BALLUFF

BIS U Basic Manual

Basic Information for Operating a
UHF RFID System

BISU

English

www.balluff.com

1 Introduction

This document describes the physical method of operation for the RF identification system BIS U and the specifications of individual components within the overall system.

Furthermore, the propagation and characteristics of electromagnetic waves in the surrounding environment and interaction with general objects and building installations are explored in detail from a practical perspective.

A separate section includes safety distances in relation to antennas for different antenna configurations, which people must maintain if they intend to remain within the wave range of antennas temporarily or permanently.

The performance characteristics specified in this documentation, such as operating frequencies and radiated power, are exemplary and relate to the valid legal provisions of the European Community.

2 Safety distances to the antenna

When using the identification system BIS U, it is possible that people will remain within the wave range of the antennas briefly or for longer periods.

In addition to product standards, which were designed to protect other radio services from interference or negative influences from the RFID system, the International Commission on Radiological Protection (ICRP) has defined a set of RF field limit values for avoiding damage to human tissue via RF fields. These are called basic values and represent the specific absorption (SA) in J/kg or specific absorption rate (SAR) in W/kg and describe the direct or indirect effects on human tissue.

Derived values that can be measured or calculated using simpler methods are adopted for practical applications. These have been defined such that the basic values are never exceeded, even under the most unfavorable exposure conditions.

For a conventional long-range antenna with a radiated power of 2 watts_{ERP} in the main dispersion direction, this lower limit value is usually exceeded if the distance is greater than 24 cm. The safety distance is 30 cm for 4 watts_{EIRP}.

The safety distance decreases accordingly for lower transmitting powers.
The result of this occupational safety regulation is that people should not be closer than 24 cm or 30 cm to the antenna for longer periods.

2 Safety Distances to the Antenna

The following measures can be taken to comply with the occupational safety regulation:

– Organizational measures that require creating operating instructions containing relevant information to ensure safe operation and that draw attention to the possibility of exposure to electromagnetic fields.
– Securing the antennas by mounting protective equipment or setting up cordons to make sure people cannot be too close to the antenna during operation.

An inspection should always be carried out at appropriate time intervals before and after the task is performed.

According to what is currently known, being in the vicinity of antennas for a brief time does not pose a health risk. Under certain circumstances during operation, the reader and antenna may interfere with pacemakers if the pacemaker wearer is within range of the antenna. If in doubt, the person involved should contact the pacemaker manufacturer or their doctor.

The following figure shows the field intensity curve in close proximity to an antenna and the limit values of the electric field strength with the EU directive as an example.

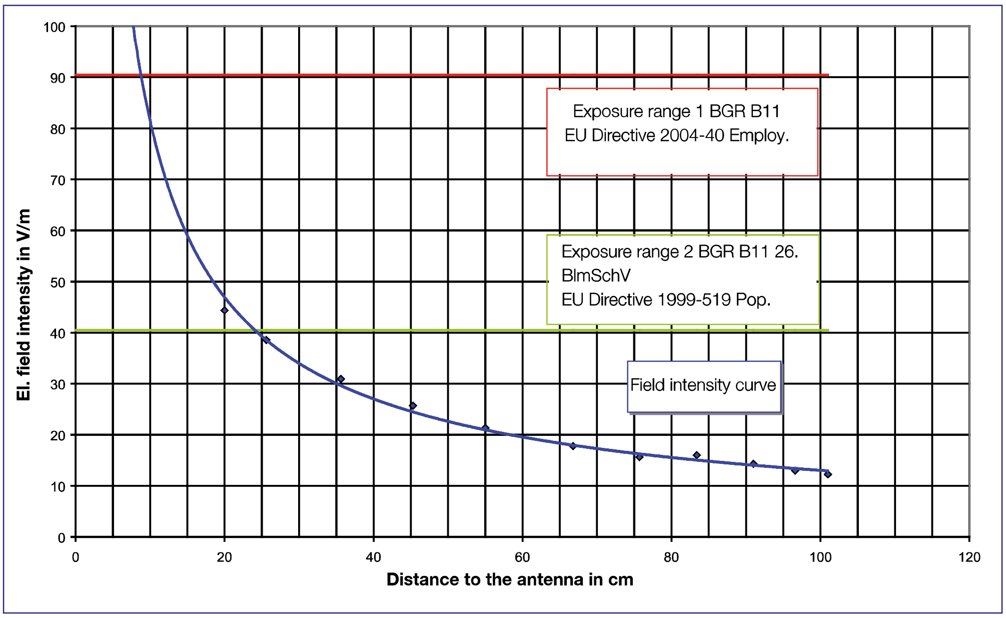

Figure 1: Electric field in close proximity to the antenna for 2 $watts_{ERP}$. Both components of the circular polarized antenna are taken into consideration

3 Basic Physical Information

The BIS U system belongs to the class of UHF identification systems.
Data carriers with air interface protocol structured according to ISO 18000-6C or the EPCglobal™ Class 1 Generation 2 standard are supported.

Detailed information for UHF identification system performance characteristics, like operating frequencies and radiated power are found in the corresponding product manuals.

The UHF technology used here facilitates a communication distance of several meters, even for passive transponders (i.e. without a separate power supply).

3 Basic Physical Information

3.1 Physics of the Transmitting Antenna

The UHF antenna is an open oscillating circuit with electric fields that extend into the surrounding environment. The simplest form of UHF antenna is an electric dipole.
However, field displacement occurs in the vicinity of the antenna due to the high excitation frequency. The energy stored in the field moves away from the antenna at nearly the speed of light.

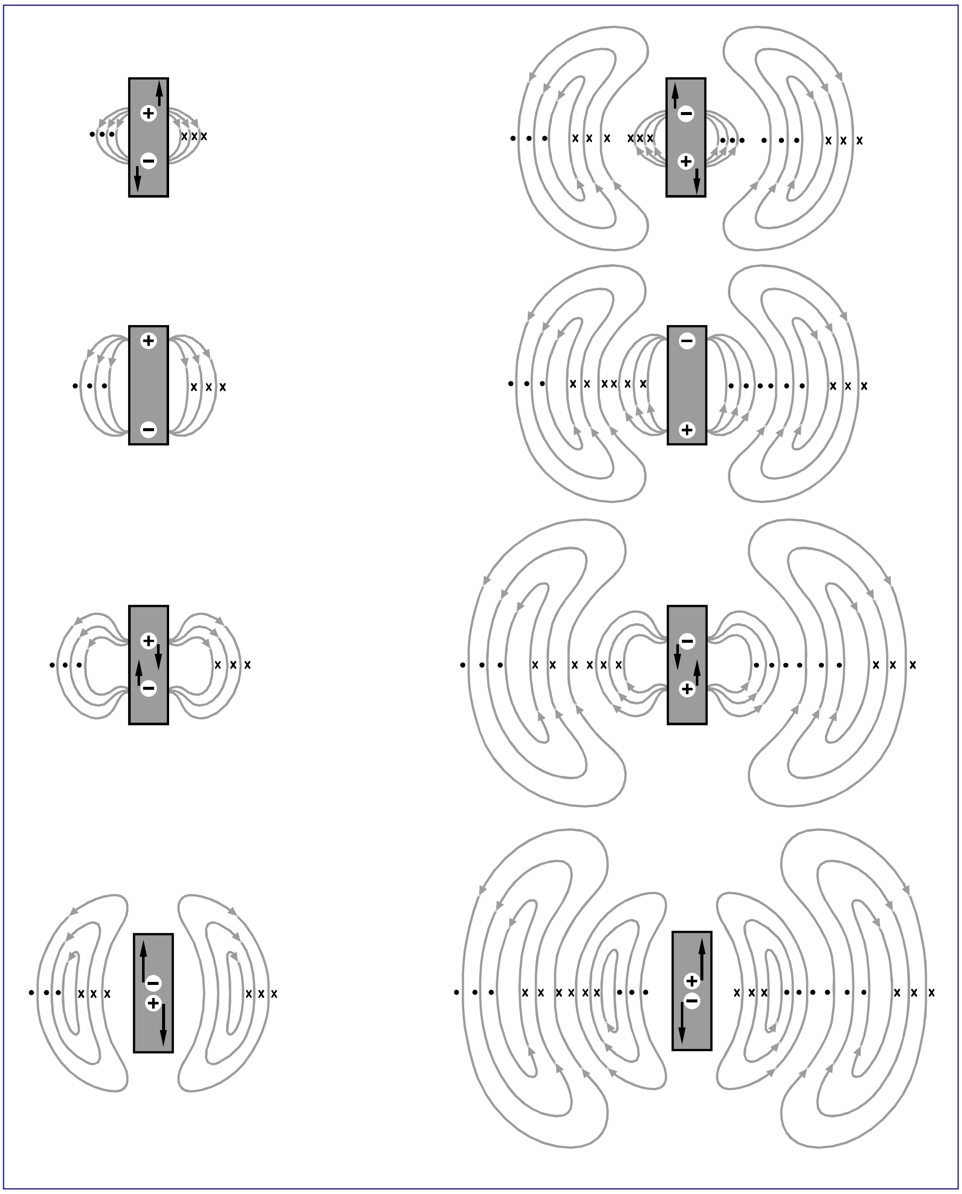

Figure 2: Schematic diagram of the displacement process

The energy propagates over an ever-increasing area as it moves away from the antenna and, as a result, the field intensity decreases reciprocally in relation to the distance.
This process of attenuation is also known as "free space loss".

3 Basic Physical Information

3.2 Physics of the Transponder

Due to their shape and size, the antennas on the data carriers are capable of reflecting as well as absorbing electromagnetic waves transmitted by the identification system BIS U.

The passive transponder (data carrier) does not have its own power supply (e.g. battery) and must therefore draw the energy it needs to operate from the electromagnetic field. A portion of the RF voltage present at the antenna connections is commutated and used to supply the IC.

However, the much larger portion of dispersed power is reflected. A time-controlled change in the reflection characteristics of the dipole antenna generates a backscattered electromagnetic wave with a modulated amplitude (intensity). The wave is detected by the antenna on the processor unit and then demodulated.

This type of information exchange between the partners of an identification system is known as electromagnetic backscatter.

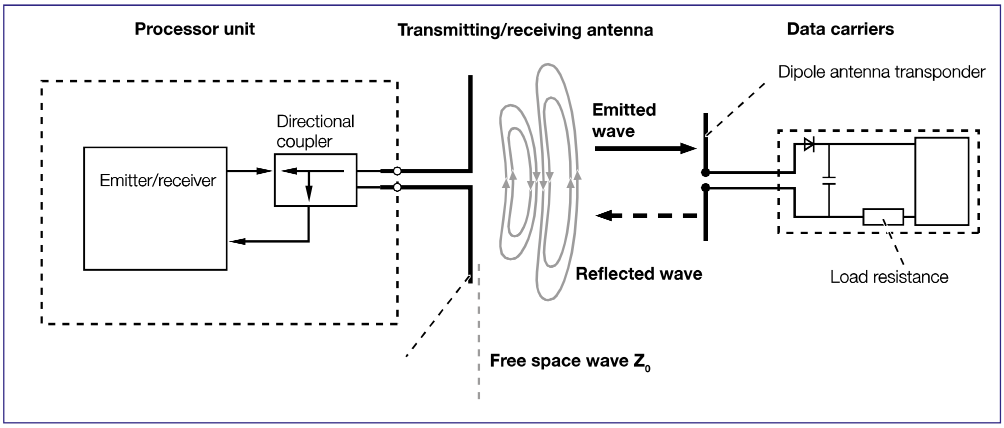

Figure 3: Schematic diagram of backscatter

4 Reference Antennas and Antenna Parameters

Only passive antennas can be connected to the BIS U processor unit. The power of the antennas is defined by a generally binding parameter set of measurable properties, which include:

- Antenna gain
- Return loss/VSWR
- Dispersion angle
- Front to back ratio
- Impedance
- Polarization
- Axial ratio
- Power rating

4.1 Reference or Standard Antennas

The comparability of different antennas and the quantitative assessment of power radiated by the antennas are achieved using reference or standard antennas.

The following antennas are used for reference purposes:

Isotropic radiator	The isotropic radiator is a hypothetical, lossless antenna that disperses radiation evenly in all directions. It generates a power density independent of the angle at distance **r**.
Half-wave dipole (λ/2 dipole)	The maximum field intensities are vertical in relation to the dipole level. A power density is generated in the shape of a figure eight.

If the same radio frequency power is supplied to both antennas, the half-wave dipole has a higher field intensity than the isotropic radiator in the main dispersion directions. There is a direct correlation between the two values; the radiated power of a half-wave dipole in the main dispersion direction is higher than that of the isotropic radiator by a factor of 1.64 (2.15 dB).

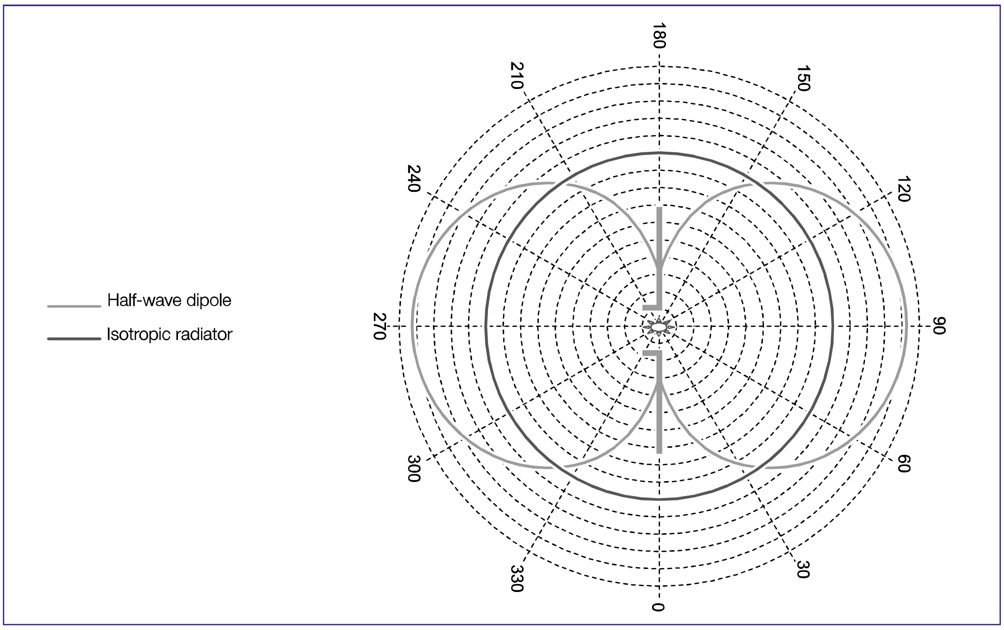

Figure 4: Vertical radiation diagram for reference antennas

4 Reference Antennas and Antenna Parameters

4.2 Antenna Gain

Real antennas bundle radiation and therefore generate maximum radiated power density in one direction (main dispersion direction).

Antenna gain must be used to make antennas with different designs or directional characteristics comparable and to define a dimension to indicate the intensity of radiated antenna power aimed in a preferred direction. The antenna gain represents the factor by which power radiated in the main dispersion direction is higher than a reference antenna.
It is standard to indicate the gain of a real antenna in relation to an isotropic radiator.

G[dBi]	Linear gain based on an isotropic radiator
G[dBic]	Circular gain based on an isotropic radiator

Figure 4 shows that radiation is also bundled for the half-wave dipole. The antenna gain based on an isotropic radiator is:

$$G[dBi]_{\text{half-wave dipole}} = 2.15\ dBi$$

4.3 Return Loss and Voltage Standing Wave Ratio

The voltage standing wave ratio (VSWR) and the return loss (RL) indicate how much of the energy flowing through the cable to the antenna is reflected to the receiving antenna input on the processor unit. A poor VSWR value can cause interference or noise.
A typical value < 1.2 to 1 is specified for the BIS U 302 antenna.

4.4 Dispersion Angle

By specifying the dispersion angle, another parameter is created for the directional characteristics of an antenna. The identified dispersion angle is the angle at which only half the power is radiated, which represents a decrease in power of 3 dB. The reference variable is the maximum value in the main dispersion direction. Since antennas are always passive components, the antenna gain correlates directly with the dispersion angle: The higher the antenna gain, the smaller the dispersion angle.

In some countries, such as European Community countries, the maximum permitted radiated power depends on the dispersion angle of the antenna in use.

In the applicable product standard, EN 302 308 (issue V1.1.2 2006-07), the permitted radiated power of an antenna correlates with the antenna dispersion angle as follows:

- Dispersion angle ≤ 70 degrees Radiated power up to 2 $watts_{ERP}$
- Dispersion angle > 70 degrees Radiated power up to 0.5 $watts_{ERP}$

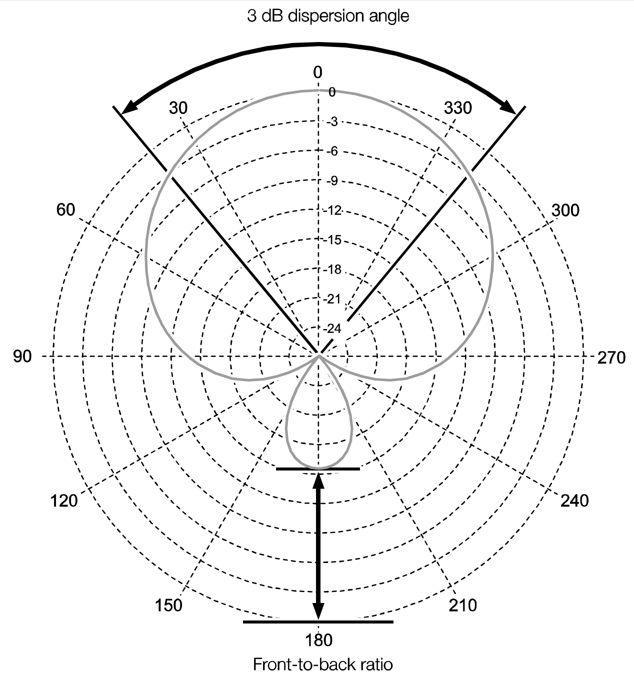

Figure 5: Radiation diagram of a real antenna - horizontal section

Two dispersion angles are specified to provide a full description: The vertical dispersion angle (elevation) and the horizontal dispersion angle (azimuth).

4.5 Front-to-back Ratio

The electromagnetic waves are also radiated by directional antennas, not only in the main dispersion direction, but also in other spatial directions, in particular a backwards spatial direction. These minor lobes should be suppressed as efficiently as possible to allow the radio fields to be aligned correctly towards the selected data carrier.

Attenuation in a backwards dispersion direction in relation to power radiated in the main dispersion direction is described as the front-to-back ratio (see figure 4).
A typical value > 18 dB is specified for the BIS U 300 antenna.

4.6 Impedance

All components must have the same real impedance to allow the transfer of power between the processor unit and the antenna.

The BIS U system is designed for connecting system components (antenna and cable) with a wave resistance or impedance of Z = 50 Ω.
Deviations in the impedance will result in maladjustment that may cause reflections or standing waves. These deviations can significantly reduce the performance of the overall system.

4.7 Polarization

The field vector of electromagnetic waves into the surrounding environment is directional. The alignment of the field vector or the direction of vibrations is described as wave polarization.
A distinction is made between linear and circular polarization, whereby antennas with the latter characteristic are more important. This is because the field intensity value for circular polarized waves is the same regardless of the spatial orientation.

The reception characteristics of most UHF data carriers are similar to those of a dipole antenna due to their design. Transmitting antennas with circular polarization are used to ensure that the data carriers function correctly whatever their position.

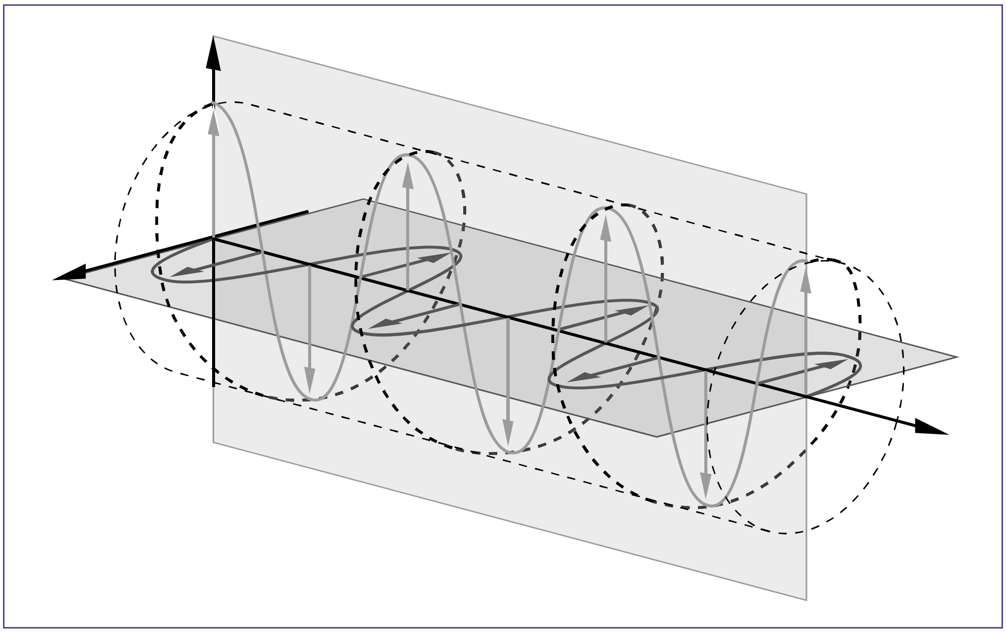

Figure 6: Circular polarized wave

With circular polarization, an additional distinction is made between circular polarization in a counterclockwise and clockwise rotational direction. This characteristic is not important in a predominant number of applications, since transponders usually have linearly polarized antenna properties.

4 Reference Antennas and Antenna Parameters

4.8 Axial Ratio

On real antennas, however, the deflection achieved along both spatial axes is never exactly the same. The polarization ellipse that develops is illustrated by the axial ratio of the two components. A typical value 1 dB is specified for the BIS U 302 antenna.

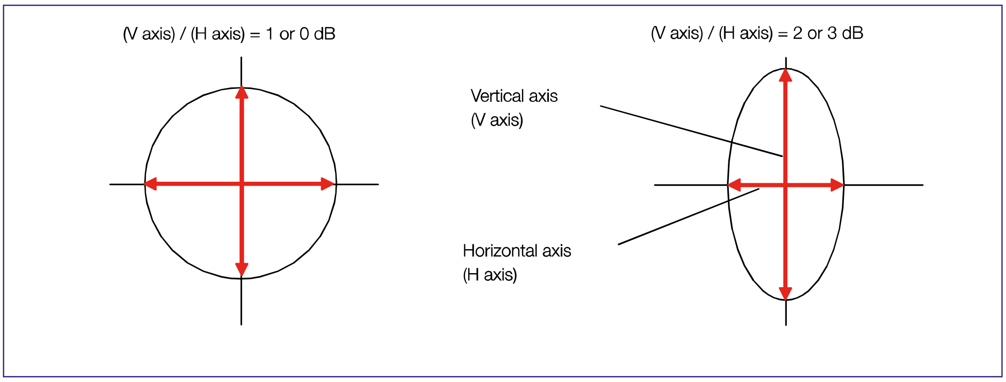

Figure 7: Axial ratio of a circular polarized antenna

4.9 Power Rating

Describes the maximum effective power with which the antenna can operate.

5 Antenna Cable

Only coaxial antenna cables with a wave resistance or impedance of Z = 50 Ω may be used to prevent reflections and vertical waves (resonance) in the antenna line.

Losses resulting from the transfer of electric power to the antenna are known as cable attenuation.

The degree of the cable attenuation depends entirely on the length of the cable, which is selected based on the cable diameter, cable configuration and frequency response. As a general rule, the cable manufacturer specifies the cable attenuation in **dB per meter** (dB/m).

6 Calculating the Radiated Power

The measurable value in the main dispersion direction always defines the radiated antenna power. Within the jurisdiction of the EU, limit values relating to the power radiated from antennas are calculated using what is known as Effective Radiated Power (ERP) based on a half-wave dipole.

Therefore, the ERP value describes the effective power that a dipole antenna supplied with P_0 radiates in the preferred direction. The ERP value of an antenna whose gain is defined based on an isotropic radiator is calculated according to the following equation:

$ERP = P_0 + G_i - 2.15\ dBi$ with

P_0[dBm]	Antenna supply power
G_i[dBi]	Antenna gain based on isotropic radiator
2.15 dBi	Gain of dipole based on isotropic radiator

Effective radiated power in relation to an isotropic radiator (Effective Isotropically Radiated Power or EIRP) is another way of indicating radiated power. Radiated power in the form of EIRP values are common in the USA, as well as in other countries.

The equations for calculating the radiated power of antennas are logarithmic and the power data is standardized to 1 mW because addition is simpler to perform. As a result, all required antenna and power parameters can be specified in decibels and simply added to one another.

The following parameters are required or used to calculate the radiated antenna power:

P_0[dBm]	Socket output power of the processor unit based on 1 mW
G[dBic]	Circular antenna gain based on the isotropic radiator
G[dBi] $_{\text{half-wave dipole}}$ **= 2.15 dB**	Antenna gain of half-wave dipole
Ak[dB]	Cable attenuation per meter
L[m]	Cable length in meters

This can be used in the following formula to calculate the equivalent radiated power of an antenna based on a half-wave dipole:

(1) $ERP[dBm] = P_0[dBm] - Ak[dB] \bullet L[m] + G[dBic] - 2.15\ dB$
$EIRP[dBm] = P_0[dBm] - Ak[dB] \bullet L[m] + G[dBic]$

The formula can be rearranged to calculate the permitted socket power of the processor unit:
(2) $P_0[dBm] = ERP[dBm] + Ak[dB] \bullet L[m] - G[dBic] + 2.15\ dB$
$P_0[dBm] = EIRP[dBm] + Ak[dB] \bullet L[m] - G[dBic]$

POWER	
Watts	dBm
4.000	36
2.000	33
1.000	30
0.500	27
0.250	24
0.125	21
4.000	36

Table 1: Correlation table

7 Component Properties and System Characteristics

In order to make the selection of system components easier and ensure that they perform the relevant tasks in the application correctly, this section discusses some of the basic properties and characteristics of UHF components.

7.1 Memory Topology of the Data Carrier

The memory for a "typical" UHF data carrier is divided up as follows:

96 bits	EPC read/write memory (can be expanded to another size, e.g. 448 bits).
512 bits	Freely accessible read/write memory area for customer-specific applications.
32 bits + 64 bits	TID - Fixed unique product and serial number
32 bits	Access password
32 bits	Kill password for destroying the transponder (not supported by BIS U)

7.2 Structure of the EPC Code

EPC codes were introduced to provide a migration path for the transition from barcodes to RFID technology. The data structure of the 96-bit EPC code is standardized in accordance with EPCglobal and the GS1 convention as follows.

ELECTRONIC PRODUCT CODE

01.0000A89.00016F.000169DC0

Header	EPC Manager	Object Class	Serial Number
0-7 bit	8-35 bit	36-59 bit	60-95 bit

Figure 8: EPC code

Header bit positions (0…7)	Represents the length of the EPC code, possible lengths from 64 to 256 bits, 01 length 96 bits
EPC manager bit positions (8…35)	Describes the product manufacturer
Object class bit positions (36…59)	Describes the product (stock keeping unit)
Serial number bit positions (60…95)	Used to distinguish between 2^{37} individuals

7 Component Properties and System Characteristics

7.3 Data Carrier Antenna Shapes

Antenna designs are predominantly limited to shapes that are very similar to a dipole because the power is drawn exclusively from the electric field in the far field. Data carriers that incorporate slot, patch or microstrip resonator antennas are exceptions to the rule because they can be mounted directly onto metal surfaces. This document does not explore these data carriers in further detail.

Data carriers with antennas similar to a dipole are available in a wide range of shapes and sizes, for example:

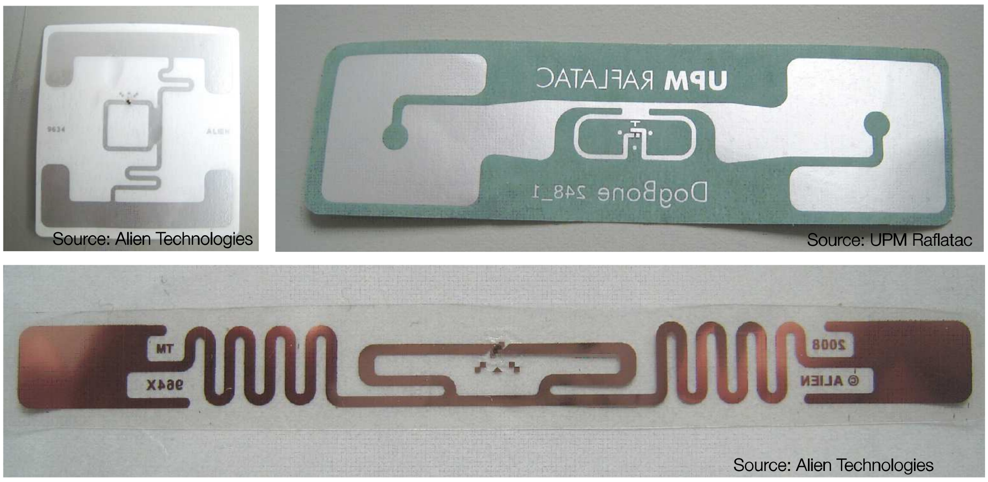

Figure 9: Data carriers with different antenna designs

The use of RF loop antennas with additional radiating elements (wave trap dipoles) achieve a reduction in the overall size and make data carriers suitable for use in the near field.

7.4 Directional Characteristics of the Data Carrier Dipole Antenna

The data carrier is sensitive to orientation because of the dipole antenna principle.

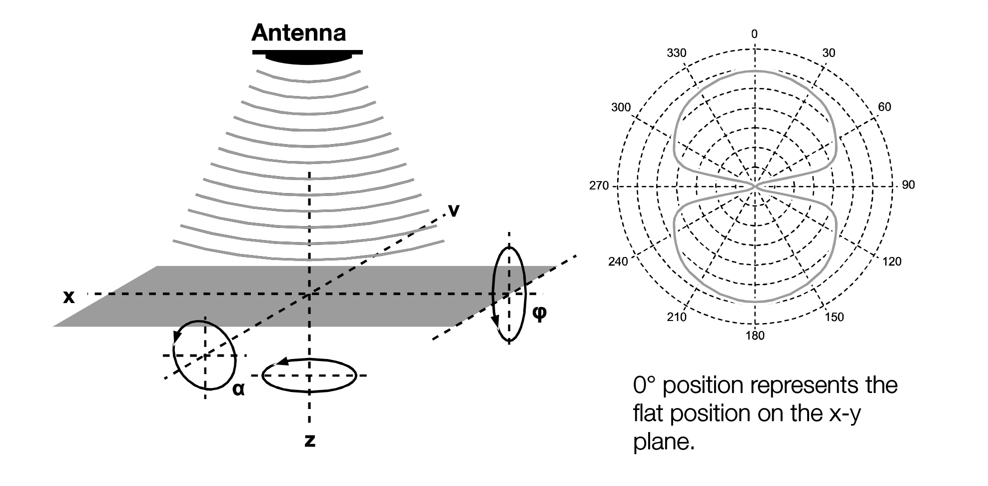

Figure 10: Directional sensitivity of the data carrier dipole antenna

The following qualitative statements apply:

- If a circular polarized transmitting antenna is used, no directional sensitivity is observed when the antenna is rotated around the z-axis.
- When the antenna is rotated around the x-axis, a reduction in sensitivity is observed at rotation angles of 90° and 270°.
- When the antenna is rotated around the y-axis, read capability is absent at rotation angles of 90° and 270°.

7.5 Responsiveness of the Data Carrier - Response Field Intensities

In order to supply power to the ICs, passive RFID data carriers are instructed to draw the required energy from electromagnetic waves radiated by the antenna on the processor unit.

The response field intensity is the minimum field intensity required to operate the integrated circuit that is present at the location of a data carrier. The use of the external electric field, which generates a sufficiently high RF voltage at the antenna connections, is largely influenced by the antenna design and capacity to adjust to the operating frequency.

The power consumption of the data carrier ICs varies for each individual semiconductor manufacturer and design generation, and has an influence on the responsiveness of the data carrier.

Responsiveness is a particularly important aspect because the processor unit can usually detect a data carrier located in a RF field of sufficient intensity.

7 Component Properties and System Characteristics

7.6 Theoretical Reading Range

Under ideal conditions, the electric field intensity in the far field (approximately > 70 cm) decreases reciprocally in relation to the distance (free space loss). Varying the antenna power generates an array of curves that allocates a unique field intensity to every point within the surrounding environment.

The theoretical reading range for the different levels of power radiated from the antenna can be determined by intersecting the response field intensity with the relevant field intensity curve. Under ideal boundary conditions, this type of reading range value is calculated in a free field or a large absorber chamber.

Antenna power in watts			
	2.0	1.0	0.25
Transponder I	260 cm	190 cm	90 cm
Transponder II	820 cm	560 cm	280 cm

Table 2: Theoretical reading ranges as a function of the antenna power

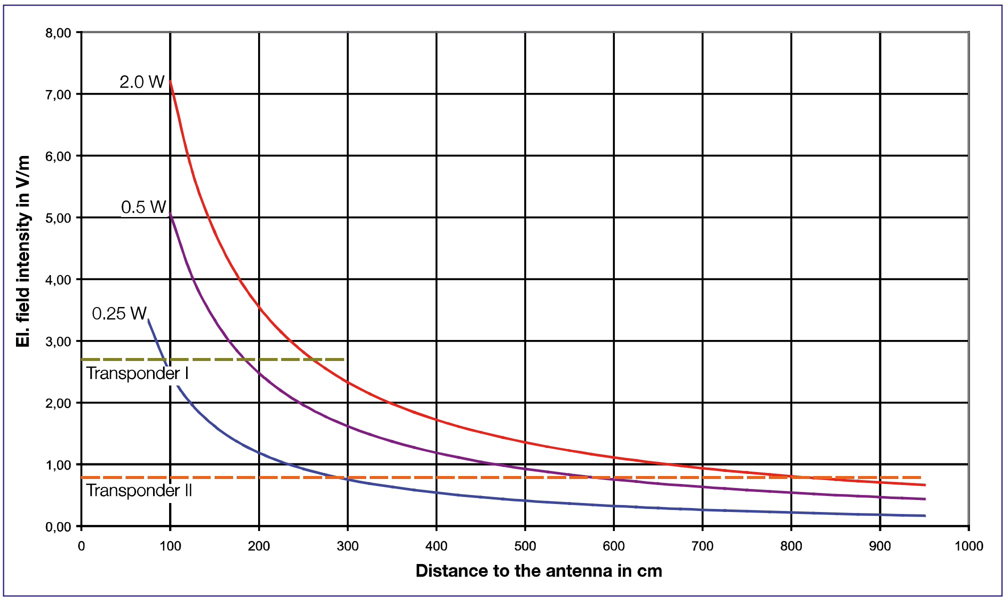

Figure 11: Determining the theoretical reading range

8 Reflection, Dispersion and Adsorption of Electromagnetic Waves

Electromagnetic waves radiated from the antenna propagate at nearly the speed of light and meet objects with different consistencies. The wave can be absorbed and reflected or scattered in all directions at different intensities.
Apart from the consistency of the material, which may be similar to metal or polar liquids, the size of the obstacles has a decisive influence on the backscattering characteristics:

Rayleigh range	The reflections are negligible if their dimensions are much smaller than the wave length.
Resonance range	The object size is comparable with the wave length. Resonant absorption and radiation from sharp objects, slots and points are observed and may cause changes in the polarization direction or result in the magnification or cancellation of fields.
Optical range	The object dimensions are large compared to the wave length. The geometry and position of the object (incidence angle of the wave) have an influence on the backscattering result. Experiences gained from the field of geometrical optics can be used with approximate equivalence.

Parts of the primary wave that overlap with stray partial waves generated by reflections, scattering or diffraction on metallic structures in the actual surrounding area can result in local magnification or reduction in the electric field intensity. If the field intensity decreases so much that it falls below the response field intensity value for the data carrier, communication between the processor unit and data carrier is interrupted. However, if interaction in the surrounding area at a point situated further in front of the antenna causes the field intensity to increase, communication between the data carrier and processor unit remains stable. Field magnification can result in super-refraction as a result.

For this reason, it is not possible to specify a reading range for a specific UHF identification system consisting of a data carrier and antenna/processor unit that is valid for all applications or boundary conditions.

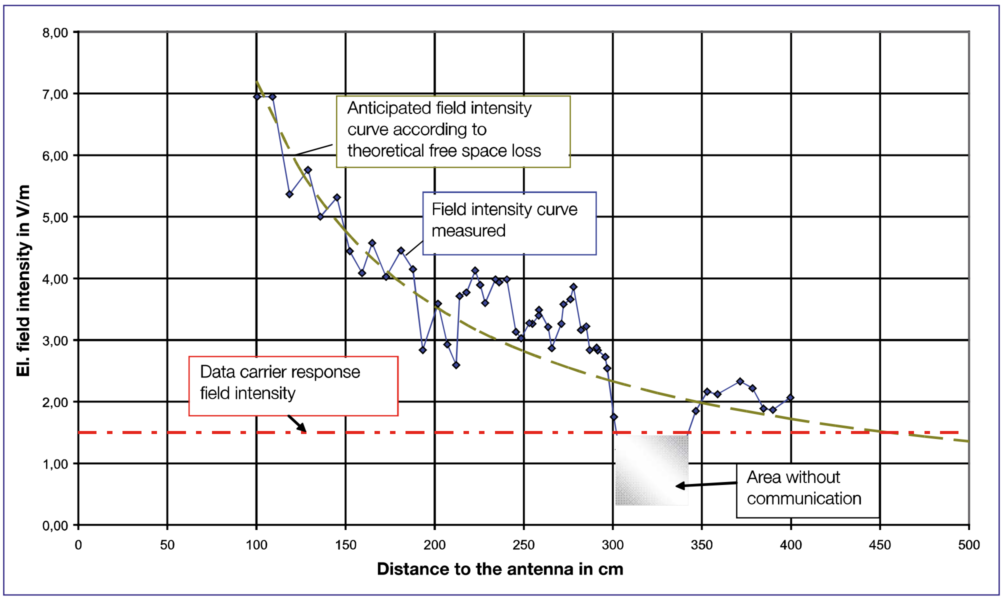

Figure 12: Appearance of areas without communication (blind spots)

As already highlighted, interaction between electromagnetic waves and objects in the actual surrounding area as well as between the waves themselves results in changes in the anticipated electric field distribution or free space loss. Selected examples should be used to demonstrate the effect of this interaction on the performance of UHF technology.

8 Reflection, Dispersion and Adsorption of Electromagnetic Waves

8.1 Changes in the Polarizing Axis Ratio

Interaction with structures in the surrounding area changes the axis components of a circular polarized wave, which are originally almost identical in size.
These changes result in noticeable differences in the reading performance or reading range depending on the degree of response field intensity and on whether the data carrier is mounted in a vertical or horizontal position.

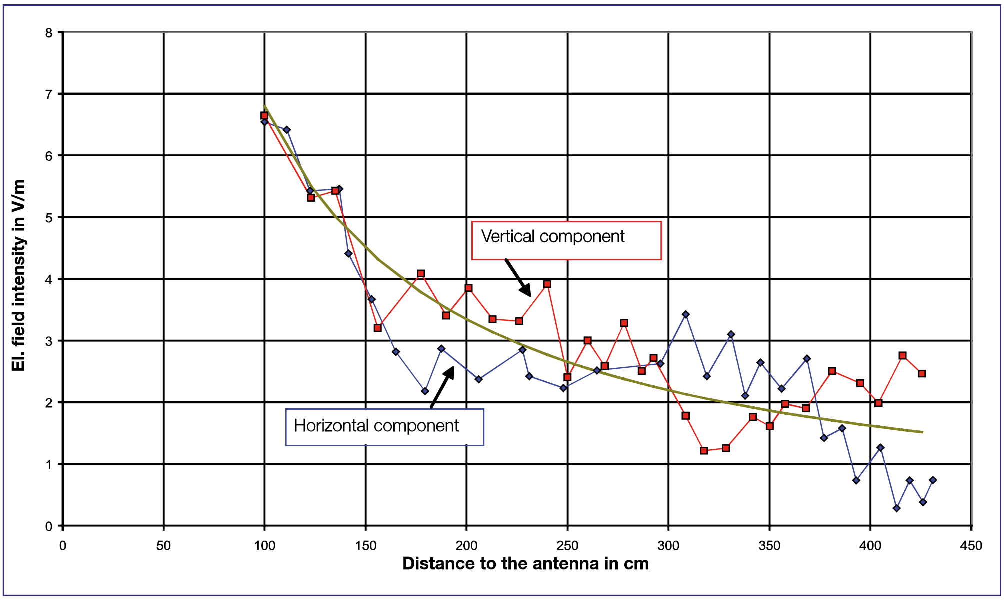

Figure 13: Changes in the axial ratio of polarization components

8.2 Effect of Different Environmental Conditions

The positioning, materials and geometry of the obstacles in the surrounding environment can vary from application to application and can therefore be expected to have a direct effect on the appearance of the electric field distribution. In Figure 14, the vertical component of the electrical field intensity curve has been measured comparatively for three different spaces in the main propagation direction using a circular polarized antenna.

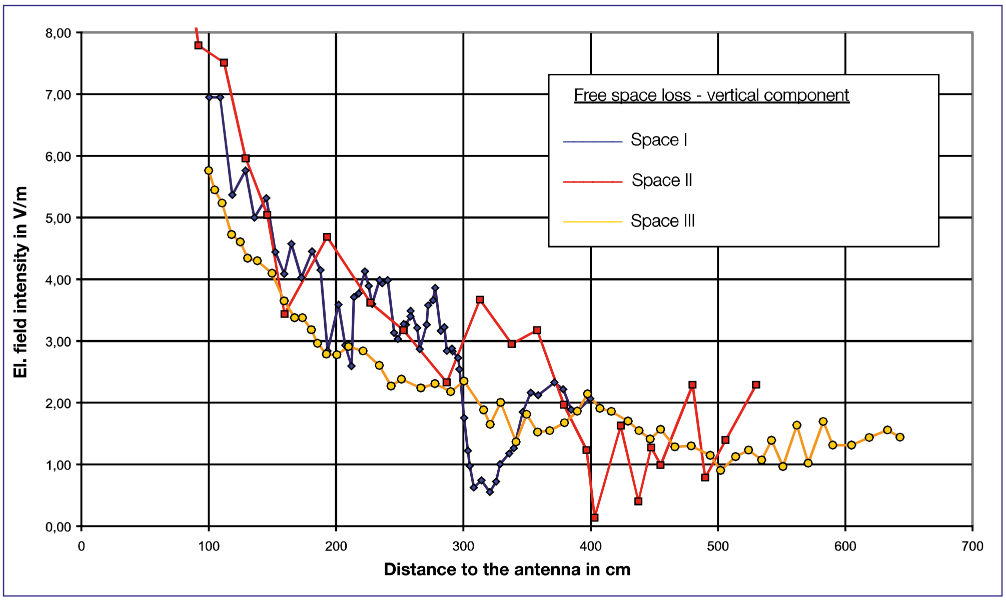

Figure 14: Free space loss curve for three different spaces in main dispersion direction

8 Reflection, Dispersion and Adsorption of Electromagnetic Waves

8.3 Attenuation of Electromagnetic Radiation

It is well-known from low-frequency RFID systems that waves permeate all electrically non-conductive materials virtually without loss. On UHF systems, a different approach must be adopted when assessing the behavior of waves penetrating materials.

– Solids or liquids that are comprised of polar molecules and contain water or carbonic substances, for example, present a high degree of RF attenuation and significantly weaken the radiation emitted by the antenna. This information confirms that objects such as the human body represents an insurmountable obstacle for the propagation of electromagnetic waves.
– Mineral oils, on the other hand, only weaken electromagnetic waves to an extremely limited extent because they consist of non-polar molecules. As a result, for instance, SmartLabels can be affixed directly to plastic mineral oil containers.
  UHF waves cannot penetrate metallic surfaces or grid structures consisting of metallic rods or mesh. This group also includes metal reinforced concrete walls.
– Electrically non-conductive, dry materials such as plastic, paper and wood are penetrated virtually without loss.

9 Antenna and Transponder Mounting Distances

9.1 Antennas on a Processor Unit

Even if the antennas are connected to a processor unit, the minimum distances for the following configurations should be respected to prevent unwanted interaction:

- Two antennas installed beside one another > 50 cm
- Two antennas installed back to back > 50 cm

9.2 Distances to Structures in the Surrounding Area

A minimum distance of 50 cm from metallic components or polar liquids must be maintained to prevent the antenna from detuning and avoid backscatter from strong electromagnetic fields.

9.3 Mounting Transponders

Mounting data carriers directly to metal surfaces can drastically reduce the reading range. Distances of at least 15 mm from the metal surface can improve the reading performance considerably, depending on the antenna design.

To prevent the data carriers from detuning, the minimum distance between two data carriers should not be less than 50 mm.

10 Operating Several Processor Units

Due to the large range available for UHF fields, it is possible that processor units will have a negative influence on one another if they are operated simultaneously and randomly select the same operating frequency.

10.1 Frequency Hopping Method

One way of avoiding interference is to configure the processor units to switch to a different transmitting channel in a random sequence (frequency hopping).

The probability of multiple readers transmitting at the same channel at the same time decreases in relation to the number of available channels within the permitted frequency band.

The number of channels can vary depending on the national provisions of different countries.

10.2 Listen Before Talk

Another way to avoid interference is a contention-based protocol called the listen before talk operating procedure. Only ten channels are available in some countries, such as European Community countries. Since the probability that several readers will be transmitting on the same channel is rather high in such cases, the availability of the channel is checked before transmission.

The processor unit only starts transmitting if the selected channel is available (listen before talk) to prevent overlapping or collisions. In order to guarantee dynamic use of the transmitting channels, the transmission time may not exceed 4 seconds. The processor unit must then wait 100 ms or switch directly to a new unused channel.

Following the amendment of ETSI standard EN 302 208 (V1.2.1), this procedure for reducing mutual interference is no longer mandatory. The procedure mentioned in section 10.3 is preferred.

10.3 Creating a Transmission Plan

Increasing the channel spacing (ETSI 302 208 V1.2.1) to 600 kHz already rules out the mutual overlapping of transmitted and received signals traveling between adjacent transmitting channels for all available radio profiles; the position of the side band in relation to the transmission frequency is determined here.

Mutual interference is prevented by allocating different transmitting channels to the processor units involved, i.e. creating a transmission plan.

The distance to the side band can be as much as 320 kHz in **Dense Reader Mode** (according to ETSI TS 102 562) and allows more than one reader to be operated on each channel.

11 Measures for Improving the Operational Reliability of UHF Systems

In a real environment, the primary wave emitted by the antenna reflects against large objects such as walls, floors, deposited transport containers etc. and causes independent, uncontrollable propagation in the form of a stray secondary wave.

In the worst case scenario, interference between the primary wave and the secondary waves can cause field attenuation. In a multi-reflective environment, it is virtually impossible to predict the field intensity at a specific location. It should also be noted that a change in the surrounding area caused by moving transportation equipment, for example, may cause the field intensity to change over time.

11.1 Field Reserve and Working Distance

Local or temporary decreases in the field intensity have the same effect as a deliberate reduction in the transmitting power during reading operations. If the transmitting power of the antenna is then reduced to a point where the data carrier can just about be detected, a decrease in the field intensity within the multi-reflective environment is followed by an interruption in communication.

Figures 12, 13 and 14 clearly show that the fluctuations increase in line with the distance to the transmitting antenna. In order to ensure that the electric field never falls below the excitation field intensity of the data carrier in a multi-reflective environment, even when the field intensity fluctuates, field reserves within range of the fluctuation amplitude must be taken into consideration. This results in a calculative increase in the response field intensity and definition of the so-called working distance at the intersection point with the power curve.

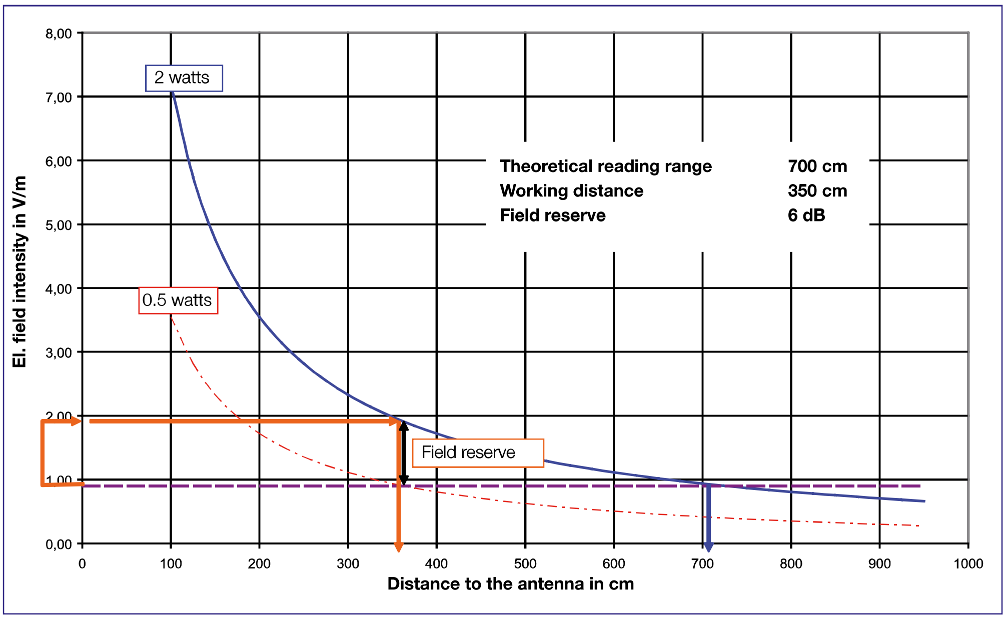

Figure 15: Graphic derivation of the working distance for a data carrier

When designing a UHF system, it is recommended that the following rules be observed:

- The values for the working distance of a data carrier specified by the manufacturer or system supplier should not be exceeded.
- For a data carrier positioned at the point of operation, the response field intensity must be calculated by reducing the transmitting power. The transmitting power must then be increased by the field reserve prior to operation. A field reserve of 50%…100% is considered sufficient for most applications.

11 Measures for Improving the Operational Reliability of UHF Systems

11.2 Using Several Antennas

Each antenna generates a different spatial field distribution pattern because the obstacles in a multi-reflective environment are positioned differently for each antenna.
It can therefore be expected that the value for the local field intensity at the transponder position will change as soon as an antenna in a different spatial position starts transmitting.

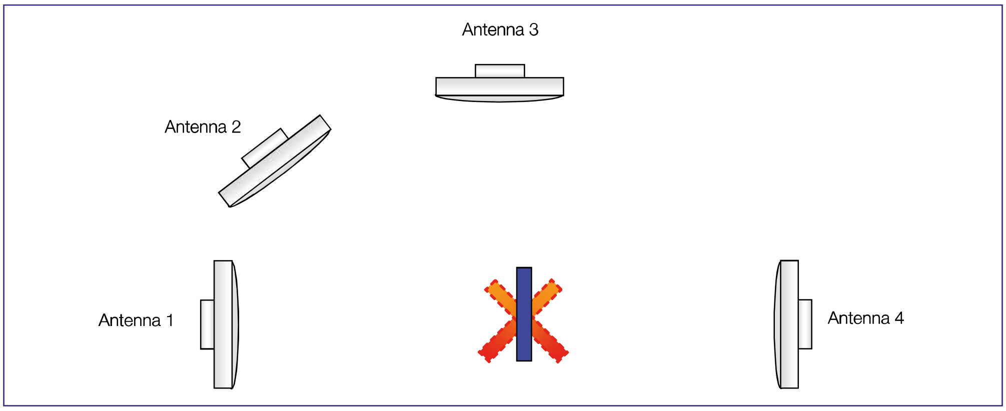

Figure 16: Arrangement of several antennas

Randomly positioned data carriers can also be detected in this kind of antenna configuration. These antenna configurations can be used in the following scenarios:

Incoming/ outgoing goods	Pallets containing goods are transported through the doors of a warehouse, trading house or industrial enterprise. In the corresponding stationary antenna configuration (gantry arrangement, gate), individual UHF data carriers affixed to pallets or even goods can be detected automatically. The scanned data may contain information about the origin and nature of the products.
Internal company commodity flows	Gantries with antennas are installed at selected points within the industrial company. Containers bearing data carriers are detected when they pass through the gantries. An overall picture of the flow of products throughout the production sequence can be obtained by analyzing the scanned data.
Non-orientated data carriers	Affixing several data carriers to rotationally symmetrical goods or containers, for example, is not viable because of data consistency issues and the costs involved. The only way to reliably detect data carriers without a specific alignment is through the use of antennas aligned towards the unidentified product from different angular positions.

www.balluff.com

Balluff GmbH
Schurwaldstrasse 9
73765 Neuhausen a.d.F.
Germany
Phone +49 7158 173-0
Fax +49 7158 5010
balluff@balluff.de
www.balluff.com

No. 883387-726 EN · 02.124544 . G17; Subject to modification.Replaces.1401.