



Tri-Mode Dimming (0-10 V & TRIAC/ELV) Constant Current LED Drivers with Fast Startup Time

| Input Voltage | Max. Output Power | Output Voltage | Output Current | Efficiency | Max. Case Temperature | THD | Power Factor | Dimming Method | Dimming Range | Startup Time |
|-----------------------|-------------------|----------------|--------------------|---------------|---------------------------------|-------|--------------|--|----------------------|--------------|
| 90 to 305 Vac maximum | 60 W | 21 to 56 Vdc | 700 mA to 1.4 A CC | ≥ 87% typical | 90°C (measured at the hot spot) | < 20% | > 0.9 | Forward-Phase, Reverse-Phase & 0 - 10V | 1 - 100% (% of lout) | 300 ms |

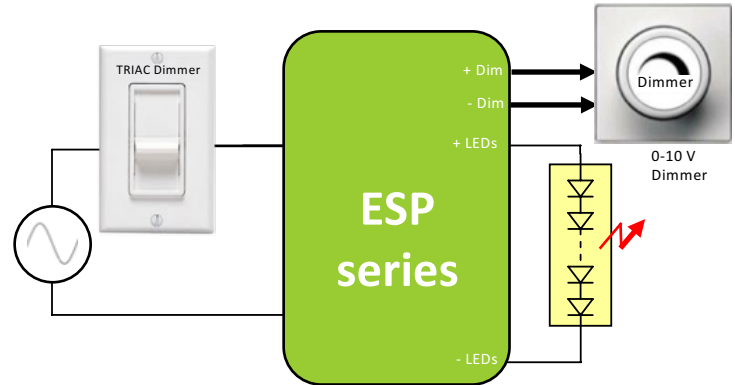
CC: Constant Current

PRODUCT DESCRIPTION

The ESP series of LED drivers is ideally suited for LED lighting applications in office, commercial and residential. These devices are compatible with most industry standard phase-cut wall-based dimmers, both forward-phase (leading-edge) and reverse-phase (trailing edge), and 0-10V wall-based dimmers and offer deep dimming from 100% down to 1%.

FEATURES

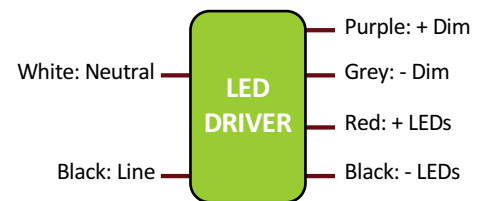
- Compatible with TRIAC (forward-phase or leading-edge) / ELV (reverse-phase or trailing-edge) and 0-10 V dimmers
- Forward-phase and reverse-phase dimming only at 120 Vac
- Linear 0-10V dimming transfer function: 10V=100%, 1V=10%, 0.1V=1%
- Lifetime: 103,500 hours at 70° C case hot spot temperature (54.3° C ambient temperature) for ESP040W-0700-56 (39.2 W)
- Protections: output open load, over-current and short-circuit (hiccup), and over-temperature with auto recovery
- Conducted and radiated EMI: Compliant with FCC CFR Title 47 Part 15 Class B (120 Vac)/Class A (277 Vac) and EN55015 (CISPR 15) at 220/230/240 Vac
- Enables ENERGY STAR® and DLC (DesignLight Consortium®) luminaire compliance
- IP64-rated case with silicone-based potting
- 90° C maximum case hot spot temperature
- Class 2 power supply
- Double-insulated power supply between input and output (class II)
- Worldwide safety approvals



TYPICAL APPLICATION DIAGRAM



PLASTIC CASE:
L 90 x W 60 x H 27.2mm
(L 3.54 x W 2.36 x H 1.07 in)



WIRING DIAGRAM

APPLICATIONS

- Recessed lighting (downlights)
- Commercial & Residential lighting
- Architectural lighting





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I - INPUT SPECIFICATION (@25° C ambient temperature)

| | Units | Minimum | Typical | Maximum | Notes |
|---|---|---------|-------------------------|--|---|
| Input Voltage Range (Vin) | Vac | 90 | 120/220/230/ 240/277 | 305 | The rated output current for each model is achieved at Vin ≥ 108 Vac and at Vin ≥ 198 Vac, at nominal load. |
| Input Frequency Range | Hz | 47 | 60 | 63 | |
| Power Factor (PF) | | 0.9 | > 0.9 | | At nominal input voltage and with nominal LED voltage |
| Inrush Current | Meets NEMA-410 requirements | | | | At any point on the sine wave and 25°C |
| Leakage Current | µA | | | 250 µA @ 120 Vac 500 µA @ 230 Vac 600 µA @ 277 Vac | Measured per IEC60950-1 |
| Input Harmonics | Complies with IEC61000-3-2 for Class C equipment | | | | |
| Total Harmonics Distortion (THD) | | | | 20% | <ul style="list-style-type: none"> • At nominal input voltage and nominal LED voltage • Complies with DLC (DesignLight Consortium) technical requirements |
| Efficiency | % | - | 87% | - | Measured with nominal input voltage, a full sinusoidal wave form and without dimmer connected |
| Isolation | Meets UL60950-1 for class II reinforced/double insulation power supply <input type="checkbox"/> | | | | |

2 - OUTPUT SPECIFICATION (@25° C ambient temperature)

| | Units | Minimum | Typical | Maximum | Notes |
|----------------------------------|--|---------|---------|---------|---|
| Output Voltage (Vout) | Vdc | 21 | | 56 | See ordering information for details |
| Output Current (Iout) | mA | 700 | | 1400 | <ul style="list-style-type: none"> • See ordering information for details • The rated output current for each model is achieved at Vin ≥ 108 Vac and at Vin ≥ 198 Vac, at nominal load. |
| Output Current Regulation | % | -5 | ±2.5 | 5 | <ul style="list-style-type: none"> • At nominal AC line voltage • Includes load and current set point variations |
| Output Current Overshoot | % | - | - | 10 | The driver does not operate outside of the regulation requirements for more than 500 ms during power on with nominal LED load and without dimmer. |
| Ripple Current | ≤ 33% of rated output current for each model | | | | <ul style="list-style-type: none"> • Measured at nominal LED voltage and nominal input voltage without dimming. • Calculated in accordance with the IES Lighting Handbook, 9th edition. |
| Dimming Range (% of Iout) | % | 1 | | 100 | The dimming range will be dependent on each specific dimmer. |
| Start-up Time | ms | | 300 | | With nominal LED voltage and without dimmer attached |
| | | | 400 | | With nominal LED voltage, with an approved dimmer attached (see list of approved dimmers in page 6) and at the full dimming conduction angle |

Output Controls

| | |
|---------------------------------|---|
| +Dim Signal, -Dim Signal | The +Dim/-Dim signal pins can be used to adjust the output setting via a standard commercial wall dimmer, an external control voltage source (0 to 10 Vdc), or a variable resistor when using the recommended number of LEDs. The dimming input permits 1% to 100% dimming. |
|---------------------------------|---|



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3 - ENVIRONMENTAL CONDITIONS

| | Units | Minimum | Typical | Maximum | Notes |
|--|---|---------|---------|---------|---|
| Operating Case Temperature (Tc) | °C | -30 | | +90 | Case temperature measured at the hot spot •tc (see label in page 11) |
| Storage Temperature | °C | -40 | | +85 | |
| Humidity | % | 5 | - | 95 | Non-condensing |
| Cooling | Convection cooled | | | | |
| Acoustic Noise | dBA | | | 22 | Measured at a distance of 1 foot (30 cm) without and with approved dimmers |
| Mechanical Shock Protection | per EN60068-2-27 | | | | |
| Vibration Protection | per EN60068-2-6 & EN60068-2-64 | | | | |
| MTBF | > 300,000 hours when operated at nominal input and output conditions, and at Tc ≤ 70°C | | | | |
| Lifetime (See graphs "Lifetime vs. Case and Ambient Temperature" in section 6) | <ul style="list-style-type: none"> •95,500 hours at Tc = 70°C (Tambient = 36.3°C) for ESP060W-1400-42 (58.8 W) •103,500 hours at Tc = 70°C (Tambient = 54.3°C) for ESP040W-0700-56 (39.2 W) •Measured at the hot spot (see hot spot •tc on label in page 11) | | | | |

4 - EMC COMPLIANCE AND SAFETY

| EMC Compliance | | |
|---|--|--|
| Conducted and Radiated EMI | <ul style="list-style-type: none"> •FCC CFR Title 47 Part 15 Class B at 120 Vac and Class A at 277 Vac, •EN55015 (CISPR 15) compliant at 220/230/240 Vac | |
| Harmonic Current Emissions | IEC61000-3-2 For Class C equipment | |
| Voltage Fluctuations & Flicker | IEC61000-3-3 | |
| Immunity Compliance | ESD (Electrostatic Discharge) | IEC61000-4-2 6 kV contact discharge, 8 kV air discharge, level 3 |
| | RF Electromagnetic Field Susceptibility | IEC61000-4-3 3 V/m, 80 - 1000 MHz, 80% modulated at a distance of 3 meters |
| | Electrical Fast Transient | IEC61000-4-4 ± 2 kV on AC power port for 1 minute, ±1 kV on signal/control lines |
| | Surge | IEC61000-4-5 ± 1 kV line to line (differential mode) / ± 2 kV line to common mode ground (tested to secondary ground) on AC power port, ±0.5 kV for outdoor cables |
| | Conducted RF Disturbances | IEC61000-4-6 3 V, 0.15-80 MHz, 80% modulated |
| | Voltage Dips | IEC61000-4-11 >95% dip, 0.5 period; 30% dip, 25 periods; 95% reduction, 250 periods |
| Transient Protection | Ring Wave ANSI/IEEE c62.41.1-2002 & c62.41.2-2002 category A, 2.5 kV ring wave | |

Safety Agency Approvals

| | | |
|------------|---|----------------------|
| UL | UL8750 recognized | UL60950-1 recognized |
| cUL | CSA C22.2 60950-1 | |
| CE | IEC61347-2-13 electronic control gear for LED Modules | |

Safety

| | Units | Minimum | Typical | Maximum | Notes |
|--|-------|---------|---------|---------|---|
| Hi Pot (High Potential) or Dielectric voltage-withstand | Vdc | 4242 | | | <ul style="list-style-type: none"> •Insulation between the input (AC line and Neutral) and the output •Tested at the RMS voltage equivalent of 3000 Vac |



ENERGY RECOVERY PRODUCTS™



ESP040

30-40 W

ESP050

41-50 W

ESP060

51-60 W

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■ 5 - PROTECTION FEATURES

Under-Voltage (Brownout)

The ESP series provides protection circuitry such that an application of an input voltage below the minimum stated in paragraph 1 (Input Specification) shall not cause damage to the driver.

Short Circuit

The ESP series is protected against short-circuit such that a short from any output to return shall not result in a fire hazard or shock hazard. The driver shall hiccup as a result of a short circuit or over current fault. Removal of the fault will return the driver to within normal operation. The driver shall recover, with no damage, from a short across the output for an indefinite period of time.

Internal Over temperature Protection

The ESP series incorporates circuitry that prevents internal damage due to an over temperature condition. An over temperature condition may be a result of an excessive ambient temperature or as a result of an internal failure. When the over temperature condition is removed, the driver shall automatically recover.

Output Open Load

When the LED load is removed, the output voltage of the ESP series is limited to 1.3 times the maximum output voltage of each model.



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6 - PREDICTED LIFETIME VERSUS CASE AND AMBIENT TEMPERATURE

Lifetime is defined by the measurement of the temperatures of all the electrolytic capacitors whose failure would affect light output under the nominal LED load and worst case AC line voltage. The graphs in figure 1 are determined by the electrolytic capacitor with the shortest lifetime, among all electrolytic capacitors. It represents a worst case scenario in which the LED driver is powered 24 hours/day, 7 days/week. The lifetime of an electrolytic capacitor is measured when any of the following changes in performance are observed:

- 1) Capacitance changes more than 20% of initial value
- 2) Dissipation Factor ($\tan \delta$): 150% or less of initial specified value
- 3) Equivalent Series Resistance (ESR): 150% or less of initial specified value
- 4) Leakage current: less of initial specified value

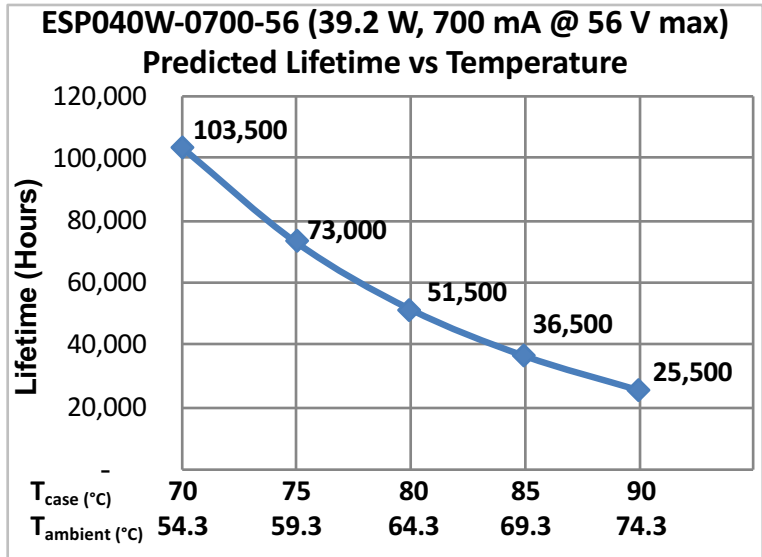
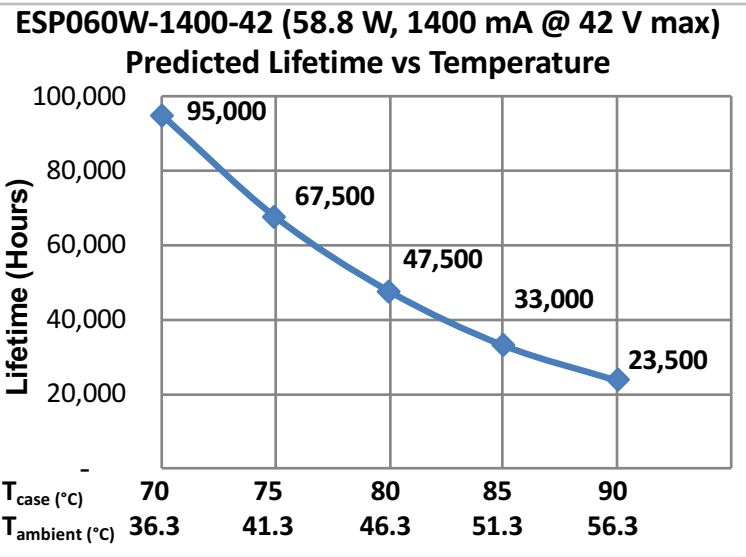


Figure 1

Notes:

- The ambient temperature $T_{ambient}$ and the differential between $T_{ambient}$ and T_{case} mentioned in the above graphs are relevant only as long as both the driver and the light fixture are exposed to the same ambient room temperature. If the LED driver is housed in an enclosure or covered by insulation material, then the ambient room temperature is no longer valid. In this situation, please refer only to the case temperature T_{case} .
- It should be noted the graph “Lifetime vs. Ambient Temperature” may have an error induced in the final application if the mounting has restricted convection flow around the case. For applications where this is evident, the actual case temperature measured at the T_c point in the application should be used for reliability calculations.



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7 - PHASE-CUT DIMMING

Dimming of the driver is possible with standard TRIAC-based incandescent dimmers that chop the AC voltage as shown in Figure 2, or with ELV dimmers. During the rapid rise time of the AC voltage when the dimmer turns on, the driver does not generate any voltage or current oscillations, and inrush current is controlled. During the on-time of the AC input, the driver regulates the output current based upon the conduction angle. The RMS value of the driver output current is proportional to the on-time of the AC input voltage. When operating with an incandescent dimmer, the RMS output current varies depending upon the conduction angle and RMS value of the applied AC input voltage. Figure 3 shows the typical output current versus conduction angle at nominal input voltage.

Forward-phase (TRIAC) and reverse-phase (ELV) dimming are working only at 120 Vac.

The ESP series offers dual dimming compatibility with both phase-cut (reverse-phase and forward-phase) and 0–10V dimmers. Phase-cut dimming always has priority over 0-10 V dimming.

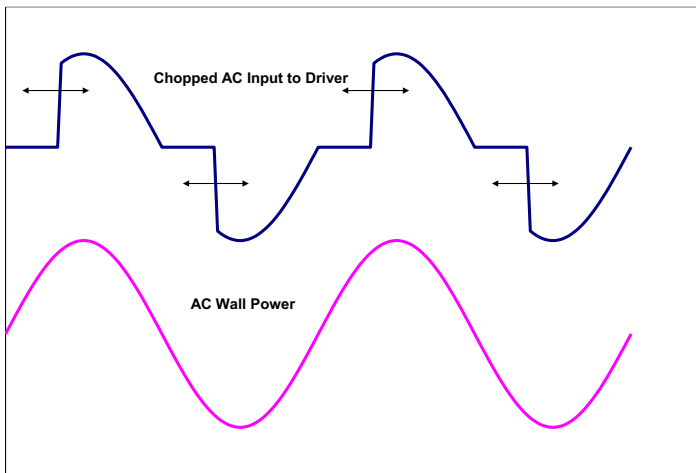


Figure 2

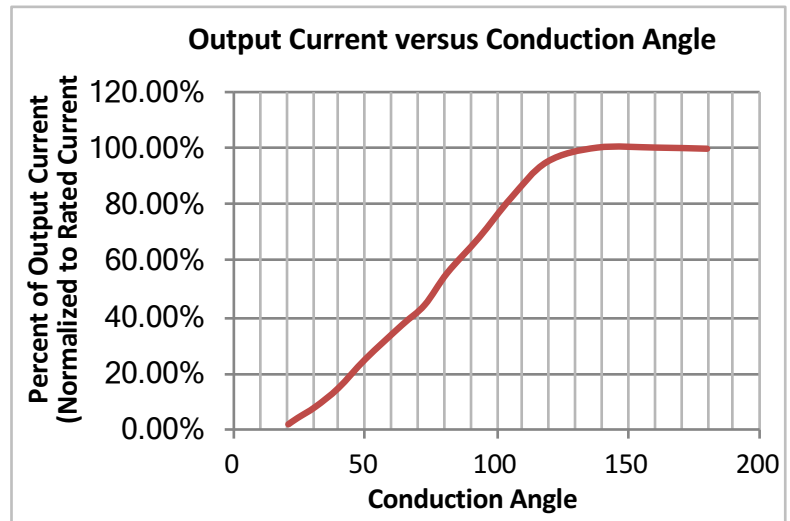


Figure 3

8 - COMPATIBLE PHASE-CUT DIMMERS & DIMMING RANGE

| 120Vac Dimmers | | | | | |
|----------------|-----------|---------|------------|------------|-----------|
| Mfg. | Model | Mfg. | Model | Mfg. | Model |
| Lutron | S-603PG | Lutron | DVELV-303P | Lutron | CT-103P |
| Leviton | IPI06-1LZ | Lutron | SELV-300P | Cooper | SLC03P |
| Leviton | 6631-2 | Leviton | 6683-IW | Leviton | IPE04 |
| Lutron | DVCL-153P | Leviton | 6161 | Lutron | MAELV-600 |
| Lutron | DV-600P | Leviton | 6633-P | Lutron | FAELV-500 |
| Lutron | TGCL-153P | Lutron | TG-600P | Lightolier | ZP260QEW |
| Lutron | S-600P | Cooper | DLC03P | Cooper | DAL06P |
| Leviton | VPE06 | Lutron | LG-600P | | |

Dimming compatibility charts are available for each model in the ESP series. Please contact your sales representative or send an email to: SaveEnergy@ERPpowerllc.com.



Tri-Mode Dimming (0-10 V & TRIAC/ELV) Constant Current LED Drivers with Fast Startup Time

9 - 0-10 V DIMMING

The ESP drivers operate only with 0-10V dimmers that sink current. They are not designed to operate with 0-10V control systems that source current, as used in theatrical/entertainment systems. Developed in the 1980's, the 0-10V sinking current control method is adopted by the International Electrotechnical Commission (IEC) as part of their IEC Standard 60929 Annex E.

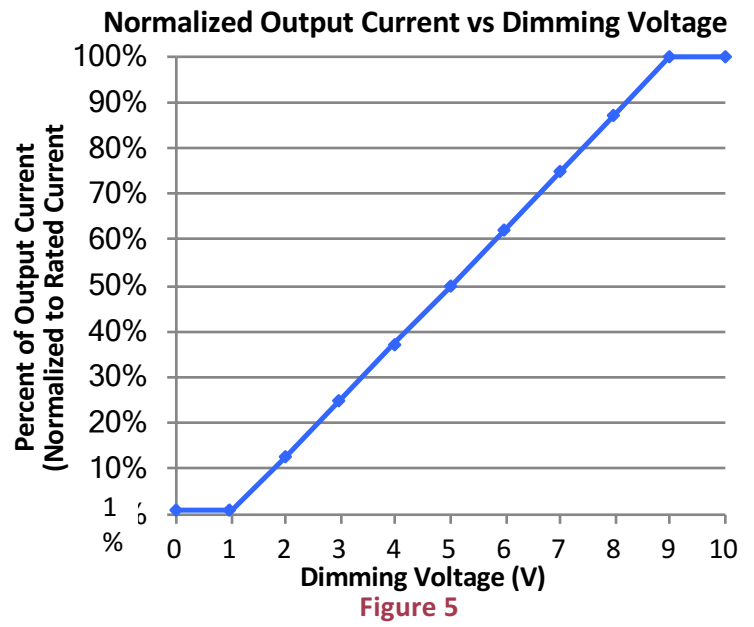
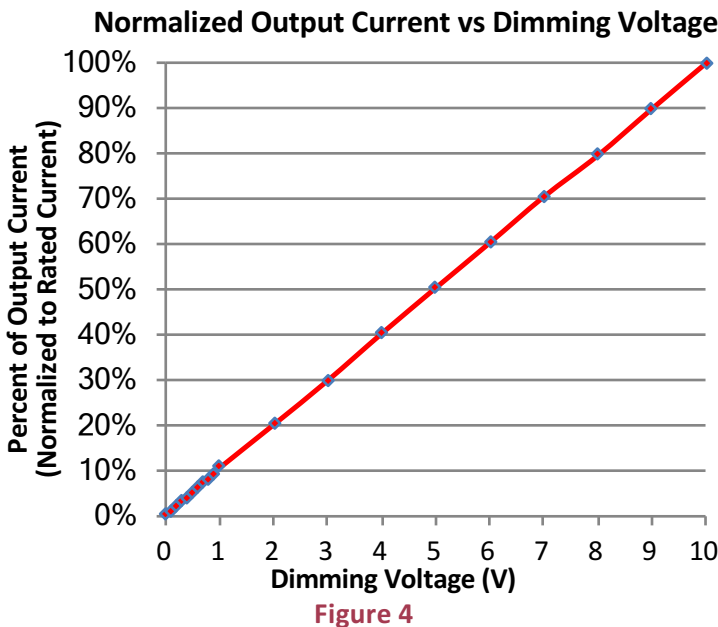
The method to dim the output current of the driver is done via the +Dim/-Dim Signal pins. The +Dim/-Dim Signal pins respond to a 0 to 10 V signal, delivering 1% to 100% of the output current based on rated current for each model. A pull-up resistor is included internal to the driver. When the +Dim input (purple) is short circuited to the -Dim wire (grey) or to the -LED wire (black), there is no output current. When the +Dim input (purple) is ≤ 1 V, the output current is programmed to $\leq 10\%$ of rated current. If the +Dim input is >10 V or open circuited, the output current is programmed to 100% of the rated current.

When not used, the -Dim wire (grey) and to the +Dim wire (purple) can be individually capped or cut off. In this configuration, no dimming is possible and the driver delivers 100% of its rated output current.

The maximum source current (flowing from the driver to the 0-10V dimmer) supplied by the +Dim Signal pin is < 1 mA. The tolerance of the output current while being dimmed shall be $\pm 8\%$ typical until down to 2V.

There are two 0-10V dimming transfer functions available, a linear curve where 10V = 100% of the output current and 1V = 10% of the output current (seen in figure 4) or a non-linear curve where the 9V = 100% of the output current and 1V = 1% of the output current (seen in figure 5). The linear curve is used across all the models of the ESP series. The non-linear curve is available as an option.

The non-linear curve is recommended when using standard in wall 0-10V logarithmic dimmers to avoid having insufficient source current available to pull the dimmer up to 10V and to account for the inability of the dimmer to pull below approximately 0.9V. In these types of installations, the modified transfer function will ensure 100% light output and dimming to 1%, regardless of the number of drivers on the 0-10V dimming line. Please contact your sales representative or send an email to SaveEnergy@ERPPowerLLC.com for additional information on the non-linear curve.





Tri-Mode Dimming (0-10 V & TRIAC/ELV) Constant Current LED Drivers with Fast Startup Time

9 - 0-10 V DIMMING (CONTINUED)

A fixed or variable resistor can be also used from the +Dim signal pin to the –Dim pin to adjust the output current. Figure 6 show the relationship of the output current to a resistor connected across the 0-10V dimming input.

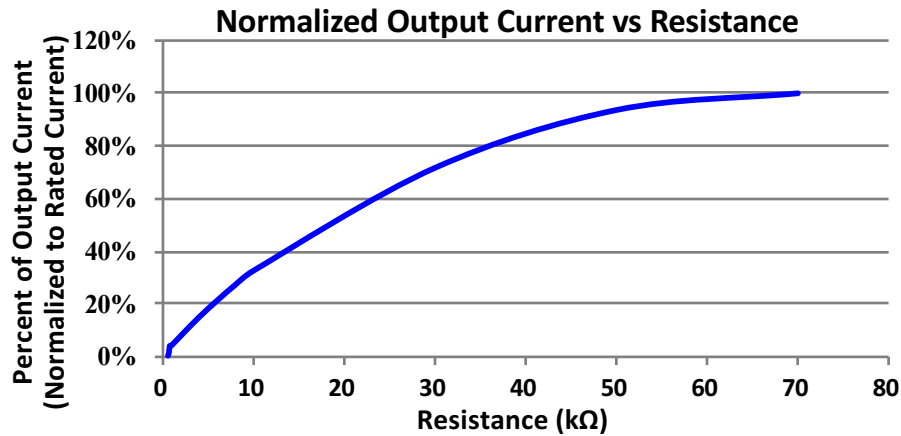


Figure 6

10 - COMPATIBLE 0-10 V DIMMERS

- Lutron, Nova series (part number NFTV)
- Lutron, Diva series (part number DVTV)
- Leviton, IllumaTech series (part number IP710-DL)



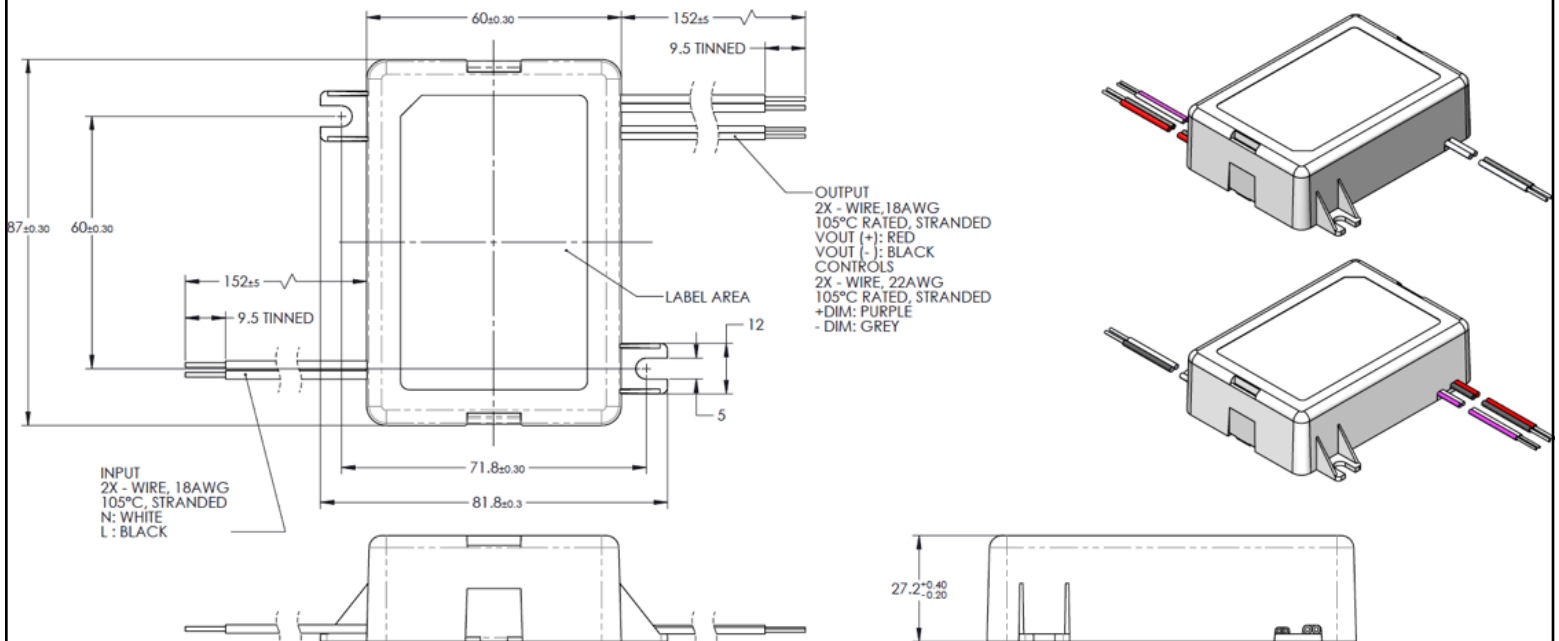
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11 - MECHANICAL DETAILS

- Packaging Options:** Plastic case
- I/O Connections:** Flying leads, 18 AWG on power leads, 22 AWG on 0-10V dimming wires, 152 mm (6 in) long, 105°C rated, stranded, stripped by approximately 9.5mm and tinned. All the wires, on both input and output, have a 300 V insulation rating.
- Ingress Protection:** IP64 rated
- Flammability Rating:** UL94 V-0 (5VA available upon request. Please contact your sales representative or send an email to: SaveEnergy@ERPpowerLLC.com).
- Mounting Instructions:** The ESP driver case must be secured on a flat surface through the two mounting feet, shown here below in the case outline drawings. Instead of using the two plastic feet, the ESP driver case can also be mounted by using two metal clips, one on each short side. The ordering part number for the two metal clips is ESP-CLIPS.

12 - OUTLINE DRAWINGS

- Dimensions:** L 87 x W 60 x H 27.2 mm (L 3.43 x W 2.36 x H 1.07 in)
- Volume:** 141.9 cm³ (8.66 in³)
- Weight:** 222 g (7.8 oz)



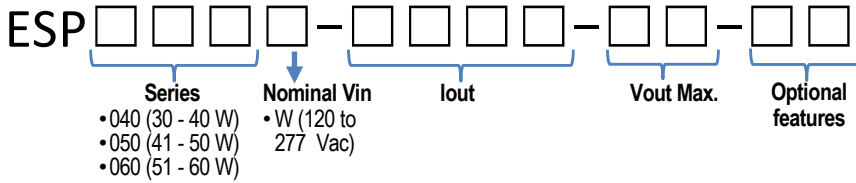
All dimensions are in mm

Figure 7



Tri-Mode Dimming (0-10 V & TRIAC/ELV) Constant Current LED Drivers with Fast Startup Time

13 - ORDERING INFORMATION - MODEL DESCRIPTION



| | ERP Part Number | Nominal Input Voltage (Vac) | Iout (mA) | Max Output Power (W) | Vout Min (Vdc) | Vout Nom (Vdc) | Vout Max (Vdc) | No Load Voltage (Vdc) | Comments |
|-----------------------------------|--------------------------------------|-----------------------------|-----------|----------------------|----------------|----------------|----------------|-----------------------|--|
| 120-277 VAC NOMINAL INPUT VOLTAGE | ESP040W: 30-40W | | | | | | | | |
| | ESP040W-0700-56 | 120 - 277 | 700 | 39.2 | 40 | 50.4 | 56 | 60 | |
| | ESP040W-0800-42 | 120 - 277 | 800 | 33.6 | 28 | 37.8 | 42 | 50 | |
| | ESP040W-0850-42 | 120 - 277 | 850 | 35.7 | 28 | 37.8 | 42 | 50 | |
| | ESP040W-0900-42 | 120 - 277 | 900 | 37.8 | 28 | 37.8 | 42 | 50 | |
| | ESP040W-0940-33-SS-F1 ^[1] | 120 - 277 | 940 | 31.0 | 28 | 29.7 | 33 | 42.9 | Customized 0-10V dimming profile (10V=100%, 1V=5%) and Dim-to-Off function (Iout=0 when 0-10V dimming wires are shorted) |
| | ESP040W-0940-43 | 120 - 277 | 940 | 40.4 | 35 | 38.7 | 43 | 50 | |
| | ESP050W: 41-50W | | | | | | | | |
| | ESP050W-1050-42 | 120 - 277 | 1050 | 44.1 | 28 | 37.8 | 42 | 50 | |
| | ESP050W-1200-42 | 120 - 277 | 1200 | 50.4 | 28 | 37.8 | 42 | 50 | |
| | ESP050W-1400-32 | 120 - 277 | 1400 | 44.8 | 21 | 28.8 | 32 | 41.6 | |
| | ESP050W-1400-34 | 120 - 277 | 1400 | 47.6 | 23 | 30.6 | 34 | 44.2 | |
| | ESP060W: 51-60W | | | | | | | | |
| ESP060W-1400-42 | 120 - 277 | 1400 | 58.8 | 28 | 37.8 | 42 | 50 | | |
| 220-240 VAC NOMINAL INPUT | ESP040E: 30 to 40 W | | | | | | | | |
| | ESP040E-0800-42 | 220/230/240 | 800 | 33.6 | 28 | 37.8 | 42 | 50 | |
| | ESP040E-0850-42 | 220/230/240 | 850 | 35.7 | 28 | 37.8 | 42 | 50 | |
| | ESP040E-0900-42 | 220/230/240 | 900 | 37.8 | 28 | 37.8 | 42 | 50 | |
| | ESP050E: 41 to 50 W | | | | | | | | |
| | ESP050E-1050-42 | 220/230/240 | 1050 | 44.1 | 28 | 37.8 | 42 | 50 | |
| | ESP050E-1200-42 | 220/230/240 | 1200 | 50.4 | 28 | 37.8 | 42 | 50 | |
| | ESP060E: 51 to 60 W | | | | | | | | |
| | ESP060E-1400-42 | 220/230/240 | 1400 | 58.8 | 28 | 37.8 | 42 | 50 | |

Notes:

- 1) The ESP040W-0940-33-SS-F1 is specifically intended to drive the Cree LMH2 3000 sunset module and exhibits a customized 0-10V dimming transfer function. It will not work with any other LED or LED string.
- 2) For additional options of output current and output voltage, contact your sales representative or send an email to: SaveEnergy@ERPPowerLLC.com
- 3) The ESP driver case can also be mounted by using two metal clips, one on each short side. The ordering part number for the two metal clips is ESP-CLIPS. By default, the ESP driver is shipped without metal clips. When metal clips are required, add ESP-CLIPS to your order.



ENERGY RECOVERY PRODUCTS™



ESP040
ESP050
ESP060

30-40 W
41-50 W
51-60 W

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I4 - LABELING

The ESP050W-1050-42 is used in figure 8 as an example to illustrate a typical label.

Top Side

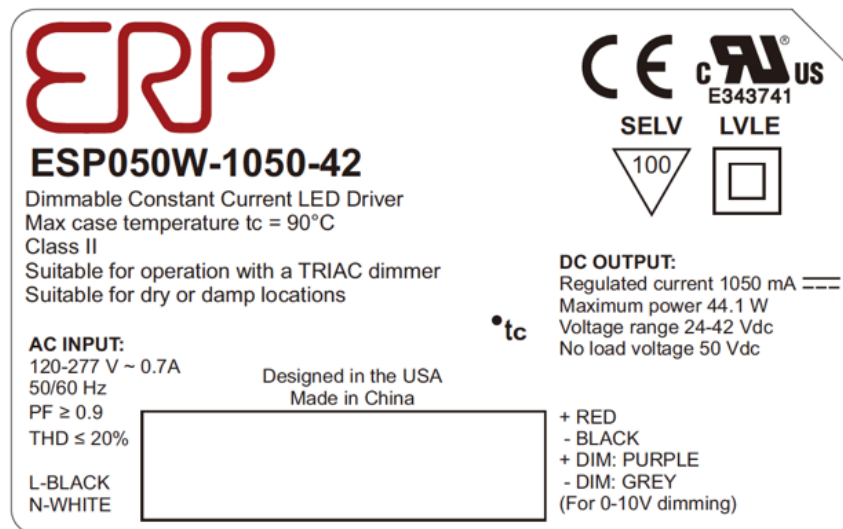


Figure 8

USA Headquarters

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Fax: +1-805-517-1411
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Moorpark, CA 93021, USA

CHINA Operations

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Fax: +86-756-6266299
No. 8 Pingdong Road 2
Zhuhai, Guangdong, China 519060

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