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Barcode Symbology Reference Guide

A guide to assist with selecting
the barcode symbology

This document Provides background information
pertaining to the major barcode symbologies to allow
the reader to understand the features of the codes.

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Introduction

This reference guide is intended to provide some guidance to assist with selecting the barcode symbology to be applied to the Omni-ID products during Service Bureau tag commissioning.

This document Provides background information pertaining to the major barcode symbologies to allow the reader to understand the features of the codes. This guide provides information on the following barcode symbologies;

• Code 128 (1-D)

• Code 39 (1-D)

• Code 93 (1-D)

• Codabar (1-D)

• Interleave 2of5 (1-D)

• Datamatrix (2-D)

• Aztec code (2-D)

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• QR Code (2-D)

Code 128

Code 128 is one of the most popular barcode selections. Code 128 provides excellent density for all-numeric data and good density for alphanumeric data. It is often selected over Code 39 in new applications because of its density and because it offers a much larger selection of characters. The Code 128 standard is maintained by AIM (Automatic Identification Manufacturers).

The Code 128-character set includes the digits 0-9, the letters A-Z (upper and lower case), and all standard ASCII symbols and control codes. The codes are divided into three subsets A, B, and C. There are three separate start codes to indicate which subset will be used; in addition, each subset includes control characters to switch to another subset in the middle of a barcode. Subset A includes the standard ASCII symbols, digits, upper case letters, and control codes. Subset B includes standard ASCII symbols, digits, upper and lower case letters. Subset C compresses two numeric digits into each character, providing excellent density.

Each character is 11 times the width of the narrowest bar; using a minimum bar width of 0.010" each character would be 0.11" wide. Using the 0.010" figure, 20 data characters plus start code, check digit, and stop code would measure 2.55" wide (the stop code is 13 times as wide as a narrow bar). Using Subset C with all-numeric data provides 2:1 compression of the data for a total width of 1.45".

Each character consists of 3 bars and 3 spaces, each of which may be 1, 2, or 3 elements wide (1 element = 1/11th of the character width). The bars always use an even number of elements and the spaces use an odd number. This provides the basis for a character-by-character consistency check during scanning. In addition, each Code 128 barcode includes a Modulo 103 checksum.

Code 128 barcodes are often used in the shipping and packaging industries.

Code 39

Code 39 is another widely used barcode symbology.

The Code 39-character set includes the digits 0-9, the letters A-Z (upper case only), and the following symbols: space, minus (-), plus (+), period (.), dollar sign ($), slash (/), and percent (%). A special start/stop character is placed at the beginning and end of each barcode. The barcode may be of any length, although more than 25 characters results in a very large code.

Each character consists of 9 elements: 5 bars and 4 spaces. Each character includes 3 wide and 6 narrow elements. Characters are separated by an inter-character gap which is the same width as a narrow bar. The ratio of wide: narrow bar width may be in the range of 1.8 to 3.4. Barcodes with a narrow bar width of less than 0.020 inches (0.508mm) should have a ratio of at least 2.5. A ratio of 3.0 is recommended. Every Code 39 barcode should be preceded and followed by a quiet zone the width of at least 10 narrow bars.

Code 39 barcodes are used in many industries and is the standard for many government barcode specifications, including the U.S. Department of Defense. Code 39 is defined in American National Standards Institute (ANSI) standard MH10.8M-1983, and is also known as USD-3 and 3 of 9.

Code 93

Code 93 is a more compact version of Code 39. It encodes exactly the same characters as Code 39, but uses 9 barcode elements per character instead of 15.

Code 93 is a really good bar-coded if limited space is available or long data strings (above 20 characters) are required.

Code 93 is used extensively in the Postal services.

Codabar (USD-4, NW-7 and 2OF7 code)

An older symbology; Codabar can encode the digits 0 through 9, six symbols (- : . $ / +), and the start/stop characters A, B, C, D, E, *, N, or T. The start/stop characters must be used in matching pairs and may not appear elsewhere in the barcode.

Codabar is used in libraries, blood banks, the overnight package delivery industry, and a variety of other information processing applications.

Interleaved 2 of 5 (code 25, I2OF5, ITF, I25)

Interleaved 2 of 5 is a numeric-only barcode widely used in warehouse and industrial applications. The data must consist of an even number of digits.

Each data character is composed of 5 elements, either 5 bars or 5 spaces. Of these 5 elements, two are wide and three are narrow. Adjacent characters are interleaved, alternating the spaces from one character with the bars of the other.

Datamatrix

DataMatrix is a two-dimensional barcode which can store from 1 to about 2,000 characters. The symbol is square and can range from 0.001 inch per side up to 14 inches per side. As an example of density, 500 numeric only characters can be encoded in a 1-inch square using a 24-pin dot matrix printer. The sample shown encodes 20 ASCII characters.

DataMatrix is being used to encode product and serial number information on electrical rating plates; to mark of surgical instruments in Japan; to identify lenses, circuit boards, and other items during manufacturing. DataMatrix symbols require a 2-D scanner; they cannot be read using an ordinary linear barcode scanner.

Aztec code

Aztec Code is a 2-dimensional style barcode symbology. The symbol is built on a square grid with a bulls-eye pattern at its center for locating the code. Data is encoded in a series of circles around the bulls-eye pattern. Each additional circle completely surrounds the previous circle causing the symbol to grow in size as more data is encoded. A dark module is a binary 1 and a light module is a binary 0. The code is orientation independent.

The smallest Aztec Code symbol is 15x15 modules square, and the largest is 151x151. The smallest Aztec Code symbol encodes 13 numeric or 12 alphabetic characters. The largest Aztec Code symbol encodes 3832 numeric or 3067 alphabetic characters or 1914 bytes of data. No empty zone is required outside the bounds of the symbol.

An Aztec code barcode is used by the railway industry for tickets sold online and printed out by customers. Aztec has also been selected by the airline industry for the electronic boarding passes.

Aztec code symbols require a 2-D scanner; they cannot be read using an ordinary linear barcode scanner.

QR code

The QR Code (Quick Response Code) is a 2-dimensional matrix code. It can encode up to 2509 numeric or 1520 alphanumeric characters and offers three levels of error detection. The smallest QR Code measures 21 X 21 cells (each cell encodes one bit) and can grow in increments of 4 cells to a maximum size of 105 X 105 cells. The squares in the bottom left, top left, and top right corners are locator patterns.

The QR Code was developed in Japan by the Nippondenso Company; it was introduced in 1994 at the Japan Scan-Tech show and was submitted to AIM for consideration as a standard in 1996. QR code symbols require a 2-D scanner; they cannot be read using an ordinary linear barcode scanner.

PDF-417 standard and micro

PDF-417 is a two-dimensional barcode which can store up to about 1,800 printable ASCII characters or 1,100 binary characters per symbol. The symbol is rectangular; the shape of the symbol can be adjusted to some extent by setting the width and allowing the height to grow with the data. It is also possible to break large amounts of data into several PDF-417 symbols which are logically linked. There is no theoretical limit on the amount of data that can be stored in a group of PDF-417 symbols.

The capacity of PDF-417 can be helpful in applications where the data must travel with the labelled item, where a host database is not always available for quick look-up. PDF-417 is being used for hazardous materials labelling; storing technical specifications and calibration data on electronic instruments; encoding fingerprints and photographs on the backs of drivers' licenses.

The maximum data density is determined by the smallest elements which can be reliably printed and scanned. Using the smallest recommended element size of 0.0075" wide and 0.010" high, the maximum data density in the binary mode is 686 bytes per square inch (106.2 bytes per square centimeter). In the printable ASCII mode the density is 1,144 characters per square inch (177.2 characters per square centimeter).

PDF-417 symbols require a 2-D scanner; they cannot be read using an ordinary linear barcode scanner.

Omni-ID

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Omni-ID is the leading supplier of passive, low-profile UHF RFID solutions. Through our patented technology, Omni-ID "cracked the code" to overcome the problems traditionally associated with RFID, enabling a broad range of new applications that improve accuracy and efficiency in asset tracking, supply chain management and work-in-process.

Our family of versatile RFID tags works reliably in the harshest environments, including on, off, and near metal and liquids and excels in solving tracking and identification challenges with unprecedented accuracy.

With offices in the USA, UK, Asia and India backed up by a purpose-built manufacturing facility in China, our mission is to drive the widespread adoption of RFID and wider IoT technologies as the optimal tracking and identification devices.

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