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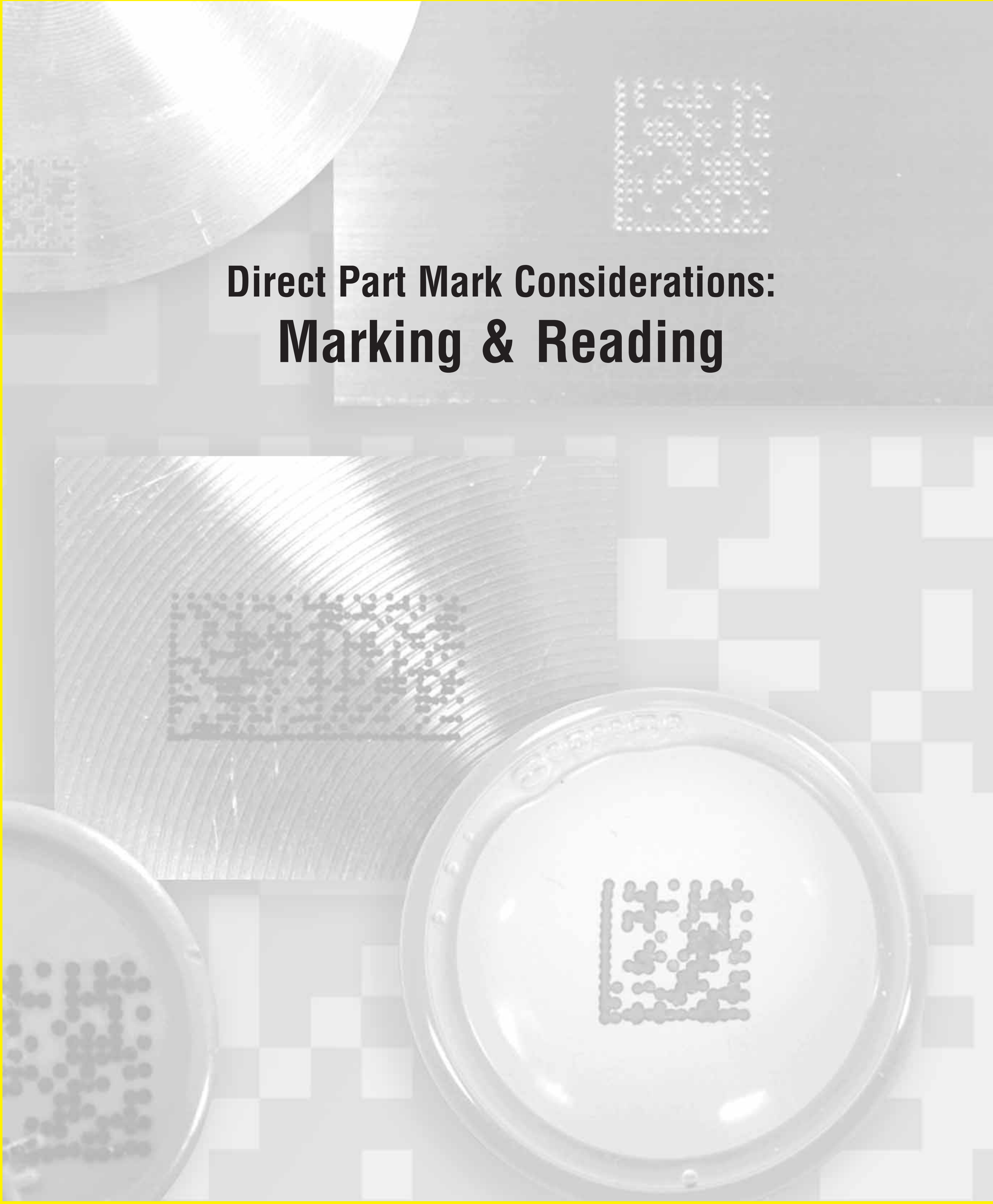
Part I

Direct Part Mark Considerations:
Marking & Reading



Implementing Direct Part Mark Identification: 10 Important Considerations

INTRODUCTION

Automatic identification of products using one-dimensional (1D) bar codes has been broadly used in many industries for more than 20 years. The part tracking data provided is vital for those that make, store, or move items through the supply chain because the data is used in production output calculations, inventory control, revenue forecasting and other business operations. Traditionally, these bar codes are applied to products with labels or as part of the product package.

Today there's a trend to extend tracking through the full life of a part so that it can be identified from the beginning of its life to the end. To address full life cycle traceability, manufacturers are marking parts with two-dimensional (2D) codes that are marked directly on the part, and automatically identifying the part throughout the manufacturing and supply chain operations. This process is known as Direct Part Mark Identification (DPMI).

Assembly and parts suppliers to the Department of Defense are increasingly implementing DPMI, as are a growing number of automotive, aerospace, medical device and electronics manufacturers. Many manufacturers are using traceability data to create a history of the part through the manufacturing process for use later in supply chain management and repair depots.

Traceability also improves quality by ensuring that the appropriate processes are performed in the correct sequence on the right parts. DPMI is key in "error proofing" initiatives. In addition to eliminating manual part number data entry errors during production operations, DPMI can also assist in data logging for safety, liability, warranty issues, satisfying regulatory requirements and for permanently identifying high-value parts that are subject to theft or counterfeiting.

Two-dimensional (2D) codes are used for DPMI applications due to their small size, error correction, and amount of data that can be stored as compared to 1D codes. These 2D codes are marked on the part using several methods depending upon the material composition, part application, and environmental conditions. Common methods include dot peening, laser, ink-jet and electro-chemical etch.

Despite the fact that industries have adopted 2D code standards and formats to meet their process application needs, and marking technologies have advanced to provide the marking solutions required, high read rate DPMI has been difficult to achieve, limiting its use. These types of codes can be difficult to read due to low contrast, variations in part surfaces and partial damage due to process and environmental conditions.

In the past, successful DPMI applications have required integration of machine vision systems to provide the desired results. But due to advances in the power of digital signal processors, imaging sensors, and decoding algorithms, DPMI solutions are now available that are more cost effective, accurate, and reliable.

Cognex ID Products can help ensure the success of your DPMI project. For additional information about selecting fixed-mount readers, hand-held readers, or code verifiers, please contact Cognex at (877) 264-6391, or visit http://www.cognex.com /products/ID/

1. Code Selection

Industry standards groups frequently define the appropriate code for a given application. For example, the Automotive Industry Action Group (AIAG) has published guidelines for Data Matrix™ and QR Code; the Air Transport Association (ATA) as part of the Spec2000 bar code specification defines Data Matrix for DPMI; the U.S. Department of Defense (DoD) specifies Data Matrix for their Unique Identification (UID).

When specified, it generally makes sense to follow the industry guidelines because it improves efficiencies throughout product manufacturing and the supply chain. However, if no guidelines are available within your industry, investigate the standards and guidelines set forth in other industries. This will allow you to define guidelines for your company on not only what code(s) to use but also recommendations on marking methods, data encoding and verification.

When there is no specified standard, Data Matrix ECC200 is recommended. This ISO code standard is the most widely supported for DPMI applications involving metal, glass, ceramic, or plastic materials. Because this code is in the public domain, marking and reading equipment suppliers have invested significant R&D resources to improve the performance of Data Matrix ECC200 supporting equipment.

Industry Specification & Guidelines	
International Standards	
ISO/IEC 16022	Bar Code Symbology Specification – Data Matrix
ISO/IEC 18004	Bar Code Symbology Specification – QR Code
ISO/IEC 15415	Bar Code Print Quality Test Specification – Two-Dimensional symbols
Automotive Industry Action Group (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
U.S. Dept. of Defense (DoD) Standards	
MIL-STD-130	Identification Marking of U.S. Military Property
ISO/IEC 15418	Information Technology Application Identifiers
IEC-15434	Information Technology – Transfer Syntax for High Capacity ADC Media
Air Transport Association (ATA) and International Aerospace Quality Group (IAQG) Standards	
ATA Spec 2000 Chapter 9	Automated Identification and Data Capture
AS9132	Data Matrix (2D) Coding Quality Requirements for Parts Marking
NASA Standards	
NASA-STD-6002	Applying Data Matrix Identification Symbols on Aerospace Parts
NASA-HDBK-6003	Application of Data Matrix Identification Symbols to Aerospace Parts Using Direct Part Marking Methods/Techniques
Electronics Industry Association (EIA)	
EIA 706	Component Marking
EIA 802	Product Marking

2. Data Encoding

The Data Matrix code offers a number of advantages for DPMI applications, including small size, high data encoding capacity, and error correction. Data encoding refers to the amount of information that is "stored" within the matrix when the Data Matrix code is generated. Code size can affect readability and is generally determined by the amount of data to be encoded, module (cell) size, and surface roughness of the area on the part where the code will be applied. When trying to comply with an industry specification, an application specification will define the size that is needed in order to be in compliance.

Deciding on what information to encode is typically driven by the company specifications and/or the requirements of the traceability project. In selecting what data to encode and what code size to mark, one should also consider the amount of available space on the part. In some applications, the Data Matrix code is used as a "license plate" for the part, reducing the amount of data encoded and size of the code. In this case, a centralized database containing manufacturing and historical data referring to the part is updated as the part is identified during manufacturing and supply chain processes. Other users take advantage of the large data capacity of the code and encode much more information about the part, creating what is referred to as a "portable database".

Although Data Matrix supports a number of different formats and error correction methods that include: ECC 000, 050, 080, 100, 140 and 200, all industry standards and guidelines for DPMI applications are based on the ECC200 format of Data Matrix. It is highly recommended that any new application adopt this code format. There are 24 square formats and 6 rectangular formats available in ECC200. This provides the user the flexibility to encode anywhere between 6 and 3116 digits in a single code. It also supports advanced encoding and error checking capabilities that are based on what is known as Reed Solomon error correction. The Reed Solomon error correction capability allows a code to be successfully decoded even though as much as 60% of the code may be damaged.

Data Matrix ECC200 Square Formats			
Symbol Size*	Encoded		
Row x Column	Numbers	Characters	Bytes
10 x 10	6	3	1
12 x 12	10	6	3
14 x 14	16	10	6
16 x 16	24	16	10
18 x 18	36	25	16
20 x 20	44	31	20
22 x 22	60	43	28
24 x 24	72	52	34
26 x 26	88	64	42
32 x 32	124	91	60
36 x 36	172	127	84
40 x 40	228	169	112
44 x 44	288	214	142
48 x 48	348	259	172

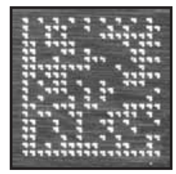
* Symbol size can be as large as 144 x 144

Data Matrix ECC200 Rectangular Formats			
Symbol Size	Encoded		
Row x Column	Numbers	Characters	Bytes
8 x 18	10	6	3
8 x 32	20	13	8
12 x 26	32	22	14
12 x 36	44	31	20
16 x 36	64	46	30
16 x 48	98	72	47

3. Marking Processes

The primary methods used to produce machine-readable symbols for DPMI include dot peening, laser marking, electro-chemical etching, and ink-jet printing. Important factors influencing the marking process decision include part life expectancy, material composition, environmental wear and tear, and production volume. Other considerations include surface texture, the amount of data to be encoded on each part, as well as the available space for, and location of, the mark on the part. The choice of marking process is typically incorporated into the component design; deviations from this design may require engineering change approval.

Dot peening is achieved by pneumatically or electromechanically striking a carbide or diamond tipped stylus against the surface of the material being marked. Reading solutions utilize lighting techniques to create contrast between the indentations forming the modules of the symbol and the surface of the part. Therefore, the quality of the indented dots is very important to the readability of the code. Dot size, shape, and spacing can be controlled through prescribed maintenance of the dot peen marker and monitoring stylus tip wear. In addition, quantitative feedback from a reading verification system (covered in Section 6) can confirm the quality of the image of the dots forming the symbol. In some cases, the application may require further preparation or processing of the part surface, such as machining or cleaning, in order to improve overall readability of a code. Dot peening is widely used in the automotive and aerospace industries due to the demanding life cycle requirements of these industries.



Dot Peen

Laser marking applies heat to the surface of a part that causes the surface of the part to melt, vaporize or change in some way in order to produce a mark. The resulting quality of the mark depends upon the interaction of the laser with the material it is marking. A laser can produce both round and square modules; typically, the laser is used to produce a square module and continuous finder pattern for higher density (large data capacity) codes. The laser marking process offers high speed, consistency, and high precision. Laser marking is widely used in the semiconductor, electronics, and medical device industries.

Laser

Electro-chemical etching (ECE) is a process whereby a mark is produced from oxidation of metal from the surface being marked through a stencil impression. This is achieved by sandwiching a stencil between the surface being marked and an electrolyte soaked pad, and passing a low voltage current between the two. ECE is recommended for round surfaces and for stress-sensitive parts. ECE is used for marking certain components of jet engines, automobiles, and medical devices.

Electro-Chemical Etch

Ink-jet printers precisely propel ink drops to the part surface, after which the fluid that makes up the ink dot evaporates, leaving a colored die on the surface of the part creating the pattern of modules that make up the mark. The application of ink-jet marking may require preparation of the part surface, as it is the chemical interaction of the ink to the surface of the part that determines the level of mark permanence and contrast. Ink-jet marking provides fast marking of moving parts, and offers very good contrast.

Ink-Jet

4. Mark Placement

The location of the code on a part can directly impact the readability of the code. The location should be clearly visible throughout the manufacturing process and, when possible, on a region on the part. Also, choose a location where the mark is in a prominent position on the part that is easily viewed by the reader. Avoid locations where there may be a surrounding surface relief that could potentially affect the illumination of the code by the reader's illumination source.

Wherever possible, it is best to provide a "clear zone" around the mark where no features, part edges, noise, or other interference comes into contact with the code itself.

In those cases where the mark must be placed on a cylindrical part, care must be taken in selecting the size of the code. Surface curvature can create distortions to the code and make proper illumination of the code very difficult. In order to mitigate this problem, a code size no larger than 16% of the diameter, or 5% of the circumference, of the part is required.

In those cases where it is impossible to accommodate these considerations, work with the reader vendor on how to effectively image and read your marks. Make sure to work with a vendor that has the product offerings to address "non-standard" DPMI applications.

Mark on Curved Surface

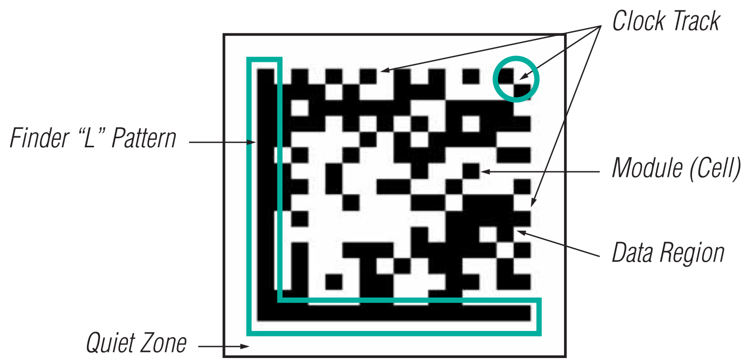
Small Code with Low Resolution

5. Readability

Readability is a term used to define how easy or difficult it is for a reader to successfully read a code. DPMI is rapidly becoming a required part of the manufacturing process, so if a code is not readable, the part is not processed, or the production line stops. Until recently, manufacturers implementing DPMI have lived with varying levels of read rates, in some cases approaching the upper 90% level; however, this level of performance is no longer acceptable. DPMI solution providers must demonstrate that they can achieve six sigma read rates, a level of quality which equates with only 3.4 defects per million reads. In order to achieve this read rate, it is important to plan, understand and implement a marking solution that builds in quality (verification) to ensure these results.

One factor that contributes significantly to overall readability is the quality of the mark. The process of inspecting the quality of a mark is known as verification, which will be discussed in the next section. A user looking to implement DPMI must understand all of the factors that affect the readability of the code. A good baseline for this is to understand the design of the Data Matrix symbology and associated issues that might impact readability.

The features that comprise the Data Matrix symbol are the quiet zone, the finder pattern, the clocking pattern, and the data region. Each individual element is referred to as a module (cell). The actual appearance of the code depends on the type of mark placed. For example, a Data Matrix code formed with a laser marking machine or printer would appear with a "continuous L pattern" and square modules; whereas, dot peen and ink-jet markers produce codes that have a "non-continuous L pattern", with a data pattern made up of round modules.



The quiet zone is a clear area free of all other markings that surrounds the symbol on all four sides. For a Data Matrix code marked with a continuous L pattern, the quiet zone width should equal the width of at least one module. It is recommended that codes formed by dots have a quiet zone equal to the width of at least four modules. This is important because defects within the quiet zone make it more difficult for the decoding algorithms to locate the symbol within the image, and adversely impact readability.

The finder pattern consists of two orthogonal lines, known as the "L pattern". The L pattern is the key feature for the reader to use to locate the position of the code in the field of view. For highest readability throughout the life cycle of the part, it is important to start with a high quality finder pattern. The traits determining finder pattern quality vary, depending on how the code is formed. Codes formed with square modules should have a continuous L pattern, and should not have breaks in the lines. For codes formed by dots, every dot must be present, distinct, disconnected, and well formed. Successful location of the code within an image is the first step in successful reading.

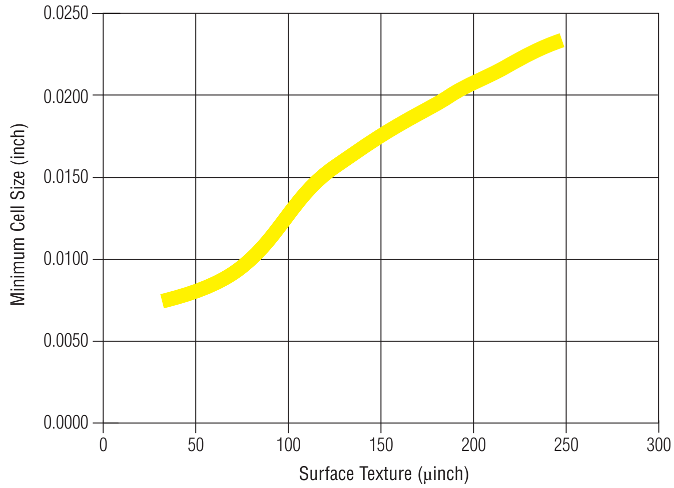
Once a code has been successfully found in the image, the next step is determining which modules are light and which modules are dark. At the opposite sides of the finder pattern, along the perimeter, there are alternating dark and light modules known as the clocking pattern, or clock track. The clocking pattern defines the configuration of the pattern of light and dark modules that make up the data region of Data Matrix code. In the ideal case, each light and dark module of the clocking pattern and data region would be of equal size. In order to achieve high readability it is important that the DPMI reader can distinguish between light and dark modules.

A code pattern with individual modules that are consistent in shape and size, and modules that are distinctively different in shape and size from other features on the surface of the part provide the basis for robust and reliable code location and reading. However, in DPMI applications this can be challenging due to variations in the surface texture, variations in part presentation during the marking process, and inherent variability of the marking machine. For example, the bumps on the surface of a cast part will show up in an image. If these bumps are similar in size and/or shape to the dot peen marks of the code, readability suffers because the code blends in with the bumps in the surrounding image.

For robust and reliable reading, cell size must be significantly larger than the grain, bumps, texture or other patterns on the surface of the part. Minimum cell size (MCS) refers to the smallest recommended cell size for a particular part or application. The International Aerospace Quality Group (IAQG) AS9132 standard provides the following guidelines to help determine the minimum cell size required in relation to the roughness of the surface.

An objective verification of the code at the marking machine will help assure that the Data Matrix mark that is produced meets the specifications of the standards, and greatly contributes to readability success downstream.

Recommended Cell Size for a Given Surface Texture



6. Verification

In order to assure that the marking equipment is applying a mark that will meet the requirements for achieving the highest read rates, it is highly recommended that a code verification system be implemented at the marking station. This is not only a critical factor for downstream reading performance, but it reduces non-conformance and the associated costs of rejected parts due to unreadable codes. A verification system will immediately detect a problem with the marking process which could be due to poor fixturing of the part, damage to the machine such as a broken tip on a dot peen machine, or incorrect settings during part changeover.

Additionally, a code verification system can also provide process feedback on the marking process that can be used for preventive maintenance. For example, the verifier can monitor the wear of the tip on a dot peen machine by analyzing dot size and flag the operator on the floor when a pin should be changed.

A code verifier is a system that includes lighting, optics, camera, Data Matrix quality metrics and software. A verification system for DPMI needs to be defined for each application due to the various types of materials, surface conditions, and marks. Lighting and optics should be configured to ensure an optimal image formation that delivers good contrast with adequate resolution. In order to have meaningful verification results it is recommended that the resolution at the verification station be at least twice that of the reading station resolution. A minimum of 10 x 10 pixels per module is required for reliable and consistent results. This can be accomplished with either higher magnification optics or a higher resolution camera. Another important step in generating consistent and meaningful results is consistent part presentation. Lastly, a calibration step needs to be implemented in order to provide a method of establishing a baseline for the lighting, optics and resolution.

There are several verification standards in use today. The verification standard selected depends on the industry application, type of mark, and marking method used. For example, for codes that are printed with high-contrast square cells (i.e. paper), the metrics defined in either the ISO 15415 or ISO 16022 specification are appropriate. ISO quality metrics, which are part of the Data Matrix specifications, measure print contrast, modulation, axial non-uniformity, and unused error correction to grade marks on an A-F scale where A is excellent and F is fail.

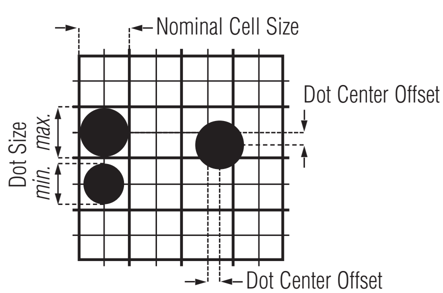
ISO 15415 quality metrics measure symbol contrast, modulation, fixed-pattern damage, axial non-uniformity, grid non-uniformity, and unused error correction. When using these ISO standards, each of the quality metrics that are defined in the following table yield a “grade” of A (4.0) through F (0.0). The overall quality of a symbol is the lowest grade achieved by any of the tests.

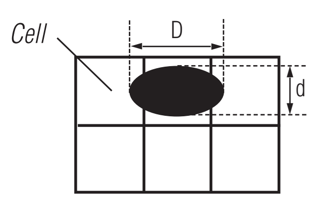
ISO 16022 - Quality Assessment Metrics					
Aim Verification Test	Symbol Decode	Symbol Contrast	“Print” Growth	“Axial” Non-uniformity	Unused Error Correction
Description	Test whether the symbol was decodable. If not, no additional information is returned	Compares the contrast between the darkest 10% & the lightest 10% of the pixels within the code	Checks the extent to which dark & light markings appropriately fill their module boundaries	Is a measure of how much the spacing between cells differs from one axis to another	Tests the extent to which damage to the code has eroded the reading safety margin that error correction provides
Results	“A”= Successful decode “F”= Failed to decode	“A” if > = 70% “B” if > = 55% “C” if > = 40% “D” if > = 20% “F” if < 20%	“A” if > = -0.50 and < = 0.50 “B” if > = -0.70 and < = 0.70 “C” if > = -0.85 and < = 0.85 “D” if > = -1.00 and < = 1.00 “F” if < -1.00 or > 1.00	“A” if < = 0.06 “B” if < = 0.08 “C” if < = 0.10 “D” if < = 0.12 “F” if > 0.12	“A” if UEC > = 0.62 “B” if UEC > = 0.50 “C” if UEC > = 0.37 “D” if UEC > = 0.25 “F” if UEC < 0.25

ISO 15415 - Quality Assessment Metrics							
	Decode	Symbol Contrast	Modulation	Fixed Pattern Damage	Axial Nonuniformity	Grid Nonuniformity	Unused Error Correction
Description	Uses the reference decode algorithm as defined by ISO 16022 to determine if the code has all its features sufficiently	Test the reflective difference between light and dark modules	Is a measure the uniformity of dark and light symbols throughout the symbol	Tests that damage to the finder pattern, quiet zone and clocking pattern in a symbol does not unacceptably impact readability	Tests for uneven scaling of the symbol that might hinder readability	Tests and measures the largest vector deviations of the grid intersections	Tests the extent to which damage has eroded the safety margin that error correction provides
Result	“A” = Successful Decode “F” = Unsuccessful Decode	“A” > = 70% “B” > = 55% “C” > = 40% “D” > = 20% “F” < 20%	Based on several test methods, see ISO 15415 specifications for underlying detail.		“A” < = .06 “B” < = .08 “C” < = .10 “D” < = .12 “F” > .12	“A” < = .38 “B” < = .50 “C” < = .63 “D” < = .75 “F” > .75	“A” > = .62 “B” > = .50 “C” > = .37 “D” > = .25 “F” < .25

The AS9132 standard is the best suited for marks produced by dot peening. AS9132 measures and tests dot size, dot position, and dot ovality to indicate whether a mark is “acceptable” or “fails”. When using the AS9132 metrics, each dot is analyzed and assigned a grade of “excellent,” “acceptable” or “failure”. The overall quality of a symbol is the lowest grade achieved by any of the tests.

AS9132 - Dot Peen Quality Assessment Metrics				
	Dot Size	Dot Center Offset	Dot Ovality	Angle of Distortion
Description	Measures and compares the actual “dot size” to the nominal cell size. No more than 2% of the dots should be outside this limit.	Measures and compares the actual “dot position” to the nominal cell position. All dots should be within this limit.	Measures the ovality (or roundness) by comparing the difference between the height (“D”) and width (“d”) of each dot. Both “D” and “d” are expressed as percentage difference from nominal.	Tests and measures the vector deviation of the grid intersections
Result	“Acceptable” = 60% to 105%	“Acceptable” = 0 to 20%	“Acceptable” < = 20%	“Acceptable” = + / - 7%





Definition of Ovality
D-d <= 20% of the Cell Size

Please refer to the Cognex Report, *Implementing Direct Part Mark Verification,* for additional information on verification.

7. Types of DPMI Reading Solutions

There are three types of reader (decoder) products for DPMI in general use today: fixed-mount readers, presentation readers, and hand-held readers.

Fixed-mount Reader

Fixed-mount readers are used in identifying parts that are handled and moved automatically by conveyor, indexer, or robot. Typically, fully automated manufacturing lines such as those found in electronics and automotive manufacturing use fixed-mount readers.

In operation, this type of reader is mounted in a fixed position where the mark can repeatably be placed in front of the reader in either continuous or indexed motion. The reader is signaled that the part is ready for reading by a "trigger." This trigger event is performed by an external sensor that detects the presence of the part or by an encoder that knows the position of the part at all times and can signal the reader to decode.

Fixed-mount readers are configured with either an integrated light source or with an external light source as required by the application. Advantages of a fixed-mount reader without an integrated light source are that it can be mounted in varying working distances from the part and supplemental lighting can be selected to meet the application needs.

It is advantageous to use fixed-mount readers that can be easily set-up, viewed and maintained over an Ethernet network for efficiency. Frequently, fixed-mount readers are part of a network of general-purpose machine vision sensors performing other inspection and gauging tasks, and must communicate over an Ethernet network to the general manufacturing control system.

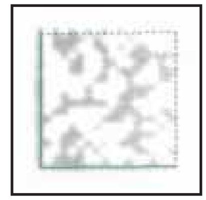
Hand-held Reader

Similar to a fixed-mount reader, a presentation reader is a reader that is mounted in a fixed position; however, it operates in a continuous reading cycle, automatically performing the decoding task once the operator places the part in front of the reader. Presentation readers can provide a very fast way of reading part codes in areas where parts are handled manually. A presentation reader can be implemented with either a fixed-mount reader or hand-held reader. Using a hand-held reader in presentation mode provides the opportunity for multi-use – as one can also remove the reader from its stand and bring it to the part.

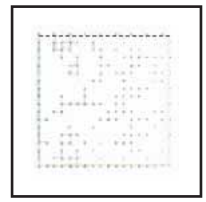
Hand-held readers are preferred in those environments where part handling is not automated or parts vary greatly in size. Hand-helds are used in job shop manufacturing operations, QC test stations, and in logistics areas. Hand-held readers come in either tethered (with a cord), or cordless configurations. Tethered hand-held readers have the advantage of not being displaced from the application location. Cordless operation is required in cases where part size or position are a practical limitation to cord length.

8. Selecting a Reading Solution

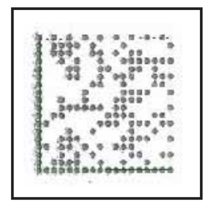
The process of evaluating and selecting a reading solution is critical to the success of the overall DPMI application. There are many factors that go into the selection process of any new equipment, but in the case of a DPMI reader, there is none more important than the read rate. The capability of the reader to consistently read codes throughout the process is critical.



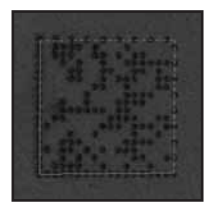
Poor Focus



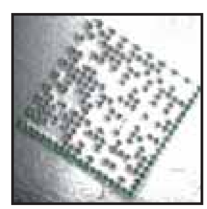
Washed Out



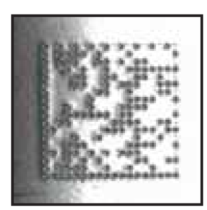
Model Image



Low Contrast



Finder Degradation



Background Problems

As has been previously discussed, there are many variables that impact the quality of the code. Verification of the code at the marking station helps eliminate reading problems caused by missing or inconsistent features of the code. However, in DPMI applications distortions to the code are quite common due to part material composition, variations in part presentation, or variability caused by the manufacturing process. It is important to select a reading solution that can tolerate a wide range of distortions to the appearance of the code no matter what the cause.

A set of sample parts that represent the range of mark quality that a reader will need to handle should serve as the basis for a preliminary test of a reader's read rate. However, a more extensive pilot test is recommended so that more read rate statistics can be gathered and analyzed.

The "model image" on the right represents how a code might appear under ideal conditions. In order to consistently read codes and achieve the required read rates, the reading solution should tolerate changes in contrast, focus and degradation to the code without a need to change underlying parameter settings. With a fixed-mount reader this is easily tested by starting with an optimal set-up as represented with the "model image" and adjusting the aperture to simulate change in contrast, focus to simulate change in depth of field, and position of the light to simulate background problems. A reading solution that consistently reads under these conditions will lower installation cost, minimize start-up issues and ultimately is critical to the overall implementation success of a DPMI application.

In addition to read rate, it is important that the reader return a result quickly. This is true no matter what type of DPMI reader is used. In operations requiring hand-held or presentation DPMI readers, accurate and fast decoding is important. While the main driver for the use of an automatic reader is to eliminate data accuracy errors, the implementation of the readers cannot slow down the process. Until recently hand-held readers were very slow in their decoding time of direct-marked parts, often times resulting in a no read. This leads to frustration on the part of the operator, and ultimately lack of use and wasted investment. It is important to look for hand-held readers that provide laser-like scanning performance across an entire set of representative sample parts. A "trigger to good read beep" should be consistently less than 1 second on all parts in order to gain operator acceptance on the factory floor.

9. Connectivity/IO

Connectivity refers to the method of interfacing the reader or verifier to a controller such as a PLC or PC so that the result of the decoding is communicated. The connectivity method depends upon the application and the type of reader involved.

In fixed-mount DPMI applications read results are usually sent to process equipment or to a database over the factory network, so the DPMI reader should offer both serial and network communications. Serial communications are used typically in applications where the read or verification results stay "local" to the work cell or factory automation equipment. Network connectivity enables the reader to communicate decoded results data to PCs and databases at the enterprise level. For establishing a communications link between a reader and a PC at the enterprise level, make sure the reader supports a broad range of standard network protocols, including:

Common Industrial Communication Protocols used in DPMI Applications	
SMTP	SMTP (Simple Mail Transfer Protocol) capability enables e-notification of problems that occur on the production line.
FTP	FTP (File Transfer Protocol) enables users to easily archive failed inspection images without writing custom software.
DHCP	With DHCP (Dynamic Host Configuration Protocol), each reader you link to the network is automatically assigned an IP address, enabling true plug-and-play performance.
DNS	This allows you to name each reader, such as "ID Reader Line 1", instead of having to rely on a 9-digit IP address.
TCP/IP client server	Look for readers with TCP/IP client server capability, as they are able to send results to other devices directly over Ethernet without any code development.
Telnet	An internet standard protocol that enables remote login and connection from host devices.
EtherNet/IP	This protocol enables readers to be linked to PLCs and other devices over a single Ethernet cable, eliminating the need for complex wiring schemes and costly network gateways.
ModBus/TCP	Another factory network protocol that permits direct connectivity to other devices over Ethernet.

Finally, as more and more ID readers are used throughout the manufacturing process, it becomes important to have a centralized way of managing them. Make sure the ID Reader will allow you to manage and control vision activity over the network from remote locations in the plant and beyond.

In the case of hand-held readers, connectivity methods depend on whether the reader is tethered (uses a cord) or cordless. Tethered readers often communicate the read result through what is called a "keyboard wedge" interface, which emulates the keystrokes of a keyboard making integration to a PC very simple. Alternatively, communications can be made over an RS232-C interface. A cordless hand-held reader uses wireless technology, such as Bluetooth®, in order to communicate to the base PC station or other controller.

10. Vendor Selection

Success in implementing a DPMI application depends upon many factors that have been outlined in this document. DPMI is a very challenging application requiring technology and know-how in solving difficult image analysis problems. Typically, companies experienced in industrial machine vision have the right know-how and technology for providing the highest DPMI read rates. Core competencies in image formation, image processing, and image analysis, give companies with machine vision background a significant edge in delivering DPMI solutions that really work. This machine vision foundation is now being brought to the market in new generations of DPMI products that pack the same power as traditional machine vision systems used in many applications in factories today. Suppliers of more traditional Auto-ID products lack the experience and know-how that comes from analyzing millions of images each year in real world conditions; as a result the ID readers coming from these companies will not succeed in delivering high read rates in DPMI applications.

The vendor should provide the support necessary to thoroughly qualify your DPMI application, and guide you through the considerations necessary to ensure installation success.

It is also important to look for a vendor with a global network of offices offering both pre- and post-sales support. This way, you can get the same consistent high level of product support anywhere in the world. This can be especially important if the system is commissioned in one location and shipped to another.

And finally, the selected supplier should have a successful track record and financial stability to maintain their role as your DPMI reading solutions provider for the long term.

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