Direct Part Mark Bar Code according to InData Systems

Overview:

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

Data Matrix bar code, like that pictured above, can be printed with virtually any size of 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 SPEC2000”, which is one of the first industry attempts to address the quality aspects of direct part marking.

Quality has been the biggest issue in the use of the marks. If the mark had been printed with a ribbon onto a paper label, there are many fine software products that can create the barcode with very accurate dimensions. The problem of etching onto the part directly causes not only the material but also the finish of the material to become part 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 react very well with a low energy laser beam (like softer metals and some plastics) 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).
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. This over or under etching causes the individual elements to be outside of the parameters outlined by the AIM and other specifications. Some decoding schemes do not consider a dot peened mark like that below, 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.

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.

**InData Systems scanning options:**

InData Systems offers several different methods of reading direct marked bar codes depending on the surface finish and curvature.
Generally our LDS and LDS-V2 (InData Systems patent number 6,352,204 B2) are used when surfaces are smooth and the etched area is recessed or roughened. The concept is much like the use of a flashlight held parallel to the floor, showing every crumb and surface scratch as a shadow. With this scheme, the actual mark usually appears as a white mark on a black background. There are cases where the etched mark only needs to be causing the surface to be a different finish to use this method.

Our LDS-M3 (patent pending) was designed initially, to address a shiny CURVED surface that had been etched with a bar code. The surface was not of a consistent enough background, due to the curvature with the low-angle illumination of our V2. Our LDS-M3 has a broad “glowing” surface that is shining down onto the surface of the bar coded area with the object that is marked held at a precise angle relative to the “glowing surface” and the return optics to the imager. This set of angles causes the shiny background to appear lighter (rather than darker) than the marks by means of a broad illumination area. This works especially well on curved surfaces.

We have found selected cases where a target can be read with either style of optics due to selected properties of the material that is etched. Both styles of optics may also use specialty guides customized by InData Systems to assure the correct positioning of the scanner relative to the object, to make it easy to use.

**Technical Considerations:**

Due to the wide variety of surface finishes, depths of marks, and consistencies of the marks (voids and breaks in the “L-pattern” being the most detrimental effect) we may need to defocus the target (usually done by drawing the scanner back away from the near contact position) or change the “print-weight” (PRTWGT command) which offsets the interpretation (threshold) of the imager.

It is fairly easy to observe if the specific optic assembly will even have a chance to enhance the imager's view of an etched target by using the “QuickView” software tool. You can connect the scanner when it is in the serial communications mode and receive images downloaded from the scanner. Either “Grayscale” images (black and white but with varying shades of gray) or a true Black and White (images with NO gray in it – only black OR white) are available as options. The true Black and white image has some indication as to what the decoding firmware may attempt to process. See the images on the next page:
First obtain a serial interface cable if the scanner being used is of the HHP4410 variety (ie not a self contained portable like the HHP7400). Then, if the scanner is normally to be used in the keyboard wedge, you should start by scanning the “QuickView Mode temporary bar code”. This will allow serial communications to the scanner at 38400 baud until power is removed from the scanner, at which time it will revert back to the settings it had before. Then plug the serial cable into your PC’s serial port (#1 is preferred) and start up the program “QuickView”. This can be downloaded from the InData Systems website, the HHP website or is also frequently included on the InData Systems software CD.

Once you have QuickView communicating with the scanner you can start “seeing” what the scanner is “seeing”. First – attempt to read an etched bar code by aiming the scanner, in the recommended orientation, and pulling the trigger. If the code reads, the scanner will beep. If not – it will keep (temporarily) the last image that it saw in memory. In either case, type in the COMMAND box “IMGSHP” and click on the “send command” button. If all is communicating properly, a grayscale image will be downloaded and displayed on your PC. This picture can be saved by clicking the “file” then “Save-as” menu bar options and typing a name (and choosing a location) for the file. “Save-as” uses the bmp format and you need NOT type the file extension. The image that has its “ribbon” on top in blue – not gray is the image that will be saved.
If the “gray-scale” appears to have reasonable clarity of the “bars and spaces” then try to type “IMGSHP1D” in the command window and click on the “send Command” button. An image will download (usually quite a bit faster) that is JUST black and white. It is similar to what the decoding firmware will attempt to decode. If there is fairly clear definition of the bars and spaces without a major amount of speckles very close to the bar code symbol and the bar code is in specification so far as bar-space ratios, etc, it should usually have been decoded.

If, in the IMGSHP1D image, the bar code does NOT have a distinct clarity without speckles, then it may be necessary to either type PRTWGT3 or PRTWGT5 (or other weights shown on the InData Systems setup sheet) in the command box and “send command” again. You MAY then type (or cause the pull-down in the Command box to re-display the “IMGSHP1D” then “send Command” again. If you wish you may scan the bar code for this “PRTWGTx” command but you must then scan the sample target again to get the image back into the scanner to download. If the changing of the PRTWGT up to 6 or down to 2 does NOT give enough clarity (and therefore decoding) then we may need to use a different optics assembly or the etched bar code may be of insufficient quality to be read reliably. Sending the actual sample in to InData Systems’ analysis labs may speed up your assessment.

We have also found that the basis of the specifications that were incorporated into the SPEC 2000 quality standard are VERY relevant to the decodability of an etched (or even a labeled) bar code on a cylindrical object. The spec calls for no greater than 18 degrees of wrap around a round or curved object. It may be difficult to figure how large a target mark may be (or small the diameter of the object) before it is un-decodable. The principal problem is the distortion of the “straight” L-pattern and the timing marks. If the perceived curvature of any side of the bar code mark is greater than one half of an element – ie -down on both the left and right and up in the middle (our measurements imply this) then the scanner will probably not be able to read it.

One interesting fact that may be overlooked is that by making the mark SMALLER you can put that mark on a smaller diameter object. Accuracy of the mark is still a critical part of the process.

In Summary, InData Systems has developed and continues to refine, optics to read low contrast bar code symbols. We would welcome working with resellers, end customers and etched mark producers to improve the ease of reading direct part marks in a variety of environments. Our optics are available on hand held scanners AND Portable data terminals for the most dynamic uses in the field. Please contact your local HHP reseller to get assistance in solving your toughest challenges in direct part mark reading.