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Accelerated testing of agricultural electronics

Accelerated testing of agricultural electronics in the laboratory can reveal weaknesses, shortcomings and faults in prototypes and other components. This can make an essential contribution to cutting development times for robust and reliable electronics. In addition, product data for farmers and public authorities can be documented. The article discusses this problem complex.

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Keywords

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Robust and reliable electronics call for precise co-ordination between design and production of components for their subsequent function in practical farming use. In particular, measures are to be taken to prevent damage being caused as a consequence of functional faults or failures. For instance the failure of an AMS-system in dairy cattle management or of air conditioning technology in a poultry house can lead to harm to the animals and thus to production losses. Demands resulting from direct on-farm use should be made of robust and reliable electronics. These units must therefore be resistant to moisture, dust, hydrogen sulphide, ammonia and other chemical influences, as well as to vibrations, shocks, falling, voltage fluctuations, static charges and high frequency interference. Thoughtlessness and faulty operation are also to be mentioned.

Danish investigations [1, 2] into the work quality and service life of electronics under practical farm conditions show that experience in producing industrial electronics cannot simply be transferred to agricultural applications without further ado. The application conditions differ too greatly. By comparison, experience gained in the field of military electronics is much more relevant for agriculture. With reference to [1, 2] and subsequent additional investigations [3, 4], it was possible to develop test programmes for accelerating testing of electronic appliances and accessories for agriculture. The equipment to be tested is subjected in the laboratory to successive test methods corresponding to various recognised national and international standards. This makes it possible to simulate certain stresses within a short period of times, which – even if not totally in line with normal practice – achieve the same stresses to which the equipment is normally exposed after a period of several years. This reduces the development time for electronic equipment substantially and can also document product specifications and allow work to be carried out systematically on improving products already in use. Furthermore, accelerated testing in the laboratory opens up opportunities for certification tasks, for instance for the public authorities.

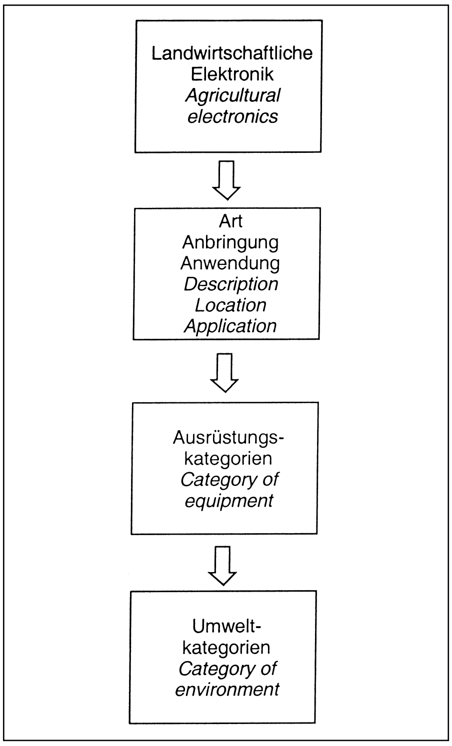

Fig. 1: Principle for determining an environmental category

Testing programmes

The testing programmes were elaborated on the basis of models which describe the connections between the equipment (appliance) and the surroundings. By defining the equipment and surrounding categories, including specifying their mutual influences, a solution has been found for a difficult problem, i.e. „the translation of extrapolations to test requirements" (*fig. 1*).

In addition to a CE coding in agreement with the EMC-Directive, electrical products must be provided with a CE coding in agreement with the Low Voltage Directive, 72/23/EEC, amended to Directive 93/68/EEC, insofar as the product is intended for use in the voltage range 50 to 1000 VAC or 75 to 1500 DC.

The environmental classification, the testing method and the scale of testing are determined from a matrix. Distinctions are made between mobile and stationary installations of the electronics and different application conditions and uses, for instance in livestock production and arable farming. Altogether 204 different testing methods are integrated in the test programmes. Most of the standards originate from the IEC (International Electro-technical Committee), EN (European Standard) and DS (Danish Standard). The principle of the matrix is that the environmental classifications for a given electronic unit arise from the point of intersection between the horizontal and vertical axis (*figure 2*). Each environmental class stands for a group of environmental parameters which are qualified by reference to a particular testing method, for instance IEC-68-2. In addition, the environmental class indicates the testing scale. In other words, it determines the frequency, duration and force of the tests.

Arable farming – stationary installation

The placement of the electronics (horizontal axis in the matrix) comprises the installation in residential buildings, animal housing, greenhouses, stores, equipment sheds, as well as in the ground and in the field. The application of the electronics (vertical axis in the matrix) comprises tasks of soil cultivation, fertilising, drilling, plant care, weed control, pest control, silage harvest, grain harvest, silage storage, grain storage and storage of root crops.

Arable farming – mobile installation

The placement of the electronics (horizontal axis in the matrix) comprises installation in the open, in the farmyard, for livestock, in cabins, on tractors, on equipment and mobile applications. The applications of the electronics (vertical axis in the matrix) comprise tasks of soil cultivation, fertilising, drilling, plant care, weed and pest control, silage and grain harvest, silage and grain storage, as well as storage of root crops.

Livestock husbandry – stationary installation

Placement of the electronics (horizontal axis in the matrix) comprises installation in residential housing, animal housing, greenhouses, stores, equipment sheds, in the ground and in the field. The application of the electronics (vertical axis in the matrix) comprises tasks in the field, in the animal housing, for feed preparation, feeding, milking, in egg production and livestock husbandry.

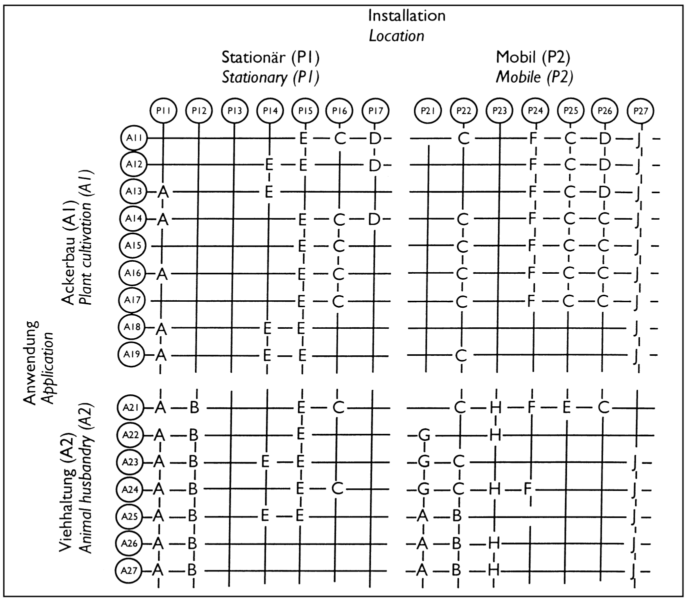

Fig. 2: Example of matrix structure

Livestock husbandry – mobile installation

The placement of the electronics (horizontal axis in the matrix) comprises installation in the open, in the farmyard, on livestock, in cabs, on tractors, on equipment and mobile applications. The applications of the electronics (vertical axis of the matrix) comprise tasks in the field, in the animal housing, in feed preparation, feeding, milking, egg production and livestock husbandry.

Climatic environment

The climatic environment comprises eight classes, whereby each class covers 14 testing methods. These also include data on the testing scale from 0 to 4, which range from short-term tests to long-term tests.

Table 1: Example of program for testing an electronic control unit for wall mounting in a pig confinement building

Environment class	Testing purpose	Testing standards		Testing methods
KMK-B	high temperature	2	-	IEC 68-2-2 (1974)
	low temperature	2	4	IEC 68-2-1 (1974)
	moisture	-	3	IEC 68-2-3 (1969)
	sulphuric acid	1	-	IEC 68-2-43 (1976)
MMK	vibrations (coincidental)	1	3	IEC 68-2-36 (1973)
	striking shock	1	2	IEC 68-2-29 (1968)
	free fall and shock	1	-	IEC 68-2-3 (1969)
	cable tugging and bending	4	2	IEC Entwurf 62D)
	operational effects	5	3	IEC 512
EMK-A	immunity, HF report	2	-	DS 5106 (1987)*
	emission, wire-transmitted interference	2	-	DS 5106 (1986)*
	emission, electric field transmitted interference	2	-	DS 5106 (1986)*
	transient, electric shock	2	-	DS 5103 (1986)*
	transient, high energy level	3	-	DS 5103 (1986)*
	transient, switching	3	-	DS 5103 (1986)*
	electrostatic discharge	3	-	IEC 801-2 (1986)*
	variations in network tension	2	-	DS 5104(1987)*
	variations in frequency	1	-	Klassifikation des Schiffes

* The Danish standards mentioned have now been replaced by the norms according to the EMC Directive 89/336/EWG. In this, the most important are EN 50081 and EN 50082. On this basis an EMC specification can be calculated in 95% of cases so that a CE identification of the product can be made.

Mechanical environment

The mechanical environment comprises three classes, whereby each class is covered by eight testing methods. These also include data on the degree of difficulty from 0 to 4, which range from short-term tests to long-term tests.

Electrical environment

This comprises three classes, whereby each class is covered by ten testing methods, including details of the degree of difficulty from 0 to 4.

Experience

Experience with testing programmes from tests show that accelerated tests (objective method) can reveal weaknesses, shortcomings and defects in the electronic equipment to be tested and can contribute to reducing the development time for new products. In addition product data can be documented to farmers and public authorities.

Literatur

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[4] Information über letzten Stand der Prüfungsmethoden ist bei Anschreiben an ein professionelles Laboratorium erhältlich, zum Beispiel DELTA, Venlighedsvej 4, DK-2970 Hørsholm