

LED iBOND

LED iBond // GRACY Horticulture

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GRACY HORTICULTURE GROWTH LIGHT PANEL WITH ADJUSTABLE SPECTRUM



Choosing the right spectrum for a specific plant is essential for crop yield, but it is also a question of ensuring that the electrical energy used, to drive the growth light panel, is used optimally by generating light photons with the highest impact on plant growth and thereby crops produced with the right quality.

Even small changes in the composition of a spectrum can lead to significant changes in yield.

The optimal spectrum for a specific type of crop can be selected based on knowledge and experience but more accurate by conducting controlled growth tests using different spectra for comparison of crops produced and its quality.

LED iBond's GRACY HORTICULTURE GROWTH LIGHT PANEL with ADJUSTABLE SPECTRUM allow growers to conduct such controlled tests and thereby determine the optimal spectrum to be used for production in scale.

GRACY Horticulture Growth Light Panel with Adjustable Spectrum

With LED iBond's GRACY HORTICULTURE GROWTH LIGHT PANEL with ADJUSTABLE SPECTRUM we allow growers to conduct controlled tests to determine the optimal spectrum to be used for production. This will be the first step before scaling to full production.

Layout of Growth Light Panel:

The Growth light panel measures 600x800 mm and contains a total of 28 points of lights. The 28 points of light are grouped into three color channels:

- 8 points of light with a Blue/Red-dominated spectrum
- 8 points of light with a Red/Far-Red-dominated spectrum
- 12 points of light with a broad spectrum

The points of light of each color channel are evenly distributed across the light panel (see illustration 1 below) to ensure a highly uniform light distribution under the panel for all colors.

Illustration of panel:

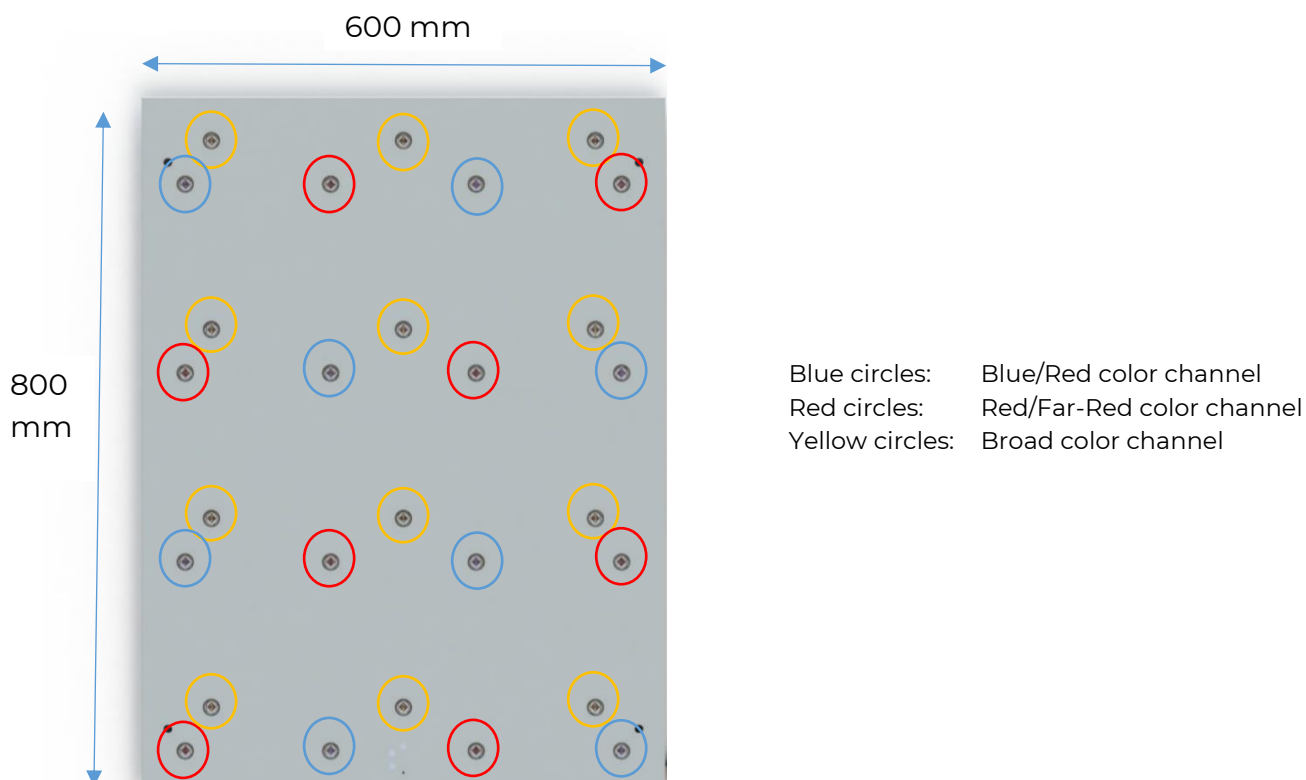
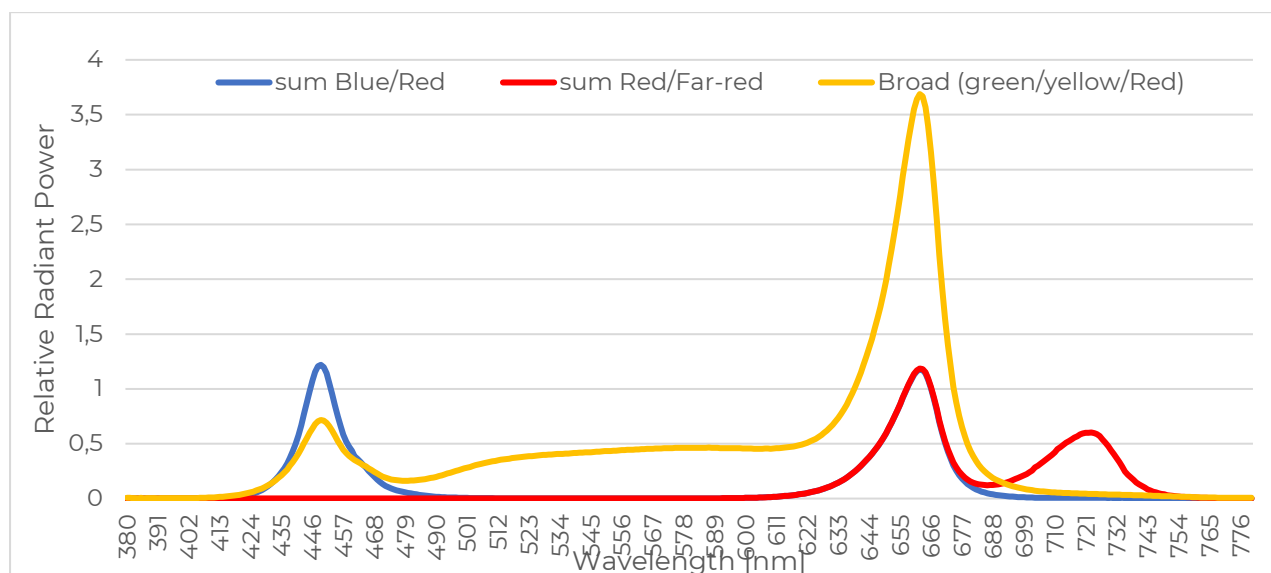


Illustration 1: Bottom view of GRACY Horticulture Growth Light Panel with 3 color channels (Blue/Red, Red/Far-Red, and Broad)

Spectrum of the three-color channels:

Graph 1 below shows the spectrum associated with each of the 3 color channels (blue/red, Red/Far-red, and broad).

It is possible to supplement the broad spectrum with either extra blue/red photons or extra red/far-red photons.

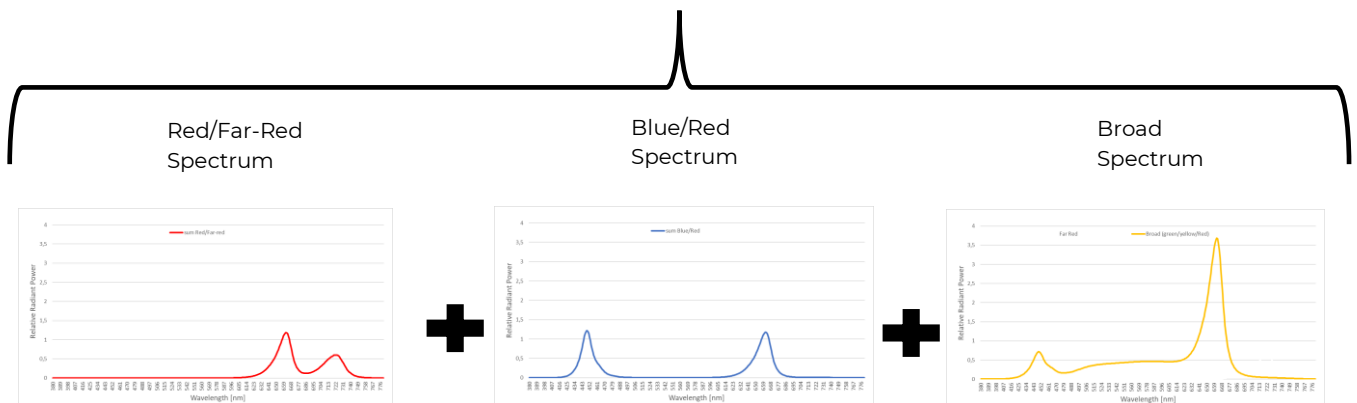
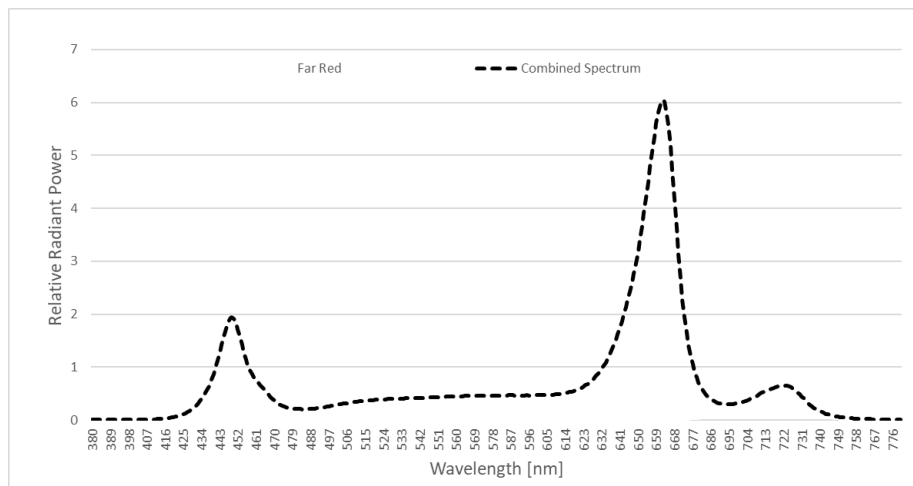
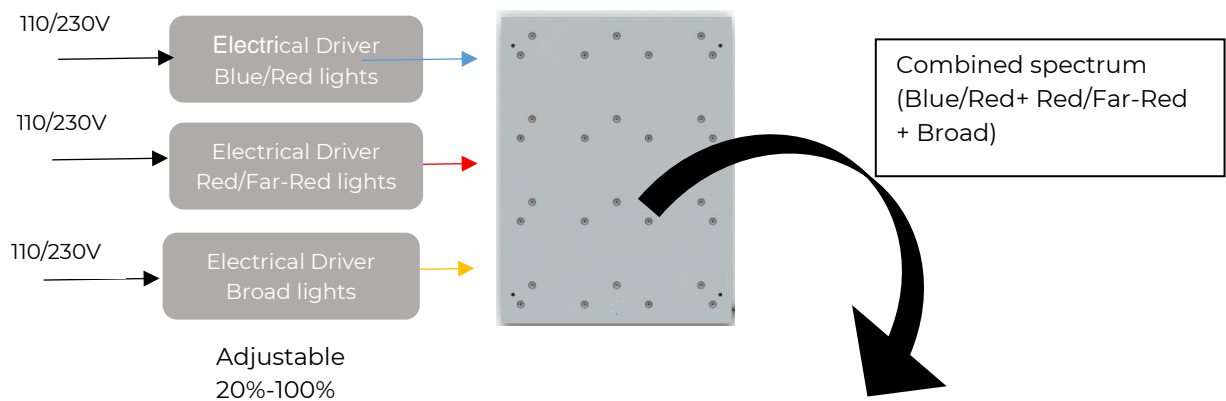


Graph 1: The 3 Spectra for each of the 3 color channels (All at maximum drive)

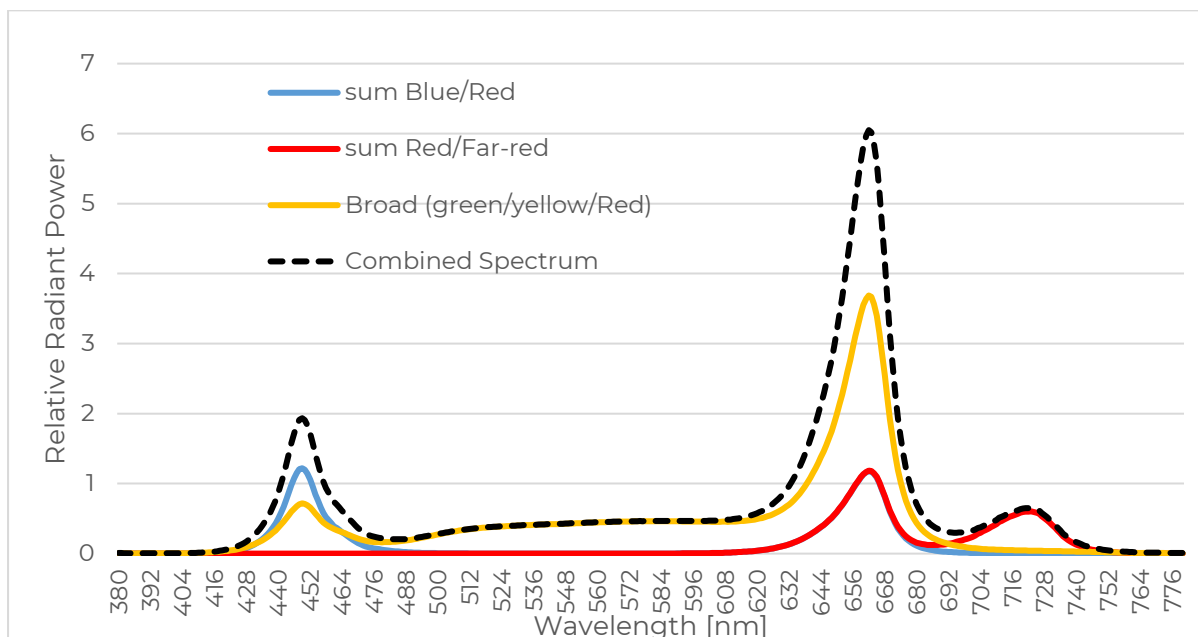
Functionality of Growth Light Panel – adjustable spectrum:

The light intensity of each color channel can be individually adjusted by controlling the electrical power from three individual LED drivers and thereby numerous different spectra can be generated.

The schematics below illustrates how the light energy from each color channel is added to form the combined spectrum that will illuminate the plants.



Spectrum of combined spectrum (maximum drive 100%):



Graph 2: The 3 Spectra for each of the 3 color channels and the combined spectrum (all color channels at maximum electrical drive - 100%)

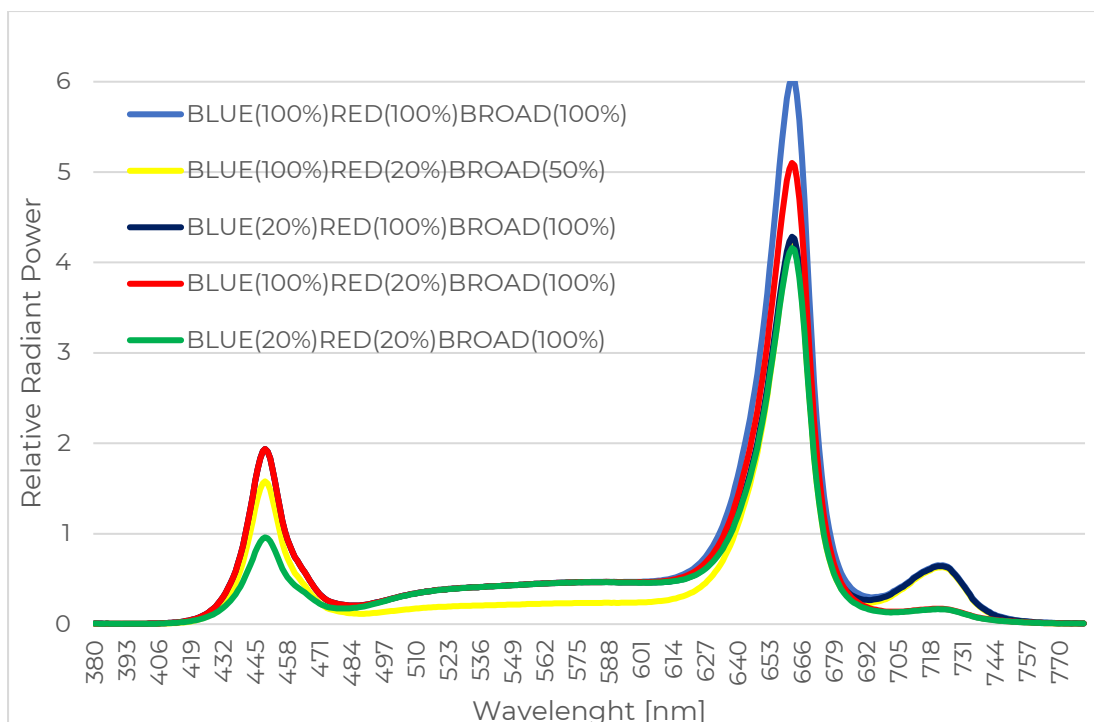
Creating customized spectrum and intensity (adjustable drive level):

The drive range for all three drivers is 20% to 100% which means that even at minimum drive all three-color channels are active and illuminated light and contribute to the combined spectrum.

By varying the drive level of the three drivers a huge variety of spectra can be generated. Table 1 and Graph 3 show example of 5 different combinations to illustrate the variety.

Blue/Red - Drive level	100%	20%	100%	20%	100%
Red/Far-Red - Drive Level	100%	100%	20%	20%	100%
Broad - Drive Level	100%	100%	100%	100%	50%
Violet 320-400nm	0%	0%	0%	0%	0%
Blue 401-500nm	17%	12%	20%	14%	19%
Green 501-577 nm	11%	13%	13%	16%	8%
Yellow 578 - 597 nm	3%	4%	4%	5%	2%
Orange 598 - 621 nm	4%	5%	5%	6%	3%
Red 622 - 699 nm	57%	58%	56%	57%	57%
Far Red 700-719 nm	3%	4%	1%	1%	5%
IR 720 - 780 nm	4%	4%	1%	2%	5%
Sum	100%	100%	100%	100%	100%

Table 1: Relative energy distribution for 5 different combinations of drive levels.



Graph 3: The 5 different Spectra generated by combination of drive levels listed in Table 1.

It is important that attention is made to the fact that drive level affects both the spectrum and the light intensity coming from the light panel. It is therefore important that the ratio between the three drive levels is kept constant to maintain the spectrum if one would like to adjust the light intensity up or down.

Please note that the spectrum of each of the three-color channels is also slightly affected by the actual drive level at which it is operated but this is an insignificant effect compared to the effect of combining the spectra from the three-color channels.

Light output power (adjustable drive level):

The total optical power from the panel is maximum 267 $\mu\text{mol/s}$ (corresponding to a maximum light intensity of 560 $\mu\text{mol/s}$ per square meter) when all three-color channels are operated with drive level of 100%.

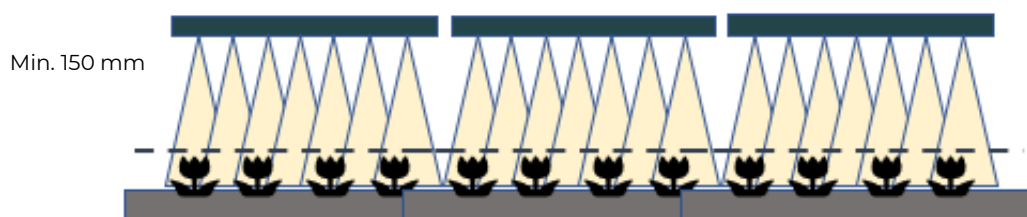
	Blue/Red	Red/Far-Red	Broad	Total
Drive level 100% for all three-color channels	52 $\mu\text{mol/s}$	52 $\mu\text{mol/s}$	164 $\mu\text{mol/s}$	267 $\mu\text{mol/s}$

Table 2: Optical power from the GRACY HORTICULTURE GROWTH LIGHT PANEL

Light output intensity (adjustable drive level):

Intensity is often referred to as PPFD (Photosynthetic Photon Flux Density) and measures the amount of micromoles of photons striking a square meter per second ($\mu\text{mol/s/m}^2$).

The actual light intensity below the Growth Light Panel depends on the distance from panel the measurement is performed. In order obtain a high light intensity uniformity the distance between the panel and the plants should be minimum 150 mm. Furthermore, the uniformity and intensity are enhanced if the panels are positions in an array



	Blue/Red	Red/Far-Red	Broad	Total
Drive level 100% for all three-color channels	109 $\mu\text{mol/s}$ per m^2 (Maximum)	109 $\mu\text{mol/s}$ per m^2	342 $\mu\text{mol/s}$ per m^2	560 $\mu\text{mol/s}$ per m^2

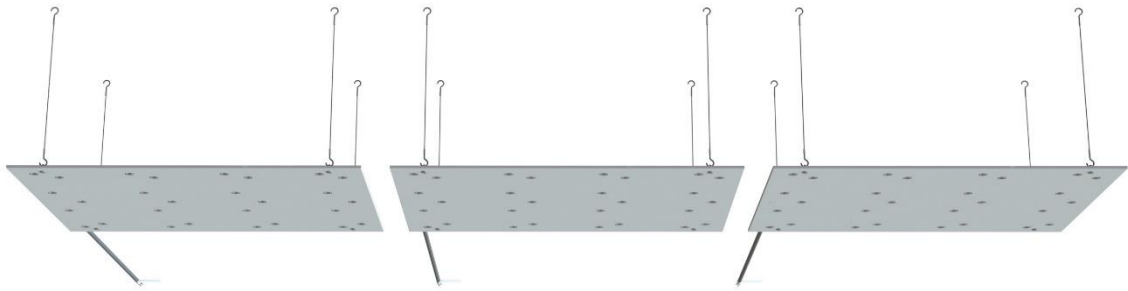
Table 3: Maximum optical light intensity (PPFD) from the GRACY HORTICULTURE GROWTH LIGHT PANEL – Measured at 0 cm

For a single Growth Light Panel, the relationship between Intensity versus distance from panel is the following:

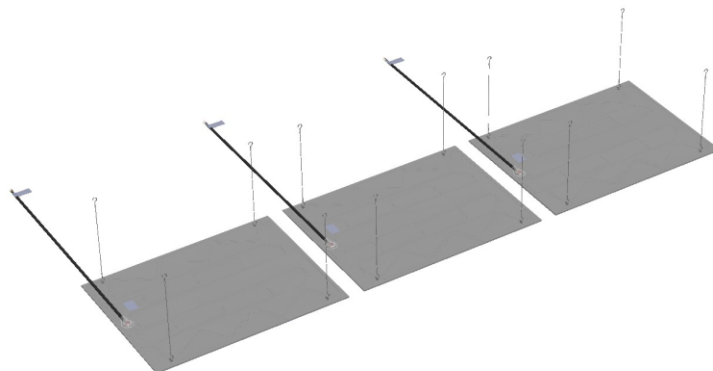
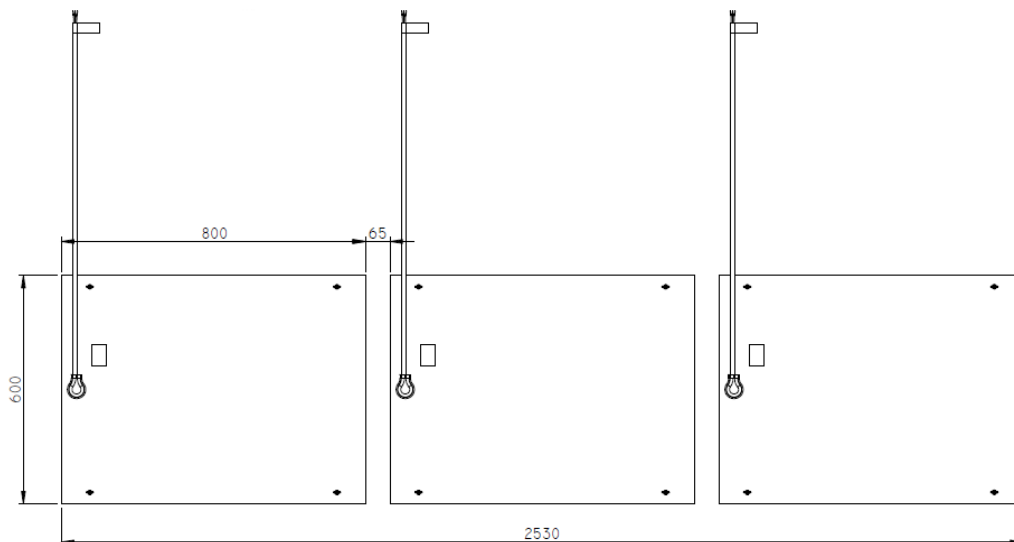
Distance	PPFD [$\mu\text{mol/s/m}^2$]	PPFD [relative]
0 mm	560	100%
150 mm		87%
300 mm		72%
450 mm		61%
600 mm		46%

Table 4: Relative PPFD versus distance from Panel. Data is for a single panel.

Three panels arranged for test bench setup:

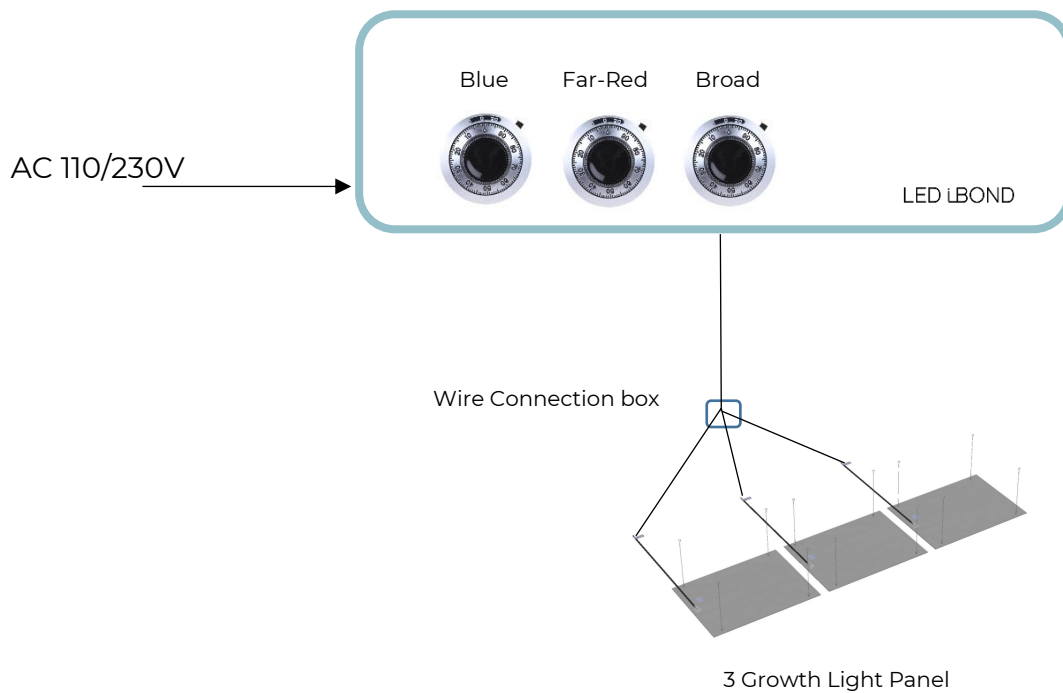


Top view:



Note: Wire system for mounting shall be ordered separately.

Control box - layout (for 3 Growth Light Panels):



Specifications:

Technology	LED
Material	ACP, Polyethylene and Aluminum
Panel Dimensions	600x800 mm
Height	6 mm (7 mm, water protection)
Dust and water-resistant (IP)	IP65
RoHS and REACH compliant	Yes
LED lifetime (Q90)	>50.000 hours
Max ambient temperature	50C – recommended
Mounting height above plant	Min. 150 mm

Light Spectra max range	410-760 nm - Adjustable (three color channels)
Light Spectra - color channels	3
Light Spectra - color 1	Blue/Red (peak at 450 nm + 660 nm)
Light Spectra - color 2	Red/Far-red (peak 660 nm + 710nm)
Light Spectra - color 3	Broad (420-710nm)

Light Power max from panel	269 $\mu\text{mol/s}$ (560 $\mu\text{mol/s/m}^2$ – 0 cm from panel)
Light Power – Color 1 only	52 $\mu\text{mol/s}$ – Blue/Red color bin
Light Power – Color 2 only	52 $\mu\text{mol/s}$ – Red/Far-red color bin
Light Power – Color 3 only	164 $\mu\text{mol/s}$ – Broad color bin

Light Power max intensity	485 $\mu\text{mol/s/m}^2$ @ 15 cm from panels in Array
Light Power max intensity	404 $\mu\text{mol/s/m}^2$ @ 30 cm from panels in Array
Light Power max intensity	341 $\mu\text{mol/s/m}^2$ @ 45 cm from panels in Array
Light Power max intensity	256 $\mu\text{mol/s/m}^2$ @ 60 cm from panels in Array

Light Spectra control	Manual with potentiometer
Light Power control	Manual with potentiometer
Electrical Power consumption	100 W – Maximum per panel

ALL VALUES ARE PRILIMINARY