TECHNICAL REPORT

ISO/TR 17350

First edition
2013-06-15

Direct Marking on Plastic Returnable Transport Items (RTIs)

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

Reference number
ISO/TR 17350:2013(E)

Contents

Page

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:

Annex A — Example of serial numbers (SNs)

Annex B — Example of structured data

Annex C — Specification of hand-held scanner

Annex D — Specification of hand-held terminal

Annex E — Specification of fixed scanner

Annex F — Specification of LED light for fixed scanner

Annex G — Specification of verifier

Annex H — Specification of LED light for verifier

Annex I — Specification of FAYb laser

Annex J — Specification of CO2 laser

Annex K — Specification of dot peen maker

Annex L — Types of LED light

Annex M — Evaluation results on samples A

Annex N — Evaluation results on samples B

Annex O — Evaluation results on samples C

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.

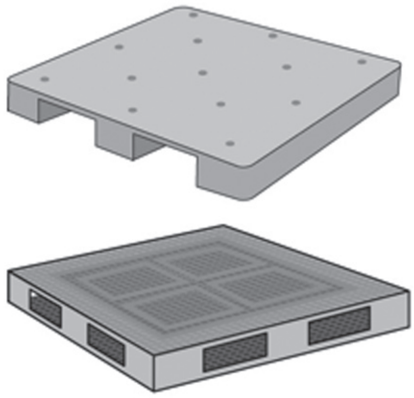


Figure 1 — Plate pallets

Figure 2 — Roll box pallet

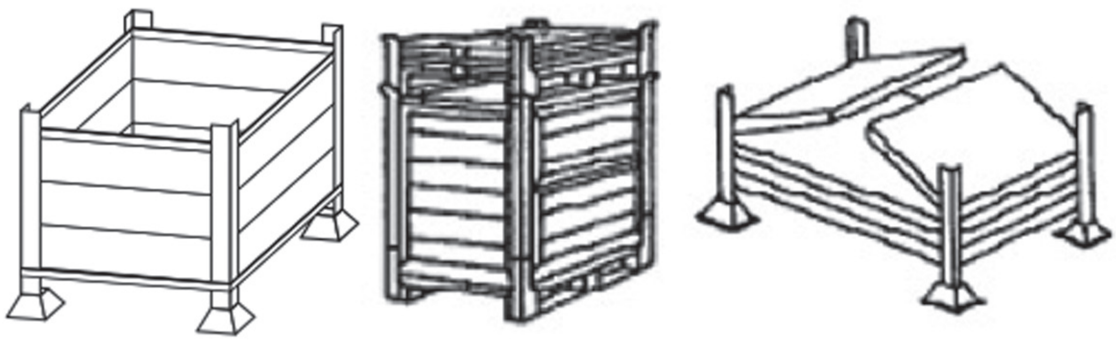


Figure 3 — Box pallets

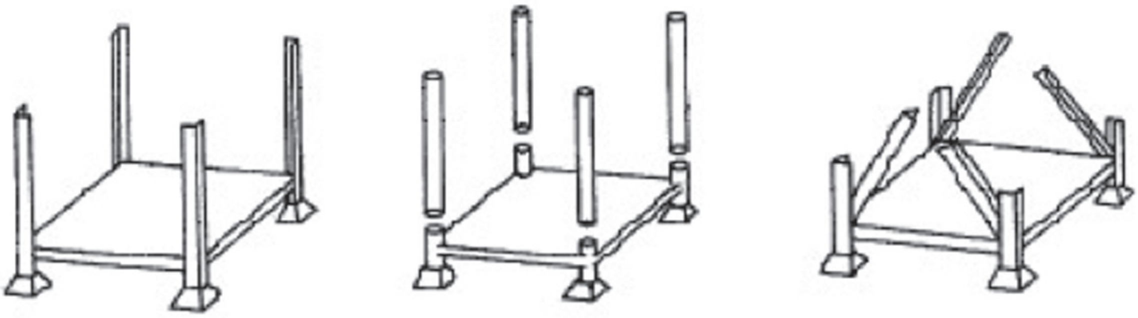


Figure 4 — Post pallets

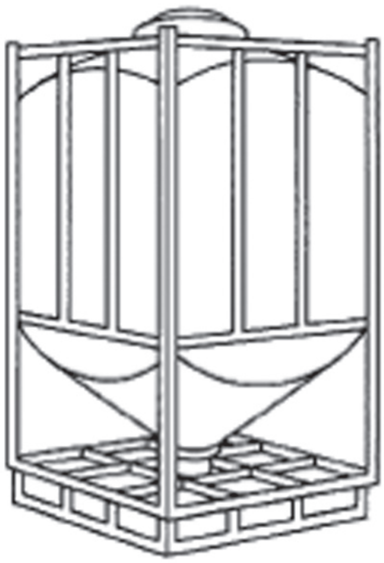


Figure 5 — Silo pallet

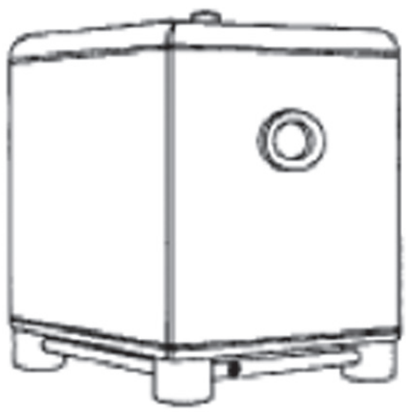


Figure 6 — Tank pallet

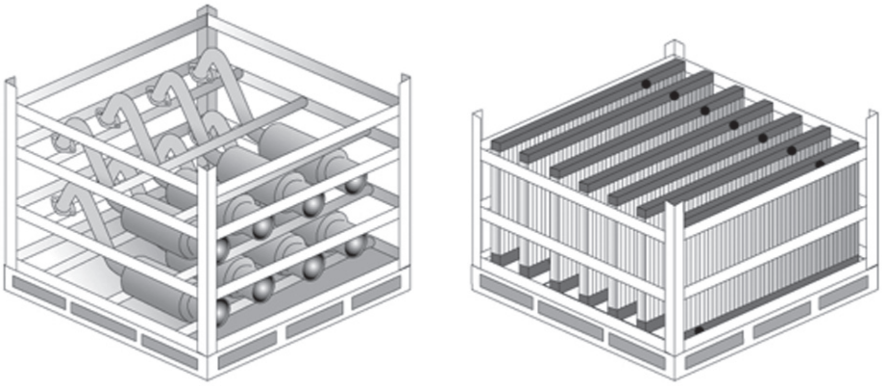


Figure 7 — Special pallets

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.

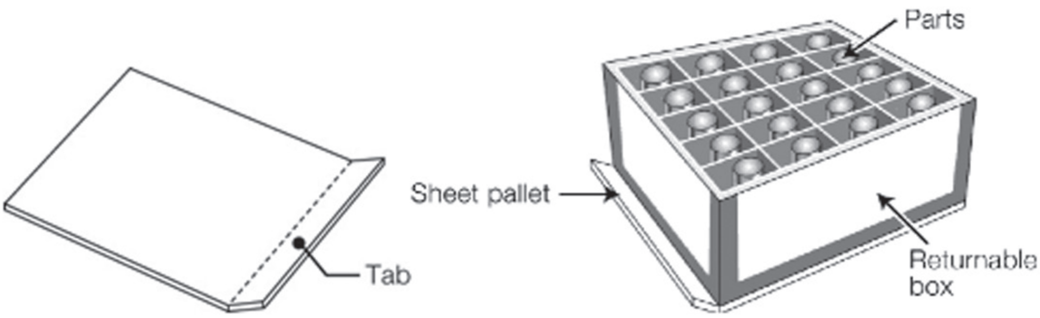


Figure 8 — Sheet pallets

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.

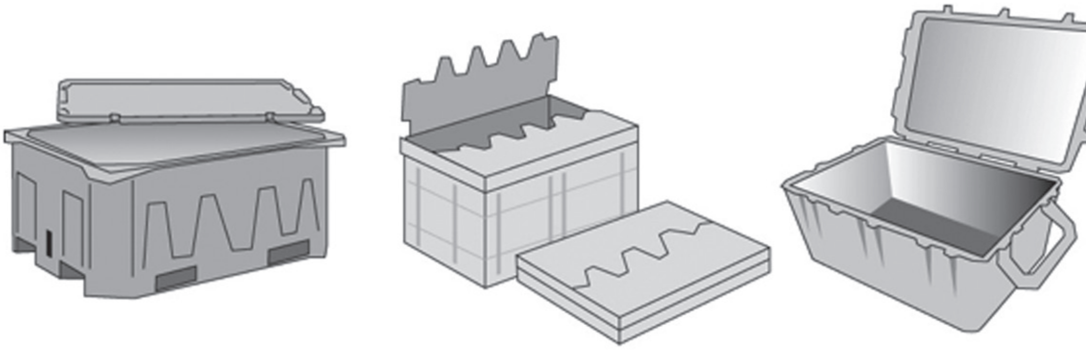


Figure 9 — Large-sized returnable transport items

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 absolvers
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.

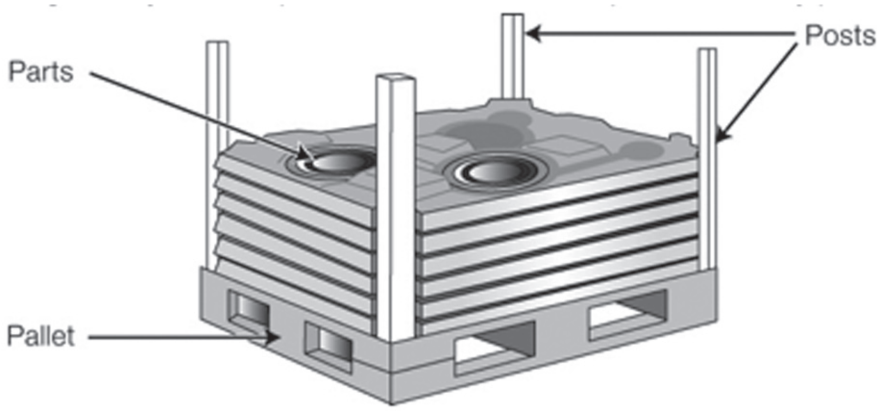


Figure 12 — Post

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.)

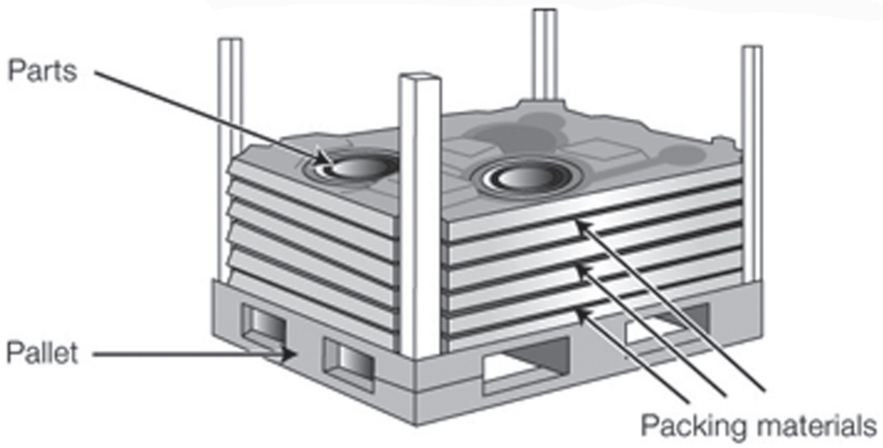


Figure 13 — Packing material

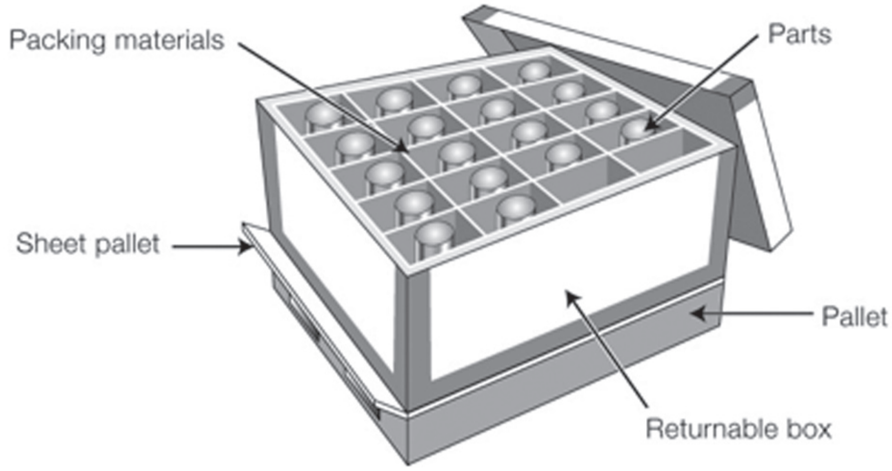


Figure 14 — Packing material

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.

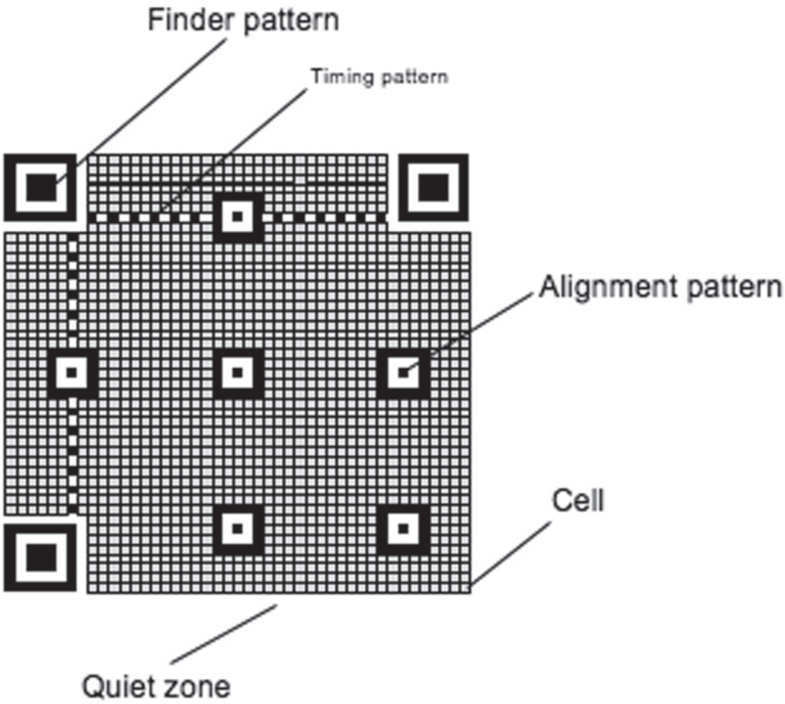


Figure 15 — Structure of QR Code symbol

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.

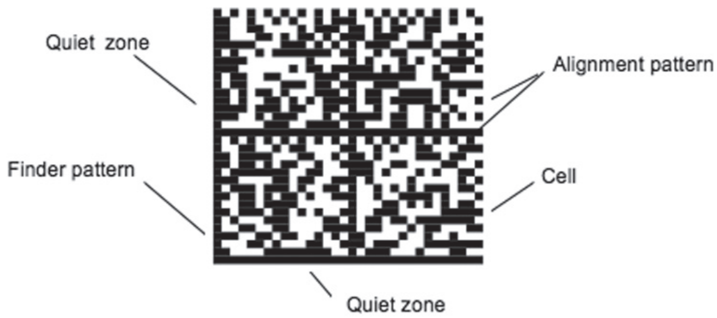


Figure 16 — Structure of Data Matrix ECC200 Symbol

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

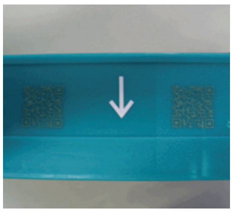
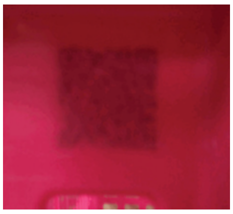
The readability of the QR Code symbol was evaluated using both a hand-held scanner (see Annex C) and a portable terminal (see Annex D). The readability of the QR Code symbol direct marked on an object varies depending on the lighting angle. In this test, a hand-held reader that supports direct marking 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	Green	60	0	75	0
GRSCR		98	1	72	0
GR603		83	36	96	0
BLBF4	Blue	42	18	0	0
BL510		62	14	0	0
BL503		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

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

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

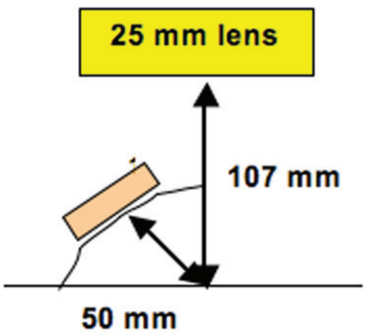


Figure 25 — Evaluation Method 1

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

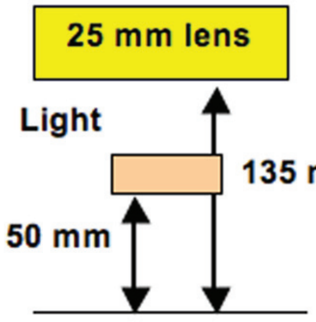


Figure 26 — Evaluation Method 2

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.

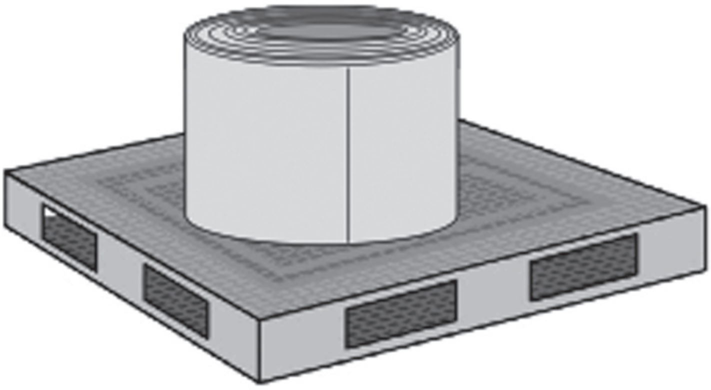


Figure B.1 — Example 1

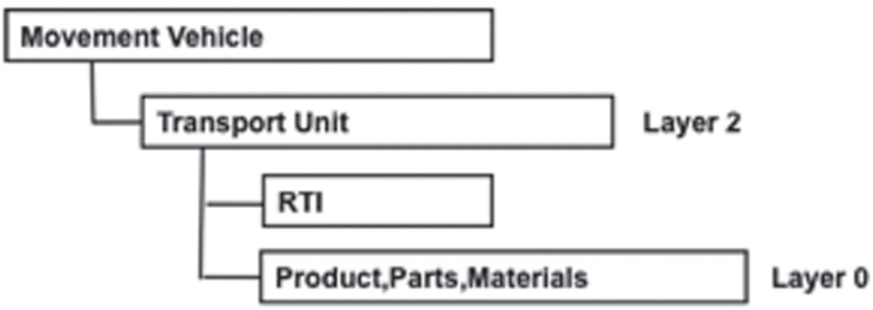


Figure B.2 — Layered structure of Example 1

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.

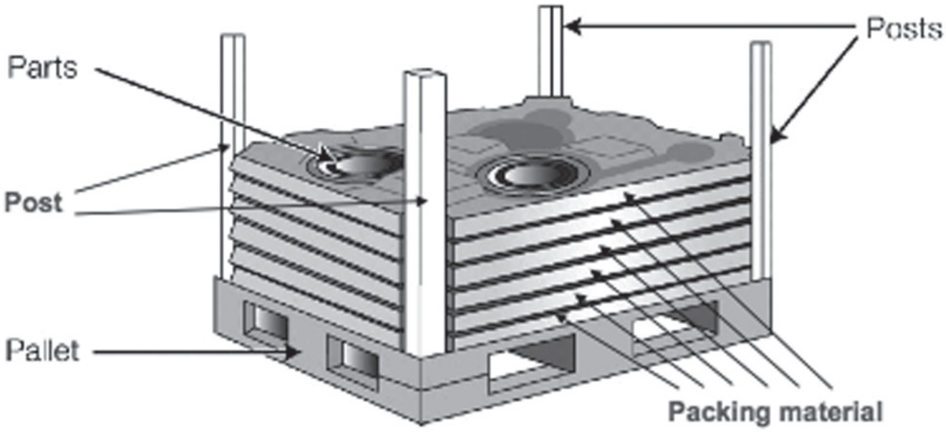


Figure B.3 — Example 2

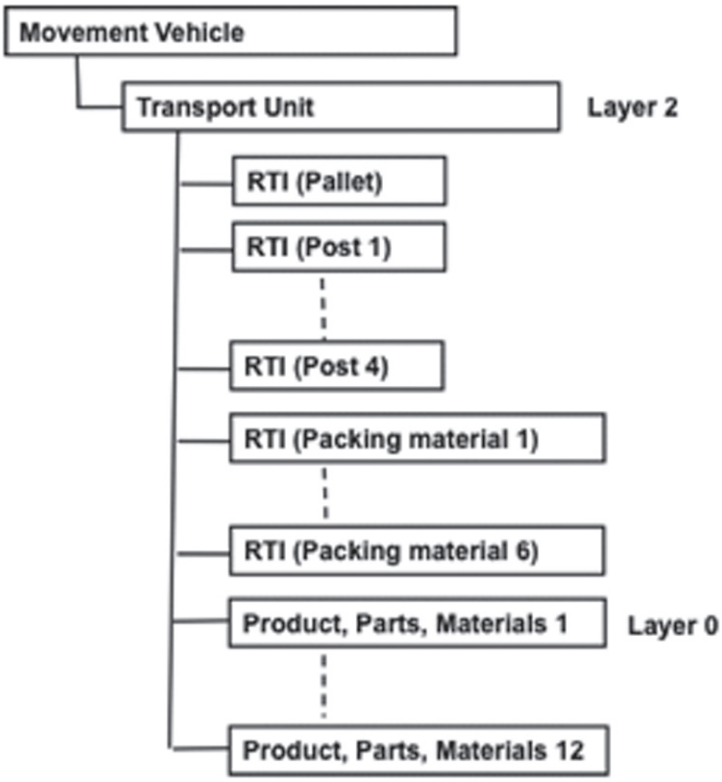


Figure B.4 — Layered structure of Example 2

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 Dark module Reflectance difference of light/dark module	0,45 min. 0,3 max. 0,3 min.
PCS value	$\frac{(\text{Light module reflectance}) - (\text{Dark module reflectance})}{\text{Light module reflectance}} \geq 0{,}35$	
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.

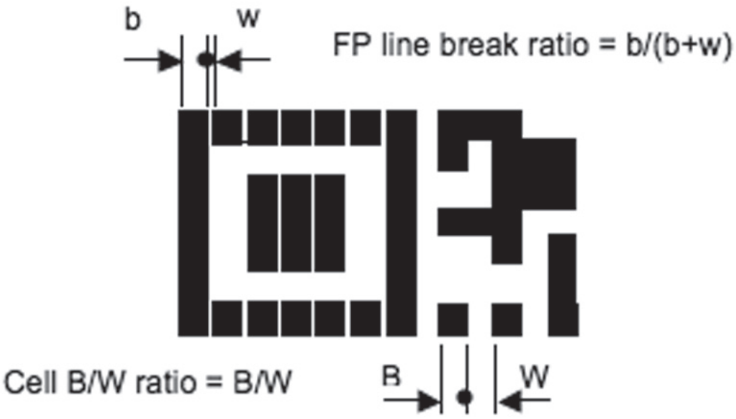


Figure C.1 — Calculation of dark/light module ratio and gap ratio between dark modules

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

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

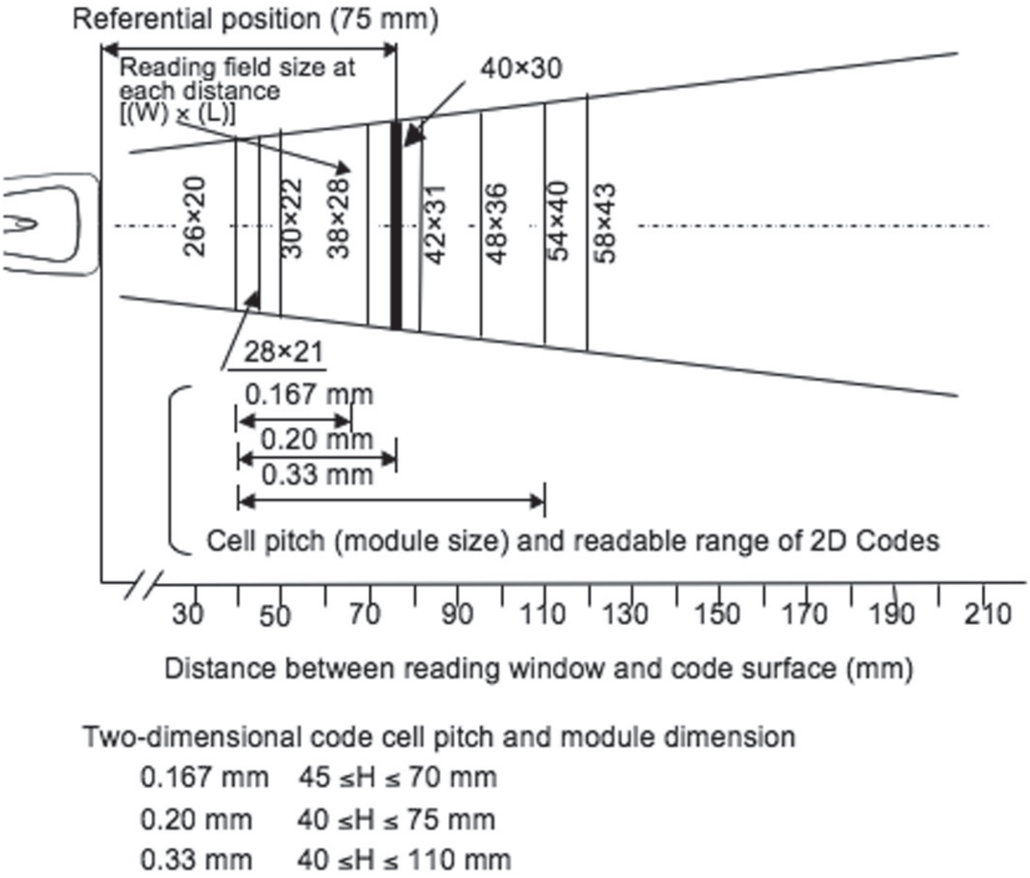


Figure C.2 — Reading specifications of the hand-held scanner used

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

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

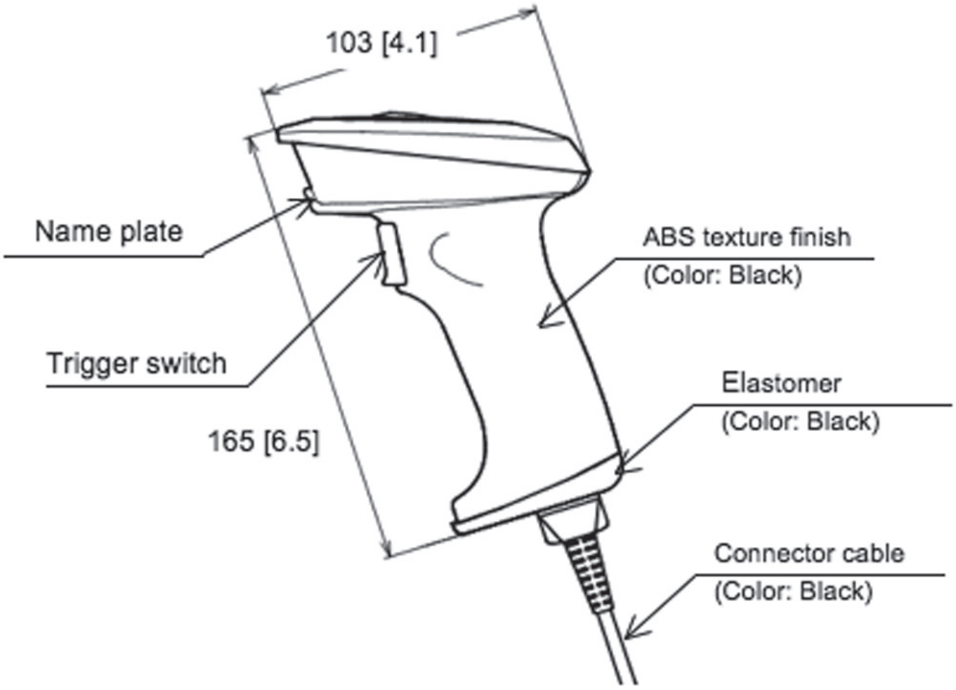


Figure C.3 — Outer dimensions of the hand-held scanner used

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.

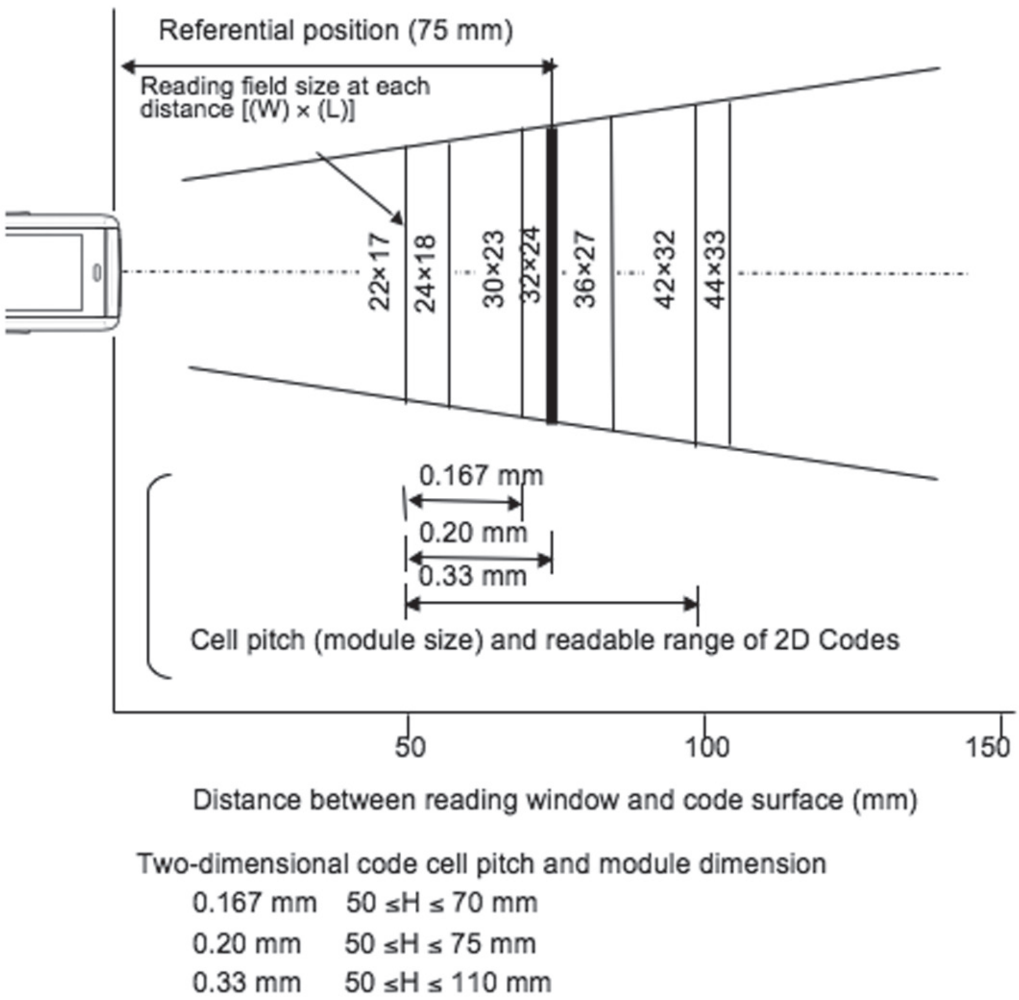


Figure D.1 — Reading specifications of a portable terminal

D.3 Outer dimensions of a portable terminal

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

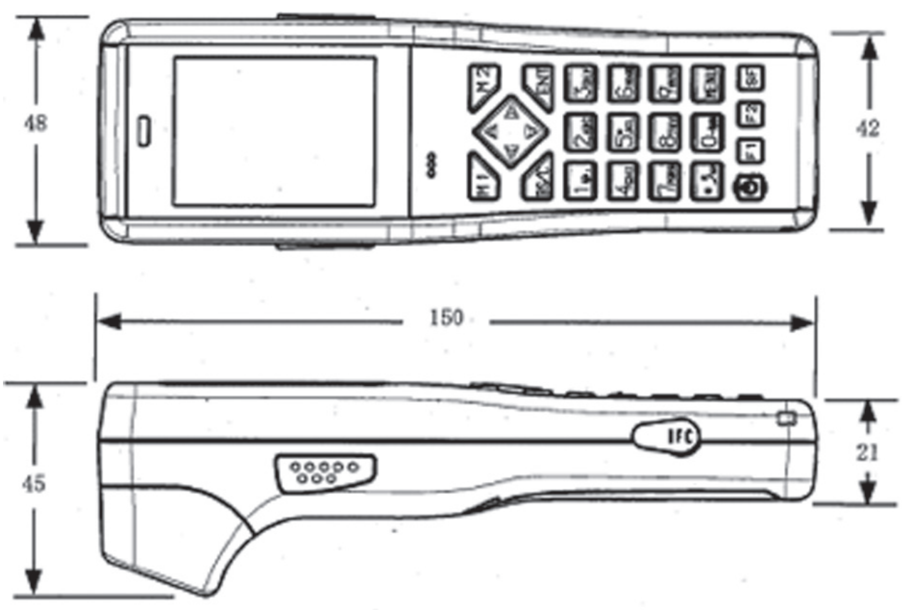


Figure D.2 — Outer dimensions of a portable terminal

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 Dark module Reflectance difference of light/dark module	0,45 min. 0,3 max. 0,3 min.
PCS value	$\frac{(\text{Light module reflectance}) - (\text{Dark module reflectance})}{\text{Light module reflectance}} \geq 0,35$	
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.

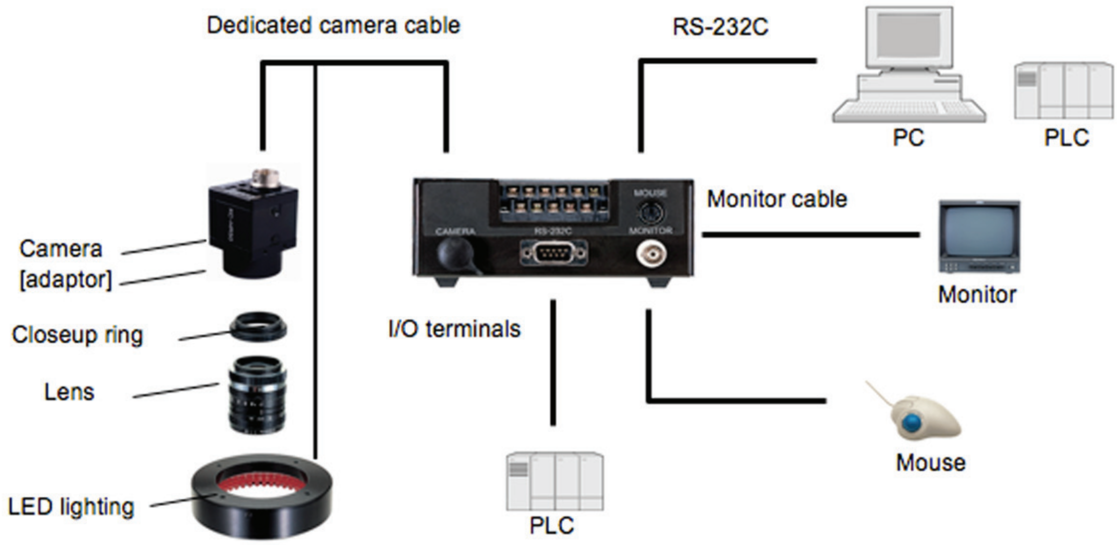


Figure E.1 — Structure of fixed scanner

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.

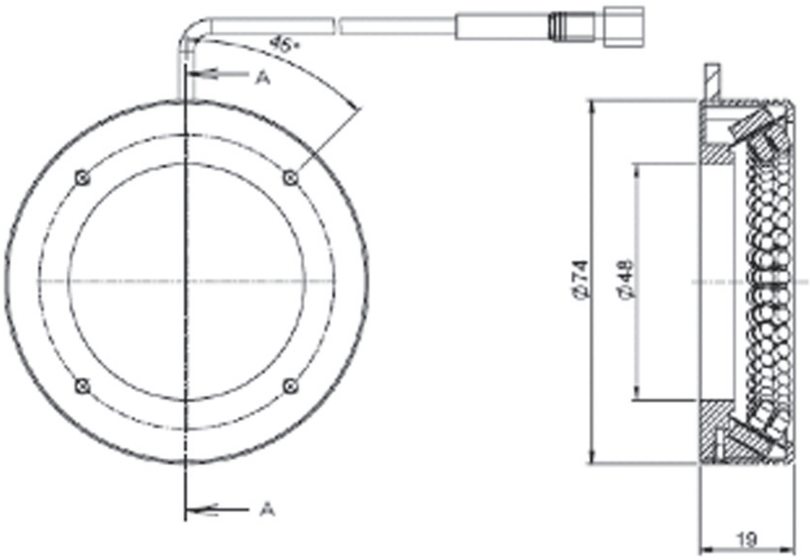


Figure F.1 — Outer dimensions of red-coloured low angle light

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.

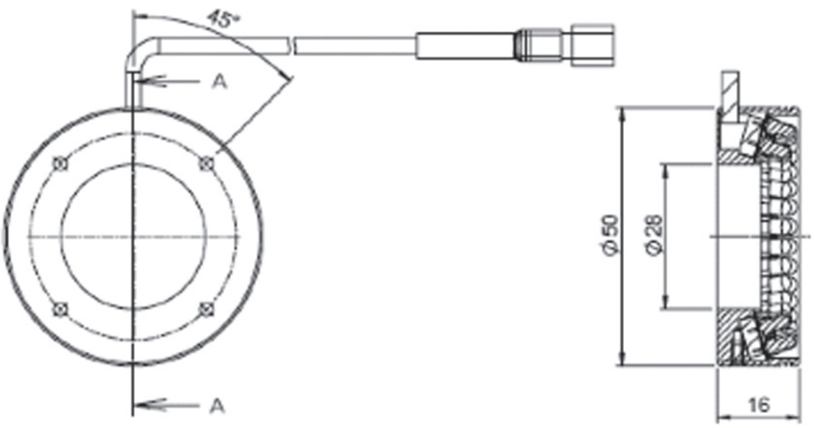


Figure F.2 — Outer dimensions of a red-coloured shower light

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.

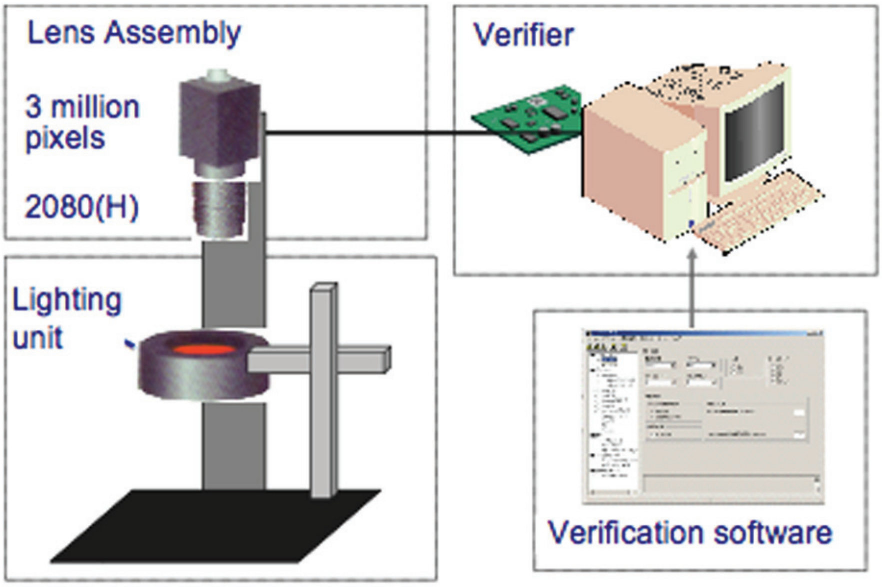


Figure G.1 — Structure of the verifier

G.2 Overall view of verifier

Figure G.2 shows the overall view of this verifier.

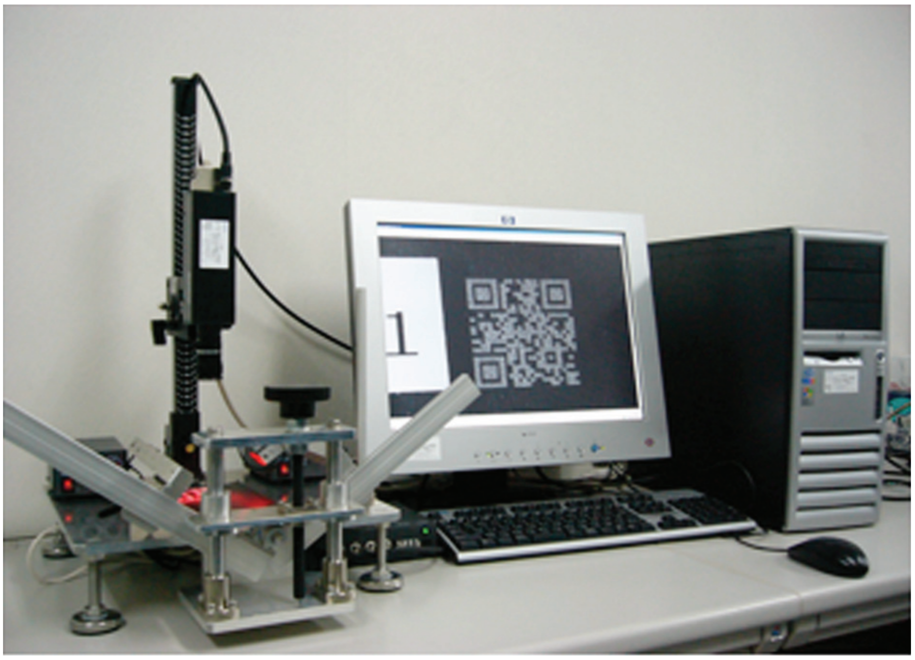


Figure G.2 — Overall view of the verifier

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.

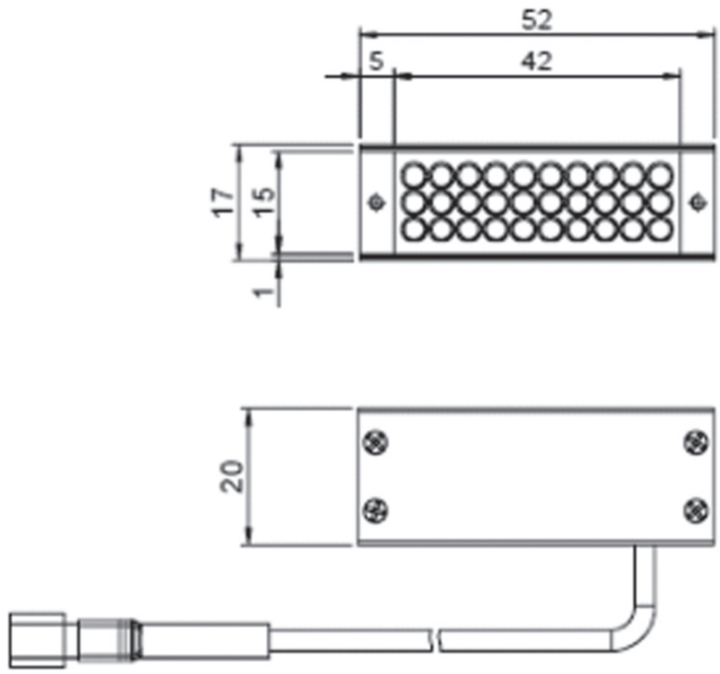


Figure H.1 — Outer dimensions of the red-coloured bar light used

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.

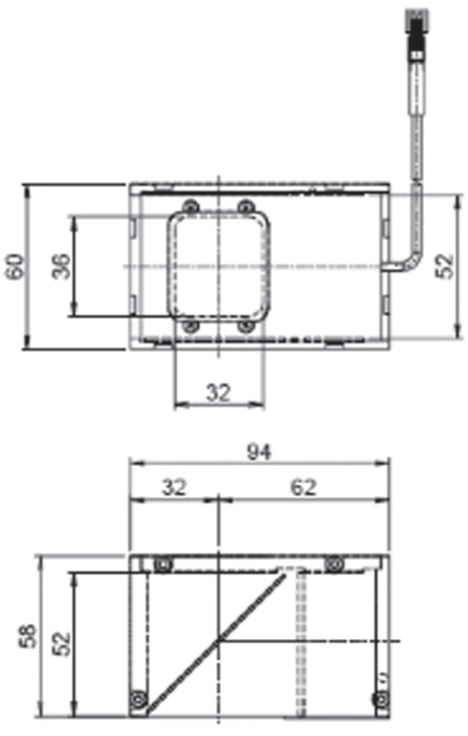


Figure H.2 — Outer dimensions of a red-coloured coaxial incident illumination

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) 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) Return connector: For console RS-232C connector: For external control.
Interface		VGA port (rear), PS2 mouse port (rear) USB connector A (front) and USB connector B (front)

I.2 Laser specifications

Table I.2 shows the specifications of laser part.

Table I.2 — Laser specifications

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.

Table I.3 — Other specifications

Marking area	90 mm × 90 mm
Scan speed	Max.12,000 mm/sec
Marking speed	700 characters/sec 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 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) 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) Return connector: For console RS-232C connector: For external control.
Interface		VGA port (rear), PS2 mouse port (rear) 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, λ = 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, 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 (ZnSe)
Spot diameter		*Φ* 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 Marking condition: 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

Figure J.1 shows the appearance of CO_2 laser.

Figure J.1 — Appearance

Annex K
(informative)

Specification of a dot peen marker

K.1 Specifications

Annex K describes the specifications of a dot peen marker.

Table K.1 shows the specifications of a dot peen marker.

Table K.1 — Specifications of a dot peen marker

Marking area	80 mm (X) × 30 mm (Y)	
Z-axis stroke	10 mm (Marking area: 6 mm)	
Materials	Ion, aluminium and copper plus their alloy, stainless, hard plastic, etc.	
Marking time	2.2 characters/sec (Character A, size 5 mm)	
Marking characters	Up to 80 types, including alphanumeric and special symbols	
Character size	2 to 30 mm (0.5 step)	
Font	Square, oblong, dot characters	
Character length	1 to 36 characters	
Supported 2D symbols	Data Matrix, QR Code, MicroQR Code	
Symbol size	Data Matrix	10 ×10 to 72 × 72 dots
	QR Code	21 × 21 to 69 × 69 dots
	MicroQR Code	11 × 11 to 17 × 17 dots
Max. No. of characters (for alphanumeric)	Data Matrix	912 characters
	QR Code	1022 characters
2D symbol marking time	Data Matrix	2,2 sec (6-digit number)
	QR Code	9,2 sec (6-digit number)
Dot pitch	0,2 to 1,5 mm, 0,025 pitch (Can be set according to the object)	
Mounted control interface	Parallel interface, serial interface (RS-232C)	
Power source	100 to 230 VAC, 50/60 Hz, 200 VA	
Air pressure source	0,3 MPa or more, 30 L/min (A,N.R)	
Size (W × H × D)	Mechanical part: Approx. 207 × 215 × 185 mm	
	Control part: Approx. 285 × 273 × 261 mm	
Weight	Mechanical part:: Approx. 7 kg	
	Control part: Approx. 9 kg	

K.2 Appearance

Figure K.1 shows the appearance of a dot peen marker.

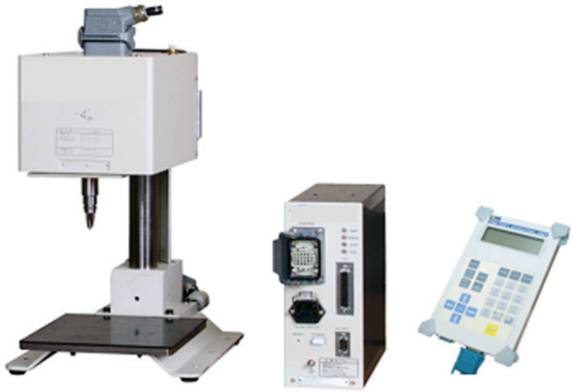


Figure K.1 — Appearance

Annex L
(informative)

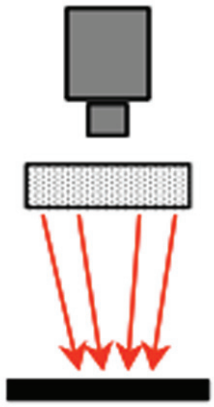
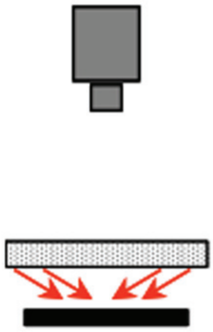
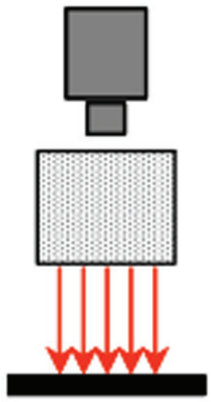
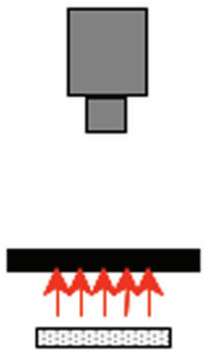
Types of LED lights

L.1 Types of LED lights

Annex L describes the outline of the reader and the verifier defined in Annex E and Annex G, respectively.

Table L.1 shows the types of LED lights.

Table L.1 — Types of LED lights

Item	Shower light (oblique light)	Low angle light (oblique light)	Coaxial light	Transmitted light
Image				
Emission method				
Remarks	The work centre is focused by radiation. Can get higher intensity of radiation.	Free of reflection even on a glossy surface. Suitable for works with a shallow uneven surface.	Specular reflection is irradiated. Suitable for works with a mirror-like surface.	Transmitted light is irradiated by evenly distributed surface emission. Suitable for transparent works.

L.2 Oblique light

Figure L.1 shows the principle of oblique light.

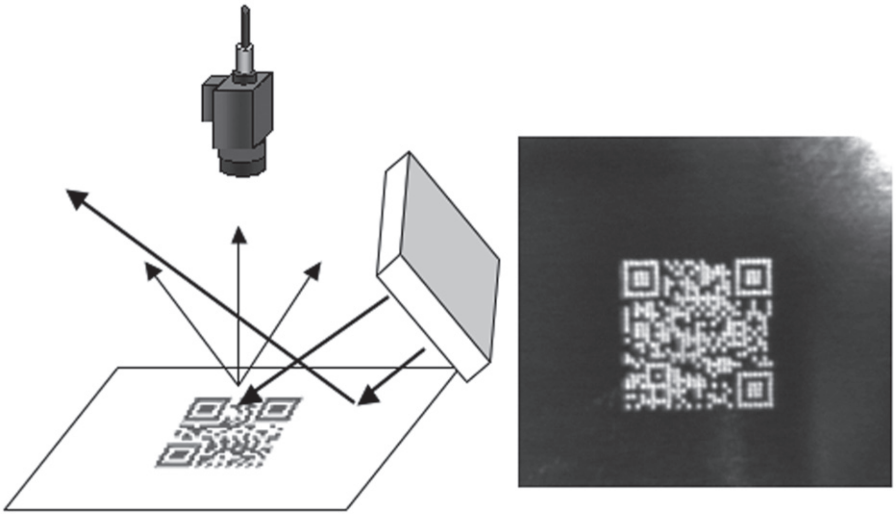


Figure L.1 — Principle of oblique light

L.3 Coaxial light

Figure L.2 shows the principle of coaxial light.

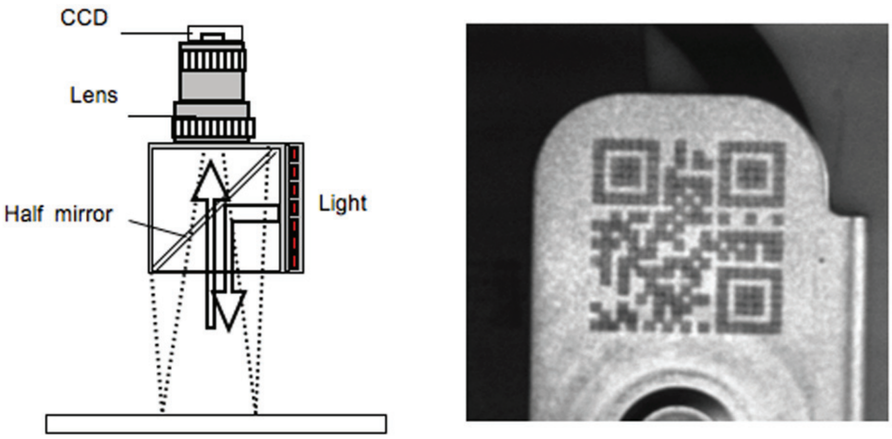


Figure L.2 — Principle of coaxial light

Annex M
(informative)

Evaluation results on Samples A

Annex M describes the results of the test conducted on the Samples A by the evaluation method 1. Two types of samples, one with 0,2 PHR of colour developer and the other with 0,4 PHR of colour developer, were tested for evaluation.

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-GL802-1	30	0	Laser power: 80 %
A-GL802-2	45	0	Scan speed: 1 800 mm/sec
A-GL802-3	30	0	Pulse frequency: 10 µs
A-GL802-4	45	0	No. or overlapped marks: 2 Tact time: 8 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-GRSCR-1	45	0	Laser power: 80 %
A-GRSCR-2	50	0	Scan speed: 1 800 mm/sec
A-GRSCR-3	45	0	Pulse frequency: 10 µs
A-GRSCR-4	45	0	No. or overlapped marks: 2 Tact time: 8 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-GR603-1	45	0	Laser power: 80 %
A-GR603-2	45	0	Scan speed: 800 mm/sec
A-GR603-3	45	0	Pulse frequency: 10 µs
A-GR603-4	45	0	No. or overlapped marks: 2 Tact time: 8 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-BL503-1	45	0	Laser power: 80 %
A-BL503-2	45	0	Scan speed: 2 000 mm/sec
A-BL503-3	45	0	Pulse frequency: 10 µs
A-BL503-4	45	0	No. or overlapped marks: 4 Tact time: 20 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-BL506-1	55	0	Laser power: 80 %
A-BL506-2	55	0	Scan speed: 1 800 mm/sec
A-BL506-3	55	0	Pulse frequency: 10 µs
A-BL506-4	40	0	No. or overlapped marks: 2 Tact time: 8 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-BL510-1	45	0	Laser power: 80 %
A-BL510-2	35	0	Scan speed: 2 000 mm/sec
A-BL510-3	45	0	Pulse frequency: 10 µs
A-BL510-4	30	0	No. or overlapped marks: 4 Tact time: 20 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-ORTUD-1	60	38	Laser power: 80 %
A-ORTUD-2	45	11	Scan speed: 1 200 mm/sec
A-ORTUD-3	45	34	Pulse frequency: 50 µs
A-ORTUD-4	40	7	No. or overlapped marks: 1 Tact time: 6 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-YE201-1	45	97	Laser power: 80 %
A-YE201-2	35	84	Scan speed: 1 200 mm/sec
A-YE201-3	NG	NG	Pulse frequency: 50 µs
A-YE201-4	40	88	No. or overlapped marks: 1 Tact time: 6 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-GRDEN-1	45	0	Laser power: 80 %
A-GRDEN-2	30	0	Scan speed: 2 000 mm/sec
A-GRDEN-3	45	0	Pulse frequency: 10 µs
A-GRDEN-4	30	0	No. or overlapped marks: 4 Tact time: 20 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-BLBF4-1	45	0	Laser power: 80 %
A-BLBF4-2	30	0	Scan speed: 2 000 mm/sec
A-BLBF4-3	45	0	Pulse frequency: 10 µs
A-BLBF4-4	30	0	No. or overlapped marks: 4 Tact time: 20 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-CL202-1	30	50	Laser power: 80 %
A-CL202-2	35	80	Scan speed: 1 200 mm/sec
A-CL202-3	NG	NG	Pulse frequency: 50 µs
A-CL202-4	45	92	No. or overlapped marks: 1 Tact time: 6 sec

Sample No.	Optimal irradiation angle	Error correction use rate	Remarks
A-TM-1	70	38	Laser power: 80 %
A-TM-2	65	11	Scan speed: 1 200 mm/sec
A-TM-3	70	7	Pulse frequency: 50 µs
A-TM-4	65	23	No. or overlapped marks: 1 Tact time: 6 sec

Annex N
(informative)

Evaluation results on Samples B

Annex N describes the results of the test conducted on the Samples B by the evaluation methods 1 and 2. These samples are tested on the dot peen marking and have no colour developer. The Sample No. that ends with the number 1 or 2 has a 0.5 mm pitch and that ends with 3 or 4 has a 0.4 mm pitch.

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-GL802-1	NG	NG	NG
B-GL802-2	NG	NG	78
B-GL802-3	NG	NG	NG
B-GL802-4	NG	NG	60

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-GRSCR-1	NG	NG	0
B-GRSCR-2	NG	NG	0
B-GRSCR-3	NG	NG	0
B-GRSCR-4	NG	NG	NG

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-GR603-1	NG	NG	0
B-GR603-2	NG	NG	0
B-GR603-3	NG	NG	21
B-GR603-4	NG	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-BL503-1	NG	NG	20
B-BL503-2	NG	NG	18
B-BL503-3	NG	NG	12
B-BL503-4	NG	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-BL506-1	50	87	-
B-BL506-2	NG	NG	0
B-BL506-3	NG	NG	0
B-BL506-4	NG	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-BL510-1	NG	NG	NG
B-BL510-2	NG	NG	NG
B-BL510-3	NG	NG	37
B-BL510-4	NG	NG	38

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-ORTUD-1	NG	NG	NG
B-ORTUD-2	NG	NG	NG
B-ORTUD-3	NG	NG	NG
B-ORTUD-4	NG	NG	NG

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-YE201-1	NG	NG	NG
B-YE201-2	NG	NG	NG
B-YE201-3	NG	NG	NG
B-YE201-4	NG	NG	NG

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-GRDEN-1	NG	NG	12
B-GRDEN-2	NG	NG	34
B-GRDEN-3	NG	NG	12
B-GRDEN-4	NG	NG	20

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-BLBF4-1	NG	NG	28
B-BLBF4-2	NG	NG	68
B-BLBF4-3	NG	NG	0
B-BLBF4-4	NG	NG	18

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-CL202-1	NG	NG	NG
B-CL202-2	NG	NG	NG
B-CL202-3	NG	NG	NG
B-CL202-4	NG	NG	NG

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
B-BK901-1	NG	NG	12
B-BK901-2	NG	NG	0
B-BK901-3	NG	NG	0
B-BK901-4	NG	NG	0

Annex O
(informative)

Evaluation results on Samples C

Annex O describes the results of the test conducted on the Samples C by the evaluation methods 1 and 2. They are white silk-screens printed on materials not containing any developer, over which a laser or dot peen marking is applied.

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-GRDEN-1	25	0	-
C-GRDEN-2	25	0	-
C-GRDEN-3	30	71	-

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-BLBF4-1	30	0	-
C-BLBF4-2	25	0	-
C-BLBF4-3	NG	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-CL202-1	NG	NG	61
C-CL202-2	NG	NG	34
C-CL202-3	NG	NG	84

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-BK901-1	35	0	-
C-BK901-2	35	0	-
C-BK901-3	NG	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-PUSPR-1	35	0	-
C-PUSPR-2	35	0	-
C-PUSPR-3	30	NG	0

Sample No.	Test method 1 Optimal irradiation angle	Test method 1 Error Correction use rate	Test method 2 Error Correction use rate
C-RESP2-1	15	0	-
C-RESP2-2	15	7	-
C-RESP2-3	NG	NG	87

Bibliography

[1] ISO 15394, *Packaging — Bar code and two-dimensional symbols for shipping, transport and receiving labels*

[2] ISO/IEC 15415, *Information technology — Automatic identification and data capture techniques — Bar code symbol print quality test specification — Two-dimensional symbols*

[3] ISO/IEC 15418, *Information technology — Automatic identification and data capture techniques — GS1 Application Identifiers and ASC MH10 Data Identifiers and maintenance*

[4] ISO/IEC 15434, *Information technology — Automatic identification and data capture techniques — Syntax for high-capacity ADC media*

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

[6] ISO/IEC 15459-5, *Information technology — Automatic identification and data capture techniques — Unique identification — Part 5: Individual returnable transport items (RTIs)*

[7] ISO/IEC 16022, *Information technology — Automatic identification and data capture techniques — Data Matrix bar code symbology specification*

[8] ISO 17364, *Supply chain applications of RFID — Returnable transport items (RTIs) and returnable packaging items (RPIs)*

[9] ISO 17365, *Supply chain applications of RFID — Transport units*

[10] ISO/IEC 18004, *Information technology — Automatic identification and data capture techniques — QR Code bar code symbology specification*

[11] ISO 22742, *Packaging — Linear bar code and two-dimensional symbols for product packaging*

[12] ISO/IEC TR 24720, *Information technology — Automatic identification and data capture techniques — Guidelines for direct part marking (DPM)*

[13] ISO/IEC TR 29158, *Information technology — Automatic identification and data capture techniques — Direct Part Mark (DPM) Quality Guideline*

ICS 55.020

Price based on 64 pages