Bioett

RF-TAG DETECTOR

ABOUT BIOETT

Bioett's business idea is to monitor the temperature for refrigerated goods like food and medicine during transport, in order to ensure that quality products are delivered. The monitoring system is using a unique technology that combines biochemistry and electronics.

THE BIOETT SYSTEM IN BRIEF

The control system from Bioett is developed for monitoring the temperature of goods during refrigerated transport. The system consists of a biosensor that is attached to the goods, a detector reading the data from the biosensor and a database for storage of information about the goods.

Olle Hydbom working with the detector

The biosensor is registering the accumulated temperature affecting the goods. The information can be used to ensure that the transport is carried out accurately, as well as provide verification of transportation quality at delivery. The data can for example be used for analysis of the distribution chain and hence facilitate optimization of the same, and thereby save money without jeopardizing quality.

Downloading of biosensor-data is performed with a detector using radio frequency for reading data from the biosensor and at the same time reading the bar code data which contains information about the specific goods. Information about the treatment of the goods during transport is then sent from the detector to the database where the information is stored for further analysis.

BIOETT & ADITUS SCIENCE

Bioett has for some time worked with a prototype detector that is sensitive for both measurement distance and the angle between detector and biosensor. During field-tests, Bioett realized that it is very difficult for the user to keep both exact measurement distance and angle. Therefore Bioett decided to evaluate a new measurement principle for minimizing reading-errors caused by reading distance and angle. To enable this Bioett needed a partner with expert knowledge in the development of electronics and software to design a measurement system evaluation platform that later should be implemented in the final detector. After evaluating several possible collaborators, Bioett chose Aditus Science for their extensive and long experience in using modern computer simulation methods and designing top-of-the-line quality products for particularly difficult measurement situations.

THE CHALLENGE

The detector reading the temperature-sensitive tags is using so called RFID technology. The new principle consists of a radio signal of certain frequency that is emitted to activate the biosensor. This signal is then

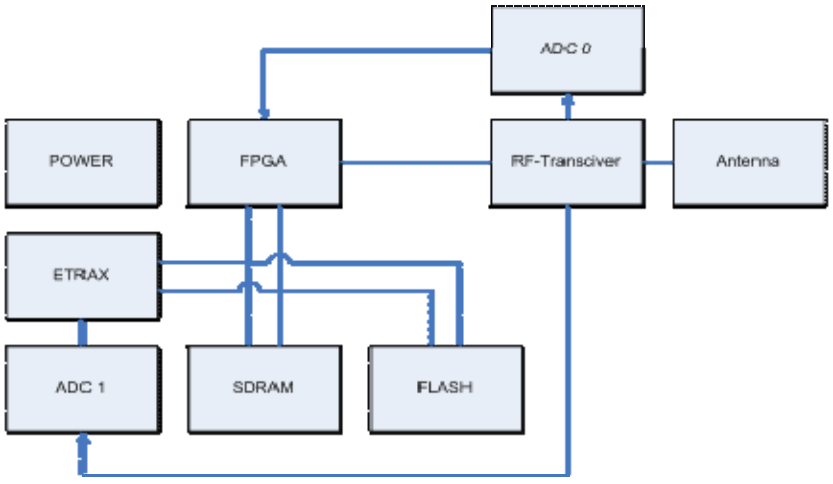
turned off and the biosensor itself generates a signal which is measured. After advanced mathematical DSP calculations the temperature effect on the goods is presented by the detector. When the final hand-held detector is produced, it will measure, not only the temperature effect, but also a bar code identifying the goods and the surface temperature on the tag by contact-less temperature measurement. Data from the detector will be sent to a database via the Internet either by direct Ethernet cable connection or a GSM modem. Moreover, Bioett wanted to have a working prototype that should be used to verify the new measurement principle. Another great challenge was that all needed to be accomplished within three months and on a very tight budget. The prototype was also to be designed for enabling rapid and simple implementation of modifications in the detection method and testing of different means of communication with the database.

Bioett strived for a very flexible hardware platform that allowed testing of different measurement methods, mathematical data handling and communications methods. To achieve this, a cost efficient programming environment allowing fast and efficient program development was imperative.

CHOOSING THE RIGHT TECHNOLOGY

Since flexibility was one of the most important requirements, Aditus used a FPGA for various DSP processing and to connect the A/D converter used for signal detection with the micro processor. The FPGA would also be used for generating the RF signal activating the biosensor. Since the FPGA can be reprogrammed easily, different measurement methods could easily be tested without modification of the hardware. The FPGA would buffer and perform DSP tasks on the fast 25 Msamples measurement data coming from the A/D converter allowing the micro processor to work efficiently. Since time and cost was of essence Aditus choose to use the Linux operating system, which is advantageous since it is an open source software (free of charge) with an enormous number of functions already implemented and tested (TCP/IP, PPP, different peripheral devices etc.) Linux is also available for many different hardware platforms.

To be able to run standard Linux a micro processor with an inbuilt MMU (Memory Management Unit) was required. Preferably with Linux already implemented and tested. The micro processor should also communicate with either a serial protocol or via Ethernet, be flexible to connect to peripheral devices and have power consumption low enough for a battery powered device.



Hardware block diagram

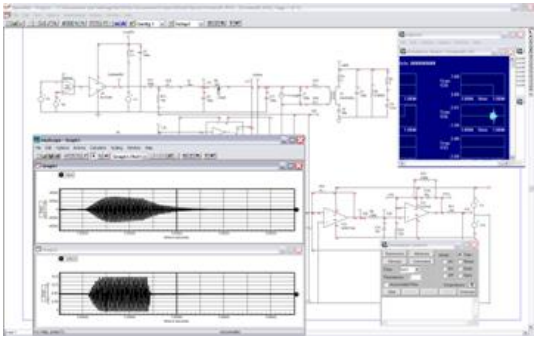
The micro processor best meeting these requirements is ETRAX FS, the latest generation of network micro processors from the Swedish company Axis Communications AB. This micro processor has all the functions necessary implemented, hence a complete system running Linux with a minimum of external components like memory and buffers for Ethernet communication could be designed quickly. The most important features of ETRAX FS is high performance, very low power consumption, the ease of integration with other parts of the system and the fact that Axis also delivers a well proven development platform based on Linux. The facts that Axis is using the ETRAX FS for their own market leading network cameras and other high technology companies are using the same micro processor for a number of demanding applications proves that the architecture is both well proven and stable. The new ETRAX FS also includes a dedicated high speed I/O processor enabling further optimization of the Bioett product by integrating the FPGA functionality in the micro processor saving hardware cost.

RUNNING THE PROJECT

After selecting micro processor it was immediately possible to start working with the software. Even without the target hardware a software engineer could write programs for data analysis and presentation. This task was carried out on an ordinary PC running Linux.

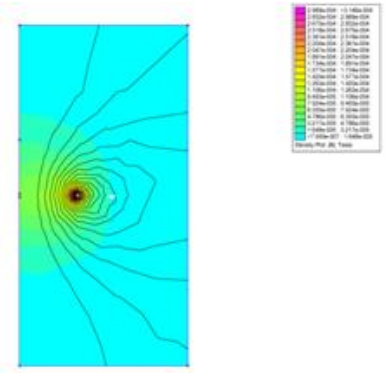
Konrad Eriksson testing the software

In parallel with the programming, design of hardware was started. A challenging part of the design was the analogue electronics for generating the RF signal and detecting the signal emitted by the biosensor. The design work was carried out using advanced SPICE simulation tools in order to rapidly evaluate different methods and select the optimal solution. By the use of computer simulation, which saved at great deal of time and money, different designs could easily and rapidly be tested in the computer without having to resort to building lots of expensive time consuming prototypes.



SPICE-simulation of RF-circuitry

When a FPGA that met the speed and complexity requirements was chosen the FPGA software coding was immediately started. The FPGA code was again tested by simulation tools running on a PC and the code could be written and tested without the need for target hardware. This meant that three activities could be performed parallel to each other; application software, FPGA software and hardware design. This cut development time tremendously.



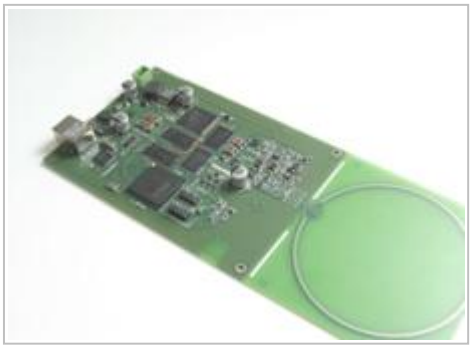
FEM-simulation of antenna

By the time the prototype hardware was delivered from the manufacturer, Note, the software for the application and the FPGA were completed and tests could commence immediately. In only one week after the hardware platform was delivered from prototype manufacturing the detector was fully operational and fulfilled all of the demands set forth by Bioett.

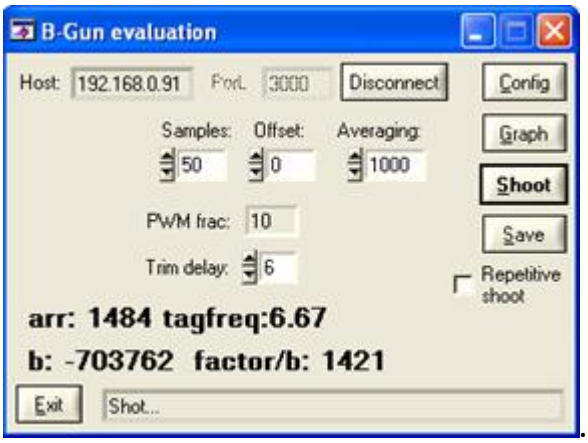
THE RESULT

In only three months time Aditus managed to develop a working detector that verified the new measurement principle. With this new detector Bioett could confidently read data from the biosensors with high accuracy. An interface for presenting the data on a PC connected to the detector was also implemented, enabling Bioett to further develop their technology for producing the biosensors.

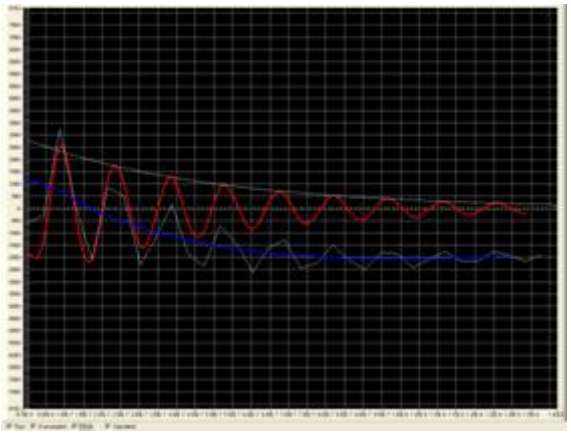
The design of the detector exceeded expectations by allowing high production volumes without any use of production routines for calibration, keeping cost per detector very low. This in turn makes it possible for Bioett to target a larger market for their systems.



Prototype board with electronics and coil for RF-signals.



User interface for measurement and configuration



Graphical representation of data from the biosensor

FUTURE DEVELOPMENT

Olle Hydbom fine tuning the production equipment

The work to build the final hand-held biosensor detector has started. The additional functions not implemented on the prototype board are added and the electronics is modified to adapt to the demands set forth by the mechanical design and layout of the final product.