# Section 5.3:

# GS1-128 Symbology Specifications

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## 5.3.1 Symbology Characteristics

The GS1-128 Bar Code Symbol has been carefully designed through joint co-operation between GS1 and Automatic Identification Manufacturers, Inc. (AIM). Use of GS1-128 Bar Code Symbols provides a high degree of security and distinguishes GS1 System Element Strings from extraneous non-standard bar code symbols.

The GS1-128 Symbology is a subset of the more general Code 128 Symbology. By agreement between AIM, Inc and GS1, use of the Function Code 1 (FNC1) in Code 128 Symbols in the first symbol character position following the Start Character has been reserved exclusively for the GS1 System.

Code 128 is fully described in "*ISO/IEC 15417, Information Technology - Automatic Identification and Data Capture Techniques - Bar code Symbology Specification - Code 128.*

The information covered in Section 5.3 includes:

- Sections 5.3.1 – 5.3.6: GS1-128 Symbology subset (using "*ISO/IEC 15417*" for reference)

- Section 5.3.7: GS1 System application-defined parameters

- Section 5.3.8: GS1 System rules for encoding/decoding Element Strings in GS1-128 Bar Code Symbols

## 5.3.1.1 GS1-128 Symbology Characteristics

The characteristics of the GS1-128 Symbology are:

- Encodable character set:

  - The Code 128 ASCII characters are in accordance with *ISO 646*. Refer to Figure 3.A.3 – 1 for more details. Spaces are not encoded in GS1-128 Bar Code Symbols).

  - Characters with ASCII values 128 to 255 may also be encoded in Code 128 Symbols. Characters with ASCII values 128 -to 255 accessed by Function 4 Character (FNC4) are reserved for future use and are not used in GS1-128 Bar Code Symbols.

  - Four non-data function characters. FNC2 and FNC4 are not used in GS1-128 Bar Code Symbols.

  - Four code set selection characters (including single character code set shift)

  - Three Start Characters

  - One Stop Character

- Continuous code type

- Six elements per symbol character comprising three bars (dark bars) and three spaces (light bars), each one, two, three, or four modules in width. The Stop Character is made up of seven elements comprising four bars (dark bars) and three spaces (light bars).

- Character self-checking

- Variable symbol length

- Bi-directionally decodable

- One mandatory Symbol Check Character (see Section 5.3.A.1).

- Data character density is 11 modules per symbol character (5.5 modules per numeric character in code set C, 13 modules per Stop Character)

- Non-data overhead:

  - GS1-128 Bar Code Symbols have a special double character start pattern consisting of the appropriate Start Character and immediately followed by a Function Code 1 (FNC1). The FNC1 adds to the symbol's non-data overhead. The total symbol overhead is 46 modules.

  - The FNC1 character may also be used as a separator character between Element Strings not contained in the pre-defined table shown in Figure 5.3.8.2.1 – 1.

- GS1-128 Bar Code Symbol size characteristics:

  - The maximum physical length is 165 mm (6.5 in.) including Quiet Zones.

  - The maximum number of data characters in a single symbol is 48.

  - For a given length of data, the symbol size is variable between limits in X-dimension to accommodate the ranges in quality achievable by the various printing processes.

## 5.3.2 GS1-128 Bar Code Symbol Structure

The GS1-128 Bar Code Symbol is made up as follows, reading from left to right:

* Leading Quiet Zone

* A Start Character (A, B, or C)          The double character

* The Function Code 1 (FNC1)            Start pattern

* Data (including the Application Identifier represented in character set A, B, or C)

* A Symbol Check Character

* The Stop Character

* Trailing Quiet Zone

The data characters represented in the symbol are shown in Human Readable Interpretation underneath or above the symbol.

Figure 5.3.2 – 1

**General Format of a GS1-128 Bar Code Symbol**



Start Pattern   Data Characters        Symbol Check
                                        Character

Stop
Character

(0 0) 3 5 0 1 2 3 4 5 1 2 3 4 5 6 7 8 9 4

Quiet
Zone

Quiet
Zone
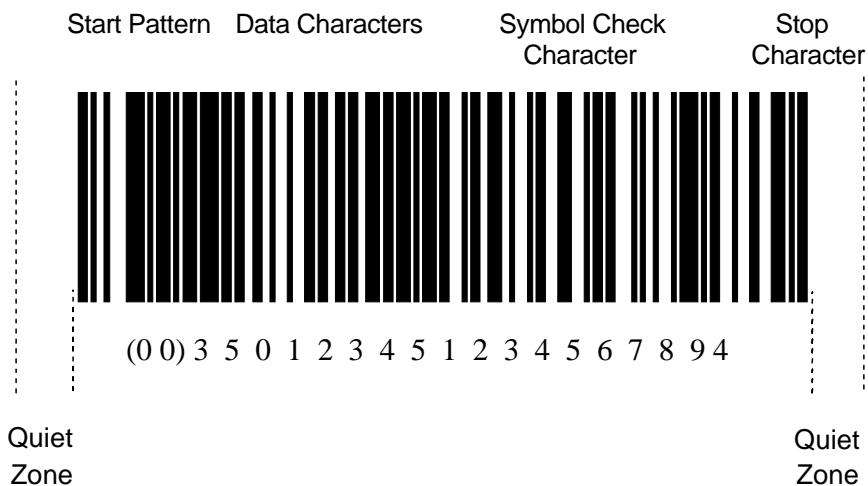
## 5.3.3 GS1-128 Symbology Character Assignments

Figure 5.3.3.2 – 1 defines all the Code 128 character assignments. In the element width column, the numeric values represent the widths of the elements in modules or multiples of the X-dimension.

GS1-128 Bar Code Symbol character assignments are identical to Code 128 Symbol character assignments.

## 5.3.3.1 Symbol Character Structure

The sum of the bar modules in any symbol character is always even (even parity) and the sum of the space modules is, therefore, always odd. This parity feature enables character self-checking.

Figure 5.3.3.1 – 1

**GS1-128 Bar Code Symbol Start Character A**
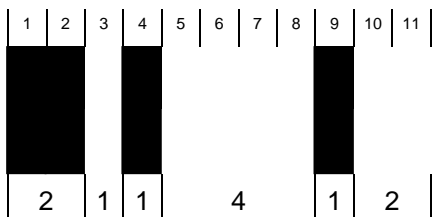


Figure 5.3.3.1 – 2 illustrates the encoding of the symbol character value 35, which represents data character C in code sets A or B or the digits 35 in code set C.

Figure 5.3.3.1 – 2

**Symbol Character Value 35**
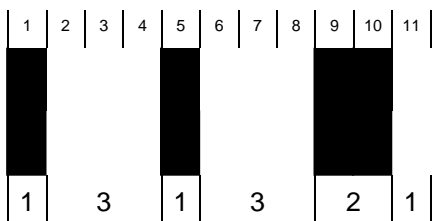


Figure 5.3.3.1 – 3

**GS1-128 Bar Code Symbol Stop Character**

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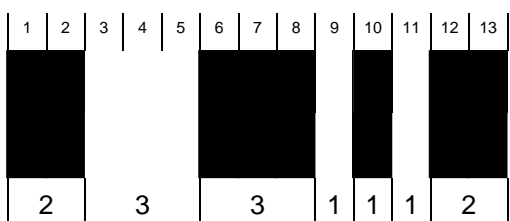
## 5.3.3.2 Data Character Encodation

Code 128 has three character sets, which are shown in Figure 5.3.3.2 – 1 as code sets A, B, and C.

GS1-128 Symbology specifies the identical character set, as defined by the International *ISO/IEC 646* Standard, to ensure international compatibility. For more information see Figure 3.A.3 – 1.

The symbol character bar (dark bar) and space (light bar) patterns shown in Figure 5.3.3.2 – 1 represent the data characters listed under the columns for code set A, B, or C. The choice of code set depends on the Start Character, the use of code A, code B, or code C characters, or the shift character. If the symbol begins with Start Character A, then code set A is defined initially. Code set B and code set C are similarly defined by beginning the symbol with Start Character B or C, respectively. The code set can be redefined within the symbol by using code A, code B, and code C characters or the shift character (see Section 5.3.3 for the use of special characters).

The same data may be represented by different Code 128 Symbols through the use of different combinations of Start, code set, and shift characters. The individual applications do not specify code sets A, B, or C. Section 5.3.A.3 contains rules to minimise the length of the symbol for any given data.

Each symbol character is assigned a numeric value listed in Figure 5.3.3.2 – 1. This value is used in calculating the Symbol Check Character value. It may also be used to provide a conversion to and from ASCII values (see Section 5.3.A.2).

Figure 5.3.3.2 – 1

**Code 128 Character Encodation**

| Symbol Character Value | Code Set A | ASCII Value for Code Set A | Code Set B | ASCII Value for Code Set B | Code Set C | Element Widths (Modules) | | | | | | Element Pattern | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B | S | B | S | B | S | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 0 | space | 32 | space | 32 | 00 | 2 | 1 | 2 | 2 | 2 | 2 | | | | | | | | | | | |
| 1 | ! | 33 | ! | 33 | 01 | 2 | 2 | 2 | 1 | 2 | 2 | | | | | | | | | | | |
| 2 | " | 34 | " | 34 | 02 | 2 | 2 | 2 | 2 | 2 | 1 | | | | | | | | | | | |
| 3 | # | 35 | # | 35 | 03 | 1 | 2 | 1 | 2 | 2 | 3 | | | | | | | | | | | |
| 4 | $ | 36 | $ | 36 | 04 | 1 | 2 | 1 | 3 | 2 | 2 | | | | | | | | | | | |
| 5 | % | 37 | % | 37 | 05 | 1 | 3 | 1 | 2 | 2 | 2 | | | | | | | | | | | |
| 6 | & | 38 | & | 38 | 06 | 1 | 2 | 2 | 2 | 1 | 3 | | | | | | | | | | | |
| 7 | apos-trophe | 39 | apos-trophe | 39 | 07 | 1 | 2 | 2 | 3 | 1 | 2 | | | | | | | | | | | |
| 8 | ( | 40 | ( | 40 | 08 | 1 | 3 | 2 | 2 | 1 | 2 | | | | | | | | | | | |
| 9 | ) | 41 | ) | 41 | 09 | 2 | 2 | 1 | 2 | 1 | 3 | | | | | | | | | | | |
| 10 | * | 42 | * | 42 | 10 | 2 | 2 | 1 | 3 | 1 | 2 | | | | | | | | | | | |
| 11 | + | 43 | + | 43 | 11 | 2 | 3 | 1 | 2 | 1 | 2 | | | | | | | | | | | |
| 12 | comma | 44 | comma | 44 | 12 | 1 | 1 | 2 | 2 | 3 | 2 | | | | | | | | | | | |
| 13 | - | 45 | - | 45 | 13 | 1 | 2 | 2 | 1 | 3 | 2 | | | | | | | | | | | |
| 14 | full stop | 46 | full stop | 46 | 14 | 1 | 2 | 2 | 2 | 3 | 1 | | | | | | | | | | | |
| 15 | / | 47 | / | 47 | 15 | 1 | 1 | 3 | 2 | 2 | 2 | | | | | | | | | | | |
| 16 | 0 | 48 | 0 | 48 | 16 | 1 | 2 | 3 | 1 | 2 | 2 | | | | | | | | | | | |
| 17 | 1 | 49 | 1 | 49 | 17 | 1 | 2 | 3 | 2 | 2 | 1 | | | | | | | | | | | |
| 18 | 2 | 50 | 2 | 50 | 18 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | | | | | | | |
| 19 | 3 | 51 | 3 | 51 | 19 | 2 | 2 | 1 | 1 | 3 | 2 | | | | | | | | | | | |
| 20 | 4 | 52 | 4 | 52 | 20 | 2 | 2 | 1 | 2 | 3 | 1 | | | | | | | | | | | |
| 21 | 5 | 53 | 5 | 53 | 21 | 2 | 1 | 3 | 2 | 1 | 2 | | | | | | | | | | | |
| 22 | 6 | 54 | 6 | 54 | 22 | 2 | 2 | 3 | 1 | 1 | 2 | | | | | | | | | | | |

| Symbol Character Value | Code Set A | ASCII Value for Code Set A | Code Set B | ASCII Value for Code Set B | Code Set C | Element Widths (Modules) | | | | | | Element Pattern | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B | S | B | S | B | S | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 23 | 7 | 55 | 7 | 55 | 23 | 3 | 1 | 2 | 1 | 3 | 1 | | | | | | | | | | | |
| 24 | 8 | 56 | 8 | 56 | 24 | 3 | 1 | 1 | 2 | 2 | 2 | | | | | | | | | | | |
| 25 | 9 | 57 | 9 | 57 | 25 | 3 | 2 | 1 | 1 | 2 | 2 | | | | | | | | | | | |
| 26 | colon | 58 | colon | 58 | 26 | 3 | 2 | 1 | 2 | 2 | 1 | | | | | | | | | | | |
| 27 | semi-colon | 59 | semi-colon | 59 | 27 | 3 | 1 | 2 | 2 | 1 | 2 | | | | | | | | | | | |
| 28 | < | 60 | < | 60 | 28 | 3 | 2 | 2 | 1 | 1 | 2 | | | | | | | | | | | |
| 29 | = | 61 | = | 61 | 29 | 3 | 2 | 2 | 2 | 1 | 1 | | | | | | | | | | | |
| 30 | > | 62 | > | 62 | 30 | 2 | 1 | 2 | 1 | 2 | 3 | | | | | | | | | | | |
| 31 | ? | 63 | ? | 63 | 31 | 2 | 1 | 2 | 3 | 2 | 1 | | | | | | | | | | | |
| 32 | @ | 64 | @ | 64 | 32 | 2 | 3 | 2 | 1 | 2 | 1 | | | | | | | | | | | |
| 33 | A | 65 | A | 65 | 33 | 1 | 1 | 1 | 3 | 2 | 3 | | | | | | | | | | | |
| 34 | B | 66 | B | 66 | 34 | 1 | 3 | 1 | 1 | 2 | 3 | | | | | | | | | | | |
| 35 | C | 67 | C | 67 | 35 | 1 | 3 | 1 | 3 | 2 | 1 | | | | | | | | | | | |
| 36 | D | 68 | D | 68 | 36 | 1 | 1 | 2 | 3 | 1 | 3 | | | | | | | | | | | |
| 37 | E | 69 | E | 69 | 37 | 1 | 3 | 2 | 1 | 1 | 3 | | | | | | | | | | | |
| 38 | F | 70 | F | 70 | 38 | 1 | 3 | 2 | 3 | 1 | 1 | | | | | | | | | | | |
| 39 | G | 71 | G | 71 | 39 | 2 | 1 | 1 | 3 | 1 | 3 | | | | | | | | | | | |
| 40 | H | 72 | H | 72 | 40 | 2 | 3 | 1 | 1 | 1 | 3 | | | | | | | | | | | |
| 41 | I | 73 | I | 73 | 41 | 2 | 3 | 1 | 3 | 1 | 1 | | | | | | | | | | | |
| 43 | J | 74 | J | 74 | 42 | 1 | 1 | 2 | 1 | 3 | 3 | | | | | | | | | | | |
| 43 | K | 75 | K | 75 | 43 | 1 | 1 | 2 | 3 | 3 | 1 | | | | | | | | | | | |
| 44 | L | 76 | L | 76 | 44 | 1 | 3 | 2 | 1 | 3 | 1 | | | | | | | | | | | |
| 45 | M | 77 | M | 77 | 45 | 1 | 1 | 3 | 1 | 2 | 3 | | | | | | | | | | | |
| 46 | N | 78 | N | 78 | 46 | 1 | 1 | 3 | 3 | 2 | 1 | | | | | | | | | | | |
| 47 | O | 79 | O | 79 | 47 | 1 | 3 | 3 | 1 | 2 | 1 | | | | | | | | | | | |
| 48 | P | 80 | P | 80 | 48 | 3 | 1 | 3 | 1 | 2 | 1 | | | | | | | | | | | |

| Symbol Character Value | Code Set A | ASCII Value for Code Set A | Code Set B | ASCII Value for Code Set B | Code Set C | Element Widths (Modules) | | | | | | Element Pattern |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B | S | B | S | B | S | 1 2 3 4 5 6 7 8 9 10 11 |
| 49 | Q | 81 | Q | 81 | 49 | 2 | 1 | 1 | 3 | 3 | 1 | |
| 50 | R | 82 | R | 82 | 50 | 2 | 3 | 1 | 1 | 3 | 1 | |
| 51 | S | 83 | S | 83 | 51 | 2 | 1 | 3 | 1 | 1 | 3 | |
| 52 | T | 84 | T | 84 | 52 | 2 | 1 | 3 | 3 | 1 | 1 | |
| 53 | U | 85 | U | 85 | 53 | 2 | 1 | 3 | 1 | 3 | 1 | |
| 54 | V | 86 | V | 86 | 54 | 3 | 1 | 1 | 1 | 2 | 3 | |
| 55 | W | 87 | W | 87 | 55 | 3 | 1 | 1 | 3 | 2 | 1 | |
| 56 | X | 88 | X | 88 | 56 | 3 | 3 | 1 | 1 | 2 | 1 | |
| 57 | Y | 89 | Y | 89 | 57 | 3 | 1 | 2 | 1 | 1 | 3 | |
| 58 | Z | 90 | Z | 90 | 58 | 3 | 1 | 2 | 3 | 1 | 1 | |
| 59 | [ | 91 | [ | 91 | 59 | 3 | 3 | 2 | 1 | 1 | 1 | |
| 60 | \ | 92 | \ | 92 | 60 | 3 | 1 | 4 | 1 | 1 | 1 | |
| 61 | ] | 93 | ] | 93 | 61 | 2 | 2 | 1 | 4 | 1 | 1 | |
| 62 | ^ | 94 | ^ | 94 | 62 | 4 | 3 | 1 | 1 | 1 | 1 | |
| 63 | _ | 95 | _ | 95 | 63 | 1 | 1 | 1 | 2 | 2 | 4 | |
| 64 | NUL | 00 | grave accent | 96 | 64 | 1 | 1 | 1 | 4 | 2 | 2 | |
| 65 | SOH | 01 | a | 97 | 65 | 1 | 2 | 1 | 1 | 2 | 4 | |
| 66 | STX | 02 | b | 98 | 66 | 1 | 2 | 1 | 4 | 2 | 1 | |
| 67 | ETX | 03 | c | 99 | 67 | 1 | 4 | 1 | 1 | 2 | 2 | |
| 68 | EOT | 04 | d | 100 | 68 | 1 | 4 | 1 | 2 | 2 | 1 | |
| 69 | ENQ | 05 | e | 101 | 69 | 1 | 1 | 2 | 2 | 1 | 4 | |
| 70 | ACK | 06 | f | 102 | 70 | 1 | 1 | 2 | 4 | 1 | 2 | |
| 71 | BEL | 07 | g | 103 | 71 | 1 | 2 | 2 | 1 | 1 | 4 | |
| 72 | BS | 08 | h | 104 | 72 | 1 | 2 | 2 | 4 | 1 | 1 | |
| 73 | HT | 09 | i | 105 | 73 | 1 | 4 | 2 | 1 | 1 | 2 | |
| 74 | LF | 10 | j | 106 | 74 | 1 | 4 | 2 | 2 | 1 | 1 | |

| Symbol Character Value | Code Set A | ASCII Value for Code Set A | Code Set B | ASCII Value for Code Set B | Code Set C | Element Widths (Modules) | | | | | | Element Pattern |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B | S | B | S | B | S | |
| 75 | VT | 11 | k | 107 | 75 | 2 | 4 | 1 | 2 | 1 | 1 | |
| 76 | FF | 12 | l | 108 | 76 | 2 | 2 | 1 | 1 | 1 | 4 | |
| 77 | CR | 13 | m | 109 | 77 | 4 | 1 | 3 | 1 | 1 | 1 | |
| 78 | SO | 14 | n | 110 | 78 | 2 | 4 | 1 | 1 | 1 | 2 | |
| 79 | SI | 15 | o | 111 | 79 | 1 | 3 | 4 | 1 | 1 | 1 | |
| 80 | DLE | 16 | p | 112 | 80 | 1 | 1 | 1 | 2 | 4 | 2 | |
| 81 | DC1 | 17 | q | 113 | 81 | 1 | 2 | 1 | 1 | 4 | 2 | |
| 82 | DC2 | 18 | r | 114 | 82 | 1 | 2 | 1 | 2 | 4 | 1 | |
| 83 | DC3 | 19 | s | 115 | 83 | 1 | 1 | 4 | 2 | 1 | 2 | |
| 84 | DC4 | 20 | t | 116 | 84 | 1 | 2 | 4 | 1 | 1 | 2 | |
| 85 | NAK | 21 | u | 117 | 85 | 1 | 2 | 4 | 2 | 1 | 1 | |
| 86 | SYN | 22 | v | 118 | 86 | 4 | 1 | 1 | 2 | 1 | 2 | |
| 87 | ETB | 23 | w | 119 | 87 | 4 | 2 | 1 | 1 | 1 | 2 | |
| 88 | CAN | 24 | x | 120 | 88 | 4 | 2 | 1 | 2 | 1 | 1 | |
| 89 | EM | 25 | y | 121 | 89 | 2 | 1 | 2 | 1 | 4 | 1 | |
| 90 | SUB | 26 | z | 122 | 90 | 2 | 1 | 4 | 1 | 2 | 1 | |
| 91 | ESC | 27 | { | 123 | 91 | 4 | 1 | 2 | 1 | 2 | 1 | |
| 92 | FS | 28 | \| | 124 | 92 | 1 | 1 | 1 | 1 | 4 | 3 | |
| 93 | GS | 29 | } | 125 | 93 | 1 | 1 | 1 | 3 | 4 | 1 | |
| 94 | RS | 30 | ~ | 126 | 94 | 1 | 3 | 1 | 1 | 4 | 1 | |
| 95 | US | 31 | DEL | 127 | 95 | 1 | 1 | 4 | 1 | 1 | 3 | |
| 96 | FNC3 | | FNC3 | | 96 | 1 | 1 | 4 | 3 | 1 | 1 | |
| 97 | FNC2 | | FNC2 | | 97 | 4 | 1 | 1 | 1 | 1 | 3 | |
| 98 | SHIFT | | SHIFT | | 98 | 4 | 1 | 1 | 3 | 1 | 1 | |
| 99 | CODE C | | CODE C | | 99 | 1 | 1 | 3 | 1 | 4 | 1 | |
| 100 | CODE B | | FNC4 | | CODE B | 1 | 1 | 4 | 1 | 3 | 1 | |

| Symbol Character Value | Code Set A | ASCII Value for Code Set A | Code Set B | ASCII Value for Code Set B | Code Set C | Element Widths (Modules) | | | | | | Element Pattern | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B | S | B | S | B | S | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 101 | FNC4 | | CODE A | | CODE A | 3 | 1 | 1 | 1 | 4 | 1 | | | | | | | | | | | |
| 102 | FNC1 | | FNC1 | | FNC1 | 4 | 1 | 1 | 1 | 3 | 1 | | | | | | | | | | | |
| 103 | Start A | | | | | 2 | 1 | 1 | 4 | 1 | 2 | | | | | | | | | | | |
| 104 | Start B | | | | | 2 | 1 | 1 | 2 | 1 | 4 | | | | | | | | | | | |
| 105 | Start C | | | | | 2 | 1 | 1 | 2 | 3 | 2 | | | | | | | | | | | |

| Symbol Character Values | Code Set A | Code Set B | Code Set C | Element Widths (Modules) | | | | | | | Element Pattern | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | B | S | B | S | B | S | B | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | Stop | | | 2 | 3 | 3 | 1 | 1 | 1 | 2 | | | | | | | | | | | | | |

Note:    The Stop Character comprises 13 modules in four bars (dark bars) and three spaces (light bars). Every other character comprises 11 modules, starts with a bar (dark bar), ends with a space (light bar), and comprises six elements, each of which varies from one to four modules in width. The numeric values in the B and S columns represent the number of modules in each bar (dark bar) or space (light bar) element respectively in the symbol characters.

### 5.3.3.3 Code Sets

### 5.3.3.3.1 Code Set A

Code set A includes all of the standard upper case alphanumeric characters and punctuation characters together with the symbology elements (e.g., characters with ASCII values from 00 to 95) and seven special characters.

### 5.3.3.3.2 Code Set B

Code set B includes all of the standard upper case alphanumeric characters and punctuation characters together with the lowercase alphabetic characters (e.g., ASCII characters 32 to 127 inclusive) and seven special characters.

### 5.3.3.3.3 Code Set C

Code set C includes the set of 100 digit pairs from 00 to 99 inclusive, as well as three special characters. This allows numeric data to be encoded as two data digits per symbol character.

### 5.3.3.4 Special Characters

The last seven characters of code sets A and B (character values 96 to 102) and the last three characters of code set C (character values 100 to 102) are special non-data characters that, though they have particular significance to the bar code reader, have no ASCII character equivalents.

### 5.3.3.4.1 Code Set and Shift Characters

Code set and shift characters shall be used to change from one code set to another within a symbol. The decoder shall not transmit them.

- Code set characters: Code A, B, or C characters change the symbol code set from the code set previously defined to the new code set, which is defined by the code character. This change applies to all characters following the code set character until either the end of the symbol, another code set character, or the shift character is encountered.

- Shift character: The shift character changes the code set from A to B or B to A for the single character following the shift character. Characters following the affected character shall revert to the code set A or B defined prior to the shift character.

## 5.3.3.4.2 Function Characters

Function Characters (FNC) provide special operations and application instructions to the bar code reading device.

- The Function Code 1 (FNC1) shall be subject to the special considerations defined in Section 5.3.A.2. An FNC1 in the first position following the Start Character of a Code-128 Symbol is at all times a reserved use, which identifies the GS1 System.

- The Function 2 Character (FNC2) (Message Append) is not used in the GS1 System. It instructs the bar code reader to temporarily store the data from the symbol containing the FNC2 and transmit it as a prefix to the data of the next symbol. This may be used to concatenate several symbols before transmission. This character may occur anywhere in the symbol. Where the sequence of data is significant, provision should be made to ensure reading of the symbols in the correct sequence.

- The Function 3 Character (FNC3) (Initialise) instructs the bar code reader to interpret the data from the symbol containing the FNC3 as instructions for initialisation or reprogramming of the bar code reader. The data from the symbol shall not be transmitted by the bar code reader. This character may occur anywhere in the symbol.

- The Function 4 Character (FNC4) is not used in the GS1 System. In Code 128 Symbols, FNC4 is used to represent an extended ASCII character set (byte values 128 to 255) as specified in ISO 8859-1 or otherwise in an application specification. If a single FNC4 is used, the value 128 is added to the ASCII value of the following data character in the symbol. A shift character may follow the FNC4 if it is necessary to change the code set for the following data character. Subsequent data characters revert to the standard ASCII set. If two consecutive FNC4s are used, the value 128 is added to the ASCII value of the following data characters until two further consecutive FNC4s are encountered or the end of the symbol is reached. If, during this sequence of extended ASCII encodation, a single FNC4 is encountered, it is used to revert to standard ASCII encodation for the next data character only. Shift and code set characters shall have their normal effect during such a sequence. The default reference character set for extended ASCII values 128 to 255 is the corresponding half of ISO 8859-1, Latin alphabet 1, but application specifications may define or reference alternative sets corresponding to byte values 128 to 255.

## 5.3.3.5 Start and Stop Characters

- Start Characters A, B, and C define the corresponding code set to be used initially in the symbol.

- The Stop Character is common to all code sets.

- The decoder shall not transmit Start and Stop Characters.

## 5.3.3.6 Symbol Check Character

The Symbol Check Character shall be included as the last symbol character before the Stop Character. Section 5.3.A.1 defines the algorithm for its calculation. The Symbol Check Character shall not be represented in the Human Readable Interpretation, nor shall it be transmitted by the decoder.

## 5.3.3.7 GS1-128 Symbology Start Pattern

The GS1-128 Symbology has special double character start patterns consisting of Start (A, B, or C) FNC1. These special Start Characters differentiate GS1-128 Bar Code Symbols from the more generalised Code 128 Symbols.

In other words, a Code 128 Symbol, which begins with one of the GS1-128 Symbology double character start patterns, is always a GS1-128 Bar Code Symbol; a Code 128 Symbol, which does not begin with this start pattern, is never a GS1-128 Bar Code Symbol.

A Function Code 1 (FNC1) may be the Symbol Check Character (in less than 1 percent of cases). It is also used as a Separator Character, when appropriate, if Application Identifiers (AIs) and their data fields are concatenated into a single bar code.

- Start A begins the GS1-128 Symbol data encodation according to character set A.

- Start B begins the GS1-128 Symbol data encodation according to character set B.

- Start C begins the GS1-128 Symbol data encodation according to character set C. Start Character C should always be used when the data inclusive of the AI begins with four or more numeric characters.

### 5.3.4 Dimensional Requirements

GS1-128 Bar Code Symbols shall conform to the dimensions in the subsections that follow.

### 5.3.4.1 Minimum Width of a Module (X-Dimension)

The minimum X-dimension is defined by the application specification and requirements (see Section 5.4), while considering the equipment available for symbol production and scanning. For GS1-128 Bar Code Symbols, the absolute minimum X-dimension is 0.250 mm (0.00984 in.). The maximum X-dimension is 1.016 mm (0.040 in.). Application specifications stipulate a target and range of the X-dimension.

The X-dimension shall be constant throughout a given symbol.

### 5.3.4.2 Quiet Zone (Light Margin)

The minimum width of the Quiet Zone to the left and right of the GS1-128 Bar Code Symbol is 10x.

### 5.3.4.3 Maximum Symbol Length

The maximum length of any GS1-128 Bar Code Symbol must be within the following limits:

- The physical length, including Quiet Zones, cannot exceed 165 mm (6.5 in.).

- The maximum number of encoded data characters is 48, including the Application Identifier(s) and Function Code 1 (FNC1) when used as a Separator, but excluding the auxiliary characters and the Symbol Check Character.

### 5.3.5 Reference Decode Algorithm

Bar code reading systems are designed to read imperfect symbols to the extent that practical algorithms permit. This section describes the reference decode algorithm used in the computation of the Decodability value described in *ISO/IEC 15416.*

The algorithm contains the following steps to decode each character:

  1. Calculate eight width measurements p, e1, e2, e3, e4, b1, b2, and b3 (see Figure 5.3.5 – 1).

Figure 5.3.5 – 1

**Decode Measurements**
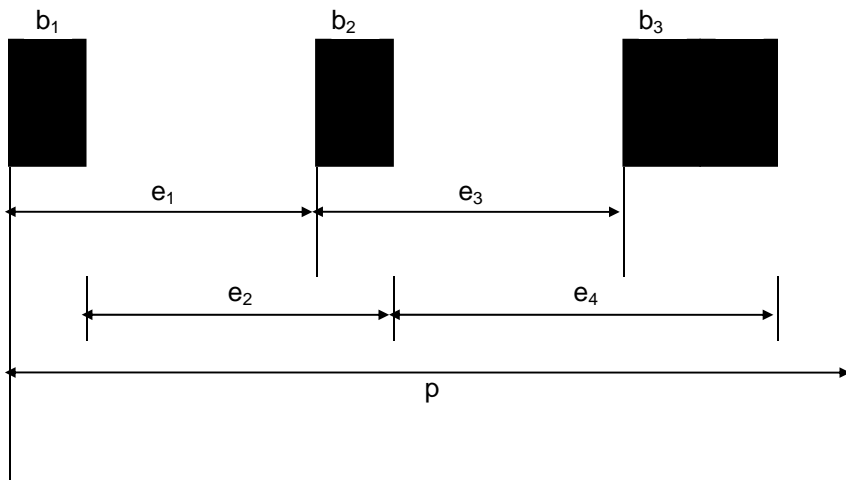


2.  Convert measurements $e_1$, $e_2$, $e_3$, and $e_4$ to normalised values $e_1$, $e_2$, $e_3$, and $e_4$, which will represent the integral module width ($e_i$) of these measurements. The following method is used for the i-th value:

    If $1{,}5p/11 \leq e_i < 2{,}5p/11$, then $E_i = 2$

    If $2{,}5p/11 \leq e_i < 3{,}5p/11$, then $E_i = 3$

    If $3{,}5p/11 \leq e_i < 4{,}5p/11$, then $E_i = 4$

    If $4{,}5p/11 \leq e_i < 5{,}5p/11$, then $E_i = 5$

    If $5{,}5p/11 \leq e_i < 6{,}5p/11$, then $E_i = 6$

    If $6{,}5p/11 \leq e_i < 7{,}5p/11$, then $E_i = 7$

    Otherwise the character is in error.

3.  Look up the character in the decode table using the four values E1, E2, E3, and E4 as the key (see Figure 5.3.5 – 2).

4.  Retrieve the self-checking symbol character value V, which is stored in the table with the character.  The value V is equal to the sum of the modules for the bars (dark bars) as defined for that character.

5.  Verify that:

    $(V-1{,}75)p / 11 < (b1 + b2 + b3) < (V + 1{,}75)p / 11$

    Otherwise the character is in error.

    The calculation indirectly uses character parity to detect all decode errors caused by single non-systematic one-module edge errors.

Using these five steps, decode the first character. If it is a Start Character, continue decoding the symbol in the normal forward direction. If it is not a Start Character but decodes as a Stop Character, attempt to decode all subsequent characters in the reverse direction.

After all characters have been decoded, make sure there was a valid Start Character, a valid Stop Character, and that the Symbol Check Character is correct.

Translate the symbol characters into the appropriate data characters from code set A, B, or C according to the Start Character, code characters, and shift characters used in the symbol.

In addition, perform other secondary checks on Quiet Zones, beam acceleration, absolute timing, and dimensions that are appropriate considering the specific reading device and intended application environment.

Note:  In this algorithm the symbol is decoded using edge to similar edge measurements (e) and an additional measurement of the sum of the three bar (dark bar) widths.

Figure 5.3.5 – 2

**Edge Differences for Decoding Code 128 Symbols**

| Char. Value | E1 | E2 | E3 | E4 | V | Char. Value | E1 | E2 | E3 | E4 | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | 3 | 3 | 4 | 4 | 6 | 54 | 4 | 2 | 2 | 3 | 6 |
| 01 | 4 | 4 | 3 | 3 | 6 | 55 | 4 | 2 | 4 | 5 | 6 |
| 02 | 4 | 4 | 4 | 4 | 6 | 56 | 6 | 4 | 2 | 3 | 6 |
| 03 | 3 | 3 | 3 | 4 | 4 | 57 | 4 | 3 | 3 | 2 | 6 |
| 04 | 3 | 3 | 4 | 5 | 4 | 58 | 4 | 3 | 5 | 4 | 6 |
| 05 | 4 | 4 | 3 | 4 | 4 | 59 | 6 | 5 | 3 | 2 | 6 |
| 06 | 3 | 4 | 4 | 3 | 4 | 60 | 4 | 5 | 5 | 2 | 8 |
| 07 | 3 | 4 | 5 | 4 | 4 | 61 | 4 | 3 | 5 | 5 | 4 |
| 08 | 4 | 5 | 4 | 3 | 4 | 62 | 7 | 4 | 2 | 2 | 6 |
| 09 | 4 | 3 | 3 | 3 | 4 | 63 | 2 | 2 | 3 | 4 | 4 |
| 10 | 4 | 3 | 4 | 4 | 4 | 64 | 2 | 2 | 5 | 6 | 4 |
| 11 | 5 | 4 | 3 | 3 | 4 | 65 | 3 | 3 | 2 | 3 | 4 |
| 12 | 2 | 3 | 4 | 5 | 6 | 66 | 3 | 3 | 5 | 6 | 4 |
| 13 | 3 | 4 | 3 | 4 | 6 | 67 | 5 | 5 | 2 | 3 | 4 |
| 14 | 3 | 4 | 4 | 5 | 6 | 68 | 5 | 5 | 3 | 4 | 4 |
| 15 | 2 | 4 | 5 | 4 | 6 | 69 | 2 | 3 | 4 | 3 | 4 |
| 16 | 3 | 5 | 4 | 3 | 6 | 70 | 2 | 3 | 6 | 5 | 4 |
| 17 | 3 | 5 | 5 | 4 | 6 | 71 | 3 | 4 | 3 | 2 | 4 |
| 18 | 4 | 5 | 5 | 3 | 6 | 72 | 3 | 4 | 6 | 5 | 4 |
| 19 | 4 | 3 | 2 | 4 | 6 | 73 | 5 | 6 | 3 | 2 | 4 |
| 20 | 4 | 3 | 3 | 5 | 6 | 74 | 5 | 6 | 4 | 3 | 4 |
| 21 | 3 | 4 | 5 | 3 | 6 | 75 | 6 | 5 | 3 | 3 | 4 |
| 22 | 4 | 5 | 4 | 2 | 6 | 76 | 4 | 3 | 2 | 2 | 4 |
| 23 | 4 | 3 | 3 | 4 | 8 | 77 | 5 | 4 | 4 | 2 | 8 |
| 24 | 4 | 2 | 3 | 4 | 6 | 78 | 6 | 5 | 2 | 2 | 4 |
| 25 | 5 | 3 | 2 | 3 | 6 | 79 | 4 | 7 | 5 | 2 | 6 |
| 26 | 5 | 3 | 3 | 4 | 6 | 80 | 2 | 2 | 3 | 6 | 6 |
| 27 | 4 | 3 | 4 | 3 | 6 | 81 | 3 | 3 | 2 | 5 | 6 |
| 28 | 5 | 4 | 3 | 2 | 6 | 82 | 3 | 3 | 3 | 6 | 6 |
| 29 | 5 | 4 | 4 | 3 | 6 | 83 | 2 | 5 | 6 | 3 | 6 |
| 30 | 3 | 3 | 3 | 3 | 6 | 84 | 3 | 6 | 5 | 2 | 6 |
| 31 | 3 | 3 | 5 | 5 | 6 | 85 | 3 | 6 | 6 | 3 | 6 |
| 32 | 5 | 5 | 3 | 3 | 6 | 86 | 5 | 2 | 3 | 3 | 6 |
| 33 | 2 | 2 | 4 | 5 | 4 | 87 | 6 | 3 | 2 | 2 | 6 |
| 34 | 4 | 4 | 2 | 3 | 4 | 88 | 6 | 3 | 3 | 3 | 6 |
| 35 | 4 | 4 | 4 | 5 | 4 | 89 | 3 | 3 | 3 | 5 | 8 |
| 36 | 2 | 3 | 5 | 4 | 4 | 90 | 3 | 5 | 5 | 3 | 8 |
| 37 | 4 | 5 | 3 | 2 | 4 | 91 | 5 | 3 | 3 | 3 | 8 |
| 38 | 4 | 5 | 5 | 4 | 4 | 92 | 2 | 2 | 2 | 5 | 6 |
| 39 | 3 | 2 | 4 | 4 | 4 | 93 | 2 | 2 | 4 | 7 | 6 |
| 40 | 5 | 4 | 2 | 2 | 4 | 94 | 4 | 4 | 2 | 5 | 6 |
| 41 | 5 | 4 | 4 | 4 | 4 | 95 | 2 | 5 | 5 | 2 | 6 |
| 42 | 2 | 3 | 3 | 4 | 6 | 96 | 2 | 5 | 7 | 4 | 6 |
| 43 | 2 | 3 | 5 | 6 | 6 | 97 | 5 | 2 | 2 | 2 | 6 |
| 44 | 4 | 5 | 3 | 4 | 6 | 98 | 5 | 2 | 4 | 4 | 6 |
| 45 | 2 | 4 | 4 | 3 | 6 | 99 | 2 | 4 | 4 | 5 | 8 |
| 46 | 2 | 4 | 6 | 5 | 6 | 100 | 2 | 5 | 5 | 4 | 8 |
| 47 | 4 | 6 | 4 | 3 | 6 | 101 | 4 | 2 | 2 | 5 | 8 |
| 48 | 4 | 4 | 4 | 3 | 8 | 102 | 5 | 2 | 2 | 4 | 8 |
| 49 | 3 | 2 | 4 | 6 | 6 | 103 | 3 | 2 | 5 | 5 | 4 |
| 50 | 5 | 4 | 2 | 4 | 6 | 104 | 3 | 2 | 3 | 3 | 4 |
| 51 | 3 | 4 | 4 | 2 | 6 | 105 | 3 | 2 | 3 | 5 | 6 |
| 52 | 3 | 4 | 6 | 4 | 6 | Stop<sub>A</sub> | 5 | 6 | 4 | 2 | 6 |
| 53 | 3 | 4 | 4 | 4 | 8 | Stop<sub>B</sub> | 3 | 2 | 2 | 4 | 6 |

Note: Stop$_A$ values are for decoding in a forward direction. Stop$_B$ values apply to the first six elements of the Stop Character starting at the rightmost side when scanned in a reverse direction.

## 5.3.6 Symbol Quality

## 5.3.6.1 General

*ISO/IEC 15416* defines a standardised methodology for measuring and grading bar code symbols. Code 128 Symbols shall be evaluated according to that standard. The reference decode algorithm defined in Section 5.3.5 shall be used for the assessment of the decode and Decodability parameters under ISO/IEC 15416.

For GS1-128 Bar Code Symbol minimum quality levels, refer to Section 5.3.7.

## 5.3.6.2 Decodability

Decodability is a measure of how closely the decode algorithm measurement values approach those in a theoretically perfect symbol. Thus, Decodability is a parameter that measures how closely the Scan Reflectance Profile is to approaching decode failure for a given printed symbol.

For the calculation of the Decodability value V, the following provisions apply, which supplement those described in *ISO/IEC 15416* for edge to similar edge decodable symbologies:

Substitute V1 for $V_C$ in the formula $V_C = K / (S / 2n)$.

Where: K = the smallest difference between a measurement and a reference threshold

N = 11 (number of modules in a symbol character)

S = total width of the character

Calculate V2:

$$V2 = \frac{1{,}75 - (ABS((W_b \times 11/S) - M))}{1{,}75}$$

Where: M = number of dark modules in the character

S = total width of the character

$W_b$ = sum of the bar (dark bar) widths in the character

ABS = mathematical term for taking the absolute of the calculation that follows it

$V_C$ is the lesser of V1 and V2.

The Stop Character includes an additional terminating bar (dark bar). For the purpose of measuring Decodability, the Stop Character should be checked twice: first using the six leftmost elements and then using the six rightmost elements from right to left. Both sets of six elements are equivalent in width to a standard character.

### 5.3.6.3 Quiet Zones (Light Margins)

The Quiet Zones to the right and left of the GS1-128 Bar Code Symbol are compulsory. Both Quiet Zones have a minimum width of 10x.

I*SO/IEC 15416* allows for additional pass/fail criteria to be stipulated by a symbology specification. In the case of a GS1-128 Bar Code Symbol, a minimum Quiet Zone of 10Z is specified. Both left and right Quiet Zones on each Scan Reflectance Profile (SRP) under *ISO/IEC 15416* shall be measured and graded as follows:

> Quiet Zone $\geq$ 10Z: Grade 4 (A)

> Quiet Zone < 10Z: Grade 0 (F)

> Where Z = the average measured width of the narrow bars (dark bars) and spaces (light bars) (one module) in the symbol

### 5.3.6.4 Transmitted Data

Transmitted data from a decoded GS1-128 Bar Code Symbol shall comprise the byte values of the data characters. It is prefixed by the symbology identifier ]C1, if used. The Start and Stop Characters, function characters, code set and shift characters, and Symbol Check Character shall not be included in the transmitted data.

For GS1-128 Symbology implementation, see .

### 5.3.7  GS1-128 Symbology Application Parameters

### 5.3.7.1 Symbol Height

For GS1-128 Bar Code Symbols used in general distribution, the minimum height of the bars (dark bars) in the symbol is 32 mm (1.25 in.). The actual symbol height used depends on the specific application requirements.

### 5.3.7.2 Symbol Length

The dimensions of the GS1-128 Bar Code Symbol depend on the number of characters encoded:

| | | | |
|---|---|---|---|
| 1 Start Character | x 11 modules | = | 11 |
| Function Code 1 (FNC1) | x 11 modules | = | 11 |
| 1 Symbol Check Character | x 11 modules | = | 11 |
| 1 Stop Character | x 13 modules | = | 13 |
| N symbol characters | x 11 modules | = | 11N |

$$(11N + 46)\ \text{modules}$$

Where N is the number of symbol characters, any auxiliary characters (shift and code characters) embedded in the data are included.

A module is equal to the X-dimension of the symbol.

Character set C allows two digits to be encoded in one symbol character. Thus, numeric data can be encoded with twice the density of other data when using character set C.

In addition, Quiet Zones to the right and left of the bar code are compulsory and both have widths of 10 modules.

Thus total symbol length, including Quiet Zones, is:

$$(11N + 66) \text{ modules} = (11N + 66) \text{ x}$$

## 5.3.7.3 Maximum Symbol Length

Two parameters have to be taken into consideration for defining the maximum length of a GS1-128 Bar Code Symbol: the physical length, which depends on the number of characters encoded and the module width (or X-dimension) used, and the number of data characters encoded excluding the auxiliary characters.

The maximum length of any GS1-128 Bar Code Symbol must be within the following limits:

- The physical length, including Quiet Zones, cannot exceed 165 mm (6.5 in.).

- The maximum number of encoded data characters is 48, including the Application Identifier(s) and Function Code 1 (FNC1) when used as a Separator, but excluding the auxiliary characters and the Symbol Check Character.

## 5.3.7.4 Human Readable Interpretation

The Human Readable Interpretation of the data in the bar code symbol must be shown below the symbol. Start, Stop, shift, and function characters, as well as the Symbol Check Character, are not shown in the human readable format.

The precise location of the Human Readable Interpretation and the font used to represent the characters are not specified for GS1-128 Bar Code Symbols. However, the characters should be clearly legible (such as OCR-B) and must be obviously associated with the symbol. The Quiet Zones must not be violated.

Application Identifiers should be clearly recognisable to facilitate key entry. This is achieved by putting parentheses around Application Identifiers in the Human Readable Interpretation.

Note: The parentheses are not part of the data and are not encoded in the bar code symbol.

## 5.3.7.5 Transmitted Data (FNC1)

The following GS1-128 Symbology implementation specifications are in accordance with *ISO/IEC 15417 Appendix 2* for transmitted data:

- The Function Code 1 (FNC1) may validly occur as the Symbol Check Character.

- FNC1 in the third or subsequent character position is transmitted as the ASCII character 29 (GS).

- Symbols using FNC1 in the first data position should have symbology identifiers enabled.

- When FNC1 is used in the first position it shall not be represented in the transmitted message, although its presence is indicated by the use of modifier value 1 in the symbology identifier.

## 5.3.8 Rules for Encoding/Decoding Element Strings in GS1-128 Symbology

## 5.3.8.1 The Basic Structure of GS1-128 Bar Code Symbols

All bar code symbologies use particular symbol characters to mark the beginning and the end of the bar code symbol. A GS1-128 Bar Code Symbol may begin with the Start Character A, B, or C, which determines the interpretation of the subsequent symbol characters. GS1-128 Symbology uses the Function Code 1 (FNC1) in the position following the Start Character. This double start pattern is reserved for GS1 System applications worldwide. This makes it possible to distinguish GS1-128 Bar Code Symbols from extraneous non-standard bar code symbols.

## 5.3.8.2 The Basic Structure of Each GS1-128 Bar Code Symbol

Figure 5.3.8.2 – 1

**GS1-128 Bar Code Symbol Structure**

| Start Character A , B, or C | Function Code 1 (FNC1) | Element String | | Symbol Check Character | Stop Character |
|---|---|---|---|---|---|
| | | Application Identifier | Data Field (s) | | |

This is the data area of the symbol. It may vary in length and comprise several Element Strings. The scanner transmits this area together with the symbology identifier as a full string

These symbol characters are required in each symbol.
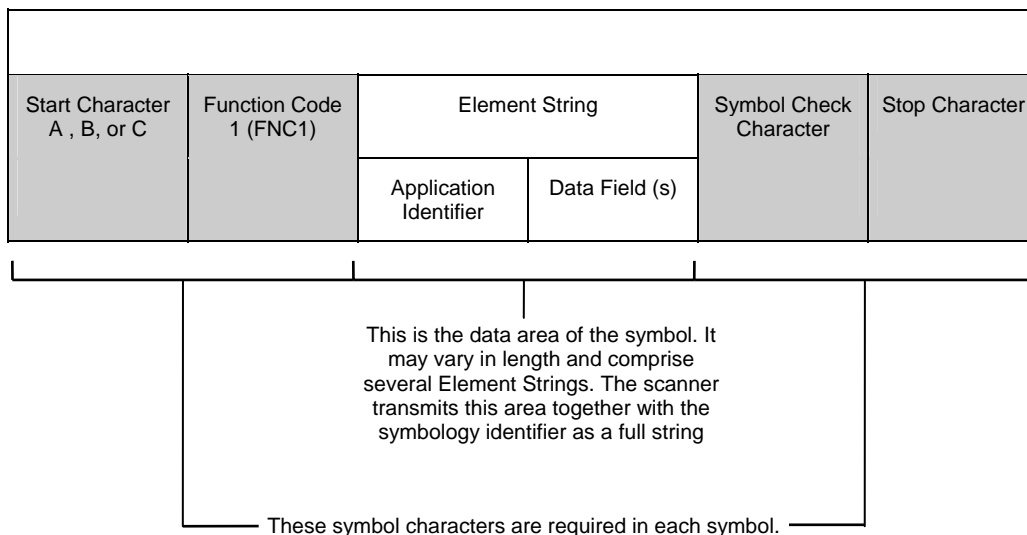
Since GS1-128 Bar Code Symbols vary in length, it is important to ensure that:

- Not more than 48 data characters are encoded (see the data area of Figure 5.3.8.2 – 1)

- The physical length does not exceed 165 mm (6.5 in.) including Quiet Zones

The maximum length allows several Element Strings to be encoded in one bar code symbol, a process called concatenation. Concatenation is advantageous because it means that the symbology elements are only needed once, and the space required for the symbol is smaller than when separate bar code symbols are used to encode each Element String. It also improves scanning accuracy, allowing for single scanning rather than multiple scanning. The various Element Strings can be transmitted from the bar code reader as a single full string.

The various Element Strings, which are transmitted from concatenated bar code symbols, have to be analysed and processed. To simplify this procedure and reduce the symbol size, the lengths of some Element Strings are pre-defined (see Figure 5.3.8.2.1 – 1). Element Strings that are not contained in Figure 5.3.8.2.1 – 1 and that do not appear at the end of the symbol (encoded immediately before the Symbol Check Character) must immediately be followed by an FNC1 to separate it from the Element String that follows.

## 5.3.8.2.1 Pre-Defined Length Application Identifiers

Figure 5.3.8.2.1 – 1 contains all Application Identifiers that have a predefined length and, therefore, do not require a Function Code 1 (FNC1) separator.

Figure 5.3.8.2.1 – 1

| Element Strings with Pre-Defined Length Using Application Identifiers | | | |
|---|---|---|---|
| First Two Digits of the Application Identifier | Number of Characters (Application Identifier and Data Field) | First Two Digits of the Application Identifier | Number of Characters (Application Identifier and Data Field) |
| 00 | 20 | 17 | 8 |
| 01 | 16 | (18) | 8 |
| 02 | 16 | (19) | 8 |
| (03) | 16 | 20 | 4 |
| (04) | 18 | 31 | 10 |
| 11 | 8 | 32 | 10 |
| 12 | 8 | 33 | 10 |
| 13 | 8 | 34 | 10 |
| (14) | 8 | 35 | 10 |
| 15 | 8 | 36 | 10 |
| (16) | 8 | 41 | 16 |

Figure 5.3.8.2.1 – 1 is limited to the listed numbers and will remain unchanged. Those numbers in parentheses are not yet assigned.

## 5.3.8.2.2    Application Identifier Digits 23

The first two digits of the Application Identifier (23n) presented a special case. The first digit following AI (23n) indicates the length of the Element String. No Separator Character was required when AI (23n) is used in a concatenated Element String. Application Identifier (23n) is no longer supported.

## 5.3.8.3 Concatenation

Using the GS1-128 Bar Code Symbol, it is possible to concatenate (chain together) discrete Element Strings. Figure 5.3.8.2.1 – 1 specifies the total Element String length (including the Application Identifier) associated with the first two digits of an Application Identifier. Application Identifiers starting with two digits that are not included in Figure 5.3.8.2.1 – 1 have a variable length even if the definition of the Application Identifier specifies a fixed length data field.

## 5.3.8.3.1 Concatenation of the Pre-Defined Length Element Strings

Concatenated Element Strings constructed from Application Identifiers with a pre-defined length do not require a Separator Character. Each Element String is immediately followed by either the next Application Identifier or the Symbol Check Character and Stop Character.

For example, concatenation of net weight (4 kg) with the associated Global Trade Item Number™ (GTIN™) 95012345678903 does not require the use of a Separator Character. From <u>Figure 5.3.8.2.1 – 1</u>, Element Strings with Pre-Defined Length Using Application Identifiers:

- 01 has a pre-defined Element String length of 16 digits.

- 31 has a pre-defined Element String length of 10 digits.

Figure 5.3.8.3.1 – 1

GTIN 95012345678903                                             Net weight 4.00 kg



(0 1) 9 5 0 1 2 3 4 5 6 7 8 9 0 3                  (3 1 0 2) 0 0 0 4 0 0
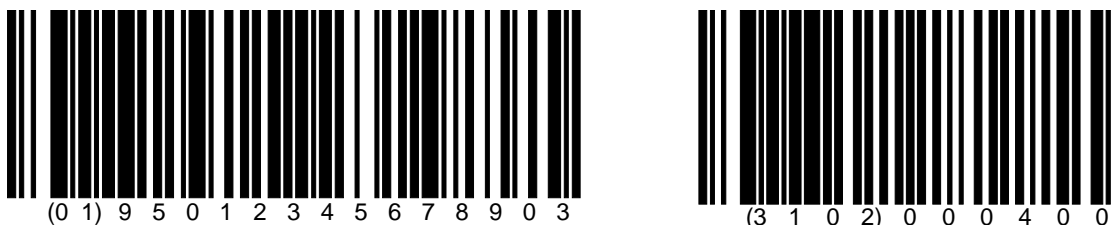
Figure 5.3.8.3.1 – 2

GTIN 95012345678903 + Net weight 4.00 kg



(0 1) 9 5 0 1 2 3 4 5 6 7 8 9 0 3 (3 1 0 2) 0 0 0 4 0 0
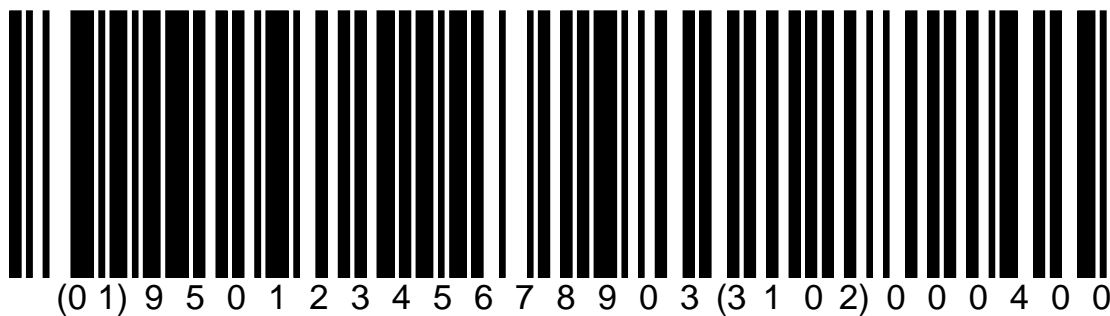
## 5.3.8.3.2 Variable Length Data Strings

Concatenating Element Strings of variable length, which includes all Application Identifiers that do not start with two characters contained in Figure 5.3.8.2.1 – 1, involves the use of a Separator Character. The Separator Character used is the Function Code 1 (FNC1). It is placed immediately after the last symbol character of a variable length data string and is followed by the Application Identifier of the next Element String. If the Element String is the last to be encoded, it is followed by the Symbol Check and Stop Characters and not the FNC1 Separator Character.

For example, concatenation of price per unit of measure (365 currency units) and batch number (123456) requires the use of a Separator Character immediately after the price per unit of measure.

Figure 5.3.8.3.2 – 1



Price per unit of measure 365



Batch number 123456

Figure 5.3.8.3.2 – 2

Price per unit of measure 365                  Batch number 123456
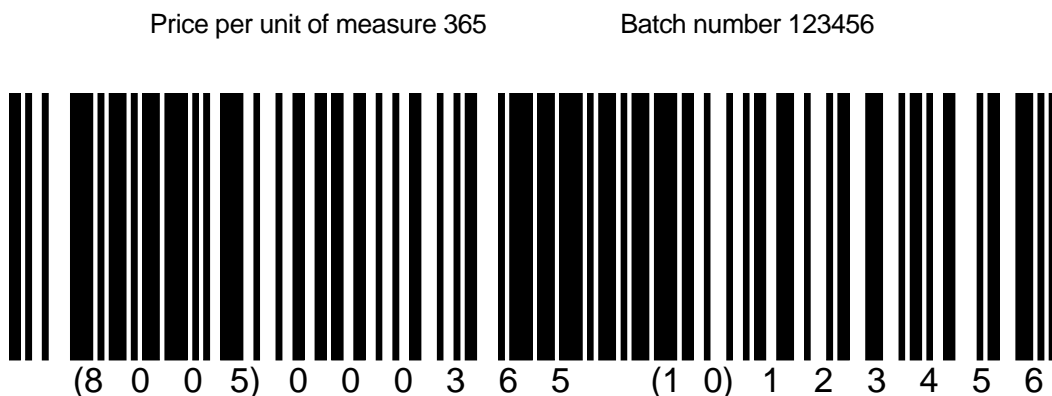


Note:  The FNC1 is not shown in Human Readable Interpretation.

## 5.3.8.3.3 Pre-Defined and Variable Length Element Strings

When concatenating a mixture of pre-defined and other Element Strings, place the pre-defined Element Strings before the variable length Element Strings. The Separator Character is not used to terminate pre-defined Element Strings, and hence, fewer symbol characters are required in the concatenated bar code.

## 5.3.8.4 The Separator Character (FNC1)

The Separator Character appears in the decoded data string as <GS> (ASCII character 29, 7-bit character set ISO 646). All Element Strings not of pre-defined length must be followed by a Function Code 1 (FNC1) separator when followed by another Element String in a single bar code symbol. An FNC1 is not  is required at the end of the last Element String represented in a GS1-128 Bar Code Symbol. The processing routine shown on the next page allows for a FNC1 entered by error after an Element String contained in <u>Figure 5.3.8.3.2 – 1</u>.

Refer to <u>Section 5.3.7</u> for additional information on encoding/decoding FNC1.

## 5.3.8.5 Mixing GS1-128 Symbology with Other Symbologies

Global Trade Item Numbers™ (GTINs™) may be carried in any of the GS1 System endorsed symbologies. When additional data is required beyond the GTIN, GS1-128 Bar Code Symbols are used. The GS1-128 Symbology specification does not eliminate other GS1 Symbologies. In these cases, the GTIN is printed using an ITF-14 Symbol or other GS1 System symbologies and additional data using a GS1-128 Bar Code Symbol.

## 5.3.8.6 Symbol Placement

The preferred placement for a supplementary GS1-128 Symbol is on the same horizontal plane as the bar code symbol containing the Global Trade Item Number™ (GTIN™), SSCC, or other stand-alone GS1 System identification number. The supplementary symbol(s) should be as close as possible to the main symbol and must not interfere with the Quiet Zones.

- Orient the supplementary symbols in the same direction as the main symbol. Main symbol placement guidelines are given in <u>Section 6.0</u>.

- Concatenated symbols must follow the symbol placement guidelines given in <u>Section 6.0</u>. based upon the GS1 System ID number they encode (GTIN, SSCC).

## 5.3.8.7 Processing GS1-128 Bar Code Symbols - Basic Required Logic

See <u>Figure 7.9 – 1</u> for a flow chart of the logic required to accurately parse GS1-128 Bar Code Symbols from the full data strings output from a scanner.

## 5.3.A.1 Appendix 1: (Normative) Additional Features of Code 128

### 5.3.A.1.1 Symbol Check Character

The Code 128 Symbol Check Character shall be calculated according to the following rules.

1. Retrieve the symbol character value from Figure 5.3.3.2 – 1.

2. Each symbol character position is given a weight. The Start Character is weighted 1. Then, beginning on the left with the first symbol character following the Start Character, the weights are 1, 2, 3, and 4 to...n for all following symbol characters up to, but not including, the Symbol Check Character itself; n denotes the number of symbol characters representing data or special information in the symbol, exclusive of the Start and Stop Characters and Symbol Check Character.

   Note:  Both the Start Character and the first symbol character following the Start Character (the Function Code 1 (FNC1) for all GS1-128 Bar Code Symbols) are weighted by one.

3. Each symbol character value is multiplied by its weight.

4. The products of the calculations in step 3 are totalled.

5. The sum of the products is divided by 103.

6. The remainder derived from the calculation in step 5 is the symbol character value of the Symbol Check Character.

Figure 5.3.A.1 –1 shows how to calculate the Symbol Check Character value for the batch number 2503X using the GS1-128 Bar Code Symbol.

Figure 5.3.A.1 – 1

Start C  FNC1  $10^{\curlyvee}$  25  03  Code B  X  [Symbol Check Character]  Stop

| Characters | Start C | FNC1 | 10 | 25 | 03 | Code B | X |
|---|---|---|---|---|---|---|---|
| Character values (Step 1) | 105 | 102 | 10 | 25 | 3 | 100 | 56 |
| Weights (Step 2) | 1 | 1 | 2 | 3 | 4 | 5 | 6 |
| Products (Step 3) | 105 | 102 | 20 | 75 | 12 | 500 | 336 |
| Sum of products (Step 4) | | 1150 | | | | | |
| Divide by 103 (Step 5) | | 1150 / 103 = 11 | | | | | |
| Remainder = Symbol Check Character value | | 17 | | | | | |

The Symbol Check Character shall be positioned immediately following the final data or special character and before the Stop Character.

Note: The Symbol Check Character shall not be shown in the Human Readable Interpretation.

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$^{\curlyvee}$ Application Identifier (10) is defined as batch or lot number.

## 5.3.A.2 Appendix 2: (Informative) Relationship of Symbol Character Value to ASCII Value

In order to convert symbol character value (S) to ASCII decimal value or vice versa, the following relationships are applicable for code set A and code set B.

- Code set A

  If $S \leq 63$,

  ASCII value = S + 32

  If $64 \leq S \leq 95$,

  ASCII value = S - 64

  - Code set B

  If $S \leq 95$,

  ASCII value = S + 32

The resulting values are shown in Figure 5.3.3.2 – 1.

Note: As described in Section 5.3.3, the Function 4 Character (FNC4) is not used in the GS1 System. However, the presence of FNC4 in Code 128 Symbols has the effect of adding 128 to the ASCII value of the following data character or characters derived from the rules given above.

## 5.3.A.3 Appendix 3: (Informative) Use of Start, Code Set, and Shift Characters to Minimise Symbol Length

The same data may be represented by different GS1-128 Bar Code Symbols through the use of different combinations of Start, code set, and shift characters.

The following rules should normally be implemented in printer control software to minimise the number of symbol characters needed to represent a given data string (and, therefore, reduce the overall symbol length).

1. Determine the Start Character:

    a. If the data consists of two digits, use Start Character C.

    b. If the data begins with four or more numeric data characters, use Start Character C.

    c. If an ASCII symbology element (e.g., NUL) occurs in the data before any lowercase character, use Start Character A.

    d. Otherwise, use Start Character B

2. If Start Character C is used and the data begins with an odd number of numeric data characters, insert a code set A or code set B character before the last digit, following rules 1c and 1d above to determine between code sets A and B.

3. If four or more numeric data characters occur together when in code sets A or B and:

    a. If there is an even number of numeric data characters, then insert a code set C character before the first numeric digit to change to code set C.

    b. If there is an odd number of numeric data characters, then insert a code set C character immediately after the first numeric digit to change to code set C.

4. When in code set B and an ASCII symbology element occurs in the data:

    a. If following that character, a lowercase character occurs in the data before the occurrence of another symbology element, then insert a shift character before the symbology element.

    b. Otherwise, insert a code set A character before the symbology element to change to code set A

5. When in code set A and a lowercase character occurs in the data:

    a. If following that character, a symbology element occurs in the data before the occurrence of another lowercase character, then insert a shift character before the lowercase character.

    b. Otherwise, insert a code set B character before the lowercase character to change to code set B

6. When in code set C and a non-numeric character occurs in the data, insert a code set A or code set B character before that character, and follow rules 1c and 1d to determine between code sets A and B.

Note 1:  In these rules, the term "lowercase" is used for convenience to mean any code set B character with Code 128 Symbol character values 64 to 95 (ASCII values 96 to 127) (e.g., all lowercase alphanumeric characters plus `{|}~DEL). The term "symbology element" means any code set A character with Code 128 Symbol character values 64 to 95 (ASCII values 00 to 31).

Note 2:  If the Function Code 1 (FNC1) occurs in the first position following the Start Character, or in an odd-numbered position in a numeric field, it should be treated as two digits for the purpose of determining the appropriate code set.

## 5.3.A.4 Appendix 4: (Informative) Guidelines for the Use of Code 128

### 5.3.A.4.1 Autodiscrimination Compatibility

Code 128 Symbols may be read by suitably programmed bar code readers that have been designed to autodiscriminate these symbols from other symbologies.  Code 128 Symbology is fully distinguishable from, and thus compatible with, the following linear symbologies:

- ITF (Interleaved 2-of-5)

- Codabar

- Code 39

- Code 93

- EAN/UPC

- Telepen

- Reduced Space