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**Information and documentation —  
RFID in libraries —**

**Part 4:  
Encoding of data elements based on  
rules from ISO/IEC 15962 in an RFID  
tag with partitioned memory**

*Information et documentation — RFID dans les bibliothèques —*

*Partie 4: Encodage des éléments de données RFID fondé sur les règles  
de l'ISO/CEI 15962 dans une étiquette de RFID avec la mémoire  
divisée*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 4, *Technical interoperability*.

This second edition cancels and replaces the first edition (ISO/TS 28560-4:2014), which has been technically revised.

The main changes are as follows:

- a few updates are made and a new clause (see [Clause 11](#)) about RFID Emblem has been added;
- [Annexes B, C and D](#) have been changed to informative.

A list of all parts in the ISO 28560 series can be found on the ISO website.

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](http://www.iso.org/members.html).

## Introduction

Libraries are implementing radio frequency identification (RFID) as item identification to replace bar codes. RFID streamlines applications like user self-service, security, and materials handling. This standard data model for encoding information on RFID tags increases the cost-effectiveness of the technology within libraries particularly through greater interoperability of RFID tags and equipment, and enhance support for resource sharing between libraries.

A standard data model, taking into account the lessons learned from the national schemes and vendor solutions was developed with ISO 28560-1, which defines the set of mandatory and optional data elements. ISO 28560-2 and ISO 28560-3 define encoding rules for those libraries that choose to use High Frequency RFID technology operating at 13,56 MHz.

This document defines encoding rules for those libraries that choose to use UHF RFID technology operating at 860 MHz to 960 MHz, with the interrogators (readers) set to conform to local radio regulations that specify only part of this spectrum. The UHF tags can function efficiently in any of the radio regulated regions. This document uses encoding rules that are specified in ISO/IEC 15962, as does ISO 28560-2. Some of the encoding rules are different because of the nature of the different RFID technology, but a number of rules are similar if not identical.

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# Information and documentation — RFID in libraries —

## Part 4:

# Encoding of data elements based on rules from ISO/IEC 15962 in an RFID tag with partitioned memory

## 1 Scope

This document defines rules for ISO 28560-1 data elements to be encoded in radio frequency identification (RFID) tags with a memory structure that is partitioned into four memory banks. This primarily applies to ISO/IEC 18000-63 (previously known as ISO/IEC 18000-6 Type C) operating in the UHF frequency, but not necessarily restricted to this technology.

The rules for encoding a subset of data elements taken from the total set of data elements defined in ISO 28560-1 are based on ISO/IEC 15962, which uses an object identifier structure to identify data elements. This document defines the rules for encoding a unique item identifier in a specific memory bank, known as MB 01, taking into account different requirements for privacy. It also defines the rules for encoding other relevant data in a separate memory bank, known as MB 11. Each of these memory banks is addressable using different command set of the appropriate RFID technology.

As with other parts of ISO 28560, this document is appropriate for the needs of all types of libraries (including academic, public, corporate, special, and school libraries).

This document provides essential standards-based information about RFID in libraries. A source of additional information about implementation issues is provided in [Annex A](#).

## 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/IEC 15961-1, *Information technology — Radio frequency identification (RFID) for item management: Data protocol — Part 1: Application interface*

ISO/IEC 15962, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions*

ISO/IEC 18000-63, *Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C*

ISO/IEC 18046-1, *Information technology — Radio frequency identification device performance test methods — Part 1: Test methods for system performance*

ISO/IEC 18046-2, *Information technology — Radio frequency identification device performance test methods — Part 2: Test methods for interrogator performance*

ISO/IEC 18046-3, *Information technology — Radio frequency identification device performance test methods — Part 3: Test methods for tag performance*

ISO/IEC 18047-6, *Information technology — Radio frequency identification device conformance test methods — Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

ISO 28560-1, *Information and documentation — RFID in libraries — Part 1: Data elements and general guidelines for implementation*

### 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 access method

component of the *DSFID* (3.8) that is responsible for declaring the ISO/IEC 15962 compaction and encoding rules on an RFID tag

Note 1 to entry: In this document, the term is only relevant to Memory Bank 11, containing optional data elements.

#### 3.2 air interface protocol

rules of communication between an RFID interrogator and the RFID tag of a particular type, covering frequency, modulation, bit encoding, and command sets

#### 3.3 application command

instruction issued from the application to the ISO/IEC 15962 data protocol processor in order to initiate an action or operation with the RFID tag(s) through the interrogator

#### 3.4 application family identifier AFI

mechanism used in the data protocol and the *air interface protocol* (3.2) 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: In this document, the term is only relevant to Memory Bank 01, containing the data elements comprising the UII.

#### 3.5 arc

specific branch of an object identifier tree, with new arcs added as required to define a particular object

Note 1 to entry: The top three arcs of all object identifiers are compliant with ISO/IEC 9834-1 ensuring uniqueness.

#### 3.6 data format

component of the *DSFID* (3.8) that is a mechanism used in the data protocol to identify how *object identifiers* (3.12) are encoded on the RFID tag, and (where possible) identify a particular data dictionary for the set of relevant object identifiers for that application

Note 1 to entry: In this document, the term is only relevant to Memory Bank 11, containing optional data elements. The data format declares the *Root-OID* (3.14) in an efficient manner, so that a complete object identifier can be reconstructed for external communications.

#### 3.7 data protocol processor

implementation of the processes defined in ISO/IEC 15962, including data compaction, formatting, support of the command/response unit, and an interface to the tag driver



### 3.8 data storage format identifier DSFID

code that consists of, at least, the *access method* (3.1) and *data format* (3.6)

Note 1 to entry: In this document, the term is only relevant to Memory Bank 11, containing optional data elements.

### 3.9 digital vandalism

unauthorized modification of data on an RFID tag that either renders it unusable or falsely represents another identifier

### 3.10 Memory Bank MB

designated name of a *segmented memory structure* (3.15)

Note 1 to entry: In this document, the Memory Banks 00, 01, 10, and 11 are using binary notation.

### 3.11 metadata

type of data or information about data

Note 1 to entry: In the context of this document, metadata can be the *Relative-OID* (3.13) in relation to the data, the precursor in relation to the compacted and encoded bytes, or the *AFI* (3.4) and *DSFID* (3.8) in relation to the data.

### 3.12 object identifier

value (distinguishable from all other such values), which is associated with an object

### 3.13 Relative-OID

particular *object identifier* (3.12) that constitutes the remaining *arcs* (3.5) after the *Root-OID* (3.14)

### 3.14 Root-OID

particular *object identifier* (3.12) that constitutes the first, second, and subsequent common *arcs* (3.5) of a set of object identifiers (hence, the common root)

### 3.15 segmented memory structure

memory storage that is separated into separate elements and requires multiple addressing elements for access

Note 1 to entry: In this document, this has the same meaning as partitioned memory.

### 3.16 tag driver

implementation of the process to transfer data between the data protocol processor and the RFID tag

### 3.17 unique item identifier UII

encodable data that when combined with an object identifier prefix renders the combination unique within the rules of the application domain

## 4 Applicability and relationship with other systems

### 4.1 General

The use of the ISO/IEC 18000-63 air interface protocol brings with it a set of different standards which can be deployed to support RFID in libraries. Three different device architectures are discussed below from the library application to the RFID tag. It should be noted that with the development in UHF RFID, the LMS/ILS is not the only end point (or start point for encoding) in an RFID system. Therefore, under the heading of “library application”, the following also needs to be considered:

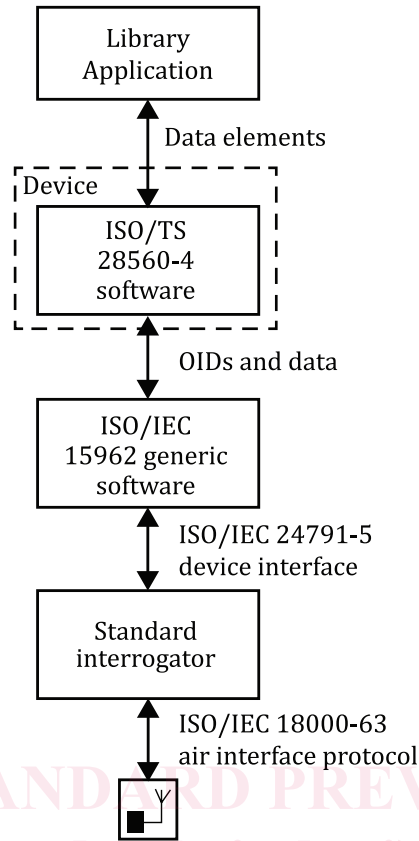
- the library management system/integrated library system;
- software linked to encoding devices used by book suppliers;
- portable devices, with on-board processing, which exchange data (as necessary) with the LMS/ILS on a transaction or even batch mode basis;
- sortation systems that can operate somewhat autonomously from the LMS/ILS;
- software to support quality control devices;
- mobile phones and other user-centric portable devices.

Some of the architectures described below offer different perspectives on how to achieve interoperability. The one described in 4.2 offers more opportunities for using generic modules, while the one described in 4.3 can be called the “traditional model” replicating structures used by libraries that have implemented RFID using 13,56 MHz technology, while the one described in 4.4 can be considered a compromise between the other two architectures. There is no requirement to adopt one of these architectures; in fact, some might be more suited to some type of device (e.g. portable devices, RFID tunnel readers) or some type of operator (e.g. a book supplier compared with a circulation library). Some of the choices might depend on the interfaces supported by hardware devices and software components.

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### 4.2 Independent standards-based components

[Figure 1](#) shows an architecture where individual hardware and/or software modules communicate between different layers.



**Figure 1 — Architecture using all standard components**

Using the example of reading data from the tag (i.e. bottom up in [Figure 1](#), the inverse applies for encoding data).

- a) The ISO/IEC 18000-63 air interface protocol is used between the tag and the interrogator to transfer encoded bits within commands and responses.
- b) The interrogator supports the device interface standard (ISO/IEC 24791-5) and communicates to upper layers using this protocol, typically to a stand-alone ISO/IEC 15962 software implementation.
- c) In turn, after decoding the data on the tag, the ISO/IEC 15962 software simply communicates to an ISO/TS 28560-4 software implementation:
  - object identifiers and the de-compacted data, where these are encoded using standard ISO/IEC 15962 compaction rules;
  - object identifiers and the still compacted data bytes for data elements defined as application-specific.
- d) The device, shown in dotted lines, is capable of processing some front-line function. A typical example is the self-check terminal, but can be any other device designed or configured for a library application. The ISO/TS 28560-4 software module can be integrated in the device or can directly interface with it, based on the implementation and design requirements. This software decodes the additional application-specific data elements and passes on all the data elements to specific software in the library device (e.g. circulation control terminals, sortation systems, portable devices) for processing.
- e) The library device processes the data elements in a manner relevant to library applications, including the LMS/ILS using a communication protocol implemented by the library, such as SIP 2.0.

### 4.3 Integrated encoding/decoding software

Figure 2 illustrates an architecture that has a more integrated software component but uses the standard air interface protocol and the device interface protocol from the interrogator module.

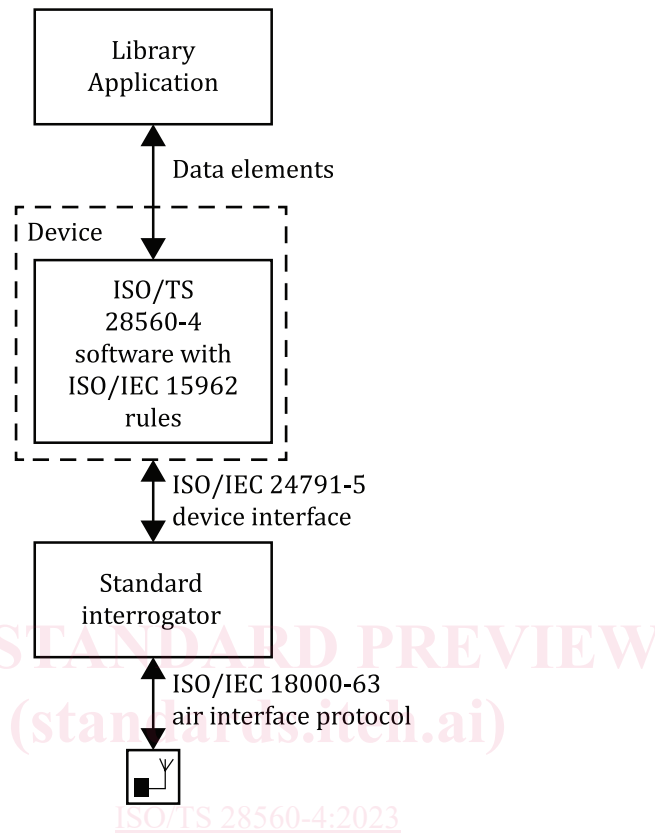
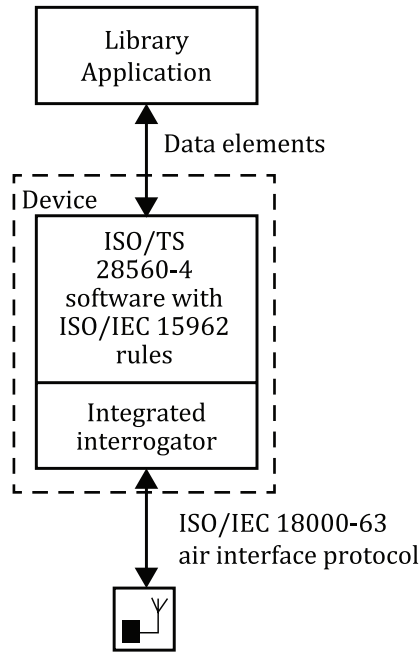


Figure 2 — Architecture with integrated data element software component

The software module that processes the data according to ISO/IEC 15962 rules is incorporated into a software product that also deals with all the ISO/TS 28560-4 encoding rules. This means that the interface between the software and any device with which it is associated or embedded communicates ISO 28560-1 data elements to library application modules.

### 4.4 Legacy-based architecture

Figure 3 shows an architecture that is not dissimilar to that, which is common for RFID systems based on 13,56 MHz technology.



**Figure 3 — Legacy-based architecture**

Using the same example of reading data from the tag, as in 4.2, the ISO/IEC 18000-63 air interface protocol communicates directly with an interrogator integrated directly into the front-line library device. This either embeds, or makes calls to, a software module that supports all the requirements of ISO/TS 28560-4 including the encoding rules of ISO/IEC 15962.

The advantage of this architecture is that it might be familiar to system vendors. The disadvantage is that the application interface of the interrogator is probably based on some proprietary protocol. In turn, this means that some aspects of the ISO/IEC 28560-4 software might also require a customised interface.

## 5 Requirements

### 5.1 Data elements

The data elements shall be conformant with ISO 28560-1.

**NOTE** There is a degree of flexibility in using locally defined codes that enable enhancements and variations to be implemented while still conforming with the basic set of data elements.

### 5.2 RFID air interface: ISO/IEC 18000-63 for UHF

#### 5.2.1 General

The air interface for compliant RFID tags and interrogators is specified in ISO/IEC 18000-63. RFID tags have what is known as a segmented memory structure, where four different memory banks are supported and separately addressable. The memory banks are using the following binary notation:

- 00 for password;
- 01 for the unique item identifier;
- 10 for tag identification, which can include serialization;
- 11 for additional user data, which in the case of ISO/TS 28560-4, will include the optional data.

Memory is organized in a 16-bit word for commands to read and write the data, but the actual memory structure is left to the chip manufacturer to decide on how this is implemented.

There are different national and regional radio regulations for the use of RFID within the UHF frequency spectrum between 860 MHz and 960 MHz.

### 5.2.2 Air interface conformance

The air interface conformance shall be tested in accordance with the procedures of ISO/IEC 18047-6.

### 5.2.3 Tag performance

Where there are requirements to test tag performance, these shall be done in accordance with ISO/IEC 18046-3.

### 5.2.4 Interrogator performance

Where there are requirements to test interrogator (reader) performance, these shall be done in accordance with ISO/IEC 18046-2.

### 5.2.5 System performance

Where there are requirements to test system performance, these shall be done in accordance with ISO/IEC 18046-1.

## 5.3 RFID air interface: Other air interface protocols

Although the segmented memory structure is used for other air interface protocols, this document currently provides no specific advice and guidelines on implementing with an air interface protocol other than ISO/IEC 18000-63.

## 5.4 Data protocol

ISO/IEC 15961-1 specifies the application commands that are used to define the communication requirements between the application and the RFID tag. The relevant commands are described in [Annex B](#).

The process rules of ISO/IEC 15962 shall be used to encode and decode data from the RFID tag. In particular, the following constraints shall apply:

- encoding in memory bank 00 is for passwords;
- encoding in memory bank 01 shall comply with the ISO/IEC 15962 rules for a Monomorphic-UII. Encoding in MB 01 is mandatory with the rules as defined in [6.2](#);
- encoding in memory bank 11 shall comply with the No-directory access method, and be used for encoding the optional data elements defined in ISO 28560-1;
- no alternative access method shall be supported until this document is revised;
- no encoding is possible in memory bank 10.

Memory bank 11 is defined as optional in ISO/IEC 18000-63, and therefore, not all RFID tags include this memory bank. Increasingly, MB 11 is incorporated in RFID tag products, so should be used to support the encoding rules defined in this document.

## 5.5 RFID interrogators (RFID readers)

RFID interrogators shall support all memory banks so that tags with three or four memory banks and different sized memory are all interoperable.

In order to achieve interoperability, RFID interrogators shall be based on open architecture RFID standards defined by ISO/IEC JTC 1/SC 31. Particular standards are specified in this document. This means that any one of the manufacturer's reading/writing equipment shall be able to read or write to any other manufacturer's RFID tags, and that any manufacturer's RFID tags shall be able to be read and/or programmed by any other manufacturer's reader/writer.

## 6 Data elements

### 6.1 General

The set of data elements that comprises the data dictionary for this document is fully described in ISO 28560-1 and repeated and adapted for this document as outlined in [Table 1](#). Only one data element is mandatory, the primary item identifier. All others are optional, but can be selected to meet the requirements of individual libraries, and/or for particular items.

[Table 1](#) shows the Relative-OID value, the format for input data, and advice about locking the data element as an encoded data set on the RFID tag. A maximum length of 255 characters should apply to all data elements that have a variable length display format.

**Table 1 — List of data elements**

N <sup>a</sup>	Name of the data element	Status	Display format	Lock
0	Unique item identifier (UII)	Mandatory	One of six formats {Primary item identifier} {Primary item identifier}.S {Primary item identifier}.{set information} {Owner institution}.{Primary item identifier} {Owner institution}.{Primary item identifier}.S {Owner institution}.{Primary item identifier}.{set information}	Should be locked
1	Primary item identifier	Not explicitly used (see UII N 0)	Variable length alphanumeric Character set = ISO/IEC 646 International Reference Version (IRV)	Not applicable
2	Content parameter	Optional	Bit mapped code (see 6.4)	Optional
3 <sup>b</sup>	Owner institution (ISIL)	Optional	Variable length field (maximum of 16 characters) based on ISO 15511	Optional
4	Set information	Optional	{Total in set/part number} structure (maximum ≤ 255)	Optional
5	Type of usage	Optional	Single octet (coded list)	Optional
6	Shelf location	Optional	Variable length alphanumeric Character set = ISO/IEC 646 IRV	Optional
7	ONIX media format	Optional	Two uppercase alphabetic characters	Optional
8	MARC media format	Optional	Two lowercase alphabetic characters	Optional
9	Supplier identifier	Optional	Variable length alphanumeric Character set = ISO/IEC 646 IRV	Optional