BARCODES

Book: Computer Peripherals (3rd Edition)- Barry M. Cook & Neil H. White

Prepared By: Lec Anika Binte Islam

What is Barcode?

- A barcode is a machine readable data representation made up of bars of dark and light areas which represent a set of data, often a string of numbers.
- This pattern of black lines and white spaces stores the data.
- Once a barcode is scanned with a barcode scanner, or a smart phone in some cases, the data is translated into readable information.

What are Barcodes used for?

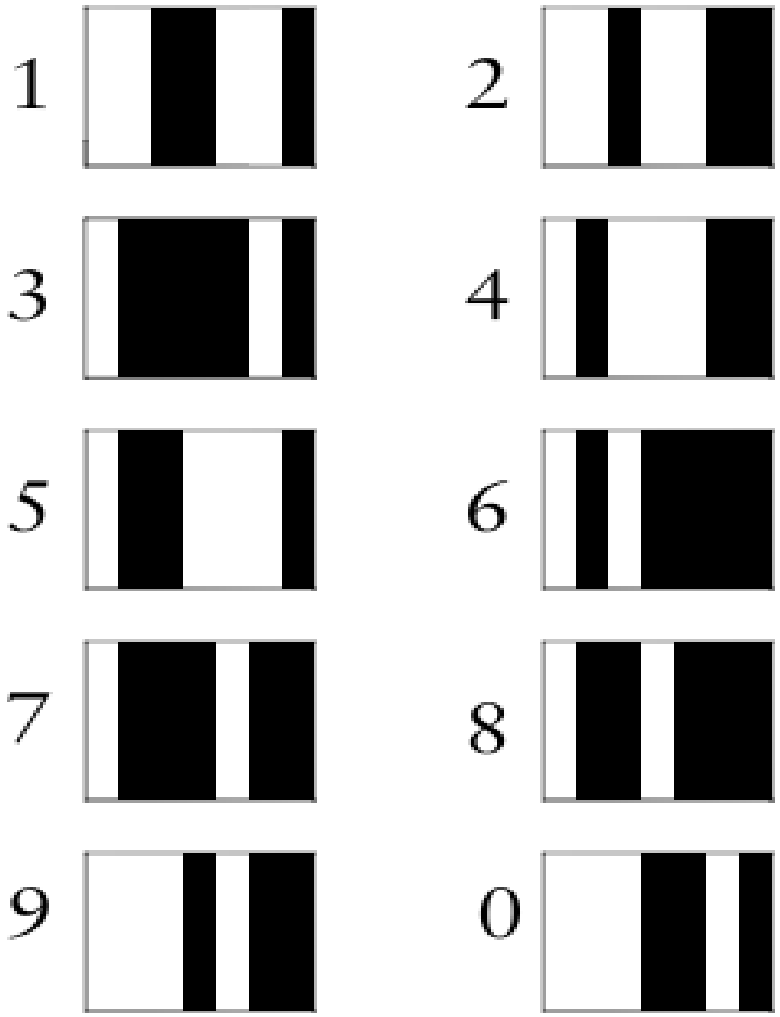
- Giving every item that you want to classify its own, unique number and then simply print the number on the item so an electronic scanning device can read it.
- Problem:
  - a misprinted eight could look like a three to a computer.
  - or a six is identical to nine if you turn it upside down which could cause all sorts of chaos at the checkout if you scanned the wrong way up.
- What we really need is a completely reliable way of printing numbers so that they can be read very accurately at high speeds. That's the problem that barcodes solve.

How Barcodes represent 0-9

- Looking at a barcode, can't make head or tail of it-Where one number ends and another one begins.
- Each digit in the product number is given the same amount of horizontal space- exactly 7 units.
- To represent any of the numbers from zero through nine, we simply color those seven units with a different pattern of black and white stripes

How Barcodes represent 0-9

The number **one** is represented by coloring in two white stripes, two black stripes, two white stripes, and one black stripe, while the number **two** is represented by two white stripes, one black stripe, two white stripes, and two final black stripes.



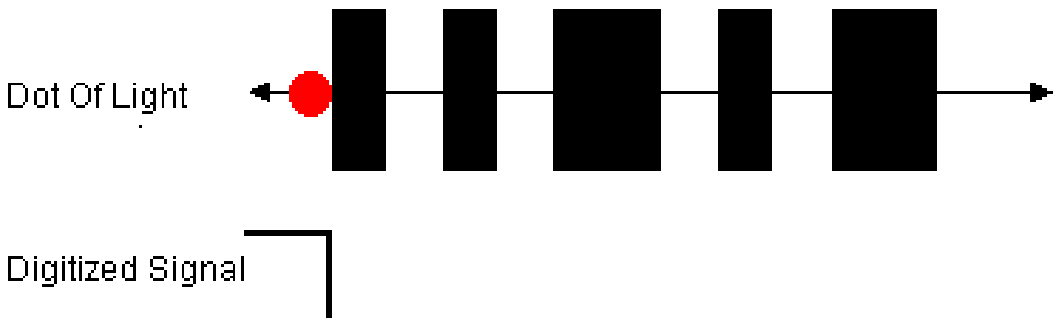
1D Barcode

Barcodes Information

- A long barcode represents three different types of information:
  - The first part of a barcode tells the country where it was issued.
  - The next part reveals the manufacturer of the product.
  - The final part of the barcode identifies the product itself.
- Most products carry a simple barcode known as the **UPC (universal product code)**—a line of vertical stripes with a set of numbers printed underneath it

Barcode Scanner

- Reading barcode involves determining the widths of the dark and light bars across the pattern and transform it into a digital representation.
- Elements of bar code may be only fractions of a millimeter wide
  - the reader has to focus to at least this resolution if a clean output is to be produced

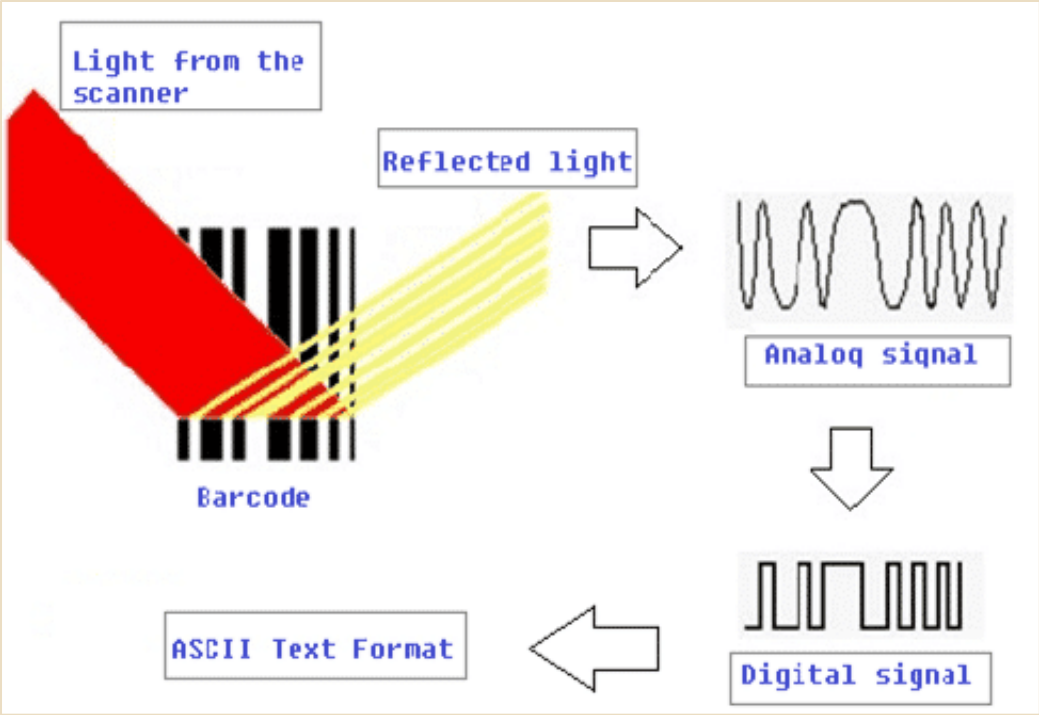


How does a barcode scanner works?

- Barcode scanners have to be able to read the black-and-white zebra lines on products **extremely quickly** and feed that information to a computer or checkout terminal, which can identify them immediately using a product database.
- Lets' assume, each black line corresponding to a one and each white line a zero.
- Scanning head shines LED or laser light onto barcode.
- Light reflects back off barcode into a light-detecting electronic component called a photoelectric cell.
- White areas of the barcode reflect most light; black areas reflect least.
- As the scanner moves past the barcode, the cell generates a pattern of on-off pulses that correspond to the black and white stripes.

How does a barcode scanner works?

- An electronic circuit (decoder) attached to the scanner converts these on-off pulses into binary digits (zeros and ones).
- The binary digits are sent to a computer attached to the scanner, which detects the code as 11101011.



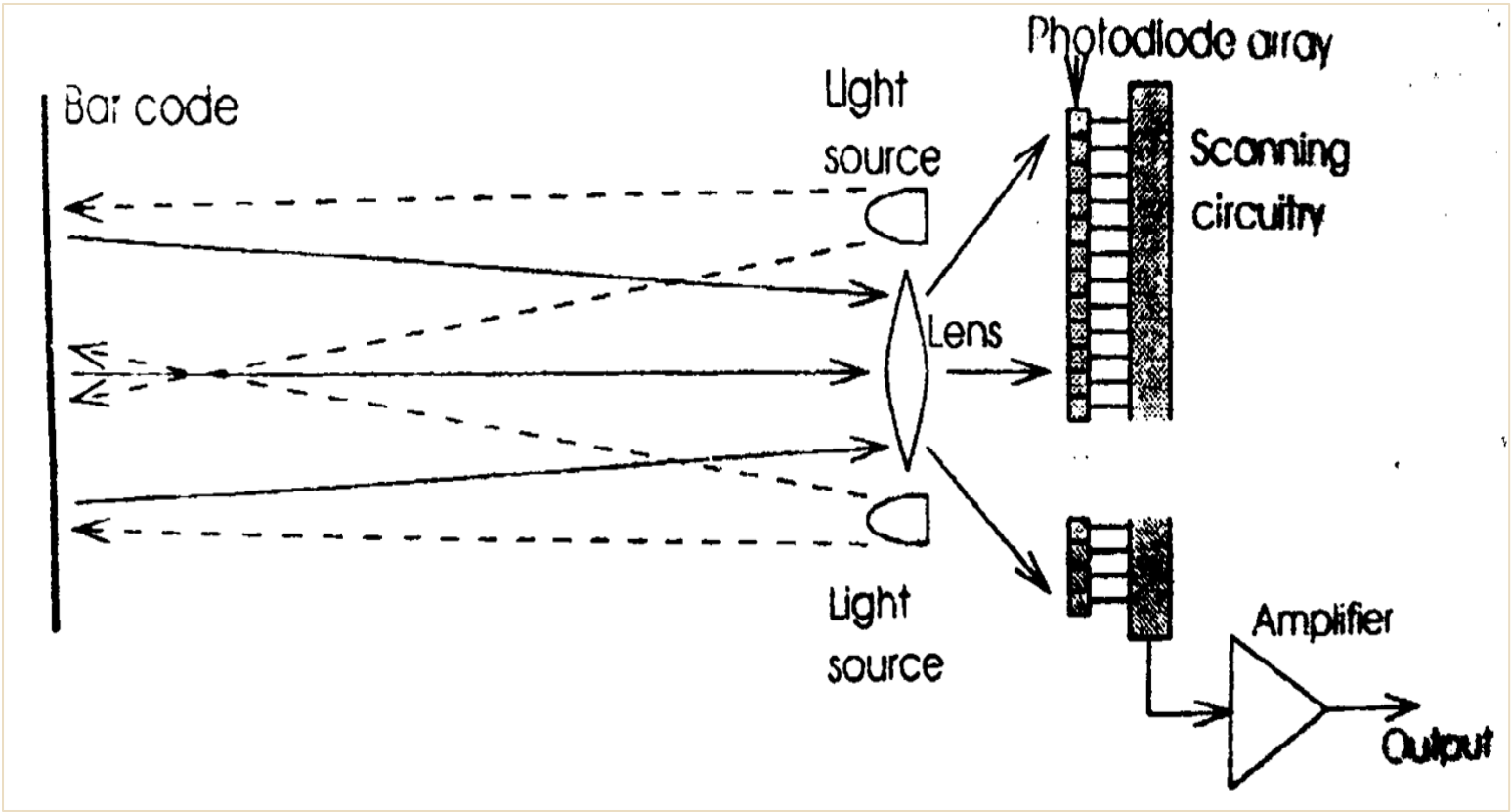


Fig: CCD Scanner Arrangement

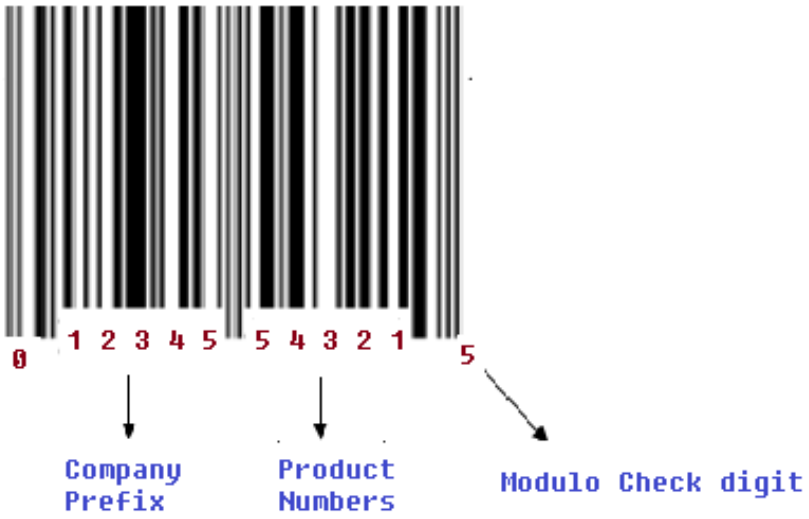
Types of barcode scanner

- Pen Scanner:
  - Need to run it across the barcode so it can reach each block of black or white in turn
- Wand Scanner:
  - A wand scanner, the CCD or photocells read the entire code at once.
- Laser Scanner:
  - The laser beam being bounced around at high-speed by a spinning wheel so it reads products (literally) in a flash

The best barcode scanners are so accurate that they make only one mistake in something like 70 million pieces of scanned information!

Codes

- UPC- Universal Product Coding
- EAN-European Article Number
- Numbers to be coded consist of-
  - Prefix(1 digit for UPC, 2 for EAN)
  - Manufacturer number (5 digits)
  - Item reference (5 digits)
  - Check digit (1 digit)



Codes

- UPC-A is 12 digit number
  - The scan able area of every UPC-A barcode follows the pattern SLLLLLLLMRRRRRRE,

    -where S (start), M (middle), and E (end) guard patterns are represented the same way on every UPC-A barcode and the L (left) and R (right) sections collectively represent the 12 numerical digits that make each UPC-A unique.
  - The total width for a digit is always 7 modules; consequently,
  - UPC-A 12-digit number requires a total of $7 \times 12 = 84$ modules.
  - A complete UPC-A is 95 modules wide: 84 modules for the digits, combined with 11 modules for the S (start), M (middle), and E (end) guard patterns.

Codes

- Codes used on either side of the center line are different so that the direction of scan can be determined
  - A scanner can determine whether it is scanning a symbol from left-to-right or from right-to-left (the symbol is upside-down).
  - After seeing a **S** (start) or **E** (end) guard pattern (they are the same, *bar-space-bar*, whichever direction they are read), the scanner will first see odd parity digits, if scanning left-to-right, or even parity digits, if scanning right-to-left.
  - With the parity/direction information, an upside-down symbol will not confuse the scanner.
    - When confronted with an upside-down symbol, the scanner may simply ignore it or recognize the digits and put them in the right order.

Codes

- For UPC
  - Left hand digits are encoded using **‘Left Hand A’**
- For EAN
  - Left hand digits are encoded using mixture of **‘Left Hand A’** and **‘Left Hand B’**
- The first digit determines which coding to use for each of the remaining six digits.

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Table 7.1 *UPC/EAN character set ('1' represents a dark band)*

Number	Left Hand A	Left Hand B	Right Hand
0	0001101	0100111	1110010
1	0011001	0110011	1100110
2	0010011	0011011	1101100
3	0111101	0100001	1000010
4	0100011	0011101	1011100
5	0110001	0111001	1001110
6	0101111	0000101	1010000
7	0111011	0010001	1000100
8	0110111	0001001	1001000
9	0001011	0010111	1110100

Table 7.2 *Code for the first prefix character in EAN13*

Number	Prefix 2	Data 1	Data 2	Data 3	Data 4	Data 5
0	A	A	A	A	A	A
1	A	A	B	A	B	B
2	A	A	B	B	A	B
3	A	A	B	B	B	A
4	A	B	A	A	B	B
5	A	B	B	A	A	B
6	A	B	B	B	A	A
7	A	B	A	B	A	B
8	A	B	A	B	B	A
9	A	B	B	A	B	A

Example-1

Code: 9 780340 606 582 ⟶ Total digit 13 ⟶ EAN

9 (Table 7.2)

A	B	B	A	B	A

First 6 digits after 9

7	8	0	3	4	0
Left Hand A	Left Hand B	Left Hand B	Left Hand A	Left Hand B	Left Hand A
0111011	0001001	0100111	0111101	0011101	0001101

Last 6 digits

6	0	6	5	8	2
Right Hand	Right Hand	Right Hand	Right Hand	Right Hand	Right Hand
1010000	1110010	1010000	1001110	1001000	1101100

Example-2

Code: **012345 678905** → Total digit 12 → UPC

First 6 digits

0	1	2	3	4	5
Left Hand A	Left Hand A	Left Hand A	Left Hand A	Left Hand A	Left Hand A
0001101	0011001	0010011	0111101	0100011	0110001

Last 6 digits

6	7	8	9	0	5
Right Hand	Right Hand	Right Hand	Right Hand	Right Hand	Right Hand
1010000	1000100	1001000	1110100	1110010	1001110

Calculating the checksum

1. Add the values of the digits in even positions.
2. Multiply this result by 3.
3. Add the values of the digits in odd positions
4. Sum the results of steps 2 and 3.
5. To calculate the check digit, take the remainder of (result/10 or result%10) and if not 0, subtract from 10.

Example of check digit calculation

- Example (UPC):

Assume the barcode data = 01234567890X

1. 1+3+5+7+9=25
2. 25x3=75
3. 0+2+4+6+8+0= 20
4. 75 + 20 = 95
5. 95%10=5

   10-5=5

Example of check digit calculation

- Example (EAN 13):

Assume the barcode data = 9 780340 606 58X

1.7+0+4+6+6+8=31

2. 31 x 3=93

3. 9+8+3+0+0+5=25

3. 25+93=118

4. 118+X=120 (next highest number multiple of 10)

X=120-118=2

"Be healthy and stay safe"