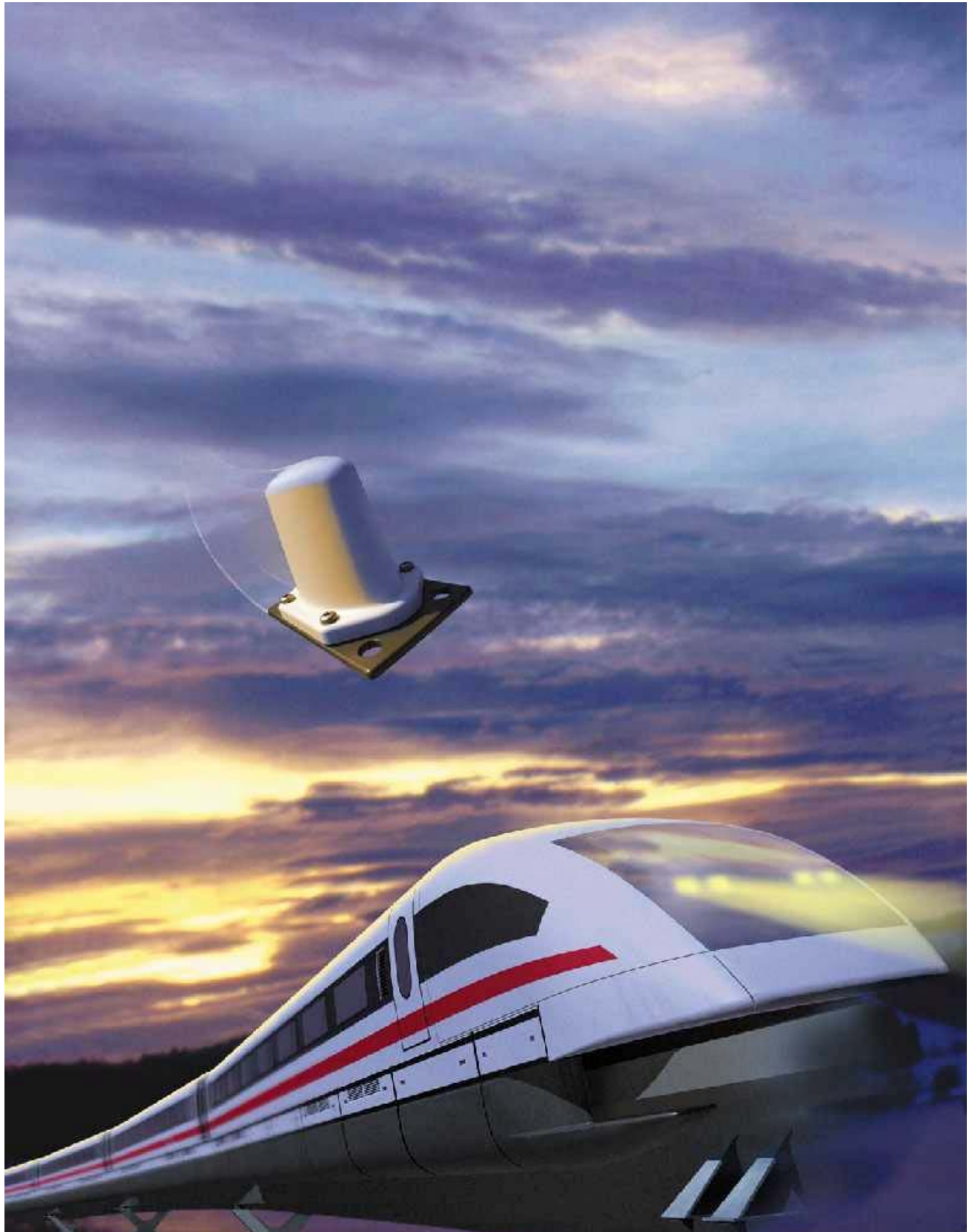


Installation Guidelines for Train and Bus Antennas



1 Abstract

1.1 Quality is the key

Train antennas made by Kathrein are well known as reliable and highly sophisticated products. Our antennas are distinguished by excellent voltage protection against accidentally high voltage contacts due to well developed grounding elements implemented in the overall design.

Train antennas are faced to extreme environmental conditions and need to withstand tremendous operational conditions. The following documents should help to understand functionality and learn more about proper installation procedures.



2 Design

Depending on frequency and design constraints Kathrein antennas are designed as $\lambda/4$ radiators or as $\lambda/2$ radiators. For proper functionality $\lambda/4$ radiators have to be mounted on a conductive surface creating a ground plane. Train antennas are usually vertical polarized. Impedance is 50 Ohm.

Kathrein antennas are type approved by the “Deutsche Bundesbahn” (German Railway).

Key features of Kathrein antennas to pass the “Deutsche Bundesbahn” requirements is the ability to limit connector voltage to 60 V in case of contact with the high tension lines. Current flow of 40 kA over a time frame of 100 ms and high voltages of up to 42 kV could be applied under worst case conditions.



68 – 87.5 MHz



410 - 470 MHz



GSM 900 + GPS
(incl. amplifier)

3 Installation

3.1 Ground Plane

Fundamental RF basics require metallic surfaces for certain antenna designs. Utilizing $\lambda/4$ technologies depends on a sufficient ground plane surface to finally distribute RF wave into the surroundings. Thus those particular antennas need to be mounted against a conductive surface to create the required ground plane.

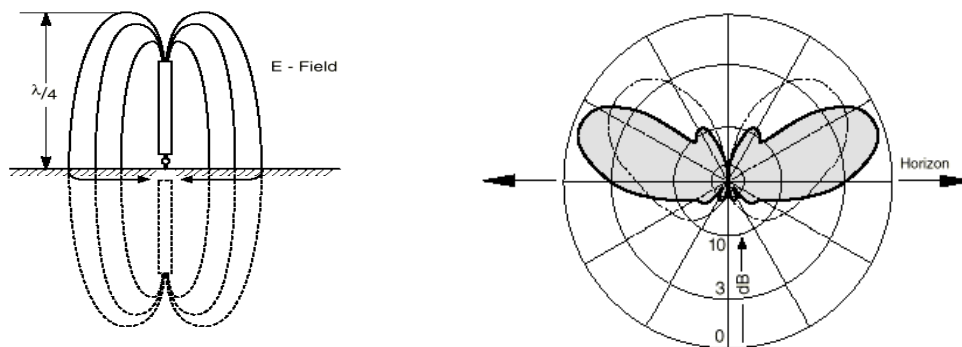


Figure 1: Electrical field and radiation pattern of a $\lambda/4$ antenna design

Each data sheet leaves detailed information about surface size. We strongly recommend not to stay under the minimum mounting requirements. Antennas easily will lose VSWR performance, and radiation pattern may change dramatically.

3.1.1 Metallic Surfaces

In most of the cases the roof of trains is made out of metallic materials. These materials have a reasonable conductivity to achieve best radiation results. For safety reasons these surfaces need to offer sufficient grounding to finally guide high voltages and currents to the ground.

3.1.2 Non-Metallic Surfaces

Trains designs appear more and more with non-metallic surfaces mostly present at the front or the end of a train. Apparently those areas are preferred installation areas for antennas.

As explained previously antennas require ground planes made out of conductive material. Several designs may apply to create such a plane. Metallic foils might be placed underneath a non-metallic train body. Other metals might be laminated into Fiberglass constructions. The antenna flange needs to have good electrical contact to these additional ground planes

The same mandatory rule applies as with metallic surfaces: A sufficient grounding of the antenna needs to be considered in the design. Any kind of grounding needs to handle high currents and voltages, and finally lead it to the ground.

3.2 Grounding

In case of an accident or a failure of the high tension line (overhead contact line) high voltage and current might be applied to the antenna. To protect personal and equipment, connector voltage of the antenna is supposed not to exceed 60 V. To guarantee low connector voltages, antenna flanges need to be grounded thoroughly.

- unpainted areas near the four mounting holes of the antenna flange.

To achieve best conductivity mounting surfaces at the antenna socket and the mating surface of the train should be clean. Any paint residues or other pollution needs to be removed prior to the mounting process.

- In case of non-metallic roof surfaces with an additional ground plane of e. g. thin material, a separate grounding of the antenna mounting flange is required.

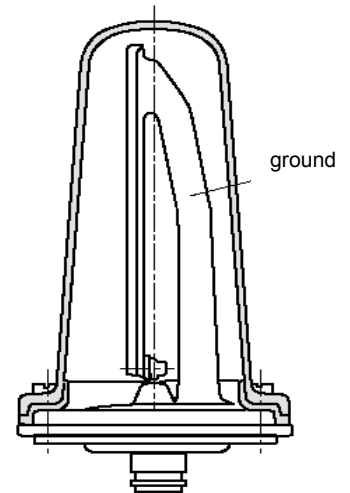


Figure 2: Inside grounding

3.3 Mounting

Most antennas are designed with a standardized foot print of the mounting socket. Dimensions are stated in the data sheets.

3.3.1 Mounting Sockets

Antenna sockets offer four screw holes to tighten the flange against the mounting surface. We recommend the following:

- Mounting against a separate flange with integrated mounting bolts. This flange is usually welded to the train.

In general, mounting screws or nuts should not add more than 15 mm to the mounting surface.

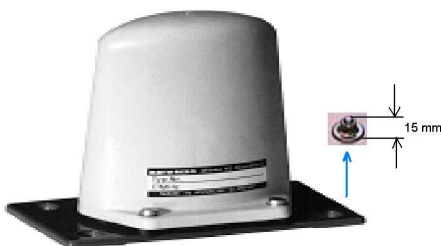


Figure 3: Low profile broad band antenna with mounting screws

In case of an antenna installation with screws through the antenna socket into the vehicle, particular attention should be paid to the sealing of the screws under consideration of the grounding instructions.

3.3.2 Mounting Position



Figure 4: Challenging, but inadequate installation of a train antenna

The antennas have to be mounted directly to the ground plane.

Depending on the overall mounting situation (*please refer to paragraph 3.6*) it's tempted to elevate antennas against the trains roof with high flanges or other challenging constructions. To avoid mistuning and malfunctioning antennas it is mandatory not to follow these installation ideas. Resonance frequency, radiation pattern, and VSWR would change dramatically or could be lost completely.

3.4 Sealing

To avoid corrosion and leaky into the vehicle, antenna connectors need to be sealed against the mounting plate. Every Kathrein antenna is supplied with detailed mounting instructions. An O-ring is supplied with each antenna to seal the through hole into the vehicles body against the antennas connector. To achieve advanced sealing mating surfaces between the antenna socket and mounting flange/mounting surface are supposed of being flat.

Sealing also needs to be performed around mounting holes if no mounting flanges are used. Corrosion at mating surfaces between the antenna and the mounting plane is critical for proper function of the antenna.

3.5 Painting

For optical reasons the color of train antennas sometimes has to match certain colors. Kathrein antennas are particularly suitable for subsequent, long-lasting painting since the visible parts (radomes) are generally made of fiberglass (polyester), to which paint adheres very well. A thin layer of paint eventually has only a negligible influence on the electrical characteristics.

General remarks:

- We recommend that painting is only performed by qualified professional painting companies. If required painting on site may also be possible (and permissible).
- We recommend that painting should only be applied to visible surfaces: e.g.
 - Fiberglass radome
 - Antenna socket, upper surface – please refer to instructions stated in our data sheets
- Suitable commercial paints consist of one or two components. The manufacturer's instruction for use and processing must be observed. Paints with metallic effects or metallic components are not permissible.

3.6 Obstacles close to the antenna

For proper wave propagation from the antenna into the surroundings a flat roof without any obstacles would be preferred.

Trains sometimes have a number of structures for multiple purposes on the trains top. Any obstacles close to the antenna may impact radiation pattern and radiated waves. It is difficult to leave general guidelines about minimum distances. As a rule over the thumb antennas should face no obstacles within a radius of approximately 1 m or more.



3.7 Distances to other antennas

The distance to other antennas depends on the required antenna isolation. This value has to be clarified with the suppliers of the installed mobile communication system.

An isolation of 30 dB is a preferred value. As a rule over the thumb, a distance of approximately 5 – 7 Lambda is required for antennas operating the same frequency band.

Due to the selectivity of different systems, antennas operating in different frequency bands require distances that can be even smaller.