Introduction

SCAMAX® document scanners are primarily used to digitize business documents and forms. Therefore, the standard calibrations of the devices are designed for the creation of compressed, clear color images, with the best possible qualitative conversion (*binarization*) into B/W images for subsequent processing, from a wide range of documents.
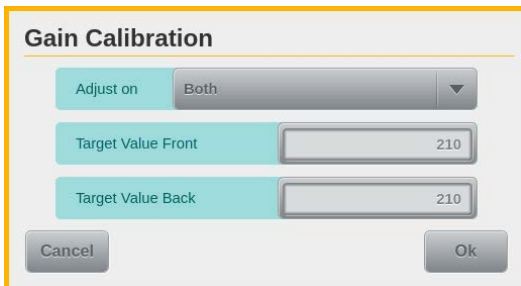
For some time now, the guidelines of international quality standards such as **ISO** (*International Organization for Standardization*) or **FADGI** (*Federal Agencies Digitization Guidelines Initiative*) have been used as assessment criteria for processing in the field of cultural assets (*archives, libraries, etc.*). Since these guidelines were developed for still image capturing by photo, reflected light or flatbed systems, it was previously considered unlikely that document scanners with rotating paper transport would be able to meet the necessary requirements.

Due to the excellent image quality of the cameras used and the precise transport system of the **SCAMAX®** document scanners, we are able to comply with the standard values of **ISO 19264-1 Level B** and **FADGI *****.

The following description contains all steps for the special calibration of the scanner and the determination of device-specific values to generate the necessary correction value tables.
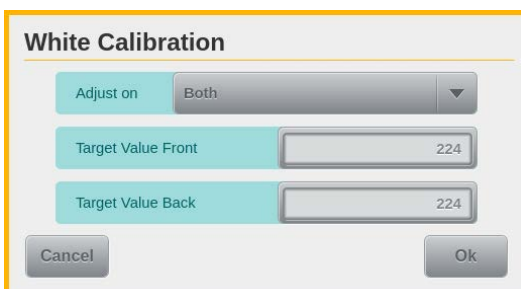
1. Scanner Calibration

The following calibration should be accomplished by someone who has completed a technical training for this type of scanner, as access to the scanner's service menu is required beside a clean sheet of InoTec white balance paper (*Art.No. s9100002 - please do **not** use other kind of paper!*).

The first step is a Gain Calibration to a **Target Value** of **210** (*default is 250*). For this purpose, the value of the fields **Target Value Front/Back** in the corresponding mask of the **Gain Calibration** button in the menu Service-> Calibration is changed accordingly and, after inserting the white balance paper, the calibration is started with the button **OK**. The last used target value will be stored in the scanner and thus also used in the future during a gain calibration performed via the similar button in the menu *Administration->Calibration*.

Also the White Calibration, as 2nd step of this calibration, is performed with a lower target value of **224** (*default is 260*). Like at the gain calibration, the value of the **Target Value Front/Back** fields is also changed here in the associated mask and saved for future calibrations from the areas *Service* and *Administration*. Then, as usual, perform the White Calibration with the paper provided for this purpose.

Actions to achieve the quality criteria for digital images according to FADGI with a SCAMAX® 6x1 series document scanner

InoTec

2. Reference Image in the sRGB Color Range

After performing the calibration described in the previous chapter, a reference image for each camera used has to be created with this scanner. A measured target must be used as a template for the reference image(s). In our example we refer to a **DICE** target from *Image Science Associates.* This targets must be handled with care, because only a clean target will give correct values. Reference images must always be saved as uncompressed color images in Tiff format. This can be done directly using an image editing program like **GIMP** (*see next chapter*) or a scanning solution like **SCAMAX scan** that can receive and save uncompressed images. The scanner should be turned on *several minutes* before scanning reference images so that it is already at *operating temperature*! In addition, the *Paper Passage Setting* in the scanner (*see chapter 5.4.2 in the User Manual*) should be turned to the smallest value.
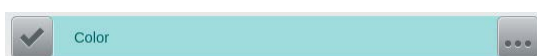
At the *Image Presettings* in the scan profile, the **Image Adjustment** must be enabled…
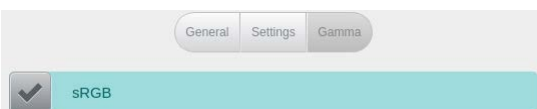
…and the option **sRGB** must be selected in the corresponding settings mask *Gamma*.
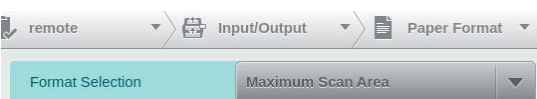
The same *Main Resolution* (*here 300 dpi*) must be selected, which will also be used in production

At the *Front Side Settings* the **Color** image must be marked…

…and the *Compression* must be changed to **24Bit uncompressed**, in the mask with the same name.

For the sake of simplicity **Maximum Scan Area** should be chosen at the *Format Selection* in the corresponding mask *Paper Format*.

In order to protect the test originals (*IT8 card, etc.*) that are still to be scanned, from now on the *Feeder Mode* should be switched to **Manual** and the *Separation* should be **deactivated** via the scan profile or the corresponding function keys in the scanner's scan screen.
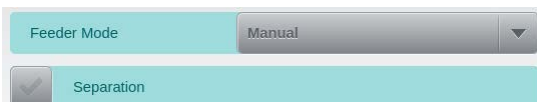
Test originals should be ejected to the rear output tray by setting the corresponding option to *Current Output to Rear at* **Every Scanned Sheet** in the *Output* mask.
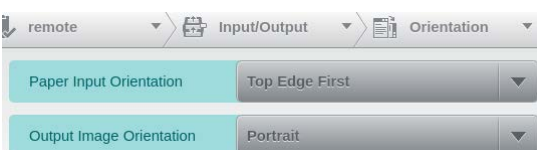
In the *Orientation* mask at the same sub menu, the *Paper Input Orientation* must be set to **Top Edge First** while the *Output Image Orientation* stays at **Portrait**.
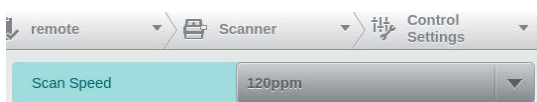
Using the setting screen *Operation* at the menu *Scanner* or the corresponding function key in the scanner's scan screen, the *Scan Speed* should be set to **120 ppm** or (*with Slow Mode Option*) even slower.
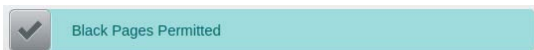
At the same mask the option *Black Pages Permitted* should also be activated.

With these settings, the present target must be scanned. Please make sure that the target is pulled in as straight as possible. When using SCAMAX scan, the scanned image can now be saved via *File->Save As* or *CTRL-S*. In the corresponding dialog, any path and file name can be specified for saving the image. **Tiff single pages** has to be selected as *File type* and *Color* must set to **Uncompressed** via at the button *Options*.When using SCAMAX scan, the four images can now be saved via *File->Save As* or *CTRL-S*.

3. Creation of Correction Value Tables

With the previously created reference image, a correction value table is generated in the next step which is calculated based on measured values and loaded onto the scanner as a so-called *Camera Curve*. The necessary measured values must be determined from the grayscale patches 10 to 21, which are located in the center of the target, from the data of the so-called Lab color space.
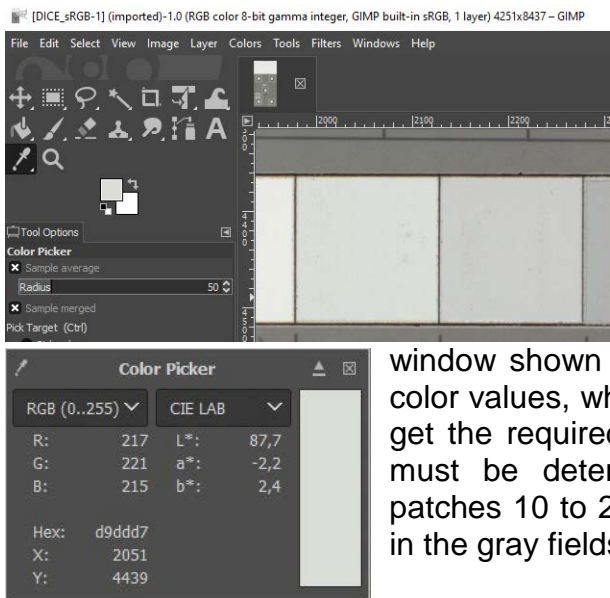
For this we use the free image editor **GIMP**. This shows the image with a built-in sRGB profile by default and is able to list average values for **L*a*b*** from a pre-defined sampling area by the *Color Picker* function. We recommend to choose an area size that covers at least 70% of one gray field's height. As soon as the activated Color Picker is clicked into the loaded image for the first time, the additional window shown on the left appears, offering two selections for color values, where **CIE LAB** must be selected at least once to get the required values. Using these settings, the Lab values must be determined from the above-mentioned grayscale patches 10 to 21. The sampling area should always be placed in the gray fields as centred as possible.
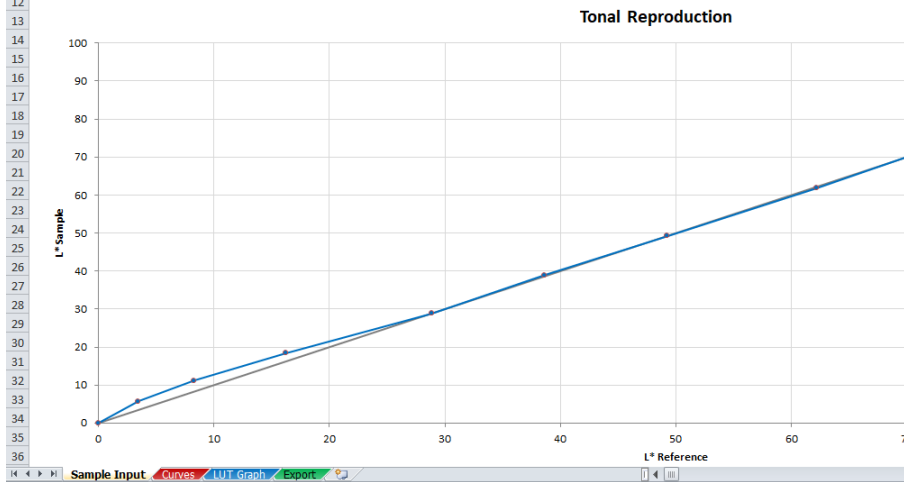
These values are required for the Excel workbook *TonalCorrection-DICE-Lab*, which is provided with this description and consists of four tables. At the table *Sample Input*, the reference values from the grayscale patches **10** to **21** of the used DICE target must be entered in the lines **6 - 8**. Into lines **9 - 11** of the *Sample* section, the values determined with **GIMP** have to be entered. The graph below the input area shows the tonal deviation of reference and measurement from the theoretical ideal line. After entering the two ranges of values, the workbook should be saved under a new name in order to avoid having to re-enter the values for further tests.
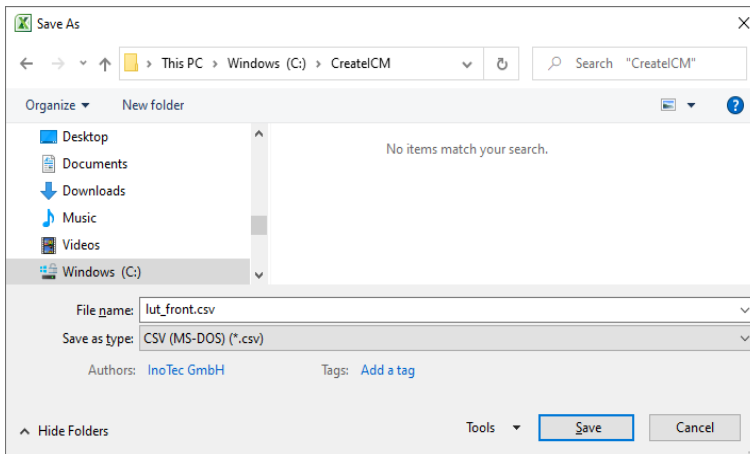
Sample Input

			Patch 21	Patch 20	Patch 19	Patch 18	Patch 17	Patch 16	Patch 15	Patch 14	Patch 13	Patch 12	Patch 11	Patch 10	
Ideal	L*	0,00	5,00	10,00	15,00	30,00	40,00	50,00	60,00	70,00	80,00	85,00	90,00	95,00	100,00
	a*	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	b*	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Reference	L*	0,00	3,44	8,29	16,19	28,86	38,62	49,25	62,15	72,06	82,14	87,34	92,02	97,06	100,00
	a*	0,00	-0,23	-0,81	-0,05	0,54	-0,18	-0,16	-1,07	-1,19	-1,06	-0,75	-0,60	-0,40	0,00
	b*	0,00	0,49	0,19	0,73	0,60	-0,04	0,01	0,19	0,28	0,43	0,21	0,23	1,13	0,00
Sample	L*	0,00	5,70	11,20	18,40	28,80	38,90	49,20	61,80	72,30	82,00	87,70	92,80	97,20	100,00
	a*	0,00	0,90	0,20	-0,20	-0,90	-1,30	-1,30	-1,20	-1,30	-1,00	-2,20	-1,80	-1,70	0,00
	b*	0,00	0,40	0,40	0,00	0,40	0,50	0,50	0,80	0,90	1,50	2,40	2,60	2,10	0,00

Tonal Reproduction

The second spreadsheet *Curves*, contains calculation fields in different blocks, which finally lead to a linear correction table for the scanner. The input field *Factor*, which is preset with the value **100**, should **not** be changed, as otherwise correction values might be determined which possibly lead to a non-compliance with the quality specifications. In the table *LUT Graph*, the colour gradient of the 1024 correction values per colour channel is graphically illustrated.

Curves

LUT Graph
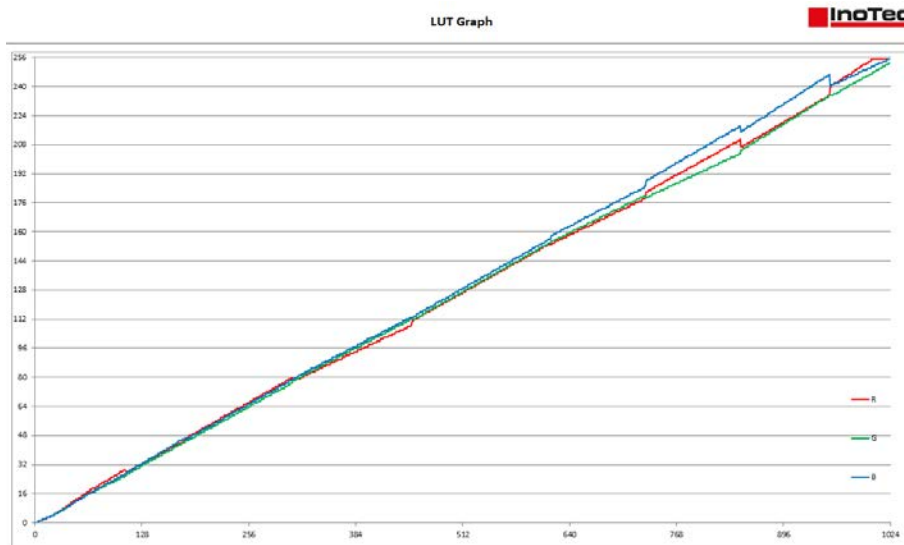
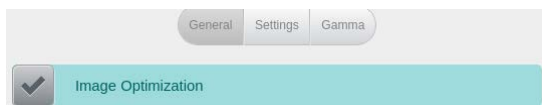The last table *Export* contains the correction values which must be saved as a CSV file for further use. For that, you have to switch to this table to make it the "active" one. Pressing the *F12* key, the *Save As* dialog opens, in which the desired path is to be selected and as a file name for correction values the term *lut_front.csv* is to be entered for the front side or *lut_back.csv* for the rear side. *CSV (MS-DOS)* must be selected as type. The two messages which are displayed during the following saving process must be confirmed with *OK* and *Yes*. Afterwards the workbook should be closed without saving it again.

To use the created CSV file *lut_front.csv* as a *Camera Curve* on the scanner, first it has to be copied to the root directory of a USB stick. If a CSV file named *lut_back.csv* was created for the rear camera for double-sided scanning in compliance with the quality guideline, this file must also be copied to the stick. After the USB stick is connected to the scanner, switch to the *Export/Import - Updates* screen in the menu *Service* on the scanner display and select the button *Cam Curves Import* to transfer the correction values.

4. Checking the Effectivity via OpenDICE

In the final step, it must be checked whether the previously performed scanner calibration, in conjunction with the correction values of the LUT, is sufficient to meet the requirements of FADGI ***. For this check, an uncompressed color image in Tiff format must be created again from the target used, with the scan settings which already has been described in **Chapter 2**. But this time using the correction values created and transferred to the scanner in the previous chapter. This is achieved by *enabling* the option *Image Optimization* in the mask *General* of the activated *Image Adjustment*, at the scan profile's *Image Presettings* which automatically *disables* the option *sRGB* in the *Gamma* settings mask.

In practice, the *GoldenThread* analysis software from the target manufacturer *Image Science Associates* is used to check the reference images or, as in our example, the open source solution *OpenDICE*. This solution can be downloaded together with a description, a material table (*Config_materials.xlsx*) and an example of a reference file for the used target from the official FADGI website - see:
http://www.digitizationguidelines.gov/guidelines/digitize-OpenDice.html
In order to check with *OpenDICE*, the image of the target must be present with a sRGB profile attached. This is achieved e.g. by saving the image in GIMP.

After installing **OpenDICE**, a reference file according to the downloaded example with the values of the target used must be created and stored in the path of the reference image together with the material table. After starting the tool a dialog appears (*see left*), where in the first field the material must be changed to *Documents (Unbound): General Collections*. By that, a window opens for selecting the material table. Afterwards the used *target* (*here DICE*) and the desired *FADGI level* have to be selected. The activation of *Manual Detection* isn't required according to the description, but our experience shows that an automatic detection of the evaluation zones often leads to a hint to use it after all. Now the button *Load Profile* is used to load the created table with the reference values and then the button *Load Image* must be clicked to load the last created reference image. When *Manual Detection* is activated, the loaded reference image is now displayed in a viewer, with the option to first define the detection area and then, in a new display, to correct the placement of the detection zones. Further details can be found in chapters 5 and 6 of the OpenDICE description. After correcting the zones, the evaluation is started, while the viewer stays open, via the button *Run* in the main dialog and the result is displayed in several overview windows. An explanation of these overviews and the various export options can be found in the description of the software.

We strongly recommend to follow the sequence of steps described here, otherwise the OpenDICE software may behave incorrectly. If an analysis has to be performed several times on the basis of different reference images, e.g. due to optimizations (see next chapter) or for front and back sides, it is sufficient to close all overview windows and load the new reference image in the main dialog.

5. Improvements

Test series have shown that FADGI *** is sometimes not achieved at the first attempt, since the Tonal Response limits are not met for very light or very dark shades of gray (*patches 10-12 or 19-21*). In the figure you can see that the RGB values of patch 10 to 12 are very close to the upper limit or even exceed it This can be prevented by manually adjusting the measured *L** values of these patches in **line 9** of the table **Sample Input**. The change of the corresponding *L** values must be in the **same** direction as the deviation. Thus, if the values are exceeded, like in the figure, they must be raised, and if they are fallen short of, they must be lowered. To get a feel for the effect, we recommend starting with a change in the amount of 1.0. A CSV file must be created again from the Excel worksheet and loaded onto the scanner (*see end of* **Chapter 3**). Finally, carry out the steps from this **Chapter 4** again.

Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Tone Response				
Patch #10 Red	Fail	239.5	251.7	249.5
Patch #10 Green	Fail	239.5	252.7	249.5
Patch #10 Blue	Pass	239.5	248.3	249.5
Patch #11 Red	Pass	227.1	236.7	237.1
Patch #11 Green	Fail	227.1	237.3	237.1
Patch #11 Blue	Pass	227.1	233.0	237.1
Patch #12 Red	Pass	213.0	221.8	223.0
Patch #12 Green	Fail	213.0	223.4	223.0
Patch #12 Blue	Pass	213.0	220.6	223.0

In addition to Tonal Response, *White Balance* compliance may also fail. This can occur directly or as an interaction of an adjustment of the values for the Tonal Response. However, errors at the White Balance are corrected by adjusting the values of *a** or *b**. In the White

Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
White Balance				
Patch #10 Green - Blue	Fail	-4.0	4.4	4.0
Patch #10 Green - Red	Pass	-4.0	1.0	4.0
Patch #10 Blue - Red	Pass	-4.0	-3.4	4.0
Patch #11 Green - Blue	Fail	-4.0	4.3	4.0
Patch #11 Green - Red	Pass	-4.0	0.6	4.0
Patch #11 Blue - Red	Pass	-4.0	-3.7	4.0

Balance section shown, you can see that the green/blue values in patches 10/11 have exceeded the upper limit, while the green/red values are okay and the blue/red values are borderline in the lower range. Thus, it can be assumed that the blue content is too low and must be increased. To ensure this, the values *a** and *b** of the relevant patches must be determined again from the reference image that was analyzed with OpenDice (*see* **Chapter 3**). These values must be compared with the reference values of the corresponding patches in **line 7/8** of the table **Sample Input**. In case of a significant deviation, the associated sample value must be adjusted in the reverse procedure. If the measured value is higher than the reference value, the corresponding sample value in **line 11** of the table **Sample Input** is also *increased* to compensate the deviation. If the measured value is below the reference value, the corresponding sample value must be *reduced*. Please note here that *a** and *b** can also contain negative values. In such cases a measured value of *-1.5* isn't *higher* than a reference value of *-0.5*, but *lower*. The corresponding sample value must therefore be **reduced**.

Since the values of *a** and *b** represent a coordinate in a three-dimensional color space, the effect of a deviation is influenced by the respective other value. If one of the measured values is very close to the corresponding reference value, the deviation of the other value does not have as strong an effect as if both values deviate significantly. Therefore, it may be necessary and useful to adjust both values in such a case. Furthermore, it is recommended to check the values of the adjacent patches, since an alignment of the values also affects these patches.

After adjusting the sample values in **line 11** of the table **Sample Input**, a CSV file has to be created again from the Excel worksheet and loaded onto the scanner (*see end of* **Chapter 3**). Finally, carry out the steps from this **Chapter 4** again.

If the test is performed with a lower resolution than 400 dpi and without **Deskew** enabled, it is very likely that the limits of the horizontal resolution will be exceeded. This is due to the very high sharpness of the optics used in these resolution ranges. Although this is not a disadvantage in terms of quality, it still ensures that the test is not passed. If this is considered an issue, the sharpness can be artificially reduced for resolutions lower than 400 dpi by scanning with a *Main Resolution* of **400 dpi** and saving the color image with a *reduced resolution*. This can be selected in the *Colour Settings* of the Scan Profile if a higher main resolution was **previously** set.

In case of doubt or for further assistance, please contact our support.