| VDA | RFID for Vehicle Identification in Production, Logistics and for the Realization of Services | 5520 |
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# RFID for Vehicle Identification in Production, Logistics and for the Realization of Services

This non-binding VDA Recommendation has the following **objectives**:

- Standardized use of RFID for vehicle identification in cross-company processes
- Standardization of data structures on RFID transponders
- Definition of requirements for the use of RFID transponders for vehicles
- Additional visual labels for temporary identification purposes (e.g. standardised vehicle distribution label)

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**Warning**

The vehicle identification number (VIN) is considered to be personal data. Therefore, it is subject to European privacy policy. Using the VIN after having delivered the vehicle to the customer (for Tracking & Tracing purposes) requires appropriate legitimation and adequate documentation. Please contact your data security engineer for further details.

## Document Maintenance Summary

| Date | Action | Description |
|---|---|---|
| 2017-09-12 | Addition | Warnings regarding the potential influence of European privacy policy (cf. p.2) |

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**Abbreviations**

| | |
|---|---|
| AFI | Application Family Identifier |
| an | Alphanumeric |
| bit | Binary Digit |
| BTN | Body Tag Number |
| CRC | Cyclic Redundancy Check |
| DI | Data Identifier |
| EDI | Electronic Data Interchange |
| EDIFACT | Electronic Data Interchange for Administration, Commerce and Transport |
| EOT | End of Transmission |
| EPC | Electronic Product Code |
| EPCIS | Electronic Product Code Information Services |
| ERP | Equivalent Radiated Power |
| GS1 | Global Standards One |
| HEX | Hexadecimal |
| IEC | International Electrotechnical Commission |
| IP | International Protection |
| ISO | International Organization for Standardization |
| IT | Information technology |
| km/h | Kilometres per hour |
| m | Metre |
| mm | Millimetre |
| MB | Memory Bank |
| ms | Millisecond |
| n | Numeric |
| OEM | Original Equipment Manufacturer |
| PC | Protocol Control |
| PON | Production Order Number |
| RFID | Radio Frequency Identification |
| SN | Serial Number |
| TID | Tag Identification |
| UHF | Ultra High Frequency |
| UII | Unique Item Identifier |
| UM | User Memory |
| VDA | Verband der Automobilindustrie<br>(German Association of the Automotive Industry) |
| VDS | Vehicle Descriptor Section |
| VIN | Vehicle Identification Number |
| VIS | Vehicle Identifier Section |
| WMI | World Manufacturer Identifier |

# 1 Introduction

Radio frequency identification (RFID) allows for greater automation and data capture that is much more granular than with other established technologies for automated identification, such as for example barcodes. This applies in particular to RFID in the ultra-high frequency range (UHF). Based on the principle of object serialisation, RFID caters for the automated capture of logistical objects. The technology allow for example for the bulk input of objects without visual contact, so that large volumes of objects can be captures for logistics purposes. Given the technology-specific characteristics of RFID and its applications, RFID offers huge optimisation potential for the flow of information and goods along the automotive supply chain.

## 1.1 *Position of RFID in the automotive industry*

Typical applications of RFID are the control and tracking of vehicles, components and containers. The automotive industry has for many years been using RFID, but this is normally still only done in closed loops inside individual companies. Over the last few years, the focus has shifted to open loop systems which allow for the use of RFID across different companies. Such solutions require however standards and rules to ensure that the RFID transponders and the data can be used and shared across corporations.

Given these developments, the German Association of the Automotive Industry (VDA) has published the following recommendations for the use of RFID technology:

- VDA 5500 – Basic Principles for RFID Application in the Automotive Industry
- VDA 5501 – RFID in Container Management
- VDA 5509 – AutoID/RFID-Application and Data Transfer for Tracking Parts and Components in the Vehicle Development Process
- VDA 5510 – RFID for Tracking Parts and Components in the Automotive Industry
- VDA 5520 – RFID in Vehicle Distribution Processes

These industry recommendations contain the main recommendations for the application of RFID technology in cross-company processes in the automotive industry.

The document in hand focuses on the application-specific details and requirements for the identification of vehicles. VDA 5520 refers to the general requirements for RFID applications according to VDA 5500 – Basic Principles for RFID Application in the Automotive Industry. At the same time, it takes into account the specifications and requirements laid down in *ISO 3779 – Road Vehicles – Vehicle Identification Number (VIN)*.

The document is structured as follows: Chapter 2 defines the technical requirements of the use of passive RFID transponders. Chapter 3 lays down the principles for the creation of RFID-specific data structures for vehicle control and tracking. In certain scenarios, it is advisable to use visual identification codes or labels (plan text and/or barcode/DataMatrix) on the vehicle. The relevant recommendations are contained in chapter 4. Chapter 5 describes the requirements for RFID-specific data exchange.

## 1.2 *Advantages of RFID in vehicle identification*

RFID identification of vehicles has a number of advantages over visual identification methods (plain text label, barcode, DataMatrix):

- Vehicles can be identified automatically and without visual contact
- UHF RFID transponders can be read from large distances
- Multiple vehicles can be identified together (bulk capture)
- Vehicles can be identified even under adverse conditions (e.g. dust, dirt)
- RFID transponders can withstand high mechanical impacts

These advantages of RFID technology allow for the implementation of economical solutions along the entire vehicle life cycle, using just one RFID transponder per vehicle. Some options for the use of RFID are outlined below, based on the life cycle phases of production, distribution and logistics, vehicle use and disposal:

- Production
    - Control of machinery and equipment (welding robots, painting robots, screw driving technology) according to customer job
    - Automated tracking of vehicles in conveyor systems
    - Automated tracking and tracing of vehicles from the end of the assembly line to shipping
- Logistics/distribution
    - Automated capture of lorry loads when driving into and leaving a compound
    - Automated control of transport system traffic and of vehicles transported to and from a compound
    - Automated tracking, tracing and inventory maintenance of vehicles in a compound
    - Automated documentation of technical services at the vehicle terminal of the logistics partners
    - Automatic identification of vehicles for all partners along the distribution chain, based on common standards

- Vehicle use phase
    - Automatic identification of vehicles in car repair shops
    - General services for car drivers (parking fees, access control, road tolls, fleet management, etc.)
    - Automated checks and services at filling stations (correct fuel, oil, etc.)
- Disposal
    - Automated access to information regarding the environmentally friendly and efficient disposal of vehicles

Based on the above advantages of RFID with regard to making processes more efficient and reducing errors, companies cooperating in a cross-company RFID solution gain access to more granular and thus more accurate information, so that decisions regarding the various production and life cycles of vehicles can be made quicker and on up-to-date data.

# 2 Technical requirements for RFID transponders

The main technical requirements for the use of RFID for the purpose of vehicle identification are described below. This section of the document describes the implementation of the general recommendations for the use of RFID in the automotive industry laid down in VDA 5500 with regard to RFID transponders in vehicles

## 2.1 *Function of passive RFID transponders*

According to VDA 5500, passive RFID transponders are particularly suitable for the automated identification of vehicles. Passive transponders are inexpensive and can be read over a relatively large distance (approx. 10 m). They are thus a flexible solution for both the temporary and permanent identification of vehicles.

## 2.2 *Air interface and frequency range*

The air interface must conform to ISO/IEC 18000-63/EPC Class 1 Gen 2. For more details regarding the permissible frequency ranges and the use of passive RFID transponders in the automotive industry, see VDA 5500.

## 2.3 *Structure and size of memory banks*

Passive RFID transponders conforming to ISO/IEC 18000-63/EPC Class 1 Generation 2 feature four logical memory banks (MB):

- MB 00 "RESERVED" – Kill- and Access-Password
- MB 01 "EPC" – Unique Item Identifier (UII)
- MB 10 "TID" – Tag Identification Data (manufacturer, type, chip serial number)
- MB 11 "USER" – User Memory (UM)

The precise size of the memory banks depends on the type of chip in the RFID transponder. The transponder type and the chip must be chosen based on the actual data structure and data volume to be saved on the RFID transponder.

In cross-company RFID processes, memory bank MB 01 holds the ISO 3779 Vehicle Identification Number (VIN). The VIN consists of 17 alphanumeric (an) digits. The UII requires 19 alphanumeric digits, as it includes control bits. With 6-bit coding, this corresponds to 116 bits (see chapter 3.3.2).
For more information regarding the use of memory blocks for vehicle identification, see chapter 3.

## 2.4 *Transponder type, positioning and fixture*

The transponder type, positioning and fixture depend primarily on the actual application (temporary or permanent fixture/use) and the actual general conditions. Temporary applications include for example vehicle identification transponders for the control of machines and equipment's during production. Another example of a temporary application is automatic identification in distribution processes. As RFID transponders can be used for multiple applications, there are further synergies. At the other end of the spectrum, we have permanent transponders that remain attached to the vehicle throughout its service life and can be used for many different applications. For transponders used in connection with shipping, it is important that they can be completely removed without leaving behind any residue or marks. Figure 1 illustrates a few well-established uses of passive RFID transponders:


Windscreen
(temporary)

Side window
(temporary)


Registration plate
(temporary, permanent)

VIN slot
(permanent)

| | |
|---|---|
|  |  |
| Car body (at early stage in assembly process) (permanent) | Bumper, after assembly (permanent) |

**Figure 1: Transponder positions for vehicle identification**

As a rule, the type of the RFID transponder, its fixture and the position of the transponder on the vehicle depends on the envisaged application and must be determined in comprehensive static and dynamic tests.

This recommendation does not prescribe a fixed position for the RFID transponder on the vehicle, so that the company that affixes the transponder can choose freely where to place it. For cross-company transponder applications, we recommend however that the transponder is positioned so that it is easily detected by the reference RFID gate described below.

- One antenna each on both sides of the vehicle track at a height of 1000 mm (floor to centre of antenna)
- Antennae are at a distance of 4000 mm to each other
- Alignment of the antennae at an angle of 30° away from the direction of travel (see Figure 3)
- Use of circular polarization antennae with a horizontal and vertical aperture of 70° (+/- 5°)
- Reader configuration
    - Radiated power at antenna of 2 W ERP
    - Q value of 0
    - Configured so that at every inventory, command "Select" is sent to the transponders, in order to ensure that all transponders are detected at all times
    - Multiplex configuration adjusted to ensure that the antenna output changes after completion of each inventory

The test gate layout is illustrated in Figure 2 and Figure 3.

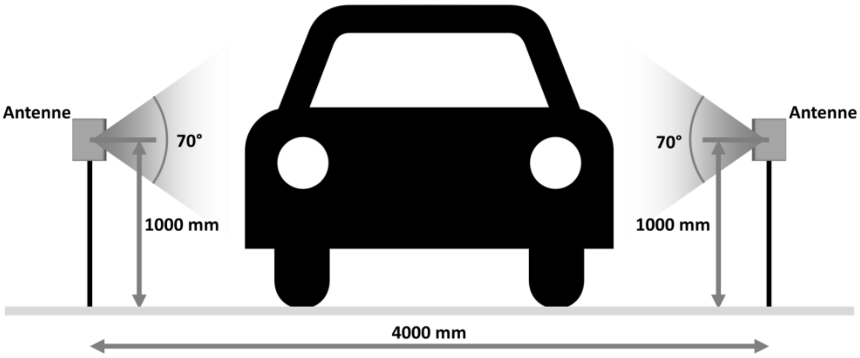



**Figure 2: Reference RFID gates (front view)**

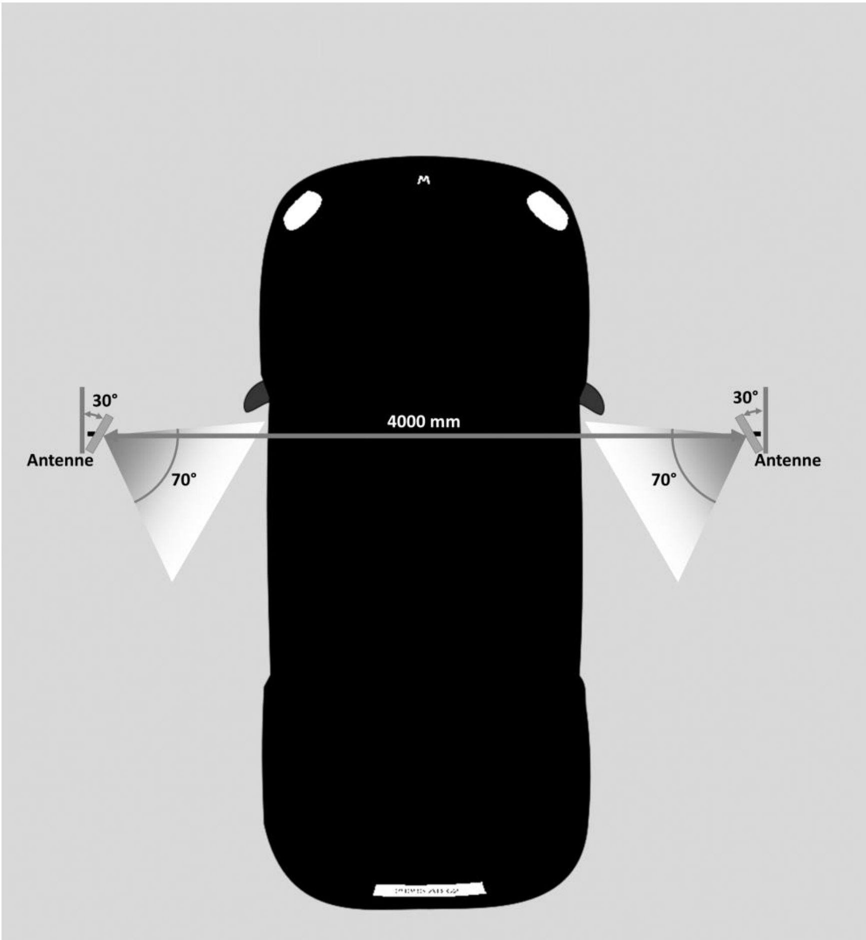



**Figure 3: Reference RFID gates (top view)**

Instructions for the performance of the test

- The vehicle speed should not exceed 30 km/h (speedometer speed).
- To evaluate the test results the transponders should be read at least ten times per vehicle passage by the reference RFID gate.
- For the test run to be deemed successful, at least ten test runs should be completed in sequence as follows (vehicle position relative to RFID gate):

- Passage at the centre of the gate
- Passage to the very left of the gate
- Passage to the very right of the gate

## 2.5 *Ambient conditions for transponders*

When used in the automotive industry, RFID systems are exposed to industry-specific conditions that might affect their performance (e.g. read/write speed, reach). These include:

- Reflection and shielding by metal or liquids
- Absorbent surfaces (e.g. carbon)
- Resonance-detuning surfaces (e.g. glass)
- Interference by other radio systems (in same or difference frequency band)
- Electrostatic discharge

The actual effect of the above factors might differ from application to application (see also chapter 2.4). Also to be taken into account are the velocities of the vehicles to be identified. To identify the best positions for the transponders, it is necessary to perform tests.

## 2.6 *Other external influences and service life*

The RFID transponder should meet the requirements of IP 68 according to IEC 60529:

- No ingress of dust; complete protection against contact.
- Suitable for continuous immersion in water.

The vehicles equipped with RFID transponders might be shipped to different climate zones. That is why the RFID transponders must be able to work properly at ambient temperatures of -40° to +70°C.

The RFID transponders identify the individual vehicle (temporary/permanent installation). For temporary identification, the transponder should work reliably for a period of 24 months under the conditions that prevail at the assembly site. For permanent identification, the RFID transponder must retain its functionality for the product life cycle of the vehicle.

The fixture of the transponder to the vehicle must meet the actual application requirements (temporary/permanent) and the ambient conditions.

# 3 RFID data structures

The definition of a standardized data structure is a key factor for the cross-company identification of vehicles. The main principles for RFID-specific data structures are laid down in VDA 5500. The vehicle-related details are described below.

## 3.1 Use of memory banks

Memory bank MB 01 contains the unique vehicle identifier (Unique Item Identifier → UII). Within MB 01, a number of filters are used to speed up the identification of vehicles and to reduce the amount of data to be sent to the IT systems upon identification of the vehicle (see VDA 5500).

The use of memory bank MB 11 (User Memory → UM) for cross-company applications has not yet been standardized, and the supply change partners must define its use in bilateral agreements. Memory bank MB 11 (UM) can be used to store additional data, such as special object properties and process data.

Memory bank MB 10 is used by the chip manufacturer to store the unique tag identifier (TID). By combining TID and UII, it is possible to check the data record for uniqueness. Linking TID and UII is thus an effective method to prevent fraud (copy protection).

## *3.2 Data standards (ISO/IEC, GS1)*

When choosing the data standards, observe the recommendations in VDA 5500. VDA recommends adopting an identification system based on the ISO/IEC standards, and the chapters below therefore refer to vehicle identification data structures conforming to the ISO/IEC standards.

## *3.3 Writing to memory bank MB 01 (ISO/IEC)*

The general principles for unique item identification based on the relevant ISO-IEC standards are described in detail in VDA 5500. This document only covers the aspects relevant for cross-company vehicle identification. The globally unique VIN is encoded in 6 bits and stored in memory bank MB 01. After writing, the memory bank is protected with a lock or permalock command with a password to prevent subsequent changes to the data (see also chapter 3.5).

According to the ISO/IEC standards, memory bank MB 01 provides mechanisms for the filtering of the data during reading, namely Application Family Identifiers (AFI) and Data Identifiers (DI). These identifiers and other important features of ISO/IEC-based vehicle identification are explained below.

### 3.3.1 Application Family Identifier (AFI)

For the identification of vehicles, ISO/IEC 15961-2 DATA CONSTRUCTS REGISTER, version May 2015, provides the AFI "90". By using the AFI "90", it is possible to identify a vehicle quickly and without ambiguity, as filtering by installed RFID-marked components happens already at AFI level.

| AFI | Standard |
|---|---|
| 90 | Odette for Vehicle Identification Number Monomorphic-UII using 6-bit compaction in ISO/IEC 18000-63 tags |
| A1* | ISO 17367 – Supply chain applications of RFID – Product tagging |

**Table 1: Application Family Identifier (AFI)**

*** Note:** The use of AFI A1 for vehicle identification according to IS0 17367 Product Tagging (tracking of products and assemblies) is no longer recommended.

### 3.3.2 Data Identifier (DI)

A key feature of the RFID data structures based on ISO/IEC standards is the implementation of established DIs. This ensures conformity and compatibility with currently used barcode and DataMatrix systems, allowing for the coexistence of barcode/DataMatrix and RFID and gradual yet seamless migration to RFID. According to ANSI MH10.8.2, the VIN of a complete vehicle is encoded by means of DI "I". The UII is terminated with EoT.

The general data structure for RFID-based identification of vehicles is shown in Table 2.

| DI | VIN | EOT |
|---|---|---|
| I | W0L0XAP68F4050901 | <EOT> |
| an 1 | an 17 | 1 |

**Table 2: DI "I" – Example of data content structure**

In addition to the above DI "I", transport vehicles for complete vehicles or other goods can be identified with DI "4I" "Globally unique transport vehicle". For this purpose, an label attached to the windscreen of the transport vehicle is the preferred option (see Figure 4). This ensures that the RFID scanner can distinguish between the DI of the transport vehicle and the DIs of the vehicles or goods loaded on it. In addition, it allows for a differentiation between transport vehicle and the transported vehicles in a system with IT-based aggregation, so that the entire load can be tracked by means of the UII of the transport vehicle. Furthermore, the VIN can be stored with the vehicle registration number in the RFID transponder, so that the transport vehicle can subsequently be tracked, identified and authenticated with camera systems reading its registration plate.


**Figure 4: Example of application of label on transport vehicle**

For more information on DI "4I" and example for the step-by-step coding/decoding of a sample data structure, see appendix (7.3.2).

Another option for vehicle identification in the context of production, or when shipping car bodies and vehicles without VIN is DI "5I" "Production Vehicle Identifier". For more information on DI "5I", see appendices 7.1 and JAIF LR05 Global Radio Frequency Identification (RFID) Item Level Standard.

### 3.3.3 Coding scheme for vehicle identification

The coding scheme DI "I" for vehicle identification is as follows:

| 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 MB11$_2$<br>1 = Valid User Data in MB11$_2$ |
| 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<br>Go to end of data / end of available memory | DI | "**I**" | 1 an | Data Identifier I for VIN |
| | VIN | "W0L0XAP68F4050901 " | 17 an | VIN |
| | <EOT> | 0b100001 | 6 bit | End of Transmission ISO 17367 Table C1 |
| | Bit Padding | 0b10000010000010 | 14 bits | Padding according to ISO/IEC 15962 chapter 13.1 |
| | ***Subtotal*** | | | ***128 bits*** |
| | **TOTAL MB01$_2$ BITS:** | | | **160 bits** |

**Table 3: Coding scheme for vehicle identification**

**Note:** <EoT> and any padding bits within MB 01 and MB 11 are used as control or padding digits. They do however not form part of the actual data content, and are therefore not transmitted to the downstream IT application systems.

The step-by-step coding/decoding of a data structure for vehicle control and tracking is explained in an example in the appendix (see also 7.3.1). For more information, refer to VDA 5500.

## *3.4 Writing to memory bank MB 11 (ISO/IEC)*

The structure of MB 11 for the storage of additional object and project data is object-independent. For more information, see VDA 5500.

When using MB 11, one should distinguish between permanent RFID transponders and RFID transponders that are only temporarily used. Permanent transponders should only contain information that does not change over the life cycle of the vehicle.

For temporary RFID transponders that might for example be used during shipping of the vehicle, MB 11 might contain data that is relevant for all organisations involved in the process, such as the destination of the shipment. On the other hand, MB 11 might contain information that is only of use to the respective process owner, such as the parking place of the vehicle. This approach is of particular relevance where decisions regarding the movement of the vehicle along the process chain are to be made locally and without connection to a centralised IT system (offline).

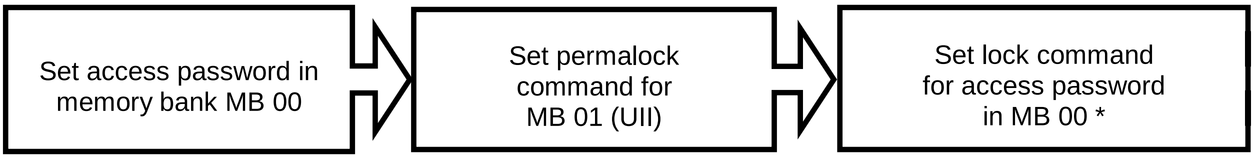
The data in MB 11 can be deleted or overwritten before the vehicle is passed on to the next process owner. This process owner then has the option to use MB 11 to store information that is relevant for its own processes.

A coding example of MB 11 based on a component is included in the appendix of VDA 5510.

## *3.5 Implementation of read/write protection and kill command*

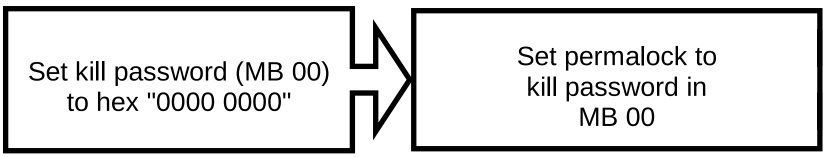
For cross-company vehicle identification, memory bank MB 01 should be protected to prevent overwriting after the final VIN has been stored. This ensures that the VIN contained in MB 01 cannot be changed or otherwise tampered with. It is however not recommended to apply permanent UII write protection, until the vehicle has been assigned a final VIN with DI "I" or DI "4I" and the transponder is intended for this data. To permanently prevent deactivation of the RFID transponder, the kill password in data bank MB 00 should be a "NULL" password that cannot be changed. The required protection measures are outlined below.

Permanent protection of MB 01 (not changeable):




Protection of MB 01 (access password changeable):


After setting the access password, permanent protection against transponder deactivation (kill command) can be implemented as follows:




*** Note:** The lock or permalock for a password in MB 00 ensures that the password is protected against read access. If a permalock is applied to MB 01 or MB 11, an additional lock for the access password is not mandatory, as the permalock cannot be reset, even with the correct access password.

For more detailed information, refer to VDA 5500.

# 4 Additional visual identification labels on vehicles

In addition to RFID-based identification, it is recommended to equip vehicles with visual labels as described below. Such labels are particularly relevant for vehicle shipping processes (shipping labels). In addition, it is recommended to apply the RFID system to the vehicle to indicate that it is equipped with RFID transponders.

## *4.1 Use of plain text and 1D/2D codes*

Where permanent RFID identification is used, additional visual labels are generally omitted. For temporary identification (e.g. distribution labels), we recommend however to use additional plain text or 1D/2D code labels. The data structures for 1D code (code 128) and 2D DataMatrix codes correspond to that inside the RFID transponder. For further information regarding the data structures of 1D and 2D codes, refer to VDA 5500.

## *4.2 Use of RFID emblem*

Where RFID identification is used, we recommend applying the RFID emblem according to ISO/IEC 29160 to the vehicle (see also VDA 5500):


**Figure 5: Symbol identifying products with RFID identification according to ISO 17367**

For more information regarding the RFID emblem, see http://www.rfidemblem.eu/.

## ***4.3 Layout of vehicle shipping labels***

The main standardization feature for the layout of shipping labels is the uniform selection of data that is relevant along the distribution chain and the standardized arrangement of the main data fields in a standard block. To enable OEMs to place bespoke information on the label, a non-standardized block for OEM-specific data is provided below the standard block. In order to ensure that the VIN, which is the key identifier of the vehicle, can be easily read, it must be printed in full (17 digits, alphanumeric, in plain text and as linear barcode (code 128) according to ISO/IEC 15417). Figure 6 shows the recommended layout of a shipping label.

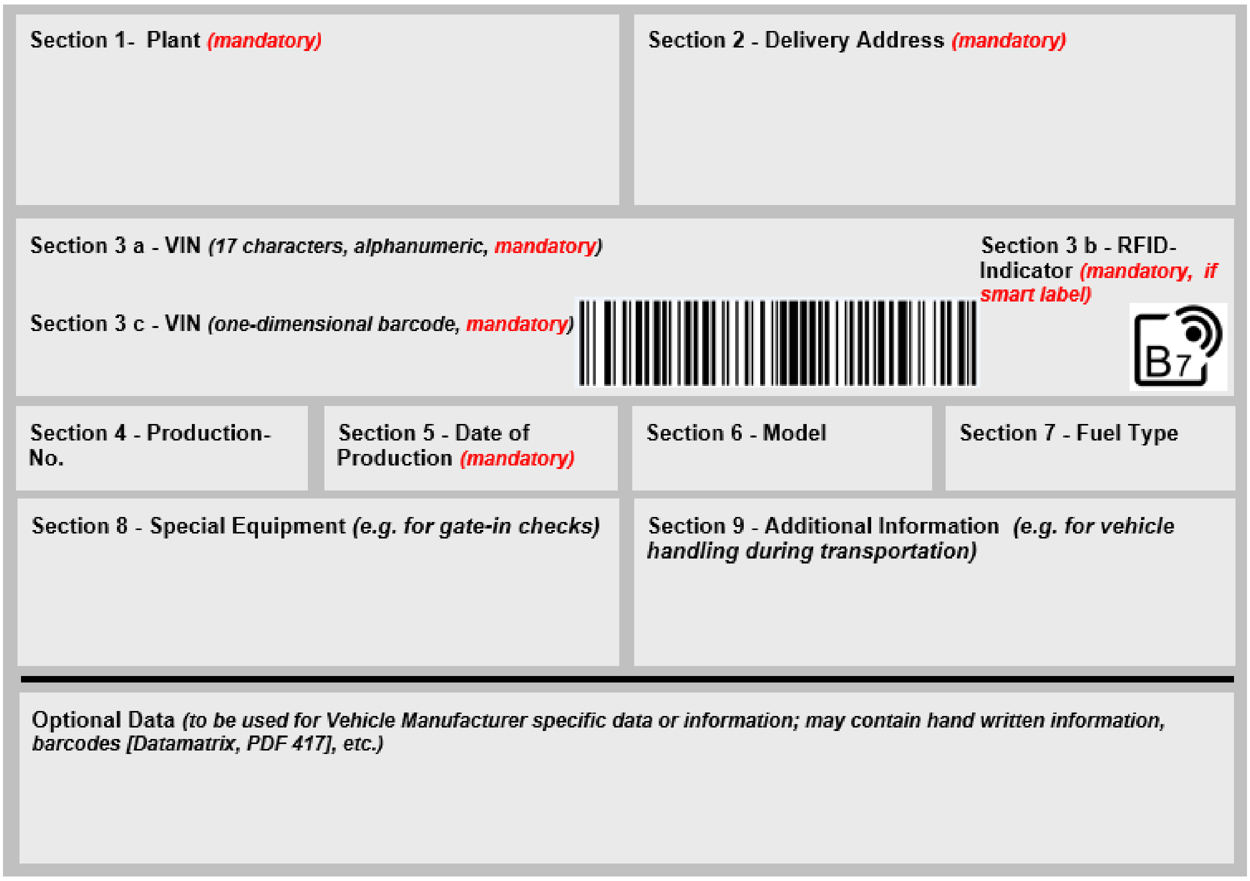



**Figure 6: Recommended layout for DIN A5 shipping labels**

As an alternative to the DIN A5 label, a data field layout for the currently most popular format devised for thermal transfer printers with or without RFID module (print head width = 4"/102 mm) has been defined (see Figure 7). Again, the standard block must be clearly set off from the optional block

For the specifications of the data fields, this VDA recommendation follows the generally recognised "*Electronic Data Interchange (EDI)/ United Nations Electronic Data Interchange for Administration, Commerce and Transport*" (EDIFACT) specifications. The specifications are shown in Table 4. The table shows the field number, the designation, the length of the data fields and whether their content is alphanumeric or numeric.

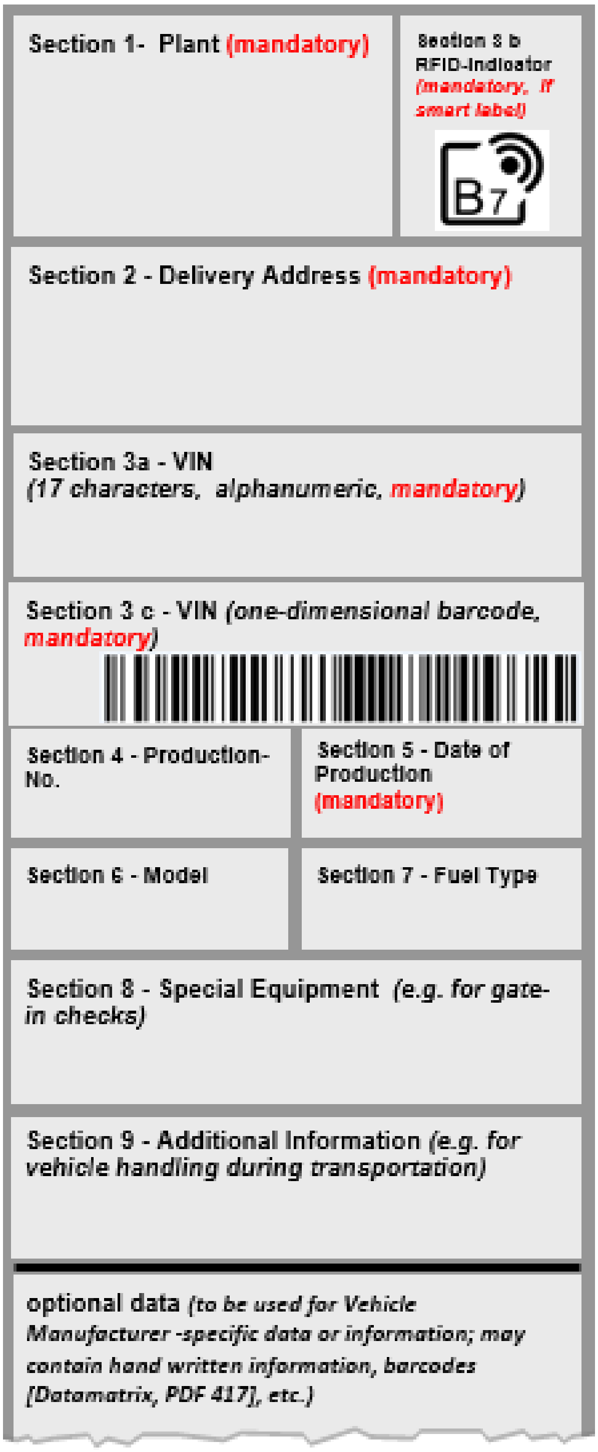



**Figure 7: Recommended layout and content of shipping label in portrait format**

| No. | Designation | Field specification (equivalent EDI/ EDIFACT data formats in brackets) | Example |
|---|---|---|---|
| 01 | **Production plant** | | |
| | Plant code<br>Location<br>Country | an.25 (an.35)<br>an 35 (an 256)<br>an 3 (an 3) | SI<br>Sindelfingen plant<br>DE |

| | | | |
|---|---|---|---|
| **02** | **Shipping address** | | |
| | Code of port of destination<br>Port of destination<br>Country | an.35 (an.25)<br>an.35 (an.256)<br>an 3 (an 3) | DEBHV<br>Bremerhaven<br>DE |
| | Code of destination station<br>Destinations station<br>Country | an.35 (an.25)<br>an 35 (an 256)<br>an 3 (an 3) | 711<br>Wolnzach<br>DE |
| | Dealer<br>Address<br>Postal code<br>City/town<br>Country | an 35 (an 35)<br>an 35 (an 35)<br>an 10 (an 17)<br>an 35 (an 35)<br>an 3 (an3) | AH Peter Gruber<br>Detmolder Strasse 10<br>77801<br>Lahr<br>DE |
| **03a** | **VIN** | an 17 (an 35) | WP1ZZZ98POS123456 |
| **03b** | **RFID indicator** | an 7 (an 7) | RFID B7 or |
| **03c** | **VIN** | | |
| **04** | **Production number** | an 35 (an 35) | 01501 |
| **05** | **Date of manufacture** | an 35 (an35) | 200705231530 |
| **06** | **Model** | | |
| | Model code | an 35 (an 35) | 980101 |
| | Model designation | an 35 (an 256) | 911 Cabrio |
| **07** | **Fuel type** | an 17 (an 17) | Super |
| **08** | **Extra equipment** | n * an 35 (an 17) | Radio/CD with navigation |
| **09** | **Transport-relevant additional information** | n * an 35 (or n * an 70 or coded an 3) | Bump stop |

**Table 4: Field specifications and examples**

For more examples of shipping labels, see appendix 1.

# 5 Company-internal and cross-company data exchange

Cross-company data exchange is implemented by means of Electronic Data Interchange (EDI) messages (e. g. Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT)), which is a well-established method. Alternatively, web services might be used to transmit the data. One such solution is *auto-gration*, a web service developed specifically for the automotive industry. For more information, see http://www.auto-gration.eu/.

In addition, companies might use messages according to ISO 19987 EPC Information Services (EPCIS) for their internal and external data exchange, which allows for the exchange and recording of detailed event data regarding objects and processes. For more information, refer to VDA 5500.

# 6 References


- ANSI MH10.8.2 – Data Identifier and Application Identifier Standard http://www.mhi.org/standards
- IEC 60529 – Degrees of protection provided by enclosures (IP Code)
- ISO 3779 – Road Vehicles – Vehicle Identification Number (VIN)
- ISO/IEC 15417 – Information technology – Automatic identification and data capture techniques – Code 128 bar code symbology specification
- ISO/IEC 15418 – Information Technology – Automatic Identification and Data Capture Techniques – GS 1 Application Identifiers and ASC MH 10 Data Identifiers and Maintenance
- ISO/IEC 15459-2 – Information technology – Unique identifiers – Part 2: Registration procedures
- ISO/IEC 15961-1 – Information technology – Radio frequency identification (RFID) for item management – Data protocol: application interface
- ISO/IEC 15962 – Information technology – Radio frequency identification (RFID) for item management – Data protocol: data encoding rules and logical memory functions
- ISO 17367 – Supply Chains Applications of RFID – Product tagging
- ISO/IEC 18000-63 – Information technology – Radio frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz
- ISO/IEC 19987:2015 – Information technology – EPC Information services – Specification
- ISO/IEC 29160 – Information Technology – Radio Frequency Identification for Item Management – RFID Emblem
- JAIF Global Radio Frequency Identification (RFID) Item Level Standard
- VDA 5500 – Basic Principles for RFID Application in the Automotive Industry
- VDA 5510 - RFID for Tracking Parts and Components in the Automotive Industry

# 7 Appendix

## 7.1 Data Identifiers (DIs) for vehicle identification (ISO/IEC)

| Structure | Data Identifier | Description |
|---|---|---|
| an1+an17 | I | Exclusive Assignment - Vehicle Identification Number (VIN) as defined in the U.S. under 49 CFR, §§ 565 and internationally by ISO 3779. (These are completely compatible data structures) |
| an2+an21…35 | 4I | Globally unique transport vehicle identifier (e.g., Trucks) consisting of the Vehicle Identification Number (VIN) as defined in the U.S. under 49 CFR §§ 565, and internationally by ISO 3779, followed by the “+” character, then followed by the government-issued Vehicle Registration License Plate Number assigned to the transport vehicle in the form of “4I” “VIN” “+” “government-issued Vehicle Registration License Plate Number” assigned to the transport vehicle (quotes and spaces shown for clarity only; they are not part of the data).<br>Note: This DI is never to be concatenated with other DIs in a linear symbol or other media where the concatenation character is a plus (+) character<br>Examples:<br>4I1CPH423GA4G102745+GBQ7198<br>4IWGV110000CMSP7891+KA-PA-777 |
| an2+an5…48 | 5I | Unique production vehicle identifier that will be used during the vehicle production processes, consisting of the Body Tag Number (BTN; or any other descriptor used to identify the raw car body, or stated another way, the assemblage of parts that are used to start the vehicle’s production), followed by the “+” character, then followed by the Production Order Number (PON), followed by the “+” character, and then followed by the manufacturer-assigned Serial Number (SN). NOTE: The SN component shall be replaced by the VIN as soon as the VIN is available in the assembly process.<br>The construction will be as follows;<br>“5I” “BTN” “+” “PON“ “+” “SN”<br>changing to (when VIN available)<br>“5I” “BTN” “+” “PON“ “+” “VIN”<br><br>NOTE: Quotes and spaces are shown for clarity only; they are not part of the data.<br>NOTE: This DI is never to be concatenated with other DIs in a linear symbol or other media where the concatenation character is a plus (+) character.<br><br>Examples:<br>SN version: 5IABCD1234+CO1234+W0L201600500001<br>VIN version: 5IABCD1234+CO1234+W0L0XAP68F4050901 |

**Table 5: Data identifiers for vehicle identification according to ANSI MH10.8.2**

## *7.2 Code table (6-bit encoding)*

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

**Table 6: 6-bit character encoding according to ISO 17367 Table C.1**

## 7.3 Coding examples according to ISO/IEC 17367

### 7.3.1 Coding example of MB 01 for a VIN (DI "I")

Table 7 shows a coding example for an OEM-specific VIN according to ISO 3779.

| 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) | | | | | | | |

**Table 7: Sample Vehicle Identification Number (VIN)**

**Note:** For the exact syntax of the OEM-specific VIN, its implementation and possible additional data (e.g. colour codes), please refer to the internal guidelines and standards of the respective OEMs.

The vehicle ID (plain text) is encoded in 6 bits (see also Table 6). The data string is filled with padding bits until the total length of the UII corresponds to an even number of bytes. This means that the UII length within a PC section (header) can be written in 16-bit words (2 bytes).

| **Reference-ID (plain text)** |
|---|
| IW0L0XAP68F4050901 |

| **Compaction 6-bit code including <EoT>** | | | | | |
|---|---|---|---|---|---|
| 001001 | 010111 | 110000 | 001100 | 110000 | 011000 |
| 000001 | 010000 | 110110 | 111000 | 000110 | 110100 |
| 110000 | 110101 | 110000 | 111001 | 110000 | 110001 |
| 100001 | | | | | |

| **Split into 8-bit fragments including padding bits** | | | | | |
|---|---|---|---|---|---|
| 00100101 | 01111100 | 00001100 | 11000001 | 10000000 | 01010000 |
| 11011011 | 10000001 | 10110100 | 11000011 | 01011100 | 00111001 |
| 11000011 | 00011000 | 01100000 | 10000010 | | |

| **Hex code representation** | | | | | |
|---|---|---|---|---|---|
| 25 | 7C | 0C | C1 | 80 | 50 |
| DB | 81 | B4 | C3 | 5C | 39 |
| C3 | 18 | 60 | 82 | | |

**PC data (see section 3.3.3):**

UII-length of 16-bit words: 0b ***0100 0*** (16 bytes → # 8 words)

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*** | (hex 41) |

| Protocol Control | AFI |
|---|---|
| 41 | 90 |

Coded UII content**:**

| PC | AFI | UII ReferenceID | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 90 | 25 | 7C | 0C | C1 | 80 | 50 | DB | 81 | B4 | C3 | 5C | 39 | C3 | 18 | 60 | 82 |

### *7.3.2* **Coding example of MB 01** for transport vehicle label (DI "4I")

Table 8 shows an example of the use data structure

| DI | VIN | Separator | Vehicle Registration License Plate Number | EOT |
|---|---|---|---|---|
| 4I | WMA06XZZ7CW160566 | + | HB LG 123 | <EOT> |
| an 2 | an 17 | 1 | variable x char (an) | 1 |

**Table 8: DI "4I" – Example of data content structure**

The coding scheme for a transport vehicle label is as follows:

| 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 $MB11_2$<br>1 = Valid User Data in $MB11_2$ |
| 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<br>Go to end of data / end of available memory | DI | "4I" | 1 an | Data Identifier I for VIN |
| | VIN | "W0L0XAP68F4050901" | 17 an | VIN |
| | Separator | + | 1 an | + sign separator ($2B_h$) |
| | Vehicle Registration LPN | GGAB1234 | 1...X an | Up to x alphanumeric characters in capital letters |
| | <EOT> | 0b100001 | 6 bit | End of Transmission ISO 17367 Table C1 |

| | | | | |
|---|---|---|---|---|
| | Bit Padding | 0b10,<br>0b1000,<br>0b100000,<br>0b10000010,<br>0b1000001000,<br>0b100000100000,<br>or<br>0b10000010000010 | 2, 4, 6, 8, 10, 12 or 14 bits | Padding according to ISO/IEC 15962 chapter 13.1 |
| | ***Subtotal*** | | ***Variable*** | ***Up to 240 bits*** |
| | **TOTAL MB01$_2$ BITS:** | | **VARIABLE** | **UP TO 272 BITS** |

The transport vehicle label ID (plain text) is encoded in 6 bits (see also Table 6). The data string is filled with padding bits until the total length of the UII corresponds to an even number of bytes. This means that the UII length within a PC section (header) can be written in 16-bit words (2 bytes).

| **Reference ID (plain text)** |
|---|
| 4IW0L0XAP68F4050901+GGAB1234 |

| **Compaction 6-bit code including <EoT>** | | | | | |
|---|---|---|---|---|---|
| 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 (see section 3.3.3):**

| | | |
|---|---|---|
| UII-length of 16-bit words: | 0b ***0101 1*** | (22 bytes → # 11 words) |
| 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*** | (hex 59) |

| Protocol Control | AFI |
|---|---|
| 59 | 90 |

Coded UII content**:**

| PC | AFI | UII Reference ID | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | 90 | D0 | 95 | F0 | 33 | 06 | 01 | 43 | 6E | 06 | D3 | 0D | 70 | E7 | 0C | 6B | 1C | 70 | 42 | C7 | 2C | F4 | 86 |

## *7.4 Example of shipping label*

Annex 1