

# 3 EAN Bar Codes

Bar codes are almost universal today and are used in just about every industry. They were first suggested for automation in grocery stores in 1932 in the thesis of a Harvard Business School student, but it was not until the 1950s that the idea of a scanner installed at check-outs was conceived. It took another two decades for a combination of technology advancement and economic pressure to bring about the commercial use of bar codes and optical readers in retail trading. In 1973 the *UPC* (Universal Product Code) was adopted as a standard. In 1976 a variation known as the *EAN* (European Article Numbers) was also standardised. Other types of bar codes, namely *Interleaved Two of Five* (ITF) and *Code 3 of 9*, have also been developed (see Units 8 and 9).

In the UK, the *Article Number Association* was formed to administer and promote the use of article numbering. The association has now merged with the Electronic Commerce Association under the trading name e.centre.

[www.e-centre.org.uk/](http://www.e-centre.org.uk/)

There are two types of commonly used bar codes: 8-digit and 13-digit.

The 8-digit codes are most commonly used on products sold in only one country.

## 8-digit EAN

Three examples of 8-digit EAN symbols are shown opposite. These are used by large stores for their own brands.

Each bar code consists of

- left hand guard*
- left hand four numbers*
- centre guard*
- right hand four numbers*
- right hand guard.*

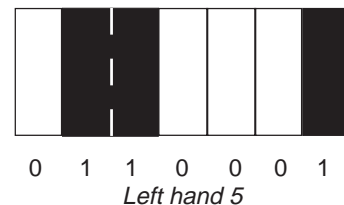


Looking at the code for each number, you will notice that the representation of a number is dependent on whether it is on the left or right hand side. In fact, each representation is designed using a *seven* module system. For example, a magnified left hand side 5 is shown below (the dashes are shown here to emphasise the seven module design – they are not actually shown on the code).

Each number has two white and two black strips of varying thickness, following the rules that

- the first module must be white
- the last module must be black
- there are in total either 3 or 5 black modules.

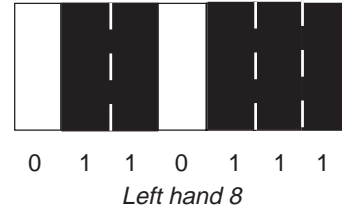
A convenient way of representing each number is given by using 0 (white) 1 (black) giving 0 1 1 0 0 1 for 5, as shown opposite.



Here is another example that uses 5 black modules; it can be written as

0 1 1 0 1 1 1

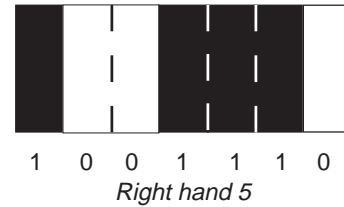
and it represents 8 on the left hand side of a code.



### Activity 1 Left hand codes

With the rules listed above, write down all the possible codes for left hand numbers.

Appendix 1 gives the complete set of codes for left hand numbers – called *Number Set A*. The codes for the right hand side are determined by interchanging 0s and 1s (i.e. white and black interchanged) – called *Number Set C*.



The two sets of codes are used so that the computer can recognise whether it is reading the numbers from left to right or from right to left.

These bar codes, as with ISBN numbers, incorporate a check digit as their final digit. It is chosen so that,

$$3 \times (\text{1st} + \text{3rd} + \text{5th} + \text{7th number}) + (\text{2nd} + \text{4th} + \text{6th} + \text{8th number})$$

is exactly divisible by 10. For example, for

**0 0 3 6 8 1 2 4**

it means that

$$3 \times (0 + 3 + 8 + 2) + (0 + 6 + 1 + 4) = 3 \times 13 + 11 = 39 + 11 = 50$$

is exactly divisible by 10.



### Example

Find the check digit,  $x$ , for the 8-digit EAN code

**5 0 2 1 4 2 1  $x$**



### Solution

The number

$$3 \times (5 + 2 + 4 + 1) + (0 + 1 + 2 + x) = 36 + 3 + x = 39 + x$$

must be exactly divisible by 10, so  $x = 1$ .



## Exercise 1

Find the check digits for the following 8-digit EAN codes.

- (a) 0 0 0 8 6 3 9
- (b) 5 0 2 1 4 2 1
- (c) 0 0 4 2 6 5 5



## Exercise 2

Do the following 8-digit EAN codes have the correct check digits? Correct any check digit that is wrong.

- (a) 0 0 0 3 4 5 4 8
- (b) 0 0 3 9 6 3 4 9
- (c) 5 0 1 6 8 6 2 2

The check digit is a means by which the computer can confirm that it has correctly read the number. On products that are not flat, such as bread, where the number could easily be mis-read, this is important. If the scanner cannot read the number correctly it is usually keyed in by the checkout assistant.



## Activity 2 Errors

- (a) The 8-digit EAN code  

**5 0 2 6 8 0 2 0**

 has one error. Can you identify it?
- (b) If the computer reads *one* of the first seven digits incorrectly, will the check digit always now be incorrect?



## Activity 3 Errors

Instead of using a 7-module framework for each number, use an 8-module framework. How many distinct patterns are there now? Do you need to change the rule(s) above?

## 13-digit EAN

Examples of this code are found on many grocery products. Three such codes are shown opposite.



The first digit, which as you can see is not represented directly in the code, together with the second digit, indicates the country in which the article number was allocated; e.g. 50 represents the UK, 31 represents France, etc. The next five digits are issued to a



particular manufacturer, and the next five identify the product. The final number, as in 8-digit bar codes, is the check digit.

All six right hand numbers are coded using number set **C** but the six left hand numbers are coded using a combination of number sets **A** and **B** ( see Appendix 2) according to the first digit. For example, if the first digit is 5, then the next six digits are coded according to the number sets **A B B A A B**.



### Activity 4

Using the tables in Appendix 3, can you see how number set **B** is obtained?



### Activity 5

Using three As and three Bs, how many different possible combinations exist for the coding of the six left hand numbers in the code?

In fact, the first digit 0 uses the code **A A A A A A**, whereas all other first digits are coded using 3 As and 3 Bs as indicated in Appendix 3.

So when the computer reads a 13-digit EAN code,

- it determines the number sets used for the first left hand side number,
- the extra left hand number is found from the chart in Appendix 3,
- the computer now checks the check digit for the whole 3-digit number (see below).

A method similar to that used for 8-digit EAN codes is used for determining the check digit, except that all 13 numbers are included, so that the number

$$3 \times (2\text{nd} + 4\text{th} + \dots + 12\text{th number}) + (1\text{st} + 3\text{rd} + \dots + 13\text{th number})$$

must be divisible by 10.



### Example

Show that the 13-digit EAN

5 0 0 0 1 5 9 3 1 9 8 2 9

has the correct check digit.



### Solution

We need to check that

$$3 \times (0 + 0 + 5 + 3 + 9 + 2) + (5 + 0 + 1 + 9 + 1 + 8 + 9)$$

is divisible by 10. This gives

$$3 \times 19 + 33 = 57 + 33 = 90$$

which is divisible by 10.



### Exercise 3

*Check that the three 13-digit EAN codes shown earlier have correct check digits.*

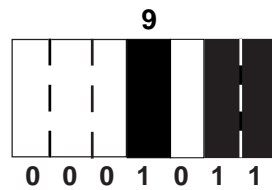
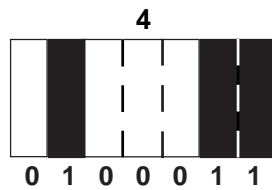
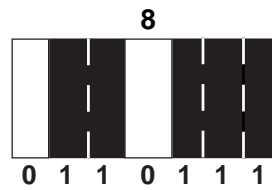
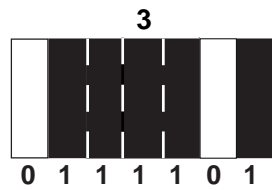
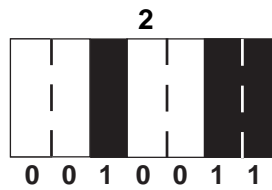
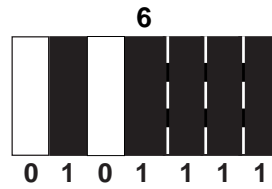
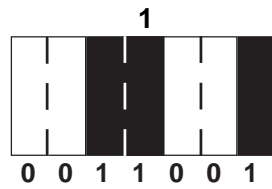
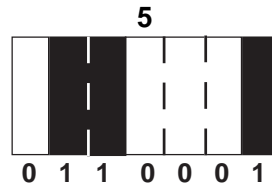
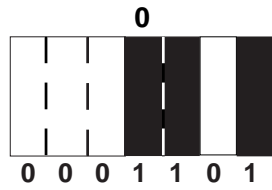


### Activity 6

How could you design a bar code system that codes letters and digits?

# Appendix 1

## Left hand codes



# Appendix 2

## Number sets

Value of digit	Number set A (odd)	Number set B (even)	Number set C (even)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			

# Appendix 3

## Coding system for left-most digit of EAN 13

<b>Value of digits</b>	<b>Number sets for coding left hand numbers</b>
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