EUROPEAN UGM 2011

KATHREIN RFID

Embedded UHF RFID Transponder into the Layout of a Printed Circuit Board

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Outline

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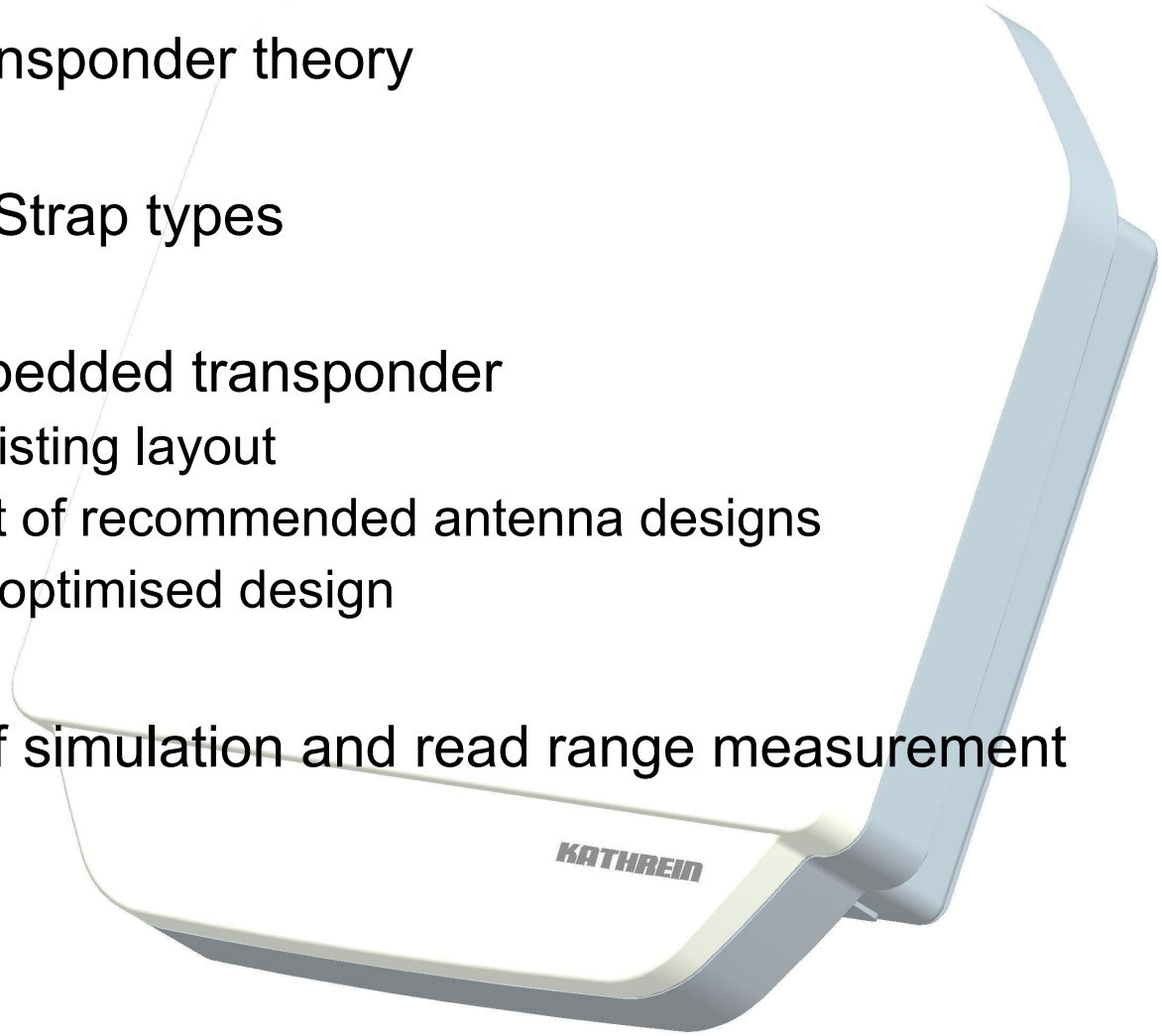
1. UHF RFID transponder theory

2. Murata MagicStrap types

3. Design of embedded transponder
   a. Import of existing layout
   b. Assessment of recommended antenna designs
   c. CST based optimised design

4. Comparison of simulation and read range measurement

5. Conclusion



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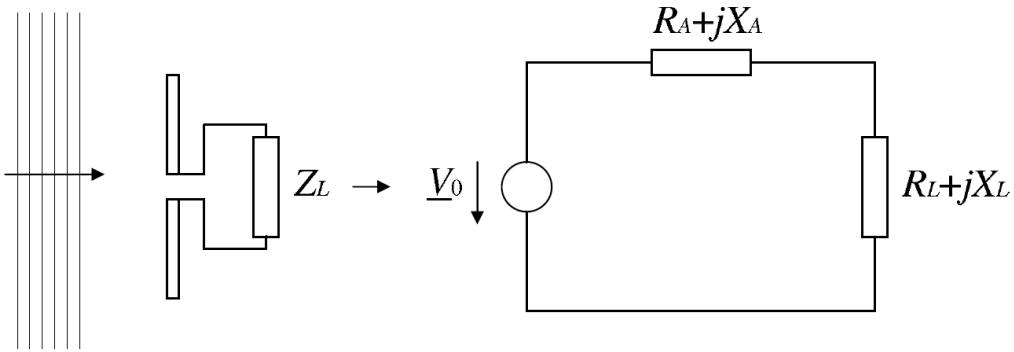
Simplified transponder equivalent circuit



Power delivered to the load

$$P_L = \frac{1}{2}\frac{|V_0|^2}{4R_A} \cdot g(\Delta, \Gamma)$$

Transmission coefficient (TC)

$$g(\Delta, \Gamma) = \frac{4\Delta}{(1+\Delta)^2 + \Gamma^2}$$

$$\Delta = \frac{R_L}{R_A}, \Gamma = \frac{X_A + X_L}{R_A}.$$

Transmission coefficient:

shows the amount of power delivered to the load

TC equals 0 (0%) – no power is transferred to the load

TC equals 1 (100%) – the available power is transferred to the load

2. Murata MagicStrap® Types

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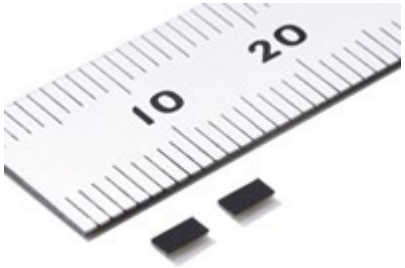

SMD RFID module, which incorporates a standard IC and enables the traceability of PCBs from the first manufacturing step

Impedances at minimum operating power

			Type1	Type2	Type3	Type4
Parameter		MAGICSTRAP® P/N	LXMS31ACNA - 009 LXMS31ACNB - 019	LXMS31ACNA - 010 LXMS31ACNB - 020	LXMS31ACNA - 011 LXMS31ACNB - 021	LXMS31ACNA - 012 LXMS31ACNB - 022
Impedance value	@866.5 MHz	R	15	12	25	80
		X	-45	-107	-200	-405
	@915.0 MHz	R	25	12	25	80
		X	-45	-107	-200	-420
	@953.0 MHz	R	30	9	20	60
		X	-48	-105	-195	-425

MAGICSTRAP® Technical Data Sheet

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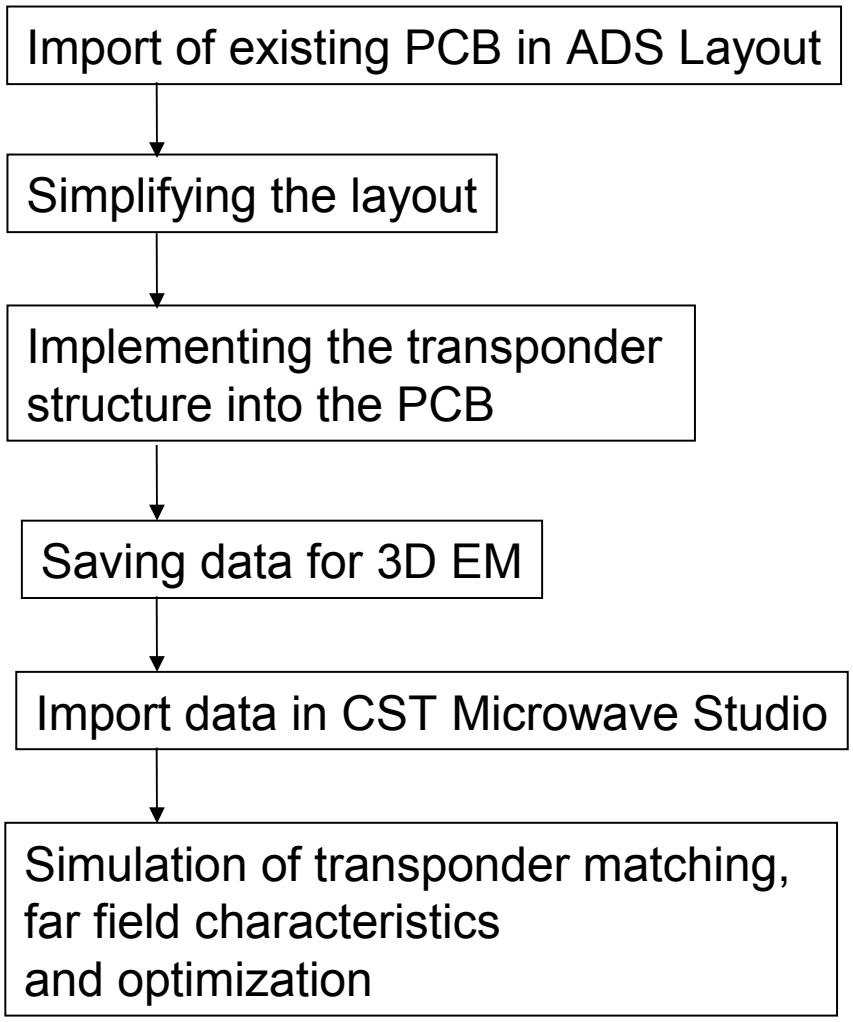
Design steps



Goal

To obtain a high TC, not only for a single PCB, but also for the boards in a panel with multiple PCBs

3.a Import of existing layout

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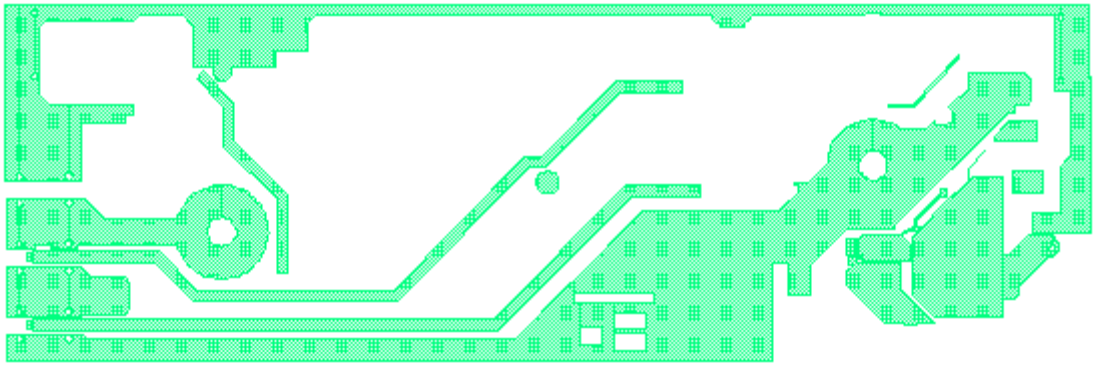
Import of .dxf data in ADS

Layout simplification



Export data for 3D Simulation in CST

Interoperability between ADS Layout und CST Microwave Studio offers excellent export and import capabilities

3.b Assessment of recommended design

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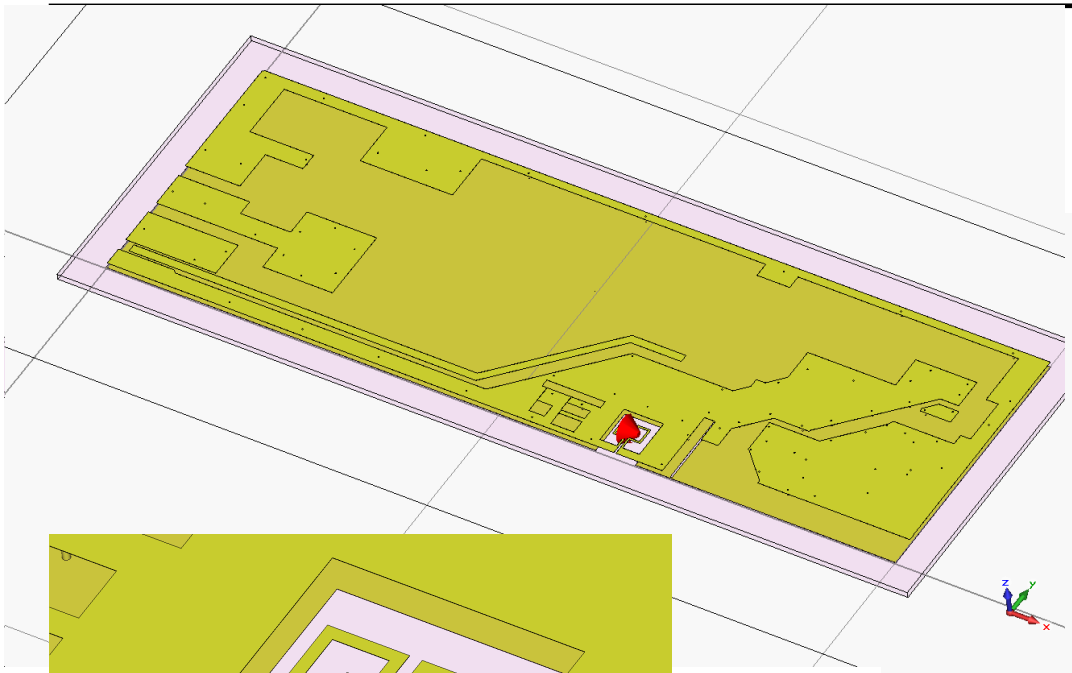

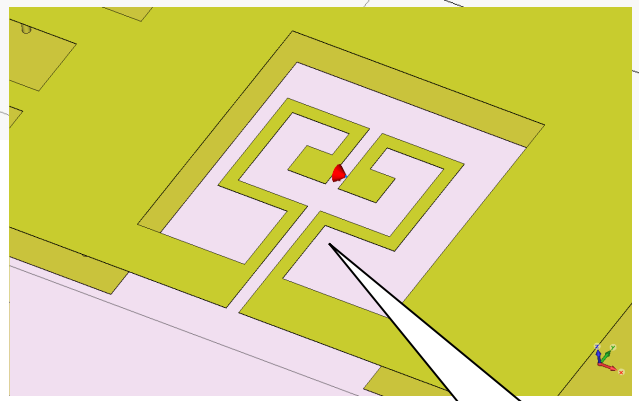

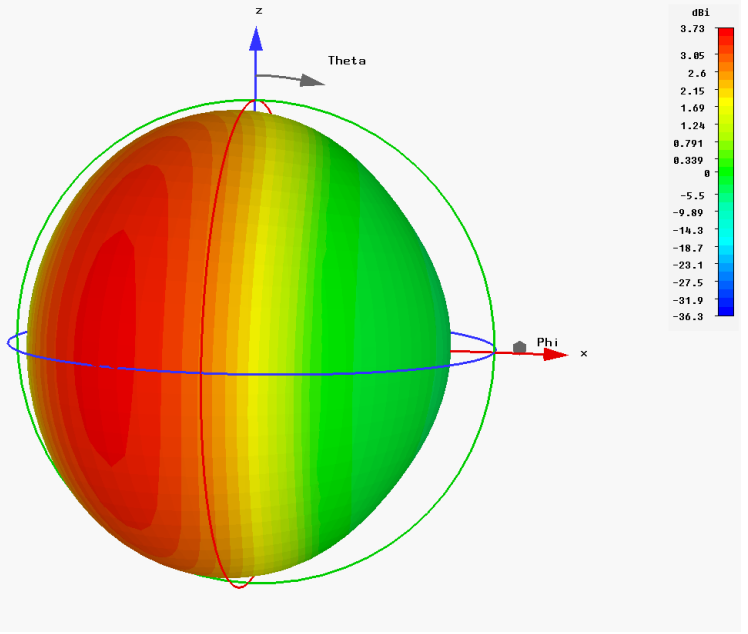

Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	Farfield (f=0.8665) [1]
Component	Abs
Output	Directivity
Frequency	0.8665
Rad. effic.	-1.475 dB
Tot. effic.	-16.18 dB
Dir.	3.727 dBi

Gain:3.73 dBi

Port
4.7+j157

For this particular PCB the TC is 17%

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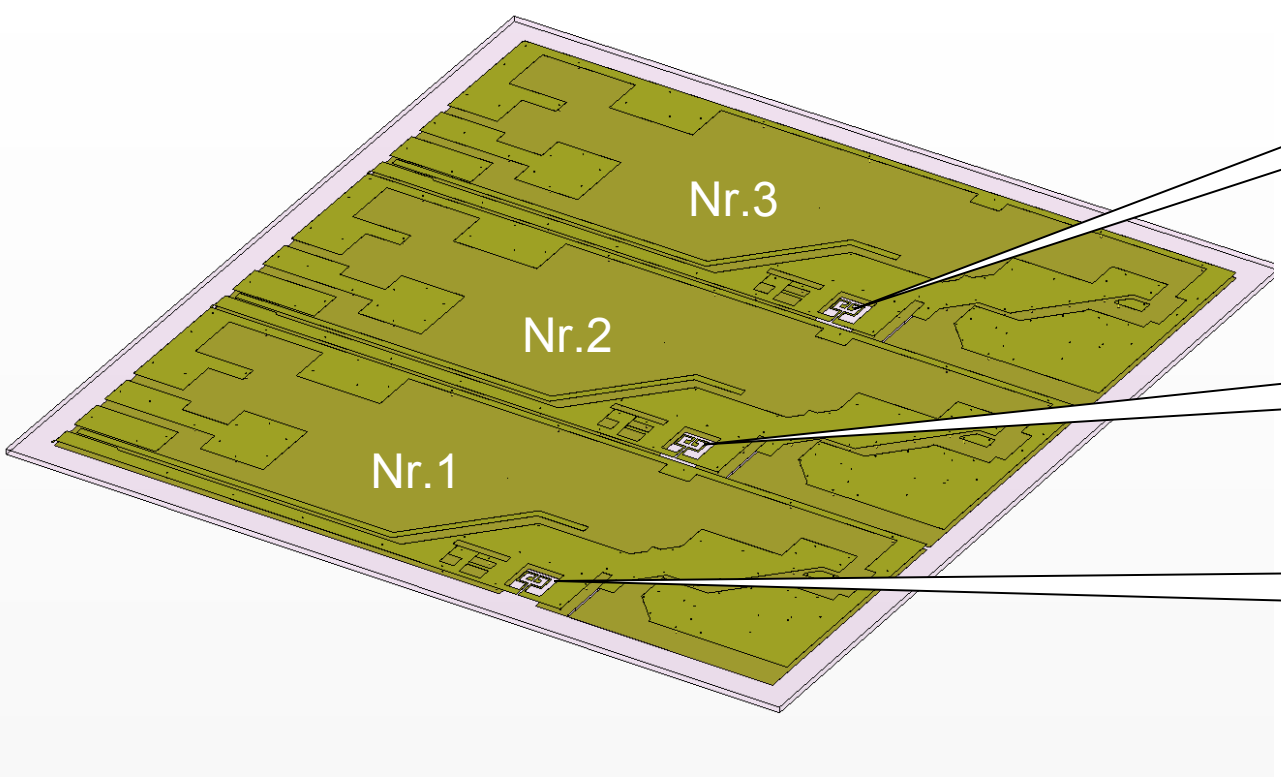
Port impedances of recommended antenna designs in a panel with multiple PCBs



Port3
11+j165

Transmission coeff.:43%

Port2
12+j166

Transmission coeff.:47.55%

Port1
5+j157

Transmission coeff.:18%

The port impedances show rather good matching
between Murata Chip and recommended antenna design

3.b Assessment of recommended design

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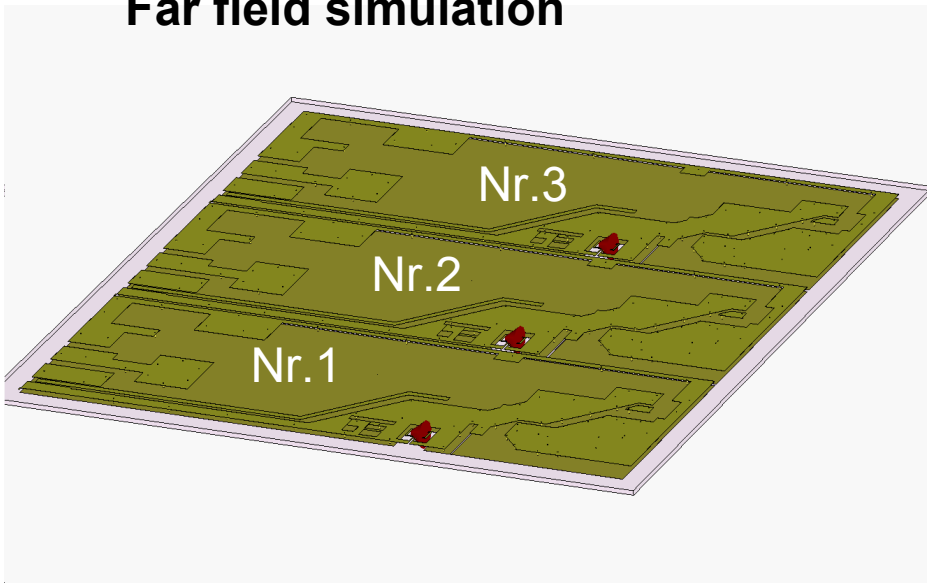
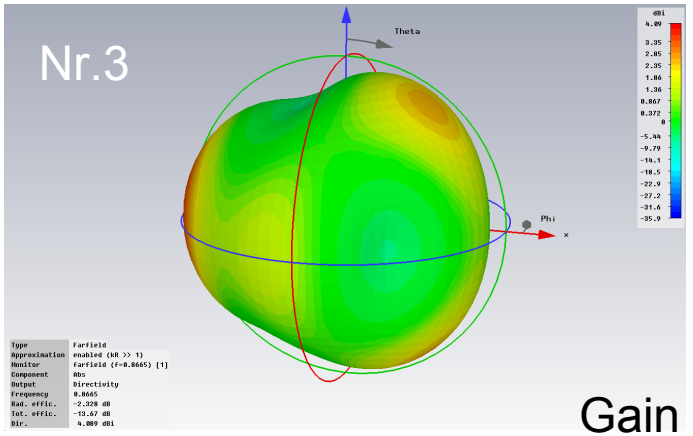
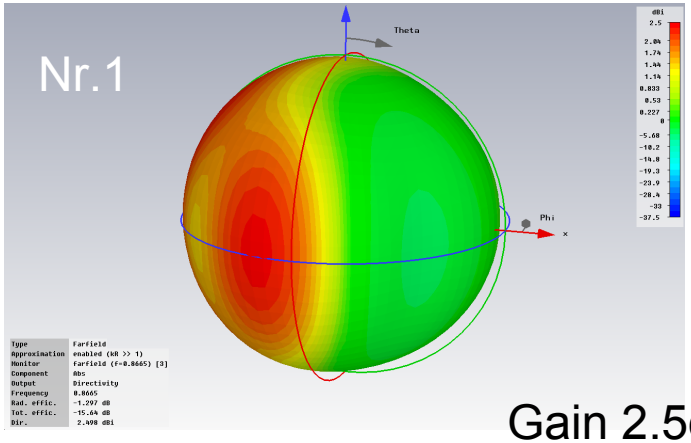
Far field simulation

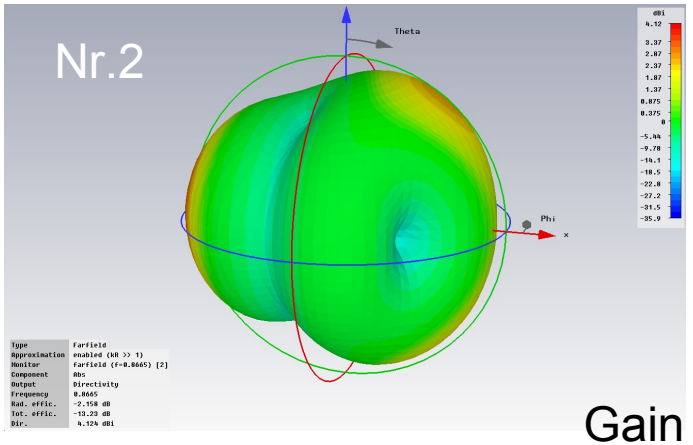




Gain 4dBi



Gain 2.5dBi



Gain 4dBi

3.c CST based optimised design

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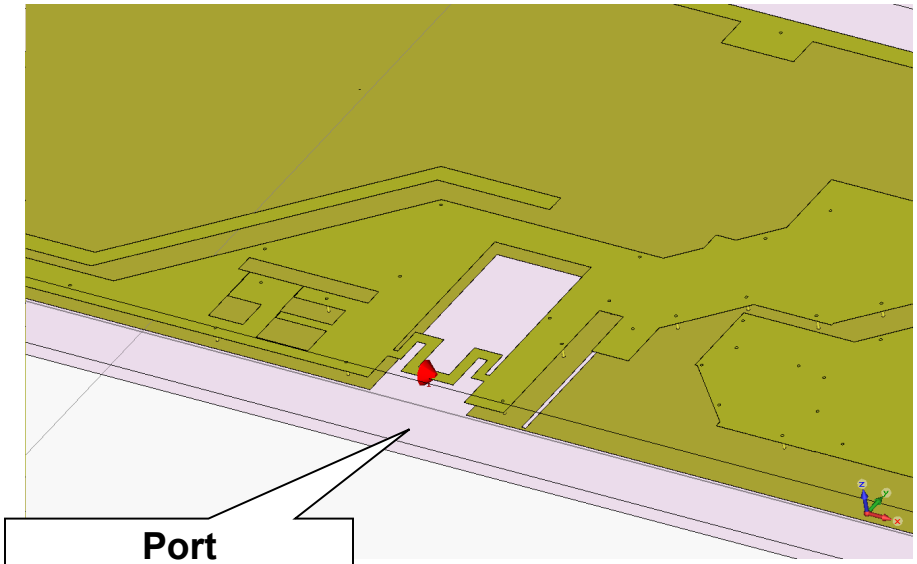
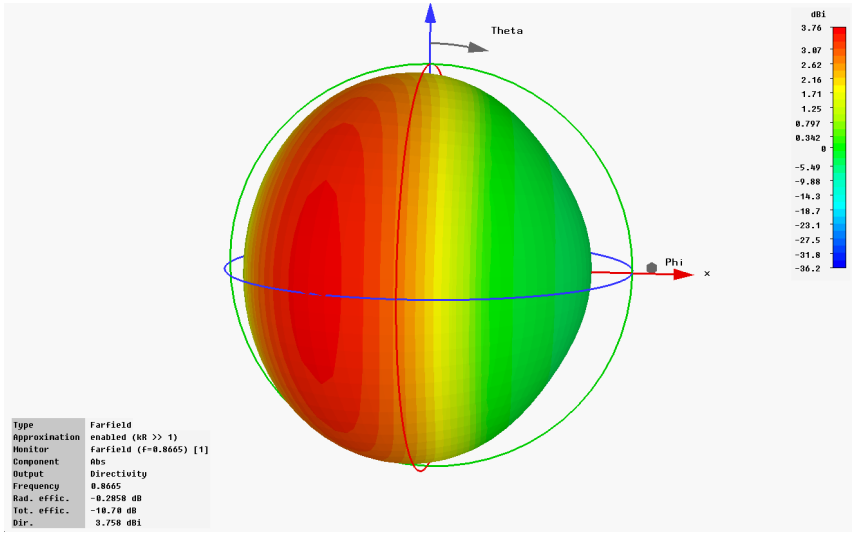
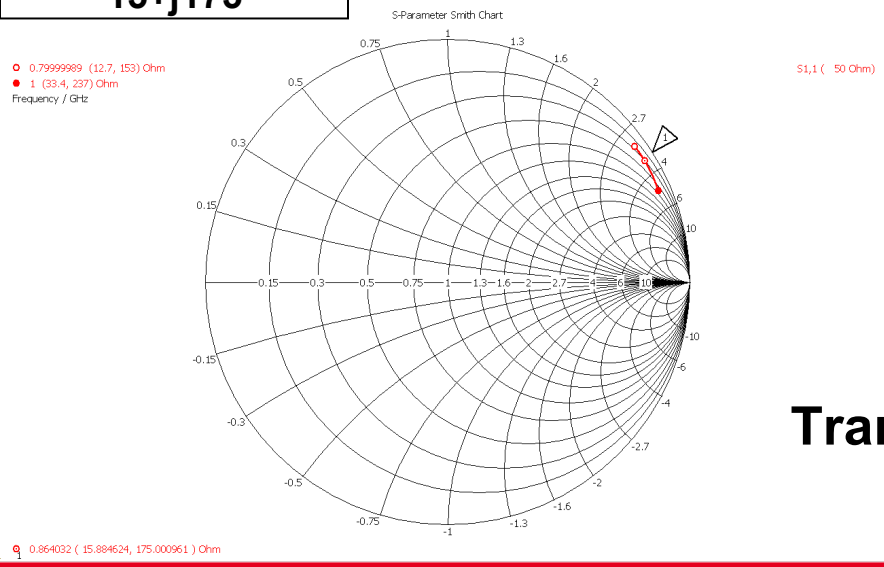


Port
15+j175





Gain:3.76 dBi

Transmission coef.:67%

3.c CST based optimised design

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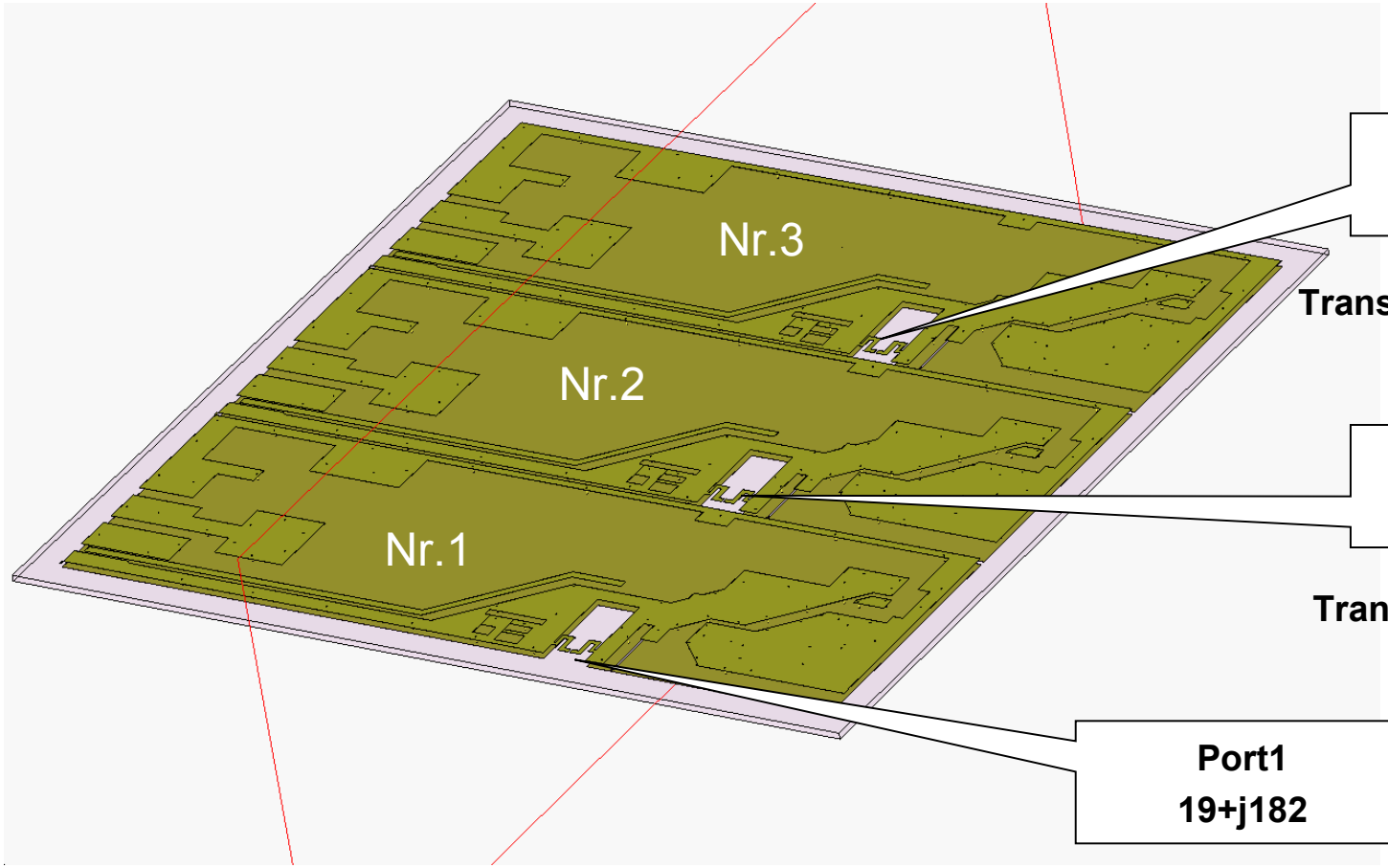

The goal is to provide good matching in the panel with multiple PCBs
This way a good read performance can be achieved at the production lines

3.c CST based optimised design

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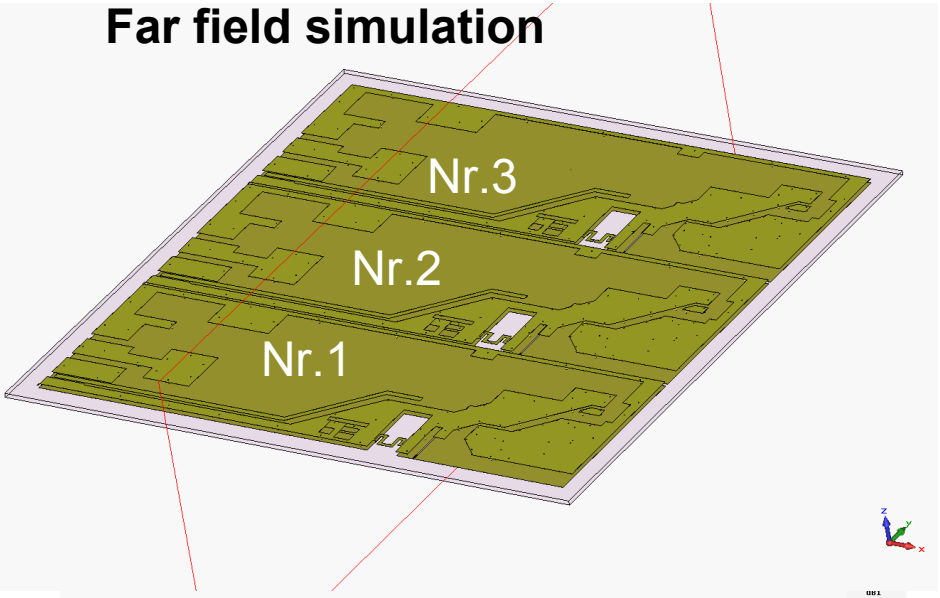
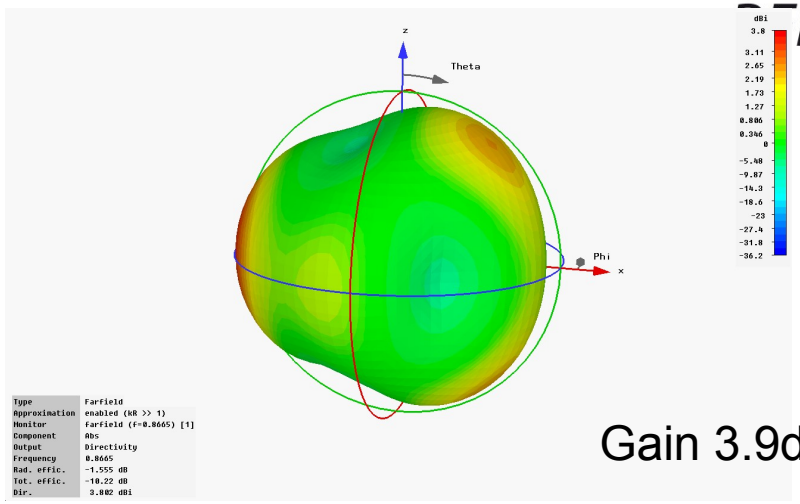
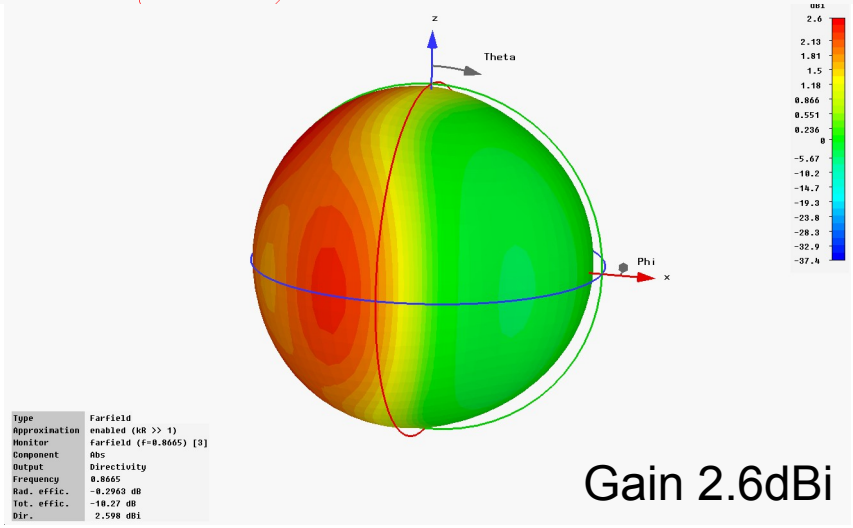
Far field simulation

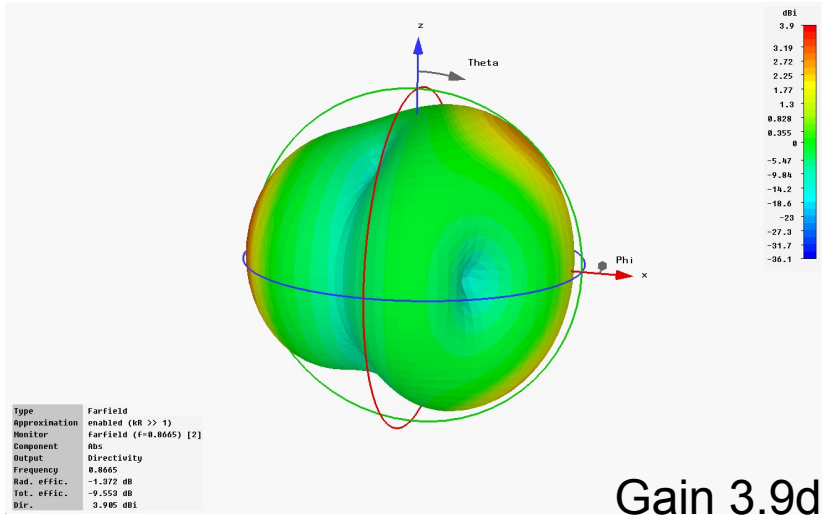




Gain 3.9dBi



Gain 2.6dBi



Gain 3.9dBi

4. Comparison simulation in MoM

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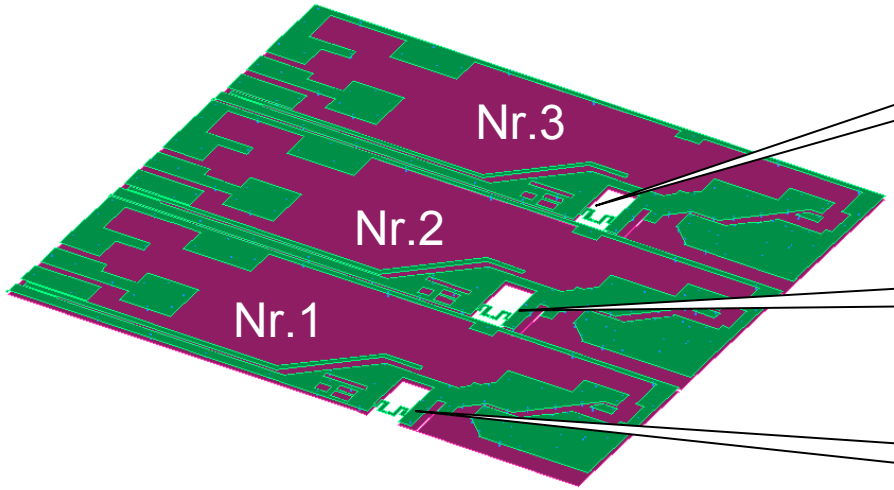

Port3
24+j185

Transmission coef.:91%

Port2
27+j187

Transmission coef.:94%

Port1
18+j192

Transmission coef.:94%

Transmission coefficient Recommended design	
	CST
Port 1	18%
Port 2	48%
Port 3	43%

Transmission coefficient Optimised design		
	CST	MoM
Port 1	84%	94%
Port 2	92%	94%
Port 3	93%	91%

The comparison of simulation results shows a good agreement

4. Read range measurement

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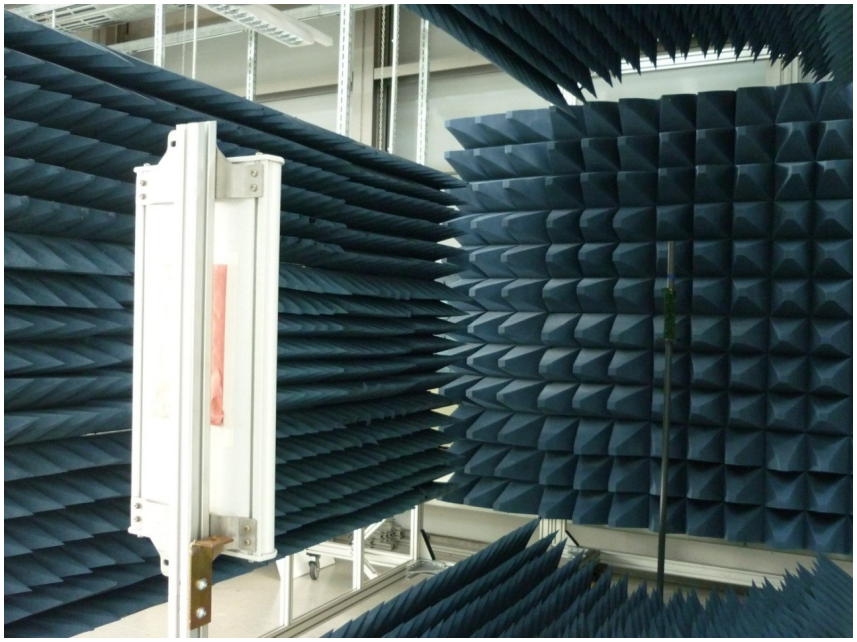

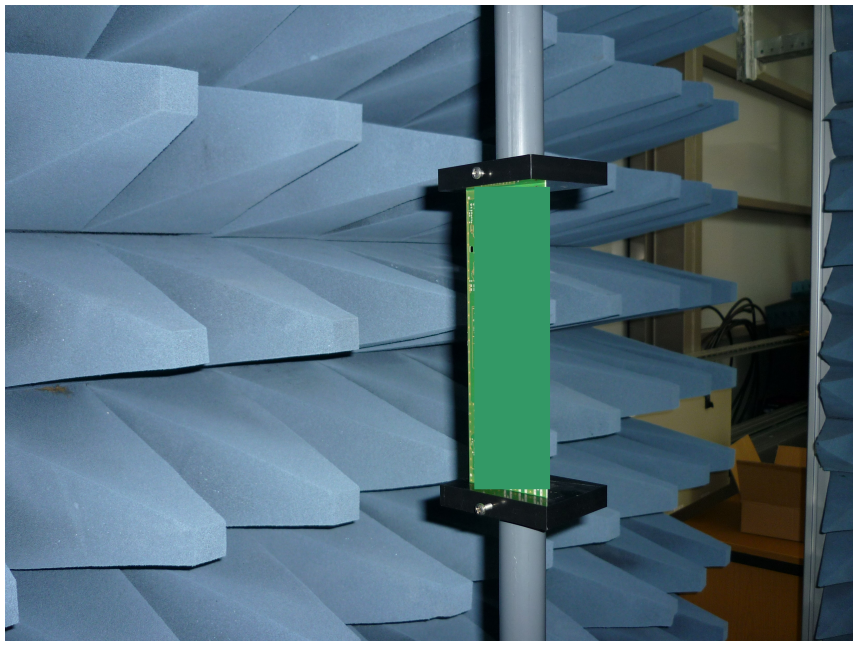

Read range based on 2 W ERP

Recommended design	Optimised design
4 m	6.9 m

4. Selectivity with Ultra Low Range Antenna

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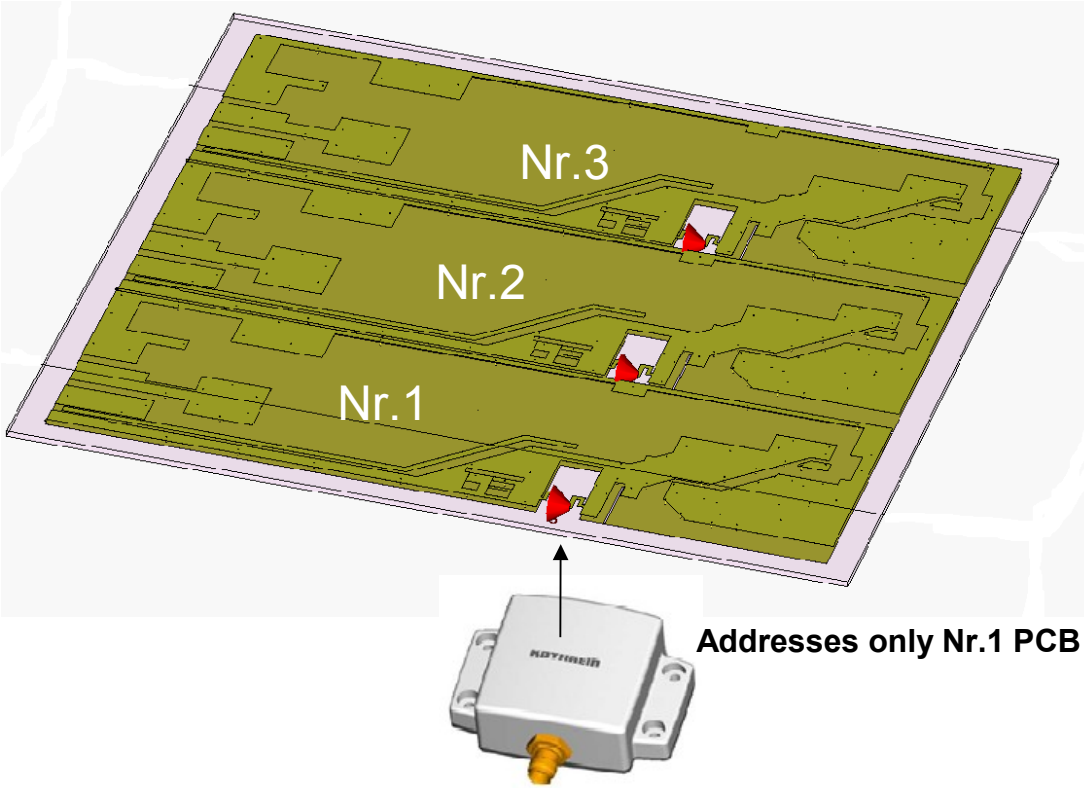

- Limited read range < 10 cm
- Extremely high selectivity (typ. 5 cm)
- Extremely low gain (< -30 dBi)
- Dimensions: 7 cm x 9 cm
- High mechanical robustness (IP67)
- Ideal for conveyor belts and access systems
- No interference by metallic objects in the vicinity

The Ultra Low Range Antenna reads selectively a single board in a panel with multiple PCBs

5. Conclusion

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CST Microwave Studio is a very good tool for embedding and analysing UHF RFID transponders in the layout of existing boards

The recommended designs from Murata show a relative good matching to chip impedances

The layout of a single board can be further optimised to match the chip impedance and achieve a greater read range

The Low Range Antennas ensure very high selectivity for addressing a single board in a panel with multiple PCBs