Underappreciated and Unheralded - 433 MHz RFID

Vehicle ID, Gated Entry, Asset and Personnel Tracking Applications

By Douglas L. Cram

Over the past fifteen years, I have been involved with the manufacture and implementation of many different radio frequencies and their associated products. The RFID (Radio Frequency Identification) products I refer to have been extensively used for access control, gated entry, perimeter security, asset tracking and monitoring, theft prevention, automated vehicle identification, supply chain management, work in process monitoring, and even livestock tagging. There are five commonly used radio frequencies that accomplish multiple combinations of the above tasks, some of which are classified as passive, meaning that the tags draw power from a reader emitting RF (Radio Frequency); and some of which are active, meaning that tags are independently powered and the “readers” are actually receivers or transceivers (please see the side bar for a brief primer on these frequencies). Choosing the correct frequency and deciding whether to utilize active or passive tags has long been one of the most difficult parts of RFID implementation, right up there with meeting customer expectations. Varying frequencies perform differently depending on a multitude of considerations, some of which include: physical environment/layout, type of objects to be tagged/tracked/monitored; presence of potential interference from other RF transmitters and/or harmonics from power sources and presence of metallic or liquid substances, just to mention a few! Another critical factor in choosing the correct RFID solution is the customers budget and investment threshold, I have often seen a customer demanding the performance of an active tag RFID solution while only being willing to spend the money on a less expensive passive tag solution, a guaranteed recipe for failure and dissatisfied customers.

I am not going to insult your intelligence by telling you that I have found the “perfect solution” for any application, but for the applications specifically referred to in this article; Vehicle ID, Gated Entry, Asset and Personnel Tracking Applications; I am convinced that the little known and underutilized 433 MHz frequency holds the key to increased levels of security, customer satisfaction, return on investment and profitability. Now, in the interest of fairness and full disclosure, you should know that my company is a collaborative partner with a manufacturer of 433 MHz RFID products and I do aggressively market a 433 MHz product called “tres by RFID, Inc.”

Market Penetration: Many other frequencies are much better known to end users and integrators alike, due in no small part to their penetration of the public thoroughfares and marketplaces. Most everyone has, at one time or another, used a 125 kHz Prox or 13.56 MHz Smart Card to gain access to their office building, health club or other public facility or place of employment. On a daily basis, many of us speed through the automated toll lanes using 902-928 MHz tags and readers for toll collection or gain access to our gated communities using a similar product. And most everyone not hiding under a rock has heard some level of buzz about the “Wal-Mart initiative” involving the tagging of goods at the pallet level for supply chain monitoring. But just outside of the mainstream public view, our own Department of Defense (DOD) has settled on the use of 433 MHz for the tracking of assets and management of their incredibly huge supply chain. There are also hundreds, maybe even thousands of gated, perimeter security applications currently taking advantage of the unique characteristics of this frequency.

433 MHz Characteristics: Too often, people focus on the RFID solution that provides them with the longest possible read range, without adequate consideration as to whether or not they really need that robust of a read range. The desire for these long/robust read ranges, combined with poor training and/or installation practices, can be traced to many of the problems that have given 433 MHz an erroneously
bad reputation over the years. It is important to understand that 433 MHz is a reflective frequency, meaning that it will reflect off metal surfaces and can often result in “renegade reading” of tags that are not in the desired read zone (as opposed to 915 MHz whose field will collapse unto itself when it encounters metal). A real world example of this “renegade reading” would be tags in a metal structure (i.e. a warehouse) reading beyond their desired limits because the RF is constantly reflecting off the metal surfaces. Another characteristic of 433 MHz that can be self defeating is its’ ability to transmit through walls, floors and ceilings. This characteristic can be of great advantage if properly controlled, and an absolute menace if not. A good example of a menace would be a parking garage and a 433 MHz receiver (reader) on level three reading the tags of vehicles on level two, causing phantom gate openings. These characteristics can be controlled through two common methodologies, the first being proper antenna use and the second being determination and discrimination of signal strength characteristics. A circular polarized antenna (see picture 1) will provide a directional reading pattern, useful in a vehicular entry situation where you need to define specific lanes. An omni directional antenna (see picture 2) would provide a wide area of coverage, not unlike a large globe surrounding the antenna, depending how the antenna was oriented to the ground plane. This would be desirable when monitoring assets in a specific zone (i.e. a room or section of a parking lot), or perhaps creating an alarm zone at a door. Signal strength determination involves calibrating your receiver to only recognize tags that are reading at a specific strength which translates to controlling the distance from which tags are read. This signal strength discrimination, in combination with proper antenna selection, can, and usually does, make the difference between the success and failure of an installation.

**FCC Certification:** It is critical to understand that any device transmitting radio frequency sold in the United States is subject to regulation by the FCC (Federal Communications Commission). FCC Part 15 certification, among other things, certifies that a signaling device does not cause interference with other RF devices. In the case of 433 MHz products, the FCC also limits the amount of data that can be transmitted at this frequency in a given period of time. It is essential that prior to investing in any RF transmitting device, you first verify that the device has a FCC certification number. In the case of active tag technologies, this certification would be assigned to the individual tags. In the case of passive tag technologies, the certification would be assigned to the reader.

**Return on Investment (ROI) Breakthrough:** There is an inverse relationship in the cost comparison of active vs. passive RFID products. In the case of passive tag products, the readers are relatively expensive and the tags are inexpensive. In the case of active tag technology, the readers (receivers actually) are relatively inexpensive and the tags are more expensive. There is a “crossover point” where one technology becomes more expensive than the other depending on the number of readers/receivers and the number of tags involved. Up until now, the active tag has been at an “ROI disadvantage” due to its’ significantly higher cost; after all, it is a battery powered transceiver. It has always been commonplace to do your ROI calculations based on the “per year” cost of a tag – for example: a passive tag that costs the end user $ 12.00 and will last six years has a per year cost of $ 2.00. An active tag that costs the end user $ 25.00 and has a five year battery life has a per year cost of $ 5.00. It has often been a difficult choice to compare these costs and decide if the inherent advantages of active tag technology (increased read ranges and tracking abilities) are worth the increased costs involved, especially when the application involves a large number of tags. Difficult until now that is – the new generation of 433 MHz tags have replaceable batteries! This means that you can drive your per year tag cost down significantly by replacing batteries in the active tags, therefore enjoying the distinct advantages of active technology while making your ROI decision much easier!
Disclaimer: I can’t stress enough the importance of having an experienced, trained RFID technician with knowledge of multiple frequencies involved in any decision regarding the use of RFID technologies, whether active or passive. In all my RFID industry experience, I can honestly say that the over 99% of failed installations have been due to improper training, poor installation practices, unrealistic customer expectations or an overzealous salesperson trying to “shoehorn” the wrong product into an application. Do your homework, look at the true costs involved, and don’t forget the underappreciated and, until now, unheralded 433 MHz products.

A Brief Frequency Primer

125 kHz – Low Frequency
Almost always passive - Proximity Readers
Read only – Read Ranges 1 to 24 inches

13.56 MHz – High Frequency
Always passive – Smart Card/Tag Readers
Read/Write – Read Ranges 1 to 15 inches

433.92 MHz – Ultra High Frequency
Always Active – AVI/Asset Tracking Readers
Mostly Read Only – Read Ranges 6 to 1,000+ feet

902-928 MHz – Ultra High Frequency
Mostly Passive, Some Active – AVI/Supply Chain Readers
Read/Write – Read Ranges 3 to 20 feet (passive)

2.45 GHz – Ultra High Frequency
Always Active – AVI Readers
Read Only – Read Ranges 6 to 30 feet

AVI = Automated Vehicle Identification

About the author: Douglas Cram has been in the Security industry for over twenty years, with the most recent fifteen of those years focused in the RFID industry. He is best known as one of the founders of Applied Wireless Identifications Group and has worked in a hands-on capacity with hundreds of gated entry, perimeter security and asset monitoring/tracking applications. His current company, cramZ marketing services, is involved with development of 433 MHz active tag product in collaboration with RFID, Inc. He can be reached via email at doug@cramzmarketing.com or via phone at (770) 529-1040.