



Test Report SilverFast Multiexposure and Scanner Dynamic Range

Image Engineering Dietmar Wueller,
Augustinusstr. 9D,
50226 Frechen,
Germany,
Phone +49 (2234) 912141
Fax +49 (2234) 912142
www.image-engineering.de

05.02.2007

Introduction

In Version 6.5 of the scan software SilverFast by LaserSoft Imaging® a feature called Multi Exposure was added to increase the dynamic range of scanners.

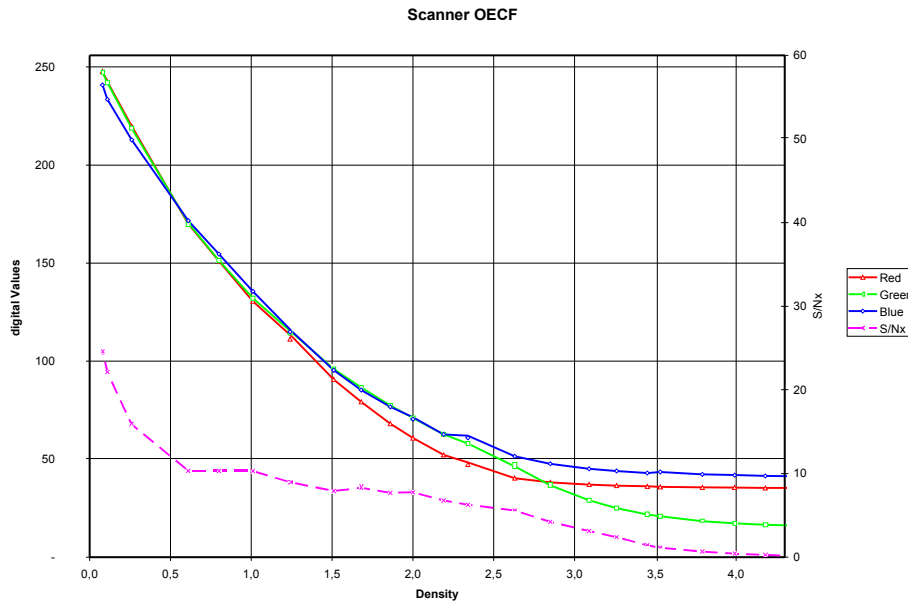
For scanners that offer different exposure times multiple images are scanned with at least one image at each exposure time. These images are combined to a high dynamic range image.

This study was made to evaluate the dynamic ranges achieved by using this technology and compare the result to a single scan. To determine the dynamic ranges the method described in ISO 21550 was used.

Evaluated Scanners

Nikon LS-5000

Serial Number: 202375, SilverFast 6.5.0r3d

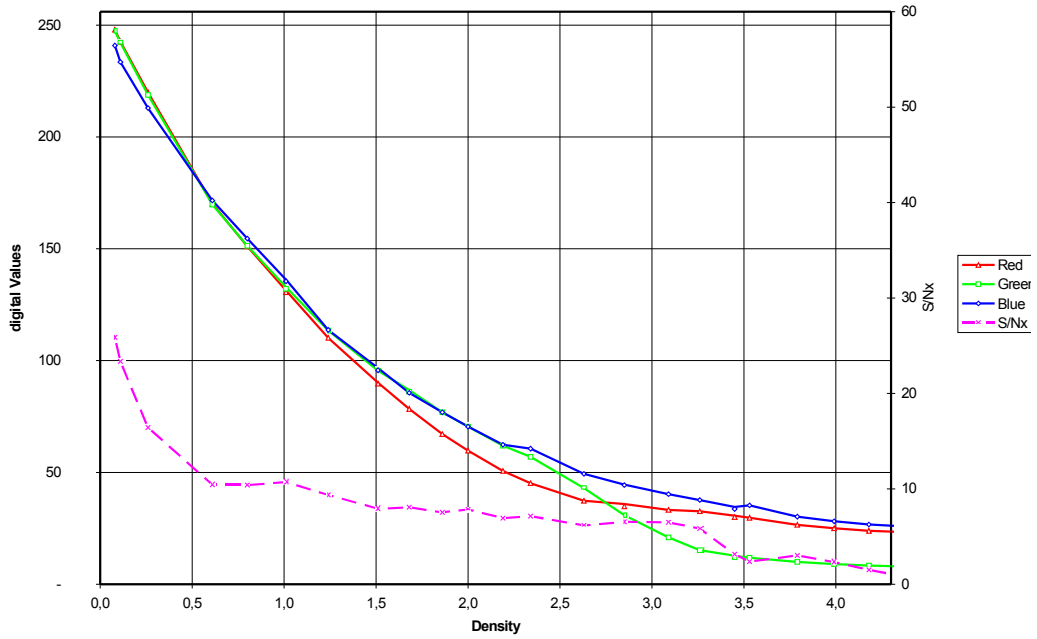


Grey Scale Data		OECF Data			Signal to Noise Ratio			Noise Data			Color distance			
Densities	Transmission	Red	Mean Output Levels Green	Blue	Y	g	s (DL)	S/Nx	Red	Standard deviation Green	Blue	Absolute G - R	Absolute G - B	
4.53	0,000030	35,40	16,00	41,17	21,94	10325,86	3,38	0,09	1,44	3,23	2,26	19,40	25,17	
4.34	0,000046	35,38	16,23	41,33	22,11	11325,69	3,42	0,15	1,49	3,28	2,19	19,15	25,10	
4.18	0,000066	35,35	16,57	41,50	22,36	14232,08	3,37	0,28	1,46	3,25	2,07	18,79	24,93	
3.99	0,000102	35,53	17,30	41,78	22,94	14928,93	3,46	0,44	1,48	3,34	2,06	18,23	24,48	
3.79	0,000162	35,64	18,37	42,26	23,77	14218,73	3,43	0,67	1,45	3,34	1,90	17,27	23,89	
3.53	0,000295	35,87	20,92	43,45	25,72	12734,15	3,31	1,14	1,46	3,22	1,89	14,95	22,53	
3.45	0,000355	36,19	21,77	42,95	26,36	11766,73	2,90	1,44	1,31	2,82	1,65	14,42	21,18	
3.26	0,000550	36,51	25,05	43,94	28,85	12130,21	2,80	2,38	1,30	2,69	1,84	11,46	18,89	
3.09	0,000813	37,03	29,01	45,08	31,88	10662,30	2,77	3,13	1,32	2,63	2,11	8,02	16,07	
2.85	0,001413	38,19	36,66	47,65	37,78	9013,31	3,01	4,23	1,31	2,81	2,85	1,52	10,98	
2.63	0,002344	40,30	46,30	51,52	45,40	6450,87	2,70	5,59	1,38	2,30	3,70	6,00	5,22	
2.34	0,004571	47,31	57,97	60,95	55,92	3564,52	2,60	6,26	1,50	1,92	4,48	10,66	2,98	
2.19	0,006457	52,21	62,69	62,60	60,45	2379,27	2,26	6,79	1,45	1,61	3,96	10,48	0,09	
2.00	0,010000	60,82	70,99	70,49	68,79	2040,13	2,63	7,76	1,74	1,81	4,76	10,16	0,50	
1.86	0,013804	68,10	77,39	76,71	75,36	1538,83	2,76	7,69	1,81	1,88	5,11	9,29	0,68	
1.68	0,020893	79,27	86,58	85,30	84,93	1168,98	2,94	8,30	1,96	2,09	5,41	7,31	1,28	
1.51	0,030903	90,64	98,01	95,38	94,82	849,81	3,32	7,91	2,19	2,47	5,97	5,37	0,63	
1.24	0,057544	111,26	114,40	114,95	113,77	583,09	3,74	8,97	2,41	2,82	6,63	3,13	0,55	
1.01	0,097724	130,56	132,13	135,65	132,05	388,01	3,67	10,32	2,14	2,54	6,83	1,57	3,52	
0.80	0,158489	151,12	151,38	154,67	151,56	266,34	4,09	10,32	2,40	2,68	7,80	0,26	3,29	
0.61	0,245471	170,08	169,76	171,69	169,97	185,84	4,42	10,33	2,77	3,20	7,93	0,32	1,92	
0.26	0,549541	219,93	218,83	212,92	218,64	130,64	4,52	15,87	3,10	3,66	7,48	1,10	5,91	
0.11	0,776247	242,58	242,10	233,53	241,59	99,60	3,49	22,14	2,63	3,09	5,37	0,48	8,58	
0.08	0,831764	247,88	247,39	240,89	247,03	97,99	3,31	24,61	2,82	3,15	4,41	0,48	6,51	
										Mean	2,93	Mean Color distance		9,68

Kalkulation of Dynamic range			
Target value S/Nx	1,00		
patch s/Nx < Target	5,00	0,67	3,79
patch s/Nx > Target	6,00	1,14	3,53
max Density	3,61		
Patch max Value	24,00		
min Density	0,08		
Dynamic range	3,53		

The OECF and dynamic range achieved with a single scan.

Scanner OECF



Grey Scale Data		OECF Data			Signal to Noise Ratio				Noise Data			Color distance		
Densities	Transmission	Red	Mean Output Levels Green	Blue	Y	g	s (DL)	S/Nx	Red	Standarddeviation Green	Blue	Absolute G - R	Absolute G - B	
4.53	0.000030	22.98	7.77	25.40	12.28	19468.82	0.93	0.62	0.90	0.64	1.28	15.22	17.63	
4.34	0.000046	23.42	8.01	26.04	12.59	19255.36	0.94	0.94	0.91	0.64	1.31	15.41	18.02	
4.18	0.000066	23.90	8.34	26.76	12.98	21267.38	0.93	1.52	0.88	0.64	1.31	15.56	18.42	
3.99	0.000102	25.03	9.05	28.19	13.83	21210.73	0.93	2.33	0.89	0.64	1.34	15.97	19.14	
3.79	0.000162	26.53	9.98	30.26	14.96	18540.36	1.00	3.01	0.98	0.64	1.57	16.55	20.28	
3.53	0.000295	29.77	11.88	35.31	17.38	10199.46	1.27	2.37	1.25	0.66	2.40	17.89	23.42	
3.45	0.000355	30.07	12.15	33.67	17.51	8974.50	1.01	3.15	0.91	0.63	1.80	17.92	21.52	
3.26	0.000550	32.61	15.26	37.65	20.57	16167.30	1.52	5.85	0.63	1.24	2.27	17.35	22.38	
3.09	0.000813	33.26	20.93	40.29	24.95	14784.97	1.85	6.48	0.64	1.60	2.53	12.33	19.36	
2.85	0.001413	34.89	30.89	44.33	32.71	11605.21	2.51	6.54	0.74	2.19	3.38	4.00	13.45	
2.63	0.002344	37.35	43.03	49.39	42.28	7932.20	3.01	6.17	0.98	2.57	4.35	5.68	6.36	
2.34	0.004571	45.16	56.98	60.61	54.73	4078.63	2.61	7.14	1.38	1.89	4.71	11.82	3.63	
2.19	0.006457	50.63	61.94	62.37	59.57	2496.62	2.33	6.93	1.42	1.64	4.17	11.31	0.43	
2.00	0.010000	59.71	70.44	70.51	68.17	2086.75	2.66	7.85	1.65	1.83	4.91	10.73	0.07	
1.86	0.013804	67.15	76.88	76.89	74.81	1550.74	2.84	7.53	1.83	2.01	5.16	9.73	0.02	
1.68	0.020893	78.39	86.09	85.59	84.42	1170.89	3.03	8.07	1.96	2.24	5.42	7.70	0.50	
1.51	0.030903	89.66	95.53	95.71	94.29	839.99	3.28	7.92	2.18	2.52	5.69	5.86	0.18	
1.24	0.057544	110.15	113.46	113.71	112.77	586.25	3.60	9.37	2.31	2.73	6.00	3.30	0.25	
1.01	0.097724	130.55	132.10	135.46	132.01	400.02	3.65	10.71	2.14	2.49	6.86	1.54	3.36	
0.80	0.158489	151.11	151.35	154.61	151.53	286.72	4.07	10.99	2.43	2.70	7.69	0.24	3.27	
0.61	0.245471	170.12	169.79	171.58	169.99	186.07	4.38	10.42	2.80	3.14	7.95	0.33	1.79	
0.26	0.549541	219.94	218.80	212.88	218.62	130.70	4.37	16.43	3.08	3.53	7.27	1.14	5.92	
0.11	0.776247	242.62	242.14	233.50	241.62	99.71	3.31	23.36	2.55	2.90	5.22	0.48	8.65	
0.08	0.831764	247.91	247.43	240.86	247.06	97.95	3.15	25.87	2.72	2.97	4.34	0.48	6.57	
Mean										2.52	Mean Color distance			9.44

Kalkulation of Dynamic range			
Target value S/Nx	1,00		
patch s/Nx < Target	2,00	0,94	4,34
patch s/Nx > Target	3,00	1,52	4,18
max Density	4,32		
Patch max Value	24,00		
min Density	0,08		
Dynamic range	4,24		

The OECF and dynamic range achieved with a multi exposure scan.

Epson Perfection 4990 Photo

Serial number: GEEW004363

Grey Scale Data		Signal to Noise Ratio [Y Channel]			
Density Y	Transmission	Y	g	s (DL)	S/Nx
0,00	1,000000	250,35	69,33	1,81	38,26
0,11	0,776247	234,84	69,37	1,19	45,09
0,14	0,724436	231,24	86,80	1,21	51,86
0,25	0,562341	214,35	121,10	1,62	42,10
0,50	0,316228	180,39	177,59	1,92	29,30
0,86	0,138038	141,69	341,84	2,19	21,52
1,26	0,054954	102,93	771,01	2,85	14,88
1,73	0,018621	63,85	1563,53	2,76	10,54
2,33	0,004677	35,25	2876,38	3,15	4,28
2,93	0,001175	22,28	8584,24	6,25	1,61
3,19	0,000646	15,15	8470,77	7,40	0,74
3,44	0,000363	14,17	2454,58	7,56	0,12
3,81	0,000155	13,87	-903,09	7,53	-0,02
4,17	0,000068	14,16	-11056,52	7,02	-0,11
3,47	0,000339	9,04	-12190,01	8,03	-0,51
4,36	0,000044	10,66	-39549,56	8,36	-0,21
4,58	0,000026	11,94	-80367,63	7,91	-0,27
4,80	0,000016	12,85	419230,81	7,66	0,87
4,95	0,000011	8,57	-30884,50	8,13	-0,04
5,01	0,000010	10,00	-675441,82	8,37	-0,79
5,20	0,000006	11,26	371176,24	8,09	0,29
5,40	0,000004	8,68	-197756,56	8,04	-0,10
5,48	0,000003	9,69	-343365,99	8,29	-0,14
5,71	0,000002	8,58	814642,44	8,06	0,20

Calculation of Dynamic range [Y channel]			
Target value S/Nx	1,00		
patch s/Nx < Target	10,00	1,61	2,93
patch s/Nx > Target	11,00	0,74	3,19
max Density	3,11		
Target value S/Nx	255		
patch s/Nx < Target	1,00	38,26	0,00
patch s/Nx > Target	2,00	45,09	0,11
min Density	0,00		
Dynamic range	3,11		

The dynamic range without multi exposure.

Grey Scale Data		Signal to Noise Ratio [Y Channel]			
Density Y	Transmission	Y	g	s (DL)	S/Nx
0,00	1,000000	250,42	68,51	1,71	40,10
0,11	0,776247	235,09	68,62	1,05	50,70
0,14	0,724436	231,53	86,32	1,08	58,14
0,25	0,562341	214,69	121,17	1,53	44,60
0,50	0,316228	180,62	178,04	1,84	30,55
0,86	0,138038	141,84	346,25	2,11	22,64
1,26	0,054954	102,39	780,80	2,55	16,81
1,73	0,018621	62,90	1578,32	2,17	13,53
2,33	0,004677	34,04	2996,15	1,99	7,03
2,93	0,001175	20,30	7380,58	3,67	2,36
3,19	0,000646	14,57	9027,92	3,66	1,59
3,44	0,000363	12,53	6208,81	4,17	0,54
3,81	0,000155	11,44	1364,11	4,55	0,05
4,17	0,000068	11,66	-14616,07	4,39	-0,22
3,47	0,000339	4,40	-16866,32	4,99	-1,14
4,36	0,000044	6,46	-47495,01	5,58	-0,37
4,58	0,000026	7,99	-131976,23	5,44	-0,64
4,80	0,000016	9,82	581964,86	4,82	1,92
4,95	0,000011	3,62	53560,92	4,73	0,13
5,01	0,000010	5,41	-841053,11	5,36	-1,53
5,20	0,000006	6,96	491556,31	5,56	0,56
5,40	0,000004	3,63	-373062,71	4,76	-0,31
5,48	0,000003	5,09	-592630,86	5,31	-0,37
5,71	0,000002	3,74	993339,39	4,74	0,41

Calculation of Dynamic range [Y channel]			
Target value S/Nx	1,00		
patch s/Nx < Target	11,00	1,59	3,19
patch s/Nx > Target	12,00	0,54	3,44
max Density	3,33		
Target value S/Nx	255		
patch s/Nx < Target	1,00	40,10	0,00
patch s/Nx > Target	2,00	50,70	0,11
min Density	0,00		
Dynamic range	3,33		

The dynamic range with multi exposure

Epson Perfection V700 Photo

Serial number: G33W002522

Grey Scale Data		Signal to Noise Ratio [Y Channel]			
Density Y	Transmission	Y	g	s (DL)	S/Nx
0,00	1,000000	249,29	55,77	1,24	44,80
0,11	0,776247	236,81	55,06	1,38	30,88
0,14	0,724436	233,99	67,14	1,41	34,44
0,25	0,562341	221,03	105,64	1,66	35,70
0,50	0,316228	188,71	168,15	1,82	29,24
0,86	0,138038	152,19	312,14	2,05	21,02
1,26	0,054954	117,35	771,25	2,71	15,64
1,73	0,018621	76,54	1637,25	3,23	9,44
2,33	0,004677	46,54	3173,67	3,21	4,62
2,93	0,001175	31,85	6907,02	5,32	1,52
3,19	0,000646	26,76	7288,01	5,75	0,82
3,44	0,000363	25,35	4583,14	6,53	0,25
3,81	0,000155	24,48	238,94	7,19	0,01
4,17	0,000068	24,80	-9090,10	6,93	-0,09
3,47	0,000339	20,88	-8892,32	9,36	-0,32
4,36	0,000044	21,87	-37567,14	8,91	-0,18
4,58	0,000026	23,11	-139620,45	8,18	-0,45
4,80	0,000016	25,28	393573,48	6,86	0,91
4,95	0,000011	20,68	95634,38	9,61	0,11
5,01	0,000010	21,84	-718415,37	8,82	-0,80
5,20	0,000006	24,04	388730,39	7,57	0,32
5,40	0,000004	20,75	-788219,34	9,77	-0,32
5,48	0,000003	22,75	-828227,68	8,30	-0,33
5,71	0,000002	20,94	1330955,19	9,58	0,27

Calculation of Dynamic range [Y channel]			
Target value S/Nx	1,00		
patch s/Nx < Target	10,00	1,52	2,93
patch s/Nx > Target	11,00	0,74	3,19
max Density	3,10		
Target value S/Nx	255		
patch s/Nx < Target	1,00	44,80	0,00
patch s/Nx > Target	2,00	30,88	0,11
min Density	0,00		
Dynamic range	3,10		

The dynamic range without multi exposure.

Grey Scale Data		Signal to Noise Ratio [Y Channel]			
Density Y	Transmission	Y	g	s (DL)	S/Nx
0,00	1,000000	249,27	55,31	1,12	49,49
0,11	0,776247	236,89	54,94	1,32	32,25
0,14	0,724436	234,07	68,66	1,31	37,85
0,25	0,562341	220,65	106,61	1,65	36,41
0,50	0,316228	188,54	168,75	1,94	27,52
0,86	0,138038	151,65	312,51	2,25	19,20
1,26	0,054954	116,92	770,25	2,67	15,84
1,73	0,018621	76,14	1642,52	2,70	11,33
2,33	0,004677	45,99	3316,96	2,18	7,12
2,93	0,001175	30,33	6649,98	2,53	3,09
3,19	0,000646	25,65	7732,17	2,68	1,86
3,44	0,000363	23,78	8449,75	3,42	0,90
3,81	0,000155	21,64	5367,86	4,51	0,18
4,17	0,000068	21,60	-9779,80	4,44	-0,15
3,47	0,000339	16,17	-12126,98	7,47	-0,55
4,36	0,000044	17,41	-48178,27	6,93	-0,30
4,58	0,000026	19,01	-215704,59	5,88	-0,96
4,80	0,000016	22,56	667263,27	4,02	2,63
4,95	0,000011	14,81	186380,05	8,25	0,25
5,01	0,000010	16,69	-1232364,68	7,24	-1,66
5,20	0,000006	20,72	746727,92	5,14	0,92
5,40	0,000004	14,54	-1770703,02	8,44	-0,83
5,48	0,000003	18,69	-1773354,00	6,12	-0,96
5,71	0,000002	15,08	2651841,78	8,25	0,63

Calculation of Dynamic range [Y channel]			
Target value S/Nx	1,00		
patch s/Nx < Target	11,00	1,86	3,19
patch s/Nx > Target	12,00	0,74	3,44
max Density	3,38		
Target value S/Nx	255		
patch s/Nx < Target	1,00	49,49	0,00
patch s/Nx > Target	2,00	32,25	0,11
min Density	0,00		
Dynamic range	3,38		

The dynamic range with multi exposure.

Conclusions

If a scanner provides multiple exposure levels the Multi Exposure feature of SilverFast increases the dynamic range.

Multi Exposure	without	with
Nikon LS-5000	3,53 D	4,24 D
Epson Perfection 4990 Photo	3,11 D	3,33 D
Epson Perfection V700 Photo	3,10 D	3,38 D

Values in densities

Frechen 06th of February 2007

Image Engineering Dietmar Wueller