



DON'T LET EMI RUIN YOUR DAY: NEW SHIELDING CHALLENGES

EMC Shielding & Thermal Solutions Team

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT



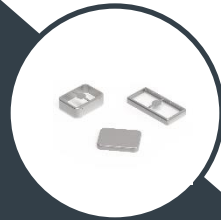
Shielding Basics



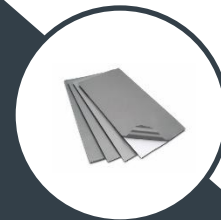
EMC Gaskets



EMC Tapes



Board Level Shielding



Magnetic Absorbers

AGENDA

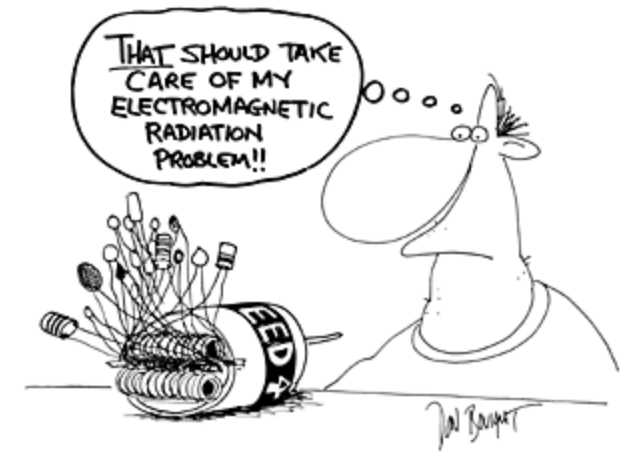
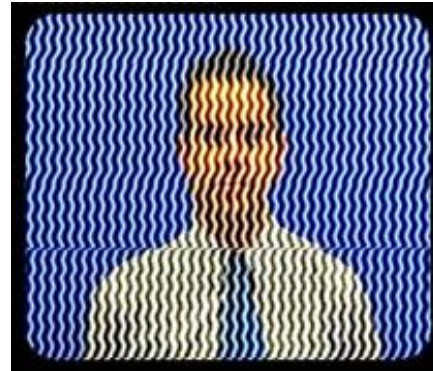
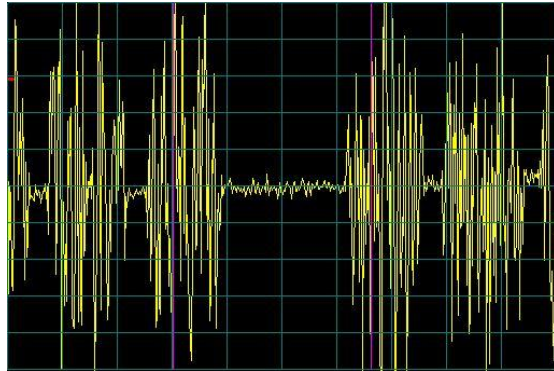
SHIELDING BASICS

Why shield components?



WHY SHIELDING MATERIALS?

- For the user of an electric or electronic device radiation can cause annoying effects:
 - Noise
 - Resonances
 - Errors
 - Malfunction

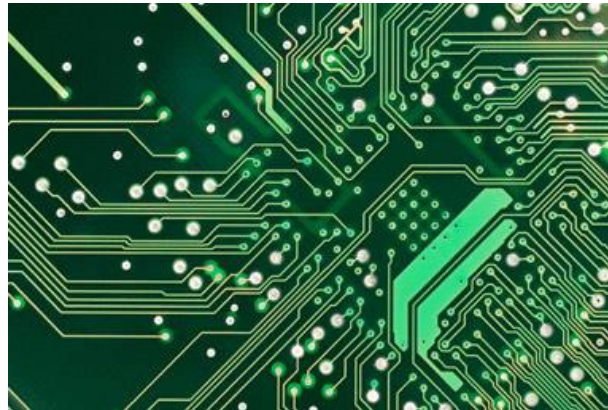


SHIELDING BASICS - WHERE CAN I HAVE EMI?

- Electromagnetic fields are radiated from and received by conductive structures
- Possible antennas:



Cables, interfaces,
apertures



Traces, groundplanes,
vias, slits

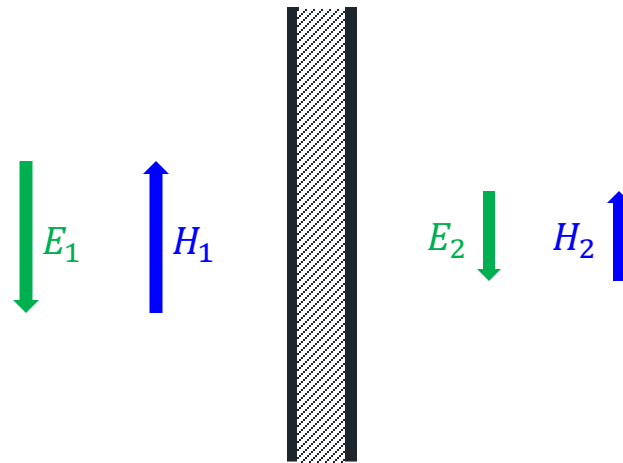


Components, heatsinks,
integrated circuits

SHIELDING BASICS – SHIELDING EFFECTIVENESS

- The **Shielding Effectiveness** SE , given in decibel, characterises the **quality** of an electromagnetic shield
- The field amplitudes E_1 and H_1 in front of the shield are compared with the field amplitudes E_2 and H_2 behind the shield

$$SE = 20 \cdot \log\left(\frac{E_1}{E_2}\right) \text{ dB} = 20 \cdot \log\left(\frac{H_1}{H_2}\right) \text{ dB}$$



SHIELDING BASICS – RULE OF THUMB

- In order to **maximize the field reflection** in the proximity of the noise source (near field), we need a shield
 - with **high electric conductivity** (= low impedance) against electric fields

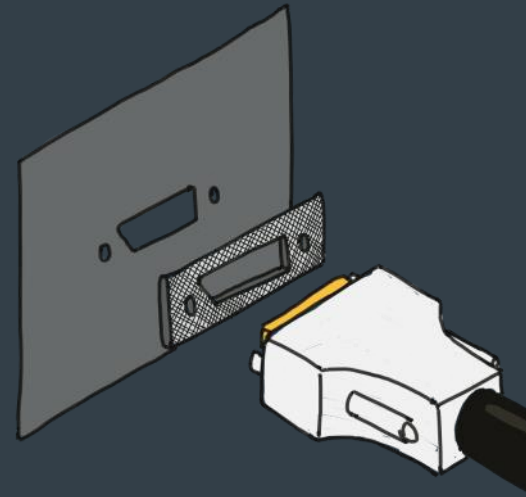


- with **high magnetic conductivity** (= high permeability) against magnetic fields

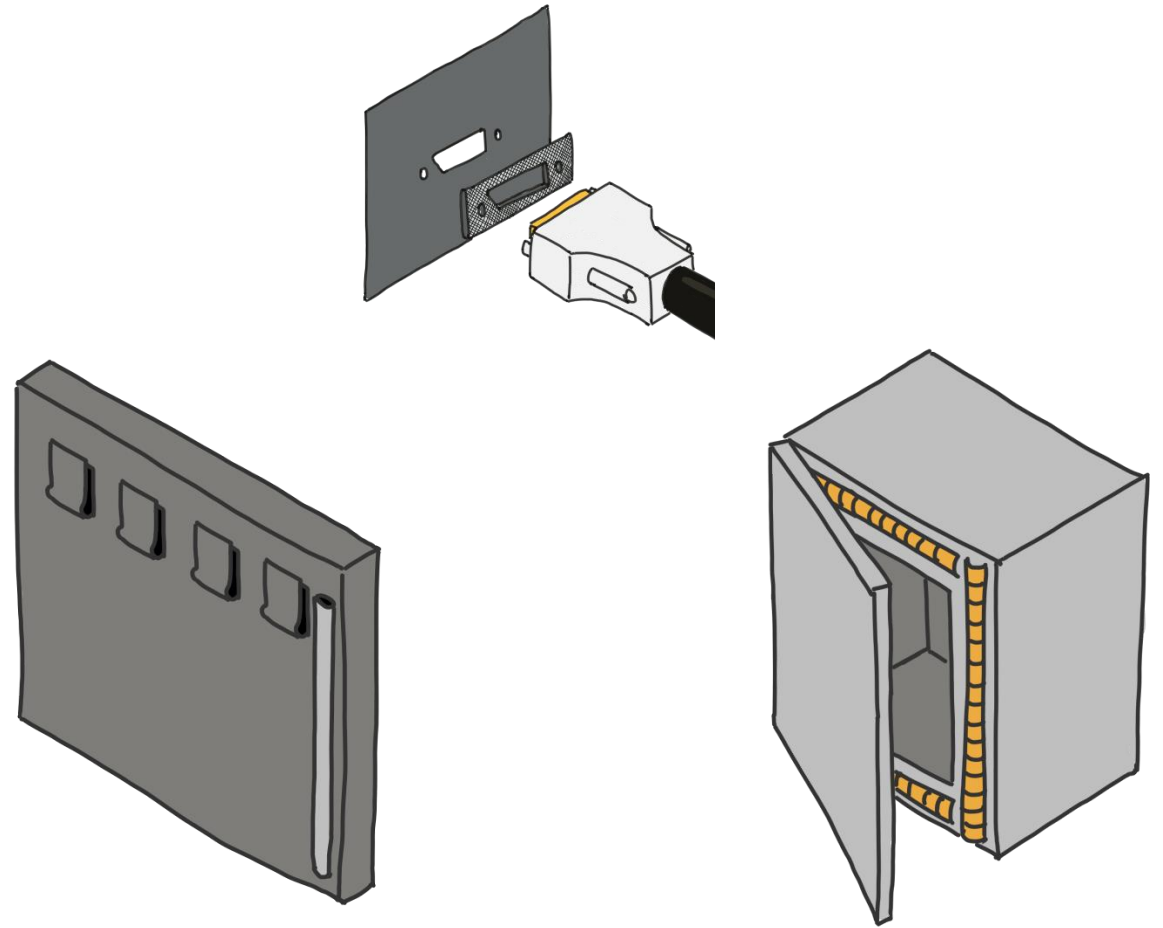
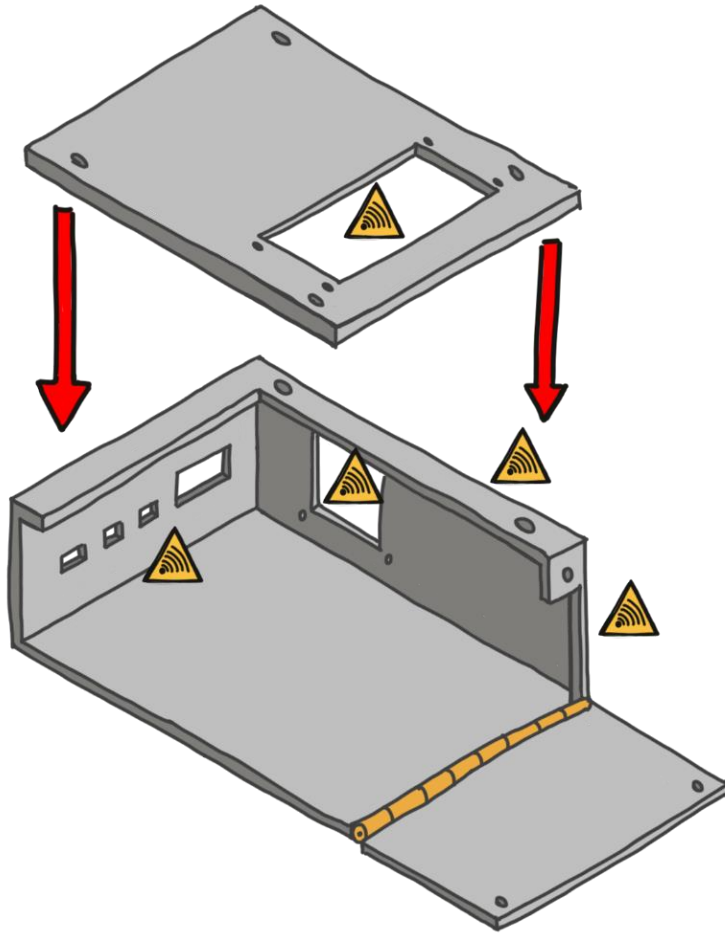


- In order to **maximize the field absorption** inside the shield, the shield should
 - Have high electric and magnetic conductivity
 - Be as thick as possible

EMC GASKETS

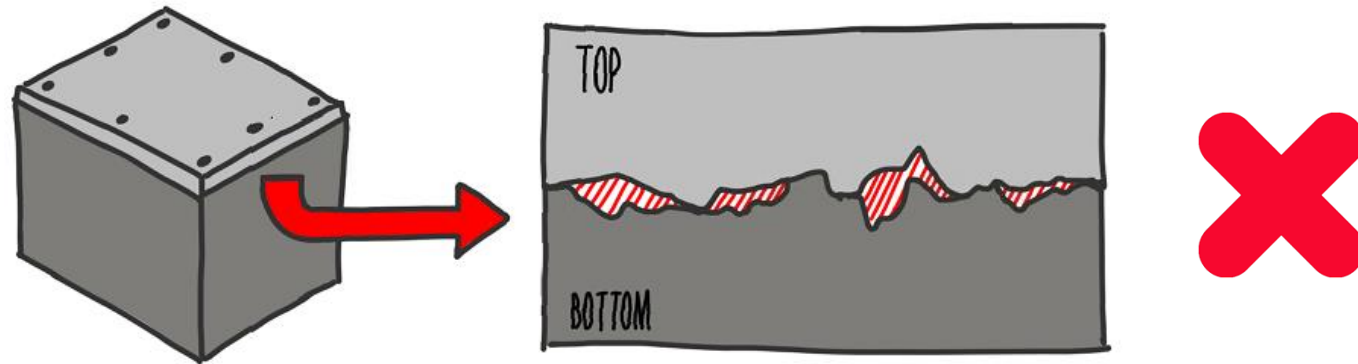


EMC GASKETS - WHERE DO THEY GO?



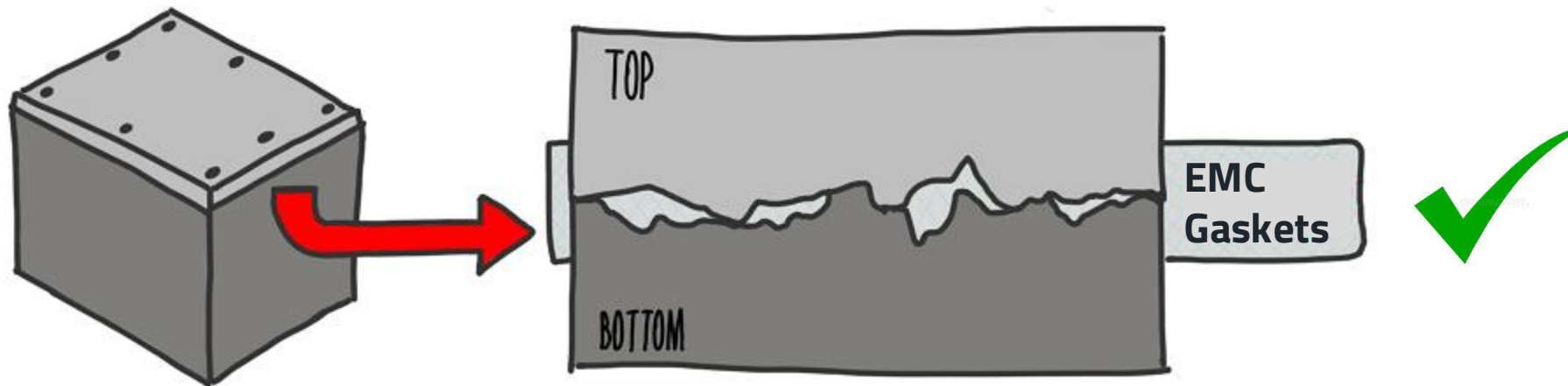
EMC GASKETS - PLACEMENT & COMPRESSION

- Bad contact between surfaces



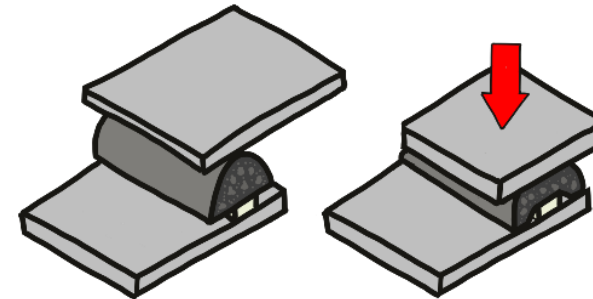
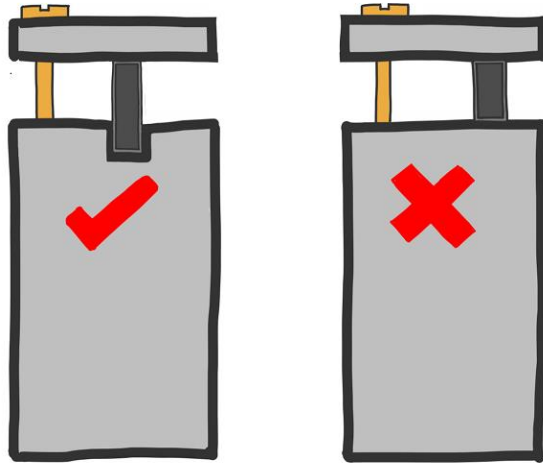
EMC GASKETS - PLACEMENT & COMPRESSION

- How we can solve a bad contact?



EMC GASKETS - PLACEMENT & COMPRESSION

- Placement
 - Good
 - Have a small section of the cover to get into the enclosure, for ensuring a good electrical connection
 - Compress it 20%



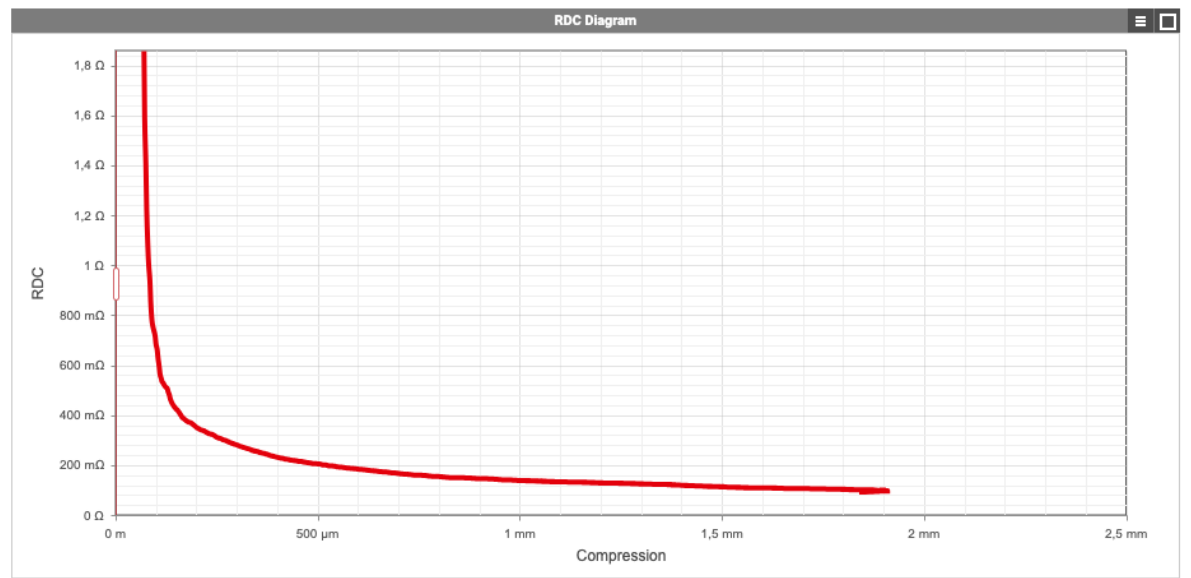
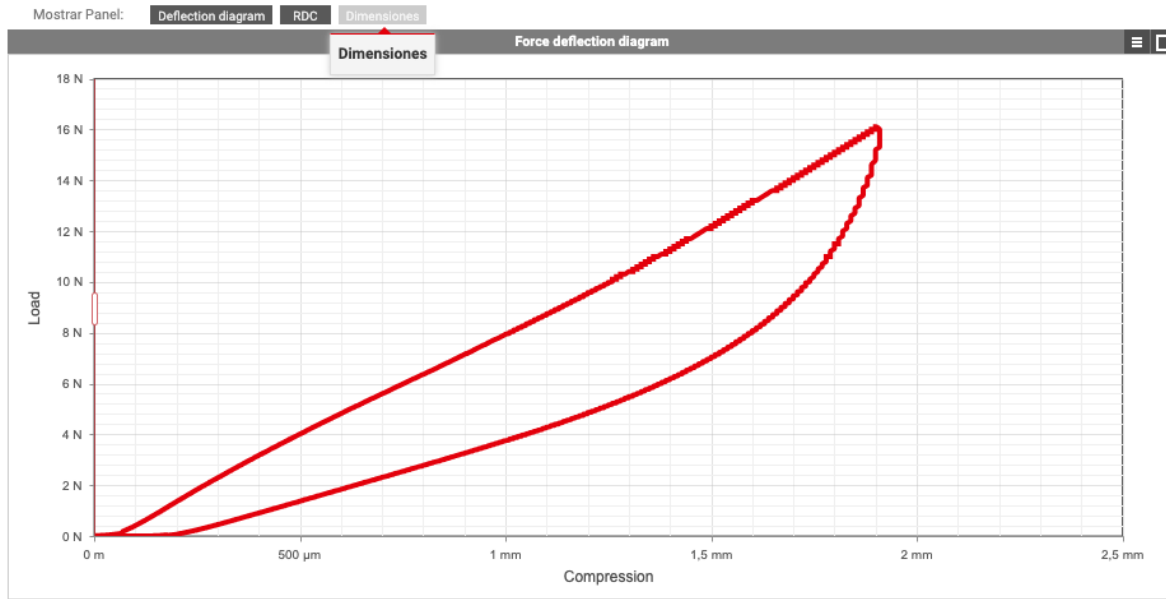
- Avoid
 - Use of greases (avoiding degradation by abrasion)
 - Use of non-conductive adhesives (this will increase the Rdc of the gasket)

EMC GASKETS - REDEXPERT! (EMC GASKETS MODULE)

Código	Serie	Descripción	Spec	L	W	H	Working Height Min	Working Height Max	Inner Diam...	Outer Dia...	Profile	Raw Material	Outside Material
38401001	WE-EGS	Conductive Elastomer Gasket		1000 mm	3,96 mm	3,96 mm	3,17 mm	2,77 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401002	WE-EGS	Conductive Elastomer Gasket		1000 mm	4,75 mm	4,72 mm	3,78 mm	3,30 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401003	WE-EGS	Conductive Elastomer Gasket		1000 mm	6,35 mm	6,35 mm	5,08 mm	4,45 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401004	WE-EGS	Conductive Elastomer Gasket		1000 mm	7,92 mm	7,92 mm	6,34 mm	5,54 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401005	WE-EGS	Conductive Elastomer Gasket		1000 mm	7,92 mm	7,92 mm	6,34 mm	5,54 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401006	WE-EGS	Conductive Elastomer Gasket		1000 mm	12,4 mm	8,23 mm	6,58 mm	5,76 mm	-	-	Hollow D profile	Nickel-plated Graphite (NIC)	Silicone
38401101	WE-EGS	Conductive Elastomer Gasket		1000 mm	1,40 mm	1,63 mm	1,30 mm	1,14 mm	-	-	D profile	Nickel-plated Graphite (NIC)	Silicone
38401102	WE-EGS	Conductive Elastomer Gasket		1000 mm	1,57 mm	1,73 mm	1,38 mm	1,21 mm	-	-	D profile	Nickel-plated Graphite (NIC)	Silicone

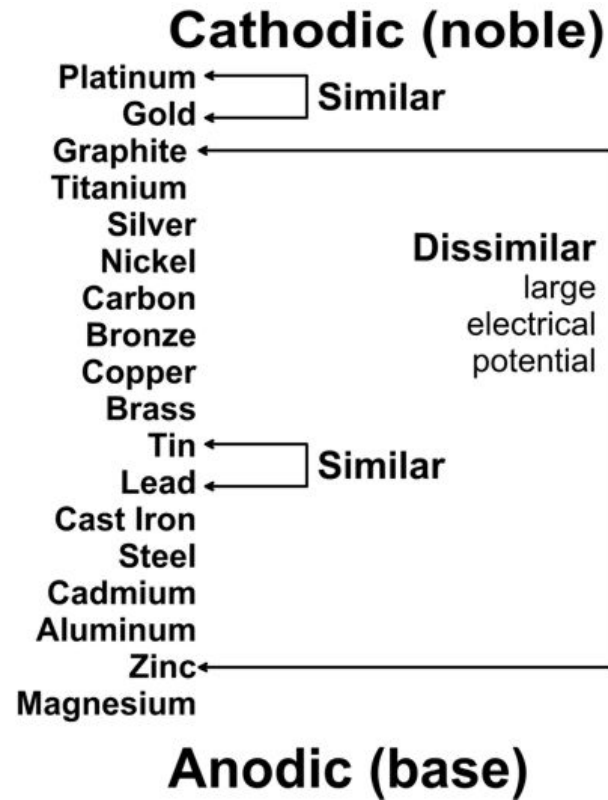
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AÑADIR
MÁS



EMC GASKETS - MATERIAL MATCHING

- Galvanic Corrosion



EMC GASKETS - TYPES

- Types of EMC Gaskets

- Conductive Elastomer Gaskets → Conductive filler mixed with rubber material



- Conductive Fabric over Foam Gasket → Conductive textile wrapped over a PU sponge core



- Contact Stripe Gasket → Made of elastic metallic material

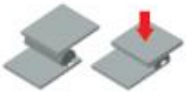


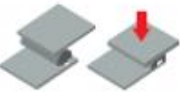


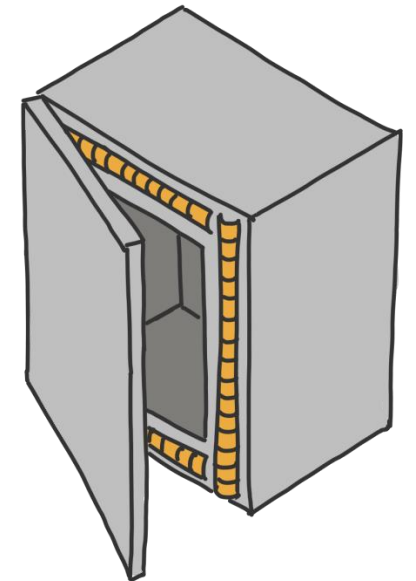
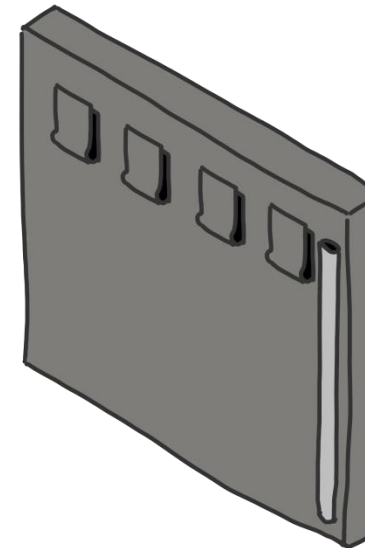
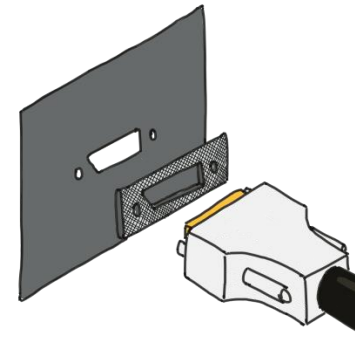
- Knitted wire mesh gaskets → Composed mainly by a metallic wire mesh



EMC GASKETS – CHEATSHEET

How we can choose the proper EMC gasket?

Ingress Protection	IP68	IP54	IP20	IP40
	High protection for normal applications	Low protection for normal applications	Nearly no protection for normal applications	Protected against particles of more than 1 mm diameter
Compression Force Needed	+++ High Compression Force	++ Medium Compression Force	+ Low Compression Force	+++ High Compression Force
	Fixed applications, high sealing effect needed	General applications	Applications which require open & close function	Fixed applications, high sealing effect needed
Attachment Method	 Mechanical Force Compressible Conductive Elastomer Material	 Adhesive Tape Conductive/ Non-Conductive PSA	 Clip On & Screw Hole Elastic Beryllium Copper Alloy with Nickel plating	 Mechanical Force Knitted Monel Wire Over Elastomer Material
	Application examples: O-Rings for I/O entries, highly sealed housings, etc.	Application examples: not environmental exposed housing, medium sealed housing, etc.	Application examples: EMC chambers, industrial ovens, etc.	Application examples: Industrial ovens, rough environments
Operating Temperature Range	-50°C to +150°C Highest temperature range for extreme temperatures	-40°C to +85°C Low temperature range for general applications	-40°C to +120°C Medium temperature range for extended needs	-30°C to +80°C Low temperature range for general applications



EMC TAPES



HOUSING PROBLEMS-APERTURES



EMC TAPES

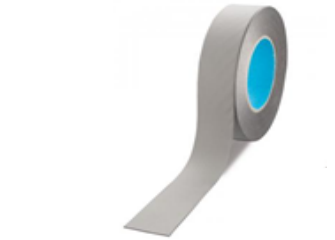
- How we can choose the proper EMC Tape?

- **1. Material**

- It must take into account the material of the contact surface in order to avoid corrosion

- **2. Flexibility**

- Flexible



- Less flexible

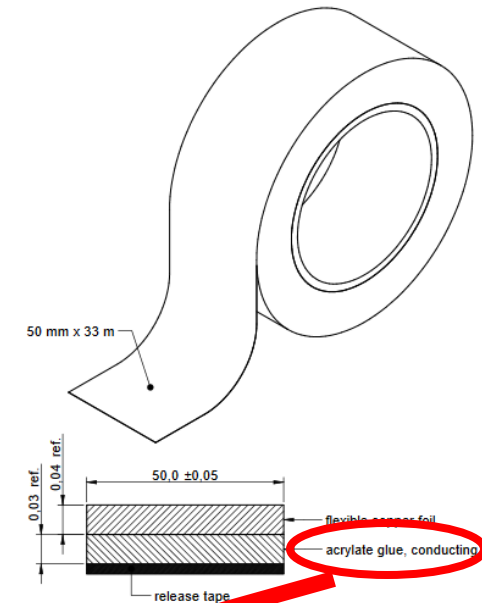
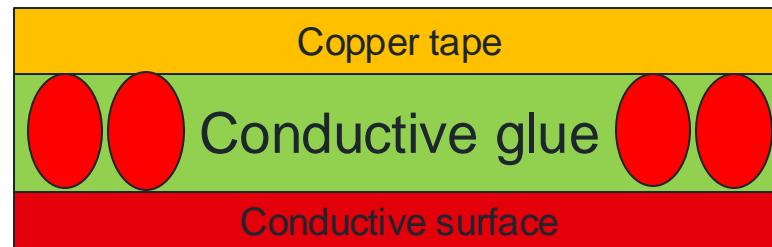


EMC TAPES TIPS

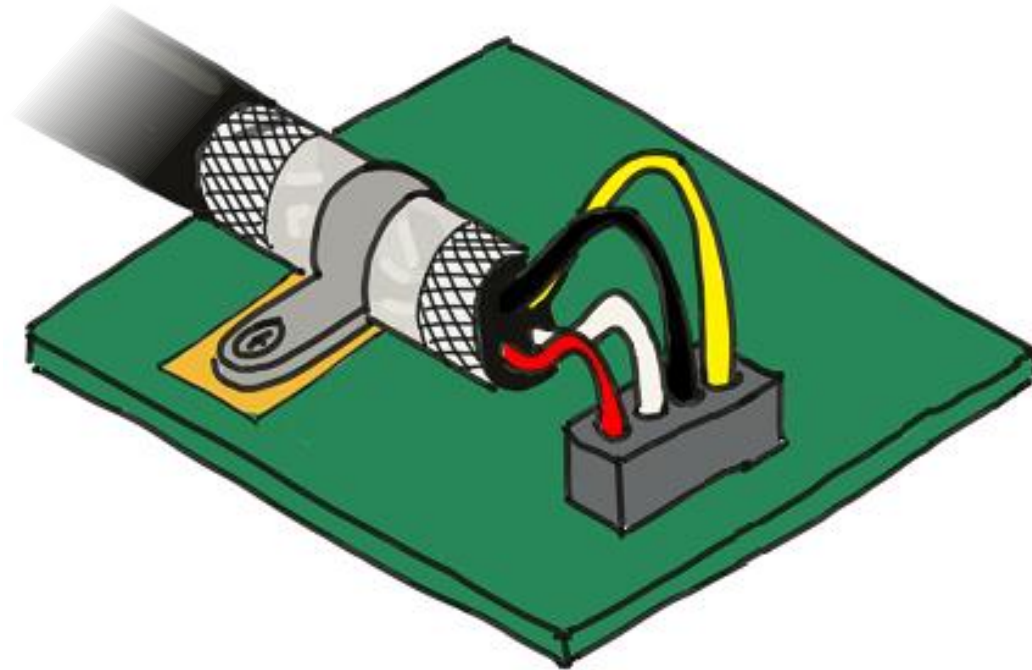
- The conductive glue is not fully conductive.
- There are conductive bubbles in the glue, which must be connected between the conductive part of the tape and the conductive surface, where it is glued to, by hard pressing.



- Bubbles in glue (shown in red).
- Bubbles will connect the CU-Tape with the surface, when pressed.

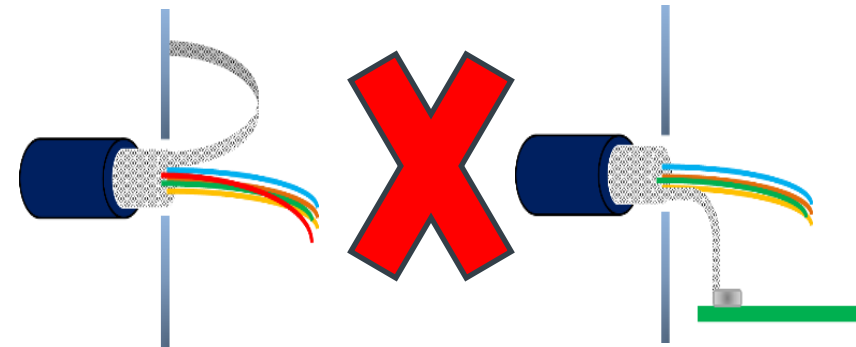
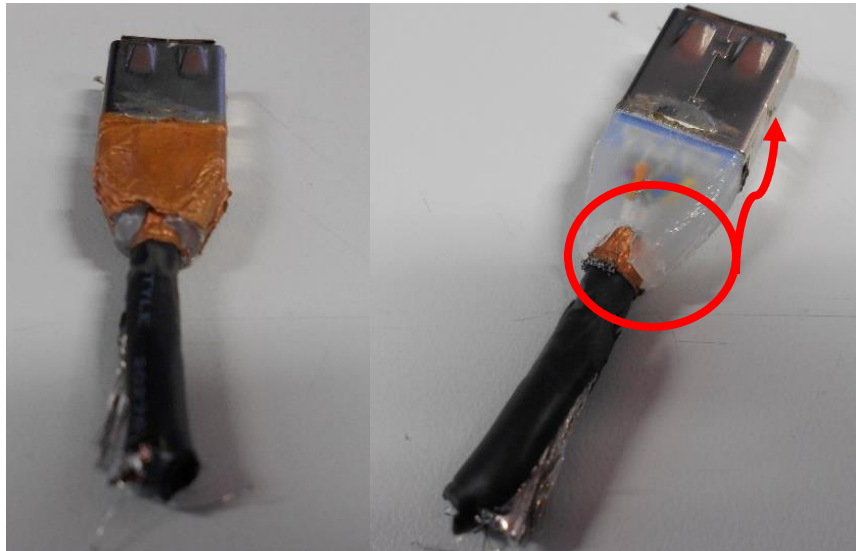


SHIELDING THE CABLES



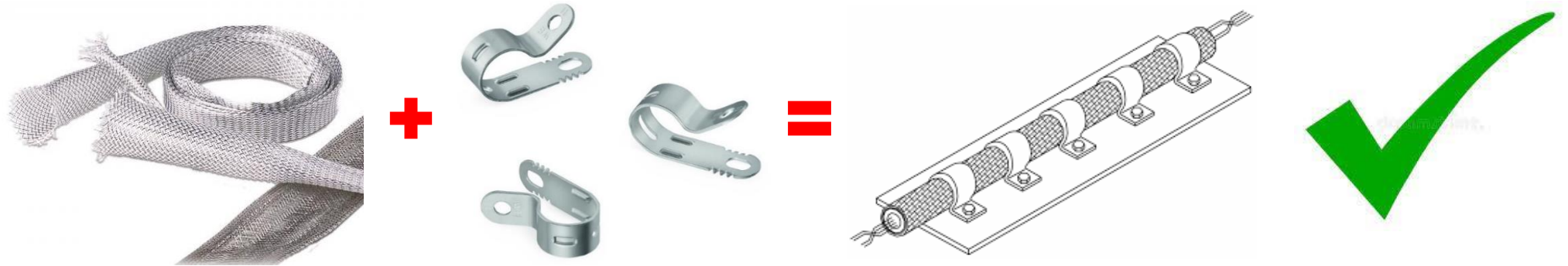
SHIELDING CABLES PROBLEMS

- **Bad shielded cables**
 - **Pigtails**
 - NOT full connection
 - Inductive coupling in pigtail loop



SHIELDING CABLES PROBLEMS

- How we can shield a cable properly?



Conductive nylon weave + Metal clips

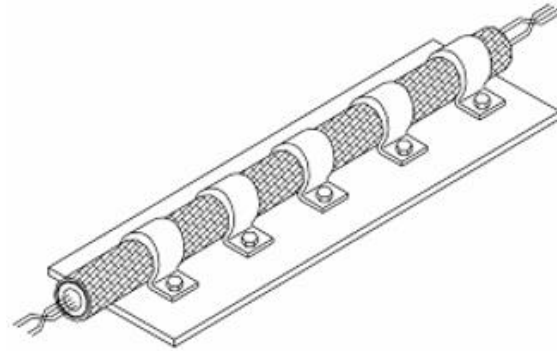


EMC Shielding Textile

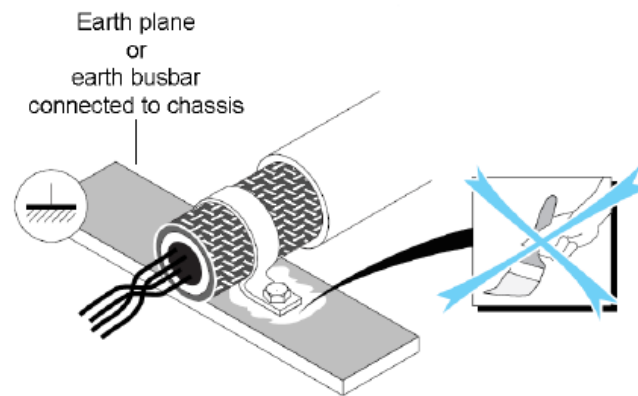


SHIELDING CABLES TIPS

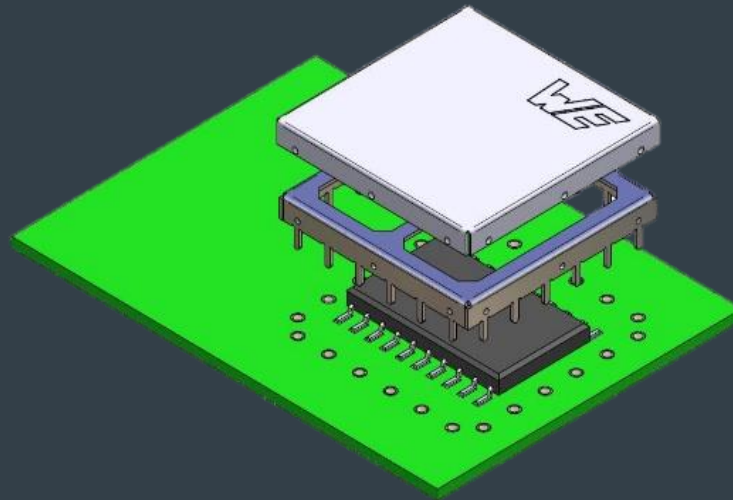
- Shield connected on 360° to the cable



- Don't use any type of painting on the connection metal clip- ground plane

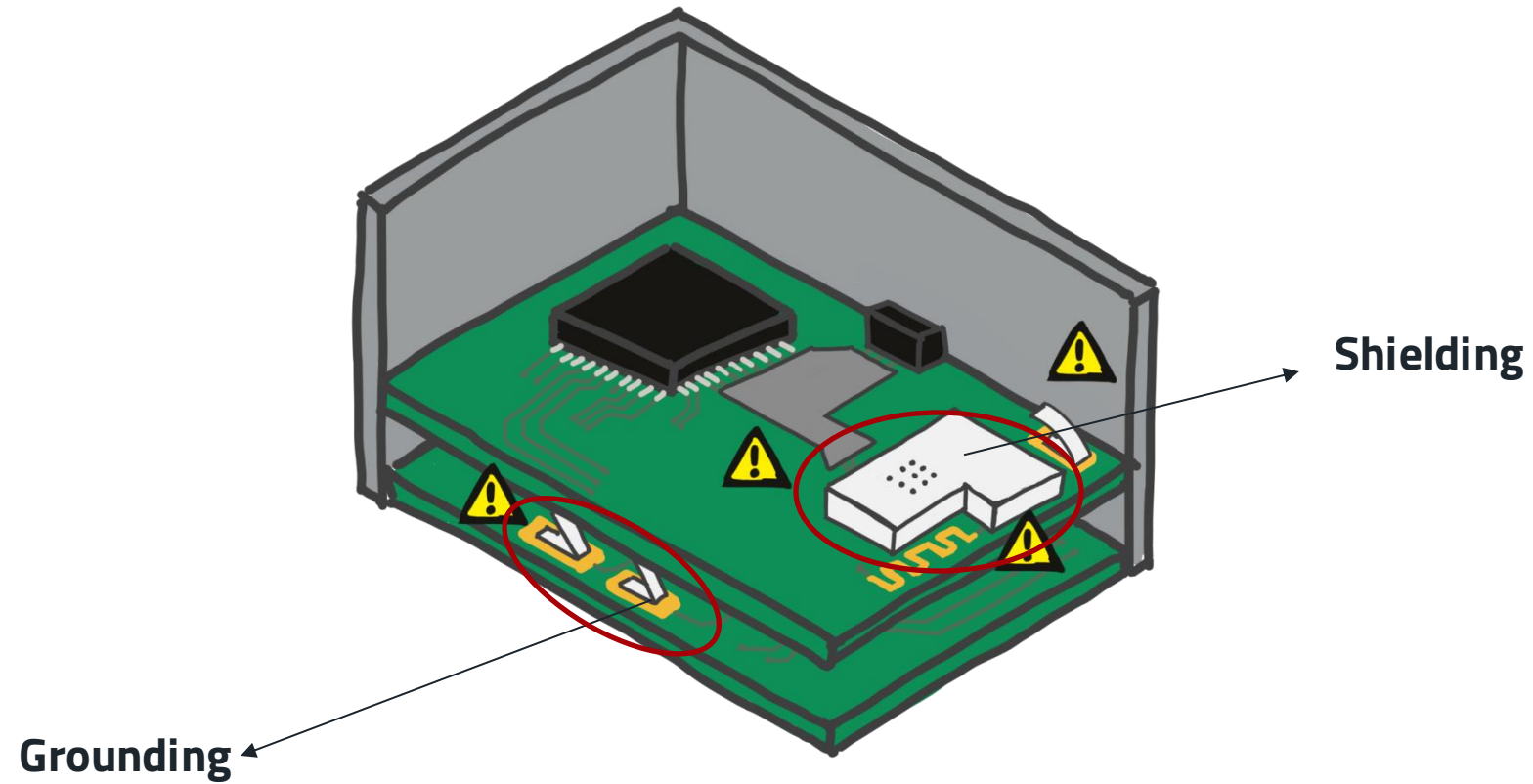


BOARD LEVEL SHIELDING



BLS - PCB SHIELDING

- How we can solve these intra/inter decoupling?



BLS - WHAT THERE IS?

- What there is on the market?

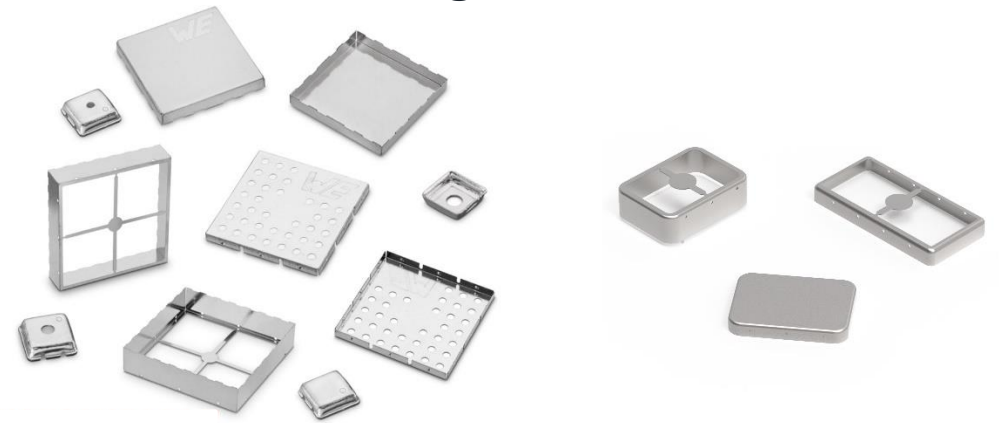
Contact Springs



SMT Gaskets



Shielding Cabinets/Cans



Grounding

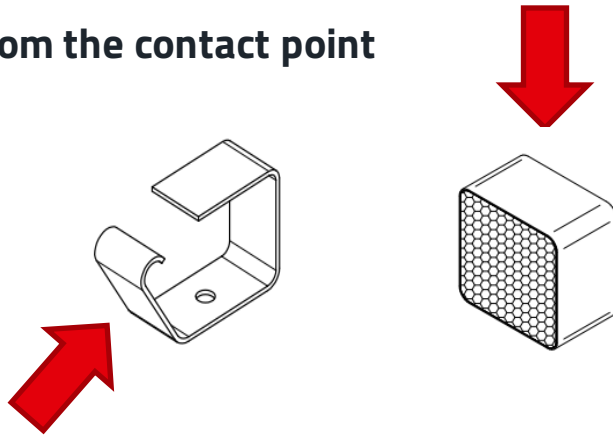
Shielding

BLS - PLACEMENT

- How we can choose the proper SMT Grounding contact?

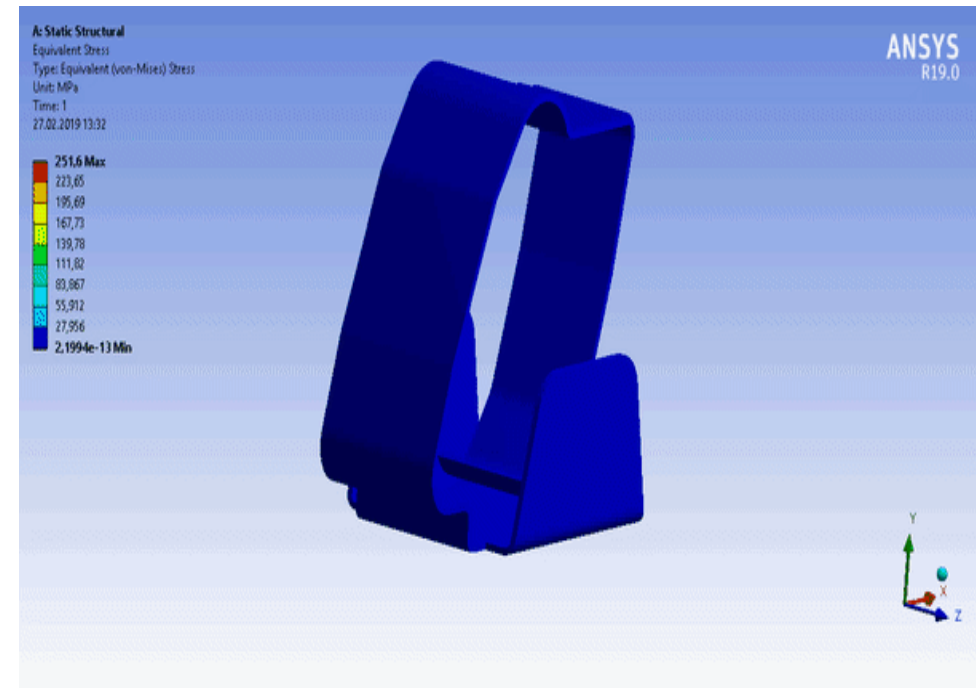
- **1. Direction from the contact point**

- Horizontal
- Vertical



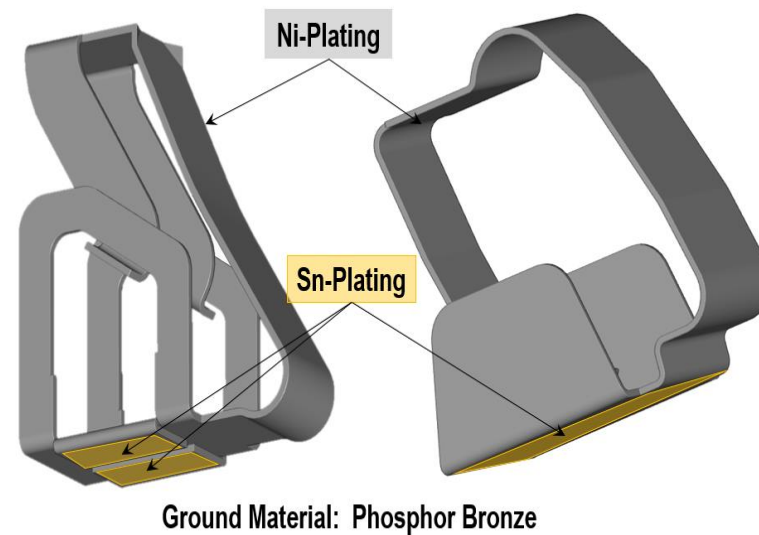
- **2. Recommended working height**

- Rule of thumb: Removing 20%-30% from the original height
 - Obtain the proper Rdc without material wear



BLS - MATERIALS

- How we can choose the proper SMT Grounding contact?
- 3. Galvanic corrosion
 - Plating: Gold (most used due to is a noble material), Nickel and Tin
 - Solderability: The material selection will affect solderability!



BLS- REDEXPERT! (GROUNDING CONTACTS MODULE)

Código	Serie	Descripción	Spec	L	W	H	Working Height Min	Working Height Max	Material	Plating	Automotriz	
331041402053	WE-SECF	SMT Contact Spring / Finger			4,10 mm	2,00 mm	5,30 mm	5,00 mm	4,40 mm	Copper Beryllium	Gold plated	✓
331051472057	WE-SECF	SMT Contact Spring / Finger			4,70 mm	2,00 mm	5,70 mm	5,40 mm	4,60 mm	Copper Beryllium	Gold plated	✓
331061603010	WE-SECF	SMT Contact Spring / Finger			6,00 mm	3,00 mm	10,0 mm	9,70 mm	8,30 mm	Copper Beryllium	Gold plated	✓
331081302025	WE-SECF	SMT Contact Spring / Finger			3,00 mm	2,00 mm	2,50 mm	2,20 mm	2,00 mm	Copper Beryllium	Gold plated	✓
331141352540	WE-SECF	SMT Contact Spring / Finger			3,50 mm	2,50 mm	4,00 mm	3,70 mm	3,40 mm	Copper Beryllium	Gold plated	✓
331151702562	WE-SECF	SMT Contact Spring / Finger			7,15 mm	2,50 mm	6,20 mm	5,90 mm	5,00 mm	Copper Beryllium	Gold plated	✓
331161452070	WE-SECF	SMT Contact Spring / Finger			4,50 mm	2,00 mm	7,00 mm	6,70 mm	6,00 mm	Copper Beryllium	Gold plated	✓
331161702513	WE-SECF	SMT Contact Spring / Finger			7,00 mm	2,50 mm	13,0 mm	12,5 mm	10,0 mm	Copper Beryllium	Gold plated	✓

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AÑADIR
MÁS

Mostrar Panel: **Deflection diagram** RDC Imagen Dimensiones Huella Dibujo 3D

Force deflection diagram

RDC Diagram

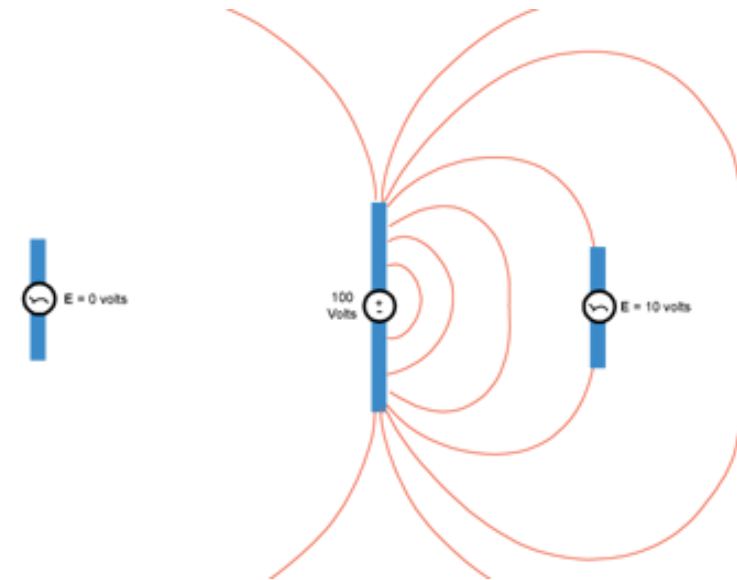
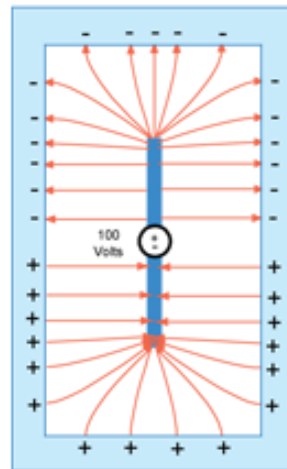
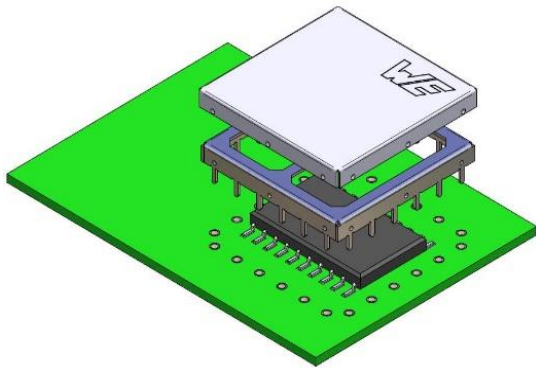
Imagen

Dimensiones

Diseño de Huella Recomendado

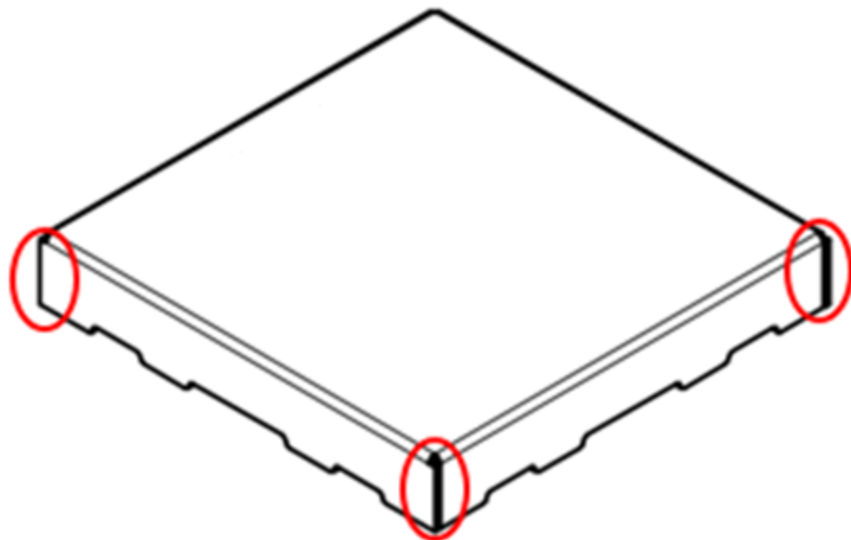
BLS - WHY ARE THEY NEEDED FOR?

- The Shielding cabinets protect sensitive areas of the PCB, and reduce the radiation or coupling of electromagnetic fields acting as a Faraday cage.



BLS - TYPES

- How we can choose the proper Shielding cabinet
- Structure
 - Standard Shielding cabinets → Produced by a generic stamp and bending (they have small openings on the corners)

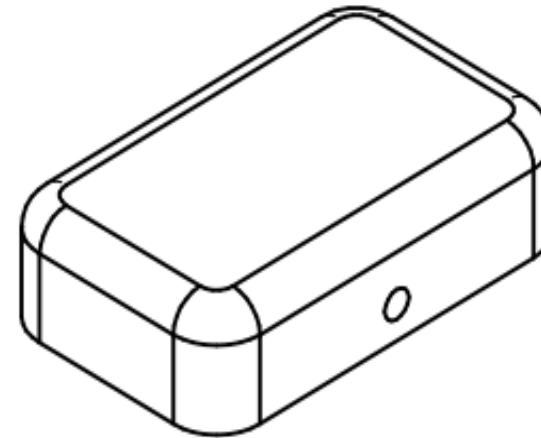


Standard / Traditional solutions (low frequency)

BLS - HIGH FREQUENCY

- **Structure**

- Seamless cabinets → Production method for these parts is Deep drawing, meaning that there are no openings on edges or sides (increasing the Shielding Effectiveness)



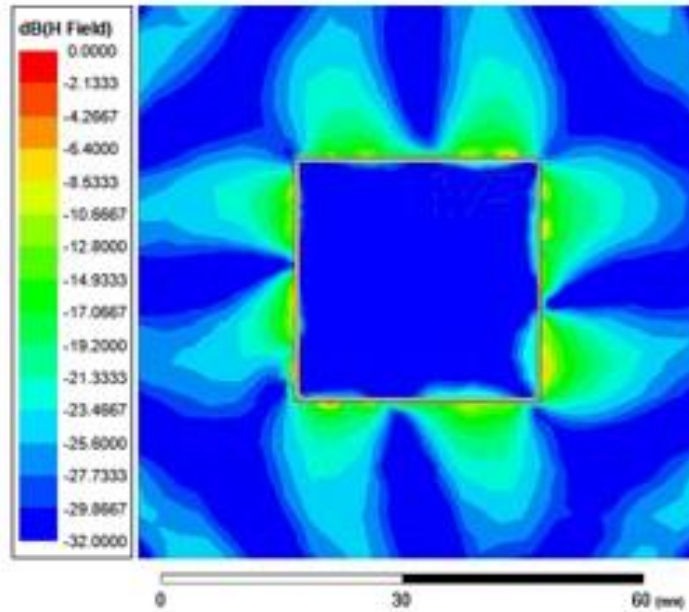
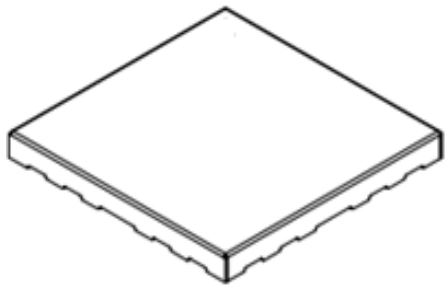
IOT
Internet of Things

 **IO-Link** 

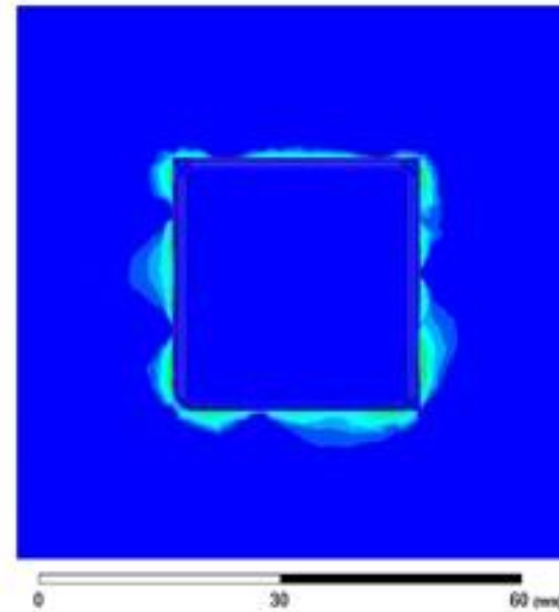

GNS

BLS - HIGH FREQUENCY

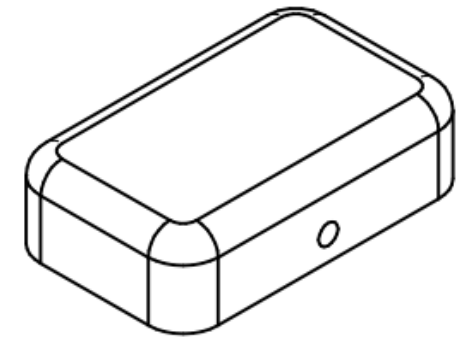
- Frequency measurement: 8 GHz



Standard Shielding cabinet

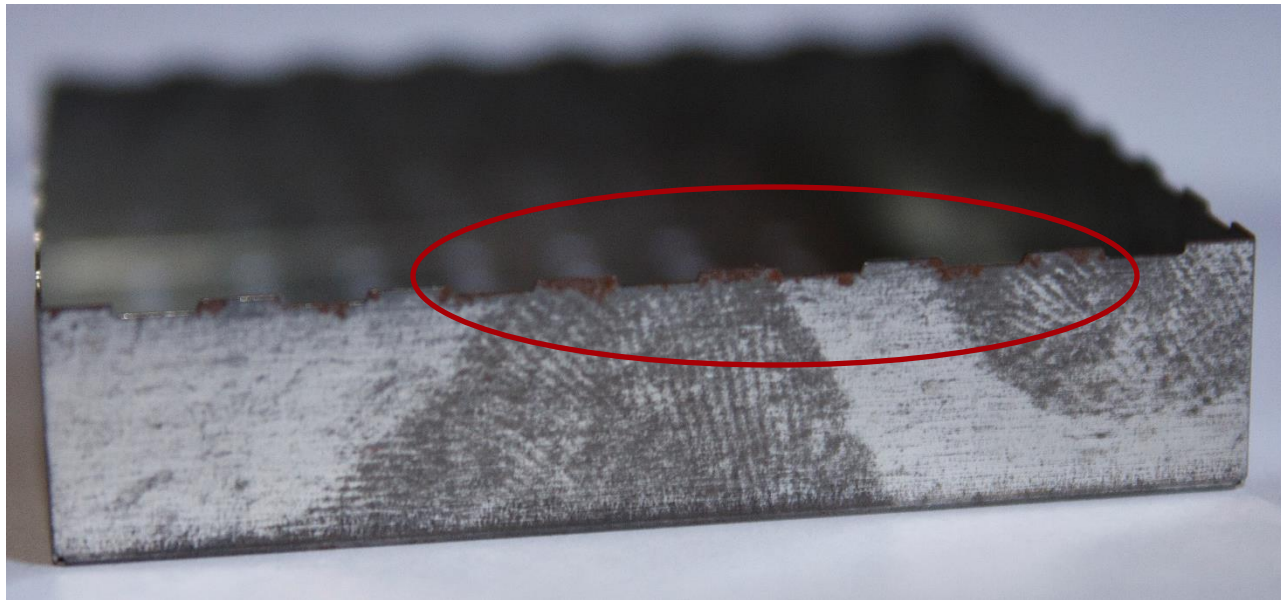


Seamless cabinet



BLS - HUMIDITY ENVIROMENTS

- Humidity Resistance needed?
 - If it is needed, Nickel-Silver material is the key!



Tin plated



Nickel-Silver

BLS - STANDARD DIMENSIONS!

260 + Standard Sizes

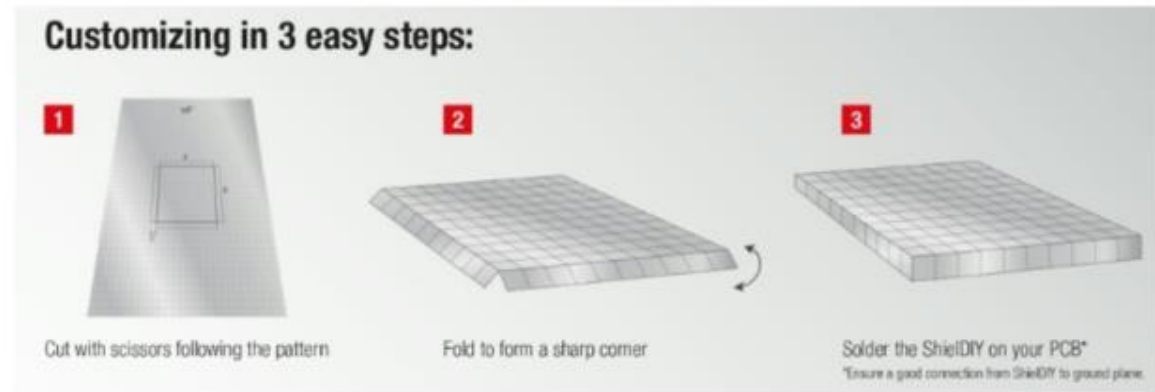


BLS - PROTOTYPING

- Prototyping
 - Shielding cabinet clips → These clips make One piece type and prototyping solutions (DIY Shielding) pluggable
 - DIY Shielding → Pre carved metallic sheets (Nickel-Silver usually) than can be cut and folded. Perfect to test several solutions

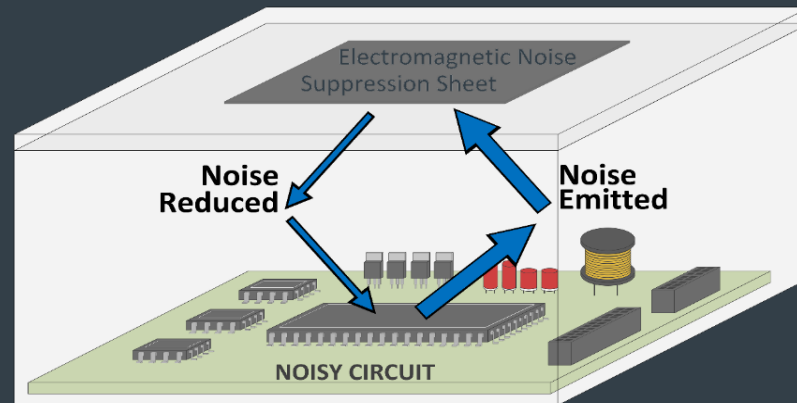


Shielding cabinet clips



DIY Shielding

MAGNETIC ABSORBERS



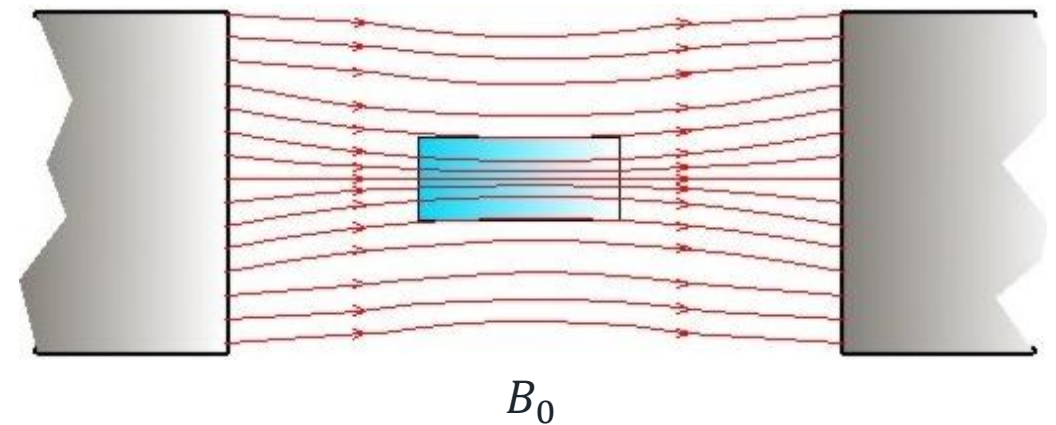
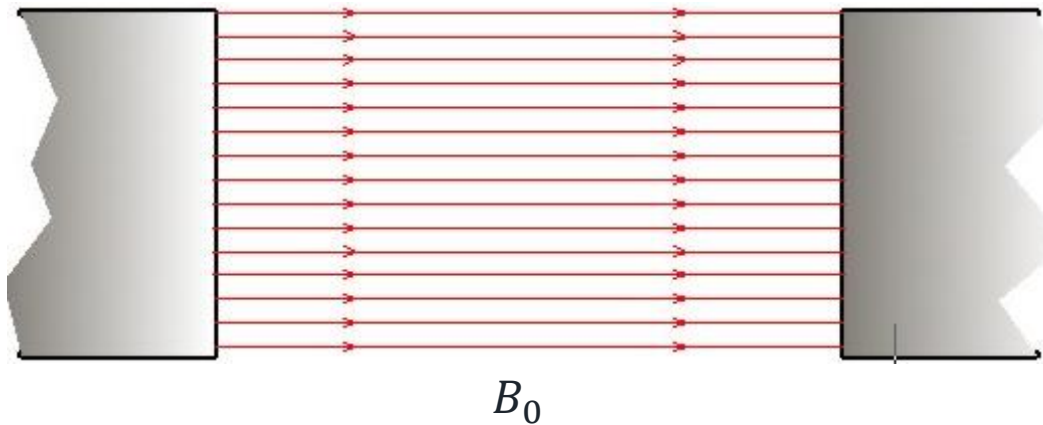
BASIC SHIELDING CONCEPTS

PERMEABILITY

- Any magnetic material has the capability of influencing any magnetic field that surrounds it
 - Relative Permeability μ_r

$$\mu_r = \frac{B}{B_0} = \frac{\mu}{\mu_0}$$

- These materials are more susceptible to a magnetic field than the air surrounding them.
 - Magnetic fields will be more concentrated within them



BASIC SHIELDING CONCEPTS

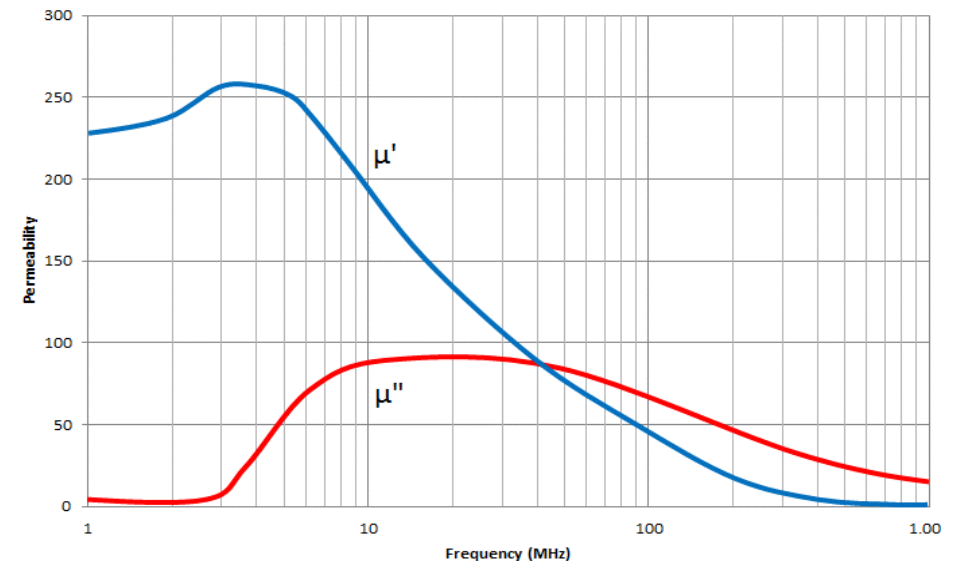
PERMEABILITY

- When μ_r is expressed in its complex form:

$$\mu_r = \mu' - j\mu''$$

Reflection $\xrightarrow{\quad}$ μ' $\xleftarrow{\quad}$ μ'' Absorption

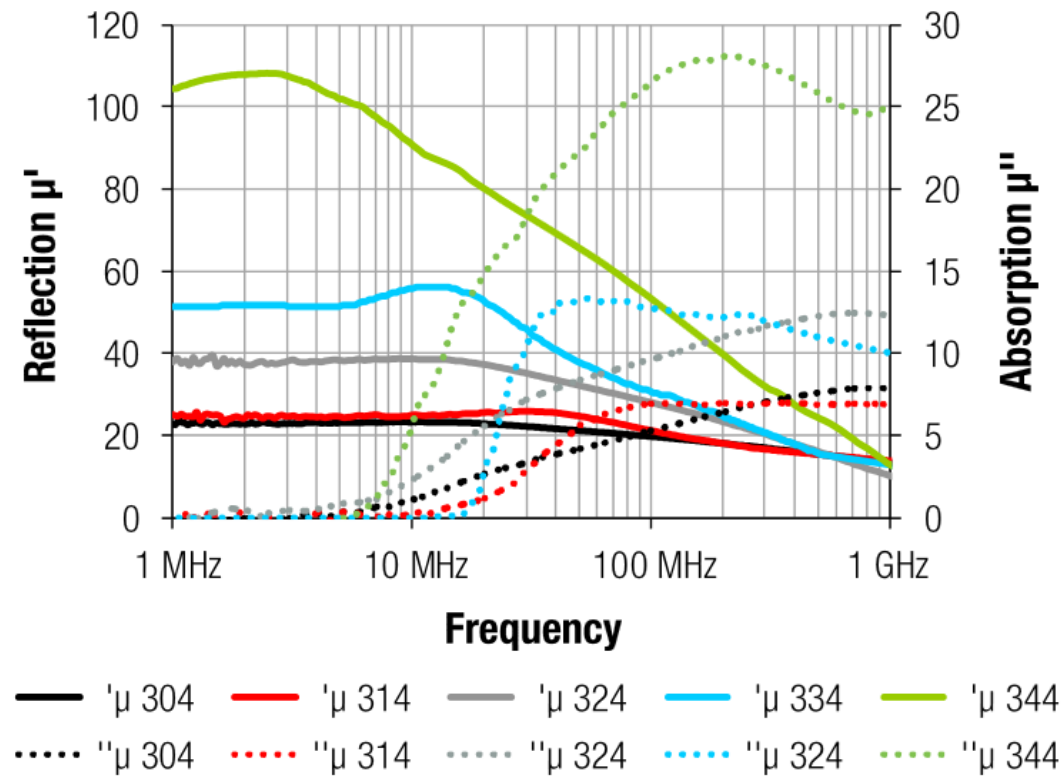
- Depending on the application needs a material can be in a particular set of frequencies:
 - Reflective: concentrate magnetic field
 - Absorber: collect magnetic field and transform it to heat energy



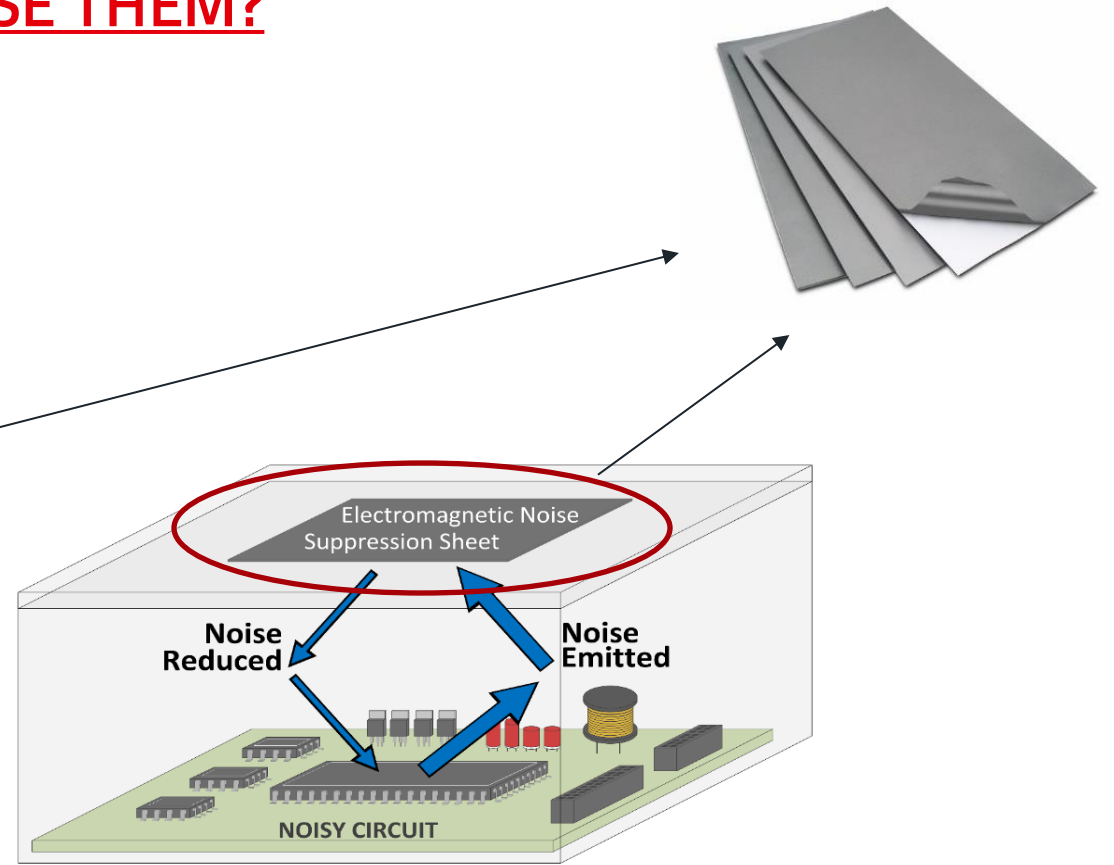
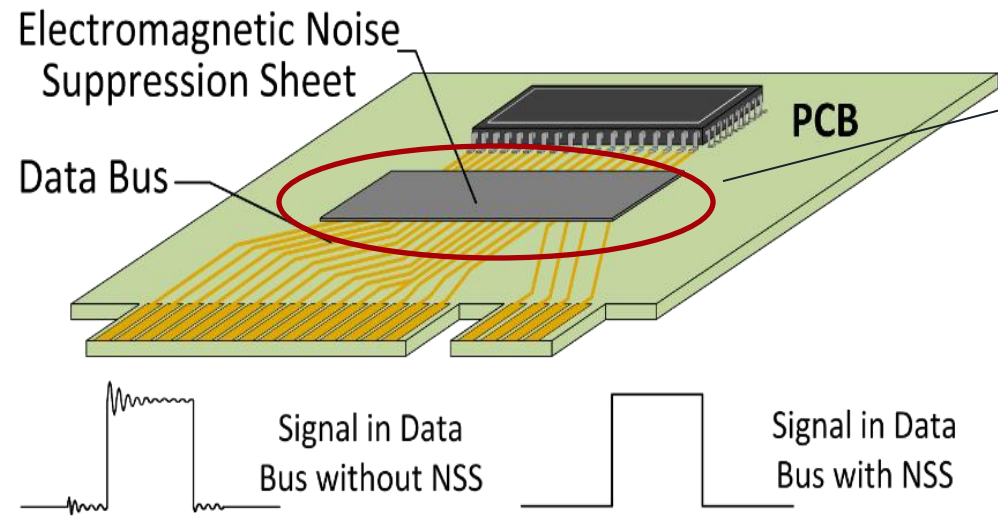
BASIC SHIELDING CONCEPTS

PERMEABILITY

- WE-FAS reflection & absorption



MAGNETIC ABSORBERS - WHERE CAN I USE THEM?

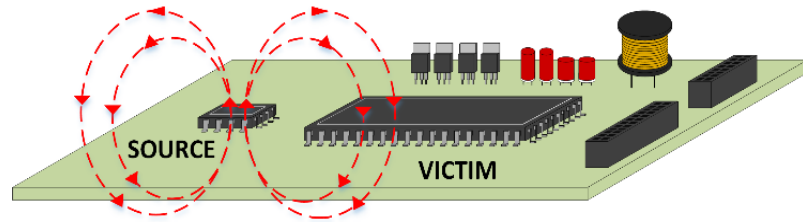


MAGNETIC ABSORBERS - WHAT THERE IS ON THE MARKET?

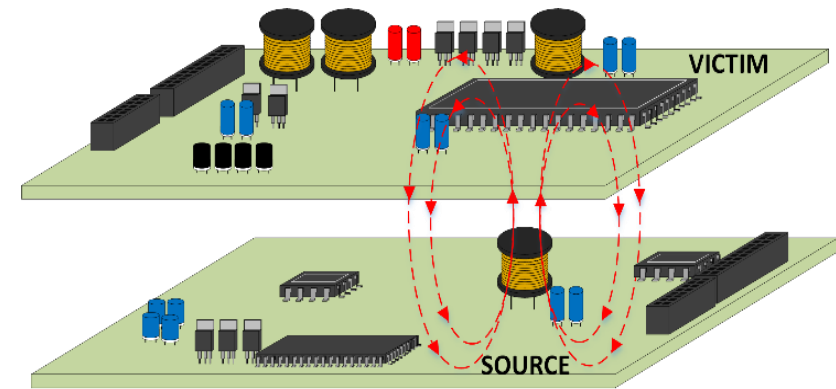
- **Flexible Absorber:** This composite material is formed by a polymer filled with ferrite powder. It offers high flexibility, but their magnetic properties are reduced because of the polymer
- **Flexible Sintered Ferrite Sheets:** They are composed by pre-cracked thin ferrite plates and are the best option for magnetic flux management due to its high permeability at low frequencies



MAGNETIC ABSORBERS - INTERDECOUPLING VS INTRADECOUPLING

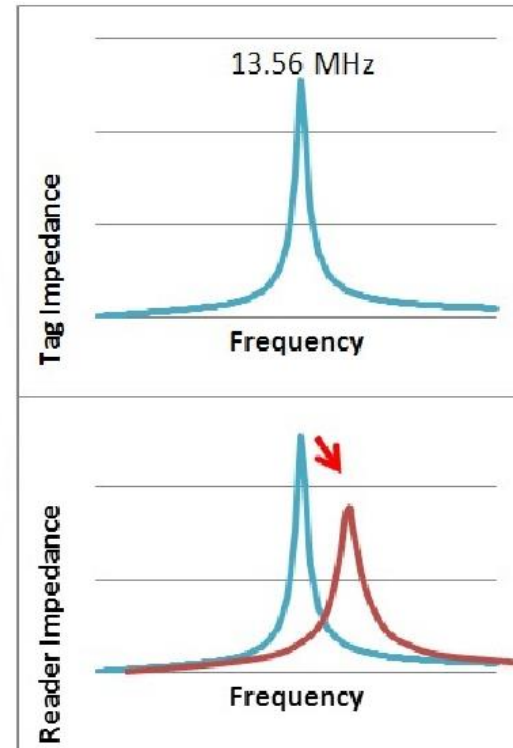
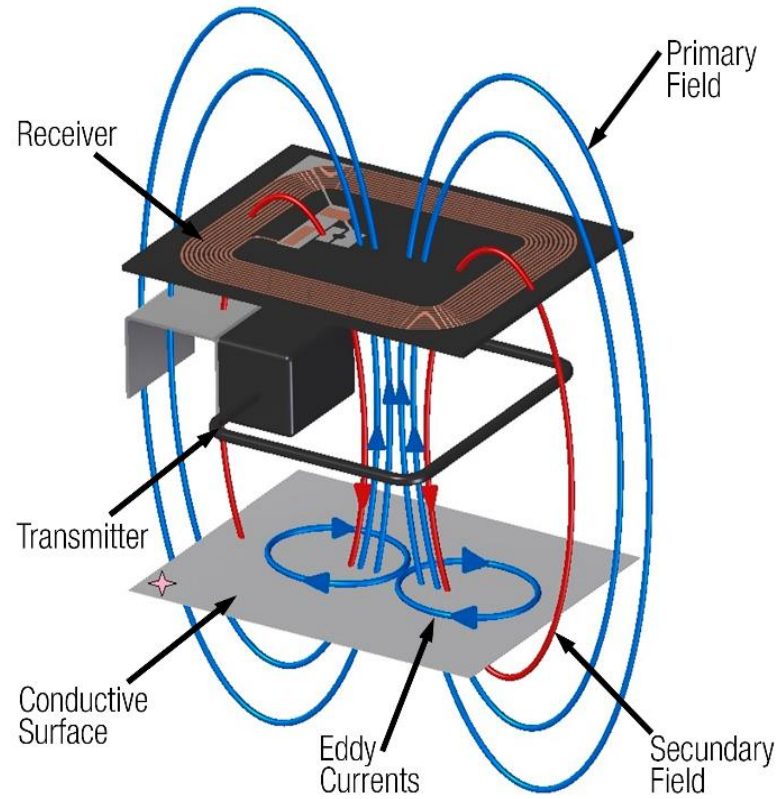


Intradecoupling



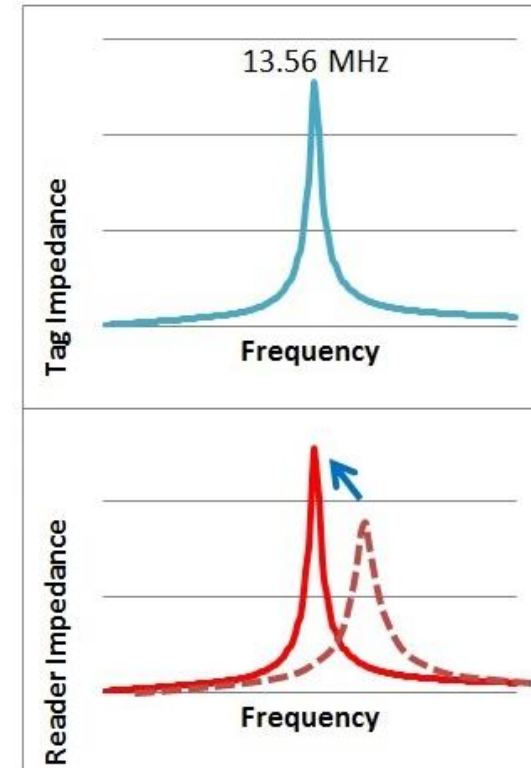
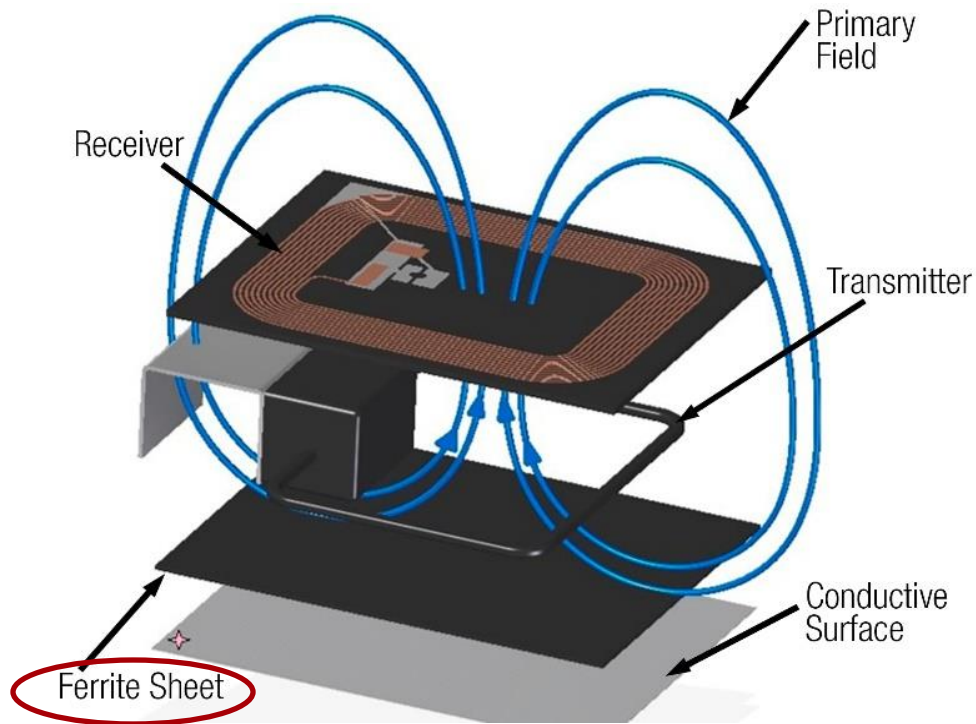
Interdecoupling

MAGNETIC ABSORBERS - NFC/RFID & WIRELESS POWER APPLICATIONS



MAGNETIC ABSORBERS - NFC/RFID & WIRELESS POWER APPLICATIONS

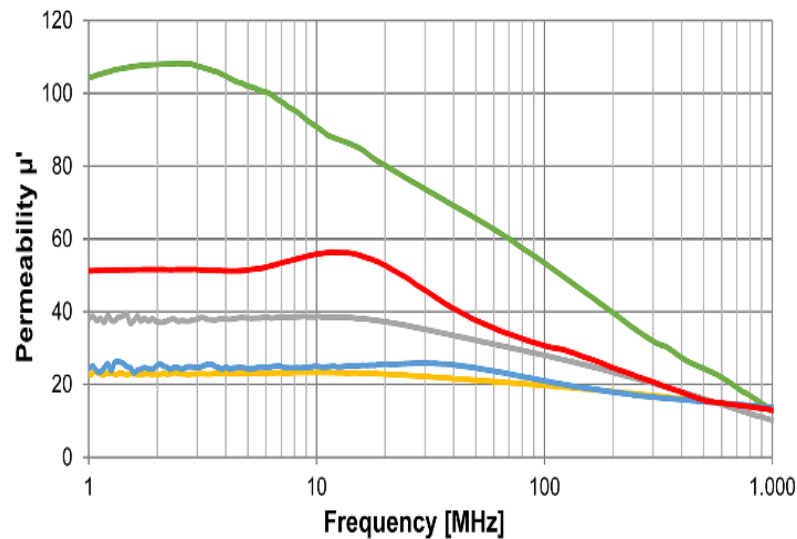
- How we can solve a NFC/RFID problem?



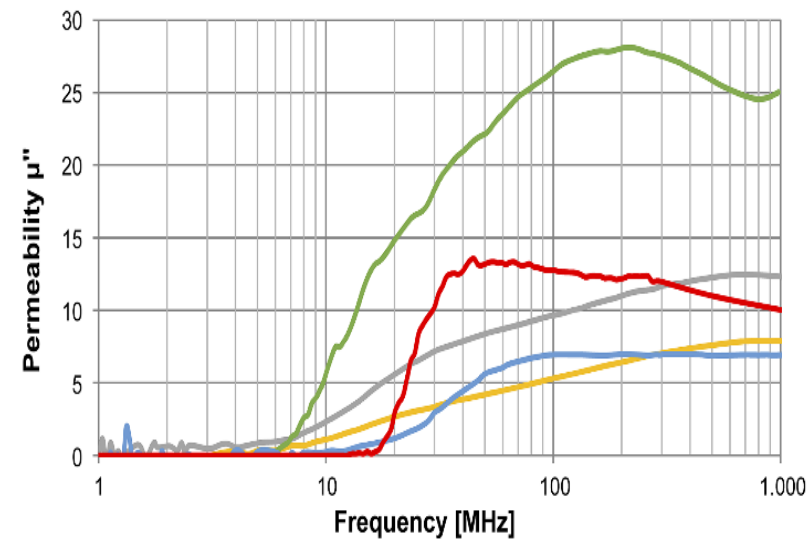
MAGNETIC ABSORBERS – FREQUENCY RANGE

- How we can choose the proper Magnetic Absorber?
- One of the most important parameter that describes the material's ability to absorb electromagnetic noise is the permeability (μ).

$$\mu_r = \mu' - j\mu''$$



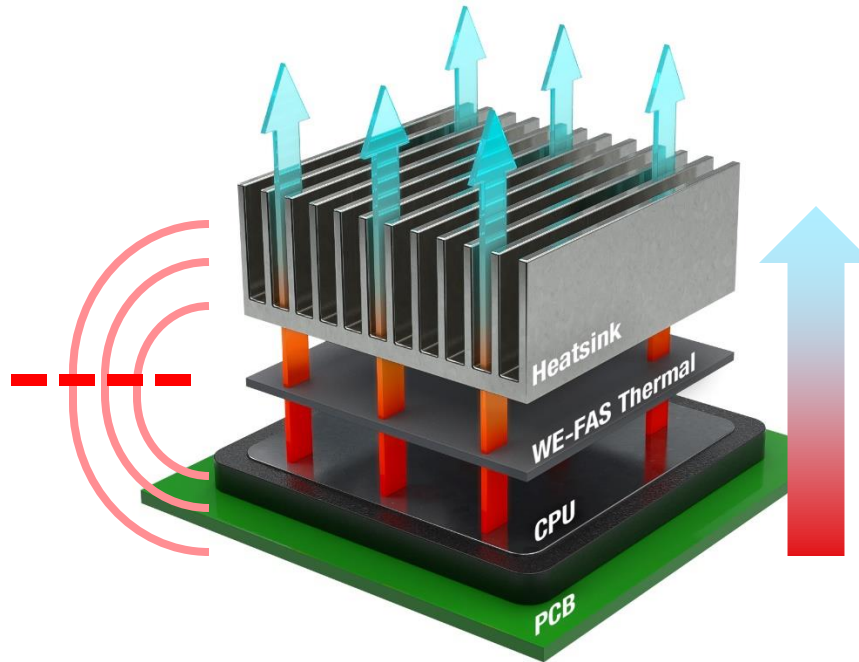
Reflection



Absorption

MAGNETIC ABSORBERS – THERMAL MANAGEMENT

EMI Suppressing
1 MHz – 3 GHz



Thermally Conductive
1.4 W/mK

MAGNETIC ABSORBERS – REDEXPERT! (MAGNETIC SHIELDING)

REDEXPERT

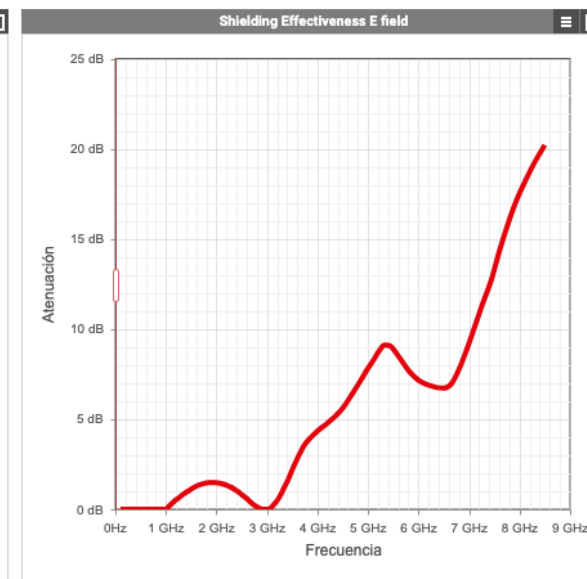
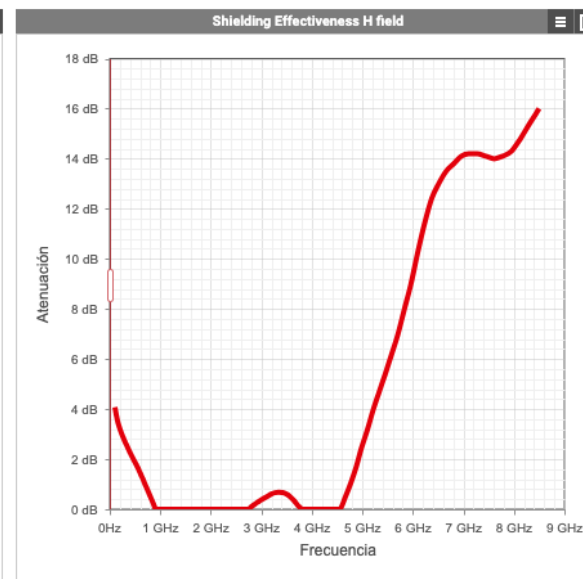
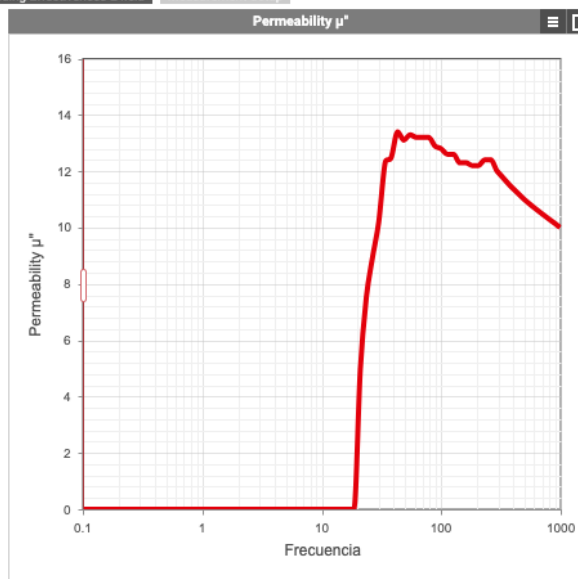
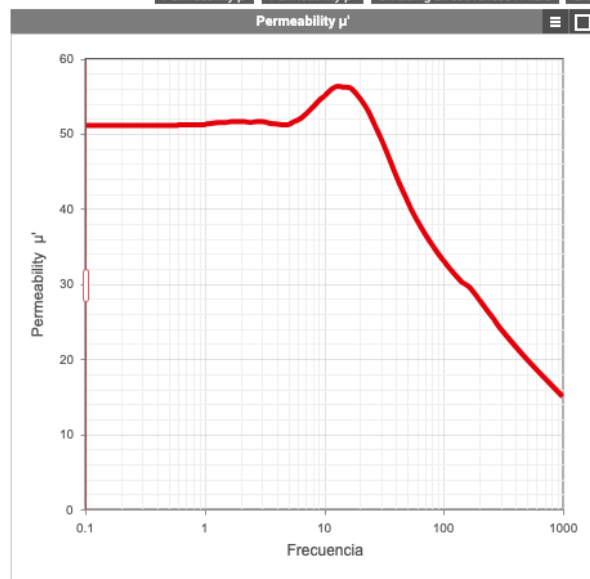
Código	Serie	Spec	L	W	Thick...	Surface Resistance	Peel ...	Ther...	μ' @ ...	μ'' @ ...	μ' @ ...	μ'' @ ...	Adhe...	T _{min}	T _{max}	Flamabi...
371100	WE-EMIP		15000 mm	50,0 mm	0,07200 ...	1,00e+7 Ω/cm2	400 N/cm		87,6	100	9,72	0,0100	0,0100 mm	-25,0 °C	105 °C	No
371101	WE-EMIP		105,00 mm	74,0 mm	0,07200 ...	1,00e+7 Ω/cm2	400 N/cm		87,6	100	9,72	0,0100	0,0100 mm	-25,0 °C	105 °C	No
371102	WE-EMIP		297,00 mm	210 mm	0,07200 ...	1,00e+7 Ω/cm2	400 N/cm		87,6	100	9,72	0,0100	0,0100 mm	-25,0 °C	105 °C	No
31401	WE-FAS RFID		297,00 mm	210 mm	0,1000 mm	1,00e+8 Ω/cm2	400 N/cm		25,0	25,5	1,00	0,0100	0,0300 mm	-20,0 °C	90,0 °C	Yes
31402	WE-FAS RFID		297,00 mm	210 mm	0,2000 mm	1,00e+8 Ω/cm2	400 N/cm		25,0	25,5	1,00	0,0100	0,0300 mm	-20,0 °C	90,0 °C	Yes
31403	WE-FAS RFID		297,00 mm	210 mm	0,3000 mm	1,00e+8 Ω/cm2	400 N/cm		25,0	25,5	1,00	0,0100	0,0300 mm	-20,0 °C	90,0 °C	Yes
33401	WE-FAS RFID		297,00 mm	210 mm	0,1000 mm	1,00e+5 Ω/cm2	400 N/cm		55,0	51,2	1,00	0,0100	0,0300 mm	-20,0 °C	90,0 °C	Yes
33402	WE-FAS RFID		297,00 mm	210 mm	0,2000 mm	1,00e+5 Ω/cm2	400 N/cm		55,0	51,2	1,00	0,0100	0,0300 mm	-20,0 °C	90,0 °C	Yes

Haga clic y escriba o suelte un Código aquí

AÑADIR

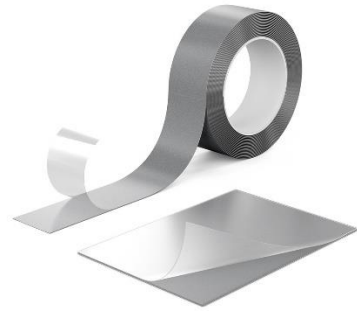
MÁS

Mostrar Panel: **Permeability μ'** Permeability μ'' Shielding Effectiveness H field Shielding Effectiveness E field Measurement Setup

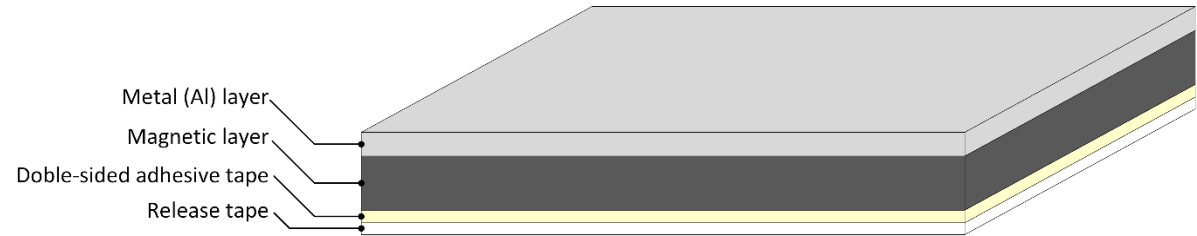


...AND HOW TO SOLVE THEM!

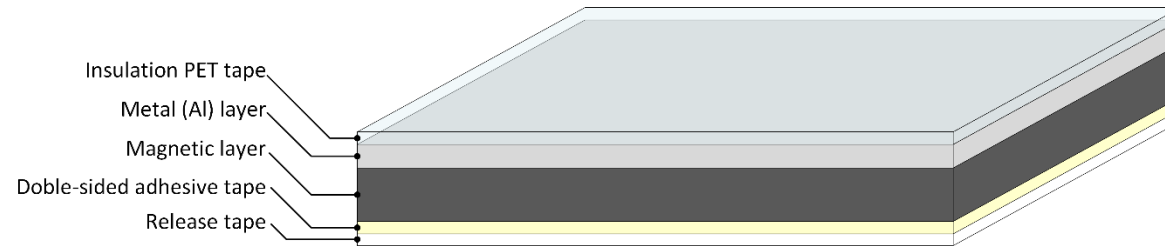
MAGNETIC ABSORBERS – WE-EMI PATCH



EMI Patch
WE-EMIPatch



Non-Isolated Conductive layer



Isolated Conductive layer

...AND HOW TO SOLVE THEM!

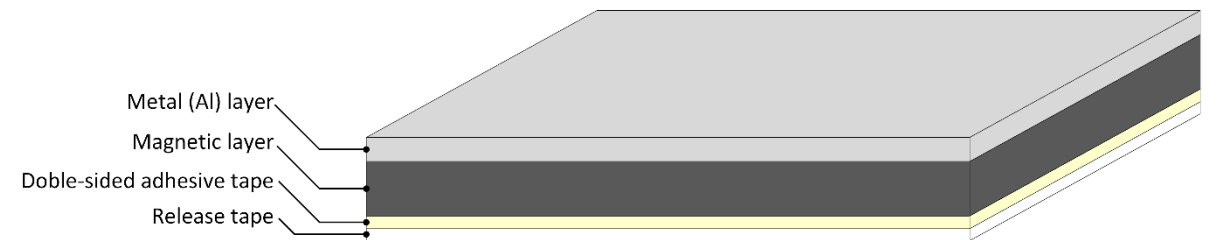
MAGNETIC ABSORBERS – WE-EMI PATCH



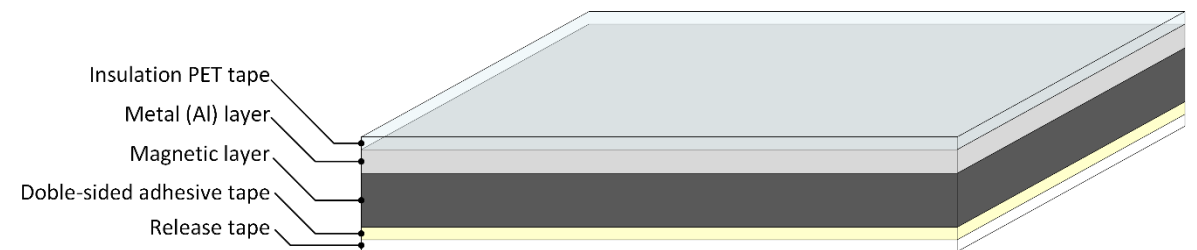
- The EMI Patch™ is the band-aid for EMI.
- Perfectly adaptable solution for testing, EMC Labs and also final production.
- Its application versatility and wide frequency effectivity make it a great product for the racks and labs.

- WE-FAS with metal layer included for better shielding effect in both high and low frequencies.
- Flexible and thin (0.1 mm).
- Easy placing, adhesive tape available as standard.
- Standard sizes on roll and sheet.
- Customizable: dimensions, thickness, layers order, permeability, metal layer,...

- A7 74x105 mm
- 210 x 300 mm
- Roll 50 mm x 15m



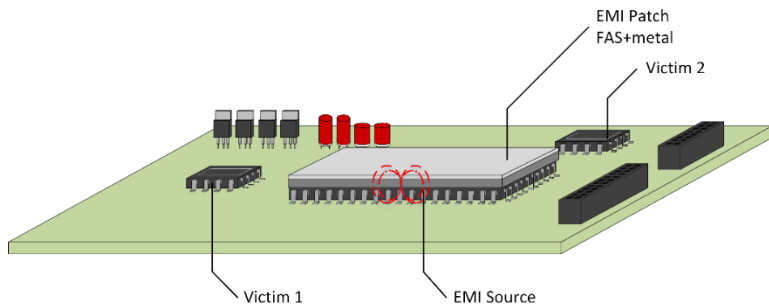
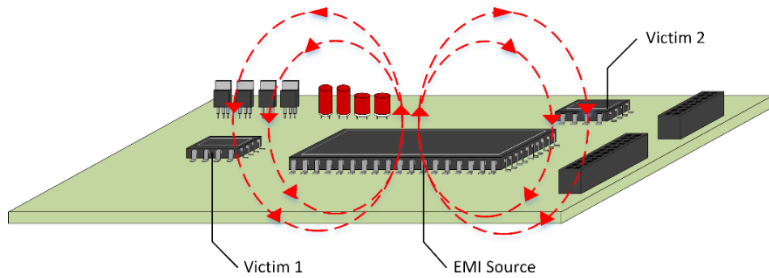
Non-Isolated Conductive layer



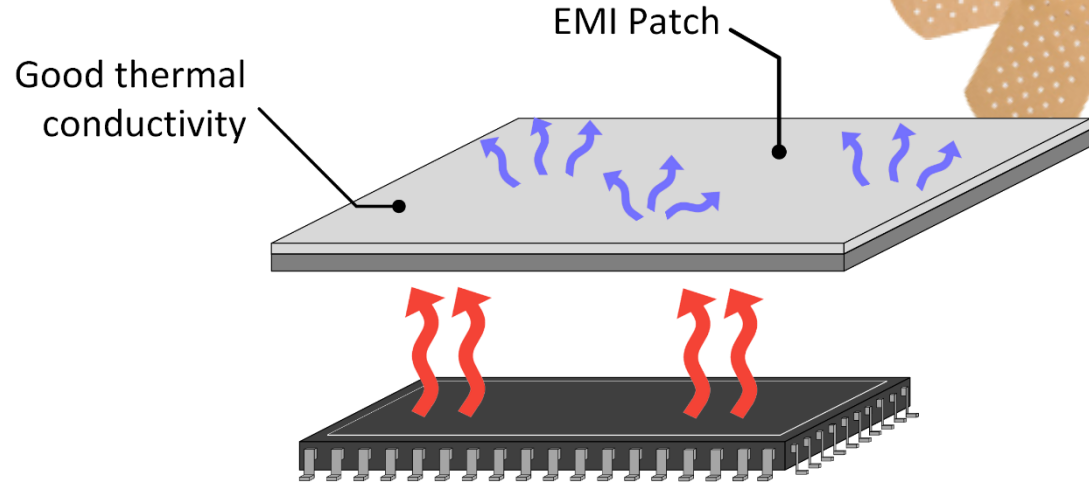
Isolated Conductive layer

...AND HOW TO SOLVE THEM!

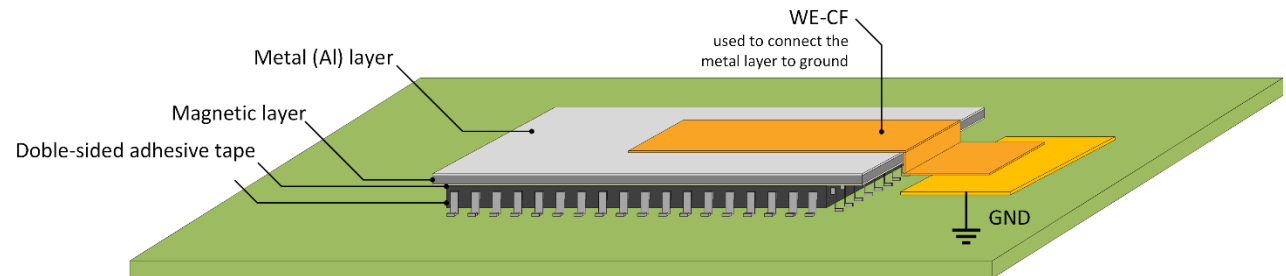
MAGNETIC ABSORBERS – WE-EMI PATCH



High attenuation of EMI



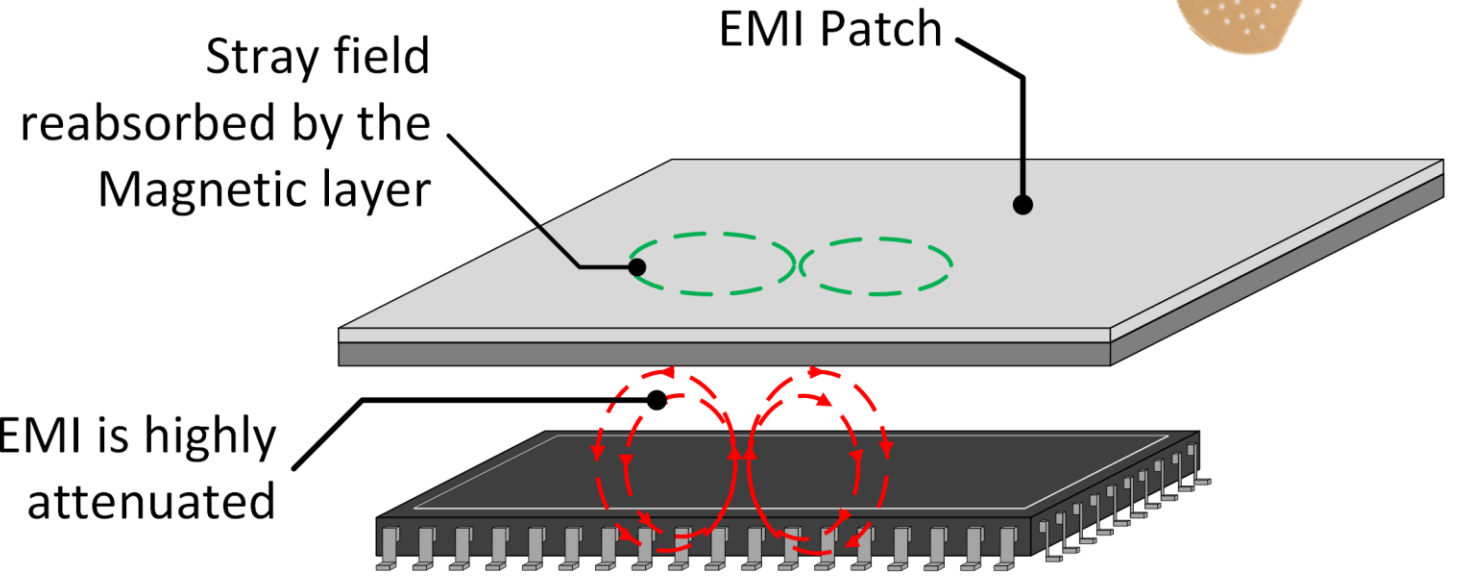
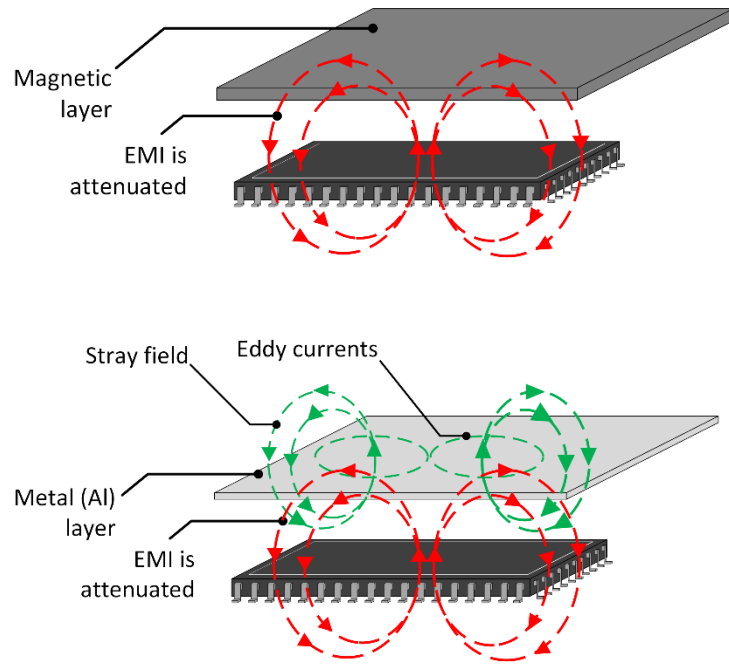
Metal layer helps to dissipate heat



Non-isolated layer allows to make GND connections

...AND HOW TO SOLVE THEM!

MAGNETIC ABSORBERS – WE-EMI PATCH



Grounding the metal layer is not a need

Transmission Attenuation Power Ratio Analysis of Flexible Electromagnetic Absorber Sheets Combined with a Metal Layer

by [Jorge Victoria](#)^{1,2}, [Adrian Suarez](#)^{1,*}, [Jose Torres](#)¹, [Pedro A. Martinez](#)¹, [Antonio Alcarria](#)^{1,2}, [Julio Martos](#)¹, [Raimundo Garcia-Olcina](#)¹, [Jesus Soret](#)¹, [Steffen Muetsch](#)² and [Alexander Gerfer](#)²



...AND HOW TO SOLVE THEM!

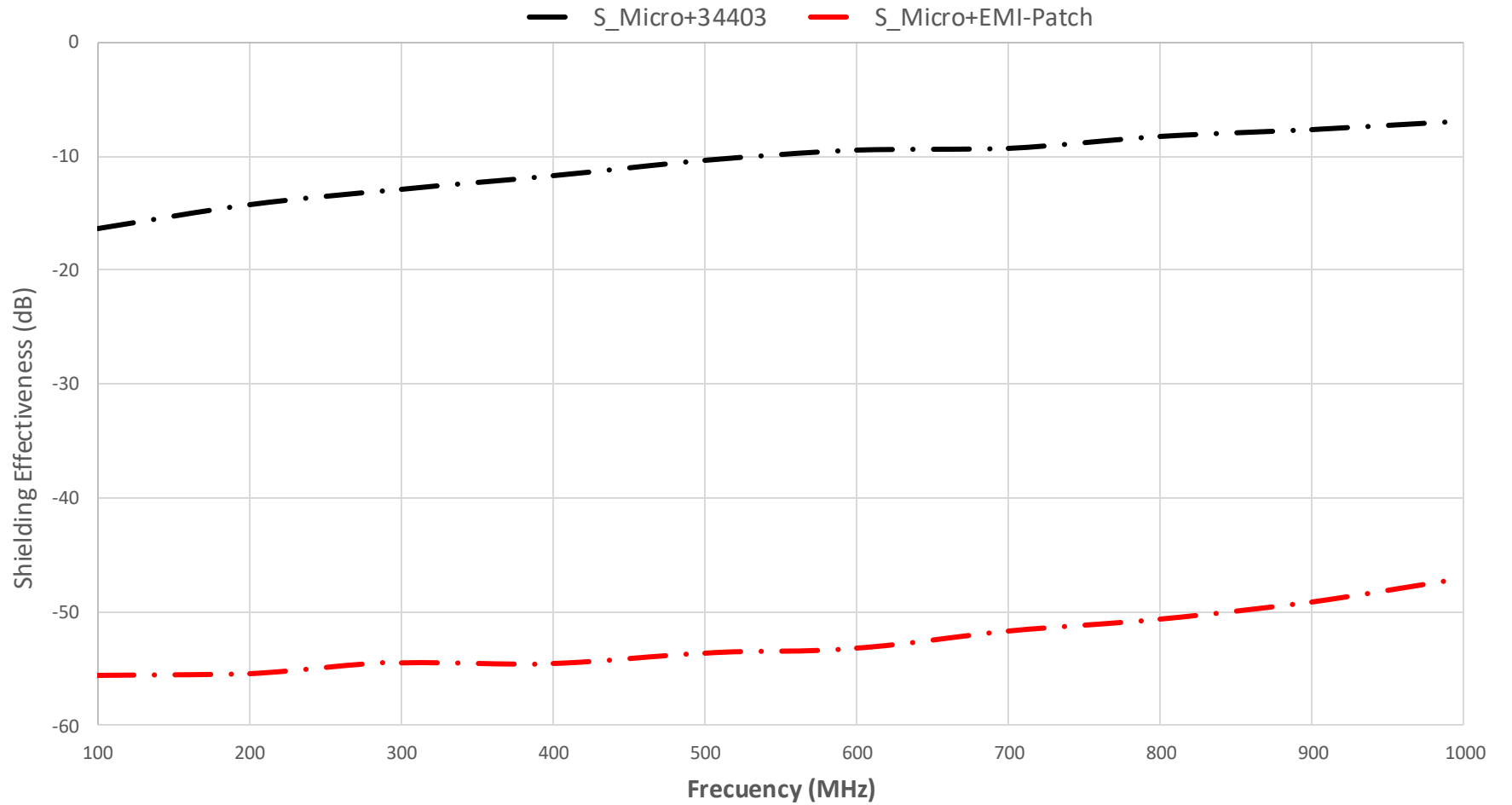
WE-FAS vs WE-EMIP



Flexible Absorber Sheet
(permeability → 100)



EMI Patch



...AND HOW TO SOLVE THEM!

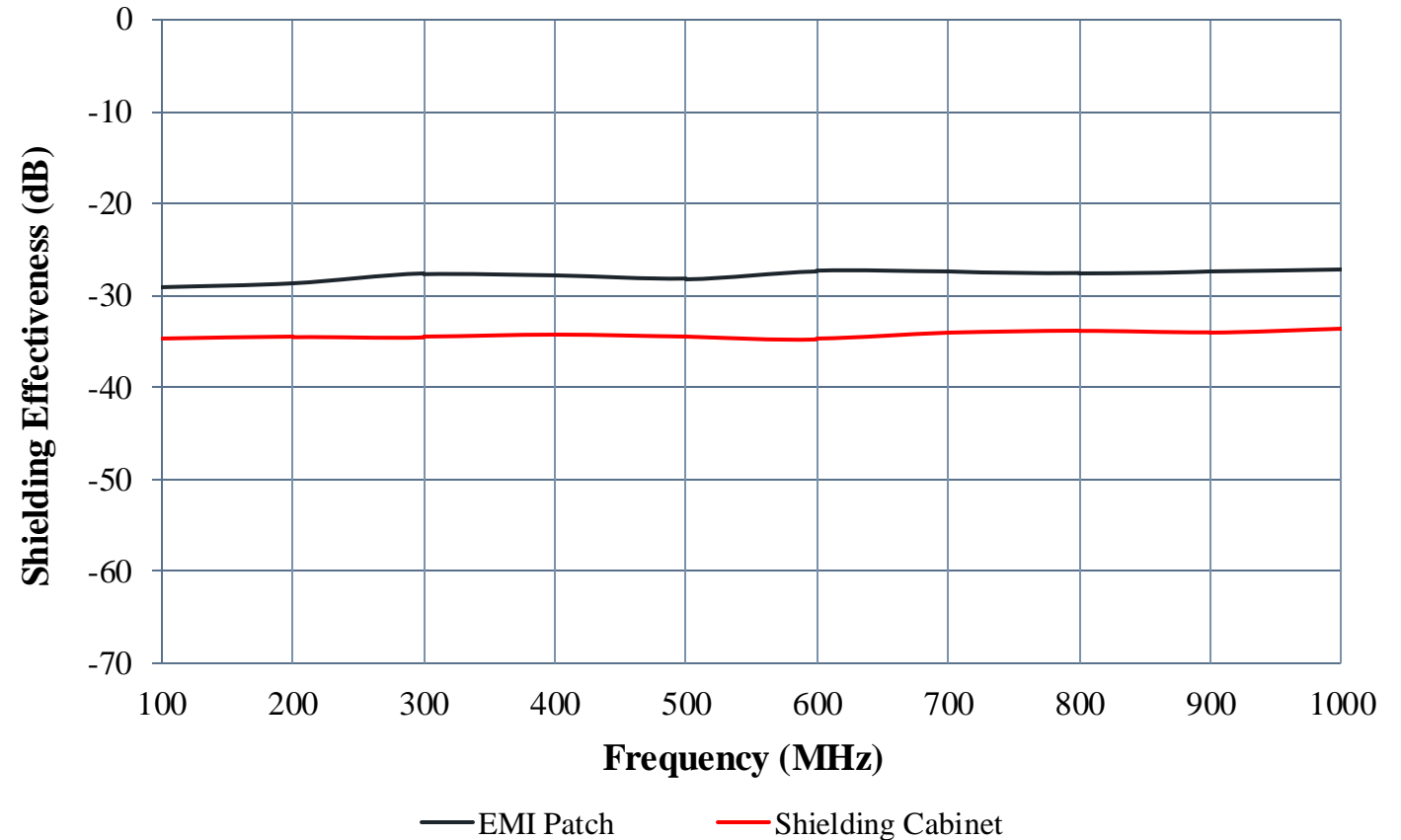
WE-FAS vs WE-SHC Seamless



EMI Patch



Fully Seamless



THANK YOU FOR YOUR TIME!

Qs?

