Barcodes
EAN13, 2D codes

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Plan

- Barcodes
- Linear barcodes
- Barcodes 2D
- Cases study

Barcode

- An optical machine-readable representation of data
  - Data is represented by varying the widths and spacings of parallel lines

- First use:
  - Identification of railroad cars (1967)
  - First use of UPC – Universal Product Code: 1974 (chewing gum pack)
- Most common use nowadays:
  - Supermarket checkout systems

Linear barcodes

- Linear because data is only on one dimension

Barcodes

- Universal Product Code (UPC) common formats:

Standard UPC-A

GTIN-12 in UPC-A

Standard UPC-E

- Used mostly in USA and Canada
- Is being phased out → EAN

Barcode

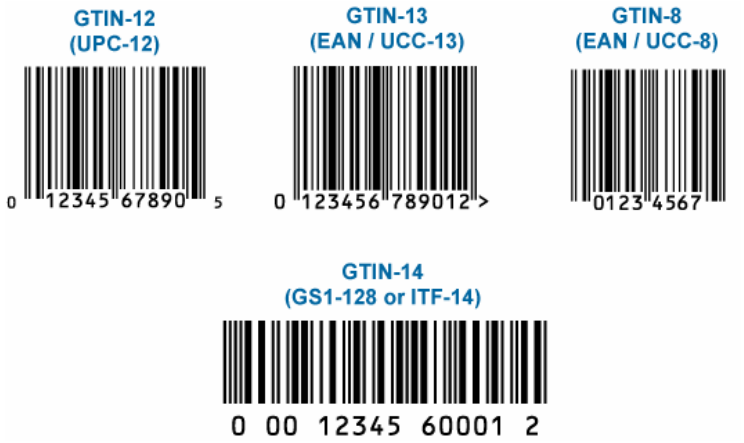
- EAN – European Article Number
  → International Article Number (but still EAN)

- EAN-13 – 13 digits (12 + 1 check)
  - Superset of UPC
  - Defined by the standards organization "**GS1**"
  - Used worldwide for marking products often sold at retail point of sale
  - Numbers encoded in UPC and EAN barcodes are known as Global Trade Item Numbers (GTIN)

Global Trade Item Number (GTIN)

- Identifies product information (number usually read through a bar code scanner)
- Identifier is unique and universal
- GTINs may be 8, 12, 13 or 14 digits long
- GTIN-13s may be encoded in EAN-13 and other codes

Examples of GTIN codes



GTIN formats

Num.-system	GTIN-Format													
Position of digits	*T1*	*T2*	*T3*	*T4*	*T5*	*T6*	*T7*	*T8*	*T9*	*T10*	*T11*	*T12*	*T13*	*T14*
GTIN-14	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14
GTIN-13	0	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13
GTIN-12	0	0	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
GTIN-8	0	0	0	0	0	0	N1	N2	N3	N4	N5	N6	N7	N8

- Example for GTIN-13
  - N1-N2 / N1-N3 – Country code (assigned by GS1)
  - N1-N6 / N1-N7 – Company prefix (assigned by GS1)
  - N8-N12 – Item code (allocated by the company)
  - N13 – Check digit

GS1 country codes

- Some examples:
  - 000 – 019 U.S. and Canada
  - 300 – 379 France and Monaco
  - . . .
  - 400 – 440 Germany (440 code inherited from old East Germany on reunification, 1990)
  - 450 – 459 Japan
  - 460 – 469 Russia
  - . . .
  - 500 – 509 United Kingdom
  - 520 – 521 Greece
  - . . .
  - 539 Ireland
  - 540 – 549 Belgium and Luxembourg
  - **560 Portugal**
  - 569 Iceland
  - . . .
  - 840 – 849 Spain
  - . . .

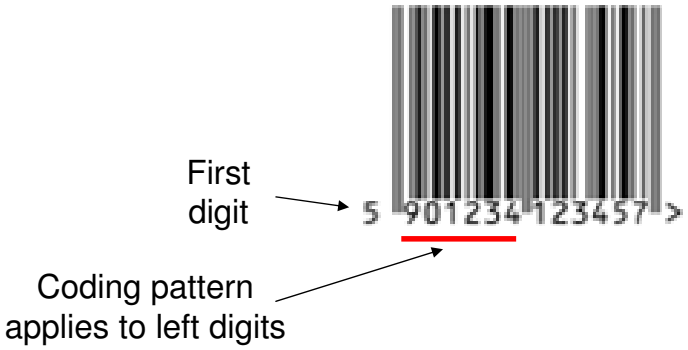
If first digit = **2**:
Reserved for local use (store/warehouse), for items sold by variable weight

EAN barcode – Encoding rules

- EAN-13 encoding rules encode the leading 13th digit by modifying the encoding of the left-hand half of the barcode
- The original rules for UPC are treated as a '0' if read as EAN-13. A UPC barcode XXXXXXXXXXXX therefore is the EAN-13 barcode 0XXXXXXXXXXXX.

First digit	Coding pattern
0	EEEEEE
1	EEOEOO
2	EEOOEO
3	EEOOOE
4	EOEEOO
5	**EOOEEO**
6	EOOOEE
7	EOEOEO
8	EOEOOE
9	EOOEOE

E = Even (normal)
O = Odd (inverted)



EAN encoding rules

- First digit coding
  - Applies only to left digits (6 digits)
  - Right digits use always “Even” coding

First digit	Coding pattern
0	EEEEEE
1	EEOEOO
2	EEOOEO
3	EEOOOE
4	EOEEOO
5	EOOEEO
6	EOOOEE
7	EOEOEO
8	EOEOOE
9	EOOEOE

Digit coding

	Even (normal)	**O**dd (inverted)
0	3211	1123
1	2221	1222
2	2122	2212
3	1411	1141
4	1132	2311
5	1231	1321
6	1114	4111
7	1312	2131
8	1213	3121
9	3112	2113

EAN encoding rules

- Digits coding

space / bar / space / bar

Left digits may be coded like this (Even) or “inverted” (Odd)

bar / space / bar / space

Right digits always coded in this way (even)

Example: 0 (even) = 3211 0 (odd) = 1123

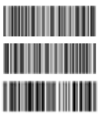
EAN encoding rules

- Calculation of checksum digit (rightmost digit)
  - Calculated from the data digits before it.
  - The checksum is calculated taking a varying **weight** value **times** each **number** in the barcode to make a **sum**.
  - The weight for a specific position in the EAN code is either 3 or 1, which alternate so that the final data digit has a weight of 3; the same algorithm is used in other GTINs and the Serial Shipping Container Code (SSCC).
  - In an **EAN-13** code, the weight is 1 for odd positions and 3 for even positions (weights for EAN-13 are: 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3).
  - The checksum digit is then the digit which must be added to this sum to get a number evenly divisible by 10.

- Example:
  - If the sum is 63 $1xN1 + 3xN2 + 1xN3 + 3xN4 + 1xN5 + 3xN6 + 1xN7 + 3xN8 + 1xN9 + 3xN10 + 1xN11 + 3xN12$
  - 63 modulo 10 = 3
  - 10 minus 3 makes the checksum = 7

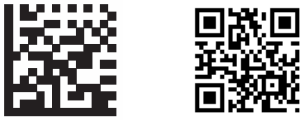
2D barcodes

- Market requested:
  - Codes capable of storing more information, more character types (not just numbers), and that could be printed in a smaller space.
- Approach
  - Increasing the number of bar code digits or layout multiple bar codes
  - Problems:
    - enlarge the bar code area
    - complicate reading operations
    - increase printing cost
- Solution: 2D barcode
  - QR code (1994)



Multiple bar code layout

2D Code with stacked bar codes



2D Code (matrix type)

2D barcodes

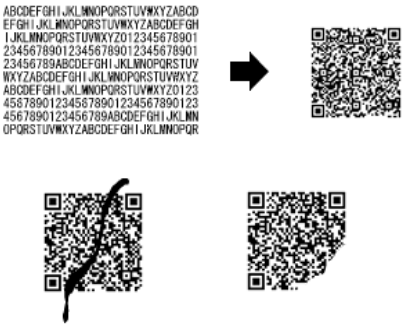
- QR Code = Quick Response code

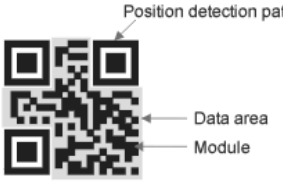
Typical 2D Codes

	QR Code	PDF417	DataMatrix	Maxi Code
				
Developer (country)	DENSO (Japan)	Symbol Technolog. (USA)	RVSI Acuity CiMatrix (USA)	UPS (USA)
Type	Matrix	Stacked Bar Code	Matrix	Matrix
Numeric capacity	7,089	2,710	3,116	138
Alphanumeric	4,296	1,850	2,355	93
Binary	2,953	1,018	1,556	
Kanji (Japan)	1,817	554	778	
Main features	Large capacity, small printout size High speed scan	Large capacity	Small printout size	High speed scan
Standardiza-tion	AIM International JIS, ISO	AIM International ISO	AIM International ISO	AIM International ISO

QR Code (Quick Response Code)

- High Capacity Encoding of Data
- Small Printout Size
- Dirt and Damage Resistant
- Readable from any direction in 360°





QR Code uses

- Initially used to track parts in vehicle manufacturing
- Now: much wider range of applications, including commercial tracking, entertainment and transport ticketing, product marketing and in-store product labeling.
- Many applications target mobile-phone users (via mobile tagging).
- Users may receive text, add a vCard contact to their device, open a Uniform Resource Identifier (URI), or compose an e-mail or text message after scanning QR codes.
- Google has a popular API to generate QR codes
- Apps for scanning QR codes can be found on nearly all smartphone devices.

Case study (1)

- Logistics Control System for Food Products
  - 2D barcode: **QR code**
  - Product code, expiration date, manufacturing history, and other data are encoded into QR Code
  - The data is used for logistics management of food products
- Benefits
  - Enables first-in first-out execution based on expiration date control
  - Improves traceability based on manufacturing history control

Case study (2)

- Shipping Control System for Garment Products
  - 2D barcode: **QR code**
  - Shipping destination, product code, color, size, and other data are encoded into QR Code for printing on shipping instructions of garment products.
  - The data is used for shipping control
- Benefits
  - Prevents shipping mistakes
  - Enables instant gathering of shipping instruction data using handy terminals

References

- http://en.wikipedia.org/wiki/Barcode
- http://en.wikipedia.org/wiki/Universal_Product_Code
- http://en.wikipedia.org/wiki/International_Article_Number_(EAN)
- http://en.wikipedia.org/wiki/List_of_GS1_country_codes
- http://www.gtin.info/

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