LUX-TSI Ltd., Pencoed Technology Park,
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Report Number: TRN-21467

Report Number	TRN-21467
Subcontract Report (if applicable)	N/A
Customer	
Contact	
Product Type	LED Ewindow
Test Purpose	Analysis of spectral measurements
Sales Order	Q-LUX18-22614
Works Order Number	12114
LAB Test Method Reference	TES-109100
Test Standards	N/A
Lab Location Reference	LUX-TSI
Approved by	Gareth Jones
Date of Test	23 August 2018
Reported by	Hazel Hung
Number of products tested	1

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Date: 28-Aug-18

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Spectral Measurements

50 Spectral measurements were taken with a Bentham monochromator at a distance of 980mm central to the item, under the following conditions:

- 5 Dimming level: 10, 25, 50, 75, 100%
- 10 Nominal sun CCT values: 2621K, 2700K, 3000K, 3500K, 4000K, 4500K, 5000K, 5300K, 5700K, 5835K

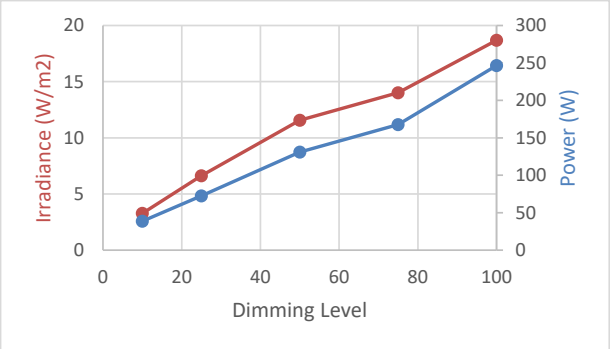
This spectral irradiance data was then processed to provide the following parameters:

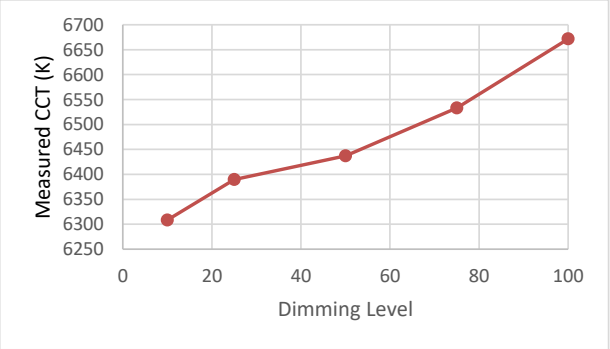
- Rhodopic lux
- Chloropic lux
- Erythropic lux
- Melanopic lux
- Cyanopic lux

The above 'opic lux values were calculated using Lucas et al (2014) Trends in Neurosciences 37(1):1-9.

Data for Nominal Sun CCT 5836K

Dimming level	10	25	50	75	100	
Sun CCT (K)	5835	5836	5835	5836	5836	
Sky (CCT)	9414	9416	9414	9416	9416	Variance from average CCT
Power (W)	38.66	72.58	131.11	167.58	246.52	
Measured CCT	6308.4	6389.7	6437.3	6533.2	6671.5	5.61%
x	0.316	0.315	0.315	0.313	0.312	
y	0.331	0.328	0.323	0.322	0.318	
Irradiance (W/m2)	3.27	6.62	11.57	14.01	18.68	
Photopic lux	906.13	1820.53	3143.94	3785.62	5000.53	
Erythropic lux	888.28	1787.02	3094.12	3728.16	4937.84	
Chloropic lux	919.26	1849.60	3193.88	3857.32	5121.61	
Rhodopic lux	934.97	1886.14	3264.57	3957.17	5289.21	
Melanopic lux	935.78	1893.45	3289.72	3999.03	5384.06	
Cyanopic lux	877.58	1811.47	3233.78	3950.22	5350.94	



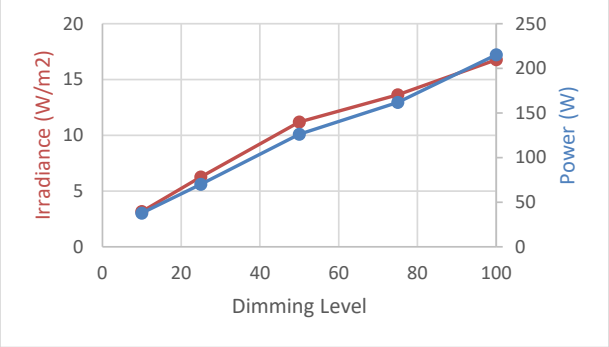


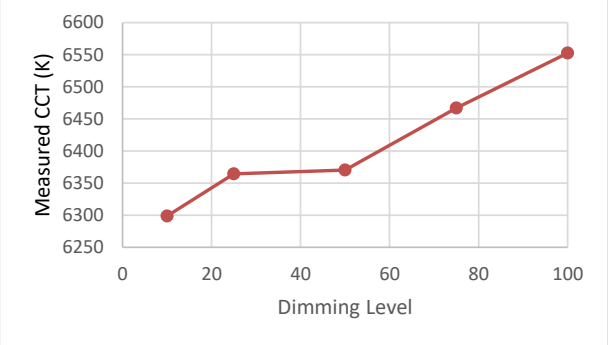
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Data for Nominal Sun CCT 5700K

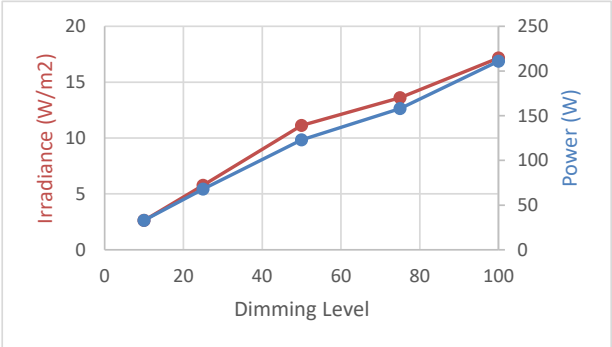
Dimming level	10	25	50	75	100	
Sun CCT (K)	5709	5710	5709	5710	5710	
Sky (CCT)	9178	9179	9178	9179	9179	Variance from average CCT
Power (W)	37.8	69.91	126.22	161.8	215.14	
Measured CCT	6298.7	6364.2	6370.5	6466.8	6552.5	3.96%
x	0.316	0.315	0.316	0.314	0.313	
y	0.331	0.328	0.324	0.323	0.320	
Irradiance (W/m2)	3.16	6.26	11.20	13.62	16.77	
Photopic lux	874.65	1724.02	3044.70	3684.43	4500.33	
Erythropic lux	857.35	1691.85	2996.15	3628.21	4440.33	
Chloropic lux	887.04	1750.23	3086.78	3747.41	4592.23	
Rhodopic lux	901.85	1782.97	3147.22	3836.15	4721.91	
Melanopic lux	902.33	1788.22	3166.69	3871.70	4789.78	
Cyanopic lux	845.68	1706.59	3106.03	3810.64	4738.84	

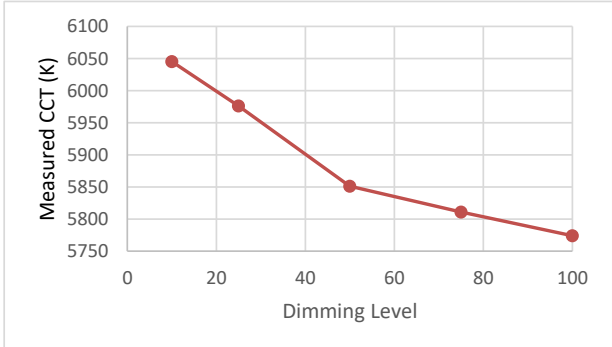




Data for Nominal Sun CCT 5300K

Dimming level	10	25	50	75	100	
Sun CCT (K)	5331	5332	5331	5332	5332	
Sky (CCT)	8469	8470	8469	8470	8470	Variance from average CCT
Power (W)	32.9	67.78	122.79	157.88	210.92	
Measured CCT	6045.3	5976.1	5851.1	5811.1	5774	4.60%
x	0.321	0.323	0.325	0.326	0.327	
y	0.334	0.333	0.332	0.331	0.329	
Irradiance (W/m2)	2.62	5.76	11.13	13.60	17.16	
Photopic lux	724.66	1582.55	3036.49	3671.00	4602.20	
Erythropic lux	710.92	1554.70	2987.98	3619.38	4545.17	
Chloropic lux	729.49	1588.04	3031.88	3660.39	4586.41	
Rhodopic lux	735.55	1596.72	3033.19	3662.36	4588.10	
Melanopic lux	733.02	1591.07	3019.49	3653.32	4587.48	
Cyanopic lux	676.87	1489.08	2859.25	3490.35	4393.59	



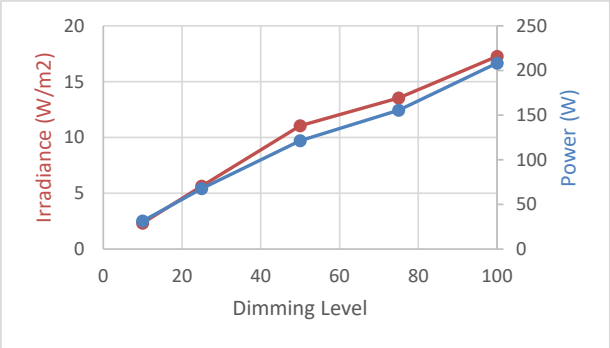


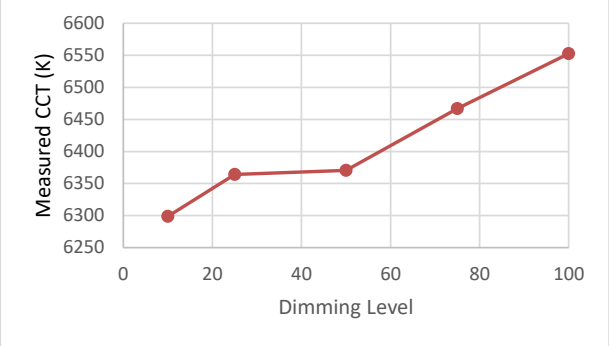
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Data for Nominal Sun CCT 5000K

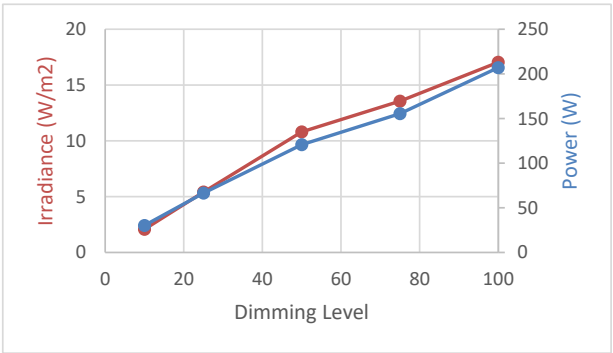
Dimming level	10	25	50	75	100	
Sun CCT (K)	4953	4953	4953	4953	4953	
Sky (CCT)	7759	7761	7759	7761	7761	Variance from
Power (W)	31.35	67.73	121.44	155.41	208.31	average CCT
Measured CCT	5545.1	5367.6	5218.1	5203	5189.1	6.71%
x	0.331	0.336	0.339	0.339	0.339	
y	0.340	0.342	0.341	0.339	0.338	
Irradiance (W/m2)	2.33	5.64	11.05	13.54	17.26	
Photopic lux	641.60	1544.95	3004.88	3644.39	4627.92	
Erythropic lux	630.75	1520.09	2962.26	3598.41	4575.34	
Chloropic lux	635.29	1517.58	2933.10	3555.12	4515.10	
Rhodopic lux	628.87	1487.76	2855.92	3464.16	4401.37	
Melanopic lux	621.20	1462.83	2803.75	3408.67	4340.47	
Cyanopic lux	557.35	1322.58	2557.74	3145.44	4019.08	

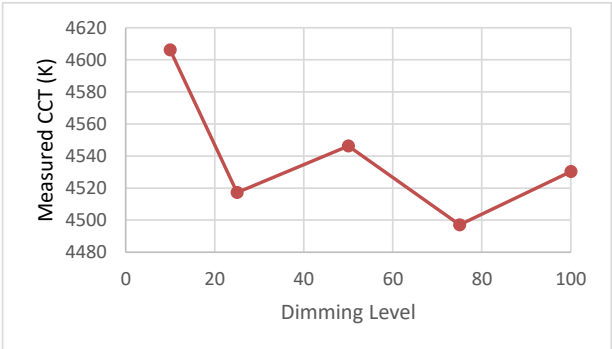




Data for Nominal Sun CCT 4500K

Dimming level	10	25	50	75	100	
Sun CCT (K)	4449	4449	4449	4449	4449	
Sky (CCT)	6814	6814	6814	6815	6815	Variance from
Power (W)	30.31	66.57	120.8	155.56	207.08	average CCT
Measured CCT	4606.1	4517.2	4546.3	4497.1	4530.3	2.40%
x	0.356	0.359	0.358	0.359	0.358	
y	0.356	0.357	0.353	0.353	0.350	
Irradiance (W/m2)	2.08	5.41	10.80	13.56	17.04	
Photopic lux	564.90	1469.98	2922.26	3659.10	4557.52	
Erythropic lux	557.58	1450.74	2887.52	3619.41	4514.03	
Chloropic lux	537.89	1391.05	2769.46	3460.47	4318.74	
Rhodopic lux	507.71	1301.28	2597.51	3237.94	4056.32	
Melanopic lux	489.28	1247.32	2499.21	3115.95	3920.49	
Cyanopic lux	408.16	1052.18	2154.62	2692.08	3446.41	



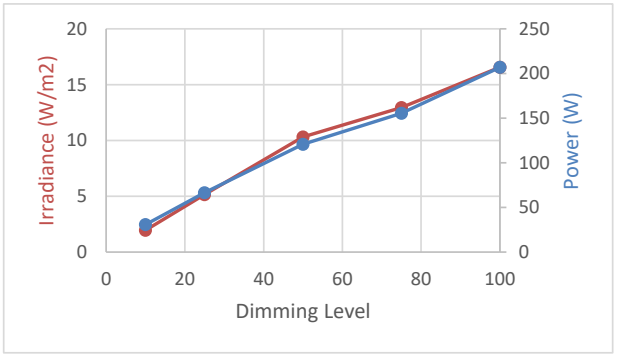


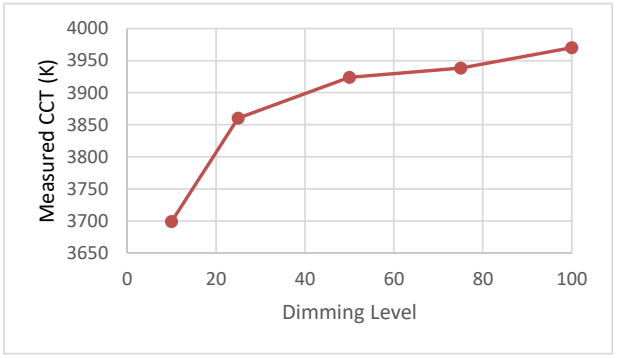
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Data for Nominal Sun CCT 4000K

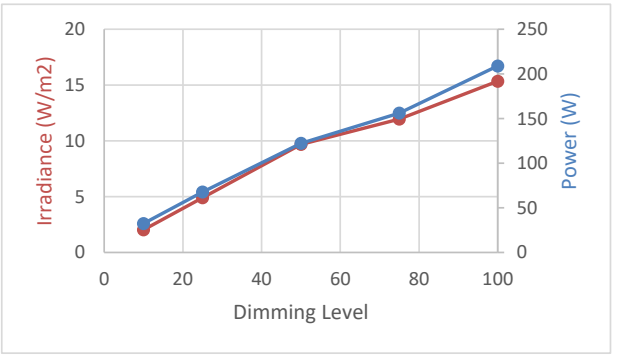
Dimming level	10	25	50	75	100	
Sun CCT (K)	3944	3944	3944	3945	3945	
Sky (CCT)	5868	5868	5868	5869	5869	Variance from average CCT
Power (W)	30.75	66.62	120.66	155.58	206.89	
Measured CCT	3698.8	3860.1	3923.9	3938.5	3970.2	7.00%
x	0.392	0.384	0.381	0.380	0.378	
y	0.376	0.372	0.368	0.366	0.364	
Irradiance (W/m2)	1.95	5.15	10.32	12.94	16.56	
Photopic lux	522.13	1387.09	2777.77	3478.68	4439.57	
Erythropic lux	517.93	1373.63	2752.58	3449.28	4405.45	
Chloropic lux	471.01	1263.78	2541.91	3187.79	4078.93	
Rhodopic lux	413.10	1122.79	2272.54	2856.68	3670.09	
Melanopic lux	381.74	1044.93	2127.94	2682.44	3461.00	
Cyanopic lux	281.90	806.45	1695.61	2156.75	2821.99	

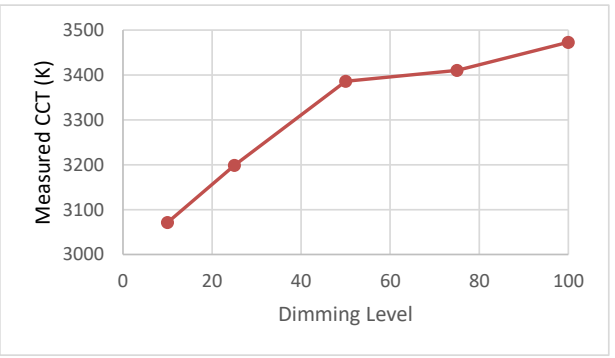




Data for Nominal Sun CCT 3500K

Dimming level	10	25	50	75	100	
Sun CCT (K)	3440	3440	3440	3441	3441	
Sky (CCT)	4922	4922	4922	4924	4924	Variance from average CCT
Power (W)	32.41	67.68	122.25	156.04	208.9	
Measured CCT	3071.2	3198.4	3385.8	3409.9	3472.9	12.14%
x	0.431	0.421	0.408	0.406	0.402	
y	0.400	0.394	0.384	0.382	0.378	
Irradiance (W/m2)	2.03	4.90	9.68	11.94	15.34	
Photopic lux	537.57	1306.84	2587.71	3190.48	4093.50	
Erythropic lux	535.39	1299.87	2572.57	3173.43	4073.35	
Chloropic lux	458.30	1128.29	2274.68	2812.14	3629.96	
Rhodopic lux	367.47	922.87	1914.90	2377.96	3099.04	
Melanopic lux	319.83	814.72	1727.90	2155.66	2832.55	
Cyanopic lux	193.68	529.06	1225.81	1554.29	2099.13	



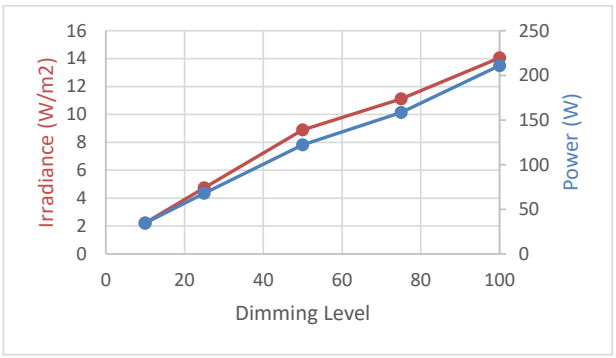


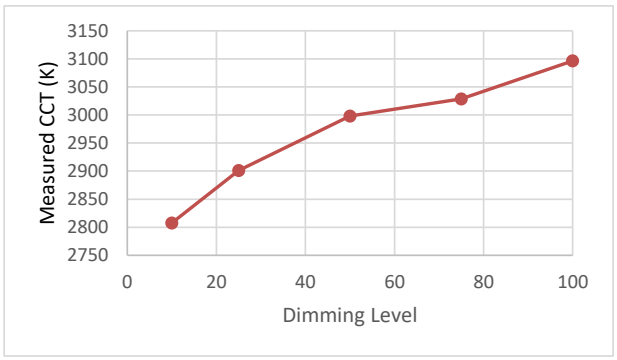
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Data for Nominal sun CCT 3000K

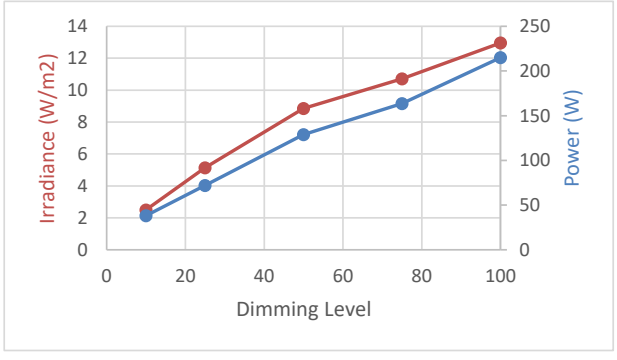
Dimming level	10	25	50	75	100	
Sun CCT (K)	3062	3062	3062	3062	3062	
Sky (CCT)	4213	4213	4213	4214	4214	Variance from average CCT
Power (W)	34.51	68.03	122.16	158.49	210.96	
Measured CCT	2807.6	2901.2	2998.4	3028.7	3096.4	9.74%
x	0.453	0.445	0.435	0.432	0.426	
y	0.411	0.408	0.400	0.398	0.393	
Irradiance (W/m2)	2.22	4.74	8.88	11.12	14.05	
Photopic lux	583.69	1258.12	2361.47	2953.91	3730.22	
Erythropic lux	583.20	1254.42	2354.77	2946.56	3722.28	
Chloropic lux	482.34	1050.74	1997.23	2508.57	3194.56	
Rhodopic lux	367.01	811.61	1577.16	1995.08	2577.93	
Melanopic lux	307.51	687.26	1362.60	1735.96	2272.25	
Cyanopic lux	160.96	381.25	830.23	1089.99	1494.94	

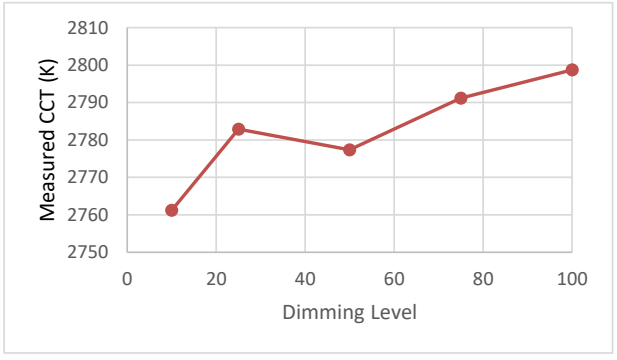




Data for Nominal Sun CCT 2700K

Dimming level	10	25	50	75	100	
Sun CCT (K)	2684	2684	2684	2747	2747	
Sky (CCT)	3504	3504	3504	3622	3622	Variance from average CCT
Power (W)	38.19	72	128.88	163.49	214.89	
Measured CCT	2761.2	2782.9	2777.4	2791.2	2798.7	1.35%
x	0.458	0.456	0.455	0.453	0.451	
y	0.416	0.415	0.412	0.410	0.407	
Irradiance (W/m2)	2.50	5.14	8.85	10.71	12.95	
Photopic lux	661.79	1361.00	2342.87	2834.13	3422.39	
Erythropic lux	660.77	1358.31	2340.66	2832.53	3423.83	
Chloropic lux	542.56	1118.91	1926.77	2336.71	2828.66	
Rhodopic lux	404.97	839.24	1445.50	1761.24	2141.99	
Melanopic lux	334.02	694.40	1201.25	1472.05	1803.69	
Cyanopic lux	165.93	350.74	631.99	796.67	1007.38	



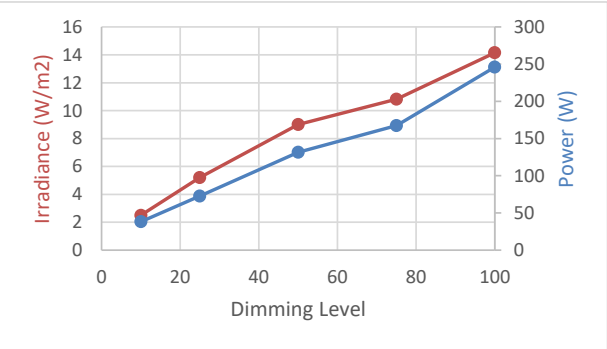


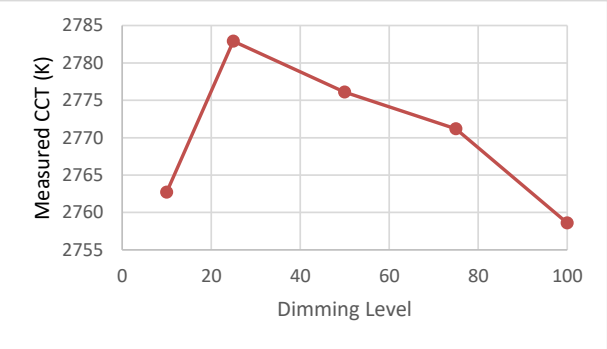
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Data for Nominal Sun CCT 2621K

Dimming level	10	25	50	75	100	
Sun CCT (K)	2621	2621	2621	2621	2621	
Sky (CCT)	3386	3386	3386	3386	3386	Variance from
Power (W)	38.16	72.77	131.58	167.51	245.96	average CCT
Measured CCT	2762.7	2782.9	2776.1	2771.2	2758.6	0.88%
x	0.458	0.456	0.455	0.455	0.454	
y	0.416	0.415	0.412	0.411	0.408	
Irradiance (W/m2)	2.50	5.21	9.01	10.83	14.15	
Photopic lux	661.60	1379.02	2384.62	2864.12	3735.86	
Erythropic lux	660.57	1376.32	2382.58	2863.51	3740.63	
Chloropic lux	542.52	1133.76	1960.93	2355.45	3072.86	
Rhodopic lux	405.23	850.37	1470.93	1767.08	2304.52	
Melanopic lux	334.35	703.64	1222.60	1472.30	1930.55	
Cyanopic lux	166.25	355.35	644.15	787.22	1061.68	





Results of the tests show the following:

1. Similar linear performance of irradiance and power with dimming level across all CCT values.

2. The measured CCT values change of up to 1-12% across dimming levels, with nominal sun CCT values of 3000 and 3500K showing the largest variation.

3. Measured CCT values are offset from the display sun CCT values due to the sky backlight.

4. Referring to photometric reports GNC-21469 and GNC21477, the luminous efficacy has been measured to be 21 lm/W at 2624K (100%) and 27 lm/W at 5658K (100%). It it believed that the low efficacy is due to loss of light through the sky image and the prismatic front panel.

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Colour Plots

