GUIDELINE

FOR

DIRECT PART MARKING

OF

AERO ENGINE PARTS

This Guideline is prepared in according to the experimental work which was done within MTU *Aero Engines* and should help you to achieve the quality of IAQG-Standard for 2D-Data-Matrix Symbols.

Edition 01

Preface

SPEC 2000 Bar Code specification is an international standard which provides a way to exchange information quickly and accurately. In SPEC2000 Chapter 9 you can learn all about the marking contents.

In the Aircraft Industry, especially for Aero Engine Manufacturers, many components will be marked with a 2D Data Matrix by **D**irect **P**art **M**arking (DPM). The technologies which can be used are Dot Peening, Laser, Electro-Chem. Etching or Ink Jet. The company which is responsible for the component design will define the appropriate marking method for their components.

The Quality Requirements are defined in a Quality Standard of the **I**nternational **A**erospace **Q**uality **G**roup (IAQG), and will be published in Oct. 2001. This standard was created by a IAQG-Sub-Group; their members are from the Aircraft Industry (see page 3).

The Quality Spec. contains the requirements you must achieve. It will not show you how to improve the technology on your shop floor. The Aircraft Industry is interested in how SPEC 2000 is realized world-wide, and DPM of 2D-Data-Matrix Symbols is a marking technology very much in coming. It also is a great chance to improve part tracking inside our companies and save costs. The vision of SPEC 2000 will only become reality if we all try hard enough to mark our parts with the required quality. Readability is the key to the success of this technology.

With this Guideline we would like to share our know-how which we gathered in extensive investigations with our suppliers. If you still have questions about DPM, you are welcome to contact the representative of DPM in your customer company (see page 3).

This Edition contains DPM with Dot Peening. As soon we have save daters for other markimg methots like Laser and Electro-Chemical-Etching we will revise this guideline with a new Edition. We wish you an easy start in implementing DPM in your company, and thank you for your support for SPEC 2000.

Regards

Goetz Lebkuechner

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2D-Data-Matrix Guideline

Contents

2D-Data-Matrix Guideline

2D-Data-Matrix Marking Methods

	Rotor Parts	Casings	Sheet Metal Parts	Blades	Vanes
Dot Peening	X	X	X	X	X
Laser		X	X	X	X
Electro Chem. Etching		X	X	X	X
Ink Jet	X	X	X	X	X
Printed Stickers	X	X	X	X	X

X = accepted by all Aero Engine Manufacturers

X = depend on the wall thickness of the part

X = not accepted by all Aero Engine Manufacturers

X = for a interim marking

2D-Data-Matrix Borderlines for Dot Peening

- **Overlapping of oversized Dots**
  For major rotor parts, which are life limited components, oversized dots which are overlapping in a 2D-Data-Matrix are not acceptable. They can fold down burs and therefore affect the life of the component. In addition, the readability can be negatively affected. Therefore the dot size should not exceed 100% of the nominal cell size.

- **Undersized Dots**
  To ensure the readability of a 2D-Data-Matrix, the dot size should not be smaller than 60% of the nominal cell size.

2D-Data-Matrix Symbol Size

The available marking space for a 2D-Data-Matrix on aero engine parts is usually very limited (see sample on Page 8).

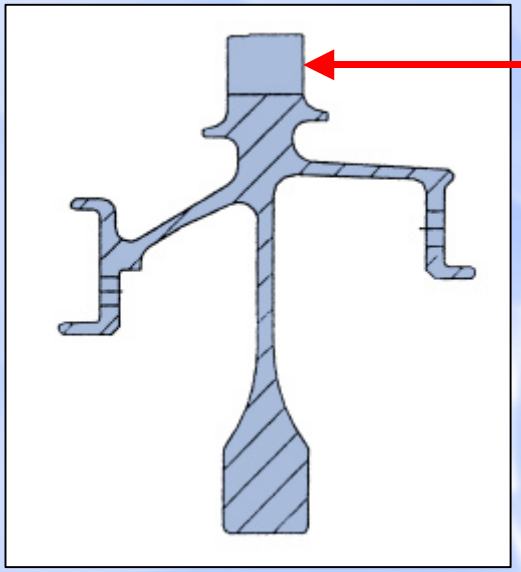
As dot peening is the only accepted marking method for rotating parts, marking tests with different marking machines were required to improve this technology. Test results have shown that the smallest nominal cell size which can be reliably marked and is well decodable has a size of 0.0087 inch (0.22 mm). You will find the necessary space for a 2D-Data-Matrix Symbol for this nominal cell size in Table 1, page 9.

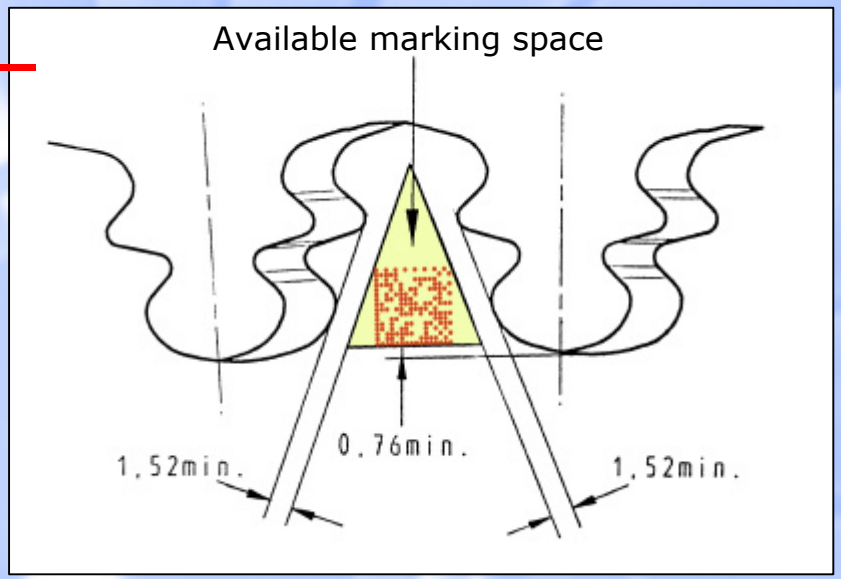
Depending on the particular needs, we recommend tests to improve the reliability of the hardware used. This test should determine the smallest nominal cell size you need to produce and to verify to the 2D-Data-Matrix IAQG Quality Standard.

2D-Data-Matrix Guideline

2D-Data-Matrix Symbol Size

Example: **PW 6000, LPT-Disk Stg. 3**





Data Element : USN
2D Matrix Code : USN 36856FLDLAH1002
Characters : 18x18
Matrix Size : 0.16x0.16” / 4,0x4,0 mm
Nominal Cell Size : 0.0087” / 0,22 mm

2D-Data-Matrix Guideline

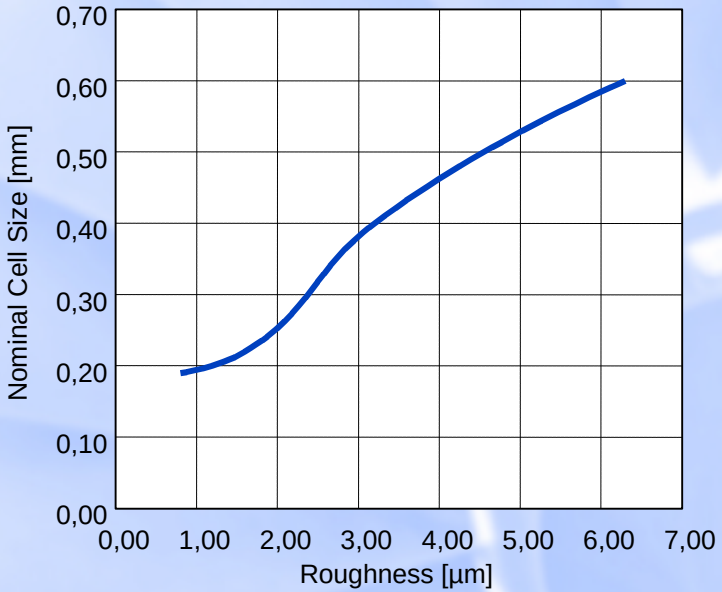
2D-Data-Matrix Symbol Size

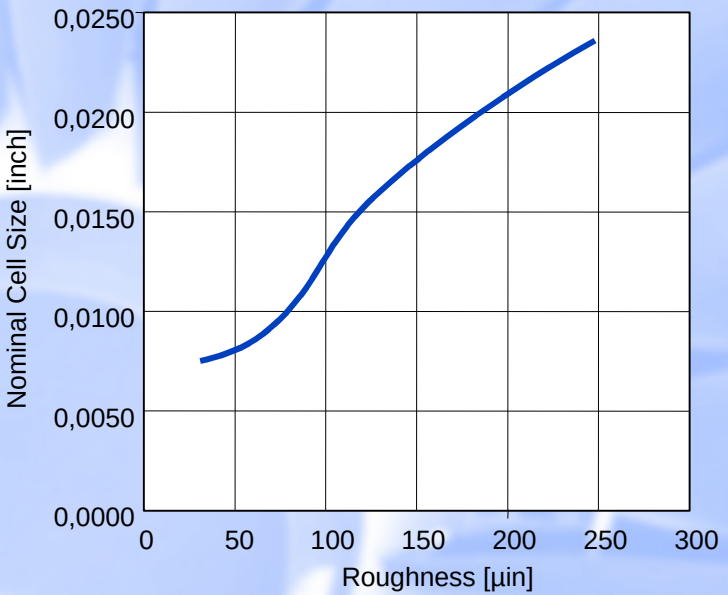
Symbol Size		Data Range	Data Capacity		Nominal Cell Size	
Row	Column		Num Cap.	Alphanum Cap.	0,22 mm	0,0087 inch
					Symbol Size [mm]	Symbol Size [inch]
Square Symbol						
10	10	8x8	6	3	2,20 x 2,20	0,087 x 0,087
12	12	10x10	10	6	2,64 x 2,64	0,104 x 0,104
14	14	12x12	16	10	3,08 x 3,08	0,121 x 0,121
16	16	14x14	24	16	3,52 x 3,52	0,139 x 0,139
18	18	16x16	36	25	3,96 x 3,96	0,156 x 0,156
20	20	18x18	44	31	4,40 x 4,40	0,173 x 0,173
Rectangular Symbol						
8	18	6x16	10	6	1,76 x 3,96	0,069 x 0,156
8	32	6x14 (2x)	20	13	1,76 x 7,04	0,069 x 0,277
12	26	10x24	32	22	2,64 x 5,72	0,104 x 0,225
Recommended Roughness of the Target Surface					Ra = 1,50 µm	Ra = 0.00005"

Table 1

2D-Data-Matrix Guideline

2D-Data-Matrix Symbol Size





The surface roughness of the part affects the readability of a dot peened 2D Data Matrix. The surface roughness between and around the dots is producing background noise for scanners. The pictures above show the recommended nominal cell size for a given surface roughness.

2D-Data-Matrix Verification

IAQG-Quality-Requirements

QUALITY	Excellent	Acceptable
Stylus Angle	60, 90 or 120°	
Stylus Point Radius	Subject to Engineering Requirements	
Dot Size (% of the Nominal Cell Size)	70 to 90%	60 to 100%
Dot Depth	Subject to Engineering Requirements	
Dot Center Offset (% of the Nominal Cell Size)	0 to 10%	10 to 20%
Angle of Distortion	± 3,5°	± 7,0°

Table 2

The Dot Size shall not exceed 100% of the nominal cell size and, for purposes of readability, shall not be less than 60% of the nominal cell size.
The ovality of the dot shall not exceed 20% of the cell size. No more than 2% of the total number of cells may contain dots that are outside of these ranges.
The minimum dot size shall not be less than 0.0071" or 0,18 mm.

Recommendation: Due to they machine tests, a 2D-Data-Matrix Symbol is secure readability with a nominal cell size of 0.0087” (0.22 mm). Only two dot peen machines were not able to mark a 2D-Data-Matrix within the quality requirements of the IAQG-Spec. (see the required ranges in table 3, page 12 and our test results on page 21 and 22).

2D-Data-Matrix Verification

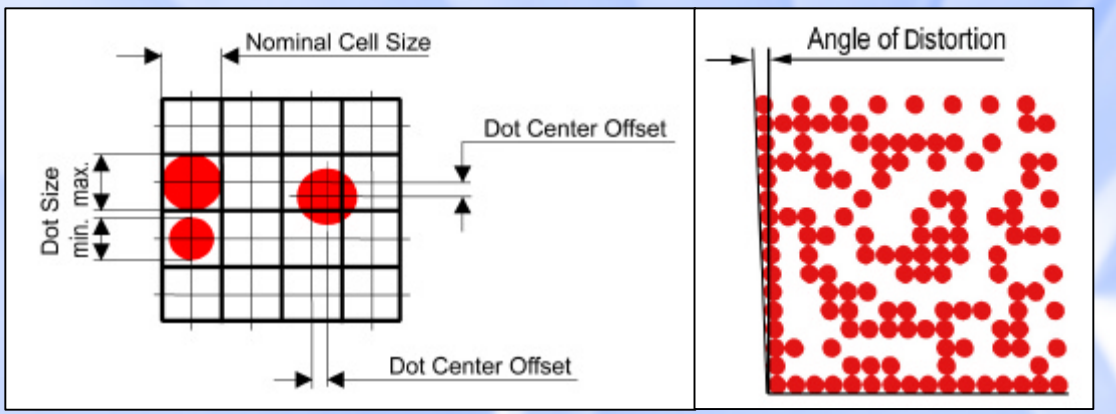
Nominal Cell Size [inch]	0,0087			
VERIFICATION	excellent	acceptable	not acceptable	
Stylus Angle	60 or 90°			
	[inch]	[inch]	[inch]	[inch]
Stylus Point Radius	0,0039	0,0039	0,0039	0,0039
Dot Size	0,0061 - 0,0078	0,0052 - 0,0087	> 0,0087	< 0,0052
Dot Depth	0,0048 - 0,0062	0,0069 - 0,0006	> 0,0069	< 0,0006
Dot Center Offset	0,0009 - 0,0000	0,0017 - 0,0009	> 0,0022	> 0,0022
Angle of Distortion	± 3,5°	± 7°	> 7°	> 7°
Roughness of the Target Surface	Ra = 0.00005" or better			

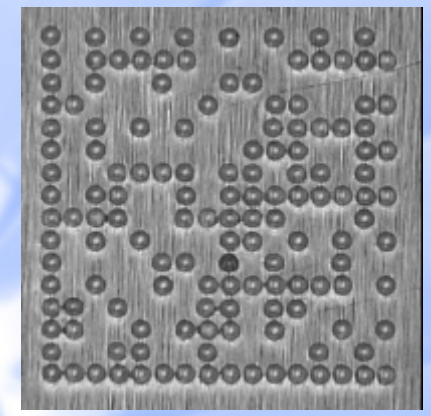
Nominal Cell Size [mm]	0,22			
VERIFICATION	excellent	acceptable	not acceptable	
Stylus Angle	60 or 90°			
	[mm]	[mm]	[mm]	[mm]
Stylus Point Radius	0,100	0,100	0,100	0,100
Dot Size	0,154 - 0,198	0,132 - 0,220	> 0,220	< 0,132
Dot Depth	0,072 - 0,036	0,092 - 0,026	> 0,092	< 0,026
Dot Center Offset	0,022 - 0,000	0,044 - 0,022	> 0,055	> 0,055
Angle of Distortion	± 3,5°	± 7°	> 7°	> 7°
Roughness of the Target Surface	Ra = 1,50 µm or better			

Table 3 smallest recommended nominal cell size for dot peening

2D-Data-Matrix Guideline

2D-Data-Matrix Verification





Sample 20x
excellent quality

- **First Article Inspection**

  The First Article Inspection of a 2D-Data-Matrix-Symbol will be performed with microscope measurements and a reading test by scanner. The magnification should be 40 to 50x. The measurements will consist of the min. and max. dot size, the dot center offset and the angle distortion.

- **Production**

  In production, the verification will consist of a reading test. The dot size will be improvement with a 10x magnifying glass to ensure that the 2D-Data-Matrix Symbol has no oversized or undersized dots.

2D-Data-Matrix Guideline

Major Influence for Dot Peening

- **Hardness of the target material**
  The dot size of a 2D-Data-Matrix will be affected be the hardness variation of the target material. For turbine engine materials the hardness variation will be within acceptable limits.

- **Marking force**
  Due to the very small dot size which have to be produced, the force has to be very constant. Marking machines with an electro-magnetic system are consistent. Marking machines with an air-pressure system often have a problem with pressure variation of the air-supply system. A variation of 15 psi for an air-supply system is not unusual. For DPM and the required dot size, the air-pressure should be adjusted within ±2.5 psi.

- **Stylus-to-target distance**
  The dot size of a 2D-Data-Matrix is also controlled by the stylus-to-target distance. The sensitivity of this parameter depends on the mass of the stylus, the marking force and the hardness of the target material.

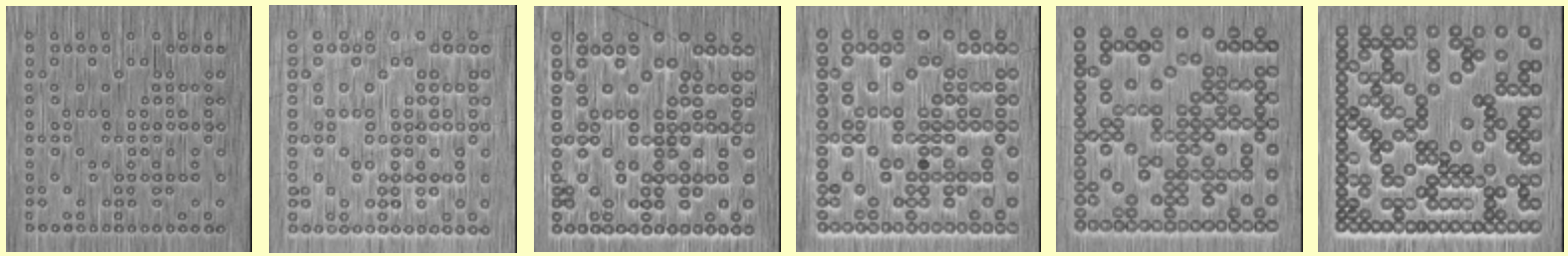
Testing Dot Peen Machines (Electro-Magnetic System)

The test of dot peening machines should concentrate on the smallest nominal cell size and should be carried out with the softest material which has to be marked. The stylus radius and angle must correspond to the nominal cell size.

Testing Dot Peen Machines with an Electro-Magnetic System

1. First mark a row of 2D-Data-Matrix Symbols, and increase or decrease the stylus-to-target distance until you have at least a variation of dot sizes in the range of 60 to 100% of the nominal cell size (see pictures below). During the tests, measure the stylus-to-target distance with very accurate gauges and record all parameters (Target-Material/Stylus-Type/Force/Stylus-to-Target-Distance).
2. Evaluate all symbols and measure the min. and max. dot size, the dot center offset and the angle of distortion (see page 13).
3. Plot a graph which contains the min. and max. dot size with respect to the stylus-to-target distance (see graph on page 16 and 17).

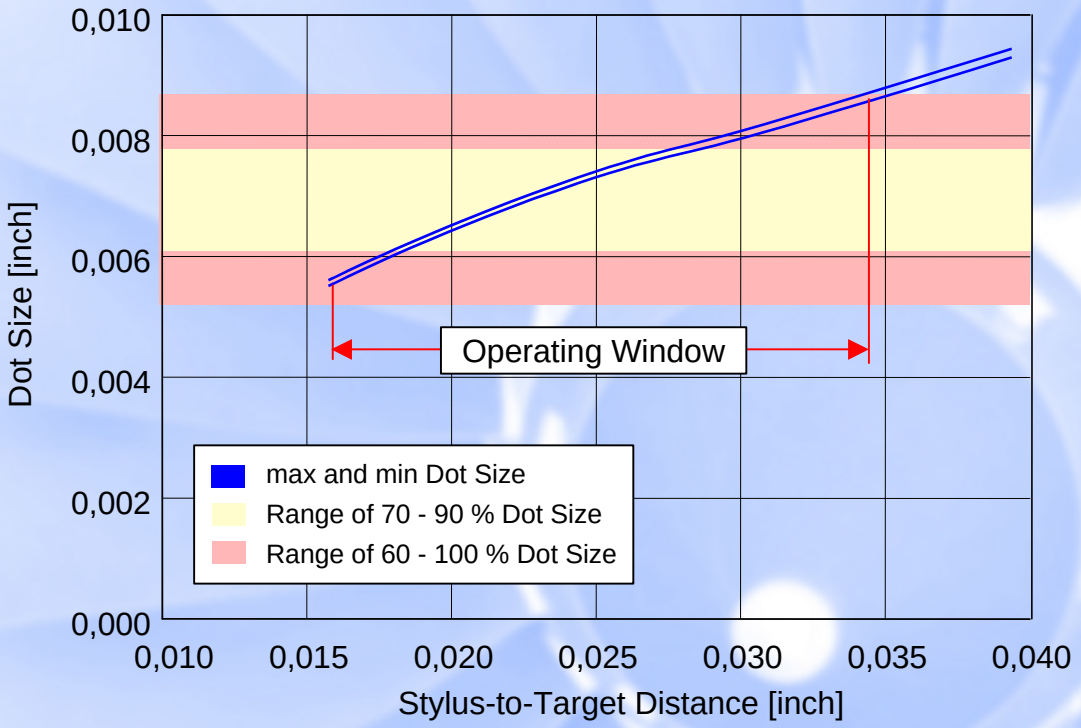
Test-Row of 2D-Data-Matrix Symbols

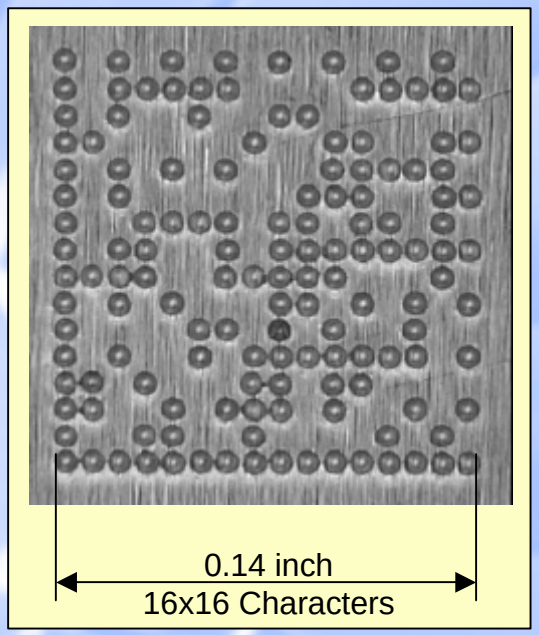


Test No. 1 | Test No. 2 | Test No. 3 | Test No. 4 | Test No. 5 | Test No. 6

2D-Data-Matrix Guideline

Testing Dot Peen Machines (Electro-Magnetic System)



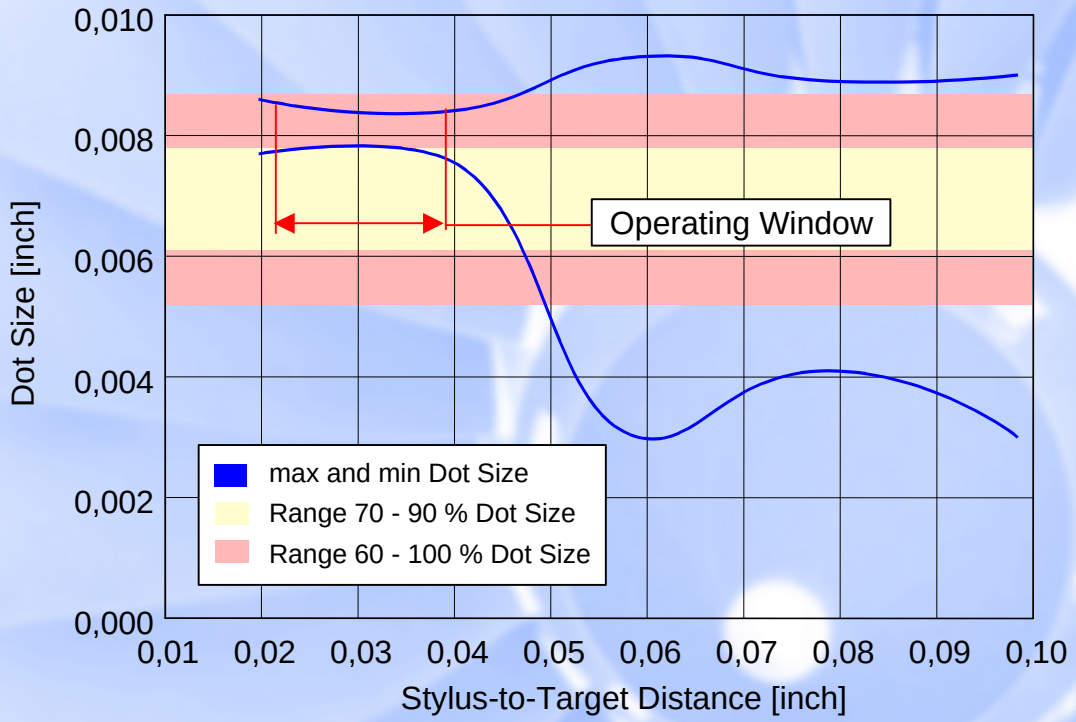


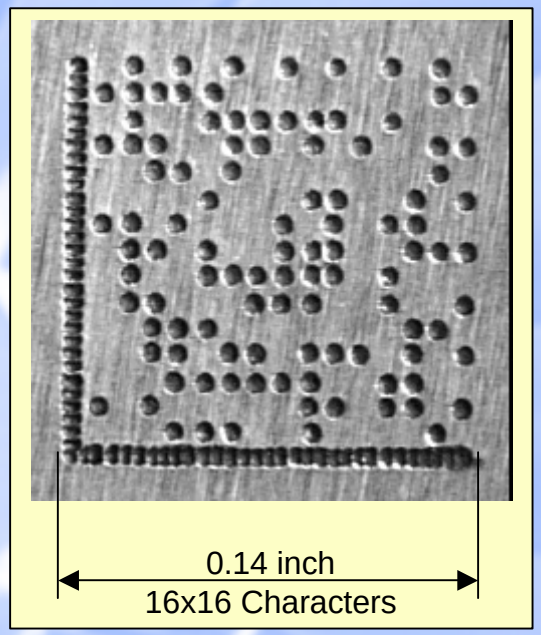
Such low-slope curves where the max. and min. are close together show that this machine operates very reliably.

Recommendation: For DPM, we recommend implementing a motor driven z-axis with an automatic surface detection in every dot peen machine. Such an installation saves marking time and ensures a constant quality.

2D-Data-Matrix Guideline

Testing Dot Peen Machines (Electro-Magnetic System)





The graph above shows a dot growth which is not stable. This machine can only operate in a very small window. The large dot size variation indicates a possible mechanical problem with the stylus guide bushing. The overlapping of the dots is not permissible.
Such a 2D-Data-Matrix will not be accepted by the IAQG-Quality Spec.

Testing Dot Peen Machines (Air Pressure System)

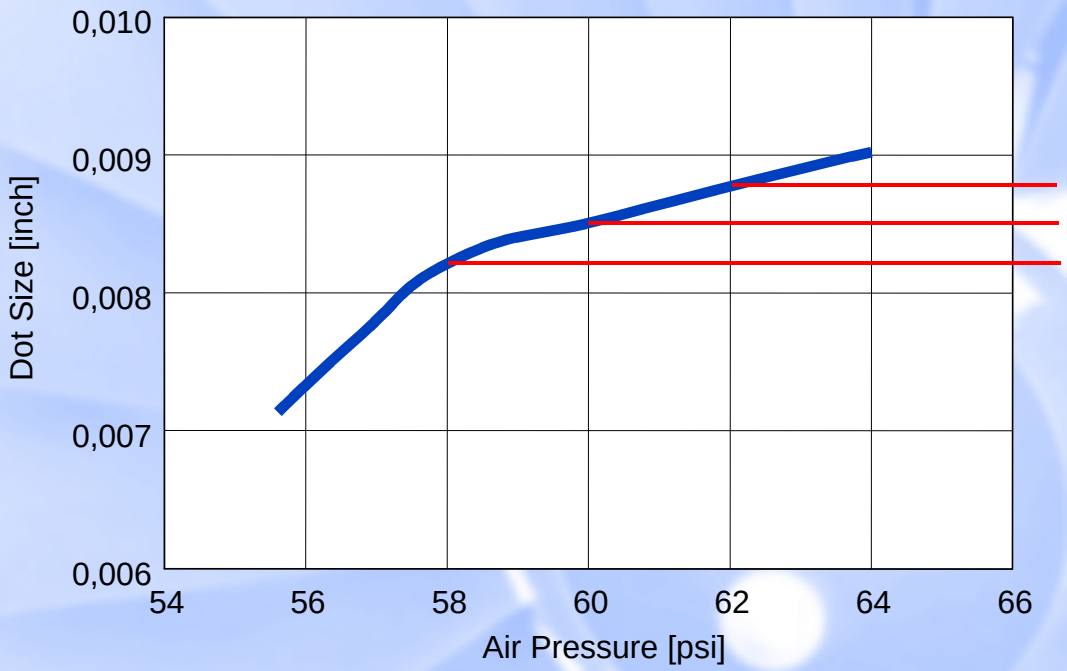
Testing Dot Peen Machines with an Air Pressure System

Typical air supply systems can have a pressure variation of 15 psi throughout the day. Dot size variation is affected/subject to the marking system air pressure. This should be considered with machine tests. Therefore a second test row with a pressure variation is necessary.

1. First mark a row of 2D-Data-Matrix Symbols and increase or decrease the stylus-to-target distance until you have at least a variation of dot sizes in the range of 60 to 100% of the nominal cell size. During the tests measure the stylus-to-target distance with very accurate gauges, control the constancy of the air-pressure and record all parameters (Target-Material/Stylus-Type/Air-Pressure/Stylus-to-Target-Distance).
2. Evaluate all symbols and measure the min. and max. dot size, the dot center offset and the angle of distortion (see page 13).
3. Mark a second test row with variation in air-pressure. For this test, use the stylus-to-target distance which has produced a dot size of 80% of the nominal cell size. Change the air-pressure up and down from the initial pressure level in small steps (2 psi).
4. Measure the min. and max. dot size and calculate the mean dot size of each symbol.
5. Calculate the dot growth with respect to the pressure change. The result should be the dot growth [in % growth per psi increment] (see page 19).
6. Now correct the measured dot sizes from the first marking test with the amount of dot growth in % which you expect due to your air-supply system.
7. Plot a graph which contains the min. and max. dot size with respect to the stylus-to-target distance with the corrected numbers (see graph on page 20).

2D-Data-Matrix Guideline

Testing Dot Peen Machines (Air-Pressure System)



Calculating the dot growth in percent

for max. Dot Size

$\frac{D2}{D1}$ x 100 = 103,5%

for min. Dot Size

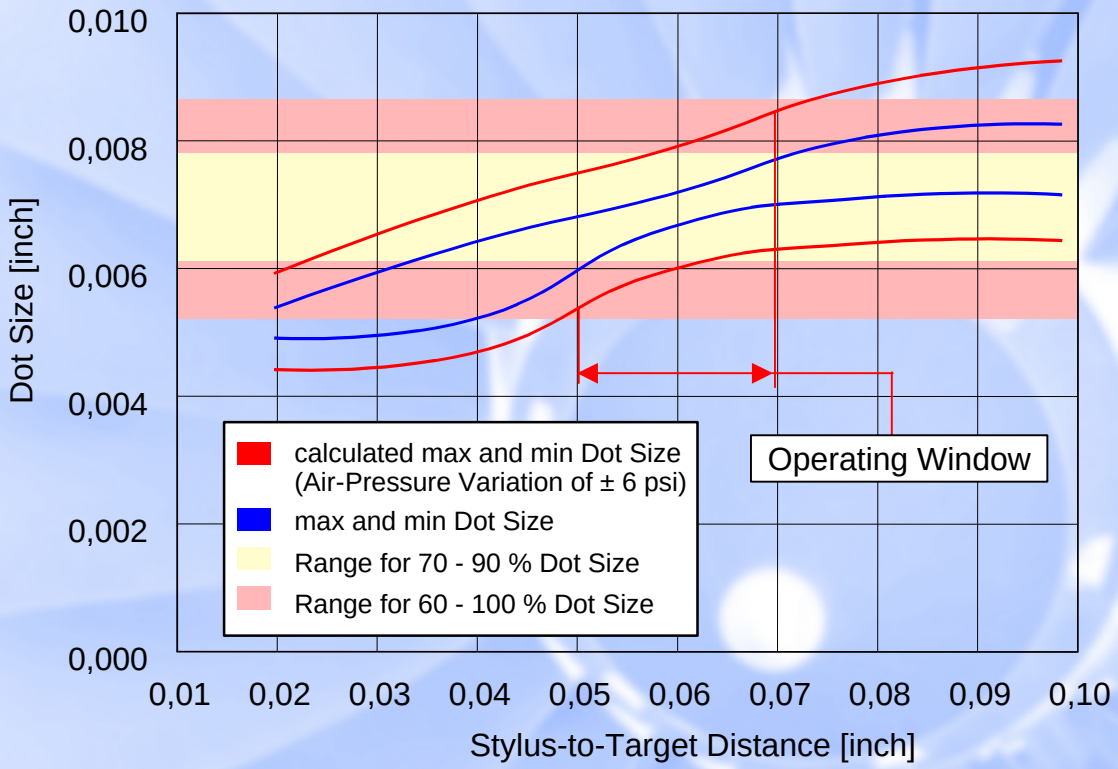
$\frac{D3}{D1}$ x 100 = 96,5%

The calculated dot growth for this example is ± 3.5% for 2 psi.

The graph above shows dot growth with respect to the air-pressure variation.

2D-Data-Matrix Guideline

Testing Dot Peen Machines (Air-Pressure System)



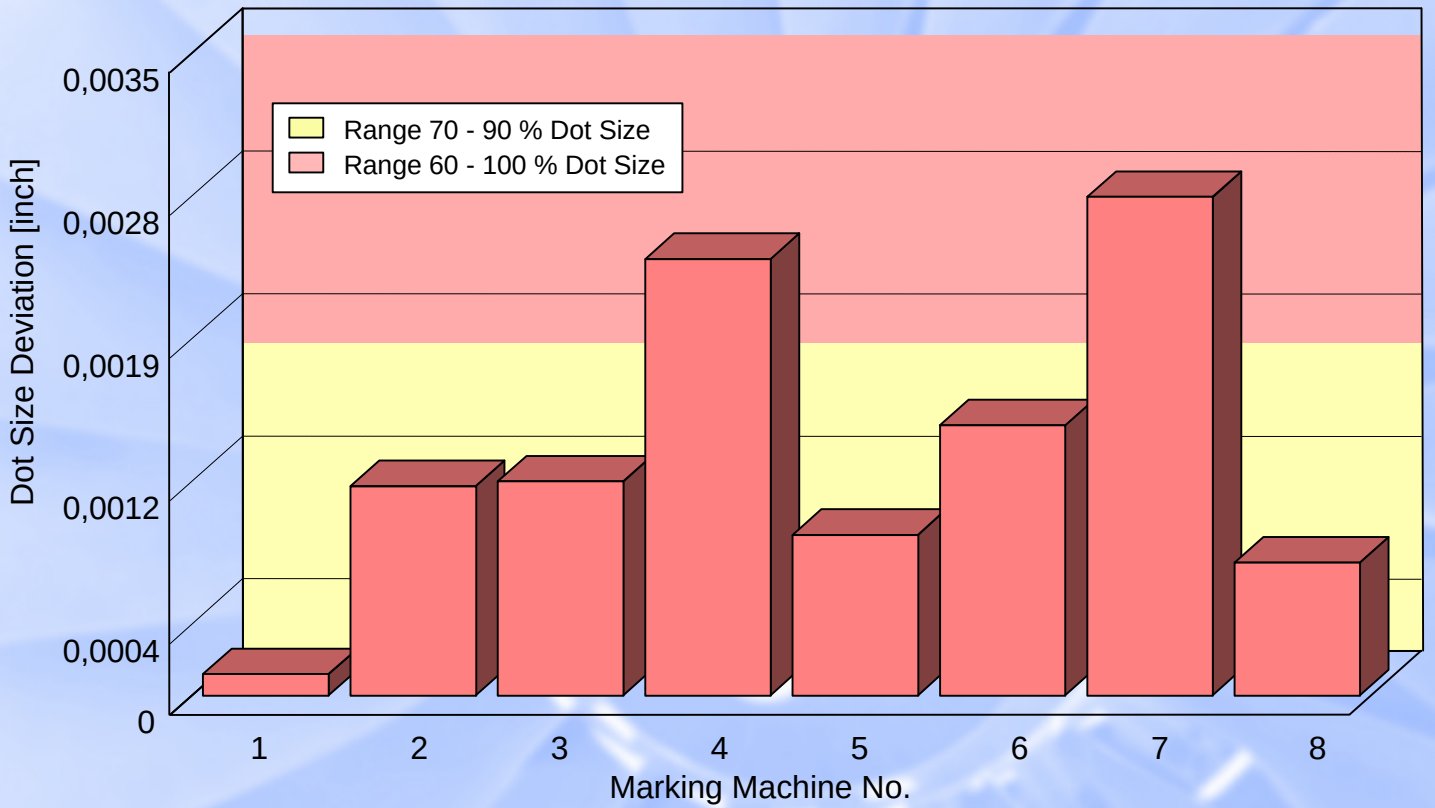
From the air pressure supply system we expect a pressure variation of ± 6 psi.

Therefore the test was corrected with a dot growth of ±10,5% (see the red lines in the graph).

The graph above shows dot growth with an air-pressure system.

2D-Data-Matrix Guideline

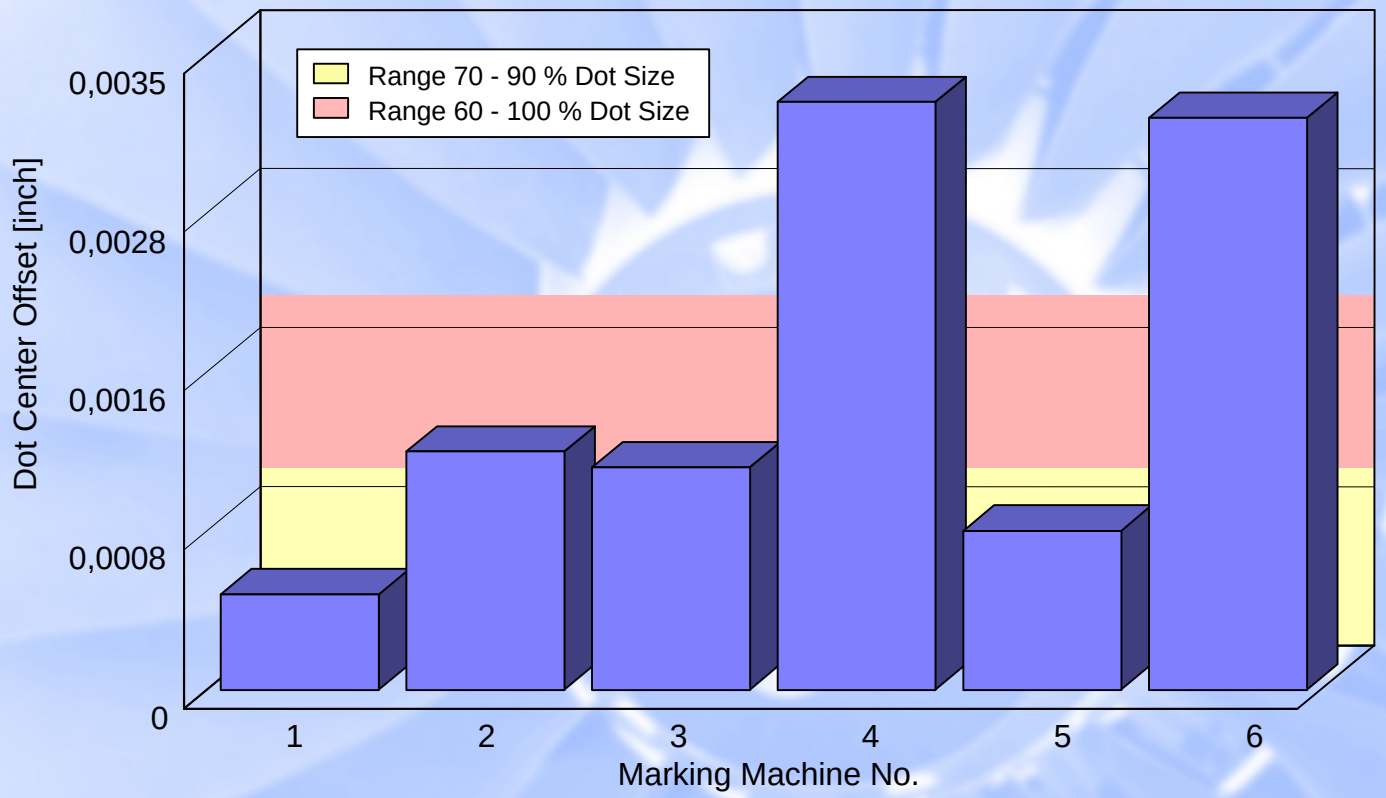
Dot Size Deviation



Two of the eight tested machines produced a dot size deviation greater than desired.
There is no leeway left for other process variations.

2D-Data-Matrix Guideline

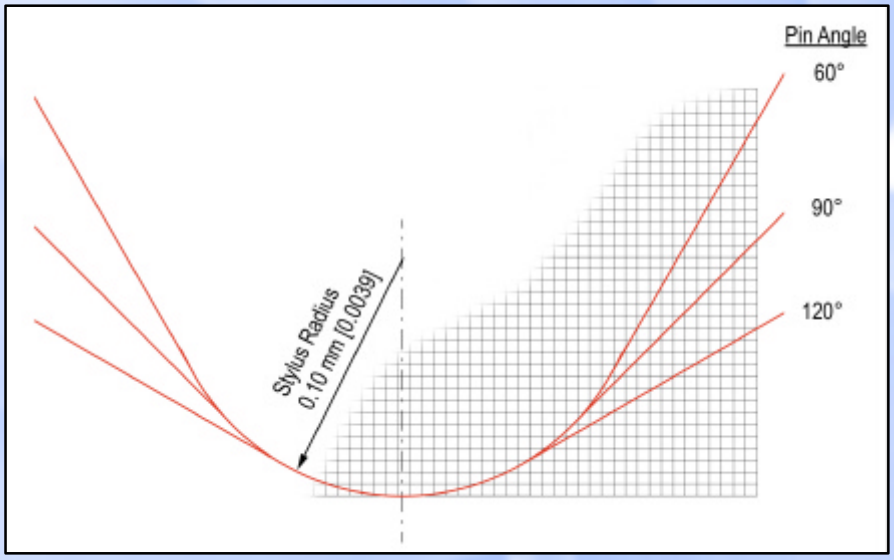
Dot Center Offset

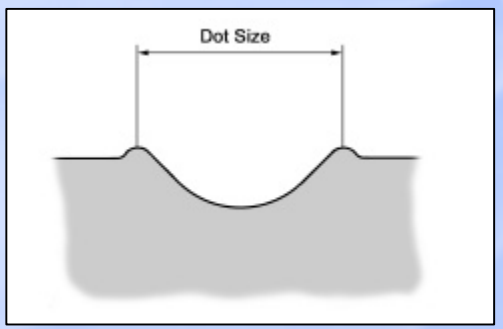


Two of the six machines produced an extremely high dot center offset; they don't achieve the requirements of the IAQG-Quality Standard.

2D-Data-Matrix Guideline

Dot Depth





The dot size should be measured from the top with a microscope 40 to 50x or photographic techniques involving scaled measurements.

The dot depth of a 2D-Data-Matrix is very important for the readability. A shallow depth can cause illumination problems.
For example, the dot depth can be measured with a Scanning Mechanical Microscope; a rather expensive piece of equipment which is not always available.
As the dot depth is a function of the stylus radius, the pin angle and the actual dot size, we produced CAD plots with a magnification of 500x and measured the depth with respect to the dot diameter. To approximate the real depth, subtract the stylus wear from this theoretical value. We believe this method is sufficient for this purpose.
You are welcome to use the following tables and graphs to establish your dot depth.

2D-Data-Matrix Guideline

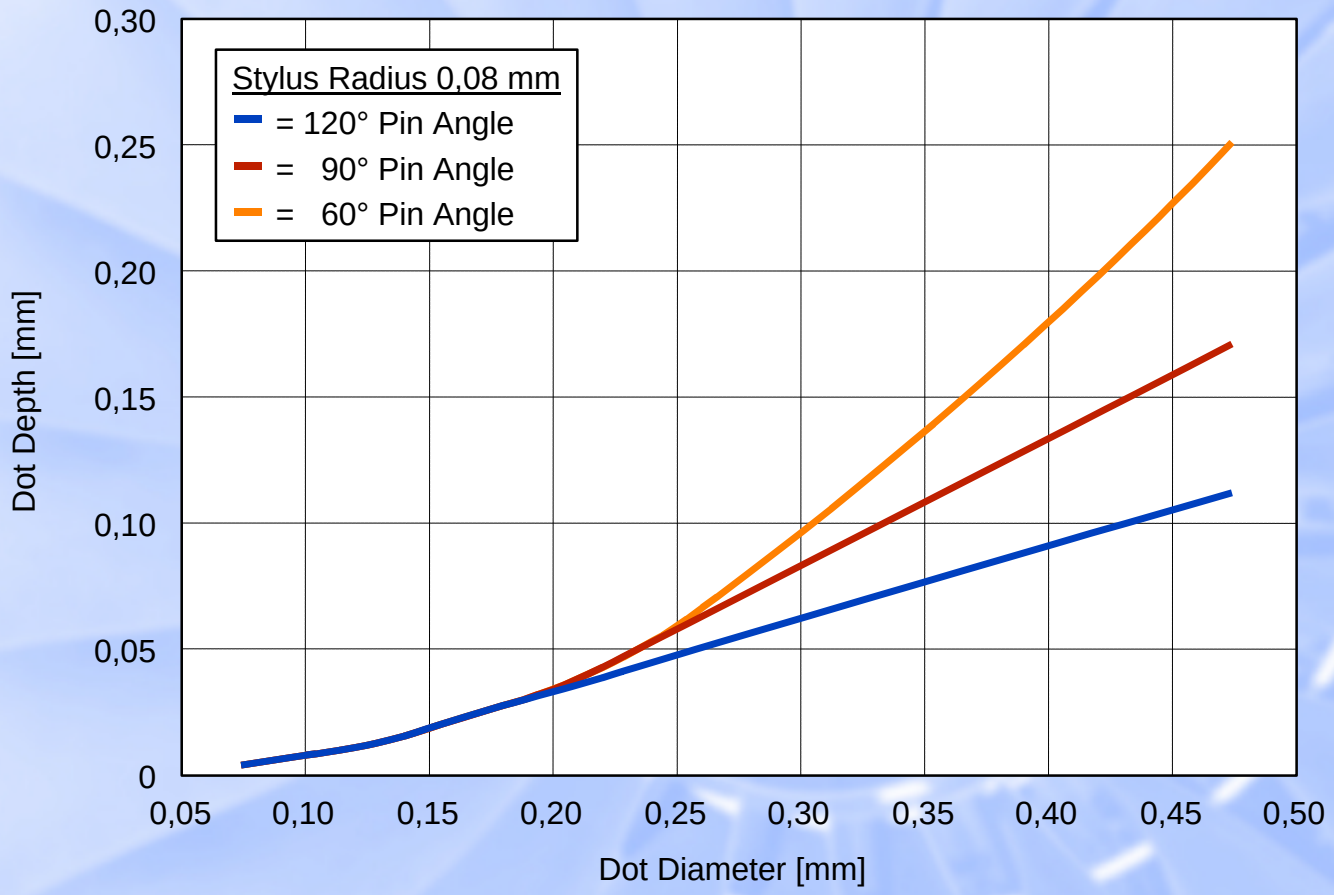
Dot Depth

Radius =	0,080 mm			Radius =	0,0031 inch		
Dot Size	Stylus Angle			Dot Size	Stylus Angle		
	120°	90°	60°		120°	90°	60°
	Dot Depth				Dot Depth		
[mm]	[mm]	[mm]	[mm]	[inch]	[inch]	[inch]	[inch]
0,074	0,004	0,004	0,004	0,0029	0,0002	0,0002	0,0002
0,094	0,007	0,007	0,007	0,0037	0,0003	0,0003	0,0003
0,114	0,010	0,010	0,010	0,0045	0,0004	0,0004	0,0004
0,134	0,014	0,014	0,014	0,0053	0,0006	0,0006	0,0006
0,154	0,020	0,020	0,020	0,0061	0,0008	0,0008	0,0008
0,174	0,026	0,026	0,026	0,0069	0,0010	0,0010	0,0010
0,194	0,032	0,032	0,032	0,0076	0,0012	0,0013	0,0013
0,214	0,037	0,040	0,040	0,0084	0,0015	0,0016	0,0016
0,234	0,043	0,050	0,050	0,0092	0,0017	0,0020	0,0020
0,254	0,049	0,060	0,062	0,0100	0,0019	0,0024	0,0025
0,274	0,055	0,070	0,079	0,0108	0,0022	0,0028	0,0032
0,294	0,060	0,080	0,096	0,0116	0,0024	0,0032	0,0038
0,314	0,066	0,090	0,114	0,0124	0,0026	0,0036	0,0045
0,334	0,072	0,100	0,131	0,0131	0,0028	0,0040	0,0052
0,354	0,078	0,110	0,148	0,0139	0,0031	0,0044	0,0059
0,374	0,083	0,121	0,165	0,0147	0,0033	0,0047	0,0065
0,394	0,089	0,131	0,182	0,0155	0,0035	0,0051	0,0072
0,414	0,095	0,141	0,199	0,0163	0,0037	0,0055	0,0079
0,434	0,101	0,151	0,217	0,0171	0,0040	0,0059	0,0086
0,454	0,106	0,161	0,234	0,0179	0,0042	0,0063	0,0092
0,474	0,112	0,171	0,251	0,0187	0,0044	0,0067	0,0099

Table 4 Dot Depth for Stylus Radius 0,08 mm [0.0031 inch]

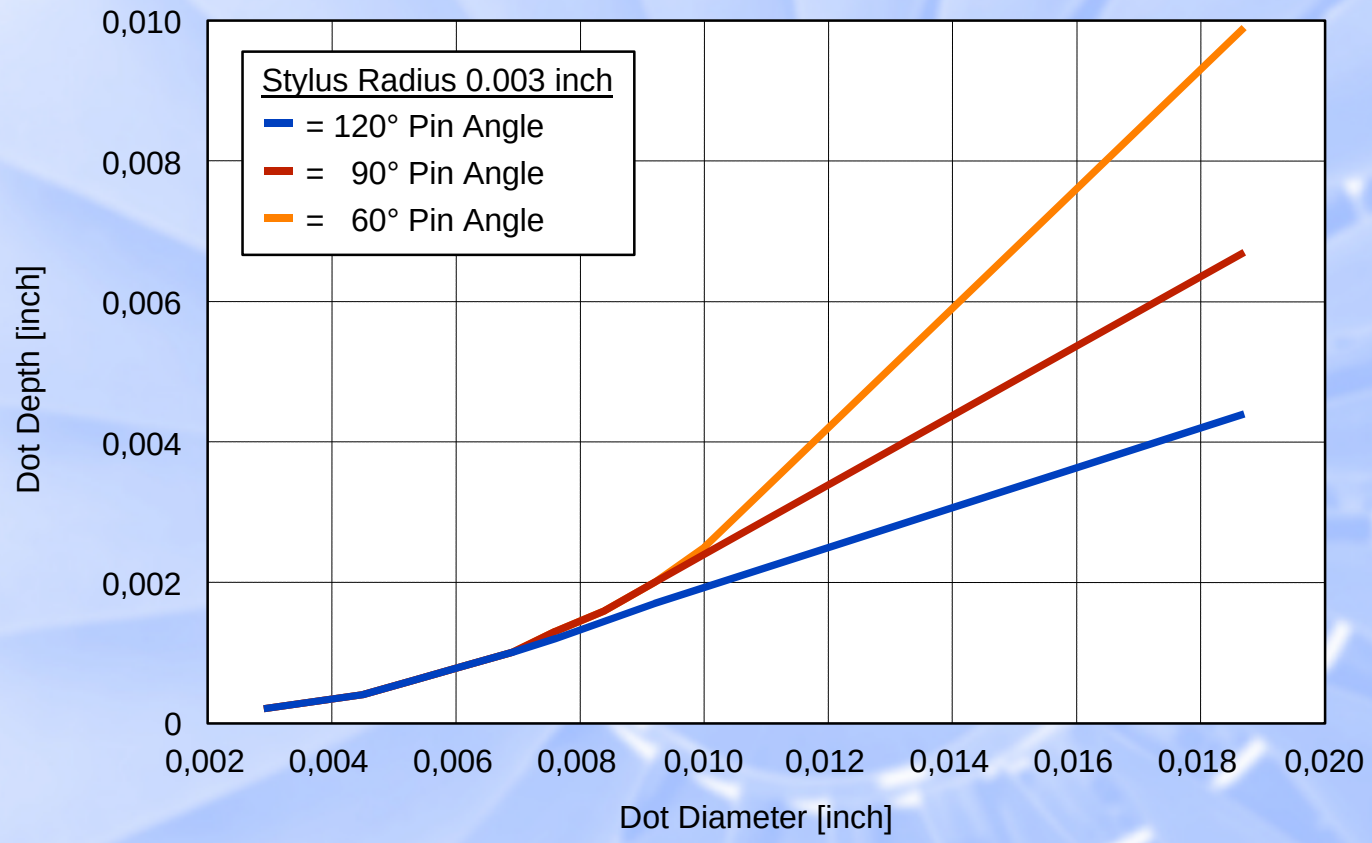
2D-Data-Matrix Guideline

Dot Depth



2D-Data-Matrix Guideline

Dot Depth



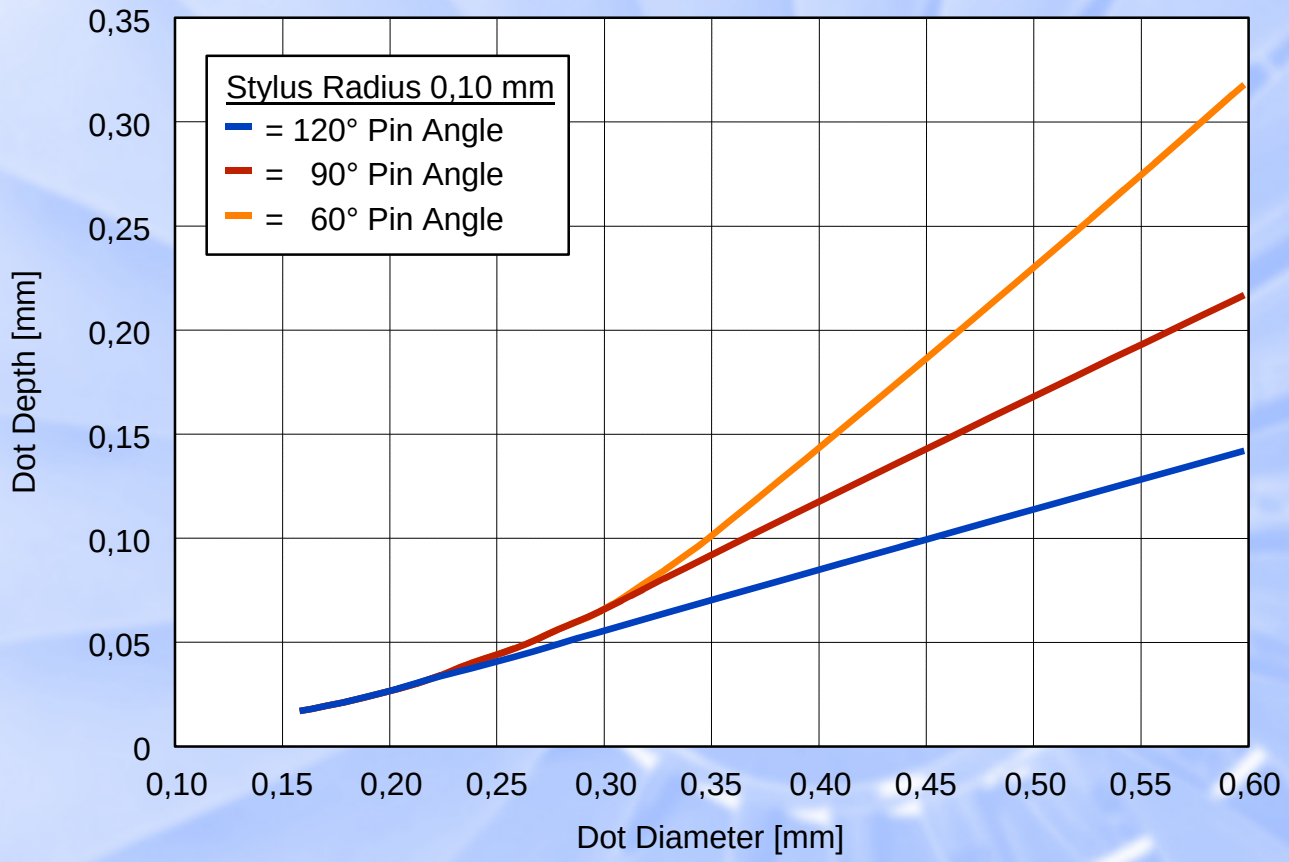
Dot Depth

Radius =	0,100 mm			Radius =	0,0039 inch		
Dot Size	Stylus Angle			Dot Size	Stylus Angle		
	120°	90°	60°		120°	90°	60°
	Dot Depth				Dot Depth		
[mm]	[mm]	[mm]	[mm]	[inch]	[inch]	[inch]	[inch]
0,158	0,017	0,017	0,017	0,0062	0,0007	0,0007	0,0007
0,178	0,021	0,021	0,021	0,0070	0,0008	0,0008	0,0008
0,198	0,026	0,026	0,026	0,0078	0,0010	0,0010	0,0010
0,218	0,032	0,032	0,032	0,0086	0,0012	0,0013	0,0013
0,238	0,038	0,040	0,040	0,0094	0,0015	0,0016	0,0016
0,258	0,043	0,047	0,047	0,0102	0,0017	0,0019	0,0019
0,278	0,049	0,056	0,056	0,0109	0,0019	0,0022	0,0022
0,298	0,055	0,065	0,065	0,0117	0,0021	0,0026	0,0026
0,318	0,061	0,076	0,078	0,0125	0,0023	0,0030	0,0031
0,338	0,067	0,086	0,092	0,0133	0,0026	0,0034	0,0037
0,358	0,072	0,096	0,108	0,0141	0,0028	0,0038	0,0043
0,378	0,078	0,106	0,125	0,0149	0,0030	0,0042	0,0050
0,398	0,084	0,116	0,143	0,0157	0,0033	0,0046	0,0057
0,418	0,090	0,126	0,160	0,0165	0,0035	0,0050	0,0063
0,438	0,096	0,136	0,178	0,0172	0,0037	0,0054	0,0070
0,458	0,101	0,146	0,195	0,0180	0,0040	0,0058	0,0077
0,478	0,107	0,157	0,212	0,0188	0,0042	0,0061	0,0084
0,498	0,113	0,167	0,230	0,0196	0,0044	0,0065	0,0091
0,518	0,119	0,177	0,247	0,0204	0,0047	0,0069	0,0097
0,538	0,125	0,187	0,264	0,0212	0,0049	0,0073	0,0104
0,558	0,130	0,197	0,282	0,0220	0,0051	0,0077	0,0111
0,578	0,136	0,207	0,299	0,0228	0,0054	0,0081	0,0118
0,598	0,142	0,217	0,318	0,0235	0,0056	0,0085	0,0125

Table 5 Dot Depth for Stylus Radius 0,10 mm [0.0039 inch]

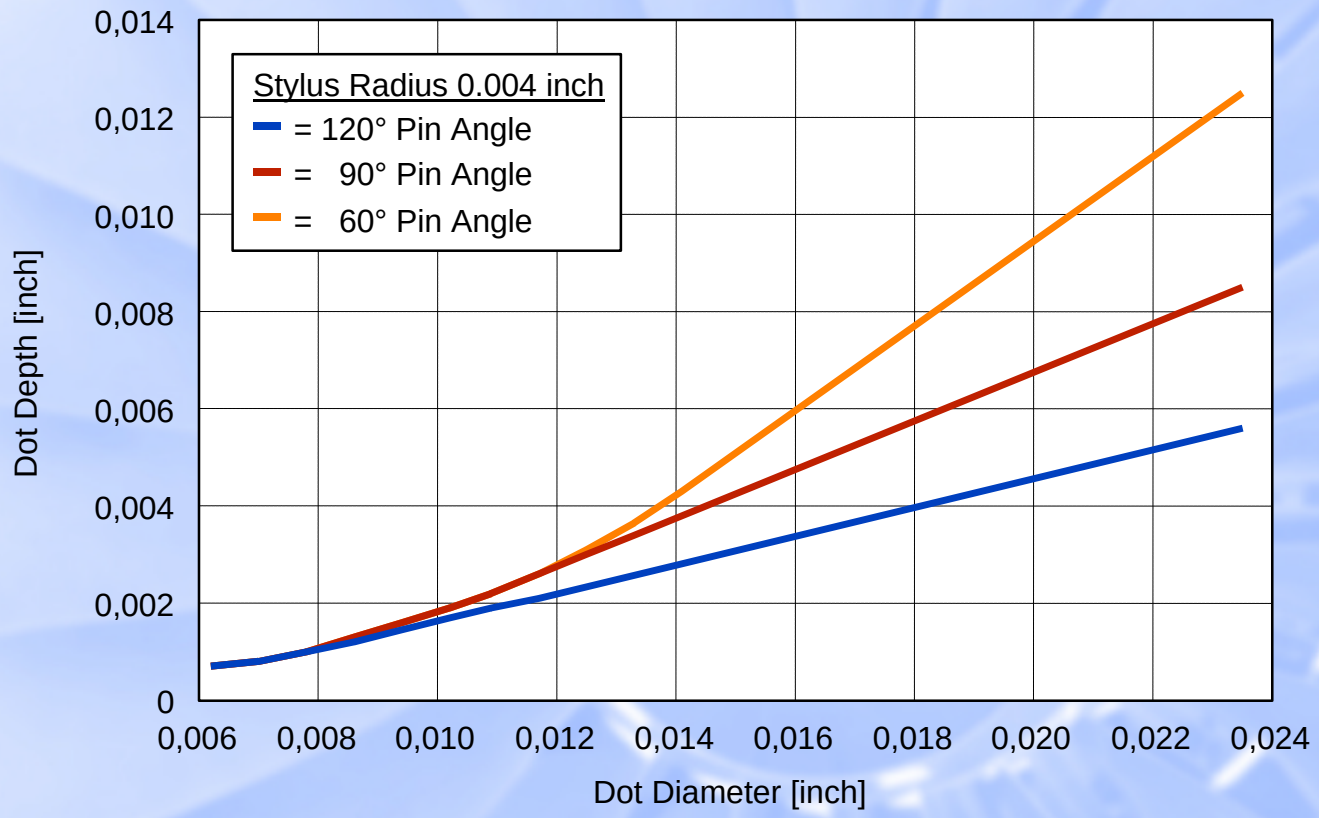
2D-Data-Matrix Guideline

Dot Depth



2D-Data-Matrix Guideline

Dot Depth



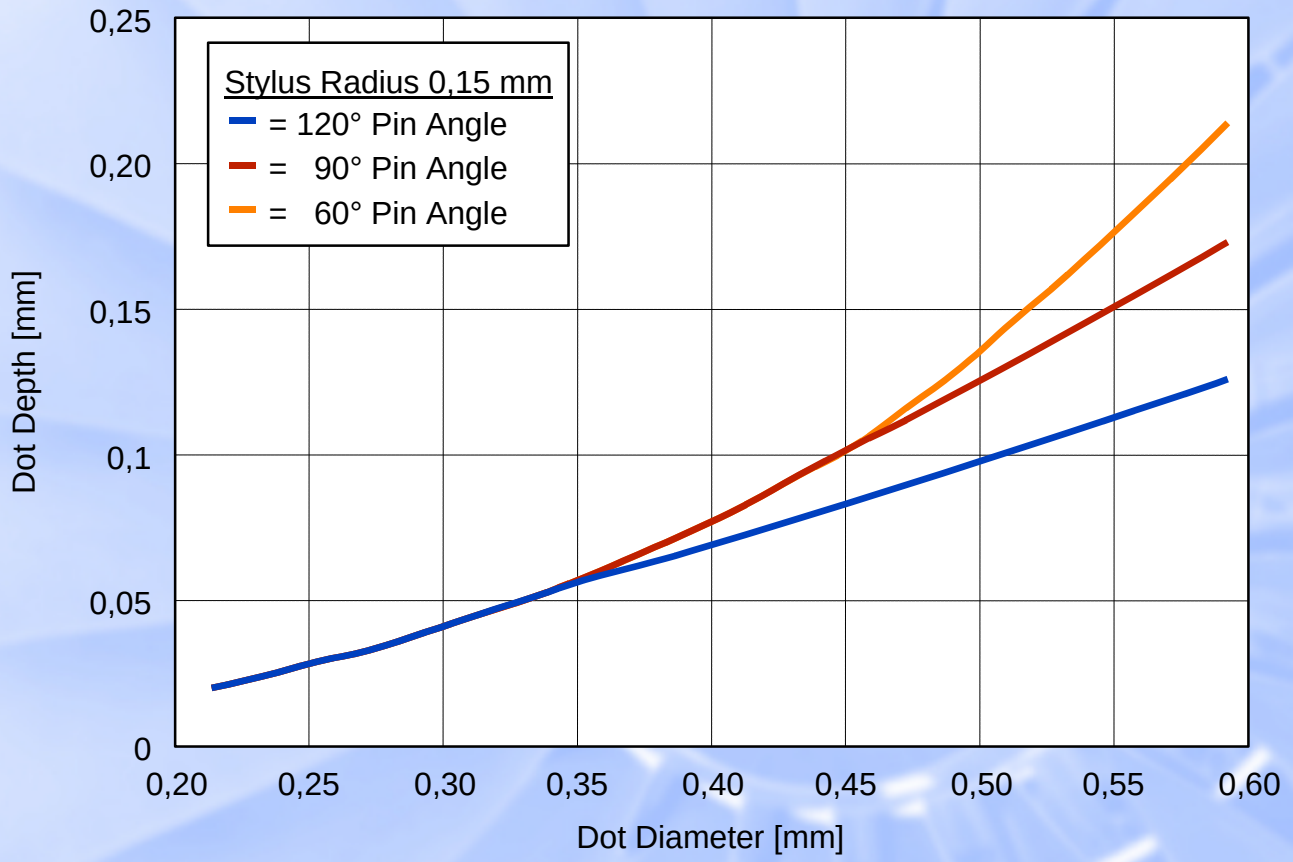
Dot Depth

Radius =	0,150 mm			Radius =	0,0059 inch		
Dot Size	Stylus Angle			Dot Size	Stylus Angle		
	120°	90°	60°		120°	90°	60°
	Dot Depth				Dot Depth		
[mm]	[mm]	[mm]	[mm]	[inch]	[inch]	[inch]	[inch]
0,214	0,020	0,020	0,020	0,0084	0,0008	0,0008	0,0008
0,232	0,024	0,024	0,024	0,0091	0,0009	0,0009	0,0009
0,253	0,029	0,029	0,029	0,0100	0,0011	0,0011	0,0011
0,272	0,033	0,033	0,033	0,0107	0,0013	0,0013	0,0013
0,293	0,039	0,039	0,039	0,0115	0,0015	0,0015	0,0015
0,312	0,045	0,045	0,045	0,0123	0,0018	0,0018	0,0018
0,333	0,051	0,051	0,051	0,0131	0,0020	0,0020	0,0020
0,352	0,057	0,058	0,058	0,0139	0,0022	0,0023	0,0023
0,373	0,062	0,066	0,066	0,0147	0,0024	0,0026	0,0026
0,392	0,067	0,074	0,074	0,0154	0,0027	0,0029	0,0029
0,413	0,073	0,083	0,083	0,0163	0,0029	0,0033	0,0033
0,432	0,079	0,093	0,093	0,0170	0,0031	0,0037	0,0037
0,453	0,085	0,103	0,103	0,0178	0,0033	0,0041	0,0041
0,472	0,091	0,112	0,116	0,0186	0,0036	0,0045	0,0046
0,493	0,097	0,122	0,130	0,0194	0,0038	0,0049	0,0051
0,512	0,102	0,132	0,146	0,0202	0,0040	0,0052	0,0057
0,533	0,108	0,143	0,162	0,0210	0,0042	0,0056	0,0064
0,552	0,114	0,153	0,179	0,0217	0,0045	0,0060	0,0071
0,573	0,120	0,163	0,197	0,0226	0,0047	0,0064	0,0077
0,592	0,126	0,173	0,214	0,0233	0,0049	0,0068	0,0084

Table 6 Dot Depth for Stylus Radius 0,15 mm [0.0059 inch]

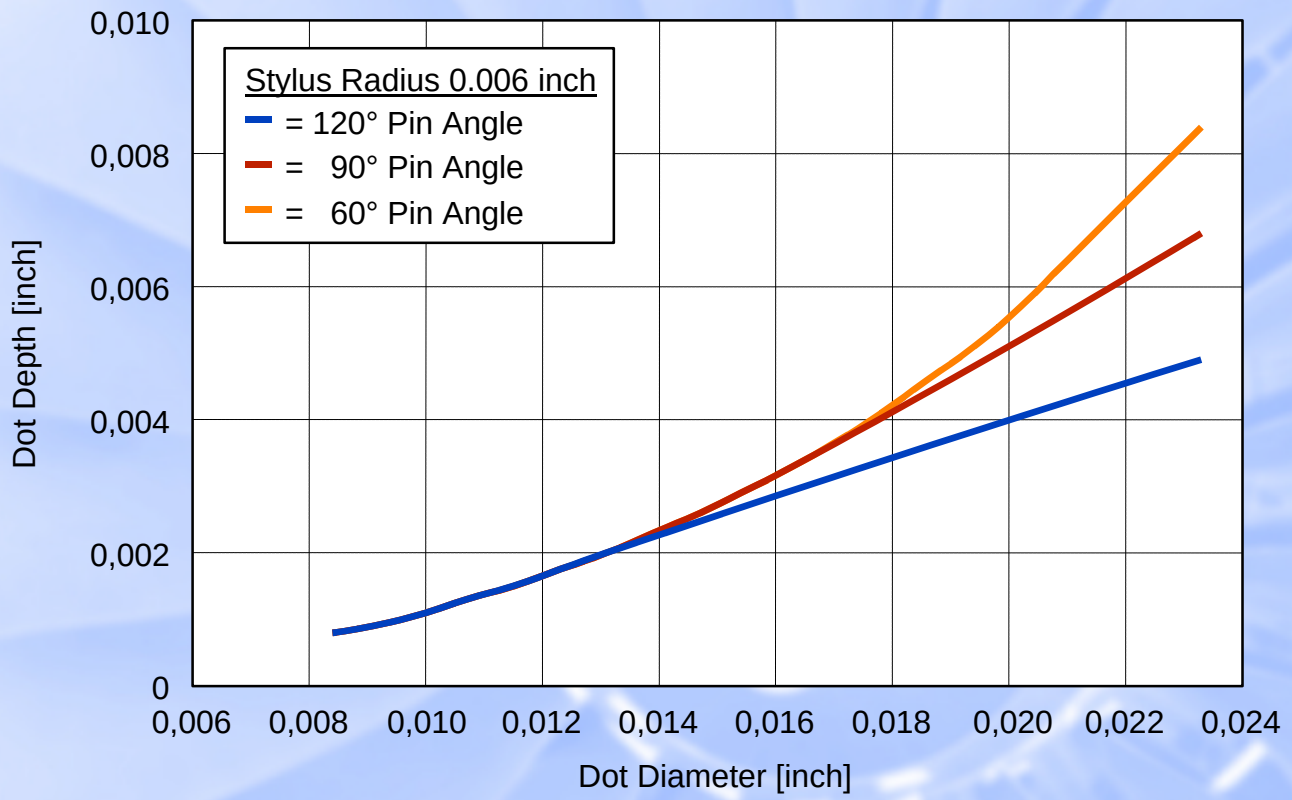
2D-Data-Matrix Guideline

Dot Depth

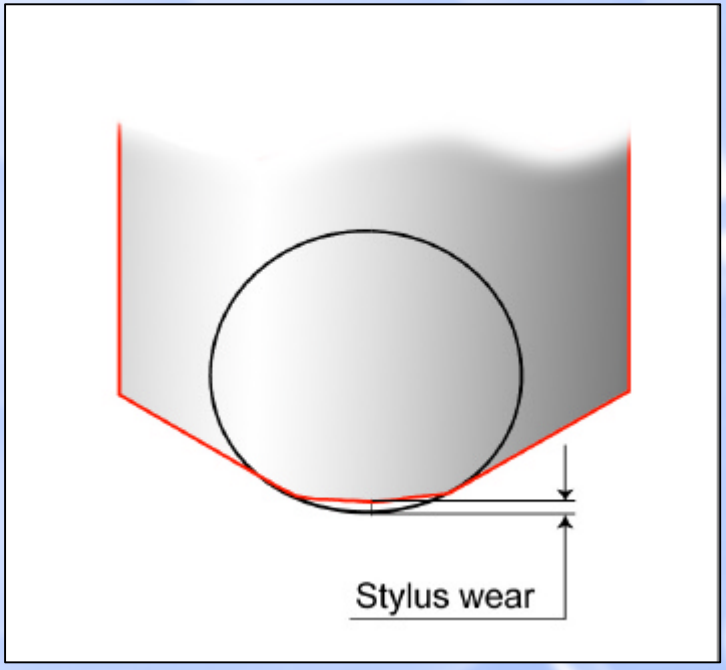


2D-Data-Matrix Guideline

Dot Depth



Measuring the Stylus Wear



- The wear of a stylus can be measured with a comparator and radius stencil.

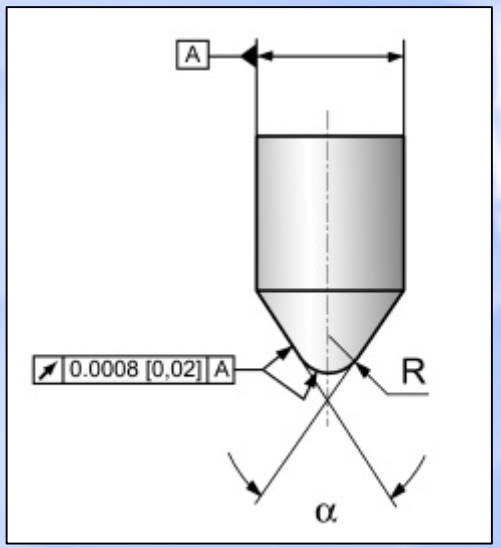
  Magnification 100x

- If you subtract the stylus wear from the theoretical dot depth from the tables, you will get an adequate verification of the achieved dot depth.

Recommendation for Stylus Grinding

Nominal Cell Size	[mm]	0,22	Stylus Angle	a	[°]	60/90/120
	[inch]	0,0087			[°]	± 2
Stylus Radius R	[mm]	0,100	Center line offset		[mm]	0,02
		± 0,01			[inch]	0,0008
	[inch]	0,0039	Surface Roughness		[µm]	0,80
		± 0,0004			[inch]	0,00003

Table 7



You may think that the tolerances, especially the tolerance of the center line offset with 0.0008 inch [0.02 mm], are too tight. But, as the stylus is rotating during the marking operation, a tight tolerance can reduce center offset problems in a 2D-Data-Matrix. At any rate, all tolerances were developed with our tool grinding department and they feel comfortable with these values. A good quality in stylus grinding is not a waste of expense.

2D-Data-Matrix Guideline

Recommendation for Stylus Grinding

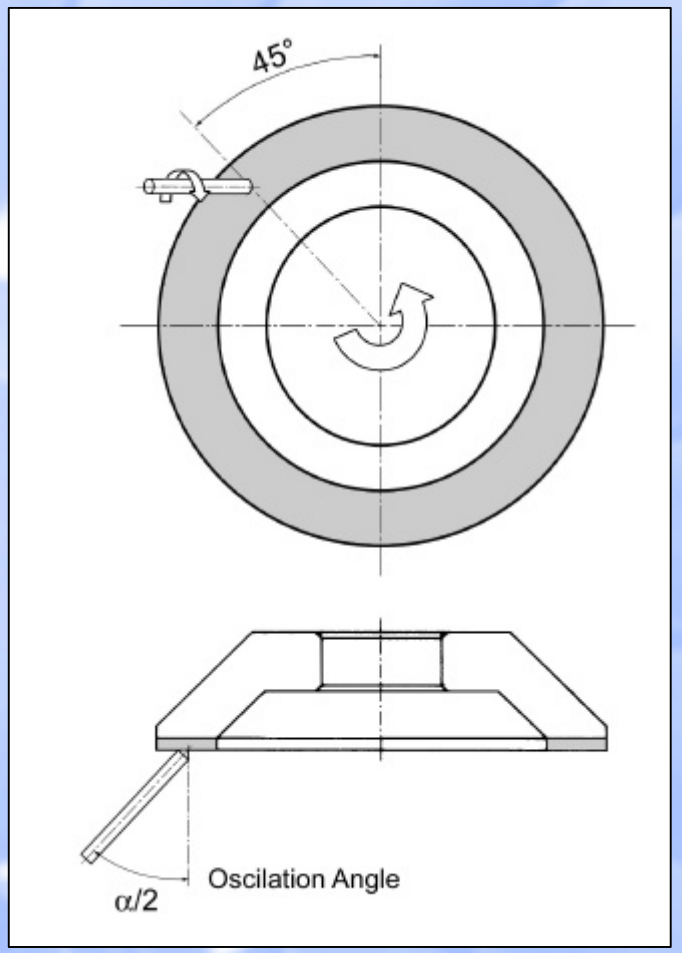
Grinding scores which have a circular or axial orientation are not desired. These orientations can cause illumination problems for scanners.

Therefore we grind the Stylus Tip in a 45° counter-clockwise position relative to the grinding disk axes (see the sketch). The surface of the stylus tip will show tangential grinding scores, which reduce illumination problems.

The stylus tip should be ground with a diamond wheel D20 KBT-C75 and a Grinding Speed of :

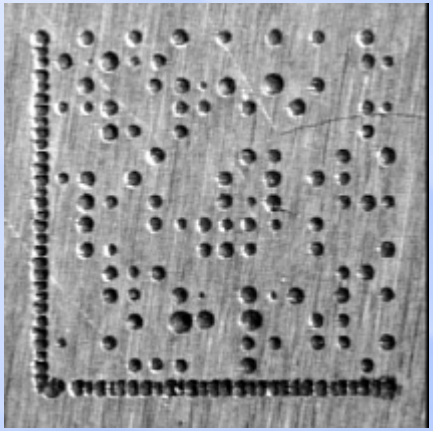
vc = 20 – 30 m/s

vc = 66 – 99 SF/s.



2D-Data-Matrix Guideline

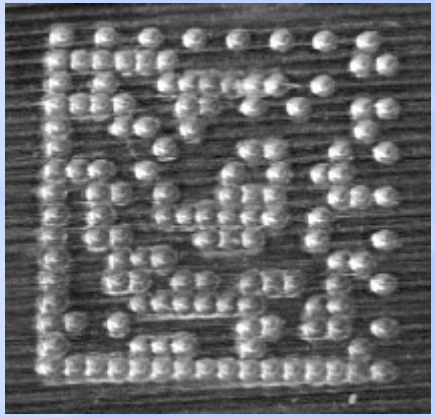
Marking Errors



Extreme Dot Growth

An extreme dot growth can be caused by a sticky oil in the stylus guide system or if the force supply is not operating consistently.

First we would clean the stylus with the guide system in an ultrasonic cleaner. If this does not help, you need a special service or repair.
Such a machine can not be approved for the IAQG-Spec. if the dot growth can not be reduced to a range of 60-100% of the required nominal cell size.



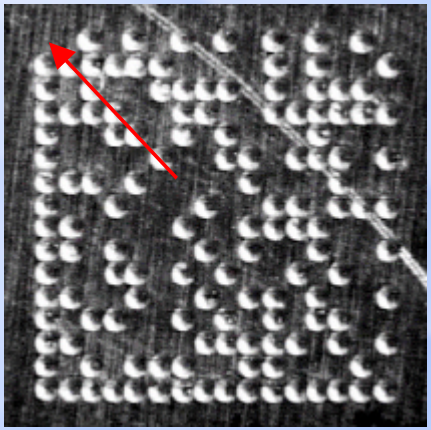
Oversized Dots

Oversized dots are a result of too high force or the wrong stylus-to-target distance.

Reduce force or stylus-to-target distance.

2D-Data-Matrix Guideline

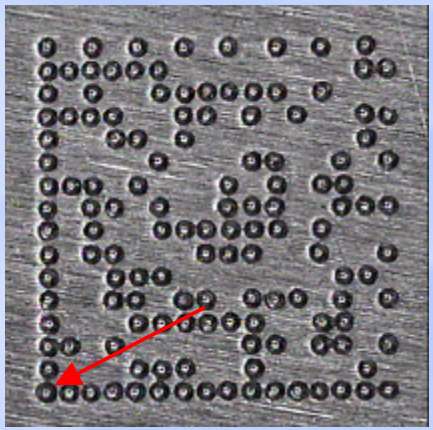
Marking Errors



First Dot is missing

This error can be caused by an air pressure system if there is a hose between the control valve and the piston. When the marking operation is started, there is no pressure in the hose while the feed system is starting.

Reduce the feed rate, so air pressure can be built up.



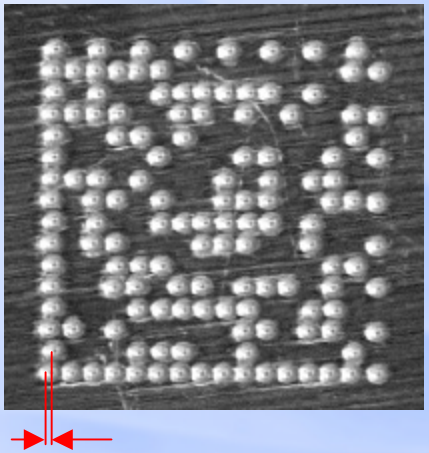
First Dot is too big

This error is caused by an air pressure system which has the control valve directly on top of the piston. There is a static pressure which is higher than the operating pressure.

Check for any bottlenecks in the air pressure system. If there are non, then reduce the operation air pressure to reduce the dot growth of the first dot. The total dot variation can be accepted within the range of 60-100% of the nominal cell size.

2D-Data-Matrix Guideline

Marking Errors

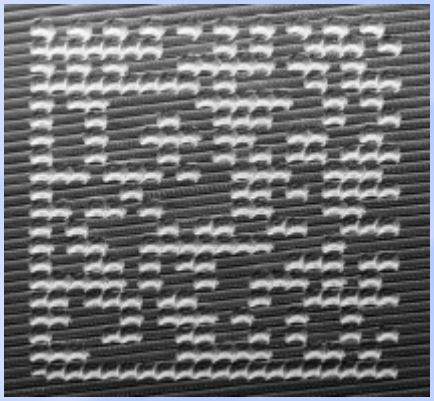


Center Offset

Every second row in this symbol has a horizontal center offset.

This center offset is typical for a machine which has too much axial clearance. The dots were marked bi-directionally.

This problem can be corrected by programming the machine to mark only from one direction.



Dots with a Comma Form

This form can be caused by a chipped stylus tip or a too-high feed rate.

First check the condition of the stylus tip. If the tip is o.k., then reduce the feed rate.