Conquering Electromagnetic Hurdles

EMC shielding solutions in the automotive sector

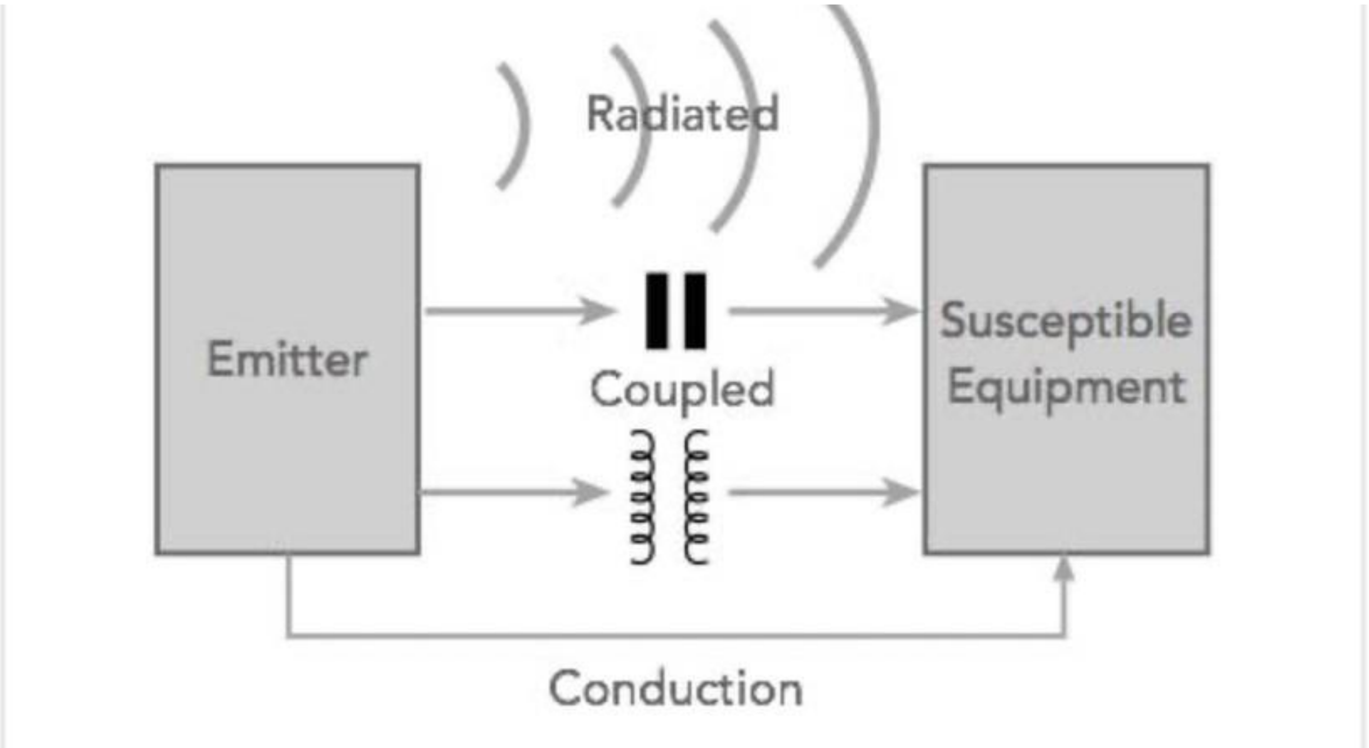
EMC Basics

What is EMC?

"EMC is defined as the ability of devices and systems to operate in their electromagnetic environment without impairing their functions and without faults and vice versa.
Electromagnetic compatibility, EMC ensures that operation does not influence the electromagnetic environment to the extent that the functions of other devices and systems are adversely affected."

EMC Basics

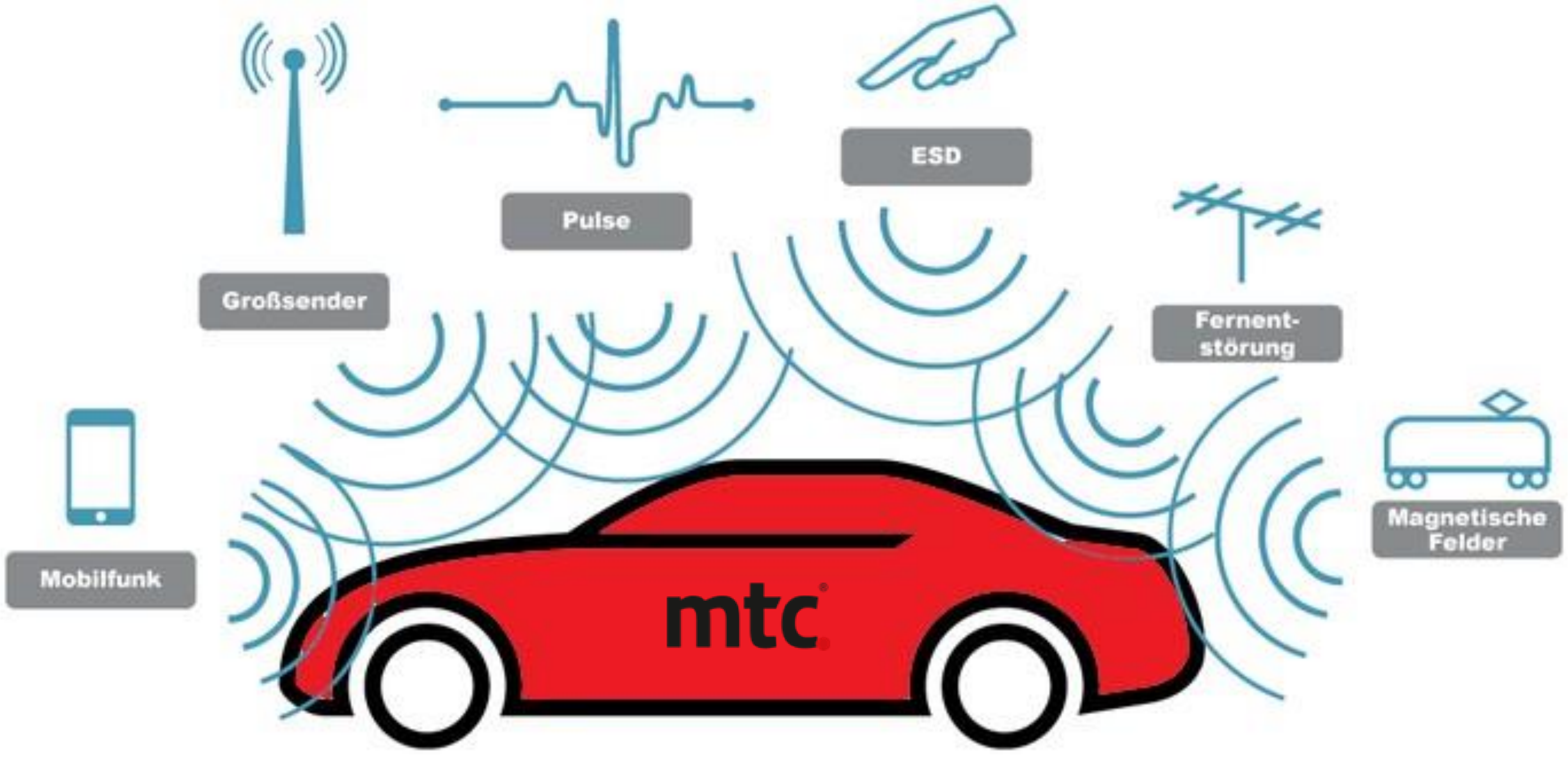
What is EMC?



EMC Basics

Sources of interference?

„The source of interference is a component or a system that creates interfering signals“



„Susceptible equipment is a component or equipment which is influenced by the interfering signal”

EMC Basics

Frequencies and critical slot length

Frequency	Wave length (λ)	Critical slot
1 Hz	300.000 km	15.000 km
10 Hz	30.000 km	1.500 km
100 Hz	3.000 km	150 km
1 kHz	300 km	15 km
10 kHz	30 km	1,5 km
100 kHz	3 km	150 m
1 MHz	300 m	15 m
10 MHz	30 m	1,5m
50 MHz	6 m	30 cm
100 MHz	3 m	15 cm
1 GHz	30 cm	15 mm
3 GHz	10 cm	5 mm
5 GHz	6 cm	3 mm
10 GHz	3 cm	1 mm

Computation of Wave length:

Wave length = Speed of light / Frequency

λ = 300.000km/s / xxx Hz

Critical slot length in industrial applications:

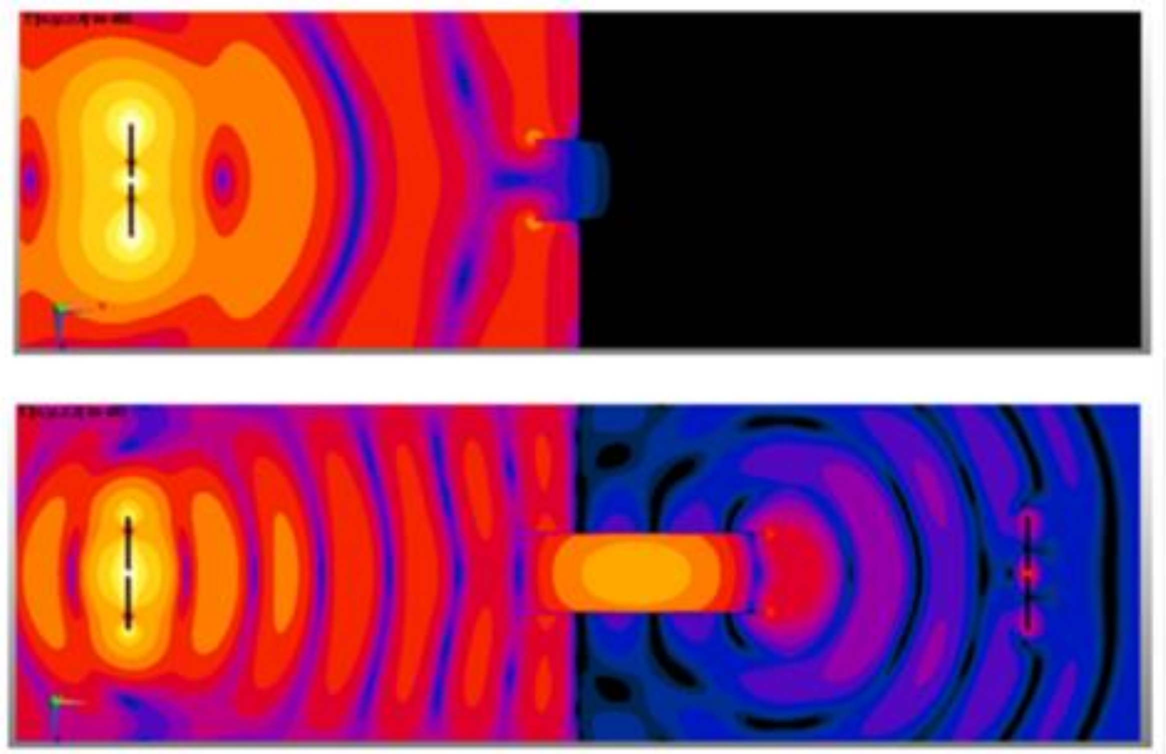
critical slot length x = λ / 20

Critical slot length in military applications:

critical slot length x = λ / 50

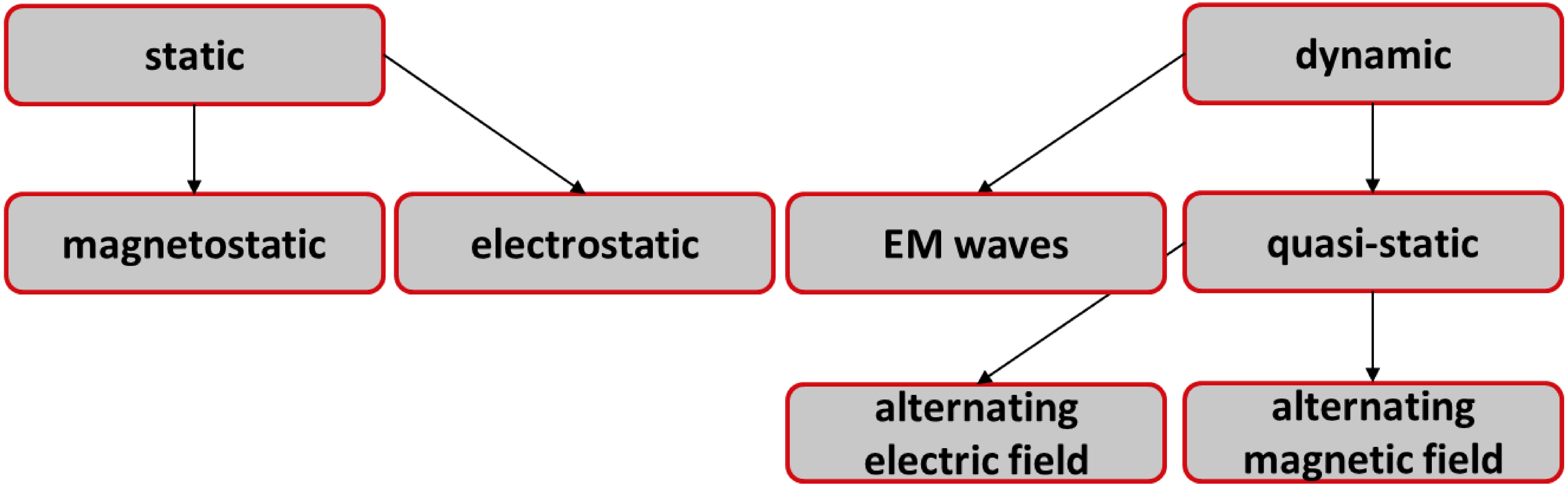
f = 1,28 GHz

f = 2,56 GHz



EMC Basics

Different types of electromagnetic fields



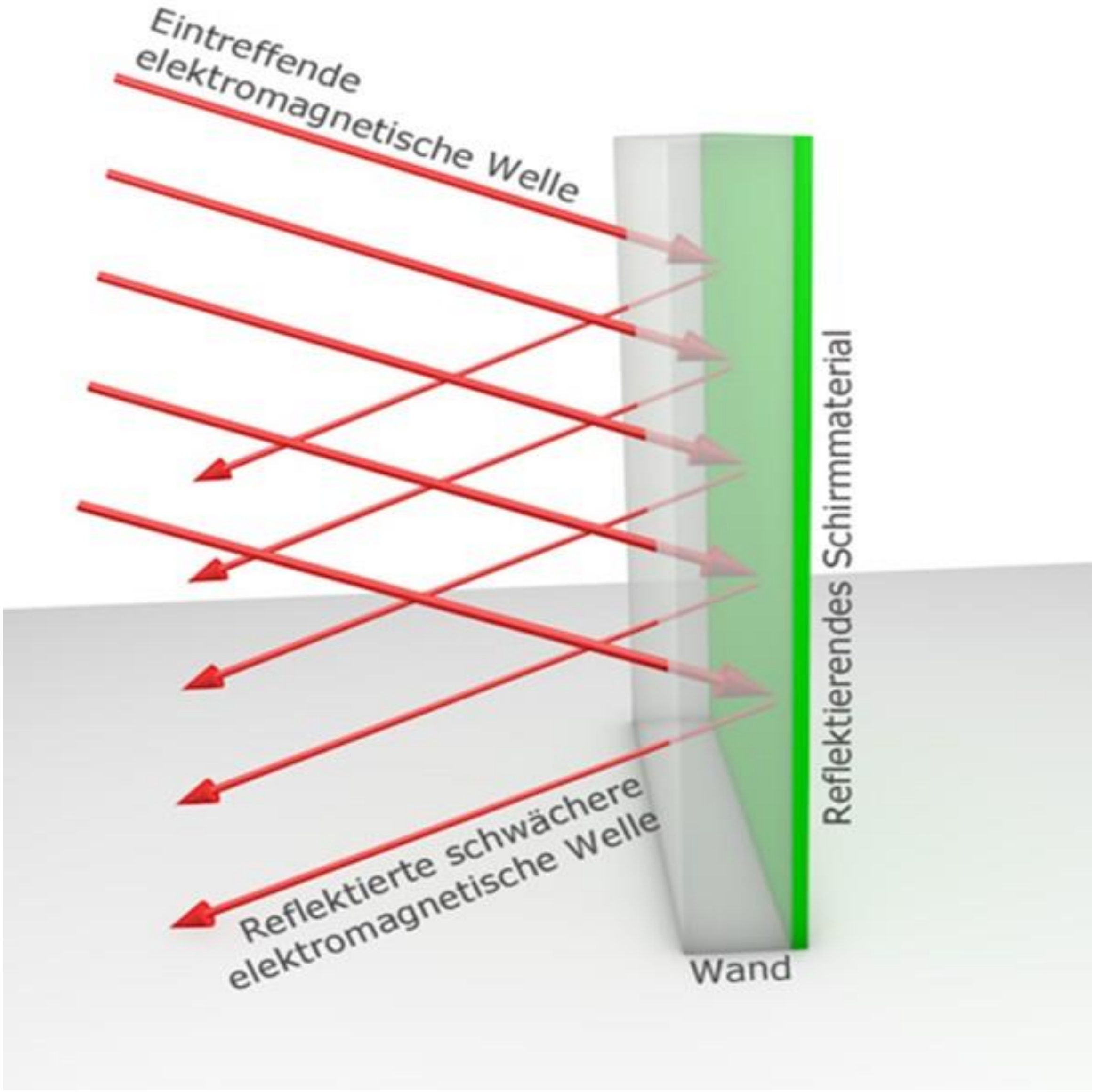
Shielding solutions for different types of electromagnetic fields

electrostatic	**magnetostatic**	**alternating electromagnetic field**	**Electromagnetic wave fields**
$f = 0$	$f = 0$	$f < c_0/d$	$f > c_0/d$
Characteristics: No induction	Characteristics: No induction	How to shield:	How to shield:
Shielding achievable with a Faraday cage	Shielding achievable with high permeability materials	Electrodynamic shield	Electrodynamic shield, absorbtion, reflection

Solutions to minimize slots

Slow alternating magnetic fields:
using high permeability materials in a sufficient thickness

Alternating electromagnetic fields:
overall a high electrical conductivity
With increasing frequencies, the thickness of the material becomes less relevant, whereas the effects of slots within the shield increase



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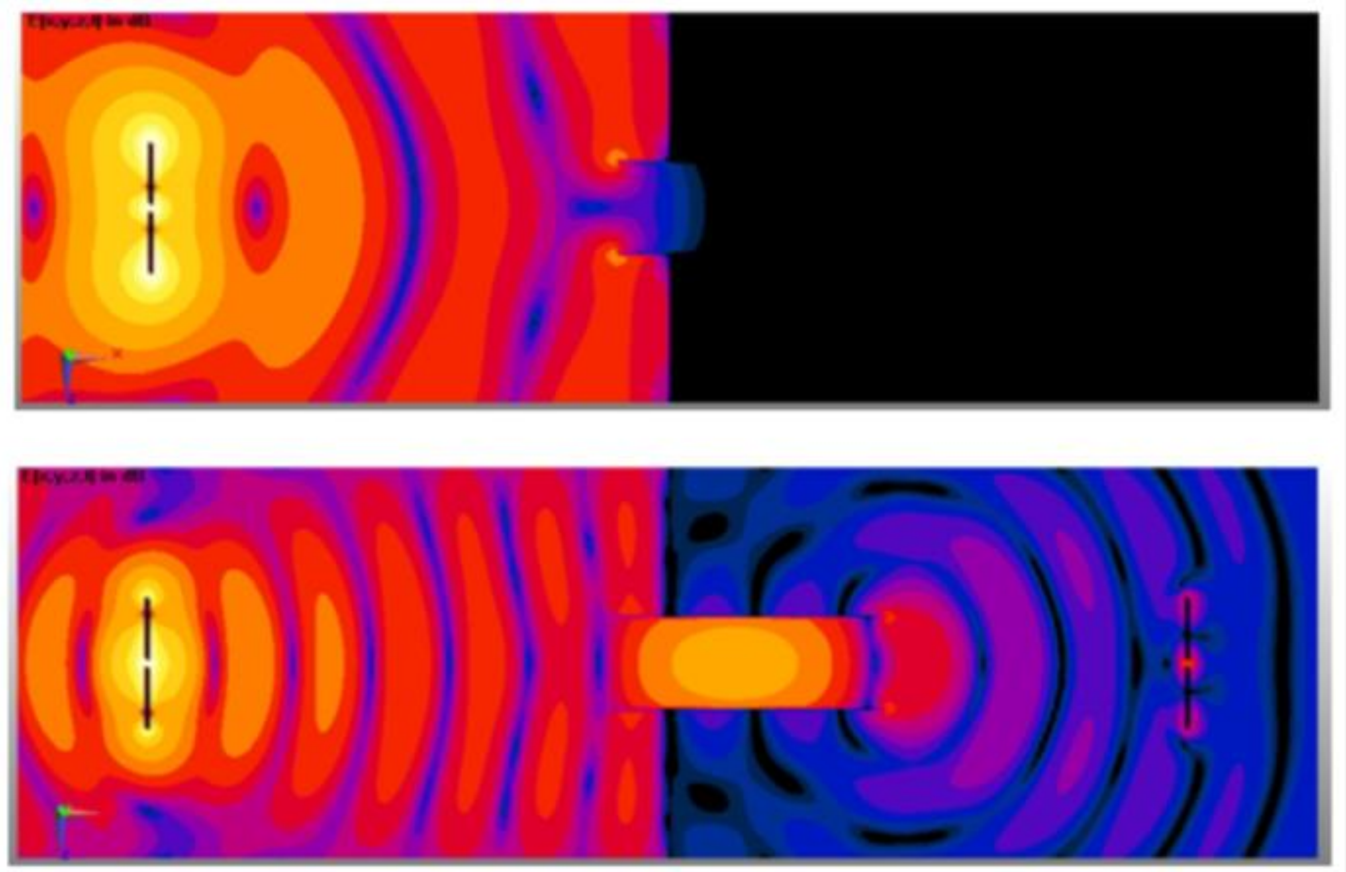
Minimizing Slot lengths for HF Applications

Best possible solutions:
Creating a mostly seamless casing.
This can best be achieved by welding or soldering the components.

Issues:
While these procedures create the most seamless casings, the reality is, that for most applications, it is either too impractical or too expensive as they require a large amount of labor and restrict the flexibility of the final product.

f = 1,28 GHz

f = 2,56 GHz



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Typical Problems in the Automotive Industry

Economical requirements:
Due to the economic pressure and the efficiency requirements for the product, aluminum and polymers are the preferred materials nowadays.

Durability requirements:
The durability of cars needs to exceed more than a decade, despite the influences of different types of corrosion, and abrasion, also affecting the choice of materials

Maintenance requirements:
For maintance purposes, the assembly and disassembly of modules need to be guaranteed. Therefore restricting the possible methods of connecting components.

Corrosion Issues –Galvanic Corrosion

Basics:
Galvanic corrosion is dependent on the electrochemical potential of the metal, as well as the electrolytic compounds of the environment.
The larger the difference in their electrochemical potential, the higher the rate of corrosion.

Hauptwerkstoff / Kontaktwerkstoff	Flächenverhältnis	Kupfer / Kupfer-Beryllium	Edelstahl	Zinn	Zink	Gold	Silber	Nickel	Aluminium	Baustahl	Stahlguß	Niedriglegierter Stahl	Chromstahl	Carbon	Graphit	Monel	Magnesium
Kupfer / Kupfer-Beryllium	klein		K	K	S	G	G	K	S	S	S	S	S	M	M	G	S
	groß		G	K	G	K	K	G	S	G	K	G	K	G	G	K	S
Edelstahl	klein	K		K	S	G	G	G	S	S	M	M	M	G	G	G	S
	groß	G		K	G	K	K	K	M	G	G	G	G	G	G	K	S
Zinn	klein	S	G		S	M	M	M	K	S	S	G	M	M	M	M	S
	groß	M	M		G	G	G	G	S	G	G	M	G	G	G	G	S
Zink	klein	G	G	G		S	S	S	M	G	G	G	G	S	S	M	S
	groß	G	G	G		S	S	S	M	G	G	G	G	M	M	M	M
Gold	klein	G	G	M	S		K	G	M	M	M	M	G	G	G	G	M
	groß	K	G	G	M		K	K	M	M	M	M	G	K	K	K	G
Silber	klein	G	G	M	S	K		K	M	M	M	M	G	K	K	G	M
	groß	K	K	G	M	K		K	M	M	M	M	G	K	K	K	G
Nickel	klein	K	G	G	S	G	G		M	M	M	M	G	G	G	K	S
	groß	K	K	G	S	K	K		M	M	M	M	G	G	G	K	S

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Corrosion Issues –oxidation Corrosion

Types of metal oxidation:

Precious metals – barely any oxidation (gold, silver, e.g.)

Less precious metals – rust, verdigris (iron, copper)

Base metals – creation of an insulating, oxidized layer (aluminum, zink, tin)

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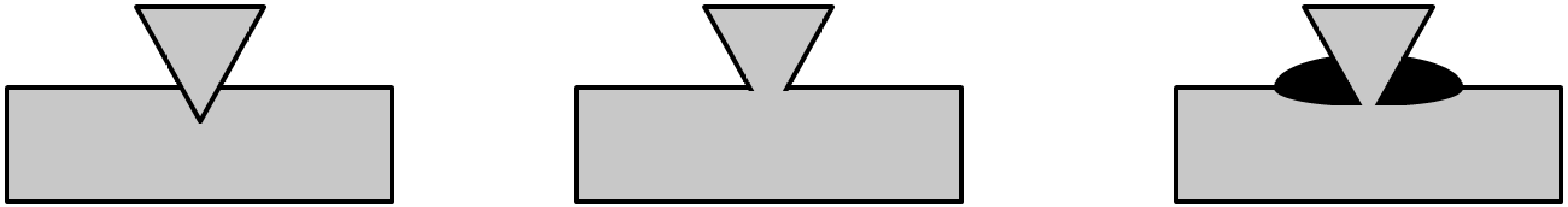
Corrosion Issues –oxidation Corrosion

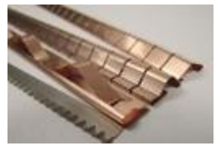
Fretting:

Caused by high amounts of vibration, fretting is the result of oxidation layers breaking and reoxidizing – therefore creating more and more insulating metaloxides.



EMC gaskets

Fabric over Foam gaskets



Contact spring strips

Electrically conductive elastomers

Knitted wire gaskets

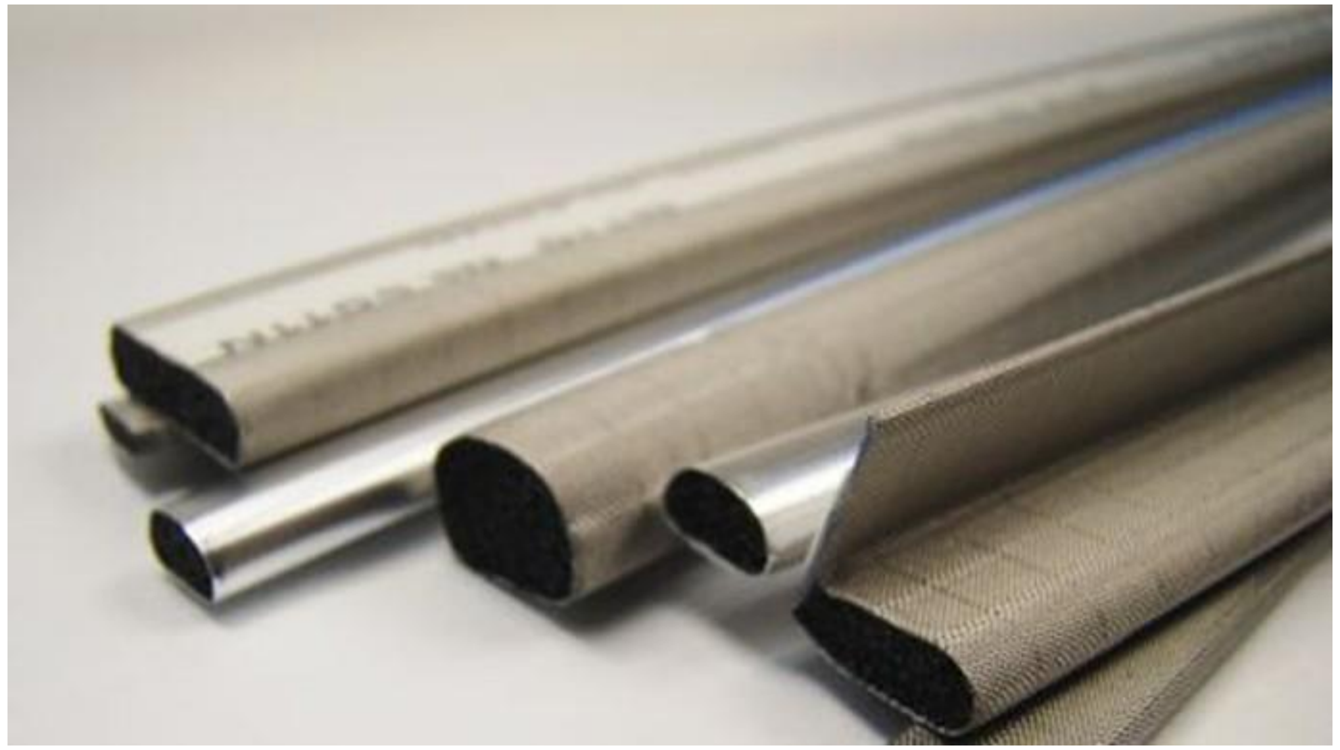
Types of Gaskets – Fabric over foam

Advantages:

- low contact pressure required
- Great for large component tolerances
- Cheap solution

Disadvantages:

- Elasticity being affected by temperature and time
- low conductivity
- Barely any effect against oxidized layers
- Only suitable for low currents



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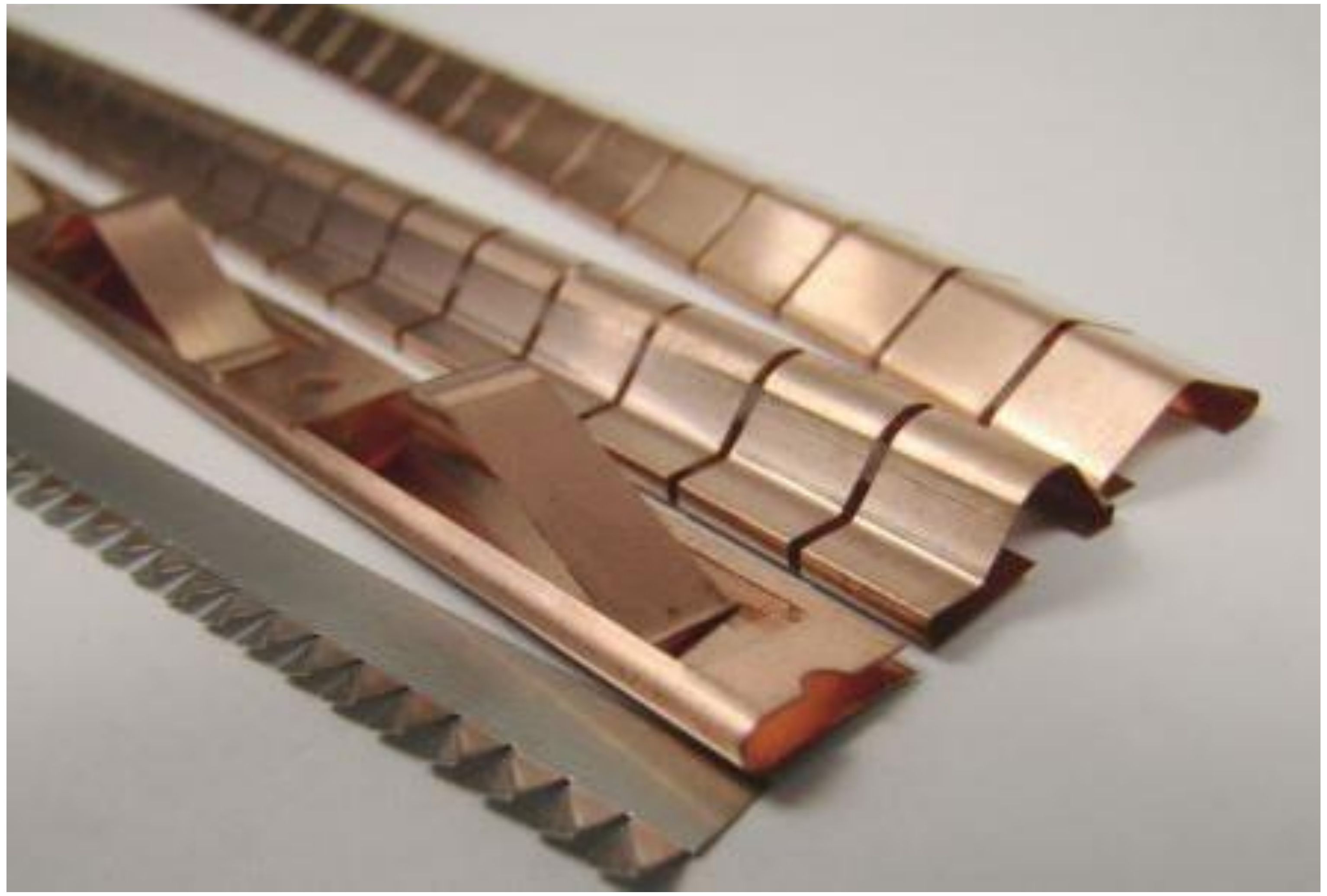
Types of Gaskets – contact springs

Advantages:

- Great contact properties
- Long time durability
- Ability to transport high currents

Disadvantages:

- Highly affected by mechanical damages
- Not suited for high component tolerances
- No IP class
- Expensive



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Types of Gaskets – Wire gaskets

Advantages:

- Good electrical conductivity
- Very resiliant to large deformations
- Ability to transport large currents
- Effective against oxidated layers

Disadvantages:

- high contact pressure required
- Only suitable for lower IP classes
- Weak to shear forces

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Types of Gaskets – Conductive Polymers

Advantages:

- Low contact pressure required
- Great for large component tolerances
- Protection against oxidation and galvanic corrosion
- Electrical conduction combined with high ingress protection

Disadvantages:

- Elasticity being affected by temperature and time
- Low conductivity
- No effect against oxidized layers

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Join us at our booth for an exclusive demonstration showcasing our EMC/EMI scanning solutions

Exploring EMC/EMI Issues with Real Time Scanning Techniques from Y.I.C Technologies

Are you ready to revolutionize your design testing process and take control of your EMC/EMI challenges? Acal BFi and our partner Y.I.C Technologies invites you to an exclusive demonstration that will change the way you approach testing and problem-solving.With a bench-top scanner from Y.I.C. Technologies, design teams can personally test their designs without the need to rely on another department, a test engineer, or off-site testing. This solution is both time-efficient and cost-effective, offering a superior alternative to chambers or manual probe testing. The scanner empowers design engineers to diagnose and visualize the root causes of potential EMC/EMI issues within the range of 150 kHz to 8 GHz, delivering repeatable and dependable results that identify the cause of a design failure in less than a second.

Thank you!

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