VDA | Verband der Automobilindustrie

Standardized Encoding of Logistics Master Data on Product Packaging in the Aftermarket

VDA 9007

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1 Introduction

1.1 Foreword

In the automotive industry, logistics master data are encoded in various ways in logistic supply chain processing so that products can be identified. The data generally appear on the packaging label as one or two-dimensional barcodes in line with various standards.

Standardized coding brings benefits in the automotive supply chains. It means the same technologies can be used for scanning and standardized interfaces to the IT systems can be used in process handling. Furthermore it enhances process reliability, thus reducing the susceptibility to errors. Additional information can also be transmitted.

1.2 Objectives of this recommendation

This recommendation aims to establish a standard for unified representation of logistically relevant data on the packaging of aftermarket products. The data should be represented in a two-dimensional Data Matrix Code in such a manner that the code can be placed on a common product label. It is assumed that an area of approx. 2 cm x 2 cm will be available on the label.

The primary objective is to support logistics processing in the supply chain from the supplier to the customer. With the data represented in a two-dimensional Data Matrix Code (DMC), it is possible to read the relevant data quickly and reliably using a scanner during the various stages of logistic processing such as handling and packing. An IT interface will be used to transmit the data to the warehouse management system.

The product data have also to ensure product traceability. The system has to provide reliable support for processing returns in the case of a complaint about faults (e.g. logistical errors or defects in the product).

The volume of data that can be recorded in two-dimensional codes can support additional processes. For example, this standard includes serialization of the product to protect against plagiarism (cf. VDA Recommendation 9004), and an internet hyperlink to the product, to make further information accessible. Such information could be installation instructions, safety or customs notices, or a connection to internal data systems.

The fields defined carry master data of the product. Information about specific deliveries is not encoded. This avoids the need to create complex DMCs for each consignment and ensures that the matrix does not exceed the limited space available on the label.

This recommendation also describes the business meaning of the individual fields.

Application of this standard should also enable agreements between the customer and the supplier to be encoded. To this end, various types of fields with different meanings are used in the Data Matrix code.

A verification process is described for checking adherence of agreements between customer and supplier.

1.3   Content of this recommendation

Chapter 1 sets out the objectives of the recommendation. Chapter 2 describes the area of application of the standardized logistic data on the product packaging in the aftermarket in the supply chain. The field contents defined in the Data Matrix code, which contain the product data, are described in Chapter 3. This chapter also indicates which field types are to be used in each case, and their business meaning. Chapter 4 explains the label area required for the DMC under certain technical conditions. Chapter 5 describes a process for verifying that the contents are correctly encoded in the required quality and ensuring adherence of agreements between the client and the supplier.

2 Area of application, context and prerequisites

This chapter provides an overview of application in business and of the recommended technical implementation. It also describes limitations to and prerequisites for applicability.

2.1 Business application

Standardized logistics data on product packaging are intended to support the logistic processing of saleable units in the aftermarket supply chain. This includes the entire processing, from the supplier's plant, distribution networks of the supplier and the OEMs, all the way to the OEM's workshop or the consumer. A schematic view of a typical supply chain is given below.

Supply Chain
(typified)

Customer,
Workshop

OEM / Supplier:
Distribution Centers,
central, decentral

Plant – Tier1, Tier 2, ...

Information Flow

Material Flow
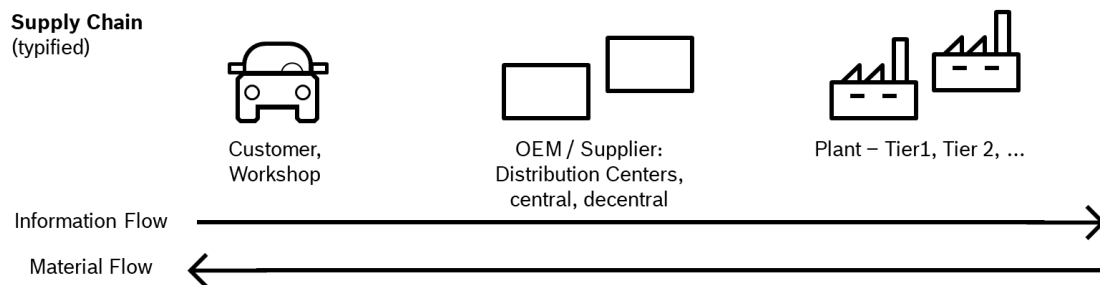
This recommendation and its definition of a Data Matrix code for efficient, IT-supported application serve the following objectives:

- Supporting logistics processing in "forward processing" of the proper delivery of products,

- Supporting logistics processing in "backward processing" in the case of quality complaints, from customers all the way to the manufacturer,

- Quality assurance: error prevention/reduction by means of unified, standardized use of data relevant to logistics,

- Supporting additional information such as internet links to pages with further information about the product (e.g. installation instructions or market/marketing-specific data),

- Integrating an identification code for product and brand protection (VDA 9004),

- Application at all saleable packaging levels (single packs, multi-packs and bulk packs (=pallets)). The following diagram illustrates the relationships between the various packaging levels.

Examples of saleable units:

Overview of Packaging Units

Product .... ◇ ─────────────┐
                                                 │
                                                 ▼
                                    ▢ .... Individual pack

                                    ▢▢
                                    ▢▢ ───────→ ▢ .... Multi-pack

                                         ▢▢
                                         ▢▢ ───────→ ▢ .... Bulk-pack
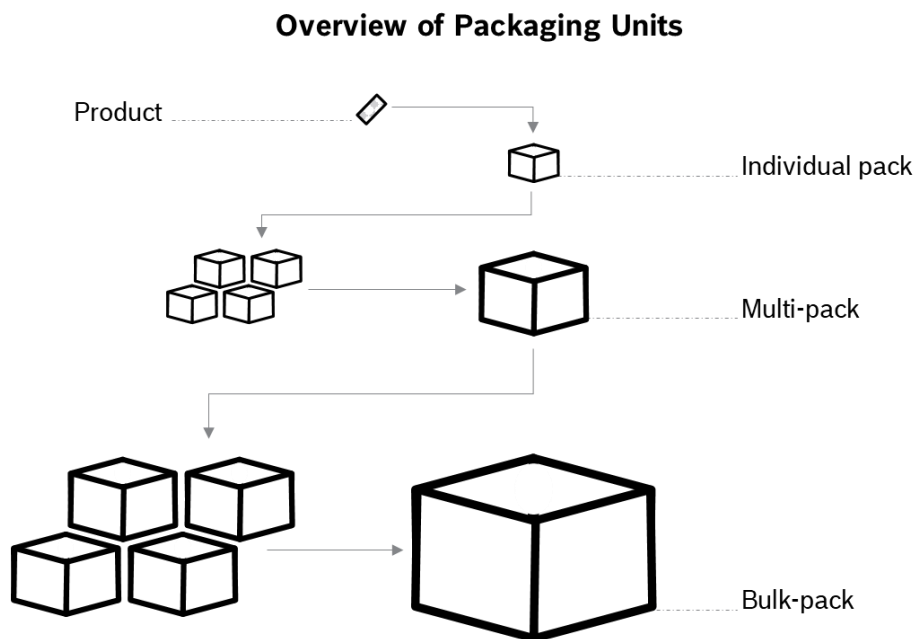
2.2   Technical implementation of Data Matrix Codes

2.2.1   Data Matrix Code

In the automotive industry, the Data Matrix code ECC 200 (cf. ISO IEC 16022) has become established for encoding information in 2D symbols. It provides high data density and fault tolerance.

Today's common printers can achieve module sizes of 0.33 mm in high quality, which allows 259 alphanumeric characters to be encoded on a space totaling 20 mm x 20 mm. If more space is available, up to approx. 1,500 characters can be encoded in each symbol.

2.2.2   Different field types and their meaning

2.2.2.1   Mandatory field

Meaning: This field *must* contain the identifier in the DMC, and it must contain encoded field content.

2.2.2.2   Optional field

Meaning: This field *may* contain an identifier in the DMC.

Case 1: If the field is used, an identifier is contained in the DMC and corresponding field content is encoded.

Case 2: If the field is not used, neither an identifier nor corresponding field content is encoded in the DMC.

2.3   Scope of application

The following points have to be taken into account when defining the purpose of application for the standardized logistics data on product packaging in the aftermarket:

- The sole purpose of using the Data Matrix code to carry information is its application on saleable product packaging. In particular, the Data Matrix Code is not designed for application on products themselves.

- The definition of the encoded contents is limited to product-specific data. In particular no delivery or consignment information is included. Encoding the wide range of shipment relations in a Data Matrix Code would run contrary to the objective of simple reproduction and processing. As an alternative, consignment-specific or delivery-specific information such as customs guidelines can be accessed through a database accessed via the field "Hyperlink".

- This recommendation does not define guidelines for creating labels. It only indicates the required size of the Data Matrix Code for application to a label. The product packaging, including the content and form of its labels, is agreed between the client and the supplier. As a rule, the packaging requirements form part of the contract between the client and the supplier.

- The standard is determined by the fields defined in Chapter 4. Any use of additional fields represents a deviation from the standard.

2.4   Prerequisites for application in the supply chain

Use of this recommendation requires a contractual agreement between the OEM and the supplier. The OEM and the supplier must have agreed application of the recommendation and the fields and contents to be used.

3   Field contents and encoding in the Data Matrix code

3.1   General information

This recommendation describes a standard for representing logistics information in a Data Matrix Code (DMC). It includes the defined fields with identifiers, content, field length, etc. It also differentiates between mandatory fields that must always be filled and optional fields that may be filled.

The table below shows the structure of the fields that are listed in the following sections. Here "Max. field length" designates the maximum field length, and "Fix. field length" designates a fixed field length.

Data field	Contents
Data identifier	According to ANSI
Description of identifier	According to ANSI (in English)
Data type	{mandatory field, optional field}
Field content	Description of the content
Max./Fixed field length	n (integer)
Meaning	Explanations of the business meaning and notes for filling the field

3.2 Encoding logistics data on aftermarket product packaging

3.2.1 Label information fields

Data identifier	12P
Description of identifier	Document type
Data type	Mandatory field
Field content	Identification of the symbol
Fixed field length	2
Meaning	AL: Aftermarket Label

Data identifier	9K
Description of identifier	Generic transaction reference number
Data type	Mandatory field
Field content	Version of the coding standard
Max. field length	4
Meaning	Label version for identification, support for versioning program codes

3.2.2 Fields containing material number information/mandatory fields

Data identifier	P
Description of identifier	Item identification code assigned by customer
Data type	Mandatory field
Field content	Material number of the first placer
Max. field length	21
Meaning	The part is identified primarily from the material number issued by the first placer

Data identifier	Q
Description of identifier	Quantity
Data type	Mandatory field
Field content	Quantity of the packaging unit in the defined unit of measure
Max. field length	5
Meaning	Quantity of the packaged products in the packaging unit

Data identifier	3Q
Description of identifier	Unit of measure
Data type	Mandatory field
Field content	Product's basic unit of measure
Max. field length	2
Meaning	Unit of measure for the packaged products, as coded according to ANSI X12.3 (see list of codes in the annex)

Data identifier	4L
Description of identifier	Country of origin, two-character ISO 3166 country code
Data type	Mandatory field
Field content	Country of origin in ISO 3166 alpha-2 format
Fix. field length	2
Meaning	Country in which the material was produced or assembled

3.2.3 Fields containing supplier information

Data identifier	6V
Description of identifier	Manufacturer's identification code (mutually defined)
Data type	Optional field
Field content	Code for identifying the supplier at the OEM
Max. field length	13
Meaning	This field enables the first placer to identify the supplier of a material. The content of this field is mutually agreed by the OEM and the supplier.

Data identifier	1P
Description of identifier	Item identification code assigned by supplier
Data type	Optional field
Field content	Supplier's material number
Max. field length	20
Meaning	Supplier's material number, if agreed with the OEM

Data identifier	30P
Description of identifier	Additional item identification code assigned by supplier
Data type	Optional field
Field content	Code for unique identification of the material at the supplier in conjunction with the material number of the first placer
Max. field length	4
Meaning	Representation of a code defined by the supplier if mutually agreed. This code, in combination with the first placer's material number, enables the supplier to uniquely identify the material.

3.2.4   Additional material information fields

Data identifier	16D
Description of identifier	Production date
Data type	Optional field
Field content	Production date of the material in the format YYYYMMDD
Fix. field length	8
Meaning	Date of the last step of material production

Data identifier	14D
Description of identifier	Expiration date
Data type	Optional field
Field content	Expiration date of the material in the format YYYYMMDD
Fix. field length	8
Meaning	Expiration date as defined by the first placer

Data identifier	22P
Description of identifier	Third level item identification, assigned by customer
Data type	Optional field
Field content	Marker for parts relevant to safety
Max. field length	2
Meaning	Information about parts classified as relevant to safety

3.2.5   Supplementary fields for logistic traceability (e.g. support for serialization, cf. VDA 9004)

Data identifier	13V
Description of identifier	DUNS number identifying supplier
Data type	Optional field
Field content	First placer's DUNS number (sale to customers)
Fix. field length	9
Meaning	This field identifies the first placer of the good. It is relevant only if the products are serialized according to ISO 5005 / VDA 9004.

To identify the serial number, one of the data identifiers S, 3S and 4S is used, depending on the size of the packaging. The diagram below illustrates the connection between the data identifier and the packaging sizes.

Product

Individual pack
S – Serial number of product

Multi-Pack
3S – Unique number of multi-pack

Bulk-pack
4S – Unique number of bulk-pack

Data identifier	S
Description of identifier	Serial number
Data type	Optional field
Field content	Serial number of the product
Max. field length	20
Meaning	In combination with the first placer's material number and DUNS number it enables unique identification of the product. Application only in combination with all required information pursuant to ISO 5005/VDA 9004, whereby only one of the fields S, 3S or 4S may be used.

Data identifier	3S
Description of identifier	Unique package identification assigned by supplier (lowest level of packaging)
Data type	Optional field
Field content	Unique identification number of the multi-pack
Max. field length	20
Meaning	It enables unique identification of the multi-pack, with which, in combination with the first placer's material number and DUNS number, the individual products inside the multi-pack can be identified. Application only in combination with all required information pursuant to ISO 5005/VDA 9004, whereby only one of the fields S, 3S or 4S may be used.

Data identifier	4S
Description of identifier	Package identification assigned by supplier to master packaging
Data type	Optional field
Field content	Unique identification number of the bulk pack
Max. field length	20
Meaning	Enables unique identification of the bulk pack, which in combination with the first placer's material number and DUNS number enables identification of the individual products inside the bulk pack. Application only in combination with all required information pursuant to ISO 5005/VDA 9004, whereby only one of the fields S, 3S or 4S may be used.

3.2.6 Other fields/supporting additional use cases

Data identifier	1T
Description of identifier	Batch number
Data type	Optional field
Field content	Production batch
Max. field length	12
Meaning	Unique identification of the supplier's production batch.

Data identifier	20P
Description of identifier	Additional part information (customer assigned)
Data type	Optional field
Field content	Free text field for individual use by the first placer
Max. field length	21
Meaning	In this field the first placer can accommodate additional information about the material (e.g. service provider key number for an external packaging provider, or packing date).

Data identifier	31P
Description of identifier	Second level part identification, supplier assigned
Data type	Optional field
Field content	Additional information from the supplier
Max. field length	10
Meaning	Internal quality information from the supplier in encoded form, e.g. the supplying plant.

Data identifier	32P
Description of identifier	Third level part identification, supplier assigned
Data type	Optional field
Field content	URL of a website with product information
Max. field length	30
Meaning	The first placer has the option of referring the user to a page with additional product information, e.g. via a URL.

3.3   Overview of field contents

The table below provides a brief overview of the fields and their contents. The field length type "max" stands for "maximum field length" and the type "fix" stands for "fixed field length."

Grouping	Data identifier	Description	Field type	Field length	Field length type
Label information fields					
	12P	Document type	mandatory	2	fix
	9K	Generic transaction reference number	mandatory	4	max
Fields with material number information/mandatory fields					
	P	Item identification code, assigned by customer	mandatory	21	max
	Q	Quantity	mandatory	5	max
	3Q	Unit of measure	mandatory	3	max
	4L	Country of origin, two-character ISO 3166 country code	mandatory	2	fix
Fields with supplier information					
	6V	Manufacturer's identification code	optional	11	max
	1P	Item code, assigned by supplier	optional	18	max
	30P	Additional item identification code, assigned by supplier	optional	4	max
Additional material information fields					
	16D	Production date	optional	8	fix
	14D	Expiration date	optional	8	fix
	22P	Third level item identification, assigned by customer	optional	2	max
Supplementary fields for logistic traceability (e.g. serialization support, cf. VDA 9004)					
	13V	DUNS number identifying supplier	optional	9	fix
	S	Serial number	optional	20	max
	3S	Unique package identification assigned by supplier (lowest level of packaging)	optional	20	max
	4S	Package Identification assigned by supplier to master packaging	optional	20	max
Additional fields/support for additional use cases					
	1T	Batch number	optional	12	max
	20P	Additional part information, assigned by customer	optional	21	max
	31P	Second level part identification, assigned by supplier	optional	10	max
	32P	Third level part identification, assigned by customer	optional	30	max

4   Technical information for implementation

4.1   Basic technical information

The DMC must be generated pursuant to ISO/IEC 16022. The quality of the 2D symbol can be measured in accordance with ISO/IEC 15415 and should satisfy at least quality grade B. Several criteria are used to assess the quality on a scale from 0 = not readable to 4 = excellent readability. Values in the range from 2.5 to 3.5 are equivalent to grade B.

The data string must be syntactically structured and interpreted in accordance with ISO/IEC 15434, format 06. The data set is made up of fields that are qualified by data identifiers (DI). The DI used must comply with ANSI MH 10.8.2 / ISO/IEC 15418 (see Chapter 3).

Character sets

The values 0 to 127 are assigned in accordance with ISO/IEC 646, whereby the G0 set and the C0 set are used. In the C0 set, the characters 28 to 31 are modified to encode FS, GS, RS and US. The characters 32 to 127 correspond to the UN/EDIFACT UNOB character set of syntax version 2.

The values 128 to 255 are assigned in accordance with ISO 8859-1 (also called extended ASCII). This character set corresponds to the UN/EDIFACT UNOC character set of syntax version 3.

4.2   Exemplary values

The minimum size of the modules depends on the printing technology used. Every module should have a side length of at least 4 points to produce a sharp image with sufficient contrast between the light and dark areas. The minimum printer resolution is 300 dpi (dots per inch). This results in a minimum side length of 0.33 mm (roughly equal to 13 mil). The symbol must be surrounded by a quiet zone at least double the width of one module, i.e. 0.66 mm.

If the space available measures 20 mm x 20 mm, the maximum size of the symbol that can be placed on it is 52 x 52 modules. If the modules are 0.33 mm wide, the symbol will occupy an area of 17.2 mm x 17.2 mm, not including the quiet zone. If a module side length of 5 points is selected, the size of the module will be 0.42 mm and the symbol will require an area of 21.8 x 21.8 mm, not including the quiet zone. This kind of symbol can hold up to 304 alphanumeric characters including control characters.

If a smaller quantity of data is to be encoded, smaller symbols can be used. If the matrix used contains 48 x 48 modules, the symbols will occupy an area of only 15.8 mm x 15.8 mm using 4-point modules, or 20.2 x 20.2 mm using 5-point modules (not including the quiet zone). In this case the data capacity will be 259 characters including control characters.

In general, modules with longer sides are preferred if sufficient space is available on the packaging, because they improve both quality and readability.
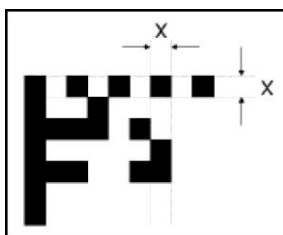

Figure: Module size of code symbols (x)

4.3   Examples

Two fictitious examples are given below with different uses for the field contents. Examples of the meaning of the mandatory fields and the optional fields are shown. It is clearly shown that unused optional fields do not appear either as identifiers or with "empty" content.

The table shows the examples with the assigned fields and contents:

Grouping data identifier	Description	Field type	Field length	Field length type	Example 1	Example 2
Label information fields						
12P	Document type	mandat	2	fix	AL	AL
9K	Generic transaction reference number	mandatory	4	max	1.0	1.0
Fields with material number information/mandatory fields						
P	Item identification code, assigned by customer	mandatory	21	max	ABC123	ABC123
Q	Quantity	mandatory	5	max	10	10
3Q	Unit of measure	mandat	3	max	PC	PC
4L	Country of origin, two-character ISO 3166 country code	mandatory	2	fix	DE	DE
Fields with supplier information						
6V	Manufacturer's identification code	optional	11	max	S321	S321
1P		optional	18	max		
30P	Item code, assigned by supplier Additional item identification code, assigned by supplier	optional	4	max	V1	V1
Additional material information fields						
16D	Production date	optional	8	fix	20180124	20180124
14D	Expiration date	optional	8	fix	20220123	–
22P	Third level item identification, assigned by customer	optional	2	max		
Supplementary fields for logistic traceability (e.g. support for serialization, cf. VDA 9004)						
13V	DUNS number identifying supplier	optional	9	fix	101010101	–
S	Serial number	optional	20	max	–	–
3S	Unique package identification assigned by supplier (lowest level of packaging)	optional	20	max	–	–
4S	Package Identification assigned by supplier to master packaging	optional	20	max	–	–
Other fields / support for additional use cases						
1T	Batch number	optional	12	max	–	–
20P	Additional part information, assigned by customer	optional	21	max	00950L/S8	–
31P	Second level part identification, assigned by supplier	optional	10	max	–	–
32P	Third level part identification, assigned by customer	optional	30	max	www.vda.de	–

Examples 1 and 2 result in the following Data Matrix codes and readable contents. The DMC shown can be read using a scanner.

Example 1

The syntax string needed for generating the symbol looks like this:

[)>^{R}S06^{G}S12PAL^{G}S9K1.0^{G}SPABC123^{G}SQ10^{G}S3QPC^{G}S4LDE^{G}S6VS321^{G}S30PV1^{G}S 16D20180124^{G}S14D20220123^{G}S13V101010101^{G}S20P00950L/S8^{G}S32Pwww.vda.de^{R}S^{E}O$_T$[1]

Data Matrix symbols[2]:

Module size 0.33 mm

Module size 0.42 mm

Module size is determined automatically (i.e. the entire 18 x 18 mm area is used)

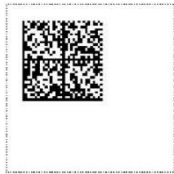[1] ^{R}S = CHR(30), hex IE; ^{G}S = CHR(29) , hex 1D; ^{E}O$_T$ = CHR(04), hex 04
[2] The maximum symbol size was set at18 x 18 mm, and the border is 22 x 22 mm.

Example 2

The syntax string needed for generating the symbol looks like this:

[)>^{R}S06^{G}s12PAL^{G}s9K1.0^{G}sPABC123^{G}sQ10^{G}s3QPC^{G}s4LDE^{G}s6VS321^{G}s30PV1^{G}s 16D20180124^{R}s^{E}O$_T$
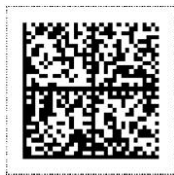
Data Matrix symbols:

 Module size 0.33 mm

 Module size 0.42 mm

 Module size determined automatically (i.e. the entire 18 x 18 mm area is used)
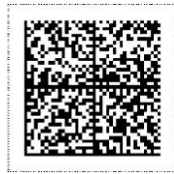
Example	DMC	Contents read	
1		Data identifier	Example 1 content
		12P	AL
		9K	1.0
		P	ABC123
		Q	10
		3Q	PC
		4L	DE
		6V	S321
		30P	V1
		16D	20180124
		14D	20220123
		13V	101010101
		20P	00950L/S8
		32P	www.vda.de
2		Data identifier	Example 2 content
		12P	AL
		9K	1.0
		P	ABC123
		Q	10
		3Q	PC
		4L	DE
		6V	S321
		30P	V1
		16D	20180124

4.4 Technical equipment

A printer with a minimum resolution of 300 dpi should be used for creating a DMC. The quality requirements described in section 4.1 above apply. In general, the 2D symbol should be printed in black on a white background. If the printing process provides support, the module size should automatically be set to the largest possible that will enhance the readability of the code with smaller quantities of data. However, the module size should not exceed 0.5 mm.

When choosing a scanner, the user should ensure that it can read and interpret the control codes ^{G}S, ^{R}S and $^{E}O_T$ correctly. This is often not the case with scanners that emulate a keyboard using USB.

5   Process for agreeing to use Data Matrix codes

The sustainable use of the DMC in the supply chain all the way from the supplier to the final customer (workshop or consumer) requires a transparent and comprehensible coordination process. Agreement is required not only generally on the use of the DMC for selected products and product ranges, but also on the use and specific content of the various fields. A written agreement is recommended.

Measures should be implemented at the level of the supplier and the customer (OEM) in the parts process to ensure quality and minimize risks in the ongoing process.

Possible risks (not exhaustive):

-   Faulty connection to logistics systems leads to incorrect content in the DMC.

-   Insufficient print quality of the DMC leads to problems or errors in reading.

-   Non-agreed contents such as supplier's part number or other information from the supplier are transmitted unfiltered to the customer.

5.1 Agreement between first placer and supplier

The first placer's general purchasing conditions and packaging guidelines should regulate the general use of the Data Matrix code and describe the requirements for fields, contents and the corporate identity.

On this basis, the following should be agreed with the individual suppliers: the scope of use (products/product ranges), the necessary optional contents and responsibility for the data origin (who makes the data for printing the Data Matrix Code available). The correct layout and consistent content of the label/printed packaging should be checked.

5.2   Quality assurance in the process

5.2.1   Process for new parts

The process for new parts – both at the supplier and at the first placer – should include checks on the layout and contents of the individual labels/printed packaging. If any deviations are identified, corrective measures have to be defined with the supplier. The same process should be applied when parts in stock are migrated.

5.2.2   Supplier's packaging process

The supplier ensures that the required technology is available for generating and printing the Data Matrix Code.

The supplier's logistics processing has to involve testing random samples of Data Matrix Codes for compliance with the agreed requirements.

If any deviations are identified, corretive measures should be implemented immediately. In the case of parts already dispatched with contents that deviate from those agreed, the first placer has to be informed and any necessary corrective measures have to be agreed.

5.2.3 Examination in the first placer's flow of goods

In the warehouse, and during picking and dispatch processes, random samples of Data Matrix codes should be read and checked against the agreed requirements.

This can be carried out during the regular process of receiving goods for example, or as part of a scheduled warehouse/dispatch audit.

Any deviations will trigger the agreed complaints process.

6 Annex

6.1 Abbreviations, terms and definitions

ANSI	American National Standards Institute
	Data

DMC	Data Matrix Code
DUNS	*Data Universal Numbering System:* system allocating numbers for unique identification of companies, corporate divisions, public bodies, business operators and self-employed operators. These numbers are managed by Dun & Bradstreet.
First Placer	The party introducing the item into the market (market introduction).
IT	Information Technology
OE	Original Equipment
OEM	Original Equipment Manufacturer
URL	Uniform Resource Locator

6.2 Literature

VDA Recommendation 9004 "Nomenclature for an Optically Neutral Identification Code for Spare Parts and its Verification" Internet link:
https://www.vda.de/de/services/Publikationen/vda-empfehlung-9004.html

6.3 Approved ANSI X12.3 Units of Measure and Codes

ANSI X12.3	Meaning	UN/EDIFACT
PC	Piece	PCE/C62
ST	Set	SET
MR	Meter	MTR
CM	Centimeter	CMT
MM	Millimeter	MMT
SM	Square meter	MTK
CR	Cubic meter	MTQ
C8	Liter	LTR
X7	Leaf	LEF
PR	Pair	PR
RL	Roll	RO
KG	Kilogram	KGM
GR	Gram	GRM
DK	Kilometer	KMT
MP	Metric ton	TNE