

Tips on Encoding the Unique Item Identifier (UII) Mark and Building the Concatenated UII

BASIC DEFINITIONS YOU NEED TO KNOW

The unique item identifier (UII) is defined in two separate contexts:

1. DoD UII Data Set. A UII is a set of data elements marked on an item in a Data Matrix EC200 symbol that is globally unique and unambiguous. For items that are serialized within the enterprise identifier, the UII data set includes the data elements of (a) enterprise identifier and (b) a unique serial number (Construct #1). For items that are serialized within the part, lot or batch number within the enterprise identifier, the UII data set includes the data elements of (a) enterprise identifier, (b) the original part, lot or batch number, and (c) the serial number (Construct #2). In addition to the two constructs, the UII data set may be a fully concatenated UII in a single data element, such as would be defined by the use of data qualifiers 25S and UID, or a DoD recognized IUID equivalent, such as would be defined by the use of data qualifiers I, 22S, 8002, 8003, or 8004.
2. Use. The generic term, UII, has evolved through usage to mean the concatenated UII as a common database key without regard to the UII data set being used. In this context, the term “UII” may be used to designate a concatenated UII, or the DoD recognized IUID equivalents of Global Individual Asset Identifier (GIAI), Global Returnable Asset Identifier (GRAI) when assets are serialized, Vehicle Identification Number (VIN), or Electronic Serial Number ((ESN), for cell phones only).

A complete understanding of the UII can be assured by the use of precise terms in written and verbal communications. Some terms that should be used when referring to the UII are as follows:

“UII data elements” designates the data elements encoded within a Data Matrix EC200 symbol placed on an item. These data elements may be the already concatenated DoD recognized IUID equivalents or a fully concatenated UII when described by their appropriate data qualifiers.

“Concatenated UII” designates: (a) the resulting data string when the data elements in a UII mark have been stripped of all data qualifiers and linked (concatenated) along with an issuing agency code, or (b) the resulting data string when the data qualifiers have been removed from the already concatenated DoD recognized IUID equivalents or a fully concatenated UII encoded in a UII mark.

“UII equivalent” or “DoD recognized IUID equivalent” designates any of the four specific equivalents: Global Individual Asset Identifier (GIAI), Global Returnable Asset Identifier (GRAI) when assets are serialized, Vehicle Identification Number (VIN), or Electronic Serial Number ((ESN), for cell phones only).

“UII symbol” designates the Data Matrix ECC 200 symbol that carries the UII data elements in the ISO/IEC 15434 syntax string.

“UII mark” designates the physical representation of the UII Symbol when attached to the item for unique identification purposes.

WHAT’S THE DEAL WITH THE UII MARK AND THE CONCATENATED UII?

As we noted above, the UII is marked on an item with data elements that are unambiguous and globally unique. The UII data elements are encoded into a Data Matrix symbol with a software package (Note - a DoD recognized IUID equivalent or a fully concatenated UII may be encoded in the symbol in lieu of separate data elements). The Data Matrix with the encoded UII data elements is placed on the item by a label or directly marked on the item. An imager can then be used to retrieve the UII data elements from the item, which can then be assembled into a concatenated¹ UII either manually or automatically and transmitted to a database. Data about the item can then be associated with the concatenated UII.

The concatenated UII provides a path to knowledge that: (a) enables precision and speed through the use of automatic information data capture technologies, and (b) enables unique item tracking in DoD business systems and provides reliable and accurate data for management, financial accountability and asset management purposes.

The deal is that we have to get the UII data elements marked on the item in the right way, or we can’t retrieve them from the item. Also, we have to build the concatenated UII the right way so that we have a correct common key for our databases and don’t have duplicate concatenated UIIs.

HERE ARE THE BASICS

First, as stated previously, the UII is a set of data elements that is encoded in a Data Matrix symbol with Error Correction Code 200. (Just to note - the concatenated UII may also be encoded in the Data Matrix along with its data elements for whatever reason, but it has to be an additional data

¹ Concatenate means to connect or link in a series.

element identified by the appropriate data qualifier in addition to the required UII set of data elements.)

Second, the set of data elements you will have to encode is driven by the method used to uniquely identify the item. The item can be uniquely identified by a Construct #1, serialization within the enterprise identifier; a Construct #2, serialization within the original part, lot or batch number; a DoD recognized item unique identification (IUID) equivalent², or by an already fully concatenated UII. (Note - The equivalents already come fully concatenated.)

Third, a data qualifier must identify each encoded data element in the Data Matrix symbol. A data qualifier is basically the name for the data element. The data qualifier itself is represented by a code.³

Fourth, the data elements used to uniquely identify the item must be precisely encoded in the Data Matrix ECC 200 symbol in a message string, which is assembled to comply with the syntax formats of ISO/IEC 15434, Transfer Syntax for High Capacity Automatic Data Capture Media. Syntax format is just a fancy way of saying the way words are put together to form a construction, such as a phrase.

Fifth, the concatenated UII has to be formed in a prescribed way if it is not already an equivalent or a fully concatenated UII and transmitted to the IUID Registry. You can find out more about data submission at <http://www.acq.osd.mil/dpap/UIID/DataSubmission.htm>.

JUST WHAT IS A DATA MATRIX?

Data Matrix symbols have a checkerboard appearance, with each uniformly spaced square shaped cell corresponding to a data bit. They are constructed of a mosaic of light and dark elements that must all be read before any characters can be recognized. Data Matrix symbols are encoded with binary code requiring an imager to read them. A Data Matrix looks like this.



WHAT DOES THIS ENCODING MEAN?

The machine-readable symbology for UII is the Data Matrix ECC 200 (Defined by ISO/IEC 16022), which is a two-dimensional representation

² As noted previously, they are the EAN.UCC Global Individual Asset Identifier (GIAI) for serially-managed assets, the EAN.UCC Global Returnable Asset Identifier (GRAI) for returnable assets that are serialized, the ISO Vehicle Identification Number (VIN) for vehicles, and the Electronic Serial Number (ESN) for cellular telephones only.

³ ISO/IEC International Standard 15418, Information Technology–EAN/UCC Application Identifiers and ASC MH 10 Data Identifiers and Maintenance and Air Transport Association Common Support Data Dictionary are the sources for the data qualifiers used to encode UII data elements.

of ASCII characters. **ASCII** (*American Standard Code for Information Interchange*) is a character set and a character encoding based on the Roman alphabet. It is most commonly used by computers and other communication equipment to represent text and by control devices that work with text. The Data Matrix is used to encode data that mainly contains ASCII characters (0-127). It encodes one alphanumeric or two numeric characters per byte.⁴

LET'S REVIEW THE BASICS

Okay, this is it.

We have a DoD compliant UII mark when we encode the UII data elements, the already concatenated DoD recognized IUID equivalents, or a fully constructed UII in a Data Matrix ECC 200 symbol:

- a. Using ISO/IEC 15418 or ATA CSDD data qualifiers to name the data elements, and
- b. Using ISO/IEC 15434 syntax formats to arrange the data elements in a precise message string, whose specific contents is determined by the UII construct, the DoD recognized IUID equivalent, or the fully concatenated UII that we are encoding.

Well, that's a mouth full, so let's look at the pieces in more detail.

WHAT TOOLS DO I NEED TO GET STARTED?

You will need a barcode generation software package to encode the data to develop labels or transmit the data to a direct part-marking device. Possible sources for such software packages can be found at <http://www.aimglobal.org/>.

WHAT ARE THE DATA ELEMENTS WE'RE GOING TO ENCODE?

Remember that we said the UII set of data elements are defined by the UII Construct or DoD recognized IUID equivalent being used? Okay, so here are the data elements we may want to encode:

- a. Construct #1 – (1) Enterprise identifier and (2) serial number unique within the enterprise.
- b. Construct #2 – (1) Enterprise identifier; (2) original part, lot or batch number; and (3) serial number unique within the original part, lot or batch number.

⁴ ASCII character codes (0-127) represent alphabetic and numeric characters as well as special characters (punctuation, symbols and non-printing control characters). See <http://en.wikipedia.org/wiki/ASCII> for all you ever want to know about ASCII and more.

- c. DoD recognized IUID equivalents – GIAI, GRAI with serialized assets, VIN, and ESN (for cell phones only).
- d. Fully concatenated UIIs described by their own unique data qualifiers other than those data qualifiers for the DoD recognized IUID equivalents. There are just two cases that fit this category; the data identifier 25S and the text element identifier UID.

There is a business rule⁵ that says you may encode additional data elements in the data matrix along with the UII data elements. If you do this, you have to make sure each data element is identified with a data qualifier that is not used to encode the UII data elements, and the UII data elements come first in the message syntax string, which is discussed below.

NOW HOW DO WE NAME THESE DATA ELEMENTS?

Remember that we used data qualifiers to name data elements. These data qualifiers⁶ have to define each data element placed on the item. Specific data qualifiers are used to tell the imaging devices whether to read the UII by using Construct #1, Construct #2, an already concatenated UII format, or an IUID equivalent. Table 1 shows the different data qualifiers for each of the data elements that are used for determining uniqueness.

⁵ Business Rule #13, Department of Defense Guide to Uniquely Identifying Items, Version 1.5, June 7, 2005.

⁶ There are three types of data qualifiers being used: Data Identifiers (DIs) (Format 06), Application Identifiers (AIs) (Format 05), and, within the aerospace industry, Text Element Identifiers (TEIs). ISO/IEC International Standard 15418, Information Technology–EAN/UCC Application Identifiers and ASC MH 10 Data Identifiers and Maintenance, governs DIs and AIs. Air Transport Association (ATA) Common Support Data Dictionary (CSDD) defines TEIs. ISO/IEC International Standard 15434, Information Technology–Transfer Syntax for High Capacity Automatic Data Capture Media, contains formats for using DIs and AIs in syntax encoding. DoD has submitted a request to add a format for TEIs to ISO/IEC 15434. In the interim, DoD uses the format code DD to refer to TEIs in the ISO/IEC 15434 syntax.

Data Element	DI (Format 06) ISO/IEC 15434	AI (Format 05) ISO/IEC 15434	TEI ATA CSDD
Enterprise Identifier CAGE/NCAGE DUNS GS1 Company Prefix DoDAAC Other Agencies	17V 12V 3V 7L 18V ⁷	95	CAG, MFR or SPL ⁸ DUN EUC
Serial Number within Enterprise Identifier			SER or UCN ⁹
Serial Number within Original Part Number	S	21	SEQ
Original Part Number	1P	01	PNO
Lot/Batch Number	1T	10	LOT, LTN or BII
Concatenated UIIs	25S ¹⁰ I ¹¹ 22S ¹²	8002 ¹³ 8003 ¹⁴ 8004 ¹⁵	UID
UII not including the IAC (CAGE + Serial Number within CAGE)	18S ¹⁶		USN or UST ¹⁷
Current Part Number ¹⁸	30P	240	PNR

Table 1. Data Qualifiers

⁷ Data identifier 18V is the concatenation of the Issuing Agency Code (IAC) + Enterprise Identifier (EID). This data identifier would be used for all other EIDs, which were assigned by an issuing agency that has an assigned IAC but does not have their own specific EID data identifier.

⁸ MFR – Manufacturer CAGE Code. Identifies the manufacturer, government agency or other organization controlling the design and the part number assignment of the subject part. SPL – Supplier CAGE Code. Identifies the organization assigning a Unique Component Identification Number (UCN), where the organization is not the manufacturer, government agency, or other organization controlling the design of the serialized component.

⁹ SER – Part Serial Number (Serial Number within Enterprise). The SER is the manufacturer's serialized identity for an individual part, component or component end item. UCN – Unique Component Identification Number. The UCN is the permanent tracking identity assigned to an in-service part in lieu of the manufacturer's serial number.

¹⁰ 25S is a data identifier defined as the identification of a party to a transaction (as identified by data identifier 18V), followed by a supplier assigned serial number (For UII purposes, this has to be unique serialization within the EID that assigns the UII data elements). Thus, for UII purposes, 25S must represent the following string of concatenated elements – IAC + EID + Unique serial number within the EID, which directly corresponds to a concatenated UII using Construct #1.

¹¹ DI I identifies a U. S. Vehicle Identification Number – VIN.

OKAY, NOW WHICH DATA QUALIFIERS ARE USED WITH WHICH CONSTRUCT OR EQUIVALENT?

Table 2 shows which data qualifiers are used with which construct or DoD recognized equivalent.

Data Qualifiers	Construct #1	Construct #2	DoD Recognized IUID Equivalents
Data Identifiers	18S 25S	17V, 12V, 3V, 18V 1P or 1T S	I 22S
Application Identifiers		95 01 or 10 21	8002 8003 8004
Text Element Identifiers	CAG, MFR or SPL, DUN, EUC SER or UCN USN or UST	CAG, MFR or SPL, DUN, EUC PNO, LOT or BII SEQ UID	

Table 2. Data Qualifiers and Their Usage by Constructs/Equivalents

HOW DO I DEAL WITH THIS SYNTAX THING?

The machine-readable symbology for UII mark is the Data Matrix ECC 200 (ISO/IEC 16022), which is a two-dimensional representation of ASCII characters. To permit translation of the encoded string of ASCII characters, the characters are ordered according to the precise rules of ISO/IEC International Standard 15434, Information Technology–Transfer

¹² DI 22S identifies a cellular mobile telephone electronic serial number.

¹³ AI 8002 identifies a cellular mobile telephone electronic serial number.

¹⁴ AI 8003 identifies a GRAI.

¹⁵ 8004 is the application identifier for the Global Individual Asset Identifier (GIAI). The GIAI is up to 30 characters and is a combination of the GS1 Company Prefix and an Individual Asset Reference, which is assigned by the holder of the GS1 Company Prefix.

¹⁶ In the case where the EID is the CAGE Code, data identifier 18S may be used. 18S is defined as the concatenation of the CAGE Code (EID) + Unique serial number within the CAGE Code. This is UII Construct 1. This data element does not contain the IAC, which must be added.

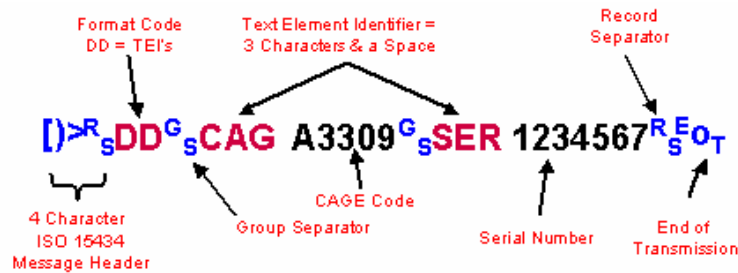
¹⁷ USN – The concatenation of MFR + SER. UST – The concatenation of SPL + UCN. These elements do not contain the IAC, which must be added.

¹⁸ The current part number is not part of the UII. It is an additional data element that may be encoded in the ISO 15434 syntax and placed on the item in a separate data matrix symbol, or, in the case of severe space limitations, it may be encoded in the same data matrix along with the UII data elements (see MIL-STD-130).

Syntax for High Capacity ADC¹⁹ Media—the “syntax.”²⁰ Each data string is assembled beginning with a message header consisting of the compliance indicator and a record separator. The compliance indicator is the ASCII code for the three characters [,), and > which are assembled in that order—[]>. The record separator that follows the compliance indicator is also an ASCII-coded character but it does not have a printable representation. The convention for depicting the record separator uses ^R_S to represent the single ASCII-coded character. Because the record separator also appears at the end of the formatted data in the data string, it is known as the format trailer character. There are two other ASCII-coded characters that are used in UII encoding that do not have printable representations. They are the data element separator—^G_S—and the message trailer character—^E_{OT}. The decimal ASCII codes for ^R_S, ^G_S, and ^E_{OT} are 30, 29 and 4 respectively. The hexadecimal codes are 1E, 1D and 4 respectively.

The message header is followed by a two-character format code to identify the semantics of the formatted data elements. The format code, the data qualifiers and the data values in the remainder of the data string are separated using the data element separator—^G_S—between each element of the formatted data. The formatted data is terminated using the format trailer character—^R_S—after the last data element, and the data string is terminated using the message trailer character—^E_{OT}—to indicate the end.

Figure 1 shows UII data elements encoded in ISO/IEC 15434 syntax.



Note: This example uses construct #1 with Text Element Identifiers (TEI).

Figure 1. UII Mark ISO/IEC 15434 Syntax Example

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The Data Matrix containing this syntax message is shown in Figure 2. The free text depicts the data elements and their data qualifiers.

¹⁹ ADC – Automatic Data Capture.

²⁰ Syntax—the way words are put together to form constructions, such as phrases and sentences. This standard defines the manner in which the data is transferred to the high capacity ADC media from a supplier’s information system and the manner in which the data is transferred to the recipient’s information system.



Figure 2. Encoded UII Data Matrix Mark

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When the UII data elements are concatenated, the IAC “D” for CAGE is added and the text element identifiers are stripped out to yield the concatenated UII as: DA33091234567.

IS THE JOB NOW FINISHED?

Once the UII data elements are encoded in the Data Matrix, the concatenated UII can be constructed and forwarded to the IUID Registry. The concatenated UII is formed by stripping out the data qualifiers and adding the Issuing Agency Code²¹ to the string of UII data elements encoded in the Data Matrix, with the exception of the DoD recognized IUID equivalents and in those instances where certain data qualifiers are used that already include the IAC in the definition of the data qualifier. The following are the rules for when you don’t add an IAC in the concatenation:

- DO NOT add an IAC to the GIAI, GRAI, VIN and ESN.
- DO NOT add an IAC when data identifiers I, 3V, 18V, 22S and 25S are used.
- DO NOT add an IAC when application identifiers 01, 8002, 8003, and 8004 are used.
- DO NOT add an IAC when text element identifiers EUC and UID are used.

The imaging device can be programmed to recognize the IAC from the type of enterprise identifier being used. Table 3 shows the more common enterprise identifiers in use and their IACs.

²¹ The issuing agency code, or IAC, is that assigned by the Registration Authority for ISO/IEC 15459-2, Registration Procedures. The current Registration Authority of ISO/IEC 15459-2 is NEN–Nederlands Normalisatie-instituut. The IAC represents the agency that issued the enterprise identifier. The IAC can be derive from the data qualifier for the enterprise identifier and does not need to be marked on the item.

Issuing Agency Code	Issuing Agency	Enterprise Identifier
0 - 9	EAN-International	EAN.UCC
LB	Telcordia Technologies, Inc	ANSI T1.220
UN	Dun & Bradstreet	DUNS
D	Allied Committee 135	CAGE
LH	European Health Industry Business Communications Council	EHIBCC
LD	Department of Defense	DODAAC

Table 3. Issuing Agency Codes

So, How is the Concatenated UII Put Together?

Once the data elements are identified to the imaging device, it needs instructions on how to put the data element fields together to define the unique identification.

Figure 3 shows how the concatenated UII is constructed within Format Codes 05, 06 and DD with the various data qualifiers. High capacity imagers shall conform to ISO/IEC 15434. This is crucial to unique item identification, since the process of identifying and concatenating the data elements must be unambiguous²².

²² Enterprises may have a mark on the item such as a design authority, etc., but that mark will need a different enterprise identifier (EID) data qualifier than the EID data qualifier used for the UII.

	Required Data Elements	Resultant Concatenated UII
Format Code 05		
<i>Construct 1</i> (use IUID equivalents)	8004 8003 8002	Constructed IUID equivalent (GIAI) Constructed IUID equivalent (GRAI) Constructed IUID equivalent (ESN)
<i>Construct 2</i>	01 & 21 95, 10 & 21	01 + 21 95 + 10 + 21
Format Code 06		
<i>Construct 1</i>	18S 25S 22S I	D + 18S 25S Constructed IUID equivalent (ESN) Constructed IUID equivalent (VIN)
<i>Construct 2</i>	3V, 1P & S 17V, 1P & S 12V, 1P & S 7L, 1P & S 18V, 1P & S <i>Substitute 1T in place of 1P if serialization within the lot/batch number applies</i>	3V + 1P + S D + 17V + 1P + S UN + 12V + 1P + S LD + 7L + 1P + S 18V + 1P + S
Format Code DD		
<i>Construct 1</i>	MFR & SER CAG & SER DUN & SER EUC & SER SPL & UCN CAG & UCN DUN & UCN EUC & UCN USN UST UID	D + MFR + SER D + CAG + SER UN + DUN + SER EUC + SER D + SPL + UCN D + CAG + UCN UN + DUN + UCN EUC + UCN D + USN D + UST UID
<i>Construct 2</i>	MFR , PNO & SEQ CAG , PNO & SEQ DUN , PNO & SEQ EUC , PNO & SEQ SPL , PNO & SEQ <i>Substitute LOT , LTN or BII in place of PNO if serialization within the lot/batch number applies</i>	D + MFR + PNO + SEQ D + CAG + PNO + SEQ UN + DUN + PNO + SEQ EUC + PNO + SEQ D + SPL + PNO + SEQ

Figure 3. Concatenated Unique Item Identifier (UII) Construction

OKAY, NOW LET'S BUILD A UII MARK AND CONCATENATE THE UII!

These are the data elements we have: (a) Enterprise Identifier – CAGE 98897, (b) Original Part Number – 4L0014-163B, and (c) Serial Number – SA10197.

Okay, let's assign the data qualifiers. We'll use data identifiers (DI). The DI for CAGE is 17V, 1P for original part number, and S for serial number within the original part number.

Now we attach the DIs to the front of the data elements and this gives us the values that we will encode in the message syntax that goes in the Data Matrix. This operation results in the following values to encode:

Enterprise Identifier – 17V98897

Original Part Number – 1P4L0014-163B

Serial Number – SSA10197

Notice that there are no spaces or any characters separating the DI from the data values.²³

Remember that we are using DIs, so what format code do we use to tell our imager to get ready to read data fields that are defined by DIs? That's right, format 06!

Well, now we're ready to sling together our message syntax, so here goes:

[D]>^R_S06^G_S17V98897^G_S1P4L0014-163B^G_SSSA10197^R_S^E_OT

And that's it. Notice that there are no spaces throughout the string.

At this stage, you've got to open your handy dandy barcode generation software package, select Data Matrix, and enter the message syntax string depicted above. If you've got a good package, it will provide an insert capability from a menu to enter the special ASCII characters for ^R_S, ^G_S, and ^E_OT. The resulting Data Matrix looks like this:



When you add the IAC, this is the concatenated UII:

D988974L00014-163BSA10197

That's right, a "-" is permitted in the UII along with a "/", but these two are the only special characters allowed.

²³ If we were using TEIs, there would be a space, because the TEI consists of three alpha characters plus a space. That's something you need to remember, otherwise, you could get tripped up when using TEIs if you didn't put the space in!

DON'T DO THAT, NOW!

To wrap this up, we need to review some real important things that you DON'T want to do when building the UII

1. Don't encode the UII data element string without a format code.
2. Don't 'hard code' RS (for ^R_S), GS (for ^G_S) and EOT (for ^E_{OT}) vice using the ASCII codes.
3. Don't forget to use the message header, group separators, record separator, and end of transmission in the syntax string.
4. Don't use the same enterprise identifier more than once in the message string.
5. Don't forget to use the appropriate data qualifier when encoding a concatenated UII or a DoD recognized IUID equivalent.
6. When building a concatenated UII, don't add an IAC for the GIAI, GRAI, VIN and ESN or when the data qualifiers of 01, 8002, 8003, 8004, I, 3V, 18V, 22S, 25S, EUC and UID are used.
7. Don't mix the use of Data Identifiers, Application Identifiers or Text Element Identifiers in the message string.
8. Don't forget that the TEI consists of three alpha characters and a space. The space must be encoded also.
9. Don't encode the Issuing Agency Code in the syntax string. The Issuing Agency Code is a part of the concatenated UII, it is not actually marked on the item.
10. Don't insert separators such as "/" or "-" instead of the proper group separator character.
11. Don't fail to include the original part number when serialization is within the original part number.
12. In the concatenated UII, don't use any special characters except the "/" or "-".
13. Don't encroach on the quiet zone of the symbol (one cell width buffer required around the symbol).

14. Don't include the data qualifiers in the concatenated UII which is transmitted to the IUID Registry.