DOI 10.5162/IMCS2012/P4.2

Variety of RFID sensor transponders & communication ways

Constanze Eberhardt[1], Sylvo Jaeger[2], Victor Garcia[3]
microsensys GmbH, In der Hochstedter Ecke 2, 99098 Erfurt, Germany
ceberhardt@microsensys.de[1]
sjaeger@microsensys.de[2]
vgarcia@microsensys.de[3]

Abstract:
Radio frequency identification kept entering a lot of applications during the last years. The range of RFID based auto-ID projects extends from scan only over applications using the transponder's internal read/write-memory up to combination with RFID-Based sensor transponders and data loggers. Mutuality between those Data created by all these applications now has to be collected and forwarded by mobile devices as well as stationary systems. Many different possibilities from the technological side as well as a huge amount of platforms and environments provide a big variety of accumulated data structures. Compatible system solutions combining data provided within those various environments are hard to define, because opportunities and platforms (especially in the mobile market) are changing very fast. So this article should give an overview of the technological aspects beginning at the RFID frontend ending on resulting data.

Key words: RFID, logger, sensor, transponder, network

Smart objects and communication

The main goal is to introduce the idea of RFID technology and how this technology provides the opportunity to create a "smart object" - a transponder with an integrated sensor and/or logging functionality. These sensor transponders are indeed very smart objects, which allow identification plus measurement of specific physical characteristics (temperature, pressure, humidity or shock) and retrieve the samples with relatively low power consumption to a more human readable way. With these RFID powered sensors and all corresponding RFID components a complete sensor network could be built and implemented.

Sensor networks

Within today's literature there are described "sensor networks", which mainly involve active sensors. This means using a transmitter to send the data obtained by the sensor. The data transmission is performed using technologies like WiFi, Bluetooth™ or ZigBee™. The data transport in these "sensor networks" is different from what we understand as "RFID sensor network" or "RFID network" in general and in this type of data transmission (involving RFID) there are many different kinds: one way identification, decentralized data storage (one or more RFID sensor combined in a passive device powered by a RFID reader) or at last small RFID data loggers, which are devices that combine sensors (driven by microprocessors for measuring), identification and decentralized data storage - all in one. We want to explain these different device types as well as to give a description of the way to handle and transfer data and information provided in an all-embracing way.

RFID technology

Basic system components

Radio Frequency Identification (RFID) is a very smart wireless Auto-Identification-Technology. This technology consists of three special components: an RFID transponder (TAG), an RFID read/write unit (a reader, which includes an antenna for wireless communication with the TAG) and a package of customized software. See figure [1]

Fig. 1: basic RFID system components

As advanced before, the communication between TAG and reader is made wirelessly and because of that, both of these elements must have an antenna. The communication between reader and host computer (with the needed help of a driver and/or customized software) can be done in a lot of different ways, wireless or not, between which the most common in the present times are USB or Bluetooth™. The data management should take care of these different ways – stationary antennas collecting data of moving objects, RFID reader are connected to handheld devices, which collect and transmit identification/sensor data of stationary or moving objects.

Types of RFID systems

There are two main aspects from the way the communication between TAG and reader is made that helps to divide the systems in different types: the frequency and the way the communication is build and if the TAG generates electromagnetic field or not. Talking of the frequency, there are currently three main types of RFID systems. In the next sections there will be further details.

Frequency

Between the different device types in the market, there are a variety of RFID technologies depending on the frequency of the waves that enable the communication between TAG and reader. This includes: LF (low frequency, for example 125 kHz), HF (high frequency, for example 13,56 MHz), UHF (ultrahigh frequency, for example 868 MHz), or µ waves (micro waves, for example 2,45 GHz).

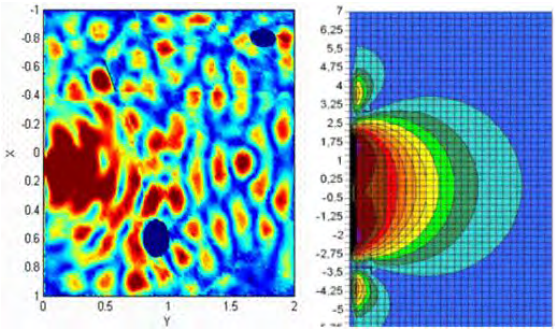

Fig. 2: streamlines of the UHF (left) and HF (right) field

Because of this differentiation of frequencies each technology differs in operation mode, reading distance, data communication rate, antenna design, functionality depending on the surroundings (water, metal…), security features or anti-collision functionality.

Electromagnetic field gene-ration

This is a very important feature to the topic of this document: sensor transponders. There are two types of sensor transponders: passive and semi-active. When speaking about RFID this normally mean passive devices, which do not generate electromagnetic fields. In the range of sensor transponders we observe a mix between passive and semi-active devices, which work as data loggers.
The former passive sensor transponders use the electromagnetic field generated only by the reader to power its communication and sensor circuitry, measure the physical values, and send back the answer modulating the field.

Fig. 3: Casio IT-800 with RFID-Module and passive TELID®412 UHF temperature transponder (Picture: CASIO Europe, Norderstedt)

Semi-active sensor transponders, also called data loggers, work in a little bit different way. Both device types behave in the same way when the communication with the reader is done. The difference between them is, that the

internal circuitry that provides functionality is powered by a power supply (battery, rechargeable) in the second of them, but on the contrary, it is not so at first. The communication is made just using the electromagnetic field of the reader, but other functionality can be made with help of the power supply, like e.g. sensor measurements.

Fig. 4: RFID temperature sensor data logger e.g. for the transport of pharmaceuticals

Beneath passive and semi-active transponders we want to have a look at the category of active devices. Active sensors generate an electromagnetic field and modulate it to send data to the reader antenna, which is not to be described as RFID. So there has to be a power supply that provides the needed energy to the components and the antenna to provide full functionality. This section collects sensor networks like WiFi, Bluetooth™ or ZigBee™. Although the way of communication differs from "real RFID", the data collection is quite equal. The way of communication is in most cases bi-directional.

Best type RFID system

There is no best type, each type has its own characteristics and features. The main goal in the decision between them is to find the RFID system that fits best into the planned application and required features. Some of the features work with an UHF or HF frequency. This all have an influence on the antenna design and consequently in the final mechanical design of the device. Usually, a HF antenna is a coil and an UHF antenna for long distance communication is a dipole. And of course, there are differences in the reading distance and data communication rate.

So the market requirement brings a variety of different devices with itself. The logistic market in most cases requires long reading range, automatic and fast bulk data capture, which result in most cases in UHF solutions. In the maintenance and facility management sector as well as for probe management we speak about single scans to identify and measure exactly one object without collisions, which makes a HF solution more suitable.
If you need an active or passive transponder depends on the application. For the majority of the applications a passive transponder would suit perfectly, but there may be specific applications where an active transponder may be needed, for example to improve the communication range or to power very complex or power consuming circuitry.

Applications

The most extended use of RFID technology is for purposes of contactless identification and individual data storage in several applications. In addition to these highly extended applications, microsensys GmbH combines RFID transponders to offer ID and read/write memory with sensors. Some example of application can be: the logistic industry, in which the transport control is one of the applications that better fits for an RFID system; the production industry, where the process can be monitored, prototyping or quality management measurement. In each of these applications, being able of logging physical values like temperature, pressure, humidity or shock, it is quite important to monitor the physical characteristics in the transport, production or quality control.
In this process flow a lot of different data structures are generated, which are also collected in different ways. The two main options are: stationary readers moving the TAG to/through them or mobile devices, which enable to collect the data where the TAG is.
Overall the data consists of many different components such as location data and time stamps collected at scanning time, data provided by RFID memory (identification, data memory) and at last sensor data, which can be one or more sensor values or a collection of data in case of data loggers. See figure [3] and [4]

iID® network

The mix of all these data components, provided in totally different ways, should now be transferred and evaluated by backend systems. Therefore microsensys created a system solution called iID® network, combining readers of different RFID technologies within a network system. This network system consists in several types of components: transponders, readers, communication bus and host controller. This can be seen in figure [5].

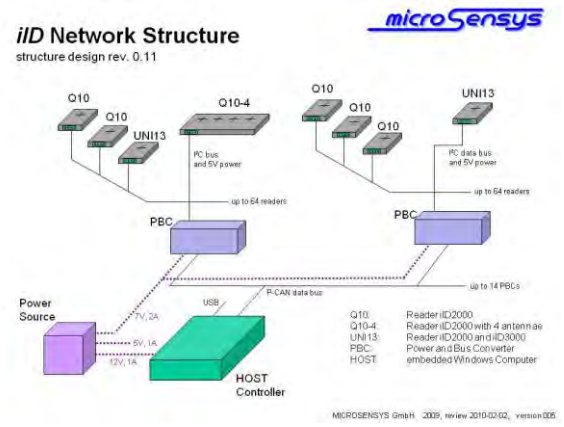

Fig. 5: iID® network structure

The TAGs can be sensor TAGs (transponders with an integrated sensor) or data loggers (transponders with integrated sensor and memory, where the samples can be saved). The first type normally are passive transponders that use the reader power not only to return the identification number of the transponder or the data stored in its memory, but to get the value from an attached sensor and transmit it to the reader. The second type needs, in order to save the sensor samples and have a log of the evolution of these sensor values, a microcontroller powered by a power supply. This microcontroller can be programmed to get the sensor value and store it in memory after a specified amount of time. microsensys implements these data loggers as semi-active transponders, that means passive transponders with a battery that powers only the sample acquisition circuitry, leaving the communication be handled by the reader.

The next main components in the network are the readers. Readers will be responsible for collecting the data from the TAGs in a wireless way. This can be made in LF, HF, or UHF as described in previous sections, each of them with its specific features. These readers should be connected to build the network. They can be connected in different ways, using well established bus interfaces like CAN, RS485 or I²C bus. All the data collected in this part of the network, could be forwarded based on UDP protocols to a HOST controller, using LAN or WLAN components.

At last, on the other end of the network should be a terminal that collects all the data and processes it in any way the user / client wishes. The future goal is to extend data provided from these networks by data provided from mobile devices like PDA's or cell phones, creating a highly integrated and flexible sensor network.