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Radio-frequency identification of animals — Code structure ultra high frequency transponders

Identification par radiofréquence des animaux — Structure du code des transpondeurs à ultra haute fréquence

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Foreword

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This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document does not use EPC coding but ISO coding. To define an ISO 18000-63 transponder as assigned for animal identification only, an Application Family Identifier (AFI) shall be implemented according to ISO 15961. The AFI is used in an ISO 18000-63 transponder to select in the bulk reading process only those transponders programmed for the dedicated application.

This document does not specify the characteristics of the transmission protocols between transponder and transceiver. These characteristics are the subject of ISO 18000-63.

Transponders are in conformance with this document provided they meet the requirements given in Clauses 5 and 6.

Radio-frequency identification of animals — Code structure ultra high frequency transponders

1 Scope

This document defines the rules for encoding the animal identification code in a specific memory bank known as MB 01 in the memory of an ISO 18000-63 transponder (UHF RFID technology).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11784, *Radio frequency identification of animals — Code structure*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
unique item identifier
UII
96-bit pattern which defines a unique number that contains the *DSFID* (3.2), the animal identification header, the animal identification code and the 8-bit CRC

Note 1 to entry: If the ISO 18000-63 transponder has more than 96 bits of UII memory, the additional bits are considered UII Trailer bits and shall be set to 0 as default value.

Note 2 to entry: See *DSFID* (3.2), *animal identification header* (3.3), *animal identification code* (3.4), *8-bit CRC* (3.15) and ISO 18000-63 *transponder* (3.30).

3.2
data storage format identifier
DSFID
8-bit number defined by ISO/IEC 15962 that indicates the application and how the data is structured into the UII memory of the ISO 18000-63 transponder, i.e. the access method and data format

Note 1 to entry: See *UII* (3.1) and ISO 18000-63 *transponder* (3.30).

3.3
animal identification header
16-bit code reserved for future use

Note 1 to entry: The animal identification header shall be set to 0 as default.

3.4
animal identification code
64-bit pattern which unequivocally identifies an animal comprising the country code or manufacturer's code, the national identification code and the control bits

Note 1 to entry: The animal identification code is defined by the ISO 11784.

Note 2 to entry: See *country code* (3.5), *manufacturer's code* (3.6), *national identification code* (3.7) and *control bits* (3.8).

3.5
country code
10-bit pattern to define the country where the transponder was issued or used, according to ISO 3166-1

3.6
manufacturer's code
10-bit pattern identifying the manufacturer of the transponder

Note 1 to entry: The manufacturer's code is used as alternative to the country code, when no competent authority is available to issue the country code authorization.

Note 2 to entry: ISO has appointed the International Committee for Animal Recording (ICAR) as the registration authority (RA) competent to register and manage manufacturer codes used in the radio frequency identification (RFID) of animals in accordance with ISO 11784 and ISO 11785.

3.7
national identification code
38-bit code field with a unique number within a country, where the code structure and sequence is defined by the country in charge

3.8
control bits
16-bit code that contains the animal application bit, the retagging counter, the user information field, the reserved field, the RUDI bit and the data block bit

Note 1 to entry: See *animal application bit* (3.9), *retagging counter* (3.10), *user information field* (3.11), *reserved field* (3.12), *RUDI-bit* (3.13) and *data block bit* (3.14).

3.9
animal application bit
bit which signals whether the transponder is used for animal identification or not

Note 1 to entry: In all animal applications this bit shall be 1.

3.10
retagging counter
three-bit counter for counting the number of retagging

3.11
user information field
five-bit field for additional user information, used only in conjunction with the country code

Note 1 to entry: See *country code* (3.5).

3.12
reserved field
6-bit code reserved for future use

3.13
RUDI-bit
bit indicating the existence of data in the User Memory (MB11)

Note 1 to entry: The RUDI-bit shall have the same value of the UMI bit. The RUDI-bit and UMI bit shall be encoded with the value 0 if the User Memory is empty or not available.

Note 2 to entry: See *country code* (3.5) and *UMI* (3.19).

3.14
data block bit
bit indicating the existence of data in the additional UII memory

3.15
8-bit CRC
8-bit Cyclic Redundancy Check computed over the contents of the UII

Note 1 to entry: The 8-bit CRC protects the information against bit flipping.

3.16
memory bank
MB
designated name of a segmented memory structure

Note 1 to entry: For this document, the memory banks are: 00 (Reserved), 01 (UII memory), 10 (TID), and 11 (User memory) using binary notation.

Note 2 to entry: See ISO 18000-63 *transponder* (3.30).

3.17
storedCRC
16-bit CRC automatically generated, computed over the contents of the StoredPC and the UII

Note 1 to entry: The storedCRC does not protect against bit flipping (unintentional change of state of a bit stored in memory).

Note 2 to entry: See *StoredPC* (3.18) and *UII* (3.1).

3.18
storedPC
protocol-control information stored in the UII Memory Bank (MB 01) that contains the Length Indicator, the UMI, the XI, the Toggle Bit and the AFI

Note 1 to entry: See *StoredPC* (3.18), *UMI* (3.19), *XI* (3.20), *toggle bit* (3.21) and *AFI* (3.22).

3.19
user memory indicator
UMI
Boolean flag in the UII Memory Bank (MB 01) indicating whether the User Memory Bank (MB 11) is present and contains data

Note 1 to entry: The UMI bit shall have the same value of the RUDI-bit.

Note 2 to entry: See *RUDI-bit* (3.13).

3.20
extended protocol control indicator
XI
bit in the UII Memory Bank (MB 01) indicating whether XPC words are present

3.21
toggle bit
Boolean flag in the UII Memory Bank (MB 01) indicating whether the presence of an Application Family Identifier (AFI)

Note 1 to entry: The Toggle bit shall be encoded with the value 1 to indicate the presence of the AFI.

Note 2 to entry: See *AFI* (3.22).

3.22
application family identifier
AFI
code programmed in the UII Memory Bank (MB 01) used to select a class of RFID tags relevant to an application, or aspect of an application, and to ignore further communications with other classes of RFID tags with different identifiers

Note 1 to entry: This document does not use GS1 EPC coding but ISO coding.

Note 2 to entry: Application Family Identifier is defined in ISO/IEC 15961-3.

3.23
ISO coding
application whose usage denotes an acceptance of ISO standards and policies and where in MB01 an Application Family Identifier as defined in ISO/IEC 15961-3 is encoded

3.24
kill password
32-bit password in the Reserved Memory Bank (MB 00) that is presented to the tag in order to complete the mandatory "Kill" command

Note 1 to entry: The "Kill" command is used to permanently silence a tag.

Note 2 to entry: For ISO 6881 transponders, the use of the Kill Command is disabled (see 5.2).

3.25
access password
32-bit password in the Reserved Memory Bank (MB 00) that is presented to the tag in order to perform privileged operations

3.26
tag identifier
TID
64-bit unique unmodifiable, pre-programmed identification number generated by the IC manufacturer in the TID Memory Bank (MB 10) that guarantees the uniqueness of each device on the market and ensures full traceability

3.27
backward compatibility
compatibility with former generation systems and/or databases

3.28
transceiver
device used to activate and then communicate with a transponder (also called RFID reader)

Note 1 to entry: See *transponder* (3.29).

3.29
transponder
device which transmits its stored information when activated by a transceiver and may be able to store new information

Note 1 to entry: See *transceiver* (3.28).

3.30
ISO 18000-63 transponder
device in accordance with ISO/IEC 18000-63 which transmits its stored information when activated by a transceiver and may be able to store new information

Note 1 to entry: In this document, the ISO 18000-63 transponder shall have a minimum of 96 bits of UII memory encoding size.

Note 2 to entry: See *transceiver* (3.28).

4 Symbols (and abbreviated terms)

AFI	Application Family Identifier
CRC	Cyclic Redundancy Check
DSFID	Data Storage Format Identifier
EPC	Electronic Product Code
ICAR	International Committee for Animal Recording
IEC	International Electrotechnical Commission
ISO	International Standard Organization
LF	Low Frequency
LFSR	Linear Feedback Shift Register
MB	Memory Bank
PC	Protocol Control
RA	Registration Authority
RFID	Radio Frequency Identification
RFU	Reserved for Future Use
TID	Tag Identifier
UHF	Ultra-High Frequency
UII	Unique Item Identifier
UMI	User Memory Indictor
XPC	Extended protocol control

5 General requirements

5.1 General

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

— 00 – Reserved memory for passwords.

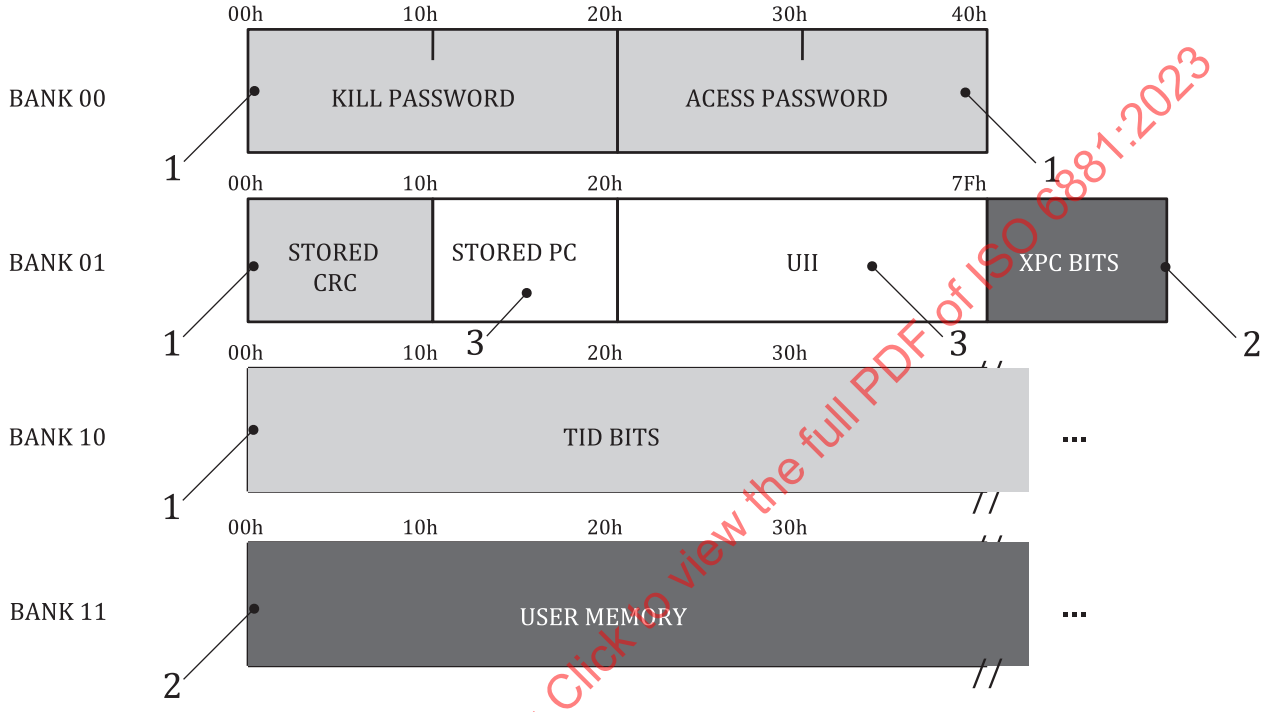
— 01 – UII memory for the unique item identifier.

— 10 – TID memory for tag identification.

— 11 – User memory for additional user data.

NOTE The Memory Bank 11 is optional and might not be supported in some ISO 18000-63 transponders. The use of Memory Bank 11 to store additional user data shall be indicated by setting the RUDI bit and the UMI bit to 1.

The structure of the memory banks of an ISO 18000-63 transponder is shown in Figure 1.



Key

1 fixed
2 optional
3 animal code

Figure 1 — Memory map of ISO 18000-63 transponder

5.2 Structure of Reserved Memory Bank (MB 00)

This Memory Bank is used to store the Kill Password and Access Password.

The Kill Password is a 32-bit password that shall be presented to the tag in order to complete the "Kill" command. The 32-bit Kill Password is stored at locations 00_{HEX} to $1F_{HEX}$. The "Kill" command is used to permanently silence a tag.

The Access Password is a 32-bit password that shall be presented to the tag in order to perform privileged operations. The 32-bit Access Password is encoded at location 20_{HEX} to $3F_{HEX}$.

The default un-programmed value is zero. A tag with a non-zero Access Password requires the interrogator to issue this password before entering the secured state of the tag.

This document does not specify the use of Access password. The Kill Password shall be set to zero and permanently locked to avoid the use of the Kill Command.

5.3 Structure of TID Memory Bank (MB 10)

The 64-bit TID shall be programmed and write permalocked at wafer test by the IC manufacturer, before customer delivery. This guarantees the uniqueness of each device on the market.

The 64-bit TID is stored at locations 00_{HEX} to $3F_{HEX}$.

5.4 Structure of UII Memory Bank (MB 01)

5.4.1 General

This Memory Bank contains the UII and associated syntax. See Figure 2.

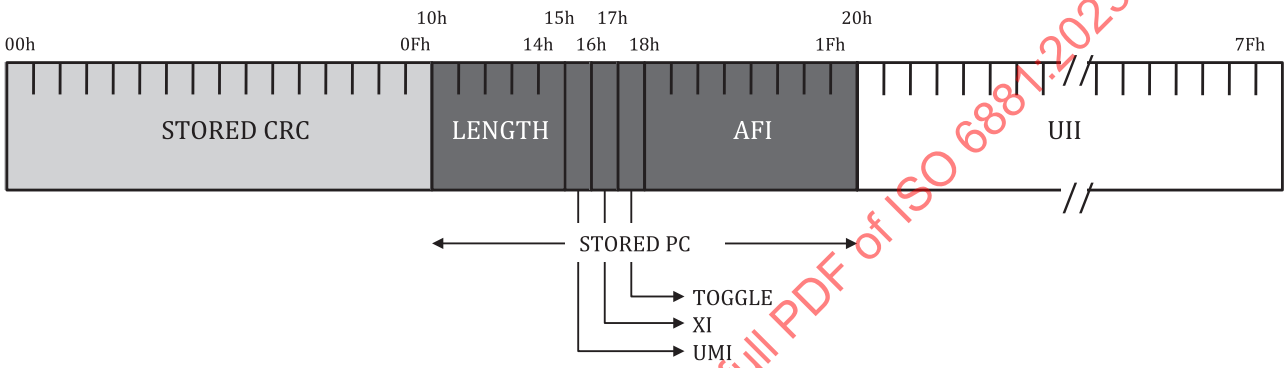


Figure 2 — MB 01 Memory Map for an ISO 18000-63 transponder for animal identification purpose

The first word at memory address location 00_{HEX} to $0F_{HEX}$ contains a storedCRC-16. This is automatically generated when the tag is processed. The rules and algorithm for that are explained in ISO/IEC 18000-63:2021, Annex F.

The second word contains a StoredPC at memory locations 10_{HEX} to $1F_{HEX}$.

In the sequence of the StoredPC, the MB01 contains the UII at memory locations 20_{HEX} to $7F_{HEX}$.

5.4.2 Structure of the StoredPC

The structure of the StoredPC is significant and relevant to this document as follows:

— A UII Length Indicator encoded in memory locations 10_{HEX} to 14_{HEX} represents the number of 16-bit words comprising the UII field. The transceiver should read the Length Indicator to check the UII memory size.

— A User Memory Indicator (UMI) is stored in location 15_{HEX}. This bit indicates whether the user memory bank (MB 11) is present and contains data. The UMI bit shall have the same value of the RUDI-bit.

— An Extended Protocol Control Indicator (XI) is stored in location 16_{HEX}. This bit indicates whether an XPC word is present. The function of this bit is beyond the scope of this document. The XI bit shall be encoded with the value 0 to indicate the absence of XPC words.

— The Toggle Bit is a boolean flag indicating whether the next 8 bits represents reserved memory or an Application Family Identifier (AFI). It is encoded in memory location 17_{HEX}. In this document, the Toggle Bit shall be encoded with the value 1 to indicate that the following eight bits are the AFI.

— An AFI Code: 0xAF with the Dataformat Decimal Value of 32 which is defined under the authority of AIM and registered at ISO/IEC 15961 Data Construct Register. This document does not use EPC

coding but ISO coding. The AFI is encoded in memory locations 18_{HEX} to $1F_{HEX}$ with the bit values AF_{HEX}.

The structure of the StoredPC is shown in Table 1.

Table 1 — Structure of the StoredPC

5 bits - Length					1 bit - UMI	1 bit - XI	1 bit - Toggle bit	8 bits - AFI							
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
0	0	1	1	0	X	X	1	1	0	1	0	1	1	1	1

5.4.3 Structure of the UII

5.4.3.1 General

In this document focused on animal identification, the Unique Item Identifier (UII) contains the 64-bit Animal Identification Code shall be in accordance with ISO 11784, guaranteeing a unique electronic code structure worldwide and across LF and UHF technologies and providing backward compatibility with data structure on existing national traceability databases. The ISO 18000-63 transponder shall have a minimum of 96 bits of UII memory.

If the ISO 18000-63 transponder has more than 96 bits of UII memory, the additional bits shall be set to zero. In case the additional bits contain data, the Data Block indicator bit shall be set to 1.

The structure of the 96 bits UII is shown in Table 2.

Table 2 — Structure of the UII

		MS byte								LS byte							
		MS bit							LS bit	MS bit							LS bit
70h-7Fh	End	b15 User info	b14 User info	b13 User info	b12 User info	b11 Retag	b10 Retag	b9 Retag	b8 Ani-mal	b7 CRC	b6 CRC	b5 CRC	b4 CRC	b3 CRC	b2 CRC	b1 CRC	b0 CRC
60h-6Fh		b31 CC / MFC	b30 CC / MFC	b29 CC / MFC	b28 CC / MFC	b27 CC / MFC	b26 CC / MFC	b25 CC / MFC	b24 CC / MFC	b23 Data blk	b22 Rudi	b21 RFU	b20 RFU	b19 RFU	b18 RFU	b17 RFU	b16 User info
50h-5Fh		b47 ID	b46 ID	b45 ID	b44 ID	b43 ID	b42 ID	b41 ID	b40 ID	b39 ID	b38 ID	b37 ID	b36 ID	b35 ID	b34 ID	b33 CC / MFC	b32 CC / MFC
40h-4Fh		b63 ID	b62 ID	b61 ID	b60 ID	b59 ID	b58 ID	b57 ID	b56 ID	b55 ID	b54 ID	b53 ID	b52 ID	b51 ID	b50 ID	b49 ID	b48 ID
30h-3Fh		b79 Head-er	b78 Head-er	b77 Head-er	b76 Head-er	b75 Head-er	b74 Head-er	b73 Head-er	b72 Head-er	b71 ID	b70 ID	b69 ID	b68 ID	b67 ID	b66 ID	b65 ID	b64 ID
20h-2Fh	Start	b95 DSFID	b94 DSFID	b93 DSFID	b92 DSFID	b91 DSFID	b90 DSFID	b89 DSFID	b88 DSFID	b87 Head-er	b86 Head-er	b85 Head-er	b84 Head-er	b83 Head-er	b82 Head-er	b81 Head-er	b80 Head-er

The structure of the UII is described as follows:

— A data storage format identifier (DSFID) is encoded in memory locations 20_{HEX} to 27_{HEX}, The DSFID is 32_{HEX}, an 8-bit number defined by ISO/IEC 15962 that indicates how the data is structured into the memory of the ISO 18000-63 transponder, i.e. the access method and data format.

— An Animal Identification Header is encoded in memory locations 28_{HEX} to 37_{HEX}. The Animal Identification Header is a 16-bit code reserved for future use. RFU values are reserved for future extensibility. Third parties, including but not limited to solution providers and end users, shall not use these RFU values for proprietary purposes.

— An Animal Identification Code is encoded in memory locations 38_{HEX} to 77_{HEX}, The Animal Identification Code is a 64-bit pattern to identify an animal comprising the Country Code or Manufacturer's Code, the National Identification Code and the Control Bits.

— A 8-Bit CRC is encoded in memory locations 78_{HEX} to $7F_{HEX}$. The CRC-8 computed over the contents of the UII memory, that is, from the location 20_{HEX} to 77_{HEX} of MB 01.

5.4.3.2 Structure of the Animal Identification Code

The Animal Identification Code is a bit pattern, located in the UII memory, to identify an animal comprising the Country Code or Manufacturer's Code, the National Identification Code and the Control Bits. The structure of the Animal Identification Code is in accordance with ISO 11784, guaranteeing a unique electronic code structure worldwide and across LF and UHF technologies and providing backward compatibility with data structure on existing national traceability databases.

The structure of the Animal Identification Code is shown in Table 3.

Table 3 — Structure of the Animal Identification Code

ISO 11784 DATA STRUCTURE (FROM 38h TO 77h)																										
38 BITS NATIONAL IDENTIFICATION CODE					10 BITS COUNTRY CODE			1 BIT DATA BLOCK	1 BIT RUDI BIT	5 BITS UNUSED																
38	39	3A ...5B	5C	5D	5E	5F ... 66	67	68	69	6A	6B	6C	6D	6E	6F	70	71	72	73	74	75	76	77			
X	X	...	X	X	X	...	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	1			

The structure of the Animal Identification Code is described below:

— A National Identification Code is encoded in memory locations 38_{HEX} to $5D_{HEX}$, The National Identification Code is a 38-bit code field with a unique number within a country.

— A Country Code or Manufacturer's Code is encoded in memory locations $5E_{HEX}$ to 67_{HEX}, The Country Code is a 10-bit pattern to define the country where the transponder was issued, according to ISO 3166-1. The Manufacturer's Code is a 10-bit pattern identifying the manufacturer of the transponder.

— Control Bits are encoded in memory locations 68_{HEX} to 77_{HEX}. The Control Bits contains the:

  — Data Block indicator bit that indicates the existence of a data block in the UII Trailer;

  — RUDI-bit that indicates the existence of data in the User Memory (MB11). The RUDI-bit bit shall have the same value of the UMI bit;

  — Reserved field that are 5-bit pattern reserved for future use. RFU values are reserved for future extensibility. Third parties, including but not limited to solution providers and end users, shall not use these RFU values for proprietary purposes;

  — User information field. The content of this 5-bit pattern is informative. It is defined by the country, as coded in the country code field;

— Retagging counter that are 3 bits pattern that indicate a retagging with the same identification number. This counter shall be zero for the first assignment of a transponder to an animal;

— Animal application bit indicates whether the transponder is used for animal identification or not. In all animal applications this bit shall be 1.

5.4.3.3 CRC-8

The CRC is implemented as a linear feedback shift register (LFSR). The Shift register computes the LFSR function, the Polynomial register holds the polynomial that defines the LFSR and the Seed register enables initialization of the starting data.

This component requires that the Seed and Polynomial registers are initialized prior to start. Computation of an n-bit LFSR result is specified by a polynomial with n + 1 terms, the last of which is the X^0 term where $X^0 = 1$.

The CRC-8 polynomial is $x^8 + x^2 + x + 1$. The CRC algorithm assumes the presence of the X^0 term, so that the polynomial for an n-bit result can be expressed by an n bit rather than (n + 1) bit specification.

To specify the polynomial specification, write an (n + 1) bit binary number corresponding to the full polynomial, with 1's for each term present.

The CRC-8 polynomial would be 100000111_{BIN} or 107_{HEX}. Then, drop the right-most bit (the X^0 term) with the value 1 to obtain the CRC polynomial value.

To implement the CRC example, the Polynomial register is loaded with a value of 07_{HEX}. A rising edge of the input clock shifts each bit of the input data stream, MSB first, through the Shift register, computing the specified CRC algorithm. Eight clocks are required to compute the CRC for each byte of input data.

CRC-8 is to be applied to the DSFID + Animal Identification Header + Animal Identification Code.

Annex A provides a reference source code for calculating the CRC-8.

6 Backward compatibility

6.1 General

The structure of the Animal Identification Code and the meaning of each bit pattern is in accordance with ISO 11784, guaranteeing a unique electronic code structure worldwide and across LF and UHF technologies and providing backward compatibility with data structure on existing national traceability databases. The backward compatibility with the ISO 11784 is shown in Figure 3.

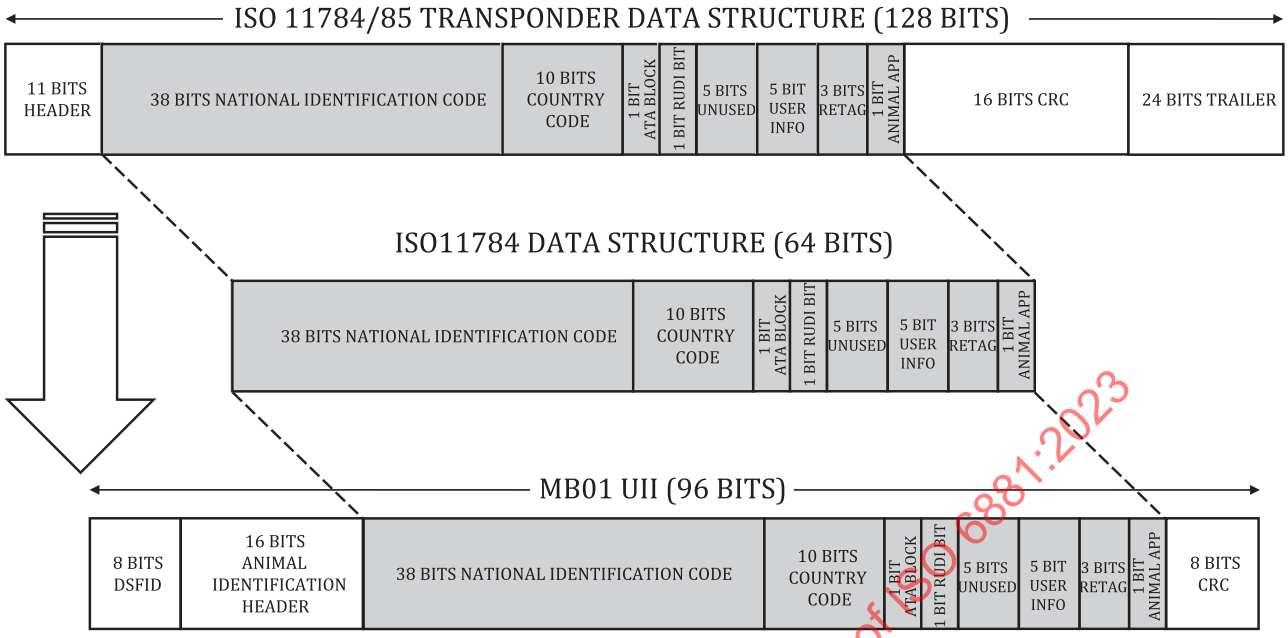


Figure 3 — Backward compatibility with the ISO 11784 scheme

6.2 LF transponders (for reference)

There are 3 different memory sections in a LF transponder in accordance with ISO 11784, ISO 11785 and ISO 14223:

— Identification Code.

— Trailer.

— Extended memory.

NOTE The Extended memory can be equal or larger than 64 bits. The RUDI-bit in the Animal Identification Code indicates the presence of data in this memory. The ISO 14223 series gives guidance for the use of the Extended memory in ISO 11784 transponders.

The 64 bits Animal Identification Code is located at the Identification Code memory in a LF transponder. It is not necessary to have a flag bit to indicate the use of this memory since it is mandatory and always present.

The 24 bits Trailer memory is always present in an LF transponder. The Data Block indicator bit in the Animal Identification Code indicates the presence of data in this memory.

6.3 UHF transponders

There are 3 different memory sections to store data in the Memory Banks of an UHF transponder:

— UII;

— UII Trailer;

— User memory.

The Animal Identification Code is located at the UII memory (MB01). The UII memory shall have at least 96 bits. It is not necessary a flag bit to indicate the use of this memory since it is mandatory and always present.