Understanding 2D Verification

Comparing Evaluation Parameters for Data Matrix Symbol Verification

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Understanding 2D Verification Using a Comparison of Symbol Quality Evaluation Parameters

This white paper defines the verification evaluation parameters of two global quality standards for 2D symbols and gives examples of variations in 2D symbol quality as evaluated by these parameters. The purpose of Data Matrix symbol verification is to ensure reliability and consistency of symbols based on the strict criteria outlined by global quality standards such as:

> *- ISO/IEC 15415*
> *- AIM DPM*

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ISO/IEC 15415 Evaluation Parameters

The ISO/IEC 15415 standard specifies the methodologies for measuring, evaluating, and grading 2D symbol characteristics in order to indicate the quality of the mark. In addition, the standard identifies possible causes for symbol degradation. Users with less than optimal symbols due to problems with marking methods or substrate inconsistencies can use this information to correct and improve their marks and achieve better symbol quality.
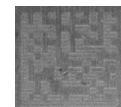
AIM DPM Quality Guideline

The AIM DPM Quality Guideline was developed to assess the symbol quality of direct part marks. It defines modifications to the measurement and grading of certain symbol quality parameters.
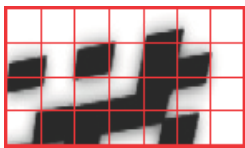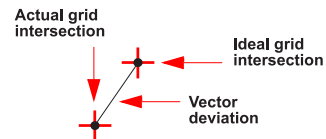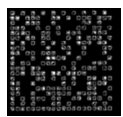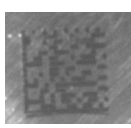
Parameter Comparisons

	ISO/IEC 15415	AIM DPM
Axial Non-Uniformity	✓	✓
Symbol Contrast	✓	
Cell Contrast		✓
Modulation	✓	
Cell Modulation		✓
Decodability	✓	✓
Fixed Pattern Damage	✓	✓
Grid Non-Uniformity	✓	✓
Minimum Reflectance		✓
Reflectance Margin	✓	
Unused Error Correction	✓	✓
Print Growth	For Reference Only	

Parameter Comparisons

Parameter	Description	ISO/IEC 15415	AIM DPM
Axial Non-Uniformity	Axial Non-Uniformity is the amount of deviation along the symbol's major axes. In this example, the symbol's Y-axis dimension is clearly greater than its X-axis dimension. This indicates that the marking process is resulting in the Y-dimensions of individual modules being greater than their X-dimensions. This inconsistency of X- and Y-dimensions typically indicates movement of the object as it is being marked.	✓	✓
Symbol Contrast	Symbol Contrast is the value difference between light and dark symbol elements, and between the Quiet Zone and perimeter elements. This example shows a low-contrast symbol. The dark elements (etched) and the light elements (the substrate's surface) are too close in value, which undermines readability.	✓	
Cell Contrast	Cell Contrast is the value difference between light and dark symbol elements, and between the quiet zone and perimeter elements. This example shows a low-contrast direct part mark symbol. The light and dark elements are too close in value, which undermines readability.		✓
Modulation	Modulation refers to the reflectance uniformity of a symbol's light and dark elements. In this example, notice that the light/dark values of some elements are inconsistent.	✓	
Cell Modulation	Modulation refers to the reflectance uniformity of a symbol's light and dark elements. In this example of a dot peen mark, notice that the light/dark values of some of the elements are inconsistent.		✓
Decodability	Decodability refers to a symbol's ability to be decoded per a standard reference decode algorithm. This example shows a high-quality 2D symbol.	✓	✓
Fixed Pattern Damage	Fixed Pattern Damage refers to finder pattern and clock pattern damage. Notice the missing elements in the clock pattern and the damaged L-pattern in the example symbol.	✓	✓

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Parameter Comparisons

Parameter	Description	ISO/IEC 15415	AIM DPM

Grid Non-Uniformity

Grid Non-Uniformity refers to a symbol's cell deviation from the ideal grid of a theoretical "perfect symbol". The Data Matrix reference decode algorithm is applied to a binarized image of the symbol, comparing its actual grid intersections to ideal grid intersections. The greatest distance from an actual to a theoretical grid intersection determines the Grid Non-Uniformity grade.

The reference decode algorithm plots the symbol's grid intersections and compares them to an ideal grid.

Symbol Detail

Actual grid intersection
Ideal grid intersection
Vector deviation

The largest vector deviation on the grid determines the Grid Non-Uniformity grade.

✔ (ISO/IEC 15415) ✔ (AIM DPM)

Minimum Reflectance

Minimum Reflectance refers to the minimum reflectance of light by the symbol's light elements. In this example, notice that the symbol's light elements must exhibit a minimum reflectance to ensure contrast against the dark substrate and to allow readability.

✔ (AIM DPM)

Reflectance Margin

Reflectance Margin measures how well each element of the symbol is correctly distinguishable as light or dark in comparison to the global threshold. Low reflectance margin, such as that illustrated by this example, may increase the probability that a symbol element may be incorrectly identified as dark or light.

✔ (ISO/IEC 15415)

Unused Error Correction

Unused Error Correction indicates the amount of available Error Correction in a symbol. Error Correction is a method of reconstructing or replacing data that is lost through symbol damage. 100% Unused Error Correction is ideal, as shown in this example.

✔ (ISO/IEC 15415) ✔ (AIM DPM)

Print Growth

Overprint

Print Growth refers to the deviation (larger or smaller) of actual element size from intended element size due to printing problems. When a symbol is printed, the ink may "bleed" when it comes in contact with the substrate, causing an Overprint. If there is not enough ink, or if there is some other problem with printing equipment, the result may be an Underprint.

Underprint

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