The Global Language of Business

2D Barcode Overview: Use in General Distribution

Important: As with all GS1 Standards and solutions, adherence to the guidance in this document is voluntary, not mandatory. It should be noted that use of the words "must" and "require" throughout this document relate exclusively to technical recommendations for the proper application of the standards to support the integrity of your implementation.

Introduction

Around the world, businesses are looking for ways to efficiently obtain important data where it is needed and looking heavily at 2D barcodes to accomplish this goal.

U.S. industry has set the Sunrise 2027 milestone date to enable 2D barcode capabilities at retail point-of-sale and non-retail healthcare environments, such as hospitals. General distribution, transport, logistics, and other places where barcodes are scanned are not included in Sunrise 2027, though companies are actively assessing whether the use of 2D barcodes could add value to their business operations in these environments. This overview document provides information to determine what barcode(s) may support business needs in distribution and logistics for any industry, such as enabling end-to-end supply chain visibility.

Barcode Type Overview*

1D (Linear) Barcodes sometimes referred to as *linear* barcodes, are a type of data carrier that is made up bars and spaces that represent data.

2D Barcodes are a type of data carrier that uses dark and light spaces in a grid pattern to represent data.

***Barcodes used in this overview are not full size**

General Distribution Data

General Distribution includes cases, pallets, and other product configurations scanned in warehouses, distribution centers, and throughout transport and logistic activities. General distribution scanning can also include the barcodes on a GS1 Logistic Label that contain information such as a Serial Shipping Container Code (SSCC).

The purpose of using a barcode or other type of data carrier in any environment is to allow information about a physical object to be captured, shared, and used. In GS1 Standards, GS1 Application Identifiers (AIs) are ~~used in~~ encoded in barcodes to tell systems what information is being interacted with and enable systems to process it accordingly. This section provides a high-level overview of AIs frequently used in general distribution environments along with GS1 Digital Link use cases.

The full list of GS1 Application Identifiers can be found in section 3.2 of the GS1 General Specifications.

Trade items are defined as any product or service where there is a need to retrieve predefined information about it and it may be priced, ordered, or invoiced at any point in the supply chain.

Name	AI	Purpose
Global Trade Item Number (GTIN)	01	Uniquely identifies the trade item
Batch or Lot Number	10	Identifies a group of the same product, all of which were manufactured under identical conditions to support traceability and other use cases.
Sell By Date	16	Indicates the date specified by the manufacturer as the last date the retailer is to offer the product for sale to the consumer
Expiration Date	17	Indicates the last date in which the quality attributes (e.g., nutrient content, color, flavor, texture, etc.) expected by the consumer are guaranteed. The product should not be marketed after this date.
Serial Number	21	Identifies an individual instance of a product for its lifetime
Variable Count of Items	30	Indicates the number of items contained in a variable measure product
Net Weight, Pounds	320n	Indicates the net weight of a variable measure product in pounds. Additional options exist for other units of measure.

Logistic units are defined as an item of any composition that is established for transport and/or storage that needs to be managed through the supply chain. These AIs are generally seen on a GS1 Logistic Label.

Name	AI	Purpose
Serial Shipping Container Code (SSCC)	00	Uniquely identifies a logistic unit
Trade Items Contained in Logistic Unit	02	Indicates the GTIN of the trade items contained is the GTIN of the highest level of trade item contained in the logistic unit and is used in combination with SSCC (00) and count of trade item pieces (37)
Count of Trade Item Pieces Contained in a Logistic Unit	37	Indicates the number of products or number of product pieces contained in the respective logistic unit. Used in combination with AI (00) and (02)
Global Location Number (GLN) of the Production or Service Location	416	Indicates where something was produced or serviced

Linking to Resources Using GS1 Digital Link URI

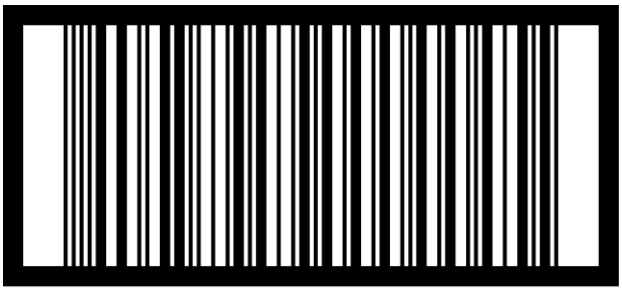
The GS1 Digital Link URI Standard puts GS1 Application Identifiers into a web-friendly format that enables enhanced connections to online business-to-business or business-to-consumer information. Current uses of GS1 Digital Link URI are focused on retail consumer applications, though possible uses in general distribution environments are being explored. Some potential uses include linking to:

- Information about whether the product has been recalled
- Safety information about the product or logistic unit, such as handling instructions
- Source for support such as a helpdesk, chat support, or email
- Traceability information

Barcode Options

Barcodes approved for use and implemented in current general distribution environments are largely 1D (e.g., ITF-14, GS1-128) barcodes. Most scanning systems and processes are currently optimized for these 1D barcodes, though 2D barcodes may offer advantages in certain scenarios. For barcode and encoded data information, see the 2D Barcodes Consideration section.

- **1D Barcodes**
  - **ITF-14** can only contain a Global Trade Item Number (GTIN). ITF-14 works best for use cases where only the GTIN is required, and barcodes are being directly applied to corrugate.



  - **GS1-128** allows for the GTIN and additional data, such as expiration date or batch/lot number to be encoded. These barcodes can hold up to 48 data characters, though may not be able to use all available characters as there is a 6.5-inch overall size limitation. GS1-128 is also commonly used on a GS1 Logistic Label for encoding a SSCC.

- **2D Barcodes**
  - **GS1 DataMatrix** allows for up to 2,335 encoded characters. It uses the GS1 element string syntax that is seen in other GS1 barcodes, like GS1-128. This data format is heavily used throughout the supply chain to support sharing important data where it is needed in healthcare, with fresh foods, on logistic units and a variety of other places. It does not offer the easier web compatibility of QR Code and Data Matrix with GS1 Digital Link URI.

(01) 1 06141 41 99999 3
(3202) 001935
(11) 221025
(10) 298123456789
(416) 0061414 10000 7

- **2D barcodes with GS1 Digital Link URI** encode GS1 data in a web-friendly format that allows the information to be used for traditional supply chain applications, while also connecting to online resources. This allows GS1 Digital Link in QR Code and Data Matrix to combine GS1 identifiers with the benefits of the web.
  - **QR Code with GS1 Digital Link URI** is the current preference for engagement through mobile devices because the default camera application on a mobile device is able to automatically scan the QR Code and connect the user to the website or other resource.

https://example.com/01/00614141999996/10/123456?17=280115

  - **Data Matrix with GS1 Digital Link URI** can also be used to connect users to the web, but not all mobile device cameras can automatically process this barcode type at this time.

https://example.com/01/00614141999996/10/123456?17=280115

Important: 1D barcodes cannot be removed until all stakeholders expected to scan the barcode are fully capable of interacting with 2D barcodes. **This means that both a 1D and 2D barcode would be required during any transition period.**

2D Barcode Considerations

The primary driver for 2D barcodes is their ability to encode more data than their 1D counterparts. For some, the data capacity of a GS1-128 (48 data characters or 6.5-inch length limit) is sufficient for their data needs. For others, GS1-128 is not capable of meeting current or future data needs. This section provides information to help compare barcodes and the requirements to implement them.

Summary 2D Barcode Advantages and Disadvantages

Potential 2D Barcode Advantages
Can encode more data in a smaller footprint than 1D barcodes
Have built-in error corrections that supports reliability
Versions that support GS1 Digital Link URI can readily link to online resources

Potential 2D Barcode Disadvantages
Require camera/image-based scanning hardware
Software updates may be required to process GS1 Digital Link URI
Printers optimized for 1D barcode printing may require changes to print 2D barcodes

Ability to Encode Data

Different types of barcodes can hold varying amounts of data. In addition to that, the data itself is structured to enable specific capabilities. This data formatting, known as the syntax, is an important consideration when determining what type of barcode is best suited to support requirements. The three barcode syntaxes in the GS1 System of Standards are plain, GS1 element string, and GS1 Digital Link URI.

Table 1 - Overview of the three GS1 barcode syntaxes and their use

	Plain	GS1 Element String	GS1 Digital Link URI
			
Type of Data	Contains only the primary identifier	Can contain the primary identifier **plus attribute data**	Can contain the primary identifier plus attribute data **in a web compatible format**
Syntax Example (GTIN, Expiration Date, Batch/Lot Number)	00614141999996	(01)00614141999996 (17)280115 (10)123456	https://example.com /01/00614141999996 /10/123456?17=280115
Barcodes	EAN/UPC and ITF-14	GS1-128 and GS1 DataMatrix	QR Code and Data Matrix
Best For	Use cases that only require a GTIN	Use cases that require data other than only a GTIN	Use cases that benefit from connecting users to an online resource
Limitation	Cannot encode more than GTIN	Size of GS1-128 can be a barrier for small packages or when large amounts of data is required. When implementing GS1 Data Matrix, trading partner collaboration is needed to ensure scanning capabilities are in place.	This syntax is not specified for open supply chain use.

Error Correction

2D barcodes used in the GS1 System of Standards use Reed-Solomon error correction which allows barcodes with damage or are otherwise obscured to have the encoded data reconstructed *to a point*. 1D barcodes do not have this feature.

The higher the percentage of error correction, the more space is dedicated as error correction and the more likely a scanning system will tolerate print issues and process the barcode. In general distribution settings where barcodes are exposed to environmental factors and potential damage, this error correction can be beneficial.

For GS1 DataMatrix and Data Matrix, the error correction level cannot be changed. The percentage of error correction ranges 25-33%.

For QR Code, the amount of space dedicated to error correction (EC) is determined by the party creating the barcode. The overall size of the QR Code will change depending on the amount of ~~how much~~ error correction ~~is~~ selected between ~~of the~~ four options: 7%, 15%, 25%, or 30%. The increase in size between the four options is shown below. These barcodes are all encoding https://example.com/01/00614141999996.


7% EC


15% EC


25% EC


30% EC

Size

The design of 2D barcodes, such as GS1 DataMatrix or QR Code, allows for more data to be encoded into a smaller space than 1D barcodes. For example, the barcodes below all encode the same GTIN, expiration date, batch/lot number, and serial number in their respective syntaxes.


(01)00614141999996(17)271231(10)ABC123(21)SN123


(01)00614141999996
(17)271231
(10)ABC123
(21)SN123


https://example.com/01/00614141999996/10/ABC123/21/SN123?17=271231

Important: 1D barcodes cannot be removed until all stakeholders expected to scan the barcode are fully capable of interacting with 2D barcodes. **This means that both a 1D and 2D barcode would be required during any transition period and that *more* package and/or label space would be required during that time.**

System Capability Requirements

Any time a new barcode type or different data components are being evaluated for use, systems need to be assessed and updated accordingly. The time required to complete these updates throughout the places where the barcodes will be scanning dictate how long a dual-marking transition period would take.

- **Printing**: Printing methods are sometimes optimized for specific barcode types or data. For instance, a printing plate used for ITF-14 barcodes will not be effective for 2D barcodes. Additionally, printing dynamic data, such as a serial number, where the barcode is not the same on all instance of the product has additional nuances to set up.
- **Hardware**: 2D barcodes require image-based scanning systems. If existing hardware is not the correct technology type, they would have to be replaced so that 2D barcodes can be scanned.
- **Software**: The ability to read specific types of barcodes and data syntaxes must be programmed and enabled for the barcode to be correctly processed. Additional updates may be needed to optimize how systems handle multiple barcodes on a single product/label.
- **Receiving Systems**: Having additional data in a barcode has limited value if systems are not able to ingest, store, use, and share that data.

Determining Next Steps

Companies assessing whether to move forward with a 2D barcode must engage with their internal and external partners to ensure the path forward is collaborative and that solutions are both capable of meeting business needs and compliant with standards and any applicable regulations.

Capable

- Is the barcode capable of encoding a GS1 data syntax/format?
- Can the barcode be created and/or applied at the speed and quality required?
- Are those intended to interact with the barcode able to process it and do so at an adequate speed for the application?

Compliant

- Does the barcode help meet regulatory requirements?
- Is the barcode approved for standardized use for your application?

Collaborative

- Have the data, barcode, packaging, scanning hardware/software, and receiving systems capability to store/use data all been considered?
- Have all internal and external stakeholders been brought together to agree on and enable the transition to the future solution?
    - Stakeholders can include trading partners, solution providers, and GS1 US. These stakeholders may include those involved with label design, printing, scanning, data storage, processing, etc.

Want to Learn More?

- GS1 US Resources
    - Sunrise 2027
    - GS1 Digital Link
    - GS1 US Supply Chain Visibility
- Standards and Guidelines
    - GS1 North American Industry Guidance for Standard Case Code Labeling
    - GS1 Logistic Label Guideline

If you have any questions about 2D barcodes, please contact GS1 US at Sunrise2027@gs1us.org.

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