

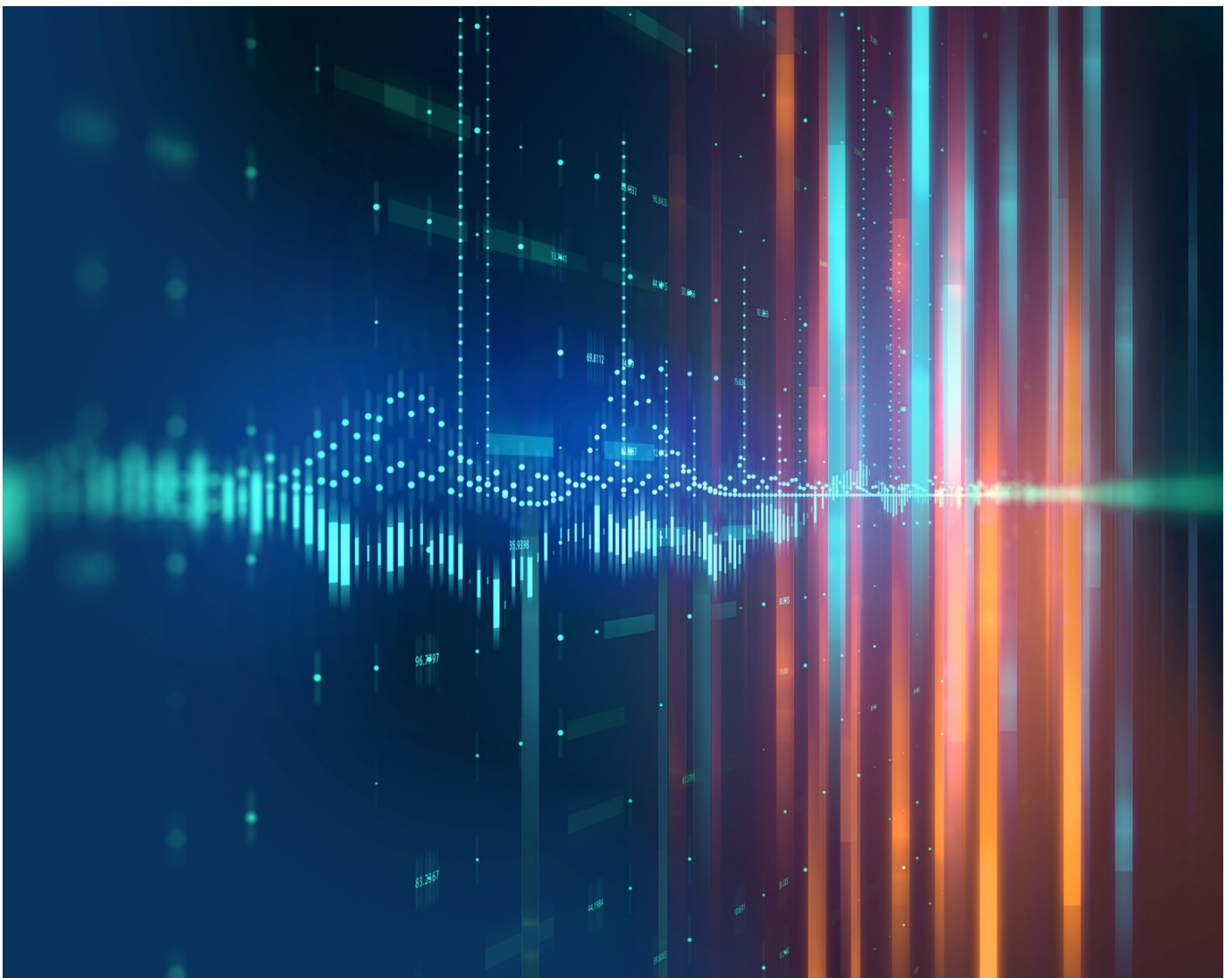


RFID Item Level Standard

Ref LR05

Version 2.0

Published October 2017





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Global Radio Frequency Identification (RFID) Item Level Standard

Version 3, Issued 2021





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INTRODUCTION

This Radio Frequency Identification (RFID) Item Level Standard describes best practices, processes, and methods for item¹ identification, verification, traceability, product characteristics, and Vehicle Identification Number (VIN²) throughout the global automotive supply chain. An extensive effort has been undertaken by the automotive industry to make data interchangeable between 2D (e.g., Data Matrix / QR Code) optical symbols and electronic media such as RFID to permit the user to select the appropriate technology with a minimum impact on IT infrastructures. These technologies complement each other and may be used jointly or separately as the application may require. This document is focused on the application of RFID to achieve these ends.

Core to achieving data interchangeability is the use of ANSI MH10-based Data Identifiers (DIs) and ISO or EPC/GS1 standards-based Data Syntax; this document will reflect the adoption of these methodologies.

This standard will also provide additional data-use details: what data to put in which Memory Bank (MB), which data syntax standards to use where, and how to use them effectively. This standard provides details on the MB01 (0x01)-centric Monomorphic Unique Item Identifier (UII) and what data to put into MB11 (0x11) (the User Memory Bank), and how that data should be placed there. The intent is to reduce ambiguity through concise explanations and details.

Two regional documents were used by the committee to create the core of this standard: the AIAG B-11 *Item-Level Radio Frequency Identification (RFID) Standard* and the Odette recommendation *RFID for Tracking of Parts and Assemblies / VDA 5510*.

NOTE: Two processes not addressed within this standard are shipping labels and returnable containers. These processes are detailed in the following automotive global documents:

- JAIF B-16 Global Transport Label Standard for the Automotive Industry
- JAIF RC-6 Global Guideline for Returnable Transport Items

This standard is built on these assumptions:

1. Only passive or battery-assisted passive RFID tags are used.
2. The air interface protocol is ISO/IEC 18000-63, previously known as ISO/IEC 18000-6, Type C / GS1 UHF Gen 2.
 - a. With trading partner agreement, only ISO/IEC 18000-3, Mode 3 (ASK) / GS1 HF Gen 2 (ASK) may be used.
 - b. For the purposes of this document, ISO/IEC 18000-6, Type C / GS1 UHF Gen 2 shall be referred to as “UHF” and ISO/IEC 18000-3, Mode 3 (ASK) / GS1 HF Gen 2 (ASK) shall be referred to as “HF”.
 - c. For the purposes of this document, references to ISO/IEC 18000-63 also shall be applicable to ISO/IEC 18000-3, Mode 3 (ASK).
3. The data syntax is ISO/IEC 15962, or ISO/IEC 17367; Data Identifier (DI)-based.

¹ Within this document, the terms *item*, *product*, *part*, *component*, *module*, and *assembly* are synonymous.

² VIN and vehicle identification are synonymous within this document.



In this document, the word “shall” indicates a requirement, and the word “should” indicates a recommendation.

It is the supplier’s responsibility to provide RFID tags that meet this standard. Strict adherence to these specifications for RFID tags for item-level identification will reduce implementation costs and increase benefits throughout the industry.

Various number-type designators are available and have been used in various documents;

- **17hex**, **17h**, **17_H**, **17_h**, or **0x17** is used to denote HEX-based data.
- **0b15** or **15₂** is used to denote BINARY-based data.
- **10₁₀** or **10** is used to denote DECIMAL-based data.

NOTE: For this document, the following ISO-based designators shall be used:

- **Decimal** numbers shall be shown with only the written number, without a radix; e.g., ‘123456’.
- For **hexadecimal** numbers, the prefix ‘0x’ shall be used to the left of the number; e.g., ‘0x31’.
- For **binary** numbers, the prefix ‘0b’ shall be used to the left of the number; e.g., 0b1011.

NOTE: Long strings of binary numbers shall not be prefixed; however, the text shall clearly state “the binary (equivalent) (expression) (value) is as follows:”

NOTE: There are several terms that are used frequently in this document: Their proper designation is Memory Bank 0b01 (MB01), Memory Bank 0b10 (MB10), Memory Bank 0b11 (MB11), PC Bit 0x15 (PC Bit 15), and PC Bit 0x17 (PC Bit 17). In this document, these terms shall be used as indicated within the parentheses; i.e., MB01, MB10, MB11, PC Bit 15, and PC Bit 17.

NOTE: Spaces have been added to binary and hex data for clarity ONLY.

In this document, single control characters (ISO 646, 6-bit and 8-bit encoding) are represented as ^G_S, ^EO_T, and ^R_S, etc.

Bold used within this document is only for emphasis and does not indicate a requirement. For example, Data Identifiers (DIs) **37S** and **I** are bolded to have them stand apart from the data.

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CHANGES FROM V2 TO V3:

- The Acknowledgement section was removed.
- 8-bit encoding to allow the use of UTF-8 was added to the document.
- An 8-Bit AFI (0xAC) was added to Table 2.
- Annex M added showing 8-bit encoding examples.
- The Foreword was removed from the document, and its contents were added to the Introduction.
- Tables 24, M.1, M.2 and M.3 were added.
- The length of OD CIN (Odette Company Identification Number) was increased from “an4” to “an6”.



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1 SCOPE

This standard is based on ISO and GS1 standards. They ensure compatibility between readers and tags using Issuing Agency Codes from UN, OD, LA, VTD, TAJ, D, and GS1.

This global standard recommends the basic features of data carriers as applied to an item, product, part, component, module, or assembly. Specifically, this standard:

- Provides recommendations for the identification of “items”:
- As used in this document, the terms *item*, *product*, *part*, *component*, *module*, and *assembly* are synonymous terms. For descriptions, see **Product** in Section 3.
- Specifies the air interface standards required between the RF interrogator and RF tag.
- Specifies the semantics and data syntax to be used.
- Provides a unique identifier for traceability.
- Specifies the minimum RFID system performance requirements.
- Specifies a minimum User Memory Bank (MB11) size.
- Specifies the process to be used to interface with business applications and the RFID system.
- Provides specific business process application recommendations for:
 - Item Identification
 - Verification (error proofing)
 - Item Traceability
 - Item Characteristics
 - Vehicle Identification (VIN)
 - Anti-counterfeiting



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2 NORMATIVE REFERENCES

For undated references, use the most recent published version. For dated references, use the most recent dated release if the date is newer than that referenced below.

49 CFR 574.5 *Tire Identification Requirements.*

AIAG B-11 *Item Level Radio Frequency Identification (RFID) Standard*

ANS MH10.8.2 *Data Identifier and Application Identifier Standard.*

EPC™ *Tag Data Standard*

EPC™ *Radio-Frequency Identity Protocols Class-1 Generation 2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz Version 1.2.0* (in this document, referred to as GS1 UHF Gen 2).

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

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

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

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

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

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

ISO/IEC 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 17367: *Supply chain applications of RFID — Product tagging.*

ISO/IEC 18000-63 (18000-6C): *Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C.*

ISO/IEC 18046-1: *Information technology — Radio frequency identification device performance test methods — Part 1: Test methods for system performance*

ISO/IEC 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 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: *Information technology — Automatic identification and data capture techniques — Harmonized vocabulary (all parts).*

ISO/IEC 29160: *Information technology -- Radio frequency identification for item management -- RFID Emblem*

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JAIF B-16 *Global Transport Label Standard for the Automotive Industry.*

Odette LR03 - *RFID for Tracking Parts and Assemblies / VDA 5510.*

Register of AIM assigned Issuing Agency Codes for ISO/IEC 15459:
http://www.aimglobal.org/?Reg_Authority15459



3 TERMS AND DEFINITIONS

Many terms and definitions associated with the subject of this standard have special meaning. Definitions of other related terms used in this document can be found in the documents referenced in Section 2.

Table 1: Terms and Definitions

TERM	DEFINITION
AFI	Application Family Identifier. Stored in the second byte of the Protocol Control Word (0x18 to 0x1F)
Alphanumeric	A character set that contains alphabetic characters (letters) and numeric digits (numbers) and usually other characters such as punctuation marks.
ANS	American National Standards Institute document prefix.
ANSI	American National Standards Institute
ANSI MH10	Unit Loads & Transport Packages committee under ANSI.
ANSI MH10.8	Coding and Labeling of Unit Loads subcommittee under ANS MH10.
Antenna	The conductive element that radiates and / or receives radio frequency energy to and from the Tag .
Assembly	Within this document, the terms <i>item</i> , <i>product</i> , <i>part</i> , <i>component</i> , <i>module</i> , and <i>assembly</i> are synonymous. See Product .
Assigned Relative OID	See OID .
Battery-assisted Passive RFID Tag	A tag that uses a battery to improve its functionality and range and functions as a passive tag if the battery is depleted.
Binary	A numbering system with only two values: 0 (zero) and 1 (one). Mathematical base 2, or numbers composed of a series of zeros and ones. Represented by 0bX, Examples: MB0b01, 0b011
Bit	Short for Binary Digit ; the smallest unit of data in a computer; i.e., “1”, “0”. Shown as 0b1 and 0b0.
Byte	There are 8 bits in a byte; usually data are stored, or instruction sets are made up of bit multiples called bytes.





TERM	DEFINITION
Company Identification Number (CIN)	As used in this document, the manufacturer, or the owner of the item. It consists of NEN-assigned company identity (see IAC , below) or GS1-assigned Company Prefix.
Character	The smallest group of elements that represents one number, letter, punctuation mark, or other information.
Component	Within this document, the terms <i>item</i> , <i>product</i> , <i>part</i> , <i>component</i> , <i>module</i> , and <i>assembly</i> are synonymous. See Product .
CRC-16	Cyclic Redundancy Check. Stored in the first word of MB01 (from bit 0x00 to 0x0F).
Customer	In a transaction, the party that receives, buys, or consumes an item or service.
Data Field	A message consisting of a Data Identifier immediately followed by its associated data.
Data Format	Letters and numbers used to denote the type of data allowed within the referenced data field and the total quantity of that type of data allowed in the data field. Examples: “an...6” means up to 6 characters of alphanumeric data are allowed. “n...12” means up to 12 characters of numeric-only data are allowed. “an6” means that 6 characters of alphanumeric data are required. “n12” means that 12 characters of numeric-only data are required.
Data Identifier (DI)	A specified character string that defines the specific data that immediately follows, as defined by ANS MH10.8.2.
Decimal	Numbered or preceding by tens; based on ten; the decimal system. A base 10 numbering system, whose numbers are represented by X when a decimal number needs to be denoted from a hexadecimal number (hexadecimal = 0xX).
DSFID (Data Storage Format Identifier)	One-byte indication, conforming to ISO/IEC 15962, of how data are structured in the tag memory. In ISO/IEC 18000-6 Type C-based parts, it shall reside in the first byte location within the User (MB11).



TERM	DEFINITION
EPC	Electronic Product Code™. A globally unique serial number that identifies an object in the supply chain. EPC numbers may be associated to individual objects or to collections of items like cases and pallets.
GS1, Inc. (GS1)	A consensus-based, not-for-profit standards organization created as a joint venture between GS1 (formerly known as EAN International) and GS1 US™ (formerly the Uniform Code Council, Inc. ®).
HEX Hexadecimal	A base-16 number system. The hexadecimal numbers are 0-9 and then the letters A-F, whose numbers are represented by <u>0x</u> X when a hexadecimal number needs to be denoted from a decimal number (underscored characters = hex indicator; decimal = X).
High Frequency (HF)	That band of radio frequencies encompassing 3 MHz to 30 MHz. For the purpose of this standard, the frequency 13.56 MHz.
IAC	Issuing Agency Code.
ID	Abbreviation for “Identification”.
IEC	International Electrotechnical Commission. International standards and conformity assessment for government, business, and society for all electrical, electronic, and related technologies.
Interrogator	See Reader and Reader / Writer .
ISO	International Organization for Standardization. ISO is a network of the national standards institutes of 156 countries on the basis of one member per country. A Central Secretariat in Geneva, Switzerland, coordinates the system.
ISO/IEC	Represents work done and / or supported by both the ISO and IEC organizations.
ISO/IEC 18000-63	Synonymous with ISO/IEC 18000-6C
Item	Within this document, the terms <i>item</i> , <i>product</i> , <i>part</i> , <i>component</i> , <i>module</i> , and <i>assembly</i> are synonymous. See Product .



TERM	DEFINITION
JAIF	<p>Joint Automotive Industry Forum</p> <p>An international organization, made up of AIAG, JAMA, JAPIA, and Odette, that represents the global automotive industry.</p>
Length of data	<p>The length is stored in the Protocol Control word byte, in MB01, in bits 0x10 to 0x14, and indicates the number of 16-bit “words” in the UII data. The CRC-16 and PC Word of MB01 are excluded from this length.</p> <p>See also Word.</p>
Life	<p>The defined period for which the Tag is expected to be functional.</p>
<p>Lock / Locking  Lock  Unlock</p>	<p>The ability of the Tag protocol to cause a memory bank to be “read-only.” Once “locked,” that memory location can only be changed back to “read / write” by using the lock/unlock password.</p>
LSB	Least Significant Byte
lsb	least significant bit
Manufacturer	<p>Actual producer or fabricator of an item; not necessarily the supplier in a transaction. Best practice should include site-specific manufacturing identification for use in traceability.</p>
Memory Bank (MB)	<p>ISO/IEC 18000-63 - and GS1 TDS 1.4 or later-compliant tags have four (4) individually usable memory banks, numbered Memory Bank 00 (binary) through Memory Bank 11 (binary). Reference Figure 3.</p>
Module	<p>Within this document, the terms <i>item</i>, <i>product</i>, <i>part</i>, <i>component</i>, <i>module</i>, and <i>assembly</i> are synonymous.</p> <p>See Product.</p>
Monomorphic UII	<p>When PC Bit 17 of MB01 = 0b0, under the rules of GS1 TDS 1.4 or later, all of the features of a Monomorphic UII are self-declaring through the GS1 identity types, i.e., SGTIN-96.</p> <p>When PC Bit 17 of MB01 = 0b1, under the rules of ISO/IEC 15961-2, all of the features of a Monomorphic UII are self-declaring through the registration of the particular AFI code value used, i.e., 0xA1 or 0xA5 (hazard materials).</p> <p>This document references ISO/IEC 17367. Therefore, the Item Level identification data consist of a Monomorphic UII whose recommended maximum size is 35 characters. The Monomorphic Item Level UII shall not contain a DSFID.</p>



TERM	DEFINITION
MSB	Most Significant Byte
msb	most significant bit
NCAGE	NATO Commercial And Governmental Entity code
Object Identifier (OID)	A unique, specially formatted number that is composed of a most significant part assigned by an internationally recognized standards organization to a specific owner and a least significant part assigned by the owner of the most significant part. For example, the unique alphanumeric / numeric identifier registered under the ISO registration standard to reference a specific object or object class.
Part	Within this document, the terms <i>item</i> , <i>product</i> , <i>part</i> , <i>component</i> , <i>module</i> , and <i>assembly</i> are synonymous. See Product.
Part Serial Number (PSN)	Supplier-managed part serial number. In this document, it is a subset of the Serial Number component of the DI and IAC and CIN and SN data structure of the DI “25S”.
Passive RFID Tags	Tags are externally powered, usually by the carrier signal radiated from the interrogator’s antenna; usually containing no internal power source.
Permalock	The ability of the Tag protocol to cause a memory bank to be “read-only.” Once “locked,” that memory location cannot be unlocked.



<p>Product</p>	<p>Within this document, the terms <i>item, product, part, component, module, and assembly</i> are synonymous.</p> <p>The result of a process.</p> <p style="margin-left: 40px;">NOTE 1: There are four generic product categories, as follows:</p> <ul style="list-style-type: none"> • Services (e.g., transport); • Software (e.g., computer program, dictionary); • Hardware (e.g., engine mechanical part); • Processed materials (e.g., lubricant). <p>Many products comprise elements belonging to different generic product categories. Whether the product is then called <i>service, software, hardware, or processed material</i> depends on the dominant element. For example, the offered product “automobile” consists of hardware (e.g., tires), processed materials (e.g., fuel, cooling liquid), software (e.g., engine control software, driver's manual), and service (e.g., operating explanations given by the salesman).</p> <p style="margin-left: 40px;">NOTE 2: Service is the result of at least one activity necessarily performed at the interface between the supplier and customer and is generally intangible. Provision of a service can involve, for example, the following:</p> <ul style="list-style-type: none"> • An activity performed on a customer-supplied tangible product (e.g., automobile to be repaired); • An activity performed on a customer-supplied intangible product (e.g., the income statement needed to prepare a tax return); • The delivery of an intangible product (e.g., the delivery of information in the context of knowledge transmission); • The creation of ambience for the customer (e.g., in hotels and restaurants). <p>Software consists of information and is generally intangible and can be in the form of approaches, transactions, or procedures.</p> <p>Hardware is generally tangible, and its amount is a countable characteristic.</p> <p>Processed materials are generally tangible, and their amount is a continuous characteristic.</p> <p>Hardware and processed materials often are referred to as “goods.”</p>
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TERM	DEFINITION
Protocol Control (PC) Word or Protocol Control Bits	The PC-Word (16 bits) starts at memory location 0x10 and contains the following: <ul style="list-style-type: none"> • Length of UII stored in bits 0x10 to 0x14 (see Length of data); • User Memory indicator in bit 0x15; • Extended Protocol Control indicator in bit 0x16; • Numbering System Identifier (NSI) indicator in bit 0x17; and • Attribute / AFI stored in bits 0x18 to 0x1F.
Radio Frequency Identification (RFID)	Systems that read and / or write data to RF Tags that are present in a radio frequency field projected from RF reading / writing equipment.
Read	The excitation, extraction, decoding, and presentation of data from a Tag .
Read Range	The range at which an RFID system may reliably read from desired Tags under defined conditions.
Reader	The electronic device that extracts and separates the information from the Tag using a defined protocol.
Reader / Writer	The electronic device that can change the contents of a read / write Tag , according to a protocol, while the Tag is attached to its object.
RoHS	Restriction of Hazardous Substances Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
Serial Number	A number indicating place in a series and used as a means of identification.
Supplier / Vendor	In a transaction, the party that produces, provides, or furnishes a product or service.
Supplier / Vendor ID	The numeric or alphanumeric code used to identify the supplier / vendor. See CIN .
Tag	For the purposes of this standard, “ Tag ” refers to the RFID transceiver, plus the information storage mechanism, attached to an object and read-from / written-to using a Reader , or Reader / Writer .



TERM	DEFINITION
Tag ID (TID)	Tag ID memory bank (MB10). Globally unique identification of the individual silicon chip. Shall be serialized and locked by the silicon manufacturer.
Traceability	Sometimes referred to as genealogy or history of an item. Traceability shall answer at minimum the following four questions: the What, the Who, the Which, and the When. Example: What = part number; Who = manufacturer or assembler; Which = lot, batch, or serial number; When = date of production or assembly.
Ultra-High Frequency (UHF)	That band of radio frequencies encompassing 300 MHz to 3 GHz. For the purposes of this standard, the frequencies from 860 MHz to 960 MHz.
UII	Unique Item Identifier: Descriptor for data that reside within the UII Memory Bank (MB01) of an ISO/IEC 18000-63 / GS1 UHF Class 1 Gen 2 RFID tag.
VIN Vehicle Identification Number	The VIN (sometimes incorrectly referred to as “VIN number”) is a unique serial number used by the automotive industry to identify individual motor vehicles (also applies to towed vehicles, motorcycles, and mopeds as defined in ISO 3833).
Vendor	See Supplier / Vendor ID .
Verification	Confirmation by examination and provisions of objective evidence that specified requirements have been fulfilled; the act of reviewing, inspecting, testing, checking, auditing, or otherwise establishing and documenting whether or not items, processes, services, or documents conform to specified requirements.
Word	Data block of two bytes (16 bits) length. The Length of Data is stored in the Protocol Control Word and expresses the number of words. See also Length of Data .
Write	The process of transferring data to the Tag ; the Tag 's internal operation of storing data. It may include reading the data to verify accuracy.
Write Range	The range at which an RFID system may reliably write to desired Tags under defined conditions.



4 INTRODUCTION OF RFID

4.1 Positioning of RFID in the Automotive Environment

A fundamental benefit of RFID technology is to optimize processes by using automatic item identification. Not only are classes distinguishable (e.g., parts with the same part number) as in the past, but individual entities of a class (e.g., airbag module with part number 123 and part serial number 234) are also individually distinguishable. Processes can be controlled more precisely and in tighter control cycles through better differentiation.

RFID technology has been applied for decades in the automotive industry, primarily in closed loop systems, which serve exclusively for the use of internal company processes.

These in-house ‘closed loop RFID applications’ are limited in number and scope and are elementary in nature. They may also be part of a larger process in an open loop system.

The real potential of using RFID occurs when the different elements of the value chain use the same standards and technologies and information is processed at every stage in an open loop system where information is shared among trading partners. (See Figure 1)

Note: As used within this document, the EoT character (End of Transmission – the control character used to unambiguously indicate the end of the UII data stream within Memory Bank 01binary) will be the exclamation mark (“!”), represented by the binary bit pattern “100001”. In case there is an agreement between two parties, usage of EOT character may be optional.



RFID Vision in Automotive Scope of Applications

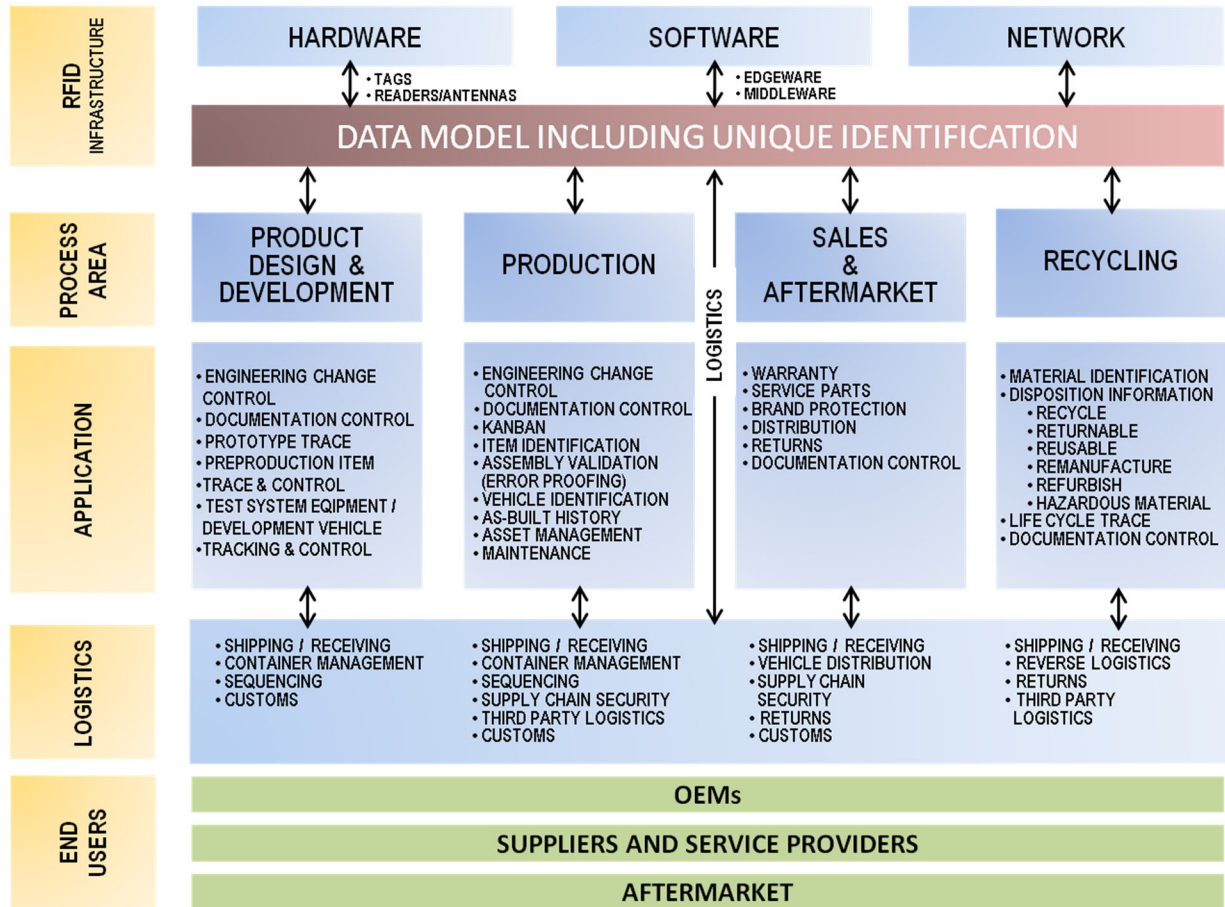


Figure 1: RFID Vision in Automotive

The use of a tag throughout an enterprise’s processes has significant business benefits. For example, a tag in a component can support the following additional functions:

- Production documentation control.
- If an internal sequence is produced, the assignment of a sequence number to the part can take place.
- The correct installation of the assembly into the vehicle can be ensured through comparison of code number/order number with the customer order/build sequence/position.
- During the installation of the parts, part identification numbers together with the vehicle data can be automatically recorded and saved. If problems are later discovered in the production batch from which the part originated, targeted re-calls are possible with a minimum of disruption and cost.
- In the case of a warranty claim, it is possible to check whether the original part from the factory is still fitted.



- Optimization of process control within the replacement parts chain.
- For quality assurance purposes, safety-critical parts can be scanned to guarantee that the quality assurance requirements have been adhered to as specified in the supplier warranty documentation.
- In recycling operations, the material content can be determined from the data on the tag, which simplifies the sorting process.

The co-operative interaction within the whole value chain can only be realized when the required hardware components, data transmission protocols, system interfaces, and data structures are operated between the participating process partners in accordance with commonly defined and applied standards.

For additional general information on RFID systems implementation and operations, please see ISO/IEC TR24729-1 *Radio frequency identification for item management – implementation guidelines – Part 1: RFID-enabled labels and packaging supporting ISO/IEC 18000-63*.

RFID provides the automotive industry with a technology that operates exclusively in material flow and production control, i.e., it serves the synchronous representation of material flow and the flow of information. Precisely when a part / assembly is physically available, the accompanying information is also available and vice versa. Therefore, RFID cannot substitute permanently for the use of back-end systems and their linking via EDI processes. EDI data streams "hurry ahead of the product" and can also be used for planning. Back-end systems ensure a central view of the data. Therefore, particularly in the exchange between the partners in the supply chain, EDI information in parallel with the RFID-supported material flow cannot be abandoned for the foreseeable future.

For this standard, item processes and assembly processes between trading partners were reviewed. The individual processes are described within the Odette LR03 - *RFID for Tracking Parts and Assemblies* and VDA 5510 documents. The data fields to be stored on the tag are described in Section 5 of this B-21 document. Special attention has been directed to the encoding system as well as to the requirements for the tag and reader technology.

4.2 RFID; GENERAL

Only read / write, passive (or battery-assisted passive) RFID Tags shall be used, with additional specifications as outlined in the RFID Specifications (Section 7) of this standard.

All performance characteristics noted in the following RFID sections, and in Section 7, are for the tag and antenna / interrogator system **only**. They do not take into consideration host data-acquisition time, legacy-system latency time(s), or other human- or host-system-induced limiting factors.

With recent revisions to ISO/IEC 18000-63 and the GS1 Tag Data Standards Version 1.5 or later, the global RFID-using community now has globally accepted Standards to enable meeting the needs of both the OEMs and the supply chain (retail segments included) on the same tag at the same time.

4.2.1 RFID Data Fields and Data Identifiers

Only one, monomorphic, UII shall be used in Memory Bank 0b01 (MB 0b01).

NOTE: Once a term has been fully explained and a presumptive qualifier is used, the binary number shall not be prefixed, e.g., Memory Bank 0b01 (MB01). Once fully explained (as in the previous sentence), it shall be referred to thereafter as MB01.

Every data field encoded into MB0b11 shall consist of a Data Identifier (DI) followed by its associated data.



Only Data Identifiers complying with ANS MH 10.8.2 (reference ISO/IEC 15418) shall be used.

No data associated with the DIs shall exceed the maximum character length as defined in this standard or in ANS MH10.8.2.

NOTE: All Data Identifiers, including the 5N series, are codified in the ANSI MH10.8.2 Data Identifier and Application Identifier Standard. This standard can be found at: <http://www.mhi.org/standards/di> See Section 5.2 for MB01 data construction details and Section 0 for MB11 data construction details.

4.2.2 Using Data Fields in MB11

Whenever any data fields are used in MB11, Data Identifier usage shall be as described in Section 5.3.

4.3 AIDC Link to EDI

Automatic identification and data capture technologies (AIDC), e.g., barcodes, two-dimensional symbols, and radio frequency identification are a natural enhancement to electronic data interchange (EDI). EDI documents (or transactions) serve as the means by which trading partners communicate supply chain data with one another, from the purchase order, release schedule, then to the ship notice, delivery receipt, invoice, and material usage data. Of these, the Ship Notice/Manifest (a.k.a. ASN), captured in the ANSI ASC X12 856 or the UN/EDIFACT DESADV, provides detailed information on product that is shipped from a supplier to a customer.

However, when product arrives at the receiving dock, a need exists to link the received physical product with the previously received EDI data. This is where AIDC comes in, where the container transaction license plate serial number is read (refer to JAIF B-16 *Global Transport Label Standard for the Automotive Industry*), which in turn accesses the associated information in the received EDI file. Products can be received by serial number or product code, quantity, and purchase order reference.



5 DATA STRUCTURES

5.1 Reasons for and Use of the Data Structure

The data structure described here is based on the existing logistics process within the automotive industry and current standards. It contains data fields that are selected or modified in the various logistics processes.

Portions of MB11 can be locked. The remaining data fields can be optionally overwritten within the process flow as many times as necessary to ensure that they are always up to date.

5.1.1 Data Organization According to ISO/IEC 18000-63

The fundamental structure of the data on the tag is defined in the "air interface" according to ISO/IEC 18000-63.

For the purposes of this document, ISO/IEC 18000-63 and 18000-3 Mode 3 (ASK) are considered the same.

If "user data" are stored on the tag in MB11, this shall be indicated on the tag according to ISO/IEC recommendations. ISO/IEC 18000-63 starts from a logical subdivision of the tag memory into four data segments, which are shown in Figure 2.

5.1.2 Data Structure on the Tag (Air Interface)

ISO/IEC 18000-63 assumes a logical division of the tag storage into four data segments, which are represented in Figure 2:

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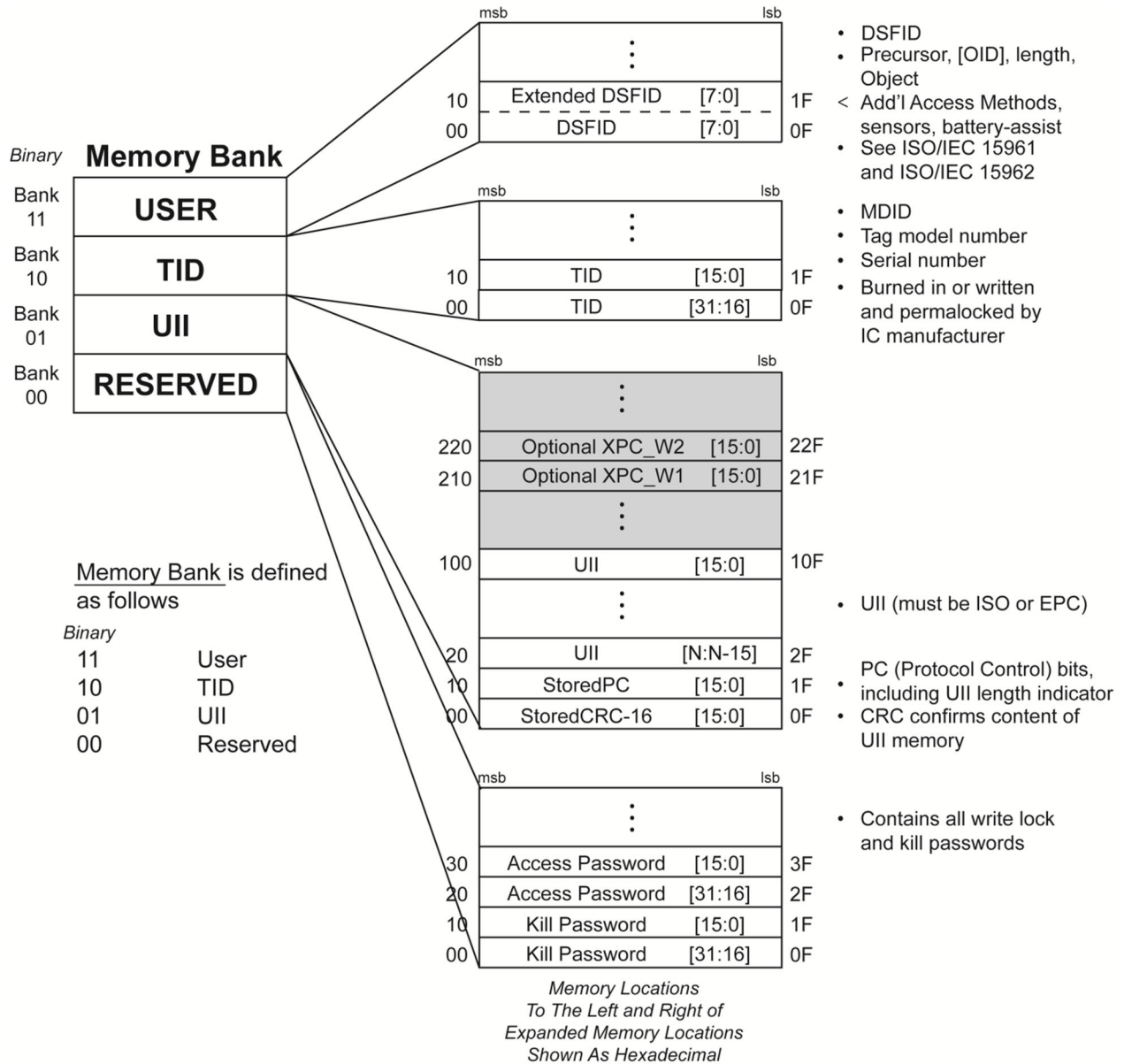


Figure 2: Memory Structure of ISO/IEC 18000-63 RFID Tag

Note: Use of the shaded areas are not recommended by this standard.

The following subsections describe the essential contents of these memory segments:

5.1.2.1 Reserved:

MB00 = Password management

- Access password
- Kill password



5.1.2.2 UII: (See Section 5.2 for additional details.)

MB01 = UII (Unique Item Identifier) :

- CRC: calculated checksum on the tag for data verification
- PC: contains several data fields, including;
 - Length of the UII field in Words (one Word equals two bytes)
 - Bit 15: Switch; whether user data are saved or not in MB11
 - Bit 17: Switch; if an EPC or an ISO number stands in the UII field. See Table 3.
 - Characteristic of the AFI field (Application Family Identifier). See Table 2.
- UII field: contains the unique part ID
 - This standard requires that the UII field shall not exceed 240 bits.

The UII shall be constructed according to ISO/IEC 15459-4. This standard supports that both data syntaxes may exist within the same tag population environment.

The AFI serves as a primary filter that supports in distinguishing what kind of object has been read by the RFID application (e.g., automotive part, container). In this manner, the AFI supports in filtering relevant from irrelevant data. Additionally, the AFI defines which kind of coding has been applied (6-bit, 8-bit). Standardized AFIs are listed in ISO/IEC 15961-2 Data Constructs Register and specified in ISO/IEC 17364-17367.

The Data Constructs Register provides AFIs for identifying parts and components and one for identifying Vehicles.

Table 2: Application Family Identifier (AFIs)

AFI	Standards
A1	Monomorphic UII using 6-bit compaction for ISO 17367 Product tagging
A4	Monomorphic UII using 6-bit compaction for ISO 17367 Product tagging (Hazardous Materials)
90	Odette for Vehicle Identification using the ISO/IEC 15962 6-bit compaction Monomorphic-UII in ISO/IEC 18000-63 tags
AC	Monomorphic UII using 8-bit compaction for ISO/IEC 1736x series of standards

NOTE: For 8-bit encoding, refer to the example described in ANNEX M.

Table 3 shows four conditions that can be represented via the assignment of PC Bits 0x15 and 0x17 in MB01:

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Table 3: Usage of MB11 in an ISO/IEC 18000-63 Tag

		MB01: Protocol Control Bit 0x17	
		0b0 = EPC-based data in MB01	0b1 = Monomorphic ISO AFI-based data in MB01
MB01: Protocol Control Bit 0x15	0b0 = No data in MB11	- EPC-based UII Data in MB01 - No User Data in MB11	- Monomorphic ISO AFI-based UII Data in MB01 - No User Data in MB11
	0b1 = Data in MB11	- EPC-based UII Data in MB01 - User Data in MB11	- Monomorphic ISO AFI-based UII Data in MB01 - User Data in MB11

5.1.2.3 TID:

MB10 = TID (Tag ID);

- Unique part and serial number of the **Tag** itself (not the part to which the Tag is attached).
- Serialized and permanently locked by the tag manufacturer.

NOTE: The TID is created and programmed by the silicon manufacturer.

5.1.2.4 User Memory: (See Section 5.3 for additional details.)

MB11 = User Memory Bank:

- Data area which can be formatted and organized by the user
- The structure of the data to be stored in MB11 shall contain;
 - Unique Data Identifiers and related content.
 - All fields are OPTIONAL, i.e., use of the data is determined by the specific processing rules agreed to between trading partners.
 - These fields are explained in detail in Section 5.3.
- MB11 has the capability of being locked.
 - If data are ever desired to be written into MB11, and MB01 is also desired to be locked, data must be written into MB11 *BEFORE* MB01 is locked.

5.1.3 TID Memory Bank – MB10 (SERIALIZED AND LOCKED)

The Tag ID (TID) Memory Bank provides a number of chip identity options, called Allocation Class (AC). These options provide different tag identity profiles that can be used to identify individual RFID chips uniquely and unambiguously – and through the chips, the RFID tags that are made from them. See ISO/IEC 15693 for complete details on these Allocation Classes.

There are three (3) options listed under ISO/IEC 15693 that are relevant to this document: 0xE0, 0xE2, and 0xE3.



- 0xE0 is the AC for the basic ISO/IEC 7816-6 company issuer identifier codes consisting of the 8-bit identifier followed by a 48-bit serial number.
- 0xE2 will contain serialization if both of the following conditions are met:
 1. Bit 0x08 of the TID memory bank (the msb of the TAG MDID) has a value of "1".
 2. Bits 0x20-0x22 do not equal zero when treated as a 3-bit unsigned number. The msb of this number is bit 0x20.

If condition "1", above, is met, there is a 16-bit XTID header present from address 0x20-0x2F of the TID memory bank. There may also be more data present in the TID that is not covered by this specification.

- 0xE3 builds on the existing AC 0xE0 for compatibility. The AC is followed by the 8-bit I.C. manufacturer's registration number, the 2-byte User Memory present and size data, the 48-bit unique tag ID, the 1-byte XTID, and the 15-byte XTID Header data. Table B.2 of ISO/IEC 15963 shows the TID format for Allocation Class 0xE3.

This standard requires that the chip contain a uniquely serialized TID. The serialized TID shall also be "locked." To be in compliance with this standard, the Tag ID (MB10) shall be serialized (globally unique) and locked by the silicon manufacturer.

5.2 Data Structure for Unique Item Identifier (MB01)

Identification of the tagged object is accomplished via the UII as outlined under ISO/IEC 18000-63. Figure 3 outlines the arrangement of data elements within the UII.

The UII shall be "locked" according to ISO/IEC 18000-63 or GS1 UHF Gen 2 air interface protocols.

The UII should contain no more than 35 characters. With a 240-bit UII, a maximum of forty (40) 6-bit characters can be encoded.

NOTE 1: Any appropriate DI from ANS MH10.8.2 is allowed for use.

NOTE 2: DI's mentioned in this document are recommendations, not requirements.

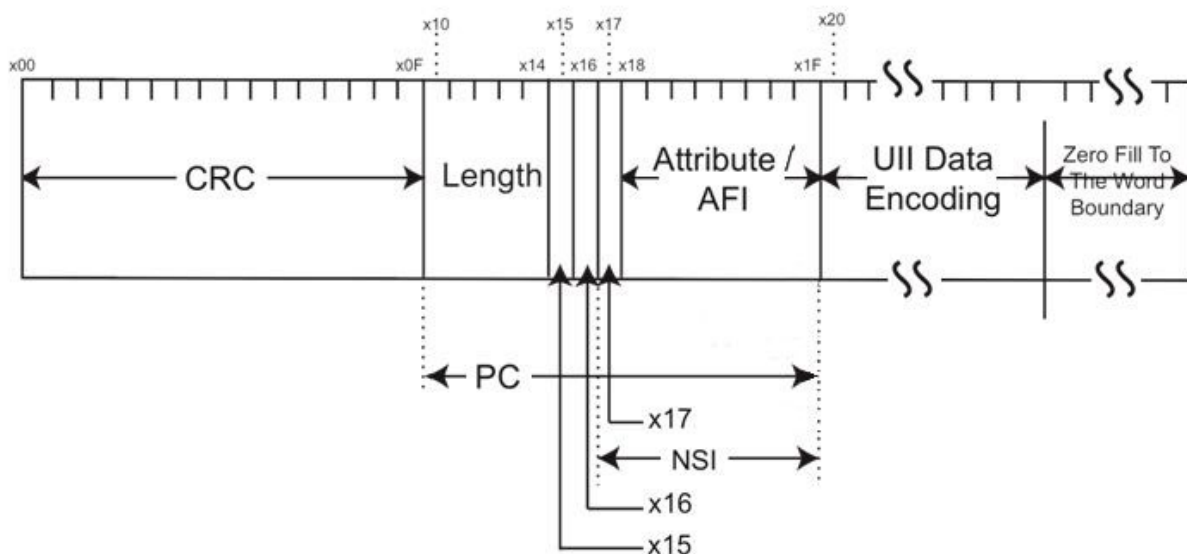


Figure 3: ISO/IEC 18000-63 MB01 layout



5.2.1 Ull Coding Scheme with UN (DUNS), OD (Odette), LA (JIPDEC), VTD (TEIKOKU DATABANK), TAJ (National Tax agency JAPAN), 0-9 (GS1), or D (NCAGE) format

When using 6-bit encoding, the formatting of the data on the RFID tag shall use the "ASCII-Character-to-6-Bit-Encoding Table," according to ISO/IEC 15962 (see Table 9).

When using UTF-8 encoding, convert each data character into its code value using ISO/IEC 10646.

5.2.1.1 Part identification (Ull) using DI 37S with UN (DUNS), OD (Odette), LA (JIPDEC), VTD (TEIKOKU DATABANK), TAJ (National Tax agency JAPAN)

The previous version of this document recommended the application of DI 25S, which states strictly defined string lengths. Practice has shown that PN and SN may vary in length. The JAIF recommends using DI "37S" in future RFID applications and in existing applications where possible.

DI 37S states that the part number (PN) and the part serial number (PSN) are declared separately by using the "+" character.

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Table 4: Data Structure for Identifying Parts and Components using DI “37S” and IAC “UN”

DI	IAC	CIN	PN	Separator	PSN
Data Identifier	Issuing Agency Code	Company Identification Number	Part Number	Separator	Part Serial Number
37S	UN	Variable	Variable	+	Variable
3 char (an)	2 char (a)	9 char (n)	x char (an)	1 char	y char (an)

The following table represents a DI “37S” data encoding into MB01 and contains two major sections: 1) the CRC and the Protocol Control Word, and 2) the UII.

NOTE: The terms “Variable” and “Fixed” in the Value column of Table 5 refer to the actual data used, not the length of that data.

Table 5: MB 01 Coding Scheme for Parts and Components

Bit Location (HEX)	Data Type	Value	Size	Description
MB 01: CRC + Protocol Control Word				
00 – 0F	CRC-16	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	Variable	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field.
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB112 1 = Valid User Data in MB112
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ not used
17	PC bit 0x17	0b1	1 bit	1 = Data interpretation rules based on ISO
18 – 1F	AFI	0xA1 or 0xA4	8 bits	Application Family Identifier used according to ISO/IEC 15961 and ISO 17367. For hazardous parts use A4.
	Subtotal		32 bits	
MB 01: Unique Item Identifier (UII) with 6 bit encoding				

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Global Radio Frequency Identification (RFID) Item Level Standard

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Bit Location (HEX)	Data Type	Value	Size	Description	
Start at location 20 Go to end of data / end of available memory	DI	“37S”	3 an	Data Identifier 37S for Part Identification	
	Issuing Agency Code (IAC)	“OD”, “UN”, “LA”, “VTD” or “TAJ”	2 or 3 an	Issuing Agency Code, according to DUNS, Odette, JIPDEC, TEIKOKU DATABANK, National Tax agency JAPAN	
	Company Identification Code (CIN)	As defined by the IAC	6 an (OD), 9 n (UN and VTD), 12 an (LA), 13 n (TAJ)	Company Identification Number	
	Serial Number (SN)	Part Number (PN)	1...X an	Variable number of alphanumeric characters for the PN ID assigned by the owner	
	<i>Consist of Part Number, Separator and Part Serial Number</i>	+	(Separator)	1 an	“+” sign separator (2Bh)
		Part Serial Number (PSN)		1...Y an	Up to Y alphanumeric characters, in capital letters
	^E OT	0b100001	6 bit	End of Transmission	
Padding until the end of the last 16-bit Word	0b10, 0b1000, 0b100000, 0b10000010, 0b1000001000, 0b100000100000, or 0b1000001000001 0	2, 4, 6, 8, 10, 12 or 14 bits	Word Padding According to ISO/IEC 15962		
Subtotal			Variable	Up to 240 bits	
TOTAL MB01:			VARIABLE	UP TO 272 BITS	



NOTE 1: EOT and padding bits are used for control purposes and Word padding. They are not part of the reference-ID within the UII (MB01) and the data that is stored to the UM (MB11), i.e., both EOT and padding bits are removed when decoding the data.

NOTE 2: See Annex M for UII (MB01) 8–Bit Coding Scheme for Parts and Components.

5.2.1.2 NATO (NCAGE) Construct for Use with Passive Gen2 RFID Tags

The DOD requires passive Gen2 RFID tags be attached to all shipment units at the case and pallet level. The requirement includes formatting the data in accordance with the GS1 Tag Data Specification. For those companies that do not own an EPC company manager number, or those that chose not to use their EPC company manager number, there is a “DOD Construct” a.k.a. “DOD 96” that allows use of the Commercial and Government Entity (CAGE) code in lieu of the EPC company manager number.

The North Atlantic Treaty Organization (NATO) Allied Committee 135 (AC 135) controls the issuance of NCAGE or NATO CAGE codes. The term “CAGE” nominally refers to an NCAGE code issued by AC 135 to the military of the member nation. AC 135 has published rules that ensure that NCAGE codes are individually unique. CAGE codes and NCAGE codes are the same length (5 alphanumeric characters).

Detailed instructions on how to assemble an EPC- and DOD-compliant RFID tag ID are found at the United States Department of Defense *Supplier’s Passive RFID Information Guide*, latest version.

How to use the UII memory area (MB01) is described in “GS1 Tag Data Standards,” Version 1.5 or later.

The following table represents the data that are encoded into MB01 and contains two major sections: 1) the CRC and the Protocol Control Word, and 2) the UII.

NOTE: The terms “Variable” and “Fixed” in the Value column of Table 6 refer to the actual data used, not the length of that data.



Table 6: The Unique Identification (UII) of an RFID Tag (MB01) for DOD

Bit Location (HEX)	Data Type	Value	Size	Description
MB01: CRC + Protocol Control Word				
00 – 0F	CRC	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	Variable	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field.
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB11 1 = Valid User Data in MB11
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ not used
17	PC bit 0x17	0b0	1 bit	0 = Data interpretation rules based on EPC
18 – 1F	Attribute	0b00000000	8 bits	No AFI with EPC Format
	Subtotal		32 bits	
MB01: UII				
In this example, all UII data use 6-bit encoding values from Table 9; not used positions are padded with leading zero(s) (ASCII “zero” [0x30]).				
Start at 20. Go to end of data / end of available memory	Header	0x2F 00101111	8 bits	Header for DOD 96
	Filter Value	0b0000 or 0b0001 or 0b0010	4 bits	0000 = Pallet (palletized unit load) 0001 = Case (shipping and exterior container) 0010 = Unit Pack All other combinations = reserved for future use



Bit Location (HEX)	Data Type	Value	Size	Description
	Government Managed Identifiers	“Space” followed by 5 alpha-numeric characters	48 bits	NCAGE or CAGE code preceded by a “space”: Or DODAAC - 6 characters (reserved for use only to identify U.S. military activities) (Displayed in hex format – Annex H)
	Serial Number	Variable	36 bits	Binary format using left-padded zeros
	Subtotal		96 bits	
	TOTAL MB01:		128 BITS	

5.2.2 ISO-based Coding Scheme for Vehicle Identification (VIN) in MB01 using AFI “0x90”

AFI “0x90” is a monomorphic 6-bit encoded data string that is used to identify vehicles as differentiated from the parts that make up that vehicle.

Using AFI “0x90” and the DI “I”, the following table represents an actual VIN data encodation into MB01. It contains two major sections: 1) the CRC and the Protocol Control Word, and 2) the UII.

Table 7: Coding Scheme for Vehicle Identification (VIN) in MB01

Bit Location (HEX)	Data Type	Value	Size	Description
MB01: CRC + Protocol Control Word (Header)				
00 –0F	CRC-16	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	0b01000	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB112 1 = Valid User Data in MB112
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ not used
17	PC bit 0x17	0b1	1 bit	1 = Data interpretation rules based on ISO



Bit Location (HEX)	Data Type	Value	Size	Description
18 – 1F	AFI	0x90	8 bits	Application Family Identifier used according to ISO/IEC 15961-2 Data Construct Register
	Subtotal		32 bits	
MB01: Unique Item Identifier (UII) with 6 bit encoding				
Start at location 20 Go to end of data / end of available memory	DI	“I”	1 an	Data Identifier I for VIN
	VIN	“W0L0XAP68F4050901”	17 an	VIN
	^E _{OT}	0b100001	6 bit	End of Transmission
	Padding	0b10000010000010	14 bits	Word Padding According to ISO/IEC 15962
	Subtotal		128 bits	
	TOTAL MB01:		160 bits	

NOTE: See Annex M for UII (MB01) 8–Bit Coding Scheme for Vehicles.

5.3 Data Structure in the User Memory Bank (MB11)

For MB11, data structures shall conform to ISO/IEC 15434 and ISO/IEC 15418 (which refers to ANSI MH 10.8.2), Data Format 06 "Data using ASC MH 10 Data Identifiers" to enable conversion between optical symbology and RFID media.

When using RFID, ISO/IEC 15962 Access Method 0 (No Directory) Format 3 or Access Method 0 (No Directory) Format 13 shall be used.

The minimum User Memory Bank (MB11) size shall be 512 bits.

5.3.1 Data Requirements

A unique identifier shall be saved in MB01 on the tag as a minimum requirement (see Section 5.2). In application Scenarios 2 and 3 in Section 6, additional user data are required. The requirements vary depending upon the business processes and agreements with the participating partners.

“User Memory” Memory Bank 11 (MB11) can take numerous forms from a data semantics and syntax perspective. When PC Bit 15 = 0b1 (indicating that there are data in MB11) and PC Bit 17 = 0b1 (indicating an ISO versus an EPC structure), the first 8 to 16 bits of user memory are encoded according to the DSFID rules in ISO/IEC 15961-1, ISO/IEC 15961-2, and ISO/IEC 15962.

This document describes, and recommends, Access Method 0 and Formats 3 or 13 for encoding data within MB11.



5.3.2 Data Storage Format Identifier (DSFID)

The single-byte DSFID (Data Storage Format Identifier) defines the Access Method and the Data Format, and has the following structure:

- Bits 8 and 7 define the Access Method, which determines how data are encoded on the tag.
See Table 8.
 - This standard recommends Access Method "No Directory," with binary bit value '00'.
- Bit 6 is the Extended Syntax indicator (recommended = "0").
 - When bit 6 = "1" the following apply:
 - Bit 8 is the Extensibility Bit
 - Bits 7 and 6 are the Extended Syntax
 - Bits 5 and 4 are the Memory Length
 - Bits 3 to 1 are the Battery-assisted, Full-function Sensor, Simple Sensor indicators
 - Subsequent bytes contain the data, in 6-bit encoding.
 - When using Format 3, the data stream is terminated by the "E_{OT}" character.
- Bits 5 through 1, inclusive, describe the Data Format.
 - A DSFID value of "0x03" indicates the use of "No Directory, ISO/IEC 15434 - based Data Syntax." The SG1 standing document "SG1 Guidelines for 15962" explains the use of this method with Format 06, 6-bit encoding.
 - A DSFID value of "0x0D" indicates the use of "No Directory using the ISO/IEC 15962 Assigned Relative OID DI Table." This is the recommended format.
 - A DSFID value of "0x8D" indicates the use of "Packed Objects, using the ISO/IEC 15962 Assigned Relative OID DI Table."
 - The Special Features Flag (SFF) shall be set to "00".

Table 8: Assigned and Reserved Access Methods

15961 integer code	15962 DSFID bit code	15962 SFF bit code	Name	Description
0	00	00	No-Directory	This structure supports the contiguous abutting of all the Datasets.
1	01	00	Directory	The data are encoded exactly as for No-Directory , but the RFID tag supports an additional directory, which is first read to point to the address of the relevant object identifier.
2	10	00	Packed-Objects	This is an integrated compaction and encoding scheme that formats data in an indexed structure as defined by the Application administrator (see ISO/IEC 15961-2).



15961 integer code	15962 DSFID bit code	15962 SFF bit code	Name	Description
3	11	00	Tag-Data-Profile	This is an integrated compaction and encoding scheme for a fixed set of data elements, each of a defined length.
4 – 15	00	01	RFU	Reserved for future revisions of ISO/IEC 15962.

5.3.2.1 Access Method 0, Format 3; ISO 17367 Defined Encoding Assigned to ISO/IEC 15434.

Using the DSFID and Precursor, ISO/IEC 15962’s Format 3 eliminates the need to encode the following portions of the ISO/IEC 15434 message envelope: the Compliance Indicator and Format Trailer “[] > ^{R_s}”, the Format Header (as used in this document for DIs; “**06** ^{G_s}”), and the message’s final Format Trailer/Message Trailer characters “^{R_s} ^{E_{OT}}”. Data encoding is accomplished by using the 6-bit data characters in Table 9. For further details, see ISO/IEC 17367.

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Table 9: Six-bit Character Encodation Table

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

NOTE: The above character set is 6-bit encoding created through the simple removal of the two high-order bits from the ISO 646 8-bit ASCII character set, save the shaded values. The shaded values are re-assigned, as provided, to minimize the bit count when using the ISO/IEC 15434 envelope.

When using 6-bit encoding, only the following characters are allowed:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, * (asterisk), + (plus sign), - (dash), . (period or full stop), ^EO_T (End of Transmission), ^RS (Record Separator), ^GS (Group Separator), and the “SPACE” character.

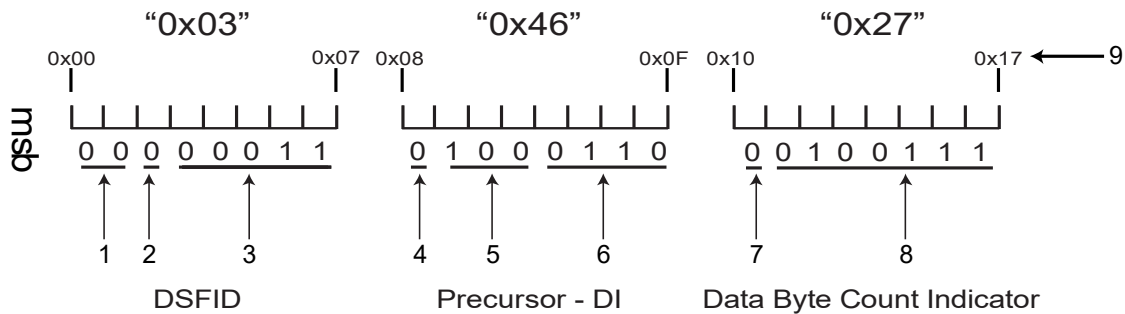
When using 8-bit encoding, UTF-8 is to be used.

5.3.2.2 Synopsis of Access Method 0, Format 3 encoding:

- The first byte of memory is a DSFID that always has the fixed value 0x03, indicating that memory uses Access Method 0 and encodes Format 3 (ISO/IEC 15434) messages. See ISO 17367 for encoding/decoding and translation guidance.
- The second byte of memory is a Precursor, which is a fixed value for a given ISO/IEC 15434 Format Indicator (true for all but the exception conditions covered in ISO/IEC 15962 and 15434).
 - To be compliant with this standard when using Format 3, a fixed Precursor value of 0x46 will always be used, indicating 6-bit encoding and ISO/IEC 15434 Format Indicator 6 (for DIs).



- The third byte of memory indicates the length (in bytes) of the data, encoded as an EBV-8 value. For all but the longest ISO/IEC 15434 messages (those longer than 127 bytes), this number is encoded in a single byte.
- The subsequent bytes (whose length was indicated by the preceding byte) contain the data, in 6-bit encoding (reference Table 9).
 - This standard recommends that only one 15434 message be encoded.



EXPLANATION OF NUMBERS IN FIGURE:

- 1 Access Method: “0” (see ISO/IEC 15962)
- 2 Extend Syntax – turns on additional byte of DSFID Byte (turned off in this instance)
- 3 Data Format “03” (ISO/IEC 15434)
- 4 Extension Bit – (see ISO/IEC 15962)
- 5 Compaction bits (indicating 6-bit table)
- 6 Format Envelope (specifically DI “06”)
- 7 Byte Count Indicator switch (set to “0” to signify final byte of byte count)
- 8 Bit values for Byte Count Indicator (variable based on length of data)
- 9 Bit position in memory

Figure 4: ISO/IEC 18000-63 and ISO/IEC 18000-3 Mode 3 Structure of Memory Bank "11"; First 16 Bits

NOTE: For the purpose of the above example, battery-assist and sensors are shown as not present.

NOTE: The information stored in the Length component of the Protocol Control Word differs based on whether the data length is equal to, or less than 1024 bits. Table 10 and Table 11 show the difference.

NOTE: Only the Control Information section of Tables 10 and 11 shows the change in the data length component (Byte Count Indicator Length). The User Memory sections of Tables 10 and 11 show the same data.



Table 10: ISO/IEC-Encoding of MB 11 (Object Length ≤ 1024 bits):

Position	Data Type	Value	Size	Description
MB 11: User Memory (UM): Control Information (Header) for MB 11 ≤ 1024 bits				
1	DSFID	0x03	1 byte	Data Structure Format Identifier
2	Precursor	0x46	1 byte	Compaction Code + Relative OID)
3a	Byte Count Indicator Switch	0b0	1 bit	0b0 “0 binary” declares that the next 7 bits are used to define the length of the following application data (object length ≤ 1024 bits). No additional bytes used for indicating the object length.
3b	Byte Count Indicator Length	Variable	7 bit	Object Length in Bytes
	<i>Subtotal</i>		<i>24 bits</i>	
MB 11: User Memory (UM): User- and Application Data				
1	Data Identifier	<DI>	6 ... 24 bit	Data Identifier “1”
2	Data	alphanumeric (an)	6 bit characters	Data
3	Group Separator	^G _S 0b011110; from Table 9	6 bit	Group Separator
4	Data Identifier	<DI>	6 ... 24 bit	Data Identifier “2”
5	Data	alphanumeric (an)	6 bit characters	Data
6	..	..	..	..



Position	Data Type	Value	Size	Description
7	End of Transmission	E_{OT} 0b100001	6 bit	End of Transmission
8	Word Padding	0b10, 0b1000, 0b100001, 0b10000110, 0b1000011000, 0b100001100001, or 0b10000110000110	2, 4, 6, 8, 10, 12 or 14 bits	Word Padding According to ISO/IEC 15962 for MB 11
Total MB 11			Variable	Up to chip limit

As mentioned above, the content of the control section in MB 11 depends on the size of the data that is stored into MB 11. Table 11 shows the control information when the application data (object length) in MB 11 is > 1024 bits:

Table 11: ISO/IEC-Encoding of MB 11 (Object Length > 1024 bits):

Position	Data Type	Value	Size	Description
MB 11: User Memory (UM): Control Information (Header) for MB 11 > 1024 bits				
1	DSFID	0x03	1 byte	Data Structure Format Identifier
2	Precursor	0x46	1 byte	Compaction Code + Relative OID
3a	Byte Count Indicator Switch	0b1	1 bit	1 binary Declares that an additional byte is used to define the application data length (object length). The next 7 bits and the relevant 7 bits of the additional, following byte are concatenated to indicate extended application data (object length > 1024 bits)
3b	Byte Count Indicator Length	Variable	7 bit	First part of the length declaration.



Position	Data Type	Value	Size	Description
4a	Byte Count Indicator Switch	0b0	1 bit	0 binary Declares that the next 7 bits are used to indicate the application data length.
4b	Byte Count Indicator Length	Variable	7 bit	Example: <u>3b: 40000001</u> (128 bytes) <u>4b: 00000010</u> (2 bytes) Total Object Length: 130 bytes
Subtotal			32 bits	

5.3.2.3 Access Method 0 Format 13; ISO/IEC 15961-2 Defined Encoding Assigned to ISO/IEC 15962 Assigned Relative OID DI Table

- When using Format 13, the first byte of memory is a DSFID that always has a fixed value of **0x0D**, indicating that user memory is encoded using Access Method 0 and Format 13 (ISO/IEC 15962 Assigned Relative OID DI Table).
- The second byte of memory is a Precursor, consisting of an Offset bit, Compaction code (3 bits), and value from the Assigned Relative OID DI Table for the DI used (4 bits).
- The third byte of memory indicates the length (in bytes) of the data, encoded as an EBV-8 value.
- The subsequent bytes (whose length was indicated by the preceding byte) contain the data, using the encoding schema (compaction) as denoted within the Precursor (Integer, Numeric, 5-bit, 6-bit, or 7-bit).

The above pattern of Precursor, Length of Data, and Data is repeated for each datum written into User Memory.

NOTE: See Annex M for User Memory (MB11) 8–Bit Coding Scheme

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6 RFID TAG DATA SCENARIOS

The tag data structures described below permit three fundamentally different scenarios of the RFID tag data handling processes; each places different demands on the total system. ‘Total system’ in this context means all resources necessary for the RFID-centric process, including the tag, reader, network, middleware, applications, organization, etc.

Addressing the tag data in the description of these scenarios below, there is a reference to the logical ‘part ID’ (UII) stored in MB01. The exact definition of this ID is explained in Section 5.2.

‘User data’ refers to all data stored in the User Memory Bank - MB11.

The three scenarios that follow allow read-access to the part ID (UII) on the tag.

6.1 Scenario 1: Tag Contains UII in MB01 (locked); No Data in MB11

In this scenario there is a UII in MB01; there are no data in MB11, and the only data field that is read on the tag is the globally unique Part ID (UII). The UII shall be locked and cannot be over-written (see definition “**Lock/Locking**”).

In a ‘UII-only’ scenario, all other information related to the part shall be accessed via the relevant back-end system or other databases.

This scenario represents a secure and expedient way of accessing data on the RFID tag.

This can be of importance when performing bulk reads on a pallet containing multiple RFID tags (e.g., via an RFID-enabled portal).

Additional “item data” shall be read in this case from the back-end system or database.

6.2 Scenario 2: Tag Contains UII in MB01 (locked) and Data in MB11 (locked)

In addition to the UII (globally unique Part ID) written to MB01, this scenario covers item-attendant data programmed into the User Memory Bank (MB11).

In this scenario, the UII (MB01) and the item-attendant user data (MB11) are written to the tag at the same time and locked.

Access to the tag data is ‘read only’ in all process steps.

All additional data required, beyond the data from the tag, shall be accessed via the relevant back-end system(s).

This scenario provides point-of-use access to relevant data contained within the RFID tag (e.g., color, revision level, part number, or manufacturing date).

6.3 Scenario 3: Tag Contains UII in MB01(locked) and Data in MB11 (not locked)

In addition to the UII (globally unique Part ID, written to MB01), this scenario covers item-attendant data contained in the User Memory Bank (MB11). The UII (MB01) is locked. The item-attendant user data (MB11) written to the tag are unlocked.



Whatever data that needs to be exchanged between partners in the supply chain relating to parts shall be defined bilaterally between the partners.

NOTE: In accordance with ISO/IEC18000-63, the ability to write data to MB11 is only possible for the entire User Memory Bank and not at the individual field level. In addition, security permissions based on generic roles assigned to a specific group of users for specific data access permission (read-only, update, etc.) is not possible.

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7 TECHNICAL SPECIFICATIONS FOR RFID TAGS

The specifications described below satisfy the process requirements of the automotive industry. These process requirements are included in Section 6. The technical specifications shall be strictly complied with in order to achieve an acceptable RFID system.

7.1 Tag Types

Only passive or battery-assisted passive UHF-based (specifically 860 MHz - 960 MHz) and, with trading partner agreement, HF-based (13.553 MHz – 13.567 MHz) RFID tags are used.

- Air interface shall be ISO/IEC 18000-63 for UHF and shall be ISO/IEC 18000-3M3 (ASK) for HF.
- To be compliant to ISO/IEC 18000-63, ISO/IEC 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* and ISO/IEC 18046-1 *Information technology – Radio frequency identification device performance test methods – Part 1: Test methods for system performance* shall be followed.
- To be compliant to ISO/IEC 18000-3M3 (ASK), ISO/IEC 18047-3 *Information technology — Radio frequency identification device conformance test methods – Part 3: Test methods for air interface communications at 13,56 MHz* and ISO/IEC 18046-1 *Information technology – Radio frequency identification device performance test methods – Part 1: Test methods for system performance* shall be followed.

7.2 Tag Memory Size

The Tag's overall minimum memory size should be no less than 1,024 bits (128 bytes).

A Tag memory size of 256 bytes (2,048 bits) or larger may be required to meet the requirements of certain applications.

A minimum UII Memory Bank (MB01) size of 240 bits is recommended for the ISO-based UII data of up to 35 characters (6-bit encoding).

The minimum User Memory Bank (MB11) size shall be 512 bits.

7.3 Anti-collision Mechanism for Multi-reader Systems

Anti-collision schemas for multi-reader systems shall be in accordance with ISO/IEC 18000-63.

The following should also be noted upon installation of the system:

To exclude collision errors caused by multiple UHF readers with overlapping fields of detection, the recommendations of ETSI (European Telecommunications Standards Institute) in the Technical Report ETSI TR 102 436 *Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Installation and Commissioning of RFID Systems Operating at UHF* should be followed.

7.4 Environmental Conditions

The protection mechanism for reader/writer and tag should be a minimum of IP67.



The IP 67 (International Protection rating) protection should be the minimum to ensure proper efficiency in the logistics/production environments subject to commercial agreements between RFID users and RFID Technology Providers. The protection that IP 67 provides is described in Figure 5.

6	Effective against	Dust tight. No ingress of dust; complete protection against contact	
7	Liquids	Immersion up to 1 m. Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).	Test duration: 30 minutes Immersion at depth of 1 m

Figure 5: Definition of IP67

Selecting protection for the tag shall also consider the following;

- Complete protection of the tag from physical damage that would cause the tag to malfunction during its intended use life, water and dust.
- Protection against adverse conditions caused by submersion in oil, coolants, water, snow, rain, container cleaning agents, etc. Limited functionality while under such adverse conditions is acceptable. Full functionality shall occur once the tag is removed from the adverse condition.
- Operational temperature range:
 - -40° to +80° Celsius
- Storage temperature range:
 - -50° to + 120° Celsius
- Appropriate measures that guarantee readability are necessary under adverse weather conditions.
- Protection for exposure to oil spray, cutting fluid, steam, etc., shall be considered on an individual basis.

7.5 Tag Location

The tag should be placed in such a position that reading with relevant reading equipment will be possible. Consideration of production processes coupled with requirements for installation of parts and any need to read the part after installation shall be considered and agreed to between trading partners.

7.6 Security / Locking Data (Permalock Command)

The RFID protocols that this standard is based on provide the ability to “lock” data through specific commands in the interrogator-based software command set.

Using the Permalock command for the UII data within MB01 shall be required.



7.7 EMI and EMC

Electromagnetic Interference (EMI) is anything electromagnetic that causes undesired responses or degradation of performance in electrical or electronic equipment. EMI can occur through conduction (electric current), radiation (electromagnetic field), inductive coupling (magnetic field), and capacitive coupling (electric field).

Surprisingly enough, EMI can cause not only “no-reads” but also “side-reads” as well (reading tags other than that at which the reader is aimed, due to reflection, spurious emissions, etc.).

Electromagnetic Compatibility (EMC) is the capability of equipment to operate in their intended environment without causing or receiving degradation due to unintentional EMI.

Useful sources of information for solving Electromagnetic Compatibility (EMC) interference problems are:

- ETSI TR 102 436 Electromagnetic compatibility and Radio spectrum Matters (ERM); Installation and commissioning RFID systems operating at UHF
- ISO/IEC 24729– 3, Information technology – Radio frequency identification for item management – Implementation guidelines – Part 3: Implementation and operation of UHF RFID interrogator systems in logistics applications.

7.8 Tag Life Span

Passive tags shall, at a minimum, last for the life of the part to which they are attached.

For the “End of Life” (Recycling) the RF tags and RF “Smart Labels” compliant with this standard should follow the regulatory requirements of the applicable country / region / standards as e.g., RoHS in the European Union and United States.

7.9 Relative Speed Through Portals

The higher the speed of transit through the portal, the higher the probability of read errors.

Effective reading speed depends on several factors, such as:

- Location of the tag on the part, in relation to the antenna
- Distance between tag and antenna
- Location/position of antenna relative to tag
- Type of tag chip
- Size of tag antennas
- Environment (e.g., nearby metal, ambient RF activity/noise, type of material the tag is mounted to, etc.)

7.10 RFID Regulations

Tags compliant to this standard shall meet the following requirements:

- The tag shall be interrogated within the approved power levels, number of channels, channel widths, channel separations, duty cycle, and other regulatory parameters of the applicable country / region / standard in which the tag and antenna are used.



7.11 Tag Identification Mark

RF tags and RF “Smart Labels” compliant with this standard should include one or more of the internationally accepted RFID emblems. For further information on the RFID emblems, refer to ISO/IEC 29160. Figures 6 and 7 are provided for reference only.



Figure 6: RFID Emblem for ISO/IEC 18000-63 Using ISO/IEC 15434 and Data Identifiers



Figure 7: Generic RFID Emblem Not Showing Air Interface or Data Format

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8 BUSINESS PROCESS APPLICATIONS

Within the scope of this standard, the following common industry process applications have been identified. See Figure 1 for context within the RFID Vision in Automotive.

- Item Identification (See Section 8.2)
- Verification (error proofing) (See Section 8.3)
- Item Traceability (See Section 8.4)
- Item Characteristics (See Section 8.5)
- VIN (See Section 8.6)
- Anti-counterfeiting (See Section 8.7)

8.1 Application-Specific Data structures

To increase security and integrity of the data encoded in the RFID tag, the tags shall have the TID (globally unique Tag Identification of the individual silicon chip.) serialized and locked by the silicon manufacturer.

A unique identifier shall be saved in Memory Bank 01 (MB01) on the tag as a minimum requirement. In all the applications described below, Memory Bank 11 (MB11) or “User Memory” can contain additional user data and are described in Section 0. The requirements vary depending upon the business processes and agreements with the participating partners.

The schema detailed in the next sections shall be followed in order to support the applications described in Sections 8.2 to 8.7.

8.1.1 Summary of Tag Memory Layout

ISO/IEC 18000-63 RFID tags support four memory banks; MB00, MB01, MB10, and MB11. Germane to this document are Memory Banks MB01, MB10, and MB11.

This section and Table 12 show the data structure for MB01, the names for and contents of MB10 and MB11, and the to-be-compliant-to-this-document status of these memory banks. See Figure 2 for additional memory bank details.

Table 12: Comparison of ISO and EPC Data Structures in MB01, MB10 and MB11

	MB01 (UII)				MB10	MB11
ISO (See Table 5 for MB01 encoding)	DI	IAC	CIN	SN	TID	USER MEMORY
EPC (See Table E.1)	Header and Filter Value and Partition		Company Prefix	Item Reference and Serial Number		

- MB01: UII (Unique Item Identification) - Globally unique, locked, mandatory – user-created.



- MB10: TID (Tag Identification) - Globally unique, locked, mandatory – silicon manufacturer- created.
- MB11: User Memory – Optional data, optional locking.

8.1.2 Data Field Identification

The Data Identifier(s) (DIs) are defined in the application sections.

8.1.3 Recommended Maximum Data Length

When placed in MB01, identification data should contain a recommended maximum of 35 characters (exclusive of the Data Identifier), and should not exceed a recommended maximum of 40 characters (240 6-bit characters).

As an example, encoding a UII consisting of 40 alphanumeric characters requires an MB01 size of 240 bits (when using 6-bit encoding). Along with the UII, MB01 also contains the Protocol Control information (CRC and PC), which consists of 32 bits. This leads to a MB01 size of 272 bits (32 bits + 240 bits).

Note that UIIs larger than 40 characters may lead to performance limitations (i.e., reading time, overall process timing).

8.1.4 Character Set

When using 6-bit encoding, only the following characters are allowed: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, * (asterisk), + (plus sign), - (dash), . (period or full stop), ^EO_T, ^RS, and ^GS from Table 9.

When using 8-bit encoding, UTF-8 is to be used.

See Annex M for 8-bit encoding details.

8.1.5 UII (MB01) Data Structure

The acronyms used in Table 13 below are explained in detail in the sections that follow the table.

Table 13: UII (MB01) Data Structure

Identifier	Structure				
37S	IAC	CIN	PN	+	SN
25S	IAC	CIN	SN (Consists of PN and part SN)		
I	Vehicle Identification Number (VIN)				
4I	VIN	+	Vehicle Registration License Plate Number		
5I	Body Tag Number (BTN)	+	Production Order Number (PON)	+	SN

8.1.5.1 Issuing Agency Code (IAC)

The Issuing Agency Code (IAC), which consists of a range from one (1) to a maximum of three (3) characters, is a code used to identify the entity / organization / company authorized by the appropriate



registration authority as an issuing agency in accordance with ISO/IEC 15459-2. Any IACs registered by AIM may be used with mutual agreement between trading partners. Recommended IACs are listed below:

Table 14: Issuing Agency Codes

Agency	Description	IAC	Characters
Dun & Bradstreet	Data Universal Numbering System (DUNS)	UN	2 (an)
Odette Europe	Odette Numbering System	OD	2 (an)
Teikoku Databank Ltd.	Teikoku Databank Ltd.	VTD	3 (an)
JIPDEC	Japan Information Processing Development Center	LA	2 (an)
NATO AC135	North Atlantic Treaty Organization The Group of National Directors on Codification (AC 135)	D	1 (an)
National Tax agency JAPAN	National Tax agency JAPAN	TAJ	3 (an)

8.1.5.2 Company Identification Number (CIN)

The Company Identification Number (CIN) is a unique code that is assigned by the issuing agency to each individual company. Each issuing agency has its own format for the CIN.

To be in compliance with this standard, the user shall have a unique CIN allocated by the appropriate issuing agency. See Table 15.

Table 15: Data Format Examples - CIN

IAC		CIN
DUNS	UN	9 numeric
JIPDEC	LA	12 alphanumeric
NATO AC135	D	Reference AC135
Odette	OD	6 alphanumeric
TEIKOKU DATABANK LTD.	VTD	9 numeric
National Tax agency JAPAN	TAJ	13 numeric

8.1.5.3 Serial Number (SN)

The supplier-assigned (or managed) SN, in combination with IAC and CIN, shall constitute a globally unique identifier for the item.



When using DI “37S” the IAC, CIN, PN, “+” and PSN shall be fixed and unchangeable for that specific item throughout its lifetime. DI “37S” is recommended due to its ability to be easily parsed.

When using DI “25S” the IAC, CIN, SN shall be fixed and unchangeable for that specific item throughout its lifetime. Within DI “25S”, the SN should be composed of a mutually-agreed-upon structure of concatenated PN and a SN, as illustrated in

Table 13 (note the different formats between DIs “37S” and “25S”).

The Serial Number (SN) shall be composed of the character set identified in Section 8.1.4.

The Part Serial Number (PSN) may be constructed in many different manners, such as identification of producing site, date produced, time produced, production line, final test station identification, lot, batch, heat, etc. See Annex I.

8.2 Item Identification – MB01-centric

The ability to identify an item at its lowest level is the part number. In addition, since the same part number may be provided by multiple suppliers, it is desirable to identify the specific source (site) that produced the item. The minimal data elements to meet item identification shall contain one of the following:

- An ISO-defined globally unique item identity; DI “37S” is recommended. (See also Annex B)
- EPC Coding Scheme for Item Identification (SGTIN-96). (See Annex E)

Table 16: Item Identification Structure Used in MB01

DI	Data Construction		
37S	IAC	CIN	PN + PSN
25S	IAC	CIN	SN

NOTE: Since the data are represented in binary, trading partners shall agree on how data would be represented in Human-Readable (HR) and / or within a 2D symbol if required.

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Table 17: ISO-based Example of MB01 Unique Item Identification Using DI “37S”

MB01														
Value to be stored	Electronic representation of data in tag memory (ASCII/Binary)													Bits
37SUN1234 5678999755 512300FFF AS+123456	3	7	S	U	N	1	2	3	4	5	6	7	8	240
	110011	110111	010011	010101	001110	110001	110010	110011	110100	110101	110110	110111	111000	
	9	9	9	7	5	5	5	1	2	3	0	0	F	
	111001	111001	111001	110111	110101	111000	111001	111001	111001	110111	110101	110000	000110	
	F	F	A	S	+	1	2	3	4	5	6	EOT	Word Pad*	
000110	000110	000001	010011	101011	110001	110010	110011	110100	110101	110110	100001	100000 100000		

*NOTE 1: See 5.2.1.1 and Annex B for further details for correctly utilizing the Word Pad process.

NOTE 2: The above table is based on 6-bit encoding. See Annex M for 8-bit encoding examples.

Table 18: ISO-based Example of MB01 Unique Item Identification Using DI "25S"

MB01														
Value to be stored	Electronic representation of data in tag memory (ASCII/Binary)													Bits
25SUN 014841806 PART NUMBER 0000001 A2B3C4	2	5	S	U	N	0	1	4	8	4	1	8	0	240
	110010	110101	010011	010101	001110	110000	110001	110100	111000	110100	110001	111000	110000	
	6	P	A	R	T	N	U	M	B	E	R	0	0	
	110110	010000	000001	010010	010100	001110	010101	001101	000010	000101	010010	110000	110000	
	0	0	0	0	1	A	2	B	3	C	4	EOT	Word Pad*	
110000	110000	110000	110000	110001	000001	110010	000010	110011	000011	110100	100001	100000 100000		

*NOTE 1: See 5.2.1.1 and Annex B for further details for correctly utilizing the Word Pad process.

NOTE 2: The above table is based on 6-bit encoding. See Annex M for 8-bit encoding examples.



8.2.1 MB11-Based Customer-Assigned Source and Item Identification

To facilitate a customer-assigned item identification, it is required that it be programmed into User Memory (MB11). The information in this section is based on that presumption.

For 6-bit encodation of Access Method 0, Format 13, see Table 19 and Annex D.

See Annex M for 8-bit encodation examples.

Table 19: Example of a Customer-Assigned Item Identification Placed in MB11

Value to be stored	Electronic representation in tag memory (HEX)	Bytes	Bits
18VUN987654321P876543 21	0D 4F 11 09 54 EE 78 DF 6D 74 CF 2C 40 4F 00 06 E3 7D B5 D3 3C B1	22	176

NOTE: Since the data are represented in hex, above, and written to the tag in binary, trading partners shall agree on how data would be represented in Human-Readable (HR) notation and / or within a 2D symbol, if required.

8.3 Verification

Verification or error proofing is the process of validating that the correct item is selected and / or installed in an assembly / production operation. An item may be engineered so that it can only be installed in a specific manner. In other cases, a “picking light” system might be used to identify the item to be used.

A Part Number provides the ability to identify an item at its lowest level – in a non-globally unique fashion.

See Table 16 for an ISO-based MB01-centric data construct.

8.4 Item Traceability Data Placed into MB01 (DI “37S”)

The ability to track (trace) a vehicle’s “as-built” history (in conjunction with the VIN) through the product life cycle (cradle to grave) processes requires a unique differentiation of items.

The supplier shall use data identifier “37S” to assign globally unique item identification, with trading partner agreement. See Table 17.

The supplier’s item data is collected during the individual manufacturing / production / assembly processes and stored long-term. When used with the customer’s database, and as outlined in this section, the data allows, in combination with any campaigns, an exact determination of those vehicles in which a specific item or items were installed. The customer and supplier shall ensure that the data record of an item is maintained over its life cycle and remains globally unique. All detailed information about this item from the supplier (e.g., batch of raw materials used, manufacturers of the items supplied, test results, default settings, manufacturing site, manufacturing equipment, etc.) are to be documented and archived so that, when required, data are available on the functional, manufacturing, and material quality of the item(s) quickly, accurately, and unambiguously.

8.5 Item Characteristic(s): UII (MB01) and User Memory (MB11)

Having globally unique item identification (37S or 25S, as recommended by this document), coupled with key specific item characteristics, enable business processes. This capability supports warranty validation,



quality control, product development, calibration parameters, service, etc. RFID tags are read/write capable, i.e., the data can be both static (locked but readable) and dynamic (readable and writable). “New capabilities = new possibilities.”

Examples of product characteristics are test stand results for radiator pressure test; current draw for a lighting module; measured torque of a fastener; Radio Frequency (RF) of a device or any other significant measurement data that are determined to be significant for quality control or warranty. In some cases, product characteristics are needed for use by processes such as piston size match to cylinder bore.

A major opportunity for leveraging product characteristics is when new technologies are being introduced, for example, electric vehicle batteries. Because there is no history yet, “We don’t know what we don’t know”.

Consider an individual Lithium-ion (Li-ion) cell as an example. Having product characteristics such as open circuit voltage, internal cell resistance, ambient temperature of the test stand, etc., might be key parameters that engineering would like to know. For instance, a cell’s open circuit voltage is measured at the customer’s first quality control station and compared with the value recorded on the tag by the supplier’s final test audit. This triggers a go/no-go event and supports documentation for the return process. Using this methodology, critical data are available at site of use.

8.6 MB01-centric Vehicle Identification Number (VIN)

The VIN (sometimes incorrectly referred to as “VIN number”) is a unique serial number used by the automotive industry to identify individual motor vehicles (also applies to towed vehicles, motorcycles, and mopeds as defined in ISO 3833). Since 1981, the VIN consists of 17 characters, which do not include the letters I (i), N (o), or Q (q) (to avoid confusion with numerals 1 and 0).

Modern-day Vehicle Identification Number systems are based on two related standards, ISO 3779, and ISO 3780. The VIN is composed of only the DI “I” and the 17-character vehicle identification number as specified within these two standards. See Table 20 and Table 21 for details.

Table 20: Vehicle Identification Number (VIN) Definition

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
VIN	W	0	L	0	X	A	P	6	8	F	4	0	5	0	9	0	1
Function	World Manufacturer Identifier (WMI)			Vehicle Descriptor Section (VDS)						Vehicle Identifier Section (VIS)							

World Manufacturer Identifier (WMI): The first three characters uniquely identify the manufacturer of the vehicle using the World Manufacturer Identifier or WMI code.

Vehicle Descriptor Section (VDS): The 4th to 9th positions in the VIN are the Vehicle Descriptor Section or VDS. This is used, according to local regulations, to identify the vehicle type and may include information on the automobile platform used, the model, and the body style.

NOTE: The 9th position is used by the United States as a check digit, as detailed under 49 CFR, §§ 565.

Vehicle Identifier Section (VIS): The 10th to 17th positions are used as the Vehicle Identifier Section or VIS. This is used by the manufacturer to identify the individual vehicle in question. This may include information on options installed or engine and transmission choices, but often is a simple sequential number.



Model Year: The 10th digit is required worldwide to encode the model year of the vehicle. Besides the three letters that are not allowed in the VIN itself (I, O, and Q), the letters U and Z and the digit 0 are not used for the Model Year Code.

Plant Code: The 11th character encodes the factory of manufacture of the vehicle. Although each manufacturer has its own set of plant codes, its location in the VIN is standardized.

8.6.1 MB01 Encodation Example: VIN DI = I

The vehicle manufacturer shall assign VIN data and shall use the “I” data identifier.

The data in Table 21 are encoded according to ISO/IEC 17367. For encodation details, see Annex B.

NOTE: Along with encoding the VIN into the UII Tag Encoding segment of MB01, an AFI of “0xA1” would be encoded into the Attribute / AFI segment of MB01. See Figure 3.

Table 21: Example of 6-Bit Encoding of the VIN Data into the UII of MB01

Value to be stored	Electronic representation of data in tag memory (ASCII/Binary)												Bits	
I W0L0X AP68F40 50901	I	W	0	L	0	X	A	P	6	8	F	4	0	128
	001001	010111	110000	001100	110000	011000	000001	010000	110110	111000	000110	110100	110000	
	5	0	9	0	1	EOT	Word Pad*							
	110101	110000	111001	110000	110001	100001	10000010000010							

*NOTE: See 5.2.2 and Annex B for further details for correctly utilizing the Word Pad process.

NOTE 1: Table 21 does not show the AFI encoded; see Annex C for a full encodation of MB01 when PC Bit 17 = 1.

NOTE 2: This record shall be locked via the Permalock command. This is the ability of the tag protocol to cause a memory location to be “read-only.” Once “locked,” that memory location cannot be unlocked.

NOTE 3: Table 21 shows a 6-bit encoding example - see Annex M for 8-bit encoding examples.

8.6.2 MB01 Encoding Example: DI “4I” - Globally unique transport vehicle

In addition to DI “I”, DI “4I” (Globally unique transport vehicle) can be used to identify commercial vehicles such as Auto transporters. DI "4I" can be used together with a RFID-based Supply Chain Label, preferably attached to the windshield.

DI “4I” provides several advantages. Auto transporters and the vehicles it is transporting can be pre-assigned within IT, and the RFID reader network can be used to verify that the correct auto transporter picked up the correct vehicles. The entire load (auto transporter + the transported vehicles) can be tracked based on the UII of the car transporter.



Furthermore, the identification and authentication of the car carrier can be done by examining the VIN and the vehicle registration number that has been written into the transponder. This is usually done by video-based camera systems. See Figure 8.

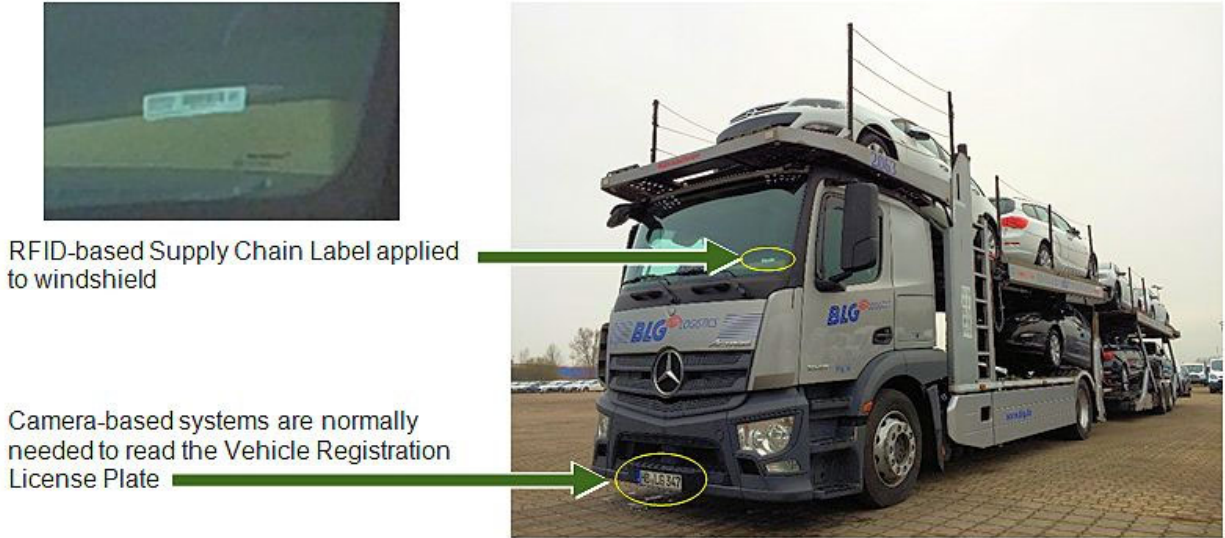


Figure 8: Example of a RFID-based Supply Chain Label attached to a Windshield

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Table 22: ISO-based Example of MB01 Unique Item Identification Using DI “4I”

MB01														
Value to be stored	Electronic representation of data in tag memory (ASCII/Binary)												Bits	
4IW0L0X AP68F405 0901+GG AB1234	4	I	W	0	L	0	X	A	P	6	8	F	4	176
	110100	001001	010111	110000	001100	110000	011000	000001	010000	110110	111000	000110	110100	
	0	5	0	9	0	1	+	G	G	A	B	1	2	
	110000	110101	110000	111001	110000	110001	101011	000111	000111	000001	000010	110001	110010	
	3	4	EOT	Word Pad*										
110011	110100	100001	10											

*NOTE: See 5.2.2 and Annex B for further details for correctly utilizing the Word Pad process.

NOTE 1: Table 22 does not show the AFI encoded; see Annex B for a full encodation of MB01 when PC Bit 17 = 1.

NOTE 2: This record shall be locked via the Permalock command. This is the ability of the tag protocol to cause a memory location to be “read-only.” Once “locked,” that memory location cannot be unlocked.

NOTE 3: Table 22 shows a 6-bit encoding example - see Annex M for 8-bit encoding examples.

8.6.3 MB01 Encoding Example: DI “5I” - Unique Production Vehicle Identifier

There are various production scenarios where it is necessary to have an unambiguous method to differentiate between the vehicles in production and finished vehicles. At the beginning of vehicle production, the VIN number is usually not yet available or assigned to the body for which it is intended, and a unique identification for control purposes is required. In general, this unique production vehicle identification is based on a body number, and optionally, a production order number.

Following are just a few of the benefits of using DI 5I:

- Being able to use the same data structure concept as that for finished vehicles (with DI “I”) in the vehicle production processes.
- Being able to track unfinished vehicles and separating them from finished product - as well as other “things” - is now possible using AFI 90 and DI “5I”.
- Controlling the vehicle in cell production processes (Industry 4.0)

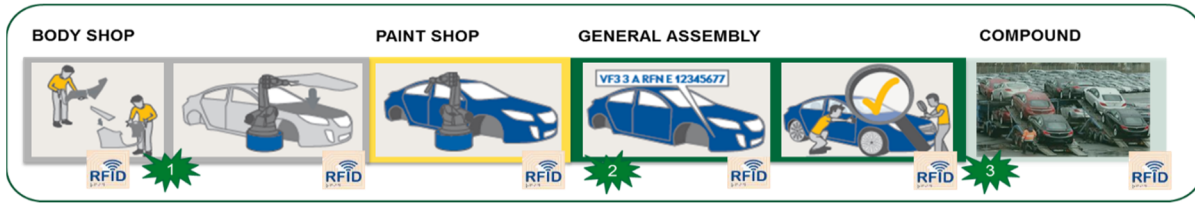


Figure 9: Typical steps in vehicle production

The descriptions, below, correspond with the numbers in the Figure 9 graphic, above. The graphic is for illustration purposes only and is not intended as a specific definition of vehicle production.

1. In the Body shop, DI “5I”, along with the Body Tag Number, Production Order Number and Serial Number would be assigned and applied.
2. The VIN assignment/application would occur in General Assembly. The use of DI “5I”, using either the SN or the VIN configuration, versus using DI “I”, provides separation of unfinished vehicles from finished (legal) vehicles during the assembly / quality audit process.
3. When the vehicle is transferred from production to sales the datastream represented by DI “5I” would be replaced with the datastream made up of and represented by DI “I”.

Table 23: Production Vehicle Identification Structure Used in MB01

AFI	DI	BTN		PON		SN	E _{OT}
Application Family Identifier	Data Identifier	Body Tag Number	Separator	Production Order Number	Separator	Serial Number	End of Transmission
90	5I	x char (an)	+	y char (an)	+	z char (an)	100001

DI “5I” can be used with a bar code, a 2D symbol and / or RFID technology. If an RFID tag is used for this identification, then at the end of the production line either the tag must be removed or MB01 has to be re-programmed with the VIN only (data identifier "I"), and subsequently locked.

•

Table 24: ISO-based Example of MB01 Unique Item Identification Using DI “5I”

MB01														
Value to be stored	Electronic representation of data in tag memory (ASCII/Binary)													Bits
	5	I	A	B	C	D	1	2	3	4	+	C	O	224



5IABCD1 234+CO1 234+W0L 0XAP68F 4050901	110100	001001	000001	000010	000011	000100	110001	110010	110011	110100	101011	000011	001111
	1	2	3	4	+	W	0	L	0	X	A	P	6
	110001	110010	110011	110100	101011	010111	110000	001100	110000	011000	000001	010000	110110
	8	F	4	0	5	0	9	0	1	EOT	<i>Word Pad*</i>		
	111000	000110	110100	110000	110101	110000	111001	110000	110001	100001	<i>10000010</i>		

*NOTE: See 5.2.2 and Annex B for further details for correctly utilizing the Word Pad process.

NOTE 1: Table 24 does not show the AFI encoded; see Annex B for a full encodation of DI “4I” into MB01 when PC Bit 17 = 1.

NOTE 2: Table 24 shows a 6-bit encoding example. See Annex M for 8-bit encoding examples.

8.7 Methods for Fraud Prevention and Detection

Effective methods of fraud prevention and detection are essential to successful business. The options provided below are not all-inclusive but are provided as informational.

There are two different methods for fraud prevention and detection:

- Object-oriented methods
- System-oriented methods

Object-orientated methods focus on protecting the object-ID and/or data of parts or components. This implies encryption methods that protect the reference-ID (UII) and possibly additional data stored to the UM against unauthorized access. Please review ISO TC 247 for further details.

An additional object-orientated method consists in matching the object-ID (UII) and the inalterable TID, which is issued by the chip producer (Figure 10). The composed reference-ID is stored in a database. Parts and components that are not maintained in the database are likely to be counterfeits.

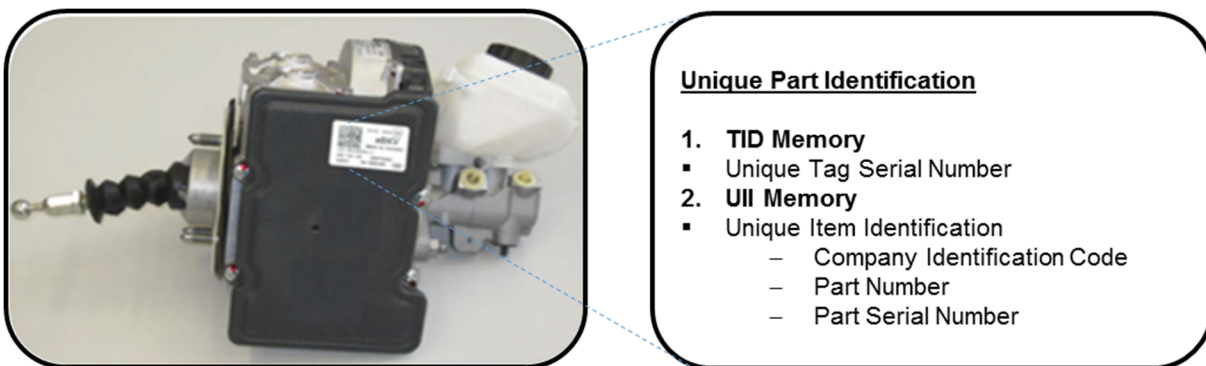


Figure 10: Example of Counterfeit Measures - Object-Oriented Method

System-orientated methods imply that the parts and components are frequently captured throughout the supply chain and their entire product life cycle. This results in very detailed electronic documentation, which can be used to run plausibility checks, i.e., inconsistencies support in detecting counterfeits and localizing potential origins. System-orientated methods require a very high level of partner collaboration



and process/system integration. The addressed parts and components are frequently captured, and the accumulated data is kept in central database systems (see Figure 11) which are shared by the business partners (shared repository).

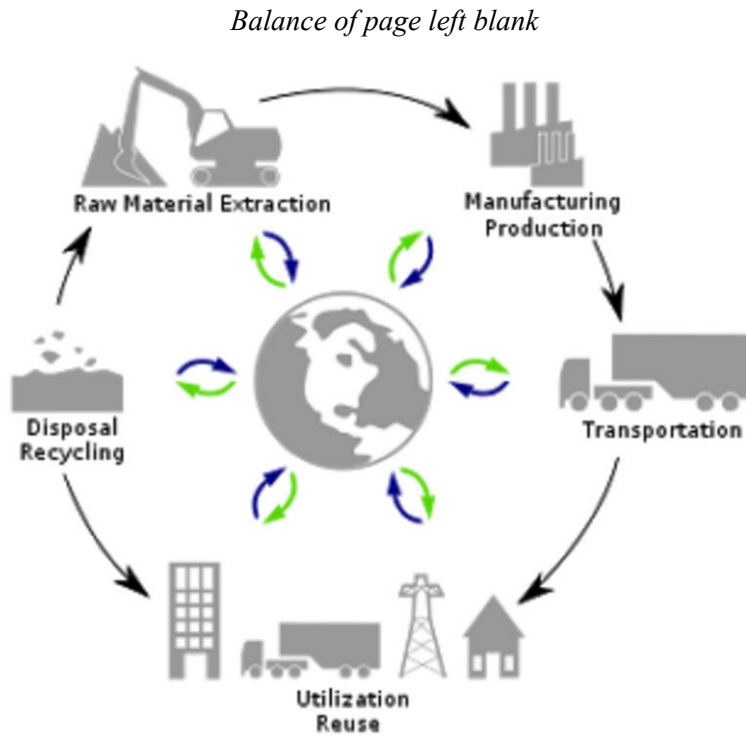


Figure 11: Example of Counterfeit Measures - System-Oriented Method

8.8 Data Retention Requirements

Should the need arise (e.g., safety or quality event), the supplier shall have (with mutual trading partner agreement) the capability to obtain sufficient data from their system(s) to provide applicable data (plant site, materials, processes, test data, etc.) and these data should be retained in compliance with the respective country's requirements.

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Appendix



ANNEX B: MB01; ISO -BASED DATA FORMAT EXAMPLES

(Informative)

NOTE 1: The AFI shall NOT be encoded as part of the UII when PC Bit 17 = 1. The AFI is programmed into the Attribute / AFI section of MB01, starting at memory location 0x18 through memory location 0x1F. See ISO/IEC 15961-2 for details on the AFI. See Figure 2.

NOTE 2: This Annex shows 6-bit encoding examples. See Annex M for 8-bit encoding examples.

The reference-ID is 6-bit encoded (cf. Table 9). The string is padded until an even number of bytes is reached. In the PC area (header) the UII length is declared in 16-bit words (2 bytes).

DI “37S” in the UII (MB01)

For the step-by-step details on how the data were encoded, see ISO/IEC 17367.

UII

37SUN12345678999755512300FFFAS+123456

Binary value using 6-bit Compaction, including E_{OT}

110011	110111	010011	010101	001110	110001
110010	110011	110100	110101	110110	110111
111000	111001	111001	111001	110111	110101
110101	110101	110001	110010	110011	110000
110000	000110	000110	000110	000001	010011
101011	110001	110010	110011	110100	110101
110110	100001				

Entire datastream assembled into 8-bit bytes, including padding bits

11001111	01110100	11010101	00111011	00011100	10110011
11010011	01011101	10110111	11100011	10011110	01111001
11011111	01011101	01110101	11000111	00101100	11110000
11000000	01100001	10000110	00000101	00111010	11110001
11001011	00111101	00110101	11011010	0001 1000	00100000

Hex code representation of each binary byte

CF	74	D5	3B	1C	B3
D3	5D	B7	E3	9E	79
DF	5D	75	C7	2C	F0
C0	61	86	05	3A	F1
CB	3D	35	DA	18	20

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PC data (Byte 1):

UII-length of 16-bit words:	0b <i>0111 1</i>	(30 bytes → 15 words [16 bits = 1 word])
Valid User Memory:	0b <i>1</i>	(User Memory)
XPC:	0b <i>0</i>	(not used – reserved)
EPC or ISO code:	0b <i>1</i>	(ISO)
All PC bits:	0b <i>0111 1101</i>	(0x7D)

PC (Byte 1) **AFI (Byte 2 of PC)**
0x7D **0xA1**

Coded UII content (including PC and AFI) in HEX, in the form PC (1*) – AFI (2*) - UII:

1*	2*	UII																													
7	A	CF	74	D5	3B	1C	B3	D3	5D	B7	E3	9E	79	DF	5D	75	C7	2C	F0	C0	61	86	05	3A	F1	CB	3D	35	DA	18	20
D	1																														

*NOTE:

“1*” refers to byte 1 of the Protocol Control Word (Length, PC Bits 15, 16 and 17).

“2*” refers to byte 2 of the Protocol Control Word, the Application Family Identifier (AFI).

See Figure 3.

VIN in the UII (MB 01)

Note: The exact syntax of the OEM-specific VIN whose individual implementation and possible additions (e.g., color codes) can be found in the supplementary guidelines and standards of the respective OEM.

UII

IW0L0XAP68F4050901

Using 6-bit Compaction, including E_{OT}

001001	010111	110000	001100	110000	011000
000001	010000	110110	111000	000110	110100
110000	110101	110000	111001	110000	110001
<i>100001</i>					

Entire datastream assembled into 8-bit bytes, including padding bits

00100101	01111100	00001100	11000001	10000000	01010000
11011011	10000001	10110100	11000011	01011100	00111001
11000011	00011000	<i>01100000</i>	<i>10000010</i>		



Hex code representation of the binary bytes

25	7C	0C	C1	80	50
DB	81	B4	C3	5C	39
C3	18	60	82		

PC data (Byte 1):

UII-length of 16-bit words:	0b 0100 0	(16 bytes → 8 words [16 bits = 1 word])
Valid User Memory:	0b 0	(User Memory)
XPC:	0b 0	(not used – reserved)
EPC or ISO code:	0b 1	(ISO)
All PC bits:	0b 0100 0001	(0x41)

PC (Byte 1)
0x41

AFI (Byte 2 of PC)
0x90

Coded UII content in HEX (including PC and AFI), in the form PC (1*) – AFI (2*) - UII:

1*	2*	UII															
41	90	25	7C	0C	C1	80	50	DB	81	B4	C3	5C	39	C3	18	60	82

*NOTE:

“1*” refers to byte 1 of the Protocol Control Word (Length, PC Bits 15, 16 and 17).

“2*” refers to byte 2 of the Protocol Control Word, the Application Family Identifier (AFI).

See Figure 3.

UII (MB01) Globally unique transport vehicle (DI “4I”)

Table B.1: Description of DI “4I”

Data Identifier	Object Type	Separator	Vehicle Registration License Plate Number
4I	Variable	+	Variable
2 char (an)	17 char (an)	1 char	x char (an)

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Table B.2: MB01 Coding Scheme for Globally unique transport vehicle (DI “4I”)

Bit Location (HEX)	Data Type	Value	Size	Description
MB 01: CRC + Protocol Control Word (Header)				
00 –0F	CRC-16	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	0b01000	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB112 1 = Valid User Data in MB112
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ not used
17	PC bit 0x17	0b1	1 bit	1 = Data interpretation rules based on ISO
18 – 1F	AFI	0x90	8 bits	Application Family Identifier used according to ISO/IEC 15961-2 Data Construct Register
	Subtotal		32 bits	
MB 01: Unique Item Identifier (UII) with 6 bit encoding				
Start at location 20 Go to end of data / end of available memory	DI	“4I”	1 an	Data Identifier “4I”
	VIN	“W0L0XAP68F4050901”	17 an	Vehicle Identification Number
	Separator	+	1 an	“+” sign separator (0x2B)
	Vehicle Registration LPN	GGAB1234	1...X an	Up to “x” alphanumeric characters, in capital letters
	^E _{OT}	0b100001	6 bit	End of Transmission
	Padding	0b10, 0b1000, 0b100000, 0b10000010, 0b1000001000, 0b100000100000, or 0b10000010000010	2, 4, 6, 8, 10, 12 or 14 bits	Word Padding According to ISO/IEC 15962
	Subtotal		Variable	Up to 240 bits



Bit Location (HEX)	Data Type	Value	Size	Description
	TOTAL MB01 BITS:		VARIABLE	UP TO 272 BITS

UII

4IW0L0XAP68F4050901+GGAB1234

Compaction 6-bit code including E_{OT}

110100	001001	010111	110000	001100	110000
011000	000001	010000	110110	111000	000110
110100	110000	110101	110000	111001	110000
110001	101011	000111	000111	000001	000010
110001	110010	110011	110100	100001	

Split into 8-bit fragments including padding bits

11010000	10010101	11110000	00110011	00000110	00000001
01000011	01101110	00000110	11010011	00001101	01110000
11100111	00001100	01101011	00011100	01110000	01000010
11000111	00101100	11110100	10000110		

Hex code representation

D0	95	F0	33	06	01
43	6E	06	D3	0D	70
E7	0C	6B	1C	70	42
C7	2C	F4	86		

PC data (Byte 1):

UII-length of 16-bit words:	0b 0101 1	(22 bytes → 11 words [16 bits = 1 word])
Valid User Memory:	0b 0	(user memory)
XPC:	0b 0	(not used – reserved)
EPC or ISO code:	0b 1	(ISO)
All PC bits:	0b 0101 1001	(0x59)

PC (Byte 1)

0x59

AFI (Byte 2 of PC)

0x90

Coded UII content in HEX (including PC and AFI), in the form PC (1*) – AFI (2*) - UII:

1*	2*	UII																					
59	90	D0	95	F0	33	06	01	43	6E	06	D3	0D	70	E7	0C	6B	1C	70	42	C7	2C	F4	86

*NOTE:



“1*” refers to byte 1 of the Protocol Control Word (Length, PC Bits 15, 16 and 17).

“2*” refers to byte 2 of the Protocol Control Word, the Application Family Identifier (AFI).

See Figure 3

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ANNEX C: MB11; ACCESS METHOD 0, FORMAT 3 DATA EXAMPLE

(Informative)

ENCODING

The following data encoding example is provided to show how the “As-Built” example of an ISO/IEC 15434 message is to be encoded in User Memory (UM), using Access Method 0 and Format 3, as outlined in ISO/IEC FDIS 15962:2011. This Annex uses 6-bit encoding. See Annex M for 8-bit encoding examples.

The UM data is coded similar to the UII data. The first part of the data represents the header. The length of the header is three or four bytes, depending on the length of the following data string.

In the following, we describe how to code the UM content.

Table C.1: Sample Data for Encoding MB11

DI	Description	Sample	DI+Data Length
1P	Supplier part number	5221886	9
2P	Engineering change level	00C	5
52P	Color code	F1F	6
2Q	Weight	2	3
4D	Manufacturing date (Julian YYDDD)	15045	7

The complete data string including DIs, actual data contents and separators is 6-bit encoded and padded according to ISO/IEC 15962 for MB11 until an even number of bytes is reached.

UM Data

1P5221886^G_S2P00C^G_S52PF1F^G_S2Q2^G_S4D15045

The sample string consists of 30 characters. Additionally, 5 control characters are used (including ^EO_T). This results in 35 characters. Therefore, the coding sample requires 35 * 6 = 210 bits. Consequently, the length of the header is 3 bytes (24 bits). This results in a total length of 234 bit. The string is padded with 6 padding bits to reach an even number of 16 bit Words (header + data string). The overall length including padding is 240 bits (30 bytes = 15 16-bit Words).

Binary value using 6-bit Compaction, including ^EO_T

110001	010000	110101	110010	110010	110001
111000	111000	110110	011110	110010	010000
110000	110000	000011	011110	110101	110010
010000	000110	110001	000110	011110	110010
010001	110010	011110	110100	000100	110001
110101	110000	110100	110101	100001	

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Entire datastream assembled into 8-bit bytes, including padding bits

11000101	00001101	01110010	11001011	00011110	00111000
11011001	11101100	10010000	11000011	00000000	11011110
11010111	00100100	00000110	11000100	01100111	10110010
01000111	00100111	10110100	00010011	00011101	01110000
11010011	01011000	01 100001			

Hex code representation of each binary byte

C5	0D	72	CB	1E	38
D9	EC	90	C3	00	DE
D7	24	06	C4	67	B2
47	27	B4	13	1D	70
D3	58	61			

Header data (see Table 10):

DSFID:	0h	03		
PreCursor:	0h	46		
Byte Count Indicator Switch:	0b		0	(only one length byte)
Byte Count Indicator Length:	0b		001 1011	(27 bytes of "6-bit data")
All header bytes:	0h	03	46	1B

Coded UM content (including header):

DSFID: **0x03**

Precursor: **0x46**

Byte Count Indicator: **0x1B**

Data (in HEX):

C5 0D 72 CB 1E 38 D9 EC 90 C3 00 DE D7 24 06 C4 67 B2 47 27 B4 13 1D 70 D3 58 61

Entire MB11 encodation (in HEX; spaces used for clarity – they are not part of the data):

03 46 1B C5 0D 72 CB 1E 38 D9 EC 90 C3 00 DE D7 24 06 C4 67 B2 47 27 B4 13 1D 70 D3 58 61

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ANNEX D: MB11; ACCESS METHOD 0, FORMAT 13 DATA EXAMPLES

(Informative)

The following data encoding examples (using 6-bit encoding) are provided to show how the ISO/IEC 15962 data syntax rules are used in MB11 (User Memory). See Annex M for 8-bit encoding examples.

DSFID **0x0D** (No Directory Access Method) is used in all examples.

NOTE: Spaces have been added to binary and hex data for clarity ONLY.

1) Customer Part Number:

P1234567890ABCDEFGH

DI: P

- Using the ISO/IEC 15962 Assigned Relative OID DI Table, the value for DI “P” = 15 / 0b1111 / 0x0F. As the Relative OID is larger than 14, it must be encoded in a separate byte; see Precursor, below.
- Compact data (excluding DI) using **6-Bit Compaction**, Precursor value = 0b100.

Data: **1234567890ABCDEFGH**

- Convert each data character (disregard DI) to HEX (using Table G.1 in Annex G), then to byte-based Binary:
 - 0X31 32 33 34 35 36 37 38 39 30 41 42 43 44 45 46 47 48
 - 00110001 00110010 00110011 00110100 00110101 00110110 00110111
00111000 00111001 00110000 01000001 01000010 01000011 01000100
01000101 01000110 01000111 01001000
- Strip off leading binary “00” and “01” from each byte, and concatenate remaining 6-bit segments to bit-string:
 - 1100011100101100111101001101011101101101111100011100111000000001
000010000011000100000101000110000111001000
- Divide bit-string, starting with MSB, into 8-bit bytes. Pad as appropriate (binary “1000” in this example):
 - 11000111 00101100 11110100 11010111 01101101 11111000 11100111
00000000 01000010 00001100 01000001 01000110 00011100 1000**1000**
- Convert binary to HEX: C7 2C F4 D7 6D F8 E7 00 42 0C 41 46 1C 88

Complete Message Construction:

- Precursor: 0b01001111 / 0x4F
 - Offset = 0b0
 - Compaction Code = 0b100



- Relative OID value >14 = 0b1111 (Requires Relative OID be placed in additional byte)
- Relative OID: 15 – 15 = 0 / 0b0000 / 0x00
- Length code: 14 / 0b1110 / 0x0E

Message encoded (in hex): **4F 00 0E C7 2C F4 D7 6D F8 E7 00 42 0C 41 46 1C 88**

- In this example, the DSFID “0x0D” is encoded as the first byte within User Memory (MB11).

Complete MB11 Message: ASCII Data to DSFID, Precursor, Relative OID, Length of Data, Compacted Data - in HEX:

P1234567890ABCDEFGH ↔ **0D 4F 00 0E C7 2C F4 D7 6D F8 E7 00 42 0C 41 46 1C 88**

The complete encoding requires 18 bytes, or 144 bits.

2) Mutually Defined;

ZBETWEEN TRADING PARTNERS 12345

DI: Z

NOTE: This DI shall be used only with trading partner agreement and definition.

Using the ISO/IEC 15962 DI Table, the value for DI “Z” = 103 / 0b1100111 / 0x67. As the Relative OID is larger than 14, it shall be encoded in a separate byte; see Precursor, below.

Compact contents using **6-Bit Compaction**, Precursor value = 0b100.

Data: BETWEEN TRADING PARTNERS 12345

Convert each data character (disregard DI) to HEX (using Table G.1 in Annex G), then to byte-based Binary:

```
42 45 54 57 45 45 4E 54 52 41 44 49 4E 47 50 41 52 54 4E 45 52 53 31 32 33 34 35
01000010 01000101 01010100 01010111 01000101 01000101 01001110 01010100 01010010
01000001 01000100 01001001 01001110 01000111 01010000 01000001 01010010 01010100
01001110 01000101 01010010 01010011 00110001 00110010 00110011 00110100 00110101
```

Strip off leading binary “00” or “01” from each byte and concatenate remaining 6-bit segments to bit-string:

```
000010000101010100010111000101000101001110010100010010000001000100001001001110
000111010000000001010010010100001110000101010010010011110001110010110011110100
110101
```

Divide bit-string, starting with MSB, into 8-bit bytes. Pad as appropriate (binary “100000” in this example):

```
00001000 01010101 00010111 00010100 01010011 10010100 01001000 00010001 00001001
00111000 01110100 00000001 01001001 01000011 10000101 01001001 00111100 01110010
11001111 01001101 01100000
```

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Convert binary to HEX: 08 55 17 14 53 94 48 11 09 38 74 01 49 43 85 49 3C 72 CF 4D 60

Complete Message Construction:

- Precursor (binary/hex) = 0b01001111 / 0x4F
Offset (binary) = 0b0
6-Bit Compaction Code (binary) = 0b100
Relative OID value >14 = 0b1111 (Requires Relative OID be placed in additional byte)
- Relative OID; 103 – 15 = 88 / 0b100001 / 0x41
- Length of data = 21 / 0b10101 / 0x15
- Compacted data in HEX = **08 55 17 15 53 94 48 11 09 38 74 01 49 43 85 49 3C 72 CF 4D 60**
- In this example, the DSFID “0x0D” is encoded as the first byte within User Memory (MB11).

Complete Message: ASCII Data to DSFID, Precursor, Relative OID, Length of Data, Compacted Data - in HEX:

ZBETWEEN TRADING PARTNERS 12345 ↔ 0D 4F 41 15 08 55 17 14 53 94 48 11 09 38 74 01 49 43 85 49 3C 72 CF 4D 60

The complete encoding requires 25 bytes, or 200 bits.

3) Tire ID;

21SMKB5A8WR2405

DI: 21S

Using the ISO/IEC 15962 DI Table, 21S = 08 / 0b1000 / 0x08 and encodes directly into the Precursor; see **Encoding the Precursor field**, below.

Encoding the Tire ID user data length code

Length code (hex): 09
Tire ID message length = 9 bytes.
(Length between 0 and 127 bytes is encoded with 1 byte and a lead binary bit of 0.)

Binary: 00001001

HEX: 09 48 09 34 B0 B5 07 85 D2 CB 4C 35

Encoding the Tire ID user data

Data: MKB5A8WR2405

Compacts as (hex): 34 B0 B5 07 85 D2 CB 4C 35

Compaction: 6-bit

M	K	B	
0x4D	0x4B	0x42	- (balance of data =) 5A8WR2405
01001101	01001011	01000010	- HEX conversion
001101	001011	000010	- Binary conversion of HEX data
			- Drop first two bits in each byte



ANNEX E: SGTIN-96 DATA FORMAT

(Informative)

Table E.1: SGTIN-96 Data Format

Header	Filter Value	Partition	Company Prefix	Item Reference	Serial
8 bits	3 bits	3 bits	20-40 bits	24-4 bits	38 bits
0011 0000 (actual value)	0-7** (decimal capacity)	0-7*** (decimal capacity)	999,999 - 999,999,999,999 (Max decimal range*)	9,999,999 - 9 (Max decimal range*)	274,877,906,943* (decimal capacity)

NOTE:* Maximum decimal value range of Company Prefix and Item Reference fields varies according to the contents of the Partition field.

NOTE:** Refer to EPC Tag Data Standard (latest published version).

NOTE:*** Refer to EPC Tag Data Standard (latest published version).

The SGTIN consists of the following information elements:

The **Company Prefix**: assigned by GS1 to a managing entity.

The **Item Reference**: assigned by the managing entity to a particular object class. The Item Reference for the purposes of UII encoding is derived from the GTIN by concatenating the Indicator Digit of the GTIN and the Item Reference digits and treating the result as a single integer.

NOTE: The Indicator Digit (binary 0b0 or 0b1), when set to 0, indicates that there is NOT a leading zero digit in the Item Reference number. When the Indicator Digit is set to 1, this indicates that there IS a leading zero digit in the Item Reference number.

The **Serial Number**: assigned by the managing entity to an individual object.

NOTE: The data in this Annex are provided for informational purposes only. To obtain the complete construction details of the SGTIN-96, refer to GS1’s Tag Data Standard, latest revision.

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ANNEX F: MINIMUM RFID SYSTEM PERFORMANCE

(Informative)

RFID system performance shall be as specified within the ISO/IEC 18000-63 / GS1 UHF Gen 2 air-interface standards. The following information was provided by ODIN Technologies, which has sole responsibility for its accuracy. There are many factors, besides those mentioned here, that can affect encode speeds.

ISO/IEC 18000-63 / GS1 UHF Gen 2 Write Process:

The Gen 2 command sequence for a write operation takes place in two steps:

Step 1: Inventory – Time estimation – 5 milliseconds (10^{-3} seconds or ms)

The total time for inventory depends on the reader platform, link frequencies, query command, and Q value. The Inventory process takes place in the following sequence:

1. Reader sends a Query
2. Tag responds back with an RN16
3. Reader acknowledges with an ACK
4. Tag responds back with MB01; CRC, PC Word, UII.

Step 2: Write (16-bit) – Time estimation - approximately 15 ms

The write process takes place only after a successful Inventory cycle. The entire inventory and write cycle is repeated until all the bits are fully written. The time taken to complete the write cycle largely depends on the reader platform. The write process takes place in the following sequence:

1. Reader request for the RN # (ReqRN)
2. Tag responds back with a RN16
3. Reader sends a write command, which contains the address where to write the UII, user memory, or reserved memory data
4. Tag writes 16 bits
5. Tag transmits RN16
6. Reader acknowledges the RN16
7. The above steps are repeated for each 16-bit data string

Theoretical calculations:

The calculated write time for encoding 96 bits UII:

$$5 \text{ ms (inventory)} + ([96/16] * 15 \text{ ms}) \text{ (write)} = 95 \text{ ms}$$

Actual measurements: (Information provided by ODIN Technologies)

Measured time to encode Alien Higgs 3, Impinj Monza 3, and NXP G2XX silicon (96 bits)

- Reader used for the test Sirit IN510
- Power level 1 watt at the connector
- Antenna gain used for the test 6 dBi

**Table F.1: Actual Read/Write Measurements**

Silicon	Approximate time (ms)	Approximate Encode Speed (feet/min)*
Alien Higgs 3	95	335
Impinj Monza 3	51	620
NXP G2XX	51	620

*NOTE: The conveyor speed at which the full UII (96 bits) can be successfully encoded.



ANNEX G: ISO 646 CHARACTER REPRESENTATION

(Normative)

Table G.1: ISO 646 Character Set

HEX	DEC	ASCII /ISO 646 Character	HEX	DEC	ASCII /ISO 646 Character	HEX	DEC	ASCII /ISO 646 Character
00	00	NUL	2B	43	+	56	86	V
01	01	SOH	2C	44	,	57	87	W
02	02	STX	2D	45	-	58	88	X
03	03	ETX	2E	46	.	59	89	Y
04	04	EOT	2F	47	/	5A	90	Z
05	05	ENQ	30	48	0	5B	91	[
06	06	ACK	31	49	1	5C	92	\
07	07	BEL	32	50	2	5D	93]
08	08	BS	33	51	3	5E	94	^
09	09	HT	34	52	4	5F	95	_
0A	10	LF	35	53	5	60	96	`
0B	11	VT	36	54	6	61	97	a
0C	12	FF	37	55	7	62	98	b
0D	13	CR	38	56	8	63	99	c
0E	14	SO	39	57	9	64	100	d
0F	15	SI	3A	58	:	65	101	e
10	16	DLE	3B	59	;	66	102	f
11	17	DC1	3C	60	<	67	103	g
12	18	DC2	3D	61	=	68	104	h
13	19	DC3	3E	62	>	69	105	i
14	20	DC4	3F	63	?	6A	106	j
15	21	NAK	40	64	@	6B	107	k
16	22	SYN	41	65	A	6C	108	l
17	23	ETB	42	66	B	6D	109	m
18	24	CAN	43	67	C	6E	110	n
19	25	EM	44	68	D	6F	111	o
1A	26	SUB	45	69	E	70	112	p
1B	27	ESC	46	70	F	71	113	q
1C	28	F _S	47	71	G	72	114	r
1D	29	G _S	48	72	H	73	115	s
1E	30	R _S	49	73	I	74	116	t
1F	31	U _S	4A	74	J	75	117	u
20	32	SP	4B	75	K	76	118	v
21	33	!	4C	76	L	77	119	w
22	34	"	4D	77	M	78	120	x
23	35	#	4E	78	N	79	121	y
24	36	\$	4F	79	O	7A	122	z
25	37	%	50	80	P	7B	123	{
26	38	&	51	81	Q	7C	124	|
27	39	'	52	82	R	7D	125	}
28	40	(	53	83	S	7E	126	~
29	41	)	54	84	T	7F	127	DEL
2A	42	*	55	85	U			



ANNEX H: RFID AND 2D SYMBOLOGIES

(Informative)

While this version of this standard is principally centered on RFID, it is the intent of this standard to encourage interoperability between RFID tags and labels, especially via 2D-based data. Much benefit is to be gained by using both technologies seamlessly within an enterprise.

The AIAG standards B-4 *Parts Identification and Tracking Application* and B-11 *Item Level RFID* are recommended for your review. The JAIF B-16 *Global Transport Label Standard for the Automotive Industry* is recommended for your review as a reference for logistics.

NOTE: The non-printable control characters G_S , R_S and $^E_{O_T}$ do not have a human-readable / printable representation, i.e., a symbol to represent them. Therefore, software programmers might code their programs to represent these control characters using ISO 646 viewable / printable characters to aid human readability. For example, R_S as ▲; G_S as ↔; and $^E_{O_T}$ as ◆ or simply as a space between data fields without R_S or $^E_{O_T}$ being displayed. Unfortunately, there is no consistent recommendation or standard, so it is left up to the software providers to adopt their own representations.

Optical-Media-to-RFID-6-Bit-Encoding Example

The creation of the unique item identity, UII, starts at the creation of the part. What is not shown in the following “As Built” example is that each sub-assembly’s UII has its own UII. It has already been created by the manufacturer and placed onto the sub-assembly using a 2D symbology-based label.

The following data example shows how data can be read from a 2D Data Matrix symbol and then seamlessly encoded within an RFID tag. It also shows where specific data are placed within the RFID tag, and how they are encoded.

Figure H.1 illustrates a gas tank and the parts that are assembled into it, along with the label that is used to identify each part.

Figure H.2 shows a 2D Data Matrix symbol with all five (5) pieces of data shown, plus a traceability code for the entire assembled gas tank encoded into it.

NOTE: In the following examples, the DIs are not included in the Human-Readable Information - by design. The DIs are encoded within the Data Matrix symbol. See Table H.1.

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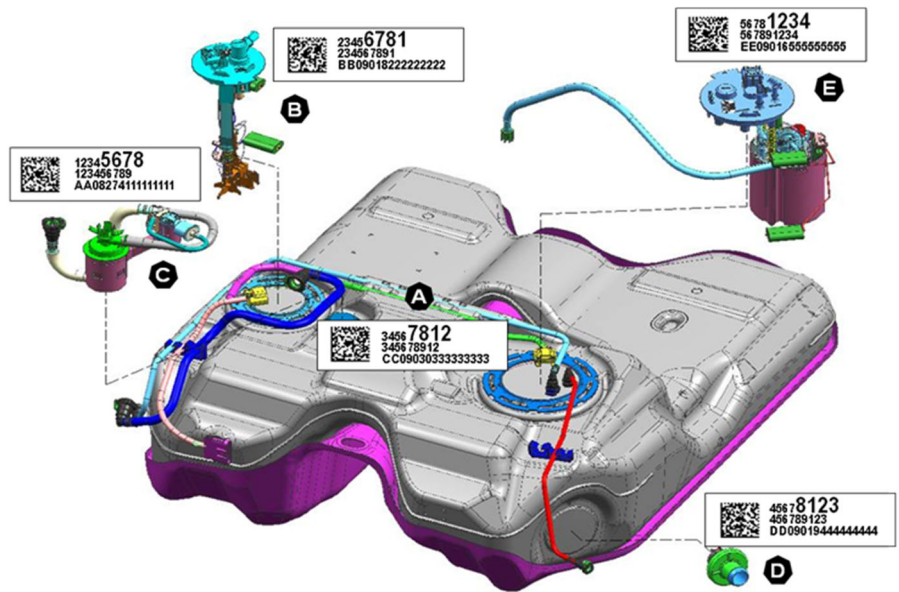


Figure H.1: Gas Tank and Associated Items (parts)

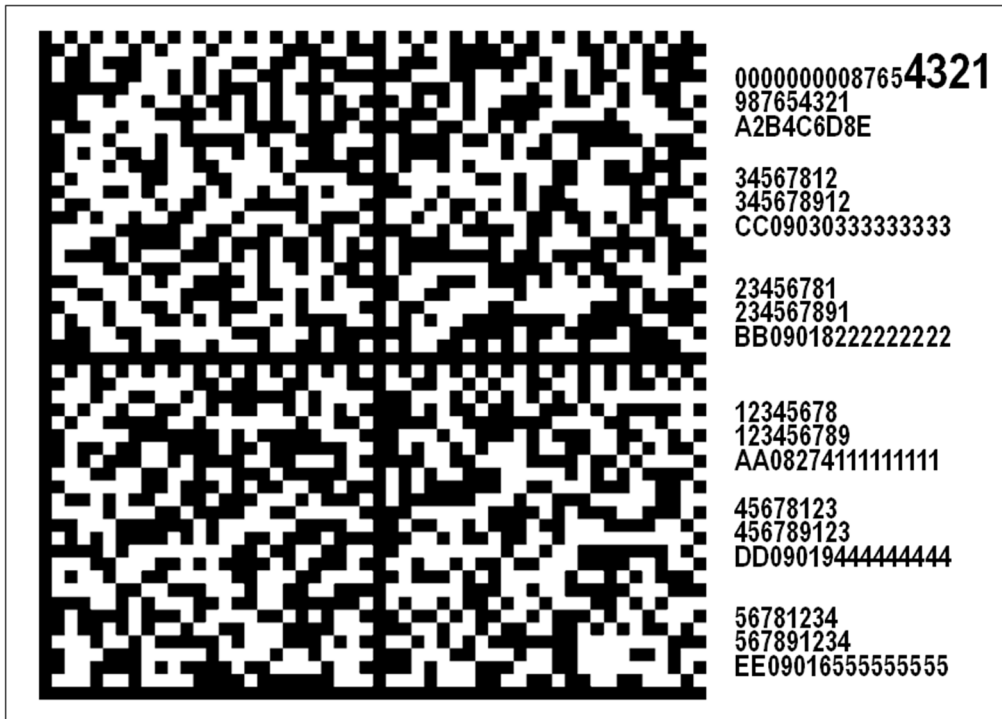


Figure H.2: 2D Symbol with “As Built” Data Encoded Within It

NOTE: The Human-Readable Information (HRI) shown in Figure does not show the DIs used for each of the data elements. The complete construction of the data, including the DIs, is shown in Figure H.3 below. (The data are shown in rows for clarity only).



```

~6
25SUN98765432100000000087654321A2B4C6D8ERS
P34567812GS 12V345678912GS TCC09030333333333RS
P23456781GS 12V234567891GS TBB09018222222222RS
P12345678GS 12V123456789GS TAA08274111111111RS
P45678123GS 12V456789123GS TDD09014444444444RS
P56781234GS 12V567891234GS TEE09016555555555

```

Figure H.3: The Data; As Encoded Within a Data Matrix Symbol using Macro 06 (~6)

NOTE: Header and Trailer 06 Macro (“~6” represents Macro 06): The 06 Macro saves 8 alphanumeric characters in the encodation of ISO/IEC 15434 Data Syntax Standard. Data Matrix ISO/IEC 18004 provides a means of abbreviating the header and trailer into one character. This feature was created to reduce the number of symbol characters needed to encode data in a symbol using the ISO/IEC 15434 Data Syntax Standard. The 06 Macro character applies only when in the first symbol character position. The header will be transmitted as a prefix to the data stream and the trailer will be transmitted as a suffix to the data stream.

When PC Bit 17 of MB01 = “1”, the “25S”-based data, which is the Traceability Code in the 2D symbol, will be used to create the Unique Item Identifier (UII) in MB01.

When PC Bit 17 of MB01 = “0”, GS1 data constructs would be used for the UII, as outlined for Serialized Unique Item Identifiers under GS1’s TDS v1.5 or higher.

The remaining five lines of data will be programmed into the User Memory Bank (MB11). See later in this section for details.

Figure H.4 below shows the relationship between each data segment and the physical entity it describes.

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Figure H.4: The Data; As Encoded Within a Data Matrix Symbol



Table H.1: Subassembly Information that Makes Up the “As-Built” Data

Assembly	DI	Part Number	DI	IAC	DUNS	DI	Trace Code
Gas Tank	25S	0000000087654321	NA	UN	987654321	NA	A2B4C6D8E
Part A	P	34567812	12V	NA	345678912	T	CC09030333333333
Part B	P	23456781	12V	NA	234567891	T	BB09018222222222
Part C	P	12345678	12V	NA	123456789	T	AA08274111111111
Part D	P	45678123	12V	NA	456789123	T	DD09019444444444
Part E	P	56781234	12V	NA	567891234	T	EE09016555555555

NOTE: “NA” = Not Applicable



Table H.2: Description of "As-Built" Data; As Programmed into MB01 and MB11

	Data Type	AFI / DI / EPC Type	Data	Character Count	Encoded # of Bits	Total # of Bits
MB01	MB01 Tag overhead		CRC16 (16 bits) + Protocol Control Word (16 bits)		32	32
	<p>The following data would be placed in the UII partition (starting at 0x20) of Memory Block 01; when PC bit 17 = "0"</p> <p>(NOTE: In the PC Bit 17 = 0 and PC Bit 17 = 1 examples below, the data used are <u>NOT</u> the same.)</p>					
	EPC See Annex F	SGTIN-96	URI data: urn:epc:tag:sgtin-96:0.1234567.012345.123456789012 Encoded data, in hex: 0x30 18 78 90 03 DC 9E 5C BE 99 1A 14	-	96	128
	<p>The following data would be placed in the UII partition (starting at 0x20) of Memory Block 01; when PC bit 17 = "1"</p> <p>(NOTE: When PC Bit 17 = 1, an AFI (in this document: "0xA1") shall be programmed into memory locations 0x18 to 0x1F of MB01. See Section 5.2.1)</p>					
	ISO See Annex C	25S	UN98765432100000000012345678A2B4C6D8E	40	240	272



The following data would be placed in Memory Block 11 (NOTE: MB01 PC bit 15 = 1; MB01 PC Bit 17 = 0 or 1; using Access Method 0, Format 3.)					
Description	DI	Data	Data Separator / Terminator	Encoded # of Bits	Total # of Bits
Protocol overhead (DSFID; Precursor; Length of Data)	-	“0x03” is the DSFID for “Access Method 0 (No Directory), Format 3 (ISO/IEC 15434)”; “0x46” is the Precursor for ISO/IEC 15434 Format Indicator 06 (DIs); “0x8119” is the length of the data in this example. (See NOTE 1 following the table)		32 (NOTE 1)	32
Customer-Assigned Item Identification Code	P	34567812	G_S	60	92
DUNS number identifying manufacturer *	12V	345678912	G_S	78	170
Traceability Number assigned by the Customer	T	CC0903033333333	R_S	108	278
Customer-Assigned Item Identification Code	P	23456781	G_S	60	338
DUNS number identifying manufacturer	12V	234567891	G_S	78	416
Traceability Number assigned by the Customer	T	BB0901822222222	R_S	108	524
Customer-Assigned Item Identification Code	P	12345678	G_S	60	584
DUNS number identifying manufacturer	12V	123456789	G_S	78	662
Traceability Number assigned by the Customer	T	AA0827411111111	R_S	108	770
Customer-Assigned Item Identification Code	P	45678123	G_S	60	830

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DUNS number identifying manufacturer	12V	456789123	G_S	78	908
Traceability Number assigned by the Customer	T	DD09019444444444	R_S	108	1016
Customer-Assigned Item Identification Code	P	56781234	G_S	60	1076
DUNS number identifying manufacturer	12V	567891234	G_S	78	1154
Traceability Number assigned by the Customer	T	EE09016555555555	$R_S E_{OT}$ (See NOTE 2 following the table)	102	1256

* A complete list of Issuing Agency Codes can be found at http://www.aimglobal.org/?Reg_Authority15459

NOTE 1: The Protocol overhead consists of the following: DSFID (1 byte), Precursor (1 byte), and Length of Data (up to 2 bytes). The total Protocol overhead is 4 bytes (32 bits).

NOTE 2: The single-character message trailer characters “RS”, “EOT” are not encoded. See Annex D for details.

For details on the Access Method 0, Format 03 example shown in H.2 above, see Annex C.

For detailed Access Method 0, Format 13 examples, see Annex D.

For 8-bit examples, see Annex M.

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ANNEX J: USE OF BATCH / LOT NUMBERS WITH SERIALIZATION

(Informative)

Occasionally a company will produce a product that is serialized, not only within the part number but also within a lot or batch. Examples of batch and serialization are products like engines, where the block is manufactured and molded on a batch basis and the finished engine is valuable enough to be serialized for tracking and management. Examples of lot and serialization are automotive electronics, where the lot refers to items that are otherwise identical except for software loads affecting capability, so the end item is serialized for tracking and management.

The serial number is occasionally reinitialized to zero with each batch or lot. The batch or lot number must be combined with the serial number to achieve uniqueness. Thus, the globally unique identity of the item would include the IAC, CIN, part number or lot or batch, and serial number.

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ANNEX J: ANSI X12.3 DATA ELEMENT NUMBER 355 UNIT OF MEASURE CODE

(Informative)

Table J.1 is not a complete list of the qualifiers.

Table J.1: Examples of ANSI X12.3 355 Data Element Number 355 Unit of Measure (Qualifier)

Qualifier	Definition	Qualifier	Definition
2G	Volts (AC)	68	Ampere
2H	Volts (DC)	CE	Centigrade
2N	Decibels	DN	Deci Newton-Meter
2P	Kilobyte	FA	Fahrenheit
2Z	Millivolts	G9	Gigabyte
4K	Milliamperes	HJ	Horsepower
4L	Megabytes	HP	Millimeter H ₂ O
4S	Pascal	HZ	Hertz
70	Volt	NU	Newton-Meter

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ANNEX K: DATA CONSTRUCTS

(Informative)

This table is shown separately because the Data Constructs Steering Committee expects that some Data Formats can be used for different applications in a non-conflicting manner. The Data Formats are shown as decimal values. This is not a complete list. See ISO/IEC 15962-2, latest edition, for complete details.

Table K.1: Data Formats

Data Format (Decimal)	Assigned Organization or Function	Root-OID	Comments
0	Not-Formatted	Not applicable	This value is the default for an RFID tag yet to be formatted, so the system may assume that the tag has no encoded data. The DSFID (combining the Data Format with the Access Method) shall be 00HEX.
1	Full-Featured	Not applicable	This is used where each OID has to be encoded in full, i.e., without truncating the Root-OID. This is relevant where the RFID tag is likely to contain a mixture of OIDs from different domains, or one from a minor domain.
2	Root-OID-Encoded	Encoded on the tag	This is useful for small domains requiring to encode a set of data. This data format requires the Root-OID to be encoded but then truncates all OIDs so that only the Relative-OID needs to be encoded.
3	ISO-15434	1 0 15434	This standard supports a number of message structures originally intended for two-dimensional barcodes.
4	ISO-6523	1 3	This standard deals with the registration of domains to the level of the International Code Designator (ICD). Examples include DUNS, EAN location codes, all internet IP addresses, NATO, plus many government and multinational company schemes. This data format allows existing organization structures to be supported with the minimum of change. (See Note “ICD Issues.”)



Data Format (Decimal)	Assigned Organization or Function	Root-OID	Comments
5	ISO-15459	1 0 15459	ISO/IEC 15459 provides a mechanism to support unique identification codes across multiple industry and commercial sectors. The various parts of this standard provide the basis for track and trace codes for all levels in supply chains.
6	ISO-28560-2	1 0 15961 6	This standard addresses the encoding of data on RFID tags in the library community and defines all the Relative-OID values.
7	RESERVED	—	—
8	ISO-15961-Combined	1 0 15961	This allows any combinations of OID that have the common Root-OID {1 0 15961} to be encoded. The Relative-OID then becomes the next arc (which can differ for different objects), followed by another arc identifying the particular data element. The structure was developed so that two or more related organizations could share encoding - by agreement – without one having all the encoding efficiencies. Joint registration by the relevant organizations should be a requirement for data constructs to be assigned.
9	GS1-AI	1 0 15961 9	This data format enables GS1 Application Identifiers to be used as the Relative-OID in an Object Identifier structure.
10	ANS-DI-Algorithm	1 0 15961 10	This data format enables ANS MH10 Data Identifiers to be used as the Relative-OID in an Object Identifier structure. The alphanumeric DI is converted to a Relative-OID using an algorithm defined in ISO/IEC 15961:2004
11	RESERVED	—	—
12	IATA-Baggage	1 0 15961 12	The Relative-OID values are defined in the IATA RP1740C standard.
13	ANSI-DI-Mapping Table	1 0 15961 13	This data format enables ANS MH10 Data Identifiers to be used as the Relative-OID in an Object Identifier structure in a more efficient encoding manner than data format 10.
14 to 28	RESERVED	—	—



Data Format (Decimal)	Assigned Organization or Function	Root-OID	Comments
29	Closed system data fully encoded to ISO/IEC 15962 rules	The Root-OID is implied.	This Data Format enables closed system or prototype data to be encoded in a manner compliant with the 15962 encoding rules (i.e., by declaring the relevant Access Method). Because those implementing the application know the interpretation of the Relative-OID values, the Root-OID is implied and does not require to exist or to be registered.
30	Closed system data not encoded to ISO/IEC 15962 rules	Not applicable	The complete DSFID shall be 00011110, to indicate that the encoded bytes are passed through unchanged in ISO/IEC 15962 and ISO/IEC 24791 implementations.
31	Extended Data Format	Not applicable	Various extension mechanisms are included in ISO/IEC 15962 Rev1 for the DSFID; one enables an additional 256 Data Format to be assigned. If the First DSFID has the value xxx11111, then the Data Format that is encoded is one that is defined in the following rows on this table.
32 to 287	RESERVED		These values are reserved for open system applications as registered under Part 2 of ISO/IEC 15961, when an extension mechanism is invoked under ISO/IEC 15962 rules for a multiple-byte DSFID.

Table K.2 is not a complete listing. See ISO/IEC 15962-2 for complete details.



Table K.2: Access Methods

Method	Structure	Comments
0	No-Directory	This Access-Method provides the simplest set of encoding rules. The basic rule is to link a data Object to an Object-Identifier and support this with appropriate syntactical components to create a Data-Set. The Data-Sets are concatenated to produce a contiguous sequence of encoded bytes in the Logical Memory Map.
1	Directory	The Directory structure supports all the encoding rules of the No-Directory structure but additionally supports the encoding of a directory at the higher address values within the Logical Memory Map on the RFID tag. When the Directory structure is used, any command seeking to selectively read data can first access the directory to find the memory address of the beginning of the Data-Set, and then go to that location to read the bytes that represent the encoding of the Data-Set. NOTE: The Directory may be written to the RFID later than the initial encoded data.
2	Packed-Objects	The Packed-Object structure has been introduced in the first revision of ISO/IEC 15962 and this edition of this part of ISO/IEC 15961. The encoding scheme is fundamentally different because it takes a set of Object-Identifiers and their Objects and encodes them in an indexed structure that integrates compaction and encoding. The Packed-Object encoding scheme requires a rule-based table for each Data-Format, which calls up specific compaction schemes for the individual elements. The compaction schemes are standard, irrespective of the Data-Format. The Packed-Object scheme requires more complex encoding and decoding rules than the No-Directory and Directory Access-Methods but offers significant encoding efficiency even over the basic No-Directory structure when a number of Object-Identifiers need to be encoded. This can reduce the amount of memory required on the RFID tag and can reduce the size of message transferred across the air interface in response to a read command. Application domains need to define a table of indexed Relative-OIDs for this Access-Method to be implemented. It can only be applied as an alternative to the No-Directory or Directory Access-Methods on a particular RFID tag; however, tags with any of the Access-Methods may be intermixed in the same application.
3	Tag-Data-Profile	The Tag-Data-Profile scheme is intended to support fixed message structures, typically where a number of Object-Identifiers and their Objects need to be encoded. The fixed message structure is best suited for applications that are reasonably homogeneous and additionally have a consistent requirement for exactly the same Object-Identifiers to be encoded on all RFID tags in the application. Each Tag-Data-Profile requires registration.



Method	Structure	Comments
4	Multiple Records	The Multiple-Records encoding process overlays a structure onto the No-Directory, Packed-Objects, and Tag-Data-Profile Access-Methods for multiple instances of these, and even a mixture of these Access-Methods, to be encoded in the same Logical Memory. This is achieved through the introduction of an encoded MR-header and a preamble for each record. This allows the encoding of individual records to fully comply with the inherent Access-Method. This also enables the same Object-Identifier to be encoded in separate records, with one rule that supports a list of the same data element in one record. There are three main classes of application supported by the Access-Method and these can also be intermixed. One class enables different data formats and owners of data to share the same RFID tag but under the control of the original owner of the tag. Another supports a time sequence of history records of the same type to be repeated. The third major class supports hierarchically related records, e.g., for supply chain delivery or bill of material types of structure.
5-15	RFU	Reserved for future encoding schemes to be defined in ISO/IEC 15962 and invoked under rules for a multiple byte DSFID. Some of the new Access-Methods might be possible to be inherent encoding schemes in Multiple-Records. This can only be determined as the encoding schemes are developed.

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ANNEX L: ANSI DATA IDENTIFIER REQUEST FORM

(Informative)

Rev. ANS MH10.8.2-7262 (DI)

Reference: _____

Date: _____

ANS MH10.8.2 DATA IDENTIFIER REQUEST FORM

COMPLETE ALL PARTS. Submit to:

EMAIL: DIRequests@MHI.org

MAIL: DIMC
c/o MHI
8720 Red Oak Blvd – Suite #201
Charlotte, NC 28007-3992
USA

PHONE: +1 704.676.1190

Ask For Data Identifier Request Desk

Incomplete forms or those with inadequate support for the change requested will be returned to the submitter. The ANS MH10.8.2 DI Maintenance Committee will notify submitters of the status of the work request following their review.

URL for Publicly Available Continuous Maintenance version of ASC MH10.8.2 Data Identifiers and Application Identifiers for current version of ANSI MH10.8.2: <http://www.mhi.org/standards/di>

REQUEST FOR: New Data Identifier
 Data Identifier Interpretation

ORGANIZATION: _____

CONTACT PERSON: _____

ADDRESS: _____

TELEPHONE: _____



EMAIL ADDRESS: _____

1. PROPOSED DATA IDENTIFIER

In the first paragraph, provide a short description (20 words or less) which would be included as a description for the proposed Data Identifier. After the first, descriptive, paragraph, additional information may be provided.

For an interpretation, provide a comprehensive description of the aspect of the identifier that needs interpretation.

**PAGE 2 (DATA IDENTIFIER REQUEST)****2. BUSINESS CASE**

Explain why you need the proposed assignment. Provide a complete scenario that tells what the business function, operation, or problem is that will be satisfied by a new assignment to the ANS MH10.8.2 Data Identifier Standard. If the proposed DI is already in use by your organization, please identify how long this identifier has been in use and other organizations you are aware of who employ the same identifier. The ANS MH10.8.2 DI Maintenance Committee requires enough information to be able to propose an alternate solution if necessary. Be specific because this will also appear in the ANS MH10.8.2 Voting Package and will be the only information that voters have on which to base their decision on.



PAGE 3 (DATA IDENTIFIER REQUEST)

3. DEFINITIONS

Definitions for new assignments and for industry-specific terms must be complete. For new ANS MH10.8.2 DI, provide a proposed assignment and a DI definition. RULES: (1) Acronyms/abbreviations cannot be added to the standards - they must be spelled out. (2) Provide an expanded assignment definition for each DI which is not completely self-explanatory, that is, terms that are not in general business use or that are industry specific. (3) Provide code source references for all externally published (non-ANS MH10.8.2) code lists cited (use the Form for New or Revised Code Source Reference). If one exists, provide a precise description of the structure of the data as foreseen by your organization for this application. Indicate data elements involved and their formal (numeric, alphanumeric, fixed or variable length, number of decimals). Indicate the business function of each data element in the application.



PAGE 4 (DATA IDENTIFIER REQUEST)

4. MEDIA AND APPLICATION USE

- *With what media (e.g., bar code, 2D symbol, RF tag, etc.) do you intend to use the proposed Data Identifier?*

- *At what stage will the Data Identifier and data be created and applied?*

- *On to what and when will the media be applied (package, label, tag, document, etc.)?*

- *Why does the information need to be machine-readable?*

- *When and where is the media read?*

- *Describe the use of the Data Identifier by other users than the originator:*

- *What is the number of potential users?*

5. Justification

Describe the benefits (hard and soft savings) expected from the application.

6. Additional Information

Feel free to attach any addition information related to your organization and the application.

Date: _____

Signature: _____



PAGE 5 (DATA IDENTIFIER REQUEST)

Data Identifier Data Dictionary Record

NOTE: When multiple options follow a heading, choose one and remove the others.

Example:

As currently listed: **Class:** Numeric / Alpha / Alphanumeric / Binary

After selection: **Class:** Alpha

DATA DICTIONARY DETAILED ENTRY			
NAME:	Version	Key	
XML Tag:	DI:		
Definition:			
<p style="text-align: center;">Class: Numeric / Alpha / Alphanumeric / Binary Remarks:</p> <p>Decimals: Yes / No</p> <p>Min_Length:</p> <p>Max_Length:</p> <p>Case Sensitive: Yes / No</p>			
Business Rules:			
Data Element Source / Authority:			
APPLICATION AREAS			
Area	Application	Category	Remarks
USES			
Application Area	Usage	Type	Specific Use
ALIAS: Production Date			
^a Table footnote.			



ANNEX M: MB01; ISO-BASED DATA FORMAT FOR 8-BIT ENCODING EXAMPLES

(Normative)

Table M.1: MB01 Coding Scheme for Parts and Components

Bit Location (HEX)	Data Type	Value	Size	Description
MB 01: CRC + Protocol Control Word				
00 – 0F	CRC-16	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	Variable	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field.
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB11 1 = Valid User Data in MB11
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ - not used
17	PC bit 0x17	0b1	1 bit	1 = Data interpretation rules based on ISO
18 – 1F	AFI	0xAC	8 bits	Application Family Identifier used according to ISO/IEC 15961 and ISO 17367.
	Subtotal		32 bits	
MB 01: Unique Item Identifier (UII) with 8 bit encoding				
Start at location 20	DI	“37S”	3 an	Data Identifier “37S” for Part Identification
Go to end of data / end of	Issuing Agency Code (IAC)	“OD”, “UN”, “LA”, or “VTD” or “TAJ”	2 or 3 an	Issuing Agency Code, according to DUNS, Odette, JIPDEC, or TEIKOKU DATABANK, National Tax agency JAPAN



Bit Location (HEX)	Data Type	Value	Size	Description
available memory	Company Identification Code (CIN)	As defined by the IAC	6 an (OD), 9 an (UN and VTD), 12 an (LA), 13 n (TAJ)	Company Identification Number
	Serial Number (SN)	Part Number (PN)	1...X an	Variable number of alphanumeric characters for the PN ID assigned by the owner
	Consist of Part Number,	+ (Separator)	1 an	“+” sign separator
	Separator and Part Serial Number	Part Serial Number (PSN)	1...Y an	Up to Y alphanumeric characters, in capital letters
	E _{OT}			
	Padding until the end of the last 16-bit Word	0b00000000	8 bits	Word Padding according to ISO/IEC 15962
	Subtotal		Variable	Up to 320 bits
	TOTAL MB01:		VARIABLE	UP TO 352 BITS

NOTE: The AFI shall NOT be encoded as part of the UII when PC Bit 17 = 1. The AFI is programmed into the Attribute / AFI section of MB01, starting at memory location 0x18 through memory location 0x1F. See ISO/IEC 15961-2 for details on the AFI. See Figure 2. The reference-ID is 8-bit encoded. In the PC area (header) the UII length is declared in 16-bit words (2 bytes).



DI “37S” in the UII (MB01)

For the step-by-step details on how the data were encoded, see ISO 17367.

UII= 37SUN12345678999755512300FFFAS+123456^{N_{UL}}

Hex code representation of each binary byte					
33	37	53	55	4E	31
32	33	34	35	36	37
38	39	39	39	37	35
35	35	31	32	33	30
30	46	46	46	41	53
2B	31	32	33	34	35
36	00				

PC data(Byte1):

UII-length of 16-bit words: 0b **1001 1** (38 bytes = 19 words [16 bits = 1 word])

Valid User Memory: 0b **1** (User Memory)

XPC: 0b **0** (not used – reserved)

EPC or ISO code: 0b **1** (ISO)

All PC bits: 0b **1001 1101** (0x9D)

Coded UII content (including PC and AFI) in HEX, in the form PC (1*) - AFI (2*) - UII:

1*	2*	UII																																					
9D	AC	33	37	53	55	4E	31	32	33	34	35	36	37	38	39	39	39	37	35	35	35	31	32	33	30	30	46	46	46	41	53	2B	31	32	33	34	35	36	00



Table M.2: Coding Scheme for Vehicle Identification (VIN) in MB01

Bit Location (HEX)	Data Type	Value	Size	Description
MB 01: CRC + Protocol Control Word (Header)				
00 – 0F	CRC-16	Hardware assigned	16 bits	Cyclic Redundancy Check
10 – 14	Length	0b01001	5 bits	Represents the number of 16-bit words excluding the PC field and the Attribute/AFI field
15	PC bit 0x15	0b0 or 0b1	1 bit	0 = No valid User Data, or no MB11 1 = Valid User Data in MB11
16	PC bit 0x16	0b0	1 bit	0 = “Extended PC word“ not used
17	PC bit 0x17	0b1	1 bit	1 = Data interpretation rules based on ISO
18 – 1F	AFI	0xAC	8 bits	Application Family Identifier used according to ISO/IEC 15961-2 Data Construct Register
	Subtotal		32 bits	
MB 01: Unique Item Identifier (UII) with 8 bit encoding				
Start at location 20 Go to end of data / end of available memory	DI	“I”	1 an	Data Identifier I for VIN
	VIN	“W0L0X AP68F405 0901”	17 an	VIN
	E _{OT}			
	Padding	0b000000 00	8 bits	Word Padding according to ISO/IEC 15962
	Subtotal		144 bits	
	TOTAL MB01:		176 bits	



VIN in the UII (MB 01)

NOTE: The exact syntax of the OEM-specific VIN, whose individual implementation, and possible additions (e.g., color codes), can be found in the supplementary guidelines and standards of the respective OEM.

UII=IW0L0XAP68F4050901

Hex code representation of the binary bytes					
49	57	30	4C	30	58
41	50	36	38	46	34
30	35	30	39	30	31

PC data (Byte 1):

UII-length of 16-bit words: 0b **0100 1** (18 bytes = 9 words [16 bits = 1 word])
 Valid User Memory: 0b **0** (User Memory)
 XPC: 0b **0** (not used – reserved)
 EPC or ISO code: 0b **1** (ISO)
 All PC bits: 0b **0100 1001** (0x49)

Coded UII content in HEX (including PC and AFI), in the form PC (1*) - AFI (2*) - UII:

1*	2*	UII																	
49	AC	49	57	30	4C	30	58	41	50	36	38	46	34	30	35	30	39	30	31



ENCODING

The following data encoding example is provided to show how the “As-Built” example of an ISO/IEC 15434 message is to be encoded in User Memory (UM), using Access Method 0 and Format 3, as outlined in ISO/IEC 15962.

The UM data is coded similar to the UII data. The first part of the data represents the header. The length of the header is three or four bytes, depending on the length of the following data string. Table M.3 describes how to code the UM content.

Table M.3: Sample Data for Encoding MB11

DI	Description	Sample	DI+Data Length
1P	Supplier part number	5221886	9
2P	Engineering change level	00C	5
52P	Color code	F1F	6
2Q	Weight	2	3
4D	Manufacturing date (Julian YYDDD)	15045	7

The complete data string including DIs, actual data contents and separators is 8-bit encoded and padded according to ISO/IEC 15962 for MB11 until an even number of bytes is reached.

UM Data =

]>^R_s06^G_s1P5221886^R_s06^G_sP00C^R_s06^G_s52PF1F^R_s06^G_s2Q2^R_s06^G_s4D15045^R_s^E_{OT}



Hex code representation of each binary byte					
5D	29	3E	1E	30	36
1D	31	50	35	32	32
31	38	38	36	1E	30
36	1D	50	30	30	43
1E	30	36	1D	35	32
50	46	31	46	1E	30
36	1D	32	51	32	1E
30	36	1D	34	44	31
35	30	34	35	1E	04

Header data (see Table 10):

DSFID: 0h **03**
 Precursor: 0h **76**
 Byte Count Indicator Switch: 0b **0** (only one length byte)
Byte Count Indicator Length: 0b **011 0110** (54 bytes of “8-bit data”)
 All header bytes: 0h **03 76 36**

Coded UM content (including header):

DSFID: **0x03**

Precursor: **0x46**

Byte Count Indicator: **0x1B**

Entire MB11 encodation (in HEX; spaces used for clarity – they are not part of the data):

03 76 36 5D 29 3E 1E 30 36 1D 31 50 35 32 32 31 38 38 36 1E 30 36 1D 50 30 30 43 1E 30 36 1D 35 32 50 46 31 46 1E 30 36 1D 32 51 32 1E 30 36 1D 34 44 31 35 30 34 35 1E 04



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