

## Barcode Symbology information and History



### Telepen Symbology

- Devised by George Sims, Chairman of SB Electronic Systems Limited, in early 1972
- Only symbology to directly represent the full ASCII character set without shift characters
- Double density numeric only mode
- Very compact. Up to 8 ASCII characters or 16 digit per inch
- Easy to print. Fixed 3:1 ratio. Tolerance at least 0.4x
- Extremely secure. Negligible risk of misreading
- Supported by most leading manufacturers

### History and Description

The original motivation to develop a bar code system goes back to 1971. Computer technology had developed very rapidly but not the means to enter data into computer systems. This was particularly apparent with a very successful system for automating hospital biochemical laboratories where there was a need for fast accurate input of test request data and the correct identification of patients and samples.

This application, together with the potential for others such as point of sale, provided sufficient motivation to set up a company in 1972 to develop a hand-held black and white bar code system.

Although another British and an American company were also working along these lines, this was not known and it was therefore necessary to devise a symbology.

The perceived requirements were as follows:

1. Representation of full ASCII character set.
2. Space required should not exceed twice that for human-readable printing
3. Possible to produce on conventional printers
4. Very high security
5. All characters should take up the same amount of space

It was considered that any general-purpose data entry device should be capable of handling the full range of characters.

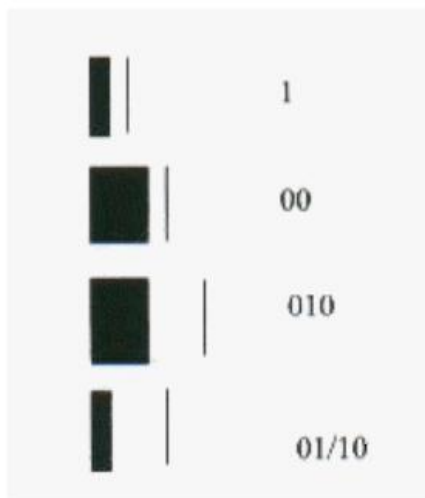
The information content of any symbology is clearly of crucial significance.

For widespread acceptance of the technology it was considered essential that it should be possible to generate the code with conventional printer mechanisms, especially as the fundamental concept is machine-readable data on ordinary paper.

Since a major benefit of bar coding is accuracy, negligible misreading was considered absolutely vital.

The length of the code for a given number of characters clearly should not vary with the data. Adjusting the widths of the bars within a character to achieve this is also not acceptable.

A wide to narrow bar ratio of 3 : 1 is implied, since in order to fulfil the conventional printing requirement an integral relationship is necessary and 2 : 1 does not allow sufficient margin for print tolerances.



There are four possible combinations of wide and narrow bars and spaces. Ideally one would like these to represent binary data in order to simplify decoding.

If the first pattern is defined as representing binary 1 there is, at first sight, no way of representing binary 0 in the same space. It is, however, possible to represent binary sequences.

We need to be able to represent binary 00, 010, 0110, 01110, etc.

The second pattern, which is twice the width of the first, may be defined as representing binary 00.

The third pattern, which is three times the width of the first, may be defined as representing binary 010.

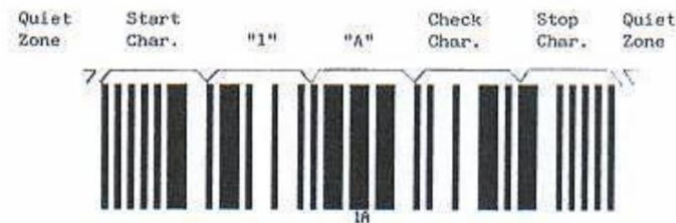
The fourth pattern may be defined as representing binary 01, sequences, 01110 etc. could easily be represented by just inserting the first pattern missing line appropriately in between. There, is of course, no possibility of a fifth pattern and the scheme would appear to fail. Fortunately, however, it is not necessary to repeat the fourth pattern since binary 01 01 would be encoded as 010 1. It is therefore possible for it to represent 01 and 10 alternately.

As an example, 01110 is encoded by:



A binary string may now be extremely efficiently encoded. Exactly twice as efficiently as, for example, Plessey code. Although multi-width symbologies such as EAN and Code 128 appear to have good packing densities, very much tighter tolerances are required, so that for a given printing method they are not nearly as efficient. Reading is also, of course, more difficult.

The benefit of a fixed wide to narrow ratio should also not be overlooked. Although tolerances may vary with the ratio, the decoder has to allow for the specified range. Ability to detect a transition is the only criterion in defining tolerances. Scanner spot diameter may also be greater in relation to the module width if accurate measurement is not necessary.



There are two further levels in defining a complete **Telepen** symbology.

Firstly, with the above procedure 8-bit even-parity characters are encoded least significant bit first, as with serial data transmission.

Secondly, the data characters together with a start code, stop code and block check character are formatted into the complete symbol.

Although the symbology allows for intercharacter gaps, since the width of the last space is implied, readers normally check for continuity so the standard is defined without gaps.

The front (start) code is binary 01011111 (ASCII\_)

The rear (stop) code is binary 11111010 (ASCII z) When reading forward a wide black bar is encountered first following a series of narrow bars, which may be used by the reader for synchronisation if required.

When reading in reverse a wide space is encountered first after the same series of narrow bars.

The block check character is modulo 127.

The symbol is very secure as, in addition to the powerful block check characters, a valid end code is required as well as even/parity/binary characters and sensible ratios.

An interesting additional attribute of the check character is that it is impossible for two specks or for two voids to compensate for each other.

There is no mirror image problem.

Encoding or decoding may, of course, be accomplished by reference to a table of character patterns as with other symbologies. The ability to directly decode into binary potentially enables real-time decoding with high-speed laser scanners. Telepen was originally decoded by TTL logic since microprocessors were not then available.

For numeric-only applications, twice the packing density may be achieved by packing two digits into one character. Of the remaining 28 characters, 10 pack 0X – 9X and the rest stay as control characters. It should be noted this is just a procedure for packing data and is not strictly related to the symbology.

When generated at 80 dots per inch (nominal element width of 0.0125 inch) the actual packing density is 5 alpha characters per inch or 10 digits per inch.

At the maximum recommended density over 16 digit per inch is achievable.

Any future extended character sets may, of course, be easily accommodated by increasing the number of bits per character.

Telepen systems have been implemented in many countries and very widely in the UK. Most Universities and other academic libraries use **Telepen**, as do many public libraries.

Other users include the motor industry, Ministry of Defence and innumerable well-known organisations for many different applications.

**Telepen** is the only symbology to meet all the essential requirements.

The ultimate test is, of course, that **Telepen** has been used very effectively for over 25 years with no problems.

## Check Character Calculation

1. Add the ASCII values of each character excluding the start and stop characters.
2. Divide by 127.
3. Unless remainder equals zero subtract from 127.
4. The character whose ASCII value is the result is the check character.
5. In the unlikely event of wishing to encode just NUL characters the check character is exceptionally ASCII 127 (NUL).

## Example

Data: Telepen

ASCII values: 84+101+108+101+112+101+110

Total: 717

$717/127 = 5$  remainder 82

$127 - 82 = 45$

Check character is – (minus sign)

Note that in *Numeric Mode* the check character is based on the ASCII values of the characters representing each of the numeric pairs.

## Numeric Mode

If the reader encounters a DLE character (ASCII 16) when Numeric Mode is enabled this will not be transmitted but all subsequent characters in the block will be transmitted as ASCII characters without unpacking. The DLE character is of course included in the check calculation. This facility is very useful for being able to incorporate an alphanumeric suffix in the data or to transmit command information to the reader or computer. If the data consists of an odd number of digits and it is not acceptable to add a leading zero, insert a DLE character before the last digit and encode that as a normal ASCII character. Alternatively some readers allow an X character to be discarded or converted to another character such as NUL.

## AIM Telepen

The AIM Uniform Symbol Specification does specify two alternative sets of end codes. One allows the reader to determine that the symbol contains compressed numeric data. The other allows the DLE character to switch from ASCII mode into numeric mode. Not all manufacturers support this. See the AIM USS for details.

## Autodiscrimination

Telepen is fully distinguishable from and thus compatible with other symbologies. Some are, however, very unreliable and all are less reliable than Telepen so it is recommended that a reader's valid set of symbologies is restricted to those needed.

## Tolerances

Telepen is much more tolerant of printing errors than other symbologies. The maximum deviation from the nominal width of a bar or space should not exceed  $0.4x$  where  $x$  is the nominal width of a narrow bar or space. For open systems the minimum value of  $x$  is 0.0075 inch or 0.19 mm. For normal applications the recommended value of  $x$  should be between 0.010 inch and 0.0125 but will depend on the number of dots per inch produced by the printer and their diameter. Clearly a small tolerance will improve the reading range of a scanner and help with adverse optical effects.

If not normal printing on paper consideration should be given to the optical properties of the materials including the effect of any laminate applied. An example of a potential problem is that light from a laser scanner diffuses through plastic so that the amplitude of the signal returned from a wide space is greater than that from a narrow space.

It will probably be necessary to have more dots for the spaces than for the bars in order to equalise their width when printed. If the nominal width of the narrow bar is ***b*** and the narrow space ***w***, so that  **$b+w = 2x$** , then the width of the wide bar should be  **$2b+w$**  and the wide space  **$2w+b$** . The character width will then not vary.

## Fonts

Although the characters may be generated from first principles, printing will normally be accomplished by means of a Windows based application. A Windows font for Telepen is available free of charge from here:

<https://advanova.co.uk/wp-content/uploads/2022/05/TPAssist-Setup-4.zip>

There are two versions. One gives the standard height. The other is shorter so that different heights may be built up.

## Character Set

The full ASCII character set is shown below. Characters are sequential downwards.

# TELEPEN

