Considerations for RFID Technology Selection

RADIO FREQUENCY IDENTIFICATION SYSTEMS OPERATE IN THE ISM RADIO FREQUENCY BANDS WHERE NO RADIO LICENSE IS REQUIRED. EACH FREQUENCY BAND HAS ADVANTAGES AND LIMITATIONS WHICH MUST BE CONSIDERED WHEN DESIGNING AN RFID SYSTEM. THE REQUIREMENTS OF THE RFID APPLICATION DICTATE WHICH RFID FREQUENCY BAND AND TRANSPONDER TYPE SHOULD BE USED.

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Radio Frequency Identification (RFID) systems consist of an electronic data carrier device and reader that communicate information using radio technology. The contactless transfer of data has numerous applications in commerce and industry. RFID is more flexible than optical, magnetic, and contact smart card technology.

There are several categories of RFID technology, and each has both advantages and disadvantages. The requirements of the application determine which RFID technology is appropriate. This article describes the characteristics which are most important in RFID technology selection.

RFID systems are commonly classified according to the properties of the data carrier, called a transponder or tag. The two major classes of RFID transponders are active and passive.

Active transponders contain a battery or are connected to an external power source. Passive transponders are powered by the RF field. Passive transponders are smaller, have lower cost, and require no periodic maintenance. Active transponders are capable of longer communication distance and can perform data collection tasks even when no reader is present.

The simplest RFID devices are single-bit electronic article surveillance (EAS) tags. The EAS system simply detects the presence or absence of an EAS transponder in the reader zone. EAS tags are widely used by retailers in electronic anti-theft systems. The operating frequency and method of construction of EAS tags varies, but in general, the EAS reader excites the tag and listens for a reactive or resonant response. EAS tags are passive and most do not contain integrated circuits.

Most RFID systems utilize passive transponders more complex than EAS tags. These passive transponders are commonly categorized according to the frequency of operation. RFID systems operate in the unlicensed radio frequency bands known as ISM (Industrial, Scientific, and Medical). While regulations vary from country to country, there are several frequency bands that Europe, Japan, and the United States have all designated as ISM, and most RFID systems operate at these frequencies. It is important to note that while ISM radio devices do not require a license, they are still subject to signal emission limits that vary by country.

The frequency categories and most common RFID system frequencies are listed in Table 1, along with key characteristics. The cost of reader hardware tends to decrease as the technology matures, because communication protocols are standardized

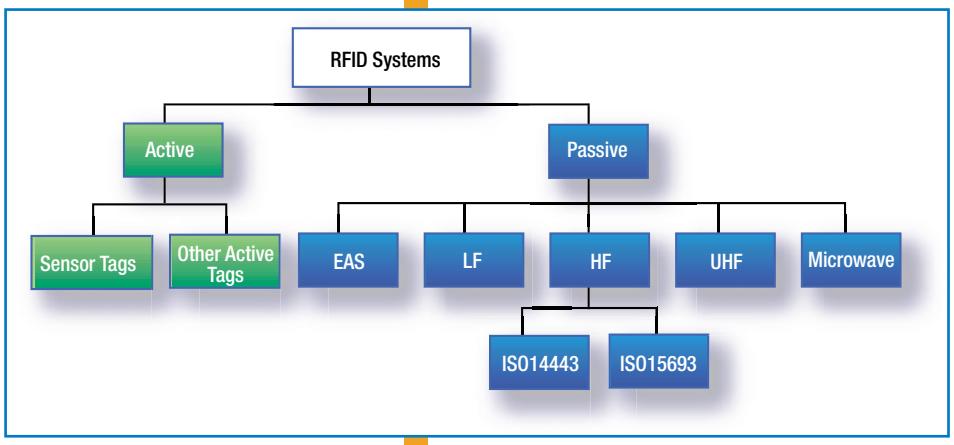

Figure 1: RFID Family Tree

Frequency BAND	Common Frequ.	Coupling	Communication Range Typical	Maximum	Data Rate	Maturity	Reader Cost
LF	125 to 135kHz	Inductive	20 cm	100 cm	Low	Very Mature	Low
HF	13.56 Mhz	Inductive	10 cm	70 cm	High	Established	Medium
UHF	868 to 928 Mhz	Backscatter	3 m	10 cm	Medium	New	Very High
Microwave	2.45 Ghz	Backscatter	3 m	?	Medium	In Development	Very High
	5.8 Ghz	Backscatter	3 m	?	Medium	Future Development	Very High

Table 1: Passive RFID Frequency Bands and Characteristics

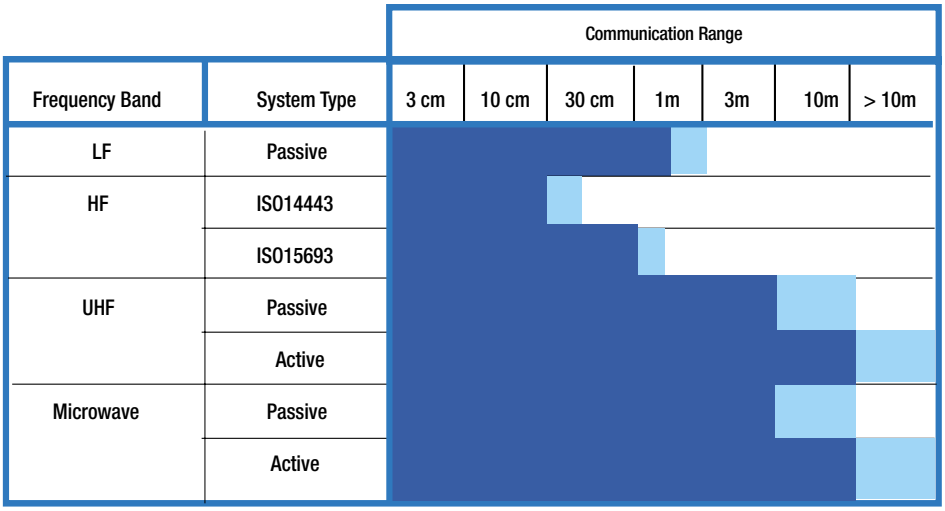

Figure 2: Communication Range of RFID Systems

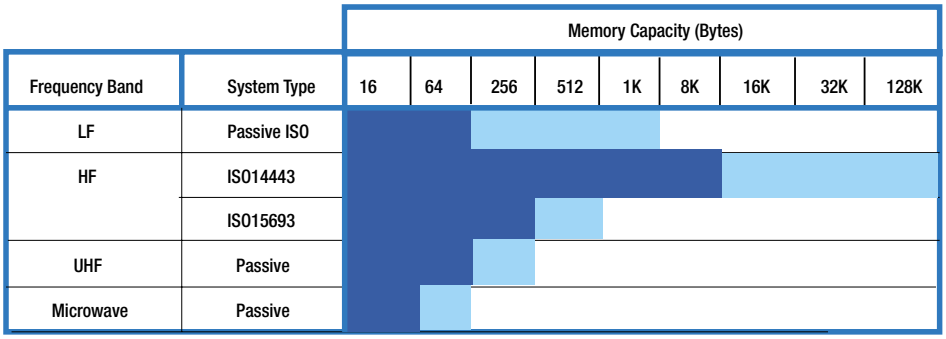

Figure 3: Transponder Memory Capacity for Passive RFID Systems

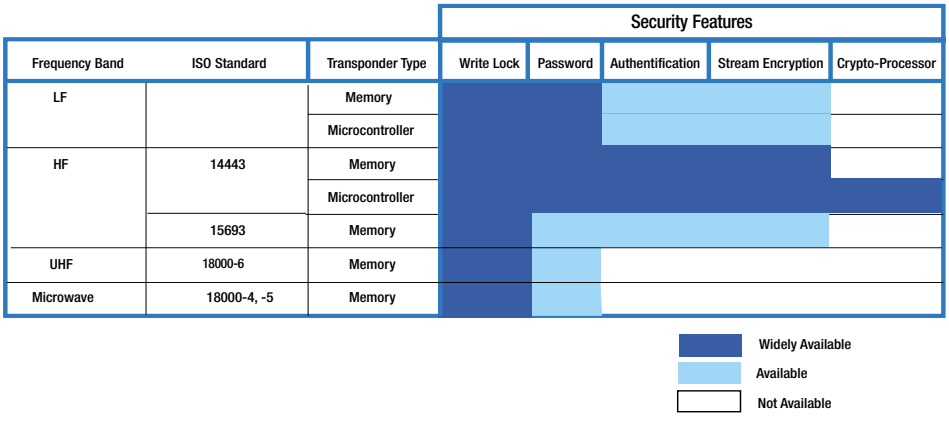

Figure 4: Transponder Security for Passive RFID Systems

Frequency BAND	Atmel Product Family	Transponder ICs	Contact
LF	RFID	Passive	rfid@atmel.com
HF	Secure RF	Passive	securerf@atmel.com
UHF	RFID	Passive	rfid@atmel.com
	Smart RF	Active	smartrf@atmel.com
Microwave	RFID	Passive	rfid@atmel.com
	Smart RF	Active	smartrf@atmel.com

Table 2: Atmel RFID Products by Frequency Bands

and integrated-circuit-based readers are introduced. In many applications, the hardware cost is only one-third of the installed system price, with applications and data management software comprising the most expensive components of the system.

Even within a frequency band, the communication range of RFID systems varies widely, because range is dependent on antenna design, system power, transponder power consumption, and receiver sensitivity. The ideal RFID system would have very long range and high data transfer rate, with low power; unfortunately, physics prohibit this ideal system. Communication range and data rate are not independent. High data rates can only be achieved at relatively short range, and very long range can only be obtained at low data rates.

The three key selection parameters of range, memory size, and security features are illustrated in Figures 2, 3, and 4 for each frequency category. The compromises that are necessary in selecting an RFID technology are clearly illustrated. Applications requiring large data transfers or high security must utilize ISO14443 systems in the high frequency (HF) band. Applications with a very long-range requirement will utilize UHF or microwave technology. For mid-range systems, either low frequency (LF) or HF may be used.

Active RFID systems are not as widely deployed as passive systems. Active systems are custom designed for specific applications and have not been standardized. As a result, it is more difficult to discuss them in general terms. The most popular frequency band for active RFID is UHF due to the obvious range advantages of active UHF RFID and the availability of ISM radio components. In the United States, active UHF systems have been installed in the 433 MHz, 889 MHz, and 902 to 928 MHz ISM bands.

With more than 30 years of experience in RFID, Atmel supplies a wide variety of transponder ICs and reader components. Atmel is the world's leading supplier of passive, low-frequency, RFID-integrated circuits. Atmel also provides a full line of passive, high-frequency ICs, including the CryptoRF family of contactless smart card ICs. A new family of passive UHF transponder ICs, with the lowest power consumption and longest communication range in the industry, is currently being introduced. Atmel supplies a wide variety of ISM and wireless radio circuits suitable for active UHF and microwave RFID, including the Smart RF family of UHF transmitters with integrated AVR microcontroller. ■

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