A n t e n n e n / A N T E N N A

Messprotokoll / MEASUREMENT REPORT

MEASURED PRODUCT

Decoupling between two GSM-R antennas depending on the distance to each other

Contents

List of figures

List of tables

ANTONICS-ICP GmbH•Ameisenweg 5•16727 Velten
Telefon +49 3304 25 42 04•Telefax +49 3304 25 43 48•HRB 7807NP, Neuruppin
Internet: http://www.antonics.de•E-Mail: info@antonics.de

1. Introduction

The decoupling between two spatially close mounted antennas is one of the most frequent questions from system distributors and transport companies. It is often set by the receiver modules, decides about the antenna placement on the vehicle's roof and thus goes into the purchase decision process. This document has taken up this issue and explains with reference to two GSM-R antennas, and with the help of simulation software, how such distance and isolation are interrelated.

2. Theoretical previews

The decoupling (also called attenuation) between antennas is generally understood as the sub-suppression of the mutual coupling between two or more antennas, for example, in antenna arrays. This mutual coupling means that the antenna not only receives signals of a desired wireless connection but also receives it from the antenna in their proximity. The antennas react to each other and the wireless connection is disturbed. In the worst case no more communication is possible. This applies both to the receive and the transmit case, and can change the directivity of the antennas concerned.

There are different approaches to improve the isolation between antennas. The use of different polarization levels is one of them, as well as the shielding with help of sheets or use of filters. The most effective - and probably also the cheapest – is to increase the distance between the antennas.

The decoupling is specified in dB. It is measured by feeding a signal in one antenna and measuring how much of this signal it is still arriving to a different antenna. The smaller the value, the greater the decoupling. A rule of thumb says, that for a good decoupling a distance 5 - 10 λ ([λ] Lambda= wavelength) should be adhered to. In practice it is turning out, that good decoupling can be already achieved at a distance of 3 λ. For GSM-R this means that the antennas should be mounted min. one meter apart (3 x $\lambda_{(900\ MHz)}$ ≈ 100 cm).

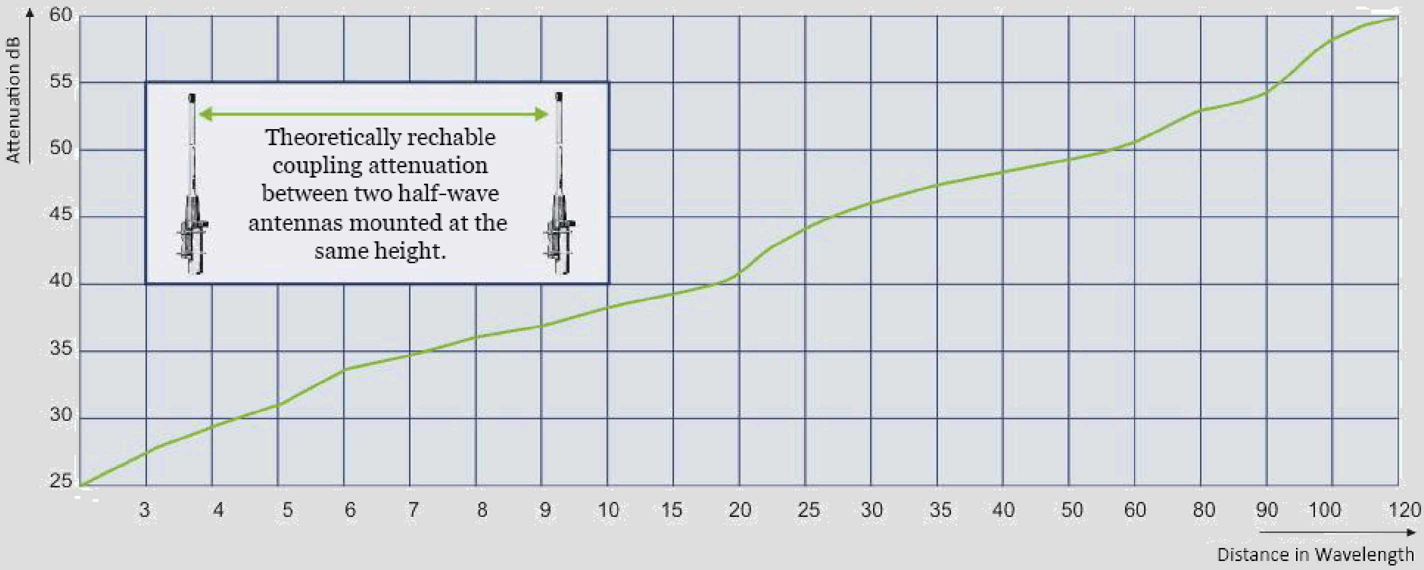


Fig. 1 – Decoupling dependent on distance using the example of two dipils (Source: Procom)

ANTONICS-ICP GmbH•Ameisenweg 5•16727 Velten
Telefon +49 3304 25 42 04•Telefax +49 3304 25 43 48•HRB 7807NP, Neuruppin
Internet: http://www.antonics.de•E-Mail: info@antonics.de

3. Simulation results

3.1. Preparation of the simulation

Using a 3D field simulation software it is presented, how the decoupling between two antennas increases with a rising distance. Therefore there were two Antonics OmPlecs-TOP 200 AMR MF 04 5 – antennas on the vehicle roof installed and the parameter s_{21} (Fig. 2) has been calculated, that means how much of the injected signal of antenna ② is measured by antenna ①.

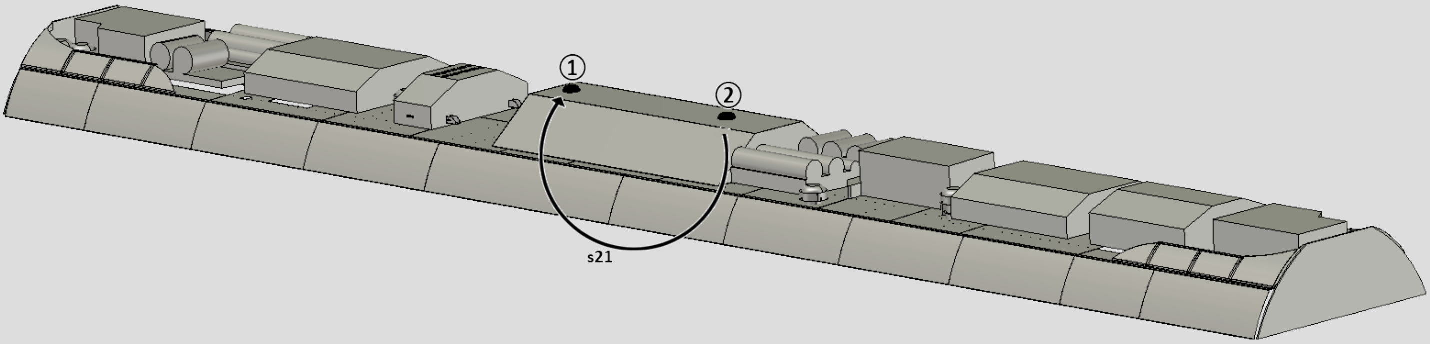
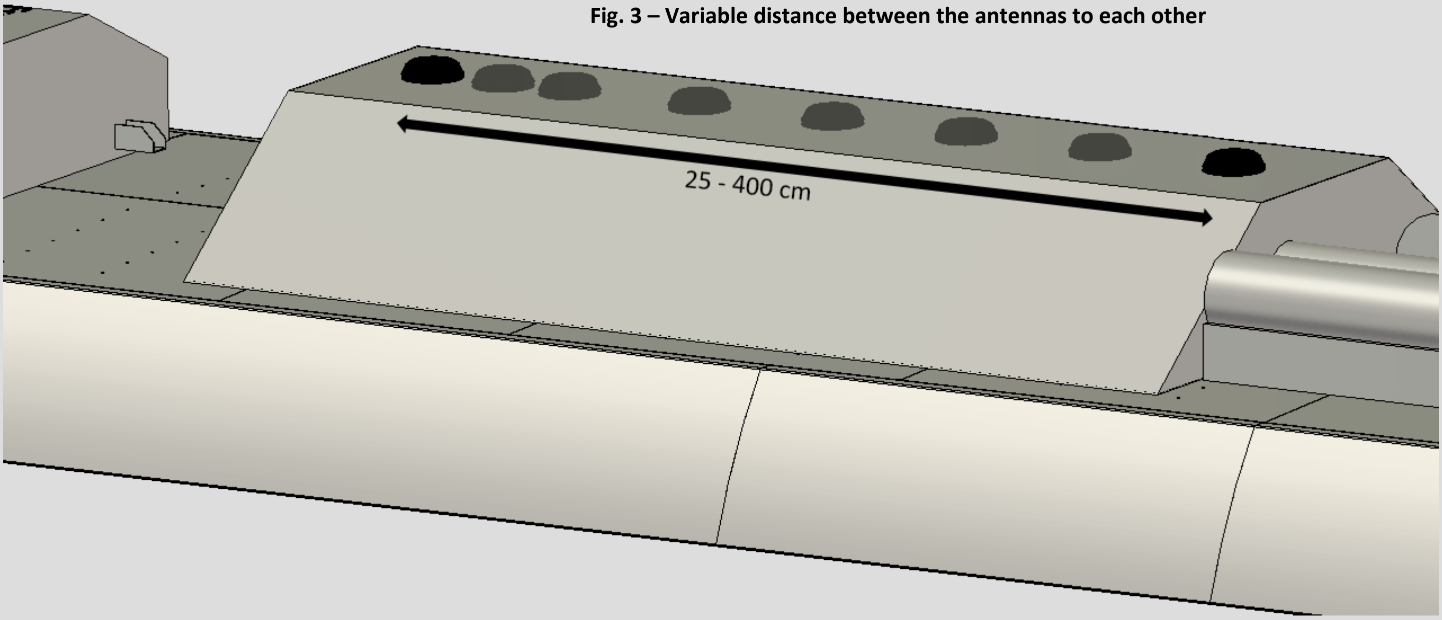


Fig. 2 - OmPlecs-Antennas on train-roof / Simulation of decoupling s21

The distance between the two antennas varies between 25 - 400 cm and the decoupling at each step is calculated. The first steps are made smaller, to be able to represent the decoupling differentiated. The decoupling rises within these smaller steps faster (is therefore better) than at a greater distance (Fig. 5).

Fig. 3 – Variable distance between the antennas to each other



ANTONICS-ICP GmbH•Ameisenweg 5•16727 Velten
Telefon +49 3304 25 42 04•Telefax +49 3304 25 43 48•HRB 7807NP, Neuruppin
Internet: http://www.antonics.de•E-Mail: info@antonics.de

3.2. Decoupling between 25 cm to 400 cm distance

After the distance between the two antennas in nine steps steadily increased, the calculated decoupling curves have been summarized in a diagram. With the help of this diagram it is very good to see how the decoupling with a rising distance of the antennas to each other also increases (Fig. 4).

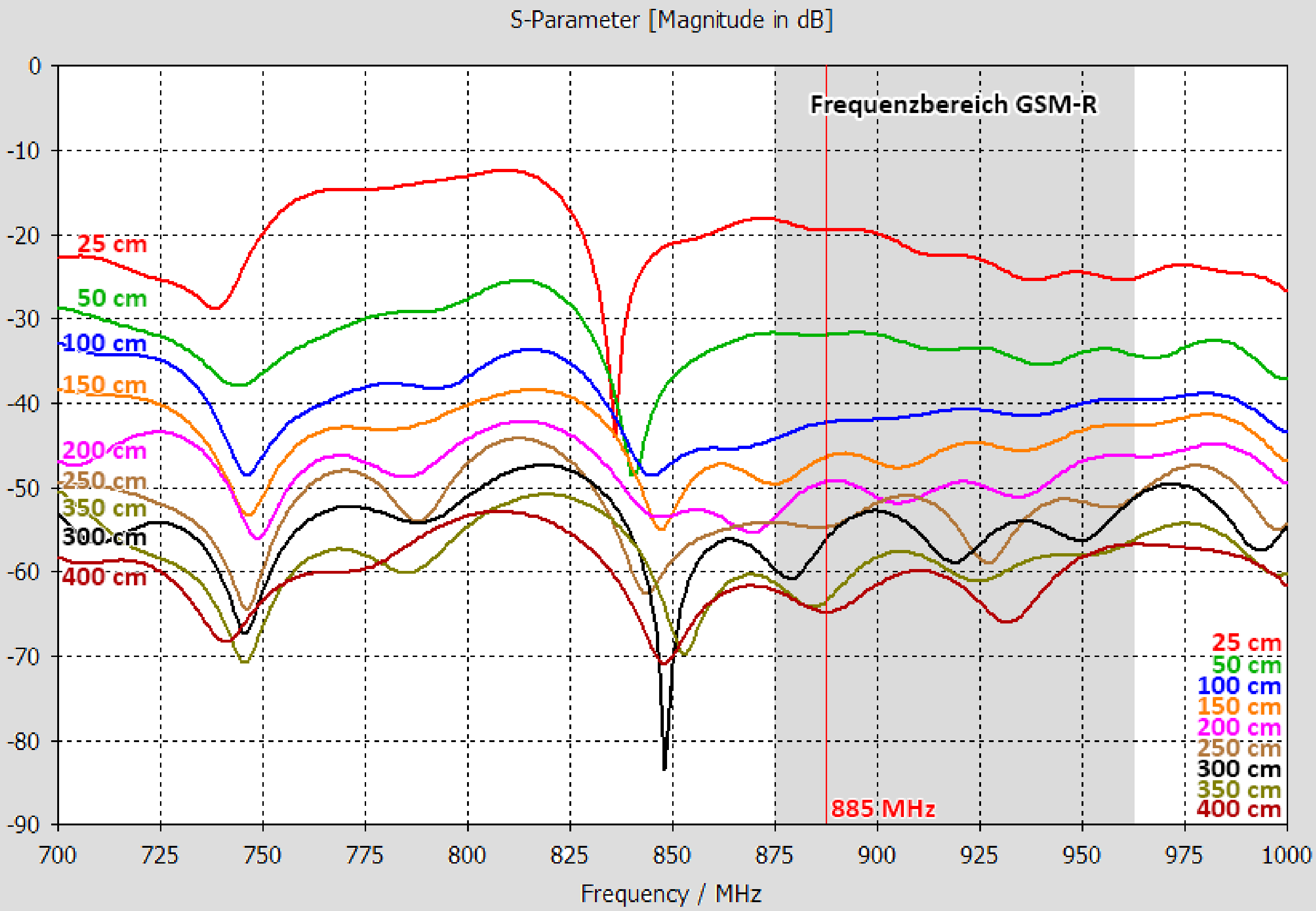


Fig. 4 – Decoupling curves in function of the distance of the antennas to each other

In case of the smallest distance, the decoupling at 885 MHz is quite good (-19.5 dB), this distance was equivalent to about 75% of a wavelength in the GSM-R Band. An increase in the distance to 50 cm (1.5 times wavelength) already brings an improvement of 12.5 dB, the decoupling is now up to -32 dB. This is already sufficiently good for many applications.

A distance of 100 cm (about three wavelengths) already bring a good -42.5 dB decoupling. Although a magnification of the distance beyond brings a further improvement in decoupling, the decoupling values rise no longer so sharply (-47 dB at 150 cm distance ≙ 4.5 times wavelength, -57.7 dB at 300 cm distance ≙ 9 times wavelength). The graph in Fig. 5 makes this clear. It represents the decoupling values for frequency f= 885 MHz about the distance between the two antennas, and illustrates how the decoupling flattens with an increasing distance.

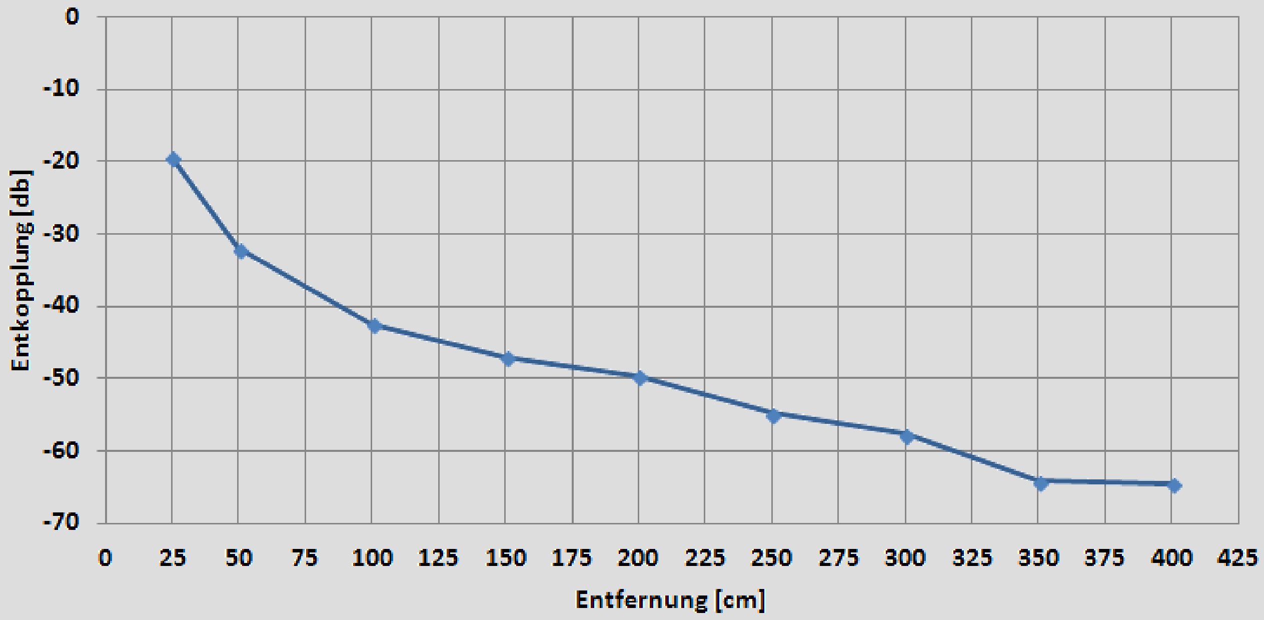


Fig. 5 – Course of decoupling values at f = 885 MHz over the distance

Table 1 – Summary table of decoupling values at f = 885 MHz over the distance

Distance [cm]	25	50	100	150	200	250	300	350	400
Decoupling [dB]	-19,5	-32	-42,5	-47	-49,6	-54,8	-57,7	-64,2	-64,6

4. Conclusion

The simulation shows how an increase in the distance between two antennas can significantly improve the decoupling between these. The distance depends on the wavelength of the lowest frequency range used, that is, the lower the frequency the greater the distance. The distance is also a result of the requirements of the train operator. It is known that the Deutsche Bahn request decoupling values up to -60 dB. From the simulated values is seen that a distance of 350 cm is sufficient to meet this requirement. 350 cm correspond to the GSM-R frequency range of a distance of a little over 10 wavelengths.

Of course when mounting, the directional characteristic must be observed. Two directional spotlights arranged in opposite directions to each other will not interfere even with a small physical proximity as much as is in the case of two omnidirectional antenna. The information contained herein should be construed as a guide. By constructions near the antenna and the use of various types of antennas, polarization levels and frequency ranges can influenced the decoupling positively or negatively. A measurement of the actual antenna assembly delivers here the more precise results.

ANTONICS-ICP GmbH•Ameisenweg 5•16727 Velten
Telefon +49 3304 25 42 04•Telefax +49 3304 25 43 48•HRB 7807NP, Neuruppin
Internet: http://www.antonics.de•E-Mail: info@antonics.de

ANTONICS
ANTENNEN | ANTENNAS

CONTACT

ANTONICS-ICP GmbH
Ameisenweg 5 (Businesspark Velten)
16727 Velten
GERMANY

Phone: +49 3304 25 42 04 Internet: www.antonics.de
Fax: +49 3304 25 43 48 Mail: sales@antonics.de

ANTONICS
ANTENNEN | ANTENNAS