Gray Balance Control in Offset Printing with the ECI/bvdm Gray Control Strip

ECI/bvdm Gray Control Strip (S) • FOGRA39

Instructions for Use

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1 Gray Balance Process Control – Easy, Practical, Effective

The aim of process control at press side is to quickly achieve the desired color results. When the more important press parameters, such as standardized plate production, dot gain, paper and ink have been determined, then it won't take very long to balance the inking for the best possible outcome.

The ECI/bvdm Gray Control Strip has been developed for printers as an aid to help balance the press process in the best way possible by utilizing a standardized proof. That's why the ECI/bvdm Gray Control Strip is based on the same color characterization data that are used in industry standard ICC profiles (for example, the ECI profiles) and the Ugra/FOGRA CMYK Media Wedge in prepress. ECI offset profiles are based on color characterization data from FOGRA.

2 The ECI/bvdm Gray Control Strip

Gray balance patches that allow a quick and convenient visual control are good aids for accurate inking. That's why the "ECI/bvdm Gray Control Strip" relies on this one simple rule: "Chromatic gray (CMY) has to look exactly like true gray (K)".

The aim is therefore, to match the ECI/bvdm Gray Control Strip chromatic gray patches to the true gray patches by controlled inking. That is, the technical tone consisting of defined cyan, magenta and yellow (chromatic gray) values is compared to a tone value that consists of pure black (true gray). By "balancing out" the colors at the press, two patches that consist of two different sets of values ideally end up looking the same.

The Human Eye as "Metering Device"

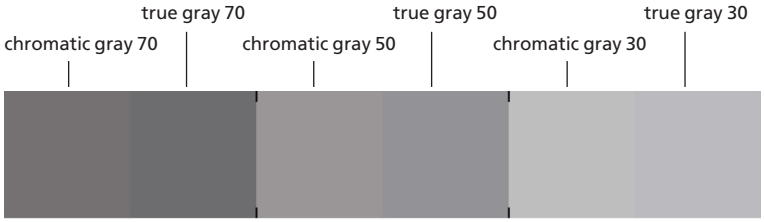
Because the human eye is well suited in comparing colors that are directly adjacent to each other, and in particular are very sensitive in detecting color differences within the gray zone, they serve as a "visual metering device" when using the ECI/bvdm Gray Control Strip for assessment. By visually controlling the gray balance patches, deviations in inking can be recognized and corrected in due time press side, before these have a chance to show up on the printed image. Yet visually controlling the gray balance in no way replaces a metered evaluation of full tone color coordinates and the tone value increase or using an automatic color control that may be on hand.

Why Gray Balance?

Standard process offset printing states that the correct dot gain for each different printing ink is one of the most important preconditions for balancing printing and proof. It has also been determined that the difference between the colors is not to be too great (key word: spread), or a deviation, for instance in the gray balance, may occur.
Usually the dot gain of each single process color is measured to verify this stipulation. Even before a measurement is made, a color shift (e.g. a red cast) in the chromatic gray patch when compared to the true gray patch can be detected by simply inspecting it with the naked eye. Fundamentally, it is very useful to make an assessment based on screened mixed colors (in this case the chromatic gray patch), since most images consist of those tertiary colors. Print control elements that contain only screened primary color values (no mixed colors) are not suitable for this type of initial evaluation.

"How Gray is Gray?" or "Which Gray Balance is the Right One?"
One approach in defining the most suitable chromatic gray patches involves establishing exactly those CMY color value combinations from out of respective color characterization data that match comparable values of pure black (true gray), and/or that arrive at exactly the same CIELAB color values when metering the color.

The chromatic gray patches on the ECI/bvdm Gray Control Strip were determined using this method. These correspond with the definition for chromatic gray in compliance with the international press process standard ISO 12647-2: "A colour having the same a* and b* CIELAB values as a half-tone tint of similar L* value printed with black ink.".



ECI/bvdm Gray Control Strip (S) • FOGRA39

	CMY 70	K 70	CMY 50	K 50	CMY 30	K 30
CIE L*	45,53	45,53	61,82	61,82	76,12	76,12
CIE a*	0,0	0,0	0,0	0,0	0,0	0,0
CIE b*	-0,75	-0,75	-1,16	-1,16	-1,52	-1,52
C	66	–	45	–	27	–
M	56	–	36	–	19	–
Y	56	–	36	–	20	–
K	–	70	–	50	–	30

Table 1: CIELAB color coordinates and CMYK values of true gray (K) and chromatic gray patches (CMY) for offset printing on coated paper (FOGRA39).

Respective characterization data for all printing conditions may be taken from the CIELAB values for black. Characterization data are determined by means of test targets (e.g. ECI2002 test table) that were printed on specific papers under controlled conditions. These data also serve as a basis for the creation of ICC profiles, which may be applied for data preparation and proofing.

Table 1 illustrates the CIELAB color coordinates and CMYK color values of the three chromatic gray (CMY 70, CMY 50, CMY 30) and true gray (K 70, K50, K 30) patches for standardized offset printing on coated paper (characterization data FOGRA39).

In printing, each chromatic gray and true gray pair look the same to the human eye and ideally the color measurements show the CIELAB color values from the characterizations file of the respective printing condition (here: FOGRA39).

It is also important to make sure that the respective ECI/bvdm Gray Control Strip is applied according to the type of paper used, since different CIELAB values of the black patches and different CMY values result depending on the printing process and printing condition.

Definitions of the ECI/bvdm Gray Control Strip gray patches for offset printing are each based on the FOGRA characterization data for standardized offset printing in compliance with ISO 12647-2. The ECI produces ICC profiles by means of these characterization data, which can be downloaded from the ECI website. They also constitute a part of the Altona Test Suite Application Kit.

FOGRA published new characterization data sets in June 2008: FOGRA41 for offset printing on MFC paper (machine finished coating), FOGRA42 for heatset web offset printing on SNP paper (standard newsprint) and for offset printing using non periodic screening on coated (FOGRA43) and uncoated white paper (FOGRA44).

A list of current versions and their classification according to paper type can be seen in Table 2 on page 14.

Is Process Control of Other Printing Parameters Still Necessary?
The ECI/bvdm Gray Control Strip serves as an "early warning system" or "quick test". When a visual balance of true gray and chromatic gray on the press is impossible to arrive at the conventional way, such as by a change in the inking, this is an indication that some basic printing process parameters need adjustment. As a rule, deviations may be corrected by changing influencing factors (i.e.: another ink, adjustment of CtP curves). In order to locate and remedy the fault, it is required to review the dot gain and full tone color coordinates of the inks and make an assessment of additional areas (e.g. slur / doubling), which are typically included in machine control bars. The ECI/bvdm Gray Control Strip is therefore not a substitute for printing control elements, but rather a supplement to these.

Gray Balance – An ECI or bvdm Invention?
No! Gray balance is a known issue in the printing industry since decades. Fogra covered the issue in many studies – the first was issued in the year 1953. In fact in printing the control of the gray balance has been in practice for many years, for example it is utilized in the "Ugra/FOGRA Minitarget" (www.ugra.ch and www.fogra.org) and the density-based color control systems from System Brunner (www.systembrunner.ch). Simple chromatic gray patches are still in common use in Scandinavian newspapers.

2.1 ECI/bvdm Gray Control Strip Versions

The ECI/bvdm Gray Control Strip is available in three different layouts. Depending on intended purpose and available space they can either be applied singularly or in combination.

The Basic "S" Version

The ECI/bvdm Gray Control Strip "S" version consists of three true gray / chromatic gray pairs. The true gray patches are arranged in 70%, 50% and 30% tone values of the black ink. The tone values for cyan, magenta and yellow in the respective chromatic gray patches were determined from absolute colorimetric color conversions of CIELAB values (of the respective black ink value).

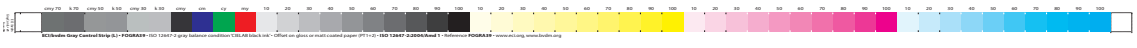
Illustration 1: The Basic ECI /bvdm Gray Control Strip "S" Version

Two items are to be noted. Firstly, the CIELAB value of the true gray patches originate from the corresponding characterizations file. Secondly, when determining the chromatic gray patches the black generation setting was "none" (without black ink).
The control element is 36 x 8 mm. Each patch is 6 x 6 mm. The identification line of the wedge allows you to verify the utilized printing conditions. In this respect it is recommended to show the Identification line on the printing forme.

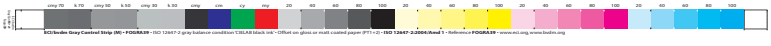
The Expanded Versions "L", "M" and "M i1"

The ECI/bvdm Gray Control Strip versions "L" and "M" are based on the basic "S" version and contain additional patches for the measurement of other process parameters.

Version "L"



Version "M"



Version "M i1"

Illustration 2: Expanded versions "L" and "M" with their density values above each patch, identification lines below and an abbreviated version on the left side of the wedge.

Layout "L"

The "L" layout is 291 mm wide and has a height of 10 mm, whereas each patch (with exception of the last patch) is 5.5 mm wide. When necessary, patch density values and the identification line below may be cut off so that its height may be reduced to 6 mm.

This layout consists of 51 control patches in all, which may be grouped as follows:

Illustration 3: ECI /bvdm Gray Control Strip patches divided into groups

– **Start and end patch,** required for positioning hand-held scanning devices in front of the first measurable patch and for their phase out after the last patch.

– **Paper-white patch** used as a reference value for densitometers and to determine the paper color coordinate.

– **Three gray balance patch pairs,** consisting each of one chromatic gray and one true gray patch for visual gray balance control. The true gray patches are laid out in the tone values of 70%, 50% and 30%. The chromatic gray patches are created from out of the primary colors cyan, magenta and yellow so that each printing condition indicated in the ECI/bvdm Gray Control Strip identification line can ideally be visually matched to the true gray patches.

– **Solid color overprint patches (trapping patches),** for the visual and technical evaluation of secondary colors (M + Y, C + Y, C + M), also for the tertiary color black (C + M + Y). This allows the detection of ink trapping problems.

– **Halftone step wedges** in the four primary colors: black, yellow, magenta and cyan. Each halftone step wedge contains the tone values from 10% to 100% in 10% increments. It serves for the visual (by way of inking standards) and technical control of solid color inking and to determine characteristic curves of printing.

Since it is often very hard to distinguish between neighboring control patches, small white or solid-tone guide lines that border each patch and that have no affect on the automatic measurement of scanning devices were added to aid the positioning of the sensing head.

Printing Conditions

The identification line below the patches contains the name of the control wedge and the layout version (L). Following that are the printing conditions, a reference to the respective characterization file standard and the gray condition in compliance with ISO 12647-2. The Internet addresses of the project partners are also listed including those addresses where the ECI/bvdm Gray Control Strip may be downloaded. Because the large version may be shortened to save space you will find at the left of the end patch another three short lines with the abbreviated names and the reference name of the layout version, the wedge version (“v1”) and the characterization file name This information allows the easy identification of each wedge.

Layout “M”

Layout “M” at a width of 197.5 mm is the abbreviated version of Layout “L”. This version should only be applied when there is not enough available space on the paper format for the application of version “L”. This can be the case for instance when short grain pages are to be processed in A4 format.
Of course the 10 mm height of layout “M” may also be reduced to 6 mm by cutting off the patch density values on the top and the identification line underneath. The width of each control patch is 6 mm. Layout “M” also differs from Layout “L” only by the number of the primary color halftone steps, where instead of 10% increments, 20% increments from 20% to 100% tone values have been indicated.

Layout “M i1”

Between the patches marked “Start” and ”Stop“ the layout “M i1” contains patches for the fast measurement of CIELAB values and tone value increase curves with scanning devices. Six gray balance patches for the visual assessment have been added to the lower end of the control strip.

Illustration 4: “ECI/bvdm Gray Control Strip (M i1)”

Layout “tvi 10”

The purpose of this control strip is the assessment of production prints with regard to the specifications defined by the standard ISO 12647-2. For that reason the strip contains solid-tone and overprint patches as well as halftone steps in 10% increments. The “ECI/bvdm tvi 10” can be used for all printing conditions as it does not contain graybalance patches. The color sequence of the control patches is optimized for fast measurments with scanning devices.

Illustration 5: “ECI/bvdm tvi 10”

Important Note Regarding Measurement with Scanning Devices
The space for control strips on printing sheets is very limited. For that reason the control patches of the layouts “M i1” and “tvi 10” are smaller than specified by the manufacturer X-Rite for the manual measurement in scan mode using the ruler. Devices marked “Rev A” at the bottom side are not suited for the measurement of these strips in scan mode. Using i1Pro devices marked “Rev B”, “C” or “D”, in some cases errors in scan mode measurements may occure – in particular on uncoated paper types with an uneven surface or coarse screening. All revisions (Rev A-D) will work properly if mounted on the iO scanning table. In order to achieve reliable measurement results it is recommended to measure the same control strip in the modes “strip” and “patch” and to compare the two results. In the case of significant differences choose the reliable “patch” mode and do not use the ruler.

3 Implementation of the ECI/bvdm Gray Control Strip

Which ECI/bvdm Gray Control Strip Version Should I Use?
In order to make the right selection for the correct wedge to use, you have to consider the printing conditions (see also Table 2 on page 14). Aside from this, there are three different layout versions available per printing condition. This allows you to choose the most suitable version according to the amount of space available.

Example: A matt-coated paper (paper type 2) is intended for the final printed product. The matching FOGRA characterization data is identified as FOGRA39. If there is enough room available on the paper, the “L” or “M” expanded version should be utilized. This will allow a visual check of the gray patches as well as a technical measurement of the characteristic printing curves. In this case use the “ECI_GrayConL_FOGRA39.pdf” wedge. If there is only very little available space, the basic “S” version identified as “ECI_GrayConS_FOGRA39.pdf” should be used. The basic “S” version is key for the visual control of a press run.

How is the ECI /bvdm Gray Control Strip Positioned?
All the different versions of the ECI/bvdm Gray Control Strip are available as PDF files. Choose the version that best suits the printing conditions and position the ECI/bvdm Gray Control Strip for instance in your imposition program as a supplement to your usual control aids. In work environments that do not allow PDF files, the EPS version of the wedge, for example “ECI_GrayConL_FOGRA39.eps”, may be applied. Make sure that the printing condition in the identification line that this wedge represents is still discernable.

The basic version “S” should be at right angles to the printing direction, for example placed below the color bar you normally use. A repeated placement enables a color balance assessment.

The two expanded versions “M” and “L” as well as the “ECI/bvdm tvi 10” must be positioned between the pages at right angles to the gripper edge; wedges positioned parallel to the gripper edge would distort the dot gain calculation of unavoidable inking deviations between the ink zones. Under some circumstances the analysis of the wedge may be distorted on account of atypical inking behavior when it is placed at the edge of the paper.

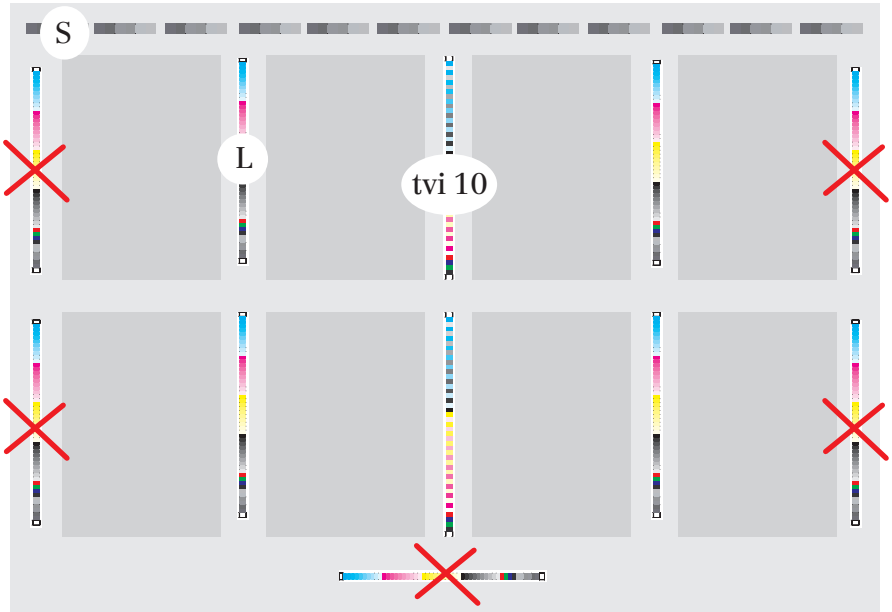


Illustration 6: Placement of the “S”, “L” and “tvi 10”version on sheets with **long** cut-off pages. The red X marks unsuitable positioning.

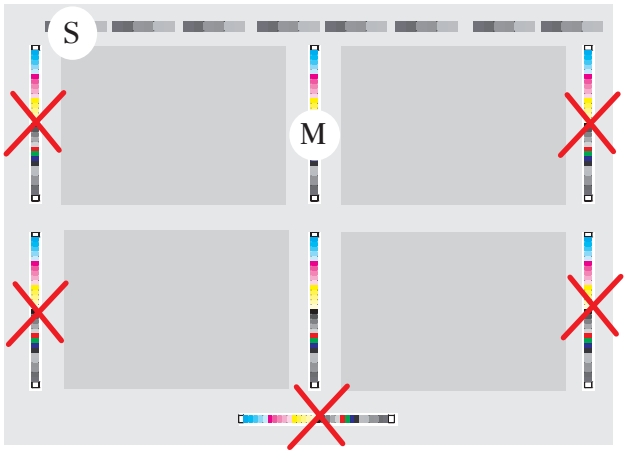


Illustration 7: Placement of the “S” and “M” version on sheets with **short** cut-off pages. The red X marks unsuitable positioning.

What Can be Done when K-Gray and CMY-Gray Patches do not Match?
In principle, the standardized offset printing process in compliance with ISO 12647-2 and/or "ProzessStandard Offsetdruck" (bvdm 2001, 2003) guidelines is to be instituted. Target values and tolerances are itemized in the "MedienStandard Druck 2004" (download of current version at www.bvdm.org).

When however the chromatic gray and true gray patches do not correspond, try adjusting the inking and damping control of one or more of the process colors to arrive at a good match.
Example: a) When the chromatic gray patch has a red cast when compared to the true gray patch, decrease the magenta and yellow inking or increase cyan.
b) When the chromatic gray patch is too light when compared to the true gray patch, increase the CMY primary inks or reduce true gray.

It is to be noted that the gray balance patches only illustrate a bias. In order to find out whether the primary color inking is to be reduced or increased you must make an additional assessment of other control bars, for example check the halftone wedge of the "L" or "M" version of the ECI/bvdm Gray Control Strip.

In some circumstances deviations arise that do not allow themselves to be corrected by adjusting the inking. Let us take for example the following case: The 50% patch is acceptable, but the 30% is not chromatic. The characteristic printing curve of the entire tonal gradation is not balanced. Initially you have to rule out any printing faults (for example slur / doubling, gradual fading, etc,).

Then it is absolutely essential that a characteristic printing curve with a sufficient increase in tone value is created throughout (for example by means of the expanded ECI/bvdm Gray Control Strip "L" version). A calculated correction of the CtP system may become necessary as a result of the findings.

It should also be noted that there are a multitude of possible causes for printing problems, for instance in connection with the materials being used (paper, ink, blanket, additives, etc.). The bvdm ProzessStandard Offsetdruck extensively describes possible causes and gives trouble-shooting instructions. The Altona Test Suite Application Kit documentation describes pre-tests to determine the most optimal inking and the correct tone value increase.

Gray Balance Remarks

It is well known that with process inks in offset printing, inking and damping fluctuations show up more distinctly in chromatic gray image areas than in colored image areas. This is why gray balance patches in color control bars have been instrumental in the indication of printing process disorders. Gray balance control should be carried out allowing for the following constraints.

On the one hand it depends on the prevailing printing conditions, for instance the type of paper or the screening which tone value combination of primary colors (cyan, magenta, yellow and black) result in an actual chromatic gray in the print. Most of the control aids available up until now (for example the FOGRA control strips) have only one single version of the gray balance scale. In conventional film / plate making, managing a large number of control strips coordinated to all the different printing conditions would have been extremely inconvenient and would probably have presented a potential source of trouble. Still, gray balance deviations in the print run can be well detected with the aforementioned control aids. By comparing the gray balance patches on the o.k. print and print run sample, fluctuations can be easily detected despite the inaccuracy of chromatic gray balance patches. Today thanks to automated workflows it is easy to display control aids on full-page films or printing plates that match the intended printing conditions.

On the other hand, the gray balance is dependant on printing parameters that are influenced by at least these four factors: the dot gain, the solid color inking of the primary colors, overprinting and paper color. A gray balance control alone can therefore not give any information about any potential cause for errors and in itself does not allow an assessment for recommendations at the press. Now as ever screened patches of the primary colors, solid color and solid color overprint patches are required in color control bars. This also applies to automated control systems that function according to the gray balance control principle.

The gray balance of the o.k. sheet are reference for the process control of the entire print run – even if the respective chromatic gray patches are not perfectly neutral.

A color cast in the chromatic gray patches of the ECI/bvdm Gray Control Strip not neccessarily indicates the same color cast in gray tones of images. In particular dark image areas contain a significant amount of black ink. This minimizes the color cast caused by the chromatic inks cyan, magenta and yellow.

4 The Different ECI/bvdm Gray Control Strip Versions

ECI and bvdm offer free versions of the ECI/bvdm Gray Control Strip for the most important offset standard printing conditions. These are labeled by name (file name, identification).

Printing condition	Characterization data	Profile file name	ECI/bvdm Gray Con Strip
Offset, Paper type 1+2 Gloss and matt coated paper Tone value increase curves A (CMY) and B (K)	FOGRA**39**	ISOcoated_v2_eci.icc ISOcoated_v2_300_eci.icc	ECI_GrayConS_FOGRA**39** ECI_GrayConM_FOGRA**39** ECI_GrayConM_i1_FOGRA39 ECI_GrayConL_FOGRA**39**
Offset, Paper type 3 LWC paper (Light Weight Coated) Tone value increase curves B (CMY) and C (K)	FOGRA**28**	ISOwebcoated.icc	ECI_GrayConS_FOGRA**28** ECI_GrayConM_FOGRA**28** ECI_GrayConM_i1_FOGRA28 ECI_GrayConL_FOGRA**28**
Offset, Paper type 4 Uncoated paper, white Tone value increase curves C (CMY) and D (K)	FOGRA**29**	ISOuncoated.icc	ECI_GrayConS_FOGRA**29** ECI_GrayConM_FOGRA**29** ECI_GrayConM_i1_FOGRA29 ECI_GrayConL_FOGRA**29**
Offset, Paper type 5 Uncoated paper, yellowish Tone value increase curves C (CMY) and D (K)	FOGRA**30**	ISOuncoatedyellowish.icc	ECI_GrayConS_FOGRA**30** ECI_GrayConM_FOGRA**30** ECI_GrayConM_i1_FOGRA30 ECI_GrayConL_FOGRA**30**
Offset, SC paper Super calandered paper Tone value increase curves B (CMY) and C (K)	FOGRA**40**	ISOsc_eci.icc	ECI_GrayConS_FOGRA**40** ECI_GrayConM_FOGRA**40** ECI_GrayConM_i1_FOGRA40 ECI_GrayConL_FOGRA**40**
Offset, MFC paper Machine finished coating paper Tone value increase curves B (CMY) and C (K)	FOGRA**41**	PSO_MFC_paper_eci.icc	ECI_GrayConS_FOGRA**41** ECI_GrayConM_FOGRA**41** ECI_GrayConM_i1_FOGRA41 ECI_GrayConL_FOGRA**41**
Offset, SNP paper Standard newsprint paper Tone value increase curves C (CMY) and D (K)	FOGRA**42**	PSO_SNP_paper_eci.icc	ECI_GrayConS_FOGRA**42** ECI_GrayConM_FOGRA**42** ECI_GrayConM_i1_FOGRA42 ECI_GrayConL_FOGRA**42**
Offset, Paper type 1+2 Gloss and matt coated paper Non periodic screening, 20 µm Tone value increase curve F (CMYK)	FOGRA**43**	PSO_Coated_NPscreen_ ISO12647_eci.icc PSO_Coated_300_NPscreen_ ISO12647_eci.icc	ECI_GrayConS_FOGRA**43** ECI_GrayConM_FOGRA**43** ECI_GrayConM_i1_FOGRA43 ECI_GrayConL_FOGRA**43**
Offset, Paper type 4 Uncoated white paper Non periodic screening, 30 µm Tone value increase curve F (CMYK)	FOGRA**44**	PSO_Uncoated_NPscreen_ ISO12647_eci.icc	ECI_GrayConS_FOGRA**44** ECI_GrayConM_FOGRA**44** ECI_GrayConM_i1_FOGRA44 ECI_GrayConL_FOGRA**44**

Table 2: Available versions of the ECI/bvdm Gray Control Strip

Other Printing Conditions

As above listed ECI/bvdm Gray Control Strips cover the most important standard offset printing conditions these versions should be used.

Upon request ECI will create special versions of the ECI/bvdm Gray Control Strip for publishers of characterization data and profiles available on the ECI website.

As an exception the opportunity is available to create your own versions corresponding to special printing conditions. For this purpose ECI and bvdm offer InDesign documents free of charge for the four “S”, “M” and “L”versions of the ECI/bvdm Gray Control Strip. These InDesign documents along with a manual are located in the folder “Custom” which is a part of the download package.

5 Imprint

Publisher:
European Color Initiative (ECI)
c/o Olaf Drümmer
callas software gmbh
Schönhauser Allee 6/7
10119 Berlin, Germany
www.eci.org

Bundesverband Druck und Medien e.V. (bvdm)
Biebricher Allee 79
65187 Wiesbaden, Germany
www.bvdm.org

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6 Contributors

The following persons have cooperated in the development of the ECI/ bvdm Control Strip:

Michael Adloff *(twentyfour seven digitale prepress services gmbh, Düsseldorf)* **Harry Belz** *(bvdm, Wiesbaden)* **Dr. Günter Bestmann** *(Heidelberger Druckmaschinen AG, Kiel)* **Wolfgang Brügelmann** *(Druckzentrum Köln West Druckerei Peipers GmbH, Köln)* **Sascha Bugai** *(Lean Produktion GmbH & Co. KG, Hamburg)* **Dieter Dolezal** *(Hirte Medien-Service GmbH & Co. KG, Hamburg)* **Olaf Drümmer** *(callas software GmbH, Berlin)* **Axel Faber** *(Langebartels+Jürgens GmbH, Hamburg)* **Bernd-Olaf Fiebrandt** *(Verband Druck und Medien in Baden-Württemberg e.V., Ostfildern)* **Kurt Fuchsenthaler** *(Heidelberger Druckmaschinen AG, Heidelberg)* **Dr. Johannes Hoffstadt** *(GMG GmbH & Co. KG, Tübingen)* **Jan-Peter Homann** *(homann colormanagement, Berlin)* **Andreas Kraushaar** *(FOGRA Forschungsgesellschaft Druck, München)* **Steffen Kujus** *(Oldenbourg Digitaltechnologie, Kirchheim bei München)* **Karl Michael Meinecke** *(bvdm, Wiesbaden)* **Roland von Oeynhausen** *(Otterbach Medien KG, Rastatt)* **Prof. Ronald Schaul** *(Hochschule der Medien, Stuttgart)* **Ulrich Schmitt** *(FOGRA Forschungsgesellschaft Druck, München)* **Florian Süßl** *(MetaDesign AG, Berlin)*