

BUBO LED TUBE

Technical Data Sheet

Applies to article numbers:

LTL-24-1/2-02
LTL-24-02
LTL-24-P-1/2-02
LTL-24-P-02
LTL-24-P-ww-1/2-03
LTL-24-P-ww-1/2-SA-03
LTL-24-P-ww-02
LTL-24-P-ww-SA-02



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1 DESCRIPTION

The LED tube comes in several varieties and lengths suitable to apply in various cage and aviary systems. The smart design allows it to easily connect series of the LED tube in one line. With special power supplies it is possible to control the brightness from 0 up to 100%.

The standard Hato LED tube comes with amber colour LEDs in two brightness' and two different lengths. A warm-white tube in a CCT of 2900K is also available.

All tubes are designed to work with an optimal voltage of 24VDC.

Features:

- Uniform brightness on long lines
- Quick installation with plug-and-play connectors
- High protection grade for dust and water (IP67)
- Long life span of 50,000 – 70,000 hours depending on temperature and model
- Warm-white and amber colour available
- Special versions available upon request

Applications:

- Aviary systems
- Broiler cages
- Colony systems



Contents

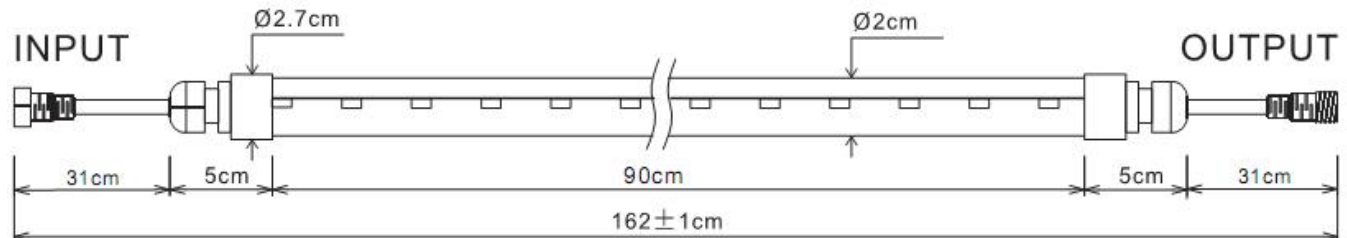
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2 OUTLINE DIMENSIONS

2.1 Amber tube 0.9m normal output (LTL-24-1/2-02)

2.2 Amber tube 0.9m high output (LTL-24-P-1/2-02)

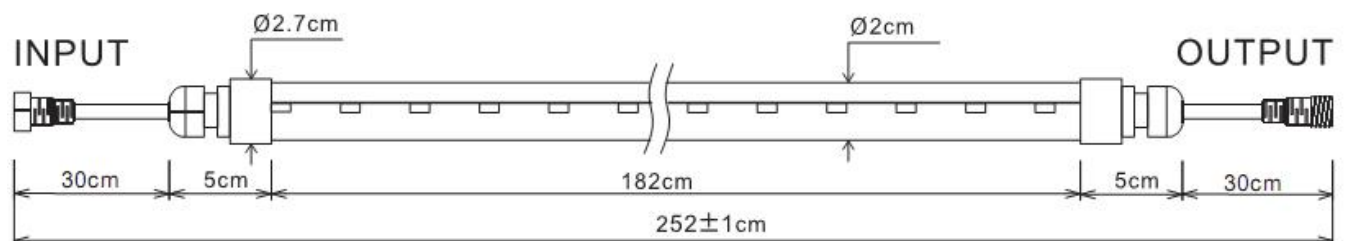
2.3 Warm-white tube 0.9m high output (LTL-24-P-1/2-ww-03)



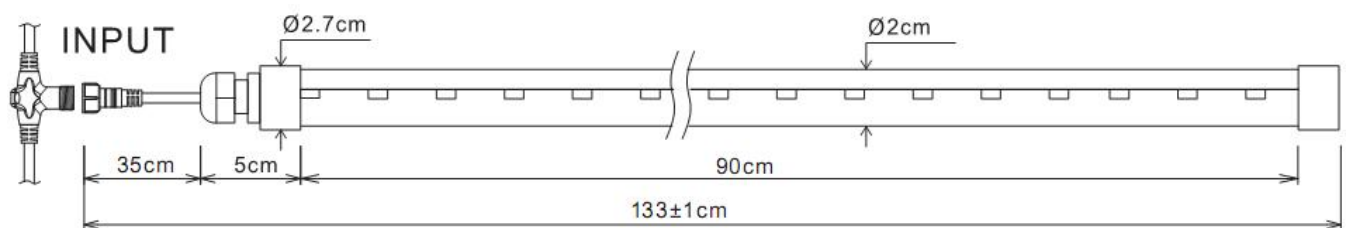
2.4 Amber tube 1.8m normal output (LTL-24-02)

2.5 Amber tube 1.8m high output (LTL-24-P-02)

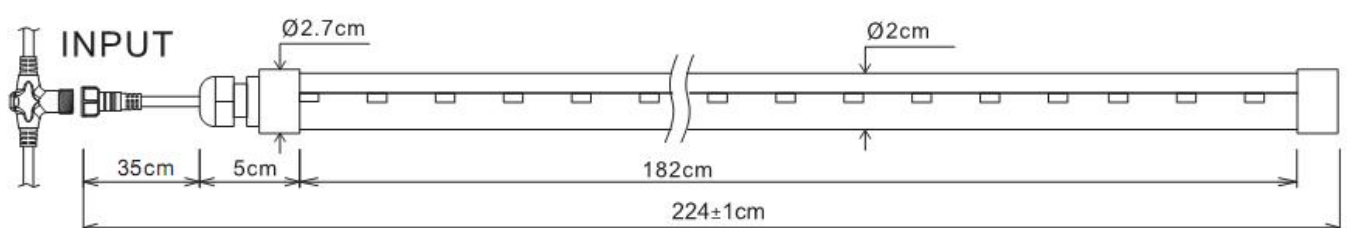
2.6 Warm-white tube 1.8m high output (LTL-24-P-ww-02)



2.7 Warm-white tube 0.9m high output single connector (LTL-24-P-1/2-ww-SA-03)



2.8 Warm-white tube 1.8m high output single connector (LTL-24-P-ww-SA-02)



3 ELECTRICAL AND OPTICAL CHARACTERISTICS


3.1 Amber tube 0.9m normal output (LTL-24-1/2-02) (24 LED's)

1 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	28	35	42	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	40	44	48	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	97	108	119	lx
Dominant Wavelength	λ	593	595	597	nm
Current Consumption	I	46	48	50	mA
Power Consumption	P	1.09	1.15	1.21	W
Through-wiring Impedance ^[2]	Z	43	46	49	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	17.4	18.5	19.6	V
Current consumption at 50% light ^[3]	$I_{50\%}$	22	23	25	mA
Light off Voltage ^[4]	$U_{0\%}$	11.8	12.5	13.3	V
Viewing Angle	$2\theta_{1/2}$	106	110	-	°

2 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	75	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	480	mA
Number of Tube in Series	n	95	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	± 400	V

 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width $\leq 10\text{msec}$ and duty cycle $\leq 1/10$


3.2 Amber tube 1.8m normal output (LTL-24-02) (40 LED's)

3 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	46	58	70	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	36	40	44	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	90	100	110	lx
Dominant Wavelength	λ	593	595	597	nm
Current Consumption	I	89	94	98	mA
Power Consumption	P	2.14	2.25	2.36	W
Through-wiring Impedance ^[2]	Z	68	72	76	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	18.5	19.7	20.9	V
Current consumption at 50% light ^[3]	$I_{50\%}$	44	46	49	mA
Light off Voltage ^[4]	$U_{0\%}$	12.2	13.0	13.8	V
Viewing Angle	$2\theta_{1/2}$	106	110	-	°

4 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	125	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	800	mA
Number of Tube in Series	n	50	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	± 400	V

 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width $\leq 10\text{msec}$ and duty cycle $\leq 1/10$


3.3 Amber tube 0.9m high output (LTL-24-P-1/2-02) (40 LED's)

5 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	46	58	70	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	50	55	61	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	171	190	209	lx
Dominant Wavelength	λ	593	595	597	nm
Current Consumption	I	89	94	98	mA
Power Consumption	P	2.14	2.25	2.36	W
Through-wiring Impedance ^[2]	Z	43	46	49	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	17.4	18.5	19.6	V
Current consumption at 50% light ^[3]	$I_{50\%}$	44	46	49	mA
Light off Voltage ^[4]	$U_{0\%}$	11.8	12.5	13.3	V
Viewing Angle	$2\theta_{1/2}$	106	110	-	°

6 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	125	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	800	mA
Number of Tube in Series	n	70	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	±400	V

 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width ≤ 10msec and duty cycle ≤ 1/10


3.4 Amber tube 1.8m high output (LTL-24-P-02) (80 LED's)

7 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	93	116	139	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	54	60	66	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	182	202	222	lx
Dominant Wavelength	λ	593	595	597	nm
Current Consumption	I	178	188	197	mA
Power Consumption	P	4.28	4.50	4.73	W
Through-wiring Impedance ^[2]	Z	68	72	76	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	18.5	19.7	20.9	V
Current consumption at 50% light ^[3]	$I_{50\%}$	89	93	98	mA
Light off Voltage ^[4]	$U_{0\%}$	12.2	13.0	13.8	V
Viewing Angle	$2\theta_{1/2}$	106	110	-	°

8 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	250	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	1600	mA
Number of Tube in Series	n	36	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	± 400	V

 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width $\leq 10\text{msec}$ and duty cycle $\leq 1/10$


3.5 Warm-white tube 0.9m high output (LTL-24-P-1/2-WW-03) (12 LED's)

9 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	153	170	187	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	149	165	182	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	356	395	435	lx
Correlated Colour Temperature	CCT	2900	2950	3000	K
Colour Rendering Index	Ra	80	-	-	%
Luminous Efficiency	H	53.0	61.8	71.6	lm/W
Current Consumption	I	109	115	120	mA
Power Consumption	P	2.61	2.75	2.89	W
Through-wiring Impedance ^[2]	Z	43	46	49	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	18.8	20.0	21.2	V
Current consumption at 50% light ^[3]	$I_{50\%}$	54	57	60	mA
Light off Voltage ^[4]	$U_{0\%}$	15.0	16.0	17.0	V
Viewing Angle	$2\theta_{1/2}$	110	120	-	°

10 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	300	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	600	mA
Number of Tube in Series	n	46	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	± 1000	V

 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width $\leq 10\text{msec}$ and duty cycle $\leq 1/10$


3.6 Warm-white tube 1.8m high output (LTL-24-P-ww-02) (18 LED's)

11 Initial electrical and optical characteristics at 24V DC

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux	Φ	306	340	374	lm
Illuminance at 0°, 50cm distance ^[1]	E_v	149	165	182	lx
Illuminance at 0°, 24cm distance ^[1]	E_v	356	395	435	lx
Correlated Colour Temperature	CCT	2900	2950	3000	K
Colour Rendering Index	Ra	80	-	-	%
Luminous Efficiency	H	53.0	61.8	71.6	lm/W
Current Consumption	I	218	229	241	mA
Power Consumption	P	5.23	5.50	5.78	W
Through-wiring Impedance ^[2]	Z	68	72	76	m Ω
Voltage at 50% light ^[3]	$U_{50\%}$	18.8	20.0	21.2	V
Current consumption at 50% light ^[3]	$I_{50\%}$	108	114	120	mA
Light off Voltage ^[4]	$U_{0\%}$	15.0	16.0	17.0	V
Viewing Angle	$2\theta_{1/2}$	110	120	-	°

12 Absolute maximum ratings

Parameter	Symbol	Value	Unit
Forward Voltage	U_F	25	V DC
Reverse Voltage	U_R	25	V DC
Forward Current Single Tube	I_F	450	mA
Through Wiring Current	I_{MAX}	7.5	A
Peak forward Current ^[5]	I_{PF}	900	mA
Number of Tube in Series	n	24	pcs
Storage Temperature	T_{stg}	-40 ~ +80	°C
Operating Temperature	T_{opr}	-25 ~ +40	°C
Relative Humidity	RH	20 ~ 80	%
ESD Sensitivity	U_{ESD}	±1000	V

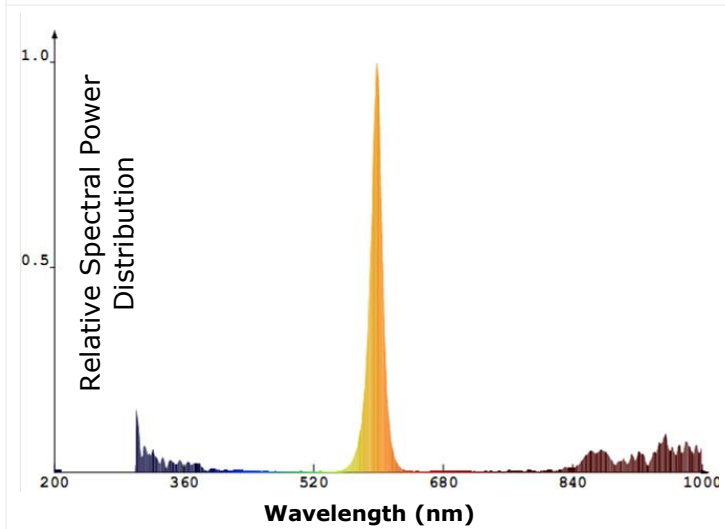
 Exceeding maximum ratings may permanently damage product!

- [1] Highest illuminance level straight under LED tube in the middle of it at mentioned distance from LED tube centre to measurement point
- [2] Resistance of + and - wires together of internal wiring used to connect to next tube
- [3] Supply voltage and current where only 50% of initial luminous flux is produced
- [4] Supply voltage where LED tube is completely off with no light output
- [5] Pulse Width ≤ 10msec and duty cycle ≤ 1/10

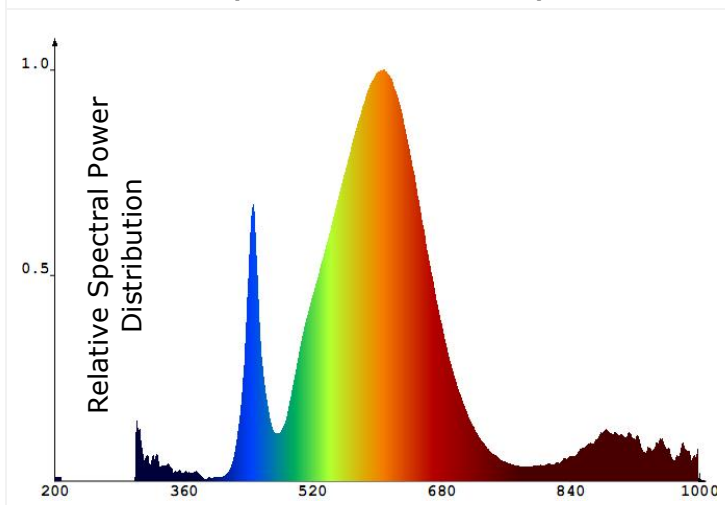
4 TYPICAL CHARACTERISTIC GRAPHS

All values measured and shown in graphs are measured at $T_A = 25^\circ\text{C}$, unless otherwise noted.

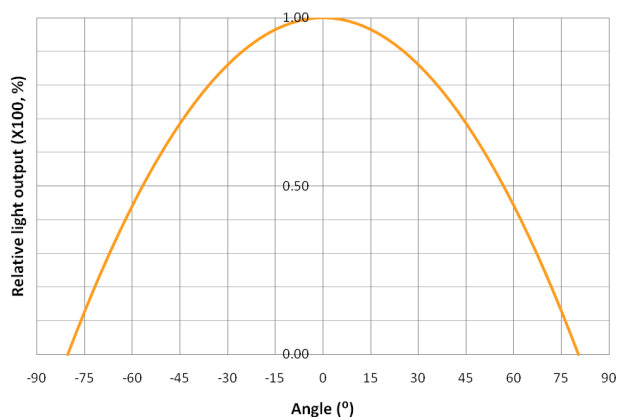
13 Colour spectrum for amber products



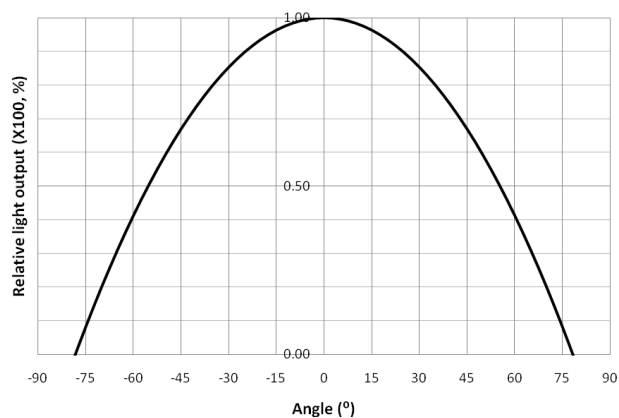
14 Colour spectrum for warm-white products



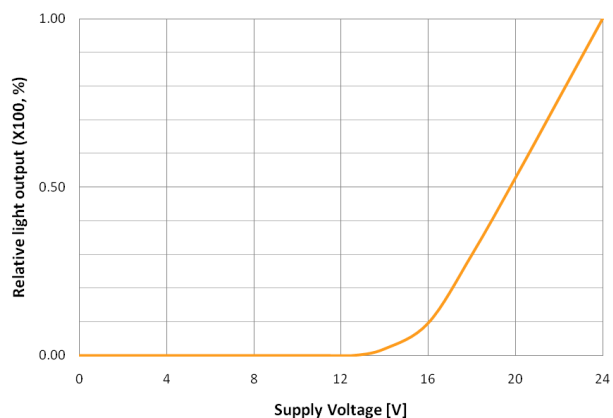
15 Average Relative Illuminance versus Radiation Angle for Amber products



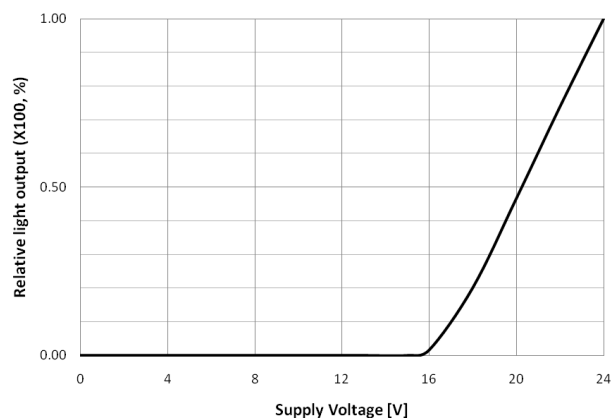
16 Average Relative Illuminance versus Radiation Angle for Warm-white products

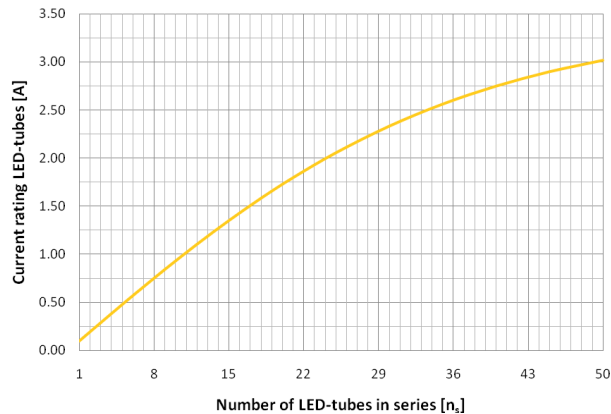
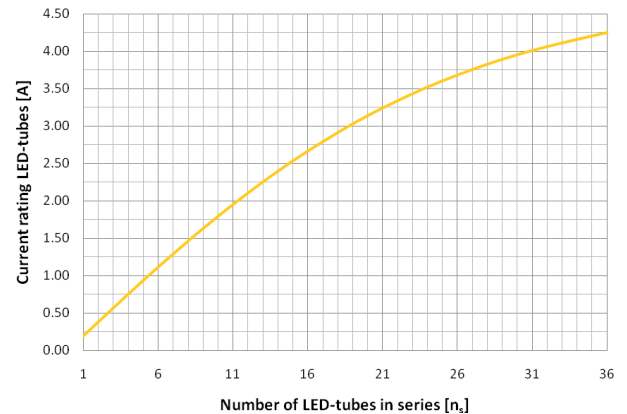
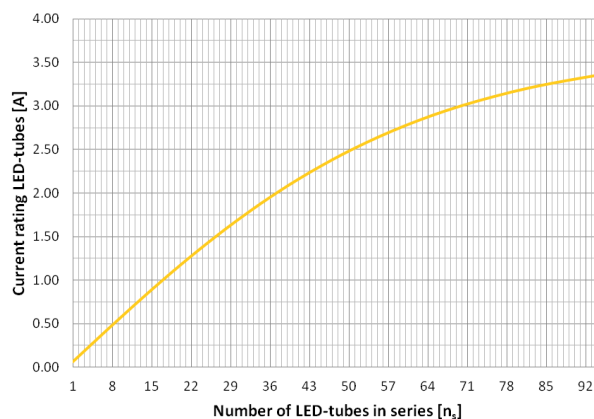
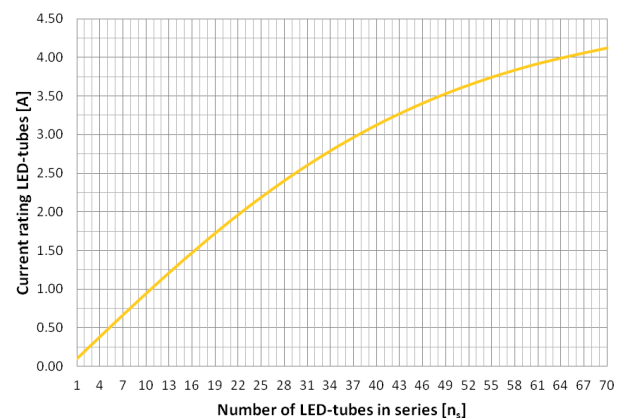
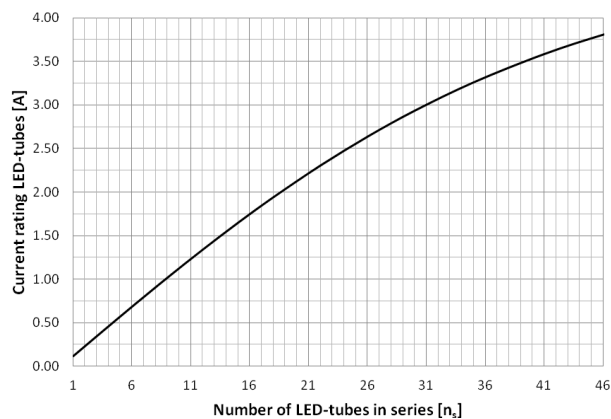
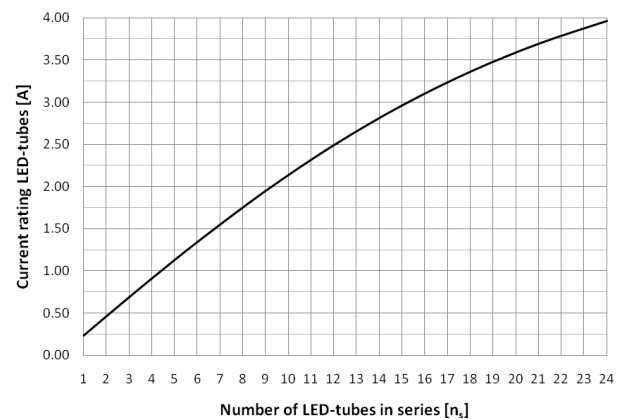


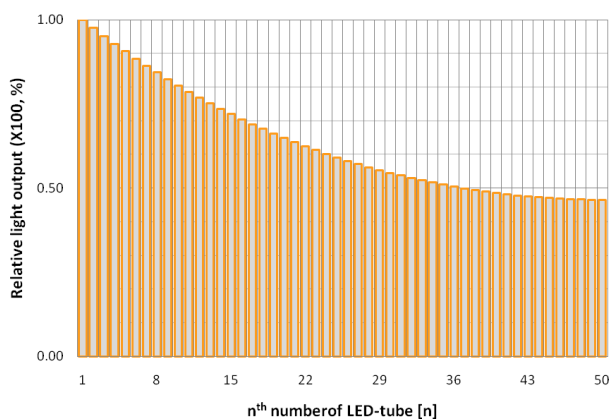
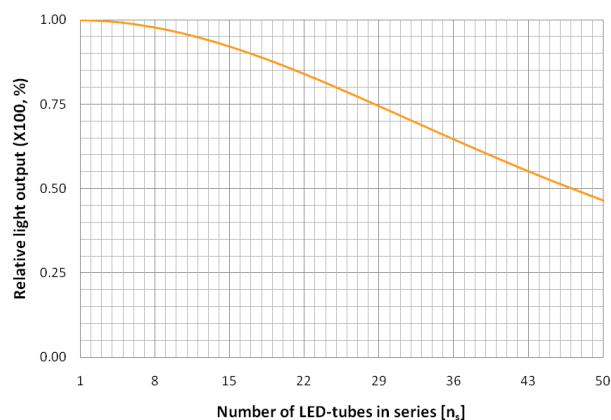
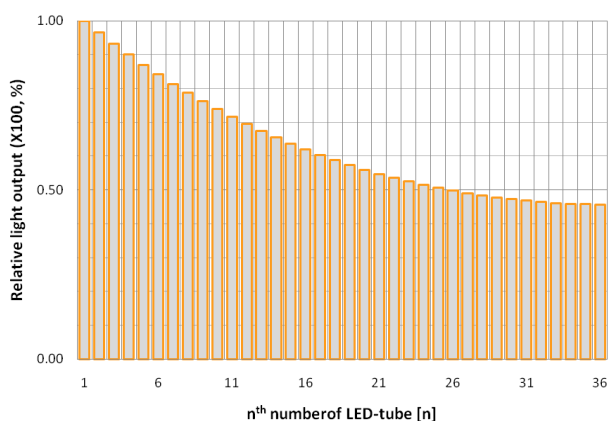
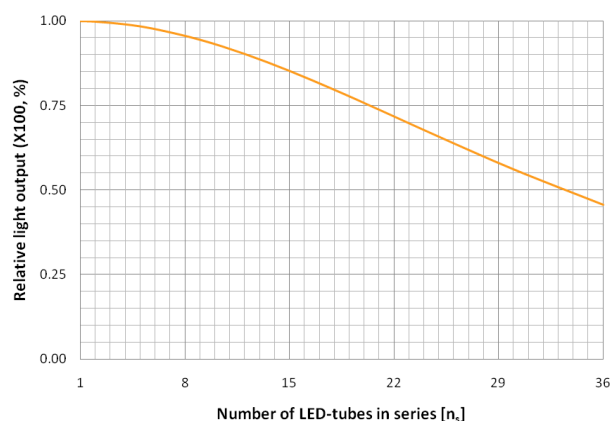
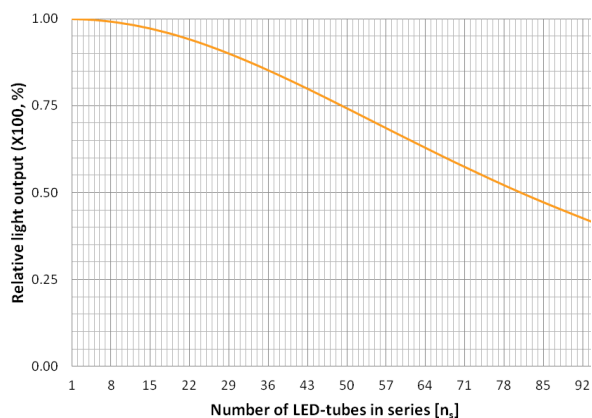
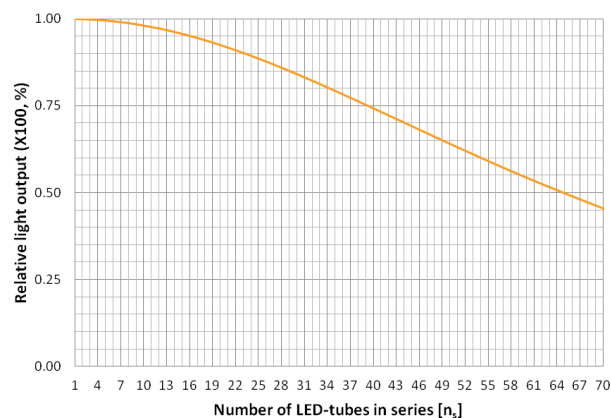
17 Relative Light Output versus Supply Voltage for Amber products



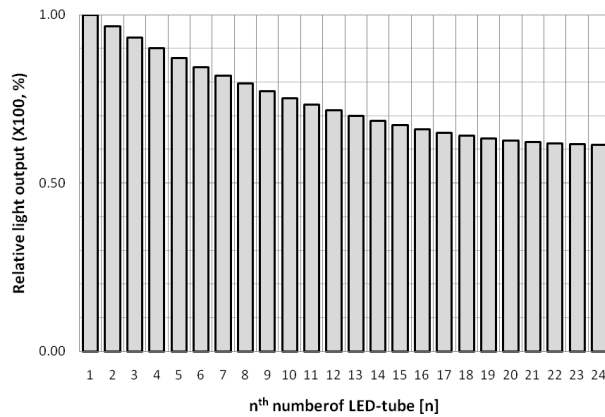
18 Relative Light Output versus Supply Voltage for Warm-white products



19 Current consumption versus number of LED tubes in series for Amber products

LTL-24-02

LTL-24-P-02

LTL-24-1/2-02

LTL-24-P-1/2-02
20 Current consumption versus number of LED tubes in series for Warm-white products

LTL-24-P-ww-1/2-03

LTL-24-P-ww-02

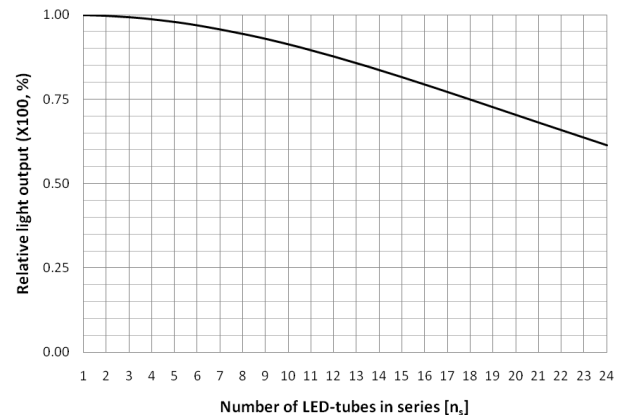
21 Relative Light Output for Each LED tube when connecting 50 in series

LTL-24-02
22 Relative Light last LED tube compared to first LED tube versus number of LED tubes in series

LTL-24-02
23 Relative Light Output for Each LED tube when connecting 36 in series

LTL-24-P-02
24 Relative Light last LED tube compared to first LED tube versus number of LED tubes in series

LTL-24-P-02
25 Relative Light last LED tube compared to first LED tube versus number of LED tubes in series

LTL-24-1/2-02

LTL-24-P-1/2-02

26 Relative Light Output for Each LED tube when connecting 24 in series



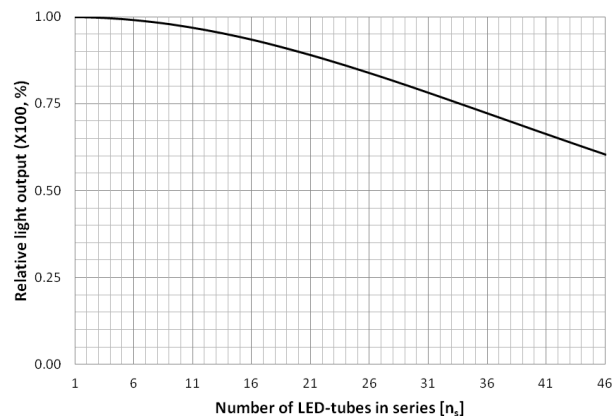
LTL-24-P-WW-02

27 Relative Light last LED tube compared to first LED tube versus number of LED tubes in series



LTL-24-P-WW-02

28 Relative Light last LED tube compared to first LED tube versus number of LED tubes in series

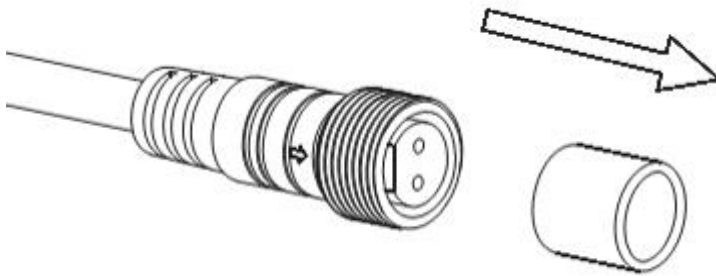


LTL-24-P-WW-1/2-03

5 INSTALLATION AND MOUNTING

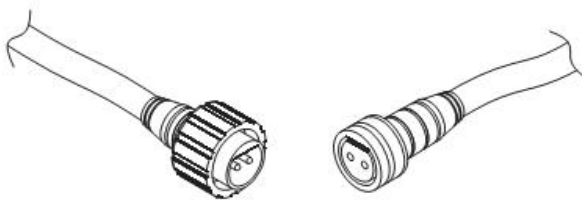
All models can be installed and mounted in the same ways. Please keep in mind not to exceed the maximum number of LED tubes in series, depending on the model used.

The incoming power cable should always be connected to the input male connector as shown on picture below. Output connector is always female and can be used to connect to the next input connector. The output connector of the last LED tube should **always** be closed with a cable end cap (LTS-10-01, see also Chapter 6 *Accessories*) to prevent water and dust from getting in and short-circuit risks. All output connectors have a clear plastic tube inside to prevent deforming of the connector during transport. This tube should be removed before assembly!



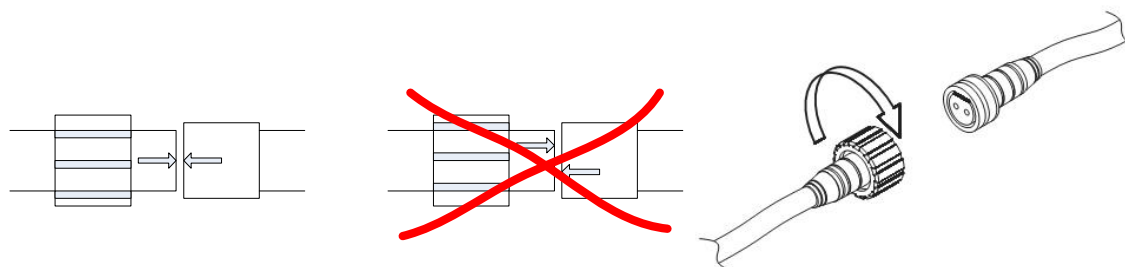
5-1 Remove plastic tubes before assembly

Do not use heavy force when connecting tubes together. Close connector hand tight.



5-2 Left male connector with pins, right female connector with socket

Please observe arrow marks on each connector which should be facing each other during connection.



5-3 Place connectors aligned with arrows and turn nut tight by hand around female connector

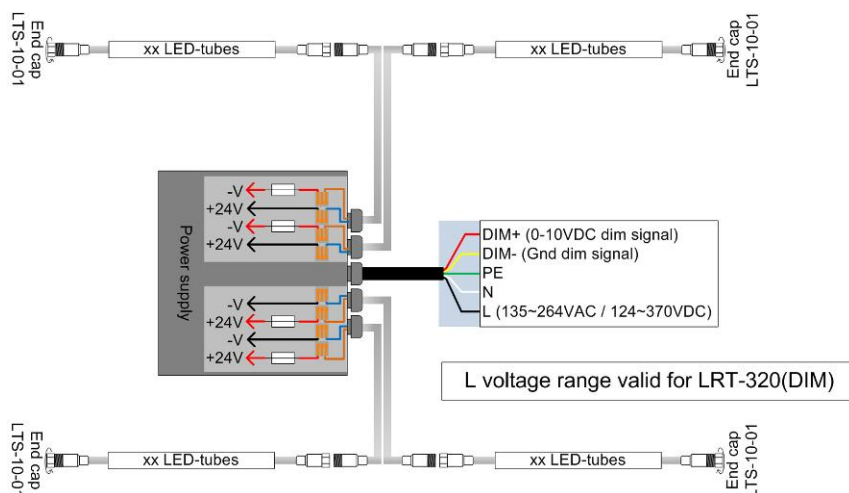
After connectors are joint end-to-end, make sure the cable closing ring on male connector is turned tight enough on female connector to maintain IP-grade.

For mounting stainless steel clips are available, which can be clamped around the LED tube. Special clips with an anti-slip layer are also available to avoid moving clips when mounted on steel wires. Chapter 6 *Accessories* contains order code and details for these items.

5.1 Electrical installation

Diagrams below show a few different connection schematics possible to connect LED tubes to power supplies. Different setups are also possible, while following maximum ratings from used LED tube.

It is always recommended to protect each LED tube line with a fuse in the beginning to prevent too high current levels in case of installation errors or product faults. Fuse should have a maximum rating of 7.5A and should be adjusted depending on load attached and of an anti-surge type.

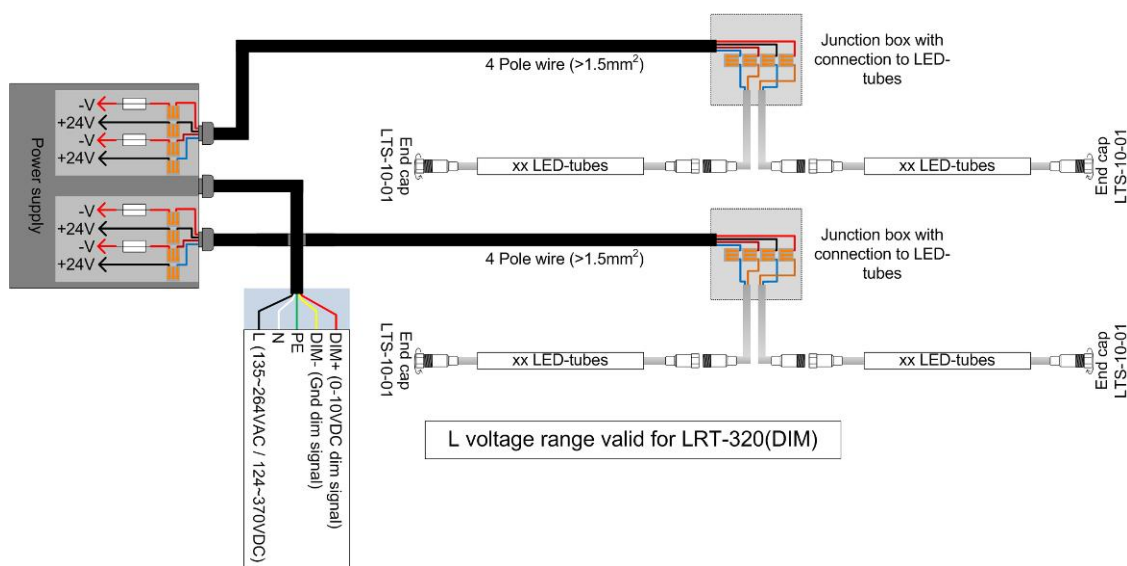


xx Represents maximum number of LED tubes in series as listed in *Maximum Ratings (Number of Tube in Series)* for used product. Colour of wires is for reference. Only colour of wires of extension cables represent products LTC-300-01/LTC-3000-01.

The maximum number of LED tubes, which can be connected to one power supply, depends on the power supply and enclosure used. Also ambient temperature around the power supply (enclosure) can limit rated load. Maximum ambient temperature for power cases is 40°C for full load.

As a rule of thumb, the output power of the power supply divided by the typical power consumption of the used product. This value indicates the maximum number of LED tubes to connect to one power supply in different series. Please check table **Fout!**

Verwijzingsbron niet gevonden. for these values for the typical 320W power supplies (order code LRT-320(DIM)). **Please note that this value is different than the maximum number of tubes to connect in series!**



It is always a good idea to divide long LED tube series to maintain a uniform light output over the full line. LED power supply should always be placed as close as possible to starting of LED tubes, but if necessary to move power supply to a different location further away from LED tubes, use thick cables to limit power loss over cables. When possible, keep cable lengths as short as possible to keep system as efficient as possible.

Feeding LED tubes in the middle of the system to two sides gives the benefit of using less cable while still maintaining high uniformity.

The table on the next page shows the main parameters which can be used as a quick reference for installation calculations. Please find for the last columns a reference below with an explanation of its contents.

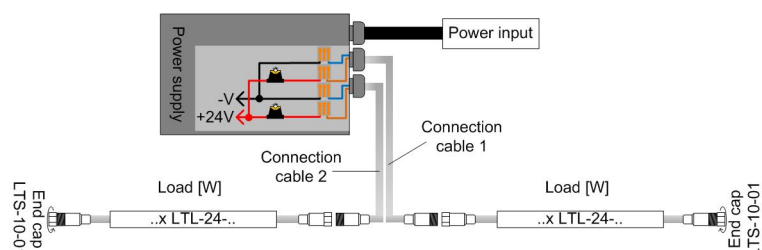
- [1] Number of LED tubes in series after which last tube gives 20% less light output then first LED tube (80% of light level of first tube).
- [2] Number of LED tubes in series after which last tube gives 30% less light output then first LED tube (70% of light level of first tube).
- [3] For safety reasons the maximum number of tubes that can be placed. in a single series.
- [4] Maximum number of LED tube of mentioned type that can be connected to the Hato 320W power supply (LRT-320(DIM) see also chapter 6 Accessories). **This number should never be connected in one single series, but can be added up by creating several parallel series.**
- [5] Recommended number of RVS clips to mount a single tube (see also chapter 6 Accessories). Recommended to use at least 2 PVC clips for ends to prevent moving of the clips.

29 Quick reference data for various LED tube types

Article	Typical power	80% maintenance [1]	70% maintenance [2]	Maximum tubes in series [3]	Maximum tubes with 320W supply [4]	Clips needed per LED tube [5]
LTL-24-1/2-02	1.15 W	43 pcs	55 pcs	95 pcs	279 pcs	3
LTL-24-02	2.25 W	25 pcs	32 pcs	50 pcs	143 pcs	4
LTL-24-P-1/2-02	2.25 W	34 pcs	44 pcs	70 pcs	143 pcs	3
LTL-24-P-02	4.5 W	18 pcs	23 pcs	36 pcs	72 pcs	4
LTL-24-P-1/2-ww-03	2.75 W	29 pcs	38 pcs	46 pcs	117 pcs	3
LTL-24-P-1/2-ww-SA-03	2.75 W	29 pcs	38 pcs	46 pcs	117 pcs	3
LTL-24-P-ww-02	5.5 W	16 pcs	20 pcs	24 pcs	59 pcs	4
LTL-24-P-ww-SA-02	5.5 W	16 pcs	20 pcs	24 pcs	59 pcs	4

5.1.1 Connection cable lengths

Table below (30) shows a table with recommended maximum connection cable lengths between power supply and a series of LED tubes. Load is expressed in Watt's. On the second table (31) an indication is shown of how many LED tubes of a few types have to be connected in series to approximately get the mentioned load.



Please note that these values should not be used to calculate the number of LED products to connect to one power supply! For this value check data in table 29.

Lengths are calculated assuming a voltage loss of 1V over the connection cable. This loss can be compensated on the power supply (e.g. increase voltage and measure voltage at first LED tube to set it at 24V DC).

30 Max cable lengths connection cable between power supply and LED tube series

	Max length based on thickness cable [m]				
Load [W]	2x1.5mm ²	2x2.5mm ²	2x4mm ²	4x2.5mm ²	2x 14AWG
40	25	41.5	66.5	83.5	34.5
50	20	33	53	66.5	27.5
60	16	27.5	44	55.5	23
70	14	23.5	38	47.5	19.5
80	12	20.5	33	41.5	17
90	11	18	29.5	37	15

31 Approximate number of LED tubes in series to get indicated load

	Quantity of LED-tubes in series (for example)			
Load [W]	LTL-24-P-ww-02	LTL-24-P-1/2-ww-03	LTL-24-02	LTL-24-P-02
40	8	15	20	9
50	10	20	25	12
60	12	24	33	15
70	15	30	46	18
80	17	36	53	21
90	23	46	66	27

Values in **bold** show a number of LED tubes in series with less than 20% light drop from first to last LED tube in series. *Italic* values shows a number with less than 30% light drop. Values in **white letters** show a number in series with more than 30% light drop and are not recommended.

Based on secondary fuse value used (see 5.1.2 Electrical safety), there is also a maximum of (connection) cable length (table 32). In case cables are longer, a short circuit on the end will not trip the fuse.

Please note that the cables and wirings inside LED tubes should also be included in this maximum!

32 Max total cable based on fuse values and thickness cable

	Max tot cable length[m]				
Fuse value	2x1.5mm ²	2x2.5mm ²	2x4mm ²	4x2.5mm ²	2x 14AWG
4A	200	345	550	1100	290
7.5A	110	180	290	580	150

5.1.2 Electrical safety

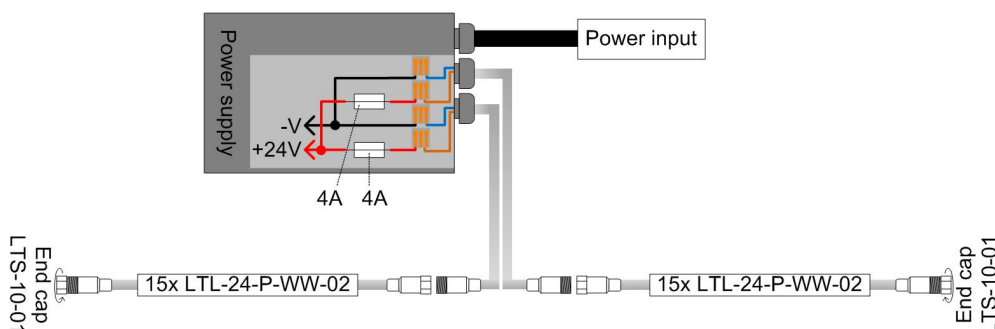
As mentioned before, it is strongly advised to place a fuse in between 24V DC output of power supply and LED tube series. This fuse can be an anti-surge glass fuse with a DC voltage rating of at least 30V DC. Maximum value should be 7.5A, but for optimal protection it is best to dimension the fuse current rating, based on the number of LED tubes connected in series.

To do this, please find the current rating for the type and number of tubes connected in series [n_s] in the suitable graph 19 or 20. Read out the current rating for the tubes connected series, add 20% to this value and round up to the nearest fuse current rating available.

In case multiple LED tube series are connected to one output, the current rating for each channel should be added for the fuse current rating. Best solution however, would be to use one fuse for each series of LED tubes in for example a junction box if a cable splits or split the number of lines immediately after the power supply with multiple fuses. This way if an error occurs on one line, the other line connected to the same power supply, will not go out. Also this allows for more exact fuse dimensioning.

For example:

One power supply is used to drive two LED tube lines with each 15 warm-white LED tubes in series (LTL-24-P-WW-02). In the "Current versus LED tubes in series" graph for this type it can be seen that current is almost 3A for 15 of these tubes connected in series at 24V DC. Add 20% to 3A (3.6A) and round up to nearest value could give a fuse rating of 4A. Power supply has one output of 24V DC, so two fuses should be added to this output to create 2 separate lines, which both have 2 wires going to the first LED tube.



A fuse holder with wires could be used to allow for easy mounting directly to output of power supply (see chapter 6 Accessories fuse set for example, order code LRT-2F7.5).




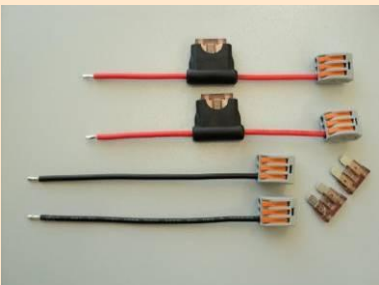
5.1.2.1 Hato Protection Unit




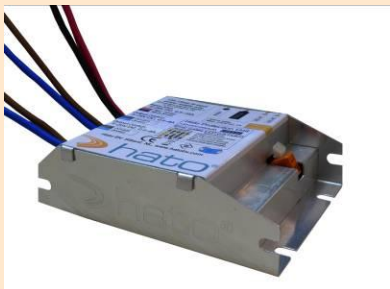
As an alternative to fuse, the Hato Protection Unit can also be used for a better more uniform protection without worrying about exactly dimensioning a fuse. Due to its advanced functions, it not only detects short circuits, but also monitors for sudden increases and decreases in power consumption and shuts down LED-products automatically in case faults are detected.

A separate datasheet for this product is available upon request with more details on connection and usage of this product combined with for example the LED-tube (see also chapter 6 Accessories).

6 ACCESSORIES

The list below contains most accessories available used to mount, power and protect the LED tube system. Other customized options also might be available upon request.

Stainless steel clip	Order code: LAC-20-RVS(/PVC)
	<p>Stainless steel fixing clip for LED tube, 20mm For quick assembly on 3mm wire to connect tubes in series. Also available in dipped plastic to prevent moving of the clips on LED tube. PVC colour is gray (LAC-20-RVS/PVC).</p>
Seal cap for cable	Order code: LTS-10-01
	<p>Waterproof seal cap for the extension cable of the LED tube light.</p> <p>One needed to close the last LED tube in each line to prevent water and dust from getting in connector and cable.</p>
Extension cable	Order code: LTC-300-01 / LTC-3000-01
	<p>Extension cable for LED tube Length: 300mm / 3000mm, including plugs, wires used 1.5mm² Colour: grey with white plugs</p> <p>Used to cover distance between following LED tubes or to connect power supply to first LED tube. When connected to power supply, male connector should be cut off.</p>
Fuse set 2x 7.5A	Order code: LRT-2F7.5
	<p>Fuse set for LED products 2x 7.5A with 2 spares. Use between output of power supply and LED tubes.</p>

Dimmable power supply	Order code: LRT-320DIM
	<p>Dimmable power supply 0-100% brightness 0-10V control-input, cooling fan inside Electronic transformer rated 320W - 13Amps. Input: 135 ~ 264V AC (47 ~ 63Hz), 124 ~ 370V DC Output: 13~24V DC stabilized Switch in front (left bottom) to switch between 13~24VDC (LED tube) and 17~24V DC (LED-rope) (default).</p> <p>Note: please ensure enough heat dissipation is possible when enclosing power supply!</p>
Fixed power supply	Order code: LRT-320
	<p>Fixed output power supply 100% brightness Cooling fan inside Electronic transformer rated 320W - 13Amps. Input: 135 ~ 264V AC (47 ~ 63Hz), 124 ~ 370V DC Output: 24V DC stabilized</p> <p>Note: please ensure enough heat dissipation is possible when enclosing power supply!</p>
Stainless steel case	Order code: NTB
	<p>Stainless steel case for LRT-320(DIM). Can house one power supply with Hato Protection Unit on top (order code: LRT-HPU-24V2x8A) using special bracket (order code: LRT-HPU-SUP).</p>
Hato Protection Unit	Order code: LRT-HPU-24V2x8A
	<p>High performance device for measurement, self-diagnosis and protection of short circuit and other problems with linear 24VDC LED lighting systems.</p>

APPENDIX A: CHANGELOG

Date	Description	By
2011-05-02	First release of datasheet	F. Grommen
2011-05-25	Changed lux values @ 50cm from new measurements	F. Grommen
2011-08-25	Added new WW tube, modified tables, added safety	F. Grommen
2011-12-15	Added half amber tube graphs, various text and specs corrections	F. Grommen
2012-01-16	Added tables for WW 0.9mtr. Added current / light attenuation graphs half LED tubes (WW & amber), changed accessories.	F. Grommen
2012-02-07	Various typographical errors fixed	F. Grommen
2012-06-20	Replaced 01 amber tube versions with 02	F. Grommen
2012-06-26	Modified product drawings with SMD LED's	F. Grommen
2012-09-11	Updated accessories with new photo, updated and HPU	F. Grommen
2012-09-18	Updated power consumption, delete old white types	F. Grommen
2012-09-18	Added graph with main characteristics for various tubes	F. Grommen
2012-09-25	Update electrical safety section to include Protection Unit	F. Grommen
2013-07-08	Added -03 for half tube, warm white, -02 type removed	F. Grommen
2014-01-17	Added table with recommended max connection cable lengths	F. Grommen