SECTION 26 09 43

DISTRIBUTED DIGITAL LIGHTING CONTROLS

BASED ON DFD MASTER ELECTRICAL SPEC DATED 09/03/24

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

1. - GENERAL

SCOPE

Provide Distributed Digital Lighting Controls (controls) as indicated on the drawings and as specified herein. The controls shall consist of a series of standalone digital load controllers and intelligent low-voltage devices dedicated to the room/space they are serving. All local devices shall be connected via an In-Room Network, enabling digital communication between devices. Digital Lighting Control Panels, where indicated on the drawings, may also be used for lighting control as part of the overall lighting control scheme.

Include the following paragraph for new buildings and major renovations.

[Provide a hybrid system of Networked Central Controls (relay Panels) and Distributed Digital Lighting Controls. System shall include a Central Lighting Server to allow full integration of the distributed and centralized lighting control devices. The system architecture shall connect multiple In-Room local networks for centralized building-wide monitoring and management via a Global Network and PC-based software. Refer to the drawings for which rooms/spaces are to be connected to the Global Network. The system architecture shall allow standalone digital load controllers and associated devices to function in some default capacity, even if network connectivity to the Global Network is lost. All system devices shall be networked to allow complete building control. Interface with Building Automation and Audio-Visual Systems shall be provided.]

The controls shall provide time-based, sensor-based (e.g., occupancy/vacancy and daylight sensors), and/or manual control as indicated in the lighting sequences of operation on the drawings. The controls shall turn lighting loads ON/OFF and shall dim the lighting where indicated.

Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference Standards

Design/Performance Requirements

Quality Assurance

Submittals

Operation and Maintenance Data

Extra Materials

PART 2 - PRODUCTS

System Requirements

[Central Lighting Server]

Digital Load Controllers (Room Controllers)

Digital Motion Sensors

Digital Daylight Sensors

Digital Manual Controls

Digital LED Luminaires

Digital Auxiliary Input/Output (I/O) Interface Modules

Digital Lighting Control Panels (Relay and Dimming Panels)

Configuration Tools

Network Cables

[Network Interfaces]

PART 3 - EXECUTION

Delivery, Storage, and Handling

Project Conditions

Sensor Layouts

Auxiliary Contacts for HVAC Interlock

Installation

Field Quality Control

Sequence of Operation

Post Start-up Tuning

Warranty

Product Support and Service

Construction Verification Items

Agency Training

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 26 08 00 – Commissioning of Electrical

Section 26 51 00 – Interior Lighting

REFERENCE STANDARDS

NFPA 70 National Electrical Code; National Fire Protection Association

NEMA National Electrical Manufacturers Association

FCC Federal Communications Commission – Emission Standards

UL Underwriters Laboratories, Inc. Listings

UL 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces

UL 20 General-Use Snap Switches

UL 508 Standard for Industrial Control Equipment

UL 916 Standard for Energy Management Equipment

UL 924 Standard for Emergency Lighting and Power Equipment

DESIGN/PERFORMANCE REQUIREMENTS

Distributed Digital Lighting Controls shall accommodate the square-footage coverage requirements for each area controlled utilizing digital load controllers, digital occupancy/vacancy sensors, digital daylighting sensors, digital switches, digital lighting control panels, and accessories that suit the required lighting and electrical system parameters.

System shall conform to requirements of NFPA 70.

System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

System shall be listed under UL sections 916 and/or 508.

Equipment shall be capable of UL 924 listing for emergency lighting operations.

QUALITY ASSURANCE

Installer Qualifications:

Company certified by the manufacturer and specializing in installation of Distributed Digital Lighting Control products with minimum three years documented experience.

Manufacturer Qualifications:

All dimmers and cabinet fabrications shall take place in the U.S. manufacturing plant. The manufacturer shall have a factory authorized stocking service center within 150 miles from the job site. In addition, the manufacturer shall have a toll free 24-hours hotline with a maximum response time of 20 minutes, 24 hours a day 365 days a year.

Factory trained Manufacturer Representatives shall be available to verify system installation, proper

operation and conformance to customer requirements. Factory or Manufacturer Representatives shall be

available for on-site training and telephone support.

The manufacturer shall have manufactured electronic lighting controls for a minimum of ten (10) years.

Companies that assemble dimming racks or banks from components supplied by others will not be acceptable

All dimming and low voltage switching systems shown on the plans and specified herein shall be by the same manufacturer.

Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and

enclosures.

The system shall be listed or registered with Underwriters Laboratories Inc. for its intended purpose. The

system shall be rated by Underwriters Laboratories Inc. as suitable for use with 90C copper wire.

All applicable components/assemblies shall meet emission standards as suitable by the FCC as specified in

Part 15, Subpart J for Class A installations

The controls shall meet the following specifications:

• Operational ambient temperature: operating temperature: 14F to 104F (–10C to40C).

• Operational ambient humidity: not to exceed 45% RH at 32F to 85% RH at 95F (0C to 35C).

• Static immunity: greater than 15KV.

• Conducted lighting and line transient immunity: 6 kV spikes.

SUBMITTALS

Shop Drawings:

Shop drawings shall include the following:

* Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature)
* All manufacturers shall submit to the specifying engineer a line-by-line compliance comparison between each specifications requirement and the system being proposed. Any ambiguities in the drawings or specifications shall be brought to the attention of the specifying engineer for clarification.
* Riser Diagrams – typical per room type (detailed drawings showing interconnectivity of devices)
* Other Diagrams – as needed for special operation or interaction with other system(s)
* Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up
* Hardware and Software Operation Manuals
* Other operational descriptions as needed

Occupancy Sensor Shop Drawings

* Symbols on drawings are diagrammatic and represent design intent only. Provide manufacturer-recommended layout drawings showing quantity and location of sensors and associated wiring diagrams.

Closeout Submittals:

* Project Record Documents: Record actual installed locations **and settings for each** lighting control device and show interconnecting wiring.
* Operation and Maintenance Manual:
* Include approved Shop Drawings and Product Data.
* Include Sequence of Operation, identifying operation for each room or space.
* Include manufacturer's maintenance information.
* Operation and Maintenance Data: Include detailed information on device programming and setup.
* Include startup and test reports.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

EXTRA MATERIALS

Provide the following spare materials:

* One (1) ON/OFF Load Controller with three relays
* One (1) ON/OFF/Dimming Load Controller with three relays
* One (1) of each type of motion sensor used
* One (1) daylight sensor
* One (1) two-button digital wall switch
* Two (2) five-button digital wall switch
1. - PRODUCTS

SYSTEM REQUIREMENTS

Lighting control zones shall consist of one or more intelligent lighting control components (digital load controllers), be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.

Network Characteristics

* In-Room Network:
* The In-Room network shall be a free topology lighting control network using physical wiring connections and communication protocol designed to control a room/space/small area of a building.
* Digital room devices connect to the In-Room network, which provides both communications and power to room devices.
* Global Network (In-Room to In-Room Network):
* The Global network shall be a linear topology network to connect In-Room networks and relay panels (if applicable) for centralized control.
* Each In-Room Network to be connected to the Global Network shall include a single network bridge, and the network bridge is the only room-based device that is connected to the Global Network.
* The Global Network shall utilize communications cabling as specified by the manufacturer. The maximum cable run for each segment (distance between In-Room Networks) shall meet manufacturer limitations.

Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the Global Network or the management software becoming unavailable.

All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e., not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

System shall be capable of using a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.

[Connect all noted In-Room Networks to the Global Network for building-wide monitoring and management via PC-based Management Software and/or the building automation system (BAS). Provide optional Management Software for remote system control, status monitoring, and creation of lighting control schedules and profiles.]

[CENTRAL LIGHTING SERVER

The Architectural Control Server shall be the Unison Paradigm Central Control Server (P-CCS) as manufactured by ETC, Inc., or equal.

Connections shall be made between lighting system components over standard Ethernet distribution systems using 10/100BaseT.

The server shall be tested to UL standards and labeled ETL Listed.

The server shall be RoHS Compliant (lead-free).

The server shall be CE compliant.

Mechanical

P-CCS electronics shall be contained in a single assembly.

The assembly shall be housed in a formed steel body.

The server shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, powder coat paint.

Mounting holes shall be provided for installation of a rack mount kit.

User Interface

The P-CCS power button shall be backlit for use in low-light conditions.

The P-CCS shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.

The P-CCS shall provide rear-panel connections for (2) RJ45 jack for Ethernet connection to the processor for configuration, Virtual Touchscreen (VTS) and web-browser-based system access.

Architectural Lighting System configuration and program information shall be stored in solid state memory, which does not require battery backup.

The P-CCS shall provide a hard drive for storage of system configurations.

Electrical

The P-CCS shall support 100-240VAC power input and utilize an external transformer power supply

The P-CCS shall allow for nearly silent operation.

The server shall utilize microprocessor based, solid state technology to provide multi-processor lighting and building control.

The server shall provide two IEE802.3u Ethernet connections for 100BASE-TX communication with the lighting control system.

The Primary Ethernet port shall be reserved for connection to the lighting control system.

The Secondary Ethernet connection shall be used for interface with BACnet IP enabled building systems.

Both Connections shall support Virtual Touchscreen (VTS) functionality.

Following a loss of power, the P-CCS shall return to its previous power state upon power being restored.

Functional

Shall support up to 64 Architectural Control Processors (ACP).

Shall support up to 64 individual projects.

Shall support multi-user Live Control and Live Edit simultaneously.

System shall support the use of Network Time Protocol for real time clock synchronization.

System shall support remote firmware upload over an Ethernet connection from a connected PC running the Light Designer software.

Failure of a single Processor shall not prohibit continuing operation of the remaining connected system.

Shall log system error messages using Syslog.

The server shall support ANSI E1.17 Architecture for Control Networks (ACN).

Operation

The Control System shall be designed to allow control of lighting and associated systems via Virtual Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.

System macros and sequences shall be programmable via Light Designer system software.

System time clock events shall be programmable via the Virtual Touchscreen, Light Designer system software, the processor user interface, or the internal web server.

Time clock events shall be assigned to system day types. Standard day types include weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. System shall support programming of additional custom or special day types.

Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight-saving time.

A Color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.

The color picker shall be provided with a default layout that requires no user configuration

The Color Picker shall provide RGB faders in addition to the default HSB color wheel for color selection

Color picker values shall allow for numerical value input in addition to color wheel and fader control

The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels

Virtual Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via Light Designer, the Windows-based configuration program.

Optional button functions include preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.

Optional fader functions include master control, individual channel control, fade rate control or preset master control. ]

DIGITAL LOAD CONTROLLERS (Room Controllers)

General

Digital load controllers shall be simple to install and shall not have dip switches or potentiometers, or require special configuration.

The controllers shall include the following features:

* Standard junction box mounting.
* Low voltage connection using standard RJ-45 connectors and CAT5e cable. Other wiring topologies are acceptable if controls accomplish all requirements specified in these documents.
* Each connected load shall be capable of any of the following behaviors: Manual ON, Automatic ON, Automatic ON to 50 percent, or Automatic ON to Preset level or last level set.
* UL 2043 plenum rated.
* Manual override and LED indication for each load.
* Power supply to power the digital load controller itself and the peripheral sensors and controls connected to the In-Room Network.
* Dual voltage (120/277 VAC, 60 Hz), rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming).
* Zero cross circuitry for each load.
* All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

ON/OFF Load Controllers

Controllers shall include the following:

* Multiple relay configurations per unit.

ON/OFF/Dimming Load Controllers

Controllers shall include the following:

* Multiple relay configurations per unit.
* Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected LED driver.
* One dimming output per relay.
* 0-10V Dimming: Where indicated, one 0-10 volt analog output per relay for control of compatible LED drivers. The 0-10 volt output shall automatically close upon loss of power to the Controller to assure full light output from the controlled lighting.
* Line Voltage, Forward Phase Dimming: Where indicated, one forward phase control line voltage dimming output per relay for control of compatible LED drivers, forward phase compatible ELV, and incandescent loads.
* Each load shall have an independently configurable preset ON level for Normal Hours and After-Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After-Hours events.

DIGITAL MOTION SENSORS

General

Sensors shall be available in wall, ceiling, corner-mounted, or wall-switch configurations.

Sensors shall use either passive infrared (PIR) sensing, or if dual technology, passive infrared and passive acoustic or passive infrared and ultrasonic sensing for detecting room occupancy.

Sensors shall be able to function together with other sensors in order to provide expanded coverage areas.

Features

Sensors shall be provided with the following features:

* Sensitivity Adjustment, Time Delay, Detection Technology, and Walk-Through Mode.
* Dual-Technology Sensors shall have independent configurable trigger modes to choose proper technology according to space use to eliminate false-triggers.
* Each sensor may be programmed to control specific loads within an In-Room network.
* Each sensor shall allow remote programming through a handheld commissioning tool via a two-way infrared (IR) transceiver or by configuration through a local network device.

Digital Wall Switch Motion Sensors

Digital wall switch motion sensors shall be provided with the following features:

* Shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
* One- or two-button switches for one or two switch-legs.
* Optional daylight sensor feature for daylighting override.

DIGITAL DAYLIGHT SENSORS

Daylight sensors shall be provided with the following features:

* Digital daylighting sensors shall work with room controllers to provide automatic switching, bi-level, tri-level, or dimming daylight harvesting capabilities for any load type connected to a room controller.
* Daylighting sensors shall be interchangeable without the need for rewiring.
* Sensor light level range shall be from 1-250 foot-candles (fc).
* For switching daylight harvesting, the daylight sensor shall provide a field-selectable deadband (separation) between the “ON” setpoint and the “OFF” setpoint that will prevent the lights from cycling excessively after they turn OFF.
* For dimming daylight harvesting, the daylight sensor shall provide the option, when the daylight contribution is sufficient, of turning lights OFF or dimming lights to a field-selectable minimum level.
* Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
* Daylight sensors shall have an independently configurable fade rate for both increasing and decreasing light level in units of percent-per-second.
* Daylight Sensors shall provide adjustable cut-off time (0-120 minutes). Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off.
* Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
* Each sensor shall allow remote programming through a handheld commissioning tool via a two-way infrared (IR) transceiver or by configuration through a local network device.

DIGITAL MANUAL CONTROLS

Wall Switches

Low voltage dimming and momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 Button configurations.

Wall switches shall include the following features:

* Buttons may be programmed as Load or Scene Buttons.
* Buttons may be programmed as ON/OFF, ON only, or OFF only.
* Switch buttons may be bound to any load on a room controller and are not load type dependent.

Dimmer Switches

* Raise/lower dimming adjustment controls.
* Dimmer switches shall include multiple LEDS to indicate load levels.
* Dimmer switches shall be able to be ganged with multi-button switches under the same wall plate.
* Three-way and 4-way switch locations are supported for ON/OFF or Dimming control.

Digital Scene Switches

* Scene switches allow for Preset Scene recall and dimming override control.

Touchscreen Panel Controls

Provide Touchscreen Panel Controls where indicated. Refer to lighting plans for locations. Touch Panel Controls shall be used for adjusting lighting and to set up and control preset lighting scenes in the associated room/space.

Touchscreen Panel Controls shall be provided with the following features:

* Full-color multi-touch capacitive touchscreen for controlling lighting and system components
* Control up to 16 dynamic lighting zones/scenes per touch screen or acting as up to 16 ON/OFF/DIM control switches
* Lighting zones/scenes can be comprised of lighting intensity, color, color temperature, and luminaire position
* Modify color and color temperature using a digital color palette and UV rating scale
* Proximity screen sensor for auto “wake-up”
* Auto dimming and user adjustable backlight
* Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens. User programmable screen lock limiting access to all feature controls and programming
* Full alpha-numeric scene and zone naming
* Configurable interface to reflect project requirements
* Lighting zones/scenes support control of forward/reverse phase dimming, 0-10V, RGB, tunable white, and moving fixtures
* Integral astronomical time clock enables lighting scenes
* Partition status control and visualization
* Direct DMX control
* Digital motion senor control
* Digital daylight harvesting response
* Shall have the ability to control connected load through time schedules.
* RS-232/contact closure capable for 3rd party integration
* Local wireless Bluetooth connectivity with mobile app
* Device shall have a micro-USB style connector for local computer connectivity.
* Remote-mounted power supply
* Ability to program and control Tunable White and RGBW color changing lighting

Handheld LCD Touchscreen Controls shall be provided with the following features:

* Seven-inch (7”) WVGA (800x480) 24-bit color HANDHELD LCD touchscreen station.
* Wireless Touchscreen stations shall support default and fully graphical control pages.
* Wireless Touchscreen stations shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
* Wireless Touchscreen stations shall allow programming of page passcode, lock out and visibility levels.
* Wireless Touchscreen stations shall support location awareness to automatically load the configuration required dependent on the connection point to the system.
* Wireless Touchscreens shall support option accessories including:
	+ The Docking Stations shall support a wired Ethernet connection to the control system as well as charging capabilities for the touchscreen.
	+ Wireless Access Station shall provide connection between the wireless touchscreen and the lighting control system.

Touchscreen Master Control Station shall be provided with the following features:

* Eighteen- and one-half inch (18.5”), backlit liquid crystal display (LCD) with a minimum resolution of 1366 by 768 pixels and 24-bit colour depth with a touch interface.
* Touchscreen Master Control Station shall be able to set up and control/recall and/or override any/all preset lighting scenes in the facility.
* Touchscreen stations shall support fully graphical control pages.
* The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
* Touchscreen stations shall also allow programming of page passcode, lock out and visibility levels.
* Touch Screen shall connect to the System using Ethernet network:
	+ Ethernet network shall be 10/100BaseTX, auto MDI/MDIX.
	+ Network shall utilize Unshielded Twisted Pair (UTP) CAT6 wiring.
* The Touchscreen shall have a capacitive touch overlay over the display.
* The Touchscreen shall support table-top, wall mount (VESA) and/or 19” rack mounting.
* The Touchscreen shall provide interaction with the lighting system using the System Central Control Server as an interface.
* The Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.

DIGITAL LED LUMINAIRES

Digital LED Luminaires are allowed, but not required.

Digital LED Luminaires are luminaires with embedded controls (a.k.a. “enabled” luminaires). Enabled luminaires to have a mechanically-integrated control device, allowing the luminaires to communicate digitally with other digital lighting controls. All lighting control devices and “enabled” luminaires within a controlled room/space shall be networked together, enabling digital communication between devices.

DIGITAL AUXILIARY INPUT/OUTPUT (I/O) INTERFACE MODULES

General

* Operate on Class 2 power supplied by In-Room network.
* Status LEDs indicate if input is energized.
* UL 2043 plenum rated where required.

Switched Contact Closure Interface

* Utilized for automatic control via input from other sources such as switches, relay-based system, BAS, etc.
* Includes 24VDC output and input terminals for momentary or maintained third party contact closure inputs.
* Utilize input module for an Auto ON and Sweep OFF function input from other sources for the controlled area. During normal hours of operation, all local low-voltage devices are fully operational. During after hours, a timer shall be applied to all low-voltage switches or dimmers so that the room will automatically sweep off every two hours following switch activation. Provide a blink warning to alert occupants of impending OFF.
* Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
* Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
* Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (e.g., toggle the lighting load) or run a local/remote control profile.
* Specific I/O devices shall sense state of low-voltage outdoor photocells.
* Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).

Serial Data Interface

* Utilized for control from A/V system to send ON/OFF/Preset commands to In-Room Network.
* Includes 24VDC output and 10 pin RS232 connection.
* Coordinate programming with the Distributed Digital Lighting Control System manufacturer’s technician and the A/V system technician for successful interface between both systems.

DIGITAL LIGHTING CONTROL PANELS (RELAY and DIMMING PANELS)

General

It is the intent of this paragraph to provide a Digital Lighting Control Panel as part of an integrated lighting control system. Contractor is responsible for confirming that the panels and associated peripheral devices such as sensors and manual controls interoperate as a single system.

Digital Lighting Control Panels shall be incorporated into the lighting control system Global Network where used.

Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

* The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
* The interior construction shall provide total isolation of line voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel.
* Direct wired switch inputs associated with each relay shall support two-wire, momentary or maintained contact switches.
* Digital inputs shall support digital switches, digital I/O modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital I/O modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
* Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells associated with the lighting control panel as necessary to meet the project requirements.

Relays

Relays shall provide the following ratings and features:

* Panel shall provide one 0-10VDC dimming output paired with each relay.
* Each relay shall contain an LED status light and an override pushbutton. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
* Relays shall be individually replaceable in a modular plug-in design.
* Relays shall be single-phase normally-closed latching type relays capable of switching 120/277 VAC or two-phase relays capable of switching 208/240/480 VAC loads.
* Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
* Tested to 300,000 mechanical on/off cycles.
* Relay operation shall be automatically sequenced to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

Digital Network Clock

* Each panel shall include a digital clock capable to issue system wide automation commands.
* The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and shall include battery backup for the clock function and for program retention. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
* The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours to automation groups that implement pre-configured control scenarios. Scenarios shall include:
	+ Scheduled ON / OFF
	+ Manual ON / Scheduled OFF
	+ Astro ON / OFF (or Photo ON / OFF)
	+ Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
* Schedules programmed into the clock of any one panel shall be capable of executing local schedules or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost.

CONFIGURATION TOOLS

A configuration tool facilitates optional customization of In-Room networks.

* Provide two Configuration Tools for the project.
* Provide free, downloadable PC software for direct programming of In-Room Networks.

Features and functionality of the wireless configuration tool shall include but not be limited to:

* Optional customization of In-Room networks using two-way wireless communications or USB interface.
* Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number.
* Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.

NETWORK CABLES

In-Room Networks

This specification is based on CAT5e data cables for In-Room Networks. Other wiring topologies are acceptable if controls accomplish all requirements specified in these documents.

Use manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors for In-Room Networks. If manufacturer’s cables are not used, each field-terminated cable shall be tested prior to installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.

UL 2043 plenum rated where required.

Global Network

The Global Network, where used, shall utilize communications cabling as specified by the manufacturer. The maximum cable run for each segment (distance between In-Room Networks) shall meet manufacturer limitations.

Include the following heading and five sub-paragraphs if a PC-based management system or BAS interface is required for the project.

GENERAL NETWORK

General

Network shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/100Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.

Connections shall be made between consoles, face panels, architectural processors, dimmers, Net3 Gateways, and computers over standard Ethernet distribution systems using 100BaseT, 100BaseFL, or greater wiring. All installations shall conform to established Ethernet wiring practice, and installation shall be performed by contractors qualified to do this type of work. All wiring shall be tested at Category 5e or higher for full bandwidth operation to the appropriate IEEE standard.

The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the Entertainment and Architectural lighting control.

Capacities

The network shall support DMX routing, patching, and prioritization for up to 63,399 universes (32,767,488 DMX addresses). Each address may be input or output from any port on any DMX gateway in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of gateways supported by the Ethernet topology.

The network shall support multiple network hosts including consoles, gateways, dimming racks, computers, file servers, printers, and architectural control processors with discrete command lines and control. The lighting network shall support multiple venues within a system and discrete systems on the same network.

System Configuration and Monitoring

Network device configuration shall be via Net3 Gateway Configuration Editor (GCE) software and/or ANSI E1.17 Architecture for Control Networks (ACN).

Patch addresses shall support viewing and manipulation via ANSI E1.17 ACN.

* The system shall permit complete user flexibility allowing the system operator to patch each DMX input address to any ANSI E1.31 streaming ACN address, and DMX output to span streaming ACN universes.
* The lighting system shall support assignment of DMX offsets, truncation of DMX universes, and provide choice of DMX port prioritization.
* The lighting system shall support the DD start code extension to ANSI E1.31 which provides priority per address such that multiple control sources can share universes with discrete control per address.
* Lighting systems that do not support the above-mentioned address patching capabilities shall not be suitable.

The system shall allow assignable labels for all network devices to allow easy identification by system users.

Each network device shall have a discrete and unique IP address provided automatically by the software. The user may edit this IP address. Systems that do not support automated IP allocation with IP collision avoidance, and systems that do not allow complete reconfiguration of the above-mentioned features over ANSI E1.17 ACN shall not be acceptable.

All configuration data for each network device shall be held at the device and system operation shall not require continuous on-line operation of the network configuration software. Lighting console operators shall be able to back up the network configurations in the lighting control console. In the event of a network device failure, the operator shall be able to apply the configuration of the failed device to a replacement device of the same type without manually reentering settings. Systems that do not support configuration backup as described above shall not be accepted.

Architectural and Entertainment systems connected to the same network shall be capable of arbitrating control over E1.31 Streaming ACN (sACN) level data. The system shall be capable of alternating control of individual address data between architectural and entertainment systems without intervention by the user. The user shall dictate the conditions under which system shall automatically take control. The network shall allow user override of the selected defaults. Systems which require direct user intervention to allocate control of dimmers between architectural and entertainment lighting systems shall not be accepted.

The Net3 network shall allow multiple DMX input sources to be prioritized on the same universe as network native sources using E1.31 Streaming ACN prioritization. Multiple DMX inputs may be assigned to the same streaming ACN address (this provides multi-source control for a particular address). Likewise, the system shall support E1.31 prioritization of multiple simultaneous network sources. Systems that cannot prioritize multiple DMX inputs and multiple native network sources on a network shall not be deemed suitable.

The lighting network shall allow each DMX input address to be assigned a priority on the network allowing each DMX control level coming into the system to participate in full arbitration. Addresses with the highest priority shall have control, with lower priority addresses being ignored. Addresses assigned the same numeric priority, between 1 and 200, shall respond in highest level takes precedence (HTP) manor.

The network shall require a valid DMX signal present at the input to initiate prioritization. Systems that do not allow for prioritized HTP for DMX inputs to the network shall not be allowed.

Operational Features

Each DMX gateway shall control up to 512 DMX addresses per port, within the confines of up to 63,999 DMX universes (32,747,488 address). The specific DMX data input or output by the gateway shall be configurable by the user.

Duplicate outputs of DMX data (DMX splitter) and discrete outputs shall be fully supported.

Merging of multiple DMX input sources on a single gateway without gateway with DMX output on the same gateway shall be supported without connection to the network. The gateway shall support assignment of priority to each input source independently

File transmission, synchronization and access to software shall be supported.

[NETWORK INTERFACES

Global Network Bridge:

* Provide one bridge for each In-Room Network that is to be connected to the Global Network.
* UL 2043 plenum rated where required.
* Manufacturer-specified network cable shall daisy-chain all network bridges together.
* The Global Network Bridge module connects an In-Room Network to a segment of the Global Network for communication between rooms, relay panels, and a Global Management Controller or BAS.
* The Global Network Bridge shall be provided as a separate module connected on the In-Room network.
* Global Network Bridge shall make all room devices connected to the In-Room network and all device parameters visible to the Global Management Controller via the Global Network.
* The global network bridge shall link back to front-end controller for connection to building LAN for centralized programming and BAS interface (optional).
* If a network bridge loses communication with the Global Network, In-room network shall stay active and operate as normally programmed. There shall be no disruption to local control.

Global Management Controller:

* For networked applications, the system shall include at least one Global Management Controller to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP or encrypted SSL TCP/IP traffic via a configurable port.
* Each Global Management Controller shall have integral support for at least three segments of the Global Network. Each segment may alternately be connected to the Global Management Controller via external routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment of the Global Network.

Operational features of the Controller shall include the following:

* Connection to PC or LAN via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
* Graphical user interface shall be compatible with current internet browsers and shall not require installation of any lighting control software on an end-user PC.
* Log-in security capable of restricting some users to view-only or other limited operations.
* Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
* Ability to set up schedules for rooms and panels; view and override current status of panel channels and relays; and assign relays to groups. Schedules shall automatically set controlled zones or areas to either a normal-hours or after-hours mode of operation. Support for a minimum of 100 unique schedules, each with up to four-time events per day. Support for annual schedules, holiday schedules and unique date-bound schedules.
* Ability to group rooms and loads for common control by schedules, switches, or network commands.

Network Equipment

Provide all necessary network components, i.e., routers, switches, repeaters, etc. as suggested by the manufacturer for a complete Global Network System.

Global Network cables shall be furnished and installed by this contractor per manufacturer requirements.

BAS Integration

Provide capabilities for integration with a Building Automation System **(**BAS**)** via BACnet protocol.

At a minimum, the following points shall be available to the BAS via BACnet IP connection to the Global Management Controller: Room occupancy state; Room schedule mode; Room switch lock control; Individual occupancy sensor state; Load ON/OFF state; Load dimming level; Panel relay state; and Global Management Controller Group schedule state.

Management Software

Every device parameter (e.g., sensor time delay and photocell setpoint) shall be available and configurable remotely from the software.

Software shall require all users to log in with a Username and Password.

Software shall provide at least three permission levels for users.

All sensitive stored information and privileged communication by the software shall be encrypted.

All device firmware and system software updates must be available for automatic download and installation via the internet.

Software shall be capable of managing systems interconnected via a WAN (wide area network).]

1. - EXECUTION

DELIVERY, STORAGE, AND HANDLING

Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

PROJECT CONDITIONS

Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's absolute limits.

Do not install equipment until following conditions can be maintained in spaces to receive equipment:

Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).

Relative humidity: Maximum 90 percent, non-condensing.

SENSOR LAYOUTS

Confirm quantity and provide appropriate coverage by sensors on a per-space requirement. Symbols on drawings are diagrammatic and represent design intent only.

Occupancy sensors shall be installed at locations indicated on the manufacturer’s submittal layout drawings. Sensors shall be located to prevent false triggering of the lights to ON when no occupant is present.

AUXILIARY CONTACTS for HVAC INTERLOCK

Provide auxiliary dry contacts for HVAC/BAS interlock via Digital Auxiliary Input/Output (I/O) Interface Modules when required. Refer to the “Occ Sensor Interlock” column in the Air Terminal Schedule on the HVAC drawings. Provide one auxiliary contact for each HVAC zone per the Air Terminal Schedule to signal occupancy to the BAS system.

The occupancy sensors, room controllers, and auxiliary contacts shall be configured such that the sensors still detect occupancy and control the auxiliary contacts regardless of whether the lights are ON or OFF (e.g., The occupant has turned the lights OFF because there is enough daylight, but the occupant is still occupying the space, so the occupancy sensor senses the occupant and closes the auxiliary contacts for Air Terminal control).

The HVAC/BAS wiring to the auxiliary contacts shall be by the Division 23 contractor.

INSTALLATION

Install system in accordance with the approved system shop drawings and manufacturer's instructions.

Install all room/space devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.

If pre-terminated cable is not used for room/space wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.

Install all room-to-room digital devices using manufacturer-supplied network wire. Network wire substitution is not permitted and may result in loss of product warranty.

Low-voltage wiring topology must comply with manufacturer's specifications.

Document final wiring locations, routing, and topology on as-built drawings.

All line-voltage connections shall be tagged to indicate circuit and switched legs.

Test all devices to ensure proper communication.

Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

Adjust time delay so that controlled area remains lighted while occupied.

Provide written or computer-generated documentation on the configuration of the system including room-by-room description including:

* Sensor parameters, time delays, sensitivities, and daylighting setpoints.
* Sequence of operation, (e.g., manual ON, Auto OFF. etc.)
* Load Parameters (e.g., blink warning, etc.)

Tighten all panel Class I conductors at circuit breakers and at loads to torque ratings as marked on enclosure UL label.

All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

Run separate neutrals for any phase dimmed branch load circuit. Different types of dimmed loads shall have separate neutrals.

Verify all loads to be free from short circuits prior to connection to room controllers.

Control-voltage cables shall be installed in conduit. However, they may be installed free-air (without conduit) above accessible ceilings if the cable meets NEC requirements for the application, unless specified to be in conduit in other sections of the specifications. See requirements for free-air cable installation below.

Control cables for controlling HVAC and lighting equipment connected to emergency power shall be routed in raceways separate from each other.

FIELD QUALITY CONTROL

Electrician/Low Voltage Technician: Any low voltage wiring made onsite by electrical or low voltage contractor must be verified end to end with industry standard test equipment capable of printing or producing a digital file of the testing results.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Manufacturer in writing a minimum of three (3) weeks prior to system start-up and testing.

Tests and Inspections: Manufacturer's service representative or electrical/low-voltage contractor installing low voltage cabling that is not pre-terminated from the manufacturer shall perform the following inspections and prepare reports:

Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports:

* Verify end-to-end testing of all low voltage wiring that is not pre-terminated from the manufacturer. Provide detailed results via paper or digital format downloadable from testing equipment.
* Verify Class I and II wiring connections by validating system performance.
* Set IP addresses and other network settings of system front-end hardware per facility’s IT. instructions.
* Verify/complete task programming for all switches, dimmers, time clocks, and sensors.
* Verify that the control of each space complies with the Lighting Sequence of Operation.
* Correct any system issues and retest.

Provide a report in table format with drawings or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:

* Date of test or inspection.
* Loads per space.
* Fixture Address identification.
* Quantity and Type of each device installed.
* Reports providing each device's settings.

Provide Sequence of Operation descriptions either here or on the plans. Provide separate Sequences of Operation for areas/room that are intended to operate differently than other areas/rooms. The Sequence(s) of Operation shown below are examples only and shall be edited for the intended operation for your specific project.

SEQUENCE of OPERATION

[See plans for Sequence of Operation descriptions.]

[See below for Sequence of Operation descriptions:

1. NON-DAYLIT AREAS
	1. Automatic Control
		1. Time based: ON at 6:00am, OFF at 11:00pm, seven days/week. Confirm hours with User Agency.
		2. Lights OFF during Holidays.
		3. Blink-warn before lights turn OFF.
	2. Manual control via Low Voltage Control Station.
		1. ON/OFF Button shall toggle between lights ON and OFF.
		2. Users may raise or lower levels by pressing arrow buttons from 10% to 100%. Dim settings to be retained until changed by users.
2. DAYLIT AREAS
	1. Automatic Control
		1. Time based: ON at 6:00am, OFF at 11:00pm, seven day/week. Confirm hours with User Agency.
		2. Lights OFF during Holidays.
		3. Blink-warn before lights turn OFF.
		4. Automatically dim lights down based on input from daylight sensor.
	2. Manual control via Low Voltage Control Station.
		1. ON/OFF Button shall toggle between lights ON and OFF.
		2. Users may raise or lower levels by pressing arrow buttons from 10% to 100%. Dim settings to be retained until changed by users.

POST START-UP TUNING

Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from initial occupancy. Provide a detailed report to the Architect/Owner of post start-up activity.

WARRANTY

Manufacturer shall provide a 5-year limited warranty on products within this installation, except where otherwise noted, and consisting of a one-for-one device replacement.

PRODUCT SUPPORT AND SERVICE

Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

The Contractor, through their supplier, shall provide training on the system operation for the owner as part of this contract. The training shall consist of two (2) four-hour sessions.

In addition, provide one (1) 4-hour programming/training session for exterior lighting “night” time settings. This training session shall be arranged after dusk in order to properly adjust dimming presets for all exterior lighting.

All training sessions shall be videotaped and turned over to the User Agency.

END OF SECTION