Challenges and Solutions in the Antenna Design for RFID R/W System Applications

Andrey S. Andrenko
Fujitsu Laboratories LTD.
YRP R&D Center, 5-5, Hikari-no-Oka, Yokosuka, 239-0847, Japan
E-mail: andrey@labs.fujitsu.com

Radio frequency identification (RFID) technology relates to short-range wireless communications and uses the radio frequency to read certain information on a device known as a tag. Originally, basic ideas of RFID operation have been formulated a decade ago while the last several years have seen a renewed interest leading to various practical implementations and designs. In general, any RFID system consists of one or more tags and read/write (R/W) device incorporating, as its main part, a R/W antenna. Tags are devices that can come in many sizes and form, but are usually small and lightweight. They are commonly used for wireless data communication with R/W devices at distances ranging from a few millimeters to several meters.

Because of its flexibility and convenience RFID technology is now used in a variety of applications including supply chain processing, security systems, inventory control, mail delivery, and counterfeit product prevention. Most RFID tags contain integrated circuit (IC) chip, to store and process data, and also an integrated antenna, which is used as the communication interface with R/W antenna system. The IC chip requires power to operate, which in the initial designs was supplied by a battery. Recently, most applications require the tags to be small and inexpensive, so the so-called passive (no-battery) chips became common and widely used. Read-only tags are used when the data is to be programmed once, and tag in such a case only sends the stored information to the reader antenna. Read-write tags can be reprogrammed when the information needs to be updated according to the needs of the application. Several frequency bands are used in RFID deployment, such as low frequency (LF) at 125 – 135 KHz, high frequency (HF) at 13.56 MHz known as International Scientific and Medical (ISM) band, ultra high frequency (UHF) band from 860 MHz to 960 MHz, and 2.45 GHz band. Much effort is currently being devoted to the development of various UHF applications and solutions. Standards organizations are working with governments to harmonize UHF frequencies. However, today the bandwidth of this frequency varies from region to region. The United States has specified 915 MHz while the EU has allocated 868 MHz for RFID applications. Recently, Japan has specified 950 to 956 MHz as UHF RFID band. Therefore, this variation of frequency allocation requires that RF manufacturers produce country-specific tags and R/W devices creating a potential disconnect in the attempts to come up with the truly seamless international supply chain.

This short course would discuss the performance requirements and present the design of various R/W antennas for RFID system applications. There are several key performance parameters of all UHF RFID systems. The tag antennas are linearly polarized but, according to basic operational principle, numerous RFID tag transponders must be read simultaneously. Therefore, to guarantee the signal reception from arbitrary oriented linearly polarized tags an R/W antenna has to produce circularly polarized EM radiation. Right hand circular polarization (RHCP) has been defined as polarization standard for RFID antenna operation. So, RHCP axial ratio (AR) is the first critical parameter of an R/W antenna. Another key performance characteristic of all RFID systems is read range. It depends on the antenna gain of both tags and R/W system. That is why high R/W antenna gain is another critical requirement of any R/W antenna design. Many applications demand small and compact readers so that single radiator designs rather than array antennas are usually being implemented. Taking into account the performance requirements noted above, shrinking the size of RFID R/W antennas presents unique design challenges. Finally, considering the commercial mass production of RFID R/W systems, the antenna design has to be as cost effective as possible.

The first example to be discussed is a RHCP circular patch antenna that has been designed and optimized for 953 MHz frequency operation meeting all the conditions demanded for RFID R/W applications. CST Microwave Studio has been used for full-wave EM simulation and optimization. For the sake of simplicity single feed design has been selected. It has also been decided that RF circuit boards are to be placed on the opposite side of antenna ground plane thus minimizing the total dimensions of R/W system. In such a case, coaxial feed is a natural choice to feed the antenna. Maximizing the antenna gain has been achieved by employing patch antenna without any dielectric substrate, i.e. by placing patch element at some distance above the ground plane. Four small cylindrical dielectric pads are used for antenna support.

Another type of R/W antenna to be presented in this short course is RHCP planar 2-element dipole printed on a glass substrate for RFID show case applications. The design issues related to antenna element integration with a feeding twin line would be discussed and CP AR performance of such an antenna would be presented in the details.

The planned duration of this short course is half-day.