

Design Express Reference Manual

Developed by the Lighting Controls Academy, Design Express was created to help project teams specify the intent and performance of lighting control systems, with a baseline expressing compliance with Section C405 of the 2024 International Energy Conservation Code (IECC). The templates can be used to create and customize Control Intent Narratives (CIN) and Sequences of Operations (SOO) based on code-compliant templates. This *Reference Manual* explains how to navigate, interpret, and complete the templates so that they are usable for projects.

Purpose of the Tool

IES-LP-16 recommends developing a Control Intent Narrative (CIN), which expresses the design intent for a proposed lighting control system, and a Sequence of Operations (SOO), which expands the CIN to actionable settings. The LCA's CIN/SOO Tool combines these documents in a single matrix, organizing lighting control requirements in a standardized format. By documenting each requirement, the Tool serves as both a design aid and record of due diligence for commissioning.

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Disclaimer

This template is based on minimum requirements from the 2024 IECC and provided for educational purposes only. It is not a substitute for professional design, engineering, or consulting services. Users use and adapt at their own risk. Consult the Authority Having Jurisdiction (AHJ) for final code interpretation. The Lighting Controls Academy, NEMA, and their affiliates assume no liability for errors, omissions, or misuse.

How to Use the Tool

Each cell in the top rows of the matrix has helpful tips that will pop up when selected. Most of this information is redundant to what is stated in this guide but should help remind you how to utilize each column effectively.

FADE RATE SECONDS (ADJ)		COLOR CONTROL	
ON	OF	Time duration for fade in/out transitions.	NABLE /HITE

Example pop-up for Fade Rate

1. Review Applicable Requirements

Begin by reviewing the applicable energy codes and project requirements. While the matrix was pre-populated with the intention of meeting IECC 2024, not all requirements will apply to every project. It is the designer's responsibility to ensure that this document, whether pre-populated or not, is compliant with code and project requirements.

Also, read the pages labelled “Description” and “Disclaimer” included in the matrix file.

2024 IECC	Description	Disclaimer
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2. Determine Compliance Strategy

For each applicable requirement, note how it will be addressed in your project. For example, if a code section requires automatic shutoff, document whether this is achieved through an occupant sensor, time switch, or building automation system. Add or remove information from the various cells to match the strategies required.

3. Edit and Add Information

Edit any **[RED]** text, specifying exact information required. Modify or add language to cells that are incomplete or inaccurate. Add columns or space types to the matrix that are needed but not included in the template.

4. Remove Unused Information

Delete any columns, rows, or cells not being used to reduce the amount of information and space the matrix occupies on a sheet.

5. Provide Supporting Notes

Use the “Notes and References” column to explain details, cite drawing sheet numbers, or record coordination items with the electrical engineer, architect, or owner. This step is critical for demonstrating intent during plan review or inspection.

6. Finalize and Share

Once complete, the matrix can be submitted by pasting it onto the design drawings, attaching it to written specifications, or submitted alongside design documents. Keeping the matrix updated throughout design development and construction ensures accurate compliance tracking, while also confirming design intent.

Best Practices

- **Update Early and Often** – Begin filling out the matrix during schematic design and refine it as the project develops.
- **Coordinate Across Disciplines** – Many lighting control requirements involve architectural layouts, electrical design, and owner preferences. Use the matrix as a shared coordination tool.
- **Use Consistent Terminology** – Match your notes to the language in the code and project documents for clarity.
- **Leverage for Training** – The matrix is also an effective way to teach junior staff or new team members about energy code requirements.

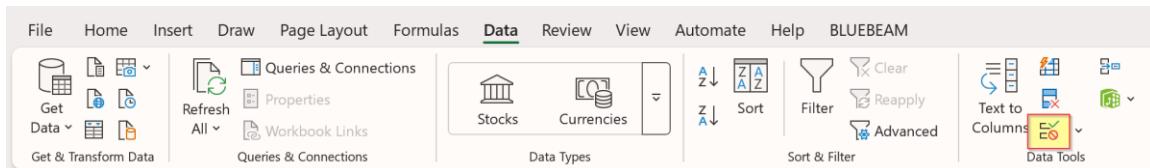
Software and Editing

Excel File

The Tool's matrix is designed to be used in a spreadsheet editing software (e.g. Microsoft Excel, Apple Numbers, Google Sheets). Originally created in Microsoft Excel, this document can be imported into other spreadsheet software for modification. The formatting of this document may change if used in a different software, so please keep in mind that features identified in this guide may not work as described.

Drop-down Lists

The drop-down lists in the matrix were added using Data Validation, found under the Data tab and in the Data Tools section. When the cell with the drop-down list is selected, clicking the  button will open the Data Validation tool for that list. Drop-down lists are defined in the Settings tab and can be edited by adding or removing items in the list (separated by commas). Alternately, they can be completely removed by clicking the "Clear All" button and then "OK." Each cell individually has its own list, so to modify the lists of multiple cells you will need to copy the new cell and paste it into the other cells you want to modify.



Data Validation
?
X

Settings
Input Message
Error Alert

Validation criteria

Allow:
List
Data:
between
Source:
occupant sensor, time-switch

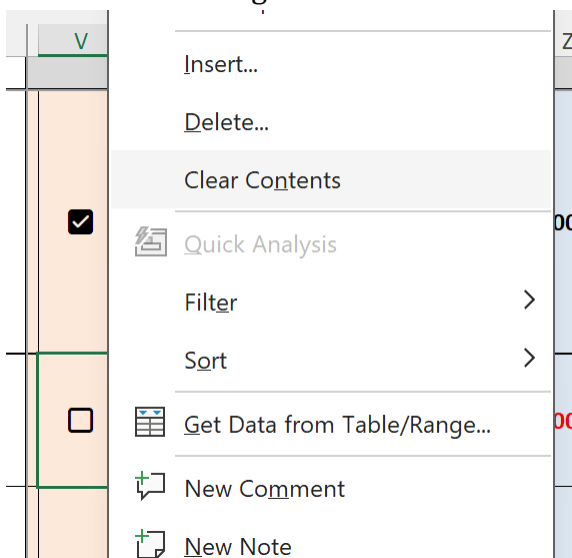
☒ Ignore blank
☒ In-cell dropdown

☐ Apply these changes to all other cells with the same settings

Clear All
OK
Cancel

Check Boxes

Some of the cells use check boxes. To remove the checkbox, make sure the box is unchecked then right-click the cell and select “Clear Contents.”



Layout

Header

At the top left of the matrix is the Header, which includes general information about the document and project. This can be removed or edited to meet the project's needs. Any text in **[RED]** is intended to be edited by the user and should not be left as-is.

Information in the Header includes:

- *Type of Matrix* - There are various types of matrices offered. Ensure you start with the one most relevant to your project type.
- *Sequence of Operations* - Title of the document. This can be added, edited, or removed.
- *Reference Specification Section/s* - Some projects will use written spec sections (e.g. 26 09 23). This is where the designer can identify pertinent written sections to the matrix.
- *Reference Drawing/s* - Some projects have additional documents related to the SOO. This is where the designer can identify pertinent drawings to the matrix.
- *Project Operating Schedule* - Some projects have a typical operating schedule. This is where the designer can identify the typical opening and closing times for the building. This is helpful for time-switch control so that if the building hours change, individual cells will not need to be edited if they specify "open" or "close."

OFFICE SOO, IECC 2024				
SEQUENCE OF OPERATIONS				
REFERENCE SPECIFICATION SECTION/S: [SECTION #]				
REFERENCE DRAWING/S: [DRAWING #]				
PROJECT OPERATING SCHEDULE: OPEN = [TIME] ; CLOSE = [TIME]				

Example of a Header

Space Types

The matrix is structured so that space types populate the first column, identifying which space has which provisions.

SPACE TYPE
Open Plan Office (≤600 sq ft zones)

Categories

The matrix is then separated into large categories, each with subsections that capture the essential details of lighting controls. Each category has its own color to identify it and its subsections.

PROJECT PARAMETERS

Project parameters concern how each space interacts with the larger building and what types of loads are typical for each space.

OCCUPANT SENSOR (SUPERSEDES TIME-SWITCH AND DAYLIGHT)

Occupant Sensor contains information specific to occupant sensors, programming, and setpoints. This section supersedes Time-Switch and Daylight Response (below), meaning that the programming takes priority when conflicting with these other two categories.

TIME-SWITCH (SUPERSEDES DAYLIGHT ONLY)

Time-Switch contains information specific to timed controls, programming, and setpoints. This section supersedes Daylight Response (below), meaning that the programming takes priority when conflicting with this category.

DAYLIGHT RESPONSE

Daylight Response contains information specific to daylight controls, programming, and setpoints.

MANUAL CONTROL (SUPERSEDES ALL)

Manual Control contains information specific to manual control devices, programming, and specialty lighting. This section supersedes the Occupant Sensor, Time-Switch, and Daylight Response categories (above), meaning the programming takes priority when it conflicts with these other three categories.

ADDITIONAL SETTINGS

Additional Settings contains information specific to features that extend beyond code compliance.

INTEGRATION

Integration contains information specific to integration with other systems or features.

NOTES AND REFERENCES

Notes and References is a section specific to any unique requirements, parameters, or references for each space type not included elsewhere in the document.

Sub-Sections

Each category has different sub-sections specific to that category, and they each have different requirements and types of information.

Project Parameters

PROJECT PARAMETERS		
CONNECTIVITY		LOAD TYPE(S)
STANDALONE / NETWORKED	WIRED / WIRELESS	CONTINUOUS DIMMING / NON-DIM

Standalone / Networked identifies whether a space type is not connected to adjacent spaces or the building (standalone) or is connected to an adjacent space or the building (networked). A dropdown list includes additional language to “see specifications” if this is defined elsewhere in the design documentation.

standalone
networked
see specifications

Wired / Wireless identifies whether the space will have devices that require a wired or wireless communication method. A dropdown list includes additional options to be more specific about the communication method being employed, and it also includes language to “see specifications” if this is defined elsewhere in the design documentation.

wired
wireless
DALI
DALI+
KNX
Bluetooth
Bluetooth NLC
see specifications

Load Type(s) is to identify what the common load types in the space will be. A dropdown list includes additional options to be more specific about the dimming

types being employed, and it also includes language to “see specifications” if this is defined elsewhere in the design documentation.

continuous dimming
non-dim
0-10V
phase cut dimming
DMX512
DALI2
see specifications

	PROJECT PARAMETERS		
	CONNECTIVITY		LOAD TYPE(S)
	STANDALONE / NETWORKED	WIRED / WIRELESS	CONTINUOUS DIMMING / NON-DIM
SPACE TYPE			
Open Plan Office (≤600 sq ft zones)	networked	wireless	continuous dimming

Example of a pre-filled Project Parameters category

Occupant Sensor

OCCUPANT SENSOR (SUPERSEDES TIME-SWITCH AND DAYLIGHT)							
TYPE	TURN ON		REDUCE / TURN OFF			NARRATIVE	
DUAL-TECH / PIR / ULTRASONIC	AUTO / MANUAL	LEVEL	TIMEOUT (ADJ)	AUTO / MANUAL	LEVEL	TURN ON	REDUCE / TURN OFF

Type is to identify the type of occupant sensor that will be used in the space type. A dropdown list includes additional options to be more specific about the sensor types being employed, and it also includes language to “see specifications” if this is defined elsewhere in the design documentation.

dual-tech
pir only
ultrasonic only
see specifications

Turn On identifies the occupant detection-based settings to turn lighting On.

- *Auto/Manual* defines whether the lighting will automatically turn On when occupancy is detected or only manually when activated by a switch.
- *Level* is the intensity of the fixture, zone, or preset being controlled when turned On.

Reduce / Turn Off identifies the occupant detection-based settings to reduce or turn lighting Off.

- *Time (Adj)* identifies the time in minutes before the occupant sensor turns Off the lighting in the space.
- *Auto/Manual* identifies whether the lighting automatically turns Off after the timeout period has expired or only when activated by a manual switch.
- *Level* is the intensity of the fixture, zone, or preset being controlled when turned Off.

Narrative is the plain language description of the sequence of operation for occupant sensor control, based on the parameters identified in the previous sub-sections. Ideally, On is defined separately from Off and specific setpoints or timeouts are referenced in the previous columns.

	OCCUPANT SENSOR (SUPERSEDES TIME-SWITCH AND DAYLIGHT)							
	TYPE	TURN ON		REDUCE / TURN OFF			NARRATIVE	
	DUAL-TECH / PIR / ULTRASONIC	AUTO / MANUAL	LEVEL	TIMEOUT (ADJ)	AUTO / MANUAL	LEVEL	TURN ON	REDUCE / TURN OFF
SPACE TYPE								
Open Plan Office (≤600 sq ft zones)	dual-tech	auto	100%	20 min	auto	0%	Upon occupancy within a control zone, lighting in that zone will automatically turn On to Level. In other unoccupied zones, lighting will remain at the Reduce/Turn Off Level.	Upon all occupants leaving a control zone, after Timeout, lighting in that zone will automatically go to Reduce/Turn Off.

Example of a pre-filled Occupant Sensor category

Time-Switch

TIME-SWITCH (SUPERSEDES DAYLIGHT ONLY)					
TURN ON		REDUCE / TURN OFF		NARRATIVE	
TIME (ADJ)	LEVEL	TIME (ADJ)	MANUAL OVERRIDE TIMEOUT (ADJ)	TURN ON	REDUCE / TURN OFF

Turn On identifies the time-based settings to turn the lighting On.

- *Time* refers to what time of day the lighting will turn On at. The Header information for Open can be used here, instead of an exact time.
- *Level* is the intensity of the fixture, zone, or preset being controlled when turned On.

Reduce / Turn Off identifies the time-based settings to reduce the lighting or turn it Off.

- *Time* refers to what time of day the lighting will turn On at. The Header information for Close can be used here, instead of an exact time.
- *Manual Override Timeout (Adj)* refers to how long lighting will remain On after a manual override has been activated.

Narrative is the plain language description of the sequence of operation for time-switch control, based on the parameters identified in the previous sub-sections. Ideally, On is defined separately from Off, and specific setpoints or timeouts are referenced in the previous columns.

	TIME-SWITCH (SUPERSEDES DAYLIGHT ONLY)					
	TURN ON		REDUCE / TURN OFF		NARRATIVE	
	TIME (ADJ)	LEVEL	TIME (ADJ)	MANUAL OVERRIDE TIMEOUT (ADJ)	TURN ON	REDUCE / TURN OFF
SPACE TYPE						
Open Plan Office (≤600 sq ft zones)	Open	100%	Close	2 hours	Turn lighting On at scheduled Time to Level.	Turn lighting Off at scheduled time and when space is unoccupied. Keep the lights on for Manual Override Timeout when activity by manual override controls.

Example of a pre-filled Time-Switch category

Daylight Response

DAYLIGHT RESPONSE	
DIMMING	
CONTINUOUS / STEP / NON-DIM	SETPOINT (ADJ)

Continuous / Step / Non-Dim refers to whether the dimming will operate without any noticeable steps (continuous), with noticeable steps (step), or switching On and Off without the ability to dim (non-dim).

Setpoint (Adj) refers to the adjustable light level setpoint to maintain on a task surface. This requires the designer to specify an appropriate footcandle measurement.

	DAYLIGHT RESPONSE	
	DIMMING	
	CONTINUOUS / STEP / NON-DIM	SETPOINT (ADJ)
SPACE TYPE		
Open Plan Office (≤600 sq ft zones)	continuous	40 fc

Example of a pre-filled Daylight Response category

Manual Control

MANUAL CONTROL (SUPERSEDES ALL)			
DEVICE		ADDITIONAL LIGHTING CONTROLS	
SCENES IN ADDITION TO ON/OFF	RAISE & LOWER	COLOR CONTROL	ON/OFF FOR SUPPLEMENTAL LIGHTING

Device identifies the manual controls such as scenes, raise/lower, color adjustment, and supplemental lighting On/Off.

- *Scenes in Addition to On/Off* are used if other scenes are requested. The designer should add the quantity of scenes and elaborate on their names, if possible. Lighting levels of each scene and zone within the scene should be represented in a scene schedule, not included in this matrix.
- *Raise & Lower* refers to the addition of a raise and lower function that allows the user to raise or lower the active scene.

Additional Lighting Controls identifies if other manual lighting controls are required, such as color control or separate manual control in the space for non-general lighting such as accent, display, decorative, supplemental, etc.

	MANUAL CONTROL (SUPERSEDES ALL)			
	DEVICE		ADDITIONAL LIGHTING CONTROLS	
	SCENES IN ADDITION TO ON/OFF	RAISE & LOWER	COLOR CONTROL	ON/OFF FOR SUPPLEMENTAL LIGHTING
SPACE TYPE				
Open Plan Office (≤600 sq ft zones)	3 Scenes Day Night Event	☒	Tunable white adjustment via raise/lower buttons to change color temperature from 2700K up to 4000K	☒

Example of a pre-filled Manual Control category

Additional Settings

ADDITIONAL SETTINGS								
SETPOINT (ADJ)		FADE RATE SECONDS (ADJ)			COLOR CONTROL		LIMITS	
ADR	EMERGENCY LIGHT LEVEL (UL924)	ON	OFF	ADR	COLOR TUNING	TUNABLE WHITE	HIGH-END TRIM (ADJ)	LOW-END TRIM (ADJ)

ADR refers to the Automated Demand Response setpoint, which is the level to which lighting will be adjusted during an ADR event.

Emergency Light Level (UL924) refers to the level of lighting that will be activated during an emergency event such as a power loss or a fire alarm.

Fade Rate Seconds (Adj) refers to the time duration for fade-in/-out transitions for each scene. More columns can be added for additional scenes.

Color Control defines additional parameters required for controlling the color of lighting that can change color.

Limits define the maximum allowed illumination level of the lighting when adjusted to maximum (High-End trim) or the minimum allowed illumination level of the lighting, excluding Off, when adjusted to minimum (Low-End trim) in the space.

	ADDITIONAL SETTINGS								
	SETPOINT (ADJ)		FADE RATE SECONDS (ADJ)			COLOR CONTROL		LIMITS	
	ADR	EMERGENCY LIGHT LEVEL (UL924)	ON	OFF	ADR	COLOR TUNING	TUNABLE WHITE	HIGH-END TRIM (ADJ)	LOW-END TRIM (ADJ)
SPACE TYPE									
Open Plan Office (≤600 sq ft zones)	80%	100%	5	5	10	none	Maintain color temperature while adjusting intensity of tunable white fixtures	90%	0%

Example pre-populated Additional Settings category

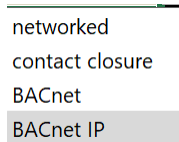
Integration

INTEGRATION				
AUTOMATIC RECEPTACLE CONTROL	COMMUNICATION			
OCCUPANT SENSOR / TIME- SWITCH	BUILDING MANAGEMENT (BMS)	WINDOW TREATMENT	FIRE ALARM	AUDIO/VIDEO

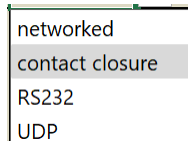
Please note that while helpful information has been provided for the Integration category, this section alone is insufficient for a complete specification of the integration between the systems. Additional documentation should be provided alongside the matrix to clarify the programming requirements of the integration.

Automatic Receptacle Control defines how plug loads are controlled. Common applications include Occupant Sensor and Time-Switch, which are provided in a drop-down list.

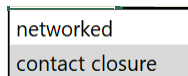
Building Management (BMS) defines how communication will be achieved between the lighting control system and the BMS. Common applications have been included in a drop-down list.



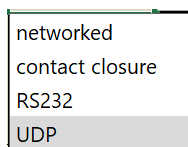
Window Treatment Integration defines how communication will be achieved between the lighting control system and shades or blinds. Common applications have been included in a drop-down list.



Fire Alarm defines how communication will be achieved between the lighting control system and the fire alarm system. Common applications have been included in a drop-down list.



Audio/Video defines how communication will be achieved between the lighting control system and the audio/video system. Common applications have been included in a drop-down list.



	INTEGRATION				
	AUTOMATIC RECEPTACLE CONTROL	COMMUNICATION			
	OCCUPANT SENSOR / TIME- SWITCH	BUILDING MANAGEMENT (BMS)	WINDOW TREATMENT	FIRE ALARM	AUDIO/VIDEO
SPACE TYPE					
Open Plan Office (≤600 sq ft zones)	occupant sensor	BACnet IP	contact closure	contact closure	UDP

Example pre-populated Integration Category

Conclusion

Design Express was created to facilitate better communication and documentation of the lighting control system design and intent. By using this tool, designers should have a great starting point for their lighting controls design. While this template already includes many good parameters, designers are free to edit and revise to support their own workflow when designing lighting control systems.