



Dynalite

Engineering Specification

Revision 10

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Background

Dynalite is a highly specialized company whose principal mission is to provide 'cutting edge' solutions for lighting control. Our achievements have been recognized worldwide, and Dynalite is generally the system of choice for projects involving integration with third-party vendor's equipment and for large-scale applications.

Dynalite's philosophy is to provide the best solution possible for each and every project. This is the key to our success. We are at the core of connected systems, providing innovative quality products which integrate seamlessly, creating enhanced user experience leveraging on our extensive Lighting & integrated controls expertise. Our team collaborates end to end in the Design and Manufacturer of robust world-class products. This allows our end customers to effectively adapt systems to their needs into the future, in a scalable & energy efficient manner without compromise.

Our considerable investment in Research and Development ensures that we remain at the forefront of our industry. Our position as a world leader in lighting management systems for the future is sustained through our total commitment to innovation.

We are represented around the world by distributors and dealers who are handpicked for their ability to provide the highest possible level of service.

Dynalite lighting control system has been entrusted with many highly demanding applications in airports, tunnels, and hospitals, manufacturing, warehousing, hotels, and homes.

Ongoing research and development enable Dynalite to create secure automated systems that control tens of thousands of individual light luminaires in mission critical sites like hospitals across the globe. Our networks are engineered to deliver an alert notification of power or system failure. This provides the assurance necessary in applications where continuous operation is vital, such as airports, road tunnels, healthcare, & assisted living.

Dynalite's modular product design philosophy also improves system flexibility. Through this approach, specific application requirements can be accommodated with greatly reduced lead times. As an industry leader Dynalite is committed to creating superior lighting control and energy management systems, setting new benchmarks in performance and efficiency.

In receiving the International Association of Lighting Designers award for Most Innovative Product, the Dynalite control system has been independently recognized as 'A user friendly and sensible modular approach, with reliability that can be depended upon in the most critical project applications. Ready to scale from small single suit fit outs to an entire campus.

Dynamalite's commitment to quality starts with all devices being designed internally and cross network tested to ensure seamless operation regardless of the functionality or network scale. All hardware is manufactured in-house and individually tested to real project conditions to ensure that every project can depend on a Dynamalite solution.

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1 Introduction

This document refers to the Network Lighting Control System (NLCS).

The manufacturer of the control system components shall be an established supplier who has a minimum of twenty years' design experience with multiple generations of unit development which have been improved upon with field proven devices. The manufacturer of the control system components shall have extensive examples of local reference projects demonstrating their competence in successful delivery of control system projects.

The manufacturer shall be able to demonstrate continuous involvement in the local NLCS or BMS market to ensure future support.

The manufacturer is responsible for all devices on the network to be full internal interoperability tested with all other devices at scale of the control system within the project. This is to ensure seamless operation and full support for all system functionality so that no network system incompatibilities are discovered on site.

The manufacturer's product range shall support both UL and CE certification so that the system architecture can be used globally. This requirement allows clients to have a global specification and define consistent features and functionality for all projects regardless of the region where the system is installed.

Any manufacturer certification shall be clearly shown with consistency within their own documentation to the certification authority. There shall be no ambiguity regarding part codes or conditions of which the certifications are applicable.

All products supplied as DALI-2 devices within the lighting-control system shall be listed in the DALI Alliance / DiiA Product Database under the exact product model, order code, catalogue number, or full part number being supplied to the project. Products that claim DALI-2 functionality but cannot be verified against the DALI Alliance / DiiA Product Database shall not be accepted.

Any product providing BACnet functionality shall be BACnet Testing Laboratories certified and listed in the public BTL Listing of Tested Products.

All control system components shall be from the same manufacturer. The manufacturer shall directly support the following options within its own range of products.

- User Interfaces (UI) / Keypads
- Color Touchscreens
- Sensors:
 - Passive Infrared (PIR)
 - Dual technology occupancy sensing Ultrasonic (US) & (PIR)
 - Photo Electronic light level (PE)
- Infrared Receive (IR)
- Relay Switching Controllers
- Double Throw Relay Motor Controllers

- Phase-cut (leading edge or forward phase and trailing edge or reverse phase) Power modification Dimming Controllers
- Signal Dimming Controllers supporting 1-10V, DALI Broadcast
- DALI-2 multi master
 - DALI emergency
 - DALI energy / diagnostics
 - DALI input devices
- Modular output controllers
- PWM LED Controllers
- Head-end user software
- Personal apps

Integration and networking gateways to other systems:

- Secure and encrypted Ethernet 10/100 Base T
- KNX gateway
- BACnet/IP gateway
- DMX512 Tx & Rx
- Somfy via RS-485
- Modbus via RS-485
- RS-232
- RS485
- Low level Dry Contact
- Analog 1-10V input/output
- Infra-red Tx & Rx

2 Approved Vendors

The equipment shall be Signify Dynalite or approved equal.

3 Compliance

In accordance with CE & UL compliance requirements, the network control system shall comply with the applicable European EMC Directive, Low Voltage Directive, Radio Equipment Directive, RoHS Directive, REACH Directive and other relevant international standards including but not limited to the following:

Low Voltage Directive: 2014/35/EU

Essential (safety) requirements for electrical equipment and components designed for use with a voltage rating of between 50 and 1000 V AC and between 75 and 1500 V DC.

EN 50491-3: Electrical safety requirements for HBES/BACS

EN 50491-4-1: General functional safety requirements for HBES/BACS

EN 60730-1: Automatic electrical controls Part 1: General Requirements

EN 62368-1: Information technology equipment – Safety – Part 1: General requirements

EN 60669-2-1: Particular requirements – Electronic switches

EMC Directive: 2014/30/EU

EN 50491-5-1: EMC requirements, conditions and test set-up for HBES/BACS
 EN 50491-5-2: EMC requirements for HBES/BACS
 EN 61000-6-1: Immunity for residential, commercial and light-industrial environments
 EN 61000-6-3: Emission standard for residential, commercial and light industry
 EN 61000-4-2: Electrostatic discharge immunity
 EN 61000-4-3: Radiated RF immunity
 EN 61000-4-4: Electrical fast transient/burst immunity
 EN 61000-4-5: Surge immunity
 EN 61000-4-6: Conducted RF immunity
 EN 61000-4-8: Power frequency magnetic field immunity
 EN 61000-4-11: Voltage dips, short interruptions and voltage variations immunity

RoHS Directive: EU and NAM RoHS Directive 2011/65/EU

REACH Directive: EC No. 1907/2006

EN 62386 Digital addressable lighting interface (DALI):

EN 62386-101: General requirements – System components
 EN 62386-103: General requirements – Control devices
 EN 62386-104: General requirements – Wireless system components
 EN 62386-202: Control gear for self-contained emergency lighting
 EN 62386-202: Control gear for centrally supplied emergency lighting
 EN 62386-301: General requirements – Input devices, push buttons and binary inputs
 EN 62386-302: Particular requirements – Absolute input devices
 EN 62386-303: Particular requirements – Occupancy sensors
 EN 62386-304: Particular requirements – Light Sensors

UL Listed / cUL Listed product certification, where applicable

UL 916 Energy Management Equipment, where applicable to the product function

UL 924 Emergency Lighting and Power Equipment, where applicable to emergency-lighting control functions

BTL certified and listed BACnet products

UKCA – UK conformity Assessed

RCM- The Regulatory Compliance Mark.

The NCS manufacturer shall also have in place and demonstrate active waste minimization and CO2 footprint minimization work practices.

3.1 Product certification and third-party listings

All lighting-control products supplied to the project shall carry the relevant third-party product certification required for the country of installation and for the function being performed by the device.

For projects requiring North American certification, applicable lighting-control devices shall be UL Listed and/or cUL Listed under the relevant product category. Certification shall apply to the exact product model, order code, firmware version where applicable, and electrical rating being supplied to the project.

Certification of a similar product, product family, internal component, software stack, or previous product generation shall not be accepted as evidence of compliance for the installed product.

Lighting-control products used as energy management, lighting automation, sensing, monitoring, or control equipment shall be certified to UL 916, Energy Management Equipment, or another applicable UL standard relevant to the product's function and installation method.

Where a lighting-control product is used to perform emergency-lighting control, emergency override, emergency transfer, UL 924 response, or other life-safety-related emergency-lighting functionality, the product shall be certified to UL 924, Emergency Lighting and Power Equipment, or shall be used only as part of a documented and approved UL 924-compliant emergency-lighting control method.

Products that provide BACnet functionality shall be BACnet Testing Laboratories certified and shall be included in the public BTL Listing of Tested Products. The BTL listing shall apply to the exact BACnet product, product model, firmware version, device profile, and supported BACnet functionality being supplied to the project.

A BACnet Protocol Implementation Conformance Statement, use of a certified BACnet software stack, or general statement of BACnet compatibility shall not be accepted as a substitute for BTL certification and listing of the installed BACnet product.

The tenderer shall provide certification evidence for all applicable products, including UL/cUL listings, UL 916 listing where applicable, UL 924 listing or approved emergency-lighting compliance method where applicable, BTL listing for BACnet products, and DALI Alliance database listing for DALI-2 products.

3.2 DALI

All DALI-2 products supplied as part of the lighting-control system shall be listed in the DALI Alliance / DiiA Product Database under the exact product model, order code, catalogue number, or full part number being supplied to the project.

The database listing shall clearly identify the manufacturer, product name, product type, certification status, and applicable IEC 62386 parts supported by the supplied device.

Generic product-family listings, partial model references, similar product variants, superseded products, internal component certification, or certification of another product within the same manufacturer's range shall not be accepted as evidence of DALI-2 certification for the installed device.

Where a product is supplied in multiple variants, firmware versions, regional versions, or hardware revisions, the tenderer shall demonstrate that the exact supplied variant is covered by the DALI Alliance / DiiA listing.

The tenderer shall provide evidence of the DALI Alliance / DiiA Product Database listing for all applicable DALI-2 controllers, DALI-2 control devices, DALI-2 input devices, DALI-2 sensors, DALI-2 push-button

interfaces, DALI-2 dry-contact interfaces, DALI emergency devices, and DALI control gear supplied to the project.

Products that claim DALI-2 functionality but cannot be verified against the DALI Alliance / DiiA Product Database using the supplied product model, order code, catalogue number, or full part number shall not be accepted.

4 System Architecture

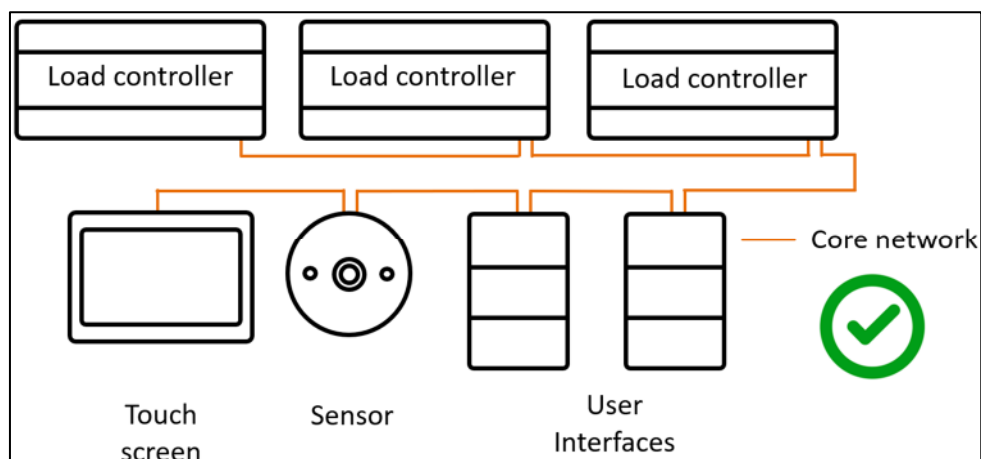
The control system shall allow all devices to directly communicate with each other so There is a distributed control architecture. For example, user interfaces communicating directly with load controllers, without requiring the intervention of a central processing unit or moving messages through sub networks. This is required so that the system is not dependent on a single network device which could create a crucial point of failure, excessive networking communication, repetitive messaging, or networking complexities. Control systems that require a central processing unit shall not be considered. Control system network communications shall be streamline and allow for a single instruction from any devices directly to any other network devices.

System which are dependent on load controllers connecting to a sub network from a “master” gateway controller shall not be accepted as there is a single point of failure, repetitive networking messages, & complexity in multiple protocols.

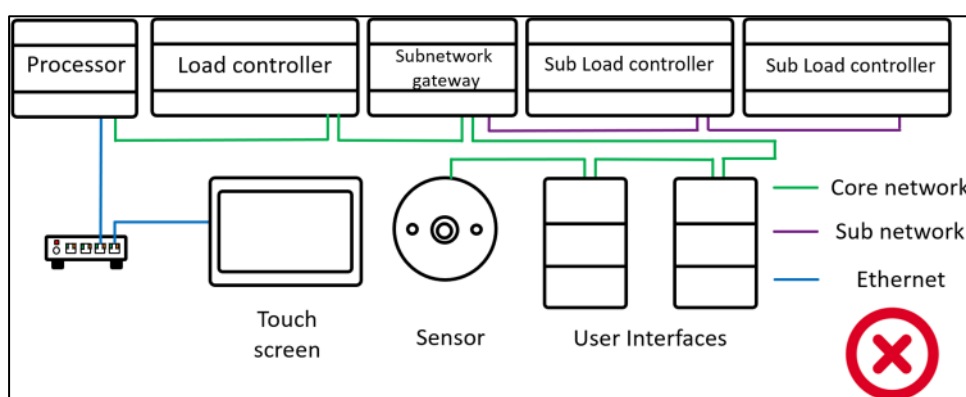
All network devices (load controllers, User interfaces, touch screens, & sensors) within the system shall utilize the same communication protocol. Any systems that do not have their own core protocol but are dependent on a site's LAN Ethernet network work to pass messages between all their DALI load controllers shall not be accepted. LCM systems may use sites LAN ethernet for system scaling with network trunk architected, BMS integration, remote access, and management. This is required so that the lighting control system is not dependent on IT infrastructure to perform its core responsibility. Lighting control systems dependent on “sub networks” which do not utilize a single core protocol shall not be accepted. This is to reduce the dependence on bridging gateways to sub networks which add potential points of failure and unnecessary network complexity.

The control system shall achieve the required functionality by using distributed intelligence across all network architecture. In the event of a network cable being severed, the system shall automatically continue to operate as two independent lighting control networks. Systems that require operator intervention or where one or both networks cease to run in case of a network cable cut shall not be accepted.

This is an example of an acceptable system architecture where all devices communicate directly with each other.



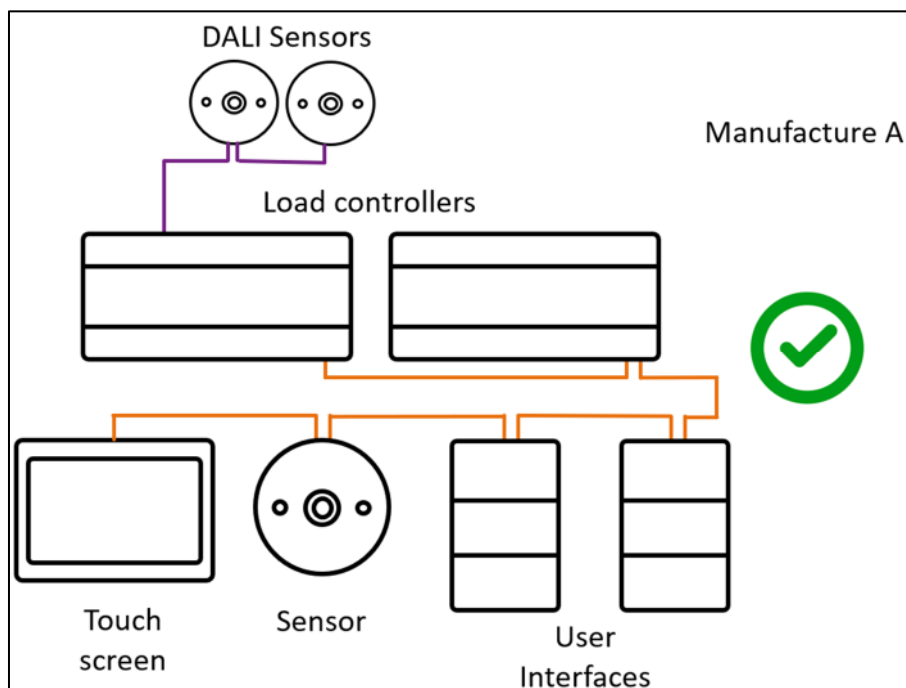
This is an example of an unacceptable architecture which requires multiple network gateways to pass messages between devices.



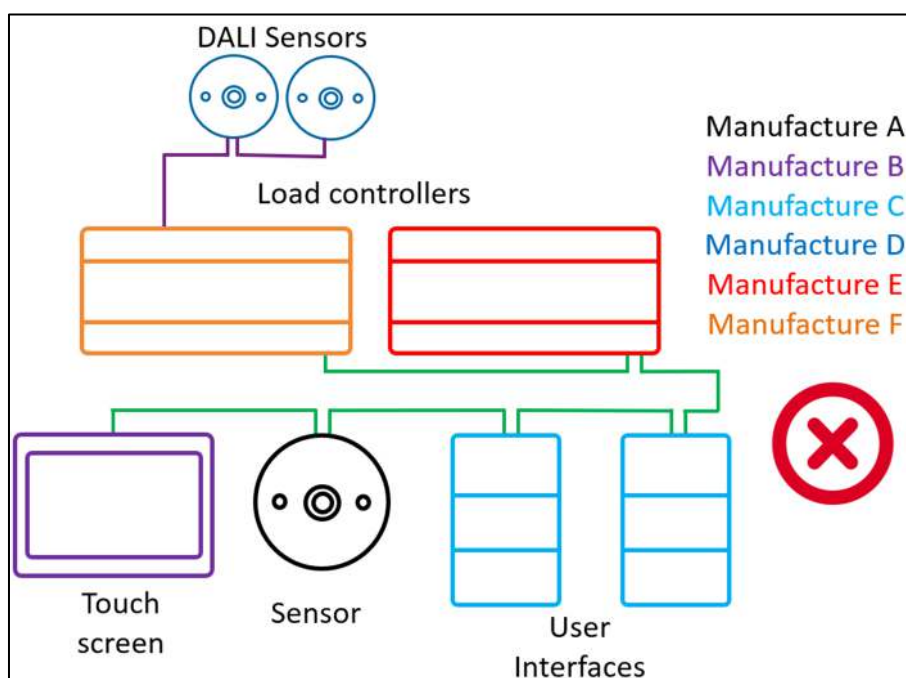
All network devices are to be configured from the same network communications port as their operation port. Systems devices requiring additional network communications ports for configuration or firmware update shall not be accepted. A single communication port for firmware update, configuration, and operation is needed to ensure that configuration changes to the control system can be performed by a commissioning engineer quickly and easily without the need to use multiple protocols being installed, change the network cabling, or having direct access to a network device. This also allows for changes to the system configuration from the user Head-end software.

All network devices are to be supplied from the same manufacturer who has tested each device individually and as an interconnected network solution at project scale. This is to ensure that any combination of network devices has already been proven by a single manufacturer to be compatible with each other and cross supported for the same functionality. It shall not be accepted that network devices follow the same “universal” protocol but internally have different strategies to achieving the same functionality. This is required so that there is consistency in the systems response to the project’s required functionality. There shall never be a need to reduce functionality or add supporting devices on site to achieve the required functionality due to the combination of devices being used.

This is an example of an acceptable system solution of which all devices are from the same manufacturer regardless of its function or network.



This is an example of an unacceptable system where each network device is from a different manufacturer.



The control system shall use advanced Windows based graphical programming to configure all network devices and define the behavior and relationship between network devices. The software shall be capable of configuring any device within the system from any location on the network. The software shall not be dependent on extra plugins or drivers to enable configuration of devices.

The performance of the system shall not be affected when the PC is disconnected. The ability to interrogate the system and save the uploaded configuration information to disk shall be included. The ability to log all network messages to a file for later analysis while the PC is connected to the network shall be included.

All load controllers and UIs shall be supplied with a basic configuration that allows the control system to run in a default way at once upon installation. This allows for UIs to send on, off and preset selection commands onto the network. All load controllers correctly connected to the network shall respond to these messages appropriately. Achievement of this functionality shall not require any commissioning.

All configuration information downloaded from the configuration PC to devices on the network shall be stored in the relevant device, contained within non-volatile EEPROM or FLASH memory. This data shall remain secure for an indefinite period, upon loss of supply. Devices that use battery or supercapacitor backed up RAM shall not be considered. When supply is restored, the system shall automatically return to the same state as when supply was lost, without requiring any user intervention.

Within the system configuration software, the system's UIs and channel outputs shall be capable of being logically grouped then viewed as the defined logical groups, so that preset scenes and states can be easily configured for each logical group. This is required so that during project's commissioning the control system can be viewed as a logical group, in line with the actual physical area so that it's from the same perspective ultimate end-user. Systems that can only be viewed or configured with reference to a physical controller or channel shall not be accepted.

Lighting control systems shall be run in an on-premises enterprise architecture with all required devices for scheduling, day-to-day operations, checking system status, maintenance, or making configuration changes are available from head-end software tools. Lighting control systems dependent on external cloud or server connection for any functionality shall not be accepted. The system shall be fully functional without the need for any ongoing external connection to the original manufactures cloud or any other external cloud services. This is to ensure the integrity of the system can be maintained by the project and is never dependent on an external service which may end without the project's knowledge.

Any system which is dependent on cloud connection for configuration or synchronization shall not be accepted as the system shall not be dependent on the project's IT or other services to be at a required state before the lighting control system configuration can begin.

During configuration no system commissioning software shall be dependent on multiple additional add-ons to function.

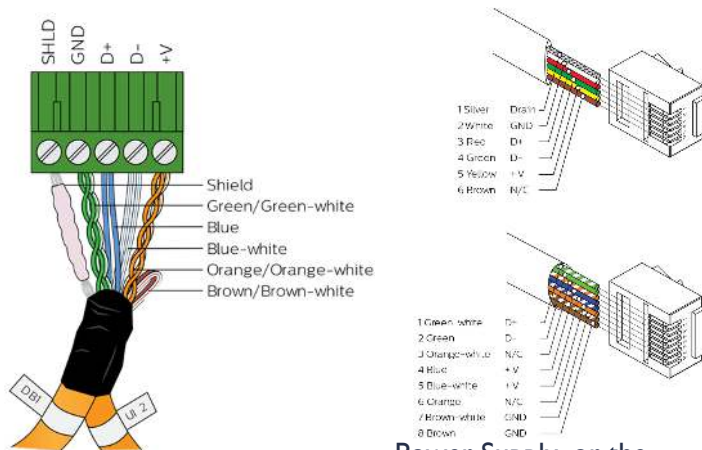
All system components firmware shall be updated from the same software that is used for system commissioning. The core system protocol shall be used for all firmware and commissioning updated. When commissioning teams are on site there shall be no need for alternative direct connections to devices, mandatory cloud support, memory card replacement, or whole device replacement if a firmware update is required. Automatic cloud firmware update is acceptable, but the commissioning teams and clients shall have ultimate authority of enabling or disabling this feature. Any DALI-2 device firmware update is to be natively supported by the DALI-2 controller without the need for any other manufacturers' support.

The system commissioning process shall not depend on multiple software packages or smart device applications of which system configuration details need to be then moved from one platform to another to complete the commissioning process. Only systems that use a single commissioning tool for all configurations, DALI addressing assignment, DALI diagnostics, Graphical UI configuration shall be accepted.

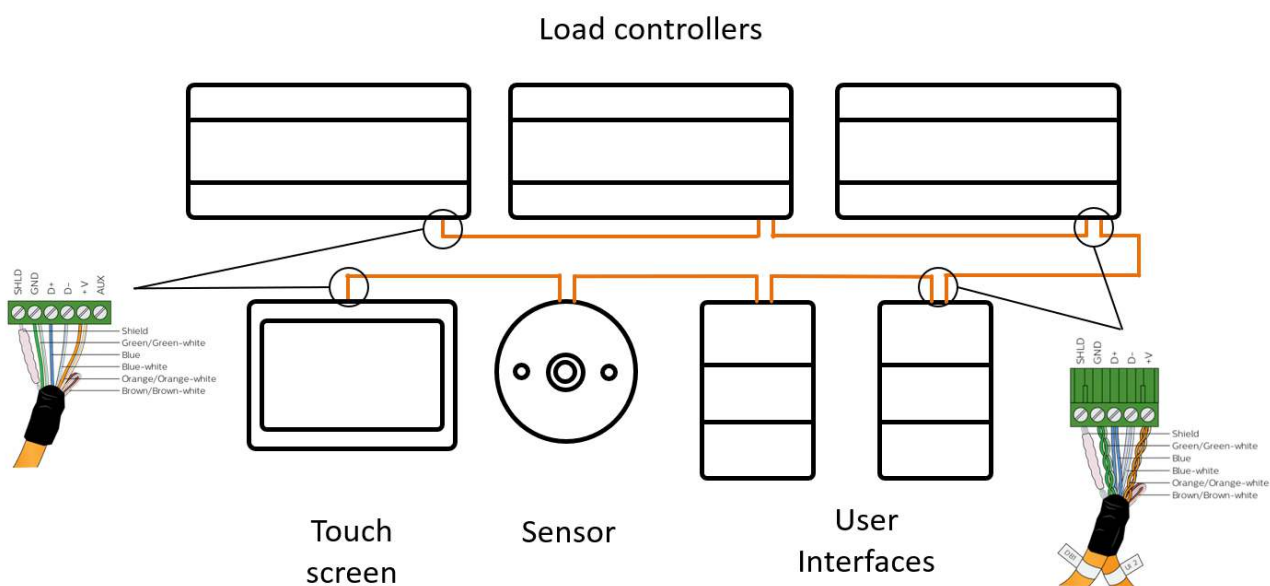
The commissioning software shall not require additional licenses to be purchased for configuration of the system components, required functionality, or network scale. This is to remove any hidden costs associated with commissioning the system after the project configuration has begun.

5 Network Physical Layer

The Control Network shall utilize an industry standard RS-485 multi-drop control bus. Data connections between devices on the network shall be of a four-conductor type, with two conductors dedicated for distribution of a Safety Extra Low Voltage (SELV) DC supply only, to power keypads and sensors. There shall be an integral SELV DC power supply contained in each Load Controller. The failure of a single Load Controller shall not affect the SELV DC performance of the network. Except for industry standard subnetworks, control systems that multiplex data and SELV DC Supply on the same conductors or systems that require external, standalone SELV DC power supplies to power four Uls shall not be considered. Devices shall be connected to the control network via pressure pad type screw terminals, RJ45 or RJ12 connectors.



Power Supply, or the



Every load controller contributes power to the communications network. Network systems that require a mandatory network power supply to sustain communication shall not be accepted. The control system network power can be supplemented by an external power supply to meet the requirements of devices that are dependent on network power.

The control system shall allow for a single load controller to directly power at least four control system button Uls without the need for an external power supply. Supplementary power supplies to network power are acceptable.

Screen based UI shall be powered directly from the core network. UI with screens that are dependent on external power supplied shall not be accepted.

System networks which are dependent on a single device to send a clock or synchronizing signal to other network devices, coordinating network messages shall not be accepted as this architecture creates an unacceptable single point of failure.

All load controllers shall internally support the required resources such as mains power supply, microprocessor, memory, direct communication port, and internal logic so that devices are independently responsible for their functionality. This is required so that there are no hidden extra accessories that are required for network devices to operate. Control systems which are dependent on external network accessories for devices such as external power supplies, mandatory network power supplies or centralized processors to achieve their core functionality shall not be accepted.

The network shall use industry standard CAT5 shielded cables to connect all network devices. There shall be no need for a system to use specialized cables that are unique for the system. This is required to give flexibility in the options of cables to be used and seek cost effective solutions where available while meeting the CAT5 shielded spec.

When a project needs to scale the lighting control system to cover multiple floors / buildings, the system network shall support direct solution with its own devices. Systems dependent on 3rd party devices to build network devices or connected to projects own LAN shall not be accepted.

6 Network topology

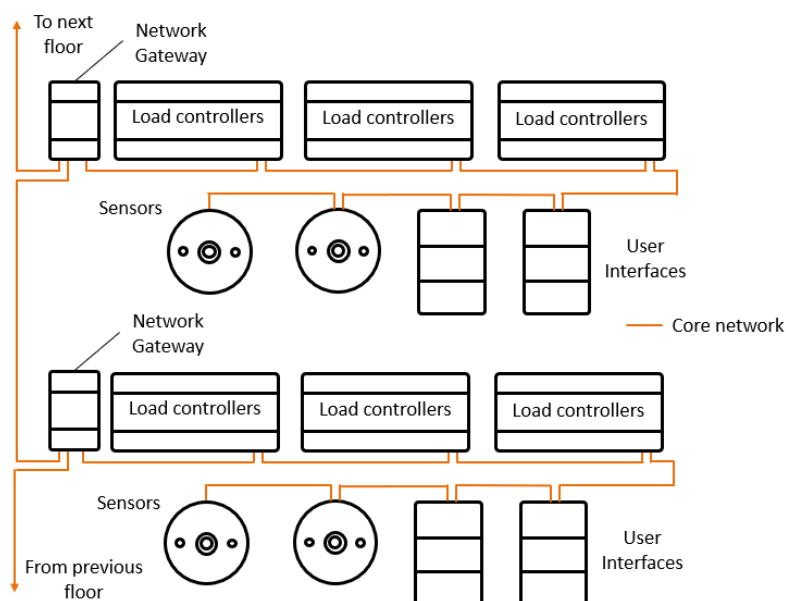
A single native lighting control network shall directly support 120 network devices without the need for bridges or gateways to manage system messaging or addressing at scale. Systems dependent on network 'Line' or 'zone' couplers to build a network scale to meet project scale shall not be accepted as there are unacceptable risks of single points of failure and configuration complexities which cannot be accepted.

Accessories shall be available from the system manufacturer to enable the creation of an individual network spurs shall be galvanically isolated from trunks, with devices that enable message filtering to minimize unnecessary trunk and spur network traffic. It shall be possible for controllers or gateways to connect to networks of luminaires, sensors and user interfaces.

If a project is broken up over multiple sections or floors which requires larger network scale from the lighting control system, then multiple native networks shall be connected using gateway devices. These gateways use the system's own native network in trunk and spur network topology or ethernet base devices to start each individual network. The gateways shall be configured by the system's own configuration software and not require third-party switches/bridges for native protocol operations.

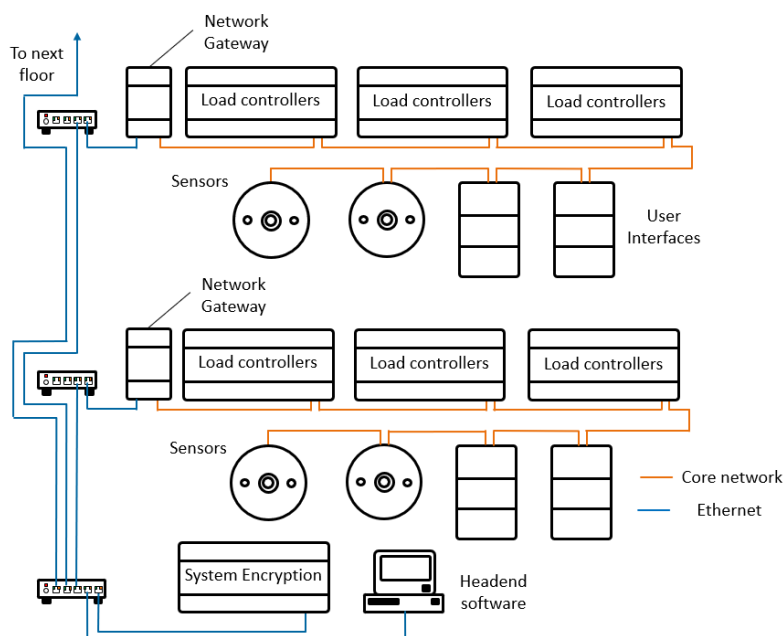
Network gateways shall perform network message filtering functionality to ensure only relevant network messages are passed onto the spur network it is managing.

An example of how a larger system scale can be created, using the system's own core protocol can be seen here.



If ethernet gateways devices are needed, they shall be from the same manufacturer as the lighting control system and not require any accessories for communicating to the native network. Ethernet gateways shall directly communicate the core systems protocol. All ethernet devices shall be configured with the same commissioning tools that are used for the core lighting control system to ensure seamless alignment of communication and functionality.

An example of building a system using sites LAN can be seen here. Each floor network is started from an ethernet gateway which will filter network messages and manage each floor as its own system.



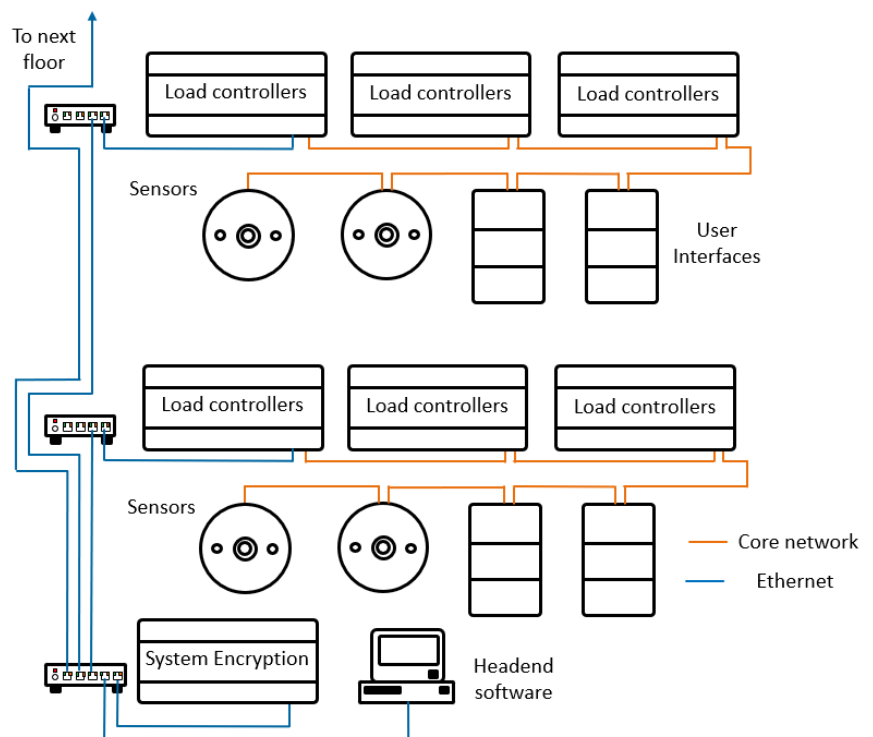
When using site's own LAN network to build system scale, the lighting control system's ethernet devices shall use TLS1.2 or newer encryption with mutual authentication between each other to ensure site security.

Systems which are dependent on 3rd party devices to pass messages on Ethernet networks or provided encryption shall not be accepted. The system shall provide its own end – end encryption devices on premises to take on the security responsibility.

System BMS gateways shall provide separate VLAN/BMS and VLAN lighting connections from the same device.

Load controllers shall support direct connection to the site's LAN and shall only communicate to the manufacturers' own system encryption devices. Load controllers that are connected to the sites LAN will also be able to perform gateway functionality to pass on network messages to the system's own core protocol.

An example of building a system using sites LAN can be seen here. A load controller is connected directly to a sites LAN and will only communicate to the system encryption device. The load controller will also pass on network messages to the system's own core network on its floor.



7 Protocol

All control system devices shall be capable of running on a single network using the same protocol. Control systems that do not allow all products from the same manufacturer to be connected in a single network, subnetwork, or are designed so different component types operate on different protocols shall not be accepted.

The system protocol shall support an area addressing layer to which multiple physical channels and UIs can be assigned. The area addressing shall be capable of changing from one scene to another with a single network message.

Changes to the addressing area where a physical channel or UI belongs shall be capable of being made with commissioning software without the need to make changes to the physical power or network cabling.

The control system area addressing shall allow for multiple areas to be linked together. This allows dynamic changes to a live network to be made without additional UI configuration.

The protocol shall support network messages to control a logical addressing area with a single message. This network message shall contain all the information to instigate a scene change. Information within this message shall contain:

1. The logical area address that is being controlled.
2. The scene that is being selected.
3. The fade time to transition between selected scenes.

Control systems that require multiple channel level messages for each physical or virtual channel to instigate a scene change shall not be accepted. This is required to reduce commissioning complexities and avoid inconsistent responses when transitioning between scenes.

All UIs that belong in an area shall update and synchronize their indicator status automatically from the same network message that instigated the scene change. Control systems that require a dedicated or separate network message to synchronize their indicator status shall not be accepted as this adds commissioning complexities and introduces a high risk of system indicators becoming unsynchronized.

All network devices are to support the same network structure, development method, and firmware type. This is to ensure seamless and fully supported functionality between all network devices.

All network devices shall be cross tested together by the manufacturer to ensure their performance as a system and ensure that all devices are compatible with one another. Ultimate responsibility for testing the system components to be completely compatible with each other shall reside with a single manufacturer.

All network devices shall be fully capable of directly communicating to each other and triggering all supported functionality. Control systems that are dependent on centralized logic processors to perform basic system functionality shall not be accepted.

The network protocol shall be an event-based message packet type. The output state of load controllers shall recall preset levels stored within the controller's memory for each relevant network message. To ensure network traffic is minimized, the system shall be capable of recalling a preset scene or state involving all controller channels bound to the same logical area from a single network message associated with that area. Control systems that require multiple network messages, or a message for each control channel to recall a preset scene or state, shall not be accepted.

The control system shall be capable of supporting 65,530 separates logically addressed areas, and at least 64 preset states within each area. Each area shall be able to contain 65,530 logical output channels and an unlimited number of physical channels. The system shall be capable of executing fade times ranging from 0 seconds to 23.3 hours, adjustable in 0.02 second increments, within a single network message. There shall be no need for additional gateways, bridges, line couplers, or zone couplers required for the system to operate at 65,530 logical addresses

The network protocol shall also support variable length packets, baud rate, and incorporate a file transfer control to allow over-the-network upgrades of device firmware and other settings. The protocol shall also support message source identification.

The control system protocol shall have a public documentation detailing how presets, area control, channel level are supported for transparency of the system functionality.

The lighting-control system shall support logical control independent of the physical DALI line, controller location, or load-controller type.

Input devices, sensors, switches, dry-contact interfaces, user interfaces, and software commands shall be capable of controlling logical lighting areas that extend across multiple DALI lines, multiple DALI controllers, and multiple non-DALI load controllers without requiring the controlled area to be wired onto a single DALI line.

Where a DALI-2 input device is connected to a DALI line, the associated control event shall be capable of being translated by the DALI controller into the lighting-control system's native network protocol and distributed to any required lighting area, channel, task, scene, or integration point within the lighting-control system.

Systems that restrict input devices to control only the DALI line, DALI group, DALI address, or local controller to which the device is physically connected shall not be accepted.

Systems that require the physical DALI wiring topology to match the logical control zoning of the project shall not be accepted.

8 System Functionality

8.1 General

The control system shall be capable of readily deploying all functionalities outlined within this section, with configuration software using intuitive mouse click and drag, drop down dialogue box, or other similar intuitive user programming methods.

8.2 Occupancy Control

Through sensor-based occupancy detection, management of the artificial lighting level required at any given time for vacant and occupied areas is enabled. This feature shall be capable of functioning at the same time as light level detection, especially in areas that experience elevated levels of daylight i.e., adjacent to windows. A single sensor can trigger a response from multiple lighting groups if needed as well direct 3rd party system such as HVAC. The system shall not have tiered sensors with different levels of features, functions or addressability. Sensor shall not be dependent on BMS/BACnet to execute functionality.

8.2.1 Multistep sensor response

When no movement is detected, the control system shall be capable of dimming lights to a background level for a grace period to notify that the lights will soon switch off and then switch all lights off after another timeout period.

The control system, when used in conjunction with scheduling functionality, can automatically change the delay the system uses to respond to no occupancy. This is to allow for trading hours and after hours to have different time out periods.

8.2.2 Daylight Override/Harvesting

When motion is detected in an area with natural light it shall be possible to configure the control system to only operate the luminaries if the light level is below a certain threshold.

All lighting control system's daylight sensors shall be capable of both open loop and close loop operations. Sensors shall be dynamic and be able to change between open or close loop methods from a network message to give a fine tune response to different time of day requirements. Systems which have discreet open or closed loop daylight sensors or sensors that cannot dynamically change their operation mode via a network message shall not be accepted.

All sensors within the system shall be capable of dynamically changing their target lux level, step dimming timing, or loop strategy (open / closed) from receiving a scheduled network message. This is required so that the system can adjust itself to achieve the correct balance of energy savings methods with occupancy comfort.

System shall support making 1% ramping adjustments to the lighting so not to draw attention of the occupants while performing its energy management functionality.

8.2.3 Step-over Patterns

In large open office areas and public areas where areas may overlap, the control system shall provide flexibility in setting up lighting behavior in adjacent or related areas such as atriums or lobbies. The system shall be capable of activating or maintaining desired or proportional light levels in multiple areas adjacent to where occupancy has been detected.

8.2.4 Multizone sensor management

A single occupancy sensor shall be capable of triggering multiple lighting zones to turn on lighting in longer corridors and associated areas if needed. This feature shall be dynamic so that the sensors occupancy response can trigger different zones depending on the site's current schedule status.

8.2.5 Corridor Hold-on (Linking)

The control system shall have provision to link areas like function rooms, offices, meeting rooms, waiting/lobby areas, or seminar rooms to a corridor, waiting, or lobby area (exit path). The control system shall be capable of ensuring that a corridor is switched on if one of the areas/offices it services is still in use. Furthermore, the system shall enable lights in the corridor to be dimmed when it is unoccupied if personnel are still present in neighboring areas/offices, for an optimal balance between safety and energy conservation.

8.2.6 Cascaded Corridor Hold-on

It shall be possible to configure egress path lighting to be cascaded, to create multiple levels dependencies. This enables rooms to keep associated corridors lit, corridors to keep elevator/lobbies lit, elevator/lobbies to keep reception areas lit, etc.

8.3 Light Level Control

8.3.1 Switching

The control system shall be capable of implementing basic switching control to turn lights on and off from a flexible choice of networked user interfaces.

8.3.2 Dimming

The system shall be capable of implementing dimming control of lighting from a flexible choice of networked user interfaces. This shall be achieved by a protocol (or signal) to a lamp driver (DALI addressable, DALI Broadcast, DSI, 1-10V or DMX512) or by power control of phase-cut and pulse width modulation (PWM) dimmers.

8.3.3 Scene Setting Task Tuning

To ensure that lighting levels and color temperature are appropriate for the intended task in a particular area, the control system shall provide means for users and operators to create and adjust light intensity levels and/or preset scenes across any lighting circuit/channel associated with the area/space readily and intuitively.

8.3.4 Color Component and White Balance Control

The system shall have provision to represent and control luminaires that incorporate multiple channels for the adjustment of color (RGB) or tunable white (warm white/cool white). When integrating white balance control in a DALI network, IEC 62386-209 requiring only one DALI DT8 address shall be used for controlling both cool/warm white balance and dimming level.

The system shall automatically adjust the tunable white color temperature to match the requirement for the time of day so to be in tune with the person's biorhythms. Users shall have the option to override the system from a user interface to a selected a particular color temperature via scenes. If needed the user shall be able to return the lighting to the correct color temperature for that time of day.

When an occupancy sensor detects a user, the system shall turn on the lighting to the correct color temperature for that time of day.

From a manual user interface an occupant can independently ramp the color temperature or the lighting level.

8.3.5 Corridor-Row Offset

The system shall utilize closed loop light level management to control extra lighting rows offset from the window rows, for at least two extra rows. Zones adjacent to windows receive more daylight than those closer to the core of the building, including corridors in open space. The system shall be capable of implementing:

- Light level control of luminaires in the window areas and the core areas to be defined by a ratio.
- Window area luminaires to be dimmed to a lower level than the luminaires in corridor or core areas.
- The area in-between dimmed to a pre-defined percentage in reference to both window and core area levels.

8.3.6 Power Demand Response

The lighting control system shall be capable of receiving instructions from power supply companies through the Open ADR method, or from other supplies, such as solar power systems, to perform load shedding and help prevent overwhelming the power supply which could cause a total failure of the supply system.

There shall be 4 levels of load shedding available for the system to step down its current power consumption.

The local users shall have no way of interfering with or overriding this functionality.

Sensors and user interfaces shall only be able to operate at load shedding level when it is triggered. They shall not have the ability to override the load sheading strategy.

8.3.7 Load Shedding

Provision shall be available to allow some or all luminaires to dim or switch off when the buildings energy consumption is more than predefined limits. It shall be possible for the maximum limit to be static or dynamically set, potentially by the energy provider.

8.4 Personal Control

8.4.1 Manual Light Control

The system shall have provision to enable manual user controls to be implemented where appropriate. Manual controls shall also be able to change the behavior of automated functions such as daylight harvesting, occupancy detection or illumination management.

8.4.2 Dedicated User Interfaces

The system shall enable manual control to be implemented via the provision of keypads or touchscreens typically installed at the point of entry into areas or zones, where appropriate.

The user interfaces shall be resilient to cleaning products (anti-bacterial & sterilizing) commonly used within hospitals so that they do not deteriorate.

User interfaces shall be available with custom labeling per button in text and logos. A simple and easy to use customer tool shall be available which shall allow customers to enter labeling details. This tool shall allow for use of both text and logos on the same button.

Buttons shall be available in a larger size than 1cm (about 0.39 in) x 1cm (about 0.39 in) for easy accessibility purposes.

8.4.3 Virtual User Interfaces

The system vendor shall also offer a range of virtual interface options for manual user control including but not limited to applications for tablets and smart phones, and popup dialogues that reside in the system tray area of Windows desktop computers.

8.5 Time Control

8.5.1 Scheduling

It shall be possible for lights to be switched on, off, dimmed or to behave differently according to a specific schedule. It shall be possible for schedules to be adjusted for weekends, public holidays or other shut down periods.

The system shall be capable of sending out a site-wide instruction for all tunable white lighting to be set to the correct color temperature for that time of day.

8.6 Advanced Control

8.6.1 Sequences/Tasks/Events

The system shall include a facility to implement conditional and sequential logic control routines. It shall be possible for the control routines to be located and run from management software on a PC connected to the lighting control network or embedded within individual network devices. It shall be possible to embed tasks within sensors, keypads, load controllers, network interfaces and gateways. Operation of logic control routines shall not depend on a central control unit.

8.6.2 Dynamic Area Linking

The system shall have provision to dynamically combine or separate control areas for applications where demountable partitions are being used (typically in areas such as meeting rooms, training rooms and conference centers). When partitions are opened the user interfaces and lighting shall combine to act as one

single control space. Conversely when the partitions are closed the user interfaces and lighting shall separate into the discrete area in which they are located.

It shall be possible to establish links between a minimum of 24 different areas and it shall be possible to define if control between the areas is unidirectional or bidirectional. It shall be possible to initiate linking via partition position activated reed or micro switches connected to dry contact inputs or from user interfaces.

9 Load controllers

9.1 General

All Load Controllers shall be designed to operate continuously at 100% of rated load. They shall be convection cooled, with no cooling fans or other forced ventilation employed to reduce noise and increase long-term reliability. Systems that are fan dependent or fan assisted, or which recommend regularly scheduled maintenance for air filtration components are not acceptable.

A load controller's housing shall completely cover / conceal all internal electronic componentry. No electronic components shall be exposed. Any DIN-Rail housing that allows electronic components to be exposed shall not be accepted. This is to prevent frayed wiring from falling into the housing during installation or on-going works within installation, which could cause device failure or electrical fire.

Load controllers shall be available in wall mount and DIN-rail mount configurations. Wall mount controllers shall be suitable for direct installation incorporating a suitable fire-rated enclosure with appropriate protection from access to live parts. DIN-rail controllers shall be designed for installation within a switchboard and have a section profile consistent with an IEC style circuit breaker to ensure compatibility with standard load center enclosures. Several types of compatible load controllers shall be natively available, including:

- Leading and trailing edge power dimming phase control devices for the operation of incandescent lamps, iron core magnetic and electronic transformers
- Switching output devices for controlling ON/OFF loads,
- 1-10V, DSI, DALI broadcast and DALI signal-dimming devices for controlling electronically dimmable luminaires,
- Pulse Width Modulated (PWM) DC devices for controlling LED loads.

Controllers with fixed outputs shall be completely pre-assembled and factory tested by the control system manufacturer. Modular controllers shall have interchangeable control modules tested by the control system manufacturer available for assembly by the client's installer.

All DIN rail load controllers within the control system are to follow the same physical layout architecture, including the location and order of the terminals. All devices power supply terminations shall be located at the top left side of the device and the terminal order starting from the left to be Earth, Neutral, & then Active supply. Control systems with inconsistent terminal layout or order between different DIN-Rail devices shall not be accepted. This layout consistency is required to ensure the installers can quickly terminate the system with a reduced risk of error.

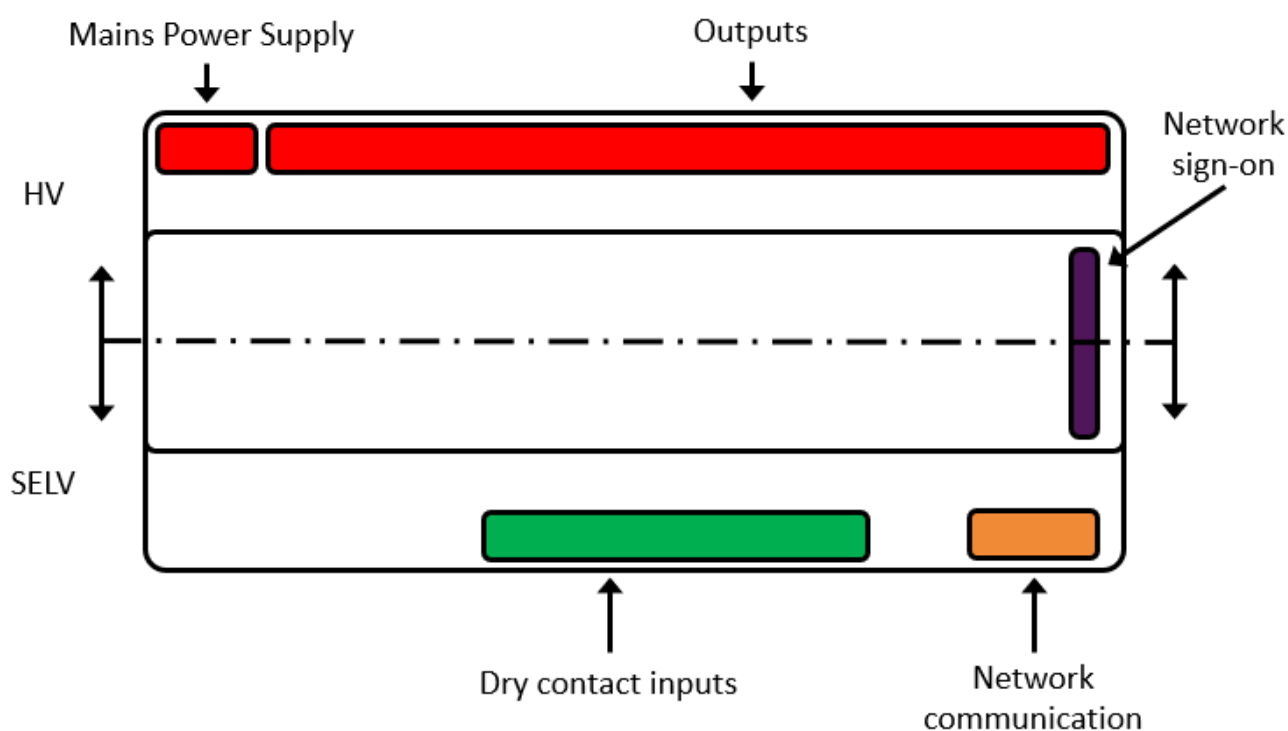
All output load termination shall be on the top side of DIN-Rail device.

All networks (System protocol, dry contact, DMX512, & Ethernet) termination shall be located at the bottom side of the DIN-Rail device. This is needed so that there is correct physical segregation between the **Safe Extra Low Voltage** network cabling and mains **High Voltage** side.

If a controller supports Dry Contact inputs these are to be on the bottom side of device.

A network sign on button shall be accessible from the top of the device so that non licensed electrical installers can still identify the device on the systems network. Systems with no network sign on or a button which requires the distribution board covers to be removed shall not be accepted as this is dependent on licensed electrical installers to grant access to this functionality.

Example of required DIN-rail device lay out required to bring consistency into the installation.



It shall be possible to individually configure channels within all load controllers to unique areas that can be separately controlled. Dimming channels shall have the ability to be software configured to provide either dimmed or switched output. It shall be possible to set minimum and maximum output levels for all channels. Each dimmer shall contain selectable dimming curves.

Configuration data relating to individual area names, individual channel names, preset levels, toggle levels and panic level shall be stored within the non-volatile memory of each respective controller. The controller also supports device names, area names and channel names each up to 40 characters in length. The controllers shall also be capable of supporting up to 170 presets. These settings shall be downloadable with the vendor's software. Any system that does not provide or restrict access to the settings shall not be accepted.

All load controllers shall incorporate a dry contact 'AUX' input to allow for hospital's BMS to directly trigger a required emergency or UL924 response without being dependent on the lighting control system's own network. The AUX input shall be located next to the network terminals. Lighting system controllers which are dependent on external devices to receive dry contact emergency inputs shall not be accepted. The AUX input shall be capable of performing the following minimum functions:

- Keypad Disabled / Panic / Program Disable
- Sign on Message
- Execute logic macro
- Defined Network Message transmission
- UL924 trigger
- Emergency input response.

Load controllers shall be available with various individual channel output capacities, ranging from 1A to 20A. Up to 12 channels shall be available in a single device.

Each load controller shall have a configurable start up delay that defines the time from when power is restored to a load controller, to when the load controller sends out its sign-on message and starts to initialize outputs. This setting is useful for staggering the startup of multiple load controllers or preventing them from cluttering the network with sign-on messages when the system is first energized, thus leaving the network clear for other peripherals to configure the load controllers before they revert to their previous state.

Load controllers with dual serial control ports shall be available, for the duplication of control network cabling, to guard against the failure of one data cable. The Load Controller shall be configurable to:

- Obey control signals from either port
- Obey the main port if a DMX512 signal is detected
- Obey the secondary port if signal is lost on main port
- Obey the highest level received from either port.

At start-up after loss of power, it shall be possible to configure load controllers to revert to one of the following output conditions:

- All circuits full on
- All circuits off
- All circuits to previous condition prior to power loss
- All circuits to a specific scene

Load controllers shall respond to a global 'emergency' network message. Once in emergency mode, the load controllers shall turn all circuits to 100% until they receive an 'un-emergency' message. Disabled devices shall not be able to send network messages whilst in emergency mode.

Load controllers shall be able to monitor the network for loss of communications by listening for a network watchdog message. When a load controller has not heard a network watchdog message for a user-defined period (indicating loss of communications), the load controller shall revert to one of the following load conditions:

- All circuits full on
- All circuits off
- All circuits to previous condition prior to communication loss
- All circuits to a specific preset

Load controllers shall incorporate a service diagnostic indication LED. The LED shall operate in the following modes:

- *Normal Operation* - The Service LED shall blink briefly, approximately once per second when the dimmer is operating correctly on a quiet network or with no data cable connected.
- *Network Activity Detected* - When network activity is detected, the Service LED shall indicate network activity by blinking on and off at approximately twice the normal speed for a few seconds and then revert to normal speed.
- *DMX512 Network Activity Detected* - When DMX512 is detected, the Service LED shall flash continuously at a rate of 2 Hz.

Load controllers shall incorporate a service switch. The Service Switch, when pressed momentarily, shall cause a sign-on message to be transmitted onto the network. If the transmission is successful, the Service LED will indicate network activity detected. The sign-on message shall contain information about the device, such as: box number, device type and embedded firmware version. If the Service Switch is pressed and held for four seconds, the device shall perform a reboot. If the service switch is pushed three times in close succession the controller shall drive all outputs 100%.

It shall be possible to upgrade the firmware of all load controllers from any network access point over the control network. Controllers shall not require separate communication ports for receiving firmware updates or configuration changes.

Load controllers shall not have additional network communication ports for service or future development as they are security vulnerabilities which could be exploited by malicious motivated actors.

Any devices using Ethernet/IP communication shall use TLS1.2 encryption or newer to prevent creating a security vulnerability within the system and becoming a liability for the entire site.

All controllers shall be field serviceable and shall not be a permanently sealed device requiring replacement as the only option for servicing.

9.2 Switching controllers

Switching controllers shall be used for lighting circuits and general electrical loads where automated on/off operation is required. Controllers shall incorporate relays of appropriately rated capacity for typical lighting loads.

Relay contact ratings shall be 2 - 20A continuous AC3 ratings.

9.2.1 Relay controller for bi-directional motor control (blinds)

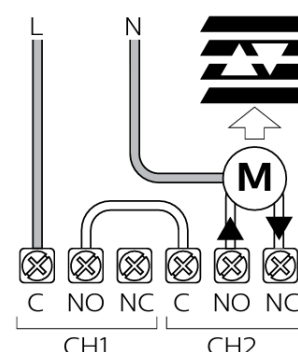
The lighting control system range shall include a native relay controller which supports SPDT (Single Pole Double Throw) relays that shall be used for driving bi-directional motors.

The relay load controller's firmware shall utilize two SPDT relays (first for enabling power, feeding into a second for selecting direction) for driving a single bi-directional motor device so that the lighting system shall control the direction and stop the motors at any position. This is required so that its mechanically

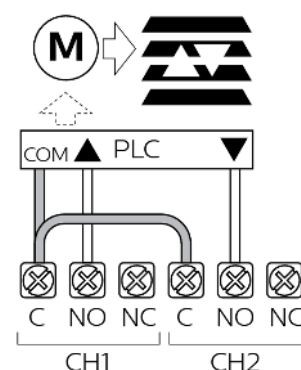
impossible to drive a motorized devices in two directions at the same time which will damage or destroy the device. Devices which are dependent on interlocking software to prevent driving motorized devices in two directions at the same time shall not be acceptable.

The control system configuration software shall allow for the linking of two double throw relay channels so that they shall be used for the control of bi-directional blinds. The devices' firmware shall operate the two SPTD relay to ensure that the power relay is open before changing the directional relay. This is to prevent the relays from being exposed to excessive power rush which will cause them to weld closed.

An example of how the relay controller SPDT output connections shall be used for direct power to a motorized blind. This configuration is required so that it allows for directional control and stopping the blind in any position. This is also required so that it's impossible for the system to drive the blind both up and down at the same time.



An example of how the relay controller SPDT output connections shall be used for dry contacts into a PLC device which is managing the directional motorized blind.



Systems depending on software interlocking the driver relays shall not be accepted.

9.3 Signal Dimming Controllers

9.3.1 Broadcast Signal Dimming Controllers

Signal dimming shall be used to control luminaires with integral dimming control gear. Signal dimming controllers shall use commissioning software to select the output as 1-10V or DALI Broadcast.

9.3.2 DALI Addressing Controllers

DALI controllers shall be DALI-2 certified with the DiiA and shown on their website of the supported features that have been independently certified.

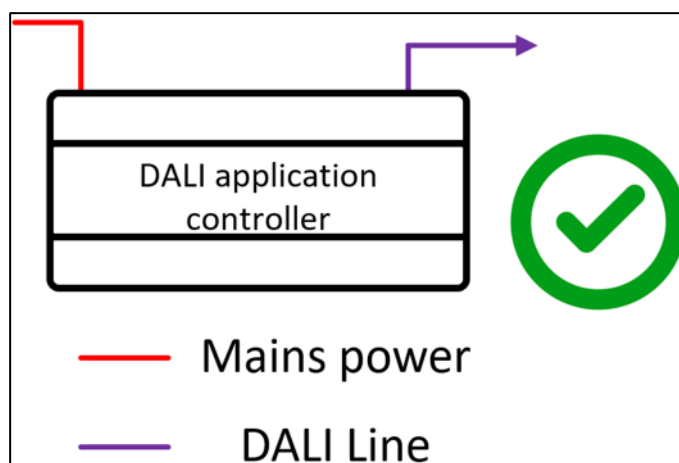
DALI addressable controllers shall be used where independent control of each individual luminaire is required. Each DALI universe shall control a maximum of 64 individually addressable luminaires per DALI loop. It shall be possible under normal circumstances to connect at least 255 DALI universe controllers to a control network to individually control 16,575 LED drivers. It shall also be possible to upgrade to a method whereby 65,000 separate DALI controllers can be connected on to a single control network to individually control 4,225,000 LED drivers.

DALI universe controllers shall incorporate all required circuitry to connect directly to each DALI loop without the use of third-party products. They shall be self-contained and support:

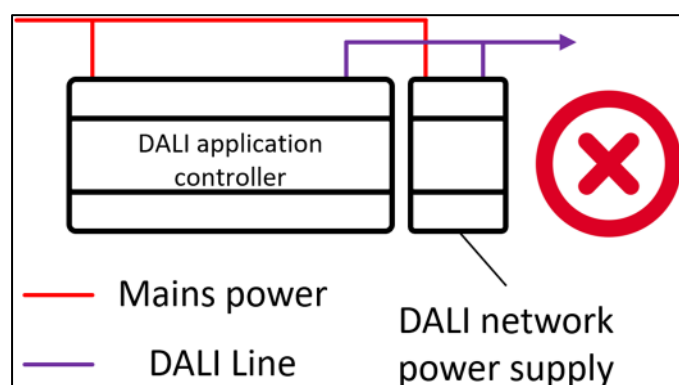
- Controller unit power supply
- DALI network power supply
- DALI network interface
- Scene controller
- Direct network connection to vendor's network

Control systems that require controllers with external or separate power supplies, external DALI transmitter, external DALI network interfaces, external scene controllers, or devices to integrate to vendor's network shall not be accepted. The DALI load controllers shall support 100 – 277VAC supply for consistent globally specification. Furthermore, systems that require the introduction of multiple interface connections through assembly of individual components for DALI universe adaptation shall not be accepted.

This is an example of DALI application controller with an internal DALI power supply that is not dependent on any external accessories to perform its functionality. This is the only acceptable installation method of DALI application controllers as the installation is streamline, there are no hidden supporting accessories, installation costs, and the correct emergency level response from DALI drivers can be expected if there are any issue with the DALI application controller.



This is an example of a DALI application controller, dependent on an external DALI network power supply. This is an unacceptable method of supporting a DALI network, as this installation is dependent on external accessory devices which hides the system true cost, adds complexities to the installation, and shall not allow the correct emergency response from DALI drivers if the DALI application controller encounters an issue.



DALI controllers with a built in DALI network power supply shall be designed in such a way that if there are any internal critical failures, the device shall drop its DALI power supply output, so that the correct DALI emergency response can be triggered.

The DALI lighting system components shall be connected as a set of individual loops each initially comprising fifty (50) DALI devices per loop. Each loop shall be expandable to incorporate a total of sixty-four (64) DALI devices if required. Loop wiring shall comprise three (3) power (active, neutral and earth) and two (2) data/control cables following the same route. An un-switched active may be incorporated in cable runs for DALI emergency fitting support. Cables shall comply with the circuiting requirements of this specification. DALI loops may be connected in a radial, star, or bus topology or a combination of these. Ring topologies are not acceptable.

DALI loops shall be installed in a logical manner. The addressing sequence for individual DALI devices within a DALI loop is by way of the IEC standard address randomization process. In applications where DALI device short addresses have been pre-assigned, the lighting control system shall be capable of preserving the short address assignments when enumerating the universe. The lighting control system shall be capable of utilizing the 16 native scene groups within the DALI system specification 62386-101.

Individual DALI universes shall be controlled together via the DALI universe controllers. The control system shall have the capacity to manage each individual DALI universe over multiple controllers together as one system. Any network user interface shall have the capacity to send a single network message that when required can affect multiple DALI universes to respond. The lighting control system shall be able to manage one logical control area or lighting group over multiple DALI universes and over multiple DALI universe controllers. This is required so that the physical lighting looms do not need to follow the project layout and that the control system can be updated and changed with new lighting groups without the need for adjusting the cabling. Any system that requires the physical DALI loop to be wired in the same configuration as the logical areas shall not be accepted.

The DALI interface shall be able to communicate with each driver individually (short address mode) or with the DALI group addresses (group and scene mapping mode). This shall happen automatically. This choice will overcome the limitations of 16 group addresses, and the slow speed of the DALI protocol specifically relating to avoiding the “Mexican Wave” effect of LED drivers arriving at the target level at different times.

Controllers shall also be capable of interrogating DALI luminaires to provide the following diagnostic information.

- Lamp failure
- Driver failure
- Driver run time tracking for each driver and lamp output.
- Device Online / Offline status

A user service switch shall be available allowing the universe controller to be set to DALI broadcast test mode, allowing installation testing and verification of all DALI network wiring by slowly flashing correctly terminated DALI luminaires.

Commissioning of the DALI luminaires shall be undertaken by the Control System Supplier. The system shall also have provision for either off-site or on-site commissioning. A system that requires off-site enumeration of LED drivers/drivers is not acceptable. Single universe DALI controllers shall automatically enumerate LED drivers when powered on. This automatic enumeration shall constantly run during normal operation to allow one for one DALI driver replacement without the need for any commissioning.

The control system shall be directly capable of supporting DALI replacement functionality via auto enumeration or Head-end software. This method shall be intuitive and straightforward, not requiring knowledge of the lighting control system or DALI addressing architecture. This functionality is required so that the end-user is self-dependent on managing the lighting control system.

The DALI controller shall continually seek driver addressing details from the DALI lines that it manages. The controller shall upload all the required driver addressing data to then be made available to the commissioning software when instructed.

If a single DALI driver is replaced, the control system shall support an automatic recovery function. The control system shall automatically detect the change and make the required adjustments within the network to accommodate the new driver. There shall be no need to manually interface the control system to replace the updated driver.

DALI universe controllers shall support both normal and emergency 202 DALI fixtures. Control systems that require separate DALI controllers for normal and emergency DALI luminaires shall not be accepted. The control system shall also be capable of testing and reporting on the lamp status and battery condition of DALI emergency luminaires. The system shall be able to report the outcome of functional and duration tests.

DALI controllers shall support tunable white as described in part 209 of the DALI specification. Systems that are dependent on driving separate drivers for warm and cool white for tunable white functionality shall not be accepted.

9.3.3 DALI Multi-Master Controllers

Where practical DALI Multi-Master controllers shall be used that permit connection of DALI-2 input devices i.e., sensors, and dry contact interfaces to the DALI universe loop to reduce wiring. DALI input devices are to be fully powered from the DALI bus. DALI devices that require an additional power supply or mains power shall not be considered.

The settings and firmware updating for DALI-2 input devices shall be completely supported by manufactures DALI load controller and commissioning software. There shall be no need for the manufacture's commissioning software to require supplemented components to support firmware update or configuration.

Any DALI input devices that require direct or manual via DIP switches or rotary ports adjustment shall not be accepted.

Any firmware updates shall be directly supported from the controller to the DALI-2 sensors. The system shall support automated scheduled firmware updated so that any required maintenance performed by the system can be done outside of expected occupancy hours of the project.

The DALI controllers shall be capable of interpreting and relaying messages issued by these DALI-2 input devices to send required instructions via the DALI load controller, to the control system core protocol, so that the DALI input devices can also control lighting outside of the universe, other types of lighting loads, or system integration, where it is connected to the lighting control system.

The manufacturer shall provide a clear table of supportable ratio of DALI drivers and sensors. This table of supportable items shall be absolute and require no additional considerations of DALI addressing, bus power,

instances allocation, or any other inherent system limitation. This transparency is required so that the control system does not become the limitation of the system design.

The table below is an example of what is expected from the manufacturer.

Number of DALI-2 sensors	Number of DALI drivers
16	64
20	54
22	44
26	34
30	24
34	14
40	0

The system shall support a max of 15 dry contact input devices per network as included within the table of supportable sensors.

DALI Multi-Master universe controllers shall have provision to dynamically adjust luminaire fade rates, open / closed loop functionality, number of addressable areas affected, or time out as configured in either the DALI user interfaces, devices on the control network, scheduled event or headend software instructions. This is required to allow the system being fine-tuned to balance the needs of the occupants and owners of the system.

The manufacturer shall publish the supported DALI-2 input-device capacity for each DALI controller and DALI line. Published capacity shall be based on supported operating conditions and shall not rely only on theoretical DALI addressing limits.

The published capacity shall identify the supported number of DALI control gear devices, DALI-2 input devices, DALI-2 sensors, DALI-2 dry-contact input devices, DALI-2 push-button devices, DALI bus power supply current, and any instance, event, memory, polling, processing, or performance limitation that affects the supported system design.

Where a DALI-2 input device contains multiple instances, including but not limited to push-button instances, occupancy instances, light sensor instances, absolute input instances, rotary control instances, or indicator/status output functions, the manufacturer shall state how these instances affect the supported device quantity and system performance.

Systems that advertise DALI-2 input-device capacity only by reference to the theoretical 64 control gear / 64 control device addressing structure, without publishing the practical supported combination of drivers, input devices, bus current and instances, shall not be accepted.

9.3.4 DIN-rail Mount DALI Universe Controllers

DALI universe controllers shall be offered in DIN-rail mount configuration, and available in single or triple universe configurations to control up to 64 or 192 DALI addresses respectively. The controllers shall be powered (100 – 277 VAC) from mains supply without the need for an external power supply.

DIN-rail Mount DALI universe controllers shall optionally incorporate standby power management via an integral 20A switched output per universe for control of the mains power circuit feeding luminaires connected to each universe. This output shall automatically disconnect the mains power supply to the luminaires when all luminaires on the associated DALI universe is set to 0% output (off state), removing all standby current consumption from the DALI luminaires. This function shall be completely automated by the lighting control system and require no additional commissioning. Control systems that do not allow for the integrated power supply management to the LED drivers or dependent on external devices to perform this function are not acceptable.

The controllers shall incorporate an integral mains supply relay for each driver control output circuit so that power can be removed from the lighting circuit when the driver control channel is set to 0% output (off state). The relay shall have an appropriately rated capacity for typical lighting loads. Control systems that require an external DALI converter shall not be acceptable.

9.3.5 DALI Commissioning

The control system and DALI LED drivers are to be commissioned via a common graphical commissioning software interface providing graphical representation of all DALI luminaires and control system products.

Configuration of the DALI controller shall not require purchasing of additional license to enable features, functions, scale, or additional devices that can be added to the system. This is to prevent hidden costs being added to the system after being awarded.

The system's DALI controllers shall automatically start scanning their associated DALI networks for all available devices (drivers & input devices) when first powered up. This is required to speed up the commissioning process so that all required DALI devices addressing information is available and ready within the DALI controller. System which requires the controllers to be manually triggered to search for DALI devices addressing details shall not be accepted.

DALI load controllers shall support setting and reconfiguring DALI addresses, group addresses and scene level settings. Systems that require third-party commissioning software to set DALI addresses, group addresses and scene level settings shall not be acceptable.

Initial programming shall be via graphical icon positioning and grouping, writing data to products and a single database simultaneously. Systems where DALI LED drivers shall be pre-configured causing intermediate commissioning layers shall not be acceptable.

From the DALI controller, installers shall be able to test their termination by individually triggering each of the DALI networks to flash all correctly connected drivers for a set period.

DALI controllers shall provide diagnostic feedback querying the network such as DALI bus low voltage, backward-frame communication errors, excessive drivers, DALI bus short circuit, cross DALI line short, and communication quality.

The controller shall expose the DALI network traffic detailing type of message, description as well the code. Each network messages shall be time stamped so that traceable diagnostics of the bus can be performed. It shall be possible to download the DALI network traffic for further analysis if required.

9.4 DIN rail Multipurpose Controllers

DIN rail Multipurpose Controllers shall be used in applications where operation of various small load types is required in a specific location, i.e., waiting area, meeting rooms, cafeteria etc.

The controllers shall have 8 output channels and be housed in a 12-unit width DIN-rail mount enclosure. Controllers shall have a maximum load of 16A.

There shall be a range of plug-in output modules available to suit various load types including:

- Signal dimming module with 2 channels, software configurable to DALI Broadcast, 1-10V and DSI.
- Leading Edge / Forward phase power dimming module
- Trailing Edge / Reverse phase power dimming module
- Switching module
- Curtain module
- Fan module

The controller shall optionally incorporate front panel channel status indicators with a manual override toggle switch for each output.

10 User Interfaces

A range of compatible user interface options shall be available from the same manufacturer of the control system for direct connection to the control network, including:

- Pushbutton Keypads
- LCD Display for menu navigation and option selection
- Color Touchscreens
- Virtual Interfaces such as browser or mobile app-based

All network devices shall receive bulk firmware updates if needed.

It shall be possible for the lighting control system to simultaneously update the network user interfaces configuration for faster adjustments and tuning of the system's performance.

10.1 Keypad common features

Keypads shall be of the correct size to suit locally available wall boxes.

Button caps of pushbutton keypads shall be able to be labeled or engraved. These shall be readily interchangeable with custom engraving available if required.

The keypad shall communicate directly to the control system using the core protocol.

All keypads shall be ‘universal’ in that any button or key-switch input shall be capable of being triggered the following events:

- Select a preset
- Set a channel to a level
- Start a task
- Stop a task
- Link / unlink areas
- Send any valid user-defined network message, or sequence of messages

Keypads shall contain an internal macro control facility that shall allow them to perform conditional and sequential logic. Systems that rely on an external logic processor or centralized logic processor shall not be acceptable.

Keypads shall provide an immediate, local status LED response upon button activation or detection of a network message with the same command function to indicate the corresponding change in system state. The status LEDs shall also be independently controllable across the control network.

All keypads shall be completely configurable via the control system protocol and commissioning software. There shall be no requirement for direct connection to the keypad for configuration and the commissioning software shall not require additional drivers or plugins to complete the configuration. Control system keypads that require direct connection and additional commissioning software drivers or plugins shall not be accepted.

It shall be possible to upgrade the firmware of all keypads over the control network.

Keypads shall incorporate a Sign-On. The Sign-On, when activated manually, shall cause a "Sign-on" message to be transmitted onto the network. The Sign-On function shall be capable of being triggered from pressing any two of the standard User Interface buttons at the same time. There shall be no need to remove the User Interface from its mounting location to gain access to the Sign-On trigger. The sign-on message shall contain information about the device, such as: network address/ID, device type and embedded software version which is intended to identify the device on the network for faster configuration. Systems which do not support network identification of user interfaces from the device shall not be accepted.

The user interfaces shall include proximity detection that wakes them from an ultra-low power standby mode when an occupants/user approaches the keypad. When in standby mode all indicators shall be completely off and only reveal themselves when the proximity sensor is triggered.

User interface keypads shall also include an ambient temperature sensor. When requested With the NLCS the keypad shall be capable of communicating the local current temperature to the core network. Internal logic within the sensor shall also be capable of triggering a network message when a particular temperature is detected. The temperature range shall be 5 to 40° C (41 to 104° F) with an accuracy +/- 1.5° C (35° F). The core network shall support the ability to dynamically change the system’s reference temperature sensor or take an average from multiple user interfaces if required.

User interfaces keypads shall have an interchangeable communications module that is compatible with the full range of all user interfaces within the manufacturer’s range. This communication module contains all the configuration information needed for the keypad’s functionality. The communications module shall be configurable without the application module.

It shall be possible to upload 16 different configurations to the keypad which can be selected during installation using an accessible DIP switch enabling fast deployment of keypads on-site for different applications.

The user interface keypads shall support an IP22 rating allowing for more flexible installation options.

User interfaces are made of material which will not fatigue when cleaned with hospital grade disinfectants, bleaches, or anti-bacterial cleaners.

User interfaces shall not have sharp edges to prevent accidental harm.

The user interfaces construction shall allow for smooth button operation even though during the installation excessive torque force may have been used on the mounting screws or installed on an uneven wall surface.

Each of the buttons shall be capable of being labelled with text or icons to indicate functionality. This shall be easily configured using an online tool that does not require the user to have an in-depth knowledge of the system or its part codes. This is required so that end-users can directly configure their desired finishes and labeling options.

User interfaces button configuration shall allow templated programming for the following functionality.

- Pre-set selection
- Ramping of lighting level
- Ramping of color temperature
- Room Join / Un join
- Toggle preset
- All lighting on / off

10.1.1 Antumbra Button

Keypads shall be capable of supporting up to 6, 4, or 2 buttons, and it shall be possible to mechanically configure using alternate key assemblies to provide fewer buttons if required.

10.1.2 Antumbra Display

Within the system there shall be an option for a keypad with a built-in color display that shall allow system information to be communicated to the user. This keypad shall match the same look, feel and finish of the standard button keypads.

The display shall be capable of showing the following system information.

- Current scene selected (via dynamic icon or text)
- Current time
- Current measured temperature

- Current set point temperature
- HVAC mode and fan speed
- Bar graph to indicate lighting or volume channel level
- Data point by percentage to indicate lighting or volume channel level

Keypads with built-in LCDs shall be able to display dynamic information in a range of languages and icons.

The display keypad shall support different modes of operation for trading hours and after- hours functionality.

The Display shall not require an auxiliary power input for the device. The unit shall be completely supportable from the system's own core network cabling.

The User Interface with color display shall be directly configured from the system single Commissioning tool. There shall be no need for additional commissioning tools that is not used for all other devices.

10.1.3 Antumbra Touch

Keypads that utilize capacitive touch technologies, with no moving parts, shall be available from the control system vendor. These panels shall provide simulated audible button press action feedback.

10.1.4 Revolution

Keypads shall also be available which provide rear text or icon RGB illuminated engraving. It shall be possible to individually control the rear text RGB illumination for each button independently and set via software the text illumination intensity for the whole keypad.

The keypad shall be available with different button sizes and configurations to meet different project needs.

There shall be a 4" touch screen that can be accommodated in a single gang wall box. This display shall be custom configurable from available templates from the commissioning software and allow multiple pages.

The Display shall not require an auxiliary power input for the device. The unit shall be completely supportable from the system's own core network cabling.

The User Interface with color display shall be directly configured from the system single Commissioning tool. There shall be no need for additional commissioning tools that is not used for all other devices.

10.1.5 User Apps

The control system shall have available a control app which will be compatible with Apple and Android operating systems. The app shall be available directly from Apple App Store or Google Play Store respectively.

The control app shall allow users to send the following commands to the lighting-control system:

- Select a system preset which could change lighting, blinds, and trigger AV.

- Show a slider for channel or area level control of lighting.
- Show a slider for tunable white warm to cool temperature selections.
- Show a slider for RGB full color control.
- Operation of motorized blinds, shades, black out, or awning.
- Adjustment of HVAC setpoint and fan speed.

The lighting-control system shall include an Ethernet gateway to connect to the project Wi-Fi network and provide access to lighting-control system functionality.

10.2 Sensors

Sensors shall be installed in appropriate locations to minimize energy consumption, through daylight harvesting and occupancy detection control. The multifunctional sensors shall contain a photoelectric (PE) sensor, a motion detector (PIR) and an IR receiver in the same package. The sensor shall be capable of supporting all three detection elements at the same time. For example, the sensor will detect occupancy through the PIR which will recall a light level, the occupant can then select a preset via an IR remote to give the sensor a LUX range to manage. The PIR sensor will continue to detect the occupant until the area is vacant.

Systems dependent on discrete motion and light level sensors shall not be accepted. Only multi-functional devices with combination of both motion and light level sensors are to be used. Network sensors shall simultaneously perform both motion and light level detection.

All sensors shall be true network devices with no requirement for extra accessories to perform their core functions. Sensors shall receive updates to their firmware or configuration without any need to uninstall or separately connect to the device. Sensors shall be powered directly from the lighting control system's network to simplify the installation and ongoing maintenance.

Lighting control systems which employ sensors with dry contact outputs that need to be paired with dry contact input integration devices shall not be accepted. This is required to simplify the lighting control system's application, reduce installation complexity, & allow for true visibility of sensor cost to be known.

A single control system shall have within its range the following PIR scan pattern angles available to allow for flexible design of the sensor layout and to ensure all areas can be covered.

- 360°
- 90°
- 30°

All sensors that use 360° PIR scanning pattern shall be available in surface and recessed mounting options.

All sensors that use 90° & 30° PIR scanning patterns shall have a flexible ball joint that allows for the sensor to be aimed into the right location. Sensor with fixed positions or dependent only on masking accessories shall not be acceptable.

All wall mounted sensors shall be directional so that they can be aimed at the area requiring to be monitored.

Sensors shall be supplied with all the required components to complete their full installation. Sensors which need to be supported with separately supplied mounting accessories that are not included in the devices main packaging shall not be accepted to allow for full visibility of sensor cost, installation requirement, and reduce complexity of supporting.

The sensors IR receive shall support industry standard RC5 commands. Supplier of the sensors shall also have available within its range, compatible handheld remote IR controllers that are capable of the following functionality.

- Preset select.
- Ramping of lighting
- Toggle on / off

The multifunctional sensor shall be capable of acting like a conventional motion detector, with a user-definable timer. Sensors shall also incorporate an intelligent function that automatically extends the no-motion time-out period if motion is detected immediately after the sensor sets the status to unoccupied.

The network sensor shall support multiple response requirements to support different operational functionality at varying times throughout the day. Transitioning between the different modes are to be triggered by a scheduler within the control system.

The system shall include a bedside sensor capable of detecting when a guest leaves their bed and shall then trigger the appropriate response such as turning on the room lighting at an appropriate level, turning on bathroom lighting, and notify nursing staff that they have left their bed.

The network sensor shall work in conjunction with any color temperature biorhythm strategies to automatically recall the appropriate lighting color temperature for the time of day.

Sensors shall incorporate at least 8 preset control modes for motion detection and 8 preset control modes for illuminance control, to provide effective occupancy and daylight harvesting control.

Sensors shall be available that utilize either Passive Infra-red (PIR) or a combination of PIR and Ultrasonic (US) for occupancy detection. It shall be possible with the sensor that incorporates both PIR and US sensing detectors to configure the sensor so that it utilizes either or both detectors for motion detection.

The sensors shall also include a function that enables them to enter a testing witness mode, whereby the timeout delay is shortened so that effective occupancy control can be quickly verified during commissioning. It shall be possible to enable and disable witness mode across a complete site or section thereof, from within the commissioning software without the need to modify or enter new configuration data individually for each sensor. Systems that require configuration data to be modified on a sensor-by-sensor basis to implement a witness mode shall not be accepted.

Photoelectric PE monitoring shall be incorporated in all occupancy sensors as a standard feature and shall be independent of the occupancy detection function. PE trending shall be available via the control system software, where sensitivity can also be calibrated.

PE sensors shall be capable of operating in a closed loop function where they are directly measuring the natural daylight and the contribution from artificial lighting. Additionally, the sensor shall support open loop daylight regulation where they directly measure only the natural daylight. One PE sensor in open loop configuration shall be able to adjust every lighting group on the entire network.

PE sensors shall be capable of adjusting the lighting through incremental changes so that the occupants are not aware of the changes.

Sensors shall be easily configurable to achieve daylight dependent (harvesting) regulation. The sensor shall be capable of providing PID (Proportional-Integral-Derivative control) illuminance control for applications where continuous regulation is preferred. It shall be possible to dynamically enable and disable the sensor by sending a network message.

During the commissioning process the sensor shall be capable of being set to stream current PE levels back to the commissioning software. This information is to be presented in a graphical format so that the commissioning engineer can assess the conditions and set the thresholds for triggering actions in the control system.

For rapid deployment of basic illuminance management control, the sensors shall incorporate a function that enables them to be auto calibrated. It shall be possible to initiate auto-calibration across a complete site or section thereof, from within the commissioning software with a few simple mouse clicks without the need to modify or enter new configuration data individually for each sensor. Systems that require configuration data to be modified on a sensor-by-sensor basis to implement auto-calibration shall not be accepted.

The sensor shall support direct communication to the core network utilizing the same protocol. This functionality is required so that the sensor can send data information back on the current environmental conditions that it is detecting.

The sensor is to be directly powered by the core network. Sensors that require an external power supply shall not be accepted.

Any systems with sensors which are dependent on external accessories for network communications shall not be accepted as there are hidden costs and complexities which are difficult to bring visibility too.

All sensor configuration settings shall be made from commissioning software via the control network. Sensors which incorporate manual adjustments such as potentiometers or DIP switches to set luminance thresholds levels are prohibited. All configuration data required for normal operation including area, illuminance thresholds, motion detect actions etc. shall reside in the sensor's non-volatile memory.

DALI-2 sensor shall be manufacturer validated, configurable and firmware updatable via the standard systems workflow.

10.3 Touchscreens

Configurable color LCD touchscreens shall be used in locations where complex user interface requirements exist that are likely to change over time, and where it is advantageous to provide access to some system maintenance functionality.

LCD touchscreens shall support capacitive touch inputs from user.

The touchscreen shall be capable of monitoring network traffic and displaying decoded 'plain English' network messages for diagnostics. It shall be possible to download custom graphics to the touchscreen. The touch interface shall be capable of initiating any of the following events by pressing a graphical button:

- Go to a new screen page
- Select a preset scene
- Set a channel to a level
- Start/Stop a task
- Link / unlink areas
- Send any valid user-defined network message, or sequence of messages

The touchscreen shall contain an internal task engine that shall allow the panel to perform conditional and sequential logic. Systems that rely on an external logic processor or centralized logic processor shall not be acceptable. All set-up and configuration information shall be stored on the touchscreen in non-volatile memory.

The touchscreen shall have user password protection to access the configuration and set-up features.

The touchscreen shall be developed by the same manufacturer as the lighting control system and support direct communication via its main native protocol to ensure that it can leverage the full functionality of the lighting control system. Any system's touchscreen which is dependent on network gateways, ethernet connection to main system, or an external processors device shall not be accepted.

Common configuration software for the lighting control system and the touchscreen shall be made available to ensure commissioning teams do not need to translate between software packages during a project configuration.

Touchscreens shall not be dependent on a removable memory card for retaining its configuration or firmware. Such additions are a vulnerability which could be exploited.

Touchscreens shall include built-in temperature and humidity sensors.

Touchscreens shall include a real timer clock and scheduling functionality. Editing of schedules shall be supported through the touch screen itself.

The touch screen shall support being mounted within an industry standard mounting wall box. Devices are dependent on the manufacturers' own mounting box shall not be accepted.

11 Networking and Integration

11.1 RS-485 Gateways

RS-485 network bridges shall be used in strategic locations on the LAN as necessary to establish a trunk and spur topology for efficient data transport. Network bridges shall also be installed where required to facilitate serial communication with third-party systems.

RS-485 network bridges shall contain two RS-485 data ports, galvanically isolated from each other. The network bridge shall allow bi-directional variable message passing to block or pass messages based on:

- Area or
- Message type

The RS-485 bridge shall contain an internal task engine that allows the interface to perform conditional and sequential logic. Control systems that rely on an external logic processor or centralized logic processor shall not be acceptable.

It shall be possible to configure the network bridge as follows:

- One RS-485 port as DMX512 Transmit, capable of transmitting 64 channels of DMX512 levels
- One RS-485 port as DMX512 Receive, capable of receiving 64 channels of DMX512 and converting them to channel level messages.

11.2 RS-232 Gateways

RS-232 network gateways shall be available for serial port integration between the control system network and third-party systems, including AV systems, lighting desks, data projectors, HVAC, BMS and security systems. RS-232 network gateways shall be powered from mains supply or the control network.

RS-232 network gateways shall include a programmable logic controller capable of comprehensive conditional and sequential logic and arithmetic function processing. A library of data formats shall be available for systems integrators or shall be capable of being created using the onboard conditional logic engine to assemble and transmit user-defined data strings.

No additional commissioning tools shall be required for these devices.

11.3 Ethernet Gateways

Ethernet network gateways shall be available to establish trunk and spur topology with an Ethernet trunk, to provide remote control of sites, to collect system operation data and to interface to a range of IP based protocols and third-party systems.

Ethernet network gateways shall support IPv4 and IPv6 protocols, with static or DHCP assigned IP addressing and configurable routing.

Ethernet network gateways shall include an integral webserver for browser-based control scenarios, an action scheduler and an internal task engine that allows the interface to perform conditional and sequential logic. Control systems that rely on external logic processor or centralized logic processor shall not be acceptable.

11.4 Remote TCP/IP Access Interface

A remote access interface shall be available which shall allow an end-user or manufacturer representative to 'tunnel in' to the lighting control system to control, configure, or commission the system over TCP/IP via a

100BaseT Ethernet network. It shall be possible to perform all functions across the 100BaseT interface that can be performed whilst connected directly to the lighting control network. The interface shall also incorporate an embedded web server which enables system control pages to be authored and stored on the device which can be viewed across a TCP/IP network from any connected PC, tablet or smart phone using a standard web browser.

11.5 HVAC valve controllers

The control system shall have within its range a dedicated Fan Coil Unit Controller designed for direct connection to components commonly found in Heating, Ventilation, and Air Conditioning (HVAC) plants with Fan Coil Units (FCU).

The unit shall support automated hysteresis response so that it can correctly respond to changes of temperature and prevent the system from oscillating out of control.

The device shall be universal for supporting controlling of Triac (Valve) outputs for controlling valves and relays used for switching FCU fans and auxiliary heaters or 0-10V outputs, used for controlling valves and fans with analog inputs.

4-pipe, 3-pipe, or 2-pipe systems shall be supported by the same unit.

Fan speed control shall be optional for three speeds which are selectable from three relay outputs or a variable 1-10v speed, allowing for silent operation of the fan speed.

A General-Purpose Relay output shall be included within the same unit that could be used for floor heating or other related functions for managing temperature requirements.

The device's configuration software shall include a configuration wizard that will automate the commissioning process and calibration of responses.

The device shall have multiple modes allowing for the unit's responses to be tuned depending on the area's occupancy or intended occupancy.

System shall support valve control curve configuration to ensure optimal operation of valve drives, the valve control curve shall be configured with the following features:

- Linear dependency of the valve position vs. valve control value in the active valve opening range. Refer to valve specifications.
- Restriction of the valve minimum and maximum position. Many valves have almost no flow when they are slightly opened and already reach their maximum flow rate at 60 – 80%. Some valves also generate a disruptive whistling with a low flow rate. These effects can be virtually eliminated by limiting the active valve opening range. Refer to valve specifications.
- The positioning frequency of the valve drive can be reduced by configuring the valve minimum control efforts (%) required to make the valve move.
- Restriction of the valve control value. Due to these limits, the valve output does not react to the control value in the lower and upper limit ranges. With valve minimum

level (%) and valve maximum level (%), valve movement can be avoided when there is a negligible demand for heating or cooling.

It also features four configurable control inputs for interfacing with dry contact outputs, 0-10VDC outputs and a 20 kΩ NTC temperature sensor.

To facilitate the use of a single platform for all electrical services the controller integrates local HVAC control with core communication protocol from lighting control system, enabling interaction with the entire control network.

The unit shall include four I-10v inputs which shall be capable of being used for confirming the valve position or other low level inputs such as “drip tray full”

11.6 BACnet gateways

The system shall support BACnet integration to allow BMS systems visibility of the Lighting Control system status as well trigger top level functions such as scheduling messages.

The system shall support BACnet from a dedicated device which shall distribute the BMS requirements to the lighting control system. This is required so that the BMS system does not need to address multiple IP devices within the control system, doubling the configurations from the BMS and LCM, and so that the LCM is not constrained by the limitations of the BMS.

The BACnet gateway shall be a native device from the manufacturer to ensure that it follows the same system architecture as the system and that it's seamlessly supported. The gateway shall be directly configurable from the LCM commissioning software without the need for additional applications.

Where remote access or cloud-assisted support is available, it shall be optional and shall not be required for local lighting-control operation, BACnet integration, commissioning, scheduling, diagnostics, or maintenance.

The BACnet gateway shall support two Ethernet ports so that it shall be physically connected to the BMS VLAN and the Lighting VLAN without the need for additional IP hardware.

The BACnet gateway shall be mains powered (100 – 277VAC) so that it does not need to be paired with any external power supplies.

11.7 Timeclocks

Network timeclocks shall be utilized where local adjustment to automated lighting control events are required via a direct connection to the control network. The timeclock shall incorporate a calendar and will have the ability to calculate the theoretical sunrise and sunset times, at any time of the year, for any geographical location.

The timeclock shall be able to perform various functions at designated times on designated days, including selecting specific preset scenes in specific areas, lock or unlock keypads, activate or de-activate sensors and motion detectors, execute sequences of network control messages.

The timeclock shall be capable of initiating events or sequences of events at a specific time or time difference from sunrise or sunset on a:

- Day of the week
- Day of the month
- Calendar date

Sunrise and sunset information may be determined by latitude and longitude settings, and the timeclock shall automatically keep track of daylight saving, and leap years.

The time clock shall be capable of storing up to 250 automatic timed events and contain an internal task engine to perform conditional and sequential logic.

The system shall have its own native network timeclocks to trigger scheduled events and not be dependent on cloud connection for such functionality.

11.8 Dry Contact Input Interface

Dry contact input interfaces shall be used where required to integrate control from other systems and devices via switch or relay closure. Dry contact input interfaces shall be galvanically isolated for immunity to noise, and to protect internal electronics. It shall be possible to connect the dry contact interface to switches located up to 20 meters from the interface. The dry contact interface shall have an isolated internal power supply powered from the network cable to provide a reference voltage for inputs.

The device shall also optionally support receiving analog inputs of 0-10 or 0-5 VDC.

The interface shall contain an internal task engine that shall allow the interface to perform conditional and sequential logic. Control systems that rely on an external logic processor or centralized logic processor shall not be acceptable.

The dry contact interface shall be capable of initiating any of the following events:

- Select a preset scene
- Set a channel to a level
- Start a task
- Stop a task
- Link / unlink areas
- Send any valid user-defined network message, or sequence of messages

11.9 Miniature Dry Contact Interface

Miniature dry contact interface devices shall be used to connect third-party sensors, custom switches, to the lighting control network. The miniature dry contact interface shall be no larger than 53mm x 30mm x 15mm suitable for mounting within compact wiring enclosures. The interface shall have 8 inputs and 8 outputs for LED indicators, and shall be capable of initiating any of the following events on a change of state of the contact:

- Select a preset scene
- Set a channel to a level

- Link / unlink areas
- Send any valid user-defined network message
- Emulate the operation of a motion detector

Miniature dry contact interfaces shall be available which connect directly to a DALI bus for multi-master controller. The device shall also be software configurable and firmware updatable over the DALI bus from the control network.

Where DALI-2 dry-contact input devices are used, each input shall be individually configurable from the lighting-control system commissioning software.

Each dry-contact input shall be capable of triggering standard lighting-control functions including, but not limited to, preset scene recall, area on/off control, channel-level control, profile or mode change, sensor override, partition/linking logic, emergency test initiation where supported, and execution of a system task or sequence.

A DALI-2 dry-contact input device shall not be limited to controlling only the DALI group, DALI address, or DALI line to which it is physically connected. The lighting-control system shall be capable of translating validated DALI-2 input events into the manufacturer's native control protocol so that inputs connected to one DALI line can control lighting areas, channels, scenes, tasks, or integration functions located across other DALI lines, other load-controller types, or other sections of the lighting-control system.

Where input devices support indicator outputs, LED feedback, or status indication, these outputs shall be configurable by the commissioning software and shall be documented with their electrical ratings, wiring limitations, isolation method, and permitted use cases.

DALI-2 dry-contact input devices shall be listed in the DALI Alliance / DiiA Product Database under the exact supplied part number and shall be manufacturer-validated for operation with the proposed DALI controller, commissioning software, firmware version, and supported system functions.

11.10 Dry Contact Output Interface

Dry contact output interfaces shall be used where required to provide control to other systems and devices via switch or relay closure. The dry contact output interface shall use electro-mechanically isolated outputs and have zero off-state leakage. Devices that use transistors or other devices with off-state leakage shall not be permitted. Outputs shall be rated to a minimum of 10A.

The interface shall contain a minimum of 8 x SPDT outputs for connection to other devices. The interface shall contain an internal task engine that shall allow the interface to perform conditional and sequential logic. Control systems that rely on an external logic processor or centralized logic processor shall not be acceptable.

11.11 Integration into third-party systems

The control system shall have a facility to integrate to third-party systems such as:

- Audio-visual systems
- Building management systems

- HVAC systems
- PABX systems
- Access control systems
- RS-232
- Infrared

Direct network connection to common AV control systems shall be possible, and the manufacturer shall have interface libraries written for the following popular systems:

- AMX
- Crestron

It shall be possible to integrate the lighting control network to other systems using any of the following methods:

- Using system management software:
 - OPC
 - API
- Using dedicated control network gateway interfaces
 - KNX
 - BACnet with BTL listing
 - Modbus 485
 - Somfy

12 Software

12.1 Management Software

The management software shall support direct importation of the commission software files. This is required to prevent a misalignment of configuration between the hardware configuration and the Head-end management software, ensuring full access to all system functionality, and to reduce commissioning time for faster project handover.

Intuitive site management software shall be provided to allow the control system to be operated and managed by local client personnel. The site management software shall be mouse driven and run under the Windows operating system and incorporate secure multi-level user access control. The software shall incorporate a two-dimensional graphic environment where icons can be positioned to represent each element in the control system including individual luminaires. To assist site navigation the software shall be capable of importing floor plan backgrounds from common drawing file formats, the minimum being wmf, emf, pdf, jpg, jpeg, png, bmp, tiff, and gif formats. The software shall display virtual wiring on the PC, and it shall be possible to change logical areas using mouse click and drag techniques.

The lighting control software shall enable luminaires to be controlled individually, in groups or areas. It shall enable luminaires to be assigned to a group by clicking and dragging them to a floor plan region. It shall be possible to double click anywhere within the area boundary to access a preset editing view for the respective area.

The head-end software shall not require extensive training or in-depth knowledge to operate its features and functions.

The software shall enable the system to be readily reconfigured using mouse click and drag techniques or similar to accommodate changes in floor plan layouts and area groupings.

Luminaire icons within the floor plan environment of the control software shall change color to reflect the actual status of the lamp. For example, a yellow lamp is on, a grey lamp is off. A blinking lamp indicates that the allowable lamp run time has been exceeded, and the lamp shall be replaced.

The head-end software shall allow the user to make instantaneous lighting-level adjustments and adjust preset scenes on the native network and DALI network. When this is done, new levels shall be capable of being saved directly to the load controllers responsible for managing the lighting groups. This requirement is so that end Users can adjust the system when required without being dependent on external technical support teams.

The head-end software shall allow for adjustment of the network (including DALI) sensor time outs and target lux levels for a given area. When such changes to an area are made the software shall then adjust all the required settings in the physical devices in the local areas.

The system shall be able to keep track of luminaire data such as manufacturer, part number, wattage, life expectancy, managing load controller, date installed, and location.

The head-end software shall support direct management of all control system devices and be capable of reporting back to the end-user any faults that may arise.

It shall be possible to display the full properties of a luminaire, within a properties dialogue box, which can be readily accessed from a drop-down menu on the respective luminaire icon. The luminaire properties dialogue box shall include but not be limited to the following information:

- Area
- Lamp Control Group
- Luminaire location / ID number
- Lamp makes and model
- Manufacturer estimated lamp life
- Cumulative true running hours
- Cumulative weighted running hours (incandescent lamps, corrected for power)
- Real time lamp active status
- Date of last lamp replacement

The lighting control system shall incorporate an action scheduler to automate time-based events. It shall be possible to trigger scheduled events as a 'One off' timed event or a recurring event. 'One off' events are scheduled for a specific date and time. The scheduler shall be capable of initiating events or sequences of events on a specific time or time difference from sunrise or sunset on a:

- Day of week
- Day of month
- Calendar date

Sunrise and sunset information may be determined by latitude and longitude, and the system shall automatically keep track of daylight saving, and leap years. It shall be possible to schedule the date of recurring events in several ways:

- At a specific day and time each week
- On a specific day of the month
- On a specific day of the week each month

Similarly, the time of recurring events can be scheduled in several ways:

- At a specific time, each day
- At a specific time before or after sunrise/ sunset

For recurring events provisions shall also be included for the end-user to schedule exceptions.

The system management software shall also incorporate a macro-based logic control builder that utilizes a plain language function editor. The macro builder shall be capable of handling sequential control routines. The macro facility shall also present a range of standards or common control routine templates, to assist in implementation of typical control scenarios.

The lighting control software shall incorporate user logon access security. The system shall be capable of displaying alternate menu structures in accordance with the permission profile defined for each user. The system shall automatically log out users after a defined period has elapsed since the last keyboard or mouse activity. The system shall also record the time that each user logs on, logs off, and if the log off was manual or automatic for review by the system administrator.

12.2 Commissioning software

All aspects of the software shall be produced by the hardware manufacturer. This is to ensure that the software has access to all the features and functions of the network control system.

The software shall have access to all hardware configuration variables from primary installation. The commissioning software shall not require additional external 3rd party add-ons or drivers to configure different hardware components. This is required so that the commissioning software will fully support all network devices without issues of conflict between additional 3rd party add-ons or drivers.

The commissioning software shall support scanning the control system to find all devices. This feature is required so that commissioning engineers do not require direct access to all devices, forcing them to perform a network sign on identification.

The system's network devices shall be capable of performing a network sign-on to identify themselves on the network. The sign on trigger can be performed without uninstalling the device. Systems which require devices to be uninstalled to perform network sign-on shall not be accepted.

It shall be possible to pre-commission the software off-site without any connection to the lighting control network. Completion of commissioning using the pre-configuration approach, shall then only involve connecting the PC with commissioning software to the lighting control network, signing on of network devices, and then downloading all configuration data to the devices.

Off-site pre-commissioning shall also be possible for systems that incorporate DALI controllers and luminaires. Provision shall also be included to accommodate both enumerated and non-enumerated DALI luminaires.

All DALI commissioning, addressing, grouping, scene assignment, DALI-2 input-device configuration, DALI diagnostics, DALI emergency testing setup, and DALI device replacement workflows shall be performed using the lighting-control system manufacturer's standard commissioning software.

The lighting-control system manufacturer's commissioning software shall remain the single source of truth for DALI addressing, DALI grouping, DALI scenes, DALI emergency configuration, DALI-2 sensor configuration, DALI-2 input-device configuration, diagnostics, replacement workflows, and project records.

The lighting-control system shall not require third-party DALI commissioning tools, DALI configuration utilities, control-gear manufacturer tools, USB-DALI interfaces, mobile applications, cloud tools, or separate manufacturer-specific software to complete normal project commissioning, maintenance, fault finding, or device replacement.

Third-party DALI tools shall not be used to create, modify, store, or maintain the project's DALI addressing, grouping, scene, emergency, sensor, input-device, or driver configuration unless expressly approved by the client and documented as a project-specific exception.

Where DALI control gear requires manufacturer-specific parameterisation, such configuration shall be completed before installation or shall be fully coordinated and documented so that it does not create a separate unmanaged DALI configuration database outside the lighting-control system.

Systems that require third-party DALI configuration software, external DALI commissioning interfaces, USB-DALI programmers, control-gear manufacturer utilities, mobile applications, cloud tools, or separate project databases to complete normal DALI commissioning shall not be accepted.

To ensure on-time completion of commissioning, it shall be possible to independently operate and commission sections of a facility, i.e., individual floors of a multi-story building, as discrete networks. The commissioning and management software shall also enable configuration files for each of the respective individual areas to be merged into a master site file as they are completed and connected to the overall site network.

The software shall also be capable of configuring all parameters of DALI devices connected to the DALI universe controllers including enumeration of short addresses. The lighting control system shall be able to configure LED drivers without having to use 'Driver Suppliers Software' or hardware creating intermediate third-party databases. DALI universe controllers and configuration software shall be capable of natively supporting all DALI configuration and control functionality. Systems that require separate third-party software and interfaces to enumerate devices and assign short addresses shall not be accepted. The lighting control systems DALI load controller shall support all DALI commissioning requirements. Lighting control systems that are dependent on additional third-party hardware for the commissioning process shall not be accepted.

The commissioning software shall be able to configure all elements of the lighting control system. Any commissioning software that requires additional external 3rd party patches, plug-ins or drivers to commissioning shall not be accepted.

The commissioning software shall allow multiple programmers on the same network at the same time.

The commissioning software shall automatically produce a report containing all systems settings.

The commissioning software shall be able to display the raw protocol in a network monitoring window. Each network message shall be translated to simple descriptive language in real time. It shall be possible for the commissioning engineer to “copy” direct from the network monitoring window.

The network monitor shall be capable of logging network traffic and allowing this to be exported into a plain text file. This is required to allow the network log file to be sent to a support department for diagnosis of system performance.

13 Monitoring

13.1 System Health Monitoring

The control system shall be able to assign essential and non-essential lighting on a circuit-by-circuit basis from the PC. It shall be possible to monitor and control the entire system in real-time.

The control system shall be capable of monitoring and displaying a comprehensive range of diagnostic and fault information including but not limited to circuit run time data, re-lamping schedules, on/off status, MCB trip status, DALI luminaire status and other diagnostic information. The system shall also be capable of initiating emergency lighting tests for luminaires that incorporate DALI control gear and incorporate a comprehensive facility for reporting test results. It shall be possible to program, initiate and monitor emergency luminaire testing from the system software. When a failure event is detected, it shall be possible to generate a report and direct it to an e-mail address or group of addresses, or a printer. It shall be possible to generate preventative maintenance reports from the software that indicate lamps that have operated past a specified allowable run time.

All lighting control network activity, as well as run time and configuration data shall be logged to an SQL compatible database. The end-user shall be able to use the built-in reporting functions or third-party SQL reporting tools to run custom reports. Alternatively, it shall be possible to export the data manually or automatically to a spreadsheet, text file, e-mail, or word processing document for the end-user to analyze.

It shall be possible for the lighting control software to be programmed to run the daily system tests to verify that all devices are operating properly. This information shall be displayed graphically using a floor plan view interface and logged to a database. The database shall be capable of running daily maintenance schedules. It shall be possible for reports to be automatically generated and e-mailed to the maintenance personnel each day.

The cumulative running hours of each luminaire shall be available from the lighting control software floor plan view interface. This information shall also be available from the database, where custom reports can be generated, or exported to a spreadsheet, word processing document, or text file. This information assists in efficiently planning re-lamping areas based on actual running hours, rather than estimated running hours.

Supporting DALI emergency reporting for durations tests, storing the results and escalating if any issues are found or some drivers are failing testing.

13.2 Energy Monitoring

The lighting control system shall be capable of logging the notional power consumption for any luminaire, circuit, area and range of areas. The system shall log running hours and output level to provide an estimate of lighting energy consumption.

It shall be possible to generate the following information:

- average energy consumption across a time period
- the power consumption of a control group
- the power consumption of a luminaire
- daily consumption profiles and plan peak load shedding

For the purpose of calculating and reporting on notional power consumption, it shall be possible to define notional power consumption profiles for all installed luminaire types, plotting power against dimmed output level. It shall be possible to enter this in either raw data format or via a graphical plot.

Provision shall be included for the user to generate custom reports, graphs, and analyze data using common software tools.

The system software shall also be capable of reporting on actual energy consumption via networked third-party power meters.

13.3 Energy Performance Monitoring

The system shall incorporate a utility to publish real-time notional energy performance data in a dashboard format via a web server, which can be readily viewed from PCs or other portable devices with standard web browsers. The purpose of this facility is to provide clear visibility of lighting system energy performance to occupants, to encourage utilization behavior that reduces energy demand. The utility shall be configurable to display energy usage information for any user-defined area or zone. Web pages shall include timeline graphs, which can also include comparative historical data, so that current performance can be readily benchmarked. Pages shall also be capable of displaying instant and accumulated year-to-date savings in absolute energy, cost and carbon volume terms.

13.4 Installation and Commissioning

The lighting control system shall be tested and commissioned to meet all the requirements set down in this specification. The system shall be set up initially in accordance with the [client's and/or consultant's] instructions and left working.

The project shall be commissioned in accordance with CIBSE, 'Chartered Institute of Building Services Engineers' code M – Commissioning management and code L – Commissioning process for lighting and NCS.

The commissioning agent shall have documented and in place, a 'Safe Work Method' statement.

The lighting control system shall be fully supported by the supplier, including:

- Importation and conversion of building CAD layouts
- On-site Testing
- Full Commissioning
- Application Engineering
- Client Demonstration
- Client Training
- Operation and Maintenance Manuals

14 Site Documentation and Configuration Information

Copies of all site commissioning software configuration files, and source files for all as-built site documentation, shall be provided to the client/end-user on flash drive.

The system shall be supported by online documentation that is searchable from a single location. Where AI-assisted support is provided, it shall be based on manufacturer-approved product information.



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