A new standard for using official animal identification schemes for livestock animals in RFID applications worldwide

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Abstract

The paper gives the concept of the ISO New Work Item Proposal WD 23636. The basic principle is that official animal identification schemes, which are presently in use, shall be applied in future to RFID based systems. The aim is to avoid the introduction of an extra electronic number. The first part describes how the animal numbers allocated on a national basis are converted into an Animal Identification Number (AIN) that is unique worldwide. It is achieved by adding a "header" to the visible number on the eartag. It contains the ISO 3166 country code and a key for the National Encoding Scheme (NES). The Animal Identification Number, is a worldwide unique number, that will be used for all kind of data processing. However it contains as nucleus the number the farmer is familiar with. The second part describes how the Animal Identification Number is stored in the memory of an ISO/IEC 18000-63 transponder. To characterize the transponder, which are used for animal identification an "Application Family Identifier" is introduced. The AIN is encoded in numeric and alphanumeric characters. In the third part the quality aspects of the UHF technology are discussed and test procedures described.

Keywords: animal identification number, ISO/IEC 18000-63 transponder, ISO 11784, WD 23636, UHF

Introduction

This paper gives the concept of the ISO New Work Item Proposal WD 23636. It includes the following parts:

- Part 1 – Animal Identification Number (AIN). A worldwide unique number that will be used for all kind of data processing. It is based on well established visual schemes.

- Part 2 – Encoding of AIN in Short UII in ISO/IEC 18000-63 Transponder.

- Part 3 – Evaluation of conformance of ISO/IEC 18000-63 Transponder. Quality provisions that shall be fulfilled in order to prove the reliability that is achieved with ISO 11785 Transponder. This part is under development.

Part 1 : The Animal Identification Number AIN

Official Animal Identification schemes have been developed in different countries in different ways. These schemes are used for official identification and registration of livestock animals. They are based on government regulations, are standardized and successfully introduced.

Examples of such livestock identification schemes can be found worldwide: Argentina, Brazil, France, Germany, UK, USA, and so on. These systems make use of visual numbering on ear tags and are the backbone for registration, animal movement, tracing diseases, etc.

Increasing international trade of live animals calls for an Animal Identification Number AIN, that is unique worldwide and based on the existing schemes.

The ISO 11784 Standard: "Radio-frequency identification of animals - Code structure" was published 2 decades ago (1996) without giving consideration to the existing visual schemes.

In the meantime technologies for automatic data capture were developed, which allow for larger transponder memory space than the 64 bit required for ISO 11784. This allows to store the more complex, visual schemes directly in an RFID tag

Using the visual IDs on tags would avoid matching to references via networks and data base access.

The task now is to define an Animal Identification Number AIN based on existing visual schemes and accommodate it in an RFID memory. For economic and availability reasons a 128 bit memory is a preferred solution.

To maintain the uniqueness of the individual Animal Identification Number worldwide is a key issue that shall be standardized.

As stated above, the visual systems used for livestock identification differ from country to country. The legal responsibility is with the national Competent Authority. However there is always an official organization, Issuing Organization, that administers these schemes: i.e. assign the individual animal number to the tag, distribute the tags and records them in a data base.

Examples for bovine animals are given in table 1.

In addition a "Retagging Counter" has to be included in the RFID data of the tag. The retagging counter is an important feature for the traceability of livestock animals – in visual tags some countries use different color for the retagged tag.

Table 1. Examples of visual schemes for bovine animals.

Visual scheme, presently used	Number
NUES 9 (USA, APHIS)	23 ELV 4574
VVO (Germany : Viehverkehrsverordnung)	DE 03 487 70062
SISBOV (Brazil, 2017)	105 51 000001234 5

In order to identify the different visual schemes, they have to be translated into a worldwide unique message: the Animal Identification Number (AIN). It is composed of two elements:

- AIN Header, and
- AIN Body.

The message will start with an AIN Header that characterizes the origin of the used scheme. The AIN Header contains the following information:

- Country of the Issuing Organization (NCC = Numeric Country Code).
- National Encoding Scheme (NES) - e.g. according to different species.

It is followed by the AIN Body. The AIN Body contains the following information:

- The Retagging Counter
- A string of alpha numeric characters representing the visual scheme

Such data construct may be used for different high-capacity automatic data capture (ADC) media like RFID according to ISO 18000-63, ISO 18000-M3, NFC, ISO 14223, or optical 2D codes.

The usage in optical codes can rationalize the work with animal passports and documents considerably.

Procedure

The basis are the visual schemes, administered by Issuing Organizations, which act on governmental regulations.

They are responsible for the unicity of the individual animal number in the relevant country. To relay on that unicity is a key to the new Standard.

Examples of issuing organizations are:

- USA
  Animal and Plant Health Inspection Service (APHIS)
- Germany
  Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz
- Brazil
  Secretaria de Defesa Agropecuária (SDA/MAPA)

In practice they delegate the task of administration of the animal numbers to sub entities. These entities are responsible for ordering and distribution of the tags. For example in Germany this is mainly done by the so called LKV (Landes Kontroll Verband) for bovine animals.

Animal Identification Number AIN

In order to keep the unicity of the national animal number on a worldwide level, the origin of the animal number has to be shown. To achieve this target an AIN header is put up in front. It is composed by the following elements:

- Numeric Country Code (NCC) according to ISO 3166;
- National Encoding Scheme (NES) allocated by the Registration Authority.

Header of the AIN message

Numeric Country Code (NCC)

NCC represents the Numeric Country Code and is 10 bits in length. The numbering of NCC is according ISO 3166. The NCC is responsible for maintaining the unicity of the national animal number on a worldwide level.

Examples of NCC are:

- 840 – USA
- 276 – Germany
- 076 – Brazil

National Encoding Schemes (NES)

NES represents the National Encoding Schemes and is 6 bits in length, allowing 64 schemes for each country. According to the country for each species there are different schemes in use (e.g. bovine, swine, caprine). Examples for National Encoding Schemes in the USA are:

- NUES 9 for cattle
- NUES 8 for sheep and swine
- Flock-based number
- Location-based number

Each scheme has to be identified by a key number (NES).

The competent authority, that wants to make use of this Standard has to apply for the National Encoding Schemes (NES) for the different species.

The NES key numbers will be allocated by a Registration Authority (e.g. ICAR) and public access of the allocation has to be guaranteed.

A NES was reserved for non official schemes and tests (NES = 63). It is mandatory to store the country code of the country where the test are performed.

The following keys for NES will be pre-defined in the Standard:

00	NES for official schemes with 64 bits representation without specie definition. The AIN body carries an ISO 11784 type number. This means the 64 bits are allocated as described in ISO 11784. Using an ISO 11784 structure is allowed only with a country code in the AIN header. ISO 11784 numbers containing a manufacturer code instead of Country Code is not allowed.
01..62	NES for official schemes with 16-character alphanumeric representation.
63	NES for unofficial schemes with 16-character alphanumeric representation. In this case the body contains a number wich does not belong to an official scheme and is used in a limited area only. Examples are test transponder or transponder used for farm management or scientific purposes. The transponders using NES = 63 can be reused. Using this key the uniqueness is not guaranteed.

The AIN Body is composed by the retagging counter and the visual number of the animal. The Retagging counter is 1 digit in length and is numeric format. The Visual number of the animal is alphanumeric and the length may vary depending of the technology of the tag used.

Body of the AIN message

Examples of the AIN Body are:

- "0" "23 ELV 4574" – USA
- "1" "DE 03 487 70062" – Germany
- "1" "105 51 0000012345" – Brazil

NCC,NES,R,PPPPPPPPPPPP
where

Composition of the Unique Animal Number (AIN)

- "NCC" is 10 bits Country Code according ISO 3166,
- "NES" is the National Encoding Scheme registered and maintained by the Registration Authority,
- "R" (n1) is the retagging counter
- "PPPPPPPPPPPP" (an12) is the visual animal number

Some examples the data construct for different countries are shown below.

The Issuing Agency that is responsible for identification of bovine animals is Animal and Plant Health Inspection Service (APHIS). This organization has introduced the NUES 9 and the AIN(US) scheme for bovine animals.
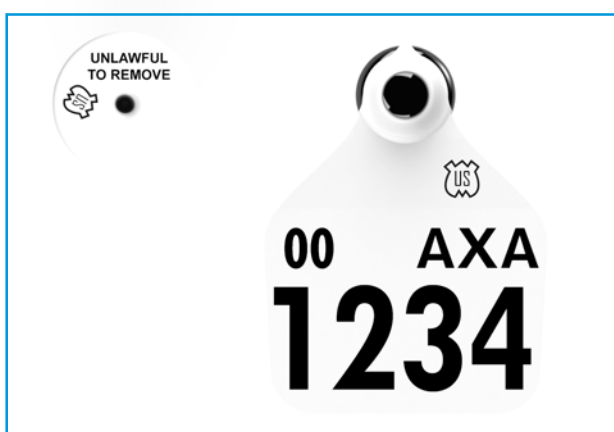
AIN for United States of America

Figure 1. NUES 9 official ear tag.

Table 2. Data construct for encoding the unique animal number from NUES 9.

AIN Header		AIN Body	
NCC	NES	Retagging counter	Animal ID
840	01	0	"00 AXA 1234"

Table 3. Details of data construct for encoding the unique animal number from NUES 9.

Description	Data	Lenght	Type	Remarks
NCC	840	10 bits	Numeric	Country Code according to ISO 3166.
NES	01	6 bits	Numeric	e.g. for NUES9.
Retagging counter	0	1 digit	Numeric	"0" represents the original tag issued and "1" is the first retagging.
Visual number	00 AXA 1234	-	Alphanumeric	Unique animal number as given in the visual scheme. Same as visual animal number.

There is a further scheme used in the US. It is managed by *Animal Identification Number Management System* (AINMS or sometimes shortened to just AIMS) that is used to allocate groups of 840 numbers to approved tag manufacturers.

The AIN(US) starts with 840 (the first three digits are the Country Code for USA) followed by a string of 12 digits. As the AIN(US) always starts with 840 we have a redundancy with the NCC in the AIN Header.

There are 2 options to encode the AIN(US):

• If there is no species information required AIN may use the 64-bit representation of ISO 11784. It includes the country code from bit 17 to 26 and the 12 digit individual animal number from bit 27 to 64 (National Identification Code). In this case the NES shall be "00" and the AIN body will contain 64 bit, or

• If a species information has to be included a different NES has to be allocated. In such a case Aphis has to apply for a new NES (for example "02") for bovine animals containing the visual data, which is a 3 digit country code and the 12 digit individual animal number.

The figures of the AIN(US) scheme will be included in the AIN as reported in table 4 and table 5.

The Competent Authority will have to decide which way to go.

Part 2 : Encoding of AIN in Short UII in ISO/IEC 18000-63 transponder

The aim of the present Part 2 of the standard is to accommodate the AIN in the Short Unique Item Identifier (Short UII) memory format of an ISO/IEC 18000–63 transponder. For economic and availability reasons a 128 bit memory is a preferred solution.

Table 4. Data construct for encoding the unique animal number from AIN(US).

AIN Header		AIN Body	
NCC	NES	Retagging counter	Animal ID
840	00	-	0x8000D200BA2C2B15$_{HEX}$
840	02	0	"840 003 123 456 789"

Table 5. Details of data construct for encoding the unique animal number from AIN(US).

Description	Data	Lenght	Type	Remarks
NCC	840	10 bits	Numeric	Country Code according to ISO 3166.
NES	00	6 bits	Numeric	64-bit representation of ISO 11784 structure.
Retagging counter	-	-	-	Not applicable.
Visual number	840 003 123 456	64 bits	Numeric	Unique animal number as given in the visual scheme. According with ISO 11784.

Essential features are the introduction of an Application Family Identifier (AFI) and the URN Code 40 encoding rules.

When using ISO/IEC 18000-63 transponders for animal identification, the AIN shall be stored in the UII memory.

General tag features

ISO/IEC 18000-63 transponders have what is known as a segmented memory structure, where four different memory banks are supported and separately addressable. Using binary notation, the memory banks (MBs) are:

- MB00 : RESERVED – for access and login passwords,
- MB01 : UII – for the Unique Item Identifier,
- MB10 : TID – for tag identification (TID), and
- MB11 : USER – for additional user data.

The Memory is organised in a 16-bit word unit for commands to read and write the data. In this concept the UII shall be limited to 128 bit for commercial reasons. Its content is given in Table 6 and Figure 2.

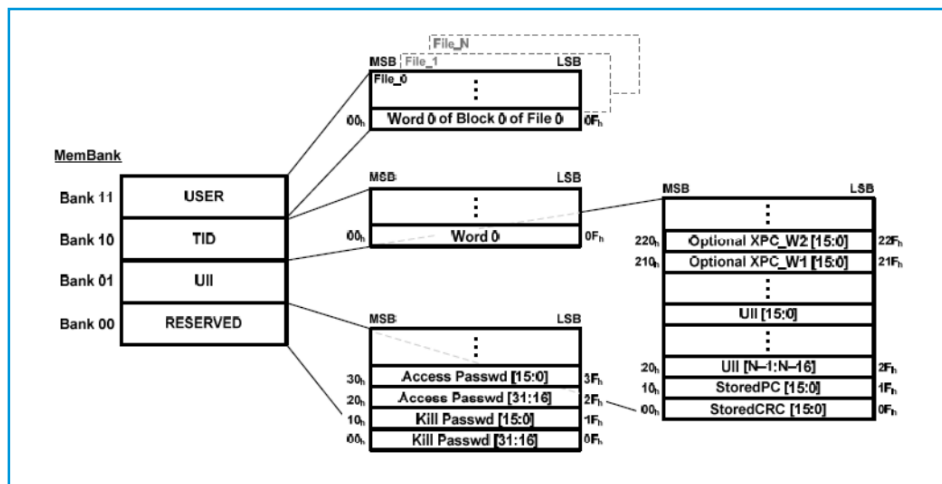Figure 2. Logical Memory Map as per ISO/IEC 18000-63.

Figure 2. Logical Memory Map as per ISO/IEC 18000-63.

Table 6. Structure of the 128 bit memory UII.

Memory name	Lenght (bits)	Start in (MB 01)	End at (MB 01)
DSFID	8	20_{HEX}	27_{HEX}
AIN Header - NCC	10	28_{HEX}	31_{HEX}
AIN Header - NES	6	32_{HEX}	37_{HEX}
AIN Body	96	38_{HEX}	97_{HEX}
CRC	8	98_{HEX}	$9F_{HEX}$
Total	128		

Structure of MB 01

This memory bank contains the UII and associated syntax.

The first word contains a stored CRC-16 ("StoredCRC"). This is automatically generated each time the the tag is power-cycled as per ISO/IEC 18000-63.

The second word contains a Protocol Control word ("StoredPC") defining among others the length of the UII and the AFI whose value is defined under the authority of ISO.

Figure 3 below illustrates the complete MB01 memory structure for this standard.

AFI

To define an ISO/IEC 18000–63 tag as assigned for animal identification only, an Application Family Identifier (AFI) shall be implemented according to ISO 15962. The AFI is used in UHF and HF RFID technologies to differentiate transponders programmed for the desired application from transponders programmed for other applications that are not relevant for the application in question. This differentiation will accelerate the processing due to a reduced number of tags being considered.

Word	msb														lsb
00ₕ	StoredCRC														
01ₕ	StoredPC														
	Length			UMI	XI	T=1		Application Family Identifier (AFI)							
02ₕ	Data Storage Format Identifier (DSFID) = **0x1E** Closed system data not encoded to ISO/IEC 15962 rules							AIN Header MSB							
03ₕ	AIN Header LSB							AIN Byte 0 (MSB)							
04ₕ	AIN Byte 1							AIN Byte 2							
05ₕ	AIN Byte 3							AIN Byte 4							
06ₕ	AIN Byte 5							AIN Byte 6							
07ₕ	AIN Byte 7							AIN Byte 8							
08ₕ	AIN Byte 9							AIN Byte 10							
09ₕ	AIN Byte 11 (LSB)							CRC-8							

Figure 3. MB 01 Memory Map used by this ISO NWIP.

Encoding and decoding needs to be invoked for complete 16 bit words. The UII is composed of 128 bits. The UII shall contain:

UII

- A Data Storage Format Identifier (DSFID)

- An Animal Identification Number (AIN) , composed by:

  - AIN Header, and AIN Body, that is the Retagging Counter digit plus the Visual IDentification number, as defined in Part 1 .

- CRC 8

The complete structure of the UII is shown in Table 6 and Figure 4 below.

AIN body is defined in Part 1. For ISO/IEC 18000-63 RFID tags the UII is 96-bit lenght. If the AIN body has less than 96 bit padding with zero is required.

AIN body

A CRC-8, resulting from the UII memory. CRC-8 is enough to protect data lengths up to 248 bits. Hence it is suitable to fit the 128 bits memory of the UII memory

CRC 8

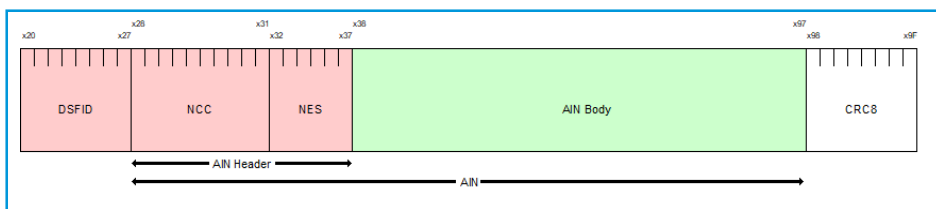The AIN Body including the Retagging Counter digit in an ISO/IEC 18000–63 transponder must be encoded via URN Code 40.

URN Code 40

Figure 4. Structure of the 128 bit memory UII.

The URN Code 40 coding stores 3 alphanumeric characters in 16 bits. Applying this code to a memory section (AIN Body) of 96 bits, allows to store 18 alphanumeric characters.

The DSFID, AIN Header and the CRC8 are not encoded via URN Code 40.

By using the URN Code 40 encoding, the last alphanumeric of the string shall be a PAD character. This information will be used by the reader to determine the end of the visual identification number, so we have 17 alphanumeric characters as maximum lenght of the visual identification number.