INTERNATIONAL STANDARD

**ISO 14223-2**

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# Radiofrequency identification of animals — Advanced transponders —

## Part 2: Code and command structure

*Identification des animaux par radiofréquence — Transpondeurs évolués —*

*Partie 2: Code et structure de commande*



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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 14223-2 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

ISO 14223 consists of the following parts, under the general title *Radiofrequency identification of animals — Advanced transponders*:



— *Part 1: Air Interface*

— *Part 2: Code and command structure*

The following part is under preparation:



— *Part 3: Applications*

## Introduction

This part of 14223 specifies the communication interface of the radio frequency (RF) system for advanced transponders for animals. The technical concept of advanced transponders for animal identification described is based upon the principle of radio frequency identification (RFID) and is an extension of the standards ISO 11784 and ISO 11785. Apart from transmission of the (unique) identification code of animals, the application of advanced technologies facilitates the storage and retrieval of additional information (integrated database), the implementation of authentication methods and the reading of data from integrated sensors, etc.

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# Radiofrequency identification of animals — Advanced transponders —

# Part 2: Code and command structure

## 1 Scope

This part of ISO 14223 specifies the code and command structure between the transceiver and the advanced transponder used in the radiofrequency identification of animals, this specification being fully backwards-compatible with those of ISO 11784 and ISO 11785. As a direct extension of ISO 11785, it is intended to be used in conjunction with that International Standard.

## 2 Normative references



The following referenced documents are indispensable for the application 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*

ISO 11785, *Radio frequency identification of animals — Technical concept*

ISO/IEC 7816-6, *Identification cards — Integrated circuit cards — Part 6: Interindustry data elements for interchange*

ISO 24631-1, *Radiofrequency identification of animals — Part 1: Evaluation of conformance of RFID transponders with ISO 11784 and ISO 11785 (including granting and use of a manufacturer code)*

## 3 Conformance

### 3.1 Transponder

For conformance with this part of ISO 14223 to be claimed, a transponder shall be FDX-ADV or HDX-ADV.

NOTE Nothing in this International Standard prevents a transponder being of more than one type, although for technical reasons, it is unlikely that such transponders are ever marketed.

### 3.2 Transceiver

For conformance with this part of ISO 14223 to be claimed, a transceiver shall support both FDX-ADV and HDX-ADV. When in the inventory mode, the transceiver shall alternate between FDX-ADV and HDX-ADV interrogation. The transceiver shall move back to ISO 11785 mode after completion of the advanced operation.

## 4 Terms and definitions

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

**4.1**
**advanced transponder**
transponder conforming to ISO 14223, downward compatible according to ISO 11784 and ISO 11785, with facilities for storage and retrieval of additional data, integrated sensors, etc.

**4.2**
**advanced mode**
operating method of the advanced transponder after reception of a valid command

**4.3**
**anticollision sequence**
algorithm used to prepare for and handle a dialogue between transceiver and one or more transponders out of several in its energizing field

**4.4**
**byte**
eight bits of data designated b1 to b8, from the most significant bit (MSB, b8) to the least significant bit (LSB, b1)

## 5 Abbreviated terms



BSS block security status

CRC cyclic redundancy check

CRCT response cyclic redundancy check flag



DSFID data storage format identifier

EOF end of frame

FDX full duplex

IC integrated circuit

ICR integrated circuit reference number

HDX half duplex

LSB least significant bit

MFC integrated circuit manufacturer code

MSB most significant bit

MSN manufacturer serial number

NOB number of blocks per page

NOP number of pages

NOS number of slots

NRZ non-return to zero

NSS number of sensors

RF radio frequency

RTF reader talk first

RFU reserved for future use

SOF start of frame

UID unique identifier (includes MFC and MSN)

# 6 Transmission protocol

## 6.1 Basic elements

The advanced transmission protocol defines the mechanism for exchanging instructions and data between the transceiver and the transponders, in both directions.

It is based on the following concepts.

— The transponders are by default conformant with ISO 11784 and ISO 11785. This shall be evaluated conformant with ISO 24631-1. For advanced instructions the transceiver has the ability to communicate with a transponder in the advanced mode. In this mode the transponder is communicating in RTF mode and does not start to respond unless it has received and decoded a valid request from the transceiver.



— The transponders are uniquely identified by 48 bit UID, programmed at the manufacture of the integrated circuit. The UID coding is defined in 6.2.



— An identification code of 64 bits according to ISO 11784 is stored in page 0 (the four blocks given in Table 11 can be used to store the full ISO 11785 protocol) of the user memory area (blocks 0 to 3). This identification code shall be programmed and locked by the transponder issuer in order to avoid manipulations.

The advanced mode protocol is based on

— a request from the transceiver to the transponder, and

— a response from the transponder to the transceiver.

The protocol is bit-oriented. The number of bits transmitted after a SOF depends on the respective request and response.

Flags are used for the control of request and response format. The setting of the flags indicates either request and response variants (e.g. number of slots) or the presence of optional fields. In the case of optional fields, when the flag is set to one (1), the field is present. When the flag is reset to zero (0), the field is absent.

RFU flags shall be set to zero (0).

## 6.2 Unique identifier

The UID is used for addressing each transponder uniquely and individually.

The length of the UID is 48 bits, the format of the UID is presented in Table 1. The IC manufacturer is responsible for setting the UID as defined by this part of ISO 14223 and for ensuring the uniqueness of the MSN.

**Table 1 — UID format**

| MSB | LSB |
|---|---|
| 48 ..... 41 | 40 ..... 1 |
| IC manufacturer code (MFC) | IC manufacturer serial number (MSN) |

The UID shall comprise

— the 8 bit MFC, according to ISO/IEC 7816-6, and

— the 40 bit MSN, a unique serial number assigned by the IC manufacturer.

### 6.3 Request format

A request consists of the following elements:

— SOF;

— flags;

— command;

— parameters (depending on the command);

— data (depending on the command);

— CRC (optional);

— EOF.



The general request format is presented in Table 2.

**Table 2 — General request format**

| SOF | flags | command | parameters | data | CRC | EOF |
|---|---|---|---|---|---|---|

Each request starts with a SOF. The fields are transmitted successively from the first field (flags) to the last field (e.g. CRC). All fields are transmitted LSB first. At the end of a request, an EOF is appended.

The allocation of the LSB and MSB for each field of the request format is shown in Table 3.

**Table 3 — Allocation of LSB and MSB to the request fields**

| | LSB MSB | LSB MSB | LSB MSB | LSB MSB | LSB MSB | |
|---|---|---|---|---|---|---|
| SOF | Field 1 (5 bits) (Flags 1 … 5) | Field 2 (6 bits) (Command) | Field 3 (Parameters) | Field 4 (Data) | Field 5 (16 bits) (CRC) | EOF |

## 6.4 Response format

A response consists of the following elements:

— SOF pattern;

— error flag;

— error code;

— data (depending on the command);

— CRC (is optional depending on command and flag settings);

— EOF pattern.

The format of the general response if there is no error is presented in Table 4 and that of the general response if there is an error in Table 5.

**Table 4 — General response format if no error**

| | | | | |
|---|---|---|---|---|
| SOF | Error flag 0 | Data | CRC | EOF |



**Table 5 — General response format if error**

| | | | | |
|---|---|---|---|---|
| SOF | Error flag 1 | Error code | CRC | EOF |



Each response begins with a SOF. The subsequent fields are transmitted successively from the first field (Flag) to the last field (e.g. CRC). All fields are transmitted LSB first. At the end of a response, an EOF is appended.

The allocation of the LSB and MSB for each field of the response format is shown in Table 6.

**Table 6 — Allocation of LSB and MSB to response fields**

| | LSB MSB | LSB MSB | LSB MSB | |
|---|---|---|---|---|
| SOF | Field 1 (1 bit)<br>(Error flag) | Field 2 (⩾3 bits)<br>(Error code or data) | Field 3 (16 bits)<br>(CRC) | EOF |

## 6.5 Request flags

### 6.5.1 General

In each request, five flags are used, with flag b1 to be transmitted first. The specific meaning of the request flags depends on the context. The meaning of request flags b1 to b3 is explained in Table 7, that of b4 and b5 where the inventory flag is *not* set in Table 8 and that where the inventory flag *is* set in Table 9.

**Table 7 — Meaning of request flags b1 to b3**

| Bit | Flag name | Value | Description |
|---|---|---|---|
| b1 | PEXT (protocol extension) flag | 0 | No protocol format extension |
| | | 1 | RFU |
| b2 | INV (inventory) flag | 0 | The meaning of flags b4 to b5 is according to Table 8 |
| | | 1 | The meaning of flags b4 to b5 is according to Table 9 |
| b3 | CRCT | 0 | CRC shall *not* be appended to the transponder response |
| | | 1 | CRC shall be appended to the transponder response |

**Table 8 — Request flags b4 to b5 definition when inventory flag is *not* set**

| Bit | Flag name | Value | Description |
|---|---|---|---|
| b4 | SEL (select) flag | 0 | Request shall be executed by any transponder according to the setting of the address flag. |
| | | 1 | Request shall be executed only by transponder in selected state. The address flag shall be set to 0 and the UID field shall not be included in the request. |
| b5 | ADR (address) flag | 0 | Request is not addressed. UID field is not included. It shall be executed by any transponder. |
| | | 1 | Request is addressed. UID field is included. It shall be executed only by that transponder whose UID matches the UID specified in the request. The SEL flag shall be set to 0. |



**Table 9 — Request flags b4 to b5 definition when the inventory flag is set**

| Bit | Flag name | Value | Description |
|---|---|---|---|
| b4 | RFU | 0 | — |
| b5 | NOS flag | 0 | 16 slots |
| | | 1 | 1 slot |

A further description of these flags is given in 6.5.2 to 6.5.4.

### 6.5.2 NOS flag

The NOS flag (see Table 10) is used by the INVENTORY command to select the number of slots during execution of the anticollision sequence.

**Table 10 — Meaning of NOS flag**

| NOS flag | Meaning only for INVENTORY command |
|---|---|
| 0 | 16 slots |
| 1 | 1 slot |

### 6.5.3 SEL flag and ADR flag

The SEL flag and ADR flag are used by all commands except the INVENTORY and READ UID commands.

When both the ADR flag and the SEL flag are set to 0, the request shall not contain a UID. Any transponder in the ready state receiving such a request shall execute it (if possible) and shall return a response to the transceiver as specified by the command description.

When the ADR flag is set to 1 (addressed mode), the request shall contain the UID of the addressed transponder. Independent of the state, any transponder receiving such a request shall compare the received UID (address) to its own ID. If it matches, it shall execute it (if possible) and return a response to the transceiver as specified by the command description. If it does not match, it shall remain silent and keep its current state.

When the SEL flag is set to 1 (selected mode), the request shall not contain a transponder UID. Only the transponder in the selected state receiving such a request shall execute it (if possible) and shall return a response to the transceiver as specified by the command description. Other transponders not in the selected state shall keep their current state and be silent. The combination of ADR and SEL flag is not supported.

Table 11 gives an overview of the meaning of the SEL flag and ADR flag.

**Table 11 — Meaning of SEL flag and ADR flag**

| SEL | ADR | Meaning for all commands except INVENTORY and READ UID |
|---|---|---|
| 0 | 0 | No UID is attached. All transponders in the ready state shall execute this command. |
| 0 | 1 | The UID is attached. Only the transponder with corresponding UID shall execute this command. |
| 1 | 0 | No UID is attached. Only the transponder in the selected state shall execute this command. |
| 1 | 1 | RFU |



### 6.5.4 CRCT flag

The CRCT flag specifies whether or not the transponder is to attach a CRC in its response. The CRC implementation on the transponder is mandatory.

## 6.6 Response flag and error code

The error flag indicates whether or not the transponder has detected an error (see Table 12). If it is set to 1, the response error field shall be returned according to Table 13.

If the transponder does not support specific error codes (as listed in Table 13) it shall answer with the error code 7 “unknown error”.

**Table 12 — Error flag**

| Error flag | Meaning |
|---|---|
| 0 | No error |
| 1 | Error detected |