Features

- Independent Three Output Channels
- Independent Three Dimming Channels
- 135W Channel Power Transfer (Optional)
- Hot-plugging Protection
- LED Parallel Protection
- Ultra High Efficiency (Up to 95%)
- Full Power at Wide Output Current Range (Constant Power)
- Adjustable Output Current (AOC)with Programmability
- Isolated 0-10V/PWM/Resistor/3-Timer-Modes Dimmable
- Adjustable Dimming Curve
- INV Digital Dimming, UART Based Communication Protocol
- Dim-to-Off
- Hold Time Adjustable
- Fade Time Adjustable
- Always-on Auxiliary Power: 12Vdc, 250mA
- Low Inrush Current
- Output Lumen Compensation
- End-of-Life Indicator
- Input Surge Protection: DM 6kV, CM 10kV
- All-Around Protection: IOVP, IUVP, OVP, SCP, OTP
- IP66/IP67 and UL Dry/Damp/Wet Location
- TYPE HL, for Use in a Class I, Division 2 Hazardous (Classified) Location
- 5 Years Warranty

Description

The *ESM-1K2TxxxMx* series is a 1200W, 3-channel, constant-current, programmable and IP66/IP67 rated LED driver that operates from 249-528Vac input with excellent power factor. This driver can support 3-channel luminaires to adjust current separately. It provides an auxiliary voltage and dim-to-off functionality for powering low voltage, wireless controls. The dimming control supports 0-10V dimming as well as two-way communication via Digital Dimming, a UART based communication protocol. The high efficiency of these drivers and compact metal case enables them to run cooler, significantly improving reliability and extending product life. To ensure trouble-free operation, protection is provided against input surge, input under voltage, input over voltage, output over voltage, short circuit, and over temperature.

Models

Channel	Adjustable Output Current Range(A)	Full-Power Current Range(A)(1)	Default Output Current(A)	Output Voltage Range(Vdc)	Max. Output Power(W)	Typical Efficiency(2)	Typical Power Factor		Model Number(3)(4)
							277Vac	480Vac	
1	0.46-5.7	4.6-5.7	5.7	81-202	930	95.0%	0.99	0.96	ESM-1K2T570Mx
2	0.185-2.1	1.85-2.1	1.85	45-73	135				
3	0.185-2.1	1.85-2.1	1.85	45-73	135				

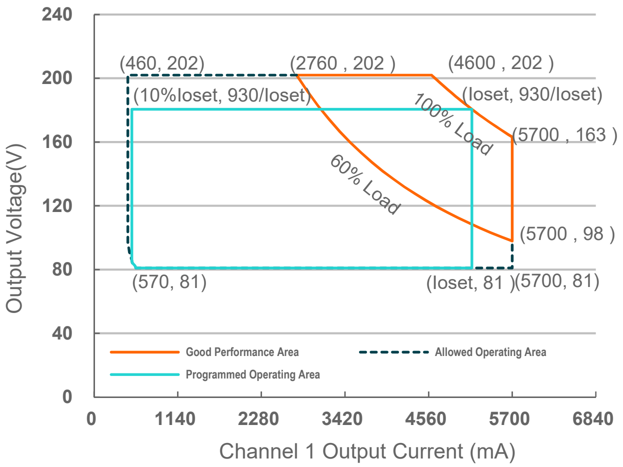
Notes: (1) Output current range with constant power at 1200W.
(2) Measured at 100% load and 480Vac input (see below "General Specifications" for details).
(3) Certified input voltage range: 277-480Vac;
(4) x = G are UL recognized, ENEC, etc. models; x = T are UL recognized, etc. models.

● Power Transfer Combination

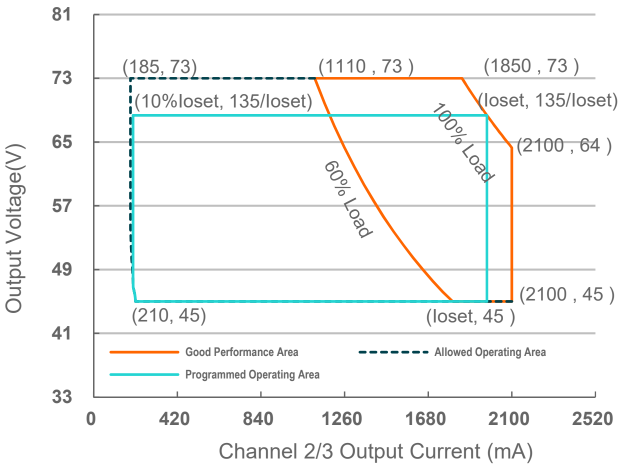
Channel	Adjustable Output Current Range(A)	Full-Power Current Range(A)(1)	Default Output Current (A)	Output Voltage Range (Vdc)	Max. Output Power (W)	Typical Efficiency(2)	Notes
1	0.46-5.7	4.6-5.7	5.7	81-202	930	95.0%	Default mode
2	0.185-2.1	1.85-2.1	1.85	45-73	135		
3	0.185-2.1	1.85-2.1	1.85	45-73	135		
1	0.53-6.5	5.3-6.5	6.5	81-202	1065	95.0%	When CH2 is dimmed to off, the power can be transferred to channel 1 by setting Inventronics Programing software.
2	-	-	-	-	-		
3	0.185-2.1	1.85-2.1	1.85	45-73	135		
1	0.53-6.5	5.3-6.5	6.5	81-202	1065	95.0%	When CH3 is dimmed to off, the power can be transferred to channel 1 by setting Inventronics Programing software.
2	0.185-2.1	1.85-2.1	1.85	45-73	135		
3	-	-	-	-	-		
1	0.59-7.4	5.9-7.4	7.4	81-202	1200	95.0%	When CH2 and CH3 are dimmed to off, the power can be transferred to channel 1 by setting Inventronics Programing software.
2	-	-	-	-	-		
3	-	-	-	-	-		

Notes: (1) Output current range with constant power at 1200W.
(2) Measured at 100% load, default output current and 480Vac input.

I-V Operating Area



Note : 4600mA≤Ioset≤5700mA



Note : 1850mA≤Ioset≤2100mA

Input Specifications

Parameter	Min.	Typ.	Max.	Notes
Input AC Voltage	249 Vac	-	528 Vac	
Input DC Voltage	352 Vdc	-	500 Vdc	
Input Frequency	47 Hz	-	63 Hz	

Input Specifications (Continued)

Parameter	Min.	Typ.	Max.	Notes
Leakage Current	-	-	0.75 MIU	UL 8750; 480Vac/60Hz, grounding effectively
			0.70 mA	IEC 60598-1; 480Vac/60Hz, grounding effectively
Input AC Current	-	-	5.18 A	Measured at 100% load and 277 Vac input.
	-	-	2.98 A	Measured at 100% load and 480 Vac input.
Inrush Current(I^2t)	-	-	1.26 A^2s	At 480Vac input, 25℃ cold start, duration=41.8 ms, 10%Ipk-10%Ipk.
PF	0.90	-	-	At 277-480Vac, 50-60Hz, 60%-100% Load (720-1200W)
THD	-	-	20%	

Output Specifications

Parameter	Min.	Typ.	Max.	Notes
Output Current Tolerance	-5%Ioset	-	5%Ioset	100% load
Output Current Setting(Ioset Range) CH1 CH2 CH3	 460 mA 185 mA 185 mA	 - - -	 5700 mA 2100 mA 2100 mA	
Output Current Setting Range with Constant Power CH1 CH2 CH3	 4600 mA 1850 mA 1850 mA	 - - -	 5700 mA 2100 mA 2100 mA	
Total Output Current Ripple (pk-pk)	-	5%Iomax	10%Iomax	100% load, 20 MHz BW
Output Current Ripple at < 200 Hz (pk-pk)	-	2%Iomax	-	70%-100% load
Startup Overshoot Current	-	-	10%Iomax	100% load
No Load Output Voltage CH1 CH2 CH3	 - - -	 - - -	 230 V 85 V 85 V	
Line Regulation	-	-	±0.5%	100% load
Load Regulation	-	-	±3.0%	
Turn-on Delay Time	-	-	0.5 s	Measured at 277-480Vac input, 60%-100% Load
Temperature Coefficient of Ioset	-	0.03%/°C	-	Case temperature = 0°C ~Tc max
12V Auxiliary Output Voltage	10.8 V	12 V	13.2 V	
12V Auxiliary Output Source Current	0 mA	-	250 mA	Return terminal is “Dim−“
12V Auxiliary Output Transient Peak Current@ 6W	-	-	500 mA	500mA peak for a maximum duration of 2.2ms in a 6.0ms period during which time the average should not exceed 250mA.
12V Auxiliary Output Transient Peak Current@ 10W	-	-	850 mA	850mA peak for a maximum duration of 1.3ms in a 5.2ms period during which time the average should not exceed 250mA.

Note: The three Independent channels cannot be connected to each other, otherwise the driver will not work properly or even be damaged.

General Specifications

Parameter	Min.	Typ.	Max.	Notes
Efficiency at 277 Vac input: CH1+CH2+CH3 Io= (4600+1850+1850) mA Io= (5700+2100+2100) mA	91.5% 91.5%	93.5% 93.5%	- -	Measured at 100% load and steady-state temperature in 25°C ambient; (Efficiency will be about 2.0% lower if measured immediately after startup.)
Efficiency at 400 Vac input: CH1+CH2+CH3 Io= (4600+1850+1850) mA Io= (5700+2100+2100) mA	92.5% 92.5%	94.5% 94.5%	- -	Measured at 100% load and steady-state temperature in 25°C ambient; (Efficiency will be about 2.0% lower if measured immediately after startup.)
Efficiency at 480 Vac input: CH1+CH2+CH3 Io= (4600+1850+1850) mA Io= (5700+2100+2100) mA	93.0% 93.0%	95.0% 95.0%	- -	Measured at 100% load and steady-state temperature in 25°C ambient; (Efficiency will be about 2.0% lower if measured immediately after startup.)
Standby Power	-	1.5 W		Measured at 480Vac/50Hz; Dimming off
MTBF	-	204,000 Hours	-	Measured at 480Vac input, 80%Load and 25°C ambient temperature (MIL-HDBK-217F)
Lifetime	-	120,000 Hours	-	Measured at 480Vac input, 80%Load and 70°C case temperature; See lifetime vs. Tc curve for the details
	-	57,000 Hours	-	Measured at 277Vac input, 100%Load and 40°C ambient temperature
Operating Case Temperature for Safety Tc_s	-40°C	-	+90°C	
Operating Case Temperature for Warranty Tc_w	-40°C	-	+80°C	Case temperature for 5 years warranty Humidity: 10%RH to 95%RH
Storage Temperature	-40°C	-	+85°C	Humidity: 5%RH to 95%RH
Dimensions Inches (L × W × H) Millimeters (L × W × H)	13.94 × 5.67 × 1.91 354 × 144 × 48.5			With mounting ear 14.92 × 5.67 × 1.91 379 × 144 × 48.5
Net Weight	-	4900 g	-	

Dimming Specifications

Parameter		Min.	Typ.	Max.	Notes
Absolute Maximum Voltage on the Vdim (+) Pin		-20 V	-	20 V	
Source Current on Vdim (+)Pin		90 uA	100 uA	110 uA	Vdim(+) = 0 V
Dimming Output Range with 10%-100%	CH1 CH2 CH3	10%Ioset	-	Ioset	4600 mA ≤ Ioset ≤ 5700 mA 1850 mA ≤ Ioset ≤ 2100 mA 1850 mA ≤ Ioset ≤ 2100 mA
	CH1 CH2 CH3	460 mA 185 mA 185 mA	-	Ioset	460 mA ≤ Ioset ≤ 4600 mA 185 mA ≤ Ioset ≤ 1850 mA 185 mA ≤ Ioset ≤ 1850 mA
Recommended Dimming Input Range		0 V	-	10 V	Default 0-10V dimming mode.
Dim off Voltage		0.35 V	0.5 V	0.65 V	
Dim on Voltage		0.55 V	0.7 V	0.85 V	
Hysteresis		-	0.2 V	-	

Dimming Specifications (Continued)

Parameter	Min.	Typ.	Max.	Notes
PWM_in High Level	3 V	-	10 V	Dimming mode set to PWM in Inventronics Programing Software.
PWM_in Low Level	-0.3 V	-	0.6 V	
PWM_in Frequency Range	200 Hz	-	3 KHz	
PWM_in Duty Cycle	1%	-	99%	
PWM Dimming off (Positive Logic)	3%	5%	8%	
PWM Dimming on (Positive Logic)	5%	7%	10%	
PWM Dimming off (Negative Logic)	92%	95%	97%	
PWM Dimming on (Negative Logic)	90%	93%	95%	
Hysteresis	-	2%	-	

Safety &EMC Compliance

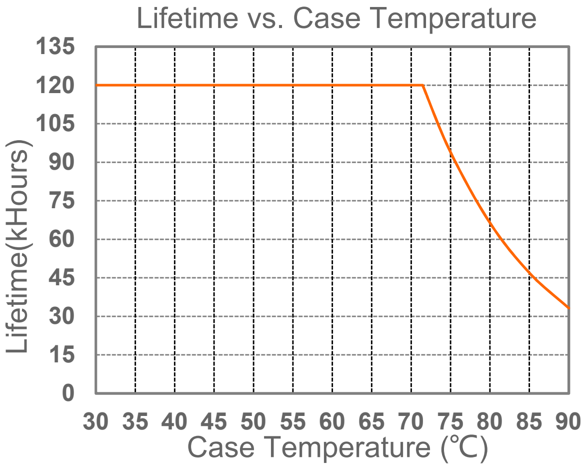
Safety Category	Standard
UL/CUL	UL 8750,CAN/CSA-C22.2 No. 250.13
ENEC & CE	EN 61347-1, EN 61347-2-13
UKCA	BS EN 61347-1, BS EN 61347-2-13
CB	IEC 61347-1, IEC 61347-2-13
Performance	**Standard**
ENEC	EN 62384
EMI Standards	**Notes**
BS EN/EN IEC 55015(1)	Conducted emission Test &Radiated emission Test
BS EN/EN IEC 61000-3-2	Harmonic current emissions
BS EN/EN 61000-3-3	Voltage fluctuations & flicker
FCC Part 15(1)	ANSI C63.4 Class B
	This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: [1] this device may not cause harmful interference, and [2] this device must accept any interference received, including interference that may cause undesired Operation.
EMS Standards	**Notes**
BS EN/EN 61000-4-2	Electrostatic Discharge (ESD): 8 kV air discharge, 4 kV contact discharge
BS EN/EN 61000-4-3	Radio-Frequency Electromagnetic Field Susceptibility Test-RS
BS EN/EN 61000-4-4	Electrical Fast Transient / Burst-EFT
BS EN/EN 61000-4-5	Surge Immunity Test: AC Power Line: Differential Mode 6 kV, Common Mode 10 kV
BS EN/EN 61000-4-6	Conducted Radio Frequency Disturbances Test-CS

Safety &EMC Compliance (Continued)

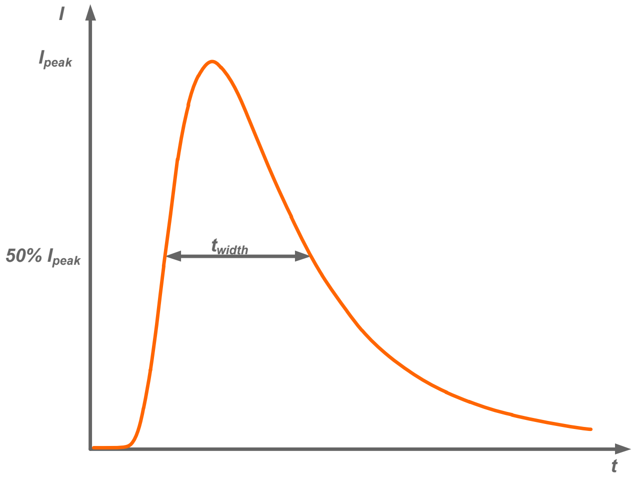
EMS Standards	Notes
BS EN/EN 61000-4-8	Power Frequency Magnetic Field Test
BS EN/EN 61000-4-11	Voltage Dips
BS EN/EN 61547	Electromagnetic Immunity Requirements Applies To Lighting Equipment

Note: (1) This LED driver meets the EMI specifications above, but EMI performance of a luminaire that contains it depends also on the other devices connected to the driver and on the fixture itself.

Lifetime vs. Case Temperature

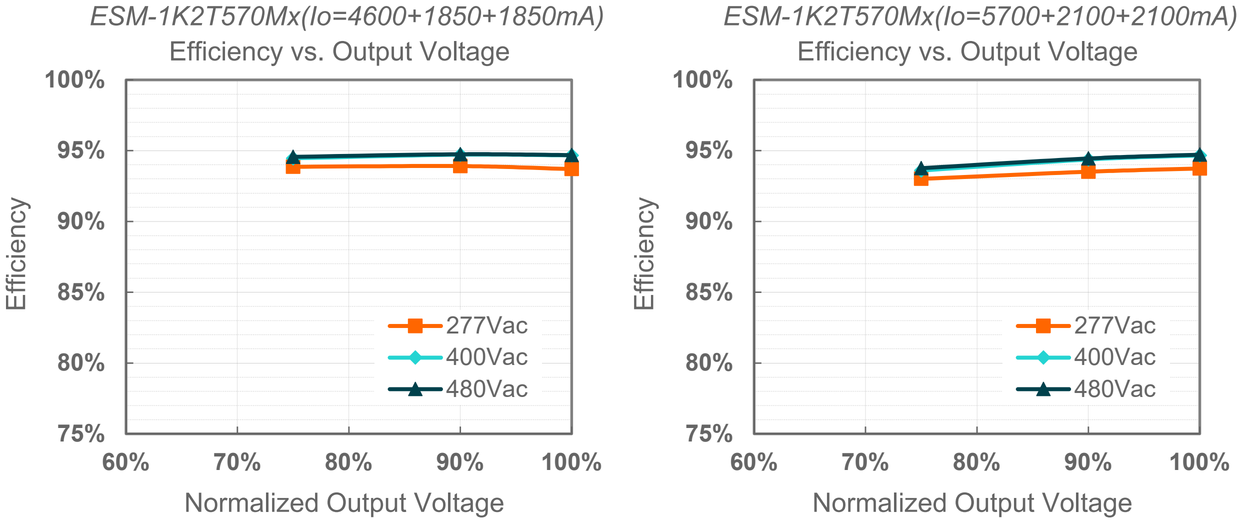


Inrush Current Waveform

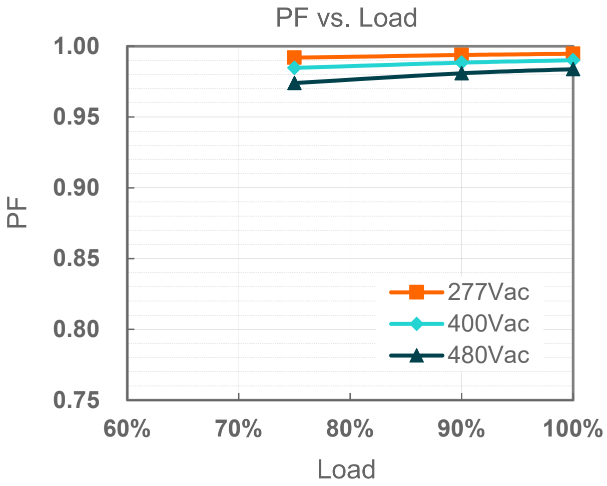


Input AC Voltage	I_{peak}	t_{width} (@ 50% Ipeak)
480V	6.35A	11.8ms

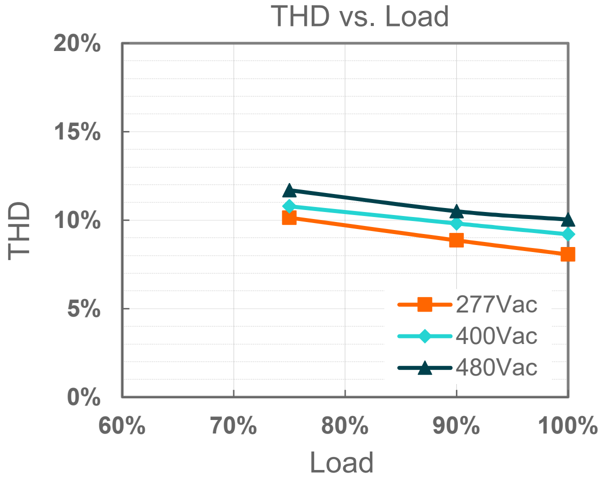
Efficiency vs. Load



Power Factor

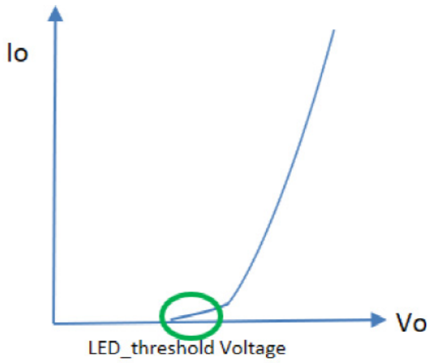


Total Harmonic Distortion



Hot-plugging Protection

This feature protects LEDs when connecting to a driver that is already powered on. This is disabled by default and can be enabled through the Inventronics Programing software.



LED threshold voltage (Vth) is the minimum voltage required for current to flow through the LED load. After this threshold is met, the LED forward voltage (Vf) increases as the current increases.

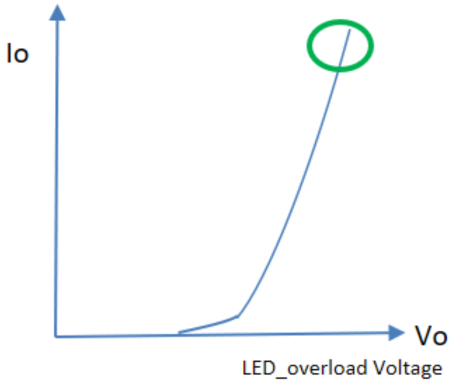
Set Vth close to, but higher than the actual LED threshold voltage for optimized performance. The greater the difference between the Vth setting and the actual LED threshold voltage, the higher the overshoot current will be. The Vth setting must be lower than Vf.

Please test, program, and tune this feature for each LED load design.

Parameter			Min.	Typ.	Max.	Notes
Hot-plugging Protection	LED Threshold Voltage Setting Range	CH1	81 V	-	202 V	Set Vth close to, but higher than the actual LED threshold voltage
		CH2	45 V	-	73 V	
		CH3	45 V	-	73 V	
	Setting Tolerance		-2%	-	2%	

Parallel LED Protection

This feature helps protect parallel LEDs from a high, overcurrent condition by limiting the voltage. This is disabled by default and can be enabled through the Inventronics Programing software.



Set V_overload close to, but higher than the maximum forward voltage for optimized performance. The greater the difference between the V_overload setting and the maximum forward voltage, the higher the overload stress will be. The V_overload setting must be higher than Vf.

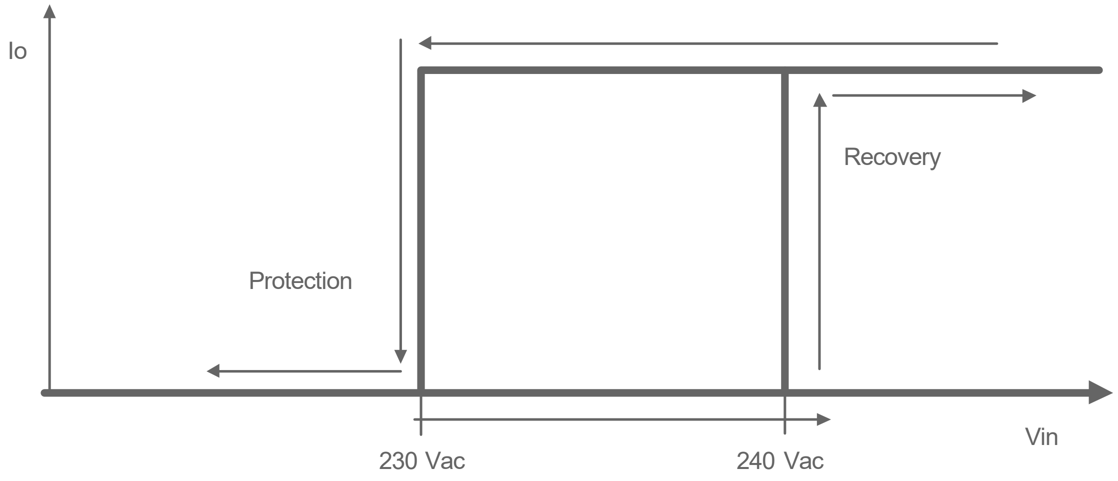
Please test, program, and tune this feature for each LED load design.

Parameter			Min.	Typ.	Max.	Notes
Parallel LED Protection	Overload Voltage Setting Range	CH1	85 V	-	210 V	Set V_overload close to, but higher than the maximum LED forward voltage
		CH2	45 V	-	76 V	
		CH3	45 V	-	76 V	
	Setting Tolerance		-2%	-	2%	

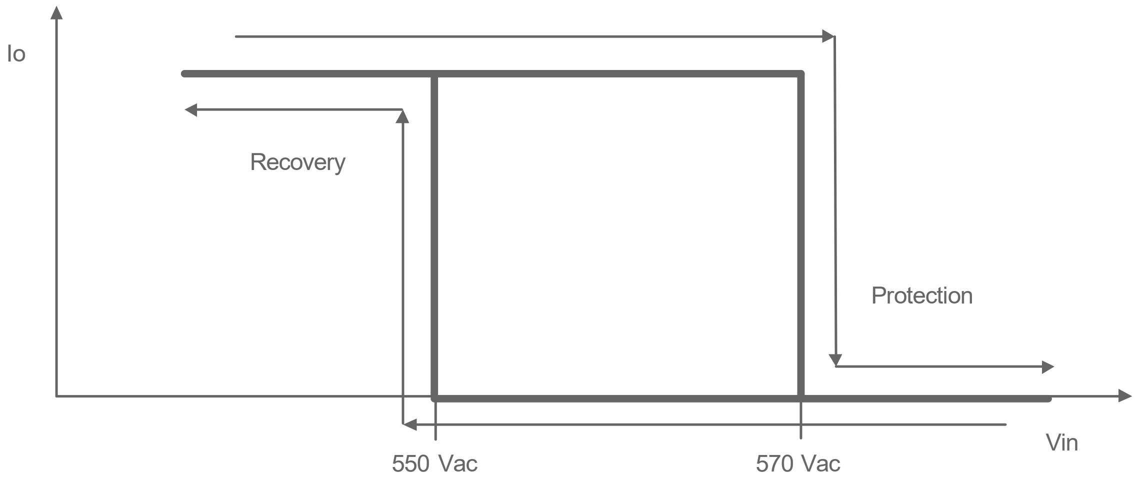
Protection Functions

Parameter		Min.	Typ.	Max.	Notes
Over Temperature Protection		Decreases output current gradually, returning to normal after over temperature is removed.			
Short Circuit Protection		Auto Recovery. No damage will occur when any output is short circuited. The output shall return to normal when the fault condition is removed.			
Over Voltage Protection		Limits output voltage at no load and in case the normal voltage limit fails.			
Input Under Voltage Protection (IUVP)	Input Protection Voltage	220 Vac	230 Vac	240 Vac	Turn off the output when the input voltage falls below protection voltage.
	Input Recovery Voltage	230 Vac	240 Vac	250 Vac	Auto Recovery. The driver will restart when the input voltage exceeds recovery voltage.
Input Over Voltage Protection (IOVP)	Input Over Voltage Protection	550 Vac	570 Vac	590 Vac	Turn off the output when the input voltage exceeds protection voltage.
	Input Over Voltage Recovery	530 Vac	550 Vac	570 Vac	Auto Recovery. The driver will restart when the input voltage falls below recovery voltage.
	Max. of Input Over Voltage	-	-	590 Vac	The driver can survive for 8 hours with a stable input voltage stress of 590Vac.

- **Input Under Voltage Protection Diagram**



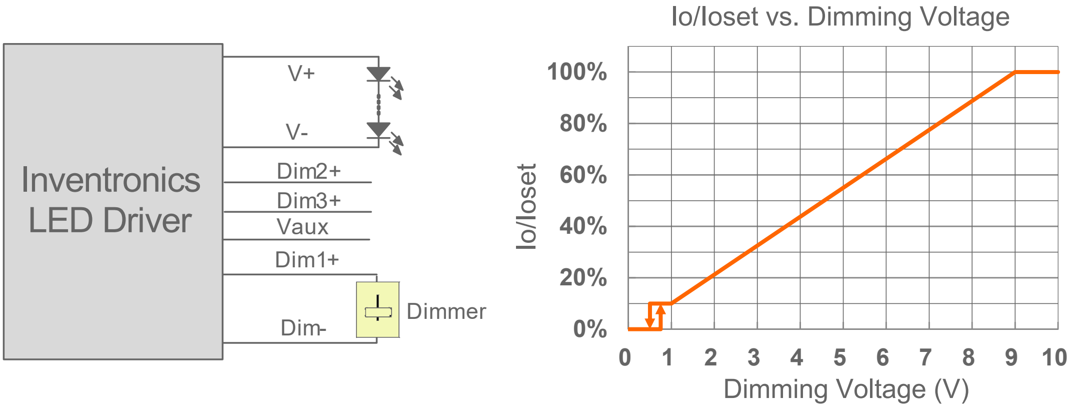
- **Input Over Voltage Protection Diagram**



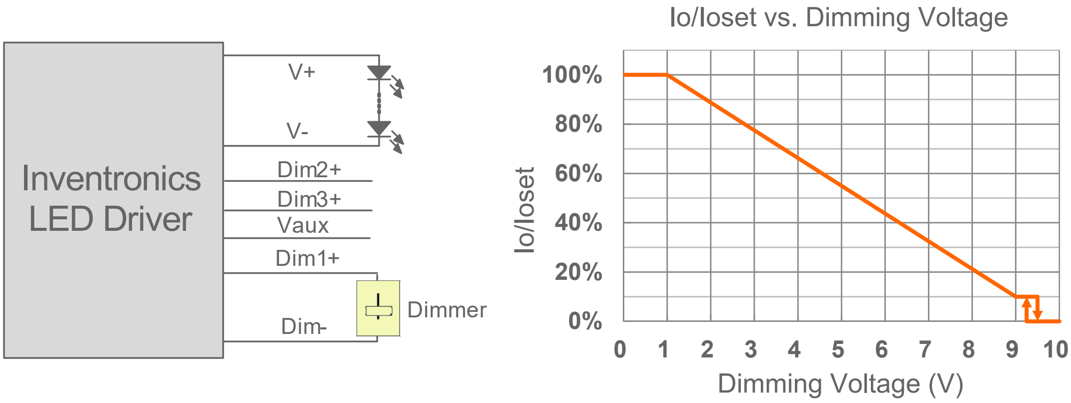
Dimming

● 0-10V Dimming

The recommended implementation of the dimming control is provided below.



Implementation 1: Positive logic

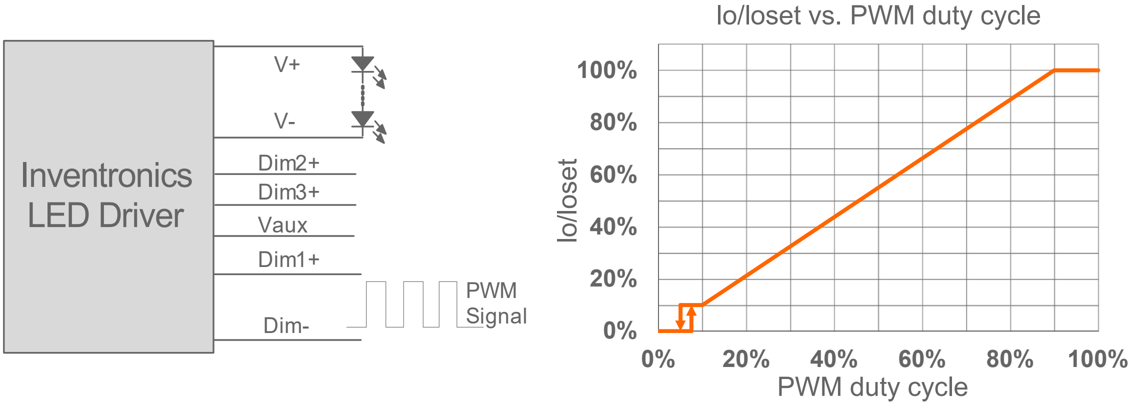


Implementation 2: Negative logic

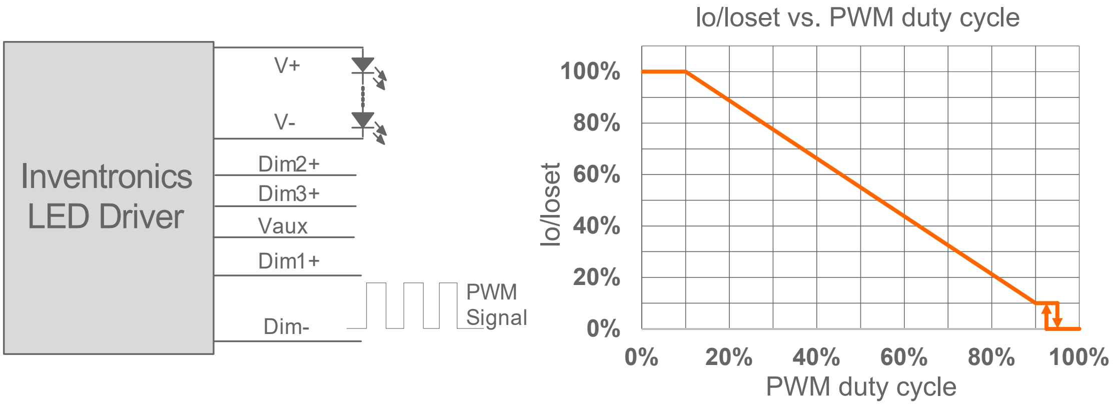
Notes:
1. Do NOT connect Dim− to the output V− or V+, otherwise the driver will not work properly.
2. The dimmer can also be replaced by an active 0-10V voltage source signal or passive components like zener.
3. When 0-10V negative logic dimming mode and Dim+ is open, the driver will dim to off and be standby.

● PWM Dimming

The recommended implementation of the dimming control is provided below.



Implementation 3: Positive logic


Inventronics LED Driver
V+
V-
Dim2+
Dim3+
Vaux
Dim1+
Dim-
PWM Signal
Io/Ioset vs. PWM duty cycle
Io/Ioset
100%
80%
60%
40%
20%
0%
0%
20%
40%
60%
80%
100%
PWM duty cycle

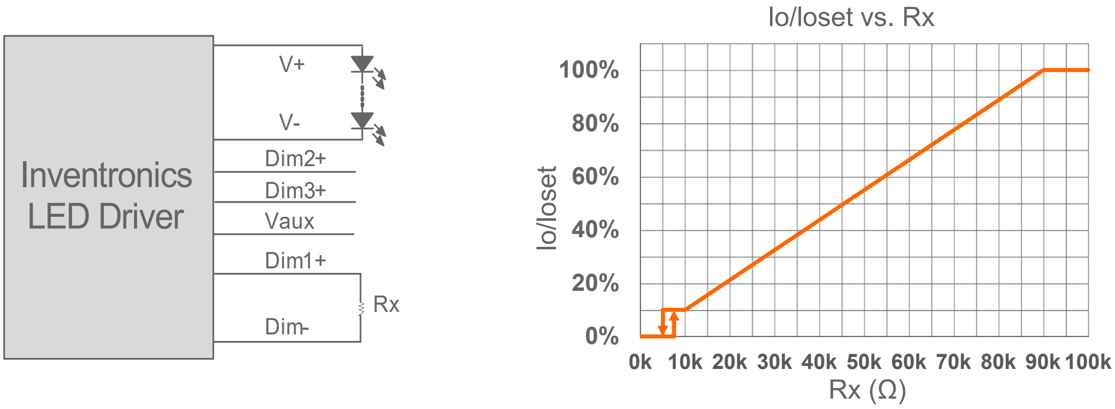
Implementation 4: Negative logic

Notes:

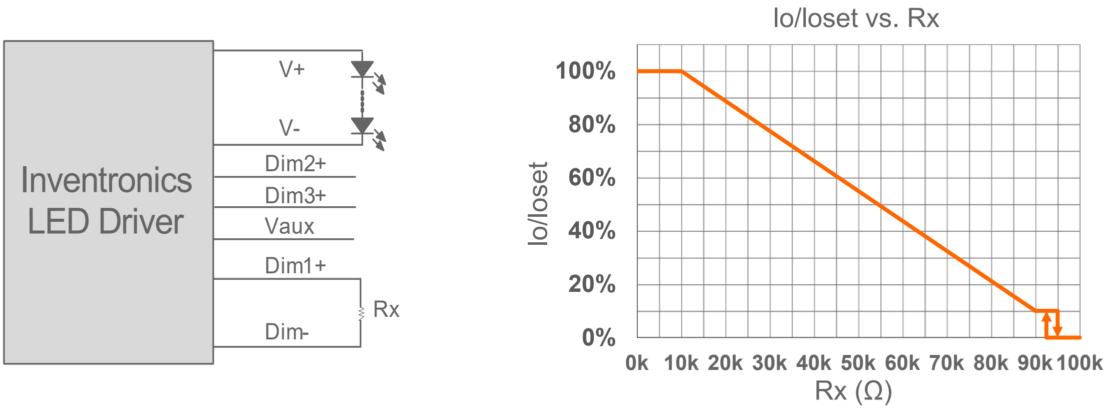
1. Do NOT connect Dim− to the output V− or V+, otherwise the driver will not work properly.
2. When PWM negative logic dimming mode and Dim+ is open, the driver will dim to off and be standby.

Resistor Dimming

The recommended implementation of the dimming control is provided below.


Inventronics LED Driver
V+
V-
Dim2+
Dim3+
Vaux
Dim1+
Dim-
Rx
Io/Ioset vs. Rx
Io/Ioset
100%
80%
60%
40%
20%
0%
0k
10k
20k
30k
40k
50k
60k
70k
80k
90k
100k
Rx (Ω)

Implementation 5: Positive logic


Inventronics LED Driver
V+
V-
Dim2+
Dim3+
Vaux
Dim1+
Dim-
Rx
Io/Ioset vs. Rx
Io/Ioset
100%
80%
60%
40%
20%
0%
0k
10k
20k
30k
40k
50k
60k
70k
80k
90k
100k
Rx (Ω)

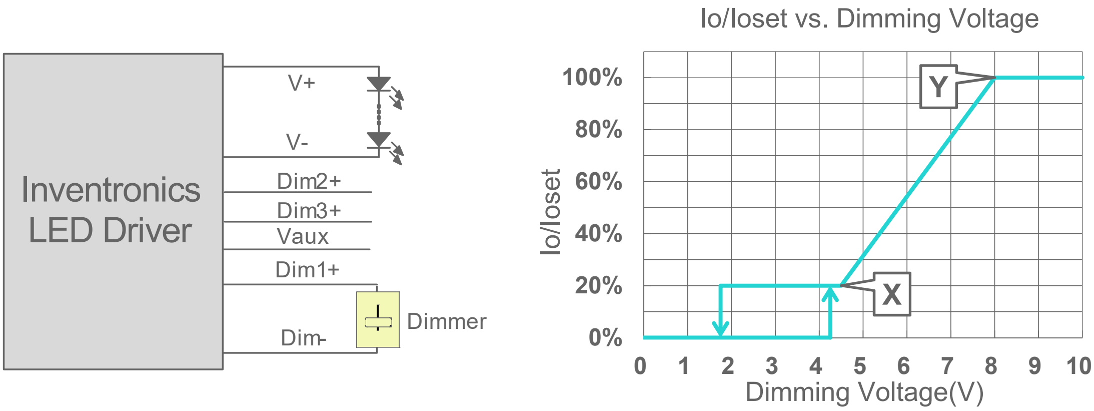
Implementation 6: Negative logic

Notes:

1. Do NOT connect Dim− to the output V− or V+, otherwise the driver will not work properly.
2. When resistor negative logic dimming mode and Dim+ is open, the driver will dim to off and be standby.

Adjustable Dimming Curve

0-10V dimming curve can be set as corresponding dimming voltage by Inventronics Multi Programmer. Take the positive logic dimming as an example, the recommended implementation of the dimming control is provided below.



Implementation 7: Positive logic

Notes:

1. Do NOT connect Dim− to the output V− or V+, otherwise the driver will not work properly.
2. The dimmer can also be replaced by an active 0-10V voltage source signal or passive components like zener.
3. When dimming voltage X point is set to be smaller than Y point, the dimming curve is positive logic; conversely, when X point is set to be bigger than Y point, the dimming curve is negative logic.
4. For best dimming accuracy, the difference between X point and Y point is advised more than 4V.
5. Dimming off voltage adjustable.

Time Dimming

Time dimming control includes 3 kinds of modes, they are Self Adapting-Midnight, Self Adapting-Percentage and Traditional Timer.

- **Self Adapting-Midnight**: Automatically adjusts the dimming curve based on the on-time of past two days (if difference <15 minutes), assuming that the center point of the dimming curve is midnight local time.
- **Self Adapting-Percentage**: Automatically adjusts the on-time of each step by a constant percentage = (actual on-time for the past 2 days if difference <15 min) / (programmed on-time from the dimming curve).
- **Traditional Timer**: Follows the programmed timing curve after power on with no changes.

Output Lumen Compensation

Output Lumen Compensation (OLC) may be used to maintain constant light output over the life of the LEDs by driving them at a reduced current when new, then gradually increasing the drive current over time to counteract LED lumen degradation.

Hold Time Adjustable

When AC power is first applied to the LED driver, enabling a “Hold” period can allow devices powered by the Auxiliary voltage to stabilize before the driver fades up to the maximum dimming level. During this period, the driver will not respond to external dimming commands but will respond again after the hold time ends. Both the initial dimming percentage and the duration of this hold period can be adjusted by the Inventronics Multi Programmer. This function is disabled by default.

Fade Time Adjustable

There is a “Fade” period after the “Hold” period. The soft-start time and dimming slope applied to all dimming transitions can be adjusted individually. It is adjusted by the Inventronics Multi Programmer. This function is disabled by default.

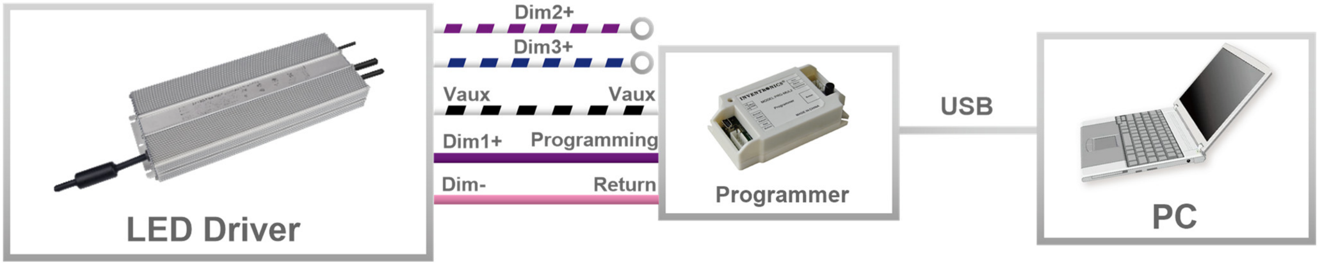
- ### End Of Life

  End-of-Life (EOL) is providing a visual notification to a user that the LED module has reached the end of manufacturer-specified life and that the replacement is recommended. Once active, an indication is given at each power-up of the driver, which the driver indicates this through a lower light output during the first 1 minute before normal operation is continued.

- ### Digital Dimming

  Inventronics Digital Dimming is a UART (Universal Asynchronous Receive Transmitter) based communication protocol. Please refer to Inventronics Digital Dimming file for details.

Programming Connection Diagram

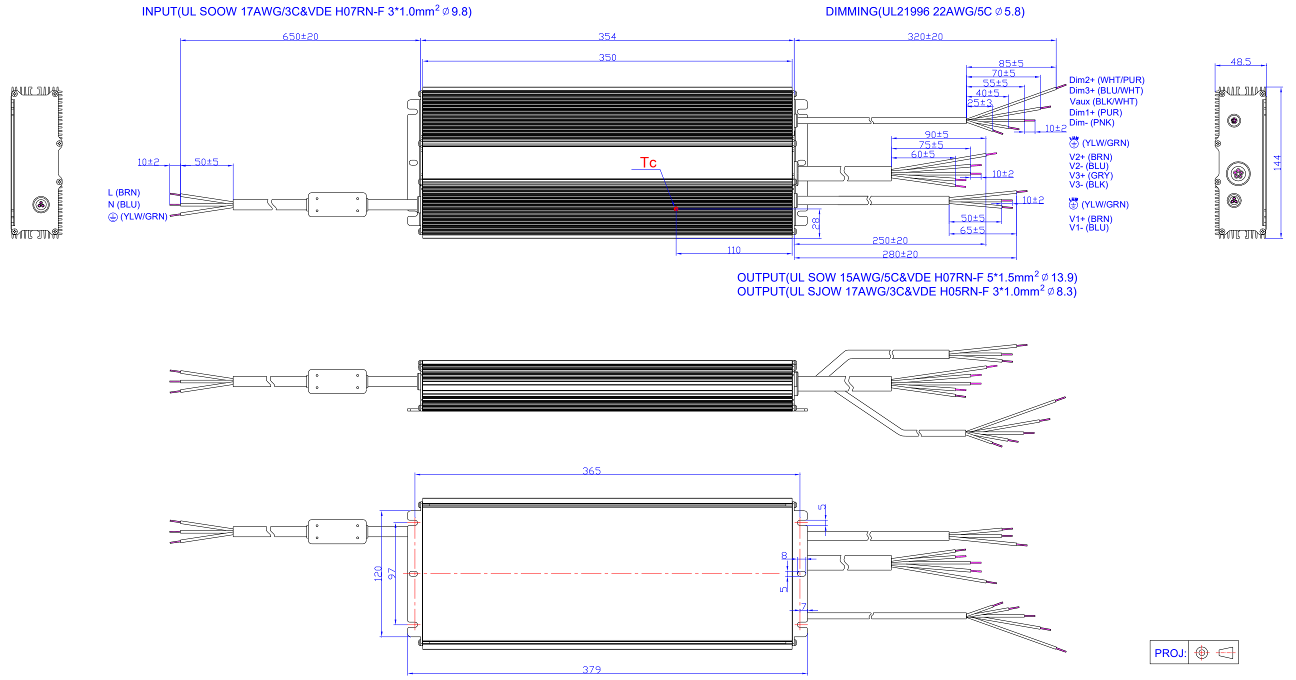

Dim2+
Dim3+
Vaux
Vaux
Dim1+
Programming
Dim-
Return
LED Driver
Programmer
USB
PC

Note: The driver does not need to be powered on during the programming process.

- **Please refer to PRG-MUL2 (Programmer) datasheet for details.**

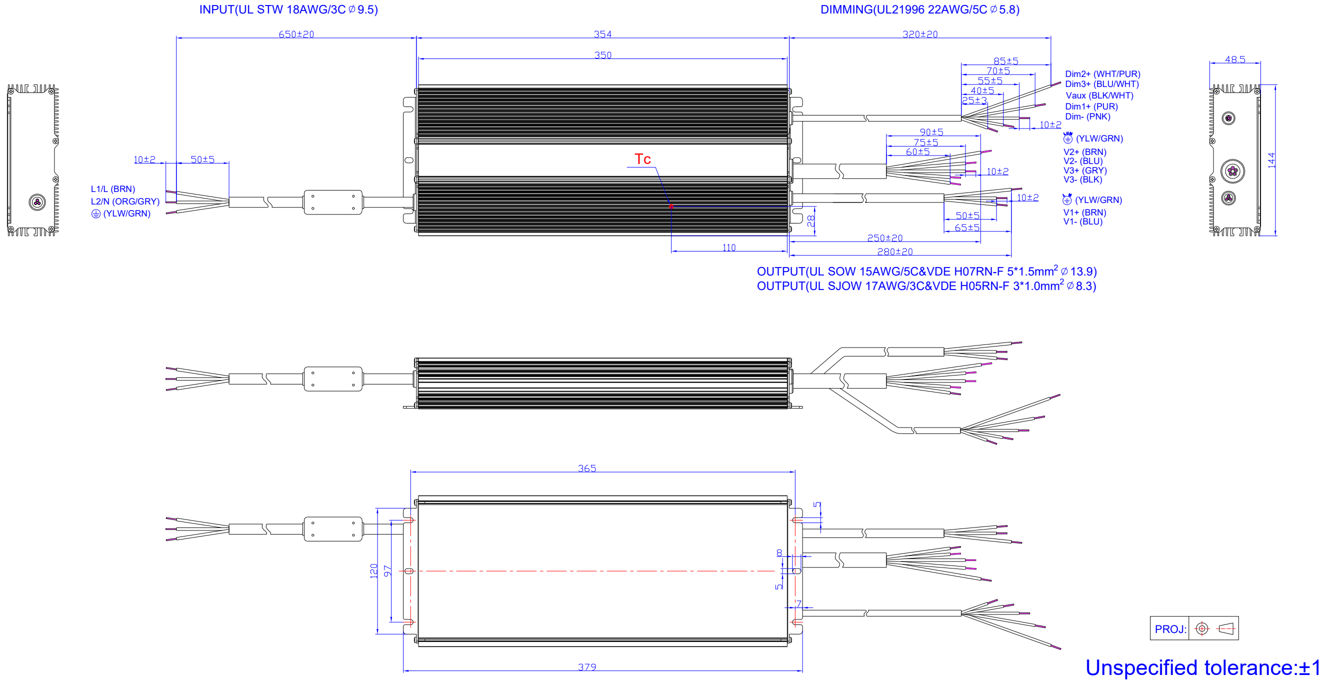
Mechanical Outline

ESM-1K2T570MG


INPUT(UL SOOW 17AWG/3C&VDE H07RN-F 3*1.0mm² ⌀9.8)
DIMMING(UL21996 22AWG/5C ⌀5.8)
650±20
354
350
320±20
85±5
70±5
55±5
40±5
25±3
10±2
Dim2+ (WHT/PUR)
Dim3+ (BLU/WHT)
Vaux (BLK/WHT)
Dim1+ (PUR)
Dim- (PNK)
(YLW/GRN)
90±5
75±5
60±5
10±2
V2+ (BRN)
V2- (BLU)
V3+ (GRY)
V3- (BLK)
10±2
(YLW/GRN)
V1+ (BRN)
V1- (BLU)
50±5
65±5
250±20
280±20
28
110
Tc
10±2
50±5
L (BRN)
N (BLU)
(YLW/GRN)
48.5
144
OUTPUT(UL SOW 15AWG/5C&VDE H07RN-F 5*1.5mm² ⌀13.9)
OUTPUT(UL SJOW 17AWG/3C&VDE H05RN-F 3*1.0mm² ⌀8.3)
365
120
97
5
8
5
7
379
PROJ:

Unspecified tolerance:±1

ESM-1K2T570MT


INPUT(UL STW 18AWG/3C ∅9.5)
DIMMING(UL21996 22AWG/5C ∅5.8)
650±20
354
350
320±20
85±5
70±5
55±5
40±5
25±3
10±2
Dim2+ (WHT/PUR)
Dim3+ (BLU/WHT)
Vaux (BLK/WHT)
Dim1+ (PUR)
Dim- (PNK)
90±5
75±5
60±5
10±2
(YLW/GRN)
V2+ (BRN)
V2- (BLU)
V3+ (GRY)
V3- (BLK)
10±2
(YLW/GRN)
V1+ (BRN)
V1- (BLU)
48.5
144
Tc
10±2
50±5
L1/L (BRN)
L2/N (ORG/GRY)
⏚ (YLW/GRN)
28
110
50±5
65±5
250±20
280±20
OUTPUT(UL SOW 15AWG/5C&VDE H07RN-F 5*1.5mm² ∅13.9)
OUTPUT(UL SJOW 17AWG/3C&VDE H05RN-F 3*1.0mm² ∅8.3)
365
5
120
97
8
5
7
379
PROJ:

Unspecified tolerance:±1

RoHS Compliance

Our products comply with reference to RoHS Directive (EU) 2015/863 amending 2011/65/EU, calling for the elimination of lead and other hazardous substances from electronic products.

Revision History

Change Date	Rev.	Description of Change		
		Item	From	To
2023-04-04	A	Datasheet Release	/	/
2024-01-10	B	Format	/	Updated
		Features	/	Updated
		Input Specifications	/	Updated
		Inrush Current Waveform	/	Updated
		Dimming	/	Updated