
ColorKinetics OneSpace TW

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White paper: Integration of OneSpace TW panels with circadian rhythm control

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1 Introduction

The ColorKinetics OneSpace portfolio consists out of 2 product ranges:

- ColorKinetics OneSpace Luminous Ceiling (OS LC)
- ColorKinetics OneSpace Prefab (OSP)

The differences between these 2 portfolios are mainly defined by the dimensions.

OneSpace Prefab comes in ready to mount panels with dimensions from 900mm x 900mm up to 1800mm x 3000mm.

OneSpace Luminous Ceiling is available in bigger sizes, up to 3000mm x 9900mm.

Because OneSpace Luminous Ceiling is too big to be delivered, ready to mount, in a box, the panel is divided in smaller modules that are installed as one panel on location.

With respect to controls and system integration the general control architecture is the same for both product ranges. The key difference is the total amount of drivers that are used in the panels. The total number of drivers is depending on the dimension of the panel.

OneSpace panels can be controlled via DALI or 0-10V control systems. The Tunable White panels are only available with DALI interface. 0-10V is only available for the fixed white versions and only for the US region.

White papers, similar as this one, are available for following topics:

- Integration of fixed white OneSpace panels with DALI controls
- Integration of fixed white OneSpace panels with 0-10V controls
- Integration of OneSpace TW panels with DALI controls
- Integration of OneSpace panels - occupancy / daylight harvesting
- Integration of OneSpace TW panels - circadian rhythm control
- OneSpace - Enabling internal DALI power supply of Philips Xitanium SR driver

For more information please contact your ColorKinetics representative.

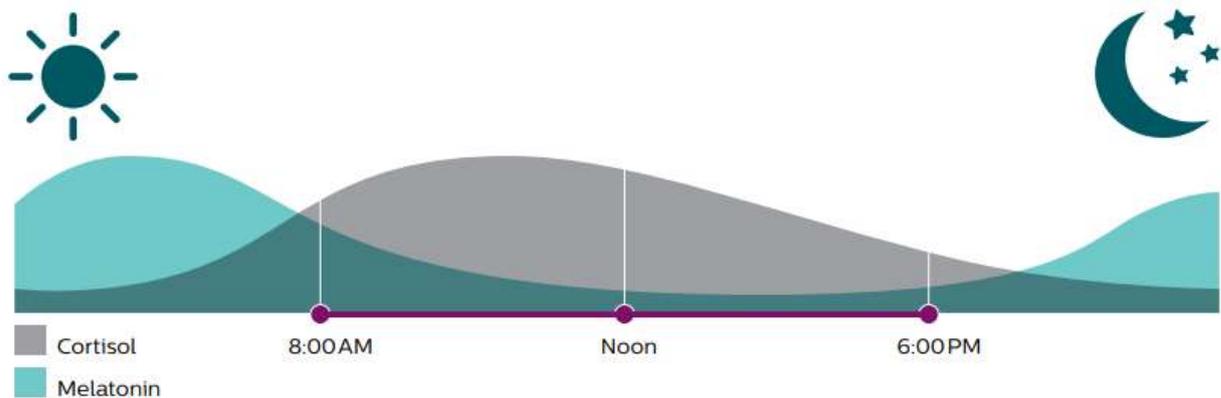
2 Tunable white

Lighting has a profound effect on the human body. It's more than just how we see. It also affects how we feel and how we function. Philips tunable white solutions are designed to help maximize the influence of lighting on your daily life.

The effect of light on our biological clock is important as it influences many aspects of our physical and emotional well-being. This biological clock is regulated by light and darkness, by the daily cycles of night and day and the time we spend asleep and awake. In the morning, as the sun comes up, light levels increase, the color of light shifts towards cooler color temperatures, and we wake up and become active.

On the other hand, in the evening, as the sun goes down and the color of light shifts towards warmer color temperatures, we unwind, relax and prepare for sleep. Our body's hormone levels rise and fall with these light cycles.

Cortisol production increases with morning light and decreases throughout the course of the day. Melatonin levels increase as darkness sets in and decrease as morning approaches. In our modern society, we spend much of our time indoors - at home, in a school, office, shop or hospital. Those who must stay indoors for significant parts of their time under static lighting conditions run the risk of disrupting their biological rhythms.



3 Control interface OneSpace TW

With OneSpace Tunable White we can control 2 parameters:

- Color temperature  2700K 6500K
- Lumen Output  0% 100%

OneSpace TW uses 2 sets of LEDs. The ratio between the Warm white (2700K) and Cold White (6500K) LEDs define the final color temperature. A OneSpace TW panel has 2 sets of drivers. Each set of drivers drive or the Cold White or the Warm White LEDs. Each set of drivers is grouped in a separate E-Box. This means that each module or panel has 2 E-boxes. 1 for the Cold White and another one for the Warm White drivers.

Only for the smallest OneSpace panels/modules, that only need 1 driver per set of LEDs, the 2 drivers are installed in the same E-Box. In that case the drivers are marked with CW or WW label.

3.1 DALI interface explanation

OneSpace modules/panels are controllable via a DALI 207 interface (digital addressable lighting interface). DALI is a two-way communication protocol that permits devices to be individually addressed and it also allows multiple devices to be addressed simultaneously via multicast or broadcast messages.

Each device is assigned a unique static short address in the numeric range 0 to 63. Which makes it possible to have maximum 64 devices on one DALI network. More devices can be controlled if a broadcast signal is used with a limit that the DALI bus current does not exceed 250mA.

Data is transferred between controller and devices via an asynchronous, half-duplex, serial protocol at a data rate of 1200 bit/s.

A two-pair wire cable is used for the DALI network. The network can be arranged in a bus or star topology, or a combination of these. DALI is not classified as SELV (Separated Extra Low Voltage) and therefore its wiring may be run next to mains cables or within a multi-core cable that includes mains power.

DALI wires can be connected to a device without regard for polarity with a maximum length of 300 meters.

3.1.1 DALI 209 vs 207

DALI 209 is introduced to simplify the controls of tunable white luminaires. Where DALI 207 needs multiple addresses for a TW setup, DALI 209 only needs one address. The driver needs to be DALI 209 compatible.

Short summary:

- DALI Type 6, also known as DALI 207
- DALI Type 6 for Tunable White uses two DALI short addresses.
Higher cost and complexity to achieve TW.
- DALI Type 8, also known as DALI 209
- Allows a user to change light color (DALI RGB systems), color temperature and intensity.
- A DALI Type 8 driver uses one DALI short address for Tunable White

Benefits DALI 209 vs DALI 207:

- Reduction number of DALI short addresses.
- Reduction number of DALI drivers needed to provide this color changing capability (if driver complies to DALI 209).
- Save on cost and complexity.

3.1.2 TW control via DALI 207 group addresses

TW control via DALI 207 group addresses

The drivers used for OneSpace TW panels are DALI 207 compatible. The separate E-boxes can be controlled via group address 0 (warm white) and 1 (cold white).

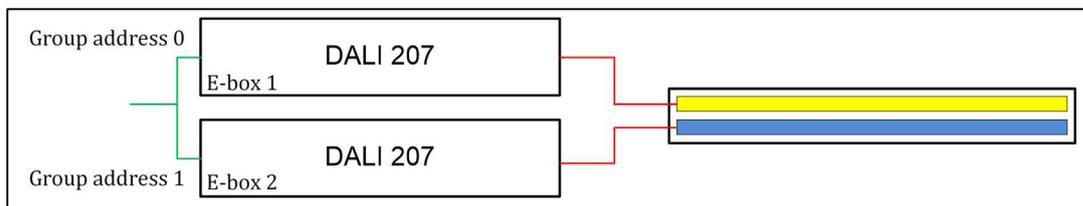


Figure 2: DALI 207 TW control via group address 0 and 1

Following table shows the ratio between WW and CW drivers for given CCT setting. For a CCT between the given values a linear approach can be used for calculation.

Table 1: CCT vs Driver power ratio

| CCT [K] | DRIVER POWER | |
|-------------|--------------|------|
| | 2700 | 6500 |
| 6500 | 0% | 100% |
| 6163 | 10% | 90% |
| 5817 | 20% | 80% |
| 5462 | 30% | 70% |
| 5098 | 40% | 60% |
| 4725 | 50% | 50% |
| 4342 | 60% | 40% |
| 3948 | 70% | 30% |
| 3543 | 80% | 20% |
| 3127 | 90% | 10% |
| 2700 | 100% | 0% |

3.1.3 TW control via additional DALI 209 interface

A DALI 207 interface can be made compatible with DALI 209 by adding an DT8 to DT6 convertor as in below example.

A DT8 to DT6 convertor that is compatible with OneSpace panels is available at Lunatone.

<https://www.lunatone.com/en/product/dali-dt8-to-dt6/>

Large Luminous Surfaces does not supply Lunatone components. These must be sourced locally. There is a Lunatone convertor available with a Philips code. **This version must be used with OneSpace panels.** The usage of other types can result in faulty DALI communication towards the driver.

- Lunatone DT8toDT6 – Philips version: 89453859



Figure 3: Lunatone DT8 to DT6 convertor

The Lunatone DT8toDT6 convertor uses the DALI power on the input network to power the 2 output DALI networks. This means that although the DALI controller will only “see” 1 device (Lunatone), the power load on the output (OneSpace drivers) must be taken into account when the DALI PSU is calculated.

3.1.4 DALI specifications OneSpace TW

DALI specifications Philips Xitanium drivers:

- Philips Xitanium 75W 0.7-2.0A 54V SR 230V
 - o 12nc: 9290.015.05006
 - o CE and CCC
- Philips Xitanium 75W 2.0A 54V SR 120-277V
 - o 12nc: 9290.007.27513
 - o UL
- DALI power consumption per driver: 2mA max.

Factory default settings:

1. Power on setting: DALI 229
 - When power is applied to the OneSpace Prefab, it will go to 50% light output. (mixed color)
2. System failure setting: DALI 229
 - When the DALI signal is lost the OneSpace Prefab goes to 50% light output. (mixed color)
3. Maximum: DALI 254
 - This is the maximum dimming level, so 254 mean Max DALI output is Max power setting.
4. Minimum: DALI 85
 - This is the minimum dimming level, so 85 means that the OneSpace Prefab panel is dimmable to 1%.
5. E-box 1: Warm color 2700K
6. E-box 2: Cold color 6500K
7. E-box 1: DALI group address 0
8. E-box 2: DALI group address 1

In case of small TW panels (see table below) only one E-box is needed with two drivers inside. This E-box can then be controlled via group address 0 (warm) and 1(cold) because there is only one DALI input connector.

3.2 Hardware explanation OneSpace

OneSpace has two major components

1. light panel (or module)
2. E-box that is connected to the light panel.

The E-box consists out of Philips Xitanium constant current drivers together with a terminal block for connecting mains and control interface.



Figure 4: Inside look of an E-box with the maximum quantity of drivers

The number of drivers inside an E-box vary with the size of the panel. Below table describes the number of drivers inside the E-box. In case of multiple OneSpace Prefab panels or in case of a OneSpace Luminous Ceiling panel which consists out of multiple modules, multiple E-boxes must be connected to the same control interface. Always check the maximum number of drivers that can be connected to the used control system. Contact your control system representative for more information.

Table 2: number of drivers vs panel/module size

| Number of 75W drivers vs module/panel size | | Width (mm and ft) | | | | |
|--|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | | 600/ 2 | 900/ 3 | 1200/ 4 | 1500/ 5 | 1800/ 6 |
| Length (mm and ft) | 900/ 3 | 1x E-box 2 drivers | 1x E-box 2 drivers | | | |
| | 1200/ 4 | 1x E-box 2 drivers | 1x E-box 2 drivers | 1x E-box 2 drivers | | |
| | 1500/ 5 | 1x E-box 2 drivers | 1x E-box 2 drivers | 1x E-box 2 drivers | 2x E-box 2 drivers | |
| | 1800/ 6 | 1x E-box 2 drivers | 1x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 3 drivers |
| | 2100/ 7 | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 3 drivers | 2x E-box 3 drivers |
| | 2400/ 8 | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 3 drivers | 2x E-box 3 drivers |
| | 2700/ 9 | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 3 drivers | 2x E-box 3 drivers |
| | 3000/ 10 | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 2 drivers | 2x E-box 3 drivers | 2x E-box 3 drivers |

Table 3: DALI current consumption per E-box

| E-box type | DALI current consumptions |
|-----------------|---------------------------|
| E-box 1 driver | 2mA max |
| E-box 2 drivers | 4mA max |
| E-box 3 drivers | 6mA max |

When setting up the DALI network it is important that the number of drivers in the project is known. If the maximum number of 64 devices in a DALI network is exceeded, a second DALI network is needed.

The number of drivers in the network also define the needed DALI power supply (together with all other DALI devices in the network). Be aware that the number of drivers can be higher than the number of E-boxes.

3.2.1 Example: 40 panels (size 1200mm x 2700mm).

Below example describes a project with 40 panels of the size 1200mm x 2700mm.

Each panel (or module) has 2 E-box with 2 drivers inside. So, we need $2 \times 40 \times 2 = 160$ DALI addresses.

This is not possible within 1 DALI network, so we must use multiple networks if we want to control all the panels (or modules) separately by an BMS.

For group control you can also use a broadcast signal.

A simple dimmer that sends a broadcast signal can control hundreds of panels if we make sure that we use the right hardware (DALI repeaters and DALI power supplies).

Each driver consumes 2mA on the DALI network, so in this example this would be 320mA (without taking into account the control devices in the network).

3.3 Inrush currents CE & CCC E-box

When using a lot of panels, care must be taken that the inrush currents are still within limits of the used circuit breaker. The following specification are valid for the Philips Xitanium 75W CE/CCC drivers that are inside the E-box.

Table 4: Inrush current - CE & CCC

| Specification | Value | Unit | Condition |
|-----------------------------------|-------|------|---|
| Inrush current I _{peak} | 24.9 | A | Input voltage 230V |
| Inrush current T _{width} | 215 | µs | Input voltage 230V, measured at 50% I _{peak} |
| Drivers / MCB 16A type B | ≤ 24 | pcs | |

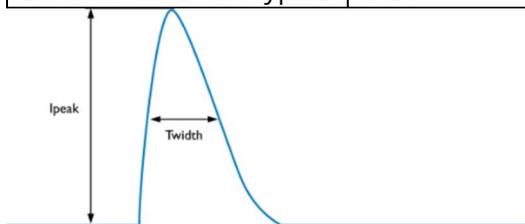


Figure 5: Inrush Current CE & CCC - info

Table 5: Number of drivers per MCB type

| MCB | Rating | Number of drivers |
|----------|------------|----------------------------------|
| B | 10A | 15 |
| B | 13A | 19 |
| B | 16A | 24 (default in datasheet) |
| B | 20A | 30 |
| B | 25A | 37 |
| C | 10A | 24 |
| C | 13A | 32 |
| C | 16A | 40 |
| C | 20A | 49 |
| C | 25A | 62 |

So, for a panel with 3 drivers, maximum 8 panels can be connected to an MCB 16A type B.

3.4 Inrush currents UL E-box

Table 6: Inrush current - UL

| Specification | Value | Unit | Condition |
|---------------------------|-------|---------|---|
| Inrush current I_{peak} | 24 | A | Input voltage 120Vrms |
| Inrush current Twidth | 369 | μs | Input voltage 120Vrms, measured at 10% I_{peak} |
| Inrush current I_{peak} | 57 | A | Input voltage 277Vrms |
| Inrush current Twidth | 348 | μs | Input voltage 277Vrms, measured at 10% I_{peak} |

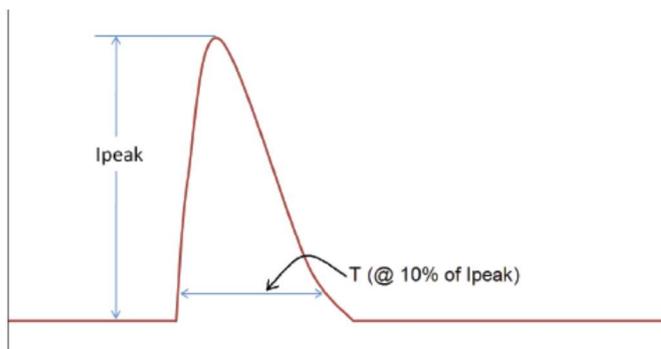


Figure 6: Inrush Current UL - info

4 Circadian rhythm control

Circadian rhythm control can be achieved in many ways. It can be done by programming the right daytime and color combinations in a BMS system or standalone with circadian rhythm control devices.

Below an example can be found for a standalone setup. No commissioning is needed. TA Lunatone DALI CDC is used together with the Lunatone DT8toDT6 convertor for automatic day time based adjustment of the color temperature and light level. Custom setup is possible with commissioning software of Lunatone.

<https://www.lunatone.com/en/product/dali-cdc/>

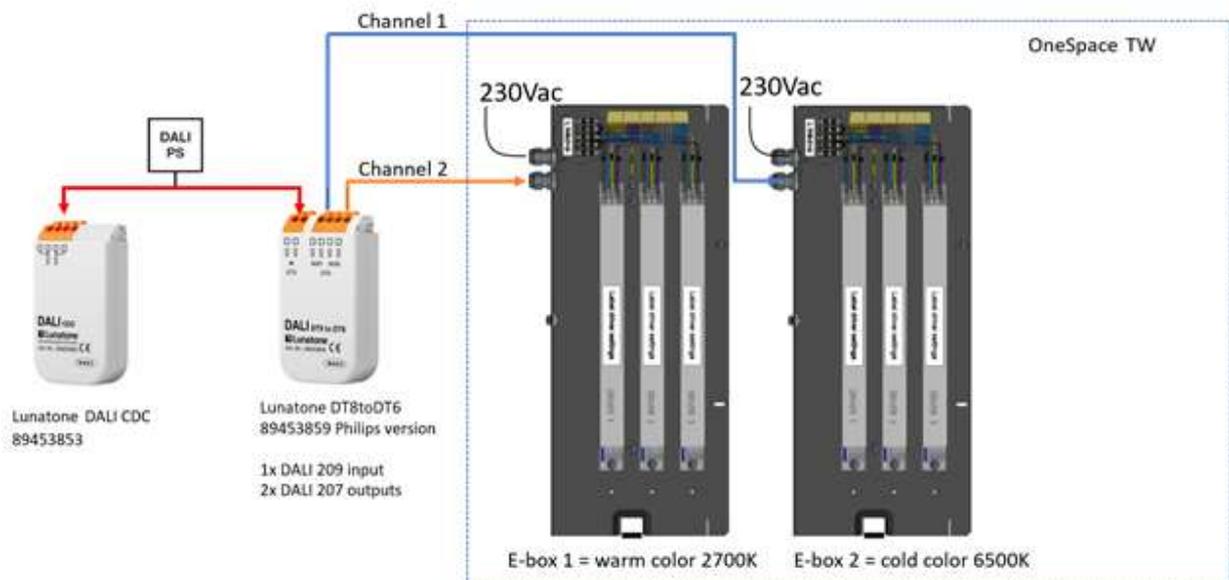


Figure 7: Example of TW setup with Lunatone DT8toDT6 convertor and Lunatone DALI CDC