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# Returnable Transport Items Identification

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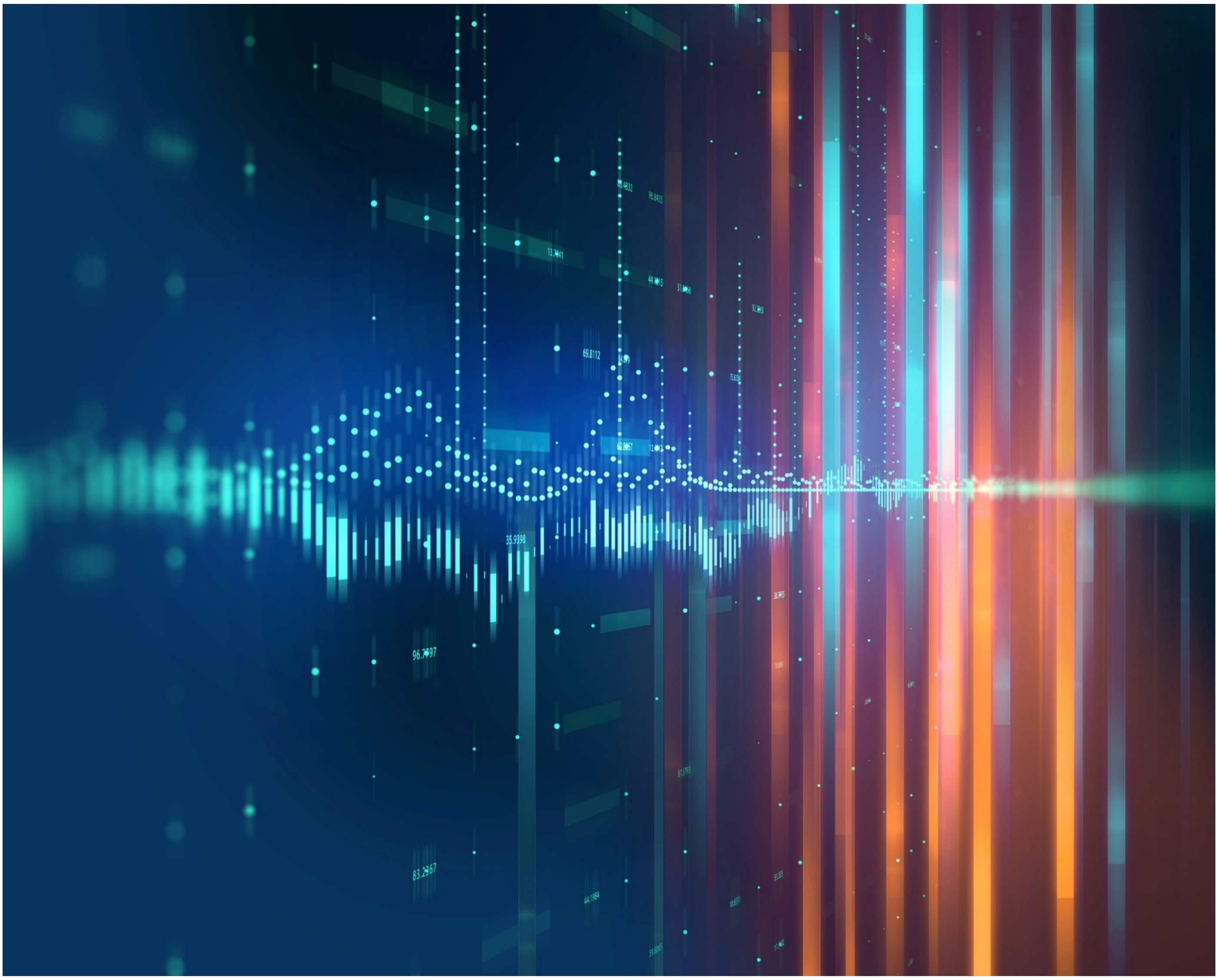

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# *INTRODUCTION*

This document was crafted through the efforts of the members of the JAIF (Joint Automotive Industry Forum – made up of the associations AIAG, JAMA/JAPIA and Odette). It defines the data carrier selection, data structure and storage of data for Returnable Transport Items (RTIs). It was developed to address the well-identified business needs in Europe, Japan, and the U.S., using automatic identification technology – especially RFID tags.

It is desired that this document will enable international traceability and recycling of returnable transport items and will also facilitate processes such as customs clearance.

In this document, the word 'should' is a recommendation; the word 'shall' is a requirement.

In the Annexes of this document, "Normative" is information that is a required part of this standard; "Informative" is information that is provided within the standard, which, while related, is not part of this standard.

Nothing in this document supersedes applicable laws and regulations.

In this document, the RFID tags' Memory Banks will be depicted as MB00, MB01, etc. This indicates the binary value of the Memory Bank; MB01binary, etc. Binary values may also be shown as 0b00, 0b01, 0b0000, etc.

The Protocol Control Bits (PC Bits) are hexadecimal values and will generally be shown as PC Bit 15, PC Bit 16, etc., which denotes PC Bit 15hexidecimal, PC Bit 16hexidecimal, etc. Hexadecimal values may also be shown as 0x15, 0x16, etc.

Application Family Identifiers (AFI) are hexadecimal values and will generally be shown as AFI A1, AFI A3, etc., which denotes AFI A1hexidecimal, AFI A3hexidecimal, etc. Hexadecimal values may also be shown as 0xA1, 0xA3, 0xAC, etc.

In this document, single character control codes are represented as ${}^{G}{}_{S}$ , ${}^{E}{}_{OT}$, ${}^{R}{}_{S,}$ etc.

# CHANGES FROM V2 TO V3:

1. The Foreword was removed, and its contents were added to the Introduction.
2. The Acknowledgement section was removed.
3. 8-bit encoding was added using UTF-8.
4. Annex S was added to provide 8-bit encoding examples.
5. The 8-bit AFI "0xAC" was added to Table 2.
6. Numerous editorial changes were made to enhance clarity.
7. The length of OD CIN (Odette Company Identification Number) was increased from "an4" to "an6".

# 1 SCOPE

This document is based exclusively on ISO structures. They ensure compatibility between readers and tags using Issuing Agency Codes from UN, OD, LA, D, TAJ and GS1.

This global guideline recommends the basic features of data carriers applied to Returnable Transport Items (RTIs) and Returnable Packaging Items (RPIs) for use within Layer 2 and Layer 3 of the supply chain (see Figure 1). This document:

- Provides recommendations for the identification of returnable transport items.
- Provides a unique identifier for traceability of returnable transport items.
- Specifies the semantics and data syntax to be used.
- Specifies the minimum performance requirements.
- Specifies the data protocol to be used to interface with business applications and the RFID system.
- Specifies the air interface standards required between the RF interrogator and RF tag.
- Makes recommendations about additional information on the RF tag, such as license plates.
- Specifies the Rewriteable Hybrid Media.
- Specifies minimum requirements for the design of labels containing linear or two-dimensional symbols on returnable transport items to convey data between the trading partners.
- Provides specific recommendations regarding the choice of linear symbologies and two-dimensional symbologies, specific quality requirements and classes of symbol density.
- Provides guidance for the label design for data presented in linear symbols, two-dimensional symbols, or human readable form.

Within this document, the term RTI is a general term covering both Returnable Transport Items (RTI) and Returnable Packaging Items (RPI). There will be sections within this document where specifics about RTIs and RPIs are explained and the relevant individual reference (“RTI” or “RPI”) will be used.

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# 2 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. See Annex K for other standards.

ISO 445 *Pallets for material handling - Vocabulary*

ISO 830 *Freight containers – Vocabulary*

ISO 21067-1 *Packaging – Vocabulary – Part 1: General terms*

ISO/IEC 15415 *Information technology —Automatic identification and data capture techniques – Bar code symbol print quality test specification – Two-dimensional symbols*

ISO/IEC 15417 *Information technology —Automatic identification and data capture (AIDC) techniques – Code 128 bar code symbology specification*

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

ISO/IEC 15459-5 *Information technology —Automatic identification and data capture techniques – Unique identification – Part 5: Individual returnable transport items (RTIs)*

ISO/IEC 15961-1 *Information technology – Data protocol for radio frequency identification (RFID) for item management – Part 1: Application protocol*

ISO/IEC 15961-2 *Information technology – Data protocol for radio frequency identification (RFID) for item management – Part 2: Registration of RFID data constructs*

ISO/IEC 15962 *Information technology – Data protocol for 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 — Part 1: Unique identification for RF tags numbering systems*

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

ISO/IEC 16388 *Information technology —Automatic identification and data capture techniques – Code 39 bar code symbology specification*

ISO/IEC 17364*, Supply chain applications of RFID -- Returnable transport items (RTIs) and returnable packaging items (RPIs)*

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*

ISO/IEC 18004 *Information technology —Automatic identification and data capture techniques – QR Code bar code symbology specification*

ISO/IEC 1961-3 *Information technology – Data protocol for radio frequency identification (RFID) for item management – Part 3: RFID data constructs*

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

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# 3 TERMS AND DEFINITIONS

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 (all parts), ISO 830, ISO 445, ISO 21067, and the following apply.

**Table 1: Terms and Definitions**

| TERM | DEFINITION |
|---|---|
| **air interface** | conductor-free medium, usually air, between a transponder and the reader/interrogator through which data communication is achieved by means of a modulated inductive or propagated electromagnetic field<br>NOTE: For the purposes of this document the air interface shall follow ISO/IEC 18000-63 specifications.<br>[ISO 19762, 05.01.01] |
| **Application Family Identifier (AFI)** | mechanism used in the data protocol and the air interface protocol to select a class of RF tags relevant to an application, or aspect of an application, and to ignore further communications with other classes of RF tags with different identifiers<br>[ISO/IEC 19762, 3] |
| **Code 128** | continuous, variable length, linear symbology capable of encoding the full ASCII-128 character set, the 128 extended ASCII character set, and four non-data function characters<br>[ISO 22742, 3.2] |
| **Code 39** | discrete, variable length, linear symbology encoding the characters 0 to 9, A to Z, and the additional characters "-" (dash), "." (period), " " (space), "$" (dollar sign), "/" (slash), "+" (plus sign), and "%" (percent sign), as well as a special symbology character to denote the start and stop character, conventionally represented as an "*" (asterisk)<br>[ISO 22742, 3.1] |
| **components** | parts (e.g., bare printed circuit board, integrated circuits, capacitor, diodes, switch, valve, spring, bearing, bracket, bolt, etc.) of a first level/modular assembly<br>[ISO 28219, 3.3] |
| **data element separator** | specified character used to delimit discrete fields of data<br>[ISO 22742, 3.6] |

| TERM | DEFINITION |
|---|---|
| **Data Matrix** | error correcting two-dimensional matrix symbology, capable of encoding various character sets including strictly numeric data, alphanumeric data, and all ISO/IEC 646 (ASCII) characters, as well as special character sets<br>[ISO 22742, 3.8] |
| **direct mark** | generic term referring to methods of applying a permanent mark directly onto the surface of an item<br>For the purposes of this document, both “direct mark” and “direct part mark” are synonymous.<br>[ISO 19762] |
| **error correction** | mathematical procedure that allows the detection and rectification of errors to take place<br>[ISO 22742, 3.15] |
| **error detection** | use of the error correction characters to detect the fact that the number of errors in the symbol exceeds the error correction capacity<br>NOTE: Error detection will keep the symbol from being decoded as erroneous data. The error correction algorithm can also provide error detection by detecting invalid error correction calculation results.<br>[ISO 22742, 3.16] |
| **inlay / inlet** | substance usually made of a film onto which RF tags’ IC chip and antenna are jointly attached |
| **integrity** | designed such that any modification of the electronically stored information, without proper authorization, is not possible<br>[ISO 17364, 4.7] |
| **ISO Unique Item Identifier** | ISO/IEC 18000-63 tag with Protocol Control bit 17hex set at “1binary” indicating that what follows is an Application Family Identifier (AFI)<br>[ISO 17364, 4.9] |

| TERM | DEFINITION |
|---|---|
| **label** | adhesive backed media capable of being marked with information in machine-readable and/or human-readable form<br>[ISO 28219, 3.8] |
| **manufacturer** | actual producer or fabricator of an item; not necessarily the supplier in a transaction<br>[ISO 28219, 3.9] |
| **product packaging** | commercial unit of components defined by the supplier, including, if applicable, their means for protection, structured alignment or for automated assembly<br>[ISO 22742, 3.4] |
| **QR Code** | error correcting matrix symbology, consisting of an array of nominally square modules arranged in an overall square pattern, including a unique finder pattern located at three corners of the symbol and intended to assist in easy location of its position, size and inclination.<br>[ISO 22742, 3.35] |
| **radio frequency identification (RFID)** | systems that read the unique identity of an RF tag. RFID incorporates the use of electromagnetic, or electrostatic coupling in the radio frequency portion of the spectrum to communicate to or from a tag through a variety of modulation and encodation schemes<br>[ISO/IEC 19762-3] |
| **returnable packaging item (RPI)** | any material used for the protection of goods during handling, delivery, storage, and transport that are returned for further usage<br>[ISO 17364] |
| **returnable transport item (RTI)** | any product for the purposes of transport, handling and/or distribution of one or more products or product packages that are returned for further usage, examples are pallets with and without cash deposits as well as all forms of reusable crates, trays, boxes, roll pallets, barrels, and trolleys<br>[ISO 17364] |
| **RF tag** | combination of radio transmitter and radio receiver which transmits a signal automatically in response to an appropriate triggering signal<br>[ISO/IEC 19762-3] |

| TERM | DEFINITION |
|---|---|
| **serial number** | unique numeric, digital, or alphanumeric code assigned by the supplier to an entity for its lifetime<br>EXAMPLE: Computer serial number, traceability number and contact tool identification.<br>[ISO 22742, 3.37] |
| **supplier** | party that produces, provides, or furnishes an item or service<br>[ISO 28219, 3.12] |
| **traceability number** | code assigned by the supplier to identify/trace a unique group of entities (e.g., lot, batch)<br>[ISO 22742, 3.42] |
| **transport unit** | transport packaging containing a single product/product package or collection of product/product packages (same or different) designed to enable these to be handled as a single transport entity<br>[ISO 17364] |
| **transport unit with RTI** | one or more transport packages or other items held together by means such as pallet, slip sheet, strapping, interlocking, glue, shrink wrap, or net wrap, making them suitable for transport, stacking, and storage as a unit |

# 4 SUPPLY CHAIN MODEL

The "supply chain" is a multi-level concept that covers all aspects of taking a product from the raw material stage to a final product, including shipping to a final place of sale, use and maintenance and potentially to the point of disposal of the product. This supply chain further includes reverse logistics/returned goods. Each of these levels covers many aspects of dealing with products, and the business process for each level is both unique and overlaps other levels.

Figure 1, below, provides a graphical representation of the 'supply chain'. The figure is a conceptual model of supply chain relationships, not a 'one-for-one' representation of physical objects. Although several layers in Figure 1 have clear physical counterparts, some common supply chain items fit into several layers, depending on their usage.

This document is intended to focus on Layers 2 and 3 in the "supply chain" as shown in Figure 1. Information for other layers is also provided in Annex A. Annex L lists organizations relevant.

This document complies with:

- ISO 15394 *Packaging - Bar code and two-dimensional symbols for shipping, transport and receiving labels*,
- 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*,
- ANS MH10.8.2 *Data Identifier and Application Identifier Standard*

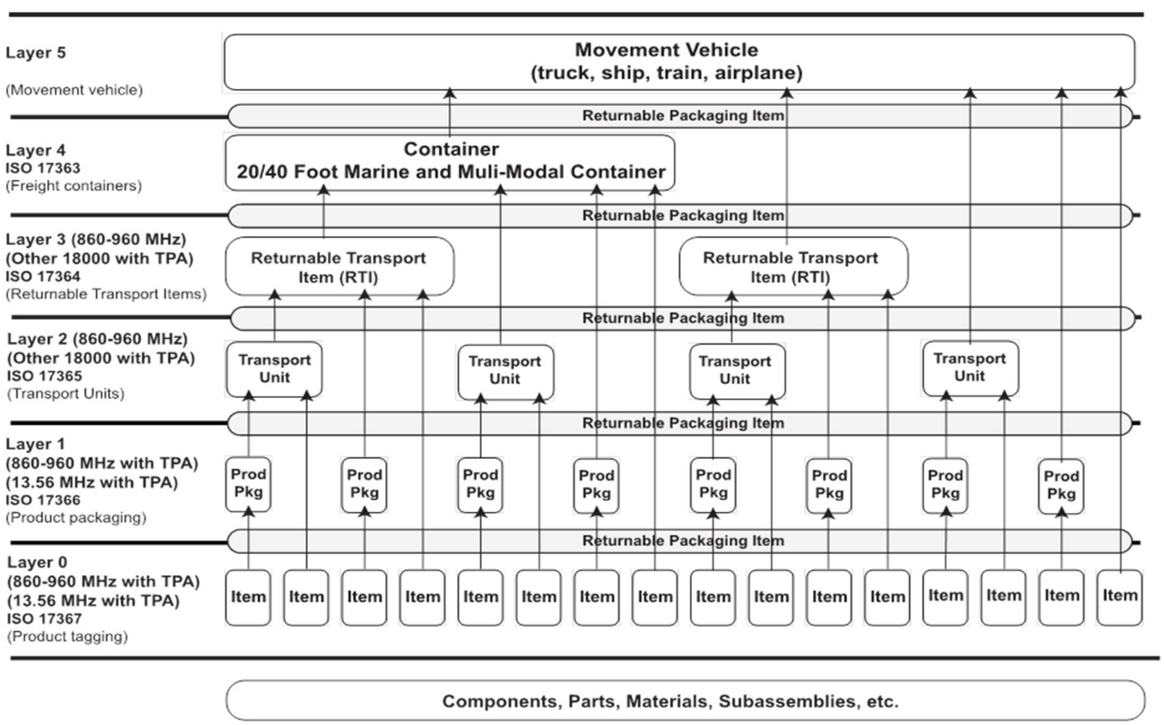


**Figure 1: Supply chain layers (ISO 1736X Series)**

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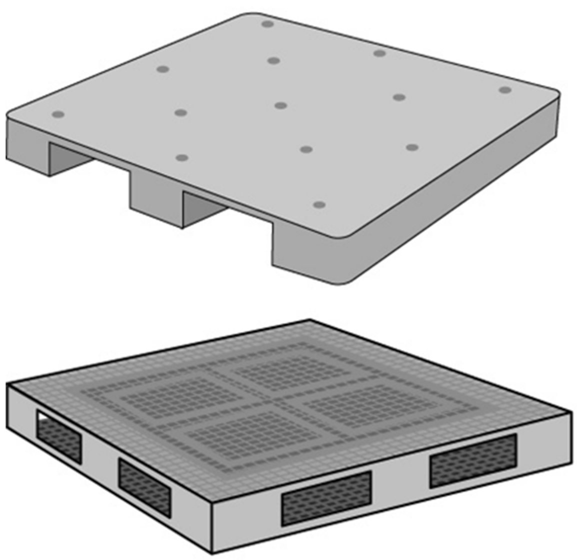
# 5 RETURNABLE TRANSPORT ITEM (RTI) AND RETURNABLE PACKAGING ITEM (RPI)

For the purposes of this document, Returnable Transport Items (RTIs) typically refer to logistics materials mainly used between vehicle manufacturers and the automotive parts manufacturers and suppliers in shipping (transferring) parts and assemblies. The aim of this document is to stipulate the identification method used for RTIs, to aid in the establishment of an efficient RTI control system throughout the global automotive industry. However, since various types of RTIs of different sizes and materials can be found in use, it is difficult to apply the same definition to all the types of RTIs used in the industry. To make it applicable to various types of RTIs including those not exemplified here, the focus of this document is placed on the typical RTI characteristics as defined below.

## 5.1 Returnable transport items and returnable packaging items of Layer 3

### 5.1.1 Pallets

Figures 2 through 9, below, show typical examples of RTIs in Layer 3, which includes a flat pallet, roll box pallet, box pallet, post pallet, silo pallet, tank pallet and sheet pallet. In the automotive industry, pallet-formed RTIs that are specially designed for automotive parts and components are widely implemented (see Figure 6). This document is applicable to this type of special pallet.



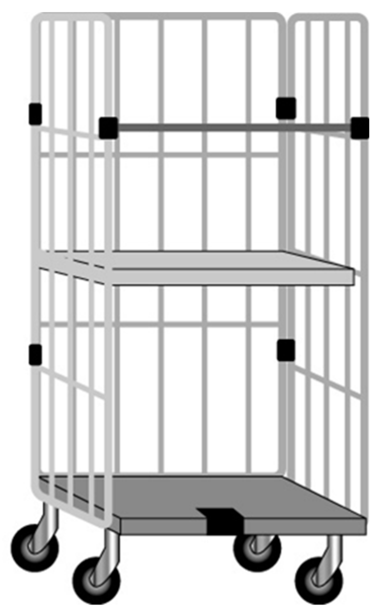


**Figure 2: Plate pallets (left picture) Roll box pallet (right picture)**

**Figure 3: Box pallets**

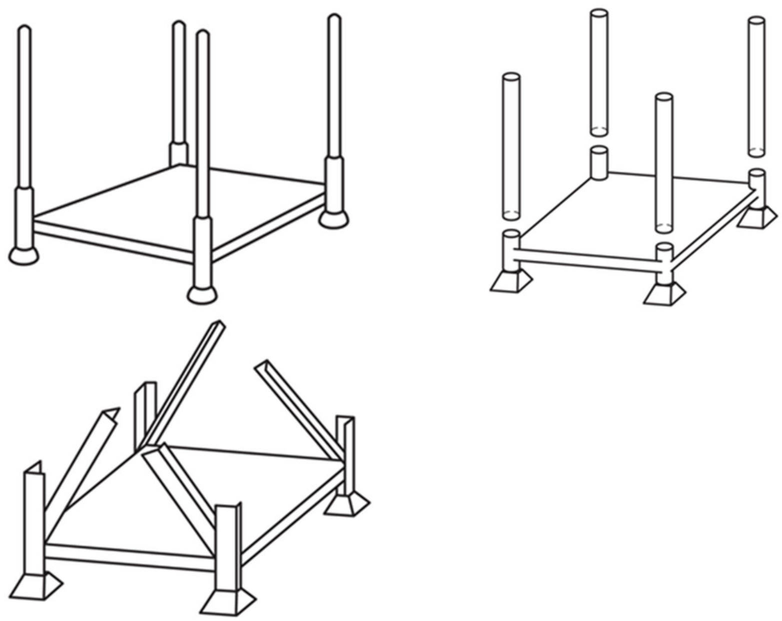


**Figure 4: Post pallets**

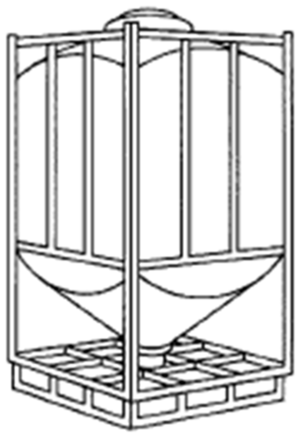



**Figure 5: Silo pallet (left picture) Tank pallet (right picture)**

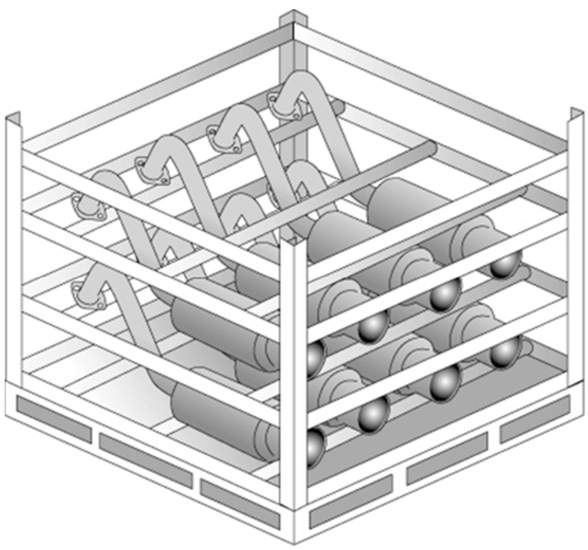
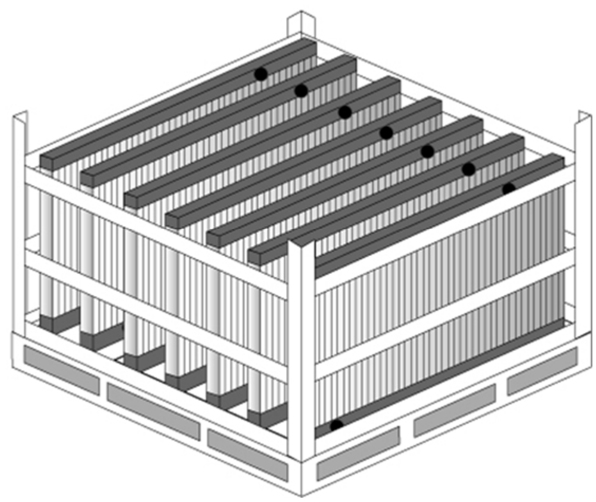



**Figure 6: Special pallets**

### 5.1.2 Sheet pallet / Slip sheet

A sheet pallet, or a slip sheet, is a sheet-like packing material that is used instead of a plate pallet when loading a returnable transport item on a carrier vehicle, such as a truck. This sheet pallet facilitates easy handling of the returnable transport item by reducing the friction generated between the returnable transport item and the undercarriage of the truck. By pulling the tab of the sheet pallet, the returnable transport item is smoothly unloaded from the truck without difficulties (see Figure 7). The sheet pallet can also be used under the returnable transport item ("returnable box" in Figure 7).

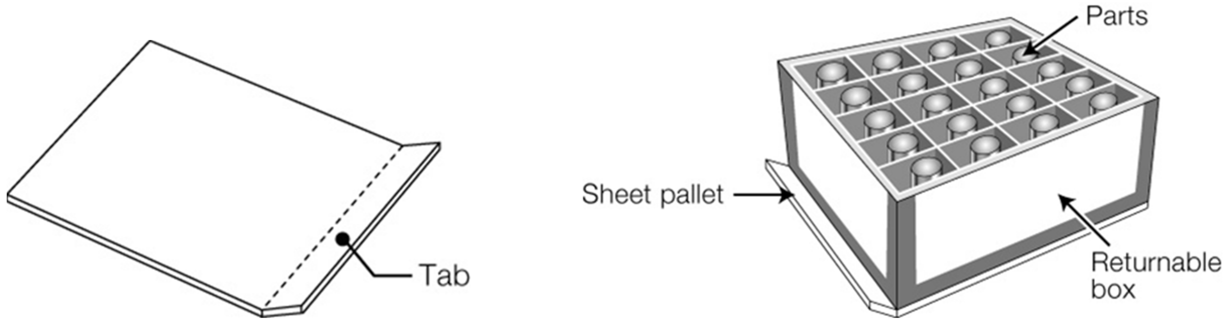



**Figure 7: Sheet pallet**

## 5.2 Returnable transport items and returnable packaging items of Layer 2

Figures 8 through 10, below, show typical examples of Returnable Transport Items as defined in Layer 2. This includes a returnable transport item with a size and shape capable of carrying more than one object on a flat pallet. Basically, metallic drums and barrels used in carrying liquids, oils or powders are not the target of this document. However, this document may be used for the container that is repeatedly used (meeting the requirements of an RTI) for carrying non-solid substances associated with vehicle production such as gasoline, oil, coating materials or hydrogen.

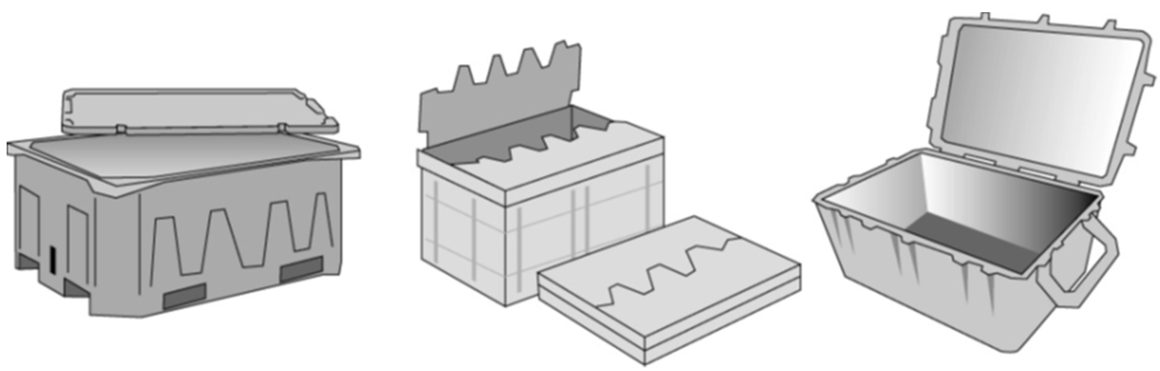


**Figure 8: Large-sized RTIs**

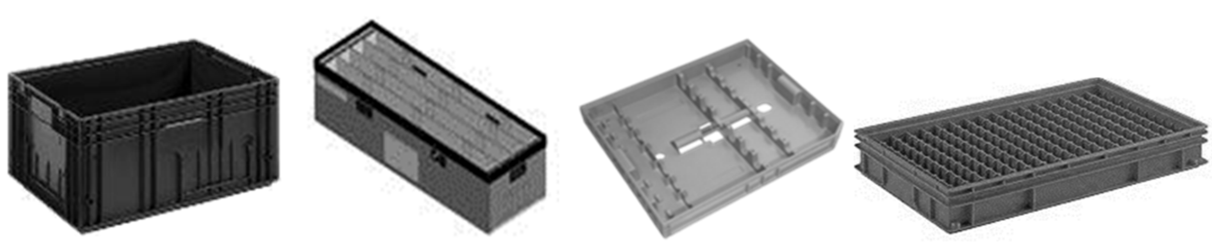


**Figure 9: Medium-sized RTIs**

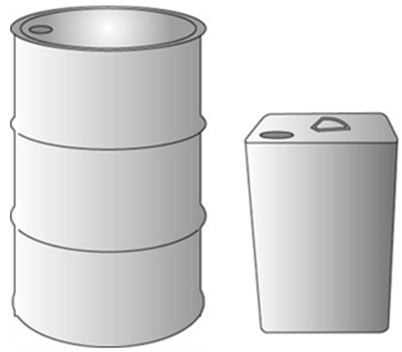


**Figure 10: Liquid containers, like metallic drums**

## 5.3 Partitions

Some of the pallets and returnable transport items are equipped with shock absorber-type materials so as to protect them from potential damage caused by a shock or vibration experienced in the transportation flow. An effective solution is the use of partitions or sorting boards for separating the contents into appropriate groups, making it possible to place many items on a single pallet or RTI. This kind of accessory for a pallet or RTI is defined as a “partition” in this document. The typical example of this is a post-type of partition used with the post pallet. Also included in this group is packing material used to protect or arrange the contents between the posts, or a packing material for dividing the inside of the RTI into several smaller sections (see Figures 11, 12 and 13). This document is applicable to these kinds of partitions.

### 5.3.1 Posts

Figure 11 shows a post that is normally used to securely fix packing materials onto the post pallet. Generally, these posts are made of plastic or metal.

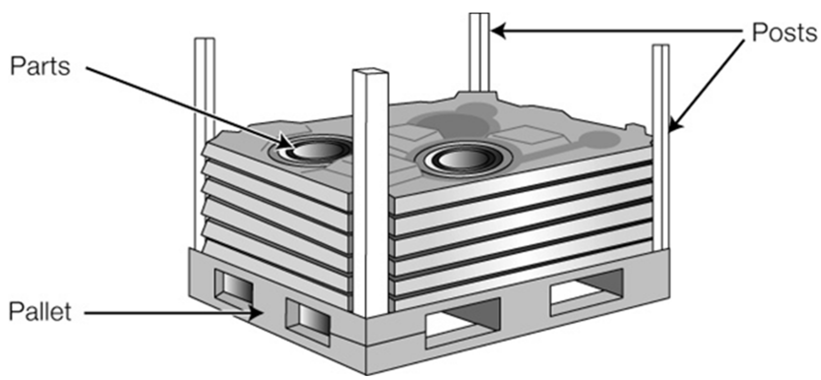



**Figure 11: Post**

### 5.3.2 Packing materials

Some form of packing materials should be provided to protect the items from any shock or vibration that may be encountered during transportation. They are also used to protect the product from being touched or hit by the pallet in which they are placed. Packing materials are generally made of high resilient flexible substances like plastic, urethane, and polystyrene foam.

Packaging materials can also be called Returnable Packaging Items (RPI) or auxiliary packaging materials and can be blister packs, "egg crates", sheet pallets, lids, foil, lining, etc. The purpose of these items is to pack materials safely. These "auxiliary packaging materials" are NOT load bearing and cannot be used as a load carrier.

This document is applicable to these kinds of packing materials (see Figure 12 and Figure 13).

When using this document to create Unique Item Identifiers (UIIs) for RTIs, the same principles apply to RPIs.

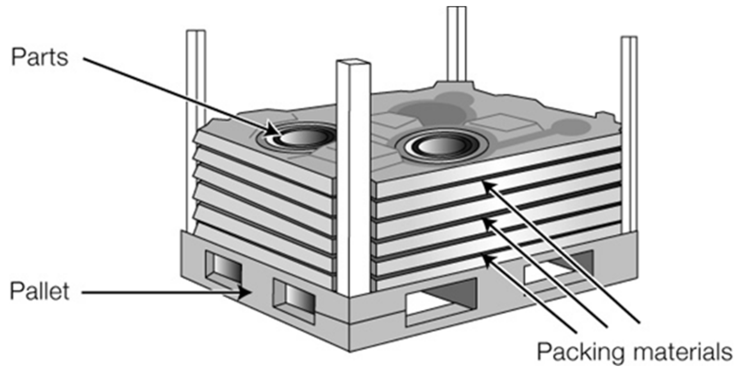



**Figure 12: Packing material**

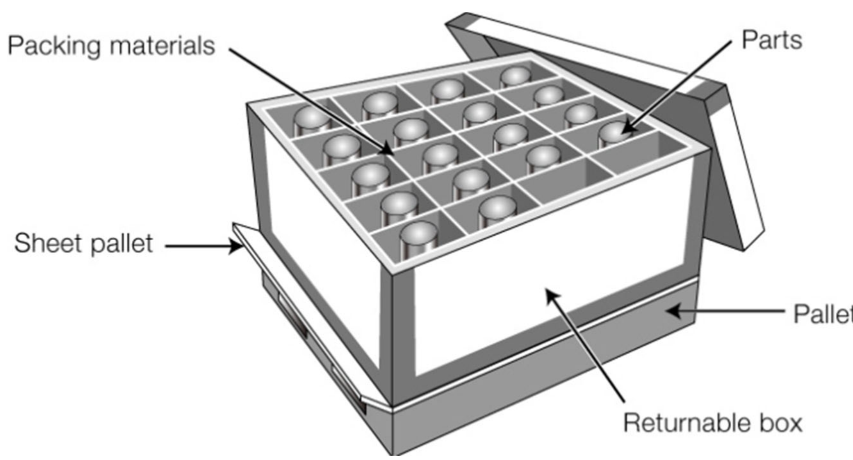



**Figure 13: Packing material**

# 6 DATA STRUCTURE OF RTI RFID TAGS

## 6.1 Data Organization and Syntax According to ISO/IEC 18000-63

The organization of the data on the tag is defined in ISO/IEC 18000-63, as a logical division of the tag storage into four data segments. See Figure 14.

RFID requirements not specified in this document shall comply with ISO/IEC 17364. The data compaction described here shall conform to ISO/IEC 17364.

> NOTE: Data size is byte-based (8-bits) for each data section, e.g., UII, DSFID, precursor, etc., and word-based (16-bit) for the entire transmitted data stream. See Access Commands in ISO/IEC 18000-63.

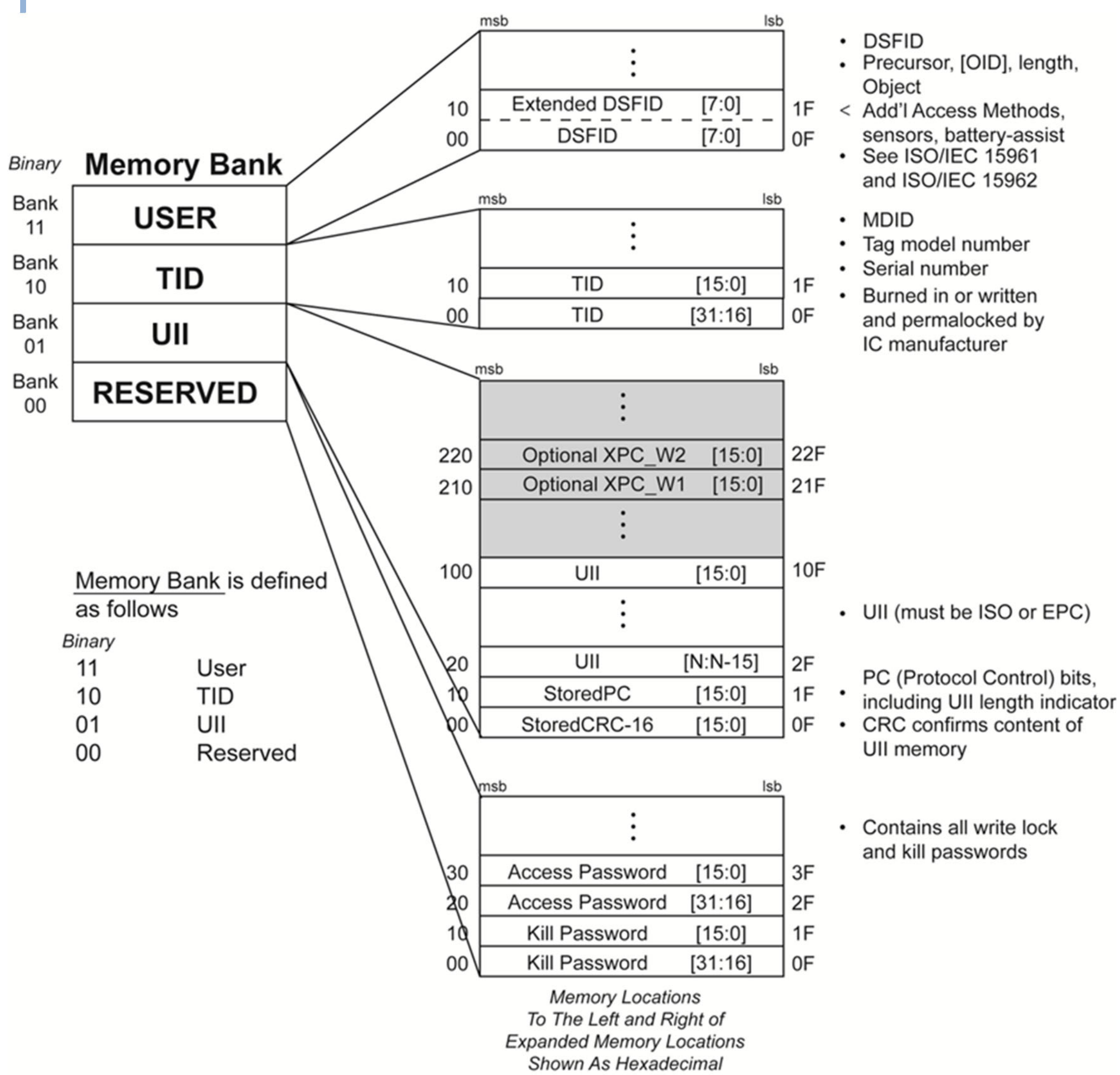



**Figure 14: Memory Structure of ISO/IEC 18000-63 RFID Tag**

> NOTE: Shaded areas are not recommended for use by this document.

The essential contents of these segments are:

### 6.1.1 Reserved:

Memory Bank (MB) 00: Password management, which contains;

- Access password

  If the Access Password = “0”, no password is required to enter the Secured state of the tag.
  If the Access Password ≠ “0”, a password is required to enter the Secured state of the tag.
  See Figure R.1 in Annex R, which outlines the password process when switching from one state to the other.
  This document recommends that the RFID tag has an Access Password encoded and Locked in MB00.
- Kill password

  This document recommends that the Kill Password be set to “0”, and the Kill Password PermaLocked - once the UII has been programmed into MB01, so that the tag may not be able to be killed, ever.

### 6.1.2 UII:

See Section 6.2 for additional details.

The RTIs’ unique identifier (consisting of DI, IAC, CIN and SN) is always stored in MB01 (Unique Item Identifier Memory Bank).

MB01 = UII (Unique Item Identifier), consisting of;

- CRC: calculated checksum on the tag for data verification
- PC: contains several data fields, including:
  - Length of the UII field in Words (one Word equals two bytes)
  - Bit 15: Switch; whether user data are saved or not in MB11
  - Bit 17: Switch; if an EPC or an ISO number is encoded in the UII field. See Table 3.
  - Characteristic of the AFI field (Application Family Identifier). See Table 2.
- UII field: contains the unique part ID
  - This document recommends that the UII field should have at least 240 bits.

The UII shall be constructed according to ISO/IEC 15459-4. This document supports that both data syntaxes may exist within the same tag population environment.

The AFI serves as a primary filter in distinguishing what kind of object has been read by the RFID application (e.g., automotive part, container, etc.). In this way, the AFI supports in filtering relevant from irrelevant data. Additionally, the AFI defines which kind of coding has been applied. Available, standardized AFIs are listed in ISO/IEC 15961-2 Data Constructs Register and specified in ISO 17363 through ISO 17367.

ISO/IEC provides two 6-bit encoding AFIs for identifying returnable transport items. One AFI is for standard returnable transport items and an additional one for returnable transport items containing hazardous materials. There is a third AFI that is usable. It is a general AFI and specifies that the data is encoded using the 8-bit UTF-8 characters.

If a returnable transport item contains hazardous materials, the material handler shall observe the attached Material Safety Data Sheet. The specific hazardous goods code shall include the appropriate Data Identifier and qualifier and be protected in MB11. See Table F.2 in Annex F.

**Table 2: Application Family Identifier (AFIs)**

| AFI (HEX) | STANDARDS |
|---|---|
| A3 | Monomorphic-UII using 6-bit compaction for ISO/IEC 17364 returnable transport unit |
| A8 | Monomorphic-UII using 6-bit compaction for ISO/IEC 17364 returnable transport unit, but containing hazardous materials |
| AC | Monomorphic-UII using 8-bit compaction for ISO/IEC 1736x series of standards |

Four conditions can be represented via the assignment of PC Bits 15 and 17 in MB01. Those conditions are explained in the following bullets and visualized in Table 3.

- If MB11 (User Memory) is used (contains data), PC bit 15 in MB01 is set to “1”. When PC bit 15 in MB01 is set to “0”, MB11 (User Memory) is not used (does not contain data) (see Figure F.1 in Annex F).
- When PC bit 17 in MB01 is set to “1” this indicates that the data in MB01 is an ISO-compliant construct, using an AFI whose value is either “0xA3”, “0xA8” or “0xAC” as specified in Annex D. Setting PC bit 17 in MB01 to “0” indicates that the data in MB01 will be a GS1-compliant construct.

**Table 3: Usage of PC Bits 15 and 17 within an ISO/IEC 18000-63 Tag**

| | | MB01: PROTOCOL CONTROL BIT 0x17 | |
|---|---|---|---|
| | | 0b0 = EPC-based data in MB01 | 0b1 = Monomorphic ISO AFI-based data in MB01 |
| MB01: PROTOCOL CONTROL BIT 0x15 | 0b0 = No data in MB11 | - EPC-based UII Data in MB01 - No User Data in MB11 | - Monomorphic ISO AFI-based UII Data in MB01 - No User Data in MB11 |
| | 0b1 = Data in MB11 | - EPC-based UII Data in MB01- User Data in MB11 | - Monomorphic ISO AFI-based UII Data in MB01 - User Data in MB11 |

### 6.1.3 TID:

(See Section 6.3 for additional details.)

MB10 = TID (Tag ID);

- Unique part and serial number of the Tag (not the part to which the Tag is attached).
- Serialized and strongly recommended to be permanently locked by the tag manufacturer.

NOTE: The TID is created and programmed by the silicon manufacturer.

### 6.1.4 User Memory:

(See Section 6.4 for additional details.)

Optional data may be written to a tags' User Memory bank (MB11) if the User Memory bank exists and its capacity can accommodate the data. Trading partner agreement is not required when the optional data is intended for use exclusively within a client's own system, or it is standards-based data. Optional data may be encrypted or locked at the discretion of the tag writer. The syntax of optional data shall conform to ISO/IEC 15961 and ISO/IEC 15962. When using linear or 2D symbologies, ISO 15394 provides specific examples of optional data elements using the ISO/IEC 15418 semantics and the ISO/IEC 15434 syntax.

MB11 = User Memory Bank:

- Data area which can be formatted and organized by the user
- The structure of the data to be stored in MB11 shall contain;
  - Unique Data Identifiers and related content.
  - All fields are OPTIONAL, i.e., use of the data is determined by the specific processing rules agreed to between trading partners.
  - These fields are explained in detail in Section 6.4.
- MB11 has the capability of being locked.
  - If data are ever desired to be written into MB11, and MB01 is also desired to be locked, data must be written into MB11 BEFORE MB01 is locked.

## 6.2 Unique Identifier (UII - MB01) of Returnable Transport Items (RTIs) and Returnable Packaging Items (RPIs)

Identification of the tagged object is accomplished via the UII as outlined under ISO/IEC 18000-63.

> NOTE 1: As used within the automotive industry, the $^{E}O_{T}$ character (End of Transmission – the character used to unambiguously indicate the end of the UII datastream within Memory Bank 01) will be the exclamation mark ("!"), represented by the binary bit pattern "100001". This character is not part of the reference-ID within the UII.
>
> NOTE 2: With mutual agreement between trading partners, "100001" does not need to be applied.

The UII shall be "locked" according to the latest editions of ISO/IEC 18000-63 or GS1 UHF Gen 2 air interface protocols.

The UII should contain no more than 35 characters. With a 240-bit UII field, a maximum of forty (40) (when using 6-bit encoding) characters can be encoded. If additional characters are required, an RFID tag with larger memory would be needed.

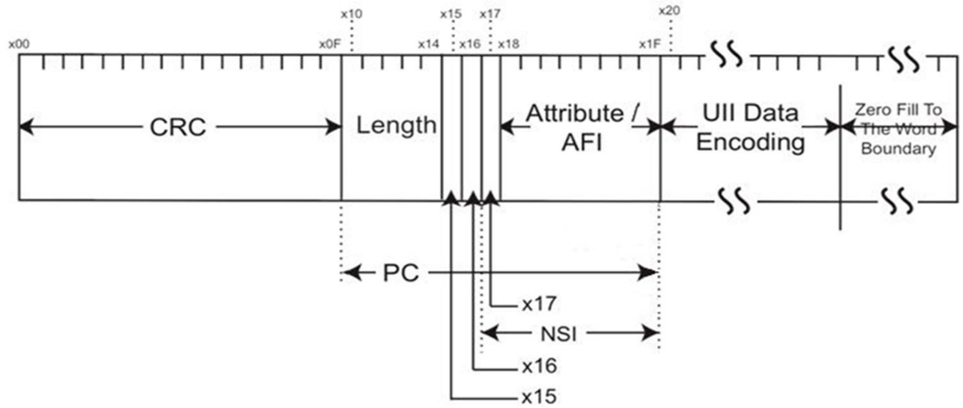



**Figure 15: MB01 layout in an ISO/IEC 18000-63 RFID tag**

### 6.2.1 Data field identification

Data Identifiers "25B", "26B", "27B", "28B", "29B" and "55B" are defined in ANS MH10.8.2. Using AIDC media, including DIs, is described in ISO/IEC 15459-5. Each of these DIs is a monomorphic, unique, item identification for RTIs (see Annex B). See Table 4 for the construction of the data fields for these specific DIs.

While the above DIs have been specifically pointed out, any *applicable* ANS MH10.8.2 DI is acceptable for use.

In previous versions of this document, Annex N listed commonly used DIs. That Annex has been removed from this document and a new document has been created for this purpose. For details about this document of commonly used DIs in the automotive industry, please see the Odette website: www.odette.org

### 6.2.2 Maximum data length

The structure of the data content and maximum data size shall be as defined by the DIs stated in ANS MH10.8.2.

### 6.2.3 Character set

When using 6-bit encoding, the RTIs unique identity shall only contain upper-case alphabetic characters and numeric digits of the Invariant Character Set of ISO/IEC 646; see ISO/IEC 15459-3.

When using 8-bit encoding, the UTF-8 character set shall be used.

NOTE: An Issuing Agency may put additional restrictions on the identities for RTIs / RPIs.

Any data processing system shall be capable of processing identities using the full repertoire of characters permitted for identities for RTIs or RPIs.

### 6.2.4 UII Data structure

Table 4 below shows the RTI's Unique Item Identifier (UII) data structure. The acronyms are explained in detail in the sections that follow Table.

**Table 4: Data Structure**

| DI | IAC See 6.2.4.1 | CIN See 6.2.4.2 | SERIAL NUMBER See 6.2.4.3 | | | DATA LENGTH (Excluding DI) |
|---|---|---|---|---|---|---|
| Data Identifier | Issuing Agency Code | Company Identification Number | RTI Identifier Component (where applicable) | Data Separator (where applicable) | Serial Number Component (where applicable) | |
| **25B** | IAC | CIN | RTI Serial Number | | | Up to 35 characters |
| **26B** | IAC | CIN | RTI Number | + | RTI Serial Number | Undefined |
| **27B** | IAC | CIN | RTI Type Code | + | RTI Serial Number | 20 to 50 characters |
| **28B** | IAC | CIN | RTI Type Code | + | RTI Serial Number | 20 to 50 characters |
| **29B** | IAC | CIN | RPI | + | RPI Serial Number | Up to 50 characters |
| **55B** | IAC | CIN | RPI Serial Number | | | Up to 50 characters |

#### *6.2.4.1 Issuing Agency Code (IAC)*

The Issuing Agency Code (IAC), which consists of from one (1) to a maximum of three (3) alpha-numeric, or strictly numeric (IAC-dependent), characters, is a code used to identify the entity/organization/company authorized by the appropriate registration authority as an issuing agency in accordance with ISO/IEC 15459-2. IACs include, for example, UN (Dun & Bradstreet), OD (Odette Europe), LA (JIPDEC/CII), TAJ (National Tax agency JAPAN) and D (NATO AC135).

#### *6.2.4.2 Company Identification Number (CIN)*

The Company Identification Number (CIN) is a unique code that is assigned by the issuing agency to each individual company. Each issuing agency has its own format for the CIN.

The CIN code may be partly determined by the company.

Users that want to use linear or two-dimensional symbols or RFID, in compliance with this document, shall have a unique CIN allocated by the appropriate issuing agency.

#### *6.2.4.3 Serial Number (SN)*

When the SN is combined with IAC and CIN, the combination shall constitute a globally unique identifier for the RTI. Once created and attached to an RTI the IAC, CIN and SN combination is intended to be fixed and unchangeable for that specific RTI throughout its lifetime.

The Serial Number (SN) may be composed of numeric, alphabetic, or alphanumeric characters. The Serial Number does not need to be a sequence number.

The Serial Number is to be constructed according to the IAC/CIN-defined data constructions. See Annex P.

The data structure for the Serial Number can thus have two formats (see Table 5 and Table 6):

a. An unstructured Serial Number;

**Table 5: Unstructured Serial Number data structure (Example; DI 25B and DI 55B)**

| DI | SERIAL NUMBER |
|---|---|
| 25B | SN |
| 55B | SN |

b. A structured Serial Number composed of an RTI object (RTI, RTIN, RTITC, RPI) and its Serial Number (RTISN, RPISN);

**Table 6: Structured Serial Number data structure (Example; DIs 26B through 29B)**

| DI | SERIAL NUMBER | | |
|---|---|---|---|
| | RTI Object | Separator | Serial Number |
| 26B | RTIN | + | RTISN |
| 27B | RTITC | + | RTISN |
| 28B | RTITC | + | RTISN |
| 29B | RPIN | + | RPISN |

The JAIF recommends using DIs “26B” through “29B” in future RFID applications, and in existing applications, where possible.

Different definitions and examples of the Serial Number are provided in Annex P.

NOTE: Any *applicable* ANS MH10.8.2 DI is usable.

### 6.2.5 UII (MB01) Coding Examples

The following sections provide detailed coding examples of UII data.

#### *6.2.5.1 UII Coding Scheme with UN (DUNS), OD (Odette), LA (JIPDEC), VTD (TEIKOKU DATABANK), TAJ (National Tax agency JAPAN), 0-9 (GS1), or D (NCAGE) format*

When using 6-bit encoding, the formatting of the data on the RFID tags shall use Table 11, "ASCII-Character-to-6-Bit-Encoding".

When using 8-bit encoding, the UTF-8 character set shall be used.

#### *6.2.5.2 Packaging identification (UII) using “26B”, “27B”, “28B” and “29B” with UN (DUNS), OD (Odette), LA (JIPDEC), VTD (TEIKOKU DATABANK), TAJ (National Tax agency JAPAN)*

The previous version of this document recommended the application of DI 25B, which states strictly defined string lengths. Practice has shown that PN and SN may vary in length. Therefore, the JAIF recommends using DIs “26B”, “27B”, “28B” and “29B” for future RFID applications, and existing applications where possible. However, any *applicable* MH10.8.2 DI is allowed.

DI "26B", "27B", "28B" and "29B" states that the RTI or RPI type and the RTI or RPI serial number are declared separately by using the "+" character.

**Table 7: Example Data Structure for Identifying Small Load Carrier RTI using DI "28B" and IAC "UN"**

| DI | IAC | CIN | RTI TC | SEPARATOR | RTISN |
|---|---|---|---|---|---|
| **Data Identifier** | **Issuing Agency Code** | **Company Identification Number** | **RTI Type Code** | | **RTI Serial Number** |
| 28B | UN | Variable | Variable | + | Variable |
| 3 char (an) | 2 char (a) | 9 char (n) | x char (an) | 1 char | y char (an) |

Table 8 represents a data encodation into MB01 and contains two major sections: 1) the CRC and the Protocol Control Word, and 2) the UII.

> NOTE: The terms "Variable" and "Fixed" in the Value column of Table 8 refer to the actual data used, not the length of that data.

**Table 8: MB 01 Coding Scheme for RTI or RPI**

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB 01: CRC + Protocol Control Word** | | | | |
| 00 – 0F | CRC-16 | Hardware assigned | 16 bits | Cyclic Redundancy Check |
| 10 – 14 | Length | Variable | 5 bits | Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field. |
| 15 | PC bit 0x15 | 0b0 or 0b1 | 1 bit | 0 = No valid User Data, or no MB11<br>1 = Valid User Data in MB11 |
| 16 | PC bit 0x16 | 0b0 | 1 bit | 0 = "Extended PC word" not used |
| 17 | PC bit 0x17 | 0b1 | 1 bit | 1 = Data interpretation rules based on ISO |
| 18 – 1F | AFI | 0xA3 or 0xA8 | 8 bits | Application Family Identifier used according to ISO/IEC 15961 and ISO 17364. For hazardous parts use A8. |
| | ***Subtotal*** | | ***32 bits*** | |

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB 01: Unique Item Identifier (UII) with 6 bit encoding** | | | | |
| Start at location 20 Go to end of data / end of available memory | DI | "26B", "27B", "28B" or "29B" | 3 an | Data Identifier for RTI (RPI) Identification |
| | Issuing Agency Code (IAC) | "OD", "UN", "LA", "VTD" or "TAJ" | 2 or 3 an | Issuing Agency Code, according to DUNS, Odette, JIPDEC, TEIKOKU DATABANK or National Tax agency JAPAN |
| | Company Identification Code (CIN) | As defined by the IAC | 6 an (OD), 9 n (UN and VTD), 12 an (LA), 13 n (TAJ) | Company Identification Number |
| | Serial Number (SN)<br><br>Consisting of RTI (RPI) Type Code, Separator and RTI (RPI) Serial Number | RTI (RPI) Type Code | 1...X an | Variable number of alphanumeric characters for the RTI (RPI) type assigned by the owner |
| | | + (Separator) | 1 an | "+" sign separator (0x2B) |
| | | RTI (RPI) Serial Number | 1...Y an | Up to Y alphanumeric characters, in capital letters |
| | $^{E}O_{T}$ | 0b100001 | 6 bit | End of Transmission character |
| | Padding until the end of the last 16-bit Word | 0b10, 0b1000, 0b100000, 0b10000010, 0b1000001000, 0b100000100000, or 0b10000010000010 | 2, 4, 6, 8, 10, 12 or 14 bits | Word Padding According to ISO/IEC 15962 |
| | ***Subtotal*** | | ***Variable*** | ***A minimum of 240 bits*** |
| | **TOTAL MB01:** | | **VARIABLE** | **A minimum of 272 BITS** |

NOTE 1: $^{E}O_{T}$ and padding bits are used for control purposes and Word padding. They are not part of the reference-ID within the UII (MB01) and the data that is stored to the UM (MB11), i.e., both $^{E}O_{T}$ and padding bits are removed when decoding the data.

NOTE 2: See Annex S for UII (MB01) 8-bit Coding Scheme examples for RTI or RPI

#### *6.2.5.2.1 NATO (NCAGE) Construct for Use with Passive Gen2 RFID Tags*

The DOD requires passive GS1 Gen2 RFID tags be attached to all shipment units at the case and pallet level. The requirement includes formatting the data in accordance with the GS1 Tag Data Specification. For those companies that do not own an EPC company manager number, or those that chose not to use their EPC company manager number, there is a "DOD Construct" a.k.a. "DOD 96" that allows use of the Commercial and Government Entity (CAGE) code in lieu of the EPC company manager number.

The North Atlantic Treaty Organization (NATO) Allied Committee 135 (AC 135) controls the issuance of NCAGE or NATO CAGE codes. The term "CAGE" nominally refers to an NCAGE code issued by AC 135 to the military of the member nation. AC 135 has published rules that ensure that NCAGE codes are individually unique. CAGE codes and NCAGE codes are the same length (5 alphanumeric characters).

Detailed instructions on how to assemble an EPC- and DOD-compliant RFID tag ID are found at the United States Department of Defense Supplier's Passive RFID Information Guide, Version 14.0 or later.

How to use the UII memory area (MB01) is described in "GS1 Tag Data Standards," Version 1.5 or later.

The following table represents the data that are encoded into MB01 and contains two major sections: 1) the CRC and the Protocol Control Word, and 2) the UII.

NOTE: The terms "Variable" and "Fixed" in the Value column of Table 9 refer to the actual data used, not the length of that data.

**Table 9: The Unique Identification (UII) of an RFID Tag (MB01) for DOD**

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB01: CRC + Protocol Control Word** | | | | |
| 00 – 0F | CRC | Hardware assigned | 16 bits | Cyclic Redundancy Check |
| 10 – 14 | Length | Variable | 5 bits | Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field. |
| 15 | PC bit 0x15 | 0b0<br>or<br>0b1 | 1 bit | 0 = No valid User Data, or no MB11<br>1 = Valid User Data in MB11 |
| 16 | PC bit 0x16 | 0b0 | 1 bit | 0 = "Extended PC word" not used |
| 17 | PC bit 0x17 | 0b0 | 1 bit | 0 = Data interpretation rules based on EPC |
| 18 – 1F | Attribute | 0b00000000 | 8 bits | No AFI with EPC Format |

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| | ***Subtotal*** | | ***32 bits*** | |
| **MB01: UII**<br>**In this example, the UII data uses 6-bit encoding values from Error! Reference source not found.; not used positions are padded with leading zero(s) (ASCII “zero” [0x30]).** | | | | |
| Start at 20<br>Go to end of data / end of available memory | Header | 0x2F<br>00101111 | 8 bits | Header for DOD 96 |
| | Filter Value | 0b0000<br>or<br>0b0001<br>or<br>0b0010 | 4 bits | 0000 = Pallet (palletized unit load)<br>0001 = Case (shipping and exterior container)<br>0010 = Unit Pack<br>All other combinations = reserved for future use |
| | Government Managed Identifiers | “Space” followed by 5 alpha-numeric characters | 48 bits | NCAGE or CAGE code preceded by a “space”:<br>Or<br>DODAAC - 6 characters (reserved for use only to identify U.S. military activities)<br>(Displayed in hex format) |
| | Serial Number | Variable | 36 bits | Binary format using left-padded zeros |
| | ***Subtotal*** | | ***96 bits*** | |
| | **TOTAL MB01:** | | **128 BITS** | |

## 6.3 TID Memory Bank – MB10 (SERIALIZED AND LOCKED)

Tag ID (TID), Memory Bank 10, provides several chip identity options, called Allocation Class (AC). These options provide different tag identity profiles that can be used to identify individual RFID chips uniquely and unambiguously – and through the chips, the RFID tags that are made from them. See ISO/IEC 15693 for complete details on these Allocation Classes.

There are three (3) options listed under ISO/IEC 15963 that are relevant to this document: 0xE0, 0xE2, and 0xE3.

- 0xE0 is the AC for the basic ISO/IEC 7816-6 company issuer identifier codes consisting of the 8-bit identifier followed by a 48-bit serial number.
- 0xE2 will contain serialization if both of the following conditions are met:
  1. Bit 0x08 of the TID memory bank (the msb of the TAG MDID) has a value of ”1”.
  2. Bits 0x20-0x22 do not equal zero when treated as a 3-bit unsigned number. The msb of this number is bit 0x20.

If condition “1”, above is met, there is a 16-bit XTID header present from address 0x20-0x2F of the TID memory bank. There may also be more data present in the TID that is not covered by this specification.

- 0xE3 builds on the existing AC 0xE0 for compatibility. The AC is followed by the 8-bit I.C. manufacturer’s registration number, the 2-byte User Memory present and size data, the 48-bit unique tag ID, the 1-byte XTID, and the 15-byte XTID Header data. Table B.2 of ISO/IEC 15963 shows the TID format for Allocation Class 0xE3.

> NOTE: THIS DOCUMENT REQUIRES THAT THE CHIP CONTAINS A GLOBALLY UNIQUE SERIALIZED TID, AND THAT THE TID BE “LOCKED” BY THE SILICON MANUFACTURER.

## 6.4 Data Structure in the User Memory Bank (MB11)

For MB11, data structures shall conform to ISO/IEC 15434 and ISO/IEC 15418 (which refers to ANSI MH 10.8.2), Data Format 06 "Data using ASC MH 10 Data Identifiers" to enable conversion between optical symbology and RFID media.

When using RFID, ISO/IEC 15962 Access Method 0 (No Directory) Format 3 or Access Method 0 (No Directory) Format 13 shall be used.

When placing data into the User Memory bank (MB11), it is recommended that the minimum User Memory Bank (MB11) size should be 512 bits.

> NOTE: The information in this section is predicated on 6-bit encoding. See Annex S for 8-bit encoding examples.

### 6.4.1 Data Requirements

As a minimum requirement, a unique identifier shall be saved in MB01 on the tag; even if there is no data stored in User Memory (MB11) (see Section 6.2).

The requirements regarding the user memory vary depending upon the business processes and agreements with the participating partners.

“User Memory”, Memory Bank11 (MB11), can take numerous forms from a data semantics and syntax perspective. When PC Bit 15 = 0b1 (indicating that there are data in MB11) and PC Bit 17 = 0b1 (indicating an ISO versus an EPC structure), the first 8 to 16 bits of user memory are encoded according to the DSFID rules in ISO/IEC 15961-1, ISO/IEC 15961-2, and ISO/IEC 15962.

This document describes, and recommends, Access Method 0 and Formats 3 or 13 for encoding data within MB11.

### 6.4.2 Data Storage Format Identifier (DSFID)

The single-byte DSFID (Data Storage Format IDentifier) defines the Access Method and the Data Format, and has the following structure:

- Bits 8 and 7 define the Access Method, which determines how data are encoded on the tag. See Table 10.
    - This standard recommends Access Method "No Directory," with binary bit value ‘00’.

- Bit 6 is the Extended Syntax indicator (recommended = “0”).
  - When bit 6 = “1” the following apply:
    - Bit 8 is the Extensibility Bit
    - Bits 7 and 6 are the Extended Syntax
    - Bits 5 and 4 are the Memory Length
    - Bits 3 to 1 are the Battery-assisted, Full-function Sensor, Simple Sensor indicators
    - Subsequent bytes contain the data, in 6-bit encoding.
    - When using Format 3, the data stream is terminated by the “$^{E}O_{T}$” character.
- Bits 5 through 1, inclusive, describe the Data Format.
  - A DSFID value of “0x03” indicates the use of “No Directory, ISO/IEC 15434 -based Data Syntax.” The SG1 standing document “SG1 Documents for 15962” explains the use of this method with Format 06, 6-bit encoding.
  - A DSFID value of “0x0D” indicates the use of “No Directory using the ISO/IEC 15962 Assigned Relative OID DI Table.” This is the recommended format.
  - A DSFID value of “0x8D” indicates the use of “Packed Objects, using the ISO/IEC 15962 Assigned Relative OID DI Table.”
  - The Special Features Flag (SFF) shall be set to “00”. See Table 10

NOTE: See Annex S for UTF-8 encoding examples.

**Table 10: Assigned and Reserved Access Methods**

| 15961 INTEGER CODE | 15962 DSFID BIT CODE | 15962 SFF BIT CODE | NAME | DESCRIPTION |
|---|---|---|---|---|
| 0 | 00 | 00 | No-Directory | This structure supports the contiguous abutting of all the Data-Sets. |
| 1 | 01 | 00 | Directory | The data are encoded exactly as for No-Directory, but the RFID tag supports an additional directory, which is first read to point to the address of the relevant object identifier. |
| 2 | 10 | 00 | Packed-Objects | This is an integrated compaction and encoding scheme that formats data in an indexed structure as defined by the Application administrator (see ISO/IEC 15961-2). |
| 3 | 11 | 00 | Tag-Data-Profile | This is an integrated compaction and encoding scheme for a fixed set of data elements, each of a defined length. |
| 4 – 15 | 00 | 01 | RFU | Reserved for future revisions of ISO/IEC 15962. |

#### 6.4.2.1 Access Method 0, Format 3; ISO/IEC 15961-2 Defined Encoding Assigned to ISO/IEC 15434.

Using the DSFID and Precursor, ISO/IEC 15962's Format 3 eliminates the need to encode the following portions of the ISO/IEC 15434 message envelope: The Compliance Indicator and Format Trailer "[ ) > ${}^{R}{}_{S}$", the Format Header (as used in this document for DIs; "06 ${}^{G}{}_{S}$" and the message's final Format Trailer/Message Trailer characters "${}^{R}{}_{S}$ ${}^{E}{}_{OT}$". Data encoding is accomplished by using the 6-bit data characters in Table 11.

**Table 11: Six-bit Character Encodation Table according to ISO 17364**

| Character | Binary Value | Character | Binary Value | Character | Binary Value | Character | Binary Value |
|---|---|---|---|---|---|---|---|
| Space | 100000 | 0 | 110000 | @ | 000000 | P | 010000 |
| ${}^{E}{}_{OT}$ | 100001 | 1 | 110001 | A | 000001 | Q | 010001 |
| <Reserved> | 100010 | 2 | 110010 | B | 000010 | R | 010010 |
| ${}^{F}{}_{S}$ | 100011 | 3 | 110011 | C | 000011 | S | 010011 |
| ${}^{U}{}_{S}$ | 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 |

| Character | Binary Value | Character | Binary Value | Character | Binary Value | Character | Binary Value |
|---|---|---|---|---|---|---|---|
| * | 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 | $^{G}{}_{S}$ | 011110 |
| / | 101111 | ? | 111111 | O | 001111 | $^{R}{}_{S}$ | 011111 |

NOTE: Table 11, above, is 6-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.

As used in this document, only the following characters from Table 11 are allowed:

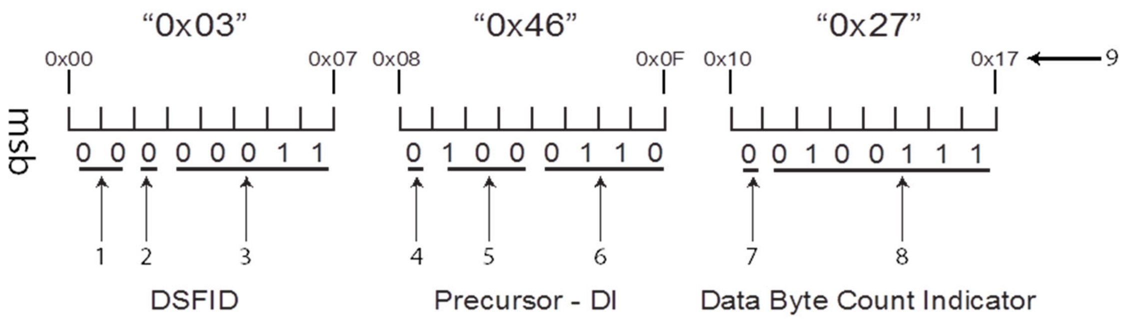
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, * (asterisk), + (plus sign), - (dash), . (period or full stop), $^{E}{}_{OT}$ (End of Transmission), $^{R}{}_{S}$ (Record Separator), $^{G}{}_{S}$ (Group Separator) and the “SPACE” character.

NOTE 1: See Annex S for 8-bit encoding examples.

NOTE 2: When using 8-bit encoding, UTF-8 is the character set.

#### *6.4.2.2 Synopsis of Access Method 0, Format 3 encoding:*

- The first byte of memory is a DSFID that always has the fixed value 0x03, indicating that memory uses Access Method 0 and encodes Format 3 (ISO/IEC 15434) messages. See ISO 17367 for encoding/decoding and translation guidance.
- The second byte of memory is a Precursor, which is a fixed value for a given ISO/IEC 15434 Format Indicator (true for all but the exception conditions covered in ISO/IEC 15962 and ISO/IEC 15434).
    - To be compliant with this document when using Format 3 and 6-bit encoding, a fixed Precursor value of 0x46 will always be used, indicating 6-bit encoding and ISO/IEC 15434 Format Indicator 6 (for DIs).
- The third byte of memory indicates the length (in bytes) of the data, encoded as an EBV-8 value. For all but the longest ISO/IEC 15434 messages (those longer than 127 bytes), this number is encoded in a single byte.
- The subsequent bytes (whose length was indicated by the preceding byte) contain the data, in 6-bit encoding (reference Table 11).
    - This standard recommends that only one ISO/IEC 15434 message be encoded.




Key:

| | |
|---|---|
| 1 | Access Method: "0" (see ISO/IEC 15962) |
| 2 | Extend Syntax – turns on additional byte of DSFID Byte (turned off in this instance) |
| 3 | Data Format "03" (ISO/IEC 15434) |
| 4 | Extension Bit – (see ISO/IEC 15962) |
| 5 | Compaction bits (indicating either 6-bit table or UTF-8 character set) |
| 6 | Format Envelope (specifically DI "06") |
| 7 | Byte Count Indicator switch (set to "0" to signify final byte of byte count) |
| 8 | Bit values for Byte Count Indicator (variable based on length of data) |
| 9 | Bit position in memory |

**Figure 16: ISO/IEC 18000-63 and ISO/IEC 18000-3 Mode 3 Structure of Memory Bank 11; First 24 Bits**

> NOTE: For the purpose of the above example, battery-assist and sensors are shown as "not present".

The information stored in the Length component of the Protocol Control Word differs based on whether the data length is equal to, or less than 1024 bits. Tables 12 and 13 show the difference.

> NOTE: Only the Control Information section of Tables 11 and 12 shows the change in the data length component (Byte Count Indicator Length). The User Memory sections of Tables 11 and 12 show the same data.

**Table 12: ISO/IEC-Encoding of MB 11 (Object Length ≤ 1024 bits):**

| POSITION | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB 11: User Memory (UM): Control Information (Header) for MB 11 ≤ 1024 bits** | | | | |
| 1 | DSFID | 0x03 | 1 byte | Data Structure Format Identifier |
| 2 | Precursor | 0x46 | 1 byte | Compaction Code + Relative OID |
| 3a | Byte Count Indicator Switch | 0b0 | 1 bit | "0 binary" declares that the next 7 bits are used to define the length of the following application data (object length ≤ 1024 bits). No additional bytes used for indicating the object length. |
| 3b | Byte Count Indicator Length | Variable | 7 bit | Object Length in Bytes |
| | ***Subtotal*** | | ***24 bits*** | |
| **MB 11: User Memory (UM): User- and Application Data** | | | | |
| 1 | Data Identifier | <DI> | 6 … 24 bit | Data Identifier "1" |
| 2 | Data | alphanumeric (an) | 6 bit characters | Data |
| 3 | Group Separator | GS 0b011110 | 6 bit | Group Separator |
| 4 | Data Identifier | <DI> | 6 … 24 bit | Data Identifier "2" |
| 5 | Data | alphanumeric (an) | 6 bit characters | Data |
| 6 | .. | .. | .. | .. |
| 7 | End of Transmission | EOT 0b100001 | 6 bit | End of Transmission According to ISO 17363 through ISO 17367. |
| 8 | Word Padding | 0b10, 0b1000, 0b100001, 0b10000110, 0b1000011000, 0b100001100001, or 0b10000110000110 | 2, 4, 6, 8, 10, 12 or 14 bits | Word Padding<br><br>According to ISO/IEC 15962 for MB 11 |
| | ***Total MB 11*** | | ***Variable*** | ***Up to chip limit*** |

As mentioned above, the content of the control section in MB 11 depends on the size of the data that is stored into MB 11. Table 13 shows the control information when the application data (object length) in MB 11 is > 1024 bits:

**Table 13: ISO/IEC-Encoding of MB 11 (Object Length > 1024 bits):**

| POSITION | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB 11: User Memory (UM): Control Information (Header) for MB 11 > 1024 bits** | | | | |
| 1 | DSFID | 0x03 | 1 byte | Data Structure Format Identifier |
| 2 | Precursor | 0x46 | 1 byte | Compaction Code + Relative OID |
| 3a | Byte Count Indicator Switch | 0b1 | 1 bit | 1 binary<br>Declares that an additional byte is used to define the application data length (object length). The next 7 bits and the relevant 7 bits of the additional, following byte are concatenated to indicate extended application data (object length > 1024 bits) |
| 3b | Byte Count Indicator Length | Variable | 7 bit | First part of the length declaration. |
| 4a | Byte Count Indicator Switch | 0b0 | 1 bit | 0 binary<br>Declares that the next 7 bits are used to indicate the application data length. |
| 4b | Byte Count Indicator Length | Variable | 7 bit | Example:<br>3b: ~~1~~0000001 (128 bytes)<br>4b: ~~0~~0000010 (2 bytes)<br>Total Object Length: 130 byte |
| | ***Subtotal*** | | ***32 bits*** | |

NOTE: See Annex S for 8-bit UTF-8 encoding examples

#### 6.4.2.3 Access Method 0 Format 13; ISO/IEC 15961-2 Defined Encoding Assigned to ISO/IEC 15962 Assigned Relative OID DI Table

- When using Format 13, the first byte of memory is a DSFID that always has a fixed value of 0x0D, indicating that user memory is encoded using Access Method 0 and Format 13 (ISO/IEC 15962 Assigned Relative OID DI Table).
- The second byte of memory is a Precursor, consisting of an Offset bit, Compaction code (3 bits), and value from the Assigned Relative OID DI Table for the DI used (4 bits).
- The third byte of memory indicates the length (in bytes) of the data, encoded as an EBV-8 value.
- The subsequent bytes (whose length was indicated by the preceding byte) contain the data, using the encoding schema (compaction) as denoted within the Precursor (Integer, Numeric, 5-bit, 6-bit, or 7-bit).

The above pattern of Precursor, Length of Data, and Data is repeated for each datum written into User Memory.

## 6.5 Tag security

### 6.5.1 Data integrity

To prevent the alteration or erasure of data, users shall have the ability to exercise the function commonly called "locking" data. Tag manufacturers shall have the option of locking parts of the tag data for identification and storage of the data related to the manufacturer, not the user memory (see 6.3). A CRC-16 is required to enhance the accuracy of the data. The location of the CRC-16 shall be as per the memory map in Table F.2 in Annex F. The definition of CRC-16 is given in Annex F.3.b.

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# 7 DATA STRUCTURE OF OTHER AUTOMATIC IDENTIFICATION TECHNIQUES

## 7.1 Linear symbology data field structure

If the length of data to be encoded exceeds the ability of a linear symbol to display effectively, the use of two-dimensional symbols is recommended.

The Data Identifier for RTIs shall precede data encoded in the Code 128 (ISO/IEC 15417) or Code 39 (ISO/IEC 16388) symbologies.

**Table 14: Stored data structure of linear symbol**

| DI | DATA STRUCTURE | | | | |
|---|---|---|---|---|---|
| 25B | IAC | CIN | RTISN | | |
| 26B | IAC | CIN | RTIN | + | RTISN |
| 27B | IAC | CIN | RTITC | + | RTISN |
| 28B | IAC | CIN | RTITC | + | RTISN |
| 29B | IAC | CIN | RPI | + | RPISN |
| 55B | IAC | CIN | RPISN | | |

Specific Data Identifiers are assigned to accommodate concatenation of specific fixed length data fields.

## 7.2 Two-dimensional symbology data field structure

Data encoded to be compliant with this document shall use the syntax identified in ISO/IEC 15434. The Message Header (first 7 characters; [ ) > $^{R}{}_{S}$ 06 $^{G}{}_{S}$ [NOTE: Spaces shown for clarity only]) and Message Trailer (the last 2 characters; $^{R}{}_{S}$ $^{E}O_{T}$) are fixed for this application, in accordance with the ISO/IEC 15434 standard. The " $^{E}O_{T}$" character is ISO/IEC 646 Decimal 04. Certain symbologies support the use of a single codeword to encode the message header and message trailer character strings. Refer to applicable symbology standards (see Annex C).

## 7.3 Rewritable hybrid media data field structure

### 7.3.1 RFID data field structure

Refer to Section 6 for the structure of the RFID data field.

### 7.3.2 Linear symbology data field structure

Refer to Section 7.1 for the structure of the linear symbology data field.

### 7.3.3 Two-dimensional symbology data field structure

Refer to Section 7.2 for the structure of the two-dimensional symbology data field.

### 7.3.4 Structure of data transmitted by a multi-media reader

A multi-media reader is a device capable of reading and then transmitting the data stored in linear symbols, two-dimensional symbols and RF tags conforming to the technological concepts defined in ISO/IEC 15459-1, ISO/IEC 15459-5, ISO/IEC 15459-4, or ISO/IEC 15459-6. For RF tags, the Data Carrier Identifier "Z2", specified in ISO/IEC 15424, should be applied (see Annex E). In this case, an AFI (in hexadecimal) is transmitted after the identifier "Z2" as described in Annex D. Refer to Annex G for more information.

**Table 15: Structure of data transmitted by multi-media reader**

| DATA CARRIER IDENTIFIER | AFI (HEX) | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) |
|---|---|---|---|
| ]Z2 | A3 | 25B | IAC CIN SN |

NOTE: The Data Carrier Identifier "]" should be 5Dhex, as defined in ISO/IEC 646.

# 8 RFID TAG REQUIREMENTS

## 8.1 Transponder Types, Location and Mounting

RTI applications may include various transponder types such as hard tags and smart labels. The choice for a specific RFID transponder mainly depends on the RTI type the RFID transponder is applied to. This is particularly important regarding metal RTIs or RTIs exposed to electrostatic discharge (ESD). Such applications may require special on-Metal or ESD-resistant RFID transponders.

The type and positioning of the transponder significantly influences the performance of the whole RFID application. Therefore, the transponder type and the positioning shall be tested extensively before putting the RFID solution into practice. This also includes RTI sets as indicated in Figure 17. The RFID transponders shall point to the outside of the RTI sets and shall be shifted to assure that all RTIs can be captured. Note that RFID transponders, which are placed very close to each other, may negatively influence each other's performance:

| BEST PERFORMANCE | POTENTIAL RESTRICTIONS | PROBLEMATIC |
|---|---|---|

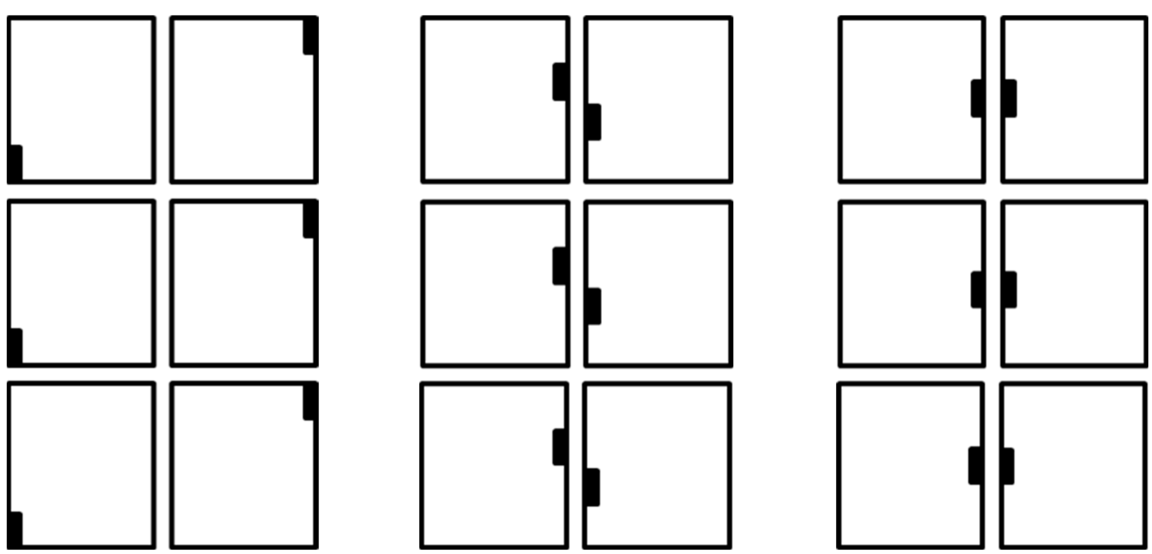


**Figure 17: Positioning of RFID Transponders**

It may be necessary to apply more than one RFID transponder to the RTIs to provide for reliable RFID performance. Figure 18 shows appropriate RFID transponder positions:

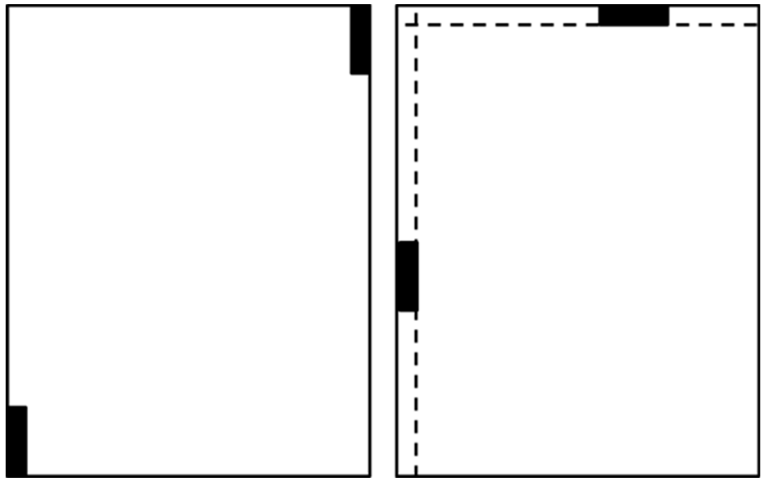


**Figure 18: Positioning of multiple RFID Transponders**

RFID transponders for RTI applications may be exposed to harsh industrial environments for a long period of time. This also applies to the mounting. Typically, the following mounting methods are used:

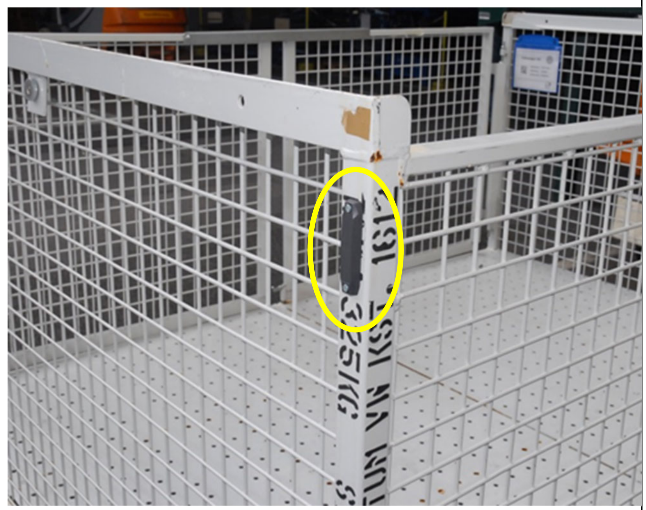
- Adhesive bonding
- Screws, rivets
- Embedded transponders

Note that there are different types of embedded transponders. The RFID transponders may be directly embedded into the RTI material (i.e., plastics). The RFID transponders may also be integrated into metal RTIs (slot antennas). This method implies that the material of the RTI itself acts as an antenna.

> NOTE: Ensure that the applied mounting method reduces the possibility of accumulating humidity (condensation, rain, snow etc.) between the RFID transponders and the actual RTI surface. Humidity may compromise RFID performance.

In summary, the mounting method shall comply with the specific RFID application environments. Figure 19, below, shows examples of appropriate mounting methods for different RTI applications.

**Metal RTI with Hard Tag**



**Metal RTI with Hard Tag**


**Plastic RTI with Smart Label**

**ESD RTI with Smart Label**

**Figure 19: RTIs equipped with RFID Transponders**

The choice of appropriate RFID transponders, the positioning and the mounting method also depends on the objects that are shipped or stored within the RTIs. Objects made out of metal may cause performance issues. This particularly applies for bulk materials (e. g., screws). The performance may also be affected by other RTIs. This particularly applies to RTI sets that contain multiple RTI units. Figure 20 shows an example of RFID transponders that point to the outside of the RTI set so they can be read successfully. The other transponders may possibly be “blocked” by surrounding RTIs and their contents. Such circumstances negatively influence RFID performance.

## 8.2 Combined RTI and transport unit data

When there are application requirements to encode both the identity of the asset as well as a unique pointer to a database, e.g., Shipment ID or license plate, it is possible to encode these unique identities in either one or two RF tags. If two tags are used in the ISO system, each tag shall have its own unique AFI, which is, “A2hex” or “A7hex” for license plate (shipment identification) and “A3hex” or “A8hex” for the RTI AFI. AFI “AChex”, denoting 8-bit encoding, may also be used. The respective ISO/IEC 15459-5 Data Identifier follows the AFI, as specified in ISO/IEC 15418.

Data Identifiers for an RTI can be one of the set of DIs “26B” through “29B”, or any other *applicable* MH10.8.2 DI. In the case of the transport unit, that Data Identifier is the appropriate “J” DI. For ISO/IEC 18000-63-based RFID tags, the Unique RTI Identifier shall be written to the UII portion of MB01, and locked. The transport unit’s identifier shall be preceded by the appropriate “J” series DI and written, along with any additional data (with the appropriate DI), and locked in User Memory.

An example of why combining information is the best practice: Assign individual RTIs (children) to the applicable master units (parents). Post these aggregations to supporting IT systems using appropriate data exchange formats. Whenever the master unit is captured, the RFID system draws from the aggregation data and resolves the child-parent relations to identify the individual RTI units that have been loaded to the carrier pallet.

One example of encoding multiple data, as described in the paragraph above, in RFID tags is shown in Figure 20. This graphic shows how bulk-reading RFID tags may not result in 100% read accuracy due to the “obstructions” provided by the other packages / packaging. But by using combined RTI and transport unit data, all the packages can be ultimately identified through the back-end look-up process.

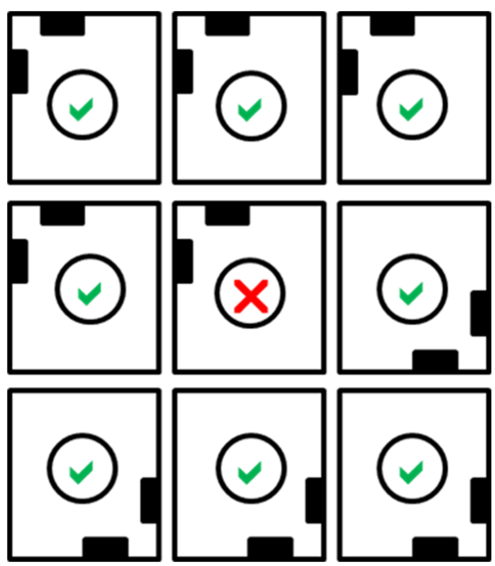


**Figure 20: Capturing RTI Sets**

## 8.3 Back-up – Human Readable Interpretation (HRI)

Human-readable interpretation (HRI) is the literal representation of all the data on the tag.

Use of HRI is strongly recommended for data that is critical to the use of the items, as HRI will serve as the main backup if an RF tag cannot be read, or incorrectly read, for any reason.

If optically readable media is used, the trading partners shall agree upon a linear symbol, either Code 39 or Code 128, or a two-dimensional symbol, either QR Code or Data Matrix.

Figure 21 shows an example of a 2D symbol with HRI.

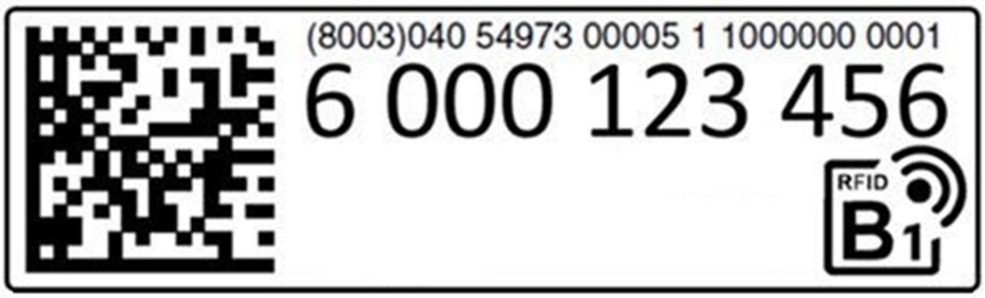



**Figure 21: 2D Symbol with human-readable interpretation**

## 8.4 Tag lifetime

Tags attached to the RTI are intended to be continuously used throughout the life of the RTI.

Tags attached to the RTI are indispensable for the promotion of recycling of not only RTIs but also tags.

The functional life of the tag is recommended to be no shorter than the life of the RTI to which it is attached.

## 8.5 Minimum reliability

A reading system in which tags are positioned, programmed, and read in accordance with the provisions of ISO/IEC 18046 and Section 6.1, should have a minimum read reliability of 99.99%. That is, no more than one no-read event in 10,000 readings, and a read accuracy of 99.998%, i.e., two incorrect readings in 100,000 readings.

## 8.6 Air interface

This document recommends the air interface specification ISO/IEC 18000-63.

## 8.7 Tag recyclability

Items using RF tags that require recycling shall conform to applicable regulatory requirements.

## 8.8 Tag identification mark

RTIs, RF tags, and RF label inlays compliant with this document should include one or more of the internationally accepted RFID emblems. For further information on the RFID emblems, refer to ISO/IEC 29160.

Figure 22 shows the RFID emblem B1 (License plate ID plus optional application data), which should be used when RTIs are tagged according to ISO 17364.


**Figure 22: RFID emblem for RTIs according to ISO/IEC 17364**

# 9 REWRITABLE HYBRID MEDIA REQUIREMENTS

An RF tag does not have the ability to visually display the data encoded within it. For this reason, the use of an additional media such as paper or a display monitor is necessary in applications where the information shall be visually checked. This requires the industry to migrate from optical media (linear symbols or two-dimensional symbols) to reusable RF tags.

As described in Annex J, rewritable hybrid media is ideal for a transport unit with RTI (RTI including parts). In the automotive industry much time is consumed in reading linear and two-dimensional symbols used in various applications. Replacing those symbols with RF tags is an efficient method for reducing operating time. In addition, some RF tags are operable in conveyor lines running as fast as 2 meters per second. However, the cost of the tag/use is likely to increase if high capacity memory is required, because the reading speed generally decreases as the size of memory capacity increases. Since the RF tag is supported by semiconductor technologies, the data stored in the tag may be lost or become unavailable if the tag is damaged. For this reason, a label combining the use of an RF tag with a linear or two-dimensional symbol is recommended. This means that a rewritable hybrid media that can reprogram the data in the RF tags as well as in the linear or two-dimensional symbols would be of benefit.

## 9.1 Linear symbol requirements

Refer to Section 10.

The print quality conforms to ISO/IEC 29133. The number of rewritable times shall be more than 500 times.

## 9.2 Two-dimensional symbol requirements

Refer to Section 10.

The print quality conforms to ISO/IEC 29133. The number of rewritable times shall be more than 500 times.

## 9.3 RFID requirements

Refer to Section 7.

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# 10 LAYOUT AND LOCATION OF LINEAR AND 2D LABELS

## 10.1 Layout

Layout refers to the positioning of the fields on the label and direct marking. The layout will depend on the available space on the RTI and other factors such as industry sector business rules, trading partner agreements and/or customer labeling and direct marking requirements. See Annex O.

## 10.2 Location

Location refers to the positioning of the label on the RTI. Each label should be in a position that facilitates scanning without degrading the safety or performance of the RTI. Consideration should be given to reading the symbol or RF tag in the installed-on-the-RTI position.

## 10.3 Titles of linear symbol and two-dimensional symbol

A title is recommended on the label for all symbol fields. The title shall include the appropriate Data Identifier enclosed in parentheses. Data Identifier titles shall be in accordance with ISO/IEC 15418. Titles may be positioned above or below the symbol.

If the real estate available for labeling or marking is not large enough to support the title and the user is employing symbols, the title may be abbreviated to include only the Data Identifier, enclosed in parentheses. In extreme cases of insufficient real estate for labeling or marking, the title may be eliminated. Elimination of the title should be mutually agreed upon between the trading partners.

## 10.4 Human readable interpretation (HRI)

Human Readable Interpretation is the literal representation of all the data on the tag.

For linear symbols, HRI should be printed above or below the symbol. The HRI of the encoded data shall be printed legibly. The recommended height of the upper-case alpha characters is 2.0 mm. The minimum height of the upper-case alpha characters shall be 1.25 mm.

For linear symbols, the HRI shall include all the data within the linear symbol with the DI being shown in parentheses. Figure 23 provides an example of HRI of a linear symbol.


**Figure 23: Example label with 1D barcode symbol and HRI.**

For two-dimensional symbols, portions of the data should be shown in the HRI when necessary or required by application. However, human-readable interpretation of two-dimensional symbols is recommended but not required. See Figure 21.

It is strongly recommended that HRI of the data be applied on a returnable transport items' RF tag. When HRI is used, it shall be placed on the exterior of the RTI as required elsewhere in this section. ISO-standard two-dimensional symbols, e.g., Data Matrix or QR Code, encoded in conformance with ISO/IEC 15434 or ISO/IEC 15418 should be considered as a primary back-up to RF tags on RTIs. An additional level of back-up of the HRI may also be a consideration.

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# 11 LINEAR AND 2D SYMBOLOGY REQUIREMENTS

## 11.1 Symbology recommendations

Recommended linear symbols: Code 128 or Code 39.

Recommended 2D symbols: Data Matrix or QR Code.

## 11.2 Linear symbology requirements

The linear symbologies referenced in this document shall use ISO/IEC 15417 (Code 128, see Section 3) or ISO/IEC 16388 (Code 39, see Section 3).

## 11.3 Two-dimensional symbology requirements

Label information can be encoded in two-dimensional symbols conforming to ISO/IEC 16022 (Data Matrix ECC200, see Section 3), or ISO/IEC 18004 (QR Code Model 2, see Section 3). The data stream shall be as specified in ISO/IEC 15459-5 (see Annex B and Annex E).

The encoding of data shall follow the ISO/IEC 15434 syntax rules using message Format 06 (see Annex C).

### 11.3.1 Data Matrix symbology requirements

The Data Matrix ECC200 symbol (see Figure 24) referenced in this document is defined in ISO/IEC 16022.

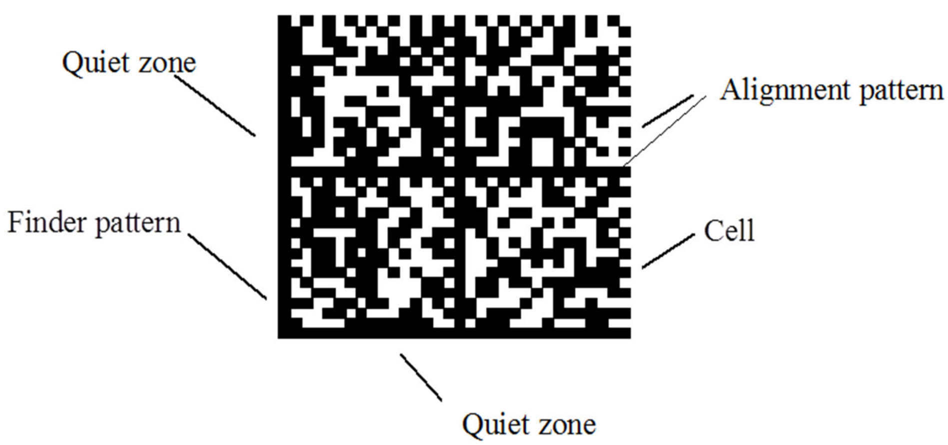


**Figure 24: Structure of Data Matrix ECC200 Symbol**

#### *11.3.1.1 "X" dimension*

The appropriate "X" dimension for a symbol is determined by many factors including available marking area, surface type, and environment and reading device(s) used. The "X" dimension of a Data Matrix ECC200 symbol is equivalent to the cell size. It is recommended that the user implement a system using the largest "X" dimension that will enable the symbol to fit in the available area.

The minimum open system "X" dimension shall be 0.25 mm. "X" dimensions of less than 0.25 mm or greater than 0.51 mm are not recommended because these symbols may be difficult to scan in an open system environment. Regardless of the element width, the symbol shall meet the symbol quality requirements in Section 11.3.2.6 (see Table 16).

#### 11.3.1.2 Element height

The height of any individual cell of the Data Matrix ECC200 symbol should be equal to the "X" dimension.

#### 11.3.1.3 Symbol size

To establish a known field of view for reading the label, the symbol size should not be smaller than 25 mm by 25 mm (see Table 16).

The user should implement a system using the largest "X" dimension that will enable the symbol to fit in the available area, up to the maximum dimensions shown in Table 16. This will allow for the best possible scanner performance. The printed symbol size will depend on the amount and type of data encoded. The character count in Table 16 includes data overhead characters (specifically, message header, Data Identifiers, data element separators, data, and message trailer characters).

**Table 16: Data Matrix ECC200 alphanumeric data capacity for label**

| "X" Dimension | | | | |
|---|---|---|---|---|
| **Symbol Size** (with Quiet Zone) | **0.25 mm** (0.010 inch) | **0.34 mm** (0.013 inch) | **0.42 mm** (0.016 inch) | **0.51 mm** (0.020 inch) |
| 25 mm x 25 mm | 1042 | 418 | 304 | 214 |
| 35 mm x 35 mm | 1954 | 1042 | 682 | 418 |
| 45 mm x 45 mm | 2335 | 1573 | 1222 | 682 |
| 55 mm x 55 mm | 2335 | 2335 | 1573 | 1222 |

#### 11.3.1.4 Quiet zone

The Data Matrix ECC200 symbol shall have minimum quiet zones of one (1) "X" dimension width on all four sides of the symbol. It is not the intent of this document to require an additional quiet zone beyond the minimum required by ISO/IEC 16022.

#### 11.3.1.5 Error correction level

The Data Matrix symbol shall have an error correction level of ECC200 as defined in ISO/IEC 16022.

#### 11.3.1.6 Symbol quality

Data Matrix symbol print quality shall be measured at the consignee's point of scan, in accordance with ISO/IEC 16022 and ISO/IEC 15415 in the light range (e.g., 660 nm).

The minimally acceptable overall symbol grade of 2.0/10/660 applies to the final symbol on the item at the point of receipt. It is recommended that the overall symbol grade, at the point of printing the symbol, be equal to or exceed 2.5/10/660 to allow for process variations and possible degradation from packaging, storage, shipping, handling and use.

When printing on label stock, the methodology for measuring symbol quality shall be as specified in ISO/IEC 15415.

#### *11.3.1.7 Encryption*

Encryption shall not be used for mandatory data fields.

#### *11.3.1.8 Character set*

The character set shall be upper case alphabetic characters and numeric digits, as well as the recommended field separators, record separators, segment terminators and compliance indicator. It is recommended that the resultant data stream from scanning a Data Matrix symbol follow the syntax described in ISO/IEC 15434, using Data Matrix Macro character 237.

Macro Code 237 consists of; [ ) > $^{R}{}_{S}$ 06 $^{G}{}_{S}$ and $^{R}{}_{S}$ $^{E}{}_{OT}$. (Spaces have been added between the characters for visual clarity only and are not part of the macro).

Many encoders will automatically invoke Macro 237 when they see the characters “[ ) >” (Spaces have been added between the characters for visual clarity only and are not part of the macro). So, it may not be necessary to attempt to force Macro 237 into the encoding scheme.

### 11.3.2 QR Code symbology requirements

The QR Code Model 2 symbol (see Figure 25) referenced in this document is defined in ISO/IEC 18004.

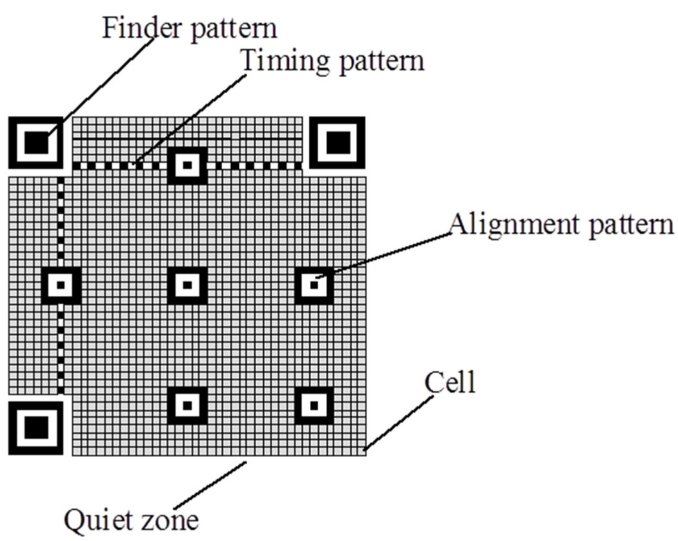


**Figure 25: Structure of QR Code Model 2 Symbol**

#### *11.3.2.1 "X" dimension*

The appropriate "X" dimension for a symbol is determined by various factors including an available marking area, surface type, environments and reading device(s) used. The "X" dimension of a QR Code Model 2 symbol shall be equivalent to the cell size. It is recommended that the user implement a system using the largest "X" dimension that still enables the symbol to fit in the available area.

The minimum open system "X" dimension shall be 0.25 mm. "X" dimensions of less than 0.25 mm or greater than 0.51 mm are not recommended because such symbols may be difficult to scan in an open system environment (see Table 17). Regardless of the element width, the symbol shall meet the symbol quality requirements in Section 11.3.2.6.

#### *11.3.2.2 Element height*

The height of any individual cell of the QR Code Model 2 symbol should be equal to the "X" dimension.

#### *11.3.2.3 Symbol size*

To establish a known field of view for reading the label, the symbol size should not be smaller than 25 mm by 25 mm (see Table 17).

The user should implement a system using the largest "X" dimension that will enable the symbol to fit in the available area, up to the maximum dimensions in Table 17. This will allow for the best possible scanner performance. The printed symbol size will depend on the amount and type of data encoded. The character count in Table 17 below includes data overhead characters (specifically, message header, Data Identifiers, data element separators, data, and message trailer characters).

**Table 17: QR Code Model 2 alphanumeric data capacity for labels**

| | | "X" Dimension | | | |
|---|---|---|---|---|---|
| **Symbol Size** (with Quiet Zone) | **Error Correction Level** | **0.25 mm** (0.010 inch) | **0.34 mm** (0.013 inch) | **0.42 mm** (0.016 inch) | **0.51 mm** (0.020 inch) |
| 25 mm × 25 mm | M | 734 | 366 | 178 | 122 |
| | Q | 531 | 259 | 125 | 87 |
| | H | 408 | 200 | 93 | 64 |
| 35 mm × 35 mm | M | 1732 | 909 | 528 | 311 |
| | Q | 1268 | 644 | 376 | 221 |
| | H | 958 | 493 | 283 | 174 |
| 45 mm × 45 mm | M | 3054 | 1542 | 970 | 600 |
| | Q | 2181 | 1094 | 702 | 426 |
| | H | 1658 | 864 | 557 | 321 |
| 55 mm × 55 mm | M | 3391 | 2506 | 1452 | 970 |
| | Q | 2420 | 1787 | 1094 | 702 |
| | H | 1852 | 1394 | 864 | 557 |

#### 11.3.2.4 Quiet zone

The QR Code Model 2 symbol shall have a minimum quiet zone of four (4) times the “X” dimension width on all four sides of the symbol. It is not the intent of this document to require additional quiet zone beyond the minimum required by ISO/IEC 18004.

#### 11.3.2.5 Error correction level

The error correction level shall be either M (approximately 15%), Q (approximately 25%), or H (approximately 30%) as identified in ISO/IEC 18004. The error correction level is determined by many factors, including surface type, the environment, symbol quality, and reading device(s) used.

The error correction level L (approximately 7%) is not recommended for QR Code Model 2.

#### 11.3.2.6 Symbol quality

QR Code symbol print quality shall be measured at the consignee’s point of scan, in accordance with ISO/IEC 18004 and ISO/IEC 15415 in the light range (e.g., 660 nm).

The minimally acceptable overall symbol grade of 2.0/10/660 applies to the final symbol on the item at the point of receipt. It is recommended that the overall symbol grade, at the point of printing the symbol, be equal to or exceed 2.5/10/660 to allow for process variations and possible degradation from storage, shipping, handling and use.

When printing on label stock, the methodology for measuring symbol quality shall be as specified in ISO/IEC 15415.

#### 11.3.2.7 Encryption

Encryption shall not be used for mandatory data fields.

#### 11.3.2.8 Character set

The character set shall be upper case alphabetic characters and numeric digits, as well as the recommended field separators, record separators, segment terminators and compliance indicator. It is recommended that the resultant data stream from scanning a QR Code Model 2 symbol follow the syntax described in ISO/IEC 18004.

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# *ANNEX A: EXAMPLES OF RETURNABLE TRANSPORT ITEMS (RTI) AND CONTAINERS*

**(Informative)**

A reusable RTI is used in each of the layers in the supply chain layers shown in Figure 1 in Section 4. This includes air cargo and railway containers whose main purpose is to carry product associated with vehicle production. Layers 4, 1 and 0 described in this Annex are not a part of this document and are provided for reference purposes only.

## A.1 Freight Containers of Layer 4

Freight containers, indicated by Layer 4 in Figure 1, include air cargo and railway containers. Their main purpose is to carry substances associated with vehicle production such as liquids, oil and powders as shown in Figure A.1, below. However, the containers in Layer 4 shall be excluded from the scope of this document.

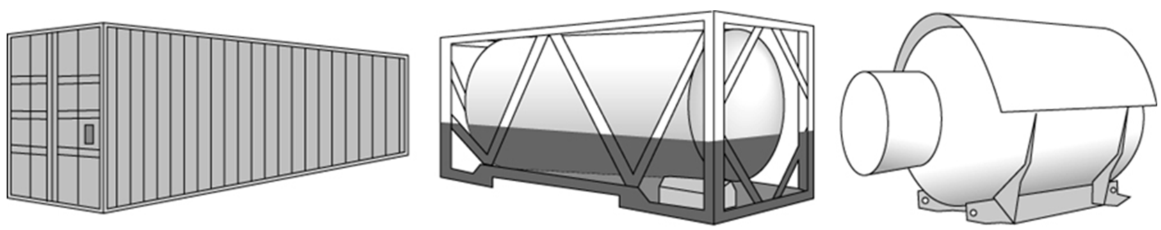


**Figure A.1: Example of freight containers**

## A.2 Returnable Transport Items of Layer 3

Refer to Section 5.1.

## A.3 Returnable Transport Items of Layer 2

Refer to Section 5.2.

## A.4 Returnable Transport Items of Layer 1 and Layer 0

Most containers in Layer 1 are designed to carry liquid or powder substances and are normally made of paper, plastic, glass, or metal. Particularly, metallic cases, e.g., for transporting milk or soft drinks (see Figure A.2), glass bottles, e.g., for wine or beer (see Figure A.3) and plastic cases (see Figure A.4) are classified in this category. Some of these cases or bottles are reused and recycled, mainly in the consumer market.

However, the containers in Layer 1 and Layer 0 are excluded from this document, because their use is not common in the automotive sector. This document may be used for the container that is repeatedly used for carrying substances associated with vehicle production such as electrical parts/assemblies, lubricants, coolant, or washer liquid.

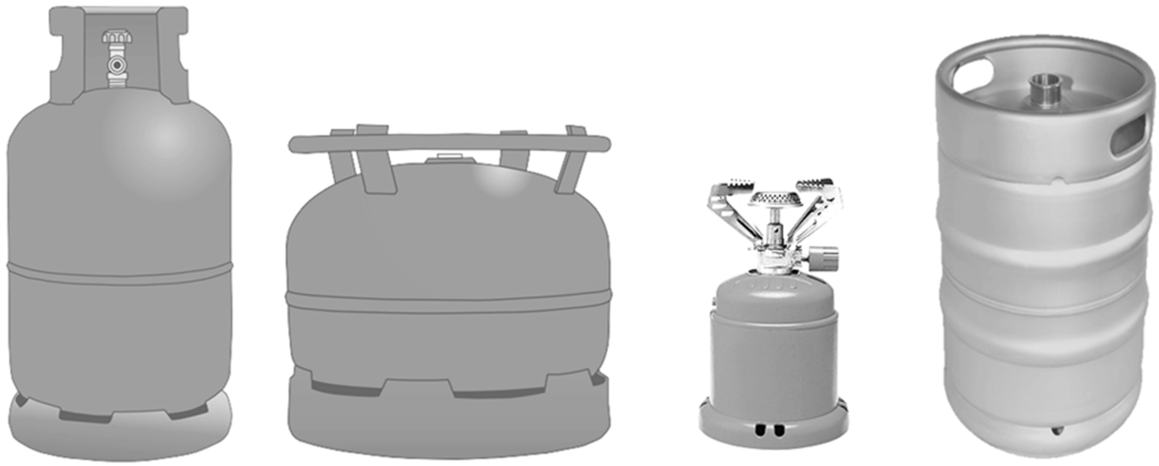


**Figure A.2: Examples of metallic cases**

**Figure A.3: Examples of glass bottles**

**Figure A.4: Examples of plastic bottles**

# ANNEX B: UNIQUE IDENTIFIERS OF RETURNABLE TRANSPORT ITEMS AND TRANSPORT UNITS

**(Normative)**

Refer to ISO/IEC 15459-1, *Information technology — Unique identifiers — Part 1: Unique identifiers for transport units* and ISO/IEC 15459-5, *Information technology — Unique identifiers — Part 5: Unique identifiers for returnable transport items (RTIs).*

## B.1 Roles of the Issuing Agency in Providing Application Guidance for Returnable Transport Items and Transport Units

In addition to the requirements of an issuing agency outlined in ISO/IEC 15459-2 and ISO/IEC 15459-3, each issuing agency is expected to provide documents if returnable transport item identification is relevant to its IAC domain.

## B.2 Considerations with Unique Returnable Transport Item Identification

The construction of the Unique RTI Identifier includes (as one of the relevant DIs) the DI "25B", the Issuing Agency Code (IAC), Company Identification Number (CIN), and Serial Number (SN), in the form "25B" IAC CIN SN, assuming that the Serial Number is unambiguous within the CIN. Additionally, DIs "26B" (Unique Returnable Transport Item identifier), "27B" (Globally unique asset identifier of a Large Load Carrier RTI), "28B" (Globally unique asset identifier of a Small Load Carrier RTI), and "29B" (Globally Unique Returnable Packaging Item (RPI) identifier) may also be used to identify RTIs and RPIs. The data in DI "26B" is simpler to parse due to the "+" character used to separate the data elements. However, use the Unique Returnable Transport Item Identifier (DIs "25B" through "29B") that is most appropriate to your application. See Table B.1 for examples of different RTI types and the DIs that are used with them. Any *applicable* DI from ANS MH10.8.2 is allowed.

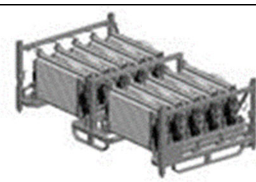
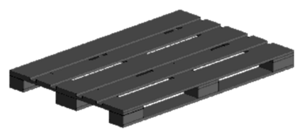
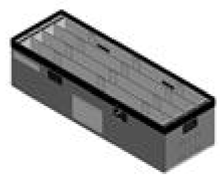
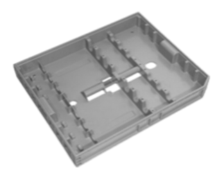
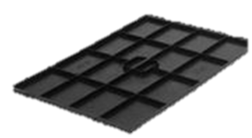
In some cases, Serial Numbers are not unambiguous within the CIN but are unambiguous within the specific asset type under the control of a company. If the Serial Number is not unambiguous within the enterprises, the Unique RTI Identifier must include the manufacturer's asset type code. The Unique RTI Identifier established by the Unique RTI Identifier issuer cannot be the same as that established by another. Following ISO/IEC 15459-2 ensures that the Unique RTI Identifiers are unambiguous.

## B.3 ISO/IEC15459-5 and MH10.8.2

Under the rules of Odette, to whom the Issuing Agency Code "OD" has been allocated by the registration authority, the Unique RTI Identifier consists of no more than 50 alphanumeric characters. The characters following the Issuing Agency Code "OD" are allocated by Odette to automotive entities. The unique identifier issuer then assigns the remaining characters. See Figure B.1.

Table B.1 provides information on various applicable DIs and the items to which they are applied.

**Table B.1: Examples of DIs used with automotive RTIs and RPIs**

| DI | DESCRIPTION | EXAMPLES | |
|---|---|---|---|
| 25B<br>or<br>26B | Identifier for RTIs |  | |
| 27B | Large RTIs (Large Load Carriers (LLC), Racks, Pallets) | <br> | <br> |
| 28B | Small RTIs (Small Load Carrier (SLC), self-supporting packaging) | <br> | <br> |
| 29B | Returnable Packaging Item (RPI) (Lid, Blister Intermediate Layers Inlays) |  |  |

An example of a typical Unique RTI Identifier issued under the rules of "Odette" follows.

In this example, the IAC is "OD", the CIN is "CIN001", the Serial Number is "OSN12345", and the RTI type code is "0000000RTIA1B2C3D". See Figure B.1.

Figure B.1, below, shows an Odette-based unique identifier (Data Identifier “25B”; DI not shown in this example) for a returnable transport unit.

OD CIN001 0000000RTIA1B2C3D OSN12345

- OSN12345: Serial Number (could be sequential, but does not have to be)
- 0000000RTIA1B2C3D: Unique Code allocated to the RTI Type by the company
- CIN001: Unique code allocated by Odette to a company as the company identification number (CIN)
- OD: Unique Issuing Agency Code (IAC) allocated to Odette by the RA (Registering Authority)

**Figure B.1: Unique identifier for Odette RTI identification**

This unique identifier can be contained in a linear symbol or other AIDC (Automatic Identification and Data Capture) media with the RTI Data Identifier “25B”. When scanned, the linear symbol would be expected to pass the following data string to the computer system:

**Table B.2: Data stream - Code 128**

| DATA CARRIER IDENTIFIER | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER |
|---|---|---|
| ]C0 | 25B | ODCIN0010000000RTIA1B2C3DOSN12345 |

> NOTE: The Data Carrier Identifier “]” should be 0x5D defined in ISO/IEC 646.

## B.4 ISO/IEC 15459-1

Figure B.2 shows an ISO/IEC 15459-1 unique identifier (Data Identifier “J”) for transport units.

J NL Y 1234567890

- 1234567890: Unique code allocated to the transport unit by the company
- Y: Unique code allocated by sub-domain to the company
- NL: Unique sub-domain code allocated to a sub-domain by the UPU
- J: Unique Issuing Agency Code (IAC) allocated to "UPU" by the RA

**Figure B.2: Unique identifier for ISO/IEC 15459-1 transport units**

This unique identifier can be contained in a Code 128 linear symbol with the ISO/IEC 15459-1 Data Identifier “J”. When scanned, the linear symbol would be expected to pass the following data string to the computer system (Table B.3):

NOTE: UPU - Universal Postal Union (UPU) is an international organization that coordinates postal policies among member nations, and hence the world-wide postal system. Each member country agrees to the same set of terms for conducting international postal duties. Universal Postal Union's headquarters are in Berne, Switzerland.

**Table B.3: Data stream – ISO/IEC 15459-1**

| DATA CARRIER IDENTIFIER | ISO/IEC 15459-1 DATA IDENTIFIER | UNIQUE IDENTIFIER |
|---|---|---|
| ]C0 | J | JNLY1234567890 |

NOTE: The Data Carrier Identifier "]" should be 0x5D, as defined in ISO/IEC 646.

## B.5 Class Identification

- 1 0 15459 5 3: for an RTI Identifier for supply chain management equivalent to ISO/IEC 15459-5 Data Identifier 25B;
- 1 0 15459 1 2: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier J;
- 1 0 15459 1 3: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 1J;
- 1 0 15459 1 4: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 2J;
- 1 0 15459 1 5: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 3J;
- 1 0 15459 1 6: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 4J;
- 1 0 15459 1 7: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 5J;
- 1 0 15459 1 8: for a Transport Unit Identifier equivalent to ISO/IEC 15459-1 Data Identifier 6J.

NOTE: J - Unique license plate number

1J - Unique license plate number assigned to a transport unit which is the lowest level of packaging, the unbreakable unit.

2J - Unique license plate number assigned to a transport unit which contains multiple packages.

3J - Unique license plate number assigned to a transport unit which is the lowest level of packaging, the unbreakable unit and which has EDI data associated with the unit.

4J - Unique license plate number assigned to a transport unit which contains multiple packages, and which is associated with EDI data.

5J - Unique license plate number assigned to a mixed transport unit containing unlike items on a single customer transaction and may or may not have associated EDI data.

6J - Unique license plate number assigned to a master transport unit containing like items on a single customer transaction and may or may not have associated EDI data.

# ANNEX C: SYNTAX FOR HIGH-CAPACITY AUTOMATIC DATA CAPTURE MEDIA

**(Normative)**

Refer to ISO/IEC 15434, Information technology — Syntax for high-capacity automatic data capture (ADC) media.

This Annex provides guidance on how to store data in the RFID tags User Memory Bank or in two-dimensional symbols Data Matrix or QR Code.

**Table C.1: Format header table showing associated separators**

| FORMAT INDICATOR | VARIABLE HEADER DATA | FORMAT TRAILER | FORMAT DESCRIPTION |
|---|---|---|---|
| 00 | | | Reserved for future use |
| 01 | ${}^{G}{}_{S}$vv | ${}^{R}{}_{S}$ | Transportation |
| 02 | | | Complete EDI message / transaction |
| 03 | vvvrrr${}^{F}{}_{S}{}^{G}{}_{S}{}^{U}{}_{S}$ | ${}^{R}{}_{S}$ | Structured data using ANSI ASC X12 Segments |
| 04 | vvvrrr${}^{F}{}_{S}{}^{G}{}_{S}{}^{U}{}_{S}$ | ${}^{R}{}_{S}$ | Structured data using UN/EDIFACT Segments |
| 05 | ${}^{G}{}_{S}$ | ${}^{R}{}_{S}$ | Data using GS1 Application Identifiers |
| 06 | ${}^{G}{}_{S}$ | ${}^{R}{}_{S}$ | Data using ISO/IEC 15459-5 Data Identifiers |
| 07 | | ${}^{R}{}_{S}$ | Free form text |
| 08 | vvvvrrnn | | Structured data using CII Syntax Rules |
| 09 | ${}^{G}{}_{S}$ ttt...t ${}^{G}{}_{S}$ ccc...c ${}^{G}{}_{S}$ nnn...n ${}^{G}{}_{S}$ | ${}^{R}{}_{S}$ | Binary data (file type) (compression technique) (number of bytes) |
| 10-11 | | | Reserved for future use |
| 12 | ${}^{G}{}_{S}$ | ${}^{R}{}_{S}$ | Structured data following Text Element Identifier rules |
| 12-99 | | | Reserved for future use |

NOTE 1: vv represents the two-digit version of Format '01' being used

NOTE 2: ${}^{R}{}_{S}$ represents the Format Trailer character.

NOTE 3: ${}^{F}{}_{S}$ represents the Segment Terminator.

NOTE 4: ${}^{G}{}_{S}$ represents the Data Element Separator.

NOTE 5: ${}^{U}{}_{S}$ represents the Sub-Element Separator.

| | |
|---|---|
| NOTE 6: vvvrrr | represents the three digit Version (vvv) followed by the three digit Release (rrr). |
| NOTE 7: vvvvrrnn | represents the four digit Version (vvvv) followed by the two digit Release (rr) followed by the two digit Edition indicator (nn). |
| NOTE 8: ttt...t | represents the file type name. |
| NOTE 9: ccc...c | represents the compression technique name. |
| NOTE 10: nnn...n | represents the number of bytes. |

# *ANNEX D: ASSIGNMENT OF APPLICATION FAMILY IDENTIFIERS (AFI)*

**(Normative)**

Refer to ISO/IEC 17364, Supply chain application of RFID — Returnable transport items (RTIs).

Following an AFI and Data Identifier, unique identification is provided by three components; Issuing Agency Code (IAC), Company Identification Number (CIN), and Serial Number (SN). Only AFI's "0xA3", "0xA8" or "0xAC" in Table D.1 are supported by this document.

**Table D.1: AFI assignments**

| AFI (HEX) | ASSIGNMENT | ISO 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 unit |
| A3 | 17364_Non-EPC | ISO 17364 – Supply chain applications of RFID – Returnable transport item |
| 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 unit (HazMat) |
| A8 | 17364_HazMat | ISO 17364 – Supply chain applications of RFID – Returnable transport item (HazMat) |
| A9 | 17363_Non-EPC | ISO 17363 – Supply chain applications of RFID – Freight container |
| AA | 17363_HazMat | ISO 17363 – Supply chain applications of RFID – Freight container (HazMat) |
| 90 | 15961-2 | ISO/IEC 15961-2 – Data Constructs Register |
| AC | 15961-2 | ISO/IEC 15961-2 – Data Constructs Register – 8-bit encoding for ISO/IEC 1736x series of standards |

# *ANNEX E: DATA CARRIER IDENTIFIERS*

**(Normative)**

Refer to ISO/IEC 15424, Information technology — Automatic identification and data capture techniques — Data Carrier Identifiers (including Symbology Identifiers).

This Annex provides guidance on how to distinguish between different data carriers used in the same application. The use of a Data Carrier Identifier is recommended for easy recognition of the target application even if more than one data carrier exists in the application.

## E.1 Code 39

Code character: A

**Table E.1: Code 39 assignments**

| MODIFIER CHARACTER VALUE | OPTION |
|---|---|
| 0 | No check character validation nor full ASCII processing; all data transmitted as decoded |
| 1 | Modulo 43 check character validated and transmitted |
| 3 | Modulo 43 check character validated but not transmitted |
| 4 | Full ASCII character conversion performed; no check character validation |
| 5 | Full ASCII character conversion performed; modulo 43 check character validated and transmitted |
| 7 | Full ASCII character conversion performed; modulo 43 check character validated but not transmitted |

## E.2 Code 128

Code character: C

**Table E.2: Code 128 assignments**

| MODIFIER CHARACTER VALUE | OPTION |
|---|---|
| 0 | Standard data packet. No FNC1 in first or second symbol character position after start character. |
| 1 | GS1-128 data packet – FNC1 in first symbol character position after start character |
| 2 | FNC1 in second symbol character position after start character |
| 4 | Concatenation according to International Society for Blood Transfusion specifications has been performed; concatenated data follows. |

## E.3 QR Code

Code character: Q

**Table E.3: QR Code assignments**

| MODIFIER CHARACTER VALUE | OPTION |
|---|---|
| 0 | Model 1 symbol |
| 1 | Model 2 symbol, ECI protocol not implemented |
| 2 | Model 2 symbol, ECI protocol implemented |
| 3 | Model 2 symbol, ECI protocol not implemented, FNC1 implied in first position |
| 4 | Model 2 symbol, ECI protocol implemented, FNC1 implied in first position |
| 5 | Model 2 symbol, ECI protocol not implemented, FNC1 implied in second position |
| 6 | Model 2 symbol, ECI protocol implemented, FNC1 implied in second position |

## E.4 Data Matrix

Code character: d

**Table E.4: Data Matrix assignments**

| MODIFIER CHARACTER VALUE | OPTION |
|---|---|
| 0 | ECC 000 to ECC 140 |
| 1 | ECC 200 |
| 2 | ECC 200, FNC1 in first or fifth position |
| 3 | ECC 200, FNC1 in second or sixth position |
| 4 | ECC 200, ECI protocol implemented |
| 5 | ECC 200, FNC1 in first or fifth position, ECI protocol implemented |
| 6 | ECC 200, FNC1 in second or sixth position, ECI protocol implemented |

## E.5 Other than Linear and 2D Symbols

Code character: z

**Table E.5: Assignments of other than linear and 2D symbols**

| MODIFIER CHARACTER VALUE | OPTION |
|---|---|
| 0 | Keyboard |
| 1 | Magnetic stripe |
| 2 | Radio frequency (RF) tag |
| 3 to F | May be assigned by device manufacturer |

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# *ANNEX F: TAG MEMORY AND APPLICATION FAMILY IDENTIFIER (AFI)*

**(Normative)**

Refer to ISO/IEC 17364, Supply chain application of RFID — Returnable transport items (RTIs).

## F.1 UII Memory Bank (MB01)

When PC bit 17hex of MB01 is set to "1binary" indicating that AFI's are used in MB01, the ISO/IEC 15961 AFI for returnable transport items, A3hex or A8hex, shall be placed in bits 18hex through 1Fhex, as described below in Figure F.1. (Reference the UII memory bank) and Table F.1.

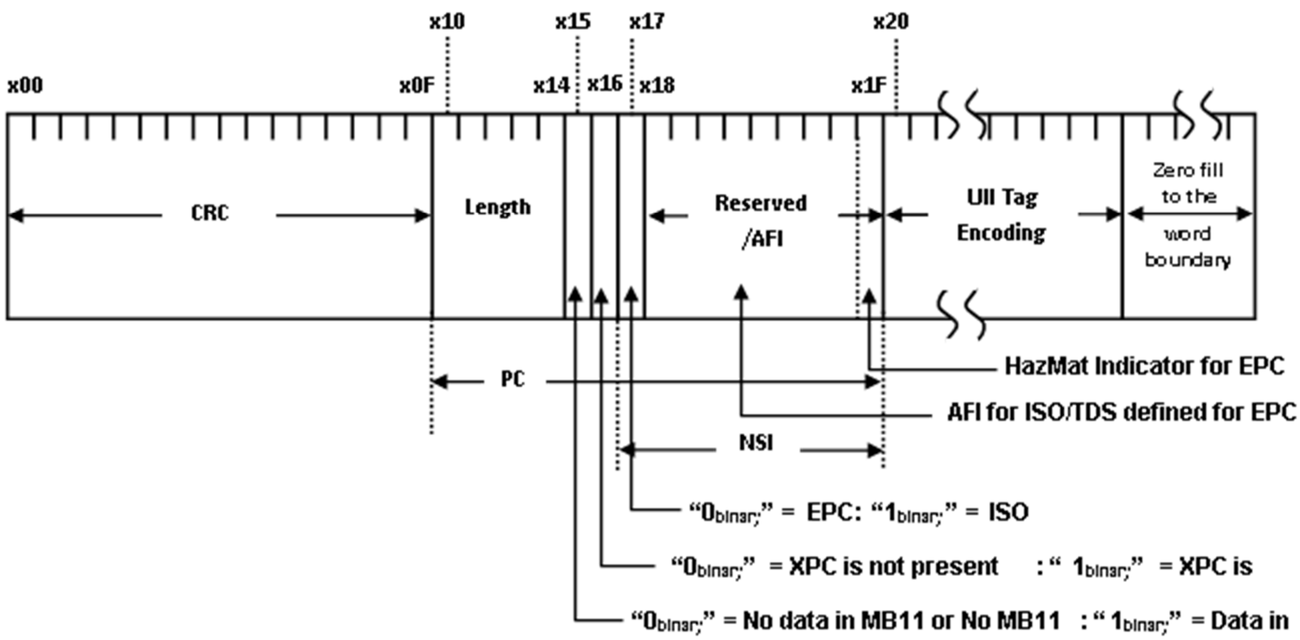


**Figure F.1: MB01 data structure**

## F.2 Tag Memory

Figure F.2 provides a graphical representation of an ISO/IEC 18000-63 RFID tags' memory.

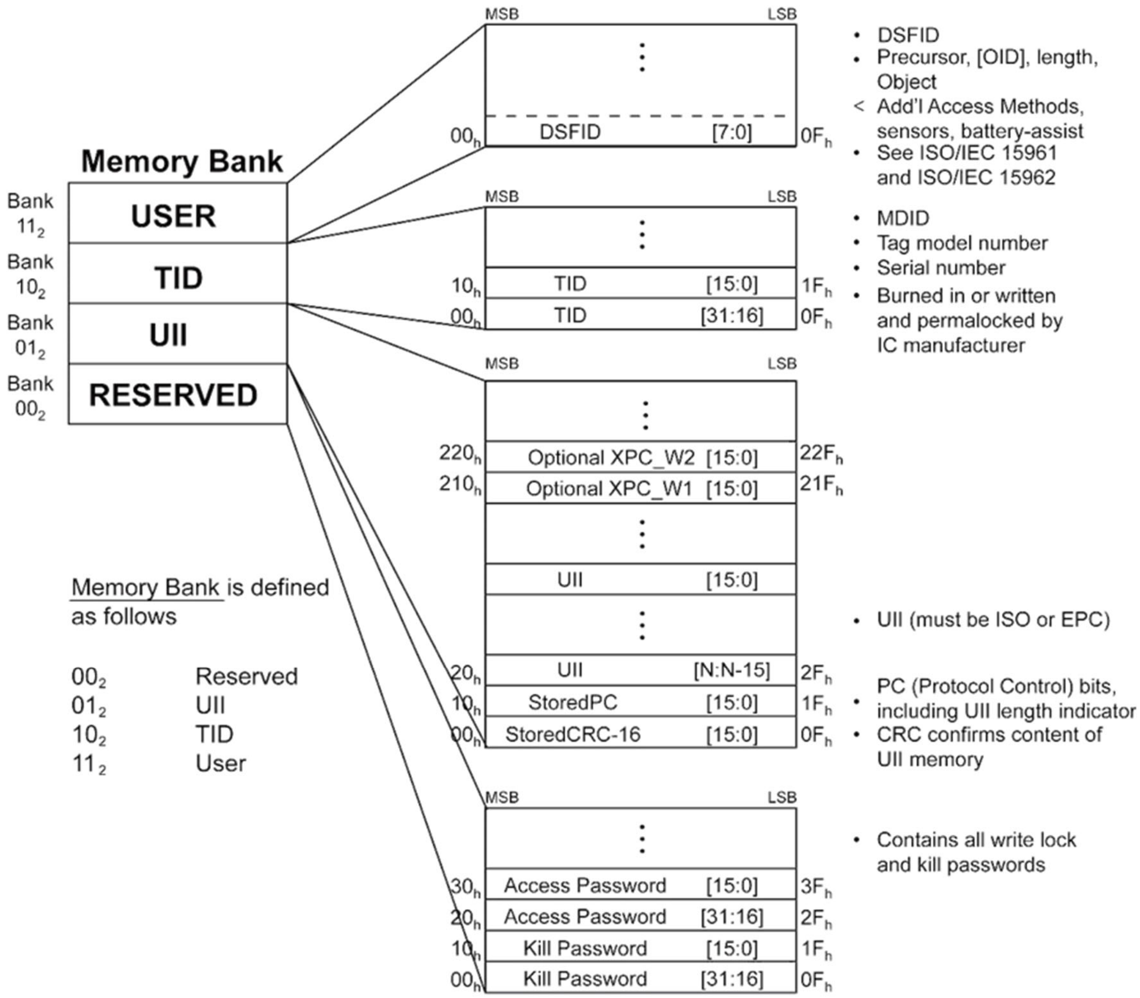


**Figure F.2: Memory map for segmented memory tags**

## F.3 Tag Memory Banks

An ISO/IEC 18000-63 RF tags memory shall be logically separated into four distinct banks, each of which may comprise one or more memory words. The memory banks are:

a. MB00: Reserved memory shall contain the kill and access passwords. The kill password shall be stored at memory addresses 00hex to 1Fhex; the access password shall be stored at memory addresses 20hex to 3Fhex. 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. MB01: UII memory shall contain a CRC-16 at memory addresses 00hex to 0Fhex, Protocol-Control (PC) bits at memory addresses 10hex to 1Fhex, and a code, i.e., a monomorphic UII, that identifies the object to which the tag is or will be attached beginning at address 20hex. The PC is subdivided into a UII length field in memory locations 10hex to 14hex, an indication of structured data in user memory (MB11) is stored in the User Memory bit 15hex, a PC extension indicator bit in memory location 16hex, an ISO/EPC bit in memory location 17hex, and either an Application Family Identifier (AFI) or a Numbering System Identifier (NSI) in memory locations 18hex to 1Fhex: PC Bit 17hex = "0binary" denotes an NSI, and PC Bit 17hex = "1binary" denotes an AFI.

NOTE: CRC (Cyclic Redundancy Check) is the method of error checking which occurs during a serial transportation of digital data.

c. MB10: TID memory shall contain an 8-bit ISO/IEC 15963 allocation class identifier at memory locations 00hex to 07hex. TID memory shall contain sufficient identifying information above 07hex 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 11100010binary (E2hex); TID memory locations 08hex to 13hex contain a 12-bit tag mask-designer identifier (obtainable from the registration authority), TID memory locations 14hex to 1Fhex contain a vendor-defined 12-bit tag model number, and the usage of tag memory locations above 1Fhex is defined in version 1.5 and above of the EPCglobal™ Tag Data Standards.

   For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000-63 and whose ISO/IEC 15963 allocation class identifier is 11100000binary (E0hex); TID memory locations 08hex to 0Fhex contain an 8-bit manufacturer identifier, TID memory locations 10hex to 3Fhex contain a 48-bit tag serial number (assigned by the tag manufacturer), the composite 64-bit tag ID (i.e. TID memory 00hex to 3Fhex) is unique among all classes of tags defined in ISO/IEC 15963, and TID memory is PermaLocked at the time of manufacture.

   For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000, Part 2, Type A and whose ISO/IEC 15963 allocation class identifier is 11100000binary, this identifying information shall comprise an 8-bit Tag manufacturer identification at memory locations 08hex to 15hex and a 48-bit tag serial number at memory locations 16hex to 3Fhex.

d. MB11: User Memory allows user-specific data storage. The Data Storage Format ID (DSFID) 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 PC bit 15hex of MB01 being set to a "1binary". When PC bit 15hex of MB01 is set to a "0binary" it indicates that there is no data within User Memory.

## F.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 10hex to 1Fhex, with bit values defined as follows:

- Bits 0x10 – 0x14: The length of the UII that a Tag backscatters, in words:
  00000binary: One word (addresses 10hex to 1Fhex in UII memory).
  00001binary: Two words (addresses 10hex to 2Fhex in UII memory).

00010binary: Three words (addresses 10hex to 3Fhex in UII memory).

…

…Continue this process from three words to 31 words…

…

11111binary: 32 words (addresses 10hex to 20Fhex in UII memory).

- Bit 15hex: User Memory; shall be set to "0binary" for tags without data in User Memory (MB11) and shall be set to "1binary" for tags with data in User Memory.
- Bit 16hex: Shall be set to "0binary" if there is no extension of the PC bits and shall be set to "1binary" if the PC bits are extended by an additional 16 bits.

NOTE 1: If a Tag implements XPC bits then PC bit 16hex shall be the logical OR of the XPC bits contents. The Tag computes this logical OR, and maps the result into PC bit 16hex, 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 17hex: Shall be set to "0binary" if encoding an EPC and shall be set to "1binary" if encoding an ISO/IEC 15961 AFI in Bits 18hex – 1Fhex
- Bits 18hex – 1Fhex: A numbering system identifier (NSI) whose default value is 00000000binary and which may include an AFI as defined in ISO/IEC 15961 (when encoding the tag pursuant to ISO standards). The MSB (Most Significant Bit) of the NSI is stored in memory location 18hex.

The default (unprogrammed) PC value shall be 0000hex.

Table F.1 summarizes the content of an EPC RTI tag when identifying hazardous material contents.

**Table F.1: Segmented memory of Memory Bank "01"; EPC HazMat RTI**

| PROTOCOL CONTROL BITS RUN FROM 0x10 – 0x1F | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 0/1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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 | Numbering System Identifier (NSI) | | | | | | | Haz Mat |

Table F.2 summarizes the content of an ISO RTI tag when identifying hazardous material contents.

**Table F.2: Segmented memory of Memory Bank "01"; ISO HazMat RTI**

| PROTOCOL CONTROL BITS RUN FROM 0x10 – 0x1F | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 0/1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 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) | | | | | | | |

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# *ANNEX G: TRANSMITTING DATA WITH MULTI-MEDIA READER*

**(Informative)**

A multi-media reader is a device capable of reading and then transmitting the data stored in linear symbols, two-dimensional symbols and RF tags conforming to the technological concepts defined in ISO/IEC 15459-1, ISO/IEC 15459-5, ISO/IEC 15459-4, or ISO/IEC 15459-6.

In some applications, a multi-media reader designed to read a linear symbol, two-dimensional symbol and RFID tag may also be used for a rewritable hybrid media. Considering that there may only be one communication line available for data transmission between a multi-media reader and a host computer, the host computer shall be able to identify from which data carrier the data has been transmitted. Tables G.1 through G.5 describes examples of the data to be transmitted.

## G.1 Linear Symbology

**Table G.1: Linear symbology transmitted data (Code 128)**

| DATA CARRIER IDENTIFIER | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) |
|---|---|---|
| ]C0 | 25B | IAC CIN SN |

NOTE: The Data Carrier Identifier "]" should be 5Dhex, as defined in ISO/IEC 646.

**Table G.2: Linear symbology encoded data**

| ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) |
|---|---|
| 25B | IAC CIN SN |

## G.2 Two-Dimensional Symbology

**Table G.3: Two-dimensional symbology transmitted data (QR Code)**

| DATA CARRIER IDENTIFIER | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) |
|---|---|---|
| ]Q1 | 25B | IAC CIN SN |

NOTE: The Data Carrier Identifier "]" should be 5Dhex, as defined in ISO/IEC 646.

**Table G.4: Two-dimensional symbology encoded data**

| MESSAGE HEADER | FORMAT INDICATOR | DATA ELEMENT SEPARATOR | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) | FORMAT TRAILER | MESSAGE TRAILER |
|---|---|---|---|---|---|---|
| [)>$^{R}{}_{S}$ | 06 | $^{G}{}_{S}$ | 25B | IAC CIN SN | $^{R}{}_{S}$ | $^{E}{}_{OT}$ |

## G.3 RFID

The use of Data Carrier Identifier Z2 conforming to ISO/IEC 15424 is recommended for RF tags (see Annex E). In this case, the Application Family Identifier (AFI) in Annex D of this document is transmitted directly after the Data Carrier Identifier Z2 (see Table G.5).

**Table G.5: Structure of data transmitted by multi-media reader**

| DATA CARRIER IDENTIFIER | AFI | ISO/IEC 15459-5 DATA IDENTIFIER | UNIQUE IDENTIFIER (CONSISTING OF) |
|---|---|---|---|
| ]Z2 | A3 | 25B | IAC CIN SN |

NOTE: The Data Carrier Identifier "]" should be 5Dhex, as defined in ISO/IEC 646.

# *ANNEX H: ENCRYPTION OF DATA*

**(Normative)**

## H.1 General

The unique identifier of a returnable transport item or a transport unit shall not be protected by encryption. Other data may be encrypted upon agreement between the trading partners.

## H.2 RFID

The data stored in the ISO/IEC 18000-63 UII memory bank (MB01) shall not be encrypted.

In contrast, data in the ISO/IEC18000-63 User Memory bank (MB11) may be encrypted, if agreed upon between the trading partners, according to the ISO/IEC 18000-63 standard. Data is encrypted and decrypted on the application side.

## H.3 Two-Dimensional Symbology

Data not disclosed to the user should be stored via encryption either in QR Code or Data Matrix. Data encryption and decryption is performed on the application side.

## H.4 Rewritable Hybrid Media

Refer to Annex H.2 for RFID and Annex H.3 for two-dimensional symbols.

# ANNEX I: RECOMMENDED RFID SPECIFICATIONS

**(Informative)**

This document recommends the ISO/IEC 18000-63, GS1 Gen2 v2 air interface standard.

This Annex is provided as a summary of ISO/IEC 18000-63; see the standard for details.

## I.1 Read / Write Function

### I.1.1 Reading range

The reading range should be at a minimum of 2 meters. Reading range depends on many factors.

### I.1.2 Writing range

The writing range should be at a minimum of 1 meter. Writing range depends on many factors.

### I.1.3 Anti-collision

The anti-collision protocol should be as defined in ISO/IEC 18000-63.

## I.2 Environmental Conditions

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.

### I.2.1 Operating temperature range

-20 ºC to +60 ºC (“non-harsh” environments)

-40 ºC to +70 ºC (“harsh” environments)

### I.2.2 Storage temperature range

-40 ºC to +80 ºC (maximum temperature range that the tag should withstand)

### I.2.3 Operating humidity range

10% to 95% RH (non-condensing)

### I.2.4 Storage humidity range

0% to 95% RH (non-condensing) (maximum humidity range that the tag should withstand)

# *ANNEX J: REWRITABLE HYBRID MEDIA*

**(Informative)**

## J.1 Thermal Rewritable Technology

Thermal rewritable technology, which achieves a high black and white contrast and is erasable at a high speed, is practical and suitable for continual reuse. Thermal rewritable technology is categorized into chemical rewritable and physical rewritable.

In general, this rewritable technology is used in combination with a sheet-like media ("rewritable media" below,) composed of a substrate (plastic film such as PET or paper), a rewritable display layer, and a printer equipped with a function to clear records.

### J.1.1 Chemical rewritable

Figure J.1 below illustrates the basic coloring and discoloring processes of the chemical rewritable technology.

In chemical rewritable (CR) technology, images are made to chemically appear or disappear through controlled application of heat. Color appears when temperatures just above 180 °C are applied to the media followed by rapid cooling. Color disappears when temperatures ranging from 130 °C to 170 °C are applied to the media.

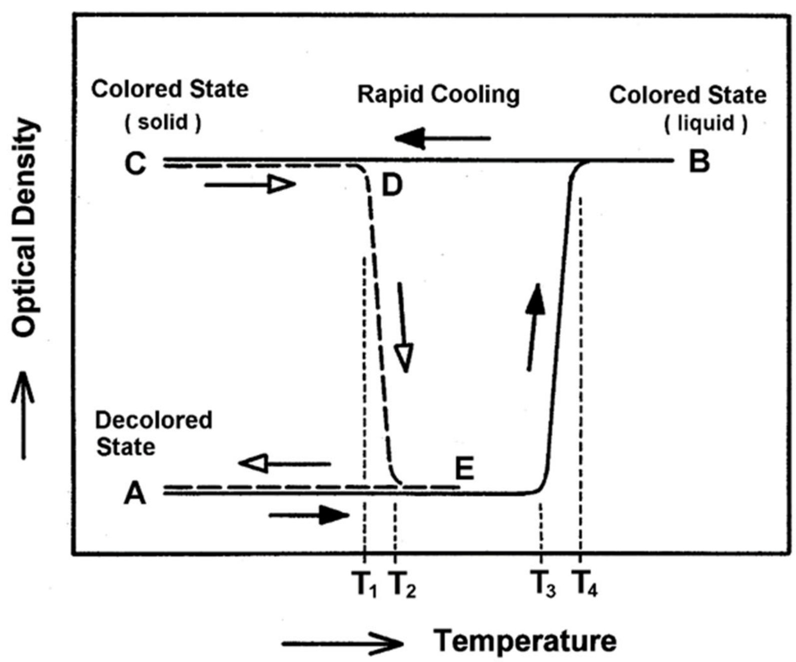


**Figure J.1: Coloring /decoloring process**

### J.1.2 Physical rewritable

The contactless laser recoding method of the physical rewritable (PR) technology creates and clears an image by irradiating the media's rewrite section with laser light so the media's recording layer absorbs the light (see Figure J.2). With the PR technology, images are made to physically appear or disappear through the controlled application of heat. Images appear at >130 °C and disappear between 100 °C and 120 °C.

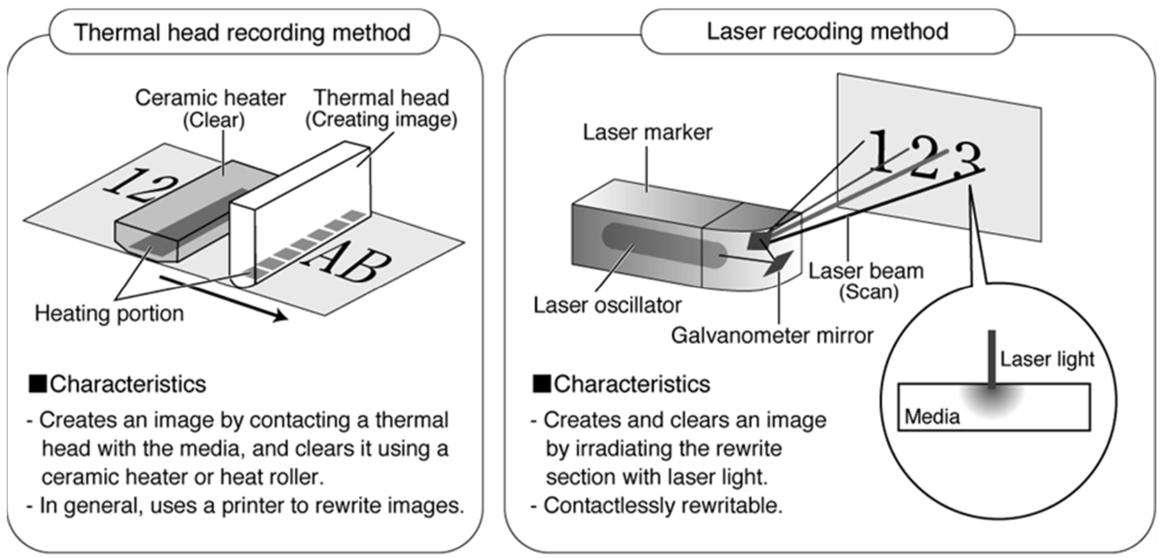


**Figure J.2: Rewritable media recording methods**

In Figure J.2, the thermal head has small heating elements laid in a sheet or column. When current is applied to specific heating elements, they create characters or image data on the rewriteable media.

## J.2 Rewritable Hybrid Media

### J.2.1 General

An RF tag does not have a visual data representation feature. For this reason, the use of an additional media such as paper or a display monitor is necessary in applications where the information shall be visually checked. This requires the industry to migrate from optical media (linear symbols or two-dimensional symbols) to RFID media or labels using disposable RF tags. In this case, the label or the tag needs to be replaced at each cycle of data, consuming a considerable amount of paper for the label, and a considerable amount of metal for the RF tag. Results will be additional costs and adverse impact on the environment.

However, by combining an RF tag and rewritable media, a composite data carrier is achieved, which supports printable linear symbols and two-dimensional symbols as well as human readable information. It will change the data carrier from a single use to multiple uses. In addition to the cost reductions offered by this hybrid media, there can be a positive effect on the environment.

For a successful RFID operation, a method of recovery is necessary if the chip embedded in the RF tag gets damaged or broken. Since RFID is a rewritable media, such a recovery means should also be rewritable. The rewritable hybrid media is a technology developed as an efficient recovery solution, as illustrated in Figure J.3 below.


**Figure J.3: Rewritable hybrid media**

## J.2.2 Concept of rewritable hybrid media

Rewritable hybrid media has an ability to address difficult problems associated with RF tags. In addition, it is provided with the following advantages.

a. Provides visualization of the digital information in the RF tag
b. Simultaneously rewrites the electronic information and the display information, thereby providing duplicate sources of information
c. Capable of coexistence with existing systems such as a linear symbol, thereby providing seamless linkage with existing infrastructures.
d. Significantly reduces operational cost, as well as environmental impact with repeated rewrite and reuse

## J.2.3 Construction and characteristics

A typical Rewritable Hybrid Media data carrier comprises an active rewritable layer sandwiched between a surface protection layer and substrate and backing layers, incorporating the RF tag. A range of commercially available products has also been developed including two types of contact and non-contact erasure/printing device. See Figure J.4 below.

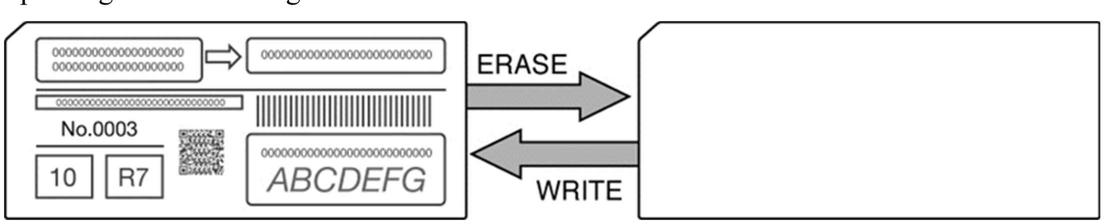


**Figure J.4: Typical rewritable hybrid media data carrier**

# ANNEX K: RELATED ISO STANDARDS

**(Informative)**

## K.1 ISO/IEC 18001

*Information technology – Radio frequency identification for item management – Application requirements profiles*

## K.2 ISO/IEC 18047-3

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

## K.3 ISO/IEC 18047-6

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

## K.4 ISO/IEC 18047-7

*Information technology — Radio frequency identification device conformance test methods — Part 7: Test methods for active air interface communications at 433 MHz*

# *ANNEX L: RELEVANT ORGANIZATIONS*

**(Informative)**

## L.1 AIAG

Automotive Industry Action Group; http://www.aiag.org/scriptcontent/index.cfm

## L.2 AIM Global

Association for Automatic Identification and Mobility; http://www.aimglobal.org/

## L.3 ANSI

American National Standards Institute; http://www.ansi.org/

## L.4 ANSI/MH 10

An ANSI-accredited committee responsible for the development of American national standards on unit-load and transport-package sizes, package testing standards, definitions and terminology, standardization of unit-load height, sacks and multi-wall bag standards, coding and labeling of unit-loads; http://www.autoid.org/ANSI_MH10/Default.htm

## L.5 ANSI/MH 10/SC 8

An ANSI-accredited committee responsible for the development of American national standards on the coding and labeling of transport packages and transport units with RTIs, product packaging, and radio frequency identification for returnable containers. ANSI/MH 10/ SC 8 serves as the US Technical Advisory Group (TAG) to ISO/TC 122; http://www.mhi.org/standards/di

## L.6 GS1

GS1 is an organization dedicated to the design and implementation of logistics standards and solutions to improve the efficiency and visibility of retail supply and demand chains globally; http://www.gs1.org/

## L.7 IEC (International Electrotechnical Commission)

The IEC is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies — collectively known as "electrotechnical"; http://www.iec.ch/

## L.8 ISO (International Organization for Standardization)

ISO is the world's largest developer and publisher of International Standards; http://www.iso.org/iso/home.htm

## L.9 JAIF

Joint Automotive Industry Forum. Consists of AIAG (U.S.), JAMA/JAPIA (Japan) and Odette (Europe).

## L.10 JAMA

Japan Automobile Manufacturers Association Inc.; www.jama.or.jp

## L.11 JAPIA

Japan Auto Parts Industries Association; www.japia.or.jp

## L.12 JISC

Japanese Industrial Standards, Committee (JISC); http://www.jisc.go.jp/

## L.13 ODETTE

Organisation for Data Exchange by Tele Transmission in Europe; http://www.odette.org

## L.14 VDA

Verband der Automobilindustrie (German Association of the Automotive Industry (VDA); http://www.vda.de/

# *ANNEX M: ISO/IEC 646 CHARACTER SET*

**(Normative)**

**Table M.1: ISO/IEC 646 character set**

| HEX | DEC | ASCII / ISO 646 | HEX | DEC | ASCII / ISO 646 | HEX | DEC | ASCII / ISO 646 |
|---|---|---|---|---|---|---|---|---|
| 00 | 00 | NUL | 30 | 48 | 0 | 60 | 96 | ' |
| 01 | 01 | SOH | 31 | 49 | 1 | 61 | 97 | a |
| 02 | 02 | STX | 32 | 50 | 2 | 62 | 98 | b |
| 03 | 03 | ETX | 33 | 51 | 3 | 63 | 99 | c |
| 04 | 04 | EOT | 34 | 52 | 4 | 64 | 100 | d |
| 05 | 05 | ENQ | 35 | 53 | 5 | 65 | 101 | e |
| 06 | 06 | ACK | 36 | 54 | 6 | 66 | 102 | f |
| 07 | 07 | BEL | 37 | 55 | 7 | 67 | 103 | g |
| 08 | 08 | BS | 38 | 56 | 8 | 68 | 104 | h |
| 09 | 09 | HT | 39 | 57 | 9 | 69 | 105 | i |
| 0A | 10 | LF | 3A | 58 | : | 6A | 106 | j |
| 0B | 11 | VT | 3B | 59 | ; | 6B | 107 | k |
| 0C | 12 | FF | 3C | 60 | < | 6C | 108 | l |
| 0D | 13 | CR | 3D | 61 | = | 6D | 109 | m |
| 0E | 14 | SO | 3E | 62 | > | 6E | 110 | n |
| 0F | 15 | SI | 3F | 63 | ? | 6F | 111 | o |
| 10 | 16 | DLE | 40 | 64 | @ | 70 | 112 | p |
| 11 | 17 | DC1 | 41 | 65 | A | 71 | 113 | q |
| 12 | 18 | DC2 | 42 | 66 | B | 72 | 114 | r |
| 13 | 19 | DC3 | 43 | 67 | C | 73 | 115 | s |
| 14 | 20 | DC4 | 44 | 68 | D | 74 | 116 | t |
| 15 | 21 | NAK | 45 | 69 | E | 75 | 117 | u |
| 16 | 22 | SYN | 46 | 70 | F | 76 | 118 | v |
| 17 | 23 | ETB | 47 | 71 | G | 77 | 119 | w |
| 18 | 24 | CAN | 48 | 72 | H | 78 | 120 | x |
| 19 | 25 | EM | 49 | 73 | I | 79 | 121 | y |
| 1A | 26 | SUB | 4A | 74 | J | 7A | 122 | z |
| 1B | 27 | ESC | 4B | 75 | K | 7B | 123 | { |
| 1C | 28 | FS | 4C | 76 | L | 7C | 124 | \| |
| 1D | 29 | GS | 4D | 77 | M | 7D | 125 | } |
| 1E | 30 | RS | 4E | 78 | N | 7E | 126 | ~ |
| 1F | 31 | US | 4F | 79 | O | 7F | 127 | DEL |
| 20 | 32 | SPACE | 50 | 80 | P | | | |
| 21 | 33 | ! | 51 | 81 | Q | | | |
| 22 | 34 | " | 52 | 82 | R | | | |
| 23 | 35 | # | 53 | 83 | S | | | |
| 24 | 36 | $ | 54 | 84 | T | | | |
| 25 | 37 | % | 55 | 85 | U | | | |
| 26 | 38 | & | 56 | 86 | V | | | |
| 27 | 39 | ' | 57 | 87 | W | | | |
| 28 | 40 | ( | 58 | 88 | X | | | |
| 29 | 41 | ) | 59 | 89 | Y | | | |
| 2A | 42 | * | 5A | 90 | Z | | | |
| 2B | 43 | + | 5B | 91 | [ | | | |
| 2C | 44 | , | 5C | 92 | \ | | | |
| 2D | 45 | - | 5D | 93 | ] | | | |
| 2E | 46 | . | 5E | 94 | ^ | | | |
| 2F | 47 | / | 5F | 95 | _ | | | |

# *ANNEX N: 2D SYMBOLOGIES FOR DIRECT MARKING*

**(Informative)**

This Annex provides guidance on direct marking two-dimensional symbols used to identify returnable transport items.

## N.1 QR Code Symbol Requirements

### N.1.1 “X” dimension

“X” dimensions of less than 0.15 mm or greater than 0.25 mm are not recommended when direct marking (see Table N.1).

### N.1.2 Symbol size

The symbol size should not be smaller than 10 mm by 10 mm when direct marking (see Table N.1).

**Table N.1: QR Code-Model 2 alphanumeric data capacity for Direct Marking**

| “X” DIMENSION | | | | |
|---|---|---|---|---|
| **Symbol Size** (with Quiet Zone) | **Error correction level** | **0.150mm** (0.006 inch) | **0.200mm** (0.008 inch) | **0.250mm** (0.010 inch) |
| 10mm×10mm | M | 311 | 154 | 61 |
| | Q | 221 | 108 | 47 |
| | H | 174 | 84 | 35 |
| 15mm×15mm | M | 909 | 419 | 221 |
| | Q | 644 | 296 | 157 |
| | H | 493 | 227 | 122 |
| 20mm×20mm | M | 1637 | 816 | 483 |
| | Q | 1172 | 574 | 352 |
| | H | 910 | 452 | 259 |
| 25mm×25mm | M | 2632 | 1326 | 816 |
| | Q | 1867 | 963 | 574 |
| | H | 1431 | 744 | 452 |

### N.1.3 Symbol quality

The QR Code Model 2 symbol shall have a minimum symbol quality of 2.0/05/660, where the minimum overall symbol grade is 1.5/05/660, measured with an aperture size of 0.20 mm with a narrowband light source. The light sources angle should be selected to get the most readable image

ISO/IEC 15415 provides additional guidance on grading parameters in application specifications, in particular the relationship between aperture size and susceptibility to gaps and other defects.

Guidance for placing a direct mark on various substrates can be found in ISO/IEC TR 24720.

## N.2 Data Matrix Symbol Requirements

### N.2.1 "X" dimension

"X" dimensions of less than 0.15 mm or greater than 0.25 mm are not recommended for direct marking (see Table N.2).

### N.2.2 Symbol size

The symbol size should not be smaller than 10 mm by 10 mm for direct marking (see Table N.2).

**Table N.2: Data Matrix ECC200 alphanumeric data capacity for Direct Marking**

| "X" DIMENSION | | | |
|---|---|---|---|
| **Symbol Size** (with Quiet Zone) | **0.150 mm** (0.006 inch) | **0.200 mm** (0.008 inch) | **0.51 mm** (0.020 inch) |
| 10 mm x 10 mm | 418 | 214 | 127 |
| 15 mm x 15 mm | 1042 | 550 | 304 |
| 20 mm x 20 mm | 1573 | 1042 | 550 |
| 25 mm x 25 mm | 2335 | 1573 | 1042 |

### N.2.3 Symbol quality

Data Matrix ECC200 symbols shall have a minimum symbol quality of 2.0/05/660, where the minimum overall symbol grade is 1.5/05/660, measured with an aperture size of 0.20 mm with a narrowband light source. The light sources angle should be selected to get the most readable image.

ISO/IEC 15415 provides additional guidance on grading parameters in application specifications, in particular the relationship between aperture size and susceptibility to gaps and other defects.

Guidance for placing a direct mark on various substrates can be found in ISO/IEC TR 24720

# ANNEX O: DEFINITION OF SERIAL NUMBER (SN)

**(Informative)**

Annex O provides definitions and examples of the Serial Number structure used in the unique identifier for RTIs under ISO/AFI encoding (see 6.2.4.3).

The SN can be either an unstructured number (sequential or not) or a combination of structured RTI data (also called Object Data [OD]) and a unique sequence number (also called Object Sequence Number [OSN]).

## O.1 Unstructured Number as SN

The term “unstructured serial number” means that the data within the Serial Number block of the Unique RTI Identification data string, as outlined within this document, is to be viewed in its entirety as unique data and cannot be parsed into smaller portions of data.

## O.2 Structured Number as SN

The Serial Number can be composed of structured data. In this case, one component would be called the Object Data (OD) and another component would be called the Object Sequence Number (OSN). See O.2.1 and Table O.1 for further details.

### O.2.1 JAMA-JAPIA-suggested structured SN

General: RTIs are independently controlled by the unit of allocation for individual companies defined by the appropriate issuing agency. However, most companies that have more than one production facility may control the RTIs by each of its facilities using different types of RTIs.

Most RTIs are equipped with Partitions as shown in Section 5.3. The Partitions shall be controlled and managed in combination with the associated returnable transport item.

The elements of the structured serial number are shown in Table O.1.

**Table O.1: Possible elements that comprise a SN**

| SERIAL NUMBER (SN) | | | |
|---|---|---|---|
| OD (Object Data) | | | OSN (Object Sequence Number) |
| FIC (Factory Identification Code) | KC (Kind Code) | PC (Partition Code) | |

A company can elect not to use any of the FIC, KC and PC partitions, as long as their RTIs are guaranteed to be uniquely serial numbered within the company’s global operation.

#### *O.2.1.1 Factory Identification Code (FIC)*

When RTIs are valuable assets that shall be controlled at each production site; a company, having manufacturing facilities both at home and abroad, shall uniquely identify each facility either through a unique Company Identification Number (CIN) for each site or shall have a Factory Identification Code (FIC) to independently track the RTIs. The FIC length is recommended not to exceed 3 characters.

#### *O.2.1.2 Kind Code (KC)*

Except for a few examples using only one kind of RTI in the system, different types of RTIs are usually required for each factory in transporting a variety of items. A code developed to identify the type of RTI is referred to as a Kind Code (KC). The length of the KC is recommended not to exceed 2 characters.

#### *O.2.1.3 Partition Code (PC)*

Certain types of RTIs may have one or more partitions as part of its structure. The Partition Code (PC) is a code used to identify the type of those partitions. The length of the PC is recommended not to exceed 2 characters.

#### *O.2.1.4 Object Sequence Number (OSN)*

The OSN is a number that, in combination with the OD, makes a serial number unique within a company's global operation. Thus, the OSN shall be exclusive within the same OD (FIC, KC and PC).

### O.2.2 Definition for a structured SN when using DI "25B"

When using DI "25B", the RTI-Type (RT) is considered as critical RTI data (Object Data) and must be stored in the SN in MB01. Apart from different definitions for the format of the RT and the OSN, both have different definitions for their CIN (Company Identification Number). As optimal utilization of the memory size in MB01 is strived for, the most optimum Data Compaction should be used on all fields that can be reduced in bit size. For more information on Data Compaction see Annex P.

All fields described from O.2.2.1 to O.2.2.3 are fixed length and padded with leading zeros if so required.

The structure of the serial number in Table O.2 offers an example respecting these requirements.

**Table O.2: Possible elements that comprise a SN**

<table>
<tr><th colspan="2">SERIAL NUMBER (SN)</th></tr>
<tr><td>OD (Object Data)</td><td rowspan="2">OSN<br>(Object Sequence Number)</td></tr>
<tr><td>RTI-Type (RT)</td></tr>
</table>

#### *O.2.2.1 Company Identification Number (CIN)*

**Table O.3: Data format - CIN**

| IAC | CIN |
|---|---|
| OD | 6 alphanumeric |
| UN | 9 numeric |

#### *O.2.2.2 RTI-Type (RT)*

**Table O.4: Data format - RT**

| IAC | RT |
|---|---|
| OD | 17 alphanumeric |
| UN | 17 alphanumeric |

> NOTE: The same RTI can have different RTI-Type descriptions and/or formats depending on the CIN that named the RTI.

#### *O.2.2.3 Object Sequence Number (OSN)*

The OSN is a number that, in combination with the OD, makes a Serial Number unique globally. Thus, the OSN shall be exclusive within the same OD (RT).

**Table O.5: Data format - OSN**

| IAC | OSN |
|---|---|
| OD | 8 alphanumeric |
| UN | 8 alphanumeric |

# *ANNEX P: DATA COMPACTION FOR MB11*

**(Informative)**

Refer to ISO/IEC 15962 *Information technology - Radio frequency identification (RFID) for item management - Data protocol: Data encoding rules and logical memory functions*.

## P.1 Situating ISO/IEC 15962 in the Data Protocol Environment and Covered Topics

The data protocol used to exchange information in a radio frequency identification (RFID) system for item management is specified in ISO/IEC 15961 and in ISO/IEC 15962. Both are required for a complete understanding of the data protocol in its entirety; but each focuses on one particular process:

- ISO/IEC 15961 addresses the interface with the application system.
- ISO/IEC 15962 deals with the processing of data and its presentation to the RF tag, and the initial processing of data captured from the RF tag.

ISO/IEC 15962 covers the following topics:

- Provides the encoded structure of object identifiers according to the rules of the Access-Method defined by the application command
- Specifies the data compaction rules that apply to the encoded data, with variants for the different Access-Methods
- Specifies additional syntax features associated with the Access-Method defined by the application command
- Specifies formatting rules for the data, based on the selected Access-Method and the architecture of the Logical Memory Map defined by the Tag Driver
- Defines how application arguments e.g., to lock data, are transferred to the Tag Driver
- Defines responses to the application

## P.2 General Definition of Compaction

Data compaction is an encoding mechanism, or algorithm, to process the original data in a way that it is represented efficiently in a data carrier. This efficiency is obtained by reducing the byte length of the original data through compaction. Different compaction schemes exist and are used in relation to the hexadecimal character range of the data. The compaction algorithm should choose the most optimum compaction scheme based on the data content to be compacted. The major benefit of compaction is to reduce the number of bytes stored in the RF tag and thus reducing the number of bytes transferred across the air interface. When no compaction is used, the UTF-8 character set is to be used.

### P.2.1 Limitation of the described compaction rules

Compaction and formatting rules differ depending on the Access Methods. There are four defined Access Methods. Annex P will only address compaction logic for Access Method 00 (No-Directory).

**Table P.1: Explanation of Access Methods**

| 15961 INTEGER CODE | 15962 DSFID BIT CODE | NAME | DESCRIPTION |
|---|---|---|---|
| 0 | 00 | No-Directory | This structure supports the contiguous abutting of all the Data-Sets |
| 1 | 01 | Directory | The data is encoded exactly as for No-Directory, but the RF tag supports an additional directory, which is first read to point to the address of the relevant object identifier. |
| 2 | 10 | Packed-Objects | This is an integrated compaction and encoding scheme that formats data in an indexed structure as defined by the Application administrator (see ISO/IEC 15961-2) |
| 3 | 11 | Tag-Data-Profile | This is an integrated compaction and encoding scheme that supports fixed message structures as defined by the Application administrator (see ISO/IEC 15961-2) |

## P.3 Compaction Encoding Rules for No-Directory Access Method

Data compaction is applied to Data Objects to reduce the number of bytes that are transferred across the air interface. The compaction shall be done according to the Compact-Parameter received from the ISO/IEC 15961 application commands (see ISO/IEC 15961-1). Data compaction performs all the processes necessary to compact Data Objects and to determine the Compaction Type, which is encoded on the RF tag as part of the Precursor (see Annex P.3.5.1 The Precursor). The Object-Identifier remains unchanged and is not subject to any form of compaction to enable it to be directly identifiable by the application and the Logical Memory. The command argument Object-Lock remains unchanged and is passed through to the next stage of processing: data formatting.

### P.3.1 Compaction process

The command argument Compact-Parameter determines whether the Object is subject to the compaction process or not, based on the following integer values.

**0** **Application-Defined:** The data object is read by and passed through the data compaction process without any compaction being applied but is assigned the Compaction Type Code 000binary.

**1** **Compact:** The data object is read by and passed through the data compaction process to be compacted as efficiently as possible and assigned the appropriate Compaction Type Code in the range 001binary to 110binary.

**2** **UTF8-Data:** The data object is read by and passed through the data compaction process without any compaction being applied but is assigned the Compaction Type Code 111binary to indicate that it is compliant with the UTF-8 transformation of ISO/IEC 10646.

**3** **Packed-Objects:** If this Compact-Parameter is presented in conjunction with the Access-Method No-Directory, then an error has occurred, and the encoding process should cease.

**4 to 14 Reserved:** If these Compact-Parameters are presented, then an error has occurred, and the encoding process should cease.

**15** **De-Compacted-Data:** If this Compact-Parameter is presented, then an error has occurred because this code is reserved for the decoding process and the encoding process should cease.

The Object is read by and passed through the data compaction process.

1. The data Object itself is transformed to its compacted form. If the command argument Compact-Parameter:
   a. is set to 1 (Compact), the data Object input string is compacted
   b. is set to 0 (Application-Defined), or to 2 (UTF8-Data), the input string is not compacted but the data Object is still processed through step 2 and step 3.
2. The 3-bit Compaction Type Code is assigned (see Annex P.3.2).
3. The length of the compacted data Object is defined.

## P.3.2 Data Compaction Schemes and Codes

Data compaction shall be applied to each entire Data Object. The selection of the data compaction scheme is determined by parsing the bytes in the Data Object and analyzing their values to determine in what hexadecimal range they reside. Table P.2 shows the Compaction Schemes in sequence of preferred application, starting with the most efficient.

**Table P.2: Explanation of Compaction Codes**

| CODE VALUE | NAME | DESCRIPTION | HEXADECIMAL RANGE | |
|---|---|---|---|---|
| | | | Low | High |
| 000 | Application defined | As presented by the application | - | - |
| 001 | Integer | Not used in direct 15434 encoding | 30 | 39 |
| 010 | Numeric | Not used in direct 15434 encoding | 30 | 39 |
| 011 | 5 bit code | Not used in direct 15434 encoding | 41 | 5F |
| 100 | 6 bit code | Modified alphanumeric as in ISO/IEC 15962 | 20 | 5F |
| 101 | 7 bit code | US ASCII | 00 | 7E |
| 110 | Octet string | Unaltered 8-bit | 00 | FF |
| 111 | UTF-8 string | UTF-8, a transformation format of ISO/IEC 10646 | 00 | FFFFFFFF |

NOTE: The Integer, 4-bit, and 5-bit code compaction schemes cannot be used because they do not support the <EOT> control character.

## P.3.3 Encoding the length of the compacted Data Object

The length of all Data Objects on output from the compaction process (including the Data Objects not intended for compaction, or not achieving a compacted state) shall be determined and encoded as follows:

1. If the length is between 0 and 127 bytes, the length is encoded in one byte with the lead bit = 0

   0bbbbbbb where bbbbbbb = length in bytes

2. If the length is between 128 and 16383 bytes, the length is encoded in two bytes as follows:
   a. Set the first bit of the lead byte = 1 and the first bit of the second byte = 0.

   1bbbbbbb 0bbbbbbb

   b. Convert the length (in bytes) to its binary value.
   c. Encode the value in the bits 7 to 1 of each byte of the length encoding.
3. If the length is between 16384 and 2097151, the length is encoded in three bytes as follows:
   a. Set the first bit of the lead byte = 1 and the first bit of the last byte = 0 and the first bit of all intervening bytes = 1.

   1bbbbbbb 1bbbbbbb 0bbbbbbb

   b. Convert the length (in bytes) to its binary value.
   c. Encode the value in the bits 7 to 1 of each byte of the length encoding.

## P.3.4 Processing the Object-Identifier and the Relative-OID

The Object-Identifier in the application command is compliant with the rules of ISO/IEC 8824-1. It may also be presented in a truncated form as a Relative-OID.

For a detailed description of the processing of the Object-Identifier refer to ISO/IEC 15962. For a detailed description of the processing of the Relative-OID refer to ISO/IEC 15962.

## P.3.5 Encoding the length of the Object-Identifier or Relative-OID

For a detailed description of the length encoding of the Object-Identifier or Relative-OID refer to ISO/IEC 15962.

### *P.3.5.1 The Precursor*

The Precursor is a single metadata byte that is always the first byte of the Data-Set and provides information about:

1. Offset
2. Compaction Code
3. Object-Identifier

> NOTE: Annex P.3.5 only describes the Precursor structure for the Data Format different from Data Format 2 (Root-OID-Encoded).

For more detailed information on Data Formats refer to ISO/IEC 15961.

**Table P.3: Explanation of the Precursor Structure**

| PRECURSOR BIT POSITIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| MSb | | | | | | | LSb |
| Offset | Compaction Code | | | Object Identifier | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

The first bit (MSb – Most Significant bit), bit 7 of the Precursor, indicates the Offset. Table P.4 shows the meaning that the bit has:

**Table P.4: Explanation of the Offset Bit**

| MSb | DESCRIPTION |
|---|---|
| $0_2$ | No Offset is present |
| $1_2$ | An additional byte follows as part of the Precursor |

NOTE: Annex P.3.5 only addresses Offset 0 (No Offset).

Bits 6 to 4 contain the Compaction Code. Table P.5 show the Compaction codes that can be used:

**Table P.5: Explanation of the Compaction Code**

| NAME | CODE VALUE (BINARY) |
|---|---|
| Application defined | 000 |
| Integer | 001 |
| Numeric | 010 |
| 5 bit code | 011 |
| 6 bit code | 100 |
| 7 bit code | 101 |
| Octet string | 110 |
| UTF-8 string | 111 |

Bits 3 to 0 contain the Object Identifier.

The contents of the Object Identifier depend on the value of the Relative-OID.

When the Relative-OID is in the decimal range 01 to 14 the Object Identifier will be encoded as 0001binary to 1110binary.

When the decimal value of the Relative-OID is 0, or greater than 14, the Object Identifier will be encoded as 1111binary.

## P.4 Data Compression Schemes

The schemes shall apply to the entire Data Object, i.e., it is not possible to switch schemes in the middle of a Data Object. Nor shall a compaction scheme straddle two or more Data Objects. By applying data compaction to a complete Data Object, it can be extracted in its compacted form as part of a read or write command.

The schemes are defined below in sequence of greatest potential compaction to no compaction, thus from most- to least-efficient.

## P.4.1 Integer compaction (The Precursor is 001binary)

Integer compaction is designed to compact decimal integers from the decimal value 10 to 9999999999999999999 (i.e., any 2-digit to 19-digit value) to a binary format. All input bytes shall be in the range 30hex to 39hex (decimal "0" through decimal "9") and the leading byte(s) shall not be 30hex (decimal "0"). If the decimal integer value is less than 10, or is longer than 19 digits, or the leading byte(s) are 30hex, numeric compaction shall be applied.

The rules for integer compaction are:

1. If the decimal numeric value is 10 to 9999999999999999999, convert to a binary value.

   NOTE: This allows for conversion within a 64-bit value (or 8 bytes). Some program languages can support a simple data type conversion to an integer value (different names are used). If the language does not support a data type conversion of a decimal value of 19 digits, then a two-stage process should be used:

   a. Use the data type conversion up to the limit of the program language

2. Align to a byte boundary by padding with leading zero bits, if required. Depending on the conversion procedure used, it could be necessary to strip off any leading bytes with the value 00hex to achieve the minimum encoded length. The encoded byte string should not include (encode as integer) code value 001binary in the Precursor.

## P.4.2 Numeric compaction (The Precursor is 010binary)

Numeric compaction is designed to encode any decimal numeric character string, including leading zeros. The character string shall be 2 or more characters long. Numeric compaction preserves the original character string length so that, once decoded, leading zeros, if present, are output. All input bytes shall be in the range 30hex to 39hex.

The rules for numeric compaction are:

1. Convert each decimal digit to its 4-bit binary equivalent (Binary Coded Decimal).
2. If the numeric character string has an odd number of digits, append an additional 4-bit string "1111binary" to align the compaction to byte boundaries.
3. Encode each 4-bit pair as a byte. Define the compacted sequence as numeric, code value 010binary in the Precursor.

   NOTE: During the decode process, if the last byte has the value "xF", the last four bits "1111binary" are discarded to recreate the numeric character string of an odd number of decimal digits.

## P.4.3 5-bit compaction (The Precursor is 011binary)

5-bit compaction is designed to encode uppercase Latin characters and some punctuation. All input bytes shall be in the range 41hex to 5Fhex. The character string shall be 3 or more characters long. Up to 37% of memory space can be saved using this scheme. P.5 shows the ISO/IEC 646 characters that can be encoded.

The rules for 5-bit compaction are:

1. For each character:
    a. Confirm that the byte value is in the range 41hex to 5Fhex.
    b. Convert the byte value to its 8-bit binary equivalent.
    c. Strip off the lead 3 bits “010binary”.
    d. Write the remaining 5-bits to a bit string.
2. Once all the characters have been converted to 5-bit values and concatenated, divide the resultant bit string into 8-bit segments starting with the most significant bit. If the last segment contains less than 8 bits, pad with “0binary” bits.
3. Convert the 8-bit segments to hexadecimal values.
4. Encode the converted byte sequence as 5 bit code, code value 011binary in the Precursor.

NOTE: During the decode process, each 5-bit segment of the compacted bit string has “010binary” added as a prefix to re-create the 8-bit value of the source data. If “0binary” pad bits are present at the end of the compaction bit string, they are discarded.

NOTE: If 5, 6, or 7 pad bits are present, the decoder could attempt to convert the first 5-bits to the source data. However, this results in character 40hex, which is not supported in 5-bit compaction and shall be discarded.

### P.4.4 6-bit compaction (The Precursor is 100binary)

6-bit compaction is designed to encode uppercase Latin characters, numeric digits, and some punctuation. All input bytes shall be in the range 20hex to 5Fhex. If the trailing byte(s) are 20hex, 7-bit compaction shall be used. The character string shall be 4 or more characters long. Up to 25% of memory space can be saved using this scheme. P.5 shows the ISO/IEC 646 characters that can be encoded.

The rules for 6-bit compaction are:

1. Check for byte 20hex in the final position(s). If found, go to 7-bit compaction, otherwise continue steps 2 to 5.
2. For each character:
    a. Confirm that the byte value is in the range 20hex to 5Fhex.
    b. Convert the byte value to its 8-bit binary equivalent.
    c. Strip off the leading 2 bits: “00binary” for bytes 20hex to 3Fhex or “01binary” for bytes 40hex to 5Fhex.
    d. Concatenate the remaining 6-bits to a bit string.
3. Divide the resultant bit string into 8-bit segments starting from the most significant bit. If the last segment contains less than 8 bits pad, as appropriate, with the first two, four or all bits of the pad string “100000 binary”.
4. Convert the 8-bit segments to hexadecimal values.
5. Encode the converted byte sequence as 6-bit code, code value 100binary in the Precursor.

During the decode process, each 6-bit segment of the compacted bit string is analyzed.

   a. If the first bit is “1binary”, the bits “00binary” are added as a prefix before converting to values 20hex to 3Fhex.
   b. If the first bit is “0binary”, the bits “01binary” are added as a prefix before converting to values 40hex to 5Fhex.

If pad strings “10”, “1000” or “100000 binary” are present at the end of the encoded bit string, they are discarded.

If 6 pad bits are present, the decoder could attempt to convert this to source data. This results in character 20hex that is not supported in this final position and shall be discarded.

The example below shows the effect of processing the Object through the data compaction process.

EXAMPLE:

The Object content {ABC123456} converts to hex as 41 42 43 31 32 33 34 35 36. Analyzing this byte stream shows that all values are in the range 20hex to 5Fhex, enabling 6-bit compaction to be used. The Object byte stream converts as follows:

HEX: 41 42 43 31 32 33 34 35 36

Binary:

10000001 10000010 10000011 00110001 00110010 00110011 00110100 00110101 00110110

Remove bits 8 & 7:

000001 000010 000011 110001 110010 110011 110100 110101 110110

As this is only 54 bits, the first two bits of the pad string "10" are appended and the 56 bit string is divided into a sequence of 8-bit values:

00000100 00100000 11110001 11001011 00111101 00110101 11011010

Convert to hex: 04 20 F1 CB 3D 35 DA

## P.4.5 7 bit compaction (The Precursor is 101binary)

7-bit compaction is designed to encode all ISO/IEC 646 characters including control characters except for DELETE. All input characters shall be in the range 00hex to 7Ehex. The character string shall be 8 or more characters long. Up to 12% of memory space can be saved using this scheme. P.5 shows the ISO/IEC 646 characters that can be encoded.

The rules for 7-bit compaction are:

1. For each character:
   a. Confirm that the byte value is in the range 00hex to 7Ehex.
   b. Convert the byte value to its 8-bit binary equivalent.
   c. Strip off the lead bit “0binary”.
   d. Concatenate the remaining 7-bits to a bit string.
2. Once all the characters have been converted to 7-bit values, divide the resultant bit string into 8-bit segments starting with the most significant bit. If the last segment contains less than 8-bits, pad with “1binary” bits.

3. Convert the 8-bit segments to hexadecimal values.
4. Encode the converted byte sequence as 7 bit code, code value 101binary in the Precursor.

> NOTE: During the decode process, each 7-bit segment of the compacted bit string has bit "0" added as a prefix to recreate the 8-bit value of the source data. If "1" pad bits are present at the end of the encoded bit string, they are discarded. If 7 pad bits are present, the decoder could attempt to convert these to source data. However, this results in character 7Fhex, which is not supported in 7-bit compaction and shall be discarded.

EXAMPLE:

The Data Object content {Ace#123451337} converts to hex as 41 63 65 23 31 32 33 34 35 31 33 33 37.

Analyzing this byte stream shows that all values are in the range 00hex to 7Ehex, enabling 7-bit compaction to be used. The Object byte stream converts as follows:

HEX: 41 63 65 23 31 32 33 34 35 31 33 33 37

Binary:

01000001 01100011 01100101 00100011 00110001 00110010 00110011 00110100 00110101 00110001 00110011 00110011 00110111

Remove leading (leftmost) bit:

1000001 1100011 1100101 0100011 0110001 0110010 0110011 0110100 0110101 0110001 0110011 0110011 0110111

As this is only 91 bits, the first five bits of the pad string "11111" are appended and the 96 bit string is divided into a sequence of 8-bit values:

10000011 10001111 00101010 00110110 00101100 10011001 10110100 01101010 11000101 10011011 00110110 11111111

Convert to hex: 83 8F 2A 36 2C 99 B4 6A C5 9B 36 FF

> NOTE: Although the last encoded byte contains all 1s, decoding from the first byte in 7 bit steps ensures that the pad bits are correctly recognized and discarded.

### P.4.6 Octet string – unaltered 8-bit encoding (The Precursor is 110binary)

Octet string encoding is used when none of the above compaction schemes can be invoked. It encodes all bytes in the range 00hex to FFhex. The encoded byte string is identical to the source byte string. Encode as octet string, code value 110binary in the Precursor.

> NOTE: No decode processing is required.

## P.5 ISO/IEC 646 Characters Supported by the Compaction Schemes

**Table P.6: Character Set supported by Compaction Schema for Octet-based data**

| ISO/IEC 646 CHARACTER | OCTET VALUE (HEX) | INCLUDED IN COMPACTION TYPE | | | |
|---|---|---|---|---|---|
| | | 7 bit code | 6 bit code | 5 bit code | Numeric code |
| NUL | 00 | • | | | |
| SOH | 01 | • | | | |
| STX | 02 | • | | | |
| ETX | 03 | • | | | |
| EOT | 04 | • | | | |
| ENQ | 05 | • | | | |
| ACK | 06 | • | | | |
| BEL | 07 | • | | | |
| BS | 08 | • | | | |
| HT | 09 | • | | | |
| LF | 0A | • | | | |
| VT | 0B | • | | | |
| FF | 0C | • | | | |
| CR | 0D | • | | | |
| SO | 0E | • | | | |
| SI | 0F | • | | | |
| DLE | 10 | • | | | |
| DC1 | 11 | • | | | |
| DC2 | 12 | • | | | |
| DC3 | 13 | • | | | |
| DC4 | 14 | • | | | |
| NAK | 15 | • | | | |
| SYN | 16 | • | | | |
| ETB | 17 | • | | | |
| CAN | 18 | • | | | |
| EM | 19 | • | | | |
| SUB | 1A | • | | | |
| ESC | 1B | • | | | |
| FS | 1C | • | | | |
| GS | 1D | • | | | |
| RS | 1E | • | | | |
| US | 1F | • | | | |
| SPACE | 20 | • | • | | |
| ! | 21 | • | • | | |
| “ | 22 | • | • | | |
| # | 23 | • | • | | |
| $ | 24 | • | • | | |

| ISO/IEC 646 CHARACTER | OCTET VALUE (HEX) | INCLUDED IN COMPACTION TYPE | | | |
|---|---|---|---|---|---|
| | | 7 bit code | 6 bit code | 5 bit code | Numeric code |
| % | 25 | • | • | | |
| & | 26 | • | • | | |
| ‘ | 27 | • | • | | |
| ( | 28 | • | • | | |
| ) | 29 | • | • | | |
| * | 2A | • | • | | |
| + | 2B | • | • | | |
| , | 2C | • | • | | |
| - | 2D | • | • | | |
| . | 2E | • | • | | |
| / | 2F | • | • | | |
| 0 | 30 | • | • | | • |
| 1 | 31 | • | • | | • |
| 2 | 32 | • | • | | • |
| 3 | 33 | • | • | | • |
| 4 | 34 | • | • | | • |
| 5 | 35 | • | • | | • |
| 6 | 36 | • | • | | • |
| 7 | 37 | • | • | | • |
| 8 | 38 | • | • | | • |
| 9 | 39 | • | • | | • |
| : | 3A | • | • | | |
| ; | 3B | • | • | | |
| < | 3C | • | • | | |
| = | 3D | • | • | | |
| > | 3E | • | • | | |
| ? | 3F | • | • | | |
| @ | 40 | • | • | | |
| A | 41 | • | • | • | |
| B | 42 | • | • | • | |
| C | 43 | • | • | • | |
| D | 44 | • | • | • | |
| E | 45 | • | • | • | |
| F | 46 | • | • | • | |
| G | 47 | • | • | • | |
| H | 48 | • | • | • | |
| I | 49 | • | • | • | |
| J | 4A | • | • | • | |
| K | 4B | • | • | • | |
| L | 4C | • | • | • | |
| M | 4D | • | • | • | |
| N | 4E | • | • | • | |

| ISO/IEC 646 CHARACTER | OCTET VALUE (HEX) | INCLUDED IN COMPACTION TYPE | | | |
|---|---|---|---|---|---|
| | | 7 bit code | 6 bit code | 5 bit code | Numeric code |
| O | 4F | • | • | • | |
| P | 50 | • | • | • | |
| Q | 51 | • | • | • | |
| R | 52 | • | • | • | |
| S | 53 | • | • | • | |
| T | 54 | • | • | • | |
| U | 55 | • | • | • | |
| V | 56 | • | • | • | |
| W | 57 | • | • | • | |
| X | 58 | • | • | • | |
| Y | 59 | • | • | • | |
| Z | 5A | • | • | • | |
| [ | 5B | • | • | • | |
| \ | 5C | • | • | • | |
| ] | 5D | • | • | • | |
| ^ | 5E | • | • | • | |
| _ | 5F | • | • | • | |
| ` | 60 | • | | | |
| a | 61 | • | | | |
| b | 62 | • | | | |
| c | 63 | • | | | |
| d | 64 | • | | | |
| e | 65 | • | | | |
| f | 66 | • | | | |
| g | 67 | • | | | |
| h | 68 | • | | | |
| i | 69 | • | | | |
| j | 6A | • | | | |
| k | 6B | • | | | |
| l | 6C | • | | | |
| m | 6D | • | | | |
| n | 6E | • | | | |
| o | 6F | • | | | |
| p | 70 | • | | | |
| q | 71 | • | | | |
| r | 72 | • | | | |
| s | 73 | • | | | |
| t | 74 | • | | | |
| u | 75 | • | | | |
| v | 76 | • | | | |
| w | 77 | • | | | |

| ISO/IEC 646 CHARACTER | OCTET VALUE (HEX) | INCLUDED IN COMPACTION TYPE | | | |
|---|---|---|---|---|---|
| | | 7 bit code | 6 bit code | 5 bit code | Numeric code |
| x | 78 | • | | | |
| y | 79 | • | | | |
| z | 7A | • | | | |
| { | 7B | • | | | |
| \| | 7C | • | | | |
| } | 7D | • | | | |
| ~ | 7E | • | | | |

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# ANNEX Q: MB01; ISO -BASED DATA FORMAT EXAMPLES

**(Informative)**

> NOTE: The AFI shall NOT be encoded as part of the UII when PC Bit 17 = 1. The AFI is programmed into the Attribute / AFI section of MB01, starting at memory location 0x18 through memory location 0x1F. See ISO/IEC 15961-2 for details on the AFI. See Figure 15

The reference-ID is 6-bit encoded (cf. Table 10). The string is padded until an even number of bytes is reached. In the PC area (header) the UII length is declared in 16-bit words (2 bytes).

DI "26B" in the UII (MB01)

For the step-by-step details on how the data were encoded, see ISO/IEC 17364.

> NOTE: See Annex S for 8-bit encoding examples

**Reference ID (plain text)**
**26BUN123456789A153097+CS71489453**

**Binary value using 6-bit Compaction, including $^{E}O_{T}$**

| | | | | | |
|---|---|---|---|---|---|
| 110010 | 110110 | 000010 | 010101 | 001110 | 110001 |
| 110010 | 110011 | 110100 | 110101 | 110110 | 110111 |
| 111000 | 111001 | 000001 | 110001 | 110101 | 110011 |
| 110000 | 111001 | 110111 | 101011 | 000011 | 010011 |
| 110111 | 110001 | 110100 | 111000 | 111001 | 110100 |
| 110101 | 110011 | *100001* | | | |

**Entire data-stream assembled into 8-bit bytes, including *padding bits***

| | | | | | |
|---|---|---|---|---|---|
| 11001011 | 01100000 | 10010101 | 00111011 | 00011100 | 10110011 |
| 11010011 | 01011101 | 10110111 | 11100011 | 10010000 | 01110001 |
| 11010111 | 00111100 | 00111001 | 11011110 | 10110000 | 11010011 |
| 11011111 | 00011101 | 00111000 | 11100111 | 01001101 | 01110011 |
| 100001*10* | *00001000* | | | | |

**Hex code representation of each binary byte**

| | | | | | |
|---|---|---|---|---|---|
| CB | 60 | 95 | 3B | 1C | B3 |
| D3 | 5D | B7 | E3 | 90 | 71 |
| D7 | 3C | 39 | DE | B0 | D3 |
| DF | 1D | 38 | E7 | 4D | 73 |
| 86 | 08 | | | | |

**PC data (Byte 1):**

| | | | |
|---|---|---|---|
| UII-length of 16-bit words: | 0b | ***0110 1*** | (26 bytes → 13 words [16 bits = 1 word]) |
| Valid User Memory: | 0b | ***0*** | (no user memory) |
| XPC: | 0b | ***0*** | (not used – reserved) |
| EPC or ISO code: | 0b | ***1*** | (ISO) |
| All PC bits: | 0b | ***0110 1001*** | (0x69) |

| **PC (Byte 1)** | **AFI (Byte 2 of PC)** |
|---|---|
| 0x69 | 0xA3 |

**Coded UII content (including PC and AFI) in HEX, in the form PC (1*) - AFI (2*) - UII:**

| 1* | 2* | UII | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 69 | A3 | CB | 60 | 95 | 3B | 1C | B3 | D3 | 5D | B7 | E3 | 90 | 71 | D7 | 3C | 39 | DE | B0 | D3 | DF | 1D | 38 | E7 | 4D | 73 | 86 | 08 |

NOTE:
"1*" refers to byte 1 of the Protocol Control Word (Length, PC Bits 15, 16 and 17).
"2*" refers to byte 2 of the Protocol Control Word, the Application Family Identifier (AFI).
See Figure 15.

# ANNEX R: LOCKING THE INFORMATION ON THE RFID TAG

**(Informative)**

RFID-equipped objects circulate in open-loop environments, subjecting the RFID Tags to potential misuse. This particularly applies to MB01, which contains the unique ID (UII). Corrupting the unique ID may cause severe application and handling errors. Therefore, we recommend protecting against write access once the UII has been written to MB01. And the RFID transponder shall also be protected against deactivation (kill).

Transponders that are compliant with ISO/IEC 18000-63 have two different passwords; an Access Password and a Kill Password (32 bits each). The passwords are stored in the Reserved Memory Bank, MB00.

As soon as an RFID tag is being addressed by an interrogator, it enters one of two different states:

1. Open (factory default)
2. Secured (restricted access)

If the Access Password = “0”, no password is required to enter the Secured state of the tag. If the Access Password ≠ “0”, a password is required to enter the Secured state of the tag. Figure R.1 illustrates the process when switching from one state to the other.

This document recommends that the RFID tag has an Access Password encoded and Locked in MB00.

This document recommends that the Kill Password be set to “0”, and the Kill Password PermaLocked, **once the UII has been programmed into MB01**, so that the tag may not be able to be killed, ever.

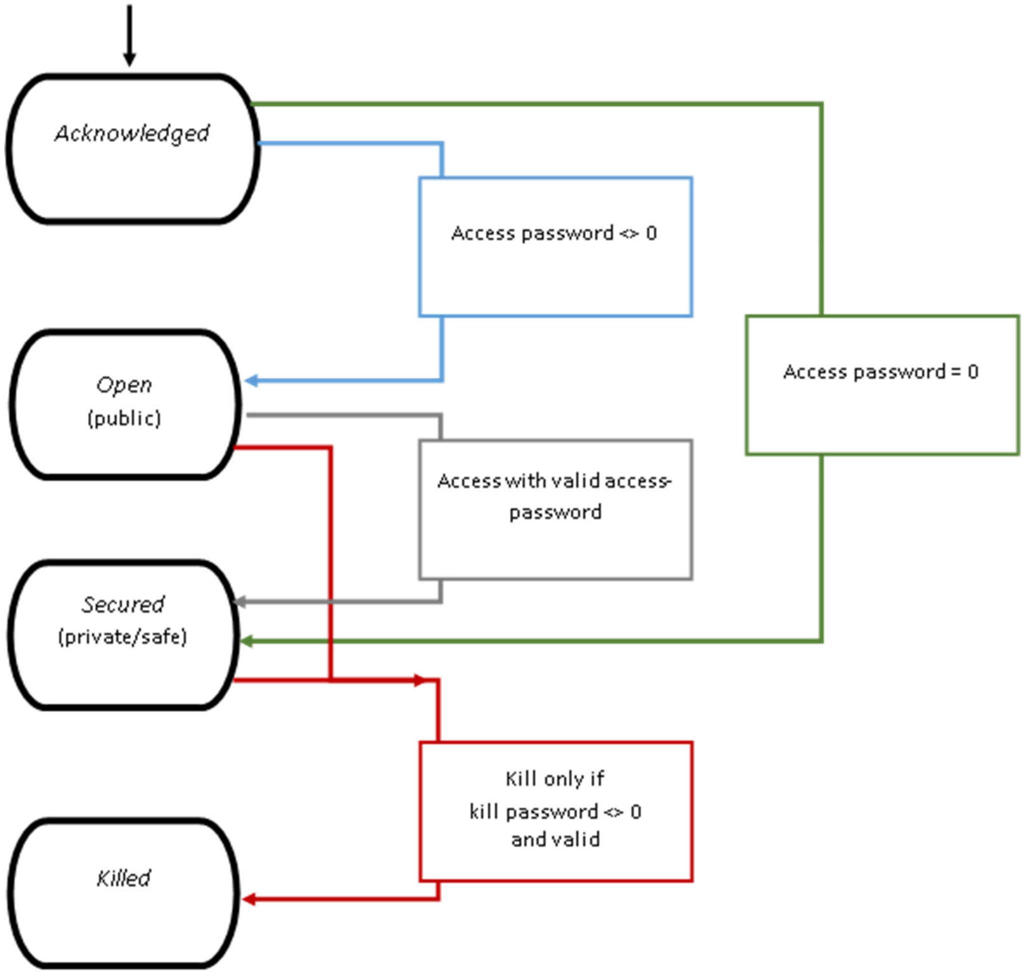



**Figure R.1: ACCESS / KILL Tag State Diagram**

NOTE: See Tag State Diagram figure in ISO/IEC 18000-63 for details.

The Secure state allows executing lock commands, which control the read/write access to the RFID transponder. This implies that each of the relevant memory banks of the RFID transponder is controlled separately. According to ISO/IEC 18000-63, and as shown in Table R.1, RFID transponders provide for the following locking options:

**Table R.1: Memory Bank Lock options according to ISO/IEC 18000-63**

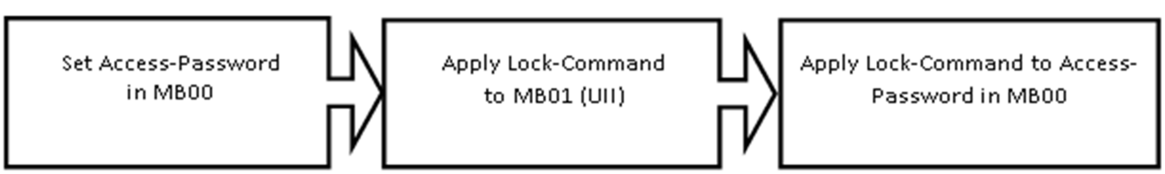
| OPTIONS | UII (MB01) / UM (MB11) |
|---|---|
| Unlocked | Associated memory bank is writeable from either the Open or Secured states. |
| Perma-Unlocked | Associated memory bank is permanently writeable from either the Open or Secured states and cannot be locked. |
| Locked | Associated memory bank is writeable from the Secured state but not from the Open states. |
| Perma-Locked | Associated memory bank is permanently not writeable from either the Open or Secured states. |
| **Options** | **PASSWORDS (MB00)** |
| Unlocked | Associated password location is readable and writeable from either the Open or Secured states. |
| Perma-Unlocked | Associated memory bank is permanently writeable from either the Open or Secured states and can’t be locked. |
| Locked | Associated password location is readable and writeable from the Secured state but not from the Open state. |
| Perma-Locked | Associated password location is not readable or writeable from either the Open or Secured states. |

MB00 (Passwords) may be protected against read and write access. MB01 (UII) and MB11 (UM) may be protected against write access only.

The kill command allows deactivating RFID transponders. Deactivating RFID transponders is irreversible. Therefore, this document highly recommends protecting RFID transponders against deactivation by setting the Kill Password in MB00 to “0binary” (cf. Figure R.1).

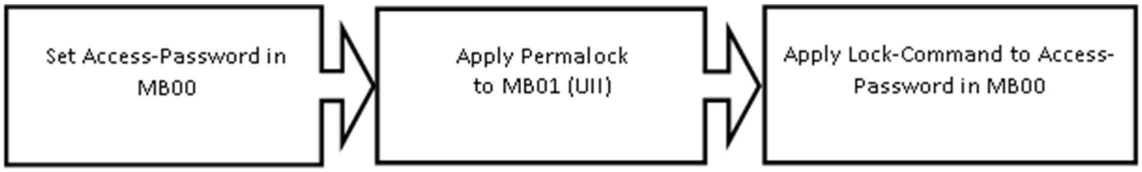
In Option 1 and Option 2, below, we show how to apply the read/write protection and prevent the RFID transponder from being deactivated.

**Option 1**: Protect UII against write access (reversible, password required) and lock Access-Password (reversible):



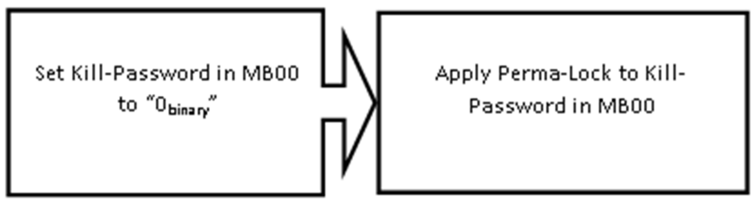

Locking the Access-Password in MB00 protects the password against read access and potential misuse.

**Option 2:** Permanently protect UII against write access (irreversible) and lock Access-Password (reversible):




Locking the Access-Password in MB00 protects the password against read access and potential misuse. This step may be omitted when applying a Permalock to MB01 since the Permalock is irreversible and permanently protects the UII against write access even if the correct Access-Password is provided.

After the write access to MB01 has been restricted, protect the RFID transponder from being deactivated by disabling the kill-command:




See ISO/IEC 18000-63, latest edition, for further details on read/write protection and the kill-command.

> NOTE: Several RFID equipment manufacturers implement proprietary commands for read/write protection. These commands may provide enhanced read/write options. Please review the manufacturer´s technical specifications and the applicable APIs for further information on hardware-specific read/write functionalities.

# ANNEX S: MB01; ISO-BASED DATA FORMAT EXAMPLES

**(Normative)**

**Table S.1: MB01 Coding Scheme for RTI or RPI**

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| **MB01: CRC + Protocol Control Word** | | | | |
| 00 – 0F | CRC-16 | Hardware assigned | 16 bits | Cyclic Redundancy Check |
| 10 – 14 | Length | Variable | 5 bits | Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field. |
| 15 | PC bit 0x15 | 0b0 or 0b1 | 1 bit | 0 = No valid User Data, or no MB11<br>1 = Valid User Data in MB11 |
| 16 | PC bit 0x16 | 0b0 | 1 bit | 0 = "Extended PC word" not used |
| 17 | PC bit 0x17 | 0b1 | 1 bit | 1 = Data interpretation rules based on ISO |
| 18 – 1F | AFI | 0xAC | 8 bits | Application Family Identifier used according to ISO/IEC 15961 and ISO 17364.<br>For hazardous parts use A8. |
| | ***Subtotal*** | | ***32 bits*** | |
| **MB 01: Unique Item Identifier (UII) with 8 bit encoding** | | | | |
| Start at location 20<br>Go to end of data / end of available memory | DI | "26B", "27B", "28B" or "29B" | 3 an | Data Identifier for RTI (RPI) Identification |
| | Issuing Agency Code (IAC) | "OD", "UN", "LA", "VTD" or "TAJ" | 2 or 3 an | Issuing Agency Code, according to DUNS, Odette, JIPDEC, TEIKOKU DATABANK or National Tax agency JAPAN |

| BIT LOCATION (HEX) | DATA TYPE | VALUE | SIZE | DESCRIPTION |
|---|---|---|---|---|
| | Company Identification Code (CIN) | As defined by the IAC | 6 an (OD), 9 n (UN and VTD), 12 an (LA), 13 n (TAJ) | Company Identification Number |
| | Serial Number (SN)<br><br>Consisting of RTI (RPI) Type Code, Separator and RTI (RPI) Serial Number | RTI (RPI) Type Code | 1...X an | Variable number of alphanumeric characters for the RTI (RPI) type assigned by the owner |
| | | + (Separator) | 1 an | "+" sign separator |
| | | RTI (RPI) Serial Number | 1...Y an | Up to Y alphanumeric characters, in capital letters |
| | EOT | | | End of Transmission character |
| | Padding until the end of the last 16-bit Word | 0b00000000 | 8bits | Word Padding<br>According to ISO/IEC 15962 |
| | ***Subtotal*** | | ***Variable*** | ***A minimum of 320 bits*** |
| | **TOTAL MB01:** | | **VARIABLE** | **A minimum of 352 bits** |

NOTE: The AFI shall NOT be encoded as part of the UII when PC Bit 17 = 1. The AFI is programmed into the Attribute / AFI section of MB01, starting at memory location 0x18 through memory location 0x1F. See ISO/IEC 15961-2 for details on the AFI. See Figure 15

The reference-ID is 8-bit encoded. In the PC area (header) the UII length is declared in 16-bit words (2 bytes).

DI "26B" in the UII (MB01)

For the step-by-step details on how the data were encoded, see ISO/IEC 17364.

**Reference ID (plain text)**

**26BUN123456789A153097+CS71489453**

**Hex code representation of each binary byte**

| | | | | | |
|---|---|---|---|---|---|
| 32 | 36 | 42 | 55 | 4E | 31 |
| 32 | 33 | 34 | 35 | 36 | 37 |
| 38 | 39 | 41 | 31 | 35 | 33 |
| 30 | 39 | 37 | 2B | 43 | 53 |
| 37 | 31 | 34 | 38 | 39 | 34 |
| 35 | 33 | | | | |

**PC data (Byte 1):**

| | | | |
|---|---|---|---|
| UII-length of 16-bit words: | 0b | ***1000 0*** | (32 bytes → 16 words [16 bits = 1 word]) |
| Valid User Memory: | 0b | ***0*** | (no user memory) |
| XPC: | 0b | ***0*** | (not used – reserved) |
| EPC or ISO code: | 0b | ***1*** | (ISO) |
| All PC bits: | 0b | ***1000 0001*** | (0x81) |

**Coded UII content (including PC and AFI) in HEX, in the form PC (1*) – AFI (2*) - UII:**

| 1* | 2* | UII | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 | AC | 32 | 36 | 42 | 55 | 4E | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 41 | 31 | 35 | 33 | 30 | 39 | 37 | 2B | 43 | 53 | 37 | 31 | 34 | 38 | 39 | 34 | 35 | 33 |

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5) ISO/IEC 15424 *Information technology – Automatic identification and data capture techniques – Data Carrier Identifiers (including Symbology Identifiers)*

6) ISO/IEC 15459 (all parts) *Information technology – Automatic identification and data capture techniques – Unique identification*

7) ISO/IEC 15963 *Information technology – Radio frequency identification for item management – Part 1: Unique identification for RF tags numbering systems*

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13) Odette *Transport Label*

14) Odette/VDA, *RFID in supply chain container management*

15) VDA 5500 *Basic Principles for RFID Application in the Automotive Industry*

*16)* VDA 5501 *RFID in Container Management*

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