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

*Technologies de l'information — Identification par radiofréquence
(RFID) pour la gestion d'objets — Protocole de données: règles
d'encodage des données et fonctions logiques de mémoire*

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 15962 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This second edition cancels and replaces the first edition (ISO/IEC 15962:2004), which has been technically revised.

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Introduction

The technology of radio frequency identification (RFID) is based on non-contact electronic communication across an air interface. The structure of the bits stored on the memory of the RFID tag is invisible and accessible between the RFID tag and the interrogator only by the use of an air interface protocol, as specified in the appropriate part of ISO/IEC 18000. The result of the transfer of data between an application and an interrogator in open systems requires data to be encoded in a consistent manner on any RFID tag that is part of that open system. This is not only to allow equipment to be interoperable, but in the special case of data carriers, for the data to be encoded on the RFID tag in one systems implementation for it to be read at a later time in a completely different and unknown systems implementation. The data bits stored on each RFID tag must be formatted in such a way as to be reliably read at the point of use if the RFID tag is to fulfil its basic objective. This reliability is achieved through the specification of a data protocol using the application-defined arguments defined in ISO/IEC 15961-1 and the data encoding rules of this International Standard. Additionally, ISO/IEC 24791-1 specifies a software system infrastructure architecture that enables RFID system operations between business applications and RFID interrogators. Specific parts of ISO/IEC 24791 address data management requirements (ISO/IEC 24791-2) and device interface requirements (ISO/IEC 24791-5). These support defined implementations that incorporate the encoding rules of this International Standard and the functional rules of the commands and responses in ISO/IEC 15961-1.

Manufacturers of RFID equipment (interrogators, RFID tags, etc.) and the users of RFID technology require a standards-based data protocol for RFID for item management. ISO/IEC 15961-1 to ISO/IEC 15961-3, this International Standard, and ISO/IEC 24791 specify this protocol, which is layered above the air interface standards defined in ISO/IEC 18000.

The transfer of data to and from an application, supported by appropriate application commands, is the subject of ISO/IEC 15961-1. This International Standard specifies the overall process and the methodologies developed to format the application data into a structure to store on the RFID tag.

Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions

1 Scope

The data protocol used to exchange information in an RFID system for item management is specified in ISO/IEC 15961 and in this International Standard. Both International Standards are required for a complete understanding of the data protocol in its entirety; but each focuses on one particular interface:

- ISO/IEC 15961 addresses the interface with the application system.
- This International Standard deals with the processing of data and its presentation to the RF tag, and the initial processing of data captured from the RF tag.

This International Standard focuses on encoding the transfer syntax, as defined in ISO/IEC 15961 according to the application commands defined in ISO/IEC 15961. The encodation is in a Logical Memory as a software analogue of the physical memory of the RFID tag being addressed by the interrogator.

This International Standard

- defines the encoded structure of object identifiers;
- specifies the data compaction rules that apply to the encoded data;
- specifies a Precursor for encoding syntax features efficiently;
- specifies formatting rules for the data, e.g. depending on whether a directory is used or not;
- defines how application commands, e.g. to lock data, are transferred to the Tag Driver;
- specifies processes associated with sensory information and the transfers to the Tag Driver;
- defines other communication to the application.

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

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radio frequency identification (RFID)*

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-3 and the following apply.

NOTE For terms defined below and in ISO/IEC 19762-1 or ISO/IEC 19762-3, the definitions given below apply.

3.1.1

data compaction

mechanism, or algorithm, to process the original data so that it is represented efficiently in fewer bytes in a data carrier than in the original presentation

3.1.2

Data Processor

implementation of the processes defined in this International Standard, including the Data Compactor, Formatter, Logical Memory, and Command/Response Unit

3.1.3

Precursor

byte, sometimes a sequence of bytes, used in the Directory and No-Directory Access-Methods that acts as metadata for the subsequent Object-Identifier and Object

3.1.4

Relative-OID

particular object identifier where a common root-OID (for the first and subsequent arcs) is implied, and remaining arcs after the Root-OID are defined by the Relative-OID

3.2 Conventions

Conventionally in International Standards, long numbers are separated by a space character as a "thousands separator". This convention has not been followed in this International Standard, because the arcs of an object identifier are defined by a space separator (according to ISO/IEC 8824 and ISO/IEC 8825). As the correct representation of these arcs is vital to this International Standard, all numeric values have no space separators except to denote a node between two arcs of an object identifier.

4 Conformance

Conformance to this International Standard shall depend on the functional capability of the device as defined in the following three sub-clauses.

4.1 Conformance with the air interface

A conformant implementation of this International Standard shall support one or more air interface protocols through the tag drivers defined in Annex C. Declarations of conformance shall refer to the specific air interface protocol(s). This applies to encoders, decoders, or more comprehensive devices.

4.2 Conformance with the application interface

The conformance requirements depend on the type of device as follows:

4.2.1 Encoders and the application interface

Within the constraints of the air interface protocol supported, a conformant implementation of this International Standard on an encoder shall support the application commands defined in 8.2 and the associated process argument, as defined in Clause 10.

A conformant RFID tag shall have its encoding in a state that can be properly decoded by a conformant decoder (see 4.2.2).

4.2.2 Decoders and the application interface

Within the constraints of the air interface protocol supported, a conformant implementation of this International Standard on a decoder shall support the application commands defined in 8.3 and the associated process argument, as defined in Clause 10.

4.2.3 Comprehensive encoder/decoder devices and the application interface

Within the constraints of the air interface protocol supported, a conformant implementation of this International Standard on an encoder/decoder shall support the application commands defined in 8.2 and 8.3 and the associated process argument, as defined in Clause 10. In addition, the **Delete-Object** (see 8.4.2) and **Modify-Object** (see 8.4.3) commands shall be supported. Other commands defined in 8.4 may be supported, and each command that is supported shall be declared.

4.3 Conformance with the Access-Method

The conformance requirements depend on the type of implementation as follows:

4.3.1 Encoders and the Access-Method

A conformant implementation of this International Standard on an encoder shall support the encoding rules and formatting rules of one or more **Access-Methods** as defined in Clause 11 and associated Annexes. Declarations of conformance shall refer to the specific **Access-Method(s)** supported.

4.3.2 Decoders and the Access-Method

A conformant implementation of this International Standard on a decoder shall support the decoding rules and formatting rules of all the **Access-Methods** as defined in Clause 11 and associated Annexes.

An interrogator is not expected to fully support the decoding functions of all the **Access-Methods**, and the following shall apply to achieve conformance:

- For full conformance, the decoder process on the interrogator shall output the **Object-Identifier**, **Object** and other arguments as required in the responses to the commands.
- For partial conformance, the decoder process on the interrogator shall output the byte string that represents the encoded package (depending on the **Access-Method**) containing the requested **Object-Identifier**. The encoded package then needs to be fully decoded by a decoder process, external to the interrogator, that is fully compliant with the rules defined in this International Standard.

Declarations of conformance shall refer to the specific **Access-Method(s)** supported.

4.3.3 Comprehensive encoder/decoder devices and the Access-Method

A conformant implementation of this International Standard on an encoder/decoder shall support the encoding rules and formatting rules of one or more **Access-Methods** as defined in Clause 11 and associated Annexes. Declarations of conformance shall refer to the specific **Access-Method(s)** supported. The decoding function shall be as defined in 4.3.2.

5 Protocol model

5.1 Overview

RFID supports bit encodation in the RFID tag memory. Unlike other data carrier standards prepared by ISO/IEC JTC1 SC31 which require encodation schemes that are specific to the individual data carrier technology, ISO/IEC 18000 does not specify the interpretation of bits or bytes encoded on the RFID tag memory. However, as an RFID tag is a relay in a communication system, each tag used for open systems item management needs to have data encoded in a consistent manner. The prime function of ISO/IEC 15961-1 is to specify a common interface between the application programs and the RFID interrogator. The prime function of this International Standard is to specify the common encoding rules and logical memory functions.

RFID tags utilise electronic memory, which is typically capable of increasing data capacity as new generations of product are introduced. Differences in data capacity of each RFID tag type, whether similar or dissimilar, are recognised by the data protocol defined in these two International Standards.

Different application standards may have their own particular data sets or data dictionaries. Each major application standard for item management needs to have its data treated in an unambiguous manner, avoiding confusion with data from other applications and even with data from closed systems. The data protocol specified in these International Standards ensures the unambiguous identification of data.

5.2 Layered protocol

The protocol layers of an implementation of RFID for item management are illustrated schematically in Figure 1 — Schematic of protocol layers for an implementation of RFID for item management.

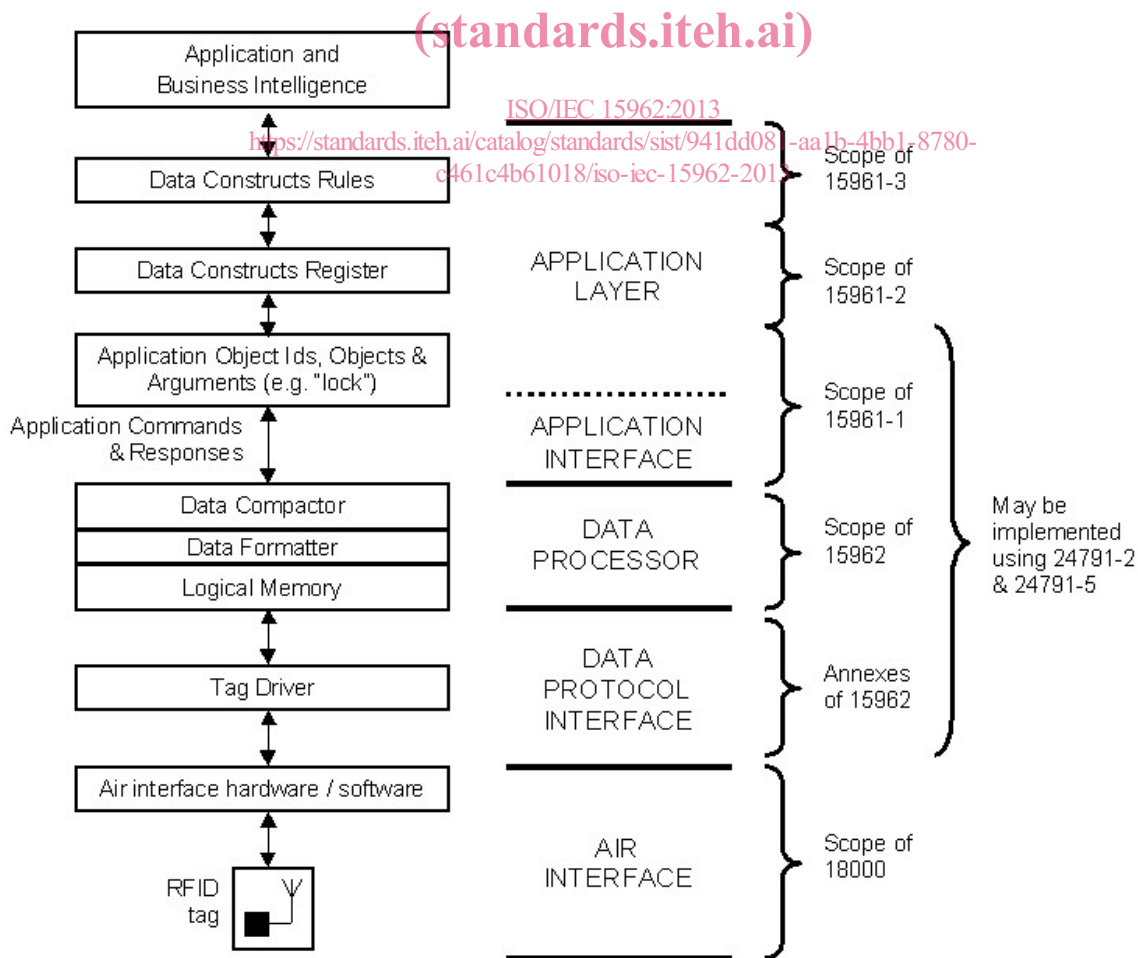


Figure 1 — Schematic of protocol layers for an implementation of RFID for item management

5.2.1 Application layer - as defined in the various parts of ISO/IEC 15961

The RFID data protocol specifies how data is presented as objects, each uniquely identified with an object identifier, which are meaningful to the application and can be encoded on the RFID tag. ISO/IEC 15961-3 specifies the data construct rules for the AFI, DSFID, object identifier for the unique item identifier, and object identifier structure for other item-related data. This ensures that each piece of data can be uniquely identified, both within the scope of a particular application and between applications.

Each application needs to be registered according to the rules of ISO/IEC 15961-2 so that the data constructs can be declared and used in an unambiguous manner.

The RFID data protocol in ISO/IEC 15961-1 defines functions and arguments used to construct application commands and responses. This is so that application programs can specify what data to transfer to and from the RFID tag and to append, update, selectively lock, delete data, or perform other functions on the RFID tag.

To illustrate how the functions and arguments are assembled into a structured format, a number of commands and responses have been constructed using an abstract syntax. This is independent of the host application, operating system, and programming language and also independent of the specific command structures between the interrogator and tag driver. The abstract syntax used in ISO/IEC 15961-1 is similar to that used in ISO/IEC 24791-5, and is intended to enable closer integration with that standard. The original version of ISO/IEC 15961:2004 included commands defined using ASN.1 abstract syntax. For backward compatibility the commands that were originally defined in this manner have been included in an annex of ISO/IEC 15961-1.

This RFID data protocol also defines arguments and codes to support responses of data that is read from an RFID tag, including error messages, which are returned to the application.

The abstract syntax may be used as a basis to prepare commands in different programme languages, supporting the functionality and arguments of the abstract commands.

5.2.2 Application interface - as defined in ISO/IEC 15961-1

The application interface may be implemented in a number of different ways that are not explicitly defined in this International Standard, nor in ISO/IEC 15961-1. The basic requirement is to identify data objects distinctly from all others using object identifiers, even to enable different data formats to be intermixed on the same RFID tag. The application interface also needs to define command and response arguments unambiguously, so that they can be intermixed with data on the same wired or wireless network.

One major class of implementation, described as a *straight-through process*, is appropriate where the functions and arguments used to construct commands and the arguments and codes used to construct responses, as specified in this International Standard, are directly input to the encoding processes of ISO/IEC 15962. Such input can be from computer screens or forms, or more direct transfers from host systems. The advantage of this process is that it avoids the creation of the transfer encoding (see below), but requires more rigorous adherence to the functional requirements of the commands and responses. ISO/IEC 15961-1 imposes no constraints on the particular application interface process to be adopted, other than the requirement that it be integrated with the encoding rules of ISO/IEC 15962.

An alternative process, consistent with the first edition of ISO/IEC 15961, is to use the abstract syntax for defining the commands and responses in a structured, consistent and verifiable manner. It is then necessary to generate the transfer encoding that defines the byte stream transferred between the processes of this International Standard and those of ISO/IEC 15962.

Whichever approach is used, the encoding rules of ISO/IEC 15962 shall be followed, and the encoding on the RFID tag has to be compliant with all the arguments in the commands specified in ISO/IEC 15961-1.

5.2.3 Data Protocol Processing - as defined in this International Standard

The RFID data protocol specifies how data is encoded, compacted and formatted on the RFID tag and how this data is retrieved from the RFID tag to be meaningful to the application.

This RFID data protocol provides for a set of schemes that compact the data to make more efficient use of the memory space.

This RFID data protocol also supports various storage formats to enable efficient use of memory and efficient access procedures.

5.2.4 Data Protocol Interface - as defined in this International Standard

Each air interface protocol standard in ISO/IEC 18000 has its own specific rules for defining commands and responses. Furthermore, some air interface protocols can support different tag architectures with different memory sizes, and possibly support optional commands. The data protocol provides a mechanism to interface with these rules through specific tag drivers. These allow the basic application commands and responses of ISO/IEC 15961-1 to be applied independently of the air interface protocol and specific tag architecture.

The tag driver component of the data protocol provides the mapping rule from the generic processes to the specific tag requirements. These mapping rules are used to write data and to read data.

Additional tag drivers can be specified as new air interface protocols are introduced in the ISO/IEC 18000 series of standards.

5.3 Flexible implementation configurations

This RFID data protocol specifies the application level communication and the RFID tag interrogator level rules for data encoding, compaction and storage formats. This protocol may be implemented:

- with the International Standard incorporated into the software system infrastructure architecture defined in ISO/IEC 24791. This is the recommended approach for any networked application.
- with ISO/IEC 15961 Part 1 and this International Standard incorporated into stand-alone software or devices that have as its output conformant encoding and / or conformant decoding with responses compliant to the responses of ISO/IEC 15961-1.

5.4 Functional processes – interrogator implementation

There are various functional processes that need to take place to write data to an RFID tag and to read data from it. Figure 2 — Logical functions and interfaces of ISO/IEC 15962 with other RFID system components shows a schematic of an example implementation where the processing of the data protocol resides in the interrogator. This illustration is provided to help with the understanding of the processes, and although a typical implementation, many others are possibly compliant with this data protocol.

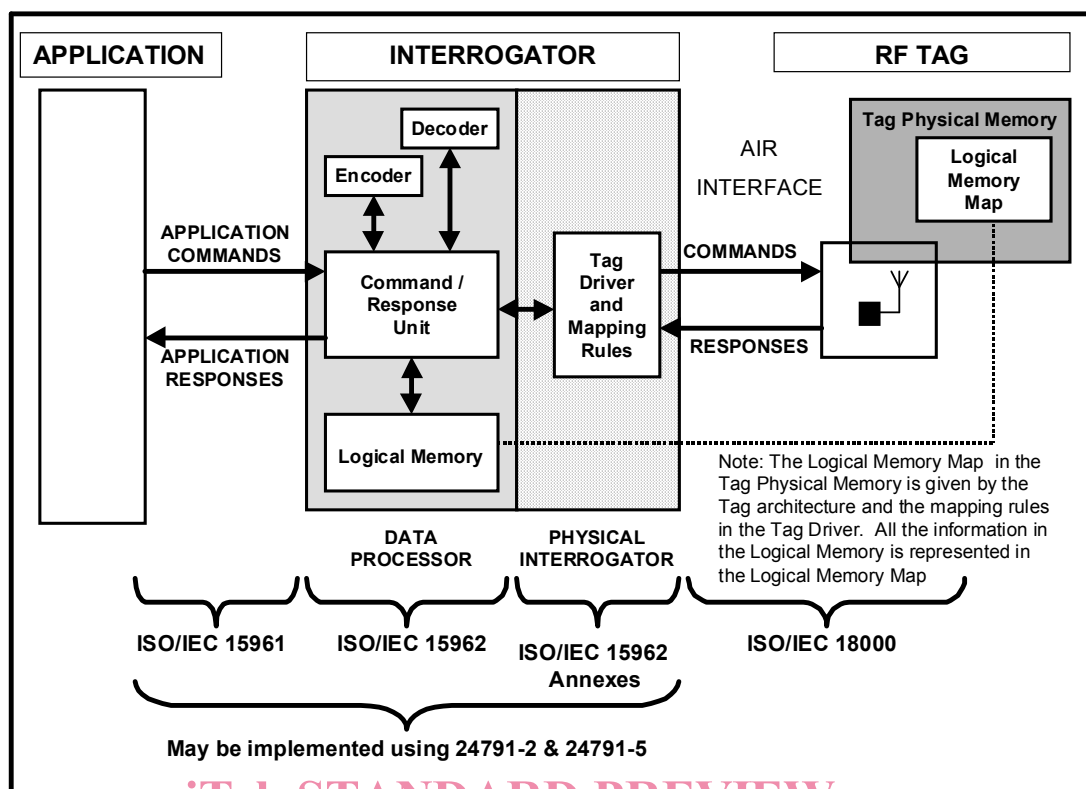


Figure 2 — Logical functions and interfaces of ISO/IEC 15962 with other RFID system components

5.4.1 Functional processes – application interface

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The data flows between the application and the Data Processor are formatted according to this International Standard and are not compacted. However, there are numerous established systems where data is formatted to be compliant, for example, with a bar code related syntax. It is therefore reasonable to insert interface modules in the data flow to convert from and to existing application formats.

NOTE Careful consideration should be given to the extent that established systems need to be supported relative to the potential benefits to be gained from adopting the data protocol specified in this International Standard and ISO/IEC 15961-1. This is because this protocol has been developed around the features of RFID, such as selective read/write and the ability to lock data. Older protocols are unlikely to support such features.

5.4.2 Functional processes – interrogator

In the process illustrated in Figure 2 — Logical functions and interfaces of ISO/IEC 15962 with other RFID system components, the interrogator is the module in which all the basic processing of the data protocol takes place and there is an interface to the RFID tag. Different implementations might separate some of the functions described below and have an interface between the application and the physical interrogator.

5.4.2.1 Data processor

The Data Processor provides all the processing, which is as specified in this International Standard and is required for handling application data. It consists of the following components, all of which are described more fully below: Command/Response Unit, Logical Memory, Encoder (which supports a Data Compactor and Formatter function) and Decoder (which supports the inverse functions of the Encoder). The Data Processor can physically reside anywhere between the application software and the tag driver but shall contain all the components. Some, or all, of the Data Processor functions may be implemented using processes defined in ISO/IEC 24791-2 and ISO/IEC 24791-5.