lamaPLC Communication: RFID

Radio-frequency identification (**RFID**) uses electromagnetic fields to identify and track tags attached to objects automatically. An RFID system consists of a tiny radio transponder called a tag, a radio receiver, and a transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data back to the reader, usually an identifying inventory number. This number can be used to track inventory goods.

Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

Unlike a barcode, the tag does not need to be within the reader's line of sight, so it may be embedded in the tracked object. RFID is one method of automatic identification and data capture (**AIDC**).

RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line,[citation needed] RFID-tagged pharmaceuticals can be tracked through warehouses,[citation needed] and implanting RFID microchips in livestock and pets enables identification of animals. Tags can also be used in shops to expedite checkout and prevent customer and employee theft.

Since RFID tags can be attached to physical money, clothing, and possessions or implanted in animals and people, the possibility of reading personally linked information without consent has raised serious privacy concerns. These concerns resulted in the development of standard specifications addressing privacy and security issues.

In 2014, the world RFID market was worth US$8.89 billion, up from US$7.77 billion in 2013 and US$6.96 billion in 2012. This figure includes tags, readers, software/services for RFID cards, labels, fobs, and all other form factors. The market value is expected to rise from US$12.08 billion in 2020 to US$16.23 billion by 2029.

History

In 1945, Leon Theremin invented the *“Thing”*, a listening device for the Soviet Union which retransmitted incident radio waves with the added audio information. Sound waves vibrated a diaphragm, which slightly altered the resonator's shape, modulating the reflected radio frequency. Even though this device was a covert listening device, rather than an identification tag, it is considered a predecessor of RFID because it was passive, being energised and activated by waves from an outside source.

Similar technology, such as the Identification, friend or foe transponder, was routinely used by the Allies and Germany in World War II to identify aircraft as friendly or hostile. Transponders are still used by most powered aircraft. An early work exploring RFID is the landmark 1948 paper by Harry Stockman, who predicted that *“Considerable research and development work has to be done before the remaining basic problems in reflected-power communication are solved, and before the field of*

useful applications is explored."

Mario Cardullo's device, patented on January 23, 1973, was the first true ancestor of modern RFID, as it was a passive radio transponder with memory. The initial device was passive, powered by the interrogating signal, and was demonstrated in 1971 to the New York Port Authority and other potential users. It consisted of a transponder with 16-bit memory as a toll device. The basic Cardullo patent covers using*radio frequency* (**RF**), sound, and light as transmission carriers. The original business plan presented to investors in 1969 showed uses in transportation *(automotive vehicle identification, automatic toll system, electronic license plate, electronic manifest, vehicle routing, vehicle performance monitoring)*, banking *(electronic chequebook, electronic credit card)*, security *(personnel identification, automatic gates, surveillance)* and medical *(identification, patient history)*.

In 1973, Steven Depp, Alfred Koelle, and Robert Freyman at the Los Alamos National Laboratory performed an early demonstration of reflected power *(modulated backscatter)* RFID tags, both passive and semi-passive. The portable system operated at 915 MHz and used 12-bit tags. This technique is used by most of today's UHFID and microwave RFID tags.

In 1983, the first patent to be associated with the abbreviation RFID was granted to Charles Walton.

In 1996, David Everett, John Frech, Theodore Wright, and Kelly Rodriguez were granted the first patent for a batteryless RFID passive tag with limited interference.

Readers

The type of tag and reader can classify RFID systems. There are three types:

- A *Passive Reader Active Tag* (**PRAT**) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), allowing flexibility in applications such as asset protection and supervision.
- An *Active Reader Passive Tag* (**ARPT**) system has an active reader, which transmits interrogator signals and receives authentication replies from passive tags.
- An *Active Reader Active Tag* (**ARAT**) system uses active tags activated with an interrogator signal from the active reader. A variation of this system could also use a *Battery-Assisted Passive* (**BAP**) tag, which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Passive RFID: Comparison by frequency band

As mentioned earlier, passive RFID tags are an essential component of RFID technology. These tags operate at different frequencies and are classified into three main types based on the frequency.

Low-Frequency (LF) RFID tags: These tags operate at 125-134 kHz and have a relatively short read range of 10 cm. LF RFID tags are commonly used in animal identification and access control applications.

High-Frequency (HF) / NFC Near Field Communication tags: These tags operate at a frequency

of 13.56 MHz and have a read range of up to several feet. HF RFID tags are commonly used in retail inventory management and asset tracking applications.

Ultra-High-Frequency (UHF) RFID tags: These tags operate at 868-915 MHz frequency and have a read range of up to 20 meters. UHF RFID tags are commonly used in applications such as supply chain management and asset tracking, where longer read ranges are required.

What is the difference between NFC and RFID?

NFC (*Near Field Communication*) and **RFID** (*Radio Frequency Identification*) are two wireless communication technologies that operate in the radio frequency spectrum. NFC is a specialized subset within the family of RFID technology using a specific set of short-range communication protocols.

It operates on a base frequency of 13.56 MHz and has a typical range of 2cm. NFC and UHF RFID share some similarities, such as the ability to wirelessly transmit data between devices. However, there are also several key differences between them. They differ in their range, frequency, applications, and compatibility.

difference	**NFC**	**UHF RFID**
Frequency range	13.56 MHz	856 MHz to 960 MHz
General read range	< 10 cm	Up to 20 meters
Typical use cases	Product authentication, Brand protection, Consumer engagement, Mobile payments	Asset tracking through the supply chain, Real-time inventory management, Loss prevention
Reader	Smartphone	Handheld reader, Fixed infrastructure reader
Number of tags scanned at a time	One	Multiple
Cost of tags	Medium to low	Low

Transponder protocols

Transponder Chip	**Frequency**	**Usable data size**	**Encoding Scheme**
EM4100	125Khz	64 bit Read Only	Manchester Encoding
T5567	125Khz	224 bits R/W (7 x 32bit)	Manchester, FSK,PSK,Biphase,NRZ
T5557	125Khz	224 bits R/W (7 x 32bit)	Manchester, FSK,PSK,Biphase,NRZ

EM4100 Protocol

RFID transponders (Tags) are devices carrying digital information that can be read from a distance by an RFID transceiver (Reader). In order to read the information stored on the RFID tags, the reader must know how the information is stored and the protocol for extracting it. One of the more common data formats for RFID transponders is the EM4100 protocol, named so because the microchip at the heart of the Tag is based on the controller chip made by the company EM Microelectronic.

EM4100-compatible RFID transponders carry 64 bits of Read-Only memory. This means that

information can be read from the Tag, but no data can be changed or new data written to the card once the card has been programmed with the initial data.

The Transponder and Reader use the individual cycles of the RF field to synchronize the data transmission between the two. The synchronizing clock's frequency then becomes the frequency of the RF field used.

RFID system clock frequencies vary according to the application required. The typical band used for low-frequency, short-distance sensing of Tags is between 100- 150 kHz. A system frequency of 13.56 MHz might be used for longer-range sensing, or another frequency as the application requires.

Of course, the designer of an RFID system is restricted to using particular frequency bands, as RFID systems are radio-emitting devices and, therefore, under the control of the local radio frequency regulator bodies.

T5557 Read/Write RFID Transponder

The Atmel T5557 is a 330-bit read/write RFID transponder operating in the 125 kHz band. Its memory is structured in 10 blocks of 33 bits. However, only 224 bits are available for the storage and retrieval of user-defined data. This is structured as seven blocks of 32 read/write data bits. Among the many functions available, the T5557 RFID transponder is capable of :

- Selectable data rates RF/2 to RF/64
- Selectable Modulation Encoding. Manchester, FSK, PSK, Biphase, NRZ.
- Maximum block feature.
- Password protected Read and Write
- Direct access block read and write

Sources

Wikipedia (here)

RFID topics on lamaPLC

Page	Date	Tags
• ISM Band	2025/11/10 18:53	ism, ism band, rfid, nfc, dash7, hc-12, arduino, zigbee, z-wave, bluetooth, wi-fi, thread, miwi, nrf24, starlink, wiegand, rf, communication, bus, radio, ku band, ka band, k band, x band
• lamaPLC Communication: DASH7	2024/11/16 20:21	bus, communication, dash7, ism, srd, aes 128, d7a, blast, iot, rfid
• lamaPLC Communication: IoT	2025/05/31 22:50	communication, iot, internet, iomt, 6lowpan, ipv4, ipv6, bluetooth, ble, li-fi, nfc, rfid, wi-fi, zigbee, z-wave, lte-advanced, 5g, lora, dash7, lpwan, lorawan, sigfox, nb-iot, weightless, rpma, mioty, vsat, ethernet, thread, matter

• lamaPLC Communication: NFC	2025/05/31 22:16	communication, nfc, rfid, bluetooth, ble, manchester, ask, iso iec 18092
• lamaPLC Communication: RFID	2025/05/31 21:52	communication, rfid, radio, rf, aidc, prat, arpt, arat, bap, uhf, nfc, em4100, t5557, tag, manchester, fsk, psk, biphase, nrz

communication, RFID, radio, RF, AIDC, PRAT, ARPT, ARAT, BAP, UHF, NFC, EM4100, T5557, tag, Manchester, FSK, PSK, Biphase, NRZ

This page has been accessed for: Today: 3, Until now: 5