

RFID

Technology & Applications

Basic principles of RFID



Radio Frequency Identification (RFID) is a well established high-performance electronic identification technology similar to chip cards, which are already well known in the market. In contrast to chip card systems, the reading and writing procedures are carried out wirelessly, via electromagnetic fields, without requiring any contact.

Data is recorded on an electronic data carrier which can be read or processed with read/write devices. In the simplest (so-called Read Only) applications, the unique serial number of the data carrier is read and referenced to data in an external database or server.

RFID systems consist of two main components:

- › The transponder (chip + antenna), an electronic data storage unit, which is attached to the object (or person) to be identified
- › A reader (also able to write) which includes an antenna to communicate with the transponder (or tag)

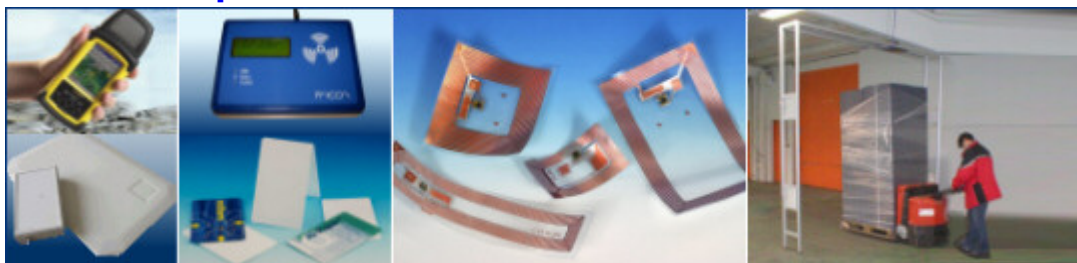
A **transponder** can be described as an electronic data carrier, which can be read and written to contactlessly and without sight and contact. A transponder has many different characteristics. Transponders vary significantly, not only due to their basic frequency. Memory type, capacity, access mode, security level and protocol all influence the suitability for an application. The transponder stores data in a microchip that is attached to a small antenna for communication with the reader. When a reader communicates with a tag, it induces power via a magnetic or electromagnetic field, and transmits a data pulse to the transponder, which carries out the instructions issued by the reader.

The RFID system is triggered when the **antenna** sends an electromagnetic wave to the tag. This is the basis of contactless identification. The design of the antenna greatly influences the performance of the whole system, so care must

be taken to design an antenna that takes full advantage of the technology for the specific application.

The **reader** manages the contactless communication with transponders. Integrated or external antennas connected to the reader send commands (through electromagnetic waves) to the transponder and process the information returned by the tag. The primary task of the reader is to generate the transmission signal, filter the return signal and prepare the data for processing by a computer or PLC.

RFID Components in Detail



RFID is a technology with multiple diverse application opportunities. And each of these applications requires components with different special features. It is essential, therefore, to have a high standard of technology know-how and an up-to-date knowledge of market developments to be able to provide optimal system integration.

The basic components of an RFID system are: transponders, readers and antennas. These are described below.

Transponder

A transponder is an electronic data carrier that can be read and written to without contact or even line-of-sight, and can be classified as follows:

- » Active or passive
- » Read Only or Read/Write
- » Low Frequency (LF) operating at up to 135 KHz
- » High Frequency (HF) operating at up to 13,56 MHz
- » Ultra High Frequency (UHF) operating at 869 to 915 MHz
- » Microwave (uW) operating above 2,45GHz

They come in many types and forms, such as Smart Labels, Smart Cards, Tickets, Plastic Discs, Glass Capsules and many others.

- Some Fields of application:
- » Public Transport Ticketing
 - » Event Ticketing

Reader

Readers perform the communication with the transponders via integrated or external antennas. A reader generates and modulates the signals sent to the transponder and decodes the returning signal, thus being able to read or write data from or to a transponder. It then sends the data to a computer to be analysed and used in IT systems.

The readers are typically classified by their operating frequencies, protocols and power outputs, but more importantly can be divided into two main groups: Fixed readers and Hand-held readers.

Fixed readers

Most RFID systems use fixed (stationary) readers wired to external antennas specifically designed for a particular application. The readers are controlled by a host system connected to the reader by Ethernet, RS232, RS485 or other protocols. The host system also processes the information from the reader(s).

Hand-held readers

Hand-held readers are complete RFID systems with an antenna integrated into the device. They are ergonomically designed to make them easy to carry and use, and have an in-built computer, keyboard and display. Data gathered by the hand-held reader can be buffered and transferred to a host system through a docking station or by W-Lan.



Antennas

The antenna is the device that interfaces contactlessly with the transponder by inducing power via a magnetic or electromagnetic field. The design of an antenna determines, in large part, the range and 'field of capture' of the system. A great deal of importance is therefore given to correct design and tuning of antennas.

Most antennas are of the simple 'loop antenna' type, but for larger read ranges and fields, specially constructed gate antennas are designed.

Loop Antenna

A loop antenna consists of a closed conductive loop. The different shapes and dimensions of these loops are virtually limitless, which is why loop antennas are most commonly used.

Due to their flexibility, they can be integrated into buildings, furniture and a variety of applications where antennas must be concealed. And they can be moulded into plastic casings for standard off-the-shelf applications.

As opposed to sensor antennas, loop antennas are capable of evenly spreading the magnetic field in all directions, thus producing a well distributed and even read and write field.



Gate antenna

By connecting antennas in parallel a wider read range can be achieved. Though theoretically this would double the range of the individual antennas, in practice the total range is slightly below the theoretical maximum.

Typical applications for gate antennas are Warehouse Docking doors, Conveyors and Personnel Access control entrances.

An important criterion for [selecting RFID systems](#) is the frequency band on which the reader (reading device) communicates with the transponder. Care must be taken here to ensure that the RFID system is not influenced by other radio systems, and that it does not cause interference in other systems.

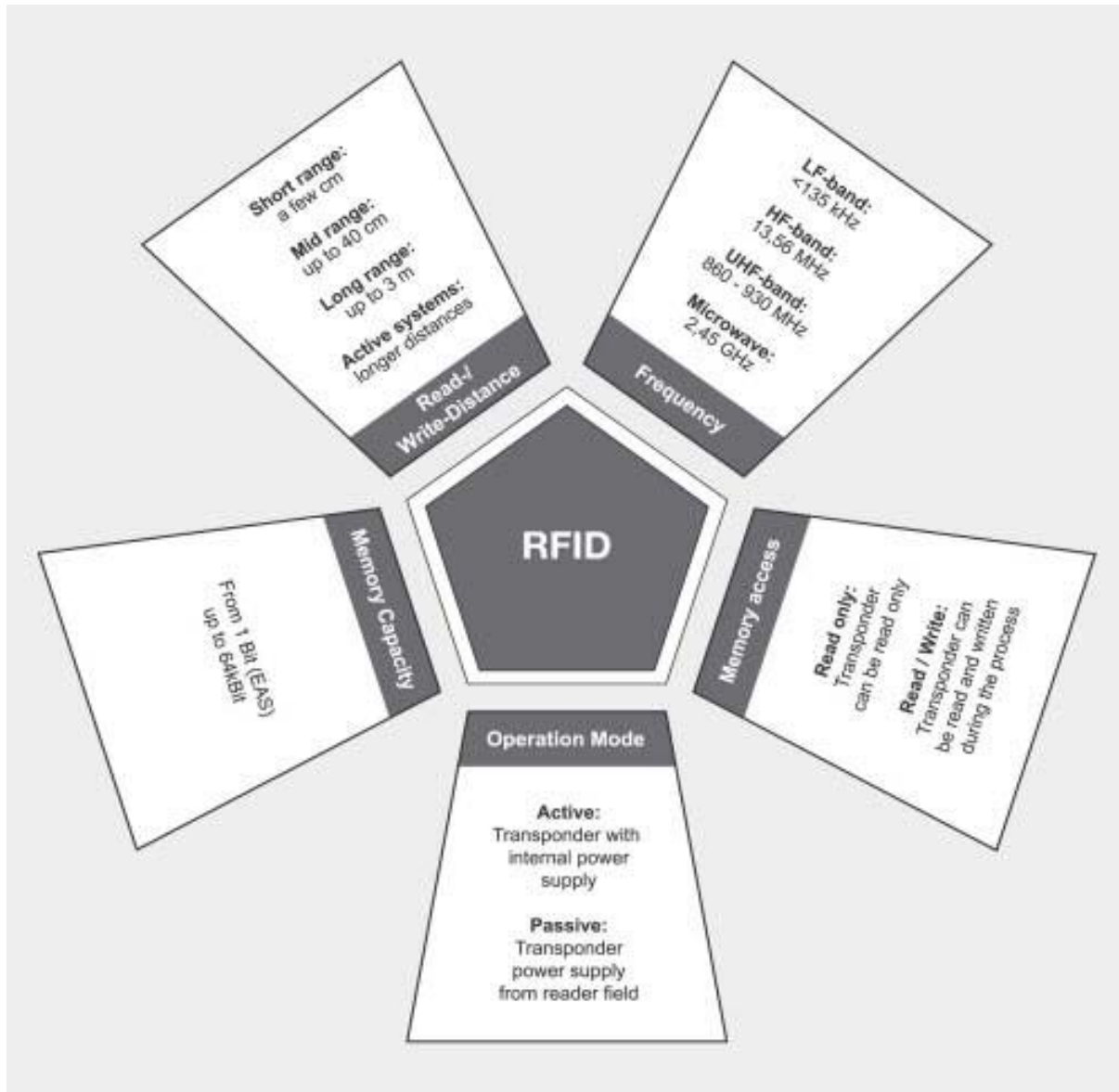
RFID applications work on the [ISM frequency bands](#) (ISM = Industrial, Scientific, Medical), which as the name implies are mainly reserved for applications in the fields of industry, science and medicine.

There is [no universally applicable RFID frequency](#), and not all frequencies can be used world-wide.

Frequency	Typical range	Advantages	Disadvantages
100–135 kHz	up to 100 cm (passive)	<ul style="list-style-type: none"> » Use of low cost passive transponders » Good penetration of non-metallic objects, water and organic tissue » Standardisation by ISO 11784/5 » Relatively uninfluenced by metallic surroundings » Frequency band available worldwide » High transmission power allowed 	<ul style="list-style-type: none"> » Bulky transponder designs (large number of antenna coils) » Low data capacity » Low transmission speed
13.56 MHz	up to 100 cm (passive)	<ul style="list-style-type: none"> » Use of low cost passive transponders » Standardisation by ISO 15693, parts 1-3 » Greater data capacity » Medium data transmission speed (26 kBit/s) » Frequency band available worldwide 	<ul style="list-style-type: none"> » Highly influenced by metallic environment » Reading range restricted by legal regulations » Long operating ranges require large antenna designs
869, 915 MHz	up to 5 m (passive)	<ul style="list-style-type: none"> » Long operating range » Simple antenna design » Cost-efficient » Standardisation (EPC) 	<ul style="list-style-type: none"> » Poor penetration of water and organic tissue
869 MHz 2.45 GHz	up to 100 m (active)	<ul style="list-style-type: none"> » High data transmission speeds » Long operating range 	<ul style="list-style-type: none"> » Design complexity » Price » Battery Life » Lack of standards

RFID technology is made up of a wide spectrum of frequencies and types to cover all possible applications.

The main characteristics of an RFID system can be seen in the diagram



Advantage of RFID over other auto-ID-systems

- » High level of security (unique ID prevents counterfeiting)
- » Contactless communication. No galvanic contact required between the reader and transponder
- » No line of sight required between the reader and transponder
- » Withstands harsh environments. Hardly affected by moisture
- » Rugged transponder construction. Withstands mechanical stress
- » Large data storage capacity
- » Simultaneous identification. Several tags can be read in a single transaction
- » Orientation insensitive. Can be read from most orientations (frequency dependant)
- » Memory flexibility. Can be programmed, reprogrammed or locked
- » Data protection feature. Transponder can be programmed to prevent unauthorised reading

Some RFID-system limitations

- » Cannot read through metal. Proximity to metal can influence performance
- » Can be affected by interference from radio systems in proximity with the tag or reader
- » Dependence on national and international radio regulations. Lack of standards in some regions
- » No possibility of reading data from the tag in the event of a system failure (may require human readable backup text)