The Global Language of Business

GS1 US RFID Foodservice Implementation Guideline

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Document Summary

Document Item	Current Value
Document Title	GS1 US RFID Foodservice Implementation Guideline
Document Description	This guideline clarifies case/carton source tagging requirements for foodservice suppliers to minimize disparate supplier tagging requirements.

Change Log

Version	Date	Change
1.0	June 29, 2023	Publication
1.1	September 17, 2024	Errata corrections and updated reference links, including link to educational content.

Executive Summary

Tracking cases/cartons with EPC-encoded RAIN RFID technology offers benefits relating to *visibility, traceability and operational efficiencies*. Foodservice industry stakeholder interest in RFID has increased significantly both as a result of the benefits of the technology as well as regulatory drivers. Such interest has prompted the adoption of tag data standards that best address use cases for perishable goods. This guideline clarifies case/carton source tagging requirements for foodservice suppliers to minimize disparate supplier tagging requirements.

For food products and consumer-facing food packaging, this guideline specifies supplier case/carton:

- Tag encoding
- Tag marking
- Tag placement

This guideline does not specify supplier case/carton requirements for operational supplies, which presumably are tagged using encoding schemes commonly used for general merchandise. A video series that provides an overview of this guideline may be found *here*.

Technical Summary

This document provides technical directives for foodservice case/carton tagging of food products and consumer-facing food packaging. These product categories are distinguished from other categories such as general merchandise as these products concern perishable goods and related consumer-facing packaging. General merchandise tagging guidance is outside the scope of this document and documented elsewhere.[1]

- Tag encoding
  - Leverage the DSGTIN+, which requires manufacture line encoding of a date value.
  - If not already encoding serial number, opt to encode a serial number of 8 hexadecimal characters
  - If Batch/Lot is business critical data, encode it as "+AIDC data" following the DSGTIN+ EPC.
  - Other application identifiers, such as net weight, may be appended if business critical.
- Tag marking
  - Mark cases/cartons with the EPC logo to indicate the presence of a GS1 standards compliant RFID tag. Such marking is normally printed onto the tag.
- Tag placement
  - If already applying a Case Label with a GS1-128 barcode, leverage this to simplify the line encoding process.
  - Engage an accredited laboratory to assess and confirm viability of tag placement.
  - A standalone RFID tag or corrugate-embedded tag approach may be used if not applying a label.

[1] For resources regarding general merchandise source tagging see: *https://site.gs1us.org/RFID-success.html*

1 Introduction

The Foodservice industry has been leveraging the GS1-128 barcode to encode GTIN and Attribute Data (e.g., Batch/Lot, Date, Serial Number and Net Weight) for many years. Industry participants have recently taken steps to aggressively investigate and pilot the use of the Electronic Product Code (EPC) in RAIN RFID tags for carton-level tracking. Such solutions provide high-speed inventory visibility without line-of-sight scanning.

The numerous RFID solution benefits relating to inventory visibility include the enhanced ability to track and recall products, enhanced inventory accuracy, and reduced labor to perform supply chain functions. Beyond encoding the GTIN and Serial Number (which provides unique identification of objects and is foundational to traceability), there are significant benefits in encoding attribute data such as Date and Batch/Lot into the tag memory. This facilitates use cases such as quickly identifying instances of a recalled lot for disposal or marking down products approaching their expiration date. The tag encoding scheme (SGTIN-96) used in the apparel and general merchandise industry historically has not included the streamlined capability to capture and share such traceability data.

To accommodate these and other requirements from the business and technical communities, GS1 Global Office convened two separate Mission-Specific-Workgroups (MSWGs), working in parallel to modernize GS1's EPC Tag Data Standard (TDS) and GS1s "Gen2" UHF Air Interface Protocol. The scope of that effort included consideration of use cases for perishable items. This resulted in significant optimization of both the tag data structure and reader-to-tag communication protocol.

Important: As with all GS1 Standards and solutions, this guideline 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.

GS1 US recommends that any organization developing an implementation should consult with their own counsel to determine the compliance of such an implementation with any rights of third parties. Each company is individually responsible for meeting all statutory and/or regulatory requirements for their company and their products. Consult with your company's legal counsel or compliance team (regulatory or quality) for more specific information about current statutory and regulatory requirements applicable to your company and products.

1.1 Scope

In Scope	Out of Scope
▪ Manufacturer and/or supplier source tagging in the foodservice industry. ▪ Case/carton trade units containing food products and foodservice customer-facing food packaging, where such case/cartons are identified with a GTIN.	▪ Logistics units ▪ Inner pack or item identifiers ▪ Point-of-sale (POS) at retail ▪ Reusable containers ▪ Solutions not using GS1 standards

1.2 Who Should Use this Document?

This document is applicable to industry stakeholders such as solution providers, suppliers, processors, manufacturers, distributors, wholesalers, and operators. Specifically, this applies to stakeholders in the Foodservice industry using GS1 Standards and RAIN RFID technology.

1.3 Business Context

This guideline provides a means to drive a common set of source tagging requirements. This better enables the digital communication of attribute data at the point of product interaction across the supply chain. To best reduce barriers to adoption and minimize implementation effort, the following design principles have been applied:

- Solution agnostic: The approach is agnostic to various inventory control systems and enables key use cases even if core legacy systems do not support relevant functions or data structures.
- Ease of solution adoption: Traceability data is readily accessible when reading the RFID tag using the same standard to collect the tag identity.
- Ease of data search: Incorporating traceability data into a carton RFID tag allows for targeted tag searches with no required database lookup. This enables focused communication with only the RFID tags that are subject to a specific search, instead of interrogating all the tags in an area and checking each tag against a database.
- Easily shared: Storing traceability attribute data in the RFID tag allows the relevant data to be transported with the product. Any reader in proximity can capture this data. This aligns with available GS1-128 functionality to capture key product information.

1.4 Use Case Examples

1.4.1 Recall Response

Cartons of product are loaded at a distribution center for delivery to a set of retailer or operator locations. Day after day, the RFID tags on these cartons are automatically read and associated with the delivery route. This data may also be automatically collected in the retailer/operator receiving process. A recall alert is raised that requires immediate remediation. Because the manufacturer encoded traceability data into the RFID tag, the parties involved now have this critical information readily available.

- This allows the distributor or retailer/operator to quickly narrow the scope of stores subject to recall action. The distributor and operator/retailer save significant time and expense in remediation activities. The manufacturer avoids erosion of the brand image.
- Following this recall notice, an operator or retailer employee performs an inventory cycle count using an RFID reader device. The device searches the RFID tags for the specific Batch/Lot or serialization range and GTIN in question. The reader device specifies to the body of RFID tags that it is only looking for tags meeting the search criteria, allowing for only the tags in question to be detected and located.
- In parallel, other cartons that are in the scope of the recall are received at another distribution center. The dock door, conveyor, or forklift readers used in the inbound receiving process automatically read the carton RFID tags and issues an immediate alert/alarm regarding the cartons matching the recall notice.
- Such automation of data collection provides visibility that significantly contributes to regulatory compliance initiatives.

1.4.2 Fresh Food Management

By encoding the relevant date attribute into the carton RFID tag, similar use cases may be implemented for fresh food management. For example, a dock door reader can provide an immediate alert if cartons are delivered past their vendor acceptance requirements. A forklift solution or conveyor system can immediately detect expiration data and respond in the moment, diverting products based on key attribute data read directly from the RFID tag. Employees using hand-held RFID scanners to capture inventory in operator locations can simultaneously capture expiration data which can be used for fresh

food management. Such data can be used for various inventory management purposes, including FEFO (First Expired First Out) based picking or driving demand creation mechanisms such as limited time offers on digital signage.

1.4.3 Operational Efficiencies

Because the RFID technology allows data collection without line of sight, palletized cartons may be read without the effort of depalletizing. High value products (such as prime steaks) are moved through the supply chain with the variable weight encoded in the GS1-128 barcode. The current practice to obtain this information is to depalletize and barcode scan the GS1-128 barcode on each carton. The cartons are then immediately repalletized. The solution in this application guideline can encode that variable weight into the RFID tag which eliminates the need for depalletization.

Beyond automating and validating receiving, the RFID technology enables numerous inventory management use cases such as the fast and accurate capture of inventory. Use cases and benefits across the supply chain are further documented in the *RFID Advantage* document.

2 GS1 Application Identifiers (AIs) Used in This Document

Please refer to Section "GS1 Application Identifier definitions" in the *GS1 General Specifications* for full details on GS1 Application Identifiers. The EPC encoding scheme to be used for food products and consumer-facing food packaging is the DSGTIN+ encoding. This encoding requires the Global Trade Item Number® (GTIN®), serial number, and a date AI. In addition to this, if the Batch/Lot AI (10) is considered business-critical, then that should also be included. The AIs that are recommended for encodings associated with food products and consumer-facing food packaging are indicated in figure 2-1.

Figure 2-1 GS1 Application Identifiers most relevant to this guideline

AI	Data Content	Core Requirement
01	Global Trade Item Number (GTIN)	Required
10	Batch or lot number	Required only if business-critical
11	Production date	One of these dates is required
13	Packaging date	
15	Best before date	
16	Sell by date	
17	Expiration date	
7006	First Freeze date	
7007	Harvest (start) date[2]	
21	Serial number	Required
310n	Net weight, kilograms (variable measure trade item)	Not required
320n	Net Weight, pounds (variable measure trade item)	Not required

2.1 Global Trade Item Number (GTIN) - AI (01)

The key for unique identification of products (as opposed to instances of a product) is the GTIN, which is assigned AI (01). GTINs are used to identify "trade items" (i.e., products and services). They are assigned by the entity normally responsible for the creation of the product.

A company may license a GS1 Company Prefix by joining a GS1 Member Organization. This gives the company the ability to create GTINs.

A GTIN is required for the RFID tag encoding described in this document.

[2] Note that the Harvest date AI allows for one or two dates. The first AI is the start date, and the optional second date is the end date. Only the start date is able to be encoded using the DSGTIN+ when encoding AI (7007).

2.2 Serial Number – AI (21)

RFID tagging requires serialization, which leverages AI (21). The business entity that is the holder of the GS1 company prefix license is responsible for serialization, however that responsibility may be delegated. The only serialization requirement is to have a unique GTIN + Serial Number combination per product instance. If a supplier does not already make use of AI (21) for product identification (for example if using a barcode-based data carrier), the recommendation is to encode an 8-character upper case hexadecimal serial number[3]. This provides a capacity of 4.29 billion possible serial numbers per product and optimizes use of tag memory when using the DSGTIN+ encoding scheme.

A supplier already using AI (21) can continue to do so, using the same method of serialization for encoding RFID tags. A longer serial number and/or a serial number with a larger number of possible values per character will consume more tag memory (e.g., a numeric serial number consumes less memory than an alphanumeric serial number with the same number of characters).

2.3 Date Application Identifiers

The following are commonly used date identifiers for foodservice applications.

Application Identifier	Description
11	Production date
13	Packaging date
15	Best before date
16	Sell by date
17	Expiration date
7006	First freeze date
7007	Harvest (start) date[4]

These dates are expressed numerically as year, month, and day (YYMMDD). Different date application identifiers tend to be used for different product categories based on business requirements.

One of the above date application identifiers is required for the RFID tag encoding described in this document.

2.4 Batch or Lot Number - AI (10)

The GS1 Application Identifier (10) is used and typically assigned at the point of manufacture. While the batch or lot number is less specific than a serial number, it may be considered a business-critical means of tracking products. If considered business critical, then this AI is required.

[3] Leveraging a hexadecimal serial number maximizes the serialization capacity held within a tag's memory. An 8-character upper case hexadecimal serial number is recommended if a serial number scheme is not already in use. See figure 4.1-1 and section 4.2 for further information.

[4] Note that the Harvest date AI allows for one or two dates. The first AI is the start date, and the optional second date is the end date. Only the start date is able to be encoded using the DSGTIN+ when encoding AI (7007).

2.5 Net Weight (310n) or (320n)

Net Weight may be expressed in kilograms (Application Identifier (310n)) or in pounds (Application Identifier (320n)). This is an example of an optional AI that may be used where specific business needs require.

Figure 2.2 is an example of the string's format. Its digit A4 indicates the implied decimal point position, where, for example, the digit 0 means that there is no decimal point, and the digit 1 means that the decimal point is between N5 and N6. For example, the 789.355 lbs. will be AI (3203).

Figure 2.2 Format of the element string

GS1 Application Identifier	Applicable value
A_1 A_2 A_3 A_4	N_1 N_2 N_3 N_4 N_5 N_6

3 Relevant Data Carriers

In the GS1 System of Standards, a very clear distinction is made between data and a data carrier. GS1 Standards provide normative definitions of various data elements, and these definitions hold true regardless of the form that data takes or how data is transmitted. A "data carrier" as that term is used in GS1 Standards is a means of physically affixing data to a physical object so that the data can be captured without human data entry. In the GS1 System, data carriers include a variety of types of barcodes and radio frequency identification (RFID) tags.

3.1 GS1-128 barcode

GS1-128 barcodes are commonly used to encode trade item data and logistic unit information for cartons and pallets. Specific attribute information can be encoded in GS1-128 barcodes using GS1 Application Identifiers (AIs).

Additional details regarding GS1-128 barcode makeup and sizing may be found in "Linear barcodes - GS1-128 symbology specifications" of *GS1 General Specifications*.

3.2 RFID Tag

An RFID system includes a reader and a transponder (or tag), which has a microchip with an attached antenna. Passive tags do not have their own power source, rather, they are powered by being in proximity to a reader.

Regarding RFID Tags:

- Data is stored (in a binary format) in a microchip. This data is commonly referred to as the EPC when GS1 standards are used.
- RFID tags communicate with dedicated readers by means of radio frequency (which does not require line of sight).

The technology described in this document leverages passive communication, meaning that the tag is only activated in response to a reader signal. The tag carries data in a standardized format known as the Electronic Product Code (EPC). This standardized format includes GS1 Identification Keys and GS1 Application Identifiers.

4 EPC Encoding

The *GS1 EPC Tag Data Standard (TDS)* defines the Electronic Product Code (EPC), including its correspondence to GS1 keys and other codes. TDS specifies the bit-level data that is carried on EPC-encoded RFID tags.

Date-prioritized Serialized Global Trade Item Number (DSGTIN+)
The GS1 Tag Data Standard (TDS) defines various EPC binary encodings, including DSGTIN+, a date prioritized serialized GTIN in which a critical date value appears before the GTIN within the binary encoding. This is particularly useful for perishable goods, stock rotation and management of goods with limited remaining shelf life. This enables an RFID reader to select products from any brand owner or manufacturer where the critical date matches a specified value such as products whose use-by date or sell-by date is today, so that they can be removed from the sales area or discounted for quick sale.

An example of the structure of the DSGTIN+ encoding follows in figures 4.1 and 4.2.

Figure 4.1 DSGTIN+ base encoding

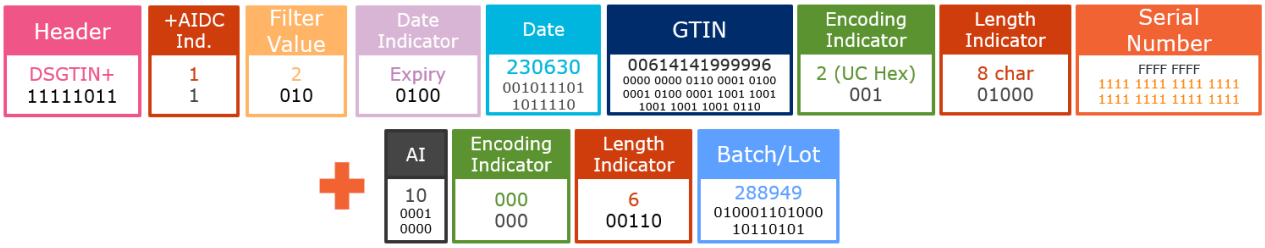
An explanation of each element follows:

- Header – the first 8 bits indicates the encoding scheme (e.g., SGTIN-96, SGTIN+, DSGTIN+)
- +AIDC Indicator – indicates if additional data is encoded beyond the core EPC identifier (which for the DSGTIN+ is composed of the Date, GTIN, and Serial Number)
- Filter Value[5] – this indicates if the product is a point-of-sale item, case, inner pack, unit load, …
- Date Indicator – indicates what type of date is about to be described
- Date – the value of the date indicated
- GTIN – the product identifier in 14-digit (GTIN-14) format
- Encoding Indicator - Indicates the data type of the next value to follow. In this example, it indicates that the serial number is an upper-case hexadecimal value
- Length Indicator: the number of digits that the following value encodes
- Serial Number: this is the value of the Serial Number previously described by the encoding and length indicators

Note: Some AIs have set data types and lengths (e.g., AI (17) expiration date is always 6 numeric digits) and therefore do not require the Encoding Indicator or Length Indicator.

[5] Note: The Filter Value always occupies three bits at a constant memory address (29h-2Bh) in the EPC Memory Bank, but capturing parties are not encouraged to derive significance from the decoded Filter value, to avoid the risk of potential misinterpretation.

Figure 4.2 DSGTIN+ encoding with Batch/Lot



An explanation of each added or changed element (as compared to figure 4.1-1) follows:

- +AIDC Indicator – note that this is now set to "1", as additional data is appended to the EPC beyond the Date, GTIN, and Serial Number
- AI – This indicates that Batch/Lot AI (10) follows
- Encoding Indicator - Indicates the data type of the value to follow. In this example, it indicates that the following value is numeric.
- Length Indicator: the number of digits that the following value encodes
- Batch/Lot: this is the value of the Batch/Lot previously described by the encoding and length indicators

4.1 EPC Memory Considerations

The example from figure 4.1 shows the recommended base encoding (assuming Batch/Lot is not business critical) and encodes exactly 128 bits. At the time of the writing of this document, many commonly available RFID tags have an EPC capacity with a maximum of 128 bits[6].

If additional data such as Batch/Lot is considered business critical and therefore required, such data is able to be added (per the example shown in figure 4.2). In such a case, the chip powering the RFID tag must have sufficient memory. The length and data type of the batch/lot data will determine the amount of additional memory required. Examples with varying Batch/Lot values follow in Table 4.1.

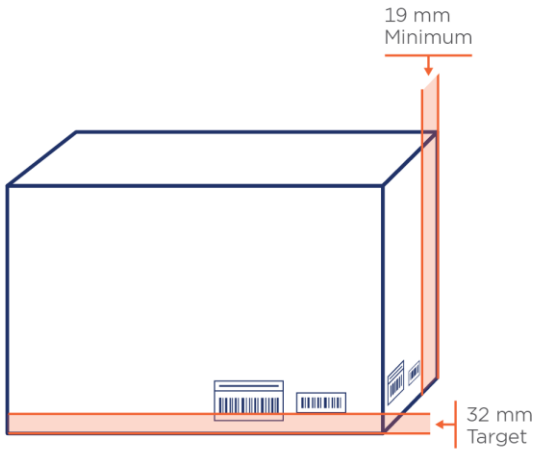
Table 4.1 EPC Memory Examples for DSGTIN+ with varying Batch/Lot values

Batch/Lot Values with DSGTIN+	Total EPC Bits
10-digit numeric Batch/Lot value: 1234567890	192
12-digit URN Code 40 (upper case alphanumeric): ABC456789XYZ	208
15-digit URN Code 40: ABC456789XYZ123	224
15-digit mixed case alphanumeric: ABC456789xyz123	240

[6] On a technical note, EPC tags are encoded in 16-bit blocks (called "words"), and thus encoding 128 bits also enables any appended data (starting on the 129th bit, if there is sufficient memory) to occur on a word boundary, which has minor performance benefits. For this reason, the total encoded bits will always be a multiple of 16, with unused bits padded as zeros.

5 Tag Placement and Marking Guidance

The Case Label with a GS1-128 barcode is a commonly used and logical means of attaching an RFID inlay to a case/carton. The GS1 label placement on cartons and outer cases is described in the *GS1 General Specifications* section titled "Symbol Placement on cartons and outer cases". This specifies a target location where the bottom of the GS1-128 barcode is 32mm vertically from the base, and anywhere horizontally on that plane so long as the barcode is not within 19mm of the edge. Further guidance is found in the *GS1 Logistic Label Guideline – Section 8.2* Adherence to this standard is important for numerous logistical reasons.



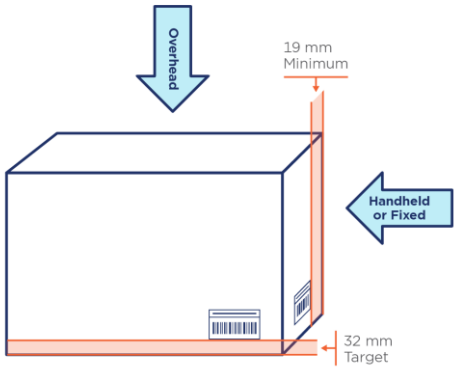
While the above diagram shows two separate labels, a common practice is to have a wide wrap-around edge label that covers two sides of a carton with one label. In any case, there should be only one RFID inlay per case/carton. Where more than one side is labelled, the side on which the RFID inlay is positioned should be assessed by a lab based on factors described below. There may be reason to separately attach an RFID tag (instead of embedding the inlay in the GS1-128 label) due to performance considerations relating to GS1-128 label placement. This document outlines such criteria, noting that a testing laboratory would be integral to determining tag placement.

5.1 Tag Placement Factors

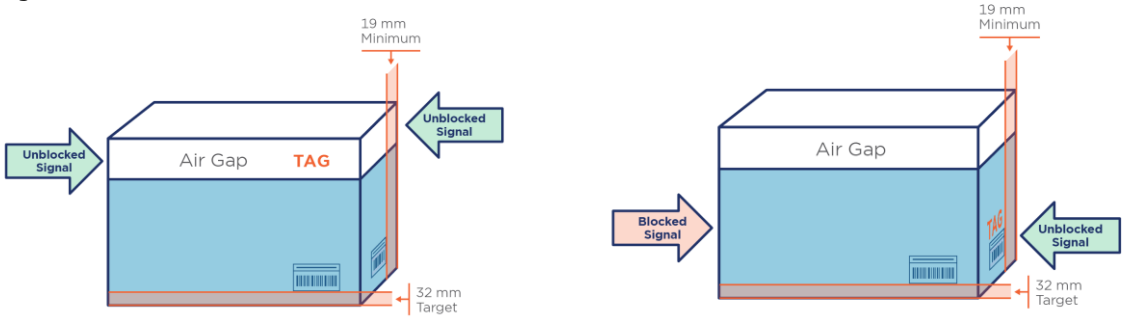
The following factors may impact the performance or viability of an RFID inlay. A testing laboratory will consider these factors when evaluating tag placement and appropriate tag inlay types.

- Intended Use Cases: A use case is a specific business process in a specific context where the RFID technology may be used. Examples of use cases include cycle counting items with a hand-held device or receiving items at a dock door with a wall-mounted reader. A use case description makes clear how the data collection occurs (e.g., with a handheld device verses a wall-mounted dock door reader) and includes an understanding of the read duration, number of tags, and distance between tags and reader antenna. This has process implications and trade-offs. A user with a handheld device can check to see if all expected items were read and can directly drive corrective action if detecting issues in the moment. A fixed reader requires no labor and might be used for contactless deliveries as it automatically turns on when the door opens but may not be able to directly drive corrective action. The RFID inlay, inlay placement on packaging, and product characteristics must mesh together to ensure reliable data collection. An additional example follows.

- The use case reader infrastructure: This may impact readability based on tag placement. For example, a tag may perform better when used with a hand-held reader (approaching the tag from a horizontal plane) as opposed to an overhead reader (approaching the tag from a vertical plane). Noting that a tag placed on the top plane of the case/carton (which may be more ideal for an overhead reader) would easily be blocked when another product is stacked on it. These distinctions may cancel out as an overhead solution is always on.



The carton content: This may be highly absorptive (such as dense liquid products). If an RFID label is applied to the outside of a case/carton, then the corrugate thickness will be helpful in providing a minimal distance from the absorptive material. However, the content may block a signal coming from the opposite side of the case/carton. In such a case, the RFID tag may be placed in the upper (air gap) portion of the case/carton. (The blue space indicating where product is filling the case/carton.) This would be most impactful when reading palletized case/cartons unless all RFID tags are faced out.



- Carton inspection: An RFID tag has a very small amount of metal used for the microchip and antenna. If using a metal detector (e.g., in the manufacturing environment) after applying the RFID label then the label should be placed in such a manner as to be appropriately masked so as to not trigger a false reading.
- Avoiding damage: The final factor has to do with ensuring that the normal handling of the product does not result in damage to the tag. In addition to this, tag placement should avoid the possibility for adjacent palletized cartons to not have their RFID tags directly touching, as doing so could impact readability. Finally, the tag should not be placed in a location that might be removed (e.g., the case/carton lid) as a part of normal operations.

The evaluation of these factors will include consideration for the variety of read paradigms and use cases employed across the supply chain, evaluating if using the standard location for a GS1-128 barcode will meet the requirements of the paradigms for a given product category.

5.2 Carton Marking

The EPC logo (see figure 5.1) shall be printed on the GS1-128 barcode free format area to indicate the presence of an EPC-encoded tag. This will enable trade partners to understand what case/cartons are tagged. Information and logo graphics may be found at this link *GS1 guidelines on the use of RFID* .

Figure 5.1 – EPC Logo

5.3 Standalone RFID Label Marking

In the event that the RFID inlay must be placed in a location other than where the GS1-128 label is located, a standalone label with the RFID inlay may be encoded, and applied or an inlay may be pre-placed in the corrugate and encoded with a fixed reader.

If adding a standalone RFID label to a carton:

- The standalone RFID label should be on the same side as an existing GS1-128 barcode label. This is considered a best practice and the default approach; however, a detailed lab analysis could result in another location.
- If there are multiple GS1-128 barcode labels (such as on the long and short side of the case, which is a best practice), the side on which to place the standalone RFID label will be determined by a testing laboratory. Such placement will also note operational considerations such as the eventual placement of case/cartons on store shelving with the narrow side facing out.
- The standalone RFID label shall have the EPC logo printed on it, as well as a 2D barcode (GS1 DataMatrix or QR Code) and human readable elements included that match all the application identifiers encoded in the RFID tag.
- All data carriers on a case/carton shall have the same AI value whenever the same AI is defined. For example, if an RFID tag contains an expiration date and a barcode contains an expiration date, both shall have the same value.

6 EPC and GS1-128 Barcode Alignment

A principle of GS1 standards is that data elements are defined in a data carrier-neutral way so that their semantics are the same regardless of what data carrier is used to affix them to a physical object. Standards for each data carrier therefore define a carrier-specific representation of carrier-neutral data elements, allowing those data to be encoded in a manner compatible with the physical constraints of the carrier. This section addresses alignment with the GS1-128 barcode, but the same principles will apply if other barcode data carriers are used.

Barcode alignment rules:

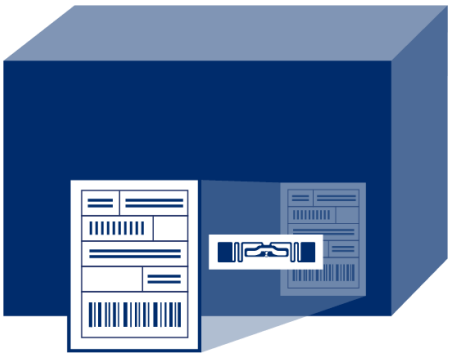
- Only barcodes containing AI (01) GTIN as the primary GS1 Key are relevant to this guideline.
- Where the GS1-128 and RFID tag AI values match, the same data should be encoded. At no point should two data carriers on the same case/carton define the same AI with different values.
- To the extent possible, the same data encoded in the RFID tag should be encoded in the GS1-128 barcode. If the GS1-128 barcode does not have sufficient carrying capacity to do this, then a separate GS1 DataMatrix or QR Code should be encoded and added to the case label. Placement of the GS1 DataMatrix should follow the standard as defined in the *GS1 General Specifications* section titled GS1 Logistic Label design. Further information is also available in the *GS1 Logistic Label Guideline*.

Figure 6-1 Data Carrier Benefits and Limitations

	GS1-128 Barcode	2D Barcode (GS1 DataMatrix or QR Code)	RFID
May Carry GTIN, Serial Number, Batch/Lot, Weight, and/or Date	Yes		
GS1 Element String Example (GTIN, Serial Number, Expiration Date, Batch/Lot Number)	(01) 00614141999996 (21) FFFFFFFF (17) 230630 (10) 288949		
Best For	GS1 compliant case / carton labels	Standalone RFID label marking, or as an additional barcode for case labels	Use cases that require data capture without line of site. Use cases that benefit from item level serialization.

	GS1-128 Barcode	2D Barcode (GS1 DataMatrix or QR Code)	RFID
Limitation	Size of GS1-128 can be a barrier for small packages or when large amounts of data is required. It has a 48-character limit. Multiple barcodes may be needed to carry all attribute data on the same label.	GS1 Data Matrix is not approved for open supply chain use due to limited system scanning capabilities.	The length of the EPC, including attribute data, is limited to the memory of the RFID tag. Therefore, the data requirements of the EPC must be known to select the appropriate tag.

6.1 GS1-128 Barcode and RFID Encoding Processes



A case label with a GS1-128 barcode is commonly affixed to cartons to carry identification and attribute data. The same process step used to print and apply the GS1-128 barcode may be employed to encode and attach the RFID tag. The upgraded printer (if supported), or similar printer and mechanism that encodes and applies the case label may be configured to print GS1-128 barcodes while also encoding RFID inlays embedded in the label stock. This allows the same or similar quality control mechanisms to be leveraged to ensure proper tag encoding and application.

Alternatively, manufacturers/suppliers may opt to have RFID tags embedded by the corrugate supplier. In this case, it is possible that a partial encoding of the RFID tag may be encoded at point of corrugate creation (assuming dedicated cartons for specific GTINs) with similar information (such as a GTIN and Serial Number) printed on the corrugate as well. In addition to this printing, a best practice is to mark the exterior of the corrugate where the RFID tag is placed (presumably in the interior of the corrugate).

The remaining AI values may be encoded by the Manufacturer/producer on the production line. In this setting, a strategy for allowing RFID tags to be written would be used by the corrugate supplier, followed by (if concerns warrant) the manufacturer write protecting the RFID tag after encoding additional production data. For additional information, see Section 7.

7 Line Encoding Process Implications

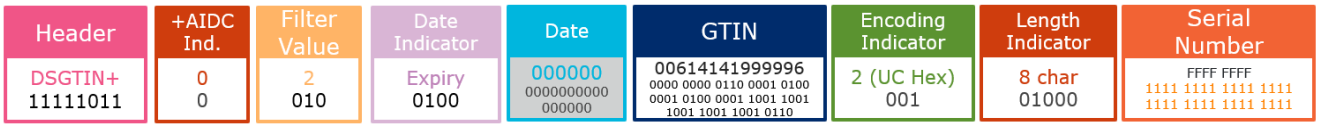
If opting to leverage RFID tagging pre-placed in corrugate, manufacturers/suppliers may choose to either fully encode the tags on their production line or receive partially pre-encoded tags and complete the encoding on the production line. In either scenario, the date, and possibly additional data such as batch/lot would be line encoded, requiring the same line encoding equipment.

- Fully encoding the tags on the production line will require knowing the product identifier (the GTIN) and assigning a serial number. This will require some form of serialization management.[7] While the step of fully encoding a tag takes slightly longer than partially encoding a tag, research has shown that this is well within the capabilities of the technology as applied in foodservice case/carton line encoding environments.[8]
- If partially encoding the tags on the production line, the assumption is that the GTIN and Serial Number are pre-encoded, though this is not required. (Given that the GTIN + Serial number combination together must be unique per product instance, this would suggest that the two are encoded together.) As a result, this would require ensuring that the specific supplied corrugate for a particular product is used, which may be cumbersome for production operations. To address and align with this process challenge, the product identification data (the GTIN and optionally the serial number) may be inkjet printed on the corrugate. A best practice is to align printing with encoding.
- Regardless of line encoding approach, a best practice is to permalock the RFID tag after encoding to ensure it is not able to be overwritten as it proceeds through the supply chain.
- If leveraging EPCIS to capture and/or communicate event data with supply chain partners, the line encoding action that completes the tag encoding triggers the "Commissioning" event.[9]

7.1 Partial Encoding Technical Details

In the event that a DSGTIN+ encoded tag is intended for use with a particular GTIN, such data as shown in figure 7.1 may be pre-encoded. The Date value shall be pre-encoded with all zero values and will be overwritten in the production line. Note that the date type (such as an expiration date as shown in this example) is also pre-encoded. As previously noted in a technical footnote, the Date value itself aligns with a 16-bit word boundary, which simplifies the encoding process. The greyed block (Date) indicates what data is line encoded, with the other data pre-encoded.

Figure 7.1 Example of pre-encoded DSGTIN+ with null date value



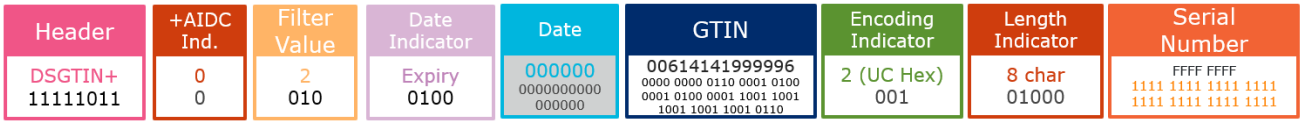
[7] See the *Developing an RFID Serialization Plan* for an overview of RFID serialization management.

[8] Significant technical research performed during the creation of this document as well as case study review support this statement, said research to be provided in an ancillary document.

[9] For more information about EPCIS, see *EPCIS & CBV | GS1*

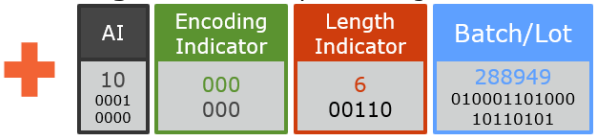
If the same encoding as above is to also include additional data such as a Batch/Lot, such data as shown in figure 7.2 may be pre-encoded. As with the above example, the Date value shall be pre-encoded with all zero values and will be overwritten in the production line. The date type (such as an expiration date as shown in this example) is also pre-encoded. Because additional data will be encoded, extending beyond the serial number, the +AIDC indicator bit is pre-encoded to "1". The greyed blocks indicate what data is line encoded, with the other data pre-encoded.

Figure 7.2 Pre-encoded DSGTIN+ with null date that will have additional data added



The additional AIDC data as seen on the second line of figure 4.2 is then appended during the line encoding process[10].

Figure 7.3 Excerpt from figure 4.2



[10] NOTE: Whenever additional "AIDC data" is appended during a line encoding process, the Length (or "**L**") bits (10h – 14h of the EPC memory bank) of the Stored PC word **must** be updated. The Length bits indicate the number of 16-bit words comprising the EPC field, beginning with the 8-bit, EPC Binary Header at bit 20h and including any optional "AIDC data" appended to the EPC itself. For details, please consult TDS.

Glossary

Term	Definition	Also Known As
Attribute Data	For the purposes of this document, Attribute Data refers to data such as Batch/Lot, Date, and Net Weight. Such data enables stakeholder access to retrieve additional information, beyond item unique identity, about items.	Attribute Data
DSGTIN+	The DSGTIN+ is a date prioritized, serialized GTIN encoding scheme designed specifically for perishable items. This is the recommended encoding scheme for the specific scope of this document.	DSGTIN+
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 standardized 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.	EPC®
EPCIS	*EPCIS* is GS1's flagship data sharing standard for enabling visibility, within organizations as well as across an entire supply chain of trading partners and other stakeholders. It helps provide the "**what, when, where, why** and **how**" of products and other assets, enabling the capture and sharing of interoperable information about status, location, movement and chain of custody.	EPCIS
EPC Logo	The EPC Logo is commonly used to indicate the presence of a GS1 standards-compliant RFID tag.	EPC Logo
EPC Tag Data Standard	*GS1's EPC Tag Data Standard (TDS)* defines the Electronic Product Code (EPC), including its correspondence to GS1 keys and other codes. TDS also specifies data that is carried on EPC-encoded RAIN RFID tags, including the EPC, User Memory data, control information, and tag manufacture information.	TDS
Global Trade Item Number	The GS1 identification key used to identify trade items. The key comprises a GS1 Company Prefix, an item reference and check digit.	GTIN
GS1 Application Identifier	GS1 Application Identifiers (AIs) are prefixes used in barcodes and EPC-encoded RFID tags to define the meaning and format of data attributes.	AI
GS1-128 barcode symbology	A subset of Code 128 which uses the function that allows the encoding of element strings. GS1-128 barcodes are used for business-to-business identification of shipment units such as cartons.	GS1-128
Radio Frequency Identification	A technology that uses radio frequency electromagnetic fields or waves to automatically identify and track tags attached to objects. An RFID system consists of RFID tags and readers. When triggered by a radio frequency electromagnetic interrogation signal from a nearby RFID reader, the RFID tag transmits digital data, usually a unique identifier like an EPC, back to the reader. For the purposes of this document, this term is synonymous with the term "RAIN RFID" in regard to technology and employs the GS1 EPC standard regarding *tag data structure*.	RFID

Term	Definition	Also Known As
RAIN RFID	RAIN RFID is a term to encompass RFID technology based on a frequency range of 860-960 MHz, using passive tags, as specified by the *GS1 Gen2 air interface protocol* as well as the ISO/IEC 18000-63 technical standard.	UHF passive RFID
Serialized Global Trade Item Number	The SGTIN EPC scheme corresponds to a combination of a GTIN key plus a serial number. The serial number in the SGTIN is defined to be equivalent to AI (21) in the GS1 General Specifications. The SGTIN is used to assign a unique identity to an instance of a trade item, such as a specific instance of a product or SKU.	SGTIN
SGTIN-96	The SGTIN-96 is an encoding scheme that encodes the SGTIN with 96 bits of data. Within that encoding scheme, 38 bits are allocated for the Serial Number value.	SGTIN-96
SGTIN+	The SGTIN+ is an SGTIN encoding scheme introduced by TDS 2.0. It encodes a Serialized Global Trade Item Number and allows for additional AIDC data, based on GS1 Application Identifiers (AIs) to be encoded in EPC memory. In the context of this Foodservice Implementation Guideline's recommendations, The DSGTIN+ encoding scheme (see above) is preferred to the SGTIN+ scheme.	SGTIN+

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