# TECHNICAL REPORT

# ISO/TR 17350

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# Direct Marking on Plastic Returnable Transport Items (RTIs)

*Inscription directe sur les éléments restituables en plastique de transport (RTIs)*

**ISO/TR 17350:2013(E)**

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# Foreword

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

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote. Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

In exceptional circumstances, when the technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 17350 was prepared by Technical Committee ISO/TC 122, *Packaging*.

# Introduction

The typical returnable transport item (RTI) used in physical distribution is a pallet. In the logistics industry, however, carton boxes, which are normally loaded on a pallet and tightly bound with a rope or net, are traditionally used. For environmental reasons, in recent years, these carton boxes are being replaced by plastic RTIs (returnable box). This is a growing trend, especially in the manufacturing industry, where RTIs are regarded as an important delivery means in the transportation between production sites and where RTIs are implemented for carrying items from the distribution centre to the retailer.

However, the lack of a well-established structure to control RTIs (owner management) has created problems resulting in uncontrolled, discarded, lost or stolen RTIs. Generally, in supply chain management, an RTI filled with items is exchanged among the trading partners in the conventional forward logistics and the same RTI is emptied and collected for reuse in the reverse logistics (return process). Because no efficient RTI management system currently exists, collection of RTIs has not been successful and this is adversely affecting the efficiency of the overall shipping process. An ideal solution would be the use of an identification code to uniquely identify individual RTIs.

Data carriers for this potential management system could include OCR, linear symbols, two-dimensional symbols or RFID. The use of an OCR-based reader is not recommended because of its cost and linear symbols are not practical for storing a large amount of data. Taking these factors into consideration, a 2D symbol may be a reasonable choice for marking RTIs.

Two methods are available for applying 2D symbols on RTIs; labelling and direct marking. Most labels are accompanied by the risk of peeling off during a long cycle of reuse, but using a highly durable label that resists peeling comes at a higher cost. For that reason, this technical report proposes marking 2D symbols directly on the RTIs. And because a variety of colours are used for RTIs and achieving a 100 % read rate for some colours is nearly impossible, this technical report is intended to provide guidance to determine the most appropriate marking and reading method for resin-made RTIs.

This Technical Report contains 15 annexes, all of which provide informative information:

# Direct Marking on Plastic Returnable Transport Items (RTIs)

## 1 Scope

This Technical Report provides guidance on

— Returnable transport items (RTIs)

— Identification codes used for RTIs

— Specifications for two-dimensional symbols

— Method for direct marking

— Reading method for direct marking

## 2 Normative references

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

ISO 445, *Pallets for materials handling — Vocabulary*

ISO/IEC 19762 (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ISO 21067, *Packaging — Vocabulary*

## 3 Terms, definitions and abbreviations

For the purposes of this document, the terms, definitions, and abbreviations given in ISO/IEC 19762 (all parts), ISO 445 and ISO 21067 apply.

NOTE    Within this document, "NG" is an abbreviation for "no good".

## 4 Types of Returnable Transport Items (RTIs)

The term Returnable Transport Items (RTIs) typically refers to logistics materials used among suppliers for shipping (transferring) parts/components and assemblies. The purpose of this technical report is to recommend a method to identify RTIs for the establishment of an RTI control system that can be shared throughout the industry. However, considering the fact that RTIs of different sizes and materials are used in the market, it is difficult to apply the same definition to all the types of RTIs. The focus of this report is on the typical RTI characteristics as defined below.

### 4.1 Pallets

Figures from 1 to 7, below, show typical examples of pallets, which include a flat pallet, roll box pallet, box pallet, post pallet, silo pallet, tank pallet and sheet pallet. In the manufacturing industry, pallet-formed RTIs specially designed for the industry are widely implemented (see Figure 7). This technical report applies to RTIs illustrated in Figures 1, 3, 4 and 7.
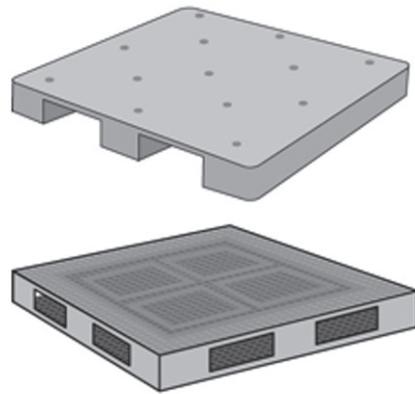
**Figure 1 — Plate pallets**



**Figure 2 — Roll box pallet**
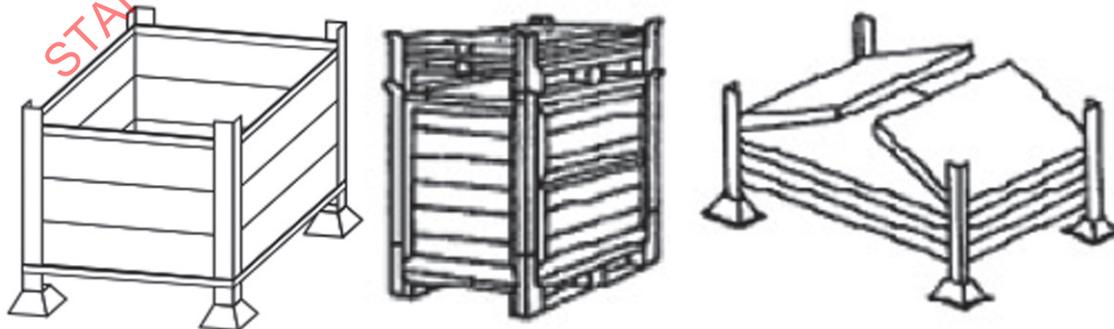


**Figure 3 — Box pallets**
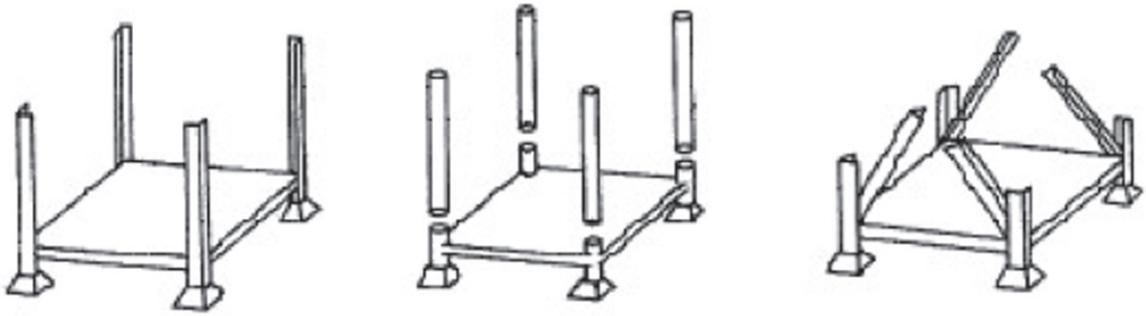
**Figure 4 — Post pallets**
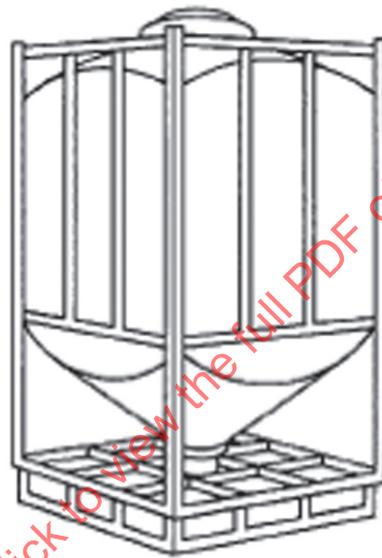


**Figure 5 — Silo pallet**
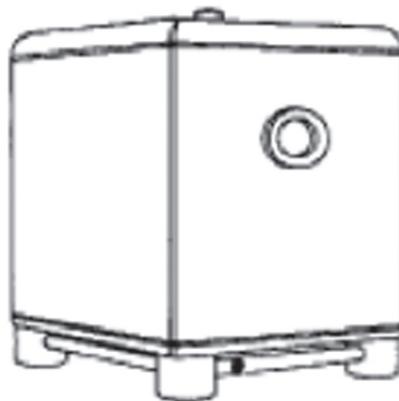


**Figure 6 — Tank pallet**
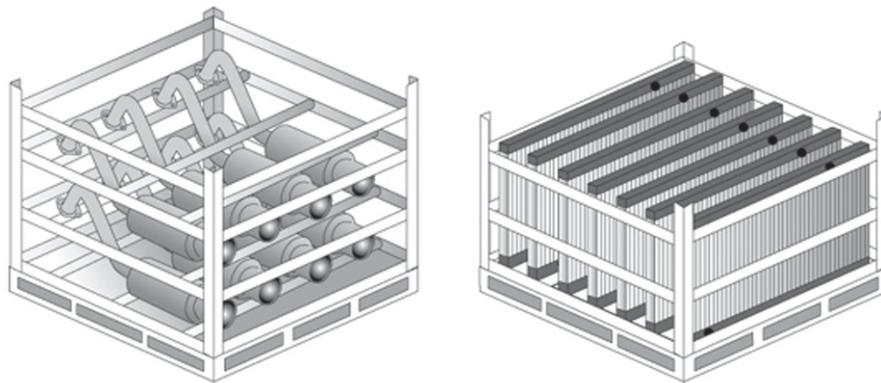
**Figure 7 — Special pallets**

## 4.2   Sheet pallet (Slip sheet)

A sheet pallet, or a slip-sheet, is a sheet-like packing material that is used instead of a plate pallet when loading a returnable box on a carrier vehicle, such as a truck. This sheet pallet facilitates easy handling of the returnable box by reducing a friction generated between the returnable box and the undercarriage of the truck. By pulling the tab of the sheet pallet, the returnable box is smoothly unloaded from the truck without difficulties. The sheet pallet can also be used under the returnable box (see Figure 8). This technical report is also applicable to the sheet pallet in Figure 8.
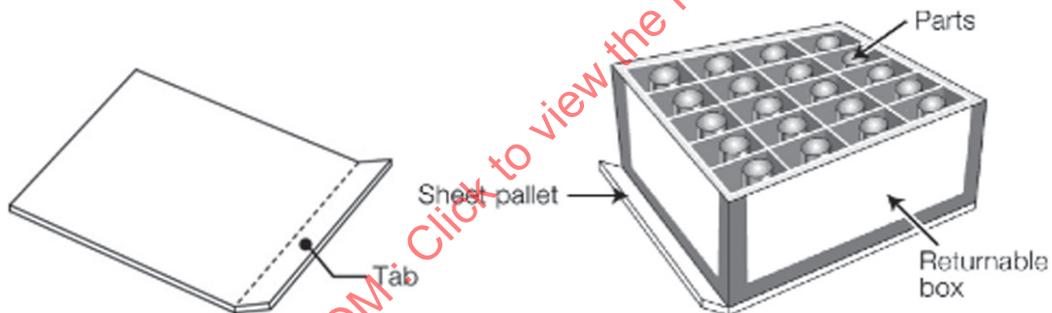


**Figure 8 — Sheet pallets**

## 4.3   Returnable boxes

Figures 9 and 10 below show typical examples of returnable boxes, including those for carrying multiple objects on a flat pallet. Metallic drums and barrels used for liquids, oil or powders are not included in this technical report. It does, however, apply to containers for carrying non-solid substances such as beverages, detergent or coating materials.
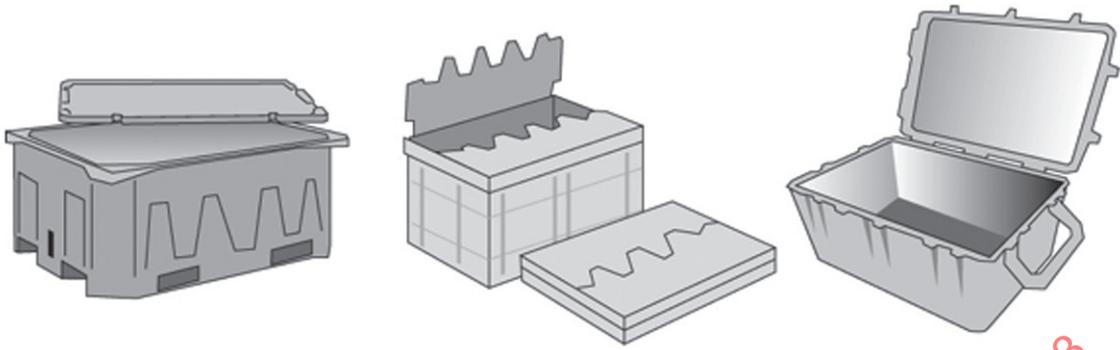
**Figure 9 — Large-sized returnable transport items**



**Figure 10 — Medium-sized returnable transport items**



**Figure 11 — Liquid containers, like metallic drums**

### 4.3.1 Plastic returnable containers

Plastic returnable boxes, made mainly of polypropylene, have been widely used for carrying beer for more than 20 years and they are now regarded as a typical RTI. Since its first appearance, the plastic container has been recognized in the logistics industry as an alternative to the cardboard box or wooden crate.

#### 4.3.1.1 Applications

The largest application for plastic returnable boxes is to store and/or deliver parts and components for vehicles and electronic home appliances. This is followed by applications in the grocery supermarkets and convenience stores.

Table 1 — Typical applications for plastic containers

| Application | Examples |
|---|---|
| Manufacturing | Storage or delivery of parts/components used in vehicles and electronic home appliances |
| Logistics | Apparel, convenience stores and supermarkets |
| Others | Agriculture and fishery |

The use of plastic returnable boxes is effective only if a well-established system for collecting and reusing them is provided as part of the shipping process. In general, the plastic returnable boxes currently seen on the market come in two types, namely a simple plastic box (composed of a single piece) and a foldable plastic box (composed of multiple pieces). There is not much difference in the price between the two, however, the foldable plastic box is more convenient and suitable for storage and is widely used.

#### 4.3.1.2 Materials for plastic returnable boxes

Most plastic returnable boxes are made of polypropylene (PP), not polyethylene (PE). In general, the use of polyethylene is limited to items for cold climates or applications specific to refrigerator cars. Other kinds of plastic boxes made of polycarbonate or ABS are also seen on the market, but those actually implemented to the fields are very few. This Technical Report addresses polypropylene-made RTIs.

### 4.3.2 Plastic returnable corrugated boxes

Similar to a paper-based returnable cardboard box, the hollow structure is adopted for a plastic-based corrugated container for keeping and carrying parts and components in the production of vehicles and electronic home appliances. Due to its outstanding characteristics, such as durability against shock and a high level of hygiene, the plastic box is regarded as ideal for keeping and carrying highly sensitive parts. This plastic box is also replacing wooden crates.

#### 4.3.2.1 Applications for returnable plastic corrugated boxes

The largest application for plastic returnable corrugated boxes is for industrial use, followed by public engineering and building works. Most of these RTIs are used as returnable boxes for keeping and carrying parts and components used in a broad range of products related to liquid crystal display TVs and automobiles.

#### 4.3.2.2 Materials for returnable plastic corrugated boxes

The type of resin used for plastic corrugated returnable boxes is mostly polypropylene. The use of polyethylene is mainly limited to the items used in cold climates or applications specific to refrigerator cars.

Table 2 — Typical applications of plastic corrugated boxes

| Application | Examples |
|---|---|
| Packing materials | Returnable boxes, partition boards/cushions, shock absorbers |
| Public engineering and building materials | Protection sheets, partitions, heat insulating material supporters |
| Agriculture and fishery | Fishery products, agricultural product container cases |
| Others | Office equipment/supplies, interior materials for automobile, slip sheets |

## 4.4 Partitions

Some pallets and returnable boxes are equipped with shock absorber-type materials to protect them from shock or vibration in the transportation flow. An effective solution is the use of partitions or sorting boards to separate the contents, making it possible to place many items on a single pallet or in a returnable box. This is defined as a "partition" in this technical report. A typical example in this report would be a post-type partition used with the post pallet as illustrated below in Figure 12. This group also includes packing material used to protect or arrange the contents between the posts or for dividing the contents into several smaller sections as illustrated in Figures 13 and 14.

### 4.4.1 Posts

Figure 12 shows a post normally used to securely fix the packing material or returnable box onto the post pallet. These posts are generally made of plastic or metal, but this report covers only plastic-made posts.
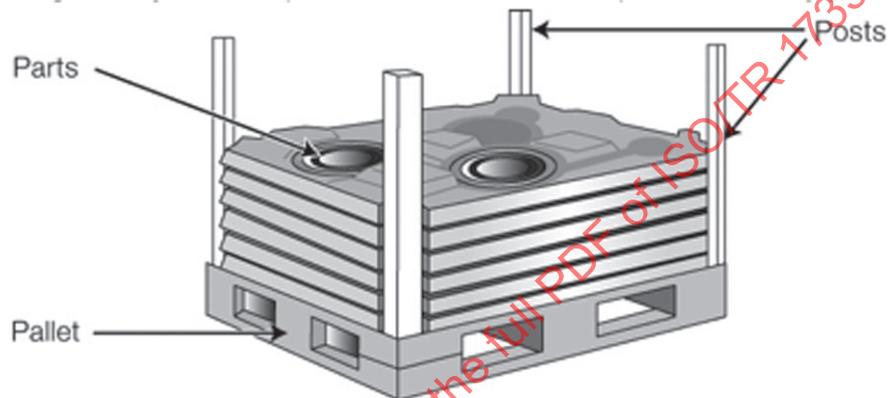
**Figure 12 — Post**

### 4.4.2 Packing materials

Packing materials should be provided to protect the items from shock or vibration that may be encountered during transportation. They are also used to protect the product from being touched or hit by the pallet or returnable box in which they are placed. This report applies to packing materials made of high resilient flexible substances like plastic, urethane, and polystyrene foam. (See Figures 13 and 14.)
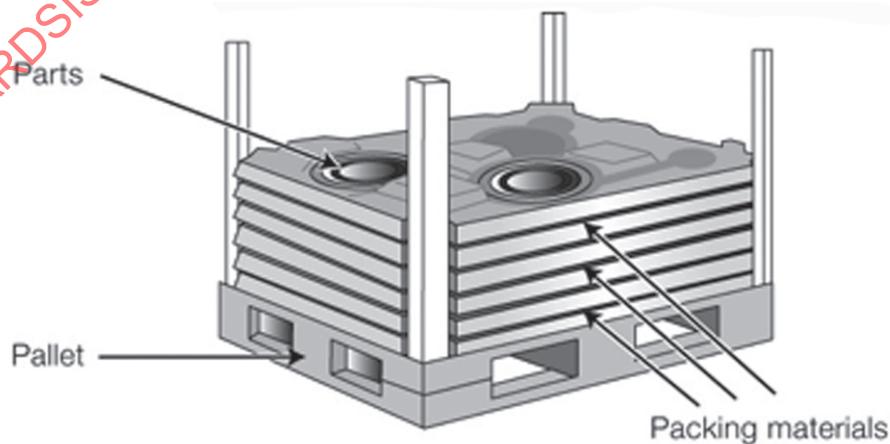
**Figure 13 — Packing material**
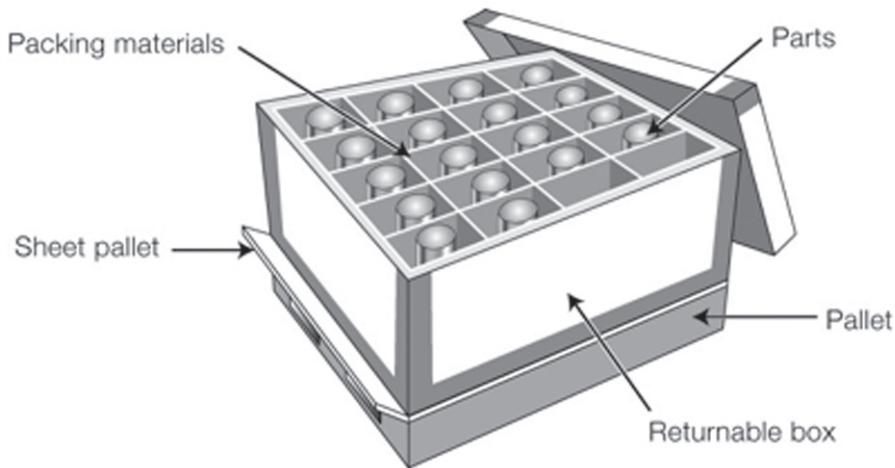
**Figure 14 — Packing material**

# 5 Unique Identifier of Returnable Transport Items (RTIs)

## 5.1 Data field identification

For the identification of returnable transport items, the Data Identifier "25B" defined in ISO/IEC 15459-5 should be used. See the data structure in Table 3.

## 5.2 Maximum data length

RTI identification data should contain a maximum of 35 characters, not including the Data Identifier. With the express agreement of the trading partners, this length may be extend up to, but shall not exceed 50 characters (exclusive of the Data Identifier). This specification of data length supports the language that appears in ISO/IEC 15459-5.

## 5.3 Character set

The character set defined in ISO/IEC 646 is recommended.

## 5.4 Data structure

Table 1 shows an example of the RTI Unique Item Identifier (UII) data structure. A description of the GS1 data structure is found in ISO/IEC 15459-5.

**Table 3 — Data structure**

| 25B | IAC | CIN | SN |
|-----|-----|-----|-----|

### 5.4.1 Issuing Agency Code (IAC)

The Issuing Agency Code (IAC), which consists of a maximum of three (3) characters, is used to identify the entity/organization/company authorized by the appropriate registration authority as an issuing agency in accordance with ISO/IEC 15459-2. This includes, for example, UN (Dun and Bradstreet), OD (Odette Europe) and LA (JIPDEC/CII).

### 5.4.2 Company Identification Number (CIN)

The Company Identification Number (CIN) is a unique code assigned by the issuing agency to individual companies. Each issuing agency has its own format for the CIN. Depending upon the specific issuing agency employed the CIN may be followed by a Factory Identification Code (FIC), Kind Code (KC), and Partition Code (PC) as described in ISO Technical Report 17370.

### 5.4.3 Serial Number (SN)

When the Serial Number (SN) is combined with IAC and CIN, the combination constitutes a globally unique identifier for the RTI. Once created and attached to an RTI, the combination of CIN and SN shall be fixed and unchangeable for that specific RTI throughout its lifetime. The Serial Number (SN) may be composed of numeric or alphabetic characters or a combination. The structure is illustrated in Annex A.

### 5.4.4 Structured data

In transportation, items in a returnable box are usually protected with packing materials. When emptied, the returnable box should be returned, along with the packing materials. This implies the importance of unique identification data in a structured format on the returnable boxes and the packing materials. The data format defined in Annex B illustrates the relation between the returnable box and the associated packing materials.

## 6 Marking method

### 6.1 Label

Since each RTI has its own globally unique number as shown in Table 3, creating unique labels for individual items is critical. However, the process of creating individual labels is more costly than creating a large number of identical labels. In addition, most labels are accompanied by the risk of peeling off during a long cycle of reuse and must be able to withstand cleaning from time to time. But using highly durable labels comes with a higher cost.

### 6.2 Direct marking

#### 6.2.1 Definitions

Direct marking is a technique categorized as an Automatic Identification and Data Capture (AIDC) technology, in which a mark is placed directly on the product (item, part/component and its package) without using labels or nameplates. Direct marking can also refer to the symbol itself that is marked using this technique.

#### 6.2.2 Marked symbols

Several symbols can be used for identification purposes, including OCR (Optical Character Recognition), linear and two-dimensional symbol. However, only matrix-based 2D symbols are included in this technical report.

#### 6.2.3 Considerations

A wide range of products and materials are marked using a variety of direct marking methods, making the development of a universal standard on the quality of marking more complicated than one for printing a symbol on paper-based media. However, if companies make use of only proprietary standards, worldwide standardization of direct marking beyond the framework of individual companies and industries will be difficult and this may adversely affect the widespread use of direct marking

### 6.2.4   Necessity

The establishment of Information systems throughout the supply chain network (work process, production facilities, transportation and logistics) from manufacturing to sales has helped to provide consumers with quality products at lower prices. Furthermore, considering an array of major issues that confront us, such as the environment, effective use of natural resources and guarantees for the safety and security of consumers, a well-organized lifecycle management system that supports the recycling and reuse of products should be established. As a solution to this problem, it is recommended all the required information be directly marked on all the related products.

### 6.2.5   Technology

The direct marking technology includes laser marking, dot peen marking, ink jet marking, thermal marking and sandblast marking. This technical report supports both laser and dot peen marking. Ink jet marking can be evaluated using the method normally used for labels.

Ink jet marking can be used regardless of the colour by using silk-screen printing on a plastic surface and then marking the symbol on top of that with black ink. Most plastic boxes are cleaned using either with neutral or alkali detergent. When using ink jet, it is very important to choose an ink that can withstand cleaning at least 100 times with a neutral or alkali detergent without causing degradation or deterioration in the quality of mark.

Example of detergents:

— Sodium hydroxide (approx. 5 %) + potassium hydroxide (approx. 5 %)

— Sodium peroxide (approx. 25 %) + sodium carbonate (approx. 60 %)

### 6.2.6   Marked symbols

Several symbols can be used for identification purposes, including OCR (Optical Character Recognition), linear and two-dimensional symbols. However, only matrix-based 2D symbols are included in this technical report. ISO/IEC 18004 QR Code is used as the test sample in this Technical Report.

## 7   Two-dimensional symbology requirements

The RTI's unique number can be encoded in two-dimensional symbols conforming to ISO/IEC 18004 (QR Code) or ISO/IEC 16022 (Data Matrix). The encoding of data should follow the syntax rules and message format defined in ISO/IEC 15434. When considering the size of a two-dimensional symbol, the larger the symbol, the longer it will take to create the mark. Users are encouraged to evaluate the size of the symbols and "X" dimensions with which they will be confronted along side of the reading equipment that will be available.

### 7.1   QR Code requirements

The QR Code symbol referenced in this Technical Report is defined in ISO/IEC 18004.
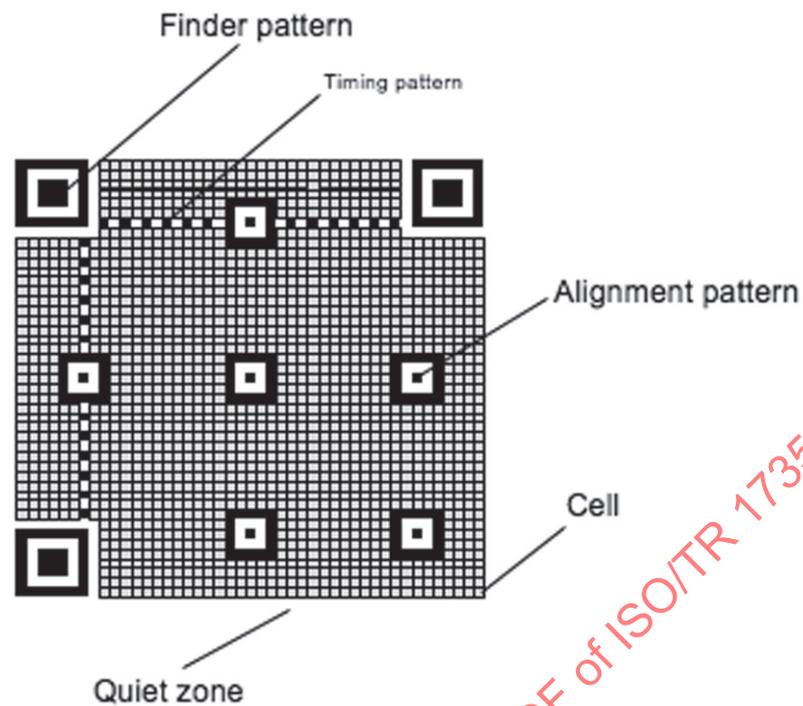
**Figure 15 — Structure of QR Code symbol**

### 7.1.1 "X" dimension

"X" dimensions shall be 0.4 mm or greater, but not larger than 0.8 mm for direct marking. Table 4 shows recommended "X" dimensions with associated data capacity. With express trading partner agreement, the "X" dimension may be as small as 0.15 mm or symbols sizes as small as 10 mm x 10 mm.

**Table 4 — QR Code alphanumeric data capacity for direct marking**

| "X" Dimension | | | | | |
|---|---|---|---|---|---|
| Symbol Size (Without Quiet Zone) | Error correction level | 0,150 mm (0,006 inch) | 0,40 mm (0,0157 inch) | 0,60 mm (0,0236 inch) | 0,80 mm (0,0315 inch) |
| 10 mm x 10 mm | M | 419 | 38 | - | - |
| | Q | 296 | 29 | - | - |
| | H | 227 | 20 | - | - |
| 20 mm x 20 mm | M | 1 839 | 221 | 90 | 38 |
| | Q | 1 322 | 157 | 67 | 29 |
| | H | 1 016 | 122 | 50 | 20 |
| 30 mm x 30 mm | M | 3 391 | 528 | 221 | 122 |
| | Q | 2 420 | 376 | 157 | 87 |
| | H | 1 852 | 283 | 122 | 64 |
| 40 mm x 40 mm | M | 3 391 | 970 | 419 | 221 |
| | Q | 2 420 | 702 | 296 | 157 |
| | H | 1 852 | 557 | 227 | 122 |
| 50 mm x 50 mm | M | 3 391 | 1 637 | 656 | 366 |
| | Q | 2 420 | 1 172 | 470 | 259 |
| | H | 1 852 | 910 | 365 | 200 |

### 7.1.2 Quiet zone

The QR Code Model 2 symbol should have a minimum quiet zone of four (4) times the "X" dimension width on all four sides of the symbol.

### 7.1.3 Error correction level

The error correction level should be M (approximately 15 %), Q (approximately 25 %), or H (approximately 30 %) as identified in ISO/IEC 18004. The error correction level is determined by many factors, including the surface type, operating environment, symbol quality, and reading device(s) used. The error correction level L (approximately 7 %) is not recommended for QR Code Model 2.

### 7.1.4 Symbol quality

#### 7.1.4.1 Ink jet marking and label

A QR Code Model 2 symbol should be measured according to ISO/IEC 15415 and have a minimum symbol quality of 2.0/08/660, in which the minimum overall symbol grade is 1.5/08/660, where "08" indicates the symbol is measured with an aperture size of 0,20 mm and "660" indicates that the symbol is illuminated with a narrowband light source centred around 660 nm. The light source angle should be 45 degrees.

ISO/IEC 15415 provides additional guidance on grading parameters, in particular the relationship between aperture size and susceptibility to gaps and other defects.

#### 7.1.4.2 Laser marking and dot peen marking

A QR Code Model 2 symbol should be measured according to ISO/IEC TR 29158 "Direct Part Mark (DPM) Quality Guideline" and have a minimum symbol quality of DPM2.0/15-30/660/(30Q|90), in which the minimum overall symbol grade is DPM1.5/15-30/660/(30Q|90), where "15 to 30" indicates an X-dimension range of 0,4 to 0,8 mm, "660" indicates that the symbol is illuminated with a narrowband

light source centred around 660 nm. The "30Q" light source angle should be 45 degrees. ISO/IEC TR 24720 "Guidelines for direct part marking (DPM)" is recommended as a recommendation for directly marking a QR Code symbol on various materials.

### 7.1.5 Encryption

Encryption should not be used for a mandatory data field.

### 7.1.6 Character set

The character set should be upper case alphabetic characters and numeric digits, as well as the recommended field separators, record separators, segment terminators and compliance indicator. It is recommended that the resultant data stream from scanning a QR Code Model 2 should symbol follow the syntax described in ISO/IEC 15434.

## 7.2 Data Matrix requirements

The Data Matrix ECC200 symbol referenced in this technical report is defined in ISO/IEC 16022.



**Figure 16 — Structure of Data Matrix ECC200 Symbol**

### 7.2.1 "X" dimension

"X" dimensions shall be 0,4 mm or greater, but not larger than 0.8 mm for direct marking. Table 4 shows recommended "X" dimensions with associated data capacity. Table 5 shows recommended "X" dimensions with associated data capacity. With express trading partner agreement, the "X" dimension may be as small as 0,15 mm or symbols sizes as small as 10 mm x 10 mm.

**Table 5 — Data Matrix ECC200 alphanumeric data capacity for Direct Marking**

| "X" Dimension | | | | |
|---|---|---|---|---|
| Symbol Size (Without Quiet Zone) | 0,150 mm (0,006 inch) | 0,40 mm (0,0157 inch) | 0,60 mm (0,0236 inch) | 0,80 mm (0,0315 inch) |
| 10 mm x 10 mm | 418 | 52 | 16 | 6 |
| 20 mm x 20 mm | 1 954 | 259 | 91 | 52 |
| 30 mm x 30 mm | 2 335 | 550 | 259 | 127 |
| 40 mm x 40 mm | 2 335 | 1 042 | 418 | 259 |
| 50 mm x 50 mm | 2 335 | 1 573 | 682 | 304 |

### 7.2.2 Quiet zone

The Data Matrix ECC200 symbol should have minimum quiet zones of one (1) "X" dimension width on all four sides of the symbol.

### 7.2.3    Error correction level

A Data Matrix symbol should have an error correction level of ECC200 as defined in the ISO/IEC 16022.

### 7.2.4    Symbol quality

#### 7.2.4.1    Ink jet marking and label

Data Matrix symbol print quality should be measured at the consignee's point of scan, in accordance with ISO/IEC 16022 and ISO/IEC 15415 in the light range (e.g. 660 nm).

The minimally acceptable overall symbol grade of 2.0/10/660 applies to the final symbol on the item at the point of receipt. It is recommended that the overall symbol grade, at the point of marking the symbol, be equal to or exceed 2.5/10/660 to allow for process variations and possible degradation from packaging, storage, shipping, handling and use.

#### 7.2.4.2    Laser making and dot peen marking

Evaluation of laser marking and dot peen marking should conform to ISO/IEC TR 29158. ISO/IEC TR 24720 is provided as a guideline for directly marking a Data Matrix symbol on various materials.

### 7.2.5    Encryption

Encryption should not be used for a mandatory data field.

### 7.2.6    Character set

The character set should be upper case alphabetic characters and numeric digits, as well as the recommended field separators, record separators, segment terminators and compliance indicator. It is recommended that the resultant data stream from scanning a Data Matrix symbol should follow the syntax described in ISO/IEC 15434, using the Data Matrix Macro characters/codewords, including "237" can be found in ISO/IEC 16022, Clause 5.2.4.7.

Macro Code 237 consists of; [] > $R_S$ 06 $G_S$" and "$R_S$ $E_{O_T}$. (Spaces have been added between the characters for visual clarity only, and are not part of the macro.)

## 8    Experimental Test 1

### 8.1    Objective

This test was conducted to evaluate the print results and characteristics of direct marking on resin materials.

### 8.2    Test sample

Test samples selected are returnable boxes generally used in the automotive and logistics industry as shown in Figures 17 and 18. The returnable box shown in Figure 17 is a green foldable plastic box, and the one in Figure 18 is a simple plastic box in two colours, pink on the left and purple on the right.

**Figure 17 — Returnable box used in the automotive industry**



**Figure 18 — Returnable box used in the logistics industry**

## 8.3 Marker

The test was conducted using the laser marker defined in Annex I. The marking time is shown in Table 6.

**Table 6 — Marking requirements**

| Item | Requiments | |
|---|---|---|
| Laser power | 80 % | |
| Scan speed | 1200 mm/s | |
| Pulse frequency | 10 µs | |
| Marking time | Automobile: | 6,45 sec |
| | Logistics (purple): | 6,76 sec |
| | Logistics (pink): | 9,26 sec |

## 8.4 Two-dimensional symbol

The two-dimensional symbol used for this test is QR Code Model 2, Version 4, with the Error Correction Level Q and a 0.4 mm module size. Presuming that QR Code is most often read with a hand-held scanner or a portable terminal, the cell size was selected as a user-friendly feature.

## 8.5 Marked data

The marked data should comply with Table 7. Refer to Annex A for the structure of the Serial Number.

**Table 7 — Marked data**

| Item | Data Identifier | Issuing Agency | Company Code | Serial No. |
|---|---|---|---|---|
| Data | 25B | LA | 506002 | N5THA50001 |
| Example | [)>$^R_S$ 06 $^G_S$ 25BLA506002N5THA5001 $^R_S$ $^E$O$_T$ | | | |

## 8.6 Reader

The readability of the QR Code symbol was evaluated using both a hand-held scanner (see Annex C) and a portable terminal (see Annex D). The readability of the QR Code symbol direct marked on an object varies depending on the lighting angle. In this test, a hand-held reader that supports direct marking was used to evaluate the reading results with a light source similar to a coaxial light.



**Figure 19 — Hand-held scanner and portable terminal**

## 8.7 Evaluation results

Table 8 below shows the results of the evaluation.

**Table 8 — Evaluation results**

| Item | Automobile | Logistics (purple) | Logistics (pink) |
|---|---|---|---|
| Image |  |  |  |
| Scanner | OK | OK | NG |
| Terminal | OK | OK | NG |

## 8.8 Considerations

As mentioned above, a polypropylene-based returnable box comes in a variety of colours. The result of this test indicates a better readability is achieved for darker colours. Considering that a variety of materials are being used in the production of a broad range of returnable boxes, a variety of colour

developers are also contained in the boxes. Therefore, not only the material of the box, but also the effect of colour developers should be examined with respect to the following:

a) Laser marker colour on a resin surface depends largely on the colour and components of the resin. Check the difference in the colours.

b) Determine the amount of colour developer to be added to the resin plastic samples, which will affect both the robustness and the cost of the returnable boxes.

c) Evaluate the marks created not only by a dot peen marker but also by a laser marker.

d) Find and evaluate the optimal light axis angle, the light source colour and the incident angle using a verifier.

# 9 Experimental Test 2

## 9.1 Objective

Mark a QR Code symbol directly on resin materials (polypropylene) that are easy to obtain and widely used for returnable boxes and determine if the QR Code symbol is successfully scanned. The purpose of this test was to evaluate the print quality and readability of QR Code symbols directly marked on resin materials containing colour developers of 0,4 PHR and 0,2 PHR.

## 9.2 Test sample

The test was conducted using two sets of sample plates, each made of resin (polypropylene) and using a total of 13 different colours, as shown in Figures 20 to 23. Table 9 is a list of the sample plate colour symbols along with the basic colour tones and CMYK values.

Table 9 — Sample plate colour symbols and CMYK values

| Sample plate symbols | Colour tone | CMYK value | | | |
|---|---|---|---|---|---|
| | | Cyan | Magenta | Yellow | Key Plate |
| CL202 | White | 0 | 2 | 49 | 0 |
| BK901 | Black | 12 | 18 | 20 | 100 |
| GRDEN | | 60 | 0 | 75 | 0 |
| GRSCR | Green | 98 | 1 | 72 | 0 |
| GR603 | | 83 | 36 | 96 | 0 |
| BLBF4 | | 42 | 18 | 0 | 0 |
| BL510 | | 62 | 14 | 0 | 0 |
| BL503 | Blue | 85 | 38 | 0 | 0 |
| BL506 | | 100 | 46 | 10 | 0 |
| GL802 | Gray | 45 | 37 | 36 | 0 |
| ORTUD | Orange | 0 | 77 | 100 | 0 |
| YE201 | Yellow | 0 | 4 | 98 | 0 |
| TM | Gray | | | | |

**Figure 20 — 0.4 PHR mark plate 1**



**Figure 21 — 0.4 PHR mark plate 2**

**Figure 22 — 0.2 PHR mark plate 1**



**Figure 23 — 0.2 PHR mark plate 2**

## 9.3 Marker

The type of marker selected for this test is the laser marker specified in Annex I. Table 10 shows the marking conditions of this laser for the power, scan speed, pulse cycle, code pattern, number of overlapped marks and tact time of the laser marker, which are assumed to be the most appropriate conditions obtained from the test results. For example, the amount of heat applied to the sample becomes lower in the sample BK901 (black resin) due to the reduced power, speed, pulse frequency and number of overlapped marks for the laser marker.

**Table 10 — Print conditions**

| Sample plate symbol | Power (%) | Speed (mm/s) | Pulse cycle (µs) | Code pattern | No. of overlapped marks | Tact (sec) |
|---|---|---|---|---|---|---|
| CL202 | 80 | 1200 | 50 | 8128 | 1 | 5,64 |
| BK901 | 30 | 1000 | 10 | 8125 | 1 | 3,92 |
| GRDEN | 80 | 2000 | 10 | 8128 | 4 | 20,21 |
| GRSCR | 80 | 1800 | 10 | 8126 | 2 | 8,05 |
| GR603 | 80 | 1800 | 10 | 8126 | 2 | 8,05 |
| BLBF4 | 80 | 1800 | 10 | 8126 | 2 | 8.05 |
| BL510 | 80 | 2000 | 10 | 8128 | 4 | 20,21 |
| BL503 | 80 | 2000 | 10 | 8128 | 4 | 20,21 |
| BL506 | 80 | 1800 | 10 | 8126 | 2 | 8,05 |
| GL802 | 80 | 1800 | 10 | 8126 | 2 | 8,05 |
| ORTUD | 80 | 1200 | 50 | 8128 | 1 | 5,64 |
| YE201 | 80 | 2000 | 50 | 8125 | 1 | 3,72 |
| TM | 80 | 1200 | 50 | 8128 | 1 | 5,64 |

## 9.4   Two-dimensional symbol

The two-dimensional symbol selected for this test is QR Code Model 2, Version 4, with the Error Correction Level Q and a 0.4 mm module size.

## 9.5   Marked data

The marked data should comply with Table 7. Refer to Annex A for the structure of the Serial Number.

## 9.6   Reader (evaluation device)

The readability of the QR Code symbol was determined by using a hand-held scanner as defined in Annex C, a portable terminal described in Annex D and a fixed scanner as described in Annex E. The lighting angle of the hand-held scanner used was fixed and is similar to a coaxial light. Both types of illumination defined in Annex F were used in this test.

## 9.7   Reading evaluation method

The test was conducted to assess the readability of the symbols using the three types of readers under the conditions of Table 11 and by measuring the time duration required for each of the readers to successful read the symbols 10 times on a scale of four grades; Excellent (A), Good (B), Fair (C) and Failed.

**Table 11 — Reading confirmation methods**

| Model type | Reader type/condition | 5 sec. or less | 5,1 to 10 sec. | 10,1 to 20 sec. | 20 sec. or more |
|---|---|---|---|---|---|
| | • Hand-held scanner<br>• Manual reading<br>• Test result: Average of 3 tests by 3 operators | Excellent<br>(A) | Good<br>(B) | Fair<br>(C) | Failed<br>(F) |
| | • Portable terminal<br>• Manual reading<br>• Test result: Average of 3 tests by 3 operators | | | | |
| | • Fixed scanner<br>• Test result: Average of 3 tests at a fixed position<br>• Lighting:<br>Red, low angle<br>Red, shower | | | | |

## 9.8 Evaluation results

Table 12 below shows the results of the evaluation, which indicates that the fixed scanner scored an "Excellent (A)" for both lighting methods (low lighting and shower lighting) and the hand-held scanner achieved a "Good (B)" or higher for all the test samples excluding the sample No. GRSCR. It is clear from these results that the performance of both scanners is adequate for reading bar codes or 2D symbols. In contrast, the hand-held scanner ended up as "Failed (F)" for nine of the test samples and many "Fair (C)" except the sample BK901 (black). This could be a problem with using a hand-held scanner in actual applications.

Table 12 — Evaluation results

| Sample plate No. | Hand-held scanner | | Hand-held scanner | | Fixed scanner | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Low angle lighting | | Shower lighting | |
| | 0.4 | 0.2 | 0.4 | 0.2 | 0.4 | 0.2 | 0.4 | 0,2 |
| CL202 | B | B | C | C | A | A | A | A |
| BK901 | B | A | A | A | A | A | A | A |
| GRDEN | B | B | C | C | A | A | A | A |
| GRSCR | B | C | F | F | A | A | A | A |
| GR603 | B | B | C | C | A | A | A | A |
| BLBF4 | B | B | F | F | A | A | A | A |
| BL510 | B | B | F | F | A | A | A | A |
| BL503 | B | B | C | B | A | A | A | A |
| BL506 | B | B | C | C | A | A | A | A |
| GL802 | B | B | C | F | A | A | A | A |
| ORTUD | B | B | B | C | A | A | A | A |
| YE201 | B | B | F | F | A | A | A | A |
| TM | B | A | B | B | A | A | A | A |

## 9.9 Considerations

a) Laser markings on the sample plate should be evaluated according to the power, scan speed, pulse cycle, code pattern, number of overlapped marks and tact time of the laser marker. See Table 10.

b) Light green (GRDEN) and light blue (BL510 and BL503) colours should be drawn repeatedly (up to four times) using a low laser power.

c) The tact time for marking a symbol is determined by the scan speed and number of overlapped marks of laser marker. Light green (GRDEN) and light blue (BL510 and BL503) need 20.21 s. See Table 10.

d) There is a clear difference in the abilities of the hand-held scanner and the portable terminal. This is most likely due to the effect of the optical characteristics of the readers.

e) The testing confirmed that reading with a hand-held scanner and a portable terminal will become unstable (the same lighting angle cannot be sustained during a reading) due to mirror reflection or natural light.

f) The test results do not indicate that the amount of colour developer used in the material to be marked is directly associated with the readability of the symbol. A better result cannot be obtained just by increasing the amount of colour developer.

g) A verifier should be used to evaluate the optimal light axis angle, light source colour and incident angle.

## 10 Experimental Test 3

### 10.1 Objective

The purpose of this test is to evaluate the mark results and characteristics of direct marking on three samples: the 1st sample without colour developer, the 2nd sample containing 0,2 PHR colour developer and the 3rd sample containing 0,4 PHR colour developer.

### 10.2 Test sample

The samples selected for this test are returnable boxes of the type frequently used in the automobile industry (foldable plastic box) and the logistics industry (simple plastic box). Up to 15 polypropylene sample plates of different colours, with the 13 colours used in Test 2 plus an additional two colours, were developed for this test. Figure 24 shows the additional sample plates and Table 13 shows the additional colour plate symbols. The sample plate symbols in Table 13 are specified by their basic colours and their CMYK values.

**Table 13 — Additional sample plate symbols and CMYK values**

| Sample plate symbol | Colour tone | CMYK value | | | |
|---|---|---|---|---|---|
| | | Cyan | Magenta | Yellow | Key Plate |
| REPS2 | Pink | 20 | 100 | 14 | 0 |
| PUSPR | Purple | 57 | 100 | 0 | 0 |



**Figure 24 — Additional samples**

The following three groups of samples were tested:

Sample A:     Test sample for evaluating laser marking with colour developer, the amount of which is 0,2 PHR or 0,4 PHR

Without sunshine and with 500 h (the same sample as in Test 2)

Sample B:     Test sample for evaluation of dot peen marking without colour developer

Dot pitch is 0,4 mm and 0,5 mm

Sample C:     Test sample for evaluating laser marking and dot peen marking with colour developer

Marked on silk print (white)

### 10.2.1 Sample A

The samples in A are designed for the evaluation of laser marking and are the same samples used in Test 2. The samples are divided into four groups according to the amount of colour developer used in

the sample material (one with 0,2 PHR and the other 0,4 PHR) and the time the material is exposed to sunshine (one that is not exposed to sunshine at all and the other exposed to 500 h). See Table 14.

**Table 14 — Sample A Identification numbers**

| Amount of colour developer: 0,2 PHR | | | Amount of colour developer: 0,4 PHR | | |
|---|---|---|---|---|---|
| Sunshine weather | | | Sunshine weather | | |
| Non | | 500 hours | Non | | 500 hours |
| A-GL802-1 | A-GL802-2 | A-GL802-3 | A-GL802-4 | A-GL802-5 | A-GL802-6 |
| A-GRSCR-1 | A-GRSCR-2 | A-GRSCR-3 | A-GRSCR-4 | A-GRSCR-5 | A-GRSCR-6 |
| A-GR603-1 | A-GR603-2 | A-GR603-3 | A-GR603-4 | A-GR603-5 | A-GR603-6 |
| A-BL503-1 | A-BL503-2 | A-BL503-3 | A-BL503-4 | A-BL503-5 | A-BL503-6 |
| A-BL506-1 | A-BL506-2 | A-BL506-3 | A-BL506-4 | A-BL506-5 | A-BL506-6 |
| A-BL510-1 | A-BL510-2 | A-BL510-3 | A-BL510-4 | A-BL510-5 | A-BL510-6 |
| A-ORTUD-1 | A-ORTUD-2 | A-ORTUD-3 | A-ORTUD-4 | A-ORTUD-5 | A-ORTUD-6 |
| A-YE201-1 | A-YE201-2 | A-YE201-3 | A-YE201-4 | A-YE201-5 | A-YE201-6 |
| A-GRDEN-1 | A-GRDEN-2 | A-GRDEN-3 | A-GRDEN-4 | A-GRDEN-5 | A-GRDEN-6 |
| A-BLBF4-1 | A-BLBF4-2 | A-BLBF4-3 | A-BLBF4-4 | A-BLBF4-5 | A-BLBF4-6 |
| A-CL202-1 | A-CL202-2 | A-CL202-3 | A-CL202-4 | A-CL202-5 | A-CL202-6 |
| A-BK901-1 | A-BK901-2 | A-BK901-3 | A-BK901-4 | A-BK901-5 | A-BK901-6 |
| A-TM-1 | A-TM-2 | A-TM-3 | A-TM-4 | A-TM-5 | A-TM-6 |

**10.2.2  Sample B**

The samples in B are used for evaluation of dot peen marking and have no colour developer.

The samples that end with the number 1 or 2 have a 0,5 mm pitch and those that end with 3 or 4 have a 0,4 mm pitch. See Table 15.

**Table 15 — Samples B Identification numbers**

| Dot pitch | | | |
|---|---|---|---|
| 0,5 mm | | 0,4 mm | |
| B-GL802-1 | B-GL802-2 | B-GL802-3 | B-GL802-4 |
| B-GRSCR-1 | B-GRSCR-2 | B-GRSCR-3 | B-GRSCR-4 |
| B-GR603-1 | B-GR603-2 | B-GR603-3 | B-GR603-4 |
| B-BL503-1 | B-BL503-2 | B-BL503-3 | B-BL503-4 |
| B-BL506-1 | B-BL506-2 | B-BL506-3 | B-BL506-4 |
| B-BL510-1 | B-BL510-2 | B-BL510-3 | B-BL510-4 |
| B-ORTUD-1 | B-ORTUD-2 | B-ORTUD-3 | B-ORTUD-4 |
| B-YE201-1 | B-YE201-2 | B-YE201-3 | B-YE201-4 |
| B-GRDEN-1 | B-GRDEN-2 | B-GRDEN-3 | B-GRDEN-4 |
| B-BLBF4-1 | B-BLBF4-2 | B-BLBF4-3 | B-BLBF4-4 |
| B-CL202-1 | B-CL202-2 | B-CL202-3 | B-CL202-4 |
| B-BK901-1 | B-BK901-2 | B-BK901-3 | B-BK901-4 |

### 10.2.3  Sample C

The samples in C are white silk-screens printed on materials not containing any developer, over which a laser or dot peen marking is applied.

#### 10.2.3.1  Sample C (for laser marking)

**Table 16 — Sample C Identification numbers 1**

| Laser marker | |
|---|---|
| C-GRDEN-1 | C-GRDEN-2 |
| C-BLBF4-1 | C-BLBF4-2 |
| C-CL202-1 | C-CL202-2 |
| C-BK901-1 | C-BK901-2 |
| C-PUSPR-1 | C-PUSPR-2 |
| C-RESP2-1 | C-RESP2-2 |

#### 10.2.3.2  Sample C (for dot peen marking)

**Table 17 — Sample C Identification numbers 2**

| Dot peen marker |
|---|
| C-GRDEN-3 |
| C-BLBF4-3 |
| C-CL202-3 |
| C-BK901-3 |
| C-PUSPR-3 |
| C-RESP2-3 |

### 10.3  Markers

The laser marker defined in Annex I and Annex J and the dot peen marker defined in Annex K were used in the test.

#### 10.3.1  Lasers (LP-V10U and LP-430U)

— Laser power: 80 %

— Scan speed: 1800 mm, 2000 mm and 1200 mm/sec

— Pulse cycle: 10μs

— Number of overlapped marks: twice

— Tact time: 8 s

#### 10.3.2  Dot peen marker (VM1000)

— Air pen: Type C (springless)

— Stylus: Edge angle 50°

— WD (mm): 6

— Air pressure (MPa: megapascal): Drive pressure 0,1/Return pressure 0,05

## 10.4 Two-dimensional symbol

The two-dimensional symbol selected for this test is QR Code Model 2, Version 4, with the Error Correction Level Q and a module size of 0,4 mm (high) × 0,4 mm (wide). The test was conducted in the Alphanumeric Mode. The QR Code specification is defined in ISO/IEC 18004.

## 10.5 Marked data

a)  The data marked with the laser marker consisted of the 67 two-byte alphanumeric characters as follows:

"1234567890ABCDEFGHIJKLMNOPQRSTABCDEFGHIJKLMNOPQRSTUVWXYZ12341234567"

b)  The data marked with the dot peen marker consisted of the 36 two-byte alphanumeric characters as follows: "1234567890ABCDEFGHIJKLMNOPQRSTUVWXYZ"

## 10.6 Evaluation Device

The test results were evaluated with the verifier defined in Annex G. The coaxial incident illumination and the oblique light in Annex H were used. See Annex L.

## 10.7 Evaluation Methods

### 10.7.1 Evaluation Method 1

In the configuration shown in Figure 25, find the optimal irradiation angle ideal for reading a symbol by changing the angle under the following test conditions:

— Lens focus distance: 25 mm

— Close ring: 5 mm

— Focal point: 0,7

— Aperture: between 8 and 16

— Light source: Red bar lighting



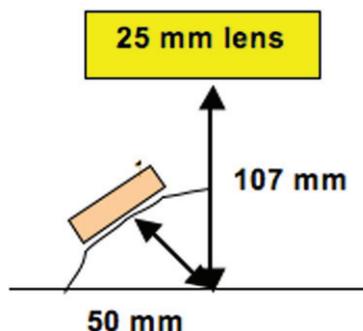**Figure 25 — Evaluation Method 1**

### 10.7.2 Evaluation Method 2

In the configuration shown in Figure 26, evaluate the readability of a symbol under the following test conditions:

— Lens focus distance: 25 mm

— Close ring: 5 mm

— Focal point: 0,7

— Aperture: between 8 and 16
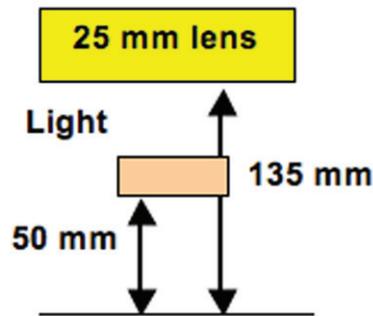
— Light source: Red coaxial lighting



**Figure 26 — Evaluation Method 2**

## 10.8 Evaluation results

### 10.8.1 Evaluation results on Sample A

The test was assessed using Evaluation Method 1. The test result is provided in Annex M.

### 10.8.2 Evaluation results on Sample B

The test was assessed using both Evaluation Methods 1 and 2. The test result is provided in Annex N.

### 10.8.3 Evaluation results on Sample C

The test was assessed using both Evaluation Methods 1 and 2. The test result is provided in Annex O.

## 10.9 Conclusion of evaluation results

### 10.9.1 Evaluation results on Sample A

a) The material of each test sample varies by the degree of hardness and by the colour.

b) The optimal print condition for the laser printer depends on the colour.

c) The following test samples are arranged in the order of readability from the worst (left) to the best (right):

YE201, CL202, ORTUD, A-TM-1

d) The optimal lighting angle is between 30 degrees and 60 degrees.

e) Most of the symbols in Sample A are readable with oblique light.

### 10.9.2 Evaluation results on Sample B in

a) The symbols in Sample B with a dot peen mark are difficult to read by oblique light.

b) The symbols in Sample B with a dot peen mark are difficult to read by coaxial light.

c)   The following test samples are arranged in the order of readability from the worst (left) to the best (right):

YE201, CL202, BL510

d)   The readability of a print with a 0,4 mm dot pitch is better than a print with a 0,5 mm dot pitch, suggesting that high print quality can be achieved using a 0,4 mm dot pitch

### 10.9.3   Evaluation results on Sample C

a)   The sample with the worst readability is CL202. This may be attributed to the hardness of the resin or to the colour used in the sample, but the reason cannot be explicitly answered.

b)   The result on Sample C confirms the results on Samples A and B.

c)   The samples BK901 and PUSPR are both readable with a laser printer or a dot peen marker.

# Annex A
## (informative)

# Example of serial numbers (SNs)

## A.1 Structured number as SN

This Annex describes the basic structure of Serial Numbers used for returnable transport items (RTIs).

Data that are given meaning by RTIs are considered to be part of the Serial Number (SN). In this case, one component would be called the Object Data (OD) and another component would be called the Object Sequence Number (OSN). The Object Data itself is composed of more than one attribute. The Serial Number is structured data consisted of two elements of an Object Data component and an Object Sequence Number.

## A.2 Example for a structured SN

In general, the allocating unit within individual companies independently, defined by the appropriate issuing agency controls the serial number. The issuing agency code and company identification numbers are assigned in compliance with ISO/IEC 15459, Parts 5, 3, and 2. However, most companies that have more than one production facility may control the RTIs at each of its facilities using different types of RTIs. Most RTIs are equipped with Partitions that must be controlled and managed as a combined set along with the associated returnable transport item.

The elements of the structured Serial Number are shown in Table A.1.

**Table A.1 — Possible elements that comprise a SN**

| Serial Number (SN) | | | |
|---|---|---|---|
| OD (Object Data) | | | OSN (Object Sequence Number) |
| FIC (Factory Identification Code) | KC (Kind Code) | PC (Partition Code) | |

A company is able to select the option not to use any or all of the FIC, KC and PC, as long as their serial numbers of the RTIs are guaranteed to be unique within the company's global operation.

### A.2.1 Factory Identification Code (FIC)

RTIs are controlled at each production site. A company with manufacturing facilities both at home and abroad, should uniquely identify each facility either through a unique Company Identification Number (CIN) for each site or by a Factory Identification Code (FIC) to independently track the RTIs. The FIC is recommended not to exceed 3 characters.

### A.2.2 Kind Code (KC)

Except for a few examples, using only one kind of RTI in the system, several types of RTIs are usually required for each factory to transport items. A code developed to identify the type of RTI is referred to as a Kind Code (KC). The KC length is recommended not to exceed 2 characters.

## A.2.3  Partition Code (PC)

Certain types of RTI have one or more partitions as part of its physical structure. The Partition Code (PC) is used to identify the type of those partitions. The length of the PC is recommended not to exceed 2 characters.

## A.2.4  Object Sequence Number (OSN)

The OSN is a number that, in combination with the OD, makes a serial number unique within a company's global operation. Thus the OSN is the solo number exclusively used within the same OD (FIC, KC and PC).

# Annex B
(informative)

# Example of structured data

## B.1 Example 1

Annex B describes the ordered structure of returnable transport items (RTIs).

Figure B.1 shows the structure in which a rolled steel material is loaded on the pallet. Figure B2 is the layered structure of Figure B.1, when marked as a transport unit and placed in-transit by a movement vehicle.
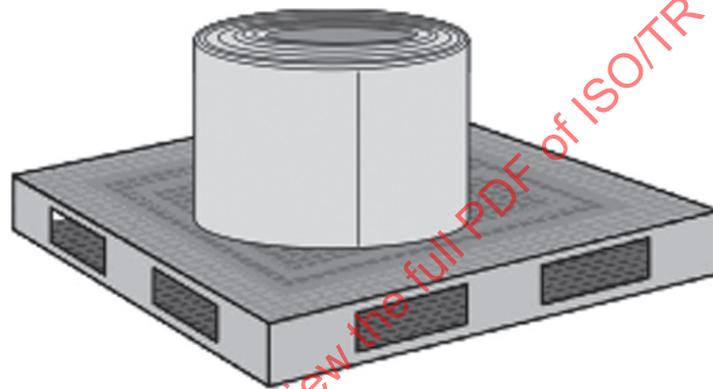


**Figure B.1 — Example 1**
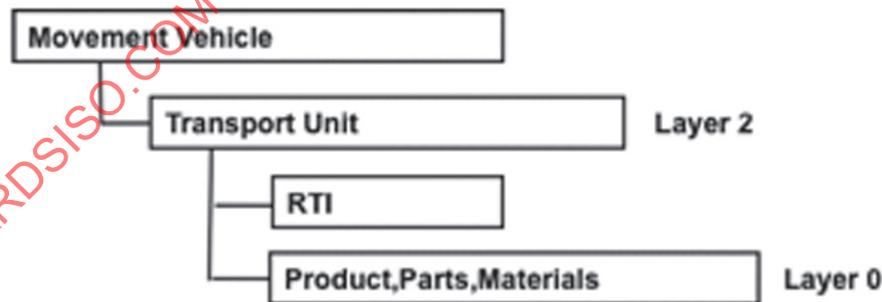


**Figure B.2 — Layered structure of Example 1**

## B.2 Example 2

Figure B.3 shows Example 2. Figure B.3 shows the structure carrying 12 components protected with 6-layered packing materials supported by the four posts placed at the corners.
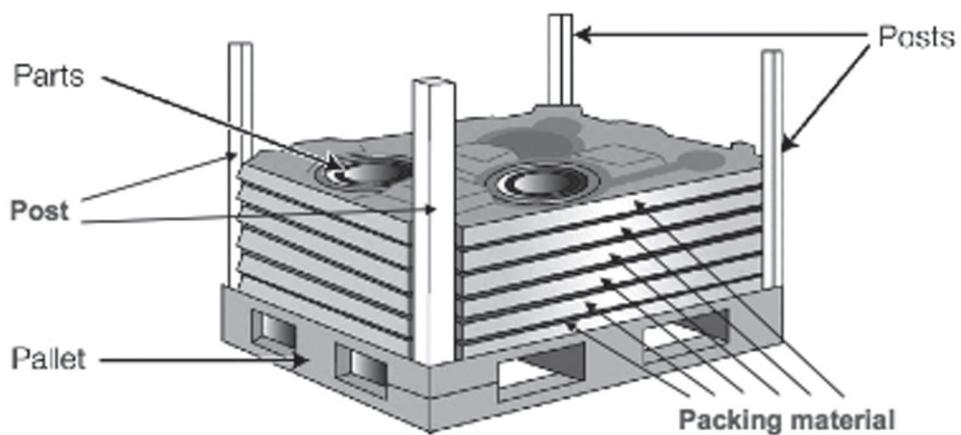
**Figure B.3 — Example 2**
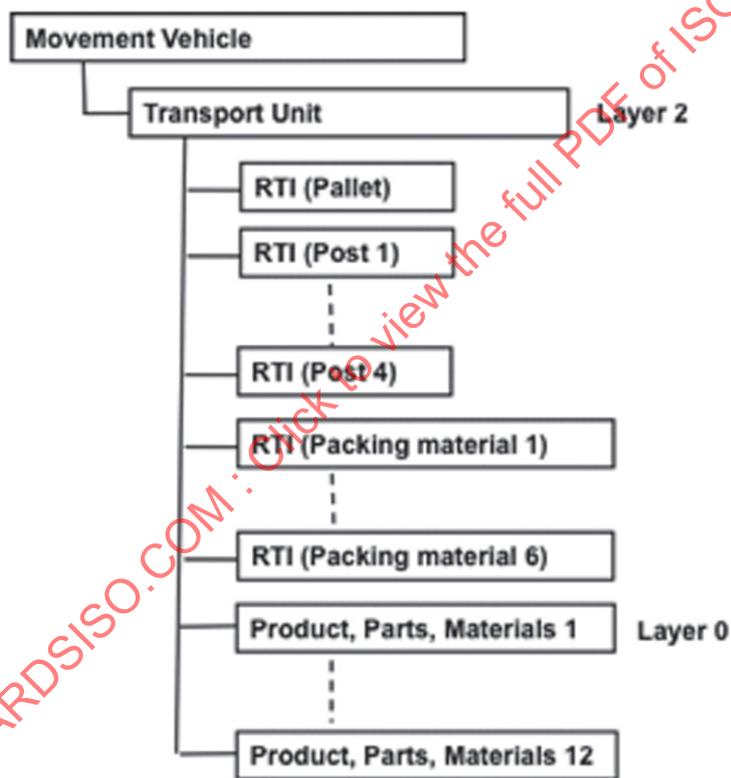


**Figure B.4 — Layered structure of Example 2**

# Annex C
## (informative)

# Specification of the hand-held scanner used to read DPM symbols

## C.1 Symbol specifications of the hand-held scanner used

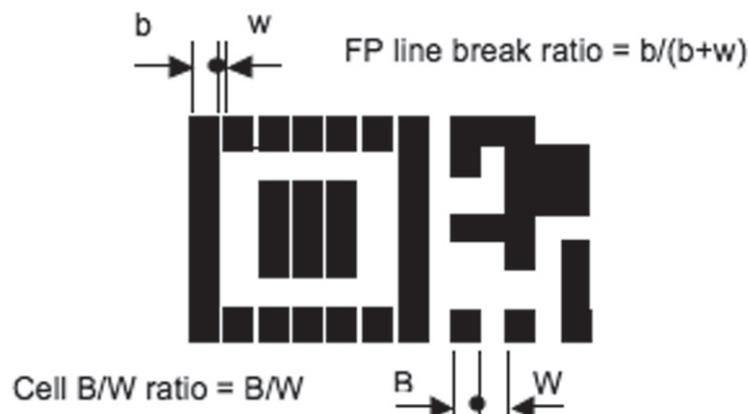Annex C describes the specifications for the hand-held scanner used to read DPM symbols.

Table C.1 shows the specifications of the symbols readable with the hand-held scanner used.

**Table C.1 — Symbol specifications of the hand-held scanner used**

| Item | Specification | |
|---|---|---|
| Light source | Red color (633 nm typ.) | |
| Symbol reflectance | Light module<br>Dark module<br>Reflectance difference of light/dark module | 0,45 min.<br>0,3 max.<br>0,3 min. |
| PCS value | $\dfrac{\left(\text{Light module reflectance}\right) - \left(\text{Dark module reflectance}\right)}{\text{Light module reflectance}} \geq 0,35$ | |
| Dark/light module ratio | $0,6 \leq \dfrac{\text{Dark module size}}{\text{Light module size}} \leq 1,8$ | |
| Gap ratio between dark modules | $0,5 \leq \dfrac{\text{Dark module size}}{\text{Dark module size} + \text{Gap ratio between dark modules}}$ | |

The PCS value and reflectance shall be measured with light sources having a spectral band of 610 to 650 nm and a peak of 633 nm.
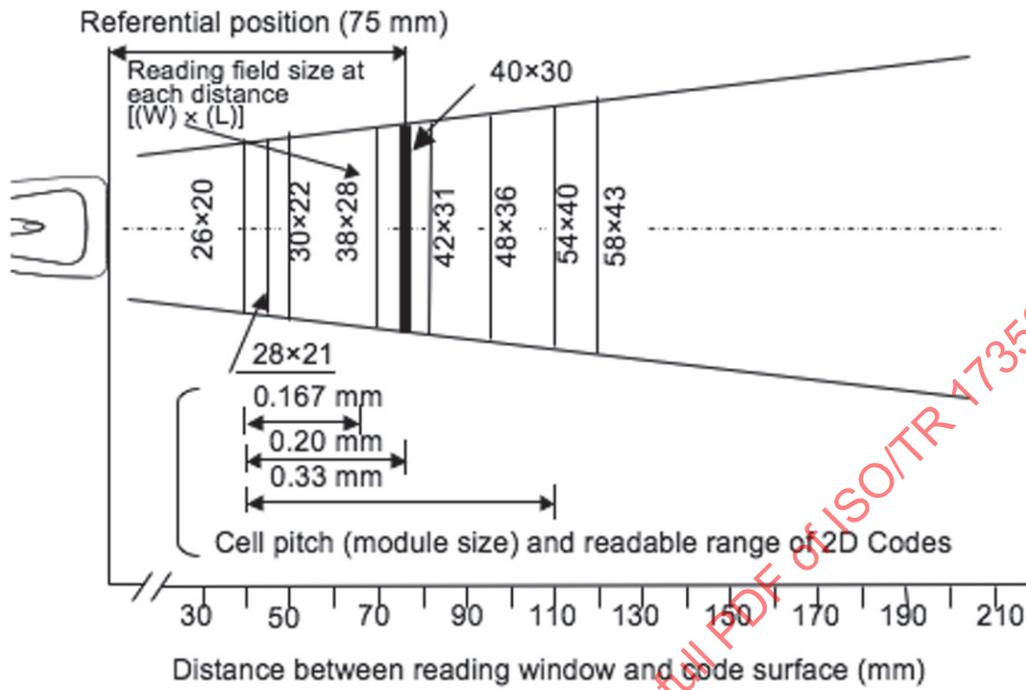
NOTE    Calculation of a dark/light module ratio and a gap ratio between dark modules conforms to Figure C.1.



**Figure C.1 — Calculation of dark/light module ratio and gap ratio between dark modules**

## C.2    Reading specifications of the hand-held scanner used

Table C.2 shows the specifications of the hand-held scanner used.



**Figure C.2 — Reading specifications of the hand-held scanner used**

## C.3    Outer dimensions of the hand-held scanner used

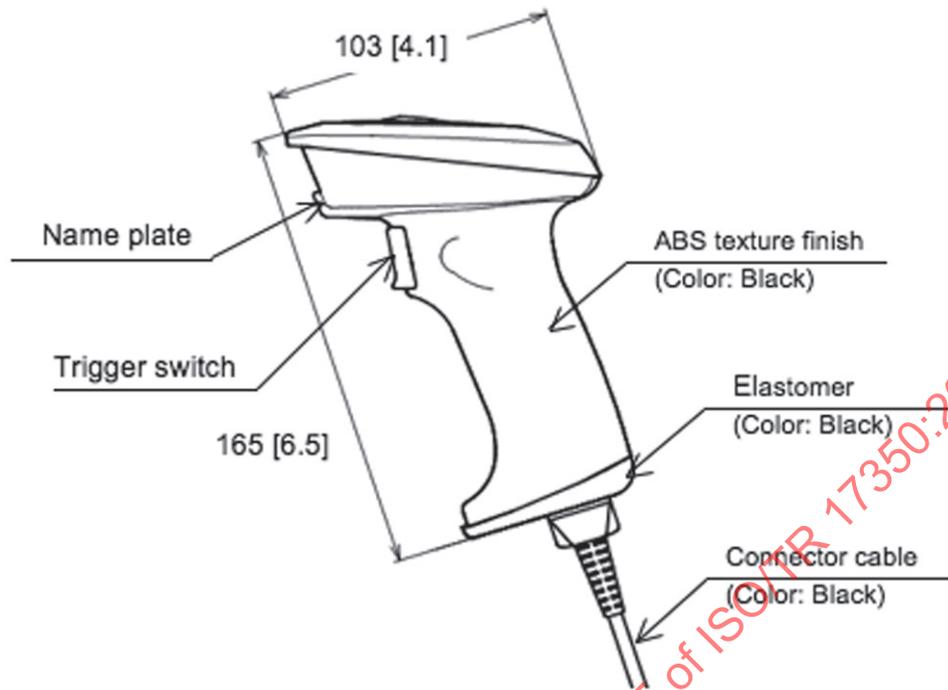Table C.3 shows the outer dimensions of the hand-held scanner used.

**Figure C.3 — Outer dimensions of the hand-held scanner used**

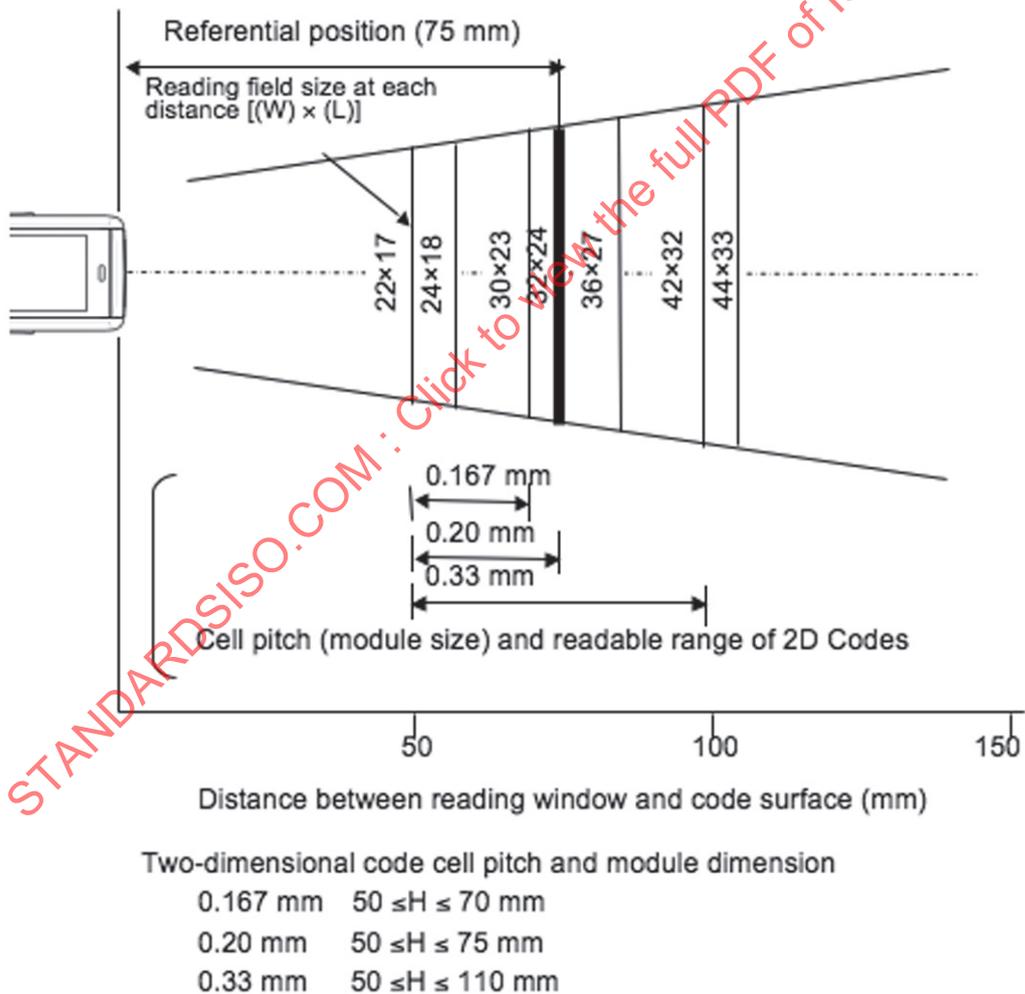# Annex D
## (informative)

# Specification of a hand-held terminal

## D.1 Symbol specifications of portable terminal

Annex D describes the specifications of a portable terminal.

The same reading specifications defined in Table C.1 in Annex C apply to the portable terminal.

## D.2 Reading specifications of a portable terminal

Figure D.1 shows the reading specifications of a hand-held terminal.



Figure D.1 — Reading specifications of a portable terminal

## D.3 Outer dimensions of a portable terminal

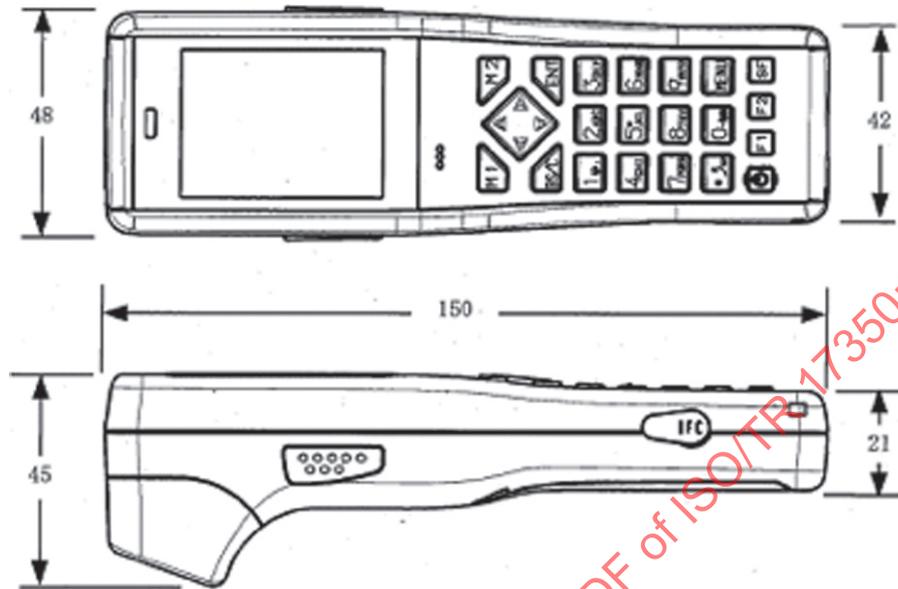Table D.2 shows the outer dimensions of a portable terminal.



**Figure D.2 — Outer dimensions of a portable terminal**

# Annex E
(informative)

# Specification of the fixed scanner used

## E.1 Symbol specifications of fixed scanner

Annex E describes the specifications of the fixed scanner used.

Table E.1 shows the specifications of the symbols readable with the fixed scanner used.

**Table E.1 — Symbol specifications of the fixed scanner used**

| Item | Specification | |
|------|------|------|
| Light source | Red color (633 nm typ.) | |
| Symbol reflectance | Light module<br>Dark module<br>Reflectance difference of light/dark module | 0,45 min.<br>0,3 max.<br>0,3 min. |
| PCS value | $$\frac{\left(\text{Light module reflectance}\right) - \left(\text{Dark module reflectance}\right)}{\text{Light module reflectance}} \geq 0,35$$ | |
| Dark/light module ratio | $$0,6 \leq \frac{\text{Dark module size}}{\text{Light module size}} \leq 1,8$$ | |
| Gap ratio between dark modules | $$0,5 \leq \frac{\text{Dark module size}}{\text{Dark module size} + \text{Gap ratio between dark modules}}$$ | |

The PCS value and reflectance shall be measured with light sources having a spectral band of 610 to 650 nm and a peak of 633 nm.

NOTE    Calculation of a dark/light module ratio and a gap ratio between dark modules conforms to Figure C.1.

## E.2 Camera specifications of the fixed scanner used

Table E.2 shows the camera specifications of the fixed scanner used.

**Table E.2 — Camera specifications of the fixed scanner used**

| Item | Specification |
|---|---|
| Type of structure | 1/3 model, progressive IT CCD camera |
| No. of effective pixels | 659 × 494 |
| Rated power | 12 VDC, 0,15A |
| Weight | 50 g |

## E.3 Structure of the fixed scanner used

Figure E.1 shows the structure of the fixed scanner used.
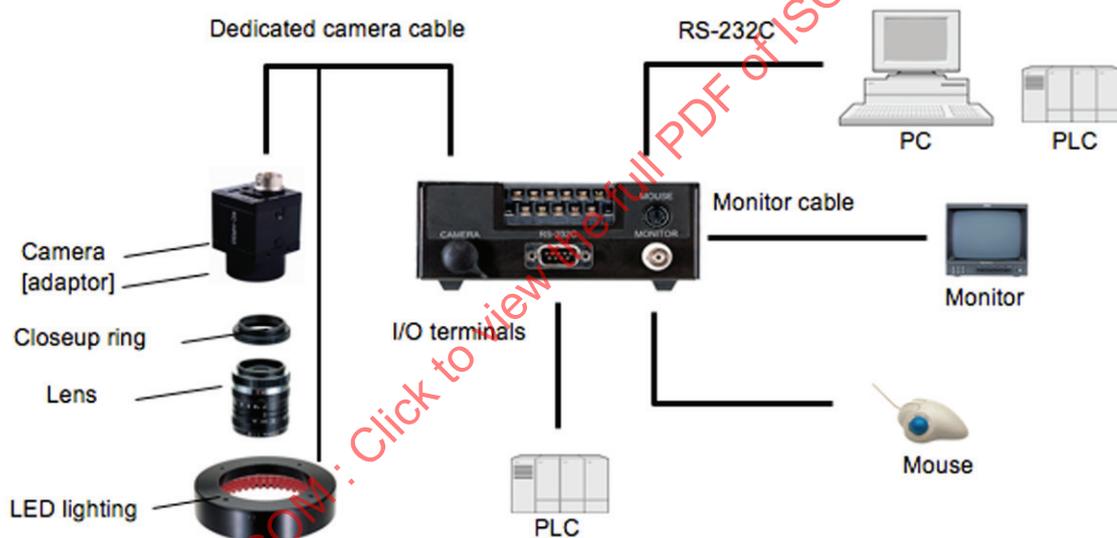


**Figure E.1 — Structure of fixed scanner**

# Annex F
## (informative)

# Specification of LED light for the fixed scanner used

## F.1   Red-coloured low angle light

### F.1.1   Specifications of a red-coloured low angle light

Annex F describes the specifications of LED light used for the fixed scanner used.

Table F.1 shows the specifications of red-coloured low angle light.

**Table F.1 — Specifications of red-coloured low angle light**

| Item | Specification |
|---|---|
| LED luminescent colour | Red |
| No. of LEDs | 90 units |
| Peak emission wavelength | 660 nm typ. |
| Input voltage | 12 VDC |
| Consumption power | 4,5 W max. |
| Case material | Aluminium alloy |
| Recommended height of light (distance) | 5 mm - 30 mm |

### F.1.2   Outer dimensions of a red-coloured low angle light

Figure F.1 shows the outer dimensions of red-coloured low angle light.



**Figure F.1 — Outer dimensions of red-coloured low angle light**

## F.2 Red-coloured shower light
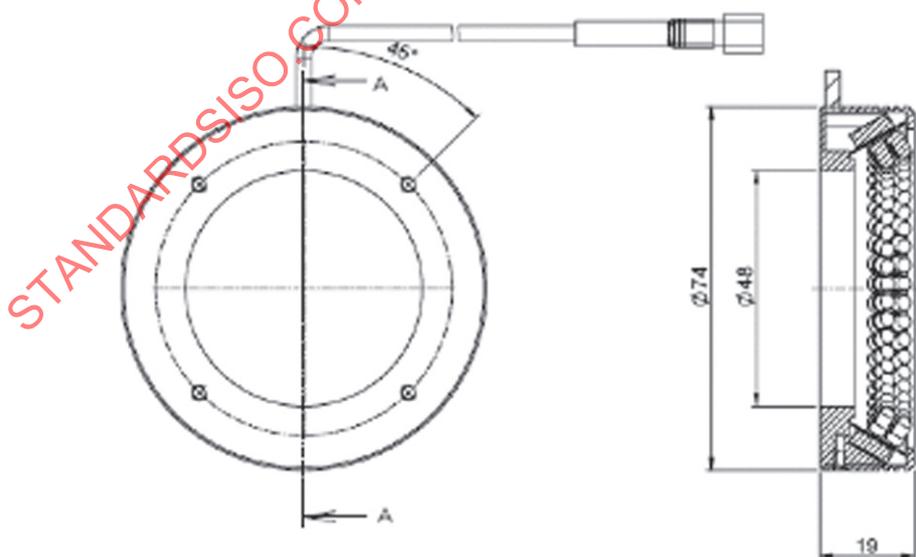
### F.2.1 Specifications of a red-coloured shower light

Table F.2 shows the specifications of a red-coloured shower light.

**Table F.2 — Specifications of red-coloured shower light**

| Item | Specification |
|------|---------------|
| LED luminescent colour | Red |
| No. of LEDs | 60 units |
| Peak emission wavelength | 660 nm typ. |
| Input voltage | 12 VDC |
| Consumption power | 3,0 W max. |
| Case material | Aluminium alloy |
| Recommended height of light (distance) | 40 mm - 100 mm |

### F.2.2 Outer dimensions of a red-coloured shower light

Figure F.2 shows the outer dimensions of red-coloured shower light.
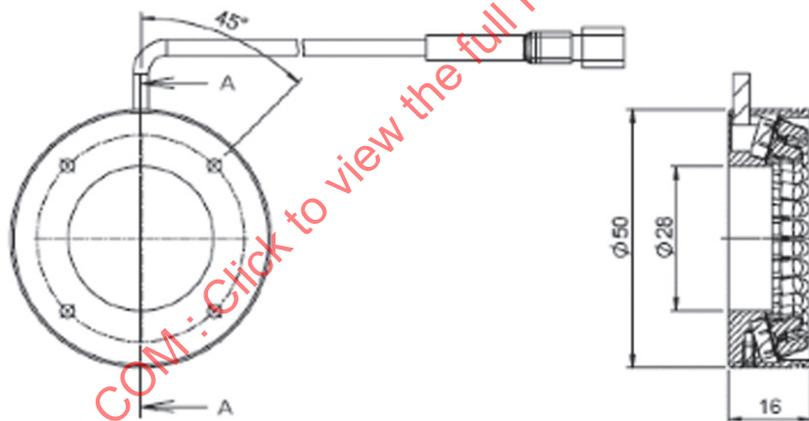


**Figure F.2 — Outer dimensions of a red-coloured shower light**

# Annex G
## (informative)

# Specification of the verifier used

## G.1 Structure of verifier

Annex G is a general description of the verifier used for Test 3. For more details on this verifier, refer to ISO/IEC TR 24720.
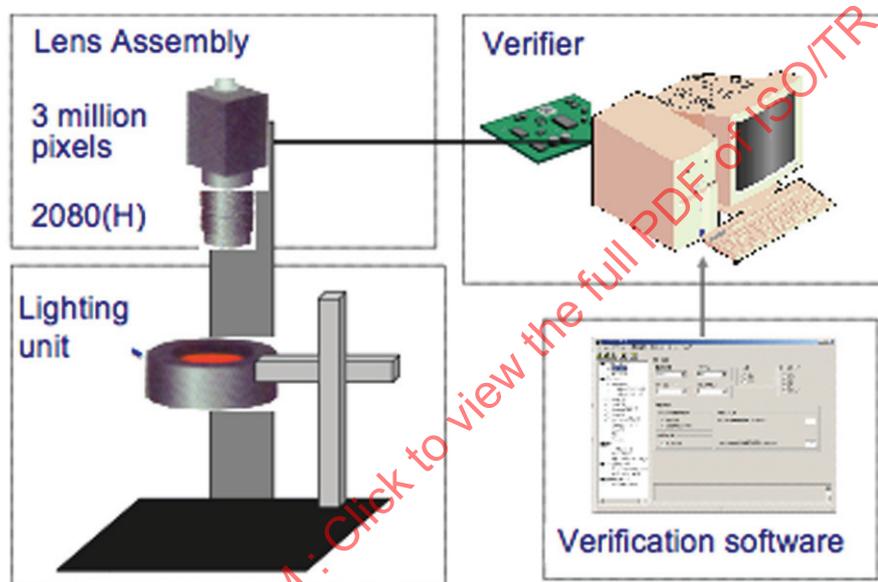
Figure G.1 shows the structure of this verifier.



**Figure G.1 — Structure of the verifier**

## G.2 Overall view of verifier

Figure G.2 shows the overall view of this verifier.
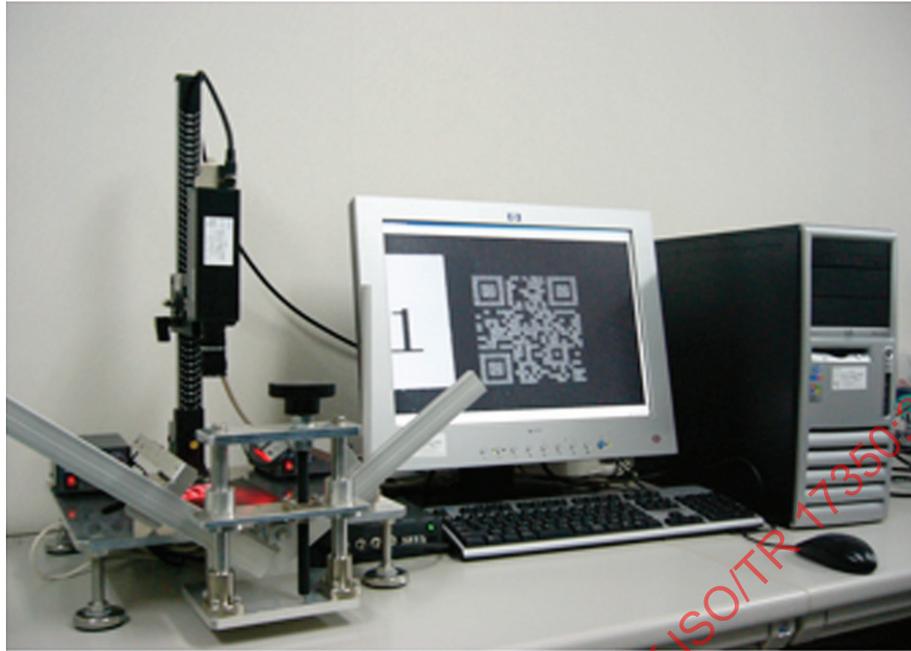
**Figure G.2 — Overall view of the verifier**

## G.3  Test items on verifier

Table G.1 shows the items to be tested using this verifier.

**Table G.1 — Test items by the verifier used**

| Item | Specification |
|---|---|
| Symbol contrast | Distributional analysis of contrast on all modules |
| Uniformity of axis | Comparison of the dimension x1 and x2 between the finder patterns |
| Timing pattern | Measurement of displacement among the timing patters |
| Disparity in marking | Measurement of gain/loss in the timing patterns. |
| Reference decoding | Reading enabled/disabled |
| Error correction use rate | Measurement of the error correction use rate as part of general characteristics. |

# Annex H
## (informative)

# Specification of LED light for the verifier used

## H.1  Red-coloured bar light

### H.1.1  Specifications of the red-coloured bar light used

Annex H describes the outline for the reader and the verifier used in Annex E and Annex G, respectively.

Table H.1 shows the specifications of red-coloured bar light.

Table H.1 — Specifications of the red-coloured bar light used

| Item | Specification |
|------|---------------|
| LED luminescent colour | Red |
| No. of LEDs | 30 units |
| Peak emission wavelength | 660 nm typ. |
| Input voltage | 12 VDC |
| Consumption power | 1,5 W max. |
| Case material | Polyacetal, SPCC |
| Recommended height of light (distance) | 15 mm - 60 mm |

### H.1.2  Outer dimensions of the red-coloured bar light used

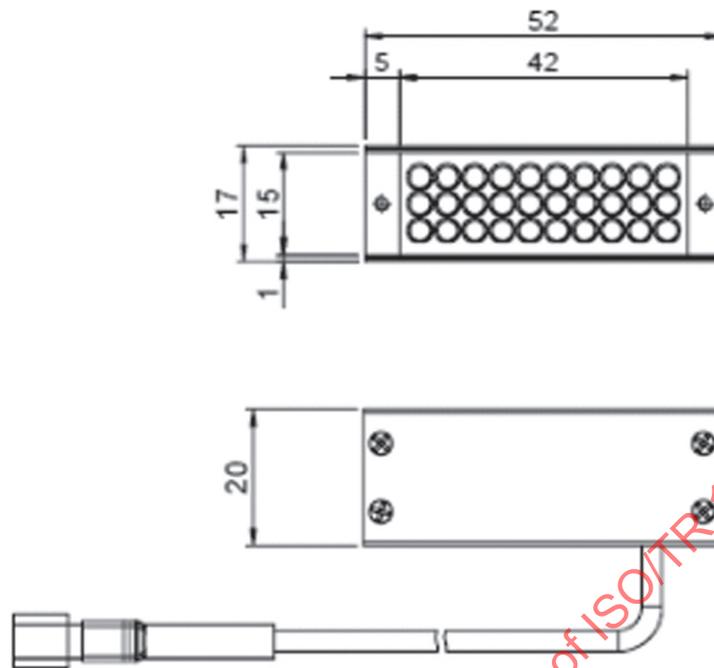Figure H.1 shows the outer dimensions of red-coloured bar light.

**Figure H.1 — Outer dimensions of the red-coloured bar light used**

## H.2 Red-coloured coaxial incident illumination

### H.2.1 Specifications of a red-coloured coaxial incident illumination

Table H.2 shows the specifications of red-coloured coaxial incident illumination.

**Table H.2 — Specifications of red-coloured coaxial incident illumination**

| Item | Specification |
|---|---|
| LED luminescent colour | Red |
| No. of LEDs | 90 units |
| Peak emission wavelength | 660 nm typ. |
| Input voltage | 12 VDC |
| Consumption power | 6,6 W max. |
| Case material | Aluminium alloy, acrylic, polyacetal |
| Recommended height of light (distance) | 20 mm - 120 mm |

### H.2.2 Outer dimensions of a red-coloured coaxial incident illumination

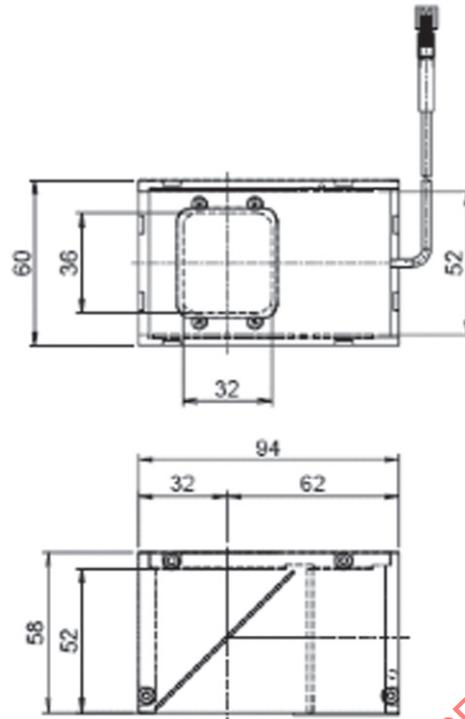Figure H.2 shows the outer dimensions of red-coloured coaxial incident illumination.

**Figure H.2 — Outer dimensions of a red-coloured coaxial incident illumination**

# Annex I
## (informative)

# Specification of the FAYb laser used

## I.1   Specifications

Annex I describes the specifications of the FAYb laser used.

Table I.1 shows the general specifications of the FAYb laser used.

Table I.1 — General specifications of the FAYb laser used

| Item | | Specification |
|---|---|---|
| Power voltage | | 100 to 120 VAC ± 10 % or 200 to 240 VAC ± 10 % (auto switching)<br>50/60 Hz frequency |
| Consumption power | | 390 VA (100 VAC), 420 VA (200 VAC) |
| Power supply for external device | Rating | +12VDC 300mA max. (isolated source) |
| I/O connector | Input form | Bidirectional photo-coupler (isolated input) |
| | Rated input voltage | +12 to +24 VDC |
| | Output form | Photo-coupler (isolated output) |
| | Protection function for short circuit | None |
| | Max. output current | 20 mA (current lead-in) |
| | Residual voltage | +2,0 VDC or less |
| | Max. applied voltage | +30 VDC |
| Serial communication | Communication form | Conforming to EIA-RS-232C standard (9 pin PC/AT)<br>Return connector: For console<br>RS-232C connector: For external control. |
| Interface | | VGA port (rear), PS2 mouse port (rear)<br>USB connector A (front) and USB connector B (front) |

## I.2   Laser specifications

Table I.2 shows the specifications of laser part.

<p align="center">**Table I.2 — Laser specifications**</p>

| | | |
|---|---|---|
| Marking laser | | Yb: Fibre laser, λ = 1060 nm |
| | Laser oscillator | Ave. output: 12 W, pulse oscillation |
| | Max. output | 15 W |
| | Laser pulse cycle | 10 to 50 μs |
| Pumping LD lifetime | | 30 000 hours (Expected value) |
| Guide laser | | Red semiconductor laser, λ = 655 nm Class II |
| | Max. output | 1 mW |
| LD pointer | | Red semiconductor laser, λ = 655 nm Class II |
| | Max. output | 1 mW |
| Laser class | | Class IV |
| Scanning method | | Galvanoscanning method |
| Spot forming method | | F θ lens |
| Spot diameter | | Φ 60 μm (theory value) |

## I.3 Other specifications

Table I.3 shows other specifications.

<p align="center">**Table I.3 — Other specifications**</p>

| | |
|---|---|
| Marking area | 90 mm × 90 mm |
| Scan speed | Max.12,000 mm/sec |
| Marking speed | 700 characters/sec<br>Marking condition: When 1 mm x 1 mm alphanumeric character is marked. |
| Moving speed of flying object | 240 m/min or slower |
| Laser pumping time | Approx. 20 sec |
| Cooling method | Forcible-cooling for both controller and head |
| Weight | Controller: Approx. 22 kg<br>Head: Approx. 9 kg |

## I.4 Appearance

Figure I.1 shows the appearance of FAYb laser.

**Figure I.1 — Appearance**

# Annex J
(informative)

# Specifications of a CO$_2$ laser

## J.1 General specifications

Annex J describes the specifications of CO$_2$ laser

Table J.1 shows the general specifications of a CO$_2$ laser.

**Table J.1 — General specifications of CO$_2$ laser**

| Item | | Specification |
|---|---|---|
| Power voltage | | 90 to 132 VAC or 180 to 246 VAC (auto switching) <br> 50/60 Hz frequency |
| Consumption power | | 1000 VA (100 VAC), 1200 VA (200 VAC) |
| Power supply for external device | Rating | +12VDC 300mA max. (isolated source) |
| I/O connector | Input form | Bidirectional photo-coupler (isolated input) |
| | Rated input voltage | +12 to +24 VDC |
| | Output form | Photo-coupler (isolated output) |
| | Protection function for short circuit | None |
| | Max. output current | 20 mA (current lead-in/lead-out) |
| | Residual voltage | +2,0 VDC or less |
| | Max. applied voltage | +30 VDC |
| Serial communication | Communication form | Conforming to EIA-RS-232C standard (9 pin PC/AT) <br> Return connector: For console <br> RS-232C connector: For external control. |
| Interface | | VGA port (rear), PS2 mouse port (rear) <br> USB connector A (front) and USB connector B (front) |

## J.2 Laser specifications

Table J.2 shows the general specifications of the laser lightsource.

**Table J.2 — Laser specifications**

| Marking laser | | $CO_2$ laser, $\lambda$ = 10.6µm |
|---|---|---|
| | Laser oscillator | Ave. output: 30 W |
| | Max. output | 75 W |
| Output stability | | ±3 % typ. (Laser power 20 or large, and in 10 min after start-up) |
| Guide laser | | Red semiconductor laser, $\lambda$ = 655 nm Class II |
| | Max. output | 1 mW |
| LD pointer | | Red semiconductor laser, $\lambda$ = 655 nm Class II |
| | Max. output | 1 mW |
| Laser class | | Class IV |
| Scanning method | | Galvanoscanning method |
| Spot forming method | | F $\theta$ lens (ZnSe) |
| Spot diameter | | $\Phi$ 185 µm |

## J.3   Other specifications

Table J.3 shows other specifications.

**Table J.3 — Other specifications**

| Marking area | 110 mm × 110 mm |
|---|---|
| Scan speed | Max.12,000 mm/sec |
| Marking speed | 700 characters/sec<br>Marking condition:<br>When 1 mm x 1 mm alphanumeric character is marked. |
| **Moving speed of flying object** | **240 m/min or slower** |
| **System start-up time** | **Approx. 60 sec** |
| Laser pumping time | Approx. 15 sec |
| Cooling method | Forcible-cooling for both controller and head |
| Weight | Controller: Approx. 12 kg Head: Approx. 20 kg |

## J.4   Appearance

shows the appearance of $CO_2$ laser.



**Figure J.1 — Appearance**