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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

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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:

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

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 for R ≥ GT*

MARGIN = 0 for *R < GT*

and for modules whose correct state is dark:

*MARGIN = 2 * (GT – R) / SC for R < GT*

MARGIN = 0 for *R ≥ 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.