F E A T U R E S

Dotcodes

The Ideal Identification System For Exacting Applications

In many processes where automation has been introduced the need for identification of items, products and raw materials is indispensable. To facilitate this identification process, many different encoding systems have been developed, the barcode being the best known. But another code that encompasses many of the advantages of other encoding systems and adds a few of its own is the dotcode.

The Dotcode

A dotcode consists of a matrix of 6 × 6 to 9 × 9 points which can be empty or filled with a dot. The combination of empty and filled points form a binary number, giving a numeric or alphanumeric value (equivalent to a number or text). The corners of the matrix are always filled, so that the code can be read in all positions. The dependability of the system is greater than that of barcodes because it is not necessary accurately to measure the width of a bar, but only to distinguish if a dot is present or not. The dotcode is self-checking and the tolerances of the dots are determined by software.

Why Use a Dotcode?

Because the dotcode is readable in all positions, it is particularly attractive for applications where the position of the code carrier (the product) is unpredictable. But, above all, the dotcode is suitable for use in rough conditions because of the in-built security and the "wide" tolerances. Other reasons for using the dotcode are the high information density and hence its small size in comparison with a barcode. Some examples are:

- So that the shafts can be aligned during engine assembly, codes are put on the top. The shafts must be oriented correctly and the room for a code is limited, making the dotcode ideal for this application.
- During the manufacture of aluminium castings, the semi-manufactured parts must be identified. Because of the high temperatures in the furnaces and the fact that no foreign matter may be used, the code cannot be applied in the normal manner. Therefore the dotcode is applied in the form of small indentations in the shafts. This makes the code perfectly readable in every position.
- Dotcodes on beer and lemonade crates give information about the production of the crate and its contents The brewery uses this information to sort crates automatically and to take specified crates out of circulation. The dotcode is used here because of the cheapness of the application, the small size and the small risk of damage (see Figure 1).
- Finally, an added advantage is that even faded codes can be read. This is particularly important in laundries where every piece of clothing is marked with a label, as the code fades with every wash. The dotcode makes it unnecessary to replace the code after only a few washes. The code may even be lightly crumpled or crookedly delivered. Because of the small size of the label, it is more comfortable to wear and hardly even shows (see Figure 2).

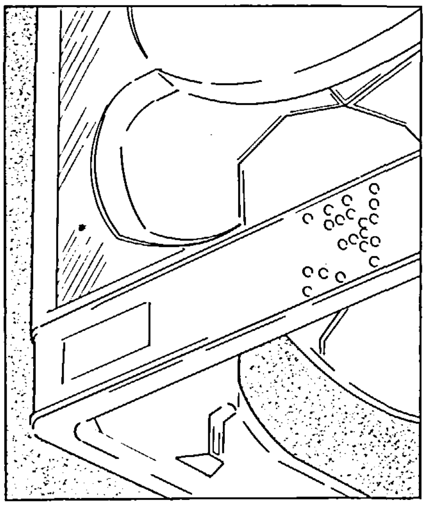

Figure 1. Use of Dotcodes on Beer and Lemonade Crates

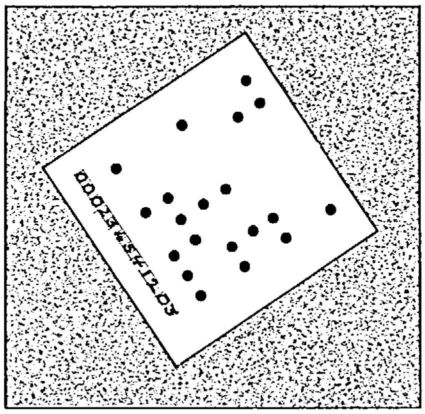

Figure 2. Laundry Label

The Video Camera

A low cost video camera is used to read the dotcode. This compact camera is simple to mount, thanks to the c-mount screw fittings making it suitable for mounting on a wide range of objects. The use of a CCD IC in the camera guarantees long life.

The Dotcode Reader

Philips have developed a fast and flexible dotcode reader. A maximum of four cameras can be connected to one dotcode reader, depending on the application and required response time. An unmanned reading station can have one or two cameras connected, the maximum four cameras being used in a manually operated station.

The Monitor

During installation or maintenance of the system a monitor is used to adjust the cameras. This shows if the camera is sharply focused and if the code is well positioned on the screen. The monitor is also used to position the label for reading points where the dotcode is positioned by hand.

The Computer

The dotcode reader passes the decoded number to a computer. The computer then takes the necessary action.

Reading Codes at a Distance

The reading distance of a camera is dependent on the lens. The greater the focal length, the greater the reading distance. Normally this is between zero and two metres, but this can be extended using telephoto lenses. By choosing the correct focal length, a camera can easily be integrated into an existing production process.

Which Code for Which Application?

The code that you choose to use is dependent on the application. It can be numeric or alphanumeric and have differing lengths. This makes it possible to replace a serial number (normally used in factories) by information contained in the dotcode (for example, an article's name, or a name with postal code and house number). The amount of information that can be contained in a dotcode depends on the number of dots used. Therefore there are dotcodes with formats of 6 × 6, 7 × 7, 8 × 8 and 9 × 9 dots. To give an impression of the capabilities, a 7 × 7 dotcode gives over 2,000 million possibilities.

Dotcode Specification

The following specification outlines the most important criteria for the production and reading of the dotcode.

Main Values of the Dotcode

- centrepoint distances between two dots = twice dot diameter;
- 6 × 6 up to 9 × 9 matrix;
- within a zone of twice the dot diameter around the total dotcode matrix, no other dots (neither neighbouring matrix nor alien) are allowed;
- within the dotcode matrix are no additional dots are allowed (other than belonging to the matrix);
- removal of dots within the coding is not allowed;
- coding is allowed to be created as black dots and white background or vice versa.

Tolerances

- The allowed tolerances of the dotcode are calculated from the absolute values, controlled by the corner dots and dot diameter: theoretical dot distances (centre point) = centrepoint distance corner dots/codesize −1).
- The dots have to be positioned within a circle of 0.6 times the theoretical centrepoint distance of the dots, with the centrepoint as the optimal theoretical location.
- The dot size equals centrepoint distance/2, with an allowed variation in dot diameter of 5 per cent within one dotcode matrix.
- The allowed deviation in horizontal and vertical centrepoint distance of the corner dots equals dot diameter divided by ten (see Figure 3).
- The allowed deviation between dots at the diagonals is equal to the dot diameter divided by ten (see Figure 3).
- The minimum contrast difference between the dots and the remaining surface of the matrix is 80 per cent. Contrast variation within the dots is allowed, as long as the minimum contrast is obtained.
- The code carrier (substrate) transparency has to be taken into account for calculation of the contrast.
- The edge of the dot has to be regular in such a way that a variation in diameter is within ±5 per cent. Outside these borderlines, the minimum contrast difference is valid.
- If dots cannot be pressed or printed, the possibility exists of creating the dots by holes or even heights in the surface. For these codes, the same tolerances are valid (as for the printed zones). The shape of the dot, however, is dependent on material, illumination, read-out cycle, and environmental factors. Philips should be consulted to create an optimum for various applications, with regards to dot type, shape and angle.

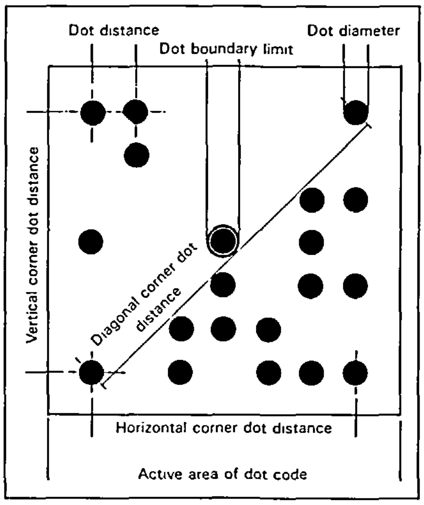

Figure 3.

Dotcode Structure

Dotcodes consist of a square $N * N$ matrix, partially filled with circular dots. The four corner dots always have to be present. Four other dots — or rather the absence of three and presence of one — contain the information in the orientation of the matrix. Two more allow information on mirrored codes. In total, ten dots are required for orientation.

To prevent erroneous read-outs — owing to contamination or other reasons — a CRC check has been added in the dot pattern. CRC stands for cyclic redundancy check (see Figure 4). It is a method of checking the printed or marked code, rather like a check-sum at the end of a data block. The decimal code is converted to binary. Then eight zeros are added to the end. A random number, in this case Octal 407, is "exclusively-or" -ed with the binary code until all the digits of the original binary numbers are reduced to zero. The number left in the place of the added eight zeros is the check. Hence eight dots are reserved for CRC. When the computer reads the code, it carries out the mathematics and compares the result with the check result.

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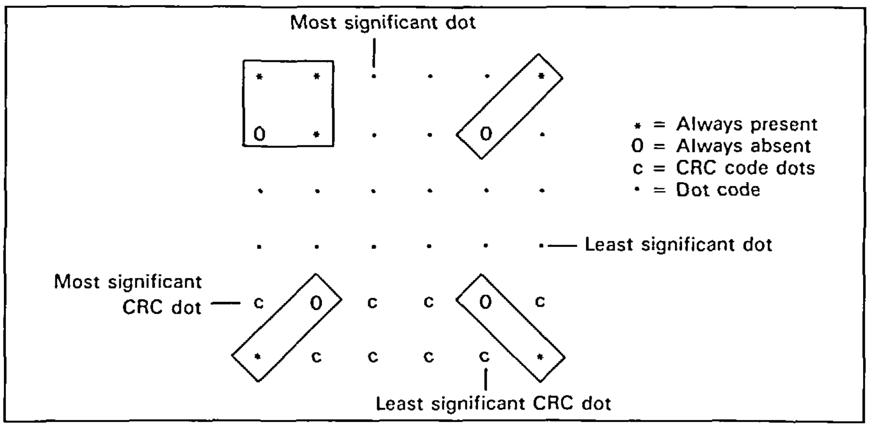

Figure 4. 6 × 6 Code