RFID—What is it?

Overview

RFID (Radio Frequency Identification) is a means of storing and retrieving data through electromagnetic transmission to an RF compatible integrated circuit, and is now being seen as a radical means of enhancing data handling processes.

A range of devices and associated systems are available to satisfy an even broader range of applications. Despite this diversity, the principles upon which they are based are quite straight forward, even though the technology and technicalities concerning the way in which they operate can be quite sophisticated.

Physics and Electronic Foundations

System Components

RFID systems have several basic components or technical characteristics that define them. These are:

- A **reader**, including an **antenna**
  The device that is used to read and/or write data to RFID tags.
- A **tag**
  A device that transmits to a reader the data.
- The **communication** between them
  RFID uses a defined radio frequency and protocol to transmit and receive data from tags.

Types of RFID Tags

RFID tags can be segregated into two major classifications by their power source:

- **Active tags**
  Active tags contain both a radio transceiver and battery to power the transceiver. Because there is an onboard radio on the tag, active tags have substantially more range (~300 feet) than passive or "active/passive tags." Active tags are also considerably more expensive than passive tags and, as with any battery-powered product, the batteries must be replaced periodically.
- **Passive tags**
  Passive tags can be either battery or non-battery operated, as determined by the intended application. Passive tags reflect the RF signal transmitted to them from a reader or transceiver and add information by modulating the reflected signal. A passive tag does not use a battery to boost the energy of the reflected signal. A passive tag may use a battery to maintain memory in the tag or power the electronics that enable the tag to modulate the reflected signal.
    - **Battery-less ("pure passive" or "beam powered")**
      Pure passive tags do not contain an internal power source such as a battery, and are thus easier, and less expensive to manufacture. These purely passive or

"reflective" tags rely upon the electromagnetic energy radiated by an interrogator to power the RF integrated circuit that makes up the tag itself.

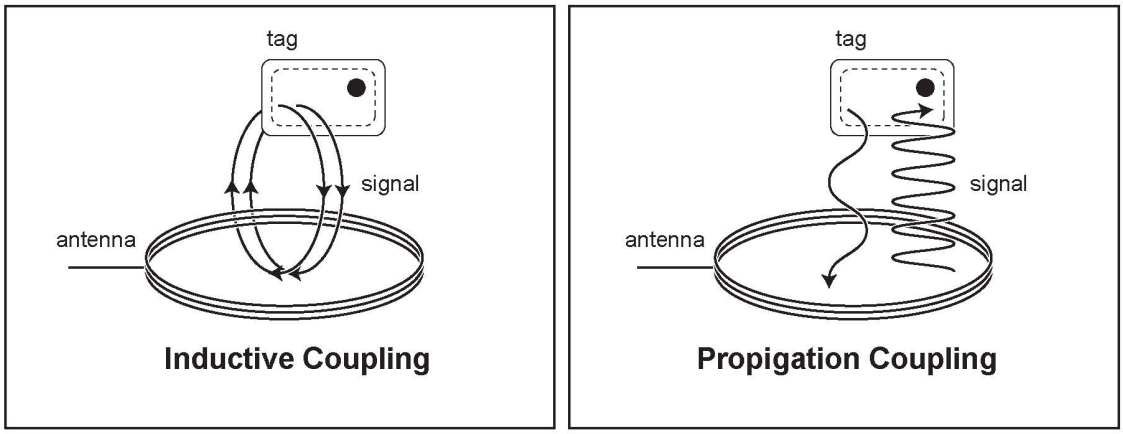
- **With a battery ("active/passive")**
  There is a version of a passive tag that does contain a battery. This type of passive tag has some of the enhanced, and speed attributes of a true active tag, but still communicates in the same method, as do other passive tags. These active / passive tags that do contain an internal power source, usually are much more complex integrated circuits with multiple components. Consequently, they are more expensive to make and purchase.

RF tags can also be distinguished by their memory type:

- **Read / write**
  Read / write memory just as the name implies, can be read as well as written into. Its data can be dynamically altered.
- **Read only (typically "chipless")**
  Read only type of tag memory is factory programmed and cannot be altered after the manufacturing process. Its data is static.

Read only memory is the less expensive of the two. As RFID markets and applications grow, this price difference will become less for overall system cost justification.

Types of Communication



Tags and a reader communicate by wireless signal in a process known as *coupling*.

Two methods of wireless signal distinguish and categorise RFID systems:

- Close proximity electromagnetic, or inductive coupling
- Propagating electromagnetic waves.

Coupling is via antenna structures forming an integral feature in both tags and readers.

Transmitted data is influenced by the channels through which it must pass, including the *air interface*. Structuring the bit stream to ensure error-free, asynchronous data transfer through this channel is often referred to as *channel encoding*. Although transparent to the user of an RFID system this coding scheme is important to engineers as often appears in system specifications.

Various encoding schemes can be distinguished, each exhibiting different performance features.

Transferring data efficiently via the air interface requires the data to be superimposed upon a rhythmically varying (sinusoidal) field or carrier wave. This process of superimposition is referred to as *modulation*, and various schemes are available for this purpose. They are essentially based upon changing the value of one of the primary features of an alternating sinusoidal source, its amplitude, frequency or phase in accordance with the data carrying bit stream. In this way it is similar to the way AM or FM radio works.

On this basis one can distinguish amplitude shift keying (ASK), frequency shift keying (FSK) and phase shift keying (PSK).

Radio Frequency and Range

Because RFID uses electromagnetic radio signals to operate, its effective operation is subject to the same physical laws any RF operating device is.

The RF field distance or space between an RFID interrogator antenna and the corresponding RFID tag, and the frequency of operation are directly interrelated.

Thus, different RFID frequencies have different RF effective ranges.
Two terms used often are *near field*, and *far field*.

Frequency Band	**Characteristics**	**Typical Applications**
Low 100-500 kHz	Short to medium read range Inexpensive low reading speed	Access control Animal Identification Inventory Control Car immobiliser
Intermediate 10-15 MHz	Short to medium read range Potentially inexpensive medium reading speed	Access control Smart Cards
High 850-950 MHz 2.4-5.8 GHz	Long read range High reading speed Line of sight required Expensive	Railroad car monitoring Toll collection systems

Early in the technology's development, three carrier frequencies were identified and used to refer to different ranges: Low (125kHz), Intermediate (13.56 MHz) and High (2.45 GHz).

Today there are eight frequency bands in use around the world for RFID applications, identified by number and not name. Despite this, many companies still organize their products by low, intermediate, and high range.