BS ISO 17365:2013

BSI Standards Publication

Supply chain applications of RFID — Transport units

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National foreword

This British Standard is the UK implementation of ISO 17365:2013. It supersedes BS ISO 17365:2009, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee IST/34, Automatic identification and data capture techniques.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Second edition
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Supply chain applications of RFID — Transport units

Applications de chaîne d'approvisionnements de RFID — Unités de transport

Reference number
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Foreword

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

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 17365 was prepared by Technical Committee ISO/TC 122, *Packaging*.

This second edition cancels and replaces the first edition (ISO 17365:2009), which has been technically revised.

This International Standard has one annex, Annex A, which provides normative information.

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 *Supply 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) and returnable packaging items (RPIs);*

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

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

— 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 following work is considered valuable:

— 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.

This International Standard defines the requirements for RFID tags for transport units. Transport units are defined here as either a transport package or a unit load (see ISO 17364:2013, 4.6 and 4.9).

An important concept here is the use cases of such things as *unitized loads*, pallets and returnable transport items. How a pallet is used can determine whether it is covered under ISO 17364 as a *returnable transport item* or within this International Standard as a *transport unit*. If ownership title of the pallet remains with its owner then the applicable International Standard is ISO 17364. If the ownership title of a pallet is transferred to the customer as part of a unitized load then it is considered an element of that unitized load, and this International Standard is applicable.

Specific to transport units is the grouping of (packaged) products, in order to make these more suitable for efficient and effective transport and distribution. The transport unit provides an added value for the product being sold, mostly in terms of logistics performance. RFID tagged transport units can help further optimize the supply chain.

Additionally, this edition of this International Standards introduces the concept of returnable packaging items (RPIs). RPIs are components of the transport unit that must be tracked as well as the transport unit itself as an asset of the owner/shipper. Annex A in ISO 17364:2013 provides guidance on RPIs.

Supply chain applications of RFID — Transport units

1 Scope

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

— provides specifications for the identification of the transport unit,

— 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 18046 for performance, and ISO/IEC 18047-6 (for ISO/IEC 18000-63, 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) 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 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC/IEEE 8802-15-4, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)*

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 15459-1, *Information technology — Automatic identification and data capture techniques — Unique identification — Part 1: Individual transport units*

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/IEC 16022, *Information technology — Automatic identification and data capture techniques — Data Matrix bar code symbology specification*

ISO 17364:2013, *Supply chain applications of RFID — Returnable transport items (RTIs) and Returnable packaging items (RPIs)*

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 18000-63, *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 18004, *Information technology — Automatic identification and data capture techniques — QR Code bar code symbology specification*

ISO/IEC 18046 (all parts), *Information technology — Radio frequency identification device performance test methods*

ISO/IEC 18047 (all parts), *Information technology — Radio frequency identification device conformance test methods*

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ISO 21067, *Packaging — Vocabulary*

ISO/IEC/IEEE 21451-7, *Information technology — Smart transducer interface for sensors and actuators — Part 7: Transducer to radio frequency identification (RFID) systems communication protocols and Transducer Electronic Data Sheet (TEDS) formats*

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*

ISO/IEC 29160, *Information technology — Radio frequency identification for item management — RFID Emblem*

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

GS1 EPC, *Tag Data Standard, Version 1.6*

GS1 *General Specifications*

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

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 (all parts), and ISO 21067 apply.

For the purposes of this document, hexadecimal characters are represented as 0xnn, where “nn” is the hexadecimal value.

5 Concepts

5.1 Differentiation between this layer and the preceding layers

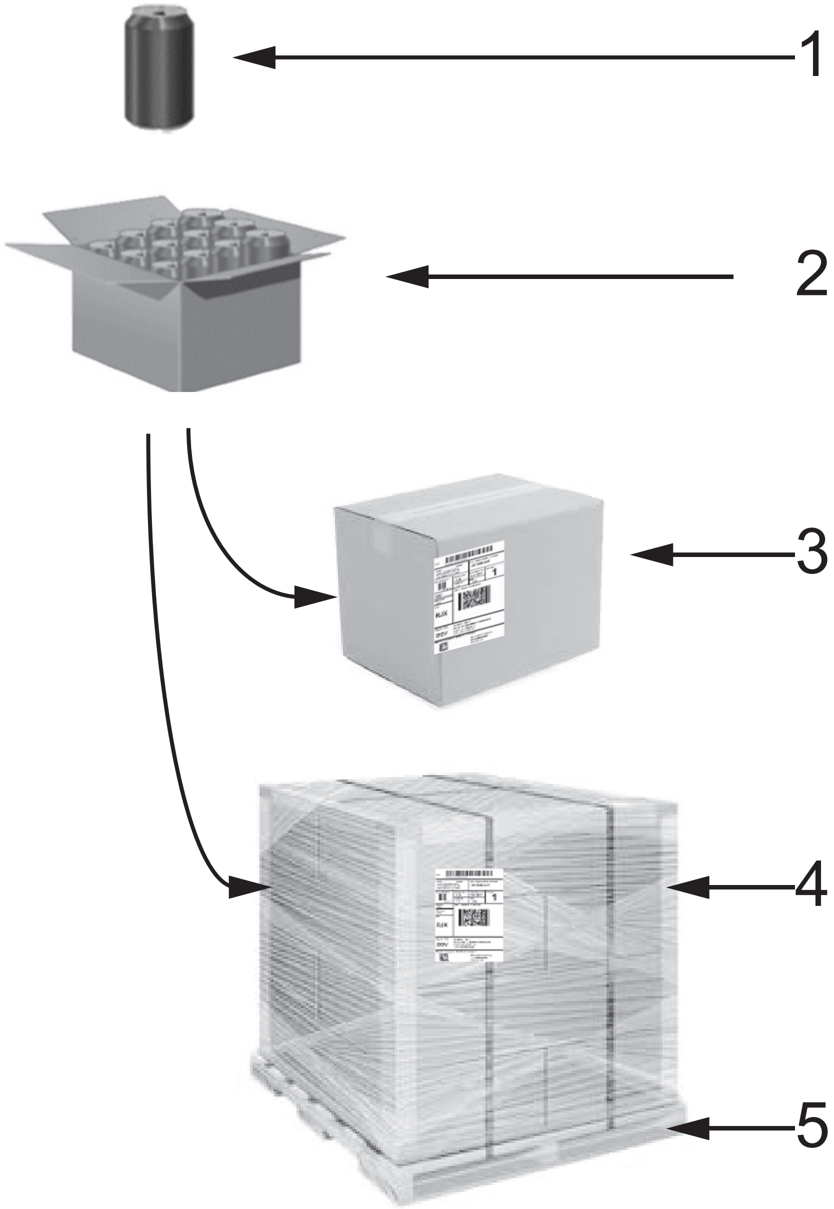
Figures 1 and 2 give a graphical representation of supply chain layers. They show a conceptual model of possible supply chain relationships, not a one-for-one representation of physical things. Although several layers in Figure 2 have clear physical counterparts, some common supply chain physical items fit in several layers depending on the use case. For example, as shown in Figure 2, 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 this International Standard as a transport unit; and a pallet that is integral to a single item would be covered by ISO 17366 as product packaging.

The term “supply chain layers” is a multi-level concept that covers all aspects of taking a product from raw materials to a final product to shipping to a final place of sale, use, maintenance and potentially disposal and returned goods. 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.

The Item Level through Freight Container Level layers are addressed within the suite of standards for “supply chain applications of RFID” and are intended to enhance supply chain visibility. The Movement Vehicle Level is the purview of ISO/TC 204/WG 7.

The Transport Unit Level in Figure 2, and specifically transport units (as defined in ISO 17364:2013, 4.7) is the subject of this International Standard.

Transport unit layer tags can be distinguished from following or preceding 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 transport unit layer tags.



Key

1 primary packaging – consumer packaging – *(product)*

2 secondary packaging – outer packaging – *(product package)*

3 tertiary packaging – transport packaging – *(transport unit)*

4 tertiary packaging – unitized transport packaging – *(transport unit)*

5 pallet – *(returnable transport item – RTI)*

Figure 1 — Packaging

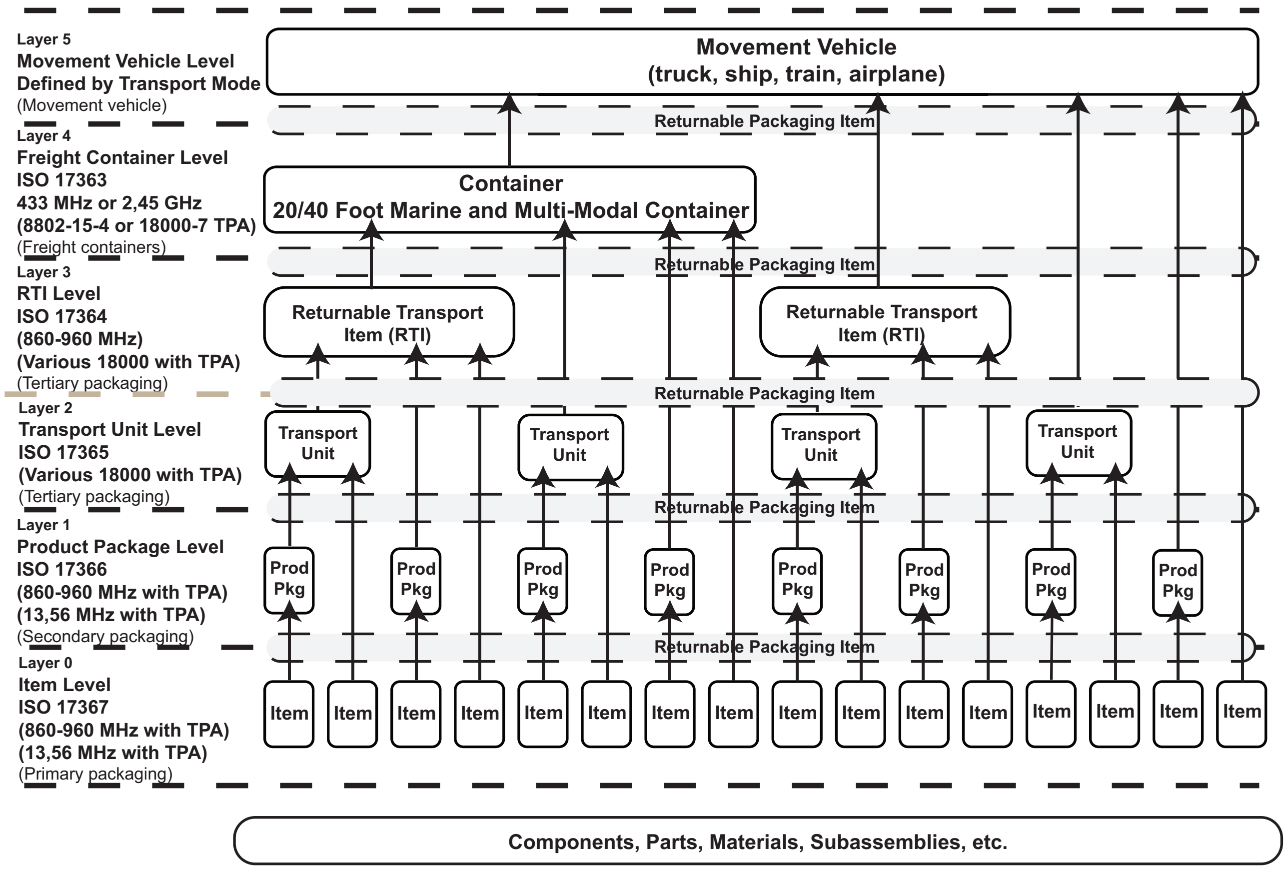


Figure 2 — Supply chain layers

5.2 Returnable packaging item

At all layers within the supply chain are materials that are shipped to a customer with full expectation that such devices will be returned to the supplier. These returnable packaging items (RPIs) are assets of value as well as potentially the physical transport unit. RPIs and their identification are well addressed in Annex A of ISO 17364.

5.3 Unique identification of transport units

5.3.1 General

Unique transport unit identification is a process that assigns a unique data string to an individual transport unit, or in this case to an RFID tag that is associated to the transport unit. 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.

The information on items in the supply chain is often held on computer systems and may be exchanged between parties involved via electronic data interchange (EDI) and extensible mark-up language (XML) schemas. The unique item identifier is used as a key to access this information.

The unique transport unit identifier described above shall be the unique identifier as described in ISO/IEC 15459-1. 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 transport unit identifier defined in this International Standard.

Transport unit tagging provides unique identification of transport units. The minimum data elements required for unique identification are an enterprise identifier/company identification number and a serial number that is unique within that enterprise identifier.

This International Standard uses the following identification mechanisms for unique transport unit identification:

— unique identifier for transport units (ISO/IEC 15459-1;

— GS1 Serial Shipping Container Code (SSCC).

5.3.2 International unique identification of transport units

The unique identifier of ISO/IEC 15459 provides identification schemes for various layers of the supply chain, from layer 1 (products) up to layer 4 (returnable transport items). The unique identification of transport units shall use ISO/IEC 15459-1. Unique identification is provided contextually 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 15961-3, Data Constructs Register and shown below in Table 1 permits identification of the supply chain layer, i.e. product = 0xA1, transport unit = 0xA2, returnable transport item = 0xA3, and product package = 0xA5.

Table 1 — 1736x AFI Assignments

AFI	Assigned organization or function
0xA1	ISO 17367 product tagging
0xA2	ISO 17365 transport unit
0xA3	ISO 17364 returnable transport item or returnable packaging item
0xA4	ISO 17367 product tagging, containing hazardous materials
0xA5	ISO 17366 product packaging
0xA6	ISO 17366 product packaging, containing hazardous materials
0xA7	ISO 17365 transport unit, but containing hazardous materials
0xA8	ISO 17364 returnable transport item or returnable packaging item, containing hazardous materials
0xA9	ISO 17363 freight containers
0xAA	ISO 17363 freight containers, containing hazardous materials

EPC does not use AFIs; consequently, there are no AFIs used for transport units employed in retail applications using EPC. AFI 0xA2 may be used for transport units intended solely for commodities other than consumer goods. Annex A provides an in-depth discussion of the ISO approach to encoding.

The Data Identifier shall be one of the "J" series shown in Table 2. To define its class (in the ISO/IEC 15459 sense), the unique identifier of transport units 'J, 1J, 2J, 3J and 4J' can be up to 35 alphanumeric characters in length, excluding the Data Identifier (an..2+an..35) and the unique identifier of transport units '5J, and 6J' can be up to 20 alphanumeric characters in length, excluding the Data Identifier (an..2+an..20). With the mutual agreement of the trading partners the length may be extended to 50 characters (an3+an..50). See Table 2.

Table 2 — ISO UII element string

Format of the license plate	
Data Identifier	IAC, company identification number (CIN), serial number
J, 1J, 2J, 3J, 4J	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_{35}
5J, 6J	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_{20}

5.3.3 Serial shipping container code (SSCC)

The serial shipping container code (SSCC) is a unique item identifier (UII) capable of providing unique item identification of transport units.

To define its class, the UII shall have an associated class identifier, which is the Application Identifier "00".

A logistic unit is an item of any composition established for transport and/or storage that needs to be managed through the supply chain. The identification and symbol marking of logistic units enables a large number of user applications. In particular, the SSCC provides a link between the physical logistic unit and information pertaining to the logistic unit that is communicated between trading partners using electronic data interchange (EDI).

The SSCC element string AI (00) is used for the identification of logistic units. Each individual logistic unit is allocated a unique number, which remains the same for the life of the logistic unit. When assigning an SSCC, the rule is that an individual SSCC number shall not be reallocated within one year of the shipment date from the SSCC assignor to a trading partner. However, prevailing regulatory or industry organization specific requirements may extend this period.

In principle, the SSCC provides a unique reference number that can be used as the key to access information regarding the logistic unit in computer files. However, attributes relating to the logistic unit (e.g. ship-to information, logistic weights) are also available as standardized element strings. See Table 3.

Table 3 — SSCC element string

Format of the element string			
SSCC			
Application Identifier	Extension digit	GS1 Company Prefix/Serial Reference	Check digit
00	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_{18}

The Application Identifier (00) indicates that the data field contains an SSCC.

The extension digit is used to increase the capacity of the Serial Reference within the SSCC. The company that constructs the SSCC assigns the extension digit.

GS1 Member Organizations allocate the GS1 Company Prefix to a system user (see GS1 *General Specifications*). This makes the SSCC unique worldwide but does not identify the origin of the unit.

The structure and content of the Serial Reference is at the discretion of the system user responsible for its assignment.

The check digit is explained in the GS1 *General Specifications.* Its verification, which shall be carried out in the application software, ensures that the number is correctly composed.

5.4 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 transport unit 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 this layer

The layer represented by the transport unit is characterized by the following unique aspects.

Individual transport units are identified by a shipment control number (SSCC or J-series Data Identifier).

The transport unit is the source of information about the environmental condition of the unit or package. This includes data on temperature, humidity, shock, and other physical characteristics.

The RF tag associated with the transport unit is written to or read from as part of one or more of the following business processes:

building a transport unit;

assembly of the next higher level in the supply chain;

— shipment;

— in transit;

— cross-docking;

— in-check/receipt;

— de-aggregation of the transport unit.

In conclusion, the transport unit and the system in which it is used are closely intertwined. Additionally, all variations possible in different supply chains are also observed in the transport unit layer of the supply chain due to the nature of the transport unit and its usage.

7 Data content

7.1 Introduction

Subclauses 7.2 to 7.8 describe the data content of RFID tags for the transport unit 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.

NOTE 1 As specified elsewhere in this International Standard, use is made of ISO/IEC 18000-63, and ISO/IEC 18000-3, Mode 3 tags. Where necessary, use is made of the specific (memory) terminology of those tags.

NOTE 2 For the purpose of transport unit tagging only, both write once/read many (WORM) and read/write tags are used. This is done to enable transport unit owners to assign specific and permanent UIIs to their transport units.

7.2 System data elements

7.2.1 Unique transport unit identification

The first data element on a compliant tag shall be the unique identification described in ISO/IEC 15459-1. The length and nature of this unique identification is defined in this data element. For an ISO/IEC 18000-63 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). A unique identifier of transport units 'J, 1J, 2J, 3J and 4J' can be up to 35 alphanumeric characters in length, excluding the Data Identifier (an..2+an..35) and the unique identifier of transport units '5J and 6J' can be up to 20 alphanumeric characters in length, excluding the Data Identifier (an..2+an..20). With the mutual agreement of the trading partners this length can be extended to 50 characters (an3+an..50). Annex A provides an in-depth analysis of encoding.

7.2.2 Data semantics

Tags that only encode the unique transport unit identity should conform to ISO/IEC 15961. This data structure shall conform to Annex A. Tags containing complex data structures or larger data sets shall include semantics that conform to ISO/IEC 15418 and Annex A of this International Standard.

7.2.3 Data syntax

Tags that only encode identity are considered to have no syntax. Tags containing complex data structures or larger data sets shall conform to Annex A of this International Standard.

7.2.4 Tag character set

Tags using Data Identifiers shall employ characters from the character set 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, [, \,], :, ;, <, =, >, ?, @, (,), *, +, -, ., /, <GS>, <RS>, <FS>, <US>, <EOT>, and Space, as shown in Table A.1.

7.3 Tag structure

7.3.1 Unique item identifiers (UIIs) for transport units

Memory Bank "01" of a transport unit shall contain either an ISO/IEC defined AFI or an EPC GS1 defined EPC. The ISO/IEC 15961, AFI for transport units is 0xA2, in bits 0x18 – 0x1F as described in Tables 1 and 4. Support for ISO standards (including AFIs) is indicated when bit 0x17 is set to "1". Alternatively, support for GS1 EPC coding is indicated when bit 0x17 is set to "0" as described in the GS1 EPC Tag Data Standard.

NOTE A 96-bit SSCC is represented by EPC header 0x31.

7.3.2 Tag memory

Figure 3 provides a graphical representation of tag memory.

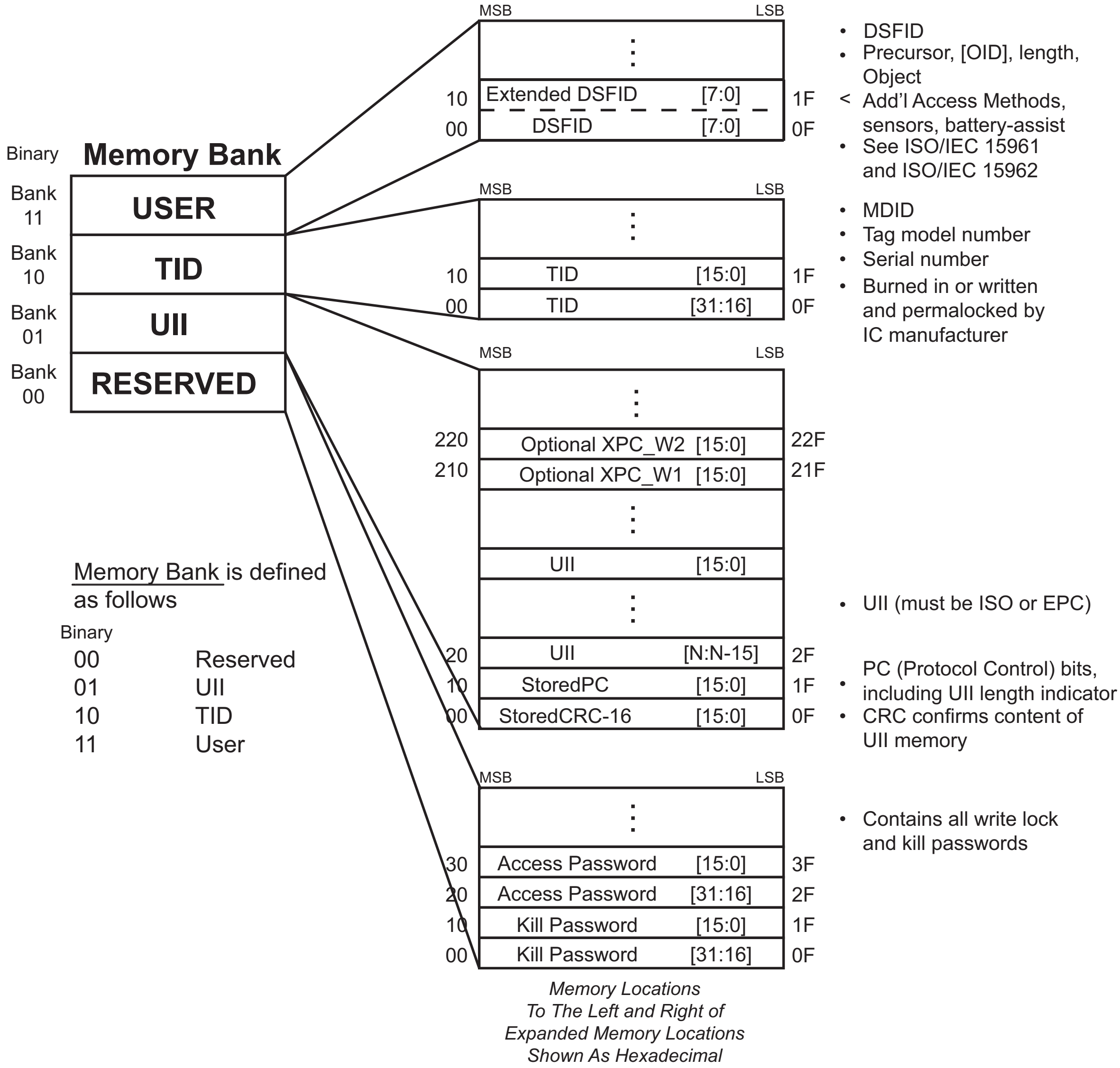


Figure 3 — Segmented memory map

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 3. The memory banks are as follows.

a) Reserved memory (MB00): shall contain the kill and access passwords. The kill password shall be stored at memory addresses 0x00 to 0x1F; the access password shall be stored at memory addresses 0x20 to 0x3F. 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 (MB01): shall contain a CRC-16 at memory addresses 0x00 to 0x0F, Protocol-Control (PC) bits at memory addresses 0x10 to 0x1F, and a code, i.e. a UII, that identifies the object to which the tag is or will be attached beginning at address 0x20. The PC word is subdivided (see Table 4 and Figure A.2). The CRC-16, PC, and UII shall be stored MSB first (the UII's MSB is stored in location 0x20).

c) TID memory (MB10): shall contain an 8-bit ISO/IEC 15963-allocation class identifier at memory locations 0x00 to 0x07. TID memory shall contain sufficient identifying information above 0x07 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 111000102 (0xE2), this identifying information shall comprise a 12-bit tag mask-designer identifier at memory locations 0x08 to 0x13 and a 12-bit tag model number at memory locations 0x14 to 0x1F. Tags may contain tag- and vendor-specific data (for example, a tag serial number) in TID memory above 0x1F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-63, Type C and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise an 8-bit IC manufacturer registration number at memory locations 0x08 to 0x0F and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x10 to 0x3F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise an 8-bit IC manufacturer registration number at memory locations 0x08 to 0x0F and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x10 to 0x3F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-63, Type C or ISO/IEC 18000-3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 111000112 (0xE3), this identifying information shall comprise an 8-bit IC manufacturer registration number at memory locations 0x08 to 0x0F, a 16-bit user memory and size definition according to ISO/IEC 15963 from memory locations 0x10 to 0x1F, and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x20 to 0x4F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-63, Type C and ISO/IEC 18000-3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 11100011_2 (0xE3), this identifying information shall comprise an 8-bit IC manufacturer registration number at memory locations 0x08 to 0x0F, a 16-bit user memory and size definition according to ISO/IEC 15963 from memory locations 0x10 to 0x1F, and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x20 to 0x4F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-7 and whose ISO/IEC 15963 allocation class identifier is 00010001_2 (0x11), this identifying information shall comprise an 8-bit tag mask-designer identifier at memory locations 0x08 to 0x0F and a 32-bit tag serial number at memory locations 0x16 to 0x1F.

For ISO/IEC 15459-1 tags operating conformant to ISO/IEC 18000-2, Type A and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise an 8-bit tag manufacturer identification at memory locations 0x08 to 0x15 and a 48-bit tag serial number at memory locations 0x16 to 0x3F.

d) User memory (MB11): allows user-specific data storage. The storage format 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 0x15 PC-bit. A zero in the 0x15 PC bit shall indicate that there is no user memory at MB11 or that there is no data in MB11. Further information on MB11 can be found in Annex A.

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 0x10 to 0x1F, with bit values defined as follows:

— Bits 0x10 to 0x14: The length of the (PC + UII) that a tag backscatters, in words:

  — 00000_2: one word (addresses 0x10 to 0x1F in UII memory).

  — 00001_2: two words (addresses 0x10 to 0x2F in UII memory).

  — 00010_2: three words (addresses 0x10 to 0x3F in UII memory).

  - — 11111_2: 32 words (addresses 0x10 to 0x20F in UII memory).

- — Bit 0x15: 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 0x16: Shall be set to “0” if there is no extension of the PC bits 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 0x16 shall be the logical OR of the XPC bits contents. The tag computes this logical OR, and maps the result into PC bit 0x16, 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 0x17: Shall be set to “0” if encoding an EPC and shall be set to “1” if encoding an ISO/IEC 15961, AFI in Bits 0x18 – 0x1F.

- — Bits 0x18 – 0x1F: The Attribute bits 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 Attribute bits is stored in memory location 0x18. Bit 0x1F has been designated within the GS1 EPC system to be used as an indicator that the transport unit contains Hazardous Materials.

The default (unprogrammed) PC value shall be 0x0000. Table 4 summarizes the content.

Table 4 — Segmented memory — Memory bank “01”

Protocol Control bits run from 0x10 to 0x1F															
					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 bit = 1	ISO Application family identifier (AFI)							
Length indicator					User memory	XPC bit	EPC/ISO bit = 0	EPC Attribute bits							Haz Mat

7.5 Data elements

7.5.1 Unique transport unit identifier

The UII–Transport unit shall be present on all conformant transport unit tags. For non-retail tags, the unique transport unit identifier shall conform to ISO/IEC 15459-1 and shall be used as described in 5.3.2. For retail tags, the unique transport unit identifier shall conform to *GS1 EPC Tag Data Standard*, Version 1.6 for the SSCC-96 and shall be used as described in 5.3.3.

7.5.2 Hazardous goods

RFID tags for items that are 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 18000-63 and ISO/IEC 18000-3, Mode 3. The presence of hazardous material for ISO transport units is indicated by the AFI “A8” in bits “18” to “1F” of memory bank MB01 as defined in ISO/IEC 18000-63 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 identification requirements of numerous applications and industry groups. As such, it is applicable 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. The semantics of other user data shall conform to ISO/IEC 15961 and ISO/IEC 15418. The syntax of other user data shall conform to Annex A. ISO 15394 provides specific examples of other data elements using the ISO/IEC 15418 semantics and the ISO/IEC 15434 syntax.

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 15459-1.

7.7 Combined transport unit and RTI data

7.7.1 General

RFID tags are available in different formats. There are read only, write once/read many (WORM) and full read/write. All tags shall have the tag ID written to them by the manufacturers in accordance with ISO/IEC 15963 and locked. If read only or WORM tags are employed, two tags shall be used. One tag represents the unique transport unit identifier and the second represents the unique RTI. Unique RTI identification is addressed at length in ISO 17364.

7.7.2 ISO data structures

For full read/write tags, additional tag data shall include the appropriate UII–transport unit identifier and the UII–RTI identifier. The mandatory data to be written to the tag shall be a function of the type of tag and the purpose of the specific tag application. For practical purposes, both the UII–RTI and the UII–transport unit identifier should be encoded using ISO/IEC 15961, the syntax of ISO/IEC 15434 and the semantics of ISO/IEC 15418.

Where there are application requirements to encode both the identity of the asset (ISO 17364) as well as a shipment ID or license plate (this International Standard) it is possible to encode these unique identities in either one or two RF tags. In the case of two tags within the ISO system, each tag would include its own unique AFI, that is, “0xA2” for license plate (shipment identification) and “0xA3” for the RTI AFI. The AFIs are followed by the respective ASC MH10 Data Identifier as specified in ISO/IEC 15418. In the case of the transport unit, that Data Identifier is the appropriate “J” Data Identifier. In the case of the RTI, that Data Identifier is “25B”.

When encoding both data structures in a single tag that has a monolithic memory structure (e.g. ISO/IEC 18000-2, Type A), the first data structure shall be the UII–RTI, preceded by the DI “25B” and shall be locked, and the second data structure shall be the UII–transport unit that will change with each trip of the RTI, preceded by the “J” DI. For tags having a segmented memory structure (e.g. ISO/IEC 18000-63 and ISO/IEC 18000-3 Mode 3), the UII–RTI shall be written to the UII memory and locked. The UII–transport unit shall be preceded by the “J” DI and, along with any additional data (with the appropriate DI), be written and locked in user memory. When combining multiple data structures, the syntax of the data shall comply with ISO/IEC 15434.

7.7.3 GS1 EPC data structures

Where there are application requirements to encode both the identity of the asset (GRAI) as well as a unique pointer to a database, e.g. shipment ID or GS1 Serialized Shipping Container Code (SSCC), it is possible to encode these unique identities in either one or two RF tags. In the case of two tags within the EPC GS1 system, each tag would include its own unique header, that is, “31” for SSCC and “33” for GRAI. In the case of encoding both data structures in a single tag, the first data structure (96 bits) shall be the GRAI and shall be locked, and the second data structure (96 bits) shall be the SSCC that will change with each trip of the transport unit. Since both data fields are fixed length, there is no requirement for a data element separator.

GS1 Member Organizations allocate the GS1 Company Prefix to a system user (see GS1 *General Specifications*). This makes the SSCC unique worldwide but does not identify the origin of the unit.

7.8 Unique item serialization

Unique item identification shall be ensured 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 15459-1 using the rules of ISO/IEC 15459-3.

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

The data structure identifying the asset shall be locked. This information shall only be changed in the case of change of ownership. For tags having a monolithic memory structure, the data structure identifying the shipment shall be appended to the asset license plate and shall be rewritable for new shipments.

For tags having a segmented memory structure, the asset license plate shall be stored in the memory segment dedicated to the item license plate (i.e. UII memory). The data structure identifying the shipment shall be stored in the memory segment dedicated to additional data (i.e. user memory) and shall be rewritable.

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. Locking of data shall be at the discretion of the user, except for Tag ID (MB10), which shall be locked by the manufacturer. A CRC-16 is required to enhance the integrity of the data. The location of the stored CRC-16 shall be as per the memory map in Figure A.2.

8.3 Data preservation

For transport units in the supply chain, it should be possible at the retail point-of-sale of any (packed) product to disable the tag, e.g. by a *kill-command*.

8.4 Interrogator authentication

A tag's data storage and transfer protocols shall provide for the user-enabled option to require authentication of the interrogator's authorization prior to reading the tag data.

8.5 Non-repudiation/audit trail

Tags shall be capable of supporting non-repudiation when programmed to provide non-forgeable evidence that a specific action occurred.

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 given in Figure 4 are examples of the RFID emblem and EPC GS1 seal as described in ISO/IEC 29160.

Figure 4 — ISO and EPC GS1 RFID compliance emblems

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.

10 Human readable information

10.1 Human readable interpretation

Either human readable interpretation or human readable translation of Unique Item Identifiers is required.

Human readable interpretation is the literal representation of all of the data on the tag, including semantics. When human readable interpretation is used, it shall be placed on the exterior of the transport unit, as required elsewhere in this section. 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, e.g., Data Matrix ECC 200 or QR Code or with trading partner agreement PDF417, encoded in conformance with ISO/IEC 15434 and ISO/IEC 15418, should be considered as a primary backup to RF tags on products. An additional level of backup of human readable interpretation may be considered.

ISO/IEC/TR 24729-1 shows how to encode within a 2D symbol everything that is in an RF tag. What is most likely needed, however, is to encode the same data in a 2D symbol and RF tag, so that a host computer receives the same information, regardless of media. This is accomplished by the means contained in Annex A.

10.2 Human readable translation

HRI of either ISO UII or EPC tags shall be the upper case alphabetic and numeric representation of the encoded data as specified in ISO/IEC/TR 24729-1 and Annex A of this International Standard.

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.

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.

If optically readable media is used, the International Standards shown in Figure 5 shall be used.

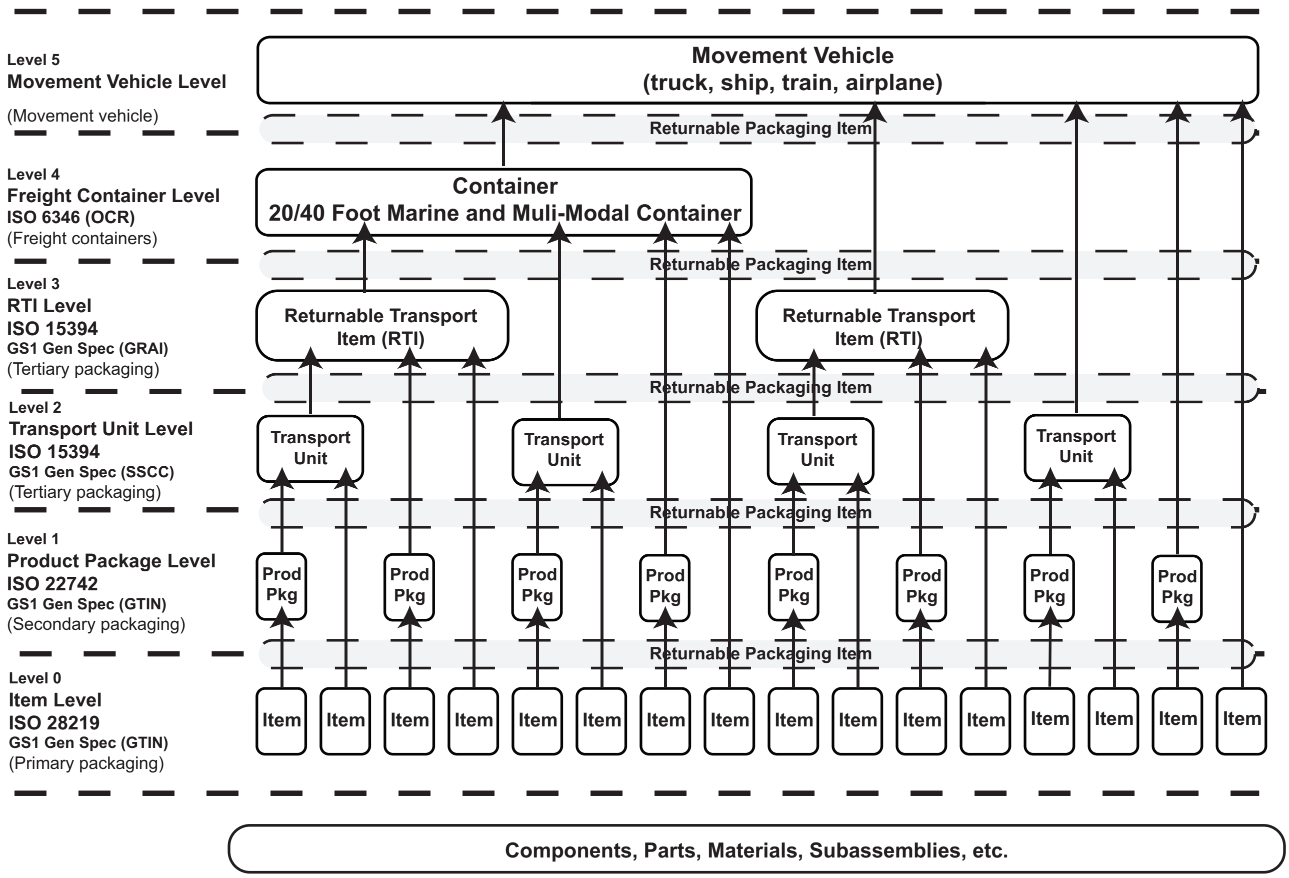


Figure 5 — Supply chain standards for bar codes and two-dimensional symbols

11 Tag operation

11.1 Data protocol

The data protocol for this International Standard shall support the requirements of Annex A.

11.2 Minimum performance requirements (range and rate)

The performance for tags shall be measured in accordance with ISO/IEC 18046-3. Minimum performance requirements will vary for different functional applications of RFID. Table 5 shows the typical performance requirements for three passive tags and one active tag 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)] The performance for interrogator shall be measured in accordance with ISO/IEC 18046-2. The performance for systems shall be measured in accordance with ISO/IEC 18046-1.

Table 5 — Typical tag performance

Parameter	**860 MHz to 960 MHz** ISO/IEC 18000-63	**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 transport unit user community.

— The transport unit 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).

— Read distance.

— Write distance (if applicable).

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

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.

— 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 considered.

11.4 Tag orientation

It should be assumed that the handling operation is unable to predict the orientation of the individual (packed) products in the transport unit. This may hamper the effective use of the reading equipment on site and/or *en route*. Where the transport unit also functions as an RTI, guidance can be found in ISO 17364.

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 transport units. 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 transport units 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 the transport unit will be continuously used throughout the life of the transport unit.

All tags attached to the transport unit may be used to facilitate the recycling of the transport unit and the tag itself, e.g. by holding information on plastic type. In this respect, it may also be feasible to reuse the tag after reprogramming, provided it does not compromise the supply chain data structure. The exact implementation depends on cost of the tag and environmental implications of reuse/recycling. Transport unit RFID tags shall be capable of being continuously used throughout the life of the transport unit, 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 18046 (all parts), 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

The air interface specification recommended by this International Standard is ISO/IEC 18000-63. ISO/IEC 18000-2, Type A, the ASK air interface of ISO/IEC 18000-3, Mode 3, and ISO/IEC 18000-7 may be used with trading partner agreement. It is recommended that tags supporting ISO/IEC 18000-63 also be able to support ISO/IEC 18000-3, Mode 3.

NOTE With explicit trading partner agreement ISO/IEC 18000-2, Type A and ISO/IEC 18000-7 may be used with trading partner agreement. ISO/IEC 18000-2, Type A and ISO/IEC 18000-7 do not support EPC tag, nor do they support the segmented memory structures required in this International Standard.

11.10 Memory requirements for application

The memory requirements for transport unit 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. Use of alternative 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.

11.11 Sensor interface, if applicable

Sensors and batteries 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.

Sensor equipped RTI RFID tags shall conform to ISO/IEC/IEEE 21451-7 for the wired or wireless interface.

The 2,45 GHz O-QPSK option of ISO/IEC/IEEE 8802-15-4 and ISO/IEC/IEEE 21451-5 shall be used for the wireless interface between the tag/access point and the sensor.

11.12 Real time clock option

A real time clock shall be included with transport unit 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. The representation of time shall be UTC (“Z” – Zulu) and formatted as described in ISO 8601, namely, yyyy-mm-ddThh:ssZ, for example 2012-01-01T14:55Z. When time is represented the character “T” serves as the delimiter between “dd” and “hh”.

11.13 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.

11.14 Tag reusability

Technologically, all RFID tags are theoretically reusable. Because of the unique identification aspects of transport units, the permanent nature of the physical attachment of the tag and the low cost of the tags themselves, product level tags are generally not reused for commercial retail items and commodity items.

High-value and mission critical items can utilize higher functionality (read/write, larger memory and possibly sensors) tags, the cost of which can justify their reuse. Tags intended for reuse shall clearly be marked with appropriate human readable characters or logos to enable identification, reclamation and return. Prior to reuse, reusable tags shall have their headers checked for data integrity and user memory cleared.

12 Tag location and presentation

Guidelines for tag location and presentation can be found in ISO/IEC/TR 24729-1.

Tag location and presentation shall allow multi-reading and omni-reading simultaneously for the transport unit and the products it contains. To minimize damage, the tag location should be recessed on the outside of the transport unit or inside the transport unit.

12.1 Material on which the tag is mounted or inserted

The potential disturbance of metals and other reflective materials as well as liquids and other absorptive materials within the transport unit shall be considered in the design to minimize disturbance of the RF signal.

12.2 Geometry of the package/tag environment

Products/product packages should be placed into transport units in such a way to minimize the disturbance of the RF signal. This pertains to both the transport unit and the products it is containing. See ISO/IEC/TR 24729-1.

13 Interrogator and reader requirements

13.1 Safety and regulatory considerations

All RFID tags and readers shall comply with IEEE C95-1 and ICNIRP Guidelines.

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 the appropriate authorities.

13.2 Data privacy

13.2.1 Aggregated data

Security of aggregated data shall be the responsibility of the collector. Data collectors and data storage operators shall comply with all applicable personal privacy regulations and rules governing the collection, storage and dissemination of personal data. Personal data collected by or incident to the reading of an RFID tag shall be accorded the same protection and security as personal data collected by any other means.

13.2.2 Company proprietary data

Company proprietary data shall be identified beforehand and companies wishing to restrict the collection of company proprietary data from RTI RFID tags shall utilize appropriate forms of data security. As security/protection of tag data can be compromised, use of RFID RTI tags to carry sensitive, classified or proprietary data should be limited.

14 Interoperability, compatibility and non-interference with other RF systems

All RFID systems including tags, interrogators and readers shall operate on a strict non-interference basis with all other RF systems operating in the same spectrum. All RFID systems including tags, interrogators and readers claiming conformance with this International Standard shall be interoperable and compatible at the specific frequency designed.

Annex A
(normative)

Encoding

A.1 General

This International Standard recommends three possible forms of encoding for ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 RF tags:

— a GS1 EPC compliant form for either or both the Unique Item Identifier (UII) in Memory Bank “01” and User Memory in Memory Bank “11”. The segmentation of Type C and Mode 3 tags is illustrated in Figure A.1 below. EPC encoding is detailed in GS1 EPC TDS 1.6;

a structure employing ISO/IEC 15962;

a simplified structure, encoding an entire ISO/IEC 15434 message as a unit, employing a no directory, encoding six-bit defined in ISO/IEC 15962 as described in the remainder of this annex.

A.2 Basics

Each of these encoding forms can be unambiguously discerned from the other by the content of bits 0x17 through 0x1F of Memory Bank “01”, as illustrated in Figure A.2, and bits 0x00 through 0x1F of Memory Bank “11”.

When ISO/IEC 15434 was created, it was intended to support all AIDC media, including RFID. As RFID developed, a completely different set of encoding schema was developed around a set of standards, ISO/IEC 15961 and ISO/IEC 15962.

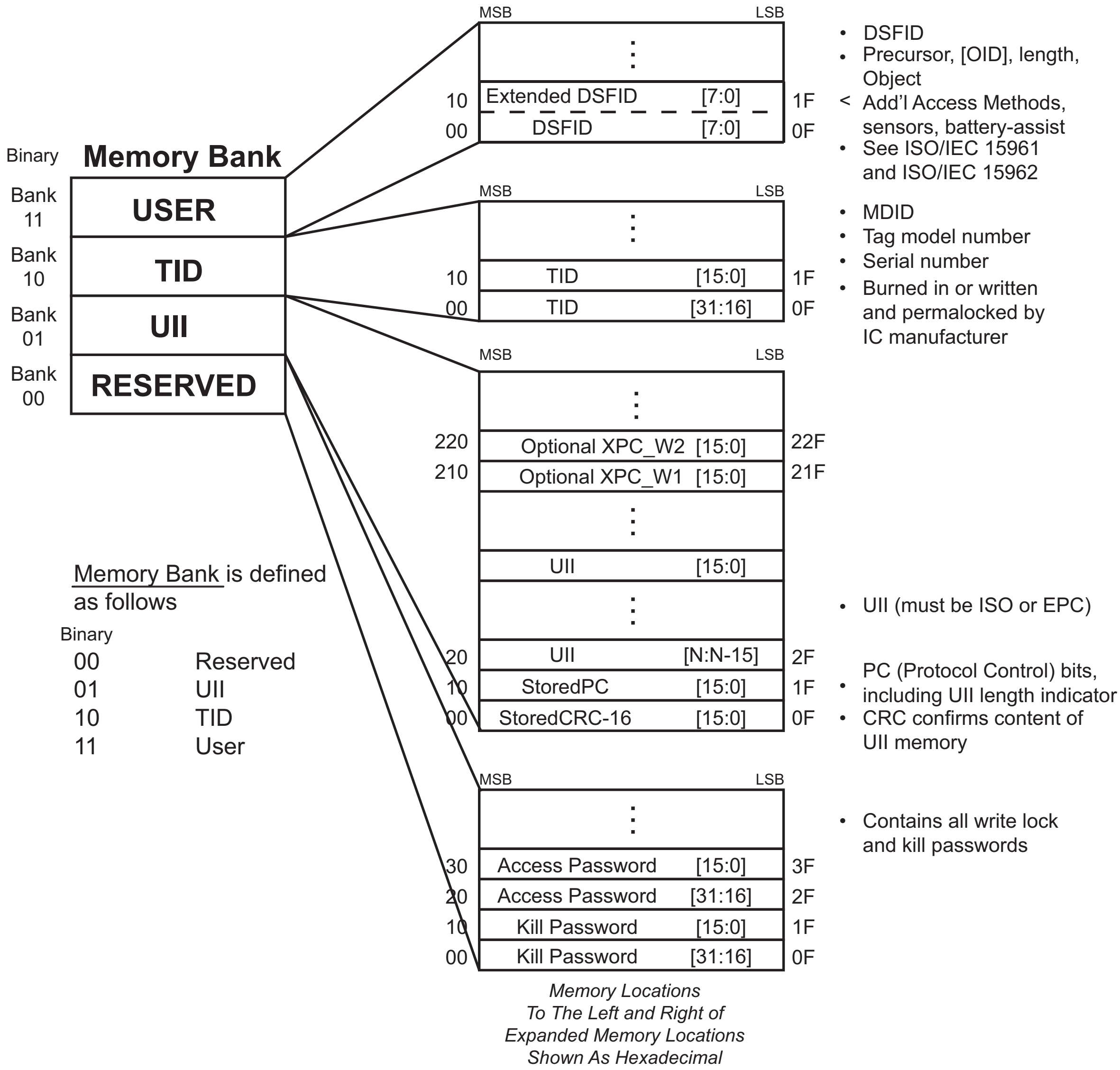


Figure A.1 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 Logical Memory Structure

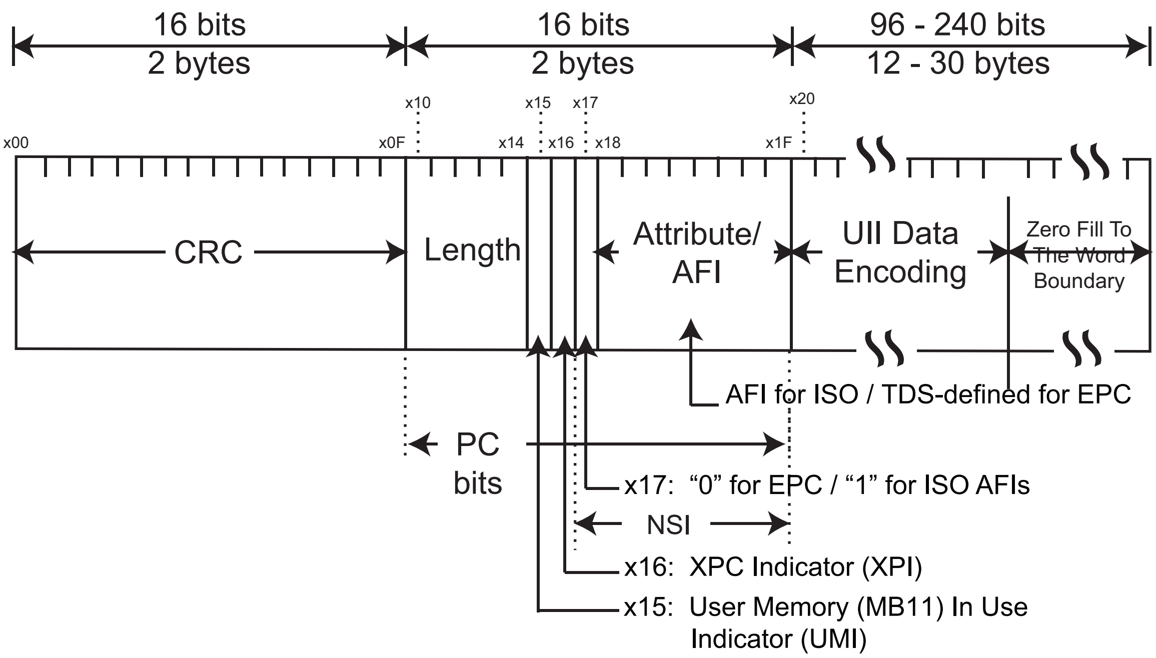
A key concept in this simplified encoding form, in both MB01 and MB11, is the use of a six-bit encoding as shown in Table A.1.

Table A.1 — Six-bit encoding

Space	100000	0	110000	@	000000	P	010000
<EOT>	100001	1	110001	A	000001	Q	010001
<Reserved>	100010	2	110010	B	000010	R	010010
<FS>	100011	3	110011	C	000011	S	010011
<US>	100100	4	110100	D	000100	T	010100
<Reserved>	100101	5	110101	E	000101	U	010101
<Reserved>	100110	6	110110	F	000110	V	010110
<Reserved>	100111	7	110111	G	000111	W	010111
(	101000	8	111000	H	001000	X	011000
)	101001	9	111001	I	001001	Y	011001
*	101010	:	111010	J	001010	Z	011010
+	101011	;	111011	K	001011	[	011011
,	101100	<	111100	L	001100	\	011100
-	101101	=	111101	M	001101	]	011101
.	101110	>	111110	N	001110	<GS>	011110
/	101111	?	111111	O	001111	<RS>	011111

NOTE Table A.1 is six-bit encoding created through the simple removal of the two high-order bits from the ISO 646-8-bit ASCII character set, save the shaded values. The shaded values are re-assigned, as provided, to minimize the bit count when using the ISO/IEC 15434 envelope.

The <Reserved> values in Table A.1 are not to be used without a re-issuance of this International Standard that reflects the defined values and functionality. An example would be a decision of the GS1 community to use this encoding and petitioning for the encoding of an ECI. Additionally, the presence of one or more of these characters might signal a different behaviour on the part of the decoder. While these <Reserved> values are not used in this iteration of this International Standard, they should not be used for any other purpose than defined by this International Standard.



NOTE 1 User Memory (MB11) in Use Indicator (UMI).

NOTE 2 XPC Indicator.

NOTE 3 "0=Binary/1=AFI+ISO/IEC 15459".

NOTE 4 AFI for ISO/TDS-defined for EPC / 29161 defined for ISO binary.

NOTE 5 Last bit of AFI for ISO/Haz Mat for EPC.

Figure A.2 — Type C and Mode 3 structure of Memory Bank "01"

A.3 Encoding of Memory Bank "01" Unique Item Identifier

Bit 0x17 is the switch between ISO formats and EPC formats. When Bit 0x17 is set to a "0", the UII encoding is as per the GS1 EPC Tag Data Standard, Version 1.6. When Bit 0x17 is set to a "1", the UII encoding is as per ISO/IEC 15459 preceded by an ISO/IEC 15961, Application Family Identifier (AFI). The specific AFIs defined for the ISO 1736x series of International Standards are shown in Table A.2.

Table A.2 — 1736x Application Family Identifiers (AFIs)

AFI	Assigned organization or function
0xA1	ISO 17367 product tagging
0xA2	ISO 17365 transport unit
0xA3	ISO 17364 returnable transport unit
0xA4	ISO 17367 product tagging, but for hazardous materials
0xA5	ISO 17366 product packaging
0xA6	ISO 17366 product packaging, but for hazardous materials
0xA7	ISO 17365 transport unit, but containing hazardous materials
0xA8	ISO 17364 returnable transport unit, but containing hazardous materials
0xA9	ISO 17363 freight containers
0xAA	ISO 17363 freight containers, but containing hazardous materials

For the purposes of illustration, encoding of a product is shown. Transport units would be identically encoded except for the AFI and the DI. A linear bar code symbol encoding the data providing unique item identification comprises the Data Identifier (DI), Issuing Agency Code (IAC), Company Identification (CIN), and Serial Number (SN). Such a unique item identification linear bar code would be represented in Code 128 as shown in Figure A.3.

— DI = 25S

— IAC = UN (DUNS)

— CIN = 043325711

— SN = MH8031200000000001

Figure A.3 — Code 128 encoding "25SUN043325711MH8031200000000001"

Adding the AFI to the structure for RFID purposes we have

— AFI = 0xA1

— DI = 25S

— IAC = UN (DUNS)

— CIN = 043325711

— SN = MH8031200000000001

Looking then at a completed data structure, using the encoding defined above and using DUNS as the Issuing Agency Code (IAC), we find that MB01, when encoding a Product, this data structure is 25SUN043325711MH8031200000000001 and is represented in MB01 as follows:

Table A.3 — MB01 structure of AFI and UII (DUNS) Using Six-bit Encoding

AFI = 0xA1			**2**	**5**	**S**	**U**	**N**	**0**	**4**	**3**	**3**	**2**	**5**	**7**	**1**
1010 0001			110010	110101	010011	010101	001110	110000	110100	110011	110011	110010	110101	110111	110001
1	**M**	**H**	**8**	**0**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
110001	001101	001000	111000	110000	110011	110001	110010	110000	110000	110000	110000	110000	110000	110000	110000
0	**0**	**1**													
110000	110000	110001													

Alternatively, looking at a completed data structure using the encoding defined above, using ODETTE as the Issuing Agency Code (IAC), we find that MB01 when encoding a Product having an:

— AFI = 0xA1

— DI = 25S

— IAC = OD (ODETTE)

CIN = CIN1

SN = 0000000RTIA1B2C3DOSN12345 (This example shows the SN composed of Object Type and Object Serial Number)

. . . we have an MB01 structure as shown in Table A.4.

Table A.4 — MB01 structure of AFI and UII (ODETTE) Using Six-bit Encoding

AFI = 0xA1			2	5	S	O	D	C	I	N	1	0	0	0	0
1010 0001			110010	110101	010011	001111	000100	000011	001001	001110	110001	110000	110000	110000	110000
0	**0**	**0**	**R**	**T**	**I**	**A**	**1**	**B**	**2**	**C**	**3**	**D**	**O**	**S**	**N**
110000	110000	110000	010010	010100	001001	000001	110001	000010	110010	000011	110011	000100	001111	010011	001110
1	**2**	**3**	**4**	**5**											
110001	110010	110011	110100	110101											

In both cases, once the AFI is stripped from the message, the output of the RFID reader is identical to that of the linear bar code.

A.4 Encoding of Memory Bank “11” User Memory

To indicate that data resides in MB11 (User Memory) bit 0x15 of MB01 is set to a “1”. Likewise, the presence of an AFI in MB01 cannot declare the format for MB11 because some users may choose to implement EPC encoding for MB01 and ISO encoding for MB11, in cases where MB01 is to be read by retailers and MB11 by industrial consumers. Further, it is preferable that there exists no confusion between the structures defined herein and those defined in ISO/IEC 15962. Consequently, MB11 must declare its access method and format.

A.4.1 DSFID

Data encoding starts with the DSFID (Data Storage Format Identifier) that encodes the access method and Data-Format. When using direct ISO/IEC 15434 encoding, the DSFID is “0x03”. See Figure A.4 for how this byte fits into the sequence of the first three encoded bytes.

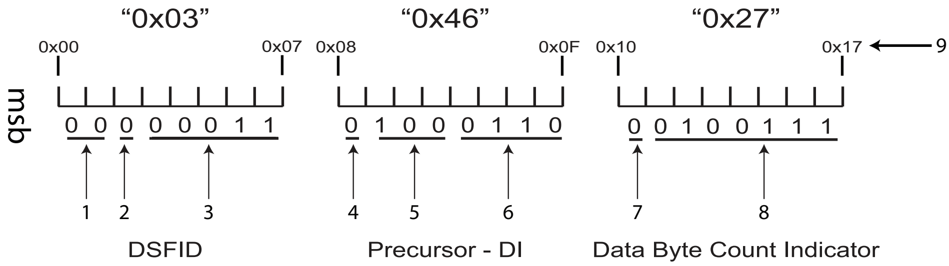
A.4.1.1 Precursor byte

Data encoding continues with the Precursor and it encodes the extension bit in the most significant position, the compaction type (next three bits) and the ISO/IEC 15434 Format envelope (four least significant bits). For ISO/TC 122 applications the only permitted Precursor is byte “0 100 0110” or “0x46” (i.e. extension bit is a “0” in the case of no sensors or battery assist, a compaction type 4 which indicates use of the special 6-bit table defined in this annex and an ISO/IEC 15434 format envelope “06”). See Figure A.4 for how this byte fits into the sequence of the first three encoded bytes.

A.4.1.2 Data byte-count indicator

Some air interface protocols allow for optimization in noisy environments by varying the number of bytes sent in each transmission. Therefore, it is useful to know at the beginning the number of bytes in tag memory that contain data. For many ISO/IEC 15434 DI data encoding applications, the number of bytes needed to encode the data will be a number less than 127 and therefore handled in one byte. For larger messages, two bytes are used where the first byte begins with “1” and the second byte begins with “0” as in ISO/IEC 15962:—, D.2. The number of bytes is encoded in the 14 remaining bits (e.g. 200 bytes is encoded as “10000001 01001000”).

For example, if a message contains 51 6-bit characters, it will be encoded in 39 bytes (i.e. the last bit of the last character is in the 39th byte and in this case there are six un-encoded bits which require padding). Therefore, the data byte-count indicator is “0x27”. See Figure A.4 for how this byte fits into the sequence of the first three encoded bytes.



NOTE 1 Access Method (#0 as listed in Table 7 of ISO/IEC 15962:—).

NOTE 2 Extended Syntax – turns on additional byte of DSFID byte (turned off in this instance).

NOTE 3 Data Format 03 (ISO/IEC 15434).

NOTE 4 Extension Bit – not specified in this example.

NOTE 5 Compaction bits (indicating 6-bit table).

NOTE 6 Format Envelope (specifically DI "06").

NOTE 7 Byte Count Indicator switch (set to "0" to signify final byte of byte count).

NOTE 8 Bit values for Byte Count Indicator (variable based on length of data).

NOTE 9 Physical memory addresses (0x00, 0x07, 0x08, 0x0F, 0x10, and 0x17).

NOTE 10 For the purpose of the above example battery-assist and sensors are shown as not present.

Figure A.4 — Type C and Mode 3 Structure of Memory Bank "11" 1st 24 bits

A.5 Encoding and decoding

A.5.1 Encode process

1. Starting with a valid ISO/IEC 15434 DI message, strip "[) > RS 06 GS" from the front and "<RS> <EOT>" from the end.

2. Convert every data character into its code value using Table A.1.

3. When encoding multiple "06" Format Envelopes (e.g. to represent a message containing several "records" from the same data format in order to describe the subassemblies of a complex part) reduce each internal ISO/IEC 15434 sequence "<RS> <06> <GS>" indicating a new "record" to a single <RS> character (encoded as "011111" from Table A.1).

4. Encode an <EOT> pattern after the last encoded data character.

5. Lay out the 6-bit characters as bits and then group them into 8-bit bytes.

6. Add the first 2 or 4 bits of an <EOT> character (i.e. "10" or "1000") or the entire <EOT> character (i.e. "100001" from the 6-bit character set) to fill un-encoded bits in the last byte, if any, as padding bits.

7. Determine the byte number that contains the last bit of the <EOT> character, convert the decimal count into binary and encode explicitly as the data byte-count indicator.

8. Encode the DSFID, Precursor, data byte-count indicator, data, <EOT> and padding bits (if any) into memory.

NOTE Because only one ISO/IEC 15434 message is allowed to be encoded in a single RFID data carrier, there is no need to encode a zero byte as a terminator after the last data byte.

A.5.2 Decode process

1. Examine the DSFID and Precursor bytes and verify that they are equivalent to 0x03 0x46.

2. Process the next 8 bits and convert the resulting data byte-count indicator to a decimal value to determine the number of bytes containing data.

3. Starting with the next bit, group the following bits into character bit-sets from the 6-bit code table and continue until the number of bytes containing data has been parsed.

4. Assign data characters according to Table A.1 — URN Code 40 Character Set and delete all complete and incomplete <EOT> characters from the end.

5. For any encoded <RS> character that is not immediately followed by "06" and a <GS> character, expand the <RS> to "RS 06 GS".

6. Add "[) > RS 06 GS" to the beginning of the transmission and "RS EOT" at the end.

7. Transmit the entire ISO/IEC 15434 compliant message. Optionally, the receiver may wrap the ISO/IEC 15434 message in an OID format as a single data object. When using this option, the complete OID of the message is {1 0 15434 06}.

A.6 Encoding and decoding example

A.6.1 Translation and encoding procedure from ISO/IEC 15434 data to Access Method 0 Data Format 3

1. To prepare a typical DI input message in ISO/IEC 15434 format for encoding using ISO/IEC 15962 Access Method 0 Data-Format 3, the following steps are performed.

2. Verify that the input message is a valid ISO/IEC 15434 DI message.

3. The DSFID indicating Access Method 0 and Data Format 3 is encoded.

4. The leading message envelope characters "[) > RS 06 GS" and the trailing "RS EOT" are discarded.

5. The data is encoded into 6-bit codewords from Table A.1.

6. Add an <EOT> character.

7. Add part or all of an <EOT> to fill the last data byte, if necessary.

8. Encode the DSFID, Precursor, data byte-count indicator, data, <EOT> and padding into memory.

A.6.2 Decoding and Translation procedure from Access Method 0 Data-Format 3 to ISO/IEC 15434 data

The system will see this information as ISO/IEC 15434-6-bit DI data by reading the DSFID byte.

1. The system discards the DSFID, Precursor and data byte-count indicator at the beginning.

2. The encoded bytes are parsed into 6-bit codes, discarding any pad bits and the encoded <EOT> character, and then into data according to Table A.1.

3. The system adds "[) > RS 06 GS" to the beginning of the transmission and "RS EOT" at the end.

4. The system transmits the entire ISO/IEC 15434 compliant message.

5. Optionally, the receiver may wrap the entire ISO/IEC 15434 message in an OID format as a single data object.

A.6.3 Data encode and decode example

The following example encodes ISO/IEC 15434 DI data in an application with a mandatory <EOT> requirement.

Starting data:

[)><RS>06<GS>25SUN043325711MH8031200000000001 <GS>1T110780<GS>Q21<GS>4LUS<RS><EOT>

The data on the tag from the above message is as follows (with DIs in bold font):

25SUN043325711MH8031200000000001 <GS> **1T**110780 <GS> **Q**21 <GS> **4L**US <EOT>

Where:

UII = **25S**UN043325711MH8031200000000001

LOT = **1T**110780

QTY = **Q**21

CoO = **4L**US

Data to bit conversion:

There are 51 6-bit characters (50 plus <EOT>), which translates to 39 data-bytes. There is a need to fill six trailing bits for byte alignment so in this case an entire <EOT> character is encoded. See Table A.5.

Table A.5 — Type C and Mode 3 Structure of Memory Bank "11" 1st 16 bits

DSFID = 0x03	**Precursor = 0x46**	**Data byte-count = 0x27**	**2**	**5**	**S**	**U**	**N**	**0**	**4**	**3**	**3**	**2**	**5**
00000011	01000110	00100111	110010	110101	010011	010101	001110	110000	110100	110011	110011	110010	110101
7	**1**	**1**	**M**	**H**	**8**	**0**	**3**	**1**	**2**	**0**	**0**	**0**	**0**
110111	110001	110001	001101	001000	111000	110000	110011	110001	110010	110000	110000	110000	110000
0	**0**	**0**	**0**	**0**	**0**	**1**	**<GS>**	**1**	**T**	**1**	**1**	**0**	**7**
110000	110000	110000	110000	110000	110000	110001	011110	110001	010100	110001	110001	110000	110111
8	**0**	**<GS>**	**Q**	**2**	**1**	**<GS>**	**4**	**L**	**U**	**S**	**<EOT>**	**pad**	
111000	110000	011110	010001	110010	110001	011110	110100	001100	010101	010011	100001	100001	

A.6.3.1 Complete contents of tag memory

Using the Access Method 0 Format 3 encoding, including a DSFID, ISO/IEC 15434 Precursor byte, 39 bytes of data (compressing 51 6-bit characters including the <EOT>), and six pad bits, the final tag encodation in hexadecimal is as follows.

03 46 27 CB 54 D5 3B 0D 33 CF 2D 77 C7 13 48 E3 0C F1 CB 0C 30 C3 0C 30 C3 0C 31 7B 15 31 C7 0D F8 C1 E4 72 C5 ED 0C 55 38 61

A.6.3.2 Transmitted data

The header characters and the "<RS> <EOT>" are reinserted into the message. The following data string is transmitted from the reader.

[) > RS 06 GS 25SUN043325711MH8031200000000001 GS 1T110780 GS Q21 GS 4LUS RS EOT

A.6.3.3 Conclusion

When encoded in a 2D symbol, the output would be identical:

[)><RS>06<GS>25SUN043325711MH8031200000000001 <GS>1T110780<GS>Q21<GS>4LUS<RS><EOT>

Figure A.5 — QR Code encoding the contents of MB01 and MB11 [)><RS>06<GS>25SUN0433257 11MH8031200000000001 <GS>1T110780<GS>Q21<GS>4LUS<RS><EOT>

Figure A.6 — DataMatrix encoding the contents of MB01 and MB11 [)><RS>06<GS>25SUN04332 5711MH8031200000000001 <GS>1T110780<GS>Q21<GS>4LUS<RS><EOT>

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