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1 Introduction

The GS1 System uses the following bar code symbologies as the data carriers:

- The EAN/UPC Symbology is exclusively reserved for encoding Global Trade Item Numbers (GTINs). EAN/UPC Bar Codes must be used for all trade items which are scanned at the Point-of-Sale (POS) in retail outlets and may be used on other non-retail trade items. EAN-8 and UPC-E Bar Codes are only used on very small retail trade items to encode the GTIN-8 and zero-supressed GTIN-12 respectively.
- The ITF-14 Symbol is exclusively used for encoding GTINs printed on non-retail trade items not passing through the retail POS. The ITF-14 Bar Code is better suited for direct printing on to corrugated fibreboard.
- The GS1-128 Symbol is a precise subset of the 'Code 128' Symbology. Its use is exclusively licensed by GS1. This extremely flexible symbol is used for the encoding of GS1 Identification Keys as well as encoding attribute information using Application Identifiers.

Unit type	EAN-8 UPC-E	EAN-13 UPC-A	GS1-128	ITF-14
Retail trade item	✓	✓		
Non-retail trade item		✓	✓	✓
Logistic Unit			✓	
Location			✓	
Asset			✓	
Document or Service Relationship			✓	

TABLE 1. Bar Code Options

- The GS1 DataBar Symbology is a family of bar codes which can be printed as stand-alone symbols or with an accompanying 2D Composite Component printed directly above the GS1 DataBar linear component. GS1 DataBar has been approved for bilateral use between trading partners from 2010. In 2014 GS1 DataBar becomes an open symbology and all scanning environments must be able to read these symbols. To date, symbol specifications have been developed for retail Point-of-Sale only.
- The GS1 DataMatrix Symbol is a stand-alone two-dimensional matrix symbology that is made up of square modules arranged within a finder pattern. A GS1 DataMatrix Symbol can only be scanned with an imaging scanner.

1.1 Symbology Operational Bands

Consideration for selecting the correct bar code specification is based on where the symbol will actually be scanned, or the bar code operative scanning environment. The six operative scanning environments for GS1 Bar Codes are;

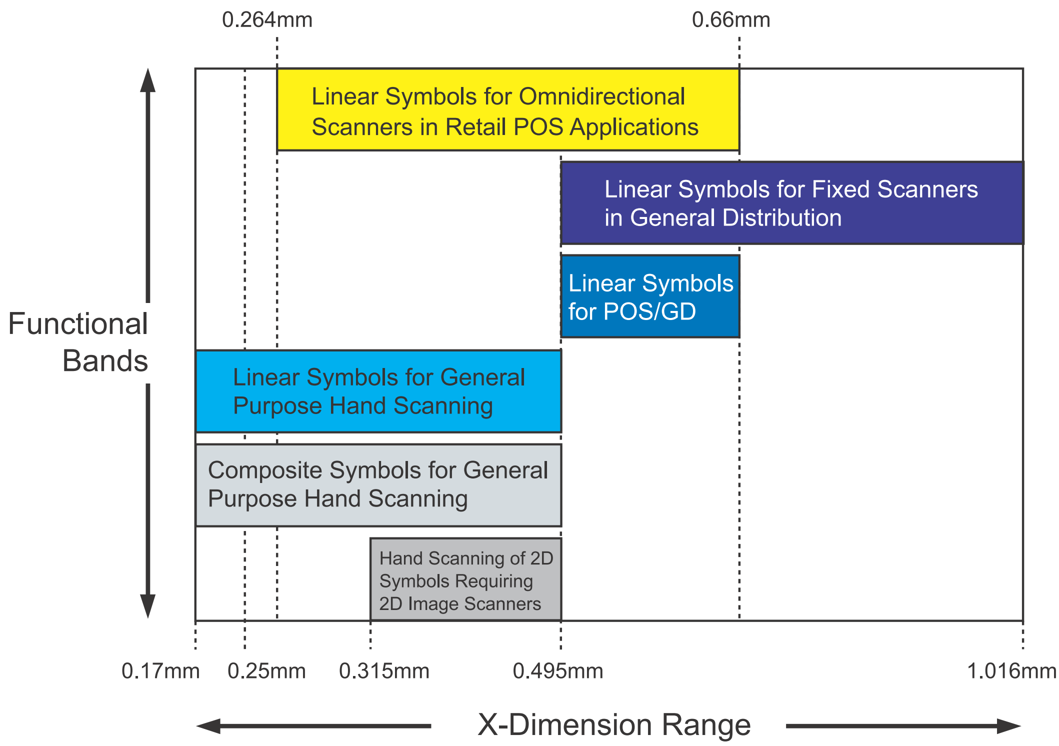

Figure 1 - Symbology Operational Bands

Omnidirectional Scanners in Retail POS Applications

This band is primarily intended for retail operations to provide orientation-free scanning. Scanners are designed to read over-square bar codes such as EAN/UPC and those GS1 DataBar Symbols that can be read by omnidirectional scanners. The approximate average distance between scanner and bar code is 100mm.

Fixed Scanners in General Distribution

The fixed scanners in General Distribution band is primarily intended to facilitate automated scanning of trade items packaged for transport and logistic units using fixed mount scanners. In this environment it is essential to maintain symbol height and location to achieve acceptable scan rates.

Both Retail POS and General Distribution

Linear bar codes for both Retail and General Distribution band covers trade items in specific packaging suitable for transport purposes in General Distribution Scanning but that are also scanned at the retail POS.

General Purpose Hand Scanning

This scanner band covers a broad range of applications. Bar code size must be within the maximum and minimum boundaries for the symbology, but the target size is directly related to the exact usage as specified by the application guidelines. It has been divided into three bands. One for linear general purpose hand scanning and two bands for two-dimensional bar codes, Composite component and Data Matrix. In general, the rule is that Composite Components shall be printed at the same density as their linear host. Data Matrix Symbols shall be printed at densities that are 50 percent greater than corresponding linear symbols with Composite Components. Therefore, the bands for linear symbols and Composite Components are very similar in density and if the same scanner types are chosen, as in the case of Composite Symbols, the bands become one.

1.2 Symbology Identifiers

All scanning equipment has the ability to recognise the symbology of the bar code that has been scanned. Some scanners have the optional feature of being able to transmit a **Symbology Identifier**. The Symbology Identifier is a three character data string of format **]cm** comprising a flag character, code character and a modifier character.

Character	Description
]	The flag character (which has an ASCII value of 93) denotes that the two characters following are symbol identifier characters.
c	The code character denotes the type of symbology.
m	The modifier character denotes the mode in which the symbology is used.

TABLE 2. Symbology identifier definitions

Note: If used the symbology identifier is transmitted as a prefix to the data message.

The symbology identifiers used in the GS1 System are as follows:

Symbology identifier*	Symbology format	Content
] E 0	EAN-13, UPC-A or UPC-E	13 digits
] E 1	Two-digit EAN/UPC Add-on	2 digits
] E 2	Five-digit EAN/UPC Add-on	5 digits
] E 3	EAN-13, UPC-A or UPC-E with Add-on**	15 or 18 digits
] E 4	EAN-8	8 digits
] I 1	ITF-14	14 digits
] C 1	GS1-128	Standard AI Element Strings
] e 0	GS1 DataBar***	Standard AI Element Strings
] e 1	GS1 Composite	Data packet containing the data following an encoded symbol separator character.
] e 2	GS1 Composite	Data packet containing the data following an escape mechanism character.
] d 2	GS1 DataMatrix	Standard AI Element Strings

* Symbology identifiers are case sensitive.
** EAN/UPC Bar Codes with Add-Ons may be considered either as two separate bar codes, each of which is transmitted separately with its own symbology identifier, or as a single data packet. The system designer shall select one of these methods.
*** The same symbology identifier is used for all versions of GS1 DataBar

TABLE 3. Symbology Identifiers

1.3 Disclaimer

Every possible effort has been made to ensure that the information and specifications in this manual are correct, however GS1 Australia expressly disclaim liability for any errors. In addition, no warranty or representation is made that this manual will not require modification due to developments in technology or changes or additions to the GS1 System.

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2.1 Structure

The EAN/UPC Symbology consists of four symbol types;

- EAN-13 encodes a GTIN-13
- EAN-8 encodes a GTIN-8
- UPC-A encodes a GTIN-12
- UPC-E encodes a zero suppressed GTIN-12

EAN-13, UPC-A and UPC-E Bar Codes can be accompanied by an Add-On Symbol. For details of Add-On Symbols contact GS1 Australia.

For EAN/UPC Symbol dimensions refer to chapter 9, section 9.6.5 EAN/UPC Bar Code Dimensions on page 87.

EAN-13, EAN-8 and UPC-A Symbols follow a standard structure. An example with an EAN-13 is shown in Figure 2 below.

- Left Quiet Zone
- Left guard bar pattern
- Left half of the encoded numbers
- Centre guard bar pattern
- Right half of the encoded numbers
- Right guard bar pattern
- Right Quiet Zone

The structure of a UPC-E Symbol is as follows:

- Left Quiet Zone
- Left guard bar pattern
- Encoded numbers
- Special guard bar pattern
- Right Quiet Zone

Figure 2 - EAN-13 Bar Code Format

2.2 Encoding EAN/UPC Symbols

Each human readable digit in an EAN/UPC Symbol is represented by a combination of seven dark and light modules, collectively called a symbol character. An EAN/UPC symbol character has two dark bars and two light bars, comprising of between one and four modules each, as seen in the figure below.

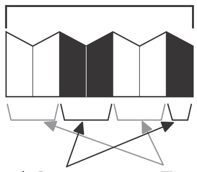


Figure 3 - EAN/UPC Symbol Character

Auxiliary symbol characters are in addition to the symbol characters representing the human readable interpretation. They comprise fewer modules and are used as guard bar patterns for beginning, ending and separating the symbol.

Symbol Type	Left Quiet Zone	Left guard bar pattern	Left half character	Centre guard bar pattern	Right half character	Right guard bar pattern	Right Quiet Zone	Total
EAN-13	11 modules	3 modules	6 x 7 = 42 modules	5 modules	6 x 7 = 42 modules	3 modules	7 modules	113 modules
EAN-8	7 modules	3 modules	4 x 7 = 28 modules	5 modules	4 x 7 = 28 modules	3 modules	7 modules	81 modules
UPC-A	9 modules	3 modules	6 x 7 = 42 modules	5 modules	6 x 7 = 42 modules	3 modules	9 modules	113 modules

The number of modules listed for Quiet Zones is the minimum allowable.
The total number of modules includes the minimum left and right Quiet Zones.

TABLE 4. EAN-13, EAN-8 and UPC-A Structure and Total Modules

Symbol Type	Left Quiet Zone	Left guard bar pattern	Characters	Special guard bar pattern	Right Quiet Zone	Total
UPC-E	9 modules	3 modules	42 modules	6 modules	7 modules	67 modules

The number of modules listed for Quiet Zones is the minimum allowable.
The total number of modules includes the minimum left and right Quiet Zones.

TABLE 5. UPC-E Structure and Total Modules

Each symbol character is encoded from different number sets known as A, B, and C, while the encodation of auxiliary characters remain the same. Note that symbol characters representing digits in:

- Number set A have an **odd** number of dark modules (shown as 1's inTable 7). These are called symbol characters with **odd parity**.
- Number sets B and C have an **even** number of dark modules. These are called symbol characters with **even parity**.
- Number sets A and B always begin with a light module on the left (shown as 0's in Table 7), and end with a dark module on the right.
- Number set C always begins on the left with a dark module and end on the right with a light module.

For EAN-13 Symbols the left half of the symbol is encoded by variable parity (see "Variable Parity Encoding of the 13th Digit" on page 10) using a combination of characters from number sets A and B, determined by the value of the 13th digit. The right half of the symbol is always encoded using number set C.

Note: The 13th digit is always the digit in the left most position of the GTIN-13 (for GTIN-13s allocated by GS1 Australia this number is a 9), with the remaining 12 digits in the number, represented by symbol characters, in sequence from left to right.

For EAN-8 and UPC-A Symbols the left half of the bar code is encoded using number set A, while the right half is encoded using number set C

UPC-E Symbols are encoded by variable parity from either number sets A or B, the combination of which is dependent on the value of the Check Digit.

Every symbol character in a bar code begins and ends with a different module than the one before or after it, be it light or dark. This means that you can always visually distinguish the boundary between two characters, which is essential for unambiguous decoding.

See Table 7 on page 11 for a list of all combinations of dark and light modules for each human readable digit. The number sets in this table are shown graphically in Figure 5 on page 12.

2.2.1 Variable Parity Encoding of the 13th Digit

For an EAN-13 Bar Code you encode the value of the 13th digit by permutation, using number sets A and B for the six digits in the left half of the bar code. This is known as using variable parity coding. For all possible permutations for the 13th digit, see Table 6. The EAN-13 Symbol itself comprises 12 symbol characters. The 13th human readable digit is not represented by a symbol character.

Australia's country prefix is 93, therefore, the 13th digit for numbers using this prefix is always **9**.

Using prefix 9 causes the left half of the bar code to have variable parity, because it comprises a combination of number set A (odd parity) and number set B (even parity) symbol characters.

Figure 4 uses the GTIN-13 9312345678907 as an example.

	Number sets used for coding left half of bar code					
Value of 13th digit	12th digit	11th digit	10th digit	9th digit	8th digit	7th digit
0	A	A	A	A	A	A
1	A	A	B	A	B	B
2	A	A	B	B	A	B
3	A	A	B	B	B	A
4	A	B	A	A	B	B
5	A	B	B	A	A	B
6	A	B	B	B	A	A
7	A	B	A	B	A	B
8	A	B	A	B	B	A
9	A	B	B	A	B	A

TABLE 6. Coding system for the 13th digit

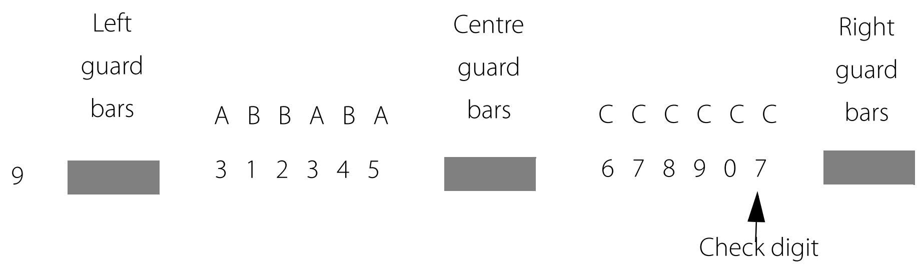


Figure 4 - EAN-13 Permutation for Bar Code Digit Positions

2.2.2 EAN/UPC Symbol Encodation

Symbol Characters

All EAN/UPC Symbol characters are 7 modules.

Value of digit	Number set A	Number set B	Number set C
0	0 0 0 1 1 0 1	0 1 0 0 1 1 1	1 1 1 0 0 1 0
1	0 0 1 1 0 0 1	0 1 1 0 0 1 1	1 1 0 0 1 1 0
2	0 0 1 0 0 1 1	0 0 1 1 0 1 1	1 1 0 1 1 0 0
3	0 1 1 1 1 0 1	0 1 0 0 0 0 1	1 0 0 0 0 1 0
4	0 1 0 0 0 1 1	0 0 1 1 1 0 1	1 0 1 1 1 0 0
5	0 1 1 0 0 0 1	0 1 1 1 0 0 1	1 0 0 1 1 1 0
6	0 1 0 1 1 1 1	0 0 0 0 1 0 1	1 0 1 0 0 0 0
7	0 1 1 1 0 1 1	0 0 1 0 0 0 1	1 0 0 0 1 0 0
8	0 1 1 0 1 1 1	0 0 0 1 0 0 1	1 0 0 1 0 0 0
9	0 0 0 1 0 1 1	0 0 1 0 1 1 1	1 1 1 0 1 0 0
Note: 0 represents a light module and 1 represents a dark module.			

TABLE 7. Module Composition of EAN/UPC Symbol Characters

Auxiliary Characters

An auxiliary symbol character is a representation in dark bars and light bars (spaces) of data other than human readable digits; that is, left guard bar pattern, centre guard pattern, right guard bar pattern or special guard bar pattern.

The composition of modules for these auxiliary symbol characters is shown in the table below.

Auxiliary characters	Number of modules	Module set
Left and right guard bar pattern	3	1 0 1
Centre guard bar pattern	5	0 1 0 1 0
Special guard bar pattern (for UPC-E Symbols)	6	0 1 0 1 0 1
Add-On Guard Bar Pattern	4	1 0 1 1
Add-On Delineator	2	0 1
Note: 0 represents a light module and 1 represents a dark module		

TABLE 8. Module Composition of EAN/UPC Auxiliary Characters

2.2.3 Module Composition Represented Graphically

Symbol Characters

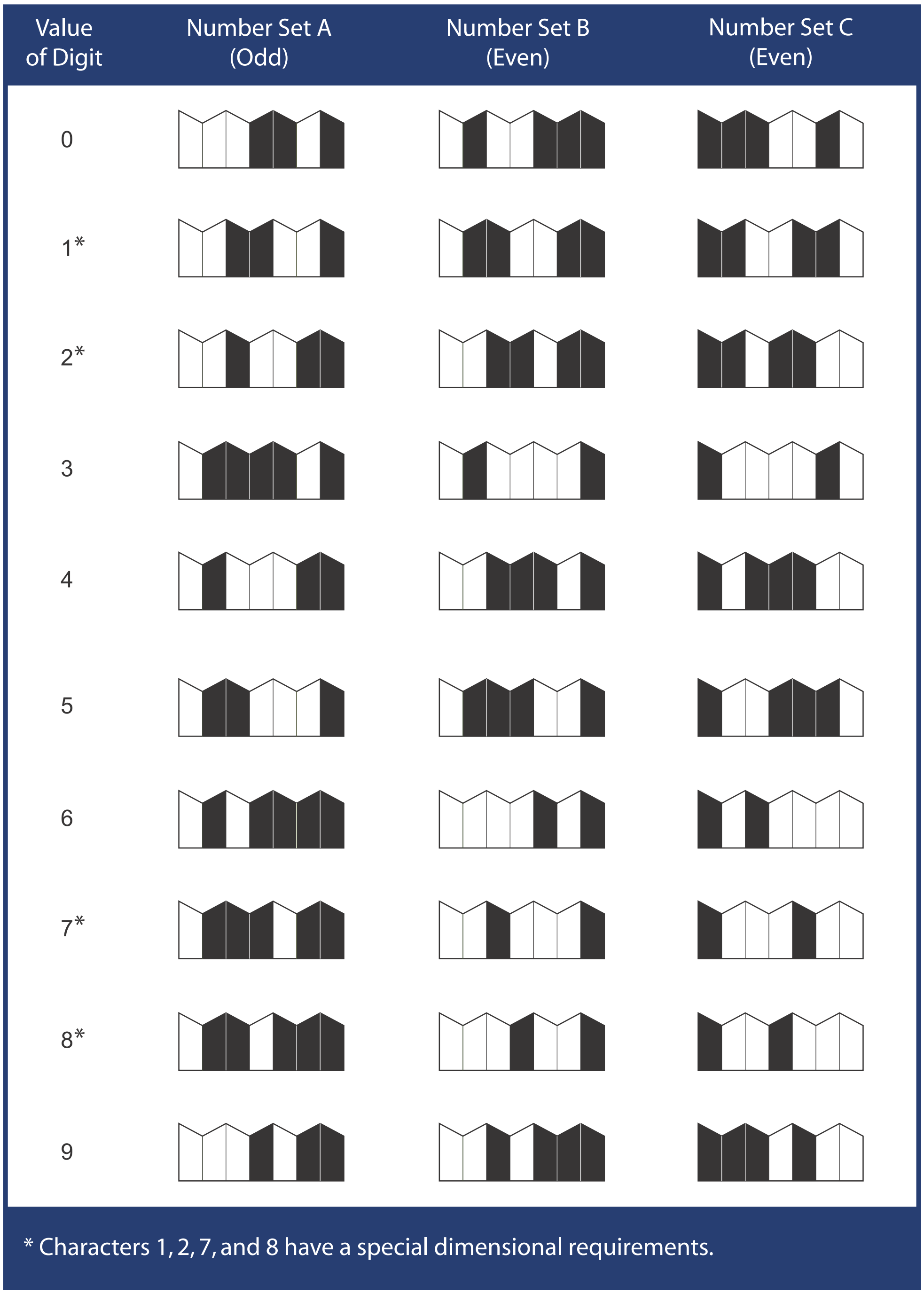


Figure 5 - Graphic Representation of EAN/UPC Symbol Characters

Auxiliary Characters

Auxiliary Character	Graphic Representation
Left and Right Guard Bar Pattern	
Centre Guard Bar Pattern	
UPC-E Special Guard Bar Pattern	

Figure 6 - Graphic Representation of EAN/UPC Auxiliary Characters

2.2.4 Nominal Dimensions of Symbol Characters

Bar codes can be printed at various densities to accommodate a variety of printing and scanning processes. The width of each bar (dark element) and space (light element) is determined by multiplying the X-dimension (the width of a single module) by the module width of each bar and space (1, 2, 3, or 4). There is an exception for characters 1, 2, 7, and 8. For these characters the bars and spaces are reduced or enlarged by one-thirteenth of a module to provide a uniform distribution of bar width tolerances and thus improve scanning reliability. The reduction or enlargement in millimetres at nominal size (X-dimension 0.33mm) of the bars and spaces for the characters 1, 2, 7, and 8 in the number sets A, B, and C is shown in Table 8.

	Number Set A		Number Sets B and C	
Character Value	Bar (Dark Element)	Space (Light Element)	Bar (Dark Element)	Space (Light Element)
1	-0.025	+0.025	+0.025	-0.025
2	-0.025	+0.025	+0.025	-0.025
7	+0.025	-0.025	-0.025	+0.025
8	+0.025	-0.025	-0.025	+0.025
Note: All measurements are in millimetres				

TABLE 9. Reduction/Enlargement for Characters 1, 2, 7 and 8 at nominal size (X-dimension 0.33mm)

For details on the X-dimensions for EAN/UPC Bar Codes please refer to chapter 9, section 9.6.5 EAN/UPC Bar Code Dimensions on page 87.

3.3 Structure

An ITF-14 Bar Code can encode a GTIN-14, GTIN-13 or a GTIN-12. However, as the total number of digits encoded must be 14, one filler zero should be added in front of a GTIN-13 and two filler zeros in front of a GTIN-12 when these GTINs are encoded in an ITF-14 Bar Code.

All ITF-14 Bar Codes follow a standard structure:

- Left Quiet Zone
- Start pattern
- Representation of the digit pairs
- Stop pattern
- Right Quiet Zone

Bearer Bars are required above and below. Where printing plates are required the bar code is surrounded by a Bearer Bar. See the GS1 Australia User Manual - Numbering and Bar Coding for more information on Bearer Bars.

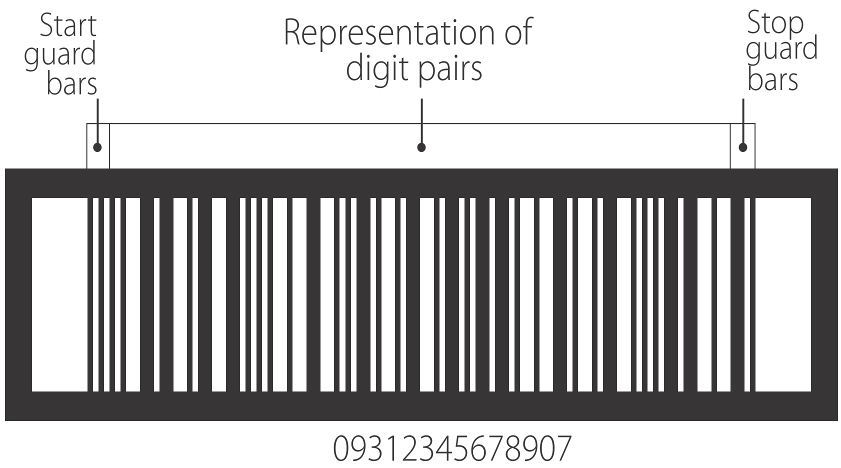


Figure 7 - ITF-14 Bar Code Format

3.4 Encoding ITF-14 Symbols

The Human Readable Interpretation is encoded in an ITF-14 Bar Code in interleaved pairs. The first character in each pair is represented by five dark bars, and the second is represented by five light bars. This is called a symbol character and an ITF-14 Symbol includes seven pairs of symbol characters representing data.

ITF-14 Symbols have only two bar widths; wide and narrow. The bar width ratio (comparison between the narrow and wide bars) is 2.5:1, meaning that the wide bars are 2.5 times the width of a narrow bar. While the preferred ratio is 2.5:1, the acceptable range is 2.25:1 - 3.0:1.

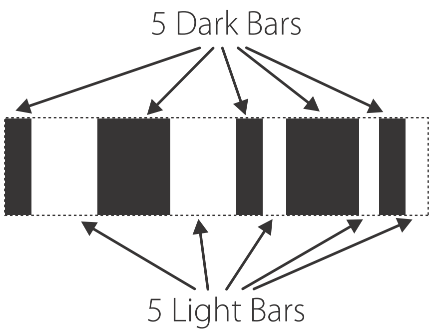


Figure 8 - ITF-14 Symbol Character

Auxiliary symbol characters are in addition to the symbol characters representing the human readable digits. They comprise fewer modules and are used as start and stop patterns for the beginning and end of the symbol.

3.4.1 How to Compose an ITF-14 Bar Code

Take the 14 human readable digits and form seven digit pairs.

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

Using Table 10 on page 17, convert each digit pair into its wide (1) and narrow (0) representation. Start with the first pair on the left of the GTIN. Repeat the conversion for every pair of digits.

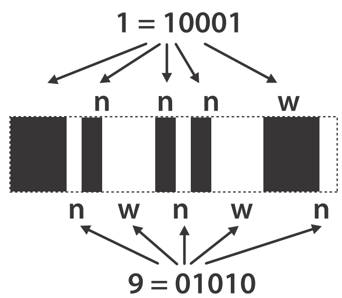
In each pair of digits, the:

- **left**-hand digit is represented by **dark** bars.
- **right**-hand digit is represented by **light** bars.

Place the zeros and ones alternatively, starting with the left digit. Repeat for every pair of digits in the GTIN.

Convert the zeros and ones into narrow and wide, and dark or light bars

1 is the ***left digit*** so it is represented by ***dark bars***



9 is the ***right digit*** so it is represented by ***light bars***

Figure 9 - Sample ITF-14 Digit Pair Converted into Wide (1) and Narrow (0) Bars

Repeat this for all digit pairs; then add stop and start patterns. Each subsequent representation of a digit pair immediately follows the previous one. For example, the number 3852 looks like.

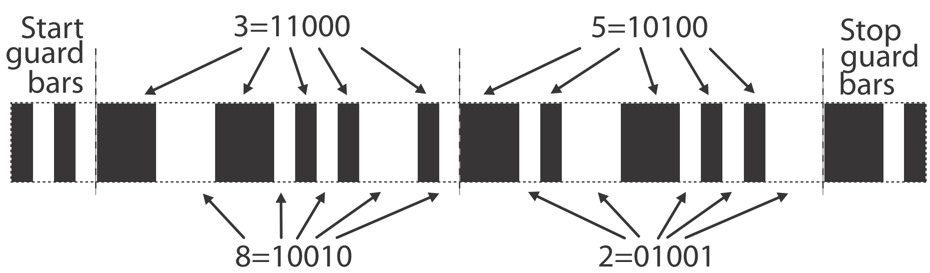


Figure 10 - Sample ITF-14 Start Pattern, two Digit Pairs, and Stop Pattern

3.4.2 ITF-14 Character Module Composition

Use the tables below to determine the module composition of each character.

Symbol Characters.

Value of the digit	Structure
0	0 0 1 1 0
1	1 0 0 0 1
2	0 1 0 0 1
3	1 1 0 0 0
4	0 0 1 0 1
5	1 0 1 0 0
6	0 1 1 0 0
7	0 0 0 1 1
8	1 0 0 1 0
9	0 1 0 1 0
Note: 0 represents a narrow bar and 1 represents a wide bar.	

TABLE 10. ITF-14 Human Readable Digit Representations in Bars

Auxiliary Characters

Each ITF-14 Bar Code has two auxiliary characters that each consist of five modules; start pattern, and a stop pattern.

A start pattern comprises:

- one narrow dark bar
- one narrow light bar
- one narrow dark bar, and
- one narrow light bar

A stop pattern comprises:

- one wide dark bar
- one narrow light bar, and
- one narrow dark bar

For a graphical representation of the start and stop patterns see Figure 10 on page 16.

4.1 Structure

A GS1-128 Bar Code encodes a GTIN in a 14 digit data string and may also encode attribute data using Application Identifiers (AIs). When a GTIN-13 or GTIN-12 is encoded in a 14 digit data string, one or two filler zeros respectively must be added in front of the GTIN. With the use of AIs a GS1-128 Bar Code can encode alpha numeric attribute data and the GS1 Identification Keys for identifying Logistic Units, Locations, Assets, Documents, Services, Shipments and Consignments.

All GS1-128 Symbols follow as standard structure:

- Left Quiet Zone
- Start Character
- Function 1 Symbol Character (FNC1)
- Representation of the encoded characters with each set of information beginning with the appropriate AI
- Symbol Check Character (modulo 103)
- Stop Character
- Right Quiet Zone

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

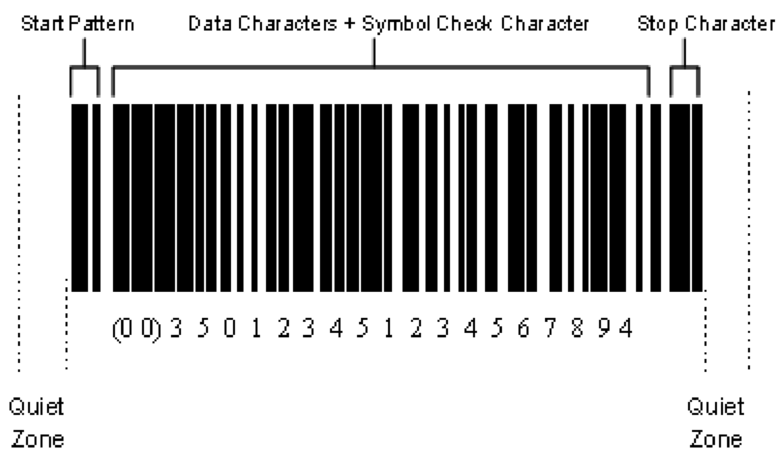


Figure 11 - General Format of a GS1-128 Bar Code

Note: The Start Pattern in the figure above consists of the Start Character and FNC1.

4.2 Encoding GS1-128 Symbols

Each symbol character except the stop character in a GS1-128 Bar Code comprises 11 modules grouped into three dark bars and three spaces. The stop pattern comprises 13 modules grouped into four dark bars and three spaces.

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 feature enables character self-checking. An example of a symbol character can be seen below in Figure 12.

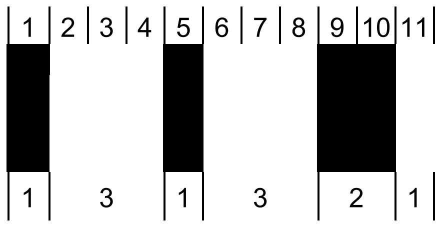


Figure 12 - GS1-128 Symbol Character Value 35

A list of all the combinations of dark and light modules for each human readable character is given in Table 12.

4.2.1 Character Sets

There are three ways to represent each character, called code sets A, B, and C.

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.

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.

Code Set C

Code set C is for numerical characters only and 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.

4.2.2 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.

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, and C characters allow a 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 applied 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.
- The shift character has a similar function to the "shift" key on a keyboard. It allows a character set change from A to B or B to A for the **single character** that immediately follows the shift character. Subsequent characters revert to the character set defined prior to the shift character.

Function Characters

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

- The Function 1 Symbol Character (FNC1) is always encoded after the Start Character in a GS1-128 Bar Code to differentiate GS1-128 Bar Codes from the more generalised Code-128 bar codes. In other words, any Code-128 bar code in the world that has an FNC1 immediately following the Start Character is always a GS1-128 Bar Code. FNC 1 is also used as a separator character when variable length AIs and their data fields are concatenated into a single bar code. This character is transmitted as character <GS>, ASCII value 29. (Please note that it is not permissible to encode the GS character in the bar code in place of the FNC1 as a separator character).
- The Function 2 Character (FNC2) (Message Append) is not used in the GS1 System.
- 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.

4.2.3 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.

4.2.4 Symbol Check Character

The Symbol Check Character (Modulo 103) is the last symbol character before the Stop Character and is mandatory. The Symbol Check Character must not be represented in the Human Readable Interpretation or transmitted by the decoder. Follow the steps below to calculate the Symbol Check Character. In less than 1% of cases, **FNC1** is the Symbol Check Character.

Step 1: Retrieve the symbol character value from Table 12 on page 23.

Step 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 FNC1, the weights are 1, 2, 3, and 4 to...n for all subsequent 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 FNC1 following the Start Character are weighted by 1

Step 3: Multiply each symbol character value by its weight.

Step 4: Add the totals of the calculations from step 3.

Step 5: Divide the result of step 4 by 103.

Step 6: The remainder derived from the calculation in step 5 is the symbol character value of the Symbol Check Character. Find the value of the remainder in Table 12 on page 23. You can then see the associated representation in the appropriate character set, or as bars and spaces.

Below is an example of a Symbol Check Character calculation for the Batch/Lot Number 2503X45 encoded using AI (10).

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

TABLE 11. Symbol Check Character example calculation

4.2.5 Encoding GS1-128 Bar Codes Efficiently

Always try to minimise the GS1-128 Bar Code length. Make sure you follow the guidance provided in this section.

Note: The term **data** refers to the Application Identifier followed by a string of human readable characters.

A Start character precedes every group of data. Control characters are listed under character set A, positions 64 to 95, of Table 12 on page 23.

The conditions for using the different Start characters are:

- when the data begins with four or more digits, use Start C
- when the data begins with less than four digits, and a control character occurs in the data before any lower case character, use Start A
- otherwise, use Start B.

If you use Start C and the data begins with an odd number of digits, place a Code A or Code B before the last digit. Use the above guidelines to choose between Code A and Code B.

When four or more digits occur together in character sets A or B:

- if there is an even number of digits in the group, insert Code C before the first digit
- if there is an odd number of digits in the group, insert Code C immediately after the first digit.

When in character **set B** and a control character appears in the data:

- followed by a lower case character before another control character appears, insert the Shift character before the control character
- otherwise, insert Code A before the control character.

When in character **set A** and lower case character appears in the data:

- followed by a control character before another lower case character, insert the Shift character before the lower case character
- otherwise, insert Code B before the lower case character.

When in character **set C**, and a non-numeric character occurs in the data:

- insert Code A or B before the non-numeric character using the above guidelines to choose between Code A and B.

4.2.6 Data Character Encodation

GS1-128 Symbology specifies the identical character set as defined by the International ISO/IEC 646 Standard, to ensure international compatibility. The symbol character bar (dark bar) and space (light bar) patterns shown in Table 12 represent the data characters listed under the columns for code set A, B, or C. Every character apart from the Stop Character starts with a bar and ends with a space and comprises 6 elements, each of which vary from one to four modules in width. The numerical values in the B and S columns represent the number of modules in each bar or space element respectively in the symbol characters.

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 "Special Characters" on page 20 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 Character, code set, and shift characters. The individual applications do not specify code sets A, B, or C. Section 5.4.8.10 contains rules to minimise the length of the symbol for any given data.

Each symbol character is assigned a numeric value listed in Table 12. 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.

Value	Code set A	Code set B	Code Set C	Element Widths (Modules) B S B S B S
0	SP	SP	00	2 1 2 2 2 2
1	!	!	01	2 2 2 1 2 2
2	"	"	02	2 2 2 2 2 1
3	#	#	03	1 2 1 2 2 3
4	$	$	04	1 2 1 3 2 2
5	%	%	05	1 3 1 2 2 2
6	&	&	06	1 2 2 2 1 3
7	'	'	07	1 2 2 3 1 2
8	(	(	08	1 3 2 2 1 2
9	)	)	09	2 2 1 2 1 3
10	*	*	10	2 2 1 3 1 2
11	+	+	11	2 3 1 2 1 2
12	,	,	12	1 1 2 2 3 2
13	-	-	13	1 2 2 1 3 2
14	.	.	14	1 2 2 2 3 1
15	/	/	15	1 1 3 2 2 2
16	0	0	16	1 2 3 1 2 2
17	1	1	17	1 2 3 2 2 1

TABLE 12. Data character representation in GS1-128 Bar Codes

Value	Code set A	Code set B	Code Set C	Element Widths (Modules) B S B S B S
18	2	2	18	2 2 3 2 1 1
19	3	3	19	2 2 1 1 3 2
20	4	4	20	2 2 1 2 3 1
21	5	5	21	2 1 3 2 1 2
22	6	6	22	2 2 3 1 1 2
23	7	7	23	3 1 2 1 3 1
24	8	8	24	3 1 1 2 2 2
25	9	9	25	3 2 1 1 2 2
26	:	:	26	3 2 1 2 2 1
27	;	;	27	3 1 2 2 1 2
28	<	<	28	3 2 2 1 1 2
29	=	=	29	3 2 2 2 1 1
30	>	>	30	2 1 2 1 2 3
31	?	?	31	2 1 2 3 2 1
32	@	@	32	2 3 2 1 2 1
33	A	A	33	1 1 1 3 2 3
34	B	B	34	1 3 1 1 2 3
35	C	C	35	1 3 1 3 2 1
36	D	D	36	1 1 2 3 1 3
37	E	E	37	1 3 2 1 1 3
38	F	F	38	1 3 2 3 1 1
39	G	G	39	2 1 1 3 1 3
40	H	H	40	2 3 1 1 1 3
41	I	I	41	2 3 1 3 1 1
42	J	J	42	1 1 2 1 3 3
43	K	K	43	1 1 2 3 3 1
44	L	L	44	1 3 2 1 3 1
45	M	M	45	1 1 3 1 2 3
46	N	N	46	1 1 3 3 2 1
47	O	O	47	1 3 3 1 2 1
48	P	P	48	3 1 3 1 2 1
49	Q	Q	49	2 1 1 3 3 1
50	R	R	50	2 3 1 1 3 1
51	S	S	51	2 1 3 1 1 3
52	T	T	52	2 1 3 3 1 1
53	U	U	53	2 1 3 1 3 1

TABLE 12. Data character representation in GS1-128 Bar Codes

Value	Code set A	Code set B	Code Set C	Element Widths (Modules) B S B S B S
54	V	V	54	3 1 1 1 2 3
55	W	W	55	3 1 1 3 2 1
56	X	X	56	3 3 1 1 2 1
57	Y	Y	57	3 1 2 1 1 3
58	Z	Z	58	3 1 2 3 1 1
59	[	[	59	3 3 2 1 1 1
60	\	\	60	3 1 4 1 1 1
61	]	]	61	2 2 1 4 1 1
62	^	^	62	4 3 1 1 1 1
63	_	_	63	1 1 1 2 2 4
64	NUL	’	64	1 1 1 4 2 2
65	SOH	a	65	1 2 1 1 2 4
66	STX	b	66	1 2 1 4 2 1
67	ETX	c	67	1 4 1 1 2 2
68	EOT	d	68	1 4 1 2 2 1
69	ENQ	e	69	1 1 2 2 1 4
70	ACK	f	70	1 1 2 4 1 2
71	BEL	g	71	1 2 2 1 1 4
72	BS	h	72	1 2 2 4 1 1
73	HT	i	73	1 4 2 1 1 2
74	LF	j	74	1 4 2 2 1 1
75	VT	k	75	2 4 1 2 1 1
76	FF	l	76	2 2 1 1 1 4
77	CR	m	77	4 1 3 1 1 1
78	SO	n	78	2 4 1 1 1 2
79	SI	o	79	1 3 4 1 1 1
80	DLE	p	80	1 1 1 2 4 2
81	DC1	q	81	1 2 1 1 4 2
82	DC2	r	82	1 2 1 2 4 1
83	DC3	s	83	1 1 4 2 1 2
84	DC4	t	84	1 2 4 1 1 2
85	NAK	u	85	1 2 4 2 1 1
86	SYN	v	86	4 1 1 2 1 2
87	ETB	w	87	4 2 1 1 1 2
88	CAN	x	88	4 2 1 2 1 1
89	EM	y	89	2 1 2 1 4 1

TABLE 12. Data character representation in GS1-128 Bar Codes

Value	Code set A	Code set B	Code Set C	Element Widths (Modules) B S B S B S
90	SUB	z	90	2 1 4 1 2 1
91	ESC	{	91	4 1 2 1 2 1
92	FS	¦	92	1 1 1 1 4 3
93	GS	}	93	1 1 1 3 4 1
94	RS	~	94	1 3 1 1 4 1
95	US	DEL	95	1 1 4 1 1 3
96	FNC 3	FNC 3	96	1 1 4 3 1 1
97	FNC 2	FNC 2	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	FNC 4	CODE B	1 1 4 1 3 1
101	FNC 4	CODE A	CODE A	3 1 1 1 4 1
102	FNC 1	FNC 1	FNC 1	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

TABLE 12. Data character representation in GS1-128 Bar Codes

	Bars (B) and spaces (S) B S B S B S B
STOP	2 3 3 1 1 1 2

TABLE 13. Stop character representation in a GS1-128 Bar Code

4.3 GS1-128 System Considerations and Processing Software

Wherever possible, AIs and fixed field lengths have been chosen to result in an even number of numeric characters. This reduces the length of the bar code, because GS1-128 symbols can pack a pair of digits into one symbol character.

Although GS1-128 Bar Codes can encode any length alphanumeric field, data fields take up less space when they are all numeric and have an even number of digits. For example, when assigning batch numbers, select even length numeric batch numbers to produce the shortest bar code.

Note: AIs with three digit identifiers, for example AI (400) - Purchase Order Number, require an odd number of data digits to make an even length field.

AIs identify field lengths as either:

pre-defined

variable

When several AIs and their data fields are concatenated into one bar code, each variable length field must be followed by the FNC 1 character unless it is the last field encoded in the symbol. See Figure 31 on page 65 for a list of pre-defined length AIs.

The symbology identifier prefix **]C1** identifies the symbology being read by the scanner. GS1-128 Bar Codes must be processed to break them into fields through their respective AIs. 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 8 Page 64).

User Application AIs

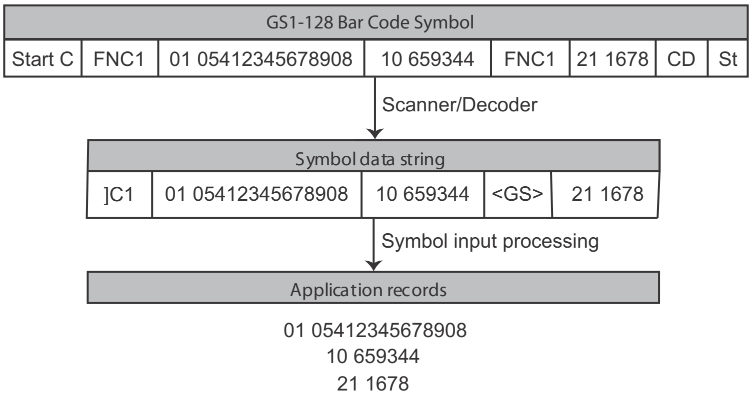
In addition to the fixed length field indicators described in Chapter 8 Page 64 and shown in Figure 31 on page 65, you need to define a table of AIs which will be used by your applications.

Scanner/Decoder

The scanner/decoder:

- reads the bar code, identifies Code-128 and decodes the bar code
- verifies the bar code's integrity by checking the value of its Check Digit (by the modulo 103 algorithm)
- creates the symbology identification, that is, start character + FNC 1 =]C1
- translates the FNC 1 separator character into <GS> (ASCII 29)
- formats the symbol data string
- transmits the symbol data string to the symbol input processing software of the computer.

The GS1-128 Bar Code Symbol in this example contains a GTIN, Batch Number, and Serial Number.



Note: Separators and spaces are shown for easy reading.

Figure 13 - Bar Code Input Processing Chart

Symbol Input Processing

Symbol input processing software:

- verifies that symbology is GS1-128 by checking the symbology identifier]C1
- separates the AIs in the symbol data string using pre-defined length indicator table and <GS> separator
- transmits each AI and its data field to the application processing software

See "Processing of Data from a GS1 Symbology using GS1 Application Identifiers" on page 68 for a flowchart showing the basic logic for decoding a Symbol encoding GS1 Application Identifiers.

Transmitted Data

All data characters are included in the data transmission.

The shift characters, code characters, symbol Check Digit, and stop pattern are not transmitted.

The double character start pattern (Start A, B, or C) plus FNC 1 are transmitted as]C1. This special string of characters identifies the GS1-128 Bar Code from other symbologies.

The FNC1, used as a separator when multiple AIs and their data fields are concatenated, is transmitted as character <GS> (ASCII 29). It is not permissible to substitute a GS character set for the FNC1 within the bar code itself.

Never use the character string]C1 and the character <GS> in the user data portion of any Application Identifier.

The AI is not part of the data field. When the data is used in other applications, such as EDI, the AI must be dropped.

5.1 Structure

There are seven different GS1 DataBar Symbols and these are further classified into **three groups** based on the structure of the symbol.

The First Group

- GS1 DataBar Omnidirectional
- GS1 DataBar Stacked Omnidirectional
- GS1 DataBar Stacked
- GS1 DataBar Truncated

These GS1 DataBar Symbols encode Application Identifier (01) and each one contains four data characters and two finder patterns. They are capable of being scanned in four separate segments, each consisting of a data character and an adjacent finder pattern. The two finder patterns together encode a modulo 79 check value for data security.

Figure 14 - Group One Symbol Structure

The left and right Guard Bar Patterns consist of a narrow space and narrow bar. The symbols do not require Quiet Zones.

The Second Group

- GS1 DataBar Limited

This GS1 DataBar Symbols encode Application Identifier (01) but the first digit can only be zero or one.

The following figure shows the structure of the GS1 DataBar Limited Bar Code. A GS1 DataBar Limited Symbol contains two data characters and a check character. The check character encodes a modulo 89 check value for data security.

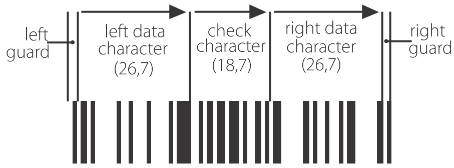


Figure 15 - GS1DataBar Limited Bar Code Structure

The left and right Guard Bar Patterns consist of a narrow space and narrow bar. The GS1 DataBar Limited Bar Code does not require Quiet Zones.

The Third Group

- GS1 DataBar Expanded
- GS1 DataBar Expanded Stacked

These symbols are variable in length and capable of encoding up to 74 numeric or 41 alphabetic characters. They can encode the Application Identifier (01) and additional information such as Batch Number using the appropriate Application Identifiers.

The figure below shows the structure of a six-segment GS1 DataBar Expanded Symbol. GS1 DataBar Expanded Symbols contain a check character, 3 to 21 data characters and 2 to 11 finder patterns, depending on the symbol length. GS1 DataBar Expanded is capable of being scanned in separate segments, each segment consisting of a data character or check character and the adjacent finder pattern. The check character encodes a modulo 211 check value for data security.

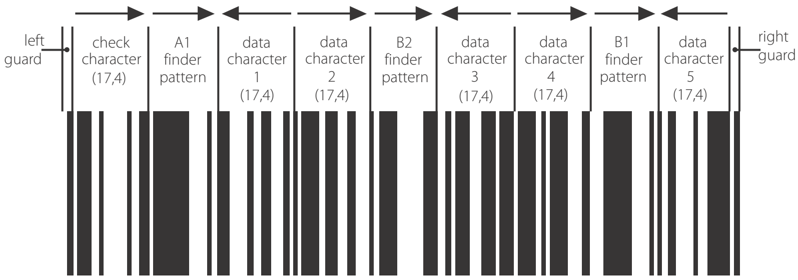


Figure 16 - GS1 DataBar Expanded Structure

The left and right Guard Bar Patterns consist of a narrow space and narrow bar. GS1 DataBar Expanded versions do not require Quiet Zones.

5.2 Encodation

- Encodable character set:
    - GS1 DataBar Omnidirectional, GS1 DataBar Stacked Omnidirectional, GS1 DataBar Stacked, GS1 DataBar Truncated and GS1 DataBar Limited: digits 0 through 9 (with the restriction of GS1 DataBar Limited to 0 or 1 in the first digit)
    - GS1 DataBar Expanded versions: a subset (Table 1) of the International Standard ISO/IEC 646, consisting of the upper case and lower case letters, digits, spaces, and 20 selected punctuation characters in addition to the Function 1 Symbol Character (FNC1)
- 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.
- Code type: continuous, linear bar code symbology
- Maximum numeric data capacity (including implied Application Identifiers (AIs) where appropriate, but not including any encoded FNC1 characters):
    - GS1 DataBar Omnidirectional, GS1 DataBar Stacked Omnidirectional, GS1 DataBar Stacked, GS1 DataBar Truncated and GS1 DataBar Limited: AI (01) plus a 14-digit numeric item identification
    - GS1 DataBar Expanded versions: 74 numeric or 41 alphabetic characters
- Error detection:
    - GS1 DataBar Omnidirectional, GS1 DataBar Stacked Omnidirectional, GS1 DataBar Stacked, GS1 DataBar Truncated: mod 79 checksum
    - GS1 DataBar Limited: mod 89 checksum
    - GS1 DataBar Expanded versions: mod 211 checksum
- Character self-checking
- Bidirectionally decodable
- Quiet Zones: none required

Additional Features

Additional GS1 DataBar features include:

- Data compaction: Each member of the GS1 DataBar family has data compaction methods optimised for the data strings that it will encode. GS1 DataBar Expanded versions are also optimised for specific sequences of Application Identifiers (AIs) that are commonly used.
- Component linkage: All GS1 DataBar Symbols include a linkage flag. If the linkage flag is 0, then the GS1 DataBar Symbol stands alone. If the linkage flag is 1, then a 2D Composite Component and its separator pattern is printed above the GS1 DataBar Symbol with the separator pattern aligned and contiguous to the GS1 DataBar symbol.
- Edge to similar edge decoding; All GS1 DataBar family data characters, finder patterns, and symbol Check Characters can be decoded using edge-to-edge measurements.
- GS1-128 Symbol emulation: Readers set to the GS1-128 Symbol emulation mode transmit the data encoded within the GS1 DataBar Symbol as if the data were encoded in one or more GS1-128 Symbols.
- Large data characters: GS1 DataBar Symbol's data characters do not directly correspond to the encoded data character. The symbol's data characters encode thousands of possible combinations to increase the encoding

efficiency. They are then combined mathematically to form the encoded data string. Details can be found in ISO/IEC 24724: Information technology, automatic identification and data capture techniques Reduced Space Symbology (RSS) bar code symbology specification (formerly RSS, now GS1 DataBar)

5.3 Compressed Element String Sequences

While GS1 DataBar Expanded Symbols can encode any sequence of Application Identifier (AI) data up to the maximum capacity of the symbol, certain sequences of AI Element Strings have been selected for special compression in GS1 DataBar Expanded versions. 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.

The selected sequences are two types: fixed length, where the sequence of selected AI Element Strings is the only data encoded, and open-ended, where the sequence occurs at the start of the symbol's data, and other AI Element Strings may be added following the sequence. If the data to be encoded in a GS1 DataBar Expanded Symbol starts with a sequence defined as fixed length but is followed by additional AI Element Strings, all the data will be encoded normally without special compression.

5.3.1 Fixed-Length Sequences

AI (01) - Weight with Limited Range

This sequence consists of the two Application Identifier (AI) Element Strings AI (01), followed by AI (3103), AI (3202), or AI (3203) for weight. The AI (01) Element String must start with an Indicator value of 9 for variable measure. Using AI (3103) (weight in grams), the special compression can only be applied up to a maximum weight of 32.767 kg. Using AI (3202) (weight in 0.01 lbs.) the special compression can only be applied up to a maximum weight of 99.99 lbs. Using AI (3203) (weight in 0.001 lbs.) the special compression can only be applied up to a maximum weight of 22.767 lbs. If the weight is in excess of these values, the sequence defined in "AI (01) - Weight and Optional Date" on page 34 still enables special compression to be performed.

AI (01) - Weight and Optional Date

This sequence consists of the two or three Application Identifier (AI) Element Strings AI (01), AI (310n), or AI (320n) for weight (n ranging from 0 to 9) and optionally AI (11), AI (13), AI (15), or AI (17) for date. The AI (01) Element String must start with an Indicator value of 9 for variable measure. If the date is not needed, this sequence still gives additional compression when the weight is outside the ranges required by the AI (01) and weight with limited range sequence above.

5.3.2 Open-Ended Sequences

AI (01) and Price

This sequence consists of the two Application Identifier (AI) Element Strings, AI (01), followed by AI (392x) for price or AI (393x) for price with ISO currency code (where x is in the range of 0 to 3). The AI (01) Element String must start with an Indicator value of 9 for variable measure. For example, this sequence is used for an AI (01) Element String, price and weight, because the fixed-length sequence AI (01) and weight does not give additional compression if the AI Element String for price is added to the end since the length of the sequence is fixed.

AI (01)

Any sequence that starts with AI (01) will have special compression applied to the AI (01). So when the data includes AI (01), it should always be the first Element String encoded.

5.4 Data Transmission and Symbology Identifier Prefixes

5.4.1 Default Transmission Mode

The GS1 System requires the use of Symbology Identifiers. GS1 DataBar family symbols are normally transmitted using Symbology Identifier prefix "]e0" (See "Symbology Identifiers" on page 4.) For example, a GS1 DataBar Symbol encoding AI (01) Element String 09312345678907 produces the transmitted data string "]e00109312345678907". 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 8 Page 64).

If a 2D Composite Component accompanies a GS1 DataBar family linear symbol, the AI Element String data from the 2D Composite Component immediately follows the linear component's data. However, readers have an option to transmit only the linear component data and ignore the 2D Composite Component.

5.4.2 GS1-128 Symbol Emulation Mode

Readers also have an option for GS1-128 Symbol emulation mode. This mode emulates the GS1-128 Symbol for data transmission. This mode is used for applications programmed for GS1-128 but not yet programmed to recognise the Symbology Identifier prefix "]e0." The Symbology Identifier for GS1-128 emulation mode is "]C1."

GS1 DataBar Expanded Symbols that exceed 48 data characters are transmitted as two messages so as not to exceed the maximum GS1-128 Symbol message length. Each of the two messages has a Symbology Identifier prefix of "]C1" and does not exceed 48 data characters. The two messages are split at a boundary between two Element Strings. This mode is inferior to the normal transmission mode as message integrity may be lost when a message is split.

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 Composite Symbology 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.

6.3 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 17

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

Figure 17 - GS1 DataBar Limited Composite Symbol with CC-A

In Figure 17 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

(01)03812345678908(10)ABCD123456(410)3898765432108

Figure 18 - GS1-128 Composite Symbol with CC-C

In Figure 18, 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 14 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
GS1 DataBar Limited	Yes (3 columns)	No
GS1 DataBar Expanded and GS1 DataBar Expanded Stacked	Yes (4 columns)	No

TABLE 14. 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 15 and Table 16), and the four-column CC-A version has three RAP columns,(see Table 17).

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

TABLE 15. Two Column CC-A Structures

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

TABLE 16. Three Column CC-A Structures

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

TABLE 17. Four Column CC-A Structures

Table 18 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 18. 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 19) and the three- and four-column CC-B versions have three RAP columns (see Table 20 and Table 21).

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

TABLE 19. Two Column CC-B Structures

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

TABLE 20. Three Column CC-B Structures

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

TABLE 21. 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 22 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 22. 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 23.

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 23. 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.

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

The Human Readable Interpretation of the linear component of the GS1 Composite Symbol must be shown below the linear component. If there is a Human Readable Interpretation of the 2D Composite Component, there is no required location, but it should be close to the GS1 Composite Symbol.

The precise location of the human readable characters and the font used to represent them are not specified for GS1 Composite Symbols. However, the characters should be clearly legible (such as OCR-B) and must be obviously associated with the symbol.

Application Identifiers (AIs) should be clearly recognisable to facilitate key entry. This is achieved by putting the AI between parentheses (brackets) in the Human Readable Interpretation.

Note: The parentheses are not part of the data and are not encoded in the bar code, following exactly the same principle that applies to GS1-128 Symbols.

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 17 on page 40, where the same data is shown using the all - AI format.

Exp.Date: June 15, 2001 Lot#:A123456

(01)13112345678906

Figure 19 - Human Readable Interpretation

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.

6.4 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 "]e001100123456789021 0ABC123" (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 8 Page 64). 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".

6.5 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.

6.6 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.

6.7 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 24. Data Capacity of CC-B

6.7.1 Sample Composite Symbols.

9 312345 678907
(99)1234-abcd

Figure 20 - EAN-13 Symbol with a Four-Column CC-A Component

(01)03612345678904(11)990102

Figure 21 - GS1 DataBar Omnidirectional Symbol with a Four-Column CC-A

(01)03412345678900(17)010200

Figure 22 - GS1 DataBar Stacked Symbol with a Two-Column CC-A

(01)03512345678907

Figure 23 - GS1 DataBar Limited Symbol with a Three-Column CC-B

(01)93712345678904(3103)001234
(91)1A2B3C4D5E

Figure 24 - GS1 DataBar Expanded Symbol with a Four-Column CC-A

(01)03212345678906
(21)A1B2C3D4E5F6G7H8

Figure 25 - GS1-128 Symbol with a Four-Column CC-A

Note: All diagrams not to scale.

7 GS1 DataMatrix Symbology

7.1 Introduction

GS1 DataMatrix is a standalone, two-dimensional matrix symbology that is made up of square modules arranged within a perimeter finder pattern. Unlike a Composite Component® Symbol (refer to Chapter 6 Composite Symbology on page 37), GS1 DataMatrix does not require a linear symbol.

This chapter provides only a brief technical description and overview of the GS1 DataMatrix symbology. A more detailed technical specification can be found in the International Standard *ISO/IEC 16022.* The GS1 System has adopted GS1 DataMatrix partly because it can encode GS1 System data structures and offers other technical advantages. Its compact design and the existence of various production methods that accommodate placing the symbology onto various substrates offer certain advantages over other symbologies currently in the GS1 System.

Data Matrix ISO version ECC 200 is the only version that supports GS1 System data structures, including Function 1 Symbol Character (FNC1). The ECC 200 version of Data Matrix uses Reed-Solomon error correction, and this feature helps correct for partially damaged symbols. GS1 DataMatrix refers to the ECC200 version of Data Matrix with FNC1encoded at the beginning of the data string. This version of Data Matrix is similar in stability to ISO versions of current GS1 System Symbologies.

Some of the production processes that can be used to produce GS1 DataMatrix Symbols are as follows:

- Direct part marking, such as is done by dot peening on items, such as automotive, aircraft metal parts, medical instruments, and surgical implants
- Laser or chemically etched parts with low contrast or light marked elements on a dark background (e.g., circuit boards and electronic components, medical instruments, and surgical implants)
- High-speed ink jet printed parts and components where the marked dots cannot form a scannable linear symbol
- Very small items that require a symbology with a square aspect ratio and/or cannot be marked within the allocated packaging space by existing GS1 DataBar and Composite Symbols

GS1 DataMatrix Symbols are read by two-dimensional imaging scanners or vision systems. Most other scanners that are not two-dimensional imagers cannot read GS1 DataMatrix. GS1 DataMatrix Symbols are restricted for use with new niche applications that will involve imaging scanners throughout the supply chain.

7.2 GS1 DataMatrix Features and Basics

This corner is always a white square for ECC 200

"L" Shaped finder pattern

Figure 26 - GS1 DataMatrix Symbol

- The figure above represents a GS1 DataMatrix Symbol with 20 rows and 20 columns (including the perimeter finder pattern but not including Quiet Zones).
- GS1 DataMatrix solid "L" shaped finder or alignment pattern is one module wide.
- GS1 DataMatrix Quiet Zone is one module wide on all four sides. As with other bar code Quiet Zones, do not print in this area.
- ECC 200 symbols can always be recognized from older versions of Data Matrix because the corner opposite the middle of the finder pattern is a zero module or white in normal print.
- For Square GS1 DataMatrix symbols, only an even number of rows and columns exist. Depending on data requirements, symbols can range from 10 row by 10 columns (10 x10) to 144x144 (including finder pattern but not the Quiet Zone)
- For normal printing, a module is one X by one X in dimension. Representation of data: A dark module is a binary one and a light module is a binary zero (or a light module is a binary one and a dark module is a binary zero for a symbol with reflectance reversal).
- ECC 200 (ECC = Error Checking and Correction) that uses Reed-Solomon error correction. Table 25 on page 58 shows the fixed amounts of error correction associated for each allowable GS1 DataMatrix Symbol size.
- FNC1 for GS1 System compatibility shall be encoded at the beginning of the data string and should be used as a group separator. When a FNC1 is used as a group separator, it shall be represented in the transmitted message by the ASCII character <GS> (ASCII value 29).
- Encodable character set:
    - Values 0 - 127 in accordance with ISO/IEC 646 International Reference Version (e.g., all 128 ASCII characters)
    - Values 128 - 255 in accordance with ISO/IEC 8859-1; Latin alphabet No. 1. These are referred to as extended ASCII.
    - The GS1 System requires that only the subset of ISO/IEC 646 International Reference Version defined in the GS1 General Specifications be used for Application Identifier (AI) Element Strings.
- Data characters per symbol (for the maximum symbol size):

- Alphanumeric data: up to 2335 characters
- Eight-bit byte data: 1556 characters
- Numeric data: 3116 digits

* Large, square ECC Symbols (at least 32 X32) will include alignment patterns to separate the data regions.
* Code type: matrix (Composite Component® is a stacked type)
* Orientation independence: Yes (requires a two-dimensional imaging scanner)
* Summary of additional features inherent or optional in GS1 DataMatrix:
    - Reflectance reversal: (Inherent) Symbols can be read when marked so that the image is either dark on light or light on dark.
    - Rectangular symbols: Six symbol formats are specified in a rectangular form.
    - Extended Channel Interpretation (ECI) capability allows GS1 DataMatrix to encode data from other alphabets.

7.3 GS1 DataMatrix Structure

The technical description of GS1 DataMatrix contained within this section provides additional information based on ISO technical specification 16022, and it is provided as a further aid in the development of specific applications. GS1 DataMatrix Symbols shown in the following subsections have been magnified to show detail.

7.3.1 Square and Rectangular Formats

GS1 DataMatrix may be printed in a square or rectangular format. The square format is usually used as it has a larger range of sizes and is the only format available for symbols encoding a large amount of data. The largest rectangular symbol can encode 98 digits, while the largest square symbol can encode 3,116 digits. An enlarged rectangular symbol and an equivalent square symbol are shown in the figure below, both containing the same data.

Figure 27 - Rectangular and Square GS1 DataMatrix Symbols

7.3.2 GS1 DataMatrix Symbol Sizes

The size of a GS1 DataMatrix Symbol depends on the amount of data encoded, the X-dimension of the symbol and whether or not a square or rectangular symbol is used.

For the minimum X-dimension of a GS1 DataMatrix Symbol for healthcare, see Chapter 4 Regulated Healthcare Trade Items in the GS1 Australia User Manual, Numbering and Bar Coding, or contact GS1 Australia.

For direct part marking applications other than healthcare, the minimum X-dimension is 0.255 mm, the target is 0.300 mm and that maximum is 0.615mm.

For keys other than a GTIN, (i.e. GLN, GSRN, GIAI and GRAI) in applications other than healthcare, the minimum X-dimension for a GS1 DataMatrix Symbol is 0.380 mm, the target is 0.380 mm and that maximum is 0.495mm.

GS1 DataMatrix Symbology has multiple sizes to match various data content (refer to Table 25 and Table 26)GS1 DataMatrix Symbols have 24 sizes of the square format ranging from 10 by 10 modules up to 144 by 144 modules, not including the 1X surrounding Quiet Zone. The rectangular format has 6 sizes from 8 by 18 modules up to 16 by 48 modules not including the 1 X surrounding Quiet Zone. GS1 DataMatrix sizes of 52 by 52 or larger have 2 to 10 interleaved blocks of Reed-Solomon error correction codewords.

The term "codeword" is used often to describe attributes concerning the encodation of data into GS1 DataMatrix Symbols. ISO 16022 defines codeword as "A symbol character value. An intermediate level of coding between source data and the graphical encodation in the symbol. Codewords are typically eight bits of data. Function 1 Symbol Character (FNC1), two numerics, and one alpha all take up one codeword each.

Symbol Size		Data Region		Mapping Matrix	Total Codewords		Reed-Solomon Block		Interleaved Blocks	Data Capacity			Error Correction Overhead %	Max. Correctable Codeword Error/ Erasure
Row	Col	Size	No.	Size	Data	Error	Data	Error		Num. Cap.	Alphanum. Cap.	Byte Cap.		
10	10	8x8	1	8x8	3	5	3	5	1	6	3	1	62.5	2/0
12	12	10x10	1	10x10	5	7	5	7	1	10	6	3	58.3	3/0
14	14	12x12	1	12x12	8	10	8	10	1	16	10	6	55.6	5/7
16	16	14x14	1	14x14	12	12	12	12	1	24	16	10	50	6/9
18	18	16x16	1	16x16	18	14	18	14	1	36	25	16	43.8	7/11
20	20	18x18	1	18x18	22	18	22	18	1	44	31	20	45	9/15
22	22	20x20	1	20x20	30	20	30	20	1	60	43	28	40	10/17
24	24	22x22	1	22x22	36	24	36	24	1	72	52	34	40	12/21
26	26	24x24	1	24x24	44	28	44	28	1	88	64	42	38.9	14/25
32	32	14x14	4	28x28	62	36	62	36	1	124	91	60	36.7	18/33
36	36	16x16	4	32x32	86	42	86	42	1	172	127	84	32.8	21/39
40	40	18x18	4	36x36	114	48	114	48	1	228	169	112	29.6	24/45
44	44	20x20	4	40x40	144	56	144	56	1	288	214	142	28	28/53
48	48	22x22	4	44x44	174	68	174	68	1	348	259	172	28.1	34/65
52	52	24x24	4	48x48	204	84	102	42	2	408	304	202	29.2	42/78
64	64	14x14	16	56x56	280	112	140	56	2	560	418	277	28.6	56/106
72	72	16x16	16	64x64	368	144	92	36	4	736	550	365	28.1	72/132
80	80	18x18	16	72x72	456	192	114	48	4	912	682	453	29.6	96/180
88	88	20x20	16	80x80	576	224	144	56	4	1152	862	573	28	112/212
96	96	22x22	16	88x88	696	272	174	68	4	1392	1042	693	28.1	136/260
104	104	24x24	16	96x96	816	336	136	56	6	1632	1222	813	29.2	168/318
120	120	18x18	36	108x108	1050	408	175	68	6	2100	1573	1047	28	204/390
132	132	20x20	36	120x120	1304	496	163	62	8	2608	1954	1301	27.6	248/472
144	144	22x22	36	132x132	1558	620	156	62	8 **	3116	2335	1556	28.5	310/590

TABLE 25. ECC 200 Square Symbol Attributes***

Symbol Size		Data Region		Mapping	Total		Reed-Solomon		Inter	Data Capacity			Error	Max. Correct-able
				Matrix	Codewords		Block		leav ed	Nu m.	Alpha num.	Byte	Corre ction	Codeword
Row	Col	Size	No.	Size	Data	Error	Data	Error	Bloc ks	Cap.	Cap.	Cap.	Over head %	Error/ Erasure
							155	62	2**					

* Note: Symbol size does not include Quiet Zones
** Note: In the largest symbol (144x144), the first eight Reed-Solomon blocks shall be 218 codewords long encoding 156 data codewords. The last two blocks shall encode 217 codewords (155 data codewords). All the blocks have 62 error correction codewords.
*** Equivalent to Table 11 in the international standard ISO-16022, first edition, 2000-05-01.

TABLE 25. ECC 200 Square Symbol Attributes***

Symbol Size		Data Region		Mapping Matrix	Total Codewords		Reed-Solomon Block		Inter-leaved	Data Capacity			Error Correction Qverhead	Max. Correctable Codeword
Row	Col	Size	No.	Size	Data	Error	Data	Error	Blocks	Num. Cap.	Alpha num. Cap.	Byte Cap.	%	Error/ Erasure
8	18	6x16	1	6x16	5	7	5	7	1	10	6	3	58.3	3/+
8	32	6x14	2	6x28	10	11	10	11	1	20	13	8	52.4	5/+
12	26	10x24	1	10x24	16	14	16	14	1	32	22	14	46.7	7/11
12	36	10x16	2	10x32	22	18	22	18	1	44	31	20	45.0	9/15
16	36	14x16	2	14x32	32	24	32	24	1	64	46	30	42.9	12/21
16	48	14x22	2	14x44	49	28	49	28	1	98	72	47	36.4	14/25

* Note: Symbol size does not include Quiet Zones
** Note: In the largest symbol (144x144), the first eight Reed-Solomon blocks shall be 218 codewords long encoding 156 data codewords. The last two blocks shall encode 217 codewords (155 data codewords). All the blocks have 62 error correction codewords.
*** Equivalent to Table 7 in the international standard ISO-16022, second edition, 2006-09-15

TABLE 26. ECC 200 Rectangular Symbol Attributes***

The square format is divided into 4 to 36 data regions for symbols sized 32 by 32 modules and larger. The rectangular format symbols may also be divided into two data regions. Each data region is separated from the other regions by alignment patterns that consist of an alternating pattern of ones and zeroes and a solid line of ones (a dark line when there is no reflectance reversal). Figure 28 shows a four-segment square symbol on the left and a two-segment rectangular symbol on the right, each with hypothetical data shown to create the effect.

Figure 28 - Segmented GS1 DataMatrix Symbols: Square and Rectangular Formats

(Sizes of these GS1 DataMatrix Symbols are larger than what would be used in a typical application so that typical alignment patterns can be easily seen.)

7.3.3 Human Readable Interpretation of GS1 DataMatrix Symbols

The Human Readable Interpretation of the primary Application Identifier (AI) Element String encoded in the GS1 DataMatrix Symbol should be shown with the symbol. How the human readable data will be shown shall be determined by the specific application guidelines. Typical conventions, as used for GS1 DataBar and Composite Component Symbols, place the key information, such as the Global Trade Item Number (GTIN), in the human readable data underneath the bar code, while secondary information is placed above. The characters should be clearly legible (such as OCR-B) and must be obviously associated with the symbol.

AIs should be clearly recognisable to facilitate key entry. This is achieved by putting the AI between parentheses (brackets) in the Human Readable Interpretation.

Note: The parentheses are not part of the data and are not encoded in the bar code, following the same principles that apply to GS1-128 Symbols and GS1 DataBar Expanded Symbols.

For GS1 DataMatrix Symbols encoding large amounts of data, it may not be practical to display all the data in Human Readable Interpretation form. 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 (GS1 Identification Keys), such as the GTIN, must always be shown. Application Specifications may provide additional guidance on Human Readable Interpretation.

7.3.4 Data Transmission and Symbology Identifier Prefixes

The GS1 System requires the use of Symbology Identifiers. GS1 DataMatrix uses the Symbology Identifier of "]d2" (see Figure 29) for GS1 System compliant symbols that have a leading Function 1 Symbol Character (FNC1). This indicates that Application Identifier (AI) data is encoded equivalent to the Symbology Identifier "]C1" for GS1-128 Bar Codes and "]e0" for GS1 DataBar Symbology and Composite Symbols. For more information on Symbology Identifiers, see the International standard ISO/IEC 15424 Information technology - Automatic identification and data capture techniques - Data Carrier Identifiers.

For example, a GS1 DataMatrix Symbol encoding AI (01) with the GTIN 10012345678902 produces the transmitted data string "]d20110012345678902." 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 8 Page 64).

	Message Content	Separator
]d2	Standard AI Element Strings	None

Figure 29 - Symbology Identifier for GS1 DataMatrix ECC 200

7.3.5 Width and Height of a Module (X)

The range of the X-dimensions will be defined by the application specification, having due regard to the availability of equipment for the production and reading of symbols and complying with the general requirements of the application.

The X-dimension shall be constant throughout a given symbol. The X-dimension should apply to both the width and height of the modules.

7.3.6 Symbol Quality Grade

The International Standard ISO/IEC 15415 Information technology - Automatic identification and data capture techniques - Bar code print quality test specification - Two-dimensional symbols methodology shall be used for measuring and grading GS1 DataMatrix. The print quality grade is measured by verifiers that comply with the standard. The grade includes a grade level, measuring aperture, the wavelength of light used for the measurement, and the illumination angle relative to the symbol.

A symbol grade is only meaningful if it is reported in conjunction with the illumination and aperture used. It should be shown in the format grade/aperture/light/angle, where:

- "grade" is the overall symbol grade as defined in ISO/IEC 15415 Information technology - Automatic identification and data capture techniques - Bar code print quality test specification - Two-dimensional symbols (e.g., the arithmetic mean to one decimal place of the Scan Reflectance Profile or scan grades). For GS1 DataMatrix, the grade number may be followed by an asterisk, *, which indicates that the surroundings of the symbol contain extremes of reflectance that may interfere with reading. For most applications, this should be specified as causing the symbol to fail.
- "aperture" is the diameter in thousandths of an inch (to the nearest thousandth) of the synthetic aperture defined in ISO/IEC 15415 Information technology - Automatic identification and data capture techniques - Bar code print quality test specification - Two-dimensional symbols.
- "light" defines the illumination: A numeric value indicates the peak light wavelength in nanometres (for narrow band illumination); the alphabetic character W indicates that the symbol has been measured with broadband illumination (white light) the spectral response characteristics of which must imperatively be defined or have their source specification clearly referenced.
- "angle" is an additional parameter defining the angle of incidence (relative to the plane of the symbol) of the illumination. It shall be included in the reporting of the overall symbol grade when the angle of incidence is other than 45 degrees. Its absence indicates that the angle of incidence is 45 degrees.

Note: This international standard provides for 30 degrees and 90 degrees illumination in addition to the default 45 degrees.

The aperture is normally specified as being 80% of the minimum X-dimension allowed for the application. The printing method must produce the GS1 DataMatrix "L" pattern with gaps between the dots less than 25% of the specified aperture. If symbols with greater than the minimum X-dimension are allowed by the application, the same absolute maximum gap dimension must be maintained.

Examples:

- 2.8/05/660 would indicate that the average of the grades of the Scan Reflectance Profiles, or of the scan grades, was 2.8 when these were obtained with the use of a 0.125mm aperture (ref. no. 05) and a 660nm light source, incident at 45 degrees.
- 2.8/10/W/30 would indicate the grade of a symbol intended to be read in broadband light, measured with light incident at 30 degrees and using a 0.250mm aperture (ref. no. 10), but would need to be accompanied either by a reference to the application specification defining the reference spectral characteristics used for measurement or a definition of the spectral characteristics themselves.
- 2.8/10/670* would indicate the grade of a symbol measured using a 0.250mm aperture (ref. no. 10), and a 670nm light source, and indicates the presence of a potentially interfering extreme reflectance value in the surroundings of the symbol.

Recommended symbol grades for GS1 DataMatrix are dependant on the intended application. For further information please contact GS1 Australia.

7.3.7 Advice for Selecting the Symbology

Any use of GS1 DataMatrix should comply with GS1 System global application guidelines and be restricted to those applications defined by the GS1 System for GS1 DataMatrix. GS1 DataMatrix will not replace other GS1 System Symbologies. Existing applications that are satisfactorily utilising EAN/UPC Symbols, ITF-14 Symbols, GS1-128 Symbols, GS1 DataBar Symbology Symbols, or Composite Symbols should continue to use them.

When using GS1 DataMatrix Symbols to encode the Global Trade Item Number (GTIN), any required additional data should be included within the same symbol

Note: Scanning systems that need to read GS1 DataMatrix Symbols must be 2D imaging scanners and be appropriately programmed to read the GS1 System version of DataMatrix or ECC 200.

8.1Basic Structure of GS1 Bar Codes using GS1 Application Identifiers

All GS1 bar code symbologies that use GS1 Application Identifiers have particular symbol characters to indicate that the data is encoded according to the GS1 Application Identifier rules. For example the GS1-128 Symbology uses the Function 1 Symbol Character (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 Codes from extraneous non-GS1 bar codes.

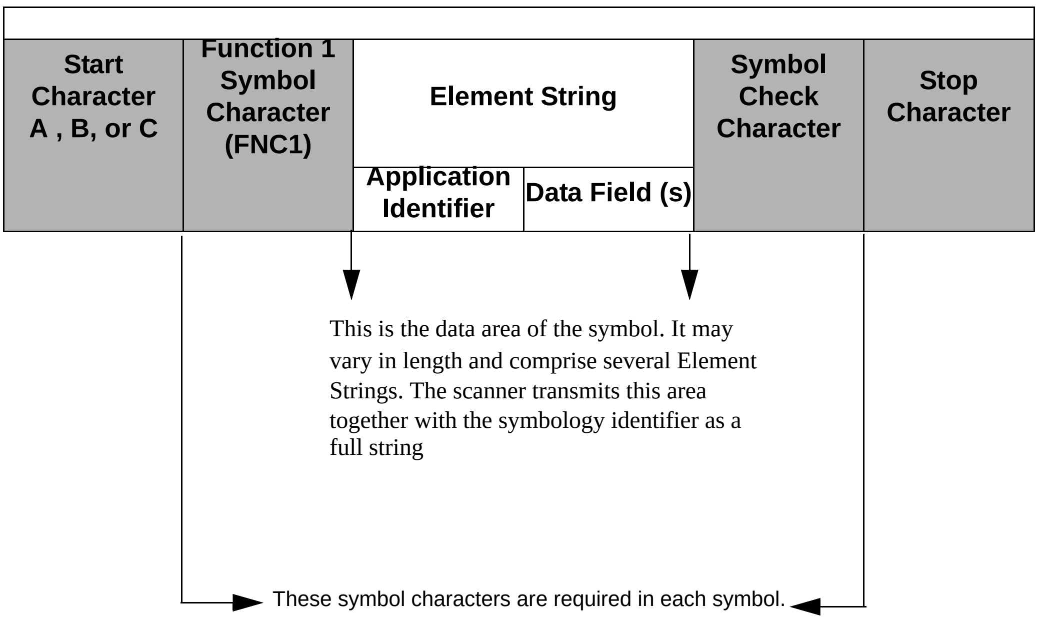


Figure 30 - Example GS1-128 Bar Code Structure

All GS1 bar code symbologies that use GS1 Application Identifiers allow several Element Strings to be encoded in one bar code, 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 codes 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 codes, 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 31). Element Strings that are not contained in Figure 31and that do not appear at the end of the symbol (encoded immediately before the Symbol Check Character) must be delimited to separate them from the Element String that follows. The delimiter shall be a Function 1 Symbol Character in GS1-128 Symbology, GS1 DataBar Expanded Versions and GS1 Composite Symbology and should be a Function 1 Symbol Character in GS1 DataMatrix Symbology.

Figure 31 contains all Application Identifiers that have a predefined length and, therefore, do not require a Function 1 Symbol Character (FNC1) separator.

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 31 - Element Strings with Pre-Defined Length Using Application Identifiers

Note: Figure 31 is limited to the listed numbers and will remain unchanged. Those numbers in parentheses are not yet assigned. Application Identifiers starting with two digits that are not included in Figure 31 have a variable length even if the definition of the Application Identifier specifies a fixed length data field.

8.2 Concatenation

8.2.1 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 (4.00 kilograms) with the associated Global Trade Item Number (GTIN) 95012345678903 does not require the use of a Separator Character.

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

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

GTIN 95012345678903

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

Net weight 4.00 kg

(3 1 0 2) 0 0 0 4 0 0

Figure 32 - Data Encoded in two GS1-128 Symbols

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 33 - Data Encoded in one Concatenated GS1-128 Symbol

8.2.2 Variable Length Data Strings

Concatenating Element Strings of variable length, including all Application Identifiers that do not start with two characters contained in Figure 31 involves the use of a Separator Character. The Separator Character used is the Function 1 Symbol Character (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 A1.2 – 1 Data Encoded in two GS1-128 symbols

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

Price per unit of measure 365 Batch number 123456

Figure 34 - Data Encoded in two GS1-128 Symbols

Price per unit of measure 365 Batch number 123456

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

Figure 35 - Data Encoded in one Concatenated GS1-128 Symbol

Note: **T**he FNC1 is not shown in Human Readable Interpretation.

8.2.3 Other considerations when using Concatenation

Concatenation is an effective means for presenting multiple Element Strings in a single bar code and should be used to conserve label space and optimise scanning operations when permitted by the application guideline (e.g., concatenation shall not be used with the GS1-128 bar code containing the SSCC on cartons or outer-cases).

When concatenating a mixture of pre-defined and other Element Strings, the pre-defined Element Strings should appear before the variable length Element Strings.

The FNC1 Separator Character appears in the decoded data string as <GS> (ASCII character 29, 7-bit character set ISO/IEC 646). An FNC1 is not required at the end of the last Element String represented in a GS1 Symbology using GS1 Application Identifiers. The processing routine allows for a FNC1 entered by error after an Element String contained in Figure 31.

(01)90614141000015(3202)000150

Figure 36 - Example of GS1 DataBar Expanded Stacked Bar Code that uses Concatenation

Concatenation may not be desirable in all circumstances (e.g., GS1 Logistic Labels are often constructed using multiple rows of bar code), in such cases the bar code containing the additional attribute data encoded using GS1 Application Identifiers should be printed in close proximity to the bar code containing the GS1 Identification Key.

8.3 Processing of Data from a GS1 Symbology using GS1 Application Identifiers

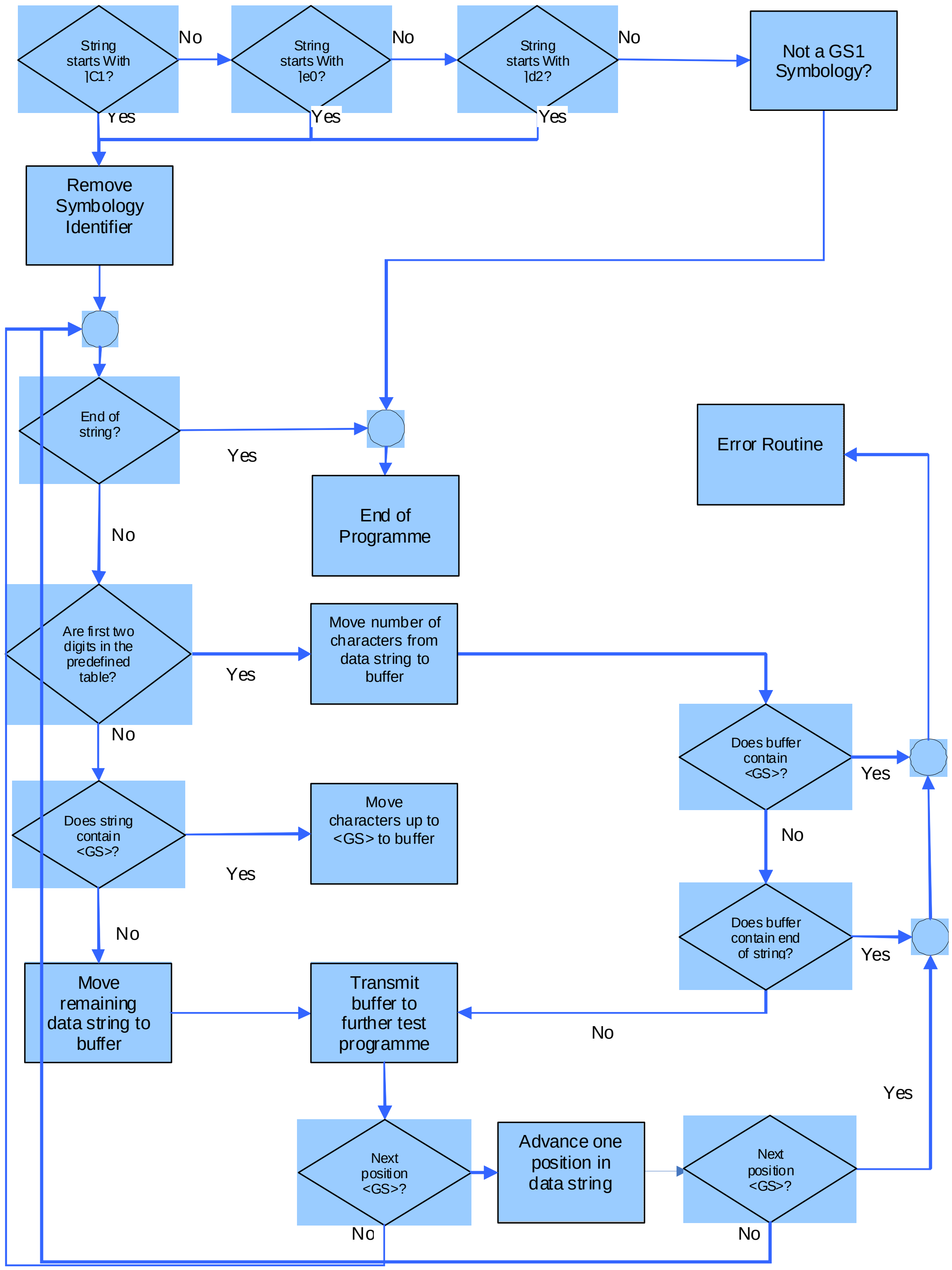
Figure 37 on page 68 is a flowchart of the basic logic required for processing of data that includes GS1 Application Identifiers. This system logic holds true for any GS1 Symbology using GS1 Application Identifiers. The Symbology Identifiers listed in Figure 37 are:

]C1 = GS1-128

]e0 = GS1 DataBar and Composite Symbols

]d2 = GS1 DataMatrix

Figure 37 - Decoding Software Flowchart


String starts With]C1?
No
String starts With]e0?
No
String starts With]d2?
No
Not a GS1 Symbology?
Yes
Yes
Yes
Remove Symbology Identifier
End of string?
Yes
End of Programme
Error Routine
No
Are first two digits in the predefined table?
Yes
Move number of characters from data string to buffer
No
Does buffer contain <GS>?
Yes
Does string contain <GS>?
Move characters up to <GS> to buffer
Yes
No
No
Does buffer contain end of string?
Yes
Move remaining data string to buffer
Transmit buffer to further test programme
No
Yes
Next position <GS>?
Advance one position in data string
Next position <GS>?
No
No

9.1 Introduction

This section is for printers, film master suppliers, and anyone else interested in producing bar codes used in the GS1 System. It outlines:

- the considerations to make during the production processes
- methods that allow you to achieve acceptable quality for the authorised GS1 Symbologies: EAN/UPC, ITF-14, and GS1-128

Note: The beginning of this section contains general printing information. Specific details for each symbology are provided later in this section.

GS1 does not directly specify required dimensions and tolerances in the final printed bar code. Instead, they specify conditions to fulfil at each stage of the production process. By adhering to these conditions, scanning equipment should be capable of reading the bar code you produce.

If you do want to check that a printed bar code meets the requirements of this manual, you must use verification equipment that responds exactly in accordance with the printing requirements stated in this section. This is particularly vital in regard to the spectral range you choose.

Results you obtain from inappropriate verification equipment can be seriously misleading in both over and under estimating the acceptability of printed bar codes.

9.2 General Printing and Production Information

Different Ways to Print a Bar Code

There are three ways you can print a bar code:

- at source - as part of the final film of the packaging; often called source marking
- on-line - printing directly onto the package during production
- print and apply method - a label applied to the package when required

Producing an accurate bar code on an item **at source** involves a number of separate processes, each contributing to the quality of the final result. This section describes these processes.

Producing **on-line** and **print and apply method** bar codes uses printing machines that convert data into bar codes. These processes are almost totally automated and are covered briefly in this section. In addition, "Thermal Bar Code Label Printers" on page 107 contains information regarding Thermal Transfer, Direct Thermal and General Office Printing of Bar Codes.

Production Processes for Source Marked Bar Codes

The main processes in producing a source marked bar code are:

- assessing the printing conditions
- determining the magnification factor and bar width reduction necessary to compensate for the printing conditions
- producing a film master that represents the bar code
- making printing plates
- printing the bar code on the packaging
- performing print quality checks.

These processes, except producing the film master, are normally undertaken by specialist printers. Specialist film master suppliers produce the film masters. Both specialists employ techniques at their own discretion to produce bar codes that are within GS1 specifications.

Note: Read all general information; then follow the information under the headings in this section for the type of bar code you are printing.

9.3 Print Gain and Variation

When a film master with nominal (100%) X-dimensions (module widths) is converted into a printing plate and printed onto a package, the printed bars usually end up wider than the bars on the film master. The amount by which a printed bar is wider than the same bar on the film master is called print gain, and is caused by factors such as:

- plate making
- print pressure
- absorbent substrate
- ink coverage.

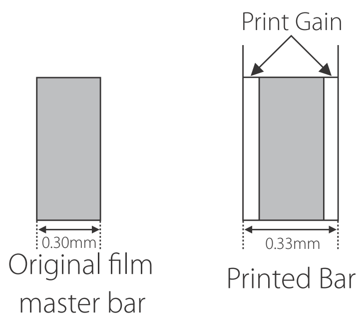


Figure 38 - Typical Print Gain for a Single Bar in an EAN-13 Bar Code

During the course of a print run, the extent of print gain usually differs between individual impressions. The difference in the amount of print gain is called variation.

Note: In preparation for printing a bar code, you must first assess the **average print gain** and **extent of variation** you encounter in the normal printing process.

Basic Assessment Method for Determining the Print Gain and Variation

Use proper sampling over a sufficient variety of production. Measure the bars directly from the printed bar codes. Determine the:

- average extremes of **print gain** (G)
- **variation** about this average (V).

The film master supplier makes compensations for both these factors when preparing the film master.

Mathematically, if print gain is G, variation is V, the original bar width on the film master is N, and the printed bar width is L, then:

$$L = N + G \pm V$$

The **extent of variation** in print gain determines the magnification factor to use.

The **extent of average print gain** determines the Bar Width Reduction (BWR). This is the amount by which the bars on the film master must be reduced in width to correct for the print gain.

9.4 Print Quality Checks

If all allowances are properly made in the preparation of the film master, it may be sufficient to only carry out spot checks in the course of, and during, the print run. Spot checks carried out regularly during a print run can give a good indication if print quality is deteriorating.

Perform a spot check by:

- Verifying using a verifier which uses the ISO grading (ANSI) method.
- Taking a direct measurement of a particular bar in the printed bar code or the first two bars and spaces.

ISO/IEC 15416 describes a method for looking at the quality of a printed bar code using an ISO(ANSI) based verifier as a tool. The verifier is programmed to look at certain characteristics of the bar code the way a scanner would, provide scan grades, and after ten scans provide an ISO symbol grade.

GS1 utilises the ISO method, but specifies the minimum grade necessary for every GS1 Bar Code depending on which symbol is used, where it is used, or what identification code it is carrying. In addition to the minimum grade, GS1 also specifies the verifier aperture width and wavelength. This would be similar to a university using a standardised test to determine whether applicants qualify for admission. Several universities may utilise the same standardised test, but each sets the minimum score necessary for their applicants to be admitted.

The table below provides you with a quick reference list of the bar code quality parameters depending on their type, their application, or the identification code they are carrying.

Symbology	ISO (ANSI) Passing Grade	Aperture	Wavelength (nanometers)
EAN/UPC	1.5 (C)	6 mils (0.15mm)	670nm +/-10
ITF-14 < 62.5% Magnification (X-dimension 0.64mm)	1.5 (C)	10 mils (0.25mm)	670nm +/-10
ITF-14 ≥ 62.5% Magnification (X-dimension 0.64mm)	0.5 (D)	20 mils (0.50mm)	670nm +/-10
GS1-128	1.5 (C)	10 mils (0.25mm)	670nm +/-10
GS1 DataBar	1.5 (C)	6mils (0.15mm)	670nm +/-10
GS1 DataMatrix	1.5(C)	6mils (0.15mm)*	670nm +/-10

* Thee effective aperture for GS1 DataMatrix quality measurements should be taken at 80 percent of the minimum X-dimension allowed for the application.

TABLE 27. Required ISO Grades for GS1 Bar Code

For example a EAN/UPC Bar Code will always be verified using a 6 mils aperture, a 670nm (nanometer) +/-10 wavelength of light, and require a minimum symbol grade of 1.5 (C).

9.5 Colours, Contrast, and Reflectance

Scanners recognise a bar code by “seeing” the difference between light and dark areas. Various factors can affect the recognition process. Their explanations follow.

Reflectance and Reflection Density

Light areas show high reflectance values whereas dark areas show low values.

The reflection density required for the dark bars depends on the reflection density of the light background being used.

Mathematically, when R is the reflectance and D is reflection density:

$$D = -\log_{10} R$$

Measure reflectance to ensure your bar code is acceptable. Make the measurements under the following conditions, with equipment meeting the stated specifications.

In **Geometric** conditions, centre the incident illumination 45° to the normal of the sample and the reflected light collected by a receiver subtending a solid angle centred on the normal to the sample. The sampling aperture should be a circular area of a minimum 0.2 mm and maximum 0.56 mm in diameter.

In **Spectral** conditions, illuminate the sample by light having a spectral power distribution which corresponds to CIE source A, obtained using a gas filled, coiled-tungsten filament lamp operating at a correlated colour temperature of 2856K.

The photometric receiver of the reflected light should have a relative spectral sensitivity corresponding to a photomultiplier with an S-4 response as specified by the American Joint Electronic Devices Engineering Council, used with a Wratten 26 filter meeting nominal specifications.

Contrast

Print Contrast Signal (PCS) is affected by the reflectance of the light and dark bars.

Mathematically, when PCS is print contrast, RL is the reflectance of the light background, and RD is the reflectance of the dark background:

$$PCS = \frac{R_L - R_D}{R_L}$$

Figure 39 - PCS Equation

For ITF-14 and GS1-128 Bar Codes, most values of R_L require less contrast than EAN/UPC Bar Codes. However, ITF-14 and GS1-128 Bar Codes with R_L values greater than 65 have more stringent specifications than equivalent EAN/UPC Bar Codes. Refer to Table 28 and Table 29.

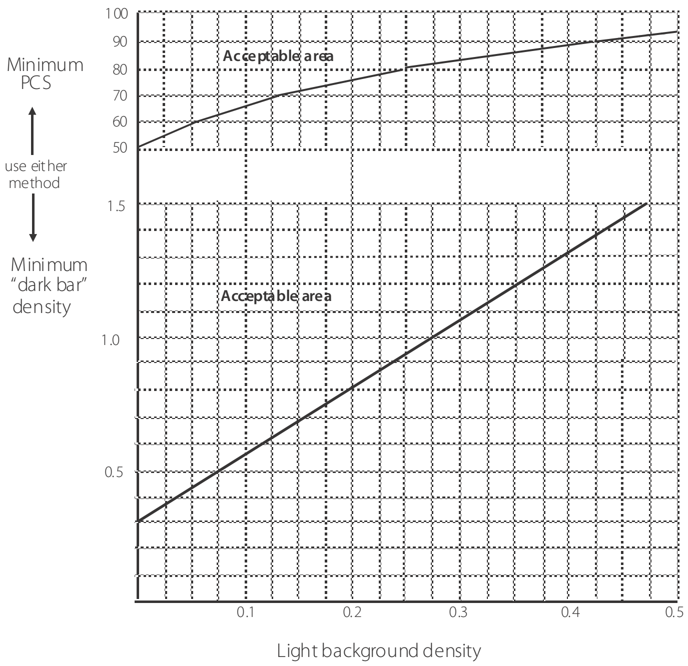


Figure 40 - EAN/UPC Bar Code Symbol Density and PCS

Light Bars		Dark Bars		Minimum PCS
D	RL	D	RD	RL –RD / RL
0	100	0.300	50.1	0.499
0.025	94.4	0.365	43.1	0.543
0.050	89.1	0.430	37.1	0.583
0.075	84.1	0.495	32.0	0.619
0.125	74.9	0.625	23.7	0.683
0.15	70.8	0.69	20.4	0.712
0.175	66.8	0.755	17.6	0.737
0.2	63.1	0.82	15.1	0.76
0.25	56.2	0.95	11.2	0.801
0.275	53.1	1.015	9.6	0.818
0.3	50.1	1.08	8.3	0.834
0.325	47.3	1.145	7.2	0.849
0.35	44.7	1.21	6.2	0.862
0.375	42.2	1.275	5.3	0.874
0.4	39.9	1.34	4.6	0.886
0.425	37.5	1.405	3.9	0.896
0.45	35.5	1.47	3.4	0.904
0.475	33.5	1.535	2.9	0.914
0.5	31.6	1.6	2.5	0.921

TABLE 28. EAN/UPC Bar Code Density, Reflectance, and PCS

Light bars		Dark bars		Minimum PCS
D	Minimum RL	D	Minimum RD	$\frac{RL - RD}{RL}$
0.97	> 80	0.699	20.00	0.75
0.125	75	0.727	18.75	0.75
0.155	70	0.757	17.50	0.75
0.187	65	0.789	16.25	0.75
0.222	60	0.824	15.00	0.75
0.26	55	0.861	13.75	0.75
0.301	50	0.903	12.50	0.75
0.347	45	0.949	11.25	0.75
0.398	40	1.000	10.00	0.75
0.456	35	1.058	8.75	0.75
0.523	30	1.125	7.50	0.75
0.602	25	1.204	6.25	0.75

TABLE 29. GS1-128 and ITF-14 Bar Codes Density, Reflectance, and PCS

Colour

Use any dark and light colour combination that conforms to the reflectance and contrast specifications stated previously. Make the background the light colour.

As a general guide to colour selection, it is the blue content of a colour that produces the dark tone when viewed through a Wratten 26 filter. Red and yellow colours correspond to the light tones.

Do not use high gloss inks or substrates for the background, because they upset the reflectance and colour combinations.

Show Through

For some items, the inside material may show through the light areas of the packaging. This may make the package colour appear dark to the scanner. In these cases, calculate the reflectance and contrast from a **finished** item, not just the outer package.

Different packaging materials reflect light differently, according to the dimensions of the bars and spaces. This is especially evident on transparent and translucent packages, where the background (that is, the spaces) is not printed.

In these cases, calculate the bar code contrast specifications from a **finished** item. Make contrast measurements using the bar code parts where the bars and spaces are at a minimum width, for example, in the centre pattern of an EAN/UPC Bar Code.

When there is the possibility of show through, it is preferable to print both the light background and the dark bars.

Transparent Wrapper

A transparent wrapper over the printed bar code tends to slightly reduce the contrast. If you use a transparent wrapper over the printed bar code, consider the transparent wrapper an integral part of the symbol. Make all reflectance measurements with the wrapper over the bar code.

Specularly Reflecting Materials

Avoid using specularly reflecting materials (those that are **very** reflective) for either light or dark areas in a bar code. If such material is the substrate for a bar code, it is advisable to overprint the substrate with two inks having sufficiently different light absorbing characteristics to meet the print contrast requirements.

If you cannot avoid using specularly reflecting materials, and the bar code surface is rigid, **print** the **spaces** in a **light** colour. **Leave** the **bars** in the **reflective substrate**, preferably the bare substrate. Otherwise, print a portion of the bar area with a transparent ink that does not significantly change the reflectance.

If the bars are not printed, it is preferable to varnish the entire bar code. In these circumstances it is not recommended to print bar codes under 100% magnification. Ensure the human readable digits are highly visible.

When using this method, the accuracy of the bar code dimensions is critical.

Film master manufacturers have to execute bar width expansion and create reverse orientation of film (positive becomes negative and vice versa). They "fatten" the human readable digits to make them more "visible."

Obscuring Patterns

You may need to obscure bar codes in some circumstances, for example, on the individual unit packs in a multipack container that carries its own bar code.

One way to obscure a bar code is to print a solid layer of ink over the bar code. However, this is not always 100% effective. It is better to print a distraction, in the form of an obscuring pattern, over the bar code.

The obscuring pattern printed over the bar code must meet the same print contrast signal level as the bar code you are covering. See “Contrast” on page 76.

Make sure the bar width for the obscuring pattern is the “target” module width for the magnification factor of the bar code being obscured. Make sure the space width of the obscuring pattern is no more than twice its own bar width.

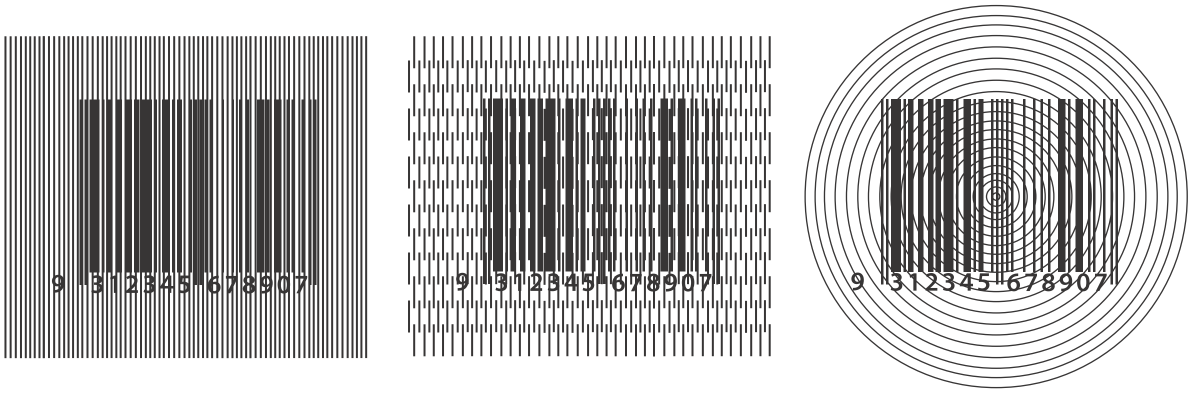


Figure 41 - Patterns that Obscure a Bar Code

9.6 EAN/UPC Bar Code Specifications

9.6.1 EAN/UPC Magnification

The size of the bar code has historically been known as magnification. This technique relies upon setting a nominal size (100% magnification) that is directly related to a given X-dimension (module width). The more precise X-dimension is now also used to specify permissible bar code sizes.

The extent of variation (V) in print gain determines the magnification factor by which the bar code must be magnified (or reduced) in relation to the nominal size.

Adopt any value of magnification (M) between 80% - 200% (X-dimension 0.27mm - 0.66mm) by interpolation of Figure 42 on page 82 and Table 30 on page 83.

Note: For General Distribution Scanning the magnification range is 150% - 200% (X-dimension 0.50mm - 0.66mm).

The left column inTable 30 is based on a regular sequence of values of M. The right column is based on a regular sequence of values of V.

The finer the ink gain, the smaller the bar code; the broader the ink gain, the larger the bar code.

Note: For any magnification factor below 100% (X-dimension 0.33mm), the amount of acceptable print gain variation rapidly becomes smaller.

Determining the magnification factor determines the amount of space required on the package to accommodate the bar code.

The space required needs to accommodate the overall length and height of the bar code which is between 80% and 200% magnification (X-dimension 0.27mm - 0.66mm).

For scanning in a General Distribution Scanning Environment the magnification range 150% - 200% (X-dimension 0.46mm - 0.66mm).

Note: Wherever possible, use a magnification higher than the minimum. This greatly increases the bar code scanning reliability. If you reduce the magnification to below nominal, you may reduce its reliability.

Note: It is the print quality of the bar code and the scanning environment that determines the minimum magnification factor you must apply, **not** a predetermined space on the package.

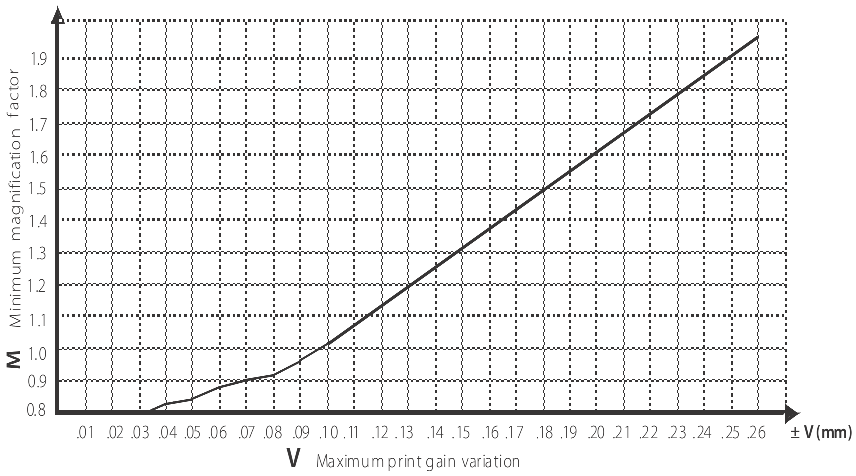


Figure 42 - Relationship between Maximum Print Gain Variation and Minimum Magnification

Continuous sequence of values of M			Continuous sequence of values of V		
Maximum print gain variation	Minimum magnification	X-dimension	Maximum print gain variation	Minimum magnification	X-dimension
±0.035	0.80	0.26	±0.04	0.82	0.27
±0.051	0.85	0.28	±0.06	0.88	0.29
±0.069	0.90	0.30	±0.08	0.94	0.31
±0.085	0.95	0.31	±0.10	1.00	0.33
±0.101	1.00	0.33	±0.12	1.14	0.38
±0.108	1.05	0.35	±0.14	1.25	0.41
±0.115	1.10	0.36	±0.16	1.39	0.46
±0.124	1.15	0.38	±0.18	1.52	0.50
±0.132	1.20	0.40	±0.20	1.65	0.55
±0.140	1.25	0.41	±0.22	1.78	0.59
±0.147	1.30	0.43	±0.24	1.90	0.63
±0.152	1.35	0.45	±0.26	2.00	0.66
±0.163	1.40	0.46	—	—	—
±0.171	1.45	0.48	—	—	—
±0.178	1.50	0.50	—	—	—
±0.184	1.55	0.51	—	—	—
±0.192	1.60	0.53	—	—	—
±0.201	1.65	0.54	—	—	—
±0.209	1.70	0.56	—	—	—
±0.216	1.75	0.58	—	—	—
±0.224	1.80	0.59	—	—	—
±0.233	1.85	0.61	—	—	—
±0.241	1.90	0.63	—	—	—
±0.250	1.95	0.64	—	—	—
±0.256	2.00	0.66	—	—	—

Note: In the heading of this table, M = magnification, V = print gain variation.
All measurements are in millimetres.

TABLE 30. Relationship between Maximum Print Gain Variations and Minimum Magnification

9.6.2 EAN/UPC Film Master Tolerances

The magnification factor compensates for variation in print gain and is the minimum magnification you apply to a bar code.

It does not take into account any further magnification required to compensate for tolerances in the preparation of the film master itself, nor does it allow any additional safety margin.

The permissible tolerances when preparing a film master are:

- ± 0.005 mm on any module width
- ± 0.013 mm on any complete symbol character or auxiliary pattern

Consult your film master supplier regarding the variation in tolerance to expect, in practice, in the film master. Add this amount to the variation value (V) you calculated in respect to the print gain. See "Print Gain and Variation" on page 72.

Generally, it is best to add the amount of the modular tolerance (0.005 mm) to the variation value (V) before looking up the required value of M in Table 30 on page 83.

9.6.3 EAN/UPC Bar Width Reduction

Film master suppliers compensate for the extent of the demonstrated print gain. They achieve this by applying Bar Width Reduction (BWR) to the film master. BWR is equal to the print gain.

Reduce the width of **every** bar by the same amount on the film master symmetrically, that is, on **both** the left and right sides, by the total amount of the print gain.

Note: Apply the bar width reduction to the film master **after** carrying out any magnification to the bar code, **not** before. The only exception is when printing by Flexography, or any other process producing a print gain in excess of 0.3mm.

The bar width reduction is equal to the average print gain in all cases and is not affected by the magnification of the bar code.

When the film master is printed with its bars reduced by the BWR, the average print gain restores the bars to their ideal width. Variation in the average print gain has already been allowed for in the choice of magnification. The tolerance of bar width reduction is ± 0.008mm.

Note: Never reduce a bar in a bar code on the printing plate below 0.13mm.

If the effect of the magnification factor and bar width reduction combined causes a single module bar to go below 0.13mm, increase the magnification factor until the bar reaches the acceptable width of 0.33 mm. Mathematically:

$$(0.33 \times M) - G \geq 0.13 \text{ mm}$$

9.6.4 On-Site Production of EAN/UPC Bar Codes

The processes described previously for source marked bar codes are not relevant for on-site printers.

In some circumstances, automatic label printing machines are used on-site to convert numerical data directly into a bar code. The performance of these machines must be specified in order to control their output. It is necessary to stipulate the tolerance permitted in the printed bar code.

The nominal EAN/UPC X-dimension (module width) is 0.33 mm. Tolerances for bar code labels are defined for various X-dimensions (module widths) corresponding to magnifications 80% - 200%.

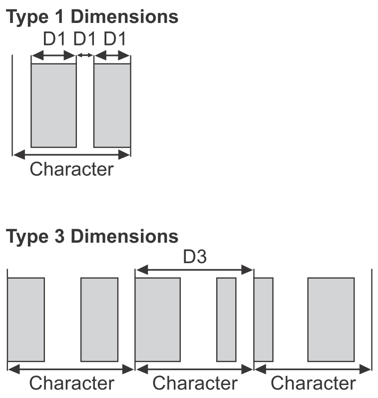
Different tolerances may apply to different types of dimensions. There are four different dimensions in an EAN/UPC Bar Code.

- The measurement of a bar (space) inside a character.
- The measurement of the width between corresponding edges of the bars inside the character.
- The measurement between corresponding edges of corresponding bars in adjacent characters.
- The measurement of the space between the last and first bars of adjacent characters.

See Table 31 on page 86.

These dimensions and tolerances may also be used by packaging manufacturers to ensure that printing is of an acceptable quality.

The dimensions given in Table 31 do not represent a standard for source marked bar codes, but can be used by film master suppliers, verification equipment, scanning equipment, and printers as a reference.



Magnification	X-dimension (Module width)	Tolerance D1	Tolerance D2	Tolerance D3
80%	0.26	±0.032	±0.038	±0.075
85%	0.28	±0.052	±0.041	±0.081
91%	0.30	±0.072	±0.044	±0.087
97%	0.32	±0.092	±0.047	±0.093
100%	0.33	±0.101	±0.049	±0.096
103%	0.34	±0.105	±0.050	±0.099
109%	0.36	±0.115	±0.053	±0.104
115%	0.38	±0.124	±0.056	±0.110
121%	0.40	±0.134	±0.059	±0.116
127%	0.42	±0.143	±0.062	±0.122
133%	0.44	±0.152	±0.065	±0.128
139%	0.46	±0.162	±0.068	±0.133
145%	0.48	±0.171	±0.071	±0.139
151%	0.50	±0.181	±0.073	±0.145
158%	0.52	±0.190	±0.076	±0.151
164%	0.54	±0.199	±0.079	±0.157
170%	0.56	±0.209	±0.082	±0.162
176%	0.58	±0.218	±0.085	±0.168
181%	0.60	±0.228	±0.088	±0.174
188%	0.62	±0.237	±0.091	±0.180
194%	0.64	±0.246	±0.094	±0.186

Note: Type 4 dimensions are not subject to explicit tolerances but must not be less than 0.2 mm.
All measurements are in millimetres.

TABLE 31. EAN/UPC Bar Code Dimensions and Tolerances for Types 1, 2, and 3 Dimensions

9.6.5 EAN/UPC Bar Code Dimensions

EAN-13 Bar Code Dimensions

Magnification	X-dimension	Width	Bar Height	Left Quiet Zone	Right Quiet Zone
80%	0.26	25.08	18.28	2.90	1.85
85%	0.28	26.65	19.42	3.09	1.96
90%	0.30	28.22	20.57	3.27	2.08
95%	0.31	29.78	21.71	3.45	2.19
100%	0.33	31.35	22.85	3.63	2.31
105%	0.35	32.92	23.99	3.81	2.43
110%	0.36	34.49	25.14	3.99	2.54
115%	0.38	36.05	26.28	4.17	2.66
120%	0.40	37.62	27.42	4.36	2.77
125%	0.41	39.19	28.56	4.54	2.89
130%	0.43	40.76	29.71	4.72	3.00
135%	0.45	42.32	30.85	4.90	3.12
140%	0.46	43.89	31.99	5.08	3.23
145%	0.48	45.46	33.13	5.26	3.35
150%	0.50	47.03	34.28	5.45	3.47
155%	0.51	48.59	35.42	5.63	3.58
160%	0.53	50.16	36.56	5.81	3.70
165%	0.54	51.73	37.70	5.99	3.81
170%	0.56	53.30	38.85	6.17	3.93
175%	0.58	54.86	39.99	6.35	4.04
180%	0.59	56.43	41.13	6.53	4.16
185%	0.61	58.00	42.27	6.72	4.27
190%	0.63	59.57	43.42	6.90	4.39
195%	0.64	61.13	44.56	7.08	4.50
200%	0.66	62.70	45.70	7.26	4.62

Note: In the heading of this table, Width = Width of bar code excluding Quiet Zones,
Bar Height = Bar Height excluding guard bar patterns.
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

TABLE 32. EAN-13 Bar Code Dimensions

EAN-8 Bar Code Dimensions

Magnification	X-dimension	Width	Bar Height	Left Quiet Zone	Right Quiet Zone
80%	0.26	17.69	14.58	1.85	1.85
85%	0.28	18.79	15.50	1.96	1.96
90%	0.30	19.90	16.41	2.08	2.08
95%	0.31	21.00	17.32	2.19	2.19
100%	0.33	22.11	18.23	2.31	2.31
105%	0.34	23.22	19.14	2.43	2.43
110%	0.36	24.32	20.05	2.54	2.54
115%	0.38	25.43	20.96	2.66	2.66
120%	0.40	26.53	21.88	2.77	2.77
125%	0.41	27.64	22.79	2.89	2.89
130%	0.43	28.74	23.70	3.00	3.00
135%	0.45	29.85	24.61	3.12	3.12
140%	0.46	30.95	25.52	3.23	3.23
145%	0.48	32.06	26.43	3.35	3.35
150%	0.50	33.17	27.35	3.47	3.47
155%	0.51	34.27	28.26	3.58	3.58
160%	0.53	35.38	29.17	3.70	3.70
165%	0.54	36.48	30.08	3.81	3.81
170%	0.56	37.59	30.99	3.93	3.93
175%	0.58	38.69	31.90	4.04	4.04
180%	0.59	39.80	32.81	4.16	4.16
185%	0.61	40.90	33.73	4.27	4.27
190%	0.63	42.01	34.64	4.39	4.39
195%	0.64	43.11	35.55	4.50	4.50
200%	0.66	44.22	36.46	4.62	4.62

Note: In the heading of this table, Width = Width of bar code excluding Quiet Zones,
Bar Height = Bar Height excluding guard bar patterns.
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

TABLE 33. EAN-8 Bar Code Dimensions

UPC-A Bar Code Dimensions

Magnification	X-dimension	Width	Bar Height	Left Quiet Zone	Right Quiet Zone
80%	0.26	25.08	18.28	2.38	2.38
85%	0.28	26.65	19.42	2.52	2.52
90%	0.30	28.22	20.57	2.67	2.67
95%	0.31	29.78	21.71	2.82	2.82
100%	0.33	31.35	22.85	2.97	2.97
105%	0.36	32.92	23.99	3.12	3.12
110%	0.36	34.49	25.14	3.27	3.27
115%	0.38	36.05	26.28	3.42	3.42
120%	0.40	37.62	27.42	3.56	3.56
125%	0.41	39.19	28.56	3.71	3.71
130%	0.43	40.76	29.71	3.86	3.86
135%	0.45	42.32	30.85	4.01	4.01
140%	0.46	43.89	31.99	4.16	4.16
145%	0.48	45.46	33.13	4.31	4.31
150%	0.50	47.03	34.28	4.46	4.46
155%	0.51	48.59	35.42	4.60	4.60
160%	0.53	50.16	36.56	4.75	4.75
165%	0.54	51.73	37.70	4.90	4.90
170%	0.56	53.30	38.85	5.05	5.05
175%	0.58	54.86	39.99	5.20	5.20
180%	0.59	56.43	41.13	5.35	5.35
185%	0.61	58.00	42.27	5.49	5.49
190%	0.63	59.57	43.42	5.64	5.64
195%	0.64	61.13	44.56	5.79	5.79
200%	0.66	62.70	45.70	5.94	5.94

Note: In the heading of this table, Width = Width of bar code excluding Quiet Zones,
Bar Height = Bar Height excluding guard bar patterns.
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

TABLE 34. UPC-A Bar Code Dimensions

UPC-E Bar Code Dimensions

Magnification	X-dimension	Width	Bar Height	Left Quiet Zone	Right Quiet Zone
80%	0.26	13.47	18.28	2.38	1.85
85%	0.28	14.31	19.42	2.52	1.96
90%	0.30	15.15	20.57	2.67	2.08
95%	0.31	15.99	21.71	2.82	2.19
100%	0.33	16.83	22.85	2.97	2.31
105%	0.35	17.67	23.99	3.12	2.43
110%	0.36	15.51	25.14	3.27	2.54
115%	0.38	19.36	26.28	3.42	2.66
120%	0.40	20.20	27.42	3.56	2.77
125%	0.41	21.04	28.56	3.71	2.89
130%	0.43	21.88	29.71	3.86	3.00
135%	0.45	22.72	30.85	4.01	3.12
140%	0.46	23.56	31.99	4.16	3.23
145%	0.48	24.40	33.13	4.31	3.35
150%	0.50	25.25	34.28	4.46	3.47
155%	0.51	26.09	35.42	4.60	3.58
160%	0.53	26.93	36.56	4.75	3.70
165%	0.54	27.77	37.70	4.90	3.81
170%	0.56	28.61	38.85	5.05	3.93
175%	0.58	29.45	39.99	5.20	4.04
180%	0.59	30.29	41.13	5.35	4.16
185%	0.61	31.14	42.27	5.49	4.27
190%	0.63	31.98	43.42	5.64	4.39
195%	0.64	32.82	44.56	5.79	4.50
200%	0.66	33.66	45.70	5.94	4.62

Note: In the heading of this table, Width = Width of bar code excluding Quiet Zones,
Bar Height = Bar Height excluding guard bars patterns.
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

TABLE 35. UPC-E Bar Code Dimensions

9.7 ITF-14 Bar Code Specifications

9.7.1 ITF-14 Magnification Factor

The size of the bar code has historically been known as magnification. This technique relies upon setting a nominal size (100%) that is directly related to a given X-dimension (module width). The more precise X-dimension is now also used to specify permissible bar code sizes.

The extent of variation (V) in print gain determines the minimum magnification factor by which the entire bar code must be magnified (or reduced) in relation to the nominal size.

For General Distribution Scanning choose any value of magnification (M) between 50% and 100% (X-dimension 0.51mm - 1.02mm). See Table 36. For environments other than General Distribution Scanning, the minimum magnification factor is 25% (X-dimension 0.25mm).

The left column in Table 36 is based on a regular sequence of values of M. The right column is based on a regular sequence of values of V.

Note: Wherever possible, use a magnification factor higher than the minimum. This greatly increases the bar code scanning reliability. If you reduce the magnification to below nominal, you may reduce its reliability. See “Overall ITF-14 Dimensions” on page 94 for the dimensions of an ITF Bar Code at various magnification factors.

Note: It is the print quality of the bar code that determines the minimum magnification factor you must apply, not a predetermined space on the packaging.

Continuous sequence of values of M			Continuous sequence of values of V		
Maximum print gain variation	Minimum magnification	X-dimension	Maximum print gain variation	Minimum magnification	X-dimension
±0.127	62.5%	0.64	±0.15	65%	0.66
±0.203	70%	0.71	±0.18	68%	0.69
±0.244	80%	0.81	±0.21	71%	0.72
±0.274	90%	0.91	±0.24	79%	0.80
±0.305	100%	1.02	±0.27	89%	0.90
			±0.30	99%	1.01
Note: In the heading of this table M = Magnification, V = print gain variation. All measurements are in millimetres.					

TABLE 36. Relationship between variation and magnification for ITF-14 Bar Code

9.7.2 ITF Bar Width Reduction

Film master suppliers compensate for the extent of the demonstrated print gain. They achieve this by applying Bar Width Reduction (BWR) to the film master. BWR is equal to the print gain.

Reduce the width of **every** bar by the same amount on the film master symmetrically, that is, on **both** the left and right sides, by the total amount of the print gain.

Note: Apply the bar width reduction to the film master **after** carrying out any magnification to the bar code, **not** before.

The bar width reduction is equal to the average print gain in all cases and is not affected by the magnification of the bar code.

When the film master is printed with its bars reduced by the BWR, the average print gain restores the bars to their ideal width. Variation in the average print gain has already been allowed for in the choice of magnification.

9.7.3 Specification for the Dimensions of the Film Master

The dimensions for the specifications of the film master are shown in Table 37.

	Values of the dimensions	Tolerances
Width of a wide or narrow element of the bar code	Ideal nominal dimensions: • wide element 2.540 mm • narrow element 1.016 mm. To be corrected according to M and BWR	± M x 0.013 mm
Width of each pair of data characters	Ideal nominal dimensions: • 16.258 mm To be corrected according to M.	± M x 0.025 mm
Width of the start and stop patterns	Ideal nominal dimensions: • start character 4.064 mm • stop character 4.572 mm To be corrected according to M and BWR.	± M x 0.017 mm
Height of bars, thickness of Bearer Bar, minimum width of Quiet Zones	See Table 38 on page 93 and "Overall ITF-14 Dimensions" on page 94	± 0.127
Other dimensions of the bar code	See Table 38 on page 93 and "Overall ITF-14 Dimensions" on page 94	± 0.254

TABLE 37. ITF-14 Specifications for Manufacturing the Film Master

9.7.4 On-site Production of ITF-14 Bar Codes

The processes described previously for source marked bar codes are not relevant for on-site printers.

In some circumstances, automatic label printing machines are used on-site to convert numerical data directly into a bar code. The performance of these machines must be specified in order to control their output. It is necessary to stipulate the tolerance permitted in the printed bar code.

Tolerances for the ITF-14 Bar Codes are defined for various magnification factors, from 62.5% - 100% (X-dimension 0.64mm - 1.02mm).

In practice, packaging manufacturers may prefer to determine dimensions and tolerances by measurement to ensure that printing is of acceptable quality.

Table 38 shows an acceptable bar width dimensional tolerance for a given bar width for label printing equipment.

These do not represent a standard for source marked bar codes, but can be used by film master suppliers, verification equipment, scanning equipment, and printers as a reference.

	Width and tolerance wide and narrow elements			Width and tolerance digit pair (*)		Width and tolerance symbol start and stop pattern (*)		
Mag. (M)	Ideal width narrow bar (X)	Ideal width wide bar	Tolerance wide and narrow bar	Ideal width digit pair	Tolerance width digit pair	Ideal width start pattern	Ideal width stop pattern	Tolerance start and stop pattern
62.5%	0.635	1.588	±0.13	10.162	±0.36	2.54	2.858	±0.24
70%	0.711	1.778	±0.20	11.378	±0.41	2.844	3.2	±0.27
80%	0.813	2.032	±0.24	13.006	±0.46	3.252	3.658	±0.31
90%	0.914	2.286	±0.27	14.628	±0.52	3.656	4.114	±.035
100%	1.016	2.540	±0.30	16.256	±0.58	4.064	4.572	±0.39

* The tolerances are defined for label printing equipment. In source marking, the tolerances will be met provided the film master manufacturer respects the tolerances allowed and the printer respects the specified procedures.
X = X-dimension
All measurements are in millimetres.

TABLE 38. Dimensions and Tolerances in a Printed ITF-14 Bar Code

You can interpolate these tolerances to obtain intermediate values of M greater than 0.714. For values of M less than 0.714, the tolerance is limited by the requirement that the absolute minimum bar or space width be 0.50mm.

Allow a tolerance of ±0.5 mm for the height of the bars and the height and location of the human readable digits.

9.7.5 Overall ITF-14 Dimensions

At the nominal magnification of 100%, the X-dimension (width of a narrow element, i.e. bar) is 1.02mm and a wide element (bar) is 2.54mm.

This corresponds to the nominal symbol character dimensions given on page 97.

Figure 43 - ITF-14 Bar Code Nominal Dimensions

Note: Figure reduced below 100% for presentation purposes only

ITF-14 Bar Code Dimensions

Magnification	X-Dimension	Width	Bar Height	Quiet Zones
25%	0.25	30.62	13.00	2.54
30%	0.30	36.73	13.00	3.05
35%	0.36	42.85	13.00	3.56
40%	0.41	48.97	13.00	4.05
45%	0.46	55.09	13.00	4.57
50%	0.51	61.21	32.00	5.08
55%	0.56	67.34	32.00	5.59
60%	0.61	73.46	32.00	6.10
70%	0.71	85.70	32.00	7.11
75%	0.76	91.82	32.00	7.62
80%	0.81	97.94	32.00	8.13
85%	0.86	104.05	32.00	8.64
90%	0.91	110.19	32.00	9.14
95%	0.97	116.31	32.00	9.65
100%	1.02	122.43	32.00	10.16

Note: In the heading of this table, Width = width of bar code excluding Quiet Zones and Bearer Bars, and assumes a Bar Width Ratio of 2.5:1, Bar Height = bar height excluding Bearer Bars
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

9.7.6 Formula for Calculating the ITF-14 Symbol Width

Mathematically, when W is width, 48 is the total number of narrow elements, 29 is total the number of wide elements, BWR is the Bar Width Ratio which is nominally 2.5, and X is X-dimension (module width), which is 1.02mm at 100% magnification.

W = (48X) +(29X)BWR (excluding Quiet Zones and Bearer Bars)

9.7.7 Human Readable Interpretation

A clearly legible human-readable interpretation (proportional to the size of the bar code) of the data characters, including symbol check character, should normally be printed with the bar code encoding them. Start/stop patterns have no human-readable interpretation. Character size and font are not specified, and the interpretation may be printed anywhere in the area surrounding the bar code, although the preference is directly below the bar code ensuring Quiet Zones are not encroached upon.

9.7.8 ITF-14 Symbol Character Dimensions - Nominal Size

In the nominal size (100%), the ideal theoretical width of the bars is:

- narrow bar 1.016 mm
- wide bar 2.540 mm (2.5 times wider than the narrow bar).

The total width of an ITF-14 Bar Code at the nominal size (100%) excluding the Bearer Bar, Quiet Zones is 122.43mm.

The total width of an ITF-14 Bar Code at the nominal size (100%) including the Bearer Bar, Quiet Zones, and H gauges is 158.428 mm.

Start pattern	n x digit pairs	Stop pattern
4.064 mm	n x 16.256 mm	4.572 mm

TABLE 39. ITF-14 Bar Code Total Width excluding Quiet Zones

As shown in Table 40, the bar widths of the symbol characters are:

digit pair	= 6 narrow elements and 4 wide elements = (6 x 1.016 mm) + (4 x 2.540 mm)	= 16.256 mm
start pattern	= four narrow elements	= 4.064 mm
stop pattern	= two narrow elements + 1 wide element	= 4.572 mm

These dimensions are ideal, theoretical dimensions corresponding to an X-dimension (narrow element width) of 1.016mm (nominal size of an ITF-14 Bar Code). They are not intended to be used directly in the preparation of bar codes.

Start pattern	7 digit pairs	Stop pattern	Total
4 narrow elements	6 narrow elements 4 wide elements x 7 pairs 42 narrow elements 28 wide elements	2 narrow elements 1 wide element	48 narrow elements 29 wide elements
4.064 mm	113.792 mm	4.572 mm	122.428 mm

TABLE 40. ITF-14 Bar Code Character Dimensions

9.8 GS1-128 Bar Code Specifications

9.8.1 GS1-128 Magnification Factor

The extent of variation in print gain determines the minimum magnification factor by which the entire bar code must be magnified (or reduced) in relation to the nominal size.

For all scanning environments other than General Distribution Scanning, adopt any value of magnification (M) between 25% and 100% (X-dimension 0.25mm - 1.02mm) by interpolation of the following graph or table. For scanning in a General Distribution Scanning Environment magnification factors are between 48.7% and 100% (X-dimension 0.50mm - 1.02mm).

For GS1-128 Symbols containing the Application Identifier (00): Serial Shipping Container Code (SSCC), the minimum magnification range is 48.7% - 92.5% (X-dimension 0.50mm - 0.94mm).

See Table 41 and Figure 44 for more information. The left column in Table 41 is based on a regular sequence of values of M. The right column is based on a regular sequence of values of V.

The finer the ink gain, the smaller the bar code; the broader the ink gain, the larger the bar code.

Continuous sequence of values of M			Continuous sequence of values of V		
Maximum print gain variation	Minimum magnification	X-dimension	Maximum print gain variation	Minimum magnification	X-dimension
0.02	25%	0.25	0.05	28%	0.28
0.07	30%	0.31	0.10	33%	0.34
0.14	40%	0.41	0.15	41%	0.42
0.18	50%	0.51	0.20	54%	0.55
0.22	60%	0.61	0.25	66%	0.67
0.26	70%	0.71	0.30	79%	0.80
0.30	80%	0.81	0.35	91%	0.92
0.34	90%	0.91			
0.38	100%	1.02			
Note: In the heading of this table M = magnification, V = print gain variation. For any magnification below 100%, the amount of acceptable print gain variation rapidly becomes smaller. The values in this table respect the condition that no printed bars shall be less than 0.23mm in width. All measurements are in millimetres.					

TABLE 41. GS1-128 relationship between print gain variation and magnification

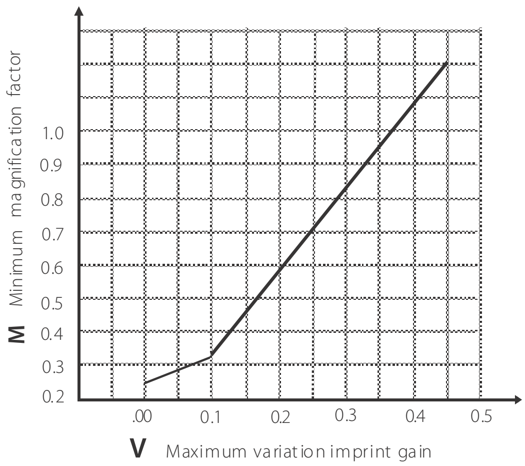


Figure 44 - GS1-128: Relationship between Maximum Print Gain Variation and Minimum Magnification Factors

The actual magnification factor you choose depends on the print quality and is derived from measuring the variation in print gain. When the GS1-128 Bar Code supplements an EAN/UPC or ITF-14 Bar Code, the magnification factor chosen must take into account the size of the EAN/UPC or ITF-14 Bar Code.

As a general rule, the GS1-128 X-dimension (module width) must not be less than 75% of the X-dimension (single module or narrow element width) in the EAN/UPC or ITF-14 main Bar Code. See Table 42 for magnification factors.

EAN-13 magnification	Minimum GS1-128 magnification	ITF-14 magnification factor	Minimum GS1-128 magnification
80%	25%	62.5%	50%
90%	25%	70%	55%
100%	25%	80%	65%
120%	30%	90%	70%
140%	35%	100%	80%
160%	40%		
180%	45%		
200%	50%		

TABLE 42. GS1-128 Magnification Factors for Various EAN-13 and ITF-14 Magnification Factors

9.8.2 GS1-128 Bar Width Reduction

Film master suppliers compensate for the extent of the demonstrated print gain. They achieve this by applying Bar Width Reduction (BWR) to the film master. BWR is equal to the print gain.

Reduce the width of **every** bar by the same amount on the film master symmetrically, that is, on **both** the left and right sides by the total amount of the print gain.

Note: Apply the bar width reduction to the film master **after** carrying out any magnification to the bar code, **not** before.

The bar width reduction is equal to the average print gain in all cases and is not affected by the magnification of the bar code.

When the film master is printed with its bars reduced by the BWR, the average print gain restores the bars to their ideal width. Variation in the average print gain has already been allowed for in the choice of magnification.

Look up the print gain variation (V) in Table 41 and Figure 44.

Note: Never print a bar less than **0.23** mm in width.

9.8.3 On-site Production of GS1-128 Bar Codes

Often the GS1-128 Bar Code is produced from equipment which produces bar codes directly from the input of data. In order to specify the performance of such printers and to control their output, it is necessary to stipulate the tolerances permitted in the printed bar code.

Tolerances are defined for various module widths corresponding to magnification factors from 25% - 100% of the nominal size (X-dimension 0.25mm - 1.016mm). Different tolerances apply to different types of dimensions.

There are three different types of dimensions in the GS1-128 Bar Code.

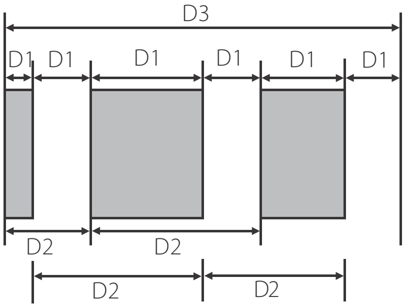
- Type 1 - measurement of a bar or space inside the bar code.
- Type 2 - measurement of the width between corresponding edges of bars within a character.
- Type 3 - measurement of the total width of a character.

Based on 100% magnification, tolerances D1, D2, and D3 apply to dimension types 1, 2, and 3:

- $D1 = \pm 0.4 X - 0.013$ mm (0.0005 inches)
- $D2 = \pm 0.2 X$
- $D3 = \pm 0.2 X$

X is the nominal minimum dimension

.



Magnification	X-dimension	Tolerance D1*	Tolerance D2	Tolerance D3
25%	0.25	0.020	0.050	0.050
30%	0.30	0.070	0.060	0.060
35%	0.36	0.127	0.070	0.070
40%	0.41	0.147	0.080	0.080
45%	0.46	0.167	0.090	0.090
50%	0.51	0.187	0.100	0.100
55%	0.56	0.207	0.110	0.110
60%	0.61	0.227	0.120	0.120
65%	0.66	0.247	0.130	0.130
70%	0.71	0.267	0.140	0.140
75%	0.76	0.287	0.150	0.150
80%	0.81	0.307	0.160	0.160
85%	0.86	0.327	0.170	0.170
90%	0.91	0.347	0.180	0.180
95%	0.97	0.367	0.190	0.190
100%	1.02	0.387	0.200	0.200

* These values respect the condition that no printed bar shall be less than 0.23mm in width.
Note: All measurements are in millimetres.

TABLE 43. GS1-128 Bar Code Dimension Tolerances, Types 1,2, and 3

9.8.4 Overall GS1-128 Dimensions

Figure 45 - GS1-128 Symbol at Nominal Size (not to scale)

The size of the GS1-128 Bar Code depends on:

- the X-dimension (magnification factor) chosen
- the number of characters encoded
- the number of non-numeric characters in the data.

The X-dimension (module width) at 100% magnification is 1.016mm.

Magnifications are between 25% and 100% (X-dimension 0.254mm to 1.016mm). For General Distribution Scanning, a minimum magnification of 48.7% (X-dimension 0.495mm) should be used.

Note: Magnification factors for (AI) 00 - Serial Shipping Container Code (SSCC) are between 48.7% and 92.5% (X-dimension 0.495mm - 0.940mm).

Mathematically, when W is width, 11 is the number of modules per symbol character, N is the number of symbol characters (excluding the start and stop characters and Symbol Check Character), 66 is the number of auxiliary character modules and X is the X-dimension (module width), which at 100% magnification is 1.016mm.

$W = (11N + 66)X$ (including Quiet Zones)

GS1-128 Bar Code Dimensions

Magnification	X-dimension	Width	Bar Height	Quiet Zones
25%	0.25	34.04	13.00	2.54
30%	0.30	40.84	13.00	3.05
35%	0.36	47.65	13.00	3.56
40%	0.41	54.46	13.00	4.06
45%	0.46	61.26	13.00	4.57
50%	0.51	68.07	32.00	5.08
55%	0.56	74.88	32.00	5.59
60%	0.61	81.68	32.00	6.10
65%	0.66	88.49	32.00	6.60
70%	0.71	95.30	32.00	7.11
75%	0.76	102.11	32.00	7.62
80%	0.81	108.91	32.00	8.13
85%	0.86	115.72	32.00	8.64
90%	0.91	122.53	32.00	9.14
95%	0.97	129.33	32.00	9.65
100%	1.02	136.14	32.00	10.16

Note: In the heading of this table, Width = Width of bar code excluding Quiet Zones,
It is recommended to always allow slightly more than the minimum required Quiet Zone to allow for any possible ink spread or registration issues.
All measurements are in millimetres.

These dimensions are only indicative of a GS1-128 Bar Code with one Application Identifier and a GTIN without any attribute data, e.g. (01)09312345678907.

TABLE 44. GS1-128 Bar Code Dimensions

9.8.5 GS1-128 Symbol Character Dimensions

In the nominal size (100%), the X-dimension (width of a single module) of a GS1-128 Bar Code is **1.016 mm**.

A GS1-128 Bar Code has a total of 11N + 66 modules (including the Quiet Zones). This is made up from all data characters plus auxiliary characters. See Table 12 on page 23 of chapter 4 .

The nominal width of each **symbol character**, with the exception of the stop character, is **11.176 mm**, and the nominal width of the **stop character** is **13.208 mm**.

The maximum number of encoded human readable characters for one GS1-128 Bar Code is 48. This number includes AIs and function characters when used as field separator characters, but excludes auxiliary characters and the Symbol Check Character.

The **total physical length** of a GS1-128 Bar Code depends on how many characters you encode and which character set you use. The maximum physical length, including Quiet Zones, is **165mm**.

Measure the width of each character, except the stop character, from the visually indicated edge (dark bar) to the visually indicated edge of the adjacent character. For the stop character, measure between its extreme visually indicated edges.

In character set C, two digits are encoded in one symbol character so you can encode numeric data with twice the density.

Note: All dimensions given are ideal, theoretical dimensions corresponding to an X-dimension of 1.016mm, ie, the nominal size bar code. These dimensions are not intended for use directly in the preparation of bar codes.

9.8.6 Human Readable Interpretation

For GS1-128 Bar Codes, show the Human Readable Interpretation of the data characters represented in the symbol, either above or below the bars.

Note: The symbol Check Digit (Mod 103) is not part of the data. Do not show it in human readable format.

Make sure AIs are clearly recognisable to assist with quick key entry. Achieve this by placing the AIs in parentheses (brackets) in the human readable form. The brackets must not be encoded in the actual bar code.

9.8.7 Concatenation

You can concatenate (combine) multiple AIs and their fields into a single bar code. See "Concatenation " on page 66

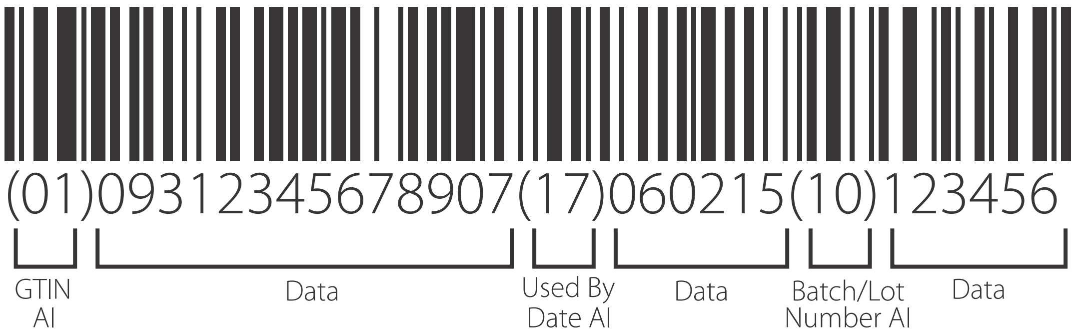


Figure 46 - Concatenated GS1-128 Bar Code

Place a FNC1 character field separator after all variable-length fields to identify the end of that field. This is not necessary for the last field in the bar code.

When the first two characters of the AI correspond to a pre-defined length indicator, you do not need to use a FNC 1 field separator character to separate the fields because their length is already known. See Table 31 on page 65 of chapter 8 .

The next AI follows immediately after the last character in the data field of the previous AI.

Figure 46 and Figure 45 show various concatenations.

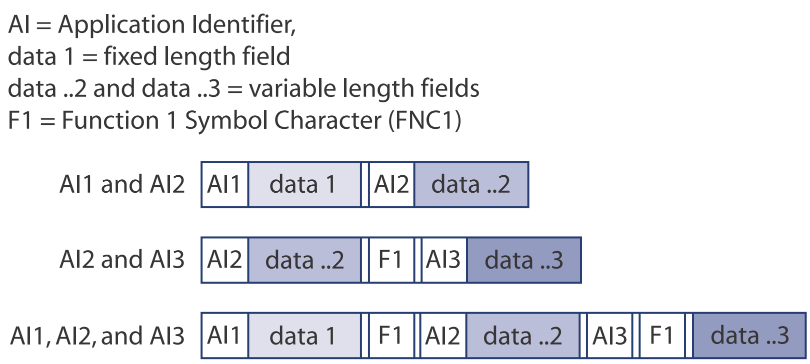


Figure 47 - Example of Concatenated Element Strings

Note: When you concatenate a number of AIs and their data fields, and only one field is of variable length, place the variable length field at the end of the bar code. This saves you from needing to include a field separator.

9.9 Thermal Bar Code Label Printers

Direct thermal and thermal transfer printers are capable of generating high quality bar codes - typically ISO Grade 3 or 4. The printers may stand-alone or they may be integrated into an application such as a weighing and labelling system. In many cases the user has no control over the size or placement of the bar code. Quality printing is easily maintained by observing the following guidelines.

Symbology Design Considerations for Direct Thermal and Thermal Transfer Printers

Direct thermal and thermal transfer printers typically contain all of the low-level software required to generate bar codes. This means that various symbology formats are loaded into the firmware of the printer. The bar code design software simply sends commands to address the firmware in the printer to create the bar code. These commands typically relate to data characters, symbol size, symbol orientation and symbol placement.

The following special factors should be considered when designing the bar code for direct thermal and thermal transfer printers:

- Generate bar codes at a corrected magnification (see **Note:** below) or an X-dimension which is supported by the resolution of the specified printer. For example, the closest X-dimension (bar width) to 0.33mm a 203 DPI printer can achieve is 0.375mm. This is because each bar width is constructed with three 203 DPI dots which individually measure 0.125mm wide. Table 45 lists achievable EAN/UPC Bar Code magnifications (after correction) addressed by several resolutions of direct thermal and thermal transfer printers.

Note: A process of altering the desired dimensions of a GS1 Bar Codes to create modules consisting of a consistent integer number of addressable imaging device dots.

- Use a bar code graphic file that was designed for the resolution or the printer specified.

General Considerations for Direct Thermal Printing

Direct thermal printing should be avoided whenever the bar code may be exposed to direct sunlight, extreme temperatures, or has a shelf life exceeding one year. These labels fade very quickly in direct sunlight, and the background darkens at elevated temperatures. Some fading also occurs as labels age at room temperature under normal indoor lighting. As labels fade or darken, the contrast decreases so that at some point the bar code can no longer be scanned.

An example of good application for thermal labels is in-store marking of meat and other perishable food items. Such labels need last only days or weeks under protected indoor conditions.

General Considerations for Thermal Transfer Consumable Supplies

Consumable supplies are an important quality consideration. For best results, the correct combination of label and ribbon materials should be chosen for the printer type and application environment. Whenever a different brand or part number of labels or ribbons is loaded on the printer, the initial set-up should be repeated.

Initial Direct Thermal and Thermal Transfer Printer Set-Up

Direct thermal and thermal transfer printers require different settings for best results on different combinations of label and ribbon materials. Manufacturers' recommendations should be followed for making the necessary changes and adjustments.

After any change (e.g. printed format, ribbon type, label type, print speed, or printhead heat intensity), it is advisable to print a test symbol and verify it using an ISO (ANSI) based verifier. If you are printing a long run of identical bar codes, it would be appropriate to verify one to determine the bar code quality. If you are printing EAN/UPC Bar Codes that will vary in data content, a test EAN/UPC Bar Code containing the digits "4 12785 12783 2" is recommended for the verification process.

When you verify the test bar code, you should expect an ISO (ANSI) grade of 4 (A) or 3 (B) using the thermal transfer process. If these grades are not achieved, you are likely to have a problem with printer adjustments, cleanliness, or some other malfunction. With some direct thermal label materials, you may only be able to produce 1.5 (C) grade symbols. While such bar codes do conform to the quality specifications, you will have less margin for process variations and degradation from handling and ageing.

In addition to verification, you should examine the test bar code for adequate Quiet Zones, bar height, and the legibility of the human readable interpretation.

Maintaining Acceptable Quality

The quality of printed bar codes tends to degrade as deposits build up on the thermal print head. Regular cleaning of the print head and guide surfaces in accordance with manufacturers recommendations is strongly advised.

Thermal print heads eventually wear out to the point where one or more dot elements fail to heat properly. When this occurs, the printed bar codes may no longer be scannable. One solution to this problem is frequent verification to assure continuing quality. Some printers can be equipped with on-line verification devices that will indicate when a problem is detected. Although such on-line verifiers may not test all of the parameters for ISO, they can be very useful for monitoring the printing process. This is particularly true after supplies replacement or printer maintenance.

An alternative method for detecting dot burnout is to print a line across the width of the bar code. Any dot failure will be immediately visible to the operator as a small break in the line as shown in the figure below:

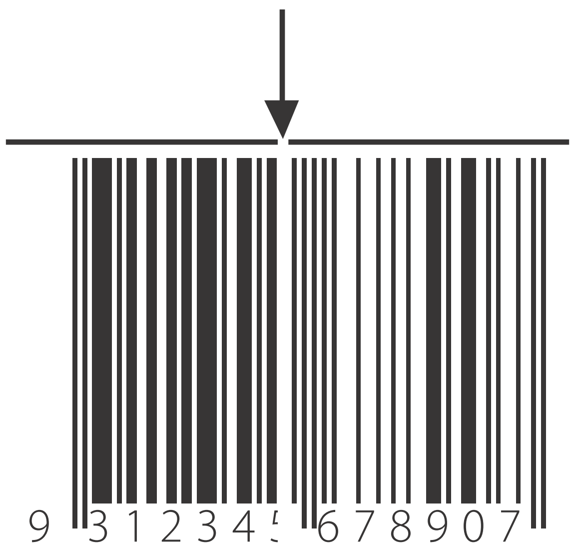


Figure 48 - Detection of Dot Burnout on Thermal/Direct Thermal Printheads

Reference DPI	Actual DPI	Dots Per Millimetre	Actual Dot Width (Centre Point to Centre Point mm)	Dots Per Module Width	MODULE WIDTH (mm)	*Corrected Magnification
200	203.2	8	0.12500	2	0.2500	**75.76%
200	203.2	8	0.12500	3	0.3750	113.64%
200	203.2	8	0.12500	4	0.5000	151.52%
200	203.2	8	0.12500	5	0.6250	189.39%
300	304.8	12	0.08333	3	0.2500	**75.76%
300	304.8	12	0.08333	4	0.3333	100.01%
300	304.8	12	0.08333	5	0.4166	126.26%
300	304.8	12	0.08333	6	0.5000	151.52%
300	304.8	12	0.08333	7	0.5833	176.77%
400	406.4	16	0.06250	4	0.2500	**75.76%
400	406.4	16	0.06250	5	0.3125	94.70%
400	406.4	16	0.06250	6	0.3750	113.64%
400	406.4	16	0.06250	7	0.4375	132.58%
400	406.4	16	0.06250	8	0.5000	151.52%
400	406.4	16	0.06250	9	0.5625	170.45%
400	406.4	16	0.06250	10	0.6250	189.39%
600	609.6	24	0.04167	6	0.2500	**75.76%
600	609.6	24	0.04167	7	0.2916	88.38%
600	609.6	24	0.04167	8	0.3333	101.01%
600	609.6	24	0.04167	9	0.3750	113.64%
600	609.6	24	0.04167	10	0.4166	126.26%
600	609.6	24	0.04167	11	0.4583	138.89%
600	609.6	24	0.04167	12	0.5000	151.52%
600	609.6	24	0.04167	13	0.5416	164.14%
600	609.6	24	0.04167	14	0.5833	176.77%
600	609.6	24	0.04167	15	0.6250	189.39%

TABLE 45. Achievable Magnifications for Thermal Printed EAN/UPC Bar Codes after correction

***Note:** The nominal EAN/UPC Bar Code can be based on a module width of either 0.013 inch or 0.33 mm. In North America, the long-standing GS1 US specifications have set the nominal module size at 0.013 inch or 13 mils. GS1 specifications and the ISO/IEC specification for EAN/UPC Symbols set the nominal module size at 0.33 mm. The international, metric nominal is 0.0606 percent smaller than the original inch-based nominal. The data in the right-most column labelled "*Corrected Magnification" are based on a nominal module width of 0.33mm.

****Note:** The allowance of magnifications 75%-80% are applicable only to on demand print processes (for example thermal or laser).

9.10 General Office Printers

General-purpose printing devices are capable of printing high quality bar codes when operated by experienced GS1 members equipped with a good bar code design software product. This category includes laser, desktop, ink jet, ion deposition, and mechanical matrix office printers. These devices are designed primarily for printing full size pages of text and graphics. However, they can be used to print retail tags by using pre-cut labels on page size backing paper. Some are also equipped with a continuous feed mechanism for producing bar codes in large quantities.

It is more difficult for the user to create high quality bar codes with general-purpose printers than it is with direct thermal transfer label printers. There are two reasons for this difficulty. First, the printed dot size for general-purpose printers is appreciably larger than the pixel dimension, as shown in Figure 49 below. This will cause the bars (dark bars) to be printed wider and the spaces (light bars) narrower than nominal, unless the software driving the printer corrects for this distortion. Second, the software that constructs the bar code may itself introduce dimensional errors.

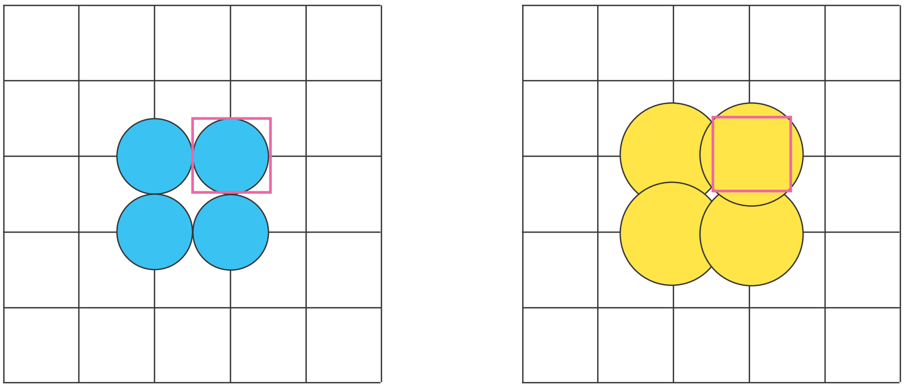


Figure 49 - Pixel-Sized Dot on the Left and Typical Size General-Purpose Printer Dot on the Right

Bar Code Design Considerations for General Purpose Printers

There are a wide variety of software packages for creating bar codes using general-purpose printers. Unfortunately, many of these packages are capable of producing bar codes with totally unacceptable quality. The following special factors should be considered when designing the bar code for general-purpose printers:

- Generate bar codes at a corrected magnification or an X-dimension which is supported by the resolution of the specified printer. For example, the closest bar width to 0.33mm a 300 DPI printer can achieve is 0.3333mm. This is because each bar width is constructed using four 300 DPI dots which individually measure 0.0833mm wide. Table 45 on page 110 lists the achievable EAN/UPC Bar Code magnifications (after correction) addressed by several different resolutions of general-purpose printers. EAN/UPC Bar Code magnifications other than those listed in this table will be printed inaccurately and may or may not achieve passing verifier grades.
- Specify one or more dots (pixels) of uniform bar width reduction to compensate for excessive bar width that is typical of general-purpose printers. For example, with a typical 300 DPI laser printer and four dots per module, best print quality is often achieved with one pixel (or dot) of bar width reduction.
- When a bar code graphic file is transferred between two parties, the printer resolution attribute should be communicated. If the printer resolution changes, the bar code file should be recreated. The bar code should be treated as a fixed design element. It should not be resized, rotated, scaled, or stretched.
- When the bar code graphic file is transferred between two parties, they should determine which bar code design attributes should be communicated. The following list should be considered as optional attributes which can be useful in assuring bar code quality:
    - printer resolution for bar width (strongly suggested)
    - "corrected magnification" factor
    - "corrected BWR" factor

These specifications should not be altered at any later stage within illustration or page layout software programs. These suggestions should provide you with quality bar codes when the output conditions match the design attributes. The most predictable results are obtained using software packages that drive the printer directly by low level software. Often, when bar code images are passed from one software application to another, the bar code may become distorted. These distorted bar codes may or may not achieve passing verifier grades.

Initial General-Purpose Printer Set-Up

Once you have the required software, hardware, and consumable materials in place, determine the bar code magnification and other parameters that you will be using to produce bar code labels or tags. Next, print two test EAN/UPC symbols in which all of the left and right hand digits are represented: for example, the following bar codes:

0 12345 01234 1

6 78912 56789 0

Verify both test EAN/UPC Bar Codes per the ISO (ANSI) method. It is desirable to achieve grade 3 (B) or better in this initial set-up. If one or both of the test bar codes are below grade 3 (B), you may be able to improve the quality by changing some of the software or printer variables. At the minimum, grade 1.5 (C) bar codes are acceptable, but they leave you with minimal margin for process variations and possible degradation from handling. In addition to verification, you should examine the test bar code for adequate Quiet Zones, bar height, and legibility of the human readable interpretation.

For small operations, the investment in a bar code verifier that conforms to the ISO (ANSI) method may not be justified. The alternative is to submit your test symbols to GS1 Australia for verification.

Finally, whenever any changes are made in software parameters, the initial set-up procedures should be repeated.

Maintaining Acceptable Quality

All printers require periodic maintenance. Laser printers, for example, not only consume toner, but also require periodic replacement of components such as drums, developers, fusers, and brushes. All of the consumable parts may be contained in a single replacement cartridge, or they may be separately installed, depending on the make and model of printer. Because bar code labels contain a higher percentage of black printing than occurs in ordinary text, fewer pages can be printed between maintenance intervals.

Printed bar codes should be checked visually for consistent appearance and verified whenever they appear doubtful. Bar code verification, whether conducted on-site or consulted, can be an effective tool for maintaining quality within a conscientiously applied program of quality assurance. Verification should be employed as a quality sampling technique, particularly after any supplies replacement or printer maintenance.

Reference DPI	Actual DPI	Dots Per Millimetre	Actual Dot Width (Centre Point to Centre Point)	Dots Per Module Width	X-dimension (module width)	*Corrected Magnification
300	304.8	12	0.0833	3	0.25000	**75.76%
300	304.8	12	0.0833	4	0.33333	100.01%
300	304.8	12	0.0833	5	0.41667	126.26%
300	304.8	12	0.0833	6	0.50000	151.52%
300	304.8	12	0.0833	7	0.58333	176.77%
300	300	11.812	0.0846	3	0.25387	76.96%
300	300	11.812	0.0846	4	0.33863	102.61%
300	300	11.812	0.0846	5	0.42329	128.27%
300	300	11.812	0.0846	6	0.50795	153.92%
300	300	11.812	0.0846	7	0.59261	179.58%

TABLE 46. General-Purpose Printer: Achievable Magnifications for EAN/UPC Bar Codes after correction

***Note:** The nominal EAN/UPC Bar Code can be based on a module width of either 0.013 inch or 0.33 mm. In North America, the long-standing UPC specifications have set the nominal module size at 0.013 inch or 13 mils. GS1 specifications and the ISO-IEC specification for EAN/UPC set the nominal module at 0.33 mm. The international, metric nominal is 0.0606 percent smaller than the original inch-based nominal. The data in the right-most column labelled "*Corrected Magnification" are based on a nominal module width of 0.33 mm.

****Note:** The allowance of magnifications 75%-80% is applicable only to on demand print processes (for example thermal or laser).

10.1 Introduction

To maintain scanning efficiency, bar code need to be printed correctly and be of a high quality. Verification equipment can assist in providing an indication of the print quality of bar codes.

Previously, GS1 Australia analysed bar code quality based on two parameters – average bar growth and print contrast. This was known as Traditional Verification. In recent years, GS1 Australia's verification service has adopted the globally used ISO/IEC 15416 method for the quality analysis of bar codes, which takes into account seven main parameters covering various aspects of print quality. The ISO method is fully compatible with the ANSI standards that were released by the American National Standards Institute ANSI). This verification method can provide a standard means of reporting between printers, brand owners and trading partners.

Unlike traditional verification, the ISO method of verification looks at a bar code in a similar way to the way a scanner sees it. It assesses the quality of the symbol compared to a perfect symbol, and grades the symbol with a grade ranging from 4-0 (A-F) based on how closely the symbol is to perfect. The ISO grade is intended to provide an indication, based on the print quality, of the likely scanning performance of the bar code in the market place. The lower the ISO grade, the higher the possibility of scanning difficulties.

Please note that the use of a verifier should be supplemented with other appropriate checks such as visual checks in order to perform a total verification process.

When interpreting the results from a verifier it is also important to remember that:

- Verifiers do not measure bar height
- Without additional software linking the decoded data to a database, it cannot be confirmed that the data content of a bar code is what it should be
- Verifiers cannot confirm the bar code's dimensions are what are intended
- A verifier cannot check that the human readable translation corresponds to the encoded data
- Even a perfect bar code at the time of production can be damaged or otherwise affected in its passage through the supply chain
- A Verifier cannot confirm whether the correct bar code symbology has been used for the intended scanning environment

10.2 Testing to the ISO Method

GS1 utilise the ISO method of verification, and specify the minimum grade necessary for every bar code, as well as specifying the verifier aperture width (size of hole in the testing equipment) and wavelength of the light source.

For example, an EAN-13 Bar Code will always be verified using a 6 mil aperture (0.15mm), a 670nm +/- 10 wavelength of light, and require a minimum ISO grade of 1.5 (C). This is typically expressed on a verification report as 1.5/06/670.

Verifiers have a menu to adjust the aperture and wavelength according to the type of bar code being assessed and the magnification of the symbol.

The table below provides you with a quick reference guide to the minimum grades for each bar code type, and the appropriate aperture sizes and wavelengths that should be used.

Symbology	ISO (ANSI) Passing Grade	Aperture	Wavelength (nanometers)
EAN/UPC	1.5 (C)	6 mils (0.15mm)	670nm +/-10
ITF-14 < 62.5% Magnification (X-dimension 0.64mm)	1.5 (C)	10 mils (0.25mm)	670nm +/-10
ITF-14 ≥ 62.5% Magnification (S-dimension 0.64mm)	0.5 (D)	20 mils (0.50mm)	670nm +/-10
GS1-128	1.5 (C)	10 mils (0.25mm)	670nm +/-10
GS1 DataBar**	1.5 (C)	6mils (0.15mm)	670nm +/-10
** All elements in any row separator patterns should be visually distinguishable			

TABLE 47 Required ISO Grades for GS1 Bar Code

There are several steps involved in arriving at an overall symbol grade.

Where as traditional verification relies on a single scan across a bar code, the ISO verification process involves the bar code being assessed based on number of scans in both directions evenly throughout the entire height of the symbol.

The requirement is for 10 scans to be taken. However, if the first 3 scans are in excess of the pass grade required and there is general consistency in the results, it is not necessary to complete the full 10 scans.

For each scan across the bar code a Scan Reflectance Profile is obtained. This is simply an analogue plot of the reflectance values measured along a single line across the entire width of the bar code. The x-axis of the plot shows linear distance across the symbol, while the y-axis shows the reflectance values. Light areas show as high reflectance values; dark areas show low values. The profile therefore consists of a series of peaks and valleys, the widths of which are proportional to those of the bars and spaces.

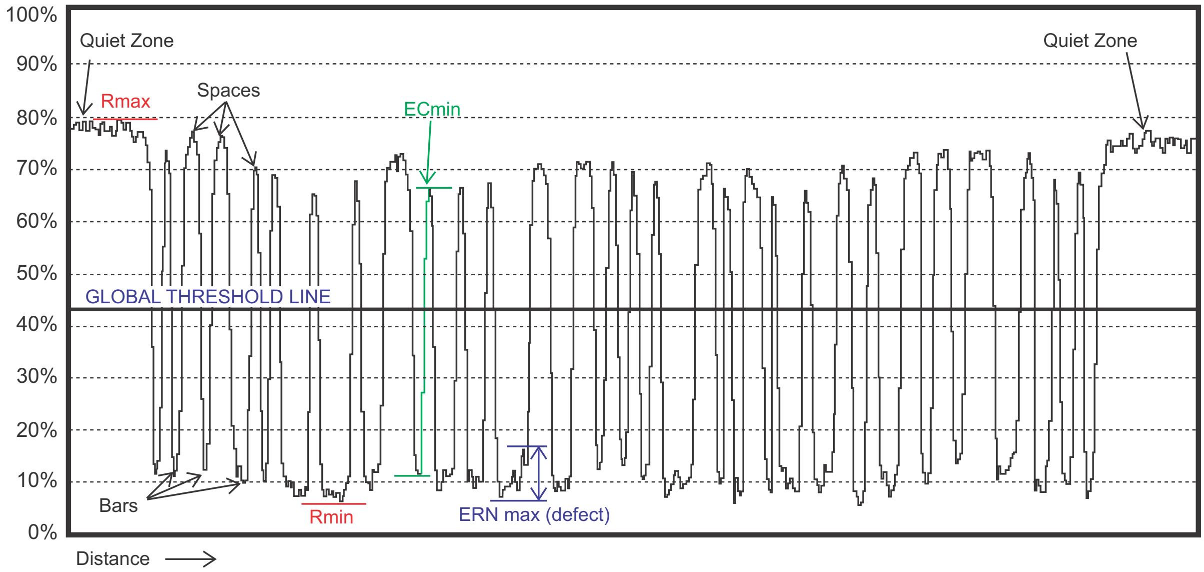


Figure 50 Scan Reflectance Profile

The Scan Reflectance Profile is then used to measure and grade the following parameters:

Decode, Symbol Contrast, Minimum Reflectance, Edge Contrast, Modulation, Defects and Decodability.

Firstly, an edge determination test is performed, which is basically whether the correct number of bars and spaces have been encountered in the Scan Reflectance Profile for the type of bar code being assessed (for example an EAN-13 Bar Code should have 30 bars and 29 spaces or a total of 59 elements).

In order for all the ISO parameters to pass, all the elements need to cross an imaginary line called the global threshold. This is half way between the highest reflectance value and the lowest reflectance value. This can be seen in the above example of a Scan Reflectance Profile, Figure 50.

10.3 Parameters Assessed Using ISO Method

Decode - (Pass 4 or Fail 0)

Decode uses the algorithm for decoding the bar code. If the symbol can be decoded the parameter is given a pass (4). If it cannot be decoded it is given a fail (0). This parameter also assesses whether or not the correct number of elements cross the global threshold. If the correct number of elements are found a 4 is given, if not then a global threshold failure has occurred and the parameter receives a 0 grade.

Grade	Threshold
4	Passes
0	Fails

TABLE 48 Decode Grades and Thresholds

Possible causes of a Decode failure and possible remedies are:

- Symbol incorrectly encoded: Re-originate symbol; over-label with correctly encoded symbol
- Bars and spaces being out of specification due to excessive print gain or loss: Apply correct bar width reduction (BWR) when originating symbol; adjust press or printer settings
- One or more elements did not cross the global threshold. If global threshold failure occurs, this also results in a Decodability grade of 0
- Too many elements detected due to defect: Correct cause of defect; adjust press (relief printing processes) to reduce haloing (a double line impression where there should only be a single line impression); replace or clean the print head (thermal/ink-jet printing)
- Incorrect Check Digit: Correct software error in origination system; re-originate symbol; over-label with correctly calculated symbol
- Quiet Zone infringement that crosses the global threshold: Enlarge box surrounding bar code; ensure symbol registration to other print allows adequate Quiet Zones; reposition symbol farther from edge of label; use larger size label

Symbol Contrast - (4, 3, 2, 1 or 0)

This is a measure of the contrast between the bar and background colours. A bar code printed in black ink on white paper will achieve the best result. Coloured backgrounds or coloured inks will affect the result. Highly glossy materials may also appear to have a lower background reflectance than expected.

The formula for calculating this measure is:

Symbol Contrast = Reflectance Max (R_{max}) – Reflectance Min (R_{min})

Grade	Threshold
4	≥70%
3	≥55%
2	≥40%
1	≥20%
0	< 20%

TABLE 49 Symbol Contrast Grades and Thresholds

Possible causes of low or failed symbol contrast and possible remedies are:

- Background too dark: Use lighter or less glossy material, or change background colour (if printed) to a lighter colour which will provide higher reflectance
- Show through from contents: Use more opaque material for package, or print opaque white underlay prior to printing symbol
- Bars too light: Change bar colour for a darker colour with lower reflectance, and increase ink weight or print head temperature (thermal printing). Watch for consequential increase in bar widths.

Minimum Reflectance - (Pass 4 or Fail 0)

In this assessment the reflectance value for at least one bar must be half or less than the highest reflectance value for a space. For example if the highest reflectance value is 80%, then at least one bar must register a reflectance value of 40% or less.

The formula for calculating this is:

$$\text{Reflectance Min } (R_{min}) \leq 0.5 \text{ Reflectance Max } (R_{max})$$

Grade	Threshold
4	$\leq 0.5\ R_{max}$
0	$> 0.5\ R_{max}$

TABLE 50 Minimum Reflectance Grades and Thresholds

The cause and solution for failed Minimum Reflectance is:

- The bar colour is too light: Change bar colour to a darker colour with lower reflectance, and increase ink weight or print head temperature (thermal printing). Watch for consequential increase in bar widths.

Minimum Edge Contrast - (Pass 4 or Fail 0)

This is the measure of the contrast between adjacent bars and spaces. The reflectance value of the bar is deducted from the reflectance value of the space. If any of these measurements is less than 15%, this parameter fails. While this grade may be acceptable, low edge contrast values may still cause low Modulation grades.

Minimum Edge Contrast is calculated according to the following formula:

Space Reflectance (min) - Bar Reflectance (max) of the worst pair.

Grade	Threshold
4	≥15%
0	< 15%

TABLE 51 Minimum Edge Contrast Grades and Thresholds

Possible causes of failed Minimum Edge Contrast and possible remedies are:

- Variations in ink weight in different parts of a symbol (uniformity of ink spread, ink viscosity): Adjust press settings to ensure even inking
- Show through of contents: Use more opaque material for package, or print white underlay prior to printing symbol
- Fluctuations in the background reflectance (for example areas of darker material in recycled corrugated substrates): Use a more consistent substrate or one with higher reflectance
- Excessive ink spread: Apply correct bar width reduction (BWR) when originating symbol

Modulation - (4, 3, 2, 1 or 0)

Modulation is a measure of Edge Contrast as a proportion of Symbol Contrast. The closer the Edge Contrast is to the overall Symbol Contrast the better as this implies that overall the differences between the bar and space reflectance values are consistent.

The formula for assessing this is:

Minimum Edge Contrast / Symbol Contrast

Grade	Threshold
4	$\geq$0.70
3	$\geq$0.60
2	$\geq$0.50
1	$\geq$0.40
0	< 0.40

TABLE 52 Modulation Grades and Thresholds

Modulation will be reduced for the same reasons as when Minimum Edge Contrast is low. A scanner will tend to see spaces as narrower than bars and also to see narrow elements as less distinct than wider ones. Consequently, if there is significant bar gain, Modulation will be reduced. Measuring with an aperture that is larger than specified will also reduce Modulation.

Possible causes of low or failed Modulation and the possible remedies are:

- Fluctuations in the background reflectance (for example areas of darker material in recycled corrugated substrates): Use a more consistent substrate or one with higher reflectance
- Show through of contents: Use more opaque material for package, or print white underlay prior to printing symbol
- Excessive ink spread: Apply correct bar width reduction (BWR) when originating symbol

Defects - (4, 3, 2, 1 or 0)

In this instance the equipment is looking for defects in the bar code, either in the form of flaws in the substrate being printed onto or in the bar code printing.

The verifier looks at the uniformity of the reflectance throughout each individual element of the bar code. If this varies significantly then there is some defect within the symbol

The formula for assessing this is:

Element Reflectance Non-Uniformity (ERN) / Symbol Contrast

Grade	Threshold
4	≤0.15
3	≤0.20
2	≤0.25
1	≤0.30
0	> 0.30

TABLE 53 Defects Grades and Thresholds

Possible causes of low or failed Defects and possible remedies are:

- Defective print head elements (thermal printing or ink-jet printing), which will tend to produce an unprinted line running through the symbol in the direction of printing: Clean or replace print head
- Satellite (ink droplets in the white area surrounding the printed bars): Clean head; change ink formulation
- Haloing (e.g. a double line impression where there should only be a single line impression): Adjust impression pressure and/or ink viscosity
- Incorrect matching of thermal transfer ribbons and substrate (poor adhesion of ink to surface): Use correct ribbon for substrate; use smoother substrate
- Insufficient Quiet Zones where the infringement does not cross the global threshold: Enlarge box surrounding bar code; ensure symbol registration to other print allows adequate Quiet Zones; reposition symbol farther from edge of label; use larger size label

Decodability – (4, 3, 2, 1 or 0)

This parameter is the measure of how close the Scan Reflectance Profile is to approaching Decode failure. Each symbology has published dimensions for element widths and provides margins or tolerances for errors in the printing and reading process. Decodability measures the amount of margin left within these tolerances before Decode failure will occur.

Grade	Threshold
4	≥0.62
3	≥0.50
2	≥0.37
1	≥0.25
0	< 0.25

TABLE 54 Decodability Grades and Thresholds

Decodability grades are influenced by bar gain or loss in most symbologies and by distortion of the symbol. Distortion can occur with relief printing processes, such as flexography, when the printing plate is stretched around the press cylinder with the bars parallel to the cylinder axis (e.g. at right angles to the print direction). A common reason for distortion with digitally-originated images is that they have been rescaled in graphics software, resulting in uneven addition or removal of pixels to or from the element widths. Print processes that tend to produce irregular bar edges, such as ink-jet and photogravure, will also likely give lower Decodability grades.

Possible causes of low or failed Decodability and possible remedies are:

- Excessive bar gain or loss (systematic): Apply correct bar width reduction (BWR) when originating symbol; adjust press settings
- Element width gain or loss (non-systematic): Correct missing pixels (burnt-out print head elements, blocked ink-jet nozzles); rectify cause of defects
- Distortion of symbol (uneven stretching of flexographic plate; non-linear disproportioning in plate-making process): Print symbol with height of bars parallel to direction of printing; do not disproportion bar code image in plate-making
- Rescaling of digitally-originated images: Ensure symbol is created in correct size; ensure software matches module widths to integer number of pixels after all adjustments
- Irregular element edges (ink-jet, photogravure, screen process printing): Change print technology; increase X-dimension/magnification factor; re-orient symbol relative to cylinder engraving angle/screen mesh
- Global Threshold failure. Refer to the Decode parameter on page 118
- Within the EAN/UPC Symbology, characters 1, 2, 7 and 8 may fail this parameter as they require an additional adjustment to their bar widths. Please refer to the Symbology Detail chapter in the GS1 Australia User Manual – Symbology and Printing for further details

Overall Symbol Grade

For each individual scan the lowest single grade of one of the seven assessed parameters (being the weakest link in the chain) becomes the symbol grade. After the required amount of scans have been taken, the symbol grades are averaged, and this becomes the Overall Symbol Grade.

- The target measurement for all bar codes is ISO Grade 4
- The minimum acceptable measurement is ISO Grade 1.5
- The only exception is for ITF-14 Bar Codes with a magnification equal to or greater than 62.5% (X-dimension 0.64mm), for which it may be difficult to achieve better than a Grade 0.5
- For ITF-14 Bar Codes that will be scanned in an automated scanning environment (fixed mount, conveyorised) an overall symbol grade of at least 1.0 is recommended
- The ISO grade achieved may provide a basis for acceptance of bar coded items by your trading partners. It is recommended that companies check with their trading partners for their specific minimum ISO grade requirements

ANSI to ISO Grade Conversion Table	
A	3.5 to 4.0
B	2.5 to 3.4
C	1.5 to 2.4
D	0.5 to 1.4
F	Less than 0.5

TABLE 55 ANSI to ISO Grade Conversion Table

Adherence to the GS1 guidelines outlined in this manual will aid in achieving an acceptable ISO grade.

GS1 Australia provides a Bar Code Verification Service, which utilises the ISO method and provides customers with a Bar Code Verification Report. Information on submitting samples for ISO verification can be obtained from www.gs1au.org or by contacting the Help Desk on 1300 366 033.

Term	Meaning
2-Dimensional Symbology	Optically readable symbols that must be examined both vertically and horizontally to read the entire message. Two-dimensional symbols may be one of two types; matrix symbols and multi-row symbols. Two dimensional symbols have error detection and may include error correction features.
Active potency	Represents the measured actual ("Active") potency of a biologic such as haemophilia products.
Add-On Symbol	A bar code used to encode information supplementary to that in the main bar code.
AI	See GS1 Application Identifier.
alphanumeric (an)	Describes a character set that contains alphabetic characters (letters), numeric digits (numbers), and other characters, such as punctuation marks.
aperture	A physical opening that is part of the optical path in a device such as a scanner, photometer, or camera. Most apertures are circular, but they may be rectangular or elliptical.
Asset Type	A component of the Global Returnable Asset Identifier (GRAI) assigned by the brand owner to create a unique GRAI.
attribute	An Element String that provides additional information about an entity identified with a GS1 Identification Key, such as Batch Number associated with a Global Trade Item Number (GTIN).
autodiscrimination	The capability of a reader to automatically recognise and decode multiple bar code symbologies.
Automatic Identification and Data Capture (AIDC)	A technology used to automatically capture data. AIDC technologies include bar codes, smart cards, biometrics and RFID.
auxiliary patterns	Components of the EAN/UPC Symbology. The centre guard bar pattern, the left guard bar pattern, and the right guard bar patterns are examples of these.
bar code	A symbol that encodes data into a machine readable pattern of adjacent, varying width, parallel, rectangular dark bars and pale spaces.
Bar Code Verification	The assessment of the printed quality of a bar code based on ISO/IEC standards using ISO/IEC compliant bar code verifiers.
bar gain/loss	The increase/decrease in bar width due to effects of the reproduction and printing processes.
Batch / Lot	The batch or lot number associates an item with information the manufacturer considers relevant for traceability of the trade item. The data may refer to the trade item itself or to items contained in it.

Term	Meaning
Bar width ratio	The comparison in bar widths between the wide and narrow modules in an ITF-14 Bar Code.
Bearer Bars	Bar abutting the tops and bottoms of the bars in a bar code, or a frame surrounding the entire symbol, intended to equalize the pressure exerted by the printing plate over the entire surface of the symbol and/or to prevent a short scan by the bar code reader.
brand owner	The party that is responsible for allocating GS1 System Identification Keys. The administrator of a GS1 Company Prefix.
Check Digit	A final digit calculated from the other digits of some GS1 Identification Keys. This digit is used to check that the data has been correctly composed. (See GS1 Check Digit Calculation).
Company Number	A component of the GS1 Company Prefix.
Composite Component	This term is used to refer to the 2D symbol component within a composite symbol.
Composite Symbology	A GS1 System composite symbol consists of a linear component (encoding the item's primary identification) associated with an adjacent 2D Composite Component (encoding attribute data, such as a batch number or expiration date). The composite symbol always includes a linear component so that the primary identification is readable by all scanning technologies, and so that 2D imager scanners can use the linear component as a finder pattern for the adjacent 2D Composite Component. The composite symbol always includes one of three multi-row 2D Composite Component versions (e.g. CC-A, CC-B, CC-C) for compatibility with linear- and area-CCD scanners and with linear and rastering laser scanners.
concatenation	The representation of several Element Strings in one bar code.
Configuration Level	Assignment or grouping of trade items that includes one or more of the same trade item.
consignment	A grouping of logistic or transport units assembled by a freight forwarder or carrier to be transported under one transport document (e.g. HWB)
coupon	A voucher that can be redeemed at the Point-of-Sale for a cash value or free item.
Coupon-12	A 12-digit GS1 System Restricted Circulation Number for coupons structured according to the rules defined in the target market.
Coupon-13	The 13-digit GS1 System Restricted Circulation Number defined according to rules in a target market used for coupons.
customer	The party that receives, buys, or consumes an item or service.
data carrier	A means to represent data in a machine readable form; used to enable automatic reading of the Element Strings.
data character	A letter, digit, or other symbol represented in the data field(s) of an Element String.

Term	Meaning
Data Matrix	A standalone, two-dimensional matrix symbology that is made up of square modules arranged within a perimeter finder pattern. Data Matrix ISO version ECC 200 is the only version that supports GS1 System identification numbers, including Function 1 Symbol Character (FNC1). Data Matrix Symbols are read by two-dimensional imaging scanners or vision systems.
data field	A field that contains a GS1 Identification Key, an RCN, or attribute information.
data titles	Data titles are the abbreviated descriptions of Element Strings which are used to support manual interpretation of bar codes.
Default Front	The side of a retail consumer trade item that is used as the starting point to capture dimensional attributes for the purpose of data alignment.
Direct Part Marking	Direct part marking refers to the process of marking a symbol on an item using an intrusive or non-intrusive method.
direct print	A process in which the printing apparatus prints the symbol by making physical contact with a substrate (e.g. flexography, ink jet, dot peening).
Document Type	A component of a Global Document Type Identifier (GDTI) assigned by the brand owner to create a unique GDTI.
Dynamic Assortment	A standard trade item grouping that comprises a fixed count of a changing assortment of two or more different retail consumer trade items, each identified with a unique GTIN. The retailer has accepted that the supplier may change the assortment without any prior notice. An example is a trade item grouping of ten toy cars that may contain any mix of possibly more than ten different toy cars that have been individually identified and notified to the retailer.
EAN/UPC Composite Symbology® Family	A family of bar codes comprising the UPC-A Composite Symbology®, UPC-E Composite Symbology®, EAN-8 Composite Symbology®, and EAN-13 Composite Symbology®.
EAN/UPC Symbology	A family of bar codes including EAN-8, EAN-13, UPC-A, and UPC-E Bar Codes. Although UPC-E Bar Codes do not have a separate Symbology Identifier, they act like a separate symbology through the scanning application software. See also EAN-8 Bar Code, EAN-13 Bar Code, UPC-A Bar Code and UPC-E Bar Code.
EAN-13 Bar Code	A bar code of the EAN/UPC Symbology that encodes GTIN-13, Coupon-13, RCN-13, and VMN-13.
EAN-8 Bar Code	A bar code of the EAN/UPC Symbology that encodes GTIN-8 or RCN-8.
EANCOM	The GS1 standard for Electronic Data Interchange (EDI) is a detailed implementation guideline of the UN/EDIFACT standard messages using the GS1 Identification Keys.
Electronic Commerce	The conduct of business communications and management through electronic methods, such as Electronic Data Interchange (EDI) and automated data collection systems.

Term	Meaning
Electronic Message	A composition of Element Strings from scanned data and transaction information assembled for data validation and unambiguous processing in a user application.
Electronic Product Code	An identification scheme for universally identifying physical objects (e.g. trade items, assets, and locations) via RFID tags and other means. The standardised EPC data consists of an EPC (or EPC Identifier) that uniquely identifies an individual object, as well as an optional Filter Value when judged to be necessary to enable effective and efficient reading of the EPC tags.
element	A single bar or space of a bar code.
Element String	The combination of a GS1 Application Identifier and GS1 Application Identifier Data Field.
Enhanced level of AIDC Marking (for Regulated Healthcar e Trade Items)	A level within a graduated system of AIDC trade item marking that provides GTIN plus attribute information.
even parity	A characteristic of the encodation of a symbol character whereby the symbol character contains an even number of dark modules.
Extension digit	The first digit within the SSCC (Serial Shipping container Code) which is allocated by the user and is designed to increase the capacity of the SSCC.
fixed length	Term used to describe a data field in an Element String with an established number of characters.
Fixed Measure Trade Item	An item always produced in the same pre-defined version (e.g. type, size, weight, contents, design) that may be sold at any point in the supply chain.
FNC1	Abbreviation for Function 1 Symbol Character.
Freight Forwarder	The party that arranges the carriage of goods including connected services and/or associated formalities on behalf of the shipper (consignor) or consignee.
Full String	The data transmitted by the bar code reader from reading a data carrier, including the Symbology Identifier as well as the encoded data.
Function 1 Symbol Character (FNC1)	A symbology character used in some GS1 data carriers for specific purposes.
General Distribution Scanning	Scanning environments that include bar coded trade items packaged for transport, logistic units, assets and location tags.
GLN Extension Component	The GLN extension component is used to identify internal physical locations within a location which is identified with a GLN (stores, factories, buildings, etc.).
Global Document Type Identifier (GDTI)	The GS1 Identification Key used to identify a document type. The key comprises a GS1 Company Prefix, Document Type, Check Digit and optional serial number.

Term	Meaning
Global Identification Number for Consignment (GINC)	The GS1 Identification Key used to identify a logical grouping of logistic or transport units that are assembled to be transported under one transport document (e.g. HWB). The key is comprised of a GS1 Company Prefix and the Freight Forwarders or Carriers transport reference.
Global Individual Asset Identifier (GIAI)	The GS1 Identification Key used to identify an individual asset. The key comprises a GS1 Company Prefix and individual Asset Reference.
Global Location Number (GLN)	The GS1 Identification Key used to identify physical locations or parties. The key comprises a GS1 Company Prefix, Location Reference, and Check Digit.
Global Returnable Asset Identifier (GRAI)	The GS1 Identification Key used to identify returnable assets. The key comprises a GS1 Company Prefix, Asset Type, Check Digit, and optional serial number.
Global Service Relation Number (GSRN)	The GS1 Identification Key used to identify the relationship between a service provider and service recipient. The key comprises a GS1 Company Prefix, Service Reference and Check Digit.
Global Shipment Identification Number (GSIN)	The GS1 Identification Key used to identify a logical grouping of logistic or transport units that are assembled by the consignor (seller) for transport shipment from that consignor to one consignee (buyer) referencing a despatch advice and/or BOL. The key is comprised of a GS1 Company Prefix, Shipper Reference and Check Digit.
Global Trade Item Number (GTIN)	The GS1 Identification Key used to identify trade items. The key comprises a GS1 Company Prefix, an item Reference Number and a Check Digit.
GS1 Application Identifier	The field of two or more digits at the beginning of an Element String that uniquely defines its format and meaning.
GS1 Application Identifier data field	The data used in a business application defined by one application identifier.
GS1 Check Digit Calculation	An algorithm used by the GS1 System for the calculation of a Check Digit to verify accuracy of data. (e.g: modulo 10 check digit, price check digit).
GS1 Common Currency Coupon Code	An identification number for coupons issued in a common currency area (e.g. the euro currency) that uses the Coupon-13 Data Structure.
GS1 Company Prefix	Part of the GS1 System identification number consisting of a GS1 Prefix and a Company Number, both of which are allocated by a GS1 Member Organisation. See also U.P.C. Company Prefix. GS1 Member Organisations assign GS1 Company Prefixes to entities that administer the allocation of GS1 System identification numbers. These entities may be, for example, commercial companies, not for profit organisations, governmental agencies, and business units within organisations. Criteria to qualify for the assignment of a GS1 Company Prefix are set by the GS1 Member Organisations.
GS1 DataBar Composite Symbology Family	A family of symbols comprising all of the GS1 DataBar bar codes, when an accompanying Composite Component is printed directly above the linear component.

Term	Meaning
GS1 DataBar Expanded Bar Code	A bar code that encodes any GS1 Identification Key plus attribute data such as weight and "best before" date, in a linear symbol that can be scanned omnidirectionally by suitably programmed Point-of-Sale scanners.
GS1 DataBar Expanded Stacked Bar Code	A bar code that is a variation of the GS1 DataBar Expanded Bar Code that is stacked in multiple rows and is used when the normal symbol would be too wide for the application.
GS1 DataBar Limited Bar Code	A bar code that encodes any GTIN with a leading digit of zero or Indicator digit of one in a linear symbol; for use on small items that will not be scanned at the Point-of-Sale.
GS1 DataBar Omnidirectional Bar Code	A bar code that encodes a GTIN. It is designed to be read by omnidirectional scanners.
GS1 DataBar	A family of bar codes, including GS1 DataBar Omnidirectional, GS1 DataBar Stacked Omnidirectional, GS1 DataBar Truncated, GS1 DataBar Stacked, GS1 DataBar Limited, GS1 DataBar Expanded and GS1 DataBar Expanded Stacked symbols.
GS1 DataBar Stacked Omnidirectional Bar Code	A bar code that is a variation of the GS1 DataBar Symbology that is stacked in two or more rows and is used when the GS1 DataBar Omnidirectional Symbol would be too wide for the application. It is designed to be read by omnidirectional checkout scanners.
GS1 DataBar Stacked Bar Code	A bar code that is a variation of the GS1 DataBar Truncated Bar Code that is stacked in two rows and is used when the GS1 DataBar Truncated Bar Code would be too wide for the application.
GS1 DataBar Truncated Bar Code	A bar code that is a truncated version of the GS1 DataBar Omnidirectional Bar Code. It is used when the GS1 DataBar Omnidirectional Bar Code would be too tall for small item marking applications. It is not intended for omnidirectional checkout scanning.
GS1 DataMatrix	GS1 implementation specification for use of Data Matrix.
GS1 Global Data Dictionary	A repository tool used to record GS1 member standards agreements on business terms and definitions used by all business units.
GS1	Based in Brussels, Belgium, and Princeton, USA, it is the organisation that manages the GS1 System. Its members are GS1 Member Organisations.
GS1 Identification Key	A numeric or alphanumeric data field defined by GS1 to ensure the global, unambiguous uniqueness of the identifier in the open demand or supply chain.
GS1 Identification Keys	A globally managed system of numbering used by all GS1 Business Units to identify trade items, logistic units, locations, legal entities, assets, service relationships, consignment, shipments and more. Any identification number that combines GS1 member company identifiers (GS1 Company Prefix) with standards based rules for allocating reference numbers is a key.
GS1 Member Organisation	A member of GS1 that is responsible for administering the GS1 System in its country (or assigned area). This task includes, but is not restricted to, ensuring brand owners make correct use of the GS1 System, have access to education, training, promotion and implementation support, and have access to play an active role in GSMP.

Term	Meaning
GS1 Prefix	A number with two or more digits, administered by GS1 that is allocated to GS1 Member Organisations or for Restricted Circulation Numbers.
GS1 Symbologies using GS1 Application Identifiers	All GS1 endorsed bar code symbologies that can encode more than a GTIN namely GS1-128, GS1 DataMatrix, GS1 DataBar and Composite).
GS1 System	The specifications, standards, and guidelines administered by GS1.
GS1 XML	The GS1 standard for Extensible Markup Language schemas providing users with a global business messaging language of e-business to conduct efficient Internet-based electronic commerce.
GS1-128 Symbology	A subset of Code 128 that is utilised exclusively for GS1 System data structures.
GS1-8 Prefix	A one-, two-, or three-digit index number, administered by GS1, that is allocated to GS1 Member Organisations for the creation of GTIN-8s or for Restricted Circulation Numbers (see RCN-8).
GTIN-12	The 12-digit GS1 Identification Key composed of a U.P.C. Company Prefix, Item Reference, and Check Digit used to identify trade items.
GTIN-13	The 13-digit GS1 Identification Key composed of a GS1 Company Prefix, Item Reference, and Check Digit used to identify trade items.
GTIN-14	The 14-digit GS1 Identification Key composed of an Indicator digit (1-9), GS1 Company Prefix, Item Reference, and Check Digit used to identify trade items.
GTIN-8	The 8-digit GS1 Identification Key composed of a GS1-8 Prefix, Item Reference, and Check Digit used to identify trade items.
Guard Bar Pattern	An auxiliary pattern of bars and spaces corresponding to start or stop patterns in bar code symbologies, and serving to separate the two halves of EAN-8, EAN-13, and UPC-A Symbols.
Hanging Item	Any retail consumer trade item that is normally presented in the store in a hanging position.
Healthcare Primary Packaging	The first level of packaging for the product marked with an AIDC data carrier either on the packaging or on a label affixed to the packaging. For non-sterile packaging the first level of packaging can be the packaging in direct contact with the product. For sterile packaging the first level of packaging can be any combination of the sterile packaging system. May consist of a single item or group of items for a single therapy such as a Kit. For packaging configurations that include a retail consumer trade item, primary packaging is a packaging level below the retail consumer trade item.
Healthcare Secondary Packaging	A level of packaging marked with an AIDC carrier that may contain one or more primary packages or a group of primary packages containing a single item.
Highest Level of AIDC Marking (for Regulated Healthcare Trade Items)	A level within a graduated system of AIDC trade item marking that provides GTIN, serialization and potentially other attribute information.

Term	Meaning
House Way Bill Number	A freight forwarder's document used mainly as a control for the goods within the freight forwarder's own service system.
Human Readable Interpretation	Characters that can be read by persons, such as letters and numbers, as opposed to symbol characters within bar codes which are read by machines.
Identification number	A number or alphanumeric field intended to enable the recognition of one entity versus another.
Indicator	A digit from 1 to 9 in the leftmost position of the GTIN-14.
Individual Asset	An entity that is part of the inventory of assets for a given company. (See also Returnable Asset.)
Individual Asset Reference	A component of the Global Individual Asset Identifier (GIAI) assigned by the brand owner to create a unique GIAI.
Interleaved 2 of 5 Symbology	Bar code symbology used for the ITF-14 Bar Code.
Inverse Exponent	The Application Identifier digit that denotes the implied decimal point position in an Element String.
Item Reference	A component of the Global Trade Item Number (GTIN) assigned by the brand owner to create a unique GTIN.
ITF Symbology	See Interleaved 2 of 5 Symbology.
ITF-14 Bar Code	ITF-14 (a subset of Interleaved 2 of 5) Bar Codes carry GTINs only on trade items that are not expected to pass through the Point-of-Sale.
Kit	A collection of different regulated healthcare items assembled for use in a single therapy.
Levels of AIDC Marking	A graduated system of AIDC marking. The graduated system is defined as minimum, enhanced and highest levels of AIDC marking.
Linear Bar Code	Bar code symbology using bars and spaces in one dimension.
Local Assigned Code (LAC)	A particular use of the UPC-E Bar Code for restricted distribution.
Location Reference	A component of a Global Location Number (GLN) assigned by the brand owner to create a unique GLN.
Logistic measures	Measures indicating the outside dimensions, total weight, or volume inclusive of packing material of a logistic unit. Also known as gross-measures.
Logistic unit	An item of any composition established for transport and/or storage that needs to be managed through the supply chain. It is identified with SSCC.

Term	Meaning
Magnification	Different sizes of bar codes based on a nominal size and a fixed aspect ratio; stated as a percentage or decimal equivalent of a nominal size.
Minimum Level of AIDC Marking (for Regulated Healthcare Trade Items)	A level within a graduated system of AIDC trade item marking that provides GTIN with no attribute information.
Module	The narrowest nominal width unit of measure in a bar code. In certain symbologies, element widths may be specified as multiples of one module. Equivalent to X-dimension.
Modulo 10	The name of the algorithm - a simple checksum formula in the public domain - used to create a check digit for those GS1 Identification Keys that require one.
Modulo 103 GS1-128 Symbol Check Character	A number which results from a modulo calculation that is encoded in the GS1-128 Bar Code as a self-checking symbol character. It is created automatically by software as a symbol overhead character and is not expressed in the Human Readable Interpretation.
Natural Base	The side of a non-retail consumer trade item package that is used as a reference point for capturing dimensional attributes for the purpose of data alignment.
Non-GTIN Packs	A packaging level for trade items where there is no trading partner requirement for GTIN identification. If a GTIN is required, then this item becomes a retail consumer trade item or standard trade item grouping.
Odd parity	A characteristic of the encodation of a symbol character whereby the symbol character contains an odd number of dark modules.
Omnidirectional Linear Bar Code	A linear bar code designed to be omnidirectionally read in segments by suitably programmed high-volume Omnidirectional Point-of-Sale (POS) scanners.
Payment slip	The end customer's notification of a demand for payment for a billable service (e.g. utility bill) comprising an amount payable and payment conditions.
Platform	Pallet or slip sheet or other device used to store or move a unit load, whether a logistics unit or a GTIN.
Point-of-Sale (POS)	Refers to the retail checkout where omnidirectional bar codes must be used to enable very rapid scanning or low volume checkout where linear or 2D matrix bar codes are used with image-based scanners.
Pre-Defined Assortment	A standard trade item grouping that comprises a fixed configuration of two or more different retail consumer items, each identified with a GTIN. Any change in the configuration of the assortment is considered a new trade item.
Price Verifier Digit	A digit calculated from the price element of a Variable Measure Number encoded using the EAN/UPC Symbology. Used to check that the data has been correctly composed.
Primary bar code	The bar code containing the identification number of the item (e.g. GTIN®, SSCC, etc.). Used to determine the placement of any additional bar code information.

Term	Meaning
Quiet Zone	A clear space which precedes the Start Character of a bar code and follows the Stop Character. Formerly referred to as "Clear Area" or "Light Margin."
Quiet Zone Indicator	A greater than (>) or less than (<) character, printed in the human readable field of the bar code, with the tip aligned with the outer edge of the Quiet Zone.
radio frequency	Any frequency within the electromagnetic spectrum associated with radio wave propagation. When a radio frequency current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on radio frequency field propagation.
Radio Frequency Identification (RFID)	A data carrier technology that transmits information via signals in the radio frequency portion of the electromagnetic spectrum. A Radio Frequency Identification system consists of an antenna and a transceiver, which read the radio frequency and transfer the information to a processing device, and a transponder, or tag, which is an integrated circuit containing the radio frequency circuitry and information to be transmitted.
RCN-8	An 8-digit Restricted Circulation Number (see Restricted Circulation Number) beginning with the GS1-8 Prefix 0 or 2.
RCN-12	A 12-digit Restricted Circulation Number (see Restricted Circulation Number).
RCN-13	A 13-digit Restricted Circulation Number (see Restricted Circulation Number).
Reduced Space Symbology® (RSS)	See GS1 DataBar
Refund Receipt	A voucher produced by equipment handling empty containers (bottles and crates).
Regulated Healthcare Retail Consumer Trade Item	A regulated healthcare trade item to be sold to the end consumer at a regulated healthcare retail Point-of-Sale (Pharmacy). They are identified with a GTIN-13, GTIN-12 or GTIN-8 utilizing linear or 2D matrix bar codes that can be scanned by image-based scanners.
Regulated Healthcare Non-Retail Consumer Trade Item	A consumer trade item not intended for scanning at POS and identified with a GTIN-14, GTIN-13, GTIN-12 or GTIN-8 utilizing linear or 2D matrix bar codes that can be scanned by image-based scanners.
Regulated Healthcare Trade Item	Pharmaceuticals or medical devices that are sold or dispensed in a controlled environment (e.g. retail pharmacy, hospital pharmacy)
Restricted Circulation Number (RCN)	Signifies a GS1 identification number used for special applications in restricted environments, defined by the local GS1 Member Organisation (e.g., restricted within a country, company, industry). They are allocated by GS1 for either internal use by companies or to GS1 Member Organisations for assignment based on business needs in their country (e.g., variable measure product identification, couponing).
retail consumer trade item	The trade item intended to be sold to the end consumer at retail Point-of-Sale. It is identified with a GTIN-13, GTIN-12 or GTIN-8.

Term	Meaning
Retailer Zero-Suppression Code	A group of ID numbers (separate from Local Assigned Codes), that enable the use of UPC-E Bar Codes in a closed system environment (not for open supply chain applications).
Returnable Asset	A reusable entity owned by a company that is used for transport and storage of goods. It is identified with a GRAI.
scanner	An electronic device to read bar codes and convert them into electrical signals understandable by a computer device.
Secondary Packaging	A level of packaging marked with an AIDC carrier that may contain one or more primary packages or a group of primary packages containing a single item.
Separator Character	Function 1 Symbol Character (FNC1) used to separate certain concatenated Element Strings, dependent on their positioning in the GS1 Bar Codes.
serial number	A code, numeric or alphanumeric, assigned to an individual instance of an entity for its lifetime. Example: Microscope model AC-2 with Serial Number 1234568 and microscope model AC-2 with Serial Number 1234569. A unique individual item may be identified with the combined GTIN and Serial Number.
Serial Reference	A component of the Serial Shipping Container Code (SSCC) assigned by the brand owner to create a unique SSCC.
Serial Shipping Container Code	The GS1 Identification Key used to identify logistic units. The key comprises an Extension Digit, GS1 Company Prefix, Serial Reference, and Check Digit
Service Reference	A component of the Global Service Relation Number (GSRN) assigned by the brand owner to create a unique GSRN.
Shipment	A grouping of logistics and transport units assembled and identified by the seller (sender) of the goods travelling under one despatch advice and/or Bill of Lading to one customer (recipient).
Short Life Items	An item, preparation or reconstituted product with limited use/shelf life, such as in healthcare a cytotoxic medicine, that has undergone some manipulation, such as addition of a diluent, in order to make it administerable to a specified patient.
Single Shipping/Retail Consumer Trade Item	A retail consumer trade item that is also regarded as a shipping item and is one to a carton (e.g. a bicycle or a television).
special characters	Special characters that are designated by the symbology specification.
Standard trade item grouping	A standard composition of trade items) that is not intended for Point-of-Sale scanning. They are identified with a GTIN-14, GTIN-13, or GTIN-12.
Sterile Packaging System	A combination of the sterile barrier system (the minimum package that prevents ingress of microorganisms and allows aseptic presentation of the product at the point of use) and the protective packaging (configuration of materials designed to prevent damage to the sterile barrier system and its contents until the point of use).

Term	Meaning
Substrate	The material on which a bar code is printed.
Supplier	The party that produces, provides, or furnishes an item or service.
Symbol	The combination of symbol characters and features required by a particular symbology, including Quiet Zone, Start and Stop Characters, data characters, and other auxiliary patterns, which together form a complete scannable entity; an instance of a symbology and a data structure.
symbol character	A group of bars and spaces in a symbol that is decoded as a single unit. It may represent an individual digit, letter, punctuation mark, control indicator, or multiple data characters.
Symbol Check Character	A symbol character or set of bar/space patterns included within a GS1-128 or GS1 DataBar Symbol, the value of which is used by the bar code reader for the purpose of performing a mathematical check to ensure the accuracy of the scanned data. It is not shown in Human Readable Interpretation. It is not input to the bar code printer and is not transmitted by the bar code reader.
Symbol Contrast	An ISO/IEC 15416 parameter that measures the difference between the largest and smallest reflectance values in a Scan Reflectance Profile (SRP).
Symbology	A defined method of representing numeric or alphabetic characters in a bar code; a type of bar code.
symbology element	A character or characters in a bar code used to define the integrity and processing of the symbol itself (e.g. start and stop patterns). These elements are symbology overhead and are not part of the data conveyed by the bar code.
symbology identifier	A sequence of characters generated by the decoder (and prefixed to the decoded data transmitted by the decoder) that identifies the symbology from which the data has been decoded.
trade item	Any item (product or service) upon which there is a need to retrieve pre-defined information and that may be priced, or ordered, or invoiced at any point in any supply chain.
trade measures	Net measures of Variable Measure Trade Items as used for invoicing (billing) the trade item.
Truncation	Printing a symbol shorter than the symbology specification's minimum height recommendations. Truncation can make the symbol difficult for an operator to scan.
Unit Load	One or more transport packages or other items contained on a platform making them suitable for transport, stacking, and storage as a unit.
U.P.C. Company Prefix	A special representation of a GS1 Company Prefix constructed from a U.P.C. Prefix and a Company Number. The U.P.C. Company Prefix is only used to create GTIN-12, Coupon-12, RCN-12 and VMN-12, which are encoded in a UPC-A Bar Code.
U.P.C. Prefix	A special representation of the GS1 Prefixes '00 - 09' with the leading zero removed. Used when representing the GTIN-12, Coupon-12, RCN-12 and VMN-12 in a UPC-A Bar Code.

Term	Meaning
unrestricted distribution	Signifies that such system data may be applied on goods to be processed anywhere in the world without restraint as to such things as country, company, and industry.
UPC-A Bar Code	A bar code of the EAN/UPC Symbology that encodes GTIN-12, Coupon-12, RCN-12, and VMN-12.
UPC-E Bar Code	A bar code of the EAN/UPC Symbology representing a GTIN-12 in six explicitly encoded digits using zero-suppression techniques.
Variable Measure Number	A Restricted Circulation Number used to identify variable measure products for scanning at Point-of-Sale. It is defined per GS1 Member Organisation rules in their country (see VMN-12 and VMN-13).
Variable Measure Trade Item	An trade item which may be traded without a pre-defined measure such as its weight or length.
VMN-12	The 12-digit Restricted Circulation Number encoded in UPC-A Symbols to allow scanning of variable measure products at Point-of-Sale. It is defined per target market specific rules that are associated with U.P.C Prefix 2.
VMN-13	The 13-digit Restricted Circulation Number encoded in EAN-13 Symbols to allow scanning of variable measure products at Point-of-Sale. It is defined per target market specific rules that are associated with GS1 Prefixes 20 through 29.
wide-to-narrow ratio	The ratio between the wide elements and the narrow elements in a bar code symbology, such as ITF-14, that has two different element widths.
X-dimension	The specified width of the narrowest element of a bar code.