OVERVIEW

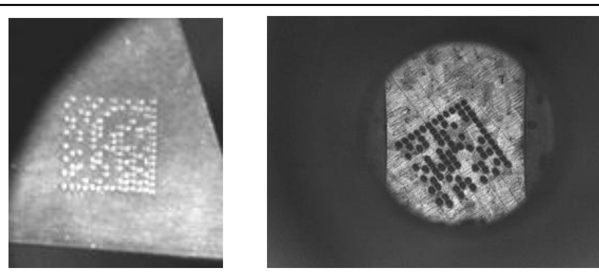
Direct Part Mark Bar Code according to InData Systems

Direct Part marking with bar code symbols has had increasing momentum in recent years as the need for traceability of parts history (manufacturer, materials used, etc), long after they have been put into service, has become necessary. Marks made with ink jet printing, laser etching, chemical etching, dot peening, and fluorescing inks are a few of the methods adopted so far. We will mainly focus on the use of Data Matrix since it appears to be the bar code of choice by most small parts marking applications.

Figure T1: ECC 200 Reference Symbol Encoding "30Q324343430794<OQQ"

Data Matrix bar code, like that pictured above, can be printed with virtually any size element as long as the rest of the criteria for the bar code is followed accurately. AIM (Automatic Identification Manufacturers) has established a standard for Data Matrix bar codes and we will assume the use of the ECC-200 (Error Correction Code methodology) standard for this document, although it is really not a restriction. The air transportation industry has adopted their ATA SPEC 2000, which is one of the first attempts of the industry to address quality aspects of direct part marking. The U.S. Government has also released their IUID (Item Unique Identification) directives through their MIL-STD-130M, which draws on the 14514 ANSI Standard for labeling on AN9132 direct part marks.

Quality has been the biggest issue in the use of direct part marks. If the mark is printed with a ribbon onto a paper label, there are many fine software products that can create a barcode with very accurate dimensions. The problem of etching directly onto a part causes not only the material, but the finish of the material, to assume some of the quality of the imprinting. Based on the metallurgical or chemical composition of the part to be identified, the best method of directly marking it varies. Some materials (like softer metals and some plastics) react very well with a low energy laser beam, while other materials require significant care (like directly etching glass due to the “crazing” or micro-fractures that can occur under the instantaneous high heat of a laser).



Samples of Dot peened materials

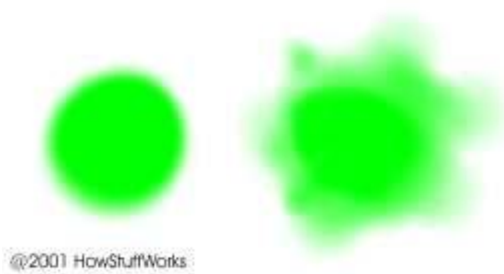
The actual accuracy of the etched mark depends on the correct choices of power, frequency and software, as it relates to the material being etched when using lasers, and similar considerations when using chemical etching and dot peening. It is easy to under-etch or over-etch the bar code if quality is not monitored closely. Over or under etching causes the individual elements to be outside the parameters outlined by the AIM and other specifications. Some decoding schemes do not consider a dot peened mark like that on the left of the photo above, to be a “legal” formation of the code, due to the “L-pattern” (which is used as a finder pattern for data matrix identification) having breaks between each dot instead of being a continuous, solid line, like the one shown in the image above on the right.

A data matrix mark is either a square symbol, like above, or a rectangular format being twice as wide as it is high, but in both cases, it is formed by two sides being a “solid L-pattern”, with alternating timing marks on the other two sides. Marks are made with light and dark elements (reversed images are acceptable) but the ratio of dark and light elements should be 50% (with a minimum of 35% to maximum of 65% per the AIM standard). Please consult the AIM standard for more details at http://www.aimusa.org/ or http://www.aimglobal.org/ on the Internet.

Media on which you print plays a large part in the quality of your image in ink jet printing. Two factors affect that quality of image. Those factors are: brightness and absorption.

Brightness is determined by the surface of the media. A coarse surface will scatter light in several directions, while a smooth surface will reflect more light back in the same direction. This makes the surface appear lighter, which makes the image appear brighter.

When ink is sprayed onto a surface, it should stay in a tight symmetrical dot, and not be absorbed into the media. If too much ink is absorbed, a phenomenon called feathering occurs, and the ink spreads out in an irregular fashion and covers a larger area than the printer expects it to. Thus, the image looks fuzzy, especially at the edges. One way to reduce the feathering effect is to ensure a non absorbing surface as in high quality ink jet paper. Low absorption is the key to the high resolution capabilities of many of today’s inkjet printers.



The dot on the left is on coated paper, and the dot on the right is on low-grade copier paper. Notice how irregular and larger the right dot is compared to the left one.

Inkjet printers are capable of printing on a variety of media from paper to labels, to adhesive backed labels.

2D Direct Parts Marking Guideline for Surface Curvature

For marking and reading, flat surfaces are preferred over curved surfaces because the curvature of an item may interfere with proper marking and thus can distort the code. If the mark is made on a round or curved surface, the symbol height should be less than 16 percent of the diameter of the part, which is approximately 5% of its circumference. For Data Matrix codes, a rectangular symbol may be considered to provide greater readability on smaller circumference parts. Use of rectangular format should only be used as a last resort and should be agreed upon by all trading partners. Neither QR Code nor Aztec code, are available in a rectangular form. Figure 4 below illustrates the proper method for marking and lighting curved surfaces.

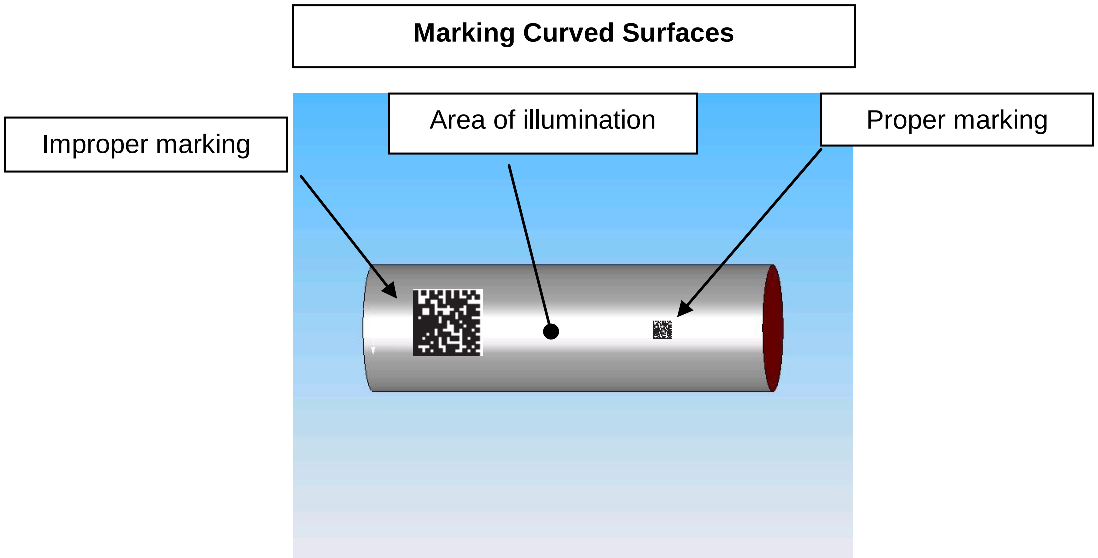


Figure 4

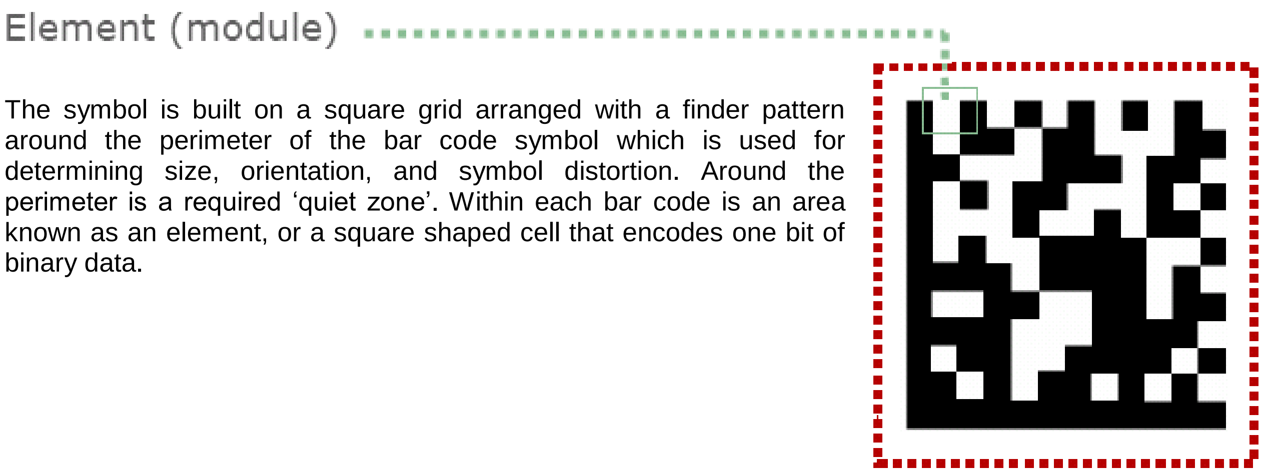
Thickness

Part or surface thickness must be taken into account when applying intrusive markings to prevent deformation or excessive weakening of the part. The degree of thickness required for intrusive marking is directly related to the heat, depth, or force applied. In most applications, the marking depth should not exceed 1/10 the thickness of the part. Part thickness is generally not a concern when applying non-intrusive markings such as a chemical etching.

About Bar Codes

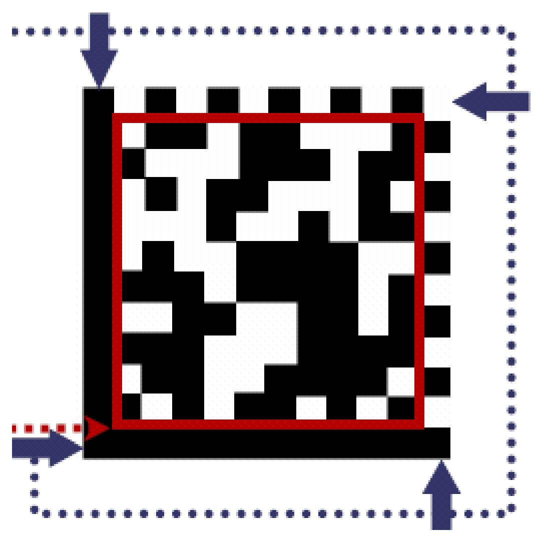
Data Matrix

Data Matrix is a high density 2 dimensional matrix style bar code that was first introduced in 1995. It uses symbology that can encode up to 3116 characters from the entire 256 byte ASCII character set. In the United States and much of the world, data matrix bar code is one of the most widely used 2D barcodes.



The symbol is built on a square grid arranged with a finder pattern around the perimeter of the bar code symbol which is used for determining size, orientation, and symbol distortion. Around the perimeter is a required ‘quiet zone’. Within each bar code is an area known as an element, or a square shaped cell that encodes one bit of binary data.

The symbol is structured with the Finder Pattern comprised of two solid lines and two alternating dark/light lines. It defines the physical size, orientation, distortion, and the number of rows and columns.



The Data Region is inside the pattern finder and contains data and error correction code words.

There are two types (square and rectangular) of Data Matrix symbols (or several if referring to ECC000 to 140 as one) each using a different error checking and correction scheme (ECC). The different types of Data Matrix symbols are identified using the terminology "ECC" followed by a number representing the type of error correction that is used by the encoding software. ECC 000 to ECC 140 are the original type of Data Matrix symbols, and are now considered obsolete. The newest version of Data Matrix is called ECC 200 and is recommended for all new Data Matrix applications.

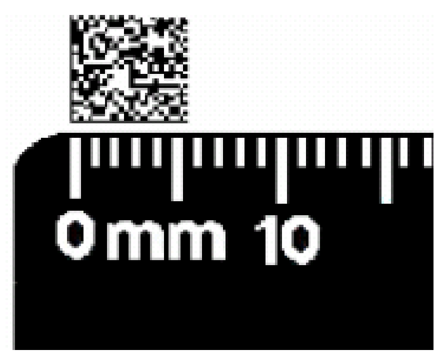
The ECC 200 version of Data Matrix uses a much more efficient algorithm for encoding data in a symbol as well as an advanced error checking and correction scheme.

The symbol can have multiple data regions. The alignment pattern separates the regions. The maximum capacity for a single data region is 88 for numeric, and 64 for alphanumeric. The symbol shape can be square (Figure 7) or rectangular (Figure 8). However, the rectangular shape is only applicable to ECC 200.

Figure 7

Figure 8

A symbol can encode 50 characters in a 6mm x 6mm square, and is readable in 360° with 2D CCD technology.



Field of View

Each optic has a field of view based on the focal length of the lens. The longer the focal length of the lens, the larger the field of view. InData Systems optics, each with its specialized type of lens allow the ability to see different types of direct part marks as well as different sizes of Data Matrix and linear bar codes. See the chart below for specific examples of which lens reads a particular size of barcode. In some cases an even smaller barcode can also be read.

The following Field of View Charts apply to both linear code and data matrix code:

M3	30 mm optic		40 mm optic		80 mm optic	
	in	mm	in	mm	in	mm
square	.25	6.2	.35	9	.6	15
narrow bar element	.005	.15	.007	.19	.010	0.25

V2	40 mm optic		80 mm optic	
	in	mm	in	mm
square	.35	9	.6	15
narrow bar element	.007	.19	.010	.25

The FAQ's in Appendix F of this manual give a verbal description of the reading capabilities of each lens.

Field of View for Interchangeable UV Optics

The suggested maximum size bar code for the interchangeable UV optic is .65 in. (16mm) square. The minimum size is affected by characteristics of the ink in which the fluorescing ink may cause the bar elements to appear significantly larger than the space elements. Fluorescing bar code marks created with an individual element of .010 in. (.38mm) or larger, are usually read easily. Reading of bar codes created with smaller elements may depend on the ink due to the 'blooming' effect of the fluoresced ink.