BALLUFF

Industrial
RFID systems

MANAGING ALL YOUR DATA

innovating automation

Automatic identification and tracking in production

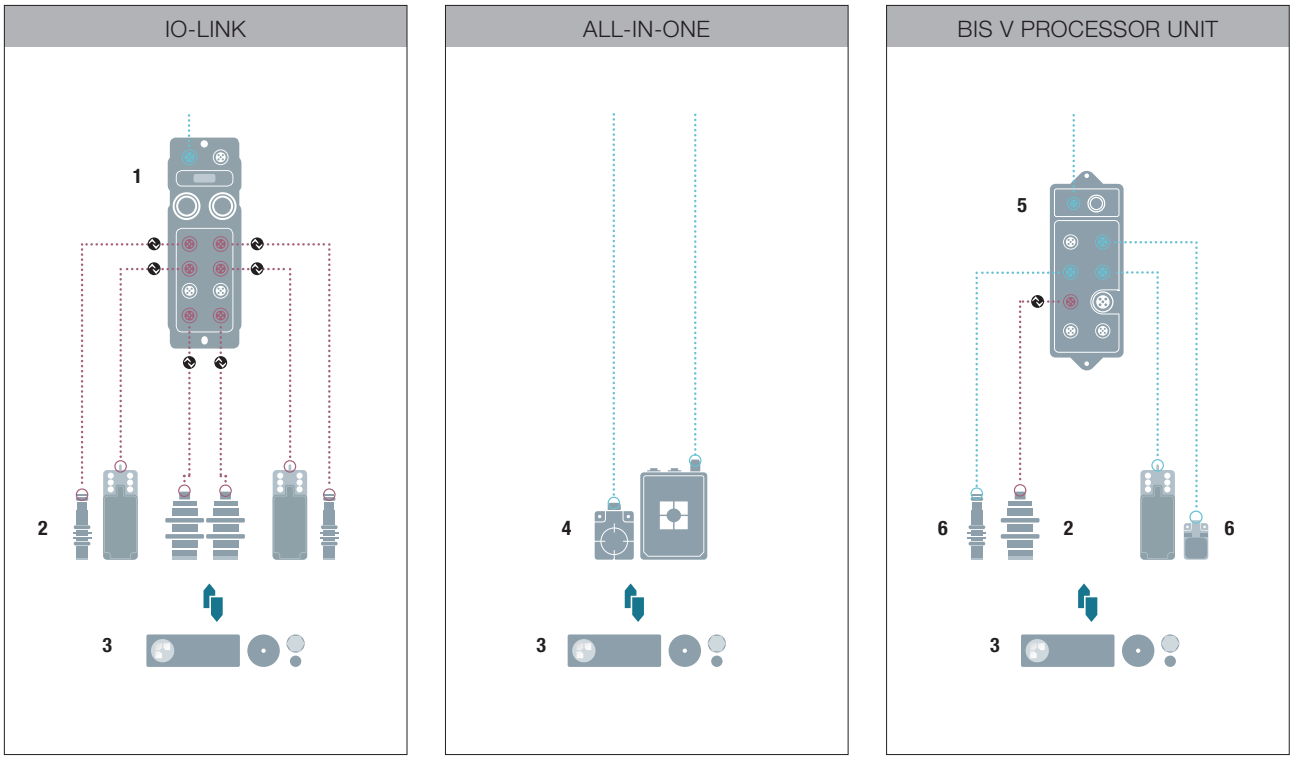
THE PERFORMANCE RANGE

Balluff offers you a wide selection of data carriers and read/write heads for LF, HF and UHF applications. With the BIS V multi-frequency processor unit, all systems can be combined with each other. This adds flexibility and saves costs through lower inventory levels.

Your Balluff solutions

- HF RFID system (13.56 MHz) BIS M
- LF RFID system (70/455 kHz) BIS C
- LF RFID system (125 kHz) BIS L
- UHF RFID system (860/960 MHz) BIS U

Go online to individually configure your own system
www.balluff.de/go/rfid-configurator



1 Network block
2 Read/write heads with IO-Link
3 Data carriers
4 Read/write heads with integrated processor unit
5 Universal processor unit
6 Read/write heads

Cost-effective solution for simple identification tasks

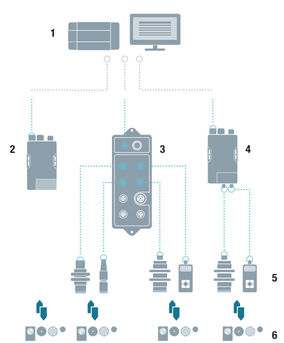
LF INDUSTRIAL RFID SYSTEM

Low frequency (LF) RFID gives you the ability to use different LF processor units. The read/write head can be connected the traditional way using cable, or can be located directly on the processor unit housing. Our most flexible and modern solution is the universal BIS V processor unit.

The most important benefits

- Ideal for reliable tool identification at short ranges
- High performance and flexible even in machining centers with coolants and lubricants
- Other applications: Workpiece transport with conveyor systems, FTS and pallet transport systems, assembly technology and resource organization
- Wear-free, maintenance-free and insensitive to dirt

LF 70/455 KHZ OR 125 KHZ



1 Controller
2 Processor unit with LF read/write heads
3 Universal processor unit
4 LF processor unit
5 LF read/write heads
6 LF data carriers

High transmission speed for large volumes of data

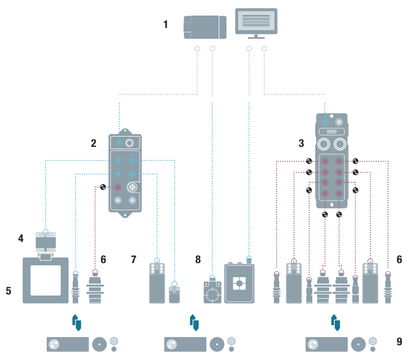
HF INDUSTRIAL RFID SYSTEM

For high frequency (HF) RFID solutions we offer three possible combinations: You can combine up to four read/write heads on the BIS V processor unit in addition to connecting an IO-Link device. Many read/write heads can be connected to one IO-Link master, and all IO-Link devices can be flexibly combined with each other. By using an all-in-one read head you have everything – read head and processor unit – in one unit.

The most important benefits

- High transmission speeds and large data quantities at ranges up to 400 mm
- Seamless integration in applications through global RFID standards ISO 15693 and ISO 14443A
- Customer-specific developments
- Applications: Parts tracking at close range, production control (palletizing, data recording on the workpiece itself, ...).

HF 13.56 MHZ



1 Controller
2 Universal processor unit
3 Network block
4 HF processor unit
5 HF antenna
6 HF read/write heads with IO-Link
7 HF read/write heads
8 HF read/write heads with integrated processor unit
9 HF data carriers

Continuous transmission security and data transparency

UHF INDUSTRIAL RFID SYSTEM

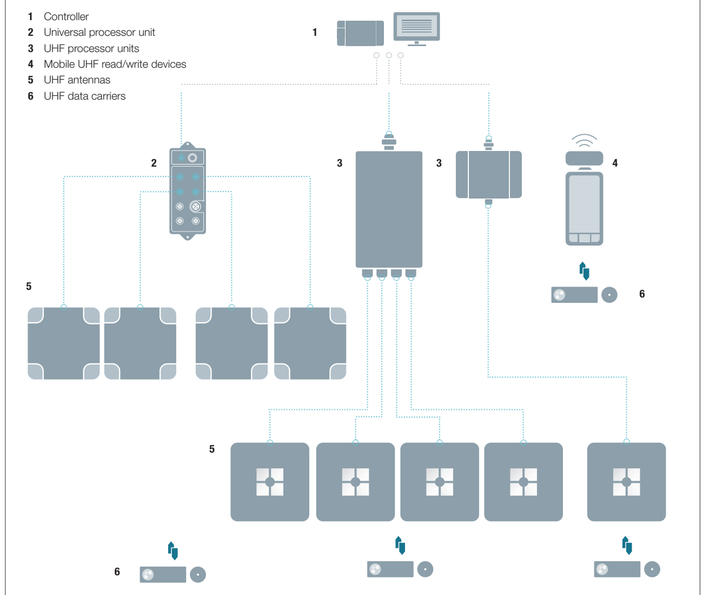
For ultra-high frequency (UHF) systems you can select from special high-performance UHF processor units. The multi-frequency BIS V processor unit is also an option. Or you can read the UHF data carriers using one of our handheld readers, for example at manual workstations.

The most important benefits

- For dynamic processes with great read distances up to 6 m and more
- Easy integration in applications using global standard interfaces and global standards: ISO 18000-6C and EPC Gen2 Class1
- Simultaneous detection of many data carriers
- Complete tailored system solutions realizable
- Applications: Traceability, tracking of automation processes, intralogistics

UHF 860/960 MHZ

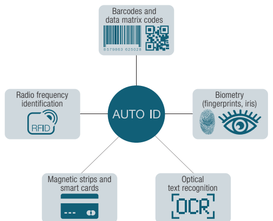
1 Controller
2 Universal processor unit
3 UHF processor units
4 Mobile UHF read/write devices
5 UHF antennas
6 UHF data carriers



WHAT IS RFID?

RFID (Radio Frequency Identification) is the communication technology for non-contact and automatic identification of objects (merchandise, goods, people, animals, for example) using electromagnetic induction or radio waves.

Along with bar codes, data matrix codes, biometry (fingerprint), optical text recognition as well as contact-type smart cards, RFID is a commonly employed technology.



Benefits
- No line of sight between data carrier and reader required
- Long data carrier service life
- High system reliability even in harsh conditions
- High memory capacity depending on data carrier

Use
- Traceability of different production objects
- Management of assets, e.g. tool identification or format part detection
- Authentication for areas and machines (access control)
- Monitoring guarantees, spare parts business and maintenance work (counterfeit protection)

THE DIFFERENT RFID SYSTEMS

RFID systems are available for three frequency ranges: Ultra-high frequency (UHF), high frequency (HF) and low frequency (LF). These are associated with various technical and physical characteristics.
- LF (low frequency, 30…300 kHz)
  Balluff system BIS C (70 kHz/455 kHz)
- HF (high frequency, 3…30 MHz)
  Balluff system BIS M (13.56 MHz)
- UHF (ultra high frequency, 300 MHz…3 GHz)
  Balluff system BIS U (860…960 MHz, country-specific frequencies)

UHF by country-specific frequencies

1 South Korea
LF: 125 kHz
HF: 13.56 MHz
UHF: 917...920.8 MHz

2 Japan
LF: 125 kHz
HF: 13.56 MHz
UHF: 916.7...920.8 MHz

3 China
LF: 125 kHz
HF: 13.56 MHz
UHF: 840.5...844.5 MHz

4 Australia
LF: 125 kHz
HF: 13.56 MHz
UHF: 920...926 MHz

5 South Africa
LF: 125 kHz
HF: 13.56 MHz
UHF: 865.6...867.6 MHz

6 Europe
LF: 125 kHz
HF: 13.56 MHz
UHF: 865.6...867.6 MHz

7 USA/Canada/Mexico
LF: 125 kHz
HF: 13.56 MHz
UHF: 902...928 MHz

8 Brazil
LF: 125 kHz
HF: 13.56 MHz
UHF: 902...907.5 MHz

WHAT ARE THE CONSEQUENCES OF THE DIFFERENT FREQUENCIES?

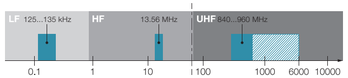
Briefly stated, different frequencies mean different working ranges, since the frequency determines the range. The frequency also affects the coupling behavior (see: How the system components communicate).

LF is best suited for close range and for difficult conditions such as metallic surroundings. LF is therefore often used in tool identification.

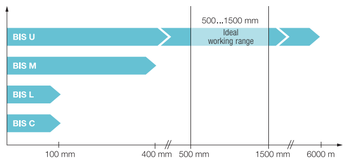
HF is ideal for parts tracking at close range up to 400 mm. With HF you can process and store larger quantities of data at high transmission speeds.

UHF typically communicates at a range of 6 m distance. UHF allows simultaneous reading of multiple data carriers (multi-tagging).

System frequencies



Working range of the Balluff BIS RFID systems



SYSTEM STRUCTURE

RFID requires three main components.
These form an RFID system:
- Data carrier (data storage)
- Read/write head (data transmission)
- Processor unit (data processing and communication)

The system components in detail

- **Data carrier (Tag/Data Carrier)**
  Stores all kinds of data which is read or written by computers or automation equipment. The data carrier antenna sends and receives the signals. Read/write versions are available in various memory capacities and with various storage mechanisms.
  – Passive data carriers: without power supply
  – Active data carriers: with power supply

- **Read/write head**
  Provides power to the data carrier, reads its data and writes new data to it. It sends this data to the processor unit where the data is further processed.

- **Antenna**
  Transmits the power.
  – HF-/LF systems: Antenna is integrated in the read/write head
  – UHF systems: Usually passive antennas without read/write head electronics (integrated into the processor unit).

- **Processor unit**
  Used for signal processing and preparation. It typically includes an integrated interface for connecting to the controller/PC system.
  UHF system: The read/write function can be integrated into the processor unit, so that only a passive antenna and the data carrier are required.

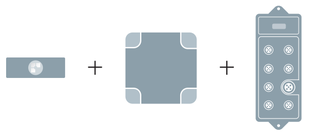
How the system components communicate

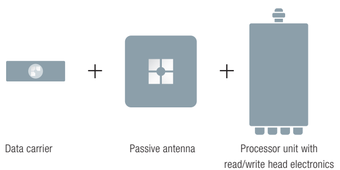
The data carrier and read/write head connect via the frequency-dependent coupling.
With UHF the coupling is via electromagnetic waves, and for LF and HF the coupling is inductive.

Components of a HF/LF system

Used at close range, the data carrier must be placed exactly within the read range of the read/write head.

Components of a UHF system





In UHF systems close placement of the data carrier in front of the antenna is not necessary because of the large working range. Still, there are a few rules (see: What to know about UHF systems).

Various industry standards are in place both for the LF/HF range and for UHF for communication between the system components. These specify how the information is transmitted. There are also proprietary manufacturer-specific solutions available (see: What you need to know about LF/HF systems/UHF systems).

SYSTEM CHARACTERISTICS

Why data storage is important

Selection of the data storage determines where data can be processed and with which components. You can use either of two storage concepts: the central database and decentralized data retention.

Central data storage
- All data records are stored in a central database
- Data carrier is simply an identifier
- Mainly for reading information

Can be LF, HF or UHF systems, but mainly used with UHF systems

Decentralized data retention
- All data records are stored on data carriers
- The data carrier stores the identifier and all data records (no central database)
- For both reading and writing information

Mainly used with HF/LF systems

WHAT YOU NEED TO KNOW ABOUT LF/HF SYSTEMS

In brief, the read/write distance in LF/HF systems is affected by the antenna shape and the traverse speed.

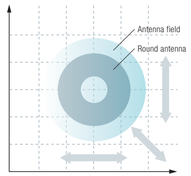
When installing the data carriers the installation conditions and close proximity of metal play a role.

Antenna shape

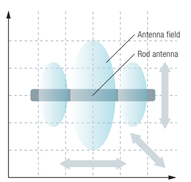
Data carriers and read/write heads are constructed with a rod or round antenna. To achieve the best results the antenna shape must be identical to that of the read/write head. This means: Use rod antenna with rod antenna or round antenna with round antenna.

The antenna shape determines different field distributions and read distances. It also determines the active communication field.

Round antenna
- The lobe of the antenna field is distributed evenly and symmetrically
- No polarization or directionality, even offset. This means the data carrier and read/write head do not have to be aligned with each other



Rod antenna
- The lobe of the antenna field is distributed unevenly and has additional sidelobes
- The is polarization and directionality, which allows greater read distances than with a round antenna
- Identical orientation of the data carrier and read/write head is important in order to achieve greater read distances



Installing data carriers

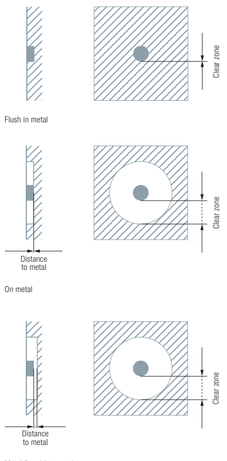
Account for distance to metal
To reach the specified read/write distance, a data carrier in a metallic environment must be mounted at a certain distance from metal and within a certain metal-free clear zone. The exact specifications can be found in the data sheets. The following distinctions are made:

- **Flush in metal**
  The sensing surface can be mounted flush on the surface of steel so that it is even with adjacent areas. The range here is less than for differently constructed/installed data carriers of the same size.

- **On metal**
  The sensing surface must not be in contact or surrounded by steel.

- **Metal-free (clear zone)**
  The entire area of the data carrier must be kept clear of any type of metal.

Observe clear zone
The clear zone is an area within which a data carrier is mounted in metallic surroundings to achieve a prescribed read/write distance.



In addition to the clear zone, optimal function depends also on the distances between the data carriers (see data sheet for detailed information).

Data carriers with various memory types are available

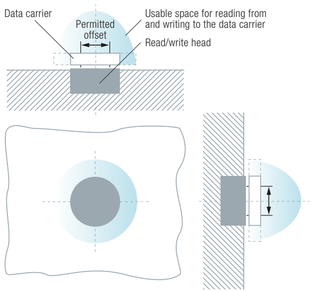
Traditional memory chips are EEPROM and FRAM. Both types use inductive coupling for power supply and data transmission. They differ in the maximum number of write cycles.

- EEPROM (Electrical erasable programmable read only memory): 100,000 to 1,000,000 write cycles
- FRAM (Ferro-electrical random access memory): 10^{10} write cycles

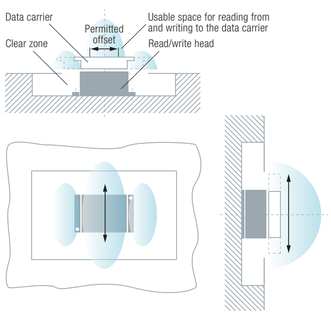
How traverse speed, read/write distance and data transmission time relate to each other

For reliable data transfer between read/write head and data carrier the latter must remain within the capture range of the read/write head for a certain length of time. The rule of thumb is: the faster the traverse speed, the closer the read/write distance.

Static read/write mode
The data carrier remains in place in front of the read/write head. This enables a greater read/write distance than in dynamic mode.

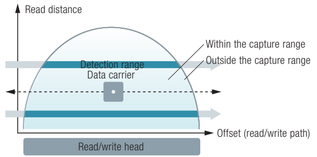


Dynamic read/write mode
The data carrier passes by the read/write head without stopping. This should be as close as possible to achieve a long read/write path.



How to calculate the traverse speed for dynamic applications

$$\text{Traverse speed (v)} = \frac{\text{Offset (s)}}{\text{Dwell time (t)}}$$



Example
How great is the offset and resulting read distance at a traverse speed of 7 m/s and a dwell time in the capture range of 45 ms.

$s = v \cdot t = 7\ m/s \cdot 0.045\ s = 0.315\ m = 315\ mm$

At least 315 mm of offset is required to read the data within a dwell time of 45 ms. Assuming the maximum offset is 340 mm, the read distance must be configured to be very short. The greater the offset of the read/write head, the greater the distance between data carrier and read/write head can be.

Important industry standards

- **ISO 15693**
  International series of standards for non-contacting chip cards, identification systems and access controls. Operates at a frequency of 13.56 MHz and is the prevailing standard in automation.

  ISO 15693 defines the protocols for communication between data carrier and read/write head. The data carriers and read/write heads from different suppliers are generally compatible if they adhere to the same standard.

- **ISO 14443**
  International series of standards for non-contact chip cards. These are used in identification systems and access controlling, but also for payment applications such as credit cards, public transportation tickets, etc. Operates at a frequency of 13.56 MHz.

  In contrast to the ISO 15693 standard, ISO 14443 specifies that the data carrier and read/write head carry a manufacturer-specific identifier. Only if the identifiers agree can they communicate with each other.

  Balluff uses the most commonly accepted contactless chip technology NXP Mifare. This complies with ISO-Standards ISO 7816 and ISO 14443A.

High performance solutions from Balluff

In addition to the industry standards there are proprietary systems that are not described by any standard. For example, high-performance solutions from Balluff that are faster and process more data than these industry standards allow.

Here the following components are used:

- **High-memory data carriers:** Data carriers with a memory capacity > 8 kilobytes.
- **High-speed data carriers:** Combined with the associated read/write heads you can achieve up to eight times greater read speeds than applications that fall under DIN ISO 15693.

WHAT YOU NEED TO KNOW ABOUT UHF SYSTEMS

Power transmission between data carrier and read/write head is essential for optimal function of a UHF RFID system. Whether and how the antennas need to be aligned with each other depends on the type of polarization of the antennas.

Relationship between antenna polarization and data carrier orientation

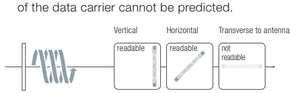
The polarization of a UHF antenna is determined by the direction of the electrical field of the wave.

- **Linear polarized antennas**
  The electrical field runs either vertical or horizontal to the surface of the ground. This means, the read/write head antenna and that of the data carrier must be identically aligned in order to transmit power.

Vertical polarization

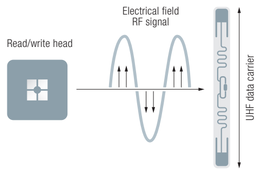
Horizontal polarization

- **Circular polarized antennas**
  The electrical field rotates clockwise or counter-clockwise to the direction of propagation. The orientation of the data carrier is thus not as critical. This makes circular polarized antennas ideal for use when the orientation of the data carrier cannot be predicted.



Circular polarization

- **Data carrier antenna**
  In UHF systems the coupling is electromagnetic. To transmit data the data carrier's antenna converts electromagnetic waves and high-frequency alternating current into each other. Here the polarization direction of the sending antenna and the orientation of the data carrier must be selected correctly. (See illustration for how to achieve optimal power transmission).



Data carrier antenna

Construction of a UHF data carrier

UHF data carriers with a dipole antenna are often selected (see illustration above). Many other antenna shapes are available as well. These offer particular properties and determine the form factor of the data carrier.

1 Antenna
2 Integrated circuit
3 Substrate


Other form factors for UHF data carriers

Typical UHF industry standards

- **ISO/IEC 18000-6:2013**
  International series of standards that provide the general description of the air interface and signal transmission. The latest standard ISO 18000-63 was published in 2015.

- **EPC Class1 Gen2**
  Was published by the standardization organization EPC global, which develops voluntary standards. EPC Class 1 Gen2 Version 2.0.1 is fully compatible with ISO 18000-63.

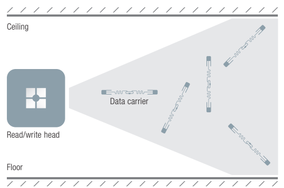
  This compatibility mans you can use the same hardware infrastructure and the same data carriers both in an ISO standard environment and an EPC environment.

Both standards are suitable for worldwide use. You must however take note of the various national RF regulations.

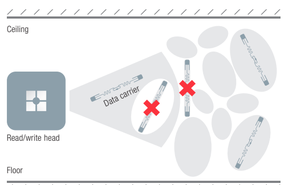
UHF antenna field requires specific test scenarios

In brief: Since the surroundings affect the antenna field, you must perform the closest possible simulation of the ambient conditions.

The UHF antenna beams its signal in a wide opening angle. Undesired reflections and absorption in a UHF RFID system mean that in practice the antenna field can be predicted only within limitations. For example when there are concrete walls, metal surfaces and safety gates made of metal.



Typical ideal antenna field



Actual antenna field

Whereas absorption converts energy into heat and thereby weakens the signal, reflection of waves can result in overlapping of wavetrains. Overall it can result in local fields with higher and lower field strengths, or even field collapses (read holes).

If a data carrier finds itself in such a read hole, it can no longer communicate with the read/write head.

Headquarters
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

CONTACT OUR
WORLDWIDE
SUBSIDIARIES

Doc. no. 949747 EN · I20 · Subject to changes.