Gary Jarvis – RH Designs Densitometer Calibration Method – Rev 1.0

The densitometer calibration method is explained in Section 2 of the RH Designs document Pluscal.pdf.

I have automated this process via a spreadsheet based calculator which can output directly the meter offsets and contrast values for your chosen paper / developer combination.

This can be achieved with a total of 28 densitometer readings across 7 contact prints of the stouffer step wedge. The spreadsheet interpolates the necessary critical highlight and DMax exposures without the need for extensive densitometer readings and the manual drawing of curves. This is achieved using an inner-linear interpolation method, which, in my experience, provides good curve matching with a minimal number of densitometer readings.

What you will need

2 no 7x5 sheets of your chosen photographic paper for calibration

A piece of plain glass, (from a picture frame 6x4 inches will do)

Densitometer

Stouffer step wedge T2115

Preparation of enlarger

The enlarger head needs to be at a specific height so as to provide a calibration illumination within $1/10^{th}$ of a stop of a reference illumination level at the base board. Accurate calibration depends on this, so care is urged in this part of the process.

Remove all filters from the light path and turn the light source on. Set the enlarger head about ¾ of the column height.

Press and hold the meter button until dlog 0000 appears, this will zero the densitometer function of the light meter. Move the enlarger head down until the meter reads HI, or adjust the aperture or both to achieve this. Now make small adjustments of the enlarger head up and down pressing the meter button repeatedly until you find the boundary of HI and dlog 0000. (Note: on later light meters there is a value of 365 which needs to be displayed).

Take your time on this stage.

Do not move the enlarger head or change aperture after this threshold has been established.

Contact prints of the Stouffer step wedge

In total, 8 test strips are required. 7 of these are contact prints of the T2115 Stouffer wedge (The step wedge is supplied with the Analyser pro / Zonemaster II but can be purchased separately, if needed).

These are contact printed one for each grade at 00 to 5.

The eighth test strip is divided into two halves; one half of the strip is covered by anything opaque such as a strip of matt board and the other half is exposed to the enlarger. This will be used to establish highlight reflection density of the paper base and the maximum black reflection density of the paper.

The Process

2 no 7x5 sheets of your chosen paper should be sufficient for the contact prints of the Stouffer step wedge and one extra test strip to determine the paper base reflection density and the paper maximum black reflection density.

Make sure your developer is at your normal working temperature range. Be consistent with your developing. I tend to develop one strip at time, and make sure I complete printing all the strips in 1 printing session.

Under safelight conditions take 1 strip of paper and write on the rear "G 00 and the exposure time in secs". i.e G 00 30 secs

Set your 00 filter on your enlarger.

There are four possible exposure times that can be used. 7.5 secs, 15 secs, 30 seconds and 60 seconds. Notice that these are all 1 stop apart. Intermediate exposures times are not permitted and will lead to a skewed calibration.

A 30 second exposure provided the full range of tones for my own example calibration illustrated here.

Place your test strip paper central on the baseboard. Place your step wedge (emulsion side down) on to your test strip. You will be able to read the numbers the right way around with emulsion side down. Hold you glass centrally over the step wedge and drop the glass to hold the step wedge in contact with the paper.

Check everything is held down tight and make your exposure.

Develop, stop, fix and wash as usual. Check in good light and make sure you have a range of tones from full white to full black.

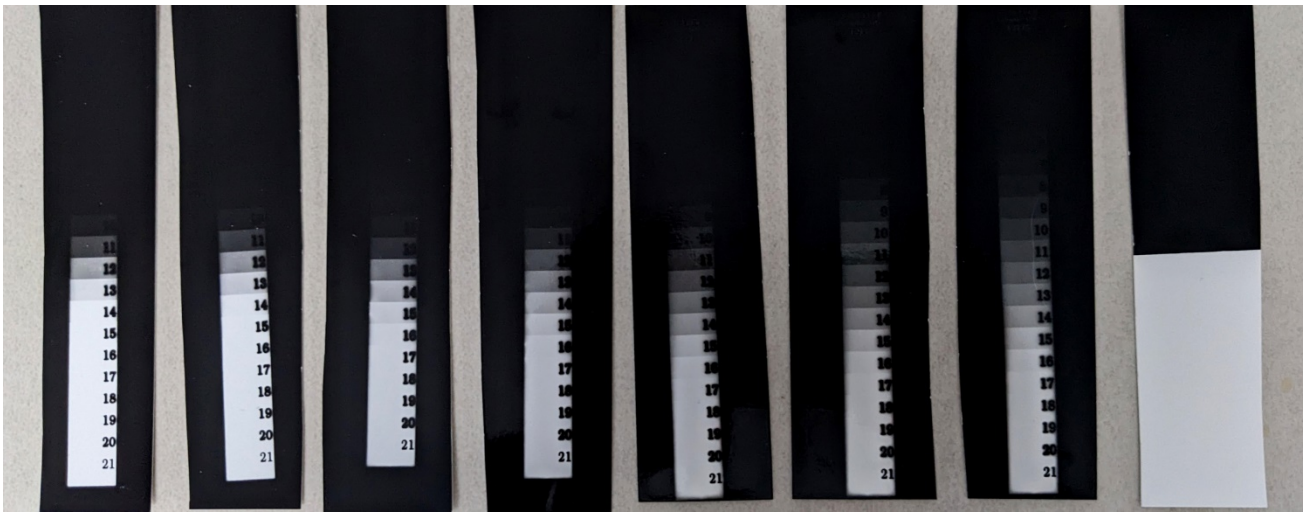
If you have not achieved this you may need double or halve the exposure time until there is a full range.

Repeat the process through Grades 0 to 5 taking care to develop, stop, fix consistently. Remember to change your filters as you go, and to write the grade and exposure time on the back of each one.

You should now have a full set of 7 contact printed step wedges hanging to dry.

For the eighth test strip, set your meter to Grade 1 take a meter reading from the enlarger with no filters in place and move the highlight exposure to the shadow end. Then increase the exposure time by 2 stops.

Cover one half of your test strip with a piece of matt board or similar and expose the strip. Develop, fix and wash. This test strip will be used to measure your paper base reflection density and your absolute maximum black reflection density.



Printed stouffer wedge contact strips and paper base / max black test strip

To be more precise you should measure the actual test strip cover glass density with the light meters densitometer function. To do this simply zero the meter under your enlarger light by pressing and holding the meter button, make

sure you get the d0000 reading. Then place your glass over the meter window and take and record the measurement. The glass I use for my contact prints has a density of 0.02 for example.

Make sure you keep your test strips nice and clean.

Densitometer measurements and entry into the spreadsheet

Calibrating the Stouffer step wedge

For an accurate meter calibration it is important that your Stouffer step wedge is calibrated. This calibration only needs to be carried out once.

Take transmission densitometer readings of each of the 21 segments and record the densities of each segment.

Enter your measured densities into cells S11- S31 of the step wedge table on the spreadsheet (these are the green cells shown below). Note that the manufacturers' specified densities are entered here by default but these can be overwritten by the user. (Note: all the green cells on the spreadsheet are available for data entry)

Step Wedge transmission values stouffer (T2115)

Step Wedge transmission steps	Target	Glass density	Step Wedge transmission values + glass density
21	3.05	0.02	3.07
20	2.90	0.02	2.92
19	2.75	0.02	2.77
18	2.60	0.02	2.62
17	2.45	0.02	2.47
16	2.30	0.02	2.32
15	2.15	0.02	2.17
14	2.00	0.02	2.02
13	1.85	0.02	1.87
12	1.70	0.02	1.72
11	1.55	0.02	1.57
10	1.40	0.02	1.42
9	1.25	0.02	1.27
8	1.10	0.02	1.12
7	0.95	0.02	0.97
6	0.80	0.02	0.82
5	0.65	0.02	0.67
4	0.50	0.02	0.52
3	0.35	0.02	0.37
2	0.20	0.02	0.22
1	0.05	0.02	0.07

Bulb	Enter test strip exposure time in secs (if other than 15secs) othewise enter 0. Enter -30 if using 7.5 sec exposure	Date
Orsram 4.9W 2700k	30	16/11/2022

Enter your exposure value into cell F7.

For 7.5 secs enter -30
For 15 secs enter 0
For 30 seconds enter 30
For 60 seconds enter 60

Enter your measured glass overlay density into cell M7. This will then automatically populate the Stouffer wedge table above in the column titled 'glass density'.

Reflection density of paper base	Paper reflection density 0.04 above paper base (highlight / light exposure)	Max paper reflection density (absolute)	Max paper reflection density above paper base (Dmax)	Paper reflection density - 90% Dmax - (Dark exposure)	Density of glass overlay
0.06	0.10	2.15	2.09	1.88	0.02

Determining the paper base and maximum paper reflection density

Take a reflection densitometer reading of the pure white and pure black portions of your black and white test strip.

Enter the paper base reading into cell H7. Enter the pure black reading into cell J7.

The spreadsheet will then calculate the critical light and dark exposure values. Cells I7 and L7 respectively (marked in red boxes above).

Starting at Grade 00 on your step wedge contact prints, using your densitometer find the reflection densities closest above and below (or at) the value of each of the target highlight and dark exposure values and enter these into the spreadsheet. (see below for example). Repeat for Grade 0 through to Grade 5.

Grade "00"				Grade 0		
Stouffer segment	Exposure value	Print Density		Stouffer segment	Exposure value	Print Density
21	-26			21	-26	
20	-11			20	-11	
19	3			19	3	
18	19			18	19	
17	33			17	33	
16	48	0.10		16	48	0.09
15	65	0.20		15	65	0.19
14	81			14	81	
13	98			13	98	
12	113			12	113	
11	127			11	127	
10	142			10	142	
9	156			9	156	
8	171			8	171	1.76
7	187			7	187	1.98
6	202	1.84		6	202	
5	219	1.93		5	219	
4	234			4	234	
4	249			4	249	
2	264			2	264	
1	278			1	278	

The spreadsheet will then compute the meter offsets and contrast values. These should then be entered directly into your Analyser pro / Zonemaster II. (See meter calibration table below for an example calibration output)

Grade	Meter software constant (A)	Dark exposure in 30ths stop (90%Dmax) (B)	Light exposure in 30ths stop (0.04) (C)	Meter offset in 30ths stop (C) - (A) (D)	Meter steps in12ths (D)* (12/30)	Meter contrast in ISO (30ths stop) B-C	
"00"	55	210	48	-7	-3	162	
0	60	180	50	-10	-4	130	
1	65	168	52	-13	-5	116	
2	68	141	54	-14	-5	86	
3	75	130	57	-19	-7	73	
4	112	147	85	-27	-11	62	
5	133	145	90	-44	-17	56	

Meter calibration

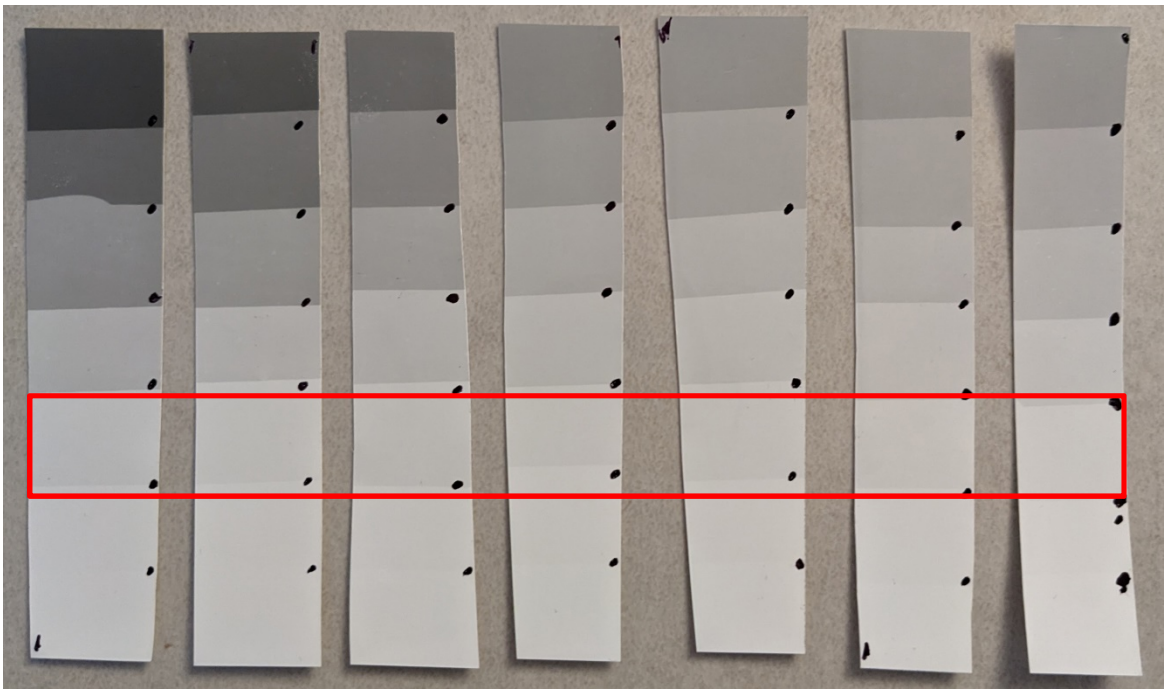
	"00	0	1	2	3	4	5
offset	-3	-4	-5	-5	-7	-11	-17
contrast	162	130	116	86	73	62	56

For the first calibration using this method, I heavily recommend a set of exposure test strips be carried out at ¼ stop intervals. Please refer to the RH designs calibration manual for the process.

Individual light meters may have variable sensitivities from the reference values.

For my own Zonemaster II I have found my light meter overexposes by 1/4 stop against the calibration.

Below are my exposure test strips made subsequent to my calibration using the above method, this was for a 2700k led bulb, Ilford MGV paper and Ilford MG Developer. The full calibration is given on the ‘ Example’ tab on the spreadsheet. The target highlight density (0.10) is shown in the red box which the meter has ¼ stop over exposed.



Exposure test strips 1/4 stop							
0.10 segment offset	-1	-1	-1	-1	-1	-1	-1
Offset adjustment	-3	-3	-3	-3	-3	-3	-3
Final meter calibration							
	"00	**0**	**1**	**2**	**3**	**4**	**5**
offset	-6	-7	-8	-8	-10	-14	-20
contrast	162	130	116	86	73	62	56

The spreadsheet therefore has the facility to enter a correction for this as per the green cells above.

In this example I offset my meter a further – ¼ stop which is an offset of -3 (-3/12ths of a stop) for each grade.

The final adjusted meter calibration is then calculated by the spreadsheet for entry into the light meter.

As a check, and to verify the method, I have also carried out a separate calibration on a 4000k led bulb and this calibration was consistent at being a ¼ stop overexposed compared to the calibration.

So, in my case, I will use a personal offset correction of -3 for all my future calibrations.

Once your unique exposure offset is established, future calibrations can be undertaken with just the Stouffer step wedge densitometer measurements compensated by your unique meter offset as determined by your own initial exposure test strips.

You may find that no other correction is required and that your meter is aligned with the calibration with no further adjustment being necessary.

I'd be happy to help with any queries and would welcome any feedback on the method, should you choose to try it.

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