Horticulture Reference Design

June 2016

Note: This document contains preliminary results. A more detailed and formal reference design document will be forthcoming.

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Cree Horticulture Reference Design

Purpose

- HPS is the current gold standard for greenhouse or sole source farming.
- LED technology has rapidly advanced to surpass traditional technology in the horticulture industry.
- Currently many LED horticulture fixtures underperform due to inefficient LEDs and poor system design: optical, thermal, and electrical design.
- This reference design showcases designing with the world's most efficient LEDs (*XP-G3* and *XP-E*) to meet HPS performance at half the wattage.

Goals

- Equivalent PPFD on a 4x4’ plot at half the wattage of an 1000W HPS solution
- Effective use of secondary optics to achieve equivalent light uniformity
- Full spectrum lighting matching that of HPS
- Effective use of LED system design to enable passive cooling
  - No active cooling fan compared to majority of the LED fixtures on the market
- Use off-the-shelf parts for assembly
- Modular design
- IP65+ rated

Incumbent : Gavita Pro HPS 1000W (With Philips Bulb)

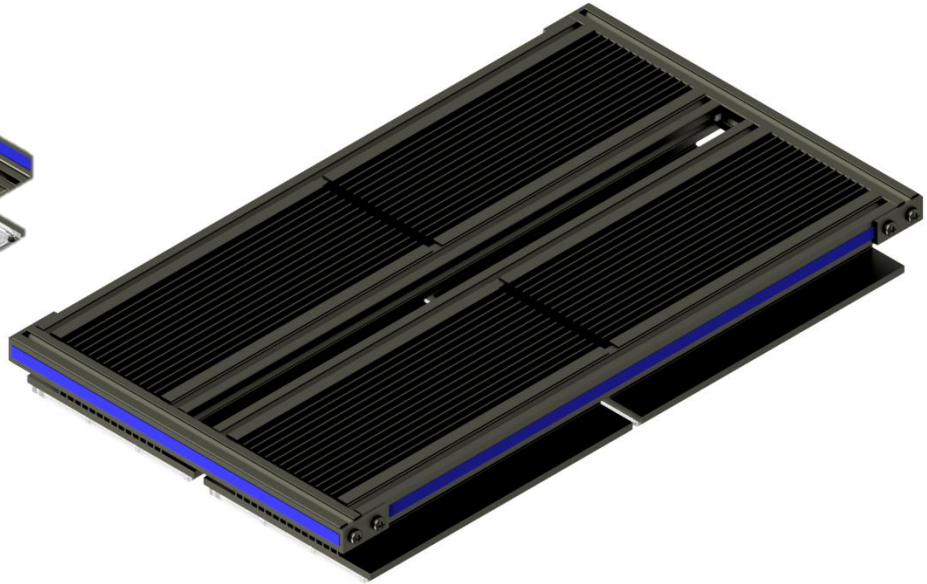
- Physical measurements (22.3”L x 9.4”W x 13.4”H)
- Weight (16lbs)
- PPF/W (1.72)*
- Wattage (1064W)

Spectral Content

Wavelengths			PPF%*	RF%
UV	300	399	0.0%	0.3%
Violet/Blue	431	500	4.8%	4.9%
Green/Yellow	501	580	26.2%	21.7%
Orange/Red	581	700	68.9%	51.8%
Far Red	701	780	0.0%	6.0%
IR	781	1000	0.0%	15.3%

*PPF measurements performed after the manufacturer’s recommended burn-in period.

Reference Design Model



Engine Pictures

Fixture Pictures (4 Engines mounted together)

Preliminary Measurements – Engine Only (No Driver)

- Physical measurements (11.25”L x 7.25”W x 2.5”H)
- Weight (5lbs)
- Full Spectrum
  - 12x 660nm *XP-E Photo Red**
  - 36x 4000K *XP-G3**
- PPF/W (1.93)
- Wattage (130W)

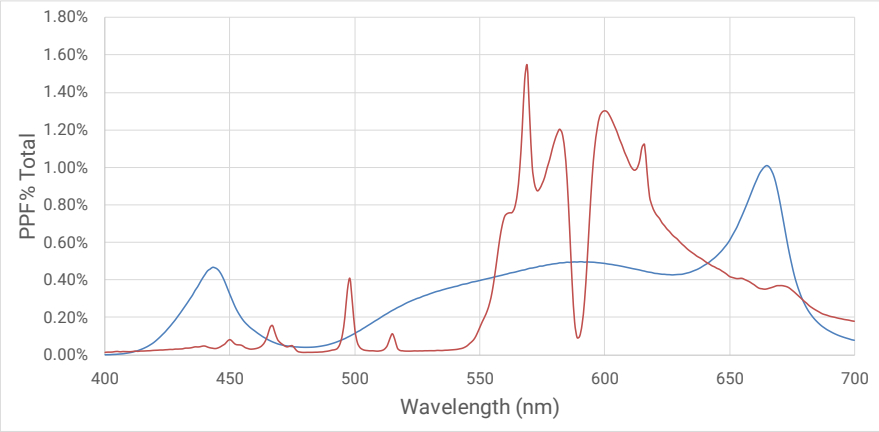
*Refer to the Cree Horticulture Feature Sheet for LED PPF performance

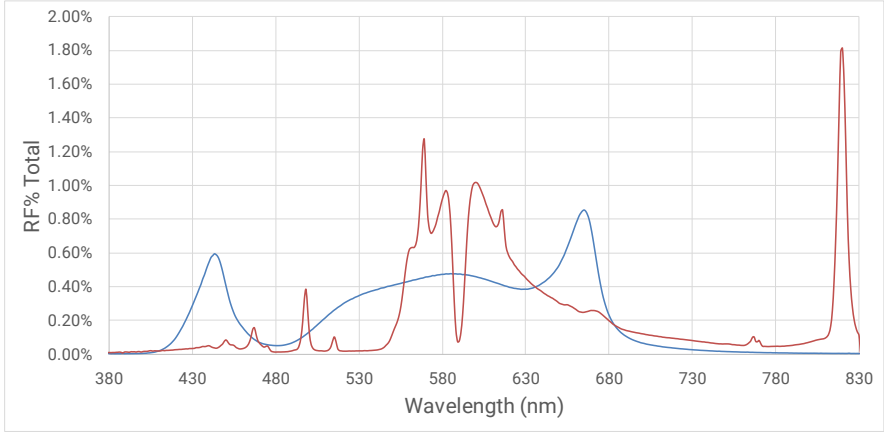
Preliminary Measurements – Fixture

- 4 engines in total
- Physical measurements (25.0”L x 15”W x 3”H)
- Fixture Weight (27lbs)
- Full Spectrum
  - 48x 660nm XP-E Photo Red*
  - 144x 4000K XP-G3*
- PPF/W (1.82)
- Wattage (553W)

*Refer to the Cree Horticulture Feature Sheet for LED PPF performance

Spectral Distribution





Reference

Wavelengths			PPF%*	RF%
UV	300	399	0.0%	0.0%
Violet/Blue	431	500	13.7%	17.3%
Green/Yellow	501	580	29.2%	30.1%
Orange/Red	581	700	57.1%	50.8%
Far Red	701	780	0.0%	1.8%
IR	781	1000	0.0%	0.0%

HPS

Wavelengths			PPF%*	RF%
UV	300	399	0.0%	0.3%
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IR	781	1000	0.0%	15.3%

*PPF measurements taken between 400-700nm

Spectral Distribution

More Violet/Blue was introduced to the reference design intentionally as customers using HPS have preferred more of a balanced spectrum.

The recipe can be fine tuned to any manufacturer specifications.

Reference

Wavelengths			PPF%*	RF%
UV	300	399	0.0%	0.0%
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HPS

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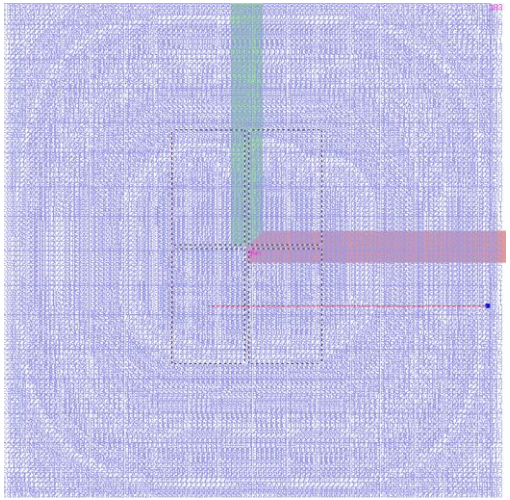
*PPF measurements taken between 400-700nm

Simulated PPFD Plots

Comparison between Gavita at 1m (min distance) to:

- Reference Design
- Typical LED replacement with spot optic
- Typical LED replacement without optics

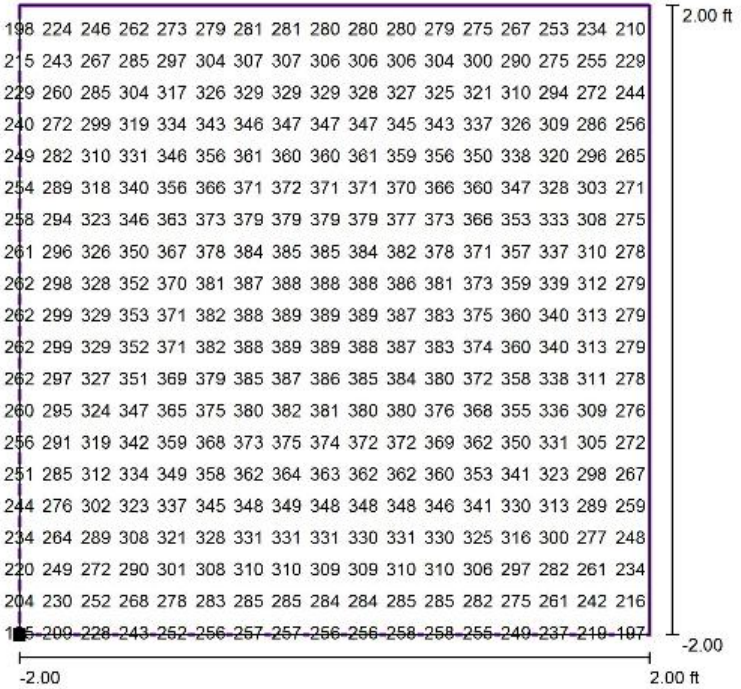


Target comparators:

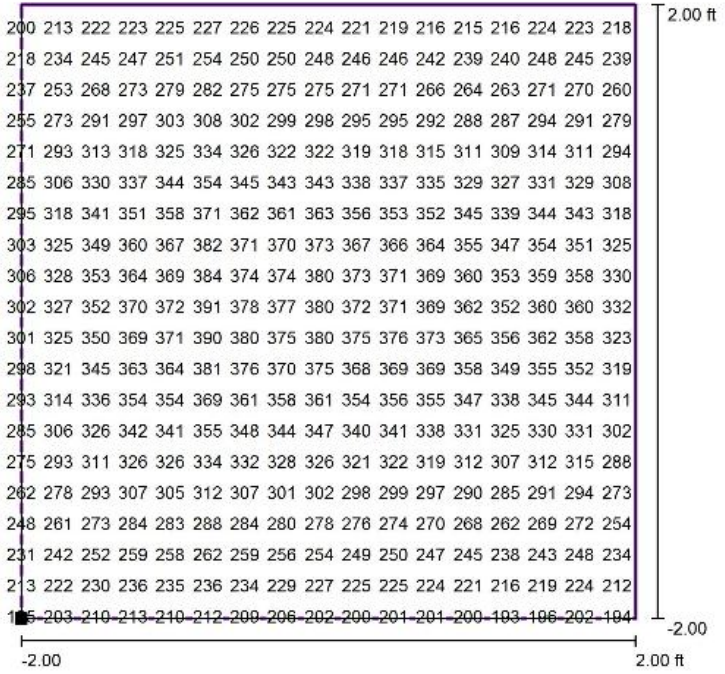
- PPFD AVG, PPFD Uniformity (min to max ratio)
- 4x4’ plot at manufacturer recommended height
- 100x100 points on the entire 4x4’ plot (10,000 points)
  - Displayed on the right is a dizzying amount of points calculated on a 4x4’ plot

Simulated PPFD Plots

Reference Design



Gavita 1000W HPS



*Not all values can be displayed

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Simulated Results at Manufacturer Recommended Height

	Reference Design	Gavita 1000W HPS	Typical LED 1 Spot Optic, 60deg	Typical LED 2 No Optic, 120deg
Height (ft)	4.9	3.2	2	0.5
PPFD Max	390	394	2335	934
PPFD Min	182	184	16	182
PPFD Avg	320	303	513	734
PPFD Uniformity* (min: max)	0.47	0.47	0.01	0.19
PPF / W	1.82	1.72	1.40	2.10
Power (W)	553	1064	600	660

Measurements from a 4x4’ grid with 10,000 measurement points (100x100)

Simulated Results at Equivalent Uniformity

	Reference Design	Gavita 1000W HPS	Typical 1 Spot Optic, 60deg	Typical 2 No Optic, 120deg
Height (ft)	4.9	3.2	6.3	2.9
PPFD Max	390	394	236	325
PPFD Min	182	184	112	152
PPFD Avg	320	303	167	254
PPFD Uniformity * (min: max)	0.47	0.47	0.47	0.47
PPF / W	1.82	1.72	1.40	2.10
Power (W)	553	1064	600	660

Measurements from a 4x4’ grid with 10,000 measurement points (100x100)

Reference Design vs HPS

	Reference Design	Gavita 1000W HPS
PPFD Center	390	394
PPFD Edge	182	184
PPFD Average	320	303
PPFD Uniformity (min: max)	0.47	.47
PPF / W	1.82	1.72
Wattage	553	1064
Lifetime	Cree XP-G3 White L90>90k hrs, Cree XP-E Photo Red R90>90k hrs	10,000 hrs to 10% failure
Min distance	Depends on optics and uniformity	3.3ft due to IR stress
IP Rating	65+	None
Spectra Tune-ability	Yes	No

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- ✓ IP65+ rated

Parts List

Part	Description	P/N	Qty
LED	Cree XP-E Photo Red 660nm	XPEPHR-L1-0000-00901	48
LED	Cree XP-G3 4000K	XPGDWT-01-0000-00LE5	144
Optic	LEDiL Strada HB	CS14130_HB-IP-2X6-W	16
PCB	SinkPad Aluminum	1950	16
Heatsink	Aavid Black Anodized	62625	4
Class 1 Flammability Paper	3M	TBA	16
TIM	Graftech HITHERM 1200	G10230	16
Frame	80/20	various	various
Driver	Mean Well	HLG-320H-C1050B	2
Potting	Henkel	TBA