INTERNATIONAL STANDARD

ISO/IEC 15961-4

First edition
2016-08-01

Information technology — Radio frequency identification (RFID) for item management: Data protocol —

Part 4: Application interface commands for battery assist and sensor functionality

Technologies de l'information — Identification par radiofréquence (RFID) pour la gestion d'objets: Protocole de données —

Partie 4: Commandes de l'interface d'application pour l'assistance de la batterie et la fonctionnalité du capteur

Reference number
ISO/IEC 15961-4:2016(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword ..... **iv**

Introduction ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Conformance **2**
4.1 General 2
4.2 Conformance of the Sensor Processor 2
4.3 Application conformance 2

5 Logical interface model **3**
5.1 General 3
5.2 Application commands 3
5.3 The sensor information model for full function sensors 3
5.4 The sensor information model for simple sensors 4

6 Simple sensor commands **5**
6.1 Current air interface reference 5
6.2 Memory mapped simple sensors 5
6.3 Ported simple sensors 6
6.3.1 Write-Sample-And-Configuration-Record 6
6.3.2 Read-Simple-Sensor-Data-Block 8
6.3.3 Other simple sensor commands 10

7 Full function sensors **10**
7.1 General 10
7.2 Write-Sample-And-Configuration 11
7.2.1 Write-Sample-And-Configuration command 11
7.2.2 Write-Sample-And-Configuration response 14
7.3 Read-Alarm-Status 15
7.3.1 Read-Alarm-Status command 15
7.3.2 Read-Alarm-Status response 16
7.4 Read-Event-Record-Segments 17
7.4.1 Read-Event-Record-Segments command 17
7.4.2 Read-Event-Record-Segments response 19
7.5 Other full function sensor commands 24

Bibliography **25**

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.

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 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

A list of all parts in the ISO/IEC 15961 series can be found on the ISO website.

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 in the memory of the RFID tag is invisible and accessible between the RFID tag and the interrogator only by the use of the appropriate air interface protocol, as specified in the corresponding part of ISO/IEC 18000. Since the initial publication of ISO/IEC 18000, it has become possible to add sensors to the RFID tag using various physical methods, but always using the air interface protocol as a consistent means of communicating between the RFID tag and the interrogator.

For sensor information, functional commands from the application and responses from the interrogator are processed in a standard way. This allows equipment to be interoperable. In special cases, when the sensor is attached to or integrated within an RFID tag, this enables configuration parameters to be encoded in one system's implementation with the resultant sensory information to be read at a later time in a completely different and unknown system's implementation. The data bits stored on each RFID tag and sensor shall be formatted in such a way as to be reliably read at the point of use if the sensor is to fulfil its basic objective. The integrity of this is achieved through the use of an application protocol, for example, as supported by the functional commands specified in this document and as specified in ISO/IEC 24791.

Manufacturers of radio frequency identification equipment (interrogators, RFID tags, etc.), manufacturers of sensors and users of RFID technology supporting sensors each require a publicly available application protocol. This document specifies the sensor encoding and processing rules, which are independent of any of the air interface standards defined in the various parts of ISO/IEC 18000. As such, the sensor encoding and processing rules are consistent components in the RFID system that may, independently, evolve to support additional air interface protocols and different types of sensors.

The documents that comprise the data protocol are the following.

— ISO/IEC 15961-1 defines the transfer of data to and from the application, supported by appropriate application commands and responses.

— ISO/IEC 15961-2 defines the registration procedure of data constructs to ensure that as new applications adopt the data protocol, it becomes a relatively straightforward process to support that application. This can be achieved by the registration authority publishing regular updates of the RFID data constructs that have been assigned, and for a means of incorporating these updates into the processes of ISO/IEC 15961-1.

— ISO/IEC 15961-3 defines the data constructs and the rules that govern their use.

— ISO/IEC 15961-4 defines the transfer of sensor data to and from the application, supported by appropriate application commands and responses.

— ISO/IEC 15962 specifies the overall process and the methodologies developed to format the application data into a structure to store on the RFID tag.

— ISO/IEC 24753 specifies the overall process and methodologies developed to format and process sensory information in a standardised manner and provide an interface with the appropriate air interface protocol.

Information technology — Radio frequency identification (RFID) for item management: Data protocol —

Part 4:
Application interface commands for battery assist and sensor functionality

1 Scope

This document provides a set of application commands and their associated responses for the following functions:

— to start and stop battery assistance;

— to select and de-select a particular sensory function supported by the RFID tag;

— to set sensor parameters both initially and ongoing;

— to start and stop the sensor monitoring the environment;

— to access sensor data;

— to establish the battery status.

ISO/IEC 24753 defines the encoding rules for identifying sensors, their functions, their delivered measurements, and the processing rules for sensor data. As such, it receives commands as defined in this document and provides the information that is required for the appropriate responses.

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 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 18000-64, *Information technology — Radio frequency identification for item management — Part 64: Parameters for air interface communications at 860 MHz to 960 MHz Type D*

ISO/IEC 24753:2011, *Information technology — Radio frequency identification (RFID) for item management — Application protocol: encoding and processing rules for sensors and batteries*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762, ISO/IEC IEEE 21451-7, ISO/IEC 24753, and the following apply.

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

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

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

3.1
sensor processor
implementation of the processes specified in ISO/IEC 24753 to convert between data and information relevant to the application layer and the bit based encoding on the sensor memory

4 Conformance

4.1 General

The commands and responses in this document are only expressed in an abstract syntax. Their structure is determined by the records and fields on the particular sensor. As such, conformance to this document for a particular sensor system is specifically indicated by the resultant proper encoding according to ISO/IEC 24753 and then passed through RFID air interface protocols to the sensor.

The arguments and fields contained in individual commands and responses identify what needs to be taken into account for correct input to the ISO/IEC 24753 Sensor Processor to achieve a valid encoding. Also, they identify what an application expects to have returned following access to a sensor on an RFID tag. Because of the way the protocol is structured, the commands and responses specified in this document are, to a large extent, independent of particular RFID tag types that support sensors. The effect of this is that ISO/IEC 24753 can specify conformance requirements for valid encoding, which this document cannot.

All the commands and arguments, and their associated processes, are specified in detail in ISO/IEC 24753. Object Identifiers are used throughout that document to uniquely identify arguments within commands and responses for each type of sensor. Object Identifiers are also used to identify fields with particular sensor records.

4.2 Conformance of the Sensor Processor

The Sensor Processor is, effectively, the implementation of ISO/IEC 24753. An implementation of ISO/IEC 24753 is required to support one or both of the following:

a) all the processes that are required to support all aspects of full function sensors for configuration and interpretation of sensor data;

b) all the processes that are required to support all aspects of simple sensors for configuration and interpretation of sensor data.

4.3 Application conformance

An application is expected to support the commands and responses that are defined in ISO/IEC 24753 for full function sensors and/or simple sensors. Therefore, this document shall support either one or both options a) and b) in 4.2 as determined by the implementation of ISO/IEC 24753 with which it interfaces.

In addition, the application conformance requirements defined by the commands and responses in this document may be simplified to address a specific type of simple or full function sensor, even to the extent of only the records and commands required for that sensor. For the commands that are supported, all the arguments in the command and response shall be supported to achieve the interface with the sensor processor.

5 Logical interface model

5.1 General

The processes defined in this document are implemented between the application and the air interface protocol. This document performs similar functions for sensory data as ISO/IEC 15961-1 does for item-related data. The relationship and basic functions of the standards are illustrated in Figure 1.

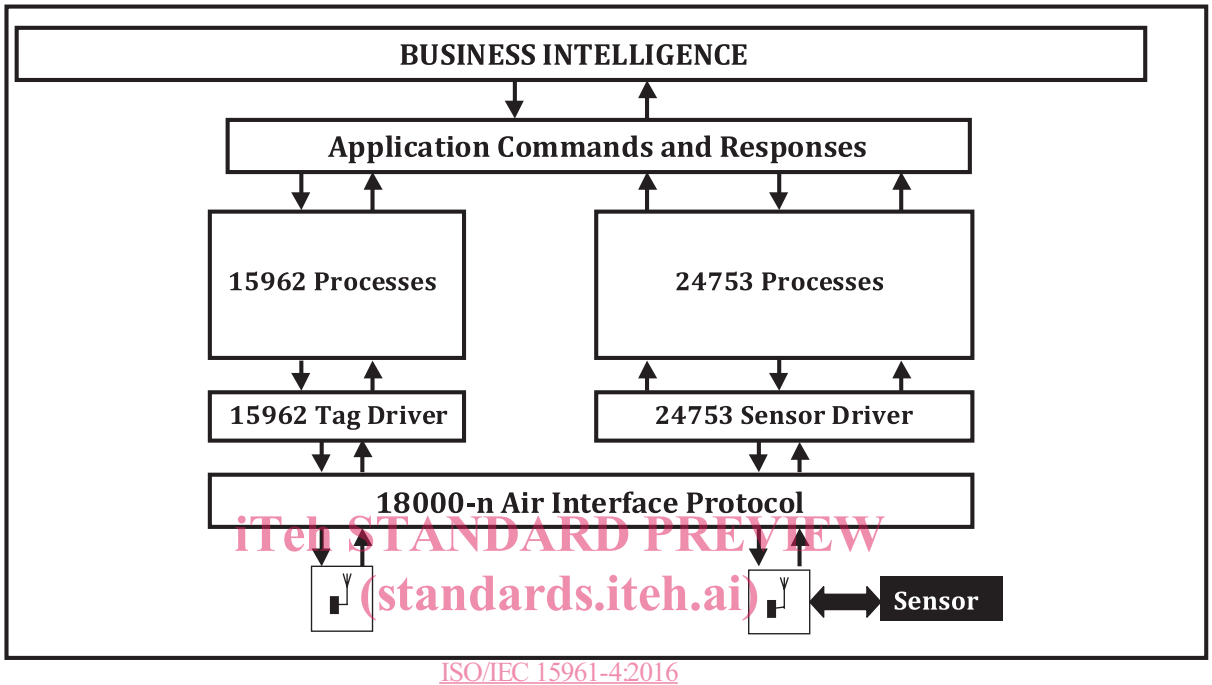

Figure 1 — Basic application interface model

ISO/IEC 24753 is an essential reading in implementing this document. Reference needs to be made to that standard for a full description of the component parts of the model relevant to sensors and batteries. An overview relevant to this document is provided below.

5.2 Application commands

A set of functional application commands is required to enable the application to identify what sensor functions are supported, to access data from sensors, to access the status of the battery power, and to reset values such as alarm values for the sensor activity. These are defined in Clause 6 for simple sensors and Clause 7 for full function sensors.

The structure of the application commands and response can be determined by clauses in ISO/IEC 24753 that use the same name. The structure of these commands may be derived from the set of Object Identifiers applicable for each command and response as specified in ISO/IEC 24753. Because of this, only selected application interface commands are fully described in this document.

5.3 The sensor information model for full function sensors

The sensor information model for full function sensors (Figure 2) shows the relationship between component processes and structures described later in ISO/IEC 24753 for full function sensors specified in ISO/IEC IEEE 21451-7. A physical sensor is defined as one that monitors a particular environmental feature capable of being expressed in terms of an SI unit or derived SI unit. A given physical sensor may support a number of logical sensors, each of which specifies a method of event data output, e.g. maximum value, observed value below a threshold qualified by a timestamp, count of events observed that are above a threshold.

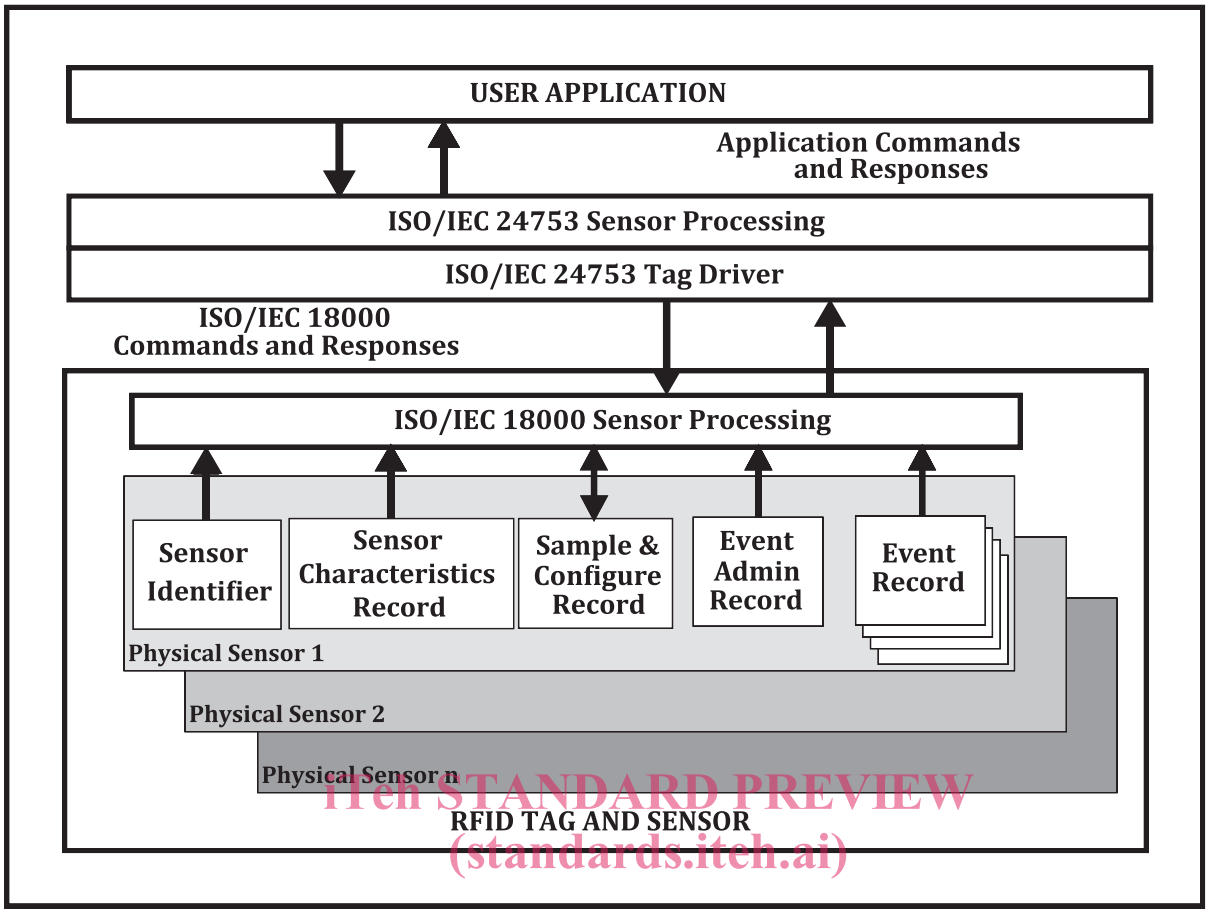

Figure 2 — Sensor information model for full function sensors

Figure 2 clearly illustrates that the commands and responses defined in this document need to be able to communicate with the Sensor Processor, which is the implementation of ISO/IEC 24753. In turn, the specific arguments within the commands and responses need to comply with the requirements of the five sensor records:

— Record 1: Sensor identifier;

— Record 2: Sensor characteristics record;

— Record 3: Sample and configuration record;

— Record 4: Event admin record;

— Record 5: Event record.

The commands are described in Clause 6.

5.4 The sensor information model for simple sensors

A simple sensor provides limited functional support to determine whether the temperature or other environmental conditions have gone outside some allowable limits. These sensors are defined as factory programmed, which restrict parameter setting from a fully open systems application, but allow data to be captured using open system air interface commands and processes.

The prime operating mode of a simple sensor is to provide the simple sensor data block using some delivery mechanism defined by the air protocol interface. The simple sensor data block is a short bit-based code that provides sensor characteristics, configuration, and alarm data. Currently, this is 32-bits long, but provision exists for a maximum length of 48-bits.

There are two formats of simple sensor. The memory-mapped simple sensor supports only the simple sensor data block, which is on the same integrated circuit platform as the data on the RFID tag. The ported simple sensor supports additional mandatory and optional records, as detailed in the list below. An annex of ISO/IEC 18000-63 defines the requirements for processing these records if present on the ported simple sensor.

NOTE ISO/IEC 18000-64 does not support ported simple sensors.

The sequence of records is as follows:

— Record 1: Simple sensor data block (mandatory for both implementations);

— Record 2: Manufacturer record (mandatory only for the ported simple sensor);

— Record 3: Authorization password record (optional for the ported simple sensor);

— Record 4: Calibration record (recommended for the ported simple sensor);

— Record 5: Sample and configuration record (mandatory only for the ported simple sensor);

— Record 6: Event record (recommended for the ported simple sensor);

— Record 7: Time synchronisation record (mandatory only for the ported simple sensor and only if the event record is present).

6 Simple sensor commands

6.1 Current air interface reference

The processing of commands (and responses) for simple sensors is specified in ISO/IEC 24753, which uses Object Identifiers to identify the specific arguments. As such, it is possible in this document to specify the structure of commands and responses in a manner that does not depend on the existence of a particular type of simple sensor. There can only be 16 different types of simple sensor, and the sensor manufacturer permanently encodes a 3-bit binary value into a predefined location in the sensor memory to identify the sensor type. In turn, the type code is included as a specific arc in the Object Identifier.

Simple sensors as specified in ISO/IEC 18000-63 and ISO/IEC 18000-64 are used throughout this document to describe arguments and processes. Later versions of these air interface protocols need to be checked for type codes not addressed here (see the current list in 6.3.1.1). If the basic design for simple sensors is maintained in the air interface protocol and in ISO/IEC 24753, then this document can persist. However, the introduction of a possible 48-bit simple sensor can only be supported with a revision to this document.

6.2 Memory mapped simple sensors

The encoding for configuring and reading memory-mapped simple sensors is specified in the ISO/IEC 18000 series of standards that support such sensors. The current air interface protocols that support the memory-mapped simple sensors to achieve this are as follows.

— For ISO/IEC 18000-63 (Type C), standard read and write commands are used in addressing the relevant memory bank to transfer the bit string representing the simple sensor data block. The simple sensor data block can also be transmitted as part of the reply to the *ACK* command, where it is appended to the unique item identifier encoded in memory bank 1.

— The simple sensor data block is transmitted as part of the data packet for an ISO/IEC 18000-64 (Type D) tag.

ISO/IEC 24753 defines two commands for memory mapped simple sensors:

— **Write-Simple-Sensor-Data-Block** command;

— **Read-Simple-Sensor-Data-Block** command.

However, no processes are specified to achieve the bit string that needs to be transferred via the air interface write command, nor any rules to interpret these bits when the simple sensor data block is read from the RFID tag. The application interface functions required are identical to two commands more fully defined for ported simple sensors in this document. Therefore, the equivalent command and response defined in this document (see 6.3.1 and 6.3.2) and the associated processes in ISO/IEC 24753 should be applied to the memory-mapped simple sensors. The memory mapped **Write-Simple-Sensor-Data-Block** command is directly equivalent to the ported simple sensor **Write-Sample-And-Configuration-Record** command (see 6.3.1). The memory-mapped **Read-Simple-Sensor-Data-Block** command is directly equivalent to the ported simple sensor command of the same name (see 6.3.1).

6.3 Ported simple sensors

6.3.1 Write-Sample-And-Configuration-Record

6.3.1.1 Write-Sample-And-Configuration-Record command

The **Write-Sample-And-Configuration-Record** command is used to write user-controlled parameters to a simple sensor, either for the initial mission or to reconfigure on a subsequent mission. The command cannot be invoked for reconfiguration if any of the alarm bits has been set. The command is only concerned with providing input that will result in the encoding of bits 22 to 4 (where bit 22 is MSB) of the simple sensor data block.

This command applies to both types of simple sensor: memory-mapped and ported simple sensor.

Before this command can be invoked, it is necessary to read the simple sensor data block on the tag. This can be achieved by invoking the **Read-Simple-Sensor-Data-Block** command (see 6.3.2) and ignoring all but these three fields, represented by the encoding in bits 31 to 23:

— sensor type, for which the following type codes apply:

  — Type 0 for temperature sensors with a span of 14 °C;

  — Type 1 for temperature sensors with a span of 28 °C;

  — Type 2 for relative humidity sensors;

  — Type 3 for impact sensors;

  — Type 4 for tilt sensors;

— measurement span;

— accuracy.

The **Password** argument is conditional because it only applies to some ported simple sensors. If the password is not known, then its size can be determined by invoking the **Read-Manufacturer's-Record** command where bits 5 and 6 declare the size of the password. The password is a write-once process and is not readable. Therefore, to process the configuration command when a password is set on the ported simple sensor, it is essential to match the password both in terms of length and value.

The **Sampling-Regime** argument applies only to temperature and humidity simple sensors. It defines one of 16 sampling intervals, ranging from 5 min to 8 h. The definition of the sample intervals and the mapping between the bit-based codes and the presentation in the application is given in tables in annexes of ISO/IEC 18000-63 and ISO/IEC 18000-64.

