Product Evaluation Report - Integrated Photon Flux

Test results reported for:
Atreum Lighting
Product Description: Linear LED fixture

Issued Report:
ATRG001-012

Original issue date:
Tuesday, March 26, 2019

Revision Issue Date:
Thursday, April 04, 2019

Prepared for:
Atreum Lighting

Testing performed by:
CSA Group
14833 NE 87th St
Redmond, WA 98052
425-605-8500
www.csagroupseattle.org/

Test report prepared by:

Marius Timbus

Marius Timbus
Test Technician
Test & Measurement Services

Test report approved by:

Aaron Miller

Aaron Miller
Laboratory Manager
Test & Measurement Services

TABLE OF CONTENTS

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

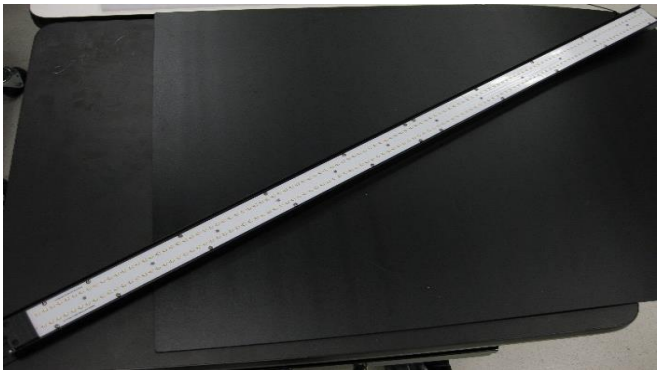
Manufacturer: Atreum Lighting
Product Description: Linear LED fixture
Report Number: ATRG001-012
Release Date: 3/26/2019

SAMPLE DESCRIPTION

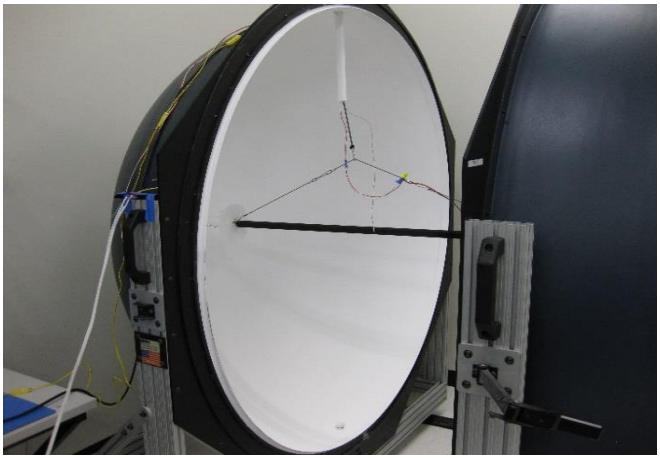
Lab sample identification:	1
Customer Identification:	
Manufacturer:	
Part number:	LM301B_16P15S XPE_3P4S
Model Number:	
Description:	Linear LED fixture

Manufacturer's ratings	
Max Current (A):	2.3
Operating voltage:	52 VDC
Wattage (watts):	-
Frequency (Hz):	DC
Type:	LED

Sample Device as Received



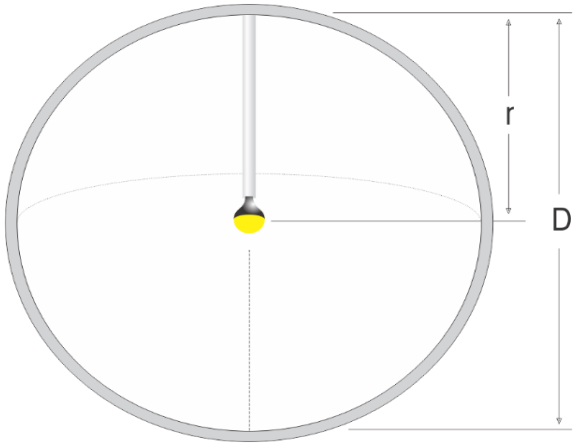
Sample Device Mounted to Test Apparatus



Equipment Geometry - Total Luminous Flux

Integrating Sphere Diameter: 1.5 meter
Optical Geometry: 4π
Base Orientation: ↓

Test Geometry - Integrating Sphere 4π, Base Up



Measurement System Description

Reference: LM-79-08 Photometric Measurements of SSL

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

An Integrating sphere system is suted for total luminous flux and color measurement of LED lamps and small-size LED luminaires which have a surface area less than 2% of the sphere area. In this system, a spectradiometer method is used and the system is calibrated for each device type using an absorption correction method. The device under test is mounted 4π, or 'center' of the sphere, and oriented with the socket base up.

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

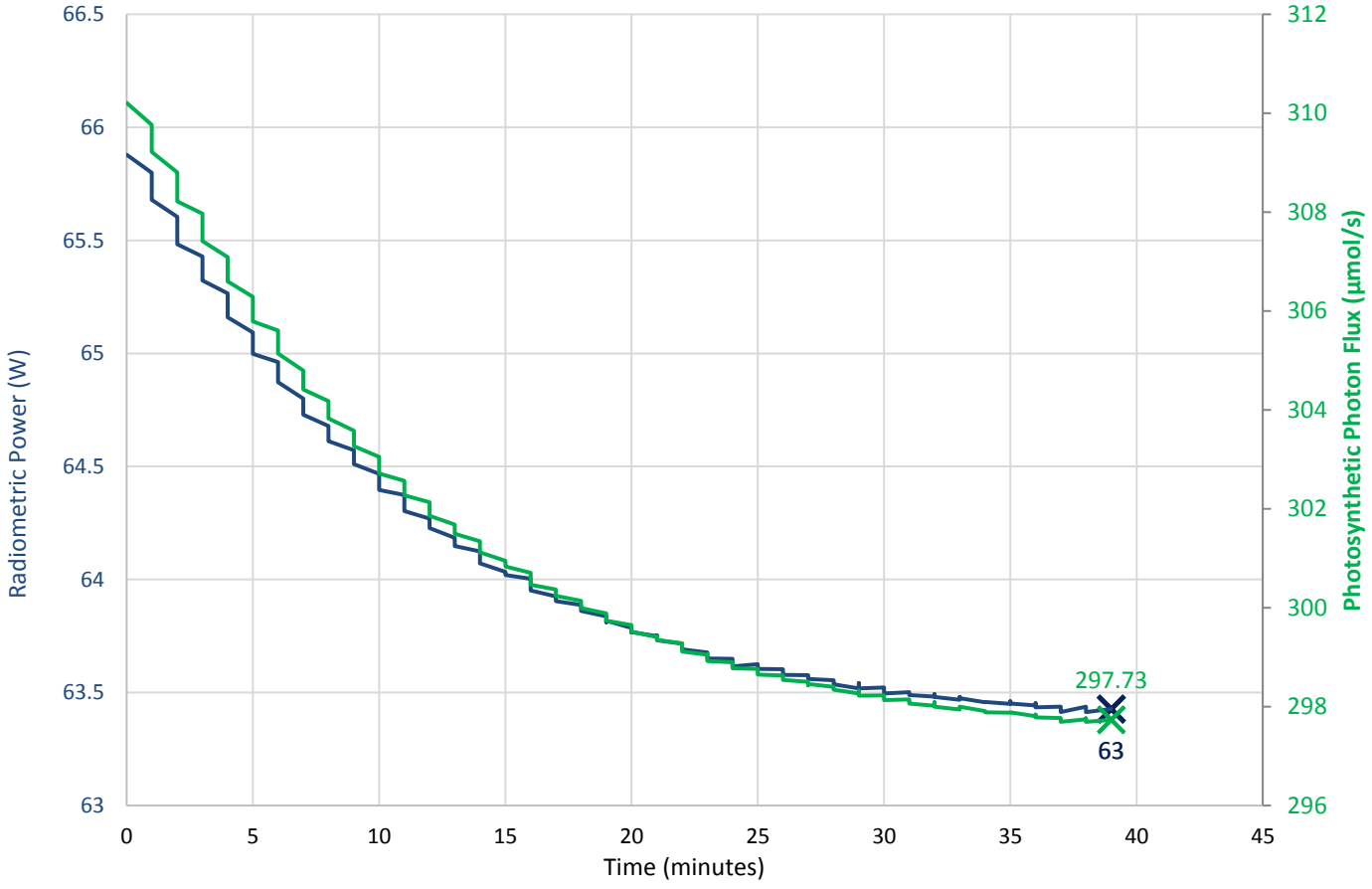
Manufacturer: Atreum Lighting
Product Description: Linear LED fixture
Report Number: ATRG001-012
Release Date: 3/26/2019

RADIOMETRIC STABILIZATION

Stabilization Description - A series of 115 measurements are recorded during the stabilization period. The final stabilized measurement, as defined by LM-79-08, is reported after 39 minutes of device runtime.

% of range	Radiometric Power (W)	Measurements in Range
99.978%	63	47
100.366%	64	18
100.755%	64	12
101.144%	64	9
101.533%	64	6
101.921%	65	7
102.310%	65	4
102.699%	65	5
103.088%	65	4
103.476%	66	4
100.000%	63	Reported

% of range	Photon Flux (µmol/s)	Measurements in Range
99.956%	297.60	45
100.379%	298.86	18
100.803%	300.12	13
101.226%	301.38	9
101.650%	302.64	7
102.074%	303.91	6
102.497%	305.17	5
102.921%	306.43	5
103.344%	307.69	4
103.768%	308.95	4
100.000%	297.73	Reported



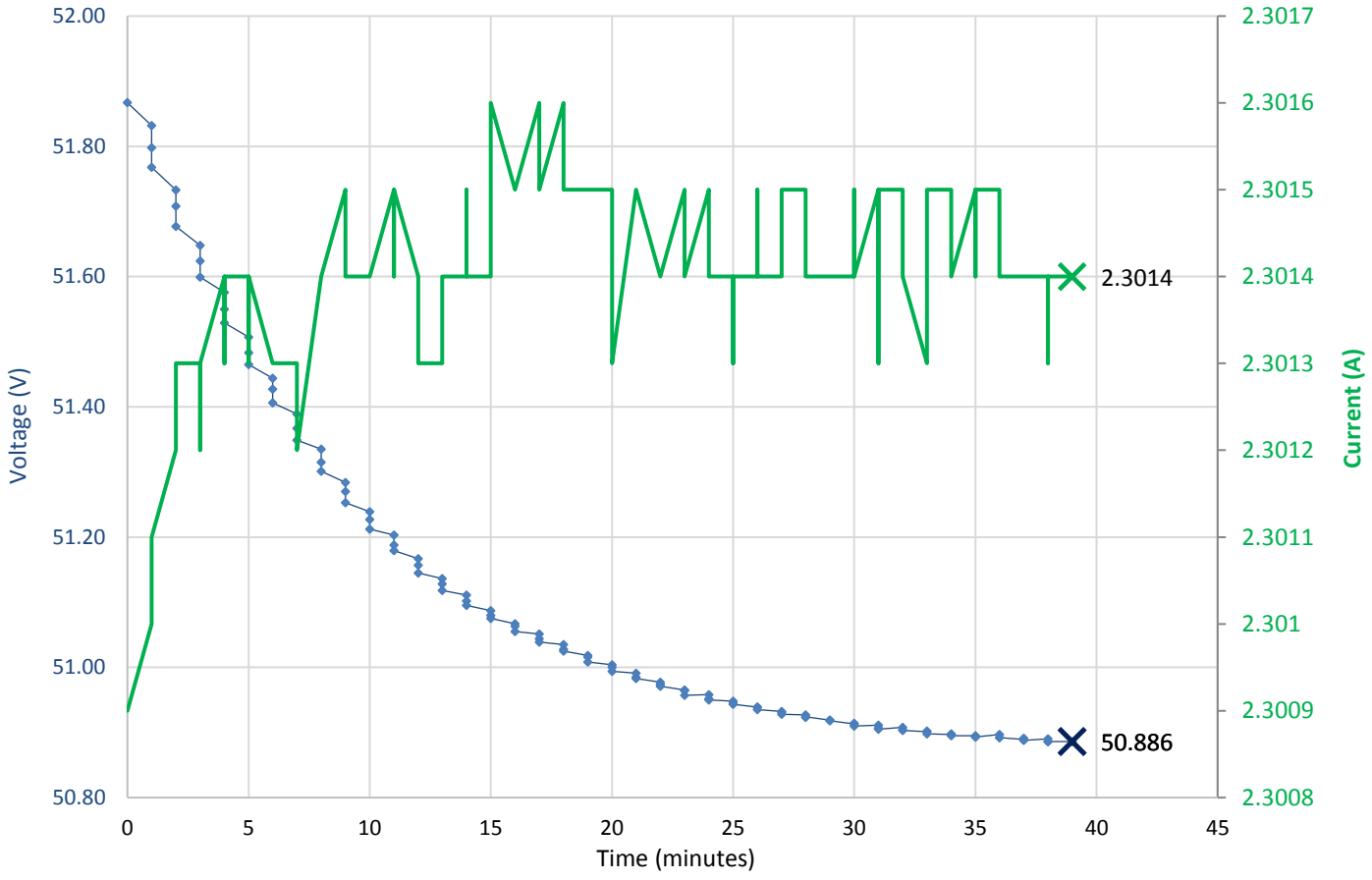
CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

ELECTRICAL STABILIZATION

Stabilization Description - A series of 115 measurements are recorded during the stabilization period. The final stabilized measurement, as defined by LM-79-08, is reported after 39 minutes of device runtime.

% of range	Voltage (V)	Measurements in Range
99.988%	50.88	52
100.182%	50.98	19
100.376%	51.08	11
100.570%	51.18	8
100.764%	51.27	6
100.958%	51.37	5
101.152%	51.47	4
101.346%	51.57	4
101.540%	51.67	4
101.734%	51.77	3
100.000%	50.89	Reported

% of range	Current (A)	Measurements in Range
99.978%	2.30	1
99.981%	2.30	2
99.984%	2.30	1
99.987%	2.30	0
99.990%	2.30	5
99.993%	2.30	16
99.997%	2.30	0
100.000%	2.30	50
100.003%	2.30	38
100.006%	2.30	3
100.000%	2.30	Reported



CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

Manufacturer: Atreum Lighting
Product Description: Linear LED fixture
Report Number: ATRG001-012
Release Date: 3/26/2019

HORTICULTURE SUMMARY

Photosynthetic Active Region (PAR) Measurements

	Value	*units*	*Description*
[1]Photosynthetic Photon Flux:	298	µmol/s	(400 - 700nm)
Photon Flux:	305	µmol/s	(350 - 1000nm)
PPF Efficacy :	2.542	µmol/joule	(PPF/Active Power)
Photon Efficacy :	2.606	µmol/joule	(Photon Flux/Active Power)
Total Intergated YPF (**µmol/s**):	265.9	µmol/s	(Yeild Photon Flux)
[2]YPF Efficacy:	2.271	µmol/joule	(Total Integrated YPF/Active Power)
Photosynthetically Active Yeild Efficiency :	89.31	%	(YPF/PPF)

NOTE 1: Photosynthetic Photon Flux: weighted equally by wavelength and summed between 400nm and 700nm.

NOTE 2: Yield Photon Flux: PPF weighted by action spectrum (average of 20 plant species as defined by McCree) and summed between 350nm and 750nm. (See Spectrum)

Radiometric Measurements

	Value	*units*
Total Integrated Radiometric Flux:	63.4	W
Peak Wavelength:	663.3	nm

Electrical Measurements

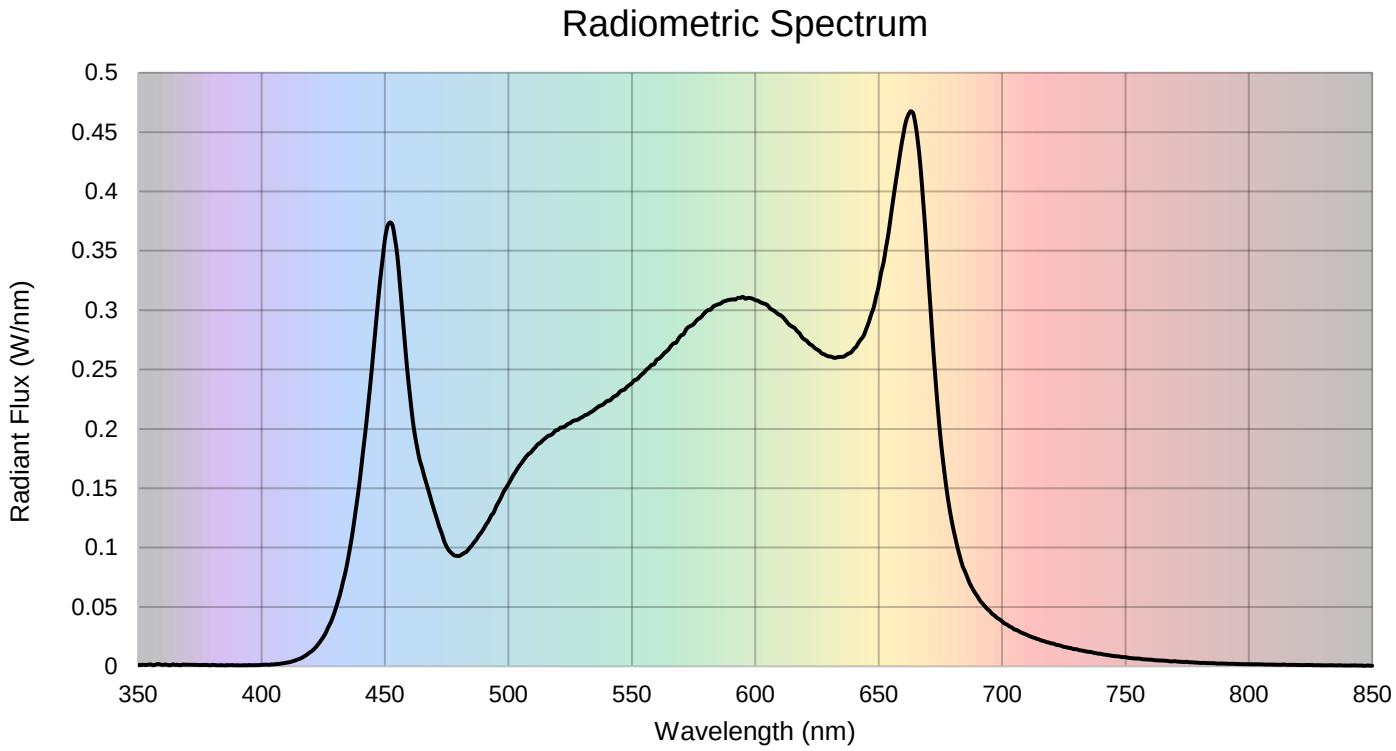
	Value	*units*
Active Power:	117.1	W
Apparent Power:	-	W
Power Factor:	-	
Voltage:	50.9	VDC
Current:	2.3	A
Frequency:	-	Hz

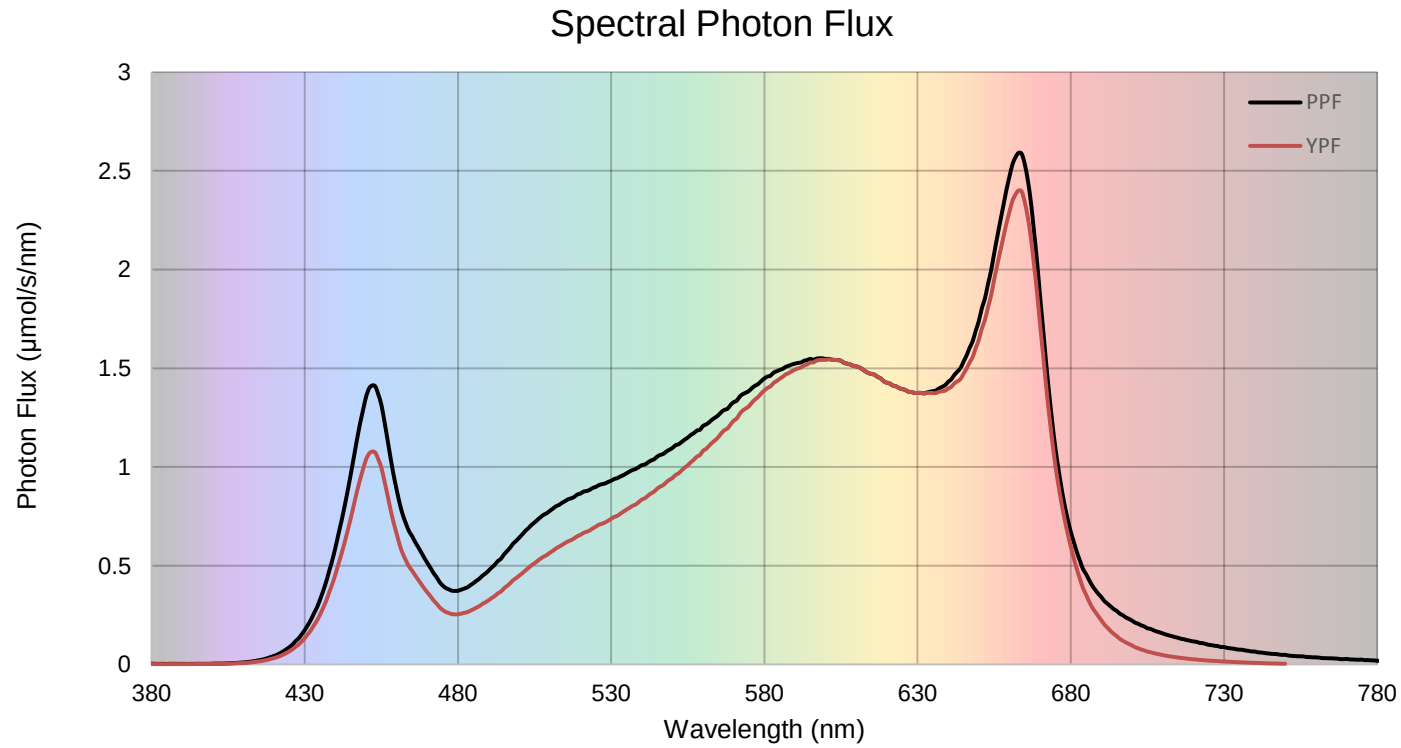
Thermal Measurements

	Value	*units*
Ambient Temperature:	25.0	°C
DUT Temperature:	56.9	°C

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

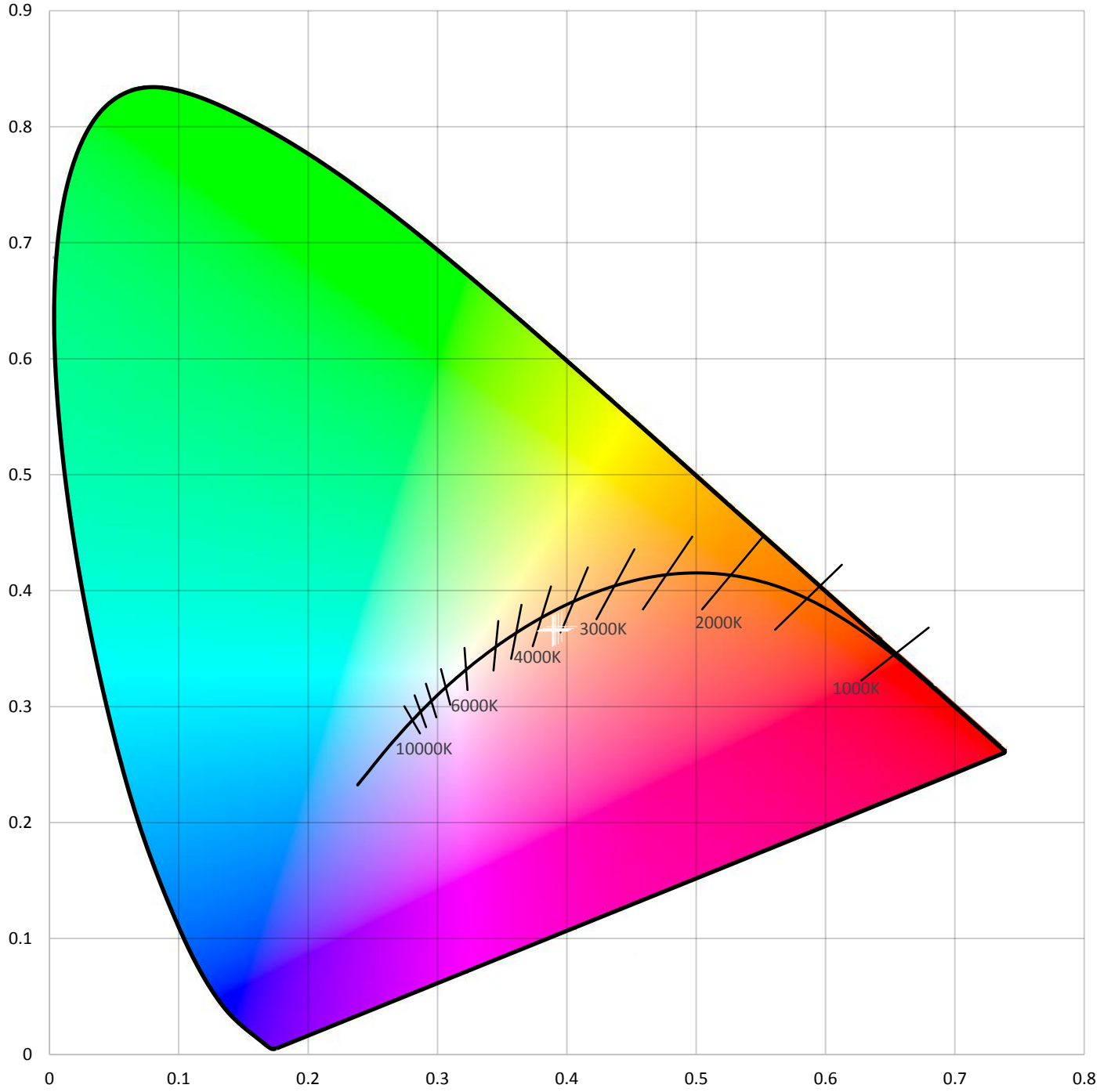
SPECTRUM





CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

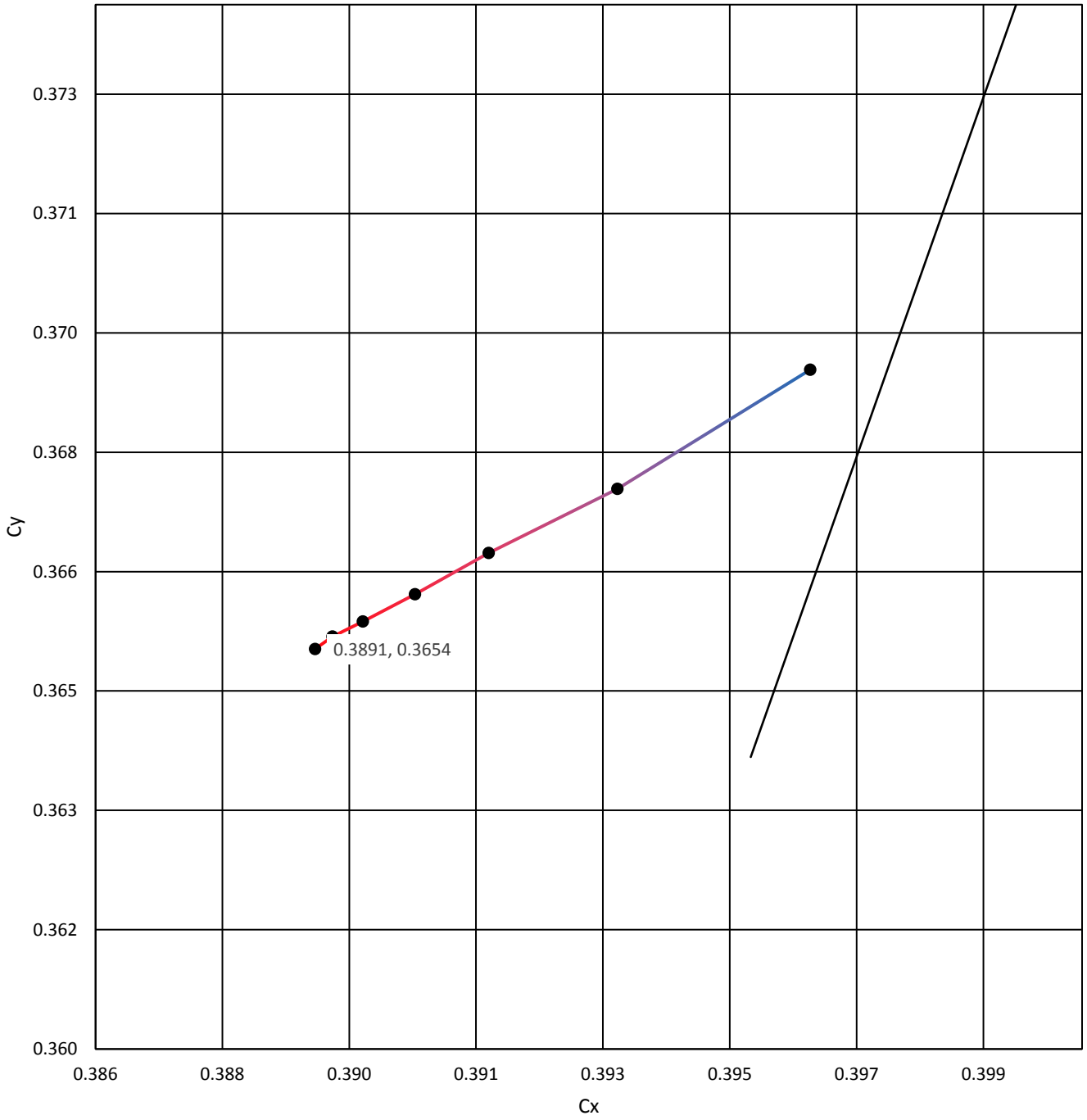
CIE 1931



CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

CX CY

Cx, Cy Description - The series of measurements reported inSummary are plotted on the CIE 1931 diagram from the first measurement (blue) to the final reported stabilized measurement (red).



CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

Product Evaluation Report - Integrated Photon Flux

Manufacturer: Atreum Lighting
Product Description: Linear LED fixture

Report Number: ATRG001-012
Release Date: 3/26/2019

SUMMARY

	Unit	Symbol	-	-	-	-	-	-	-	Reported
Time	**minutes**	**t**	2:18 PM	0:05	0:11	0:16	0:22	0:27	0:33	0:38
Luminous Flux	**lm**	**Φ_V**	18999.59	18652.58	18414.87	18276.67	18191.94	18146.88	18115.85	18094.53
Scotopic Flux	**lm**	**$\Phi_{V'}$**	32125.8	31858.6	31665.3	31554.1	31495.7	31472.1	31453.7	31452.1
Luminous Efficacy	**lm/W**	**η**	159.21	157.49	156.31	155.55	155.08	154.82	154.64	154.51
Illuminance	**cd·sr·m^{-2}**	**lm/m^2=lx**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Luminous Intensity	**cd**	**lm/sr=cd**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Luminance	**cd/m²**	**cd/m^2**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tristimulus X	**-**	**x̄(λ)**	20391.23	19966.94	19666.91	19496.60	19388.85	19330.16	19293.55	19266.47
Tristimulus Y	**-**	**ȳ(λ)**	18999.59	18652.58	18414.87	18276.67	18191.94	18146.88	18115.85	18094.53
Tristimulus Z	**-**	**z̄(λ)**	12083.69	12134.82	12143.10	12149.93	12160.52	12168.70	12173.80	12189.32
Cx	**-**	**x**	0.3961	0.3934	0.3916	0.3905	0.3898	0.3894	0.3891	0.3888
Cy	**-**	**y**	0.3691	0.3675	0.3666	0.3661	0.3657	0.3655	0.3654	0.3652
u'	**-**	**u'**	0.2387	0.2376	0.2367	0.2363	0.2359	0.2357	0.2356	0.2355
v'	**-**	**v'**	0.5005	0.4994	0.4987	0.4983	0.4980	0.4979	0.4978	0.4976
u	**-**	**u**	0.2387	0.2376	0.2367	0.2363	0.2359	0.2357	0.2356	0.2355
v	**-**	**v**	0.3337	0.3329	0.3325	0.3322	0.3320	0.3319	0.3318	0.3318
CCT	**K**	**K**	3528.79	3580.45	3620.07	3640.96	3659.39	3669.22	3671.24	3679.63
Duv	**-**	**-**	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Du'v'	**-**	**-**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gamut Area	**-**	**-**	0.75	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Dom Wl	**nm**	**λ**	585.10	585.10	585.00	584.90	584.90	584.90	584.90	584.90
Comp Wl	**nm**	**λ**	484.00	484.00	483.90	483.90	483.90	483.90	483.90	483.90
Color Purity	**%**	**λ**	29.63	28.33	27.54	27.08	26.74	26.54	26.42	26.28
Radiometric Power	**W**	**$\Phi_{E(\lambda)}$**	65.88	65.00	64.33	63.95	63.70	63.56	63.48	63.41
Flux	**W**	**Φ_E**	65.88	65.00	64.33	63.95	63.70	63.56	63.48	63.41
Peak Wl	**nm**	**λ**	657.90	659.90	661.00	661.50	662.70	662.70	663.00	663.30
FWHM	**nm**	**λ**	99.69	109.13	116.06	120.14	123.49	124.67	126.17	126.05
Centroid Wl	**nm**	**λ**	576.44	576.23	576.03	575.98	575.87	575.79	575.77	575.67
Voltage Set Point	**V**	**V**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Voltage	**V**	**V**	51.87	51.47	51.19	51.06	50.97	50.93	50.90	50.89
Current Set Point	**A**	**I**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Current	**A**	**I**	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Power	**W**	**W**	119.34	118.44	117.81	117.50	117.31	117.21	117.15	117.11
TEMP Set Point	**°C**	**°C**	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Frequency	**Hz**	**Hz**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Factor	**cos θ**	**-**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Duty Cycle	**%**	**-**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Trigger Delay	**sec**	**s**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulse Duration	**sec**	**s**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Integration Time	**sec**	**s**	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Averages	**#**	**-**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Saturation	**%**	**-**	0.75	0.70	0.66	0.64	0.63	0.62	0.61	0.61
Optical Saturation	**%**	**-**	0.75	0.69	0.66	0.64	0.62	0.62	0.61	0.61

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

Manufacturer: Atreum Lighting
Product Description: Linear LED fixture
Report Number: ATRG001-012
Release Date: 3/26/2019

EQUIPMENT

Item	Description/use	Manufacturer	Model	Serial #	Calibration Due
Spectrometer	Spectrum	Instrument Sys.	CAS-140	772314215	at use
Integrating Sphere	60"	LabSphere	AA-00463	10240111707	at use
Power Supply	DUT power supply	BK Precision	XLN 30052	17050920123	-
Power Supply	Sphere Lamp Calibration	Keithley	2425	1362476	10/16/2019
Power Analyzer	Electrical Meas.	Yokogawa	WT-210	91L137852	10/10/2019
Temperature Control	Temperature Meas.	Orb Optronix	TEC-100	11020043	-

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org

REVISION HISTORY

REVISION	DATE	APPROVED	DESCRIPTION OF REVISION
010	3/26/2019	ACM	⓪ORIGINAL
011	3/26/2019	ACM	①Vendor contact information removed from cover page at request.
012	4/4/2019	KCF	①Corrected PPF Efficacy calculation ②Added Photon Flux Efficacy

END OF REPORT

CSA Group
14833 NE 87th St, Redmond, WA 98052
425-605-8500
www.csagroupseattle.org