Laser Marking for Unique Identification White Paper

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LASER MARKING FOR UNIQUE IDENTIFICATION

A unique and global identification mark system, known as a UID, offers many advantages for tracking and traceability in the aerospace, automotive, electronics, defense or medical industries. In some areas where personal safety is a key concern, such a system has frequently been mandated. In many more cases, organizations or market sectors are looking to this type of system to gain logistical financial benefits. **Table 1** indicates a few of the main sectors where a global implementation has occurred.

Industry	Primary verification standard
Aerospace	SAE AS9132
Automotive	AIM DPM-1-2006
Defense (DoD)	MIL SPEC 130
Electronic components	EIA 706
Medical devices	Awaiting specification

Table 1 – Industries that have or will implement global marking standards

The standards relating to direct part marking (DPM) are specific to Data Matrix code symbology. This 2-dimensional (2-d) machine readable code differs distinctly from the familiar 1-d barcode found on most consumer goods; it has much greater data density, can be read more reliably, and can withstand code damage.

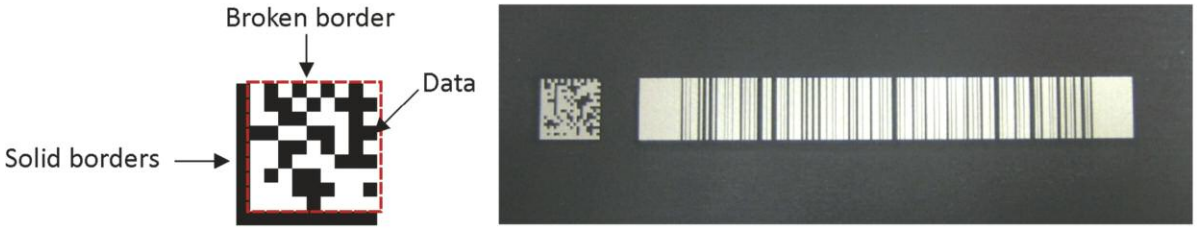
The laser is an excellent tool for DPM, because it offers a non-contact process, a permanent contrasting mark on metals and many plastics, ability to mark text, codes or graphics, and highly flexible and reliable implementation for production.

COMPARING THE BARCODE AND THE DATA MATRIX CODE

We are all very familiar with barcodes that appear on all consumer items, consisting of a series of contrasting light and dark lines that represent letters, numbers or both. The barcode is an analog code that has two key drawbacks: information density is low and it may lack readability. The barcode is physically large, and must be almost perfect in terms of both high contrast and element positioning to enable consistent readability. There are many barcodes that exist, though typical barcodes used are 2 of 5, 39, and 128.

The Data Matrix, ID or 2-d code is fundamentally different from the barcode, because these codes are digital, with characters and symbols coded by a 2-d array of light and dark cells. The digital read means that the reading algorithm simply divides the code up according to the number of rows and columns and then checks each square for either a light or dark cell. The Data Matrix (DM) code comprises a square or rectangle with solid and broken borders. The solid borders indicate the start of the code, and the broken borders allow the reader to establish the size of the code. By contrast with the barcode, the Data Matrix code has extremely high information density and is much easier to read.

As shown on **Figure 1**, the Data Matrix code has solid and broken borders indicating code orientation. The data is encoded in the light and dark "cells" contained within the red dotted square.



The data is encoded in the light and dark "cells" contained within the red dotted square. A general size comparison between Data Matrix Code both containing "Unique Identification Marking" and barcode 39 shows the much higher data density of the DM code

Figure 1 – Data matrix code compared to barcode

Table 2 provides information on density and code size, according to a nominal 0.01-inch cell size. The DM code also contains error correction capability that enables a read to still be made if part of the code has been damaged.

Symbol size Row x Column	Information capacity		Code size for 0.01 in cell
	Numeric	Alphanumeric	
12 x 12	10	6	0.12 in
18 x 18	36	25	0.18 in
24 x 24	72	52	0.24 in
32 x 32	124	91	0.32 in

Table 2 – Information density and code size

FORMATTING DATA MATRIX INFORMATION

Although DM codes can contain a large amount of information, the code is used more as a basic part identification that may contain the manufacturer and serial number, and the unique identification tag to a database that contains the critical information of the marked item. After the item is shipped, the database can be updated dynamically, providing lifetime data availability. For each industry, the required database fields will be different, but the premise is the same, providing traceability of safety critical components, tools or devices.

For example, a UID for the Department of Defense must not contain more than 78 characters, and must use the following format:

<<RS>>03<<GS>>17V0B107<<GS>>MTM-001-A320<<GS>>35149<<RS>><<EOT>>

Data Identifiers: RS = record locator; GS = Group Separator, EOT = End of Transmission

When this code is read, the ASCII codes are embedded in the text to create the required data identifiers. In this case, these are found under ISO/IEC 15418. The coded data format clearly indicates the data segments and end of the data contained within the code. See **Figure 2**.

Figure 2 – Engraved mark in steel marked to UID MIL-STD 130 specifications

LASER MARKING IDEAL FOR UNIQUE IDENTIFICATION PART MARKING

The laser is able to place contrasting marks on both metals and plastics for direct part marking. For certain applications, the code must be engraved to a certain depth for wear resistance, but in other instances minimal material penetration is needed. The laser is a highly flexible marking tool that can achieve both types of marks in a wide variety of materials. The marking software is extremely flexible, and can create the code with the necessary ASCII character delimiters and tilde symbols that can be edited as needed directly within the software. The generation of each mark with incrementing information can be pulled into the marker via a database and dynamically updated in the Data Matrix code and human readable text.