THE MET

Scene Referred Color Managed Image Capture Workflow

Version 1.0 May 2023

Scott Geffert & Chris Heins
Imaging Department

This document will present the framework of a custom calibrated color managed Adobe Lightroom photographic workflow that will work with any camera that produces a RAW file and any lighting set-up to produce digital image files that are, within the limits of the camera sensor's capabilities, consistently accurate based on objective standards.

Required Software and Hardware

1. **Digital Camera that can output RAW captures**. a tethered DSLR, mirror-less or medium format camera is preferred.
2. **Adobe Lightroom Classic**. Older versions of Lightroom will work fine, the main difference being the location of the Camera Profile drop down menu.
3. **The camera's tethering utility.** To operate the camera from the computer, for this document we used Canon EOS Utility.
4. **Matching pair(s) of lights**. Strobes, or continuous.
5. **Color chart.** Such as the X-Rite Color Checker Digital SG or Passport.
6. **Color profiling software.** Such as BasICColor Input or the Lightroom Color Checker Passport PlugIn.
7. **Munsell Linear Gray Scale.** Or similar chart with known LAB values.

Basic Workstation Set Up

Ideally, for flat art, the workstation will be a copy stand type of set up with a mounted camera rail and a pair or pairs of identical lights, camera tethered to computer, in a room where stray light can be blocked out. Clean even toned neutral background paper is preferable.

For the purposes of creating the scene referred calibration the lights should be set in a copy light arrangement, equally spaced from the camera/subject and at approximately a 30-40 degree angle of incidence to the subject. Even if the lights will not be used in this arrangement for shooting objects, it is necessary to the calibration process to achieve even, diffuse lighting on the color chart.

About this documentation

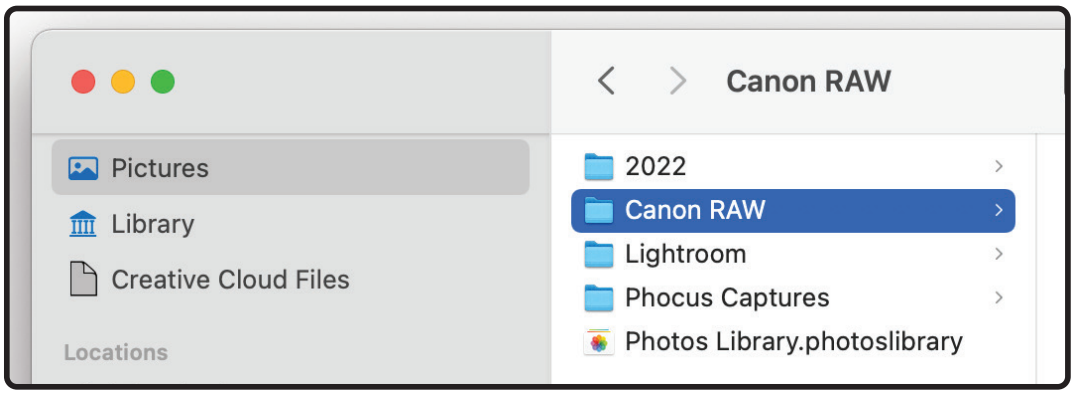
Before getting started, it is important to note that the software and hardware discussed in this document were chosen because they are widely commercially available and in use, and when employed within this workflow they are capable of producing consistently accurate and repeatable images. This is just one combination of equipment and software capable of achieving a high degree of color reproduction accuracy. Components can be swapped out for other brands or models but some testing may need to be performed to identify the right settings, especially in the case of other RAW image processing software.

As we work with the Cultural Heritage Imaging community and software manufacturers to improve this workflow we will update this document over time.

Initial Workflow Set Up

1. Folder Set Up

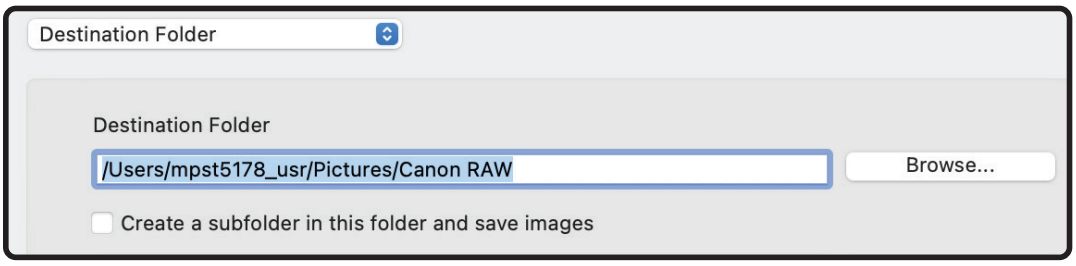
The first step is to create the folder on your computer where the camera will save the RAW captures that Lightroom will then automatically import. On a Mac go to a finder window and click on the “Pictures” location. Create a new folder in Pictures and name it “Canon RAW” or “Nikon RAW” or whatever, it just needs to be a new and EMPTY folder. This folder must remain empty until after you have designated it as the Auto Import folder in Lightroom.



2. Canon EOS Utility Preferences

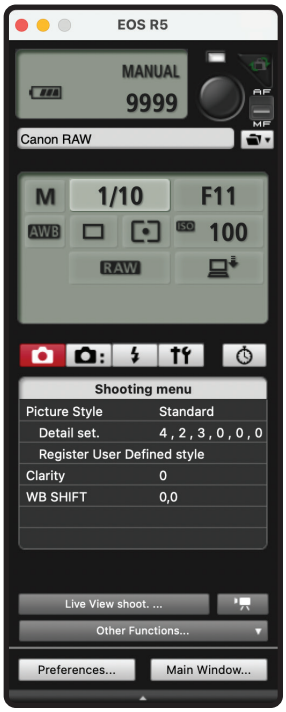
Connect camera to the computer and turn on the camera. If Canon EOS Utility app does not launch automatically, then manually do so. Click on the folder icon on the upper right of the camera control window to select the destination folder where the camera utility will save the RAW files after capture. Click on “Browse” and navigate to the “Canon RAW” folder that you created in Pictures. Make sure that the box for “Create a subfolder in this folder and save images” is **unchecked** and then click OK.

Select the new “Canon RAW” folder as the RAW file destination folder in EOS Utility.

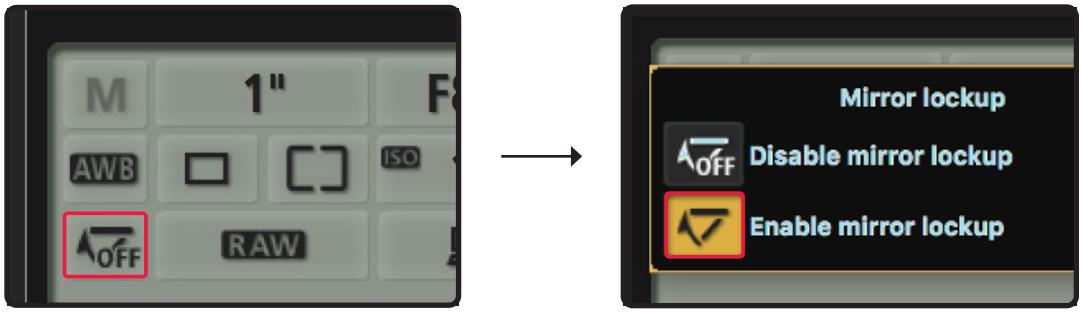


Camera Settings

Now would be a good time to address the camera controls. First, the camera should be set to manual (M) exposure, we need to have control over the aperture and shutter speed and not let the camera set exposure based on what's in front of the lens. Typically, 35mm (full frame digital) camera lenses are sharpest at an aperture around f/8 or f/11, for medium format cameras maybe f/16. Try shooting the same object at different apertures, adjusting shutter speed or strobe power to equalize exposure, and see what the optimum aperture is for the lens and use that as the standard for 2D work. Shutter speed will be determined by the light source. If using continuous (hot) lights the shutter speed will be adjusted to get correct exposure. If using strobes the shutter speed is mostly irrelevant, it can be set to 1/60 or 1/125, correct exposure should be achieved by adjusting the power setting at the strobes.



The best image quality is produced at the native (usually the lowest) ISO setting for the camera, for this Canon it is ISO 100. Raising the ISO reduces the amount of light needed for proper exposure but increases image noise. Since the camera is mounted to a tripod or copystand, longer exposure times and camera shake are not an issue. If mirror lockup is an option, use it. Mirror lockup requires two clicks of the shutter release to take a photo. The first click flips the mirror up out of the way of the camera sensor and the second click makes the exposure. This eliminates camera shake caused by movement of the mirror from having an effect on the quality of the photograph. And finally but most importantly the camera should be set to save full resolution RAW captures only, not RAW + Jpeg and not cRAW.



Enabling mirror lockup when the camera is on a tripod or camera stand and the subject is still, will mitigate any vibrations caused by mirror movement.

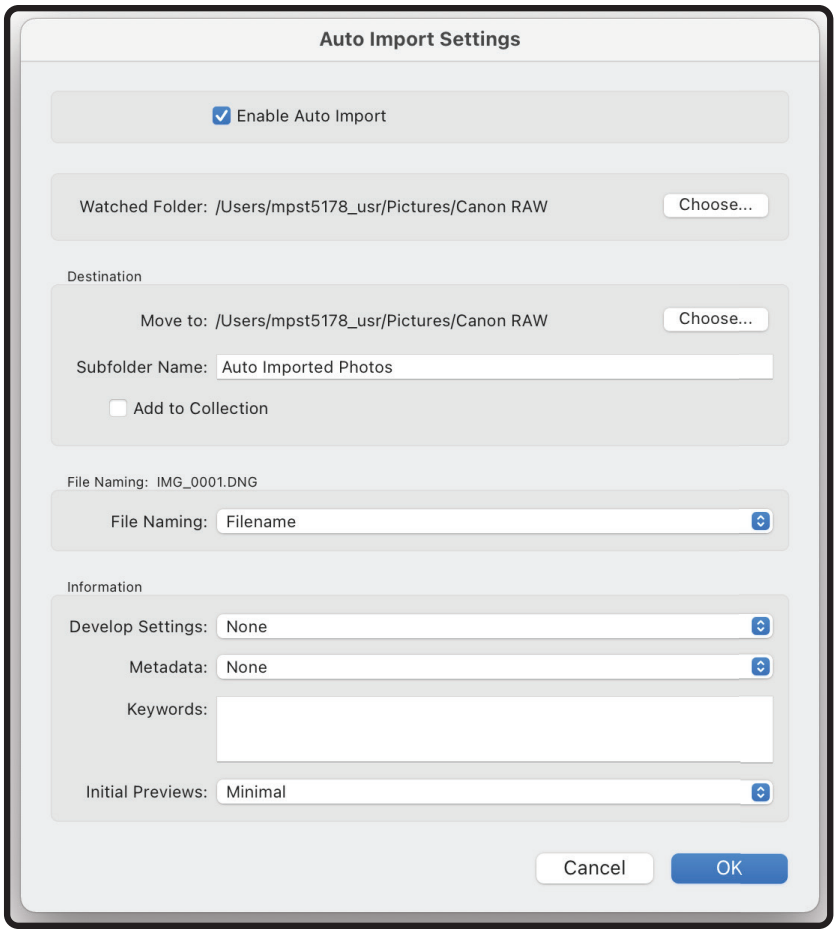
All of these settings can be changed in the EOS Utility window by clicking on the current setting, with the exception of setting manual (M) exposure which sometimes must be done on the camera.

Now that the camera and the EOS Utility have been configured, we can move on to Lightroom.

Workflow Set Up Continued

3. Lightroom Folder Set Up

The next step is to set Lightroom to watch the “Canon RAW” folder and Auto Import new captures as they appear in the folder. Launch Lightroom and from the menu go to: File → Auto Import → Auto Import Settings. Check the “Enable Auto Import” checkbox. For “Watched Folder” click “Choose” and navigate to the “Canon RAW” folder.
In the “Destination” box click “Choose” and navigate to the same “Canon RAW” folder, the “Subfolder Name” can remain “Auto Imported Photos”. The RAW captures will be moved, by Lightroom, into this subfolder inside the “Canon RAW” folder as Lightroom imports them. The rest of the settings can remain as is for now. At this point if you take a photo with Canon Utility, the photo will be saved to the “Canon RAW” folder, Lightroom will see it and automatically import the photo into your Lightroom library and the original RAW capture will be moved into the “Auto Imported Photos” subfolder.



Lightroom Auto Import Settings window. Set the Watched Folder and the Detination to be the same folder into which the camera is saving the RAW captures.

Custom Color Calibration and Develop Settings

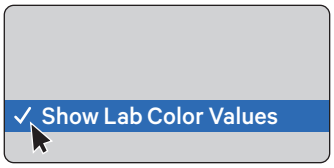
This section lays out how to create the custom scene calibration and develop settings that Lightroom will automatically apply to photos on import. Lightroom allows for the creation of custom User Presets in the Develop module, letting the user apply a consistent set of RAW processing settings to batches of images either manually or as part of the Auto Import process. Since each color calibration will be specific to the scene (the combination of camera, lens, lighting and environment), multiple User Presets can, and should, be created to reflect different combinations of equipment and environment. Presets and the camera calibration profiles, should be named in a manner that indicates all of the scene information; i.e. camera, lens, lighting, environment.

We will cover two methods of creating camera calibration profiles, the first will use the X-Rite Digital SG chart and BasICColor Input 6. The second, much simpler and quicker method uses the X-Rite Color Checker Passport chart and Color Checker Camera Calibration software. Camera calibration using the SG chart will certainly be more precise and robust as this chart contains 140 patches covering a broader range of color and tones as compared to the 24 patch Passport chart. Therefore, it is preferable to perform the SG chart calibration whenever possible, but the Passport calibration does work pretty well and is definitely better than not making a custom calibration at all.

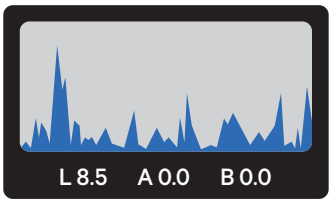
BasICColor Input & X-Rite Digital SG Chart color calibration

4. Lab Color Values

Lightroom is divided into modules by tabs that run along the top right, click on Develop and you will see a Histogram window at the top right. Control click inside the rectangular window with the Histogram and in the pop up menu select “Show Lab Color Values”, if there is already a check mark next to it then just exit the menu. In the Develop module of Lightroom, when you move the cursor over part of the image area, color values are displayed for that pixel in the Histogram window. Lightroom defaults to showing RGB values, we want to see LAB values. In the 3 co-ordinates of the LAB color system, L is luminance, the gray scale value of a color where absolute black = 0 and brightest white = 100.
The A and B values describe color, A is the Green/Red axis and B is the Blue/Yellow axis. A and B values can range from negative to positive, with a value of 0 being perfectly neutral or gray. Being able to measure the LAB values in Lightroom will be key to judging exposure and white balance and for refining the tonal response in user presets.



To make Lightroom display LAB color values instead of RGB, control click in the histogram window.



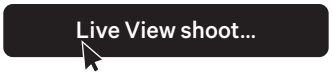
An L value of 8.5 would be very near absolute black. A and B values of 0.0 mean this color is a perfectly neutral gray.

5. Photograph the Digital SG chart

In the Canon Utility click on “Live View Shoot” to open the Remote Live View window. Place the Digital SG chart in the middle of the frame rotated so that the text is oriented correctly. Double Click inside the rectangle to auto focus or for manual focus click on the “x5” button to zoom in and focus the lens. Close out of the Live view window.

Now let’s take a photo and see if auto import has been set up correctly. Have the Lightroom window open behind the EOS Utility and click on the shutter release button. If using mirror lock up, click the shutter a second time to take a photo. The new photo should appear in Lightroom, don’t be too concerned if exposure is incorrect, we will address exposure later.

For now let’s start creating the user preset, click on Develop in the upper right of the Lightroom window and we will go through a few of the menus.

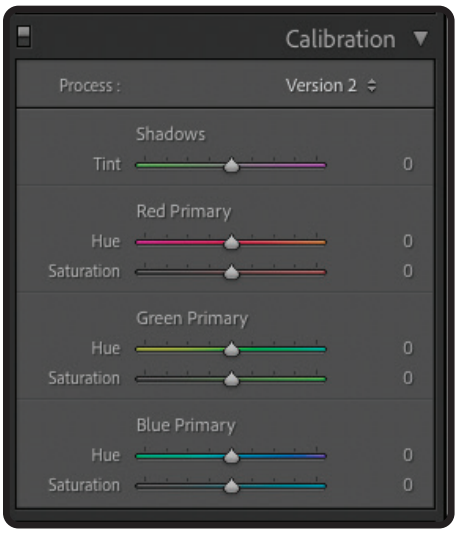


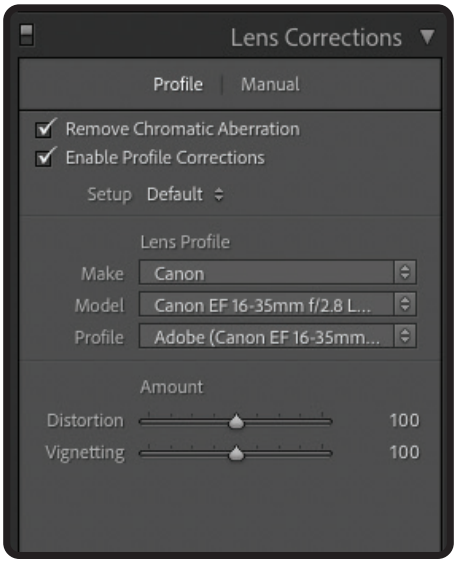
The Live View window is useful for composing, adjusting lens zoom and for focusing.

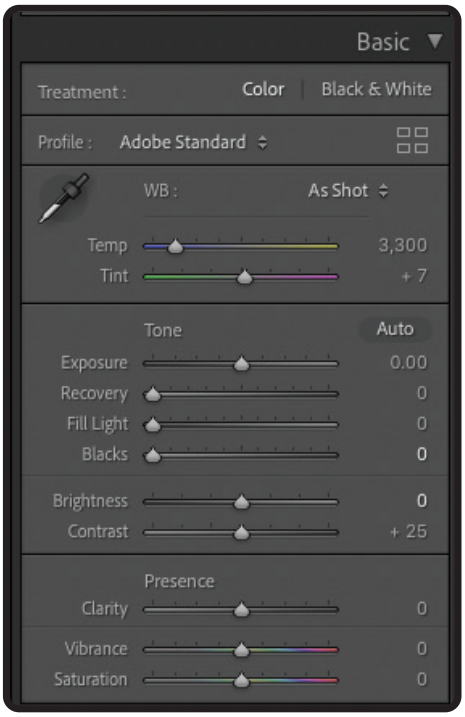
The x5 view is good for manual focusing.

6. Creating the User Preset

In the Develop module of Lightroom, on the right hand side of the application, scroll down to “Calibration” and click on the triangle to open the menu. At the top next to “Process:” change the Lightroom default setting of “Version 5 (Current)” to “Version 2”. All of the sliders should be set to 0. In older versions of Lightroom this menu is labeled “Camera Calibration” and the Process should be changed from “2012(Current)” to “2010”. Also note that in previous versions the menu for selecting a

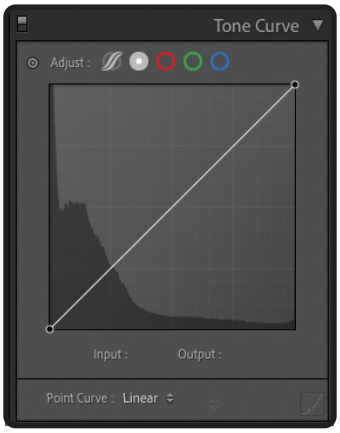






camera profile is located in the “Camera Calibration” window. Open the “Lens Corrections” menu and check the box for “Enable Profile Corrections”. If you don’t see this option, click on “Profile” in the top row. Once you enable profile corrections you may see the image change a bit and the “Lens Profile” info will fill in. The lens profile will, at least partially, correct for lens distortion and vignetting. If the lens profile info does not auto populate try selecting the Make and Model of the lens from the drop down menus. There are profiles for most common lenses, but not all. If there is no profile for the lens being used then do not enable profile corrections

Next, go to the “Tone Curve” menu, at the bottom set the “Point Curve:” to “Linear”. Lastly, open the “Basic” menu. In the bottom two sections, “Tone” and “Presence”, set all sliders to 0 except for “Contrast” which can stay at +25. “Profile” can remain as “Adobe Standard”, later in the pro-

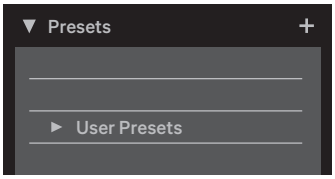


Set the Tone Curve to Linear.

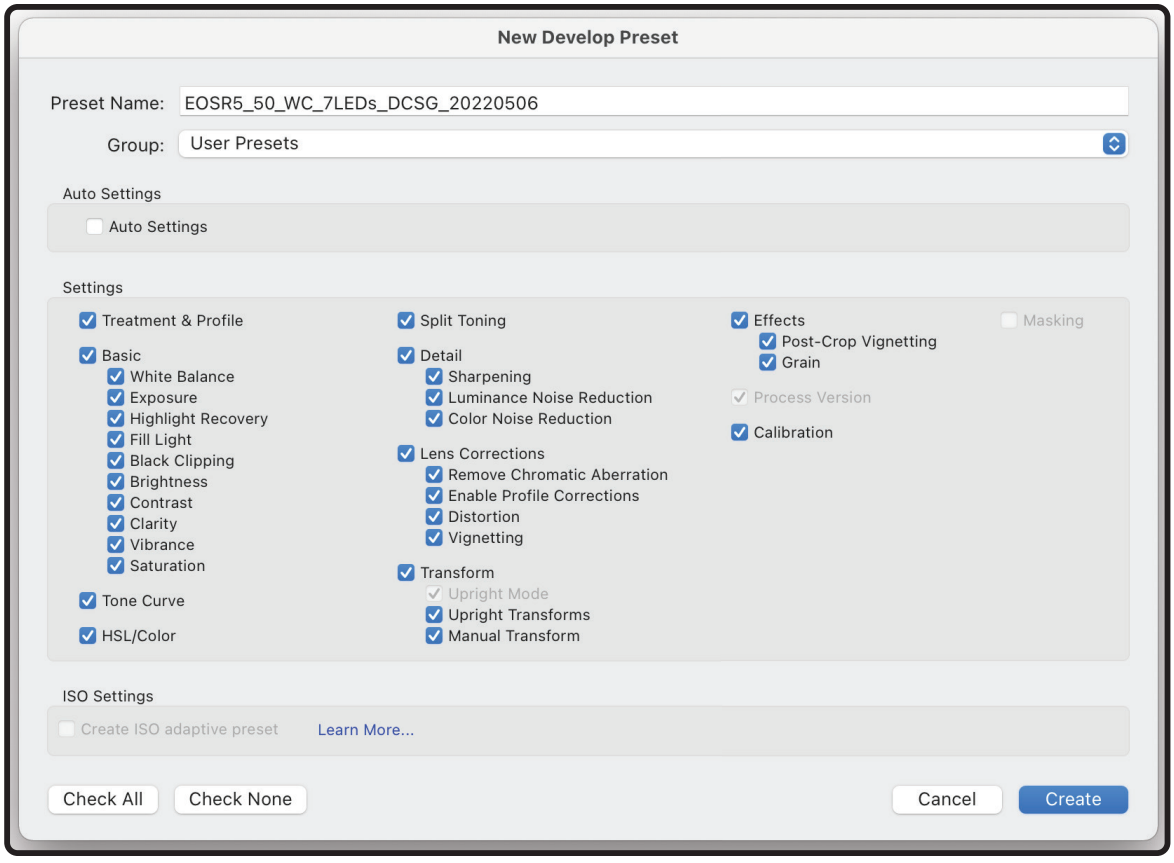
cess this will be where we apply the custom camera calibration. Near the top of the Basic menu is the White Balance Selector (the eyedropper) and sliders for Temp (color temperature) and Tint. To set the White Balance (which neutralizes the color bias of the light source), click on the eyedropper and then click on a known neutral (gray) in the image. When there is a chart or gray scale in the image, an upper middle gray patch(65-80L) is a good choice. It is best practice to consistently use the same patch for white balance.

If possible always use the same gray patch on the same chart to set white balance.

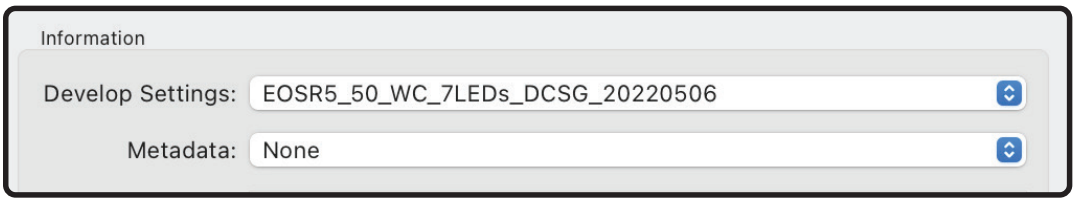
Now we are ready to create the user preset. On the left side of Lightroom open the “Presets” menu by clicking on the triangle, click on the “+” sign to create a new preset. Click the “Check All” button, make sure “Group” is set to “User Presets” and give the preset a name that identifies all of the scene info. In the screenshot below, the preset name indicates the camera (Canon EOS R5), lens (50mm), lighting (7 Westcott LED panels),



User Presets can be applied to Raw files as part of the Auto Import process.



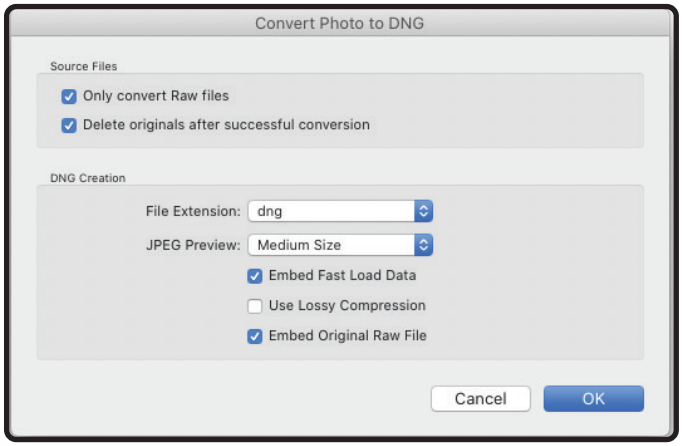
that the profile will be made from the DCSG chart, and the preset creation date. Click “Create” when finished and the new preset will appear in the “User Presets” submenu.
We can now add this develop preset to the auto import function so that all of these settings will be automatically applied to the RAW captures on import. In the menu bar go to File → Auto Import → Auto Import Settings... In the window that opens go to “Develop Settings” and select the new user preset that was just created, it will be in the “User Presets” subfolder. Click “OK”. Lightroom will now apply those develop settings as part of the Auto Import process.



7. Adjust Exposure of Chart Image and Convert to DNG

The next step is to check for even lighting and to figure out proper exposure by checking the L values in Lightroom of the white patches on the Digital SG chart. While in the Develop module of Lightroom, place the cursor over the middle of one of the four corner white patches. Underneath the Histogram on the upper right there should be LAB values displayed. The L value is luminance, for the white patch an ideal reading would be 96-97, but consistent values in the 92-97 range are acceptable. Lower L values mean that a longer exposure time, or increased strobe power, is needed. L values of 98-100 mean that the white patches, and the entire image, is over exposed. Check the L values of all 4 corner patches, they should match pretty closely. If one side reads darker, move that light closer (if possible) and shoot again. Adjust the exposure and light positions and reshoot until you get a photograph of the chart with consistent white patch readings (all within a 1 or 2 L value range of each other) in the 92-97 range. With this evenly lit and properly exposed image of the chart we will move onto BasICColor Input to create the camera calibration file, but first it is recommended to convert this chart image to a DNG file and to delete all of the improperly exposed photographs. In general if RAW files are to be archived, it is best practice to convert (or export) these native RAW files to DNGs, as the DNG files will contain all of the applied Lightroom Develop settings and calibration.

Switch to the Library module and select the thumbnail of the properly exposed chart image. Go to Library → Convert Photo to DNG...



Whether or not to “Embed Original Raw File” is entirely optional, checking this option will result in a larger DNG file size but the ability to revert back to the original RAW capture file is important to some.

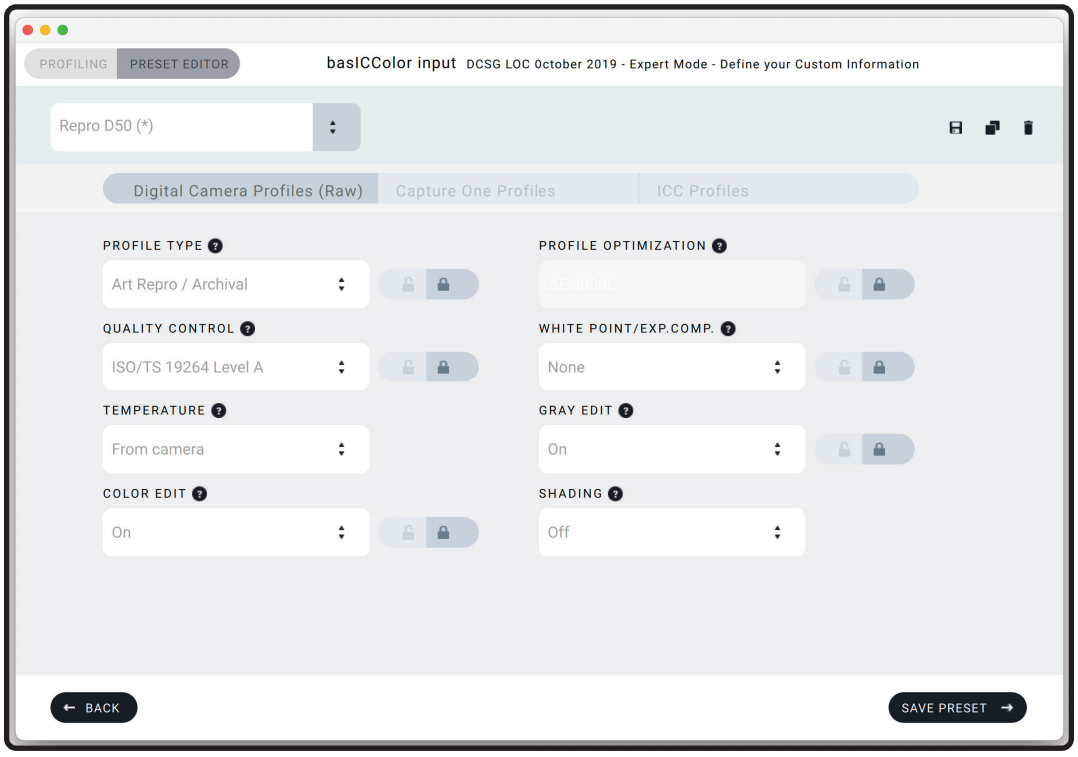
Multiple RAW files can be selected and converted to DNG in a batch through Library → Convert Photos to DNG or can be exported as DNGs by going to File → Export and selecting DNG as the “Image Format” in the File Settings section of the Export dialog window.

BasICColor Input

8. Create New Color Profile

Launch BasiCColor Input, click “Skip and start profiling” in lower right corner. Click on “Preset Editor” in upper left, then click the “+ New” button in lower right. Select the X-Rite ColorChecker Digital SG target, then click the “Expert Mode” button.

Use the settings in the following screengrab:



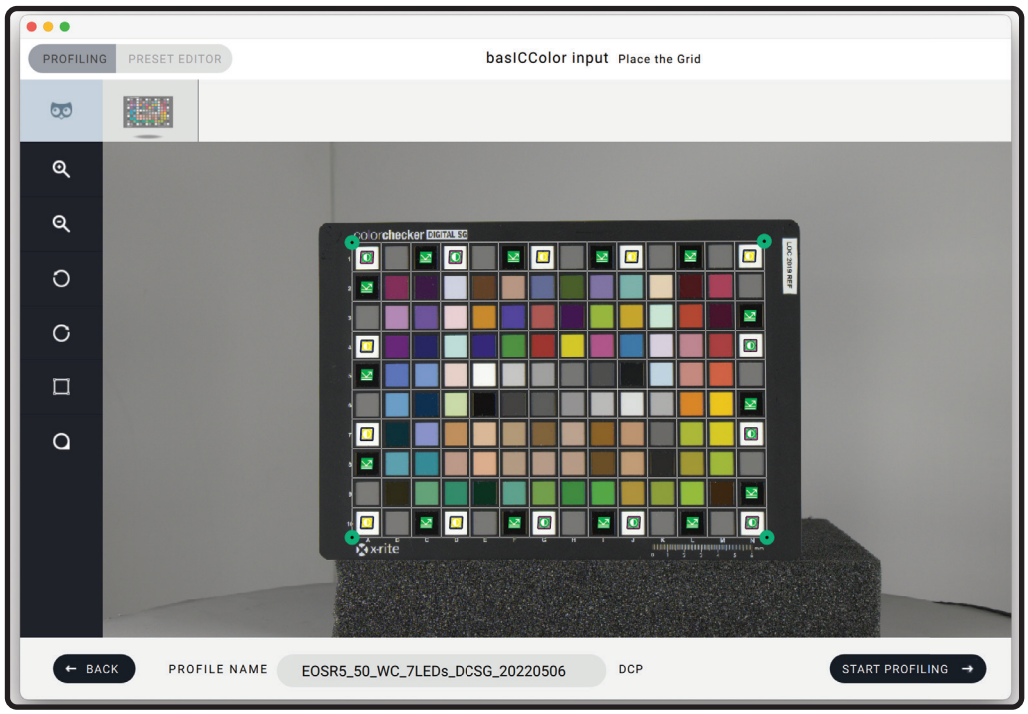
Expert Mode of the Preset Editor in BasICColor Input.

Click Save Preset, name it “ISO 19264 DCSG” and click “Add New Preset +”. Hit Profiling button in upper left and select the ISO 19264 DCSG preset from the row of buttons at the bottom of the window. Once this preset has been created it will available in the future when new scene calibrations are required.

Go back to Lightroom, select your correctly exposed shot of the DCSG chart. Control click on the thumbnail and select “Show in Finder” from the menu. A finder window will open with the DNG file highlighted, drag and drop that file onto the image of the chart in the basiCColor Input window.

After Input processes the DNG file, the chart image will open with a grid overlay. Input needs for the chart to be oriented properly, so rotate the image using the buttons on the left side so that the text on the chart reads correctly.

Adjust the layout of the grid overlay using the 4 green corner points so that the gray grid matches up with the DCSG chart.



In the “Profile Name” window re-name the profile. It is a good idea if this profile name matches the name of the user develop preset that was created in Lightroom.

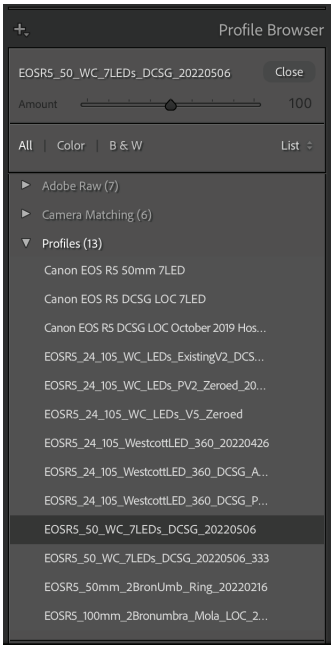
In general, it is best practice in this workflow for preset and profile names to be consistent and to identify the camera, lens and lighting being used. Once the profile has been renamed, click “Start Profiling”.

After Input finishes calculating the profile the Quality Control window appears, displaying some useful information about the quality of the color calibration. At this point the color profile has been created and saved into the proper folder on the computer and you can hit the “Quit” button in the lower right.

9. Applying the New Color Profile

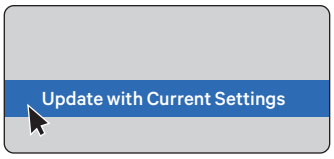
BasiCColor Input has now created the color calibration profile for the combination of camera, lens and lighting that were used to take the photo of the chart and has placed that profile in the proper folder on the computer. In order for Lightroom to load the profile, quit out of and then relaunch Lightroom.

When Lightroom opens, select the photo of the SG chart that was used to make the profile. In the Develop module go to “Profile” in the Basic menu and click on the 2 triangles next to “Adobe Standard”, click “Browse” to open the Profile Browser. Click the triangle next to “Profiles” to see the available calibrations and select the profile that was just created in BasICColor Input. The color of the chart image may change pretty drastically, and in most cases will look incorrect, but a quick resetting of the White Balance will fix this. Go to the Basic menu, select the eyedropper and click on one of the middle gray patches. After applying the camera profile and correcting white balance, the image should appear color correct but a bit dark. In the Basic menu, set the Brightness slider back to +50, which should bring the SG chart white patch values back up to the 92-97 L range.



The Profile Browser in List view.

Before moving on to the final steps in this scene calibration process, update the User Preset to include the new color profile, Brightness and White Balance settings. In the Presets menu, control click on the User Preset and select “Update with Current Settings” from the menu.

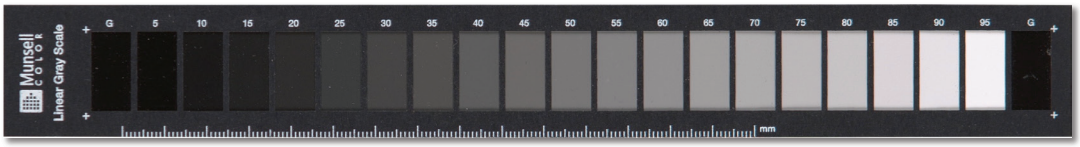


Set the Brightness slider back to 50 and update the User Preset to reflect the new settings.

Tone Adjustment Curve

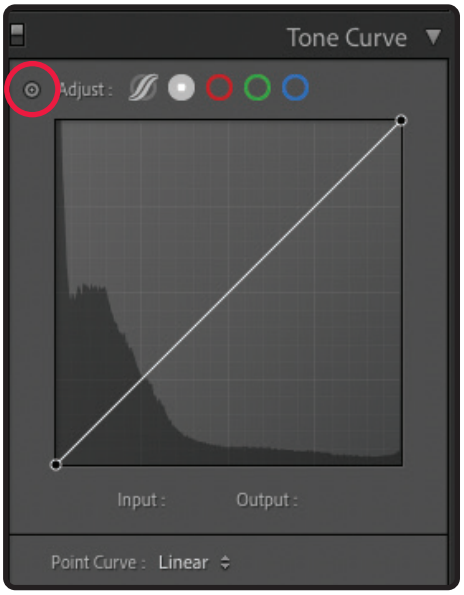
10. Add a Tone Adjustment Curve

The final leg of the scene referred calibration process is to add a tone adjustment curve to the user preset using the Munsell Linear Gray Scale. The Munsell chart features a gray scale of semi-gloss patches from 5 to 95 (L values) in increments of 5, with a gloss black (3 L) patch at both ends. Other gray scale charts, including the gray patches in the middle of the SG chart, can be used as long as the patches have known L values, but the Munsell works very well. An image of the SG chart showing the L values of the grays can be found on page 22.



Munsell Linear Gray Scale

Go back to the EOS Utility and open the Remote Live View window. Place the Munsell Linear gray scale on top of the SG chart in the middle, parallel to the lights, close the Remote Live View window and take a photo of the scene. After the image is imported into Lightroom click on the image or select 1:1 zoom in the top of the Navigator window on top left, making it easier to read the print on the gray scale.

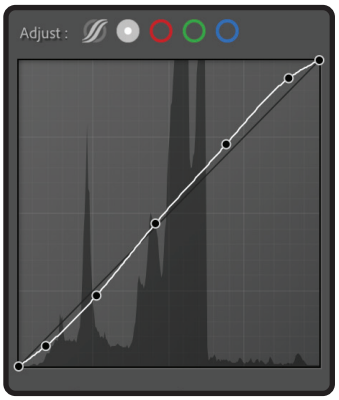


The Tone Curve adjustment tool allows you to place adjustable points on the curve by clicking on the image.

Open the Tone Curve menu in the Develop module and click on the circle in the upper left corner, this tool allows for the direct adjustment of the tone curve. Move the cursor over the image and a point will appear on the tone curve correlating to the L value of that pixel. As you move the cursor around, the point on the curve will bounce around accordingly. When you click on the image, an adjustable anchor point

will appear on the curve. Go to the middle of the 95 L patch on the Munsell chart and click to add an anchor point. Keep the cursor on the 95 patch and check the L value in the Histogram window, if it measures lower than 95 use the up arrow key to nudge the anchor point(and the tone curve) up until it does measure 95. If it measures higher than 97 the photo is overexposed.

After getting the 95 patch to measure 95 L, move on to the 75 patch, click on it to add an anchor point and use the arrow keys to adjust the curve until it measures correctly. After 75 do the same with the 50, 25 and then the 5 L patches. Now work back up the scale checking the measured L values of all the in between patches, adding points and adjusting the curve when needed. It is not recommended to add a point for every patch, if a few consecutive in between patches are off, add a point in the middle and adjust. It's OK if not all of the patches are measuring exactly correct, but it should be possible to get all within 1 or 2 L values without having an anchor point for each patch. It is better to have a more fluid, smooth curve that may be a little off in a few patches than to have an abruptly zig-zagging curve that gets every value correct.



The tone curve should be fluid and smooth.

On the right is an example of a good Tone Curve, only 5 anchor points with slight adjustments were needed to linearize the tones in the photo. Other scene calibrations may require a more aggressive curve with a few more anchor points but avoid making a curve that looks like a saw blade.

When the curve is finished, click on "Custom" at the bottom of the Tone Curve menu and select Save. Name the curve in the same manner that the User Preset and color profile were named and save it. Finally, go to the User Preset on the left side of Lightroom, control click and Update with Current Settings to add the Tone Curve adjustment to the Develop preset.

Save the tone curve and name it the same as the user preset.

Congratulations! You now have a scene referred color managed photographic workstation. While this scene calibration will remain valid if you alter the camera height or make adjustments to the positioning of lights, changing the camera body, or lens, or lights, or a change in the shooting environment, will require a new scene calibration. But, truly lastly, before putting the calibrated preset into use, a quality check should be performed.

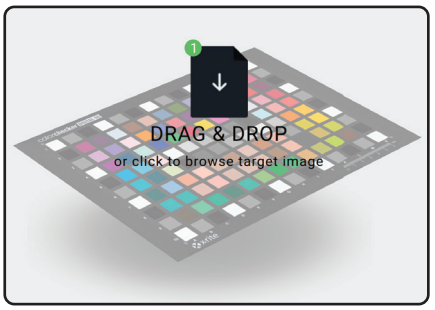
Validation

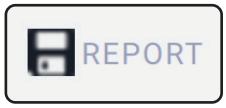
11. Validating the calibration preset

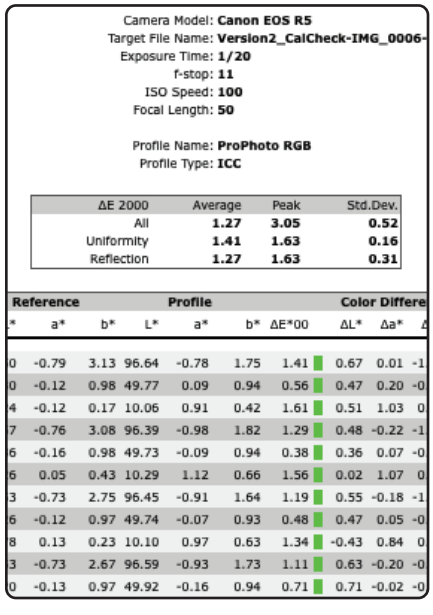
BasICColor Input can evaluate the color reproduction accuracy of the calibration by inspecting a Tiff image of the SG chart that has been processed through the preset. Shoot a new image of the SG chart by itself, it will come into Lightroom with the calibrated preset applied. Check to make sure that the exposure is correct and export the image as a Tiff file to the desktop. Go to File → Export. In the Export dialog choose Desktop as the "Export To" location and for File Settings use the settings in the screenshot below:

Open BasICColor Input and select the ISO 19264 DCSG profiling preset that was created earlier. Click and drag the SG chart Tiff image from the desktop and drop onto the chart image in the Input window. Just like when you drop the DNG file for profile creation, the window displaying the chart image with grid overlay will appear. Correct the grid if necessary but this time instead of hitting the Start Profiling button, click on the Report button on the upper right. A Save As window will open, name the Report file (give it the same name as the preset, including the date) and choose save location. The report will open in a web browser, displaying overall average and peak ΔE (delta e) data at the top, followed by individual data for each color patch and then a QC "passed" or "failed" indication at the very bottom. The standards for passing QC (in this case we used ISO 19264 Level A) have been set very high, especially for the gray patches, so if the report shows "QC failed" do not be discouraged. The SG chart patches are semi-gloss and a little flaring on one gray patch can cause a QC failure. You can tell which patches are problematic by looking for red boxes next to the ΔE*00 values in the patch data list, the green boxes are all passes. If just a few patches are failing, adjusting the lights to a lower angle of incidence and re-shooting the validation image might produce a better QC result. If that does not work or if a lot of patches are failing then the lights should be re-positioned and the process started over again.

After passing QC, put some art in front of the camera and start shooting. Always check exposure and reset white balance at the beginning of a shooting session, and aytime the camera or lights are moved.







Camera Model: **Canon EOS R5**
Target File Name: **Version2_CalCheck-IMG_0006-**
Exposure Time: **1/20**
f-stop: **11**
ISO Speed: **100**
Focal Length: **50**

Profile Name: **ProPhoto RGB**
Profile Type: **ICC**

ΔE 2000	Average	Peak	Std.Dev.
All	**1.27**	**3.05**	**0.52**
Uniformity	**1.41**	**1.63**	**0.16**
Reflection	**1.27**	**1.63**	**0.31**

Reference			Profile				Color Differe		
*	a*	b*	L*	a*	b*	ΔE*00	ΔL*	Δa*	Δ
0	-0.79	3.13	96.64	-0.78	1.75	1.41	0.67	0.01	-1
0	-0.12	0.98	49.77	0.09	0.94	0.56	0.47	0.20	-0
4	-0.12	0.17	10.06	0.91	0.42	1.61	0.51	1.03	0
7	-0.76	3.08	96.39	-0.98	1.82	1.29	0.48	-0.22	-1
6	-0.16	0.98	49.73	-0.09	0.94	0.38	0.36	0.07	-0
6	0.05	0.43	10.29	1.12	0.66	1.56	0.02	1.07	0
3	-0.73	2.75	96.45	-0.91	1.64	1.19	0.55	-0.18	-1
6	-0.12	0.97	49.74	-0.07	0.93	0.48	0.47	0.05	-0
8	0.13	0.23	10.10	0.97	0.63	1.34	-0.43	0.84	0
3	-0.73	2.67	96.59	-0.93	1.73	1.11	0.63	-0.20	-0
0	-0.13	0.97	49.92	-0.16	0.94	0.71	0.71	-0.02	-0

ΔE (ΔE 2000, ΔE*00) is a measure of color difference.
For more information see pages 22-23.

X-Rite Color Checker Passport Calibration

As an alternative, we will go through scene calibration using the Color Checker Passport and the Color Checker Camera Calibration software.

1. Install Software

The first step is to install the Color Checker Camera Calibration software. Part of this software package is a plug-in that will create a camera color profile directly from a RAW file in Lightroom. After installation is complete, if Lightroom is active, quit and relaunch.

2. Set Up Configuration

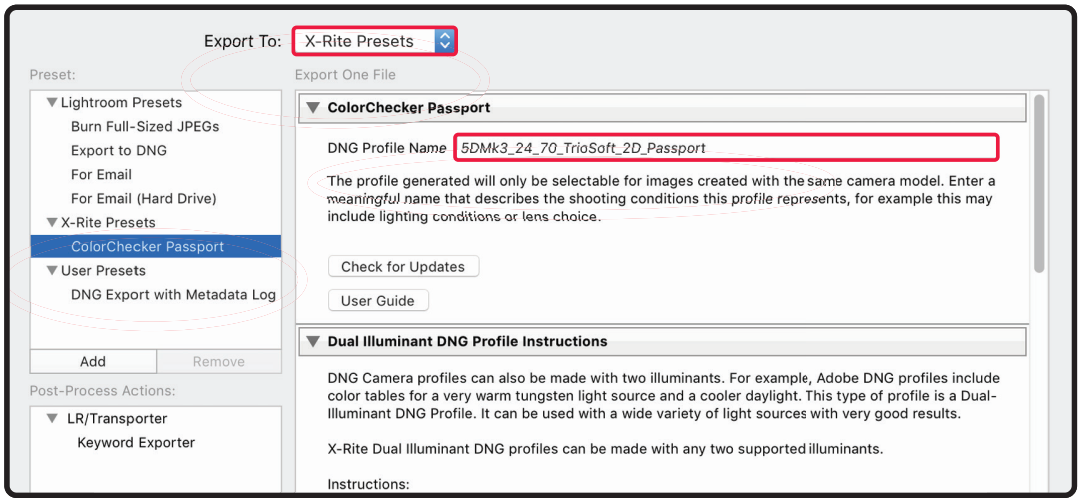
The Canon Utility set up is exactly the same as described in the previous section. Setting up Lightroom is almost entirely the same. Follow the instructions for the BasICColor calibration, with the following exceptions:

- Replace the SG chart with the Passport.
- At Step 6, when in the Basic menu of the Develop module leave the Brightness set to the default setting of +50.
- When naming the User Preset add “Passport” at the end of the name to indicate the method by which the calibration was made.

- At step 7 when checking exposure, use the white patch of the Passport, the same 92-97 L range applies.
- To check for even illumination, measure the value of the background paper at the 4 corners of the frame and around the middle, adjust lights as necessary.
- Stop after step 7 and continue with the instructions below.

3. Export with X-Rite Presets

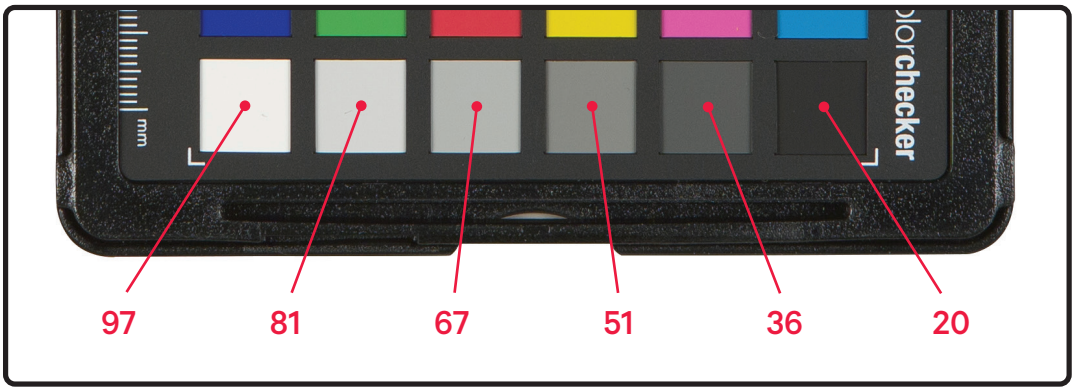
After setting up Canon Utility, the Lightroom Auto Import function with the User Preset built in, adjusting lighting and setting proper exposure, we go right to profiling. In Lightroom select the properly exposed shot of the Passport and go to: File → Export. The Export dialog window will open. On the left side of the window click on the triangle next to "X-Rite Presets" and select "Color Checker Passport".



"Export To:" should automatically switch to "X-Rite Presets". For "DNG Profile Name" fill in a descriptive name that matches the Develop Preset name. Then click Export. The Color Checker software will create the camera calibration file and place it in the proper location. Quit and relaunch Lightroom. Select the same Passport photo, go to the Basic menu in the Develop module and select the profile that was just created, go to the User Preset and Update with Current Settings.

4. Tone Adjustment Curve

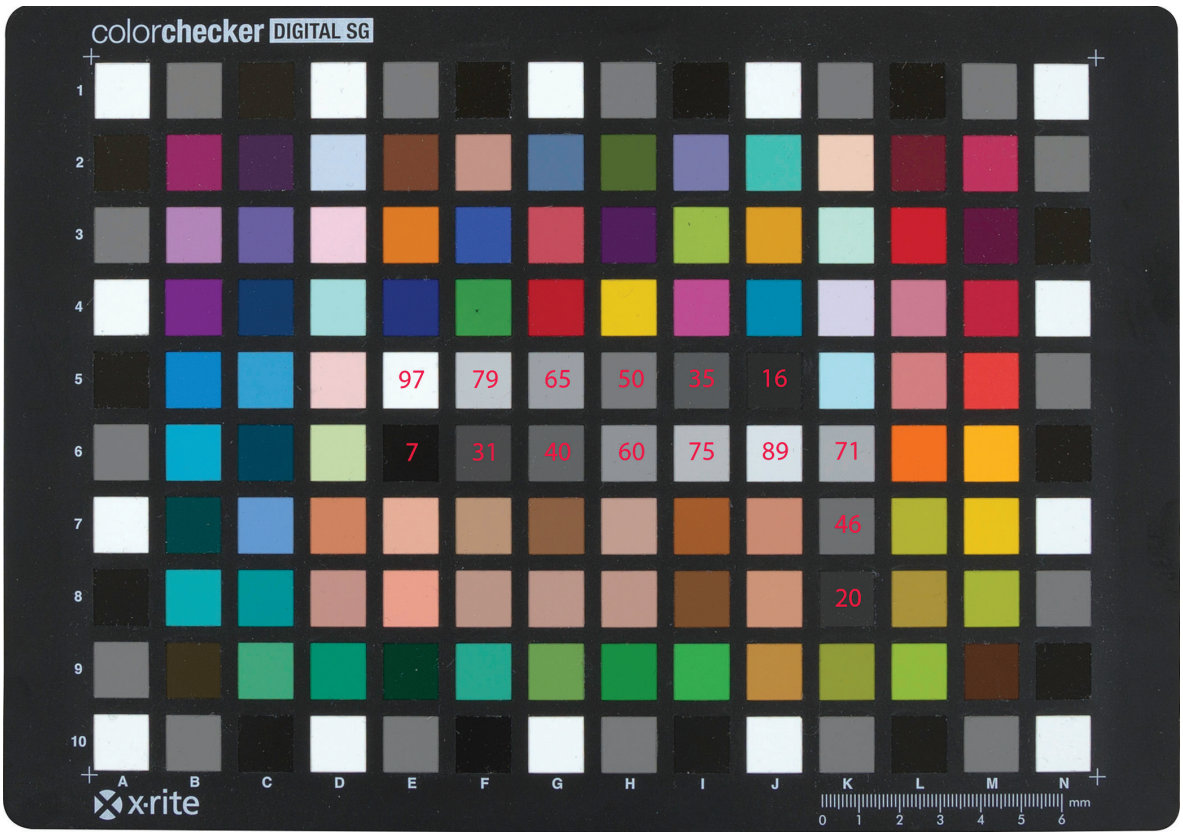
The last step is to make a Tone Adjustment Curve based on the 6 grayscale patches on the Passport. The L values are not printed on the Passport itself but the image below shows what the target values are based on the data chart on X-Rite's website.



With only 6 patches in this grayscale, it is ok to go through and check each patch, making adjustments to the tone curve as needed. Just the same as working with the Munsell grayscale chart though, a smooth fluid curve that is slightly off in value is better than a zig zagging curve that hits all the numbers precisely. When the Tone Curve is finished save and name it in the same manner as the User Preset and then go to the User Preset and Update with Current Settings.

And the Passport scene calibration is done.

Appendix

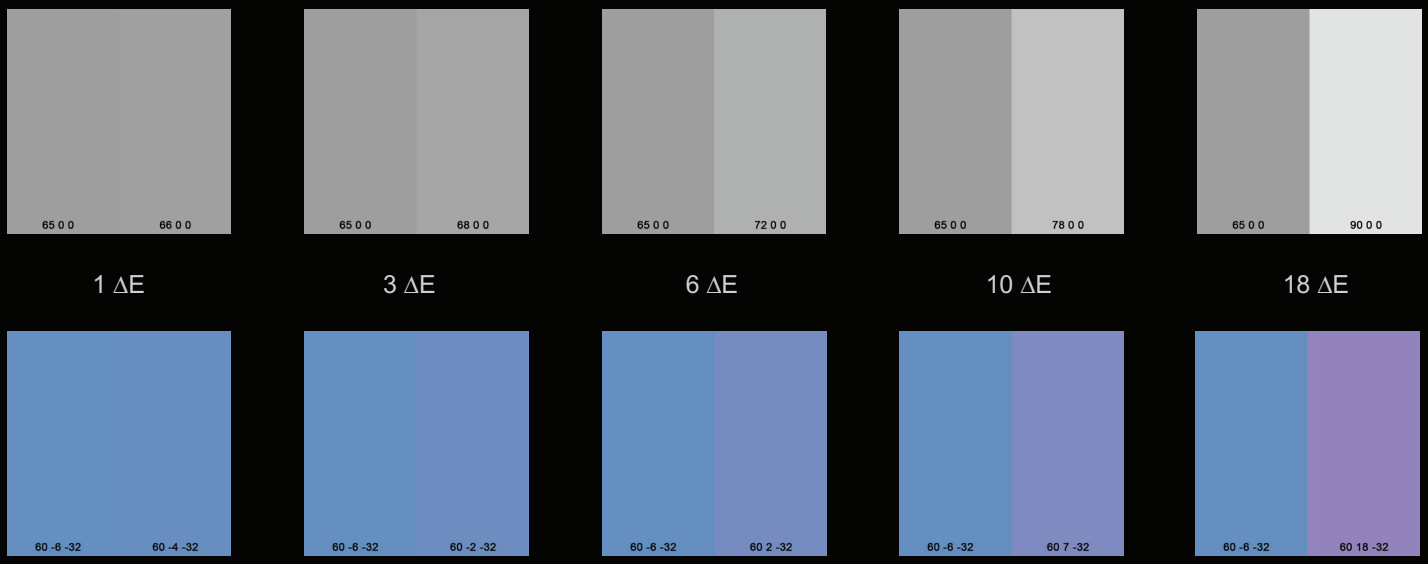


L values of the gray scale patches in the middle of the Color Checker Digital SG color chart.

What is ΔE?

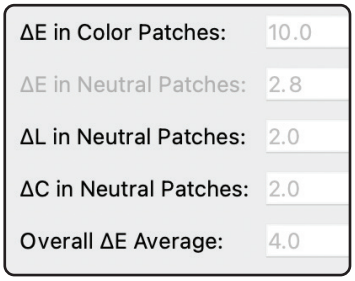
ΔE (delta e) is a metric used to quantify the difference between 2 colors. While there are various formulations for calculating ΔE values, the most commonly used version is ΔE 2000. In color management, ΔE numbers are employed to describe how accurately colors are being reproduced in a digital image, on screen, in print, etc. In this case, evaluating a calibrated photo capture system, the LAB values of color patches in a processed image of a chart (the SG chart Tiff file) are compared to the measured LAB color values taken directly from that chart. The color differences for each channel(L, A, and B) of every patch, and for each patch as a whole, and averages for the entire chart, are all calculated and expressed as ΔE values. All of this data is included in the report from BasICColor Input.

What's a ΔE?



In the above image are visual examples of 5 different ΔE measurements. Each square is divided in half, with the right halves increasing in ΔE difference from the left. In the top row, the right half changes only in L (grayscale) value and in the bottom only the A channel changes as the right half becomes more and more red.

1 ΔE is considered to be a "just noticeable difference", as you can see in both examples above the divisions are barely visible. An interesting phenomenon to notice is that the ΔL differences in the top row appear much more pronounced than the ΔA differences in the bottom row. Because of our greater sensitivity to differences in neutrals, QC tolerances are tighter for chart image gray patches than for color patches. In setting up the profiling preset in BasICColor Input we used the **ISO 19264 Level A** QC tolerances, summarized in the image on the right. Notice that the ΔE limit for color patches is 10 while the limit for neutrals is only 2.8. The ISO 19264 Level A tolerances are comparable to the Metamorfoze (Full) and FADGI (4 star) standards, so either of the 3 standards are ok to use for QC. Using this workflow it should be very possible to achieve an overall average ΔE ≤ 3 with just about any digital camera.



ISO 19264 Level A QC tolerances in Input.

Feel free to reach out with any questions or comments:

Scott Geffert - scott.geffert@metmuseum.org

Chris Heins - chris.heins@metmuseum.org

THE MET