Frank Burose, Tim Anliker, Daniel Herd, Thomas Jungbluth and Michael Zähner

Readability of electronic ear tags in stationary antenna systems

Summary

The standardised (ISO) transponders used nowadays in electronic animal tagging can only be recorded individually. In order to develop an electronic animal-tagging system capable of identifying an individual animal from among a group, transponders mounted on a plastic plate were guided through different antenna systems with a view to simulating the movement of pigs. Both ISO-transponders and those with anti-collision algorithms (AC transponders) were used. Of the variants tested an average of between 43 and 48 % of the AC transponders and between 68 and 85 % of the ISO transponders were automatically identified.

Keywords

Electronic ear tags, low frequency-transponder, stationary antenna systems, radio-frequency-identification, pigs

Introduction and aim

Although the technology used nowadays for the electronic identification of pigs with ISO ear tags allows the automatic identification of an individual animal, it cannot record an individual animal from among a group of animals. Transponders with an anti-collision process were developed in order to be able to record several transponders in the detection field. In this technology the transponders transmit their coding at a randomly selected interval and so do not “interfere” with each other [1].

The aim of the trial presented below was to test two tagging systems able to identify the animals while moving in a group. To this end the read rates of traditional electronic ear tags conforming to the ISO standard and those of a prototype with the so-called anti-collision algorithm were tested, compared and evaluated while passing a stationary antenna system.

Material und method

Different variants of the transponders for testing, which either had an anti-collision protocol allowing the scanning of animals from a group (AC transponder, 125 kHz) or conformed to ISO standards 11784 and 11785 and could only be read individually (ISO transponder, 134.2 kHz), were guided through the magnetic field of a stationary antenna system and identified. The transponder read rate was defined as

$$\frac{\text{number of transponders which were read at least once during a measurement run}}{\text{number of maximum possible transponders to be read}} \cdot 100 = \text{read rate [\%]}$$

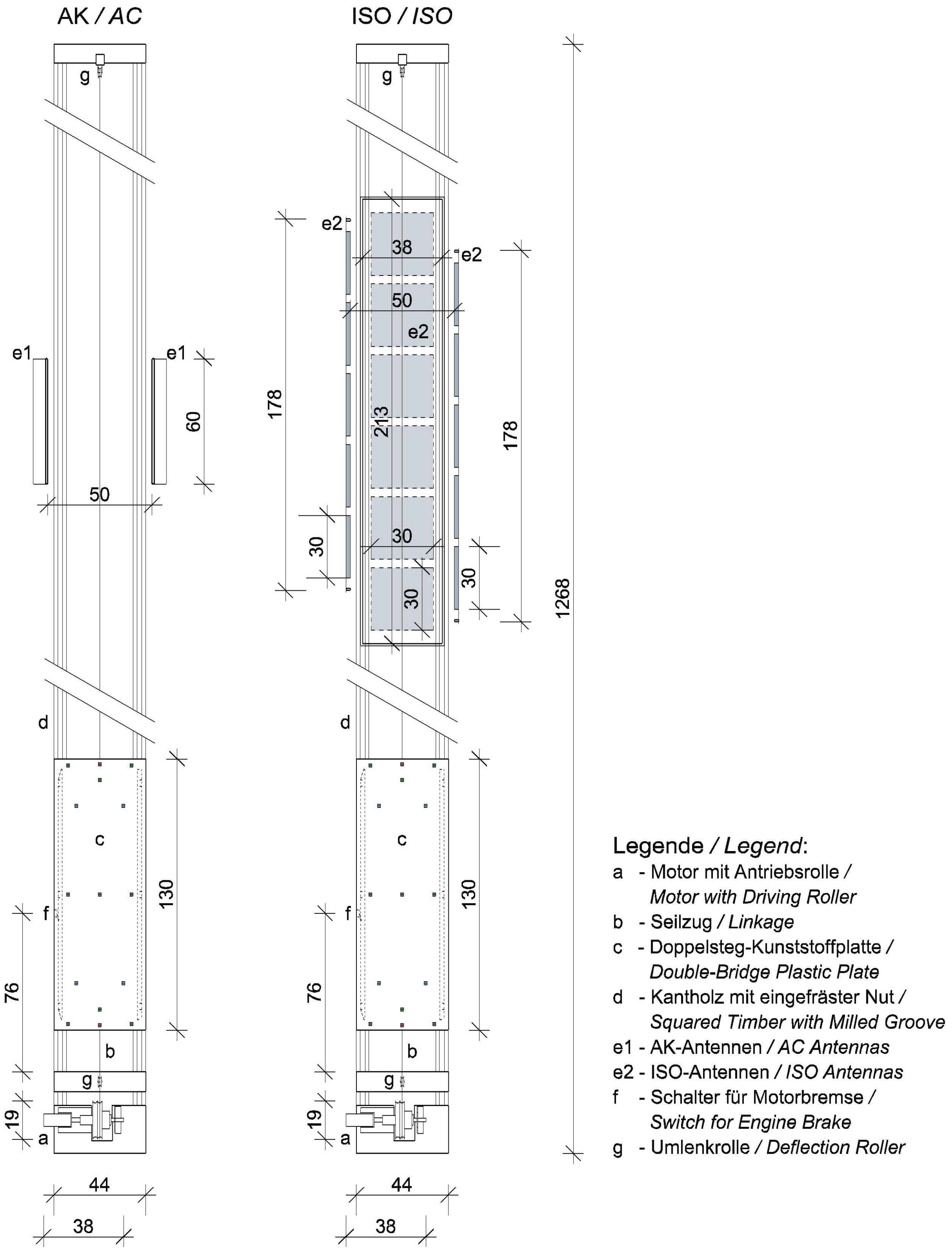

Fig. 1: Diagram of the test bench with anti-collision (AC) and ISO-antennas [cm]

The AC and ISO transponders were mounted on a plastic plate (carriage) and pulled by a linkage on two wooden rails (Figure 1). The transponders on the carriage simulated a group of pigs moving together through a stationary antenna. Nine transponders were used for a group of weaners weighing 10 kg, four for growers weighing 30 kg, and two for fatteners weighing 110 kg. The two AC antennas were positioned opposite each other to the left and right of the rail structure, in a vertical position 50 cm apart. Altogether three antennas were used to read the ISO transponders: two were suspended vertically, a third antenna was placed flat on the ground.

The transponders were tested in seven different orientations (Figure 2, Table 1). Transponder readability was tested at five different speeds: 0.5 m/s, 1.0 m/s, 1.5 m/s, 2.0 m/s and 3.0 m/s.

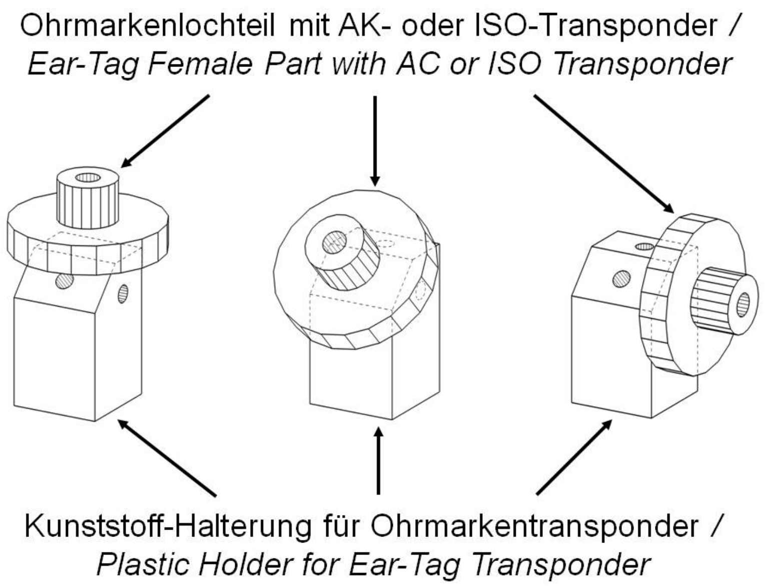

Fig. 2: Plastic holder with anti-collision (AC) or ISO ear-tag transponder (Left: orientation 1; centre: mounting for orientations 2, 3 and 4. Right: Mounting for orientations 5, 6 and 7)

Tests on each of the 210 variants (two antenna systems • three animal age levels (animals) • seven orientations • five speeds) were repeated ten times.

In a linear mixed-effect model [2] the transponder read rate (target variable) was described by four explanatory variables:

- the antenna system (transponder type)
- the number of transponders (animals)
- orientation of the transponders
- speed at which the transponders were guided through the detection area

Results

The read rate in the antenna system with AC transponders was an average of 45.9% and therefore less than with ISO transponders (75.2%). By far the worst read rate was obtained with the horizontal transponder orientation (orientation 1) (Table 1). Not one of the AC transponders was read in 150 runs. Over all three animal groups orientations six and seven performed best both in the AC and ISO transponder tests.

Tab. 1: Average read rates of anti-collision (AC) or ISO transponders in seven different orientations during simulation of pig movement

Antennen-system / ***Antenna System***	**Tier-gruppe, simuliert /** ***Animal Group, Simulated***	**Lesequote [%] / Read Rate [%]**							
		Ausrichtung der Transponder / ***Orientation of Transponders***							**Durch-schnitt /** ***Average***
		1	**2**	**3**	**4**	**5**	**6**	**7**	
AK / ***AC***	Durch-schnitt / *Average*	0.0	5.7	65.9	74.8	18.1	77.3	79.5	45.9
ISO / ***ISO***	Durch-schnitt / *Average*	1.4	59.1	92.0	90.9	90.4	95.0	97.6	75.2

Ausrichtung der Transponder */ Orientation of transponders*:
1 = Transponder horizontal */ Transponder horizontal*
2 = Transponder 45 Grad nach vorn gekippt */ Transponder tipped forward 45°*
3 = Halterung 45 Grad nach rechts gedreht, Transponder 45 Grad nach vorn gekippt */ Holder rotated 45° to the right, transponder tipped forward 45°*
4 = Halterung 90 Grad nach rechts gedreht, Transponder 45 Grad nach vorn gekippt */ Holder rotated 90° to the right, transponder tipped forward 45°*
5 = Halterung 90 Grad nach rechts gedreht, Transponder vertikal, quer zur Fahrtrichtung */ Holder rotated 90° to the right, transponder vertical, crossways to the direction of travel*
6 = Halterung 135 Grad nach rechts gedreht, Transponder vertikal */ Holder rotated 135° to the right, transponder vertical*
7 = Halterung 180 Grad gedreht, Transponder vertikal, längs zur Fahrtrichtung */ Holder rotated 180°, transponder vertical, along the direction of travel*

The influence of speed was significantly greater with the AC transponders than with the ISO transponders (Table 2). With AC transponders the read rate varied between 26 (3 m/s) and 65% (0.5 m/s) irrespective of transponder orientation, and in the case of the ISO transponders the values ranged from 73 (3 m/s) to 78% (0.5 m/s).

Tab. 2: Average read rates of anti-collision (AC) or ISO transponders for five different speeds during simulation of pig movement

Antennen-system / ***Antenna System***	**Tier-gruppe, simuliert /** ***Animal Group, Simulated***	**Lesequote [%] /** ***Read Rate [%]***					
		Geschwindigkeit [m/s] / ***Speed [m/s]***					**Durch-schnitt /** ***Average***
		0.5	**1**	**1.5**	**2**	**3**	
AK / ***AC***	Durch-schnitt / *Average*	65.0	53.6	43.3	42.0	25.7	45.9
ISO / ***ISO***	Durch-schnitt / *Average*	77.8	75.7	75.6	73.8	73.0	75.2

Statistical analysis

The results of the linear mixed-effect model with the “ear tag read rate” target variables were generated from a total of 210 variables. The antenna system, the orientation of the transponders and the speed at which the transponders were guided through the detection field were highly significant ($p< 0.0001$). The “animals” explanatory variable, symbolised by the number of transponders on the test carriage, was not significant ($p = 0.1381$).

Each of the four box plots in Figure 3 shows the read rate as a target variable together with an explanatory variable. The “orientation” box plot shows the significant link between the ear tag read rate and transponder orientation. Whereas in orientation 1 only very few transponders were identified in total, the read rate in all the other orientations was significantly higher.

The “speed” box plot shows the influence on the read rate of transponder exposure time in the detection field. At the lowest speed (0.5 m/s) the interquartile range was approx. 50 to 100%. As the speed increased the bottom quartile fell steadily to almost 0%.

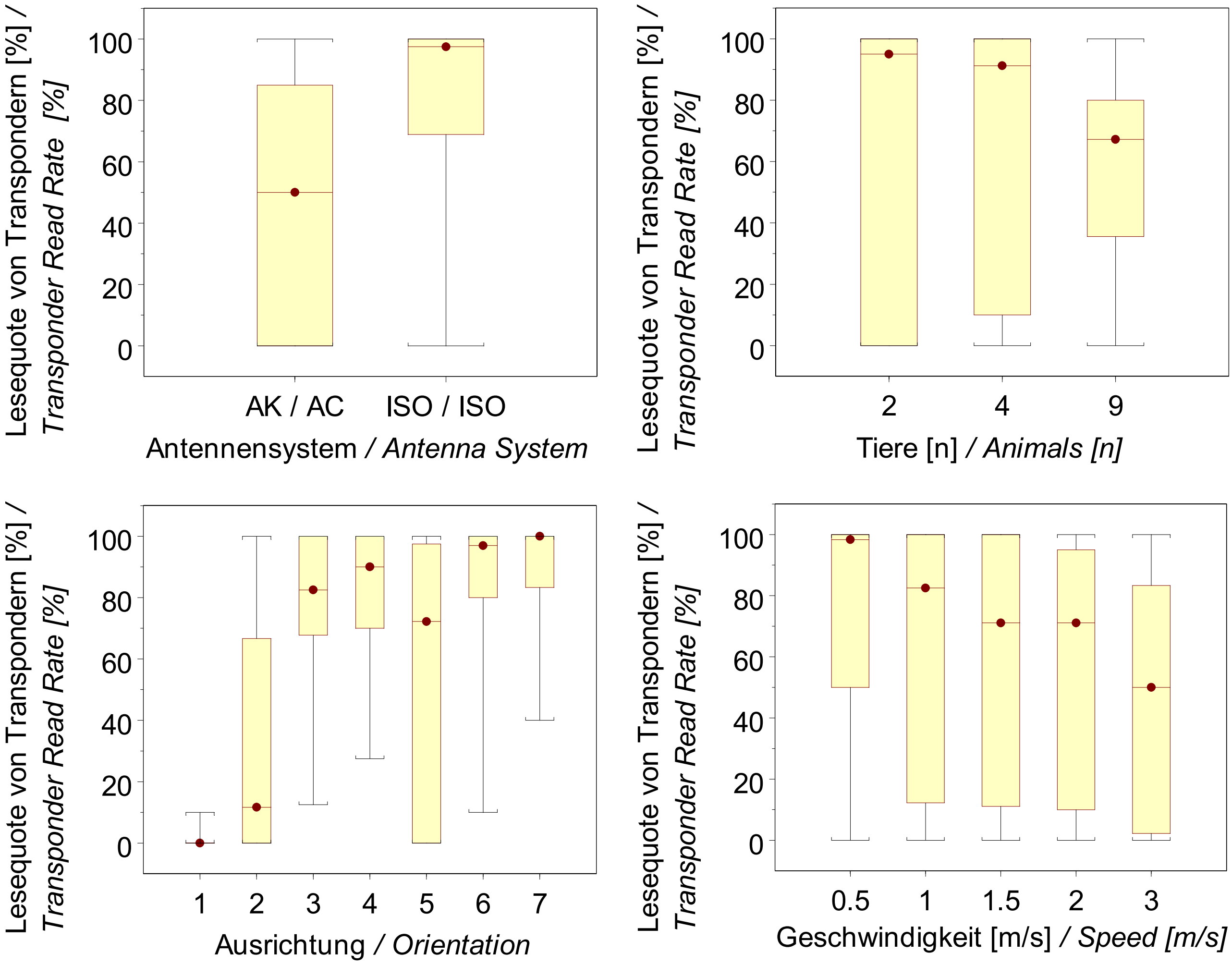

Fig. 3: Read rates of electronic ear tags as a function of the explanatory variables ear-tag type, animals, orientation and speed, shown as box plots (minimum, lower quartile, median, upper quartile, maximum)

Discussion

Only optimally positioned antennas generate the best possible magnetic detection field. The following important parameters also influence the probability of a transponder being read while crossing the detection field:

- the antenna system
- the distance between transponder and antenna, plus the number of transponders
- the orientation of the transponder to the antenna
- the speed at which the transponder is guided through the detection area

The differing results between the AC and ISO antenna systems can be explained firstly by the different types of transponder and antenna, and secondly by the varying exposure time in the detection field (AC antenna only 60 cm long).

The longer an animal remains in the detection field of a stationary antenna system, the greater the probability of its transponder being identified. Various measures can be of assistance here.

The reading range determines how great the maximum distance between antenna and transponder can be for the animal to be read when passing the antenna.

The power supply of the transponder’s copper coil (electric charge) is at its best when vertically aligned to the magnetic field lines, which means that transponders mounted horizontally on the carriage were identified in only a very few test runs. With a living animal the orientation of the transponder changes continually as it moves, so presumably the probability of a successful reading would be higher than in a simulation.

Conclusions

At the moment the findings of trials on stationary antenna systems and electronic ear tags still cast doubt on the practicability of an identification system with electronic ear tags for pigs. Electronically tagged animals can be automatically identified from among a group by means of RFID technology. Even if the results presented are not yet satisfactory with regard to read rate, they do demonstrate the potential which can be derived from the available technology. Priority must be given to improving the read rate in further studies.

Literature

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