JAIF Global Guideline for Returnable Transport Items (RTIs)

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Identification Guideline for Returnable Transport Items

Contents

Forward

In recent years, RFID technology has made tremendous progress and is now being utilized both in social life and in enterprise systems. Within the automotive industry, however, although individual enterprises make use of RFID, there are only a few examples of use between different companies in the supply chain.

The practical use of RFID has already begun globally in the logistics sector including in commercial distribution. If the individual members of the automotive industry anticipate the use of RFID between enterprises in the future and hope to build on these logistics systems, we should adopt general-purpose tags/equipment/software. With that goal in mind, the group first embraced the international standards of ISO and IEC, and then developed a general-purpose global guideline, which allows the automotive industry to co-operate with other industries.

Because co-operation with existing mission-critical systems and the database of each enterprise is critical, co-existence with current systems was a consideration during the development of this guideline. It is consistent with industry standards already widely deployed.

The RFID working group of the Joint Automotive Industry Forum (JAIF) was created to promote electronic information standardization in the automotive industries of Japan, the U.S., and Europe. The JAIF comprises the regional automotive associations of Odette (Europe), JAMA and JAPIA (Japan), AIAG and STAR (North America), co-operating together under an agreement to produce global guidelines and recommendations for use in the automotive industry. See Annex N.

This Global Guideline began as an effort to define the data carrier selection, data structure and storage of data for returnable transport items. It evolved to address the well-identified business need in Japan, the U.S., and Europe for RF tags to carry both the UII and User Data.

It is hoped that the scope of this guideline will not only realize international traceability and recycling management of returnable transport items, but will also facilitate processes such as customs clearance and promote elimination of returnable transport items tax.

In this guideline, the word ‘should’ is a recommendation; the word ‘shall’ is a requirement.

In the Annexes of this guideline, “Normative” is information that is part of the standard, “Informative” is information within the standard, which while related, is not part of the standard.

Nothing in this guideline supersedes applicable laws and regulations. This guideline is to be applied in addition to other mandatory requirements.

Introduction

Participation in the RFID working group by automotive industry groups from Japan, the U.S., and Europe has created this Global Guideline under the auspices of the JAIF. Each JAIF association holds the joint copyright for the contents of this guideline, except for the information included in public documents such as ISO standards. The English version of this guideline is the original version. Each JAIF association is responsible for translations, but the English version will always be the reference in the case of dispute.

Acknowledgements

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Identification Guideline for Returnable Transport Items

1 Scope

These guidelines are based exclusively on ISO structures. They ensure compatibility between readers and tags using Issuing Agency Codes from UN, OD, LA, D and GS1.

This global guideline recommends the basic features of data carriers applied to returnable transport items for use within the Layer 2 and Layer 3 of the supply chain (see Figure 1). In particular, this guideline:

— 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.

— specifies the reuse and recyclability of the 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.

2 Normative References

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

ISO 445, Pallets for materials handling — *Vocabulary*

ISO/IEC 646, *Information processing — ISO 7-Bit coded character set for information interchange*

ISO 830, *Freight containers — Vocabulary*

ISO 15394, *Packaging — Bar code and two-dimensional symbols for shipping transport and receiving labels*

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

ISO/IEC 15416, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification - Linear symbols*

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

ISO/IEC 15418, *Information technology — Automatic identification and data capture techniques — GS1 Application Identifiers and ASC MH 10 Data Identifiers and maintenance*

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

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

ISO/IEC 15459-1, *Information technology — Unique identifiers — Part 1: Unique identifiers for transport units*

ISO/IEC 15459-2, *Information technology — Unique identifiers — Part 2: Registration procedures*

ISO/IEC 15459-3, *Information technology — Unique identifiers — Part 3: Common rules for unique identifiers*

ISO/IEC 15459-4, *Information technology — Unique identifiers — Part 4: Unique identifiers for supply chain management*

ISO/IEC 15459-5, *Information technology — Unique identifiers — Part 5: Unique identifiers for returnable transport items (RTIs)*

ISO/IEC 15459-6, *Information technology — Unique identifiers — Part 6: Unique identifiers for product groupings*

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

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

ISO/IEC 15961-3, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: Part 3: RFID data constructs*

ISO/IEC 15961-4, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: Part 4: Application interface commands for battery assist and sensor functionality*

ISO/IEC 15962, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions*

ISO/IEC 15963, *Information technology — Radio frequency identification for item management — Unique identification for RF tags*

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

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

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

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

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

ISO 17366, Supply chain application of RFID — *Product packaging*

ISO 17367, Supply chain application of RFID — *Product tagging*

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

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

ISO/IEC TR18046, *Information technology — Automatic identification and data capture techniques — Radio frequency identification device performance test methods*

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

ISO/IEC 19762-2, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 2: Optically readable media*

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

ISO/IEC 19762-4, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 4: General terms relating to radio communications*

ISO 21067, Packaging — *Vocabulary*

ISO 22742, *Packaging — Linear bar code and two-dimensional symbols for product packaging*

ISO/IEC PRF TR24720, *Information technology — Automatic identification and data capture techniques — Guidelines for direct part marking (DPM)*

ISO/IEC TR24729-1, *Information technology — Radio frequency identification for item management — Implementation guidelines — Part 1: RFID-enabled labels and packaging*

ISO/IEC TR24729-2, *Information technology — Radio frequency identification for item management — Implementation guidelines — Part 2: Recycling and RF tags*

ISO 28219, Packaging — *Labelling and direct product marking with linear bar code and two-dimensional symbols*

ISO/IEC 29133, *Information technology — Automatic identification and data capture techniques — Quality test specification for rewritable hybrid media data carriers*

ISO/IEC 29158, *Information technology — Automatic identification and data capture techniques — Direct Part Mark (DPM) Quality Guideline*

ISO/IEC 29160, *Information technology — Automatic identification and data capture techniques — RFID Emblem*

3 Terms and Definitions

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

3.1
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

[ISO 19762, 05.01.01]

3.2
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

[ISO/IEC 19762, 3]

3.3
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)

NOTE: Each Code 39 symbol consists of a leading quiet zone, a start symbol pattern, symbol characters representing data, a stop pattern, and a trailing quiet zone. Each Code 39 character has three wide elements out of a total of nine elements. Each symbol consists of a series of symbol characters, each represented by five bars and four intervening spaces. Characters are separated by an inter-character gap. Each element (bar or space) is one of two widths. The values of the X dimension and wide-to-narrow ratio remain constant throughout the symbol. The particular pattern of wide and narrow elements determines the character being encoded. The inter-character gaps are spaces with a minimum nominal width of 1X. See ISO/IEC 16388 for the Code 39 symbology specification.

[ISO 22742, 3.1]

3.4
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

NOTE: Code 128 allows numeric data to be represented in a compact double-density mode, with two data digits for every symbol character. Each Code 128 symbol uses two independent self-checking features, character self-checking via parity and a modulo 103 check character. Each Code 128 symbol consists of a leading quiet zone, a start pattern, characters representing data, a check character, a stop pattern, and a trailing quiet zone. Each Code 128 character consists of eleven 1X wide modules. Each symbol character is comprised of three bars alternating with three spaces, starting with a bar. Each element (bar or space) can consist of one to four modules. Code 128 has three unique character sets designated as Code Set A, B and C. Code set A includes all of the standard upper-case alphanumeric keyboard characters, the ASCII control characters having an ASCII value of 0 to 95, and seven special characters. Code set B includes all of the standard upper-case alphanumeric keyboard characters, lower-case alphabetic characters (specifically ASCII character values 32 to 127), and seven special characters. Code set C includes the set of 100 digit pairs from 00 through 99, inclusive, as well as three special characters. The FNC1 character in the first character position after the start pattern of Code 128 designates that the data that follows complies with the GS1-128 standards. See ISO/IEC 15417 for the Code 128 symbology specification.

[ISO 22742, 3.2]

3.5
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

[ISO 28219, 3.3]

3.6
data element separator
specified character used to delimit discrete fields of data

[ISO 22742, 3.6]

3.7
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

NOTE: Developed by International Data Matrix in 1989 with finalized design in 1995

NOTE: The symbology has error detection and error correction features. Each data matrix symbol consists of data regions that contain nominally square modules set out in a regular array. A dark module is a binary 1 and a light module is a binary 0. There is no specified minimum or maximum for the X or Y dimension. The data region is surrounded by a finder pattern that is surrounded by a quiet zone on all four sides of the symbol. The finder pattern is a perimeter to the data region and is one module wide. Two adjacent sides are solid dark lines used primarily to define physical size, orientation and symbol distortion. The two opposite sides are made up of alternating dark and light modules. These are used primarily to define the cell structure but can also assist in determining physical size and distortion. The intellectual property rights associated with data matrix have been committed to the public domain. See ISO/IEC 16022 for the data matrix symbology specification.

[ISO 22742, 3.8]

3.8
error correction
mathematical procedure that allows the detection and rectification of errors to take place

[ISO 22742, 3.15]

3.9
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

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.

[ISO 22742, 3.16]

3.10
inlay / inlet
substance usually made of a film onto which RF tags' IC chip and antenna are jointly attached

3.11
integrity
designed such that any modification of the electronically stored information, without proper authorization, is not possible

[ISO 17364, 4.7]

3.12
ISO Unique Item Identifier
ISO/IEC 18000-6C tag with Protocol Control bit 17_{hex} set at "1' indicating that what follows is an Application Family Identifier (AFI)

[ISO 17364, 4.9]

3.13
label
adhesive backed media capable of being marked with information in machine-readable and/or human-readable form

NOTE: Both labels and direct marking methods are referred to in this guideline under the term "label".

[ISO 28219, 3.8]

3.14
manufacturer
actual producer or fabricator of an item; not necessarily the supplier in a transaction

[ISO 28219, 3.9]

3.15
product packaging
commercial unit of components defined by the supplier, including, if applicable, their means for protection, structured alignment or for automated assembly

[ISO 22742, 3.4]

3.16
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.

NOTE: Introduced in 1994 by DENSO Corporation.

NOTE: A wide range of sizes of symbol is provided for together with four levels of error correction. Module dimensions are user-specified to enable symbol production by a wide variety of techniques. The symbol size (not including the quiet zone) is 21 by 21 modules to 177 by 177 modules. The symbology efficiently encodes Kanji and Kana as well as encoding numeric, alphanumeric, and 8-bit byte data. See ISO/IEC 18004 for the QR Code symbology specification.

[ISO 22742, 3.35]

3.17
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

[ISO/IEC 19762-3]

3.18
returnable transport item (RTI)
all means to assemble goods for transportation, storage, handling and product protection in the supply chain which are returned for further usage, including for example pallets with and without cash deposits as well as all forms of reusable crates, trays, boxes, roll pallets, barrels, trolleys, pallet collars and lids.

NOTE: The term returnable transport item is usually allocated to secondary packaging. But in certain circumstances also primary packaging may be considered as a form of RTI.

NOTE: The term returnable transport equipment is considered to have the same definition as the term returnable transport item within an electronic data interchange environment.

[ISO 17364]

3.19
RF tag
combination of radio transmitter and radio receiver which transmits a signal automatically in response to an appropriate triggering signal

NOTE The signal transmitted in response is in part predetermined and is generally different from the response to an appropriate triggering signal. [IEC 60050-713 713-08-04]

[ISO/IEC 19762-3]

3.20
serial number
unique numeric, digital or alphanumeric code assigned by the supplier to an entity for its lifetime

EXAMPLE: Computer serial number, traceability number and contact tool identification

[ISO 22742, 3.37]

3.21
supplier
party that produces, provides, or furnishes an item or service

[ISO 28219, 3.12]

3.22
traceability number
code assigned by the supplier to identify/trace a unique group of entities (e.g. lot, batch)

[ISO 22742, 3.42]

3.23
transport unit
either a transport package or a transport unit with RTI.

[ISO 15394, ISO 17364]

3.24
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.

[ISO 15394, ISO 17364]

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 overlapping with other levels.

Figure 1 below provides a graphical representation of "supply chain". The figure is a conceptual model of possible 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 guideline is intended to focus on Layers 2 and 3 in the "supply chain" as shown in the figure below. Information on the cases and bottles for other layers is also provided in Annex A for referential purposes.

This guideline complies with ISO 15394 (Linear and two-dimensional symbols for shipping, transport and receiving labels), ISO 17364 (Returnable transport items) that defines the supply chain applications of RFID and ISO 17365 (Transport units). It is also consistent with ISO/IEC 15459-5 (Returnable transport items) and ISO/IEC 15459-1 (Transport units) that defines the unique identifiers of a data structure (see Annex P).

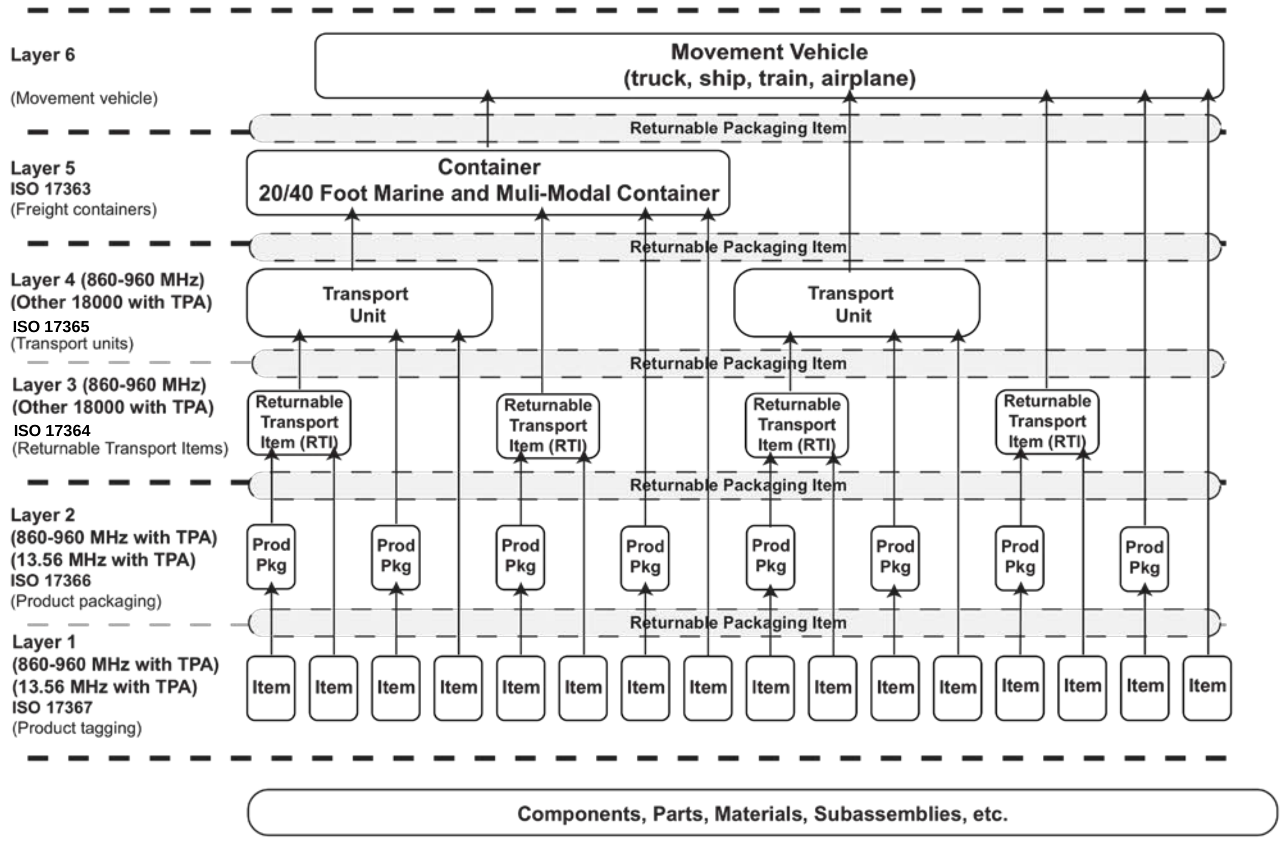

Figure 1 – Supply chain layers

5 Returnable Transport Items (RTIs)

For the purpose of this guideline, returnable transport items (RTIs) typically refer to logistics materials mainly used between vehicle manufactures and the automotive parts manufacturers and suppliers in transferring parts and assemblies. The aim of this guideline is to stipulate the identification method of RTIs, to establish an efficient RTI control system throughout the global automotive industry. However, considering the fact that 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 Layer 2 and Layer 3 RTIs including those not exemplified here, the focus of this guideline is placed on the typical RTI characteristics.

5.1 Returnable transport items of Layer 3

5.1.1 Pallets

Figures from 2 to 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 8). This guideline is applicable to this type of special pallet.

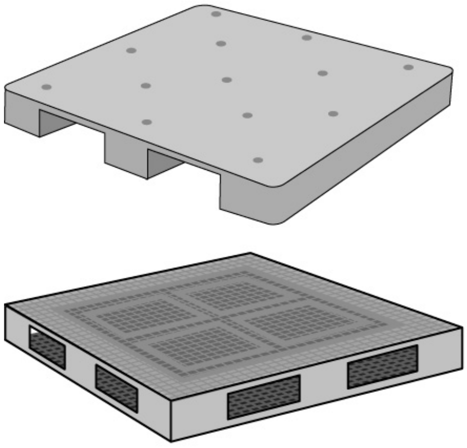

Figure 2 – Plate pallets

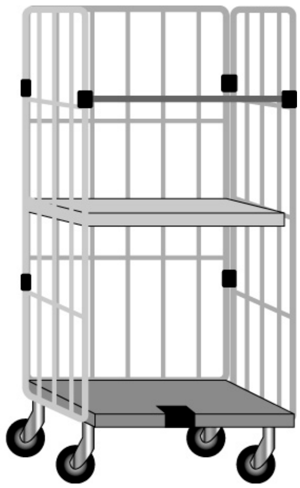

Figure 3 – Roll box pallet

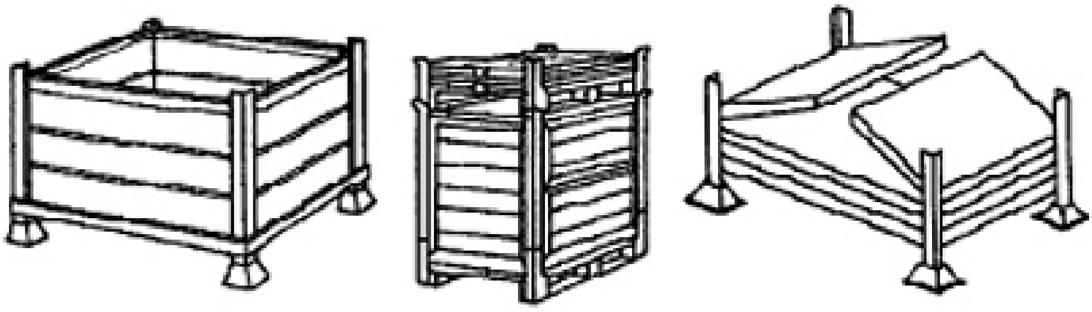

Figure 4 – Box pallets

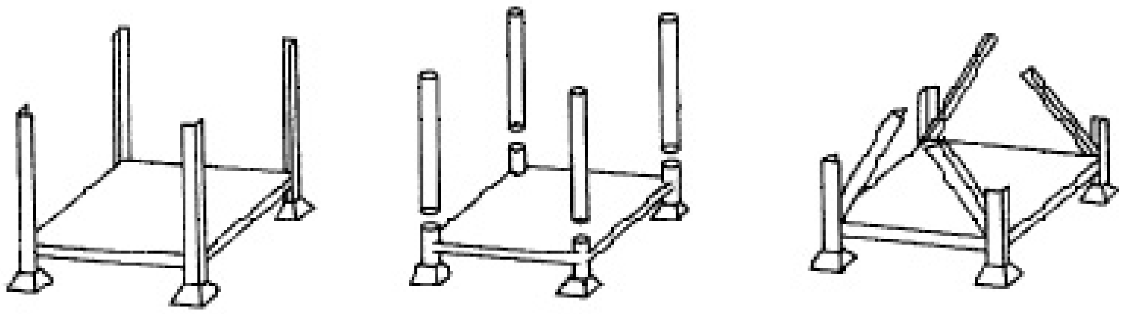

Figure 5 – Post pallets

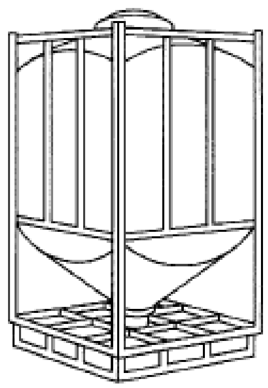

Figure 6 –Silo pallet

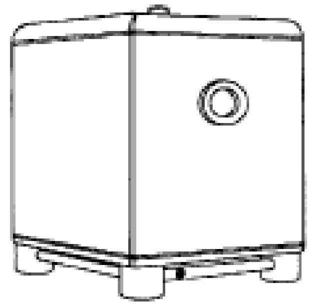

Figure 7 – Tank pallet

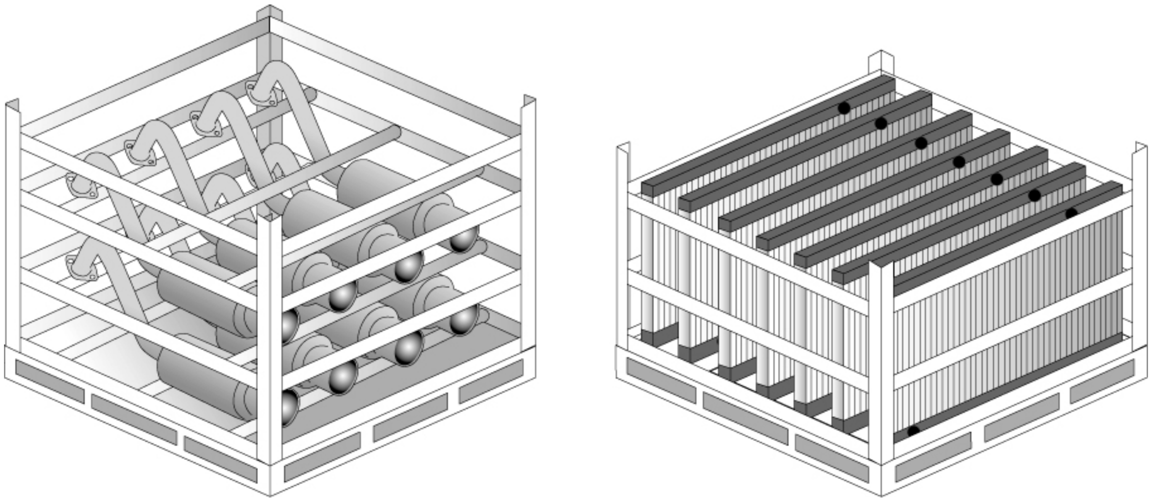

Figure 8 – Special pallets

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 a friction generated between the returnable transport item and the undercarriage of the truck. Pull the tab of the sheet pallet and the returnable transport item on the truck is smoothly unloaded from the truck without difficulties (see Figure 9). The sheet pallet can be also used between the returnable transport item and the plate pallet.

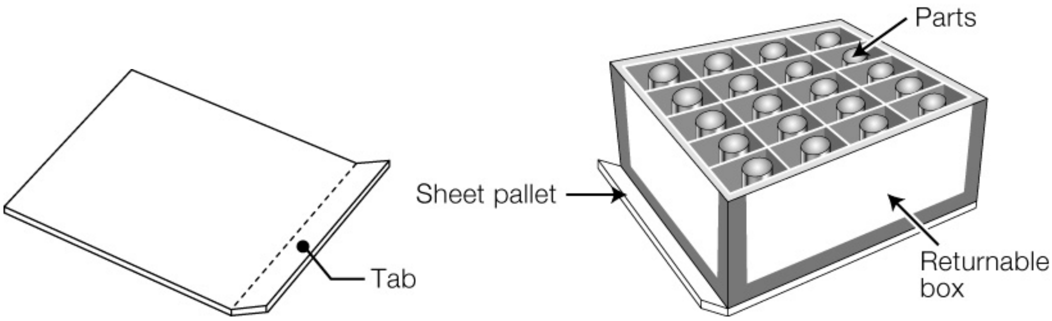

Figure 9 – Sheet pallet

5.2 Returnable transport items of Layer 2

Figures from 10 to 12 below show typical examples of returnable transport items 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, oil and powders are not the target of this guideline. However, this guideline may be used for the container that is repeatedly used for carrying non-solid substances associated with vehicle production such as gasoline, oil, coating materials or hydrogen.

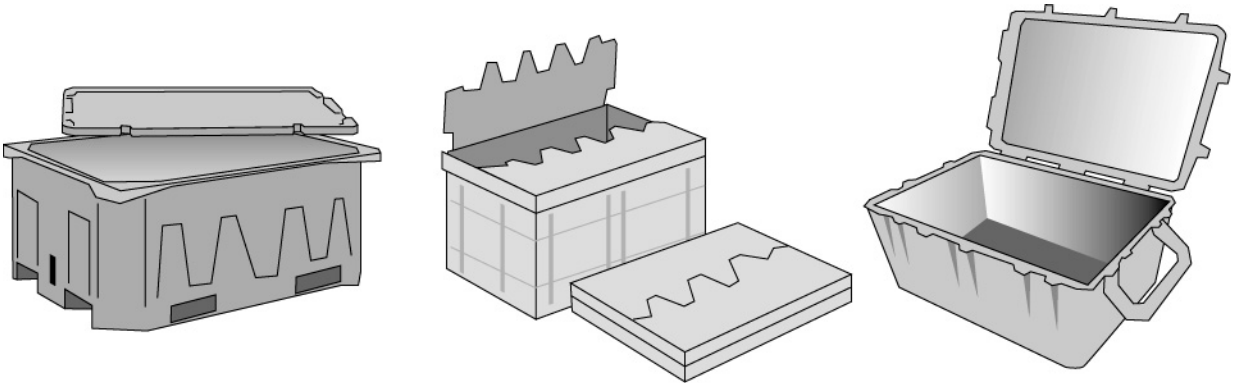

Figure 10 – Large-sized returnable transport items

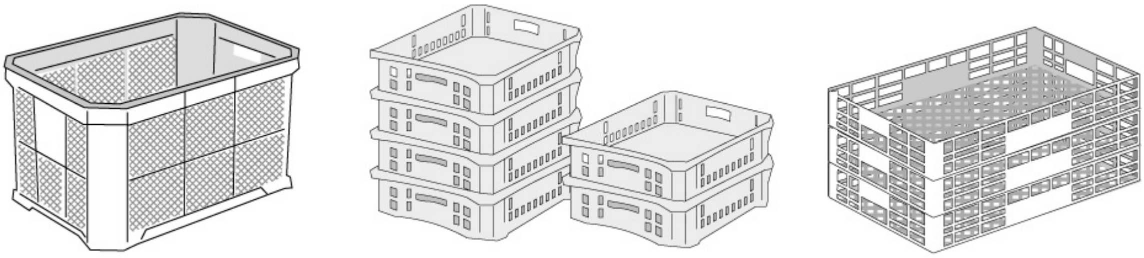

Figure 11 – Medium-sized returnable transport items

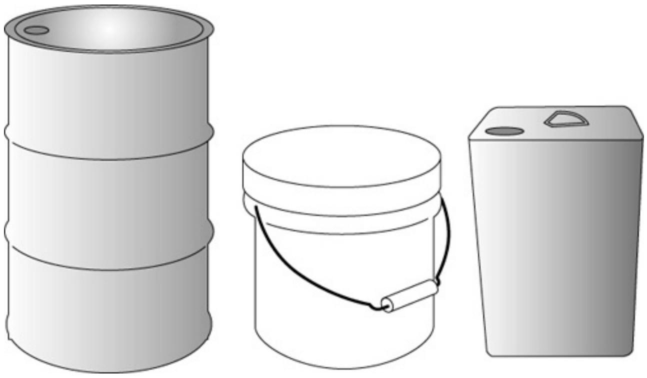

Figure 12 – Liquid-containers like metallic drums

5.3 Partitions

Some of the pallets and returnable transport items are equipped with a shock absorber so as to protect them from potential damage caused by a shock or vibration expected somewhere 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 returnable transport item. This kind of accessory for a pallet or returnable transport item is defined as a "partition" in this guideline. The typical example of this is a post-type partition used with the post pallet. Also included in this group is packing material used to place or arrange the contents between the posts, or a packing material for dividing the inside of the returnable transport item into several smaller sections (see Figures 13, 14 and 15). This guideline is applicable to these kinds of partitions.

5.3.1 Posts

Figure 13 shows a post that is normally used to securely fix packing materials or returnable transport item on the post pallet. Most of these posts are made of high durable substances like plastic or metal.

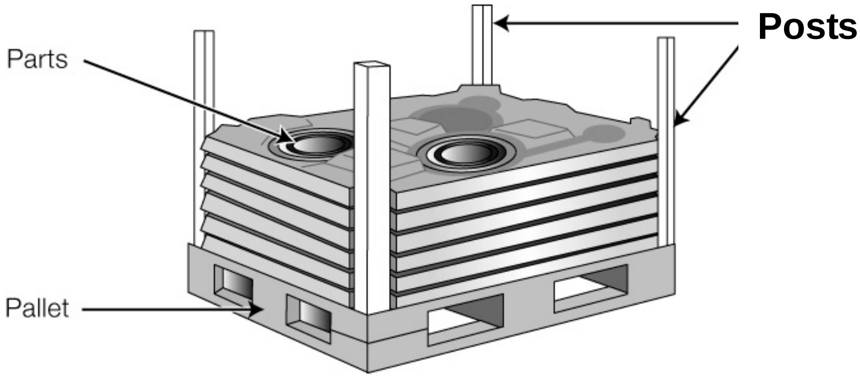

Figure 13 – Post

5.3.2 Packing materials

Some kind of packing materials should be provided to protect the items from a shock or vibration that may be encountered during transportation, or protect them from being touched or hit by the pallet or returnable transport item in which they are placed. Most of the packing materials are made of high resilient flexible substances like plastic, urethane, and polystyrene foam. This guideline is applicable to these kinds of packing materials (see Figure 14 and Figure 15).

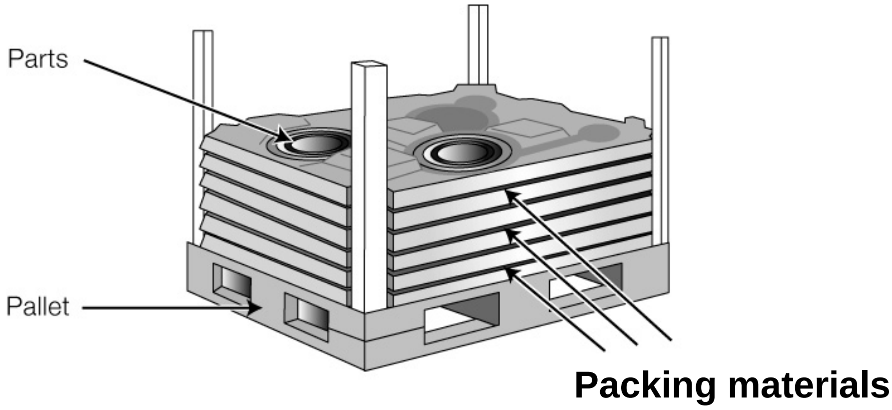

Figure 14 – Packing material

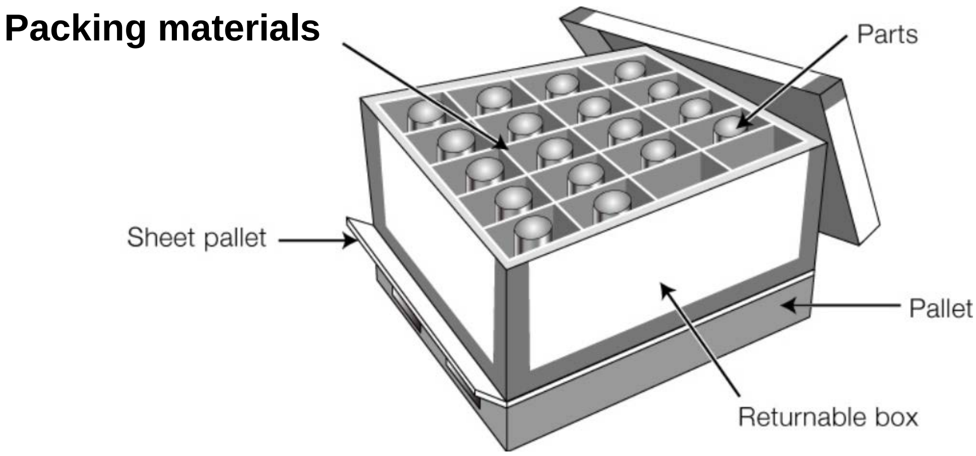

Figure 15 – Packing material

6 Unique Identifier of Returnable Transport Items (RTIs)

6.1 Data field identification

The Data Identifier “25B” is defined in ANS MH10.8.2 and its usage is described in ISO/IEC 15459-5 and shall be used as the monomorphic unique item identification for RTIs (see Annex B). See Table 1 for the definition of “25B”.

6.2 Maximum data length

RTI identification data shall contain a maximum of 35 (inclusive of the Data Identifier) characters.

A maximum of 50 characters can be used if agreed upon between the trading partners.

6.3 Character set

The identity shall only contain upper-case alphabetic characters and numeric digits of the invariant character set of ISO/IEC 646, see Annex A in ISO/IEC 15459-3.

NOTE: An Issuing Agency may put additional restrictions on the repertoire for identities for RTIs using its IAC.

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

6.4 Data structure

Table 1 below shows the RTI’s Unique Item Identifier (UII) data structure.

Table 1 – Data structure

25B	IAC	CIN	SN

6.4.1 Issuing Agency Code (IAC)

Issuing Agency Code (IAC), which consists of a maximum of 3 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. Other IACs registered by NEN may be used with mutual agreement between trading partners. This includes, for example, UN (Dun & Bradstreet), OD (Odette Europe), LA (JIPDEC/CII) and D (NATO AC135).

NOTE: Dun & Bradstreet - the Data Universal Numbering System or D-U-N-S® Number is D&B's copyrighted, proprietary means of identifying business entities on a location-specific basis.

JIPDEC/CII - "Center for the Informatization of Industry - Japan Information Processing Development Center".

NATO AC135 - The NATO Codification System is managed and run by a NATO Cadre Group consisting of the National Directors on Codification Allied Committee 135 (AC135).

6.4.2 Company Identification Number (CIN)

Company Identification Number (CIN) is a code that is assigned to each individual company by the issuing agency for unique identification of the 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 guideline, need to have a unique CIN allocated by the appropriate issuing agency.

6.4.3 Serial Number (SN)

When the SN is combined with IAC and CIN the combination shall consistute a globally unique identifier for the RTI. Once contributed to an RTI the IAC, CIN and SN combination is ment to be fixed and unchangeable for a specific RTI throughout its lifetime

Serial Number (SN) may be composed of numeric or alphabetic characters or a combination of both. 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 R.

The data structure for the Serial Number can thus have two formats (see Table 2.1 and 2.2):

a) An unstructured Serial Number

Table 2.1 – Serial Number data structure

SN

b) A structured Serial Number composed of an Object Data component and an Object Sequence Number

Table 2.2 – Serial Number data structure

OD	OSN

Different definitions of the Serial Number will be described in Annex R.

6.5 Data Field Syntax

6.5.1 RFID data field structure

Tags having no User Memory (MB11$_2$) and encode only MB01$_2$, MB10$_2$, and MB00$_2$ have no syntax and are referred to as “identity-only tags” (see Annex F). Table 1 describes the basic data structure.

Tags using multiple fields of data in MB11$_2$ (User Memory) are, for the purposes of this guideline, considered to be “complex tags”.

The definition of data storage for RF tags complies with ISO 17364 (see Annex F).

If MB11$_2$ (User Memory) is used (contains structured data), PC bit 15$_{hex}$ in MB01$_2$ is set to “1$_2$”. When PC bit 15$_{hex}$ in MB01$_2$ is set to “0$_2$” MB11$_2$ (User Memory) is not used (does not contain structured data) (see Figure F1 in Annex F).

The structure of the memory banks of ISO/IEC 18000-6C RFI tags is shown in Figure F2 in Annex F. When PC bit 17$_{hex}$ in MB01$_2$ is set to “1$_2$” this indicates that the data in MB01$_2$ is an ISO-compliant AFI (Application Family Identifier), whose value is either A3$_{hex}$ or A8$_{hex}$, as specified in Annex D. Setting PC bit 17$_{hex}$ in MB01$_2$ to “0$_2$” indicates that the data encoded in MB01$_2$ will be EPC- compliant. See Annexes K and L.

The RTI unique identifier (25B, IAC, CIN and SN) is always stored in MB01$_2$ (UII).

6.5.2 Linear symbology data field structure

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

Table 3 – Stored data structure of linear symbol

25B	IAC	CIN	SN

When concatenating data in a linear symbol, the total length should be limited to 35 data characters, including the associated Data Identifiers (DIs) and concatenation characters but not including symbology overhead characters (see Annex B). If the length exceeds the 35-character maximum message length, the use of two-dimensional symbols is recommended.

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

b) When variable length data fields need to be concatenated using the Code 39 symbology, the plus “+” character (ASCII Decimal 43) shall be used to delineate between data fields, per ISO/IEC 15418 (ANS MH10.8.2).

c) When multiple variable length data fields need to be concatenated using the Code 128 symbology with Data Identifiers, the plus “+” character (ASCII Decimal 43) shall be used to delineate between data fields, per ISO/IEC 15418 (ANS MH10.8.2).

6.5.3 Two-dimensional symbology data field structure

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

6.5.4 Rewritable hybrid media data field structure

6.5.4.1 RFID data field structure

Refer to Section 6.5.1 for the structure of RFID data field.

6.5.4.2 Linear symbology data field structure

Refer to Section 6.5.2 for the structure of linear symbology data field.

6.5.4.3 Two-dimensional symbology data field structure

Refer to Section 6.5.3 for the structure of two-dimensional symbology data field.

6.5.4.4 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 is transmitted after the identifier Z2 as described in Annex D. Refer to Annex G for more information.

Table 4 – Structure of data transmitted by multi-media reader

]Z2	A3	25B	IAC – CIN – SN
Data Carrier Identifier	AFI	ISO/IEC 15459-5 Data Identifier	Unique Identifier

NOTE: The Data Carrier Identifier “]” should be $5D_{hex}$ defined in ISO/IEC 646.

7 RFID Requirements

RF tags shall comply with ISO/IEC 18000-6C. Requirements for RFID not specified in this guideline shall comply with ISO 17364.

See Annex F for the recommended memory structure and Annex I for the recommended environmental and performance specifications.

7.1 Tag structure

7.1.1 Memory bank 01_2

$MB01_2$ shall contain the ISO/IEC 15961 AFI for returnable transport items, i.e. $A3_{hex}$ or $A8_{hex}$, in bits 18_{hex} - $1F_{hex}$ as described in Annex F.

7.1.2 Memory bank 11_2

Data, other than the UII or the AFI, shall go into the User Memory bank ($MB11_2$), and shall comply with ISO/IEC 15961 and ISO/IEC 15962.

7.1.3 Tag memory bank

In ISO/IEC 18000-6C tags, tag memory shall be logically separated into four distinct banks, each of which may comprise one or more memory words. A logical memory map is shown in Figure F.2 in Annex F.

7.2 Protocol control (PC) bits

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

7.3 Data element

7.3.1 Tag data elements

The Unique RTI Identifier shall conform to ISO/IEC 15459-5 and shall be used as described in ISO 17364.

Some users may desire that one RF tag holds the unique RTI identification data, while another RF tag holds the unique shipment identification data. Unique identification of shipments is addressed at length in ISO 17365.

$MB01_2$ contains the Unique Item Identifier for the RTI, and $MB11_2$ contains User or Business data.

Additional tag data shall include the appropriate ISO/IEC 15459-5 unique identifier. For the purposes of this guideline, the required data element in compliant tags is only the Unique RTI Identifier. However, for practical purposes, there are three unique identifiers, 1) RTI Identifier, 2) Item Identifier and 3) Transport Unit Identifier. Of these, the RTI Identifier is encoded in the UII memory bank ($MB01_2$). The transport unit and unique Item Identifiers are encoded in the User Memory bank ($MB11_2$).

The Unique RTI identifier (UII) shall be either locked, using a password, or optionally Permalocked.

NOTE: It must be noted that, when the UII has been locked (and the password is not available) or Permalocked, software CANNOT CHANGE the state of PC Bit 15_{hex} of $MB01_2$ (User Memory indicator). To protect the standards-based functionality of PC Bit 15_{hex}, it is strongly recommended that BEFORE the UII is locked or Permalocked a datum (FE_{hex} is recommended) be programmed into the first byte of $MB11_2$ (as a placeholder), and that PC Bit 15_{hex} of $MB01_2$ be changed to a “1”. Then the UII can be locked or Permalocked and $MB11_2$ can still be used correctly.”

In real-world applications there are two effective implementations; 1) Placing the Unique RTI Identifier within $MB01_2$ of a “unique-ID-only” RF tag (for example a 96-bit or 240-bit RF tag). 2) Placing the unique RTI identifier within $MB01_2$, and data that identifies the product that the RTI is carrying within $MB11_2$ on a tag that has the full complement of ISO/IEC 18000-6C / EPCglobal UHF Gen2 memory banks.

7.3.2 Hazardous materials (HazMat)

The presence of hazardous material for ISO RTIs is indicated by the AFI “$A8_{hex}$” (see Annex D) in bit 18_{hex} through $1F_{hex}$ of the PC bits of memory bank $MB01_2$ as defined in ISO/IEC 18000-6C. When the AFI value is $A8_{hex}$, 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 $MB11_2$. See Table F.2 in Annex F.

7.3.3 Optional data

Optional data may be written to a tags’ User Memory bank ($MB11_2$) 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 clients 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.

7.3.4 Data compaction

The data compaction described here shall conform to ISO/IEC 15962. See Annex T.

7.4 Traceability

Unique identification is a critical element of traceability. Traceability is an ability to identify or distinguish a particular item from similar articles or groups of similar articles.

Serialization schemes shall comply with ISO/IEC 15459-5.

7.5 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 the 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, that is, “$A2_{hex}$” or “$A7_{hex}$” for license plate (shipment identification) and “$A3_{hex}$” or “$A8_{hex}$” for the RTI AFI. The respective ISO/IEC 15459-5 Data Identifier follows the AFI as specified in ISO/IEC 15418.

In the case of the RTI, that Data Identifier is “25B”. In the case of the transport unit, that Data Identifier is the appropriate “J” Data Identifier. For tags of ISO/IEC 18000-6C, the Unique RTI Identifier shall be written to the UII memory and locked. The transport unit’s identifier shall be preceded by the DI "J" and written along with additional data (with the appropriate DI) and locked in User Memory.

7.6 Back-up

Use of human-readable interpretation (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.

7.7 Tag lifetime

Tags attached to the RTI will 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. Reusing a tag after reprogramming it is feasible without compromising the supply chain data structure. The implementation should be determined depending on the cost of the tag and environmental implications for reuse/recycling.

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

7.8 Minimum reliability

A reading system in which tags are positioned, programmed and presented in accordance with the provisions of ISO/IEC 18046 and Section 7.1 above, shall have a minimum read reliability of 99,99%, i.e. no more than one no-read event in 10 000 readings, and a read accuracy of 99,998%, i.e. two incorrect readings in 100 000 readings.

7.9 Air interface

This guideline recommends air interface specification as defined in ISO/IEC 18000-6C.

7.10 Tag recyclability

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

7.11 Tag security

7.11.1 Confidentiality

Tag users desiring to have their tags read only by authorized users shall have the ability to encrypt the data written in a tag. The tag shall be capable of having secured/encrypted data written to it and read from it without interference from the tag design or structure. Use of this feature shall be at the discretion of the user.

7.11.2 Data integrity

At the discretion of the user, tags shall have the ability commonly known as "locking" data to prevent the alteration or erasure of the data. Tag manufacturers shall have the option of locking part of the tag data for identification and storage of the data related to the manufacturer, not the user (see Annex F). 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 Figure F.2 in Annex F. The definition of CRC-16 is given in Annex F.

7.12 Tag identification mark

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

Figure 16 below shows the example of RFID emblem.

Figure 16 – Example of RFID emblem

8 Rewritable Hybrid Media Requirements

An RF tag does not have a visual 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 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 is likely to increase if high capacity memory is required, because the reading speed generally decreases as the size of memory capacity increases. Considering the fact that 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 is capable of reprogramming the data in the RF tags as well as in the linear or two-dimensional symbols should be provided.

8.1 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.

8.2 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.

8.3 RFID requirements

Refer to Section 7.

9 Layout and Location of Linear and 2D Labels

9.1 Layout

A 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 labelling and direct marking requirements. See Annex Q.

9.2 Location

A location refers to the positioning of the label on the RTI. Each label should be located 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 position.

9.3 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 labelling 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 labelling or marking, the title may be eliminated. Elimination of the title should be mutually agreed upon between the trading partners.

9.4 Human readable interpretation (HRI)

For linear symbols, the human-readable interpretation (HRI) should be printed adjacent to 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 of the data within the linear symbol without the DI.

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.

Human Readable Interpretation of the data on a returnable transport item RF tag is optional, except when required by regulation or statute. HRI is the literal representation of all of the data on the tag, including semantics. 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. 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.

10 Linear and 2D Symbology Requirements

10.1 Symbology recommendations

Code 39 and Code 128 are the recommended linear symbologies and QR Code and Data Matrix are the recommended 2D symbologies.

10.2 Linear symbology requirements

The linear symbologies referenced in this guideline shall use ISO/IEC 16388 (Code 39, see 3.3) or ISO/IEC 15417 (Code 128, see 3.4).

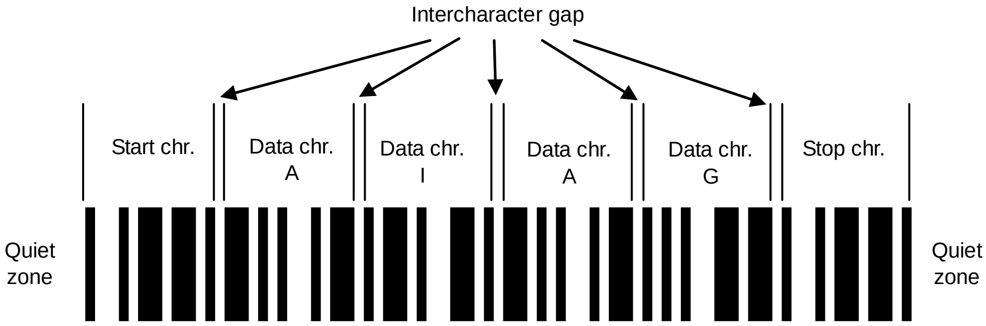

Figure 17 – Structure of Code 39

Figure 18 – Structure of Code 128

10.2.1 "X" dimension and wide/narrow ratio

The narrow element dimension (X dimension) range should be from 0.25 mm to 0.51 mm as determined by the printing capability of the supplier/printer of the label. For the smaller X dimensions, care must be given to match the X dimension to an integer multiple of the resolution of the printer. Conformance to linear symbol print quality requirements shall be determined according to Section 10.2.4 below.

When using Code 39, the wide / narrow ratio shall be within the range of 2.5:1 to 3.0:1. To enable the user to easily scan Code 39, the wide / narrow ratio should be within the range of 2.8:1 to 3.0:1.

10.2.2 Symbol height

Linear symbol height should be no less than 15 percent of the length of the linear symbol.

10.2.3 Quiet zone

The linear symbol should have minimum quiet zones of 6.4 mm adjacent to the start and stop characters. To enable the user to easily scan the linear symbol, quiet zones shall be a minimum of ten times the narrow element width (X dimension).

10.2.4 Print quality

Linear symbol print quality shall be measured at the consignee's point of scan, in accordance with ISO/IEC 15416 in the light range (ex. 660 nm).

10.3 Two-dimensional symbology requirements

Label information can be binary encoded in two-dimensional symbols conforming to ISO/IEC 18004 (QR Code Model 2, see 3.16), or ISO/IEC 16022 (Data Matrix ECC200, see 3.7). The data stream shall be as specified in ISO/IEC 15459-5 (see Annex B and E).

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

10.3.1 QR Code symbology requirements

The QR Code Model 2 symbol (see Figure 19) referenced in this guideline is defined in ISO/IEC 18004.

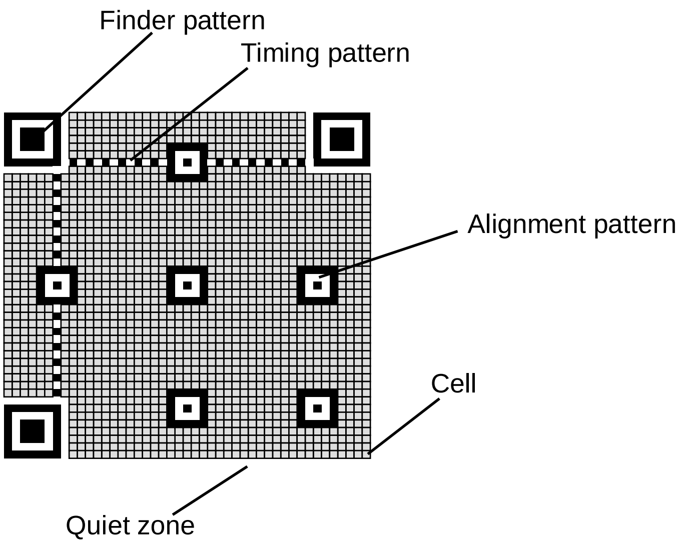

Figure 19 – Structure of QR Code Model 2 Symbol

10.3.1.1 "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 to enable the symbol to fit in the available area.

The minimum open system "X" dimension shall be 0.25 mm. The "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 5). Regardless of the element width, the symbol shall meet the symbol quality requirements in Section 10.3.1.6.

10.3.1.2 Element height

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

10.3.1.3 Symbol size

In order 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 5).

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 5. 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 5 below includes data overhead characters (specifically, message header, Data Identifiers, data element separators data and message trailer characters).

Table 5 - QR Code Model 2 alphanumeric data capacity for label

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

10.3.1.4 Quiet zone

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

10.3.1.5 Error correction level

The error correction level shall be 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 the QR Code Model 2.

10.3.1.6 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 (ex. 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.

10.3.1.7 Encryption

Encryption shall not be used for mandatory data fields.

10.3.1.8 Character set

The character set shall be upper case alphabetic characters and numeric digits, 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.

10.3.2 Data Matrix symbology requirements

The Data Matrix ECC200 symbol (see Figure 20) referenced in this guideline is defined in ISO/IEC 16022.

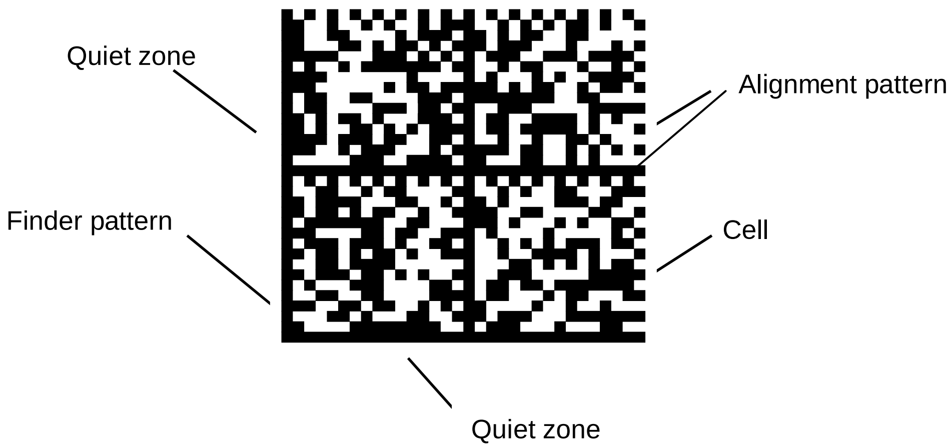

Figure 20 – Structure of Data Matrix ECC200 Symbol

10.3.2.1 "X" dimension

The appropriate "X" dimension for a symbol is determined by many factors including an available marking area, surface type, 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" dimension 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 10.3.2.6 (see Table 6).

10.3.2.2 Element height

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

10.3.2.3 Symbol size

In order 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 6).

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 6. 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 6 includes data overhead characters (specifically, message header, Data Identifiers, data element separators, data and message trailer characters).

Table 6 – 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 x55 mm	2335	2335	1573	1222

10.3.2.4 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 guideline to require an additional quiet zone beyond the minimum required by ISO/IEC 16022.

10.3.2.5 Error correction level

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

10.3.2.6 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 (ex. 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.

10.3.2.7 Encryption

Encryption shall not be used for mandatory data fields.

10.3.2.8 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 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 “$^{R}{}_{S}$ $^{E}O_{T}$”.

Many encoders will automatically invoke Macro 237 when they see “[]>”. So it may not be necessary to attempt to force Macro 237 into the encoding scheme.

Annex A
(informative)

Examples of Returnable Transport Items (RTIs) and Containers

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. Other layers including Layers 4, 1 and 0 described here are out of this guideline and provided for reference purposes only.

A.1 Freight Containers of Layer 4

Figure 1 in Section 4 illustrates the freight containers used in Layer 4. This includes air cargo and railway containers whose 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 guideline.

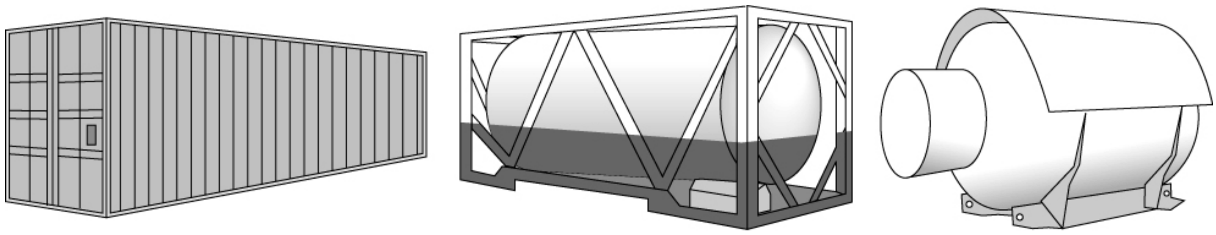

Figure A.1 – Example of containers

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 and Layer 0 are designed to put liquid or powder substances and are normally made of paper, plastic, glass or metal. Particularly, metallic cases for transporting milk or soft drinks (see Figure A.2), glass bottles for wine or beer (see Figure A.3) and plastic cases for baby powder or powder soap (see Figure A.4) are classified in this category. Some of such cases or bottles are actually reused and recycled mainly for selling products in the consumer market. Basically, however, the containers in Layer 1 and Layer 0 are excluded from this guideline, because their use is not common in the automotive sector. However, this guideline 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.

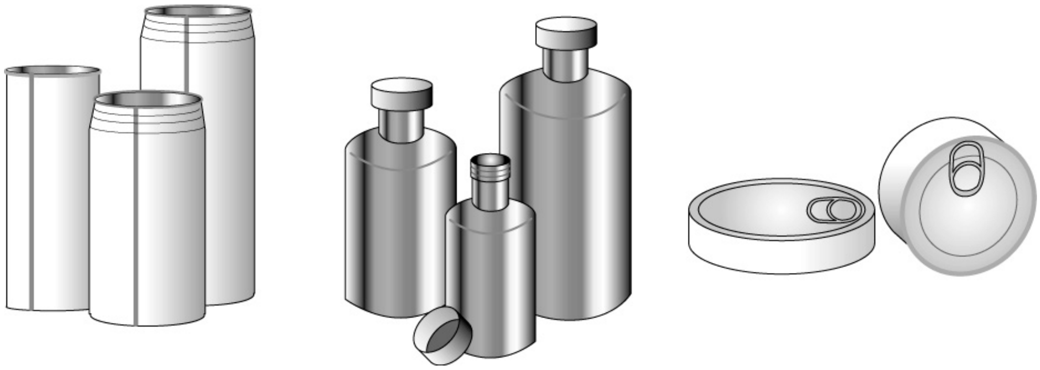

Figure A. 2 – Example of metallic cases

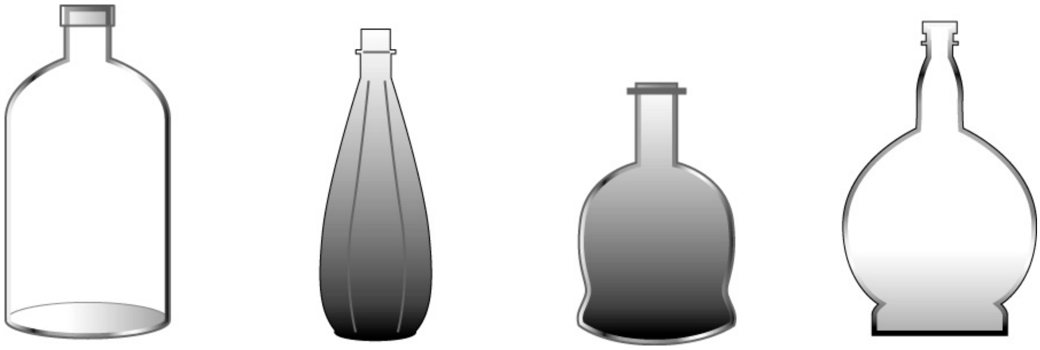

Figure A. 3 – Example of glass bottles

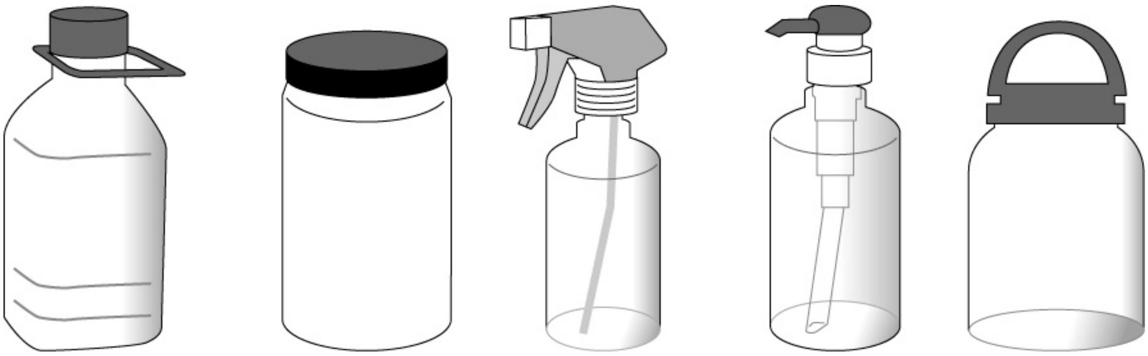

Figure A. 4 – Example of plastic cases

Annex B
(normative)

Unique Identifiers of Returnable Transport Items and Transport Units

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 guidelines 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 minimally includes the DI “25”, the Issuing Agency Code (IAC), Company Identification Number (CIN), and Serial Number (SN) assuming that the Serial Number is unambiguous within the CIN. 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. Thus the Unique RTI Identifier established by the Unique RTI Identifier issuer cannot be the same as that established by another. Moreover, ISO/IEC 15459-2 ensures all the Unique RTI Identifiers are unambiguous.

B.3 ISO/IEC15459-5 (ANS MH10.8.2)

The rules of Odette, to whom the Issuing Agency Code “OD” has been allocated by the registration authority, are that 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.

EXAMPLE: Typical Unique RTI Identifier issued under the rules of “Odette”: In this example, the IAC is “OD”, the CIN is “HUL9”, the Serial Number is “123456789123”, and the RTI type code is “ABCDEFGHIJKLMNOPQ”. See Figure B.1.

Figure B.1 below shows an Odette unique identifier (Data Identifier “25B”) for returnable transport units.

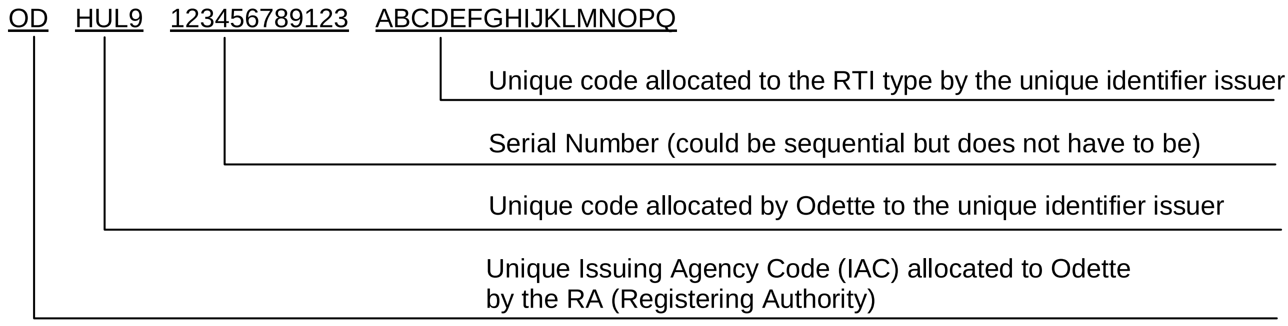

Figure B.1 – Unique identifier for Odette RTI identification

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

Table B.1 – Data stream – Code 128

]C0	**25B**	**ODHUL9123456789123 ABCDEFGHIJKLMNOPQ**
Data Carrier Identifier	ISO/IEC 15459-5 Data Identifier	Unique Identifier

NOTE: The Data Carrier Identifier “]” should be $5D_{hex}$ defined in ISO/IEC 646.

B.4 ISO/IEC 15459-1

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

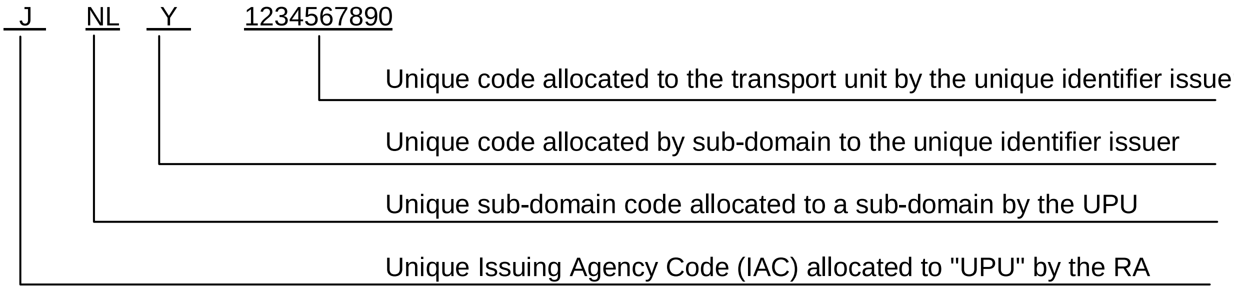

Figure B.2 – Unique identifier for ISO/IEC 15459-1 transport units

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:

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 located in Berne, Switzerland.

Table B.2 – Data stream – ISO/IEC 15459-1

]C0	**J**	**JNLY1234567890**
Data Carrier Identifier	ISO/IEC 15459-1 Data Identifier	Unique Identifier

NOTE: The Data Carrier Identifier “]” should be $5D_{hex}$ 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
(normative)

Syntax for High-Capacity Automatic Data Capture Media

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

This Annex serves as guidance on how to store data in the RFID User Memory or two-dimensional symbols.

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
(normative)

Assignment of Application Family Identifiers (AFIs)

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

Unique identification is provided by three components, namely, Issuing Agency Code (IAC), Company Identification Number (CIN), and Serial Number (SN) proceeded by an AFI or Data Identifier. Only AFI's "A3" and "A8" 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)

Annex E
(normative)

Data Carrier Identifiers

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

This Annex serves as guidance on how to distinguish different data carriers used in the same application. The use of 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

Annex F
(normative)

Application Family Identifiers (AFIs)

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

F.1 UII Memory Bank ($MB01_2$)

When PC bit 17_{hex} of $MB01_2$ is set to "1_2" indicating that AFI's are used in $MB01_2$, the ISO/IEC 15961 AFI for returnable transport items, $A3_{hex}$ or $A8_{hex}$, shall be placed in bits 18_{hex} through $1F_{hex}$, as described below in Figure F1 (reference the UII memory bank) and Table F2.

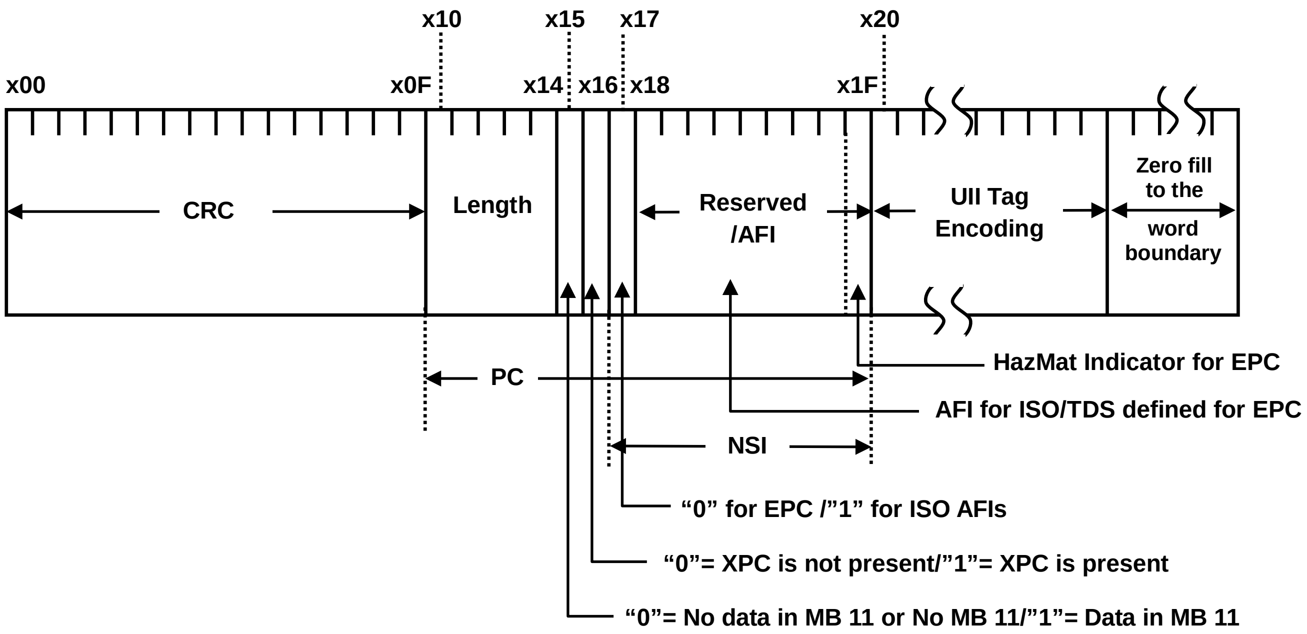

Figure F.1 – $MB01_2$ data structure

F.2 Tag Memory

Figure F.2 provides a graphical representation of tag memory.

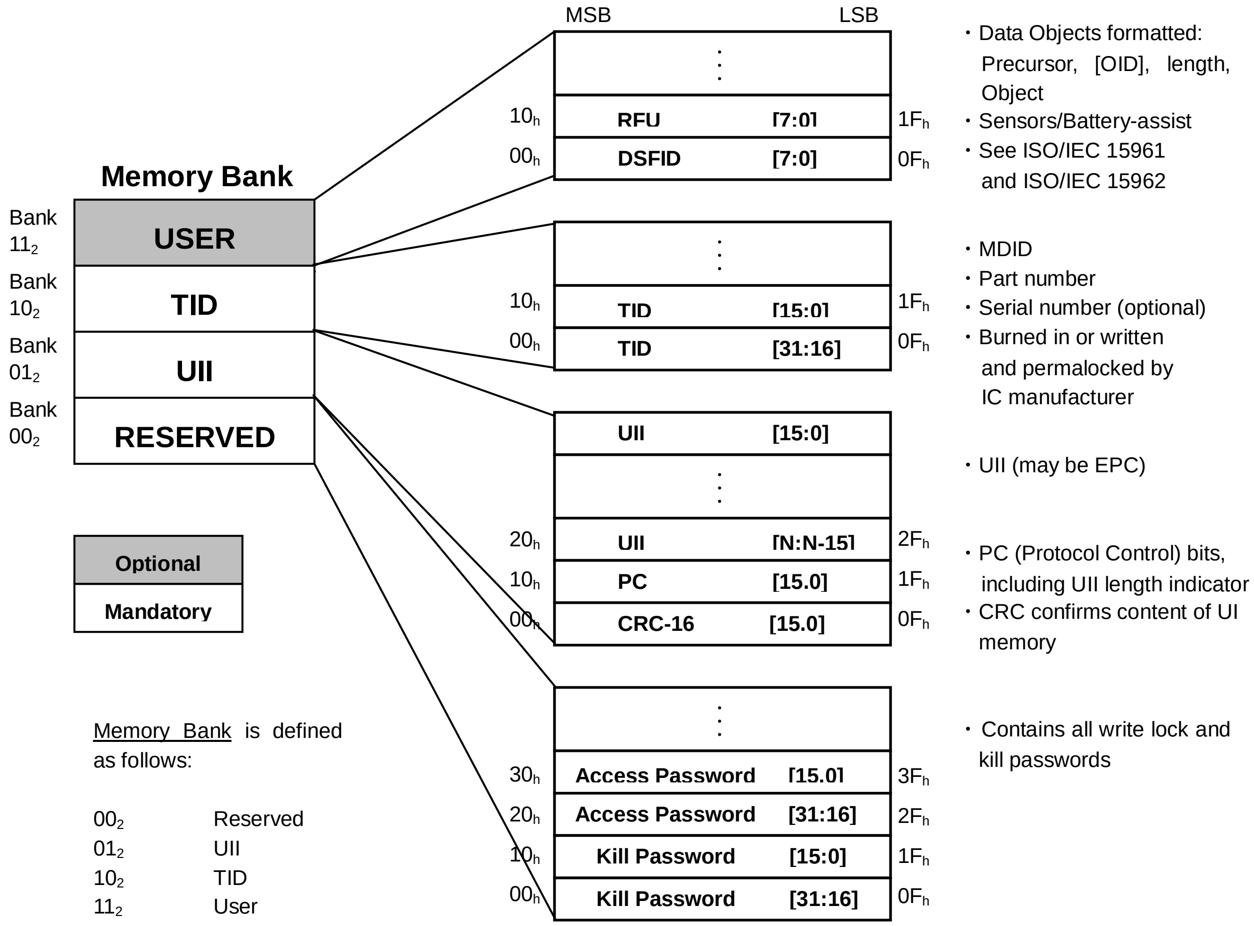

Figure F.2 – Memory map for segmented memory tags

F.3 Tag Memory Banks

An ISO/IEC 18000-6C 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) **Reserved memory** shall contain the kill and access passwords. The kill password shall be stored at memory addresses 00_{hex} to $1F_{hex}$; the access password shall be stored at memory addresses 20_{hex} to $3F_{hex}$. If a Tag does not implement the kill and/or access password(s), the Tag shall act as though it had zero-valued password(s) that are permanently read/write locked, and the corresponding memory locations in reserved memory need not exist.

b) **UII memory** shall contain a CRC-16 at memory addresses 00_{hex} to $0F_{hex}$, Protocol-Control (PC) bits at memory addresses 10_{hex} to $1F_{hex}$, and a code, i.e. a monomorphic UII, that identifies the object to which the tag is or will be attached beginning at address 20_{hex}. The PC is subdivided into a UII length field in memory locations 10_{hex} to 14_{hex}, an indication of structured data in user $MB11_2$ is stored in the User Memory bit 15_{hex}, a PC extension indicator bit in memory location 16_{hex}, an ISO/EPC bit in memory location 17_{hex}, and either an Application Family Identifier (AFI) or a Numbering System

Identifier (NSI) in memory locations 18_{hex} to $1F_{hex}$: PC Bit 17_{hex} = “0_2” denotes an NSI, and PC Bit 17_{hex} = “1_2” denotes an AFI.

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

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

For EPC tags whose ISO/IEC 15963 allocation class identifier is 11100010_2 ($E2_{hex}$). If the class identifier is $E2_{hex}$, TID memory locations 08_{hex} to 13_{hex} contain a 12-bit tag mask-designer identifier (obtainable from the registration authority), TID memory locations 14_{hex} to $1F_{hex}$ contain a vendor-defined 12-bit tag model number, and the usage of tag memory locations above $1F_{hex}$ 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 18000-6C and whose ISO/IEC 15963 allocation class identifier is 11100000_2 ($E0_{hex}$), TID memory locations 08_{hex} to $0F_{hex}$ contain an 8-bit manufacturer identifier, TID memory locations 10_{hex} to $3F_{hex}$ contain a 48-bit tag serial number (assigned by the tag manufacturer), the composite 64-bit tag ID (i.e. TID memory 00_{hex} to $3F_{hex}$) 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 11100000_2, this identifying information shall comprise a 8-bit Tag manufacturer identification at memory locations 08_{hex} to 15_{hex} and a 48-bit tag serial number at memory locations 16_{hex} to $3F_{hex}$.

d) **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 $MB11_2$ shall be indicated by PC bit 15_{hex} of $MB01_2$ being set to a 1_2. When PC bit 15_{hex} of $MB01_2$ is set to a 0_2 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 10_{hex} to $1F_{hex}$, with bit values defined as follows:

- Bits 10_{hex} – 14_{hex}: The length of the UII that a Tag backscatters, in words:
  00000_2: One word (addresses 10_{hex} to $1F_{hex}$ in UII memory).
  00001_2: Two words (addresses 10_{hex} to $2F_{hex}$ in UII memory).
  00010_2: Three words (addresses 10_{hex} to $3F_{hex}$ in UII memory).
  :
  :
  :
  11111_2: 32 words (addresses 10_{hex} to $20F_{hex}$ in UII memory).
- Bit 15_{hex}: User Memory; shall be set to “0_2” for tags without data in User Memory (MB “11_2”) and shall be set to “1_2” for tags with data in User Memory.
- Bit 16_{hex}: Shall be set to “0_2” if there are no extension of the PC bits and shall be set to “1_2” if the PC bits are extended by an additional 16 bits.

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

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

- Bit 17_{hex}: Shall be set to “0_2” if encoding an EPC and shall be set to “1_2” if encoding an ISO/IEC 15961 AFI in Bits 18_{hex} – $1F_{hex}$
- Bits 18_{hex} – $1F_{hex}$: A numbering system identifier (NSI) whose default value is 00000000_2 and which may include an AFI as defined in ISO/IEC 15961 (when encoding the tag pursuant to ISO standards). The MSB (Most Significant Bit) of the NSI is stored in memory location 18_{hex}.

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

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

Table F.1 – Segmented memory - Memory Bank “01” – EPC HazMat RTI

Protocol Control Bits run from 10_{hex} – $1F_{hex}$															
					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 - Memory Bank “01” – ISO HazMat RTI

Protocol Control Bits run from 10_{hex} – $1F_{hex}$															
					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)							

Annex G
(informative)

Transmitting Data with 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.

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

G.1 Linear Symbology

Table G.1.1 – Linear symbology transmitted data (Code 128)

]C0	25B	IAC-CIN-SN
Data Carrier Identifier	ISO/IEC 15459-5 Data Ideitifier	Unique Identifier

NOTE: The Data Carrier Identifier "]" should be $5D_{hex}$ defined in ISO/IEC 646.

Table G.1.2 – Linear symbology encoded data

25B	IAC-CIN-SN
ISO/IEC 15459-5 Data Ideitifier	Unique Identifier

G.2 Two-Dimensional Symbology

Table G.2.1 – Two-dimensional symbology transmitted data (QR Code)

]Q1	25B	IAC-CIN-SN
Data Carrier Identifier	ISO/IEC 15459-5 Data Ideitifier	Unique Identifier

NOTE: The Data Carrier Identifier "]" should be $5D_{hex}$ defined in ISO/IEC 646.

Table G.2.2 – Two-dimensional symbology encoded data

[]>$^{R}_{S}$	**06**	$^{G}_{S}$	**25B**	**IAC-CIN-SN**	$^{R}_{S}$	$^{E}O_{T}$
Message header	Format indicator	Data element separator	ISO/IEC 15459-5 Data Ideitifier	Unique identifier	Format trailer	Message trailer

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 guideline is transmitted directly after the Data Carrier Identifier Z2.

Table G.3 – Sturcuture of data transmitted by multi-media reader

]Z2	**A3**	**25B**	**IAC-CIN-SN**
Data Carrier Identifier	AFI	ISO/IEC 15459-5 Data Ideitifier	Unique Identifier

NOTE: The Data Carrier Identifier “]” should be $5D_{hex}$ defined in ISO/IEC 646.

Annex H
(normative)

Encryption of Data

H.1 General

The data on the unique identifier of returnable transport items and transport units shall not be protected by encryption. The other data may be encrypted upon agreement between the trading partners.

H.2 RFID

The data stored in the ISO/IEC 18000-6C UII memory shall not be encrypted.

In contrast, data in the ISO/IEC18000-6C User Memory may be encrypted if agreed upon between the trading partners according to the ISO/IEC 18000-6C standard. Data is encrypted and deciphered 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 decipherment 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
(informative)

Recommended RFID Specifications

This guideline recommends air interface specification as defined in ISO/IEC 18000-6C. This Annex is provided as a summary of ISO/IEC 18000-6C.

I.1 Read / Write Function

I.1.1 Reading range

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

I.1.2 Writing range

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

I.1.3 Anti-collision

The anti collision protocol should be as outlined in ISO/IEC 18000-6C.

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 C to +60℃

I.2.2 Storage temperature range

-40 C to +80℃ (maximum temperature range that the tag could 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 could withstand)

See Annex F for the recommended memory structure.

Annex J
(informative)

Rewitable Hybrid Media

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 colouring and discolouring 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.

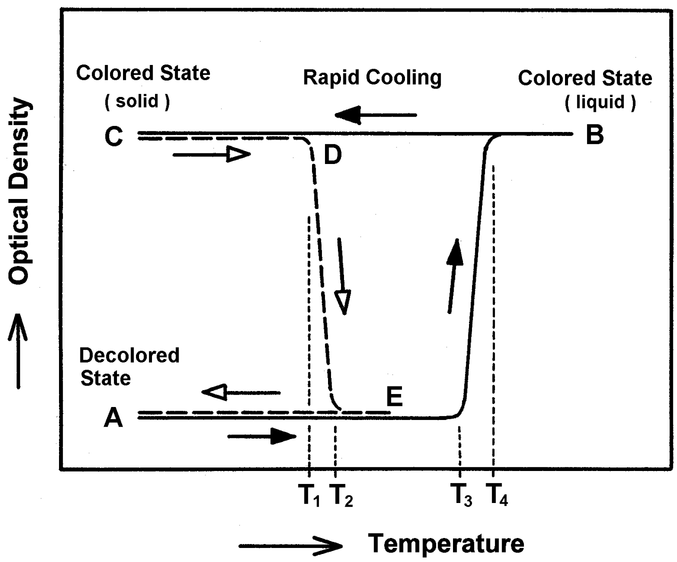

Figure J.1 – Coloring /decoloring process

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.

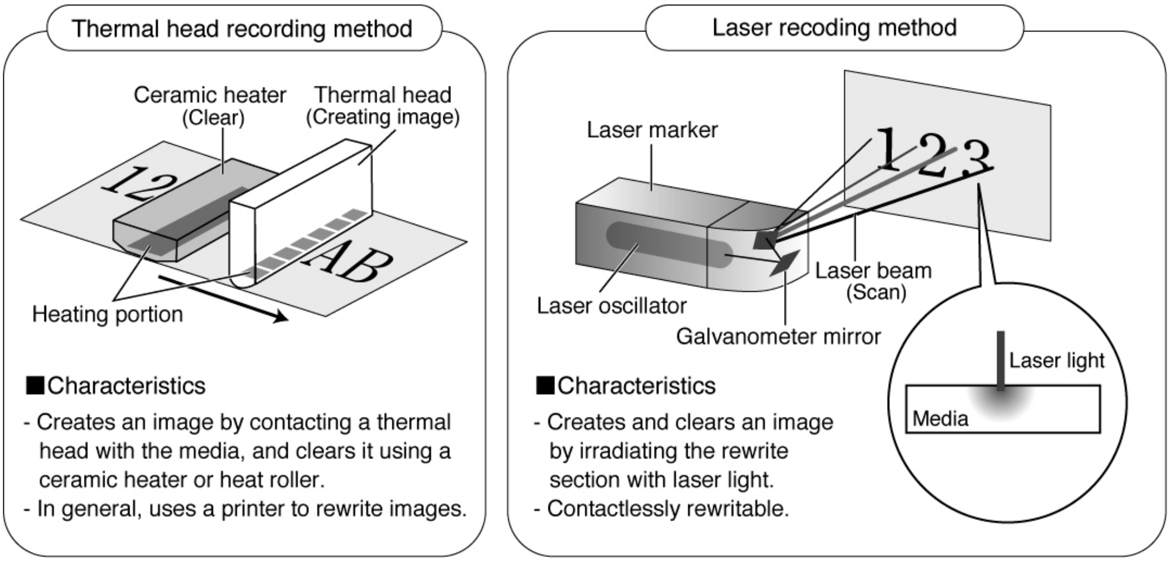

Figure J.2 – Rewritable media recording methods

In Figure J.2, the thermal head is a recording device for thermal printer with small heating element laid in a sheet or column, which selectively heats the heating element with the current applied correspondingly to the characters or image data.

J.2 Rewritable Hybrid Media

J.2.1 General

An RF tag does not have a visual 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 the 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 a multiple use. 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, some kind of recovery means 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.

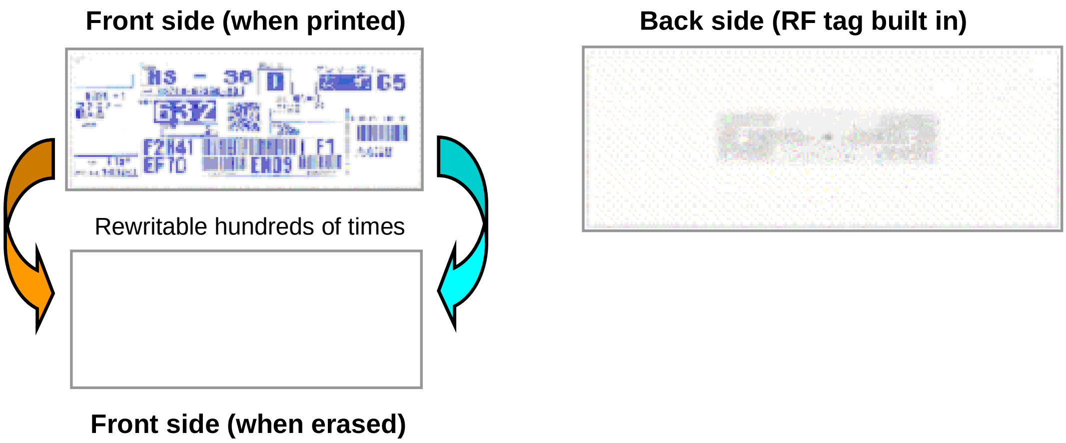

Figure J.3 – Rewritable hybrid media

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.

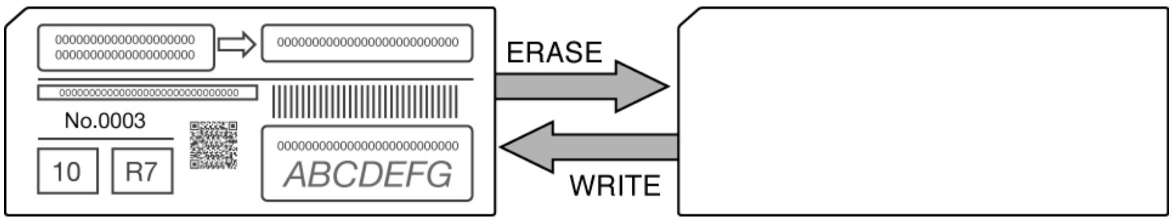

Figure J.4 – Typical rewritable hybrid media data carrier

Annex K
(informative)

GS1 Unique Identifiers

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).

Annex K is provided as an informative reference of this guideline to describe the identifiers used for returnable transport items and transport units in accordance with the rules of GS1. The definition of GS1 complies with the ISO/IEC 15459-1 and ISO/IEC 15459-5 standards, latest ratified version.

K.1 GS1 Unique Identifier for RTIs

The Application Identifier "8003" (GRAI) or "8004" (GIAI) shall be used for GS1.

The rules of GS1, to whom the Issuing Agency Codes "0" till "9" have been allocated by the Registration Authority, are that the unique identifier for RTI identification consists of no more than 14 numeric digits followed by no more than 16 alphanumeric characters. The first numeric string of characters is allocated by GS1 to the Unique Item Identification issuer (company prefix) and the following characters are assigned by the Unique RTI Identifier issuer.

EXAMPLE: Typical Unique RTI Identifier issued under the rules of "GS1": In this example, the IAC/CIN/Asset Identifier is "0009875610013" and the Serial Number is "000110780". See Figure K.1.

0 0098756100013 000110780

Unique code allocated to the RTI by the unique identifier issuer

Unique code allocated by GS1 to the unique identifier issuer

Unique Issuing Agency Code (IAC) allocated to GS1 by the RA

Figure K.1 – Unique identifier for returnable asset identification

This unique identifier can be contained in a GS1-128 symbol with the GS1 Application Identifier "8003". The GS1-128 symbol, when scanned, can be expected to pass the data string given in Table K.1 to the computer system.

Table K.1 – Data stream – GS1

]C1	8003	00098756100013000110780*
Symbology identifier	GS1 Application Identifier	Unique identifier

* In this example, the Identification Number for Assets is "**00098756100013**" and the Serial Number is "**000110780**".

K.2 GS1 Unique Identifier for Transport Units

The Application Identifier “00” (SSCC) shall be used for GS1.

The example below shows a GS1 unique identifier (SSCC) for transport units.

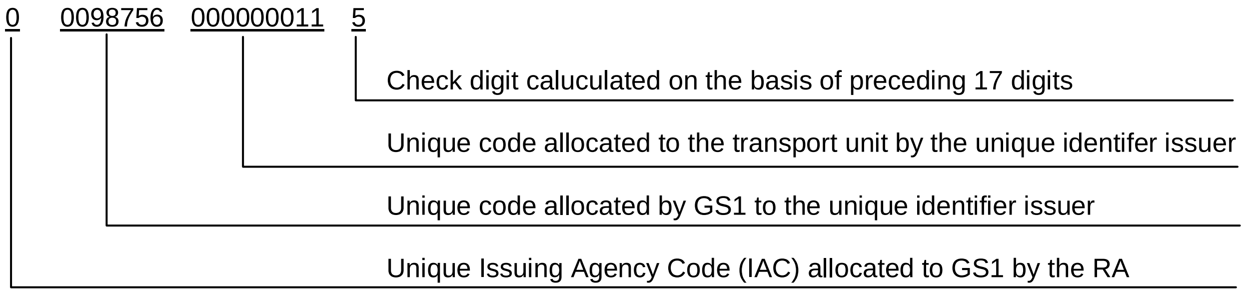

Figure K.2 – Unique identifier

NOTE: GS1 uses the term Company Prefix for the unique code allocated by GS1 to the unique identifier issuer.

This unique identifier can be contained in a GS1-128 symbol with the GS1 Application Identifier “00”. The GS1-128 symbol, when scanned, can be expected to pass the data string given in Table K.2 to the computer system:

Table K.2 – Data stream – GS1

]C1	00	000987560000000115*
Symbology identifier	GS1 application identifier	Unique identifier

* In this example, the Identification Number for Assets is “**00098756**” and the Serial Number is “**000000011**”.

K.3 Class Identification

— 1 0 15459 5 1: for an RTI identifier for supply chain management equivalent to GS1 Application Identifier **8003;**

— 1 0 15459 5 2: for an RTI identifier for supply chain management equivalent to GS1 Application Identifier **8004;**

— 1 0 15459 1 1: for a Transport Unit Identifier equivalent to GS1 Application Identifier **00.**

Annex L
(informative)

EPCglobal RTI Identification

Annex L, which is based on the EPCglobal Tag Data Standards, is provided as an informative reference of this guideline to describe information on the identifiers used for returnable transport items and transport units in accordance with the rules of EPCglobal. The definition of EPC tags complies with the EPCglobal Tag Data Standards, latest ratified version.

L.1 EPC Tag

L.1.1 EPC Memory Contents

The EPC memory bank of ISO/IEC 1800-6C (UHF Class 1 Generation 2 Tag) holds an EPC, plus additional control information. The complete contents of the EPC memory bank consist of:

L.1.1.1 CRC-16 (16 bits)

Bits that represent the error check code and are auto-calculated by the Tag.

L.1.1.2 Protocol-Control (PC) (16 bits total)

Which is subdivided into:

a) Length (5 bits)

Represents the number of 16-bit words comprising the PC field and the EPC field (below). See discussion below for the encoding of this field.

b) Reserved for Future Use (RFU) (2 bits)

Always zero in the current version of the UHF Class 1 Generation 2 Tag Protocol Specification.

c) Numbering System Identifier (NSI) (9 bits total)

Which is further subdivided into:

- Toggle bit (1 bit): Boolean flag indicating whether the next 8 bits of the NSI represents reserved memory or an ISO 15961 Application Family Identifier (AFI). If set to “zero” indicates that the NSI contains reserved memory, if set to “one” indicates that the NSI contains an ISO AFI.

- Reserved/AFI (8 bits): Based on the value of the Toggle Bit above, these 8 bits are either Reserved and must all be set to ”zero”, or contain an AFI whose value is defined under the authority of ISO.

L.1.1.3 EPC (variable length)

When the Toggle Bit is set to “zero”, an EPC Tag Encoding as defined in the remaining sections of this chapter is contained here. When the Toggle Bit is set to “one”, these bits are part of a non-EPC coding scheme identified by the AFI field whose interpretation is outside the scope of EPCglobal Tag Data Standards.

L.1.1.4 Zero fill (variable length)

If there is any additional memory beyond EPC Tag Encoding required to meet the 16 bit word boundaries specified in Gen 2 Specification, it is filled with zeros. An implementation shall not put any data into EPC memory following the EPC Tag Encoding and any required zero fill (15 bits or less); if it does, it is not in compliance with the specification and risks the possibility of incompatibility with a future version of the spec.

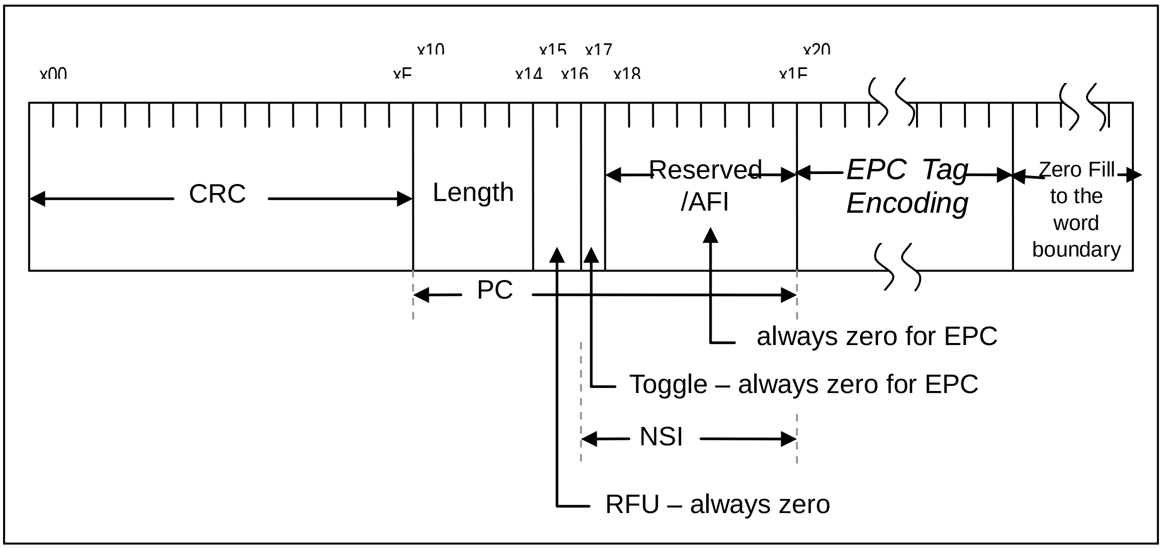

Figure L.1 – Complete contents of EPC memory bank of a UHF class1 Generation 2 Tag

Except for the 16 bit CRC it is the responsibility of the application or process communicating with the reader to provide all the bits to encode in the EPC memory bank.

L.1.2 Length Bits

The length field is used to let a reader know how much of the EPC memory is occupied with valid data. The value of the length field is the number of 16-bit segments occupied with valid data, not including the CRC, minus one. For example, if set to '00000', the length field indicates that valid data extends through bit x1F, if set to '00001', the length field indicates that valid data extends through bit x2F, and so on.

When a Gen 2 Tag contains an EPC Tag Encoding in the EPC bank, the length field is normally set to the smallest number that would contain the particular kind of EPC Tag Encoding in use. Specifically, if the EPC bank contains an N-bit EPC Tag Encoding, then the length field is normally set to N/16, rounded up to the nearest integer. For example, with a 96-bit EPC Tag Encoding, the length field is normally set to 6 (00110 in binary).

It is important to note that the length of the EPC Tag Encoding is indicated by the EPC header, and not by the length field in the PC bits. This is necessarily so, because the length field indicates only the nearest multiple of 16 bits, but the actual amount of EPC memory consumed by the EPC Tag Encoding does not necessarily fall on a multiple-of-16-bit boundary.

Moreover, there are applications in which the length field may be set to a different value than the one determined by the formula above. For example, there may be applications in which the EPC is not written to the EPC bank in one operation, but where a prefix of the EPC is written in one operation (perhaps excluding the Serial Number) and subsequently the remainder of the EPC is written. In such an application, a length field smaller than the normal value might be used to indicate that the EPC is incompletely written.

L.1.3 Notational Conventions

In the remainder of this section, EPC Tag Encoding schemes are depicted using the following notation (see Table L.1).

Table L.1 – Example of notational conventions

	Header	Filter Value	Partition	Company Prefix	Item Reference	Serial Number
SGTIN-96	8	3	3	20-40	24-4	38
Serialized Global Trade Item Number – 96 bits	0011 0000 (Binary value)	(Refer to Table 5 for values)	(Refer to Table 6 for values)	999,999 - 999,999,999,999 (Max. decimal range*)	9,999,999 - 9 (Max. decimal range*)	274,877,906,943 (Max. decimal value)

* Max. decimal value range of Item Reference field varies with the length of the Company Prefix

The first column of the table gives the formal name for the encoding. The remaining columns specify the layout of each field within the encoding. The field in the leftmost column occupies the most significant bits of the encoding (this is always the header field), and the field in the rightmost column occupies the least significant bits. Each field is a non-negative integer, encoded into binary using a specified number of bits. Any unused bits (i.e., bits not required by a defined field) are explicitly indicated in the table, so that the columns in the table are concatenated with no gaps to form the complete binary encoding.

Reading down each column, the table gives the formal name of the field, the number of bits used to encode the field's value, and the value or range of values for the field. The value may represent one of the following:

- The value of a binary number indicated by *(Binary value),* as is the case for the Header field in the example table above.
- The maximum decimal value indicated by (Max. decimal value) of a fixed length field. This is calculated as 2^{n-1}, where n = the fixed number of bits in the field.
- A range of maximum decimal values indicated by (Max. decimal range). This range is calculated using the normative rules expressed in the related encoding procedure section
- A reference to a table that provides the valid values defined for the field.

In some cases, the number of possible values in one field depends on the specific value assigned to another field. In such cases, a range of maximum decimal values is shown. In the example above, the maximum decimal value for the Item Reference field depends on the length of the Company Prefix field; hence the maximum decimal value is shown as a range. Where a field must contain a specific value (as in the Header field), the last row of the table specifies the specific value rather than the number of possible values.

Some encodings have fields that are of variable length. The accompanying text specifies how the field boundaries are determined in those cases.

Following an overview of each encoding scheme are a detailed encoding procedure and decoding procedure. The encoding and decoding procedure provide the normative specification for how each type of encoding is to be formed and interpreted.

L.1.4 GRAI-96

In addition to a Header, the EPC GRAI-96 is composed of five fields: the Filter Value, Partition, Company Prefix, Asset Type, and Serial Number, as shown in Table L2.

Table L.2 – EPC GRAI-96 bit allocation, header and maximum decimal values

	Header	Filter Value	Partition	Company Prefix	Asset Type	Serial Number
GRAI-96	8	3	3	20-40	24-4	38
Global Returnable Asset Identifier – 96 bits	0011 0011 (Binary value)	(Refer to Table 16 for values)	(Refer to Table 17 for values)	999,999 - 999,999,999,999 (Max. decimal range*)	999,999 - 0 (Max. decimal range*)	274,877,906,943 (Max. decimal value)

* Max. decimal value range of Company Prefix and Asset Type fields vary according to contents of the Partition field.

- Header is 8-bits, with a binary value of 0011 0011.
- Filter Value is not part of the GRAI or EPC identifier, but is used for fast filtering and pre-selection of basic asset types. See Table L.3.

Table L.3 – GRAI filter values

Type	Binary Value
All Others	000
Reserved	001
Reserved	010
Reserved	011
Reserved	100
Reserved	101
Reserved	110
Reserved	111

- Partition is an indication of where the subsequent Company Prefix and Asset Type numbers are divided. This organization matches the structure in the GS1 GRAI in which the Company Prefix added to the Asset Type number totals 12 digits, yet the Company Prefix may vary from 6 to 12 digits and the Asset Type from 6 to 0 digit(s). The available values of Partition and the corresponding sizes of the Company Prefix and Asset Type fields are defined in Table L.4.

Table L.4 – GRAI Partitions

Partition Value (*P*)	**Company Prefix**		**Extension Digit and Serial Reference**	
	Bits (*M*)	Digits (*L*)	Bits (*N*)	Digits
0	40	12	4	0
1	37	11	7	1
2	34	10	10	2
3	30	9	14	3
4	27	8	17	4
5	24	7	20	5
6	20	6	24	6

- Company Prefix contains a literal embedding of the GS1 Company Prefix.
- Asset Type, if present, encodes the GRAI Asset Type number.
- Serial Number contains a serial number. The 96-bit tag encodings are only capable of representing a subset of Serial Numbers allowed in the General GS1 Specifications. The capacity of this mandatory serial number is less than the maximum GS1 specification for serial number, no leading zeros are permitted, and only numbers are permitted.

L.1.5 GIAI-96

In addition to a Header, the EPC GIAI-96 is composed of four fields: the Filter Value, Partition, Company Prefix, and Individual Asset Reference, as shown in Table L.5.

Table L.5 – EPC GIAI-96 bit allocation, header and maximum decimal values

	Header	**Filter Value**	**Partition**	**Company Prefix**	**Individual Asset Reference**
GIAI-96	8	3	3	20-40	62-42
Global Individual Asset Identifier – 96 bits	0011 0100 (Binary value)	(Refer to Table 20 for values)	(Refer to Table 21 for values)	999,999 - 999,999,999,999 (Max. decimal range*)	4,611,686,018,427,387, 903 - 4,398,046,511,103 (Max. decimal range*)

* Max. decimal value range of Company Prefix and Asset Type fields vary according to contents of the Partition field.

- Header is 8-bits, with a binary value of 0011 0100.
- Filter Value is not part of the GIAI or EPC identifier, but is used for fast filtering and pre-selection of basic asset types. The Filter Values for 96-bit and 202-bit GIAI are the same. See Table L.6.

Table L.6 – GIAI filter values

Type	Binary Value
All Others	000
Reserved	001
Reserved	010
Reserved	011
Reserved	100
Reserved	101
Reserved	110
Reserved	111

- Partition is an indication of where the subsequent Company Prefix and Individual Asset Reference numbers are divided. This organization matches the structure in the GS1 GIAI in which the Company Prefix may vary from 6 to 12 digits. The available values of partition and the corresponding sizes of the Company Prefix and Asset Reference fields are defined in Table L.7.

Table L.7 – GIAI-96 Partitions

Partition Value (*P*)	Company Prefix		Extension Digit and Serial Reference	
	Bits (*M*)	Digits (*L*)	Bits (*N*)	Digits
0	40	12	42	12
1	37	11	45	13
2	34	10	48	14
3	30	9	52	15
4	27	8	55	16
5	24	7	58	17
6	20	6	62	18

- Company Prefix contains a literal embedding of the Company Prefix.

- Individual Asset Reference is a mandatory unique number for each instance. The EPC representation is only capable of representing a subset of asset references allowed in the General GS1 Specifications. The capacity of this asset reference is less than the maximum GS1 System specification for asset references, no leading zeros are permitted, and only numbers are permitted.

L.1.6 SSCC-96

In addition to a Header, the EPC SSCC-96 is composed of four fields: the Filter Value, Partition, Company Prefix, and Serial Reference, as shown in Table L.8.

Table L.8 – EPC SSCC-96 bit allocation, header and maximum decimal values

	Header	**Filter Value**	**Partition**	**Company Prefix**	**Serial Reference**	**Unallocated**
SSCC-96	8	3	3	20-40	38-18	24
Serial Shipping Container Code	0011 0001 (Binary value)	(Refer to Table 9 for values)	(Refer to Table 10 for values)	999,999 - 999,999,999, 999 (Max. decimal range*)	99,999,999,9 99 - 99,999 (Max. decimal range	[Not Used]

* Max. decimal value range of Company Prefix and Serial Reference fields vary according to the contents of the Partition field.

- Header is 8-bits, with a binary value of 0011 0001.
- Filter Value is not part of the SSCC or EPC identifier, but is used for fast filtering and pre-selection of basic logistics types. The normative specifications for Filter Values are specified in Table L.9.

  The value of 000 means “All Others”. That is, a filter value of 000 means that the object to which the tag is affixed does not match any of the logistic types defined as other filter values in the specification. It should be noted that tags conforming to earlier versions of EPCglobal Tag Data Standards, in which 000 was the only value approved for use, will have filter value equal to 000, but following the ratification of this standard, the filter value should be set to match the object to which the tag is affixed, and use 000 only if the filter value for such object does not exist in the specification.

Table L.9 – SSCC filter values

Type	**Binary Value**
All Others	000
Undefined	001
Logistical / Shipping Unit	010
Reserved	011
Reserved	100
Reserved	101
Reserved	110
Reserved	111

- Partition is an indication of where the subsequent Company Prefix and Serial Reference numbers are divided. This organization matches the structure in the GS1 SSCC in which the Company Prefix added to the Serial Reference number (prefixed by the single Extension Digit) totals 17 digits, yet the Company Prefix may vary from 6 to 12 digits and the Serial Reference from 11 to 5 digits. Table L.10 shows allowed values of the partition value and the corresponding lengths of the company prefix and serial reference.

Table L.10 – SSCC-96 Partitions

Partition Value (*P*)	Company Prefix		Extension Digit and Serial Reference	
	Bits (*M*)	Digits (*L*)	Bits (*N*)	Digits
0	40	12	18	5
1	37	11	21	6
2	34	10	24	7
3	30	9	28	8
4	27	8	31	9
5	24	7	34	10
6	20	6	38	11

- Company Prefix contains a literal embedding of the Company Prefix.
- Serial Reference is a unique number for each instance, comprised of the Extension Digit and the Serial Reference. The Extension Digit is combined with the Serial Reference field in the following manner: Leading zeros on the Serial Reference are significant. Put the Extension Digit in the leftmost position available within the field. For instance, 000042235 is different than 42235. With the extension digit of 1, the combination with 000042235 is 1000042235. The resulting combination is treated as a single integer, and encoded into binary to form the Serial Reference field. To avoid unmanageably large and out-of-specification serial references, they should not exceed the capacity specified in GS1 specifications, which are (inclusive of extension digit) 9,999 for company prefixes of 12 digits up to 9,999,999,999 for company prefixes of 6 digits.
- Unallocated is not used. This field must contain zeros to conform with this version of the specification.

Annex M
(informative)

Related ISO Standards

M.1

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

M.2

ISO/IEC TR18047-3, *Information technology — Radio frequency identification device conformance test methods — Part 3: Test methods for air interface communications at 13,56 MHz*

M.3

ISO/IEC TR18047-6, *Information technology — Radio frequency identification device conformance test methods — Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

M.4

ISO/IEC TR18047-7, *Information technology — Radio frequency identification device conformance test methods — Part 7: Test methods for active air interface communications at 433 MHz*

Annex N
(informative)

Relevant Organizations

N.1 AIAG

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

N.2 AIM Global

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

N.3 ANSI

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

N.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

N.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 unit 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.autoid.org/ANSI_MH10/ansi_mh10sc8.htm

N.6 EPCglobal

A system that combines RFID (radio frequency identification) technology, existing communications network infrastructure and the Electronic Product Code (a number for uniquely identifying an item) to enable immediate and automatic identification and tracking of an item through the whole supply chain globally, resulting in improved efficiency and visibility of the supply chain, http://www.epcglobalinc.org/home/

N.7 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/

N.8 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/

N.9 ISO (International Organization for Standardization)

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

N.10 JAIF

Joint Automotive Industry Forum

N.11 JAMA

Japan Automobile Manufacturers Association Inc., http://www.jama-english.jp/

N.12 JAPIA

Japan Auto Parts Industries Association, http://www.japia.or.jp/en/index.html

N.13 JISC

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

N.14 ODETTE

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

N.15 STAR

Standards for Technology in Automotive Retail, http://www.starstandard.org/

N.16 VDA

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

The German Association of the Automotive Industry (VDA)

Annex O
(normative)

ISO/IEC 646 Character Set

Table O.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	_			

Values non-greyed out and shown in **BOLD** are supported by this Guideline.

Annex P
(informative)

Data Identifiers Referenced in This Guideline

The Data Identifier “25T” as specified in ISO/IEC 15459-6 shall be applied to a container of substances associated with vehicle production and which are identified by a lot or batch number, such as coating materials, chemicals, plating liquids or oil etc. Many such containers are reused or recycled in the actual operations. It is possible to use “25B” specified in ISO/IEC 15459-5 on these containers. “25B” defines the vessel, “25T” defines the contents of the container, and when “25T” is used it shall be placed into User Memory for RFID.

Table P.1 – Data Identifiers referenced in this guideline

Data Identifier	Definition	ISO Data Standard	ISO ORM Application Standard	ISO RFID Application Standard
J	Identification of a party to a transaction as identified in 18V[1], followed by the supplier assigned unique license plate number	ISO/IEC 15459-1	ISO 15394	ISO 17365
25B	Identification of a party to a transaction as identified in 18V[1] (as defined in ISO/IEC 15459) followed by the supplier assigned Serial Number to a returnable transport item (RTI)	ISO/IEC 15459-5	(ISO 15394)[2]	ISO 17364
25S (product)	Identification of a party to a transaction as identified in 18V[1], followed by the supplier assigned Serial Number	ISO/IEC 15459-4	ISO 28219	ISO 17367
25S (product package)	Identification of a party to a transaction as identified in 18V[1], followed by the supplier assigned Serial Number	ISO/IEC 15459-4	ISO 22742	ISO 17366
25T (product)	Identification of a party to a transaction as identified in 18V[1], followed by the supplier assigned traceability number	ISO/IEC 15459-6	ISO 28219	ISO 17367
25T (product package)	Identification of a party to a transaction as identified in 18V[1], followed by the supplier assigned traceability number	ISO/IEC 15459-6	ISO 22742	ISO 17366

[1] 18V - Identification of a party to a transaction that uses the data format consisting of two concatenated segments. The first segment is the unique code assigned to an issuing agency by NEN in accordance with ISO/IEC 15459, the second segment is a unique entity identification assigned in accordance with the rules established by the issuing agency.

[2] ISO 15394 defines the usage of transport unit. The RTI is included as part of the transport unit in ISO 15394.

Annex Q
(informative)

Direct Marking for 2D Symbology

This Annex provides the guidance for a direct marking of two-dimensional symbols used to identify returnable transport items.

Q.1 QR Code Symbol Requirements

Q.1.1 "X" dimension

The "X" dimensions of less than 0.15 mm or greater than 0.25 mm are not recommended for a direct marking (see Table Q.1).

Q.1.2 Symbol size

The symbol size should not be smaller than 10 mm by 10 mm for a direct marking (see Table Q.1).

Table Q.1 – QR Code Model 2 alphanumeric data capacity for DM

Symbol Size (with Quiet Zone)	Error correction level	"X" Dimension 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

Q.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 right angle for the right source should be selected to get the best possible clear image

ISO/IEC 15415 provides additional guidance on selection of 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.

Q.2 Data Matrix Symbol Requirements

Q.2.1 "X" dimension

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

Q.2.2 Symbol size

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

Table Q.2 – Data Matrix ECC200 alphanumeric data capacity for DM

"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

Q.2.3 Symbol quality

The Data Matrix ECC200 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 right angle for the right source should be selected to get the best possible clear image.

ISO/IEC 15415 provides additional guidance on selection of 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 R
(informative)

Definitions of Serial Numbers (SNs)

Annex R provides the definitions and examples of the Serial Number structure used in the unique identifier for RTIs using ISO/AFI encoding (see 6.4.3).

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)) for each RTI with the same OD (sequential or not).

R.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 can not be parsed into smaller portions of data.

R.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 below for further details.

R.2.1 JAMA-JAPIA suggestion for a 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 as a combined set with the associated returnable transport item.

The structure of suggested structured serial number is provided in Table R.1.

Table R.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 select not to use any of the FIC, KC and PC, as long as their RTIs are guaranteed to be uniquely serial numbered within the company's global operation.

R.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) or shall have a Factory Identification Code (FIC) to independently track the RTIs. FIC is recommended not to exceed 3 characters.

R.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). KC is recommended not to exceed 2 characters.

R.2.1.3 Partition Code (PC)

A certain RTI has one or more partitions as part of its structure. Partition Code (PC) is a code used to identify the type of the partitions. PC is recommended not to exceed 2 characters.

R.2.1.4 Object Sequence Number (OSN)

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

R.2.2 Odette definition for a structured SN

General: In Europe the RTI-Type (RT) is considered as critical RTI data (Object Data) and must be stored in the SN in $MB01_2$. The idea behind this is that we are convinced that in +/- 85% of the tag reads in the total supply chain, knowing the IAC, CIN and RT would be sufficient. And since $MB01_2$ is always back scattered at inventory the ideal place to store the RTI is in $MB01_2$ as part of the SN. In Europe we also try to cover two IAC schemes: Odette and DUNS. Apart of different definitions for the format of the RT and the OSN both have different definitions for their CIN (Company Identification Number) also. Optimal utilization of the memory size in $MB01_2$ is strived for. Therefore the most optimum Data Compaction is used on all fields that can be reduced in bit size. For more information on Data Compaction see Annex T.

All fields described from R.2.2.1 to R.2.2.4 are fixed length and padded with leading zeros if so required.

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

Table R. 2 – Possible elements that comprise a SN according Odette

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

R.2.2.1 Company Identification Number (CIN)

Table R.3 – Data format - CIN

IAC	CIN
OD	4 alphanumeric
UN	9 numeric

R.2.2.2 RTI-Type (RT)

Table R.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 thatnamed the RTI.

R.2.2.3 Object Sequence Number (OSN)

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

Table R.5 – Data format - OSN

IAC	OSN
OD	8 alphanumeric
UN	8 alphanumeric

Annex S
(informative)

UII Memory Capacity and Supported Number of Characters for the Serial Number

The required number of pallets and returnable transport items largely depends on the needs of users and an enormous number of pallets, perhaps as many as 10 millions, will be used in some applications. This Annex is intended to describe the information on the capacity of RF tags and the number of characters supported by the Serial Number for returnable transport items.

Alphanumeric data, as shown in this annex, can only be used in the ISO format; when PC Bit 17_{hex} of $MB01_2$ = “1”.

S.1 272-Bit UII Memory

If the size of ISO/IEC 18000-6C-compliant UII memory is 272 bits, 240 bits can be reserved for the UII memory since 16 bits are required for the Protocol Control and also for the CRC (see Annex F)

In this case, up to 34 characters can be stored in 240 bits using the ISO 646 character set as represented in Annex O.

Alphanumeric (ISO 646): 34 characters (one character consists of 7 bits)

Using the UN (for 9-character CIN) as IAC allows the Serial Number to use 20 characters.

34 chr. = 3 chr. (25B) + 2 chr. (UN) + 9 chr. (CIN) + 20 chr. (SN)

S.2 256-Bit UII Memory

If the size of ISO/IEC 18000-6C-compliant UII memory is 256 bits, 224 bits can be reserved for the UII memory since 16 bits are required for the Protocol Control and also for the CRC (see Annex F).

In this case, up to 32 characters can be stored in 224 bits using the ISO 646 character set as represented in Annex O.

Alphanumeric (ISO 646): 32 characters (one character consists of 7 bits)

Using the UN (for 9-character CIN) as IAC allows the Serial Number to use 18 characters.

32 chr. = 3 chr. (25B) + 2 chr. (UN) + 9 chr. (CIN) + 18 chr. (SN)

S.3 128-Bit UII Memory

If the size of ISO/IEC 18000-6C-compliant UII memory is 128 bits, 96 bits can be reserved for the UII memory since 16 bits are required for the Protocol Control and also for the CRC (see Annex F).

In this case, up to 13 characters can be stored in 96 bits using the ISO 646 character set as represented in Annex O.

Alphanumeric (ISO 646): 13 characters (one character consists of 7 bits)

No characters can be assigned for the Serial Number if UN (for 9-character CIN) is used as IAC.

Annex T
(informative)

Data Compaction for MB11_2

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

As used within this document, compaction is only applicable to Memory Bank 11_2 (User Memory).

T.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 interface:

- 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 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.

T.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.

T.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 T will only address compaction logic for Access Method 00 (Non-Directory).

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)

T.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 T.3.6 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.

T.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 000_2.

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 001_2 to 110_2.

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 111_2 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 T.3.2).
3. The length of the compacted data Object is defined.

T.3.2 Data Compaction Schemes and Codes

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

Hexadecimal range		Description	Name	Code
Low	High			
		As presented by the application	Application defined	**000**
30	**39**	Integer	Integer	**001**
30	**39**	Numeric string (from “0” to “9”)	Numeric	**010**
41	**5F**	Uppercase alphabetic	5 bit code	**011**
20	**5F**	Uppercase alphabetic, numeric, etc…	6 bit code	**100**
00	**7E**	US ASCII	7 bit code	**101**
00	**FF**	Unaltered 8 bit (default is ISO/IEC 8859-1)	Octet string	**110**
		External compaction of ISO/IEC 10646	UTF-8 string	**111**

T.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.

T.3.4 Processing the Object-Identifier and the Relative-OID

The Object-Identifier in the application commands 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 Annex D.3. For a detailed description of the processing of the Relative-OID refer to ISO/IEC 15962 Annex D.4.3.

T.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 Annex D.

T.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: T.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.

Precursor Bit Positions							
MSB							LSB
7	6	5	4	3	2	1	0
Offset	Compaction Code			Object Identifier			

The first bit (MSB – Most Significant Bit) bit 7 of the Precursor indicates the Offset. The bit has the following meaning:

MSB	Description
0	No Offset is present
1	An additional byte follows as part of the Precusor

NOTE: Annex T.3.5 will only address Offset 0 (No Offset).

Bit 6 to 4 contains the Compaction Code. Following Compaction codes can be used:

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**

Bit 3 to 0 contains the Object Identifier.

The content of the Object Identifier depends on the value of the Relative-OID.

When the Relative-OID is in the range 01 to 14 the Object Identifier will be encoded as 0001_2 to 1110_2. When the value of the Relative-OID is 0 or greater than 14 the Object Identifier will be encoded as 1111_2.

T.4 Data Compression Schemes

The schemes shall apply to 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 lest efficient.

T.4.1 Integer compaction (The Precussor is 001_2)

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 30_{hex} to 39_{hex} (decimal “0” through decimal “9”) and the leading byte(s) shall not be 30_{hex} (decimal “0”). If the decimal integer value is less than 10, or is longer than 19 digits, or the leading byte(s) are 30_{hex}, 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 are able to support a simple data type conversion to an integer value (different names are used). If the particular 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 00_{hex} to achieve the minimum encoded length. The encoded byte string should not include Encode as integer, code value 001_2 in the Precussor.

T.4.2 Numeric compaction (The Precussor is 010_2)

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 30_{hex} to 39_{hex}.

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 “1111_2” to align the compaction to byte boundaries.
3. Encode each 4-bit pair as a byte. Define the compacted sequence as numeric, code value 010_2 in the Precursor.

NOTE: During the decode process, if the last byte has the value “xF”, the last four bits “1111_2” are discarded to recreate the numeric character string of an odd number of decimal digits.

T.4.3 5-bit compaction (The Precussor is 011_2)

5-bit compaction is designed to encode uppercase Latin characters and some punctuation. All input bytes shall be in the range 41_{hex} to $5F_{hex.}$ The character string shall be 3 or more characters long. Up to 37% of memory space can be saved using this scheme. T.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 41_{hex} to $5F_{hex}$.
   b) Convert the byte value to its 8-bit binary equivalent.
   c) Strip off the lead 3 bits "010_2".
   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 "0_2" bits.
3. Convert the 8-bit segments to hexadecimal values.
4. Encode the converted byte sequence as 5 bit code, code value 011_2 in the Precursor.

NOTE: During the decode process, each 5-bit segment of the compacted bit string has "010" added as a prefix to re-create the 8-bit value of the source data. If "0_2" 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 40_{hex}, which is not supported in 5-bit compaction and shall be discarded.

T.4.4 6-bit compaction (The Precussor is 100_2)

6-bit compaction is designed to encode uppercase Latin characters, numeric digits and some punctuation. All input bytes shall be in the range 20_{hex} to $5F_{hex}$. If the trailing byte(s) are 20_{hex}, 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. T.5 shows the ISO/IEC 646 characters that can be encoded.

The rules for 6-bit compaction are:

1. Check for byte 20_{hex} 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 20_{hex} to $5F_{hex.}$
   b) Convert the byte value to its 8-bit binary equivalent.
   c) Strip off the leading 2 bits: "00_2" for bytes 20_{hex} to $3F_{hex}$ or "01_2" for bytes 40_{hex} to $5F_{hex}$.
   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".
4. Convert the 8-bit segments to hexadecimal values.
5. Encode the converted byte sequence as 6-bit code, code value 100_2 in the Precursor.

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

a) If the first bit is “1_2”, the bits “00_2” are added as a prefix before converting to values 20_{hex} to $3F_{hex}$.

b) If the first bit is “0_2”, the bits “01_2” are added as a prefix before converting to values 40_{hex} to $5F_{hex}$.

If pad strings “10”, “1000” or “100000” 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 20_{hex} 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 20_{hex} to $5F_{hex}$, 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

T.4.5 7 bit compaction (The Precursor is 101_2)

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 00_{hex} to $7E_{hex}$. The character string shall be 8 or more characters long. Up to 12% of memory space can be saved using this scheme. T.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 00_{hex} to $7E_{hex}$.
   b) Convert the byte value to its 8-bit binary equivalent.
   c) Strip off the lead bit “0_2”.
   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 “1_2” bits.
3. Convert the 8-bit segments to hexadecimal values.

4. Encode the converted byte sequence as 7 bit code, code value 101_2 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 $7F_{hex}$, 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. Analysing this byte stream shows that all values are in the range 00_{hex} to $7E_{hex}$, 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 recognised and discarded.

T.4.6 Octet string – unaltered 8-bit encoding (The Precursor is 110_2)

Octet string encoding is used when none of the above compaction schemes can be invoked. It encodes all bytes in the range 00_{hex} to FF_{hex}. The encoded byte string is identical to the source byte string. Encode as octec string, code value 110_2 in the Precursor.

NOTE: No decode processing is required.

T.5 ISO/IEC 646 Characters Supported by the Compaction Schemes (Normative)

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	•	•		
%	25	•	•		
&	26	•	•		
‘	27	•	•		
(	28	•	•		
)	29	•	•		
*	2A	•	•		

ISO/IEC 646 Character	Octet Value (hex)	Included in Compaction Type			
		7 bit code	6 bit code	5 bit code	Numeric code
+	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	•	•	•	
O	4F	•	•	•	
P	50	•	•	•	
Q	51	•	•	•	
R	52	•	•	•	
S	53	•	•	•	
T	54	•	•	•	
U	55	•	•	•	
V	56	•	•	•	
W	57	•	•	•	
X	58	•	•	•	

<table>
<tr><th rowspan="2">ISO/IEC 646 Character</th><th rowspan="2">Octet Value (hex)</th><th colspan="4">Included in Compaction Type</th></tr>
<tr><th>7 bit code</th><th>6 bit code</th><th>5 bit code</th><th>Numeric code</th></tr>
<tr><td>Y</td><td>59</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>Z</td><td>5A</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>[</td><td>5B</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>\</td><td>5C</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>]</td><td>5D</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>^</td><td>5E</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>_</td><td>5F</td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td>`</td><td>60</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>a</td><td>61</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>b</td><td>62</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>c</td><td>63</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>d</td><td>64</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>e</td><td>65</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>f</td><td>66</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>g</td><td>67</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>h</td><td>68</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>i</td><td>69</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>j</td><td>6A</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>k</td><td>6B</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>l</td><td>6C</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>m</td><td>6D</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>n</td><td>6E</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>o</td><td>6F</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>p</td><td>70</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>q</td><td>71</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>r</td><td>72</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>s</td><td>73</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>t</td><td>74</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>u</td><td>75</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>v</td><td>76</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>w</td><td>77</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>x</td><td>78</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>y</td><td>79</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>z</td><td>7A</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>{</td><td>7B</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>|</td><td>7C</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>}</td><td>7D</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>~</td><td>7E</td><td>•</td><td></td><td></td><td></td></tr>
</table>

T.6 Six-Bit Data Compaction Used in This Gudeline

The table below is used for six-bit encoding in this guideline.

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

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

Bibliography

[1] AIAG B-11, Item-level radio frequency identification (RFID) standard

[2] AIAG B-10, Trading partner labels implementation guidelines (using linear and 2D symbologies)

[3] AIAG RC-6 Revised,Returnable transport item guideline

[4] Odette Transport Label, v1.0

[5] Odette Transport Label, v1.4.1

[6] JAIF Global Transport Label

[7] Odette/VDA, RFID in supply chain container management

[8] AIM DPM Quality Guideline

[9] AIM Global Standard for the use of the AIM RFID Emblem and index to identify RFID-enabled labels

