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.

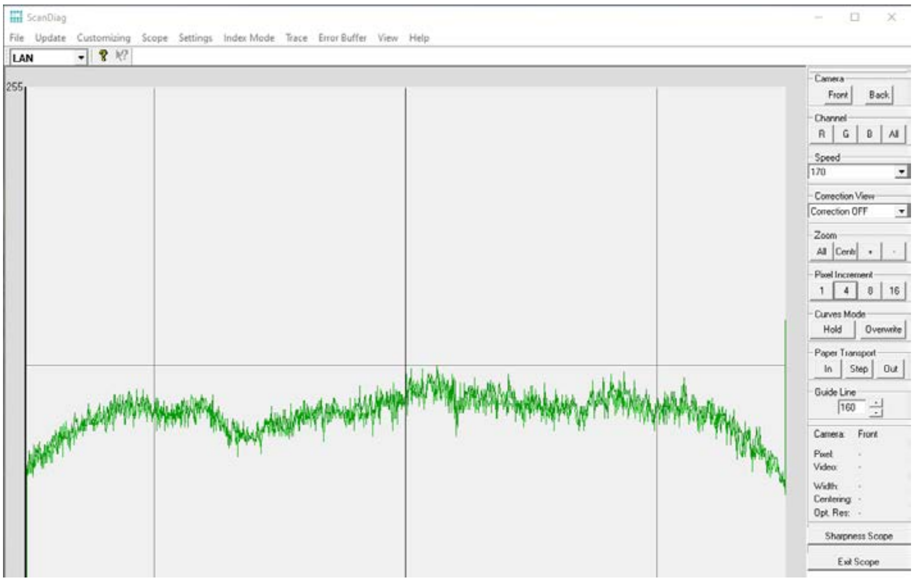
Due to the excellent image quality of the cameras used and the precise transport system of the ***SCAMAX***® document scanners, we are able to comply with the standard values of ***ISO 19264-1 Level B*** (*with minimal distortion limitation*) and ***FADGI ******.

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 and knowledge in handling the service tool ***ScanDiag*** is assumed. A clean sheet of InoTec white balance paper (*Art.No. s9100002 - please do **not** use other kind of paper!*) and the ScanDiag tool in ***version 1.8.0.1*** or higher is required.

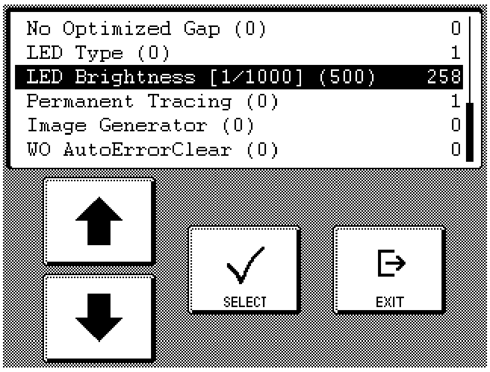
The first step is to adjust the LED brightness (*PWM*) so that the camera threshold of 160 is no longer exceeded. To do this, the ScanDiag is started with an active scanner connected



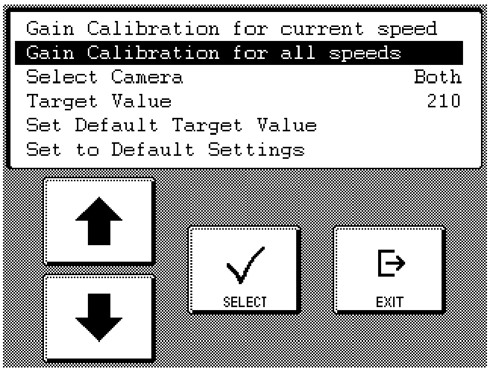
and the *Camera Scope* (*figure left*) is opened. The initially displayed green channel is sufficient for the adjustment, as it generates the highest values. In the menu on the right hand side ***Correction OFF*** must be selected as *Correction View*.
For a better evaluation the *Pixel Increment* is set to ***4*** and the *Guide Line* is set to ***160***.

If the white balance paper is pulled in via *Paper Transport* -> ***In***, the signal curve of the green channel will be considerably above 160.

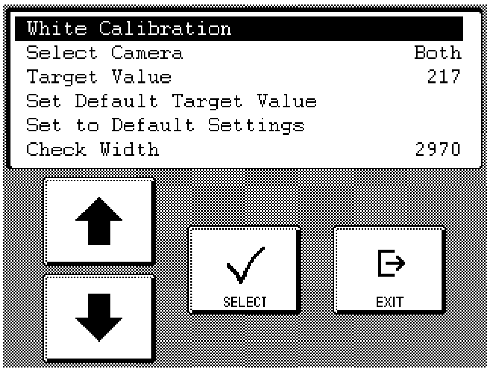
A decrease of the signal is achieved by reducing the LED brightness. As a change of the LED brightness via ScanDiag would always mean leaving the Scope view, we recommend



changing it via the menu *Parameter* inside the *Service Functions* on the scanner display. The value ***LED Brightness*** should be noted for safety reasons and successively reduced until the green signal curve in the Scope view no longer exceeds the *Guide Line* of ***160***. Please note that the change of the value is only accepted by the scanner and therefore also visible in the Scope view, after confirming and leaving the menu *Parameter*. If double-sided scanning should be possible while keeping the desired quality guideline, the maximum value of 160 must also be kept in the Scope view of the backside camera. If the correct value was determined, the white balance paper is to be ejected and ScanDiag is to be terminated.



The next step is a Gain Calibration to a ***Target Value*** of ***210*** (*default is 240*). For this purpose, the according value has to be changed in the corresponding mask of the service functions. If the unit should be used with this type of calibration for a longer term, which is likely in a production environment, it is better to adjust the default target value immediately, so that the default value of 240 is not used again for a later Gain Calibration. This is possible via the item ***Set Default Target Value***. Finally, the calibration is performed via the item ***Gain Calibration for all speeds***.

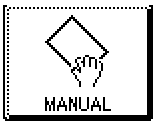


Also the White Calibration, as the last step of this calibration, is performed with a lower target value of ***217*** (*default is 260*). Like at the gain calibration, this value must be entered for temporary use under ***Target Value*** and for the longer-term alternative it has to be used under ***Set Default Target Value***, as the new default value. Then, as usual, perform the White Calibration with the paper provided for this purpose.

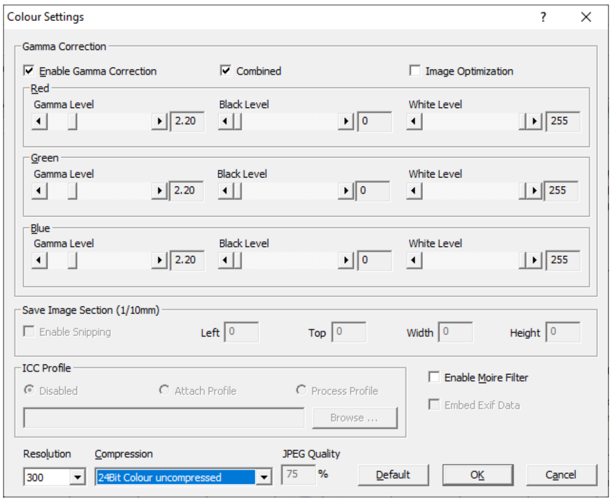
2. Creating a ICC/ICM color profile

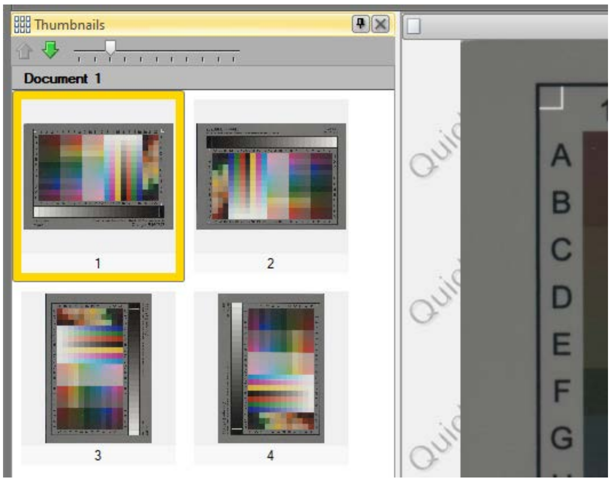
After performing the special calibrations from the previous chapter, a color profile must be created for the scanner. If there is already a color management solution available which is able to create such color profiles for devices, it can of course be used. In the following sample we use parts of the OpenSource system *ArgyllCMS.* Those are provided with this description, as a zip-archive named ***CreateICM***, including a batch file with the same name. It enables you to create so-called ICM profiles which are color profiles for Microsoft platforms. An IT8 card with associated reference file (*InoTec Part. No. s9100007*) is also required.

First the folder ***CreateICM*** has to be unpacked to the hard disk of the scan-PC (*e.g. C:\CreateICM*) from the Zip-archive mentioned above. Afterwards, scans in different input orientations must be performed from the IT8 card and saved as uncompressed color

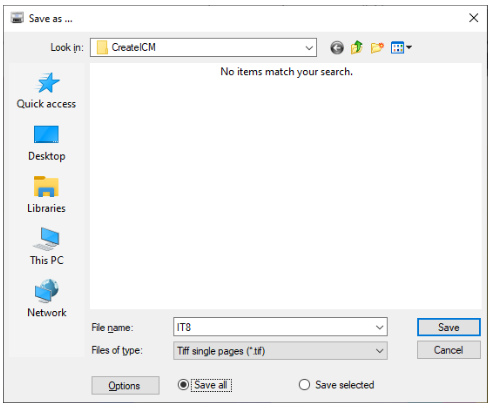


images in Tiff format. Here,we use our SCAMAX scan(+), but any other scan solution, that can receive and save uncompressed images, can also be used. From now, the *Input Mode* of the scanner should be changed to ***Manual***, to protect the test templates (*IT8 card etc.*) which still have to be scanned. The scanner should be turned on *several minutes* before scanning reference images so that it is already at *operating temperature*!



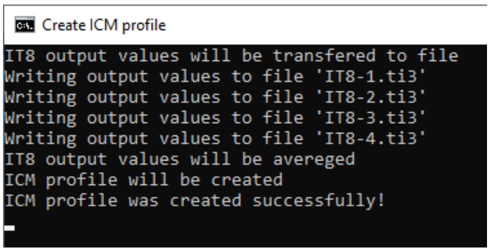


In the scanner settings, the resolution which is used in the later processing (*here 300 dpi*), should be selected now as well. The front side color image must be marked and in the corresponding settings, a *Gamma Correction* must be activated with a combined ***Gamma Level*** of ***2,2*** (*figure left*). In addition the *Image Optimization* must be ***deactivated*** and the *Compression* must be changed to ***24Bit Color uncompressed***. At the paper settings, the middle area of the driver's main dialogue, an *Output Format* selection of ***A4*** and ***Portrait*** is recommended. The *Input Orientation* must be set to ***Top Edge First*** and *Deskew* must be ***deactivated***. Via driver dialog or the scanner display the *Scan Speed* should be set to ***90 ppm*** or (*with Slow Mode Option*) even slower. With these settings, the IT8 card must be scanned once per input direction (*top, bottom, left, right*). Please make sure that the card is pulled in as straight as possible. The scanning solution should now contain four images of the IT8 card in different orientations (figure left).



When using SCAMAX scan, the four images can now be saved via *File->Save As* or *CTRL-S*. In the corresponding dialog, the previously created directory (*e.g. C:\CreateICM*) must be selected as target path and ***IT8*** as file name. ***Tiff single pages*** has to be selected as *File type* and *Color* must set to ***Uncompressed*** via at the button *Options*. If the option ***Save all*** is marked, the files ***IT8-1.tif*** to ***IT8-4.tif*** are automatically created in the target directory pushing the ***Save*** button. If another scanning solution is used, it must be ensured, that finally four uncompressed color images in Tiff-format with the same name like above are located in the mentioned destination path.

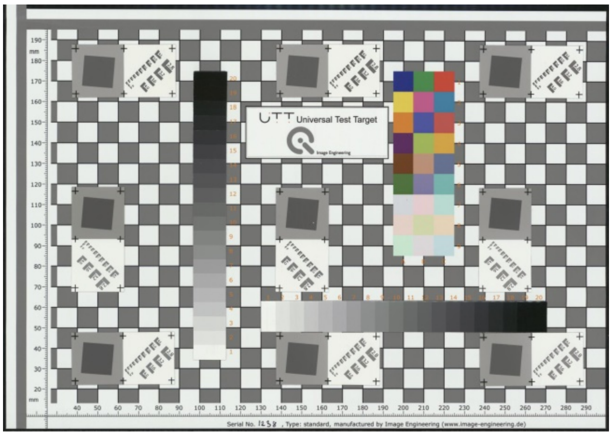
In order to create a color profile, based on the scanned IT8 images, the corresponding reference file of the IT8 card must first be copied into the same directory like the images and renamed to ***IT8-R.txt***. This text file is generally named like the charge number of the IT8 card (*e.g. R160727.txt*) and located on the supplied data carrier or can be downloaded from the manufacturer's website (*here www.coloraid.de*). If all required files are available in the target directory, the batch file ***CreateICM.bat*** can be started and, after selecting the



language and entering the desired profile name (*e.g. scanner serial number*), the various steps to create the ICM profile are performed and logged in the associated command window. When finished, the window is automatically closed and a new color profile with the previously entered name and the extension ***.icm*** is located in the target directory If double-sided scanning should be possible while keeping the desired quality guideline, this last step must carried out again, based on four uncompressed color images created with the rear side camera.

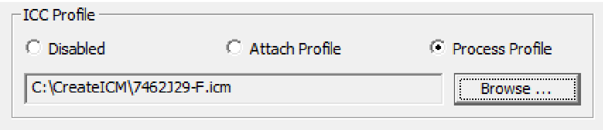
3. Creation of Correction Value Tables

Within the next step a correction value table is generated, which is calculated based on measured values and loaded onto the scanner as a so-called Lookup Table (*LUT*).



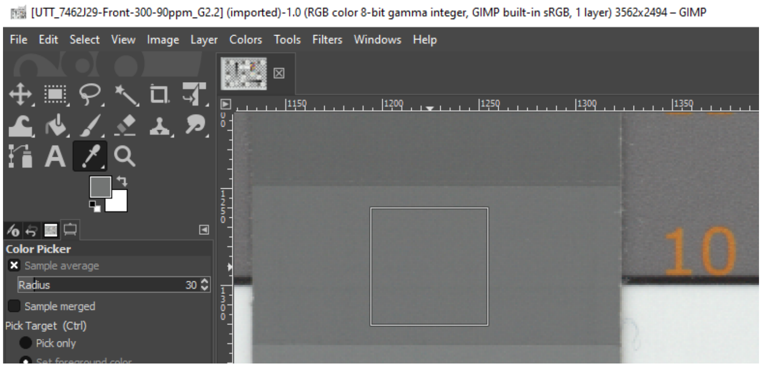
In order to determine the required measuring values, first the target of the used image analysis software must be scanned by using the previously created color profile together with certain adjustments. We refer to the ***Universal Test Target TE-262*** (*abbreviated UTT - figure left*) from *Image Engineering* in A4 format. If required, this target incl. the corresponding reference file (*Excel format*) and the also used image analysis software ***iQ-Analyzer*** can be obtained directly from the manufacturer. The targets must be handled with care, because only a clean target will give correct values.

The same scan settings are used as for the images of the IT8 card (*chapter 2*). However, this time ***Maximum Scan Area*** must be selected as *Output Format*, because the UTT target is scanned in landscape mode. Furthermore, the previously created color profile

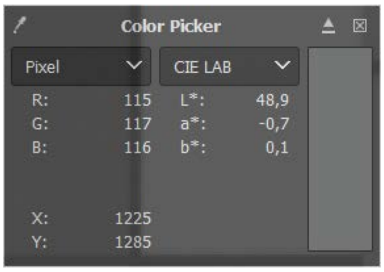


must be selected and the *Process Profile* option has to be ***activated*** in the *ICC profile* section of the color image settings (*figure left*). Also while scanning this target, it has to be ensured that it is drawn in as straight as possible. Finally, the created image has to be saved as uncompressed colour image in Tiff format with the desired path and name.

Values of the so-called Lab color space must now be determined from the grayscale

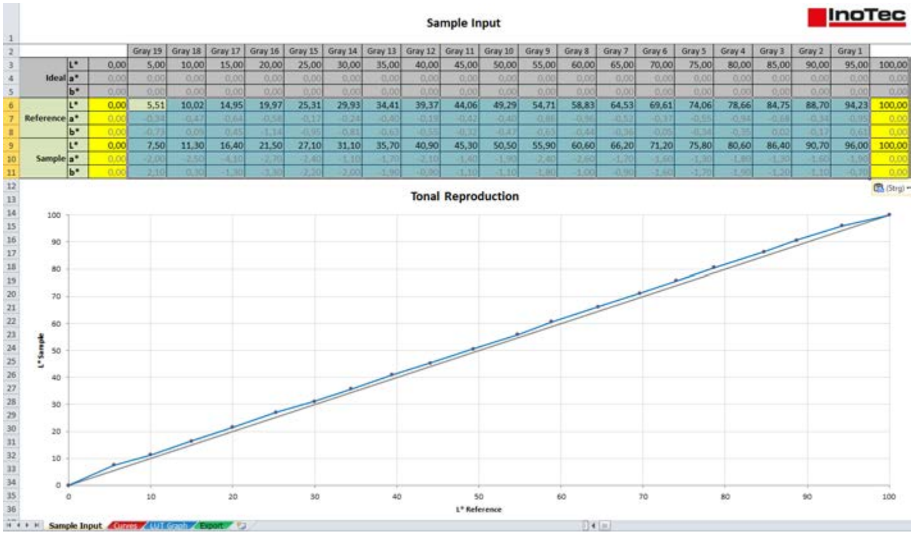


wedge, which runs from top to bottom on the left side of the image of the target. For this we use the free image editor program ***GIMP***. This is able to show average values for ***L*a*b**** from a pre-defined sampling area by the *Color Picker* function. We recommend to choose an area size that covers at least 70% of one gray field's height. As

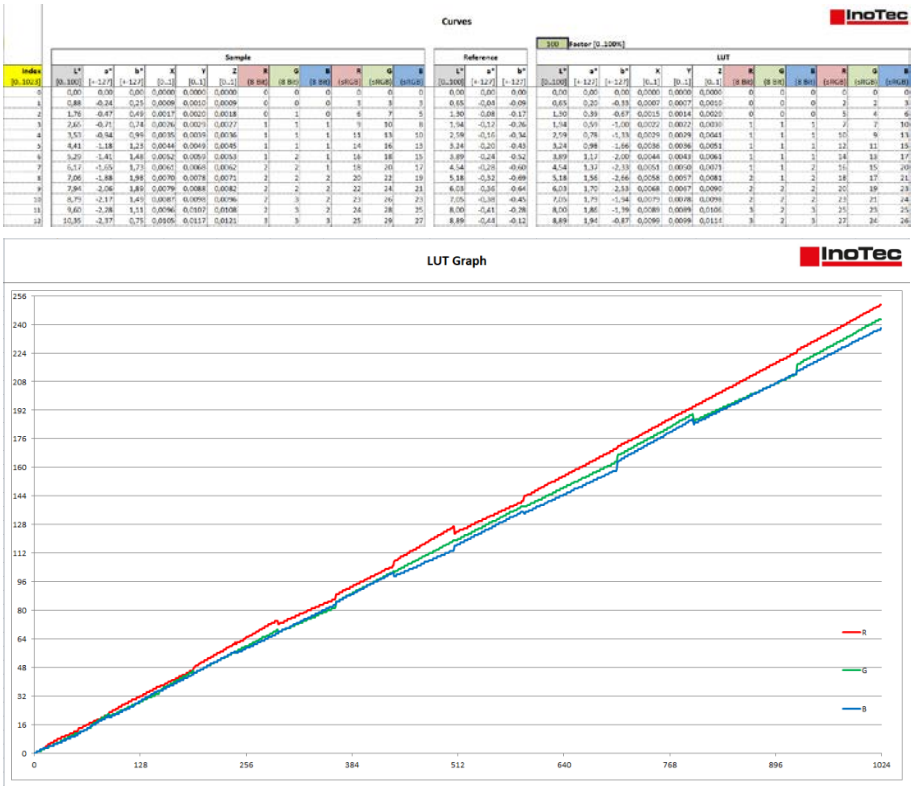


soon as the activated Color Picker is clicked into the loaded image for the first time, the additional window shown on the left appears, offering two selections for color values, where ***CIE LAB*** must be selected at least once to get the required values. Using these settings, the Lab values of the grayscale levels 1 to 19 must be determined from the above-mentioned grayscale wedge. The sampling area should always be placed in the gray fields as centred as possible.

These values are required for the Excel workbook *TonalCorrection-UTT-Lab-M06*, which is provided with this description and consists of four tables. At the table *Sample Input*, the

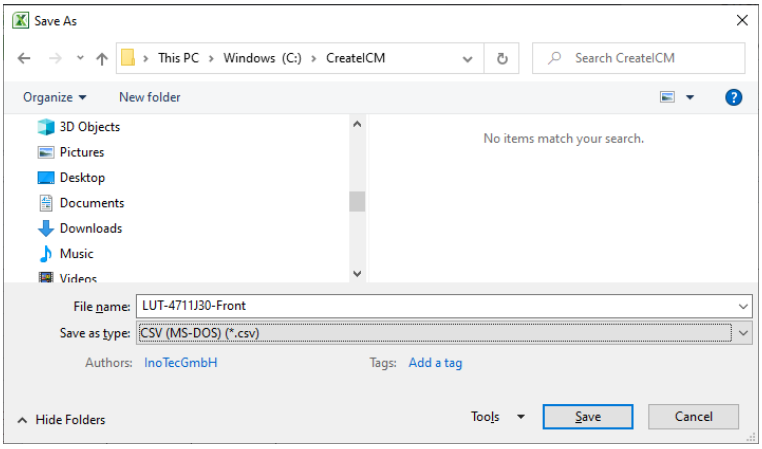


reference values from ***Gray 19*** (*dark gray*) to ***Gray 1*** (*white*) of the UTT target must to be entered in the lines ***6 - 8***. This means the values L*a*b*, which can be found in columns ***E - G***, of the lines ***GS_R_1*** to ***GS_R_19***, of the target's reference file. Into lines ***9 - 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.

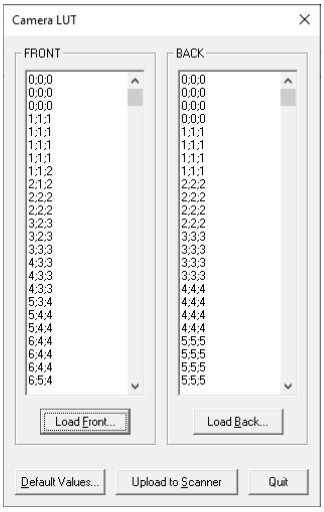


The second spreadsheet *Curves*, contains calculation fields in different blocks, which finally lead to a linear correction table for the scanner. The input field *Factor*, which is preset with the value ***100***, should ***not*** be changed, as otherwise correction values might be determined which 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.

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. By pressing the ***F12*** key, the *Save As* dialog opens, in which the desired path and file name is to be entered. ***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.



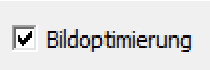
To use the created CSV file as a ***LUT*** on the scanner, it must first be transferred to the unit via ScanDiag. If the tool is connected to the scanner, the dialog shown on the left is opened with the menu item *Settings->Camera LUT Values*. Via the ***Load Front…*** button the CSV file containing the correction values can be loaded as LUT for the front side camera. The loaded values are displayed in the left column ***Front***. The button ***Upload to Scanner*** loads the LUT to the scanner, where it is directly used for future processing without restarting the scanner. If double-sided scanning should be possible while keeping the desired quality guideline, the steps from this chapter must also be performed in connection with the rear side camera and the created LUT must be loaded here via ***Load Back...*** before the upload to the scanner.



4. Checking the Effectivity via IQ-Analyzer

In the final step, it must be checked whether the previously performed scanner calibration, in conjunction with the color profile and the correction values of the LUT, is sufficient to meet the requirements of ISO 19264-1 Level C. The already mentioned image analysis software ***iQ-Analyzer*** is used for this purpose.

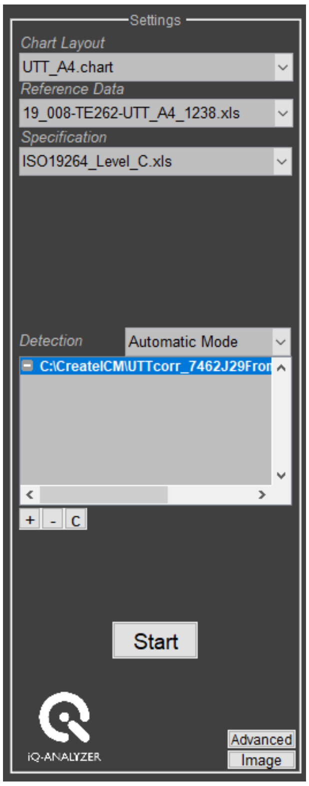
For this check, an uncompressed color image in Tiff format must be created from the UTT target again, as already described at the beginning of *chapter 3*. But this time using the LUT created in the same chapter. This is achieved by ***re-enabling*** the *Image Optimization* at the settings for the front color image.



Furthermore, the reference file of the UTT target must be copied manually to *c:\ProgramData\Image Engineering\iQ-Analyzer V6.2.2.1\Data* (*version may differ*). Before doing so, it is essential to check that the lines 56/57 of the reference file do not look like the one shown on the right:

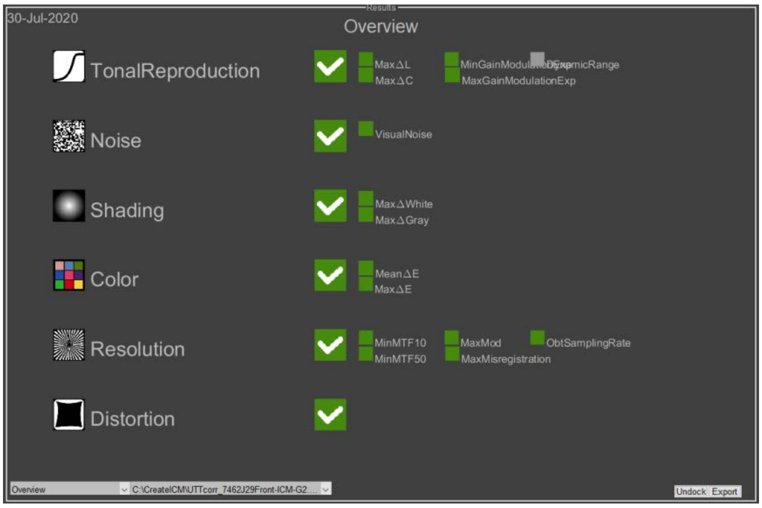
	A	B	C
56	Grey Patches	Reference Values	
57	left vertical grey scale	L*	a*

If this is the case, the line 56 has to be deleted so that line 57 moves up, otherwise errors will occur in the subsequent image analysis of the iQ-Analyzer.



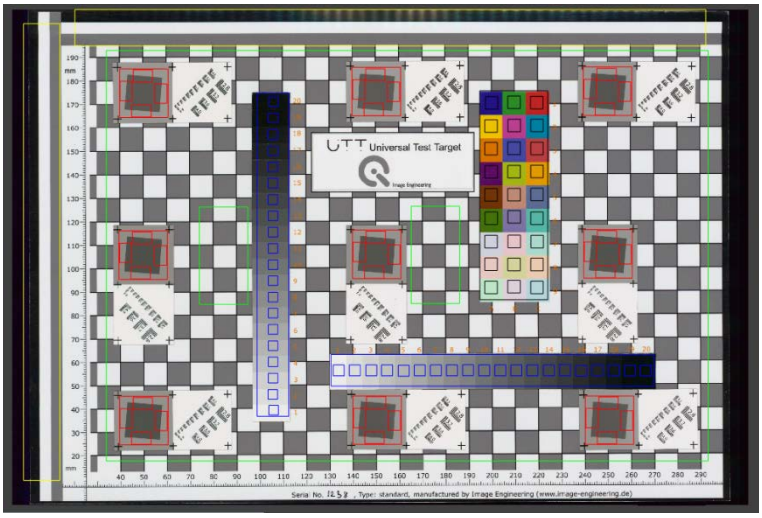
After starting ***iQ-Analyzer***, a drop-down list in the upper left corner will only appear, when the button (top right) is pushed. Selecting ***UTT*** there, the contents of the application screen will change completely and the section *Settings* will appear on the left side. First choose ***UTT_A4.chart*** as *Chart Layout* and select the previously copied reference file at the *Reference Data* section below that. For *Specification,* ***ISO19264_Level_C*** is the item to be used. Below *Detection*, which should remain in ***Automatic Mode***, the last image of the UTT target can be entered using the small **+** button. If an image for the rear camera of the scanner was also created, it can be added to be analyzed together with the front camera image. By clicking the button *Advanced* in the lower right corner of the area, an additional section can be opened in which, among other things, the color profile to be used can be selected. Since the color profile of the scanner has already been calculated with the image of the target in our case, the already pre-selected sRGB profile must be used in the analyzer.

Pushing the ***Start*** button the image analysis is initiated. At the same time a status bar appears in the upper right corner. The occurring warning regarding a "*Dynamic Range*" can be ignored.



Once the image analysis has been completed, an *Overview* appears in the main screen of the application, ideally showing green checkmarks in all six checked points (figure left). This means that the points have been passed the tests of the selected specification. If one or more points show a red cross here, the specification were not met in the corresponding kind of test.

At the lower edge of the application screen, a numerical summary and the individual test areas can be opened as detailed views via a drop-down list, in order to correctly evaluate individual deviations.



If not all points have been passed, first check if the analysis fields have been placed correctly on the image of the target. This can be done with the button *Image* (*right bottom edge at Settings area*), which switches from the *Overview* to the display of the target image with entered fields (*so-called patches - see left*). If there are significant divergences, either the scan of the UTT target should be repeated or the *Detection* can be changed to ***Manual Mode***. The further procedure for adjusting the patches can be found in the description of iQ-Analyzer.

If deviations occur in the *Color* test range, the creation of the color profile should be repeated possibly. In case of errors in the *Tonal Reproduction*, a complete repetition of the LUT creation could lead to better results. In this case it could also be tested whether a change of the ***Factor*** in the table *Curves* of our workbook leads to an improvement.

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