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Application Guideline on Data Carriers for Supply Chain Management

Directive d'application sur des supports d'informations pour le supply chain management

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Contents

Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote. Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

In exceptional circumstances, when the technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

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ISO/TR 17370 was prepared by Technical Committee ISO/TC 122, *Packaging*.

Introduction

Supply chain management makes use of a variety of data carriers, including linear symbols, two-dimensional symbols and Radio Frequency Identification (RFID). Care should be taken when using these data carriers in combination because the data structure of RFID is different from that of the other data carriers. This Technical Report outlines the basic structure of the supply chain layers defined in ISO standards. It describes how to store data in linear symbols, two-dimensional symbols and in RFID. In addition, this document shows the structure of the data transmitted from an interrogator to a host computer. This Technical Report is provided as a guideline for the effective use of these data carriers.

RFID technology, especially when equipped with the ability to additionally write data, is essential to traceability in Supply Chain Management (SCM). However, consideration should be given to the following issues for the use of RFID:

a)   Approximately 10 standards, each having its own air interface and memory structure, have been developed for the RFID technology. Work on the standardization of middleware is currently in progress in order to achieve compatibility among these standards, but middleware that supports various RFID air interfaces is not available at this time. And in addition, operators who handle only one type of RFID do not necessarily need to use middleware.

b)   The memory size of commonly available RFID is relatively small compared to the size of EDI data requiring standardized compaction methods to address this issue.

c)   The structure of the data transmitted from a linear or two-dimensional symbol to the host computer is different from the one transmitted from an RFID interrogator.

This Technical Report provides a potential solution for dealing with these challenging issues. Those wishing to understand the GS1 approach to similar issues are invited to contact GS1.

This document has 11 annexes, A, B, C, D, E, F, G, H, I, J and K, all which provide informative information.

— Annex A – Examples of Containers Used for Supply Chain Management

— Annex B – Rewritable Hybrid Media

— Annex C – Data Carrier Identifiers

— Annex D – Layered Structure of Automotive Industry

— Annex E – Layered Structure of Electric Home Appliance Industry

— Annex F – Layered Structure of Medical Industry

— Annex G – Syntax for High-Capacity Automatic Data Capture Med

— Annex H – Assignment of Application Family Identifiers (AFIs)

— Annex I – Memory Structure of ISO/IEC 18000-63 and ISO/IEC 18000-3, M3

— Annex J – Data storage capacity and number of RF tag

— Annex K – 6-bit coding scheme

Application Guideline on Data Carriers for Supply Chain Management

1 Scope

This Technical Report specifies a method to establish compatibility among various data carriers such as linear symbols, two-dimensional symbols and RFID, as well as their one-to-one relationship by illustrating the structure supporting the basic ISO-compliant supply chain control system. In particular, it

— specifies the relationship of various global standards related to the supply chain,

— illustrates the types and data structures in the layered supply chain network,

— specifies the relationship among the layered structure of the supply chain,

— specifies the management of serial numbers in supply chain management,

— specifies data storage on the named data carriers,

— specifies the required data volume for each data carrier,

— specifies the data structure between the data carrier and the reader (interrogator),

— specifies the data structure between the host system (computer) and the reader (interrogator), and

— illustrates complex data carriers (rewritable hybrid media, etc).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 19762 (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ISO 21067, *Packaging — Vocabulary*

3 Terms, definitions, and abbreviated terms

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

3.1
RHM
rewritable hybrid media

4   Supply Chain Model

4.1   Supply chain model

The "supply chain" is a multi-level concept that covers all stages of a product, from the management of raw material to the final product process, including shipping the product to the point-of-sale, the use and maintenance of the product and, depending on the application, to the point of disposal. This supply chain further includes reverse logistics and the handling of returned goods. Each of these levels is unique, but the levels overlap.

Figure 1 below is a basic concept of "supply chain" that illustrates the correlative relationship of the supply chain, not a "one-to-one" representation of physical objects. Figure 1a shows the *supply chain model for radio frequency identification (RFID)* and Figure 1b shows the *supply chain model for optically readable media (ORM)*. Although several layers in Figure 1 have clear physical counterparts, some items are categorized into more than one layer, depending on their usage. In Figure 1, RPI represents "Returnable Packaging Items". In Figure 1, RTI represents "Returnable Transport Items", defined in ISO/IEC 15459-5. The use cases of these items introduced to the supply chain management are specified in Annex A.
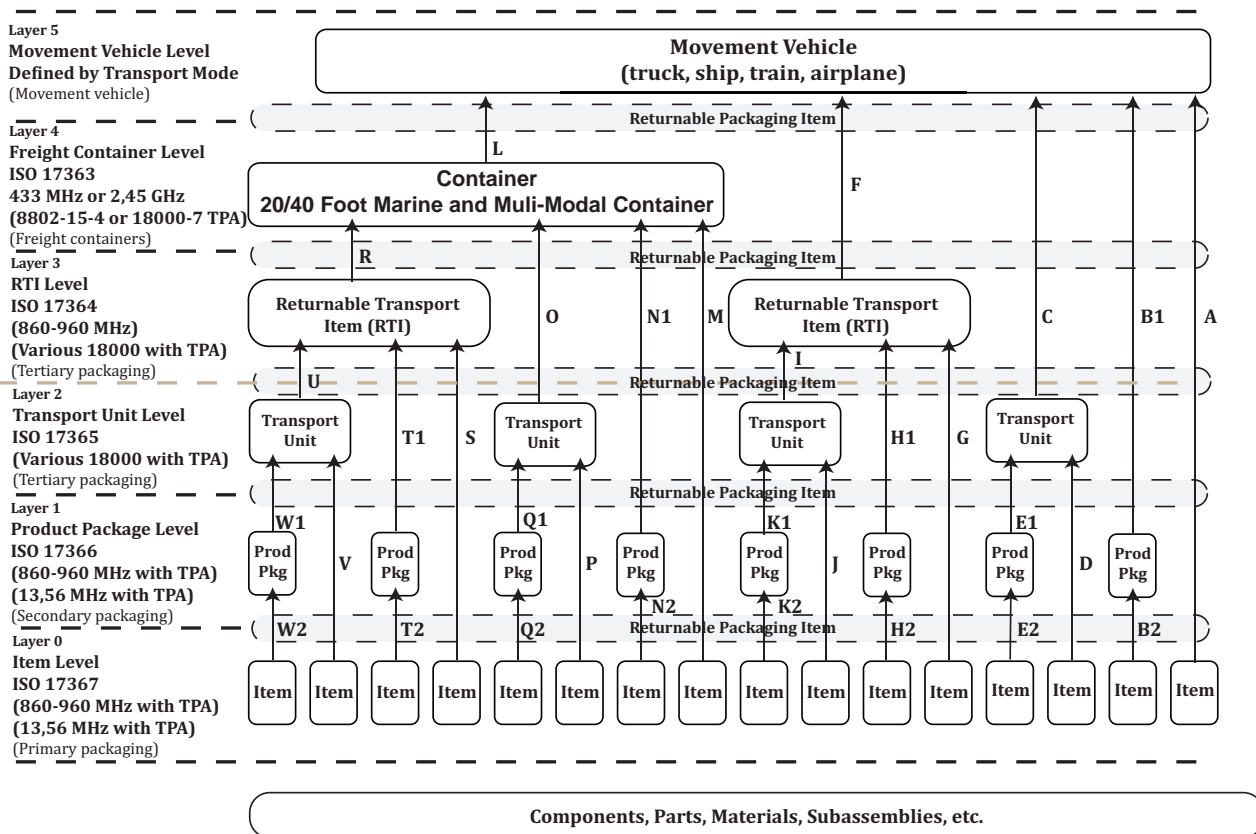
Figure 1a — Supply chain model for radio frequency identification (RFID)
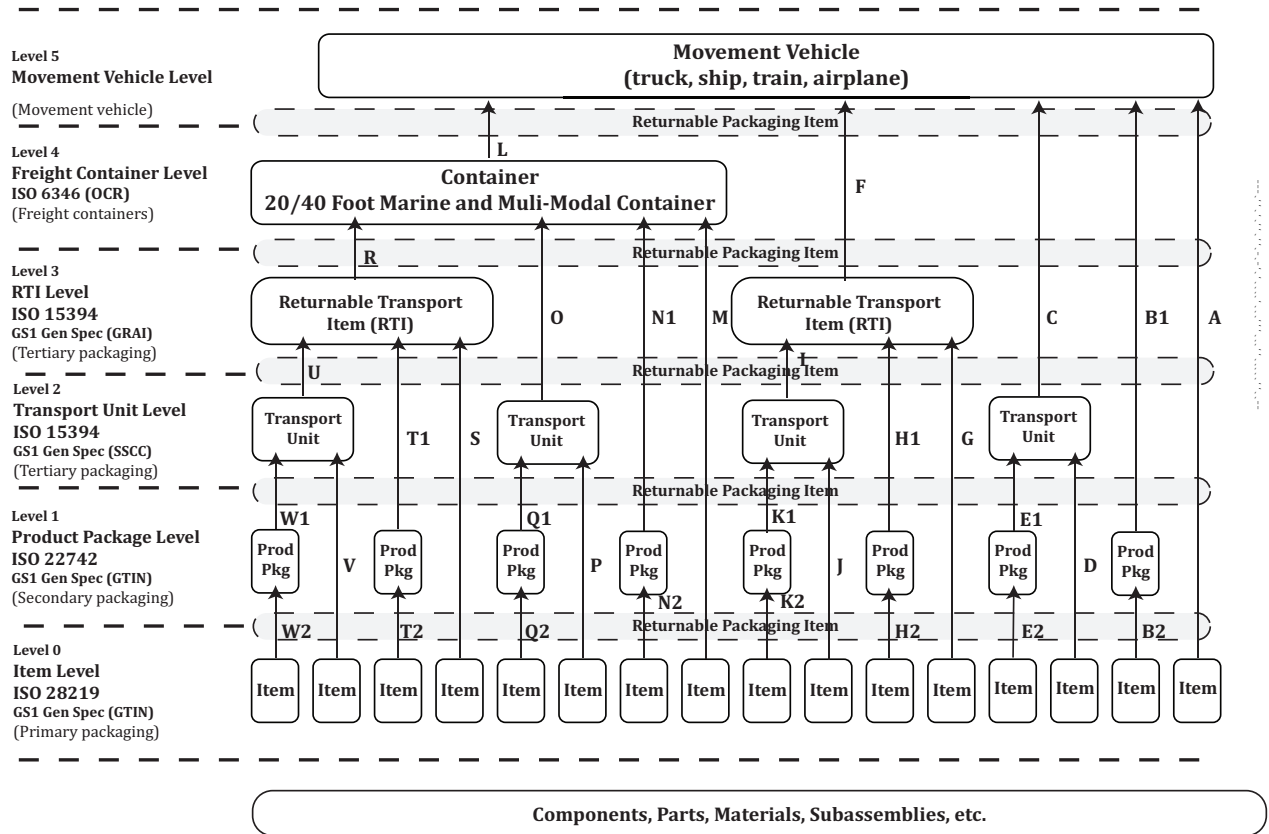
Figure 1b — Supply chain model for optically readable media (ORM)

Key

Alphabetic reference	Associated annex	Associated example
B2, B1	F	1
E2, E1	F	2
N_2, N1, L	F	3
K2, K1, I, F	F	4
Q2, Q1, O, L	F	5, 6, 7
G, F	D	1, 2, 3
W2, W1, Q2, Q1, K2, K1, E2, E1, T2	E	1, 4, 5, 8
V, P, J, D	E	2, 3, 6, 7
G, F	E	9
A	E	10

Figure 1 — Physical layer of supply chain model

4.2 Types of data carriers for supply chain management

Data carriers such as linear symbols, two-dimensional symbols and RFID, used for supply chain management should be selected based on their respective characteristics. Most readers available in today's market have the ability to automatically distinguish and read various types of linear and two-dimensional symbols, allowing the use of these symbologies without restriction.

RFID can be used at various frequencies: 135 kHz or lower, 13,56 MHz, 433 MHz, 860 MHz to 960 MHz or 2,45 GHz, and each frequency can have a separate memory structure and communication protocol, making it difficult for existing interrogators to automatically distinguish among the various frequencies.

Although the appropriate air interface can be selected depending on the specific layer of the supply chain in Figure 1, more than one interrogator should be available when using a variety of air interfaces. As this will increase the cost, the number of air interfaces should be limited to the fewest possible number.

This Technical Report uses the data carriers shown in Figure 1 as examples, including the linear symbols Code 128 (ISO/IEC 15417) and Code 39 (ISO/IEC 16388), the two-dimensional symbols QR Code (ISO/IEC 18004) and Data Matrix (ISO/IEC 16022), and RFID at 13,56 MHz (ISO/IEC 18000-3, Mode 3) and 860 to 960 MHz (ISO/IEC 18000-63) as well as a hybrid media (ISO/IEC 29133). A description of rewritable hybrid media is found in Annex B. Table 1 below is a list of the data carriers supported by this Technical Report.

Table 1 — Examples of data carriers for the supply chain

Data carrier	Type
Linear symbol	Code 39 (ISO/IEC 16388)
	Code 128 (ISO/IEC 15417)
2D symbol	QR Code (ISO/IEC 18004)
	Data Matrix (ISO/IEC 16022)
RFID	13.56 MHz (ISO/IEC 18000-3, Mode 3)
	860 - 960 MHz (ISO/IEC 18000-63)
Rewritable hybrid media	Complex data carrier (ISO/IEC 29133) in which linear and/or 2D symbols printed on a paper-based rewritable media are combined with RFID.

4.3   Characteristics of data carriers for the supply chain

In a linear or two-dimensional symbol used in the supply chain structure, the type of symbol, label or direct marking is usually selected according to the layer of the supply chain (see Figure 2 below). In the delivery process, a distributor may be required to read not only the transport label but also the product package label attached to the transport unit. In this operation, the type of label is manually identified.

In the supply chain layers shown in Figure 2, the distributor usually attaches the RF tags on the transport units. If Tags A in Layer 0, Tags B in Layer 1 and Tags C in Layer 2 use the same type of RF tag, all of the tags will be read, even if the information needed is contained only in Tags C. A mechanism should be established for selecting and reading only the intended tags.
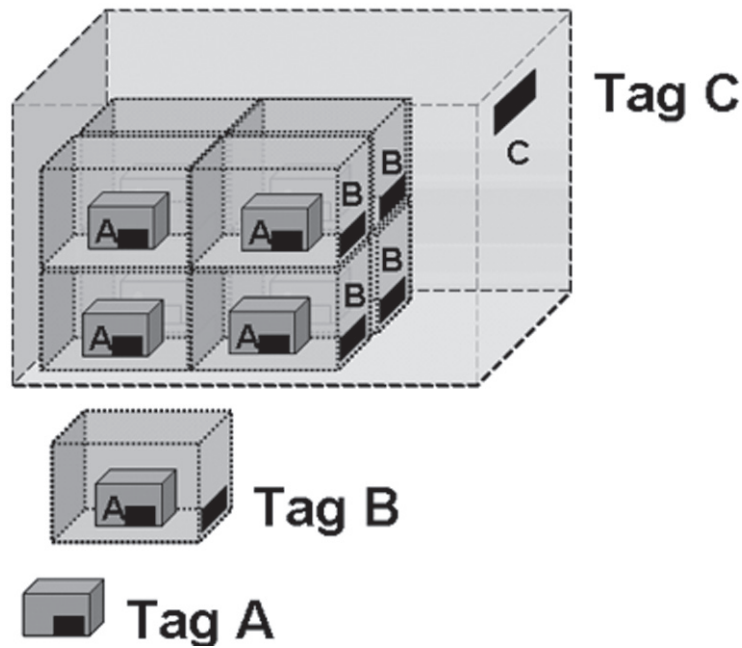
Figure 2 — Supply chain layers and RFID

5 Layers Related to Supply Chain Standards

Table 2 below outlines the layered structure of the types of standards related to supply chain management and Table 3 lists the specific standards corresponding to the layers that meet the supply chain standards identified in Table 2. The standard in Layer 0 is a data carrier standard supported by the supply chain standard. Table 1 above is a list of data carriers supported by this Technical Report.

Table 2 — Supply chain standard layers

Layer	Standards
3	Supply chain (application) standard
2	Data carrier identification standard, Data storage standard, Communication data structure standard
1	Identification standard of products and parts
0	Data carrier standard

Table 3 — Standard numbers

Layer	Standard number
0, 1, 2, 3, 4	ISO 15394, ISO 22742, ISO 28219, ISO 17363, ISO 17364, ISO 17365, ISO 17366, ISO 17367
0, 1, 2, 3	ISO/IEC 15418, ISO/IEC 15434, ISO/IEC 15962
0, 1, 2, 3	ISO/IEC 15459 Series
0, 1, 2, 3	ISO/IEC 15417, ISO/IEC 16388, ISO/IEC 16022, ISO/IEC 18004, ISO/IEC 18000-3, ISO/IEC 18000-63

The standards in Layer 1 of Table 2 are based on ISO/IEC 15418 to uniquely specify individual items and parts (components) of the layers of Figure 1. Some of the identifiers in ISO/IEC 15418 are defined in the ISO/IEC 15459 series of standards. The cross relationship of these standards is shown in Figure 3 below.

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ISO/IEC 15418 specifies the Data Identifiers widely implemented in the manufacturing industry alongside the Application Identifiers and the data structures commonly implemented in the logistics industry.

```
ISO/IEC 15418 ──────── ISO/IEC 15459-1
                 ├───── ISO/IEC 15459-4
                 ├───── ISO/IEC 15459-5
                 └───── ISO/IEC 15459-6
```
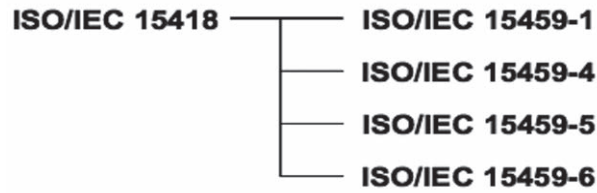
Figure 3 — Relationship of product/part identification codes

— ISO/IEC 15459-1 is a standard developed for the unique identification of items and parts.

— ISO/IEC 15459-4 for the unique identification of returnable transport items intended for delivery and transportation.

— ISO/IEC 15459-5 is a standard for unique identification of RPIs and RTIs introduced to supply chain management.

— ISO/IEC 15459-6 is a standard used for the identification of items and parts, which generally come in a liquid or power form and are controlled by a lot or batch number.

The data treated in Layer 1 is stored in the corresponding data carriers pursuant to the standards in Layer 2. The ISO/IEC 15418 (ISO/IEC 15459 Series) standards stipulating the data structure can also be referenced when storing data in a linear or two-dimensional symbol and the data structure specified in ISO/IEC 15418 is directly applied to the symbol without any changes. The method for storing large amounts of data in a two-dimensional symbol or an RF tag is defined in ISO/IEC 15434 and the method for storing data in RFID is found in ISO/IEC 15962.

Of the standards in Layer 3, ISO 15394, ISO 22742 and ISO 28219 support linear and two-dimensional symbols, whereas ISO 17363, ISO 17364, ISO 17365, ISO 17366 and ISO 17367 apply to RFID. Table 4 is a list of standards that correspond to each of the supply chain layers in Figure 1.

Table 4 — Standard numbers corresponding to the layers in Figure 1

Layer	Basic data structure	Linear/2D symbol	RFID
4	ISO 10374	—	ISO 17363
2, 3	ISO/IEC 15459-1 (ISO/IEC 15459-5)	ISO 15394	ISO 17365 (ISO 17364)
1	ISO/IEC 15459-4 (ISO/IEC 15459-5)	ISO 22742	ISO 17366 (ISO 17364)
0	ISO/IEC 15459-4 ISO/IEC 15459-6 (ISO/IEC 15459-5)	ISO 28219	ISO 17367 (ISO 17364)
NOTE Parenthetical references are shown to illustrate situations where an RTI might be considered as a product (ISO 28219) by the RTI manufacturer, or product packaging (ISO 22742).			

In this supply chain model, Layers from 0 to 3 are divided into two categories:

— transport units

— RTI and/or RPI

No standards exist for the basic data structure supporting containers in Layer 4 nor for those specifying linear and two-dimensional symbols for Layer 4 applications. It is therefore critical for the user to understand the relationship of the standards listed in Table 4.

In the standards that support both linear and two-dimensional symbols, such as ISO 15394, ISO 22742 and ISO 28219, the data structure in the ISO/IEC 15459 standards is used for linear symbols, while the structure of two-dimensional symbols is based on the ISO/IEC 15459 Series or ISO/IEC 15434. See Table 5.

Table 5 — Data storage structure of linear and two-dimensional symbols

Layer	Basic standard	Linear symbol storage structure	2D symbol storage structure	
3	ISO 15394	ISO/IEC 15459-5	ISO/IEC 15459-5	
2	ISO 15394	ISO/IEC 15459-1	ISO/IEC 15459-1	
1	ISO 22742	ISO/IEC 15459-4	ISO/IEC 15459-4	ISO/IEC 15434
0	ISO 28219	ISO/IEC 15459-4 ISO/IEC 15459-6	ISO/IEC 15459-4 ISO/IEC 15459-6	

Examples of identifiers defined in ISO/IEC 15459 Series are provided in Table 6.

Table 6 — Examples of ISO/IEC 15459 Series identifiers

Layer	Standard number	Data Identifier	Application Identifier	EPC Identifier
3	ISO/IEC 15459-5	25B or 55B	8003 or 8004	GRAI or GIAI
2	ISO/IEC 15459-1	J to 6J	00	SSCC
1	ISO/IEC 15459-4	25S or 3I (for a serialized component)	8004 (for a serialized component)	GIAI (for a serialized component)
		25P+S (for a separate serialized component)	01+21 (for a separate serialized component)	SGTIN (GTIN+S/N) (for a serialized serial component)
0	ISO/IEC 15459-4	25S or 3I (for a serialized component)	8004 (for a serialized component)	GIAI (for a serialized component)
		25P+S (for a separate serialized component)	01+21 (for a separate serialized component)	SGTIN (GTIN+S/N) (for a serialized serial component)
NOTE ISO/IEC 15459-5 predates the assignment of "55B" for RPIs. The next edition of ISO/IEC 15459-5 will be requested to include "55B".				

The Data Identifiers stored in linear symbols, two-dimensional symbols and RFID should be compatible and the data format used for reading and transmitting the data in these data carriers from a reader to a host computer should be uniform throughout the supply chain.

6   Example for Unique Identifier of Product Package

Examples of identifiers defined in the ISO/IEC 15459 Series of standards are provided in Table 6. This clause describes examples of the data structure of the identifier "25S" defined in ISO/IEC 15459-4. The identifier and data supported here are stored in linear symbols, two-dimensional symbols or in RF tags and are used for online electronic commerce. To effectively use various types of data carriers in the same application, there should be a match between the data in the data carrier and the data stored in the database of the host computer.

6.1 Data field identification

The Data Identifier "25S" defined in ISO/IEC 15459-4 and ANS MH 10.8.2 should be used for the identification of product packages. Refer to Table 7 for the data structure of the Data Identifier.

6.2 Data structure

Table 7 shows the data structure of the Unique Identifier of a package.

Table 7 — Data structure

25S	IAC	CIN	SN

6.2.1 Issuing Agency Code (IAC)

The Issuing Agency Code (IAC) is used to identify the entity, organization and/or company authorized by the appropriate registration authority as an issuing agency in accordance with ISO/IEC 15459-2. Following are examples of issuing agencies and their associated codes:

— UN (Dun and Bradstreet)

— OD (Odette Europe)

— LA (JIPDEC/CII)

— D (NATO AC135)

6.2.2 Company Identification Number (CIN)

The Company Identification Number (CIN) is a unique code assigned by the issuing agency to each individual company. Each issuing agency has its own format for the CIN. The CIN code may be partly determined by the company, i.e. Factory Identification Code (FIC). In Table 9 the FIC is illustrated as part of the Object Sequence Number.

6.2.3 Serial Number (SN)

When the Serial Number (SN) is combined with IAC and CIN, the combination constitutes a globally unique identifier for the product package. Once created and attached to the product package, the IAC, CIN and SN combination is intended to be fixed and unchangeable for that specific product package throughout its lifetime.

The Serial Number may be composed of numeric characters, alphabetic characters or a combination of both. The data significant to the package should be regarded as part of the Serial Number, as illustrated in Table 8. In this case, the data with significance is called Object Data (OD) and the identifier is called the Object Sequence Number (OSN).

Table 8 — Example of Serial Number data structure

Serial Number (SN)	
Object Data (OD)	Object Sequence Number (OSN)

In general, the Object Data are a code indicating the product or component number and it does not need to be a sequence number. The Object Sequence Number may have a structure, as illustrated in Table 9. It should be noted that the number of digits can be decreased by using a simple sequence number, if the amount of data in the data carrier is comparatively small.

Table 9 — Example of Object Sequence Number

| Object Sequence Number (OSN)			
Factory Identification Code	Data of manufacture	Time of manufacture	Simple Serial Number
3 digits	8 digits	4 digits	5 digits

6.3 Character set

The character set used in the ISO/IEC 15459 Series standards consists of upper-case alphabetic characters and numbers from the 7-bit ASCII characters defined in ISO/IEC 646.

7 Layered Structure of Supply Chain Management

7.1 Complex layered structure

Figure 4 is a tree diagram showing the supply chain structure consisting of the container, transport unit, Returnable Transport Item (RTI) and Returnable Packaging Item (RPI) loaded on a movement vehicle for the scenarios "O", "N", "L" and "H" (see Figure 1). In Figure 4, the identification number of the container complies with ISO 10374, the RPI and the RTI comply with ISO/IEC 15459-5 and the transport unit complies with ISO/IEC 15459-1. Likewise, the product package conforms to ISO/IEC 15459-4 and the product itself to either ISO/IEC 15459-4 or ISO/IEC 15459-6.
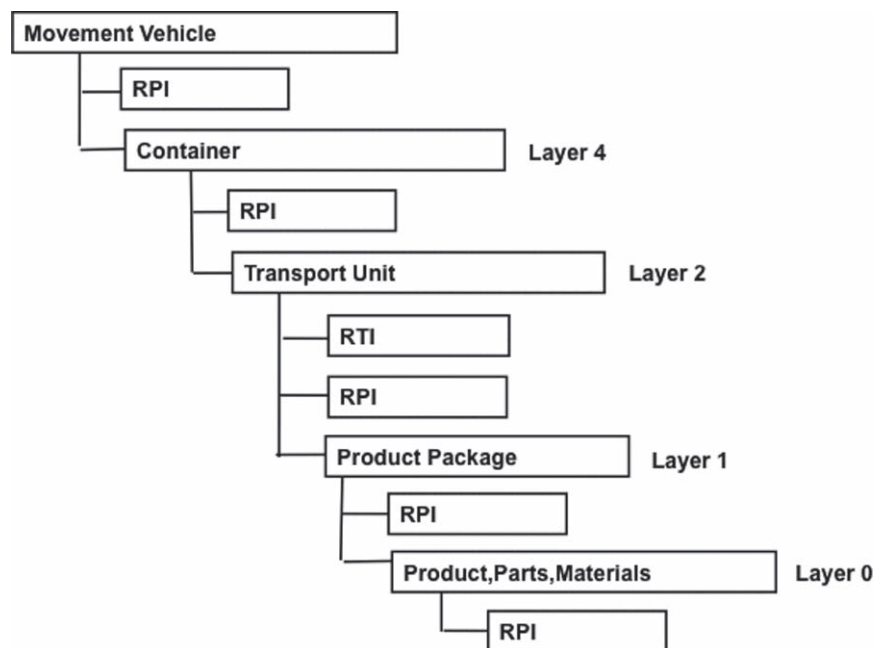
Figure 4 — Complex layered structure

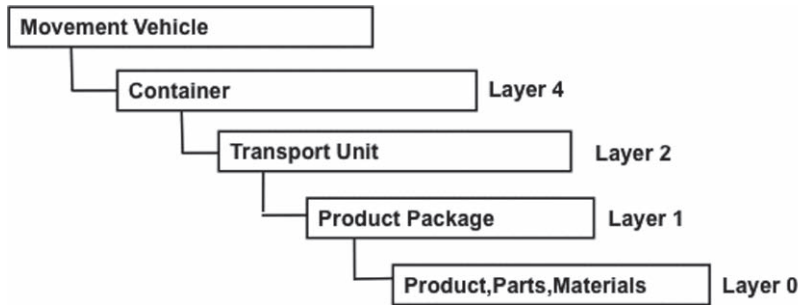Unlike the case in Figure 4 in which RPI and RTI are used, neither of them is included in the structure in Figure 5.

Figure 5 — Complex layered structure without RPI and RTI

7.2   Simplified layered structure

Figure 6 illustrates the simplest form of the structure ("A") for the supply chain model in Figure 1.
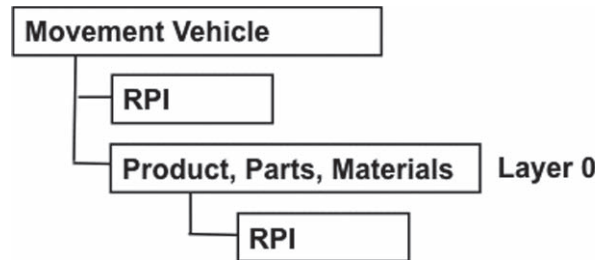

Figure 6 — Simplified layered structure

The structure of Figure 6 can be simplified as shown in Figure 7 when RPIs are not used. For example, a vehicle loaded on a dedicated cargo ship can be identified from its VIN number. If there are five hundred vehicles on the cargo ship, five hundred VIN numbers should be affixed to the lower part of the movement vehicles.
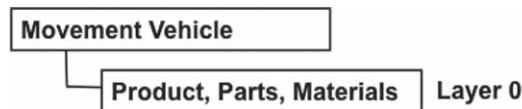

Figure 7 — Simplified layered structure without RPI

7.3   Typical layered structure

Most of the RPIs and RTIs introduced in commercial transactions are not fully controlled or managed. For example, EDI data on RPIs and RTIs is not normally included in the information exchanged between customers and suppliers, as specified in ISO/IEC 15418. In global business trading, the RPIs and RTIs are handled differently country-by-country and they are reported separately from the contents of the cargo at Customs. In the same way, separate applications for export permits are required for RPIs and RTIs when they are returned to the cargo owner (shipper). The duty tariff imposed on the cargo is then refunded following approval of the export. Figure 8 is a tree diagram showing the layered structure of this business transaction and Figure 4 is its transformed version. In contrast to Figure 8 where RPIs and RTIs are in a subordinated relation (structure) to the transport unit, RPIs and RTIs are independent from the transport unit in Figure 4.
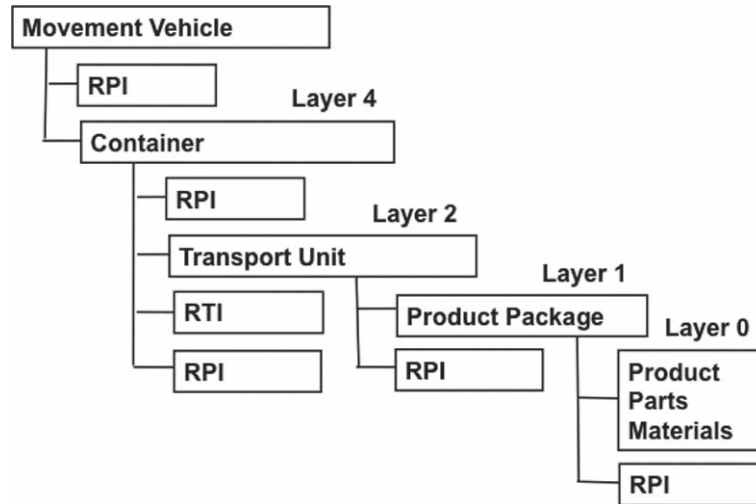
Figure 8 — Typical layered structure

7.4　In-layer relationship and layer-to-layer relationship

Figure 1 is a graphical representation of a simplified structure for supply chain management. Multiple layers are usually handled in the operations in Layer 2. In Figure 9, five transport units of like products are grouped together to form a larger transport unit that comes at the upper level. This transport unit may assume the structure as shown below.

Figure 9 — Example of strucure consisting of multiple layers

Figure 10 shows the layered structure of Figure 9. There are five transport units, each composed of a product and a product package.

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Figure 10 — Example of multi-layered strucure

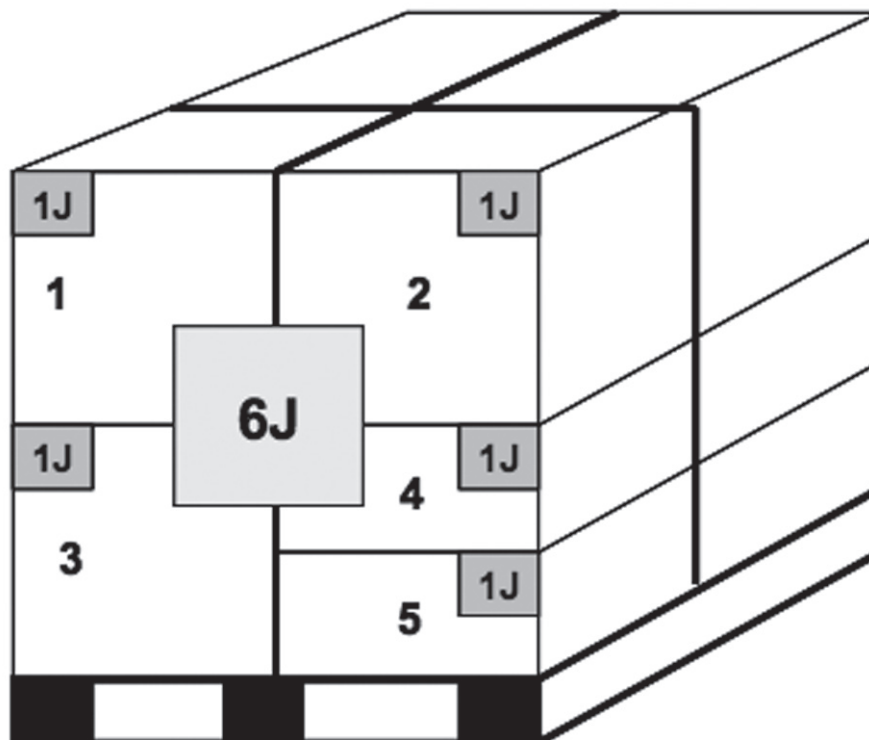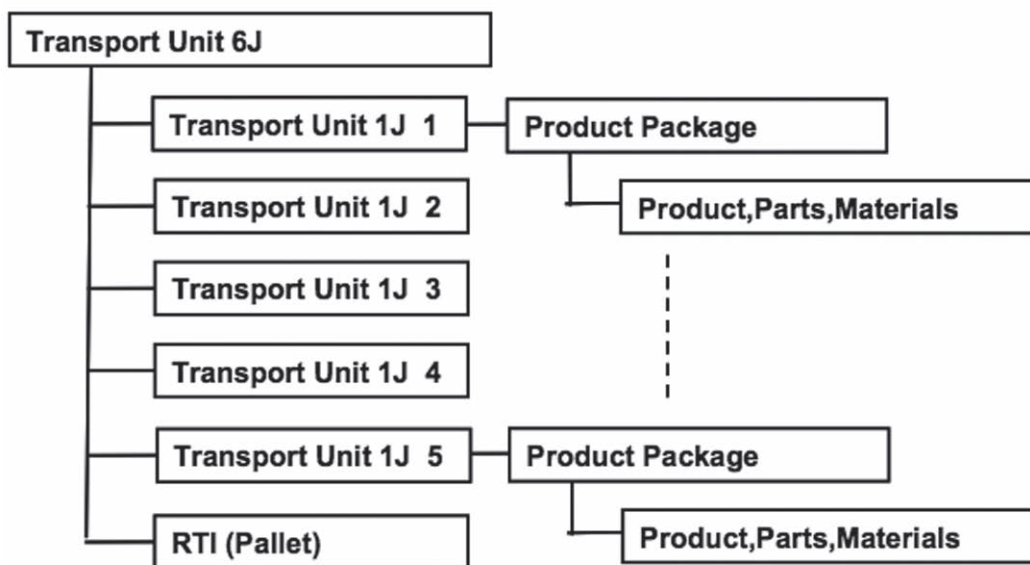More than one layer is usually involved when handling a large sized refrigerator. For instance, the refrigerator is first provided with a label in Layer 0 and then it is stored in a corrugated cardboard box on which a label in Layer 1 is applied. This cardboard package is also treated as a transport unit that belongs to Layer 2 and thus a label in Layer 3 should also be used.

7.5   Applicable use cases

Use cases currently seen in the actual applications are described in Annex D, Annex E and Annex F.

8   Data carrier system

Data Carrier system can be classified into groups of linear symbols, two-dimensional symbols, RFID or RHM.

8.1   Linear and two-dimensional symbols

Figure 11 illustrates a data carrier system using QR Code. QR Code is encoded (printed on the label etc.) from a host computer to a printer. Control commands from a host computer to a printer differ from one printer to another due to nonstandardized control commands. When readers read the QR Codes, the encoded data are sent straight to the host computer without any changes by 8 bits in most cases. In this case, adding 0 to MSB of 7 bits ASCII codes specified in ISO/IEC 646 adds up to the characters codes.

To identity the types of linear symbols or two-dimensional symbols, add the data carrier identification specified in ISO/IEC 15424 at the beginning of data. Annex C shows the main data carrier identification specified in ISO/IEC 15424.
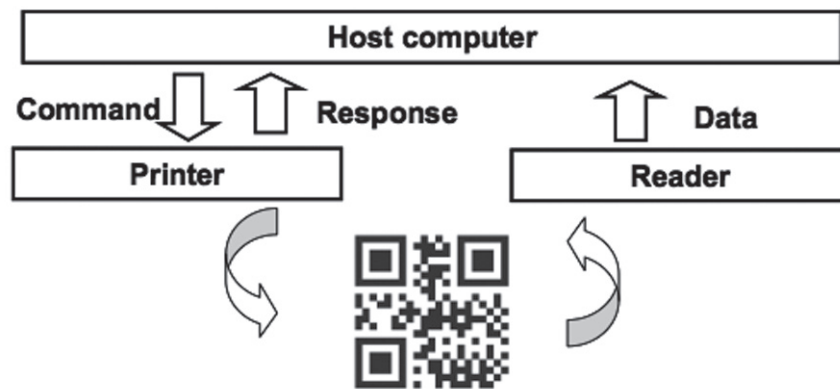
Figure 11 — Example of linear symbol and two-dimensional symbol systems

8.2   Radio Frequency Identification (RFID)

Figure 12 shows a data carrier system using RFID. The ISO/IEC 15961 series defines the application command or the response between a host computer and an interrogator. ISO/IEC 15962 specifies the data protocol, the tag driver and the mapping rule of an interrogator. The ISO/IEC 18000 series specifies the air interface between an interrogator and a RF tag. The system becomes more complex if these standards are applied, although the ISO/IEC 15961 series and ISO/IEC 15962 support all the RF tags that standardize interfaces (ISO/IEC 18000 series). It is possible to establish a system based on the air interface standard if the types of RF tags applied are limited.
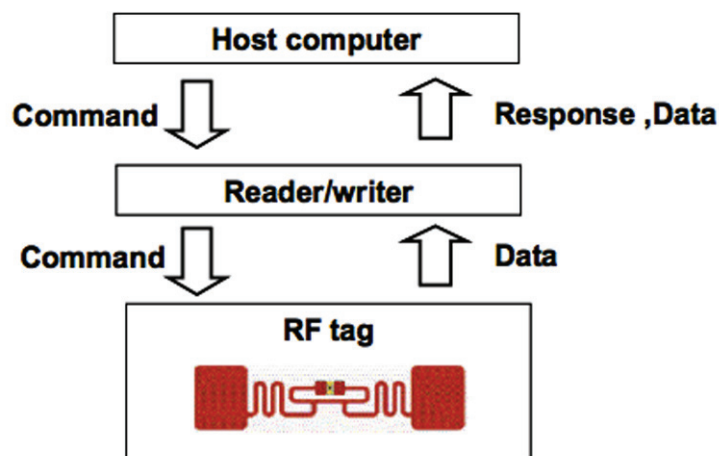
Figure 12 — Example of RFID system

The Data protocol and the mapping rule become identical when RF tags are limited to those of ISO/IEC 18000-3, Mode 3 and ISO/IEC 18000-63, which simplifies the system, allowing the method of data storage to be unified.

8.3   Rewritable Hybrid Media (RHM)

Figures 13 and 14 show the data carrier system of RHM. Figure 13 shows that the RHM printer integrates with the RF tag interrogator while the QR Code reader integrates with an RF tag interrogator. With the existing system, control commands from a host computer to a printer differ from one printer to another due to unstandardized control commands.

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Figure 13 — Example of RHM system

Figure 14 — Example of RHM system

Figure 14 shows an example of the RHM structure that separates the system of linear and two-dimensional symbols from that of RFID. Figure 14 illustrates a system that is able to operate with linear symbols, two-dimensional symbols and RFID separately. Problems arise when RFID is introduced to a system in which linear and two-dimensio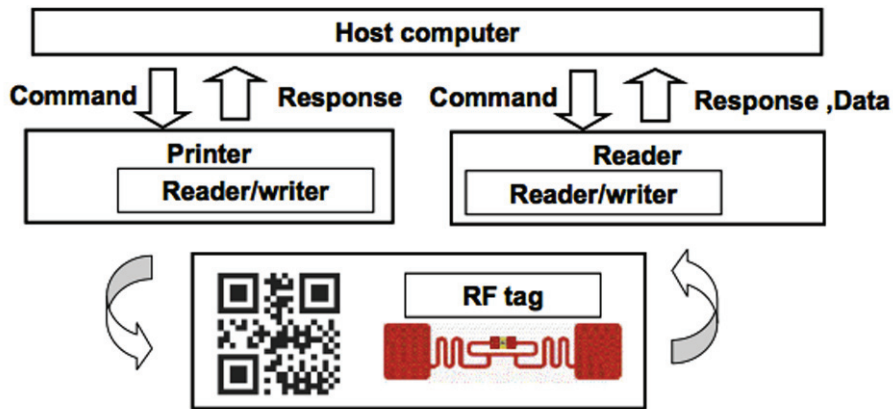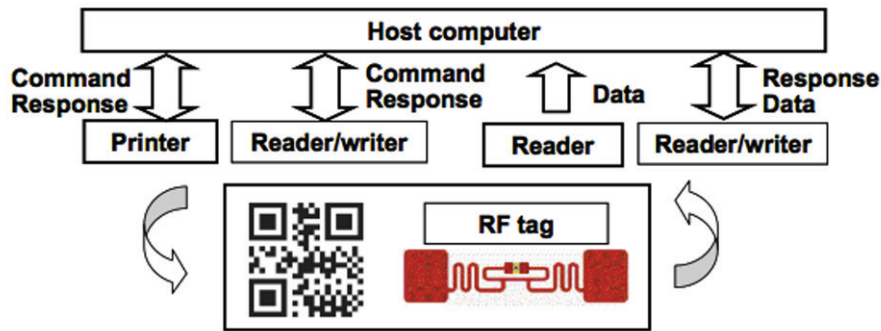nal symbols are already implemented. The system shown in Figure 14 would not be a major problem even if the application command/response to an interrogator differs. However, it would pose problems if the data format of the symbol reader is not the same as the format from the RF interrogator. It is important that the data formats are the same when the data specified in Figure 7 are stored in the symbols and RF tags. The problems stated above may not be resolvable if additional middleware is implemented between a host computer and an RF tag interrogator. It would be unsolvable following the rule of the ISO/IEC 15961 series and ISO/IEC 15962. Having said that, standardization of middleware has not been advancing.

It is vital to ensure consistency between widely available linear and two-dimensional symbols and RFID in order to make an extensive use of RFID as follows.

a) The data from the readers of linear and two-dimensional symbols and those from an RFID interrogator should be identical when the same data are stored in both the symbols and RF tags.

b) Data from an RF tag interrogator should be compliant with ISO/IEC 15418 and ISO/IEC 15434.

c) A method should be established to identify if the data are sent from RFID. RFID should also be compliant with ISO/IEC 15424, which is already applied to linear and two-dimensional symbols.

d) Unique RFID identifiers including AFIs should be excluded in the data from RF tag interrogators.

8.4 Data field structure

8.4.1 Data field structure of linear symbols

The Data Identifiers defined in both the ISO/IEC 15459 series and ANS MH10.8.2 should precede data encoded in the Code 39 (ISO/IEC 16388) or Code 128 (ISO/IEC 15417) symbols.

Table 10 — Storage data structure of linear symbol

DI	IAC	CIN	SN

When concatenating data in a linear symbol, the entire length of the symbol, excluding its Data Identifiers (DIs) and concatenation characters, should not exceed the number of characters specified in the ISO/IEC 15459 series. However, this does not include symbology overhead characters.

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

b) When variable length data fields need to be concatenated when encoding a Code 39 symbol, the plus ("+") character (ISO/IEC 646 Decimal 43) should be used to delineate between data fields, per ISO/IEC 15418 (ANS MH10.8.2).

c) When multiple variable length data fields are concatenated when encoding a Code 128 symbol that has Data Identifiers, the plus ("+") character (ISO/IEC 646 Decimal 43) should be used to delineate between the data fields as per ISO/IEC 15418.

If the resultant symbol is longer than the maximum message length specified in the ISO/IEC 15459 Series, the use of a two-dimensional symbol is recommended.

8.4.2 Data field structure of two-dimensional symbols

8.4.2.1 Data field structure specified in ISO/IEC 15459 Series

Subclause 8.1 provides information on the interaction between the host computer and the machine-readable media for linear and two-dimensional symbols. The amount of data to be encoded in a two-dimensional symbol is less limited than in linear bar code symbols.

8.4.2.2 Data field structure using ISO/IEC 15434

The use of syntax identified in ISO/IEC 15434 is recommended when encoding a large volume of data or an EDI message. The Message Header (first 7 characters; [) > ^{R}S 06 ^{G}S) and Message Trailer (the last 2 characters; ^{R}S ^{E}O$_T$) that meet the ISO/IEC 15434 standard are fixed for this application. The "^{E}O$_T$" character is ISO/IEC 646 Decimal 04. A single codeword can be used for some of the symbologies in encoding the message header and message trailer character strings. More details are given in Annex G.

8.4.3 RFID data field structure

As for RFID, this Technical Report describes only the data carriers supported by ISO/IEC 18000-3, Mode 3 and ISO/IEC 18000-63 (see Table 1). The memory bank structure of an RF tag is defined in ISO/IEC 18000-3, Mode 3 and ISO/IEC 18000-63 and is illustrated in Figure I.1 in Annex I. Tags with data encoded only in the memory banks $MB00_2$, $MB01_2$ and $MB10_2$ and no user memory ($MB11_2$) are considered to have no syntax. These tags are referred to as "identity-only tags", while tags that have data encoded into $MB11_2$ are called "item-attendant tags". The definition of data storage for RF tags complies with the ISO standards from 17364 to 17367.

If $MB11_2$ is used (including structured data), PC bit 0x15 in $MB01_2$ is set to "1_2". When PC bit 0x15 in $MB01_2$ is set to "0_2", $MB11_2$ is not used (excluding structured data).

When PC bit 0x17 in $MB01_2$ is set to "1_2" this indicates that the data in $MB01_2$ is an ISO-compliant AFI (Application Family Identifier), and the assignment is specified in Annex H. Setting PC bit 0x17 in $MB01_2$ to "0_2" indicates that the data encoded in $MB01_2$ will be EPC-compliant.

If possible, encoded data should be stored to the memory banks $MB01_2$ and $MB11_2$ using the ISO/IEC 15459 Series and ISO/IEC 15434, respectively. The 6-bit compaction table used for ISO/IEC 15434 messages can be found in Annex K.

Table 10 shows the structure of data stored in UII (Unique Item Identifier) data (0x20 or more). The Data Identifier can be clearly identified from the AFI designated by a PC bit in $MB01_2$. For ISO 1736x standards $MB01_2$ should include the appropriate Data Identifier.

Annex J describes the required number of RF tag bits for storing the Unique Identifier and data (see Table 10) to the UII data (0x20 or more).

8.4.4 Rewritable hybrid media data field structure

8.4.4.1 Linear symbol data field structure

Refer to 8.4.1 for the structure of the linear symbol data field.

8.4.4.2 Two-dimensional symbol data field structure

Refer to 8.4.2 for the structure of the two-dimensional symbol data field.

8.4.4.3 RFID data field structure

Refer to 8.4.3 for the structure of the RFID data field.

9 Structure of transmitted data

Data are encoded in a linear or two-dimensional symbol or RF tag, as defined in ISO/IEC 15459-1, ISO/IEC 15459-4, ISO/IEC 15459-5 and ISO/IEC 15459-6, as well as in ISO 15394, ISO 22742, ISO 28219 and from ISO 17364 to ISO 17367.

In some applications, a multi-media reader designed to read a linear or two-dimensional symbol or an RF tag may be used for rewritable hybrid media. As a communication path available for data transmission is limited to just one between a multi-media reader and a host computer, the host computer has to determine which data carrier to select if different data structures are present. It is also the task of the host computer to recognize from which data carrier the data has been transmitted. A data transmission method to effectively address this issue should be developed via a unified approach with regard to linear or two-dimensional symbols and RFID. This clause describes data transmission structures that meet these requirements by using the example of Data Identifier "25S". The character set used in the ISO/IEC 15459 Series standards should be upper-case alphabetic characters and the numbers from the 7-bit ASCII characters defined in ISO/IEC 646.

9.1 Structure of transmitted data in linear symbology

Table 11 shows the structure of transmitted data of a linear symbol (Code 128). Generally, no Data Carrier Identifier is used (transmitted) in typical systems.

Table 11 — Transmitted data structure in linear symbology (Code 128)

]C0	25S	IAC-CIN-SN
Data Carrier Identifier	ISO/IEC 15459-4 Data Identifier	Data
The Data Carrier Identifier "]" should be 0x5D defined in ISO/IEC 646.		

9.2　Structure of transmitted data in two-dimensional symbol

9.2.1　Structure of transmitted data specified in ISO/IEC 15459 Series

Table 12 shows the structure of transmitted data encoded according to 8.4.2.1. Generally, no Data Carrier Identifier is used (transmitted) in realistic systems.

Table 12 — Transmitted data structure 1 in two-dimensional symbology (QR Code)

]Q1	25S	IAC-CIN-SN
Data Carrier Identifier	ISO/IEC 15459-4 Data Identifier	Data
The Data Carrier Identifier "]" should be 0x5D defined in ISO/IEC 646.		

9.2.2　Structure of transmitted data specified in ISO/IEC 15434

Table 13 shows the structure of transmitted data encoded in accordance with 8.4.2.2.

Table 13 — Transmitted data structure 2 in two-dimensional symbol (QR Code)

]Q1	[) >^RS	06	^GS	25S	IAC-CIN-SN	^RS	^EO_T
Data Carrier Identifier	Message header	Format indicator	Data element separator	ISO/IEC 15459-4 Data Identifier	Data	Format trailer	Message trailer

9.3　Structure of transmitted UII data in RFID

RF data can be stored in the UII bank in $MB01_2$ and the user bank in $MB11_2$. Basically, the UII bank in $MB01_2$ is encoded in accordance with the ISO/IEC 15459 Series and the user bank in $MB11_2$ is encoded with ISO/IEC 15434. Accordingly, the method adopted by a linear symbol is recommended for this UII bank and that of a two-dimensional symbol is recommended for this user bank. See 9.2.2.

9.3.1　Structure of transmitted data in UII bank in $MB01_2$

Table 13 shows the structure of transmitted data encoded in the UII bank in $MB01_2$. The Data Carrier Identifier "Z2" defined in ISO/IEC 15424 should be used for RFID data. In this case, an Application Family Identifier (AFI) is transmitted subsequent to the Data Carrier Identifier "Z2".

Table 14 — Transmitted data structure 1 in $MB01_2$ of UII bank data

]Z2	A5	25S	IAC-CIN-SN
Data Carrier Identifier	AFI	ISO/IEC 15459-4 Data Identifier	Data
The Data Carrier Identifier "]" should be 0x5D defined in ISO/IEC 646.			

9.3.2　Structure of transmitted data in user bank in $MB11_2$

Table 16 shows the structure of transmitted data encoded in the user bank in $MB11_2$, which is used when transmitting an item-attendant data. A Data Carrier Identifier, if required, should be appended before the message header.

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Table 16 — Transmitted data structure 2 in MB11$_2$ of UII bank data

[) >^R_S	06	^G_S	25S	IAC-CIN-SN	^R_S	$^E O_T$
Message header	Format indica-tor	Data element separator	ISO/ IEC 15459-4 Data Identifier	Data	Format trailer	Message trailer

Annex A
(normative)

Examples of Containers Used for Supply Chain Management

A.1   General

A reusable RTI (returnable transport item) or RPI (returnable packaging item) is used in each of the layers in the supply chain layers. This Annex provides examples of the containers used for supply chain management. Examples of the data structures involved with product packages, RTIs, and RPIs can be found in Annex E and Clause 5, of this Technical Report and Annex A of ISO 17364.

A.2   Containers used in Layer 4

Shown in Figure A.1 below are examples of the containers used in Layer 4. These include air cargo, freight containers and railway containers that carry substances associated with vehicle production such as liquids, oil and powders.
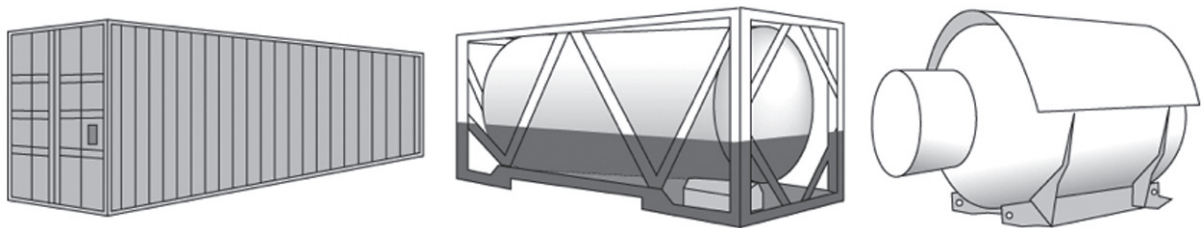

Figure A.1 — Example of containers

A.3   RTIs (pallets) used in Layer 3

Figures from A.2 to A.6 show examples of pallets.

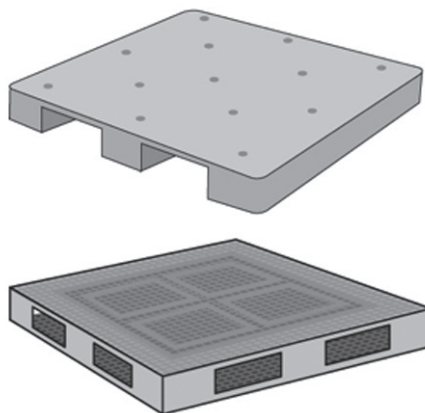**Figure A.2 — Plate pallets**

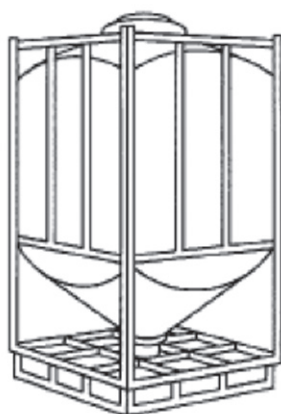**Figure A.3 — Roll box pallet**

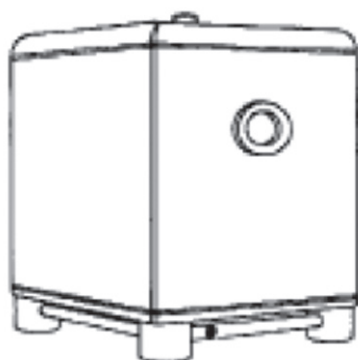

Figure A.4 — Silo pallet
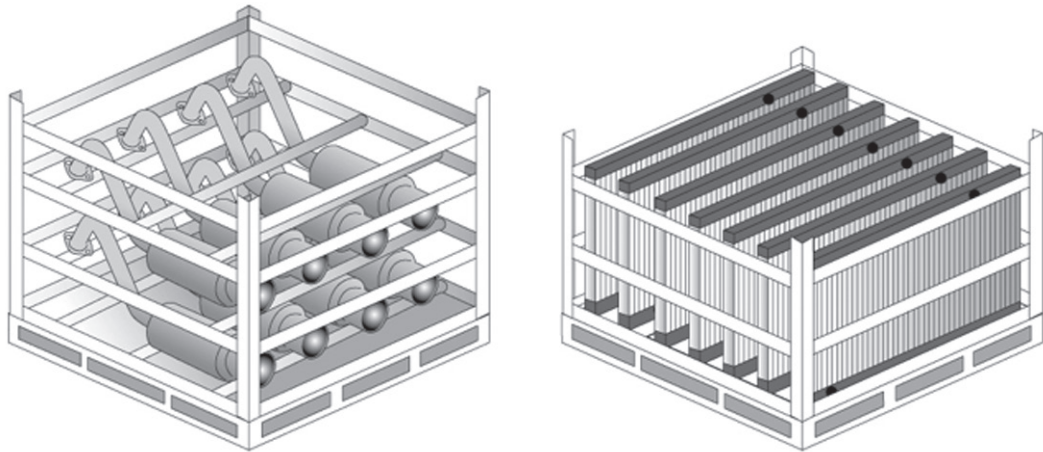

Figure A.5 — Tank pallet

Figure A.6 — Special pallets

A.4 RTIs (returnable boxes) used in Layer 3

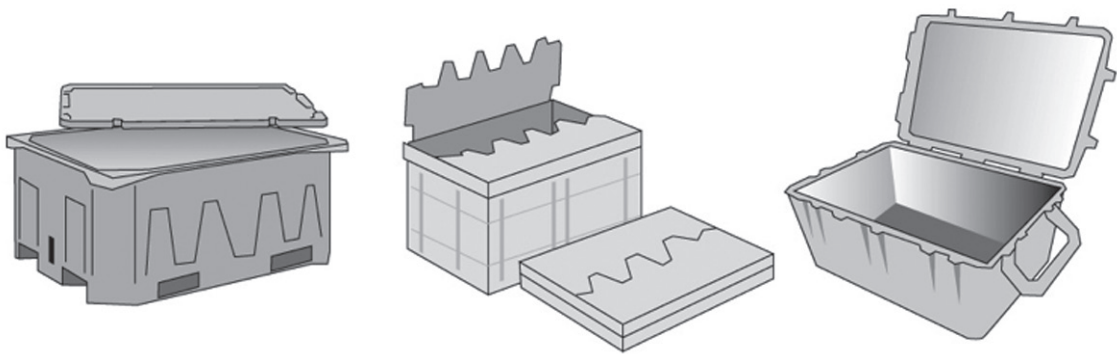Figures from A.7 to A.8 show examples of returnable boxes.

Figure A.7 — Large-sized returnable boxes
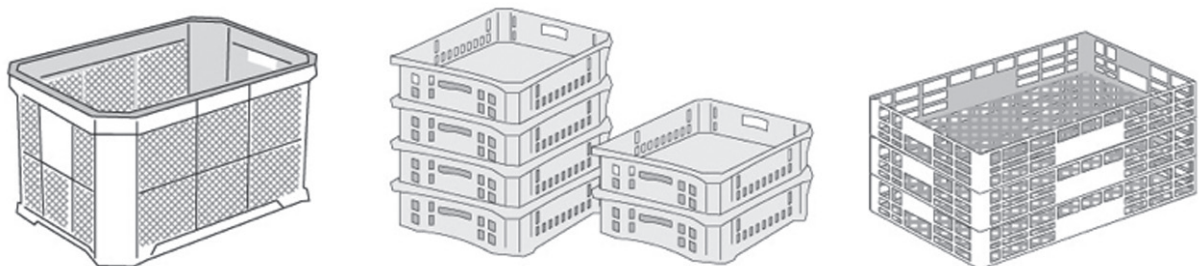
Figure A.8 — Medium-sized returnable boxes

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A.5   Liquid containers used in Layers 3 and 2

Figure A.9 shows examples of containers, such as metallic drums and barrels, for carrying liquids. These containers may be used as RTIs or RPIs depending on the application.

Figure A.9 — Liquid containers like metallic drums

A.6   Product packages used in Layer 1 and Layer 2

Most product packages in Layer 1 are designed to put liquid or powder substances and are normally made of paper, plastic, glass or metal. Particularly, metallic cases for transporting milk or soft drinks (see Figure A.10), glass bottles for wine or beer (see Figure A.11) and plastic cases for baby powder or powder soap (see Figure A.12) are classified in this category. Some of these cases or bottles are actually reused and recycled, mainly in the consumer market. There are also product packages that may be repeatedly used for carrying substances associated with vehicle production such as electrical parts/assemblies, lubricants, coolant or washer liquid.

Figure A.10 — Example of metallic cases

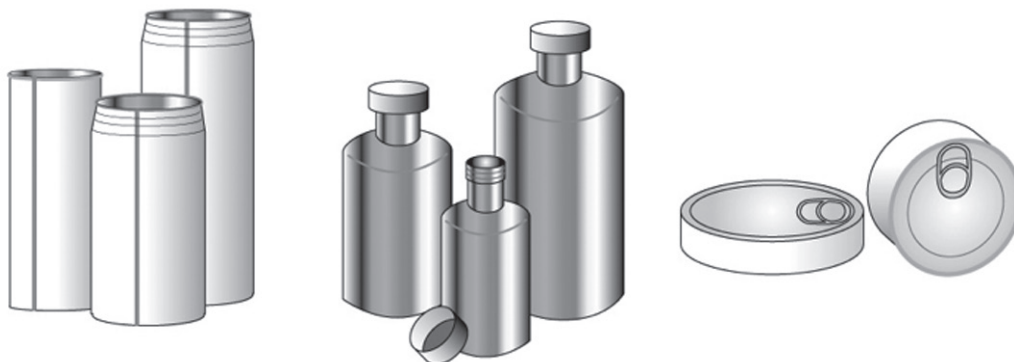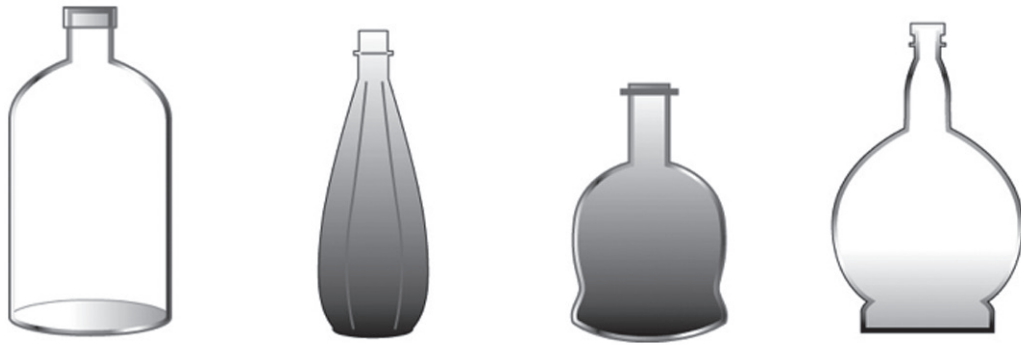**Figure A.11 — Example of glass bottles**

Figure A.12 — Example of plastic cases

Annex B
(informative)

Rewritable Hybrid Media

B.1 General

Annex B provides a general description of rewritable hybrid technology and rewritable hybrid media.

B.2 Thermal Rewritable Technology

Thermal rewritable technology, which achieves a high black and white contrast and is erasable at a high speed, is practical and suitable for continual reuse. Thermal rewritable technology is categorized into chemical rewritable and physical rewritable. In general, this rewritable technology is used in combination with a sheet-like media, composed of a substrate (plastic film such as PET or paper), a rewritable display layer, and a printer equipped with a function to clear records.

B.2.1 Chemical rewritable

Figure B.1 below illustrates the basic colouring and discolouring processes of the chemical rewritable technology in which images are made to chemically appear or disappear through controlled application of heat. Colour appears when temperatures just above 180°C are applied to the media followed by rapid cooling. Colour disappears when temperatures ranging from 130°C to 170°C are applied to the media.
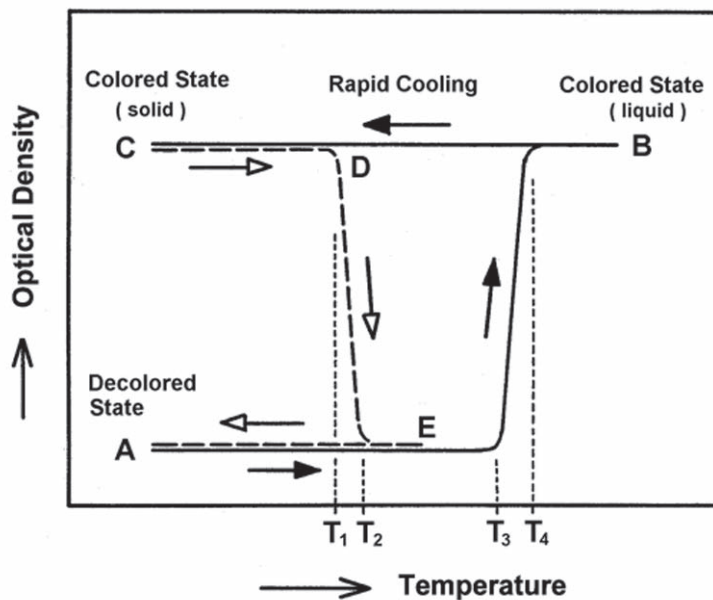

Figure B.1 — Colouring/discolouring process

B.3 Physical rewritable

Contactless laser recoding method of the physical rewritable (PR) technology creates and clears an image by irradiating the media's rewrite section with laser light causing the media's recording layer to absorb light (see Figure B.2). With this PR technology, images are made to physically appear or disappear

through the controlled application of heat. Images appear at 130°C or more and disappear between 100°C and 120°C.
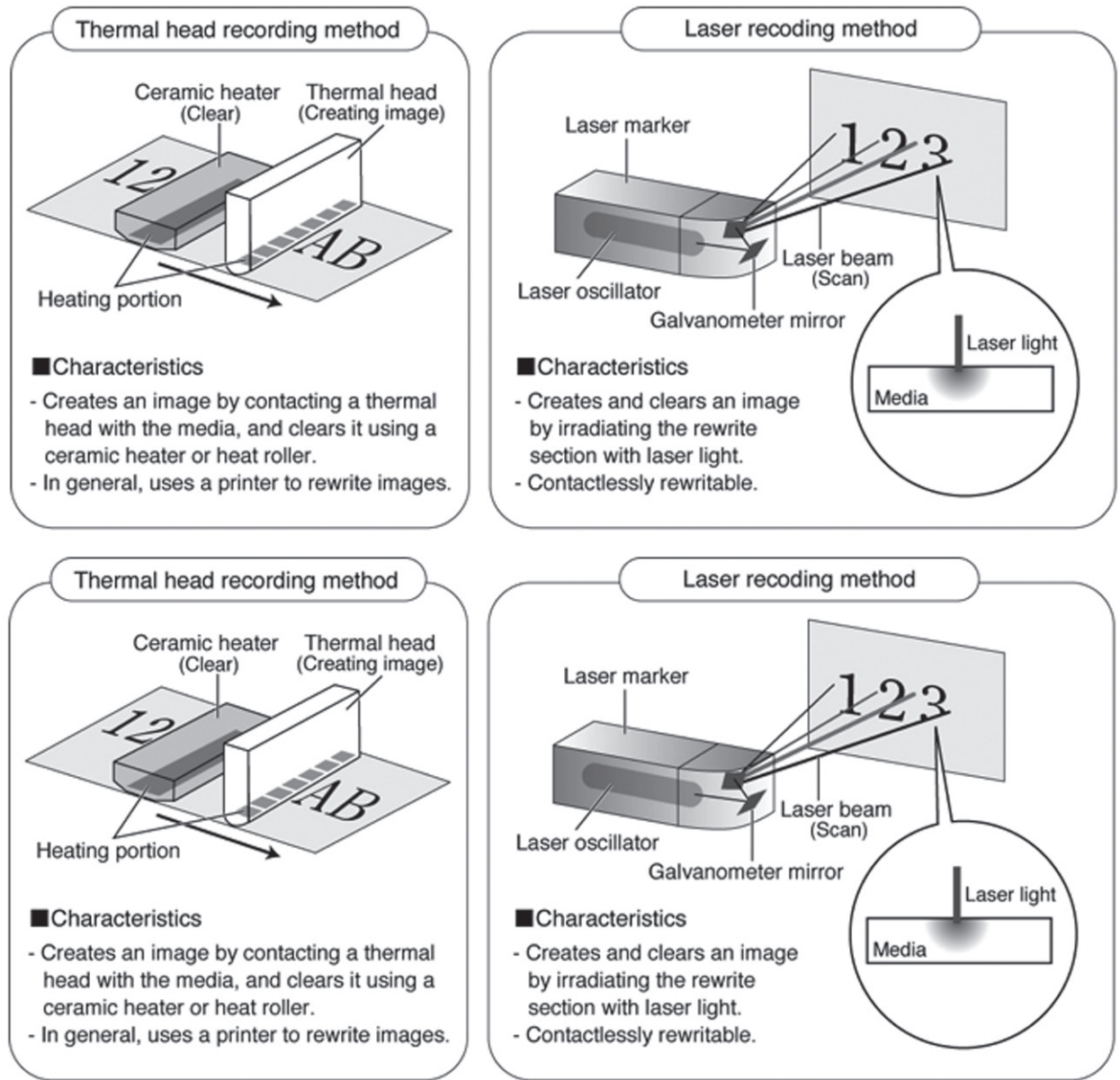
Figure B.2 — Rewritable media recording methods

The thermal head in Figure B.2 is a thermal printer and has small heating elements laid in a sheet or column. It selectively heats a heating element with applied current for printing a character or image.

B.4   Rewritable Hybrid Media

B.4.1   General

Because an RF tag does not have a visual representation mechanism, the use of an additional media such as paper or a display monitor is necessary in applications in which the information is visually checked. This requires the industry to migrate from optical media (linear symbols or two-dimensional symbols) to the RFID media or labels using disposable RF tags. In these situations, the label or the tag must be replaced for each cycle of data, consuming paper for the label, and metal for the RF tag, resulting in additional costs and an adverse impact on the environment.

However, by combining an RF tag with rewritable media, a composite data carrier can be created that supports both printable linear and two-dimensional symbols and human readable information. Not only will this reduce cost by changing the data carrier from a single use to a multiple use carrier, but it will also have a positive effect on the environment.

As illustrated in Figure 3 below, rewritable hybrid media is an efficient recovery solution for when the chip of an embedded RF rewritable tag is damaged or broken, since the hybrid media is also rewritable
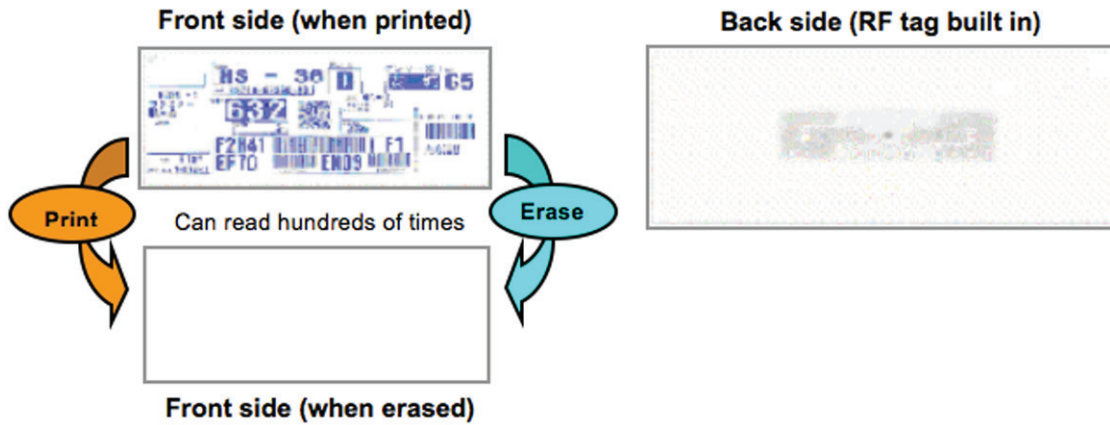
Figure B.3 — Rewritable hybrid media

B.5   Concept of rewritable hybrid media

The advantages of rewritable hybrid media are as follows:

a)   It provides visualization of the digital information in the RF tag.

b)   It simultaneously rewrites both the electronic information and the display information, thereby providing duplicate sources of the information.

c)   It is capable of coexisting with systems such as linear symbols, thereby seamlessly linking with existing infrastructures.

d)   Rewritable hybrid media significantly reduces the operational cost and environmental impact because of the ability to repeatedly rewrite and reuse.

B.6   Construction and characteristics

Typically, a rewritable hybrid media data carrier in which an RF tag is embedded consists of an active rewritable layer tucked among a surface protection layer, the substrate and the backing layer. A range of these data carriers, including contact and non-contact erasure/printing devices, is now commercially available. See Figure B.4 below
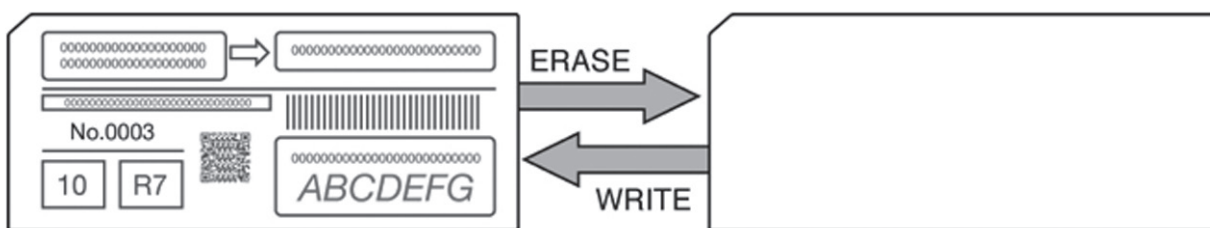
Figure B.4 — Typical rewritable hybrid media data carrier

Annex C
(informative)

Data Carrier Identifiers

C.1   General

Annex C describes typical Data Carrier Identifiers defined in ISO/IEC 15424.

C.2   Code 39

Code character "A" is used for Code 39.

Table C.1 — Code 39 assignments

Modifier character value	Option
0	No check character validation nor full ASCII processing; all data transmitted as decoded
1	Modulo 43 check character validated and transmitted
3	Modulo 43 check character validated but not transmitted
4	Full ASCII character conversion performed; no check character validation
5	Full ASCII character conversion performed; modulo 43 check character validated and transmitted
7	Full ASCII character conversion performed; modulo 43 check character validated but not transmitted

C.3   Code 128

Code character "C" is used for Code 128.

Table C.2 — Code 128 assignments

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

C.4 QR Code

Code character "Q" is used for Code 128.

Table C.3 — QR Code assignments

Modifier character value	Option
0	Model 1 symbol
1	Model 2 symbol, ECI protocol not implemented
2	Model 2 symbol, ECI protocol implemented
3	Model 2 symbol, ECI protocol not implemented, FNC1 implied in first position
4	Model 2 symbol, ECI protocol implemented, FNC1 implied in first position
5	Model 2 symbol, ECI protocol not implemented, FNC1 implied in second position
6	Model 2 symbol, ECI protocol implemented, FNC1 implied in second position

C.5 Data Matrix

Code character "d" is used for Data Matrix.

Table C.4 — Data Matrix assignments

Modifier character value	Option
0	ECC 000 to ECC 140
1	ECC 200
2	ECC 200, FNC1 in first or fifth position
3	ECC 200, FNC1 in second or sixth position
4	ECC 200, ECI protocol implemented
5	ECC 200, FNC1 in first or fifth position, ECI protocol implemented
6	ECC 200, FNC1 in second or sixth position, ECI protocol implemented

C.6   Other than Linear and 2D Symbols

Code character "z" is used for data carriers other than linear and two-dimensional symbols.

Table C.5 — Assignments of other than linear and 2D symbols

Modifier character value	Option
0	Keyboard
1	Magnetic stripe
2	Radio frequency (RF) tag
3 to F	May be assigned by device manufacturer

Annex D
(informative)

Layered Structure of Automotive Industry

D.1 General

Annex D provides examples of the structured data introduced in the automotive industry.

D.2 Example 1

In Example 1 in Figure D.1, a returnable box containing packing materials and 18 parts is placed on a pallet and a sheet pallet is placed between the returnable box and the pallet. Figure D.2 describes the layered structure of this example.
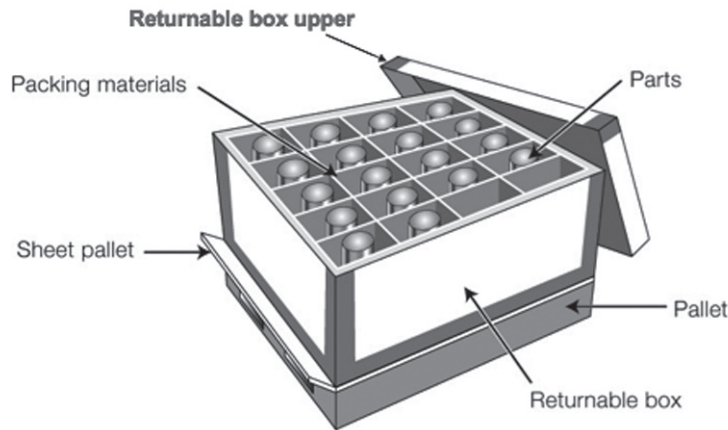
Figure D.1 — Example 1
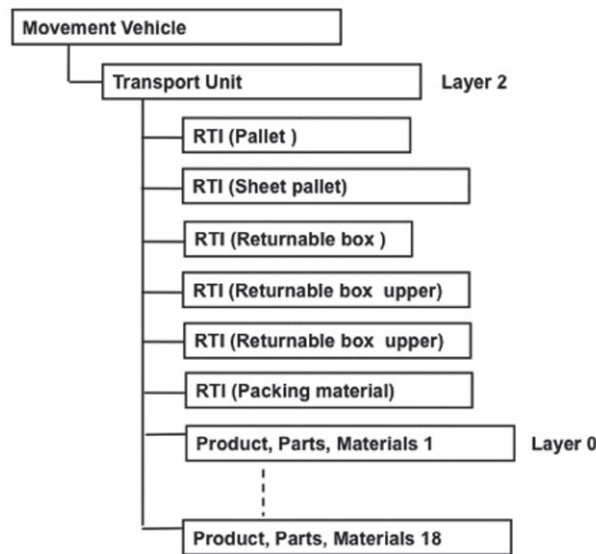
Figure D.2 — Layered structure of Example 1

D.3   Example 2

In Example 2 in Figure D.3, eight mufflers designed for automotive use are placed in a special pallet. Figure D.4 describes the layered structure of this example.
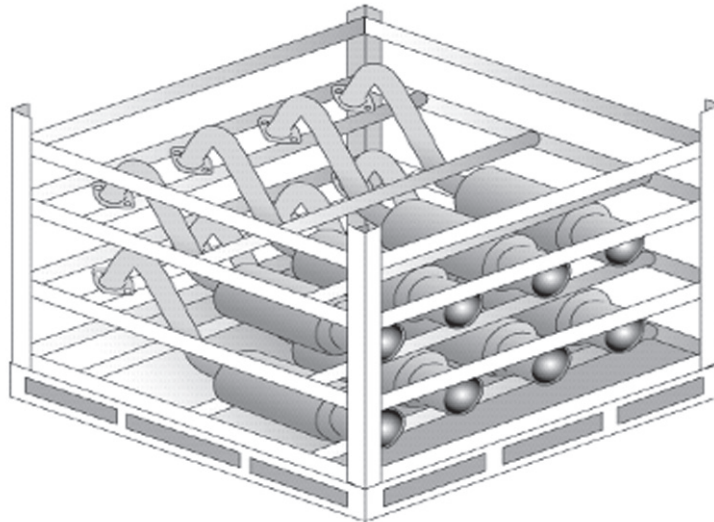
Figure D.3 — Example 2
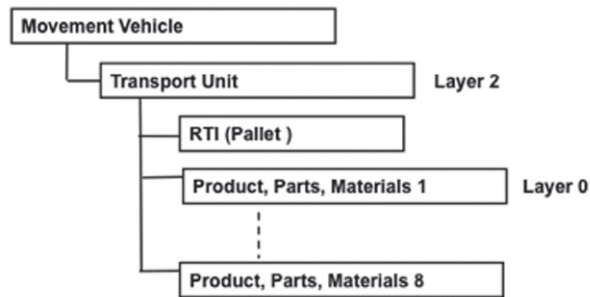
Figure D.4 — Layered structure of Example 2

D.4 Example 3

In Example 3 in Figure D.5, seven radiators designed for automotive use are placed in a special pallet. Figure D.6 describes the layered structure of this example.
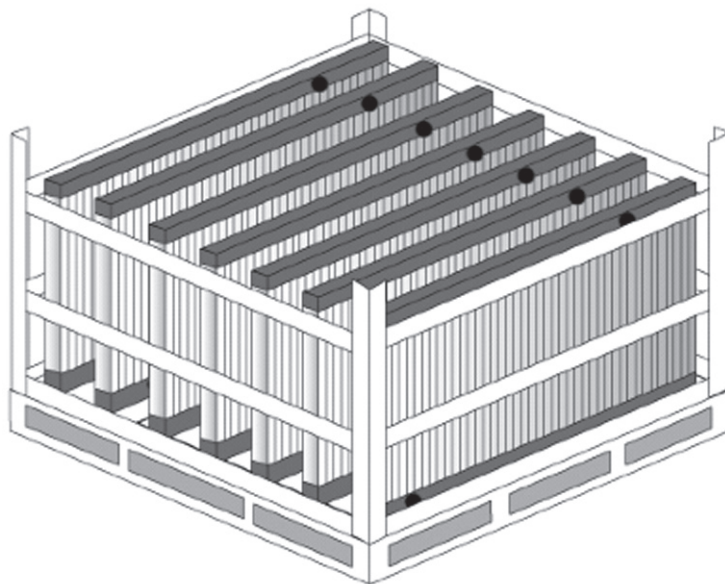
Figure D.5 — Example 3
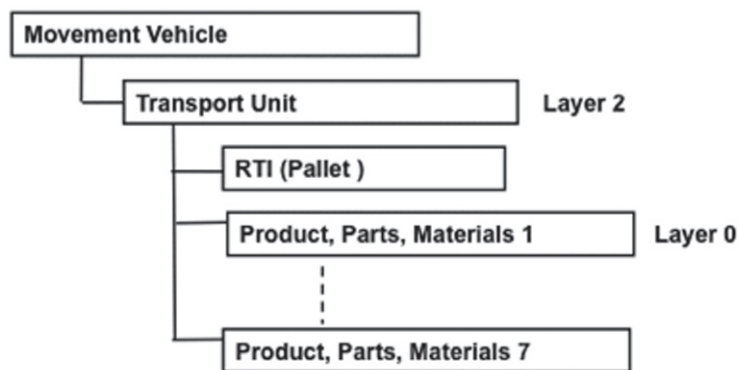
Figure D.6 — Layered structure of Example 3

Annex E
(informative)

Layered Structure of Electric Home Appliance Industry

E.1   General

Annex E provides examples of the structured data introduced in the electric home appliance industry.

E.2   Example 1

Example 1 is the RTI that contains different types of electronic components in it. In this example, several types of electronic components, each wrapped in a package, are stored in the RTI that is securely tied up with a band.
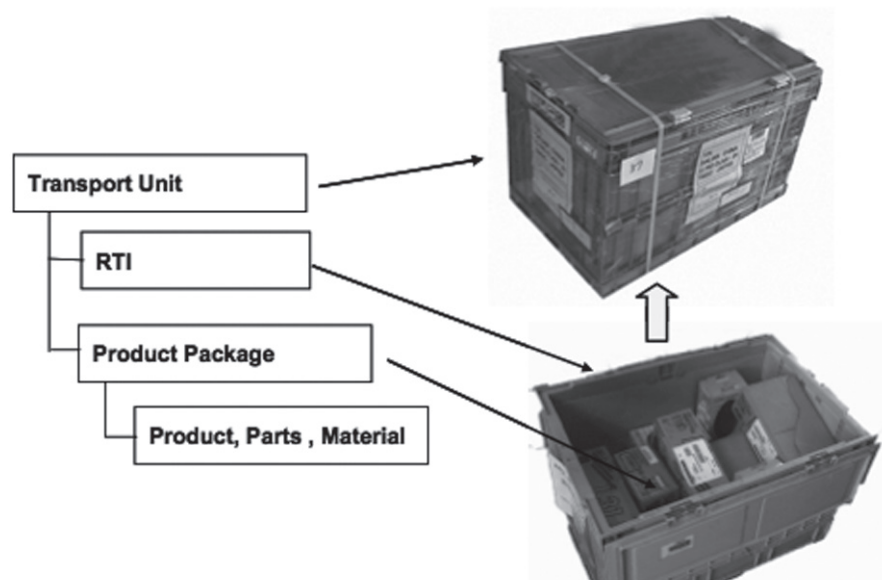
Figure E.1 — Use case of Example 1

E.3   Example 2

Example 2 shows a packaging structure of medical equipment. In this example, the medial equipment is packed in plastic film and is overly protected by an iron-based returnable frame.
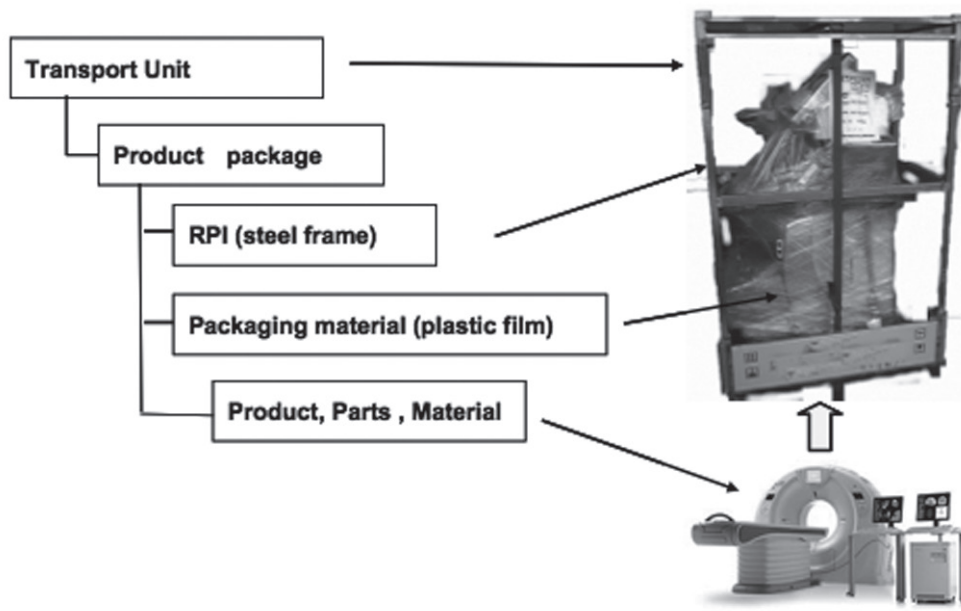
Figure E.2 — Use case of Example 2

E.4   Example 3

Example 3 shows a packaging structure of a refrigerator. In this example, the washing machine placed in a transparent plastic bag is covered with a wrap-around package and then securely tied up with a band.
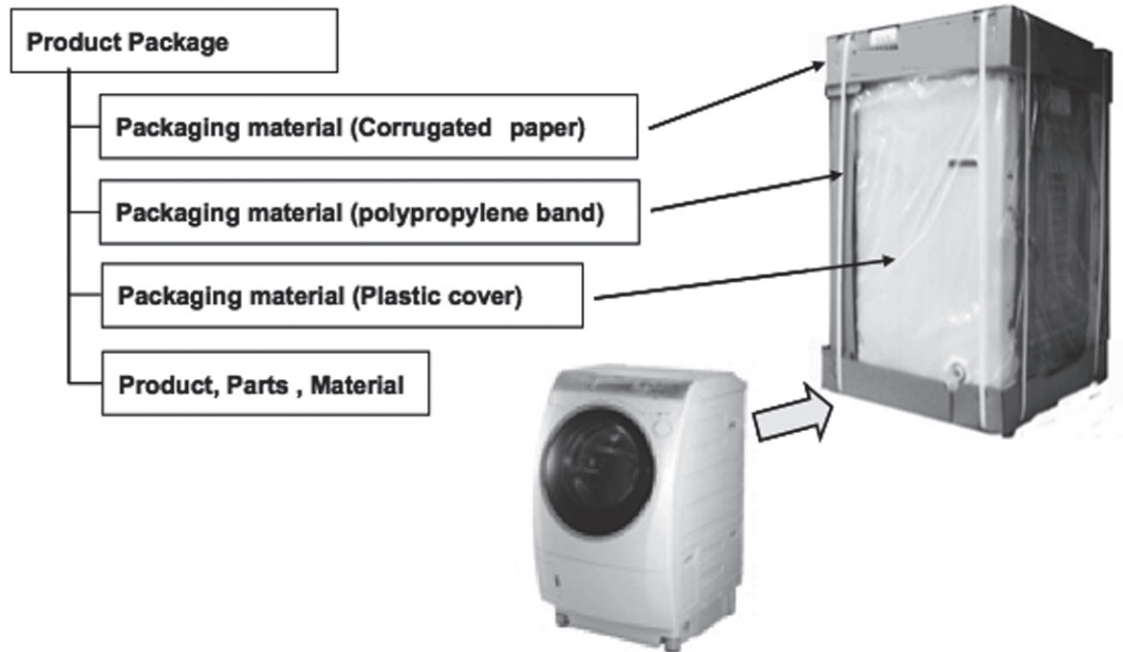
Figure E.3 — Use case of Example 3

E.5   Example 4

Example 4 shows a packaging structure of a semiconductor. The semiconductor is first packed with a reel, and then with a plastic bag, corrugated cardboard and carton-made transportation package.
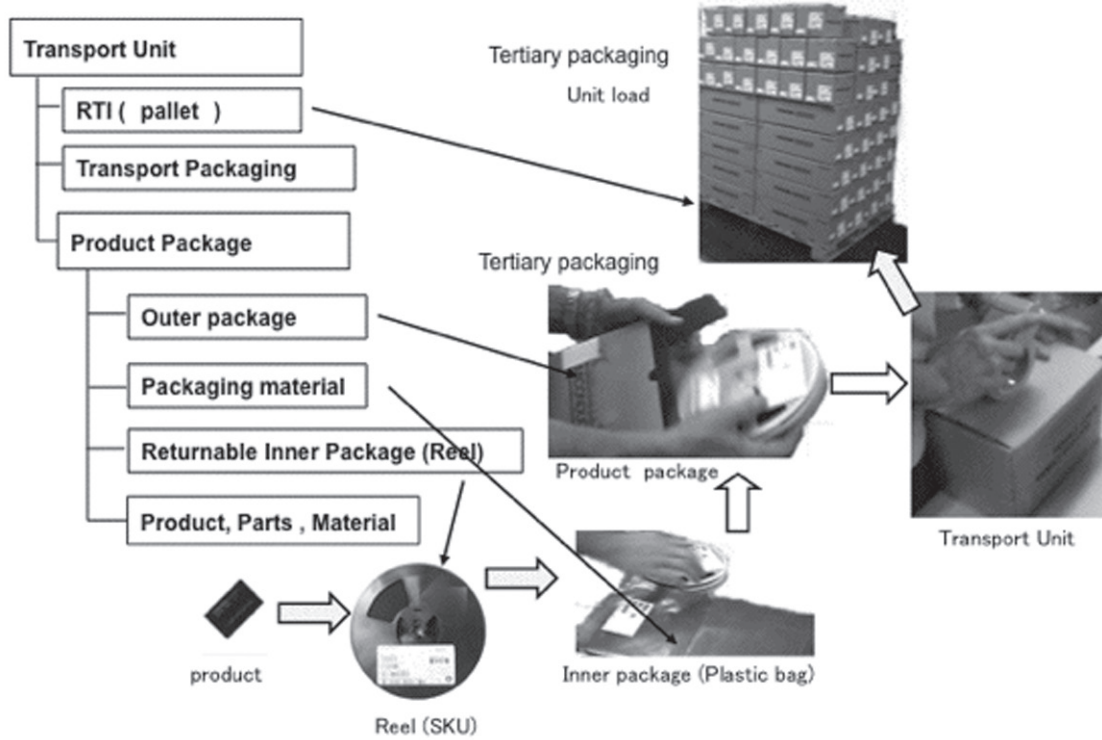
Figure E.4 — Use case of Example 4

E.6 Example 5

Example 5 shows a packaging structure of an ink cartridge package. In this example, the ink cartridge wrapped in a plastic bag is put in a paper box. Multiple of these paper boxes are collectively packed in a container as a unit load for transportation.
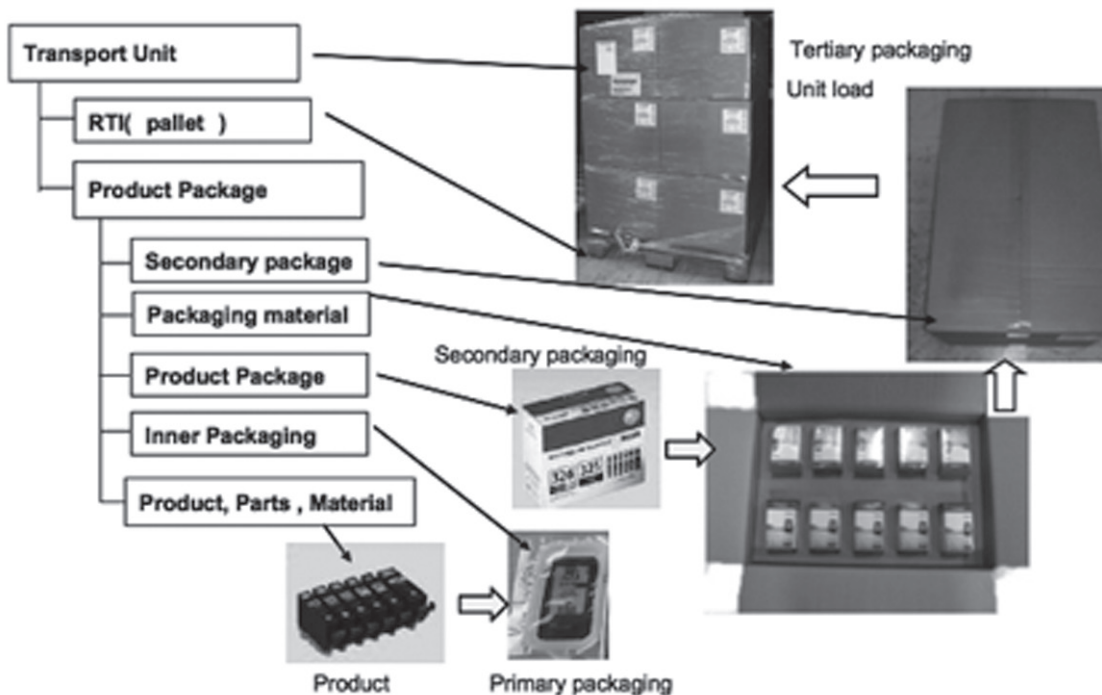
Figure E.5 — Use case of Example 5

E.7   Example 6

Example 3 shows a packaging structure of a drive battery. A specific number of drive batteries are wrapped in a plastic package called "SKU". This SKU is then put in a display box placed at a store counter and finally put in an outer carton box.
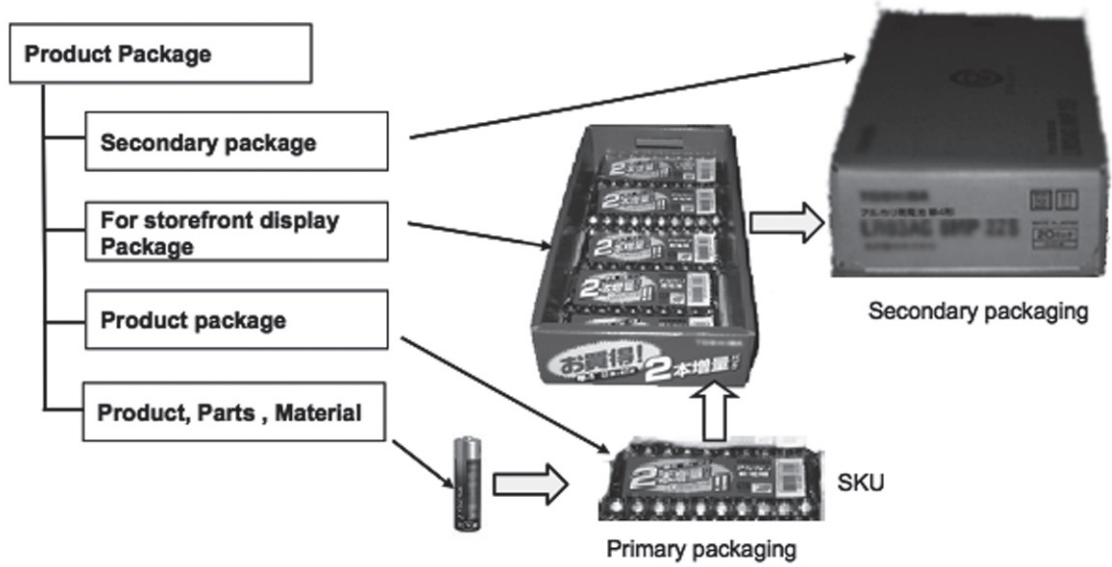
Figure E.6 — Use case of Example 6

E.8 Example 7

Example 7 shows a packaging structure of a personal computer. As illustrated in Figure E.7, all accessories associated with the PC are provided in a set of product package.
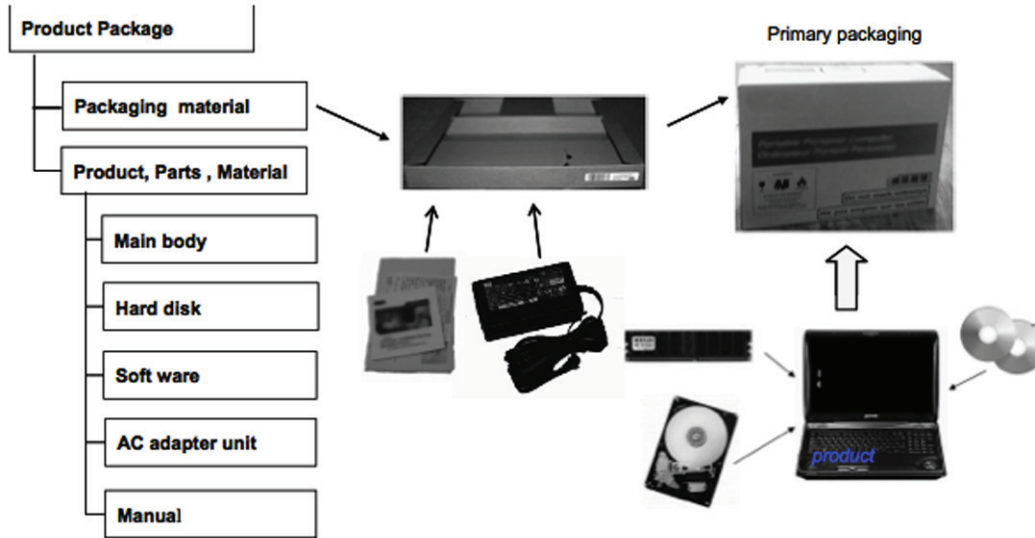
Figure E.7 — Use case of Example 7

E.9 Example 8

Example 8 shows another packaging structure of a personal computer. In this example, more than one product packages shown in Figure 7 is grouped together in a single packaging unit.
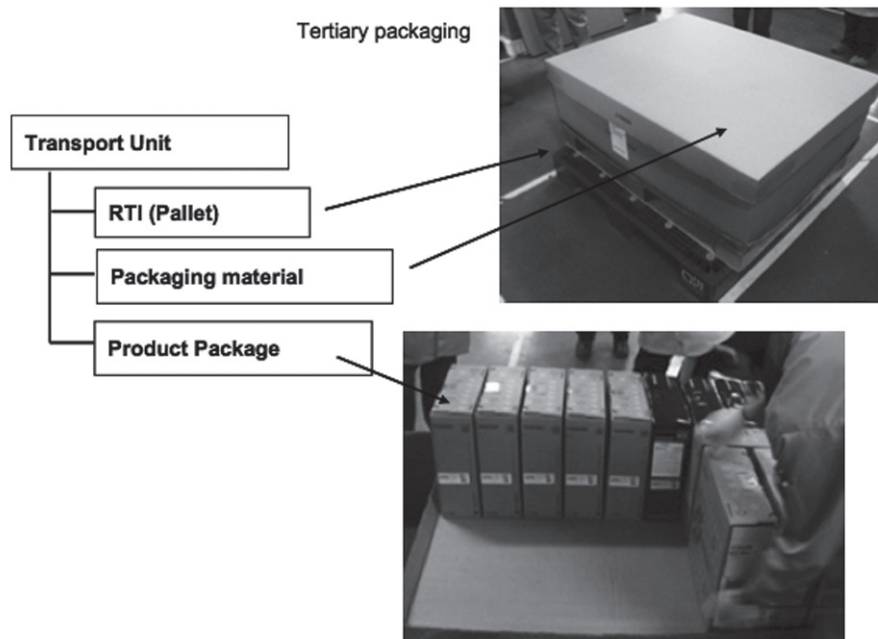
Figure E.8 — Use case of Example 8

E.10 Example 9

Example 9 shows a multi-functional printer that is packed without using an outer carton box. The printer is packed in a returnable transport item instead of an outer carton box.
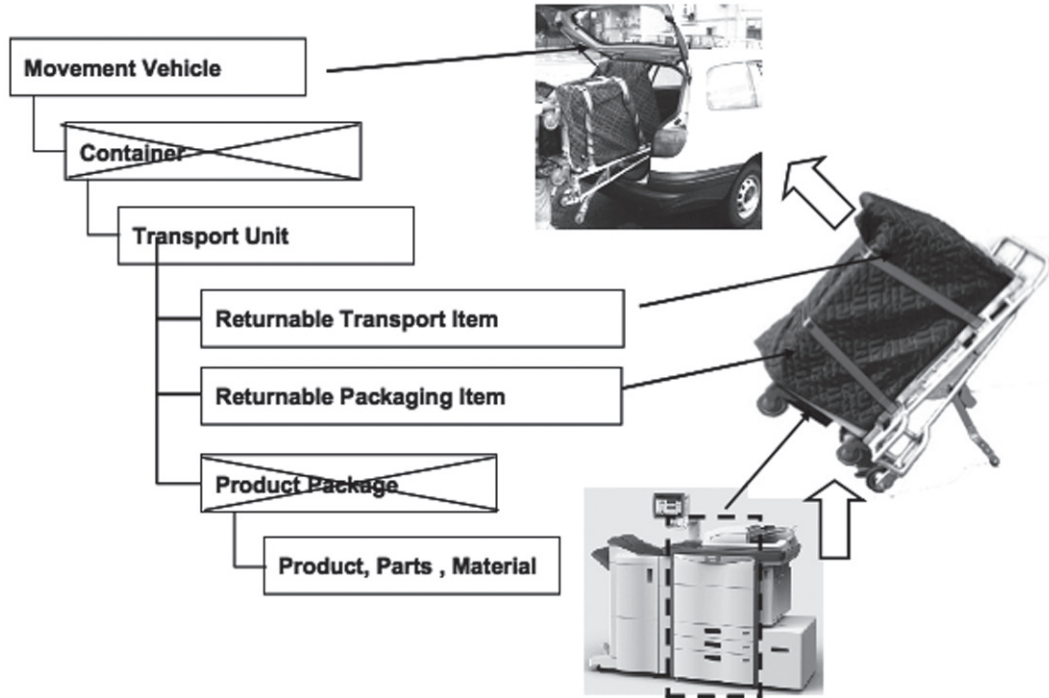
Figure E.9 — Use case of Example 9

E.11 Example 10

Example 10 shows a packaging structure of a compressor.

Compressor for refrigerators
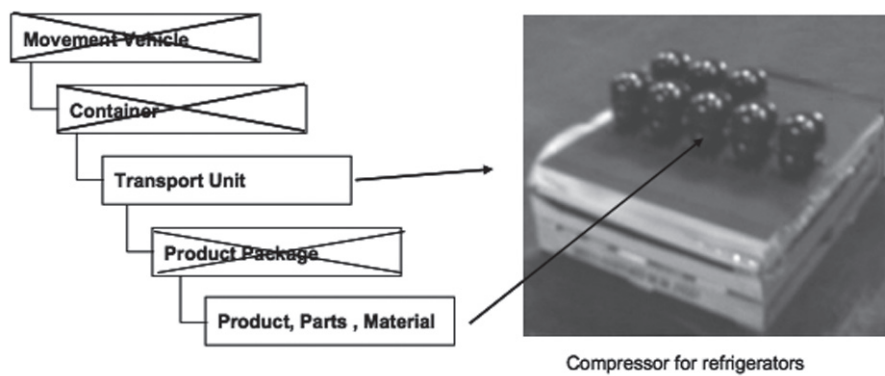
Figure E.10 — Use case of Example 10

Annex F
(informative)

Examples of Layered Structure

F.1   General

Annex F provides examples of the structured data introduced in the medical industry.

F.2   Example 1

Product packages that contain electric home appliances are directly loaded on a freight truck. No RTIs are used in this application.
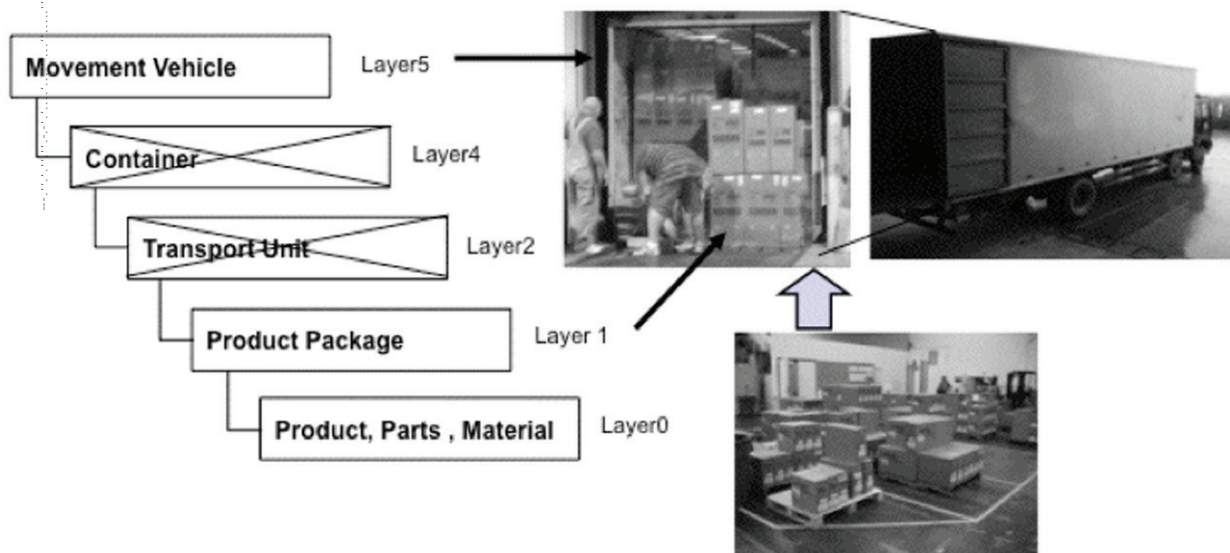
Figure F.1 — Use case of Example 1

F.3   Example 2

Product packages that contain electric home appliances are input in an RTI, which is loaded on a freight truck.
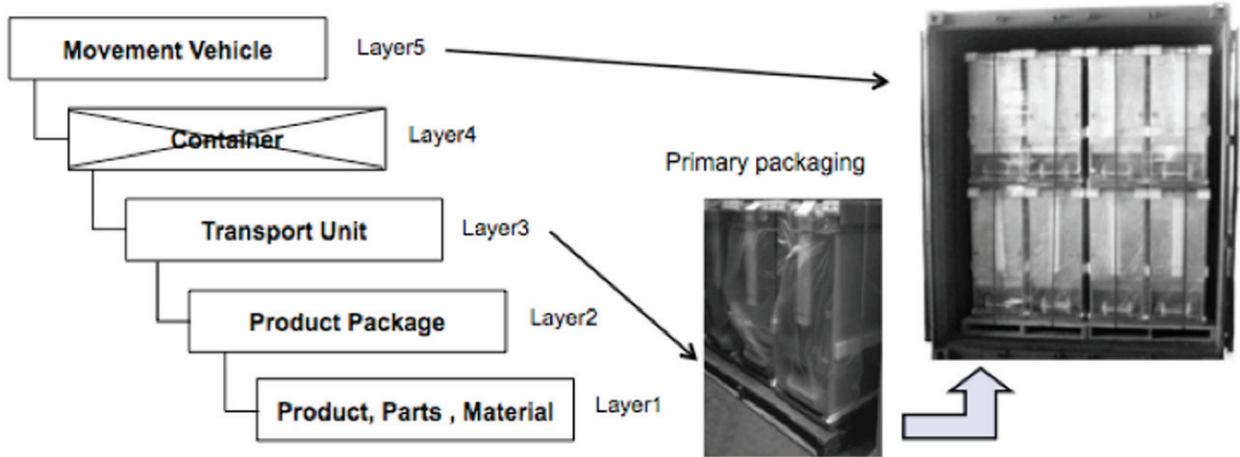
Figure F.2 — Use case of Example 2

F.4 Example 3

Product packages that contain electric home appliances are directly loaded on a container.
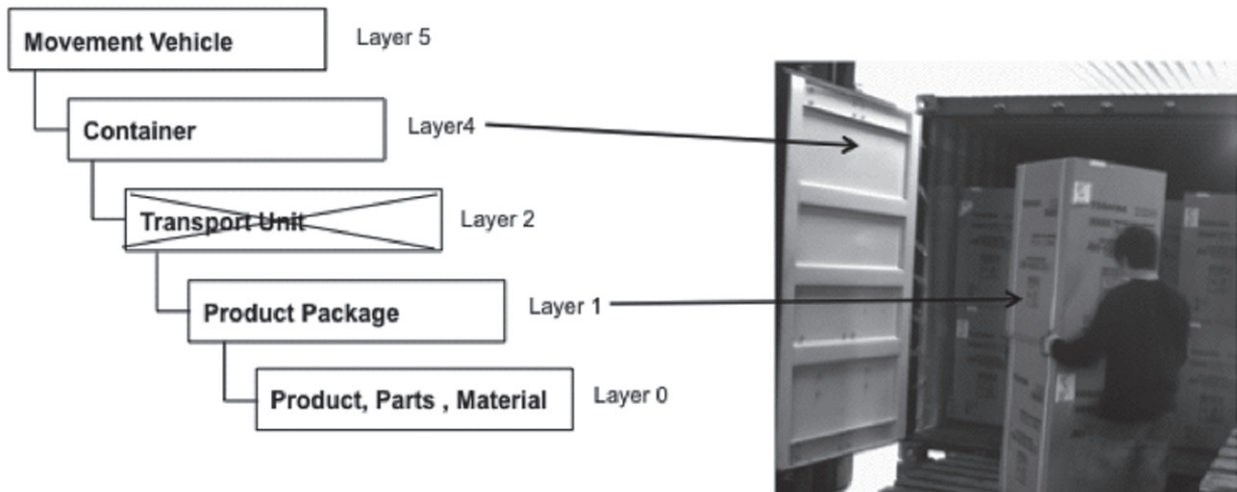
Figure F.3 — Use case of Example 3

F.5 Example 4

A group of product packages, which are wrapped and then covered by a net, constitutes one transport unit directly loaded on an airplane.
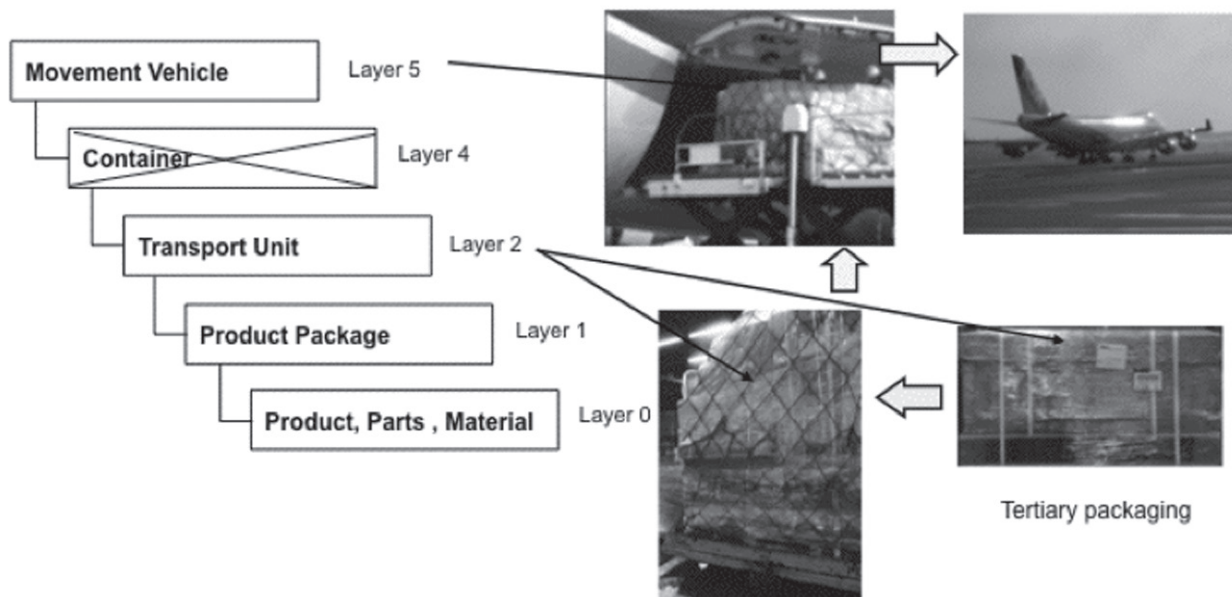
Figure F.4 — Use case of Example 4

F.6 Example 5

A group of packages, which are wrapped and then put in a container, constitutes one transport unit directly loaded on an airplane.
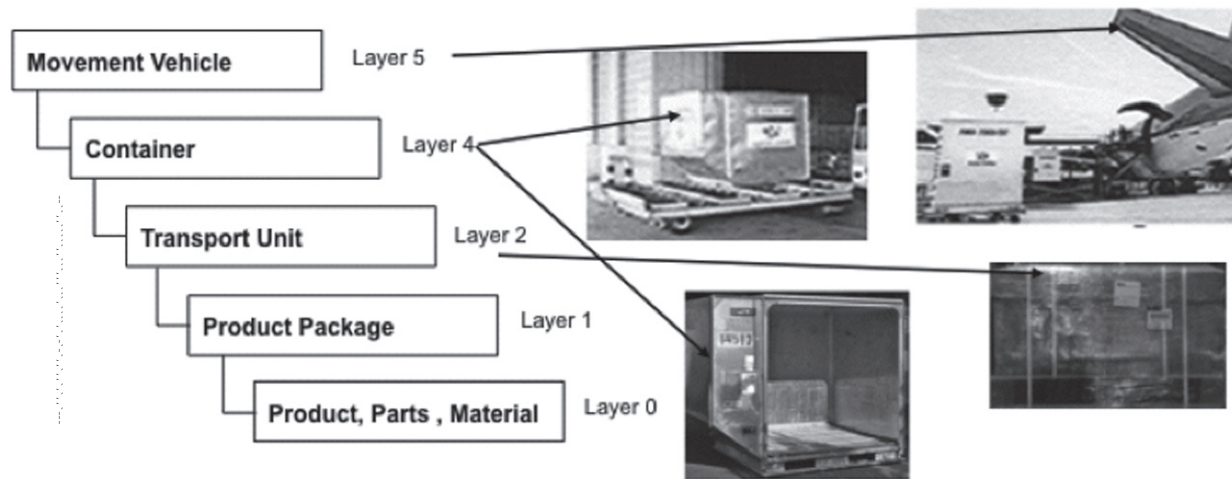
Figure F.5 — Use case of Example 5

F.7 Example 6

Containers carried by land using a freight truck are directly loaded on a freight ship.
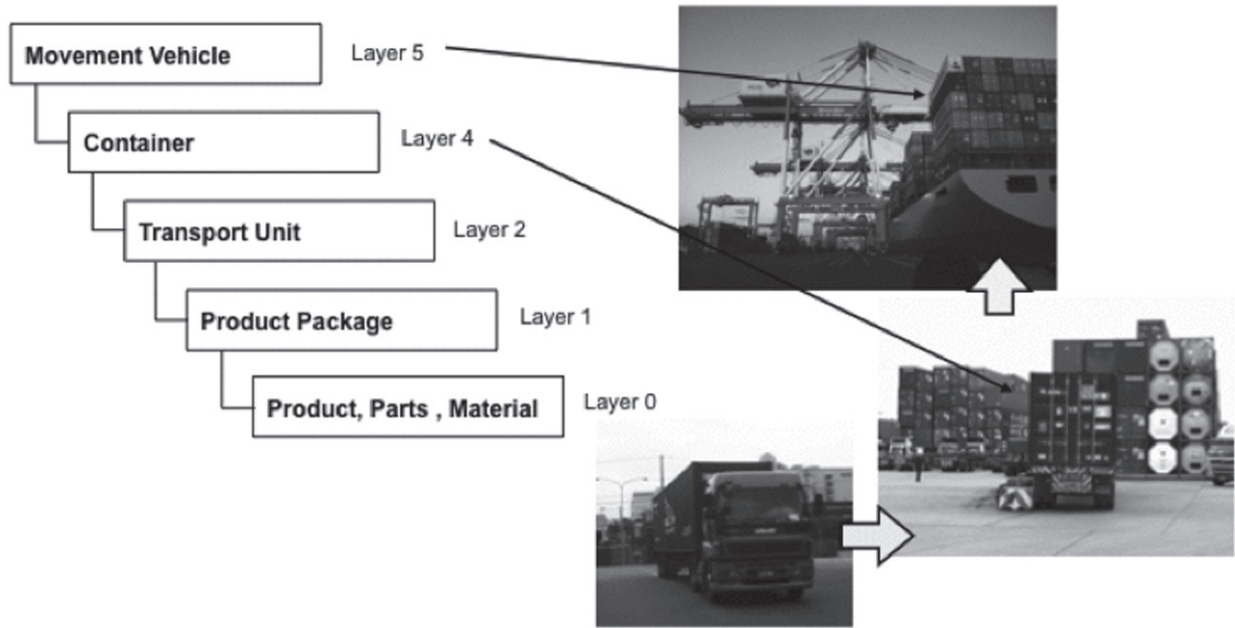
Figure F.6 — Use case of Example 6

F.8   Example 7

This example shows a product packaging used for carrying personal computers.
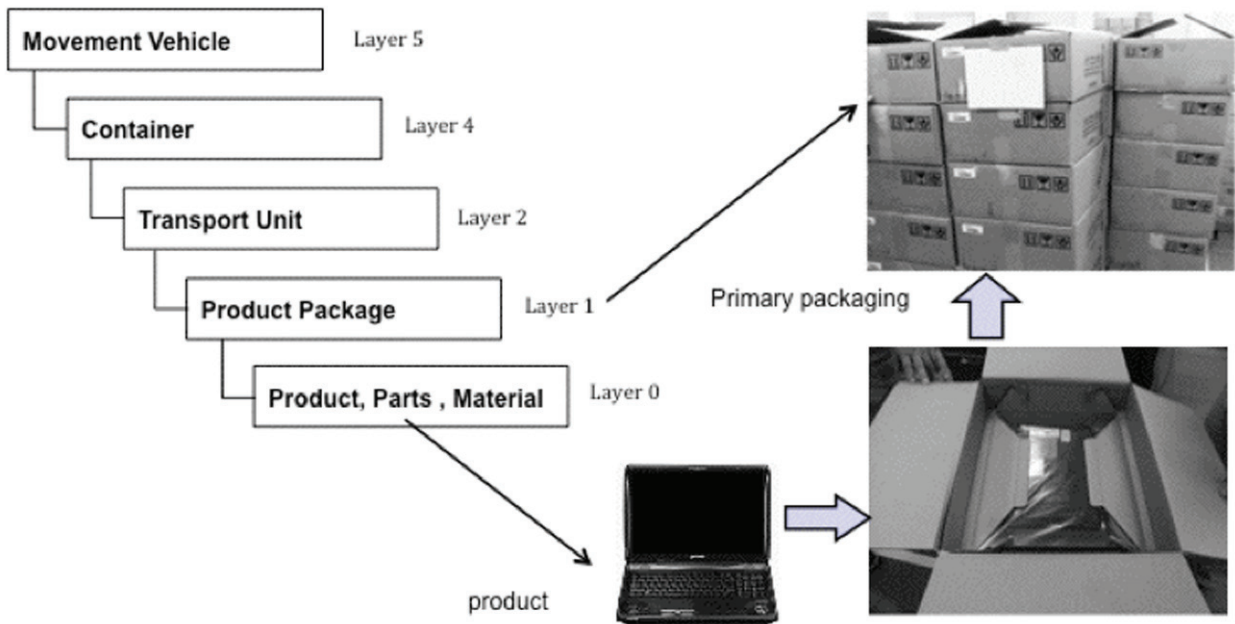
Figure F.7 — Use case of Example 7

Annex G
(informative)

Syntax for High-Capacity Automatic Data Capture Media

Table G.1 provides a description of how to store large volumes of data in a two-dimensional symbol or RF tag's user memory. Table G.2 is a list of the symbols used in Table G.1.

Table G.1 — Format header table showing associated separators

Format Indicator	Variable Header Data	Format Trailer	Format Description
00			Reserved for future use
01	$G_S vv$	R_S	Transportation
02			Complete EDI message / transaction
03	$vvvrrr F_S G_S U_S$	R_S	Structured data using ANSI ASC X12 Segments
04	$vvvrrr F_S G_S U_S$	R_S	Structured data using UN/EDIFACT Segments
05	G_S	R_S	Data using GS1 Application Identifiers
06	G_S	R_S	Data using ISO/IEC 15459-5 Data Identifiers
07		R_S	Free form text
08	$vvvvrrnn$		Structured data using CII Syntax Rules
09	$G_S\ ttt...t\ G_S\ ccc...c\ G_S\ nnn...n\ G_S$	R_S	Binary data (file type) (compression technique) (number of bytes)
10-11			Reserved for future use
12	G_S	R_S	Structured data following Text Element Identifier rules
13-99			Reserved for future use

Table G.2 — Symbols

Symbol	Description
vv	Represents a two-digit version of Format '01' being used.
R_S	Represents a format trailer character.
F_S	Represents a segment terminator.
G_S	Represents a data element separator.
U_S	Represents a sub-element separator.
vvvrrr	Represents a three-digit version (vvv) followed by a three-digit release (rrr).
vvvvrrnn	Represents a four-digit version (vvvv) followed by a two-digit release (rr) and then by a two-digit edition indicator (nn).
ttt...t	Represents a file type name.
ccc...c	Represents a compression technique.
nnn...n	Represents the number of bytes.

Annex H
(informative)

Assignment of Application Family Identifiers (AFIs)

Annex H describes the outline of Application Family Identifiers (AFIs) specified in ISO/IEC 15961-3. The AFIs in Table H.1 comply with ISO 17363-ISO 17367.

Table H.1 — AFI assignments

AFI	Assignment	ISO Standards
A1	ISO 17367	ISO 17367:— Product tagging
A2	ISO 17365	ISO 17365:— Transport unit
A3	ISO 17364	ISO 17364:— Returnable transport item
A4	ISO 17367 HazMat	ISO 17367:— Product tagging (HazMat)
A5	ISO 17366	ISO 17366:— Product packaging
A6	ISO 17366 HazMat	ISO 17366:— Product packaging (HazMat)
A7	ISO 17365 HazMat	ISO 17365:— Transport unit (HazMat)
A8	ISO 17364 HazMat	ISO 17364:— Returnable transport item (HazMat)
A9	ISO 17363	ISO 17363:— Freight container
AA	ISO 17363 HazMat	ISO 17363:— Freight container (HazMat)
NOTE	The AFI value is represented in hexadecimal numbers.	

Annex I
(informative)

Memory Structure of ISO/IEC 18000-63 and ISO/IEC 18000-3, M3

I.1   General

Annex I describes the structure and memory specified in air interface standards ISO/IEC 18000-3, M3 and ISO/IEC 18000-63 and how to use them.

I.2   Memory

Figure I.1 illustrates the structure of the RF tag memory described in ISO/IEC 18000-63 and ISO/IEC 18000-3, M3. The RF tag memory defined in ISO/IEC 18000-3, M3 and ISO/IEC 18000-63 shall be divided into four separate banks with each bank configured with one or more passwords. Each memory bank is described below. The data used in the supply chain is stored in the ($MB11_2$) user bank and bank UII ($MB01_2$).

msb ⋮ lsb

10	Extended DSFID	[7:0]	1F
00	DSFID	[7:0]	0F

- DSFID
- Precursor, [OID], length, Object
< Add'l Access Methods, sensors, battery-assist
- See ISO/IEC 15961 and ISO/IEC 15962

Binary

Memory Bank

Bank 11 — **USER**

Bank 10 — **TID**

Bank 01 — **UII**

Bank 00 — **RESERVED**

msb ⋮ lsb

10	TID	[15:0]	1F
00	TID	[31:16]	0F

- MDID
- Tag model number
- Serial number
- Burned in or written and permalocked by IC manufacturer

Memory Bank is defined as follows

Binary

11	User
10	TID
01	UII
00	Reserved

msb ⋮ lsb

220	Optional XPC_W2 [15:0]		22F
210	Optional XPC_W1 [15:0]		21F
100	UII [15:0]		10F
20	UII [N:N-15]		2F
10	StoredPC [15:0]		1F
00	StoredCRC-16 [15:0]		0F

- UII (must be ISO or EPC)

PC (Protocol Control) bits, including UII length
- indicator
- CRC confirms content of UII memory

msb ⋮ lsb

30	Access Password	[15:0]	3F
20	Access Password	[31:16]	2F
10	Kill Password	[15:0]	1F
00	Kill Password	[31:16]	0F

- Contains all write lock and kill passwords

Memory Locations
To The Left and Right of
Expanded Memory Locations
Shown As Hexadecimal

Figure I.1 — Memory map for segmented memory tags

a) Memory bank "MB00₂": Reserved memory shall contain the kill and access passwords. The kill password shall be stored at memory addresses 0x00 to 0x1F; the access password shall be stored at memory addresses 0x20 to 0x3F. If a tag does not implement the kill and/or access password(s), the tag shall act as though it had zero-valued password(s) that are permanently read/write locked, and the corresponding memory locations in reserved memory need not exist.

b) Memory bank "MB01₂": UII memory shall contain a CRC-16 at memory addresses 0x00 to 0x0F, Protocol-Control (PC) bits at memory addresses 0x10 to 0x1F, and a code, i.e. a UII, that identifies the object to which the tag is or will be attached beginning at address 0x20. The PC is subdivided into a UII length field in memory locations 0x10 to 0x14, an indication of user memory bit in memory location 0x15, a PC extension indicator bit in memory location 0x16, an ISO/EPC bit in memory location 0x17, and Attribute bits in memory locations 0x18 to 0x1F. The CRC-16, PC, and UII shall be stored MSB first (the UII's MSB is stored in location 0x20).

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

c) Memory bank "MB10": TID memory shall contain an 8-bit ISO/IEC 15963-allocation class identifier at memory locations 0x00 to 0x07. TID memory shall contain sufficient identifying information above 0x07 for an Interrogator to uniquely identify the custom commands and/or optional features that a tag supports.

For EPC tags whose ISO/IEC 15963-allocation class identifier is 11100010_2 (0xE2), this identifying information shall comprise a 12-bit tag mask-designer identifier at memory locations 0x08 to 0x13 and a 12-bit tag model number at memory locations 0x14 to 0x1F. Tags may contain tag- and vendor-specific data (for example, a tag serial number) in TID memory above 0x1F.

For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000, Part 63, Type C and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise a 8-bit I.C. manufacturer registration number at memory locations 0x08 to 0x0F and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x10 to 0x3F.

For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000, Part 3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise a 8-bit I.C. manufacturer registration number at memory locations 0x08 to 0x0F and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x10 to 0x3F.

For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000, Part 63, Type C or ISO/IEC 18000, Part 3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 11100011_2 (0xE3), this identifying information shall comprise a 8-bit I.C. manufacturer registration number at memory locations 0x08 to 0x0F, a 16-bit user memory and size definition according to ISO/IEC 15963 from memory locations 0x10 to 0x1F, and a 48-bit serial number allocated by the IC manufacturer from memory locations 0x20 to 0x4F.

For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000-7 and whose ISO/IEC 15963 allocation class identifier is 00010001_2 (0x11), this identifying information shall comprise an 8-bit tag mask-designer identifier at memory locations 0x08 to 0x0F and a 32-bit tag serial number at memory locations 0x16 to 0x1F.

For ISO/IEC 15459-5 tags operating conformant to ISO/IEC 18000-2, Type A and whose ISO/IEC 15963 allocation class identifier is 11100000_2 (0xE0), this identifying information shall comprise an 8-bit tag manufacturer identification at memory locations 0x08 to 0x15 and a 48-bit tag serial number at memory locations 0x16 to 0x3F.

d) Memory bank "MB11": User memory allows user-specific data storage. The storage format described in ISO/IEC 15961 and ISO/IEC 15962 defines the memory organization. The presence of data in user memory in MB11 shall be indicated by the presence of a "1" in the 0x15 PC-bit. A zero in the 0x15 PC-bit shall indicate that there is no user memory at MB11 or that there is no data in User Memory.

I.3   UII memory bank control protocol (MB01$_2$) structure (PC) bit

Table I.1 and Figure I.2 are diagrams that visualizes the structure of the (PC) bits of protocol control of RF tags and ISO/IEC 18000-63 and ISO/IEC 18000-3, M3.

The PC bits contain physical-layer information that a tag backscatters with its UII during an inventory operation. There are 16 PC bits, stored in UII memory at addresses 0x10 to 0x1F, with bit values defined as follows.

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

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

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

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

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

— Bit 0x15: User Memory; shall be set to "0" for tags without data in user memory (MB "11") or tags without User Memory and shall be set to "1" for tags with data in user memory.

— Bit 0x16: Shall be set to "0" if there is no extension of the PC bits and shall be set to "1" if the PC bits are extended by an additional 16 bits.

If a tag implements XPC bits then PC bit 0x16 shall be the logical OR of the XPC bits contents. The tag computes this logical OR, and maps the result into PC bit 0x16, at power up. Readers can select on this bit, and tags will backscatter it.

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

— Bit 0x17: Shall be set to "0" if encoding an EPC and shall be set to "1" if encoding an ISO/IEC 15961 AFI in Bits 0x18 – 0x1F.

— Bits 0x18 – 0x1F: A numbering system identifier Attribute bits whose default value is 00000000_2 and which may include an AFI as defined in ISO/IEC 15961 (when encoding the tag pursuant to ISO standards). The MSB of the Attribute bits is stored in memory location 0x18. Bit 0x1F has been designated within the GS1 EPC system to be used as an indicator that the RTI contains Hazardous Materials.

The default (unprogrammed) PC value shall be 0x0000. Table I.1 and Figure I.2 summarize the content.

Table I.1 — Segmented memory - memory bank "01"

					0/1	0/1	0/1									
Protocol Control bits run from 0x10 to 0x1F																
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Length indicator					User memory	XPC bit	EPC/ISO bit = 1	ISO Application family identifier (AFI)							
Length indicator					User memory	XPC bit	EPC/ISO bit = 0	EPC Attribute bits							Haz Mat
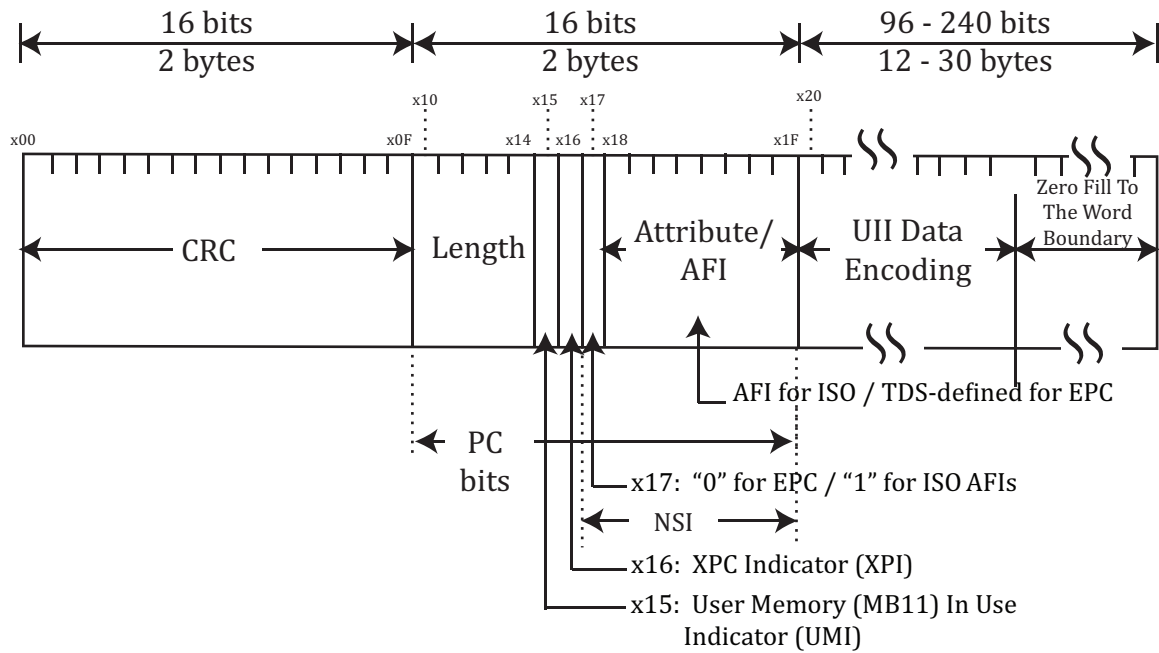
Figure I.2 — Type C and Mode 3 Structure of Memory Bank "01"

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

NOTE 2   XPC Indicator

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

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

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

Annex J
(informative)

Data storage capacity and number of RF tags

J.1   General

Annex J describes the capacity of RF tags and the number of characters supported by the Serial Number defined in ISO/IEC 18000-3, M3 and ISO/IEC 18000-63.

J.2   Maximum number of UII characters by the ISO/IEC 15459 series

The UII is specified in ISO 17364 through ISO 17367 and based on the ISO/IEC 15459 series. The maximum number of characters defined in ISO/IEC 15459 series are shown in Table J.1.

Table J.1 — Maximum number of characters for ISO/IEC 15459 series

ISO/IEC Standard No.	Subject	DI	Recommended character maximum	Character maximum with trading partner agreement
ISO/IEC 15459-1	Transport unit	J, 1J - 4J	35	50
ISO/IEC 15459-1	Transport unit	5J - 6J	20	50
ISO/IEC 15459-4	Product and product	25S	35	50
ISO/IEC 15459-6		25T	20	50
ISO/IEC 15459-5	RTI	25B	35	50
ISO/IEC 15459-5	RPI	55B	50	50

J.3   Basic structure of ISO/IEC 15459 series

Table J.2 shows the basic structure of ISO/IEC 15459-4 for the Data Identifier "25S".

Table J.2 — Basic structure of ISO/IEC 15459-4

25S	IAC	CIN	SN
3 characters	3 characters max.	12 characters max.	35 −18 = 17

J.4   When UII memory bank is 272 bits

If the size of the UII memory defined in ISO/IEC 18000-3, M3 and ISO/IEC 18000-63 is 272 bits, 240 bits can be used for the UII memory since 16 bits are required for the protocol control bits and also for the CRC. This means a maximum of 34 characters can be stored in 240 bits using the ISO/IEC 646 character set.

Alphanumeric (ISO/IEC 646): 34 characters (each character has 7 bits)

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

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

Divide the Serial Number into the Object Data and the Object Sequence Number in Table 8. If the Object Data (Product No.) is consisted of 10 characters, 10 characters shall be reserved for the Object Sequence

Number. In this case, therefore, a maximum of 10^{10} items can be supported for identification. The following formula is obtained using the 6-bit compaction defined in the ISO standards from 17363 to 17367:

Alphanumeric: 40 characters (each character has 6 bits)

40 chr. = DI (3 chr.) + UN (2 chr.) + CIN (9 chr.) + SN (26 chr.)

If the Object Data (Product No.) is consisted of 10 characters, 16 characters shall be reserved for the Object Sequence Number. In this case, therefore, a maximum of 10^{16} items can be supported for identification.

J.5   When UII memory bank is 256 bits

If the size of the UII memory defined in ISO/IEC 18000-3, M3 and ISO/IEC 18000-63 is 256 bits, 224 bits can be used for the UII memory since 16 bits are required for the protocol control bits and also for the CRC. This means a maximum of 32 characters can be stored in 224 bits using the ISO/IEC 646 character set.

Alphanumeric (ISO/IEC 646): 32 characters (each character has 7 bits)

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

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

If the Object Data (Product No.) is consisted of 10 characters, 8 characters shall be reserved for the Object Sequence Number. In this case, therefore, a maximum of 10^8 items can be supported for identification.

The following formula is obtained using the 6-bit compaction defined in the ISO standards from 17363 to 17367:

Alphanumeric: 37 characters (each character has 6 bits)

37 chr. = DI (3 chr.) + UN (2 chr.) + CIN (9 chr.) + SN (23 chr.)

If the Object Data (Product No.) is consisted of 10 characters, 13 characters shall be reserved for the Object Sequence Number. In this case, therefore, a maximum of 10^{13} items can be supported for identification.

J.6   When UII memory bank is 128 bits

If the size of the UII memory defined in ISO/IEC 18000-3, M3 and ISO/IEC 18000-63 is 128 bits, 96 bits can be used for the UII memory since 16 bits are required for the protocol control bits and also for the CRC. This means a maximum of 13 characters can be stored in 96 bits using the ISO/IEC 646 character set.

Alphanumeric (ISO/IEC 646): 13 characters (each character has 7 bits)

If the UN is used as an IAC, no characters can be allocated to the Serial Number when CIN has 9 characters. The following formula is obtained using the 6-bit compaction defined in the ISO standards from 17363 to 17367.

Alphanumeric: 16 characters (each character has 6 bits)

16 chr. = DI (3 chr.) + UN (2 chr.) + CIN (9 chr.) + SN (2 chr.)

The result indicates that the number of characters applicable for the SN is 2 characters only. This is considered to be unpractical.

Annex K
(informative)

6-bit coding scheme

This Annex shows the 6-bit character set used for compaction in both MB01 and MB11 of ISO 17364, ISO 17365, ISO 17366, and ISO 17367.

Table K.1 — Six-bit encoding

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

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

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ICS 55.020

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