DRAFT INTERNATIONAL STANDARD ISO/DIS 17366.2

ISO/TC **122**

Secretariat: **JISC**

Voting begins on:
2006-12-08

Voting terminates on:
2007-02-08

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Supply chain applications of RFID — Product packaging

Applications de chaîne d'approvisionnements de RFID — Empaquetage de produit

ICS 55.020

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

The Joint Working Group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104 prepared ISO 17366.

This standard has one annex, A, which is for information only.

— Annex A – Table of useful data elements for product life cycle management

Introduction

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

This standard has been created in to ensure compatibility both at the physical and command level and the data level with the four other standards within the suite of standards, Supply Chain Applications of RFID. Where possible this compatibility takes the form of interchangeability. Where interchangeability is not feasible, the standards within this suite of standards are interoperable and non-interfering. The standards within the complete suite of Supply Chain Applications of RFID include:

- ISO 17363, *Supply chain applications of RFID – Freight containers*,
- ISO 17364, *Supply chain applications of RFID – Returnable transport items,*
- ISO 17365, *Supply chain applications of RFID – Transport units*,
- ISO 17366, *Supply chain applications of RFID – Product packaging*, and
- ISO 17367, *Supply chain applications of RFID – Product tagging*.

These standards define the technical aspects and data hierarchy of information required in each layer of the supply chain. Air interface and communications protocol standards supported within these standards are the standards of ISO/IEC 18000; commands and messages are supported by ISO/IEC 15961 and 15962. The semantics of the standards within the suite are defined in ISO/IEC 15418 and the syntax is defined in ISO/IEC 15434.

Excluded, though embraced, is the work of:

- ISO/IEC JTC 1/SC 31 in the area of technical standards related to air interface, data semantic and syntax construction, and conformance standards.
- ISO TC 104 in the area of freight container security, including electronic seals (e-seals) (ISO 18185 in multiple parts), and container identification.

Supply chain applications of RFID — Product packaging

1 Scope

This International Standard defines the basic features of RFID for the use in the supply chain when applied to product packaging. In particular:

— Provides specifications about the encoded identification of the product packaging.

— 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.

2 Conformance and performance specifications

All of the devices and equipment that claim conformance with this standard either performance and/or conformance shall also conform to the appropriate sections and parameters specified in ISO/IEC TR18046 for performance and ISO/IEC TR18047, Parts 6 (for ISO/IEC 18000, Part 6C) and 3 (for ISO/IEC 18000, Part 3 Mode 3) for conformance.

3 Normative references

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

ISO 445*, Pallets for materials handling — Vocabulary*

ISO 830*, Freight containers — Vocabulary*

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

ISO/IEC 15418*, Information technology — 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 15394*, Packaging — Bar code and two-dimensional symbols for shipping, transport and receiving labels*

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

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

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

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

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

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

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

ISO/IEC 16022*, Information technology — International symbology specification — Data Matrix*

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

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

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

ISO/IEC TR 18046, Information technology — Automatic identification and data capture techniques — Radio frequency identification device performance test methods

ISO/IEC TR 18047-3*, Information technology — Radio frequency identification device conformance test methods — Part 3: Test methods for air interface communications at 13,56 MHz*

ISO/IEC TR 18047-6*, Information technology — Radio frequency identification device conformance test methods — Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

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

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

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

ISO/IEC TR 24729-1*, Information technology — Radio frequency identification for item management — Implementation guidelines — Part 1: RFID-enabled labels*

ISO/IEC TR 24729-2*, Information technology — Radio frequency identification for item management — Implementation guidelines — Part 2: Recyclability of RF tags*

ICNIRP Guidelines, *Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)*

IEEE 1451, *IEEE Standard for a Smart Transducer Interface for Sensors and Actuators*

IEEE C95-1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*

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

ANS MH10.8.2*, Data Identifiers and Application Identifiers*

GS1 General Specifications

EPCglobal Tag Data Standards Version 1.3

EPCglobal Tag Notification Brand Guidelines

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-3, ISO 830, ISO 445, and the following apply.

4.1
transport unit
either a transport package or a unit load

[ISO 15394, 4.2]

4.2
unit load
one or more transport packages or other items held together by means such as pallet, slip sheet, strapping, interlocking, glue, shrink wrap, or net wrap, making them suitable for transport, stacking, and storage as a unit

[ISO 15394, 4.2]

4.3
transport package
package intended for the transportation and handling of one or more articles, smaller packages, or bulk material

[ISO 15394, 4.2]

4.4
returnable transport item (RTI)
all means to assemble goods for transportation, storage, handling and product protection in the supply chain which are returned for further usage, including for example pallets with and without cash deposits as well as all forms of reusable crates, trays, boxes, roll pallets, barrels, trolleys, pallet collars and lids

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

NOTE: Freight containers, trailers and other similar enclosed modules are not covered by the term returnable transport item.

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

4.5
product package
first tie, wrap or container to a single item or quantity thereof that constitutes a complete identifiable pack.

NOTE: A product package may be an item packaged singularly, multiple quantities of the same item packaged together or a group of parts packaged together.

[ISO 22742, 3.32]

4.6
product
first level or higher assembly that is sold in a complete end-usable configuration.

[EIA 802, 3.16]

4.7
integrity
designed such that any modification of the electronically stored information, without proper authorization, is not possible.

4.8
freight containers
article of transport equipment having

a) a permanent character and accordingly strong enough to be suitable for repeated use;

b) specially designed to facilitate the carriage of goods by one or more modes of transport, without intermediate reloading;

c) fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;

d) so designed as to be easy to fill and empty;

e) having an internal volume of 1 m3 (35.3 ft3) or more.

[ISO 830, 3.1]

4.9
International Unique Identification (IUI) tag
ISO/IEC 18000-6 Type C 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)

4.10
EPC tag
ISO/IEC 18000-6 Type C or ISO/IEC 18000-3 Mode 3 tag with Protocol Control bit 17 set at “0’ indicating that what follows is an EPC header

4.11
use case
detailed description of a single activity in a business process that identifies data inputs and outputs, performance/timing requirements, the handling of error conditions and interfaces with external applications

4.12
monolithic memory structure
memory storage that is addressable by a single addressing element

4.13
segmented memory structure
memory storage that is separated into more than one element and requires multiple addressing elements for access

4.14
conveyable
tem that can be moved efficiently and safely on handling devices used to move material over a fixed line of travel

NOTE: Such material handling devices, or conveyors, are for the purposes of this standard considered to be continuous-loop belted systems moving packages or objects in a predetermined path and having fixed or selective points of loading or discharge. The width of the belt, height permitted within the facility, and weight capacity of the belt may determine whether the items are conveyable.

4.15
non-conveyable
item of such width, height, or weight to preclude its movement on conveyor systems

4.16
unitized
secured together so as to be handled as an entity

5 Concepts

5.1 Supply chain model

The "supply chain" is a multi-level concept that covers all aspects of taking a product from raw materials to a final product to shipping to a final place of sale, use and maintenance and potentially disposal and returned goods. Each of these levels covers many aspects of dealing with products and the business process for each level is both unique and overlapping with other levels. Figure 1 below provides a graphical representation of the “supply chain”. Layers 0 through 4 are addressed within the suite of standards for “supply chain applications of RFID”. Layer 5 is the purview of ISO TC 204/WG 7.

Once tagged, product packaging layer tags can be distinguished from other layer tags by 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 product packaging layer tags. The groups select methodology is further elaborated in ISO/IEC 15961 as depicted in 5.2 of this document.

Layer 1 in Figure 1 and the definition of a product package in clause 4.5 are the subject of this International Standard.

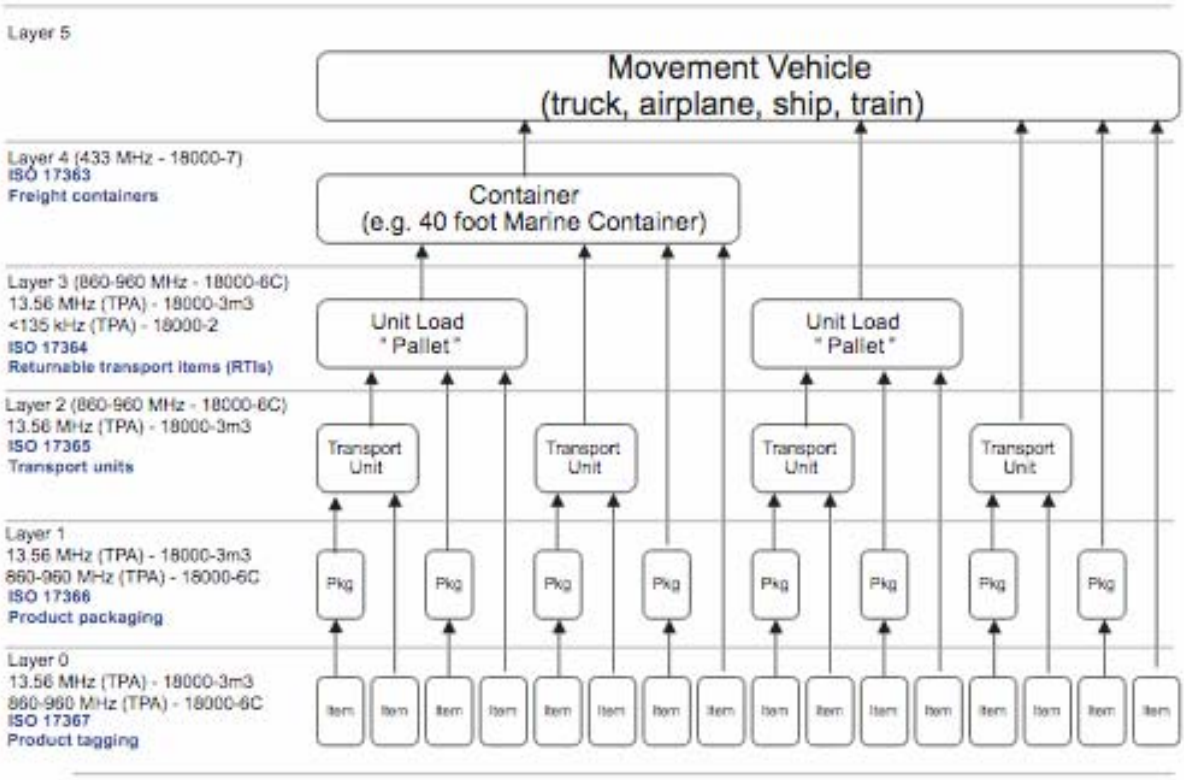

Figure 1 – Supply chain layers
(See Fig1_SupplyChainLayers.dwg)

5.2 Unique identification of product packaging

5.2.1 General

Unique product packaging identification is a process that assigns a unique data string to an individual package or in this case to an RFID tag that is associated to the package and uses that string for subsequent recognition of the package. The unique data string is called the unique item identifier; unique item identification allows data collection and management at a granular level. The benefits of granular level data are evident in such areas as maintenance, retail warranties and enabling electronic transactions of record. This granularity is possible only if each tagged package has a unique identification.

Product package layer tagging can uniquely identify products, thus providing differentiation between like and unlike product packages. Product package layer tagging can also be used to identify product packages by differentiating unlike product packages but not differentiating between like product packages. This is used for commodity where individualization is not practical or desired.

The unique item identifier described above is a unique identifier as described in 15459-4. The Unique Item Identifier (UII) as provides granular discrimination between like items that are identified with RFID tags. The unique tag ID (as defined by ISO 15963) is a mechanism to uniquely identify RFID tags and is not the unique item identifier as defined in this standard.

The minimum data elements required for unique identification are an Enterprise Identifier and a serial number that is unique within that Enterprise Identifier. Commonly a part or model number is also required to achieve unique identification.

This standard uses the following identification mechanisms for unique product package identification:

a) Unique identifier for serialised product packages (ISO/IEC 15459-4)

b) GS1 Serialized Global trade Item Number (SGTIN)

5.2.2 International Unique Identification of product packages

The unique identifier of ISO/IEC 15459 provides identification schemes for various layers of the supply chain, from layer zero (products) up to layer 3 (returnable transport items). For the unique identification of product packages use shall be made of ISO/IEC 15459-4. Unique identification is provided by three components, namely, Issuing Agency Code (IAC), Company Identification (CIN), and Serial Number (SN) preceded by an AFI and Data Identifier (DI). The AFI table in ISO/IEC 15961 permits identification of the supply chain layer, i.e. product / product package = $B1_h$, transport unit = $B2_h$, returnable transport item = $B3_h$, and product / product package = $B5_h$, The Data Identifier shall be “25S”. The ISO/IEC 15459 Registration Authority assigns the IAC. The CIN is assigned by the Issuing Agency. The company registered with the Issuing Agency assigns the serial number. The serial number shall be no longer than 20 alphanumeric characters.

To define its class (in the ISO/IEC 15459 sense) the unique Identifier shall have an associated class identifier, which is the Data Identifier "25S". For the purposes of this standard a unique identifier of product packages can be up to 35 alphanumeric characters in length, including the Data Identifier (an3+an..32).

When stored on a tag with a technology that supports AFIs the unique identifier shall also be associated with an AFI. The AFI table in ISO/IEC 15961 permits identification of the supply chain layer. "$B5_{HEX}$" is the AFI for product package.

Table 1 – IUI element string

Format of the License Plate	
Data Identifier	IAC Company Identification Number (CIN) Serial Reference → ←
25S	N_1 N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10} N_{11} N_{12} N_{13} N_{14} N_{15} N_{16} N_{17} . . . N_{35}

5.2.3 Serialised Global Trade Identification Number (SGTIN)

The EPCglobal Serialised Global Trade Identification Number (SGTIN) is a Unique Item Identifier (UII) capable of providing unique item identification of product packages.

Table 2 – SGTIN element string

	Header	Filter Value	Partition	Company Prefix	Item Reference	Serial Number
Number of bits	8	3	3	20-40	24-4	38
Reference	0011 0000 (Binary value)	(Refer to TDS v1.3 for values)	(Refer to TDS v1.3 for values)	999 999 – 999 999 999 999 (Maximum decimal range*)	9 999 999 – 9 (Maximum decimal range*)	274 877 906 943 (Maximum decimal value)

Note: Maximum decimal value range of Company Prefix and Item Reference fields vary according to the contents of the Partition field.

The SGTIN consists of the following information elements:

a) The *Header*, which is defined in the *EPCglobal Tag Data Standards Version 1.3*. The *Header* is eight (8) bits long and for an SGTIN-96 is the value 30_{HEX}.

b) The *Filter Value*, which is defined in the *EPCglobal Tag Data Standards Version 1.3.* The *Filter Value* is three (3) bits long and identifies whether an EPC is for a retail trade item, a standard trade item grouping, or a single shipping/consumer trade item.

c) The *Partition*, which is defined in the *EPCglobal Tag Data Standards Version 1.3.* The *Partition* is three (3) bits long, carries one of seven (7) values, and identifies where the subsequent *Company Prefix* and *Item Reference* numbers are divided.

d) The *Company Prefix*, assigned by GS1 to an organization. The *Company Prefix* is the same as the *Company Prefix* digits within an GS1 GTIN decimal code. The combined *Company Prefix* and *Item Reference* are 44 bits long (13 decimal digits).

e) The *Item Reference*, assigned by the "Company" entity to a particular product package. The combined *Company Prefix* and *Item Reference* are 44 bits long (13 decimal digits).

f) The *Serial Number* assigned by the managing entity to an individual object. The EPC representation is only capable of representing a subset of *Serial Numbers* allowed in the *GS1 General Specifications*. Specifically, only those *Serial Numbers* consisting of one or more digits, with no leading zeros, are permitted. The length of the *Serial Number* is 38 bits.

5.3 Additive to other identification requirements

This standard does not supersede or replace any applicable safety or regulatory marking or labelling requirements. This standard is meant to satisfy the minimum product identification requirements of numerous applications and industry groups. As such its applicability is to a wide range of industries, each of which may have specific implementation guidelines for this standard. This standard is to be applied in addition to any other mandated labelling requirements.

6 Differentiation within this layer

6.1 Business processes

Business processes such as those described below are illustrative of the applications envisioned by this standard.

a) Acquisition: Ordering including the identification of relevant specifications and requirements can be facilitated by referencing the items original acquisition data using the RFID tag's unique ID as a data base key.

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

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

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

e) Work in Process: Used to track individual components and the final assembly (bill of material) and to monitor any item through a fabrication or manufacturing process

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

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

h) Disposal: Identification of items that have recycling or other disposal requirements

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

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

k) Sortation: A process that places individual items into groups based upon some selection criteria, often performed at speed.

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

m) Network Topology: Can be used to identify discrete nodes or locations on a network.

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

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

6.2 Lot / batch vs. serial number vs. product identification only

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

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

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

Medicines are typical of the type of item that is manufactured and managed at the lot level but sold and used at the item level. Thus a particular dosage of medicine will require unique identification of that dose and the ability to reference that back to the original manufacturing lot. Looking up associated information on the information system may accomplish this reference.

6.3 Consumer products vs. industrial /government

Personal privacy considerations present a unique set of considerations for consumer products as opposed to products that remain exclusively in the industrial/government sectors. Consumer privacy regulations shall be considered in the design and operation of every consumer level product packaging scenario. Encryption and data security are addressed in Clause 8 of this standard.

7 Data content

7.1 Introduction

This clause describes the data content of RFID tags for the product package layer. It identifies amongst others:

— the data elements that must or may be present on the tag,

— the way in which the data elements are identified (semantics),

— the representation of data elements in tag memory,

— the placement of data elements in the memory of the tag.

7.2 Unique product package identification

The first data element on a compliant tag shall be the unique identification described in ISO/IEC 15459-4. The length and nature of this unique identification is defined in this data element. For an ISO/IEC 18000-6 Type C and ISO/IEC 18000-3 Mode 3 compliant tag, the "unique identification" data element is segregated from any additional (User Data) by the memory architecture. The unique identification data element shall be stored in UII memory (Bank 01) with any additional data being stored in User memory (Bank 11). For the purposes of this standard a unique identifier of product packages can be up to 35 alphanumeric characters in length, including the Data Identifier (an3+an..32).

7.3 Data semantics

Tags that only encode the unique product package identifier should conform to ISO/IEC 15961. Tags containing complex data structures or larger data sets shall include semantics that conform to ISO/IEC 15418, ISO/IEC 15962, and ISO/IEC 15961.

7.4 Data syntax

Tags that encode identity only are considered to have no syntax. Tags containing complex data structures or larger data sets shall conform to ISO/IEC 15434 and ISO/IEC 15962.

7.5 Tag structure

7.5.1 Tag header

Tag headers should contain either an ISO/IEC defined AFI or an EPCglobal defined NSI. The ISO/IEC 15961 AFI for Product Packages, i.e., $B5_{HEX}$, in bits 18_{HEX} - $1F_{HEX}$ is described below in Table 3. Support for ISO standards (including AFIs) is indicated when bit 17_{HEX} is set to "1". Alternately, such headers may contain an EPC header as described in the EPC Tag Data Standard. Support for EPCglobal coding is indicated when bit 17_{HEX} is set to "0". Note: A 96-bit SGTIN is represented by EPC header 30_{HEX}.

7.5.2 Tag memory

Figure 2 provides a graphical representation of tag memory.

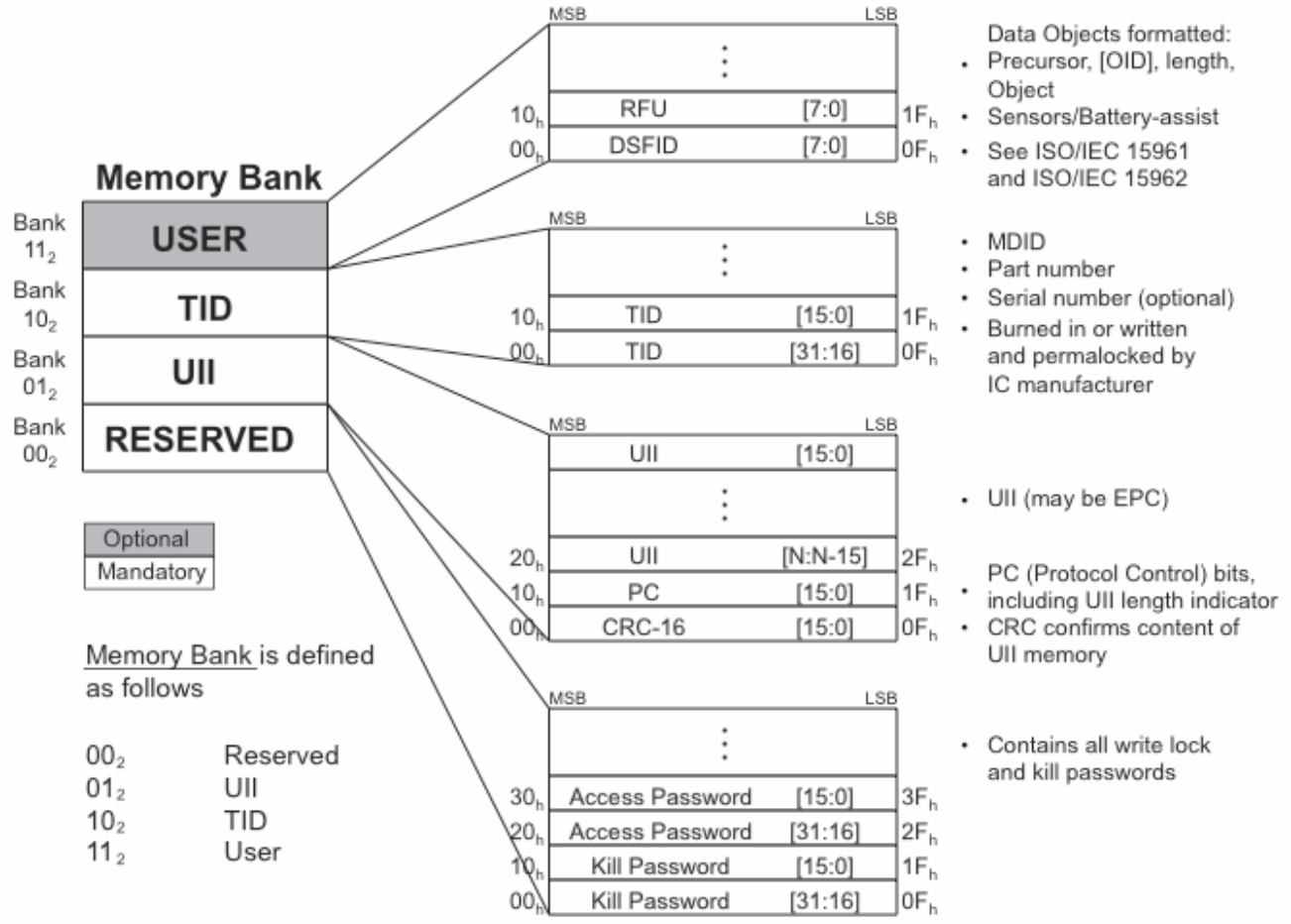

Figure 2 – Segmented memory map
(See Figure2_SementedMemoryMap.dwg)

7.5.3 Tag memory banks

Tag memory shall be logically separated into four distinct banks, each of which may comprise one or more memory words. A logical memory map is shown in Figure 2. The memory banks are:

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

b) **UII memory** shall contain a CRC-16 at memory addresses 00_{HEX} to $0F_{HEX}$, Protocol-Control (PC) bits at memory addresses 10_{HEX} to $1F_{HEX}$, and a code, that is, a UII, that identifies the object to which the tag is or will be attached beginning at address 20_{HEX}. The PC is subdivided into a UII length field in memory locations 10_{HEX} to 14_{HEX}, an indication of user memory bit in memory location 15_{HEX}, a PC extension indicator bit in memory location 16_{HEX}, an ISO/EPC bit in memory location 17_{HEX}, and a Numbering System Identifier (NSI) in memory locations 18_{HEX} to $1F_{HEX}$. The CRC-16, PC, and UII shall be stored MSB first (the UII's MSB is stored in location 20_{HEX}).

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

   For EPC tags whose ISO/IEC 15963 allocation class identifier is 11100010_2, this identifying information shall comprise a 12-bit Tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit Tag model number at memory locations 14_{HEX} to $1F_{HEX}$.

   For ISO/IEC 15459-4 tags operating conformant to ISO/IEC 18000, Part 6, Type C and whose ISO/IEC 15963 allocation class identifier is 00010011_2, this identifying information shall comprise a 12-bit Tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit Tag model number at memory locations 14_{HEX} to $1F_{HEX}$

   For ISO/IEC 15459-4 tags operating conformant to ISO/IEC 18000, Part 3, Mode 3 and whose ISO/IEC 15963 allocation class identifier is 00010100_2, this identifying information shall comprise a 12-bit Tag mask-designer identifier at memory locations 08_{HEX} to 13_{HEX} and a 12-bit Tag model number at memory locations 14_{HEX} to $1F_{HEX}$

   Tags may contain Tag- and vendor-specific data (for example, a Tag serial number) in TID memory above $1F_{HEX}$.

d) **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 15_{HEX} PC bit. A zero in the 15_{HEX} PC bit shall indicate that there is no user memory at MB11 or that there is no data in MB11.

7.6 Protocol control (PC) bits

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

a) Bits 10_{HEX} – 14_{HEX}: The length of the (PC + UII) that a Tag backscatters, in words:
   00000_2: One word (addresses 10_{HEX} to $1F_{HEX}$ in UII memory).
   00001_2: Two words (addresses 10_{HEX} to $2F_{HEX}$ in UII memory).
   00010_2: Three words (addresses 10_{HEX} to $3F_{HEX}$ in UII memory).

•
•
•

11111_2: 32 words (addresses 10_{HEX} to $1F_{HEX}$ in UII memory).

b) Bit 15_{HEX}: 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

c) Bit 16_{HEX}: Shall be set to "0" if there are no extended PC (XPC) bits or the XPC bits have a zero value and shall be set to "1" if the PC bits are extended by an additional 16 bits.

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

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

d) Bit 17_{HEX}: Shall be set to "0" if encoding an EPC and shall be set to "1" if encoding an ISO/IEC 15961 AFI in Bits 18_{HEX} – $1F_{HEX}$

e) Bits 18_{HEX} – $1F_{HEX}$: A numbering system identifier (NSI) whose default value is 00000000_2 and which may include an AFI as defined in ISO/IEC 15961 (when encoding the tag pursuant to ISO standards). The MSB of the NSI is stored in memory location 18_{HEX}.

The default (unprogrammed) PC value shall be 0000_{HEX}. Table 3 summarizes the content.

Table 3 – Segmented memory - Memory Bank "01"

Protocol Control Bits run from 10_{HEX} – $1F_{HEX}$															
					0/1	0/1	0/1								
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Length indicator					User Memory	XPC bit	EPC / ISO	Application Family Identifier (AFI) / Numbering System Identifier (NSI)							

7.7 Data elements

7.7.1 Unique product package identifier

The UII – Product package shall be present on all conformant product package tags. For non-retail tags the unique product package identifier shall conform to ISO/IEC 15459-4 and shall be used as described in 5.2.2. For retail tags the unique product package identifier shall conform to the EPCglobal Tag Data Standards Version 1.3 for the SGTIN-96 and shall be used as described in 5.2.3.

7.7.2 Hazardous goods

RFID Tags for product packages containing items that are classified as hazardous for storage, transportation, or use must contain a bit reference indicating that the item is hazardous. In addition the tag, regulations and statues may require a more detailed categorization of the hazard. The setting of this bit ("1") directs the material handler to the included Material Safety Data Sheet. This additional categorization shall not be mandatory unless it provides an approved replacement for hazard data otherwise required by the requiring authority. The specific hazardous goods code shall include the appropriate Data Identifier and qualifier and reflected in the user data memory. The presence of hazardous material is indicated by bit "09" in the extended PC (XPC) bits of memory bank MB01 as defined in ISO/IEC 18000-6C and ISO/IEC 18000-3 Mode 3.

This standard does not supersede or replace any applicable safety or regulatory marking or labelling requirements. This standard is meant to satisfy the minimum product identification requirements of numerous applications and industry groups. As such its applicability is to a wide range of industries, each of which may have specific implementation guidelines for this standard. This standard is to be applied in addition to any other mandated labelling requirements.

7.7.3 Optional data

Dependent upon the tag type and capacity, optional data may be written to tags as required. Agreement between trading partners is not required. Optional data may be encrypted or otherwise secured at the discretion of the tag writer. Note that encrypted or secured data may not be readable by subsequent applications or users. Unless written in a read-only format or locked optional data may be removed or changed by subsequent applications. Optional data shall be contained in ISO/IEC 15434 syntax and ISO/IEC 15418 semantics using ISO/IEC 15962.

7.8 Traceability

Unique identification enables traceability. Traceability can relate to specific items yielding the ability to differentiate between like items and traceability can also relate to groups of like items differentiating them from unlike items.

Serialization schemes shall comply with ISO/IEC 15459-4.

Traceability of commodity items may be achieved by concatenating data elements representing the manufacturer, the part/model number and the lot or batch number assigned by the manufacturer.

8 Data security

8.1 Confidentiality

Tag users desiring to have their tags read only by authorized users shall have the ability to secure/protect data written to a tag. The tag shall be capable of having secured/protected data written to it and read from it without interference from the tag design or structure. Use of this feature shall be at the discretion of the user. The type of security/protection to be utilized shall be commensurate with the degree of risk and vulnerability associated with the tag data, and shall be agreed upon between the enterprise writing to the tag and any/all authorized readers/users of the data.

8.2 Data integrity

Tags shall have the ability to prevent the alteration or erasure of data commonly known as "locking" data. This shall be at the discretion of the user. Tag manufacturers shall have the option of locking a portion of the tag data for identification and storage of data related to the manufacturer and not the user. A CRC-16 is required to enhance the integrity of the data. The location of the CRC-16 shall be as per the memory map in Figure 2.

8.3 Interrogator authentication

Tag's data storage schemas for user memory and future data transfer protocols should provide for the user-enabled option to require authentication of the interrogators authorization prior to reading the tag data. Reading of the tag ID alone shall not require authentication.

8.4 Non-repudiation / audit trail

Tags shall be capable of supporting non-repudiation when programmed to provide non-forgeable evidence that a specific action occurred. Nothing in this non-repudiation feature shall interfere with or degrade the performance of the tag or other tags in the field of view.

8.5 Product authentication / anti-counterfeiting

RFID devices by themselves do not prevent counterfeiting. The serialization of product and a secure chain of custody can aid in anti-counterfeiting.

9 Identification of RFID labelled material

Product packages, RF tags, and RF label inlays compliant with this standard shall include one or more of the internationally accepted RFID emblems. The accepted emblems shown in Figure 3 are the AIM Global RFID emblem as described in the *AIM Global Standard for the use of the AIM RFID Emblem and index to identify RFID-enabled labels* and the EPCglobal logo as described in *EPCglobal Tag Notification Brand Guidelines.*

Figure 3 – AIM Global and EPCglobal RFID compliance emblems

NOTE: The emblems above only represent the 860 – 960 MHz air interface for this application standard. Other air interface designations can be identified in the *AIM Global Standard for the use of the AIM RFID.*

NOTE: These graphics can be scaled to the appropriate size and are available in either Dark on Light or Light on Dark.

10 Back-up in case of RF tag failure

10.1 Human Readable Interpretation

Other than as stated in clause 5.3, human readable interpretation or human readable translation of Unique Item Identifiers are not mandatory. Where used, the mandatory information (Unique Item Identification), contained in the binary encodations in RF tags shall be represented in their octal or hexadecimal equivalent as shown in ISO/IEC TR 24729-1. ISO standard two-dimensional symbols, e.g., Data Matrix ECC 200 encoded in conformance with ISO/IEC 15434 and ISO/IEC 15418 should be considered as a primary back up to RF tags on products. An additional level of back-up of human readable interpretation may be considered.

10.2 Human Readable Information (HRI) and bar code representation of UII

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

HRI of either ISO UII or EPC tags shall be the upper case alphabetic and numeric representation of the encoded data as set forth in ISO/IEC 24729-1.

10.3 Data Titles

The use of data titles, as referenced in ISO/IEC 15418 and the EPCglobal specification, are strongly encouraged to reduce misunderstanding of the data.

10.4 Back-up

Use of human readable information is strongly encouraged for data that is critical to the items use or sale and shall function as the first backup in the event that the RFID tag is unreadable / misleading for any reason. If optically readable media is used trading partners shall agree upon a linear symbol such as Code 128, as described in ISO/IEC 15417, or a two-dimensional symbol such as Data Matrix, as described in ISO/IEC 16022 or QR Code, as described in ISO/IEC 18004.

11 Tag operation

11.1 Data protocol

The data protocol for this International Standard shall support the requirements of ISO/IEC 15961 and the semantics of ISO/IEC 15418 and ISO/IEC 15962 and the syntax of the 15434.

11.2 Minimum performance requirements (range and rate)

The performance for tags shall be measured in accordance with ISO/IEC TR 18046. Minimum performance requirements will vary for different functional applications of RFID. Table 4 shows the performance requirements for passive tags operating in the two normal configurations to transfer tag data of up to 256 bits. These specifications also relate to the writing of the tag. Greater distances may be achieved in reading from RF tags than writing to RF tags.[1]

Table 4 — Passive tag performance

Parameter	860 – 960 MHz ISO/IEC 18000-6tC	13,56 MHz ISO/IEC 18000-3m3
How Far – Minimum supported read distance	3 meters	0.7 meter
How Fast – Minimum supported item speed when read	16 km/h	16 km/h
How Many – Minimum supported effective measure of tag data transfer rate and ability to do anti-collision	500 tags/second for 500 kHz and 200 tags/second for 200 kHz bandwidth	200 tags/second

11.3 Environmental parameters

The operating environment will vary significantly by location. Consideration will be given to the following general parameter set as derived from the product package user community

— Maximum and minimum operating temperatures + 70 °C to - 40 °C.

— Humidity 95%

— Warehouse construction, including racking

— Transportation mode

— Speed and direction of movement of tag relative to reader

— Orientation of tag to reader i.e. controlled or random

— Read distance

— Write distance (if applicable)

1.1 ———————————

[1] NOTE: "In case regulatory restrictions provide less channels than there are interrogators in the environment, this performance can only be achieved by appropriate shielding of the interrogators against other interrogators.

— Electro-magnetic interference from motors, fluorescent lights, other spectrum users

— Electro-magnetic characteristics of the packaging and contents of the tagged item

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

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

— Method of attachment of form factor

— Resistance of readers to heat, moisture, impact damage

— Health and Safety regulations

— The product RFID tag must function properly in the temperature range from - 40 ºC to + 70 ºC. It must be able to endure for a specified period of time harsher conditions in the range - 50 ºC to + 85 ºC.

A description of various environmental factors associated with RFID can also be found in ISO/IEC 18001.

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

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

11.4 Tag orientation

It should be assumed that the handling operation cannot predict the orientation of the individual (packed) products in higher levels of packaging and transport. This may hamper the effective use of the reading equipment on site and/or en route.

11.5 Packaging material

A wide range of materials is utilised in primary packaging and small and large product packages (wood, metal, plastic, glass, paper, textile, etcetera). Also, materials for coding and identification as well as branding and the representation of legally required information are used. These may interfere with the RFID equipment.

11.6 Shock loads and abrasions

Typically the various product packages are subject to shock loads during the physical handling process. This may result in the intentional or unintentional damage to the RFID tag. Placement and insertion of the tag should be done in such a way that damage due to shocks is minimized.

11.7 Tag lifetime

Tags attached to the product will be continuously used throughout the life of the product. Product RFID tags shall be statistically capable of a minimum 100 000 read or read/write cycles as appropriate, without failure.

11.8 Minimum system reliability

Systems, where tags are positioned, programmed and presented to reading equipment in accordance with the provisions of ISO/IEC 18046 and clause 11.3 above, shall have an average read reliability of no less than 99,99%, i.e. no more than one no-read event in 10 000 readings, and an average read accuracy of no less than 99,998%, i.e. two undetected incorrect reading in 100 000 readings.

11.9 Air interface

Product packaging RFID tags shall operate in one of two frequency ranges and comply with the appropriate parts of ISO/IEC 18000. With agreement between trading partners either 18000-6C or 18000-3 Mode 3 may be used. It is recommended that tags supporting ISO/IEC 18000-6 Type C also be able to support ISO/IEC 18000-3 Mode 3.

11.10 Memory requirements for application

The memory requirements for product packaging RFID Tags may be grouped into three basic categories: 96 bits, 256 bits, and greater than 256 bits. Industry surveys have yielded recommendations for RF chip manufacturers to provide for 2 kbits and 4 kbits. Memory capacities shall not alter the air interface. Use of alternate memory requirements shall not result in changes to the minimum and mandatory data elements of their format or tag data structure as otherwise specified in this standard. Annex A provides a listing of useful data fields for product life cycle management totalling 152 bytes (1 216 bits).

11.11 External communications

External communications (interactive as opposed to simple data transfer and read/write) shall not be required for but may be a part of product tagging RFID Tags where the optional supporting commands meet the requirements of the optional commands in the air interface (ISO/IEC 18000). Proprietary commands should not be used.

11.12 Safety and regulatory considerations

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

All tags conforming to this standard shall meet national safety and regulatory requirements to include power, duty cycle and electromagnetic radiation.

11.13 Sensor interface, if applicable

Sensors integrated into or onto a tag and their tag operations or management shall not interfere with the operation of the tag per this standard. Battery assisted tags shall be free from interference from the battery operation and/or battery management functions. Sensor equipped product package RFID tags shall conform to IEEE 1451 for the physical interface between the tag and the sensor.

11.14 Real time clock option

A real time clock shall be included with product package RFID tags that are sensor equipped and where the application requires a time stamp. The accuracy of the time compared to actual UTC shall be no worse than ±5 seconds per day.

11.15 Non-observable data

The nature of non-observable data is such that when individual data fields within a tag are protected by an interrogator command, the command may implement whatever protection measures are chosen, provided that the protection measures do nothing to impact, interfere with or deteriorate the operation of other tags in the supply chain. Tags that are intended for use over the supply chain shall have the mandatory data elements readable.

11.16 Tag recyclability

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

The recyclability of product tags described in this standard is dependent upon the component materials used in the individual tags. The tag manufacturer shall clearly mark product tags with recycling instructions or appropriate logo to assist in the proper disposal of the tag. Guidelines for tag recyclability can be found in ISO/IEC TR24729-2.

11.17 Tag reusability

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

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

12 Tag location and presentation

Guidelines for tag location and presentation can be found in ISO/IEC TR24729-1.

12.1 Material on which the tag is mounted or inserted

The potential disturbance of metals and other reflective materials as well as liquids and other absorptive materials within the product packaging shall be considered in the design to minimise disturbance of the RF signal.

12.2 Geometry of the package/tag environment

Products should be placed into product package in such a way to minimise the disturbance of the RF signal. This pertains to both the product package and the products it is containing. See ISO/IEC TR 24729-1.

13 Interrogator and reader requirements

13.1 Safety and regulatory considerations

All RFID tags and interrogators shall comply with IEEE C95-1 and ICNIRP guidelines.

All interrogators and readers shall comply with the specific power, bandwidth and duty cycle requirements in addition to all of the local radio frequency regulations for the location in which they are used. In addition all interrogators and readers intended for use in hazardous environments shall carry the appropriate specific information.

13.2 Data privacy

13.2.1 Aggregated data

Security of aggregated data shall be the responsibility of the collector. Data collectors and data storage operators shall comply with all personal privacy regulations and rules governing the collection, storage and dissemination of personal data. Personal data collected by or incident to the reading of an RFID tag shall be accorded the same protection and security as personal data collected by any other means.

13.2.2 Company proprietary data

Security of product / packaging data collected from or incident to the reading of a product packaging RFID tag is the responsibility of the company collecting the data. Companies wishing to restrict the collection of company proprietary data from product RFID tags shall utilize appropriate forms of data security. As security/protection of tag data may be compromised, use of RFID product packaging tags to carry sensitive, classified or proprietary data should be limited.

14 Interoperability, compatibility and non-interference with other RF systems

All RFID systems including tags, interrogators and readers shall operate on a strict non-interference basis with all other RF systems operating in the same spectrum. All RFID systems including tags, interrogators and readers claiming conformance with this standard shall be interoperable and compatible at the specific frequency designed.

Annex A
(Informative)

Table of useful data elements for product life cycle management

Table A.1 – Useful data elements for product life cycle management

Name	Classification	Item	Explanation	Bytes
TID	TID	TID	Tag Identification Number (ISO/IEC 15963)	(32 bits)
UII	UII	EPC	(SGTIN)	(96 bits)
	Product identification code assigned by manufactures (15459-4 or 6)	Issuing Agency Code		
		Manufacturer code		
		Product code	Example: CF-L2M8WAXS	
		Serial number	Example: 3AKSB01019	50
User memory	Internal code of manufacturers			30
	Hazardous material	Hazardous material flag	Hazardous material flag	1
		Products revision	Revision identification number of products	5
	Data for maintenance (These data are for maintenance person's use at consumer's office or home)	Maintenance contract date	Maintenance contract date between maintenance company and user (YYMMDD)	6
		Parts exchange flag	Flag that indicate some parts were exchanged for new parts	1
		Consumable supply flag	Consumable supply flag	1
		Supplies change date	Date consumable supplies put into service (YYMMDD)	6
		Durable hours	How many hours does supply be able to use	1
	Data for Recycling (These data are using in a recycle phase and resale)	Recycle application date	Date that recycle application form was made (Date that user delivers recycle products to recycle company or carrier) YYMMDD	6
		Recycle application ID number	Number assigned to recycle product to identify each product.	11
		Product classification	Product classification flag (Classification example: Desktop PC, Laptop) This flag is used to pre-sort the products in recycle operation.	2
		Manufacturing date	Manufacturing date YYYYMMDD	8
		Durability period	Durable years from manufacturing date	2
		Resale date	Resale date of lease products (YYMMDD), Product no longer subject to manufacturer's guarantee.	6
		Resale dealer	Identification code of resale dealers	10
			Total	152 bytes

Bibliography

[1] ISO 3166-1, *Codes for the representation of names of countries and their subdivisions – Part 1, Country codes*

[2] ISO 17363, Supply chain applications of RFID – Freight containers

[3] ISO 17364, *Supply chain applications of RFID – Returnable transport items*

[4] ISO 17365, *Supply chain applications of RFID – Transport units*

[5] ISO 17367, *Supply chain applications of RFID – Product tagging*

[6] ISO/IEC 18001, *Information technology – RFID for item management – Application requirements profiles*

[7] ISO/IEC TR 24729-1, *Information technology — Radio frequency identification for item management — Implementation guidelines — Part 1: RFID-enabled labels*

[8] ISO/IEC TR 24729-2, *Information technology — Radio frequency identification for item management — Implementation guidelines — Part 2: Recyclability of RF tags*

[9] *EPC™ Radio-Frequency Identity Protocols Class-1 Generation - 2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz Version 1.0.9*