



# Philips Dynalite

## Engineering Specification

Revision 06

PHILIPS

dynalite

# Background

Philips 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 Philips Dynalite is generally the system of choice for projects involving integration with third-party vendor's equipment and for large-scale applications.

Philips 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 quality innovative products which integrate seamlessly creating an enhanced user experience leveraging on our extensive Lighting & integrated controls expertise. Our team collaborate end to end in the Design & Manufacture 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.

From a stock exchange in Shanghai, to a luxury resort in Dubai, a smart home in Sao Paulo to limestone caves in New Zealand, Philips Dynalite's innovative solutions deliver intelligent light.

Ongoing research and development has enabled Philips Dynalite to create secure automated systems that control tens of thousands of individual light fittings in high-rise office buildings from any location anywhere in the world. 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 road tunnels, computer servers or cold storage units.

Philips 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 Philips 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 Philips Dynalite control system has been independently recognized as 'A user friendly and sensible modular approach, which takes it from sophisticated domestic settings to large architectural spaces'.

# Contents

# 1 Introduction

This document refers to the Network Lighting Control System (NLCS) or Building Automation System (BAS) as the "control system".

The provider of the control system components must be an established supplier who has a minimum of twenty years design experience. The provider of the control system components shall have extensive examples of local reference projects demonstrating their competence in successful delivery of control system projects.

The supplier must be able to demonstrate continuous involvement in the local NLCS or BAS market to ensure future support.

The supplier is responsible for all devices on the network to be fully interoperability tested with all other devices 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 must 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.

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

- User Interfaces (UI) / Keypads
- Color Touchscreens
- Sensors:
    - Passive Infrared (PIR)
    - Ultrasonic (US)
    - Photo Electronic light level (PE)
    - Infrared Receive (IR)
- Relay Switching controllers
- Double throw relay motor controllers
- Phase-cut (leading and trailing edge) Power Dimming Controllers
- Signal Dimming Controllers supporting 1-10V, DSI, DALI Broadcast, DALI and DALI MultiMaster.
- Multipurpose (modular) controllers
- PWM LED controllers
- Headend user software
- Personal apps

- Integration and networking gateways to other systems:
  - Ethernet 10/100 Base T
  - KNX
  - BACnet interface (via RS-485 or Ethernet)
  - DMX512 Tx and Rx
  - LON interface
  - Somfy via RS-485
  - Modbus via RS-485
  - RS-232
  - Low level Dry Contact
  - Analog 1-10V input
  - Network scheduled timer clock
  - Infra-red transmission

# 2 Approved Vendors

The equipment shall be Philips Dynalite or approved equal.

# 3 Compliance

In accordance with CE 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 60950-1: 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 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 62386-301: 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

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

# 4 System Architecture

All network devices are to be configured from the same communications port as their operation port. Systems requiring additional device communications ports for configuration will not be accepted. A single communication port for both configuration and operation is required 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, change the network cabling, or having direct access to a network device. This also allows for changes to the system from the user headend software.

The control system shall be a network type providing distributed control, with user interfaces communicating directly with load controllers, without requiring the intervention of a central processing unit. This is required so that the system is not dependent on a single device which could create a central point of failure. Control systems that require a central processing unit will not be considered.

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

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 must 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 control system shall use a PC running intuitive and user-friendly software for the remote programming of all devices on the control network. It shall be possible to connect the PC to any point on the network, for access to the entire system. 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 operate in a default way immediately 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 will 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 will 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 is able to be viewed in logical groups, so that preset scenes and states can be easily configured for each logical area. This is required so that during project commissioning the control system can be viewed from the same perspective as the physical project layout. Systems that can only be viewed or configured with reference to a physical controller or channel will 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.

# 5 Network Physical Layer

Every load controller must contribute power to the communications network. Systems completely dependent on external network power supplies will not be accepted. The control system should allow for a single load controller to directly power at least four control system UIs without the need of an external power supply.

All load controllers must internally support the required resources such as mains power supply, micro-processor, 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 to achieve their core functionality will not be accepted.

The Control Network shall utilize an 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 Power Supply, or the 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 will not be considered. Devices shall be connected to the control network via pressure pad type screw terminals, RJ45 or RJ12 connectors.

The control system manufacturer shall also offer a range of appropriate network interfaces to enable Ethernet to be used for connecting network segments.

# 6 Network topology

Accessories shall be available from the system manufacturer to enable the creation of a trunk and spur network topology. Individual network spurs shall be galvanically isolated from trunks, with devices that enable message filtering so as 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.

# 7 Protocol

All control system devices must be capable of operating on a single network using the same protocol. Control systems that do not allow all products from the same manufacturer to be connected together in a single network, 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 can change from one scene to another with a single network message.

Changes to the addressing area where a physical channel or UI belongs, can be made with commissioning software without the need for making 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 should contain all the information to instigate a scene change. Information within this message shall contain:

a. The logical area address that is being controlled.

b. The scene that is being selected.

c. The fade time to transition between selected scenes.

Control systems that require multiple channel level messages to instigate a scene change will 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 will 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 will 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 should be fully capable of directly communicating to each other and triggering all supported functionality. Control system that are dependent on centralized logic processors to perform basic system functionality will 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, will not be accepted.

The control system shall be capable of supporting 65530 separate logically addressed areas, and at least 64 preset states within each area. Each area shall be able to contain 65530 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.

The network protocol shall also support variable length packets 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.

# 8 System Functionality

## 8.1 General

The control system shall be capable of readily deploying all functionality 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, enable management of the artificial lighting level required at any given time for vacant and occupied areas. This feature shall be capable of functioning at the same time as light level detection, especially in areas that experience high levels of daylight i.e. adjacent to windows.

### 8.2.1 Delay Timers

When no movement is detected, the control system shall be capable of dimming lights to a background level for a grace time 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

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.

### 8.2.3 Step-over Patterns

In large open office areas and public areas where areas may overlap, the control system shall provide ready 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 Open Plan Background Lighting

For larger areas equipped with multiple sensors (e.g. modern open plan offices), the system shall activate or maintain a background lighting level while at least one work island/station is still occupied. When the last work island area becomes unoccupied, the lights in the open plan must switch off (with a delay). Additionally, the control system shall enable tuning of the area to provide a balance between occupancy comfort and energy savings. An example of this is by fully illuminating the occupied areas whilst dimming the light to a standby level in adjacent unoccupied areas.

### 8.2.5 Corridor Hold-on (Linking)

The control system shall have provision to link areas like offices, meeting rooms or classrooms to a corridor (exit path). The control system must 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 level dependencies. This enables cell offices to keep corridors lit, corridors to keep lift/lobbies lit, lift/lobbies to keep reception area's lit, etc.

## 8.3 Light Level Control

### 8.3.1 Switching

The control system must 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 must 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, or 1-10V) or by power control of phase control dimmers.

### 8.3.3 Daylight Harvesting/Maintained Illuminance

Through sensor based light level detection, it shall be possible to implement level management of artificial lighting to maintain task illuminance at optimum targets. This provision shall minimize energy consumption by preventing over-illumination at any given time, especially in areas that experience high levels of daylight i.e. adjacent to windows.

### 8.3.4 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 readily and intuitively create and adjust light intensity levels and/or preset scenes across any lighting circuit/channel associated with the area/space.

### 8.3.5 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, only one DALI address shall be used for controlling both white balance and dimming level.

### 8.3.6 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 offices. The system must 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.

## 8.4 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.

### 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 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.

## 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 Area Linking

The system shall have provision to dynamically combine or separate control areas for applications where de-mountable 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 should separate into the discrete area in which they are located.

It must 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.

### 8.6.3 Load Shedding

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

# 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 in order 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.

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. Different 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 layout architecture, including the location and order of the terminals. Control systems with inconsistent terminal layout or order will not be accepted. This layout consistency is required to ensure the installers can quickly terminate the system with a reduced risk of error.

It must be possible to individually configure channels within all load controllers to unique areas that can be separately controlled. Dimming channels must have the ability to be software configured to provide either dimmed or switched output. It must 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 must be stored within the non-volatile memory of each respective controller. The controller must also support device names, area names and channel names each up to 40 characters in length. The controllers must also be capable of supporting up to 170 presets. These settings must be downloadable with the vendor's software. Any system that does not provide or can restrict access to the settings will not be accepted.

All load controllers shall incorporate a dry contact 'AUX' input. The AUX input shall be located next to the network terminals. The AUX input shall incorporate de-bouncing and requires a minimum of 200 $\mu$ s contact closure for a valid activation. 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

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 enclosure.

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 multiple load controllers 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 back 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 DMX512 signal and upon loss of signal
- Obey the secondary port
- Obey the highest level received from either port.

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

Load controllers shall 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 of time (loss of communications), the load controller must 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 should blink on 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 will blink on and off at approximately twice the normal speed for a few seconds and then revert to normal speed.
- *DMX512 Network Activity Detected* - When DMX is detected, the Service LED should 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 will perform a reboot. If the service switch is pushed three times in close succession the controller will drive all outputs to 100%.

It shall be possible to upgrade the firmware of all load controllers from any network access point over the control network.

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 2A, 5A, 10A, 16A or 20A continuous AC3 ratings.

## 9.3 Power (Phase-cut) Dimming Controllers

All power dimming controllers shall provide output power conditioning including:

- Output regulation
- Over voltage protection
- Surge protection
- Brownout and Sag protection
- Spike protection
- Soft start
- 16 bit fade resolution (65,535 steps)

Compensation for line frequency variations shall be incorporated. The dimmers shall maintain a constant light level with no visible flicker for incoming frequency variations of up to 2 Hz per second, or while connected to a generator, whichever condition is worse. The efficiency of each dimmer channel shall be equal to or better than 98%. Dimmers shall be

capable of smooth continuous dimming to 2 different dimming curves appropriate to the load type.

The dimmers must incorporate an electronic soft start facility to smoothly ramp up light levels on start up. They must also incorporate surge suppression and feed forward voltage regulation so fluctuations and variations on the supply are not passed on to the load. Leading edge dimmers must maintain a constant light level with no visible flicker for incoming voltage variations of up to 2% change in RMS voltage per line cycle.

Power dimming controllers shall be suitable for operation from either Single Phase or Three Phase supplies. Controllers rated for 40A total load or less shall be operated from a Single Phase supply. Controllers rated for more than 40A total load shall be operated from either Single Phase or a Three Phase supply.

All power dimming controllers with outputs rated 4A or greater shall incorporate integral circuit breaker protection on each output channel. Circuit breakers shall be Thermal Magnetic C-Curve with 6KA breaking capacity or approved equal. Connections for emergency lighting shall be provided on output circuits and be clearly labeled.

### 9.3.1 Leading Edge Power Dimming Controllers

Leading Edge, (LE) dimmers shall be used on general lighting circuits incorporating mains and low voltage. Leading edge dimmers must incorporate power regulating components with a nominal current rating at least 5 times greater than the dimmer channel full load rating.

For TRIAC or SCR style dimmed channel it shall be fitted with a toroidal wound, iron powder cored interference suppression choke which shall limit the rise time of the switch on transients.

### 9.3.2 Trailing Edge Power Dimming Controllers

Trailing Edge, (TE) dimmers shall be used on unique lighting circuits that incorporate trailing edge compatible low voltage electronic transformers. Trailing edge dimmers shall use MOSFET transistors as the power-regulating device. All trailing edge dimmers shall incorporate electronic overvoltage protection, and electronic short circuit protection. Trailing edge dimmers shall be capable of sensing an inductive load, and automatically revert to switching only if an inductive load is connected.

### 9.3.3 Universal dimmers Leading / Trailing edge

Phase cut dimmer channels that are able to support both Leading Edge (LE) and Trailing Edge (TE) methods of control. Universal dimmers shall use MOSFET transistors as the power-regulating device. All universal dimmers shall incorporate electronic overvoltage protection, and electronic short circuit protection.

It will be the responsibility of the commissioning engineer to select a Universal dimmer channel to be either Leading or Trailing Edge. Universal dimmers that support an automatic selection of Leading or Trailing edge will not be accepted as the automated process may choose an incorrect method, which will result in the damage or destruction of lighting hardware.

## 9.4 Signal Dimming Controllers

### 9.4.1 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, DSI or DALI Broadcast.

The controllers shall optionally incorporate an integral mains supply relay for each ballast control output circuit so that power can be removed from the lighting circuit when the ballast 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 DSI or DALI converter shall not be acceptable.

### 9.4.2 DALI Universe Controllers

DALI addressable controllers must 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 should be possible under normal circumstances to connect at least 255 DALI universe controllers to a control network to individually control 16,575 ballasts. It should 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 ballasts.

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 vendors network

Control systems that require controllers with external or separate power supplies, external DALI transmitter or external DALI network interfaces, external scene controllers and integration devices to vendor's network will not be accepted. Furthermore, systems that require the introduction of multiple interface connections through assembly of individual components for DALI universe adaptation will not be accepted.

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 will have the capacity to manage each individual DALI universe over multiple controllers together as one system. Any network user interface will have the capacity to send a single network massage that when required can affect multiple DALI universes to respond. The lighting control system must 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 NLCS 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 will not be accepted.

The DALI interface should be able to communicate with each ballast individually (short address mode) or with the DALI group addresses (group and scene mapping mode). This should happen automatically. This choice will overcome the limitations of 16 group addresses, and the slow speed of the DALI protocol specifically relating to avoiding Mexican wave effect of different ballasts arriving at target levels at different times.

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

- Lamp failure
- Ballast failure
- Ballast run time tracking for each ballast and lamp output
- Device Online / Offline status

A user service switch must 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 must also have provision for either off-site or on-site commissioning. A system that requires off site enumeration of ballasts/drivers is not acceptable. Single universe DALI controllers shall automatically enumerate ballasts when powered on. This automatic enumeration shall constantly run during normal operation to allow one for one DALI ballast replacement without the need for any commissioning.

The control system must be directly capable of supporting DALI replacement functionality via auto enumeration or headend software. This method must be intuitive and strait forward not requiring knowledge of the NLCS or DALI addressing architecture. This functionality is required so that the end-user is self-dependent on managing the NLCS.

The control system DALI solution must support an automatic recovery function were if a single driver fails and needs to be replaced, The control system will automatically detect the change and make the required adjustments within the network to accommodate the new driver. There should be no need to manually trigger the control system to replacement the updated driver.

DALI universe controllers shall support both normal and emergency DALI fittings. Control systems that require separate DALI controllers for normal and emergency DALI fittings will 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 outcome of functional/duration tests.

### 9.4.3 DALI MultiMaster Controllers

Where practical DALI MultiMaster controllers shall be used that permit connection of DALI input devices i.e. sensors, keypads 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 will not be considered.

The settings for DALI input devices shall be completely configurable from the vendors commissioning software. Any DALI input devices that require direct or manual adjustment will not be accepted.

The DALI controllers shall be capable of interpreting and relaying messages issued by these devices to the control system, so that the DALI input devices can also control lighting outside of the universe where it is connected.

DALI MultiMaster Controllers shall support up to 10 DALI user interface devices on a fully populated DALI universe. The DALI MultiMaster Controllers shall support 16 sensors/user interfaces on a 34 ballast DALI universe.

It shall also be possible to upgrade the firmware of DALI input devices via the DALI bus.

DALI MultiMaster universe controllers shall have provision to dynamically adjust luminaire fade rates as configured in either the DALI user interfaces or devices on the control network.

### 9.4.4 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 channels respectively. The controllers should be powered from mains supply without the need for an external low voltage transformer.

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 on each universe. This output should disconnect the mains power supply to the luminaires when all luminaires on the associated DALI universe are set to 0% output (off state), removing all standby current consumption from the DALI luminaires. This function should be completely automated by the lighting control

system and require no additional commissioning. Control systems that do not allow for the integrated power supply to the ballasts to be disconnected are not acceptable.

### 9.4.5 Structured Wiring Controllers

For installations that utilize structured wiring solutions, Lighting Control Modules, (LCMs) shall be supplied for final connection of the luminaires. LCMs shall be mounted within the ceiling void and typically be located to facilitate the shortest length of individual load control cabling to the luminaires as possible.

The LCMs shall provide 9 individually controlled output channels. Each output shall be a combination of an isolated dimming signal, switched mains supply of up to 5 amps maximum per channel, and a maintained active for emergency luminaires. A maximum total box load of 16 amps shall be possible.

For fast and flexible connection of luminaires, the controlled mains outputs and the dimming signal wiring shall be connected via individual, poled and gated six pin sockets that are integrated into the housing of the controller. Matching connectors shall be available with a range of cable lengths, and shall also incorporate where required a "T" junction enabling the daisy chaining of a particular output circuit up to the LCM individual output maximum load.

The LCMs shall have distributed intelligence such that it may be used 'out-of-the-box' and offer useful functionality prior to commissioning. Each LCM shall be field serviceable and shall not be a permanently sealed device requiring replacement as the only means of repair.

Each output of the controller shall be software configurable to provide DALI broadcast, DSI, or 1-10V. It shall also be possible to software configure each output to be associated with a single DALI universe per controller, so that it is possible to individually control and monitor individual DALI luminaires that are connected to a single output. DALI outputs shall also support DALI emergency luminaires. LCMs that incorporate DIP or Hexadecimal switches for the purpose of coding, programming etc. shall not be accepted.

The LCMs shall also include 3 serviceable internal fuses, each fuse protecting a group of three outputs. The rating of the fuses shall be suitable to enable a reduction in cross sectional area of wiring from the LCM to the luminaries, relative to the supply wiring to the LCM. Access to the fuses shall be via a housing aperture with integral cover shutter that is locked in place when the supply connector to the LCM is inserted.

The LCM shall also have provision to support 4 X SPDT dry contact inputs for local user switches. The LCM shall also include connection provision for 4 network sensors.

### 9.4.6 DALI Commissioning

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

DALI load controllers must 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 ballasts must be pre-configured causing intermediate commissioning layers shall not be acceptable.

## 9.5 DIN rail Multipurpose Controllers

DIN rail Multipurpose Controllers shall be used in applications where operation of various small load types is required in a single location, i.e. boardroom, private residence, hotel etc. The controllers shall have 2 to 8 output channels and be housed in a 12 unit width DIN-rail mount enclosure. Controllers shall have a maximum load of 16A. The internal structure of the controller shall be configured as a main board assembly with 4 output module sockets. Each output module shall be individually protected via a 6.3amp HRC fuse. 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. Modules occupy 1 socket.
- Leading Edge power dimming module with 4 channels, for loads up to 2 amps per channel. The module shall incorporate internal protection by a self-resetting mechanical cutout that trips in excess of 2.5A or high temperature. Module occupies 2 sockets.
- Leading Edge power dimming module with 2 channels, for loads up to 4A. The module shall incorporate internal protection by a self-resetting mechanical cutoff that trips in excess of 10 amps or in high temperature. Module occupies 1 socket.
- Trailing Edge power dimming module with 4 channels, suitable for loads up to 2 amps per channel. The module shall incorporate internal protection by a self-resetting mechanical cutoff that trips in excess of 2.5 amps or in high temperature, and an ultra-fast acting electronic cutoff that trips at 3 amps to protect the IGBT drivers. The electronic cutoff will retry 3 times to control the load then trip out permanently, requiring a reboot to reset the trip. If a load not suitable for Trailing Edge is connected, like an iron core transformer for example, the module will automatically configure itself to a switching mode. Module occupies 2 sockets.
- Trailing Edge power dimming module with 2 channels, for loads up to 4A. The module shall incorporate internal protection by a self-resetting mechanical cutoff that trips in excess of 10 amps or in high temperature. Module occupies 1 socket.
- Switching module with 2 channels, suitable for controlling most types of on/off loads up to 4A. Relays to be rated: 16A, TV5, 100A surge. Module occupies 1 socket.
- Curtain module with 1 channel. A 240 VAC changeover motor-switching control for curtain, blind, roll screen or elevator system control. Shall use a 2 amp SPST relay for movement control, this feeds power to a SPDT relay for directional drive. Module occupies 1 socket.
- Fan module with 1 channel of 400 VA fan control, suitable for 3 speed sweep fan control providing 4 settings: high, medium, low and off, suitable for only one fan per output module. Module occupies 1 socket.

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

## 9.6 Wall-mounted Multipurpose Controllers

Wall-mounted Multipurpose Controllers shall be used in applications where operation of various larger load types is required in a single location i.e. hotel etc. Different sized enclosures shall be available for a different number of multichannel output modules (2, 4 or 6 module bays). There shall be a range of plug-in output modules available to suit various load types including:

- Phase-cut dimmer module
- Signal dimmer module
- Relay module

Standard modules shall be provided for all controllers:

- Supply module
- Communications module

The controller shall be encased in a galvanized steel enclosure, suitable for surface and recess mounting. The enclosure shall be safely mountable before modules are installed. The enclosure shall include multiple knockouts to cater for flexible wiring configuration. The enclosure shall include two separate front covers so that high and low voltage sections can be accessed separately. Circuit breakers shall protrude through the front cover for visibility and ease of access.

The enclosure module bays shall include mechanical interlocks to ensure correct module location. A wiring loom shall be supplied with the enclosure, fitted with plastic collars to ensure proper wiring orientation and prevent installation errors.

All supply and communications terminals, as well as circuit protection, shall be fitted to each module. Output modules shall plug in to any available output module bay and shall not require modification for installation. All modules shall be fully encased in a metal enclosure. Output modules shall have their own microprocessor and memory, and manage their own settings. Modules shall be available in dual pole or RCBO. Module type shall be auto-detected and presented in the commissioning software. The controller shall have interchangeable communication modules to accommodate different protocols.

The supply, communications and output modules shall be individually replaceable. During servicing, replacement output modules shall be automatically rediscovered and reconfigured without commissioning software.

The phase cut output modules shall be capable of Leading/Trailing Edge dimming. The module shall attempt to identify the required dimming type using harmonic analysis, and allow manual selection of dimming type via the commissioning software.

The signal dimmer output module shall be software-selectable for 1-10V, DSI, DALI Broadcast, DALI Addressable and DALI MultiMaster.

The communications module shall have a dry contact input, an indicating LED for device and network status, an override keypad to allow testing of all modules and channels, and a service switch to enable network sign-on and device reset without opening the enclosure.

# 10 User Interfaces

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

- Pushbutton Keypads
- Fader Potentiometers
- Mechanical key switches for disabling or triggering restricted functionality or LCD Display for menu navigation and option selection
- Color Touchscreens
- Virtual Interfaces such as browser or mobile app based interfaces

## 10.1 Keypad common features

Keypads shall be of the correct size to suit locally available wall boxes. They shall be available in various fascia finishes including stainless steel, gold, brass, chrome, painted, or any common flat architectural surface finish medium to suit the client's requirements.

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

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

All keypads shall be 'universal' in that any button or key-switch input can initiate 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 must contain an internal macro control facility that will 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 should be no requirement for direct connection to the keypad for configuration and the commissioning software will not require additional drivers or plugins to complete the configuration. Control system keypads that require direct connection and additional commissioning software drivers or plugins will not be accepted.

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

Keypads shall incorporate a service mode. The service mode, when activated momentarily, shall cause a "sign-on" message to be transmitted onto the network. The sign-on message shall contain information about the device, such as: box number, device type and embedded software version.

### 10.1.1 Antumbra common features

The Antumbra keypads 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 should be completely off and only reveal themselves when the proximity sensor is triggered. They shall be able to produce a wall-wash lighting effect when proximity is detected.

Antumbra keypads shall also include an ambient temperature sensor. When requested by the NLCS the key pad is able to communicate the local current temperature to the core network. Internal logic within the sensor should also be capable of triggering a network message when a particular temperature is detected. The temperature range shall be 5 to 40° with an accuracy +/- 1.5°

Antumbra keypads shall have an interchangeable communications module that is compatible with the full range of Button/Touch application modules. This communication module is to contain 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 Antumbra keypads shall support an IP22 rating allowing for more flexible installation options.

The Antumbra keypads construction must allow for smooth and perfect 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 can be labeled with text or icons to indicate the functionality. This should be easily configured using an online tool that does not require the use to have an in-depth knowledge of the system or its part codes. This is required so that end-users are able to directly configure their desired finishes and labeling options.

### 10.1.2 Antumbra Button

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

### 10.1.3 Antumbra Display

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

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

### 10.1.4 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.

### 10.1.5 Revolution (DR2P)

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

The Keypad should be available with different button sizes and configurations to meet different project needs.

Keypads should be available in both metal and glass finishes.

When using a metal finish the keypad should support labeling direct onto the fascia to assist with functionality descriptions of the different buttons.

### 10.1.6 Classic (DPN)

Each button on the keypad should support custom labeling.

The keypad fascia is to show no evidence of mounting screws.

Faders where used, shall be capable of controlling any circuit in any area, or be assigned as a ‘master’ fader to control the overall lighting levels in an area. Facility must be available to accommodate custom keypad requirements. A range of keypad assemblies shall be capable of accepting up to 16 buttons, 22 faders, and 4 key switch inputs on one circuit board. It shall be possible to link a number of keypad circuit boards together to create custom keypads with greater than16 buttons, with all buttons appearing in a regular array.

### 10.1.7 Standard (DLP)

Each button on the keypad should support an indicator LED and custom labeling

## 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 must 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.

The sensors IR receive must 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 must support multiple response requirements for trading hours and after hour's requirements. Transitioning between the different modes is to be triggered by a scheduler within the control system.

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 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 a witness mode will not be accepted.

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

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

Sensors shall be easily configurable to achieve daylight dependent (harvesting) regulation. The sensor should be capable of providing PID 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 can be 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, will not be accepted.

The sensor must 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 will not be accepted.

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

## 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 have a resistive touch overlay over the LCD screen for control. Touchscreens shall be capable of supporting a minimum of 255 user configurable pages. Control systems that use separate buttons for operation shall not be accepted.

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 will 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 must be stored in the touchscreen in non-volatile memory.

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

## 10.4 Virtual Interfaces

Wi-Fi connected mobile touchscreen devices shall be available in areas that require sophisticated and integrated control of lighting, blinds/curtains, HVAC and potentially AV equipment, i.e. boardrooms, lectures theaters, and meeting rooms. The mobile interfaces shall provide intuitive screen layouts that simplify operation of the systems in their associated spaces. The mobile devices shall be cost-effective consumer type using free downloadable applications authored by the control system vendor. Systems that require third-party applications will not be accepted.

Applications shall be available that utilize standard templates which are automatically populated from commissioning software configuration data. Applications of this type shall be available for devices that use Apple iOS and Google Android operating systems.

Alternate applications shall also be available that permit full customization of the users screens. This type of application shall be available for devices that use the Apple iOS operating system.

Browser based access to control system functions will optionally be provided by the control system vendor.

# 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 can be created using the onboard conditional logic engine to assemble and transmit user-defined data strings.

## 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 a Programmable Logic Controller that can process comprehensive conditional and sequential logic and arithmetic functions.

## 11.4 Remote TCP/IP Access Interface

A remote access interface shall be available which will 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 100 BaseT Ethernet network. It shall be possible to perform all functions across the 100 BaseT 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 Timeclocks

Network timeclocks shall be utilized where local adjustment to automated lighting control events are required via a direct connection to the control network, without requiring a separate power supply. 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: select 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 timeclock shall be capable of storing up to 250 automatic timed events, and contain an internal task engine to perform conditional and sequential logic.

## 11.6 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 should also optionally support receiving analog inputs of 0-10 or 0-5 VDC.

The interface shall contain an internal task engine that will 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 have a jumper to select whether the internal power supply voltage is used, or an external voltage reference. The dry contact interface 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
- Start a task
- Stop a task
- Link / unlink areas
- Send any valid user-defined network message, or sequence of messages

## 11.7 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 on a MultiMaster controller. The device must also be software configurable and firmware updatable over the DALI bus from the control network.

## 11.8 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 SPDT outputs for connection to other devices. The interface shall contain an internal task engine that will 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.

### 11.9 Integration to 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
- Using dedicated control network gateway interfaces
  - KNX
  - BACnet
  - LON
  - Modbus 485
  - Somfy

## 12 Software

### 12.1 Management Software

The management software must support direct importation of the commission software files. This is required to prevent a misalignment of configuration between the hardware configuration and the headend 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 so the control system can 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 luminaries. To assist site navigation the software must 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 should not require extensive training or in-depth knowledge of a control 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 should be replaced.

From the head-end software the user can make instantaneous lighting level adjustments adjust preset scenes. When this is done, new levels can be saved directly to the load controllers responsible for managing the lighting groups. This requirement is so that end users have the ability to adjust the system when required without being dependent on external technical support teams.

The headend software shall allow for adjustment of the 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 headend 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 must include but not be limited to the following information:

- Area
- Lamp Control Group
- Luminaire location / ID number
- Lamp make and model
- Manufacturers 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 must 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 provision must 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 must be capable of handling sequential control routines. The macro facility must also present a range of standard or common control routine templates, to assist in implementation of typical control scenarios.

The lighting control software must 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 must 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 must 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 should have access to all hardware configuration variables from primary installation. The commissioning software should 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 needs to 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.

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.

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 must be able to configure ballasts without having to use 'Ballast Suppliers Software' or hardware creating intermediate third-party data bases. 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 will not be accepted. The lighting control systems DALI load controller should support all DALI commissioning requirements. Lighting control systems that are dependent on additional third-party hardware for the commissioning process will not be accepted.

The commissioning software must be able to configure all elements of the lighting control system. Any commissioning software that requires additional patches, plug-ins or drivers to perform commissioning will not be accepted.

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

The commissioning software will automatically produce a report of all system settings.

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

The network monitor should be capable of logging network traffic and allowing for 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 a 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 daily system tests to verify that all devices are operating properly. This information shall be displayed graphically using a floor plan view interface, and also 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 of areas based on actual running hours, rather than estimated running hours.

## 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 system 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 or CD-ROM at no additional cost.

# 15 Warranty and Support

All product warranties shall be managed by the appointed commissioning agent.