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Information technology - Automatic identification and data capture techniques - Bar code print quality test specification - Two-dimensional symbols - Technical Corrigendum 1 (ISO/IEC 15415:2004/Cor 1:2008)

Technologies de l'information - Techniques automatiques d'identification et de capture des données - Spécification de test de qualité d'impression des symboles de code à barres - Symboles bidimensionnels - Rectificatif technique 1 (ISO/IEC 15415:2004/Cor 1:2008)

Informationstechnik - Automatische Identifikation und Datenerfassungsverfahren - Testspezifikation für Strichcode-Druckqualität - 2D-Symbole (ISO/IEC 15415:2004/Cor 1:2008)

This corrigendum becomes effective on 20 April 2011 for incorporation in the three official language versions of the EN.

Ce corrigendum prendra effet le 20 avril 2011 pour incorporation dans les trois versions linguistiques officielles de la EN.

Die Berichtigung tritt am 20.April 2011 zur Einarbeitung in die drei offiziellen Sprachfassungen der EN in Kraft.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN ISO/IEC 15415:2005/AC:2011) has been prepared by Technical Committee JTC 1 "Information technology" in collaboration with Technical Committee CEN/TC 225 “AIDC technologies” the secretariat of which is held by NEN.

Endorsement notice

The text of ISO/IEC 15415:2004/Cor 1:2008 has been approved by CEN as a EN ISO/IEC 15415:2005/AC:2011 without any modification.

INTERNATIONAL STANDARD ISO/IEC 15415:2004

TECHNICAL CORRIGENDUM 1

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Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Two-dimensional symbols

TECHNICAL CORRIGENDUM 1

Technologies de l'information — Techniques automatiques d'identification et de capture des données — Spécification de test de qualité d'impression des symboles de code à barres — Symboles bi-dimensionnels

RECTIFICATIF TECHNIQUE 1

Technical Corrigendum 1 to ISO/IEC 15415:2004 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

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Replace 7.8.4 with the following:

7.8.4 Modulation and related measurements

7.8.4.1 Modulation

Modulation is a measure of the uniformity of reflectance of the dark and light modules respectively. Factors such as print growth (or loss), misplacement of a module relative to the grid intersection, the optical characteristics of the substrate and uneven printing may reduce the difference between the reflectance of a module and the Global Threshold. A low Modulation may increase the probability of a module being incorrectly identified as dark or light.

The reflectance value of each module in the symbol shall be measured by superimposing on the reference grey-scale image the grid determined by applying the symbology reference decode algorithm to the binarised image. Calculate MOD, the Modulation value of each module as follows:

$$MOD = 2 * (\mathrm{abs}\,(R - GT)) / SC$$

where MOD = modulation
R is the reflectance of the module
GT is the Global Threshold
SC is the Symbol Contrast

Assign the grade level for each module according to Table 6. For each codeword, select the minimum modulation grade of all modules in the codeword. As suggested by the absolute value in the function for MOD, whether a codeword is decoded correctly has no bearing on the grade level that is assigned. In this way, Modulation differs from Reflectance Margin, see 7.8.4.3.

Table 6 — Module grading for Modulation and Reflectance Margin

MOD or MARGIN	**Module Grade**
≥ 0,50	4
≥ 0,40	3
≥ 0,30	2
≥ 0,20	1
< 0,20	0

The cumulative number of codewords achieving each grade shall be counted and compared with the error correction capacity of the symbol as follows:

> For each grade level, assuming that all codewords not achieving that grade or a higher grade are errors, derive a notional Unused Error Correction grade as described in 7.8.8. Take the lower of the grade level and the notional UEC grade.
>
> NOTE This notional grade is not related to, and does not affect, the *UEC* grade for the symbol as calculated according to 7.8.8, but is a means of compensating for the extent to which error correction can mask imperfections in a symbol. If one symbol has higher error correction capacity than another symbol, then the former symbol can tolerate a greater number of codewords with low modulation than the latter. See Annex F for a fuller description of the approach.
>
> Then the Modulation grade for the symbol shall be the highest of the resulting values for all grade levels. When the symbol consists of more than one (e.g. interleaved) error correction block, each block shall be assessed independently and the lowest grade for any block shall be taken as the Modulation grade of the symbol.

Table 7 shows an example of grading Modulation in a symbol containing 120 codewords, 60 of which are error correction codewords with a capacity to correct up to 30 errors in a single error correction block. Modulation grade of the symbol in the example would be 2 (the highest value in the right-hand column).

Table 7 — Example of Modulation grading in a two-dimensional matrix symbol

MOD codeword grade level (**a**)	No. of codewords at level **a**	Cumulative no. of codewords at level **a** or higher (**b**)	Remaining codewords (treated as errors) (120 - **b**) (**c**)	Notional unused error correction capacity (30 – **c**)	Notional *UEC* (%)	Notional *UEC* grade (**d**)	Lower of **a** or **d** (**e**)
4	25	25	95	(exceeded)	<0	0	0
3	75	100	20	10	33,3%	1	1
2	15	115	5	25	83,3%	4	**2**
1	3	118	2	28	93,3%	4	1
0	2	120	0	30	100%	4	0
					Modulation grade (Highest value of **e**):		2

In this example, some codewords may contain errors but that does not affect the calculation.

7.8.4.2 Contrast Uniformity

Contrast Uniformity is an optional parameter that can be a useful process control tool for measuring localized contrast variations. Contrast Uniformity does not affect the overall grade.

Contrast Uniformity is defined as the minimum MOD value found in any module contained in the data region of the symbol in 7.8.4.1.

7.8.4.3 Reflectance Margin

Reflectance Margin is a measure of how well each module is correctly distinguishable as light or dark in comparison to the global threshold. Factors such as print growth (or loss), misplacement of a module relative to the grid intersection, the optical characteristics of the substrate, uneven printing, or encodation errors, may reduce or even eliminate the margin for error between the reflectance of a module and the Global Threshold. A low Reflectance Margin may increase the probability of a module being incorrectly identified as dark or light.

The reflectance value of each module in each codeword in the symbol shall be measured by superimposing on the reference grey-scale image the grid determined by applying the symbology reference decode algorithm to the binarised image.

Since the correct state of each module is known after decoding, any modules which are decoded incorrectly are assigned a *MARGIN* value of 0.

For modules whose correct state is light:

$$MARGIN = 2 * (R - GT) / SC \text{ for } R \geq GT$$

$$\text{MARGIN} = 0 \text{ for } R < GT$$

and for modules whose correct state is dark:

$$MARGIN = 2 * (GT - R) / SC \text{ for } R < GT$$

$$\text{MARGIN} = 0 \text{ for } R \geq GT$$

Where *MARGIN* = the reflectance margin of the module
R is the reflectance of the module
GT is the Global Threshold
SC is the Symbol Contrast

Assign the grade level for each module according to Table 6. For each codeword, select the minimum grade for *MARGIN* of all modules in the codeword. Since codewords which are misdecoded are given grade level of 0, Reflectance Margin differs from Modulation, see 7.8.4.1.

The cumulative number of codewords achieving each grade shall be counted and compared with the error correction capacity of the symbol as follows:

For each grade level, assuming that all codewords not achieving that grade or a higher grade are errors, derive a notional Unused Error Correction grade as described in 7.8.8. Take the lower of the grade level and the notional UEC grade.

NOTE This notional grade is not related to, and does not affect, the *UEC* grade for the symbol as calculated according to 7.8.8, but is a means of compensating for the extent to which error correction can mask imperfections in a symbol. If one symbol has higher error correction capacity than another symbol, then the former symbol can tolerate a greater number of codewords with low modulation than the latter. See Annex F for a fuller description of the approach.

Then the Reflectance Margin grade for the symbol shall be the highest of the resulting values for all grade levels.

Table Cor.1-1 shows an example of grading Reflectance Margin in a symbol containing 120 codewords, 60 of which are error correction codewords with a capacity to correct up to 30 errors in a single error correction block. The Modulation grade of the symbol in the example would be 2 (the highest value in the right-hand column).

Table Cor.1-1 — Example of Reflectance Margin grading in a two-dimensional matrix symbol, applying overlay procedure in Annex F

MARGIN codeword grade level (**a**)	No. of codewords at level **a**	Cumulative no. of codewords at level **a** or higher (**b**)	Remaining codewords (treated as errors) (120 - **b**) (**c**)	Notional unused error correction capacity (30 - **c**)	Notional *UEC* (%)	Notional *UEC* grade (**d**)	Lower of **a** or **d** (**e**)
4	15	15	105	(exceeded)	<0	0	0
3	70	85	35	(exceeded)	<0	0	0
2	15	100	20	10	33,3%	1	**1**
1	5	105	15	15	50%	3	**1**
0	15	120	0	30	100%	4	0
					Reflectance Margin grade (Highest value of **e**):		1

This example represents values from the same symbol used in Table 7. However, in this example ten codewords from level 4 and five codewords from level 3 are detected to contain at least one module which is on the wrong side of the global threshold and are therefore errors. These codewords are therefore counted at level 0 in this example. The resulting grade too is changed significantly.

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Replace Annex F with the following:

Annex F
(informative)

Parameter grade overlay applied to two-dimensional symbologies

This Annex describes the technique used in this International Standard to derive a final grade for a parameter from a set of notional grades determined for a set of grade levels, each determined at five fixed grade levels for the parameter.

The technique computes a notional grade for a parameter for each grade level by assuming that only modules or codewords that meet or exceed that grade level for that parameter are actually readable. The modules or codewords which are readable then result in a grade for that parameter according to the rules for that parameter (whether based on unused error correction or fixed pattern damage).

If one considers what the performance would be for a scanner that could only read codewords or modules above a particular parameter grade level, it is clear what will happen – only codewords or modules at or above that grade level may be counted towards the readability calculation for the symbol at that grade level.

For example, if codewords or modules with a grade of 2 must be counted before a grade of 3 on unused error correction or fixed pattern damage may be obtained, then the symbol must be a grade 2.

Furthermore, if codewords graded 3 or better can only result in an unused error correction or fixed pattern damage level of 2, the symbol must also be a grade 2.

However, the readability of a symbol must take into account the readability of codewords or modules at each grade level and the ability of the symbol to be read using error correction or allowing for some fixed pattern damage and the resulting grade should be the highest of these two possible outcomes.

The following procedure can therefore be established:

a) Count the number of codewords in each grade level, including higher grade levels, assume that all remaining codewords are erasures (multi-row symbols) or errors (matrix symbols) and determine an unused error correction or fixed pattern damage grade.

b) For each grade level, take the lower of the grade level and the associated unused error correction or fixed pattern damage parameter grade.

c) Select the highest of the values from step b as the symbol grade for that parameter.

This ensures that a scanner will have performance associated with the assigned grade because the scanner's ability to read codewords or modules of the assigned grade or higher will bring it within the error correction or fixed pattern damage capacity of the assigned grade level or better.

This method provides a way of accounting for imperfections in symbols which are designed to tolerate imperfections. In fact, it favours symbols with more error correction capacity, which certainly does make a symbol easier to read. It also reconciles the print quality measurement method of linear symbols with that of 2D symbols. In a sense the linear approach, which takes the worst case, is the trivial extension of the above rule in the case of no error correction. In this case, the codeword with lowest grade is always needed to get anything other than a 0 for "unused error correction". If this value happens to be a 1, then the symbol must be a 1, even if all other codewords had quality of 4.

This International Standard defines two parameters for matrix symbologies: “Modulation” and “Reflectance Margin” which make use of the technique described herein. However, they differ in that Reflectance Margin counts modules which are determined to be the wrong color state against the error correction budget whereas modulation does not. When the grade for Reflectance Margin is less than the grade for Modulation there is likely an error in the encodation of the modules or there is a substantial problem with the printing mechanism.

Additionally, an optional parameter called Contrast Uniformity is defined for process control which reports the worst case modulation value of any data module.

NOTE The notional Unused Error Correction or Fixed Pattern Damage grade used in this calculation is not related to, and does not affect, the UEC or Fixed Pattern Damage grade for the symbol as calculated according to 7.8.8 or 7.8.5, respectively.