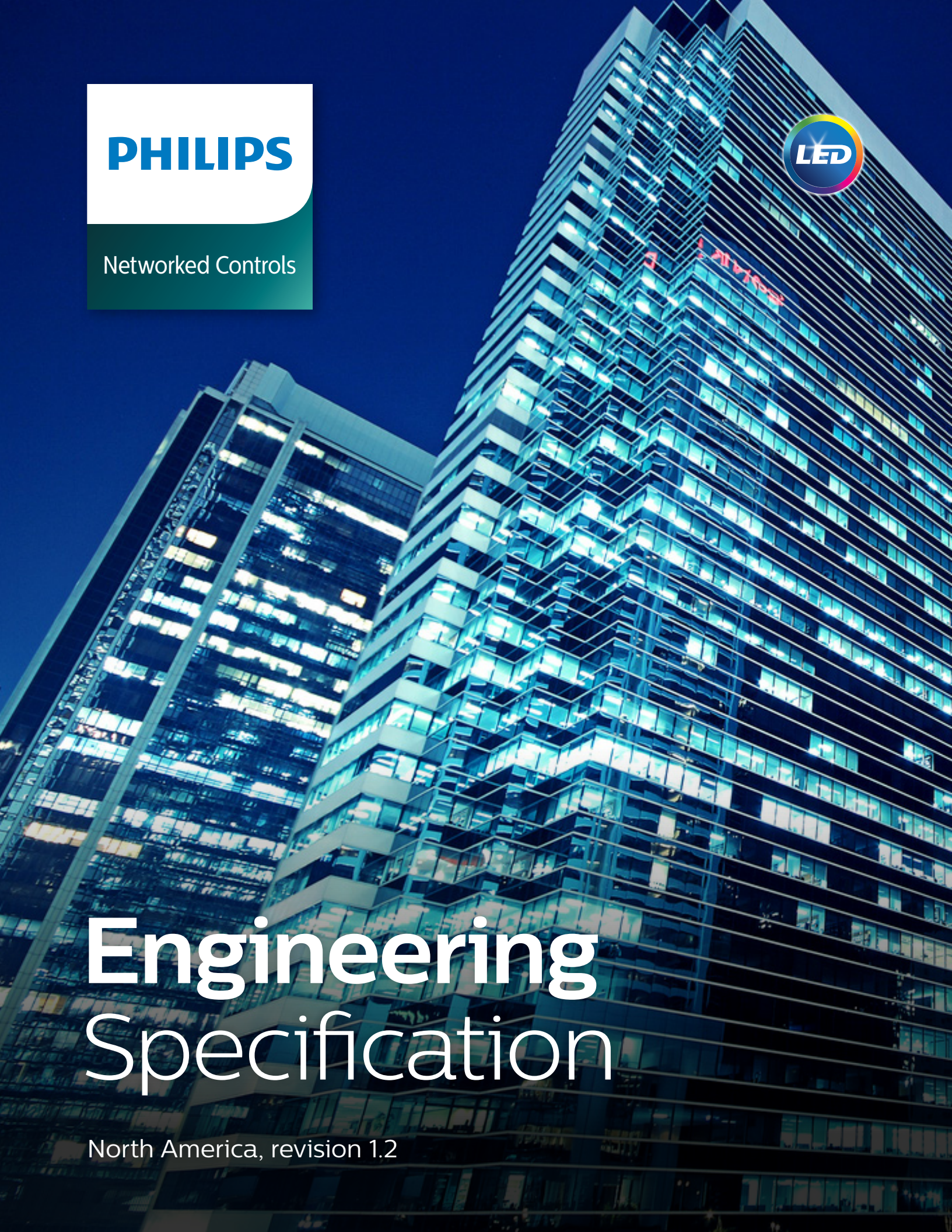

Engineering Specification

North America, revision 1.2

Contents

This document is specific to North America.
See the equivalent document for other regions.

Background

Philips Dynalite networked controls 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 vendors' equipment and for large-scale applications.

The Philips Lighting philosophy is to provide the best solution possible for each and every project. This is the key to our success. 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 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 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'.

1 Introduction

The Networked Control System, (NCS) shall be a state of the art micro-processor addressable lighting management solution, providing flexibility through independent, distributed control of any circuit within the building. The NCS shall use advanced Windows based graphical programming to enable the lighting operation to be centrally programmed and configured. **The NCS shall natively support on the 'control network' a wide range of load and interface control devices, including:**

- Keypads
- Sensors - PIR, US, PE
- LCD Touchscreens
- LED controllers
- Switching controllers
- Signal dimming controller supporting - 1-10V, DMX512, DALI
- Power dimming controllers
- Multipurpose controllers
- Integration and networking gateways to other systems:
  - DMX512
  - RS-232
  - Infra-red transmission
  - Shading
  - Ethernet 10/100 Base T
  - BACnet interface via Ethernet

The system shall be capable of creating virtual wiring links of circuits for control through software and presets or switching patterns, which may be instantly altered via the configuration PC without the need to access equipment or carry out disruptive wiring alterations.

2 Approved vendors

The equipment shall be Philips Lighting or approved equal.

3 Compliance

The network control system shall comply with the following Safety, EMC Directives and Low Voltage Directive and other relevant international standards including but not limited to the following:

- FCC Part 15A
- RoHS Compliant
- CSA 22.2 No 205
- UL916, cUL916, UL924
- Air sealed model available to meet City of Chicago Plenum requirements
- May be used to comply with the requirements of California Title 24
- ANSI C82.11 Dimming Compliant

The NCS manufacturer shall also have in place and demonstrate active waste minimization and CO_2 footprint minimization work practices.

4 System architecture

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. Control Systems that require a central processing unit will not be considered.

System to achieve required functionality by utilizing 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 system shall utilize 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 devices shall be supplied with basic settings to enable the system to operate in a default way immediately upon installation. 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 utilize battery or “supercap” 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.

It shall be possible to configure all physical controller channels and input devices with a logical overlay, so that control elements can be bound into logical areas. Each device on the network shall be capable of running conditional scripted logic tasks independently, creating a fully distributed, intelligent control system.

It shall be possible to view controller output channels in logical groups within the system configuration software, so that preset scenes and states can be easily configured for each logical area. Systems that can only be configured with reference to the physical controller or channel will not be accepted.

5 Network physical layer

The Control Network shall utilize an RS485 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 Class 2 DC supply only, to power keypads and sensors. There shall be an integral Class 2 DC power supply contained in each Load Controller. The failure of a single Load Controller shall not affect the Class 2 DC Power Supply, or the performance of the network. Except for industry standard subnetworks, systems that multiplex data and Class 2 DC Supply on the same conductors. Devices shall be connected to the 'control LAN' via pressure pad type screw terminals, and/or RJ45 connectors.

The NCS manufacturer shall also offer a range of appropriate network interfaces to enable Ethernet to be used for trunk 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 optically 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 devices must be capable of operating on a single network using the same protocol. Systems that do not allow all products from the same manufacturer to be connect together for global control, or are designed to different specifications for each 'series' of products shall not be accepted.

The network protocol shall be an event based message packet type. The output state of load controllers shall revert to 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 present scene or state involving all controller channels bound to the same logical area from a single network message associated with that area. 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 system shall be capable of supporting 65530 separate areas, and at least 64 preset states within each area. Each Area shall be able to contain 65530 Logical 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 sec increments, within a single network message.

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

8 Control 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 level management of artificial lighting required at any given time, 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 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.

8.2.2 Daylight Override

When motion is detected in an area with natural light it shall be possible to configure the 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 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 (i.e. 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 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 system shall have provision to link areas like offices, meeting rooms or classrooms to a corridor (egress path). The 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 elevator/lobbies lit, elevator/lobbies to keep reception area's lit, etc.

8.3 Light level control

8.3.1 Switching

The system must be capable of implementing basic switching control to turn lights ON and OFF from a flexible choice of networked user interface devices.

8.3.2 Dimming

The system must be capable of implementing dimming control of lighting from a flexible choice of networked user interface devices. This shall be achieved by a protocol (or signal) to a lamp driver (DALI addressable, DALI Broadcast, DMX512, 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 (e.g. 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 system shall provide means for users and operators to readily and intuitively create and adjust preset states or 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 white balance (Warm/Cool).

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 window areas and core areas to be defined by a ratio.
- Window area luminaires to be dimmed a lower level than 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 portable computing devices and mobile phones, and popup dialogues that reside in the system tray area of Windows desktop.

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 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.

8.6.4 Demand Response

Networked System shall be capable to respond to demand response requirements. This can be as a basic locally controlled event or a utility controlled OpenADR 2.0 event. For the OpenADR 2.0 event, system would rely on a signal from either a BMS or an OpenADR Client.

9 Load controllers

9.1 General

All Load Controllers shall be natural 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.

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, DMX512 and DALI signal-dimming devices for controlling electronically dimmable luminaires.

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.

The range of load controllers shall be available for different control schemes including:

- 1-10V analog
- DALI
- DMX512

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 access to the settings will not be accepted.

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

The dry contact input shall be capable of performing the following minimum functions:

- Sign on Message
- Execute logic macro
- Keypad Disabled / Panic / Program Disable
- Defined Network Message transmission

Load controllers shall be available with various individual channel output capacities, ranging from 1A to 16A. Up to 24 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 LAN' 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 a specific scene
- All circuit to previous condition prior to power loss

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 while 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 a specific preset
- All circuit to previous condition prior to communication loss

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 then the dimmer is operating correctly on a quiet network or with no data cable connected.
- Network Activity Detected - When network activity is detected, 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 DMX512 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 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 “glued shut” device requiring replacement as the only option for servicing.

9.2 Switching controllers

Switching controllers shall be utilized 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 or 20A continuous AC3 ratings.

9.3 Power dimming controllers

All power dimming controllers shall provide output power conditioning including:

- Output regulation
- Surge protection
- Spike protection
- Soft start
- Brownout and Sag protection
- Over voltage protection
- 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 10kA interrupting rating.

9.3.1 Leading Edge Forward Phase Control 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. Each dimmed channel shall be fitted with a toroidally wound, iron powder cored interference suppression choke which shall limit the rise time of the switch on transients.

9.3.2 Trailing Edge Power Reverse Phase Control 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 overload 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 LE Dimmers shall be able to be configured as TE dimmers and vice versa

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 configuration software to select the output as 1-10V, DSI or DALI Broadcast. The controllers shall incorporate an integral mains supply relay for each ballast/driver control output circuit so that power can be removed from the lighting circuit when the ballast/driver control channel is set to 0% output (off state). The relay shall have an appropriately rated capacity for typical lighting loads.

Systems that require an external DSI or DALI converter shall not be acceptable.

9.4.2 DALI Universe Controllers General

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 bus. 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 bus without the use of third-party products.
They shall be self-contained and support:

- DALI network power supply
- DALI network interface
- Direct network connection to vendors network
- Controller unit power supply
- Scene controller

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 buses each initially comprising fifty (50) DALI devices per bus. Each bus shall be expandable to incorporate a total of sixty-four (64) DALI devices if required.

Bus wiring shall comprise three (3) power (active, neutral and earth) and two (2) data/control cables following the same route. Cables shall comply with the Circuiting Requirements of this specification.

DALI buses may be connected in a radial or bus topology or a combination of these. Ring topologies are not acceptable. 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. Any system that requires the physical DALI bus to be wired in the same configuration as the logical areas will not be accepted.

DALI buses shall be installed in a logical manner. The addressing sequence for individual DALI devices within a DALI bus 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 IEC 62386.

The DALI controllers shall automatically determine whether to control each luminaire individually (short address mode) or by the DALI group addresses (group and scene mapping mode). Controllers shall also be capable of interrogating DALI luminaires to provide the following diagnostic information;

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

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.

The DALI interface should be able to ‘communicate’ to each ballast individually (short address mode) or by 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.

Configuration 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 configuration. A system that requires off site enumeration of ballasts is not acceptable.

DALI universe controllers shall support both normal and emergency DALI fixtures. The 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 test.

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 bus 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 configuration software. Any DALI input devices that require direct or manual adjustment will not be accepted. In addition to the requirements outlined under this section, the DALI MultiMaster controllers shall also comply with the requirements of section 9.4.2 above.

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 that it is connected to.

DALI MultiMaster Controllers shall support up to 10 DALI user interface devices on a fully populated DALI universe. It shall also be possible to upgrade the firmware of DALI user interfaces via the DALI universe.

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 DALI Configuration

NCS and DALI ballasts are to be configured via a common graphical configuration software interface providing graphical representation of all DALI fixtures and NCS products.

DALI load controllers must support setting and reconfiguring DALI addresses, group addresses and scene level settings. Systems that require third-party configuration 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 configuration layers shall not be acceptable.

9.5 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 e.g. 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:

- Relay module
- Signal dimmer module
- Phase control dimmer 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 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. Module type shall be auto-detected and presented in the configuration 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 configuration software.

The phase control output module 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 shall be available for direct connection to the control network, including:

- Fader Potentiometer
- Pushbutton Keypads or Touch Sensitive Keypads
- LCD Touch Sensitive Display Screens with Graphical Pushbuttons for navigation through menus and selection of options
- Infra-red Receivers for Remote Controls
- Infra-red transmitters for controlling third-party Audio and Video equipment

10.1 Keypads

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 common flat architectural surface finish medium.

Button caps of pushbutton keypads must be able to be labeled or engraved. These shall be readily interchangeable with custom engraving available if required. Keypads shall also be available which provide rear text 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.

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 a minimum of 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 than 16 buttons, with all buttons appearing in a regular array.

A range of keypads shall have a built in LCD display with dynamic text and dynamic icon labeling. Keypad range shall have the option of mechanical buttons or touch sensitive buttons. Keypads shall be capable of proximity detection, light level sensing and temperature sensing. They shall be able to produce a wall-wash lighting effect when proximity is detected. The keypads shall have an interchangeable communications module that is compatible with the full range of button panels.

Unless otherwise indicated all keypads shall be 'universal' in that any button or key-switch input can initiate the following events:

- Start a task
- Stop a task
- Link / unlink areas
- Select a preset
- Set a channel to a level
- 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.

Keypads with built-in LCDs shall be able to display dynamic information in a range of languages and icons. Keypads shall be capable of supporting a minimum of 6 buttons, and be possible to mechanically configure using alternate key assemblies to provide fewer buttons if required.

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. The keypads shall also include proximity detection that wakes them from an ultra-low power standby mode when an occupants/user approaches the keypad. The panels shall also include an ambient temperature sensor.

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.

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

10.2 Sensors

Sensors shall be installed in appropriate locations to minimize energy consumption, through daylight harvesting and occupancy detection control. The universal sensors shall contain a photoelectric (PE) sensor, a motion detector and an IR receiver in the same package. The sensor shall be available in wall mount or ceiling mount packages.

Sensors shall be easily configurable to achieve daylight control. The universal 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. Sensors shall incorporate 8 preset control modes for motion detection and 8 preset control modes for illuminance control, to provide effective occupancy and daylight harvesting control. The sensor should also be capable of providing PID (proportional, Integral, Derivative) 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. All sensor configuration settings shall be made from configuration 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.

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 configuration and commissioning. It shall be possible to enable and disable witness mode across a complete site or section thereof, from within the configuration 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 system software, where sensitivity can also be adjusted.

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 configuration 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.

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. Systems that use separate buttons for operation shall not be accepted.

The touchscreen shall be capable of monitoring the 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:

- Select a preset
- Set a channel to a level
- Link / unlink areas
- Start / Stop a task
- Go to a new screen page
- 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 the configuration and set-up features.

10.4 Virtual Interfaces

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, Wi-Fi connected mobile touchscreen devices shall be used. The interfaces shall provide intuitive screen layouts that simplify operation of the systems in their associated spaces. The 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 auto populated from commissioning software configuration data. Applications of this type shall be available for devices that use the 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 Network Bridges

The RS485 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.

The RS485 network bridges shall contain two RS485 data ports, optically 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 RS485 bridge shall contain an internal task engine that allows the interface to perform conditional and sequential logic. 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 RS485 port as DMX512 Transmit, capable of transmitting 64 channels of DMX512 levels.
- One RS485 port as DMX512 Receive, capable of receiving 64 channels of DMX512 and converting them to set channel to level messages.

The RS232 network gateways shall be available for serial port integration between a DyNet network and third-party systems, including AV systems, lighting desks, data projectors, HVAC, BMS and security systems. RS232 network gateways shall be powered from the DyNet network - Requiring no mains voltage supply. RS232 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.

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.

11.2 Remote TCP/IP Access Interface

A remote access interface shall be available which will allow an end-user or factory representative to “tunnel in” to the lighting control system to control, configure, or commission the system over TCP/IP via a 100BASE-T Ethernet network. It shall be possible to perform all functions across the 100BASE-T 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, PDA, or Web enabled mobile phone using a standard browser.

11.3 Scheduling

Network Scheduling shall be utilized where local adjustment to automated lighting control events are required via a direct connection to the control network. The scheduler 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 scheduler shall be able to perform various functions at designated times on designated days, including: Select specific Presets in specific Areas, Lock or Unlock keypads, Activate or De-Activate sensors and motion detectors, execute sequences of network control messages.

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 the week
- Day of the month
- Calendar date

Sunrise and sunset information may be determined by latitude and longitude settings, and the scheduler shall automatically keep track of daylight saving, and leap years. The timeclock shall be capable of storing automatic timed events, and contain an internal task engine to perform conditional and sequential logic.

11.4 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. It shall be possible to connect the dry contact interface to switches located up to 9 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 interface shall contain an internal task engine that will allow the interface to perform conditional and sequential logic. Systems that rely on an external logic processor or centralized logic processor shall not be acceptable.

The dry contact interface shall be capable of initiating any of the following events on a change of state of the contact:

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

11.5 Integration to third-party systems

It shall be possible to easily integrate to third-party systems such as:

- HVAC systems
- PABX systems
- RS232
- Infrared
- Audio-visual systems
- Building management systems
- Access control systems

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 to a lighting control network using any of the following methods:

- From site management software:
  - OPC
- Using dedicated control network gateway interfaces:
  - KNX
  - BACnet
  - LON
  - Modbus 485

12 Software

12.1 Lighting Management

Intuitive site management software shall be provided so the 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, tif, 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 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. Where circuit breaker trip monitoring and load current monitoring are used, the lighting control system shall provide some type of visual warning within the floor plan environment of the specific luminaires that have failed.

The system shall be able to keep track of luminaire data such as manufacturer, part number, wattage, date installed, and location. It shall be possible to display the full properties of a luminaire, within a structured 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 info:

- Lamp Control Group
- Lamp make and model
- Real time lamp active status
- Date of last lamp replacement
- Luminaire location / ID number
- Manufacturers estimated lamp life
- Cumulative true running hours
- Cumulative weighted running hours (incandescent lamps, corrected for power)
- Lamp status i.e. Good / Blown (if load monitoring is installed)
- Circuit Breaker Status (if MCB monitor has been installed)

The lighting control system shall incorporate a comprehensive scheduler to automate time-based events. It must be possible to trigger scheduled events as a 'Once Off' timed event or a recurring event. 'Once 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

nrise 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
- At a recurring times for recurring durations

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 some type of user logon access security. The system shall be capable of displaying alternate menu structures in accordance with the privilege 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 Lighting Configuration

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

Offsite pre-configuration 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 configure sections of a facility, e.g. individual floors of a multi-story building, as discrete networks. The configuration 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 configuration requirements. Lighting control systems that are dependent on additional third-party hardware for the configuration and commissioning process will not be accepted.

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

The configuration software will allow multiple programmers on the same network at the same time. The configuration software will automatically produce a report of all system settings.

13 Monitoring

13.1 System Health Monitoring

The 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 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, MCCB trip status, DALI luminaires 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 the information can be exported to a spreadsheet, word processing program, or text file. The information will be required to efficiently plan 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 luminaire types used plotting power against dimmed output level. It shall be possible to enter this in either raw data format or via a graphical plot dialogue.

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.

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

- On-site Testing
- Client Demonstration
- Client Training
- Importation and conversion of building CAD layouts
- Full configuration in support of the project commissioning
- Application Engineering
- Operation and Maintenance Manuals

15 Site documentation and configuration Information

Copies of all site documentation, shall be provided to the client/end-user at no additional cost.

16 Warranty and support

All product warranties shall be managed by the Philips agent.

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