Prinect
Color and Quality

Gray Balance Optimization
Fundamentals and Application

Prinect User Guide – Color and Quality

The aim of the “Prinect User Guide – Color and Quality” is to take a closer look at individual aspects of Prinect® color workflows. The focus here is on practical applications. Prinect allows you to achieve the right color quickly and easily, while monitoring and maintaining the quality level throughout the entire print run. With the integrated color workflow in Prinect, you print on the basis of clear and standardized values and can regulate these reliably via measuring devices. For example, you can define parameters for the automatic presetting of your printing press as early as the prepress stage, allowing prepress and the pressroom to merge into one system.

Greater operating efficiency with Prinect mean that you are in full command of your color and quality management and can reproduce results consistently and obtain the right color setting with fewer waste sheets and shorter setup times. This ensures that your print run is of a consistently high quality and you can utilize the full performance of your press. Change your color and quality management using standards which can be checked precisely and which specify the reference values for the printed product.

Your print result is subject to a wide range of influencing factors, from the paper grade, through the tone values and the ink to the press itself. Only when these influencing factors are known is it possible to perfectly align proof, plate and press with one another.

Thanks to Prinect, your production won’t let you down. It allows you to define unique, quantifiable values and tolerances that are in line with a standard, on the basis of which the proof printing, platesetter and press are synchronized with one another. This standardization guarantees consistent values in proof printing and printing, allowing you to set precise inking values and optimize your color and quality management. Inking becomes quicker and easier. In the event of deviations or customer complaints, logs account for the production process and simplify solutions. ISO Standards, Process Standard Offset, and other industry accepted specifications and procedures such as GRA-CoL in the US can be easily implemented and verified.

Standardization creates peace of mind for everyone involved: You can reliably meet customer requirements on any press and the customer receives the quality expected and comes back again. This is the best guarantee of the profitability of your print shop in the long term. The interaction of the individual components in the coloring procedure is complex. The intent of the “Prinect User Guide – Color and Quality” is to make these interactions more transparent for you, the user.

Gray Balance Optimization – Fundamentals and Application

The correct rendering of gray values is a basic quality criterion in printing. Gray values are perceived to follow the color balance of the substrate being printed on and when deviate from this condition the perception is that the color balance is off, particularly when reproducing large areas of neutral tones.

When setting up a printing process for a specified color set and printing material, the objective is to achieve the desired gray balance, while at the same time ensuring that solids are accurately inked and the tone value increase is calibrated correctly. This is generally achieved through regulation of solids (ink film thicknesses) on the printing press. However, if larger changes are necessary to correct for the gray balance, the color and tone value increase may deviate from their optimum values. Using conventional calibration procedures of targeting a defined tone value increase doesn't always result in the proper gray balance; therefore new calibration methods are required.

"Gray Balance Optimization – Fundamentals and Application" has been published in order to clarify the most important aspects relating to gray balance and to describe the gray balance optimization functions that are available in the Prinect Color Toolbox products.

Software Versions

The present publication refers to the following software versions of Prinect products:

Prinect Color Toolbox	Version 3.5
Profile Tool (option)	Version 3.5
Quality Monitor (option)	Version 3.5
Calibration Tool (option)	Version 2.6

Newer and in some cases older software versions generally support the described functions. However, changes to the user interface may occur. Information about this is given in the respective product and user documentation. The described products and options do not necessarily belong to the standard scope of delivery of your Prinect modules and in this case have to be purchased separately.

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Fundamentals
Introduction to Gray Balance Optimization

The correct reproduction of gray values is a basic quality parameter in printing. The human eye perceives the white of the printing material as neutral but the appearance is also dependant on different observation conditions. For example; it makes a substantial difference if a gray is viewed under standard light, artificial light or daylight.

A Short Historical Overview

Gray balance as it relates to the correct reproduction of gray values is a constantly discussed topic. It wasn't too long ago that gray balance really was a dominant element of color reproduction. The idea that a gray balance was linked to specific input values also originates from this time. The ISO standard for process monitoring ISO 12647-2:1996 stipulated reference values ("unless otherwise specified, gray balance should be given ... 25-19-19, 50-40-40, 75-64-64"). The analog color image scanners (drum scanners) used these reference values in its separation tables, the analog proof printing systems adapted to them and the printers adjusted their inking units in such a way that the gray balance was achieved.

Today, many analog drum scanners are no longer in use, analog proof printing methods are on the decline and digital technologies are the order of the day. Today's color image scanners and digital cameras produce data in a media-independent way (AdobeRGB, eciRGB etc.) in the same way as graphics programs. Digital proof printing systems can simulate the widest range of production processes (sheet fed offset printing, web offset printing, newspaper printing, gravure printing...) on varied types of paper using a range of different inks. Ink presetting, ink control and spectral measuring technology have changed things in the printing process as well, and as a result gray balance has lost some of its importance. This is not least reflected in the current ISO process monitoring standard ISO 12647-2:2004, in which gray balance has been omitted from the regulations without a replacement being added and has been moved to the informative annex.

Today, the only references for the printing process are the paper, the color of solids and dot gain. Gray balance is a process-dependent factor. The role that gray balance will play in printing will be considered with future advancements of ISO Standards.

Dependency of the Gray Balance on the Printing Process

A detailed insight has been gained into the behavior of the gray balance when generating characterization data and ICC profiles for sheet fed and web fed offset printing. Small changes in inking within the scope of the ISO standard tolerances quickly led to changes in the gray balance. Changes to dot gain values within the ISO standard tolerances also led to visible changes. The color sequence was not examined in detail here, but other investigations have revealed that the gray balance is considerably dependent on the print order.

Gray balance is easily achieved in lighter tone values but as the tone values increase control of the gray balance becomes more difficult. This is linked to the ink trapping characteristics when performing wet-on-wet printing. When printing lighter tone values screen dots fall over the substrate only and do not influence each other. For darker tone values the screen dots are printed on top of each other leading to more influence of ink printing on top of ink (trap).

During wet-on-dry printing (as is common in classic proof prints), ratios arise that show a tendency toward the classic gray balance. Due to ever increasing printing speeds “trap” is becoming more and more of a concern. All current characterization data (and profiles) have been generated in wet-on-wet printing.

Figure 1 shows the gray balance of the FOGRA39 characterization data for offset printing on coated paper on the left and the corresponding realization of this in a press profile with conventional black composition on the right. If you look at the 50% value of cyan and draw a vertical line downward, you will find the appropriate values in % for magenta and yellow. The conformity with the informative reference values of the ISO standard is quite good.

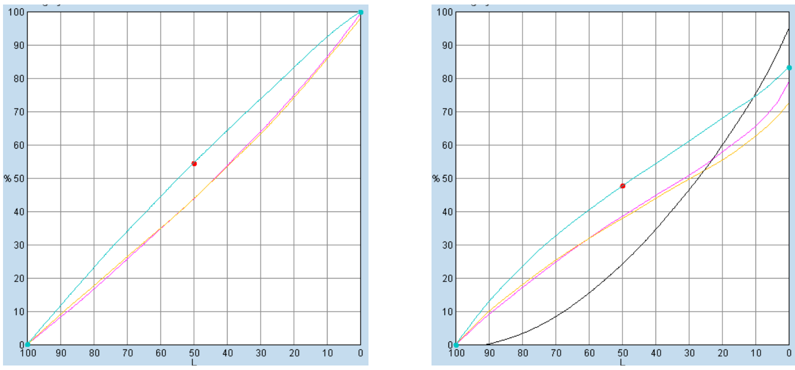


Figure 1: Gray balance FOGRA39 / ISOcoated_v2 (conventional black composition)

In classic reproduction methods separations used a short skeleton black, but this has now changed. Advancements in color reproduction technology has allowed the black in the gray area to start printing in the lighter tone values resulting in a more stable gray reproduction. The use of GCR (Gray Component Replacement, replacement of composite gray elements by black) led to a further significant improvement in gray reproduction.

It has also been observed that gray balance is dependent on the screening, which is clearly visible when comparing the gray balance between periodic screening and non-periodic screening (see Figure 2). If you look at the 50% value of cyan again here and calculate the corresponding values for magenta and yellow, you can see these differences. The figure shows a significantly different balance between the chromatic colors for attaining a neutral gray.

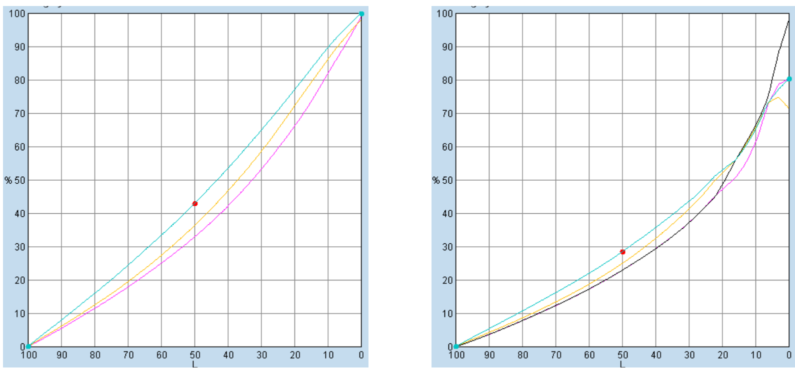


Figure 2: Gray balance FOGRA43 / ISOcoated_NP (non-chromatic composition with GCR 50)

Fundamentals
Process Calibration and Procedures

The ISO/TS 10128 technical specification for process calibration in offset printing describes various methods for calibrating a printing process during plate imaging. These are methods for calibration: adapting the tone value curves, using gray balance scales and using multidimensional transformations with device-link profiles.

The use of device-link profiles, i.e. multi-dimensional transformations of process colors, is actually not process calibration. Heidelberg supports all of the procedures listed in ISO/TS 10128 (see also the user guide on "Device-Link Profiles – Creation and Application").

Adapting Tone Value Curves

The conventional methods for calibrating tone value curves are well-known. Based on a defined reference printing condition which specifies the color of the paper and the inks when printed on this paper, the target tone values or dot gains in printing are achieved by calibrating the tone values on the printing plate.

The FOGRA39 reference printing condition describes a printing process in line with standards. The gray balance of the chromatic colors and of the combined printing of chromatic colors with black is part of the characterization data of the reference printing condition.

In day-to-day printing, deviations arise in gray reproduction. Amongst other factors, this is due to changes in the color of paper white (as a result of optical brighteners being used), ink properties, ink trapping characteristics and screening.

Gray balance is typically adjusted on the printing press by changing ink film thicknesses. Changes in ink film thicknesses lead to changes in the color of solids and screened areas and thus to changes in the tone values. This method allows you to adjust the gray rendering in important gray areas in the image.

Using Gray Balance Scales

In certain circumstances inking and/or dot gain tolerances must be exceeded in order to achieve gray balance. For this reason it is a good idea to consider gray balance requirements at the beginning of the calibration process and adjust the dot gains accordingly. This procedure results in the correct gray balance when optimum ink film thicknesses are achieved. Near-neutral scales are used for this procedure. These scales refer to the reference values of the chromatic process colors for defined gray color values. The CIE-LAB color space is generally used here. The aim of gray balance calibration is to alter the tone values on the printing plate in such a way that the targeted gray color values are reached. The manual process is somewhat abstract and is not easy for the user to carry out.

Heidelberg has developed and successfully tested a method that uses a standard ICC profile as a target, and an ICC profile of the linear (uncalibrated) printing process, to calibrate directly to the desired gray condition. This procedure results in calibrations which visually correspond to the reference printing condition in regards to contrast and gray balance, however it is possible that the tone value increase will be "uneven" in the print result. This procedure results in a very good degree of conformance between prints on different printing presses, types of paper and with different screenings.

For this process, you proceed as follows:

- Select and determine a reference printing condition
- Define and image a test chart
- Print the test chart under standardized conditions
- Measure several printed test charts, average and smooth the data
- Calculate the gray balance adjustments
- Calculate calibration curves
- Use the new calibration curves when imaging the test chart again
- Print the test charts and check the results

The gray balance optimization process is particularly suitable for visually adjusting printing conditions that do not exactly correspond to standards and where paper grades, inks, screening and ink trapping characteristics deviate from the reference printing conditions.

As a general rule this procedure does not contradict the ISO standard or the Process Standard Offset (PSO) but a sensible complementary method for achieving a certain goal.

Fundamentals
Characterization Data, ICC Profiles and the Gray Balance

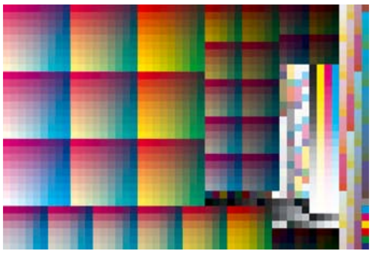
Reference and process printing conditions are described through characterization data and the appropriate ICC profiles created from them. Characterization data and ICC profiles already contain the gray balance and tone reproduction values of a printing process.

Characterization Data and Profiles

Characterization data is the specification of a clear relationship between digital tone values and measured color values in printing (CMYK process color values / CIEXYZ, CIELAB or spectral color values). Characterization data is used in workflows in the form of color management to describe different input and output processes. It represents the starting point for calculating device profiles or printing process profiles and may also be used for monitoring printing processes. Characterization data contains the gray balance and tone reproduction values of a printing process.

Characterization data is calculated using a test chart corresponding to ISO 12642-2:2006.

Figure 3: ISO 12642-2-compatible test charts (visual and random)



ICC profiles or device profiles are standardized files for describing the color properties of devices, images and graphics when working with colorimetric standards. ICC profiles supply color management systems with the required information in order to transform color data between the widest ranges of color spaces. ICC profiles contain the gray balance and tone reproduction values of a printing process.

Influence of the Color Separation on the Gray Balance

In practice, a gray is rarely made up of purely chromatic colors. When image data is separated using ICC profiles, a considerable portion of the black ink is present in the gray axis, and even dominates color composition from a certain level. Gray graphical elements such as logos or diagrams are generally printed with black only and do not require gray balance of the chromatic colors.

Gray Balance and Conventional Chromatic Composition

In conventional chromatic composition, the graying part of the chromatic colors is replaced by black from a defined threshold on. One strategy here is to begin using black at a later starting point. This black is also known as skeleton black, as it only occurs in dark gray areas. Figure 4 shows such a gray characteristic.

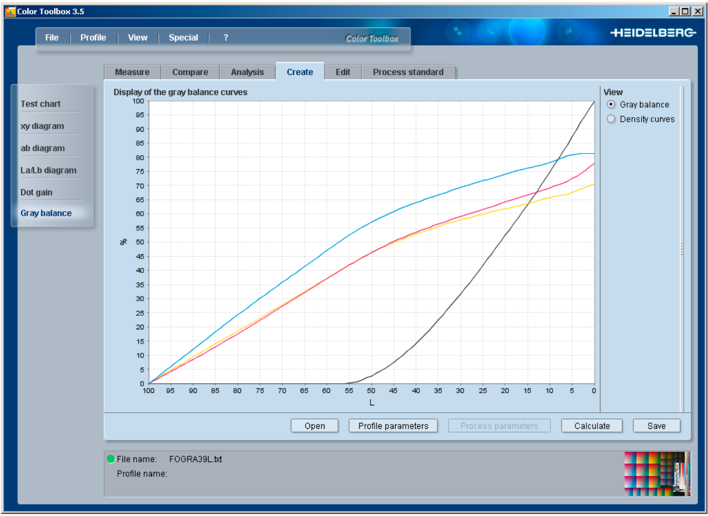


Figure 4: Gray balance of a standard profile: Conventional black with a length of 5

Today, black is often used from a very early stage, which means that chromatic colors are slowly replaced by black.

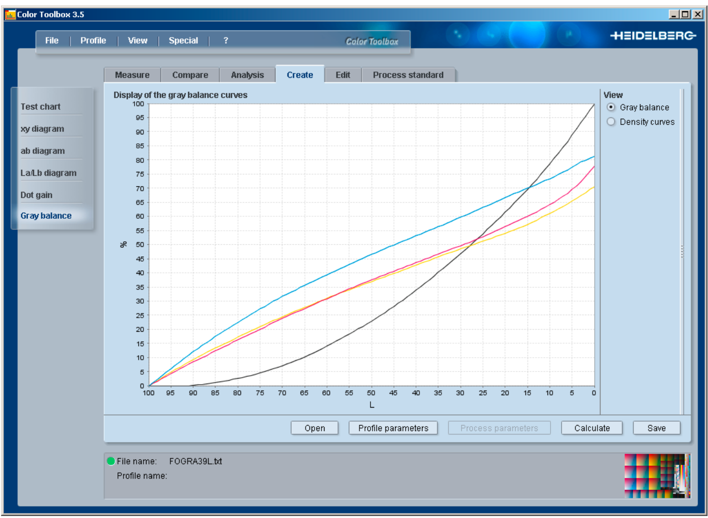


Figure 5: Gray balance of a standard profile: Conventional black with a length of 9

Figure 5 shows a typical ICC profile in which black is used at around 10% cyan. Altogether, a significant proportion of the chromatic colors are replaced by black, leading to lower sensitivity of the gray to ink variations.

Gray Balance and Achromatic Composition

A still greater proportion of chromatic colors are replaced in achromatic composition. This term originally related to the complete replacement of the chromatic color parts by black. However in practice this did not result in good printed images so the practice fell out of favor. The flexibility to adjust the starting point and extent of the chromatic color replacement for achromatic composition when creating a profile using the Profile Tool allows you to ensure a seamless transition between strong achromatic composition and short skeleton black.

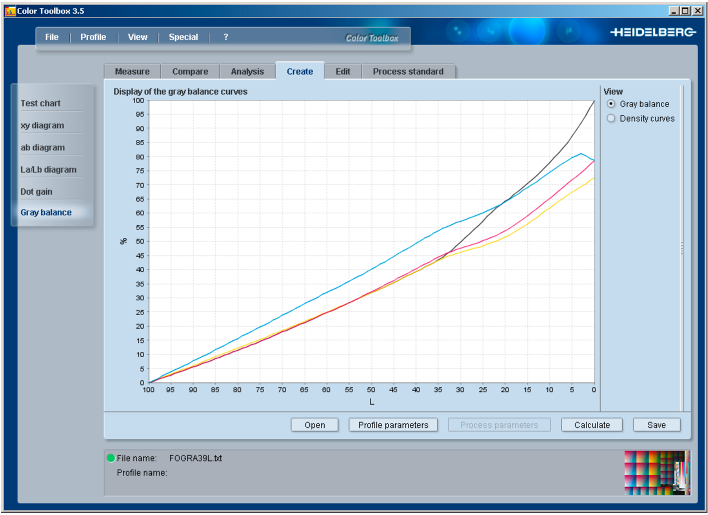


Figure 6: Gray balance of a standard profile: Achromatic composition with G50

Figure 6 shows the replacement of chromatic inks at medium achromatic composition with 50%. There are as many chromatic colors as black over a large area of the gray axis. The black only becomes dominant again in the shadow areas.

Figure 7 shows a strong achromatic composition in which 80% of the chromatic colors are replaced by black.

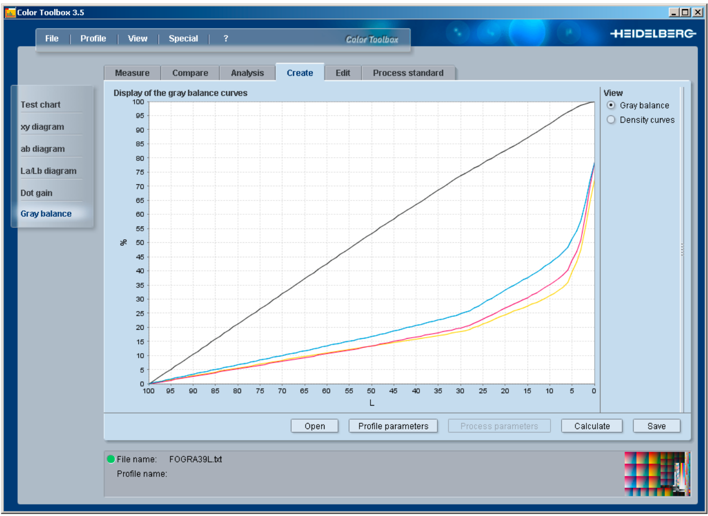


Figure 7: Gray balance of a standard profile: Achromatic composition with G80

Gray Balance and Print Stability

In Table 1 you can see the effects of different levels of black generation and GCR settings to gray balance.

Tabelle 1: Influence of black composition on fluctuations of the tone value increase of a medium gray tone with L* = 50 (values rounded)

FOGRA39	U300 K100 5-5	U300 K100 9-5	U300 K100 G50	U300 K100 G80
C / M / Y / K	57 / 46 / 46 / 3	47 / 38 / 37 / 23	40 / 32 / 32 / 32	17 / 13 / 13 / 53
L* / a* / b*	51,9 / -0,1 / -1,3	51,5 / 0,1 / -1,5	51,9 / -0,1 / -1,1	52,1 / -0,2 / -1,5
C / M / Y / K	60,5 / 46 / 46 / 3	50,8 / 38 / 37 / 23	43,2 / 32 / 32 / 32	18,4 / 13 / 13 / 53
L* / a* / b*	50,7 / -2,2 / -3,1	50,4 / -1,7 / -3,2	51,09 / -1,3 / -2,3	52,8 / -0,5 / -1,9
dE76	3,0	3,1	1,9	0,6

When using a short black in the color separation (profile U300 K100 5-5), a change in cyan has a very noticeable effect. A difference of dE = 3.0 in gray results in a clearly visible deviation which is generally no longer accepted. This also applies to a profile with a long black (U300 K100, 9-5). Although there is less cyan here, the fluctuation is comparable.

An improvement can first be seen when using a moderate achromatic composition (U300 K100 G50). A 4% fluctuation of the cyan in midtone causes color shifting of a dE of 1.9 in medium gray. This value is also not ideal, but certainly an improvement. The change only becomes small when extensive GCR is used.

Changes to this extend do not normally occur in the course of a print job, although there are always minor fluctuations of the process colors. It is therefore all the more important that these fluctuations do not have too great an influence on gray reproduction. This can be achieved using (moderate) achromatic composition.

Fundamentals
Definition of Gray Balance Scales

Gray balance is defined as a set of tone values for cyan, magenta and yellow which produces an achromatic color when printed and viewed under specific conditions. The printing conditions are defined, for instance, in the applicable process standards (Process Standard Offset, German Printing and Media Industries Federation (bvdm)) based on the ISO directives (ISO12647-2:2004 or appendix Amd1 from 2007). The viewing conditions are also standardized by ISO.

In practice there are two definitions of a gray, which are explained for informative purposes in the ISO standard 12647-2:2004:

a) a color tone which has the same a* and b* values of the CIELAB color space as the printing material and
b) a color tone which has the same a* and b* values of the CIELAB color space as a black color tone of the same brightness on the printing material.

Definition a) is more suitable for light gray values where the printing material is a significant factor. The influence of the printing material decreases in darker tone values where comparison with the black gains importance, in which case definition b) is preferred.

In practice it is sensible to construct a gray balance that combines definition a) in the highlight area and definition b) in the shadow area. There is not yet a uniform procedure for this. An initial approach would be a linear curve in the CIELAB color space between the paper white and the neutral 3-color gray in the shadow area.

However, an exact definition is not necessary for practical application. Amongst others, the approximate values from the ISO standard (25-19-19, 50-40-40, and 75-64-64) are used in the method developed by Heidelberg. Other reference values for the process colors are calculated through simple interpolations. The colorimetric values from the reference printing conditions and the profiles are determined by these reference values.

Fundamentals
Process Monitoring and Gray Balance

Process monitoring and control during printing is based on quality control strips that are used. With Prinect Image Control it is possible to use the entire print sheet for monitoring and regulation purposes. However, this special case will not be examined here.

Checking Inking Values in Printing

The reference printing conditions and reference printing profiles in sheet fed offset printing are based on a white measurement backing and standardized papers and colors. A black measurement backing is generally used when printing. Papers and colors deviate from the standard to a smaller or larger extent, and the drying behavior of the inks also results in a change to the color values. Reference values are required that take into account the various types of measurement backings, paper and ink as well as different drying behaviors. The best possible values can be ascertained with a little work and are then stored for reference purposes. These values are then used for setting up and monitoring production with the aid of different control elements such as step wedges and control targets.

Checking the Tone Value Increase

The reference printing condition indicates the tone value increase. The tone value increase should be set regardless of the measurement backing, paper, inks and drying behavior. Although in practice there are small dependencies on the measurement backing and drying, these can be disregarded with regard to the tolerances.

Tone value increase is not generally checked during make-ready and production as only a small number of color patches are available in the quality control strip; therefore a process calibration has to be performed in advance.

Today, additional control elements in the form of step wedges are often placed on the print sheet if sufficient space is available. These control elements can be assessed at a later stage and used for recalibration.

Checking the Gray Balance

Composite gray elements with values of 70-60-60 or 50-40-40, for instance, are present on some quality control strips. Reference values for these tone value combinations can be calculated from the reference printing conditions being used, however, these values can present a problem when different substrates or measurement conditions are used. In these instances neutral gray must be adjusted on press by modifying the inking and then the gray values of control elements can be used for production monitoring.

A description of gray balance based control procedures is described in the following chapter “Application”.

Application
Gray Balance Optimization Procedure

The steps required for optimizing gray balance are described as follows:

Linearization of the platesetter (optional)

Platesetter linearization is not essential, but this can be useful for purposes of end-to-end process monitoring. Linearization can be carried out using the Calibration Tool and a plate measurement device.

Imaging a set of plates with ISO 12642-2 test charts

A linear set of plates is output from a properly calibrated platesetter. This set includes a test chart for calculating an ICC profile as well as elements for process monitoring (quality control strips, step wedges) and for visually checking the gray balance. The set of plates is output without process calibration.

Run the press to a standard printing condition

Linear plates are run to standard values for inking using the color bar. After sheets are up to color and conform to standard values (usually run several hundred to a thousand sheets to stabilize the press conditions) several samples are pulled and inspected for any possible defects.

Measuring the test charts

Test charts are measured using Prinect Image Control or a suitable external measuring device. Sheets may be averaged and possibly even smoothed using Quality Monitor. Thought should be given to the backing used for measurement. If you are using a device like Prinect Image Control the backing is black because its primary function is process control. Standards clearly state that process control requires black backing. It may be necessary to measure for gray balance optimizing or profiling on an off line measurement device, or backing the targets up with white backing on the Prinect Image Control.

Calculating an ICC Profile

A standard ICC profile can be created from the linear test forms using the Profile Tool. The profile settings for area coverage, black composition and gamut mapping are of no significance here as only the absolute color values from the ICC profile are used for gray balance optimization.

Calculating Gray Balance Optimization

The gray balance optimization program in the Prinect Color Toolbox calculates and saves a correction data record by analyzing the ICC profile of the reference printing condition and the ICC profile of the linear print.

Importing Gray Balance Optimization values into the Calibration Tool

In the Calibration Tool a process calibration is calculated based on a linear set of process curves and saved in the internal database.

Output and print a set of calibrated printing plates

When the process calibration is activated, the calibrated set of plates is output again and printed according to the process standard in use. Again the sheets are brought up color using the same standard condition as the linear run, and again the press is allowed to stabilize. When sheets are ready several samples can be removed and checked both visually and metrological. At this point to the results can be compared to a proof which corresponds to the reference printing condition.

Re-measuring the calibrated test chart

The calibrated test chart can be used for process monitoring and creating a profile of the printing process during production. The inking values of the printing process and the (various) tone value increase curves can be saved as target values in the Quality Monitor.

Some details of this procedure are described in more detail below.

Application
Test Charts for Gray Balance Optimization

In principle, any test chart that is ISO 12642-2 compatible may be used along with the required quality control strips. In practice it is a good idea to place a number of additional gray elements and images on the test chart for visual comparison. It is also good practice to distribute several step wedges across the sheet for checking consistency of tone value increase.

Figure 8: Example test chart for gray balance optimization

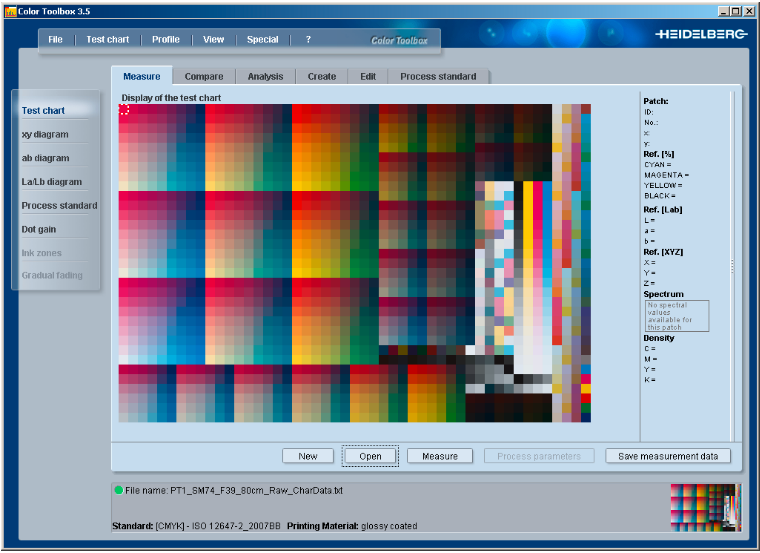
During a test print in Heidelberg, the test chart displayed above was used. In the center you can see the ISO 12642-2 test element in a randomized form that ensures even ink coverage. The step wedges for optionally evaluating the tone value increase are located on the right, left and center underneath this.

The quality control strip is automatically placed at the tail edge of the sheet when image setting. Images from the “roman 16” series of reference images sold by the German Printing and Media Industries Federation (bvdm) were used for visually checking the gray balance.

Application
Measuring and Evaluating the Test Charts with Prinect Image Control

For those who use Prinect Image Control, appropriate masks can be generated for automatic measurement of the appropriate color management target and control strips. Masks already exist for standard targets in their standard formats. In order to be assured that reliable data records are obtained, several sheets printed at different times should be measured. Measured values can be transferred to Quality Monitor via the Color Interface module of Prinect Image Control.

Figure 9: ISO 12642-2 test element in ordered view



The measured values of the ISO 12642-2 test charts are averaged using Quality Monitor. Step wedges should be used when analyzing tone value increase, particularly as they show a smoother result when averaged across the print sheet.

Application
Profile Calculation

You do not have to make any special settings in the Profile Tool for the profile calculation. The default settings for offset printing on coated or uncoated paper can be used if desired but they have no effect on gray optimization. The profile is only used temporarily for gray balance optimization and can then be deleted.

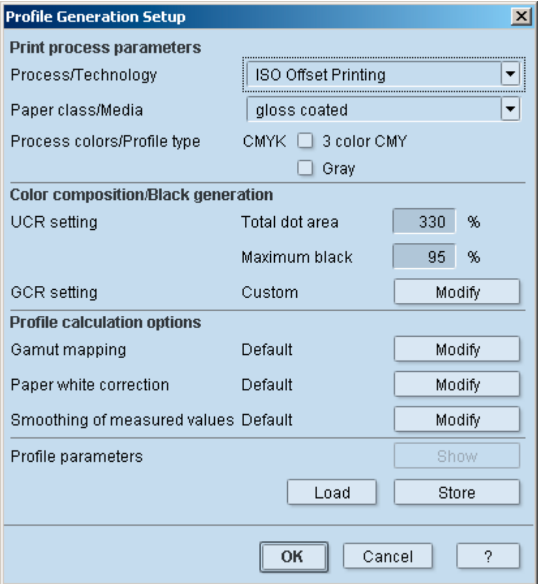


Figure 10: Profile setting parameter U=330 K=95 length=7 width=5

The averaged measured values are used to generate the profile of the uncalibrated printing process. The gray balance can be viewed following calculation.

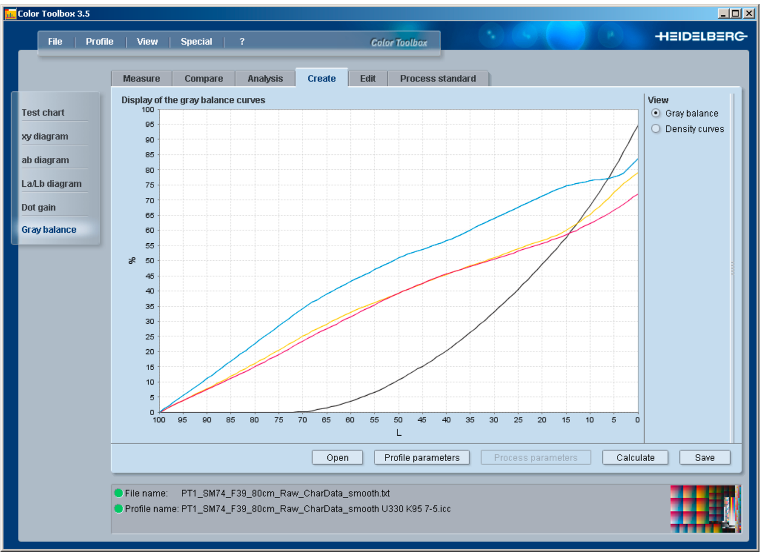


Figure 11: Gray balance out of profile (with black)

In this fairly typical example, there is too much yellow in the highlight area and the shadow area in the area of the neutral gray axis (a* = 0, b* = 0).

If you wish to view only the gray balance without the black, you can calculate a three-colored CMY profile using the Profile Tool.

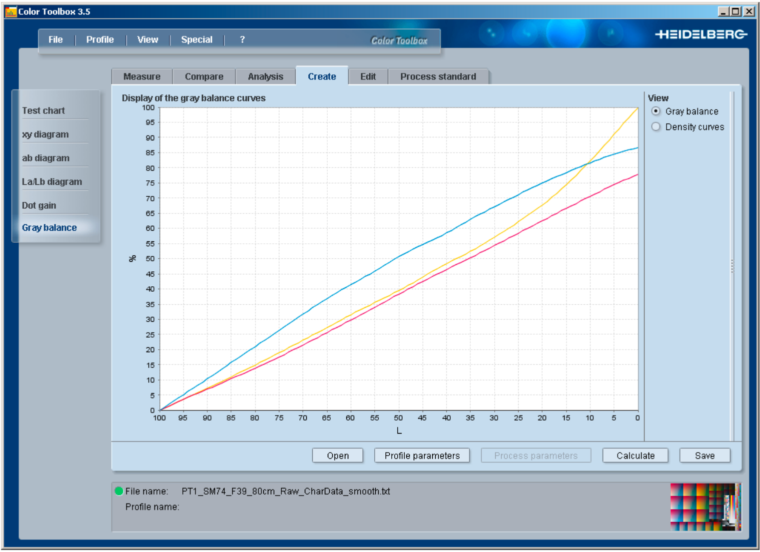


Figure 12: Gray balance out of profile (three-colored)

Here you can clearly recognize a problem in the printing process. A higher than normal amount of yellow is required for a neutral depth. As yellow was the last color to be printed, the yellow is either under-inked (an insufficient ink film thickness) or the ink trapping behavior in the three color overprint is not ideal. A visual evaluation of the print sheet confirmed that too little yellow was printed and the neutral gray tones had a strong blue tint. For these reasons great care should be exercised when using gray balance optimization. Gray balance optimization should never be used to compensate for errors in procedures or processes.

Application
Gray Balance Optimization

Gray balance optimization is opened via the “Special” drop-down list in the “Create” main program function.

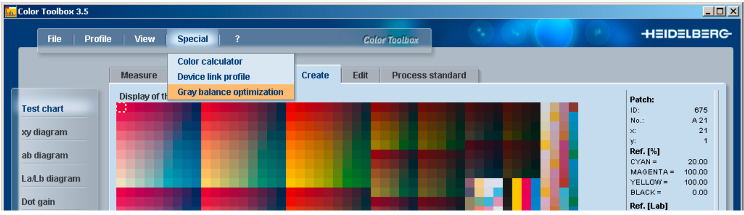


Figure 13: Opening gray balance optimization

Calculating Correction Data

The first step is to open either a reference profile or reference data. This selection is made via the corresponding buttons. The procedure for creating and changing reference data is described later.

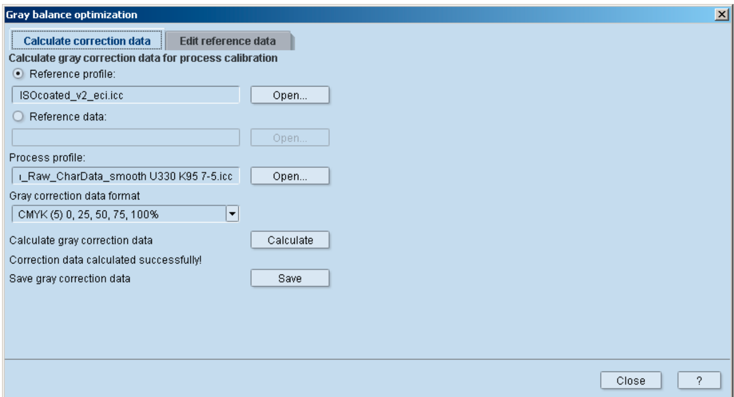


Figure 14: Gray balance optimization

The second step is to open the ICC profile of the printing process to be calibrated and select the correction data format. Gray correction data can be calculated with 5 or 8 reference points. This can be selected in the “Gray correction data format” menu.

If gray correction with 5 reference points is selected, corrections are calculated at 25%, 50% and 75% (the values relate to the cyan component). This is in most cases the best to choose from because the curves that results are extremely smooth and do not introduce any anomalies into the calibration.

Gray corrections with 8 reference points are somewhat more precise as corrections for 10%, 20%, 30%, 40%, 55% and 70% are calculated here. This selection can often lead to erratic curve shapes that are more suitable for digital type devices. Gray corrections at values greater than 75% are not advisable as black already dominates in the normal color separations. Overcompensated corrections may result if three-colored over print values in the shadow area deviate too far from the reference values. This is a common occurrence in offset printing.

At the same time as the gray correction, a correction of the tone value increase of the process color black is carried out. The number of reference points here is also 5 or 8.

After you have selected the appropriate data format, the calculation begins. This takes around 20 seconds and after completion the correction data can be saved.

The correction data can be viewed with a text editor. The data is saved in an industry standard text format similar to the characterization data of the ISO 12642 standard.

Editing Reference Data

Reference printing conditions are generally available as characterization data or ICC profiles. Information about gray balance is required for gray balance optimization, but this information cannot always be retrieved directly from the characterization data and needs to be derived from the existing data through interpolation. This is a relatively simple process using ICC profiles and a color calculator.

You can use this method to determine certain gray values (e.g. for CMY = 25%, 19%, 19%), and then edit them, for example if you wish to assign a different brightness or chroma value. This procedure is possible with the “Edit reference data” function.

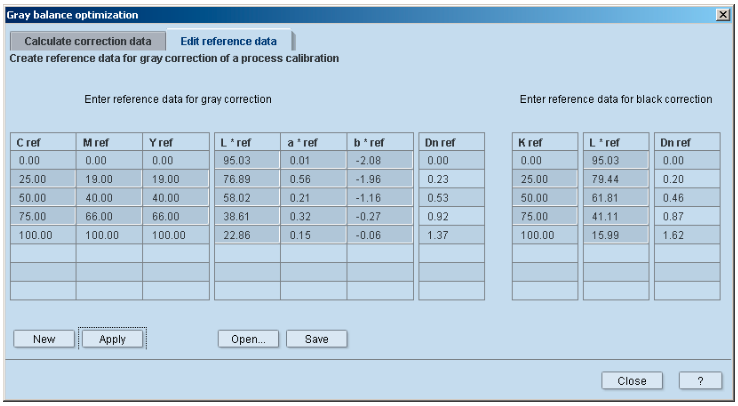


Figure 15: Applying reference data from “Calculate correction data”

Reference data can be extracted directly from the reference profile and then adjusted as desired. Depending on the correction data format, 5 or 8 data records are displayed for the gray correction and black correction. These values can be modified, saved and opened again. If desired the files can be viewed using a text editor program.

After values have been extracted completely new reference data can be created, and the default values for CMY and K can also be changed.

These functions are used to create reference data for which no reference printing process exists. Using this function you can define a new paper white for C = M = Y = 0 as well as a new gray value for C = M = Y = 100. After these two points have been modified the other values can be entered to create the desired tone value and gray balance. On the basis of these parameters you can perform a calibration and then create a reference data record for this printing process.

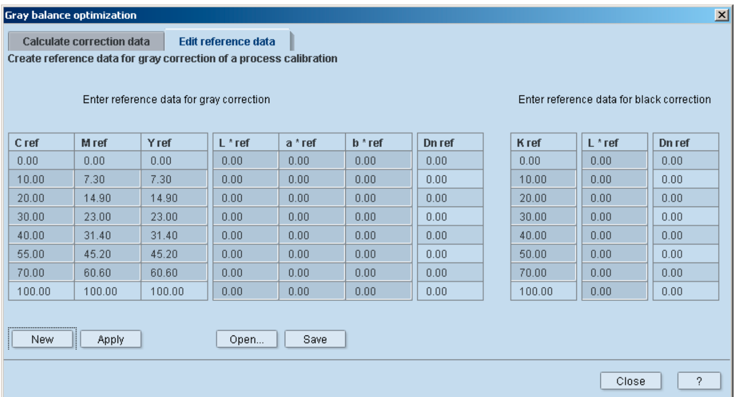
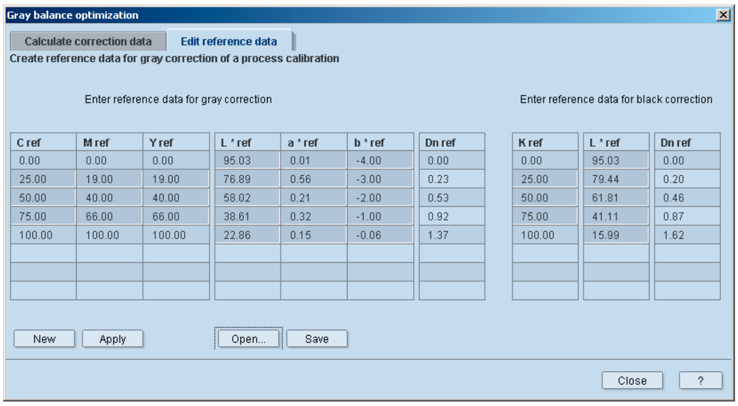


Figure 16: Creating new reference data (5 or 8 data records)

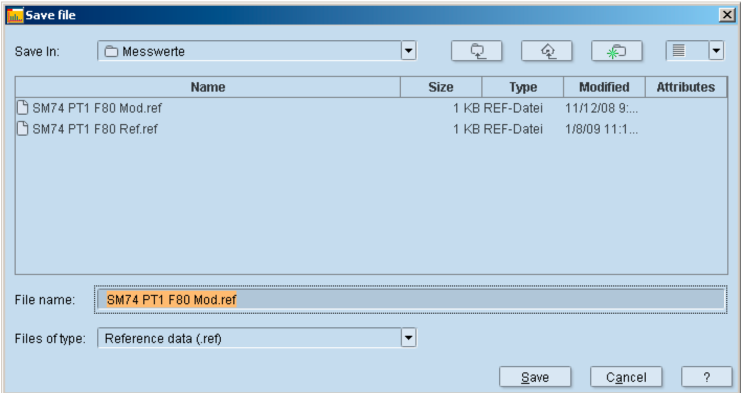
One application of these functions is the correction of the optical brighteners. Optical brighteners can typically be noticed in the b* components. If you wish to reduce the effect of the optical brighteners of the production paper, the b* value in the paper white of the reference printing condition can be increased. The gray values must then be adjusted to keep them in proportion.

Figure 17: Exemplary modification of the paper white after adopting the reference data



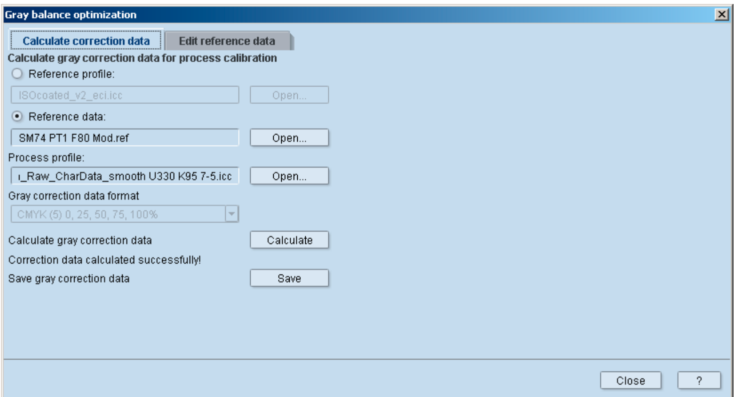
The above figure shows the change of the paper white to b* = -4.0 and possible changes to the other reference values. This data record is saved and called up when calculating the correction data.

Figure 18: Saving a modified reference data record



After saving, the reference data record can be used for calculating correction data.

Figure 19: Calculating correction data with modified reference data



The gray correction data format is specified by the format of the reference data and cannot be changed. The correction data can now be calculated and saved.

Application
Process Calibration

Once you have created a correction data record with the gray balance optimization tool, a process calibration for plate setting has to be calculated from these values using the Calibration Tool. Only the steps that deviate from the usual procedure in connection with gray balance optimization will be described at this point.

Creating a Calibration Group and a Calibration Data Record

The Calibration Tool of the Prinect Color Toolbox allows you to create a "Gray balance optimization" calibration group. This step is recommended.

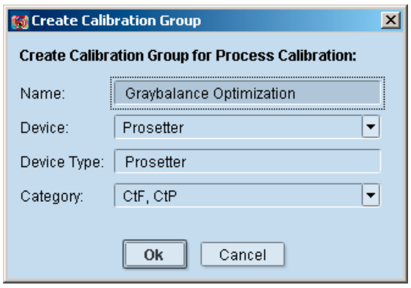


Figure 20: Creating a new calibration group

You can choose any name here as well as at any other point.

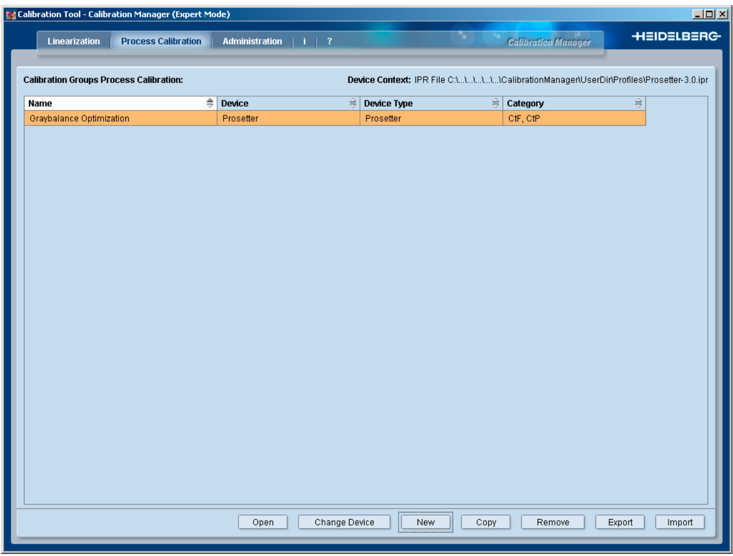
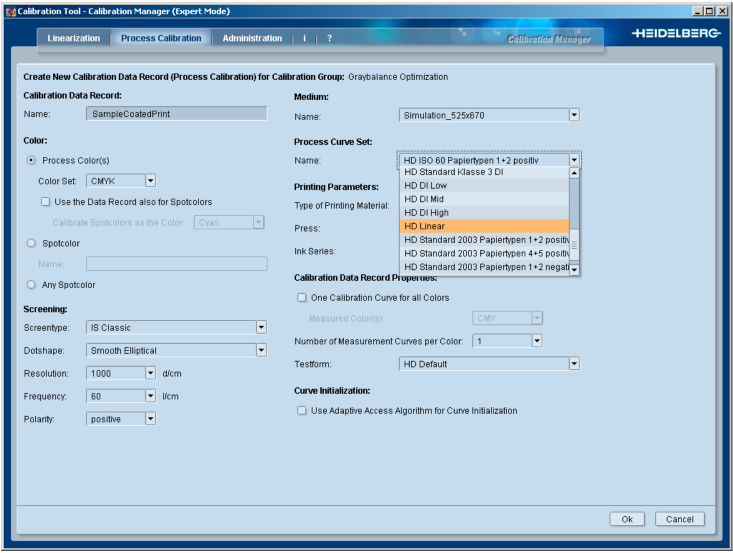


Figure 21: Creating a "Gray balance optimization" calibration group

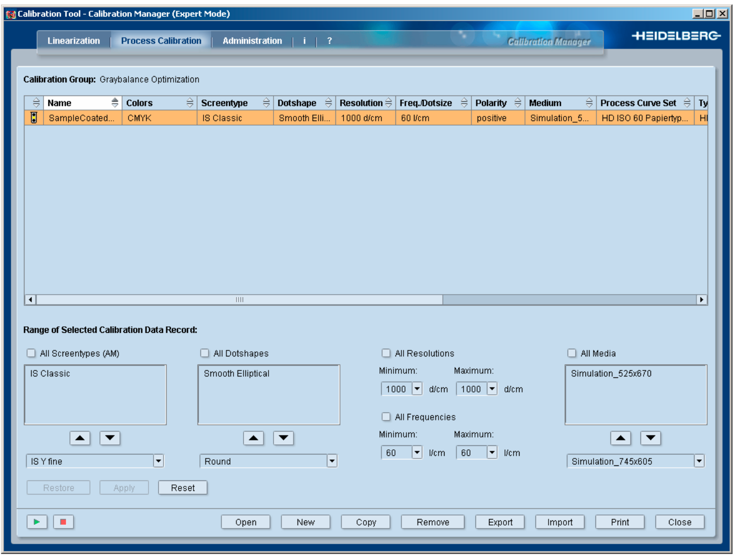
The calibration group opens and a new calibration data record is created.

Figure 22: Parameter a new “SampleCoatedPrint” calibration data record



Any name can be chosen for the data record, in this example it has been named “SampleCoatedPrint”. Color, screening, medium and printing parameters are set in the normal way. However, a linear data record, “HD Linear”, has to be selected as the set of process curves at this point. Parameterization is finished by pressing “Ok” and the data record appears in the calibration group.

Figure 23: Display and selection of the new calibration data record “SampleCoated-Print”



Importing the Gray Correction Data

Once the new calibration data record has been created, the data record is opened and the gray correction data from the gray balance optimizer is imported.

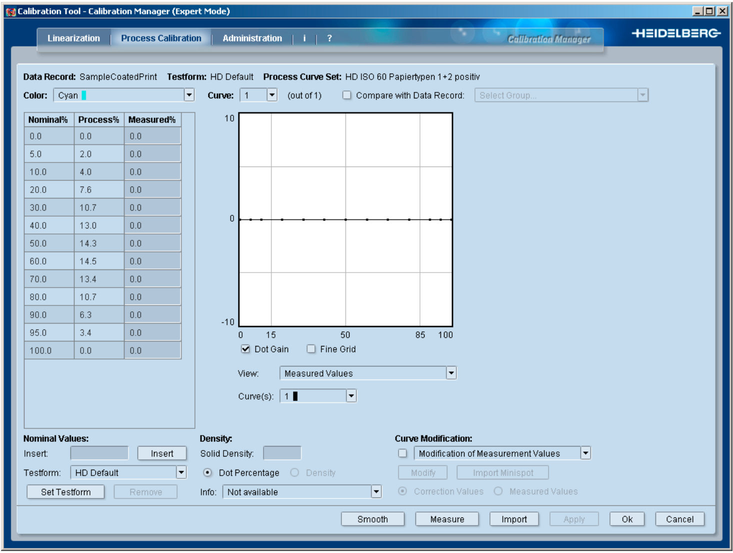


Figure 24: Importing the gray correction data

When you press the “Import” button, a small dialog box appears asking you to select the data type.

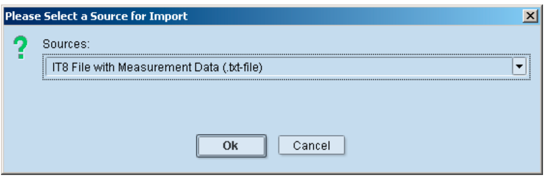


Figure 25: Selecting the type of data source

In this case “IT8 file with Measurement Data” is selected as the data type and the gray correction data record is then selected in the next dialog box. After selecting “All Colors” the data is imported and displayed in a table and a graphic.

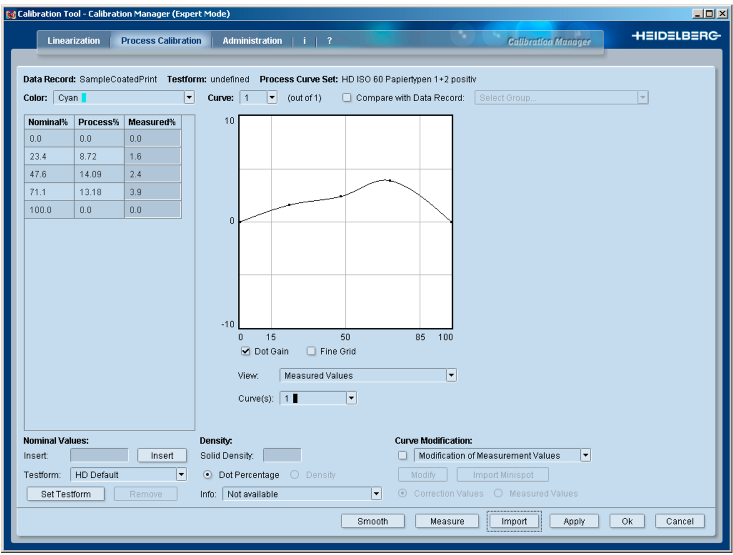


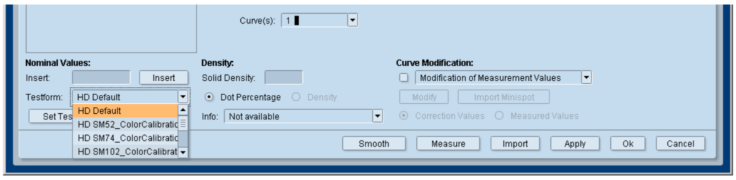
Figure 26: Display of the gray correction data record (cyan color)

The data is transferred to the database by pressing the “Apply” or “OK” buttons.

Exporting the Calibration Data Record

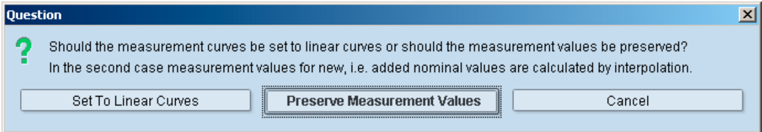
The calibration data record can be used in the Profile Tool for converting measured values. For this purpose, the calibration data record is initially changed to a different format. This can be done by inserting nominal values or more simply by selecting a test chart.

Figure 27: Converting the data record



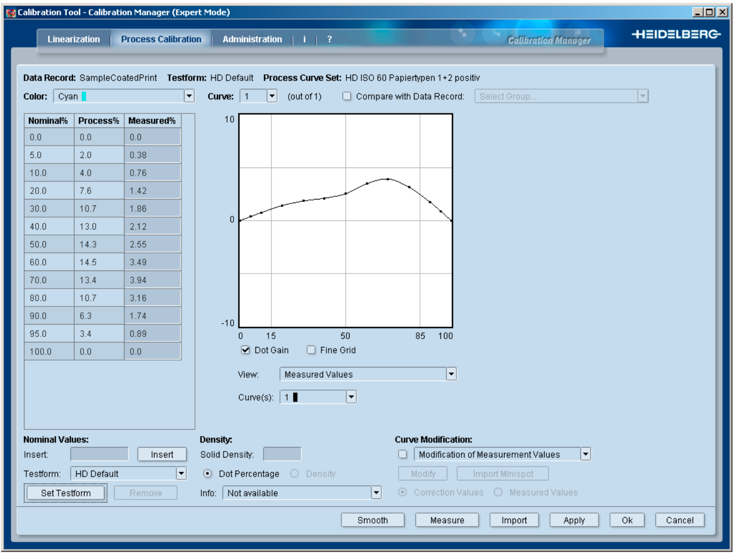
In this example the “HD Default” test chart is selected and confirmed by pressing “Set Testform”.

Figure 28: Query of test chart conversion method



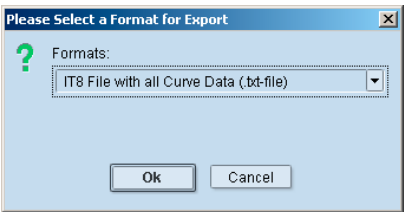
A query as to which method the test chart is to be converted by appears. “Preserve Measurement Values” should be selected here.

Figure 29: Converted measured values



The new values and curve are displayed and can be confirmed by pressing “Apply” or “OK”. The calibration data record can then be exported from the calibration group display.

Figure 30: Selection of data format



The suitable data format must also be selected here. In this case this is the format “IT8 File with all Curve Data” again. The data is then saved under a name as usual.

Application
Profile Conversion

Prinect Color Toolbox allows you to convert the measured values of the ISO 12642-2 test element using a calibration data record. This converts the CMYK process color values, after which a new profile can be calculated. This function can be used in order to simulate the print result with gray balance calibration and to make the changes visible in advance.

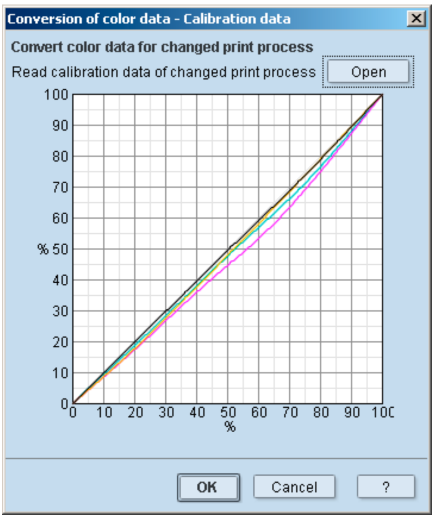
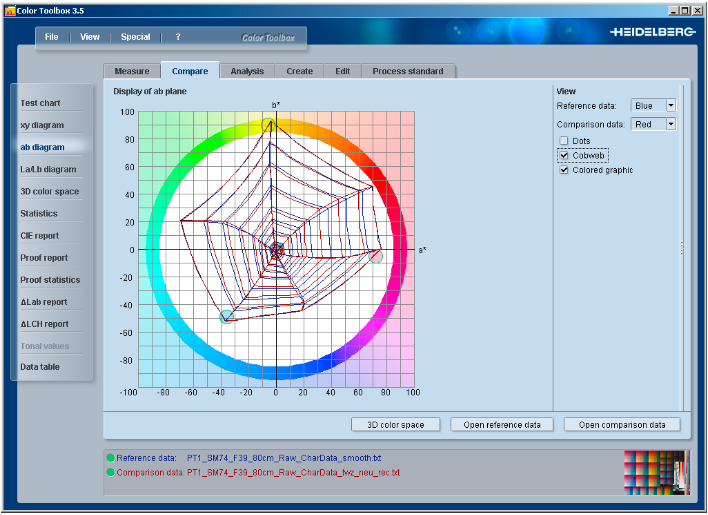


Figure 31: Converting color measurement data

Once the measured values have been converted, a profile has to be calculated from these measured values for further comparison. The same settings as described above are used for this. The profile is saved.

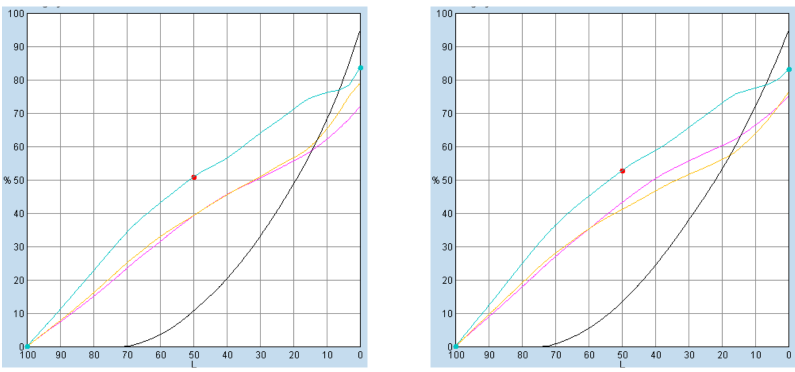
In the main program function “Measure” a new test chart is created in ISO 12642-2 format and, using the “Calculate measured data from profile” function, new measured values are calculated and saved. These and the original measured values can now be compared using the functions of the Prinect Color Toolbox.

Figure 32: Comparison of old (blue) and new (red) measured values



The medium color deviation is dE = 3.0 with a standard deviation of 1.6 and a maximum value of dE = 8.3.

Figure 33: Comparison of old (left) and new (right) gray balance and black gradation



The converted measured values and the profile can be used as the current practical printing condition for color separation and proof printing. A further print for evaluating the test charts is not a necessity, however it is sensible in order to determine the reference values for process monitoring.

Application
Monitoring and the Process Standard

Following gray balance optimization, the tone value increase curves no longer necessarily correspond to the specifications of the reference printing condition. The inking values are generally within the tolerances (unless too many optical brighteners in the paper result in an excessive shift in values). A good practice is to save the current process measurements as the default “standard” for further prints.

The Prinect Color Toolbox allows you to save the current measured values as the process standard and select them where necessary.

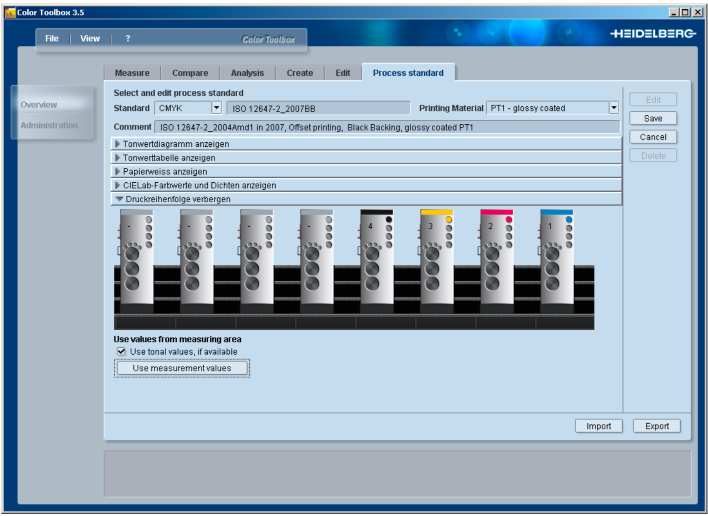


Figure 34: Applying measured values as the process standard

A new process standard can be set up in the “Process standard” main program function by pressing the “Edit” button. Initially, you have to enter a new name for the standard. It is useful at this point to enter a comment.

Go to the “Confirm measured values” button in the “Print order” tab. “Apply tone values” must be checked. All existing values are applied and can be checked and manually corrected in the corresponding tabs. The values for the secondary colors have to be added in the “Color values and densities” tab.

The “Tone value table” tab allows you to modify the tone values if necessary. The tone value curves are often a little wavy, as the values may deviate slightly from a harmonious curve depending on the design of the test chart and the position of the ink zones. The modification of the values is visible in the curves when you save the standard and open it again.

Figure 35: Entering missing values for the secondary colors

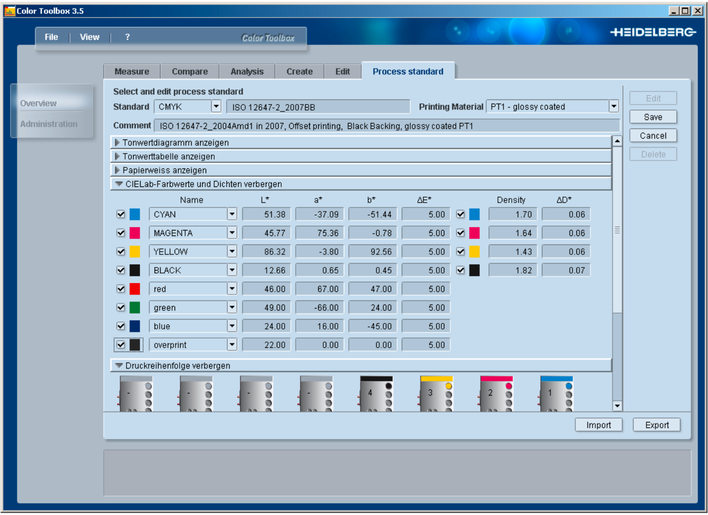


Figure 36: Manually adapting the tone value increase curves

Application
Summary

This user guide has described how to use gray balance optimization on the basis of a practical example. The gray balance optimization process is a tool for adapting a printing process to a specified gray balance derived from a reference printing condition by performing a process calibration. To ensure genuinely stable printing, a color composition with plenty of black in the gray axis should be a priority. Following calibration, the reference values have to be saved in the corresponding programs for setting up printing and the process monitoring. If all of these points are observed, a high-quality print should be attainable.

Glossary

Characterization
Colorimetric description of a (printing) process.

Characterization data
Specification of a clear relationship between digital tone values and measured color values in the print (process color values CMYK / color values CIEXYZ or CIELAB). Characterization data is used in workflows based on color management to describe different input and output processes. It represents the starting point for calculating device profiles or printing process profiles and may also be used for process monitoring.

Characterization data record (table)
Data format for transferring characterization data. The international standard ISO 12642 defines the digital tone values to be used as well as measuring conditions and the file format for printing processes.

ECI European Color Initiative
The European Color Initiative (ECI) is a group of experts who are involved in the media-neutral processing of color data in digital publication systems. It was founded in 1996 as an initiative by the Bauer, Burda, Gruner+Jahr and Springer publishing houses in Hamburg. The ECI develops reference printing conditions in cooperation with Fogra and provides resources such as ICC profiles and control elements (www.eci.org).

Fogra Graphic Technology Research Association
Fogra Graphic Technology Research Association advocates printing technology in the areas of research, development and application and aims to make the results utilizable for the printing industry. The association maintains its own institute for this purpose. Fogra provides characterization data as well as control elements (www.fogra.org).

German Printing and Media Industries Federation (bvdm)
The German Printing and Media Industries Federation (bvdm) is the employers' and trade association of the German printing industry. Its members are twelve independent state associations, in which almost 6000 print shop and media enterprises are organized. The associations of the printing industry are in turn active in national and international committees and associations in order to stand up for the interests of their member print shops. The bvdm provides publications and resources such as the Print Media Standard, the Process Standard Offset or the roman 16 reference images (www.bvdm-online.de).

Gray balance

A set of tone values for cyan, magenta and yellow in the database or on the color separation films which produces an achromatic color when printed under specific printing conditions and viewed under specific conditions.

ICC profile

ICC profiles or device profiles are standardized files for describing the color properties of devices, images and graphics when working with colorimetric standards. The ICC profiles supply color management systems with the required information in order to transform the color data between the widest ranges of color spaces.

Printing material

Paper or material similar to paper for the print job on a sheetfed offset press. The parameters of current printing materials generally deviate from the reference values of the ISO 12647-2 standard to a larger or smaller extent and exert a considerable influence on the reference values.

Print order

Specification of the sequence of colors in a press. The characterization data and profiles have been determined for a defined sequence. The usual sequence is K, C, M and Y.

Process standard

A specification of the process parameters and their values that should be used when generating color separations for four-color prints or proof prints.

Reference printing condition

A standardized, generally known printing condition, in which the measured values adopt stipulated reference values. Example: FOGRA39, offset printing according to ISO 12647-2:2004 and Amd1:2007 on 115 g/m2 coated art paper, process colors in line with ISO 2846-1. Characterization data of reference printing conditions can be downloaded from Fogra.

Reference print profile

Exemplary and practice-oriented implementation of a reference printing condition with a defined total area coverage, black composition and adjustment to the color gamut. Reference press profiles can be downloaded from the ECI.

Tone value increase (dot gain)

Difference between the tone values before and after one or more processing steps. The dot gain can also be negative (tone value decrease). This specification mainly applies to a tone value of 40%. Units: %

Tone value increase characteristic curve (dot gain curve)

Graphic display of the tone value increase of a printing process. The tone values of the data record or film are given on the horizontal axis, and the tone value increase on the vertical axis.

Literature

ISO 12642-2:2006
Graphic technology – Input data for characterization of 4-colour process printing – Part 2: Expanded data set
International standard
Source: Beuth-Verlag, Berlin (www.beuth.de).

ISO 12647-2:2004
Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithographic processes
International standard
Source: Beuth-Verlag, Berlin (www.beuth.de)

ISO/TS 10128:2009
Graphic technology – Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data
International technical specification
Source: Beuth-Verlag, Berlin (www.beuth.de)

Process Standard Offset 2001/03
Description of the inspection methods and materials, the working procedures and requirements of data and films, test and proof prints as well as plate making and print run production.
Source: German Printing and Media Industries Federation (Bundesverband Druck und Medien e.V.), bvdm, (www.bvdm-online.de)

Print Media Standard 2008
Technical guidelines for data, films, proof printing and print run production
The Print Media Standard is made up of various modules, and it is the user's own responsibility to ensure that these are organized and implemented correctly. The Print Media Standard contains information on all significant components required for correct application in the individual printing processes.
Source: German Printing and Media Industries Federation (Bundesverband Druck und Medien e.V), bvdm, (www.bvdm-online.de)

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