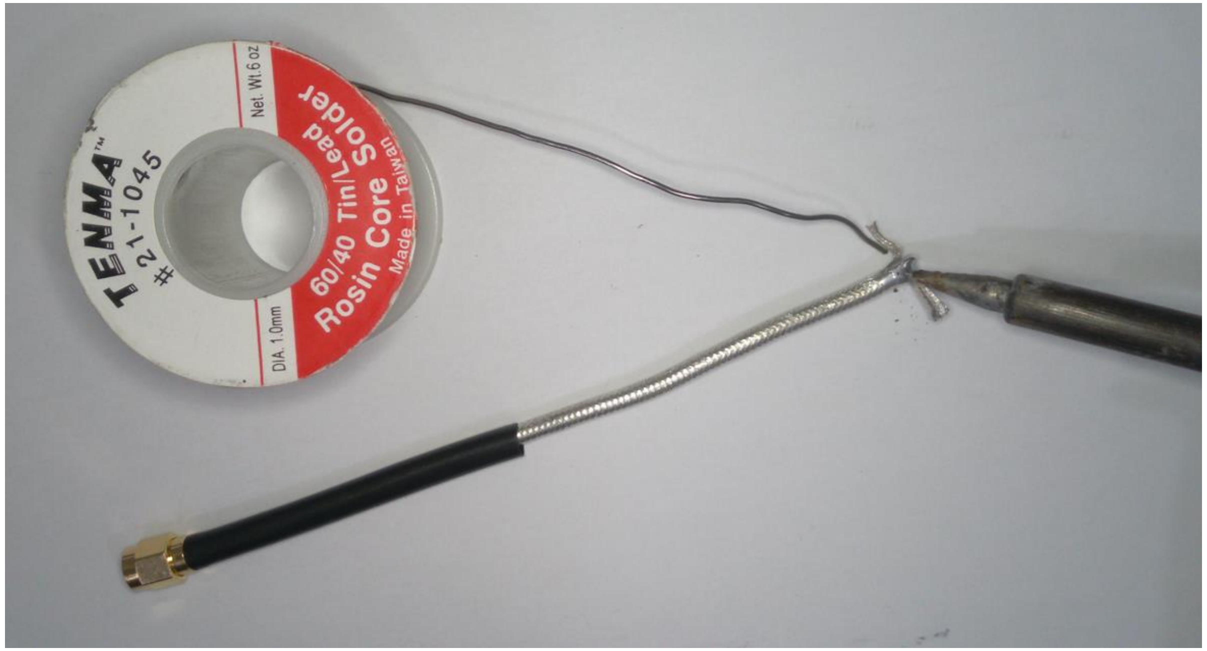
DIY MAGNETIC NEAR FIELD PROBE

Procedure

Core wire flattened against the cable.

Solder the bended core wire tip to the metal shielding of the cable body.





DIY MAGNETIC NEAR FIELD PROBE

Procedure

The core wire tip soldered to the cable's metal shielding body.

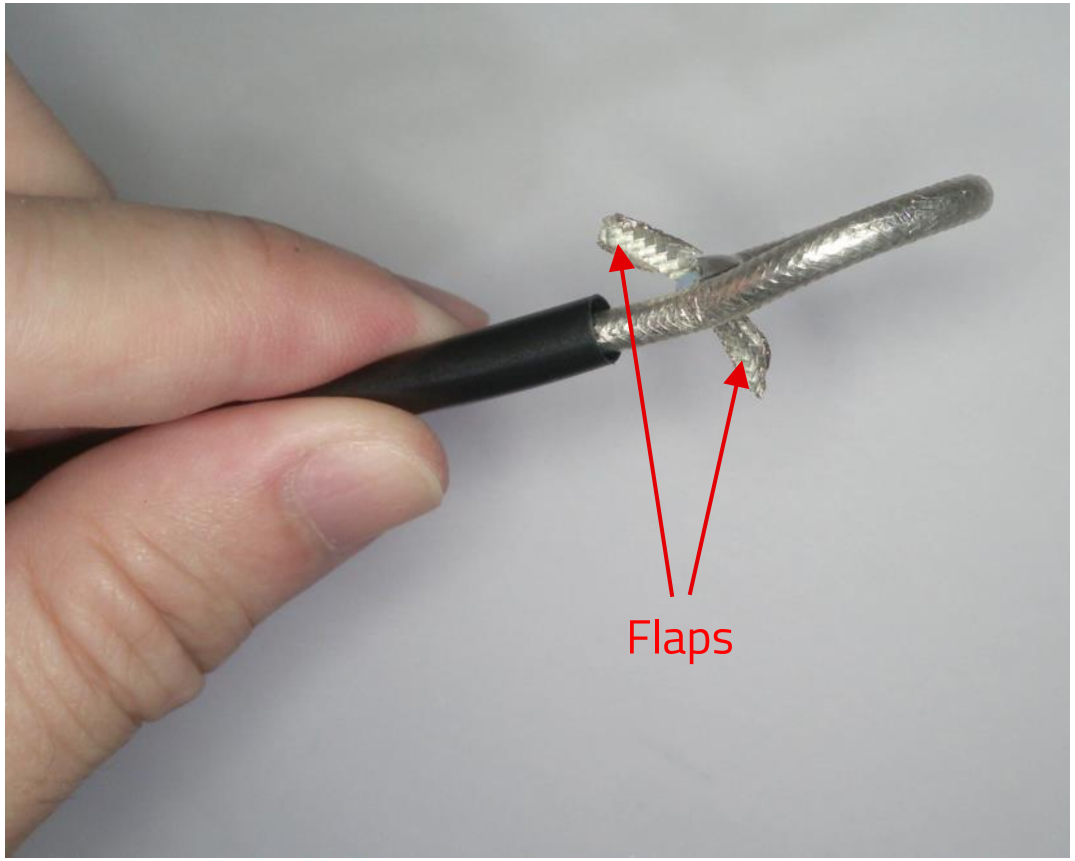
Make a loop at the end of the cable around your finger as shown.

DIY MAGNETIC NEAR FIELD PROBE

Procedure

Make the loop with an internal diameter of around 2cm.

Wrap the 2 metal shielding flaps down and around the cable.



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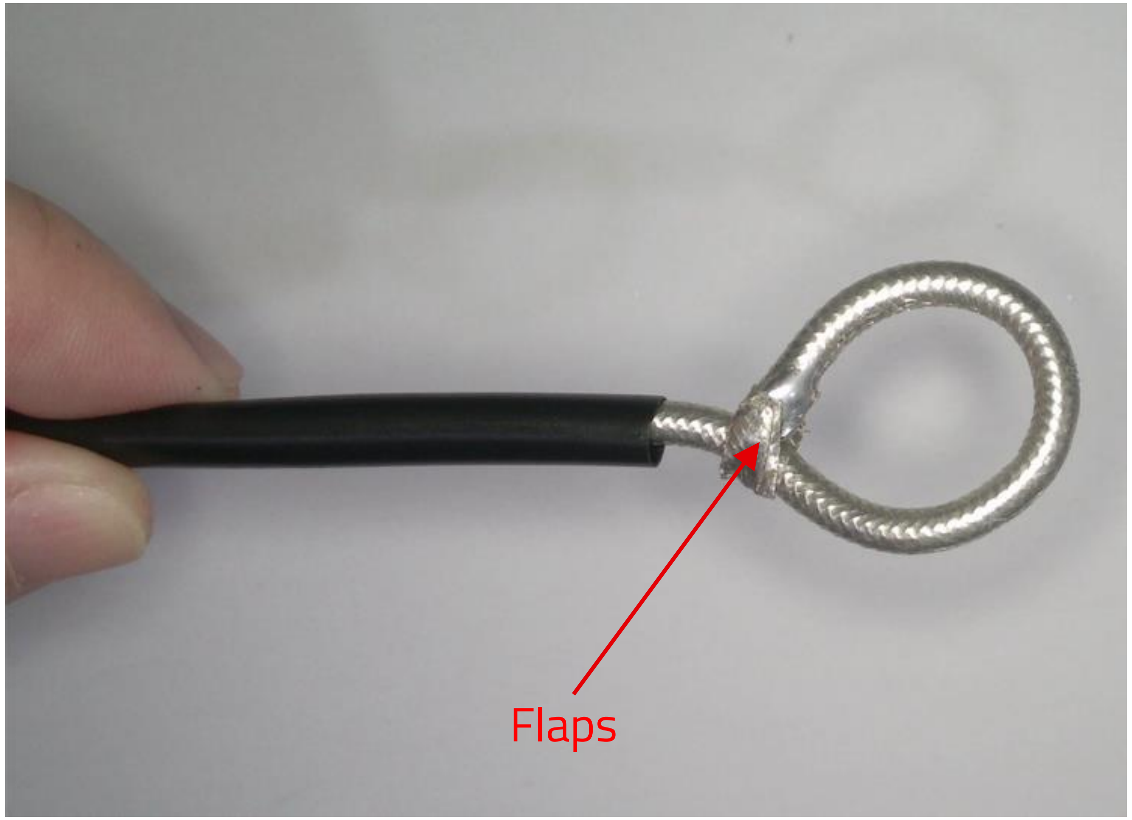
DIY MAGNETIC NEAR FIELD PROBE

Procedure

Make sure the 2 flaps are wrapped around the cable.

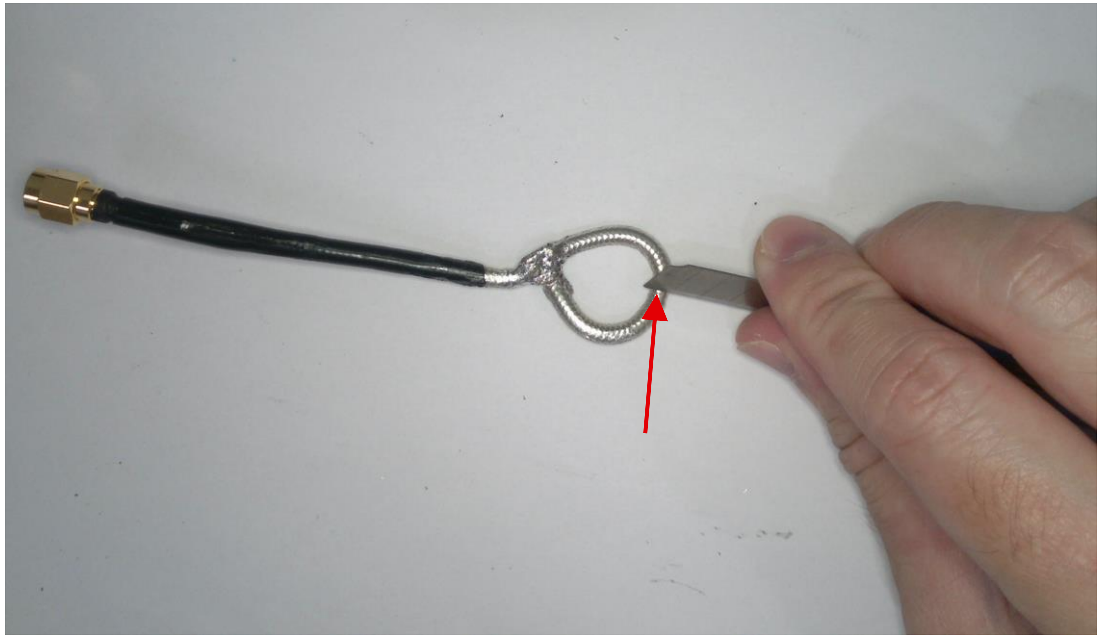


Solder the 2 flaps completely to the cable shielding, make sure there are no gaps or holes.

DIY MAGNETIC NEAR FIELD PROBE

Procedure

Cut a small (1mm width) groove at the top center of the loop.



You can make use of a cutter to help you to grind a groove.

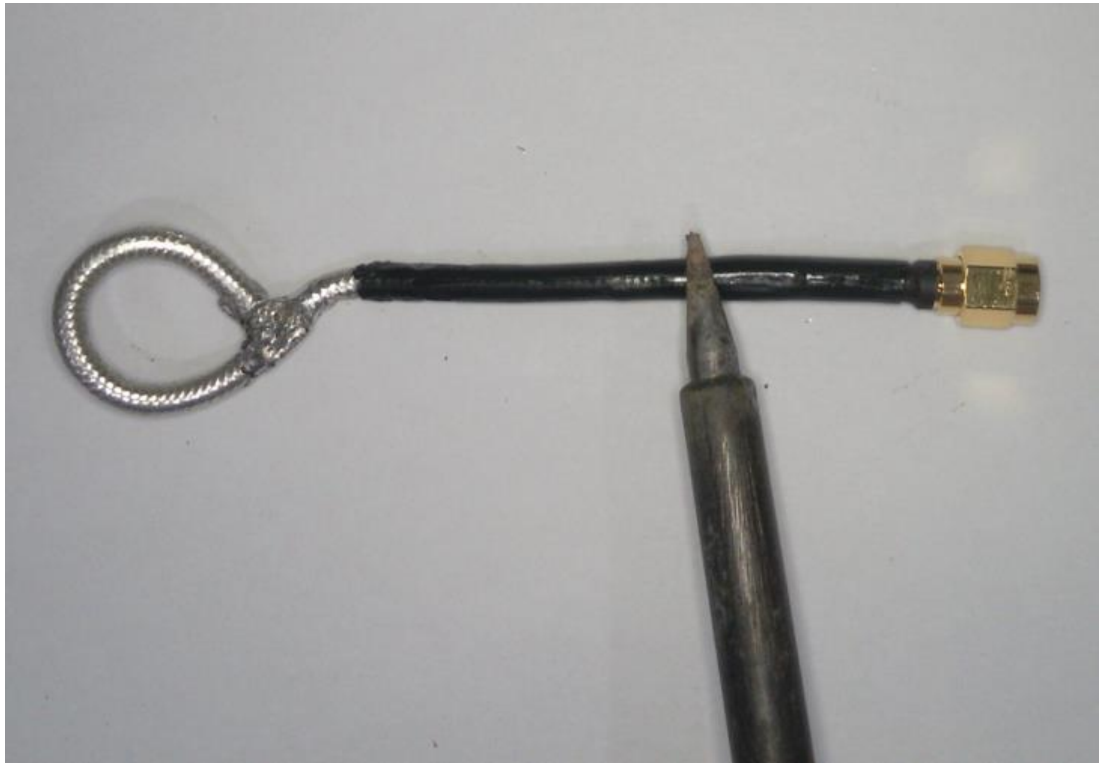
Note: Take great care not cut too deep into the plastic insulation. Just cut enough to form an exposed groove at the outer metal shielding.

DIY MAGNETIC NEAR FIELD PROBE

Procedure

1mm width groove at the top center of the loop exposing the plastic insulator.

Shrink down the heat shrink tube with a solder iron.

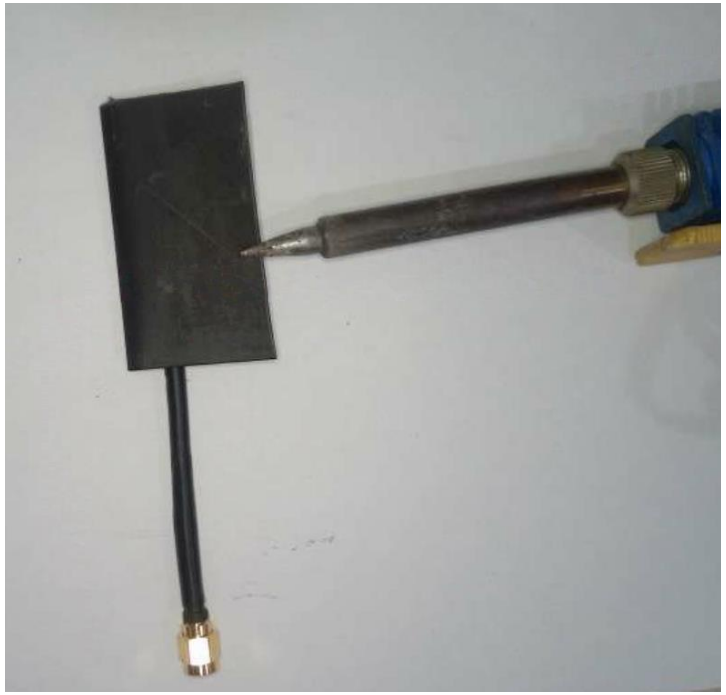


DIY MAGNETIC NEAR FIELD PROBE

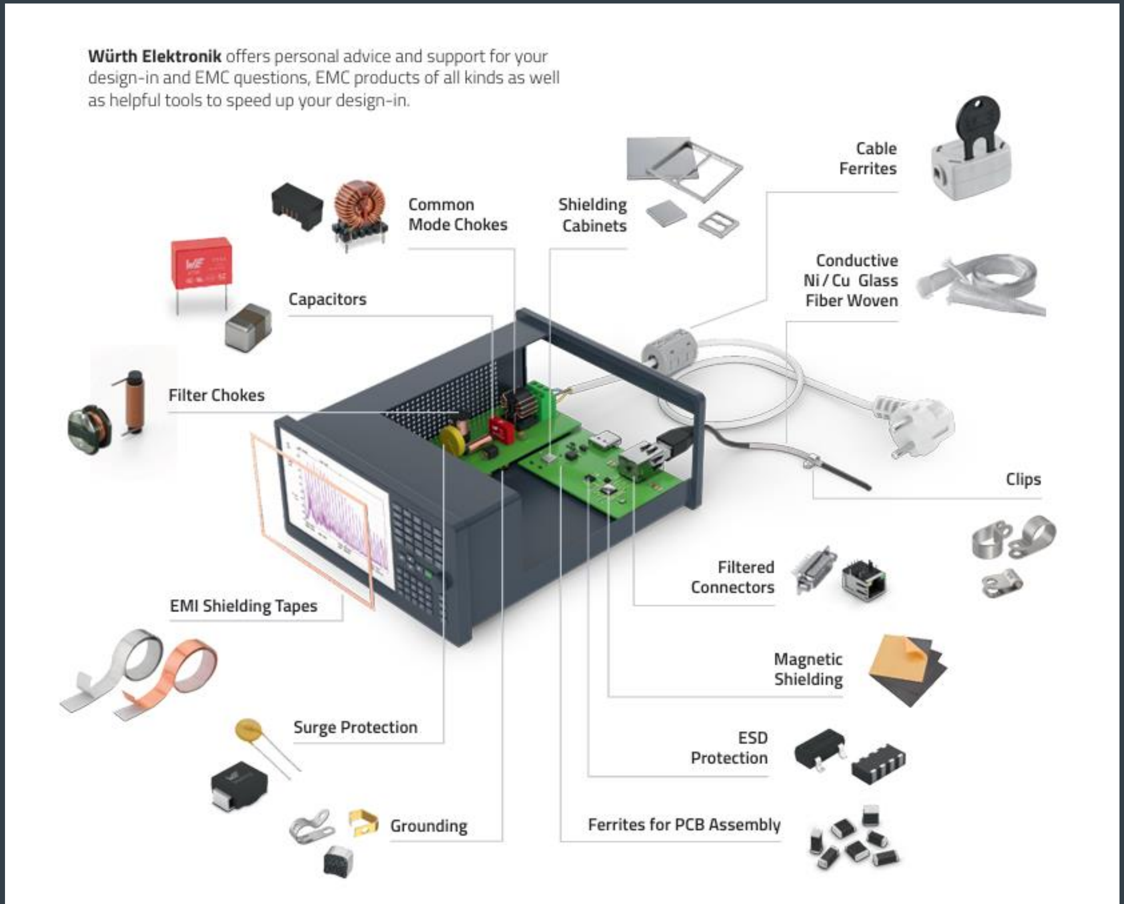
Procedure – Optional Materials

Adding PVC insulation tape to wrap around the conductive loop.

Insulation of the probe:
Cut about 6cm using a thick heat shrink tube like the 71232011. And slip it into the loop end.
Shrink down the heat shrink tube with a solder iron.



TESTING



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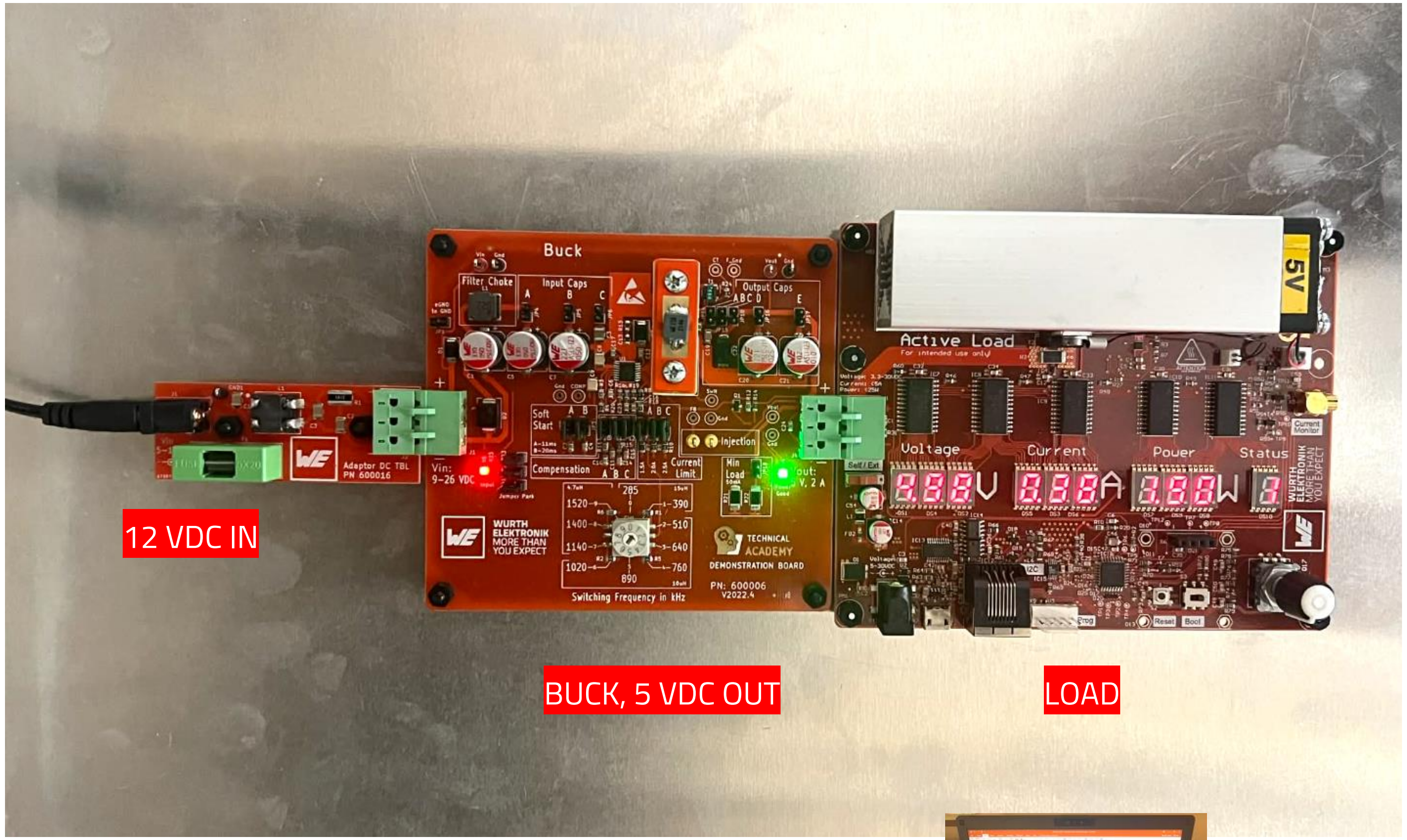
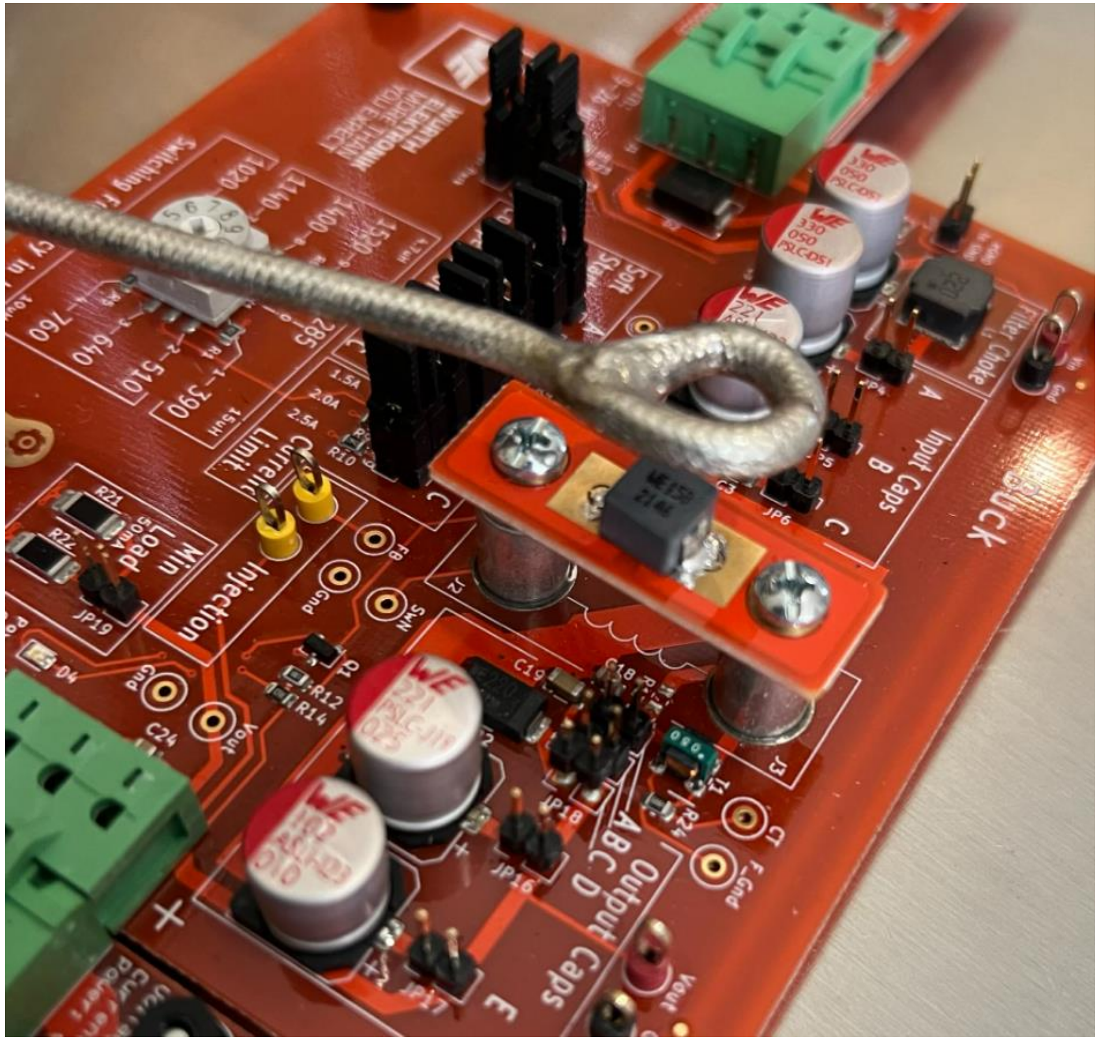
TESTING

Setup

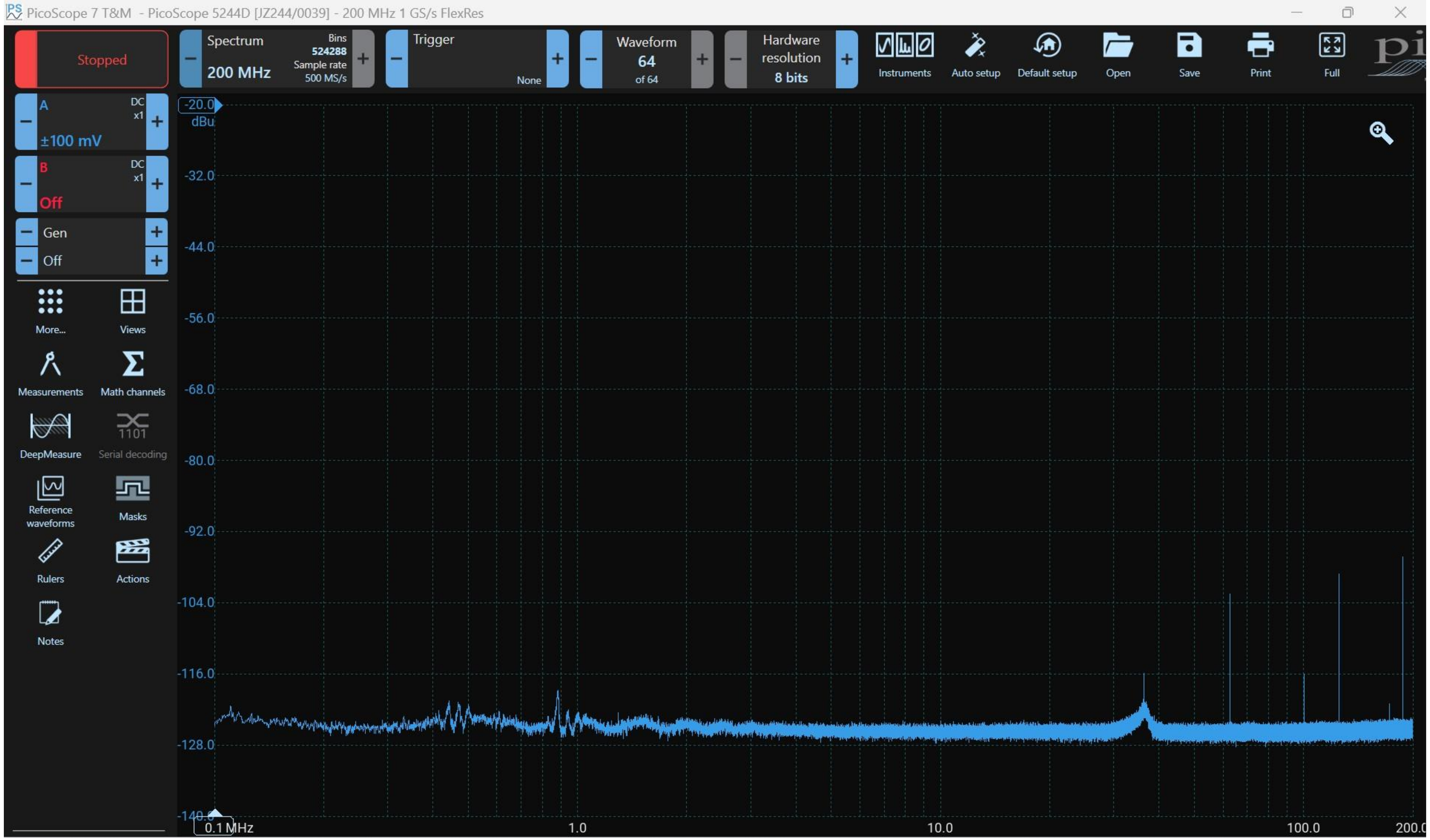


- FAE Demo Kit
- Picoscope and computer app
- DIY Near Field Probe
- Some magnetic shielding sheets



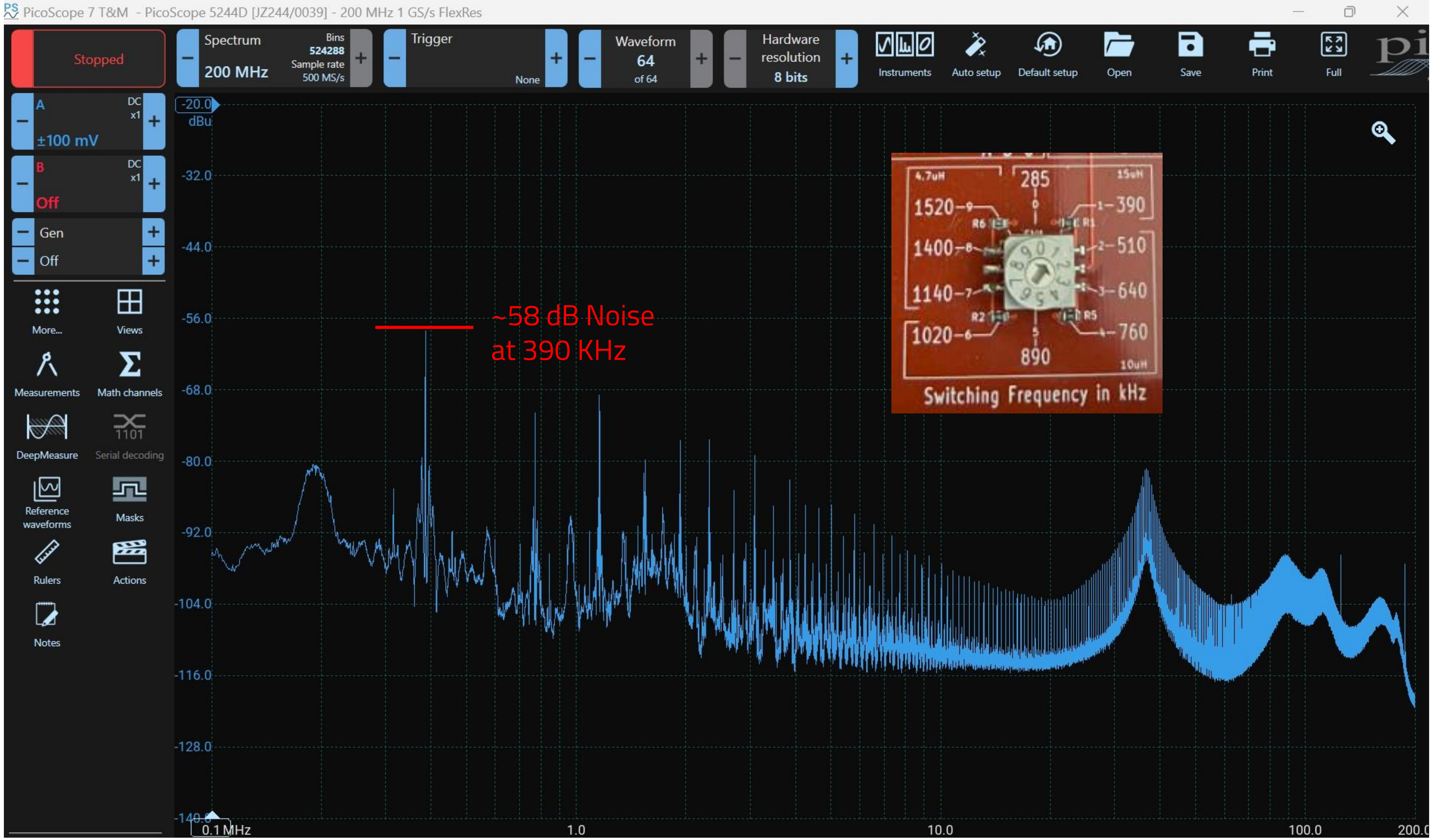
TESTING

Measurement - Noise Floor



TESTING

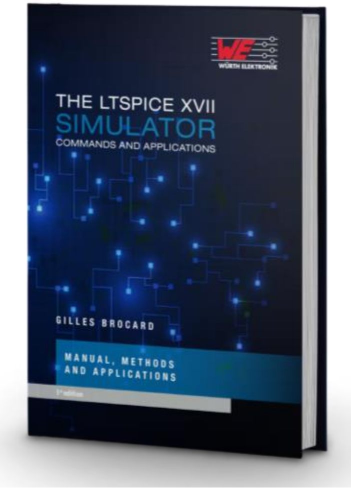
Measurement - No Shielding

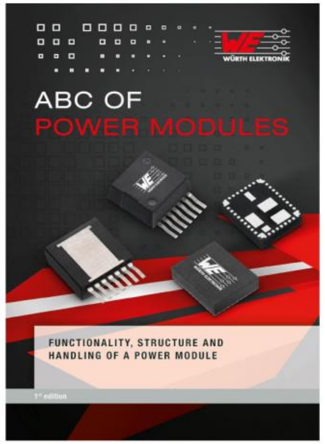


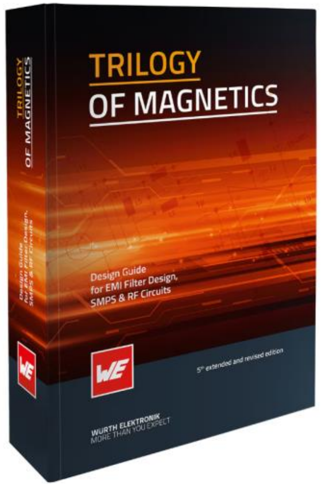
TESTING

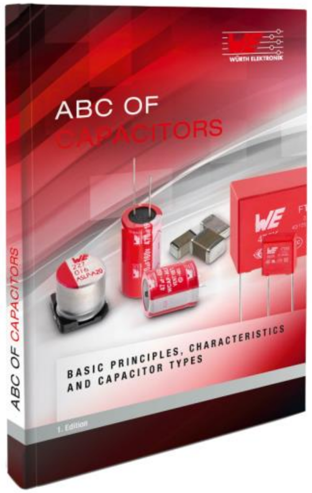
Reference guides for the winning participants

1) Shielding
2) Connectors
3) Capacitors
4) Magnetics
5) DC-DC Converters
6) Wireless Power Transfer
7) Power Modules
8) LT Spice



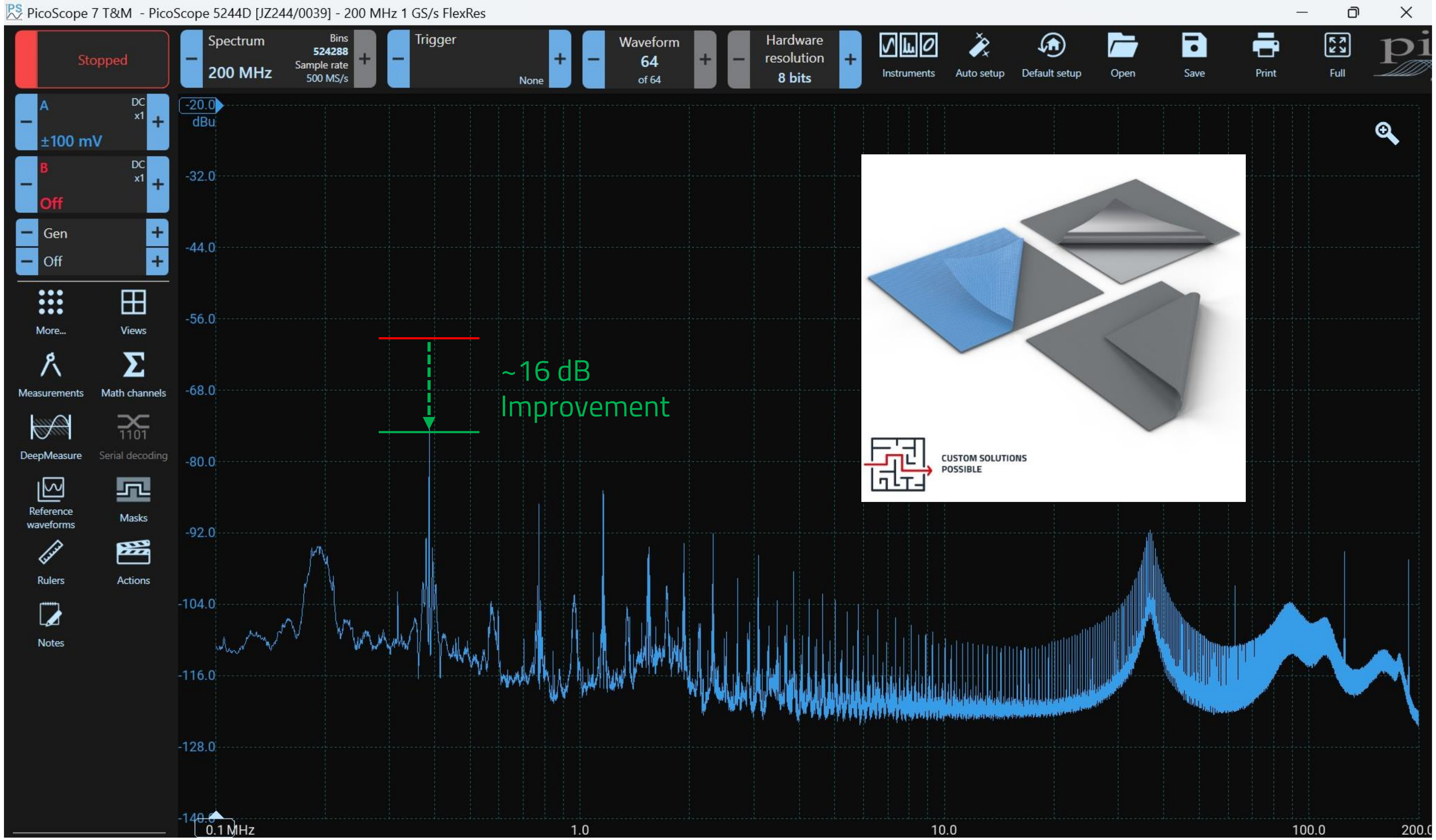






TESTING

Measurement - WE-FAS Flexible Absorber Sheet: 34411A7

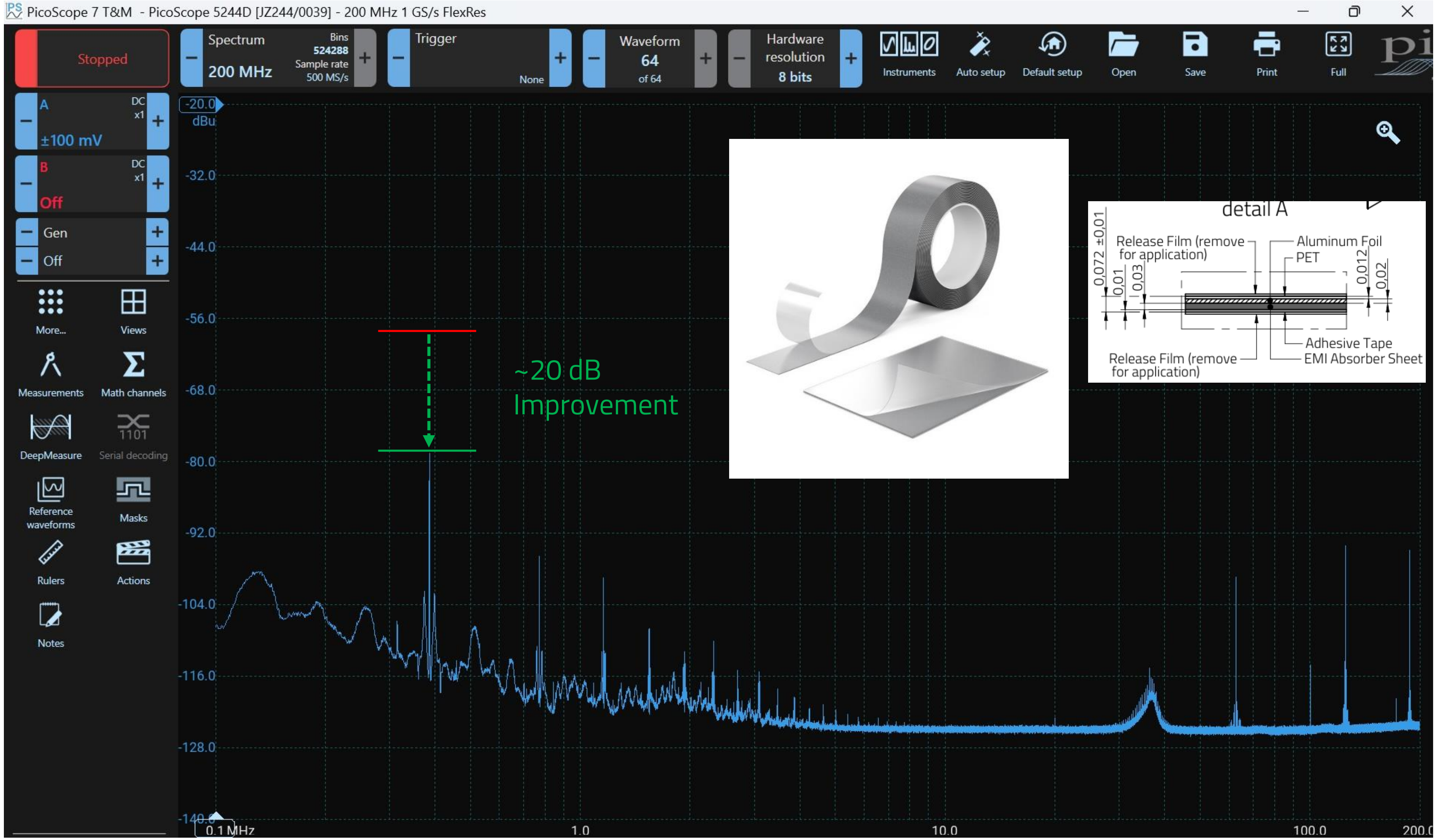


WE-FAS Characteristics

- Customizable for dimensions & form.
- Wide range working temperature of -40 up to +160 °C.
- Wide frequency range 1 MHz up to 10 GHz
- High surface resistance & High permeability.
- Extremely flexible
- Thickness available from 0.05 mm to 30 mm.
- Adhesive surface for easy installation.
- Easy to process
- Thermal conductive interface with conductivity values up to 1.4 W/mK
- Free samples.

TESTING

Measurement - WE-EMIP EMI Patch: 371101

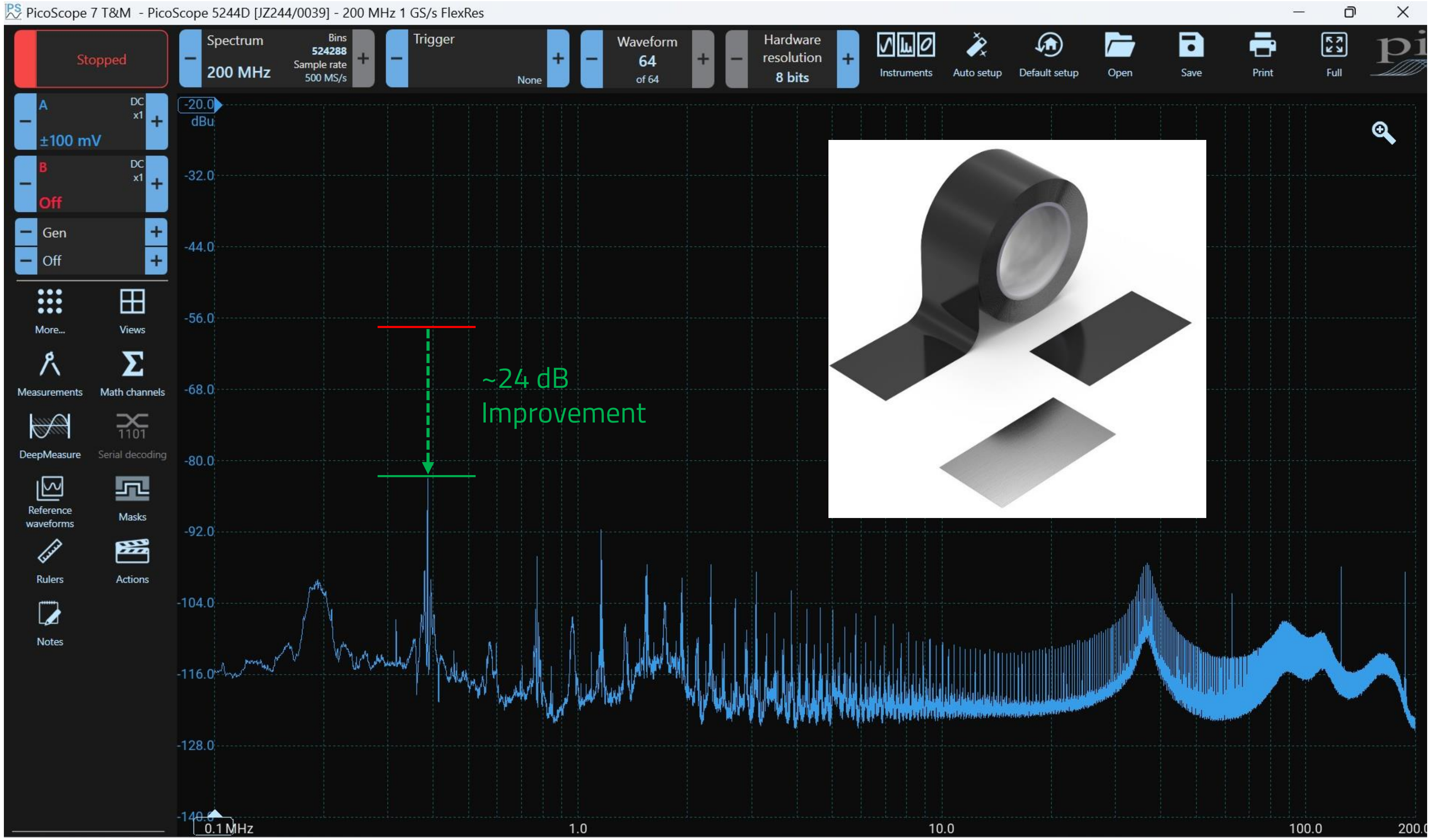


WE-EMIP Characteristics

- Hybrid material with absorber and metal layers, effective both against magnetic and electric fields
- Wide frequency range from 100 Hz up to 25 GHz
- Extremely flexible
- Very low thickness: 0.072 mm
- Isolated version with high surface resistance
- Non-isolated version which allows the connection of the metal layer to ground, housing,...
- With self-adhesive backing for easy installation
- Absorber layer with permeability of 100
- Metal layer: Aluminum
- Operating temperature: -25 up to +105°C
- Easy to process
- Custom designs on request
  - Permeability
  - Shape and size
  - Metal layer
  - Thickness
  - Isolation
  - Adhesive.

TESTING

WE-FNCS Flexible Nanocrystalline Sheets: 353012

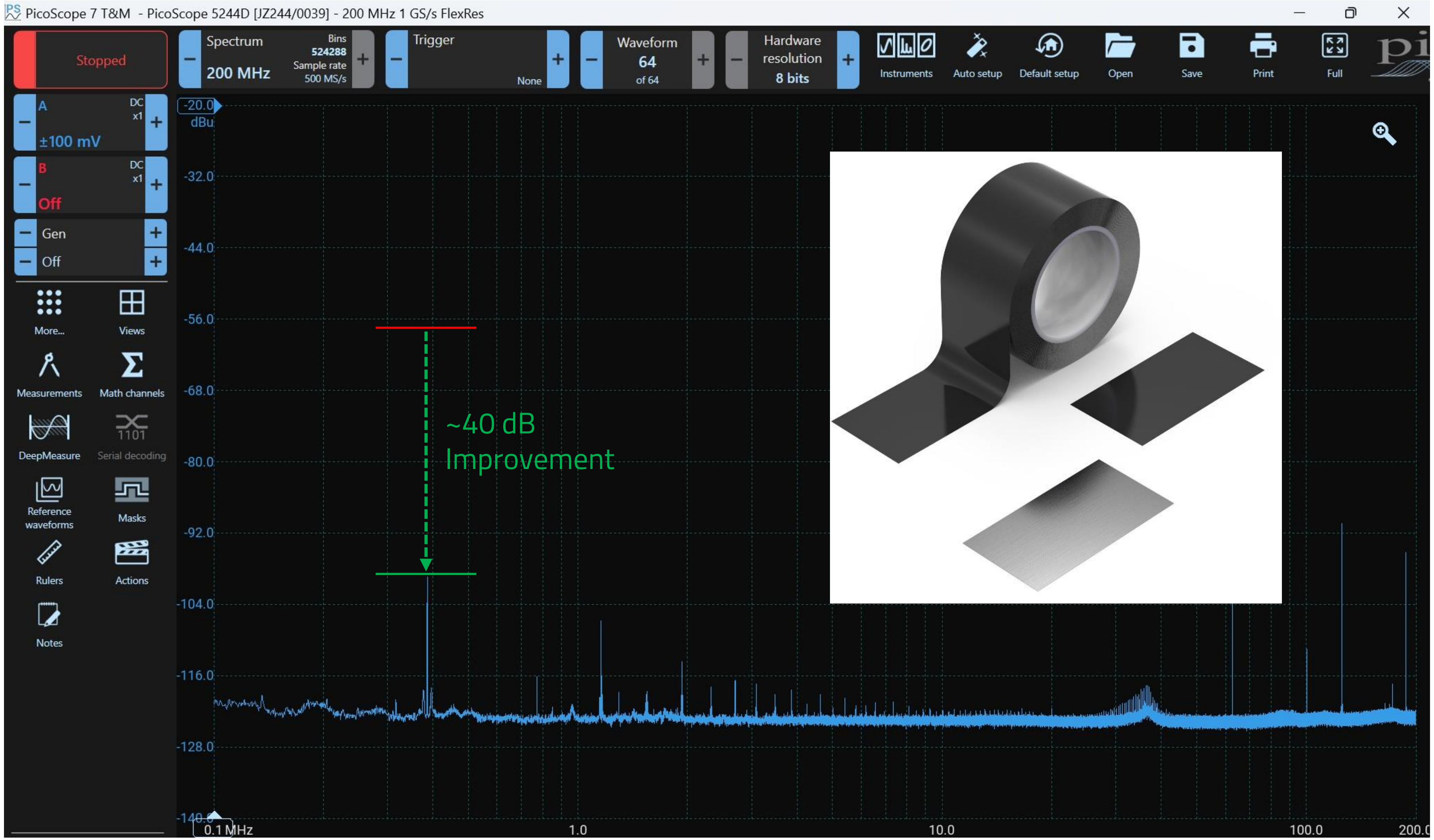


WE-FNCS Characteristics

- Cost-effective solution as an alternative to mu-metal alloys for low frequency (LF) magnetic field applications
- Customizable: Length, width, thickness, shape and permeability
- Extremely flexible and thin
- Easy placement and handling thanks to standard adhesive backing
- High surface resistance
- Easy to process
- Maximum dimensions available: Length: 100 m (on roll), width: 65 mm (as the standard parts), thickness: 0.3 mm (12 nanocrystalline layers stacked)
- Custom designs under request
- Operating temperature: -40°C up to 85°C

TESTING

WE-FNCS Flexible Nanocrystalline Sheets: 353020



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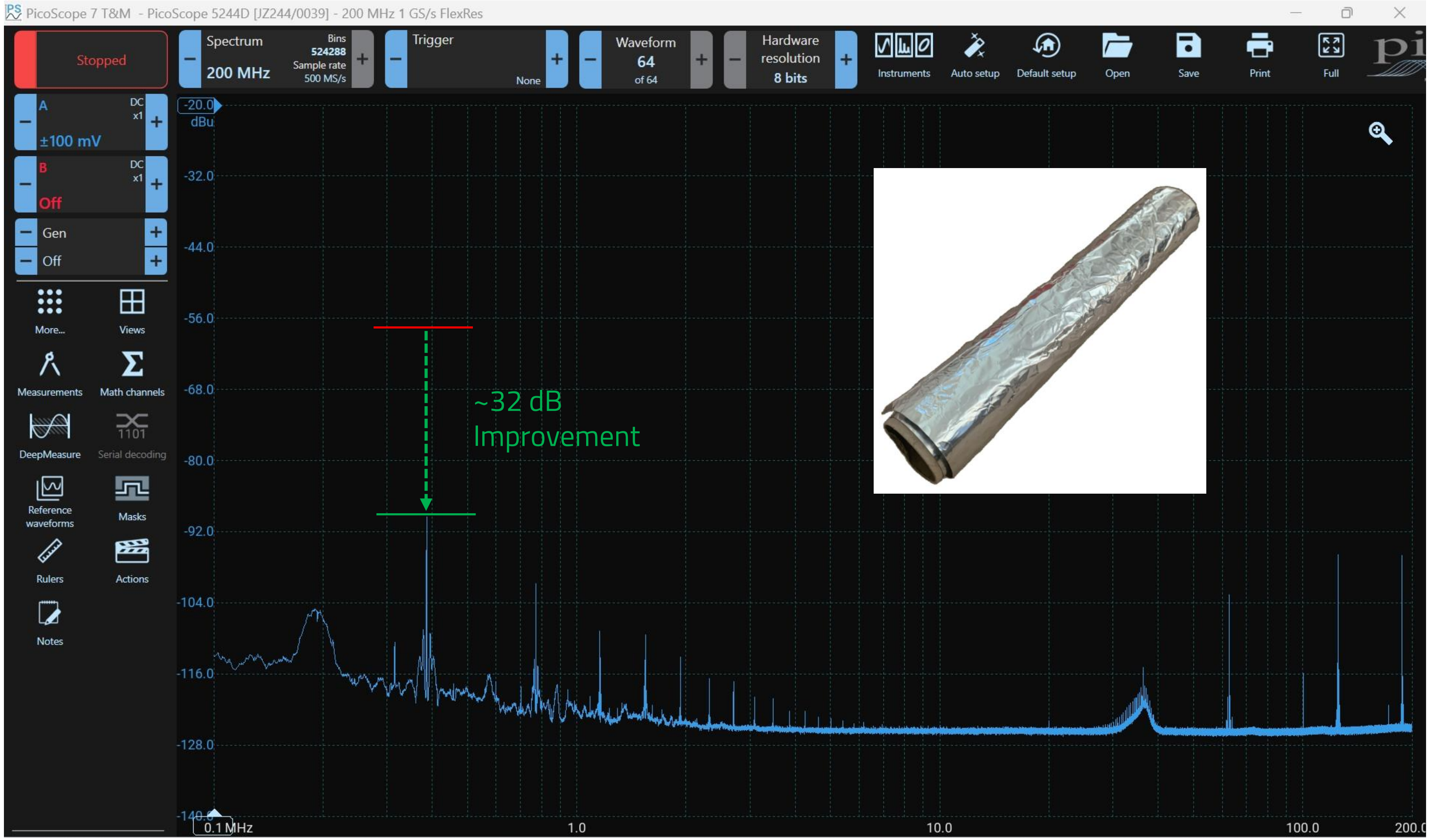
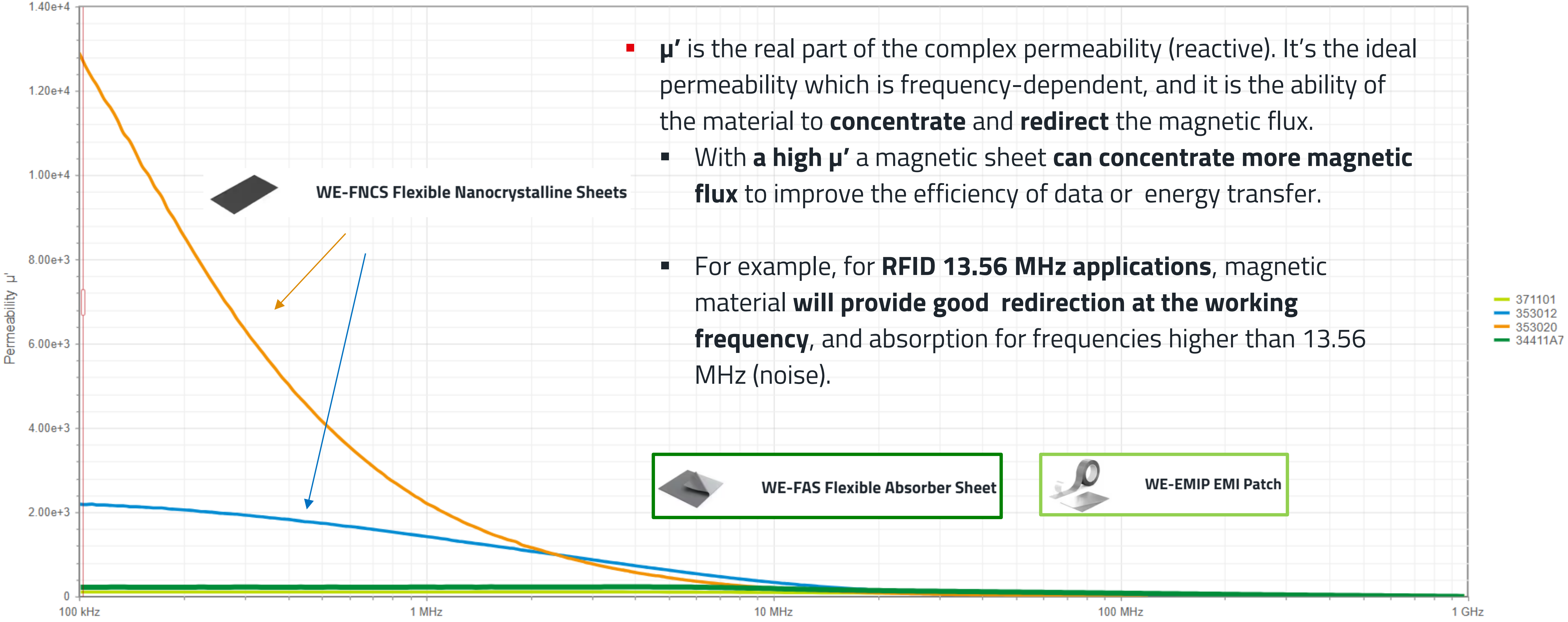
TESTING

Aluminum Foil



SHIELDING

Permeability μ': FAS EMI vs. EMIP vs. FCNS



- **μ'** is the real part of the complex permeability (reactive). It's the ideal permeability which is frequency-dependent, and it is the ability of the material to **concentrate** and **redirect** the magnetic flux.
  - With **a high μ'** a magnetic sheet **can concentrate more magnetic flux** to improve the efficiency of data or energy transfer.
  - For example, for **RFID 13.56 MHz applications**, magnetic material **will provide good redirection at the working frequency**, and absorption for frequencies higher than 13.56 MHz (noise).

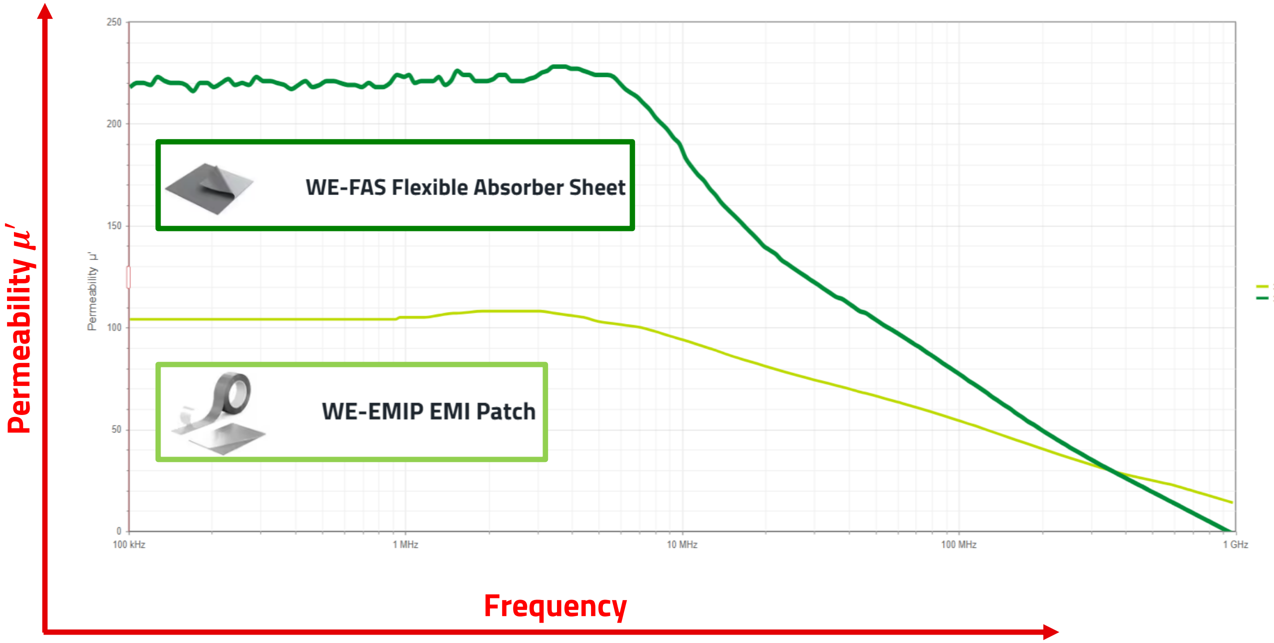
SHIELDING

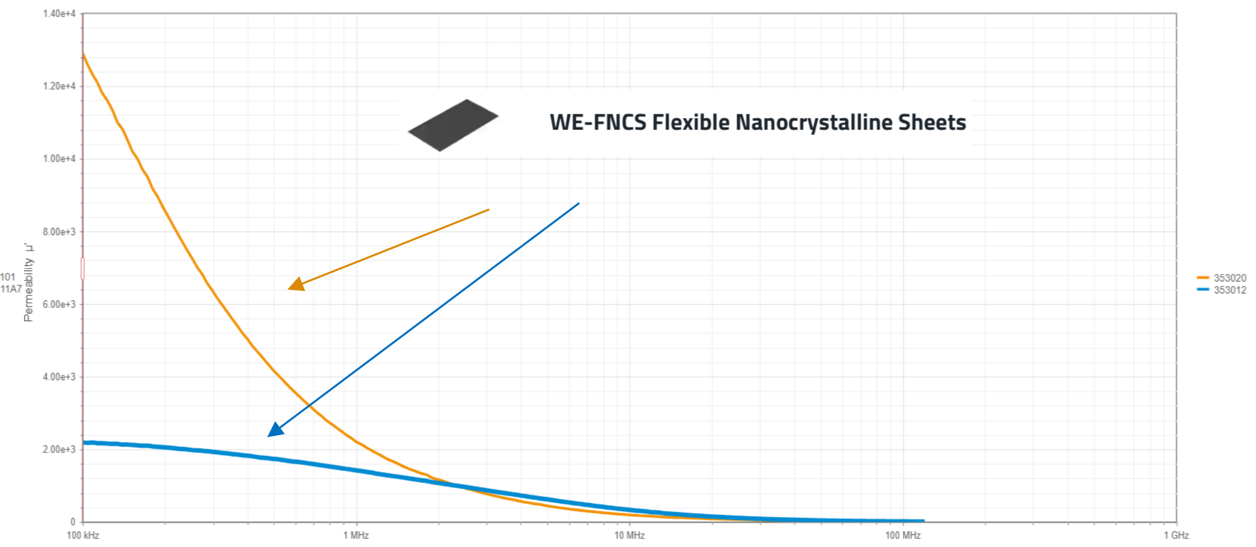
Permeability μ’: FAS EMI vs. EMIP vs. FCNS

WÜRTH ELEKTRONIK | REDEXPERT | Magnetic Shielding | Menu

Filters: Order Code ∋ 371001, 353020, 34411a7, 371101 — 4 items

	Order Code	Series	Spec	L	W	Thick...	Surface Resistance	Shielding E...	Peel ...	Ther...	μ' @ 13.56 MHz	μ' @ 1 MHz	μ'' @ 13.56 MHz	μ'' @ 1 MHz	Adhe...
✔	34411A7	WE-FAS EMI	PDF	74.000 mm	105 mm	0.1000 mm	1.00e+7 Ω/cm2		400 N/cm		163	218	70.3	0.0100	0.0300 mm
✔	353020	WE-FNCS	PDF	120.00 mm	65.0 mm	0.06000 ...	1.00e+7 Ω/cm2				137	2.21e+3	556	3.60e+3	0.0100 mm
✔	371001	WE-EMIP	PDF	105.00 mm	74.0 mm	0.07200 ...	0.00200 Ω/cm2		400 N/cm		87.6	100	9.72	0.0100	0.0100 mm
✔	371101	WE-EMIP	PDF	105.00 mm	74.0 mm	0.07200 ...	1.00e+8 Ω/cm2		400 N/cm		87.6	100	9.72	0.0100	0.0100 mm

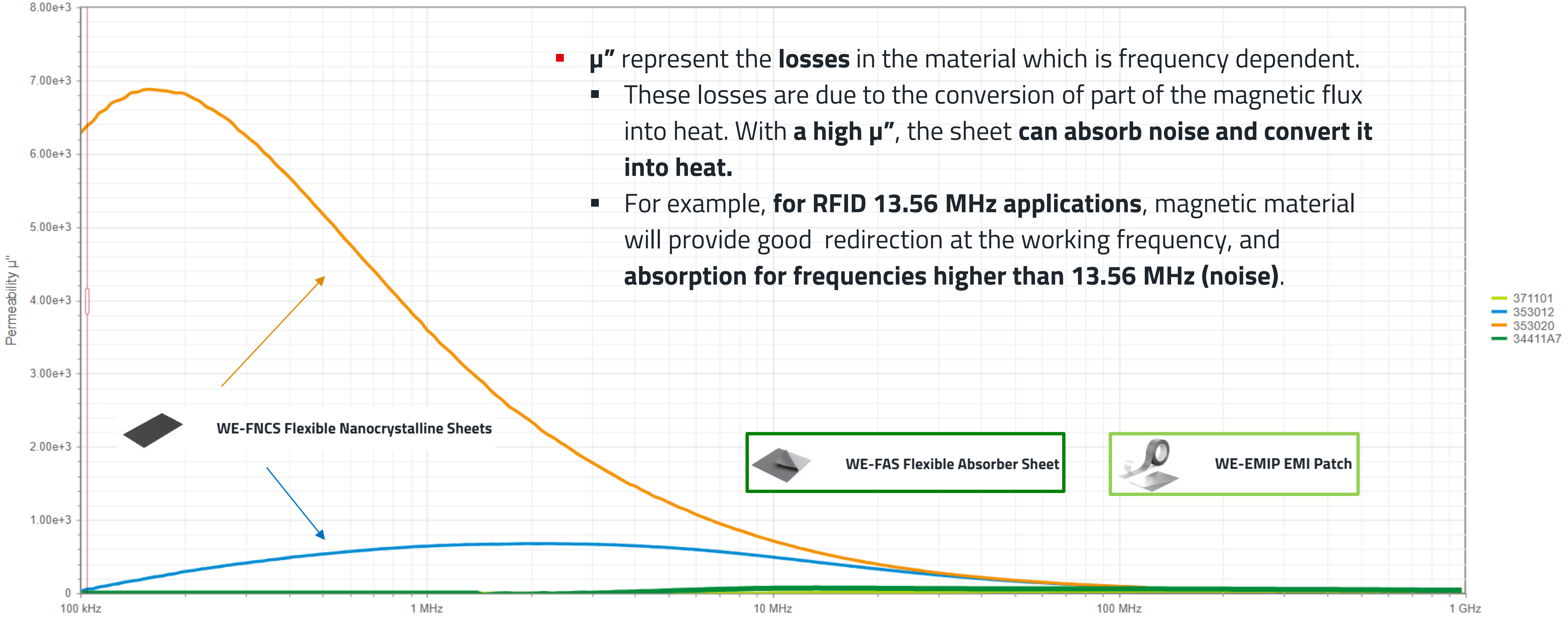




SHIELDING

Permeability μ'': FAS EMI vs. EMIP vs. FCNS

- μ'' represent the **losses** in the material which is frequency dependent.
  - These losses are due to the conversion of part of the magnetic flux into heat. With **a high μ''**, the sheet **can absorb noise and convert it into heat.**
  - For example, **for RFID 13.56 MHz applications**, magnetic material will provide good redirection at the working frequency, and **absorption for frequencies higher than 13.56 MHz (noise)**.



SHIELDING

Permeability μ'': FAS EMI vs. EMIP vs. FCNS

WÜRTH ELEKTRONIK — REDEXPERT — Magnetic Shielding — Menu

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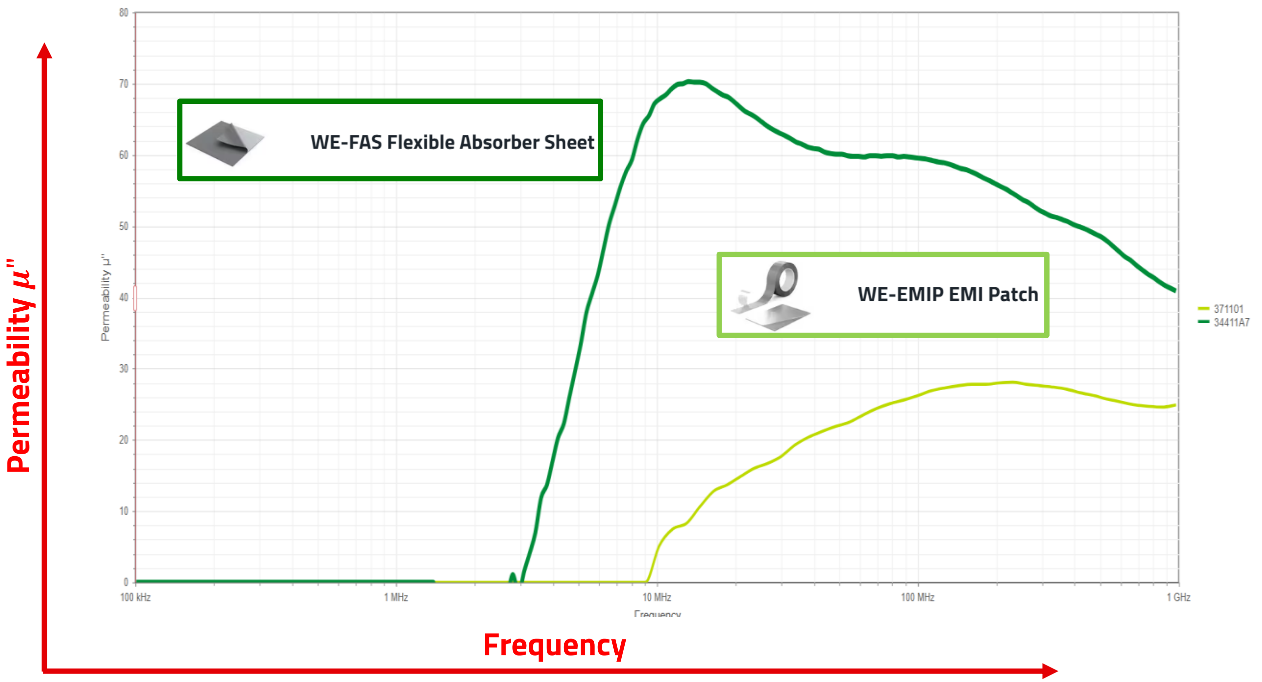
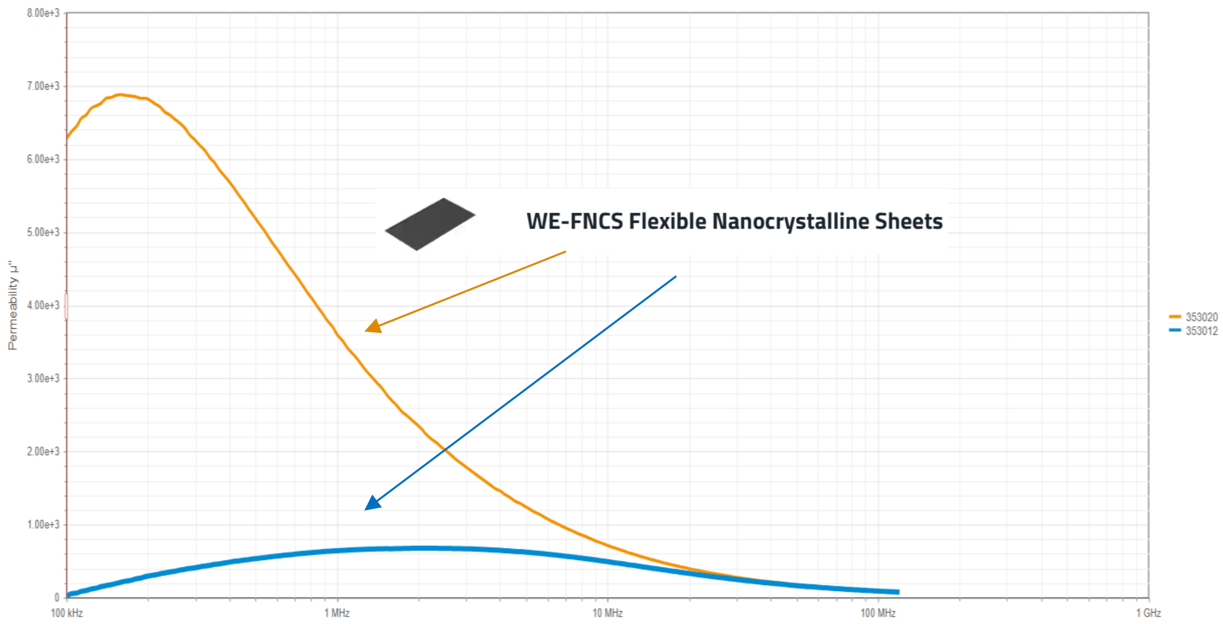
Order Code	Series	Spec	L	W	Thick...	Surface Resistance	Shielding E...	Peel ...	Ther...	μ' @ 13.56 MHz	μ' @ 1 MHz	μ'' @ 13.56 MHz	μ'' @ 1 MHz	Adhe...
34411A7	WE-FAS EMI	PDF	74.000 mm	105 mm	0.1000 mm	1.00e+7 Ω/cm2		400 N/cm		163	218	70.3	0.0100	0.0300 mm
353020	WE-FNCS	PDF	120.00 mm	65.0 mm	0.06000 ...	1.00e+7 Ω/cm2				137	2.21e+3	556	3.60e+3	0.0100 mm
371001	WE-EMIP	PDF	105.00 mm	74.0 mm	0.07200 ...	0.00200 Ω/cm2		400 N/cm		87.6	100	9.72	0.0100	0.0100 mm
371101	WE-EMIP	PDF	105.00 mm	74.0 mm	0.07200 ...	1.00e+8 Ω/cm2		400 N/cm		87.6	100	9.72	0.0100	0.0100 mm





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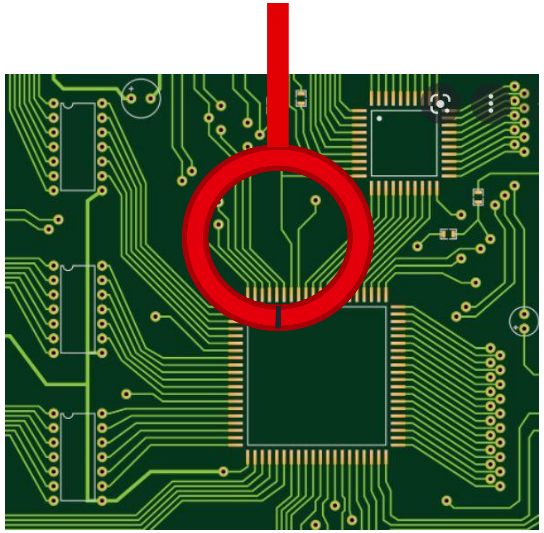
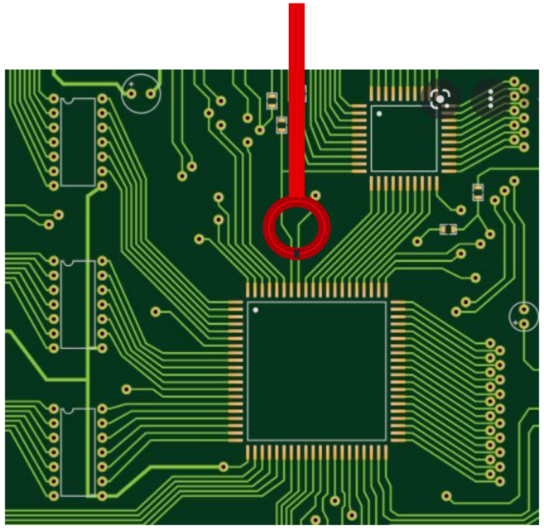
PCB TROUBLESHOOTING TIPS

Finding noise in the near field

1. Size
   - When evaluating the EMI from the PCB, the diameter of the magnetic NFP loop determines:
     - The sensitivity of the probe
     - Spatial resolution

   - Larger loop:
     - More sensitive and can pickup more magnetic field, or changes in current.
     - Less spatial resolution. Harder to pinpoint and narrow down to a single spot or trace.





PCB TROUBLESHOOTING TIPS

Finding noise in the near field

2. You can first use a larger diameter loop size, which is more sensitive to scan for potential EMI hot spot. Then shift to a smaller loop size to pin-point the exact spot.

3. The DIY magnetic NFP is used for doing relative comparison of the EMI level at the near field. Not so much for absolute value measurement like in the EMC lab.

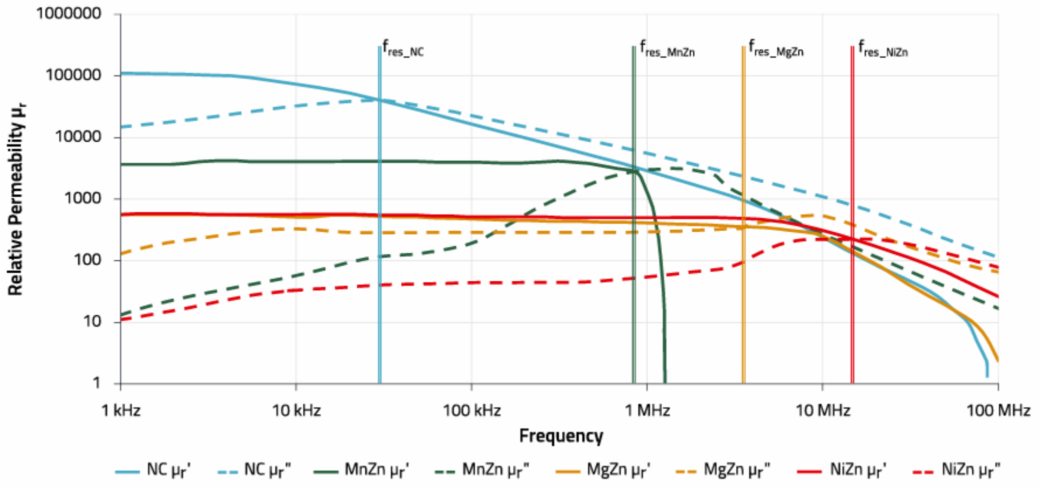
4. You can use it for before and after comparison after you have made EMI mitigating design into your PCB. For example, comparing between 2 PCB design revision. Comparing the EMI level after you have added in some filter design, etc.

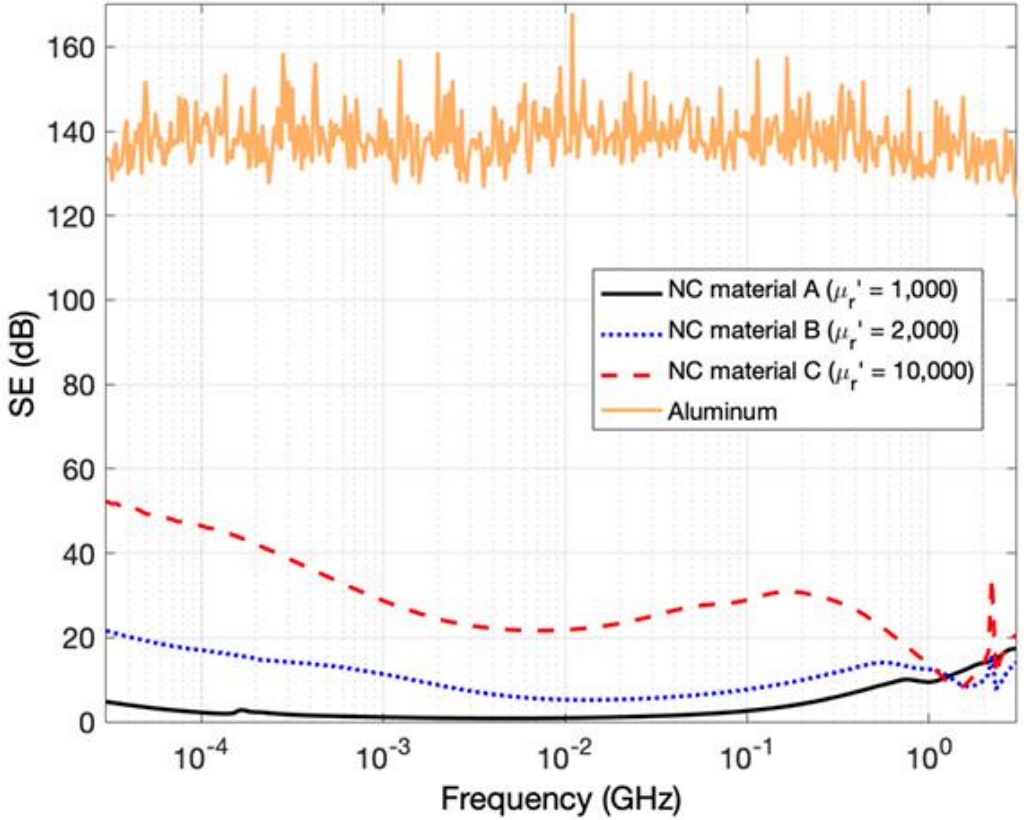
NANOCRYSTALLINE

NANOCRYSTALLINE

Overview

- NC material is not a ferrite material, but an iron-based material with a special crystal structure.
- It is a multilayer material produced by stacking and bonding different layers of nanocrystalline material, providing as result a very thin, light and highly flexible material with high permeability.
- With grain sizes in the nanometer range, typically between 1-100 nm.

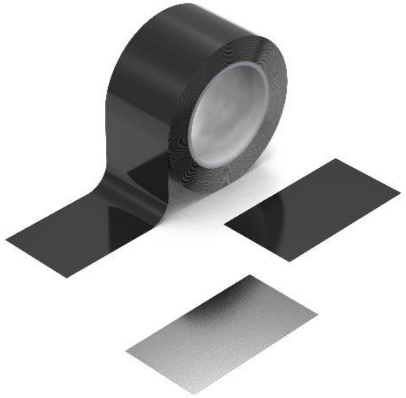


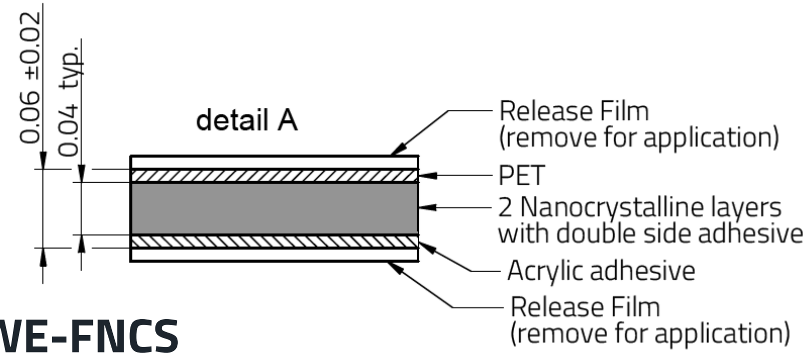


WE-FNCS

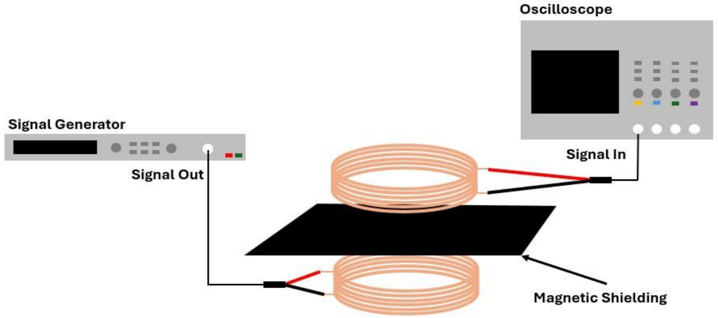
Comparison with conventional solutions

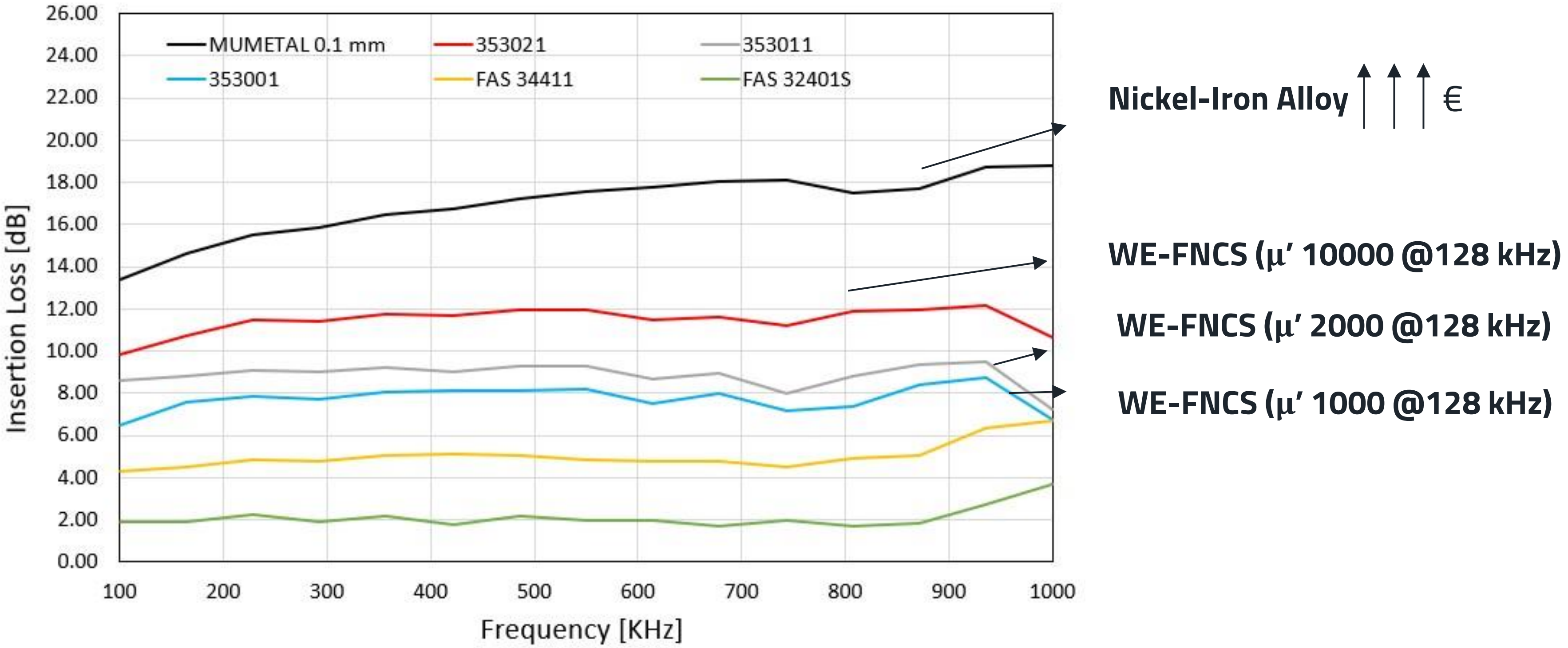
- **Insertion Loss,** and **vs. Nickel-Iron Alloy**





WE-FNCS





WE-FNCS

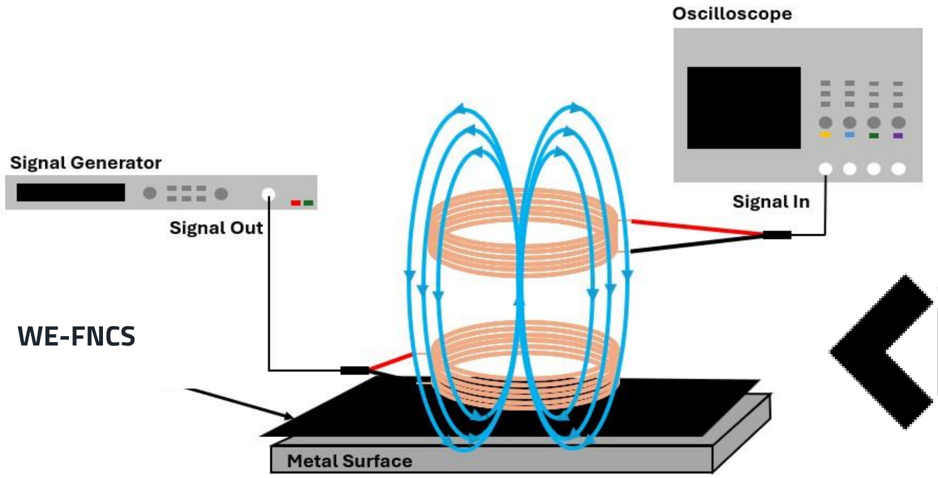
Comparison with conventional solutions

- **Overall, WE-FNCS is a more cost-effective solution, lighter, and easier to handle than the NiFe.**

	Competitor	WE-FNCS
Material Base	Nickel-Iron alloy	Nanocrystalline
Frequency range	Low frequencies (Hz-kHz)	Low frequencies (Hz-kHz)
Performance	🙂 🙂	🙂
Customizable	😐	🙂 🙂
Easy to handle	☹️ ☹️	🙂 🙂
Weight	☹️	🙂
Cost	☹️ ☹️	🙂 🙂

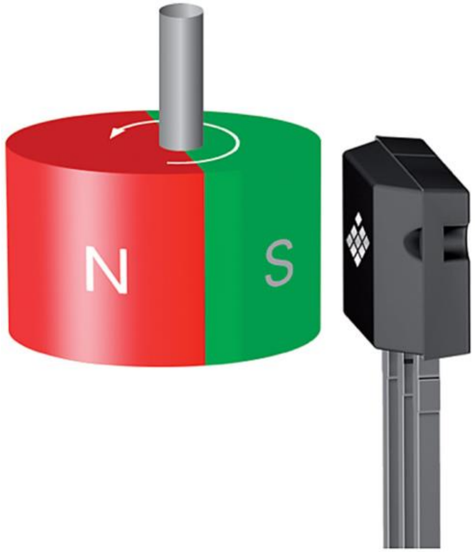
WE-FNCS

Applications



Wireless Power Efficiency

Common mode chokes



Hall sensor protection against EMI

Medical applications

WE PORTFOLIO

WE PORTFOLIO

Website Online Catalog

Components > Passive Components > EMC Components >

EMC Shielding

Filter by values H | Height L | Length W | Width

EMC Tapes

WE-CF EMC Shielding Tape | WE-TS Shielding Textiles | WE-EMIP EMI Patch

EMC Gaskets EXTENDED

WE-CSGS Contact Spring Gasket | WE-EGS Conductive Elastomer Gasket | WE-LT Conductive Shielding Gasket | + 4 more

Grounding

WE-SECF SMT EMI Contact Finger | WE-SMGS Surface Mount Solderable Gasket | WE-ST Conductive Ni/Cu glass fiber woven | WE-EEL Earthing Metal Clip | + 1 more

Magnetic Shielding EXTENDED

WE-FAS Flexible Absorber Sheet | WE-FSFS Flexible Sintered Ferrite Sheet | WE-FNCS Flexible Nanocrystalline Sheets | + 2 more

Board Level Shielding

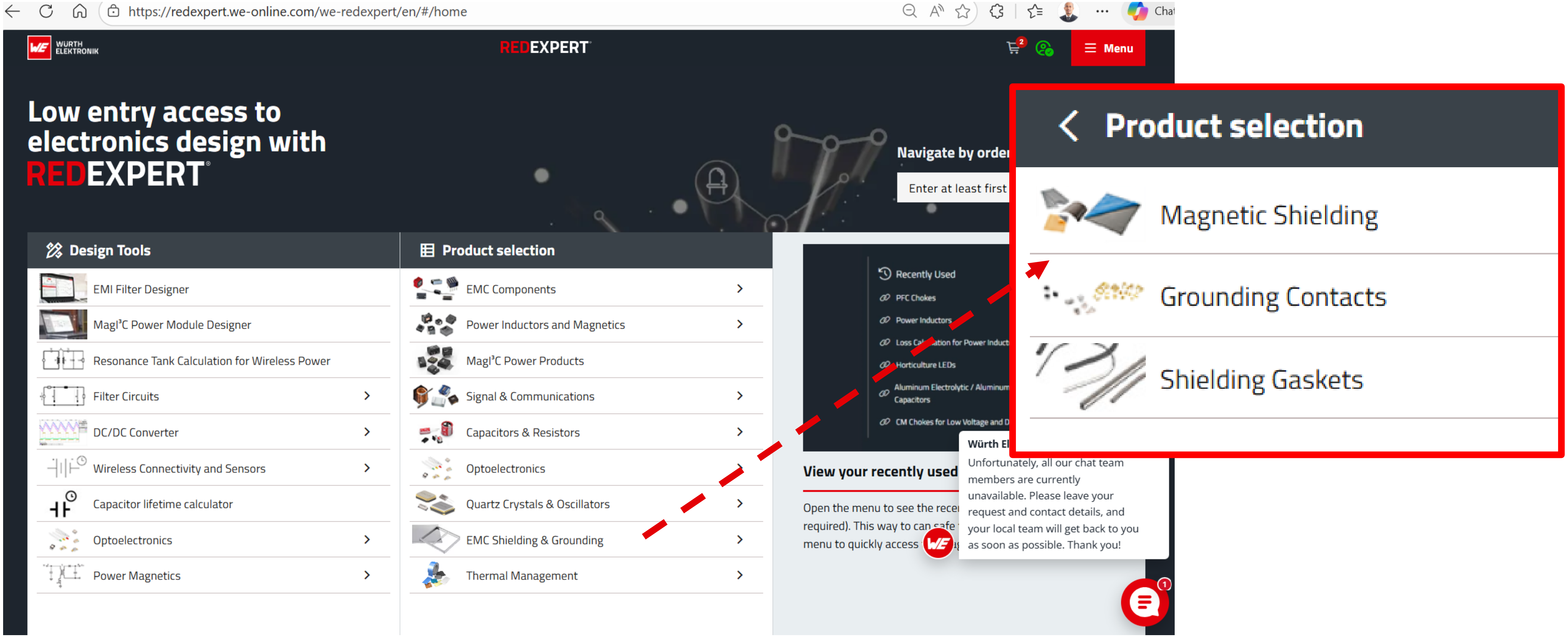
WE-SHC Shielding Cabinet | WE-SHC Seamless Shielding Cabinet | Shielding Cabinet Clip

Reference Guides Shielding

Reference Guide ABC of Shielding English

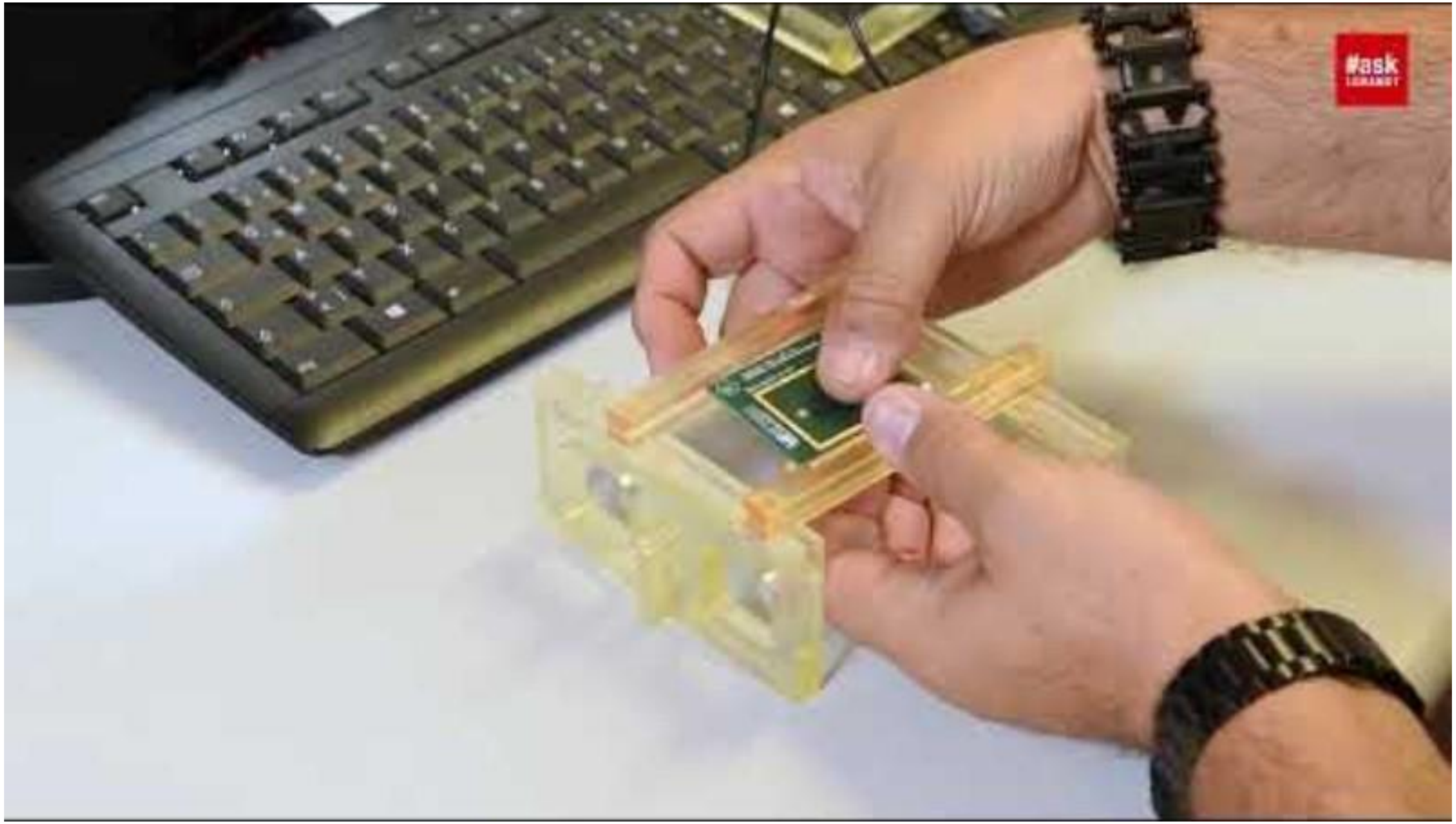
WE PORTFOLIO

REDEXPERT



SHIELDING

Design Kit ShielDIY Custom Shielding Cabinets



Characteristics

- Do It Yourself Shielding Cabinet, create your own cabinet with this kit.
- Shape your Board Level Shielding.
- Foldable and cuttable with carved lines every 5 mm.
- Material: Nickel Silver. Same performance as the tinplated steel used in the standard cabinets.
- Useful for fast prototyping.

REFERENCES

From our website

- SN026: Isolated RS-485 interface based on 4-channel Digital isolator with integrated DC/DC converter.
- SN028: Isolated CAN Interface Based on a 2-Channel Digital Isolator and an Isolated Power Supply Module.
- ANS021: Ensuring Safety without Compromising Data Integrity – Critical Characteristics of Digital Isolators.
- Industries (Application) Guide
- IC Reference Designs
- ANS022: Bridge capacitor for isolated power modules, the whole truth, no myths.
- Toolbox: Design tools.
- All Application Notes

THANK YOU

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