“EXELIXI’S” – TIRIS Fuel Controller System
A RFID Technology Application

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Abstract

RFID technology was first used in World War II for identification, friend or foe (IFF) systems, and has been available in one form or another since the 1970’s. This paper will provide an overview of this technology and its applications, like the “EXELIXI’S” – Tiris Fuel Control System

A. RFID Technology Overview

RFID technology was first used in World War II for identification, friend or foe (IFF) systems, and has been available in one form or another since the 1970’s. There is no one definitive “RFID technology”; there is a wide range of technical solutions ranging from simple, inexpensive, and common to those with more functionality, performance and cost. RFID is part of our daily lives – in car keys, toll tags, access cards … This section will provide an overview of this technology and its applications.

A.1. RFID Tag Technology Description

In its simplest form in common use today, an RFID system consists of four elements, as shown in *Figure D-1*. The RFID tag element consists of an antenna integrated with a microchip. The RFID reader and antenna transmit an electromagnetic RF signal. This signal is received by the RFID tag via the tag’s antenna. The energy in the received signal provides the power to the tag that allows the microchip to operate. This is referred to as a “passive” tag.

This data from the microchip is then added to an RF signal that is “reflected” by the tag back to the reader through the reader antenna. This process is referred to as passive backscatter. The reader contains the electronics to receive this signal from the tag, extract the RFID tag’s code from the signal, and return it to its digital form, and provide that returned code to a host computer.

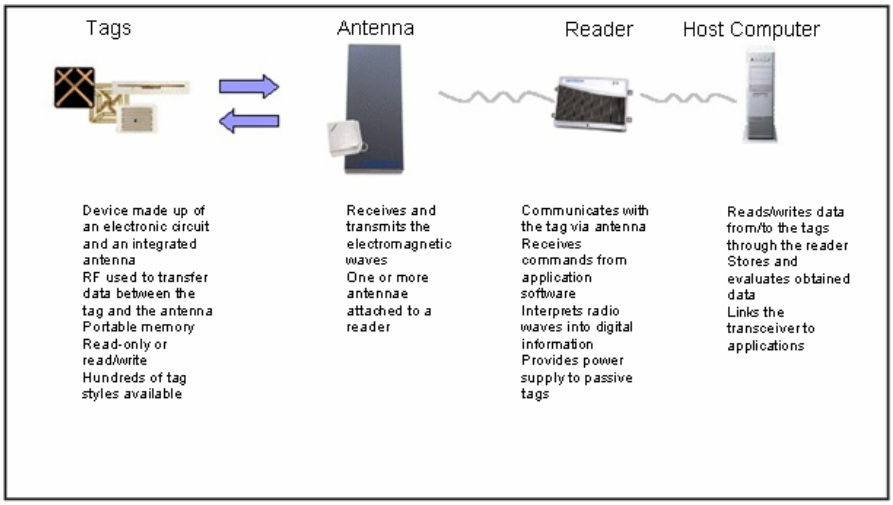

Figure D-1 Components of a Passive RFID System

A.1.1. Passive RFID System contains

- ***Tags***

Device made up of an electronic circuit and an integrated antenna RF used to transfer data between the tag and the antenna Portable memory Read-only or read/write Hundreds of tag styles available

- ***Antenna***

Receives and transmits the electromagnetic waves. One or more antennas attached to a reader

- ***Reader***

Communicates with the tag via antenna Receives commands from application software. Interprets radio waves into digital information. Provides power supply to passive tags

- ***Host Computer***

Reads/writes data from/to the tags through the reader. Stores and evaluates obtained data. Links the transceiver to applications

A.2. Passive RFID systems description

Passive tags systems are reader talk first. The tags are mute until a signal is received from a reader. Also, only one reader at a time can energize a passive tag; if more than one reader tries to "light up" a passive tag a condition known as "reader collision" occurs.

Passive RFID systems can read multiple tags at once. In a process called "singulation," the reader will rapidly cycle through tags and determine which ones are present. There are many methods of singulation, but the principle of identifying a

single tag is the same. This is very important when trying to quickly identify all tags in the reader's field, and is also important when trying to speak to specific tags.
The simplest passive RFID tags have microchips that contain a single bit. These tags are referred throughout the world as electronic article surveillance (EAS) tags and are used to prevent shoplifting. Other tags contain a simple read-only numeric code or serial number. The code, which is stored in memory on the microchip, can be written to the tag at the time of first use or applied at the time the RFID tag is manufactured. The code is used to reference information stored elsewhere, such as in a database.
Generally speaking, the more functionality embedded on a tag, the slower it is, the shorter the range and the higher the price. There are RFID tags that have greater amounts of memory, storage and functionality. For instance, some tags have separate areas for different users to access. Other tags have encryption and security features. Still other tags include microchips whose serial number is written to the chip by the user rather than at the point of RFID tag fabrication. This permits greater flexibility in the information that is written to the tag and when it is written. There are tags for almost every application – indeed, there are several thousand tag types in existence at this time. However, it is not possible today to get low cost, long range, high speed passive RFID tags with encryption and high security.
In terms of cost, passive RFID tags range from $0.25 up to $10.00, depending on functionality, packaging, and application. Serial number, read-only tags tend to be the least expensive. The prices of passive RFID tags are highly dependent on the volume of tags ordered – the prices mentioned here are for large orders (in the tens of millions). Lower volumes will generally lead to much higher per tag prices. There is potential for even lower prices for simple tags as standards solidify and as larger numbers of tags are used in the industry. Some preliminary research from sources such as Advanced Marketing Resources, Gartner and RFID Journal indicate that a passive tag with read only serial number will approach $0.05 by 2008.
In a common application of RFID technology today, RFID tags are combined into an adhesive label that can be applied to packaging for products in the consumer packaged goods supply chain. As the products are moved from manufacturer to warehouse to retailer, the products can be tracked to aid in supply chain management and inventory control. Rapid uptake of RFID in the retail supply chain is driving standards across all industries and is also pushing the cost of RFID down.

A.3. Active RFID Techology Description

Active tags may include small batteries. These "active" tags, as depicted in *Figure D-2*, allow them to broadcast a stronger signal that can be received at greater distances than the "passive tags" powered only by the signal received from the reader/antenna system. A key differentiator between active and passive tags is the style of communications. An active tag talks first – that is, it beacons.
Since the tag is not depending on a reader to be energized, and because signal processing technology is so powerful, active tags can be read at much greater ranges

than passive tags. Active tags can also be used for positioning – determining the XYZ location of the tag – through a process of triangulation.

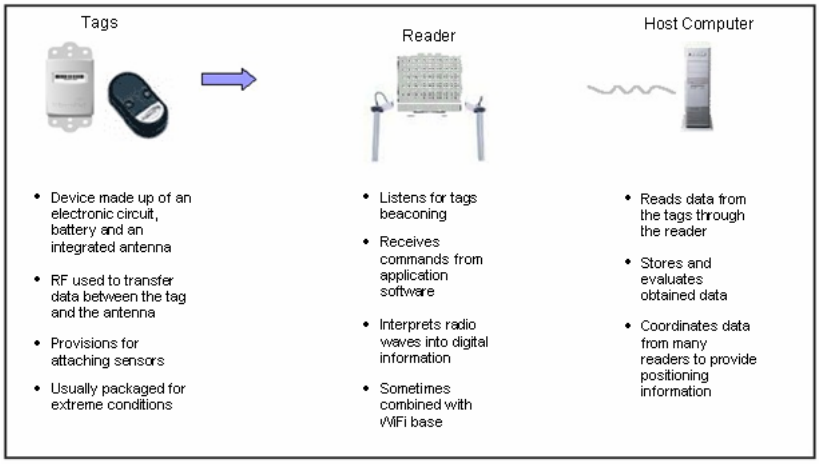

Figure D-2 Components of an Active RFID System

Since there is a communications channel involved, active tags can be integrated with sensor devices, such as temperature, location or motion sensors. These devices can take samples from the sensors, store them, and send them back to the reader along with the standard beacon signal.

A third class of tags exists, alternately referred to as semi-active, semi-passive, or battery assist tags. These tags are akin to passive tags in that they are reader talk first. A battery is present though for one of two reasons. Either it is providing a "boost" for the tag, allowing it to be read and respond in difficult RF environments, or it is used to power a sensor. Such sensors can collect data even when the tag is not powered. This data is then transmitted back to the reader when the tag is read. This is a much slower read process than standard tag reading. The battery and sensor portions of semi-passive tags can drive costs into the $5.00-10.00 range.

A.3.1. An Active RFID System contains

- ***Tags***

Device made up of an electronic circuit, battery and an integrated antenna RF used to transfer data between the tag and the antenna. Provisions for attaching sensors. Usually packaged for extreme conditions.

- ***Reader***

Listens for tags beaconing. Receives commands from application software Interprets radio waves into digital information. Sometimes combined with WiFi base

- ***Host Computer***

Reads data from the tags through the reader. Stores and evaluates obtained data. Coordinates data from many readers to provide positioning information

A.3.2. RFID Reader Technology Description

The second major component of RFID systems is the reader. For passive tags, readers energize the tags with energy, receive the results and frequently handle the low-level anti-collision algorithms that allow readers to read more than one tag at a time. For active tags, readers are responsible for listening for the tags' beaconing, and for communicating with other readers to determine positioning.

Readers are generally controlled via a software application programming interface (API) that is provided by the reader manufacturer. Generally, the API also allows for configuring the reader's read cycle, power or other settings. The API software libraries for a given reader may be priced separately for the reader, although many providers bundle the software.

A.3.3. RFID Antennas Technology Description

Antennas are the third major component of and RFID system. These can range greatly in cost, depending on functionality, application and base operating frequency. Whether it is a shelf, mat, portal, wand or directional antenna, different antennae are required for different applications.

Depending on how many antennas are required, one or many multiplexers may be necessary. A multiplexer allows many antennae to be physically connected to a reader. A configuration using multiplexers may also require an additional communications card such as an RS-485. Many readers contain built in multiplexers, and external varieties are also available.

Cabling for the systems is an important aspect of performance. Although there are generally fewer limits on the distance between reader and host computer, there are signal degradation effects in the cables connecting readers and antennae. High-grade RF cables for this purpose can be expensive, and can have distance limitations.

The combination of the reader, antennas, and multiplexer setup is sometimes referred to as a "read point."

A.3.4. Host Controller

The host controller is generally a desktop or laptop computer, positioned close to the readers. This controller serves two main functions. First, it is receiving data from the readers and performing data processing such as filtering and collation. Secondly, it serves as a device monitor, making sure the reader is functioning properly, securely and with up to date instructions. Host controllers are connected to readers through networking technologies such as Transmission Control Protocol/Internet Protocol (TCP/IP) or sometimes through serial connectivity. Generally speaking, one

controller can manage several readers, with the ratio being dependent on the data volume from those readers.

A.3.5. RFID Middleware

RFID middleware is software that facilitates communication between RFID readers and enterprise systems. It collects, filters, aggregates and applies business rules on data received from readers. Middleware is also responsible for providing management and monitoring functionality, ensuring that the readers are connected, functioning properly, and are configured the correct way. Middleware may also contain a localized data store for archival of read events.

A.4. Current RFID Applications

There are several areas in which RFID technology is being applied today. These are summarized in the following sections.

A.4.1. E-Passport

The U.S. Government Printing Office (GPO) is testing electronic passports (e-passports) embedded with RFID chips that the agency hopes to make standard within the next year.

A.4.2. Toll Collection

Toll collection for vehicles travelling at or near highway speeds is accomplished through the use of active RFID tags. There are many systems available today: EZPass, I-PASS, SunPass and FasTrak.

These systems may run at any number of frequencies, but 915 MHz and 5.8 GHz are frequently used. These systems are often linked to a credit card, allowing for stored values to be replenished without need for manually handling the tags. Some card types store value as well.

A.4.3. Payment Systems

An emerging application of this technology is to use a mobile phone enabled with an RFID chip for payments. Still other payment systems use a small key fob (e.g., SpeedPass) linked to a credit card account for payment. This style of RFID application tends to involve heavily encrypted tags with more functionality and memory and generally use the HF band with greatly reduced ranges.

A.4.4. Supply Chain

A popular, emerging application of RFID is in the area of supply chain visibility. The trend is to attach an RFID tag containing a unique identifier to an object at its point of manufacture. This tag would then be read at various intervals up to its point of sale.

Manufacturers, retailers and third party logistics providers are in differing states of pilots on products, with the major target benefits being reduction in inventory, a decrease in material handling time, safer and more secure supply chains, and potential post sale applications.

A.4.5. Access Control

A very common application for RFID is access control. Contactless badges are in use in almost every office and facility. This style of RFID badge tends to work in the LF or HF band, and generally have very low read ranges. These systems tend to utilize very proprietary formats, networks and protocols. The tags are generally packaged in a sealed ID card format. Some ID tags have thin film batteries as well for encryption and information storage.

A.4.6. Animal Tracking

RFID has a long history of being used for animal tracking. From livestock management (for animal movement, feeding, health, and market visibility) to pet tracking, RFID is relatively mature in this field. Animal tracking can be considered one of the largest implementations of asset management using RFID. Generally speaking, low frequency tags are used for animal tracking.

A.4.7. Security Applications

The RFID back-end tag database and the associated network can and certainly will use existing security mechanisms. Depending on the design of the readers and tags, these devices can leverage the security mechanisms already in place in the network and database. A number of RFID security models have been postulated. For example, Security, Inc. has developed a set of RFID Security and Privacy - Attributes - that include tag privacy, tag authenticity, reader security, and tag database security. Authorization and authentication can be supported with certain types of RFID tags but there are cost/benefit tradeoffs.

It is possible that the nature of the interconnection or the interaction between the RFID reader and the existing infrastructure could introduce an exploitable vulnerability, but if security best practices and requirements are observed in integrating the product with the network, this can be minimized.

A.4.8. Privacy applications

The amount of information gathered about individuals is growing through the proliferation of surveillance cameras and sensors; microchips and RFID tags embedded in devices and products; wireless devices that provide location data; and smart cards and interactive TV that can track viewing and buying preferences. Advances in electronic technologies allow companies and government agencies to store and process large amounts of information about individuals. The Internet provides the ultimate copier device, making this information easily available to

millions. Due to the commercial value of personal data, governments and companies have considerable financial incentives to take the time to gather information and to use machine-learning technologies and data-mining techniques to infer customer preferences based on this information.

B. RFID Summary

The following table summarizes key RFID frequencies, standards, applications and decision criteria:

Frequency Bands	Data & Speed	Read Range	Typical Usages	Strengths/Challenges	Applicable Standards
Low Frequency (LF): 125 – 134 KHz	Low read speed Small amounts of data	Very Short: inches	Access Control Animal Tagging Inventory Control Car immobilizer	low tag costs small read range small data amounts low data transfer speed No singulation	ISO 11784/11785 ISO 18000/2
High Frequency (HF): 13.553 – 13.567 MHz	Medium read speed Small to Med amounts of data	Short to Med: 1 to 3 Feet	Smart Cards Item or case level tagging	sufficient data amounts most standards in place less suseptible to interferance	ISO 15963 ISO 14443A ISO 14443B ISO 18000/3 EPC Class 0/1
Ultra High Frequency (UHF): 433 MHz	Good data speed Medium to large amounts of data	Long range 50 -300 Feet	Active tags Container seals Container tracking for DLA	read speed and range costs potential interference with certain devices	INCITS 371 .2 ISO 18000/7
Ultra High Frequency (UHF): 900-950 MHz	High read speed Small to Med amounts of data	Medium: 2 to 10 Feet	Pallet or case level tagging SENTRI/NEXUS	better vicinity read range more suseptible to interferance high data tranfer speed high tag costs	EPC Class 0/1 EPG UHF Gen 2 ISO 18000/6
Microwave Frequency: 2.45 GHz	High read speed Med amounts of data	Med to Long: 3 to 20 Feet	Container or rail car Toll collection Pallet level tagging	long read range high data tranfer speed high tag costs	ISO 18000/4 INCITS 371 .1
Microwave Frequency: 5.8 GHz	Very high read speed High data rates	Long range 50 -300 Feet	Toll tags	long read range high data tranfer speed high tag costs battery replacement	ISO 18000/5 (rejected)

Figure D-3 RFID System Characteristics

C. "Exelixi's" Tiris Fuel Control System – A RFID Technology Application

Exelixi is the Greek Pionner company in Fueling Solutions since 1995 for commercial and retail fueling operations. Design and produce expert fuel management solutions for companies with a fleet of vehicles. The company markets its products through two primary business units: Fuel Management Systems and Control Fueling Products.

Exelixi is focused on providing automated fuel control systems are designed to help companies with a fleet of vehicles to manage effectively one of their biggest assets – their fuel. Accurate and reliable fuel control systems enable operators to eliminate manual recording practices and errors, significantly improve fuel tracking for many purposes, allocate fuel consumption, eliminate fuel theft, improve driver accountability and regain control of their valuable fuel assets. High quality, low cost pump fueling systems help operators centralize and improve the accuracy of the company fuel inventory management through automated collection, storage and real-time reporting.

C.1. Exelixi's Fuel Control System will let any company:

- Accurately track every drop of fuel for job-cost allocation and tax purposes
- Eliminate manual record-keeping (removing this task from the driver has as result to improve accuracy and accountability)
- Monitoring fuel consumption by the job. Eliminate fuel theft. Gain total control and access-authorization over unattended fuel islands
- Access your fuel site data 24/7 from anywhere, via remote with/or without wireless connection

D. The Fuel Site Controller description

The heart of every ***Exelixi's Tiris Fuel System*** is the ***Fuel Site Controller***. It is located next to (or over) the pumps and stores transaction data and driver and vehicle records, including fueling restriction data critical to proper fleet management. It can store thousands of proprietary tags and transactions, so even the largest operations have room to expand. Programming is done right from the 16 keys keypad and the 2 lines backlit display. Simple menu choices guide the site manager through set-up and daily operations. It includes a *Texas Instruments* reader for proximity tags and a durable alloy keypad and a backlit LCD for visibility in bright sunlight or at night. High-impact metal case maintains its operation for years to come. The metal case follows the IP65 specifications, so as to protect the system against dust, rain, sun light and extreme field temperatures. Finally, the drivers' training about how to use the ***Exelixi's Tiris Fuel Site Controller*** is extremely simple, no more 20 minutes training needed.

E. Fuel Sites Communication / Reporter software

The Tiris Fuel software is a powerful data management and communications software package that gives a total centralized control over fueling operations. It can offers hundred of reports and statistics, by driver, vehicle or account (a combination of both) and so on. Most data can be exported to third-party database, spreadsheet and fleet maintenance or SAP programs for further processing.

F. How the Fuel System Works

- Next to tank's nozzle is placed a RFID tag which is protected within a plastic case.
- A Transceiver Loop Antenna mounts around the fuel pump's pistol, adaptable to most pistol styles or types.
- The system uses radio-wave technology to receive automatically vehicle I.D. and other important information right at the vehicle's fuel fill tube.
- Just the driver pull off the pistol from the fuel pump the controller wakes up and by using the ring antenna of the pistol, it starts to detect for proximity vehicle tags.
- In case the ring of the antenna became parallel with the nozzle of the vehicle tank, the proximity distance is regulated on 12 cm maximum. So, in practice if only the pistol has entered into car tank the fueling access is either granted or denied.
- When the system authenticates the ID of the vehicle, the pump is activated and the vehicle can be fueled. Authorization is automatic, so there's no need for the drivers to do nothing. Optionally, the driver can enter manually kilometers counter to help the company to have got better fleet maintenance scheduling and vehicle accountability. It's easy to use and the non-intervention technology ensures vehicle data accuracy.
- Driver, vehicle and transaction data are stored in the system flash memory. Over 32.000 transactions can be stored.
- The system via a RS485 wire or a Wi-Fi wireless interface transfers the stored data to the indoors PC.
- Up to 32 Fuel systems can be communicated with the PC collector / reporter program simultaneously.

G. Technologies and innovations which make the difference between other competitors Fuel Systems

- RFID proximity technology (instead of card readers)
- Transceiver Loop Antenna mounts around the fuel pumps' pistol
- RFID tags are placed next to tanks' nozzle
- Antenna's and RFID tag's topology make sure of pump activation only if the pump pistol has been put into the vehicle's tank (eliminate fuel theft)
- RFID passive tags which are used, are extremely cheaper than the active ones; and don't need any supply

H. Conclusion

During the last ten years of application RFID Technology, some *Resistances* have appeared from privacy groups to tagging technologies at the consumer level. As a result of consumer resistance, several retailers have decided to forego the use of RFID tags at the retail level at this time.

In April 2003, clothing retailer Benetton Group announced that it was postponing plans to embed RFID tags in one of its clothing lines.

In March 2004, METRO AG, the fifth largest retailer in the world, decided to abandon the use of RFID chips in its loyalty cards after protests from privacy groups. METRO continues to use RFID tags in supply management applications. These decisions signalled to many companies that they needed to do more about privacy than just understand relevant legislation. They need consumers to trust them to protect their personal information.

On November 20, 2003, a group of 45 consumer privacy and civil rights organizations from around the world issued a position statement on RFID1. These groups identified privacy and civil liberties threats posed by RFID tags, and called for the application of Fair Information Principles, such as those codified in the Privacy Guidelines of the Organization for Economic Co-operation and Development (OECD). The groups also called for a flat prohibition on human tracking or on the use of RFID tags in any way that would reduce anonymity.

In spite of the previous bad news for RFID Technology in human identification fields, the number of organizations using RFID is increasing; *especially in application fields like the "Exelixi's" Tiris Fuel Control System indicates the way.*

H. Resources

RFID is a hot technology topic, and there is tremendous hype, disinformation, and general noise on the web. Below are several websites with good information for reference.

http://www.incits.org
http://www.iso.org
http://www.epcglobalinc.org/index.html
http://www.aimglobal.org/
http://www.rfidjournal.com
http://www.rfid-handbook.de
http://www.epcglobalinc.org/public_policy/public_policy_guidelines.htm