RFID in Supply Chain Container Management
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1. INTRODUCTION

1.1 POSITIONING OF RFID IN THE AUTOMOTIVE ENVIRONMENT

In many companies, Radio Frequency ID-entification (RFID) is playing an ever more important role. For some processes in the automotive sector, radio-based identification is already superior to other identification procedures, such as bar-coding, in terms of process efficiency and quality criteria. Additional areas of application will soon become commercially viable through price reductions and technological development.

A fundamental benefit of the new technology is that not only are classes distinguishable (e.g., parts with the same code number, type of RTI) as in the past, but individual entities of a class (e.g., airbag module with code number 123 and serial number 234 or pallet cage of the type 4711 with container ID 4712) 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 development of internal company processes.

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

The real potential of using RFID with RTIs 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.
RFID Vision in Automotive
Scope of applications

Illustration 1: RFID vision in the automotive industry

The use of a transponder over several process steps has potential business benefits. For example, a transponder in a component can support the following additional functions:

- Production documentation control by the supplier
- ‘Marriage’ of code number or order number with the RTI, which is tracked via the subsequent logistics process
- If an internal sequence is produced, the assignment of an order number to the part can take place
- With the assembly in the vehicle, the correct installation can be ensured through comparison of code number/order number with the customer order
- With 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 originates, targeted re-calls are possible with a minimum of disruption
- In the case of a warranty claim, it is possible to check whether the original part from the factory is still fitted
- Usage within the replacement parts chain for optimisation of process control
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 transponder, which simplifies the sorting process.

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

For additional general information on RFID systems implementation and operations please see ISO/IEC TR24729 series.

1.2 OBJECTIVES OF THIS RECOMMENDATION

This document describes an RFID-supported process for the optimisation of Returnable Transport Items (RTIs) in the automotive supply chain.

For this purpose, the necessary data structures, including the identification logic used, as well as requirements for the underlying RFID technology are described. The aim is to define a unique Memory Bank 01 identifier for 18000-6C tags by applying suitable alternative schemes (e.g. automotive application of ISO or EPC).

Another objective of this recommendation is to define uniform interfaces for the exchange of information between different RTI management logistics systems used by partners integrated in the process. The RFID specific functionality as well as the requirements for sharing data have also been considered.

This document concentrates specifically on the automated identification of all forms of RTIs used in the automotive industry. However, many aspects may be easily transferable to other objects, such as components, vehicles or logistics locations.

A complete analysis of the use of RFID will be necessary for evaluating the impact of this new technology in terms of its potential business benefits.

This recommendation should serve as a good foundation for future work. RFID is an enabling technology for logistics operations which has specific benefits for the control of material flow. It enables the alignment of the physical and information flows of material movements. Specifically, when an RTI is physically available, the relevant and associated information about that RTI is also available.
RFID cannot replace the need to use back-end systems and EDI processes. EDI data flows take place far earlier than the movement of physical goods and are therefore valuable for logistics planning processes and visibility via core back-end systems and applications. After this recommendation has been published, it is recognised that an alignment by other responsible standards bodies for EDI documentation will be necessary.

1.3 APPROACH AND STRUCTURE OF THE RECOMMENDATION

The processes for handling empty and full RTIs between OEM, shipper and supplier were considered in the creation of this recommendation. The individual processes were specified in process detail sheets and the potential benefits of RFID were identified. These included the aspects of Asset Management supported by RFID, from the container manufacturer to the end of life, with repairs, washing operation, inventories etc.

The data required for each process step were defined in a data matrix and were used as the basis of this recommendation.

The chapter on ‘Data Structure’ defines which data fields are to be stored on the transponder. Special attention was directed to the requirements for a unique numbering system, as well as to the requirements of the transponder and reader technology.

An overview and detailed description of the application of RFID technology in the supply chain is given in section 5.1.
2. MAJOR RFID APPLICATION SCENARIOS

The data structures on the transponder described below permit three fundamentally different scenarios of the process design with RFID support, which place different demands on the total system.

By total system, we understand in this context, all resources necessary for this process, including the tag, reader, network, middleware, applications, organisation, etc.

The scenarios differ, based on the way data is stored and used on the tag:

- Does the tag on the RTI contain only a container ID, or does it contain additional user data such as date fields or destinations?
- Are data written on the tag only at the time of creation of the tag and only read afterwards in the process, or can the tag data also be changed in the process, i.e. re-written?

The 3 resulting scenarios are represented in the following matrix:

<table>
<thead>
<tr>
<th>Read/Write Permissions on Tag</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>User-Data used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Version 1: Tag contains only container ID</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>Version 2: Read access to user data</td>
<td>Version 3: Read/Write access to user data</td>
</tr>
</tbody>
</table>

Illustration 2: Matrix of the versions considered.

In the description of these scenarios below, there is a reference to the logical ‘container ID’. The exact definition of this ID is explained in Chapter 3 ‘Data Structure’.

‘User data’, refers to all user data stored on the transponder for a unique ‘container ID’.

All three scenarios allow read-access to the logical container ID on the transponder.

2.1 SCENARIO 1: TAG CONTAINS THE CONTAINER ID ONLY

The only data field that is used on the tag is the logical ‘container ID’, which is a unique reference for each RTI worldwide. This logical ‘container ID’ is protected and cannot be over-written.

All other information related to the RTI must be accessed via the relevant back-end system or other databases.
This scenario represents the safest and fastest way of accessing RFID data on the transponder (i.e., on the ‘air interface’), since the exclusive access to the container ID in the ISO-18000-6C model is faster for technical reasons than the access to all other data in the other Scenarios 2 and 3.

This can be of vital importance when performing bulk reads on a pallet containing packaging with multiple RFID transponders (e.g., via an RFID enabled gate).

Additional user data must be read in this case from the back-end system or database.

### 2.2 SCENARIO 2: TAG ALSO CONTAINS USER DATA – READ ACCESS ONLY

In addition to the logical container ID, this scenario covers user data requirements, which must be written to the tag at the point in time when the logical container ID is assigned.

This data is also protected and cannot be overwritten. It can only be written once and is ‘read only’ thereafter. For this reason, this data can be treated as master data. Access to the transponder data is ‘read only’ in all process steps.

All additional data required must be accessed via the relevant back-end system. In comparison to Scenario 1, the read operation is slowed down by the user data access.

This scenario can be useful when additional RTI data and information is required off-line (e.g., RTI acquisition date or the corresponding RTI type).

### 2.3 SCENARIO 3: TAG ALSO CONTAINS USER DATA – WRITE ACCESS ALLOWED

The container ID is protected against overwriting; the user data can be modified in the process (e.g., date time stamp).

Whatever data needs to be exchanged between partners in the supply chain relating to the movement of RTIs, must be defined bilaterally between the partners.

**Warning:** in accordance with ISO-18000-6C, a differentiation of write permission is only possible for the entire User Memory Bank (MB1...) 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.
3. TRANSPONDER DATA STRUCTURE

3.1 DATA STRUCTURE REQUIREMENTS

3.1.1 RATIONALE 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, which are selected or modified in the various logistics processes.

In a given process it is not always necessary to access the total contents of the transponder, but rather only to access individual fields. Thus the read-write access time and data transfer volume are reduced to the absolute minimum.

Individual data fields can be encrypted and documented with read-write authority. The remaining data fields can often be optionally overwritten within the process flow as many times as necessary, to ensure that they are always up to date.

3.1.2 CONTAINER ID AS UNIQUE IDENTIFIER

The process model described in this recommendation assumes that each RTI to be controlled in accordance with this proposal should be provided with one or two tags, on which a container ID is coded.

This container ID is always formatted in accordance with the ISO-18000-6C air interface standard, in line with the MB01 data segment described in Chapter 3.2. This container ID represents a unique logical identifier of the tagged object in contrast to the Tag ID, which represents a unique physical identifier for each transponder (which however is not obligatory).

The MB01 data segment of the transponder will always be read first followed by a query of the data stored in the User Memory Bank (MB11), as required.

In the following cases, three different types of RTIs have been considered, which require different processing and identification logic:

3.1.2.1 RE-USABLE RTI WITH UNIQUE OWNER ID

The majority of the RTIs considered in this recommendation are of this ‘re-usable RTI’ type, i.e., they are, as a rule, procured and brought into circulation by the customer.

After receipt of full RTIs by the customer, the contents are used and the empty RTIs are returned to the supplier for re-use. The supplier always sends this RTI to the customer who brought it into circulation originally.
The RTI can be a ‘special container’ type (i.e., a unique container constructed for a specific supply requirement) or a ‘universal container’ type (i.e., a container used for different supply requirements). The container ID is composed of the following three data segments:

**RTI owner:**
Unique global ID for the RTI owner (e.g., EPC Manager number, Odette ID (see Chapter 6) or DUNS number)

**Type of RTI:**
Container type which can be freely assigned by either the owner /or the customer

**Container ID:**
A number from a range (serial number) within a container type

For example, the **GRAI coding scheme** (Global Returnable Asset Identifier) would correspond to this requirement with the use of an EPC coding scheme.

**Warning:** All tags used for RTI identification must be compatible. This applies especially with the recommendation for placing tags on both sides of a given RTI to guarantee accurate and reliable readability. See also Chapter 4.7.

### 3.1.2.2 MULTI-PURPOSE RTI WITHOUT A UNIQUE OWNER ID

There are many containers of this kind in use, such as the VDA KLT (small container) and universal pallet cages. Such RTIs do not have a clearly defined owner and therefore can be sent within the supply chain to other customers.

No conversion concept exists to fit RFID tags to RTIs of this type, nor how it can be organised and financed. A possible alternative would be to have them converted in line with the recommendation for a Re-usable RTI with a unique Owner ID.

Alternatively, this type of RTI could also be treated in line with the recommendation below for non-returnable RTIs. The decision, as to how such pool RTIs should be processed in the future, must be considered by the Odette Logistics Functional Committee.

### 3.1.2.3 NON-RETURNABLE, DISPOSABLE TRANSPORT ITEM WITHOUT A UNIQUE OWNER ID

This category includes cartons, wooden Euro-pallets etc. Due to their low value and/or their free availability (similar to ‘Multi-purpose RTI without a unique owner ID’), the permanent fitment of RFID tags cannot be realistically considered. Therefore, the usage of RFID for these types of TIs can only be agreed bilaterally between two partners in the supply chain as described below.
The respective dispatcher (i.e., the supplier providing material to the OEM in full RTIs or the OEM returning the empties) fits a ‘non-reusable tag’ for this scenario. This is similar to the current solution for material identification tags, which are only valid for an individual delivery and are typically removed at the final destination. This type of RTI-ID is comprised of two data segments:

**RTI dispatcher:**

Global unique ID for the dispatcher of the RTI (e.g., EPC Manager number, Odette ID or DUNS number.);

RTI dispatcher is the supplier for the full RTIs, the customer or his service provider for the empties.

**RTI ID:**

Sequential ID or serial number of the ‘packing unit’ for a given dispatcher.

### 3.2 DATA STRUCTURE ON THE TRANSPONDER (AIR INTERFACE)

The principal structure of the data stored on the transponder has been defined in the “air interface” standard in accordance with ISO18000-6C.

ISO 18000-6C assumes a logical division of the tag storage into 4 data segments, which are represented in the diagram below:
The essential contents of these segments are:

**MB00₂ = Password management:**
- Access password
- Kill password

**MB01₂ = 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 is saved or not in MB11₂
- Bit 17: Switch, if an EPC or an ISO number stands in the UII field below
- Characteristic of the AFI field (Application Family Identifier)
- UII field: contains the unique container ID

The following four conditions can be represented via the assignment of the $15_{\text{hex}}$ and $17_{\text{hex}}$ bits in the MB01₂:

<table>
<thead>
<tr>
<th>MB01₂, Bit 17_{h}</th>
<th>MB01₂, Bit 15_{b}</th>
<th>MB11₂ “User Memory”</th>
<th>Usage of MB11₂ in ISO 18000-6C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 = No data in MB11₂</td>
<td>- EPC-based UII Data in MB01₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- No User Data in MB11₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = User Data in MB11₂</td>
<td>- EPC-based UII Data in MB01₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- User Data in MB11₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = EPC-based UII Data in MB01₂</td>
<td>- Monomorphic ISO AFI-based UII Data in MB01₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- No User Data in MB11₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = User Data in MB11₂</td>
<td>- Monomorphic ISO AFI-based UII Data in MB01₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- User Data in MB11₂</td>
</tr>
</tbody>
</table>

**Table 1:** Usage of MB11₂ in ISO 18000-6C
3.2.1 DATA STRUCTURE FOR UNIQUE RTI ID (UII - UNIQUE ITEM IDENTIFIER)

The UII memory area on the transponder can be accessed very quickly in comparison to the User Memory Bank (MB112), because identification of the tagged object via the air interface has the highest priority and is the fastest operation. Therefore the technical and physical restrictions of the transponder data structure need to be taken into careful consideration, especially when performing bulk reads on a pallet containing packaging with multiple RFID transponders (e.g., RFID enabled gate).

If required, the UII should be “locked” according to ISO/IEC 18000-6C or EPCglobal UHF Gen 2 air interface protocols.
The UII memory portion of the tag can be described based on two coding schemes.

### 3.2.1.1 UII BASED ON ISO CODING SCHEME (WITH ODETTE OR DUNS FORMAT)

The formatting of the data on the RFID tag must be in line with the ‘ASCII-Character-to-6-Bit-Compaction Substitution Table’, see Table 2 below, for proper 6-bit compaction according to ISO/IEC 15962.

<table>
<thead>
<tr>
<th>Char</th>
<th>Pattern</th>
<th>Char</th>
<th>Pattern</th>
<th>Char</th>
<th>Pattern</th>
<th>Char</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPACE</td>
<td>10 0000</td>
<td>0</td>
<td>11 0000</td>
<td>@</td>
<td>00 0000</td>
<td>P</td>
<td>01 0000</td>
</tr>
<tr>
<td>EOT</td>
<td>10 0001</td>
<td>1</td>
<td>11 0001</td>
<td>A</td>
<td>00 0001</td>
<td>Q</td>
<td>01 0001</td>
</tr>
<tr>
<td>&quot;</td>
<td>10 0010</td>
<td>2</td>
<td>11 0010</td>
<td>B</td>
<td>00 0010</td>
<td>R</td>
<td>01 0010</td>
</tr>
<tr>
<td>#</td>
<td>10 0011</td>
<td>3</td>
<td>11 0011</td>
<td>C</td>
<td>00 0011</td>
<td>S</td>
<td>01 0011</td>
</tr>
<tr>
<td>$</td>
<td>10 0100</td>
<td>4</td>
<td>11 0100</td>
<td>D</td>
<td>00 0100</td>
<td>T</td>
<td>01 0100</td>
</tr>
<tr>
<td>%</td>
<td>10 0101</td>
<td>5</td>
<td>11 0101</td>
<td>E</td>
<td>00 0101</td>
<td>U</td>
<td>01 0101</td>
</tr>
<tr>
<td>&amp;</td>
<td>10 0110</td>
<td>6</td>
<td>11 0110</td>
<td>F</td>
<td>00 0110</td>
<td>V</td>
<td>01 0110</td>
</tr>
</tbody>
</table>
Table 2: ASCII-Character-to-6-Bit-Compaction Substitution Table

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Value</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRC-16</td>
<td>Hardware assigned</td>
<td>16 bits</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>PC Word, bit $10_14$</td>
<td>01101</td>
<td>5 bits</td>
<td>Length of the UII data in words (2 bytes)</td>
</tr>
<tr>
<td>PC bit $15_{14}$</td>
<td>0 or 1</td>
<td>1 bit</td>
<td>$0 =$ No valid User Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$1 =$ Valid User Data</td>
</tr>
<tr>
<td>PC bit $16_{14}$</td>
<td>0</td>
<td>1 bit</td>
<td>$0 =$ ”Extended PC word“ not used</td>
</tr>
<tr>
<td>PC bit $17_{14}$</td>
<td>1</td>
<td>1 bit</td>
<td>$1 =$ data interpretation rules based on ISO</td>
</tr>
<tr>
<td>AFI</td>
<td>A3$_8$</td>
<td>8 bits</td>
<td>Application Family Identifier used in line with ISO/IEC 15961 and ISO/IEC 17364.</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>32 bits</td>
<td></td>
</tr>
<tr>
<td>UII:</td>
<td></td>
<td></td>
<td>All UII data are 6 bit compacted according to ISO 15962, not used positions are padded with leading zeros</td>
</tr>
<tr>
<td>DI</td>
<td>“25B”</td>
<td>3 an</td>
<td>Data Identifier for RTI</td>
</tr>
<tr>
<td>IAC</td>
<td>“OD”</td>
<td>2 an</td>
<td>Issuing Agency Code, i.e. Odette</td>
</tr>
<tr>
<td>Company Code (CIN)</td>
<td>“ZZZZ”</td>
<td>4 an</td>
<td>Company Identification Number</td>
</tr>
<tr>
<td>Object (RTI) Type</td>
<td></td>
<td>17 an</td>
<td>17 an characters in capital letters RTI type assigned by the RTI owner</td>
</tr>
<tr>
<td>Object Sequence Nr</td>
<td></td>
<td>1...8 an</td>
<td>Up to 8 an characters in capital letters</td>
</tr>
<tr>
<td>Padding</td>
<td>1000</td>
<td>4 bits</td>
<td>6 bit compaction Padding to byte Boundary assuming 8an OSN</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>208 bits</td>
<td></td>
</tr>
<tr>
<td>Total bits:</td>
<td></td>
<td>240 bits</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Odette Coding Scheme for RTIs (Returnable Transport Items) in MB01
### Table 4: DUNS Coding Scheme for RTIs (Returnable Transport Items) in MB01.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Value</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRC-16</td>
<td>Hardware assigned</td>
<td>16 bits</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>PC Word, bit 10 ( _{14}H )</td>
<td>01111</td>
<td>5 bits</td>
<td>Length of the UII data in words (2 bytes)</td>
</tr>
<tr>
<td>PC bit 15 ( _{14}H )</td>
<td>0 or 1</td>
<td>1 bit</td>
<td>0 = No valid User Data, 1 = Valid User Data</td>
</tr>
<tr>
<td>PC bit 16 ( _{14}H )</td>
<td>0</td>
<td>1 bit</td>
<td>0 = “Extended PC word” not used</td>
</tr>
<tr>
<td>PC bit 17 ( _{14}H )</td>
<td>1</td>
<td>1 bit</td>
<td>1 = data interpretation rules based on ISO AFI</td>
</tr>
<tr>
<td>AFI</td>
<td>A3(_{14}H)</td>
<td>8 bits</td>
<td>Application Family Identifier used in line with ISO/IEC 15961 and ISO/IEC 17364.</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>32 bits</td>
<td>All UII data are 6 bit compacted according to ISO 15962, not used positions are padded with leading zeros</td>
</tr>
<tr>
<td>UII:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI</td>
<td>“25B”</td>
<td>3 an</td>
<td>Data Identifier for RTI</td>
</tr>
<tr>
<td>IAC</td>
<td>“UN”</td>
<td>2 an</td>
<td>Issuing Agency Code, i.e. DUNS</td>
</tr>
<tr>
<td>Company Code (CIN)</td>
<td>“123456789”</td>
<td>9 n</td>
<td>Company Identification Number</td>
</tr>
<tr>
<td>Object Type (RTI)</td>
<td>17 an</td>
<td>17 an characters in capital letters, RTI type assigned by the RTI owner</td>
<td></td>
</tr>
<tr>
<td>Object Sequence Nr</td>
<td>1…8 an</td>
<td>Up to 8 an characters in capital letters</td>
<td></td>
</tr>
<tr>
<td>Padding</td>
<td>100000</td>
<td>6 bits</td>
<td>6 bit compaction Padding to byte Boundary assuming 8an OSN</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>240 bits</td>
<td></td>
</tr>
<tr>
<td>Total bits:</td>
<td></td>
<td>272 bits</td>
<td></td>
</tr>
</tbody>
</table>

#### 3.2.1.2 UII BASED ON THE EPC CODING SCHEME

The UII memory area is described for use in many industry sectors in “EPCglobal Tag Data Standards “Version 1.4. Because this scheme has the smallest data to transfer it has the fastest performance.

An EPC Identifier in GRAI-96 format consists of the following data fields and has a length of 96 bits:

- **Header**

  Determination of the so-called coding scheme, in which structure and length of the actual EPC identifier are defined (e.g. GRAI, ...)

---

**Automotive Supply Chain Best Practice Recommendation**

**RFID in Supply Chain Container Management**

**Doc Ref No: LR01**

**Version No 1.0**

**November 2009**

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• Filter value (3 bit) allows (according to coding scheme) a filtering of certain EPC identifiers by the reader
• Partition field (3 bit) determines length of the EPC manager
• Actual container ID consisting of- EPC manager (= owner of the container)
• RTI (Returnable Transport Item) type and
• RTI serial number.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Value</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRC-16</td>
<td>Hardware assigned</td>
<td>16 bits</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>PC Word, bit 10_H</td>
<td>00110</td>
<td>5 bits</td>
<td>Length of the UII data in words (2 bytes)</td>
</tr>
<tr>
<td>PC bit 15_H</td>
<td>0</td>
<td>1 bit</td>
<td>0 = no user memory</td>
</tr>
<tr>
<td>PC bit 16_H</td>
<td>0</td>
<td>1 bit</td>
<td>0 = “Extended PC word” not used</td>
</tr>
<tr>
<td>PC bit 17_H</td>
<td>0</td>
<td>1 bit</td>
<td>0 = data interpretation rules based on EPC</td>
</tr>
<tr>
<td>AFI</td>
<td>000000000</td>
<td>8 bits</td>
<td>No AFI with EPC Format</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>32 bits</td>
<td></td>
</tr>
<tr>
<td>UII</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Header</td>
<td>51_0</td>
<td>8 bits</td>
<td>Definition of Coding Scheme, i.e. EPC GRAI96</td>
</tr>
<tr>
<td>Filter</td>
<td>0_0</td>
<td>3 bits</td>
<td>Filter value for selection</td>
</tr>
<tr>
<td>Partition</td>
<td>5_0</td>
<td>3 bits</td>
<td>Partitioning of the bits available in owner/ type (i.e. 7 character owner and 6 character type)</td>
</tr>
<tr>
<td>Company Prefix</td>
<td>6-12 digits</td>
<td>20 - 40 bits</td>
<td>Company owner (EPC Manager), variable length but sum of Company Prefix and Asset Type is fixed</td>
</tr>
<tr>
<td>Asset Type</td>
<td>6-0 digits</td>
<td>24 - 4 bits</td>
<td>RTI type assigned by the owner</td>
</tr>
<tr>
<td>Serial Number</td>
<td>11 digits</td>
<td>38 bits</td>
<td>A value between 0 and 274877906943</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>96 bits</td>
<td></td>
</tr>
<tr>
<td>Total bits</td>
<td></td>
<td>128 bits</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: EPC Coding Scheme for GRAI96

3.2.2 DATA STRUCTURE IN THE USER MEMORY BANK (MB112)

3.2.2.1 DATA REQUIREMENTS

A unique identifier must be saved on the transponder as a minimum requirement (ref. Chapter 3.1.2). See also the ISO data structure model and the ‘MB01 – UII’ data segment above (ref. Chapter 3.1.2). In application Scenarios 2 and 3 in Chapter 1, additional user data are required. The requirements vary depending upon the business processes and agreements with the participating partners.

The following information is relevant when, according to Table 1 above, PC Bit 15_H = 1, PC Bit 17_H = 0 or 1.

This document describes Access Method “0”, and Formats 3 and 13 for encoding data within MB112. This document also describes the encoding schema proposed for a Harmonised 6-bit Access Method.
3.2.2.2 THE 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 6.
  - In this standard, the access method recommended is "No Directory," with bit value ‘00’.
- Bit 6 is the Extended Syntax indicator.
- Bits 5 through 1, inclusive, describe the Data Format registered under the rules of ISO/IEC 15961 Part 2.
- “03h” is the resultant DSFID for “No Directory, ISO/IEC 15434, according to ISO/IEC 15962. The SG1 standing document “SG1 Guidelines for 15962” explains the use of this method with Format 06, 6-bit encoding.
- “0Dh” is the resultant DSFID for “No Directory using the ISO/IEC 15962 Assigned Relative OID DI Table”.
- “8Dh” is the resultant DSFID for “Packed Objects, using the ISO/IEC 15962 Assigned Relative OID DI Table”.
- “TBD”, “TBD” are the DSFID and Extended Syntax bytes that denote the proposed Harmonized 6-Bit Access Method. See Table 6.

NOTE: The Assigned Relative OID DI Table can be found at:


<table>
<thead>
<tr>
<th>15961 integer code</th>
<th>15962 DSFID bit code</th>
<th>15962 SFF bit code</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00</td>
<td>00</td>
<td>No-Directory</td>
<td>This structure supports the contiguous abutting of all the Data-Sets</td>
</tr>
<tr>
<td>1</td>
<td>01</td>
<td>00</td>
<td>Directory</td>
<td>The data is 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.</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>00</td>
<td>Packed-Objects</td>
<td>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)</td>
</tr>
</tbody>
</table>
| 3                 | 11                   | 00                 | Tag-Data-Profile     | This is an integrated compaction and encoding scheme for a fixed set of data elements, each of a
3.2.2.3 ACCESS METHOD 0, FORMAT 3; ISO/IEC 15961-2 DEFINED ENCODING ASSIGNED TO ISO/IEC 15434. (SEE TABLE 6 ABOVE)

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 “[ ] > R₅”, the Format Header (as used in this document for DIs; “06 G₅”), and the message’s final Format Trailer/Message Trailer characters “R₅ Eₒ ṅ T”. Data encoding is accomplished by using the 6-bit data characters in Table 2 in section 3.2.1.1.

3.2.2.4 SYNOPSIS OF ACCESS METHOD 0, FORMAT 3 ENCODING:

- The first byte of memory is a DSFID that always has the fixed value 03ₜ, indicating that memory uses Access Method 0 and encodes Format 3 (ISO/IEC 15434) messages.

- 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, a fixed Precursor value of 46ₜ will always be used, indicating six-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 169 data characters), this number is encoded in a single byte.

- The subsequent bytes (whose length was indicated by the preceding byte) contain the data, in six-bit encoding (reference Table 2).

- The data stream is terminated by an 8-bit “0₂” byte, unless no more memory remains after the last byte of data.

---

Table 6: Assigned and Reserved Access Methods

<table>
<thead>
<tr>
<th>15961 integer code</th>
<th>15962 DSFID bit code</th>
<th>15962 SFF bit code</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBD*</td>
<td>TBD*</td>
<td>TBD*</td>
<td>Proposed Harmonised 6-bit</td>
<td>This is a proposed integrated compaction and encoding scheme for ISO/IEC 15434, Format 06 (Data Identifiers), utilizing 6-bit encoding and no directory structure, with each message terminated by an &lt;EOT&gt; character</td>
</tr>
<tr>
<td>4-15</td>
<td>00-11</td>
<td>10-11</td>
<td>Currently reserved for future revisions of ISO/IEC 15962</td>
<td></td>
</tr>
</tbody>
</table>

* Please note that this proposal was valid when this document was published, but this could be changed in future versions of ISO 15962 documents
3.2.2.5 ACCESS METHOD 0, FORMAT 13; ISO/IEC 15961-2 DEFINED ENCODING ASSIGNED TO ISO/IEC 15962 ASSIGNED RELATIVE OID DI TABLE. SEE TABLE 6

- The first byte of memory is a DSFID that always has a fixed value of 0Dh, 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 Assigned Relative OID DI Table value 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 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.
- The encoding process terminates the data stream (made up of all the Precursor, Length of Data, Data elements) with an 8-bit “02” byte, unless there is no memory available after the last byte of data.

3.2.2.6 PROPOSED HARMONISED 6-BIT ACCESS METHOD; ENCODING ISO/IEC 15434-BASED DATA ACCORDING TO ISO 1736X BASED SYNTAX. SEE TABLE 6

Under this schema, the first 8 bits of MB112 is the DSFID and the following 8 bits are an extended format byte.

- The first byte of memory (DSFID = TBD) is constructed as follows:
  - Bits 8 and 7 are the Access Method = 00
  - Bit 6 is the Extended Syntax bit = 1
  - Bits 5 through 1 are the Data Format = TBD
- The Extended Syntax byte (when used) is constructed as follows:
  - 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 six-bit encoding.
- The data stream is terminated by the <^6O_2^> character.
When the DSFID of MB112 is read and a value of TBD is present, the decoding system knows that this DSFID represents the ISO/IEC 15434 envelope beginning with "(>)$06$S" and ending with $RS$ $O_T$. The decoder can then add these characters in their appropriate places, and pass the complete ISO/IEC 15434 data stream to the host system. Because the $O_T$ character is explicitly encoded, when decoding the data stream, the ISO/IEC 15434 Envelope shall not add a second $O_T$.

3.3 EDI DATA STRUCTURES

In addition to the RFID data on the RTI, data should also be sent by EDI to the customer and to the shipper. This allows validity checking.

When the RFID container ID is read by the receiver of the goods or RTI, he can check immediately whether he has received all of the goods and/or the right RTIs.

These messages for RFID processes must ultimately be compatible with the requirements of other EDI messages like DESADV.

This should be determined by the Odette Technology Committee.
4. TECHNICAL SPECIFICATIONS

The specifications described below satisfy the process requirements of the European automotive industry. These process requirements are included in Chapter 5. The technical specifications must be strictly complied with in order to achieve an acceptable RFID system.

4.1 RFID TAG MEMORY SIZE

The Tag’s overall 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 280 bits is recommended for the ISO-based birth record data up to 35 characters.

A minimum User Memory Bank (MB11) size of 512 bits is recommended.

4.2 FREQUENCY RANGE AND READ/WRITE DISTANCES

UHF technology (860 – 960 MHz) has been applied to large RTIs and packaging units as well as to small RTIs. General points include:

- Air interface in accordance with ISO 18000-6C
- Also applies to metal RTIs
- For error-free operation in close proximity, the read/write range of the reader has to be adjustable

As soon as the ISO Guidelines 18047-6 (Compliance testing of the Air Interface) and 18046 (Performance test of an RFID System) are published, they may be included in this recommendation.

4.3 TAG TYPES

Depending on the application, data fields might need to be changed or modified. Therefore, it is necessary that a read-write transponder is used. The container ID and user data relevant to application scenario 2 must be protected data.

---

1 This recommendation applies to passive as well as semi-active transponders.
4.4 RELATIVE SPEED WHEN PASSING THROUGH GATES

The relative speed indicates the maximum possible speed for communications between transponders and antennae. For reliable reads when passing through gates, an error-free read-rate (100% at a speed of between 0 to 6 m/s has to be ensured.\(^2\)). Possible reading speed depends on several factors like location of tags, distance, location of antenna, type of tag chip, size of tag antennas etc.

4.5 ANTI-COLLISION MECHANISM

This must be in accordance with ISO 18000-6C.

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

In order to exclude errors caused by collision by multiple UHF readers with overlapping fields of detection, the recommendations of the 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.

4.6 LIFE-SPAN OF THE TRANSPONDER

Passive transponders should have a minimum service life of 15 years, subject to commercial agreements between RFID users and RFID Technology Providers.

4.7 ENVIRONMENTAL CONDITIONS

Protection mechanism:

The IP 67 protection system is the minimum necessary to ensure proper efficiency in the logistics environment for transponders exposed to the weather subject to commercial agreements between RFID users and RFID Technology Providers:

- Complete protection of the transponder from physical damage and dust.
- Protection against adverse conditions caused by submersion in water, snow, rain, container cleaning etc. Limited functionality under such adverse conditions is acceptable.

---

\(^2\) In the UHF range, a maximum data transfer rate of 40-80 kbit/s is realistic. The higher the speed, the higher the probability of read errors due to ‘blind spots’ in the range of the antenna.
Temperature range:

- -40° to +70° Celsius (for use outdoors)
- Appropriate measures that guarantee readability are necessary under adverse weather conditions
- Exposure to oil spray, cutting fluid, steam, etc. must be considered on an individual basis.

4.8 LOCATION OF THE TRANSPONDER ON THE RTI

If the transponder is not visible (e.g. embedded in a small KLT container), the location of the transponder must be shown on the outside of the RTI. In any transponder solution, the unique container identification number should also be human readable.

4.8.1 LARGE RTIS, PALLETS, LOAD UNITS

The transponders should be attached to RTIs in such a way that readability at the pallet level is guaranteed when the forklift truck has lifted the pallet. This has to be possible on the long or short side of the RTI. In both cases readability must be guaranteed from the side of the pallet.

To increase readability, it is recommended that a second transponder is attached on the opposite side, located diagonally to the first transponder. If tags with modifiable user data are used (Scenario 3), both transponders must contain the same information.

4.8.2 SMALL RTIS

It can be expected that with small RTIs, (e.g. KLTs, rotary stack RTIs, etc.) there may be serious readability difficulties when using metal RTIs with an impaired line of sight to the reader.)
The read quality is clearly improved when two transponders from different RTIs do not lie next to one another.
5. PROCESSES IN THE SUPPLY CHAIN

Supply chain illustration

RFID support for supply chain processes is only really effective when used as widely as possible by all partners involved, including:

- Suppliers
- Shippers
- External service providers – (for both empty and full RTIs)
- Customers - OEMs

The following generic process descriptions with the two illustrations below describe only the process steps and functions that are impacted by the introduction of RFID technology, vis-a-vis the conventional processes without RFID support. Inbound/outbound processes are considered. The different processes for full RTIs and empties are also described.

Internal processes (production or internal logistic processes) are not described here; these must be designed according to individual company requirements.
Filled Container Process

Empties Process

The following generic supply chain processes are described independently of the RFID tag type actually used. Therefore, in some cases, especially with the application of Scenario 3 (see also Chapter 2, tag with user data) the process described here can vary slightly.
5.1 PROCESS DESCRIPTION FOR EMPTY RTIS

ACQUISITION OF EMPTY RTIS

A globally unique container ID is assigned upon acquisition of new RTIs or components thereof. The unique container ID must be written to the transponder on the RTI and protected against overwriting before putting the RTI into circulation. The same applies to additional data, which is to be written and permanently stored on the transponder in accordance with Scenario 2 (tag contains user data – read access only).

Each RTI component to be identified must be fitted with at least one transponder.

Depending upon the physical characteristics of the RTI, additional transponders may be attached to ensure reliable read efficiency.

In bundles, each individual RTI in the bundle is fitted with a separate transponder, if it needs to be uniquely identified. (Example: inserts/foam, which are separated in the production supply and/or should be tracked in the production process of the supplier, should be fitted with separate transponders).

The technical requirements for the transponder are described in Chapter 4.

- RFID opportunities:
  - Transparency in RTI tracking is increased (for both new and/or replacement RTIs).
  - Reduction of RTI inventory and/or fewer RTI bottlenecks of empties through an increase in the speed of circulation.

RECIRCULATION OF EMPTRIES FROM CUSTOMER’S PRODUCTION FACILITIES

This relates to in-plant RTI transportation.

- RFID opportunities:
  - Routing of the empties to their respective storage place; either automatically by conveyor system or manually, supported by a visual display of the destination
  - Local control of transportation and conveyor equipment (can read the field ‘destination’)

- Requirements for RFID process:
  - Reading of transponder data in the production environment
  - Target destination must be stored in the back-end data system and/or the target destination field of the empties in use
  - Setting RTI status from full to empty
• Links to data objects (examples):
  o Selection of the destination field from the user data storage

---

**EMPTIES MANAGEMENT BY THE CUSTOMER**

Empties inventory management

There are, if needed, different levels of analysis of empties inventory management possible:

• Empties inventory at the supplier and/or at the customer based on transponder data
• Available empties inventory at the empties storage based on the transponder data

In order to ensure accurate inventory levels at both the customer and the supplier, postings are necessary when the empties enter the customer’s plant and when sent to the supplier.

• RFID opportunities:
  o Transparency in RTI tracking is increased
  o Reliably managed supplier’s RTI inventories at the customer location, based on automated recording and processing for entry and removal from storage
  o Reliable management of empties inventories at the customer’s storage location based on automated recording of the inbound and outbound movements
  o Elimination of manual postings (cost and workload reduction)
  o Reduction of RTI inventory and/or fewer empty RTI bottlenecks through increase in the speed of circulation, which in turn leads to a reduction in the warehouse space needed for storage

• Requirements for RFID process:
  o Reading of the transponder data on receipt of full RTIs + storage place assignment (RTI or supplier-related)
  o Reading of the transponder data of empties at the point of despatch
  o Reading of the transponder data of empties at their storage location
  o Multiple transponder data must be read on RTIs in bundles, if applicable

• Links to data objects:
  o Delivery note of the full RTIs from the supplier
  o Bundle content and packaging specification
  o Shipping order from empties despatch
  o Storage locations of the empties warehouse
INTERNAL EMPTIES SUPPLY AT THE CUSTOMER AND/OR SUPPLIER

Empties transfer from a given storage location to the final consumer (manufacturing area) or transfer to another storage location.

- RFID opportunities:
  - Automated / mandatory recording of internal transfer processes
  - Reliable management of the empties inventories
  - Destination of the empties can be read locally on the tag

- Requirements of the RFID process:
  - Reading the transponder data when the empties leave the storage location
  - Reading the transponder data when the empties arrive at their destination
  - Writing the destination on the transponder when the empties leave the storage location
  - Reading the intended destination when the empties arrive for verification purposes
  - If required, to read and/or write multiple transponders in bundles (only applies to destination field)

- Link with data objects:
  - Management of all internal empties storage locations
  - Reading the destination field from the User Memory Bank (MB112) on the tag

EMPTIES INVENTORY

- Determining inventory adjustments, generally once per year.

- RFID opportunities:
  - Under certain circumstances, a physical inventory may be eliminated if there is control over additions/deletions to the inventory (i.e., 100% verification of additions/deletions)
  - Simplifies inventory recording with mobile equipment – in particular with shelf storage

- Requirements of the RFID process:
  - Either 100% inventory management for each empties location
  - or recording of transponder data with mobile equipment on the day of the inventory
  - Recording of metal RTIs en block
- Link with data objects:
  - Inventory levels for both empty and full RTIs for all storage locations with correct information

**EMPTIES DESPATCH AT THE CUSTOMER**

RFID only has an indirect impact on empties despatch, since it involves a purely informational process.

- RFID opportunities:
  - Better dispatch through greater transparency of the inventory.

**SHIPPING BY THE CUSTOMER OR SERVICE PROVIDER**

Preparation of empties for shipping

- RFID opportunities:
  - Automated and completely accurate recording of the storage removal and onward shipping procedures
  - Recognizing incorrect and/or blocked RTIs
  - Comparison of the planned RTI type with the actual RTI type in the shipping data

- Requirements of RFID process:
  - Automatic recording of empty RTIs removed from the storage location
  - Correlation between the transponder data and the delivery note
  - Automatic booking of supplier empties account by the customer (booking in transit)
  - If needed, three-stage booking of empties (shipping by customer, booked to inventory of shipper, relief from shipper’s inventory following acknowledgement of receipt by supplier)
  - At the point of shipment the supplier’s address can be written to the ‘destination’ field on the tag
  - Reading of the ‘RTI type’ field at the point of shipping

- Link with data objects:
  - Validation of packaging specification
  - Accounts for empties per RTI/supplier
  - RTI inventory at the storage locations and in the plant
LABELLING AND SHIPPING OF EMPTIES BY THE SENDER (CUSTOMER OR SERVICE PROVIDER)

- RFID opportunities:
  - No labeling required if all participants in the supply chain can process the transponder data (destination and if required the package number). If required, also applicable to ‘intermediate destinations’ (e.g., cleaning service provider)
  - Increase process quality
- Requirements of RFID process:
  - Shipper can write Transport Label data, especially destination and, if required, the package number in the User Memory Bank (MB11_2)
  - Shipper and cleaning service provider must be able to process RFID in accordance with this recommendation
- Links with data objects:
  - Delivery documents
  - Delivery note as EDI message to supplier and shipper
  - Transport Label data, especially destination, and if necessary, package number in User Memory Bank (MB11_2).

TRANSPORT OF EMPTIES BY THE SHIPPER

- RFID opportunities:
  - Support for shipment via regional RTI terminal by reading the transponder data
  - Support for routing control (which package must go where?) based on destination field on the transponder
- Requirements of the RFID process:
  - Shipper must be able to process RFID in accordance with this recommendation
  - Shipper can use an unused segment in the User Memory Bank (MB11_2) for his internal control
  - Reading transponder data and linking it to an EDI delivery note from the customer
  - Check for completeness (forecast quantity required based on EDI information) without the need to decode the container ID for a customer-specific container type
• Link with data objects:
  o Delivery note from the customer
  o Assignment of a supplier and a route

RECEIVING EMPTIES AT THE SUPPLIER

Unloading empties

• RFID opportunities:
  o Automatic receiving with reliable, high quality data through validation checking for completeness and errors against delivery note
  o Recording at the individual RTI level enables backtracking of damaged or dirty RTIs
  o Mechanical detection of incorrect deliveries including validation of tag data, e.g. sender’s dedicated destination, point of origin, etc
  o Support for shipping destination control (which package must go where?) off-line, e.g. without linking to a back-end system
  o Automatic posting to the customer’s empties inventories upon receipt of the empties

• Requirements of the RFID process:
  o Reading of the transponder data upon receipt of empties
  o If appropriate, overwriting the new shipping destination (e.g. warehouse for empties storage)

• Links with data objects:
  o Delivery note from the customer
  o Packaging specification
  o Working plans with associated packaging specification

STORING EMPTIES (AT SUPPLIER)

• RFID opportunities:
  o Automated storage possible
  o Accurate and reliable inventory recording
  o Checking the customer-specific storage data of the empties
Requirements of the RFID process:

- Reading the transponder data at the point of storage of the empties
- Deletion of all old data on the transponder if required
- Writing transponder with supplier data

Links with data objects:

- Transponder data with LT container / main bundle

---

**EMPTIES STORAGE MANAGEMENT AT THE SUPPLIER**

Empties inventory

RFID opportunities:

- Reliable supplier-RTI inventory based on automated recording of the transponder data with physical movement into or out of storage (e.g. empty RTIs moving into storage, full RTIs moving out of storage)
- Reliable customer related inventory of empties at the supplier based on automated recording of movements into and out of storage
- Optimisation of truck loading with prior knowledge of container sizes and numbers

Requirements of the RFID process:

- Reading the transponder data for full RTIs moving out of storage (e.g. either RTI related data or supplier related data)
- Reading the transponder data upon receipt of the empties
- Reading the transponder data for movements into and out of the empties warehouse location
- If appropriate, ability to read multiple transponders in bundles (many tags read on one scan)
- Inventory management based on container type + location in the empties warehouse, container type + customer for supplier inventory (already received)

Links with data objects:

- Delivery note of the empties from the customer
- Bundle contents and packaging specification
- Shipping order for full RTIs
- Location of the empties warehouse
TRANSFERRING EMPTIES / INTERNAL SUPPLY (SEE ALSO CUSTOMER PROCESS)

- **RFID opportunities:**
  - Automated, customer specific recording of all empties movements
  - Reliable empties inventory at the empties warehouse location

- **Requirements of the RFID process:**
  - Reading the transponder data upon receipt of the empties by the customer
  - Reading the transponder data upon movement into storage at the destination
  - If applicable, many tags read in one scan in bundles

- **Links with data objects:**
  - Empties inventory
  - RTI and bundle master data

PERFORM EMPTIES INVENTORY

- **RFID opportunities:**
  - If appropriate, elimination of the physical inventory, if physical movements into storage are automated
  - Inventory movement data capture with mobile equipment, especially when related to shelf storage
  - RTI inventory related data capture possible without code translation

- **Requirements of the RFID process:**
  - Either... 100% reliable and "auditable" inventory management at the empties location (see above)
  - Or... accurate recording of transponder data with mobile equipment at a given point in time, e.g. annually, quarterly, monthly, ...

- **Links with data objects:**
  - RTI inventories at warehouse locations for empty and full RTIs

REPAIR / DISPOSAL OF RTIS

- Identifying and repairing, or alternatively scrapping RTIs with the permission of the owner.
Automotive Supply Chain Best Practice Recommendation
RFID in Supply Chain Container Management

- RFID opportunities:
  - More transparency over active, inactive and damaged RTIs due to a special field to identify active/inactive state
  - Linking transponder data with information stored in the owner's backend system or database

- Requirements of the RFID process:
  - (Logical) identification of RTIs that should be scrapped and/or have already been scrapped in owner's database
  - Identification of RTIs that should be scrapped which have no owner's database (based on a special field to identify active/inactive or damaged state)
  - Reading the active/inactive field (on transponder or in the database inventory) with each system contact with the owner's database

- Links with data objects:
  - RTI master data
  - Empties database

---

**EMPTIES HANDLING AT THE SUPPLIER**

Push Process

- RFID opportunities:
  - Exact empties inventories enable more accurate identification of availability
  - Automatic comparison of customer exit date versus supplier entry date (without system links possible by reading the field ‘shipping date’)

- Requirements of the RFID process:
  - Recording of the individual RTIs at the empties storage location
  - Ideally: posting of movements of empties at three levels, customer – shipper – supplier

- Links with data objects:
  - Empties account per RTI and customer
  - Empties inventory levels
Pull Process

- RFID opportunities:
  - More exact determination of the requirements for RTI orders is possible due to more accurate inventories without the need to decode the container-ID in customer and/or supplier specific container type

- Requirements of the RFID process:
  - Determining the exact inventory levels (by automatic recording)
  - Reading the container type to automatically initiate the ordering of empty RTIs

- Links with data objects:
  - Empties account per container type and customer
  - Empties inventory
  - Delivery request + packing specification

---

**EMPTIES IN PRODUCTION AT THE SUPPLIER**

Request for empties (‘call-in’) for production from the empties warehouse.

- RFID opportunities:
  - Automated ordering of empties possible, e.g., through Kanban process control of the full RTIs without decoding in a supplier specific container type
  - Less empties inventory in production
  - Optimised control of the empties supply chain (by reading the ‘destination’ field)

- Requirements of the RFID process:
  - Reliable data capture in production strongly depends on production conditions and the plant environment
  - Electronic Kanban process control can affect the requirements for empties based on information recorded on the RFID tag of a full RTI
  - Overwriting the ‘destination’ field in production

- Links with data objects:
  - Working plan and/or bill of material for the production material with information about the packaging specification requirements
  - Linking the transponder data to the production material
5.2 PROCESS DESCRIPTION FOR FILLED RTIS

Preparing empties in production (compare with above)

PACKAGING IN THE PRODUCTION AREA OF THE SUPPLIER

- RFID opportunities:
  - Transponder data are already available with empties, i.e., possibly not necessary to attach a tag for recording or scanning a package number for packaging
  - Exact tracking of the production materials over the complete lifecycle (production, storage, and shipping) – support for batch RTI tracking based on transponder data – time stamp captured in the system
  - Avoiding incorrect packaging by checking the transponder data – packing instruction stored in the back-end system
o Supplier's unique production data, which was previously controlled via a label, can be stored on the transponder

o Internal supplier load unit number or package number can be assigned here and stored on the transponder → internal labeling with load unit number can be eliminated if there is sufficient visual information with part description, quantity, quality indicator, production date, batch, transaction code number, quantity, revision status, expiration date, etc.

o Recycling of the supplier's own visual label

o Process acceleration through more efficient and error-free processes

- Requirements of the RFID process:
  
o Linking transponder data for empties in production to the production order
  
o Writing production data to the transponder

- Links with data objects (examples):
  
o RTI master data
  
o Transaction code number to be produced including revision status and construction status
  
o Production order with transponder data, lot, quantity, traceability system ...
  
o Working plan with associated packaging specification

---

### PREPARING PACKAGES IN THE SHIPPING AREA OF THE SUPPLIER

- RFID opportunities:
  
o Transponder data are already available with empties, i.e., possibly not necessary to attach a tag for recording or scanning a package number for packaging
  
o Avoiding incorrect shipments
  
o Process acceleration through more efficient and error-free processes
  
o Increased availability of empties, therefore fewer express deliveries (for both empties and full RTIs) and fewer deviations to packaging specifications
  
o Creating delivery note with up to date status based on data from the transponder
  
o If required, the package number of the GLT from production / packaging area can be used
  
o Optimum solution: material tags for small RTIs can be eliminated (if all information is stored on the small RTI transponder or all RTIs potentially)
- **Requirements of the RFID process:**
  - Link delivered empties transponder data to the shipping order
  - Under certain circumstances, writing the package number of the GLT on the transponder (if this has not already been done in the production or packaging area)
  - Reading the latest information from the transponder to create delivery note
  - Control of the delivery destination via the destination field on the tag, e.g. shipper / customer
- **Links with data objects (examples):**
  - Delivery note data
  - RTI master data
  - Shipping order with transponder data, transaction code number and revision status and construction status, batch number, quantity
  - Shipping order
  - Delivery note with transponder data

---

**LOADING OF THE PACKAGES AT THE SUPPLIER BY SHIPPER**

- **RFID opportunities:**
  - Avoiding incorrect loading (recognition of overloading/under-loading/incorrect loading)
  - Quicker loading
  - Checking of the JIS Sequence when loading a truck without a connection to a back-end system
  - Verification that the driver and the shipping employees have done their work properly
- **Requirements of the RFID process:**
  - Reader on the docking ramp to compare the delivery with the package number
  - Automatic recording of the RTIs loaded
  - Automatic creation of delivery note corrections based on actual shipments
  - Sending the (corrected) delivery note by the supplier or truck driver to customers and shippers
- Links with data objects (examples):
  - JIS sequence
  - Delivery note
  - Delivery order
  - Shipping papers
  - Invoice
  - Shipping control
  - Customs documents

**SHIPMENT OF THE PACKAGES BY THE SHIPPER**

- RFID opportunities:
  - Better utilisation of trucks en-route through early notification and better quality information sent by the supplier to the shipper (quality, data, quantity)
  - Secure and controlled loading (also without linking to a back-end system by reading the data on the transponder)
  - Less data processing and data control at the shipper
  - Better despatch through integrated data
  - Verification of the work performed by transportation and shipping personnel through automated data collection of physical movements
  - Checks on the contents of the delivery (what materials are allowed to be transported together, e.g. special requirements, hazardous material, etc.)

- Requirements of the RFID process:
  - Controlled unloading shipping orders and package quantities (RFID)
  - Under certain conditions, partial consignments remain on the truck in preparation for the main run. For such consignments is no controlled unloading (the location of the RTI on the truck can be controlled and monitored with the RFID data + delivery note)
  - Controlled loading (check freight list against RFID data)
  - Shipper must be technically capable and also organised to process the RFID data
  - Transmission of the Odette AVIEXP or the JAIF Global DESADV messages to the automotive manufacturer
Links with data objects (examples):
- Delivery note
- Invoice
- Proof of delivery and services provided

INFORMATION RELATED TO THE RECEIPT OF PACKAGES AT THE CUSTOMER

RFID opportunities:
- More accurate delivery notification by linking the transponder data with the delivery note

TRUCK CONTROL AND RAMP ALLOCATION AT THE CUSTOMER

RFID opportunities:
- Optimised utilisation of the allocated unloading zones based on the delivery note information

Requirements of the RFID process:
- None given

Links with data objects:
- None given

PHYSICAL COLLECTION OF THE PACKAGES AT THE CUSTOMER’S UNLOADING ZONE

RFID opportunities:
- Automated packing slip control (elimination of manual activities)
- Elimination of paper vouchers (bill of lading, unloading list)
- Avoid errors in unloading
- Rush deliveries can be identified during the unloading process
- Sample deliveries can be identified during the unloading process without linking to back-end systems (with a field "quality status")
- Less system dependency by reading the latest version of the data on the transponder locally, i.e. off-line

Requirements of the RFID process:
- Ability to read the packing slip information on the RFID transponder + ability to select required data fields during the unloading process
- Check against list of unloading requirements per unloading zone
• Links with data objects:
  o Delivery note
  o Delivery request
  o Booking of goods received with data on transponder

STORAGE OF THE PACKAGES AT THE CUSTOMER

• RFID opportunities:
  o Avoiding errors by checking data on transponder
  o Eliminate of manual scan procedures
  o Conveyors do not need to be linked online to back-end systems for the identification of the storage place if the storage destination is stored on the transponder
  o Ability to control use-by date for non-durable goods locally (off-line). as well as process control for next actions

• Requirements of the RFID process:
  o Data capture of packing slip information either at a gate or by a forklift
  o Automated assignment of the storage location
  o Automated warning to the forklift driver of handling errors
  o Automated feedback after storage to back-end system possible

• Links with data objects (examples):
  o Inventory management
  o Forklift management system

PRODUCTION SUPPLY AT THE CUSTOMER

Call-in Process in production - full RTIs

• RFID opportunities:
  o Pull process, i.e. automatic material call-in triggered by the removal of a full RTI from intermediate storage (inventory on the manufacturing line)
  o Avoidance of manual scanning processes
  o Controlling and blocking full RTI movements via transponder data
- Requirements of the RFID process:
  - Ability to record material inventory on the manufacturing line with a reader at intermediate storage places on the line

- Links with data objects (examples):
  - Kanban
  - Material call-in and/or inventory movements
  - Quality measurement and control

---

**REMOVAL OF FULL RTIS FROM STOCK FOR PRODUCTION SUPPLY**

- RFID opportunities:
  - Mechanized monitoring during the removal process, automatic notification to the driver of errors, and avoidance of incorrect stock removals
  - Mechanized monitoring of the delivery process, automatic notification of errors, and avoidance of incorrect deliveries
  - Elimination of manual scanning processes
  - Avoidance of transaction errors
  - Elimination of paper vouchers
  - More detailed/accurate representation of inventory levels
  - Ability to control use-by date (defined by the supplier) and process control for next actions

- Requirements of the RFID process:
  - Ability to read package slip data for packages to be removed from storage, ideally at the intermediate storage location and delivery location at gates or forklifts
  - Ability to read on the transponder from the package to be removed from storage, ideally at the intermediate storage location and delivery location at gates or forklifts
  - Ability to overwrite the destination
  - Ability to check the use-by date information
  - Ability to change quality status information

- Combination with data objects (examples):
  - Forklift management system
  - Stock removal orders
Automotive Supply Chain Best Practice Recommendation

RFID in Supply Chain Container Management

- Material call-in
- Production control

**COMMISSIONING FULL RTIS FOR PRODUCTION SUPPLY**

- **RFID opportunities:**
  - Avoidance of commissioning errors (over-delivery or under-delivery, use of incorrect RTIs) without links to back-end systems by comparing the commissioning order with the data on the transponder
  - Avoidance of errors when building sets without links to back-end systems by comparing the commissioning order with the data on the transponder
  - Checking and setting the quality status information de-centrally without links to back-end systems and system comparison runs in batch processing
  - Paperless processing

- **Requirements of the RFID process:**
  - Ability to record the packages commissioned and/or removed from inventory
  - Ability to selectively process required data fields of packages prepared and commissioned from inventory
  - Ability to overwrite the destination
  - Ability to overwrite the quality status, e.g. in the event of transport damage

- **Links with data objects (examples):**
  - Stock removal order
  - Commissioning order (production order)
  - Warehouse and inventory management

**SUPPLY OF FULL RTIS TO THE PRODUCTION LINE**

- **RFID opportunities:**
  - Avoiding incorrect deliveries by comparing the destination field on the transponder with the transit and/or destination zone without linking to back-end systems, and avoidance of the need to make corrections later in batch processing
  - Eliminate manual scan procedures
  - The destination field can be interrogated for process control of automated conveyor systems
requirements of the RFID process:

- Ability to record the package to be transferred by either a stationary gate (e.g. at or near the production line) or mobile by the forklift operator
- Ability to selectively process required data fields of tags at the production line

links with data objects:

- Transport order
- Production control
- Control of empty RTIs

special JIS process – sequenced material supply

- RFID opportunities:
  - Early recognition of errors in the RTI sequence or missing RTIs with the supplier, shipper and the customer’s incoming goods area
  - Automatic rack sequence-checking
  - Unloading performed by the truck driver on his own is auditable (enabled by automated package inspection in the incoming goods area during unloading)
  - Increase in efficiency for loading and unloading by RFID identification
  - Automated recording of RTIs at the container ID level increases transparency of RTI inventory and gives an accurate overview of RTIs in use or in process

- Requirements of the RFID process:
  - Ability to record the outgoing movement of goods at the supplier leads to the advanced shipping notification to the customer
  - Ability to provide the production numbers delivered, rack sequence numbers, and serial numbers with the delivery note from the supplier to the customer
  - Ability to record the transponder data at the receipt of goods at the customer and compare it with the delivery note (on the forklift)
  - Ability to write production sequence numbers and JIS RTI sequence in production at the supplier
  - Ability of the shipper to process RFID data in accordance with this recommendation
  - Ability to record the production sequence number and JIS RTI sequence in goods in the receiving area at the customer and comparison against the delivery note
  - Ability to overwrite the quality status information, e.g., for transport damage
Links with data objects (examples):

- Delivery truck (internal bordereau no. for financial control), delivery note, code numbers, production numbers, production sequence numbers, rack sequences, and serial numbers per transponder from the delivery note
- RTI status (where is each RTI)
- Installation and set up documentation

SPECIAL PROCESS CKD SUPPLY

In the CKD process there are some special requirements compared with normal production supply.

RFID opportunities:

- More efficient package tracking throughout the entire chain through automated package data collection and selective transponder data processing
- Simplification of customs handling by selective transponder data processing
- Simplified commissioning in the correct production sequence
- Missing parts and quantity controls
- Decentralised control based on information in the destination field on the transponder
- More flexibility for CKD participants globally through decentralized data where access to central systems and databases is not always possible
- Checking and setting quality status indicators decentrally without links to back-end systems (e.g. for transport damage)

Requirements of the RFID process:

- Ability to support shipment processes by truck and by rail for marine RTI logistics service providers, to support efficient and error-free data capture of the contents
- Ability to record the transponder data at the consolidator and re-distributor in order to track the marine RTI route to the CKD destination
- Ability to support shipment processes by truck and by rail for marine RTI logistics service providers to support efficient and error-free RTI content control
- Ability to read/write specific data at the consolidator and re-distributor for tracking the marine RTI on its way to the CKD destination
- Ability of the shipper to process RFID data in accordance with this recommendation
- Ability to overwrite the quality status information, e.g., for transport damage
Links with data objects:

- Delivery note with package reference information
- RTI reference information at the consolidator
- Order reference information at the re-distributor
6. ODETTÉ ID AND THE OSCAR SYSTEM

Odette has responded to the growing needs for unique identification in the automotive industry and has launched the OSCAR service. In case you are wondering, OSCAR stands for the Odette System for Coding And Registration. It will provide two key offerings,

1) An issuing agency service for the coding of business organisations.

2) An information service which allows access to detailed and up to date information about the organisations of registered entities and the following key benefits:

   ▪ Tailor-made for the automotive industry
   ▪ More flexible and less expensive than the two main commercially available current coding systems
   ▪ Provision of worldwide unique IDs in line with ISO standards
   ▪ Run by the automotive industry, not a commercial enterprise.

Odette is already officially recognised as a Code Issuing organisation within two of the most relevant and influential ISO standards in the area of unique identification:

   ▪ ISO 15459 – Information Technology – Unique Identifiers (Parts 1 – 6)
   ▪ ISO 6523 – Data Interchange – Structures for the identification of organisations (Parts 1 & 2)

The Odette ID or Code, recognised by both of the above standards, consists of 4 alphanumeric characters which will be used to identify main business organisational units (legal companies and individual business units).

There is also the possibility (recognised by ISO 6523) to add a 2 character alphanumeric suffix to the main 4 character code in order to identify sub-entities. Odette will use this suffix to allow companies to register individual codes for sub-organisations (e.g. receiving locations, loading docks, purchasing department, invoicing function, etc) within their main business organisations.

The OSCAR service will:

   ▪ Issue Codes for use in:
     ▪ AutoID
     ▪ Consignment ID (Licence Plate)
     ▪ Asset ID (e.g. Containers)
- Product ID (Parts Marking)
- EDI messaging
- Technical Partner ID (Sender/Receiver)
- Business process related Party ID (NAD ID)
- File transfer station identification (OFTP)
- Maintain Business Entity Datasets
- Provide Business Entity Datasets for use in Partner Databases

OSCAR delivers a high quality solution which meets the requirements of Auto ID/RFID, OFTP, EDI and the Odette Partner Identification Database (PID, VDAUPIK respectively) recommendation.

Organisation codes are often used in the automotive industry as a key element in the identification of various entities, for example:

- Trading partners
- Locations, business functions and departments within a company
- Logistics handling units
- Company Assets
- Individual parts/components
- Computer network addresses
- Engineering changes
- and more......

Currently, there is a very confused and heterogeneous situation within the industry, with companies identifying the above entities using a mixture of their own organisation codes and codes provided by external organisations such as Dun & Bradstreet or GS1/ePC.

Companies have to maintain a large number of codes of varying formats and lengths. Even if these codes can be understood in individual trading relationships, there is no way that they can be understood by other parties in the Supply Chain, such as logistics service providers, customs officials, network providers etc.

There is a growing need for a unique identification of these entities linked to factors such as:

- More stringent traceability requirements
- Increased incidence of automatic data capture (especially using RFID)

The current unique organisation codes, and rules associated with these codes, offered by some large providers, do not completely satisfy the requirements of the automotive industry. The OSCAR Code will
provide unique identification and, together with the corresponding Odette recommendations and guidelines, will overcome the deficiencies of these other coding schemes.

Examples of where OSCAR coding can be used include:

- RFID based asset management
- Parts marking
- Identification of transport handling units (License Plate)
- Identification of engineering changes
- Identification of locations and business areas within a company

OSCAR is an easy to use web-based company code issuing system which provides an added value service to the automotive industry. The combination of user-driven Odette recommendations and an easy to use cost efficient service, provides a major benefit to our industry. Recent experience with the use of RFID in the automotive supply chain has clearly indicated the urgent need for a simple, homogeneous and consistent solution.

If anyone is concerned about having to make costly internal changes, the introduction of the OSCAR ID will not require an immediate change of running systems in companies. It can be applied in areas where the need is most urgent (e.g. returnable container identification) and then extended to other applications as required.

In the context of this RFID recommendation for RTIs we only need focus on the identification of the container owner. Returnable Transport Items (RTIs) are widely used in the automotive industry. There are OEMs, suppliers and external service providers involved in the process and they all may be owners of RTIs forming a big pool in the supply chain. The identification the owner of the RTI is necessary for the overall administration of that process, inventory maintenance, invoicing and accounting processes and of course, for returning the RTIs to their owner.

Today these processes are rather non-transparent and require a high manual effort with “friction” losses. OSCAR may solve this problem. Using machine readable codes (e.g. RFID) the inventory update procedures can be automated. The increased transparency leads to reduced costs and higher flexibility in the supply chain. Also the size or the container pool may be reduced and the amount of working capital decreased.

Another aspect is related to very expensive special containers. Whereas the problem with cheap mass RTIs is the sheer number of the boxes, in this particular situation the economic benefit is related to the fact that the tracing of these containers is enhanced.

For more information or to access the OSCAR system go to: https://oscar.odette.org
7. GLOSSARY

Bundle: Bundles are packages combined into a transport unit (e.g., 12 small RTIs on a defined pallet with defined cover, and if need be, inserts).

Coding scheme: Algorithm, which defines the assignment of MB01 with the use of the air interface in accordance with ISO 18000. The length of the EPC identifier and its interpretation is particularly determined with it.

DUNS / UPIK: Global supplier numbering system.

EDI: EDI stands for Electronic Data Interchange and is the umbrella term for industry standards for the electronic exchange of business documents.

GRAI: Global Returnable Asset Identifier: Coding scheme in the EPC for the identification of reusable RTIs with RFID. Possible characteristics: GRAI96 or GRAI170; these only differ in that GRAI170 allows an alpha-numeric serial number, GRAI96 only a numeric.

KLT: Small RTIs.

Push system: Supply of packages (or general material) on the basis of requirements that the customer calculates for the supplier, i.e., without retrieval by the suppliers. The dispatcher is responsible for the package/material preparation.

Pull system: Supplier requirement of the package (of the materials) by the suppliers based on the actual inventory situation.

RFID: Radio Frequency Identification is a technology for the contact-free identification of objects of any type by means of radio waves.

RTIs: RTIs are Returnable Transport Items or reusable packaging with specific designation of the type used for the packaging management.

Supply chain: Logistics process between customers and suppliers; also multi-level, i.e., the chain of all suppliers up to the completion of the end product.

Tag: Transponder in the design of a (paper) label.

Transponder: Electronic data RTI / system for the contact-free selection of data.
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ACKNOWLEDGEMENTS

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Supporting Stakeholders:

Ford, BMW Group, Daimler, Michelin, Renault, PSA Peugeot Citroën, AB Volvo, Volkswagen Group, Continental, Geodis, Olle Hydbom

Disclaimer:

The contents of this document reflect the latest level of technical information. Application of this recommendation is the total responsibility of the user and Odette cannot be held responsible in any way for its use or application.

This recommendation has been developed from the VDA 5501 document and updated to reflect the needs of the Odette community, including the latest technical developments and the most recent versions of the related ISO standards. There are several references to documents and processes of the VDA (German Automotive Association). They have been included in order to ensure that the Odette recommendation is consistent with the equivalent VDA recommendations.