6.1 Introduction

The Composite Symbology integrates both a GS1 System linear symbol and a 2D Composite Component as a single symbology. There are three types of Composite Symbols, A, B and C, each with different encoding rules. The encoder model is designed to automatically select the appropriate type and optimise.

The linear component encodes the item's primary identification. The adjacent 2D Composite Component encodes supplementary data, such as a batch number and expiration date. The Composite Symbol always includes a linear component so that the primary identification is readable by all scanning technologies. The Composite symbol also always includes a multi-row 2D Composite Component that can be read with linear-and area-CCD scanners, and with linear and rastering laser scanners.

The Composite Symbology is described in the AIM (Association for Automatic Identification and Mobility) ITS 99-002 - International Symbology Specification - Composite Symbology.

6.2 Symbol Description

Basic Characteristics

The characteristics of the Composite Symbology are:

- Encodable character set:
    - Linear components:
        - EAN/UPC Symbol, GS1 DataBar Omnidirectional, GS1 DataBar Stacked Omnidirectional, GS1 DataBar Truncated and GS1 DataBar Stacked Symbols and GS1 DataBar Limited Symbol: digits 0 through 9
        - GS1-128 Symbol and GS1 DataBar Expanded Symbols: a subset of Table 1 of the International Standard ISO/IEC 646, consisting of the uppercase and lowercase letters, digits, spaces, and 20 selected punctuation characters in addition to the Function 1 Symbol Character (FNC1)
    - 2D Composite Components:
        - All types: GS1-128 Symbols and GS1 DataBar Expanded Symbols together with the symbol Separator Character
        - Additionally, for CC-B and CC-C: 2D Composite Component escape character
- Symbol character structure: Various (n,k) symbol characters are used in accordance with the underlying symbology of the selected linear and 2D Composite Components of the symbol.
- Code type:
    - Linear component: continuous, linear bar code symbology
    - 2D Composite Component: continuous, multi-row bar code symbology
- Maximum numeric data capacity:
    - Linear components
        - GS1 128 Symbol: up to 48 digits
        - EAN/UPC Symbol: 8, 12, or 13 digits
        - GS1 DataBar Expanded Symbol: up to 74 digits
        - Other GS1 DataBar Symbols: 16 digits
    - 2D Composite Components
        - CC-A: up to 56 digits
        - CC-B: up to 338 digits
        - CC-C: up to 2,361 digits
- Error detection and correction:
    - Linear component: a modulo check value for error detection
    - 2D Composite Component: a fixed or variable number of Reed-Solomon error correction codewords, depending upon the specific 2D Composite Component
- Character self-checking

- Bi-directionally decodable

Additional Features

The following is a summary of additional GS1 Composite Symbology features:

- Data compaction: The 2D Composite Components utilise a bit-oriented compaction mode designed to encode data efficiently using Application Identifiers (AIs).
- Component linkage: The 2D Composite Component of each GS1 Composite Symbol contains a linkage flag, which indicates to the reader that no data shall be transmitted unless the associated linear component is also scanned and decoded. All linear components except EAN/UPC Symbols also contain an explicit linkage flag.
- GS1-128 Symbol emulation: Readers set to the GS1-128 Symbol emulation mode transmit the data encoded within the GS1 Composite Symbol as if the data were encoded in one or more GS1-128 Symbols.
- A symbol separator character: A flag character to support future applications that instructs the reader to terminate transmission of the message at that point and to transmit the remaining data as a separate message.
- 2D Composite Component escape mechanism: A mechanism to support future applications that require data content beyond the ISO 646 subset encodable in the standard form of the GS1 Composite Symbology.

Symbol Structure

Each Composite Symbol consists of a linear component and a multi-row 2D Composite Component™. The 2D Composite Component is printed above the linear component. The two components are separated by a separator pattern. Up to 3X of light space is permitted between the separator pattern and 2D Composite Component to facilitate printing the two components separately; however, if the two components are printed at one time, the nominal alignment should be followed as shown in Figure 23

(01)13112345678906(17)010615(10)A123456

Figure 23 - GS1 DataBar Limited Composite Symbol with CC-A

In Figure 23 the AI (01) - Global Trade Item Number (GTIN) is encoded in the GS1 DataBar Limited linear component. The AI (17) - Expiration Date and the AI (10) - Batch/Lot Number are encoded in the CC-A 2D Composite Component.

The linear component is one of the following:

- A member of the EAN/UPC Symbology (EAN-13, EAN-8, UPC-A, or UPC-E)
- A member of the GS1 DataBar family
- A GS1-128 Symbol

The choice of linear component determines the name of the GS1 Composite Symbol, such as an EAN-13 Composite Symbol, or a GS1-128 Composite Symbol.

Note: ITF-14 Symbols cannot be used as the linear component of a GS1 Composite Symbol.

The 2D Composite Component (abbreviated as CC) is chosen based on the selected linear component and on the amount of supplementary data to be encoded. The three 2D Composite Components, listed in order of increasing maximum data capacity, are:

- CC-A: a variant of MicroPDF417
- CC-B: a MicroPDF417 symbol with new encoding rules
- CC-C: a PDF417 symbol with new encoding rules

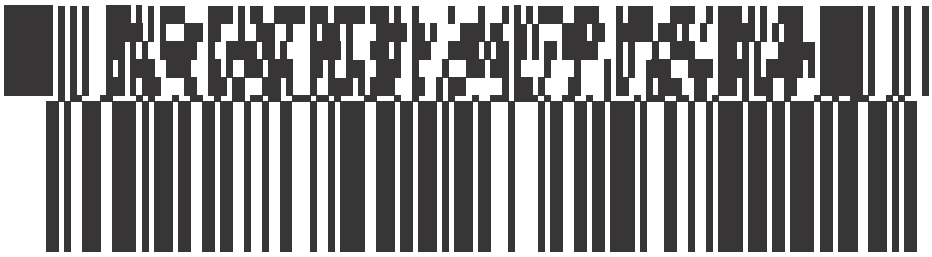

Figure 24 - GS1-128 Composite Symbol with CC-C

In Figure 24, the AI (01) - GTIN is encoded in the GS1-128 Symbol linear component. The AI (10) - Batch/Lot Number and the AI (410) - Ship-to Location are encoded in the CC-C 2D Composite Component.

Based upon the width of the linear component, a choice of "best-fit" 2D Composite Component is specified. Table 13 lists all of the permissible combinations.

Linear Component	CC-A/CC-B	CC-C
UPC-A and EAN-13	Yes (4 columns)	No
EAN-8	Yes (3 columns)	No
UPC-E	Yes (2 columns)	No
GS1-128	Yes (4 columns)	Yes (variable width)
GS1 DataBar Omnidirectional and GS1 DataBar Truncated	Yes (4 columns)	No
GS1 DataBar Stacked and GS1 DataBar Stacked Omnidirectional	Yes (2 columns)	No

TABLE 13. Permissible Combinations of Linear and 2D Composite Components

Linear Component	CC-A/CC-B	CC-C
GS1 DataBar Limited	Yes (3 columns)	No
GS1 DataBar Expanded and GS1 DataBar Expanded Stacked	Yes (4 columns)	No

TABLE 13. Permissible Combinations of Linear and 2D Composite Components

CC-A Structure

CC-A is a variant of MicroPDF417 with a unique combination of row address patterns (RAP). It is the smallest of the 2D Composite Components and can encode up to 56 digits. It has from 3 to 12 rows and 2 to 4 columns.

Each row is a minimum of 2X high (where X is the width of a module). A 1X high minimum separator pattern is positioned between the linear component and 2D Composite Component. (A different separator pattern, 6X high, is used in GS1 Composite Symbols with EAN/UPC linear components).

Each column contains one n,k = 17,4 data or error correction character (codeword) per row (n is the number of modules, and k is the number of bars and spaces). So the width of a codeword is 17X.

In addition to the codeword columns, CC-A has two or three n,k = 10,3 RAP columns that encode the row numbers (each 10X wide). The right most RAP column is terminated on the right by a 1X bar so it is 11X instead of 10X wide.

Each row also requires a 1X Quiet Zone at each end. There is no Quiet Zone required above CC-A. The separator pattern is printed directly above the linear component and no Quiet Zone is required below the CC-A.

The two-column and three-column CC-A versions have two RAP columns (see Table 14 and Table 15), and the four-column CC-A version has three RAP columns, (see Table 16).

Quiet Zone	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 14. Two Column CC-A Structures

Quiet Zone	Codeword Column	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 15. Three Column CC-A Structures

Quiet Zone	RAP Column	Codeword Column	Codeword Column	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 16. Four Column CC-A Structures

Table 17 lists all possible column and row combinations for CC-A. It also shows the capacity and size of the 2D Composite Components. For example, a two-column, five-row CC-A would be 57X wide (including 1X for the extra right-most guard

bar) by 10X high (not including the separator pattern). With an X-dimension of 0.25 mm, it would be 14.25 mm wide by 2.50 mm high.

Number of Data Columns (c)	Number of Rows (r)	Total CWs in Data Region	Number of EC CWs (k)	Percent of CWs for EC	Number of CWs for Data	Max Alpha Chars	Max Digits	CC-A Width, in X (see Note 1)	CC-A Height, in X (see Note 2)
2	5	10	4	40.00%	6	8	16	57	10
2	6	12	4	33.33%	8	12	22	57	12
2	7	14	5	35.71%	9	13	24	57	14
2	8	16	5	31.25%	11	17	30	57	16
2	9	18	6	33.33%	12	18	33	57	18
2	10	20	6	30.00%	14	22	39	57	20
2	12	24	7	29.17%	17	26	47	57	24
3	4	12	4	33.33%	8	12	22	74	8
3	5	15	5	33.33%	10	15	27	74	10
3	6	18	6	33.33%	12	18	33	74	12
3	7	21	7	33.33%	14	22	39	74	14
3	8	24	7	29.17%	17	26	47	74	16
4	3	12	4	33.33%	8	12	22	101	6
4	4	16	5	31.25%	11	17	30	101	8
4	5	20	6	30.00%	14	22	39	101	10
4	6	24	7	29.17%	17	26	47	101	12
4	7	28	8	28.57%	20	31	56	101	14

CW = Codeword; EC = Error Correction

Note 1: Includes a 1X Quiet Zone on each side

Note 2: Assumes row height = 2X; does not include separator pattern

TABLE 17. CC-A Row and Column Sizes

CC-B Structure

CC-B is a MicroPDF417 symbol uniquely identified by the codeword 920 as the first codeword in the symbol. Encoding systems normally automatically select CC-B when the data to be encoded exceeds the capacity of CC-A. CC-B can encode up to 338 digits. It has from 10 to 44 rows and 2 to 4 columns.

Each row is a minimum of 2X high (where X is the width of a module). A 1X high minimum separator pattern is positioned between the linear component and 2D Composite Component™. (A different separator pattern, 6X high, is used in GS1 Composite Symbols with EAN/UPC linear components).

Each column contains one n,k = 17,4 data or error correction character (codeword) per row (where n is the number of modules, and k is the number of bars and spaces). So the width of a codeword is 17X.

In addition to the codeword columns, CC-B has two or three n,k = 10,3 row address pattern (RAP) columns that encode the row numbers (each 10X wide). The rightmost RAP column is terminated on the right by a 1X bar, so it is 11X instead of 10X wide.

Each row also requires a 1X Quiet Zone on each end. There is no Quiet Zone required above CC-B. The separator pattern is printed directly above the linear component and no Quiet Zone is required below the CC-B.

The two-column CC-B version has two RAP columns (see Table 18) and the three- and four-column CC-B versions have three RAP columns (see Table 19 and Table 20).

Quiet Zone	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 18. Two Column CC-B Structures

Quiet Zone	RAP Column	Codeword Column	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 19. Three Column CC-B Structures

Quiet Zone	RAP Column	Codeword Column	Codeword Column	RAP Column	Codeword Column	Codeword Column	RAP Column	Quiet Zone

TABLE 20. Four Column CC-B Structures

CC-B differs from CC-A in the three-column structure in that CC-B has a third RAP column on the left end that is missing in CC-A.

Table 21 lists all the possible column and row combinations for CC-B. It also shows the capacity and size of the 2D Composite Components. For example a four-column, 10-row CC-B would be 101X wide by 20X high (not including the separator pattern). With an X-dimension of 0.25 mm, it would be 25.25 mm wide by 5.00 mm high.

Number of Data Columns (c)	Number of Rows (r)	Total CWs in Data Region	Number of EC CWs (k)	Percent of CWs for EC	Number of non-EC CWs	Number of CWs for Data (Note 1)	Max Alpha chars	Max Digits	CC-B Width, in X (see Note 2)	CC-B Height, in X (see Note 3)
2	17	34	10	29	24	22	34	59	57	34
2	20	40	11	28	29	27	42	73	57	40
2	23	46	13	28	33	31	48	84	57	46
2	26	52	15	29	37	35	55	96	57	52
3	15	45	21	47	24	22	34	59	84	30
3	20	60	26	43	34	32	50	86	84	40
3	26	78	32	41	46	44	68	118	84	52
3	32	96	38	40	58	56	88	153	84	64
3	38	114	44	39	70	68	107	185	84	76
3	44	132	50	38	82	80	127	219	84	88
4	10	40	16	40	24	22	34	59	101	20
4	12	48	18	38	30	28	43	75	101	24
4	15	60	21	35	39	37	58	100	101	30
4	20	80	26	33	54	52	82	141	101	40
4	26	104	32	31	72	70	111	192	101	52
4	32	128	38	30	90	88	139	240	101	64
4	38	152	44	29	108	106	168	290	101	76
4	44	176	50	28	126	124	196	338	101	88

CW = Codeword; EC = Error correction

Note 1: Excludes EC codewords and 2 codewords to define CC-B encodation

Note 2: Including 1X Quiet Zone on either side

Note 3: Assumes Y = 2X; does not include separator pattern

TABLE 21. CCC-B Row and Column Sizes

CC-C Structure

CC-C is a PDF417 symbol uniquely identified by the codeword 920 as the first codeword in the symbol following the symbol length descriptor. CC-C can be used as a 2D Composite Component within a GS1-128 Composite Symbol. It has the greatest data capacity of the GS1 Composite Symbols, encoding up to 2,361 digits. It has from 3 to 30 rows and 1 to 30 data/EC codeword columns.

Each row is a minimum of 3X high (where X is the width of a module). A 1X high minimum separator pattern is positioned between the linear component and 2D Composite Component.

Each column contains one n,k = 17,4 data or error correction character (codeword) per row (where n is the number of modules, and k is the number of bars and spaces). So the width of a data/EC codeword is 17X.

In addition to the codeword columns, CC-C has two 17,4 row indicator columns, a 17X wide start pattern, and a 18X wide stop pattern as illustrated in Table 22.

Each row also requires a 2X Quiet Zone on each end. There is no Quiet Zone required above CC-C. The separator pattern is printed directly above the linear component, and no Quiet Zone is required below the CC-C.

Quiet Zone	Start Pattern	Left Row Indicator Column	1 to 30 Data/EC Codeword Columns	Right Row Indicator Column	Stop Pattern	Quiet Zone

TABLE 22. CC-C Row Structure

CC-C is normally printed with the number of columns that will result in a width nearly matching the width of the GS1-128 Symbol linear component. However, as an option, the user may specify a wider CC-C to be printed. This reduces the height of the 2D Composite Component. A lower GS1 Composite Symbol may be needed to fit in a height-restricted application. A wider CC-C may also be required if the amount of data would not fit in the default width CC-C.

6.2.1 Sample Composite Symbols.

Figure 25 - EAN-13 Symbol with a Four-Column CC-A Component

Figure 26 - GS1 DataBar Omnidirectional Symbol with a Four-Column CC-A

Figure 27 - GS1 DataBar Stacked Symbol with a Two-Column CC-A

Figure 28 - GS1 DataBar

Figure 29 - GS1 DataBar Expanded Symbol with a Four-Column CC-A

Figure 30 - GS1-128 Symbol with a Four-Column CC-A

Note: All diagrams not to scale.

6.3Additional Information on GS1 Composite

Width of a Module (X)

The X-dimension of the 2D Composite Component must be the same as that of the associated linear component. Refer to the linear component's X-dimension requirements.

Special Compressed Element String Sequences

While 2D Composite Components™ can encode any sequence of Application Identifier (AI) Element Strings up to the maximum capacity of the component, certain sequences of AI Element Strings have been selected for special compression in 2D Composite Component Symbols. If the application requires the use of the AI Element Strings in one of these sequences, and they are used in the predefined sequence, a smaller symbol will result.

For special compression to be performed, the AI Element String sequence must occur at the start of the 2D Composite Component's data. Other AI Element Strings may be added following the sequence.

The AI Element Strings selected for special compression are:

- Production date and batch/lot number - AI (11) - Production Date followed by AI (10) - Batch/Lot Number
- Expiration date and batch/lot number - AI (17) - Expiration Date followed by AI (10) - Batch/Lot Number
- AI (90) followed by the Element String data starting with an alphabetic character and a digit; AI (90) may be used to encode data identifier data; the AI (90) followed by data in the data identifier format has special compression applied only if it is the start of the first Element String.

Human Readable Interpretation in Composite Symbols

For Human-Readable Interpretation (HRI) Rules see Section 9 of the GS1 Australia User Manual Numbering and Bar Coding. For HRI Rules specific to Regulated Healthcare Retail Consumer Trade Items, see Section 4 of the GS1 Australia User Manual Numbering and Bar Coding.

As an option, the data title (see GS1 Australia User Manual - Numbering & Bar Coding) may be associated with the data instead of using AIs. The figure below shows the expiration date and lot number identified with text. This can be compared with Figure 23 on page 40, where the same data is shown using the all - AI format.

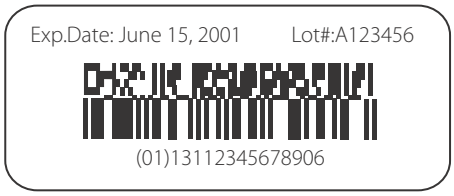

Figure 31 - Human Readable Interpretation and Non-HRI Text

For GS1 Composite Symbols encoding a large amount of data, it may not be practical to display all the data in Human Readable Interpretation form or, even if there is space to show it in this form, it may not be practical to key enter that much data. In these instances, some of the data may be omitted from the Human Readable Interpretation. However, primary identification data such as the Global Trade Item Number (GTIN) and Serial Shipping Container Code (SSCC) must always be shown. Application specifications provide guidance on Human Readable Interpretation.

Print Quality

The print quality assessment methodology defined in the International Standard ISO/IEC 15416 should be used for measuring and grading the linear components. The ISO print quality specification is functionally identical to the older ANSI and CEN print quality specifications. The print quality grade is measured by verifiers that apply the standard. The print quality grade reported includes a grade level, measuring aperture, and the wavelength of light used for the measurement.

AIM ITS 99-002 - International Symbology Specification - MicroPDF417 and ISO/IEC 15438 - Automatic identification and data capture techniques - Symbology specification - PDF417 specify the methods for determining the print quality grade of the 2D Composite Components CC-A/B and CC-C respectively. An additional grading parameter unused error correction (UEC) is defined in these specifications.

The minimum quality grade for GS1 Composite Symbols is 1.5/06/ 670 where:

- 1.5 is the overall symbol quality grade.
- 06 is the measuring aperture reference number (corresponding to an 0.15 mm or 0.006 in. diameter aperture).
- 670 is the peak response wavelength in nanometres. In addition to the print quality grade, all elements in the separator patterns should be visually distinguishable.

Both the linear component and the 2D Composite Component must independently achieve the minimum print quality grade.

Note: An international standard methodology for quality grading two-dimensional symbologies is under development and may eventually supersede the method defined in the above specifications.

Data Transmission and Symbology Identifier Prefixes

Default Transmission Mode

The GS1 System requires the use of Symbology Identifiers. GS1 Composite Symbols are normally transmitted using Symbology Identifier prefix "]e0," with the data from the 2D Composite Component™ directly appended to that of the linear component. For example, a GS1 Composite Symbol encoding (01)10012345678902(10)ABC123 produces the data string "]e0011001234567890210ABC123" (note that the Symbology Identifier prefix "]e0" is different from the Symbology Identifier prefix "]E0," which has an uppercase "E" and is used for standard EAN/UPC Symbols). However, readers have an option to transmit only the linear component data and ignore the 2D Composite Component.

Data transmission follows the same principles that apply to the concatenation of AI Element Strings in any bar code that encodes GS1 Application Identifiers (see.Chapter 9 Page 71). If the linear component data ends with a variable length AI Element String, an ASCII 29 character (GS) is inserted between it and the first character of the data from the 2D Composite Component.

GS1-128 Symbol Transmission Mode

Readers also have an option for GS1-128 Symbol emulation mode. This mode emulates the GS1-128 Symbol for data transmission. It can be used for applications programmed for GS1-128 Symbols but not yet programmed to recognise the Symbology Identifier prefix "]e0." The Symbology Identifier for GS1-128 Symbol emulation mode is "]C1." GS1 Composite Symbols that exceed 48 data characters are transmitted as two or more messages so as not to exceed the maximum GS1-128 Symbol message length. Each of the messages has a Symbology Identifier prefix of "]C1" and does not exceed 48 data characters. The messages are split at boundaries between Element Strings. This mode is inferior to the normal transmission mode as message integrity may be lost when a message is split into multiple messages.

Symbol Separator Character

The 2D Composite Component can encode symbol separator characters as defined in the decoder. This character instructs the reader to terminate the current GS1 Composite Symbol's data message and transmit the data following the symbol separator as a separate message. This new message will have the Symbology Identifier prefix of "]e1." This feature will be used for future GS1 System applications such as encoding the mixed contents of a logistical container.

2D Composite Component Escape Mechanism

The CC-B and CC-C also can encode 2D Composite Component escape mechanism codewords. These instruct the reader to terminate the current GS1 Composite Symbol's data message and transmit the data following the escape mechanism codeword as a separate message. This new message has the Symbology Identifier prefix of "]e2" for standard data message. The codewords following the escape mechanism codeword are encoded and decoded using the standard PDF417 encoding defined in ISO/IEC 15438 - Automatic identification and data capture techniques - Symbology specification - PDF417. This feature is used for future GS1 System applications that require characters beyond the ISO 646 character subset defined for Application Identifier (AI) Element String data.

Note: The protocol for "]e2" corresponds to the protocol defined for PDF417 using Symbology Identifier "]L2".

Advice for Selecting the Symbology

Any use of the 2D Composite Component should comply with GS1 System global application guidelines. The linear component of an GS1 Composite Symbol should be selected according to the application rules defined in the GS1 General Specifications, but where a choice of linear components is available for the application, consideration should also be given to the 2D Composite Component options available. A wider linear component will result in a shorter 2D Composite Component and, particularly for CC-B, a higher capacity symbol.

For CC-A and CC-B, the selection of the linear component automatically determines the number of columns of the 2D Composite Component. The selection of CC-A or CC-B is automatically determined by the amount of data to be encoded. CC-A is always used unless the data exceeds its capacity.

When the linear component is a GS1-128 Symbol, the user may specify CC-A/B or CC-C. CC-A/B will produce a smaller 2D Composite Component. However, CC-C can increase in width to match the width of the GS1-128 Symbol or be selected to be even wider. This may produce a GS1 Composite Symbol of lower height. CC-C also has a larger data capacity, so it is suitable for applications such as logistics.

If the symbol is a GS1 DataBar Composite Symbol, then using a wider GS1 DataBar Symbol such as GS1 DataBar Truncated instead of GS1 DataBar Limited may be preferable because the wider companion 2D Composite Component™ may result in a GS1 DataBar Composite Symbol of lower overall height even though the GS1 DataBar component itself is slightly taller.

If the data capacity in a two-column or three-column CC-B 2D Composite Component is inadequate to encode the required 2D component's data message, then the linear component can be changed to increase the number of columns of the companion CC-B component. This will increase the maximum data capacity of the CC-B component as shown in the figure below.

Number of CC-B Columns	Used With	Maximum Numeric Characters	Maximum Alpha Characters
2	GS1 DataBar Stacked GS1 DataBar Stacked Omnidirectional	95	55
3	GS1 DataBar Limited	219	127
4	GS1 DataBar Omnidirectional GS1 DataBar Expanded GS1 DataBar Expanded Stacked	338	196

TABLE 23. Data Capacity of CC-B