Technical Explanation for RFID Systems

Introduction

What Is an ID System?

ID (Identification) usually refers to unique identification of people and objects.
RFID, like barcodes and two-dimensional codes, is used for identifying objects.
Biometrics for uniquely identifying people includes fingerprints, and the iris of the eye.
ID system stands for the Identification System. It is a system to read and identify information on people and things, including AIDC (Automatic Identification & Data Capture).
AIDC uses devices that combine hardware and software and does not require human intervention to identify information obtained from media such as barcodes, 2 dimensional codes, RFID systems, iris, fingerprints, voice etc.

Barcode


2 Dimensional Code


RFID System


Iris


Fingerprints

etc.
Other

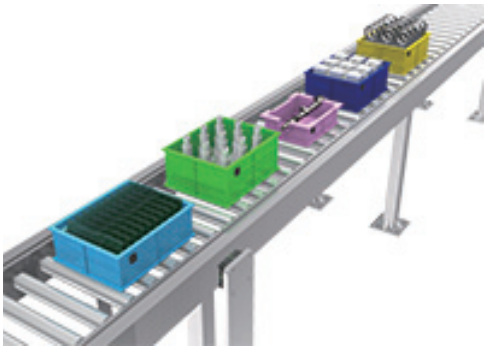
What Is an RFID System?

RFID System is an abbreviation of Radio Frequency Identification System.
It is an "Identification system using wireless communication" that enables transferring data between "RF Tags (or Data Carriers)" that are held by men or attached to objects and "Antenna (or Reader/Writers)". It is a kind of radio communication system.
RFID systems are used in various applications.
Using an RFID system allows consolidated management of objects and information.
Purposes of using RFID in a production site mainly comprises the following applications.

- Work instruction (destination instruction)
- History management (production history, work history, inspection history, etc.)

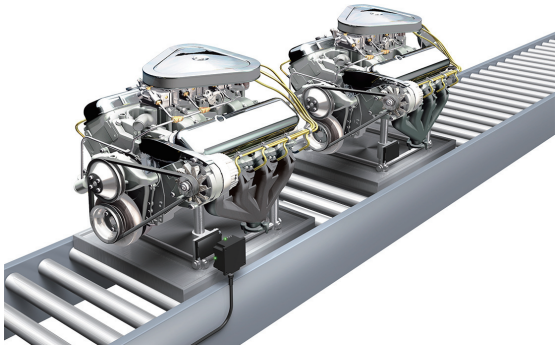
Application Example: Work instruction

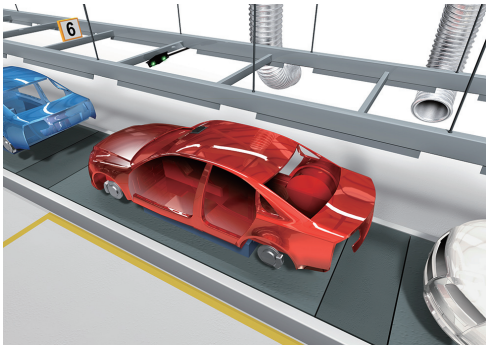
Can easily build a sorting system that reads the RF tag information of the sorting box using a Reader/Writer installed on the branching point, and uses a control system such as Programmable Controller to switch the point. Automatically performs product sorting based on inspection results.
Prevents mistakes in part identification and thus reduces the losses arising from defects by automatically reading work instructions.



Application Example: History management

Performs work according to the work instructions of the RF tags and writes the results, in the respective processes.
Supports production history management as data on operators, manufacturing dates, and inspection results with time stamp are all contained within the RF tag.
Information such as information inside the RF tag contributes to realization of productivity improvement, quality improvement, traceability, and preventive maintenance.

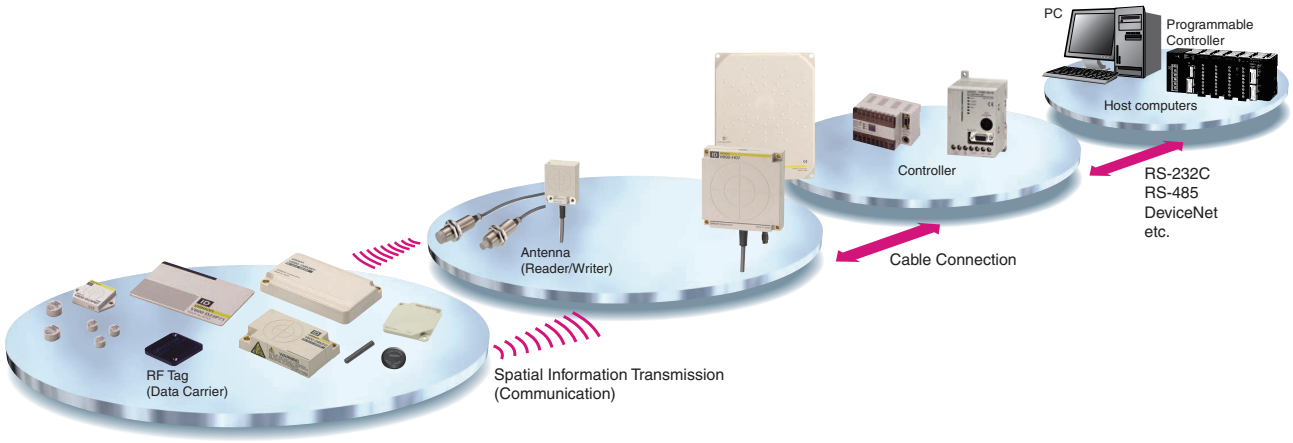


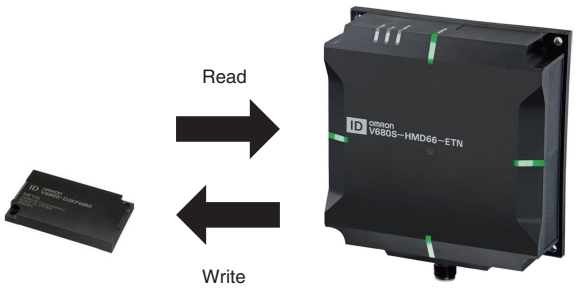


Features

The main features of RFID are as follows:

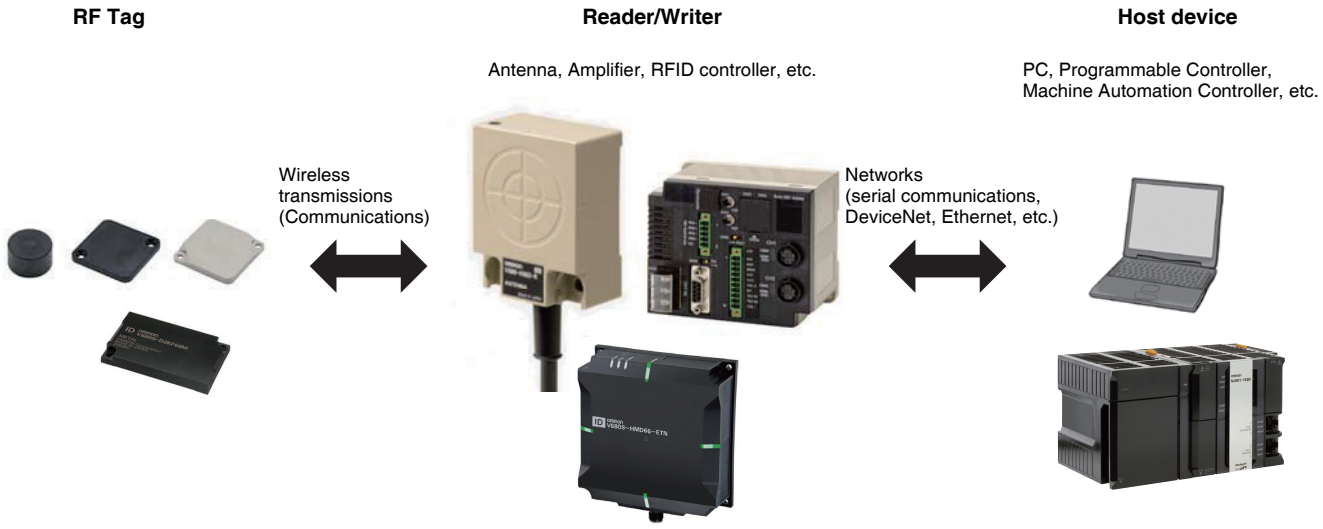
1. **Able to Read and Write data without direct contact**
   The RF tag can contain up to several kilobytes of rich information. All of the data required for each process (process history, inspection history etc) can be freely stored, without the need for direct contact. This makes it possible to develop paperless sites, where the causes of production stop are reduced.
2. **By "combining an item with its information", a highly pliable and reliable system configuration becomes possible**
   With the technology to decentralize information, the load on higher systems is reduced. This means that system development costs can also be reduced, systems can be implemented significantly faster, and the system is much more flexible when making changes. Also, "the unification of items with their information" for each process and site can make it possible to manage production/processes and product quality without errors. And, with the latest information contained in RF tags, work can continue offline in emergencies, significantly shortening the time required to restore processes.
3. **With the adoption of space transmission technology and protocols, highly reliable communication is made possible**
   As opposed to barcodes which simply look for 1 or 0, advanced space transmission technologies and specialized protocols are employed for transmission through the air. 16 bits CRC is added to the information as it is transmitted. More than 18 bits Burst errors can be detected at a ratio of 00.9985%, providing a very high reliability in the transfer. Also, since there are no mechanical devices involved such as with the Raster Scan method for barcodes, the likelihood of malfunction and other problems is greatly reduced.
4. **Reading and writing is possible without line of sight, using electric and electromagnetic wave transmission**
   Unlike barcodes, since communication occurs by means of electric and electromagnetic waves, erroneous readings due to dirt, moisture, oil etc are cancelled out. Even if there is dust, moisture etc., or anything other than metal between the antenna and the RF tag,. it will not affect transmission. And since the communication range is wide, there is no need for extreme positioning which can greatly reduce the time and cost of design.
5. **Can simultaneously access information of multiple RF tags**
   Some RFID systems are equipped with a function that allows you to simultaneously read the information of multiple RF tags existing within the transmissions area of the Reader/Writer.



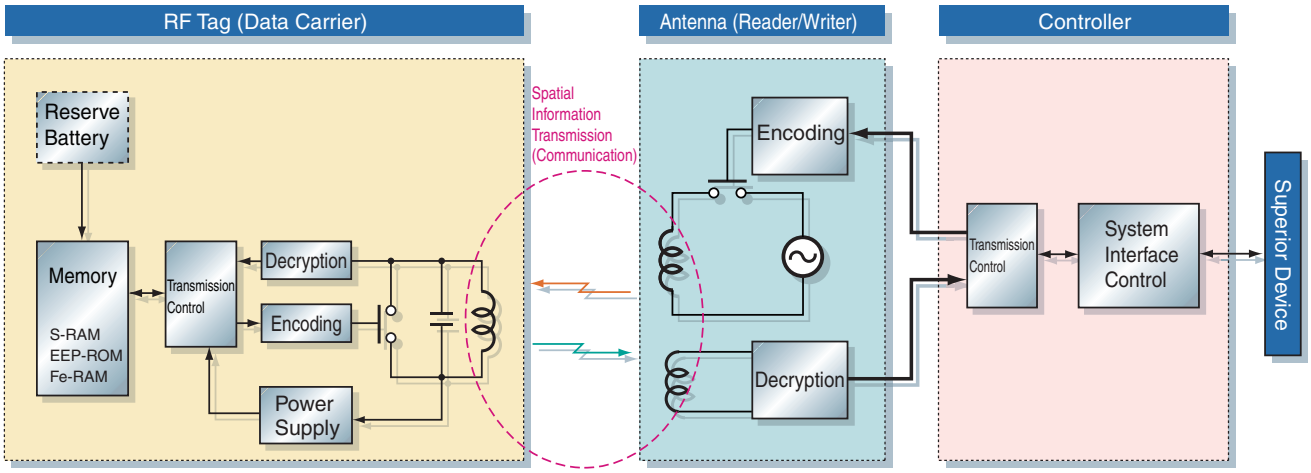


Operating Principles

Configuring an RFID system requires RF tags, Reader/Writers, and host devices.
The RFID system writes data sent from the host device to the RF tag via the Reader/Writer.
The data inside the RF tag are read through the Reader/Writer. Data inside the RF tag are rewritable.



RFID System Function Block Diagram



Classification

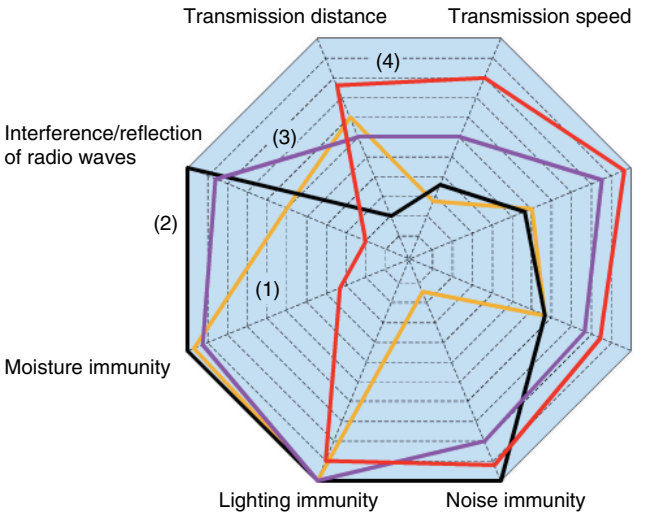
Frequency Bands

RFID, which is a system that uses radio waves, is categorized according to its frequency band.

Frequency	30 to 300 kHz	300 kHz to 3MHz	3 to 30 MHz	30 to 300 MHz	300 MHz to 3 GHz
Abbreviation	LF Low Frequency	MF Medium Frequency	HF High Frequency	VHF Very High Frequency	UHF Ultra High Frequency
Frequency used by RFID	123/135 KHz	400 to 530 KHz	13.56 MHz	Not used by RFID	433 MHz/ 860 to 960 MHz/ 2.45 GHz
Spatial transmission	Electromagnetic induction	Electromagnetic coupling	Electromagnetic induction	-	Radio wave

As a high-frequency radio wave generally has a short wavelength, it can transmit more information within a shorter time.
The radio wave also has the property of traveling in a straight line.
A low-frequency radio wave has the tendency to transmit information stably over a greater distance without being affected by variations in terrain due to its long wavelength.

Below is a radar chart of performance comparison by method.
As you can see from the chart UHF has the highest performance for transmission distance, however, regarding to Interference/ reflection of radio waves, other bands are superior. HF band has the best performance on average in all areas.
It is necessary to select an RFID system appropriate for the application.



Legend

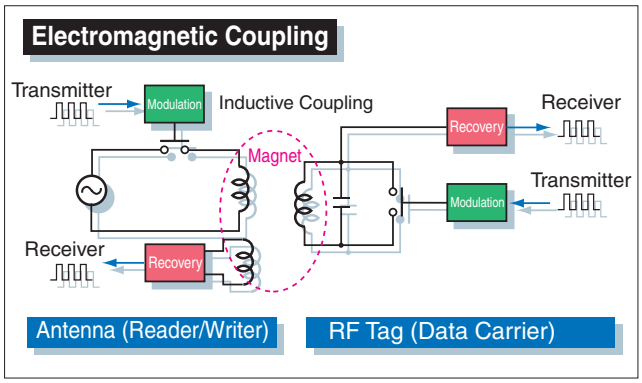
No.	Line color	Frequency band
(1)		LF band (135 kHz)
(2)		MF band (400 to 530 kHz)
(3)		HF band (13.56 MHz)
(4)		UHF band (920 MHz)

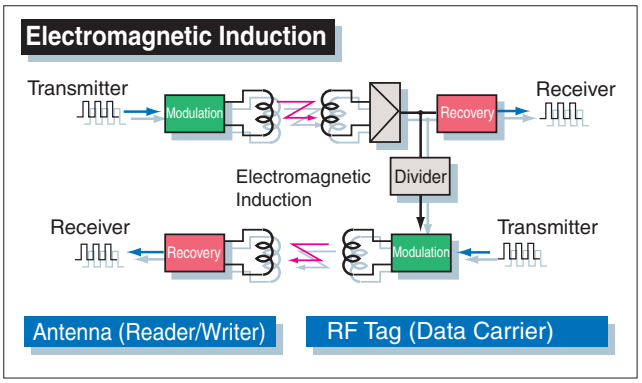
This radar chart is what was visualized based on our research data.

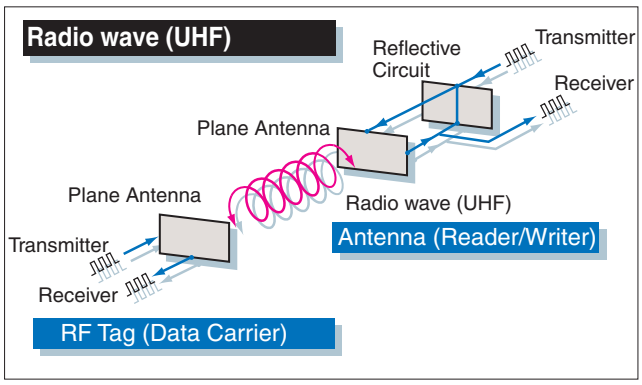
All of them assume that an RF tag of non-battery type is used.

RFID System Transmission Methods

RFID systems primarily use the following three transmission methods.







Transmission method	Electromagnetic coupling	Electromagnetic induction			Radio wave (UHF)
Communications frequency	400 to 530 kHz	120 to 150 kHz	13.56 MHz		860 to 920 MHz
Transmission distance	Not good 0 to 150 mm	Good 0 to 1 m	Not good 0 to 50 mm	Good 0 to 700 mm	Very good 0 to 10 m
Data write	Very good	Very good	Very good	Very good	Very good
Communications speed (communications rate and processing speed)	Good	Not good	Very good	Good	Good
Communications directivity and sharpness	Not good	Ensure suitability	Good	Not good	Not good
Influence of reflection/interference of radio waves	Very good	Not good	Very good	Not good	Ensure suitability
Communications stability	Good	Not good	Very good	Good	Good
Electromagnetic field noise immunity	Good	Not good	Very good	Good	Very good
Optical noise immunity	Very good	Very good	Very good	Very good	Very good
Water resistance and oil resistance (influence of moisture)	Very good	Very good	Good	Not good	Not good
Dirt resistance	Very good	Very good	Good	Good	Good
Glass and plastic penetration (influence of obstructions)	Very good	Very good	Good	Good	Good

In a broader sense, electromagnetic coupling is included in the electromagnetic induction.
Different communications methods have different features. Understand the advantages and disadvantages of each method before selecting the right communications method for your application.

RF Tags (Data Tags)

A variety of types of RF tags have been manufactured according to their respective applications.

• Classification by Shape

RF tags have various shapes because different applications require different RF tag shapes. Many RF tag types allow you to select the most suitable RF tag shape for your application.

Inlet type	Label type	Card type	Square type	Round type	Cylindrical type	Spherical type	Box type (with built-in battery)
							

• Classification by Function

OMRON mainly handles RF tags of read/write type.

One feature of RFID is the ability to freely read and write information.

Item	Read-only type (RO)	Write once read many type (WORM)	Read/write type (R/W)		
Memory types	EP-ROM	EEP-ROM	EEP-ROM	Fe-RAM	S-RAM
Function	Not rewritable after write by the manufacturer	Writable once only	Unlimitedly rewritable by user	Unlimitedly rewritable by user	Unlimitedly rewritable by user (with built-in battery)
Memory capacity	10 to 100 bytes	10 to 100 bytes	10 bytes to 10 KB	10 bytes to 10 KB	1 to 10 KB

• Classification by Power Supply Method

The most widely used tags are low-price, maintenance-free passive tags.

Active tags are effective for a RTLS (real time locating system) and other location management applications.

Passive tag	Semi-passive tag	Active tag
• Operates only with the power supplied from the antenna • Transmission distance: 1 mm to 10 m	• Operates with both the power supplied from the antenna and the energy from the built-in battery • Transmission distance: 1 cm to 10 m	• Actively operates with the energy from the built-in battery • Transmission distance: 1 to 100 m