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Automatic identification and data capture techniques — Supply chain applications of RFID — Product tagging, product packaging, transport units, returnable transport units and returnable packaging items

Techniques automatiques d'identification et de capture des données — Applications de chaîne d'approvisionnements de RFID — Étiquetage de produits, empaquetage de produits, unités de transport, éléments restituables de transport et éléments d'empaquetage restituables

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Contents

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This first edition of ISO/IEC 17360 cancels and replaces ISO 17367:2013, ISO 17366:2013, ISO 17365:2013 and ISO 17364:2013, which has been technically and editorially revised.

The main changes are as follows:

— ISO 17367:2013, ISO 17366:2013, ISO 17365:2013 and ISO 17364:2013 have been integrated into this document;

— 8-bit encoding and decoding using the UTF-8 encoding set has been added;

— binary encoding of the UII has been added;

— outdated processes and information have been updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

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

For the purposes of this document, “product”, “product packaging”, “transport unit”, and “returnable transport item (RTI) and returnable packaging item (RPI)” are all called items.

For the purposes of this document, the value of a single byte is represented using hexadecimal characters written as 0xnn, where “0x” is the hexadecimal indicator and “nn” is the hexadecimal value.

For the purposes of this document, a series of 1’s and/or 0’s followed by a subscript 2 indicates that these series of digits are to be interpreted as bit values, or as a number expressed in binary form.

For the purposes of this document, the representation of the tags memory banks (MB) 00_2, $MB01_2$, $MB10_2$ and $MB11_2$ are represented as MB00, MB01, MB10 and MB11.

Automatic identification and data capture techniques — Supply chain applications of RFID — Product tagging, product packaging, transport units, returnable transport units and returnable packaging items

1 Scope

This document defines the basic features of RFID for use in the supply chain when applied to product tagging, product packaging, transport units and returnable transport items (RTIs) and returnable packaging items (RPIs). This document:

— provides specifications for the identification of the items,

— makes recommendations about additional information on the RF tag,

— specifies the semantics and data syntax to be used,

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

— specifies the minimum performance requirements,

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

— specifies the reuse and recyclability of the RF tag.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 445, *Pallets for materials handling — Vocabulary*

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

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

ISO/IEC 15459-2, *Information technology — Automatic identification and data capture techniques — Unique identification — Part 2: Registration procedures*

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

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

ISO/IEC 18000-63, *Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C*

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

ISO/IEC 20248, *Information technology — Automatic identification and data capture techniques — Digital signature data structure schema*

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

ANSI MH10.8.2, *Data Identifiers*

GS1 *EPC Tag Data Standard (TDS)*

GS1 *General Specifications.*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 445, ISO/IEC 19762 and the following apply.

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

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

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

3.1
domain authority identifier
DAID
unique identifier of an entity fulfilling the role of a Domain Authority who is the issuer of the data contain in the tag

3.2
packaging
material used for the containment, protection, handling, delivery, storage, transport and presentation of goods

Note 1 to entry: Ownership changes at time of purchase or delivery.

3.3
returnable packaging item
RPI
material used for the “protection” of goods during handling, delivery, storage and transport that are returned for further usage

Note 1 to entry: See Annex E for details on the use of returnable *packaging* (3.2) items.

Note 2 to entry: Ownership does not change at time of purchase or delivery.

4 Concepts

Figures 1 and 2 give a graphical representation of supply chain layers. They show a conceptual model of possible supply chain relationships – not a one-for-one representation of physical things. Although several layers in Figure 2 have clear physical counterparts, some common supply chain physical items fit in several layers depending on the use case. For example, as shown in Figure 2, a repetitively used pallet under constant ownership will be covered as a returnable transport item (RTI), a pallet that is part of a consolidated unit load will be covered as a transport unit and a pallet that is integral to a single item will be covered as product packaging. See Annex E for additional details on RTIs.

The term “supply chain layers” or levels, is a multi-level concept that covers all aspects of taking a product from raw materials to:

— a final product;

— shipping;

— a final place of sale, use, maintenance;

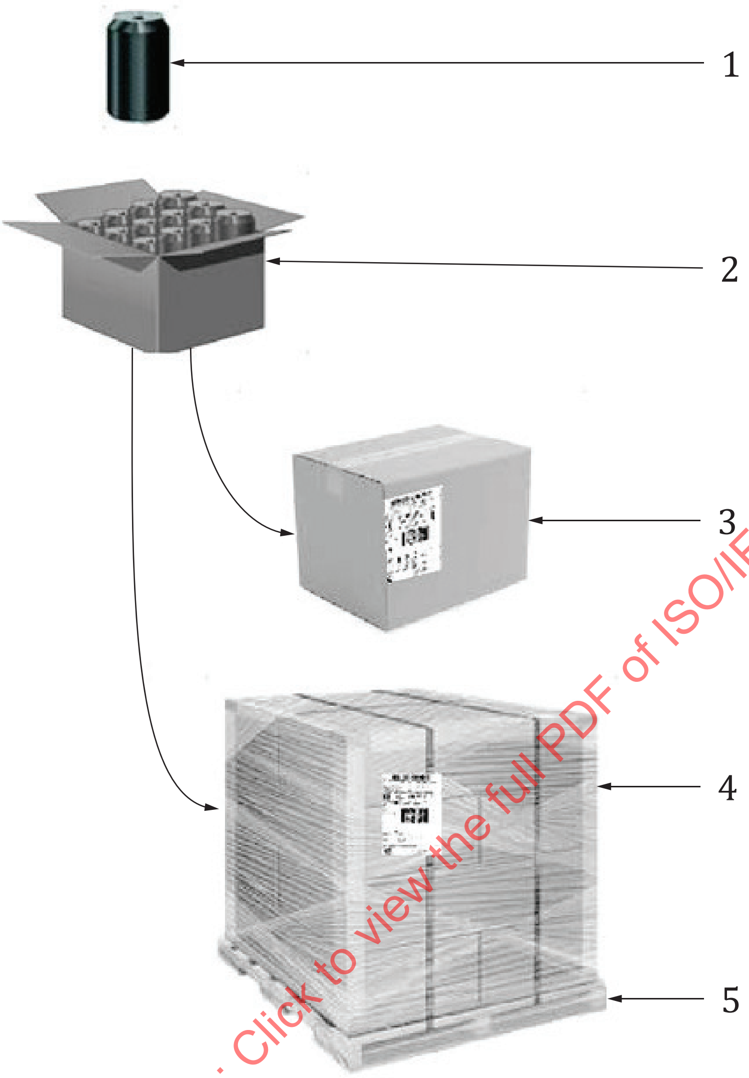
— potentially, returned goods and disposal.

Each of these levels covers many aspects of dealing with products and the business process for each level is both unique and overlaps other levels (see Annex B for additional information).

The item level through freight container level layers are addressed within the suite of standards for "supply chain applications of RFID" and are intended to enhance supply chain visibility. The movement vehicle level is not a part of the supply chain applications of RFID family of standards.

Layers 0, 1, 2 and 3 of Figure 2 are the subject of this document. Details of each of these Layers will be covered in applicable clauses of this document.

Different Layer tags can be distinguished from following, or preceding, Layer tags by the use of a *group-select* methodology contained in the RFID interrogator/reader. This *group-select* function allows the interrogator, and supporting automated information systems (AIS), to quickly identify different Layer tags.



Key

1 primary packaging (product, e.g. consumer packaging)
2 secondary packaging (outer packaging, e.g. product bulk package)
3 tertiary packaging (transport packaging, e.g. transport unit)
4 tertiary packaging (unitized transport packaging, e.g. transport unit)
5 returnable and non-returnable transport item (e.g. a pallet)

Figure 1 — Packaging

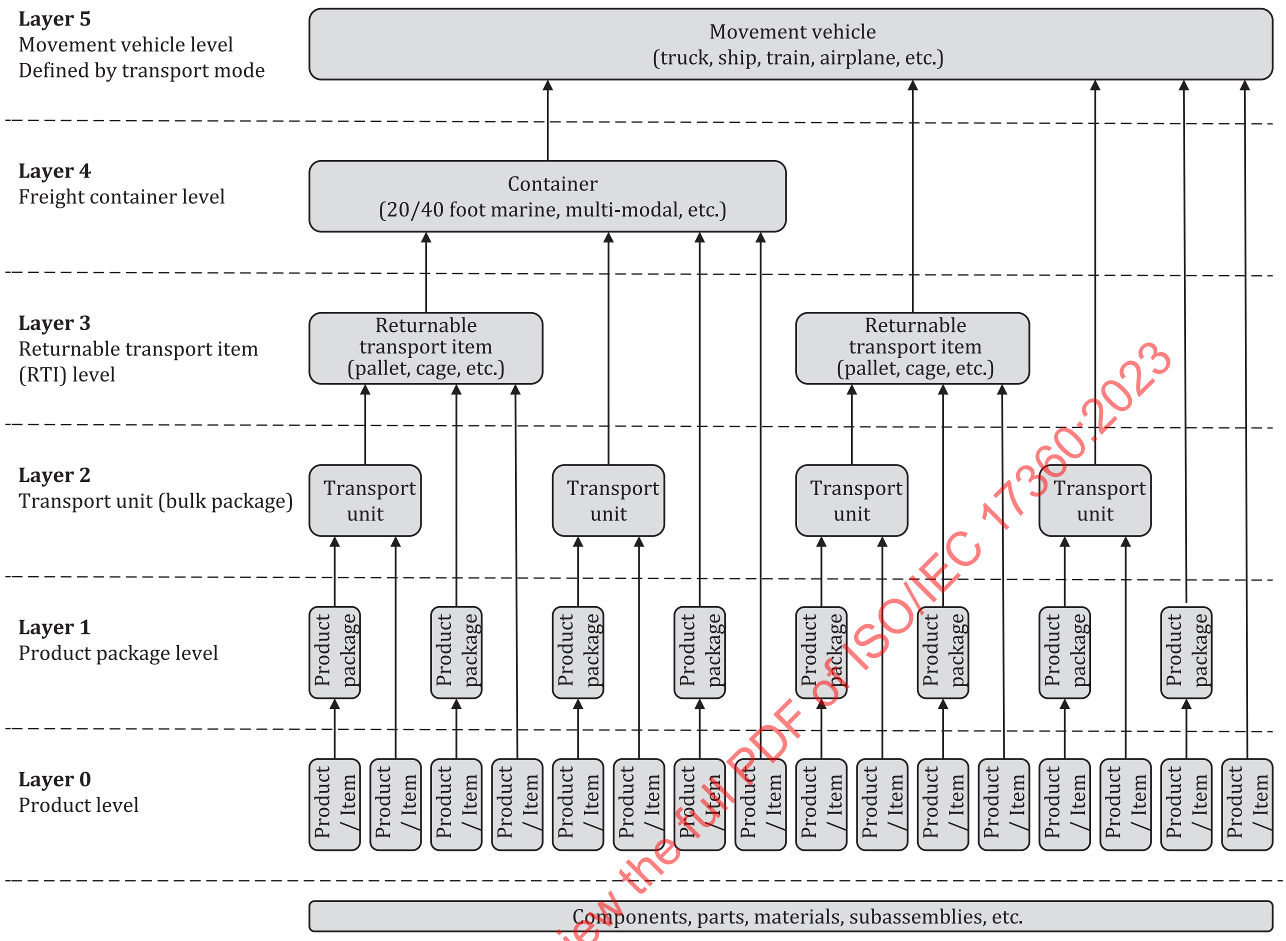


Figure 2 — Supply chain layers

5 Unique item identifier

5.1 General

Unique item identification (UII) is a process that assigns a unique data string to an individual item or in this case, to an RFID tag that is associated to the item. The unique data string is called the unique item identifier. Unique item identification of items allows data collection and management at a granular level. The benefits of having granular level data are evident in such areas as provenance, traceability, maintenance, retail warranties and enabling electronic transactions of record. The benefits are only possible if each tagged item has a unique identity.

Items that are not uniquely identified will not normally be tagged at the item level. Items to which unique item identifiers have been assigned are said to be serialized items. Traditionally, low-cost consumable items will normally be tagged at the package, or higher, level; however, recent studies have explored the ROI for tagging low-cost items.

The UII provides granular discrimination between like items that are identified with RFID tags or barcodes. See Annex C for information on using barcode labels as backup in case of RFID Tag failure. The Unique Tag ID (as defined by ISO/IEC 15963-1) is a mechanism to uniquely identify RFID tags and is not the unique product identifier defined in this document.

The minimum data elements required for unique identification are an issuing agency code (IAC), a unique enterprise identifier [Company Identification Number, (CIN)] assigned by the IAC and a serial number (SN) that is unique within that enterprise identifier.

The unique identifier of ISO/IEC 15459-1 provides identification schemes for various layers of the supply chain, from Layer 0 (products) up to Layer 3 (returnable transport items).

ISO/IEC 15459-1 and GS1 Serial Shipping Container Code (SSCC)[18] specifies the unique identification mechanisms for transport unit identification (Layer 2).

See Annex D for information on environmental factors for RFID tag operations.

5.2 UII data elements

Unique identification is provided by the minimum of the following three components:

a) IAC;

b) CIN;

c) SN.

The registration authority, as defined by ISO/IEC 15459-2, assigns the IAC. The IAC assigns the CIN. The company identified by the CIN assigns the SN. The serial number component can be composed of multiple parts – but in all cases must be a unique identifier within the CINs domain.

When using ISO/IEC 15418, the unique identity, as defined by IAC CIN SN, is preceded by an applicable ANSI MH10.8.2 Data Identifier (DI). Any applicable Data Identifier from ISO/IEC 15418 is allowed.

It is strongly recommended that once the UII has been constructed and encoded on an RFID tag that it be write-protected (locked or permalocked).

5.3 Data carrier

The data carrier/air interface shall be ISO/IEC 18000-63 or ISO/IEC 18000-3, Mode 3.

An ISO/IEC 18000-63 or ISO/IEC 18000-3, Mode 3 tags' memory is structured in three user-accessible memory banks:

a) MB01 (UII); for the purpose of this document, contains the ISO/IEC 18000-63-defined constructs of the Protocol Control bits (PC), optional Extended PC bits (XPC) and the UII.

   1) The PC bits contain flags to indicate the numbering system of the tag to be either ISO or GS1, and the existence of XPC bits and User Memory (MB11).

   2) When ISO is indicated, the PC bits contain an Application Family Identifier (AFI) that indicates the data family of the UII.

   3) The AFI is managed as specified by ISO/IEC 15961-3 and listed in the ISO/IEC 15961-2 Data Constructs Register.

   NOTE MB01 can include additional information, like tag and item flags, sensor data and other item information as indicated by the PC Bits.

b) MB10 (TID); identifies the tag according to ISO/IEC 15963-1.

c) MB11 (USER); contains user information as specified by the AFI and/or the Data Storage Format Identifier (DSFID). MB11 is optional.

As defined by the AFI, the UII format may be specified by a DSFID. The DSFID is specified and managed as described in ISO/IEC 15962 and listed in the ISO/IEC 15961-2 Data Constructs Register. The Data Constructs Register can be found in Reference [7].

5.4 Formats and encoding

5.4.1 General

Where there are application requirements to encode both the identity of the asset as well as a shipment ID or license plate, it is possible to encode these unique identities in either one or two RF tags. In the case of two tags within the ISO system, each tag will include its own unique AFI, that is, “0xA2” for license plate (shipment identification) and “0xA3” for the RTI AFI. The AFIs shall be followed by the respective ANSI MH10.8.2 Data Identifier as specified in ISO/IEC 15418. See Annex E for examples.

NOTE 1 At the time of publication of this document, assigned AFIs are: 0xA1, 0xA2, 0xA3, 0xA5, 0xAC and 0xAD. AFIs 0xA4, 0xA6, 0xA7 and 0xA8 are assigned historically for HAZMAT material and items. These AFIs are maintained for historical purposes; they are not for use by new applications. The ISO/IEC 18000-63 XPC HAZMAT flag is used to denote HAZMAT material.

NOTE 2 When using 8-bit encoding, the AFI for 8-bit encoding, 0xAC, will take precedence over and replace the AFI to denote either license plate or RTI status.

When using RFID tags, the UII for the RTI shall be written to the UII memory bank (MB01, see Figure A.1) and locked. The UII for the transport unit shall be preceded by the appropriate ANSI MH10.8.2, Category 10 license plate DI. If the license plate is to be stored on the same RFID tag, using the appropriate DI, it shall be written and locked in user memory (MB11). When combining multiple data structures, the syntax of the data shall comply with ISO/IEC 15434.

RFID tags shall have the serialized tag ID written to TID (MB10) by the manufacturers in accordance with ISO/IEC 15963-1 and permalocked.

If read-only or WORM tags are employed in identifying RTIs, two tags shall be used. One tag represents the unique transport unit identifier and the second represents the unique RTI identifier.

Subclauses 5.4.2 to 5.4.6 specify the unique item identifier methodologies that are allowed.

5.4.2 GS1 EPC bitstream encoding

For GS1 electronic product code (EPC) encoding, the numbering system identifier toggle, shown as standard toggle (T) in Figure A.2, shall be set to 0_2 (GS1). The UII shall then be an EPC as specified by GS1, *EPC Tag Data Standard (TDS)*.

5.4.3 ISO/IEC 15418 and ANSI MH10.8.2 DIs: 6-bit UII encoding

The numbering system identifier toggle, shown as standard T in Figure A.2, shall be set to 1_2 (ISO).

An ISO/IEC 15418-based UII, consisting of an applicable DI and item information, shall be encoded according to the AFI selected, as that AFI is defined by the ISO/IEC 15961-2 appointed registration authority.

When using ISO/IEC 15434-based messages within MB01, the first DI in the message shall identify the UII, which consists of IAC, CIN, and SN. It is strongly recommended that only one DI, and its data be used in MB01. In all cases, the UII shall be defined by the first DI in an ISO/IEC 15434-based message placed in MB01.

When used, multiple DIs shall be separated by the control character $^{G}{}_{S}$ (011110_2).

The messages should be terminated with the control character $^{E}O_{T}$ (100001_2).

Annex A provides additional details on 6-bit encoding and decoding.

5.4.4 ISO/IEC 15418 and ANSI MH10.8.2 DIs: UTF-8 8-bit UII encoding

The numbering system identifier toggle, shown as standard T in Figure A.2, shall be set to 1_2 (ISO).

The UII is encoded using UTF-8 encoding as specified by an appropriate AFI as shown in the ISO/IEC 15961-2 Data Constructs Register.

When using ISO/IEC 15434-based messages within MB01, the first DI in the message shall identify the UII, which consists of IAC, CIN, and SN. It is strongly recommended that only one DI, and its data, be used in MB01. In all cases, the UII shall be defined by the first DI in an ISO/IEC 15434-based message placed in MB01.

When used, multiple DIs shall be separated by the control character $^{G}{}_{S}$ (0x1D).

The messages should be terminated with the control character $^{E}O_{T}$ (0x04).

Annex A provides additional details on 8-bit encoding and decoding.

5.4.5 DSFID for ISO/IEC 15434 messages

See ISO/IEC 15961-2, Data Constructs Register, for Data Format 03 and 13 definitions, and for the specification for DSFIDs.

5.4.6 UII bitstream encoding

5.4.6.1 Encoding rules

Binary encoding provides superior benefits when encoding data that is equal to or larger than 6 characters.

The numbering system identifier toggle, shown as standard T in Figure A.2, shall be set to 1_2 (ISO).

The UII is encoded as a bitstream, as shown in Table 1, and as outlined in the steps below Table 3. It is also identified with the appropriate AFI from the ISO/IEC 15961-2 Data Constructs Register.

Table 1 — Bitstream representation of UII encoding

	UII-bitstream data elements						
UII data element	UII-Type (see Table 2)	SN-Type (see Table 3)	MB01-DS-FID-flag	MB11-DS-FID-flag	IAC+CIN (DAID encoding)	MB11-Word-Count	UII-SN (serialization)
Bit length for the data to be encoded	4 bits	2 bits	1 bit	1 bit	32, 40 or 48 bits	8 bits	n bits According to the SN-Type
Total bit length of encoded data	>48 bits to a 16-bit word boundary						

Table 2 — UII type identifier

UII-Type	**UII-Type encoding value** binary	**Description**
0	0000	General item
1	0001	Product
2	0010	Product package
3	0011	Transport unit
4	0100	Transport item

For proprietary use, a UII-Type beyond those listed in Table 2 can be used by an entity identified by an IAC CIN.

NOTE 1 There is currently no process available to assign additional UII Identifiers.

Table 3 shows the different methods of encoding the serial number element.

Table 3 — SN Type description

SN-Type	SN-Type encoding value binary	Description	Encoding rules
0	00	Decimal number.	The UII-SN shall not be followed with additional data, i.e. the UII cannot contain additional data. The UII-SN shall be padded with leading zeros.
1	01	Base-36 (hexatridecimal) number with the digit sequence "0" to "9" and then "A" to "Z".	
2	10	6-bit character set. See Table A.1.	The UII-SN shall be terminated with a complete $^{E}O_{T}$, incomplete $^{E}O_{T}$ or by the UII length, whichever comes first, or a $^{G}{}_{S}$ when followed by additional data.
3	11	Use the TID as the SN.	The SN shall be represented in text as an uppercase hexadecimal value. The UII may contain additional data following the MB11-word-count.

NOTE 2 For SN-Type 0, a UII length of six words (96 bits), and an IAC + CIN encoding length of 40 bits results in an SN length of 40 bits. For example, SN decimal number 222,722,086 is encoded as 0000 0000 0000 1101 0100 0110 0111 1000 0010 0110_2, which is 000D46782616.

NOTE 3 For SN-Type 1, a UII length of six words (96 bits), and an IAC + CIN encoding length of 40 bits results in an SN length of 40 bits. For example, SN hexatridecimal number "3OLPGM" is encoded as 0000 0000 0000 1101 0100 0110 0111 1000 0010 0110_2, which is 000D46782616. Various free web-based convertors are available; search for "base36 conversion".

NOTE 4 For SN-Type 0 and 1, the UII-SN length is the PC bits UII length in bits minus the length of the preceding six UII data elements (which is 48 bits, 56 bits or 64 bits).

NOTE 5 The TID is specified to be unique by ISO/IEC 15963-1 and ISO/IEC 18000-63.

The UII-bitstream encoding, as shown in Table 1, consists of the following elements:

a) UII-Type: 4 bits; value selected from Table 2.

b) SN-Type: 2 bits; value selected from Table 3.

c) MB01-DSFID-Flag (UII additional data DSFID): 1 bit.

   1) This bit is only valid for SN-Type 2 and 3. It shall be ignored (set to 0_2) for SN-Type 0 and 1.

   2) For SN-Type 2:

      — When the flag is set to 0_2, the UII-SN and the data stored in MB01 following the UII-SN shall use $^{G}{}_{S}$ as the data element separator, and be terminated with an $^{E}O_{T}$, incomplete $^{E}O_{T}$, or by the UII length, whichever comes first, see 5.4.6.2.

      — When the flag is set to 1_2, the data stored in MB01 following the UII-SN encoding shall start with a DSFID and follow the encoding rules of the DSFID. The UII-SN encoding and DSFID shall be separated with a $^{G}{}_{S}$, see 5.4.6.2.

   3) For SN-Type 3 (the encoded UII does not contain an UII-SN, since the TID is the SN):

      — When the flag is set to 0_2, the data stored in MB01 following the MB11-Word-Count uses a proprietary format. The length of the data is the PC bits UII length in bits minus the length of the preceding six UII data elements (UII-Type, SN-Type, MB01-DSFID-flag, MB11-DSFID-flag, IAC+CIN and MB11-Word-Count which is 48 bits, 56 bits, or 64 bits).

      — When the flag is set to 1_2, the data stored in MB01 following the MB11-Word-Count shall start with a DSFID and follow the encoding rules of the DSFID.

d) MB11-DSFID-Flag (UserMem DSFID): 1 bit;

— When the flag is set to 0_2, the data stored in MB11 uses a proprietary format.

— When the flag is set to 1_2, the data stored in MB11 shall start with an ISO/IEC 15961-1-based DSFID.

e) IAC+CIN: 32 bits, 40 bits or 48 bits; shall be encoded as specified by ISO/IEC 20248:2022, 7.5.1 DAID encoding.

NOTE The ISO/IEC 20248 encoding results in encoded data lengths of 32 bits, 40 bits or 48 bits. This is to provide bit-length efficiency as the IAC and CIN, as specified by ISO/IEC 15459-5, is of variable length.

f) MB11-Word-Count: 8 bits; providing a method to indicate that the first MB11-Word-Count 16-bit words of MB11 should be read and processed by the application. MB11 may contain more data.

NOTE Accessing MB11 data beyond the first 4080 bits is outside the scope of this document. There are various standard methods to access these bits, of which the method is typically selected and configured in the first 4080 bits of MB11.

g) UII-SN (UII encoded serialisation): n bits according to the SN-Type to fit within the ISO/IEC 18000-63 data memory 16-bit word boundary.

5.4.6.2 UII-SN termination examples

The UII-SN may be terminated with:

— a $^{G}_{S}$ when followed by other data, or

— be terminated

— by the 16-bit word boundary as specified by the UII Length in the PC bits, see Figure A.2,

— by a complete $^{E}O_{T}$, or

— an in complete $^{E}O_{T}$.

NOTE This termination method is specified in ISO/IEC 15962:2022 T.4.1, step 6.

Table 4 illustrates the UII-SN termination.

Table 4 — Valid $^{E}O_{T}$ termination within a 2-word UII

<table>
<tr><th>UII-SN Length</th><th>Encoding</th><th>UII-SN Termination</th></tr>
<tr><td>32 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxxx xxxx xxxx|</td><td>On the 16-bit word boundary.</td></tr>
<tr><td>30 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxxx xxxx xxeo|</td><td>Incomplete $^{E}O_{T}$.</td></tr>
<tr><td>28 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxxx xxxx eote|</td><td>Incomplete $^{E}O_{T}$.</td></tr>
<tr><td>26 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxxx xxeo teot|</td><td>Complete $^{E}O_{T}$.</td></tr>
<tr><td>24 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxxx eote ot__|</td><td>Complete $^{E}O_{T}$.</td></tr>
<tr><td>22 bits</td><td>xxxx xxxx xxxx xxxx|xxxx xxeo teot ____|</td><td>Complete $^{E}O_{T}$.</td></tr>
<tr><td colspan="3">Key
x : UII-SN bit
eoteot : 6 EOT encoding bits 100001_2
_ : bit not part of the encoding</td></tr>
</table>

See A.8.4 for binary encoding examples.

6 Identification of RFID labelled material

RF tags and RF label inlays compliant with this document shall include one or more of the internationally accepted RFID emblems as described in ISO/IEC 29160. Figure 3 is an example of an RFID graphical emblem.

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

Figure 3 — RFID tag graphical emblem example

Annex A
(normative)

Encoding

A.1 General

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

a) a GS1 EPC compliant form for either or both the UII in MB01 and User Memory in MB11:

   1) the segmentation of ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 tags is illustrated in Figure A.1;

   2) EPC encoding is detailed in the GS1, *EPC Tag Data Standard (TDS)*;

b) a structure employing ISO/IEC 15962:2022, Format 13 (relative OID);

c) a simplified structure, encoding an entire ISO/IEC 15434 message as a unit, employing a “no directory”, encoded in either 6-bit or UTF-8, as defined in ISO/IEC 15962 and as described in the remainder of this annex;

d) bit stream encoding.

A.2 Tag structure

Each of these encoding forms can be unambiguously discerned by the content of bits 0x17 through 0x1F of MB01, as illustrated in Figures A.1 and A.2 bits 0x00 through 0x1F of MB11.

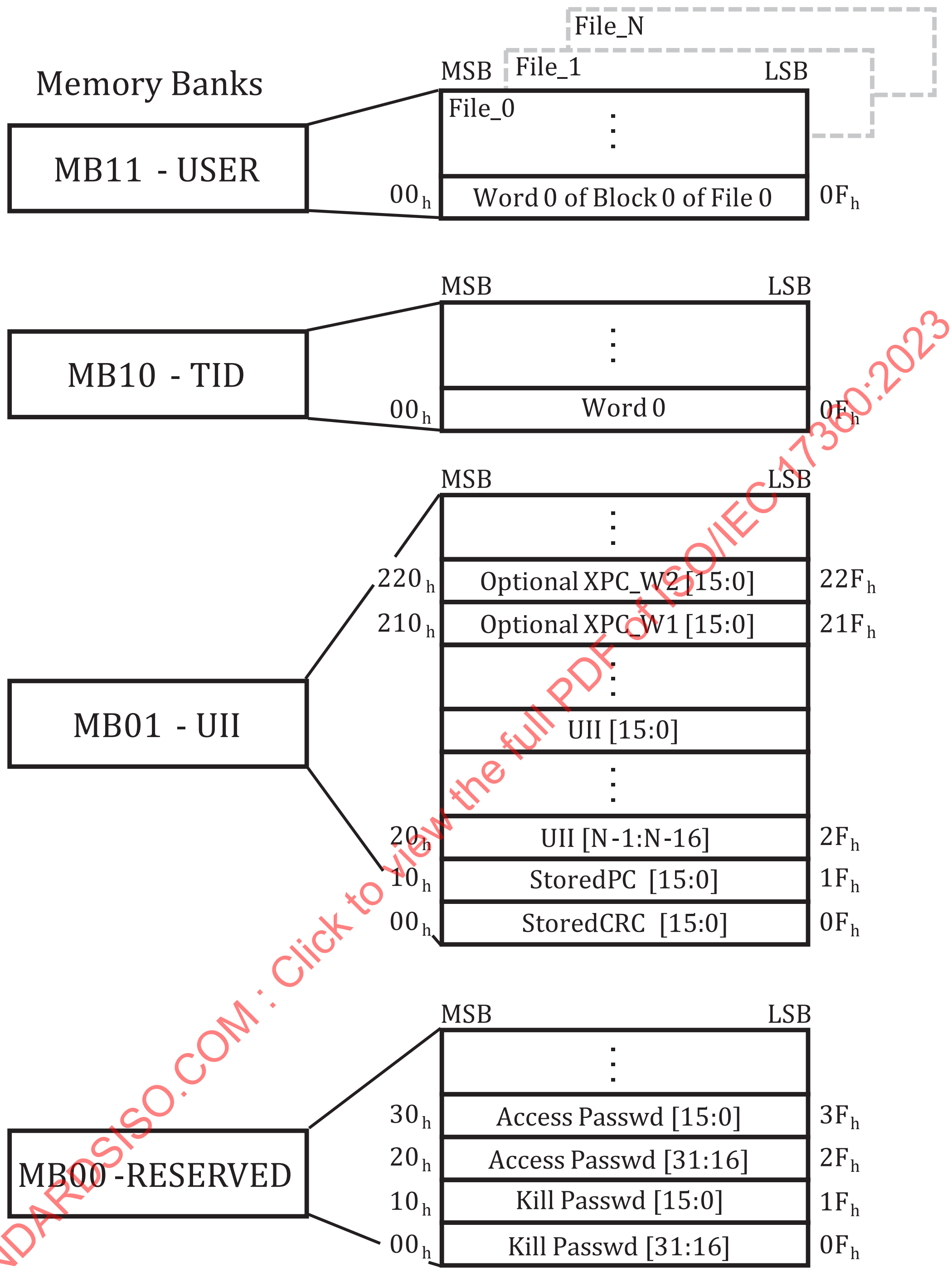


Figure A.1 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 Memory Structure

A key concept in this simplified encoding form, in both MB01 and MB11, is the use of 6-bit encoding as shown in Table A.1. The values shown are in binary.

Table A.1 — 6-bit encoding

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

NOTE Table A.1 is 6-bit encoding created through the simple removal of the high-order bit from the ISO/IEC 646 7-bit ASCII character set, save the shaded values. The shaded values are re-assigned, as provided, to minimize the bit count when using the ISO/IEC 15434 envelope.

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

A.3 Tag memory banks

Tag memory shall be logically separated into four distinct banks, each of which may comprise one or more memory words. A logical memory map is given in Figure A.1. See ISO/IEC 18000-63 for details. A general definition of the memory banks follows.

a) Reserved memory (MB00) shall contain the kill and access passwords.

b) UII memory (MB01) shall contain a CRC-16, PC bits and a code, i.e. a UII, that identifies the object to which the tag is or will be attached. See Figure A.2.

c) TID memory (MB10) shall contain an 8-bit ISO/IEC 15963-1 allocation class. TID memory shall contain sufficient identifying information for an Interrogator to uniquely identify the custom commands and/or optional features that a tag supports, and to be compliant to this document, contain a unique serial number.

d) User memory (MB11) allows user-specific data storage. The storage format described in ISO/IEC 15961-3 and ISO/IEC 15962 defines the memory organization. The presence of data in user memory in MB11 shall be indicated by the presence of a binary “1” in the 0x15 PC-bit. A binary zero in the 0x15 PC-bit shall indicate that there is no user memory at MB11 or that there is no data in MB11. Further information on MB11 can be found in this annex and ISO/IEC 18000-63.

A.4 Protocol control 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 MB01. See Figure A.2.

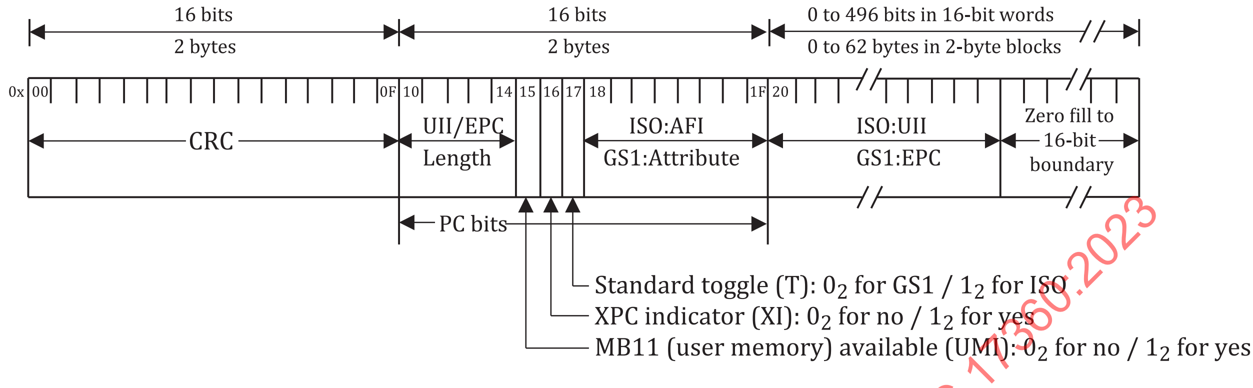


Figure A.2 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 structure of Memory Bank 01

A.5 Encoding of Memory Bank 01 unique item identifier

The standard T, the bit at memory location 0x17, of MB01 is the switch between ISO formats and EPC formats. When bit 0x17 is set to a "0_2", the EPC Identifier encoding is as per the GS1, *EPC Tag Data Standard (TDS)*. When bit 0x17 is set to a "1_2", the UII encoding is as per ISO/IEC 15459-1 for individual transport units, ISO/IEC 15459-4 for individual products and product packages, ISO/IEC 15459-5 for individual RTIs and RPIs and preceded by an appropriate ISO/IEC 15961-2 AFI.

To show an example, encoding of a product is shown. Transport units will be identically encoded except for the AFI and the DI used. A linear bar code symbol encoding the data providing unique item identification comprises the DI, IAC, CIN and SN. An example of such a unique item identification represented in a Code 128 linear bar code is shown in Figure A.3. This barcode can be the backup to an RFID tag.

Figure A.3 is encoded with the following data.

NOTE The specific DI used in this example does not mean that other DIs cannot be used. Any applicable DI from ISO/IEC 15418 and ANSI MH10.8.2 can be used.

— DI = 25S

— IAC = UN (DUNS)

— CIN = 043325711

— SN = MH8031200000000001

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

When encoded onto an RFID tag, the AFI will be added to the data structure.

— AFI = 0xA1

— DI = 25S

— IAC = UN (DUNS)

— CIN = 043325711

— SN = MH8031200000000001

A complete data structure for an RFID tag, using the information defined above, will be 0xA125SUN043325711MH8031200000000001, and the data is represented in MB01 as shown in Table A.2.

Table A.2 — MB01 structure of AFI and UII using 6-bit encoding

Information	AFI = 0xA1			2	5	S	U	N	0	4	3	3
Binary	1010 0001			110010	110101	010011	010101	001110	110000	110100	110011	110011
Information	2	5	7	1	1	M	H	8	0	3	1	2
Binary	110010	110101	110111	110001	110001	001101	001000	111000	110000	110011	110001	110010
Information	0	0	0	0	0	0	0	0	0	0	1	$^{E}O_{T}$
Binary	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110001	100001

When UTF-8 encoding is used, it is represented in MB01 as shown in Table A.3.

Table A.3 — MB01 structure of AFI and UII using ISO/IEC UTF-8 encoding and DIs

Information	AFI = 0xAC			2	5	S	U	N	0	4
Binary	1010 1100			00110010	00110101	01010011	01010101	01001110	00110000	00110100
Information	3	3	2	5	7	1	1	M	H	8
Binary	00110011	00110011	00110010	00110101	00110111	00110001	00110001	01001101	01001000	00111000
Information	0	3	1	2	0	0	0	0	0	0
Binary	00110000	00110011	00110001	00110010	00110000	00110000	00110000	00110000	00110000	00110000
Information	0	0	0	0	1	$^{E}O_{T}$				
Binary	00110000	00110000	00110000	00110000	00110001	00000100				

A.6 General information on encoding data in MB11 - User Memory

To indicate data resides in MB11 (User Memory), the bit at memory location 0x15 of MB01 is set to a "1_2". The state of the standard T does not imply format information for MB11 because users may choose to implement EPC encoding for MB01 and ISO encoding for MB11; for example, in cases where MB01 is read by retailers and MB11 by industrial consumers. The reverse encoding, ISO in MB01 and EPC in MB11, is also possible.

To avoid confusion between the structures defined herein and those defined in ISO/IEC 15962, MB11 shall declare its access method and format.

A.7 Encoding and decoding of data in MB11

A.7.1 Encoding process

A.7.1.1 6-bit encoding

The encoding steps are:

a) Starting with a valid ISO/IEC 15434 message using ANSI MH10.8.2 Data Identifiers, strip "[ ) > $^{R}_{S}$ 06 $^{G}_{S}$" from the front and "$^{R}_{S}$ $^{E}O_{T}$" from the end.

NOTE The quotes and spaces that are used to separate the ISO/IEC 15434 data characters, above and following, are not present in the actual datastream; they are shown for purposes of differentiation and clarity only.

a) If the resulting data contains the pattern "$^{R}_{S}$ 06 $^{G}_{S}$" anywhere, the four-character combination should be replaced with the single character "$^{R}_{S}$" everywhere it exists. This occurs when multiple "06" record envelopes are used, for example, when describing subassemblies of a complex part.

b) Convert the resulting data characters into their 6-bit code value using Table A.1.

c) Add a 6-bit "$^{E}O_{T}$" pattern from Table A.1 ("100001") to the end of the bit pattern after the last encoded data character. Add padding bits as needed in the form "100001".

d) Lay out the 6-bit characters as bits and group them into 8-bit bytes such that any mismatch between the data and an 8-bit boundary occurs in the last 6-bit padding bits pattern added in e).

e) Delete any bits of the last padding bits pattern that may be in a last, unfilled 8-bit byte.

f) Determine the number of bytes. Convert the count into binary and encode explicitly as the data byte-count indicator.

g) Encode the DSFID, Precursor, data byte-count indicator, data, "$^{E}O_{T}$" and padding bits (if any) into memory.

A.7.1.2 UTF-8 8-bit encoding

The encoding steps are:

a) Starting with a valid ISO/IEC 15434 DI message, strip "[ ) > $^{R}_{S}$ 06 $^{G}_{S}$" from the front and "$^{R}_{S}$ $^{E}O_{T}$" from the end.

b) List every data character into its UTF-8 code value using ISO/IEC 10646.

c) When encoding multiple "06" format envelopes (e.g., to represent a message containing several "records" from the same data format in order to describe the subassemblies of a complex part), reduce each internal ISO/IEC 15434 sequence "$^{R}_{S}$ 06 $^{G}_{S}$" indicating a new "record" to a single "$^{R}_{S}$" character.

d) Encode an "$^{E}O_{T}$" pattern after the last encoded data character.

e) Determine the byte number that contains the last bit of the "$^{E}O_{T}$" character, convert the decimal count to binary and encode explicitly as the data byte-count indicator.

f) Encode the DSFID, Precursor, data byte-count indicator, data, "$^{E}O_{T}$" and padding bits (if any) into memory.

A.7.2 Decode process using 6-bit or UTF-8

A.7.2.1 6-bit decoding

The decoding steps are:

a) Examine the DSFID and Precursor bytes and verify that they are equivalent to “0x03 0x46”.

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

c) When using 6-bit encoding; starting with the next bit, group the following bits into character bit-sets from the 6-bit code table and continue until the number of bytes containing data has been parsed.

d) Assign data characters according to Table A.1 and delete all complete and incomplete “$^{E}O_{T}$” characters from the end.

e) For any encoded “$^{R}{}_{S}$” character that is not immediately followed by “06” and a “$^{G}{}_{S}$” character, expand the “$^{R}{}_{S}$” to “$^{R}{}_{S}$ 06 $^{G}{}_{S}$”.

f) Add “[ ) > $^{R}{}_{S}$ 06 $^{G}{}_{S}$” to the beginning of the transmission and “$^{R}{}_{S}$ $^{E}O_{T}$” at the end.

NOTE The quotes spaces shown in the data string, above and following, are there for differentiation and clarity only and is not part of the encoded data content.

g) Transmit the entire ISO/IEC 15434-compliant message.

A.7.2.2 UTF-8 8-bit decoding of ISO/IEC 15434 messages with ANSI MH10.8.2 Data Identifiers

The decoding steps are:

a) Examine the DSFID and Precursor bytes and verify they are equivalent to “0x03 and 0x76”.

b) Determine the byte count by reading and interpreting the byte-count byte.

c) Read the next sequence of bytes so the number of bytes read this way matches the byte-count from the previous step.

d) Convert these bytes into characters using UTF-8 from ISO/IEC 10646.

e) Delete the “$^{E}O_{T}$” character and any padding bits from the end.

f) For any encoded “$^{R}{}_{S}$” character that is not immediately followed by “06” and a “$^{G}{}_{S}$” character, expand the “$^{R}{}_{S}$” to “$^{R}{}_{S}$ 06 $^{G}{}_{S}$”.

g) Add “[ ) > $^{R}{}_{S}$ 06 $^{G}{}_{S}$” to the beginning of the transmission and “$^{R}{}_{S}$ $^{E}O_{T}$” at the end.

h) Transmit the entire ISO/IEC 15434-compliant message.

A.8 Encoding and decoding example

A.8.1 Translation and encoding procedure from ISO/IEC 15434-based data to Access Method 0 Data Format 3

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

a) Verify that the input message is a valid ISO/IEC 15434 DI-based message.

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

c) The leading message envelope characters “[ ) > $^{R}_{S}$ 06 $^{G}_{S}$” and the trailing “$^{R}_{S}$ $^{E}O_{T}$” are discarded.

NOTE Spaces and quotes have been added to the data elements above for differentiation and clarity only. They are not part of the data to be encoded.

d) The data is encoded into 6-bit codewords from Table A.1 or 8-bit words using UTF-8 from ISO/IEC 10646.

e) Add an $^{E}O_{T}$ character at the end of the datastream.

f) Add part or all of an $^{E}O_{T}$ to fill the last data byte, if necessary.

g) Encode the DSFID, Precursor, data byte-count indicator, data, $^{E}O_{T}$ and padding (if needed) into memory.

A.8.2 Decoding and translation procedure from Access Method 0 Data Format 3 to ISO/IEC 15434 data

The system will see this information as ISO/IEC 15434 6-bit or 8-bit DI-based data by reading the DSFID byte.

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

b) The encoded bytes are parsed into 6-bit or 8-bit codes as defined by the DSFID, discarding any pad bits and the encoded $^{E}O_{T}$ character, and then into data according to Table A.1 or the UTF-8 encoding set.

c) The system adds “[ ) > $^{R}_{S}$ 06 $^{G}_{S}$” to the beginning of the transmission and “$^{R}_{S}$ $^{E}O_{T}$” at the end.

NOTE Spaces and quotes have been added to the data elements above for differentiation and clarity only. They are not part of the data to be decoded.

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

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

A.8.3 Data encode and decode example

A.8.3.1 Example data

This example encodes ISO/IEC 15434, DI-based data in an application with a mandatory $^{E}O_{T}$ requirement.

[)>$^{R}_{S}$06$^{G}_{S}$25SUN043325711MH8031200000000001$^{G}_{S}$1T110780$^{G}_{S}$Q21$^{G}_{S}$4LUS$^{R}_{S}$$^{E}O_{T}$

The data on the tag from the above message is as follows (with **DIs bolded** – bold used for clarity only):

25SUN043325711MH8031200000000001$^{G}_{S}$**1T**110780$^{G}_{S}$**Q**21$^{G}_{S}$**4L**US$^{E}O_{T}$

where

— UII = **25S**UN043325711MH8031200000000001

— LOT = **1T**110780

— QTY = **Q**21

— CoO = **4L**US

A.8.3.2 Data to bit conversion

There are 51 6-bit characters (50 plus $^{E}O_{T}$), which translates to 39 data-bytes. There is a need to fill six trailing bits for byte alignment, so in this case, an entire $^{E}O_{T}$ character is encoded. See Table A.4.

Table A.4 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 Structure of Memory Bank 11 when using 6-bit code values

Information	DSFID = 0x03	Pre-cursor = 0x46	Data byte-count = 0x27	2	5	S	U	N	0	4	3	3	2	5
Binary	110000	110000	110000	110010	110101	010011	010101	001110	110000	110100	110011	110011	110010	110101
Information	7	1	1	M	H	8	0	3	1	2	0	0	0	0
Binary	110111	110001	110001	001101	001000	111000	110000	110011	110001	110010	110000	110000	110000	110000
Information	0	0	0	0	0	0	1	$^{G}{}_{S}$	1	T	1	1	0	7
Binary	110000	110000	110000	110000	110000	110000	110001	011110	110001	010100	110001	110001	110000	110111
Information	8	0	$^{G}{}_{S}$	Q	2	1	$^{G}{}_{S}$	4	L	U	S	$^{E}O_{T}$	pad	
Binary	111000	110000	011110	010001	110010	110001	011110	110100	001100	010101	010011	100001	100001	

When using UTF-8 encoding, refer to Table A.5.

Table A.5 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 Structure of Memory Bank 11 when using UTF-8 encoding

Information	DSFID = 0x03	Pre-cursor = 0x76	Data byte-count = 0x33	2	5	S	U	N	0	4	3
Binary	00000011	01110110	00110011	00110010	00110101	01010011	01010101	01001110	00110000	00110100	00110011
Information	3	2	5	7	1	1	M	H	8	0	3
Binary	00110011	00110010	00110101	00110111	00110001	00110001	01001101	01001000	00111000	00110000	00110011
Information	1	2	0	0	0	0	0	0	0	0	0
Binary	00110001	00110010	00110000	00110000	00110000	00110000	00110000	00110000	00110000	00110000	00110000
Information	0	1	$^{G}{}_{S}$	1	T	1	1	0	7	8	0
Binary	00110000	00110001	00011101	00110001	01010100	00110001	00110001	00110000	00110111	00111000	00110000
Information	$^{G}{}_{S}$	Q	2	1	$^{G}{}_{S}$	4	L	U	S	$^{E}O_{T}$	
Binary	00011101	01010001	00110010	00110001	00011101	00110100	01001100	01010101	01010011	00000100	

A.8.3.3 Complete contents of user memory (MB11) for 6-bit encoding

Using the Access Method 0 Format 3 encoding, including a DSFID, ISO/IEC 15434 Precursor byte, 39 bytes of data (compressing 51, 6-bit characters including the $^{E}O_{T}$), and six pad bits, the final tag encodation in hexadecimal is:

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

A.8.3.4 Transmitted data

The header characters and the "$^{R}{}_{S}$ $^{E}O_{T}$" are reinserted into the message. The following data string is transmitted from the reader:

[)>$^{R}{}_{S}$06$^{G}{}_{S}$25SUN043325711MH80312000000000001$^{G}{}_{S}$1T110780$^{G}{}_{S}$Q21$^{G}{}_{S}$4LUS$^{R}{}_{S}$$^{E}O_{T}$

A.8.3.5 Encoding the data into a 2D barcode symbol

When encoded in a 2D barcode symbol, the output will be identical. Figures A.4 and A.5 show what the encoded 2D barcode symbols will look like.

Data to be encoded: [)>$^{R}_{S}$06$^{G}_{S}$25SUN043325711MH8031200000000001$^{G}_{S}$1T110780$^{G}_{S}$Q21$^{G}_{S}$4LUS$^{R}_{S}$^{E}O$_{T}$

Figure A.4 — QR code encoding the contents of an ISO/IEC 15434 message

[)>$^{R}_{S}$06$^{G}_{S}$25SUN043325711MH8031200000000001$^{G}_{S}$1T110780$^{G}_{S}$Q21$^{G}_{S}$4LUS$^{R}_{S}$^{E}O$_{T}$

Figure A.5 — DataMatrix encoding the contents of an ISO/IEC 15434 message

[)>$^{R}_{S}$06$^{G}_{S}$25SUN043325711MH8031200000000001$^{G}_{S}$1T110780$^{G}_{S}$Q21$^{G}_{S}$4LUS$^{R}_{S}$^{E}O$_{T}$

A.8.3.6 Example extension using non-ASCII data

When encoded into a 2D bar code, the users of this document shall be aware of the encoding and/or character set used on the computer system on which the application will be used. There may be instances where this document is used and the encoding and/or character set used within the system can possibly not be the UTF-8 character set. In those cases, the user of this document shall consider:

a) to use AIM Extended Channel Interpretations (ECI) to specify the encoding of data which will be encoded into a 2D bar code; or

b) to use and/or change to the UTF-8 character set on all of the computer systems which will be involved in the application.

The encode and decode example of A.8.3 is extended to include Chinese characters present in the UTF-8 character set. The data is encoded in UTF-8 on RFID.

NOTE Further revision of ISO/IEC 15962 can offer the ECI tool for RFID.

The additional data element includes a Chinese vehicle licence plate number, as follows:

Data to be added to the data stream: 7J粤Z7C59港

where

— “7J” = data identifier for a vehicle licence plate

— “粤Z7C59港” = licence plate data

The example data is:

[)>$^{R}_{S}$06$^{G}_{S}$25SUN043325711MH8031200000000001$^{G}_{S}$7J粤Z7C59港$^{R}_{S}$^{E}O$_{T}$

NOTE What can appear to be spaces in front of and behind each Chinese character is misleading, they are just spacing needed to accurately represent the character.

UTF-8 is used to encode the licence plate data in an RFID-Tag. The result of UTF-8 encoding of the data are 11 bytes (hex notation), as shown in Table A.6.

Table A.6 — Byte stream of licence plate data when using UTF-8 encoding

Data	粤	Z	7	C	5	9	港
Value in HEX	E7, B2, A4	5A	37	43	35	39	E6, B8, AF

Notice that the two Chinese characters are represented by 3 bytes each.

When encoding the above data into an RFID tags the resulting tag data is shown in Table A.7.

Table A.7 — ISO/IEC 18000-63 and ISO/IEC 18000-3, Mode 3 Structure of Memory Bank 11 when using UTF-8 encoding and non-ASCII characters

Information	DSFID = 0x03	Pre-cursor = 0x76	Data byte-count = 0x33	2	5	S	U	N	0	4	3
Binary	00000011	01110110	00110011	00110010	00110101	01010011	01010101	01001110	00110000	00110100	00110011
Information	3	2	5	7	1	1	M	H	8	0	3
Binary	00110011	00110010	00110101	00110111	00110001	00110001	0001101	01001000	00111000	00110000	00110011
Information	1	2	0	0	0	0	0	0	0	0	0
Binary	00110001	00110010	00110000	00110000	00110000	00110000	00110000	00110000	00110000	00110000	00110000
Information	0	1	$^{G}{}_{S}$	7	J	粤	...	...	Z	7	C
Binary	00110000	00110001	00011101	00110111	01001010	11100111	10110010	10100100	01011010	00110111	01000011
Information	5	9	港	...	...	$^{E}O_{T}$					
Binary	00110101	00111001	11100110	10111000	10101111	00000100					

NOTE The Roman characters are encoded in 8 bits characters and the CJK Unified Ideograph characters in 24 bits as shown in Table A.6.

To encode this message in a 2D bar code, ECI is used to flag the efficient GB18030 encoding.

The data "粤Z7C59港", encoded in GB18030, results in the bytes (hex notation) as shown in Table A.8.

Table A.8 — Byte Stream of licence plate data when using GB18030 encoding

Data	粤	Z	7	C	5	9	港
Value in HEX	D4, C1	5A	37	43	35	39	B8, DB

Notice that the two Chinese characters are represented by 2 bytes each. Compare this to Table A.6.

Following the AIM ECIs protocol, the data which will be encoded into a 2D barcode symbol is:

\000032[)>$^{R}{}_{S}$06$^{G}{}_{S}$25SUN043325711MH80312000000000001$^{G}{}_{S}$7J粤Z7C59港$^{R}{}_{S}$$^{E}O_{T}$

The resulting code is shown in Figure A.6.

Figure A.6 — QR code encoding the contents of an ISO/IEC 15434 message

\000032[])>${}^{R}{}_{S}$06${}^{G}{}_{S}$25SUN043325711MH8031200000000001${}^{G}{}_{S}$7J粤Z7C59港${}^{R}{}_{S}{}^{E}$O${}_{T}$

A.8.4 UII-bitstream encoding examples

The examples in Table A.9 are provided to illustrate the data element encodings as defined in Table 1, showing encoding the different SN-Types defined in Table 3. All the examples use:

— An UII length of 96 bits (the PC-Len in the PC bits is set to 6).

— **IAC**+CIN = "**QC**1234".

— TID, where used, is "E201:2345:6789:ABCD:EF00:12345" depicting the 96 bits of the TID.

NOTE 1 The “Product” data in Table A.9 to A.11 consist of **IAC**, CIN, *SN*. **Bold** and *italics* characters are used to emphasis the parts of the message. They are not part of the encoding process.

Table A.9 — UII Bit-stream encoding examples — SN only

<table>
<tr><th>Example number</th><th>UII-Type – binary</th><th>SN-Type – binary</th><th>MB01-DSFID-flag – binary</th><th>MB11-DSFID-flag – binary</th><th>IAC+CIN – hex – 40 bits</th><th>MB11-Word-Count - hex</th><th>UII-SN – 40 binary bits available</th></tr>
<tr><td rowspan="2">1</td><td>0001</td><td>00</td><td>0</td><td>0</td><td>8098:0004:D2</td><td>00</td><td>Hex: 000D:4678:26</td></tr>
<tr><td colspan="7">Product: QC1234222722086</td></tr>
<tr><td rowspan="2">2</td><td>0001</td><td>01</td><td>0</td><td>0</td><td>8098:0004:D2</td><td>00</td><td>Hex: 000D:4678:26</td></tr>
<tr><td colspan="7">Product: QC12343OLPGM</td></tr>
<tr><td rowspan="2">3</td><td>0001</td><td>10</td><td>0</td><td>0</td><td>8098:0004:D2</td><td>00</td><td>Binary:001101 001000 111000
110000 110011 110001 1000
Hex: 348E:30CF:18</td></tr>
<tr><td colspan="7">Product: QC1234MH8031
NOTE The example 6-bit encoding in Table A.2 is used for the 6 SN characters. The UII-SN is terminated with an incomplete ^{E}O${}_{T}$.</td></tr>
<tr><td rowspan="2">4</td><td>0001</td><td>11</td><td>0</td><td>0</td><td>8098:0004:D2</td><td>00</td><td>Hex: 000D:4678:26</td></tr>
<tr><td colspan="7">Product: QC1234E20123456789ABCDEF0012345
UII proprietary data: 000D:4678:26
NOTE UII-SN is omitted. The remainder of the 96-bit UII (tag) is used for proprietary data, in this case 40 bits. The UII Length can be shortened to only contain the data element UII-Type to IAC+CIN, which is 3 words. The MB11-Word-Count, when excluded through the length termination, will default to 0.</td></tr>
</table>

Only 40 bits of UII data is available in a 96-bit tag (96-bit UII), which may be enough for proprietary data, like a date or batch. It is typically not enough for a DSFID, in which case a larger memory tag should be used. The MB01 DSFID-formatted data is illustrated in Table A.10, in an abbreviated form to show the encoding method.

Table A.10 — UII Bit-stream encoding example — TID with UII data

UII-Type - binary	**SN-Type** - binary	**MB01-DSFID-flag** - binary	**MB11-DSFID-flag** - binary	**IAC+CIN** – hex – 40 bits	**MB11-Word-Count** - hex	**MB01 DSFID**	**UII data** – 32 bits - hex
0001	11	1	0	8098:0004:D2	00	03	01234:CDEF
Product: **QC**1234*E20123456789ABCDEF0012345* MB01 data DSFID: 3 MB01 data: 0123:CDEF							

Table A.11 illustrates MB11 DSFID formatted data. The data in Table A.4 is 39 data-bytes which requires 10 16-bit words. The MB11-Word-Count is therefore set to 0x0A. The DSFID format indicates an ISO/IEC 15434 message format. The IAC+CIN+SIN part is therefore shown in text with the MB11 data as a single message separated by $^{G}{}_{S}$.

Table A.11 — UII Bit-stream encoding examples — SN only

UII-Type - binary	**SN-Type** - binary	**MB01-DSFID-flag** - binary	**MB11-DSFID-flag** - binary	**IAC+CIN – hex** – 40 bits - hex	**MB11-Word-Count** - hex	**UII-SN – 40 bits available** - hex	**MB11 data starting with a DSFID**
0001	00	0	1	8098:0004:D2	0A	000D:4678:26	See Table A.4
Product: **QC**1234*222722086*$^{G}{}_{S}$**1T**110780$^{G}{}_{S}$**Q**21$^{G}{}_{S}$**4L**US^{E}O$_{T}$							

NOTE 2 The **bold underlined** data in Table A.11 denotes DIs.

Annex B
(informative)

Differentiation within the layers

B.1 Business processes

B.1.1 General

Business processes such as the examples described in B.1.2 to B.1.15, are illustrative of the applications envisioned by this document. It is not meant to be an exhaustive list.

B.1.2 Acquisition

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

B.1.3 Shipping

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

B.1.4 Receiving

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

B.1.5 Cross-docking

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

B.1.6 Work in process

Used to track individual components and the final assembly (bill of material) and to monitor any item through a fabrication or manufacturing process.

B.1.7 Maintenance

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

B.1.8 Inventory control

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

B.1.9 Disposal

Identification of items that have recycling or other disposal requirements.

B.1.10 Picking and put-away

Selection of items from a package or transport unit prior to placement into shelf stock in a warehouse situation or other storage situation where a specific asset is desired or knowledge of the specific item selected is required for issue.

B.1.11 Pick and place

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

B.1.12 Sortation

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

B.1.13 Identification

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

B.1.14 Network topology

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

B.1.15 Configuration management

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

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

B.2 Lot/batch versus serial number versus product identification only

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

The lowest level of identification will be product ID only. Lot and batch type items shall be marked with the product ID of the item and the lot or batch of that item that this particular item belongs to. Serialized items shall be marked with a unique serial number in conformance with the appropriate clause of ISO/IEC 15459-2, which details the differing methods of serialization that provide unique identification.

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

Medicines are typical of the type of item that is manufactured and managed at the lot level but sold and used at the item level. Thus, a particular dosage of medicine will require unique identification of that dose and the ability to reference that back to the original manufacturing lot. The unique item identification therefore requires associated information, in this case, a reference to the lot.

B.3 RTI / RPI characteristics

The supply chain layer represented by RTIs and RPIs is characterized by the following unique aspects.

— Individual transport units are identified by a shipment control number (SSCC or "J"-series ANSI MH10.8.2 Data Identifier).

— Beyond unique identification, the transport unit may also be the source of information about the environmental condition of the unit or package. This includes, for example, data on temperature, humidity, shock and other physical characteristics.

— The RTI/RPI may be used more than once.

— The same RTI/RPI can be used by different users and/or for different or multiple shipments at different moments.

— The content of the RTI/RPI may consist of tagged (packed) products and/or non-tagged (packed) products.

— The RTI/RPI has a value of its own, not directly and necessarily derived from the product that it contains.

— The possibility to have selective access to the data elements stored and/or written into the RTI/RPI RF tag is required.

— The physical handling of the RTI/RPI includes specific steps, such as cleaning, storage, repair, maintenance and transport.

A typical RTI/RPI pool system can be described as follows:

— The manufacturer produces the product.

— Primary packing is added; this can also be the RTI/RPI, for instance in the case of drums and bags for concentrated juices, water or beer.

— Packed products are packed in RTIs (multiple and different products can be included in one RTI). Small RTIs (crates, trays, boxes, barrels) are stored on large RTIs (pallet and/or roll container). Possibly protected/secured/covered by RPIs.

— RTIs are placed in transport vehicle (truck, boat, train, aeroplane) for direct transport to end user (mostly industrial) or regrouping in distribution centre (retail). Possibly protected/secured/covered by RPIs.

— RTIs/RPIs are redirected and can be (partially) emptied and refilled at distribution centre.

— RTIs/RPIs are unloaded and emptied at end-user site or retail outlet.

— Empty RTIs/RPIs are stored (nested, stacked) and collected by the (pool) owner or shipped back to the manufacturer of the packed product.

— Empty RTIs/RPIs are cleaned, stored, repaired and reprogrammed for new shipment of (packed) products.

B.4 RTI/RPI management functions

B.4.1 General

The relevant functions in RTI/RPI management and logistics are the RTI/RPI supplier, dispatcher, receiver and service providers. RTI/RPI suppliers own the RTI/RPI, control an RTI/RPI pool and make them available for use by dispatchers (RTI/RPI supplier and pool operator are used as synonymous terms).

- The RF tag associated with the transport unit is written to or read from as part of one or more of the following business processes:
  - building a transport unit;
  - assembly of the next higher level in the supply chain:
    - shipment,
    - in transit,
    - cross-docking,
    - in-check/receipt,
    - de-aggregation of the transport unit;
- dispatchers use RTIs/RPIs in the distribution of their goods; dispatchers fill empty RTIs/RPIs with goods and hand over filled RTI/RPI to receivers; dispatchers can be fillers, brand manufacturers, distribution centres, consolidation points, etc.;
- receivers receive RTIs/RPIs from dispatchers and make these items available for collection by service providers; receivers can be retailers, distribution centres, consolidation points, etc.;
- service providers collect RTI/RPI from receiver and are responsible, in the case of items subject to a deposit, for refunding this deposit and make the sorted RTI/RPI available to RTI/RPI suppliers or dispatchers.

B.4.2 Fulfilling functions

A company can fulfil more than one of these functions, for example:

- a beverage producer can use his own crates for bottles; in this case, the producer acts as an RTI/RPI supplier and a dispatcher;
- a retail distribution centre (RDC) sends received units to its outlets; in this case, the RDC acts as a receiver as well as a dispatcher;
- an RDC can sort and collect empty crates after use; in this case, the RDC acts as a receiver and a service provider;
- a pool operator collects and sorts empty crates; in this case, the pool operator acts as an RTI/RPI supplier and a service provider.

B.5 Consumer products versus industrial/government

Personal privacy considerations present a unique set of considerations for consumer products as opposed to products that remain exclusively in the industrial/government sectors.

Annex C
(informative)

Backup in case of RF Tag failure

C.1 Human readable interpretation

If human readable interpretation of Unique Item Identifiers is not used, then human readable translation is required.

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

ISO standard two-dimensional symbols (e.g., Data Matrix ECC 200, QR code, or PDF417) encoded in conformance with ISO/IEC 15434 and ISO/IEC 15418 should be considered as a primary backup to RF tags on products. An additional level of backup of human readable interpretation may be considered.

C.2 Human readable translation

If human readable translation of Unique Item Identifiers is not used, then human readable interpretation (HRI) is required.

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

HRI of either ISO UII or EPC tags shall be the upper case alphabetic and numeric representation of the encoded data as set forth in Annex A.

C.3 Data titles

The use of data titles shall be as specified in ANSI MH10.8.2 (for ISO-based applications) or the GS1 *General Specifications* (for GS1 applications).

C.4 Multiple data carriers

The use of human readable information is strongly encouraged for data that is critical to the item's use or sale and shall function as the first backup in the event that the RFID tag is unreadable/misleading for any reason. At the product marking level trading partners shall agree upon a linear symbol, such as Code 128, as described in ISO/IEC 15417 or, EAN/UPC, as described in ISO/IEC 15420. Trading partners shall agree upon the 2D barcode symbol to be used, such as Data Matrix, as described in ISO/IEC 16022 or, QR code, as described in ISO/IEC 18004.

If optically readable media is used, the documents appropriate to the Layer, as shown in Figure C.1, shall be used.

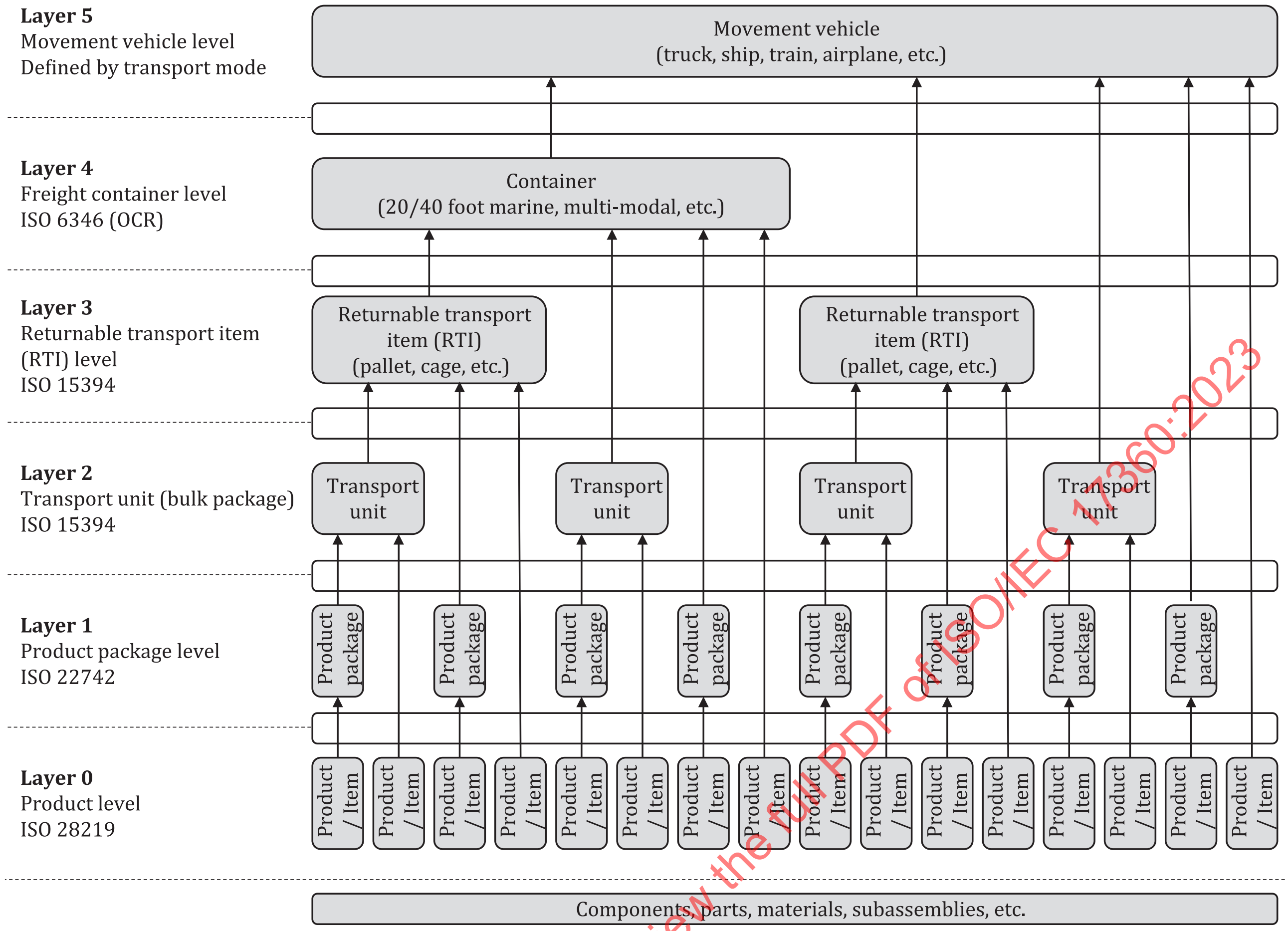


Figure C.1 — Layers of supply chain standards for bar codes and two-dimensional symbols

Annex D
(informative)

Tag operation

D.1 Environmental considerations

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

— the product RFID tag must function properly in the temperature range from −40 °C to +70 °C; it must be able to endure for a specified period of time harsher conditions in the range −50 °C to +85 °C;

— humidity 95 %;

— warehouse construction, including racking;

— transportation mode;

— speed and direction of movement of tag relative to reader;

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

— read distance;

— write distance (if applicable);

— electromagnetic interference from motors, fluorescent lights, other spectrum users;

— electromagnetic characteristics of the tagged item;

— shape and size constraints on antenna, and any requirement to decouple antenna from tagged item;

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

— method of attachment of form factor;

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

NOTE Health and safety regulations can apply.

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

If the process requires read rates in excess of 200 tags/sec sequentially, parallel readings should be considered.

D.2 Air interface

Product RFID tags shall operate in either one of two frequencies ranges and comply with the appropriate parts of the ISO/IEC 18000 series. With agreement between trading partners either ISO/IEC 18000-63 or the ASK air interface of ISO/IEC 18000-3 Mode 3 may be used. It is recommended that tags supporting ISO/IEC 18000-63 also be able to support ISO/IEC 18000-3 Mode 3.

D.3 Real-time clock option

A real-time clock shall be included with product tagging RFID tags that are sensor equipped and where the application requires a time stamp. The accuracy of the time compared to actual coordinated universal time (UTC) shall be no worse than ±5 s/d. The representation of time shall be UTC ("Z" – Zulu) and formatted as described in ISO 8601-1, namely, yyyy-mm-ddThh:ssZ, e.g. 2012-01-01T14:55Z. When time is represented, the character "T" serves as the delimiter between "dd" and "hh".

D.4 Safety and regulatory considerations

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

NOTE National safety and regulatory requirements can apply to tags conforming to this document.

D.5 Tag recycling

All tags attached to the product may be used to facilitate the recycling of the product and the tag itself. In this respect, it may also be feasible to reuse the tag after reprogramming without compromising the supply chain data structure. The exact implementation depends on the cost of the tag and environmental implications of reuse/recycling.

The recyclability of product tags described in this document is dependent upon the component materials used in the individual tags. The tag manufacturer shall clearly mark product tags with recycling instructions or an appropriate logo to assist in the proper disposal of the tag. Guidelines for tag recyclability can be found in ISO/IEC/TR 24729-2.

Attention must be paid to whether or not the tag has been "permalocked" (see ISO/IEC 18000-63 for details on this command). If the tag has been "permalocked", the tag will not be able to be reused.

D.6 Tag reusability

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

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

Attention must be paid to whether or not the tag has been "permalocked" (see ISO/IEC 18000-63 for details on this command). If the tag has been "permalocked", the tag will not be able to be reused.

D.7 Tag location and presentation

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

D.8 Material on which the tag is mounted or inserted

The potential disturbance of metals and other reflective materials, as well as liquids and other absorptive materials, shall be considered in mounting the RF tag to minimize disturbance of the RF signal.

Annex E
(informative)

Returnable packaging items

E.1 General

The concepts returnable, reusable and recyclable are frequently used interchangeably, though conceptually they are quite different. A key underlying concept of difference is ownership. Returnable items maintain the original ownership, while the ownership of reusable and recyclable items is transferred between parties. Figure E.1 shows a consumer lifecycle that explains the differences.

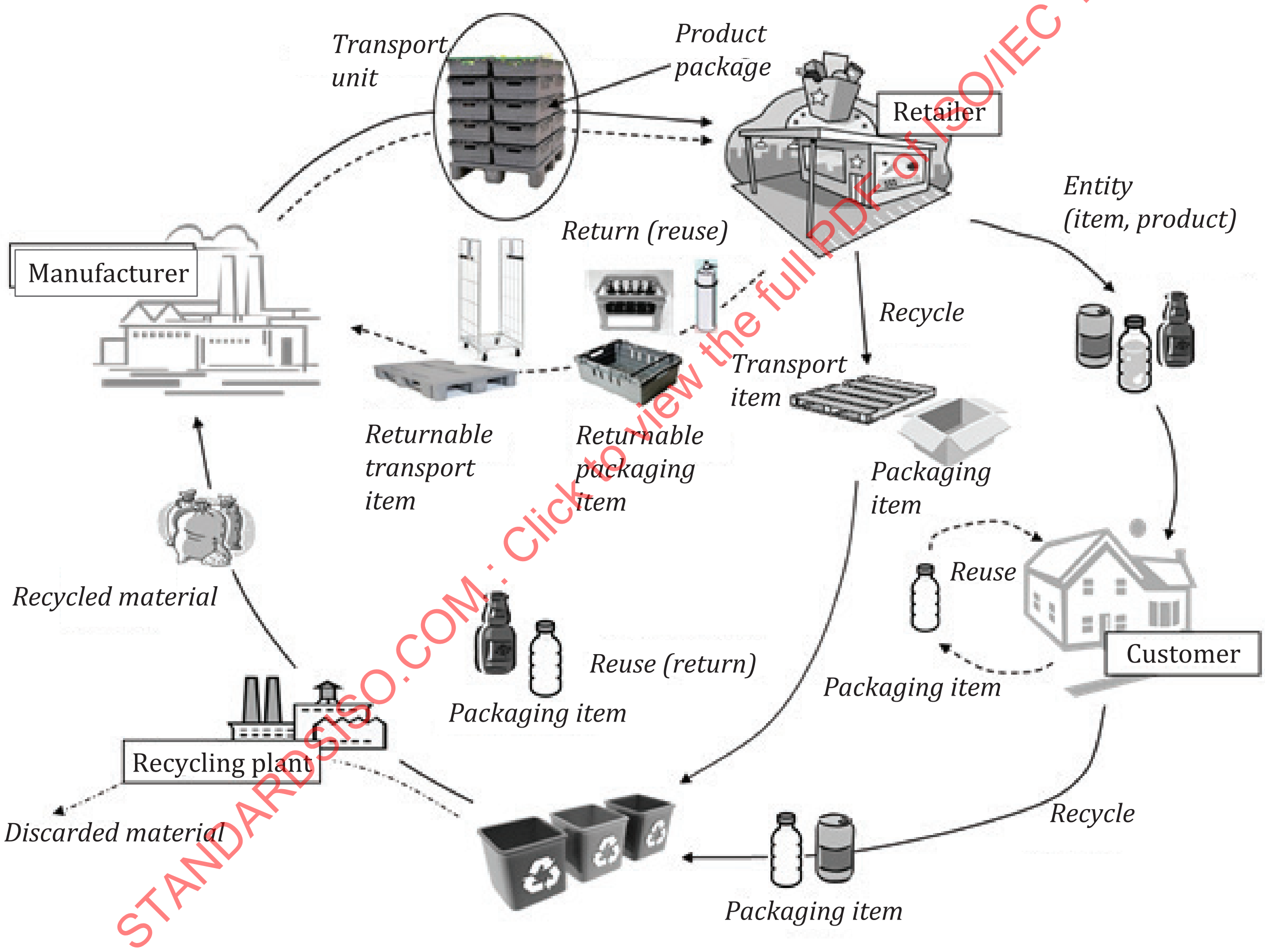


Figure E.1 — Returnable, reusable and recyclable lifecycle

E.2 Recyclable item

With a recyclable item, the ownership of the item is transferred when the item is sold. In some jurisdictions, an incentive to return the recyclable packaging is provided at the time of purchase, such as a deposit, which can be recovered when the item is returned to a location that accepts them. A typical-use recyclable item is a plastic bottle, which can be broken down into its component parts and reused.

E.3 Reusable item

With a reusable item, the ownership of the item is transferred when the item is sold. In some jurisdictions, an incentive to return the reusable packaging is provided at the time of purchase, such as a deposit, which can be recovered when the item is returned to a location that accepts them.

A typical-use recyclable item is a hard-plastic bottle, which can either be reused by the user (i.e. filling the bottle with new content after cleaning it) or disposed of at a recycling station. Its constituent parts may then be reused (i.e. cleaned and refilled) or recycled and used in the manufacturing of new bottles.

E.4 Returnable items

With a returnable item, ownership remains with the party providing the item, even though the item is sent to a customer. The supplier retains ownership of the asset with the anticipation that the customer will return the asset once it has served its original purpose.

Typical use of a returnable item is for transportation of goods in which the returnable item is to be returned for reuse. In this scenario, the content and carrier can change but the owner is still the same.

E.5 Parts of Returnable transport items and returnable packaging items

E.5.1 Partitions

Some pallets and returnable boxes are equipped with shock absorbing material to protect them from potential damage occurring during the transportation and handling process. 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 box. This kind of accessory for a pallet or returnable box is defined as a “partition”. The typical example of this is a post-type of partition used with the post pallet. Also included in this group is packing material used to place or arrange the contents between the posts or packaging material for dividing the inside of the returnable box into several smaller sections.

E.5.2 Posts

Figure E.2 shows a post that is normally used to securely fix packing materials or a returnable box onto the pallet. Most of these posts are made of highly durable substances like plastic or metal.