INTERNATIONAL STANDARD

ISO/IEC 24724

First edition
2006-11-01

Information technology — Automatic identification and data capture techniques — Reduced Space Symbology (RSS) bar code symbology specification

Technologies de l'information — Techniques d'identification automatique et de capture des données — Spécifications de la symbologie des codes à barres de la symbologie d'espace réduit (RSS)

Reference number
ISO/IEC 24724:2006(E)

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Published in Switzerland

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Foreword

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 24724 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Introduction

The GS1 Reduced Space Symbology (RSS) family contains three linear symbologies (RSS-14, RSS Limited and RSS Expanded) to be used with the GS1 system. The use of the symbology is intended to comply with the GS1 application guidelines as defined in the GS1 General Specifications.

RSS-14 encodes the full 14-digit GS1 item identification in a linear symbol that can be scanned omnidirectionally by suitably programmed point-of-sale scanners. RSS Limited encodes a 14-digit GS1 item identification with Indicator digits of zero or one in a linear symbol for use on small items that will not be scanned at the point-of-sale. RSS Expanded encodes GS1 item identification plus supplementary AI element strings such as weight and “best before” date in a linear symbol that can be scanned omnidirectionally by suitably programmed point-of-sale scanners.

RSS-14 Stacked is a variation of the RSS-14 symbology that is stacked in two rows and is used when the normal symbol would be too wide for the application. It comes in two versions, a truncated version used for small item marking applications and a taller omnidirectional version which is designed to be read by omnidirectional scanners. RSS Expanded can also be printed in multiple rows as a stacked symbol.

Any member of the RSS family can be printed as a stand-alone linear symbol or as part of an EAN.UCC Composite symbol with an accompanying 2D component printed above the RSS linear component.

GS1 RSS bar code symbols are intended for encoding identification numbers and data supplementary to the identification. The administration of the numbering system by EAN and UCC ensures that identification codes assigned to particular items are unique worldwide and that they and the associated supplementary data are defined in a consistent way. The major benefit for the users of the GS1 system is the availability of uniquely defined identification codes and supplementary data formats for use in their trading transactions.

Information technology — Automatic identification and data capture techniques — Reduced Space Symbology (RSS) bar code symbology specification

1 Scope

This International Standard defines the requirements for the RSS symbology family. It specifies the characteristics of the RSS symbology family, data character encodation, symbol formats, dimensions, print quality requirements, error detection, and decoding algorithms.

For EAN.UCC Composite symbols, ISO/IEC 24723 defines the 2D component.

2 Normative references

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

ISO/IEC 646, *Information technology — ISO 7-bit coded character set for information interchange*

ISO 4217, *Codes for the representation of currencies and funds*

ISO/IEC 15416, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols*

ISO/IEC 15417, *Information technology — Automatic identification and data capture techniques — Bar code symbology specification — Code 128*

ISO/IEC 15420, *Information technology — Automatic identification and data capture techniques — Bar code symbology specification — EAN/UPC*

ISO/IEC 15424, *Information technology — Automatic identification and data capture techniques — Data Carrier Identifiers (including Symbology Identifiers)*

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

ISO/IEC 19762-2, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 2: Optically readable media (ORM)*

ISO/IEC 24723, *Information technology — Automatic identification and data capture techniques — EAN.UCC Composite bar code symbology specification*

GS1 General Specifications (GS1, Brussels, Belgium)

3 Terms, definitions, abbreviated terms and mathematical operators

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-2 and the following apply.

NOTE For terms which are defined below and in ISO/IEC 19762, the definitions given below apply.

3.1.1
2D component
two-dimensional portion of an EAN.UCC Composite symbol, which encodes supplemental information about an item, such as its lot number or expiration date

3.1.2
AI element string
character string containing an application identifier followed by its associated data field

3.1.3
EAN/UPC
bar code symbology specified in ISO/IEC 15420

3.1.4
encodation methods
compaction schemes used by RSS Expanded and 2D components to encode commonly used AI element strings in binary strings that are shorter than would be required using general data compaction for the symbology

3.1.5
Indicator digit
leading digit of a GTIN-14 item identification number used to differentiate multiple levels of packaging or to indicate a variable measure item

3.1.6
linear component
linear portion of an EAN.UCC Composite symbol, which encodes the primary identification of an item

3.1.7
linkage flag
indicator encoded in an RSS or UCC/EAN-128 linear component to signal if a 2D component accompanies the linear component

3.1.8
segment
minimum decodable portion of a bar code symbol, consisting, in RSS, of a symbol character and its adjacent finder pattern

3.1.9
UCC/EAN-128
subset, specified in GS1 General Specifications, of Code 128 as defined in ISO/IEC 15417

3.1.10
voting
decoding technique whereby decoded segment values are saved along with a count of the number of times they have been decoded

NOTE Voting is used for decoding RSS by segments such as when used with omnidirectional scanning.

3.2 Abbreviated terms

AI Application Identifier (see ISO/IEC 15418)

3.3 Mathematical operators and notational conventions

For the purposes of this document, the following mathematical operators apply.

div integer division operator which discards the remainder

mod integer remainder after integer division

The following ISO notational conventions are used.

0,2 a comma between numbers represents a decimal value (e.g. 0,2 equals 2/10) except when used in subscripts or as an (n,k) designation

12 345 a space between digits indicates factors of a thousand

4 Symbol description

4.1 Types of RSS symbol

The RSS family consists of the following versions:

RSS-14
RSS-14 Truncated
RSS-14 Stacked
RSS-14 Stacked Omnidirectional

RSS Limited

RSS Expanded
RSS Expanded Stacked

The first group of RSS-14 configurations all contain four symbol characters in every symbol and have identical encodation rules and structure.

The second group, RSS Limited, is structurally different, containing two symbol characters and uses different encodation rules.

The third group, RSS Expanded, has yet another distinct symbology structure and set of encodation rules.

RSS-14, RSS-14 Stacked Omnidirectional, RSS Expanded, RSS Expanded Stacked are designed to be read in segments by omnidirectional scanners.

Annex J contains a summary of characteristics of the RSS family of symbologies.

4.2 Symbology characteristics

The characteristics of the RSS family are:

a) Encodable character set:

1) RSS-14 group and RSS Limited: 0 through 9

2) RSS Expanded: a subset of ISO/IEC 646, consisting of the upper and lowercase letters, digits, and 20 selected punctuation characters in addition to the special function character, FNC1

b) Symbol character structure: different (n,k) symbol characters are used for each member of the family, where each symbol character is n modules in width and is composed of k bars and k spaces.

c) Code type: continuous, linear bar code symbology.

d) Maximum numeric data capacity (including implied application identifiers where appropriate, but not including any encoded FNC1 characters):

1) RSS-14 group and RSS Limited: application identifier “01” plus a 14-digit numeric item identification

2) RSS Expanded: 74 numeric or 41 alphabetic characters (see note)

NOTE The RSS Expanded data capacity depends on the encodation method. The maximum is 74 digits for (01) + other AIs, the maximum is 70 digits for any AIs, and the maximum is 77 digits for (01) + (392x) + any AIs.

e) Error detection:

1) RSS-14 group: mod 79 checksum

2) RSS Limited: mod 89 checksum

3) RSS Expanded: mod 211 checksum

f) Character self-checking: yes.

g) Bidirectionally decodable: yes.

4.3 Summary of additional features

The following is a summary of additional RSS family features:

a) Data compaction: Each member of the family has data compaction methods optimized for the data strings that they will encode. RSS Expanded is optimized for specific combinations of application identifiers that are commonly used.

b) Component linkage: All RSS symbols include a linkage flag. If the linkage flag is clear, i.e. equal to 0, then the RSS symbol stands alone. If the linkage flag is set, i.e. equal to 1, then a 2D component is associated with the RSS family linear component and its separator pattern.

c) UCC/EAN-128 emulation: Readers set to the UCC/EAN-128 emulation mode transmit the data encoded within the RSS family symbol as if the data were encoded in one or more UCC/EAN-128 symbols.

4.4 Symbol structure

Each RSS symbol contains outside guard patterns, symbol characters, and finder patterns. Every symbol includes a method for error detection.

The guard patterns consist of two one-module wide elements forming either a bar/space or a space/bar pair at each end of the symbol. RSS-14 Stacked and RSS Expanded Stacked symbols have guard patterns at the ends of each row of the symbol. See Annex I.1 regarding printing considerations for exterior guard pattern elements.

Every symbol has two or more data characters, each with an (n,k) structure. The data characters values are combined mathematically to form the explicitly encoded data.

The finder pattern is a set of elements selected to be identifiable by the decoder so that the symbol can be recognized and the relative position of the elements can be determined. Each symbol contains one or more finder patterns. The finder patterns also function as the check character and/or segment identifiers.

All RSS symbols include a linkage flag. If the flag is set, the RSS linear component and its contiguous separator pattern shall be aligned with a 2D component in accordance with ISO/IEC 24723. Normally the RSS linear component, its contiguous separator pattern, and the 2D component are printed at the same time, comprising a single EAN.UCC Composite symbol. It is possible however, to preprint an RSS linear component with the linkage flag set in anticipation of a subsequent process in which the 2D component is added. Under such circumstances the separator pattern shall be printed with the RSS linear component in accordance with ISO/IEC 24723.

5 Symbol requirements for RSS-14

5.1 Basic characteristics

RSS-14 is a linear symbology capable of encoding 20 000 000 000 000 (2×10^{13}) values. These values are expressed as 14 digits. The first digit is a linkage flag. The following 13 digits are data characters. The 13 data characters plus an implied check digit form an GS1 14-digit item identification number including a leading Indicator digit. Values 10 000 000 000 000 and above indicate that the linkage flag is set and therefore a 2D component is present, e.g. value 10 001 234 567 890 encodes item 00012345678905 with the linkage flag equal to 1.

RSS-14 can be scanned and decoded in four segments and then reconstructed. This facilitates omnidirectional scanning. Figure 1 illustrates a stand-alone RSS-14 symbol (linkage flag equal to 0).

Figure 1 — RSS-14 symbol representing (01)20012345678909

NOTE The leading (01) is the implied application identifier and is not encoded in the symbol. The last digit, 9, is not directly encoded in the symbol, but is a calculated mod 10 check digit. See Annex A for the check digit calculation. Annex F.1 contains a complete example of encoding an RSS-14 symbol.

5.2 Symbol structure

An RSS-14 symbol, as shown in Figure 2, consists of eight regions (from left to right) comprising 96 modules:

a) a one module space and one module bar left guard pattern

b) four spaces and four bars with 16 modules comprising data character 1, (n,k) = (16,4)

c) three spaces and two bars with 15 modules comprising the left finder pattern

d) four bars and four spaces with 15 modules comprising data character 2, (n,k) = (15,4) (right to left)

e) four bars and four spaces with 15 modules comprising data character 4, (n,k) = (15,4)

f) three bars and two spaces with 15 modules comprising the right finder pattern (right to left)

g) four spaces and four bars with 16 modules comprising data character 3, (n,k) = (16,4) (right to left)

h) a one module space and one module bar right guard pattern

NOTE The data character elements are ordered toward the adjacent finder.

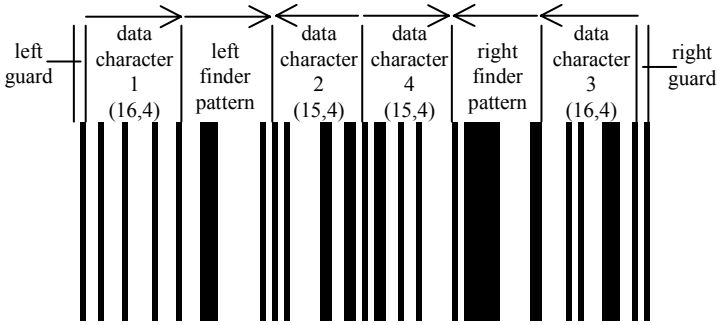

Figure 2 — RSS-14 symbol representing (01)04412345678909

The total symbol contains 46 elements (bars and spaces) comprising 96 modules. Table E.1 in Annex E lists all 46 elements of an RSS-14 symbol. An RSS-14 symbol intended for omnidirectional scanning shall have a height greater than or equal to 33X (33 modules).

No quiet zones are required. The first and last elements may appear wider than one module without affecting the symbol if the adjacent background area is the same “color” (light on the left or dark on the right).

5.2.1 Data character structure

Each of the four data characters has an (n,k) structure. The value of n is 16 for the first and third (outside) data characters and 15 for the second and fourth (inside) data characters. The value of k is 4.

In Figure 2 the arrows show the ordering of element numbers within each character. The elements of the first and fourth data characters are ordered from left to right and the elements of the second and third characters are ordered from right to left, so that the data character elements are always ordered toward the adjacent finder.

Each data character contains two subsets of odd- and even-numbered elements. The terms odd and even refer to the ordinal number of the elements in each subset. For example the odd-numbered subset consists of the first, third, fifth and seventh elements in each data character starting with the element farthest from the adjacent finder pattern. In data characters one and two, the odd elements are spaces and the even elements are bars. In data characters three and four, the odd elements are bars and the even elements are spaces.

5.2.2 Data character value

For each data character value, an algorithm assigns a pattern of element widths to the odd and even subsets. The algorithm is given the number of elements, the number of modules, maximum element width, and whether the subset can have all elements wider than one module. Annex B gives a C-language implementation of the RSS-14 data character element generation algorithm.

5.2.2.1 Outside data character values

For the outside data characters 1 and 3, the valid even element combinations shall have at least one single-module-wide element. The valid odd element subsets need not have a single-module-wide element. The even element restriction insures that the data characters have unique edge-to-similar-edge (bar plus space and space plus bar) module sums.

Table 1 shows the characteristics of the (16,4) subsets, listing the odd and even subset pairs in five groups. Both subsets have an even number of modules. The widest element widths are specified so that the number of modules in a pair of adjacent elements is never greater than nine. The total number of combinations of a (16,4) character is 2 841. The (16,4) data character value V_D is calculated by:

$$V_D = (V_{ODD} \times T_{EVEN}) + V_{EVEN} + G_{SUM}$$

where T_{EVEN} is the even subset total value, V_{ODD} is the odd subset value, V_{EVEN} is the even subset value, and G_{SUM} is the sum of the products of values for each previous group in Table 1. To encode a specific data character of V_D:

$$V_{ODD} = (V_D - G_{SUM}) \text{ div } T_{EVEN}$$

$$V_{EVEN} = (V_D - G_{SUM}) \text{ mod } T_{EVEN}$$

For example a (16,4) data character with the value of 2 315 is to be encoded. From Table 1, the value of the data character is in the range of Group 4, so G_{SUM} = 2 015 and T_{EVEN} = 70. Using the above equations:

$$V_{ODD} = (2\,315 - 2\,015) \text{ div } 70 = 300 \text{ div } 70 = 4$$

$$V_{EVEN} = (2\,315 - 2\,015) \text{ mod } 70 = 300 \text{ mod } 70 = 20$$

The data character value 2 315 is in Group 4 (see Table 1). The data character is comprised of an odd subset with 6 modules and a sequential value of V_{ODD} = 4 out of 10 (range 0 to 9) and an even subset with 10 modules and a sequential value of V_{EVEN} = 20 out of 70 (range 0 to 69). Using the routines in Annex B, the odd element widths are {1 2 2 1} and the even element widths are {1 5 1 3} giving the data character element widths of {1 1 2 5 2 1 1 3} as ordered towards the finder pattern (see Figure 2).

Table 1 — Outside data character (16,4) characteristics

Value range	Group	Sum of previous groups, G_{SUM}	Odd/even subset modules	Odd/even widest elements	Odd subset total values, T_{ODD}	Even subset total values, T_{EVEN}
0 to 160	1	0	12/4	8/1	161	1
161 to 960	2	161	10/6	6/3	80	10
961 to 2 014	3	961	8/8	4/5	31	34
2 015 to 2 714	4	2 015	6/10	3/6	10	70
2 715 to 2 840	5	2 715	4/12	1/8	1	126

5.2.2.2 Inside data character values

For the inside data characters 2 and 4, the valid odd element combinations shall have at least one single module wide element. The valid even element subsets need not have a single-module-wide element. The odd element restriction insures that the data characters have unique edge-to-similar-edge (bar plus space and space plus bar) module sums.

Table 2 shows the characteristics of the (15,4) subsets, listing the odd and even subset pairs in four groups. The odd subset has an odd number of modules and the even subset has an even number of modules. The widest element widths are specified so that the number of modules in a pair of adjacent elements is never greater than nine. The total number of combinations for a (15,4) character is 1 597. The range of allowed values of the odd subset is restricted so that the innermost element (odd element number 1) will not exceed 4 modules.

Table 2 — Inside data character (15,4) characteristics

Value range	Group	Sum of previous groups, G_{SUM}	Odd/even subset modules	Odd/even widest elements	Odd subset total values, T_{ODD}	Even subset total values, T_{EVEN}
0 to 335	1	0	5/10	2/7	4	84
336 to 1 035	2	336	7/8	4/5	20	35
1 036 to 1 515	3	1 036	9/6	6/3	48	10
1 516 to 1 596	4	1 516	11/4	8/1	81	1

The (15,4) data character value V_D is calculated by:

$$V_D = (V_{EVEN} \times T_{ODD}) + V_{ODD} + G_{SUM}$$

where T_{ODD} is the odd subset total value, V_{EVEN} is the even subset value, V_{ODD} is the odd subset value, and G_{SUM} is the sum of the products of values for each previous group. To encode a specific data character of value V_D:

$$V_{EVEN} = (V_D - G_{SUM}) \text{ div } T_{ODD}$$

$$V_{ODD} = (V_D - G_{SUM}) \text{ mod } T_{ODD}$$

Note that the significance of the even and odd subsets is reversed in these calculations compared to the (16,4) outside data characters.

5.2.3 Symbol value

The value of the symbol is formed by combining the values of the left data character pairs and the right data character pairs. The value of each data character pair is formed by combining the values of the outside and inside data characters. The data character pairs and their range of values are listed in Table 3.

Table 3 — Data character pair values

Outside data character		Inside data character		Data character pair	
(n,k)	values ($V_{OUTSIDE}$)	(n,k)	values (V_{INSIDE})	number of values	value range
(16,4)	2 841	(15,4)	1 597	4 537 077	0 to 4 537 076

The data character pair value V_{PAIR} is calculated by:

$$V_{PAIR} = (1\,597 \times C_{OUTSIDE}) + C_{INSIDE}$$

where $C_{OUTSIDE}$ and C_{INSIDE} are the data character values.

To encode the pair value V_{PAIR} into the outside and inside data characters $C_{OUTSIDE}$ and C_{INSIDE}:

$$C_{OUTSIDE} = V_{PAIR} \text{ div } V_{INSIDE}$$

$$C_{INSIDE} = V_{PAIR} \text{ mod } V_{INSIDE}$$

For example, if the data character pair value V_{PAIR} is 1 971 265, then $C_{OUTSIDE}$ and C_{INSIDE} are:

$$C_{OUTSIDE} = 1\,971\,265 \text{ div } 1\,597 = 1\,234$$

$$C_{INSIDE} = 1\,971\,265 \text{ mod } 1\,597 = 567$$

The symbol value is calculated by combining the values of the left and right data character pair values. The calculation is:

$$V_{SYMBOL} = (4\,537\,077 \times V_{LPAIR}) + V_{RPAIR}$$

where V_{SYMBOL} is the symbol value and V_{LPAIR} and V_{RPAIR} are the left and right data character pair values.

To encode the symbol value V_{SYMBOL} into the left and right data character pairs V_{LPAIR} and V_{RPAIR}:

$$V_{LPAIR} = V_{SYMBOL} \text{ div } 4\,537\,077$$

$$V_{RPAIR} = V_{SYMBOL} \text{ mod } 4\,537\,077$$

For example, if the symbol V_{SYMBOL} is 1 234 567 890, Then the value of the left pair V_{LPAIR} and the value of the right pair V_{RPAIR} are:

V_{LPAIR} = 1 234 567 890 div 4 537 077 = 272

V_{RPAIR} = 1 234 567 890 mod 4 537 077 = 482 946

Combining the values of the data characters generates 20 585 067 703 929 values, however, only the first 20 000 000 000 000 values (0 to 19 999 999 999 999) are used. The high-order digit is the 2D component linkage flag: 0 for a stand-alone RSS-14 and 1 if a 2D component adjoins the RSS-14 primary symbol. This flag is stripped from the remaining 13 digits to form the item identification. An implied mod-10 check digit is calculated and added to the end to form the EAN.UCC -14 identification number. A leading application identifier prefix 01 is added to the transmitted data, immediately after the mandatory transmitted symbology identifier,]e0 or]C1.

5.2.4 Finder patterns

The symbol has two finder patterns that also encode the symbol checksum. Each finder pattern can encode nine values. The finder patterns are positioned between the first and second data characters and between the fourth and third data characters. Since a finder pattern is adjacent to all four data characters, the symbol can be scanned in four segments. Each segment will contain a data character and a finder pattern.

5.2.4.1 Finder pattern structure

The two finder patterns each consist of 5 elements comprising 15 modules. The left finder pattern starts and ends with a space and the right finder pattern starts and ends with a bar. Finder pattern elements are numbered from the outside to the inside of the symbol as shown in Figure 2.

The sum of the modules in the elements 2 and 3 is 10 to 12, while the sum of the modules in elements 4 and 5 is 2. The ratio of the wide element pair (2 and 3) to the total width of the four adjacent elements (2 through 5) is in the range of 10:12 to 12:14. This ratio is used for the first step in the recognition logic for the finder pattern. Table 4 lists the finder pattern element widths for the nine encoded values.

Table 4 — Finder pattern values and element widths

Finder Value	Element Widths (numbered from outside to inside)				
	1	2	3	4	5
0	3	8	2	1	1
1	3	5	5	1	1
2	3	3	7	1	1
3	3	1	9	1	1
4	2	7	4	1	1
5	2	5	6	1	1
6	2	3	8	1	1
7	1	5	7	1	1
8	1	3	9	1	1

Finder pairs 8,0 and 0,8 are not used as 0 and 8 can be transformed into a reverse of the other with a single 1-X edge error. The remaining 79 possible pairs encode a mod 79 checksum value.

5.2.4.2 Checksum calculation

The two finder pattern values, C_{LEFT} and C_{RIGHT}, each have nine possible values. Finder pattern value pairs 0,8 and 8,0 are not valid. This leaves a total of $(9 \times 9) - 2$ or 79 combinations. The checksum value is equal to the mod 79 residue of the weighted sum of the widths of the elements in the data characters.