

Understanding Machine Vision Verification of 1D and 2D Barcodes

**Basics of Ensuring Barcode Readability
for Reliable Process Operation**

MICROSCAN®

Understanding Machine Vision Verification of 1D/2D Barcodes

Legible, accurate barcodes have never been more important than they are today, when automated supply chains depend on data accuracy to ensure the reliable performance of global operations. Machine vision verification is one tool that can be used to ensure that barcodes meet a consistent level of quality for readability in an automated process, and that bad codes are identified before they result in costly failures. This white paper introduces 1D and 2D barcode verification and identifies parameters for verifying codes against published standards.

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- Verification with AutoVISION®



Microscan Systems, Inc.

Why Verify?

Barcode quality is integral to the success of an automated system. In a process where quality barcodes accurately store and communicate data – from code to reader to central system – little manual intervention is required. Thanks to quality barcodes, the unique benefits of an automated system are realized: lower costs, higher productivity, and fewer errors. Poor quality barcodes, however, render the system almost as inefficient as using no automation at all. Unreadable barcodes may require re-labeling, re-scanning, or even manual entry of critical information by a human operator – disrupting the productivity of the process and causing a significant loss of time. Bad barcodes may prevent error-tracking, causing a domino effect of failures down the line and resulting in costly scrap and rework. All told, these effects completely counteract the benefits of implementing an automated system, the result being inflated cost, loss of productivity, and increased errors.

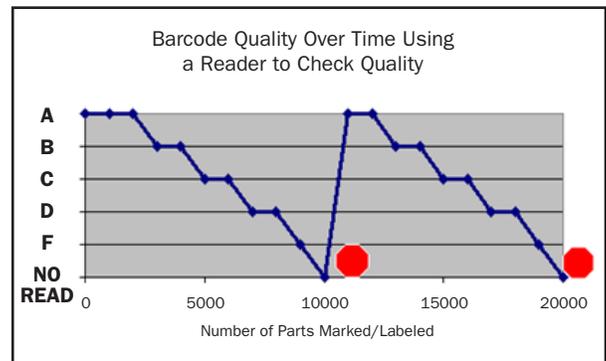
The purpose of barcode verification is to prevent this outcome and preserve the intended benefits of the automated system. Verification systems evaluate a barcode's quality against published quality standards for 1D and 2D barcodes using precision instruments such as barcode verifiers or machine vision systems. A verified barcode ensures consistent readability, supporting 100% accurate automated data capture.

When Should You Verify?

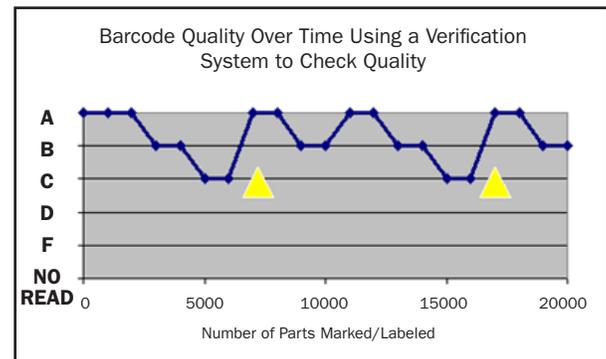
To ensure that errors are prevented as early in the automated system as possible, verification must occur before a part enters the system. A verification step should occur after a part is marked or labeled with a barcode and before the part reaches the station where the barcode is first read.



Proper verification ensures that every part is processed and shipped with a high-quality barcode, despite the fact that marking and labeling systems will degrade over time. A verification system is much more accurate than a standard barcode reader at identifying low-quality barcodes early in the process, before parts with bad barcodes make it through the line and are shipped to end customers. When barcode quality degradation is identified early, the marking or labeling system may be adjusted or replaced before unreadable barcodes are ever produced.



Without verification, bad barcodes are not identified until they are unreadable. By the time a bad barcode is identified, thousands of poor-quality barcodes may have already escaped down the line.



With verification, bad barcodes are prevented from being applied to the product, eliminating the chance for future failures.

Custom vs. True Verification

Depending on the requirements of a particular process, industry, company, or customer, there are two levels of quality grading for ensuring barcode readability: custom verification and true verification.

Custom Verification: Custom verification is a means of ensuring that barcodes are readable throughout a user-defined process. When verification parameters are customized for a particular application, a system does not check barcodes for compliance to a published barcode quality standard. Instead, it provides objective measurements for barcode quality when verification to a standard is not possible or not desired. If you are not concerned with meeting published barcode quality standards in your application, you may opt to use a subset of the default verification parameters in the verification system as the criteria for passing codes.

True Verification: True verification ensures that a barcode complies with published barcode quality standards, such as ISO 15415, ISO 15416, and AIM DPM/ISO 29158. To ensure compliance, all evaluation parameters in the machine vision system must be enabled during the verification process. These verification systems provide reports as evidence of barcode compliance, which can be sent to customers or other invested parties to provide the highest assurance of barcode quality and consistency.

What Kind of Solution Is Required?

True barcode verification relies on machine vision software that has been programmed for standards-based verification using parameters specific to ISO or AIM barcode quality standards. For compliance with each standard, codes must meet the minimum passing requirements of each parameter. Some commercially-available programs such as Microscan's AutoVISION allow the user to disable or modify the passing criteria of these parameters, enabling custom verification. With less exacting hardware requirements, and a number of easy-to-integrate smart cameras available to do the job, this type of solution can be a cost-effective way to ensure readable codes when compliance with published standards is not needed.

Selecting the right light and camera combination is key to the success of the application once an appropriate software platform has been chosen. More precise quality grading requires a higher-performance hardware solution. A smart camera with integrated optics and lighting will often be suitable for custom verification; however, barcodes that must comply with published barcode quality standards must be verified by a system with superior optics and with complete and uniform lighting by an ISO/AIM-compliant light to produce an undistorted image.



Custom Verification:
Fully-Integrated Smart Camera Vision System with Adaptable Software for Custom Verification

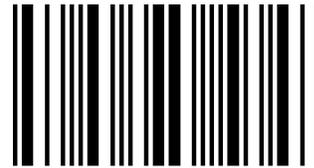
True Verification:
C-Mount Smart Camera Vision System with External Lighting and Standards-Based Verification Software

Verification Evaluation Parameters

There are a number of verification evaluation parameters that determine barcode quality and they may be used for either true or custom verification. Published barcode quality standards, such as ISO 15415, ISO 15416, and AIM DPM/ISO 29158, require that a designated set of these parameters be met to ensure that a barcode is verified to the standard, while custom grading may require that a barcode meet only a subset of these parameters. Parameters for 1D and 2D barcode evaluation are shown below.

1D Verification Evaluation Parameters

High Quality Symbol:



Parameter	Description	Example	ISO 15416
Decodability	Legibility per a reference decode algorithm		✓
Defects	VOIDS in bars or SPOTS in spaces		✓
Edge Determination	Detection of all bars and spaces using a global threshold		✓
Minimum Edge Contrast	Minimum reflectance difference for any bar/space combination		✓
Minimum Reflectance	Reflectance of the darkest bar and the lightest space		✓
Modulation	Relation between wide and narrow elements in the symbol		✓
Symbol Contrast	Difference in reflectance between the darkest bar and the lightest space		✓
Quiet Zone	Size of the quiet zone		✓

2D Verification Evaluation Parameters

High Quality Symbol:



Parameter	Description	Example	ISO 15415	AIM DPM
Axial Non-Uniformity	Amount of deviation along a symbol's major axes		✓	✓
Symbol Contrast	Difference in reflectance between light and dark symbol elements		✓	
Cell Contrast	Difference in grayscale value between light and dark symbol elements			✓
Modulation	Difference in reflectance of light and dark symbol elements		✓	
Cell Modulation	Deviation in grayscale values of symbol elements			✓
Decodability	Legibility per a reference decode algorithm		✓	✓
Fixed Pattern Damage	Damage to the quiet zone, finder pattern, or clock pattern		✓	✓
Grid Non-Uniformity	Amount of deviation of grid intersection		✓	✓
Minimum Reflectance	Minimum reflectance of light elements			✓

Parameter	Description	Example	ISO 15415	AIM DPM
Reflectance Margin	Degree to which each module is correctly distinguishable in comparison to the global threshold		✓	
Unused Error Correction	Remaining error correction available		✓	✓
Print Growth	Variation of element size that could impede readability	 		For Reference Only

Verification Grades

Barcodes are graded by verification equipment like barcode verifiers and machine vision systems, which assign values 0-4/A-F to the barcode for each of the above-listed evaluation parameters. A barcode's overall grade is determined by the worst result for each parameter, so the barcode is always as good as its poorest parameter. Typically, a barcode with a grade A, B, or C is considered acceptable quality, while a grade D or F signifies a poorly-marked or poorly-printed barcode. It is possible that a barcode with grade D or F may still be readable within a system using certain equipment, but without verification there is no guarantee that this same barcode will be readable at other points in the supply chain, by different equipment, or by end customers. By verifying barcodes to an agreed-upon barcode quality standard, such as those put forth by ISO or AIM, it is no longer a question of a barcode's readability, but rather of a particular reader's ability to read a certain grade.

Verification with AutoVISION®

Microscan's AutoVISION Machine Vision Software provides powerful tools for both text quality verification (Optical Character Verification or OCV) and barcode quality verification. Through its intuitive user interface, AutoVISION enables easy setup of both offline verification for random code and text quality checking and inline verification to verify quality as products are labeled and marked on the line. Using AutoVISION and high-performance smart cameras and lighting, a complete verification system can be implemented to determine barcode quality for both custom and true barcode verification, including conformance to three published barcode quality standards:



ISO 15416

ISO 15415

AIM DPM/ISO 29158

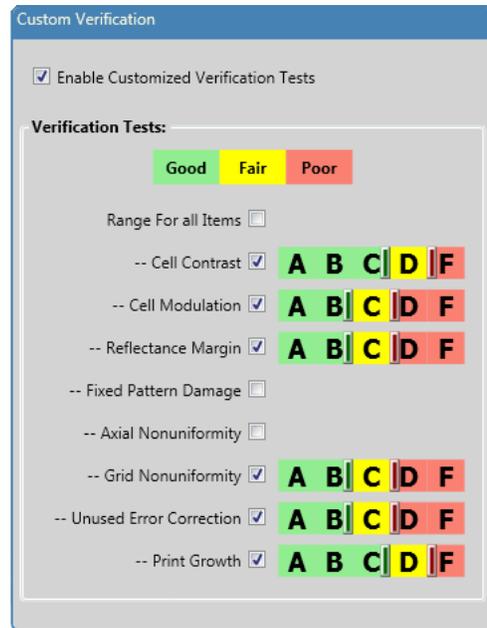
Clear and concise values are provided via the AutoVISION user interface to grade 1D and 2D barcodes for each parameter required by a barcode quality standard. AutoVISION assigns values 0-4/A-F to the barcode for each parameter and then the barcode receives an overall grade for meeting the standard.

Default parameters in AutoVISION are pre-set to grade barcodes against published barcode quality standards (ISO 15415, ISO 15416, and AIM DPM/ISO 26158), but can be adjusted in the AutoVISION Symbol Quality Verification Tool to enable custom grading to meet application-specific criteria only.

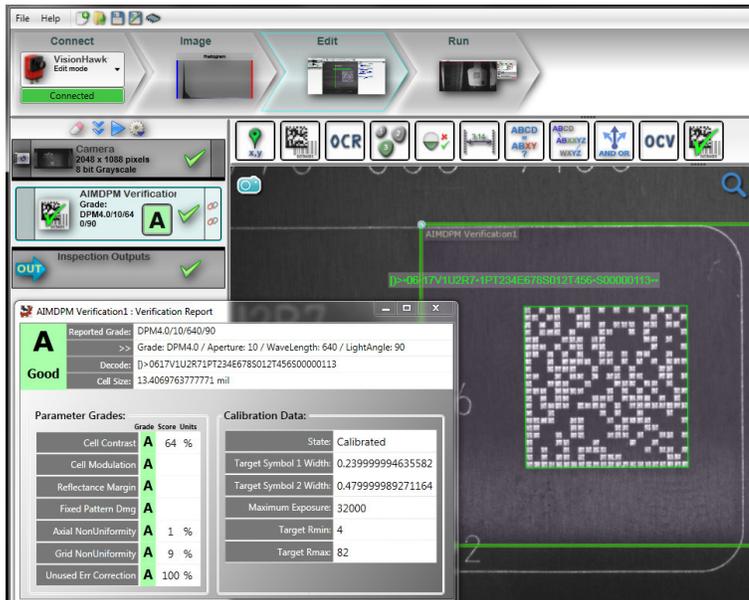
Microscan Meets Verification Needs

From 2D barcode verifiers to complete, scalable machine vision systems like AutoVISION, Microscan offers a range of products to ensure that automation systems operate at peak performance thanks to quality and compliant barcodes. For engineers tasked with meeting quality control or global standards in marking and labeling, Microscan provides project evaluations to find the right barcode verification solution for any project.

More Microscan product information and training resources are available at www.microscan.com.



Verification evaluation parameters are adjusted in the AutoVISION Symbol Quality Verification Tool to grade a barcode for custom verification.



A Data Matrix 2D barcode is verified against the AIM DPM quality standard using Microscan's AutoVISION machine vision software.

MICROSCAN®

www.microscan.com

North America (Corporate Headquarters)
 Email: info@microscan.com