

Chapter 3

UHF RFID Reader Antenna

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ABSTRACT

This chapter addresses the various design issues, requirements, and specifications in designing reader antennas for UHF RFID applications. In a typical UHF system, the RFID reader antennas are geography specific; that is, there are different antennas for different geography, namely North America, Europe, et cetera. The discussion on the design challenges and performance expectations lead to a new form of compact and broad band antenna, which will be applicable for the global UHF RFID band of 860MHz to 960 MHz. In addition, this chapter also provides potential future trends in RFID reader antenna design. The issues and challenges discussed in this chapter are envisioned to provide a roadmap to the potential challenges to be faced by a chipless RFID system.

1. INTRODUCTION

In recent years, RFID technology is seeing tremendous growth as it is been rapidly developed and used in many applications: Healthcare, supply chain management systems, pharmaceuticals, transportation, agriculture etc. RFID Readers can be divided into Fixed/Stationary readers and Mobile/Handheld Readers (Elisabeth, Kemeny, Egri, Monostori. 2006). Currently RFID systems are operating in three frequency bands: Low Frequency (LF), High Frequency (HF) and Ultra High Frequency (UHF). Microwave frequency range

(ISM band) is also used in some cases, where the frequency of choice is generally 2.4-2.485GHz. Majority of applications of microwave band relates to “active tag” system, that is, the tag is powered by battery. Globally each country has its own frequency allocation for LF, HF and UHF bands. Each frequency has advantages and disadvantages relative to its capabilities.

An appropriate choice of frequency for a RFID system deployment (LF/HF/UHF) depends on multiple factors namely reading distance, number of assets that can be tracked together, size, cost effectiveness of the system and more importantly,

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the reliability of reading (since wireless propagation is strongly dependent on environment). It is worth noting that an optimum antenna aperture is half wavelength size. Therefore, if the desired frequency of operation is lowered (longer wavelength), the physical antenna size is required to go up for better efficiency. One can now estimate the size of the efficient antenna if the carrier frequency is in hundreds of KHz! The resultant compromise in size & usability at lower frequency, does indicate that a useful LF system is based on 'near field' reading; generally through magnetic coupling. The mechanism of magnetic coupling (used for both LF & HF systems) assumes transformer like action between the reader antenna (primary coil) and the tag (secondary coil) and are well behaved very close to the reader antenna.

Low-Frequency (LF) RFID systems are typically 125 KHz, while some systems operating at 134 KHz do exist as well (Klaus, 2003) (Barthel 2009). For LF RFID systems read range is smaller (< 0.5m or 1.5 ft) and also suffers from slower read speed than the higher frequencies. LF systems tend to be less sensitive to interference than higher frequency options. But at LF, antenna volume will be large compared to other frequencies. The LF spectrum is not considered a truly global application and such deployments worldwide have got limited reach.

High Frequency (HF) RFID systems operate at 13.56MHz frequency. Working at higher frequencies extend the applicability of RFID systems due to some inherent advantages like the ability to have higher data rates (Klaus, 2003) (Barthel 2009). Similarly higher resonance frequency of the antenna circuit gives lower inductance and capacitance values. The lower antenna inductance means a fewer number of turns (5–10) (compared to 100–200 turns for the LF systems). It also presents the possibility of being produced not only from copper wire but also printed or etched on foil. These antennas are flexible and can be easily laminated in other embedded systems

(electronics). These basic advantages lead to a lowered cost for the system.

Ultra high frequency (UHF) RFID systems operate from 860MHz to 960MHz band and globally each country has its own frequency allocation (determined by the respective wireless planning regulators), e.g., 866–868 MHz in Europe, 902–928-MHz band in North and South of America, 865–867MHz in India,, 952–955 MHz in Japan (Klaus, 2003) (Barthel 2009). Deployment of UHF RFID systems have increased many-folds world wide due to their global standardization and some silent features like longer reading range, high speed reading, more data storage capability and lower cost of passive tags (Karmakar, Zakavi, & Kumbukage, 2010). The antennas used for UHF systems are typically patch, dipole, slot and helix antennas; the exact type is dependent on exact requirement. The coupling mechanism for UHF is no longer Magnetic or Capacitive. UHF RFID systems are based on backscatter principle, where, it is assumed that the passive tag resides in the far-field of the reader antenna. It is also appropriate to discuss about the gain of the UHF reader antenna. At UHF, one can use traditional antenna evaluation methods like gain & effective aperture for evaluating the reading range.

It is to be noted that typical commercial UHF readers have geography specific antennas; this is due to the fact that the reader antennas are expected to have high gain (approximately 6dBi). It is difficult to design an antenna with 5–6dBi gain for the entire frequency bandwidth (100MHz bandwidth at the centre frequency of 900 MHz). The key point in the reader antenna is that each antenna has a specific pattern of coverage. One can opt for an antenna type based on the implementation need, cost, coverage area, reading distance and size. As explained in (Foster & Burberry, 1999). antennas which are omni directional should be avoided and wherever possible, directional antennas should be used because they have the advantage of fewer disturbances to the radiation pattern and the return

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