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Universal Test Target

Technical Specification

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1. BASIC DESCRIPTION

The Universal Test Target is designed to evaluate the image quality of scanners and other digital input devices used to create digital images of documents, photos and other reflective media.

The target can be produced by any person or institution as long as these technical specs are met. It should be available as inexpensive single paper sheet that can be used even for pull through scanners. For flatbed or reprographic scanners it should be mounted on a solid backing material like aluminum or dibond.

Problems with the illumination systems of test devices shall be avoided by using a material that consists of a non structured matt or glossy surface. A matt surface is preferred but material with matt surfaces are typically limited to max densities below 2.0. For this target a max density at a minimum of 2.3 and a sufficient size of the color space to produce color patches are required. Therefore the target will usually be produced on glossy material. The material shall have a white substrate with a L* value of 94 +/- 2, an a* value between -1.0 and 1.0, and a b* value between -4.0 < b* <0.

The exact location of each feature is described in the Excel file: geometric description of Universal test target.xls This file is part of the UTT technical specification.

The following aspects have been considered for the target design:

- Uniformity
- Banding and Registration
- Distortion and Deviations
- Resolution (slanted edge and visual)
- Dynamic range and OECF
- Noise Evaluation
- Colour Reproduction
- Colour Registation
- The use of additional color targets and document reference charts
- Variable sizes of the original (starting at 420 x 300 mm; app. A3)

2. SCALABILITY

Designed as an 420 x 300 mm (app. A3) chart the target can repeatedly be put together to sizes up to A0 or even bigger. The Grey bars and scales are designed in a way that they go through the whole width and length of the target and the slanted edges are spread at equal distances of 140 mm.

Figure 1: The Basic A3 version

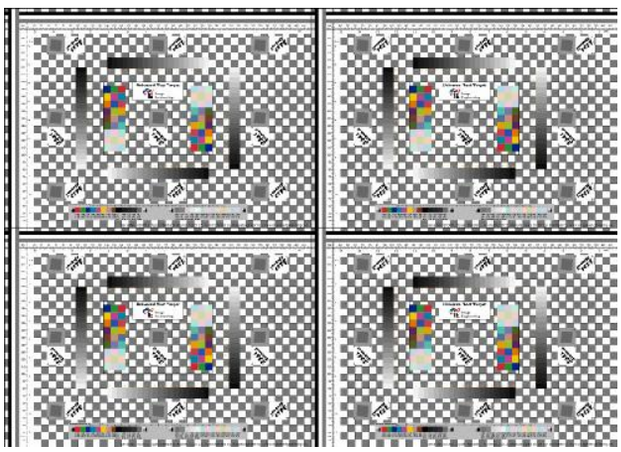


Figure 2: The A2 arrangement

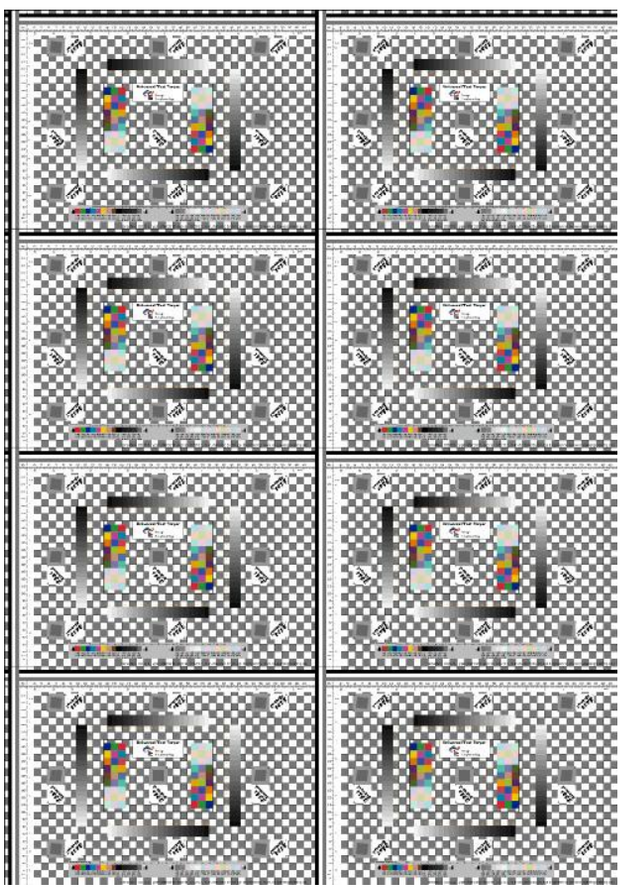


Figure 3: 8 targets combined into one A0 chart

3. TOLERANCES

If not otherwise stated the geometric tolerances are a max of 1 per mille of the absolute values. This is especially valid for the scale and the checker board.

For everything that needs to be mounted on top of the target – like the resolution boxes – the mounting should be within +/- 1mm from the assigned position.

Delta L* and Delta E* values shall be measured according to CIE 15.2 for D50 and the 2° standard observer.

$$\Delta E^*_i = \sqrt{(L^*_i - L^*_{ref})^2 + (a^*_i - a^*_{ref})^2 + (b^*_i - b^*_{ref})^2}$$

$$\Delta L^*_i = \sqrt{(L^*_i - L^*_{ref})^2}$$

For grey patches the over all mean Delta L* should be < 2 and the max Delta L* should be < 3.

The mean Delta E* (including the color aspect) for the grey patches should be < 2 and the max Delta E* should be < 3.

Within a single color patch the Delta L* value should be < 0.5.

For the color patches the Delta values are defined as follows:

Tolerances Delta E	Mean	Max
A1:C4	<5	<7
A5:C6	<4	<5
A7:C9	<2	<4

Tolerances Delta E	Mean	Max
D6:F9	<5	<7
D4:F5	<4	<5
D1:F3	<2	<4

4. CHART FEATURES

Each feature of the test target has one or multiple functions and of course there is no such thing as a perfect target. There are always compromises in one feature for the benefit of another.

But with the Universal Test Target we hope to provide a target based on the experience of a group of people who have used scanners and digital cameras for years.

The idea behind the UTT was to have a universal target for visual and automatic evaluation that covers all the basic aspects of image quality and at the same time is scalable. Therefore we have implemented a variety of features that will be explained in the following sections.

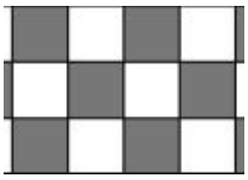
All structures designed to be neutral grey at different brightness levels should have a spectral reflectance as uniform as possible over the visual spectrum. In order to drop the cost of the target a compromise for spectral non uniformity needs to be made but kept in mind for the production process. The patches shall appear uniform under typical halogen, tungsten, and fluorescent lighting. The measured a* and b* values for all patches (D50, 2° observer) shall not exceed the +/- 4 range.

4.1 SURROUNDING BLACK LINE

A 1mm thick line surrounds the target with the center of the line being a rectangle of 420 x 300 mm. The line is needed to combine single targets into larger Arrangements of A2 to A0 and to cut the larger arrangements into smaller targets without destruction of any important features. The line lies on top of all other structures described.

4.2 BACKGROUND CHECKER BOARD

A checker board structure forms the background of the target. The patch size is 10 x 10 mm and starts with a white patch at the left lower corner of the target. The darker patches are neutral grey with a L* value of 50. Each patch is surrounded by a 0.38 (1pt) black line. The checker board can be used for uniformity analysis, white balance checking, and distortion and deviation analysis.

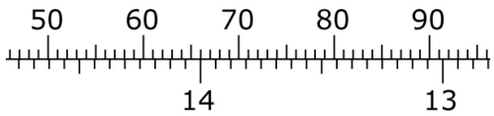


4.3 GREY BARS

Three horizontal grey bars (substrate white , max black, and L* 50) are located at the top of the target 5mm from the border crossing the whole target. A replication of the same 3 bars is also vertically oriented on the left side of the target 5mm from the border crossing the whole hight of the target. These bars are designed for a variety of different purposes. They can be used for white balancing, uniformity checks for scanners, noise analysis, stripes and dead pixel analysis, dark current analysis, etc. The vertical bar lies on top of the horizontal one.

4.4 SCALES

There are two scales, a horizontal and a vertical one with a white background located next to the inside of the color bars and lying behind the color bars and on top of the checker board. There is one center line for each scale with a millimeter and an inch scale next to it. On outside of the center line is the millimeter and on the inside is the inch scale. The exact loaction and dimensions off the scale can be found in the Excel spec sheet. The millimeter scale starts at the left side of the horizontal scale and at the bottom of the vertical one. The inch scale starts at the right side of the chart and at the top. The white background of the scales is located behind the two scales so that the crossing of both scales at 30/30 mm is visible.



The scales are used to check deviation especially but not exclusively for pull through scanners and artifacts that affect the lines of a scale.

4.5 GREY SCALES

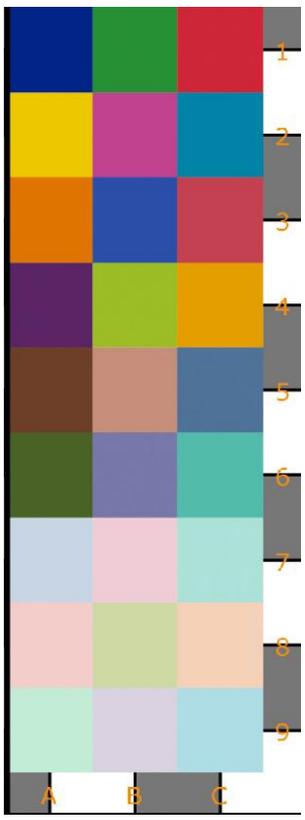
There are 4 grey scales, two horizontal ones and two vertical ones located half way between the border and the center of the target. That means the vertical ones are vertically centered and located 105 mm left and right of the center and the horizontal ones are horizontally centered and located 62.5 mm above and below the center. The vertical version of the scale is 15 mm wide and each patch is 7 mm high. And the horizontal version is 90° tilted. Each grey scale consists of 20 patches starting at L* of 5 with 5 L* value increments (5 – 95) and the last patch representing the max black of the target at a density level of app. 2.3 or above. Tolerances are given in section 3. The left vertical scale stats with L* 95 at the bottom, the right one with L* 95 at the top.

The upper horizontal scale has L* 95 on the right and the lower on the left side. Exact locations are given in the Excel spec sheet. Patch numbers start at L* 95 with 1. The numbers shall be printed on the inside of the scale in 8pt Verdana and orange color.

4.6 COLOR PATCHES

The color patches are a similar to a subset of the x-rite color checker SG. But with the production cost in mind the color have been slightly modified. The first 18 colors are similar to the original color checker and thlast 9 colors are the highlight patches of columns D and K of the color checker SG. In order to perform a detailed color check the original x-rite color checker SG or an IT8 target shall be used. The color patches with a size of 10 x 10 mm for each patch are aligned in 3 columns an 9 rows with the central patch B5 located at 150 / 150 mm from the left bottom of the target. A copy of the set is rotated 180° and placed at the same distance from the target center on its right side (E5 270 / 150). The exact locations can be found in the Excel spec sheet and tolerances for the colors are given in 3. The targeted L*, a*, b* values can be found in the following table:

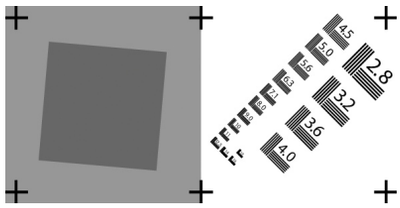
color patches	L*	a*	b*
A1	18	24	-61
A2	82	3	90
A3	61	38	74
A4	21	35	-32
A5	32	24	32
A6	45	-32	38
A7	85	-2	-9
A8	86	13	7
A9	90	-17	6
B1	53	-45	38
B2	49	55	-14
B3	35	12	-53
B4	72	-25	65
B5	64	20	19
B6	53	8	-27
B7	85	13	0
B8	85	-11	26
B9	85	4	-6
C1	46	64	34
C2	48	-34	-31
C3	48	54	21
C4	71	19	80
C5	47	-5	-25
C6	69	-35	-1
C7	86	-19	-1
C8	87	10	18
C9	85	-14	-9



The numbers shall be printed as shown on the bottom and the inside of the scale in 8pt Verdana and orange color.

4.7 SLANTED EDGES

The slanted edge structures are designed for SFR (spatial frequency response) measurements used to determine sharpness and resolution of the imaging system. They shall be combined with the visual resolution ones into a box of 50 x 25 mm. The box located on the imagined centered horizontal line shall be rotated by 90° clockwise. Each slanted edge structure is arranged on an imagined 140 mm grid from the target center. The slanted edge is located on the left side of the box with a rectangle of 25 x 25 mm and a grey level of L* 63. Centered within that box is another box of 15 x 15 cm and a grey level of L* 34 that is rotated by 5°. On the right side of the outer box there shall be another substrate white box of 25 x 25 mm that contains the visual structures described in 4.8. In the corners and the upper and lower center of the 50 x 25 mm box there shall be crosses needed for the automatic detection. These crosses consist of 3mm black lines with 0.38 mm thickness.



The exact dimensions and locations can be found in the Excel spec sheet.

The manufacturer shall be responsible for the sharpness of the slanted edge. The edge shall be sufficient (and not be the bottle neck) to measure scanner resolutions of up to 1000 Pixels per Inch (app. 20 LP/mm) according to ISO 16067.

4.8 VISUAL RESOLUTION STRUCTURES

The visual resolution structures shall be the ones specified in DIN 19051 part 2 Target starting at 2.8 LP/mm up to 18 LP/mm. They shall be centered in the white box and rotated 45° clockwise (see Image under 4.7). The manufacturer shall be responsible for an appropriate resolution up to 18 LP/mm.

4.9 ADDITIONAL CHART BORDER

Those who want to perform an additional more detailed color check can mount an IT8 target inside of the additional chart border in center of the UTT. By doing that the center SFR structure, the color patches of the UTT, and the background checker board will be covered and can not be used.The additional chart border is a transparent rectangle 150 x 100 mm with a 0.76 mm black contour line.

4.10 LABELING PATCH (for sponsor logo, provider information etc.)

The labeling patch is a substrate white rectangle with a size of 70 x 25 mm and a contour line of 0.38 mm with its center located at 210 / 187.5 mm from the bottom left of the target.

In the patch there shall be the name “Universal Test Target” printed in black letters of Verdana Bold 14pt centered at 210/195 mm from the bottom left of the target. The area below the name can be used for custom logos and descriptions.

4.11 SERIALIZATION

Each Target shall have a serial number provided by the manufacturer, the target type, an expiration date depending on the production process but no longer than 3 years from the production date and the manufacturer mentioned. Manufacturer meaning not the one who provides the target but the institution or person who printed it.

Target types: xxx

The statement shall be printed vertical from bottom to top on the right dge of the target in black letters of Verdana 10pt and having the following format: “Serial No. 000001, Type: standard, expires xx/yyyy, manufactured by XXX”

No logos or coloured structures shall be used in this place.

4.12 SPACE FOR OPTIONAL TEST PATTERN LIKE SCAN REFERENCE CHART

Optional test pattern shall not be higher than 25 mm and not be wider than 250 mm and shall be horizontally and vertically centered between the bottom and the lower slanted edge boxes.

Scan Reference Chart

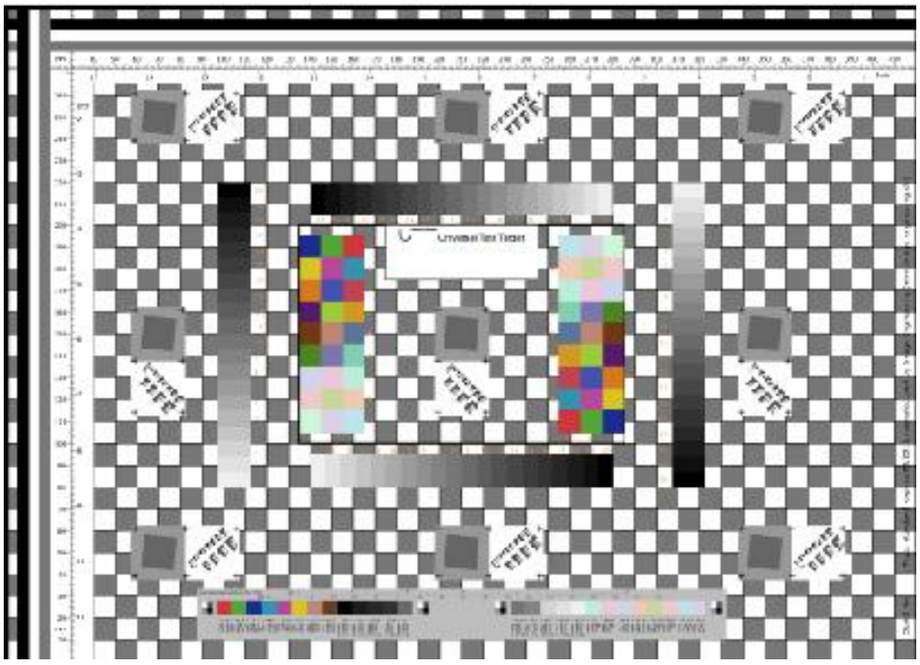
An optional scan reference chart can be placed in this area. It shall consist of color patches, grey patches, slanted edges in both directions, visual resolution pattern, and a scale.

The grey and color patches shall be a subset of the patches used in the UTT. The design of the reference chart is up to the manufacturer but it should meet the tolerances defined for the UTT.

Other Optional targets

For internal use every company may use this area for whatever it is needed. If a specific version of the UTT with optional patches becomes publicly available the manufacturer or integrator has to put the specs with tolerances of these on the utt website (send to webmaster).

5 REPRESENTATION OF THE TARGET



A representation of the Universal Test Target designed according to this specification.

6 VERSION CHANGE LOG

Version 1.1: change of slanted edge contrast from Delta L* 18 (L* min 44, L* max 62) to to the one specified in ISO 16067-1 for delta L* 29 (L*min 34, L*max 63). (17.03.2011)

Version 1.2: missing information added to document (tolerances for color patches in chapter 3)