INTERNATIONAL STANDARD

ISO/IEC 16480

First edition
2015-08-15

Information technology — Automatic identification and data capture techniques — Reading and display of ORM by mobile devices

Technologies de l'information — Techniques automatiques d'identification et capture de données — Lecture et affichage de l'ORM par dispositifs mobiles

Reference number
ISO/IEC 16480:2015(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Introduction

This is a technical engineering document intended for verifier manufacturers and application specification developers for two distinct scanning environments. One is when a bar code is sent to a mobile device or other display device (MQR) for reading by a bar code scanner (generally used for personal applications such as access control and coupons). The other is when a mobile device is used to read a bar code (MBR) with its internal photographic camera from a printed or electronically displayed symbol (generally used for advertising where the mobile device runs an application to access the internet).

Information technology — Automatic identification and data capture techniques — Reading and display of ORM by mobile devices

1 Scope

This International Standard specifies a method to assess the symbol quality rendered on electronic displays (i.e. the symbol produces its own light) when the reading device is a two-dimensional bar code imager.

In addition, this international standard specifies a method to assess the quality of symbols that are intended to be read with general-purpose cameras in ambient lighting conditions.

Further, this international standard describes modifications, which are to be considered in conjunction with the symbol quality methodology when applied to a particular symbology specification as defined in ISO/IEC 15415 and ISO/IEC 15416. It defines alternative illumination conditions, display pixel conditions and the reporting of the grading results. This document also describes appropriate ranges of symbol X-dimensions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 15415, *Information technology — Automatic identification and data capture techniques — Bar code symbol print quality test specification — Two-dimensional symbols*

ISO/IEC 15416, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols*

ISO/IEC 19762, *Information technology — Automatic identification and data capture techniques — Harmonized vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 and the following apply.

3.1
MQR
application environment where a bar code symbol is rendered on an electronic display such as found on a typical mobile device and is intended to be read by a bar code scanner

Note 1 to entry: MQR is not an acronym.

3.2
MBR
application environment where a bar code symbol is intended to be read with a general-purpose camera such as that found on a typical mobile device in ambient lighting conditions

Note 1 to entry: MBR is not an acronym.

4 Symbols and abbreviated terms

L	Luminance
Navg	Average noise (used to calculate QZN)
QZN	Quiet Zone Noise

5 Requirements

5.1 Symbol quality produced on electronic displays (MQR)

Bar code symbols are displayed on mobile device screens, generally, with device-owner specific information. See Figure 1.

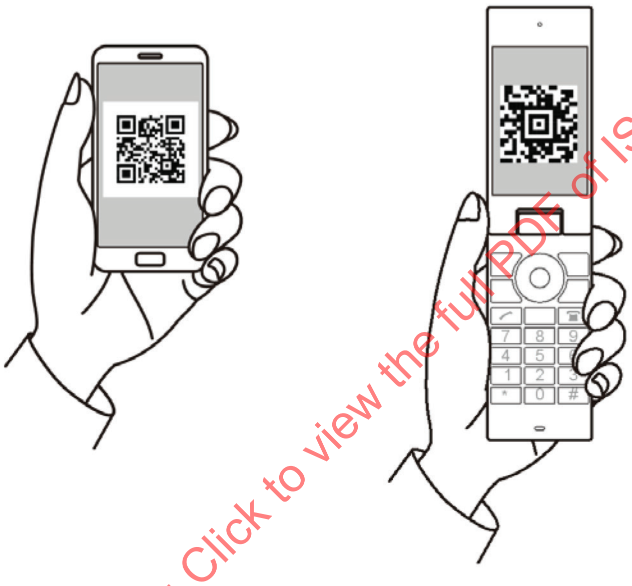

Figure 1 — Symbol displayed on mobile devices

Figure 1 shows a bar code symbol sent to a mobile device typically via the internet containing owner-specific information. The symbol is intended to be presented to an imager and read with the light produced by the mobile device.

Bar code symbols produced on electronic displays, generally, are constructed with pixels that emit light and pixels that block the light. See Figure 2.

Figure 2 — Magnified portion of Figure 1

NOTE Figure 2 shows a magnified portion of the bar code displayed on the screen (see Figure 1) of a mobile device showing the individual pixels of the screen.

5.1.1 Reading and illumination conditions

Generally, mobile devices do not have a diffuse reflective surface. Therefore it is generally not successful to attempt to read the bar code with a flying spot device (e.g. a visible laser beam).

Generally, mobile devices have a flat polished screen surface (e.g. glass) that is highly reflective. Consequently it is not generally appropriate for a bar code scanning device to illuminate the surface. In addition, generally, the only type of scanning devices capable of reading images produced on mobile devices contains linear or area sensors or arrays and are sometimes called “linear imagers”, “2D imagers” or simply “imagers”.

Generally, mobile devices produce light (i.e. backlighting) that is used directly by imagers to read symbols on the screen. The amount of backlight produced is called Luminescence. Luminescence is measured with an optometer (luminance-meter) set to the units candelas per metre squared (cd/m^2). The optometer shall be configured so that the only light collected is from pixels on the display at their maximum output.

Mobile devices should produce background illumination of greater than 90 cd/m^2 for dependable scanner performance. Displays with illumination less than 40 cd/m^2 may not be readable by some scanners.

5.1.2 Display pixel conditions

The pixels on a mobile device screen should be controlled directly and individually in order to produce a readable symbol. Specifically a black module should be rendered with exactly the same number of pixels as what would be a white module of the same size.

For instance, in Figure 2 above, the smallest black module is made up of an array of four by four pixels that have been directly controlled to exclude the background light. Similarly, precisely the same array of pixels is left open to produce a bright module.

5.1.3 Appropriate range of symbol X-dimensions

The X-dimension of a bar code symbol on a mobile device screen is the physical size of an individual pixel times the number of pixels per module. An alternate way to calculate the X-dimension is to measure the size of many modules and divide by the number of modules (often referred to as the Z-dimension). See Figure 3.

Figure 3 — Example method of calculating 2D symbol Z-dimension on mobile device screen

NOTE There are 32 modules in 10 mm (0,4 in) (between the “1” and the “5”). Therefore the Z-dimension is 0,3 mm (0,012 5 in or equivalently 12,5 mils). Therefore, the module size on this display is too small.

The appropriate range of X-dimensions for bar code symbol rendered on the display of a mobile device is 0,38 mm to 0,63 mm (0,015 in to 0,025 in).

5.1.4 Capturing an image

To capture an image for quality analysis, use a verification device that has its lights turned off or which does not have auxiliary lighting. The image should be taken in ambient lighting conditions. The image time should be such that the white areas reach between 70 and 85 percent of image sensor saturation.

5.1.5 Grading an image

5.1.5.1 Relation to 15415 and 15416

For 2D bar code symbol quality analysis, the methods of ISO/IEC 15415 shall be used with the exception that R_{max} is set to 90 % and Symbol Contrast is not graded or reported. A synthetic aperture of 0,38 mm (15 mils) shall be used to process the image to produce the reference gray scale image. The aperture size used for grading is 0,25 mm (10 mils).

While less common, if the symbol is a linear bar code, then the methods of ISO/IEC 15416 shall be used except that the scan reflectance profile set is produced in software from an image using an aperture size that is 80 % of the symbol X-dimension with R_{max} set to 90 % and Symbol Contrast not graded or reported.

5.1.5.2 Luminescence

Luminescence is graded per Table 1.

Table 1 — Luminescence grading

Luminance cd/m^2	Grade
≥ 70	4,0
60	3,0
50	2,0
40	1,0
< 40	0

5.1.5.3 Z-dimension

In addition, the Z-dimension of the symbol is calculated and reported.

A symbol is non-conforming if the measured Z-dimension is less than 0,35 mm (0,014 in) or greater than 0,65 mm (0,026 in). This allows a small tolerance on the measurement of the limits set in 5.1.3.

5.1.5.4 Quiet Zone Noise (QZN)

Evaluate the quiet zone noise (QZN) by calculating the variation in the quiet zone area as a ratio to the contrast in the symbol area. For symbologies without a defined QZ, QZN = 0.

In the reference gray-scale image, set four test lines which are the lesser of 0,5 of the QZ or two modules away from the symbol side forming a perimeter. For each test line, find the difference between the average of the lightest 10 % and the average of the darkest 10 % of the values along those lines. Navg is the largest of the differences found in any of the four test lines.

In the reference gray-scale image of the symbol area (excluding quiet zones), select the darkest 10 % and the lightest 10 % of the values. Cavg is the difference between the average of the selected light values and the average of the selected dark values.

QZN = Navg/Cavg. See Figure 4.

Figure 4 — Evaluating quiet zone noise

Quiet zone noise is graded per Table 2.

Table 2 — Quiet zone noise grading

Quiet Zone Noise	Grade
QZN ≤ 0,25	4,0 (A)
QZN ≤ 0,30	3,0 (B)
QZN ≤ 0,35	2,0 (C)
QZN ≤ 0,40	1,0 (D)
QZN > 0,40	0,0 (F)

Table 3 summarizes the test parameters and grade levels for MQR.

Table 3 — MQR test parameters and values

Parameter Grade	Decode Symbol	Luminance cd/m²	Fixed Pattern Damage	Axial Non-uniformity	Grid Non-uniformity	Modulation (interim values)	Unused Error Correction	Quiet Zone Noise
4,0 (A)	Passes	$L \geq 70$	See symbology specification	AN ≤ 0,06	GN ≤ 0,38	See ISO/IEC 15415	UEC ≥ 0,62	QZN ≤ 0,25
3,0 (B)		$L \geq 60$		AN ≤ 0,08	GN ≤ 0,50		UEC ≥ 0,50	QZN ≤ 0,30
2,0 (C)		$L \geq 50$		AN ≤ 0,10	GN ≤ 0,63		UEC ≥ 0,37	QZN ≤ 0,35
1,0 (D)		$L \geq 40$		AN ≤ 0,12	GN ≤ 0,75		UEC ≥ 0,25	QZN ≤ 0,40
0,0 (F)	Fails	$L < 40$		AN > 0,12	GN > 0,75		UEC < 0,25	QZN > 0,40

5.1.6 Reporting the grading results

The grade shall be reported with the prefix (MQR) followed by the formal grade in accordance with 15415 or 15416. In addition, the Z-dimension of the symbol is reported. For example, a grade might be MQR/2,8/10/N (Z = 0,4 mm) where the "N" means that there was no light used in the verification process and (0,4 mm) is the Z-dimension. The verification process does not illuminate the display, rather the light coming from the display is used to make the image.

5.2 Quality of symbols that are intended to be read with general-purpose cameras in ambient lighting conditions (MBR)

2D bar code symbols produced with the intention of being read by the cameras of mobile devices are generally printed symbols and in that regard, they are no different from symbols intended to be read by dedicated bar code scanners. However, generally, mobile devices do not have auxiliary lighting so the bar code symbols need to have high visual contrast. In addition, mobile device cameras are generally designed to take photographs of objects at a distance (e.g. people, scenery) and as such are not typically able to image clearly the small X-dimensions found in many bar code applications.

Producers of 1D bar code symbols should follow the relevant application standards that utilize ISO/IEC 15416.

5.2.1 Reading and illumination conditions

For the purposes of grading the bar code symbol intended to be read with a mobile device, three reading environments are defined.

MBR1 - the symbol is included in reading material of approximate A4 size or less (e.g. magazine, a shelf rack) and is intended to be read at close range (~ 25 cm). See Figure 5.

Figure 5 — Examples of MBR symbols incorporated into printed matter

MBR2 - The symbol is included as part of a display on the order of a metre in size (e.g. a poster) and is intended to be read at medium range (~ 3 m). See Figure 6.

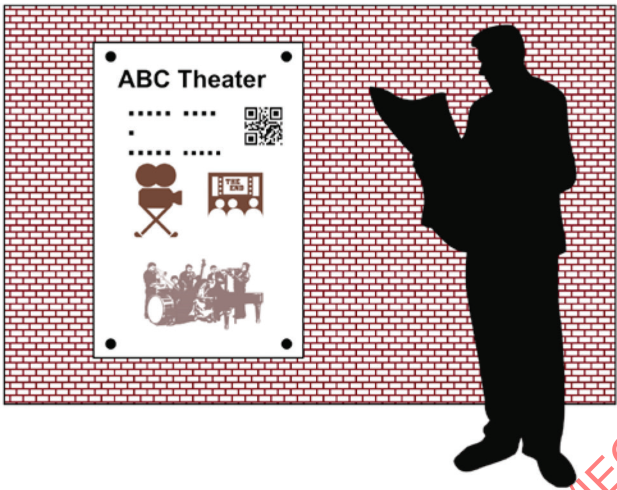

Figure 6 — Example of symbol as part of a display

MBR3 - The symbol is included as part of a large graphic on the order of 10 m in size (e.g. a billboard) and is intended to be read from far away (~15 m). See Figure 7.

Figure 7 — Example of a symbol displayed on a billboard

Generally, MBR1 and MBR2 symbols are located in artificial lighting and MBR3 symbols are located in outdoor lighting, but in all cases the lighting is broad spectrum, white light.

5.2.2 Appropriate ranges of symbol X-dimensions

— MBR1: 0,5 mm up to 1,25 mm (0,02 in to 0,05 in)

— MBR2: > 1,25 mm up to 12,5 mm (0,05 in to 0,5 in)

— MBR3: > 12,5 mm (>0,5 in)

Mobile device cameras and optics continue to improve. Some devices will be capable of reading X-dimensions smaller than 20 mils. This recommendation is made based on consumer grade mobile device testing at the time of development of this standard. Future standards may include applications with smaller X-dimensions.

5.2.3 X-dimension recommendation (MBR2 and MBR3)

When making a symbol to be able to be read from a given distance, use the following graph (or equation) to determine the minimum X-dimension for the symbol.

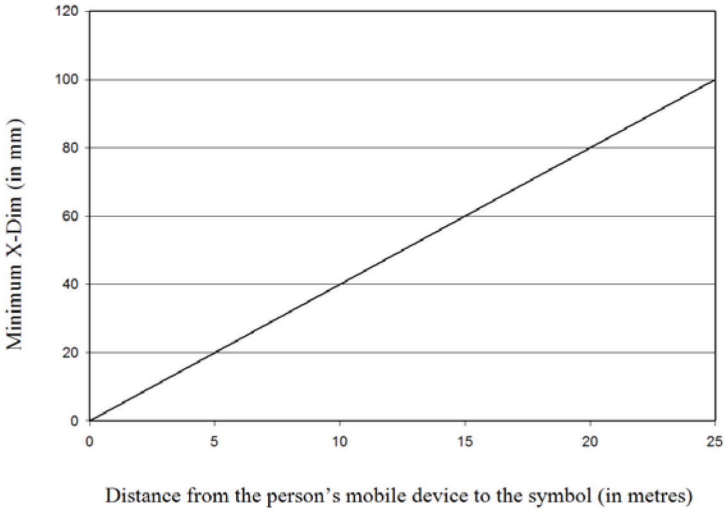

Figure 8 — Symbol X-dimension as a function of distance

Equivalently in equation form (and for distances beyond those displayed in the graph):

$X_{mm} = \mathrm{Dist}_m \times 4$

or

$\mathrm{Dist}_m = 0{,}25X_{mm}$

NOTE If possible, use an X-dimension larger than indicated by the formula.

5.2.4 Reading angle recommendation (MBR3)

Reading a symbol at an angle can cause distortion that is problematic to some mobile devices. For MBR3 symbols, placing the symbol at a point relative to the mobile device that is a small angle (e.g. less than 20°) will increase the likelihood the symbol will be readable. For example, see Figure 9.

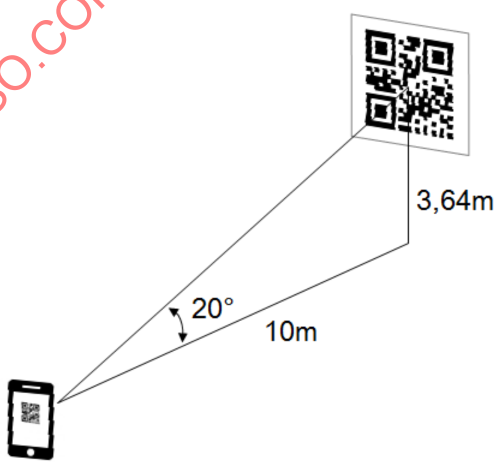

Figure 9 — Reading angle recommendation

5.2.5 Verifier setup

5.2.5.1 MBR1

MBR1 symbols should be imaged with a conventional 2D verifier using white light at 45° with adequate field of view for the symbol.

The aperture size used for grading is 0,25 mm (10 mils).

5.2.5.2 MBR2

MBR2 symbols may require special fixturing to hold the verifier and symbol still relative to one another. Symbols should be imaged with a conventional 2D verifier using white light at 45° with adequate field of view for the symbol.

The aperture size used for grading is 0,5 mm (20 mils).

5.2.5.3 MBR3

MBR3 symbols are verified in two steps.

Step 1 - Print the symbol at a much smaller X-dimension (from the original artwork or from a photo of the full-size symbol) as an MBR1 symbol and confirm correct encodation.

Step 2 - The R_{max}, R_{min} and the Symbol Contrast are measured over a small piece of the symbol using a reflectometer or the reflectometer mode of a verifier. The X-dimension is measured by hand with a ruler. The X-dimension of the light modules should be equal to the dark modules to ±10 %.

5.2.6 Symbol graphics

Putting a graphic (e.g. a logo) inside a symbol will reduce the ability to read in the presence of symbol damage. Symbols with graphics shall pass the print quality parameter “unused error correction”. Some symbologies support the ability to increase the amount of encoded error correction to accommodate this parameter. Designers of symbols with graphics should encode the symbol with a high enough error correction level to pass the print quality specification. Any graphics or logos inside the symbol shall not infringe on the fixed patterns.

5.2.7 Quiet zone

For MBR applications, the boundary of a symbol should be defined with the smaller of 1X quiet zone or the quiet zone defined in the symbology specification. All grading parameters (e.g. Symbol Contrast, Fixed Pattern Damage) should be modified according to the boundary of the symbol.

5.2.8 Grading an image

5.2.8.1 Scanning environment

Measuring the print quality of a symbol is intended to help ensure readability in a scanning environment. For MBR scanning, ambient light is used so any printing colour combination that produces contrast is acceptable. Consequently, white light is specified as a verification colour.

There are many existing verifiers that use red light. If a symbol passes using red light it will be scannable with mobile device cameras in ambient lighting so verification with red light is acceptable as an alternative to white light.

However, symbols that are intended to be read by both mobile device cameras and dedicated bar code scanners with red light illumination should be evaluated only with red light (e.g. 660 nm). For example, a symbol printed with red ink on white paper will appropriately fail verification at 660 nm indicating it will likely not be scannable by some scanners in the mixed scanning environment.

5.2.8.2 MBR1

Symbols are graded using ISO/IEC 15415 and should be equal to or better than either of the following grades 2,0/10/W or 2,0/10/660.

5.2.8.3 MBR2

Symbols are graded using ISO/IEC 15415 and should be equal to or better than either of the following grades 2,0/20/W or 2,0/20/660.

5.2.8.4 MBR3

Symbols are graded using ISO/IEC 15415 for all parameters except that R_{max} and R_{min} are the values determined in 5.2.5.3. The resulting parameters are graded using ISO/IEC 15415 and should be equal to or better than 2,0/10/W. In addition, grade the measured X-dimension variability as follows. See Table 4.

Table 4 — Measured X-dimension variability

Variability	Grade
< 7 %	4,0 (A)
< 8 %	3,0 (B)
< 9 %	2,0 (C)
< 10 %	1,0 (D)
≥ 10 %	0,0 (F)

5.2.9 Reporting the grading results

Symbol grades are reported as described in ISO/IEC 15415 prefixed with appropriate MBR designation (e.g. MBR3/2,8/10/W).