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

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 XXXXX cancels and replaces the second edition of ISO 17367:2013, ISO 17366:2013, ISO 17365:2013 and ISO 17364:2013, which has been technically and editorially revised.

The main changes compared to the previous editions are as follows:

- Integrating ISO 17367:2013, ISO 17366:2013, ISO 17365:2013 and ISO 17364:2013 into one document,
- 8-bit encoding and decoding using the UTF-8 encoding set added,
- Binary encoding of the UII added,
- Outdated processes and information 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.

This document is an integration of and replaces the following documents;

- ISO 17364, *Supply chain applications of RFID — Returnable transport items (RTIs) and returnable packaging items (RPis)*
- ISO 17365, *Supply chain applications of RFID — Transport units*
- ISO 17366, *Supply chain applications of RFID — Product packaging*
- ISO 17367, *Supply chain applications of RFID — Product tagging*

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

Descriptions unique to each category of item – outside of data encoding and decoding - will be covered in individual Annexes.

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) 00₂, MB01₂, MB10₂ and MB11₂ are represented as MB00, MB01, MB10, and MB11.

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

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 21067, *Packaging — Vocabulary*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 10646, *Information technology — Universal coded character set (UCS)*

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

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

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

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

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

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ISO/IEC 15459-4, *Information technology — Automatic identification and data capture techniques — Unique identification — Part 4: Individual products and product packages*

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

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

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

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

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 — Data structures — Digital signature meta structure*

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

ANS MH10.8.2, *Data Identifiers*

GS1 *EPC Tag Data Standard (TDS)*

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3 Terms and definitions

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

ISO and IEC maintain terminological 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 monomorphic / monomorphic UII
a data set where all the elements used to create the UII is concatenated into a single entity suitable for encoding with a single Data Identifier (DI)

3.2 DAID
domain authority identifier, as defined by ISO/IEC 20248

3.3 OID
object identifier as defined in ISO/IEC 15962

3.4 CRC
an error detection technique using a polynomial to generate a series of two 8-bit block check characters that represent the entire block of data

3.5**integrity**

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

3.6**ISO tag****international unique identification tag**

ISO/IEC 18000-63 or ISO/IEC 18000-3 Mode 3 tag with Protocol Control bit 17 set at “1” indicating that what follows is an Application Family Identifier (AFI)

3.7**packaging**

any 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.

3.8**returnable packaging item****RPI**

any 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](#).

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 would be covered as a returnable transport item (RTI); a pallet that is part of a consolidated unit load would be covered as a transport unit; and a pallet that is integral to a single item would be covered as product packaging. See [Annex E](#) for additional details on RTIs.

NOTE ISO 17363, *Supply chain applications of RFID — Freight containers*, has been transferred to ISO TC 104, is no longer the responsibility of JTC 1/SC 31/WG 8 and will not be covered in this document.

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

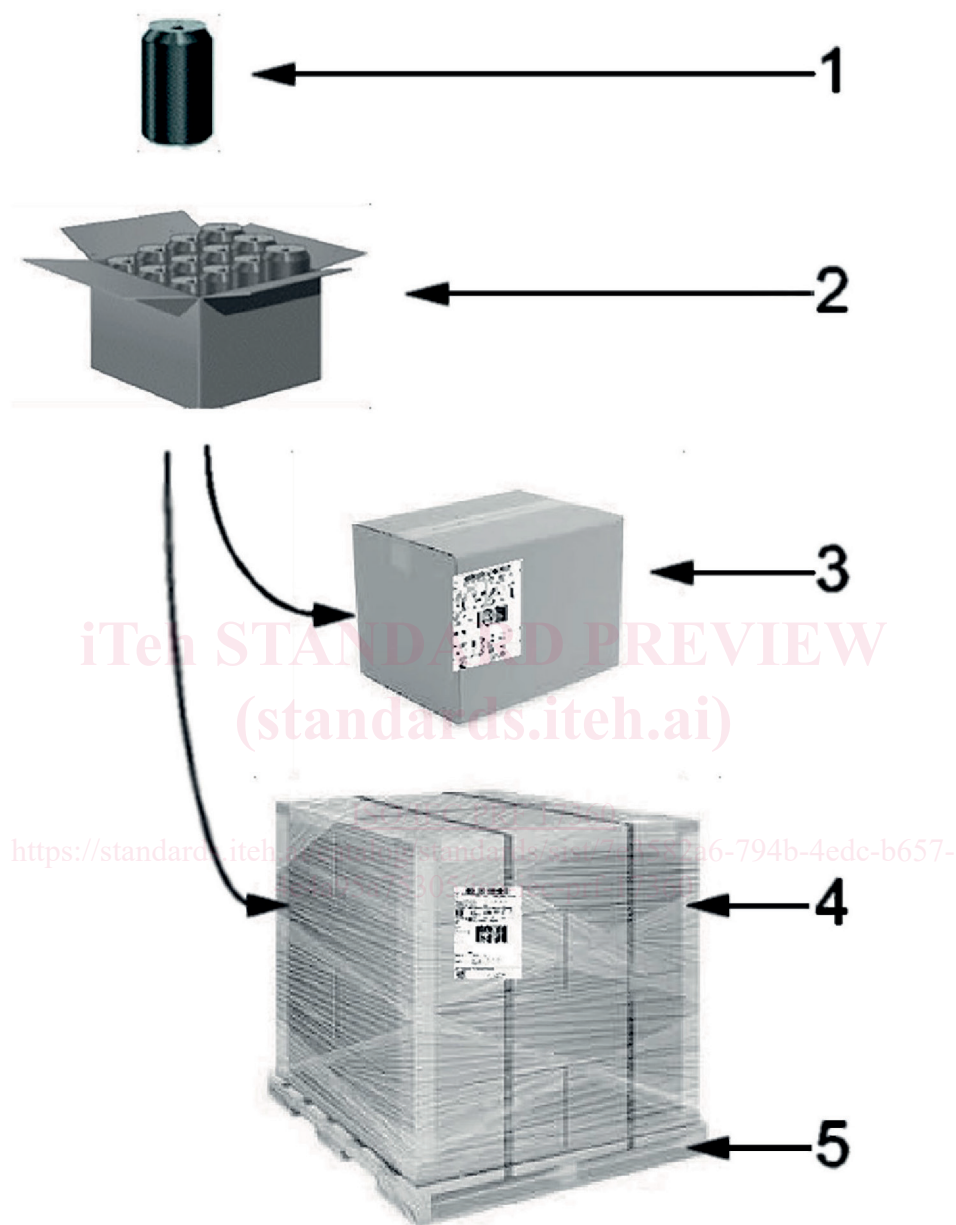
- a final product
- shipping
- a final place of sale, use, maintenance
- potentially, returned goods and disposal.

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 within 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 – consumer packaging – (product)
- 2 secondary packaging – outer packaging – (product package)
- 3 tertiary packaging – transport packaging – (transport unit)
- 4 tertiary packaging – unitized transport packaging – (transport unit)
- 5 pallet – (potentially returnable transport item – RTI)

Figure 1 — Packaging

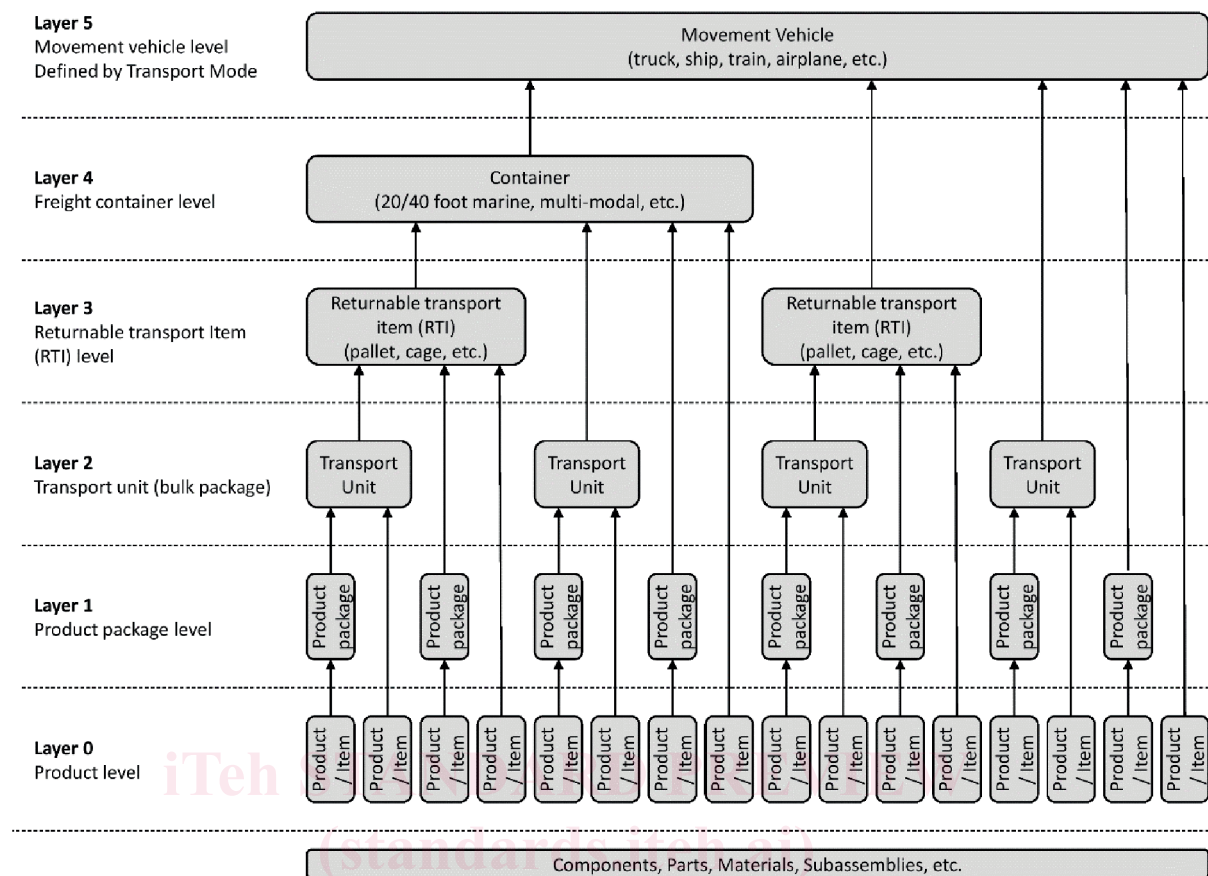


Figure 2 — Supply chain layers

5 Unique item identifier (UII)

5.1 General

Unique item identification 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 would 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 would normally be tagged at the package, or higher, level; however recent studies have explored the ROI for tagging low-cost items.¹

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) 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) Issuing agency code (IAC)
- b) Company identification number (CIN)
- c) Serial number (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 serial number (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 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 specification, contains the ISO/IEC 18000-63-defined constructs of the Protocol Control bits (PC), optional Extended PC bits (XPC) and the Unique Item Identifier (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 by the directives of 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 by the directives of ISO/IEC 15962 and listed in the ISO/IEC 15961-2 Data Constructs Register. The Data Constructs Register can be found at <https://www.aimglobal.org/registration-authority-iso-iec-15961.html>

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 would 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 If using 8-bit encoding, the AFI for 8-bit encoding, 0xAC, would 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 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.

The following sub-clauses 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 0₂ (GS1). The UII shall then be an EPC as specified by GS1 *EPC Tag Data Standard* (TDS).

5.4.3 ISO/IEC 15418 (ANS MH10.8.2) DIs: Monomorphic 6-bit UII encoding

The numbering system identifier toggle, shown as Standard toggle (T) in [Figure A.2](#), shall be set to 1₂ (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.

NOTE AFIs “0xA6”, “0xA7” and “0xA8” that currently indicate hazardous material (HAZMAT) (as of 2021), will be requested to be removed from use, and potentially reassigned. The XPC HAZMAT flag shall be used to denote HAZMAT material.

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 (011110₂).

The messages should be terminated with the control character E_{O_T} (100001₂).

[Annex A](#) provides additional details on 6-bit encoding and decoding.

5.4.4 ISO/IEC 15418 (ANS MH10.8.2) DIs: Monomorphic UTF-8 8-bit UII encoding

The numbering system identifier toggle, shown as Standard toggle (T) in [Figure A.2](#), shall be set to 1₂ (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 toggle (T) in [Figure A.2](#), shall be set to 1₂ (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.

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Table 1 — Bitstream representation of UII encoding

UII data element	UII-bitstream data elements						
	UII-Type (See Table 2)	SN-Type (See Table 3)	MB01-DSFID-flag	MB11-DSFID-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](#) may 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.	
1	01	Base-36 (hexatridecimal) number with the digit sequence "0" to "9" and then "A" to "Z".	The UII-SN shall not be followed with additional data, i.e., the UII may not contain additional data. The UII-SN shall be padded with leading zeros.
2	10	6-bit character set. See Table A.1 .	The UII-SN shall be terminated with a complete E_{OT} , incomplete E_{OT} , 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 1 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. E.g., SN decimal number 222,722,086 is encoded as 0000 0000 0000 1101 0100 0110 0111 1000 0010 01102, which is 000D46782616.

NOTE 2 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. E.g., SN hexatridecimal number "30LPGM" is encoded as 0000 0000 0000 1101 0100 0110 0111 1000 0010 01102, which is 000D46782616. Various free web-based convertors are available; search for "base36 conversion".

NOTE 3 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, 56, or 64 bits).

NOTE 4 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:

1. UII-Type: 4 bits; Value selected from [Table 2](#).
2. SN-Type: 2 bits; Value selected from [Table 3](#).
3. MB01-DSFID-Flag (UII additional data DSFID): 1 bit.
 - 3.1. This bit is only valid for SN-Type 2 and 3. It shall be ignored (set to 0₂) for SN-Type 0 and 1.
 - 3.2. For SN-Type 2:
 - 3.2.1. When the flag is set to 0₂, 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_{OT} , incomplete E_{OT} , or by the UII length, whichever comes first, see [5.4.6.2](#).