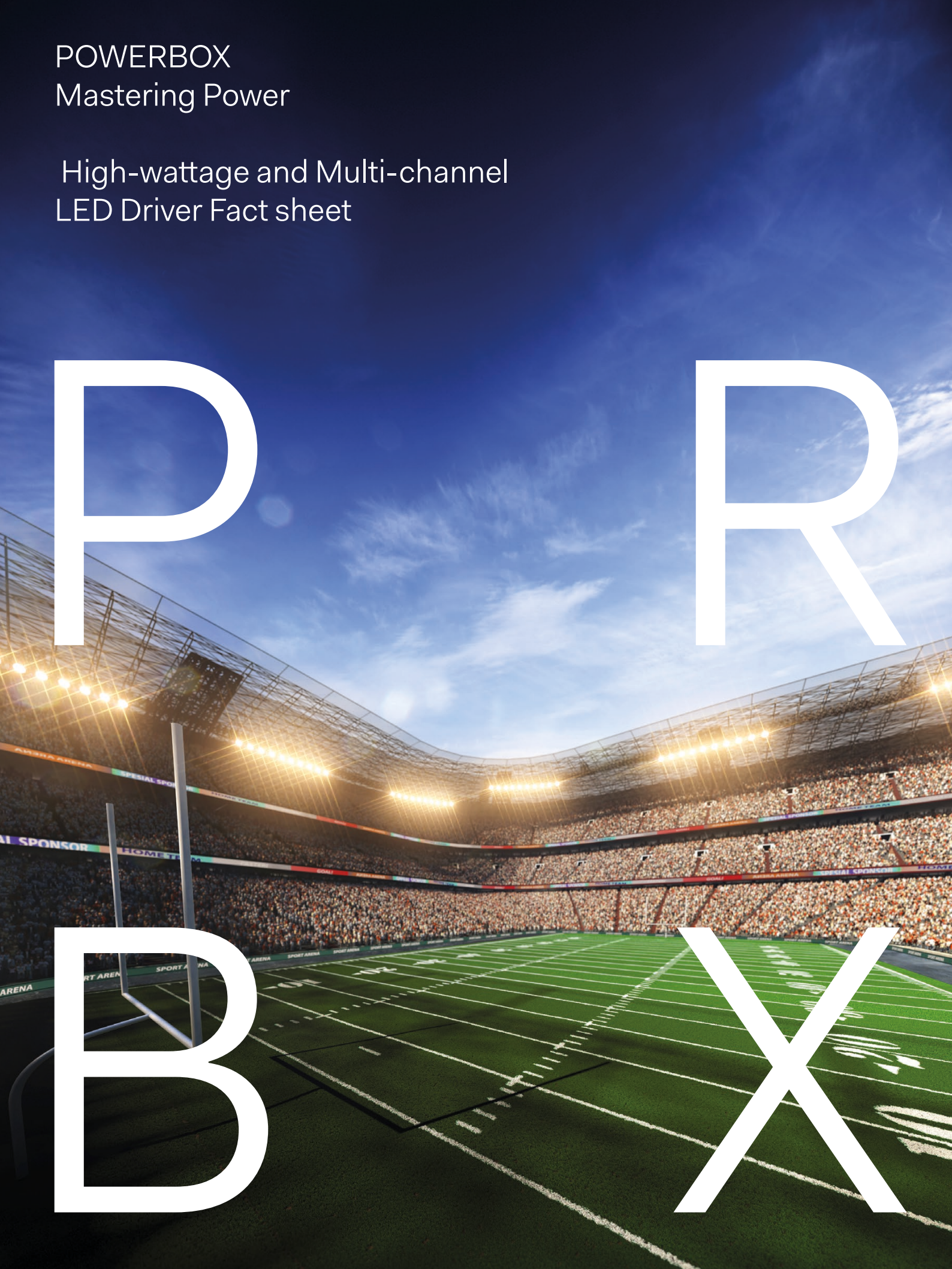
POWERBOX
Mastering Power

High-wattage and Multi-channel LED Driver Fact sheet



High-wattage and multi-channel LED driver fact sheet

Introduction
High wattage LEDs and light engines are required in UV curing, medical, stadium, stage, and plant grow light applications. In addition to the various AC input voltages, these applications typically require 400 – 1,200 watts of power as well as the requisite constant current (CC) output drive(s). Additionally, the supply, generally referred to as a "driver" in Solid State Lighting (SSL) applications, often needs to have multiple constant current output channels which need to be individually adjustable for color mixing or dimming, as required by the end application.

It is worth noting that the high power required by the SSL applications addressed by this fact sheet could also be implemented with a high wattage, constant voltage (CV) power supply followed by some number of CV to CC drivers. However, this type of implementation is simply replicating what an LED driver, of any wattage, is already doing resulting in increased complexity for the end application as well as increased costs as many of the functions of discrete LED control ICs can be easily implemented inside the CC driver. However, because of the relatively high currents involved, some applications, like high speed Visual Light Communications, will require a CV to CC architecture where the LED light is controlled and modulated in close proximity to the LED. Up to now, the CV to CC architecture has been used for high wattage SSL applications primarily because while there are large wattage CV supplies, heretofore, large wattage AC to CC drivers have simply not been available. Regardless, should the application require a large CV supply, most of the information in this fact sheet is still applicable and Powerbox can provide a cost effective CV to CC architectural solution as well.

This document is a very detailed, comprehensive but generic specification to highlight what may be required as well as what can easily be implemented in the requisite large wattage driver. This document details the broad requirements for these applications, and Powerbox's capabilities to deliver a proper solution where the driver is configured specifically for the actual LEDs being used as well as for the end application.

Format
This paper is written in a "specification format" to illustrate the requirements and make it easy to adopt to your specific requirements. Since the Devil is in the Details, this paper covers the minimum requirements of what a high-wattage and multi-channel LED driver should be designed to.

Specifications
Unless otherwise stated, specifications are at 25°C ambient, 100% load, and nominal line.

Additional Powerbox comments and explanations are preceded by "NOTE".

Input

Operating voltage
Typically 100 - 277 VAC +/-10%.

NOTE: 277VAC is used for large commercial lighting applications in the US. Household and small lighting applications typically use 115VAC. Industrial applications typically use 230VAC. Some applications may require higher AC input voltages like 208 (single or three phase), 354 (Canada's 277 equivalent), or even 380, 450, or 480 VAC. If the target market includes Japan, then the input has to go down to 90VAC.

Frequency
57 – 63 Hz.

NOTE: need operation down to 47Hz if the product is going outside of North America.

Input current
TBD maximum.

Inrush current
Typically 30A at 120 VAC and 60A at 230/277VAC, at cold start.

NOTE: the higher voltage installations are mostly immune from Inrush Currents but if the application has lots of lights operating off the same 277 and below branch circuit a lower inrush may be required.

Power Factor
0.90 minimum.

NOTE: utility companies will penalize end users for having a low power factor. However, a minimum power factor of 0.90 is usually more than enough. Higher power factors are doable as required.

Technically: Power factors below 1.0 require a utility to generate more than the minimum volt-amperes necessary to supply the real power (watts). This increases generation and transmission costs. For example, if the load power factor were as low as 0.7, the apparent power would be 1.4 times the real power used by the load. Line current in the circuit would also be 1.4 times the current required at 1.0 power factor, so the losses in the circuit would be doubled (since they are proportional to the square of the current).

Harmonic distortion
20% maximum.

NOTE: utility companies will penalize end users for having high harmonic distortion. IEEE 519-1992 defines levels of allowable harmonic currents and 20% is usually the limit for operating large power systems without a penalty. If a driver has a good power factor, having poor harmonic current distortion is generally not a problem as they are related.

Transient protection
Meets ANSI C62.41-1991 Category A, 2.5KV Ringwave
NOTE: outdoor and heavy industrial applications should go even higher. If you have multiple lights on the same branch circuit, add robust transient/surge protection on the branch circuit.

Efficiency
>85% with a 120 or 230/277 VAC input.

NOTE: low 90s is easily doable – it just costs more. However, for a lower costing 95-95% efficient driver, see the example at the end of the document.

Output

Total power
Typically 400 - 1,200 watts for these sort of applications.

LED drives
Generally constant current output(s) to directly drive the LEDs.

NOTE: could be one 400 - 600 watt drive or multiple and independent, smaller wattage drives or even two 600W drives.

Outputs
Whatever is required to properly support the application.

Examples of Powerbox high wattage drivers:

Driver #1
One 600W CC drive of 10.7A @ ~56VDC nominal drive.

Driver #2
Two 400W CC drives of 11.1A @ ~36VDC nominal drive.

Driver #3
A 600W, 6 channel driver as follows:

Channels 1 - 3: 3.0A CC @ ~40VDC nominal drive
Channels 4 & 5 4.0A CC @ ~28VDC nominal drive
Channel 6: 1.4A @ ~14.4VDC nominal drive
6 individual 12V/0.25A outputs for fan cooling the LEDs.

Accuracy
Iout setting typically accurate to +/-2.5%. NOTE: UV LEDs for curing applications may require 1% or lower accuracy.

Line regulation
Typically +/-2% maximum for a +/-10% change in AC line.

NOTE: UV curing applications may require 1% or lower regulation.

Temperature coefficient
Maximum of 0.15% per 1C.

Turn-on delay
Typically 2S maximum to 50% of Inom.

Ripple & Noise (R&N)
Typically 20% – 40% R&N, often called "flicker' in SSL in reference to the "flickering" of old fluorescent lamps. Regardless, by far, the primary component of R&N is the periodic deviations caused by the AC line frequency and that ripple will be 2X line frequency. The other periodic ripple will be caused by the driver's switching frequency, generally in the 40 - 200 KHz range, and it is typically in the range of 1-2%. In a "regular" power supply, R&N is referred to as PARD - Periodic and Random Deviations, which includes the random deviation factor which is generally not an issue in SSL.

NOTE: lower R&N is easily doable, it just costs more. One of the drivers referenced in the Outputs section was required to have an incredibly low 0.25% maximum R&N. Low R&N is easily achievable in a high wattage LED driver - it just costs more.

Dimming
Pulse Width Modulation (PWM) or linear dimming down to ~5% of Iout nominal.

NOTE: Efficiency and channel to channel current balance drops with dimming but it is typically not important as the light drops. PWM dimming can accurately go down to 1%. It is worth noting that using PWM to mix colors or change color temperature violates Philips' patents. Linear mixing does not. FYI: Philips' royalties are on the end product's selling price and are typically 2-5%.

Independent outputs
While a very large wattage driver can have a single CC output, it can also be configured to have multiple CC outputs and those outputs can be independent from each other. Those outputs can also be isolated from each other or non-isolated (cost less). Isolated outputs are generally not required in SSL applications. NOTE: this isolation is in reference to sharing a common control or return, not isolation from the AC line.

OVP protection
Outputs can have independent provision to ensure the output voltage never rises too much above the nominal drive voltage to protect the expensive LEDs in the rather rare event of a channel drive failure.

Short circuit protection
Output is not damaged with a continuous short circuit on the output(s) and will automatically recover when the fault is removed.

Fan power
Driver will typically have a 12V output to power fans to cool the LED engines and itself. Each fan power output is protected against a short circuit.

Controls and indicators

Internal fan
Driver provides power to a long life fan with its speed controlled by a NTC thermistor temperature sensor. When less cooling is required, the fan will run at a lower RPM to extend its operating life. The fan switches to a high RPM when the temperature reaches a predefined threshold to ensure that the driver always operates within its SOA.

NOTE: many of these are typically used in grow light applications.

LED fan
Driver provides power to external, fans with two speeds controlled by external temperature NTC thermistors, one for each LED light engine. Each of the fans will run at low RPMs when that light engine is cooler to extend the fan operating life. The fan goes to high RPMs when the LED light engine temperature reaches a predetermined temperature to ensure that the light engine always operates within its SOA (Safe Operating Area).

Over temperature protection

LED over-temperature
If a light engine reaches some predetermined “too hot” temperature, typically about 70C, even with its fan running at high speed, the driver will linearly reduce the LED drive current for that Light Engine and single wink all the LEDs as an early warning of an imminent fan failure or an LED over temperature condition. Single winking is defined as one ~0.2S offs occurring every ~2S. When the LED engine cools down the output will be automatically restored and the winking ceases.

If any Light Engine reaches some higher predetermined temperature, typically about 80C, the light engine shall be shut down.

Light engine outputs will automatically be restored after the temperature cools down below the threshold.

Driver over-temperature
If the LED driver operating temperature ever reaches a predetermine "too hot" point, even with its fan running at high speed, the driver will linearly reduce all LED output drive currents and double wink all the LEDs as an early warning of imminent fan failure or that the operating temperature exceeds the spec limit. Double winking is defined as two ~0.2S offs separated by ~0.5S occurring every ~2S.

If the LED driver internal temperature reaches some higher predetermined temperature exceeding its SOA, all light engine outputs are turned off.

When the driver cools down the outputs will be automatically restored.

Parallel alarms
The LED driver has an alarm interface. When two or more LED drivers are installed in a large wattage luminaire the alarm interfaces are connected together where an alarm in one driver is passed to the other causing both units to go into the same alarm mode where all LEDs are winking in unison.

Manual light control
Driver has an input for both external switches and an external potentiometer to reduce the LED operating current and the related light output on all channels. An input is provided for two switches to set the drive current to four predetermined levels, like 0%, 50%, 75%, and 100%.
An external 1K ohm potentiometer will vary the driver current from 0% to 100%, with the control area between 0% and ~10% being undefined. If nothing is connected to the External Light Control input, the drive currents automatically default to 100%. For the switches, current is reduced on switch closure and the switch interface is buffered and filtered to support operation on long twisted pair wiring.

When two or more LED drivers are installed in a large wattage luminaire the external light control lines are Remote Control: Driver may be equipped with various interfaces like 0-10, I2C, RS232/485, DMX, et cetera for remote control of the entire luminaire or individual channels as required.

TEST mode
Driver has an input for an external TEST switch where upon activation the driver will set all the LEDs at ~10% of nominal, and turn on all the fans at the lower speed for inspection and maintenance activities.

TEST diagnostics
The driver may be equipped with nonvolatile memory to record where the fan or cooling problem is. After the driver winks the LEDs to indicate that there is a cooling problem, which will most likely be a bad fan, the light is taken out of service. In the maintenance facility, a technician may plug a diagnostic tool into an I2C interface port on the TEST connector to read which fan may be bad and is in need or replacing and then clear memory after the fan is replaced.

Environmental, safety and compliance

Operating temperature
Typically 10°C (50°F) to 50°C (122°F) ambient with no derating for grow lights and factory applications. Outdoor lighting typically requires operation down to -25C or even -40C.

Storage temperature
-20C to +80C.

Operating humidity
10% to 100% RH.

Storage humidity
5% to 95% RH.

Isolation
Minimum of 1,500VAC, primary to secondary and primary to case, with reinforced/double insulation.

NOTE: a Class 1 luminaire does not need to have an isolated driver. See example towards the end of the document.

Leakage
Less than 1ma at 277VAC input.

Safety
There are a plethora of different safety standards to meet depending upon the end application. Typical safety approvals will be UL 1310 (for Class 2 outputs), UL60950 (An ITE standard but now a generic "catch-all"), UL60601 (medical), UL8750 (the new SSL standard), UL1598 (damp locations), UL844 or UL1604 (Hazardous locations). And a Class 1 driver might have UL1598. It is worth noting that above a nominal 277VAC operation there are no official UL safety standards for a driver but it can still be designed to meet the applicable portions of the closest standard.

NOTE: while the driver may have its own UL safety approval as a registered component the luminaire is generally required to be approved and listed as a device. It is more cost effective for Powerbox to do the approval on the actual luminaire.

Ground Bond
est Current meets whichever is higher: 1.5 X Rated Current for the supply or 25 A as the ground bonding current is passed between ground input and product case. The voltage drop across the ground bond is not to exceed 12 V.

Vibration
Withstands 5 – 50Hz at +/-7.35M/S8S on X, Y, and Z axis for 1 minute.

Ingress
As required depending on application and location.

Potting
Typically none on a large wattage driver.

Conformal coating
Typically these large wattage drivers are conformal coated to UL746 and UL94-V0 requirements. Humiseal IB73 or equivalent.

PCBs
Driver does not contain any Polychlorinated Biphenyl (PCB).

RoHs
Driver complies with European Directive 2002/95/EC for the elimination of lead and other hazardous substances.

MTBF
Minimum of TBD hours calculated per MIL-HDBK-217F at 50C operation. NOTE: a bigger number just costs more for using higher quality and/or derated components.

Life time
Minimum expected life of TBD hours at a 50C ambient operating temperature. NOTE: a longer life just costs more for using higher quality and/or derated components.

Warranty
Typically 2-3 years from date of receipt.

NOTE: longer just costs more for using higher quality and/or derated components.

Electromagnetic compatibility (typical)

NOTE, while the following are the key EMI (Electromagnetic Interference) requirements for SSL, depending on the end application, there are many more requirements.

Conducted and radiated
Meets FCC 47CFR Part 15, Class A (Industrial). NOTE: Class B is residential and if the product is going to Europe it will need the "EN" equivalent too.

Harmonic current
Meets EN 61000-3-3 requirements.

ESD
Meets EN 61000-4-2 with 4 KV air and 2KV contact discharge.

RF field susceptibility test
Designed to EN 61000-4-3.

Fast transient / burst
Designed to EN 61000-4-4.

AC surge/transient immunity
Meets ANSI C62.41-1991 Category A1.

NOTE: as noted earlier, outdoor and heavy industrial applications should go even higher.

Conducted RF disturbance
Designed to EN 61000-4-6.

Power frequency magnetic field
Designed to EN 61000-4-8.

AC voltage dips
Designed to EN 61000-4-11.

Electromagnetic immunity
Designed to EN 61547, Lighting Equipment.

Mechanical

There is a wide variety of electrical interfaces required on a high power LED driver. This section details some of the more common ones along with some packaging issues.

Package
A high power LED driver is typically an open frame PCB or enclosed power supply mounted in customer's luminaire. However, to get the heat and size out of the luminaire and to facilitate maintenance activities and a low MTTR (Mean Time To Repair), as LEDs last forever but the drivers don't, the driver can also be constructed as an external, stand-alone package that simply plugs into the luminaire. That also gets the safety approval requirements out of the luminaire.

Size
TBD.

Weight
TBD.

AC input connector
As required but there is a big variety. Often this is a low-cost, 3 pin Molex MiniFit Jr.

Channel connectors
As required but often a Molex MiniFit Jr.

NOTE: Very high amperage LEDs will need something more robust.

Fan connectors
Big variety here too but it is worth noting that the light engine fans may be connected through the light engine connectors which simplifies construction.

External light control
4 pin connector, Molex Microfit or equivalent.

Test
6 pin connector, Molex Microfit or equivalent.

NOTE: the TEST connector also contains the interface for paralleling the alarms, see Par. 5.4.

Part number
TBD.

Labeling
TBD. Label material to meet UL935 requirements.

Development

Test data
Powerbox shall provide test data with the engineering prototypes showing the serial number of the unit and all tests that were performed documenting conformance to this Product Specification. Any deviation or non-compliance shall be highlighted for discussion with and approval by Customer.

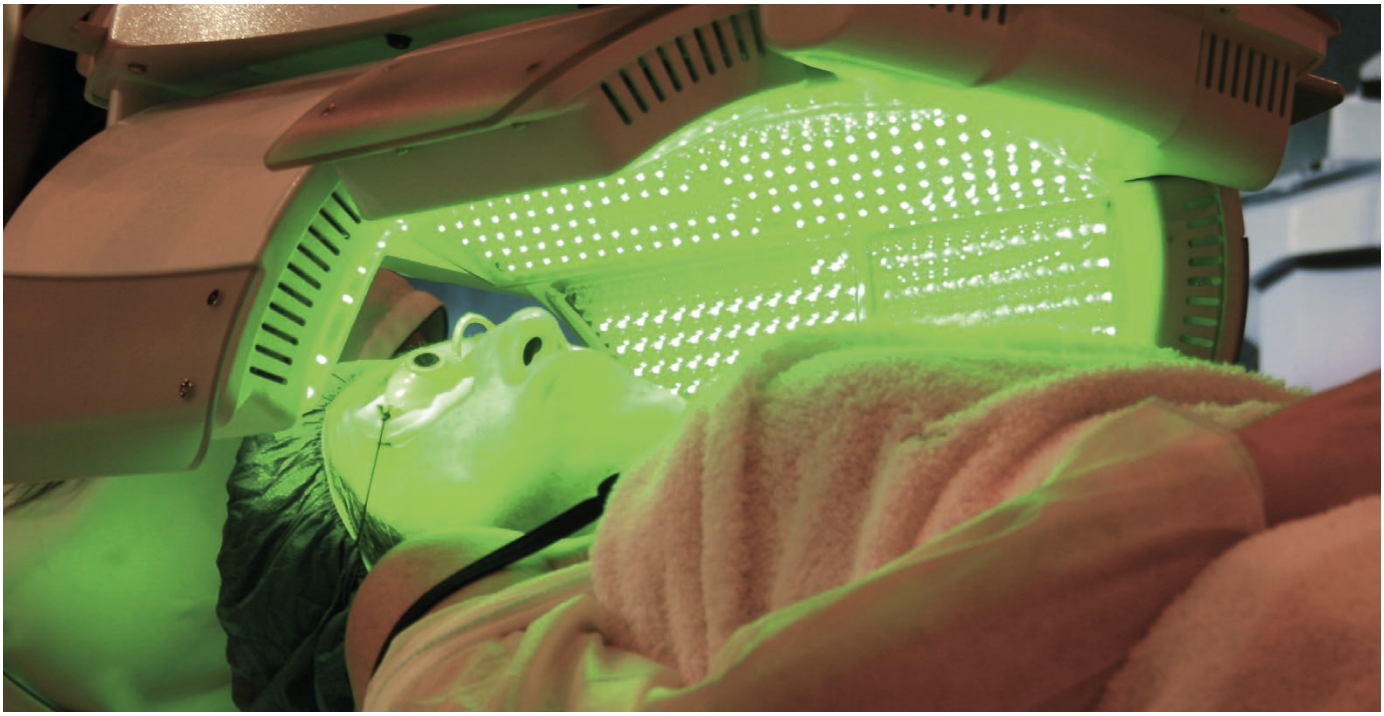
First article approval
Customer shall test, evaluate and approve first article "alpha" engineering protoypes according to this document. Customer must provide acceptance of protoypes in writing, along with any changes, modifications or corrective actions, before Powerbox can proceed to build production units. Should any changes or corrections be required, Customer can request a "beta" prototype, prior to production units, to assure deficiencies have been corrected. First article samples shall comply with all aspects of this specification but do not have formal agency approvals.

Documentation
Powerbox shall provide to Customer in electronic form complete and accurate product documentation, including testing and a wiring diagram, not later than at the time the initial prototypes are delivered to Customer. In addition, Powerbox shall provide Customer with copies of all safety and compliance documentation and certifications upon their availability.

Product change
After initial first article approval is granted by Customer, there shall be no design, process or material changes which impact form, fit, function, reliability or agency compliance without written approval from Customer prior to implementation. Any change to form, fit, or function, regardless of the effects on the specified parameters, requested by Powerbox will require prior written approval by Customer. Powerbox requested changes shall be accompanied by a reproducible set of documentation, which fully describes the change. Customer directed changes may require new first article samples for evaluation at additional costs.

Revision control
Any change affecting form, fit, function or regulatory agency approval shall cause a next level revision of the assigned part number.

Manufacturing



Burn in
Supplies shall be burned in prior to final testing. Any supply that fails final testing shall be repaired and subsequently burned in again prior to final testing. After first 1,000 supplies have been tested and yield determined the burn-in may be reduced on approval by Customer.

Labeling
Drivers shall be private labeled under a trade name or P/N to be designated by Customer and exclusive to Customer.

Manufacturing yield
Upon maturity, as defined by 12 months of operation of a minimum of 10,000 units, the total failure rate for the power supply will not exceed 0.10% (1000 PPM).

Failure analysis
Powerbox will track and accumulate all failures on product. Analysis will be completed to the component level where applicable.

Corrective action
Powerbox will replace all non-conforming parts with corrected units. Customer to contact Powerbox for a Return Merchandise Authorization (RMA) prior to returning any units.

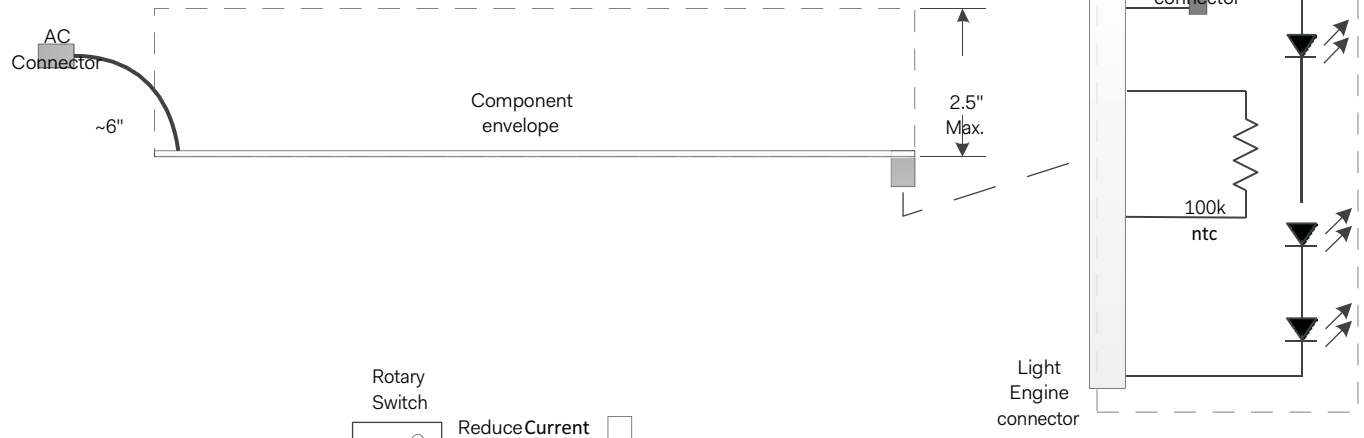
Packaging
Packaging shall be provided to prevent physical damage to the Product and to maintain it in the manufactured condition under handling and transportation environments. All materials used for this packaging shall be non-corrosive to all contained materials. Individual drivers are in a box with some TBD number in a carton. Boxes and cartons shall be labeled in a way designated by Customer. Powerbox shall provide Customer with templates for the labels and all packaging not less than 60 days prior to the date of anticipated product shipment, and Customer shall provide the final artwork to Powerbox not less than 30 days prior to the date of anticipated product shipment.

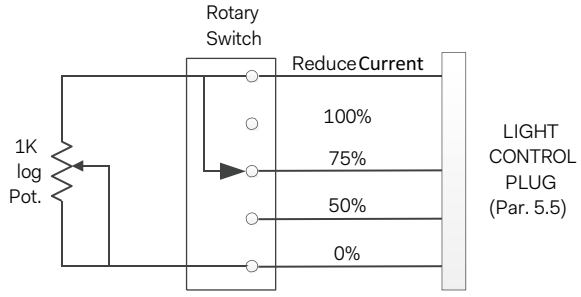
ESD protection
Each Product shall be protected from ESD. The material used for ESD protection shall not cause any contamination of its contents.

Shipping
Depending on volume, the Product shall be packed in cartons, on pallets, or bulk containers and shipped in accordance with the best commercial practices.

Mechanical drawing

There is a wide variety here too but this is an example of one 600W, multi-channel driver.



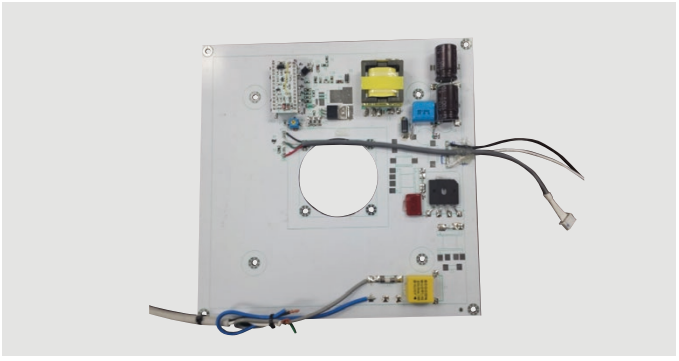


NOTE: Linear and step dimming shown. Only one is used. Rotary switch may be replaced by a SPST switch for only one light level reduction.

95% Efficient class 1 LED driver (patent pending)

An actual 120W implementation. A 600W one is not much bigger.

The hole is for a fan to cool the LEDs, not the driver, which can be safely mounted over the LEDs.



- → 95% Efficient, Low Cost, Non-isolated Driver. Efficiency is slightly higher with a single AC input
- → 90 – 305 or 250 – 528 VAC, 47~440 Hz, versions
- → >0.9 power factor
- → Instant start (<40mS)
- → Very low in-rush current (~2X normal steady state current)
- → Robust AC transient protection
- → Very small implementation with package styles as required
- → Simple cooling requirements – no fan or big heatsinks required at 600W!
- → Operation to 85C ambient at full load with no derating
- → 0-10V or ELV type phase control dimming options available
- → LED thermal feedback to keep LED in SOA option
- → 5 Year Warranty standard; optional 10 year warranty

This is the driver for LED based Troffers, High-bays, Street and Flood Lights, Stadium lights, Canopy and Parking Lot Lights, Horticultural Grow Lights, and other high power LED luminaire applications where very high efficiency is important for the customer's ROI.

About Powerbox

Who we are
The combination of our extensive standard product range, our custom design capability, and our service offering, is truly unique. 40+ years of designing power supplies for demanding applications has built a rock solid experience. Our "Making the complex simple" business idea runs throughout our operation, from our customer interface and cooperation to how we design our products.

Improving your competitiveness
The power solution chosen for any electronics has an impact on competitiveness. Function and reliability are given basics. Size, weight and audible noise might be important. Cost is always a consideration. Standards fulfillment can open up new markets. Time to market might be critical. Well executed supply chain management can generate savings. Aftermarket support has a lasting long term impact. The list goes on.

Our extensive experience and market awareness makes it simple to explain to us what you need. Together we define which power solution will serve your application the best. This close cooperation continues from conception and design, throughout production and taking into operation, well into the aftermarket phases of your product life-cycle. We contribute to your competitiveness all the way.

Making the complex simple
With our global presence we are close to you, and our knowledge and experience of working with so many different applications helps to make life easier for you. We can assist at all stages of product development, including evaluations, validations, and the writing of specifications.

We aim for simplicity in design, referring both to lean design with fewer components and to a modular approach reusing proven circuits and building blocks, maybe with some modifications.

Our services for logistics, implementation and aftermarket support makes life simpler both for you and for your customers, and our endurance makes sure it stays that way.

Quality assurance and follow-up
Quality is an integrated part of everything we do. Our design process includes extensive testing, internal as well as external. Tests are also frequently run by our customers in their respective applications. In addition to the information we gain by tracking repairs and service requests, we also do regular quality follow up together with our customers, all to ensure a long and trouble-free life for our products.
Powerbox is also certified by DNV according to ISO 9001:2008.

Manufacturing
We manufacture at selected CEMs (Contract Equipment Manufacturer), where we apply rigorous process and quality requirements. We aim for long-term relationship with our manufacturing partners. A dedicated team for CEM Management and Quality Assurance work closely with them. Both when selecting a new partner and in the ongoing relationship with our existing partners we evaluate a large number of parameters, covering company profile, organization, manufacturing processes, and quality assurance.

Caring for the environment
At Powerbox we take an active role in protecting our environment. Our contribution includes:
Streamlined solutions and lean design using fewer components reduces material used. RoHS, WEEE and REACH are among the standards governing choice of materials.

High efficiency reduces energy consumption both directly by reducing losses and indirectly by reducing the need for cooling.

Energy efficient transportation and well developed use of online meetings are important elements in our determination to meet or exceed international standards by sustaining ISO-14001 compliance or the equivalent.

Providing peace of mind
Even the best designed power solutions might require midlife support. Components involved in the design might be discontinued, or the application might be modified or changed, requiring changes in the power solution. In situations like this Powerbox' stability and endurance, and long term approach to customer relations, are true comforts.

Our offices

POWERBOX Sweden (HQ)

Västra Storgatan 22
Box 148
646 22 Gnesta
Sweden

Phone: + 46 158 703 00 (main switchboard)
Phone: + 46 158 703 10 (sales)
Fax: + 46 158 703 20
Email: info.se@prbx.com

POWERBOX Australia

Sydney Head Office
4 Beaumont Rd
Mount Kuring Gai
NSW 2080 Australia

Phone: + 61 2 9457 2200
Fax: + 61 2 9457 2255
Email: sales@powerbox.com.au

POWERBOX Benelux

Boschstraat 34
4811 GH Breda
The Netherlands

Phone: + 31 76 501 58 56
Fax: + 31 76 501 58 17
Email: info.nl@prbx.com

POWERBOX China

Room 1604
No.579 QianJin Road
Kunshan Development Zone
JiangSu province
China, 215300

Phone: + 86-512-57720011
Fax: + 86-512-57720119
Email: info.cn@prbx.com

POWERBOX Denmark

Hovedgaden 45, 1
2970 Hørsholm
Denmark

Phone: + 45 45 93 42 00
Email: info.dk@prbx.com

POWERBOX Finland

Lemminkäisenkatu 20
FIN-20520 Turku
Finland

Phone: + 358 2 273 6100
Fax: + 358 2 273 6120
Email: info.fi@prbx.com

POWERBOX France

Immeuble Le Newton
Bâtiment C
7 Mail Thimonnier
77 185 LOGNES
France

Phone: + 33 (0)1 64 11 43 43
Phone: (toll free) 0810 810 607
Fax: + 33 (0)1 64 11 43 44
Email: info.fr@prbx.com

POWERBOX Germany

Karlsstr. 23
33161 Hövelhof
Germany

Phone: +49 5257 949 25 90
Fax: +49 5257 949 25 99
Email: info.de@prbx.com

POWERBOX Italy

Via Mascagni 42
20030 Senago (MI)
Italy

Telephone: + 39 02 998 88 45
Fax: + 39 02 998 64 45
Email: info.it@prbx.com

POWERBOX Israel

13 Ha'taas St
Kfar-Saba 4442513
Eshkol-House
P.O.Box # 2122
Israel

Switchboard +972-9-7676767
Fax +972-9-7650081
Email: info.il@prbx.com

POWERBOX New Zealand

P.O Box 300 479
Albany, Auckland, New Zealand
0752

Phone: + 64 9 4158320
Fax: + 64 9 4159780
Email: sales@powerbox.co.nz

POWERBOX Norway

Grini Naeringspark 12
N-1361 Østerås
Norway

Phone: + 47 67 16 44 00
Fax: + 47 67 16 44 01
Email: info.no@prbx.com

POWERBOX Spain

Barcelona Office
Av. Mare de Déu de Bellvitge nº 3,
2A Edificio Hesperia
08907 Hospitalet del Llobregat
Barcelona
Spain

Phone: + 34 93 2969080
Fax: + 34 93 2965850
Email: info.es@prbx.com

Madrid Office
C/ Angelita Cavero 13, Oficinas 1º
28037 Madrid
Spain

Phone: + 34 91 3260436
Fax: + 34 93 2965850
Email: info.es@prbx.com

POWERBOX United Kingdom

Knights Court
Magellan Close
Andover
Hampshire
SP10 5NT
United Kingdom

Phone: +44 1264 337 800
Fax: + 44 1264 334 337
Email: info.uk@prbx.com

POWERBOX North America

1 Tara Boulevard
Suite 200
Nashua, NH 03062
USA

Phone: +1 (603) 324-7195
Fax: +1 (603) 324-7101
Email: info.us@prbx.com

www.prbx.com