

Technology Brief 13: RFID Systems

In 1973, two separate patents were issued in the United States for Radio Frequency Identification (RFID) concepts. The first, granted to Mario Cardullo, was for an **active RFID tag** with rewritable memory. An active tag has a power source (such as a battery) of its own, whereas a **passive RFID tag** does not. The second patent was granted to Charles Walton, who proposed the use of a passive tag for keyless entry (unlocking a door without a key). Shortly thereafter a passive RFID tag was developed for tracking cattle (**Fig. TF13-1**), and then the technology rapidly expanded into many commercial enterprises, from tracking vehicles and consumer products to supply chain management and automobile anti-theft systems.

RFID System Overview

In an RFID system, communication occurs between a **reader**—which actually is a **transceiver**—and a **tag** (**Fig. TF13-2**). When *interrogated* by the reader, a tag responds with information about its identity, as well as other relevant information depending on the specific application.

► The tag is, in essence, a **transponder** commanded by the reader. ◀

The functionality and associated capabilities of the RFID tag depend on two important attributes: (a) whether the tag is of the active or passive type, and (b) the tag's operating frequency. Usually the RFID tag remains dormant (*asleep*) until activated by an electromagnetic signal radiated by the reader's antenna. The magnetic field of the EM signal induces a current in the coil contained in the tag's circuit (**Fig. TF13-3**). For a passive tag, the induced current has to be sufficient to generate the power necessary to activate the chip as well as to transmit the response to the reader.

► Passive RFID systems are limited to short **read ranges** (between reader and tag) on the order of 30 cm to 3 m, depending on the system's frequency band (as noted in **Table TT13-1**). ◀

The obvious advantage of active RFID systems is that they can operate over greater distances and do not require reception of a signal from the reader's antenna to get activated. However, active tags are significantly more expensive to fabricate than their passive cousins.

RFID Frequency Bands

Table T13-1 provides a comparison among the four frequency bands commonly used for RFID systems. Generally speaking, the higher-frequency tags can operate over longer read ranges and can carry higher data rates, but they are more expensive to fabricate.

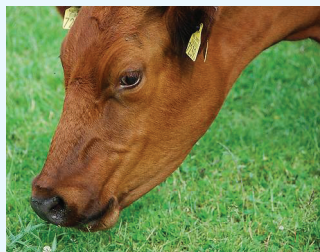


Figure TF13-1 Passive RFID tags were developed in the 1970s for tracking cows.

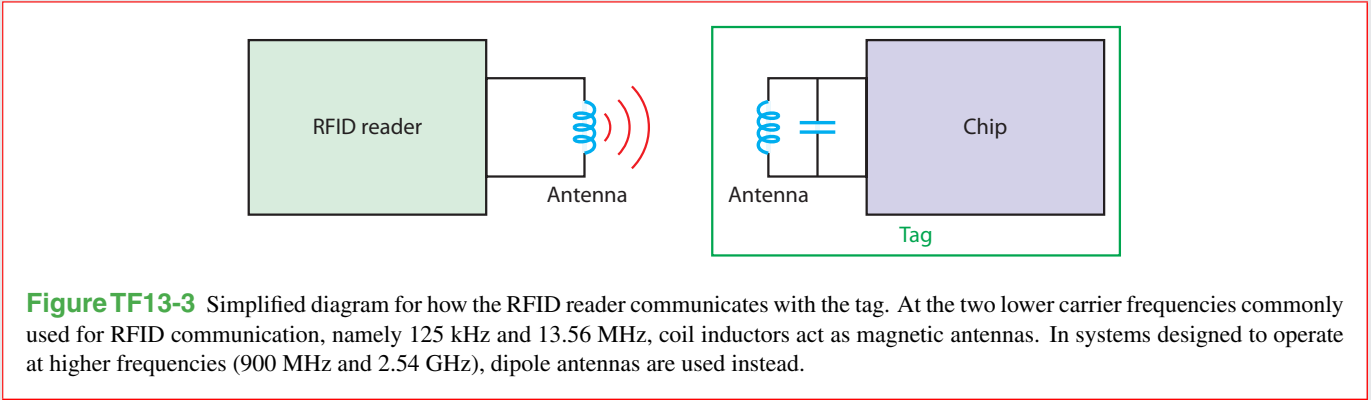
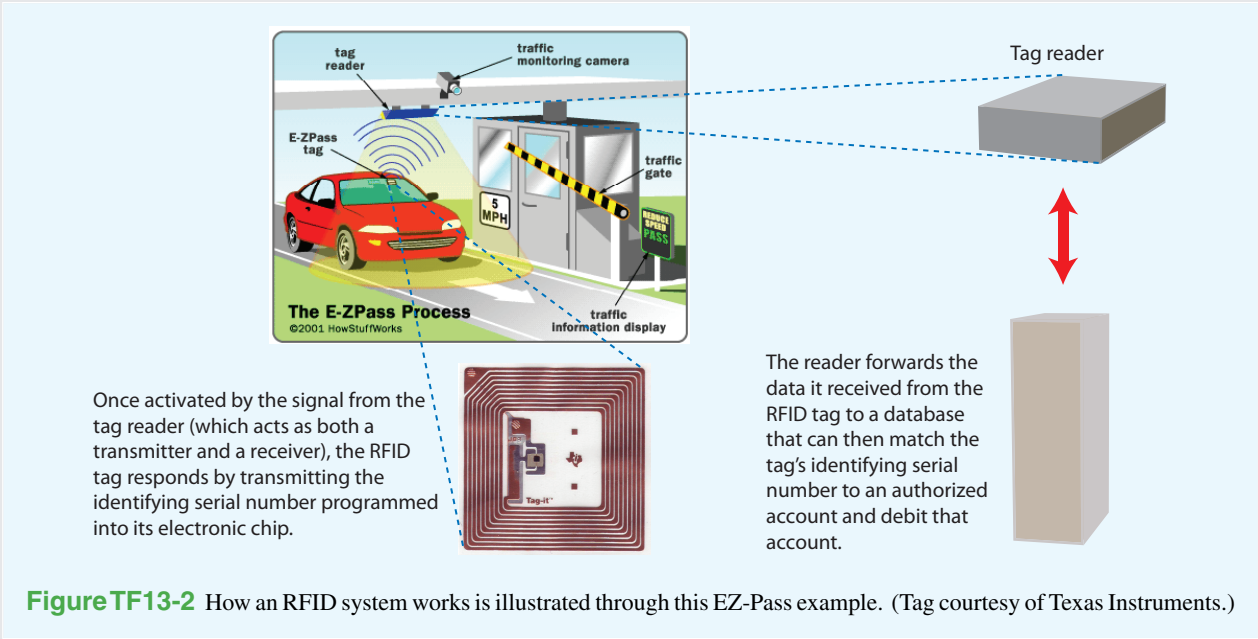


Table TT13-1 Comparison of RFID frequency bands.

Band	LF	HF	UHF	Microwave
RFID Frequency	125–134 kHz	13.56 MHz	865–956 MHz	2.45 GHz
Read range	≤ 0.5 m	≤ 1.5 m	≤ 5 m	≤ 10 m
Data rate	1 kbit/s	25 kbit/s	30 kbit/s	100 kbit/s
Typical Applications	<ul style="list-style-type: none">• Animal ID• Automobile key/antitheft• Access control	<ul style="list-style-type: none">• Smart cards• Article surveillance• Airline baggage tracking• Library book tracking	<ul style="list-style-type: none">• Supply chain management• Logistics	<ul style="list-style-type: none">• Vehicle toll collection• Railroad car monitoring