



Specification for Data Matrix Marking
Global Common

SD-1049

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REVISED

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Table of Contents

1. Scope.....	4
2. General Requirements.....	4
2.1 Code Marking Method.....	4
2.2 Code Location.....	5
2.3 Direct Part Mark Quality.....	6
A. Glossary.....	8
B. Recommendations.....	9

List of Figures

Figure 1: Guideline for marking on a curved surface..... 5
Figure 2: Quiet zone example 5
Figure 3: Error Correction ECC 200 in Keyence Marking Builder III..... 6
Figure 4: Verification Report (WebScan Barcode Verification System) 6
Figure 5: Dot Peen DPM Example..... 9
Figure 6: Laser Marker Setup Examples 10

1. Scope

This specification details general requirements and standards for Data Matrix Marking of Data Matrix Codes utilized as part identification through traceability within Nexteer Facilities. Data Matrix Codes are the preferred symbology over 1D or QR Codes. Code quality must assure 100% readability in multiple machines or stations with barcode reading capabilities. ISO 15415 (Labels) and ISO 29158 (AIM-DPM) standards must be considered during Data Matrix Code printing or marking to achieve good readability.

2. General Requirements

2.1 Code Marking Method

- 2.1.1 Material being marked – the hardness and composition of materials will have different effects on all the marking technology available.
- 2.1.2 Surface roughness – rough surfaces can create shadows or reflections that may be misinterpreted by the decoding software. Each element, or cell, of the 2D code must be at least five times greater than the surface roughness. Additional surface preparation may be required to achieve this requirement. See the chart of example material roughness and minimum cell sizes in the below.
- 2.1.3 Surface finish – the preferred finish for 2D codes is a machined surface.

Processing Category	Processing Method	Roughness Ra μ in. (μ m)	Minimum Cell Size – in. (mm)
Cast Surface	Ferrous Green Sand	1000 (25.4)	0.035 (0.89)
	Non-ferrous Sand	500 (12.7)	0.030 (0.76)
	Permanent Mold	250 (6.35)	0.025 (0.64)
	Investment Mold	125 (3.18)	0.020 (0.51)
	Die Cast	32 – 63 (0.8 – 1.6)	0.015 (0.38)
Blasting	Shot Blasting	32 – 2000 (0.8 – 50.8)	0.030 (0.76)
	Sand Blasting	32 – 2000 (0.8 – 50.8)	0.030 (0.76)
	Grit Blasting	32 – 2000 (0.8 – 50.8)	0.030 (0.76)
Machined	Profiled	500 (12.7)	0.030 (0.76)
	Milled	32 – 125 (0.8 – 3.18)	0.015 (0.38)
	Shape Turned	63 – 125 (1.6 – 3.18)	0.015 (0.38)
	Blanchard	16 – 32 (0.4 – 0.8)	0.07 (0.18)
	Ground	4 – 63 (0.1 – 1.6)	0.07 (0.18)
	Lapped	4 – 16 (0.1 – 0.4)	0.07 (0.18)

- 2.1.4 Marking area – the available marking area of the component will determine the size of the 2D code which, in turn, will determine the capability of the marking technology. The size of the 2D matrix should be as large as practical; not as small as possible. Refer to flatness requirements in Section 2.2 and Figure 1.
- 2.1.5 Cycle time – each marking method has a different effect on cycle time; dot peen DPM has the longest cycle time, label printing has the shortest cycle time.

2.2 Code Location

The location of the mark can have an impact on the readability of the code, therefore, the 2D mark shall be a reference dimension on the part print. The selection of the mark location should take the following factors into consideration:

- 2.2.1 Flatness – data matrix codes should be marked on a flat surface whenever possible. In cases where the mark is required on a curved surface, the size of the 2D code shall be no greater than 16% of the diameter, or 5% of the circumference of the part.

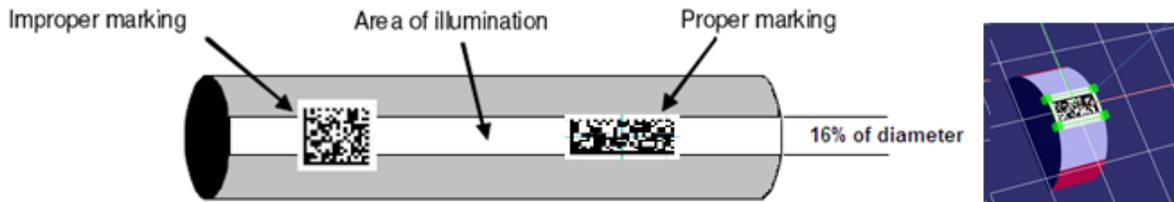


Figure 1: Guideline for marking on a curved surface

- 2.2.2 Visibility – the selected location of the mark must be visible throughout the manufacturing process where the 2D code is to be scanned (read). Marking the code in a visible location according to manufacturing processes will facilitate a more reliable operation.
- 2.2.3 Quiet zone – the selected location of the 2D mark shall be large enough to accommodate a clear area of two or more modules around the 2D code. An example is a 15mm square 2D code shall have a minimum of 1.5mm of clearance around the code.

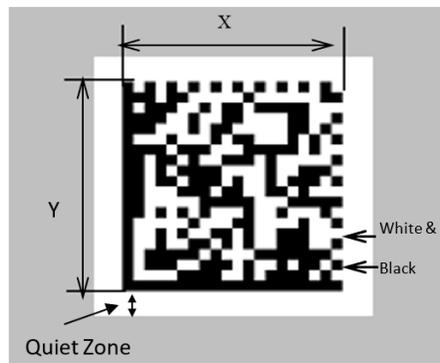


Figure 2: Quiet zone example

2.2.4 Error Correction – error correction Code ECC shall be used for 2D symbology data matrices. A majority of data matrix generation software in marking systems has ECC 200 features integrated.

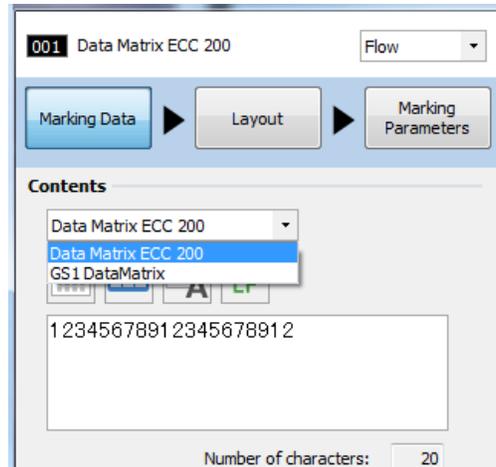


Figure 3: Error Correction ECC 200 in Keyence Marking Builder III

2.3 Direct Part Mark Quality

A quality 2D code is crucial for a successful and robust traceability system; therefore, each component marked with a 2D code shall be verified for quality by the marking supplier.

2.3.1 Verification requirements – the verification of the 2D code must comply with AIM DPM-1-2006 grading requirements. Only one of the approved lighting methods shall be used to verify the quality of the 2D code. The selected lighting method must be communicated with the grade.

Report Summary					
Data	38267677-001-92670001				
Symbology	DataMatrix				
Verified By	Alfonso Mejia				
Company Name	Nexteer Automotive				
Product Name	CCA				
Job Number	38267677-001-92670001				
Verification Grades					
Standard	Grade	Aperture	Wavelength	Lighting	Formal Grade
ISO29158 (AIM-DPM)	B (3.0)	14	660	45Q	DPM 3.0/14/660/45Q
Image					
			ISO 29158 Quality Parameters		
1. Unused Error Correction (UEC)	100%	A			PASS
2. Cell Contrast (CC)	87%	A			PASS
3a. Cell Modulation (CMOD)		A			PASS
3b. Reflectance Margin (RM)		A			PASS
4. Axial Nonuniformity (ANU)	1%	A			PASS
5. Grid Nonuniformity (GNU)	8%	A			PASS
6. Fixed Pattern Damage (FPD)	3.0	B			PASS
7. Left L' Side (LLS)		A			PASS
8. Bottom L' Side (BLS)		A			PASS
9. Left Quiet Zone (LQZ)		A			PASS
10. Bottom Quiet Zone (BOZ)		A			PASS
11. Top Quiet Zone (TOZ)		B			PASS
12. Right Quiet Zone (ROZ)		A			PASS
13. Top Transition Ratio (TR)	0%	A			PASS
14. Right Transition Ratio (RTR)	0%	A			PASS
15. Top Clock Track (TCT)		A			PASS
16. Right Clock Track (RCT)		A			PASS
17. Distributed Damage Grade (DDG)	4.0	A			PASS
18. DECODE		A			PASS
19. Minimum Reflectance (MR)	25%	A			PASS
General Characteristics					
Matrix Size	16x16 (Data: 14x14)				
Horizontal BWG	-3%				
Vertical BWG	-8%				
Encoded characters	21				
Total Codewords	24				
Data Codewords	12				
Image	Black on white				
Nominal X Dim	17.4 mil				
Contrast Uniformity	83 at module(4.9)				
MFO	82% (72% - 10%)				
Stability	89%				

Figure 4: Verification Report (WebScan Barcode Verification System)

- 2.3.2 Datamatrix Quality Grade – obtaining a data matrix grade is not verification; however, it provides a reference of the data matrix quality under the normal machine environment.
- 2.3.3 Symbology printed on labels must conform to ISO/IEC 15415:2011 “Information Technology – Automatic identification and data capture techniques – Bar Code symbol print quality test specification – Two-dimensional symbols.”
- 2.3.4 Symbology using DPM grading measurements must conform to Grade per ISO/IEC 29158 (AIM DPM-1-2006 grading). Barcode guidelines are reported as a DPM grade rather than an ISO/IEC 15415 grade.
- 2.3.5 A minimum barcode acceptance grade is “C” on an alpha scale, or “2” on a number scale. See Table 2 Grade Scale acceptance criteria below.

Grading Scale Equivalency (Best to Worst)	
Alphabetic Grade	Numeric Grade
A	4
B	3
C	2
D	1
E	0

A. Glossary

- A.1 Data Matrix: a two-dimensional matrix barcode, which encodes text or raw data in a pattern of black and white square modules.
- A.2 Direct Part Marking (DPM): the process of permanently marking an item with a barcode directly onto the surface.
- A.3 ECC 200: refers to Data Matrix symbols which are generated according to the latest (and most sophisticated) built-in error correction methods. ECC 200 shows the maximum character limits for worst-case encoding of numeric and alphanumeric strings.
- A.4 ISO/IEC 16022:2006: defines the requirement for the symbology known as Data Matrix. It specifies the Data Matrix Symbology characteristics, data character codification, symbol formats, dimensions and print quality requirements, error correction rules, decoding algorithm, and user selectable application parameters.
- A.5 ISO/IEC 15415:2011: specifies methodologies for the measurement of specific attributes of two-dimensional bar code symbols, defines methods for evaluating and grading these measurements, and deriving an overall assessment of symbol quality.
- A.6 AIM DPM-1-2006: describes modifications which are to be considered in conjunction with the symbol quality methodology defined in ISO/IEC 15415.

B. Recommendations

B.1 Dot Peening: when utilizing Dot Peen technology, barcodes must have good cell space (no overlapping) and good grid uniformity (straight lines). Finer background surface finishes may help for better readability.

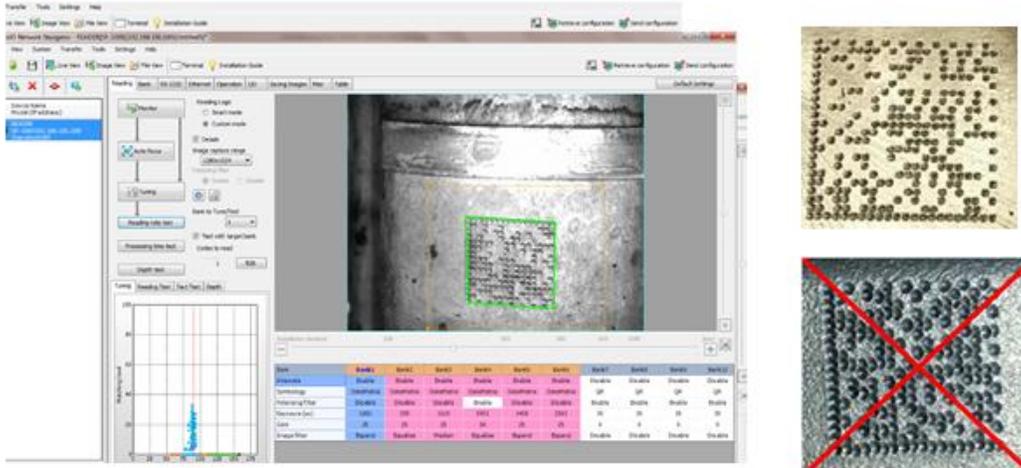


Figure 5: Dot Peen DPM Example

B.2 Most utilized Laser Marker Settings for Nexteer’s marking processes.

2D coding on Steel Shaft
-Machined surface
-Round surface (22mm diam)
-7x7 mm size
30W Laser Unit

2D coding on Aluminum (20 char)
-smooth surface
-Round surface (42mm diam)
-9.1x24.7 mm size
30W Laser Unit

note: Same settings are applied for flat surfaces

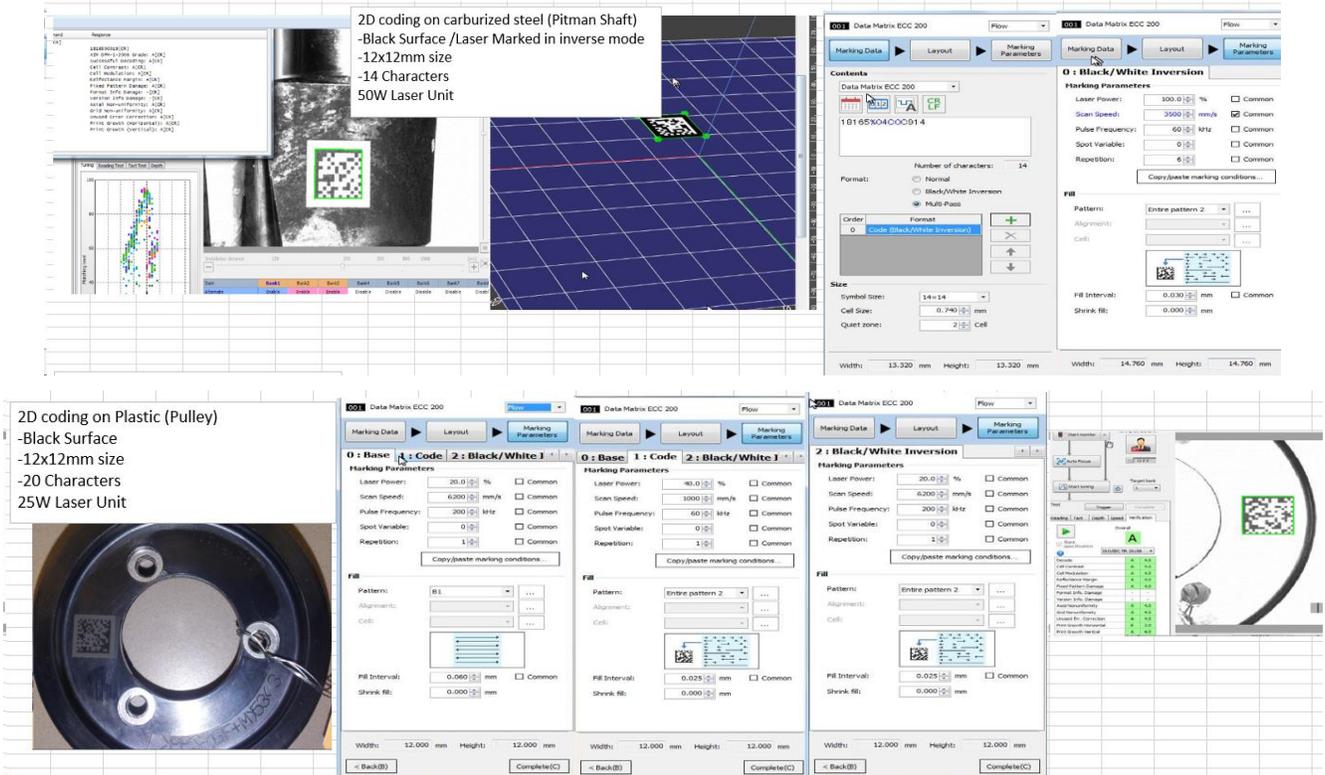


Figure 6: Laser Marker Setup Examples

RECORD OF REVISIONS

Revision No	Date	Section	Description
001	23MR20	ALL	Initial Release.
002			
003			
004			
005			
006			
007			
008			
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