MICROSCAN®

HawkEye™ 1500 Series Verification Manual

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PREFACE

Welcome!

Purpose of This Manual

This manual explains what verification is, how to use verification, and describes verification parameters.

Manual Conventions

The following typographical conventions are used throughout this manual.

- Items emphasizing important information are **bolded**.
- Menu selections, menu items and entries in screen images are indicated as: Run (triggered), Modify..., etc.

CHAPTER 1 Why Verification?

This chapter introduces verification on the HawkEye™ 1500 Smart Camera.

Introduction

One axiom of implementing traceability is that the Data Matrix code will almost never get better than it is at the instant it leaves the marker. Throughout the marking process, verification ensures that the marks are being made correctly, enabling corrections to be made to the marking method before it drifts out of tolerance and produces unusable or incomplete marks.

To accomplish this, a verifier, as opposed to a reader, is needed to show that a mark can be read, and to determine the quality of the mark. A reader only provides a read pass/fail signal to the automated production line. This digital signal does not provide any trending information to the marking equipment or operators to alert them to a potential “line down” condition. Verifiers provide an analog type sensor in the form of A through F letter grades. These grades provide the marking equipment or the operators a warning that preventative maintenance is needed. With that knowledge, the maintenance can be scheduled at a convenient time versus whenever the machine breaks.

FIGURE 1–1. Verifying with a Reader

FIGURE 1–2. Verifying with a Verifier

Care should be taken, however, to use mark quality measurements appropriate for direct part marking, because using legacy standards can lead to false alarms or to missing serious marking problems. There are different verification standards available to meet your needs. Data Matrix codes on labels can be verified with AIM standard-compliant verifier systems. Directly marked parts, however, require a type of verification specifically designed for that purpose.

Label Verification

In 1996, the Association for Automatic Identification and Mobility published a set of criteria, known as the AIM Bar Code Print Quality Guideline, to allow verification systems to grade a symbol by degree of acceptability (A through F). Developed for high-contrast paper labels, this type of verification provides a basic quantitative measure of print quality and allows printed 2-D codes to be checked against a quality standard. The important note is that the process of printing a Data Matrix on paper is an optimized process. The paper has been bleached to be as white as possible and the ink has been dyed to be as black as possible. Keeping this in mind, the grading thresholds of the AIM specification are very restrictive because the mark quality is so high. Anything less would not be appropriate or useful to the printing industry. Typical problems caught by AIM include:

- Blocked holes
- Too much or too little ink
- Inconsistent inking

Direct Part Mark (DPM) Verification

Unlike the printing process, direct part marks are generally not optimized for marking. It is more important for the parts to be optimized for their primary purpose. It is more difficult to make a high contrast laser mark on bare aluminum than on stainless steel; however, aluminum is specified more on aircraft parts due to the lighter weight. The weight is more important than the markability. When verifying the mark on aluminum, AIM generally fails the part due to low contrast. This is where DPM verification is the appropriate verification method. The DPM verifier is configurable to verify marks of different marking methods and different materials. The threshold values for grading are fixed and cannot be changed. You can configure pass/fail criteria. Then, each mark is measured against the thresholds and is given a quality grade. Variation in the grade is usually caused by one of the following:

- Marking parameters changing or marker failure
- Material formulation or surface texture changes
- Improperly fixtured or tracked parts
- Changes in environment like oil or ambient light on the part
- Improper fixturing or tracking of parts

Armed with the data from the verifier, the manufacturing line stays running because the maintenance or changes necessary to improve the mark are performed before the marks are unreadable.

The HawkEye™ 1500 is the only smart camera family with Microscan' built-in direct part mark verification capabilities.

HawkEye™ 1500 Verification Options

The HawkEye™ 1500 offers you the following verification options:

- ISO/IEC 16022:2000 verification, formerly AIM Specification
- ISO/IEC 15415:2004 Data Matrix verification (enabled by license key)
- AS9132 Rev A, 2005 Data Matrix Verification, formerly IAQG (enabled by license key)
- DPM verification (enabled by license key)
- AIM DPM-1-2006 Data Matrix verification (enabled by license key)
- ISO/IEC 15416:2000 Barcode verification, formerly ANSI X3.182-1990 (enabled by license key)

You can select Good, Fair, and Poor options graphically, and ReadRunner displays Good, Fair, and Poor feedback graphically. You can also assign Good, Fair, and Poor states to opto-isolated outputs.

Examples of Mark Quality Problems

- Improper or inconsistent mark dot/cell size

- Improper or inconsistent mark dot/cell location

- Improper overall mark geometry

- Mark or part surface damage

- Very low or inconsistent mark contrast

CHAPTER 2

Calibration & Enabling Verification

HawkEye™ calibration consists of the following:

- HawkEye™ System Normalization
- Reflectance Calibration.

Calibration ensures that every verification system provides the repeatable result per the relevant standard as compared to all other verification standards. Before performing verification, the verifier must be calibrated. The calibration process will set the contrast level and size measurement level of the verification system.

You MUST calibrate your HawkEye™ 1500 upon first time startup in your production area and, again, if you move the smart camera or the ambient light changes. The work environment where you will use your HawkEye™ 1500 should be a stable environment in terms of lighting. For example, if you work in an office near windows, there might be read considerations when you perform a read at noontime on a sunny day versus a read performed during 3rd shift at 2AM on a moonless night. We suggest you position the HawkEye™ 1500 in a fairly steady-state lighting environment where ambient light is consistent and at a low level.

The HawkEye™ 1500 comes with a Calibration Target (Microscan part number 98-UA10-0CC0). Once you have positioned your smart camera into your work space, you need to normalize and calibrate the system using this Calibration Target.

For AIM DPM-1-2006 verification, please follow the recommendation in Appendix C, “AIM DPM-1-2006 Compliant Configuration,” for setting up the HawkEye™ 1510 and DOAL-50 light (AIM DPM compliant light for 90).

HawkEye™ Normalization

HawkEye™ Normalization sets the response of individual cameras to be linearly proportional to contrast through different lighting environments and conditions. The camera’s dark level offset, gain and exposure are controlled in order to achieve this linear performance.

To perform HawkEye™ Normalization:

1. Start the HawkEye™ Normalization by selecting Start > Programs > ReadRunner 2.4.1 > Utilities > HawkEye Normalization.
2. Using the “Select Camera to Normalize” drop down selection list, select the camera that requires normalization, as shown in Figure 2–1.

FIGURE 2–1. Select a Camera to Normalize

3. After you select a camera, the Position Calibration Standard instructions are displayed, as shown in Figure 2–2.

FIGURE 2–2. Position the Calibration Standard

4. Click OK, and then click NORMALIZE.

   The normalization will run for all of the lighting types supported by the hardware.

   At the completion of the normalization process, a report of the completed results will be displayed and the program may then be closed, as shown in Figure 2–3

FIGURE 2–3. Results & Completion of Normalization

5. Click OK, and then click Close.

Reflectance Calibration

To perform Reflectance Calibration:

1. Position the Data Matrix (around 80% contrast) under the HawkEye™ 1500.
2. From the Settings menu, select Symbology and Verification. The Symbology and Verification dialog box is displayed, as shown in Figure 2–4

FIGURE 2–4. Symbology and Verification Dialog Box

3. Click Calibrate to bring up the Camera Report dialog box, as shown in Figure 2–5.

FIGURE 2–5. Calibration Dialog Box

– Light Angle — Displays INTERNAL.

– Exposure Time — Displays exposure time for the HawkEye™ 1500 camera corresponding to each light configuration. This value is normalized at factory and will not change by the Reflectance Calibration.

– Gain — Displays camera gain control value for the HawkEye™ 1500 camera corresponding to each light configuration. This value is normalized at factory and will not change by the Reflectance Calibration.

– CellUnit — Displays how the verifier relates pixel values to inches for each light.

– ContrastMax/ContrastMin — These values are used to calibrated contrast value for all verification types except AIM DPM-1-2006. These are calibrated by the reflectance calibration.

– R_cal — These values are calibrated for AIM DPM-1-2006 for reporting Minimum Reflectance.

– Status — Displays the date and time when the reflectance calibration takes place. If unsuccessful, error messages are displayed here.

4. In the Calibration Target Contrast text box, enter the value associated with the Data Matrix (80% contrast) you are using as the target. For example, if

the contrast marked for the Data Matrix on the Calibration Test Card is 82.6%, you would enter 82.6 or 83.

5. In the Calibration Target Reflectance Max text box, enter the value associated with the Data Matrix (80% contrast) you are using as the target. For example, if the R_max marked for the Data Matrix on the Calibration Test Card is 87.4%, you would enter 87.4 or 87.

6. The Live Video mode is enabled. Center the Data Matrix (about 80% contrast) on the Calibration card in the camera's field of view, as shown in Figure 2–6.

FIGURE 2–6. Data Matrix Centered in FOV

7. Click Calibrate.

   The HawkEye™ 1500 will calibrate the reader or post error messages if it can't.

   Figure 2–7 shows successful calibration.

FIGURE 2–7. Calibration Successful

8. Click Close to exit the dialog box. The Symbology/Verification dialog box will be displayed with Calibrated status, as shown in Figure 2–8.

FIGURE 2–8. Calibrated Successfully

9. To save the calibration data, use File > Save Parameters on Camera.

Enabling Verification

To enable verification, select the intended verification standard from the Symbology and Verification dialog box (see Figure 2–8).

To enable AIM DPM-1-2006:

1. Select AIM DPM-1-2006.

   The following dialog box is displayed.

FIGURE 2–9. AIM DPM-1-2006 Compliance Dialog Box

2. Click HawkEye 1510 and Use AIM DPM Compliant Light.

3. Select the a Lighting option, and click OK.

AIM DPM-1-2006 will be enabled.

CHAPTER 3

Data Matrix Verification

Verification Types

DPM

DPM verification allows a user to configure the Good, Fair and Poor levels for each of the verification parameters individually. This verification choice is ideal for process control involving Data Matrix applications that do not need to apply to a public standard.

FIGURE 3–1. DPM

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 14:59:02 | Calibrated : January 15 2008 14:32:19 | Print Form

DPM Verification™	Total	13	Good	13	Fair	0	Poor	0	Angle	91
	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count	Value	Avg Value	Val Label
Overall Grade	D	1.60	1	2	1	9	0			
Cell Size	D	1.60	1	2	1	9	0	6.80	7.46	PIXELS
Center Offset	A	4.00	13	0	0	0	0	1.60	1.30	
Size Offset	B	3.20	2	11	0	0	0	4.10	3.71	
Cell Modulation	B	3.10	1	12	0	0	0	99.00	98.43	On Cell
								84.00	85.82	Off Cell
Border Match	A	4.00	13	0	0	0	0	100.00	100.00	
Symbol Contrast	B	3.20	3	10	0	0	0	62.00	69.73	REFL_Cal
Axial Nonuniformity	A	4.00	13	0	0	0	0	0.00	0.00	
Print Growth	B	3.20	3	10	0	0	0	13.00	8.83	X
								-4.00	-0.54	Y
Unused Error Correction	A	4.00	13	0	0	0	0	1.00	1.00	
Angle of Distortion	A	4.00	13	0	0	0	0	0.00	-0.12	
	Aperture		Exposure	Gain		ECCLevel	WaveLen	Height	Width	Units
	AUTO		13804	354		ECC200	640	164	165	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	LightType	Calibrated		
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE		

(VERI_FORMATTED) Output

DPM Verification (TM) REPORT

Status	3;13;13;0;0
OverallGrade	D;1.6;1;2;1;9;0;N;B;D
GradeCellSize	D;1.6;1;2;1;9;0;Y;D;D
CellSize	6.80;7.46
GradeCenterOffset	A;4.0;13;0;0;0;0;Y;B;C
CenterOffset	1.60;1.30
GradeSizeOffset	B;3.2;2;11;0;0;0;Y;B;C
SizeOffset	4.10;3.71
GradeCellModulation	B;3.1;1;12;0;0;0;Y;B;D
CellModulation1	99.00;98.43
CellModulation2	84.00;85.82
GradeBorderMatch	A;4.0;13;0;0;0;0;Y;B;D
BorderMatch	100.00;100.00
GradeContrast	B;3.2;3;10;0;0;0;Y;C;D
Contrast	62.00;69.73
GradeAxialNonuniformity	A;4.0;13;0;0;0;0;Y;B;D
AxialNonuniformity	0.00;0.00
GradePrintGrowth	B;3.2;3;10;0;0;0;Y;B;D
PrintGrowthX	13.00;8.83
PrintGrowthY	-4.00;-0.54
GradeUnusedErrorCorrection	A;4.0;13;0;0;0;0;Y;A;C
UnusedErrorCorrection	1.00;1.00
GradeAngleOfDistortion	A;4.0;13;0;0;0;0;Y;B;D
AngleOfDistortion	0.00;-0.12
ContrastMax	248
ContrastMin	0
PixelsPerInch	680
ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	AUTO
TargetCalibContrast	82

TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
ECCLevel	ECC200
Calibrated	TRUE
Height	164.00
Width	165.00
Angle	91
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117

(VERI_DETAIL) Output

DPM Verification (TM);3;13;13;0;0;D;1.6;1;2;1;9;0;N;B;D;D;1.6;1;2;1;9;0;Y;D;D;6.80;7.46;A;4.0;13;0;0;0;0;Y;B;C;1.60;1.30;B;3.2;2;11;0;0;0;Y;B;C;4.10;3.71;B;3.1;1;12;0;0;0;Y;B;D;99.00;98.43;84.00;85.82;A;4.0;13;0;0;0;0;Y;B;D;100.00;100.00;B;3.2;3;10;0;0;0;Y;C;D;62.00;69.73;A;4.0;13;0;0;0;0;Y;B;D;0.00;0.00;B;3.2;3;10;0;0;0;Y;B;D;13.00;8.83;-4.00;-0.54;A;4.0;13;0;0;0;0;Y;A;C;1.00;1.00;A;4.0;13;0;0;0;0;Y;B;D;0.00;-0.12;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;AUTO;82;87;640;INTERNAL;ECC200;TRUE;164.00;165.00;91;195;13804;354;0x0117

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of cell size;grade score of cell size;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;cell size this cycle;cell size average;letter grade of center offset;grade score of center offset;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;center offset this cycle;center offset average;letter grade of size offset;grade score of size offset;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;size offset this cycle;size offset average;letter grade of cell modulation;grade score of cell modulation;count of grade A;B;C;D;F;is this value use to determine

good/fair/poor;minimum level of good;minimum level of fair;cell modulation 1 this cycle;cell modulation 1 average;cell modulation 2 this cycle;cell modulation 2 average;letter grade of border match;grade score of border match;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;border match this cycle;border match average;letter grade of contrast;grade score of contrast;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;contrast this cycle;contrast average;letter grade of axial nonuniformity;grade score of axial nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;axial nonuniformity this cycle;axial nonuniformity average;letter grade of print growth;grade score of print growth;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;print growth in the X dimension this cycle;print growth in the X dimension average;print growth in the Y dimension this cycle;print growth in the Y dimension average;letter grade of unused error correction;grade score of unused error correction;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;unused error correction this cycle;unused error correction average;letter grade of angle of distortion;grade score of angle of distortion;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;angle of distortion this cycle;angle of distortion average;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;ECC level;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset

Parameters

- Cell Size — The overall width divided by the number of columns or the overall height divided by the number of rows.
- Center Offset — The measurement of the difference of the cell center versus the center of the ideal grid created from the four corners of the code.
- Size Offset — The measurement of the difference of the cell sizes compared to each other.
- Cell Modulation — A measurement of theuniformity of the color of the dark areas and the light areas of the Data Matrix similar to “Modulation” but differs in the implementation details.

- Border Match — A percentage of the border cells that match the pattern of two sides solid and two sides alternating.
- Contrast — The difference in percent of the center of the distribution of the light cells of the Data Matrix versus the center of the distribution of the dark cells.
- Axial Nonuniformity — The difference between the height and the width with respect to the rows and columns.
- Print Growth — The positive or negative size relation of the cells as printed with respect to the ideal grid.
- Unused Error Correction — The amount of error correction that could be read incorrectly when the code is still readable that is currently being read correctly expressed as a percentage.
- Angle of Distortion — The difference from perpendicular of the two solid edges of the Data Matrix measured in degrees.

TABLE 3–1. DPM Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
CS Cell Size	>=10	>=9	>=7	>=5	<5	pixels
CO Center Offset	<=2.5	<=5.0	<=7.5	<=10.0	>10.0	unitless
SO Size Offset	<=2.5	<=5.0	<=7.5	<=10.0	>10.0	unitless
CM Cell Modulation	>=90%	>=80%	>=70%	>=60%	<60%	
BM Border Match	>=95%	>=90%	>=85%	>=80%	<80%	
AN Axial Nonuniformity	<=6%	<=8%	<=10%	<=12%	>12%	
PG Print Growth	<=10%	<=20%	<=30%	<=40%	>40%	
UEC Unused Error Correction	>=62%	>=50%	>=37%	>=25%	<25%	Code Words in ECC 200
AD Angular Distortion	<=2%	<=4%	<=6%	<=7%	>7%	

ISO/IEC 16022:2000

This standard is based upon information relevant to the printing of Data Matrix codes in black ink on white paper substrates and is typically only applicable to those applications.

Note: As a second edition for ISO/IEC 16022:2000, the ISO/IEC 16022:2006 document refers to ISO/IEC 15415:2004 as its print quality guidelines.

FIGURE 3–2. ISO/IEC 16022:2000

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 14:53:57 | Calibrated : January 15 2008 14:32:19 | Print Form

AIM (ISO 16022)	Total	10	Good	10	Fair	0	Poor	0	Angle	91
	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count	Value	Avg Value	Val Label
Overall Grade	B	3.20	2	8	0	0	0			
Symbol Contrast	B	3.40	4	6	0	0	0	64.00	75.88	REFL_Cal
Axial Nonuniformity	A	4.00	10	0	0	0	0	0.01	0.00	
Print Growth	B	3.20	2	8	0	0	0	17.00	7.19	X
								2.00	5.68	Y
Unused Error Correction	A	4.00	10	0	0	0	0	1.00	1.00	
	Aperture		Exposure	Gain		ECCLevel	WaveLen	Height	Width	Units
	AUTO		13804	354		ECC200	640	163	166	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	Light Type	Calibrated		
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE		

(VERI_FORMATTED) Output

AIM (ISO 16022) REPORT

Status	3;10;10;0;0
OverallGrade	B;3.2;2;8;0;0;0;Y;B;D
GradeContrast	B;3.4;4;6;0;0;0;Y;B;D
Contrast	64.00;75.88
GradeAxialNonuniformity	A;4.0;10;0;0;0;0;Y;B;D
AxialNonuniformity	0.01;0.00
GradePrintGrowth	B;3.2;2;8;0;0;0;Y;B;D
PrintGrowthX	17.00;7.19
PrintGrowthY	2.00;5.68
GradeUnusedErrorCorrection	A;4.0;10;0;0;0;0;Y;B;D
UnusedErrorCorrection	1.00;1.00
ContrastMax	248
ContrastMin	0
PixelsPerInch	680
ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	AUTO

TargetCalibContrast	82
TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
ECCLevel	ECC200
Calibrated	TRUE
Height	163.00
Width	166.00
Angle	91
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117

(VERI_DETAIL) Output

AIM (ISO 16022);3;10;10;0;0;B;3.2;2;8;0;0;0;Y;B;D;B;3.4;4;6;0;0;0;Y;B;D;64.00;75.88;A;4.0;10;0;0;0;0;Y;B;D;0.01;0.00;B;3.2;2;8;0;0;0;Y;B;D;17.00;7.19;2.00;5.68;A;4.0;10;0;0;0;0;Y;B;D;1.00;1.00;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;AUTO;82;87;640;INTERNAL;ECC200;TRUE;163.00;166.00;91;195;13804;354;0x0117ISO/IEC 15415:2004

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of symbol contrast;grade score of symbol contrast;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;symbol contrast this cycle;symbol contrast average;letter grade of axial nonuniformity;grade score of axial nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;axial nonuniformity this cycle;symbol axial nonuniformity average;letter grade of print growth;grade score of print growth;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;print growth in the X dimension this cycle;symbol print growth in the X dimension average;print growth in the Y dimension this cycle;symbol print growth in the Y dimension average;letter grade of unused error correction;grade

score of unused error correction;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;unused error correction this cycle;symbol unused error correction average;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;ECC level;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset

Parameters

- Axial Nonuniformity — The difference between the height and the width with respect to the row.
- Print Growth — The positive or negative size relation of the cells as printed with respect to the ideal grid.
- Reference Decode — This is a pass/fail measurement of the Data Matrix based upon a binary image of the code as specified in ISO/IEC 16022 (First edition - 2000, Second edition - 2006).
- Symbol Contrast — The difference in the population of dark pixels to the population of light pixels (see Figure 3–6) and compares to AIM DPM-1-2006 “Cell Contrast”.
- Unused Error Correction — The amount of error correction that could be read incorrectly when the code is still readable that is currently being read correctly expressed as a percentages and columns.

TABLE 3–2. ISO/IEC 16022:2000 Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
SC Symbol Contrast	>= 70%	>=55%	>=40%	>=20%	<20%	
PG Print Growth	<=15%	<=21%	<=26%	<=30%	>30%	Absolute value for X and Y
AN Axial Nonuniformity	<=6%	<=8%	<=10%	<=12%	>12%	
UEC Unused Error Correction	>=62%	>=50%	>=37%	>=25%	<25%	

ISO/IEC 15415:2004

This standard is a bar code print quality test specification for two-dimensional symbols. The ISO/IEC 16022:2006 document refers to this standard for its print

quality guidelines. Typically, it is applicable to high contrast marks with well defined square cells.

FIGURE 3–3. ISO/IEC 15415:2004

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 15:04:07 | Calibrated : January 15 2008 14:32:19 | Print Form

ISO 15415	Total	18	Good	11	Fair	5	Poor	2	Angle	180
	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count	Value	Avg Value	Val Label
Overall Grade	B	2.40	3	8	3	2	2			
Contrast	A	3.80	14	4	0	0	0	100.00	88.58	REFL_Cal
Axial Nonuniformity	A	4.00	18	0	0	0	0	0.00	0.00	
Grid Nonuniformity	A	3.90	16	2	0	0	0	0.20	0.22	
Unused Error Correction	A	3.70	16	0	0	2	0	1.00	0.92	
Fixed Pattern Damage	A	3.30	11	5	0	0	2			
Modulation	B	2.40	3	8	3	2	2			
Reference Decode	A	4.00	18	0	0	0	0			
Print Growth								-1.00	5.23	X
								11.00	13.57	Y
Cell Size								9.00	8.73	PIXELS
	Aperture		Exposure	Gain		ECCLevel	WaveLen	Height	Width	Units
Space20x = FALSE	AUTO		13804	354		ECC200	640	199	200	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	Light Type	Calibrated		
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE		

(VERI_FORMATTED) Output

ISO 15415 REPORT

Status	3;18;11;5;2
OverallGrade	B;2.4;3;8;3;2;2;Y;B;D
GradeContrast	A;3.8;14;4;0;0;0;Y;B;D
Contrast	100.00;88.58
GradeAxialNonuniformity	A;4.0;18;0;0;0;0;Y;B;D
AxialNonuniformity	0.00;0.00
GradeGridNonuniformity	A;3.9;16;2;0;0;0;Y;B;D
GridNonuniformity	0.20;0.22
GradeUnusedErrorCorrection	A;3.7;16;0;0;2;0;Y;B;D
UnusedErrorCorrection	1.00;0.92
GradeFixedPatternDamage	A;3.3;11;5;0;0;2;Y;B;D
GradeModulation	B;2.4;3;8;3;2;2;Y;B;D
GradeReferenceDecode	A;4.0;18;0;0;0;0;Y;B;D
PrintGrowthX	-1.00;5.23
PrintGrowthY	11.00;13.57

CellSize	9.00;8.73
Quality20Z	FALSE
ContrastMax	248
ContrastMin	0
PixelsPerInch	680
ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	AUTO
TargetCalibContrast	82
TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
ECCLevel	ECC200
Calibrated	TRUE
Height	199.00
Width	200.00
Angle	180
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117

(VERI_DETAIL) Output

ISO 15415;3;18;11;5;2;B;2.4;3;8;3;2;2;Y;B;D;A;3.8;14;4;0;0;0;Y;B;D;100.00;88.58;A;4.0;18;0;0;0;0;Y;B;D;0.00;0.00;A;3.9;16;2;0;0;0;Y;B;D;0.20;0.22;A;3.7;16;0;0;2;0;Y;B;D;1.00;0.92;A;3.3;11;5;0;0;2;Y;B;D;B;2.4;3;8;3;2;2;Y;B;D;A;4.0;18;0;0;0;0;Y;B;D;-1.00;5.23;11.00;13.57;9.00;8.73;FALSE;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;AUTO;82;87;640;INTERNAL;ECC200;TRUE;199.00;200.00;180;195;13804;354;0x0117

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of

fair;letter grade of contrast;grade score of contrast;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;contrast this cycle;contrast average;letter grade of axial nonuniformity;grade score of axial nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;axial nonuniformity this cycle;axial nonuniformity average;letter grade of grid nonuniformity;grade score of grid nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;grid nonuniformity this cycle;grid nonuniformity average;letter grade of unused error correction;grade score of unused error correction;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;unused error correction this cycle;unused error correction average;letter grade of fixed pattern damage;grade score of fixed pattern damage;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of modulation;grade score of modulation;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of reference decode;grade score of reference decode;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;print growth x dimension value this cycle;print growth x dimension average;print growth y dimension value this cycle;print growth y dimension average;cell size this cycle;cell size average;20Z dimension status;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;ECC level;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset

Parameters

- Axial Nonuniformity — The difference between the height and the width with respect to the rows and columns.
- Fixed Pattern Damage — A measurement of the errors in the borders of the Data Matrix as well as any errors in the quiet zone around the code necessary for the decoding process.
- Grid Nonuniformity — This measurement is a delta of the difference of the measured grid in relation to the ideal grid formed from the four corners of the Data Matrix.

- Modulation — In ISO/IEC 15415, a measurement of the uniformity of the color of the dark areas and the light areas of the Data Matrix (see Figure 3–6) similar to “Cell Modulation” but differs in the implementation details.
- Print Growth — The positive or negative size relation of the cells as printed with respect to the ideal grid.
- Reference Decode — This is a pass/fail measurement of the Data Matrix based upon a binary image of the code as specified in ISO/IEC 16022 (First edition - 2000, Second edition - 2006).
- Symbol Contrast — The difference in the population of dark pixels to the population of light pixels (see Figure 3–6) and compares to AIM DPM-1-2006 “Cell Contrast”.
- Unused Error Correction — The amount of error correction that could be read incorrectly when the code is still readable that is currently being read correctly expressed as a percentage.

TABLE 3–3. ISO/IEC 15415:2004 Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
Axial Nonuniformity	<=0.06	<=0.08	<=0.10	<=0.12	>0.12	X and Y
Contrast	>=0.70	>=0.55	>=0.40	>=0.20	<0.20	
Fixed Pattern Damage	This measurement is developed through a three stage process. There is no grade correlation between raw score and the final score. The initial raw value is used with an overlay technique to achieve the final result.					
Grid Nonuniformity	<=0.38	<=0.50	<=0.63	<=0.75	>0.75	
Modulation	This measurement is developed through a three stage process. There is no grade correlation between raw score and the final score. The initial raw value is used with an overlay technique to achieve the final result.					
Reference Decode	Pass				Fail	
Unused Error Correction	>=0.62	>=0.50	>=0.37	>=0.25	<0.25	

AS9132 Rev. A, 2005

This standard was originally issued as the IAQG (International Aerospace Quality Group) Data Matrix standard. This standard is directly applicable to three specific mark types; dot peen marking, laser marking and electro-chemical etch marking.

FIGURE 3–4. AS9132 Rev. A, 2005

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 14:41:17 | Calibrated : January 15 2008 14:32:19 | Print Form

IAQG (AS9132)	Total	10	Good	8	Fair	0	Poor	2	Angle	0
	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count	Value	Avg Value	Val Label
Overall Grade	B	2.40	0	8	0	0	2			
Nominal Module Size								8.00	8.12	PIXELS
Dot Size Offset	B	2.40	0	8	0	0	2	54.60	54.19	Count 1
								0.00	11.56	Count 2
Dot Center Offset	A	3.80	8	2	0	0	0	1.50	1.18	Count 1
								0.00	0.06	Count 2
Angle of Distortion	A	4.00	10	0	0	0	0	0.00	0.08	
Cell Fill								93.00	92.99	X
								90.00	94.88	Y
Ovality	B	3.00	0	10	0	0	0	0.00	0.03	
	Aperture		Exposure	Gain		ECCLevel	WaveLen	Height	Width	Units
	AUTO		13804	354		ECC200	640	146	144	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	Light Type	Calibrated		
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE		

(VERI_FORMATTED) Output

IAQG (AS9132) REPORT

Status	3;10;8;0;2
OverallGrade	B;2.4;0;8;0;0;2;Y;B;D
CellSize	8.00;8.12
GradeDotSize	B;2.4;0;8;0;0;2;Y;B;D
DotSizeOffset1	54.60;54.19
DotSizeOffset2	0.00;11.56
GradeDotCenter	A;3.8;8;2;0;0;0;Y;B;D
DotCenterOffset1	1.50;1.18
DotCenterOffset2	0.00;0.06
GradeAngleOfDistortion	A;4.0;10;0;0;0;0;Y;B;D
AngleOfDistortion	0.00;0.08
CellFillX	93.00;92.99
CellFillY	90.00;94.88
GradeOvality	B;3.0;0;10;0;0;0;Y;B;D
Ovality	0.00;0.03
ContrastMax	248
ContrastMin	0
PixelsPerInch	680

ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	AUTO
TargetCalibContrast	82
TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
ECCLevel	ECC200
Calibrated	TRUE
Height	146.00
Width	144.00
Angle	0
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117

(VERI_DETAIL) Output

IAQG (AS9132);3;10;8;0;2;B;2.4;0;8;0;0;2;Y;B;D;8.00;8.12;B;2.4;0;8;0;0;2;Y;B;D;54.60;54.19;0.00;11.56;A;3.8;8;2;0;0;0;Y;B;D;1.50;1.18;0.00;0.06;A;4.0;10;0;0;0;0;Y;B;D;0.00;0.08;93.00;92.99;90.00;94.88;B;3.0;0;10;0;0;0;Y;B;D;0.00;0.03;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;AUTO;82;87;640;INTERNAL;ECC200;TRUE;146.00;144.00;0;195;13804;354;0x0117

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;cell size this cycle;cell size average;letter grade of dot size;grade score of dot size;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;dot size offset 1 this cycle;dot size offset 1 average;dot size offset 2 this cycle;dot size offset 2 average;letter grade of dot size;grade score of dot size;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;dot center offset 1 this cycle;dot center offset 1 average;dot center offset 2 this cycle;dot center offset 2 average;letter grade of

angle of distortion;grade score of angle of distortion;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;angle of distortion this cycle;angle of distortion average;cell fill x this cycle;cell fill x average;cell fill y this cycle;cell fill y average;letter grade of ovality;grade score of ovality;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;ovality this cycle;ovality average;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;ECC level;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset

Parameters

- Dot peening
  - Angle of Distortion — The difference from perpendicular of the two solid edges of the Data Matrix measured in degrees.
  - Dot Center Offset — The linear difference of the location of the center of the cell compared to the center of the ideal grid center calculated as a percentage of the nominal cell size.
  - Dot Size Offset — The difference is the apparent size of each individual data element in the Data Matrix.
  - Matrix Size — The overall size of the code as measured linearly across the width or height.
  - Module Fill — This measures the percentage of completeness of the ideal grid.
  - Nominal Module Size — The average value of the two values: X Nominal Cell Size and Y Nominal Cell Size. X Nominal Cell Size is the Data Matrix width in pixels divided by the number of columns; Y Nominal Cell Size is the Data Matrix height in pixels divided by the number of rows.
  - Ovality — The difference of the widest part of the round cell versus the narrowest part of the round cell.
- Laser and Electro-Chemical Etching

- Angle of Distortion — The difference from perpendicular of the two solid edges of the Data Matrix measured in degrees.
- Cell Size — The overall width divided by the number of columns or the overall height divided by the number of rows.
- Contrast — Is the difference between the highest and the lowest reflectance values in a scan reflectance profile.
- Matrix Size — The overall size of the code as measured linearly across the width or height.
- Module Fill — This measures the percentage of completeness of the ideal grid.

TABLE 3–4. AS9132 Rev. A, 2005 Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
Angle of Distortion	<3.5	<7			> 7	
Cell Fill	65%-105%		P/F Only		<65% or >105%	Ref Only – Ideal is 80%
Dot Center Offset	C1< 2%	C2<2%			C2>20%	C1 is the count of cells having center offset less than 10% of nominal module size. C2 is the count of cells having center offset less than 20% of nominal module size.
Dot Size Offset	C1<2%	C2<2%			C2>2%	C1 is the count of cells having size offset errors between 70%-90% of nominal module size. C2 is the count of cells having size offset errors between 60%-105% of nominal module size.
Nominal Module Size						Ref Only
Ovality	C1 < 2%	C2 < 2%			C2 > 2%	C1 and C2 are count of cells having ovality greater than 20% of nominal module size.

AIM DPM-1-2006

This standard is applicable to a broad range of applications, industries and marking methods.

FIGURE 3–5. **AIM DPM-1-2006**

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 15:15:51 | Calibrated : January 15 2008 14:32:19 | Print Form

AIM DPM-1-2006	Total	23	Good	23	Fair	0	Poor	0	Angle	91
DPM3.0/14/640/INTERNA	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count	Value	Avg Value	Val Label
Overall Grade	B	3.80	18	5	0	0	0			
Cell Contrast	A	4.00	23	0	0	0	0	69.00	89.68	REFL_Cal
Axial Nonuniformity	B	3.80	18	5	0	0	0	0.07	0.02	
Grid Nonuniformity	A	4.00	23	0	0	0	0	0.10	0.09	
Unused Error Correction	A	4.00	23	0	0	0	0	1.00	1.00	
Fixed Pattern Damage	A	4.00	23	0	0	0	0			
Cell Modulation	A	4.00	23	0	0	0	0			
Reference Decode	A	4.00	23	0	0	0	0			
Min Reflectance	A	4.00	23	0	0	0	0	100.00	87.56	
Print Growth								-53.00	-13.25	X
								-43.00	-4.98	Y
Cell Size								17.70	13.11	PIXELS
	Aperture	Aperture%	Exposure	Gain	MeanLight	ECCLevel	WaveLen	Height	Width	Units
	14	80%	9052	354	201	ECC200	640	258	239	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	LightType	Calibrated	XDim	
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE	7.5 / 25.0	

(VERI_FORMATTED) Output

AIM DPM-1-2006 REPORT

Status	3;24;24;0;0
OverallGrade	B;3.8;18;6;0;0;0;Y;B;D
GradeCellContrast	A;4.0;24;0;0;0;0;Y;B;D
CellContrast	69.00;88.81
GradeAxialNonuniformity	B;3.8;18;6;0;0;0;Y;B;D
AxialNonuniformity	0.07;0.02
GradeGridNonuniformity	A;4.0;24;0;0;0;0;Y;B;D
GridNonuniformity	0.10;0.09
GradeUnusedErrorCorrection	A;4.0;24;0;0;0;0;Y;B;D
UnusedErrorCorrection	1.00;1.00
GradeFixedPatternDamage	A;4.0;24;0;0;0;0;Y;B;D
GradeCellModulation	A;4.0;24;0;0;0;0;Y;B;D
GradeReferenceDecode	A;4.0;24;0;0;0;0;Y;B;D
GradeMinReflectance	A;4.0;24;0;0;0;0;Y;B;D
MinReflectance	100.00;88.07
PrintGrowthX	-42.00;-14.44
PrintGrowthY	-43.00;-6.56

CellSize	17.60;13.30
CurrentMeanLight	215
ContrastMax	248
ContrastMin	0
PixelsPerInch	680
ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	14
TargetCalibContrast	82
TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
XDimensionMax	25.0
XDimensionMin	7.5
ECCLevel	ECC200
Calibrated	TRUE
Height	257.00
Width	238.00
Angle	91
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117
AperturePercentage	80

(VERI_DETAIL) Output

AIM DPM-1-2006;3;24;24;0;0;B;3.8;18;6;0;0;0;Y;B;D;A;4.0;24;0;0;0;0;Y;B;D;69.00;88.81;B;3.8;18;6;0;0;0;Y;B;D;0.07;0.02;A;4.0;24;0;0;0;0;Y;B;D;0.10;0.09;A;4.0;24;0;0;0;0;Y;B;D;1.00;1.00;A;4.0;24;0;0;0;0;Y;B;D;A;4.0;24;0;0;0;0;Y;B;D;A;4.0;24;0;0;0;0;Y;B;D;A;4.0;24;0;0;0;0;Y;B;D;100.00;88.07;-42.00;-14.44;-43.00;-6.56;17.60;13.30;215;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;14;82;87;640;INTERNAL;25.0;7.5;ECC200;TRUE;257.00;238.00;91;195;13804;354;0x0117;80

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of cell contrast;grade score of cell contrast;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;cell contrast this cycle;cell contrast average;letter grade of axial nonuniformity;grade score of axial nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;axial nonuniformity this cycle;axial nonuniformity average;letter grade of grid nonuniformity;grade score of grid nonuniformity;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;grid nonuniformity this cycle;grid nonuniformity average;letter grade of unused error correction;grade score of unused error correction;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;unused error correction this cycle;unused error correction average;letter grade of fixed pattern damage;grade score of fixed pattern damage;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of cell modulation;grade score of cell modulation;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair; letter grade of reference decode;grade score of reference decode;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;letter grade of minimum reflectance;grade score of minimum reflectance;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;minimum reflectance this cycle;minimum reflectance average;print growth in the X dimension this cycle;symbol print growth in the X dimension average;print growth in the Y dimension this cycle;print growth in the Y dimension average;cell size this cycle;cell size in the Y dimension average;current mean light;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;X dimension maximum;X dimension minimum;ECC level;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset; aperture percentage

Parameters

- Axial Nonuniformity — The difference between the height and the width with respect to the rows and columns.
- Cell Contrast — In AIM DPM-1-2006, the difference in the population of dark pixels to the population of light pixels (see Figure 3–6) and uses the sample principle as “Symbol Contrast” with modified definition.
- Cell Modulation — In AIM DPM-1-2006, a measurement of the uniformity of the color of the dark areas and the light areas of the Data Matrix (see Figure 3–6) similar to “Modulation” but differs in the implementation details.
- Fixed Pattern Damage — A measurement of the errors in the borders of the Data Matrix as well as any errors in the quiet zone around the code necessary for the decoding process.
- Grid Nonuniformity — This measurement is a delta of the difference of the measured grid in relation to the ideal grid formed from the four corners of the Data Matrix.
- Minimum Reflectance — The lowest reflectance of any sample area in the Data Matrix.
- Reference Decode — This is a pass/fail measurement of the Data Matrix based upon a binary image of the code as specified in ISO/IEC 16022 (First edition - 2000, Second edition - 2006).
- Unused Error Correction — The amount of error correction that could be read incorrectly when the code is still readable that is currently being read correctly expressed as a percentage.

FIGURE 3–6. Histogram Showing Pixel Color Populations

TABLE 3–5. AIM DPM-1-2006 Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
Cell Contrast	>=30%	>=25%	>=20%	>=15%	<15%	
Axial Nonuniformity	<=6%	<=8%	<=10%	<=12%	>12%	Calculation differs slightly from ISO 15415
Grid Nonuniformity	<=0.38	<=0.50	<=0.63	<=0.75	>0.75	Calculation differs slightly from ISO 15415
Unused Error Correction	>=62%	>=50%	>=37%	>=25%	<25%	
Fixed Pattern Damage	This measurement is developed through a three stage process. There is no grade correlation between raw score and the final score. The initial raw value is used with an overlay technique to achieve the final result.					
Cell Modulation	This measurement is developed through a three stage process. There is no grade correlation between raw score and the final score. The initial raw value is used with an overlay technique to achieve the final result.					
Reference Decode	Pass				Fail	
Minimum Reflectance	>=5%				<5%	

CHAPTER 4

Barcode Verification

ISO/IEC 15416:2000

FIGURE 4–1. ISO/IEC 15416:2000

twaddlehde00043 [CTRL] - Verification Report

January 15 2008 15:36:04 | Calibrated : January 15 2008 14:32:19 | Print Form

ANSI (ISO 15416)	Total	14	Good	4	Fair	10	Poor	0	Angle	183
	Score	2.40	OneXDim	7.50	Ratio(0)	2.00	Ratio(1)	0.00	Ratio(2)	3.90
	Grade	Avg Grade	A Count	B Count	C Count	D Count	F Count			
Final Grade	C	2.30	0	4	10	0	0			
	Scan 1	Scan 2	Scan 3	Scan 4	Scan 5	Scan 6	Scan 7	Scan 8	Scan 9	Scan 10
Grade Scan Overall	B	C	C	C	B	B	C	B	C	C
Grade Edge Deter	A	A	A	A	A	A	A	A	A	A
Grade Min Reflect	A	A	A	A	A	A	A	A	A	A
% Max Reflectance	77.00	79.00	78.00	77.00	76.00	77.00	77.00	82.00	80.00	83.00
% Min Reflectance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grade Ref Decode	A	A	A	A	A	A	A	A	A	A
Grade Min Edge Contrast	A	A	A	A	A	A	A	A	A	A
% Min Edge Contrast	53.00	55.00	54.00	50.00	47.00	49.00	46.00	53.00	50.00	53.00
Grade Symbol Contrast	A	A	A	A	A	A	A	A	A	A
% Symbol Contrast	77.00	79.00	78.00	77.00	76.00	77.00	77.00	82.00	80.00	83.00
Grade Modulation	B	A	B	B	B	B	C	B	B	B
Modulation	0.69	0.70	0.69	0.65	0.62	0.64	0.59	0.65	0.63	0.64
Grade Defects	A	B	B	B	B	B	C	B	B	B
Defects	0.15	0.19	0.19	0.20	0.17	0.17	0.25	0.17	0.16	0.20
Grade Decodability	B	C	C	C	B	B	C	B	C	C
Decodability	0.52	0.47	0.46	0.46	0.50	0.51	0.49	0.50	0.46	0.39
Start Quiet Zone	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Stop Quiet Zone	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Aperture		Exposure	Gain	Cell R	Contrast R	WaveLen	Height	Width	Units
	AUTO		13804	354	PIXELS	REFL_Cal	640	22	484	PIXELS
Cal Exposure/Gain/Offset	CalContra	CalReflec	mContrast	MContrast	Pixel/Inch	Cal ML	Light Type	Calibrated		
13804 / 354 / 0x0117	82%	87%	0	248	680	195	INTERNAL	TRUE		

(VERI_FORMATTED) Output

ANSI (ISO 15416) REPORT

Status	2;14;4;10;0
FinalGrade	C;2.3;0;4;10;0;0;Y;B;D
GradeScanOverall	B;C;C;C;B;B;C;B;C;C;Y;B;D
GradeEdgeDeter	A;A;A;A;A;A;A;A;A;A;Y;B;D
GradeMinReflect	A;A;A;A;A;A;A;A;A;A;Y;B;D
PctMaxReflectance	77.00;79.00;78.00;77.00;76.00;77.00;77.00;82.00;80.00;83.00
PctMinReflectance	0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00
GradeRefDecode	A;A;A;A;A;A;A;A;A;A;Y;B;D
GradeMinEdgeContrast	A;A;A;A;A;A;A;A;A;A;Y;B;D
PctMinEdgeContrast	53.00;55.00;54.00;50.00;47.00;49.00;46.00;53.00;50.00;53.00
GradeSymbolContrast	A;A;A;A;A;A;A;A;A;A;Y;B;D
PctSymbolContrast	77.00;79.00;78.00;77.00;76.00;77.00;77.00;82.00;80.00;83.00
GradeModulation	B;A;B;B;B;B;C;B;B;B;Y;B;D
Modulation	0.69;0.70;0.69;0.65;0.62;0.64;0.59;0.65;0.63;0.64
GradeDefects	A;B;B;B;B;B;C;B;B;B;Y;B;D
Defects	0.15;0.19;0.19;0.20;0.17;0.17;0.25;0.17;0.16;0.20
GradeDecodability	B;C;C;C;B;B;C;B;C;C;Y;B;D
Decodability	0.52;0.47;0.46;0.46;0.50;0.51;0.49;0.50;0.46;0.39
StartQuietZone	10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00
StopQuietZone	10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00
ContrastMax	248
ContrastMin	0
PixelsPerInch	680
ContrastReport	REFLECTANCE_CALIBRATED
CellUnitReport	PIXELS
Aperture	AUTO

TargetCalibContrast	82
TargetCalibReflectance	87
Wavelength	640
LightType	INTERNAL
Calibrated	TRUE
Height	22.00
Width	484.00
Angle	183
CalMeanLight	195
CalExposure	13804
CalGain	354
CalBlackOffset	0x0117

(VERI_DETAIL) Output

ANSI (ISO 15416);2;14;4;10;0;C;2.3;0;4;10;0;0;Y;B;D;B;C;C;C;B;B;C;B;C;C;Y;B;D;A;A;A;A;A;A;A;A;A;A;Y;B;D;A;A;A;A;A;A;A;A;A;Y;B;D;77.00;79.00;78.00;77.00;76.00;77.00;77.00;82.00;80.00;83.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;0.00;A;A;A;A;A;A;A;A;A;Y;B;D;A;A;A;A;A;A;A;A;A;Y;B;D;53.00;55.00;54.00;50.00;47.00;49.00;46.00;53.00;50.00;53.00;A;A;A;A;A;A;A;A;A;Y;B;D;77.00;79.00;78.00;77.00;76.00;77.00;77.00;82.00;80.00;83.00;B;A;B;B;B;B;C;B;B;B;Y;B;D;0.69;0.70;0.69;0.65;0.62;0.64;0.59;0.65;0.63;0.64;A;B;B;B;B;B;C;B;B;B;Y;B;D;0.15;0.19;0.19;0.20;0.17;0.17;0.25;0.17;0.16;0.20;B;C;C;C;B;B;C;B;C;C;Y;B;D;0.52;0.47;0.46;0.46;0.50;0.51;0.49;0.50;0.46;0.39;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;10.00;248;0;680;REFLECTANCE_CALIBRATED;PIXELS;AUTO;82;87;640;INTERNAL;TRUE;22.00;484.00;183;195;13804;354;0x0117

Delimited List of VERI_DETAIL Parameters

verification type;overall status score;counts of total;good;fair;poor;letter grade of overall grade;grade score of overall grade;count of grade A;B;C;D;F;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;final grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;overall scan grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;edge determination

grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;minimum reflectance grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;maximum reflectance percent for scan line 1;2;3;4;5;6;7;8;9;10;minimum reflectance percent for scan line 1;2;3;4;5;6;7;8;9;10;reference decode grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;minimum edge contrast grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;minimum edge contrast percent for scan line 1;2;3;4;5;6;7;8;9;10;symbol contrast grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;symbol contrast percent for scan line 1;2;3;4;5;6;7;8;9;10; modulation grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;modulation for scan line 1;2;3;4;5;6;7;8;9;10;defects grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;defects for scan line 1;2;3;4;5;6;7;8;9;10;decodability grade for scan line 1;2;3;4;5;6;7;8;9;10;is this value use to determine good/fair/poor;minimum level of good;minimum level of fair;decodability for scan line 1;2;3;4;5;6;7;8;9;10;start quiet zone for scan line 1;2;3;4;5;6;7;8;9;10;stop quiet zone for scan line 1;2;3;4;5;6;7;8;9;10;contrast maximum;contrast minimum;pixels per inch;contrast report;cell unit report;aperture;target calibration contrast;target calibration reflectance;wavelength;light type;calibrated state;code height;code width;angle;calibrated mean light;calibrated exposure;calibrated gain;calibrated black offset

Parameters

- % Max Reflectance — Percentage value of reflectance of lightest space.
- % Min Edge Contrast — Percentage value of minimum edge contrast. Edge Contrast is the difference between the bar reflectance and space reflectance of two adjacent elements.
- % Min Reflectance — Percentage value of reflectance of darkest bar.
- % Symbol Contrast — Is the difference between the highest and the lowest reflectance values in a scan reflectance profile.
- Decodability — The proportion of the available margin (between the ideal dimension of an element or combination of elements and the relevant

reference threshold) that has not been consumed by the element or combination of elements, calculated for the element or combination of elements deviating most from its ideal dimension.

- Defects — Are irregularities found within elements and quiet zones, and are measured in terms of element reflectance non-uniformity.
- Modulation — The ratio of minimum edge contrast to symbol contrast.
- Start Quiet Zone — The area outside the Start codeword that is 10 module long.
- Stop Quiet Zone — The area outside the Stop codeword that is 10 module long.

TABLE 4–1. ISO/IEC 15416 Numeric Score to Grade Level Comparison

Grade	A 4	B 3	C 2	D 1	F 0	Comments
Min Reflectance	<=0.5Rmax				>0.5Rmax	Rmax is Max Reflectance
Symbol Contrast	>=0.70	>=0.55	>=0.40	>=0.20	<0.20	
Min Edge Contrast	>=0.15				<0.15	
Modulation	>=0.70	>=0.60	>=0.50	>=0.40	<0.40	
Defects	<=0.15	<=0.20	<=0.25	<=0.30	>0.30	
Decodability	>=0.62	>=0.50	>=0.37	>=0.25	<0.25	
Quiet Zone	>=10 Modules				<10 Modules	

A

APPENDIX A

If You're Writing Your Own VB Applications

We have provided the functions listed in this appendix for those writing their own VB applications to translate the values obtained from the verification report.

GetApertureString

```
Public Function GetApertureString(Value As Long) As String
       Select Case Value
              Case 0
                     GetApertureString = "AUTO"
              Case Else
                     GetApertureString = Value
       End Select
End Function
```

GetCalibratedString

```
Public Function GetCalibratedString(Value As Long) As String
       Select Case Value
              Case 0
                     GetCalibratedString = "FALSE"
              Case 1
                     GetCalibratedString = "TRUE"
              Case Else
                     GetCalibratedString = "FALSE"
```

```
        End Select
End Function
```

GetCellUnitReportString

```
Public Function GetCellUnitReportString(Value As Long) As String
        Const CELL_UNIT_IN_PIXELS = 1
        Const CELL_UNIT_IN_MILS = 2 '/* 1/1000th inch */

        Select Case Value
                Case CELL_UNIT_IN_PIXELS
                        GetCellUnitReportString = "PIXELS"
                Case CELL_UNIT_IN_MILS
                        GetCellUnitReportString = "MILS"
                Case Else
                        GetCellUnitReportString = "???"
        End Select
End Function
```

GetContrastReportString

```
Public Function GetContrastReportString(Value As Long) As String
        Const CONTRAST_UNCALIBRATED = 1
        Const CONTRAST_SELF_CALIBRATED = 2
        Const CONTRAST_REFLECTANCE_CALIBRATED = 3

        Select Case Value
                Case CONTRAST_UNCALIBRATED
                        GetContrastReportString = "UN_Cal"
                Case CONTRAST_SELF_CALIBRATED
                        GetContrastReportString = "SELF_Cal"
                Case CONTRAST_REFLECTANCE_CALIBRATED
                        GetContrastReportString = "REFL_Cal"
                Case Else
                        GetContrastReportString = "???"
        End Select
End Function
```

GetECCLevelString

```
Public Function GetECCLevelString(Value As Long) As String
        Const IDM_QUAL_200 = 26
        Const IDM_QUAL_140_OVHD_75 = 12
        Const IDM_QUAL_100_OVHD_50 = 8
        Const IDM_QUAL_080_OVHD_33 = 6
        Const IDM_QUAL_050_OVHD_25 = 3
        Const IDM_QUAL_000_OVHD_00 = 0
        Const IDM_QUAL_250 = 27

        Select Case Value
                Case IDM_QUAL_200
                        GetECCLevelString = "ECC200"
                Case IDM_QUAL_140_OVHD_75
                        GetECCLevelString = "ECC140"
                Case IDM_QUAL_100_OVHD_50
                        GetECCLevelString = "ECC100"
                Case IDM_QUAL_080_OVHD_33
                        GetECCLevelString = "ECC080"
                Case IDM_QUAL_050_OVHD_25
                        GetECCLevelString = "ECC050"
                Case IDM_QUAL_000_OVHD_00
                        GetECCLevelString = "ECC000"
                Case IDM_QUAL_250
                        GetECCLevelString = "ECC250"
                Case Else
                        GetECCLevelString = "???"
        End Select
End Function
```

GetQuality20ZString

```
Public Function GetQuality20ZString(Value As Long) As String
        Select Case Value
                Case 0
                        GetQuality20ZString = "FALSE"
                Case 1
                        GetQuality20ZString = "TRUE"
        End Select
End Function
```

B

APPENDIX B

Verification Error Codes

TABLE B–1. Data Matrix Verification Error Codes

Error Code	Verification Error	Reason
4700	Verification Process Error	DPM Verification failed due to insufficient space around Data Matrix or other problems
4701	Verification Unsupported	DPM Verification does not support non-ECC200 codes greater than 26x26
4702	Verification Timeout	Read Timeout value set too short
4710	ISO Verification ECC200 required	ECC200 is required for ISO/IEC 15415 or AIM DPM-1-2006
4711	ISO Verification aperture too small	Data Matrix cell size is too large for the aperture 05 specified for ISO/IEC 15415
4712	ISO Verification aperture too large	Data Matrix cell size is too small for the aperture 05 specified for ISO/IEC 15415
4713	ISO Verification insufficient space	There is insufficient space surrounding the Data Matrix for ISO/IEC 15415 or AIM DPM-1-2006.
4714	ISO Verification failed RDA STEP F 1	Failed Reference Decode Algorithm in step F 1 in ISO/IEC 15415 or AIM DPM-1-2006
4715	ISO Verification failed RDA STEP F 2	Failed Reference Decode Algorithm in step F 2 in ISO/IEC 15415 or AIM DPM-1-2006
4716	ISO Verification failed RDA STEP F 3	Failed Reference Decode Algorithm in step F 3 in ISO/IEC 15415 or AIM DPM-1-2006

TABLE B–1. Data Matrix Verification Error Codes (Continued)

Error Code	Verification Error	Reason
4717	ISO Verification failed RDA STEP A E	Failed Reference Decode Algorithm in steps A through E in ISO/IEC 15415 or AIM DPM-1-2006
4718	ISO Verification failed RDA final image adjustment	Failed the final image adjustment step in AIM DPM-1-2006
4719	ISO Verification failed RDA error correction	Failed error correction in Reference Decode Algorithm in ISO/IEC 15415 or AIM DPM-1-2006
4720	ISO Verification DM Row/Column too large	Data Matrix greater than 104x104 is not supported in this software version for AIM DPM-1-2006 and ISO/IEC 15415
4721	ISO Verification cell size smaller than Min X	Cell size is smaller than Min X specified for AIM DPM-1-2006.
4722	ISO Verification cell size greater than Max X	Cell size is greater than Max X specified for AIM DPM-1-2006.

APPENDIX C

AIM DPM-1-2006 Compliant Configuration

The AIM DPM-1-2006 compliant configuration requires the following parts:

1. HawkEye™ 1510 camera with serial cable (FIS-HE15-0CS0)
2. AC power cable for camera (P/N HEPS-1500)
3. DOAL-50 V2, Red LED-D
4. AC power cable for light (P/N CPS-12)
5. DOAL-50 mounting hardware HELTMA-4L (98-LG17-0XX0)
6. C-mount lens 25mm (P/N 928-0057-4) or 35mm (P/N 928-0057-5)
7. Extension ring (P/N C0206)
8. UID stand (98-UA10-0ST0)
9. Ethernet cable (P/N HEENET-007)
10. Thumb screws (4) to attach light mount to the camera (P/N 972-0282-1)
11. Calibration Test Card (98-UA10-0CC0)
12. ReadRunner software CD (P/N A1-40168-1V240)
13. Ethernet crossover adapter (P/N HEENET-XLA)

14. Spiral wire wrap (P/N 966-0195-1)

Setting Up the UID-DPM Stand

FIGURE C–1. Dowel Pins and Thumb Screw

1. Remove the stand base and upright arm from the packaging.
2. Place the base on a level flat surface.
3. Slide the upright arm onto the two dowel pins in the back of the base.
4. Fasten the upright arm using the large thumb screw provided with the kit.
5. Be careful while moving the upright arm. The camera mounting head is spring-loaded and can move while carrying the arm.

Attaching the Camera

1. Attach the HawkEye™ 1510 camera to the stand using the ¼-20 thumb screw that protrudes from the front of the camera mount head.
2. Connect the HEPS-1500 power cable to the camera.
3. Plug the HEPS-1500 power cable into a 110V outlet.
4. Connect the HEENET-007 network cable to the camera.
5. Loop the power and Ethernet cable in the wire hook on the back rear of the camera mounting head.

Assembling the Lights

FIGURE C–2. **HELTMA-4L Bracket**

1. Assemble the HELTMA-4L to the DOAL-50 using two M6x10mm screw.

Preparing the Lenses

1. Take the lenses out of their boxes and remove the plastic over-wrap. Store the lenses with the lens covers on.
2. Remove the extension tubes from the box and remove plastic over-wrap.
3. Remove the lens protective cap from the bottom of the HawkEye™ 1510 camera.

Attaching the Lights to the Camera

FIGURE C–3. Small Hole Caps

1. Using a small screwdriver, remove the 4 small hole caps (two on each side) on the sides of the HawkEye™ camera.

FIGURE C–4. Thumb Screws

2. Using the 4 thumb screws provided, attach the HELTMA-4L bracket to the HawkEye™ camera.
3. Plug the CPS-12 power supply into a 110V outlet and attach the DB-9 connector to the light attached to the HELTMA bracket.
4. Center the light on the camera by loosening the four button head screws on the side of the HELTMA and centering the light.

Recommended Verifier Setting with 25mm Lens

f-stop = 2

Extension Ring = 6mm

Distance from front of camera to part = 8 inches (203.2 mm)

Distance from bottom of light to part = 2 inches (50.8 mm)

Field of View = 1.19 inches x 0.86 inches (30.2 mm x 21.8 mm)

FIGURE C–5. Setting 1 — 25mm Lens with 6mm Extension Ring

Recommended Verifier Setting with 35mm Lens

f-stop = 3

Extension Ring = 10mm

Distance from front of camera to part = 9 inches (228.6 mm)

Distance from bottom of light to part = 2 inches (50.8 mm)

Field of View = 0.89 inches x 0.67 inches (22.6 mm x 17.0 mm)

FIGURE C–6. Setting 2 — 35mm Lens with 10mm Extension Ring

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