Contents

1. Overview

The objective of this study was to evaluate performance of the **DPM Adapter** (Adapter) for **Honeywell's Xenon 1900/1902GER/SR/HD** scanners.

Adapter is an optical addition to the Xenon 1900/1902 scanner to extend its capabilities (resolution) to the area of very small (less than 10 mils) Data Matrix symbols. Depending upon the model HD/ SR/ER, Xenon has a resolution ranging from 5 to 7.5 mils, but for DPM samples it is worse than that – between ~ 9 – 13 mils. The Adapter is designed for SR/ER-versions. Reading technique for the "Scanner + Adapter" requires adapter to be put in contact (or close to contact) with the sample.

The overall view of the Adapter is depicted in the Table below:

		
DPM Adapter	Adapter attached to a Xenon scanner	Contact reading requirement

4 "decoding compositions" were selected for this study:

1.1 **Xenon 1900GER** (Extended Range) scanner (S/N: 10271A0528) having its own Data Matrix decoding software ("system" decoder).

1.2 Composition 1.1 + **DPM Adapter 18-LDS4X0408FG** (40 mm optics) (S/N: m34190101).

1.3 **Xenon 1900GER** scanner upgraded with the **icEveryCode™ DPM Decoder** + **DPM Adapter 18-LDS4X0408FG** (S/N: m34190101).

1.4 Composition 1.1 + **DPM Adapter 18-LDS4X0008FG** (Diffuser)

2. Test Scope

Test consisted of four separate studies, as follows:

Studies ## 1-3 involved **Xenon 1900GER**, **DPM Adapter with 40 mm optics** and **icEveryCode™ DPM Decoder:**

- Measuring decode rate for the small module size (2.5 – 10 mil) "ideal" data matrix symbols, generated by 2DTG's Encoder and printed on a regular paper – compositions ## 1.1 & 1.2 are used for decoding.
- Measuring decode rate for the small module size (2.5 – 10 mil) "ideal" data matrix symbols, generated by 2DTG's Encoder and printed on a regular paper – composition # 1.3 is used for decoding.
- Measuring decode rate for the "real life" DPM data matrix symbols with the small module size: 4 – 12 mil – compositions ## 1.2 & 1.3 are used for decoding.

Study #4 involved **Xenon 1900GHD and**, **DPM Adapter without optics** (diffuser)**:**

- Measuring decode rate for the "real life" DPM data matrix symbols with the small module size: 4 – 12 mil – compositions ## 1.2 & 1.4 are used for decoding.

3. Test Procedure and Samples

"Calibration" samples to determine DPM Adapter's "applicability scope"

3 groups of "calibration" samples were generated using 2DTG's Data Matrix Encoder - each group containing 3 square symbols of different dimension (number of modules in the symbol), as follows:

- 16x16 Data Matrix, representing the result of encodation of 15 alphabet characters
- 14x14 – encodation of 10 alphabet characters
- 12x12 – encodation of 10 numbers

Each generated sample had "Medium Density" - 5 pixels/module – recommended by ISO standard.

Each type of symbols was scaled down to 3 geometrical data Matrix dimensions: 1x1 mm, 2x2 mm and 3x3 mm (Quiet Zone is not included).

Accordingly, 9 resulting symbols had a module size in the range of 2.5 to 10 mils while density of each module was 5 pixels per module.

The results are shown in the table below.

DPM samples

Only few DPM samples were available for the test though they represented "typical" materials (steel, duralumin, plastic) and surfaces (milled, polished). All marks except one (dot peen on plastic) were Laser etched.

4. Test Results

"Calibration" tests.

Table 1 below depicts all 9 "paper" labels generated for this test as it's described in Section 3.

None of these symbols, except the one having module size 9.9 mils, were decodable just by Xenon 1900GER scanner itself (composition 1.1).

However, all of them were easily decodable when using DPM Adapter (compositions ## 1.2 & 1.3), except the one having module size 2.5 mils.

As it was expected, all symbols having module size greater than 5 mils were easily decodable by Xenon 1900GHD with the Adapter (composition 1.4).

Table 1

Encoded Text / Matrix Dimensions	Module Density	Data Matrix size (without Quiet Zone), mm		
		1x1	2x2	3x3
Module size:		**2.5 mil**	**5 mil**	**7.4 mil**
15 characters, 16x16	Medium (5 pixels/module)			
Module size:		**2.8 mil**	**5.6 mil**	**8.4 mil**
10 characters, 14x14	Medium (5 pixels/module)			
Module size:		**3.3 mil**	**6.6 mil**	**9.9 mil**
10 numbers, 12x12	(5 pixels/module)			

"DPM Test"

Table 2 below depicts 4 DPM samples available for this test. Table 3 provides visual Comparison of the captured images and results of decoding.

Xenon 1900GER scanner compositions:

- None of these symbols were decodable just by Xenon 1900GER scanner itself (composition 1.1).

- 2 samples (##1 and 4) were decoded when using DPM Adapter (40 mm optics) and system decoder (composition 1.2).
- All 4 samples were decoded when using DPM Adapter and 2DTG's decoder (composition 1.3).

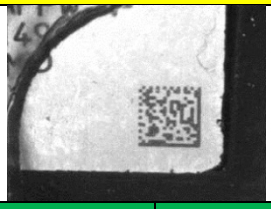
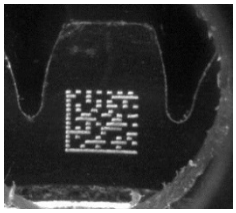
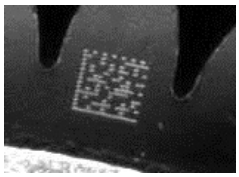
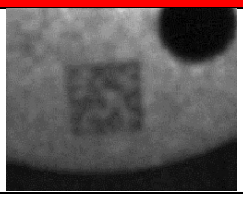
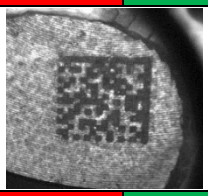
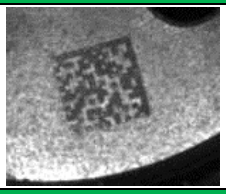
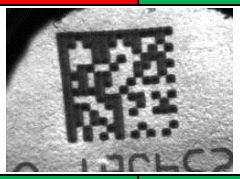
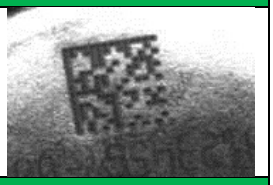
Xenon 1900GHD scanner compositions:

- Only 1 sample (# 2) was decoded by the scanner itself.
- All 4 samples were decoded when using DPM Adapter (diffuser) - composition 1.2.

Table 2

DPM # 1	DPM # 2	DPM # 3	DPM # 4
			
AMD Chip – Laser etched mark 19 characters 2x2 mm symbol size 18x18 modules **module size - 4.4 mil**	Dot Peen mark on black plastic 12 numbers 3x3 mm symbol size 14x14 modules **module size - 8.4 mil**	Laser mark on Milled steel 24 numbers 3.5x3.5 mm symbol size 14x14 modules **module size - 9.8 mil**	Laser mark on polished steel 12 characters 4.5x4.5 mm symbol size 14x14 modules **module size - 12.5 mil**

Table 3

Image	Xenon 1900GER (composition 1.1)	Xenon 1900GER + Adapter (40 mm) (composition 1.2)	Xenon 1900GER + Adapter (40 mm) +2DTG Decoder (composition 1.3)	Xenon 1900GHR + Adapter (diffuser) (composition 1.4)
Resolution "on paper"		3 mils		5 mils
DPM # 1 4.4 mils				
	Not decoded	Decoded	Decoded	Decoded
DPM # 2 8.4 mils				
	Not decoded	Not decoded	Decoded	Decoded
DPM # 3 9.8 mils				
		Not decoded	Decoded	Decoded
DPM # 4 12.5 mils				
	Not decoded	Decoded	Decoded	Decoded

5. Conclusion

1. Small DPM marks reading (less than 10-12 mils) by Xenon 1900 scanner requires DPM Adapter (either with 40 mm optics or regular diffuser).

2. Xenon 1900/1902GER with "40 mm DPM Adapter" shall be used for decoding very small Data Matrix symbols, having module size as small as 2.8 mils ("on paper"), meaning that DPM Adapter increases effective resolution of the scanner by 2-3 times.

This means that for symbols representing 10-15 encoded alphanumeric characters, the geometric size of Data Matrix should be not less than 1.5x1.5 mm.

3. 2DTG's DPM Decoder improves DPM reading even when using Adapter since the Xenon's system decoder is not designed for DPM (particularly Dot Peened) marks.

4. Diffused Adapter with 2DTG's DPM Decoder is a preferred option for the marks greater than 5 mils since it allows for non-contact reading and FOV close to default one.

   This is particularly important for the samples where the surface, containing the symbol, does not allow direct contact with the scanner. In addition, "40 mm Adapter" reduces Xenon's FOV substantially – Data Matrix size on the surface shall be less than 6 mm to fit into the Adapter's window.

All conclusions are summarized in the Table 4 below.

Table 4

"Xenon 1900/1902 + DPM Adapter" - Performance Evaluation							
Scanning Device	**Module size range**					**Reading Distance**	**Field of View**
Xenon GHD			**> 10mils**			0 - 4.5"	Manufacture's Default
Xenon GHD + DPM Adapter 18-LDS4X0008FG		**5-15 mils**				0 - 1.5"	Close to Default
Xenon GSR/GER + DPM Adapter 18-LDS4X0408FG	**3-10 mils**					Contact Reading only	Reduced to 6 mm on contact reading
Important: 2DTG's DPM Plugin has to be installed to the Xenon area imager to ensure such DPM performance.							

6. Additional notes / Limitations:

"Contact reading" requirement can make the reading procedure ergonomically inconvenient, if the object that is being scanned rests flat on the table, because the scanner is tilted away from the user. It is recommended to hold part in your hand when reading a symbol, if it's possible.