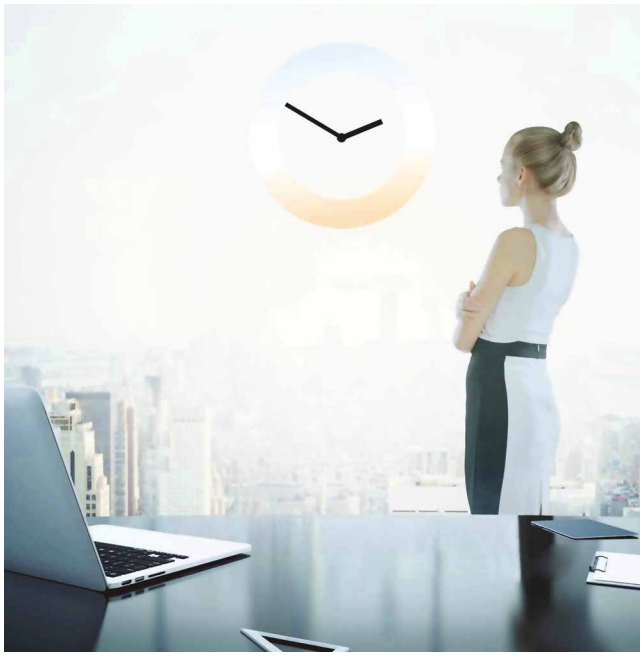
SMART Lighting

Features

4 Tunable White (TW) Dynamic Colour Mixing

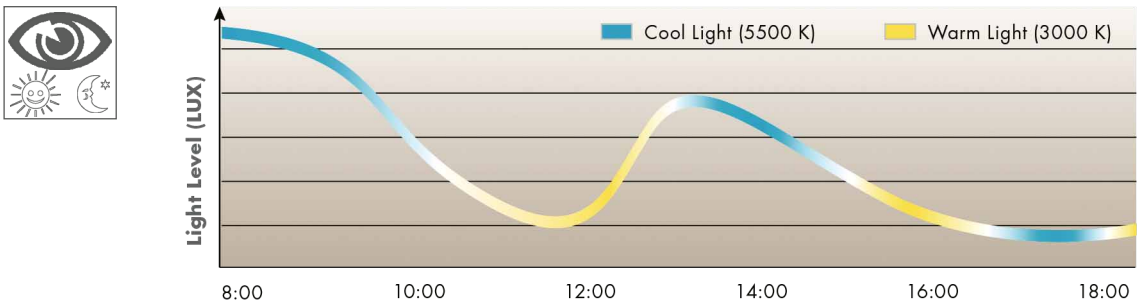
• Tuning a LED luminaire's colour

• miešanie farby svetla LED svietidla

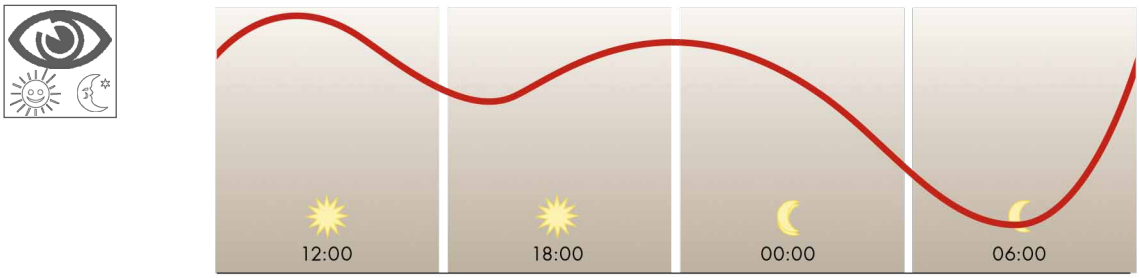


Since the LED is an electronic component, it may easily be controlled by intelligent LED drivers. One of the possibilities is to tune a LED colour, for example by composing the light from red, blue and green diodes (RGB). The result is either coloured light or white light with different colour temperatures .
Another point is the application of cool and warm light and their smooth transition resulting in different light atmosphere scenarios (tunable white TW).
Besides creating a nice environment, tuneable light can be used for healthpurposes. All human beings have an internal watch - controlled by the daylight. Bodily functions and performance vary over day time and we name this our circadian rhythm (circadian = circa one day). Cool and warm coloured light may affect whether you feel energysed or drowsy etc. Cool colour temperature lighting is suitable to be used for areas where concentration is needed, such as for working and reading.
Warm colour temperatures are used where relaxation is in place.
SEC offers you the possibility to always create a smooth and pleasant lighting scene for your project.

Vďaka inteligentným SEC elektronickým predradníkom je možné LED riadiť nielen výkonovo. Ďalšou z možností je nastavenie farby svetla, napr. mixovaním RGB LED alebo mixovaním bielych LED s rôznou teplotou chromatičnosti (TW Tunable White). Výsledkom je buď svetlo vo farebnom tóne alebo biele svetlo s rôznou teplotou chromatičnosti. Okrem možnosti vytvorenia príjemných svetelných scén je prínosom aj zdravotné hľadisko. Každý z nás má svoje "vnútorné hodiny" riadené denným svetlom. Naše telesné funkcie a výkonnosť sa menia počas dňa. Studenobiele a teplobiele svetlo môžu mať výrazný vplyv na to, či sa cítite unavený alebo plný energie.
Preto je studeno biele svetlo lepšie pre priestor a čas, v ktorom sa pracuje alebo číta, teda aktivity vyžadujúce koncentráciu.
A teplobiele svetlo je vhodné skôr pre relaxáciu a oddychové miesta.
SEC Vám ponúka možnosť vytvoriť si vždy príjemnú svetelnú atmosféru pre váš projekt.



TUNABLE WHITE TW / Dynamic lighting:
variantion in light levels and colours temperature over the course of the day



Human performance curve over the course of the day: Body and mind are fittest around 10 a.m. At 3 a.m., they reach their low.

SMART Lighting
Features

4 Human Centric Light (HCL)

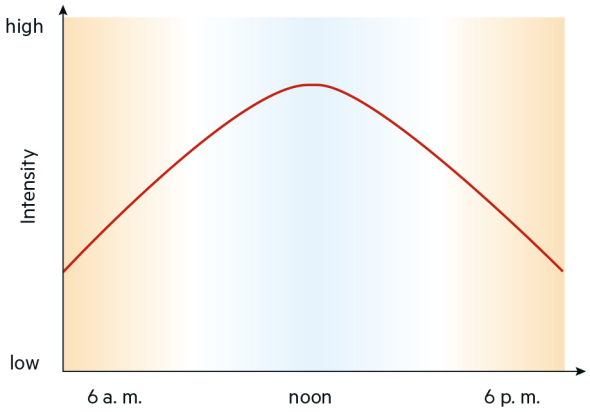
- Tuning a LED luminaire's colour
- miešanie farby svetla LED svietidla

Light individualisation with Tunable White

Tunable White describes the variable colour temperature controls from warm white to cool white light. If the right colour temeprature and illuminance are achieved, artificial light can promote human well-being also in public transport vehicles. As a pioneer in the area of Tunable White technology, SEC has consistently developed its opportunities and components since 2015.

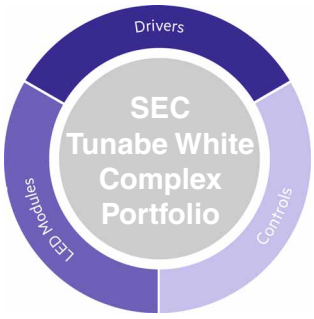


As humans, it is not uncommon for us to spend mst of our day in enclosed areas. Seamlessly adjustable colour temperatures - from cool white to warm white - bring natural lighting effects, with all of the associated advantages, from outside to inside, and make it possible to properly target individual needs and situations. As a result, **Tunable White supports the concept of Human Centric Lighting (HCL),** which puts people at the heart of lighting design. As well as perfect conditions for reading and working, HCL is primarily focused on the circadian rhythm, which controls, among other things, our body clocks. As studies have shown, cool white light with a high proportion of blue light has a stimulating effect and promotes concentration, whereas warm white light is calming. Therefore, Tunable White creates an environment that helps us in a natural way-just like daylight.

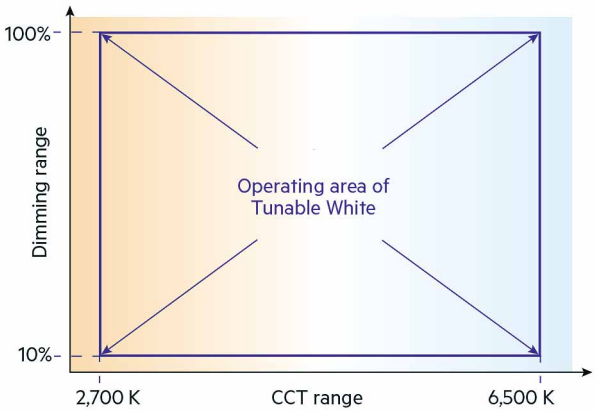


SEC Product portfolio

To simulate daylight in a manner that is as true to nature as possible, light from cool white and warm white LEDs covering entire olour palette from 2700K to 6500K is mixed together.
A driver with intelligent technology and a wide dimming range 10%(5%) to 100% are the basis of the Tunable White system.







5 DATA BUS Control

• DATA BUS Communication
• DATA BUS komunikačný systém

SMART Lighting system with data BUS communication containing all:

- lighting fixtures equipped with **addressable electronics** (SEC scope) communicating with SEC Lighting Control Unit (LCU) using our own communication protocol **(RS-485, DALI, CAN or PWM)**
- LCU collects the data on a train car level (SEC scope) communicating with train control and communication system TCMS (TCMS is train manufacturer scope) using customer defined communication protocol
- Optional **AMBIENT LIGHT SENSOR** (ALS) for additional energy savings by intelligent dimming based on ambient lighting conditions in train

There is a possibility to control and monitor all lighting fixtures in the lighting system including all:

• ADAPTIVE DIMMING
ensuring required illumination with **minimum energy consumption** based on ambient lighting level

• SERVICE DIAGNOSTICS
ensuring the **fault analysis for the maintenance** in real time including the defect item positioning information in the train (even down to LED stripe level)

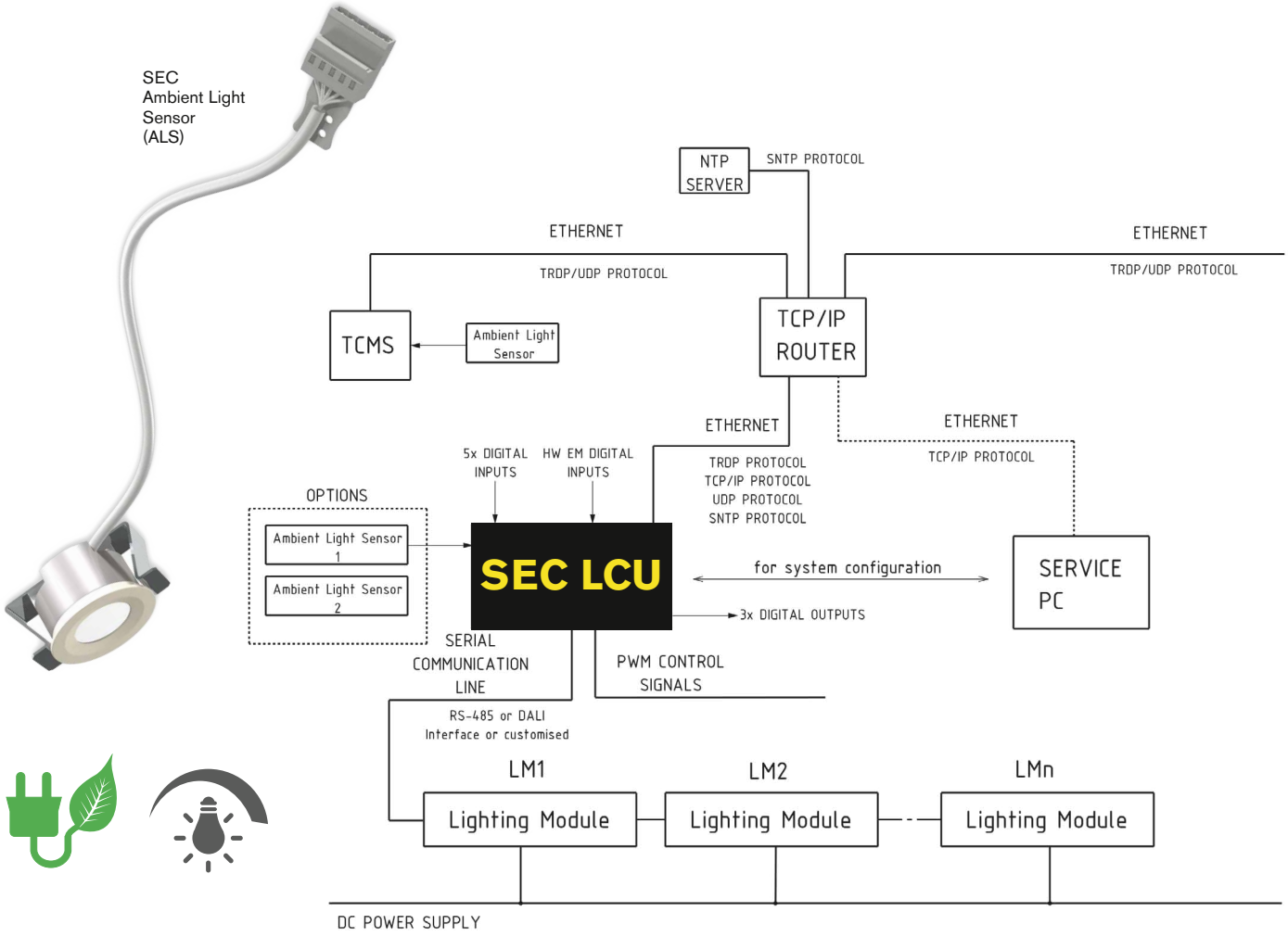
• LIGHTING SCENES
for creating **pleasant lighting atmosphere** depending on the ambient lighting conditions or time of the day or special lighting modes as for example cleaning, tunnel, night, ...etc (see also next page)

• SMART EMERGENCY LIGHTING
ensuring the possibility to **preset individual emergency lighting levels for specific areas** in train (corridors, exit areas, toilets, stairs, etc.) in **order to save the limited battery capacity** but still to meet EN13272 criteria at the same time

SMART Lighting
Features

LED Driver's terminals:
Prípojné svorky LED drivera:

• +Ucc	OUT + •
• 0V	OUT - •
• PE	
• EMERGENCY INPUT	
• DATA	
• DATA	



Tunable White & Adaptable Lighting Features - example of typical complex customised SEC solution including all: Tunable White 2700-6500K, RGB, Stepless Dimming 5-100%, Ambient Light Sensor (ALS), Customised preset lighting scenes/modes, PC Service mode, etc....

LIGHTING CONTROL UNIT - LCU

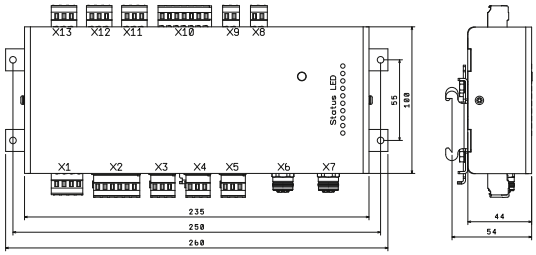
The main function of the LCU is to control the lighting system in a train.
The control is based on the **TCMS** which sends commands (inputs) **via Ethernet interface to LCU**. LCU transforms these commands into **DALI or PWM signals** for control of all the fixtures in the lighting system. The control of the fixtures can be performed by:

- either **TRDP (UDP)** commands from TCMS
- **or Automatic Control** based on 24-hours scenario
- **or** Lighting control based on **Digital inputs or Analog inputs**
- **or customised** solution...

SMART Lighting
Features

LCU settings are configured through an integrated web-based user interface.
The **WEB SERVER** provides access to the following configuration and monitoring functions:

- LCU configuration (general device parameters)
- Lighting fixture settings, including addressing, group assignment, emergency lighting parameters, and related options
- Configuration of automatic lighting control and operating modes, including scenario and mode tables
- PWM configuration for light output control
- TRDP configuration for communication and network parameters
- Real-Time status display and feedback for lighting fixtures and the LCU





NEW LCU 2.0 (Q2/2027)

LCU 2.0 represents the **next generation** of our Light Control Unit, designed with a strong focus on performance, security, safety and long-term flexibility. Built on the **NXP i.MX93 platform** and powered by an embedded **Linux operating system**, LCU 2.0 opens the door to significantly expanded software capabilities and **near-unlimited customization** tailored to customer and project-specific requirements.

Key Highlightss

- Next-generation hardware platform: NXP i.MX93
- Embedded Linux OS enabling advanced applications, long-term maintainability, and scalability
- New software architecture with extended functionality and future-ready design
- High level of software customization, allowing adaptation far beyond traditional embedded controllers
- 2× Ethernet interfaces (10/100 Mbit/s) for industrial networking and system integration

Security & Safety by Design

- Cybersecurity compliant with IEC 62443-4-1, Security Level 2 (SL 2)
- Hardware-based security with Security Element
- Secure foundations for future updates and lifecycle management

Reliability & Serviceability

- High-accuracy external RTC ensuring reliable timekeeping even in critical operating conditions
- USB service interface for diagnostics, maintenance, and service operations

SMART Lighting Features

1. ETHERNET INTERFACE

The LCU is connected to the train Ethernet network and supports both static and dynamic IP address configuration. The LCU can receive control commands addressed either to its individual IP address or to a multicast address, enabling simultaneous control of multiple LCUs. Likewise, data transmission to the control unit can be performed using unicast (IP-based) or multicast communication. The LCU listens on a user-configurable network port (or TRDP ports) and supports data exchange using the TRDP protocol, including both process data (PD) and message data (MD). In addition, communication based on a custom application-specific protocol is supported. The LCU is equipped with an integrated DHCP client, SNTP client and DNS client. When dynamic IP addressing is enabled, the LCU obtains the SNTP and DNS server addresses automatically from the DHCP server. If the LCU fails to receive configuration data from the DHCP server, it retains and applies the last success fully obtained SNTP and DNS addresses. The conditions governing IP address acquisition and fallback behaviour are configurable. When the static IP address configuration is selected, the SNTP and DNS server addresses must be configured manually by the user. All network, communication, and application parameters are configured via an integrated custom web server, which provides a user-friendly interface for system configuration, monitoring and diagnostics.

2. REAL TIME CLOCK

The LCU is equipped with an internal clock source. System time can be configured in multiple ways, either through automatic synchronisation via NTP, with periodic updates performed every 20 minutes, or manually via a service application.

3. ANALOG INPUTS

The analog inputs can be used either as inputs for the Ambient Light Sensor (ALS) function or assigned to a custom application-specific function. When configured for ALS, the analog inputs are used to measure the ambient light intensity. The acquired signal is transmitted directly to the control unit without local conversion. The conversion of the measured value to lux is performed within the TCMS. The signal processing and conversion procedure can be customised as required.

4.DIGITAL INPUTS

Digital inputs can be assigned to various control and signalling functions, including:

- PWM control switching
- Switching off DALI lighting fixtures on the DALI line
- Activation of operating modes
- Other configurable application-specific functions

The LCU also includes one dedicated digital input that is not configurable. This input is hardware-wired and is used to activate emergency lighting independently of software control.

5. DALI INTERFACE

The LCU is equipped with two independent DALI interfaces, each supporting up to 64 lighting fixtures (addresses). The LCU controls DALI control gears in full compliance with the DALI standard. Lighting fixtures can be controlled either by using individual addresses or group addresses or broadcast commands. The LCU supports assignment of lighting fixtures to upto 15 DALI groups per interface. The LCU controls lighting fixtures by setting operational parameters defined by the DALI standard, such as current light intensity and colour values. In addition, lighting fixtruers can be configured directly via the LCU, including addressing, grouping, and parameter setup. Emergency lighting operation can be activated by the LCU by switching off the DALI bus interface, causing connected lighting fixtures to enter emergency mode according to their configuration.

6. OUTPUT PWM PORTS

The PWM output frequency is configurable within a range of 200 Hz to 2500 Hz and is applied uniformly across all PWM ports. For each PWM port, it is possible to define initial light intensity and color values that are applied automatically upon LCU power-up or min /max values. The PWM outputs can be used to control light intensity and color parameters, depending on the connected lighting fixtures. For LCU variants that support PWM-only operation without bus communication, advanced PWM pattern configuration is available.

This includes:

- Assignment of PWM inputs to output ports
- Configuration of port names
- Definition of LED signaling states
- Implementation of functional groupings such as RGB, tunable white (TW), intensity control, and similar lighting functions PWM ports configured in this manner can be controlled via operating modes or automatically based on date and time schedules.

SCENARIO TABLE – AUTOMATED LIGHTING CONTROL

EXAMPLES OF LIGHTING MODES / LIGHTING SCENES:

SMART Lighting
Features

The **Scenario Table enables automatic lighting operation** when Auto Mode is enabled:

- Date-based configuration using day and month
- Individual time schedules for dimming level, Tunable White, and RGB color
- Automatic switching of lighting parameters at predefined times
- Compatible with DALI devices supporting TW and RGB
- Separate configuration for Dimming Level, RGB, and Tunable White

Lighting behavior adapts **automatically throughout the year** without manual intervention.

Group-Based Scenario Control

For advanced lighting installations, the LCU supports group-based control:

- Simple selection between Broadcast and Group mode

	Time	Intensity											
#		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	1.12
1	0:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
2	1:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
3	2:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
4	3:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
5	4:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
6	5:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	229 (50.53%)	229 (50.53%)	229 (50.53%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
7	6:0	210 (30.08%)	210 (30.08%)	229 (50.53%)	229 (50.53%)	246 (80.38%)	246 (80.38%)	246 (80.38%)	229 (50.53%)	229 (50.53%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
8	7:0	229 (50.53%)	229 (50.53%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	229 (50.53%)	229 (50.53%)	229 (50.53%)
9	8:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
10	9:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
11	10:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
12	11:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
13	12:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
14	13:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
15	14:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
16	15:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
17	16:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
18	17:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
19	18:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
20	19:0	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)	254 (100%)
21	20:0	246 (80.38%)	246 (80.38%)	246 (80.38%)	246 (80.38%)	254 (100%)	254 (100%)	254 (100%)	246 (80.38%)	246 (80.38%)	246 (80.38%)	246 (80.38%)	246 (80.38%)
22	21:0	229 (50.53%)	229 (50.53%)	229 (50.53%)	229 (50.53%)	246 (80.38%)	246 (80.38%)	246 (80.38%)	229 (50.53%)	229 (50.53%)	229 (50.53%)	229 (50.53%)	229 (50.53%)
23	22:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	229 (50.53%)	229 (50.53%)	229 (50.53%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)
24	23:0	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)	210 (30.08%)

INTENSITY CONTROL
Example of automatic intensity control based on date and time for Broadcast operation.

	Time	Colour (K)											
#		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	1.12
1	0:0	27	27	27	27	27	27	27	27	27	27	27	27
2	1:0	27	27	27	27	27	27	27	27	27	27	27	27
3	2:0	27	27	27	27	27	27	27	27	27	27	27	27
4	3:0	27	27	27	27	27	27	27	27	27	27	27	27
5	4:0	27	27	27	27	27	27	27	27	27	27	27	27
6	5:0	27	27	27	27	30	30	30	27	27	27	27	27
7	6:0	27	27	30	30	30	30	30	30	30	27	27	27
8	7:0	30	30	34	34	34	34	34	34	34	30	30	30
9	8:0	34	34	39	39	39	39	39	39	39	34	34	34
10	9:0	39	39	45	45	45	45	45	45	45	39	39	39
11	10:0	45	45	45	45	45	45	45	45	45	45	45	45
12	11:0	45	45	45	45	45	45	45	45	45	45	45	45
13	12:0	45	45	45	45	45	45	45	45	45	45	45	45
14	13:0	45	45	45	45	45	45	45	45	45	45	45	45
15	14:0	45	45	45	45	45	45	45	45	45	45	45	45
16	15:0	45	45	45	45	45	45	45	45	45	45	45	45
17	16:0	45	45	45	45	45	45	45	45	45	45	45	45
18	17:0	45	45	45	45	45	45	45	45	45	45	45	45
19	18:0	39	39	39	39	45	45	45	45	39	39	39	39
20	19:0	34	34	34	34	39	39	39	39	34	34	34	34
21	20:0	30	30	30	30	34	34	34	34	30	30	30	30
22	21:0	27	27	27	27	30	30	30	30	27	27	27	27
23	22:0	27	27	27	27	27	27	27	27	27	27	27	27
24	23:0	27	27	27	27	27	27	27	27	27	27	27	27

TW CONTROL
Example of automatic Tunable White (TW) control based on date and time for Broadcast operation.

	Time	RGB (Red,Green,Blue)											
#		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	1.12
1	0:0	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144	0,254,144
2	1:0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0	135,254,0
3	2:0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0	254,220,0
4	3:0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0	254,169,0
5	4:0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0	254,85,0
6	5:0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0	254,4,0
7	6:0	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106	254,0,106
8	7:0	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212	254,0,212
9	8:0	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254	127,0,254
10	9:0	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254	85,0,254
11	10:0	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254	0,80,254
12	11:0	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254	0,161,254
13	12:0	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254	0,237,254
14	13:0	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239	124,254,239
15	14:0	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152	159,254,152
16	15:0	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203	254,246,203
17	16:0	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202	254,170,202
18	17:0	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254	234,168,254
19	18:0	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254	160,182,254
20	19:0	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254	173,243,254
21	20:0	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158	135,254,158
22	21:0	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142	254,163,142
23	22:0	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254	244,102,254
24	23:0	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254	132,150,254

RGB CONTROL
Example of automatic RGB color control based on date and time for Broadcast operation.

SMART Lighting
Features

Pre-configured Modes and Scenario Control

The LCU features an intuitive web-based configuration interface for **defining operating modes and lighting scenarios**, ensuring flexible, stable, and reliable lighting control. Only the mode identifier is received from the TRDP network. All lighting parameters are pre-configured directly within the LCU, providing predictable behavior even in complex installations.

Mode Table Configuration

The Mode Table defines the lighting behavior for each operating mode:

- Adjustable dimming levels (0–255)
- Configurable DIM-to-percentage conversion
- Color temperature (Kelvin) setting per mode
- RGB color mixing per mode
- Support for Broadcast and Group control (Groups 0–15)

When a mode is received, the LCU automatically applies the corresponding preset parameters.

EXAMPLES OF LIGHTING MODES / LIGHTING SCENES:



- **Cleaning Mode:**
  to provide bright lighting for the personnel cleaning the car when the train is not transporting passengers. Its activation can be either by signal from TCMS “cleaning mode active” or by Cleaning Mode Button operated cleaning staff in each car individually.



- **Night Mode:**
  to reduce the lighting performance during the night time. Activated when local time is within the predefined range: start time (time of day), end time (time of day)



- **Tunnel or Station Mode:**
  to increase the light intensity when entering either tunnel or station, and return the light behaviour to normal level as soon as train exits it. Activated when TCMS signal TUNNEL or STATION occurs. The light intensity ramps up/down (enabled only during daytime)



- **Event Mode**
  to create different lighting effects (light colour and light intensity) in case of some events, for example a local football match is on this evening, or in case of the national holiday. Activated when date and time is within the predefined range



- **Last Station Mode**
  The signal / indication (light colour and light intesity) for all the passengers that the train has reached its last station and they need to leave the train

- **and any other Customised Modes are available....**

Example of mode configuration for intensity, Tunable White (TW), and RGB with support for Broadcast and Groups 0–15

SLINE MODE SETTINGS

Mode	Mode name	Broadcast			Group 0			Group 1			Group 2			Group 3			
		I	C	RGB	I	C	RGB	I	C	RGB	I	C	RGB	I	C	RGB	I
M1	Cleaning Mode	220 (39.52%)	30	254,47,0	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M2	Night Mode	216 (35.43%)	40	254,61,3	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M3	Tunel or Station Mode	254 (100%)	40	0,47,254	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M4	Event Mode	246 (80.38%)	36	23,239,254	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M5	Last Station Mode	254 (100%)	57	13,254,0	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M6	Custom mode 1	255 (M)	255 (M)	255,255,255 (M)	210 (30.08%)	40	229,254,86	203 (24.85%)	42	254,180,61	216 (35.43%)	38	191,254,0	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M7	Custom mode 2	216 (35.43%)	40	254,61,3	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M8	Custom mode 3	225 (45.30%)	47	254,15,186	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M9	Custom mode 4	229 (50.53%)	50	8,254,8	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M10	Custom mode 5	243 (74.06%)	55	254,254,254	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M11	Custom mode 6	254 (100%)	57	254,254,254	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)
M12	Custom mode 7	255 (M)	255 (M)	255,255,255 (M)	216 (35.43%)	40	127,180,254	0 (0%)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)	255 (M)	255,255,255 (M)	255 (M)

LIGHTING CONTROL UNIT LCU*1.0*-DALI

TECHNICAL DATA:

SMART Lighting

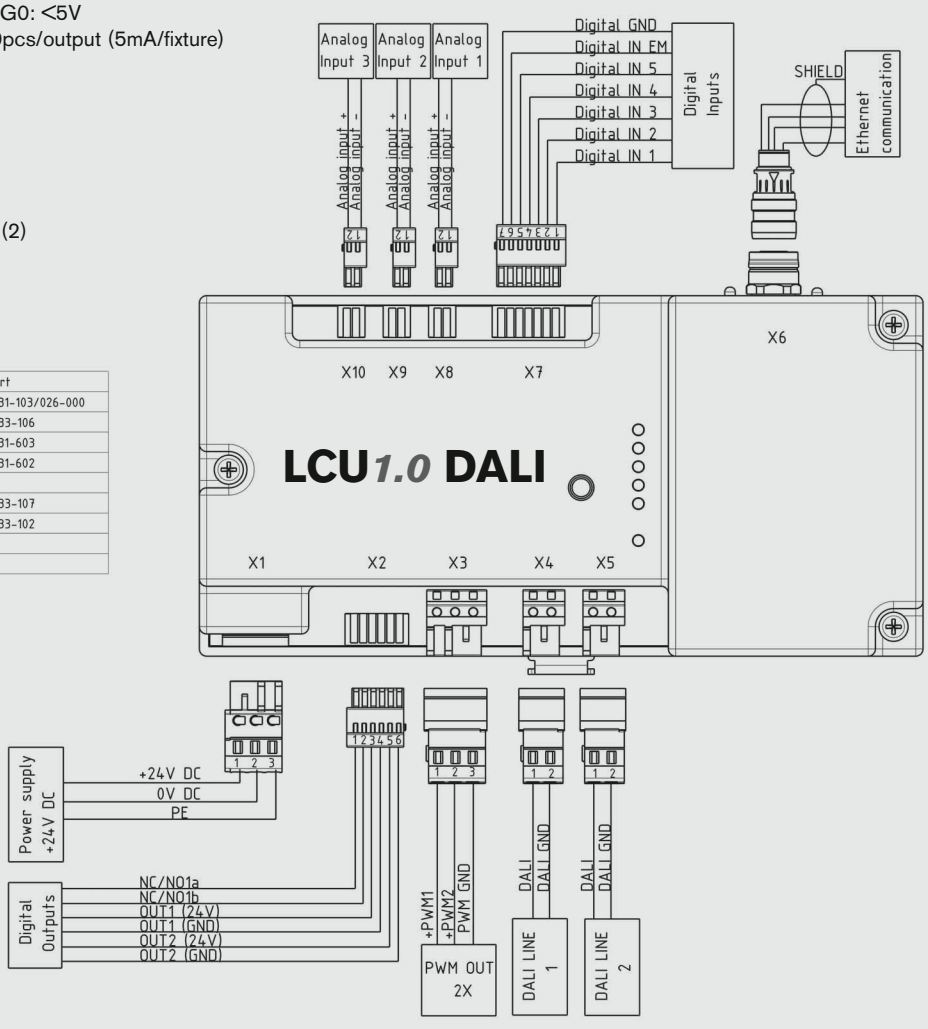
Features

- **24V DC Power Supply**
- **2x DALI Communication Lines**
- **2x PWM Output Lines**
- **1x Ethernet Interface 10/100 Mb/s**
- **5x Digital Inputs**
- **1x Digital Inputs Emergency**
- **3x Analogue Inputs 4÷20 mA**
- **1x Potential-free Digital Output**
- **2x +24V Digital Outputs**

- **Supply voltage range:**
  - 16.8V DC ÷ 33V DC
  - Interface: WAGO 231-433/001-000
- **Polarity protection:**
  - YES
- **Overvoltage protection:**
  - Continuously above 38V DC
- **Power Consumption:**
  - max 3A at 24V DC
- **2x DALI Communication Lines:**
  - max current: 250mA/line
  - Nominal voltage: 16V (EN62386-101)
  - Interface: WAGO 232-232
- **2x PWM Output Lines:**
  - Nominal voltage: 24V
  - Logic levels LOG1: 16,8V÷33V, LOG0: <5V
  - max Number of lighting fixtures: 200pcs/output (5mA/fixture)
  - Frequency: 200Hz ÷ 2.5kHz
  - Self-monitoring function: YES
  - Interface: WAGO 232-233
- **1x Ethernet Communication**
  - Connection: M12 D-code
  - Bitrate: 10/100 Mb/s
  - Interface: HARTING 21433814451(2)

- **6x Digital Inputs:**
  - Max Loading Rating: 40V/5mA
  - Galvanic Isolation: 500V
  - Interface: WAGO 733-367
- **3x Analogue Input:**
  - Max Voltage: 5V
  - Current: 4÷20mA
  - Interface: WAGO 733-362
- **1x Potential-free Digital Output:**
  - Relay Contact Data
  - max switching voltage: 220V DC / 250V AC
  - max continuous current: 2A
  - max switching power: 60W / 62.5VA
  - Initial contact resistance: <50mΩ at 10mA/20mV
- **2x +24V Digital Outputs:**
  - Logic Levels LOG1: 16,8V÷33V, LOG0: <5V
  - max Current: 0.5A/output
  - Interface: WAGO 733-366
- **RTC:**
  - Accuracy: +/- 20ppm (max +/-1.73 s/day)
  - BackUp Battery Lifetime: 10 years
- **Other:**
  - IP20
  - Weight: 450g
  - Dimensions: 200x100x60mm
  - Mechanical Interface: Fixation: DIN RAIL 35

POSITION	SEC ARTICLE	ITEM DESCRIPTION	Couterpart
X1	KNS0257	WAGO 231-433/001-000	WAGO: 231-103/026-000
X2	KNS0460	WAGO 733-366	WAGO: 733-106
X3	KNS0258	WAGO 232-233	WAGO: 231-603
X4, X5	KNS0616	WAGO 232-232	WAGO: 231-602
X6	KNS0613	HARTING 21 43 381 4451	-
X7	KNS0615	WAGO 733-367	WAGO: 733-107
X8,X9,X10	KNS0614	WAGO 733-362	WAGO: 733-102



LCU1.0-PWM LIGHTING CONTROL UNIT

TECHNICAL DATA:

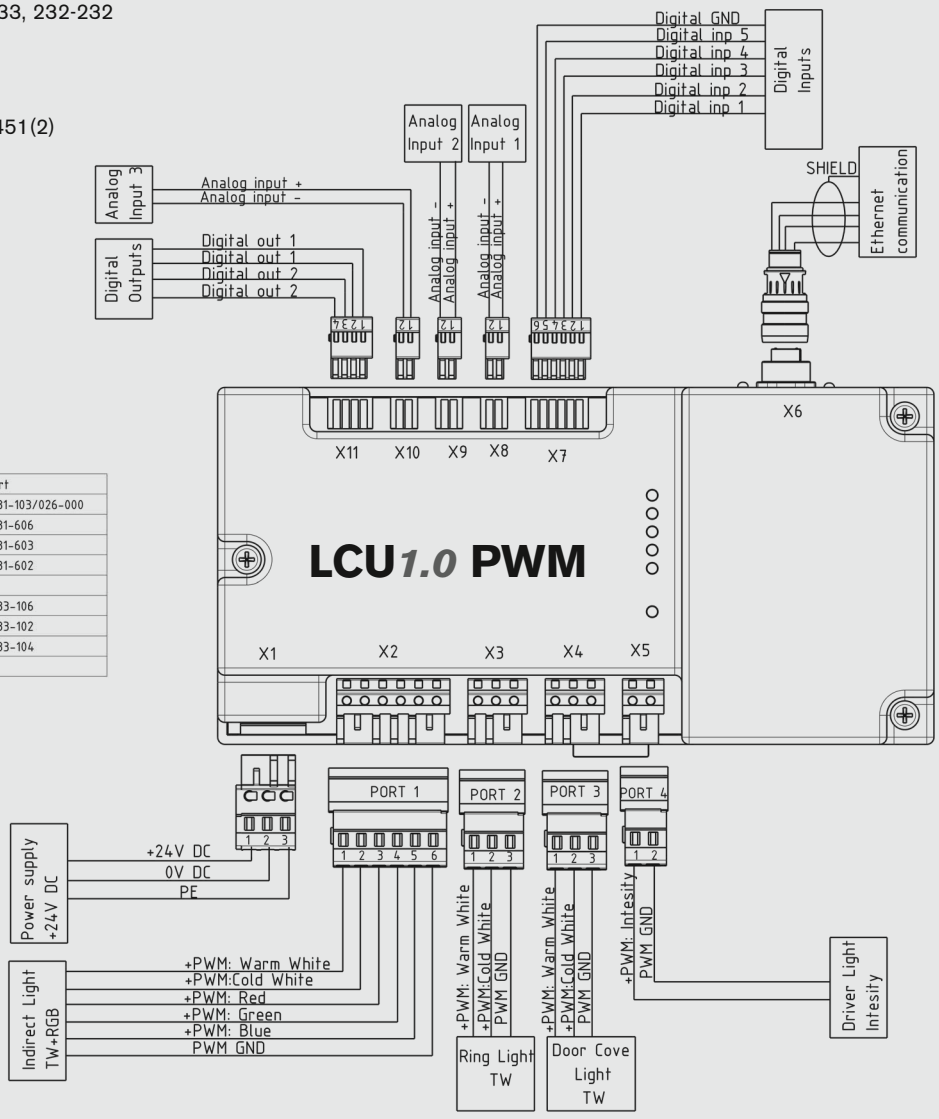
SMART Lighting

Features

0• 24V DC Power Supply
• 10x PWM Output Lines
• 1x Ethernet Interface 10/100 Mbps
• 5x Digital Inputs
• 3x Analogue Inputs 4÷20 mA
• 2x Potential-free Digital Output

- **Supply voltage range:**
  - 16.8V DC ÷ 33V DC
  - Interface: WAGO 231-433/001-000
- **Polarity protection:**
  - YES
- **Overvoltage protection:**
  - Continuously above 38V DC
- **Power Consumption:**
  - max 5A at 24V DC
- **10x PWM Output Lines:**
  - Nominal voltage: 24V
  - Logic levels LOG1: 16,8V÷33V, LOG0: <5V
  - max Number of lighting fixtures: 200pcs/output (4mA/channel)
  - Frequency: 200Hz ÷ 2.5kHz
  - Self-monitoring function: YES
  - Interface: WAGO 232-233, 232-233, 232-232
- **1x Ethernet Communication**
  - Connection: M12 D-code
  - Bitrate: 10/100 Mb/s
  - Interface: HARTING 21 43 381 4451(2)
- **5x Digital Inputs:**
  - Max Loading Rating: 40V/5mA
  - Galvanic Isolation: 500V
  - Interface: WAGO 733-366
- **3x Analogue Input:**
  - Max Voltage: 5V
  - Current: 4÷20mA
  - Interface: WAGO 733-362
- **2x Potential-free Digital Output:**
  - Relay Contact Data, WAGO 733-364
  - max switching voltage: 220V DC / 250V AC
  - max continuous current: 2A
  - max switching power: 60W / 62.5VA
  - Initial contact resistance: <50mΩ at 10mA/20mV
- **RTC:**
  - Accuracy: +/- 20ppm (max +/-1.73 s/day)
  - BackUp Battery Lifetime: 10 years
- **Other:**
  - IP20
  - Weight: 450g
  - Dimensions: 200x100x60mm
  - Mechanical Interface: Fixation: DIN RAIL 35

POSITION	SEC ARTICLE	ITEM DESCRIPTION	Couterpart
X1	KNS0257	WAGO 231-433/001-000	WAGO: 231-103/026-000
X2	KNS0617	WAGO 232-236	WAGO: 231-606
X3,X4	KNS0258	WAGO 232-233	WAGO: 231-603
X5	KNS0616	WAGO 232-232	WAGO: 231-602
X6	KNS0613	HARTING 21 43 381 4451	-
X7	KNS0460	WAGO 733-366	WAGO: 733-106
X8,X9,X10	KNS0614	WAGO 733-362	WAGO: 733-102
X11	KNS459	WAGO 733-364	WAGO: 733-104



LIGHTING CONTROL UNIT LCU2.0

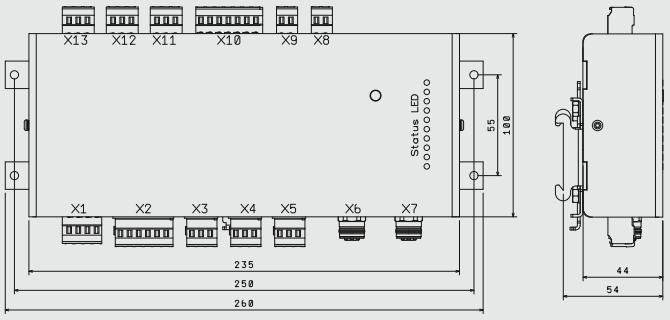
TECHNICAL DATA:

SMART Lighting

Features

- **24V or 110V DC Power Supply**
- **3x Communication Interfaces / Lines:**
  - DALI (standard)
  - RS-485 (optional)
  - CAN (optional)
- **5x PWM Output Lines**
- **2x Ethernet Interface 10/100 Mb/s**
- **5x Digital Inputs**
- **1x Digital Inputs Emergency (SIL1)**
- **2x Analogue Inputs 4÷20 mA or RS485 for Ambient Light Sensor (ALS)**
- **1x Potential-free Digital Output**
- **3x Digital Outputs -** Potencional-free Relay Conctacts

- **Supply voltage range:**
  - 16.8V DC ÷ 33V DC (optional 16,8V DC ÷ 160V)
  - Interface: WAGO 231-434/001-000
- **Protection:**
  - Polarity protectionYES
  - Overvoltage protection
- **Rated Power:**
  - max 60W (depends on version)
- **3x Communication Interfaces / Lines:**
  - max current for DALI: 250mA/line
  - Nominal voltage for DALI: 16V (EN62386-101)
  - Optional RS-485, CAN
  - Interface: WAGO 232-233 (optional for DALI: WAGO 232-232)
- **5x PWM Output Lines:**
  - Nominal voltage: 24V
  - Logic levels LOG1: 16,8V÷33V, LOG0: <5V
  - max number of lighting fixtures per PWM channel: 60pcs/PWM output (5mA/fixture)
  - Frequency: 200Hz ÷ 2.5kHz
  - Self-monitoring function: YES
  - Interface: WAGO 232-236
- **2x Ethernet Communication**
  - Connection: M12 D-code
  - Bitrate: 10/100 Mb/s
  - Interface: HARTING 21 43 381 4452
- **2x Analogue Inputs:**
  - Max Voltage: 5V
  - Current: 4-20mA
  - Galvanic Isolation: 2,5kV
  - Optional: RS-485 for Ambient Light Sensor (ALS)
  - Interface: WAGO 231-432/001-000
- **6x Digital Inputs:**
  - Max Loading Rating: 40V/5mA (optional 140V/5mA)
  - Galvanic Isolation: 2,5kV
  - 5x configurable sotware functions
  - 1x active hardware-based emergency funtion for DALI, compliant with SIL1 requirements
  - Interface: WAGO 231-437/001-000
- **3x Potential-free Digital Output:**
  - Relay Contact
  - Contact Ratings:
    - 125V, 0.24A, 30W
    - 30V, 2A, 60W
  - Initial contact resistance: < 50mΩ at 10mA/20mV
  - Interface: WAGO 231-433/001-000
- **Other:**
  - Security Element
  - External RTC with Battery Backup
  - IP20
  - Mechanical Interface: Screw Fixation or DIN rail 35 mounting
  - Dimmensions: 260x100x44mm (54mm with DIN rail)





SMART Lighting
Features

NEW LCU 2.0 (Q2/2027)

LCU 2.0 represents the **next generation** of our Light Control Unit, designed with a strong focus on all: performance, security, safety and long-term flexibility. Built on the **NXP i.MX93 platform** and powered by an embedded **Linux operating system**, LCU 2.0 opens the door to significantly expanded software capabilities and **near-unlimited customization** tailored to customer and project-specific requirements.

Key Highlightss

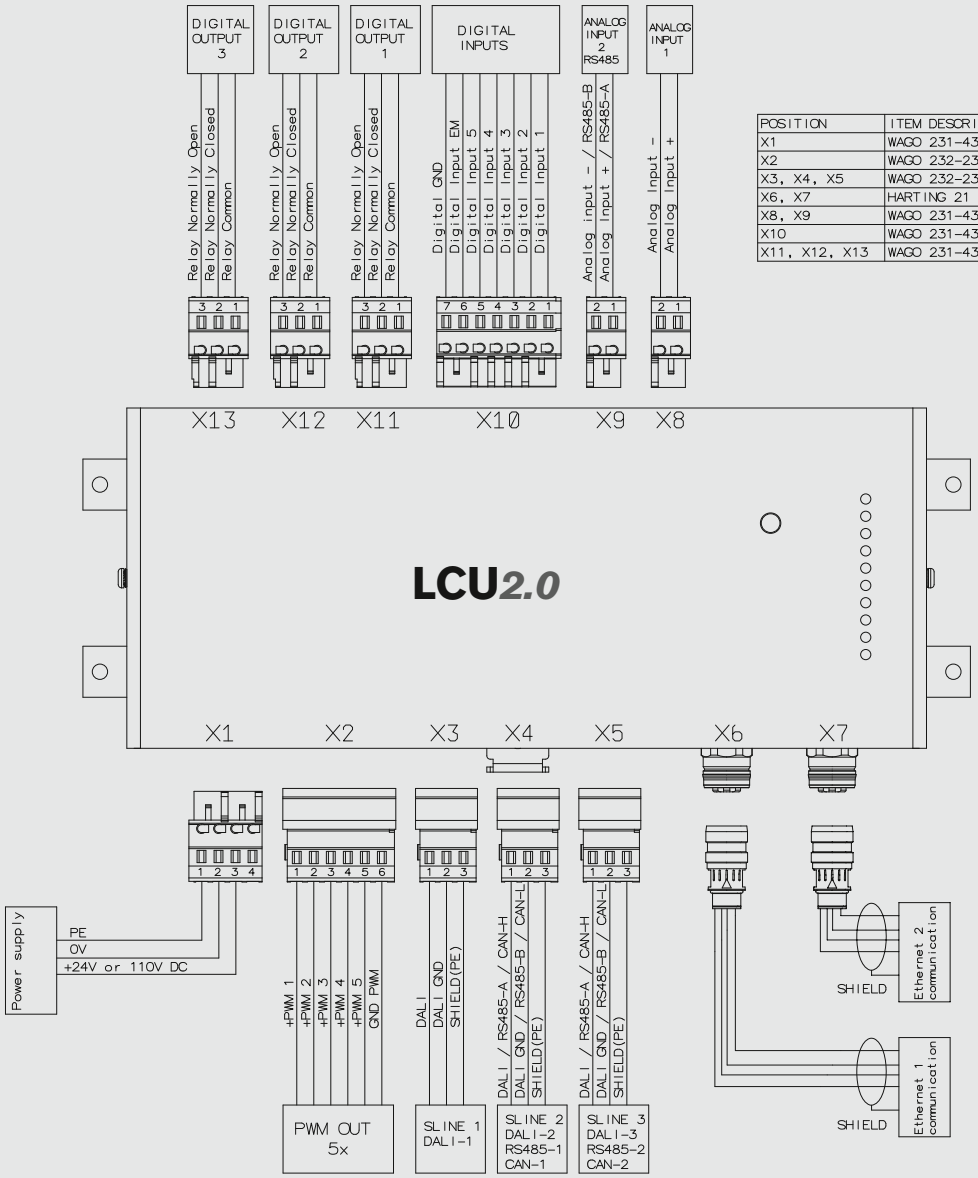
- Next-generation hardware platform: NXP i.MX93
- Embedded Linux OS enabling advanced applications, long-term maintainability, and scalability
- New software architecture with extended functionality and future-ready design
- High level of software customization, allowing adaptation far beyond traditional embedded controllers
- 2× Ethernet interfaces (10/100 Mbit/s) for industrial networking and system integration

Security & Safety by Design

- Cybersecurity compliant with IEC 62443-4-1, Security Level 2 (SL 2)
- Hardware-based security with Security Element
- Secure foundations for future updates and lifecycle management

Reliability & Serviceability

- High-accuracy external RTC ensuring reliable timekeeping even in critical operating conditions
- USB service interface for diagnostics, maintenance, and service operations



POSITION	ITEM DESCRIPTION	Couterpart
X1	WAGO 231-434/001-000	WAGO 231-104/026-000
X2	WAGO 232-236	WAGO 231-606
X3, X4, X5	WAGO 232-233	WAGO 231-603
X6, X7	HARTING 21 43 381 4451	M12 D-code
X8, X9	WAGO 231-432/001-000	WAGO 231-102/026-000
X10	WAGO 231-437/001-000	WAGO 231-107/026-000
X11, X12, X13	WAGO 231-433/001-000	WAGO 231-103/026-000

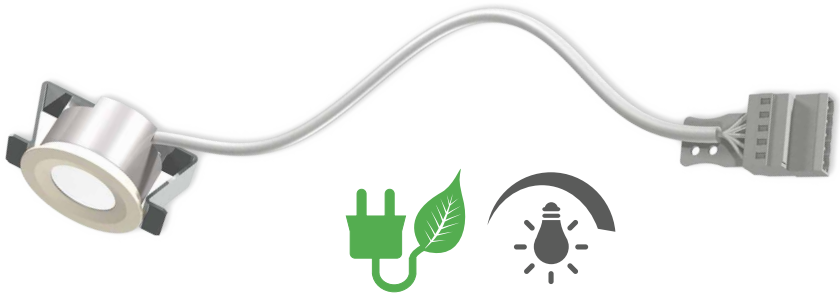
AMBIENT LIGHTING SENSOR (ALS)

Ambient Lighting Sensor is optional device for LCU for **Automatic Light Level Control** in a train interior (passanger saloon). It measures the ambient light level (sun) which contributes to achieve the required train interior light level. Based on the measured values LCU continuosly maintains the required lighting level (power of LED lighting fixtures is reduced which brings the power consumption savings).

It operates with **SEC Lighting Control Unit (LCU)**, see also page No.41-53

SMART Lighting

Features

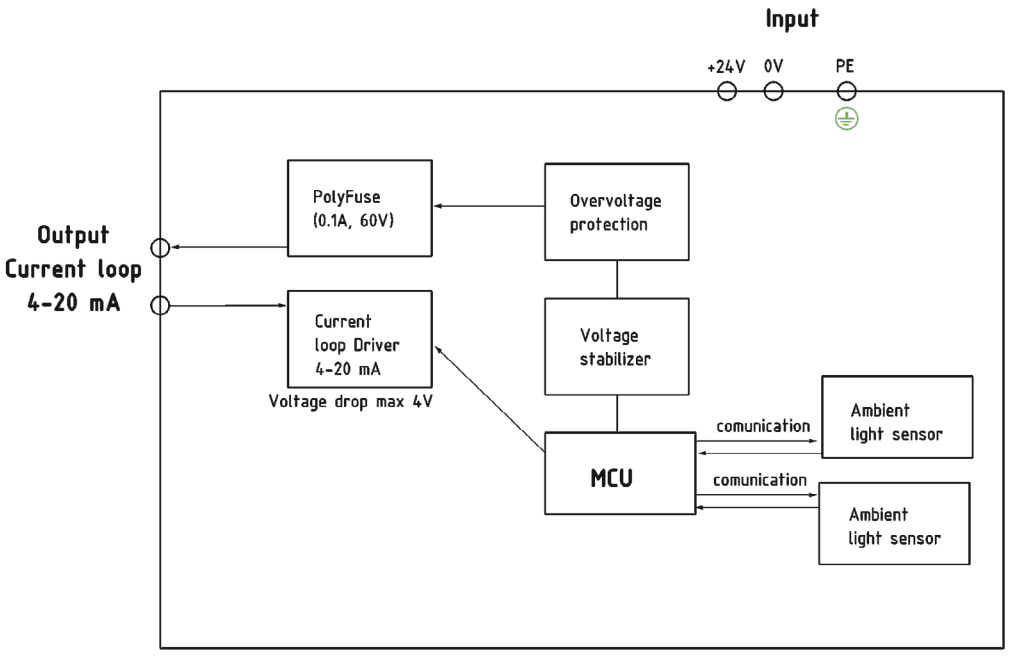


Electrical parameters:

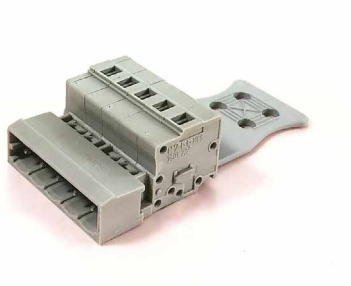
• Nominal voltage U_n:	24V DC
• Supply voltage range:	16.8V DC ÷ 33V DC
• Polarity protection:	YES
• Overvoltage protection:	Continuously above 36V DC
• Electrical interface:	WAGO connector 231-605/033-00

Outputs:

• Output current loop:	4-20 mA (optional RS-485)
• Output of lux via current:	0-1000 lux (where 0 lux = 4mA and 1000 lux = 20mA)
• Load resistance:	Max. 500 Ω (output voltage 0-10 V) Typically 250 ohms (output voltage 0-5 V)
• No-load-voltage approx.:	Un -4V
• Permissible overrating:	Approx. 10 %
• Error message:	Output current < 3.5 mA



Mechanical design
- Sensor Dome: made of solid AL, anodised or powder painted surface treatment (RAL defined by customer)
- Weight: 0.25kg
- Dimensions: see below



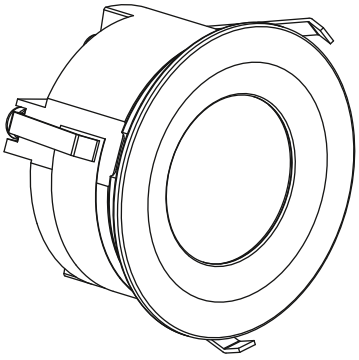
WAGO Connector PINs:
- 1: +24Vdc
- 2: 0V
- 3: PE
- 4: + Output 4-20mA (optional RS485-A)
- 5: - Output 4-20mA (optional RS485-B)

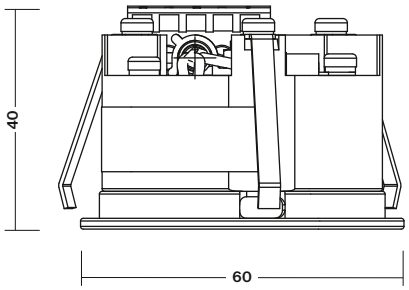
SMART Lighting
Features

Available types / Order Codes:

- Order code: **351-B-001-01-00**
  - Colour: RAL9003
  - Mechanical Interface: VERSION 2
  - Electrical interface: WAGO 231-605/000-044/033-000)
- Order code: **351-B-002-01-00**
  - Colour: RAL DESIGN 260 90 05
  - Mechanical Interface: VERSION 1
  - Electrical Intefrace: WAGO 231-605/000-044/033-000)
- Order code: **351-B-002-01-01**
  - Colour: NCS-S-4005-Y20R
  - Mechanical Interface: VERSION 1
  - Electrical Intefrace: WAGO 231-605/000-044/033-000)

VERSION 1: "CLICK" installation, screwless mounting from a ceiling panel frontside (ceiling panel thickness 1,5-3,0mm)





VERSION 2: Screwless mounting by the bracket from a ceiling panel backside (ceiling panel thickness 1,5-2,5mm)

