Barcodes

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Plan

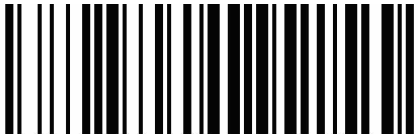
- Characteristics of an identification method
- Study of barcodes standards
  - UPC and EAN 13

Characteristics of an identification method

- Logical characteristics
  - Uniqueness
  - Fault and error tolerance
- Physical characteristics
  - Readability (human and machine)
  - Coupling to the object
  - Reading time
  - Complexity of readers

Barcodes

- Information is coded in the width of parallel bars and spaces



This is a one-dimension (1-D) linear code

- Typically bars are printed in black over a white background (it is required to have high contrast zones)
- Inexpensive automatic identification method
  - Barcodes: ~ € 0,001
  - RFID passive tags: ~ € 0,04 - € 0,20

Barcodes

- Machine readable symbols that store identifying data about a part or product with which they are associated
- Symbols are read by a barcode scanner and are decoded and processed to extract data for a variety of uses
  - For example: pricing, order fulfillment, traceability through production, sortation, shipping, etc.
- Barcode technologies provide a fast and reliable data collection to ensure part or product traceability, error-proof assembly processes and enhance customer service

Barcodes standards

- There are many specifications and standards for barcodes
  - Examples for 1-D linear codes:
    - Plessey, UPC, Codabar, Code 25 – Non-interleaved 2 of 5, Code 25 – Interleaved 2 of 5, Code 39, Code 93, Code 128, Code 128 A/B/C, Code 11, CPC Binary, DUN 14, EAN 2, EAN 5, EAN 8, EAN 13, GS1-128, (UCC/EAN-128), GS1 DataBar (RSS), ITF-14, Latent image barcode, Pharmacode, PLANET, POSTNET, OneCode, MSI, PostBar, RM4SCC / KIX, Telepen, etc.

(almost 2-D)

UPC Code

- UPC – Universal Product Code
- Published in 1973 by a group of industry and retail associations, to improve the processes of sale and inventory management
- Is mostly used in the USA and Canada
- Europe uses EAN – European Article Number (also called *International* Article Number)

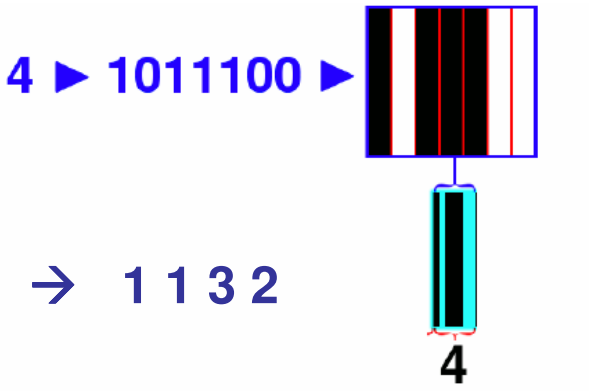
EAN is a superset of UPC

UPC Coding

- UPC-A encodes 12 decimal digits using the format
  S L L L L L L M R R R R R R E
- Guard bars:
  - S = Start
  - M = Middle
  - E = End
- Decimal digits:
  - L (left) and R (right) sections
  - Each represents 6 digits
  - L = prefix (identifies the number system used by following digits)
  - R = Error detecting check digit

UPC Coding

- Each digit is represent by a 7 bit code



- They correspond to 2 bars and 2 spaces of different widths
- Bars and spaces always alternate
- L digits start with Space; R digits start with Bar

Encoding

- Each digit is represented by a unique pattern of two bars and two spaces
- The bars and spaces are variable width; they may be one, two, three or four units wide
  - The total width for a digit is always seven units
- Bars and spaces always alternate
- Start = End = 111 (bar, space, bar)
- Middle = 11111 (space, bar, space, bar, space)
- Digits in left area: **space**, bar, space, bar
- Digits in right area: **bar**, space, bar, space
- Quite zones (before S and after E)

Encoding

- Left-side digits have odd parity - total width of the black bars is an odd number
- Right-side digits have even parity
- So, a scanner can determine whether it is scanning from left-to-right or from right-to-left

Digit	Code L	Code R
0	0001101	1110010
1	0011001	1100110
2	0010011	1101100
3	0111101	1000010
4	0100011	1011100
5	0110001	1001110
6	0101111	1010000
7	0111011	1000100
8	0110111	1001000
9	0001011	1110100

Numbering

- There are different possibilities to encode each digit, depending on the first digit (L)
- Values for first digit (prefix)
  - 0, 1, 6, 7, 8: For most products. The LLLLL digits are the manufacturer code, and the RRRRR digits are the product code.
  - 2: Reserved for local use (store/warehouse), for items sold by variable weight. For variable-weight items the LLLLL is the item number, and the RRRRR is either the weight or the price, with the first R determining which.
  - 3: Drugs by National Drug Code number (USA).
  - 4: Reserved for local use (store/warehouse), often for loyalty cards or store coupons.
  - 5, 9: Coupons: The manufacturer code is the LLLLL, the first 3 RRR are a family code (set by manufacturer), and the next 2 RR are a coupon code. This 2-digit code determines the amount of the discount, according to a table set by the GS1 US.

Numbering

- UPC-A provides a theoretical maximum of 1 trillion (10^12) unique barcodes
- In practice the number of barcodes is limited by the standards used to create them
- For instance, the last digit is the check digit and therefore can only be one correct value. This gives 100,000,000,000 (10^11) possibilities.
- Restrictions on the first digit further reduce this number (e.g.: 5x10^10).
- Five digits for a manufacturer (10^5 = 100,000 worldwide companies)
- Five digits for a part or product (10^5 = 100,000 products for each manufacturer)

Check digit

- In the UPC-A system, the check digit is calculated as follows:
  - Add the digits in the odd-numbered positions (first, third, fifth, etc.) together and multiply by three.
  - Add the digits in the even-numbered positions (second, fourth, sixth, etc.) to the result.
  - Find the result modulo 10 (i.e. the remainder when divided by 10).
  - If the result is not zero, subtract the result from ten.
- Example for barcode "036000 29145x" (x = unknown check digit)
  - Add the odd-numbered digits (0 + 6 + 0 + 2 + 1 + 5 = 14)
  - Multiply by three (14 × 3 = 42)
  - Add the even-numbered digits (42 + (3 + 0 + 0 + 9 + 4) = 58)
  - Calculate modulo ten (58 mod 10 = 8)
  - Subtract from ten (10 – 8 = 2)
  - The check digit is thus 2.

Remainder of the division by 10 (equal to least significant digit). If remainder is 0, check digit is 0.

- The check digit can detect 100% of single digit errors and 89% of transposition errors.

UPC → EAN-13

- EAN – *International* Article Number
- Superset of UPC
  - Adds an extra digit in the beginning of a UPC number
  - Expands 10 times the number of unique values
  - UPC coding is valid for EAN-13 with the extra digit = 0
    UPC value “123456 789012” = EAN-13 value “**0** 123456 789012”
  - Point-of-sale systems can now understand both equally
- EAN-13 indicates the manufacturer’s country
- All products marked with an EAN will be accepted in North America
- Any product with an existing UPC does not have to be re-marked with an EAN
- UPC is being phased-out

Questions?