ALIEN TECHNOLOGY®

RFID PRIMER

All Readers

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Alien Technology®

RFID Primer

All Readers

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CHAPTER 1
Introduction

The *RFID Primer* is designed to introduce the fundamental concepts of radio-frequency identification (RFID) technology, and to provide a glossary of commonly used RFID terms.

Audience

For the purposes of this book, we assume the readers of the *RFID Primer* have little or no previous knowledge of RFID technology.

CHAPTER 2
RFID Overview

Radio-frequency identification (RFID) technology uses radio frequency signals to acquire data remotely from tags within read (or “interrogation”) range. The data is then used for a variety of purposes such as opening doors and gates, paying tolls or tracking equipment and materials.

Although RFID can be deployed in a number of frequency bands, the products referred to in this book operate in one of two bands, specifically, in the frequency band centered at 915 MHz and the frequency band centered at 2450 MHz, depending on the type of system being used.

NOTE: For definitions of terms and clarification of words that may have multiple meanings in an RFID context, refer to Chapter 3, Glossary of Terms.

RFID vs. Barcodes

RFID is similar in some ways to barcode technology in that the tags or labels contain ID and other data readable by electronic equipment.

Read Range and Interference

An important advantage of RF over barcodes is that RF tags do not require “line of sight” to be read. That is—while a barcode must be scanned directly by a laser beam and cannot be read if something opaque stands between the reader/scanner and the label—RF tags can be read *through* a great many materials, including boxes and other radiolucent products.

The effective range of a laser-based barcode system is limited because with increased distance comes an increased chance of materials passing between the reader’s laser and the barcode label. Attempts in the past to use barcodes for toll way use or railcar identification, for example, failed because the vehicle speed—combined with the increased likelihood of rain, snow or debris interrupting the laser’s line-of-sight at the crucial moment of passage—rendered the technology very unreliable for these applications.

Visibility of Pallets, Cases and Individual Items

In manufacturing, supply chain and retail/commercial applications, barcodes have been very effective for over 25 years. The line-of-sight and range limitations have been manageable for those environments where products or cases of products moved slowly past a reader at close distances.

Barcodes themselves can contain (and convey) information about manufacturer, product family and type, and perhaps even the specific manufacturing lot. These capabilities have improved the speed and handling of products and materials around the world.

However, barcodes cannot identify a specific case of paper towels that is in the center of a pallet surrounded by other cases of towels. In addition, barcodes cannot record the temperatures a perishable product has been exposed to and calculate a more realistic expiration date for that specific item.

Neither can barcode systems identify an individual carton of milk as it rolls down the checkout conveyor and alert the cashier that its contents may be spoiled. And barcodes cannot alert the merchant of products in the consumer's pocket that have not been paid for.

RFID systems have the potential to do all of these things; a laser-based barcode system cannot.

Although RFID is being developed initially for use in the supply side of many businesses (shipping, receiving, warehousing, stocking, inventory, etc.), this technology makes it not only possible, but realistic to one day track the movement of individual products throughout a retail store and to identify critical characteristics about the item.

For the near term, businesses will benefit from automatically logging shipments and receipts of products moving in and out through their loading docks. They will be able to track the movement of products within their own facilities to improve efficiency, and reduce theft and shrinkage.

Read/Write Tag Data

Barcode data is fixed the moment the label is printed. It can never be changed unless a new label is printed and attached. On the other hand, many RFID tags can be reprogrammed in the field to reflect current information such as storage location or date placed in service.

More sophisticated RFID tags can also record dynamic conditions (such as temperature or meter usage) as they change, then transfer the current conditions (or a record of conditions) to a reader upon request.

The RFID Advantage

In short, RFID raises the standard for automatic identification technology and allows it to perform more valuable functions than have been possible with barcodes.

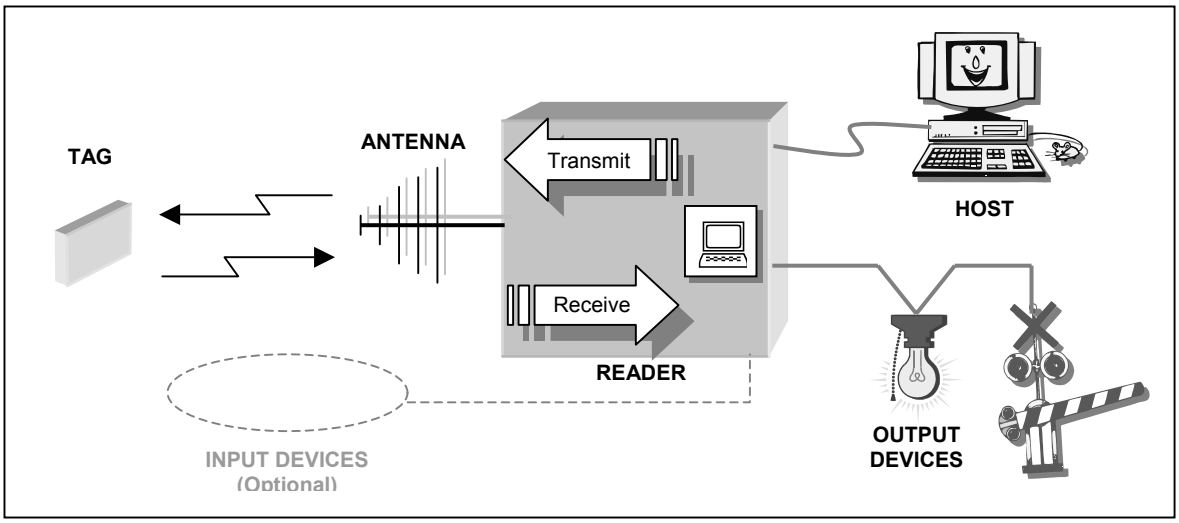
RFID Components

Any RFID system needs certain basic components. These include:

- Transmitter
- Receiver
- Microprocessor

Usually combined in a "reader" or "interrogator."

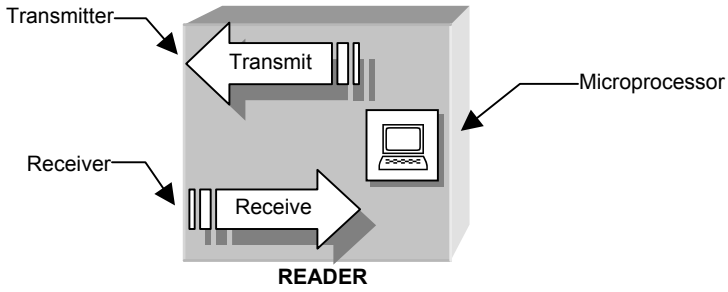
- Antenna(s)
- Tags
- Output device(s) and/or host computing device
- (Optional) input device(s)



RFID system components

Reader or Interrogator

A reader may be referred to as an "interrogator" because it asks (or interrogates) tags for their ID information and any other data they may contain.



Because the transmitter and receiver functions are working together, the reader may also be referred to as a "transceiver."

No matter what it may be called, the reader typically contains a:

- transmitter,
- receiver, and
- microprocessor.

The reader unit also contains an antenna as part of the entire system (see below).

Antenna(s)

The antenna broadcasts the RF signals generated inside the reader's transmitter into the immediate environment. The antenna also receives responses from tags within range.

In general, readers may use one or more antennas to detect and interrogate tags, although typically only one antenna can be active at a time.

CAUTION: *Reader antennas should be positioned so that personnel in the area may safely remain at least 23 cm (9 in) from the antenna's surface. See FCC OTE Bulletin 56 and 65 for further details.*

HOW ACTUAL ANTENNAS LOOK

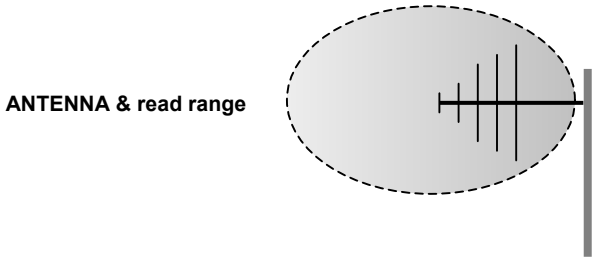
Although the antennas in our diagrams are often depicted like fish bones, it is unlikely you will see RFID antennas like this in the field.

Most reader antennas are housed in enclosures and will look like plain, shallow boxes. In some cases, the antenna may actually be contained inside the reader enclosure (which may also look like a plain box).

Tag antennas are often nothing more than etched or printed metallic patterns on a circuit board or thin film inside a small case or sandwiched between layers of a printed label.

FOOTPRINT, POLARIZATION AND READ RANGE

Antennas have patterns or "footprints" that describe the area in which their energy is most effective. Although the word *footprint* suggests a two-dimensional area, the pattern actually exists in three dimensions and is more like a large, irregularly shaped balloon (think of an inflated surgical glove).



Although an antenna may manifest its energy in a certain pattern, how your system can use that energy depends on a great many factors including antenna characteristics, tag and reader characteristics, the nature of the items tagged, and the changing nature of the reading environment.

Polarization of an antenna, expressed simply, means there is a preferred orientation of the tag to the reader antenna's energy field, which may optimize the system's ability to read tags, particularly under less than ideal conditions. *Under most normal conditions, and within the read range for the system, all functioning tags should be readable*. However, it may be possible to read tags well beyond the specified read range if they are oriented in the antenna's preferred direction. Keep in mind, however, that some systems may be designed

to limit, rather than maximize, the read range and thus may use polarization to facilitate tag discrimination.

The size of the antenna footprint and the range at which a given tag may be read are affected, in various degrees, by such factors as the output power of the transmitter, the receiver sensitivity, the type of tag (and its own internal antenna) and the tag's position relative to the reader antenna. The reading environment also plays an important part in determining how far out and where, in relation to the antenna, tags can and cannot be read.

Because an antenna's pattern is often irregularly shaped, you may get a read at long range in one spot, then move the tag a few inches to one side and not be able to get the tag to read again until you have moved it several feet closer to the antenna.

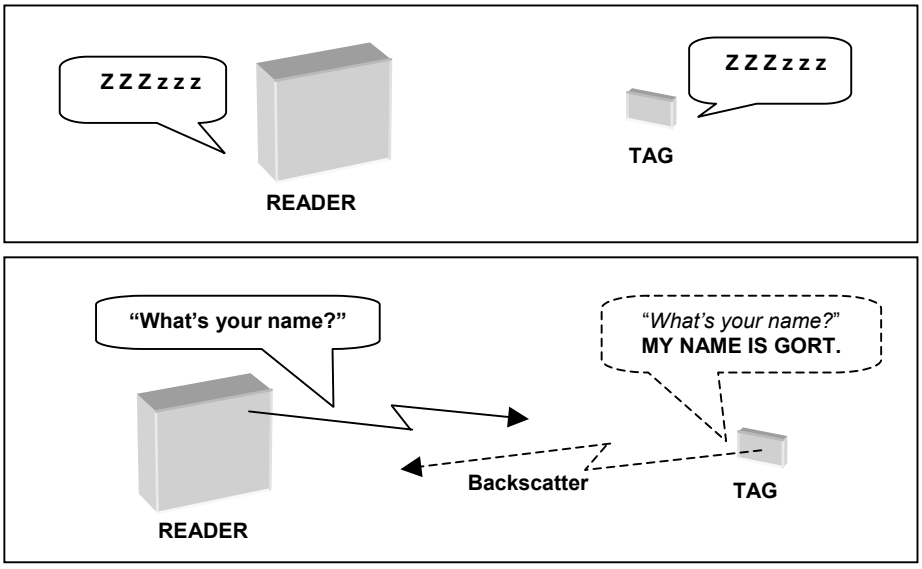
Tags

RF tags are devices—similar in principle to barcodes or even name badges—that contain identification and other information that can be communicated to a reader from a distance. However, RF tags can contain much more information than a barcode, can be read at greater distances and under more challenging conditions, and in some cases can accept new data in the field.

TAG-TO-READER COMMUNICATIONS

Tags are often classified as either *passive* or *active* to describe how they communicate with the reader. *Passive* means, simply, that the tag uses a modified form of the reader's own signal to send back its data. *Active* means the tag contains its own transmitter.

NOTE: Because the terms passive *and* active *may also be used to refer to tag power (beam power versus battery power), we will focus on the more precise terms in our discussions. Refer to the glossary at the end of this document for specific definitions.*

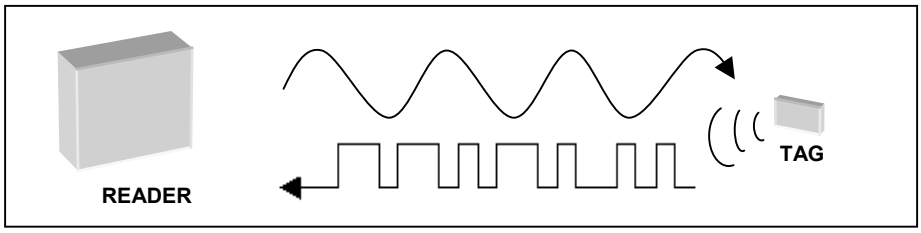


Backscatter tags reply by reflecting the reader's own RF signal, with unique tag data embedded in the modulated "backscatter."

Backscatter Tags. A "passive" tag (in the communications context) uses a method called "modulated backscatter" to convey its data to the reader. Essentially, the tag reflects (or backscatters) the RF signal transmitted by the reader and embeds its unique ID and data by modulating that reflected signal.

- **Modulated backscatter** is similar to sending messages between distant mountaintops by bouncing sunlight off mirrors using Morse Code patterns of on and off. In this scheme, communication is only possible when the light source is present.

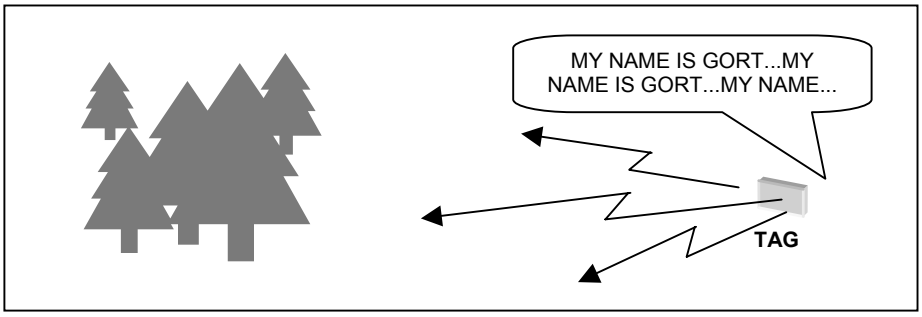
  The reader transmits a continuous-wave (CW) RF signal into the reading environment. When a tag appears in the area, it modulates, or breaks up, that CW signal into patterns of ones and zeroes that define the tag's digital data. Because it "speaks" essentially by reflecting the reader's "voice," a backscatter tag is physically incapable of communicating data outside the presence of a reader's signal.



The reader transmits a continuous wave signal. The tag breaks up (modulates) that signal into patterns of ones and zeroes that convey its data to the reader.

Active tags (in the communications context), unlike "passive" backscatter tags, contain their own transmitters, or tiny radio stations. Active tags may be considered to be either transmitters or transponders, though, to be precise, a transponder is always a transmitter tag, but not all transmitter tags are transponders, as you will see below.

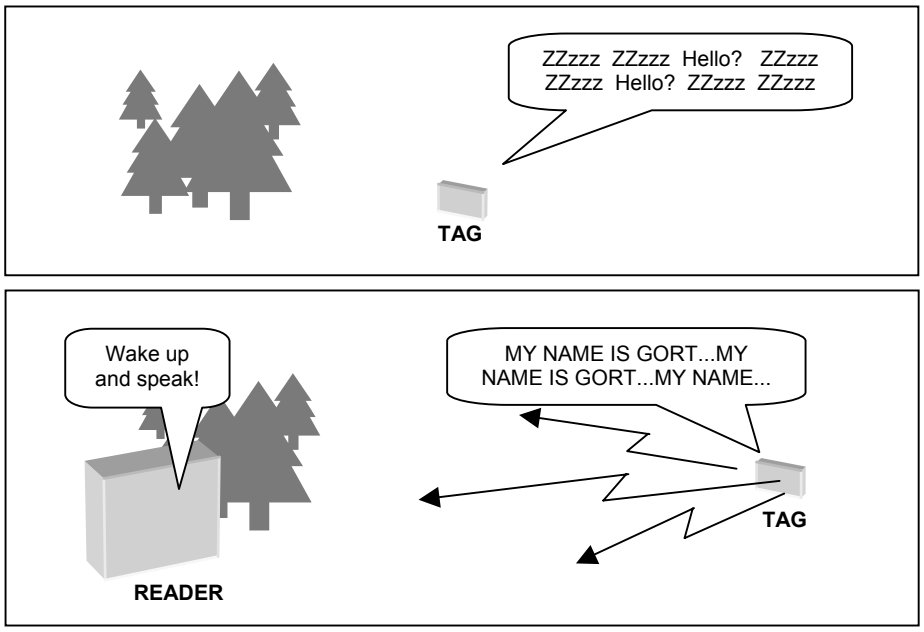
- A **transmitter** tag can broadcast a message into the environment even if there is no reader active nearby to "hear" it. This tag is like a telephone can ring even when no one is home to answer it.



Transmitter tags contain their own little radio stations and can transmit messages even the absence of a reader.

- Another type of tag is the **transponder**. To conserve power, or to minimize RF noise pollution, some active/transmitter tags may be configured to "go to sleep" or enter a quiescent or lower-power state when not being interrogated. When a reader enters the area, it then

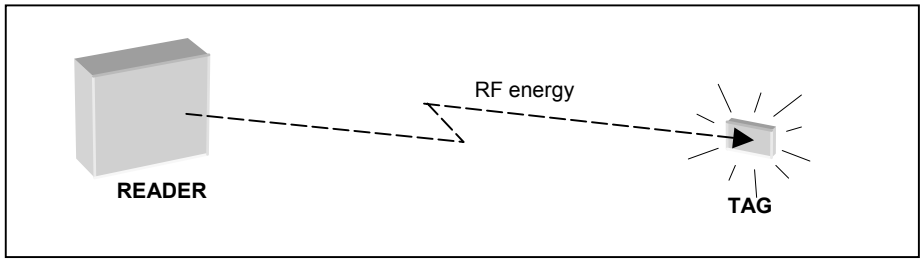
transmits a signal to “wake up” all the tags in that area. Each tag thus only transmits in response to the reader’s command. This type of active tag is called a “transmitter/responder” or “transponder.”



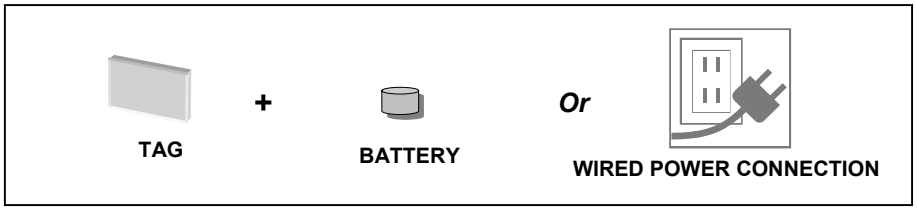
Transmitter tags that are considered transponders (transmitter/responders) go into a quiescent or low power state (“sleep”) until awakened by a reader.

TAG POWER

Tags can be powered either by the RF signal from a reader (the RF “beam”) or by direct sources of energy such as batteries or wired power connections. A battery generally gives a tag more range and can allow it to perform independent functions outside the reach of a reader’s RF signal.



Beam-powered tags are powered exclusively by the energy in the RF signal transmitted by the reader.



Other tags receive power from batteries and, for special applications, may even be wired to a power source.

NOTE: Because the terms "passive" and "active" are often used to mean "beam-powered" and "battery powered" as well as to refer to tag-reader communications methods, we will use more specific terms here. Please refer to the glossary at the end of this book for detailed definitions.

Although beam power is used more often for backscatter tags, certain transmitter tags are capable of storing energy from a reader's signal, then using that stored energy to actively transmit data.

Tags (whether backscatter or transmitter) that perform functions in addition to providing their IDs (such as recording temperature or meter usage for later transmission to a reader) normally require some kind of augmenting power source.

TAG RANGE

Tag range, like antenna range, depends on much more than just the characteristics of the tag. Reader power and sensitivity, antenna range and polarization, and the reading environment can all affect the range at which a given tag may be successfully read.

Certain attributes of the tag itself and its immediate surroundings also help determine a tag's full read range, including:

- tag power source (battery-powered tags typically have greater range than those powered exclusively by the RF beam).
- type of materials between and around the tag and the reader.
- tag position relative to the antenna's preferred orientation.
- relative tag speed (amount of time the tag is within read range, if either the tag or the reader is moving relative to the other).
- amount and rate of data to be exchanged between tag and reader and the overhead involved in error correction and other quality processes.
- the tag antenna design.

Tags, like every other element in an overall system design, affect system performance and should be configured to optimize the specific applications they are to be used for.

TAG MEMORY

Tags may have just enough memory to hold only the simplest of information, such as an ID code (little more than the amount of data on the average barcode label), or may have as much memory and processing power as a small computer. Tag memory may be read-only—or more accurately, write-once-read-many (WORM)—or read/write (R/W):

- **WORM or Read-only Memory.** Some tags are programmed once, either at the factory or by the user, then locked to prevent reprogramming. The data in these tags remains the same throughout the life of the tag.
- **Read/write Memory.** Read/write tags can be reprogrammed in the field, either by a dedicated programming device or by the reader itself. Some read/write tags can also record dynamic information such as temperature, usage, tilt and vibration, location, or date and time. When such a tag is read, it can also transmit its currently stored data to an

authorized reader. The most sophisticated (transmitter) read/write tag may, in fact, function as a wireless computer, able to interact with other tags and devices or link to the Internet.

While tags with minimal memory capacity can easily function on the tiny bit of energy provided by the RF signal alone, higher tag memory and processing demands typically require the support of a battery or other type of power source.

INPUT/OUTPUT AND ONBOARD PROCESSING (OPTIONAL)

Certain tags can be configured to perform onboard processing functions and may be also have input/output (I/O) capabilities.

A tag may be connected to an input device, such as a temperature sensor, a meter, or a tamper/tilt detector. Such tags can receive data from the input device and then convey that data (either as a record of changes over time or as the current value) to the reader upon request. Outputs, on the other hand, allow a tag to activate an attached device such as a LED or emit an audible tone (to signal its presence) or can enable or disable connected devices. (For example, an attached tag could disable a computer or other equipment if removed from authorized premises.)

Tags with onboard processing capabilities can perform a variety of calculations or functions depending upon the tag's microprocessor and power source/consumption. Such tags might work in concert with an input device, for example, recording the temperature variations a perishable product has been exposed to over time, then calculating a more realistic expiration date based on that history.

Host Computer and Input/Output Functions

In order to put the data acquired from a tag to practical use, the RFID system needs either a host computer to process that data or some kind of output function that responds to the tag data.

In many cases, both host computer and output functions are used in the RFID system.

HOST COMPUTER

Through a host computer, the RFID system can log and process tag transactions for a variety of purposes. For example:

- In a warehouse, a tag read can be associated with a location and time for the purposes of tracking objects and their movements.
- In an automated toll system, a tag read can trigger a debit from the tag owner's account.
- In an automated meter reading system, a tag read also includes gas or water usage data that can be forwarded to a customer billing system.

OUTPUT FUNCTIONS

The simplest RFID system may only react with specified outputs according to a set of rules programmed into the reader's microprocessor. For example:

- In access control applications, a tag read whose ID is on a list of authorized IDs can trigger the opening of a door or gate.

- In warehouse applications, reading the tag on a specific pallet can turn on a light, or ring a bell to indicate the desired case has been located.

INPUT FUNCTIONS

An RFID system may also be designed to respond to certain input conditions. Readers are often configured to interface with input devices such as presence detectors. A presence detector can be used, for example, to power up a reader only when an object is within range to conserve energy or minimize the radio noise in a given environment.

CHAPTER 3
Glossary of RFID Terms

*NOTE: Because there may be more than one definition for a given term or pair of terms, even within the RFID industry, you should **always ensure such terms and their intended definitions are clearly understood** within the context of any communication, whether written or verbal.*

Active Tag (communications context)
A tag that contains its own transmitter, which can broadcast data even when no reader is present. May be called a "transmitter tag." (See also "passive tag 1.")

Active Tag *(power context)*
A tag that derives its power exclusively from a source other than the reader's signal (i.e., battery-powered or direct AC powered). (See "semi-active tag" and "semi-passive tag.") (See also "passive tag 2.")

Active Tag *(processor context)*
A tag that contains an onboard processor. (This is a relatively obscure definition of the term.) (See also "passive tag 3.")

Auto ID Center (AIDC)
Auto ID Center founded at Massachusetts Institute of Technology (MIT). The MIT AIDC was split into two bodies – the MIT AutoID Labs, and EPCglobal.

AIDC
Automatic identification and data collection.

Air Interface
The means used to wirelessly enable tag-reader communications.

Antenna Polarization
The orientation of the antenna's electromagnetic (EM) field. Polarization often implies a preferred tag-antenna orientation which optimizes the antenna's ability to acquire tag signal and data. Technically, polarization relates to the orientation of EM fields at specific antenna components. In user-level discussions, however, polarization is typically referenced to the ground and assumes the antenna is in its normal mounting position.

If, for example, a horizontally polarized (parallel to the ground) antenna that is normally mounted upright on a beam or wall were mounted on its side instead, it would then be thought of as being vertically polarized (perpendicular to the ground) from the user's perspective, though the antenna's inherent polarization never changes.

Anti-collision
The ability of a reader to read multiple tags in the field (read window) virtually simultaneously. (See "discrimination.")

Attenuate
To decrease the broadcasting range of an antenna's signal.

Backscatter (backscatter modulation)
A method of tag-reader communication that uses radio frequency (RF) energy broadcast from a reader/antenna to essentially bounce the RF signal off the tag and back to the reader. The tag encodes its own identification data on the original signal and reflects (backscatters) the modified (modulated) signal back to the reader's receiver. The alternative to backscatter technology is transmitter technology (see "active tag 1"). Backscatter tags may be powered solely by the reader's signal or may include a battery for increased read range or to power an onboard processor. All Alien tags use backscatter modulation.

Battery-Powered Tag
A tag whose internal circuitry is partially or entirely powered by a battery. (See "active tag 2.") A tag that uses a combination of beam and battery power may also be called "semi-passive" or "semi-active."

Beam-Powered Tag
A tag whose internal circuitry is energized by converting a portion of the reader's RF signal ("beam") to power that enables it to modulate and reflect (backscatter) that signal to the reader. (See "passive tag 2.")

Chip
(See "integrated circuit.")

Class 1 Tag
An ultra-low-cost, beam-powered backscatter tag containing up to 96 bits of data, with WORM memory, no onboard processor, and optimal read range of 1 meter. (See "EPC")

Class 2 Tag
A low-cost, beam-powered backscatter tag with read/write memory, no onboard processor, and optimal read range of 1 meter.

Class 3 Tag
A medium-cost, battery-powered backscatter tag with read/write memory, an onboard processor, and optimal read range of up to10 meters.

Class 4 and above
Refer to the relevant AIDC specification.

Die
(See "integrated circuit.")

Discrimination
The ability of a reader to read individual tags in a field containing multiple tags. (See "anti-collision.")

Electronic Product Code (EPC)
An ultra-low-cost RFID tag containing a 64 bit unique ID code—the equivalent of the barcoded UPC (universal product code) plus additional data not accommodated by UPCs. The EPC tag falls under AIDC Class 1.

EM
Electromagnetic.

EPC
Electronic product code.

EPCglobal
A member-driven organization developing global standards for EPC use.

FCC
Federal Communications Commission (U.S. regulatory body).

Firmware
Basic programming built into the reader. Firmware consists of various sets of commands the reader is designed to understand and obey. Firmware runs on the reader's microprocessor.

Fluidic Self Assembly
A "massively parallel" process patented by Alien Technology that enables the assembly of millions of NanoBlock™ ICs per hour into RFID tag "straps."

Frequency
May refer to a very specific point on the electromagnetic spectrum (e.g. 912.55 MHz) or may refer to a frequency "band."

Frequency Band
A range of frequencies on the EM spectrum, typically defined by their applications or authorized uses as designated by organizations such as the FCC in the U.S. Frequency bands are often referred to by their center frequencies. For example, the "915 MHz band" covers frequencies ranging from 902 MHz to 928 MHz.

Frequency Hopping
A method of transmitting RF energy that minimizes interference among devices operating in the same band. The reader frequency hops from one specific point on the EM spectrum (within the frequency band) to another and another (according to a "hopping table" defined by the FCC and programmed into the reader's ROM) at precise 400 mS intervals. Because Alien tags merely reflect a modulated form of the reader's own signal, they can be read at all the frequencies used by the reader in frequency hopping.

FSA
Fluidic Self Assembly.

IC
Integrated circuit.

Inlay/Inlet
An RFID tag assembly on a film of flexible plastic or other material ready for conversion into a label or packaging. An inlay/inlet contains a NanoBlock IC, strap and antenna and is a fully functioning tag at this stage.

Input Functions
Both tags and readers can be configured to allow inputs to influence subsequent actions of the given device. A reader, for example, may be connected to a proximity sensor that tells the reader an object is within range. The reader may be set to turn on and read for an extended period, or to turn on then turn off again as soon as a tag has been read. Tag inputs

typically come from sensors in or attached to the tag for detecting temperature, humidity, shock/vibration, tampering, etc.

Integrated Circuit
Connected to a tag antenna, an RFID IC is the brain of the RF tag. It rectifies (converts) reader RF energy to power itself (in beam-powered and hybrid beam/battery-powered tags), maintains tag memory and has the intelligence to execute anti-collision functions so a reader can read many tags in its field virtually at once. Also referred to as “chip,” “die” or “device.”

Interconnect
Electrical connection from the leads of an IC to external circuits, or to an antenna in the case of a conventional tag.

Interference
Any emissions in the electromagnetic spectrum that have the capacity to disrupt, distort, weaken or cancel the effective transmission of an EM signal. In RFID, interference may come from other RFID devices operating in the same frequency band, communication devices operating in the same band, or spurious noise emissions from mechanical sources that contain frequencies in the RFID operating band. Interference is minimized through the use of RF filtering and frequency hopping.

Interrogator
(See “reader.”)

Line of Sight
Optical (barcode) systems of automatic identification require that the laser scanner have an unobstructed path (line-of-sight) to the barcode for reading the UPC. Any objects between barcode and scanner will prevent proper reading. Alien RFID systems are not limited to line-of-sight in that RF tags can be read through or around most materials.

Massively Parallel
Refers to the ability of FSA technology to assemble many thousands of NanoBlock ICs onto RFID tag straps simultaneously, versus the “serial” processing of ICs using standard pick-and-place robotic machines which handle one IC at a time.

Micron
One one-thousandth of a millimeter. (For example: 350 microns = 0.35 mm.)

Multipath
Multiple versions of the same signal (often reflected by objects or materials in the RF operating environment) that arrive at the reader at various times (like an echo). Those that arrive in phase with the original signal will enhance that signal. Those that arrive out of phase will cancel the original signal.

NanoBlock® IC
Alien’s proprietary, etched ICs that, even in very small sizes, can be handled and packaged in huge quantities using FSA. NanoBlock ICs are designed to maximize IC yields from a single silicon wafer and to facilitate Alien’s FSA manufacturing process.

Nanoscanner
Brand name for Alien's line of RFID readers.

Open Protocol (also "open system" or "open specification")
A specification that is made publicly available for all to use without payment of license or other fees. The AIDC is developing a fully open specification for adoption by its members.

Output Functions
Both tags and readers can be configured to actuate a device or process upon certain conditions. A reader may be programmed, for example, to open a door or gate, turn on a light or emit an audible tone when any tag is read or only when specific tags are read. Likewise, certain tags may be configured to turn on an LED or emit a tone when read to allow a user to find a specific tagged object. Tag outputs can be used to enable and disable devices such as laptop computers, hard drives, or night vision goggles according to predefined authorized conditions as well as to regulate temperatures, control pumps and motors, etc.

Passive Tag *(communications context)*
A tag that relies solely on backscatter modulation of a reader's signal for communication with the reader. A passive tag in this context is one that has no transmitter. (See also "active tag 1.")

Passive Tag *(power context)*
A tag that derives its power exclusively from the energy contained in the reader's incident signal (i.e., RF "beam"-powered). (See "semi-active tag" and "semi-passive tag.") (See also "active tag 2.")

Passive Tag *(processor context)*
Tag with no onboard processor. (This is a relatively obscure definition of the term.) (See also "active tag 3.")

Pick and Place (P&P)
The traditional method of placing ICs on RFID antennas. A robotic arm picks up an individual die ("IC" or "chip") and places it directly onto the RFID antenna. While this method can be executed by robots quite fast, it remains a "serial" process that involves handling once chip at a time.

Protocol
(See "specification.")

Reader
A transmitter/receiver ("transceiver") that sends out RF signals into an environment where tags are expected and acquires RF signals (either transmitted or backscattered) from the tags. Also called an "interrogator."

Read Range
Distance from a reader antenna at which tags may be successfully read. May refer to the optimal or ideal range at which tags can be read reliably under all reasonable circumstances by a system of a specific design. Read range may also refer to the maximum range at which tags can be read.

Read Window
The area (in three-dimensional space extending from a reader antenna) within which a compatible tag will be read.

RFID
Radio frequency identification.

Roll-to-Roll
Material web-based manufacturing in which a roll of flexible material (web) such as plastic is unwound and run through a process then rewound at the end of the process. This is similar to the movement of movie film through a projector. FSA is a roll-to roll process.

ROM
Read-only memory. Refers to tag or reader memory that, once programmed, can never be modified.

R/W
Read/write. Refers to tag memory that, with proper authorization, can be modified any number of times in the field, such as to reprogram tag ID for use on a new object, or to write variable data such as storage location or expiration date into tag memory.

Semi-Active Tag
A “hybrid” tag that uses both beam and battery power. (Also called a “semi-passive tag.”) The battery is used to power the tag’s internal circuitry so that it need not rely on power from the reader. The battery power enables the tag to perform functions such as monitoring time and taking periodic temperature readings when it is not in a reader’s RF field. Battery power also greatly enhances the tag’s read/write range.

Semi-Passive Tag
(See “semi-active tag.”)

Smart Label
An RFID tag in the flat, flexible form of a paper or plastic label.

Software
An external layer of programming that uses firmware commands to manipulate and control reader operation according to the user’s needs. Software runs on a host computer that communicates with the reader.

Source Tagging
The integration of tags into product packaging at the source or point of manufacture.

Specification
An RFID specification describes all the operating parameters of a system, including frequency, air interface, communication timing, anti-collision logic, etc. Alien tags operate according to the open AIDC specifications.

Strap
A NanoBlock IC on a flexible substrate with interconnected pads printed or etched to make leads to the IC. The strap is connected to a tag antenna on a

flexible substrate to create an “inlay” or “inlet.” Tag “converters” then embed these inlays/inlets in labels and product packaging.

Supply Chain
The processes involved in moving materials, components and finished goods from source to destination. Usually includes shipping/receiving, logistics, warehousing and inventory control.

Tag
An RFID device capable of receiving reader signal and returning data to the reader. Sometimes called a “transponder,” though not all tags are true transponders.

Tag Conversion
The process whereby an inlay/inlet (with its NanoBlock IC, strap and antenna) is packaged into a paper label, often with an adhesive backing. Conversion is achieved in a high-speed parallel process.

Tag Orientation
The presentation of the tag to a reader antenna. May indicate a preferred position that optimizes tag readability. The meaningful relationship of tag to reader antenna is fairly complex and internal to both devices. However, for the purposes of user discussions referencing optimal positioning, tag orientation is usually stated as relative to the ground. Thus horizontal tag orientation would indicate the longer axis of the tag is parallel with the ground. Vertical orientation would indicate the tag’s long side is perpendicular to the ground.

Transceiver
Transmitter/receiver. (See “reader.”)

Transmitter Tag
A tag that contains its own transmitter, which can broadcast data even when no reader is present. May also be called an “active tag” (definition 1).

Transponder
Transmitter-responder. A transmitter (or “active”) tag that maintains a low power level (quiescent state) until “awakened” by a reader and instructed to transmit data (respond). It can also refer to an RF tag of any type. (This is an imprecise use of the term. While all transponders are tags, not all tags are transponders.)

Wafer
Integrated circuits are manufactured in large quantities by etching many thousands of copies of the circuitry into the surface of a silicon wafer. Conventional ICs are sawn apart from one another. However, NanoBlock ICs are etched apart to minimize waste and produce the distinctive shape required for Alien’s Fluidic Self Assembly process.

Web
A roll of flexible plastic material containing specially shaped dimples or “receptacles” into which the NanoBlock ICs settle as the material is run through a solution in the FSA process.

Webstock

A roll of Alien straps, typically carrying approximately 1000 straps per linear foot on a 6 inch wide web.

WORM

Write once, read many. Refers to tag memory that is typically programmed once (either at the factory or in the field), then locked via firmware to prevent unauthorized reprogramming.