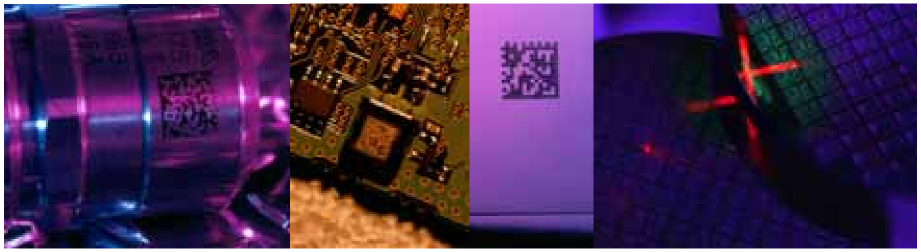
MICROSCAN

Guidelines for Direct Part Mark Identification



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1.

Introduction

— *These are only some of the many symbologies in use today.*

Code 128

PDF417

RSS

Data Matrix

QR

Bar codes have been successfully used to identify products since the 1970s when they were first introduced to the grocery retail business. Since then, they have been widely adapted by other industries. Nearly every shipping and receiving department relies on bar coding technology to improve inventory visibility. Today's manufacturer, however, can no longer be satisfied knowing how many raw components are coming in the door and the amount of completed product leaving the facility. Manufacturers must also know the status of their work-in-process inventory as well.

While the overall concept of product tracking is not new, the automated tracking of product down to the individual part and component level has proven to have even greater bottom-line impact. The most direct way to ensure complete quality control of the production process is to directly mark a part with a machine-readable code and track it through its entire life cycle. This is called Direct Part Mark Identification (DPMI).

Recognizing the benefits of direct part marking, many industry associations have already established standards for marking individual parts and components for a variety of applications. The EIA, SEMI, AIAG, DoD, and the SPEC 2000, aerospace industry have all adopted DPMI standards for applications in their industry.

Additional companies are using DPMI for their own internal applications. DPMI can be used to optimize line performance, identify defects, increase first-pass yields and as a result, reduce the costs of manufacturing. Manufacturers also rely on DPMI for identifying incoming parts for maintenance and returns, resolving warranty issues and liability claims as well as tracking high-value components to prevent theft.

Two dimensional symbols such as Data Matrix are the most common symbologies used for DPMI applications because of their small size, data capacity, error correction, and ability to be applied by a variety of marking methods. All a manufacturer needs is .1 inch of square space on a component and it can be marked with a 5 or 6 digit Data Matrix symbol. As a result, Data Matrix enables the traceability of components such as crystal oscillators or custom ASICs that in the past could not accommodate any type of machine-readable form of identification.

While 2D codes have been in existence since the early 1990s, the introduction of the smart camera designed specifically for reading linear and 2D codes has enabled the widespread adoption of the technology in the last few years. Smart cameras have succeeded where vision systems have failed in providing manufacturers with a robust imaging solution capable of high performance read rates on directly marked symbols with the ease of use and price point of a bar code scanner.

With more than 20 years experience solving auto ID applications, Microscan provides the necessary expertise to help you achieve success in your DPMI applications.

For more information on Microscan's complete product line of imagers and smart cameras, please call (425) 226-5700 or visit www.microscan.com.

2.

Symbology Selection

If your application does not have a standard, you may still benefit by reviewing standards for applications resembling your own.

Industry Standards

The first step in selecting a symbology is to familiarize yourself with applicable industry standards. Industry standards will dictate what symbology needs to be used, as well as other parameters such as density, data content, data syntax and other specifications. Each standard is different. Some provide the manufacturer with some flexibility, others do not. Please refer to *The Industry Specifications Table* for a list of current industry standards relating to DPMI applications.

INDUSTRY SPECIFICATIONS TABLE

International Standards	
ISO/IEC 16022	*Bar Code Symbology Specification – Data Matrix*
ISO/IEC 15415	*Bar Code Print Quality Test Specification – Two-dimensional symbols*
AIAG Standards	
B-1	*Bar Code Symbology Standard*
B-4	*Parts Identification and Tracking Application Standard*
B-13	*2D Symbology White Paper*
B-14	*Guidelines for use of Two-Dimensional Symbols with the B-10 Trading Partner Labels*
B-17	*2D Direct Parts Marking Guideline*
ATA and IAQG Standards	
ATA Spec 2000, Chpt. 9	*Automated Identification and Data Capture*
AS9132	*Data Matrix (2D) Coding Quality Requirements for Parts Marking*
DoD Standards	
MIL-STD-130	*Identification Marking of U.S. Military Property*
Electronics Industry Association (EIA)	
EIA 706	*Component Marking*
EIA 802	*Product Marking*
NASA Standards	
NASA-STD-6002	*Applying Data Matrix Identification Symbols*
NASA-HDBK-6003	*Application of Data Matrix Identification Symbols to Aerospace Parts Using Direct Part Marking Methods/Techniques*
Semiconductor Association (SEMI)	
SEMI T7-0303	*Back surface marking of double-sided wafers with a Data Matrix code*
SEMI T2-0298E	*Marking wafers with a Data Matrix code*
SEMI T8-0698E	*Marking of glass flat panel displays with a Data Matrix code*
SEMI T9-0200E	*Marking of metal lead-frame strips with a Data Matrix code*
SEMI T10-0701	*Test method for the assessment of Data Matrix code quality*

In addition to investigating industry standards, review the standard specifications established by ISO for the symbology. Many application challenges can be avoided simply by starting out with a good solid bar code. Following the specifications will help you accomplish this by giving you a solid foundation of the characteristics of the symbology.

Assessing Application Needs

For applications not related to a specific industry standard, it is important that you carefully evaluate the needs of your application before you select a symbology. First determine if you will be using linear bar codes or 2D codes. If you are unsure, ask the following questions:

Application Tips

- What are the goals of the application?
- What type and how much data will you need to encode?
- How much real estate is available for the symbol?
- How will the symbol be applied?
- Will the symbol be used for internal purposes only, or will it be read externally as well?
- Is symbol permanency a concern?

Two dimensional codes, such as Data Matrix, are more commonly used for direct part marking applications than linear codes. Data Matrix, for example, offers the robust Reed Solomon method of error correction and much higher data capacity.

Since Data Matrix uses only one element size to construct the code, it lends itself more easily to a broader range of marking methods than linear bar codes. Bar code symbologies rely on several different element widths to encode data, making it much more difficult to be generated with certain marking methods.

The main advantage to using a linear bar code is the ability to read it with a laser scanner. Since many direct part marks have low contrast levels, imagers often times provide a more robust reading solution.

— The MS-Q Imager from Microscan reads a variety of traditional bar codes and 2D symbols. The MS-Q Quadrus (shown here) specializes in hard to read codes directly marked onto parts.

3.

Readability

Readability is used to describe how well a reader can decode the symbol. The most important thing, before a project gets too far underway, is to be sure that you are creating the best symbology possible. It doesn't matter if you purchase an excellent reader that can read poor quality codes if others down the supply chain using less quality readers, can't decode it. Several different factors must be addressed to create a good quality code: contrast, quiet zone, error correction, element size, and mark consistency.

— Keep in mind that 2D codes can tolerate much lower contrast levels than linear 1D symbols.

Contrast

Strive for the best contrast possible between the light and dark elements of your symbol, whether it is a linear bar code or 2D symbol. Good contrast creates a strong bar code signal which makes it easier for the imager to differentiate between the light and dark elements of the symbol. This will make it easier for the imager to read the code as well as reduce the chance of noise interference. Good contrast also increases the ability to read at longer distances.

Quiet Zone

The quiet zone is the area surrounding the symbol that must be kept free of text, marks or objects. According to the ISO specification for Data Matrix, this space needs to be a minimum of a one element width surrounding the entire symbol. In a bar code, the quiet zone is commonly referred to as the space preceding the first bar and trailing the last bar in a bar code. As a general rule, this space needs to be a minimum of 10 times the width of the narrow bar in your bar code. The imager will not be able to read the bar code if text or any other mark encroaches into this area. This is the most frequently violated requirement when applying a bar code. In applications where space is at a premium, some products, such as Microscan's Quadrus EZ™ are a little more forgiving of quiet zone requirements. As a general rule, try to keep from violating the quiet zone when marking your symbol.

The diagrams below offer a more detailed look at specific parameters of a Data Matrix symbol.

Symbol Structure

Element (module)
- Square shaped cell that encodes one bit of binary data
  - – Binary "0"
  - = Binary "1"
  - Consistent size throughout code
  - Dependent on finder pattern color

Quiet zone
- AIM specification calls for a minimum of one element width (1X) on each side of the symbol

Structure finder pattern
- The outmost rows and columns
- Composed of two solid lines and alternating dark/light lines
- Used to define physical size, orientation, distortion and the number of rows and columns

Data region
- The area inside the finder pattern
- Contains data and error correction code words

Error Correction

When selecting the error correction level, unless you are adhering to a standard that says otherwise, be sure to select ECC 200 if you are using Data Matrix. This incorporates the robust Reed Solomon method of error correction, ensuring the maximum data security for your symbol. If your symbol is damaged in some way – scratched, a corner torn off or ink blotches on it, the symbol may still be readable. Since most products in the industry have standardized on ECC 200, you will have more hardware options to choose from.

— Although highly damaged this symbol can still be read with imagers such as the Quadrus EZ and MS-Q.

Element Size

Always make the symbol as large as possible. Even though 2D codes can be marked as small as 50 microns (2 mil), it is not recommended unless the application requires it. In most applications, a larger symbol is easier to mark and read accurately, and will ensure a greater depth of field. In addition to making it easier for the reader to decode the symbol, you will most likely have more equipment options to choose from. More products on the market are capable of reading a 10 mil Data Matrix code than a 2 mil Data Matrix code.

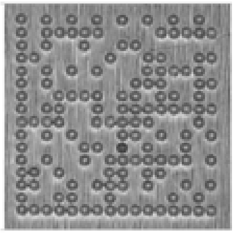
Mark Consistency

Mark consistency is critical in creating a readable code. Just because two codes appear identical to the naked eye, does not mean they look the same to the imager. Axial non-uniformity measures the consistency in spacing between the elements in both the x and y directions. In order for the 2D symbol to be readable, it is important that the elements are consistent throughout the symbol, forming a perfect square. If the symbol is not square, the distortion could be caused by slack in the marking system or from marking around a curved surface.

While some variation in mark quality can be expected, try to avoid fluctuation as much as possible. Some marking methods are more prone to consistency issues than others.

For example, to ensure you are achieving consistent marks with an ink jet system, evaluate the cleanliness of the environment. How clean is the surface of the part before it is marked? Can cleanliness be controlled? Can the part be washed before marking? If the surface has debris, such as dirt or oil, the ink will adhere to the debris instead of the part, resulting in an inconsistent, poor quality mark.

If you are using dot peen, the hardness of the stylus must be properly matched to the hardness of the part. You will also need to select the best possible shape of the stylus for your application because it directly affects how light is reflected to the mark. When determining the depth of the mark, consider comparing the relationship between the marked and unmarked areas of the part. If the mark gets too crowded to the point that the elements are overlapping one anther, then it was marked too hard. If the elements are too spread out, then it wasn't marked hard enough.



The symbol here is a good example of consistent element spacing and good mark depth.

Mark Placement

Physical Location

When determining where to place the symbol on your part, choose a location that is free from surface relief. Surface relief can make it difficult for the reader to view the code. By casting shadows over part of the symbol, surface relief can also make it much more difficult to light the symbol evenly.

Keep in mind that the quiet zone is also considered part of your symbol and must be free from surface relief as well. No exceptions. Quiet zone violations are one of the most common reasons why readers cannot decode symbols. If marks, text or surface relief infringes on this area, the reader may not be able to locate the symbol.

Curved and Reflective Surfaces

Flat surfaces are usually preferred over curved surfaces for making symbols. If a flat surface is not an option, look for an area with a uniform curve such as a cylinder. Uniform curves are much easier to mark than complex curves. The degree of curvature, the amount of distortion caused by wrapping, and the reflectivity of the surface all affect the readability of the symbol. As a general rule, the smaller the diameter of the part and the more reflective the surface, the more difficult the symbol is to read.

Highly reflective surfaces such as polished stainless steel can also present a challenge because they are more difficult to light evenly than a non-reflective surface such as plastic. Flat illumination is often the most effective way to illuminate codes marked on reflective surfaces.

The following guidelines can be applied to successfully mark a curved part on a reflective substrate with a Data Matrix code:

Application Tip

- Format the Data Matrix symbol into a rectangle, as opposed to a square.
- Position the code on the part so that the width wraps around the curve instead of the length of the symbol. This minimizes the degree of symbol distortion caused by wrapping around the curve.
- Choose the smallest density size possible, taking care that the element size is not so small that surface noise interferes with the reader's ability to decode the symbol.
- In cases where the substrate is highly reflective, diffused exterior light can be applied to the application to evenly light the symbol.

— Parts with complex curves, such as the dimples on a golf ball, are most often evaluated on a case-by case basis to determine the best solution for reading the code.

Texture

Surface texture can create a lot of noise and interfere with the reader's ability to locate and decode the symbol. If possible, select a surface that is free from debris and texture. If this cannot be avoided, look for an area where the texture is uniform in magnitude and direction. For example, brushed aluminum or stainless steel. Textures that are random in magnitude and direction, such as rough cast iron, can be more challenging. As a general rule, Microscan recommends that the element size of the matrix code be a minimum of 5 times the size of the texture noise on the surface to avoid readability problems.

5.

Marking Methods

There are many methods to mark parts. Some of the more common ways are laser etch, dot peen, electro-chem etch, and ink jet. Selecting the best method for the application is critical to achieving success. Since each method has its own advantages and limitations, it is important to educate yourself on as many methods as possible and experiment on sample parts before selecting the one for your application.

Electro-Chemical

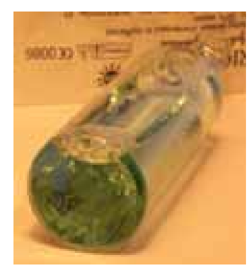
This marking process uses a low voltage electrical current to pass through a stencil to the part's surface. In order for this method to work, the part must have a conductive metal surface. This method will not work for anodized, powder-coated or non-conductive coatings. Unlike other permanent marking methods, electro-chemical etching does not weaken or distort metal parts because the molecular structure of the part is not altered beyond the depth of the mark. As a result, very thin-walled parts and those with fine surface finishes can be safely marked without damage. Since electro-chemical etching is a more involved process than other methods, it is not suited for highly automated applications and is commonly used for small product runs.

Ink Jet

This type of marking uses small, circular dots that are sprayed directly onto the surface of the part. Ink jet typically produces high contrast marks, depending on the substrate the symbol is applied to. Although permanent inks do exist, ink jet is not considered by some industry standards as a permanent marking method. Take care to ensure that you select the most appropriate ink for your substrate. Disadvantages include routine maintenance to prevent the jets from clogging, and the additional cost of consumables.

Laser Etch

This marking type uses lasers to etch the symbol directly into the surface of the part. In addition to producing a clean, high resolution mark on a variety of substrates ranging from metal to plastics to glass, laser-etching is also well-suited for automated environments requiring high volumes. Since the top layer of the part's substrate is removed during the etching-process, sometimes the minimal residue that results may not be suited for some clean-room applications. The type of laser (Yag, CO_2, YVO_4) must be matched to the application and will affect price considerably. While laser etching equipment has a higher entry cost than many marking methods, there is no additional cost of consumables and maintenance is minimal.

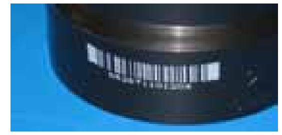
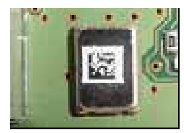
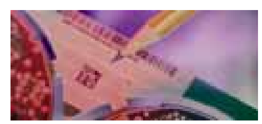
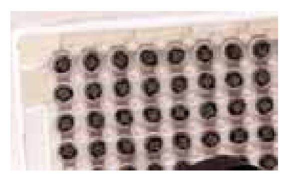


— Two examples of laser etching a symbol onto glass.

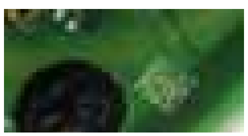
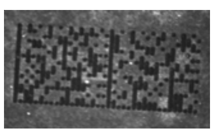
Dot Peen
Dot Peen is a percussive marking method, using changes in depth to create the contrast between the light and dark elements of the symbol. Dot peen is recommended for applications where the symbol must last the entire life cycle of the part. In the aerospace and automotive industries, this can be several years. Suitable substrates for dot peen marking must have some hardness so material memory does not return the surface to its original condition.

Additional Marking Methods
Methods available include metal stamp, engraving, electrical arc pencil, embossing, cast or forged (bumpy bar codes), molded, rubber stamp stencil, and decalcomania. While not as common as the four methods previously discussed, these are all viable marking methods for creating direct part marks and are useful for specific applications.

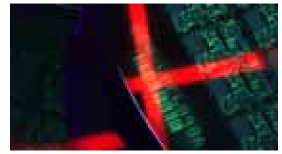
Marking Method Grid

Marking Method	Description	Advantages & Disadvantages
Ink Jet on substrate 	*Contrast levels vary widely, round element shape* ***Application:*** *- Post-packaging* *- Warehousing* *- Automotive*	***Advantage:*** *- Low-entry cost* *- High speed* *- Easy to read if contrast is good* ***Disadvantage:*** *- Not considered permanent by some industry standards* *- Dot registration can vary* *- Consumables* *- Mark quality dependant on surface cleanliness* *- Difficult to read if contrast poor*
Pre-printed packaging 	*Typically high contrast, square element shape* ***Application:*** *- Product labeling* *- Product packaging* *- Document processing*	***Advantage:*** *- Economical* *- High speed* *- Good contrast* *- Easy to read* ***Disadvantage:*** *- Less flexibility*
Thermal transfer label stock 	*High contrast, typically black on white label stock* *Square element shape* ***Application:*** *- Product labeling* *- Packaging* *- WIP tracking, various industries*	***Advantage:*** *- High contrast* *- Low-entry cost* *- Easy to read* ***Disadvantage:*** *- Not permanent* *- Higher cost: consumables*
Laser etch on silk screen 	*High contrast, square & round element shape* ***Application:*** *- Electronics*	***Advantage:*** *- Good contrast* *- No consumables* *- Permanent* ***Disadvantage:*** *- Displaces surface* *- Process creates debris*
Ink jet on plastic 	*High or low contrast, round element shape* ***Application:*** *- Bio-science* *- Pharmaceuticals* *- Packaging*	***Advantage:*** *- Low cost: limited consumables (ink)* *- Limited damage to surface* ***Disadvantage:*** *- Potentially poor resolution* *- Not permanent* *- Bleeding can affect mark quality*

Marking Method Grid

Marking Method	Description	Advantages & Disadvantages
Thermal print on foil packaging 	*Typically good contrast, square element shape* ***Application:*** *- Pharmaceutical Pkging*	***Advantage:*** *- Economical* ***Disadvantage:*** *- Reflective nature of marking method may require additional lighting* *- Deformation of surface may affect readability of code*
Ink jet on glass 	*Good contrast, round element shape* ***Application:*** *- Pharmaceutical Pkging* *- Clinical R&D* *- Electronics*	***Advantage:*** *- High contrast* *- Low entry cost* *- Limited damage to surface* ***Disadvantage:*** *- Not permanent* *- Bleeding can affect mark quality*
Laser etch on metal 	*Low contrast, square element shape* ***Application:*** *- Electronics* *- Automotive* *- Aerospace* *- DOD* *- Medical device*	***Advantage:*** *- Permanent* *- No consumables* *- High quality mark* ***Disadvantage:*** *- Process creates debris* *- Affects surface of substrate*
Laser etch on glass epoxy 	*Medium contrast, square element shape* ***Application:*** *- Electronics*	***Advantage:*** *- Permanent* *- No consumables* *- High quality mark* ***Disadvantage:*** *- Process creates debris* *- Lack of contrast; difficult to read* *- Affects surface of substrate*
Laser etch on rubber 	*Very low contrast, square or round element shape* ***Application:*** *- Automotive*	***Advantage:*** *- Permanent* *- No consumables* ***Disadvantage:*** *- Process creates debris* *- Affects surface of substrate*
Chem etch on metal 	*Typically medium contrast, square element shape* ***Application:*** *- Electronics* *- Semiconductor* *- DOD* *- Aerospace* *- Medical device*	***Advantage:*** *- Permanent* *- High quality mark* *- No debris from process* ***Disadvantage:*** *- Potentially toxic material bi-product* *- Low-volume use only* *- Potentially complex process*

Marking Method Grid

Marking Method	Description	Advantages & Disadvantages
Chem etch on silicon 	*Typically medium contrast, square element shape* ***Application:*** *- Semiconductor*	***Advantage:*** *- Permanent* *- High quality mark* *- No debris from process* ***Disadvantage:*** *- Potentially toxic material bi-product* *- Potentially complex process*
Dot peen on smooth, highly reflective metal 	*Low contrast, dependant on difference in depth to create light and dark elements* *Round or square element shape, dependant on shape of stylus* ***Application:*** *- Automotive* *- Aerospace* *- DOD*	***Advantage:*** *- Permanent* *- No consumables* ***Disadvantage:*** *- Alters surface* *- Low contrast mark* *- More difficult to read* *- Inconsistent depth will create smaller elements* *- Background noise*
Dot peen on textured metal 	*Low contrast, dependant on difference in depth to create light and dark elements* *Round or square element shape, dependant on shape of stylus* ***Application:*** *- Automotive* *- Aerospace* *- DOD*	***Advantage:*** *- Permanent* *- No consumables* ***Disadvantage:*** *- Alters surface* *- Low contrast mark* *- Very difficult to read, due to high degree of surface noise created by texture*

6.

Marking Method Selection

Before you start evaluating marking methods, first determine if an industry standard applies to your application. Industry standards will often times specify specific marking methods to be used, in addition to symbol specifications. For your reference, the Marking Method Reference Grid (located on p.17-19) provides examples of the more common DPMI marking methods in use today. If a specific marking method is not specified or recommended for your application, then use the following guidelines to help you determine the specific needs of your application. Important factors to consider are permanency, material composition of the part, manufacturing process, cost of the part, and production volume.

*— **The Marking Method Reference Grid** (p. 17-19) provides examples of the more common DPMI marking methods in use today.*

Material Composition

Be sure to select a method that will have the least amount of impact to the composition of your part. Experiment with different depths. Sometimes this can make the difference in success or failure of a method. If your part has a thin wall, you may want to avoid dot peen as it may permanently damage your part. If your part is powder-coated, electro-chemical etch will not work.

Permanency

Determine how long the symbol needs to last. This is often dictated by what is encoded in the symbol and what it is used for. If the symbol is used strictly for in-house work-in-progress tracking, than it need only survive the manufacturing process. For this type of application, ink jet may suffice. If it will be read repeatedly throughout the supply chain or for the entire life cycle of the part, than a more permanent method such as dot peen may be necessary. Keep in mind, life cycle is defined differently, depending on the industry and the part.

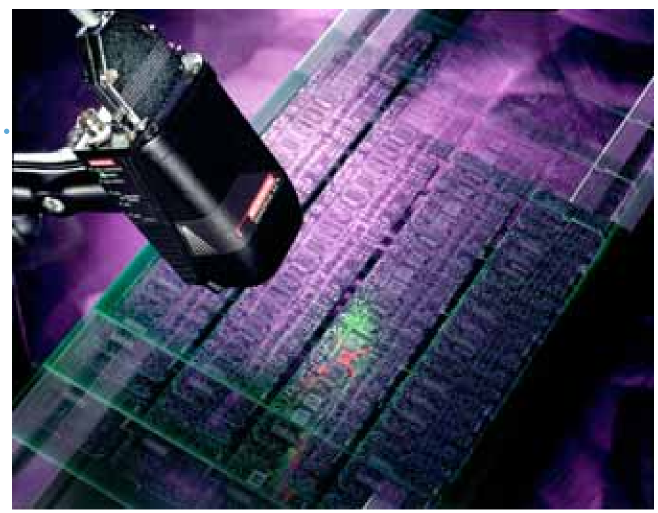
— A Data matrix code laser etched onto a crystal oscillator component for work-in-progress tracking.

Production

What is the production environment? Is it a highly automated facility? Will most of the codes be read by manual presentation? Some marking methods are better suited for high-volume production, such as ink jet and laser etching. Electro-chemical etching is better suited for low-volume or semi-automated environments. Consider how the marking method may affect output capabilities and potentially affect the cost of manufacturing.

Manufacturing Process

Determine where in the manufacturing process your part will be marked. How will the various steps affect the integrity of the symbol and its readability? For example, a manufacture of medical devices laser etched a 2D symbol on the titanium case of a device. After the device went through the wet-blasting sterilization process, the appearance and contrast levels of the 2D codes changed. These types of changes can be easily accommodated by smart cameras or imagers designed for reading a variety of code types. However, if your part is painted after it is laser etched, the laser etched mark may not have enough depth to still be readable.



— The MS-Q (above) and the Quadrus EZ™ imagers from Microscan work together in many challenging applications that require both a robust handheld imager and a fixed-mount imager.

7.

Mark Quality Validation

Symbol quality validation is the practice of comparing the quality of a direct part mark to a pre-determined standard. The pre-determined standard of measurement for the application can be an established industry specification, or it can be a quality threshold established by the factory for internal use.

Many manufacturers perform quality validation to meet standard requirements, but monitoring symbol quality can provide additional benefits as well. It can also be used to monitor how well the direct part marking equipment is performing. A smart camera mounted by the marking equipment can signal an operator when symbol quality begins to deteriorate. The operator can then make the necessary adjustments before it impacts production and parts need to be scrapped. If the codes are used for automated equipment setup during production, quality validation can reduce the risk of manufacturing errors or down time caused by unreadable codes.

Verifiers

Quality validation can be performed a few different ways, depending on the needs of the application. True symbol verification compares the symbol to the established specification, producing a report on every parameter in the specification and a symbol grade based on the results. Verifiers must be used for this purpose. In order to achieve consistent results, it is important that verification is performed in a controlled environment.

If a symbol grade based on the complete specification is not necessary, the reader can perform the quality validation. Many readers have built in software to monitor symbol quality based on several aspects of a specific specification or the needs of the application. Imagers can also perform simple quality checks by using the pass/fail setting to validate whether or not the symbol was readable. Quite often this is sufficient for codes that will only be used within the factory and do not need to be read outside the facility.

8.

Readers

Most direct part marks must be read with imagers, due to the low contrast marking methods employed to create the mark and the wide-spread use of 2D symbologies for these applications. Two dimensional codes must be read by imaging-based technology, and imagers can decode bar codes with much lower contrast levels than laser scanners. Imagers can be divided into 4 categories: hand-held imagers, presentation imagers, smart cameras and vision systems.

— Each type of reader has its advantages In order to select the best reader for your application you must consider your particular needs

Application Tips

- What is the speed of your application?
- What is the required distance between the imager and the code you are reading? Will this vary, or is it fixed? Can it be adjusted?
- What type of code will you need to read? Is it low contrast, is it on a reflective or curved surface? This will help determine if special lighting may be required.
- What is the environment like? Will you be reading codes in a freezer, or near a smelter? Will it be operating in direct sunlight? Will it need to undergo routine wash-downs?
- How will you be using the data? Will the reader be sending signals to serial devices based on de coded information? Will you require data parsing?
- Ease of use. Who will be setting up the reader? Does it need to be easy to configure to minimize downtime between product runs?

Once you know the answers to your application needs you will be able to focus on the features that you do need and spend less time comparing bells and whistles that serve no real function in solving your specific application.

Microscan offers two hand-held imagers, the MS-Q Basic and the MS-Q Quadrus.

Hand Held Imagers

Hand held imagers are designed for applications where the imager must be presented to the symbol by an operator. Excellent hand held applications can be any application that does not involve a conveyor, robot or indexer. Typically, they are used for low volume scanning, or reading parts that are too large or awkward to be presented to a fixed position reader. For example, in the aerospace industry, it is not practical to try and read a Data Matrix code on an 800 pound helicopter engine with a fixed position reader. An operator can much more easily read the code using a hand held imager. Many hand held imagers offer a variety of configurations, including wireless interfaces, providing the operator with additional mobility.

Since hand-held imagers are not designed for automated applications, their decoding rates are considerably slower than fixed imagers, and they are often not as robust. Since the reading environment quite often cannot be controlled with exterior lighting as easily as it can be with a fixed imager, many hand held imagers struggle to read the more challenging, low contrast directly marked parts. Robust optics are critical in a hand held imager if it will be used to read low contrast codes.

— Presentation readers are generally useful for speeding up some hand-presentation applications by eliminating the step of pulling the trigger each time the operator needs to read a code.

Presentation Reader

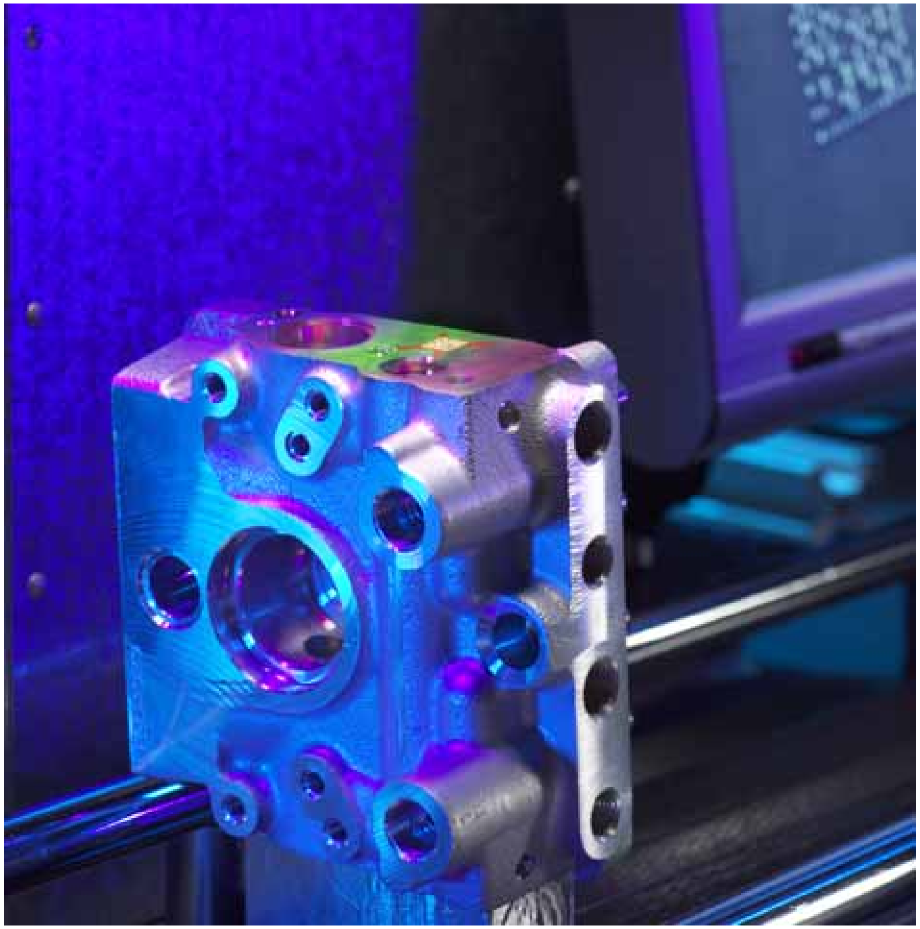
Presentation readers are hand held imagers mounted as a fixed position reader. In order to perform in dynamic applications, the reader operates in a continuous read cycle, automatically reading the code when the operator places the part in front of the imager. Since the reader operates in continuous read mode, they do not necessarily make an efficient solution for dynamic applications. Continuous read mode is recommended for diagnostics only. This mode continually outputs data from the bar code. Most manufacturers only want 1 data point for symbol decode. Continuous read also does not allow the control of the read cycle by a sensor or other device. If the read cycle cannot be controlled, then you will not be able to determine whether a product has passed the scanner.

Fixed-position Readers

Fixed-position imagers are designed for reading symbols on parts in dynamic applications where the part is presented to the imager in an automated or semi-automated environment such as the production lines found in automotive manufacturing. Instead of an operator pointing the reader at the symbol and pulling the trigger, fixed-position imagers are triggered by an external sensor. As the part approaches the reader, the sensor signals the reader to decode the symbol on the part.

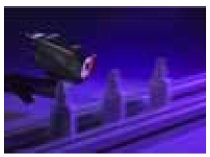
The two types of fixed position readers used for dynamic applications are vision systems and smart cameras.

— The Quadrus EZ imager is ideal for use on a line where a part is in an automated environment.



Vision Systems

Vision systems are a sophisticated imaging system made up of separate components: camera, light source, decoder and frame grabber. Since vision systems were originally designed for much more complex tasks than simply decoding a symbol, most require custom programming to accomplish a simple decode and several hours of training to operate them once they are installed. The best time to consider using a vision system for a direct part marking application is when other tasks need to be performed in conjunction with reading the 2D codes such as part inspection.



— Smart cameras bring a much lower total cost of ownership to the application compared to vision systems.

Smart Cameras

Another form of fixed position readers, smart cameras combine the separate components of a vision system into one integrated package, resembling the traditional bar code scanner. Since most smart cameras are designed to perform one task, in this case reading bar codes and 2D codes, their optics and decode algorithms are optimized for these specific applications, providing maximum performance for the application. New advancements in technology such as push button setup enable some smart cameras to be setup on line and reading codes in less than an hour without the help of a monitor or a computer. As a result, smart cameras bring a much lower total cost of ownership to the application. Not only do they have a dramatically lower entry cost, they are easier to install because they do not require the custom programming and extensive training involved with operating a vision system.

— The Quadrus EZ™ imager from Microscan is the industry leading fixed-mount 2D reader designed for tough to read symbols including dot peen and etched codes.

9.

Vendors

Direct part marking identification applications do not need to be difficult. Like other bar code or 2D code application, success begins with the best quality symbol possible. General education on the parameters that determine a good symbol will solve most application challenges before they occur. Selecting a vendor who understands DPMI applications will provide the necessary technical expertise to navigate through the remaining challenges.

— *Smart cameras from Auto ID companies will provide far superior performance in DPMI applications than vision products designed for general image analysis.*

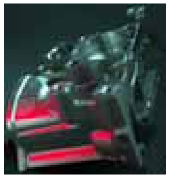
To achieve success, it is important the vendor you select be well-experienced in auto-ID applications. Due to the nature of DPMI applications and their unique requirements, they typically need to be solved on an individual basis. For this reason, it is in your best interest to select an auto ID vendor with a complete product line dedicated to solving these applications. Many auto ID vendors have been manufacturing products for linear and 2D symbol applications for years. Since auto ID products are engineered specifically for reading and decoding symbols, their optics, image processing platforms and decode algorithms are all optimized specifically for reading and decoding symbols. Machine vision companies lack experience in bar coding applications and their products are not designed for reading bar codes. As a result, their products require custom programming and a great deal of training in order to simply decode a symbol.

Criteria to consider when selecting a vendor include strong global presence and superior customer support. The vendor should offer a broad network of offices and representatives , capable of providing the local technical support you need during your installation, where ever your facility is located.

Conclusion

Like most bar coding applications, success begins with the quality of the mark itself. A solid under standing of the parameters that define the best type of symbol for an application will help eliminate most challenges before they occur. Before you move forward on implementing your DPMI solution, be sure you have taken the following steps:

Application Tips



- Established well-defined objectives for your application
- Determined the specific data requirements of your application
- Selected the most appropriate symbology
- Selected the best marking method for the substrate
- Identified the optimal location on the part for the mark
- Understand the factors that determine good readability
- Evaluated your application requirements fc the imager
- Researched vendors providing the appropriate equipment and DPMI experience

— *Following these guidelines will help you navigate through the challenges of DPMI and will ensure the success of your application.*

— Microscan bar code scanners and imagers are sold through a global network of systems integration companies who specialize in automation and bar code solutions.

Free Symbol Evaluations

Microscan is dedicated to direct part marking identification. In addition to a suite of products specifically engineered to read directly marked symbols on a variety of substrates, Microscan also offers a full service applications lab staffed by application engineers who know and understand DPMI.

During the last few years, the lab has received hundreds of 2D samples for DPMI applications. For each one, the engineers perform a very thorough evaluation of symbol quality and provide recommendations on improving readability if needed.

Symbol testing and evaluations are a free service Microscan provides to anyone interested in pursuing direct part mark identification.

Send us a sample of your 2D code today, and get your DPMI project off to a great start.

Please contact us for your nearest Microscan Preferred Partner

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10.

Symbol Quality Validation Parameters Appendix

MIL-STD-130 Symbol Quality Validation Parameters

Following are the 2D symbol validation parameters required by the DoD, based on the ISO/IEC 16022 specification.

Symbol Contrast measures the contrast between the light and dark elements of the symbol and lets the user know if contrast settings are less than acceptable. All the pixels that fall within the area of the test symbol, including its required zone, will be sorted by their reflectance values to select the darkest 10% and the lightest 10% of the pixels. The arithmetic mean of the darkest and the lightest pixels is calculated and the difference of the two means is the Symbol Contrast.

Print Growth is the extent to which dark or light markings appropriately fill or exceed their module boundaries. These values are determined by counting pixels in the clock pattern of the binary digitized image, then comparing it to a nominal value and Min. and Max. values.

Axial Non-Uniformity is a measure of how much the sampling point spacing differs from one axis to another, namely AN=abs (XAVG – YAVG) / ((XAVG + YAVG)/ 2) where abs () yields the absolute value. If a symbology has more than two major axes, then AN is computed for those two average spacings which differ the most.

Unused ECC is the correction capacity of Reed-Solomon decoding and tests the extent to which regional or spot damage in the symbol has eroded the reading safety margin that error correction provides.
It is expressed in the equation **e+2d<d-p**

- ***e*** is the number of erasures
- ***t*** is the number of errors
- ***d*** is the number of error correction code words
- ***p*** is the number of code words reserved for error detection

Axial Non-Uniformity

IAQG 9132 Symbol Quality Validation Parameters

Following are the 2D symbol validation parameters required by the IAQG specification 9132. This specification is recommended for validating the quality of dot peen marks.

Dot Center Offset

Dot Center Offset measures the deviation from the ideal dot centers. The worst case gives the quality of the worst dot in percentage and its position in the grid. Passing grades are 80 to 100%.

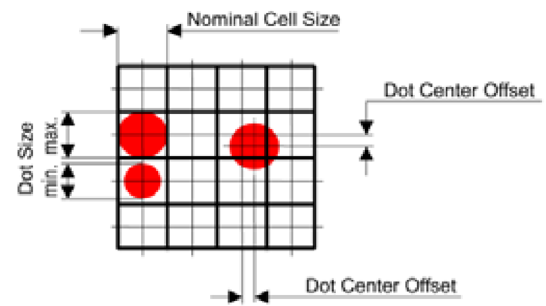
Cell Size is the percentage of the ideal cell size that the dot fills. Worst case indicates the quality of the worst dot in the percentage and its position in the grid. For dot peen symbols, this is referred to as Cell Size, and for Laser or Chemical this is called Cell Fill. The calculation used for both is similar.

Angle of Distortion is the angular deviation from a 90 degree plane between row and column.

Dot Ovality

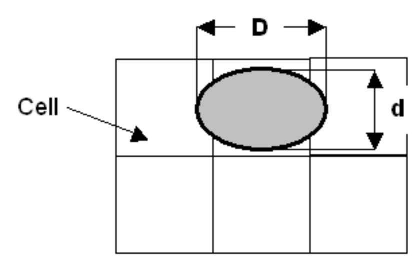
Dot Ovality identifies the extent of the oval distortion of the mark.

Definition of Nominal Cell Size, and Dot Center Offset



Definition of Ovality

D-d less than or equal to 20 percent of the cell size



*If you track with **bar codes**, then you should know **Microscan***

Microscan is a leading manufacturer of fixed position bar code scanners for automated tracking. Microscan offers a full range of products to read all linear bar codes, plus 2D symbologies and invisible ink.

See our websites for complete information on Microscan products, specifications, and applications.

- **http://www.microscan.com**
  Corporate information,
  full product line, eLearning
- **http://www.quadrus-ez.com**
  Resource for 2D symbologies
  and decoding solutions
- **http://www.smallscanners.com**
  Resource for embedding bar code
  scanners into equipment

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