Abridged Engineers Specification
DALI LIGHTING CONTROL SYSTEM

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1. General: System Description

The Contractor will allow to supply, install, test and commission a fully functioning, native DALI Compliant Lighting Control System [with a high level BMS interface] complying with the following requirements.

This DALI Networked Lighting Control System ("the system") shall only use DALI and Ethernet infrastructure for distribution of the system's messaging protocol. As such, use of non-networked devices – such as stand-alone sensors – are not permitted unless specifically called for or included on the drawings.

This lighting control system shall provide full control of all connected areas as indicated on the drawings and provide full compliance to the International Standard for Lighting Control – IEC62386, DALI, through use of appropriate, DALI Compliant systems and products.

1.1. The Lighting control system must comply with the DALI standards, must carry the DALI certification label (as proof of DALI testing); with the DALI Compliant products listed on the DALI DiiA website from a DALI Group Member.

1.2. DALI Compliance means the DALI standard – AS/NZS 62386 and IEC 62386; Including General Requirements: 101 (System), 102 (Control Gear).

1.3. The contractor shall provide, upon request, relevant DALI testing and DALI Compliance Certification documentation for all DALI Compliant devices installed.

1.4. This DALI Compliance requirement includes DALI drivers and/or DALI ballasts being provided by the luminaire manufacturer or supplier.

1.5. All input devices such as Lighting Control Panels (LCPs), light sensors and motion sensors shall be connected to the DALI line either directly or via a DALI compliant application controller as defined in the DALI Standard, such as a RAPIX DALI eHUB device, RAPIX DALI Universal Switch Input, or RAPIX motion sensor.

1.6. All output devices such as DALI relays and phase dimmers must be fully DALI Compliant and adhere to section 1.1.

1.7. The DALI Lighting control systems shall be capable of DALI Type 8 control (also known as DALI 209 and DALI Tunable White). Solutions which do not provide this control or require separate components to meet this requirement shall not be accepted.

1.8. DALI control gear described as DALI compatible rather than DALI Compliant shall not be accepted. DALI compliance is essential to meet specification compliance.

2. Building Wide Lighting Control System

2.1. The system shall be able to link all DALI lines into one integrated system through the use of Ethernet enabled DALI Zone Controllers. Each DALI Zone Controller shall include built-in Ethernet and a dual port Ethernet switch on-board to allow Ethernet Zone Controller to be inter-connected to each other without the need for each to be connected directly to the building's Ethernet switches/routers.

2.2. The programming and scheduling information for the building wide DALI system shall be stored in every DALI Zone Controller for fail-safe redundancy so that if any DALI Zone Controller goes offline the remainder of the system continues to function with any degradation limited only to the missing Zone Controller.

2.3. The DALI Zone Controllers shall perform all astronomical time schedules. The DALI Zone Controllers will automatically negotiate a time clock master on the Ethernet network to ensure that all schedules always run. If the Ethernet network between the DALI Zone Controllers is disrupted such that two or more separate Ethernet networks are created, the DALI Zone Controllers shall automatically nominate a new time clock master to ensure no schedules are missed.

2.4. The DALI Zone Controllers shall feature comprehensive systems redundancy whereby a failure of any controller allows the site project or definition information for all controllers to be retrievable from any controller.

2.5. Lighting System Controllers that store information exclusively to themselves with no redundancy shall not be accepted.

2.6. In the event of a failures of a DALI Zone Controller, a replacement device must support a means of integration whereby the IP address set the same as the device being replaced and the project loaded to it. This project file loading could be done in service in the building or as an offline activity prior to site visit.

2.7. DALI Compliant power supplies shall not be integrated in the DALI Zone Controllers. A separate DALI power supply per DALI line shall be provided to allow for simple and low cost replacement in the case of a power supply failure without needing to replace the DALI Zone Controller to return the DALI line back to operational status.

2.8. DALI controllers with embedded power supplies shall not be accepted.

2.9. DALI power supplies shall ensure the maximum current delivered to a DALI line of 250mA will not be exceeded.

2.10. The DALI Compliant power supply shall provide sufficient power to the DALI line such there shall be at least 64 mA DALI power supply margin when all luminaires and control devices are connected to a line for satisfying peak current demands that occur during the communication to ensure communication effectiveness.

2.11. The DALI Zone Controllers must display the IP address of the controller on an externally visible LCD screen for easy identification of the device without having to connect to the device or the network with a PC.

2.12. This LCD screen must also enable further diagnosis of both the controller and the DALI lines which are attached to it, including the ability to control the DALI lines directly by using built in navigation buttons and menu system, without a PC or network connection.

2.13. DALI controllers that have a reliance on an additional central point of control, such as an on-site server or an external “Cloud” server or services create a single point of failure and also a point of vulnerable entry through the Lighting control system and shall not be accepted.

2.14. The DALI Zone Controllers must support scaling from a single controller to at least 100 controllers with no degradation of service.

2.15. The DALI Zone Controllers must support adding a further 2 or 4 DALI lines by use of a low cost DALI Ethernet Interface that permits those DALI lines to be integrated into and appear as part of the DALI lines normally built into the Zone Controller physical hardware.

3. Lighting Control System Security

The intent of providing the secure lighting control system is to prevent and limit risk, damage and consequences from potential unauthorised system access for the purpose of:

i. unauthorised control of the system;
ii. preventing legitimate use of the system;
iii. unauthorised monitoring of the system;
iv. unauthorised modifications to the system; and
v. unauthorised point of entry to other networked systems.

Further, the security requirements specified below shall be included in the lighting control system to prevent and limit the risks associated with the following attack vectors:

- Impersonation attacks;
- Replay attacks;
- Man in the Middle (MITM) attacks;
- DoS / DDoS attacks; and
- Site-wide field bus attacks.

3.1. The lighting control system shall ensure that all IP lighting control message communications between its own devices are encrypted and authenticated. Systems which are incapable of providing this level of security as detailed below shall not be accepted.

3.1.1. This authentication and encryption shall be operational immediately upon energizing the lighting control system components and shall be active without the need for human intervention.

3.1.2. The lighting control system shall provide this security capability via Ethernet connected DALI line controllers.

3.1.2.1. Systems which require additional system or 3rd party hardware to achieve this level of security shall not be accepted.

3.1.3. Each DALI controller shall share the same security capabilities to eliminate a single point of failure or unauthorised access via a “weak link”.

3.1.4. The system shall only act on IP lighting control messages from secured and encrypted Zone Controllers in the project or from pre-configured and trusted IP addresses in the local network.

3.1.4.1. The receipt and action of IP lighting control messages using UDP or broadcast UDP is expressly forbidden.

3.1.5. The system shall employ a means of ignoring repeated messages to protect against replay attacks.

3.1.6. It shall not be possible to disable the message encryption, even to aid system debugging.

3.2. The lighting control system shall use a project key for authentication to prevent unauthorized access and systems changes.

3.2.1. These keys shall be randomly generated to prevent the use of common passwords.

3.2.2. The lighting control system shall provide a secure mechanism to recover stored system data only by having physical access to the DALI Line Controllers. This acts to prohibit unauthorized systems changes. It also acts to guarantee that the operator/owner is not ransomed by a single party for system maintenance in the future.

3.2.3. Systems which require system-files to maintain the system and/or systems which allow unsecured access to retrieve files from system hardware without the use of a key shall not be accepted.

3.3. The lighting control system hardware shall not have TELNET or FTP services running.

3.3.1. Systems which use these services shall not be accepted.

3.3.2. Any other open ports must apply the security requirements described herein.

3.4. The lighting control system shall have passed vulnerability testing, such as Nessus and the contractor shall, upon request, provide a copy of the vulnerability test.

3.4.1. System which are unable to provide proof of this vulnerability testing shall not be accepted.

3.5. The lighting control system's security methods shall use industry standards and not 'home-brew' or non-standardized encryption methods to ensure industry best practice protection and provide clear security upgrade paths.

3.5.1. Symmetric encryption (e.g. AES) must use a key of at least 128 bits.

3.5.2. Asymmetric encryption (e.g. RSA) must use a key of at least 512 bits.

3.5.3. Hashing functions (e.g. MD5, SHA) must be at least 128 bits.

3.5.4. Messages must use a mechanism to detect and reject messages that have been tampered with (e.g. message HMAC).

3.5.5. The system must use a mechanism to detect and reject replayed messages.

3.5.6. Block cyphers (e.g. AES) must use a random Initialisation Vector for each message.

3.5.7. Block cyphers shall not use implementations with known security issues. For example, the AES CBC (Cypher Block Chaining) mode is vulnerable to the POODLE attack.

3.6. The lighting control system shall limit unauthorized control and communication from field input devices.

3.6.1. If an attacker is able to connect to the field bus, any such connection shall have control limited to the same as the configured devices which are attached to the field bus segment to prevent the potential for site-wide control, nuisance and damage.

3.6.2. Any third-party system connected to the field bus shall have control limited to the same as the configured devices which are attached to the field bus segment to prevent the potential for site-wide control, nuisance and damage.

3.7. The lighting control system shall protect passwords using industry best-practice

3.7.1. Usernames and passwords must be stored encrypted or as a salted hash

3.7.2. Log-in credentials must be transmitted within the system encrypted or as a salted hash

3.8. The lighting control system shall ensure that all IP lighting control message communications between 3rd party systems and the lighting control system are provided using the same security methods.

4. DALI Line Occupancy Light Level Control Devices – Multi-master

4.1. Occupancy Sensors will have the ability to connect directly to the DALI line, and receive all their operating power from the DALI line, without the need for any additional DALI Application Controllers. (Must be used in conjunction with a DALI Power Supply Unit)

4.2. Occupancy Sensors may optionally have an in-built Photoelectric Cell (PE) for the ability to daylight harvest or provide constant light level control within a space.

4.3. If any light level sensor (PE Cell) is present in combination with an Occupancy Sensor, it must have the ability to be controlled separately without the need for the Occupancy Sensor to be triggered first and can act completely independent of the Occupancy Sensor.

4.4. The Occupancy / Light Level Sensor must utilise Passive Infrared Technology (PIR) with high sensitivity triggers to pick up small movement and to limit false triggers through glass or mechanical vibrations.

4.5. The Occupancy / Light Level Sensor must have a high sensitivity detection range of 5m at a 2.7m ceiling height to ensure compliance with BCA J6, Greenstar and Well Standard.

4.6. The Occupancy / Light Level Sensor must consume no more than 2 mA from the DALI Line in full operation.

4.7. The Occupancy / Light Level Sensor must include a LED indicator on the front to allow easy visual identification and location of installed sensor when commissioning.

4.8. The Occupancy / Light Level Sensor must provide the option to connect a momentary or toggle press switch directly to the sensor via a dry contact input.

4.9. The dry contact input of an Occupancy / Light Level Sensor must be capable of controlling any address, group and or scene and can be utilised to control any group not related to the PIR or PE Cell control.

4.10. The Occupancy / Light Level Sensor will allow multiple configurations including but not limited to the following; occupancy mode, vacancy mode, light level maintenance, sunset switch, fade on, fade off and dwell time.

4.11. The Dry Contact Input of an Occupancy / Light Level Sensor must allow multiple configurations, including but not limited to the following; toggle dimmer, memory dimmer, long press fade time, timer, group control, and scene control.

4.12. With the addition of a DALI Line Zone Controller the PIR, PE and Switch input must be able to control any DALI address, group and or scene on any line, controller and or floor; anywhere on the network.

4.13. The Occupancy / Light Level Sensor will also have an optional surface mount adaptor available for use in open ceilings, car parks and or stairwells.

4.14. The Occupancy / Light Level Sensor must comply with DALI standards IEC 62386-101 and IEC 62386-102.

5. DALI Line Switch Input Coupler – Multi-master

5.1. The DALI Switch Input Coupler will have the ability to connect directly to the DALI line, and receive all their operating power from the DALI line, without the need for any additional DALI Application Controllers. (Must be used in conjunction with a DALI Power Supply Unit)

5.2. The Switch Input Coupler must have a minimum of 4 dry contact inputs and preferably 6 dry contact inputs to allow lighting control from a full 6 button wall switch.

5.3. The Switch Input Coupler must consume no more than 2mA from the DALI line when in full operation.

5.4. All 6 inputs of the Switch Input Coupler must be independently configurable via the system software.

5.5. Each of the Dry Contact Inputs of the Switch Input Coupler must allow multiple configurations, including but not limited to the following; toggle dimmer, memory dimmer, long press fade time, timer, group control, and scene control.

5.6. Each of the Dry Contact Inputs of the Switch Input Coupler must allow extension of the connection cable to at least 10 metres to allow for several separated switches being wired to a common Switch Input Coupler.

5.7. Each or any of the Dry Contact Inputs of the Switch Input Coupler must allow the input to be connected to voltage free contacts of a motion sensor to allow the use of specialised motion or presence sensor if or as appropriate.

5.8. With the additional of a DALI Line Zone Controller each of the Dry Contact Inputs of the Switch Input Coupler must be able to control any DALI address, group and or scene on any DALI line, controller and or floor; anywhere on the network.

6. Lighting Control Panels – Multi-master

6.1. The system shall provide a modular switch approach whereby combinations of master and slave modules can create precisely defined lighting control panels without leaving blank or unused buttons.

6.2. Each master push button or rotary type shall be capable of being connected to up to 1 slave device, with the ability to mix and match master and slave rotary and push button styles.

6.3. All master and slave modular switches shall be able to be inserted into standard '30 mech' apertures.

6.4. Each modular switch shall have a white LED backlight colour, which can be configured to operate based on system state.

6.5. The switch plates shall, for easy circuit identification without the need or cost of button engraving, provide the ability to replace the button switch surrounds and /or the rotary dial rings with different coloured surrounds or rings respectively.

6.6. Master and slave modular switches shall include the ability to provide digital rotary dimming functionality. These digital rotary dials shall be provided with a small and a large dial to suit the aesthetics of the wall switch selected.

6.7. Master and slave modular switches with rotary dials shall provide a Quick Flick functionality - whereby a quick flick of the rotary dial either clockwise or counter-clockwise instantly dims the connected lighting to the **maximum** or **minimum** levels respectively.

6.8. Master and slave modular switches with rotary dials shall be able to adjust the fade speed associated with the rotary dial to increase or decrease the rate at which the lights dim up or down depending on the rotation of the dial.

6.9. The system shall provide automatic LED Indicator state tracking so that control of any short address or group address from one lighting control point is automatically visually indicated on all associated buttons.

7. LCD Touch Panels – Via DALI Application Controller

7.1. The system shall include an option for the addition of an LCD Touch Panel for areas where required.

7.2. The LCD Touch Panel will have a 5 inch colour LCD with capacitive touch display.

7.3. The LCD Touch Panel will have adjustable brightness.

7.4. The LCD Touch Panel will allow multiple themes for styling.

7.5. The LCD Touch Panel will have at least 1 and up to 20 Software Configurable control buttons.

7.6. The LCD Touch Panel will have the option to show on/off state, timer active and progress of fading options (up and down).

7.7. The LCD Touch Panel will support an optional fall-back page which can configured to show a blank page, time, date and time, or a customer-definable logo.

7.8. The LCD Touch Panel will be connected to one of the Smart RJ ports located on a RAPIX E-Hub via a Cat5e patch cable.

8. Desktop App for user lighting control

8.1. The lighting control system shall include a desktop software app that can run on a Windows PC to allow users to control the lighting in their local area.

8.2. The Desktop software app must allow control of at least: brightness, colour, scenes and system functions such as but not limited to building modes and enable/disable sensors.

8.3. The Desktop software app must not impose additional ongoing or future costs, for example charges for a cloud based subscription service.

8.4. The Desktop software app must allow configuration of which areas a user can control, and must allow different users of the same PC to control areas relevant to each user.

8.5. The Desktop software app must use encrypted and secured communication between the PC and the lighting control system.

8.6. The Desktop software app must store its configuration in an encrypted form to prevent a PC user from tampering with the configuration.

8.7. The Desktop software app must allow simple deployment of settings to a user by (a) a one-click installation of an encrypted settings package that can be emailed; and also (b) by silent install using Windows Group Policy.

9. System Commissioning

9.1. Initial DALI Short Addressing, DALI Scenes and DALI Group Commissioning shall be performed using the RAPIX Addressing software to ensure no time is wasted during the DALI commissioning phase and to provide a level playing field for commissioning agents and contractors.

9.2. The use of external systems, “Cloud” connected software, a centralised local building server, or similar for system commissioning is not permitted due to single point of failure and/or the potential for compromise of the lighting control system access and security.

9.3. The use of subscription or fee-based DALI addressing and commissioning software is not permitted.

10. Specific Requirements

10.1. DALI Emergency Lighting Monitoring

10.1.1. Where specified and detailed in other sections of this specification, the Monitored Emergency Lighting System shall make use of Emergency Luminaires compliant to AS/NZS 2293, and contain DALI self-contained emergency lighting drivers.

10.1.2. This DALI Monitored Emergency requirement and capability shall utilise the DALI Zone controllers allocated to control the lighting, without the addition of separate specialised hardware to provide communication and AS/NZ2293 compliance.

10.1.3. Any Emergency Monitoring software shall reside on a Windows 10 (or greater) PC and be connected to the system via Ethernet.

10.1.4. DALI Emergency and DALI LED, DALI Relay, DALI ballasts and other DALI product types shall co-exist on a single DALI line to reduce cabling and equipment requirements.

11. BMS Integration

11.1. The lighting control system will have a high level interface to the BMS to enable integration. This functionality will depend on the BMS interface required and the precise integration points determined.

11.2. This BMS integration will be achieved through software and or hardware for protocols such as BACNET, MODBUS, OPC, LON, KNX.

11.3. BMS Integration may be achieved using Eisbar Scada Software, BACIX Rapix Bacnet Gateway, MODBUS TCP, or any solution based on the RAPIX API.

12. Site Programming Requirements

12.1. The site will be programmed as per the below site requirement for each space identified:

Open Areas	Eg. Occupancy Detection with 20-minute time delay and 5 min dwell fade time. First two rows adjacent the windows will apply daylight harvesting to ensure required light levels are maintained.
Offices	Eg Vacancy detection. Short Press to turn on lights via wall switch. 15-minute time delay once unoccupied with 2-minute dwell.
Executive Offices	
Small Meeting Rooms	
Large Meeting Rooms	
Conference Rooms	
Sick Rooms	
Breakout Spaces	
Corridors	
Toilets	
Lift Lobby Foyer	

13. APPROVED MANUFACTURERS

The lighting control system will be equal to the RAPIX Lighting Control System by Ozuno.

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