Theis, Susanne; Pache, Steffen; Zietzschmann, Steffen and Bernhardt, Heinz

New electronic animal identification with a SAW-based RFID system using the ISM-Band 2.4 GHz

Currently used RFID-systems for electronic identification in livestock husbandry are usually based on a low frequency range (LF, 134.2 kHz). This technology has its limitations with regards to a reliable identification, namely in a maximum range of 1 m and in a maximum speed for moving objects of 3 m/s. The newly developed SAW-based RFID system at a licence free radio frequency of 2.4 GHz for electronic animal identification overcomes these limitations. The suitability and practicability of the newly developed SAW technique devices are currently being tested in field tests with dairy cows. Initial results have confirmed the potential for application in livestock husbandry.

Keywords

Electronic animal identification, SAW technology, identification rate

Abstract

Landtechnik 65 (2010), no. 4, pp. 248-251, 3 figures, 13 references

Electronic animal identification is a key technology in precision livestock farming. It is used for controlling and monitoring of production processes. RFID systems currently in use for electronic identification in livestock husbandry are usually based on a low frequency range (LF, 134.2 kHz) [1; 2]. LF transponders are passive, inductively coupled transponders with an integrated circuit and antenna spool. The technical concept and the code structure of these LF transponders are defined in the international ISO standards 11784 and 11785 [2; 3; 4]. In the European Union since the beginning of 2010 sheep and goats older than one year have been earmarked with a visible ear tag and in addition, with a LF transponder. The transponder has to carry the same 15-digit code as the visual ear tag for each individual animal [5; 6; 7]. It is mandatory to tag cattle with two visible ear tags. The second tag can be electronic [7; 8; 9] (**figure 1**).

Since June 2009 it has been compulsory to mark equine animals with an injectable LF transponder [10].

For identification with an LF transceiver, animals should be separated and the transceiver should be placed close to the animal. Stationary LF transceivers have reading rages of up to 1 m [1] and hand-held transceivers of approximately 12-40 cm [5]. However, there are situations in which the proximity of the animal to the transceiver cannot or should not be induced. It is not always possible to single out animals for better identification. This is the case if for example cattle on a pasture are to be identified individually and electronically with a passive transponder. The challenge is that the animals are moving and that their distance from the transceiver is greater than their natural escape distance. In order to reliably identify an animal's transponder research is being carried out into the suitability of Surface Acoustic Wave (SAW) technology in the licence free radio frequency bandwidth of 2.4 GHz for dependable identification.

The SAW technology is fundamentally different from LF systems in structure and function. Despite the fact that SAW transponders are passive, reliable recognition of moving objects at distances of up to 10 meters is achieved in industrial use. The aim of the project is it to develop and to test a SAW-based (2.4 GHz) RFID system for electronic animal identification.

Construction of SAW transponders

The SAW transponder consists of a chip and an antenna in a primary casing (together they form the transponder inlay, **figure 2**), as well as of secondary casing. The basic structure of the chip consists of a piezoelectric substrate. During the manufacturing process an interdigital transducer (IDT) and reflectors for hardware coding are applied to the piezoelectric substrate. The chip and the primary package are connected using bonding conductors. The transponder antenna is applied to a carrier material and connected to the primary casing. For secondary casing plastic ear tags or other forms and materials can be used.

Fig. 1

Official animal identification of a calf with a visual ear tag and a LF ear transponder [7; 8; 9]

Functional principles of SAW transponders

The saw transponder works according to the principle of a reflective delay line. A high frequency burst is linked using the transponder's antenna. Within the chip, the signal is converted into a surface acoustic wave by means of an inverse piezoelectric effect by the interdigital transducer (IDT). The hardware-coded reflectors carry out time selective reflection, which, in accordance with the reverse effect principle (piezoelectric effect), returns a coded high frequency signal to the reading device. This code makes a bi-unique allocation possible, which meets the electric animal identification standards [5; 7; 9].

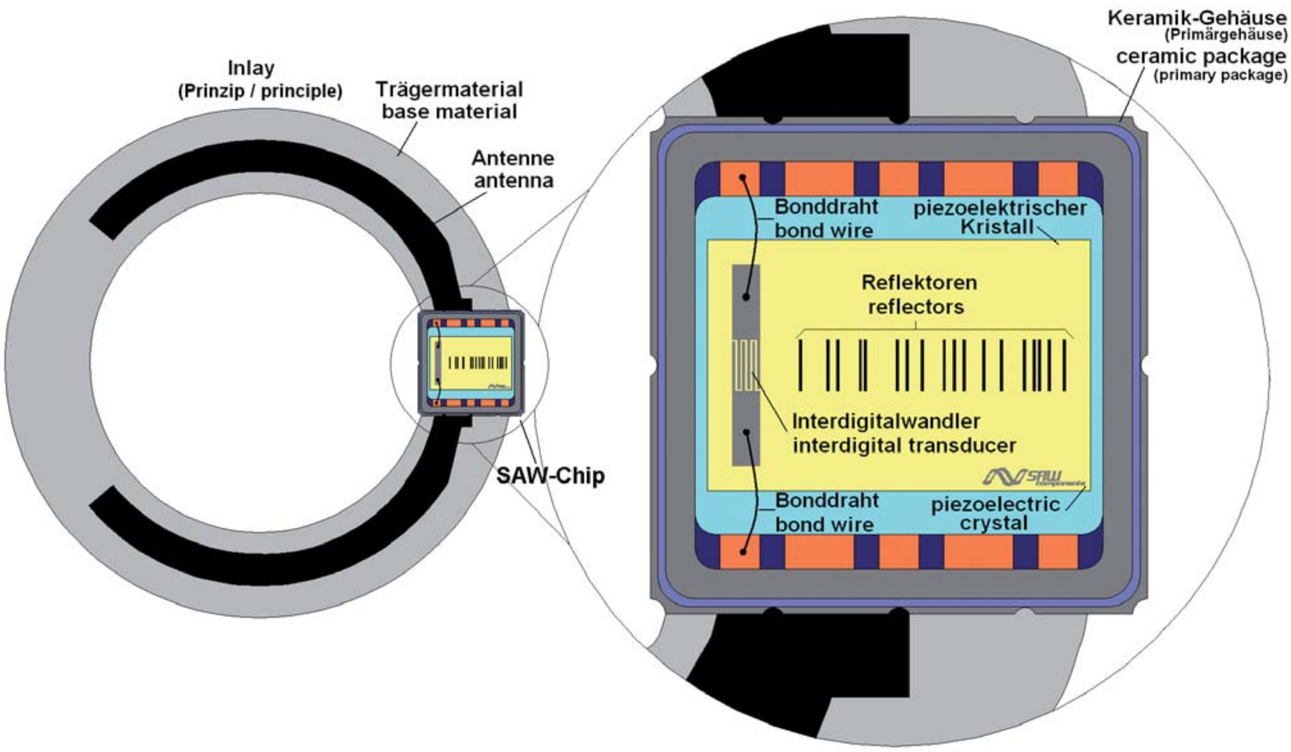
Development of new system components

SAW ear tags: The SAW ear tags developed and tested in the course of the project were constructed in the manner of a conventional LF ear tag casing. For the user, no visible differences between a round LF ear tag and an SAW ear tag are apparent (**figure 1** and **figure 3**).

The animals were tagged with SAW ear tags using standard ear tag pliers. The first field tests were carried out with SAW ear tags which had a 6-digit animal code. The code area covered 2^{20} codes. In further field tests SAW ear tags with a code area of 2^{50} codes will be tested. In these SAW ear tags, the worldwide standardized 15-digit animal code will be applied.

Hand-held transceivers and stationary transceivers: Hand-held transceivers and stationary transceivers have been developed for practical application in livestock husbandry. They consist of a transmit-receiver (transceiver) and an antenna system. The Frequency Modulated Continuous Wave (FMCW) reader employs a special type of domain sampling approach with a continuous transmission at constant amplitude but at changing frequencies. The antenna used in the transceiver is the standard antenna SPA 2400/70/9/0/LCP [11]. For the statistical evaluation of the acquired data the specific system software was developed and installed on the systems touch screen computer Schneider A4F® [12].

Fig. 2



SAW transponder inlay – schematic

Field tests

Field studies on farms were begun in April 2009 with dairy cows. The SAW-based RFID system developed in the project consists of passive transponders, tagged onto dairy cows, hand-held and stationary transceivers, a personal computer as an interface to the transceiver, and software for parametrization, signal interpretation and code recognition.

Before field tests started, the electromagnetic field strengths in the farm area of dairy farm 1 were measured with an EMC test receiver PR 100 (manufacturer: Rhode and Schwarz, Germany).

The registered field strengths were negligible. In all tests the animals were tagged with SAW ear tags using standard ear tag pliers. Studies on the identification rate achieved by the stationary transceiver (dynamic reading) took place in the selection unit of (the dairy barn of) dairy farm 1 in 2009, from July 3rd to September 30th. In total, 15 dairy cows were tagged. The identification of the selected animals by the stationary transceiver was carried out twice a day upon exiting the milking parlour.

From March 12th to April 8th 2010, another study took place in the entrance area of the rotary milking parlour of dairy farm 2. A total of 304 dairy cows were tagged. The identification by the stationary transceiver was carried out twice a day when the cow entered the rotary milking parlour and respectively by the arriving of the identification area. The cows were in a state of semi-active motion as their position on the platform was fixed even though they still had some freedom of movement.

In both dairy farms, the daily data from the LF animal identification system was stored and subsequently used to calculate the identification rate. To this end the ratio of the animals recognized by the SAW system to the animals present in the rotary milking parlour was calculated. The specially developed systems software, called SAW11 was installed on the system PC Touchscreen Computer Schneider A4F®. The data of the SAW-based system was evaluated with this software. Afterwards the data from the rotary milking parlour's LF animal identification system was set against the data from the SAW-based system.

Fig. 3

Visual and SAW ear tag

Results showed a mean identification rate of dynamic identification in dairy farm 1 of 91.4 % (n = 1,238 readings). In dairy farm 2, the identification rate of cows in semi-active motion was significantly higher, namely a mean of 98.4 % (n = 7,496 readings).

Performance and reliability of the SAW ear tags were checked at defined intervals using the hand-held transceiver corresponding to the test intervals in the IDEA project [13].

Thus for, no deficiencies in performance or reliability have been observed in the SAW ear tags which have been in testing for one year. Moreover, no loss of animals or transponders, e.g. through tearing out the ear tag, were observed during the study period.

Conclusions

In the project, an SAW-based RFID system for electronic animal identification for application in livestock husbandry was developed. The tests show that SAW-based technology at a licence free radio frequency bandwidth of 2.4 GHz can be used for electronic animal identification in cattle and that it works in practice. SAW-based RFID systems offer, in general the potential to overcome the functional limitations of LF systems. A possible reason for varying identification rates could be the ear tag position in the cow's ear. Further testing and analysis will show to what extent the identification rate can be optimized trough better positioning in the cow's ear. The aim is to optimize the whole system, so that SAW ear tags in conjunction with hand-held transceivers as well as with stationary transceivers achieve an identification rate closed to 100 %. The declared goal of the project, namely to successfully employ a 15-digit hardware-coded animal code was realized by using a 50-digit SAW ear tag, which is being tested on 1,000 dairy cows as of June 2010.

Literature

[1] Klindworth, M. (2007): Elektronische Tierkennzeichnung – Anwendung und Perspektiven. In: Precision Dairy Farming. Elektronikeinsatz in der Milchviehhaltung. Hg. Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL), Darmstadt, KTBL-Schrift 457, S. 89-98

[2] ISO 11785 (1996): Radio-frequency identification of animals – Technical concept. Hg. International Organization of Standardization, Geneva

[3] ISO 11784 (1996): Radio-frequency identification of animals – Code structure. Hg. International Organization of Standardization, Geneva

[4] ISO 11784 (2004): Radio-frequency identification of animals – Code structure. Amendment 1. Hg. International Organization of Standardization, Geneva

[5] VO (EG) Nr. 21/2004 (2003): Verordnung des Rates vom 17. Dezember 2003 zur Einführung eines Systems zur Kennzeichnung und Registrierung von Schafen und Ziegen und zur Änderung der Verordnung (EG) Nr. 1782/2003 sowie der Richtlinien 92/102/EWG und 64/432/EWG

[6] VO (EG) Nr. 1560/2007 (2007): Verordnung des Rates vom 17. Dezember 2007 zur Änderung der Verordnung (EG) Nr. 21/2004 hinsichtlich des Zeitpunkts der Einführung einer elektronischen Kennzeichnung von Schafen und Ziegen

[7] ViehVerkV (2007): Verordnung zum Schutz gegen die Verschleppung von Tierseuchen im Viehverkehr (Viehverkehrsverordnung – ViehVerkV) vom 6. Juli 2007. BGBl. I, S. 1274

[8] VO (EG) Nr. 1760/2000 (2000): Verordnung des Europäischen Parlaments und des Rates vom 17. Juli 2000 zur Einführung eines Systems zur Kennzeichnung und Registrierung von Rindern und über die Etikettierung von Rindfleisch und Rindfleischerzeugnissen sowie zur Aufhebung der Verordnung (EG) Nr. 820/97 des Rates

[9] VO (EG) Nr. 911/2004 (2004): Verordnung der Kommission vom 29. April

2004 zur Umsetzung der Verordnung (EG) Nr. 1760/2000 des Europäischen Parlaments und des Rates in Bezug auf Ohrmarken, Tierpässe und Bestandsregister
[10] VO (EG) Nr. 504/2008 (2008): Verordnung der Kommission vom 06. Juni 2008 zur Umsetzung der Richtlinien 90/426/EWG und 90/427/EWG des Rates in Bezug auf Methoden zur Identifizierung von Equiden
[11] Huber + Suhner (2008): RFID Antennen. Produktkatalog. Ausgabe 2008, S. 27. URL:www.hubersuhner.de/co-de-tk/hs-p-rf-ant-rfid-cat_de.pdf, Zugriff am 21.04.2010
[12] Schneider, P. (2010): Schneider A4F®. Lüfterloser 15“-Touchscreen. URL:http://www.mappit.de/content/index/index2.shtml, Zugriff am 21.04.2010
[13] IDEA-Project (1998-2001): Final Report. URL:http:idea.jrc.it/pages%20 idea/index%20of%20final%20report.htm, Zugriff am 26.05.2008

Authors

M.Sc. Susanne Theis and **Dr. agr. Steffen Pache** are desk officers at the Saxon State Office for Environment, Agriculture and Geology, Department of Animal Production (LfULG), Am Park 3, 04886 Arzberg-Köllitsch, E-Mail: Susanne.Theis@smul.sachsen.de

Dipl.-Phys. Steffen Zietzschmann is managing director of the company SAW COMPONENTS Dresden GmbH.

Prof. Dr. agr. Heinz Bernhardt has the chair of Agricultural Systems Engineering at the Technische Universität München.

Acknowledgement

This project is sponsored by the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV) as part of the Program to promote innovation. This program is run by the Federal Agency for Agriculture and Food (BLE).