INTERNATIONAL STANDARD

ISO 17366

First edition
2009-11-15

Supply chain applications of RFID — Product packaging

Applications de chaîne d'approvisionnements de RFID — Empaquetage de produit

Reference number
ISO 17366:2009(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

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.

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

ISO 17366 was prepared by Technical Committee ISO/TC 122, *Packaging*, in collaboration with Technical Committee ISO/TC 104, *Freight containers.*

Introduction

The *supply chain* is a multi-level concept that covers all aspects of taking a product from raw materials to a final product including shipping to a final place of sale, use and maintenance and potentially disposal. Each of these levels covers many aspects of dealing with products and the business process for each level is both unique and overlapping with other levels.

This International Standard has been created in order to ensure compatibility at the physical, command and data levels with the four other International Standards under the general title: S*upply chain applications of RFID*. Where possible, this compatibility takes the form of interchangeability. Where interchangeability is not feasible, the International Standards within this suite are interoperable and non-interfering. The International Standards within the complete series of *Supply chain applications of RFID* include

— ISO 17363, *Supply chain applications of RFID — Freight containers*,

— ISO 17364, *Supply chain applications of RFID — Returnable transport items (RTIs)*,

— ISO 17365, *Supply chain applications of RFID — Transport units*,

— ISO 17366, *Supply chain applications of RFID — Product packaging*, and

— ISO 17367, *Supply chain applications of RFID — Product tagging*.

These International Standards define the technical aspects and data hierarchy of information required in each layer of the supply chain. The air-interface and communications protocol standards supported within the *Supply chain applications of RFID* International Standards are ISO/IEC 18000; commands and messages are specified by ISO/IEC 15961 and ISO/IEC 15962; semantics are defined in ISO/IEC 15418; syntax is defined in ISO/IEC 15434.

Although not pertinent to this International Standard, the work of

— ISO/IEC JTC 1, *Information technology,* SC 31, *Automatic identification and data capture techniques*, in the areas of air interface, data semantic and syntax construction and conformance standards, and

— ISO/TC 104, *Freight containers*, in the area of freight container security, including electronic seals (e-seals) (i.e. ISO 18185) and container identification

is considered valuable.

Supply chain applications of RFID — Product packaging

1 Scope

This International Standard defines the basic features of RFID for the use in the supply chain when applied to product packaging. In particular it

— provides specifications for the identification of the product packaging,

— makes recommendations about additional information on the RF tag,

— specifies the semantics and data syntax to be used,

— specifies the data protocol to be used to interface with business applications and the RFID system,

— specifies the minimum performance requirements,

— specifies the air interface standards between the RF interrogator and RF tag, and

— specifies the reuse and recyclability of the RF tag.

2 Conformance and performance specifications

All of the devices and equipment that claim conformance with this International Standard shall also conform to the appropriate sections and parameters specified in ISO/IEC TR 18046 for performance and ISO/IEC TR 18047-6 (for ISO/IEC 18000-6, Type C) and ISO/IEC TR 18047-3 (for the ASK interface of ISO/IEC 18000-3, Mode 3) for conformance.

When, through trading-partner agreement, other specific ISO/IEC 18000 air interfaces are employed (i.e. ISO/IEC 18000-2, Type A and ISO/IEC 18000-7) the corresponding part of ISO/IEC 18047 shall be used.

3 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 445, *Pallets for materials handling — Vocabulary*

ISO 830, *Freight containers — Vocabulary*

ISO/IEC 15418, *Information technology — Automatic identification and data capture techniques — GS1 Application Identifiers and ASC MH10 Data Identifiers and maintenance*

ISO/IEC 15434, *Information technology — Automatic identification and data capture techniques — Syntax for high-capacity ADC media*

ISO/IEC 15459-4, *Information technology — Unique identifiers — Part 4: Individual items*

ISO/IEC 15961, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: 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 15963, *Information technology — Radio frequency identification for item management — Unique identification for RF tags*

ISO 17364, *Supply chain applications of RFID — Returnable transport items (RTIs)*

ISO/IEC 18000-3, *Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13,56 MHz*

ISO/IEC 18000-6, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*

ISO/IEC TR 18001, *Information technology — Radio frequency identification for item management — Application requirements profiles*

ISO/IEC TR 18046, *Information technology — Automatic identification and data capture techniques — Radio frequency identification device performance test methods*

ISO/IEC TR 18047-3, *Information technology — Radio frequency identification device conformance test methods — Part 3: Test methods for air interface communications at 13,56 MHz*

ISO/IEC TR 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/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)*

ISO 21067, *Packaging — Vocabulary*

ISO/IEC TR 24729-1, *Information technology — Radio frequency identification for item management — Implementation guidelines — Part 1: RFID-enabled labels and packaging supporting ISO/IEC 18000-6C*

ANS MH10.8.2, *Data Identifiers and Application Identifiers*

EPCglobal, *Tag Data Standards*, Version 1.3

GS1 *General Specifications*

ICNIRP Guidelines, *Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)*

IEEE 1451.7, *Smart Transducer Interface for Sensors and Actuators — Transducers to Radio Frequency Identification (RFID) Systems Communication Protocols and Transducer Electronic Data Sheet Formats*

IEEE C95-1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 445, ISO 830, ISO 17364, ISO/IEC 19762-1, ISO/IEC 19762-3 and ISO 21067 apply.

5 Concepts

5.1 Supply chain model

Figure 1 gives a graphical representation of the supply chain. It shows a conceptual model of possible supply chain relationships, not a one-for-one representation of physical things. Although several layers in Figure 1 have clear physical counterparts, some common supply chain physical items fit in several layers depending on the use case. For example, a repetitively used pallet under constant ownership would be covered by ISO 17364 as an RTI; a pallet that is part of a consolidated unit load would be covered by ISO 17365 as a transport unit; and a pallet that is integral to a single item would be covered by this International Standard as product packaging.

Layers 0 to 4 are addressed within the series of International Standards *Supply chain applications of RFID* (see Introduction). Layer 5 is addressed by the work of ISO/TC 204/WG 7.

Layer 1 in Figure 1 and product packaging (as defined in ISO 17364:2009, 4.9) are the subject of this International Standard.

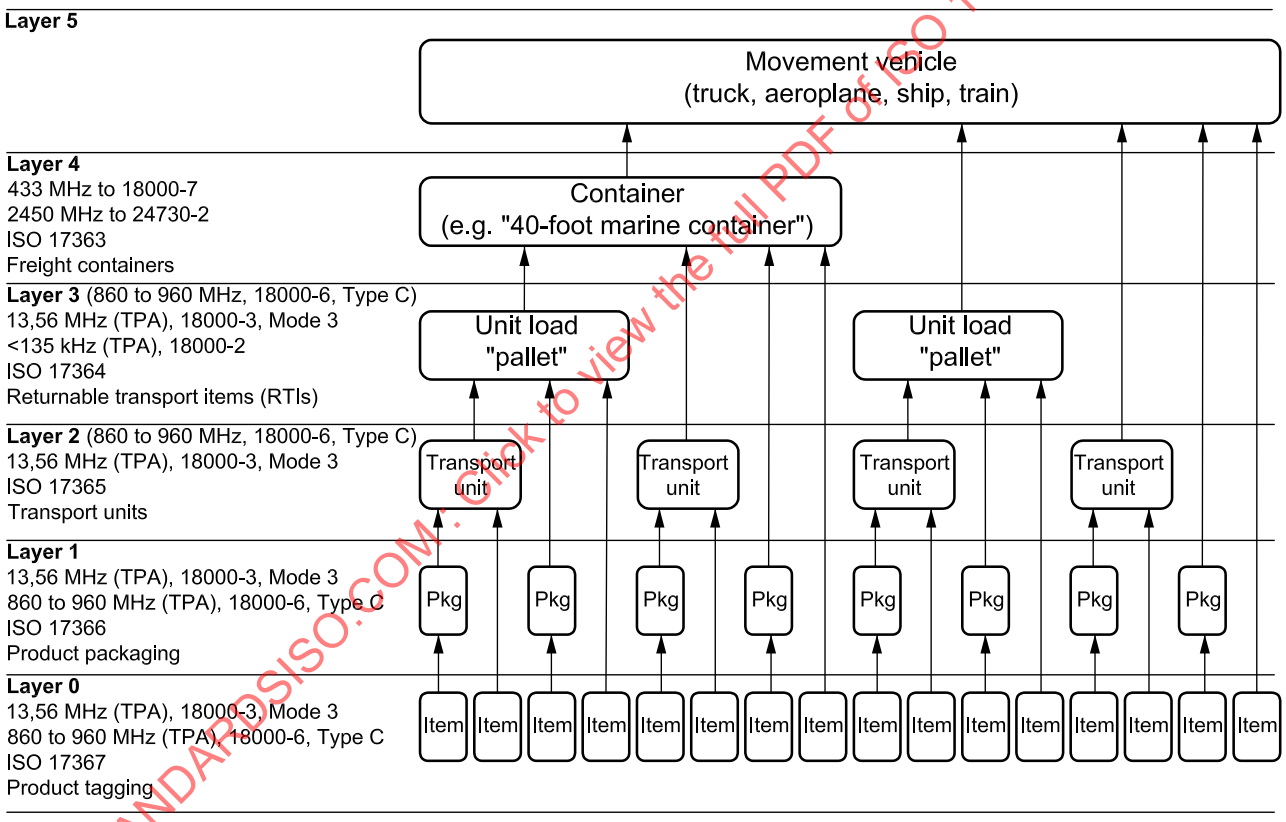

Figure 1 — Supply chain layers

Once tagged, product packaging layer tags can be distinguished from other layer tags by use of a *group select* methodology contained in the RFID interrogator/reader. This group select function allows the interrogator and supporting automated information systems (AIS) to quickly identify product packaging layer tags. As depicted in 5.2.2, the groups select methodology is further elaborated in ISO/IEC 15961.

5.2 Unique identification of product packaging

5.2.1 General

Unique product packaging identification is a process that assigns a unique data string to an individual package, or in this case to an RFID tag that is associated to the product package. The unique data string is called the unique transport unit identifier. Unique item identification of transport units allows data collection and

management at a granular level. The benefits of granular level data are evident in such areas as maintenance, warranties and enabling electronic transactions of record. This granularity is possible only if each tagged item has a unique item identifier.

Product package layer tagging can uniquely identify products, thus providing differentiation between like and unlike product packages. Product package layer tagging can also be used to identify product packages by differentiating unlike product packages but not differentiating between like product packages. This is used for commodities where individualization is impractical or undesirable.

The unique product packaging identifier described above is a unique identifier as described in ISO/IEC 15459-5. The unique item identifier (UII) provides granular discrimination between like items that are identified with RFID tags. The unique tag ID (as defined by ISO/IEC 15963) is a mechanism to uniquely identify RFID tags and is not the unique product packaging identifier defined in this International Standard.

The minimum data elements required for unique identification are an enterprise identifier and a serial number that is unique within that enterprise identifier. Commonly, a part or model number is also required to achieve unique identification.

This International Standard uses the following identification mechanisms for unique product package identification:

— unique identifiers for supply chain items (ISO/IEC 15459-4);

— GS1 Serialized Global Trade Item Number (SGTIN).

5.2.2 International unique identification of product packages

The unique identifier of ISO/IEC 15459 provides identification schemes for various layers of the supply chain, from layer 0 (products) up to layer 3 (returnable transport items). The unique identification of product packages shall use ISO/IEC 15459-4. Unique identification is provided by three components:

a) issuing agency code (IAC),

b) company identification number (CIN),

c) serial number (SN),

preceded by an AFI and Data Identifier (DI). The AFI code assignments table in ISO/IEC 15961:2004, Annex B, permits identification of the supply chain layer, i.e. product = $A1_{HEX}$, transport unit = $A2_{HEX}$, returnable transport item = $A3_{HEX}$ and product package = $A5_{HEX}$.

The Data Identifier shall be "25S". The ISO/IEC 15459 registration authority assigns the IAC. The CIN is assigned by the issuing agency. The company registered with the issuing agency assigns the serial number. The serial number shall be no longer than 20 alphanumeric characters.

Table 1 — 1736*x* AFI Assignments

AFI (HEX)	Assignment	International Standard
A1	17367_Non-EPC	ISO 17367 — *Supply chain applications of RFID — Product tagging*
A2	17365_Non-EPC	ISO 17365 — *Supply chain applications of RFID — Transport units*
A3	17364_Non-EPC	ISO 17364 — *Supply chain applications of RFID — Returnable transport items (RTIs)*
A4	17367_HazMat	ISO 17367 — *Supply chain applications of RFID — Product tagging* (HazMat)
A5	17366_Non-EPC	ISO 17366 — *Supply chain applications of RFID — Product packaging*
A6	17366_HazMat	ISO 17366 — *Supply chain applications of RFID — Product packaging* (HazMat)
A7	17365_HazMat	ISO 17365 — *Supply chain applications of RFID — Transport units* (HazMat)
A8	17364_HazMat	ISO 17364 — *Supply chain applications of RFID — Returnable transport items (RTIs)* (HazMat)
A9	17363_Non-EPC	ISO 17363 — *Supply chain applications of RFID — Freight containers*
AA	17363_HazMat	ISO 17363 — *Supply chain applications of RFID — Freight containers* (HazMat)

When stored on a tag with a technology that supports AFIs, the unique identifier shall also be associated with an AFI. EPC does not use AFIs; consequently, there are no AFIs used for product packages employed in retail applications using EPCglobal.

To define its class (in the ISO/IEC 15459 sense), the unique identifier shall have an associated class identifier, which is the Data Identifier "25S". For the purposes of this International Standard, a unique identifier of product packages can be up to 35 alphanumeric characters in length, including the Data Identifier (an3+an..32). See Table 2.

Table 2 — UII element string

Format of the license plate	
Data Identifier	IAC, company identification number (CIN), serial number
25S	N_1 N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10} N_{11} N_{12} N_{13} N_{14} N_{15} N_{16} N_{17} . . . N_{32}

5.2.3 Serialized global trade identification number (SGTIN)

The EPCglobal serialized global trade identification number (SGTIN) is a unique item identifier (UII) capable of providing unique item identification of product packages.

Table 3 — SGTIN element string

	Header	Filter Value	Partition	Company Prefix	Item Reference	Serial Number
Number of bits	8	3	3	20 to 40	24 to 4	38
Reference	0011 0000[a]	—[b]	—[b]	999 999 to 999 999 999 999[c]	9 999 999 to 9[c]	274 877 906 943[d]

NOTE Maximum decimal value range of Company Prefix and Item Reference fields vary according to the contents of the partition field.

[a] Binary value.

[b] Refer to EPCglobal, *Tag Data Standards*, Version 1.3 for values.

[c] Maximum decimal range.

[d] Maximum decimal value.

The SGTIN consists of the following information elements:

a) The *Header*, which is defined in EPCglobal, *Tag Data Standards,* Version 1.3. It is eight (8) bits long and for an SGTIN-96 is the value 30_{HEX}.

b) The *Filter Value*, which is defined in EPCglobal, *Tag Data Standards,* Version 1.3. It is three (3) bits long and identifies whether an EPC is for a retail trade item, a standard trade item grouping, or a single shipping/consumer trade item.

c) The *Partition*, which is defined in EPCglobal, *Tag Data Standards,* Version 1.3. It is three (3) bits long, carries one of seven (7) values, and identifies where the subsequent *Company Prefix* and *Item Reference* numbers are divided.

d) The *Company Prefix*, assigned by GS1 to an organization. The Company Prefix is the same as the Company Prefix digits within a GS1 GTIN decimal code. The combined Company Prefix and Item Reference are 44 bits long (13 decimal digits).

e) The *Item Reference*, assigned by the "Company" entity to a particular product package. The combined Company Prefix and Item Reference are 44 bits long (13 decimal digits).

f) The *Serial Number* assigned by the managing entity to an individual object. The EPC representation is only capable of representing a subset of serial numbers allowed in the GS1 *General Specifications*. Specifically, only those Serial Numbers consisting of one or more digits, with no leading zeros, are permitted. The length of the Serial Number is 38 bits.

5.3 Other identification requirements

This International Standard does not supersede or replace any applicable safety or regulatory marking or labelling requirements.

This International Standard is meant to satisfy the minimum product packaging identification requirements of numerous applications and industry groups. As such, its applicability is to a wide range of industries, each of which may have specific implementation guidelines for this International Standard. This International Standard is to be applied in addition to any other mandated labelling requirements.

6 Differentiation within the layer

6.1 Business processes

Business processes such as those described below are illustrative of the applications envisioned by this International Standard.

— Acquisition: ordering, including the identification of relevant specifications and requirements, can be facilitated by referencing the item's original acquisition data using the RFID tag's unique ID as a database key.

— Shipping: where items can have different configurations or capabilities, such as with computer software loads that differentiate items with otherwise identical form, fit and function, such items can be issued and shipped with the tag read providing assurance that the correct item was shipped. This level of non-intrusive tracking and tracing can serve as a front end to higher level in-transit visibility RFID applications detailed in the other International Standards of this series.

— Receiving: non-intrusive collection of receipt data can shorten data collection times, in support of automated inventory management systems and provide an electronic *transaction of record* much earlier in the process. Earlier knowledge of on-hand inventory can reduce stock outs and the need for expedited premium transportation.

— Cross docking: in addition to recording inbound receipts and outbound shipments, tagged items can be sorted. Many items will have exterior marking (tagging) that are used in lieu of reading the product tag.

— Work in process: used to track individual components and the final assembly (bill of material) and to monitor any item through a fabrication or manufacturing process.

— Maintenance: related to work in progress and differentiated in that it covers functions prior to and subsequent to the actual work. This includes fault analysis, identification, preparation of packing and packaging.

— Inventory control: item level serialization yields a granularity of visibility that supports the management of individual items. This allows data collection, tracking and tracing of individual items and selection at point of issue.

— Disposal: identification of items that have recycling or other disposal requirements.

— Picking and put-away: selection of items from a package or transport unit prior to placement into shelf stock in a warehouse situation or other storage situation where a specific asset is desired or knowledge of the specific item selected is required for issue.

— Pick and place: selection of items from shelf stock in a warehouse situation or other storage situation where a specific asset is desired or knowledge of the specific item selected is required incident to the placement of the item into or onto another asset incident to a manufacturing or assembly process.

— Sortation: process that places individual items into groups based upon some selection criteria, often performed at speed.

— Identification: process that is an inherent part of each of the functions set out above. It allows the positive differentiation of an item consistent with the business process in use. Identification can be at the discrete item level for serialized products or by commodity for non-serialized products. Identification is often the underlying base process that enables the other uses of the tag.

— Network topology: can be used to identify discrete nodes or locations on a network.

— Configuration management: discrete identification of the individual component items that comprise a higher assembly. This component data can be tiered to cover each of the multiple levels of configuration (e.g. the circuit board inside the radio installed in the communications suite of an aircraft).

The multitude of different business processes circumscribed by the supply chain will employ distinctly different groupings of functions and processes outlined above. The reading, writing or erasing of data to/from a tag is intended to effect identification and data capture about the product and the process involved and shall be integrated into business processes as required by the business process owner.

6.2 Lot/batch vs. serial number vs. product identification only

Just as different business processes have varying data requirements, different items will have varying identification requirements. Use of structured or intelligent serialization schemes include additional data such as part number or lot number in the serialization scheme and should be avoided whenever possible. This means that the serialization is unique within the enterprise.

The lowest level of identification would be product ID only. Lot and batch type items shall be marked with the product ID of the item and the lot or batch of that item that this particular item belongs to. Serialized items shall be marked with a unique serial number in conformance with the appropriate part of ISO/IEC 15459, which details the differing methods of serialization that provide unique identification.

The need to identify an item at each level is not absolute. Many items are manufactured, sold, and used at the commodity level. Examples are sand, coal and bulk liquids. These items may be marked at the lot level or simply as a generic commodity.

Medicines are typical of the type of item that is manufactured and managed at the lot level but sold and used at the item level. Thus a particular dosage of medicine will require unique identification of that dose and the ability to reference that back to the original manufacturing lot. Looking up associated information on the information system can accomplish this reference.

6.3 Consumer products vs. industrial/government

Personal privacy considerations present a unique set of considerations for consumer products as opposed to products that remain exclusively in the industrial/government sectors. Consumer privacy regulations shall be considered in the design and operation of every consumer level product packaging scenario. Encryption and data security are addressed in Clause 8.

7 Data content

7.1 Introduction

Subclauses 7.2 to 7.7 describe the data content of RFID tags for the product packaging layer. They identify, amongst others,

— the data elements that shall or may be present on the tag,

— the way in which the data elements are identified (semantics),

— the representation of data elements in tag memory, and

— the placement of data elements in the memory of the tag.

7.2 System data elements

7.2.1 Unique product package identification

The first data element on a compliant tag shall be the unique identification described in ISO/IEC 15459-4. The length and nature of this unique identification is defined in this data element. For an ISO/IEC 18000-6, Type C and ISO/IEC 18000-3, Mode 3 compliant tag, the "unique identification" data element is segregated from any additional (user data) by the memory architecture. The unique identification data element shall be stored in UII memory (Bank 01), with any additional data being stored in user memory (Bank 11). For the purposes of this International Standard, a unique identifier of product packages can be up to 35 alphanumeric characters in length, including the Data Identifier (an3+an..32).

7.2.2 Data semantics

Tags that only encode the unique product package identifier should conform to ISO/IEC 15961. Tags containing complex data structures or larger data sets shall include semantics that conform to ISO/IEC 15418, ISO/IEC 15961, and ISO/IEC 15962.

7.2.3 Data syntax

Tags that encode identity only are considered to have no syntax. Tags containing complex data structures or larger data sets shall conform to ISO/IEC 15434 and should also conform to ISO/IEC 15962.

7.3 Tag structure

7.3.1 Tag header

Tag headers should contain either an ISO/IEC defined AFI or an EPCglobal defined NSI. The ISO/IEC 15961 AFI for product packages, i.e. $A5_{HEX}$, in bits 18_{HEX} to $1F_{HEX}$ as described in Tables 1 and 4. Support for ISO standards (including AFIs) is indicated when bit 17_{HEX} is set to "1". Alternatively, such headers may contain an EPC header as described in EPCglobal, *Tag Data Standards*, Version 1.3. Support for EPCglobal coding is indicated when bit 17_{HEX} is set to "0".

NOTE A 96-bit SGTIN is represented by EPC header 30_{HEX}.

7.3.2 Tag memory

Figure 2 provides a graphical representation of tag memory.

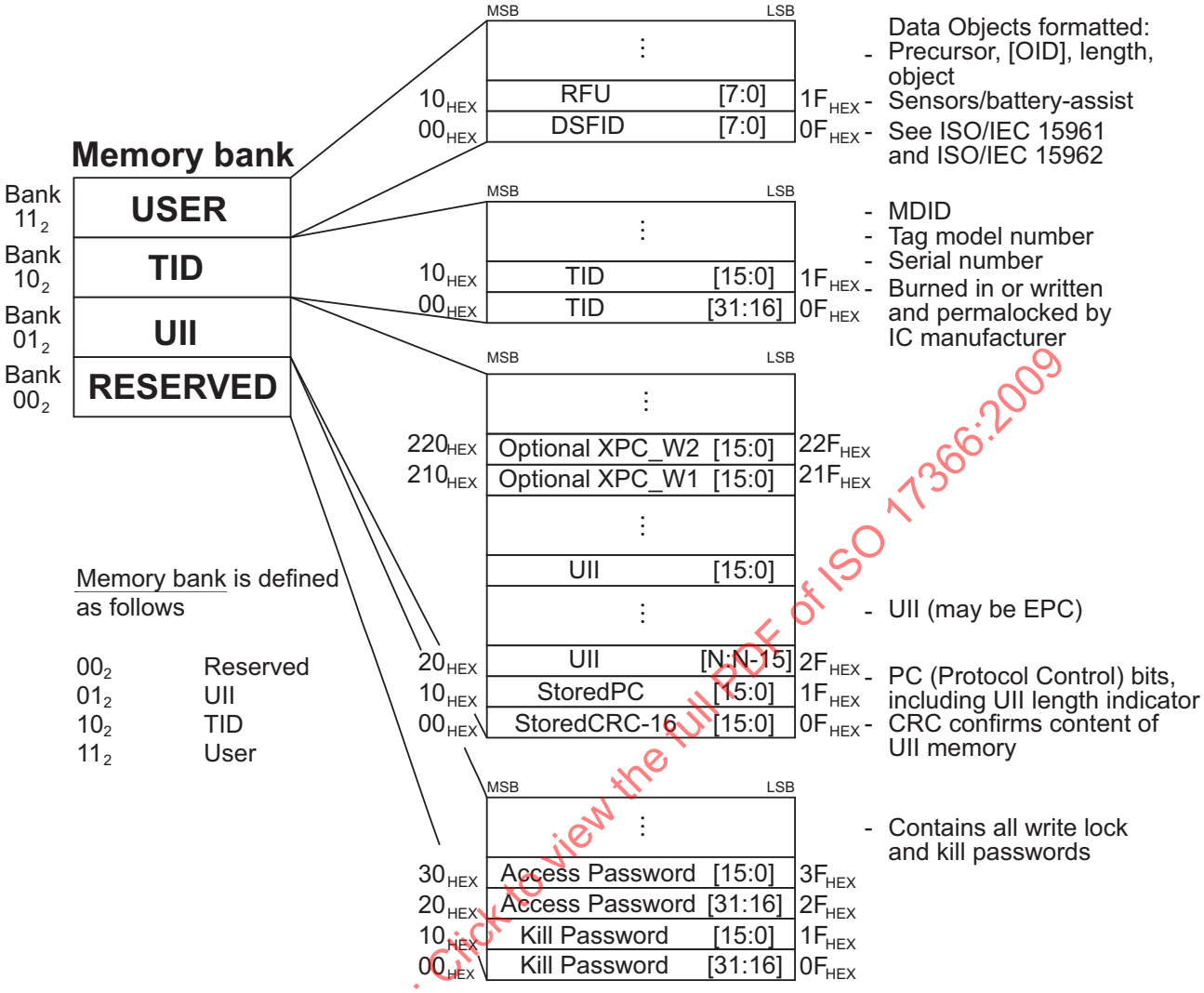

Figure 2 — Segmented memory map

7.3.3 Tag memory banks

Tag memory shall be logically separated into four distinct banks, each of which may comprise one or more memory words. A logical memory map is given in Figure 2. The memory banks are as follows.

a) Reserved memory: shall contain the kill and access passwords. The kill password shall be stored at memory addresses 00_{HEX} to $1F_{HEX}$; the access password shall be stored at memory addresses 20_{HEX} to $3F_{HEX}$. If a tag does not implement the kill and/or access password(s), the tag shall act as though it had zero-valued password(s) that are permanently read/write locked and the corresponding memory locations in reserved memory need not exist.

b) UII memory: shall contain a CRC-16 at memory addresses 00_{HEX} to $0F_{HEX}$, Protocol Control (PC) bits at memory addresses 10_{HEX} to $1F_{HEX}$ and a code, i.e. a UII, that identifies the object to which the tag is or will be attached beginning at address 20_{HEX}. The PC is subdivided into a UII length field in memory locations 10_{HEX} to 14_{HEX}, an indication of user memory bit in memory location 15_{HEX}, a PC extension indicator bit in memory location 16_{HEX}, an ISO/EPC bit in memory location 17_{HEX} and a numbering system identifier (NSI) in memory locations 18_{HEX} to $1F_{HEX}$. The CRC-16, PC and UII shall be stored MSB first (the UII's MSB is stored in location 20_{HEX}).

c) TID memory: shall contain an 8-bit ISO/IEC 15963 allocation class identifier at memory locations 00_{HEX} to 07_{HEX}. TID memory shall contain sufficient identifying information above 07_{HEX} for an interrogator to uniquely identify the custom commands and/or optional features that a tag supports.

For EPC tags whose ISO/IEC 15963 allocation class identifier is 11100010_2, this identifying information shall comprise a 12-bit tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit tag model number at memory locations 14_{HEX} to $1F_{HEX}$.

For ISO/IEC 15459-4 tags operating conformant to ISO/IEC 18000-6, Type C and whose ISO/IEC 15963 allocation class identifier is 11100000_2 ($E0_{HEX}$), this identifying information shall comprise a 12-bit tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit tag model number at memory locations 14_{HEX} to $1F_{HEX}$.

For ISO/IEC 15459-4 tags operating conformant to ISO/IEC 18000-3, Mode 3, and whose ISO/IEC 15963 allocation class identifier is 11100000_2 ($E0_{HEX}$), this identifying information shall comprise a 12-bit tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit tag model number at memory locations 14_{HEX} to $1F_{HEX}$.

Tags may contain tag- and vendor-specific data (for example, a tag serial number) in TID memory above $1F_{HEX}$.

d) User memory: allows user-specific data storage. The StorgageFormat ID described in ISO/IEC 15961 and ISO/IEC 15962 defines the memory organization. The presence of data in user memory in MB11 shall be indicated by the presence of a 1 in the 15_{HEX} PC bit. A zero in the 15_{HEX} PC bit shall indicate that there is no user memory at MB11 or that there is no data in MB11.

7.4 Protocol Control (PC) bits

The PC bits contain physical-layer information that a tag backscatters with its UII during an inventory operation. There are 16 PC bits, stored in UII memory at addresses 10_{HEX} to $1F_{HEX}$, with bit values defined as follows.

— Bits 10_{HEX} to 14_{HEX}: The length of the (PC + UII) that a tag backscatters, in words:

  — 00000_2: one word (addresses 10_{HEX} to $1F_{HEX}$ in UII memory).

  — 00001_2: two words (addresses 10_{HEX} to $2F_{HEX}$ in UII memory).

  — 00010_2: three words (addresses 10_{HEX} to $3F_{HEX}$ in UII memory).

  — ...11111_2: 32 words (addresses 10_{HEX} to $20F_{HEX}$ in UII memory).

— Bit 15_{HEX}: User memory; shall be set to “0” for tags without data in user memory (MB “11”) or tags without user memory and shall be set to “1” for tags with data in user memory.

— Bit 16_{HEX}: Shall be set to “0” if there are no extended PC (XPC) bits or the XPC bits have a zero value and shall be set to “1” if the PC bits are extended by an additional 16 bits.

NOTE 1 If a tag implements XPC bits then PC bit 16_{HEX} will be the logical OR of the XPC bits contents. The tag computes this logical OR, and maps the result into PC bit 16_{HEX}, at power up. Readers can select on this bit, and tags will backscatter it.

NOTE 2 The XPC will be logically located at word 32 of UII memory. If a reader wants to select on the XPC bits, then it issues a Select command targeting this memory location.

— Bit 17_{HEX}: Shall be set to “0” if encoding an EPC and shall be set to “1” if encoding an ISO/IEC 15961 AFI in bits 18_{HEX} to $1F_{HEX}$.

— Bits 18_{HEX} to $1F_{HEX}$: A numbering system identifier (NSI) whose default value is 00000000_2 and which may include an AFI as defined in ISO/IEC 15961 (when encoding the tag pursuant to ISO standards). The MSB of the NSI is stored in memory location 18_{HEX}.

The default (unprogrammed) PC value shall be 0000_{HEX}.

Table 4 summarizes the content.

Table 4 — Segmented memory: memory bank "01"

Protocol Control bits run from 10_{HEX} to $1F_{HEX}$															
					0/1	0/1	0/1								
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Length indicator					User memory	XPC bit	EPC/ISO	Application family identifier (AFI)/ Numbering system identifier (NSI)							Haz Mat

7.5 Data elements

7.5.1 Unique product package identifier

The UII – Product package shall be present on all conformant product package tags. For non-retail tags, the unique product package identifier shall conform to ISO/IEC 15459-4 and shall be used as described in 5.2.2. For retail tags, the unique product package identifier shall conform to EPCglobal, *Tag Data Standards*, Version 1.3 for the SGTIN-96 and shall be used as described in 5.2.3.

7.5.2 Hazardous goods

RFID tags for product packaging that is classified as hazardous for storage, transportation or use shall contain a bit reference indicating that the item is hazardous. In addition, the tag, regulations and statutes may require a more detailed categorization of the hazard. The setting of this bit ("1") directs the material handler to the included material safety data sheet. This additional categorization shall not be mandatory unless it provides an approved replacement for hazard data otherwise required by the requiring authority.

The specific hazardous goods code shall include the appropriate Data Identifier and qualifier and shall be reflected in the user data memory. The presence of hazardous material for EPC transport units is indicated by bit "1F" of memory bank MB01 as defined in ISO/IEC 18000-6, Type C and ISO/IEC 18000-3, Mode 3. The presence of hazardous material for ISO product packaging is indicated by the AFI "0 × A5" in bits "18" to "1F" of memory bank MB01 as defined in ISO/IEC 18000-6, Type C and ISO/IEC 18000-3, Mode 3.

This International Standard does not supersede or replace any applicable safety or regulatory marking or labelling requirements. This International Standard is meant to satisfy the minimum product packaging identification requirements of numerous applications and industry groups. As such, its applicability is to a wide range of industries, each of which may have specific implementation guidelines for this International Standard. This International Standard is to be applied in addition to any other mandated labelling requirements.

7.5.3 Optional data

Dependent upon the tag type and capacity, optional data may be written to tags as required. Agreement between trading partners is not required. Optional data may be encrypted or otherwise secured at the discretion of the tag writer. Note that encrypted or secured data may not be readable by subsequent applications or users. Unless written in a read-only format or locked, optional data may be removed or changed by subsequent applications. Optional data shall be contained in ISO/IEC 15434 syntax and ISO/IEC 15418 semantics using ISO/IEC 15962.

7.6 Traceability

Unique identification enables traceability. Traceability can relate to specific items yielding the ability to differentiate between like items and traceability can also relate to groups of like items differentiating them from unlike items.

Serialization schemes shall comply with ISO/IEC 15459-4.

Traceability of commodity items may be achieved by concatenating data elements representing the manufacturer, the part/model number and the lot or batch number assigned by the manufacturer.

7.7 Unique item serialization

Unique item identification can be assured by concatenating three elements of data: the issuing agency code (IAC), an enterprise identifier (relating to the IAC), and a unique serialization as described in ISO/IEC 15459-3.

Product package-RFID tag data formats shall make a clear distinction in the leading eight bits of the tag between unique product package identification and its contents, in addition to a ninth bit (at seventeenth HEX position) indicating ISO (AFI) or EPCglobal.

8 Data security

8.1 Confidentiality

Tag users desiring to have their tags read only by authorized users shall have the ability to secure/protect data written to a tag. The tag shall be capable of having secured/protected data written to it and read from it without interference from the tag design or structure. Use of this feature shall be at the discretion of the user. The type of security/protection to be utilized shall be commensurate with the degree of risk and vulnerability associated with the tag data, and shall be agreed upon between the enterprise writing to the tag and any/all authorized readers/users of the data.

8.2 Data integrity

Tags shall have the ability to prevent the alteration or erasure of data commonly known as *locking* data. This shall be at the discretion of the user. Tag manufacturers shall have the option of locking a portion of the tag data for identification and storage of data related to the manufacturer and not the user. A CRC-16 is required to enhance the integrity of the data. The location of the CRC-16 shall be as per the memory map in Figure 2.

8.3 Interrogator authentication

A tag's data storage schemas for user memory and future data transfer protocols should provide for the user-enabled option to require authentication of the interrogator's authorization prior to reading the tag data. Reading of the tag ID alone shall not require authentication.

8.4 Non-repudiation/audit trail

Tags shall be capable of supporting non-repudiation when programmed to provide non-forgeable evidence that a specific action occurred. Nothing in this non-repudiation feature shall interfere with or degrade the performance of the tag or other tags in the field of view.

8.5 Product authentication/anti-counterfeiting

RFID devices by themselves do not prevent counterfeiting; the serialization of product and a secure chain of custody can aid in anti-counterfeiting.

9 Identification of RFID labelled material

RF tags and RF label inlays compliant with this International Standard shall include one or more of the internationally accepted RFID emblems. The accepted emblems are given in Figure 3.

NOTE 1 The above emblems only represent the 860 MHz to 960 MHz air interface for this application standard. Other air interface designations can be found in ISO/IEC 29160.

NOTE 2 These graphics can be scaled to the appropriate size and are available in either dark-on-light or light-on-dark.

Figure 3 — Examples of the RFID emblem and EPCglobal seal as described in ISO/IEC 29160

10 Human readable information

10.1 Human readable interpretation

Other than as stated in 5.3, human readable interpretation or human readable translation of unique item identifiers is not mandatory. Where used, the mandatory information (UII) contained in the binary encodations in RF tags shall be represented in their octal or hexadecimal equivalent as shown in ISO/IEC TR 24729-1. ISO standard two-dimensional symbols, for example Data Matrix ECC 200 or QR code, encoded in conformance with ISO/IEC 15418 and ISO/IEC 15434, should be considered as a primary backup to RF tags on products. An additional level of backup of human readable interpretation may be considered.

10.2 Human readable information (HRI) and bar code representation of UII

Human readable translation of the data on the tag is selected data rather than complete data and may or may not contain data semantics. Human readable translation should be used when space constraints or privacy considerations do not permit the use of human readable interpretation.

HRI of either ISO UII or EPC tags shall be the upper case alphabetic and numeric representation of the encoded data as set forth in ISO/IEC TR 24729-1.

10.3 Data titles

The use of data titles shall be as specified in ANS MH10.8.2 or the GS1 *General Specifications*.

10.4 Backup

Use of human readable information is strongly encouraged for data that is critical to the item's use and shall function as the first backup in the event that the RFID tag is unreadable/misleading for any reason. If optically readable media is used, trading partners shall agree upon a linear symbol such as Code 128, as described in ISO/IEC 15417, or a two-dimensional symbol such as Data Matrix, as described in ISO/IEC 16022 or QR Code, as described in ISO/IEC 18004.

11 Tag operation

11.1 Data protocol

The data protocol for this International Standard shall support the requirements of ISO/IEC 15961 and the semantics of ISO/IEC 15418 and ISO/IEC 15962 and the syntax of ISO/IEC 15434.

11.2 Minimum performance requirements (range and rate)

The performance for tags shall be measured in accordance with ISO/IEC TR 18046. Minimum performance requirements will vary for different functional applications of RFID. Table 5 shows the typical performance requirements for passive tags operating in the three normal configurations to transfer tag data of 256 bits. These specifications also relate to the writing of the tag. Greater distances can be achieved in reading from RF tags than writing to RF tags.[1)]

Table 5 — Typical passive tag performance

Parameter	860 MHz to 960 MHz ISO/IEC 18000-6, Type C	13,56 MHz ISO/IEC 18000-3, Mode 3	<135 kHz ISO/IEC 18000-2, Type A	433,92 MHz ISO/IEC 18000-7
How far? [Minimum supported read distance (in metres)]	3	0,7	0,7	30
How fast? [Minimum supported item speed when read (in kilometres per hour)]	16	16	0	16
How many? [Minimum supported effective measure of tag data transfer rate and ability to do anti-collision (in tags per second)]	200[a] or 500[b]	200	1	1

[a] This value corresponds to the 200 kHz bandwidth.

[b] This value corresponds to the 500 kHz bandwidth.

11.3 Environmental parameters

The operating environment will vary significantly by location. A description of various environmental factors associated with RFID can be found in ISO/IEC TR 18001. Consideration will be given to the following general parameter set, as derived from the product packaging user community.

— The product packaging RFID tag shall function properly in the temperature range –40 °C to +70 °C and be able to endure, for a specified period of time, harsher conditions in the range –50 °C to +85 °C.

— An operating environment with relative humidity of 95 %.

— Warehouse construction, including racking.

— Transportation mode.

— Speed and direction of movement of tag relative to reader.

— Orientation of tag to reader (i.e. controlled or random).

1) In case regulatory restrictions provide fewer channels than there are interrogators in the environment, this performance can only be achieved by appropriate shielding of the interrogators against other interrogators.

— Read distance.

— Write distance (if applicable).

— Electromagnetic interference from motors, fluorescent lights and other spectrum users.

— Electromagnetic characteristics of the packaging and contents of the tagged item.

— Shape and size constraints on antenna, and any requirement to decouple antenna from tagged item.

— Form factor constraints in terms of size, shape, resistance to pressure, temperature, moisture, cleaning and contaminants [dust, oil (natural food, petroleum and synthetic), acids and alkalis].

— Method of attachment of form factor.

— Resistance of readers to heat, moisture, impact damage.

— Health and safety regulations.

The performance of passive RFID (range and rate) can be adversely affected by the presence of metal and/or liquids in the container, transport unit or (packaged) product. Appropriate shielding can be used to reduce interference.

If the process requires read rates in excess of 200 tags per second sequentially, parallel readings should be envisioned.

11.4 Tag orientation

It should be assumed that the handling operation is unable to predict the orientation of the individual (packed) products in higher levels of packaging and transport. This can hamper the effective use of the reading equipment on site and/or *en route*.

11.5 Packaging material

A wide range of materials (such as wood, metal, plastic, glass, paper and textile) is utilized in primary packaging and small and large product packages. Also, materials for coding and identification, as well as branding and the representation of legally required information, are used. These can interfere with the RFID equipment.

11.6 Shock loads and abrasions

Typically, the various product packages are subject to shock loads during the physical handling process. This can result in intentional or unintentional damage to the RFID tag. Placement and insertion of the tag should be done in such a way that damage due to shocks is minimized.

11.7 Tag lifetime

Tags attached to product packaging will be continuously used throughout the life of the product. Product packaging RFID tags shall be capable of a minimum 100 000 read or read/write cycles, as appropriate, without failure.

11.8 Minimum system reliability

Systems where tags are positioned, programmed and presented to reading equipment in accordance with the provisions of 11.3 and ISO/IEC TR 18046, shall have a minimum read reliability of 99,99 %, i.e. no more than one no-read event in 10 000 readings, and a read accuracy of 99,998 %, i.e. two undetected incorrect readings in 100 000 readings.

11.9 Air interface

Product packaging RFID tags shall operate in one of two frequency ranges and comply with the appropriate parts of ISO/IEC 18000. With agreement between trading partners, either ISO/IEC 18000-6, Type C or the ASK air interface of ISO/IEC 18000-3, Mode 3 may be used. It is recommended that tags supporting ISO/IEC 18000-6, Type C also be able to support ISO/IEC 18000-3, Mode 3.

11.10 Memory requirements for application

The memory requirements for product packaging RFID tags can be grouped into three basic categories: 96 bits, 256 bits and greater than 256 bits. Industry surveys have yielded recommendations for RF chip manufacturers to provide for 2 kbits and 4 kbits. Memory capacities shall not alter the air interface. Use of alternate memory requirements shall not result in changes to the minimum and mandatory data elements of their format or tag data structure, as otherwise specified in this International Standard. Annex A gives a list of useful data fields for product life cycle management totalling 152 bytes (1 216 bits).

11.11 External communications

External communications (interactive as opposed to simple data transfer and read/write) shall not be required for, but may be a part of, product packaging RFID tags where the optional supporting commands meet the requirements of the optional commands in the air interface (ISO/IEC 18000). Proprietary commands should not be used.

11.12 Sensor interface, if applicable

Sensors integrated into or onto a tag and their tag operations or management shall not interfere with the operation of the tag as required by this International Standard.

Battery assisted tags shall be free from interference from the battery operation and/or battery management functions.

Sensor equipped product packaging RFID tags shall conform to IEEE 1451.7 for the physical interface between the tag and the sensor.

11.13 Real time clock option

A real time clock shall be included with product packaging RFID tags that are sensor equipped and where the application requires a time stamp. The accuracy of the time compared to actual Coordinated Universal Time (UTC) shall be no worse than ± five seconds per day.

11.14 Safety and regulatory considerations

All tags, interrogators and antennas conforming to this International Standard shall meet the safety and regulatory requirements of the country where the technology is used. The use of passive or semi-passive (battery assisted) RFID tags shall also be restricted in hazardous environments, such as near or around explosives or flammable gasses, unless these devices have been certified as safe for such use by appropriate authorities.

All tags conforming to this International Standard shall meet national safety and regulatory requirements to include power, duty cycle and electromagnetic radiation.

11.15 Non-observable data

The nature of non-observable data is such that when individual data fields within a tag are protected by an interrogator command, the command may implement whatever protection measures are chosen, provided that the protection measures do nothing to impact, interfere with or deteriorate the operation of other tags in the