A basic RFID solution includes:

Tag

- Tag chips or integrated circuits (ICs)
- Tag antennas

Reader

- Reader antenna
- Reader control & application software

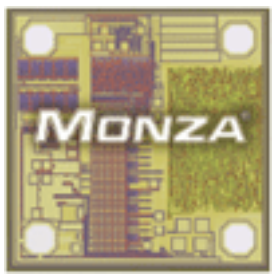
RFID Solutions

In a basic RFID system, tags are attached to all items that are to be tracked. These tags are made from a tiny tag-chip, sometimes called an integrated circuit (IC), that is connected to an antenna that can be built into many different kinds of tags including apparel hang tags, labels, and security tags, as well as a wide variety of industrial asset tags. The tag chip contains memory which stores the product's electronic product code (EPC) and other variable information so that it can be read and tracked by RFID readers anywhere.

An RFID reader is a network connected device (fixed or mobile) with an antenna that sends power as well as data and commands to the tags. The RFID reader acts like an access point for RFID tagged items so that the tags' data can be made available to business applications.

RFID Tags

An RFID tag is comprised of an integrated circuit (called an IC or chip) attached to an antenna that has been printed, etched, stamped or vapor-deposited onto a mount which is often a paper substrate or PolyEthylene Therephtalate (PET). The chip and antenna combo, called an inlay, is then converted or sandwiched between a printed label and its adhesive backing or inserted into a more durable structure.

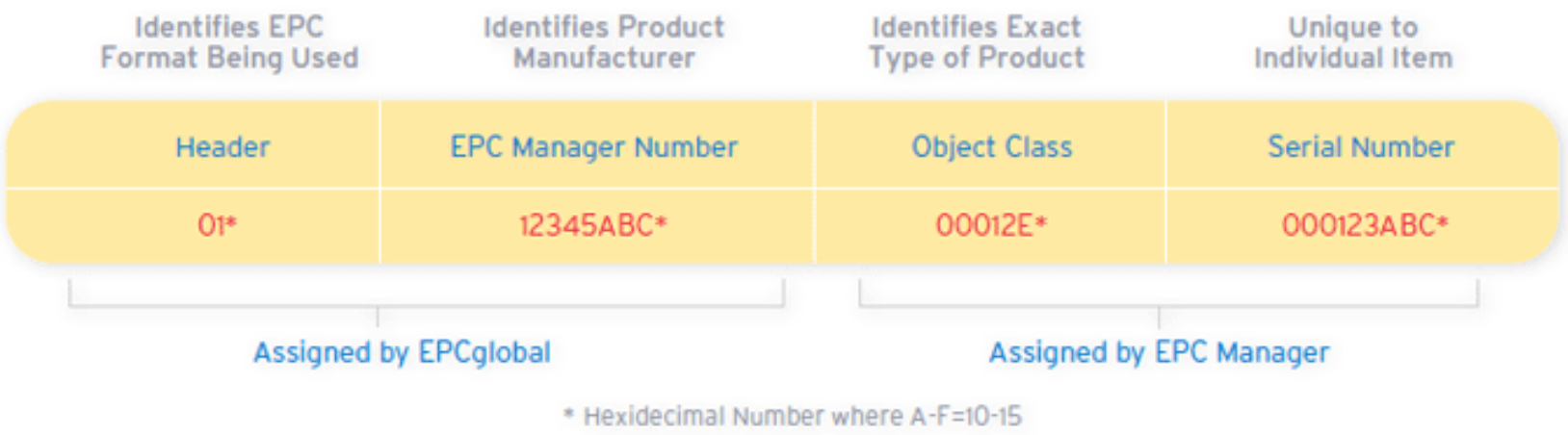


Tag Chip

The tag's chip or integrated circuit (IC) delivers performance, memory and extended features to the tag. The chip is pre-programmed with a tag identifier (TID), a unique serial number assigned by the chip manufacturer, and includes a memory bank to store the items' unique tracking identifier (called an electronic product code or EPC).

Electronic Product Code (EPC)

The electronic product code (EPC) stored in the tag chip's memory is written to the tag by an RFID printer and takes the form of a 96-bit string of data. The first eight bits are a header which identifies the version of the protocol. The next 28 bits identify the organization that manages the data for this tag; the organization number is assigned by the EPCglobal consortium. The next 24 bits are an object class, identifying the kind of product; the last 36 bits are a unique serial number for a particular tag. These last two fields are set by the organization that issued the tag. The total electronic product code number can be used as a key into a global database to uniquely identify that particular product.



Tag Antennas

Tag antennas collect energy and channel it to the chip to turn it on. Generally, the larger the tag antenna's area, the more energy it will be able to collect and channel toward the tag chip, and the further read range the tag will have. There is no perfect antenna for all applications. It is the application that defines the antenna

specifications. Some tags might be optimized for a particular **frequency band**, while others might be tuned for good performance when attached to materials that may not normally work well for wireless communication (certain liquids and metals, for example). Antennas can be made from a variety of materials; they can be printed, etched, or stamped with conductive ink, or even vapor deposited onto labels.

Tags that have only a single antenna are not as reliable as tags with multiple antennas. With a single antenna, a tag's orientation can result in “dead zones”, or areas on the tag where incoming signals cannot be easily harvested to provide sufficient energy to power on the chip and communicate with the reader. A tag with dual antennas is able to eliminate these dead zones and increase its readability but requires a specialized chip.

RFID Readers

An RFID reader, also known as an interrogator, is a device that provides the connection between the tag data and the enterprise system software that needs the information. The reader communicates with tags that are within its field of operation, performing any number of tasks including simple continuous inventorying, filtering (searching for tags that meet certain criteria), writing (or encoding) to selected tags, etc.

The reader uses an attached antenna to capture data from tags. It then passes the data to a computer for processing. Just like RFID tags, there are many different sizes and types of RFID readers. Readers can be affixed in a stationary position in a store or factory, or integrated into a mobile device such as a portable, handheld scanner. Readers can also be embedded in electronic equipment or devices, and in vehicles.

Reader Antennas

RFID readers and reader antennas work together to read tags. Reader antennas convert electrical current into electromagnetic waves that are then radiated into space where they can be received by a tag antenna and converted back to electrical current. Just like tag antennas, there is a large variety of reader antennas and optimal antenna selection varies according to the solution's specific application and environment.

The two most common antenna types are linear- and circular-polarized antennas. Antennas that radiate linear electric fields have long ranges, and high levels of power that enable their signals to penetrate through different materials to read tags. Linear antennas are sensitive to tag orientation; depending on the tag angle or placement, linear antennas can have a difficult time reading tags. Conversely, antennas that radiate circular fields are less sensitive to orientation, but are not able to deliver as much power as linear antennas.

Choice of antenna is also determined by the distance between the RFID reader and the tags that it needs to read. This distance is called read range. Reader antennas operate in either a

"near-field" (short range) or "far-field" (long range). In near-field applications, the read range is less than 30 cm and the antenna uses magnetic coupling so the reader and tag can transfer power. In near-field systems, the readability of the tags is not affected by the presence of dielectrics such as water and metal in the field.

In far-field applications, the range between the tag and reader is greater than 30 cm and can be up to several tens of meters. Far-field antennas utilize electromagnetic coupling and dielectrics can weaken communication between the reader and tags.

Reader Control and Application Software

Reader control and application software, also known as middleware, helps connect RFID readers with the applications they support. The middleware sends control commands to the reader and receives tag data from the reader.

Creating an RFID Solution

Deploying an RFID system necessitates multiple actors and many different components. Typically, installing a system requires basic hardware-including tag chips, tag antennas, readers, and reader antennas-as well as reader control and application software, and solution providers to put it all together. When all of these components come together, an infinite number of creative applications are possible. RFID system applications can help improve the quality of business operations, inventory and customer experience in a variety of industries.

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Chapter 2: How Do RFID Systems Work?