# Missing Identification Resolution, Highlighting Serialisation

## Technical Implementation Guide

***Issue 1, Nov-2009***

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The development of this guideline would not have been possible without the help of GS1 GSMP and EPCglobal members who have contributed continuously, have attended the conference calls and have taken the time to attend physical meetings throughout the whole year.

# Foreword

## Who should use this document?

This document will be crucial to anyone who is involved in identifying trade items, logistic units or packages. Any company involved in supply chain management using GS1 standards, tagging items and/or using EPC RFID technology will find this document useful. This document provides guidance for the actions to be taken when a missing identification occurs in any part of the supply chain. It supports the usage of identification systems. See the introduction for a definition of missing identification.

It is assumed that readers of this document are proficient in developing bar code and EPC applications and understand the basic principles of Automatic Identification Data Capture and Radio Frequency Identification Application. This document limits itself by not providing recommendations related specifically to any sector.

This version of the Guide only has the SGTIN and the 96 bit tag in scope. Future versions of the document could investigate larger tags and also other numbering schemes if required.

## How to use this document?

The main body of this document should be used sequentially without skipping any sections. The main body is composed of six use cases.

This document is an implementation guide that will be updated as GS1's standards evolve. Some use cases do not have a finalized implementation strategy due to the appropriate standards not yet in place. A change request has been raised, and this guide will be updated when the standards become available. While this document covers information about use cases of missing identification, it does not include information on the following topics.

- Future standards possibilities or draft work on non-complete standards
- Guidance on implementation/piloting of any RFID system
- Solutions to a technical problem on reading/scanning of a(n) bar code/ EPC RFID tag

Some information in this document is copied from the GS1 General Specifications version 9.0 and the GS1 *EPCglobal Tag Data Standards v1.4*, which are the latest published versions of these documents at the time of writing. In case there are inconsistencies between this document and future versions of Specifications or the Tag Data Standards, the General Specifications and the Tag Data Standards always take precedence.

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About EPCglobal Inc: EPCglobal Inc is a subsidiary of the global not-for-profit standards organization GS1, and supports the global adoption of the Electronic Product Code as industry-driven standards to enable accurate, immediate and cost-effective visibility of information throughout the supply chain.

For more information about EPCglobal Inc, visit: www.epcglobalinc.org

## Where to get more information

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# 1. Introduction

The purpose of this guideline is to provide use cases and possible solutions to resolve the issue of missing serialised identification. This implementation guideline provides advice when there is (lost) missing serialised item level identification in any stage of the supply chain, hence the term Missing Identification. Situations that are considered to be Missing Identification include: when an identification unit (tag or bar code) gets lost or in the case of EPC RFID the tag no longer responds or when the source is not interested in serialised identification of items but further downstream there is a need for serialised identification, then parties upstream will have difficulty making sure that the serial number is unique.

Unique Identification for items is achieved by a Global Trade Identification Number (GTIN) in combination with a unique serial number. If a batch number or logistic information gets lost on the way, it is not as crucial as when the GTIN and serial number combination gets lost because this combination uniquely identifies the item, when this information is lost, the benefits of serialisation can no longer be realised.

Serial numbers provide additional information on an item. For example, every game console has a unique identification number. This number can be used to prove ownership through registration, and it can maintain a purchase relationship. It can also be used for any time-warranty or recalls to identify parts for a console.

Serialisation can be used in quality control. In manufacturing, lots can be defective or contaminated. Serialisation allows the product to be recalled based on the specific products within the batch. A real world example is when prescription drugs or food items are recalled as they pose a health risk to the community.

Unique Identification can also be used to identify fraudulent or pirated items. The issuer chooses how the additional serialised information is constructed. Rules govern the size and format of the number.

The computer has simplified the tracking process considerably and thus, companies that may not have used serial numbers in the past now do so readily.

The implementation guideline can be used by any company using or considering to use GS1 Identification represented in EPC RFID tags or GS1 Bar Codes. The implementation guidelines are applicable to all parties involved in supply chain as well as the 3rd party logistics providers and solution providers.

# 2. Scope

This document suggests processes to handle use cases where a serialised EPC RFID tag and/or bar code need to be replaced (or added) after an item leaves its source.

The primary focus of this guideline is the Serialised Global Trade Item Number (SGTIN). The GTIN is the GS1 Identification Key used to identify trade items. The key consists of a GS1 Company Prefix followed by an Item Reference Number and a Check Digit. To get an SGTIN a serial number is added. The other keys, especially Serial Shipping Container Code - which is the key to identify logistic items - may follow during the next publication cycle of this document. The latest status of this document series is maintained at GS1. Please download the latest version from the website www.gs1.org/publications.


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## 2.1. The Guideline Assumptions

To be able to propose applicable solutions to the use cases, the following assumptions were taken into account:

1. If a serial number exists initially, it is the GS1 Company Prefix registrant (brand owner) who has serialised the object.
2. Currently all companies can provide serial numbers. Every company can make its own decision to serialise the object. The company's status, whether it is the source or the destination, would not be clear with respect to the Supply Chain.
3. As stated in the EPCglobal Tag Data Standard (TDS) the Serialised GTIN (SGTIN), EPC is equivalent to the combination of AI (01) and AI (21) as defined in the GS1 General Specifications.
4. If there is a RFID tag containing a serialised GTIN (SGTIN) EPC, the SGTIN EPC does match the original GTIN and serial number in the bar code and Human Readable (HR).

   **Note:** Be aware that there might be other information on the products such as a secondary manufacturer's number in other types of bar codes or in Human Readable form. This is outside of the scope of this document.

5. If there is an RFID tag, it carries a 96-bit EPC. The most commonly used tag at this stage is the 96-bit EPC, even though an RFID tag now can carry more data (i.e. SGTIN-198 etc.).
6. Externally-accessible EPCIS Services are not yet implemented by all parties using this guideline.
7. The vision of the EPCglobal standards includes all information on items carrying an EPC RFID tag being stored in EPCIS Services and that this information can be queried by companies that are authorised to do so via Discovery Services. This storing and sharing of information could help solving some of the issues in this guideline. Nevertheless, because at the time of writing, implementation of EPCIS Services is not yet widespread and the Discovery Services are still in development, other solutions are considered. Further versions of this document will be enhanced to include these options.

# 3. Basic definitions

The information in this section is based on the *GS1 General Specifications v9.0* and the *GS1 EPCglobal Tag Data Standards v1.4*, which are the latest published versions of these documents at the time of writing. In case there are inconsistencies between this document and future versions of the General Specifications or the EPCglobal Tag Data Standards, the General Specifications and the EPCglobal Tag Data Standards always take precedence.

## 3.1. Basic Definition of a GTIN

A trade item is any item (product or service) upon which there is a need to retrieve pre-defined information and that may be priced, ordered, or invoiced at any point in any supply chain. This definition covers services and products, from raw materials through end user products, all of which may have pre-defined characteristics.

The identification and marking of trade items enables the automation of the Point-of-Sale (through Price Look Up (PLU) files), of goods receiving, inventory management, automatic re-ordering, sales analysis, and a wide range of other business applications.

If the item is of variable measure, the respective measure or price information will often be of critical importance to business applications. Attributes relating to trade items (e.g., dates, lot number) are also available as standardised element strings.


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Each trade item that is different from another in design and/or content is allocated an identification number (GTIN), which remains the same as long as it is traded. The same identification number is given to all trade items sharing key characteristics. Such numbers must be treated in their entirety throughout the supply chain.

**Table 3-1** Format of the Element String GTIN

| | I. Digit | GS1 Company Prefix → | | | | | | ← Item Reference | | | | | | Check Digit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GTIN-14 | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | $N_{14}$ |
| GTIN-13 | 0 | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | $N_{14}$ |
| GTIN-12 | 0 | 0 | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | $N_{14}$ |
| GTIN-8 | 0 | 0 | 0 | 0 | 0 | 0 | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | $N_{14}$ |

## 3.2. Basic Definition of an SGTIN

The Serialised Global Trade Item Number (SGTIN) is a representation of AI (01) and AI (21) based on the Global Trade Item Number (GTIN) code defined above. A GTIN by itself does not fit the definition of an EPC pure identity, because it does not uniquely identify a single instance of a physical object. Instead, a GTIN identifies a particular batch class of an object, such as a particular kind of product or Stock Keeping Unit (SKU).

All representations of SGTIN support the full 14-digit GTIN format. When an SGTIN is derived from a GTIN-13, GTIN-12, or GTIN-8, zero padding digits are used as illustrated in Table 3-1, above. See the EPCglobal Tag Data Standard for complete details.

The SGTIN is represented in information systems as an Internet Uniform Resource Identifier (URI) that looks like this:

`urn:epc:id:sgtin:`$N_2N_3N_4N_5N_6N_7N_8$`.`$N_1N_9N_{10}N_{11}N_{12}N_{13}$`.SSSSS`

A “dot” character separates the digits comprising the GS1 Company Prefix from the remainder of the GTIN, and another “dot” separates these from the serial number SSSSS. Note that the indicator digit $N_1$ (or zero pad for GTIN-13, GTIN-12, and GTIN-8) is inserted following the first of these “dots”. The check digit $N_{14}$ is not included in the SGTIN URI. In the example above, the separation between the GS1 Company Prefix and the remainder of the SGTIN occurs after digit $N_8$, but in general this separation could occur after $N_7$, $N_8$, $N_9$, $N_{10}$, $N_{11}$, $N_{12}$, or $N_{13}$. In all cases, however, the $N_1$ digit follows the first dot.

As described below when encoded on an RFID tag, the partition field is used to encode the length of the GS1 Company Prefix and hence, the position of this separation.

When encoded into an EPC RFID tag using the 96-bit binary encoding (SGTIN-96 encoding), the components of the URI string are encoded into the structure illustrated in Table 3-2.

**Table 3-2** Format of the SGTIN-96 binary encoding of the SGTIN used on 96-bit RFID tags

| Header | Filter Value | Partition | GS1 Company Prefix | Item Reference | Serial Number |
|---|---|---|---|---|---|
| 8 bits | 3 bits | 3 bits | 20-40 bits | 24-4 bits | 38 bits |

**Note:** Please refer to the *EPCglobal Tag Data Standards v1.4.*


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### The fields of the SGTIN-96 binary encoding are as follows:

- *Header* is 8-bits, with a binary value of 0011 0000 to indicate the SGTIN-96 encoding
- *Filter Value* is an additional data element that is used for fast filtering and pre-selection of basic logistics types. The Filter Value is not part of the EPC and is not encoded in a bar code. The normative specifications for Filter Values are specified in the EPCglobal Tag Data Standard. Table 3-3 below reproduces the table of Filter Values referenced in the *EPCglobal Tag Data Standards v1.4*.
- *Partition* is an indication of where the subsequent GS1 Company Prefix and Item Reference numbers are divided. The available values of Partition and the corresponding sizes of the GS1 Company Prefix and Item Reference fields are shown in table 3.4.
- *GS1 Company Prefix*, assigned by GS1 to a managing entity. This field contains a binary encoding of the digits of the EPC URI that precede the first "dot".
- The *Item Reference,* assigned by the managing entity to a particular object class. This field contains a binary encoding of the digits of the EPC URI that follow the first "dot". As noted earlier, these digits include both the indicator digit (or zero pad character, when the SGTIN is derived from a GTIN-13, GTIN-12, or GTIN-8) and the GTIN Item Reference.
- The *Serial Number*, assigned by the managing entity to an individual object. This field contains a binary encoding of the digits of the EPC URI that follow the second "dot". The serial number is not part of the GTIN, but is formally a part of the SGTIN. In a bar code, the serial number is encoded using AI (21) and never starts with one or more zeros, see section 3.3.

**Table 3-3** SGTIN Filter Values

| Type | *Binary Value* |
|---|---|
| All Others | 000 |
| Retail Consumer Trade Item | 001 |
| Standard Trade Item Grouping | 010 |
| Single Shipping/Consumer Trade Item | 011 |
| Inner Trade Item Grouping not to be sold at POS | 100 |
| Reserved | 101 |
| Reserved | 110 |
| Reserved | 111 |

**Table 3-4** SGTIN Partitions

| Partition Value (P) | GS1 Company Prefix | | Indicator Digit and Item Reference | |
|---|---|---|---|---|
| | Bits | Digits | Bits | Digits |
| 0 | 40 | 12 | 4 | 1 |
| 1 | 37 | 11 | 7 | 2 |
| 2 | 34 | 10 | 10 | 3 |
| 3 | 30 | 9 | 14 | 4 |
| 4 | 27 | 8 | 17 | 5 |
| 5 | 24 | 7 | 20 | 6 |
| 6 | 20 | 6 | 24 | 7 |


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The serialised identification of trade items, which enables total connectivity of information and communication systems, is achieved through the use of Application Identifier AI (01) GTIN and AI (21) Serial Number.

## 3.3. The serial number in an SGTIN-96 binary encoding of an SGTIN

When representing serial numbers in a 96-bit EPC RFID tag using the SGTIN-96 binary encoding, only a subset of the serial numbers allowed in the GS1 General Specifications for AI (21) is permitted. Specifically, the permitted serial numbers are those consisting of one or more digits with no leading zeros, and whose value, when considered as an integer, is less than 274,877,906,944 (two to the 38th power). The serial number range is restricted to numeric values and alphanumeric serial numbers are disallowed. Leading zeros are forbidden so that the serial number can be considered as a decimal integer when encoding the integer value in binary. By considering it to be a decimal integer, "00034", "034", or "34" (for example) cannot be distinguished as different integer values. In order to insure that every encoded value can be decoded uniquely, serial numbers in the SGTIN-96 encoding cannot have leading zeros. Therefore, when the bits 00000000000000000000010010 on the tag are seen, the serial number as "34" (not "034" or "00034") is decoded.

The SGTIN-198 binary encoding is capable of representing any serial number allowed for AI (21). However, many EPC RFID tags today lack the memory capacity to hold an SGTIN-198 encoding and so this document assumes that only SGTIN-96 encodings are used.

**Note:** Application authors and database designers should take the GS1 specifications for Application Identifier (21) into account in order to accommodate the full range of allowed serial numbers.

## 3.4. How to create a GTIN using an SGTIN

The GTIN can be constructed from the SGTIN. After extracting the individual parts of the SGTIN, one can find the Indicator Digit (or filler zero if this digit is a 0), GS1 Company Prefix, Item Reference, and Serial Number. The check digit can then be calculated for the GTIN, see 3.5.

**Figure 3-1** Finding out the GTIN from an SGTIN format

EPC Tag data (bit length 96):

001100000011000000100101011110111111010001101101101101100100000000000000000000000000000110010000

| EPC | Header | Filter | Partition |
|---|---|---|---|
| bits | 00110000 | 001 | 100 |
| bit length | 8 | 3 | 3 |

| | GS1 Company Prefix | Indicator/ and Item Reference | Serial Number |
|---|---|---|---|
| bits: | 000010010101111011111101 | 00011011011011011001 | 00000000000000000000000000000110010000 |
| bit length | 24* | 20* | 38 |
| digits: | 0614141 | 112345 | 400 |

* depends on Partition value


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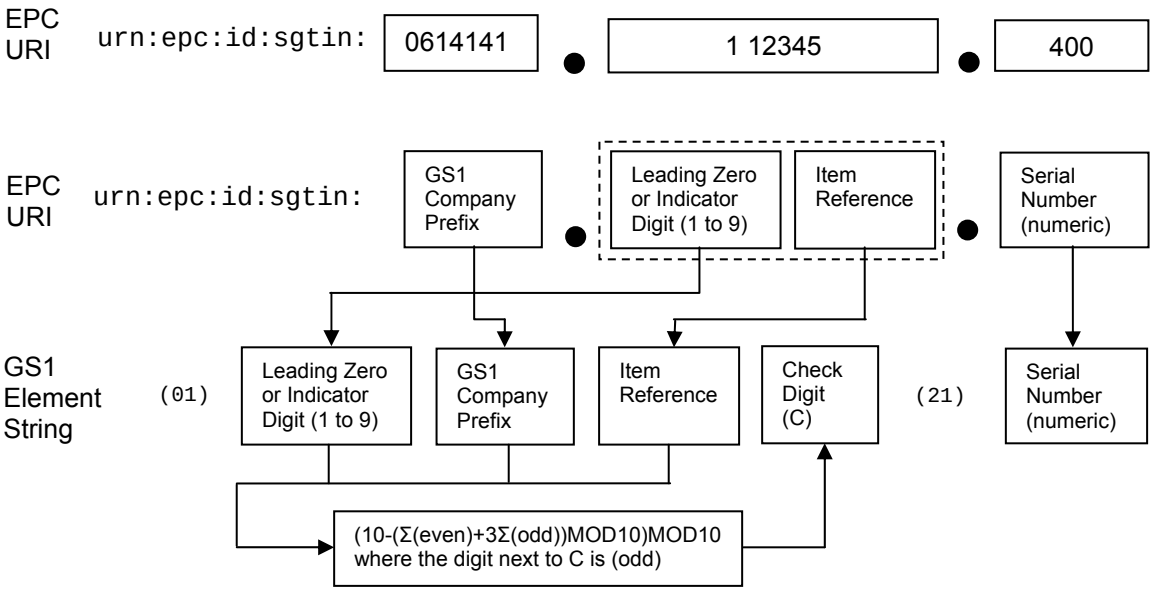
EPC URI `urn:epc:id:sgtin:0614141.112345.400`

EPC URI `urn:epc:id:sgtin:0614141.112345.400`




GS1 DataBar Expanded Bar Code Symbol *

(01)10614141123459(21)400

* This document talks about GTIN + serial number on a product scanned at point of sale. The most appropriate bar code for this application will be the GS1 DataBar. By 2010 GS1 DataBar standards will be available for bilateral agreement between trading partners for all trade items. By the target date of 2014 GS1 DataBar standards, including attribute information (using AIs), can be used by all trading partners in an open environment. At a minimum, retailers should be able to scan a GS1 DataBar and process the GTIN to the database. There are also other forms of the GS1 DataBar then the version shown here. More information on the GS1 DataBar is available on www.GS1.org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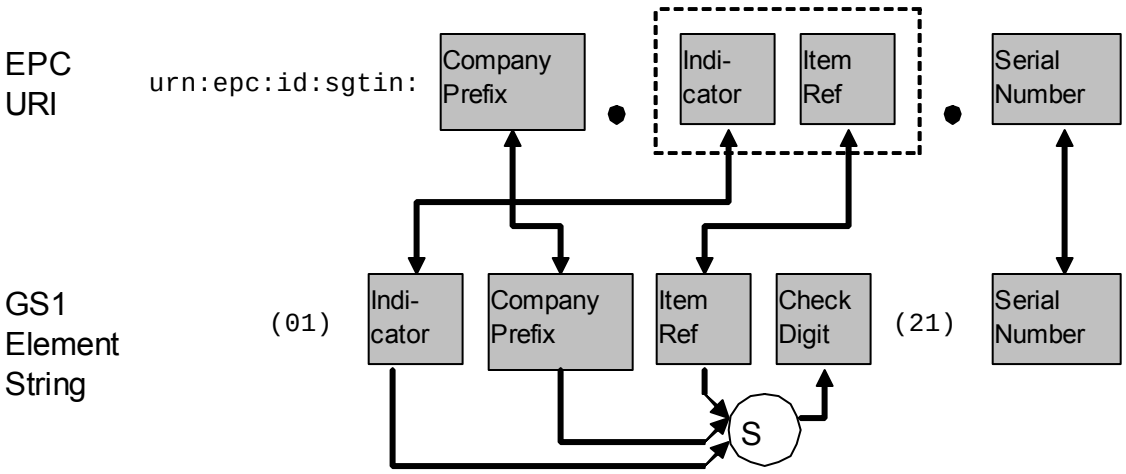


This diagram is the general way to translate a SGTIN to a GTIN. For the specific forms of the GTIN there might be additional actions needed:

| | |
|---|---|
| GTIN-12: | Delete 2 leading zeros |
| GTIN-13 | Delete 1 leading zero |
| GTIN-8 | Delete 6 leading zeros and the zero filled indicator digit. |
| Symbols that use the AI structure e.g. GS1 DataBar: | Add (01) as the AI for the GTIN. |

## 3.5. How to calculate the Check Digit

The Check Digit verifies reading and decoding of bar code symbols as well as Global Trade Item Numbers (GTINs). This is performed automatically by the bar code reader.

The Check Digit is calculated by using the table below:

**Table 3-5** Check Digit Calculation Table

| | **Digit Positions** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GTIN-8 | | | | | | | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | |
| GTIN-12 | | | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | |
| GTIN-13 | | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | |
| GTIN-14 | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | $N_6$ | $N_7$ | $N_8$ | $N_9$ | $N_{10}$ | $N_{11}$ | $N_{12}$ | $N_{13}$ | $N_{14}$ | |
| | | | | | | | | | | | | | | | |
| | Multiply Value of each position by | | | | | | | | | | | | | | |
| | X3 | X1 | X3 | X1 | X3 | X1 | X3 | X1 | X3 | X1 | X3 | X1 | X3 | | |
| | Accumulated results = sum | | | | | | | | | | | | | | |
| | Subtract sum from nearest equal or higher multiple of ten = Check digit → | | | | | | | | | | | | | | |


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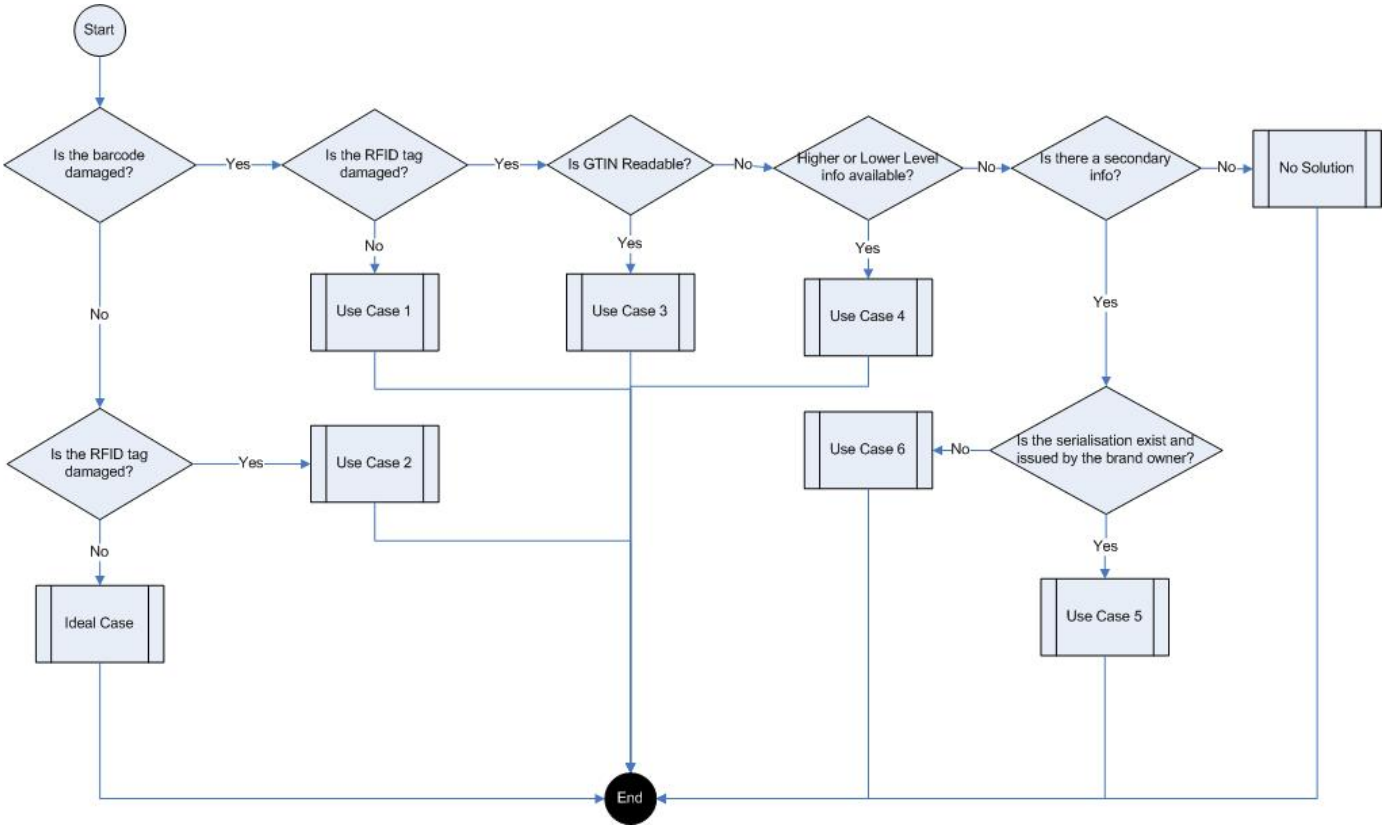
## 3.6. How to represent the Human Readable

The Human Readable digits shall be printed underneath the main symbol. It needs to be in readable font, and printed underneath the bar code. The specifications for the HR are in the GS1 General Specifications.

For additional information on EPC and Human Readable please refer to the section 5.3.6.

# 4. Flow Chart (Decision Tree)

**Figure 4-1** Flow Chart of the Use Cases





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# 5. Business Use Cases

## 5.1. General Overview of the Use Cases

**Table 5-1** Use Case Requirements Table

| Use Case | Action |
|---|---|
| 1 | GTIN + Serial Number (S/N) Needed from functional RFID tag (i.e. to make bar code) |
| 2 | EPC needed from GTIN + S/N (i.e. to make RFID from bar code or HR) |
| 3 | S/N needed from GTIN (i.e. recover S/N to make RFID and/or bar code) |
| 4 | GTIN + S/N needed from related information (e.g. pallet tag) |
| 5 | GTIN needed from secondary information (e.g. S/N, batch number) |
| 6 | S/N needed from GTIN in bar code or HR on item that never had S/N |
| 7 | GTIN or SGTIN needed from related info on item that never had S/N |
| 8 | GTIN or SGTIN needed from secondary info on item that never had S/N |

**Table 5-2** Use Case Definitions Table

| Current Status of the Item | Starting Condition of the item | |
|---|---|---|
| | GTIN + S/N at factory | GTIN only at factory |
| GTIN + S/N in RFID only | **1** | |
| GTIN + S/N in bar code or HR only | **2** | |
| GTIN in bar code or HR only | **3** | **6** |
| Everything lost, only related info[1] | **4** | **7**[2] |
| Everything lost, only secondary info[3] | **5** | **8**[4] |

## 5.2. Use Case 1: Damaged Bar code, Readable EPC RFID tag

### 5.2.1. Business Opportunity

In this use case, a company is using both the bar codes and RFID system in parallel. Regardless of the primary identification system, if one fails the other could be used to retrieve information. The primary identification system is based on bar codes. If the primary identification system, i.e., bar coding, fails; it is crucial to be able to continue the process with an EPC RFID tag based system. The primary identification system; however, should be restored.

### 5.2.2. Basic Scenario

A product has been tagged and serialised by the brand owner. Meanwhile, the recipient realised that the bar code is damaged or missing. The recipient notices that the EPC in the RFID tag is available and working. The only requirement is that a new bar code and/or a human readable need to be generated from the RFID tag.

[1] E.g., Logistics label, shipping manifest
[2] Throughout the rest of the document this use case will be considered as part of the use case 6.
[3] E.g., S/N, lot/batch numbers, package graphics, marketing information
[4] Throughout the rest of the document this use case will be considered as part of the use case 6.


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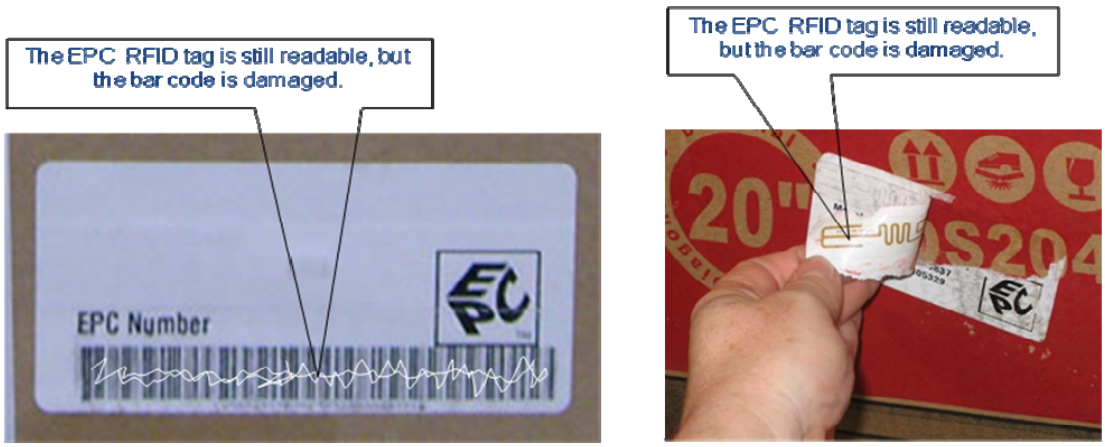
### 5.2.3. Example

**Figure 5-1** Damaged Bar code, Readable EPC RFID tag




### 5.2.4. Recommendations

First, determine the application (thereby, the appropriate symbology). For example for Point of Sale (POS) systems, a GTIN-8, GTIN-12 or GTIN-13 in EAN/UPC should be encoded as appropriate. After testing whether the EPC RFID tag works, convert the data content from the SGTIN to a GTIN in order to encode it to a bar code symbology. Step by step explanation of the solution: (for more details see the explanations in section 3)

1. Use GS1 Company Prefix, indicator digit (or filler zero) and item reference fields to create the GTIN of the product.
2. Calculate the check digit to finalize the construction of GTIN.
3. Create Human Readable form of the GTIN.
4. Print EAN/UPC bar code. (See the GS1 General Specifications for directions on how to print a bar code).

## 5.3. Use Case 2: Damaged EPC RFID tag, Readable Bar code

### 5.3.1. Business Opportunity

This example is the reverse situation of use case 1 (see section 5.2). In this use case, a company is also using both bar codes and an EPC RFID system in parallel. Regardless of the primary identification system, if one fails the other could be used to retrieve information. Nevertheless in this situation, the primary identification system is based on EPC RFID tags.

### 5.3.2. Basic Scenario

A product has been tagged and serialised by the brand owner. However, the recipient realised that the EPC RFID tag is damaged, missing, or not reading. The recipient notices that on the label or an additional label, the GTIN plus serial number and/or human readable is available. The assumption here is that an SGTIN is recoverable from the bar code or human readable.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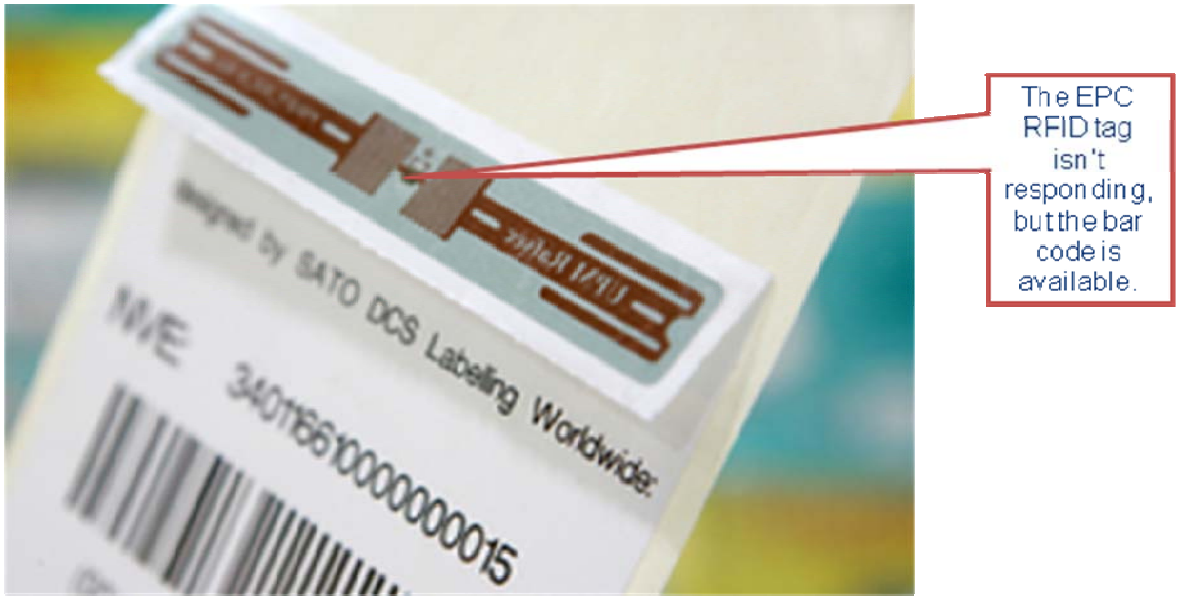
### 5.3.3. Example

**Figure 5-2** Damaged EPC RFID tag, Readable Bar code




### 5.3.4. Recommendations

**Step by step explanation of the solution:**

1. Validate the readability, if the tag cannot be read, proceed to the next step.

   First, check the distance and confirm if the tag is within the read range. The distance from which a tag can be read is called its read range. Read range depends on a number of factors, including the frequency of the radio waves used for tag-reader communication, the size of the tag antenna, the power output of the reader. If the size of the UHF antenna is reduced, that will also dramatically reduce the read range. Try to read the tag much closer to the reader and in different orientations.

   Secondly, make sure the right filter value in the reader is set, or that the reader is set to read any filter value, as this can be necessary to detect the missing tag. The normative specifications for Filter Values are specified in the Tag Data Standards and values are in Table 3-3 SGTIN Filter Values.

   Finally, if it is determined that the tag does not read, a new tag should be made.

2. Create an SGTIN using the GTIN and the serial number in the bar code or/and Human Readable.

   See section 3.2 and 3.3 for more information. Note that the bar code or/and the HR do not give information on the length of the GS1 Company Prefix. See section 5.3.5 for more information on this issue.

3. Program and affix a new tag containing the SGTIN, and remove the old tag to avoid confusion. Share the new TID (Tag Identification) with the relevant parties if downstream parties rely on the (serialised) TID in this application. One should be aware that if the tag has been replaced with a different serialised TID, then the consequences for the downstream applications relying on the serialised TID must be considered (an example is using the TID as part of an anti-counterfeiting method).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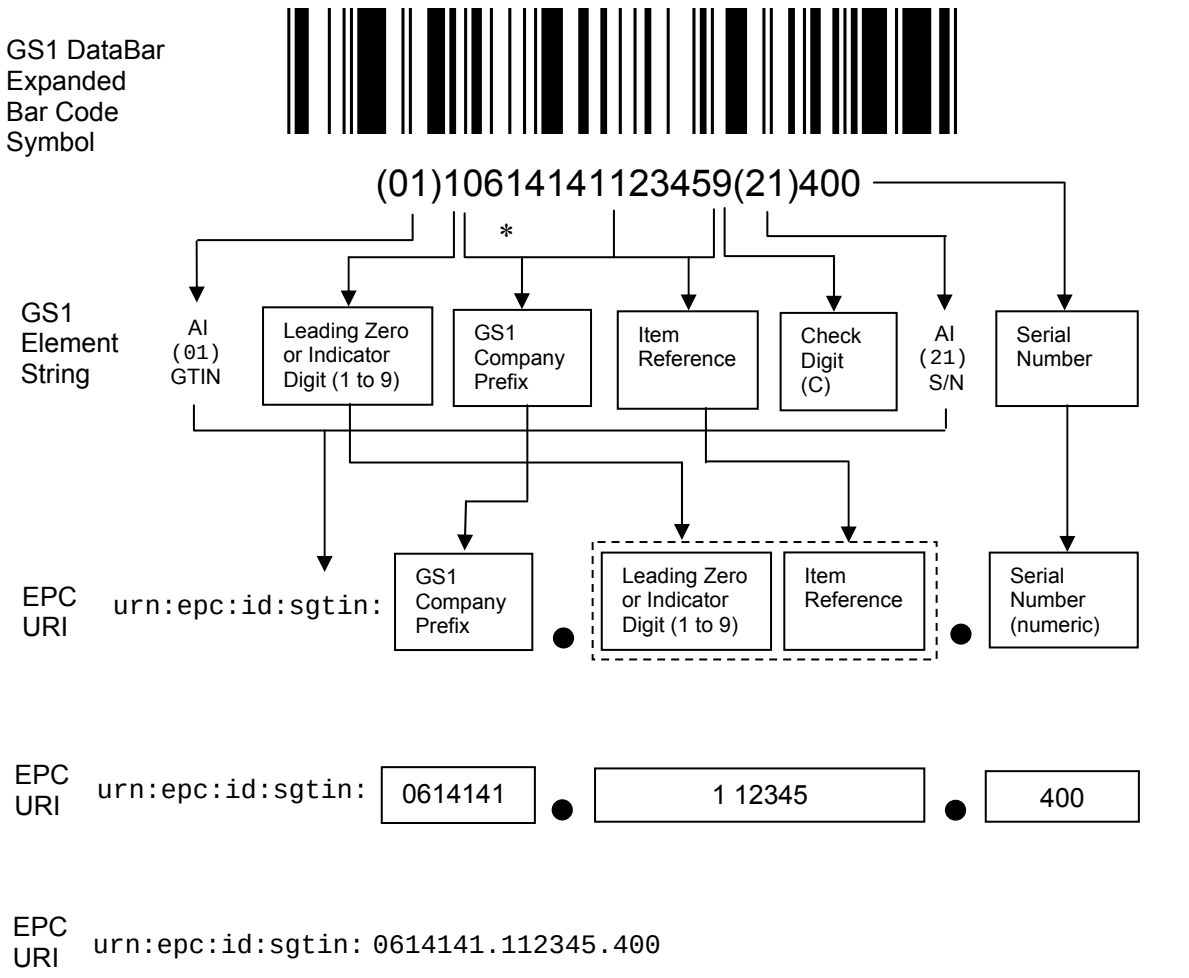
### 5.3.5. How to create an SGTIN using a GTIN and serial number read from a bar code/and human readable

An SGTIN carries a serial number in addition to the GTIN. In an EAN/UPC bar code only the GTIN is encoded. In all other GS1 Bar Codes, the GTIN would be represented as AI (01) and the serial number as AI (21). This document talks about GTIN + serial number on a product scanned at point of sale. The most appropriate bar code for this application will be the GS1 DataBar. By 2010 GS1 DataBar standards will be available for bilateral agreement between trading partners for all trade items. By the target date of 2014 GS1 DataBar standards, including attribute information (using AIs), can be used by all trading partners in an open environment. At a minimum, retailers should be able to scan a GS1 DataBar and process GTIN to the database. There are also other forms of the GS1 DataBar then the version shown here. More information on the GS1 DataBar is available on www.GS1.org.

**Figure 5-3** Finding out an SGTIN from a GTIN format




*if the GS1 Company Prefix is unknown, the leading digits of the GTIN need to be compared with a data base of GS1 Company Prefixes in order to determine the number of digits in the GS1 Company prefix for the EPC URI and to encode the Partition Bits in an EPC Tag.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EPC URI urn:epc:id:sgtin: 0614141.112345.400

Encoding the EPC URI into a 96-bit EPC tag:

EPC Header bits: SGTIN is eight bits ”00110000” from table in TDS

Filter bits: Unknown so set three bits to ”000”

Partition bits: GS1 Company Prefix is seven digits so the three partition bits are “001” from table in TDS

GS1 Company Prefix bits :“0614141” in binary is “000010010101111011111101” left-zero filled to 24-bits

Leading Zero or Indicator Digit and Item Reference bits: “112345” in binary is “00011011011011011001” left-zero filled to 20-bits

Serial Number bits: “400” in binary is “110010000” and when left-zero filled to a fixed length of 38-bits is “00000000000000000000000000000110010000”

EPC Tag Data (96 bits = 8 + 3 + 3 + 24 + 20 + 38):

001100000011000000100101011110111111010001101101101101100100000000000000000000000000000110010000

**Note:** There are some restrictions concerning encoding an AI (21) in a 96-bit tag e.g. alpha characters are not allowed. In use case 2 an EPC RFID tag was encoded with a proper serial number. For more information about the restrictions, see section 3.3.

**Note:** see TDS for additional encoding rules beyond the EPC data itself.

**Note:** To encode header, filter and partition values review section 3.2. The following additional areas require close attention: the filter value and partition value parts.

The intended use of the filter value is to allow an EPC RFID reader to select or deselect the tags corresponding to certain physical objects, to make it easier to read the desired tags in an environment where there may be other tags present. For example, if the goal is to read the single pallet tag, and it is expected that there may be hundreds or thousands of item-level tags present, the filter value can be used to select all the pallet tags and ignore the item level tags. The filter value is not encoded in a bar code symbol. Unless there is specific knowledge of the original filter value, encode filter value “000”.

Determining the partition value requires additional information beyond what is available in the bar code. The GS1 standards for the encoding of GS1 Identification Keys into bar codes, as well as for their use within associated data processing software, stipulate that the digits comprising a GS1 Identification Key should always be processed together as a unit, and not parsed into individual fields. This is different in EPCglobal standards; however, as the ability to divide a code into the part assigned to the managing entity (the GS1 Company Prefix in GS1 System types) versus the part that is managed by the managing entity (the remainder) is essential to the proper functioning of the Object Name Service (ONS). Hence, the conversion from a GTIN to an SGTIN encoding requires independent knowledge of the length of the GS1 Company Prefix.

If a new tag is required, some look-up service is needed in order to determine the partition bits. This can be done via a file of all GS1 Company Prefix numbers in order to determine the partition bits. Consultation with this database is necessary (either on-line e.g. ONS, GEPIR or stored in a database) unless parties in the supply chain (e.g. the retailer or the distributor) can check their internal databases


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to find the GS1 Company Prefix of the brand owner. GS1 is working on defining a lookup solution for all parties using the GS1 System. In many cases, a party may look up the GS1 Company Prefix in a smaller table the party constructs itself from known data. For example, in a setting where a manufacturer is only processing tags on its own products, a table that just enumerates the GS1 Company Prefixes assigned to that manufacturer suffices in place of the full table. Likewise, a distributor or retailer may use a table that includes the GS1 Company Prefixes of its known upstream manufacturers. In all cases, it is only necessary to have a list of valid GS1 Company Prefixes in order to determine the partition bits. For example in the GTIN 80652642000311, the GS1 Company Prefix is "0652642" or seven digits, so from table 3-4, the partition value is "5" which is encoded on the EPC RFID tag as "101". For more information on how to encode the SGTIN, please refer to the EPCglobal Tag Data Standards SGTIN-96 Encoding Procedure.

### 5.3.6. How to print EPC as a Uniform Resource Identifier (URI) (optional)

Human Readable information of an EPC RFID tag is not mandatory required information, but to help with implementation the following is discussed:

Use Uniform Resource Identifiers (URI) for pure identities. These contain only the unique information that identifies a specific trade item or a logistic unit. The URI of an SGTIN is defined as:

**urn:epc:id:sgtin:CompanyPrefix.ItemReference.SerialNumber**

**Note:** The ItemReference field of the SGTIN includes the Indicator digit, appended to the beginning of the item reference. Check digits are not included in URI representations.

**Here is an example:**

**urn:epc:id:sgtin:0652642.800031.400**

The corresponding GTIN-14 code is 80652642000311. This divides as follows: the first digit “8” is the indicator digit, which appears as the first digit of the ItemReference field in the URI, the next seven digits (0652642) are the CompanyPrefix, the next five digits (00031) are the remainder of the ItemReference, and the last digit (1) is the check digit, which is not included in the URI. Finally, the remaining (400) is the serial number of the SGTIN. The corresponding human readable interpretation is (01)80652642000311(21)400 and the resulting GS1-128 bar code is shown in the figure below:

**Note:** For more information on URI forms of EPC, please refer to the latest version of EPCglobal *EPCglobal Tag Data Standards v1.4*, section URI Representation.


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## 5.4. Use Case 3: Only GTIN is available

### 5.4.1. Business Opportunity

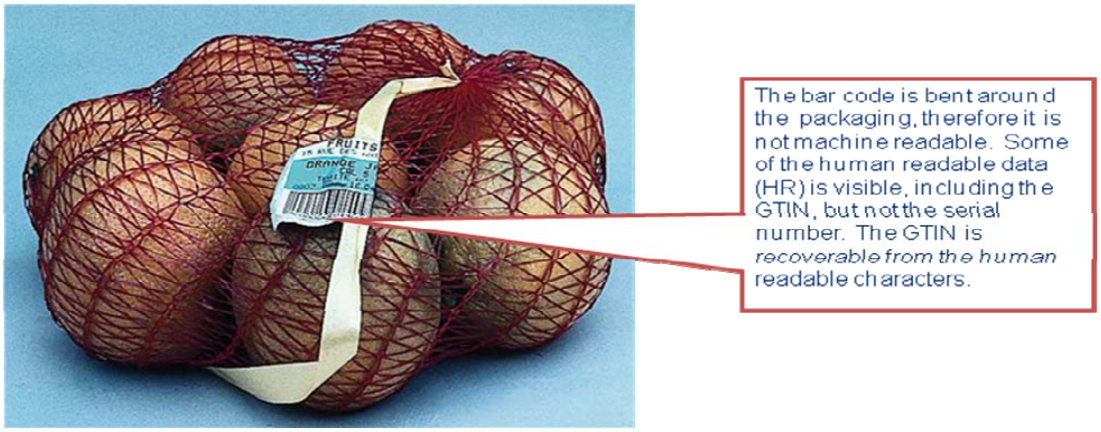
In the supply chain world, the GTIN might still be on the item in bar code or in Human Readable form, however the EPC RFID tag does not respond. The serial number (S/N) needs to be determined.

### 5.4.2. Basic Scenario

A product was serialised by the brand owner, but the S/N is lost, either because the S/N bar code is damaged or both the S/N bar code and the EPC RFID tag are unreadable. The GTIN is readable from the bar code or HR.

### 5.4.3. Example

**Figure 5-4** Damaged S/N + EPC RFID tag, Readable GTIN




### 5.4.4. Recommendations

Initially, try to determine the original serial number from other sources of information (i.e. order or inventory information). Where possible retrieve this information to recreate the bar code and/or the EPC RFID tag as described in Use Case 1 and 2. If the original serial number cannot be retrieved, the option could be to ask the brand owner to assign a new number.

In order to retrieve a new serial number, consult the brand owner. As the GTIN is known, the company can use the GEPIR system (see http://www.gepir.org) to find out the contact details of the brand owner or the details of the applicable GS1 Member Organisation that can give more information or it can use its internal supplier database. The Central serialisation would protect the uniqueness of the system. However, the downside of this option is that it is time consuming. Finding the correct brand owner, contacting the right person and obtaining the new serial number might not be feasible in some cases. If situations like this occur frequently, the brand owner can be asked to give a range of serial numbers to each partner, so they can assign one of these numbers when an serialised ID is missing.

After a new number has been assigned, the bar code and/or the EPC RFID tag can be recreated as described in Use Case 1 and 2.

Currently, more options are not available at this moment. The Missing Identification group has raised the need to be able to assign a unique serial number for the above use case in a way that is cost effective and efficient. GS1 will start a working group in the Global Standards Management Process (GSMP) to tackle the issue presented in the change request (CR number:09-000206). This change request highlights challenges that cannot be resolved in this document.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## 5.5. Use Case 4: Bar code Damaged, Readable Higher or Lower Level Information

### 5.5.1. Business Opportunity

The foundational business case for the very existence of logistics operations has always been to identify items with a system that can be read by everyone and everywhere. This use case presents a situation where the bar code is damaged but information about the item could be deduced from levels of packaging available either at a higher or lower level in the items hierarchy. How to retrieve information from these packaging hierarchies is explained below.

### 5.5.2. Basic Scenario

In this use case, the GTIN is missing, but there is information about a higher or lower level of the product (e.g. pallet or case). GTIN may be recoverable by association from an internal or an external database.

### 5.5.3. Example

**Figure 5-5** Bar code Damaged, Readable Lower Level Info

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## 5.5.4. Recommendations

The recommendation is to search for an association of a lower or higher level of product.

### 5.5.4.1. How to retrieve Information from a Higher or Lower Level Product

There are two basic levels of grouping. They are: Trade item level and logistics level. Each level is identified with a base of requirements specifically for that level. Retrieving the GTIN information from a higher level product may be possible when the GS1 System is used. The following is an example of how to reach the GTIN information from the logistics label.

**Figure 5-6** Higher Level (Logistic Label)

In this case from the Despatch Advice information, the missing number can be retrieved. For boxes where packaging identification is used, the indicator digit can be removed to determine the original GTIN. In addition a data pool can give the GTIN of a higher or lower level product.

Serialisation information retrieving is not possible from a higher or lower level product as serialisation is used to uniquely identify that item.

From a higher or lower level product only the GTIN can be retrieved. For further steps refer to Use Case 3.


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**Figure 5-7** Lower levels items are identified, but higher level information is missing.

## 5.6. Use Case 5: GTIN information missing, only Serial Number information is still available

### 5.6.1. Business Opportunity

As identification moves into the next steps of the supply chain, there are cases where identification disappears due to environmental effects. Examples can include mud on a bar code, a burned or non-responsive tag, etc. For this use case only the serial number is still available, for example in human readable form. The GTIN can be concluded for example by the Serial Number in combination with system information or information from the brand owner or the GTIN can be concluded by marketing information on the package.

### 5.6.2. Basic Scenario

As in this case there is no available information but the company graphics and the serial number. A product was tagged and serialised by the brand owner, but on the package or product both the GTIN bar code/HR are lost or not readable. All that remains is serial number, secondary data and/or package graphics.

The GTIN may be recoverable by using S/N, lot/Batch numbers and/or graphics in combination with information from systems or from the brand owner.


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### 5.6.3. Example

**Figure 5-8** No information is available.

### 5.6.4. Recommendations

The first step would be to determine the GTIN from the graphics. If it is not possible, then determine the company. This could be done by the label of the brand owner, contact details of the graphic text or the marketing information which is attached to the item.

The downstream party can contact the brand owner and provide product information from graphics (if any) and serial number or an appropriate reference source. Also the GTIN can be determined based on comparison with other products or database information. However, there is not a 100% chance that the GTIN can be retrieved.

Alternately the item can be opened to find the GTIN, however there is not a 100% chance that the GTIN can be retrieved. Once the GTIN is found proceed to the section 5.3.5, Use Cases 6: Only GTIN available downstream, No Serialisation

### 5.6.5. Business Opportunity

GTIN is available and no serialisation is present, but further downstream serialisation is required.

### 5.6.6. Basic Scenario

In this case the brand owner has not assigned a serial number but downstream within the supply chain there is a need for serialisation. The goal here is to keep the serial number unique. The original package has a GTIN in bar code with human readable.


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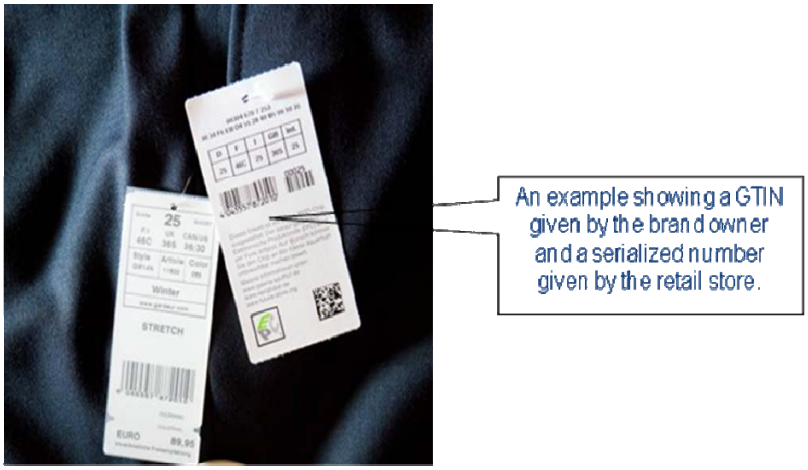
## 5.6.7. Example

**Figure 5-9** Serialisation is needed by downstream partner.




## 5.6.8. Recommendations

The ultimate challenge here is to keep the serial number unique. If serial numbers are not unique, serialisation benefits will not appear in the supply chain. In Use Case 6, the source (or the supplier) is not interested in serialisation.

For the purposes of this discussion, the "Brand Owner" is the party responsible for assigning a GTIN to a product, whether by creating a new GTIN based on a GS1 Company Prefix allocated to the Brand Owner or as it is possible in some countries by obtaining a "one off" GTIN from a GS1 Member Organization (MO). Check your GS1 Member Organisation (MO) to see what the possibilities are in your country (http://www.gs1.org/contact). There are several use cases where the serial number is required to be assigned by a party other than the Brand Owner (hereafter, a "Non Brand Owner" or "NBO").

### Variations of this use case include:

1. The Brand Owner had assigned a serial number and affixed to the product, but the tag fell off or became inoperable. (See Use Case 1.)
2. The Brand Owner is expected to serialise the product, but omitted to do so.
3. The Brand Owner does not wish to serialise, but downstream partners do – e.g., in the book industry it has been postulated that many booksellers wish to have serialised tagged books, but currently the publishers are not willing to serialise or even coordinate the serialisation.
4. Private label goods that are manufactured and serialised by multiple contract manufacturers. The Brand Owner is the party that owns the private label (e.g., a retailer's store brand), but the serialisation is done by the contract manufacturers (NBO's). This situation is described in the Multi sourcing EPC assignment document, http://www.epcglobalinc.org/standards/implementation_guidelines.

This use case describes a variation of Use Case 3. A first step that could be taken in this situation is to encourage the brand owner to serialise. If the brand owner cannot be convinced, then the Non-brand owner (NBO) is the party that will be assigning a serial number. The challenge is to keep the serial number unique. For example for a specific GTIN there can be more than one NBO that assigns a serial number.

Currently, the GS1 standards do not have a recommendation for this use case. The group has defined a Change Request that is submitted into GSMP (CR number: 09-000206). To help the CR being resolved the group also defined Business Requirements for possible solution(s).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# 6. Glossary Terms and Definitions

The following glossary was updated for the Nov-2009 publication of this document. Please refer to the glossary in the GS1 GDD (http://gdd.gs1.org/GDD/public/searchableglossary.asp) for the latest version.

| Term | Definition |
|---|---|
| Add-On Symbol | A bar code symbol used to encode information supplementary to that in the main bar code symbol. |
| Alphanumeric (an) | Describes a character set that contains alphabetic characters (letters), numeric digits (numbers), and other characters, such as punctuation marks. |
| Antenna | The conductive element that enables a RFID tag or reader to send and receive data via radio frequency. |
| Automatic Identification and Data Capture (AIDC) | A technology used to automatically capture data. AIDC technologies include bar code symbols, smart cards, biometrics and RFID. |
| Bar code | A standard method of identifying the manufacturer and product category of a particular item. The bar code was adopted in the 1970s because the bars were easier for machines to read than optical characters. Unlike RFID tags, direct line of sight is required to read bar codes. |
| 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. |
| Brand Owner | The party that is responsible for allocating GS1 System numbering and bar code symbols on a given trade item. The administrator of a GS1 Company Prefix. |
| Check Digit | A digit calculated from the other digits of an Element String, used to check that the data has been correctly composed. (See GS1 Check Digit Calculation.) |
| Company Number | A component of the GS1 Company Prefix. GS1 Member Organizations 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 organizations, governmental agencies, and business units within organizations. Criteria to qualify for the assignment of a GS1 Company Prefix are set by the GS1 Member Organizations. |
| EAN-13 Bar Code Symbol | A bar code symbol of the EAN/UPC Symbology that encodes GTIN-13, Coupon-13, RCN-13, and VMN-13. |
| Electronic Product Code RFID tag(EPC RFID tag) | RFID tag that complies with the EPCglobal standard and contains an Electronic Product Code. |
| Element String | The combination of a GS1 Application Identifier and GS1 Application Identifier Data Field. |
| EPCglobal Inc™ | A joint venture between GS1 and GS1 US. EPCglobal is a neutral, not-for-profit organization entrusted by industry to establish and support the Electronic Product Code and the global adoption of the EPCglobal Network. |


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| Term | Definition |
|---|---|
| EPCglobal Network | The EPCglobal Network is a community of trading partners engaged in the capture, sharing and discovery of Electronic Product Code-related data using EPCglobal-certified hardware and software components and standard interfaces. |
| Filter Value | Three bits used to reject unwanted RFID reads. |
| Global Standards Management Process | GS1 created the Global Standards Management Process (GSMP) to support standards development activity for the GS1 System. The GSMP uses a global consensus process to develop supply chain standards that are based on business needs and user-input. |
| Global Trade Item Number (GTIN) | The GS1 Identification Key used to identify trade items. The key is comprised of a GS1 or U.P.C. Company Prefix followed by an Item Reference Number and a Check Digit. |
| GS1 | GS1 is a leading global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across sectors. The GS1 system of standards is the most widely used supply chain standards system in the world. |
| 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 GS1 Member Organisations. |
| 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 user companies 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. |
| GS1 System | The specifications, standards, and guidelines administered by GS1. |
| GS1-128 Bar Code Symbology | A subset of the Code 128 that is utilised exclusively for GS1 System data structures. |
| 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-8 | The 8-digit GS1 Identification Key composed of a GS1-8 Prefix, Item Reference, and Check Digit used to identify trade items. |
| Header | Identifies the structure of an Electronic Product Code™ (EPC), when encoded in binary on an RFID tag. |
| Human Readable Interpretation | Characters that can be read by persons, such as letters and numbers, as opposed to symbol characters within bar code symbols, which are read by machines. |
| Indicator | A digit from 1 to 9 in the leftmost position of the GTIN-14. |


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| Term | Definition |
|---|---|
| Item (Retail) | The lowest level of the packaging hierarchy intended or labelled for individual retail sale. |
| 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. |
| MIR | Missing Identification Resolution Working Group |
| Object Naming Service (ONS) | A directory based on the worldwide Internet Domain Name System (DNS). ONS provides a means to look up pointers to information resources for an Electronic Product Code (EPC), where those pointers are registered by the company or entity responsible for creating (commissioning) the EPC. Typically ONS only refers to information resources operated by the<br>commissioning company, and not resources operated by other supply chain participants who may have information about a given EPC (see<br>Discovery Services). ONS does not contain actual data about the EPC; it only contains the network address where data resides, for example, a Uniform Resource Locator (URL) that refers to an EPC Information Services<br>(EPCIS) service operated by the company that commissioned the EPC. |
| Partition Value | Three bits to find GS1 Company Prefix in GTIN |
| Point-of-Sale (POS) | Refers to the retail type checkout where bar code symbols are normally scanned. |
| 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 | A method of automated identification using electronic tags capable of receiving/storing and/or transmitting digital information by means of, and in response to, RF energy. |
| Radio Frequency Identification (RFID) | 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. |
| Reader | A device that communicates with RFID tags. Readers encode commands to send to tags, and decode responses from the tags. Readers communicate with tags by modulating the encoded commands on to waveforms to send to tags and by demodulating the replies from waveforms that the reader receives back from the tags. Readers send the decoded tag responses to software systems, typically for subsequent business analysis. Readers and interrogators are the same thing. |


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| Term | Definition |
|---|---|
| RFID tag | A microchip attached to an antenna that sends data to an RFID reader. The RFID tag contains a unique serial number, and can also contain additional data. RFID tags can be active, passive or semi-passive tags. |
| Serial Number (S/N) | A code, numeric or alphanumeric, assigned to an individual instance of an entity for its lifetime. |
| Solution Provider | An individual or company that enables supply chain functions through the provision of products and services. Includes hardware and software companies, consultants, system integrators, and training companies. |
| Standard | A specification for hardware, software, or data that is either widely used and accepted (de facto) or is sanctioned by a standards organization (de jure). |
| 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 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. |
| Symbology | A defined method of representing numeric or alphabetic characters in a bar code; a type of bar code. |
| Tag | See RFID tag. |
| Tag ID (TID) | Tag-identification or Tag identifier, depending on context |
| 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. |
| 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. |
| UPC-A Bar Code Symbol | A bar code symbol of the EAN/UPC Symbology that encodes GTIN-12, Coupon-12, RCN-12, and VMN-12. |
| UPC-E Bar Code Symbol | A bar code symbol of the EAN/UPC Symbology representing a GTIN-12 in six explicitly encoded digits using zero-suppression techniques. |
| User Memory | Area of tag memory which is not confined to specific data content and/ or layout. Can be used to store data in a pre-determined standard content and/or format. Can also be used to store private data not intended for general interpretation. |


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# 7. Normative reference documents

The documents listed below are either directly or indirectly quoted within the document

- GS1 General Specifications v9.0 – Issue 1, Jan 09
- GS1 EPCglobal Tag Data Standard (TDS) version 1.4
- Multi-sourcing EPC Assignment Implementation Guide 1.7
- EPCglobal Glossary, located at: http://www.epcglobalinc.org/home/GS1_EPCglobal_Glossary_V34_KS_May_11_2009.pdf


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