OMRON

Easy to Read and Easy to Understand

Barcode Verifier

Technical Guide

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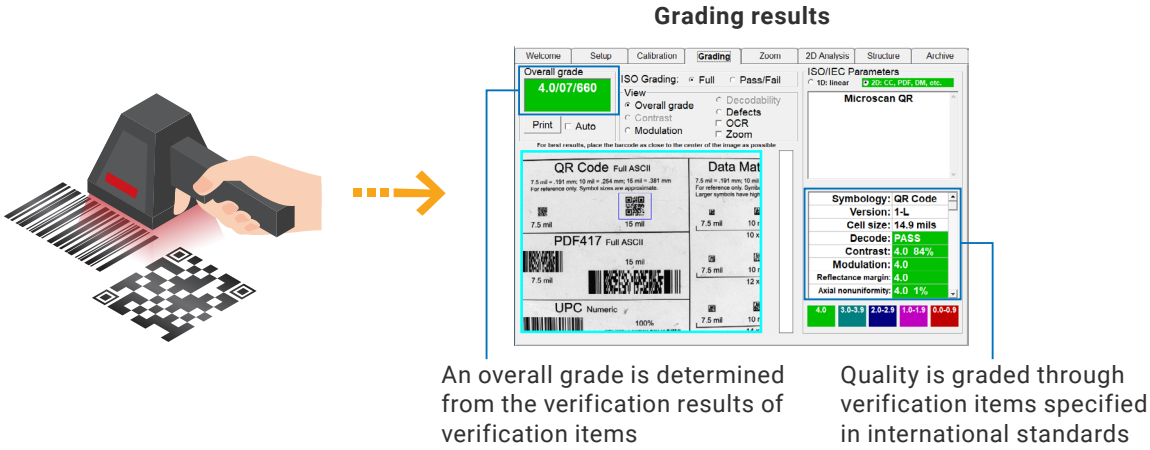
What is a barcode verifier?

Barcode verifiers are a barcode grading tool

Barcode verifiers grade barcodes by evaluating whether printed barcodes comply with applicable standards.
Barcode verifiers analyze barcode print quality from multiple points of views and manages the results numerically.
Print quality of a barcode is assigned an overall grade in the range of 0.0 to 4.0. A grade closer to 4.0 indicates a better quality.
Grades for quality regarded as acceptable in industries are generally specified by corresponding industry associations.



What barcode verifiers can do

Measure barcode mark/print quality to international standards

Barcode verifiers measure barcode marking/printing quality objectively (independent of readers and surroundings) in accordance with evaluation methods specified in international standards.

Analyze and grade barcode mark/print quality to international standards

Grading Parameters measured by a verifier, which helps identify what causes a print quality problem.

Difference between grading by barcode readers and verification by barcode verifiers

Some barcode readers provide grading of the print quality of barcodes they scan.
However, barcode readers do not comply with the standards for verification and can only perform relative evaluation, the results of which depend on the distance from the object and lighting conditions.
In addition, barcode readers are designed to try to read as many barcodes as possible. Therefore, they may well be able to read barcodes that are dirty or flawed to some extent. This poses a risk that a barcode may not be read successfully depending on readers and/or surroundings.

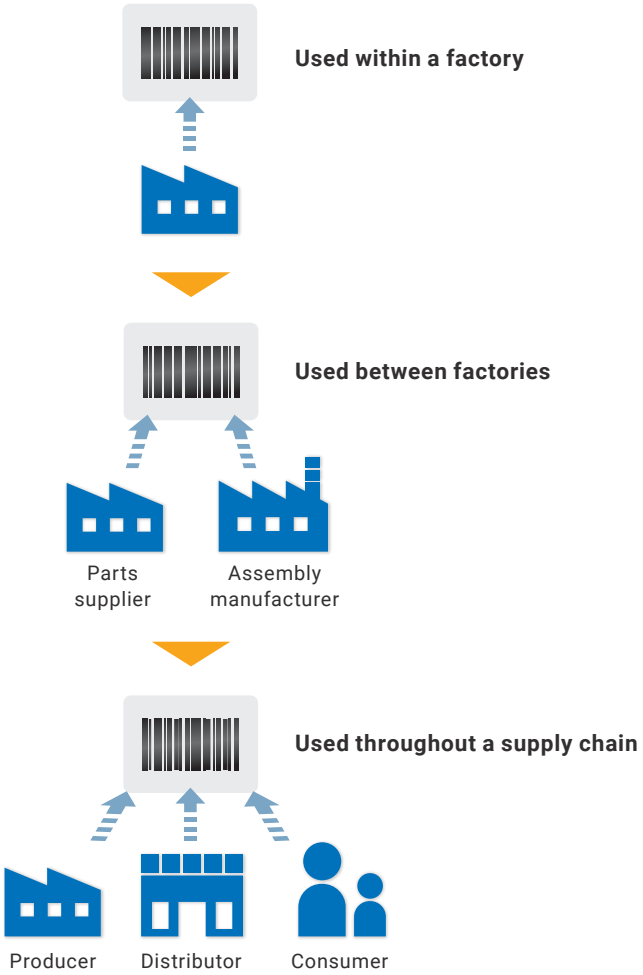
With barcode verifiers, it is possible to objectively evaluate whether print quality is satisfactory based on applicable standards, and the verification results can be used as evidence of the quality verification.

Factors driving the needs for barcode verifiers

Barcodes have so far played important roles in product traceability, and these days barcode printed/marking quality is rising as the barcodes are being utilized in more and more situations, making it necessary to take measures to mitigate impact of read errors. Print quality inspections in the barcode print process and in the parts acceptance process are implemented in various industries and for various production items. Barcode verifiers are attracting growing attention as a verification tool with high reliability required in those inspections.

Utilized in more and more situations

Processes where product information is managed or referenced through barcodes have expanded from manufacturing to distribution and consumption, driving the need to print scannable barcodes at any processes and maintain satisfactory print quality.



Growing needs in response to laws and regulations improvement

Because of increase in product recalls and medical mishaps, governments are drafting new laws, regulations, and standards are in progress in each country and industry.

Drug and Food

- Revision of Food Labeling Act requires allergen labeling
- FDA and Ministry of Health, Labour and Welfare notifications require the GS1 barcode

Barcodes are printed not only on carton boxes and shipping packaging, but also on individual packaging and sheets to tightly manage product information.

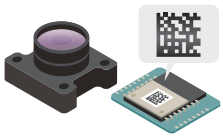
Automobile

- EV and ADAS safety requirements
- The IATF 16949 standards were established by European and American automotive manufacturers

The scope of parts to be managed with printed barcodes has expanded to brake parts and EV parts such as motors, inverters, and ECU.

Electronic device

- Conformance to EIA standards for installation of in-vehicle electrical equipment
- Expanding scope of electronic parts supplier control



Barcodes are printed on modules including onboard chips and sensors to make it possible to trace individual items.

Medical device

Conformance to UDI

To improve the safety and efficiency of medical services, more and more countries around the world are making it compulsory to identify and manage individual medical devices and tools with barcodes, and to register the data in databases.

Direct marking is required for steel tools, such as surgical scalpels, that are sterilized and cleaned for repeated use, and the UDI rules of the U.S. FDA require that direct marking be implemented gradually by 2022.

Physical distribution

Automation of transportation

With distribution networks expanding and distributed items increasing and diversifying, managing information with barcodes has become indispensable for efficient sorting of items, inventory control, and transportation with less human resources.

Problems caused by barcode quality defects

In everyday life, for example, a barcode read error at a checkout counter at a retail store will lead to time-wasting tasks, such as rescans and manual entry of a price with checking the item information.

As with the situation above, barcode read errors in a factory or a supply chain will lead to lower production efficiency, which could result in fines and penalties being put by a customer, brand image being damaged, or a more serious risk.

Specifically, the following consequences can result.

Example 1 Penalty due to returned goods

Barcodes that had been read successfully at the parts supplier could not be read during a check at the assembly manufacturer, and goods were returned.

The customer faces an unexpected cost as it is forced to manually enter parts information or to return goods to the supplier

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Decline in operating rate and revision of production plans results

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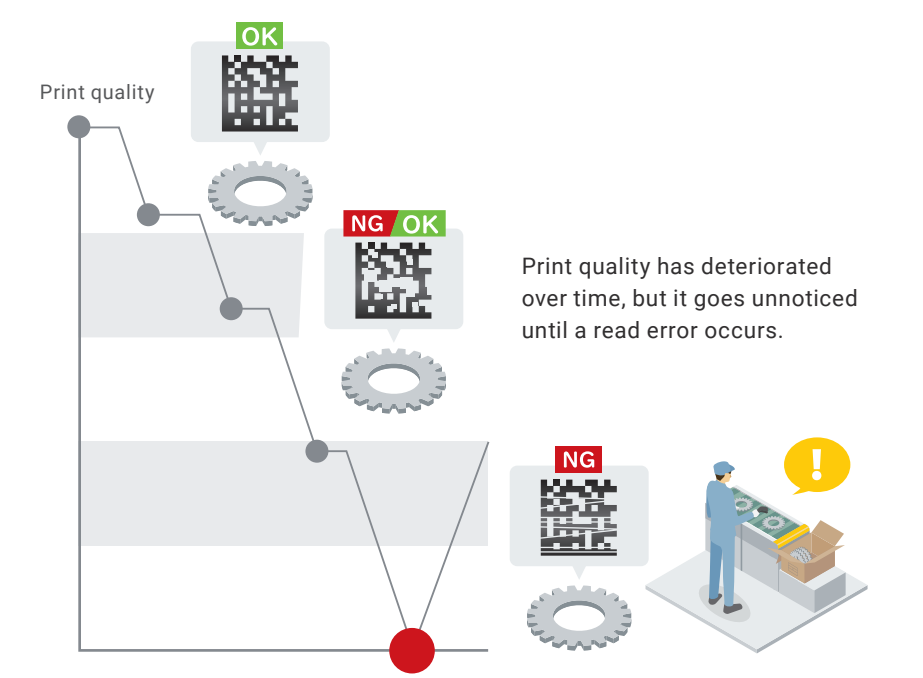
The parts supplier faces fines and penalties, brand image being damaged

Example 2 Loss of production/down time occurring



Deterioration of print quality goes unnoticed until a read error occurs

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Products with poor quality barcodes get into the production line

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Loss of production/down time increases

Barcode verifiers serve as a tool for quantifying the print quality of barcodes to prevent such troubles or help quickly identify the cause if such a problem occurs.

How does barcode verification work?

To ensure accurate verification results, it is important to achieve both a proper verification method and consistency in verification results.
The proper verification methods are specified in the print quality test specifications in ISO/IEC 15416, 15415, and 29158, and the consistency in verification results is provided in the verifier conformance specifications in ISO/IEC 15426-1 and 15426-2.
Barcode verifiers ensure the accuracy of verification results by performing verification in accordance with these international standards specifications.

Rules for grading barcode quality

Barcode grading results are calculated based on the print quality test specifications.
There are two types of grading available: overall grade and grade for each verification item.

Overall grade

Represents the verification result of barcode print quality numerically. (0.0 to 4.0)
Grades for quality regarded as acceptable in industries are generally specified by corresponding industry associations.
As an example, the following explains overall grades for verification items (ISO/IEC 15416) for linear barcodes printed on paper/labels.

3.5 to 4.0	Indicates the best read reliability. This grade should be applied to the following cases: • Barcode readers are only allowed to scan each barcode once • Using a fixed mount barcode reader that only has one scan line
2.5 to 3.4	With one scan line, barcodes may need to be rescanned.
1.5 to 2.4	Barcodes at this grade will require more rescans than those at 2.5 or higher. It is desirable to read barcodes at this grade under the conditions as given below: • Using a reader with multiple scan lines • Adopting a system design that performs rescan frequently
0.5 to 1.4	Whether scans will be successful or fail depends on the reader. A workaround, such as other means of data entry, must be prepared in case of scan failure. Before using barcodes at this grade, it is desirable to test whether they can be read.
< 0.4	It is highly likely that the barcodes cannot be read.

Grade for each verification item

Represents grading results for individual verification items provided in the print quality test specifications.
Verification items depend on the type of barcode and the printing method.

The following introduces typical barcode verification items and examples of barcodes that will result in an error in each verification.

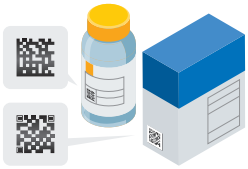
Verification items for linear barcodes printed on paper/labels (ISO/IEC 15416)

ISO/IEC 15416 is the standard for verification of linear barcodes printed on paper/labels.

Verification item	Description	Example of defect
Decode	Evaluates whether barcodes can be read by the algorithm provided in the symbology specifications.	
Symbol contrast	Evaluates the contrast between the bars and spaces by the difference between the maximum reflectance and the minimum reflectance. The larger the difference is, the higher the grade becomes.	
Minimum reflectance	Evaluates whether the reflectance of bars is small enough compared to the reflectance of spaces by the reflectance waveform. The smaller the minimum reflectance is compared to the maximum reflectance, the higher the grade becomes.	
Minimum edge contrast	Evaluates the contrast between spaces and their adjacent to neighboring bars by the difference in reflectance. The larger the difference is, the higher the grade becomes.	
Modulation	Evaluates the amount of variation in reflectance of bars and spaces. The more uniform the reflectances are across the barcode, the higher the grade becomes.	
Defects	Evaluates whether the bars and spaces are flawed or dirty. The more uniform the reflectances of the bars and spaces are, the higher the grade becomes.	
Decodability	Evaluates the actual widths of bars and spaces against the widths specified in the symbology specifications. The smaller the differences between the actual widths and the specified ones are, the easier the decoding is, and the higher the grade becomes.	

Verification items for 2D barcodes printed on paper/labels (ISO/IEC 15415)

ISO/IEC 15415 is the standard for verification of 2D barcodes printed on paper/labels.

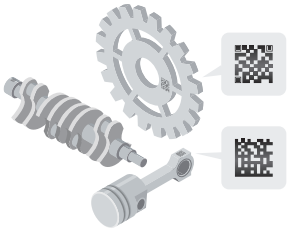


Verification item	Description	Example of defect	Data Matrix	QR Code
Decode	Evaluates whether barcodes can be read by the algorithm provided in the symbology specifications.		✓	✓
Symbol contrast	Evaluates the contrast between the cells by the difference between the maximum reflectance and the minimum reflectance. The larger the difference is, the higher the grade becomes.		✓	✓
Modulation	Evaluates the amount of variation in reflectance of light and dark cells. The more uniform the reflectances are, the higher the grade becomes.		✓	✓
Reflectance margin	Evaluates whether the cells are recognized correctly as dark or light cells.		✓	✓
Fixed pattern damage	Evaluates the amount of variation in reflectance of light and dark cells in the fixed patters (finder pattern, timing pattern, and quiet zone). The more uniform the reflectances are, the higher the grade becomes.		✓	✓
Axial non-uniformity	Evaluates the uniformity in ratio between the width and height of a barcode. The more uniform the ratio is and the squarer the shape is, the higher the grade becomes.		✓	✓
Grid non-uniformity	Evaluates the amount of deviation in barcode cell placement to a reference grid. The smaller the deviation is, the higher the grade becomes.		✓	✓
Unused error correction	Evaluates the amount of unused error correction codes* at decoding. The larger the amount is, the higher the grade becomes.		✓	✓
Format Information damage	Evaluates whether the format information of a QR code is dirty.	 (Imperfections highlighted in red)	-	✓

* The codes are provided to correct and recover the information in dirty or flawed cells.

Verification items for 2D Direct Part Marking (DPM) barcodes (ISO/IEC 29158)

ISO/IEC 29158 is the standard for verification of 2D Direct Part Marking (DPM) barcodes.



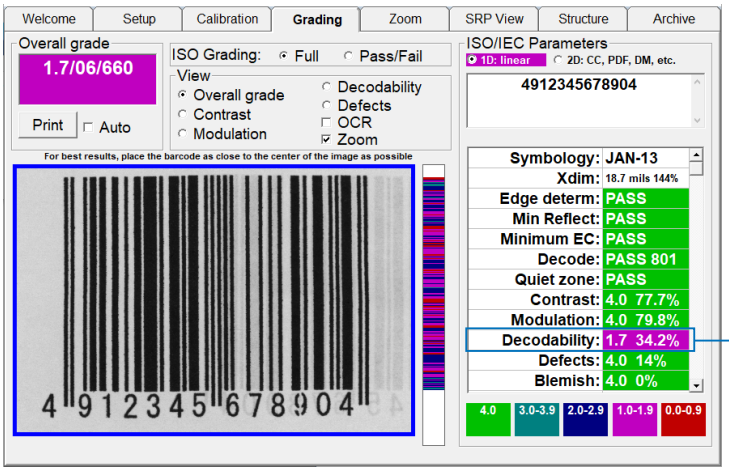
Verification item	Description	Example of defect	Data Matrix	QR Code
Decode	Evaluates whether barcodes can be read by the algorithm provided in the symbology specifications.		✓	✓
Cell contrast	Evaluates the contrast between the cells by the difference between the mean reflectance of dark cells and that of light cells. The larger the difference is, the higher the grade becomes.		✓	✓
Cell modulation	Evaluates the amount of variation in reflectance of light and dark cells. The more uniform the reflectances are, the higher the grade becomes.		✓	✓
Minimum reflectance	Evaluates whether light cells have sufficient reflectance. The larger the value is, the higher the grade becomes.		✓	✓
Fixed pattern damage	Evaluates the amount of variation in reflectance of light and dark cells in the fixed patters (finder pattern, timing pattern, and quiet zone). The more uniform the reflectances are, the higher the grade becomes.		✓	✓
Axial non-uniformity	Evaluates the uniformity in ratio between the width and height of a barcode. The more uniform the ratio is and the squarer the shape is, the higher the grade becomes.		✓	✓
Grid non-uniformity	Evaluates the amount of deviation in cell placement in a barcode to a grid. The smaller the deviation is, the higher the grade becomes.		✓	✓
Unused error correction	Evaluates the amount of unused error correction codes* at decoding. The larger the amount is, the higher the grade becomes.		✓	✓
Format Information damage	Evaluates whether the format information of a QR code is dirty.	 (Imperfections highlighted in red)	-	✓

* The codes are provided to correct and recover the information in dirty or flawed cells.

Examples of defect detected using barcode verification (For OMRON's LVS Barcode Verifiers)

Here are some examples of verification results indicating quality defects.

Example 1 Some of the bars are thinner than the criteria



(Verification standard: ISO/IEC 15416)

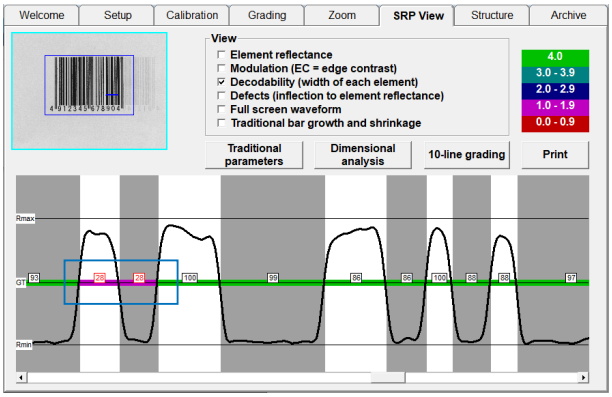
Error items

→ Possible cause of the quality defect

Incorrect printer settings for paper quality.

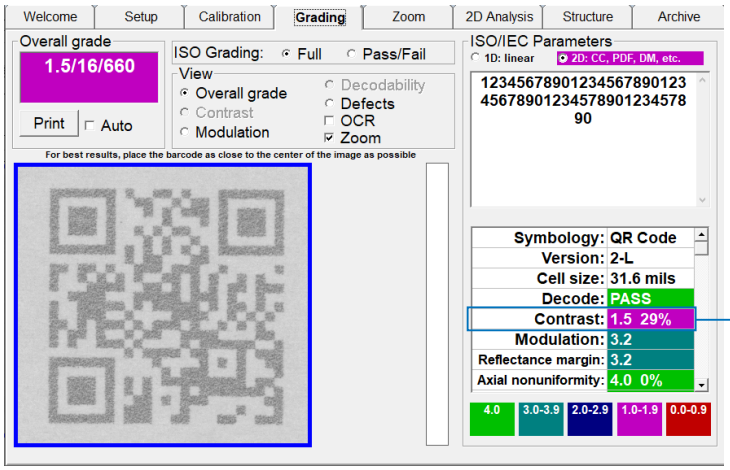
✓ To view the details in the LVS Series

Turning on [Decodability] in [Data Analysis] tab will bring the following window, which allows you to check grades for individual bars and spaces.



Bars and spaces with widths deviating from the criteria are given low grades. (Highlighted in blue)
The highlighted section indicates the cause of the quality defect.

Example 2 Cell contrast is low



(Verification standard: ISO/IEC 15415) Error items

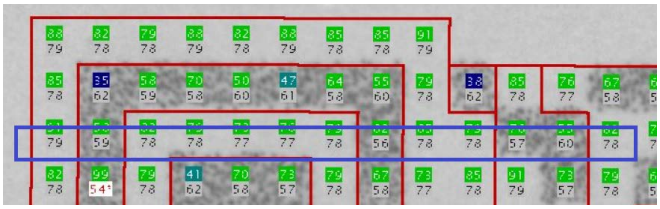
→ Possible cause of the quality defect

Print settings are incorrect.
The settings are not configured so as to provide sufficient contrast between light and dark cells.

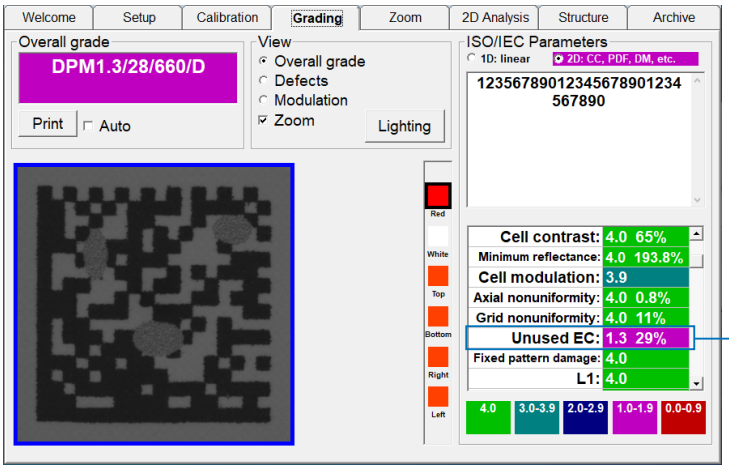
✓ To view the details in the LVS Series

Pressing [2D Analysis] tab will display the detailed analysis report, which allows you to check reflectance values of individual cells. (Highlighted in blue)

In this example, there is no remarkable difference in reflectance value between dark and light cells.



Example 3 A barcode is partially flawed



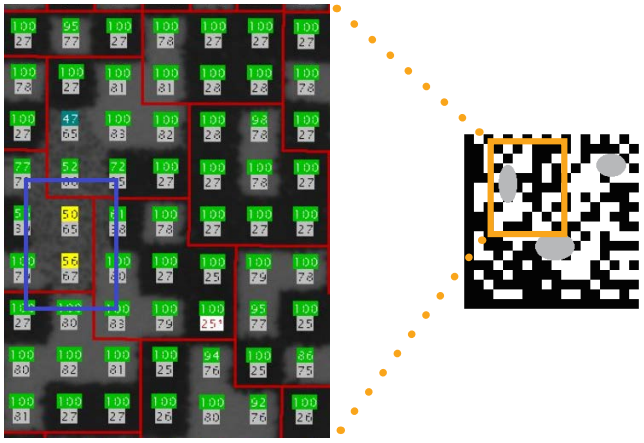
(Verification standard: ISO/IEC 29158) Error items

→ Possible cause of the quality defect

Dirt, such as oil and dust, is on the barcode.

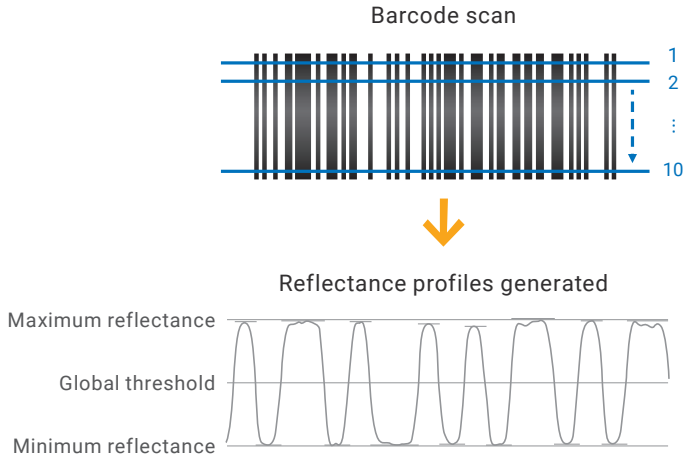
✓ To view the details in the LVS Series

Pressing the [2D Analysis] tab will display the detailed analysis report. A variable named Modulation indicates the local contrast problem.
In this example, the yellow elements indicate defective light cells recognized as dark cells, or vice versa.

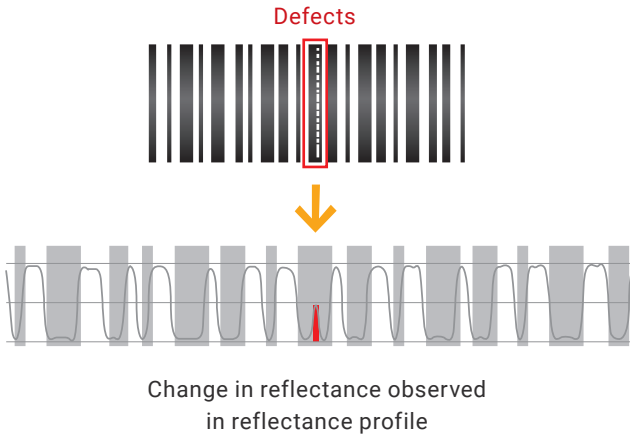


Verification principle

The following describes the verification principle by taking a linear barcode as an example. ISO/IEC 15416 specifies that ten scans of a linear barcode be performed to generate reflectance profiles based on which all verification items are evaluated.
The overall grade of the print quality is obtained by averaging the lowest overall grades at each scan.



Assume that there is one defect in a barcode. Of ten scan attempts, the reflectance of an attempt that scans the defect will change from that of the others. Observation of the change in reflectance leads to detection of the print quality problem, and results in a lower grade.

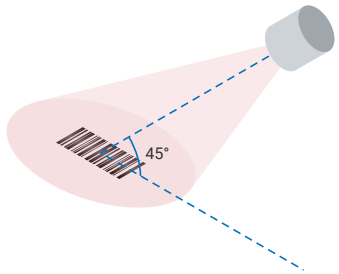


Optical arrangement

In addition to verification items, each standard specifies the angles of light sources to use in verification. Barcode verifiers are required to have specified light sources or to use an optical arrangement that is correlated with the specified optical arrangement in terms of performance. OMRON's LVS Barcode Verifiers feature the optical arrangement that meets this requirement thus can be used with confidence.

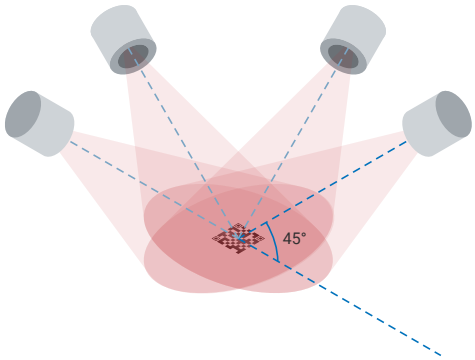
ISO/IEC 15416 (linear barcodes printed on paper/labels)

The standard specifies that a light source illuminate the target plane at an angle of 45° during verification.



ISO/IEC 15415 (2D barcodes printed on paper/labels)

The standard specifies that four light sources be used in verification and illuminate the target plane at an angle of 45°.
Although it is also possible to use an alternative optical arrangement that correlates to the specified optical arrangement in terms of performance, doing so makes it necessary to include the choice in the overall symbol grade report.



ISO/IEC 29158 (2D DPM barcodes)

- Diffuse dome light
  Non-directional light from a diffuse reflective dome.
  This is normally used for verification of curved parts.
- Perpendicular (90°) light
  Light the optical axis of which is at 90±15° to the plane of the target workpiece.
- N° directional light (four directions, two directions, one direction)
  Light the optical axis of which is in an oblique direction to the symbol surface. There is no specification for the illumination angle. The direction and angle of light used must be included in the verification result.

OMRON's LVS Barcode Verifiers support diffuse dome light and 30° light (four directions, two directions, one direction).

Accuracy criteria for verifiers

Functional requirements regarding the accuracy criteria for verifiers are specified in the verifier conformance specifications such as ISO/IEC 15426-1.
Regular calibration of a verifier makes sure that the device always conforms to the standards, and ensures the accuracy of the verifier.

Calibration method

Omron verifiers use the cards shown as calibration cards.
Printed on the cards are barcodes that give specific measurement values (reflectance, etc.), and verifiers are calibrated so that measurement values obtained from verifying the barcodes will be within acceptable ranges.

Replacement of calibration cards

Calibration cards must be replaced every two years.
Store them in a clean place away from direct sunlight, and replace a card with a new one if it is scratched, dirty, or damaged.

Standards regarding barcode verification

Standards regarding verification methods

To ensure the accuracy of barcode verification, the standards provide print quality test specifications and verifier conformance specifications.
Barcode verifiers are required to comply with the standards.

Print quality test specifications

The specifications primarily provide verification items needed for verification, and grade calculation methods for each item.
The specifications also provide strict hardware conditions such as lighting angles.

Verifier conformance specifications

It is a standard that defines functions required to have adequate accuracy as verifies and the implementation of calibration.

Standards applicable to barcodes

Symbology specifications

Symbology specifications defines symbol characteristics, such as shapes, dimensions, and digits, and encoding/decoding methods.
Symbology specifications are referenced to create barcodes correctly as specified.

Example ISO/IEC 16022

DataMatrix symbology specification.

Example ISO/IEC 18004

QR code symbology specification.

Application specifications

This document provides formats of barcodes used in specific industries and applications. Various industries establish their own standards for various applications, including military uses, medical treatment, air transport, trucking, and retailing.

Example GS1 General Specifications

This document provides the specifications of barcodes that hold attribute information necessary for world-wide distributing products, such as date of manufacture, expiration date, lot number, and serial number.

Information that is encoded in accordance with the specifications can be appropriately read with a device that supports the specifications.

Example Guidelines for Bar Code Labeling on Prescription Drugs

The guidelines were developed by The Federation of Pharmaceutical Manufacturers' Associations of Japan (FPMAJ) in response to the notification of Practice of Bar Code Labeling on Prescription Drugs issued by Ministry of Health, Labour and Welfare (MHLW) in 2006 to prevent drug mix-up accidents due to similarity in drug names and appearances.

The notification issued by MHLW requires barcode labeling on each drug packaging unit to show the product code, expiration date, quantity, and serial number as well as use of GS1 DataBar instead of the JAN code or ITF code, and the guidelines from FPMAJ provide specific introduction methods for new barcodes.

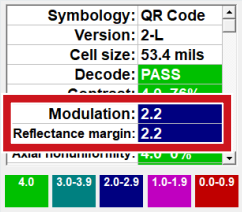
Benefits from introducing barcode verifiers

Example 1:
The verifier makes the analysis possible that led to goods being returned

Goods were returned because of quality defects of printed barcodes.
You want to identify the cause as soon as possible.

The grading results for individual verification items will help identify causes of defects.

The grading results make it possible to distinguish items with low grades and help to quickly isolate causes of quality defects.



Items resulting in errors are displayed in different colors

Also, in cases where you have trouble in identifying whether a quality defect is attributed to print quality or the read performance of a barcode reader, a barcode verifier helps you pinpoint the cause by checking print quality objectively.

Portable verifiers enables performing verification anywhere.

Portable barcode verifiers are compact and easy to carry around.

It is possible to verify the print quality of the barcode on the returned goods on the spot without moving them.

OMRON offers a lineup of portable barcode verifiers: LVS-9580/9585 Series. (▶P.24)

Example 2:
Quick determination of marking conditions and check of print quality for newly introduced markers

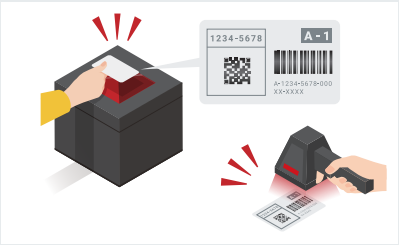
It is time consuming to determine marking conditions for newly introduced marking devices.
It does not eliminate concern about printing quality to just perform read test with barcode readers after introducing the markers.

Barcode verifiers provide print quality verification complying with international standards.

Unlike barcode readers which may provide unstable result of read tests depending on the devices and surroundings, barcode verifiers can evaluate print quality accurately in accordance with the internationally standardized verification methods.

The verification results with barcode verifiers enables completing a time-consuming marking condition determination quickly. Furthermore, adjusting the conditions for a certain level of print quality at the stage of test marking achieves stable reading at post processes, which will prevent loss of production.

The Multi-Sector Verification software upgrade option for OMRON's LVS Series (▶P.24) enables verifying multiple barcodes on a label at once.



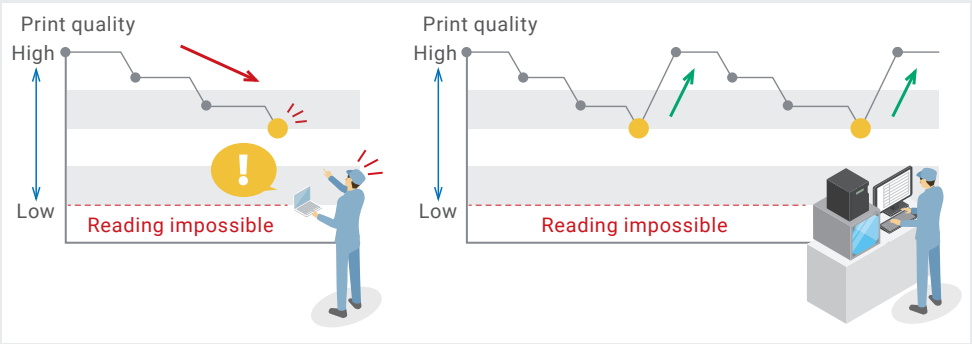
Example 3:
Predictive maintenance of marking devices

You want to prevent sudden barcode read errors to eliminate down time.

Regularly checking print quality for changes makes it possible to detect signs of deterioration in print quality.

Using barcode verifiers at the start/end of production or in regular sampling inspection enables monitoring changes in print quality.

You can prevent read errors by adjusting marking conditions upon detection of signs of quality deterioration.



Example 4:
Automatic generation of quality verification reports for delivery

You want to save verification results as quality reports for delivery or quality verification records.

The report export feature allows saving verification results.

The feature exports verification results to a file as verification evidence.

It is possible to complete the processes from verification to export of reports in several minutes, which speeds up reporting work, such as analysis of defect causes and preparation of reports, that has typically taken hours.

OMRON's LVS Series allows selecting a file format from HTML and CSV (vertical bar separated). (▶P.25)

OMRON's barcode verifiers

LVS Barcode Verifiers

This series verifies almost all linear and 2D barcodes printed on paper/labels or marked directly on parts.
The series enables off-line barcode verification to GS1, HIBC, USPS, ISO/IEC 15415/15416, etc.

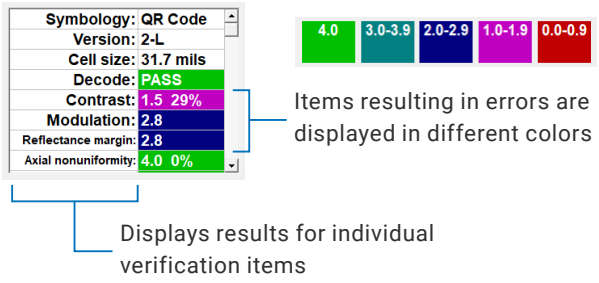
The LVS Series is available in desktop and portable types.

Desktop type	Portable type	
LVS-9510 series (for paper/labels)	**LVS-9580 series** (for paper/labels)	**LVS-9585 series** (for DPM)
		
Mounted on a table top. Verifies a barcode on an object put on the top viewing window.	Compact, lightweight handheld units. Can be connected to the tablets running Windows OS.	

Features of the LVS Series

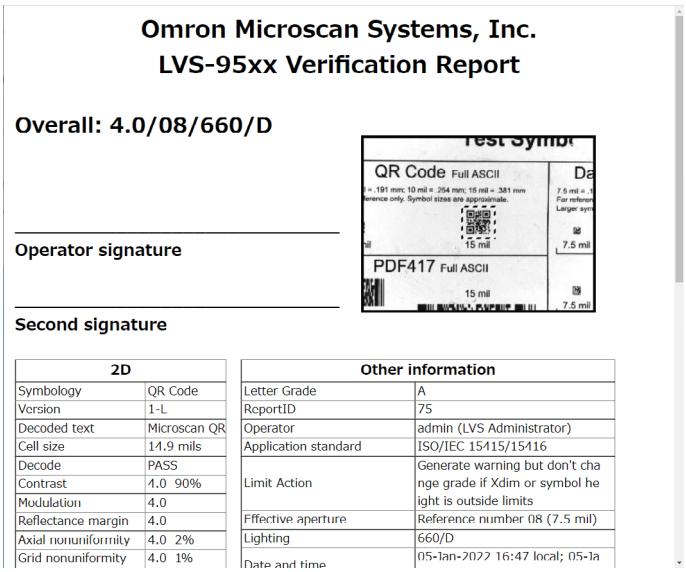
Detailed Analysis

Displays barcode verification results of individual verification items in colors.
This helps to quickly identify causes of quality defects.



Report Export

Exports verification results to an external file.
The file format can be selected from HTML and CSV. The former is for visual check and the latter for saving logs.
Use exported files as quality reports for delivery or store them in a server as evidence.



Omron Microscan Systems, Inc.
LVS-95xx Verification Report

Overall: 4.0/08/660/D

Operator signature

Second signature

2D	
Symbology	QR Code
Version	1-L
Decoded text	Microscan QR
Cell size	14.9 mils
Decode	PASS
Contrast	4.0 90%
Modulation	4.0
Reflectance margin	4.0
Axial nonuniformity	4.0 2%
Grid nonuniformity	4.0 1%

Other information	
Letter Grade	A
ReportID	75
Operator	admin (LVS Administrator)
Application standard	ISO/IEC 15415/15416
Limit Action	Generate warning but don't change grade if Xdim or symbol height is outside limits
Effective aperture	Reference number 08 (7.5 mil)
Lighting	660/D
Date and time	05-Jan-2022 16:47 local; 05-Ja

(Example: HTML format report)

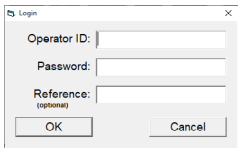
User Administration/Audit Trail features for compliance with FDA 21 CFR Part11

FDA CFR 21 Part11, established by the U.S. Food and Drug Administration (FDA), provides regulations to prevent falsification of electronic records and electronic signatures. This standard applies to drug/medical device manufacturers, organizations entrusted with analysis from the manufactures, and raw material suppliers.
Digitizing development/production-related records that are required to be submitted to FDA requires that the regulations be complied with throughout relevant manufacturing processes, and the LVS Series provides the features for compliance with the regulations.

User Administration

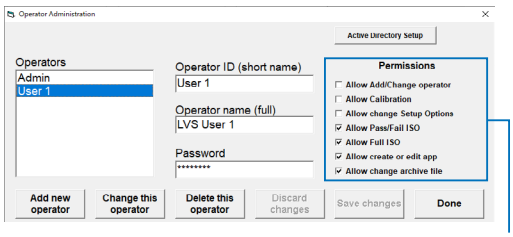
Controls access by requesting users to enter user names and passwords for system login.
User-based assignment of operation authorities is also possible.

Login window



Login requires an ID and password

User administration window



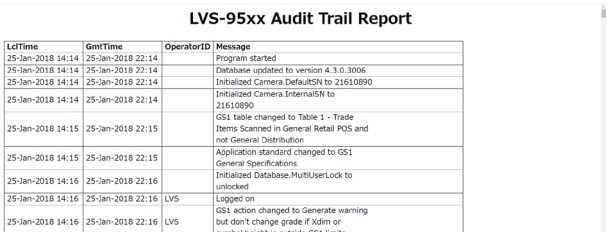
User-based authority assignment is possible

Audit Trail

Stores records of operations that users performed to make changes to the system as audit logs.

The records of changes can be stored in a database.

Operation history



LVS-95xx Audit Trail Report

LclTime	GmtTime	OperatorID	Message
25-Jan-2018 14:14	25-Jan-2018 22:14		Program started
25-Jan-2018 14:14	25-Jan-2018 22:14		Database updated to version 4.3.0.3006
25-Jan-2018 14:14	25-Jan-2018 22:14		Initialized Camera.DefaultSN to 21610890
25-Jan-2018 14:14	25-Jan-2018 22:14		Initialized Camera.InternalSN to 21610890
25-Jan-2018 14:15	25-Jan-2018 22:15		GS1 table changed to Table 1 - Trade Items Scanned in General Retail POS and not General Distribution
25-Jan-2018 14:15	25-Jan-2018 22:15		Application standard changed to GS1 General Specifications
25-Jan-2018 14:16	25-Jan-2018 22:16		Initialized Database.MultiUserLock to unlocked
25-Jan-2018 14:16	25-Jan-2018 22:16	LVS	Logged on
25-Jan-2018 14:16	25-Jan-2018 22:16	LVS	GS1 action changed to Generate warning but don't change grade if Xdim or

Records are stored in a database