ColorChecker Passport Technical Review

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14 October 2009
Revised 5 July 2010

Background

Originally released in 1976, the ColorChecker consists of color patches selected to test and aid the processing of film images. Manufactured for over 30 years, the ColorChecker has expanded from a single chart into a family of products; the SG (Semi-Gloss), the discontinued DC (Digital Chart), the little Mini, the White Balance Card and the Gray Scale Balance Card. On September 15, 2009, X-Rite has created another member of the ColorChecker family; the ColorChecker Passport.

Physical Attributes

The ColorChecker Passport is not a single chart, but 3 charts contained within a thin plastic case. At 125 x 90 mm (4.9 x 3.5 inches) in size, the Passport is the same size as a travel passport, hence the name. The case is made of ABS plastic, the stuff football helmets are made from, so it should be able to withstand even a photojournalist with several cameras hanging from the neck smashing into it. Although the case locks when shut, the case is not waterproof, so using it in the rain will damage the color charts.

It is not clear what X-Rite was thinking when they made the lanyard for the Passport. This thing is really long. The instructions state that the Passport should be worn diagonally across the photographer's chest, although judging by the length X-Rite must think all photographers are XXXL sized.

The Passport itself is comprised of three "pages"; the front and back of the case and the center "page". These are connected by a hinge and the outside covers have a locking mechanism which keeps the Passport from opening unintentionally.

The hinge requires some force to open the Passport, but this is a deliberate design feature. The hinge stiffness works in combination with some click stops to keep the Passport open at various angles for standing it up vertically, horizontally, or holding it open flat.

Color charts are attached to the inner surface of the top cover and both sides of the center page. The inside surface of the back cover is reserved for the quality guarantee along with an area for marking the date of first use and the owner's identification.

There are three charts in the ColorChecker Passport; White Balance, ColorChecker Classic and Photo Enhancement. These charts are made from paint applied to paper, so using these charts in the rain may reduce its life from the estimated 2 years to a single use. *<Begin shameless plug>* For rain, the Digital Gray Card™ from RM Imaging (rmimaging.com) is still the best choice for setting neutral balance. *<End shameless plug>*

White Balance Chart

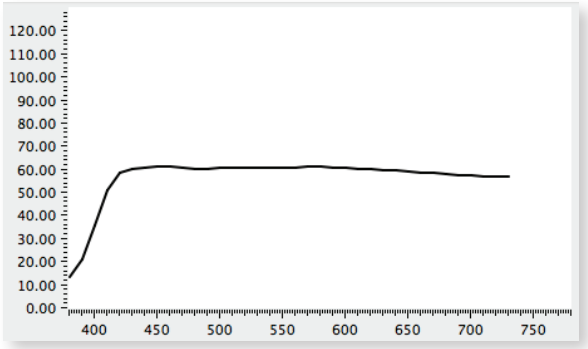
Directly opposite the guarantee on one side of the center page is the White Balance chart. This consists of a single gray patch about 90 x 60 mm (3.5 x 2.25 inches) in size.

At first glance this patch appears to be a large version of the Neutral 8 patch from the original ColorChecker, but this is not the case.

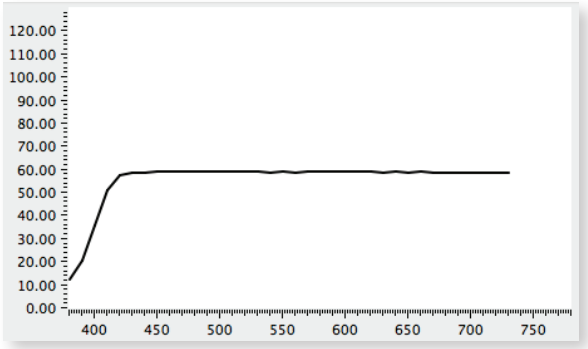
The ColorChecker Classic's Neutral 8 patch has a spectral reflectance which, although relatively flat across the spectrum, has a slope to it. This slope was due to its colorants and gave it a slight color cast, making it unsuitable for neutral balancing a digital camera.

The ColorChecker Passport's White Balance Chart is very flat across most of the spectrum. This shows that X-Rite has made a special formulation to remove any color cast.

Having a reflectance of about 60% also results in a good signal to noise ratio for the digital camera's sensor, even in low light situations.



Neutral 8 patch from the ColorChecker Classic chart.



White Balance Chart spectral reflectance.

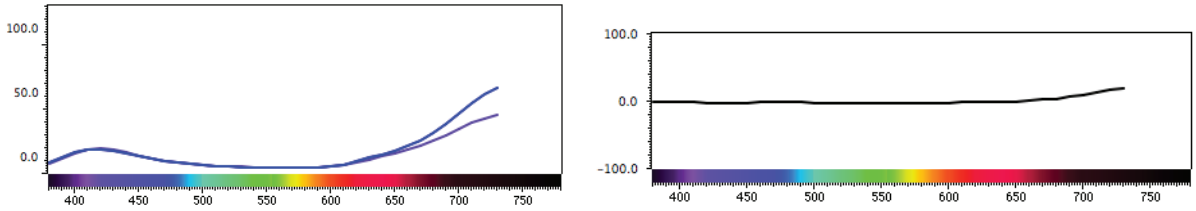
ColorChecker Classic

This is the the same ColorChecker layout that has been around since 1976. The ColorChecker DNG software, included with the Passport, uses this chart to make a profile that can be used with Adobe Camera Raw or Lightroom to color correct DNG images.

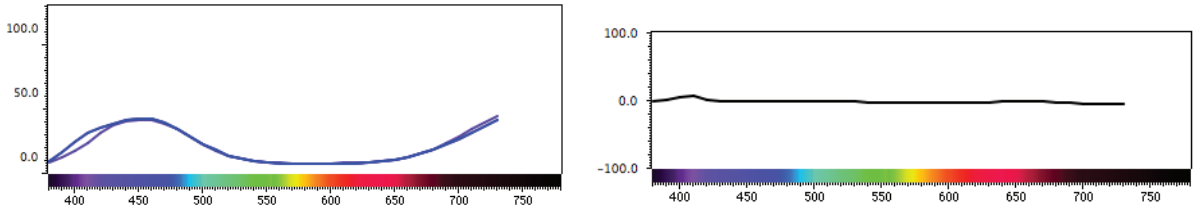
A few of the patches have been reformulated as shown by their spectral reflectance and difference graphs, but the colors appear the same.

Because of these reformulations, you should measure your own chart and make a custom reference file if you are going to use the ColorChecker Classic for making profiles.

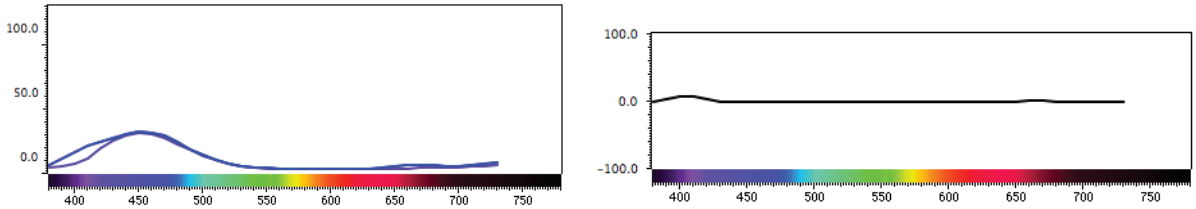
Spectrum Difference



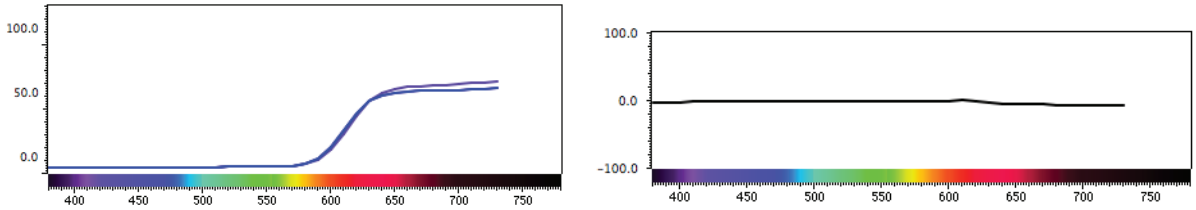
Purple patch. ColorChecker 2007 (black), ColorChecker Passport (blue).



Purplish blue patch. ColorChecker 2007 (black), ColorChecker Passport (blue).



Blue patch. ColorChecker 2007 (black), ColorChecker Passport (blue).



Red patch. ColorChecker 2007 (black), ColorChecker Passport (blue).

Photo Enhancement

This is a new chart not previously seen in the ColorChecker family. It has patches to check color reproduction, adjust the color cast of your images and to check for loss of image detail. Three main patch groups make up the Photo Enhancement chart; spectrum patches, photo enhancement patches and a clipping patches.

At the top of this chart are the 8 colorful spectrum patches. These patches can be used to check for color accuracy across the spectrum. They can also be used for editing color casts or selective areas of the image color space. These are not just copies of patches from the ColorChecker Classic chart. They are much more saturated than those from the Classic chart.

There are two rows of patches used for photo enhancement. The first row is for portrait use, as symbolized by a head with a sun behind. The leftmost patch is a neutral patch, indicated by a semi-circle inset into the bottom of the patch. The row patches have a chamfer in the upper-right corner with a small "+" in the frame. Each of these patches is progressively bluer, going from left to right. When used to set a neutral balance, the result will be a warm cast to the image, getting progressively stronger going from left to right. There are no patches to set the neutral balance cooler (bluer) because people think blue flesh tones are unhealthy, unless they are performing in Las Vegas. Warmer flesh tones are acceptable because the people appear more healthy.

The second row of photo enhancement patches are for use with landscape images. The neutral patch is in the center of the row as indicated, once again, by a semi-circle inset into the top of the patch. The two patches to the left are marked with a "-", to indicate that when they are used for setting the neutral balance the images will be cooler (bluer). This is reinforced by the mountain symbol with a snowflake on it. The two patches to the right of the neutral patch are marked with a "+" mark to indicate they will shift the neutral balance warmer (redder). The symbol for these patches is a mountain with a sun behind it.

The gray scale patches round out this chart. Called "clipping patches", they consist of a 4 patch dark sequence and a 4 patch light sequence. These patches can show if exposure settings are causing loss of detail (clipping) in dark tones or highlights.

According to X-Rite, the light set has a 1/3 EV difference from patch to patch. The dark set has the same 1/3 EV spacing except the darkest patch. The spacing between the darkest patch and its neighbor is supposed to be about 1/10 EV. However, from the measured data it appears that the spacing between the two darkest patches is closer to the 1/3 EV used for the rest of the clipping patches.

		Nominal					Measured				
Patch		**Munsell Value**	**% Reflect.**	**EV**	**Corrected for Gamma**		**Munsell Value**	**% Reflect.**	**EV**	**Corrected for Gamma**	
Photo Enhancement					**1.8**	**2.2**				**1.8**	**2.2**
Dark Clipping 1		2.00	3.13	1.65	37	53	1.93	2.95	1.56	36	51
Dark Clipping 2		2.25	3.82	1.93	42	58	2.15	3.53	1.82	40	56
Dark Clipping 3		2.50	4.61	2.20	46	63	2.50	4.60	2.20	46	63
Dark Clipping 4		2.75	5.52	2.46	51	68	2.72	5.41	3.09	50	68
Light Clipping 1		7.25	46.77	5.55	167	181	7.29	47.33	5.56	168	181
Light Clipping 2		8.00	59.10	5.89	190	201	8.00	59.15	5.89	190	201
Light Clipping 3		8.75	73.40	6.20	215	222	8.84	75.18	6.23	218	224
Light Clipping 4		9.50	90.01	6.49	241	243	9.63	93.07	6.54	245	247
ColorChecker Classic											
Black		2.00	3.10	1.65	37	53	1.99	3.10	1.63	37	53
N3.5		3.50	9.00	3.17	67	85	3.52	9.11	3.19	67	86
N5		5.00	19.77	4.31	104	122	4.97	19.54	4.29	103	121
N6.5		6.50	36.20	5.18	145	161	6.58	37.20	5.22	147	163
N8		8.00	59.10	5.89	190	201	8.10	60.90	5.93	194	204
White		9.50	90.01	6.49	241	243	9.70	94.76	6.57	247	249

Note: The nominal values are estimated from the measured reflectances and the X-Rite documented differences. The measured values are from one ColorChecker Passport, the values for your chart may be different. The EV and Gamma corrected values are calculated from the reflectances. The Munsell values are from Table II(6.5.1B) in "Color Science: Concepts and Methods, Quantative Data and Formulae" by Wyszecki and Stiles.

As shown by the table data, if you are going to use the Passport for fine art reproduction, it is very important to measure your copy of the chart because the manufacturing tolerances of the patches can have a profound affect on the expected gamma corrected values used to set exposure and check tonal reproduction.

Summary

The White Balance Chart has a very neutral gray patch, a difficult feat for such a high reflectance neutral. It is a very good reference for setting the neutral balance for your images.

The ColorChecker Classic provides a way to use the Passport for creating camera profiles; either DNG profiles with the included software, or standard ICC profiles with other programs.

Lastly, the Photo Enhancement chart has several useful sets of patches for adjusting or testing your images. The portrait and landscape patches can be used for creatively warming or cooling your images. The spectral colors make nice references for checking and adjusting selective areas of the color space. The clipping patches are great for checking highlight and shadow detail reproduction.

Taken altogether, this chart is a good addition to the ColorChecker family and I highly recommend its use.

Positives

A great combination of charts conveniently grouped together in a very clever protective case. With software included, it is a very cost-effective package.

Negatives

The software works only for DNG images, thus only for cameras that support DNG or are supported by Adobe's Camera Raw. Amateur cameras need not apply. No table of color values is supplied with the chart or on X-Rite's website (see the tables below for these omitted values). The lanyard is ridiculously long. I have caught it several times on objects while moving about. It also represents a serious threat to a photographer's "particulars" as it swings freely just below the belt.

Rating:  (out of 5 possible)

ColorChecker Passport, D65

Patch		CIELAB 1976					sRGB			Adobe 1998		
		L*	a*	b*	C*	h	R	G	B	R	G	B
White Balance		81.34	-0.22	0.36	0.42	121.13	201	201	200	201	201	200
Spectrum Red		50.26	53.87	26.54	60.05	26.22	207	74	79	181	74	79
Spectrum Orange		72.16	32.81	66.23	73.91	63.65	255	148	52	232	149	61
Spectrum Yellow		86.19	-1.26	86.64	86.65	90.83	254	211	0	242	211	49
Spectrum Green		62.57	-63.60	33.12	71.70	152.49	0	175	89	88	175	95
Spectrum Cyan		62.81	-27.02	-24.66	36.58	222.39	0	166	193	91	166	192
Spectrum Blue		52.62	2.66	-49.34	49.41	273.08	40	128	209	78	128	207
Spectrum Violet		50.83	31.10	-31.00	43.91	315.09	146	103	173	136	103	171
Spectrum Magenta		50.27	52.64	-6.23	53.01	353.25	194	78	131	171	78	129
Portrait Neutral		81.81	-0.21	0.63	0.66	108.32	202	202	201	202	202	201
Portrait Warming Level 1		82.74	-2.60	-0.69	2.69	194.88	199	206	206	201	206	206
Portrait Warming Level 2		81.88	-5.07	-1.85	5.40	200.03	190	205	206	195	205	206
Portrait Warming Level 3		81.62	-6.90	-3.03	7.54	203.67	184	206	207	191	206	207
Portrait Warming Level 4		82.29	-9.96	-4.53	10.94	204.46	178	210	212	187	210	212
Landscape Cooling Level 2		81.16	5.88	-0.23	5.88	357.77	212	197	201	207	197	201
Landscape Cooling Level 1		81.57	4.33	0.01	4.33	0.09	210	199	202	207	199	201
Landscape Neutral		81.27	-0.26	0.25	0.36	135.62	200	201	200	200	201	200
Landscape Warming Level 1		81.72	-2.55	-3.33	4.19	232.63	193	204	208	196	204	208
Landscape Warming Level 2		81.75	-4.76	-6.58	8.12	234.11	186	205	214	191	205	214
Dark Clipping 1		19.86	0.12	-0.48	0.49	284.04	51	51	52	51	51	52
Dark Clipping 2		22.06	-0.23	-0.65	0.69	250.10	55	56	57	55	56	57
Dark Clipping 3		25.57	-0.69	-0.57	0.90	219.44	62	63	64	62	63	64
Dark Clipping 4		27.87	-0.79	-0.28	0.84	199.28	66	68	68	67	68	68
Light Clipping 1		74.40	-0.58	0.49	0.76	140.03	181	182	181	181	182	181
Light Clipping 2		81.37	-0.68	0.39	0.79	149.98	200	201	200	200	201	200
Light Clipping 3		89.47	-0.78	-0.10	0.78	187.11	222	224	224	223	224	224
Light Clipping 4		97.26	-0.88	2.01	2.20	113.68	247	247	243	247	247	243
Dark skin		38.96	12.13	13.84	18.40	48.78	117	85	72	109	85	72
Light skin		65.50	15.59	16.81	22.93	47.15	195	147	129	183	147	130
Blue sky		50.69	-2.09	-21.75	21.85	264.51	92	123	156	102	123	155
Foliage		43.92	-13.33	22.19	25.88	121.00	95	109	68	99	109	70
Blue flower		56.01	10.88	-24.39	26.70	294.05	130	129	175	130	129	173
Bluish green		71.84	-32.97	1.91	33.02	176.68	98	191	170	133	191	171
Orange		61.81	32.91	55.95	64.91	59.53	222	123	51	199	123	56
Purplish blue		41.33	17.83	-46.95	50.22	290.80	72	92	174	79	92	171
Moderate red		50.35	47.10	15.00	49.43	17.66	195	83	97	172	83	96
Purple		30.48	24.51	-21.61	32.68	318.60	93	61	105	86	61	104

Patch		CIELAB 1976					sRGB			Adobe 1998		
		L*	a*	b*	C*	h	R	G	B	R	G	B
Yellow green		73.21	-26.94	59.01	64.87	114.54	162	190	65	171	190	75
Orange yellow		71.32	16.60	67.24	69.26	76.13	230	160	45	213	160	56
Blue		31.16	22.38	-50.04	54.81	294.10	49	68	151	55	68	149
Green		56.90	-41.24	35.11	54.16	139.59	76	152	74	105	152	79
Red		41.88	48.07	26.22	54.76	28.61	174	60	61	152	60	61
Yellow		82.45	-1.08	81.57	81.58	90.76	241	201	25	230	201	52
Magenta		52.05	49.70	-16.34	52.32	341.80	190	87	152	168	87	150
Cyan		52.40	-24.88	-25.64	35.73	225.86	0	137	167	66	137	166
White		97.94	-0.96	2.26	2.46	113.02	249	249	244	249	249	244
Neutral 8		82.33	-0.60	0.26	0.65	156.30	203	204	203	203	204	203
Neutral 6.5		67.43	-0.71	0.24	0.75	160.98	162	163	162	162	163	162
Neutral 5		51.31	-0.10	0.20	0.23	115.93	121	121	121	121	121	121
Neutral 3.5		36.20	-0.59	-0.73	0.94	231.08	84	86	87	85	86	87
Black		20.44	0.12	-0.54	0.55	282.37	52	53	53	52	53	53

Note 1. All values calculated for a D65 illuminant, CIE 1931 2° observer.

Note 2. These values have been calculated with SpectraShop 3 from spectral measurements from one ColorChecker Passport, the values for your chart may be different.

ColorChecker Passport, D50

Patch		CIELAB 1976					eciRGBv2			ProPhoto		
		L*	a*	b*	C*	h	R	G	B	R	G	B
White Balance		81.34	-0.13	0.28	0.31	114.69	205	205	205	190	190	190
Spectrum Red		51.88	56.97	29.39	64.10	27.29	187	87	93	151	80	64
Spectrum Orange		73.55	36.55	68.26	77.43	61.83	232	163	78	203	149	63
Spectrum Yellow		87.02	3.38	86.80	86.86	87.77	240	220	67	217	206	68
Spectrum Green		61.81	-61.50	30.18	68.51	153.86	99	181	104	82	147	86
Spectrum Cyan		61.72	-30.28	-27.23	40.73	221.97	108	168	198	103	141	178
Spectrum Blue		51.48	-4.57	-51.32	51.53	264.91	96	131	210	95	107	190
Spectrum Violet		50.95	28.29	-30.12	41.33	313.20	146	110	176	122	93	150
Spectrum Magenta		51.47	54.06	-3.59	54.18	356.20	178	88	139	146	81	109
Portrait Neutral		81.82	-0.08	0.55	0.55	98.35	207	207	206	192	192	191
Portrait Warming Level 1		82.67	-2.71	-0.91	2.86	198.58	206	210	210	192	196	196
Portrait Warming Level 2		81.74	-5.43	-2.21	5.86	202.11	200	209	210	186	194	196
Portrait Warming Level 3		81.43	-7.48	-3.49	8.25	205.03	196	210	211	183	194	197
Portrait Warming Level 4		82.00	-10.64	-5.22	11.85	206.13	194	213	215	182	197	203
Landscape Cooling Level 2		81.27	6.32	-0.13	6.33	358.82	212	202	206	196	188	190
Landscape Cooling Level 1		81.66	4.70	0.05	4.70	0.64	211	204	206	196	190	191
Landscape Neutral		81.27	-0.18	0.17	0.25	136.80	205	205	205	190	190	190
Landscape Warming Level 1		81.61	-3.00	-3.56	4.66	229.91	202	208	212	188	193	198
Landscape Warming Level 2		81.54	-5.48	-7.01	8.90	232.00	198	209	217	185	193	204
Dark Clipping 1		19.86	0.06	-0.47	0.48	277.45	60	60	60	36	36	36
Dark Clipping 2		22.05	-0.33	-0.66	0.74	243.15	64	65	65	40	40	40
Dark Clipping 3		25.55	-0.80	-0.61	1.01	217.02	71	72	73	46	46	47
Dark Clipping 4		27.85	-0.88	-0.32	0.93	199.94	76	77	77	50	51	51
Light Clipping 1		74.39	-0.56	0.42	0.70	143.23	187	188	187	168	168	168
Light Clipping 2		81.37	-0.64	0.30	0.71	155.11	205	206	205	190	191	190
Light Clipping 3		89.45	-0.69	-0.25	0.73	200.24	226	227	227	217	218	218
Light Clipping 4		97.27	-0.53	1.83	1.91	106.20	248	248	244	245	245	241
Dark skin		39.42	13.80	14.58	20.07	46.56	118	95	82	84	70	57
Light skin		66.02	18.94	17.08	25.51	42.04	189	156	140	161	135	115
Blue sky		50.23	-5.24	-22.30	22.91	256.78	113	129	161	94	102	135
Foliage		43.95	-11.76	21.96	24.91	118.17	108	119	80	78	88	57
Blue flower		55.79	8.39	-24.39	25.79	288.98	140	135	179	119	113	155
Bluish green		71.20	-33.64	0.06	33.64	179.90	143	195	178	128	170	158
Orange		63.11	36.23	57.90	68.31	57.96	202	137	72	168	119	54
Purplish blue		40.60	11.35	-47.91	49.24	283.33	93	97	177	81	75	150
Moderate red		51.66	49.55	17.45	52.53	19.40	179	95	108	144	84	79
Purple		30.67	22.77	-20.50	30.64	318.00	96	68	112	69	50	82

Patch		CIELAB 1976					eciRGBv2			ProPhoto 1998		
		L*	a*	b*	C*	h	R	G	B	R	G	B
Yellow green		73.32	-23.11	57.74	62.19	111.81	175	197	87	147	172	75
Orange yellow		72.37	20.38	68.60	71.56	73.46	214	172	72	184	153	60
Blue		30.33	14.96	-51.16	53.31	286.30	69	71	156	60	53	126
Green		56.55	-39.05	33.24	51.28	139.59	113	160	89	88	127	70
Red		43.36	51.42	28.76	58.92	29.22	160	71	74	122	63	48
Yellow		83.22	3.88	81.53	81.62	87.27	229	210	69	204	193	67
Magenta		52.99	50.02	-14.00	51.94	344.36	176	96	158	147	88	129
Cyan		51.33	-28.90	-28.04	40.27	224.13	83	142	172	78	112	148
White		97.95	-0.58	2.07	2.15	105.58	249	250	246	247	248	243
Neutral 8		82.32	-0.59	0.17	0.61	164.20	207	208	208	193	194	193
Neutral 6.5		67.42	-0.73	0.17	0.75	166.86	169	170	169	147	147	147
Neutral 5		51.32	-0.12	0.17	0.20	125.93	130	130	130	103	103	103
Neutral 3.5		36.18	-0.76	-0.77	1.08	225.14	94	95	96	67	68	68
Black		20.44	0.04	-0.53	0.53	274.83	61	61	62	37	37	38

Note 1. All values calculated for a D50 illuminant, CIE 1931 2° observer.

Note 2. These values have been calculated with SpectraShop 3 from spectral measurements from one ColorChecker Passport, the values for your chart may be different.