Extended Encoding Scheme for Chipotle

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This is a description of an encoding scheme for compressing traceability information into the 128-bit EPC memory of an RFID tag. The data contained includes an identifier, a GTIN, a date type, a date value, and an alphanumeric lot number. The following describes the purpose of each field and how it is created.

Note: Throughout this document, the notation 0xHH is used to represent a hexadecimal value. For example, 0x12 would be the hex representation of the binary number 0001 0010 which would be 18 in decimal. The asterisk character, "*", is used to represent multiplication. The arrow, "→", means "yields" or "results in." Thus, 0x12 * 0xA → 18 * 10 → 180.

Structure:

Id

8 bits. identifies the tag encoding in order to distinguish it from other tags.

GTIN

46 bits. The Global Trade Identification Number with the check digit.

Date

Type – 2 bits, a value identifying the type of date represented

Value – 13 bits, a compressed date containing the last digit of the year (4 bits), the month (4 bits), and day of month (5 bits)

Lot Number

59 bits. Up to 11 uppercase alphanumeric characters or three symbols ("-", ".", or ":").

Serial Number

The serial number is not encoded in the standard rfid memory. The TID is used as a serial number to separate individual items.

Encoding:

Id – 8 bits - The Id is chosen to distinguish this tag encoding scheme from other schemes. No value has been assigned yet.

GTIN – 46 bits – The GTIN value (less the check digit) is a 14-digit number encoded as a binary value. (Max value 70368744177663)

Date – 15 bits total – The date field consists of a date type and a date value.

Type -2 bits – The date type is derived from the following table:

Value	Meaning
0	Production/harvest date (AI 11)
1	Packaging date (AI 13)
2	Best-before date (AI 15)
3	Expiry date (AI 17)

Value – 13 bits – The date value is calculated as follows and expressed as a binary value:

Value = (512 * (last digit of year)) + (32 * month) + day-of-month

This can also be visualized as the last digit of the year in binary followed by the month in binary followed by the day in binary. (yyyymmmmdddddd)

Lot number – 59 bits total – Up to 11 uppercase alphanumeric characters or three symbols (“-“, “.”, or “:”). The encoding is done using the index of the characters in Table 1 at the end of this document. The first two characters are encoded together, followed by the remaining characters in groups of three. If there are fewer than 11 characters, the pad character (0) is used for the remaining characters. The radix-40 calculation is as follows:

Value1 = 40*A1 + A2

Value2 = 40*40*A3 + 40*A4 + A5

Value3 = 40*40*A6 + 40*A7 + A8

Value2 = 40*40*A9 + 40*A10 + A11

Where the A values are taken from Table 1 at the end of this document. The values, in binary, are concatenated to form the 59-bit stream representing the lot number.

Serial Number – There is no serial number included in the rfid stream. Instead, the TID is used to uniquely identify each item.

Encoding Example 1:

Id – FE → 0xFE

GTIN – 01234567890128 → 0x011F71FB04D0

Date Type – Expiry date, AI 17 → 3 → 0x3

Date Value - '06/11/2020 → `(0x200 * 0) + (0x20 * 6) + 11 → 0x00CB`

Lot – A1B23C45D67 →

A1 → 40*1 + 31 → 71 → 0x47

B23 → 40*40*2 + 40*32 + 33 → 4153 → 0x11A1

C45 → 40*40*3 + 40*34 + 35 → 6195 → 0x1833

D67 → 40*40*4 + 40*36 + 37 → 7877 → 0x1EC5

Lot result: 0x04711A118331EC5

Shift and combine values:

```
Id              0xFE
GTIN                047DC7EC1340    ← Shifted 2 bits left
Date Type                      3
Date Value                      0658    ← Shifted 3 bits left
Lot                                04711A118331EC5
Final           0xFE047DC7EC134306584711A118331EC5
```

Encoding Example 2 (less than 11-character lot number):

Lot – XR-7 →

XR → 40*24 + 18 → 978 → 0x3D2

-7 → 40*40*27 + 40*37 + 0 → 44680 → 0xAE88

[Pad] → 40*40*0 + 40*0 + 0 → 0 → 0x0000

[Pad] → 40*40*0 + 40*0 + 0 → 0 → 0x0000

Lot result: 0x3D2AE8800000000

Decoding Example:

Input 0x FE001A1A658B09079847CD43E0600000

Separate fields:

```
Id              0xFE
GTIN                001A1A658B08
Date Type                       1
Date Value                      0798
Lot                                 047CD43E0600000
```

Shift values:

```
GTIN              0x001A1A658B08   →    0x0006869962C2
Date Value        0x0798           →     0x00F3
```

Id - 0xFE identifies the encoding used.

GTIN – 0x0006869962C2 → 00028028003010

Date Type – 0x1 → 1 → AI 13, packing date

Date Value - 0x00F3 → 00719 → 07/19/2020

Lot – 0x047CD43E0600000 → 047 CD43 E060 0000

Calculate first two characters: 0x047 → 71

Calculate first and second character value: 71/40 = 1 with a remainder of 31

Look up characters in Table 1: 1 → A, 31 → 1

Calculate next three characters: 0xCD43 → 52,547

Calculate first value: 52547/(40*40) = 32 with a remainder of 1347

Calculate first value: 1347/40 = 33 with a remainder of 27

Look up characters in Table 1: 32 → 2, 33 → 3, 27 → “-“

Repeat for next two sets of three characters

…

Lot combined – A123-56

Table 1 – Radix-40 Character Set

Symbol	Name	ASCII	Binary	Code
	PAD			0
A	Capital letter A	0x41	01000001	1
B	Capital letter B	42	01000010	2
C	Capital letter C	43	01000011	3
D	Capital letter D	44	01000100	4
E	Capital letter E	45	01000101	5
F	Capital letter F	46	01000110	6
G	Capital letter G	47	01000111	7
H	Capital letter H	48	01001000	8
I	Capital letter I	49	01001001	9
J	Capital letter J	4A	01001010	10
K	Capital letter K	4B	01001011	11
L	Capital letter L	4C	01001100	12
M	Capital letter M	4D	01001101	13
N	Capital letter N	4E	01001110	14
O	Capital letter O	4F	01001111	15
P	Capital letter P	50	01010000	16
Q	Capital letter Q	51	01010001	17
R	Capital letter R	52	01010010	18
S	Capital letter S	53	01010011	19
T	Capital letter T	54	01010100	20
U	Capital letter U	55	01010101	21
V	Capital letter V	56	01010110	22
W	Capital letter W	57	01010111	23
X	Capital letter X	58	01011000	24
Y	Capital letter Y	59	01011001	25
Z	Capital letter Z	5A	01011011	26
–	Hyphen-Minus	2D	00101101	27
.	Full stop	2E	00101110	28

:	Colon	3A	00101110	29
0	Digit zero	30	00110000	30
1	Digit one	31	00110001	31
2	Digit two	32	00110010	32
3	Digit three	33	00110011	33
4	Digit four	34	00110100	34
5	Digit five	35	00110101	35
6	Digit six	36	00110110	36
7	Digit seven	37	00110111	37
8	Digit eight	38	00111000	38
9	Digit nine	39	00111001	39