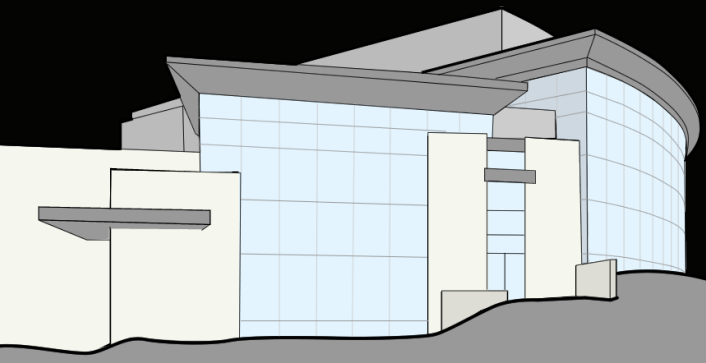
Wentz Concert Hall and Fine Arts Center

North Central College
Naperville, Illinois

Advisors: Dr. R. Mistrick, Prof. T. Dannerth

AE 472 / 897G - Final Report

Will Lesieutre



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and Fine Arts Center

North Central College, Naperville IL

Will Lesieutre - Lighting/Electrical

http://www.engr.psu.edu/ae/thesis/portfolios/2012/WWL5031

Architecture

Total size: 57,000 ft^2
3 stories above grade / 1 partially below grade
Precast concrete and curtain wall exterior, with aluminum cornice
Centrally featured lobby flanked by two entrances
Concert hall (13,000 ft^2) seats 605
Black box theater (2,500 ft^2) designed for flexible layout
Art gallery (1,400 ft^2) for showcasing both student and professional work
Design, bid, build: Constructed July 2006 - September 2008
Total cost: $30.6 million

Lighting and Electrical

Power supplied by the Naperville Department of Public Utilities
Utility owned main transformer, pad mounted on northwest of site
Emergency power by 200kW/w50 KVA, 480Y/277 3Φ diesel generator
Power conditioning used for audiovisual loads
Primarily incandescent lighting in theater area and fluorescent in offices

Structural

Steel structural system with connections to exterior embedded in precast panels by manufacturer
Maximum design loads of 30 PSF SDL and 125 PSF LL
Due to the unusually shaped spaces, there is no standard bay design
Column sizes range from W10x54 to W14x283
Beam sizes range from W10x19 to W24x104

Mechanical

Floor plenum system designed for silent air conditioning in concert hall
Ceiling diffusers and air returns used in the majority of other spaces
System is supplied by 8 RTUs and 5 air cooled condensing units
Heaters include both electric baseboards and cabinet units

Project Team

Owner
North Central College
Architect
Loebl Schlossman & Hackl
Landscape Architect
Hitchcock Design Group
Structural Engineer
Campbell & Associates
MEP and Fire Protection
WMA Consulting Engineers
Theater Planner
Schuler Shook
Lighting Designer
Schuler Shook
Acoustics & Audio Consultant
Talaske
General Contractor
Gilbane
Construction Manager
Gilbane

Executive Summary

The Wentz Concert Hall and Fine Arts Center is an exhibitional and educational facility constructed at North Central College in 2008. Located in Naperville, Illinois, the building is approximately 30 miles west of Chicago. It was designed to meet the needs of the college's educational programs, as well as to promote the arts in the wider Naperville community. This report will examine several aspects of the building and propose alternative design options.

The main focus of this study is a lighting and power redesign of four parts of the building: the main lobby, the concert hall, the music rehearsal room, and the façade. For the concert hall, it also includes studies of the space's architectural and acoustical aspects. For the lighting designs, an overarching theme is developed to help unify the spaces with each other and the overall architectural style. In the main lobby, I've performed a computer rendering using Radiance techniques learned in Flux Transfer Theory. The designs are performed with a focus on energy efficiency in what is traditionally an energy intensive building type.

Additionally, this report considers the alternative of a reduced number of transformers to serve its 120/208 V electrical loads, and the addition of a roof mounted solar array. A short circuit study of the electrical system is included, as is a protective device coordination study for a portion of the building.

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Project Background

The Wentz Concert Hall and Fine Arts Center is owned and operated by North Central College, in Naperville, Illinois. It is the college's second fine arts facility, the first being Pfeiffer Hall, with 1,050 seats. The Wentz, completed in 2008, seeks to provide a smaller concert hall, seating 605, with greatly improved acoustics.

In addition to the concert hall, the facility has Naperville's first art gallery, as well as a black box theater. It also includes music practice rooms, offices, a computer lab, and a large rehearsal space.

Existing Building Information

Project Summary

- Building Name: Wentz Concert Hall and Fine Arts Center
- Location: North Central College, Naperville Illinois
- Function: Concert hall, art gallery, education
- Size: 57,000 ft^2
- Levels Above Grade: 2 (and catwalks)
- Total Levels : 3

Design Team

- Architect: Loebl Schlossman and Hackl
- Landscape Architect: Hitchcock Design Group
- Structural Engineer: Campbell and Associates
- MEP and Fire Protection: WMA Consulting Engineers
- Theater Planner: Schuler Shook
- Lighting Designer: Schuler Shook
- Acoustics and Audio Consultant: Talaske
- General Contractor: Gilbane
- Construction Manager: Gilbane

Lighting

Being a fine arts center, lighting systems are a critical aspect of the experience. The font of house areas, including the lobby, the art gallery, and the concert hall, are lit primarily by incandescent and halogen lighting. These provide a smooth spectrum of light, giving good and consistent color rendition through all of the spaces.

Restrooms, classrooms, offices, storage areas, the computer lab, and all of the other spaces that aren't likely to be a part of a visitor's experience to the fine arts center. In these spaces, lamp life and source efficacy outweigh the concerns in more public areas, and predominantly fluorescent lighting is used.

Fluorescent lamp types include 32W T8s, 31W U shaped T8s, 21W T5s, and 26W quad tube CFLs. A high pressure sodium lamp is used on the exterior at the loading dock.

Because of the nature of the facility, lighting controls are more complicated than what you'd see in a typical project. Two dimmer racks in the dimmer room are used by the concert hall lighting control system. Lighting in the public areas can be controlled by preset wall panels, with optional lockable covers. Smaller spaces, such as restrooms, offices, practice rooms, and storage, have occupancy sensors.

Electrical

The power distribution system is laid out radially, a single point of entrance branching out through a small network panels before reaching the branch circuits. The utility serves the building at 480Y/120 volts through a pad mounted transformer outside the electrical room. From the main switchboard in the electrical room, large equipment (primarily HVAC) is served directly at 480 volts. Smaller loads (lighting, receptacles, and AV) are served through five smaller transformers throughout the building. All lighting loads are operated at 120V; there are no lights directly on the 480/277V system.

While the bulk of the electrical equipment is in the main electrical room and its neighboring emergency electrical room, the dimmer room on the first floor holds three of the five 120/277V transformers, as well as the two dimmer racks and several branch panelboards. One of these transformers (T1-DCTP-1) is an isolation transformer, serves the clean technical power system. Clean technical power is used for audio processing racks, amplifier racks, the control booth, and orange CTP receptacles throughout the concert hall's back of house spaces. The CTP loads are connected to an isolated ground. An additional three dimmer racks serve the black box theater's lighting. The remainder of the panelboards are housed in small electrical closets.

Mechanical

The building has eight RTUs, six constant air volume and two variable air volume. The CAV units serve the concert hall, stage, black box theater, main lobby, and black box lobby. The VAV units serve the first floor and the lower level. Ventilation in the concert hall is provided through vaults under the floor, divided by CMU walls to direct airflow and reduce noise. The ductwork beneath the concert hall is plastic coated and buried in a concrete enclosure. As a result, the concert hall is almost completely silent.

Electric cabinet heaters are used in the vestibules by the main entrances. A number of spaces, particularly offices and theater support along the exterior walls, also include electric baseboard heaters.

Structural

The structural system is a combination of structural steel and precast concrete. The load bearing precast wall runs around the entire concert hall area, up through the lower roof level. The wall behind the stage continues to the upper roof level. A smaller number of walls, directly adjacent to the concert hall, are load bearing CMU.

There isn't an overall column and beam grid that extends through the whole building; instead, it reacts to the shapes of the spaces. This is especially in the concert hall, where beams wrap around the edge of

the balcony, and are cantilevered out from the lower columns. The office corridor's longest span is supported by a W18x75, while shorter spans are as small as W10x33.

Fire Protection

The fire protection system is supplied by water entering the plumbing room on the north end of the building. The plumbing room contains the fire pump, as well as the fire pump control center and transfer switch to allow it to run on emergency power from the generator. The vast majority of sprinklerheads are recessed to preserve the architecturally clean spaces. The exception to this is areas without appropriately finished ceilings, including the black box theater.

Transportation

There are two hydraulic elevators, one in the lobby for handicap access between the first floor and balcony level, and a second on the office corridor between the lower level and first floor. These floors are also accessible by stairs, with the main public stairs being between the lower black box theater lobby and main lobby, and at each end of the main lobby between the first floor and balcony level. There is also a stairway at each end of the office corridor, and back of house stairways into the balcony level reverb chambers, for access to the choral balcony. The catwalk level can be reached by a spiral staircase in the north reverb chamber.

Audiovisual

Most of the facility is wired to the audiovisual system, at least to some degree. The back of house rooms (office, etc) on the lower level have ceiling speakers, as do the art gallery, main lobby restrooms, lobby balcony corridor, and others. The first floor of the lobby uses wall mounted speakers, due to the high ceiling.

The rehearsal room is outfitted with loudspeakers, a video projector, and a plug box for recording microphones. The concert hall includes several loudspeakers, and has plugboxes throughout the stage and catwalks with connections for microphones, tie lines, intercoms, speakers, video, data, and fiber. The main audio control center is at the back of the concert hall, on the first floor under the balcony.

Lighting Redesign

Main Lobby

Space description

Important both as a gathering space and for providing access to the concert hall, the main lobby is long and relatively narrow. On one side, it has a high curtain wall, and on the other a wood paneled wall and balcony level corridor.

The north end of the lobby, by the main entrance, has a lower ceiling and contains the box office and coat check. Patrons enter through this area, and proceed through the main lobby space to enter the concert hall either on the first floor, or at the balcony level by means of stairs at each end. The southern end stairs wind around an elevator, while the northern end's instead house a small seating area.

Materials

Type	**Reflectance/transmittance (approx)**
Carpet	20%
Wood	15%
Paint – Columns	80%
Paint – Ceiling	60%
Paint – Upper Wall	40%
Glazing	50%

Design Criteria

The lobby serves two main purposes: it is a main circulation path between the main entry, black box theater lobby, and concert hall, as well as a gathering area before performances and during intermissions. Lighting levels must be designed to suit both of these uses.

Illuminance (High priority)

A prefunction area outside a concert hall may adjust its lighting levels during events to allow easier transitions between spaces. Since the lobby here is also used as a central circulation space, lighting levels during events may need to be maintained at higher than the IES recommendation.

- Horizontal (average at floor)
    - 5 fc during production
    - 15 fc pre/post production and during intermissions
    - Avg:Min = 3:1
- Vertical (average at 5 ft. AFF)
    - 3 fc during production
    - 7.5 fc pre/post production and during intermissions
    - Avg:Min = 3:1

Glare (High priority)

Since the lobby is used as a transition area from the concert hall, direct glare from light sources should be avoided. Exiting the concert hall during a performance into the brighter lobby will require some adaptation, and additional glare could be blinding.

Color Rendition

Because of the rich materials used in the lobby, color rendering will be particularly important for lights illuminating the wooden walls.

Color Temperature

As discussed above, warmer color temperatures are preferred in the concert hall. As this space is directly adjacent, it will be desirable to use the same color temperature here.

Sound

While the vestibule between the lobby and concert hall helps to block light and sound, source sound emission should still be considered. In this case, quiet noises will not be problematic, but the buzz emitted by many magnetic ballasts would be undesirable.

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Power Allowance (Mandatory)

Lobby for performing arts theatre

- Lighting Power Density: 2.00 W/ft^2

- An additional allowance of up to 1.0 W/ft^2 is available for decorative lighting

Automatic Shutoff (Mandatory)

An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

Display/Accent Lighting (Mandatory)

Display or accent lighting must be controlled separately from general lighting.

Automatic Daylighting Controls for Primary Sidelighted Areas (Mandatory)

In sidelighted spaces over 250 ft^2, lamps for general lighting must be separately controlled by a multilevel photocontrol dimming system.

Design Overview

Traditionally, the lobby of a concert hall or theater is lit with incandescent fixtures. As electricity prices rise and energy code become more strict, this strategy may become inappropriate. For the Wentz Concert Hall's lobby, I've designed it to reduce energy use by transitioning to CFL fixtures, which trade the optical control and color rendition of incandescent reflector lamps for much reduced energy use.

I've also modified the *Wentz Concert Hall* signage to be edge lit with LEDs instead of using spotlight to illuminate the entire wall. This lower amount of light and strong contrasts from the edge lighting fit the overall scheme I've used for the new lighting designs.

Figure 1: Main Lobby – First Floor North Lighting Plan

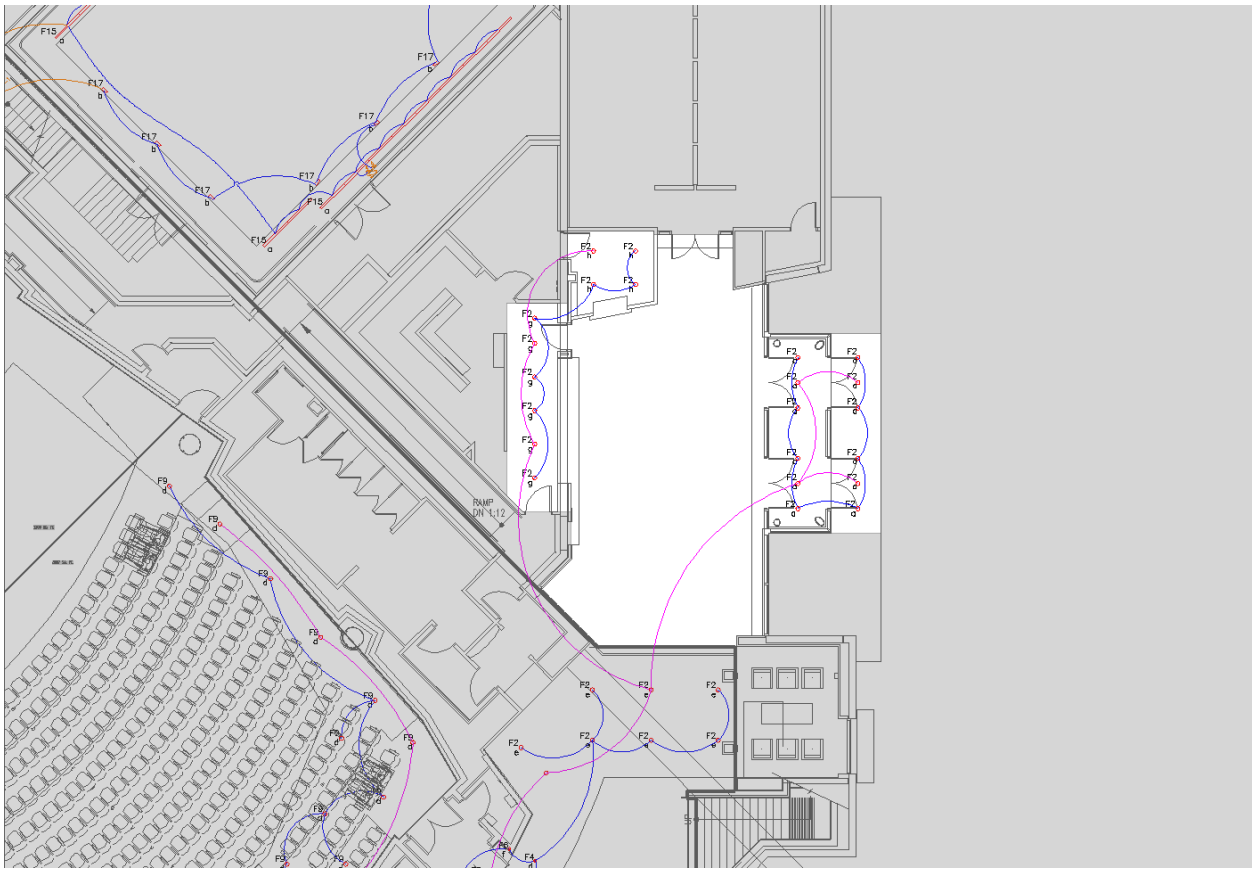


Figure 2: Main Lobby – First Floor South Lighting Plan

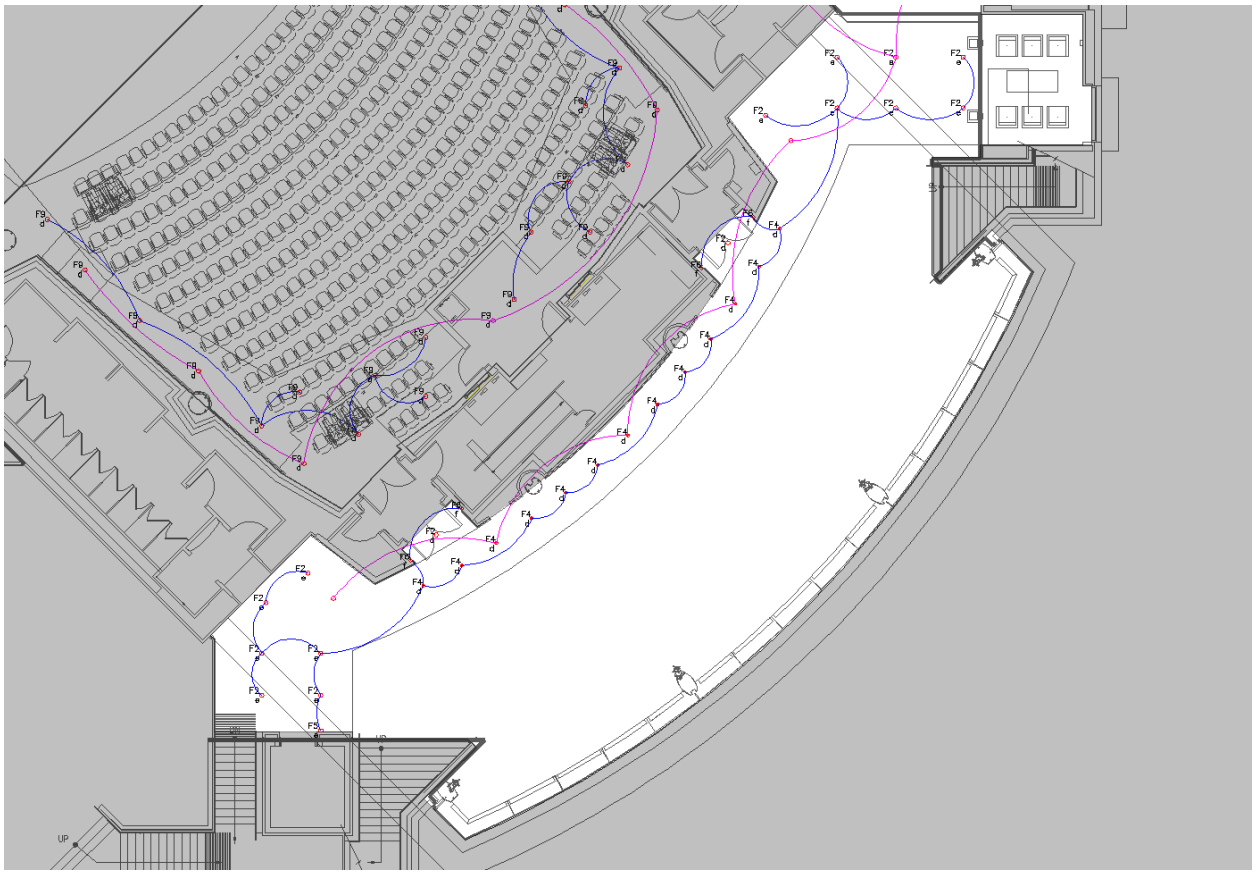


Figure 3: Main Lobby – Balcony Level North Lighting Plan

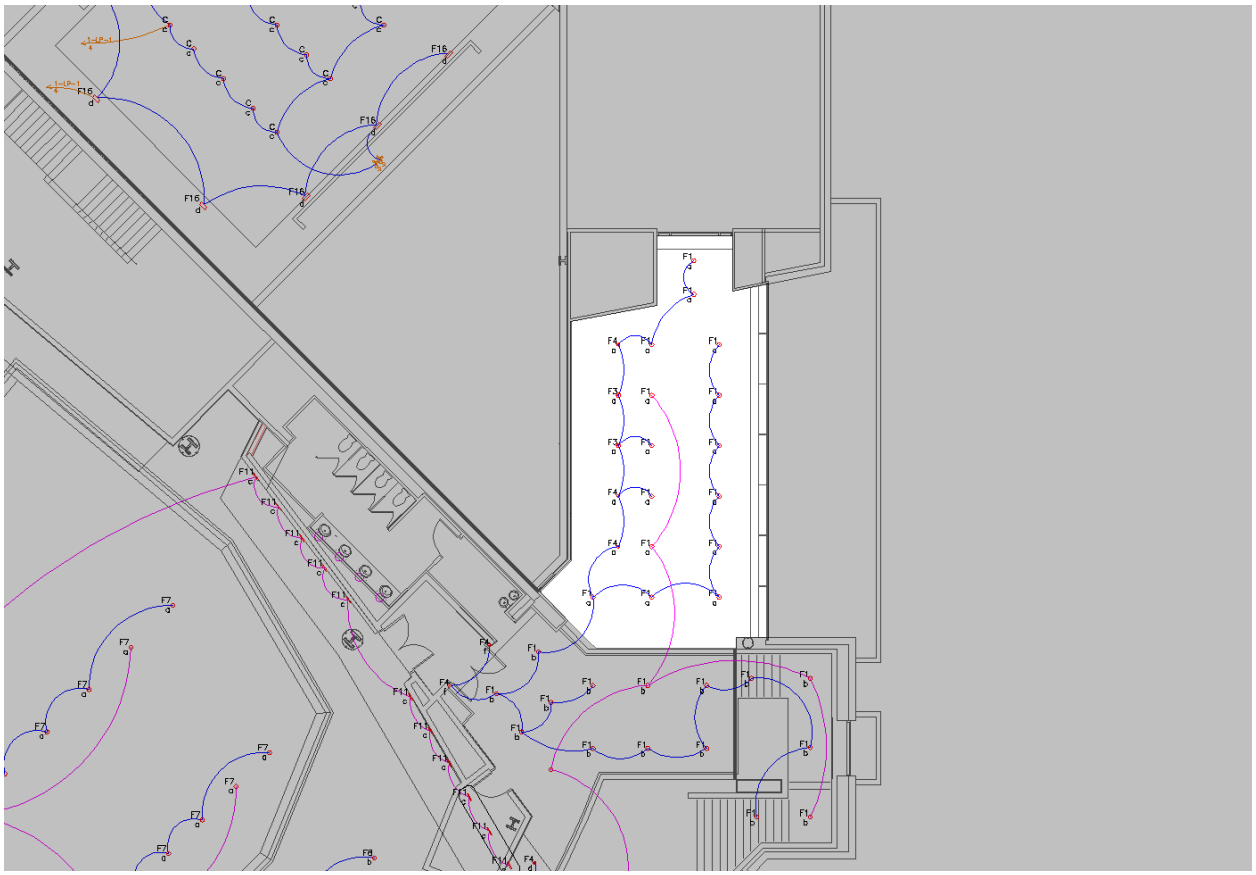
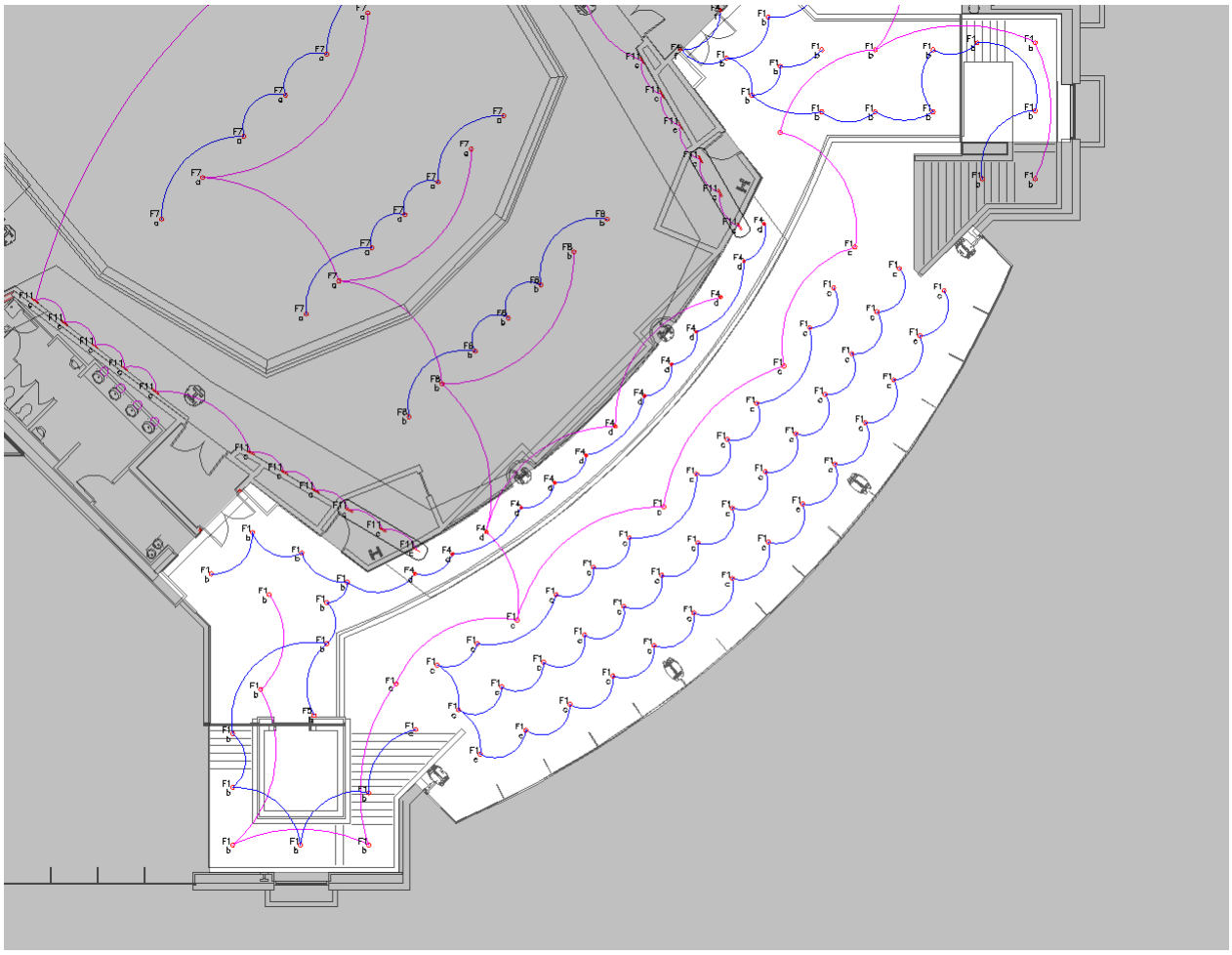


Figure 4: Main Lobby – Balcony Level South Lighting Plan



Lamp/Luminaire Selection

Most of the space uses a standard CFL downlight in various wattages to account for the high and low ceilings. The wood walls are washed using a CFL wall washer, which have a color rendering index of 82. While this won't be as ideal for the warm materials, it's consistent with the rest of the space, and is much more efficient than incandescent alternatives.

Two wall sconces are used to mark the elevator and provide a visual connection between the floors. The seating area under the north stairs will be lit with a floor and table lamp to create a more appropriate scale.

Fixture Schedule

Type	Description	Manufacturer	Catalog Number	Lamp(s)	Input Watts
F1	Unlensed 42W compact fluorescent downlight with 6" nominal aperture, white trim, and wheat reflector	Kurt Versen	P927DM-120-W-WT	(1) F42TBX/827/A/ECO by GE	43.2
F2	Unlensed 26W compact fluorescent downlight with 6" nominal aperture, white trim, and wheat reflector	Kurt Versen	P626DM-120-W-WT	(1) F26DBX/827/ECO4P by GE	26.4
F3	Unlensed 42W compact fluorescent wall washer with 6" nominal aperture, white trim, and wheat reflector	Kurt Versen	P953DM-120-W-WT	(1) F42TBX/827/A/ECO by GE	43.2
F4	Unlensed 18W compact fluorescent wall washer with 4" nominal aperture, white trim, and wheat reflector	Kurt Versen	P919DM-120-W-WT	(1) F18TBX/827/A/ECO by GE	21.3
F5	Shielded 3' T5 wall sconce with diffuse white acrylic panel	Lightolier	48022ALU-21W-120	(1) F21W/T5/830/ECO by GE	25
F6	Continuous diffuse LED strip light with dimmable driver	Birchwood Lighting	JAKE-325-TR-1-HF2N-H-30-CRx-120-CU	54 3000K LEDs per 10" section	5 W/ft

Light Loss Factors

Type F1

- LLD = 2690/3200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.76

Type F2

- LLD = 1530/1800 = 0.85
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.77

Type F3

- LLD = 2690/3200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0

- Total = 0.76

Type F4

- LLD = 1010/1200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.77

Type F5

- LLD = 1930/2100 = 0.92
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.83

Type F6

- LLD = 0.8 (estimated)
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- Total = 0.73

Control System

Lobby control zones:

a) Entry lobby downlights and wall washers
b) Balcony level downlights
c) Main lobby downlights
d) First floor and balcony wall washers
e) First floor downlights
f) Concert hall entry LEDs
g) Coat check
h) Box office

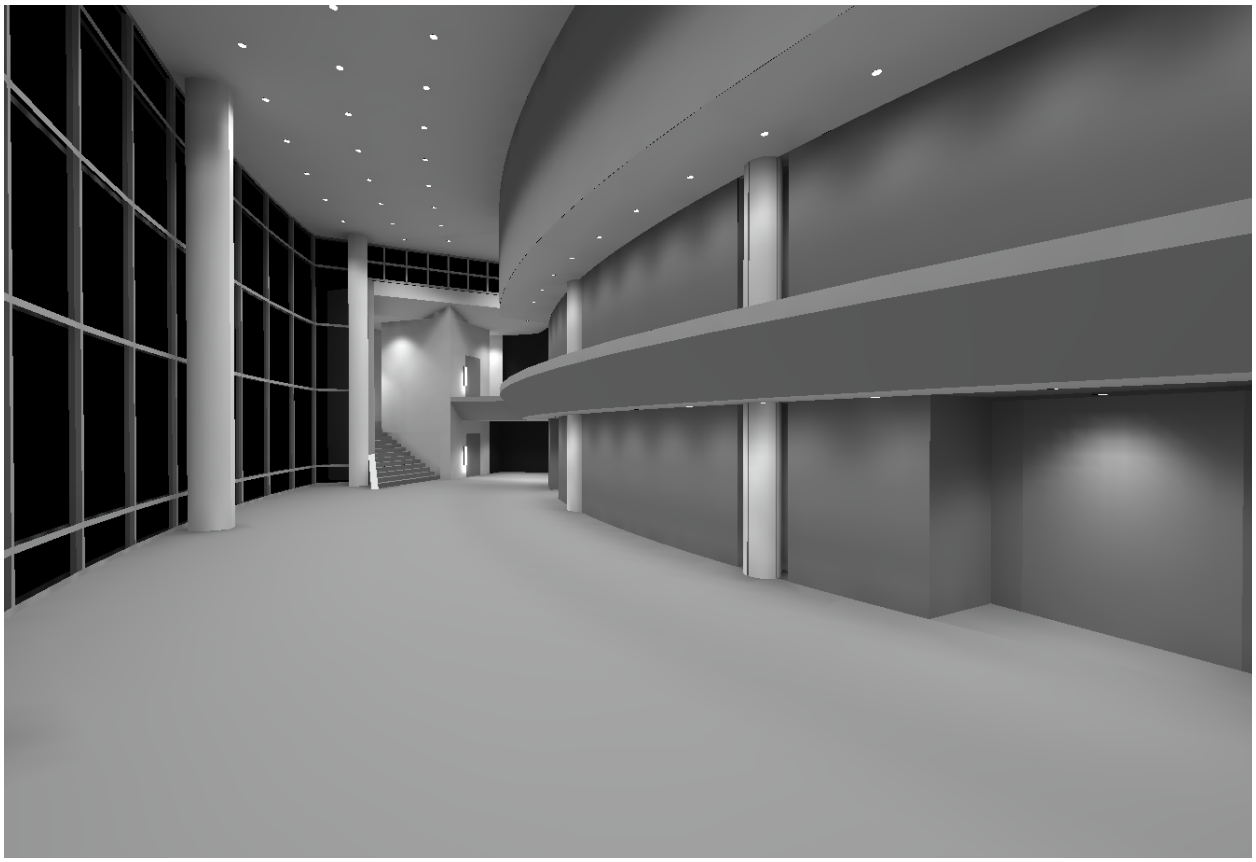
Controlled by Grafik Eye 4000. See electrical section for details of control system.

Design Performance

Figure 5: Main Lobby Rendering (north)

The large dark area in this rendering represents a transition to the art gallery, which is out of the scope of this project. As you can see, the downlights illuminate the space evenly, and wall washers highlight the wood wall on the left, as well as providing additional vertical illuminance at the coat check and box office counters.

Figure 6: Main Lobby Rendering (south)

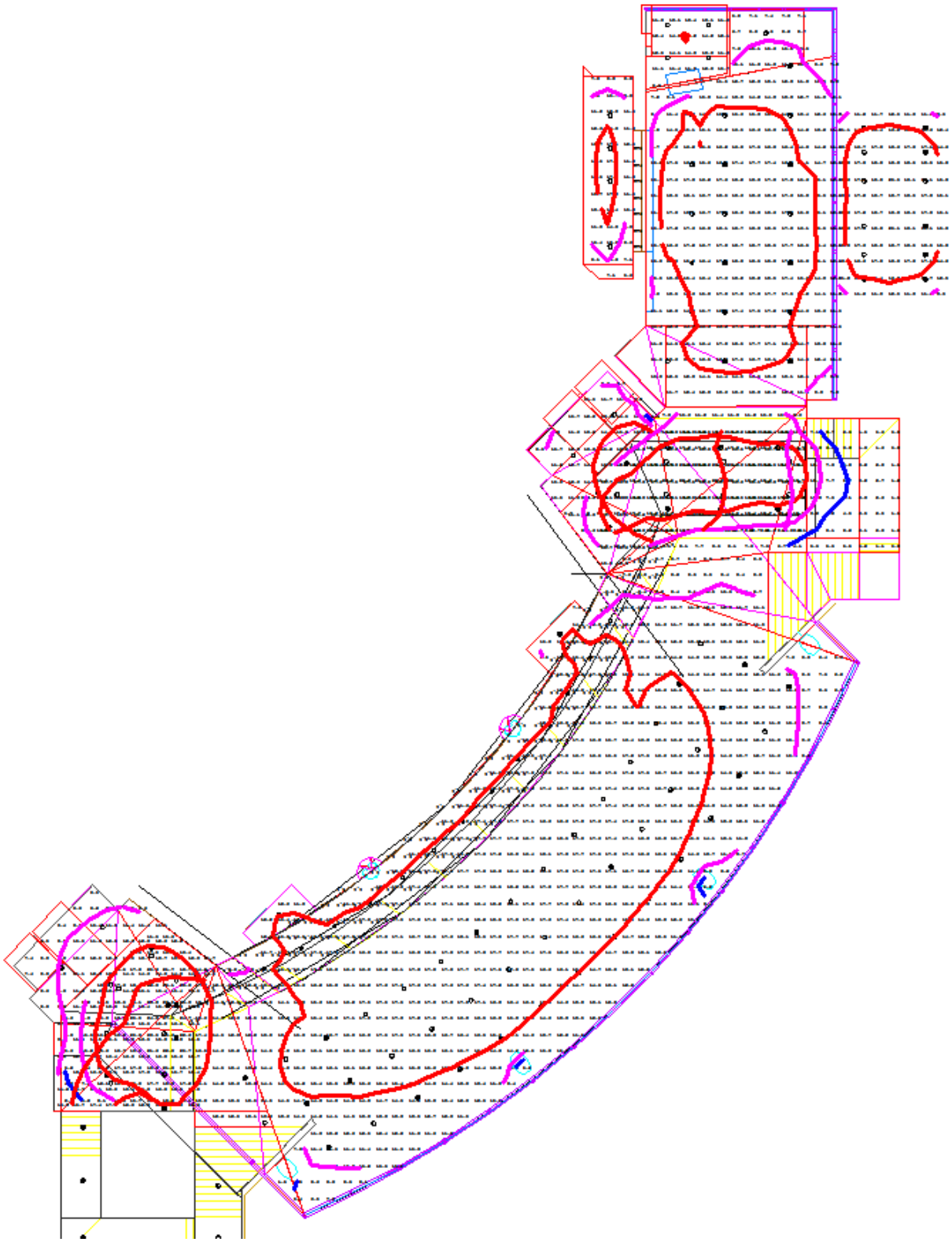


This rendering shows the larger portion of the main lobby, with one of the doors to the concert hall on the right hand side. Not illustrated are the linear seemless LED fixtures that are mounted in an arch around the door, and used to draw attention to the circulation destination. This fixture also helps tie the design of the lobby into the linear fixtures used prominently in the concert hall.

Also not included in the calculation is the large Wentz Concert Hall lettering on the upper right wall. This signage is to be lit using a flexible LED edge lighting strip, providing it with higher contrast, and avoiding shadows that would be cast by spotlights. This signage is visible from the outside, through the large curtain wall.

Circulation destinations are clearly visible: the scallop and LED arch mark the concert hall doors, a bright downlight illuminates the wall over the stairs, and a tall linear sconce visually connects the two elevator doors.

Figure 7: Main Lobby Isoilluminance Lines



Red: 15 fc Magenta: 10 fc Blue: 5 fc

The blue contour line under the north stairway is a seating area which will be illuminated by a table and floor lamp. These are not included in the calculation. All other areas are satisfactory.

Lighting Power Density

Area	7,167 ft^2
Max Power Density	2 W/ft^2
Lighting power allowance	14.334 kW
Decorative allowance	7.167 kW

Type	**Quantity**	**Watts/Fixture**	**Type total**	
F1	83	43.2	3585.6 W	
F2	40	26.4	1056 W	
F3	2	43.2	86.4 W	
F4	29	21.3	617.7 W	
F5	2	25	50 W	
F6	72.666 ft	5 W/ft	363.33 W	(Decorative)

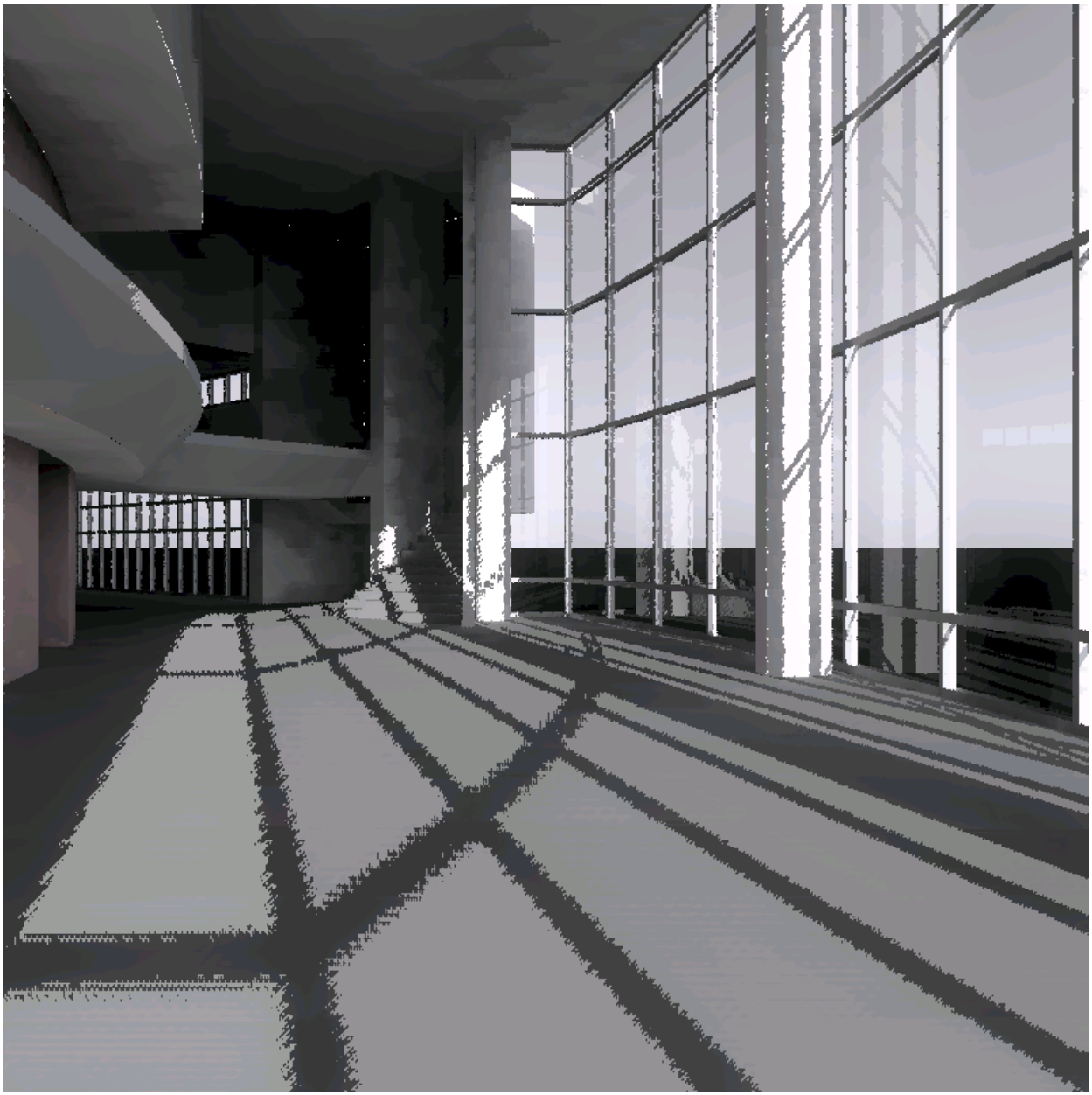
Total lighting power	5.3957 kW
Space power allowance	14.334 kW
Total decorative power	0.363 kW
Space decorative allowance	7.167 kW

Lobby meets ASHRAE 90.1 2010's lighting power density requirements for a building lobby.

Radiance Rendering (MAE Breadth)

Based on the discussions of Radiance from Flux Transfer Theory and Daylighting, I've produced a rendering of the main lobby.

Figure 8: Lobby Radiance Rendering



Concert Hall

Space description

The Wentz Concert Hall, named after Dr. Myron Wentz, is the focal point of the Wentz Concert Hall and Fine Arts Center, and the space's design plainly shows this. Spanning the first floor and balcony level, warm finishes and upholstery make the space intimate and comfortable, despite its relatively large size.

The balcony level protrudes only slightly over the back of the first floor seating, and the faceted edge of the balcony is mirrored at the perimeter below the ceiling, giving both levels a similar scale despite the wide open spaces. Curtains on the balcony level walls and behind the stage on the first floor add texture to the space, and allow for the concert hall's acoustics to be adjusted.

The walls on the first floor are finished with a textured wood panel, consisting of narrow horizontal strips, in sections that protrude various distances from the wall. The strip element is carried through the rest of the concert hall with an element on the balcony, and another series of them on the upper side walls.

Materials

Type	Reflectance (approximate)
Carpet	30%
Wood	30%
Curtains	50%
Paint – Walls	60%
Paint – Ceiling	80%
Paint – Balcony	40%

Design Criteria

Illuminance

Audience seating

The main tasks performed in the audience area are wayfinding, facial recognition, and reading programs. Lighting must be sufficient for patrons to easily and safely find their seats, and must smoothly dim to the low levels required during a performance.

- Horizontal (average at floor)
    - 0.2 fc during production
    - 10 fc pre/post production and during intermissions
    - Avg:Min = 2:1
- Vertical (average at 5 ft. AFF)
    - 0.1 fc during production
    - 3 fc pre/post production and during intermissions
    - Avg:Min = 2:1

Aisles

Used for circulation by large crowds, the aisle lighting is critical for ensuring that patrons can quickly and safely navigate the concert hall. As with other lighting in the concert hall, it must also be smoothly dimmable to very low levels.

- Horizontal (average at floor)
    - 0.2 fc during production
    - 10 fc pre/post show and during intermissions
    - Avg:Min = 5:1
- Vertical (average at 5 ft. AFF)
    - 0.1 fc during production
    - 3 fc pre/post production and during intermissions
    - Avg:Min = 2:1

Control Booths

Control of light and sound is crucial to the success of an event, but it must be done without lighting that would be distracting to the audience. To this end, control panels are frequently backlit to alleviate the need for supplemental lighting.

- Horizontal (average at floor)
    - 0.2 fc during production
    - 20 fc pre/post production and during intermissions
    - Avg:Min = 2:1

Isolation (High priority)

Given the importance of a dark environment in the concert hall during productions, care must be taken to prevent light from external sources into the space.

Glare (High priority)

Direct glare from light sources should be avoided, since it could interfere with adaptation to the low light levels. Bright light sources detract attention from the intended focus on the stage.

Color Rendition

Good color rendering is important for stage lighting, and using sources with similar color rendering throughout the space will maintain uniform appearance of room finishes.

Color Temperature

Warm materials are used throughout the space, and a similarly warm color temperature should be selected for light sources.

Sound

As the concert hall is an acoustically sensitive environment, sources should be selected to avoid background noise generation.

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Power Allowance (Mandatory)

Permanent audience / seating area for performing arts theatre

- Lighting Power Density: 2.43 W/ft^2
- Theatrical lighting equipment is exempt from this allowance, the full amount is available for architectural lighting purposes
- An additional allowance of up to 1.0 W/ft^2 is available for decorative lighting

Automatic Shutoff (Mandatory)

An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

Display/Accent Lighting (Mandatory)

Display or accent lighting must be controlled separately from general lighting.

Design Overview

The concert hall's architecture is strongly linear, with horizontal elements throughout. These include the wood paneling on the walls, wooden strips across the reverberation chamber's screen, matching strips on the balcony level walls, and a number of architectural shelves designed to match the angular profile of the balcony level's edge.

My lighting solution seeks to reduce energy usage by using glowing linear fixtures to accent these features, rather than illuminating the walls with energy-intensive incandescent wall washers or grazers. To this end, I've selected two LED fixtures: a 3.5" continuous linear fixture with a diffuse lens, and an architectural neon replacement that can be easily surface mounted for smaller accents. These two fixtures are integrated into horizontal elements, defining the space while directing audience attention forward to the stage, where walls are brightly lit.

Figure 9: Concert Hall – First Floor Lighting Plan

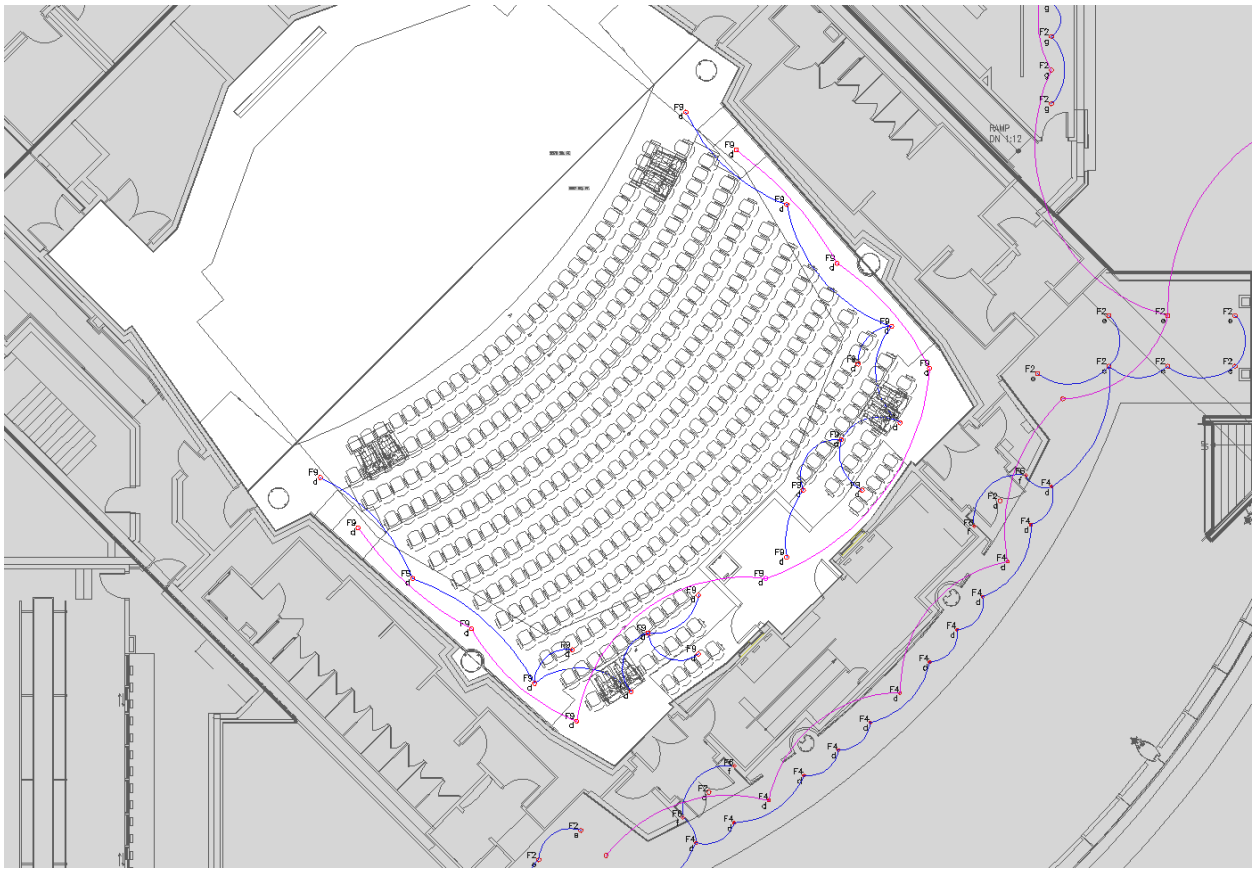


Figure 10: Concert Hall – Balcony Level Lighting Plan

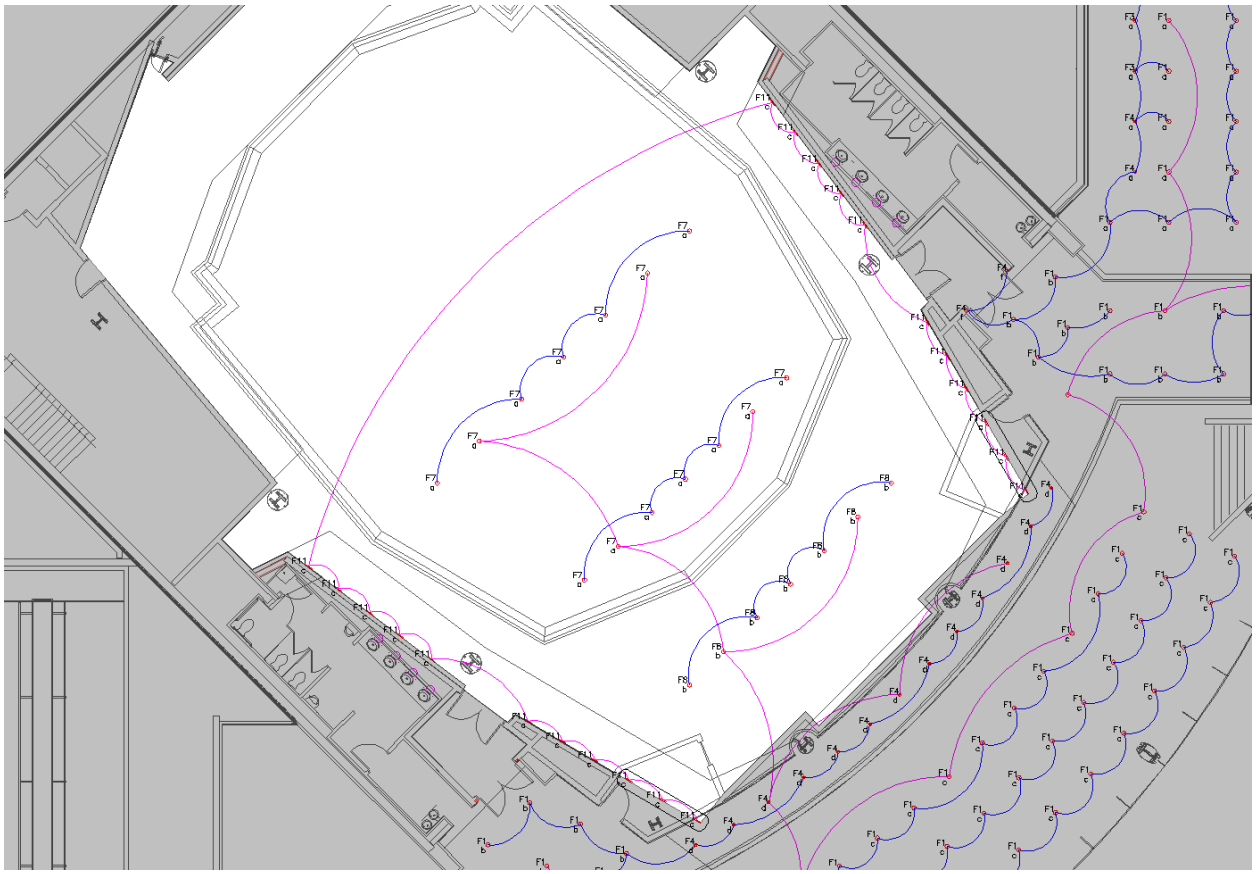
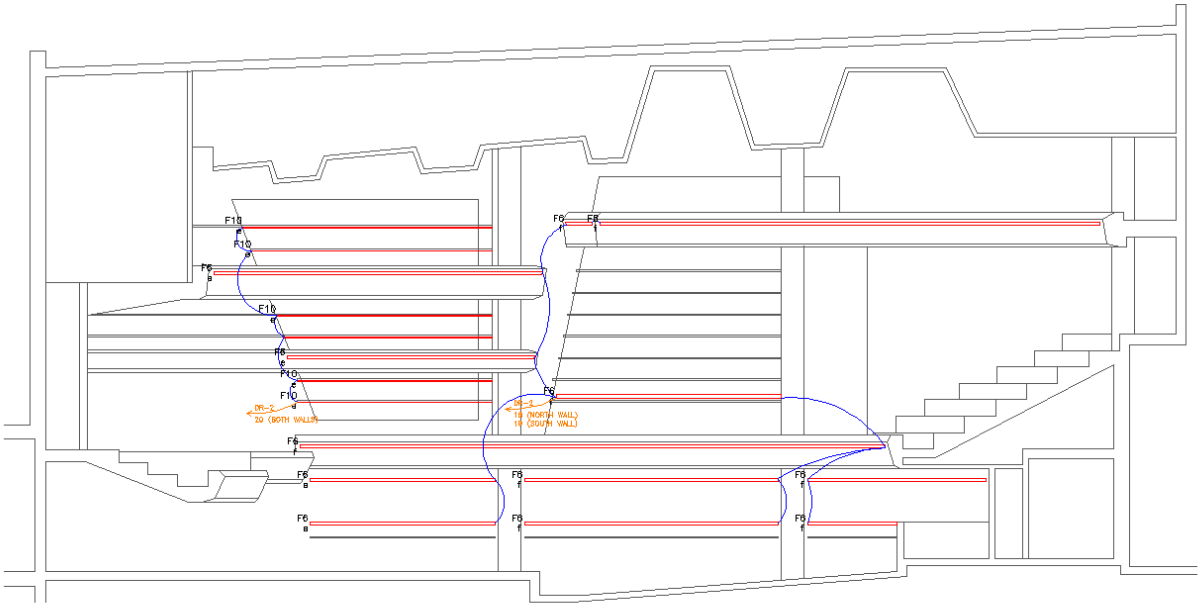


Figure 11: Concert Hall – Wall Lighting Plan



Lamp/Luminaire Selection

The primary source of light in the space is halogen incandescent downlights with PAR38 and PAR30 lamps in the upper ceiling and below the balcony. These are selected to provide light with the same color temperature and spectral distribution as the stage lights so that the room's materials will be rendered uniformly throughout.

Additional lights are LED based, including steplights for the balcony aisle where the catwalks above wouldn't allow for maintenance access to downlights. A 3.5" linear strip with a continuous diffuse lens is used as a primary architectural accent light, with smaller accents provided by an LED neon-replacement fixture. This allows for easier installation, while providing a similar linear glow.

Fixture Schedule

Type	Description	Manufacturer	Catalog Number	Lamp(s)	Input Watts
F7	Top relampable 250W PAR38 halogen downlight with white trim	Kurt Versen	C7302-W-WT	250PAR38HALFL30 by Sylvania	250
F8	Top relampable 90W PAR38 halogen downlight with white trim	Kurt Versen	C7302-W-WT	90PAR/FL25XL-EG by GE	90
F9	Top relampable 75W PAR30 halogen downlight with white trim	Kurt Versen	C7301-W-WT	75PAR30/H/FL35 by GE	75
F6	Continuous diffuse LED strip light with dimmable driver	Birchwood Lighting	JAKE-325-TR-1-HF2N-H-30-CRx-120-CU	54 3000K LEDs per 10" section	5 W/ft
F10	Linear LED neon-replacement with diffuse white light guide and dimmable driver	GE	GEWWXNLE1-30K-A	3000K LEDs	3.39 W/ft
F11	LED steplight with black front-plate, fully shielded aperture, and dimmable driver	Cole Lighting	L-2158-BLK	6W 3000K integrated LED	8

Light Loss Factors

Type F7

- 0.8 (estimated)

Type F8

- 0.8 (estimated)

Type F9

- 0.8 (estimated)

Type F6
- LLD = 0.8 (estimated)
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- Total = 0.73

Type F10
- 0.8 (estimated)

Type F11
- 0.8 (estimated)

Control System

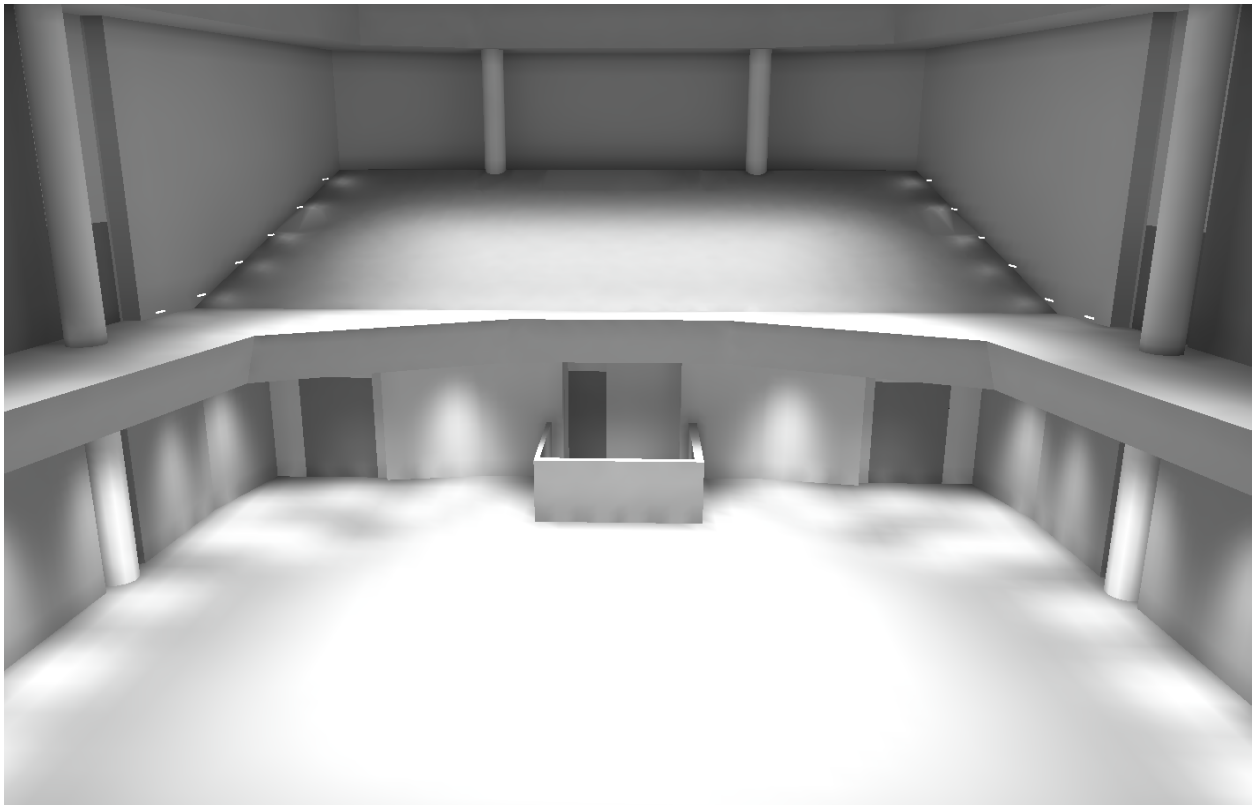
Concert hall control zones:

a) Upper downlights (for first floor seating)
b) Upper downlights (for balcony seating)
c) Balcony steplights
d) First floor downlights
e) Front linear LEDs
f) Other linear LEDs

Controlled by Grafik Eye 4000. See electrical section for details of control system.

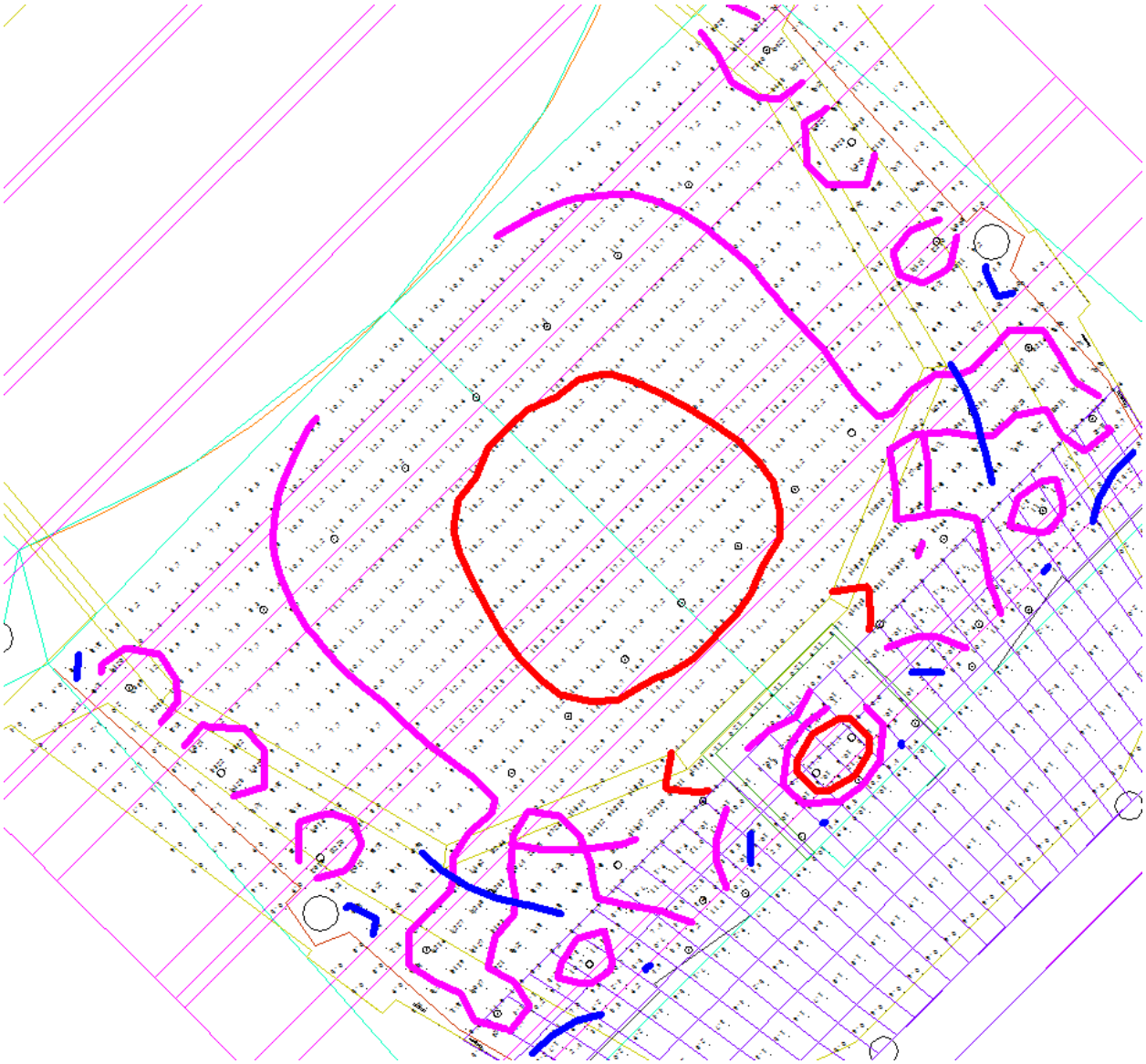
Design Performance

Figure 12: Concert Hall Light Levels



As you can see in the above rendering, the first floor is brightly illuminated. The balcony relies on steplights for the aisles because the ceiling isn't accessible from catwalks at the edge to relamp downlights. Note that the light level calculation only includes the general illumination, decorative linear fixtures were not calculated because photometry information was not available.

Figure 13: Concert Hall Isoilluminance Lines



Red: 15 fc Magenta: 10 fc Blue: 5 fc

The concert hall's audience seating area targets 10 fc, marked by the magenta lines, and it achieves that out to almost the edge of the seating area. In the center it reaches 15 fc because the catwalk's limited accessible ceiling area restricts lighting at the edges of the space. The illuminance averages 11 fc, and drops to 6 fc at some points at the edge of the seating area, within the target 2:1 average:minimum ratio.

It peaks in the rear at the control booth, with light levels in the range of 15-20 fc, as desired at full output.

Lighting Power Density

Area (audience only)	5,921 ft^2
Max Power Density	2.43 W/ft^2
Lighting power allowance	14.388 kW
Decorative allowance	5.921 kW

Type	Quantity	Watts/Fixture	Type total	
F7	14	250	3500 W	
F8	7	90	630 W	
F9	24	75	1800 W	
F6	654	5 W/ft	3270 W	(Decorative)
F10	280	3.39 W/ft	949.2 W	(Decorative)
F11	22	8	176 W	

Total lighting power	6.106 kW
Space power allowance	14.388 kW
Total decorative power	4.219 kW
Space decorative allowance	5.921 kW

The concert hall meets ASRAE 90.1 2010's power density requirements for an audience seating area.

Acoustical Breadth

The existing design uses adjustable curtains for acoustical control, allowing it to achieve a range of sound qualities to suit different types of performances. But the concert hall has a very linear architectural style, and everything else in the space is designed with hard edges. What adjustable acoustical control options could be used as an alternative?

The reverberation time, a simple metric used to summarize the acoustical performance of a space, depends on the room's volume and its total sound absorption. With the current system, absorption is modified by moving the curtains out from compartments at the back, allowing them to absorb sound that would have been reflected by the walls behind them. Can a comparable range of reverb times be achieved by changing the room's volume?

The best way to do this is by using reverberation chambers with movable wall panels. The concert hall has two reverberation chambers at the front on the balcony level. Their acoustics are adjusted by curtains across their back walls, but the volume can't be closed off from the rest of the concert hall.

The ideal reverberation time for a concert hall of this size is approximately 2 seconds at middle frequencies (500-1000 Hz). I will perform my calculations for sound at 500 Hz.

$a_{\text{total room absorption}} = \Sigma(S\alpha)$, where S = surface area and α = surface absorption coefficient

T_{60}, the time for a sound to decay by 60 decibels, is calculated by $T_{60} = 0.05V/a$.

Room volume: 369500 ft^3 with reverberation chambers
310026 ft^3 without reverberation chambers

Base Case (Chambers open, curtains hidden)

	Area (ft^2)	Material	Absorption Coefficient
1st floor Walls	4,095	1/2" Gyp. Board on 2x4s	0.05
2nd Floor Walls	15,032	1/2" Gyp. Board on 2x4s	0.05
Ceiling	7,289	1/2" Gyp. Board	0.05
Stage	2,373	Wood	0.10
Audience	2,412	Audience in upholstered seats	0.80
Floor	1,284	Heavy carpet on concrete	0.14
		Σ(Area x Absorption)	3667 Sabins
		Reverberation Time	5.03 seconds

Reverberation Chambers Closed

	Area (ft^2)	Material	Absorption Coefficient
1st floor Walls	4,095	1/2" Gyp. Board on 2x4s	0.05
2nd Floor Walls	11,856	1/2" Gyp. Board on 2x4s	0.05
Ceiling	7,289	1/2" Gyp. Board	0.05
Stage	2,373	Wood	0.1
Audience	2,412	Audience in upholstered seats	0.8
Floor	1,284	Heavy carpet on concrete	0.14
		Σ(Area x Absorption)	3508 Sabins
		Reverberation Time	4.41 seconds

Curtains Exposed

	Area (ft2)	Material	Absorption Coefficient
1st floor Walls	3,695	1/2" Gyp. Board on 2x4s	0.05
2nd Floor Walls	14,232	1/2" Gyp. Board on 2x4s	0.05
Ceiling	7,289	1/2" Gyp. Board	0.05
Stage	2,373	Wood	0.1
Audience	2,412	Audience in upholstered seats	0.8
Floor	1,284	Heavy carpet on concrete	0.14
Curtains	1,200	Mediumweight drapery	0.49
		Σ(Area x Absorption)	4195 Sabins
		Reverberation Time	4.40 seconds

As you can see, closing off the additional reverberation volume has almost the exact same effect as adding 1,200 ft^2 of mediumweight drapery. The calculated reverberation times are higher than expected, probably due to poor approximations of the materials in my calculation. If the walls were more absorptive that I've estimated, the relative effect of the curtains would actually be decreased.

Regardless, this demonstrates that the volume of reverberation chamber in the Wentz Concert Hall is sufficient to be useful in adjusting its acoustical properties. A reflective panel placed behind the screen would let changes be made with no visible distraction from the architecture.

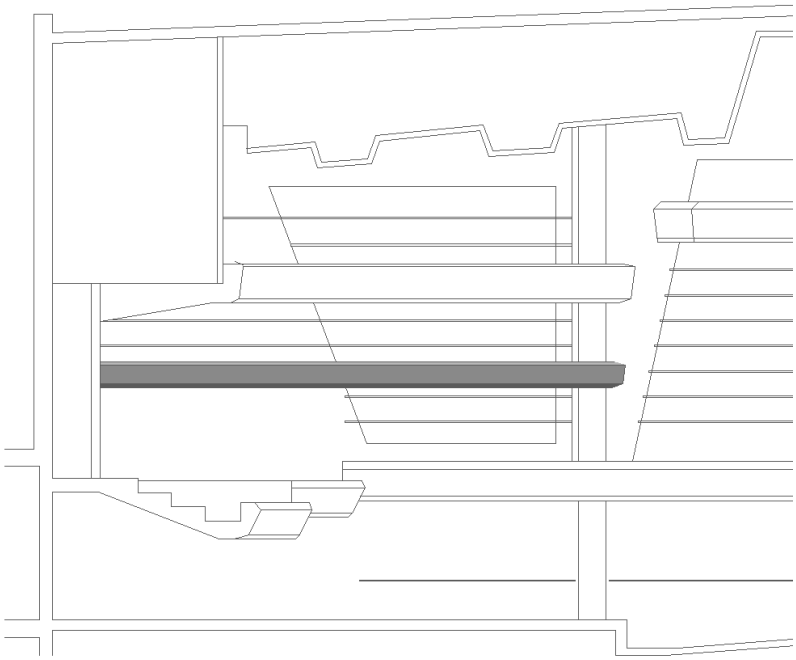
Architectural Breadth

As has been mentioned before, the concert hall has many horizontal lines. These help to direct attention toward the stage at the front, but they also mean there isn't a strong definition of the boundary between the stage and audience. For my architectural breadth, I've attempted to give this transition more spatial definition, without disrupting the room as a whole.

Figure 14: Original Concert Hall Design

You can see in the figure above that the beginning of the stage is marked by a column, which is followed by the screen into the reverberation chamber. The strong vertical of the column is a disruption of the flow of attention toward the front of the room.

Figure 15: Revised Elevation



My solution to this is to add a third shelf level, smaller than the balcony's edge and the upper shelf, above head level of a person walking along the balcony. This visually breaks up the column so that it no longer dominates the view from the audience, and creates a visual arch form using the three shelf levels and the ceiling. This arch over the stage visually separates it from the rest of the space, while avoiding a sharp transition, and ties the concert hall together more strongly than the original design.

The new shelf also serves as location to integrate wide LED strip, as seen in the concert hall lighting elevation.

Facade

Space description

The building's façade is primarily finished with architectural precast concrete in a warm yellow. It's mostly smooth with a pattern of horizontal lines, but is broken by several wide rusticated strips. At night, most of the façade's appearance comes from the inside, with light shining out from its two large lobbies.

Cornices around the two lobby masses protrude several feet at a45° angle, and are finished with aluminum panels.

Design Criteria

Illuminance (High Priority)

Façade illuminance criteria are as recommended for an area of medium night activity and LZ3 lighting zone.

Facade

- Vertical
    - 7.5 fc maximum, to highlight façade details or features
        - Apply to <20% of façade
    - 3 fc average for large illuminated areas

Entry

- Horizontal (average at grade)
    - 1.5 fc
    - Avg:Min = 2:1
- Vertical (average at 5 ft. above grade)
    - 0.8 fc
    - Avg:Min = 4:1

Wayfinding

The main entry is the primary destination for most people entering the building, though some will also be entering at the black box theater lobby. Since many visitors may not be familiar with the building, lighting can be used as a wayfinding aid.

Landmark Appearance (High Priority)

The bright lobby with its Wentz Concert Hall lettering makes a powerful landmark, which will help patrons recognize the building even if they have never seen it before. Exterior lighting should avoid overpowering this effect.

Light Pollution/Trespass

Exterior lighting should minimize light trespass to adjacent properties and light emitted upward.

ASHRAE 90.1 2010

Power Allowance (Mandatory)

Lighting Zone 3:

- Tradable allowances
  - 30 W/ft of main entrance width
  - 20 W/ft of other door width
  - 0.4 W/ft^2 of entry canopies
- Non-tradable allowances
  - 3.5 W/ft of illuminated facade

Design Overview

The façade's most attention-grabbing features are the large main lobby and the Madden Theater lobby, both of which have large curtain walls, and are visible from outside the building at night. Lighting the walls adjacent to these spaces would reduce their visual impact, so the walls on the lower floors are left dark.

Instead, color changing LED strips illuminate the high wall above the concert hall. This makes it instantly recognizable as a landmark from a large distance. Narrow beam LED fixtures near the entrances give more form to the building without floodlighting the walls, and they allude to the linear lighting designs of the interior.

Figure 16: Façade lighting plan

Lamp/Luminaire Selection

The upper wall is lit using a linear 4' RGB LED fixture, which will have a long operating life and allow the color to be cycled much more easily than with permanently colored filters. Since these mix light by adding the wavelengths they need instead of filtering out unwanted colors, they're also much more energy efficient.

For additional accent near the entries, a small LED up/downlight with symmetrical 10° degree beams mimics the impression from the linear fixtures used inside, but without requiring large penetrations and large wet-rated enclosures. Downlighting under the canopy is performed with standard fluorescent fixtures.

Fixture Schedule

Type	Description	Manufacturer	Catalog Number	Lamp(s)	Input Watts
F12	Color changing linear LED fixture with 30x60 degree beam distribution in 2' nominal lengths. IP66 rated for outdoor use	Color Kinetics	123-000030-03	RGB LEDs	35
F2	Unlensed 26W compact fluorescent downlight with 6" nominal aperture, white trim, and wheat reflector	Kurt Versen	P626DM-120-W-WT	(1) F26DBX/827/ECO4P by GE	26.4
F13	Wall mounted LED grazer with 10° up and down beams	Beta-Calco	66-2201	(2) 3800K white LEDs	4.5
F14	Wet rated cylindrical up/downlight, wall mounted with convex lens	Delray Lighting	242-BM-CUV8242.1E-WL	(2) F42TBX/830/A/ECO by GE	43.2

Light Loss Factors

Type F12

- Total = 0.8 (estimated)

Type F2

- LLD = 1530/1800 = 0.85
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.77

Type F13

- Total = 0.8 (estimated)

Type F14

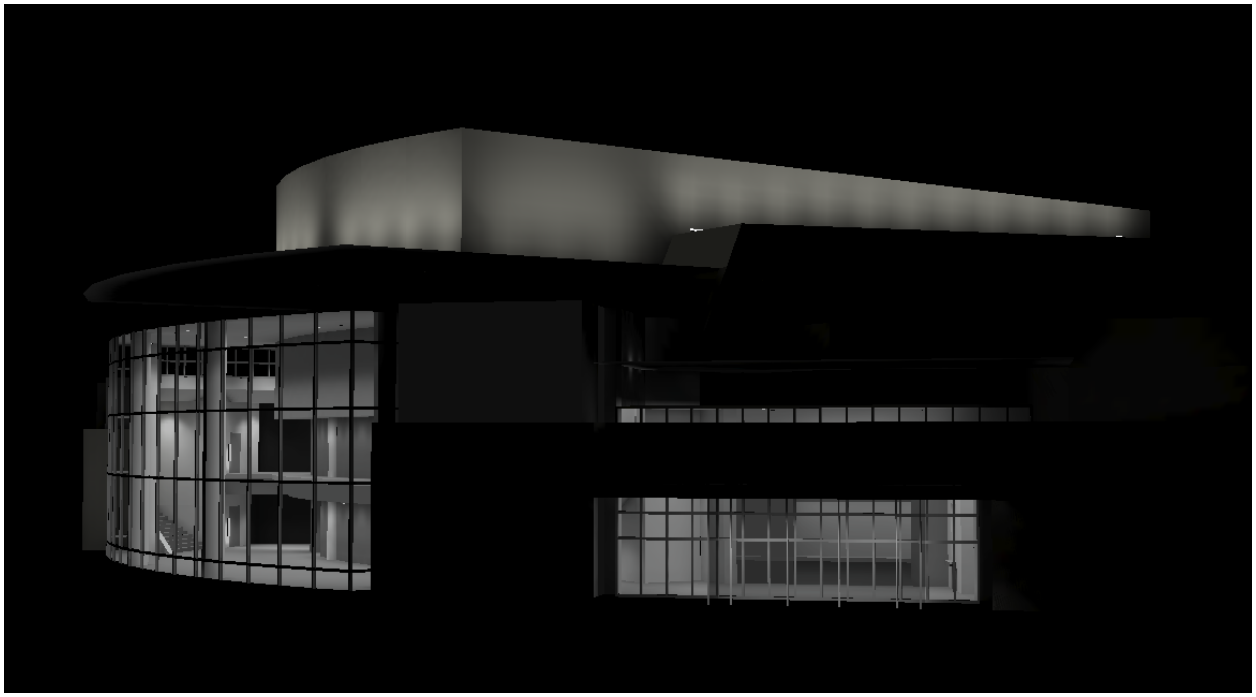
- LLD = 2690/3200 = 0.84
- LDD = 0.79 (24 month cleaning cycle, moderate dirt level)
- BF = 1.0
- Total = 0.66

Control System

The exterior lighting at the entrances are controlled with the vestibule lighting from the lobbies. Color changing LED fixtures are tied to the Grafik 4000 controls, and are managed using preset scenes.

CFL side Design Performance

Figure 17: Façade Rendering



The exterior lighting doesn't meet the IES recommended illuminance, coming in at 1.5 fc rather than the 3 fc target for large illuminated areas. This is due in part to the way the energy code is structured, where façade power allowance is based only on the illuminated walls. No additional power is freed for use by choosing to leave the majority of the building unilluminated, because the façade lighting allowance is untradeable.

The entry downlights, which are calculated in conjunction with the main lobby (north portion), can exceed the IES recommended 1.5 fc, but are on a dimming system and can be reduced. This will allow it to be brightly lit to welcome guests to a performance, but turned down as people are leaving with their eyes adjusted to the performance's lowered light levels.

Lighting Power Density

Tradable Allowances

Main entrance width	24 ft
Allowance	30 W/ft
Total other door width	72 ft
Allowance	20 W/ft
Entry canopy area	333 ft^2
Allowance	0.4 W/ft^2
Façade power allowance	2.293 kW

Type	Quantity	Watts/Fixture	Type total
F2	6	90	540 W
F13	4	75	300 W
F14	2	86.4	172.8 W

Non-tradable Allowances

Illuminated façade length	403 ft
Allowance	3.75 W/ft
Façade power allowance	1.511 kW

Type	Quantity	Watts/Fixture	Type total
F12	37	35	1.295 kW

The façade lighting design meets ASHRAE 90.1 2010's power density requirements for a building façade in zone 3.

Rehearsal Room

Space description

The rehearsal room is a high ceilinged open space, used for both music practice and teaching. Halfway up the wall, it has a technical shelf used to house AV systems, HVAC equipment, and curtain track for the lower walls. The profile of this shelf mirrors the design used repeatedly in the concert hall.

Design Criteria

Illuminance (High Priority)

Music Classroom

- Horizontal (average at 4 ft. AFF)
  - 30 fc
  - Avg:Min = 2:1
- Vertical (average at 4 ft. AFF)
  - 20 fc
  - Avg:Min = 2:1

Uniformity
Without fixed furniture, people can be seated at a chair anywhere in the room. It's important to avoid creating dark spots where music stands can't be read.

Color Temperature
Color temperature should generally be selected to match other sources in an architectural project, avoiding transitions between areas of different CCT. While there are fewer direct reasons to select a warm color temperature here, they would be consistent with the other spaces. On the other hand, some research suggests that higher color temperatures can increase focus and productivity, which could be desired in an office space.

Color Rendition
The tasks performed in these spaces do not require highly accurate color rendition, but consistency with other spaces may be a consideration.

ASHRAE 90.1 2010
Power Allowance (Mandatory)

Classroom

- Lighting Power Density: 1.24 W/ft^2
- An additional allowance of up to 1.0 W/ft^2 is available for decorative lighting

Automatic Shutoff (Mandatory)

An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

Display/Accent Lighting (Mandatory)

Display or accent lighting must be controlled separately from general lighting.

Design Overview
As with the lobby, much of the horizontal illuminance here is provided by downlights in high ceiling. Vertical illuminance is essential for reading music on slanted music stands, and must be high in all directions. This is achieved using a linear wallwasher along two sides of the room to bounce light off of the lower walls and curtains, as well as with an asymmetric CFL fixture on the side of the technical shelf. Horizontal illuminance is provided by downlights in the upper ceiling, and asymmetric uplights shine from the top of the technical shelf to illuminate parts of the walls and ceiling.

Figure 18: Rehearsal Room – Balcony Level Lighting Plan

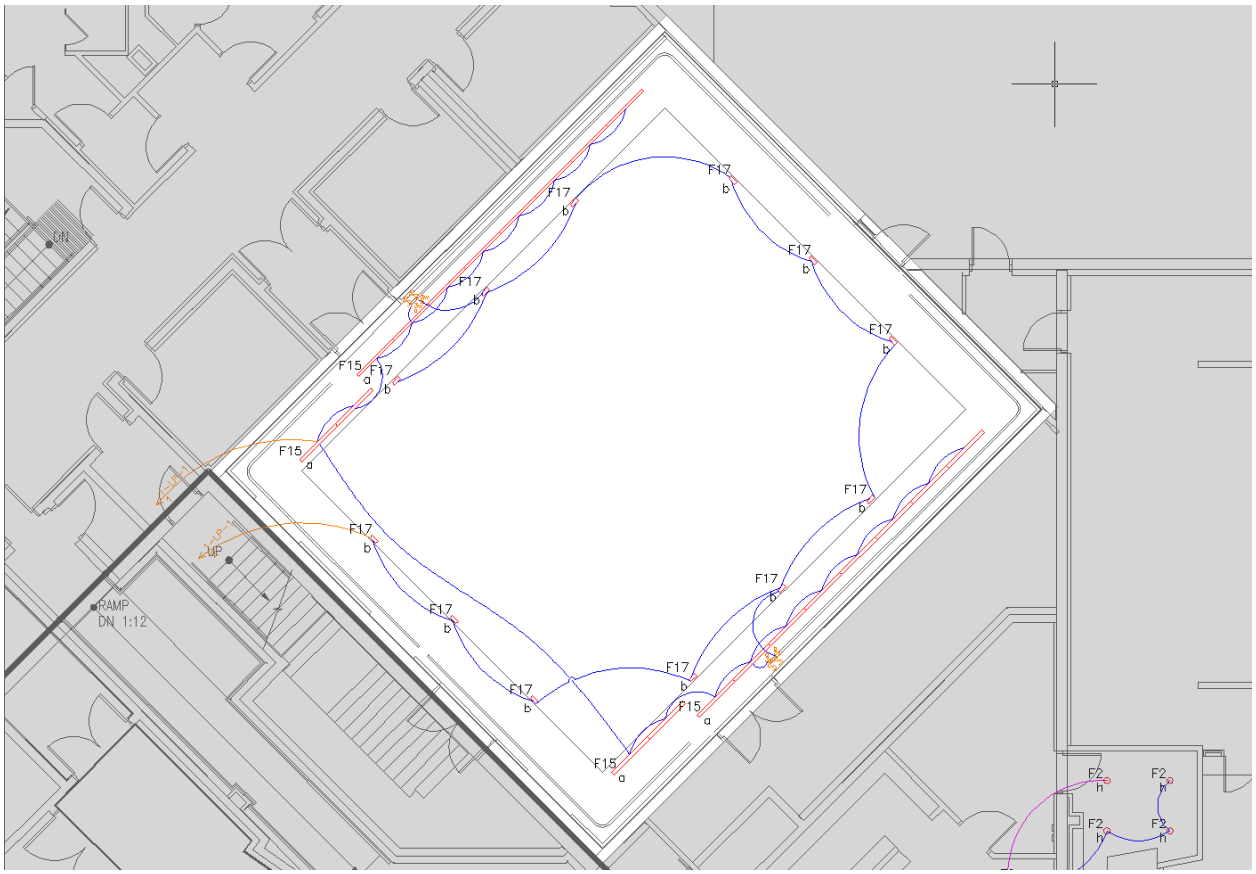
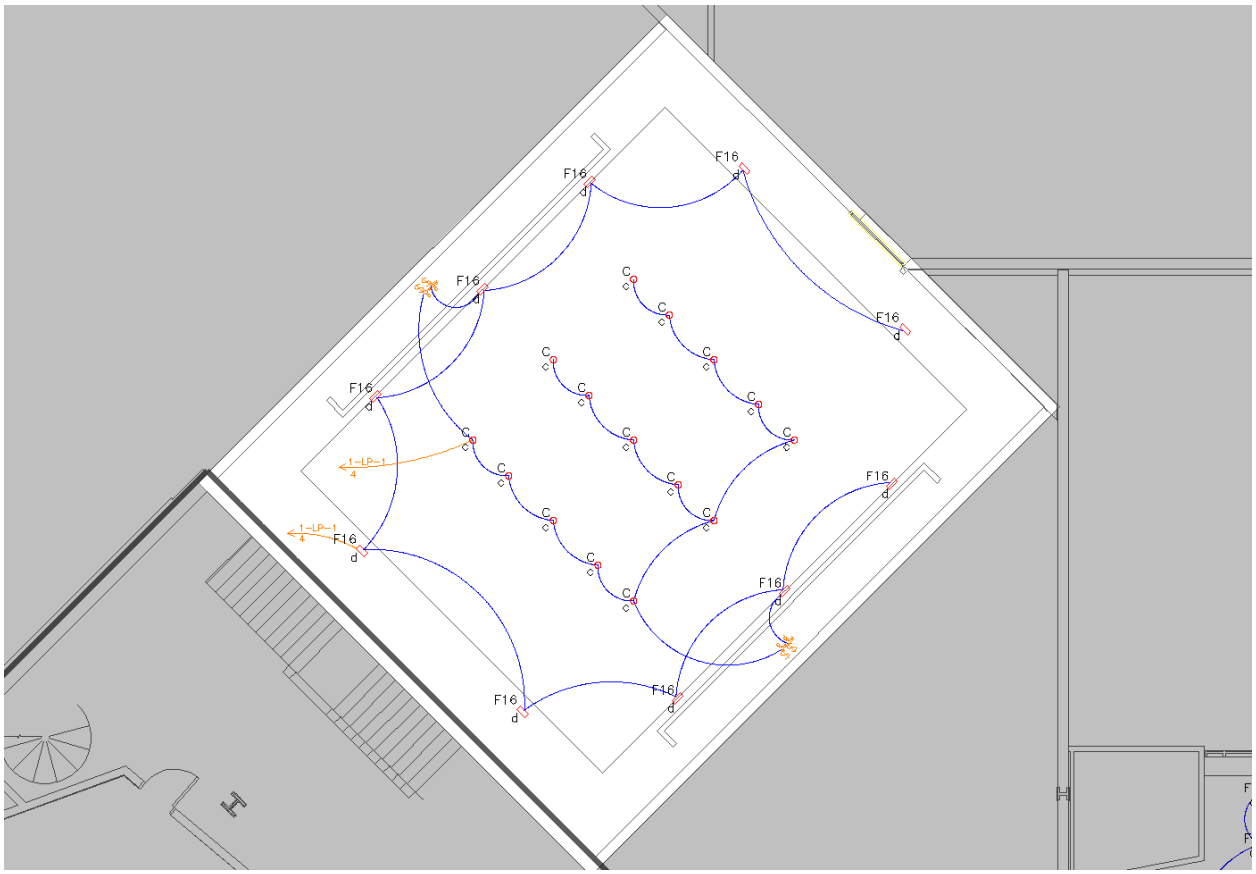


Figure 19: Rehearsal Room – Balcony Level Lighting Plan



Lamp/Luminaire Selection

In keeping with the low energy goals for the project, the space uses fluorescent fixtures. Downlights have wheat reflectors for a warmer feel, and all lamps are 3000K. This is slightly cooler than what was used in the lobby, but the rehearsal room is relatively farm removed from the warm red woods of the lobby and concert hall, and 3000K is sufficiently warm for a classroom. The linear wall washers use a standard output T5 lamp.

Fixture Schedule

Type	Description	Manufacturer	Catalog Number	Lamp(s)	Input Watts
F15	Recessed linear T5 fixture in 4' lengths with low iridescent louver	Peerless Lighting	LAR9-28T5-LDL-U4-120-C200	(1) F28W/T5/830/ECO by GE	26.8
F16	Adjustable asymmetric CFL wall washer with lockable angle and semi gloss white finish	Winona Lighting	LS8-CFM142-120-P1-SGW-X-STD	(1) F42TBX/830/A/ECO by GE	43.2
F17	Semi-recessed asymmetric CFL with semi gloss white finish	Winona Lighting	LSRU-LR-CFM142-120-P1-SGW-X-STD	(1) F42TBX/830/A/ECO by GE	43.2
F18	Unlensed 42W compact fluorescent downlight with 6" nominal aperture, white trim, and wheat reflector	Kurt Versen	P927-120-W-WT	(1) F42TBX/830/A/ECO by GE	43.2

Light Loss Factors

Type F15

- LLD = 2660/2900 = 0.92
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.83

Type F16

- LLD = 2690/3200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.76

Type F17

- LLD = 2690/3200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.76

Type F18

- LLD = 2690/3200 = 0.84
- LDD = 0.91 (24 month cleaning cycle, open/unvented)
- BF = 1.0
- Total = 0.76

Control System

The four types of lights are set up in four separate switching groups so that they can be used independently and turned off to reduce energy use when they aren't needed.

a) Linear wall washers
b) CFL side lights
c) Upper ceiling downlights
d) CFL uplights

Controlled by Grafik Eye 4000. See electrical section for details of control system.

Design Performance

Figure 20: Rehearsal Room Rendering

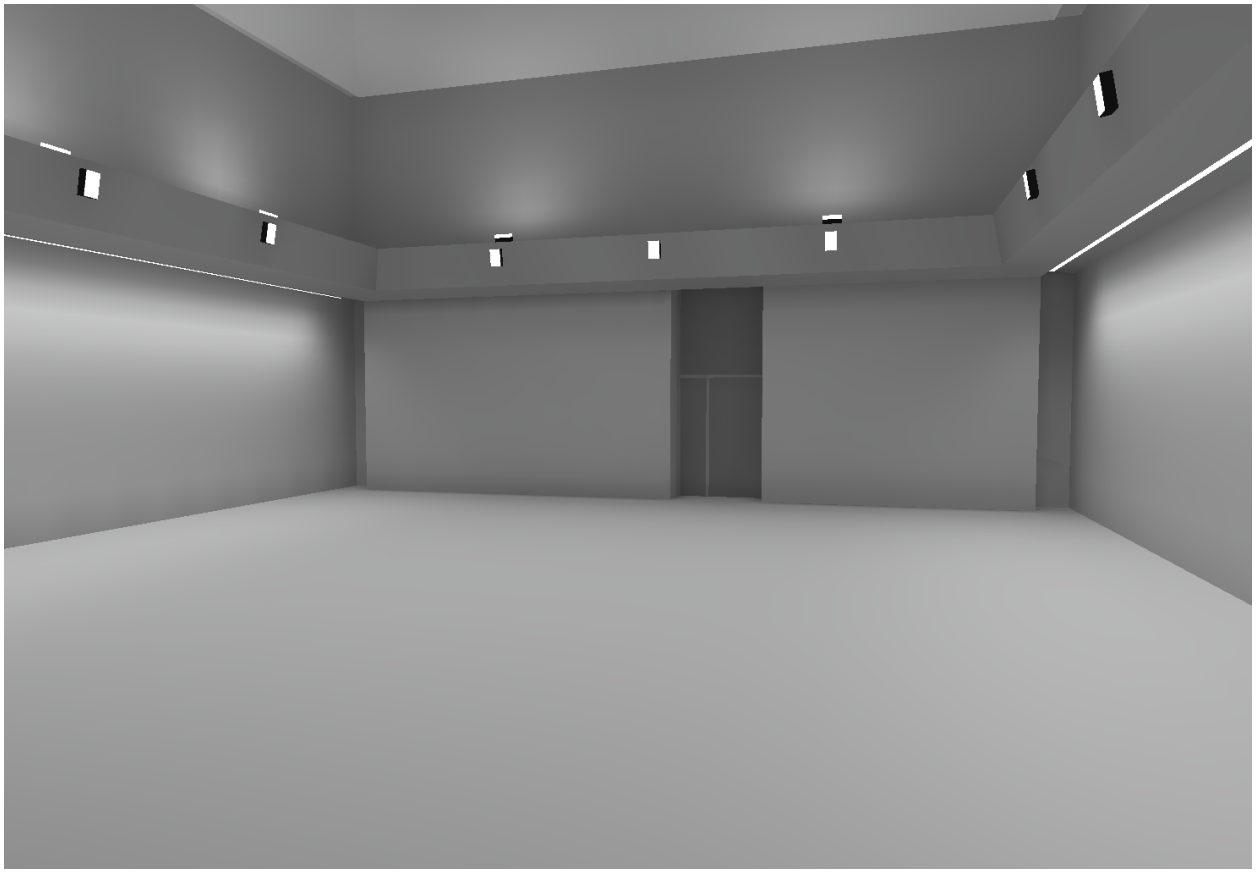
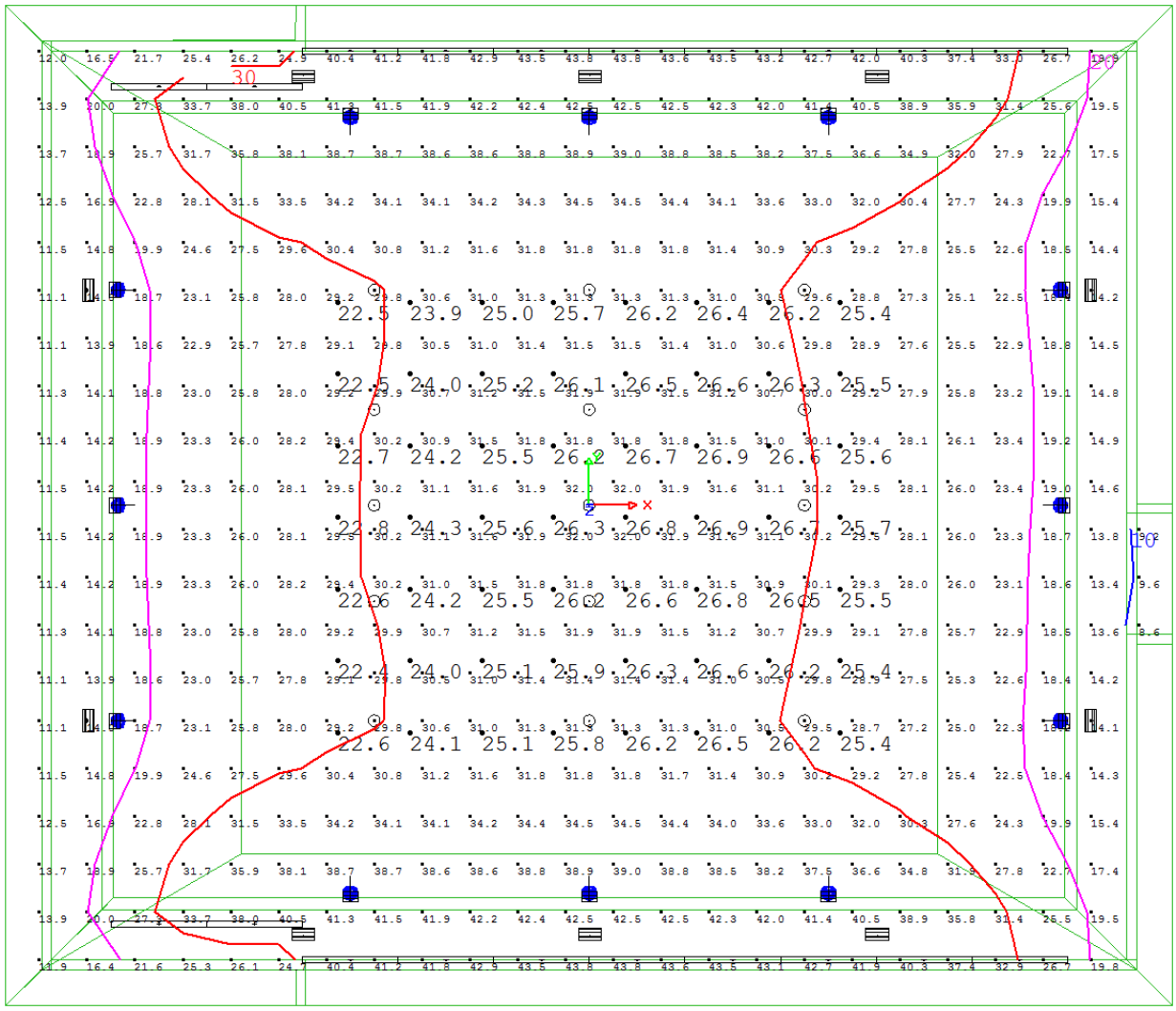


Figure 21: Rehearsal Room Isoilluminance Lines



Red: 30 fc Magenta: 20 fc Blue: 10 fc

The room is brightly illuminated, and meets the target of 30 fc in the center area and toward the sides with linear fixtures. Toward the front and back, it drops off to 20 fc, but only reaches 10 at a few points between the curtain pockets. The average to minimum ratio is 1.13:1, well below the recommended 2:1

Vertical illuminances are also as targeted, with points aimed at 45 degrees (to simulate a music stand) still receiving above 25 fc in the central area.

Lighting Power Density

Area	2,041 ft^2
Max Power Density	1.24 W/ft^2
Lighting power allowance	2.530 kW
Decorative allowance	2.041 kW

Type	Quantity	Watts/Fixture	Type total	
F15	15	26.8	402 W	
F16	10	43.2	432 W	(Decorative)
F17	12	43.2	518.4 W	
F18	20	43.2	864 W	

Total lighting power (kW)	1.784 kW
Space power allowance (kW)	2.041 kW
Total decorative power	0.432 kW
Space decorative allowance	2.041 kW

Rehearsal room meets ASHRAE 90.1 2010 power density requirements for a classroom space.

Electrical Redesign

The four redesigned spaces are the main lobby, concert hall, façade, and rehearsal room. Each of these spaces span the first floor and balcony levels. The rehearsal room and lobby are designed to use predominantly CFL sources, while the concert hall uses incandescent downlights with linear LEDs as an efficient architectural accent. The façade's main focus is the upper exterior wall of the concert hall, which is lit by color changing LEDs.

Panelboards						
Panel Tag	**Voltage**	**System**	**Rehearsal Room**	**Main Lobby**	**Concert Hall**	**Façade**
DR1	208Y/120V, 3P 4W	N		X	X	X
DR2	208Y/120V, 3P 4W	N			X	X
EM-XFR-1	208Y/120V, 3P 4W	N/E		X	X	X
1-ELP-1	208Y/120V, 3P 4W	N/E	X			
1-LL-1	208Y/120V, 3P 4W	N	X			

Control Systems

The rehearsal room, as a back of house area, uses a simple switching system, with luminaires grouped by type. There are two entrances on opposite sides of the room, and three way switching is used so that all lighting can be controlled from either one.

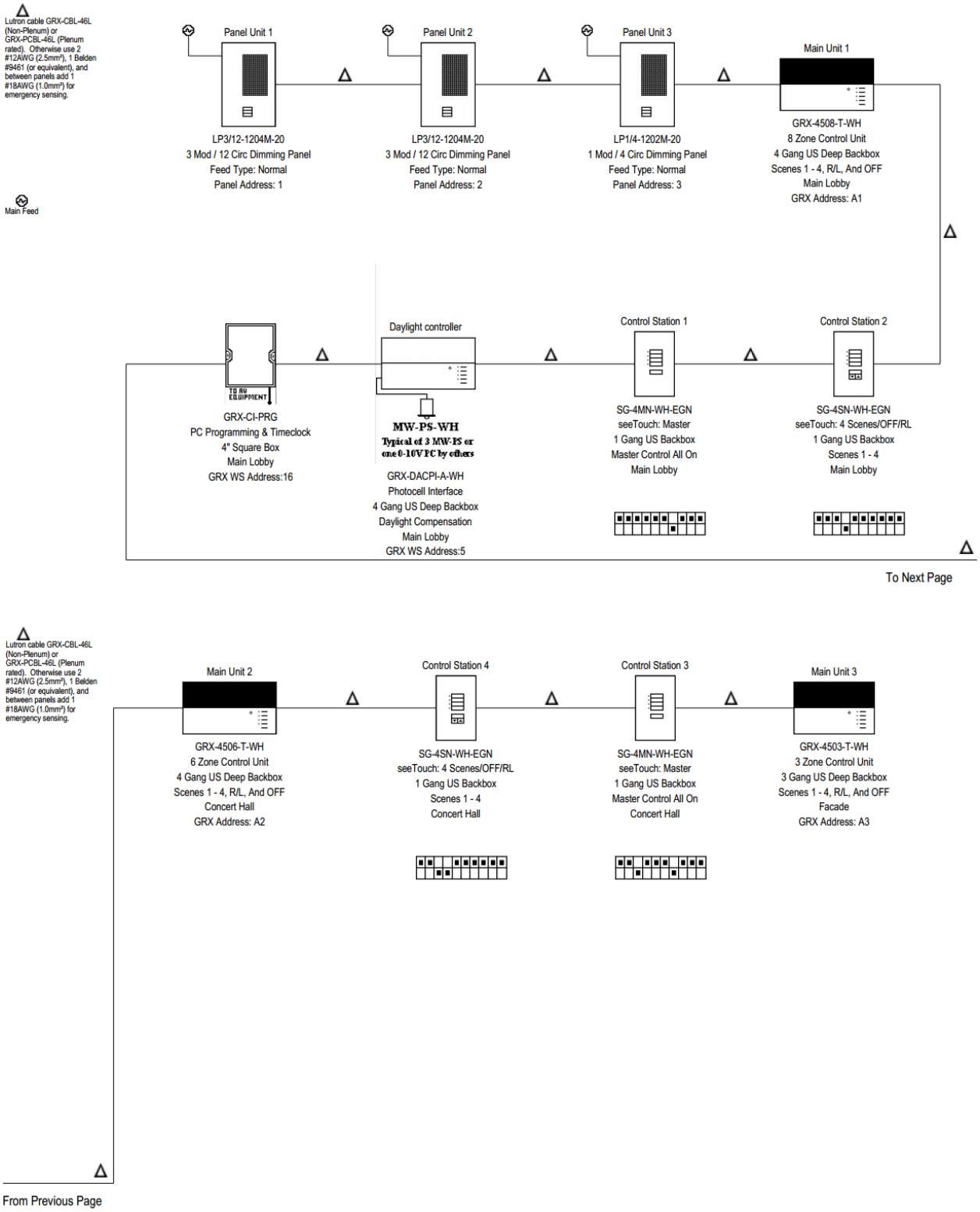
The main lobby, concert hall, and façade are operated by a Lutron Grafik Eye 4000 multi-space dimming system. This product was selected for its ability to control multiple light sources, instead of a standard dimmer rack system for incandescents only, as well as the ability to integrated with a theatrical lighting console. The Grafik Eye 4000 also allows for photosensor controlled dimming (required by ASHRAE 90.1 in the main lobby), and allows emergency lighting to be controlled along with normal lighting circuits using a dimming level override in case of normal power failure.

Table 1: Control Equipment Schedule

Grafik 4000			
Item	**Lutron Model No.**	**Description**	**Qty**
1)	LP3/12-1204M-20	120V Branch Breakers LP Dimming Panel containing 3 20A-1Pole branch breakers rated at 10,000AIC for 3 modules (12 switch legs). 4 dimming outputs per module. Max input feed = 20A (3Ø-4 Wire), 40A (1Ø-3 Wire), 60A (1Ø-2 Wire)	2
2)	LP1/4-1202M-20	120V Branch Breakers LP Dimming Panel containing 1 20A-1Pole branch breaker rated at 10,000AIC for 1 module (4 switch legs). 4 dimming outputs per module. Max input feed = 20A	1
3)	PHPM-3F-120-WH	120V Fluorescent Power Module. Enables a control to dim Lutron Hi-Lume or Eco-10 Dimming Ballasts. Module requires a neutral wire. Maximum 16A output. 2 Gang US Backbox.	16
4)	SG-4SN-WH-EGN	seeTouch series GRAFIK Eye wallstation. Recalls preset light levels for up to 4 scenes plus off. Fine-tuning of light levels with master raise/lower. Noninsert Version; Optional Backlighting. 1 Gang US Backbox.	2
5)	SG-4MN-WH-EGN	seeTouch series GRAFIK Eye wallstation. Allows Master Control of any GRAFIK Eye on a button-by button basis. Noninsert Version; Optional Backlighting. 1 Gang US Backbox.	2
6)	GRX-DACPI-A-WH	Automatically selects preset scenes on a GRAFIK Eye Control Unit in response to ambient daylight. Opaque Top Cover. Works with either 1 0-10V photocell or up to 3 Lutron MW-PS photocells. 4 Gang US Backbox.	1
7)	MW-PS-WH	Ceiling mounted daylight photosensor. Low voltage class 2, 24V DC.	1
8)	GRX-CI-PRG	RS232 and Ethernet Interface. Allows for PC Programming with GRX-3500 and GRX-4500 Control Units. Can also be used as an astronomic timeclock for any GRAFIK Eye system. Surface mount.	1
9)	GRX-4508-T-WH	8 Zone GRAFIK Eye 4000 Control Unit with PC Setup Capability and Translucent Top Cover. For use with Lutron GP, LP, and XP Power Panels. 4 Gang US Backbox.	1
10)	GRX-4506-T-WH	6 Zone GRAFIK Eye 4000 Control Unit with PC Setup Capability and Translucent Top Cover. For use with Lutron GP, LP, and XP Power Panels. 4 Gang US Backbox.	1
11)	GRX-4503-T-WH	3 Zone GRAFIK Eye 4000 Control Unit with PC Setup Capability and Translucent Top Cover. For use with Lutron GP, LP, and XP Power Panels. 3 Gang US Backbox.	1
All electrical devices should match system controls. Use Lutron NovaT* dimmers, switches, receptacles, jacks and faceplates as required.			

Panels are Lutron LP series, which use 20A modules to supply different load types. LED loads are to be dimmed using Lutron Hi-Lume drivers for 1% minimum dimming level, and CFLs below 42W also use Hi-Lume ballasts. Fixtures with 42W triple tube CFLs These two load types can be served by the same LP dimming module. Each dimming module supports up to 4 dimming zones.

Figure 22: Control System Single-Line



Existing Panelboards

The drawing set for the project does not include existing branch panelboard schedules. These are estimated based on information from the electrical and lighting design drawings to approximate loads given in the distribution panel schedules.

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	1-LP-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	173 - Electrical Closet	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	Rehearsal	1320	20A/1P	1	*			2	20A/1P	1000	Rehearsal	Lighting
Lighting	Rehearsal	1000	20A/1P	3		*		4	20A/1P	915	Rehearsal	Lighting
Existing Load	Misc	1200	20A/1P	5			*	6	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	7	*			8	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	9		*		10	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	11			*	12	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	13	*			14	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	15		*		16	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	17			*	18	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	19	*			20	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	21		*		22	20A/1P	1200	Misc	Existing Load
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	9.52	TOTAL DESIGN LOAD (KW)	31.00
CONNECTED LOAD (KW) - B Ph.	9.12	POWER FACTOR	0.91
CONNECTED LOAD (KW) - C Ph.	7.20	TOTAL DESIGN LOAD (AMPS)	95

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	1-ELP-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	100A	PANEL LOCATION:	173 - Electrical Closet	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	15A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
EM Lighting	Rehearsal	458	20A/1P	1	*			2	20A/1P	600		Existing Load
Existing Load		600	20A/1P	3		*		4	20A/1P	600		Existing Load
Existing Load		600	20A/1P	5			*	6	20A/1P	600		Existing Load
Existing Load		600	20A/1P	7	*			8	20A/1P	600		Existing Load
Existing Load		600	20A/1P	9		*		10	20A/1P	600		Existing Load
Existing Load		600	20A/1P	11			*	12	20A/1P	0		
		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	2.26	TOTAL DESIGN LOAD (KW)	7.75
CONNECTED LOAD (KW) - B Ph.	2.40	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C Ph.	1.80	TOTAL DESIGN LOAD (AMPS)	10

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	DR-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	139 - Dimmer Room	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Choral terrace R2 ce	Concert Hall	1250	20A/1P	1	*			2	20A/1P	1250	Concert Hall	Choral terrace R1 cen
Choral terrace SL	Concert Hall	1500	20A/1P	3		*		4	20A/1P	1500	Concert Hall	Choral terrace SR
Row 1 HR	Concert Hall	1725	20A/1P	5			*	6	20A/1P	1725	Concert Hall	Row 1 center
Row 2 HR	Concert Hall	1725	20A/1P	7	*			8	20A/1P	1725	Concert Hall	Row 2 CR
Row 2 CL	Concert Hall	1725	20A/1P	9		*		10	20A/1P	1725	Concert Hall	Row 2 HL
Row 3 HR	Concert Hall	1725	20A/1P	11			*	12	20A/1P	1725	Concert Hall	Row 3 CR
Row 3 CL	Concert Hall	1725	20A/1P	13	*			14	20A/1P	1725	Concert Hall	Row 3 HL
Row 4 HR	Concert Hall	1725	20A/1P	15		*		16	20A/1P	1725	Concert Hall	Row 4 CR
Row 5 HR	Concert Hall	1725	20A/1P	17			*	18	20A/1P	1725	Concert Hall	Row 5 CR
Row 5 C	Concert Hall	1725	20A/1P	19	*			20	20A/1P	1725	Concert Hall	Row 5 CL
Row 5 HL	Concert Hall	1725	20A/1P	21		*		22	20A/1P	1725	Concert Hall	Catwalk #4 HR
Catwalk #4 CR	Concert Hall	1725	20A/1P	23			*	24	20A/1P	1725	Concert Hall	Catwalk #4 CL
Catwalk #4 HL	Concert Hall	1725	20A/1P	25	*			26	20A/1P	308	Main Lobby	Column backlight
Seating sconces	Main Lobby	46	20A/1P	27		*		28	20A/1P	300	Main Lobby	Column light
Column light	Main Lobby	300	20A/1P	29			*	30	20A/1P	300	Main Lobby	Column light
Column light	Main Lobby	300	20A/1P	31	*			32	20A/1P	1575	Main Lobby	Wood washers
Bridge downlights	Main Lobby	1500	20A/1P	33		*		34	20A/1P	1500	Main Lobby	Coat check
Coat check	Main Lobby	700	20A/1P	35			*	36	20A/1P	600	Main Lobby	Main entrance
Concert entry	Main Lobby	200	20A/1P	37	*			38	20A/1P	1125	Main Lobby	Upper wall wash
North lobby track	Main Lobby	1100	20A/1P	39		*		40	20A/1P	1400	Main Lobby	North lobby accent
Ceiling uplight	Main Lobby	1500	20A/1P	41			*	42	20A/1P	1500	Main Lobby	Ceiling uplight

CONNECTED LOAD (KW) - A Ph.	18.08	TOTAL DESIGN LOAD (KW)	67.18
CONNECTED LOAD (KW) - B Ph.	19.20	POWER FACTOR	1.00
CONNECTED LOAD (KW) - C Ph.	18.70	TOTAL DESIGN LOAD (AMPS)	187

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	DR-2	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	139 - Dimmer Room	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Entry vestibules	Lobby	1000	20A/1P	1	*			2	20A/1P	1000	Concert Hall	ownlights - Row 1 out
wnlights - Row 1 inr	Concert Hall	1250	20A/1P	3		*		4	20A/1P	1000	Concert Hall	ownlights - Row 2 out
wnlights - Row 2 inr	Concert Hall	1250	20A/1P	5			*	6	20A/1P	400	Concert Hall	ownlights - Row 3 out
wnlights - Row 3 inr	Concert Hall	500	20A/1P	7	*			8	20A/1P	1200	Concert Hall	wnlights - Under balcc
hts - Under balcony	Concert Hall	200	20A/1P	9		*		10	20A/1P	600	Concert Hall	Rear wallwashers
House rear wall	Concert Hall	1080	20A/1P	11			*	12	20A/1P	1080	Concert Hall	House rear wall
House side wall	Concert Hall	1320	20A/1P	13	*			14	20A/1P	1320	Concert Hall	House side wall
Platform lower wall	Concert Hall	980	20A/1P	15		*		16	20A/1P	980	Concert Hall	Platform lower wall
latform rear lower wa	Concert Hall	1400	20A/1P	17			*	18	20A/1P	720	Concert Hall	atform center lower wa
cony rear wall wash	Concert Hall	1900	20A/1P	19	*			20	20A/1P	1440	Concert Hall	Balcony side wall
Balcony side wall	Concert Hall	1440	20A/1P	21		*		22	20A/1P	1440	Concert Hall	Chour terrace sidewall
Chour terrace sidewa	Concert Hall	1440	20A/1P	23			*	24	20A/1P	1200	Concert Hall	Chour terace rear wall
Chour terrace rear ct	Concert Hall	1080	20A/1P	25	*			26	20A/1P	2400	Concert Hall	Upper sidewall
Upper sidewall	Concert Hall	2400	20A/1P	27		*		28	20A/1P	1080	Concert Hall	Upper rear wall
Balcony rail sconces	Concert Hall	400	20A/1P	29			*	30	20A/1P	480	Concert Hall	Balcony rail sconces
Balcony rail sconces	Concert Hall	600	20A/1P	31	*			32	20A/1P	0	Main Lobby	Signage spot
Signage spot	Main Lobby	0	20A/1P	33		*		34	20A/1P	0	Main Lobby	Main lobby track
Main lobby track	Main Lobby	0	20A/1P	35			*	36	20A/1P	0	Main Lobby	Main lobby track
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	13.76	TOTAL DESIGN LOAD (KW)	41.50
CONNECTED LOAD (KW) - B Ph.	11.37	POWER FACTOR	1.00
CONNECTED LOAD (KW) - C Ph.	9.45	TOTAL DESIGN LOAD (AMPS)	115

Revised Panelboards

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	1-LP-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	173 - Electrical Closet	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Rehearsal lighting	Rehearsal Room	921	20A/1P	1	*			2	20A/1P	950	Rehearsal Room	Rehearsal lighting
Existing Load	Misc	1200	20A/1P	3		*		4	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	5			*	6	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	7	*			8	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	9		*		10	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	11			*	12	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	13	*			14	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	15		*		16	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	17			*	18	20A/1P	1200	Misc	Existing Load
Existing Load	Misc	1200	20A/1P	19	*			20	20A/1P	1200	Misc	Existing Load
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	9.07	TOTAL DESIGN LOAD (KW)	28.17
CONNECTED LOAD (KW) - B Ph.	7.20	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C Ph.	7.20	TOTAL DESIGN LOAD (AMPS)	87

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	1-ELP-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	100A	PANEL LOCATION:	173 - Electrical Closet	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	100A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
EM Lighting	Rehearsal room	130	20A/1P	1	*			2	20A/1P	600	Misc	Existing Load
Existing Load	Misc	600	20A/1P	3		*		4	20A/1P	600	Misc	Existing Load
Existing Load	Misc	600	20A/1P	5			*	6	20A/1P	600	Misc	Existing Load
Existing Load	Misc	600	20A/1P	7	*			8	20A/1P	600	Misc	Existing Load
Existing Load	Misc	600	20A/1P	9		*		10	20A/1P	600	Misc	Existing Load
Existing Load	Misc	600	20A/1P	11			*	12	20A/1P	525	Concert Hall	EM Lighting
EM Lighting	Concert Hall	176	20A/1P	13	*			14	20A/1P	1270	Concert Hall	EM Lighting
EM Lighting	Main Lobby	333	20A/1P	15		*		16	20A/1P	712	Main Lobby	EM Lighting
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	3.38	TOTAL DESIGN LOAD (KW)	10.97
CONNECTED LOAD (KW) - B Ph.	3.45	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C Ph.	2.33	TOTAL DESIGN LOAD (AMPS)	34

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	DR-1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	139 - Dimmer Room	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Choral terrace R2 ce	Concert Hall	1250	20A/1P	1	*			2	20A/1P	1250	Concert Hall	Choral terrace R1 cen
Choral terrace SL	Concert Hall	1500	20A/1P	3		*		4	20A/1P	1500	Concert Hall	Choral terrace SR
Row 1 HR	Concert Hall	1725	20A/1P	5			*	6	20A/1P	1725	Concert Hall	Row 1 center
Row 2 HR	Concert Hall	1725	20A/1P	7	*			8	20A/1P	1725	Concert Hall	Row 2 CR
Row 2 CL	Concert Hall	1725	20A/1P	9		*		10	20A/1P	1725	Concert Hall	Row 2 HL
Row 3 HR	Concert Hall	1725	20A/1P	11			*	12	20A/1P	1725	Concert Hall	Row 3 CR
Row 3 CL	Concert Hall	1725	20A/1P	13	*			14	20A/1P	1725	Concert Hall	Row 3 HL
Row 4 HR	Concert Hall	1725	20A/1P	15		*		16	20A/1P	1725	Concert Hall	Row 4 CR
Row 5 HR	Concert Hall	1725	20A/1P	17			*	18	20A/1P	1725	Concert Hall	Row 5 CR
Row 5 C	Concert Hall	1725	20A/1P	19	*			20	20A/1P	1725	Concert Hall	Row 5 CL
Row 5 HL	Concert Hall	1725	20A/1P	21		*		22	20A/1P	1725	Concert Hall	Catwalk #4 HR
Catwalk #4 CR	Concert Hall	1725	20A/1P	23			*	24	20A/1P	1725	Concert Hall	Catwalk #4 CL
Catwalk #4 HL	Concert Hall	1725	20A/1P	25	*			26	20A/1P	1359	Lobby	1st floor lighting
Main downlights	Lobby	1685	20A/1P	27		*		28	20A/1P	1296	Lobby	North lighting
South lighting	Lobby	732	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	15.93	TOTAL DESIGN LOAD (KW)	56.16
CONNECTED LOAD (KW) - B Ph.	16.33	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C Ph.	14.53	TOTAL DESIGN LOAD (AMPS)	158

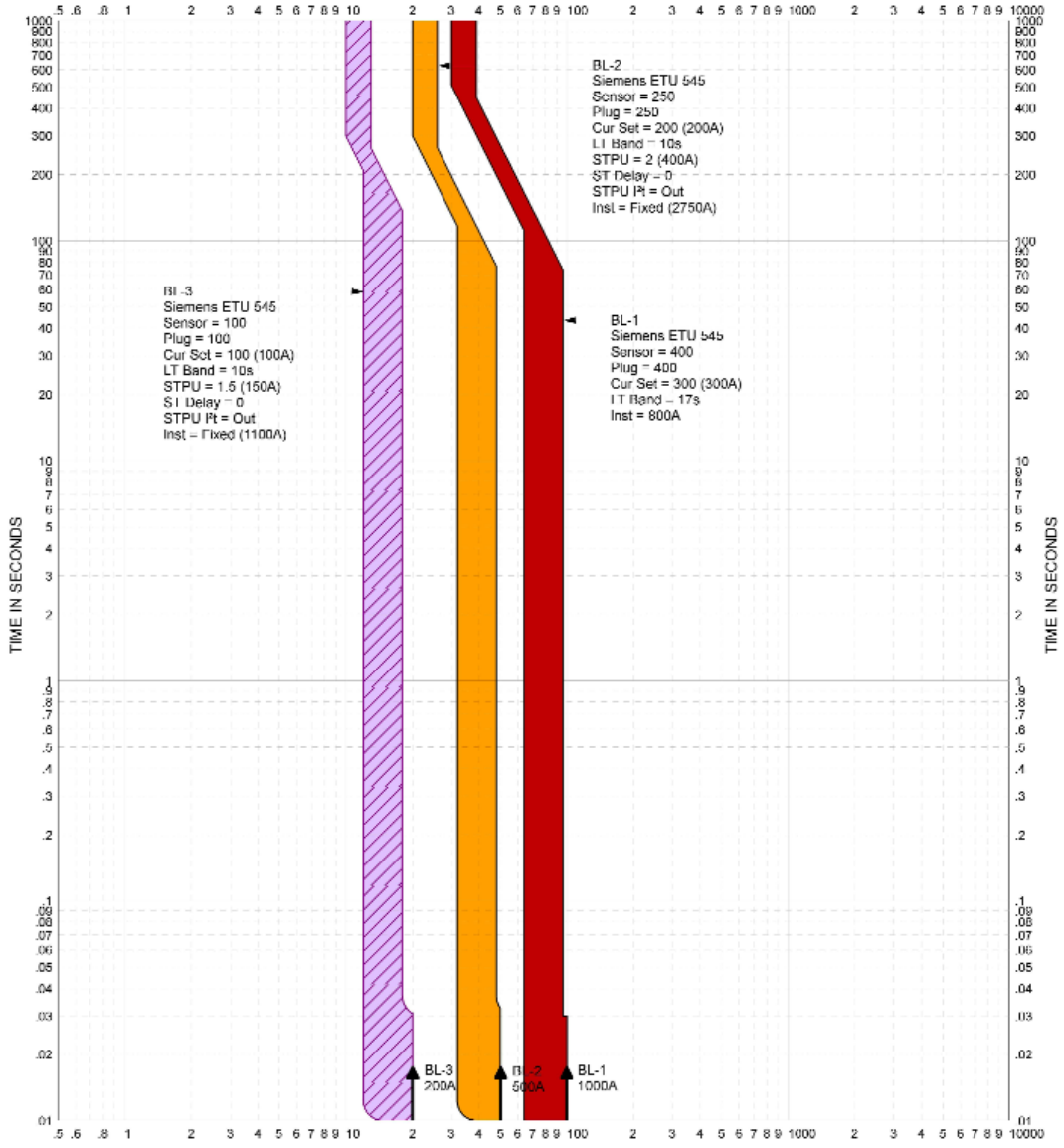
PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	DR-2	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	139 - Dimmer Room	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Entry vestibules	Lobby	1000	20A/1P	1	*			2	20A/1P	600	Concert Hall	Rear wallwashers
Platform lower wall	Concert Hall	980	20A/1P	3		*		4	20A/1P	980	Concert Hall	Platform lower wall
latform rear lower wa	Concert Hall	1400	20A/1P	5			*	6	20A/1P	720	Concert Hall	atform center lower wa
Chour terrace sidewa	Concert Hall	1440	20A/1P	7	*			8	20A/1P	1440	Concert Hall	Chour terrace sidewall
Chour terace rear wa	Concert Hall	1200	20A/1P	9		*		10	20A/1P	1080	Concert Hall	Chour terrace rear ctr
Upper sidewall	Concert Hall	2400	20A/1P	11			*	12	20A/1P	2400	Concert Hall	Upper sidewall
Upper rear wall	Concert Hall	1080	20A/1P	13	*			14	20A/1P	1200	Concert Hall	First floor downlights
Upper downlights 1	Concert Hall	1250	20A/1P	15		*		16	20A/1P	1250	Concert Hall	Upper downlights 2
Upper downlights 3	Concert Hall	450	20A/1P	17			*	18	20A/1P	1600	Concert Hall	Wide LED strips 1
Wide LED strips 2	Concert Hall	1600	20A/1P	19	*			20	20A/1P	949	Concert Hall	Narrow LED strips
Façade lighting	Façade	1644	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	9.31	TOTAL DESIGN LOAD (KW)	32.00
CONNECTED LOAD (KW) - B Ph.	8.38	POWER FACTOR	0.98
CONNECTED LOAD (KW) - C Ph.	8.97	TOTAL DESIGN LOAD (AMPS)	91

Protective Device Coordination



In the above diagram, the three protective devices are shown to be coordinated, because the time/current curves do not overlap. When a current exceeds the designed level, the breaker farthest into the system will trip first. This prevents power loss in a larger portion of the building, as well as making it easier to locate the source of the overcurrent.

Note: Overcurrent device specifications were not available; the characteristics used here are assumed values.

Short Circuit Analysis

Utility S.C.	1,000,000	kVA					
Base kVA	1,000	kVA		**ΣX**	**ΣR**	**ΣZ**	**Isc (A)**
Utility Transformer Primary							
		X = Base kVA/Utility Contribution =	0.001	0.001	0	0.001	
Utility Transformer Secondary							
%Z =	5.175	$X = \%X*kVA_{base}/(100*kVA_{transformer})$ =	0.02445	0.02545	0.0084	0.02680	**103,570**
Avg. X/R =	2.9	$R = \%R*kVA_{base}/(100*kVA_{transformer})$ =	0.0084				
%X =	4.89						
%R =	1.68						
kVA =	2,000						
Switchboard 1-SWBD-1							
Wire size =	500 kcmil	$X = (L/1000)*X_L*(1/\#\ sets)$ =	0.00052425	0.02597	0.00892	0.02746	**101,065**
# of Sets =	8	$R = (L/1000)*R_L*(1/\#\ sets)$ =	0.00052425				
Length =	90						
X_L =	0.0466						
R_L =	0.0294						
Tranformer T1-TLDP-1 Primary							
Wire size =	350 kcmil	$X = (L/1000)*X_L*(1/\#\ sets)$ =	0.0066285	0.03260	0.01403	0.03549	**78,206**
# of Sets =	1	$R = (L/1000)*R_L*(1/\#\ sets)$ =	0.005103				
Length =	135						
X_L =	0.0491						
R_L =	0.0378						
Transformer T1-TLDP-1 Secondary							
%Z =	5.175	$X = \%X*kVA_{base}/(100*kVA_{transformer})$ =	0.02934	0.06194	0.02411	0.06647	**41,760**
Avg. X/R =	2.9	$R = \%R*kVA_{base}/(100*kVA_{transformer})$ =	0.01008				
%X =	4.89						
%R =	1.68						
kVA =	225						
Panelboard 1-TLDP-1							
Wire size =	500 kcmil	$X = (L/1000)*X_L*(1/\#\ sets)$ =	0.0066285	0.06857	0.02921	0.07453	**37,241**
# of Sets =	2	$R = (L/1000)*R_L*(1/\#\ sets)$ =	0.005103				
Length =	10						
X_L =	0.0466						
R_L =	0.0294						
Isc at SP-1 (Panel)							
Wire size =	3/0 AWG	$X = (L/1000)*X_L*(1/\#\ sets)$ =	0.0066285	0.07520	0.03431	0.08266	**33,581**
# of Sets =	1	$R = (L/1000)*R_L*(1/\#\ sets)$ =	0.005103				
Length =	35						
X_L =	0.0519						
R_L =	0.0805						

Note: Transformer specifications were not available; the characteristics used here are assumed values used for the purposes of completing the calculation.

Transformer Consolidation Electrical Depth 1

As designed, the Wentz Concert Hall and Fine Arts Center has five transformers to serve its 120/208V systems. How many of these could be consolidated into a single transformer, and what would the effect of fewer but larger transformers on the overall cost of the electrical system?

One of the transformers, TLL-LDP-1, serves the kitchen and miscellaneous lighting and power loads throughout the building. Others are dedicated to more specific purposes: T1-TLDP-1 serves the concert hall, T1-TLDP-2 serves the black box theater, T1-DCTP-1 is a power conditioner for the audiovisual system, and TLL-ELP-1 receives power from an emergency transfer switch to serve most of the emergency loads.

These transformers can't all be consolidated to a central device; the clean technical power needs to remain on an isolated system with its own power conditioner. The other four can be, provided that the generator and fire pump are switched to 208/120V so that the emergency panel no longer needs a transformer.

The central transformer will be located in the main electrical room on the lower level (LL49), where TLL-LDP-1 is currently sited. To accommodate a larger transformer, the wall shared with the emergency electrical room (LL50) can be moved several feet, which no longer needs space for TLL-ELP-1.

Several changes must be made to accommodate the proposed system. Feeders directly to the 208/120V panelboards are sized up from what originally served the transformers. The generator, firepump, and emergency transfer switches are replaced to operate at 208/120V. And, of course, four of the transformers are replaced by a single large unit. The new transformer will be fed directly from the main switchboard.

Cost estimates used are total prices including materials, labor, overhead, and profit, and are based on data from Q1 2012.

Panelboards

The distribution panel LL-HDP-1 serves, T1-DCTP-1, LL-ELP-1 (via ATS-1), and TLL-LDP-1. The second and third of these transformers will be removed, and LL-HDP-1 can be removed (and replaced with a 208/120 V panel), as it would now only be serving the clean technical power transformer.

The new transformer will require a panel (located in the space left by LL-HDP-1), to distribute power to the panels originally served by their own transformers. This panel, LL-LDP, will include the following loads:

Panel	Demand Load (KVA)
1-TLDP-1	116.2
1-TLDP-2	100.3
LL-ELP-1	38
LL-LDP-1	206.9
Total	**461.4**

This gives a demand ampacity of 3841A, which can't be met with a 4000A bus switchboard.

Table 2: Original Distribution Panel Costs

	Original Design	
Tag	Panel Size	Cost
1-TLDP-1	800 A	$ 4,375.00
1-TLDP-2	1400 A	$ 5,625.00
LL-ELP-1	400 A	$ 2,860.00
LL-LDP-1	1200 A	$ 5,275.00
Total		$ 18,135.00

Table 3: Redesigned Distribution Panel Costs

	Proposed Centralized Design	
Tag	Panel Size	Cost
LL-LDP	4000 A	$12,200

Transformer

The new transformer, TLL-LDP is sized at 500 kVA to supply the LL-LDP panelboard described above.

It replaces T1-TLDP-1, T1-TLDP-2, TLL-ELP-1, and TLL-LDP-1.

Table 4: Original Transformer Costs

	Original Design	
Tag	Transformer Size	Cost
1-TLDP-1	225 kVA	$8,624
1-TLDP-2	225 kVA	$8,624
LL-ELP-1	30 kVA	$2,800
LL-LDP-1	300 kVA	$10,690.00
Total		$30,738.00

Table 5: Redesigned Transformer Costs

	Proposed Centralized Design	
Tag	Transformer Size	Cost
TLL-LDP	500 kVA	$16,325

Feeders

One effect of a centralized transformer is that larger wires are required to distribute power out to the 208/120V panelboards, increasing wiring cost.

Table 6: Original Feeder Costs

	Original Design							
Load	Type	Phase/N	Ground	Raceway	Length (ft)	Feeder cost / ft	Raceway cost / ft	Total cost
T1-TLDP-1	THHN	(3) 350	3	2 1/2"	135	16.705	28.5	$ 6,102.68
T1-TLDP-2	THHN	(3) 350	3	2 1/2"	165	15.03	28.5	$ 7,182.45
LL-ELP-2	THHN	(3) 8	10	3/4"	15	4.28	10.25	$ 217.95
LL-LDP-1	THHN	(3) 500	3	3"	30	20.72	36.2	$ 1,707.60
FPC-ATS	THHN	(4) 1	n/a	1 1/4"	25	8.48	14.85	$ 583.25
LL-HDP-1	THHN	2x (4) 500	1/0	3 1/2"	15	50.8	44.9	$ 1,435.50
T1-DCTP-1	THHN	(3) 1	8	1 1/4"	155	7.515	14.85	$ 3,466.58
Total:								$ 20,696.00

Table 7: Redesigned Feeder Costs

	Proposed Centralized Design									
Load	Design KVA	Design A	Type	Phase/N	Ground	Raceway	Length (ft)	Feeder cost / ft	Raceway cost / ft	Total cost
1-TLDP-1	133	369	THHN	(4) 400	3	3"	135	24.235	36.2	$ 8,158.73
1-TLDP-2	146	405	THHN	(4) 500	2	3"	165	27.075	36.2	$10,440.38
LL-ELP-1	30	83	THHN	(4) 5	8	1"	15	9.7	12.21	$ 328.65
LL-LDP-1	244	677	THHN	2x (4) 350	2x 3	3 1/2"	30	43.43	44.9	$ 2,649.90
FPC-ATS	80	222	THHN	(4) 3/0	4	2"	25	14.13	20.15	$ 857.00
LL-LDP	462	1282	THHN	3x (4) 500	3	(3) 2 1/2"	15	81.225	85.5	$ 2,500.88
T1-DCTP-1	75	90	THHN	(3) 1	8	1 1/4"	165	7.515	14.85	$ 3,690.23
Total:										$28,625.75

Overall cost

Table 8: Original and Redesign Cost Comparison

Category	Original Cost ($)	Centralized Cost ($)
Panels	$ 18,135.00	$ 12,200.00
Transformers	$ 30,738.00	$ 16,325.00
Feeders	$ 20,696.00	$ 28,625.75
Total	$ 69,569.00	$ 57,150.75

As you can see, the cost of the distribution panels and feeders is somewhat lower for a centralized panelboard. But this comes with the cost of slower installation and the possibility of needing to oversize feeders or branch circuits to reduce voltage drop. Additionally, centralizing the transformers introduces a single point of failure to the system. If the transformer has a defect, it would cut off power to the entire 120/208V system.

Photovoltaic Array Electrical Depth 2

With the escalating cost of energy, photovoltaic power generation has become more and more popular. In this depth, I'll propose the addition of a solar system on the Wentz Concert Hall's upper roof.

Equipment

Panel

The system uses a crystalline silicon SunPower SPR-210-BLK solar panel, with an overall efficiency of 16.89%. It produces a maximum power of 210.1 W_{DC} at 40 V_{DC} and 5.25 A_{DC}. The open circuit voltage is 47.7 V_{DC} per panel, and short circuit current is 5.75 A_{DC}. Each module is composed of 72 cells connected in series.

The panels are 61.4 inches long, 31.4 inches wide, and 1.8 inch thick. They each weigh 33 lbs. Panels are estimated to cost $2.05 per W_{DC}.

Inverter

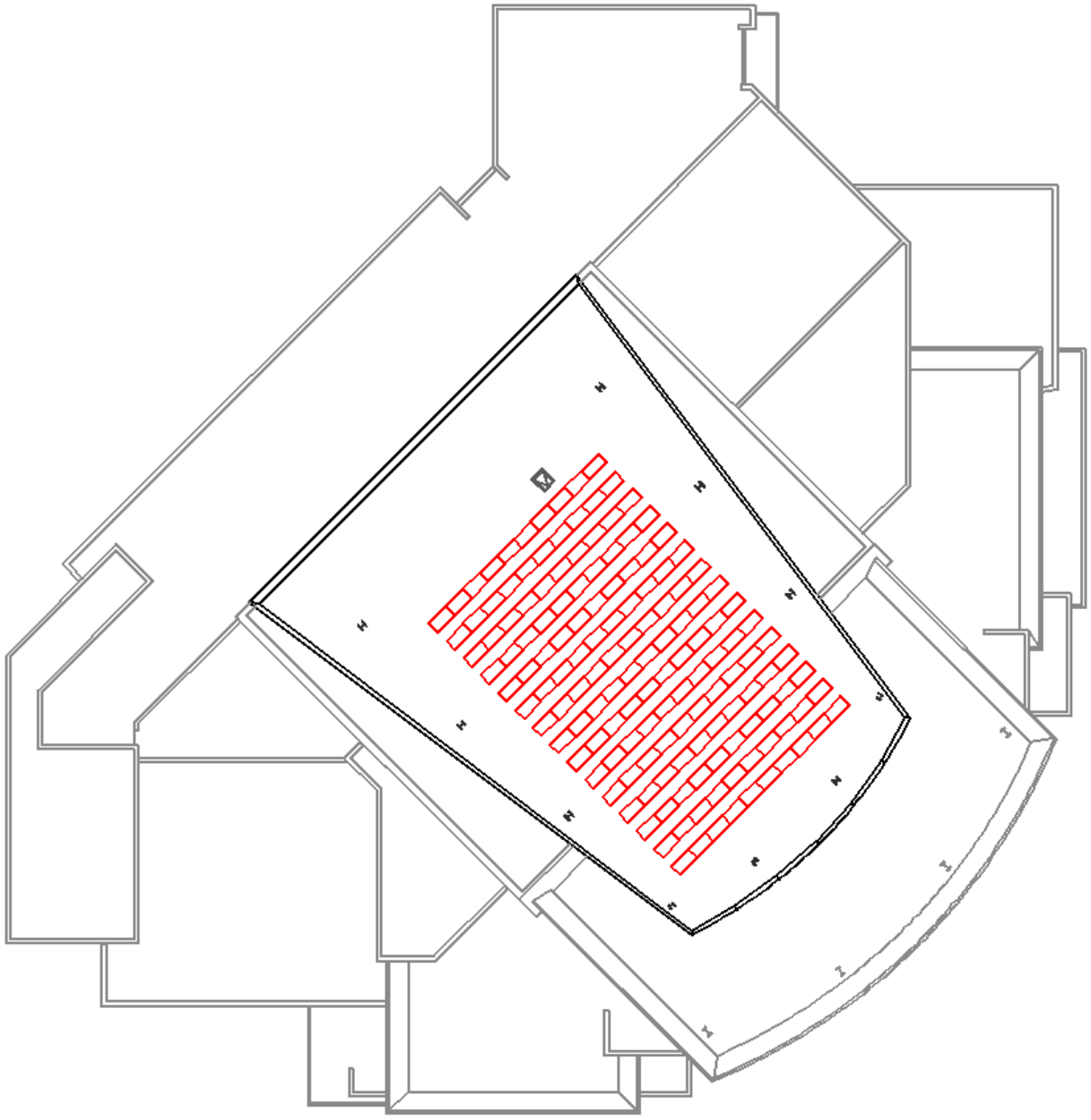
The inverter is a PV Powered PVP35kW-480, which converts from a maximum of 125 A and 600 V_{DC} to AC at 480V. It can convert up to 36.5 kW_{DC} to 35 kW_{AC}. The inverter cost is estimated at $0.37 per W_{DC}. Additional costs, such as installation and installer margin are estimated to cost $1.72 per W_{DC}.

A single inverter is used instead of microinverters because the concert hall is the highest building in the area, and inter-row shading wouldn't differ between strings because of the regular layout.

Layout

The roof has a very slight north facing slope, from 753 ft. elevation at the southeast edge, to 748 ft. toward the northwest. Modules are sloped at a relatively shallow 15 degrees, to allow tighter spacing without inter-row shading on the space constrained roof. The panels are arranged for 50% cover. They face southeast, to align with the roof and account for the building's heaver use earlier in the day.

Figure 23: Photovoltaic Array Layout



The panels extend to a closest distance of 6 feet from the edge of the roof. They are arranged in 15 rows of 10, for a total of 150 panels. Each row of 10 panels is connected in series to produce a maximum of $470V_{DC}$.

Output

With 150 panels at 210.1 W_{DC}, the system produces a maximum of 315.2 kW_{DC}. According to a simulation run in NREL's System Advisor Model, it has an annual estimated output of 39,440 kWh.

Electrical Connection

Each string has a short circuit current of 5.75A, and is protected and isolated by a small solar fuse to prevent overcurrent or reverse current in case of a fault in a string. These fuses are sized at 9A (the next size above 150% I_{SC}) and are located in a solar combiner box, which collects the DC from each string and combines it into a single DC output, which is sent to the inverter.

The inverted takes the DC current and converts to AC at 480Y/277 V, which is fed into the main switchboard. Its peak output is 35 kW at minimum 0.99 power factor. This gives a current of 73 A, and can be connected with size 3 AWG wires.

Economics

The economics are analyzed for a 25 year period with a projected inflation of 2%, real discount rate of 5.20%. In accordance with Illinois' Special Assessment for Solar Energy Systems, the property taxes are assessed at the price of a standard electrical system. It uses 5 year accelerated depreciation at the federal and state level.

Illinois doesn't currently have a market for Solar Renewable Energy Credits, but they will beginning in energy year June 2012 to May 2013. It is difficult to predict how this market will perform over the next 25 years, but I have assumed a price of $100 per MWh for 15 years. The SRECs are purchased by utility companies from independent solar operators to count toward minimum renewable generation requirements.

The estimated real levelized cost of energy of the system is 13.43 ¢/kWh. This is higher than the current electric rate, but due to inflation and increasing electric rates, the system should pay off after 22.7 years. Since the system is expected to last 25-30 years, it shouldn't lose money, but it may not be the best investment. It is more justifiable as an effort to reduce dependence on energy produced by fossil fuels than as a long term financial investment.

Conclusion

The design solutions presented here are aimed largely at reducing the Wentz Concert Hall and Fine Arts Center's electrical demands, and at creating a lighting design scheme that ties into the architectural style to achieve its effect without requiring large amounts of power. The lobby lighting is both welcoming and efficient, the concert hall has drastically reduced power requirements while giving it an even more memorable appearance, and the façade's colored top level marks the center as an important building from far away. As a long lasting institution established in 1861, North Central College has an interest looking to the future and reducing its energy dependence. These alternate designs are a good start to moving the college toward that goal.

Acknowledgements

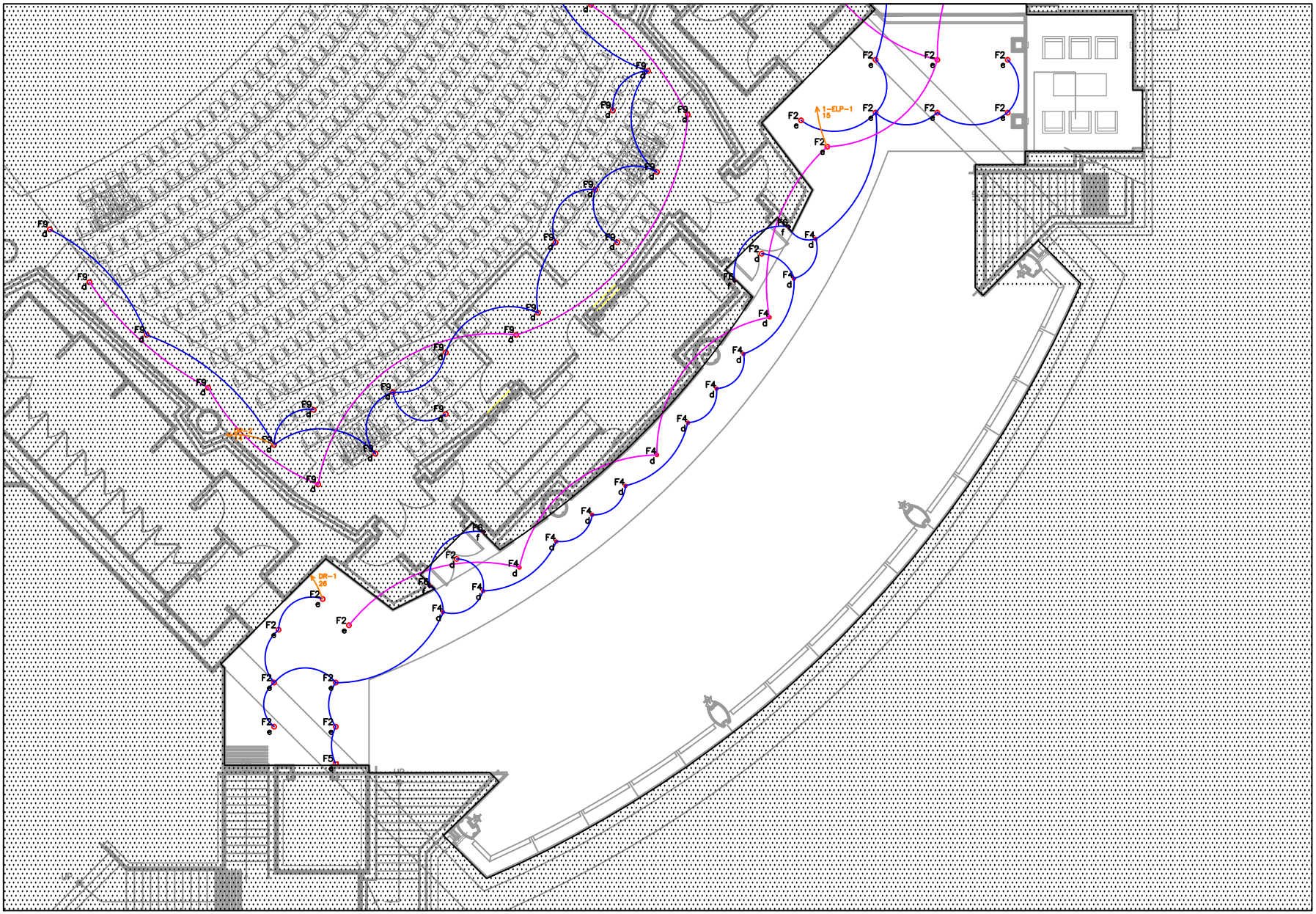
Thank you to my thesis advisors, Dr. Richard Mistrick and Prof. Ted Dannerth for their assistance throughout this project, and to Prof. Robert Holland and Prof. Kevin Parfitt for their efforts as senior thesis coordinators.

Thanks to Emily Klingensmith at Schuler Shook for her help with obtaining a building for this thesis, and to Mike Hudson and Donald Koletsos at North Central College for giving me a tour of the facility and answering questions about its design and construction.

Thank you to everyone at Schuler Shook for all that I learned during my internship there.

A special thanks to all of my friends and family, who have been incredibly supportive through my time at Penn State.

Appendix A
Electrical Plans



E1	Main Lobby – 1st level lighting plan (South)	
	Drawn: 3/31/2012	Scale: 1/16” = 1’

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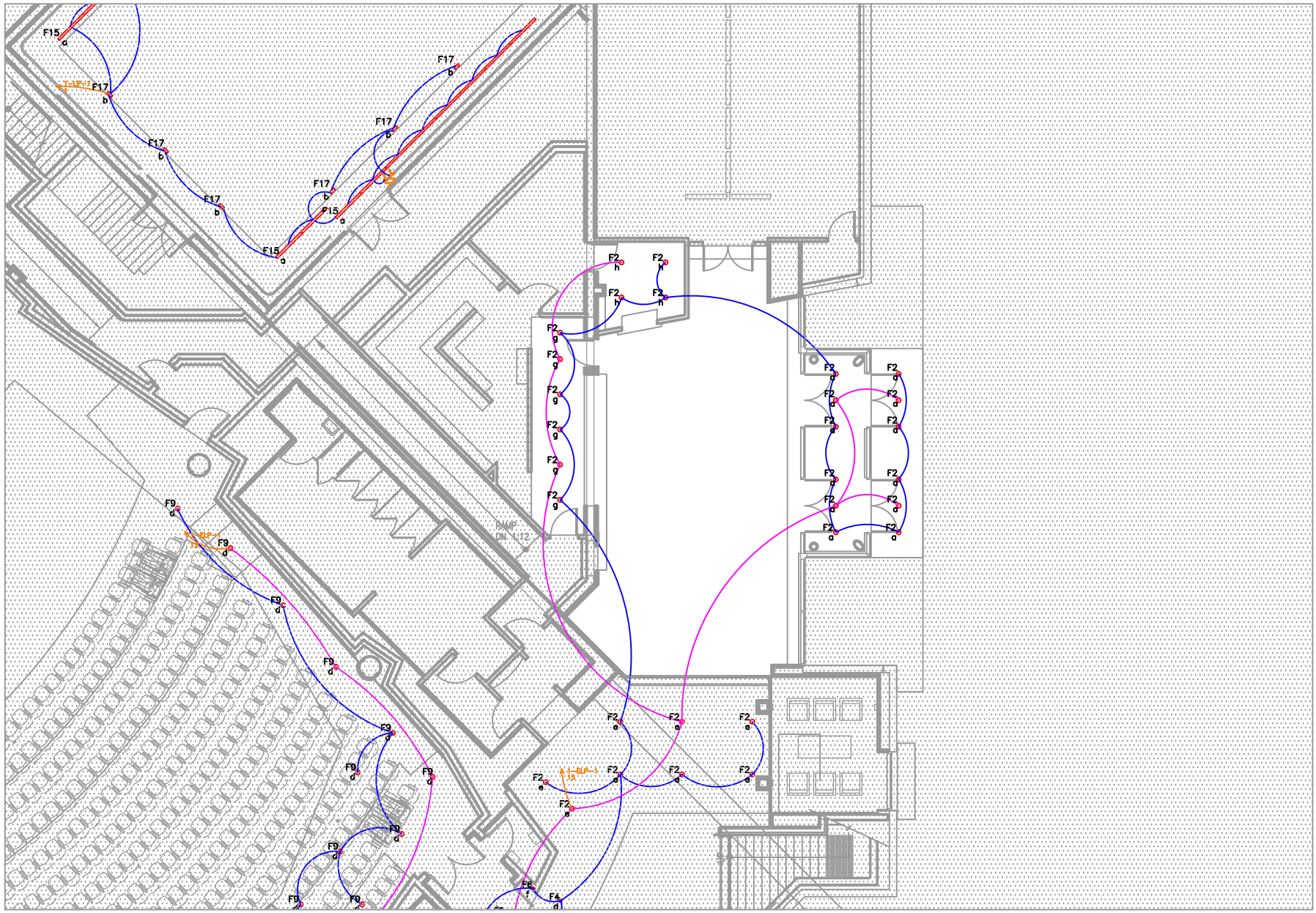

E2	Main Lobby – 1st level lighting plan (North)	
	Drawn: 3/31/2012	Scale: 1/16" = 1'

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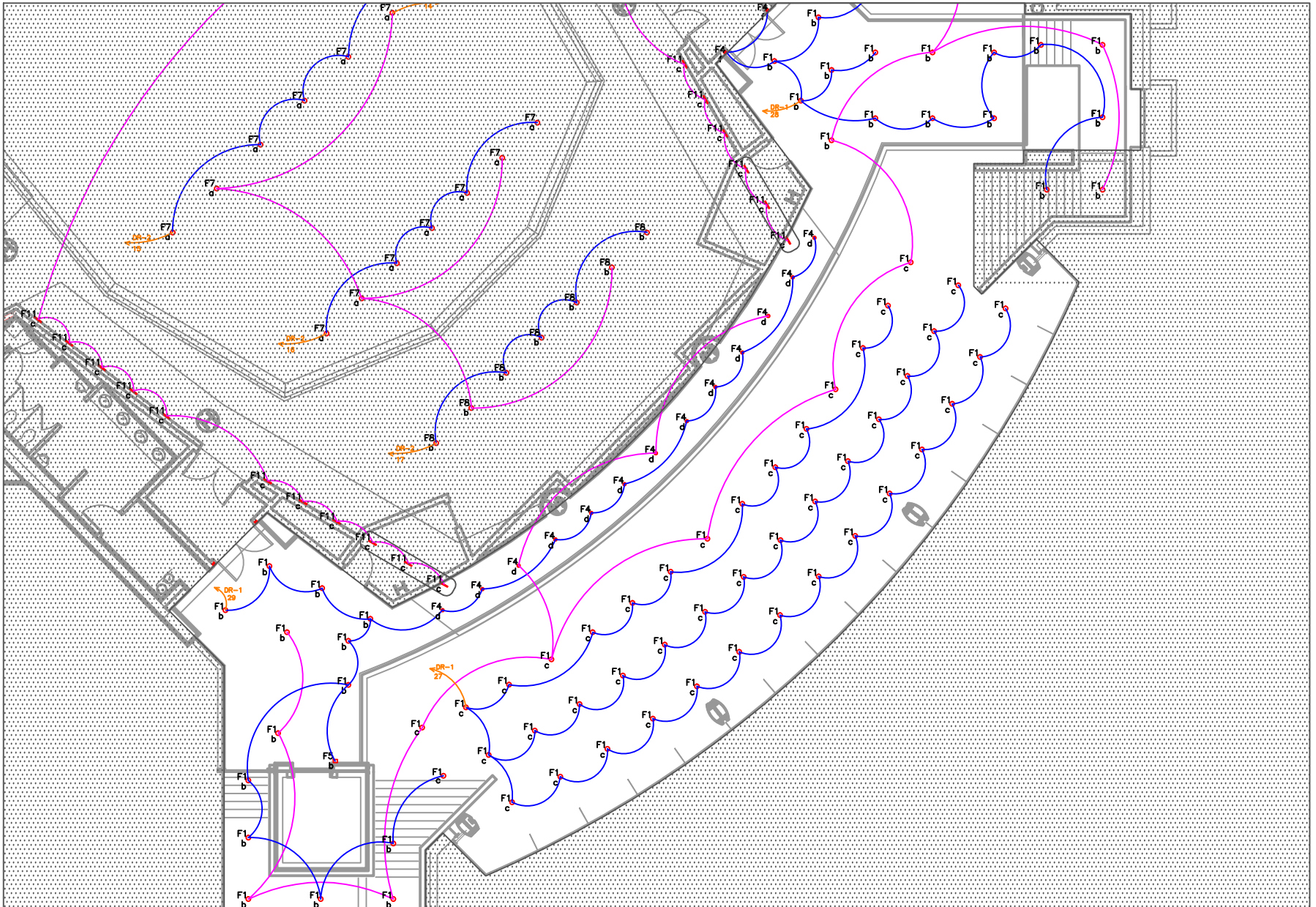

E3	Main Lobby – Balcony level lighting plan (South)
	Drawn: 3/31/2012 | Scale: 1/16" = 1'

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E4	Main Lobby – Balcony level lighting plan (North)	
	Drawn: 3/31/2012	Scale: 1/16" = 1'

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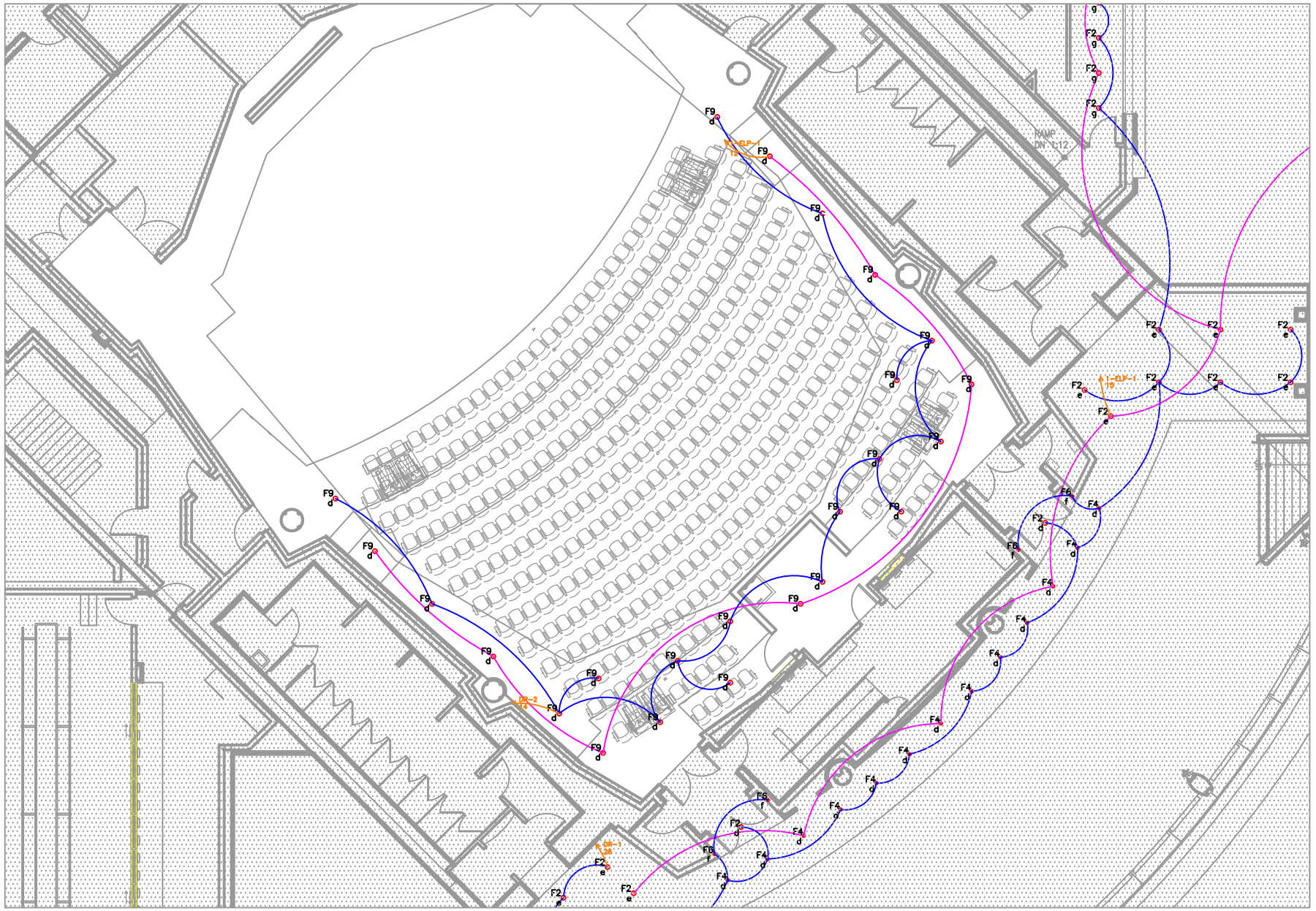

E5	Concert Hall – 1st level lighting plan	
	Drawn: 3/31/2012	Scale: 1/16" = 1'

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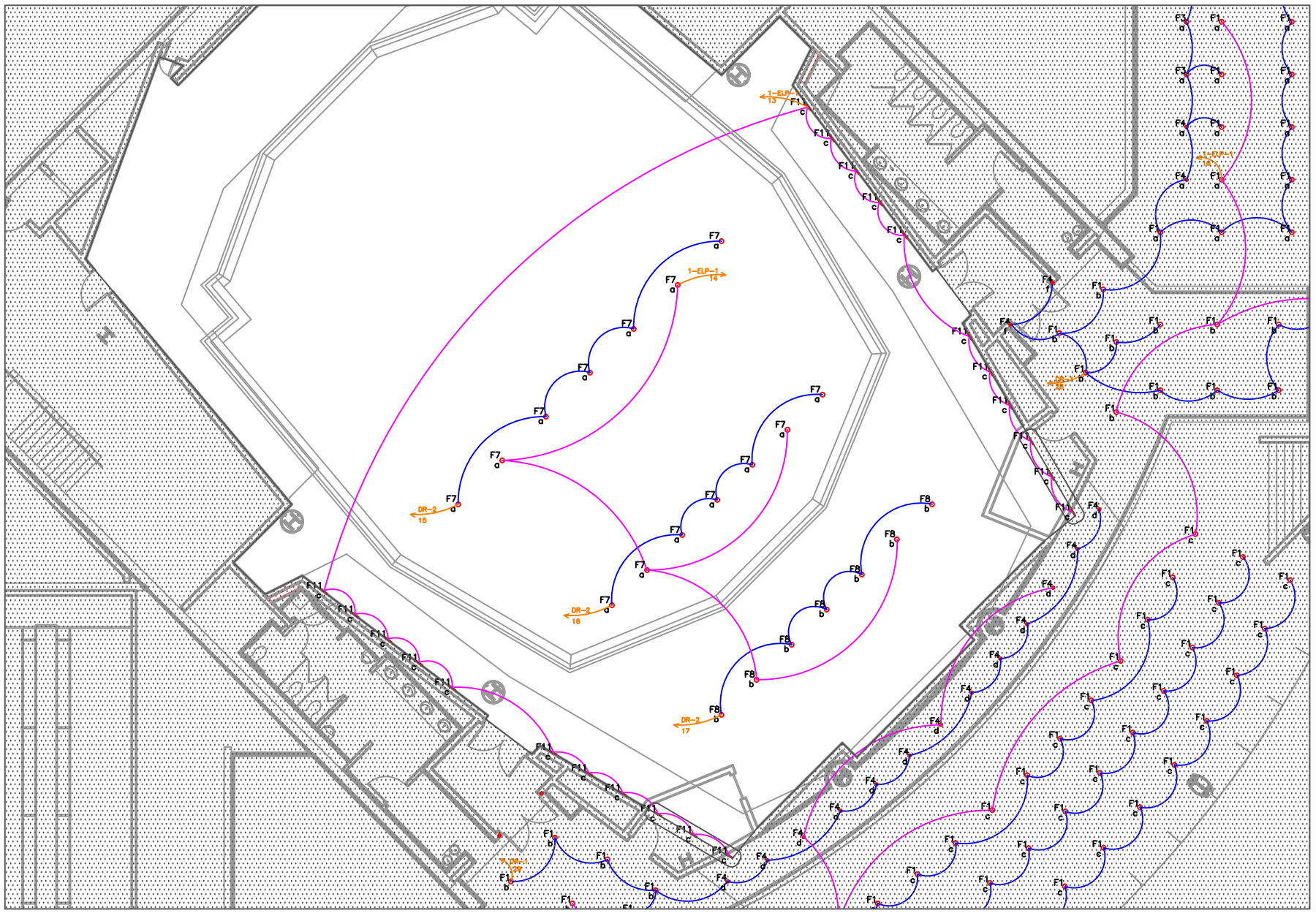

E6	Concert Hall – Balcony level lighting plan	
	Drawn: 3/31/2012	Scale: 1/16" = 1'

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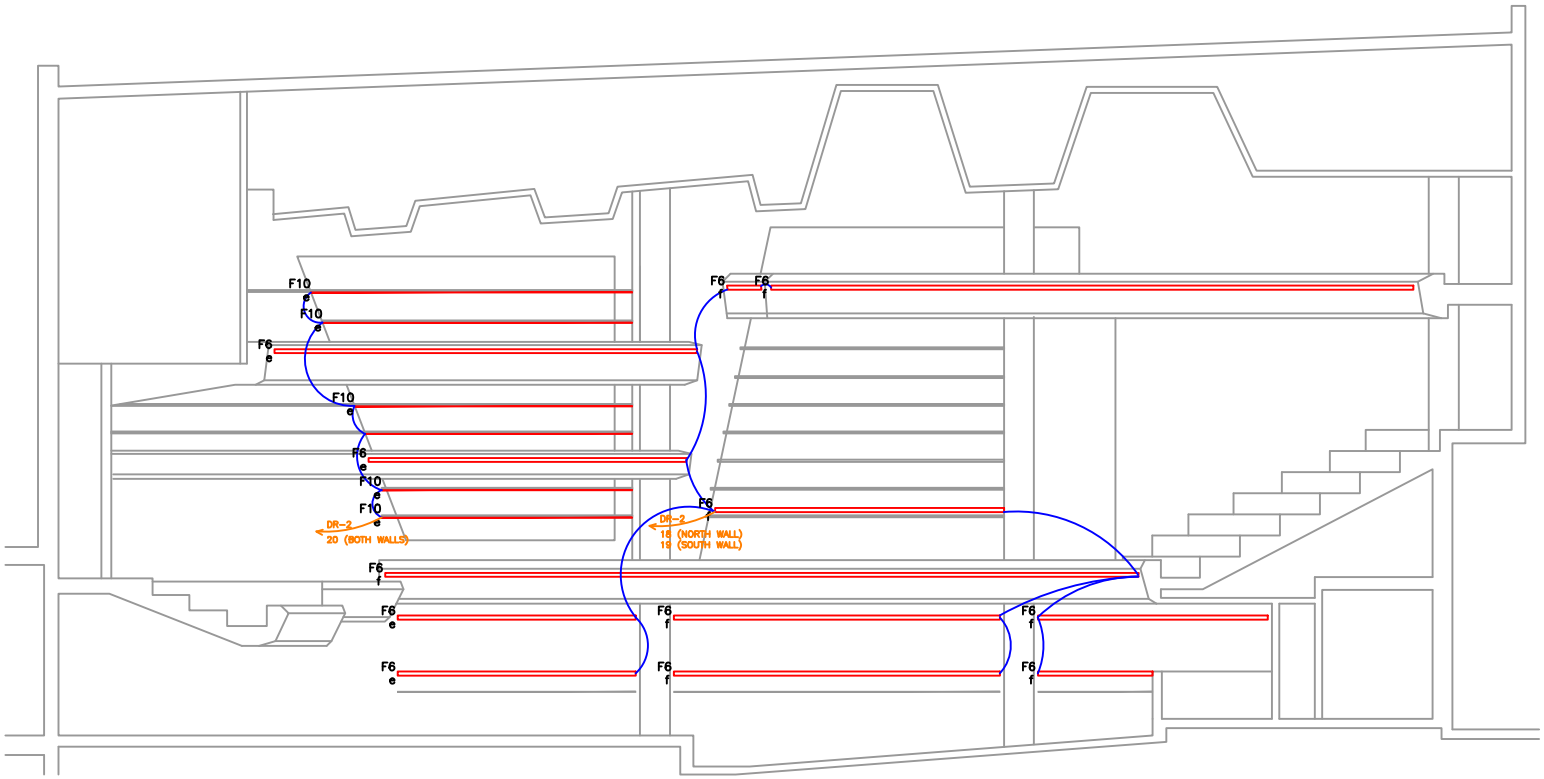

E7	Concert Hall – Side Wall Lighting Plan	
	Drawn: 3/31/2012	Scale: 1/16" = 1'

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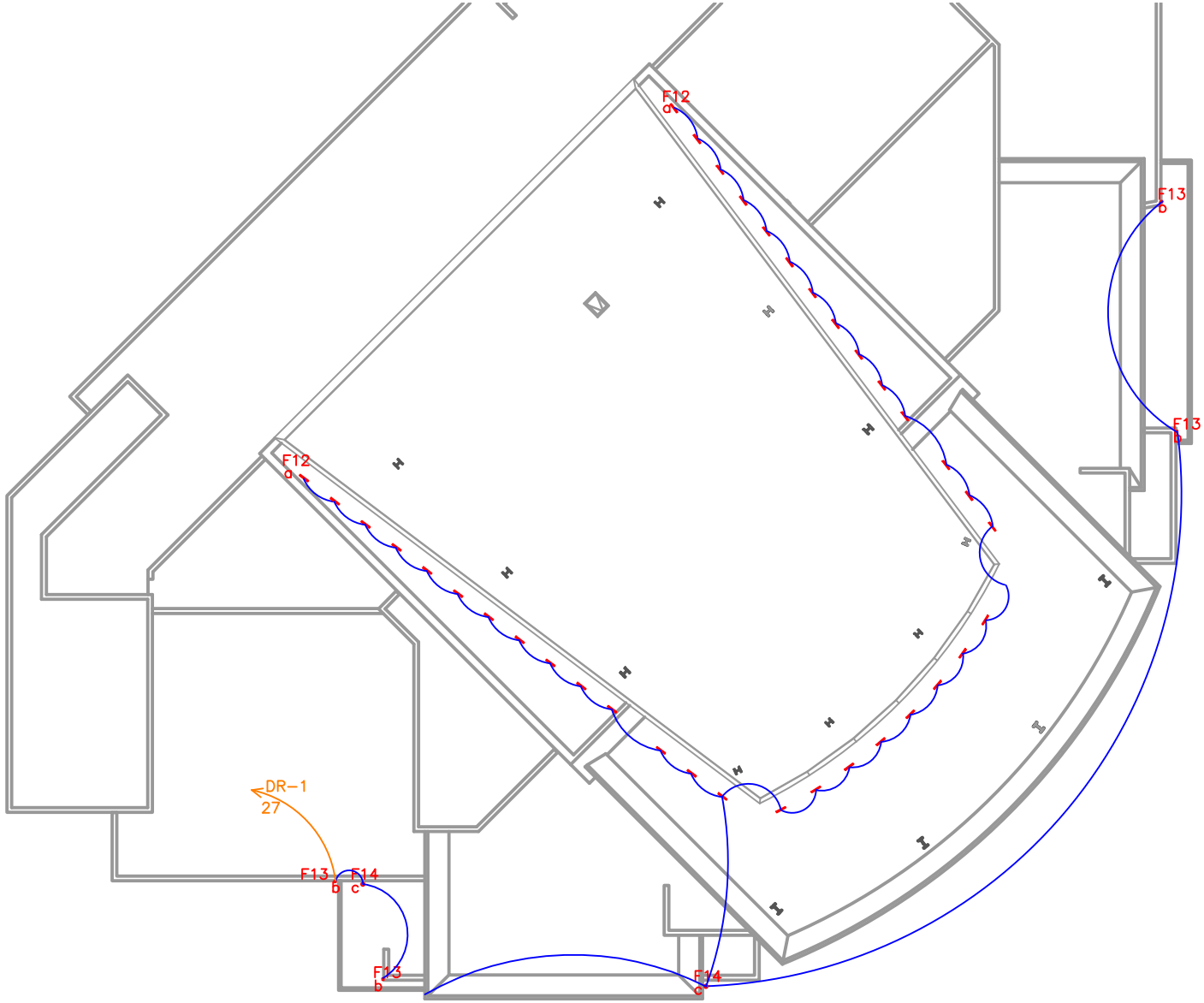

E8	Facade – Lighting Plan	
	Drawn: 3/31/2012	Scale: 1/32" = 1'

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E9	Rehearsal Room – 1st level lighting plan	
	Drawn: 3/31/2012	Scale: 3/32" = 1'

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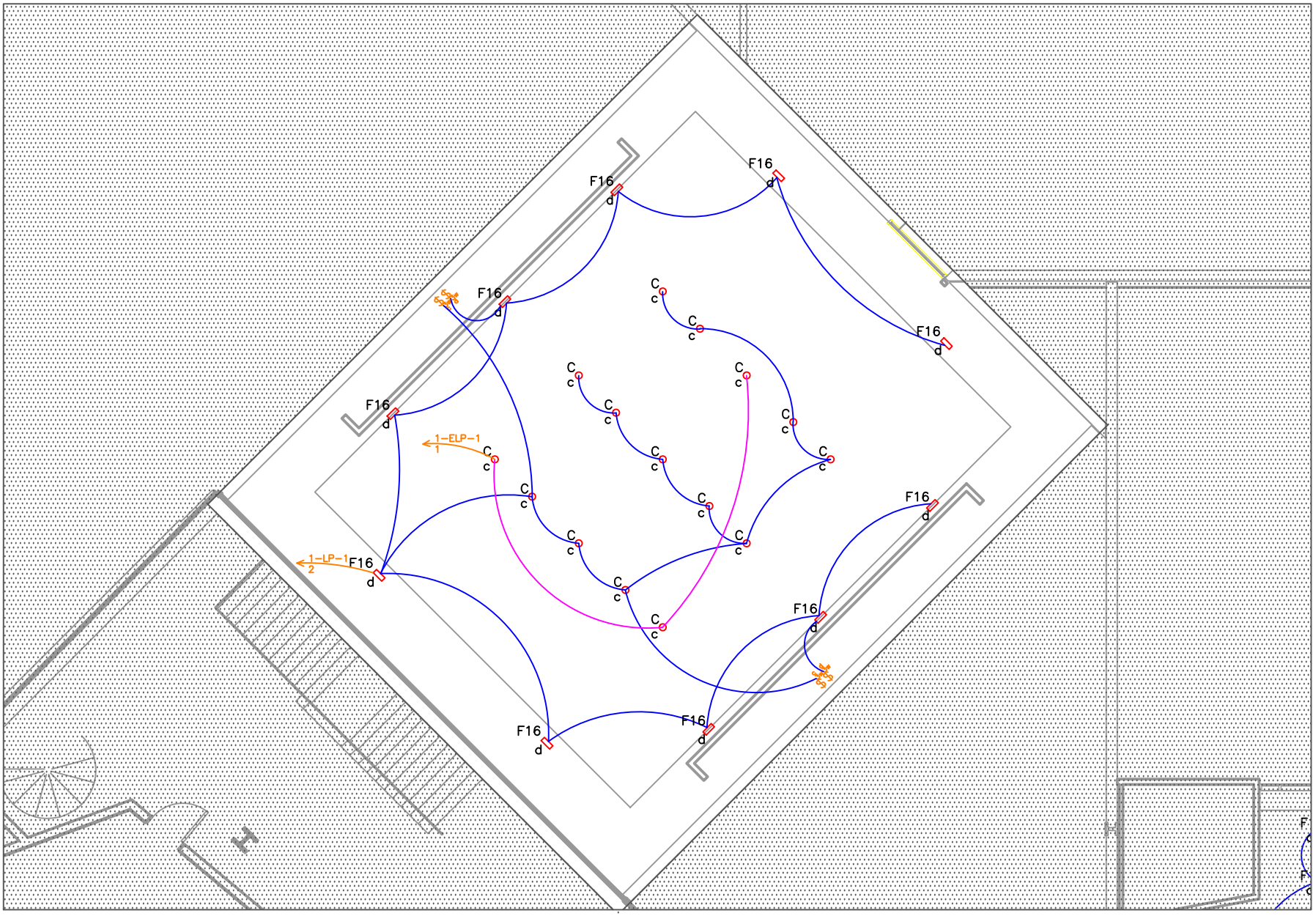

E10	Rehearsal Room – Balcony level lighting plan	
	Drawn: 3/31/2012	Scale: 3/32" = 1'

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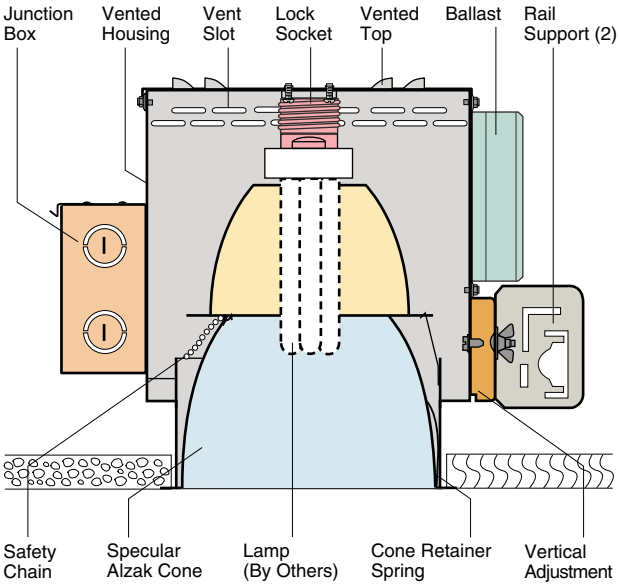
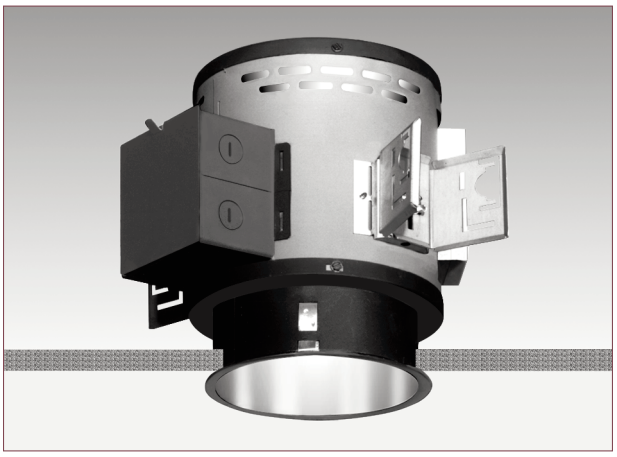
Appendix B
Luminaires, Lamps, and Ballasts





P926 One 26W or 32W Triple Tube Lamp
P927 One 42W Triple Tube Lamp

Medium Beam
5⅞" Conoid Apertures

Optics and Applications
Distribution from a single vertically mounted triple tube lamp is for general lighting. Spacing to mounting height ratios range from .93 to 1.11 depending upon which lamp is mounted. Use in corridors, entries, work stations or open area lighting in low to medium height ceilings.

Design Features
The two reflector optical system is protected by a rigid steel housing which keeps the reflectors in proper relationship to each other. The twist and lock socket prevents the lamp from falling if it is not properly engaged. It is a dependable fail-safe mechanism to prevent injury and litigation. Maximum ceiling thickness is 2". Ballast and lamp service from below.

Finish
Specular clear Alzak cones are standard. Optional colors and Softglow® finishes are available. Housings and structural parts are painted optical matte black to suppress stray light leaks. Steel parts are phosphate conditioned for corrosion resistance before painting.

Ballasts
Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage ranges from 120V through 277V. Power factor .98, starting temperature 0° F (-18° C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

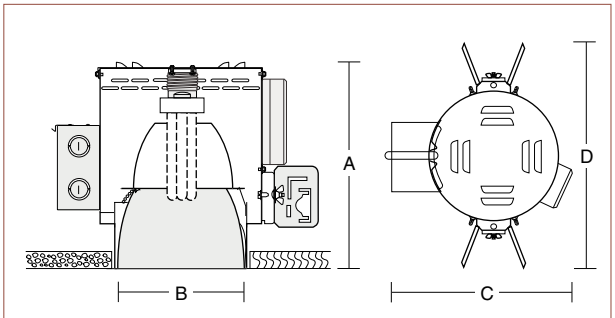
General
Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Rating (LER) data is in the photometric directory located in Section Z.

Accessories

G	Gold cone.	R2	26" support rails.
H	Mocha cone.	R5	52" support rails.
P	Graphite cone.	WT	White trim flange.
T	Titanium cone.	WHT	White complete trim.
W	Wheat cone.	V347	347 volt ballast.
Y	Pewter cone.	F	Fuse.
Z	Bronze cone.		

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
DM Dimming ballast. Specify watts and volts.
EM Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.
WRL Wattage restriction label, specify wattage.

Dimensions and Lamps



Number	A Depth*	B Aperture	C Width	D Length	Lamps
P926	9¾" 248mm	5⅞" 149mm	10½" 267mm	13¼" 337mm	26W or 32W Triple Tube
P927	10¼" 260mm	5⅞" 149mm	10½" 267mm	13¼" 337mm	42W Triple Tube

*Recess depth increases to 12½" with EM and DM accessories.

kurt versen
Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

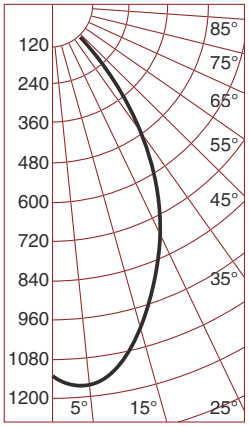
P51 P926 P927

Performance Datachart

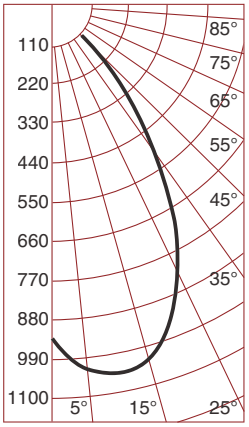
Single Unit Initial Footcandles, 30" Work Plane							Ceiling to Floor	Multiple Units Initial Footcandles, 30" Work Plane			
P926 One 32W Osram Triple Tube Read Top Data P927 One 42W Osram Triple Tube Read Bottom Data								Ceiling 80% Walls 50% Floor 20%			
Nadir	10°		20°		30°			Spacing is Maximum Over Work Plane			
FC	FC	Diam	FC	Diam	FC	Diam		Spacing	RCR 1	RCR 3	RCR 8
37 47	35 42	2' 2'	25 30	4' 4'	13 17	6' 6'	8'	5' 5'	49 66	42 56	30 39
27 33	25 30	2' 2'	18 21	5' 5'	10 12	8' 8'	9'	6' 6'	35 47	30 40	21 28
20 25	19 23	3' 3'	14 16	5' 5'	7 9	9' 9'	10'	7' 7'	26 36	23 30	16 21
13 16	12 14	3' 3'	8 10	7' 7'	4 6	11' 11'	12'	9' 9'	17 22	14 19	10 13
9 11	8 10	4' 4'	6 7	8' 8'	3 4	13' 13'	14'	11' 11'	11 15	10 13	7 9

See notes 4, 5 and 6.

Candlepower Distribution



P926 32W Triple Tube Osram
Eff. 50% S/M .95



P926 32W Triple Tube Philips
Eff. 50% S/M 1.11

Candelas

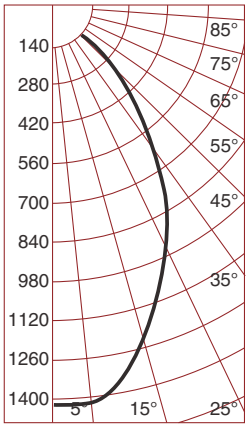
	O 32W	P 32W
o	2400*	2400*
0	1134	938
5	1152	1021
10	1109	1055
15	1023	1020
20	916	956
25	789	837
30	625	667
35	460	467
40	353	321
45	212	173
50	19	16
55	7	6
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

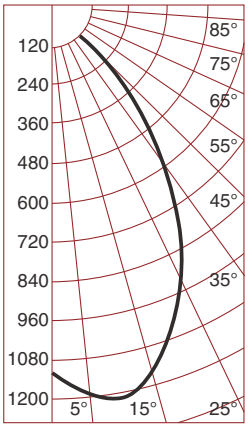
Coefficients of Utilization

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.57	.56	.55	.53	.55	.52	.53	.51	.51	.49	.47
2	.54	.52	.50	.48	.51	.47	.49	.46	.48	.45	.43
3	.51	.48	.45	.43	.47	.43	.46	.42	.45	.41	.40
4	.48	.44	.41	.39	.44	.39	.43	.38	.42	.38	.37
5	.46	.41	.38	.36	.41	.36	.40	.35	.39	.35	.34
6	.43	.38	.35	.33	.38	.33	.37	.33	.36	.32	.31
7	.41	.36	.33	.30	.35	.30	.35	.30	.34	.30	.29
8	.39	.34	.30	.28	.33	.28	.33	.28	.32	.28	.27
9	.37	.31	.28	.26	.31	.26	.31	.26	.30	.26	.25
10	.35	.30	.26	.24	.29	.24	.29	.24	.28	.24	.23

P926 One 32W Triple Tube Osram Sylvania
P926 One 32W Triple Tube Philips x .98



P927 42W Triple Tube Osram
Eff. 48% S/M .93



P927 42W Triple Tube Philips
Eff. 44% S/M 1.07

	O 42W	P 42W
o	3200*	3200*
0	1412	1104
5	1403	1188
10	1328	1211
15	1176	1154
20	1092	1063
25	958	919
30	789	747
35	611	583
40	487	441
45	355	253
50	75	23
55	10	8
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.56	.55	.54	.53	.54	.52	.52	.50	.50	.49	.46
2	.53	.51	.49	.47	.50	.47	.48	.46	.47	.45	.43
3	.51	.47	.45	.43	.47	.42	.45	.42	.44	.41	.39
4	.48	.44	.41	.39	.43	.38	.42	.38	.41	.38	.36
5	.45	.41	.38	.35	.40	.35	.39	.35	.39	.35	.34
6	.43	.38	.35	.33	.38	.32	.37	.32	.36	.32	.31
7	.40	.35	.32	.30	.35	.30	.34	.30	.34	.30	.29
8	.38	.33	.30	.28	.33	.28	.32	.28	.32	.27	.27
9	.36	.31	.28	.26	.31	.26	.30	.26	.30	.26	.25
10	.34	.29	.26	.24	.29	.24	.29	.24	.28	.24	.23

P927 One 42W Triple Tube Osram Sylvania
P927 One 42W Triple Tube Philips x .89

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P926	32W Osram Sylvania Triple Tube	10	33	66	150	12837
	32W Philips Triple Tube	12	34	62	151	10756
P927	42W Osram Sylvania Triple Tube	14	45	91	208	17796
	42W Philips Triple Tube	15	45	82	203	14468

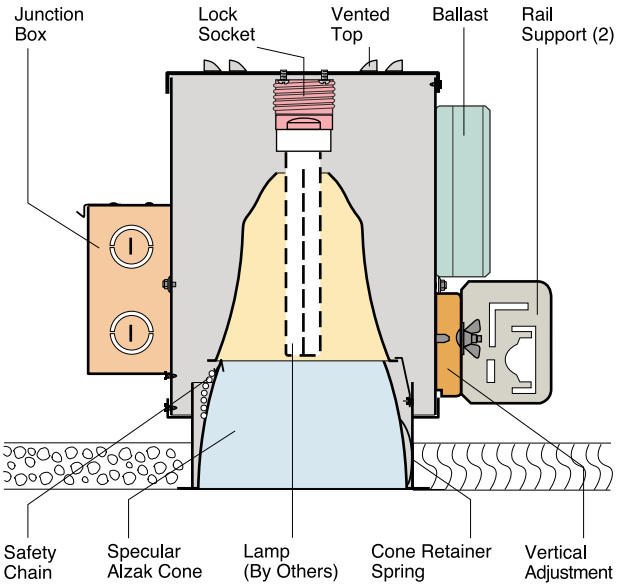
Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 7.

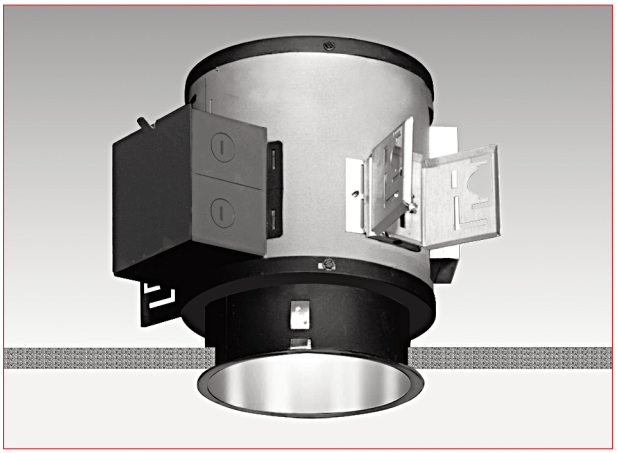
Notes

1 Data on all charts calculated with a clear specular cone finish.
2 Specular cone multipliers: Wheat x .84, Pewter x .79, Mocha x .78, Graphite x .75, Titanium x .75, Bronze x .72.
3 Softglow® cone multipliers: Wheat x .71, Mocha x .68, Pewter x .65, Graphite x .64, Titanium x .64, Bronze x .61.
4 Single unit Datachart pattern diameters are determined by the number of degrees from each side of nadir. Therefore a 20° diameter represents a total 40° pattern width at the work plane 30" above the floor. Footcandle values are at the edge of that diameter.
5 Datachart spacing is rounded off to the nearest foot.
6 Data by IES methods. Compact fluorescent data vary due to lamp differences, power input, burning position, ambient temperature and ballast characteristics. Apply a modification factor.
7 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

P626

Narrow Beam
One 26W Quad Tube Lamp
5 7/8" Conoid Aperture





Optics and Applications
Narrower distribution for general and task lighting from a single vertically mounted quad tube lamp. Spacing to mounting height ratio is .81 with a soft edge pattern. Use in corridors, entries and over work stations.

Design Features
The optical system has a computer designed primary reflector and a parabolic low brightness shielding cone. A twist and lock socket prevents the lamp from falling if it is not properly engaged. It is a dependable fail-safe mechanism to prevent injury and litigation. Maximum ceiling thickness 2". Ballast and lamp service from below.

Finish
A specular clear Alzak cone is standard. Optional colors and Softglow® finishes are available. The housing and all structural parts are phosphated for corrosion resistance before being painted optical matte black for control of stray light leaks.

Ballast
Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage range from 120V through 277V. Power factor .98, starting temperature 0°F (-18°C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

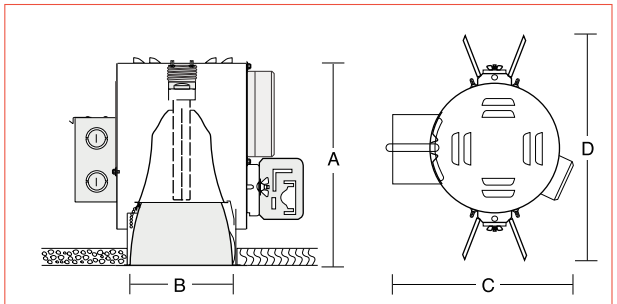
General
Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Rating (LER) data is in the photometric directory located in Section Z.

Accessories

G	Gold cone.	R2	26" support rails.
H	Mocha cone.	R5	52" support rails.
P	Graphite cone.	WT	White trim flange.
T	Titanium cone.	WHT	White complete trim.
W	Wheat cone.	V347	347 volt ballast.
Y	Pewter cone.	F	Fuse.
Z	Bronze cone.		

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
DM Dimming ballast. Specify watts and volts.
EM Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.

Dimensions and Lamps



Number	A Depth*	B Aperture	C Width	D Length	Lamps
P626	11 1/2" 292mm	5 7/8" 149mm	10 1/2" 267mm	13 1/4" 337mm	One 26W Quad Tube

For 18W lamps, add W 18 to catalog number.
*Recess depth increases to 13" with EM and DM accessories.

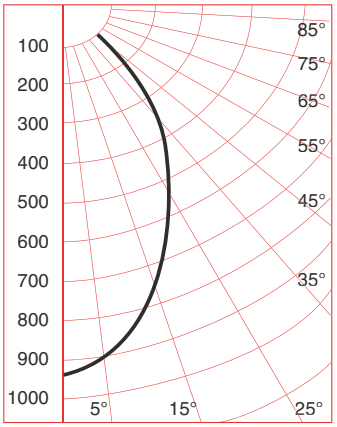
P626

Performance Datachart

Single Unit Initial Footcandles, 30" Work Plane							Ceiling to Floor	Multiple Units Initial Footcandles, 30" Work Plane			
P626 One 26W Quad Tube lamp								Ceiling 80% Walls 50% Floor 20%			
Nadir	15°		25°		35°			Spacing is Maximum Over Work Plane			
FC	FC	Diam	FC	Diam	FC	Diam		Spacing	RCR 1	RCR 3	RCR 8
31	22	3'	13	5'	6	8'	8'	4'	47	41	29
23	16	3'	9	6'	4	9'	9'	5'	34	29	21
17	12	4'	7	7'	3	11'	10'	6'	25	22	16
13	9	5'	6	8'	3	12'	11'	7'	20	17	12
11	8	5'	4	9'	2	13'	12'	8'	16	14	10

See notes 4 and 5.

Candlepower Distribution



P626 One 26W Quad Tube lamp
Eff. 48% S/M .81

Candelas

	26W
o	1800*
0	952
5	907
10	832
15	752
20	649
25	534
30	422
35	342
40	256
45	120
50	28
55	4
60	0
65	0
70	0
75	0
80	0
85	0
90	0

o Vertical Angles
* Initial Lamp Lumens

Coefficients of Utilization

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.54	.52	.51	.50	.51	.49	.49	.48	.47	.46	.44
2	.51	.48	.46	.45	.48	.44	.46	.43	.45	.42	.41
3	.48	.45	.42	.41	.44	.40	.43	.40	.42	.39	.38
4	.45	.42	.39	.37	.41	.37	.40	.36	.39	.36	.35
5	.43	.39	.36	.34	.38	.34	.38	.33	.37	.33	.32
6	.41	.36	.33	.31	.36	.31	.35	.31	.35	.31	.30
7	.39	.34	.31	.29	.34	.29	.33	.29	.32	.29	.28
8	.37	.32	.29	.27	.32	.27	.31	.27	.31	.27	.26
9	.35	.30	.27	.25	.30	.25	.29	.25	.29	.25	.24
10	.33	.28	.25	.23	.28	.23	.28	.23	.27	.23	.23

P626 One 26W Quad Tube lamp

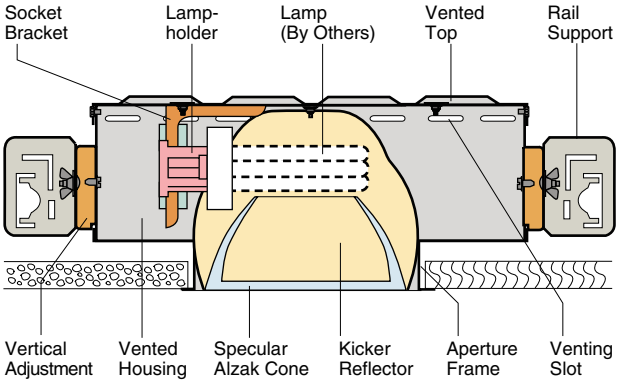
Notes

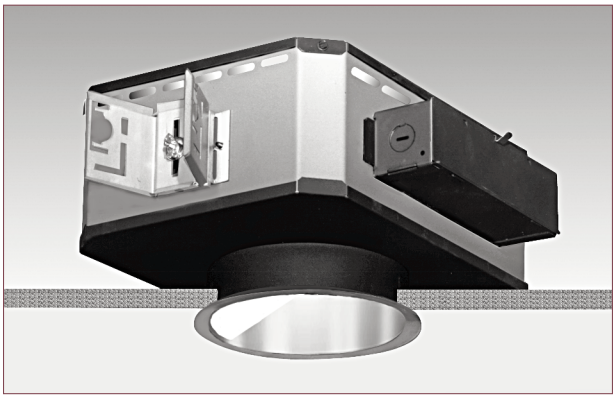
1 Data on all charts calculated with a clear specular cone finish.
2 Specular cone multipliers: Wheat x .88, Pewter x .78, Mocha x .77, Graphite x .75, Titanium x .75, Bronze x .69.
3 Softglow® cone multipliers: Clear x .92, Gold x .79, Wheat x .72, Pewter x .68, Mocha x .70, Graphite x .68, Titanium x .68, Bronze x .61.
4 Single unit Datachart pattern diameters are determined by the number of degrees from each side of nadir. Therefore a 15° diameter represents a total 30° pattern width at the work plane 30" above the floor. Footcandle values are at the edge of that diameter.
5 Datachart spacing is rounded off to the nearest foot.
6 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P626	One 26W Quad Tube	2	13	20	135	8260

Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 6.





P953

Wall Washer
One 26-32-42W Triple Tube Lamp
5 7/8" Conoid Aperture

Optics and Applications

A full circle kicker reflector directs a uniform wash light to adjacent walls. The pattern is free from spikes, striations or dropouts and features wide lateral distribution. The downlight component is uniform with a soft edge to blend with nearby units. Use in low to medium height ceilings.

Design Features

Construction allows easy access to all components. A steel housing protects the reflectors which are joined to assure predictable performance. Vented air flow design assures cool fixture temperature for optimal lamp performance. Maximum ceiling thickness 1 1/2". Ballast and lamp service from below.

Finish

A specular clear Alzak cone is standard. Optional colors and Softglow® finishes available. Housing and structural parts are phosphated for corrosion resistance, then painted optical matte black for control of stray light leaks.

Ballast

Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage ranges from 120V through 277V. Operates 26W, 32W or 42W triple tube lamps interchangeably. Power factor .98, starting temperature 0° F (-18° C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

General

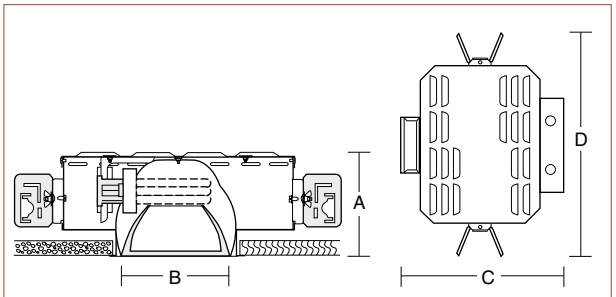
Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Ratings (LER) do not apply to wall washers.

Accessories

G	Gold cone.	R2	26" support rails.
H	Mocha cone.	R5	52" support rails.
P	Graphite cone.	WT	White trim flange.
T	Titanium cone.	WHT	White complete trim.
W	Wheat cone.	V347	347 volt ballast.
Y	Pewter cone.	F	Fuse.
Z	Bronze cone.		

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
DM Dimming ballast. Specify watts and volts.
EM Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.
WRL Wattage restriction label, specify wattage.
L Limited wall wash.
D Double wall wash.
C 250° corner wall wash.

Dimensions and Lamps

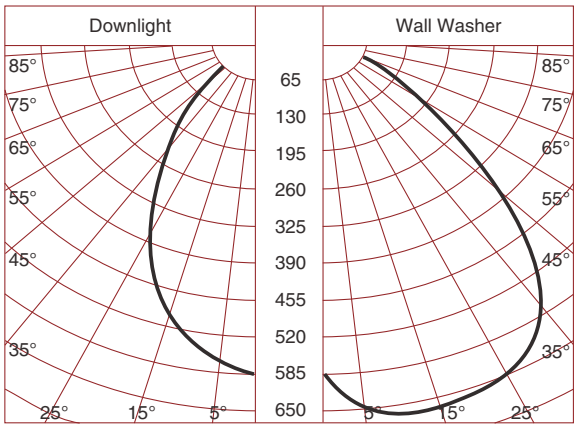


Number	A Depth	B Aperture	C Width	D Length	Lamp
P953	6" 152mm	5 7/8" 149mm	13 1/2" 343mm	19" 483mm	26-32-42W Triple Tube

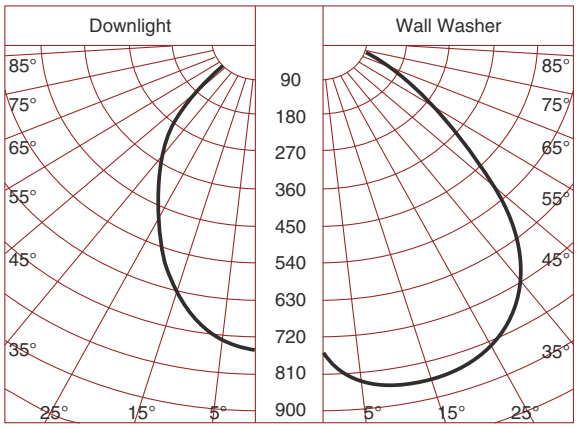
Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

P62 P953

Candlepower Distribution Curves



P953 One 32W Philips Triple Tube



P953 One 42W Philips Triple Tube

Multiple Units Footcandles

From Ceiling	2' from wall				3' from wall				4' from wall			
	2' Centers		3' Centers		3' Centers		4' Centers		4' Centers		6' Centers	
	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid
1'	40	39	31	24	13	13	11	9	6	5	5	3
2'	55	55	42	34	20	20	16	14	10	10	8	6
3'	51	51	34	33	25	25	20	17	12	12	9	7
4'	37	37	25	24	25	24	19	18	14	14	10	8
5'	26	26	17	17	21	21	16	15	14	14	10	9
6'	19	19	13	12	16	16	13	12	13	13	9	9
7'	14	14	9	9	13	12	10	10	11	11	8	7
8'	11	11	7	7	10	10	8	8	9	9	6	6
10'	7	7	4	4	6	6	5	5	6	6	4	4
12'	5	5	3	3	4	4	3	3	4	4	3	3

P953 One 32W Philips Triple Tube

From Ceiling	2' from wall				3' from wall				4' from wall			
	2' Centers		3' Centers		3' Centers		4' Centers		4' Centers		6' Centers	
	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid
1'	51	49	39	30	17	16	14	11	7	7	6	4
2'	70	70	53	43	26	25	21	18	13	13	10	7
3'	64	64	44	42	32	32	25	22	15	15	11	9
4'	47	47	31	31	31	32	24	23	18	18	13	10
5'	33	33	22	22	27	27	20	20	18	18	13	12
6'	24	24	16	16	21	21	16	16	16	16	11	11
7'	18	18	12	12	17	17	13	12	14	14	10	9
8'	14	14	9	9	13	13	10	10	12	12	8	8
9'	11	11	7	7	11	11	8	8	10	10	7	7
10'	9	8	6	6	9	9	6	6	8	8	6	6

P953 One 42W Philips Triple Tube

Notes

1 Data by IES methods. Compact fluorescent data vary due to lamp lumen differences, power input, burning position, ambient temperature and ballast characteristics. A modification factor should be applied.

2 Above data measure output of the wall washers only. No contribution from adjacent downlights or ceiling, floor or wall reflectances is included. Total illumination on the wall will increase with the contribution from other sources.

3 Data are cosine corrected to the plane of the wall. Uncorrected data are substantially higher and depend upon the angle of incidence to the wall which varies with the mounting distance from the wall.

4 Kurt Versen wall washers are designed to minimize hard shadow lines at the ceiling. Light intensity increases gradually to the maximum area, just above eye level. The field is uniform, devoid of hot spots, striations and spikes.

5 If colored cones are required, only the downlight cone will be tinted. The kicker reflector is always clear Alzak for maximum output and true color rendition.

6 Specular cone multipliers: Use for downlight and brightness data only: Gold x .91, Wheat x .87, Pewter x .81, Mocha x .81, Graphite x .78, Titanium x .78, Bronze x 75.

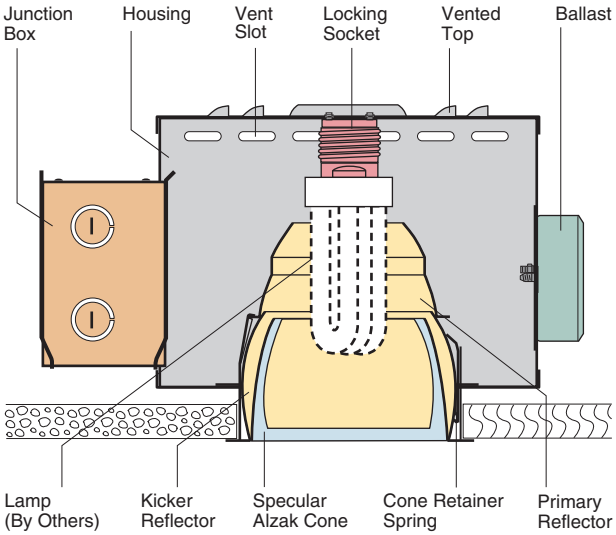
7 Softglow® cone multipliers: Use for downlight and brightness data only: Clear x .98, Wheat x .82, Mocha x .81, Pewter x .80, Graphite x .78, Titanium x .78, Bronze x .66.

8 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P953	One 32W Philips Triple Tube	6	14	29	1050	9318
	One 32W Osram Triple Tube	7	18	32	895	10000
	One 42W Philips Triple Tube	8	19	40	1413	12545
	One 42W Osram Triple Tube	9	25	44	1234	13794

Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 8.



P919

P60

Wall Washer
One 18W Triple Tube Lamp
4 1/8" Conoid Aperture

Optics and Applications

Small apertures do not perform properly with radically different lamp shapes. Philips is recommended here for its photometric characteristics. A full circle kicker reflector directs a uniform wash light to the wall. The pattern is free from spikes, striations or dropouts and features wide lateral distribution. The downlight component has a soft edge to blend with nearby units. For low to medium height ceilings.

Design Features

Construction allows easy access to all components. A steel housing protects the reflectors which are joined to assure predictable performance. Efficient air flow design assures cool fixture temperature for optimal lamp performance. Maximum ceiling thickness 1". Ballast and lamp service from below.

Finish

A specular clear Alzak cone is standard. Optional colors and Softglow® finishes are available. The housing and all structural parts are phosphated for corrosion resistance before being painted optical matte black for control of stray light leaks.

Ballast

Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage range from 120V through 277V. Power factor .98, starting temperature 0°F (-18°C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

General

Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Ratings (LER) do not apply to wall washers.

Accessories

G	Gold cone.	R2	26" support rails.
H	Mocha cone.	R5	52" support rails.
P	Graphite cone.	WT	White trim flange.
T	Titanium cone.	WHT	White complete trim.
W	Wheat cone.	V347	347 volt ballast.
Y	Pewter cone.	F	Fuse.
Z	Bronze cone.		

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.

DM Dimming ballast. Specify watts and volts.

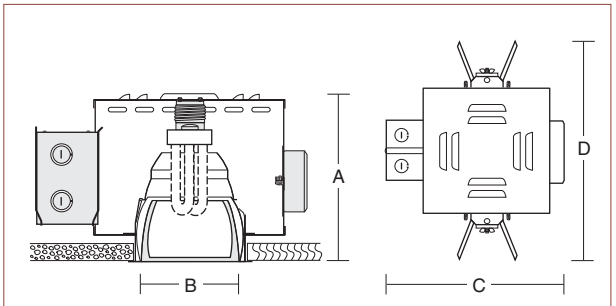
EM Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.

L Limited wall wash.

D Double wall wash.

C 250° corner wall wash.

Dimensions and Lamps



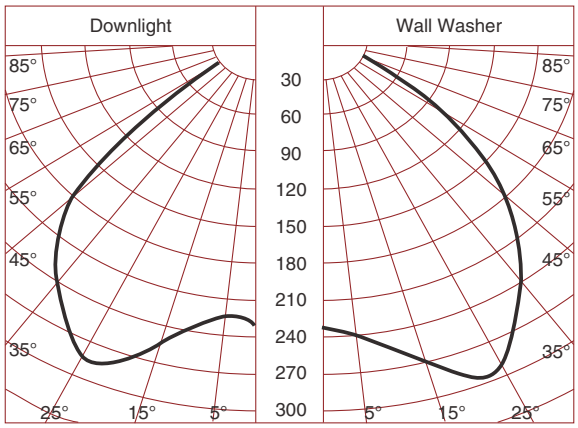
Number	A Depth	B Aperture	C Width	D Length	Lamps
P919	7 1/4" 184mm	4 1/8" 105mm	12" 305mm	14 1/4" 362mm	18W Philips Triple Tube

*Recess depth increases to 8 3/4" with EM and DM accessories.

Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

P60 P919

Candlepower Distribution Curves



P919 One 18W Philips Triple Tube

Multiple Units Footcandles

From Ceiling	2' from wall				3' from wall				4' from wall			
	2' Centers		3' Centers		3' Centers		4' Centers		4' Centers		6' Centers	
	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid
1'	15	13	12	8	4	4	3	2	2	1	1	1
2'	25	26	18	17	9	9	8	6	4	3	3	2
3'	22	22	15	15	11	12	9	8	6	6	4	3
4'	17	17	11	11	11	11	8	8	6	7	5	4
5'	12	12	8	8	9	9	7	7	6	7	4	4
6'	9	9	6	6	8	8	6	6	6	6	4	4
7'	7	7	5	4	6	6	5	5	5	5	3	3
8'	5	5	4	4	5	5	4	4	4	4	3	3
10'	4	4	3	3	4	4	3	3	4	3	2	2
12'	3	3	2	2	3	3	2	2	3	3	2	2

P919 One 18W Philips Triple Tube

Notes

1 Data by IES methods. Compact fluorescent data vary due to lamp lumen differences, power input, burning position, ambient temperature and ballast characteristics. A modification factor should be applied.

2 Above data measure output of the wall washers only. No contribution from adjacent downlights or ceiling, floor or wall reflectances is included. Total illumination on the wall will increase with the contribution from other sources.

3 Data are cosine corrected to the plane of the wall. Uncorrected data would be substantially higher and depend upon the angle of incidence to the wall which varies with the mounting distance from the wall.

4 Kurt Versen wall washers are designed to minimize hard shadow lines at the ceiling. Light intensity increases gradually to the maximum area, just above eye level. The field is uniform, devoid of hot spots, striations and spikes.

5 If colored cones are required, only the downlight cone will be tinted. The kicker reflector is always clear Alzak for maximum output and true color rendition.

6 Specular cone multipliers: Gold x .91, Wheat x .89, Mocha x .81, Pewter x .80, Graphite x .78, Titanium x .78, Bronze x .75.

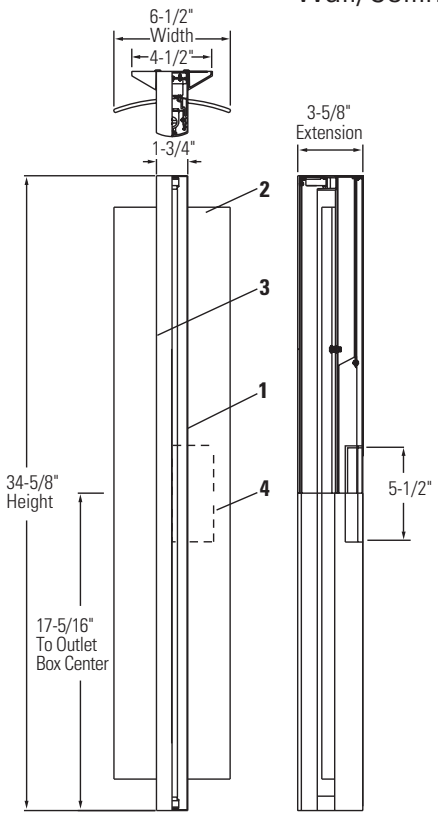
7 Softglow® cone multipliers: Clear x .98, Gold x .93, Wheat x .89, Mocha x .81, Pewter x .80, Graphite x .78, Titanium x .78, Bronze x .71.

8 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P919	One 18W Philips Triple Tube	381	322	456	9060	12322

Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 8.



Note: Luminaire can be ordered with or without diffusing shield. Order each separately .
Can be mounted vertically or horizontally.

Fixture Ordering Information

Catalog No.	Finish	Wattage	Voltage	Lamping
48022ALU	Powder Coated	21W	120/277V	T-5 Miniature Bi-Pin Fluorescent
48022AL39U	Metallic Aluminum	39W HO	120/277V	T-5 Miniature Bi-Pin Fluorescent

Diffuser Ordering Information

Catalog No.	Description	Dimensions
40875	Translucent Etched Soda Lime Glass w/ Pencil Polished Edges	31.25" L x 6.5" W x 5 mm Thick
40915	Extruded Opal Virgin Acrylic w/ Pencil Polished Edges	31.25" L x 6.5" W x 5 mm Thick

Features

1. **Housing:** Extruded and die-cast aluminum ballast and lamp chamber.
2. **Optional Diffuser/Reflector:** Curved etched glass or extruded opal virgin acrylic.
3. **Optics:** Internal white acrylic diffuser covers slit on front cover.
4. **J-Box Covers:** Die-cast split covers to enclose 4" octagonal J-Box (J-Box by others).

Mounting

Mounts directly to switch box or 4" octagonal J-Box. Octagonal box mounting requires use of "J-Box Covers" and "Support Plate" supplied standard.

Electrical

Ballast (Electronic 120/277V)	**21 W**	**39W HO**
Total Input Watts:	25W	39W
Max. Line Current:	120V = 0.21 277V = 0.10	120V = 0.34 277V = 0.15
Power Factor:	120V = 0.98 277V = 0.95	120V = 0.98 0.98 = (120V/277V)
Ballast Factor:	1.03	0.90
THD:	120V = <10% 277V = <15%	120V = <10% 277V = <10%
Starting Temp:	0°F / -18°C	0°F / -18°C

Finish

All painted parts utilized the powder coat process. Lightolier Metallic Aluminum Powder Coat Enamel.

Labels

cULus Listed. Suitable for Damp Locations.

Job Information **Type:**

Job Name:

Cat. No.:

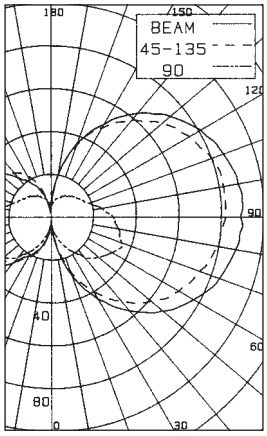
Lamp(s):

Notes:

Lightolier a Genlyte company www.lightolier.com
631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710

LIGHTOLIER®

CERTIFIED TEST REPORT NO. 2219FR
COMPUTED BY LSI PROGRAM **TEST-LITE**
LIGHTOLIER ARCHITECTURAL DECORATIVE LUMINAIRE SOLI
CAT. NO. 48022ALU / 40875, ETCHED GLASS SHIELD
1-21W PHILIPS T-5 LAMP. LUMEN RATING = 1900 LMS.
UNIVERSAL BALLAST #B228PUNVC



Prepared For:
Lightolier
Fall River, MA
Date: May 6, 2003

CANDLEPOWER

ZONE ➤ DEG. ▼	90	67.5	45	22.5	90	
			CANDELAS			
0	2	2	2	2	2	
5	4	3	4	5	5	0
15	9	10	19	22	21	2
25	15	22	34	38	37	7
35	21	31	46	50	51	13
45	27	40	57	60	63	20
55	31	47	66	69	73	26
65	35	53	72	76	81	32
75	33	58	77	80	86	36
85	30	63	80	83	89	39
95	26	65	82	84	90	39
115	17	65	72	79	84	34
125	15	60	63	73	77	28
135	14	53	54	65	68	22
145	12	44	43	57	57	15
155	10	35	29	45	44	9
165	9	22	21	31	29	4
175	6	10	12	13	13	1
180	5	5	5	5	5	

Tested according to IES procedures.
Test distance exceeds five times the greatest luminous opening of luminaire.

COEFFICIENTS OF UTILIZATION
% EFFECTIVE CEILING CAVITY REFLECTANCE

	80			70			50			30			10			0
	% WALL REFLECTION															
	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
0	31	31	31	28	28	28	24	24	24	20	20	20	16	16	16	14
1	24	23	21	22	21	19	18	17	16	15	14	13	12	11	10	9
2	20	18	16	19	17	15	15	14	12	12	11	10	9	8	7	6
3	17	15	13	16	14	12	13	11	10	10	9	8	8	7	6	4
4	15	12	10	14	11	9	11	9	8	9	7	6	7	5	4	3
5	13	11	8	12	10	8	10	8	6	8	6	5	6	5	4	3
6	12	9	7	11	8	7	9	7	5	7	5	4	5	4	3	2
7	10	8	6	10	7	6	8	6	5	6	5	4	5	3	3	2
8	9	7	5	9	6	5	7	5	4	6	4	3	4	3	2	1
9	9	6	5	8	6	4	6	5	3	5	4	3	4	3	2	1
10	8	5	4	7	5	4	6	4	3	5	3	2	4	2	2	1

ROOM CAVITY RATIO

DETERMINED IN ACCORDANCE WITH CURRENT IES PUBLISHED PROCEDURES
20% FLOOR CAVITY REFLECTANCE

Multiply Calculated footcandles by 1.6 for 39W HO Lamp.

DISTRIBUTION

Zone	Lumens	% Lamp	% Luminaire
0-30	15	.82	2.87
0-40	35	1.87	6.56
0-60	106	5.59	19.61
0-90	267	14.07	49.31
40-90	231	12.20	42.75
60-90	161	8.47	29.70
90-180	274	14.46	50.69
0-180	542	28.53	100.00

** EFFICIENCY = 28.5% **

Job Information **Type:**

Lightolier a Genlyte company www.lightolier.com
631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710

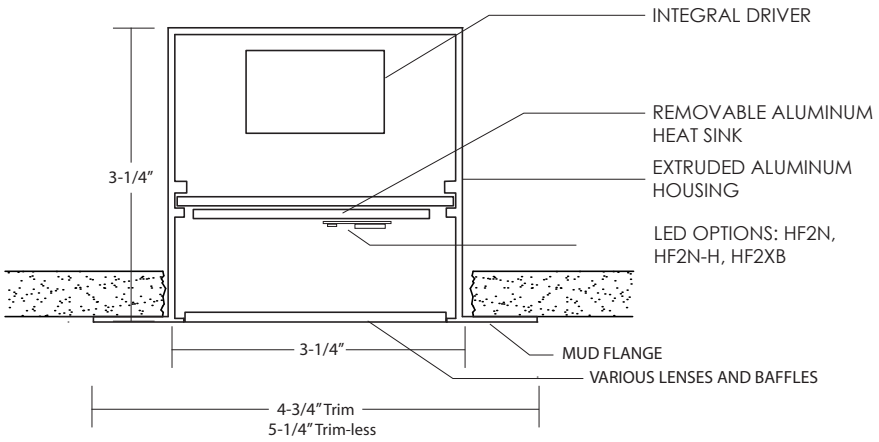
LIGHTOLIER®

JAKE -325 LED

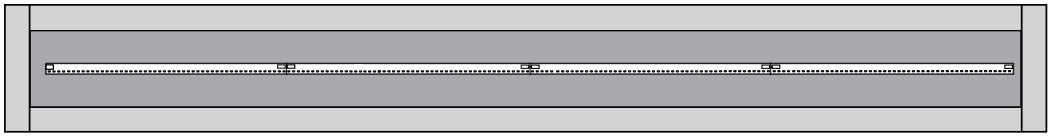
3" OPENING RECESS FIXTURES

RECESSED TRIM/TRIMLESS

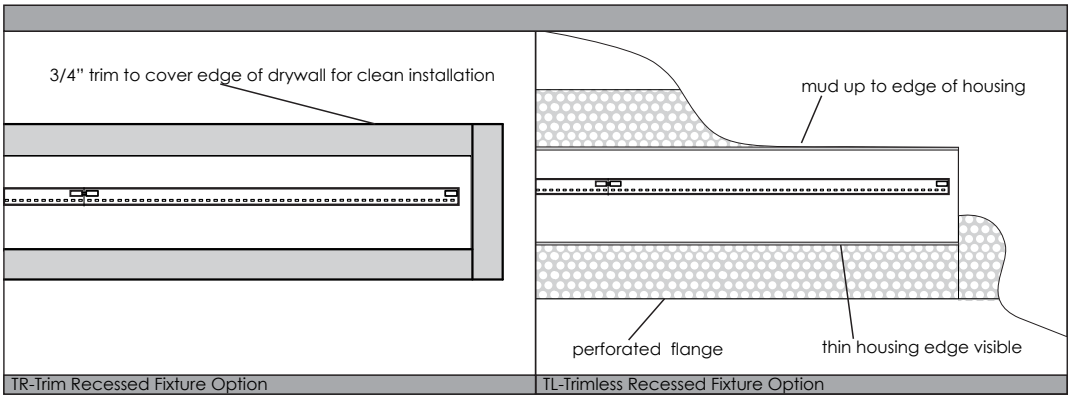
- extruded aluminum housing
- recessed housing with trim for clean aesthetic, and ease of installation
- HF2N, HF2N-H, and HF2XB light engines available. *see light engine page for specs.
- Driver are integral in fixture, dimming avaliable.
- variety of lensing options- custom colors and materials available- consult factory
- seamless contiuous run end to end board connections available.
- UL and C-UL listed for Dry and Damp locations



STAND ALONE FIXTURE OPTIONS



STAND ALONE



FIXTURE SPECIFICATIONS

JAKE-325

Model	Finish	# of boards in cross section	Light Engine	Driver	Color	Nominal Length	Voltage	Finish	Lens/ Louver
JAKE-325 **Jake** 3.25" recessed fixtures	**TR-** Trim **TL-** Trim-less	**1-** 1 board **2-** 2 boards	**HF2N** - Linear LED 10" or 4" boards, 102 emitters or 42 emitters **HF2N-H** - Linear LED 10" or 4" boards, 54 emitters or 24 emitters **HF2XB-S4** - Linear LED 11.5" board, 4 emitters	**EB** - electronic driver **DIM_1** - 1% dimming module* **DIM_10** -10% dimming driver*	**30 -** 3000k **35 -** 3500k **40 -** 4000k	LED Fixture can be specified in 10" increments **CR__** ** - Continuous Run **Specify length in nominal feet	**120** **277**	**Anodized:** **SC** - Satin Clear (Standard) **CU** - Custom* **Powder Coated:** **FB** - Flat Black *** MW - Matte White*** **CU** - Custom*	**SIW** - Satin Ice White **SIC** - Satin Ice Clear **NL** - No lens ****CU** - Custom **Louver Options** **PLSS** - Parabolic Louver Semi-Specular **BLSS** - Blade Louver Semi-Specular

**FOR FOR ANY CUSTOM OPTION, PLEASE CONTACT FACTORY - EXPECT LONGER LEAD TIMES
***NON- STOCKED ITEMS - EXPECT LONGER LEAD TIMES
-PART NUMBER EXAMPLE: JAKE325-TR-1-HF2N-EB-30-40-120-SC-SIW

Job Information

Type:

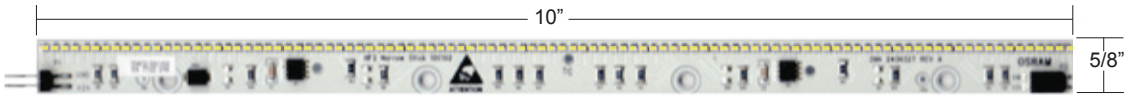
Job Name:

Location:

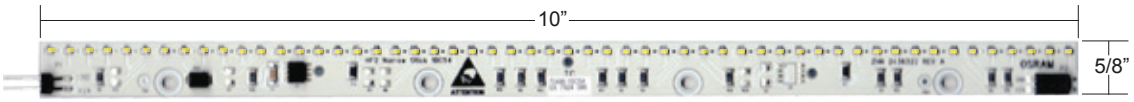
1111

BIRCHWOOD LIGHTING
714.550.7118 • fax 714.550.7151 • www.BirchwoodLighting.com

HF2XB-S4



HF2N *** 4” board also available



HF2N-H (half populated) *** 4” board also available

LED OPTIONS

- Light engines available:

  -HF2N - 102 emitters on 10” - 10 watts/ft. 540 lumens/ft.

  -HF2N-H - 54 emitters on 10” 5 watts/ft., 270 lumens/ft.

  -HF2XB-S4 - 4 emitters on 11.5” 3.9 watts/ft. 225 lumens/ft.

- please consult factory for other options
- dimmable by pulse width modulation *Contact Factory
- continuous run with several boards
- remote driver required: *see driver housing page *consult factory for driver options
- 5 year warranty on LED board and driver combination
- UL and C-UL listed for Dry and Damp locations

*terms and conditions apply, must be installed in suitable location, boards not to be used in alternite fixtures.

LED LIGHT ENGINE SPECS

HF2N

- Narrow 5/8” w board comprized with closely packed small LEDs
- High Lumen LED emitters with rated service life to 50,000 hours at 65 degrees Celsius.
- HF2N modules come in 10” and 4” sections with 102 emitters on the 10” and 42 emitters on the 4” section near continous light. 10 watts/ft. yielding 540 lumens/ft., which is 54 lumens/watt (lumen/ft. and lumens/watt based on 3000K color temp)
- Available in 3000K, 3500K and 4000K
- 120 degree beam angle
- CRI 85
- Dimmable by pulse width modulation

HF2N-H (half populated)

- Narrow 5/8” w board comprized with closely packed small LEDs
- High Lumen LED emitters with rated service life to 50,000 hours at 65 degrees Celsius.
- HF2N-H modules is half populated which in turn uses half the wattage and the operating temp is less than the full population
- HF2N-H modules come in 10” and 4” sections with 54 emitters on the 10” and 24 emitters on the 4” section near continuous light. 5 watts/ft. yielding 270 lumens/ft., which is 54 lumens/watt (lumen/ft. and lumens/watt based on 3000K color temp)
- Available in 3000K, 3500K and 4000K
- 120 degree beam angle
- CRI 85
- Dimmable by pulse width modulation

HF2XB-S4

- High Lumen LED emitters with rated service life to 50,000 hours at 40 degrees Celsius.
- HF2XB-S4 modules come in 11.5” lengths with 4 emitters per module 3.9 watts/ft. yielding 225 lumens/ft., which is 58 lumens/watt (lumen/ft. and lumens/watt based on 3000K color temp)
- Available in 3000K, 3500K and 4100K, and 5700K
- 90 degree beam angle
- HF2XB-S4 modules run on 24VDC power
- CRI 85
- Dimmable by pulse width modulation

Job Information

Type:

Job Name:

Location:

BIRCHWOOD LIGHTING
714.550.7118 • fax 714.550.7151 • www.BirchwoodLighting.com

NOTE: Specifications and dimensions are subject to change without notice.

DRIVER HOUSINGS

REMOTE DRIVER HOUSINGS

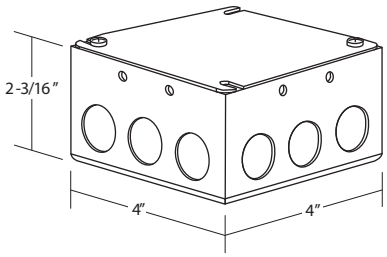
- used for remote power supplies
- formed aluminum construction
- standard finish is mill aluminum to provide excellent heat dissipation
- custom powder coat finishes are available for visable housings (consult factory)
- standard sizes shown, custom sizes are available
- driver(s) and housing(s) dependent upon run length
- all models feature several conveniently located trade size knock-outs (K.O.'s)
- consult factory for recommended maximum remote mounting distance
- UL and C-UL Listed for Dry Locations

STANDARD HOUSINGS

BB04C

- DIMENSIONS: 4" x 4" x 2-3/16
- Used for 20w Drivers, 120V only
  -HF2N - 2' fixtures
  -HF2N-H - 4' fixtures
  -HF2XB-S4 - 5' fixtures

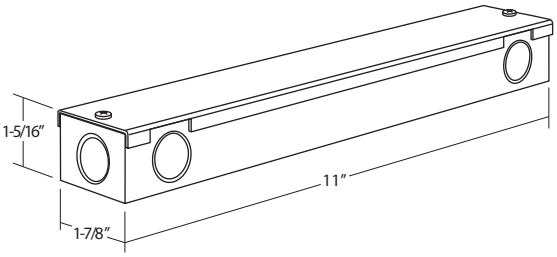
NOTE: Contact Factory about Driver Housings to be sent out prior to electrical rough-in.



BB11D

- DIMENSIONS: 11" x 1-7/8" x 1-5/16"
- Used for 75w Drivers, 120-277V
  -HF2N - 7' fixtures
  -HF2N-H - 14' fixture runs
  -HF2XB-S4 - 20' fixture runs

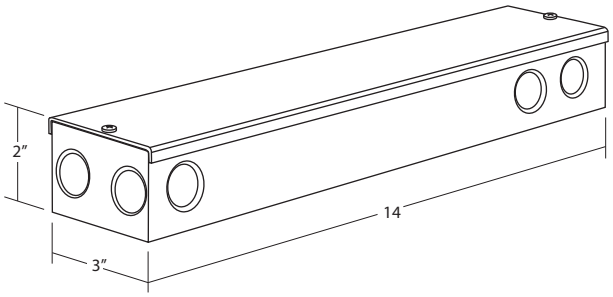
NOTE: Contact Factory about Driver Housings to be sent out prior to electrical rough-in.



BB14B

- DIMENSIONS: 14"(L) x 3" x 2
- Used for 96w Drivers, 120-277V
  -HF2N - 9' fixture run
  -HF2N-H - 19' fixture run
  -HF2XB-S4 - 25' fixture run

NOTE: Contact Factory about Driver Housings to be sent out prior to electrical rough-in.

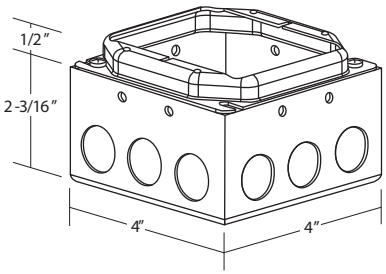


SPECIAL ORDER HOUSING

BB04C-MR

- DIMENSIONS: 4" x 4" x 2-3/16
  includes 1/2" mud ring
  *consult factory for other options
- Used for 20w Drivers, 120V only
  -HF2N - 2' fixtures
  -HF2N-H - 4' fixtures
  -HF2XB-S4 - 5' fixtures

NOTE: Contact Factory about Driver Housings to be sent out prior to electrical rough-in.



GENERAL NOTES:

- The standard Driver Housing is mill aluminum (**MA**) finish.
- Please contact factory for custom housing sizes and/or color
- Contact factory with any ballast housing questions

Job Information

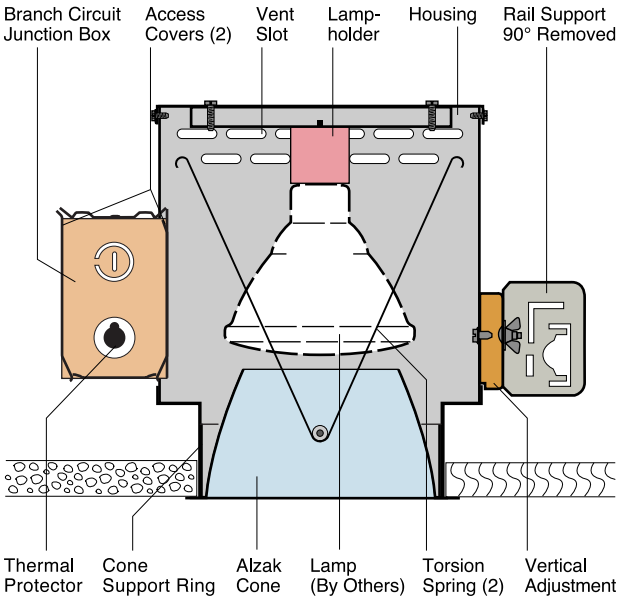
Type:

Job Name:

Location:

0110

BIRCHWOOD LIGHTING
714.550.7118 ◆ fax 714.550.7151 ◆ www.BirchwoodLighting.com



C7301
C7302

PAR Lamps to 250W
5⅞" Conoid Apertures

Optics and Applications
Distribution patterns and spacing to mounting height ratios change with the lamps accommodated by these units. Variations from narrow to broad patterns are available. See back of page for specific performance information.

Design Features
The parabolic cones gather and redirect spill light to the workplace. Performance is efficient with very low brightness from normal viewing angles. Sturdy steel housings protect and position lamps and reflectors. Maximum ceiling thickness 2". Top or bottom service.

Finish
Specular clear Alzak cones are standard. Optional colors and Softglow® finishes are available. Housings and structural parts are painted optical matte black to suppress stray light leaks. Steel parts are phosphate conditioned for corrosion resistance before painting.

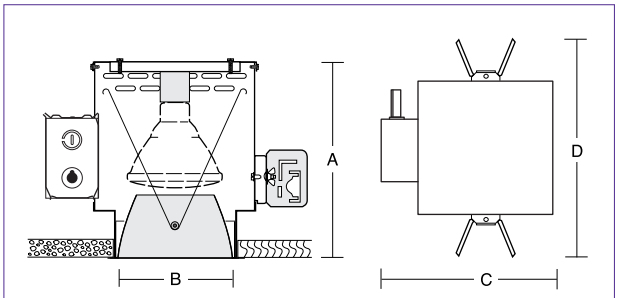
General
Fixtures are pre-wired and thermally protected, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Ratings (LER) do not apply to fixtures using reflector type lamps.

Accessories

B	Black cone.	R2	26" support rails.
G	Gold cone.	R5	52" support rails.
H	Mocha cone.	WT	White trim flange.
P	Graphite cone.	WHT	White complete trim.
T	Titanium cone.	HL	Hexcell louver*.
W	Wheat cone.	LL	Linear lens*.
Y	Pewter cone.	LP	Large prism lens*.
Z	Bronze cone.	MP	Micro prism lens*.

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
FF30-2 Accessory holder for PAR-30. Holds two accessories.
FF38-1 Accessory holder for PAR-38. Holds one accessory.
WRL Wattage restriction label, specify wattage.
For color filters, pattern control lenses, light block screens, UV filters and other accessories, contact the factory.
*Requires accessory holder.

Dimensions and Lamps



Number	A Depth	B Aperture	C Width	D Length	Lamps
C7301	8½" 216mm	5⅞" 149mm	11" 279mm	14¼" 362mm	50-75W PAR-30S
C7302	10¾" 273mm	5⅞" 149mm	11" 279mm	14¼" 362mm	45-150W PAR-38 250W PAR-38*

*Requires factory modification. To specify add -250 to catalog number, e.g. C7302-250. Fixture becomes dedicated 250W model. Contact factory for photometry.

Brightness

Number	Lamps	85°	75°	65°	55°	45°
C7301	50W PAR-30 Flood	0	1	2	3	240
	75W PAR-30 Flood	1	1	2	5	340
C7302	45W PAR-38 Flood	1	2	4	48	160
	90W PAR-38 Flood	1	5	6	10	392
	150W PAR-38 Flood	2	10	13	21	816

Data in footlamberts. Photometer readings, Maximum Brightness Method.

kurt versen
Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

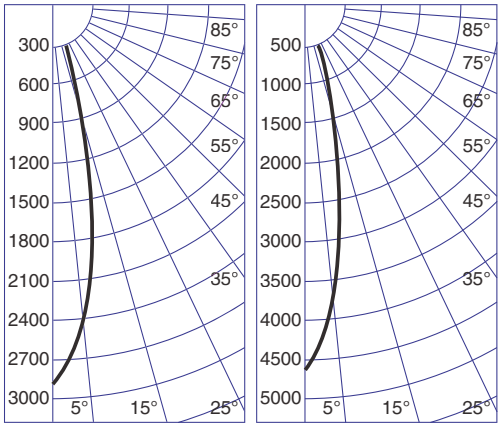
Performance Datachart

Single Unit Initial Footcandles, 30" Work Plane							Ceiling to Floor	Multiple Units Initial Footcandles, 30" Work Plane			
C7301 50W PAR-30/CAP/NFL Read Top Data C7301 75W PAR-30/CAP/NFL Read Bottom Data								Ceiling 80% Walls 50% Floor 20%			
Nadir	10°		15°		20°			Spacing is Maximum Over Work Plane			
FC	FC	Diam	FC	Diam	FC	Diam		Spacing	RCR 1	RCR 3	RCR 8
98 152	51 79	2' 2'	27 43	3' 3'	10 15	4' 4'	8'	2' 2'	155 241	144 223	124 193
70 109	36 56	2' 2'	20 30	3' 3'	7 11	5' 5'	9'	2' 2'	111 173	103 159	89 138
53 82	27 42	3' 3'	15 23	4' 4'	5 8	5' 5'	10'	3' 3'	84 130	77 120	67 104
33 51	17 26	3' 3'	9 14	5' 5'	3 5	7' 7'	12'	3' 3'	52 81	48 75	42 65
22 35	12 18	4' 4'	6 10	6' 6'	2 4	8' 8'	14'	4' 4'	36 55	33 51	28 44

Single Unit Initial Footcandles, 30" Work Plane							Ceiling to Floor	Multiple Units Initial Footcandles, 30" Work Plane			
C7302 90W PAR-38/CAP/FL Read Top Data C7302 150W PAR-38/CAP/FL Read Bottom Data								Ceiling 80% Walls 50% Floor 20%			
Nadir	10°		15°		20°			Spacing is Maximum Over Work Plane			
FC	FC	Diam	FC	Diam	FC	Diam		Spacing	RCR 1	RCR 3	RCR 8
70 137	55 108	3' 3'	27 53	4' 4'	9 18	5' 5'	10'	4' 4'	85 168	78 154	67 131
44 86	34 67	3' 3'	17 33	5' 5'	6 11	7' 7'	12'	5' 5'	53 105	48 96	42 82
30 58	23 46	4' 4'	11 23	6' 6'	4 8	8' 8'	14'	6' 6'	36 71	33 66	28 56
22 42	17 33	5' 5'	8 16	7' 7'	3 6	10' 10'	16'	6' 6'	26 52	24 48	21 40
13 25	10 20	6' 6'	5 10	9' 9'	2 3	13' 13'	20'	8' 8'	16 31	14 28	12 24

Colored cone multipliers: Gold x .98, Wheat x .97, Pewter x .95, Mocha x .95, Graphite x .92, Titanium x .92, Bronze x .89, Black x .80.

Candlepower Distribution



C7301 50W PAR-30/CAP/NFL
Eff. 89% S/M .36

C7301 75W PAR-30/CAP/NFL
Eff. 89% S/M .36

Candelas

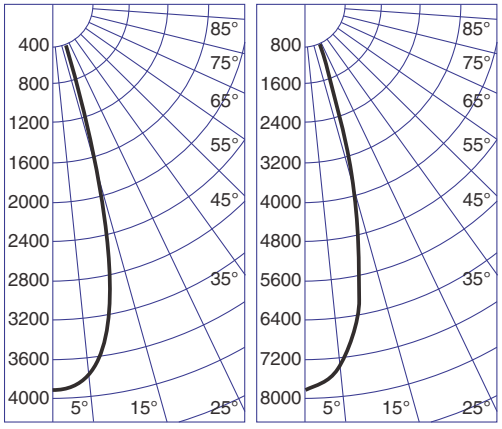
	50W	75W
o	580*	900*
0	2971	4606
5	2456	3818
10	1601	2490
15	921	1431
20	365	560
25	83	124
30	24	41
35	8	20
40	0	0
45	0	0
50	0	0
55	0	0
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

Coefficients of Utilization

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	1.07	1.05	1.03	1.02	1.03	1.00	.99	.97	.96	.94	.90
2	1.04	1.01	.98	.96	.99	.95	.96	.93	.94	.91	.88
3	1.01	.97	.94	.92	.96	.91	.94	.90	.92	.88	.86
4	.98	.94	.91	.88	.93	.88	.91	.87	.89	.86	.84
5	.96	.91	.88	.85	.90	.85	.89	.84	.87	.83	.82
6	.94	.89	.85	.83	.88	.82	.87	.82	.86	.81	.80
7	.91	.86	.83	.80	.86	.80	.85	.80	.84	.79	.78
8	.89	.84	.81	.78	.84	.78	.83	.78	.82	.78	.77
9	.87	.82	.79	.77	.82	.76	.81	.76	.80	.76	.75
10	.86	.80	.77	.75	.80	.75	.79	.75	.79	.74	.74

C7301 50W PAR-30/CAP/NFL
C7301 75W PAR-30/CAP/NFL



C7302 90W PAR-38/CAP/FL
Eff. 80% S/M .48

C7302 150W PAR-38/CAP/FL
Eff. 76% S/M .48

	90W	150W
o	1200*	2500*
0	3930	7728
5	3832	7536
10	3219	6336
15	1679	3312
20	632	1248
25	257	504
30	59	120
35	32	72
40	0	24
45	0	0
50	0	0
55	0	0
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

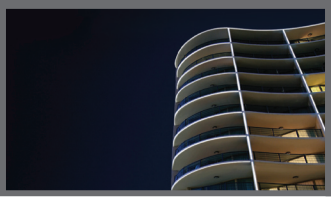
Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.94	.92	.91	.89	.90	.88	.87	.85	.84	.83	.79
2	.91	.88	.86	.84	.87	.83	.84	.81	.82	.79	.76
3	.88	.84	.82	.79	.83	.79	.81	.78	.80	.76	.74
4	.86	.81	.78	.76	.81	.76	.79	.75	.77	.74	.72
5	.83	.79	.75	.73	.78	.73	.77	.72	.75	.72	.70
6	.81	.76	.73	.71	.76	.70	.75	.70	.74	.70	.68
7	.79	.74	.71	.68	.73	.68	.73	.68	.72	.68	.67
8	.77	.72	.69	.66	.71	.66	.71	.66	.70	.66	.65
9	.75	.70	.67	.65	.70	.65	.69	.64	.68	.64	.63
10	.73	.68	.65	.63	.68	.63	.67	.63	.67	.63	.62

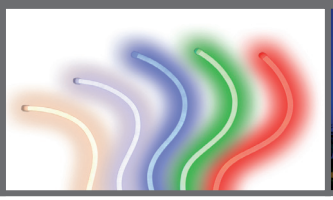
C7302 90W PAR-38/CAP/FL
C7302 150W PAR-38/CAP/FL x .95

GE
Lighting Solutions

Tetra® Contour

LED ARCHITECTURAL SERIES




Tetra Contour is comprised of a flexible LED light engine and a rigid, optically diffused light guide that can be heat formed to fit a variety of architectural needs. With a variety of colors to choose from, designers can mix-n-match components to create bold designs and attractive accent lighting without the typical worries of working with fragile neon glass.

Applications

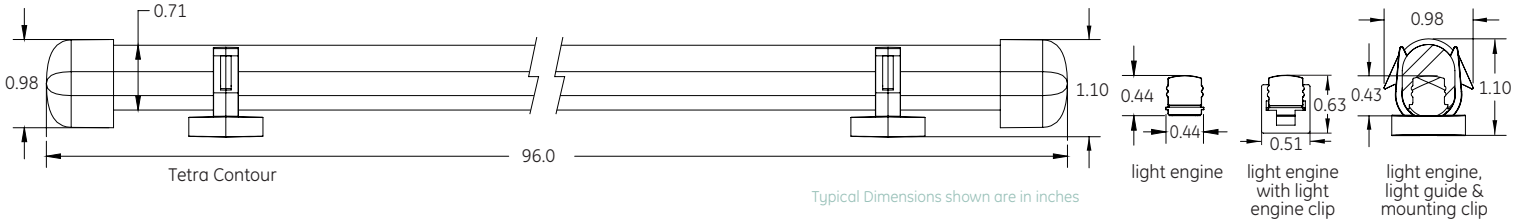
Tetra Contour is ideal for border lighting, interior art, cove and accent lighting.

Features & Benefits

- Up to 40% more energy efficient than neon
- Low-voltage 24VDC system
- Dimmable with GE 0-10V Dimming Driver or GE Dimming Module and compatible dimming controller
- Contains no lead, mercury or glass. RoHS compliant
- Long rated life of 50,000 hours
- Multiple ANSI bin color temperatures: red, green, blue, white & warm white
- Light guide colors: red, green, blue, white & clear

a product of
ecomagination℠

imagination at work



Typical Dimensions shown are in inches

Performance Data

Product Code	Description Code	Color	Wavelength/ Color Temp	Viewing Angle (light engine)	Viewing Angle (light engine w/ light guide)	Lumens ft/m (light engine)	Lumens ft/m (light engine w/ light guide)	Watts ft/m (light engine strip)	Watts ft/m (system)
75481	GERDXNLE1-A	Red	625nm	110	330	59/194	47/154	3.24/10.63	3.81/12.50
75484	GEGLXNLE1-A	Green	532nm	110	330	101/331	55/180	2.88/9.45	3.39/11.12
75485	GEBLXNLE1-A	Blue	467nm	110	330	23/75	19/162	2.88/9.45	3.39/11.12
75487	GEWWXNLE1-27K-A	White	2700K	110	330	107/351	70/230	2.88/9.45	3.39/11.12
75488	GEWWXNLE1-30K-A	White	3000K	110	330	117/384	76/249	2.88/9.45	3.39/11.12
75489	GEWWXNLE1-35K-A	White	3500K	110	330	125/410	81/266	2.88/9.45	3.39/11.12
75490	GEWWXNLE1-40K-A	White	4000K	110	330	131/430	85/279	2.88/9.45	3.39/11.12
75493	GEWHXNLE1-50K-A	White	5000K	110	330	156/512	101/331	2.88/9.45	3.39/11.12
75486	GEWHXNLE1-65K-A	White	6500K	110	330	144/472	94/308	2.88/9.45	3.39/11.12

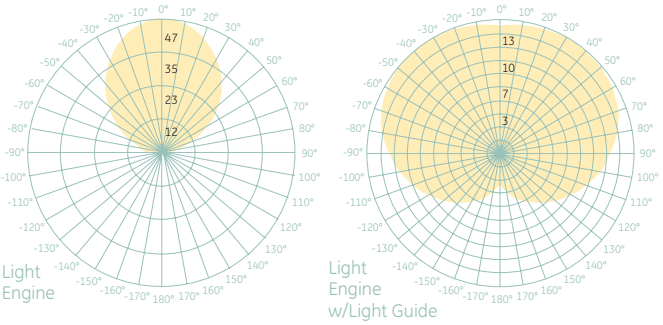
Lumen values are typical. Allow +/- 15% for binning tolerance.

Accessories

Product Code	Description Code	Product Description	Quantity
75514	9409	18 AWG Supply Wire (0.82 mm^2)	500 ft. (152.4 m)/PK
75494	GEXNWB2	Weather Box (Outdoor Use Only)	20/PK
75498	GEXNMCAC	Light Engine Mounting Clip	20/PK
75520	GEXNMC15	Light Guide Mounting Clip	50/PK
75537	GEXNBA	16 in. Silicone Bend-Aid (Reuseable)	12/PK
75612	GEDM1-A	Tetra Dimming Module (0-10V)	1/EA

For a complete list of accessories including Light Guides, refer to the Tetra Contour Component Guide

Light Output



Candela (Cd) measurements taken at 6500K

IES files can be downloaded at www.gelightingsolutions.com

Technical Specifications

Specification Item	Specification
Module Dimensions	0.44 in. x 0.44 in. x 16.25 in. (10 mm x 10 mm x 413 mm)
Length of Light Engine	8 ft. (2.44 m)
Light Engine Packaging Quantity	Red only - 12/PK, All other colors - 6/PK
GE LED Drivers	**74917** (GE020/G/V24T1-B), **74915** (GE080/G/V24T1-A), **74916** (GE100/MV/V24T1-A), **62189** (GE180/MV/V24T1-C) & **79045** (GE080/MV/D24T1-A) , 0-10V dimming
Operating Voltage	24 VDC
Minimum Loading	**74917**, **74915**, **74916, 62189 & 79045**: 8 in. (0.20 m)
Maximum Loading	**74917**: 6 ft. (1.83 m) **74915 & 79045**: 24 ft. (7.32 m) **74916**: 30 ft. (9.14 m) **62189**: 27 ft. (8.23 m) per Bank/54 ft. (16.46 m) per Driver
Remote Mounting	Standard length of 1-30 ft. (0.3-9.14m) with 18AWG (0.82mm2) supply wire; for greater lengths refer to the installation instructions.
Ambient Temperature	-40°C to +55°C
Limited Warranty	5 years
IP Rating	Light Engine IP54: Dry or damp location rated; Light Engine and Light Guide IP66: Dry, damp or wet location rated
System Certifications	

GE Lighting Solutions • 1-888-MY-GE-LED • www.gelightingsolutions.com
1-888-69-43-533

Photograph courtesy of Blake Marvin-HKS, Inc.

ARCH016-R071911
OLP-2873

C O L E L I G H T I N G

Steplites

Series	Incan.	Fluor.	HID	LED	Exterior	Interior	EM Battery	Other Options
	●	●		●	●	●		Satin brass front 277V electrical

2158 SERIES

Description

The 2158 Series of Steplites offers an ultra low-profile site fixture for low applications. Its width allows relatively wide light distribution to the side in a variety of interior or exterior locations. The rugged construction, engineering excellence, and quality makes this fixture ideal for specification in most public areas.

Features

Louvers in the 2158 Series are more widely spaced than in most fixtures of this type, allowing for significantly greater forward projected illumination. The thick cast aluminum louvered faceplate also provides exceptional durability. Cole Steplites feature an optional cast aluminum junction box which may be easily field mounted to either the back or bottom of the housing to best suit installation conditions.

Applications

The 2158 Series of Steplites are suitable for concrete pour/block wall and stud wall mounting in indoor or outdoor installations. They are ideal in low walls and step risers where wide spacing is desirable.

Custom

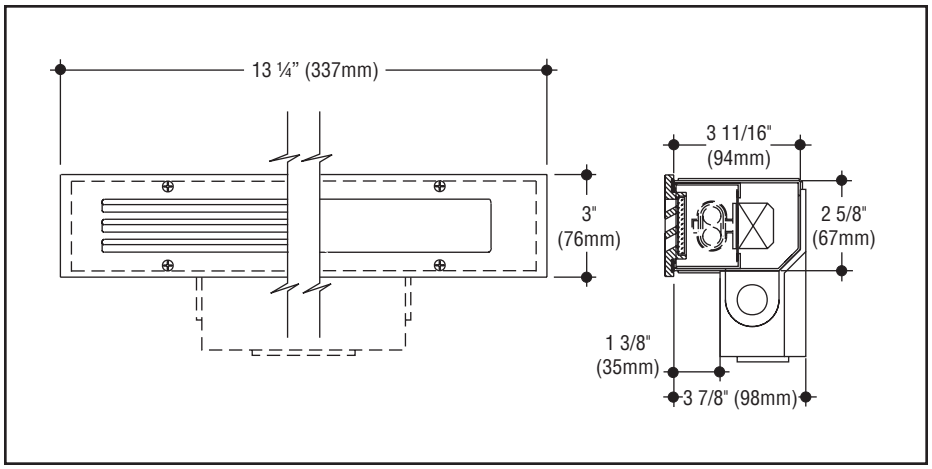
If your project demands a special fixture we would be pleased to discuss the production of modified standard fixtures or custom fixtures to suit your specific conditions. For more information on our custom capabilities, please contact your local Cole representative.

C. W. Cole & Company, Inc.
2560 N. Rosemead Boulevard
South El Monte, CA 91733-1593

Fax (626) 443-9253
Tel. (626) 443-2473
info@colelighting.com
www.colelighting.com

Steplites

2158 SERIES



Specifications

Construction

• Fixture housing is constructed from die-formed 16 gauge steel finished with a white polyester coating • Faceplate is cast aluminum with silver metallic polyester finish or 3/16" stainless steel with brushed finish • Diffuser on glass front and weatherproof louvered models is frosted tempered glass • On weatherproof models, diffuser is set in silicone sealant and faceplate is retained by stainless steel screws • Reflector is constructed of white die-formed aluminum • Optional junction box is cast aluminum with polyester coating • cETLus listed, suitable for wet locations when specified weatherproof, in any wall construction

Electrical

• Fixture is wired for compact fluorescent lamp. Ballasts are standard electronic 120V (277V/347V optional) • Junction box allows 8 wire thru-wiring, four in and four out. Provided with two ½" tapped conduit entrances in the bottom and one ½" conduit entrance in each side

Mounting

Housing has flange with holes for mounting.

Catalog Numbers	Faceplate		
Lamps	**Alum. Louver**	**Glass**	**S.S. Louver**
One 9W (CFT9W/2G7) 4 pin compact fluorescent	**F 2158-9**	**F 2158G-9**	**F 2158-9-N**
One 13W (CFT13W/2GX7) 4 pin compact fluorescent	**F 2158-13**	**F 2158G-13**	**F 2158-13-N**
6W warm white LEDs 3000°K	**L 2158**	**L 2158G**	**L 2158N**

Options

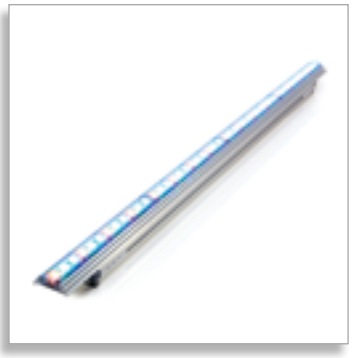
Junction Box: Bottom or back mounted junction box as required for feed-thru. Add suffix **-J**.
Weatherproof: For exterior applications. Add suffix **-W**.
Tamperproof Screws: Tamperproof allen head faceplate screws. Add suffix **-TP**.
Ballasts: 277V or 347V ballast. Add suffix **-277** or **-347**.
Alternate Faceplate Color: Black or white. Add suffix **-BLK** or **-WHT**.
Flash Opal Lens: Add suffix **-OPL**.

How to Specify

1. Select catalog number with desired features.
2. Add suffixes for options required to meet job conditions.

C. W. Cole & Company, Inc.
2560 N. Rosemead Boulevard
South El Monte, CA 91733-1593

Fax (626) 443-9253
Tel. (626) 443-2473
info@colelighting.com
www.colelighting.com



Date: _____ Type: _____

Firm Name: _____

Project: _____

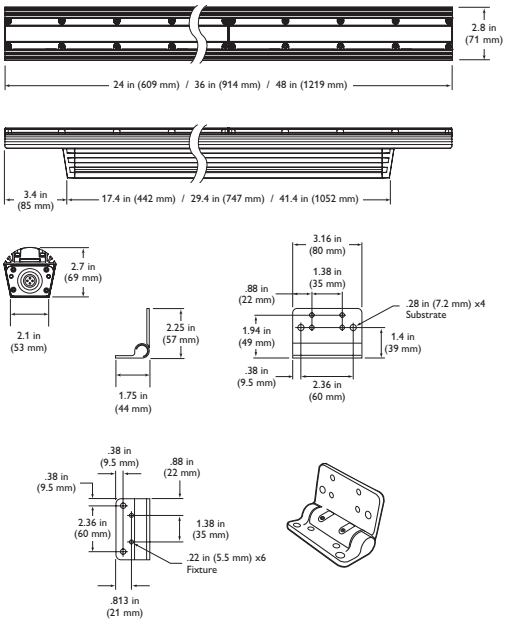
ColorGraze Powercore

30° x 60° beam angle

Linear, color-changing LED surface light for wall washing and grazing

ColorGraze Powercore linear LED lighting fixtures are optimized for surface grazing, wall-wash lighting, and efficient signage illumination. Superior light quality offers uniform beam saturation as close as 6 in (152 mm). A compact, low-profile design combined with flexible mounting options allows for discreet placement within a wide range of architectural features. Intelligent, controllable fixtures are available in standard full-color configurations. Custom configurations with additional beam angles and custom LED channels are also available to support special applications.

- Tailor light output to specific applications — Available in three standard lengths, with standard 10° x 60° and 30° x 60° beam angles. Individually addressable 1 ft (305 mm) segments accommodate fine control of color-changing effects and pre-programmed light shows.
- High-performance illumination and beam quality — ColorGraze Powercore delivers up to 368 lumens of color-changing light per foot. Superior beam quality offers striation-free saturation as close as 6 in (152 mm) from fixture placement with no visible light scalloping between fixtures.
- Integrates Powercore technology — Powercore technology rapidly, efficiently, and accurately controls power output to fixtures directly from line voltage. The Philips Data Enabler Pro merges line voltage with control and delivers them to the fixture over a single standard cable, dramatically simplifying installation and lowering total system cost.
- Versatile installation options — Constant torque locking hinges offer simple and consistent position control from various angles. The low-profile aluminum housing accommodates placement within most architectural niches.
- Superior color consistency — Optibin, a proprietary binning optimization process developed by Philips Color Kinetics, guarantees consistency of hue across LEDs, fixtures, and manufacturing runs.



- Industry-leading controls — ColorGraze Powercore works seamlessly with the complete Philips line of controllers, including Light System Manager, iPlayer 3, and ColorDial Pro, as well as third-party controllers.
- Support for installations requiring conduit to fixtures — ColorGraze Powercore Conduit fixtures have flying leads and threaded openings for 1/2 in NPT conduit to support installations in North America where conduit is required.
- Custom configurations for special applications — You can create custom configurations by exchanging the LED sources in any channel. Options include seven color temperatures ranging from 2700 K to 6500 K, Royal Blue, Blue, Green, Amber, and Red. Additional beam angles (including 9° x 9°, 10° x 30°, and 90° x 60°) are also available. Refer to the ColorGraze Powercore Ordering Information specification sheet for complete details.

For detailed product information, please refer to ColorGraze Powercore Product Guide at www.colorkinetics.com/ls/rgb/colorgraze/

PHILIPS

Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	2 ft (610 mm)	3 ft (914 mm)	4 ft (1219 mm)
Output	Beam Angle	30° x 60°		
	Lumens*	736	1104	1472
	LED Channels	Red / Green / Blue		
	Mixing Distance	6 in (152 mm) to uniform beam saturation		
	Lumen Maintenance†	100,000 hours L50 @ 25° C 90,000 hours L50 @ 50° C		
Electrical	Input Voltage	100 – 240 VAC, auto-switching, 50 / 60 Hz		
	Power Consumption *at full output, steady state*	35 W maximum	52.5 W maximum	70 W maximum
Control	Interface	Data Enabler Pro (DMX or Ethernet) Fixture firmware addressable 8- or 16-bit control		
	Control System	Philips full range of controllers, including Light System Manager, iPlayer 3, and ColorDial Pro, or third-party controllers		
Physical	Dimensions *(Height x Width x Depth)*	2.7 x 24 x 2.8 in (69 x 610 x 71 mm)	2.7 x 36 x 2.8 in (69 x 914 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	4.9 lb (2.2 kg)	8.1 lb (3.6 kg)	10.8 lb (4.9 kg)
	Housing	Extruded anodized aluminum		
	Lens	Clear polycarbonate		
	Fixture Connectors	Integral male / female waterproof connectors		
	Temperature	-40° – 122° F (-40° – 50° C) Operating -4° – 122° F (-20° – 50° C) Startup -40° – 176° F (-40° – 80° C) Storage		
	Humidity	0 – 95%, non-condensing		
	Maximum Fixture Run Lengths‡	37 @ 100 VAC 43 @ 120 VAC 56 @ 220 VAC 56 @ 240 VAC	*Configuration:* *2 ft (610 mm) fixtures installed end-to-end,* *20 A circuit, standard 50 ft (15.2 m)* *Leader Cable*	
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, PSE, CCC		
	Environment	Dry / Damp / Wet Location, IP66		

* Measurements comply with IES LM-79-08 testing procedures.

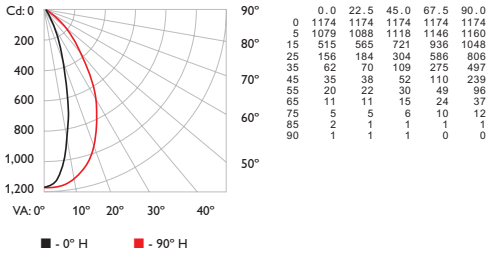
† L50 = 50% maintenance of lumen output (when light output drops below 50% of initial output). Ambient temperatures specified.

‡ These figures, provided as a guideline, are accurate for this configuration only. Changing the configuration can affect the fixture run lengths.

Photometrics

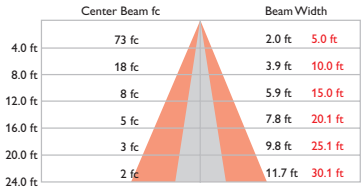
ColorGraze Powercore 2 ft, 30° x 60° beam angle

Polar Candela Distribution



	0.0	22.5	45.0	67.5	90.0
0	1174	1174	1174	1174	1174
5	1079	1088	1118	1146	1160
15	515	565	721	936	1048
25	156	184	304	586	806
35	62	70	109	275	497
45	35	38	52	110	239
55	20	22	30	49	96
65	11	11	15	24	37
75	5	5	6	10	12
85	2	1	1	1	1
90	1	1	1	0	0

Illuminance at Distance



34.3 ft (10.5 m)
1 fc maximum distance

Vert. Spread: 27.5°
Horiz. Spread: 64.2°

LED	Lumens	Efficacy
RGB	736	16.1

For lux multiply fc by 10.7

Accessories

Item	Type	Size	Item Number	Philips 12NC
Leader Cable	UL / cUL	50 ft (15.2 m)	108-000042-00	910503700322
	CE / PSE	50 ft (15.2 m)	108-000042-01	910503700323
Jumper Cable	UL / cUL	End-to-End	108-000039-00	910503700314
		1 ft (305 mm)	108-000039-01	910503700315
		5 ft (1.5 m)	108-000039-02	910503700316
	CE / PSE	End-to-End	108-000040-00	910503700317
		1 ft (305 mm)	108-000040-01	910503700318
		5 ft (1.5 m)	108-000040-02	910503700319
Glare Shield		1 ft (305 mm)	120-000081-00	910503700745
		2 ft (610 mm)	120-000081-01	910503700746
		3 ft (914 mm)	120-000081-02	910503700747
		4 ft (1.2 m)	120-000081-03	910503700748
Additional Terminators		Quantity 10	120-000074-00	910503700580
Additional Hinge		Quantity 1	120-000098-00	910503700772

Use Item Number when ordering in North America.

Fixtures and Data Enabler Pro

Item	Type	Size	Item Number	Philips 12NC
ColorGraze Powercore	10° x 60° beam angle	2 ft (610 mm)	123-000030-00	910503700308
		3 ft (914 mm)	123-000030-01	910503700309
		4 ft (1219 mm)	123-000030-02	910503700310
	30° x 60° beam angle	2 ft (610 mm)	123-000030-03	910503700311
		3 ft (914 mm)	123-000030-04	910503700312
		4 ft (1219 mm)	123-000030-05	910503700313
ColorGraze Powercore Conduit (UL / cUL only)	10° x 60° beam angle	2 ft (610 mm)	123-000020-06	910503701833
		3 ft (914 mm)	123-000020-11	910503701838
		4 ft (1219 mm)	123-000020-16	910503701843
	30° x 60° beam angle	2 ft (610 mm)	123-000020-08	910503701835
		3 ft (914 mm)	123-000020-13	910503701840
		4 ft (1219 mm)	123-000020-18	910503701845
Data Enabler Pro	3/4 in / 1/2 in NPT (US trade size conduit)		106-000004-00	910503701210
	PG21 / PG13 (metric size conduit)		106-000004-01	910503701211

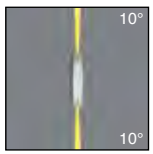
Use Item Number when ordering in North America.

Philips Color Kinetics
3 Burlington Woods Drive
Burlington, Massachusetts 01803 USA
Tel 888.385.5742
Tel 617.423.9999
Fax 617.423.9998
www.philipscolorkinetics.com

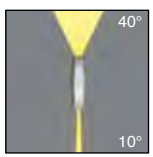
DAS-000010-02 R07 08-11

A SPECIFY LAMP/LUMINAIRE TYPE

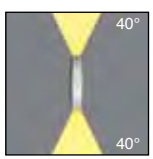
Code:	Narrow beam:	Lumens:	Color CCT:
66 2001	2 x 2W **LED**	2 x 200lm	3800K
66 2002	2 x 2W **LED**	2 x 200lm	5200K
66 2003	2 x 2W **LED**	2 x 40lm	blue



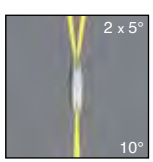
Code:	Wide/narrow beam:	Lumens:	Color CCT:
66 2011	2 x 2W **LED**	2 x 200lm	3800K
66 2012	2 x 2W **LED**	2 x 200lm	5200K
66 2013	2 x 2W **LED**	2 x 40lm	blue



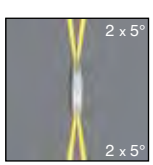
Code:	Wide beam:	Lumens:	Color CCT:
66 2021	2 x 2W **LED**	2 x 200lm	3800K
66 2022	2 x 2W **LED**	2 x 200lm	5200K
66 2023	2 x 2W **LED**	2 x 40lm	blue



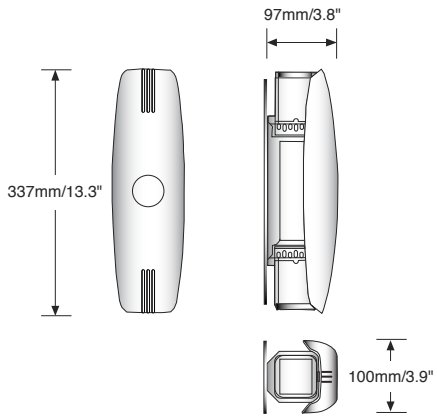
Code:	Twin narrow beam:	Lumens:	Color CCT:
66 2031	2 x 2W **LED**	2 x 200lm	3800K
66 2032	2 x 2W **LED**	2 x 200lm	5200K
66 2033	2 x 2W **LED**	2 x 40lm	blue

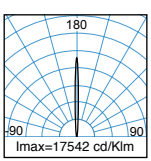


Code:	Twin narrow beam:	Lumens:	Color CCT:
66 2041	2 x 2W **LED**	2 x 200lm	3800K
66 2042	2 x 2W **LED**	2 x 200lm	5200K
66 2043	2 x 2W **LED**	2 x 40lm	blue



Note: *Due to constant changes in LEDs, please check our website for current product specifications.*

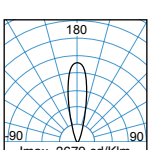




Narrow

H (ft)	DIA (ft)	fc
15	1.0	8
12	0.8	13
9	0.6	24
6	0.4	54
3	0.2	219

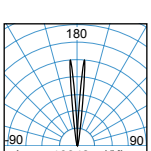
Ref: white LEDs



Wide

H (ft)	DIA (ft)	fc
15	5.0	2
12	4.0	3
9	3.0	5
6	2.0	11
3	1.0	47

Ref: white LEDs



Twin Narrow

H (ft)	DIA (ft)	fc
15	6.0	5
12	4.8	8
9	3.6	14
6	2.4	32
3	1.2	131

Ref: white LEDs

BLADE II

LED

GENERAL SPECIFICATION

Body and trim: Die-cast aluminum.

Finish: Silver powder coated, RAL9006.

Front fascia: Injection molded plastic, UV stabilized, painted RAL9006. Front fascia can be custom painted to special order.

Gasketing: Heat resistant silicone.

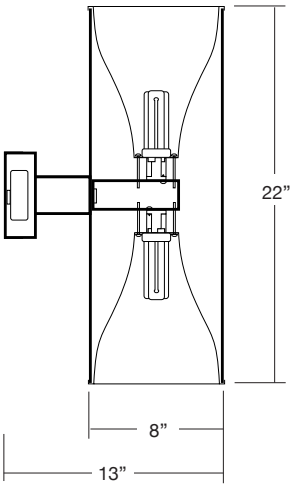
Drivers: HPF, electronic for 120-277V.

Minimum Starting Temperature: -30°C.

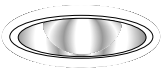
Mechanical: Mounts directly over a standard electrical junction box (by others). Blade luminaires can be mounted in any orientation.

Approval: UL, CSA. Wet location, IP67.

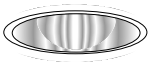
8" CYLINDER VERTICAL LAMP UP/DOWNLIGHT



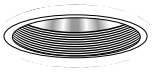
Wall Mount Cylinder



Clear Alzak® Haze



Wheat Alzak® Haze



Black Baffle

Splay with
Fresnel Lens

DELRAY LIGHTING INCORPORATED

CUV8200

SPECIFICATION INFORMATION

CYLINDER HOUSING
Constructed of seamless extruded aluminum, with a powder coat finish. 14" standard height; dimming and emergency ballast add 4". Fixture mounts to standard J-box.

REFLECTOR
Reflector is anodized, specular, durable and anti-iridescent; available in 30º cutoff (**.30**). Finishes are **A**–Clear Alzak® Haze or **G**–Wheat Alzak® Haze

TRIM OPTIONS
B–Black baffle
SP–Splay Fresnel Lens

BALLAST
Electronic enclosed, class P, HPF is supplied standard in 120V or 277V. Ballasts use 4-pin lamps and provide rapid start, .99 power factor with THD<10%.

ELECTRICAL
Ballast mounted in canopy for easy access. U.L. listed for use in damp locations. For wet locations, specify convex lens **WL**.

ACCESSORIES
WL–Wet location convex lens

FINISHES
BM–Brushed Metal, Anodized
BZ–Bronze
K–Black
W–White
S–Silver
CC–Custom Color (Must specify RAL color number.)

ORDERING INFORMATION

LAMP
2-18 18W quad tube
2-26 26W quad tube
2-32 32W triple tube
2-42 42W triple tube

SPECIFY FINISH:
☐ **BM**–Brushed Metal, anodized
☐ **BZ**–Bronze
☐ **K**–Black
☐ **W**–White
☐ **S**–Silver
CC–Custom Color
Specify RAL color #:

120V ELECTRIC
☐ **CUV8218.1E** 18W quad tube
☐ **CUV8226.1E** 26W quad tube
☐ **CUV8232.1E** 32W triple tube
☐ **CUV8242.1E** 42W triple tube

277V ELECTRIC
☐ **CUV8218.2E** 18W quad tube
☐ **CUV8226.2E** 26W quad tube
☐ **CUV8232.2E** 32W triple tube
☐ **CUV8242.2E** 42W triple tube

SUBMITTAL INFORMATION

TYPE:

PROJECT:

NOTES:

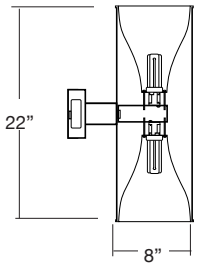
DESCRIPTION:

BURBANK,
CALIFORNIA,
91505
WWW.
DELRAY
LIGHTING.
COM

NOV 2008

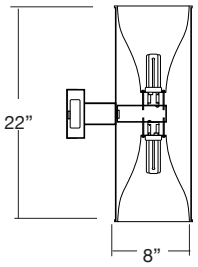
CLEAR ALZAK 30°

CUV8218



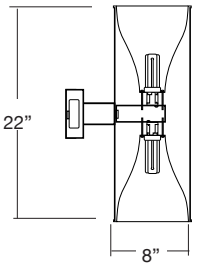
CLEAR ALZAK 30°

CUV8226



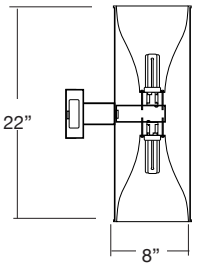
CLEAR ALZAK 30°

CUV8232



CLEAR ALZAK 30°

CUV8242



CONE OF LIGHT

MTG. HT.	FC/0•	DIA.
4’	65	3.7
6’	29	5.5
8’	17	7.3
10’	11	9.2
12’	8	11.0

50% FC at edge

MTG. HT.	FC/0•	DIA.
4’	81	3.7
6’	39	5.5
8’	19	7.3
10’	12	9.2
12’	9	11.0

50% FC at edge

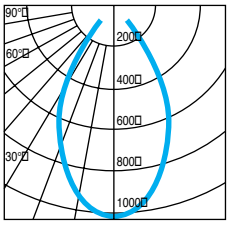
MTG. HT.	FC/0•	DIA.
4’	95	4.2
6’	42	6.4
8’	24	8.5
10’	15	10.7
12’	11	12.8

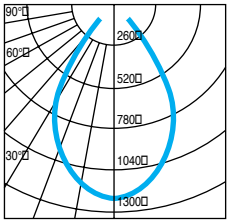
50% FC at edge

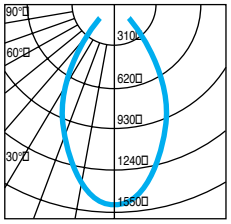
MTG. HT.	FC/0•	DIA.
4’	123	4.3
6’	54	6.6
8’	31	8.8
10’	19	10.9
12’	14	12.9

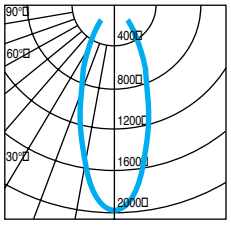
50% FC at edge

CP DISTRIBUTION









COEFFICIENTS OF UTILIZATION

% CEILING 80	(20% FLOOR)	
% WALL 70	50	30
0	75	75
1	72	71	70
2	70	67	65
3	67	64	61
4	64	60	58
5	62	57	54
6	59	55	52
7	57	52	49
8	54	49	46
9	52	47	43
10	50	44	41

% CEILING 80	(20% FLOOR)	
% WALL 70	50	30
0	71	71	71
1	69	67	66
2	66	63	61
3	63	60	57
4	61	57	54
5	58	53	50
6	55	51	48
7	53	48	45
8	50	45	42
9	48	43	39
10	46	40	37

% CEILING 80	(20% FLOOR)	
% WALL 70	50	30
0	84	84	84
1	80	78	77
2	77	74	71
3	73	69	66
4	70	65	62
5	67	61	57
6	63	58	54
7	60	54	50
8	57	50	46
9	54	47	43
10	51	44	40

% CEILING 80	(20% FLOOR)	
% WALL 70	50	30
0	79	79	79
1	76	74	73
2	73	70	67
3	69	66	63
4	66	62	58
5	63	58	55
6	60	55	51
7	57	51	48
8	54	48	44
9	51	45	41
10	49	42	39

NOTES

CUV8218
1-18W quad tube
G24q-2 electronic socket
Total lumens: 1250
Spacing criteria: .9
Wheat Alzak x.90

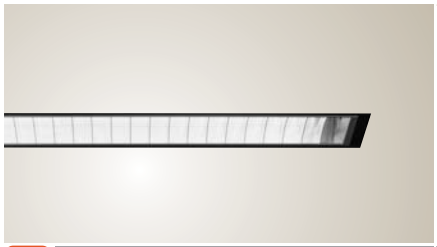
CUV8226
1-26W quad tube
G24q-3 electronic socket
Total lumens: 1800
Spacing criteria: .9
Wheat Alzak x.90

CUV8232
1-32W triple tube
G24q-3 electronic socket
Total lumens: 2400
Spacing criteria: .9
Wheat Alzak x.90

CUV8242
1-42W triple tube
G24q-4 electronic socket
Total lumens: 3200
Spacing criteria: .9
Wheat Alzak x.90

NOV 2008

PEERLESS®



Lightline® Recessed
Asymmetric T5 / T5HO

Type:

Project:

SPECIFICATIONS | 2 ½" Aperture | **LAR9**

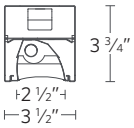
CATALOG NUMBER

FT

Examples: LAR9 G 1 54T5HO LDL U4 120 GEB10 L/LP C201 — LAR9 G 1 14T5 LDL U2 277 GEB10 LP835 C201

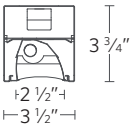
AVAILABLE FIXTURES

☐ **LAR9 - 1 2′**

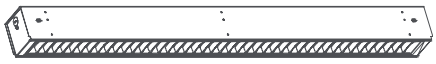


2′

☐ **LAR9 - 1 4′**



4′



SPECIFICATIONS

Construction
Housing is formed from one piece painted cold-rolled steel. Four-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts are finished with low-gloss baked enamel.

Reflectors
White painted reflector system.

Shielding
Arc-shaped, parabolic low iridescent semispecular aluminum louver.

Electrical
Specify 120 volt , 277 volt, or 347 volt. Non EL versions damp location labeled. C-UL listed and labeled. For special circuiting, consult factory.

Fixture Size
Nominal 2 ½" aperture. 2′ and 4′ lengths available.

ORDERING LOGIC

Fixture	Ceiling Type	# of Lamps in Cross Section	Lamp Type	Baffle	Nominal Length (FT)	Voltage	Ballast Type
LAR9	**G** Lay in grid	1	**24T5HO** 2′ 24W T5HO **54T5HO** 4′ 54W T5HO **14T5** 2′ 14W T5 **28T5** 4′ 28W T5	**LDL** Low Iridescent Louver	**U2** 2′ **U4** 4′	**120** **277** **347**	**GEB10** <10% ELECTRONIC Dimming Ballasts Available **ADEZ**[1,2] Advance Mark 10 dimming **ECO10**[1] Lutron ECO-10 dimming **DMHL**[1,2] Lutron Hi-Lume (FDB) - Purchased **ADZT**[1,2] Mark 7 (0-10 volt) **OSDIM**[1,2] Osram 0-10v dimming *Reference Ballast Chart on website or consult factory for other options.*

Emergency Type	Lamp Color	Finish	Options
EL[3] Emergency Battery Pack	**L/LP** No Lamp **LP830** 3000k 80+ CRI **LP835** 3500k 80+ CRI **LP841** 4100k 80+ CRI *Reference Lamp Chart on website or consult factory for other options.*	**C200** Standard White (low gloss) **C201** Black (default)	**GLR** Fast Blow Fuse **GMF** Slow Blow Fuse **CP** Chicago Plenum **NYC** New York City Calendar **FLNG** Flange Kit (dry wall only)

Notes:
1 Not available in 347 volt.
2 Only available with 54T5HO.
3 Only available with 28T5 & 54T5HO.

PEERLESS LIGHTING • 2246 5th St., Berkeley, CA 94710 • **Tel:** 510.845.2760 • **Fax:** 510.845.2776 • **www.peerless-lighting.com**

An AcuityBrands Company

PEERLESS®

Lightline® Recessed
Asymmetric T5 / T5HO

Type:

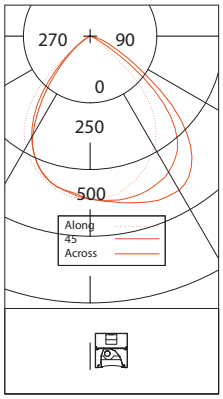
Project:

PHOTOMETRICS | 2 ½" Aperture | **LAR9**

1-LAMP 24W T5HO

FAR-FIELD PHOTOMETRY
DATE: 12-14-2009
REPORT NUMBER: 8387

CATALOG NUMBER: LAR9-1-24T5HO-WHR-SSB
LUMINAIRE: 3 1/2"W X 3 3/4"H RECESSED ASYMMETRIC DOWNLIGHT WITH WHITE PAINTED REFLECTOR AND SEMI-SPECULAR BAFFLES
LAMP(S): FP24/835/HO RATED @ 2000 LUMENS
BALLAST: QTP 2X39-24T5HO/UNV PSN
MOUNTING:
LUMEN TO CANDELA RATIO USED = 9.15
TOTAL INPUT WATTS = 26.8 AT 120.0 VOLTS
THE 0 DEGREE PLANE IS PERPENDICULAR TO THE LAMPS.



CANDELA DISTRIBUTION

0.0	45.0	90.0	135.0	180.0		FLUX
0	611	611	611	611	611	
5	621	618	608	600	594	58
15	646	623	577	567	568	168
25	667	605	518	493	494	254
35	644	558	432	368	337	288
45	511	428	269	187	155	231
55	257	173	38	47	49	94
65	93	26	7	7	12	25
75	30	6	2	2	3	7
85	3	1	0	0	0	1
90	1	1	1	1	1	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	480	24.0	42.6
0- 40	768	38.4	68.2
0- 60	1093	54.7	97.0
0- 90	1126	56.3	100.0
90-180	0	0.0	0.0
0-180	1126	56.3	100.0

TOTAL LUMINAIRE EFFICIENCY = 56.3 %
CIE TYPE - DIRECT

LUMINANCE DATA IN FOOTLAMBERTS

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	5444.	4557.	2859.
55	3380.	2273.	495.
65	1658.	458.	126.
75	874.	180.	51.
85	227.	76.	0.

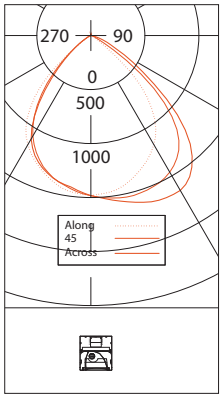
APPROVED BY:

BARE LAMP LUMEN VALUE IS RATED AT LAMP OPERATING TEMPERATURE INSIDE THE LUMINAIRE.
FOR DETAIL EXPLANATIONS, PLEASE SEE PEERLESS PUBLICATION # A62

1-LAMP 54W T5HO

FAR-FIELD PHOTOMETRY
DATE: 12-3-2009
REPORT NUMBER: 8363

CATALOG NUMBER: LAR9-1-54T5HO-WHR-SSB
LUMINAIRE: 3 1/2"W X 3 3/4"H RECESSED ASYMMETRIC DOWNLIGHT WITH WHITE PAINTED REFLECTOR AND SEMI-SPECULAR BAFFLES
LAMP(S): F54/835/HO/EA 49W RATED @ 5000 LUMENS
BALLAST: QTP 2X54T5HO/UNV PSN
MOUNTING
LUMEN TO CANDELA RATIO USED = 9.15
TOTAL INPUT WATTS = 51.8 AT 120.0 VOLTS
THE 0 DEGREE PLANE IS PERPENDICULAR TO THE LAMPS.



CANDELA DISTRIBUTION

0.0	45.0	90.0	135.0	180.0			FLUX
0	1482	1482	1482	1482	1482		
5	1516	1508	1467	1452	1438	141	
15	1598	1533	1392	1361	1364	408	
25	1656	1503	1256	1195	1226	622	
35	1595	1388	1048	913	909	718	
45	1235	1062	646	482	429	576	
55	585	406	86	125	131	225	
65	202	56	17	17	31	57	
75	53	14	5	6	9	1	
85	4	3	1	1	1	2	
90	1	0	0	0	0		

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	1171	23.4	42.3
0- 40	1888	37.8	68.3
0- 60	2689	53.8	97.2
0- 90	2765	55.3	100.0
90-180	0	0.0	0.0
0-180	2765	55.3	100.0

TOTAL LUMINAIRE EFFICIENCY = 55.3 %
CIE TYPE - DIRECT

LUMINANCE DATA IN FOOTLAMBERTS

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	6583.	5659.	3440.
55	3848.	2667.	563.
65	1801.	498.	149.
75	771.	210.	68.
85	160.	140.	40.

APPROVED BY:

BARE LAMP LUMEN VALUE IS RATED AT LAMP OPERATING TEMPERATURE INSIDE THE LUMINAIRE.
FOR DETAIL EXPLANATIONS, PLEASE SEE PEERLESS PUBLICATION # A62

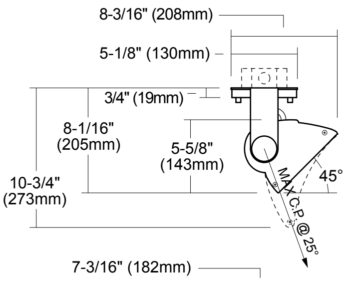
*Use a 0.58 multiplier for T5.

PEERLESS LIGHTING • 2246 5th St., Berkeley, CA 94710 • **Tel:** 510.845.2760 • **Fax:** 510.845.2776 • **www.peerless-lighting.com**

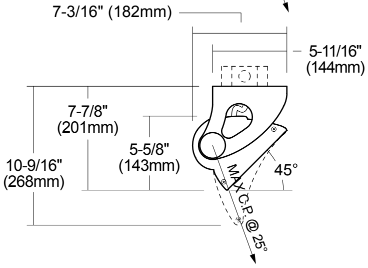
An AcuityBrands Company

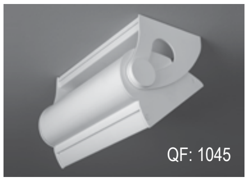
MOUNTING DETAILS

REMOTE BALLAST

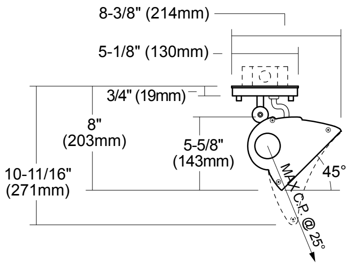


LS8 Large Simple Mount



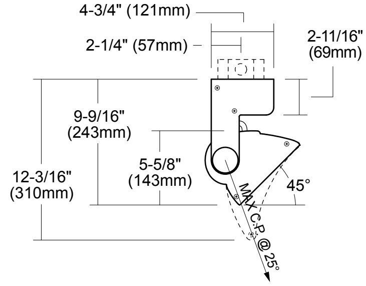


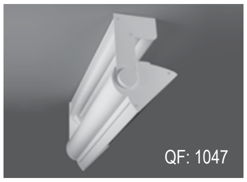
LD8 Large Deco Mount



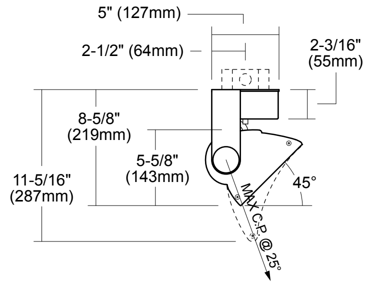
LK8 Large Knuckle Mount

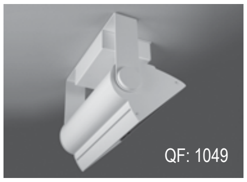
INTEGRAL BALLAST





LS9 Large Simple Mount





LS13 Large Simple Mount

surface ceiling

MOUNTING- *All standard mounts are fully adjustable and lockable. Designed for remote or integral ballast. See Mounting Details above.*

TYPE- *Large profile with smooth or ribbed detail.* ***Indoor;*** *Non-gasketed, captive extruded aluminum hinge for lens and baffle options.* ***Outdoor;*** *Silicone gasketed lens, captive extruded aluminum door with window cut-out for regressed lens.* ***Lens;*** *Open aperture is standard for indoor fixtures. Outdoor fixtures are equipped with clear acrylic lens.*

PERFORMANCE- *Asymmetric distribution provides a concentration of light on target surface for smooth illumination. Maximum candlepower aimed 25° above nadir has less than 10% spill light within the 0-25° zone and less than 2% spill light within the 90-180° zone.*

ELECTRICAL- *Electronic, HPF ballast, lamp protection circuit, and thermally protected. Provide 90°C supply wire. See Technical section for specific ballast data.*

PROFILE- P1 (basic): *Anodized, extruded aluminum specular reflector with solid aluminum endcaps and stainless steel hardware. Extruded aluminum glare control visor can be combined with P1 basic profile to create P5 profile.*

FINISHES- *An electrostatically applied wet paint system utilizes a multi-stage process to provide a durable acrylic enamel finish. Suitable for indoor and outdoor applications.*

• Winona Lighting reserves the right to make design revisions without prior notice.

PRODUCT SPECIFICATION

___ – ___ – ___ – ___ – ___ – ___ – ___ – ___

MOUNTING

Remote Ballast

- **LS8 -** simple yoke
- **LD8 -** deco yoke
- **LK8 -** knuckle

Integral Ballast

- **LS9 -** simple yoke
- **LS13 -** simple yoke

TYPE

Indoor

damp label

- **LS -** large smooth
- **LR -** large ribbed

Outdoor

wet label

- **LSW -** large smooth wet

LAMP CODE

Compact Fluorescent

LAMP CODE	DESCRIPTION	LENGTH	WEIGHT
CFM132	(1) CFM32W/GX24	12"	8 lbs.
CFM142	(1) CFM42W/GX24	12"	8 lbs.
CFM157	(1) CFM57W/GX24	12"	8 lbs.
CFM170	(1) CFM70W/GX24	16"	10 lbs.
CFM232	(2) CFM32W/GX24	20"	13 lbs.
CFM242	(2) CFM42W/GX24	20"	13 lbs.
CFM257	(2) CFM57W/GX24	20"	13 lbs.
CFM270	(2) CFM70W/GX24	25"	19 lbs.
† **FT139**	(1) FT39W/2G11	20"	13 lbs.
† **FT239**	(2) FT39W/2G11	20"	13 lbs.
† **FT140**	(1) FT40W/2G11	25"	19 lbs.
† **FT240**	(2) FT40W/2G11	25"	19 lbs.
† **FT150**	(1) FT50W/2G11	25"	19 lbs.
† **FT250**	(2) FT50W/2G11	25"	19 lbs.
† **FT155**	(1) FT55W/2G11	25"	19 lbs.
† **FT255**	(2) FT55W/2G11	25"	19 lbs.

† Not available for wet label

Linear Fluorescent

For single linear or continuous row applications see **Surface Linear Tab.**

Note: Lamps not included

VOLTAGE

- **120V -** 120 volt
- **277V -** 277 volt

PROFILE

P1 (basic)

P5 (short)

FINISH

- **SGW -** semi gloss white
- **ALP -** aluminum paint (matte)
- **SGB -** semi gloss black
- **ABP -** antique brass paint
- **LGP -** light gold iridescent paint
- **LSP -** light silver paint
- **MBP -** medium bronze paint
- **PBP -** pale bronze paint
- **PEW -** pewter paint
- **PGP -** pale gold paint
- **SPF -** standard paint finish
- **CPF -** custom paint finish (consult factory)

OPTIONS

- **X -** no options
- **CA -** clear acrylic lens (CFM lamps only)
- **EM -** emergency battery (remote mounted)
- **MP -** micro-prismatic glass (CFM lamps only)
- **PB -** parabolic blade baffle (internal mount- N/A for wet)
- **SB -** straight blade baffle (external mount)
- **SO -** special options

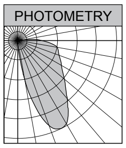
See pgs 429-431 for details

CLASS

- **STD -** standard
- **MOD -** modified

FT140W
Report #10935

PHOTOMETRY



Visit the web for detailed photometry reports

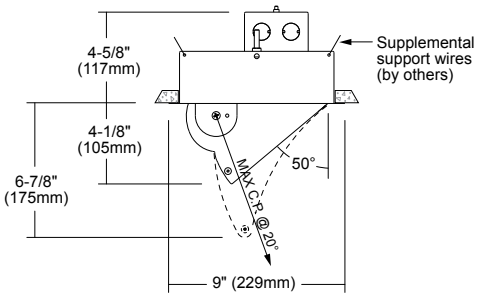
Visit www.winonalighting.com for the most complete and current information.

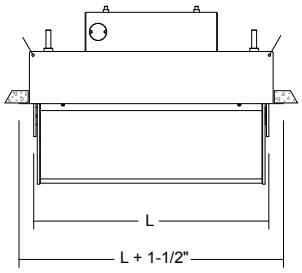
All fixtures UL listed, USA and Canada

MOUNTING DETAILS

LSRU - Universal Mount

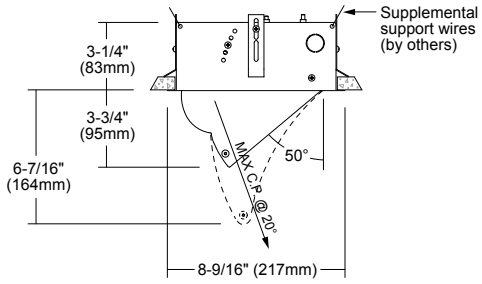
LSRU Large Universal Mount Semi-Recessed

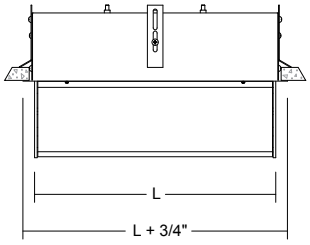




LSRS - Simple Mount (For use in accessible ceilings only)

LSRS Large Simple Mount Semi-Recessed





MOUNTING- *20 ga. CRS painted housing, welded construction, integral ballast, and painted finish. See Mounting Details above.* ***Universal;*** *Adjustable and lockable yoke design with aiming adjustment below ceiling. Installation from above or below ceiling (accessible or inaccessible ceiling types). Additional support may be required by local codes. Auxiliary mounting holes are provided with hanger wire or threaded rods (by others).* ***Simple;*** *Adjustable and lockable features concealed above ceiling with painted steel trim. Installation from above ceiling only (accessible ceiling types only). Ballast compartment provided with conduit knock-outs. Supplemental supports are required for accessible ceilings (either hanger wires or C-channels, not included). If hanger wire suspension is not possible, specify Hanger bracket* ***(HB)*** *option to accept suspension bars (not provided).*

TYPE- *Large profile with smooth or ribbed detail.* ***Indoor;*** *Non-gasketed, captive extruded aluminum hinge for lens and baffle options.* ***Lens;*** *Open aperture is standard for indoor fixtures. Outdoor fixtures shall be specified with clear acrylic lens option.*

PERFORMANCE- *Asymmetric distribution provides a concentration of light on target surface for smooth illumination. Maximum candlepower aimed 20° above nadir has less than 10% spill light within the 0-20° zone and less than 2% spill light within the 90-180° zone.*

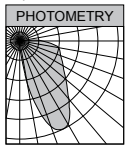
ELECTRICAL- *Integral electronic HPF ballast, lamp protection circuit, and thermally protected. Provide 90°C supply wire.*

PROFILE- P1 (basic): *Anodized, extruded aluminum specular reflector with solid aluminum endcaps and stainless steel hardware. Extruded aluminum glare control visor can be combined with P1 basic profile to create P5 profile.*

FINISHES- *An electrostatically applied wet paint system utilizes a multi-stage process to provide a durable acrylic enamel finish.*

• *Winona Lighting reserves the right to make design revisions without prior notice.*

PRODUCT SPECIFICATION

MOUNTING	TYPE	LAMP CODE	VOLTAGE	PROFILE	FINISH	OPTIONS	CLASS
Integral Ballast **LSRU -** universal * **LSRS -** simple * Accessible Ceilings only	**Indoor** damp label **LS -** large smooth **LR -** large ribbed	See lamp code table below	**120V -** 120 volt **277V -** 277 volt	 **P1** (basic)  **P5** (short)	**SGW -** semi gloss white **ALP -** aluminum paint (matte) **SGB -** semi gloss black **ABP -** antique brass paint **LGP -** light gold iridescent paint **LSP -** light silver paint **MBP -** medium bronze paint **PBP -** pale bronze paint **PEW -** pewter paint **PGP -** pale gold paint **SPF -** standard paint finish **CPF -** custom paint finish (consult factory)	**X -** no options **CA -** clear acrylic lens (CFM lamps only) **EM -** emergency battery (remote mounted) **HB -** hanger bracket (see product text) **MP -** micro-prismatic glass (CFM lamps only) **PB -** parabolic blade baffle (internal mount) **PL -** plenum rated (consult factory) **SB -** straight blade baffle (CFM lamps only) (external mount) **SO -** special options See pgs 429-431 for details	**STD -** standard **MOD -** modified FT140W Report #10935 PHOTOMETRY  Visit the web for detailed photometry reports

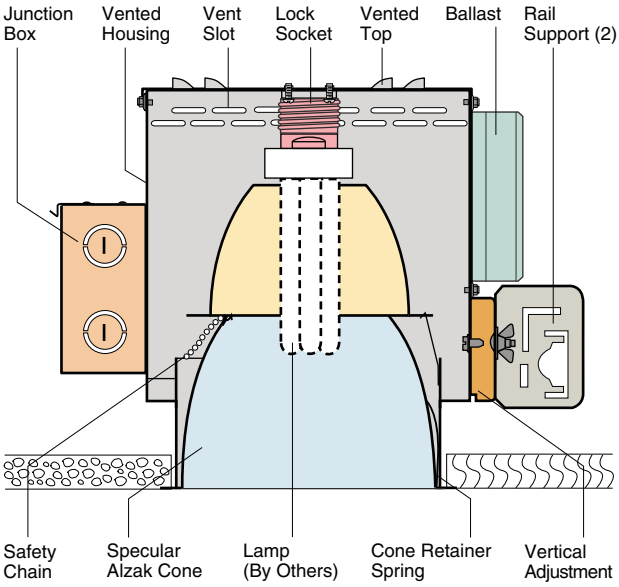
LAMP CODE

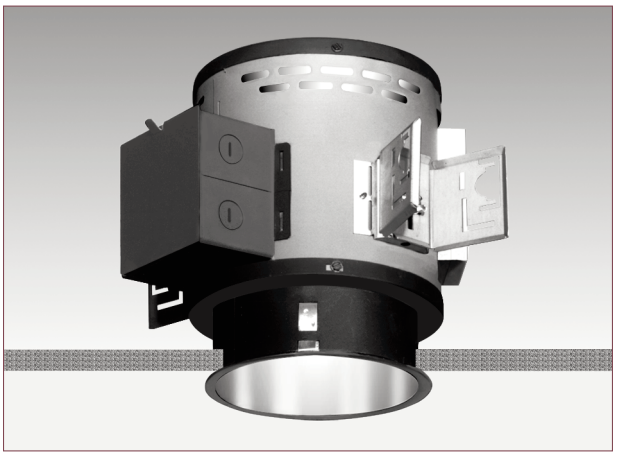
LAMP CODE	DESCRIPTION	LENGTH	WEIGHT
Universal Mount (Compact Fluorescent)			
CFM132	(1) CFM32W/GX24	13-1/2"	8 lbs.
CFM142	(1) CFM42W/GX24	13-1/2"	8 lbs.
CFM157	(1) CFM57W/GX24	13-1/2"	8 lbs.
CFM170	(1) CFM70W/GX24	17-1/2"	10 lbs.
CFM232	(2) CFM32W/GX24	21-1/2"	16 lbs.
CFM242	(2) CFM42W/GX24	21-1/2"	16 lbs.
CFM257	(2) CFM57W/GX24	21-1/2"	16 lbs.
† **CFM270**	(2) CFM70W/GX24	26-1/2"	21 lbs.
FT139	(1) FT39W/2G11	21-1/2"	16 lbs.
FT239	(2) FT39W/2G11	21-1/2"	16 lbs.
† **FT140**	(1) FT40W/2G11	26-1/2"	21 lbs.
† **FT240**	(2) FT40W/2G11	26-1/2"	21 lbs.
† **FT150**	(1) FT50W/2G11	26-1/2"	21 lbs.
† **FT250**	(2) FT50W/2G11	26-1/2"	21 lbs.
† **FT155**	(1) FT55W/2G11	26-1/2"	21 lbs.
† **FT255**	(2) FT55W/2G11	26-1/2"	21 lbs.
Simple Mount (Accessible Ceiling Only)			
CFM132	(1) CFM32W/GX24	12-3/4"	8 lbs.
CFM142	(1) CFM42W/GX24	12-3/4"	8 lbs.
CFM157	(1) CFM57W/GX24	12-3/4"	8 lbs.
CFM170	(1) CFM70W/GX24	20-3/4"	16 lbs.
CFM232	(2) CFM32W/GX24	20-3/4"	16 lbs.
CFM242	(2) CFM42W/GX24	20-3/4"	16 lbs.
CFM257	(2) CFM57W/GX24	20-3/4"	16 lbs.
CFM270	(2) CFM70W/GX24	23-3/4"	21 lbs.
FT139	(1) FT39W/2G11	20-3/4"	16 lbs.
FT239	(2) FT39W/2G11	20-3/4"	16 lbs.
FT140	(1) FT40W/2G11	23-3/4"	21 lbs.
FT240	(2) FT40W/2G11	23-3/4"	21 lbs.
FT150	(1) FT50W/2G11	23-3/4"	21 lbs.
FT250	(2) FT50W/2G11	23-3/4"	21 lbs.
FT155	(1) FT55W/2G11	23-3/4"	21 lbs.
FT255	(2) FT55W/2G11	23-3/4"	21 lbs.

† Will not fit in standard 2' x 2' t-bar ceiling. Note: Lamps not included

Visit www.winonalighting.com for the most complete and current information.

All fixtures UL listed, USA and Canada





P926 One 26W or 32W Triple Tube Lamp
P927 One 42W Triple Tube Lamp

Medium Beam
5⅞" Conoid Apertures

Optics and Applications
Distribution from a single vertically mounted triple tube lamp is for general lighting. Spacing to mounting height ratios range from .93 to 1.11 depending upon which lamp is mounted. Use in corridors, entries, work stations or open area lighting in low to medium height ceilings.

Design Features
The two reflector optical system is protected by a rigid steel housing which keeps the reflectors in proper relationship to each other. The twist and lock socket prevents the lamp from falling if it is not properly engaged. It is a dependable fail-safe mechanism to prevent injury and litigation. Maximum ceiling thickness is 2". Ballast and lamp service from below.

Finish
Specular clear Alzak cones are standard. Optional colors and Softglow® finishes are available. Housings and structural parts are painted optical matte black to suppress stray light leaks. Steel parts are phosphate conditioned for corrosion resistance before painting.

Ballasts
Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage ranges from 120V through 277V. Power factor .98, starting temperature 0° F (-18° C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

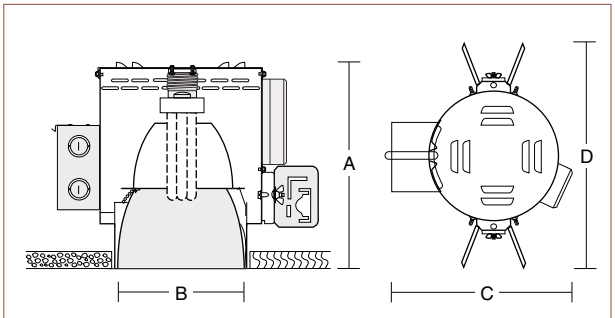
General
Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Rating (LER) data is in the photometric directory located in Section Z.

Accessories

G	Gold cone.	R2	26" support rails.
H	Mocha cone.	R5	52" support rails.
P	Graphite cone.	WT	White trim flange.
T	Titanium cone.	WHT	White complete trim.
W	Wheat cone.	V347	347 volt ballast.
Y	Pewter cone.	F	Fuse.
Z	Bronze cone.		

S Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
DM Dimming ballast. Specify watts and volts.
EM Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.
WRL Wattage restriction label, specify wattage.

Dimensions and Lamps



Number	A Depth*	B Aperture	C Width	D Length	Lamps
P926	9¾" 248mm	5⅞" 149mm	10½" 267mm	13¼" 337mm	26W or 32W Triple Tube
P927	10¼" 260mm	5⅞" 149mm	10½" 267mm	13¼" 337mm	42W Triple Tube

*Recess depth increases to 12½" with EM and DM accessories.

kurt versen
Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

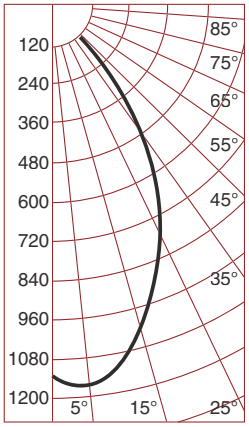
P51 P926 P927

Performance Datachart

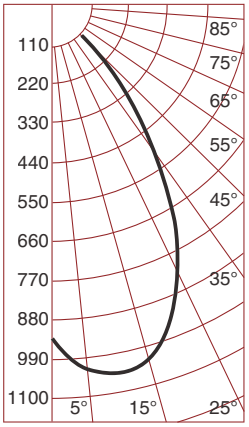
Single Unit Initial Footcandles, 30" Work Plane							Ceiling to Floor	Multiple Units Initial Footcandles, 30" Work Plane			
P926 One 32W Osram Triple Tube Read Top Data P927 One 42W Osram Triple Tube Read Bottom Data								Ceiling 80% Walls 50% Floor 20%			
Nadir	10°		20°		30°			Spacing is Maximum Over Work Plane			
FC	FC	Diam	FC	Diam	FC	Diam		Spacing	RCR 1	RCR 3	RCR 8
37 47	35 42	2' 2'	25 30	4' 4'	13 17	6' 6'	8'	5' 5'	49 66	42 56	30 39
27 33	25 30	2' 2'	18 21	5' 5'	10 12	8' 8'	9'	6' 6'	35 47	30 40	21 28
20 25	19 23	3' 3'	14 16	5' 5'	7 9	9' 9'	10'	7' 7'	26 36	23 30	16 21
13 16	12 14	3' 3'	8 10	7' 7'	4 6	11' 11'	12'	9' 9'	17 22	14 19	10 13
9 11	8 10	4' 4'	6 7	8' 8'	3 4	13' 13'	14'	11' 11'	11 15	10 13	7 9

See notes 4, 5 and 6.

Candlepower Distribution



P926 32W Triple Tube Osram
Eff. 50% S/M .95



P926 32W Triple Tube Philips
Eff. 50% S/M 1.11

Candelas

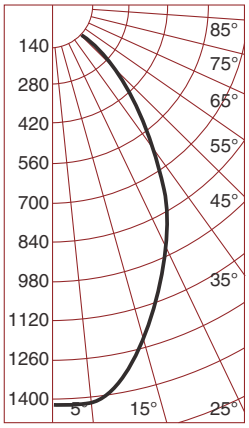
	O 32W	P 32W
o	2400*	2400*
0	1134	938
5	1152	1021
10	1109	1055
15	1023	1020
20	916	956
25	789	837
30	625	667
35	460	467
40	353	321
45	212	173
50	19	16
55	7	6
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

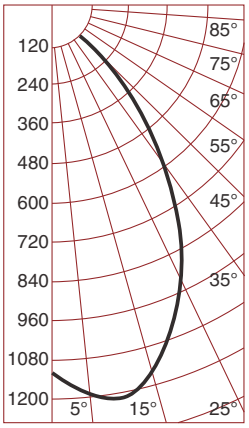
Coefficients of Utilization

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.57	.56	.55	.53	.55	.52	.53	.51	.51	.49	.47
2	.54	.52	.50	.48	.51	.47	.49	.46	.48	.45	.43
3	.51	.48	.45	.43	.47	.43	.46	.42	.45	.41	.40
4	.48	.44	.41	.39	.44	.39	.43	.38	.42	.38	.37
5	.46	.41	.38	.36	.41	.36	.40	.35	.39	.35	.34
6	.43	.38	.35	.33	.38	.33	.37	.33	.36	.32	.31
7	.41	.36	.33	.30	.35	.30	.35	.30	.34	.30	.29
8	.39	.34	.30	.28	.33	.28	.33	.28	.32	.28	.27
9	.37	.31	.28	.26	.31	.26	.31	.26	.30	.26	.25
10	.35	.30	.26	.24	.29	.24	.29	.24	.28	.24	.23

P926 One 32W Triple Tube Osram Sylvania
P926 One 32W Triple Tube Philips x .98



P927 42W Triple Tube Osram
Eff. 48% S/M .93



P927 42W Triple Tube Philips
Eff. 44% S/M 1.07

	O 42W	P 42W
o	3200*	3200*
0	1412	1104
5	1403	1188
10	1328	1211
15	1176	1154
20	1092	1063
25	958	919
30	789	747
35	611	583
40	487	441
45	355	253
50	75	23
55	10	8
60	0	0
65	0	0
70	0	0
75	0	0
80	0	0
85	0	0
90	0	0

o Vertical Angles
* Initial Lamp Lumens

Ceiling	80%				70%		50%		30%		0
Wall %	70	50	30	10	50	10	50	10	50	10	0
RCR	Zonal Cavity Method - Floor Reflectance 20%										
1	.56	.55	.54	.53	.54	.52	.52	.50	.50	.49	.46
2	.53	.51	.49	.47	.50	.47	.48	.46	.47	.45	.43
3	.51	.47	.45	.43	.47	.42	.45	.42	.44	.41	.39
4	.48	.44	.41	.39	.43	.38	.42	.38	.41	.38	.36
5	.45	.41	.38	.35	.40	.35	.39	.35	.39	.35	.34
6	.43	.38	.35	.33	.38	.32	.37	.32	.36	.32	.31
7	.40	.35	.32	.30	.35	.30	.34	.30	.34	.30	.29
8	.38	.33	.30	.28	.33	.28	.32	.28	.32	.27	.27
9	.36	.31	.28	.26	.31	.26	.30	.26	.30	.26	.25
10	.34	.29	.26	.24	.29	.24	.29	.24	.28	.24	.23

P927 One 42W Triple Tube Osram Sylvania
P927 One 42W Triple Tube Philips x .89

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P926	32W Osram Sylvania Triple Tube	10	33	66	150	12837
	32W Philips Triple Tube	12	34	62	151	10756
P927	42W Osram Sylvania Triple Tube	14	45	91	208	17796
	42W Philips Triple Tube	15	45	82	203	14468

Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 7.

Notes

1 Data on all charts calculated with a clear specular cone finish.
2 Specular cone multipliers: Wheat x .84, Pewter x .79, Mocha x .78, Graphite x .75, Titanium x .75, Bronze x .72.
3 Softglow® cone multipliers: Wheat x .71, Mocha x .68, Pewter x .65, Graphite x .64, Titanium x .64, Bronze x .61.
4 Single unit Datachart pattern diameters are determined by the number of degrees from each side of nadir. Therefore a 20° diameter represents a total 40° pattern width at the work plane 30" above the floor. Footcandle values are at the edge of that diameter.
5 Datachart spacing is rounded off to the nearest foot.
6 Data by IES methods. Compact fluorescent data vary due to lamp differences, power input, burning position, ambient temperature and ballast characteristics. Apply a modification factor.
7 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

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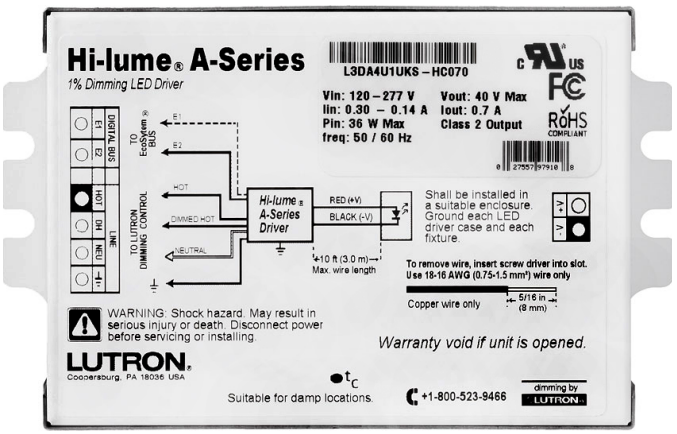
Hi-lume® A-Series Driver Overview EcoSystem® or 3-wire control

Hi-lume® A-Series Driver is a high-performance LED driver that provides smooth, continuous 1% dimming for virtually any LED fixture, whether it requires constant current or constant voltage. It is the most versatile LED driver offered today due to its compatibility with a wide variety of LED arrays, multiple form factors, and numerous control options.

Features

- Continuous, flicker-free dimming from 100% to 1%.
- Compatible with Energi Savr Node™ with EcoSystem® unit, GRAFIK Eye® QS control unit, PowPak™ dimming module with EcoSystem®, and Quantum® systems, allowing for integration into a planned or existing EcoSystem® lighting control solution. Please see chart at the end of this document or contact Lutron for details regarding compatible controls.
- Standard 3-wire line-voltage phase-control technology for consistent dimming performance and compatibility with all Lutron® 3-wire fluorescent controls.
- Protected from miswires of input power to EcoSystem® control inputs.
- 100% performance tested at factory.
- 100% burned in at factory.
- A rated lifetime of 50,000 hours @ t_C = 149 °F (65 °C).
- UL recognized for United States and Canada.
- FCC Part 15 compliant for commercial applications at 120 V~ or 277 V~.
- Pulse Width Modulation (PWM) or Constant Current Reduction (CCR) dimming methods available. See Application Note #360 for details.
- For more information please go to: www.lutron.com/HilumeLED



Hi-lume® A-Series, case type K

3.00 in (76 mm) W x 1.00 in (25 mm) H x 4.90 in (124 mm) L

Hi-lume® A-Series, case type M

1.18 in (30 mm) W x 1.00 in (25 mm) H x 14.25 in (362 mm) L

Job Name:	Model Numbers:
Job Number:	

Specifications

Performance

- Dimming Range: 100% to 1%
- Operating Voltage: 120-277 V~ at 50/60 Hz
- A rated lifetime of 50,000 hours @ t_c = 149 °F (65 °C). Contact Lutron for derating information.
- Patented thermal foldback protection
- LEDs turn on to any dimmed level without going to full brightness.
- Nonvolatile memory restores all driver settings after power failure.
- Power Factor: >0.90 at 40 W
- Standby Power Consumption: <1.0 W
- Total Harmonic Distortion (THD): <20% at 40 W
- Inrush Current: <2 A
- Inrush Current Limiting Circuitry: eliminates circuit breaker tripping, switch arcing and relay failure.
- Open circuit protected
- Short circuit protected
- Turn-on time: ≤1 second
- PWM Dimming Frequency: 550 Hz

Environmental

- Sound Rating: Class A.
- Relative Humidity: Maximum 90% non-condensing.
- Minimum operating ambient temperature t_a = 32 °F (0 °C).

Standards

- Meets ANSI C62.41 category A surge protection standards up to and including 4 kV.
- FCC Part 15 compliant for commercial applications at 120 V~ or 277 V~.
- Manufacturing facilities employ ESD reduction practices that comply with the requirements of ANSI/ESD S20.20.
- Lutron® Quality Systems registered to ISO 9001.2008.
- UL 8750 recognized.
- Class 2 output available.
- Models available to meet LED Driver requirements for Energy Star 1.1.

Driver Wiring & Mounting

- Driver is grounded by a mounting screw to the grounded fixture (or by terminal connection on the K case).
- Terminal blocks on the driver accept one solid wire per terminal from 18 to 16 AWG (0.75 to 1.5 mm^2).
- Fixture must be grounded in accordance with local and national electrical codes.
- Maximum driver–to–LED light engine wire length is 10 ft (3.0 m).

Job Name:	Model Numbers:
Job Number:	

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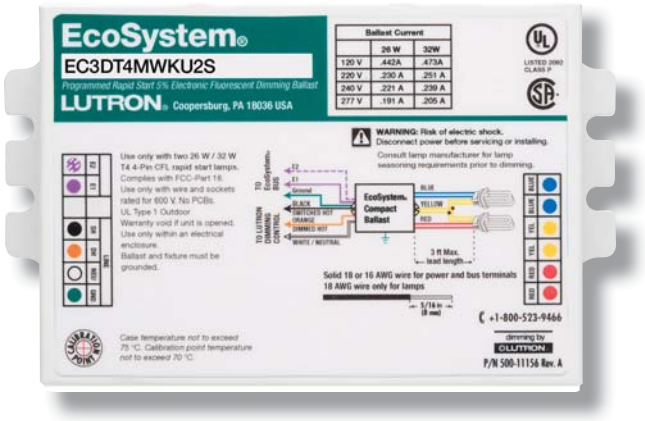
EcoSystem® Digital Ballasts

EcoSystem compact ballasts provide high-performance dimming for any compact fluorescent application, including within an *EcoSystem* Lighting Control System. *EcoSystem* compact ballasts offer 100% to 5% dimming, providing both energy savings and lighting flexibility.



***EcoSystem* ballast, case type K**

Features

- Continuous, flicker-free dimming from 100% to 5%
- Compatible with *EcoSystem* Energi Savr Node™, GRAFIK Eye® QS with *EcoSystem*, PowPak™ dimming module with *EcoSystem* unit, and Quantum® systems, allowing for integration into an existing/planned *EcoSystem* lighting control system
- Supports standard 3-wire line-voltage phase control technology.
- Programmed rapid start design ensures full-rated lamp life while dimming and cycling.
- Lamps turn on to any dimmed level without flashing to full brightness.
- Low harmonic distortion throughout the entire dimming range.
- Frequency of operation ensures that ballast does not interfere with infrared devices.
- Inrush current limiting circuitry eliminates circuit breaker tripping, switch arcing, and relay failure.
- Ultra-quiet operation.
- Protected from miswires of any input power to control lead, or from lamp leads to each other and/or ground.
- End-of-lamp-life protection circuitry ensures safe operation throughout entire lamp life
- Nonvolatile memory restores all ballast settings after power failure
- 100% compatible with all Lutron 3-wire fluorescent controls and *EcoSystem* digital controls.
- 100% performance tested at factory.
- Custom ballast factors available.
  Design tool and specifications can be found at www.lutron.com/ballasttool

Job Name:	Model Numbers:
Job Number:	

Specifications

Standards

- UL Listed (evaluated to the requirements of UL935)
- UL Type 1 Outdoor for damp locations
- California Energy Commission Listed
- CSA Certified (evaluated to the requirements of C22.2 No. 74)
- Class P thermally protected
- Meets ANSI C82.11 High Frequency Ballast Standard
- Meets FCC Part 18 Non-Consumer requirements for EMI/RFI emissions
- Meets ANSI C62.41 Category A surge protection standards up to and including 4 kV
- Manufacturing facilities employ ESD reduction practices that comply with the requirements of ANSI/ESD S20.20
- Lutron Quality Systems registered to ISO 9001.2008

Performance

- Operating Voltage: 120, 220/240, 277 V~ at 50 or 60 Hz
- Grounding: ballast and fixture must be grounded for proper dimming
- Dimming Range: 100% to 5% measured relative light output
- Lamp Starting: programmed rapid start
- Lamp Current Crest Factor: less than 1.7
- Light Output Variation: Constant ±2% light output for line voltage variations of ±10%
- Lamp Life: Average lamp life meets or exceeds specified lamp ratings
- Power Factor: 0.95 minimum
- Total Harmonic Distortion (THD): Less than 10%
- Inaudible in a 27 dBA ambient
- Maximum Inrush Current: 3 A per ballast at 277 V~, 7A per ballast at 120 V~
- Standby power: Less than 1 W

Environment

- Minimum lamp starting temperature: 50 °F (10 °C)
- Relative humidity: less than 90% non-condensing
- Sound Rating: Class A
- Maximum ballast case temperature: 167 °F (75 °C)

Ballast Wiring & Mounting

- Ballast is grounded by the specified terminal or by a mounting screw to the fixture
- Terminal blocks on the ballast accept the following wire gauges:
  Power Wiring and *EcoSystem* Bus:
  one 16 AWG (1.31 mm^2) or 18 AWG (0.82 mm^2) solid per terminal
  Lamp Wiring:
  one 16 AWG (1.31 mm^2) or 18 AWG (0.82 mm^2) solid per terminal
- Ballast mounts using two mounting tabs or studs within a fluorescent fixture
- Wiring from the ballast to lamp sockets shall not exceed 3 ft (.91 m) for T4 compact lamps
- Ballast does not have sensor terminals

Lamp Seasoning

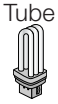
Refer to lamp manufacturer for lamp seasoning requirements prior to dimming

Warranty

5-year limited warranty with *Lutron* field service commissioning (3-year standard warranty) from date of purchase. For additional Warranty information, please visit http://www.lutron.com/ResourceLibrary/warranty/Limited%20Comm.pdf

Job Name:	Model Numbers:
Job Number:	

EcoSystem® Compact Fluorescent Ballast Models

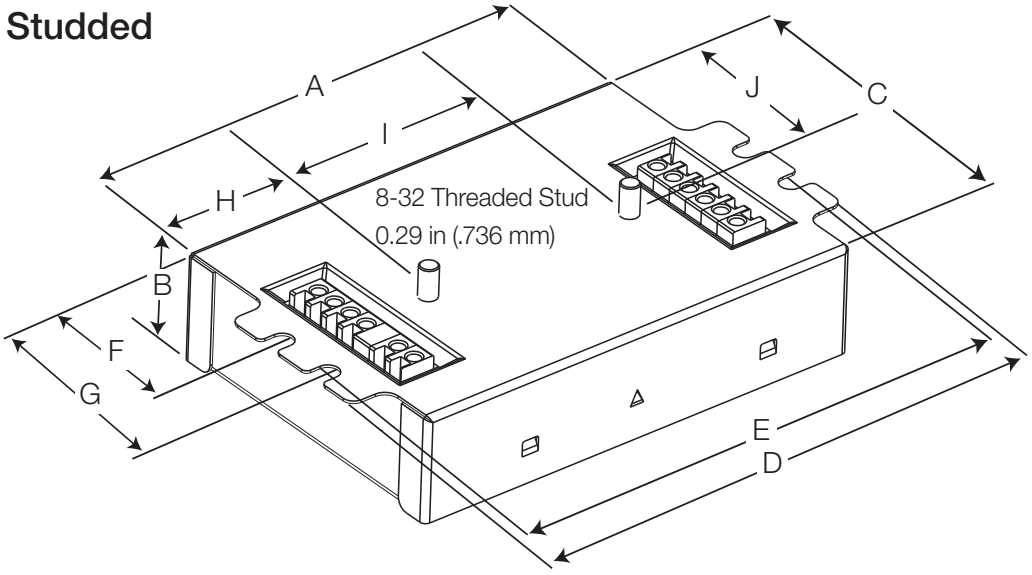
Lamp Type	Lamp Watts	No. of Lamps	Model	Case Size	Input Voltage (VAC)	Input Current (A)	Input Power (W)	Ballast Factor (BF)	System Lumens (lm)	System Efficacy (lm/W)	Ballast Efficacy Factor	Relative Efficacy (RSE)
T4 4-Pin Quad-Tube or Triple-Tube 	18 W	1	EC3DT418KU1S (Studded) EC3DT418KU1 (Non-studded)	K	120	0.18	21.3	0.95	1140	53.5	4.46	0.80
				K	220	0.10	21.1	0.95	1140	54.0	4.50	0.81
				K	240	0.09	21.4	0.95	1140	53.3	4.44	0.80
				K	277	0.08	20.8	0.95	1140	54.8	4.57	0.82
		2	EC3DT418KU2S (Studded) EC3DT418KU2 (Non-studded)	K	120	0.34	41.1	0.95	2280	55.5	2.31	0.83
				K	220	0.18	39.6	0.95	2280	57.6	2.40	0.86
				K	240	0.17	39.4	0.95	2280	57.9	2.41	0.87
				K	277	0.15	39.9	0.95	2280	57.1	2.38	0.86
	26 W	1	EC3DT4MWKU1S (Studded) EC3DT4MWKU1 (Non-studded)	K	120	0.22	26.4	0.95	1710	64.8	3.60	0.94
				K	220	0.12	26.8	0.95	1710	63.9	3.55	0.92
				K	240	0.11	26.9	0.95	1710	63.7	3.54	0.92
				K	277	0.10	27.0	0.95	1710	63.4	3.52	0.92
		2	EC3DT4MWKU2S (Studded) EC3DT4MWKU2 (Non-studded)	K	120	0.43	51.6	0.95	3420	66.3	1.84	0.96
				K	220	0.23	49.9	0.95	3420	68.5	1.90	0.99
				K	240	0.21	50.6	0.95	3420	67.5	1.88	0.98
				K	277	0.19	51.4	0.95	3420	66.6	1.85	0.96
T4 4-Pin Triple-Tube 	32 W	1	EC3DT4MWKU1S (Studded) EC3DT4MWKU1 (Non-studded)	K	120	0.29	34.8	0.95	2280	65.5	2.73	0.87
				K	220	0.15	33.0	0.95	2280	69.1	2.88	0.92
				K	240	0.14	33.6	0.95	2280	67.9	2.83	0.90
				K	277	0.12	33.2	0.95	2280	68.6	2.86	0.91
		2	EC3DT4MWKU2S (Studded) EC3DT4MWKU2 (Non-studded)	K	120	0.55	66.0	0.95	4560	69.1	1.44	0.92
				K	220	0.29	64.5	0.95	4560	70.7	1.47	0.94
				K	240	0.26	63.0	0.95	4560	72.3	1.51	0.96
				K	277	0.24	65.5	0.95	4560	69.7	1.45	0.93
	42 W	1	EC3DT442KU1S (Studded) EC3DT442KU1 (Non-studded)	K	120	0.36	43.2	0.95	3040	70.4	2.20	0.92
				K	220	0.20	42.9	0.95	3040	70.8	2.21	0.93
				K	240	0.18	42.7	0.95	3040	71.2	2.23	0.93
				K	277	0.15	42.6	0.95	3040	71.3	2.23	0.94
		2	EC3DT442KU2S (Studded) EC3DT442KU2 (Non-studded)	K	120	0.73	87.6	0.95	6080	69.4	1.08	0.91
				K	220	0.39	85.9	0.95	6080	70.8	1.11	0.93
				K	240	0.35	85.1	0.95	6080	71.5	1.12	0.94
				K	277	0.31	85.4	0.95	6080	71.2	1.11	0.93

NOTE: The "S" at the end of the ballast model number indicates a studded option. Remove the "S" for a non-studded ballast.

Job Name:	Model Numbers:
Job Number:	

EcoSystem® Compact Fluorescent Ballast Case Dimensions

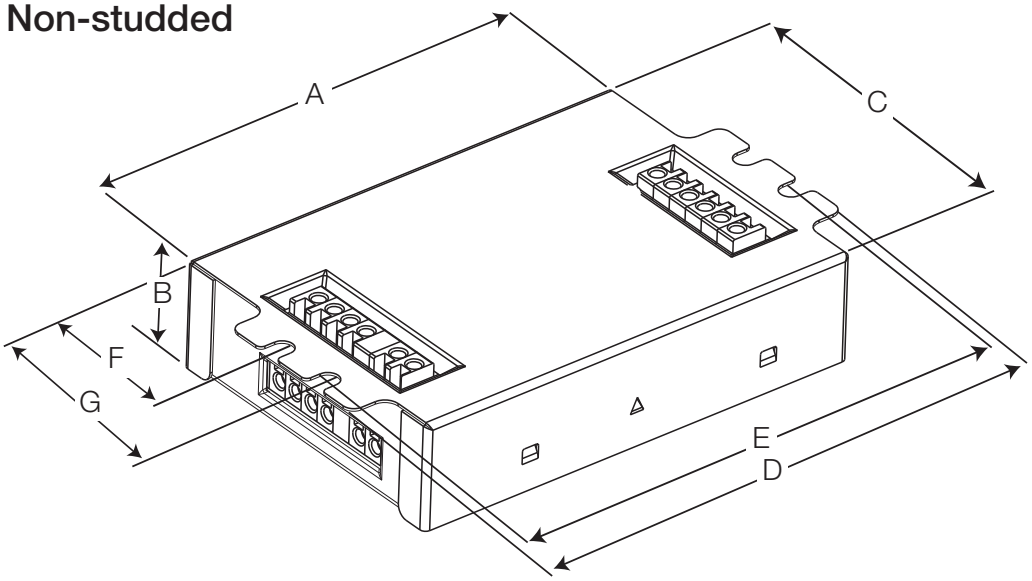
Studded



A	4.20 in (107 mm)
B	1.00 in (25 mm)
C	3.00 in (76 mm)
D	4.90 in (124 mm)
E	4.60 in (117 mm) (mounting centers)
F	1.42 in (36 mm)
G	1.99 in (51 mm)
H	1.09 in (28 mm)
I	2.00 in (51 mm)
J	1.60 in (41 mm)

NOTE: Studded version does not have side connectors.

Non-studded

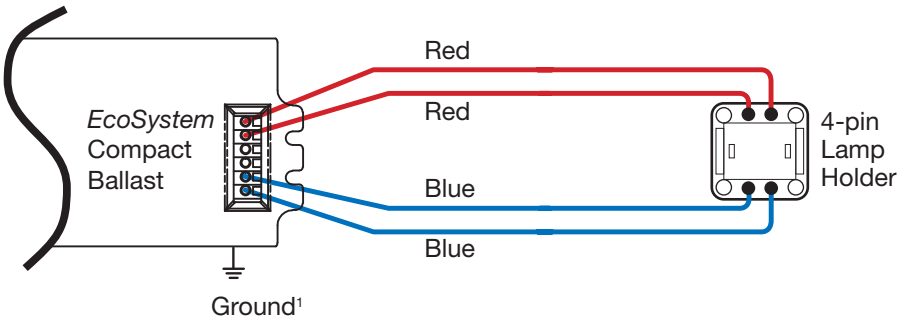


A	4.20 in (107 mm)
B	1.00 in (25 mm)
C	3.00 in (76 mm)
D	4.90 in (124 mm)
E	4.60 in (117 mm) (mounting centers)
F	1.42 in (36 mm)
G	1.99 in (51 mm)

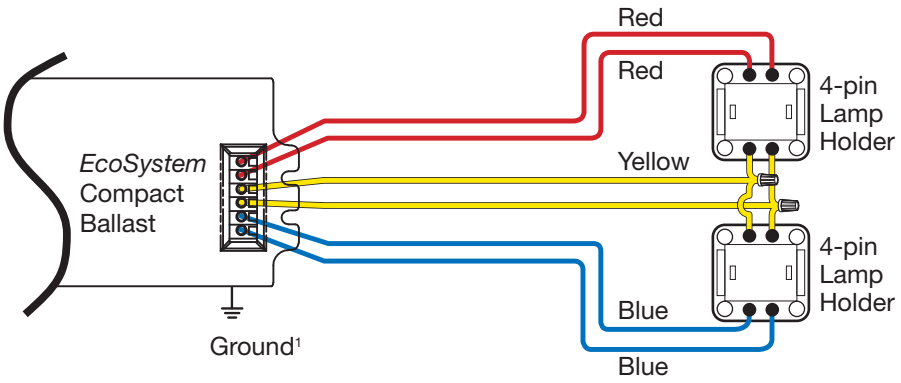
Job Name:	Model Numbers:
Job Number:	

Lamp Wiring Diagrams

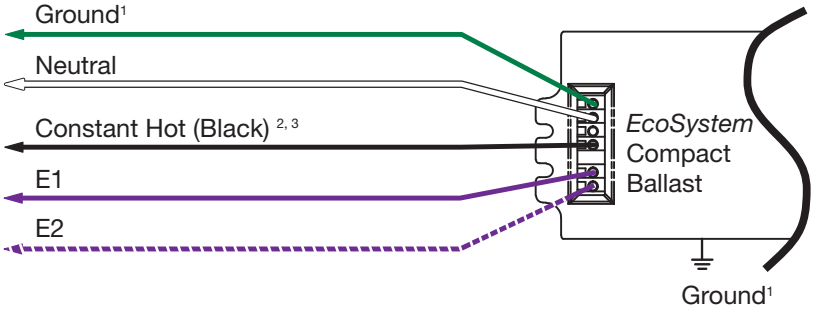
One Compact Fluorescent Lamp



Two Compact Fluorescent Lamps



EcoSystem® Power Wiring Diagrams



[1] Ballast is grounded via the case or terminal.
[2] Wire colors shown are for *Lutron* controls and ballasts only. Dimming control wires may not match ballast wire colors.
[3] The Constant Hot must not be wired to a switching device.

Note: For T4 compact lamps, maximum lamp-to-ballast wire length is 3 ft (.91 m) to guarantee proper performance.

Job Name:	Model Numbers:
Job Number:	

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EcoSystem® Bus Wiring Diagrams

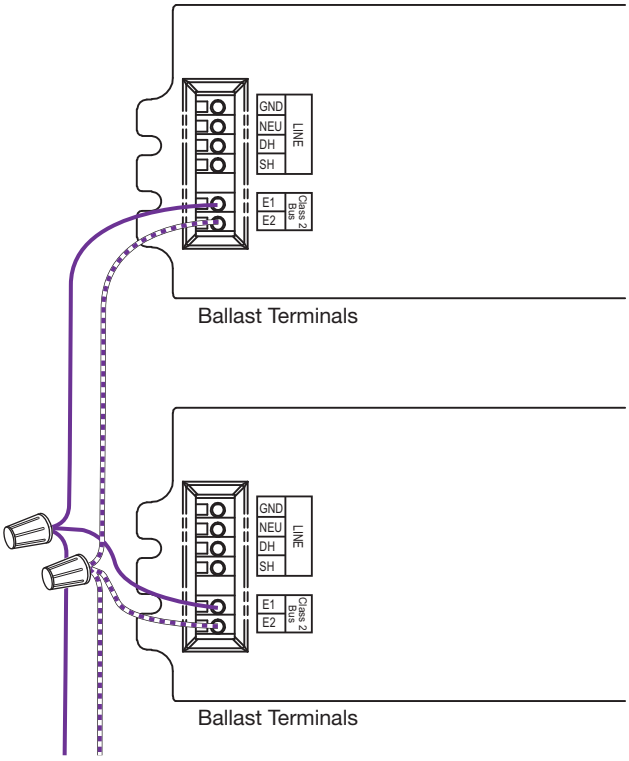
EcoSystem® Digital Link Overview

- The *EcoSystem* Digital Link wiring (E1 and E2) connects the digital ballasts and drivers together to form a lighting control system.
- Each *EcoSystem* Digital Link supports up to 64 digital ballasts or LED drivers, 64 occupant sensors, 16 daylight sensors, and 64 wallstations or IR receivers.*
- Sensors do not directly connect to*EcoSystem* H-Series ballasts.
- No 3-wire phase control with *EcoSystem* H-Series ballasts.
- E1 and E2 (*EcoSystem* digital link wires) are polarity insensitive and can be wired in any topology.
- An Energi Savr Node™ with *EcoSystem* unit, GRAFIK Eye® QS control unit with *EcoSystem*, or Quantum® system provides power for the *EcoSystem* Digital Link and supports system programming.
- All *EcoSystem* Digital Link programming is completed by using the Energi Savr App for an Apple® iPad® or iPhone® mobile digital devices, GRAFIK Eye® QS with *EcoSystem*, PowPak™ dimming module with *EcoSystem* , or *Quantum* System.
- For complete information, see *EcoSystem* Design & Application Guide (P/N 367-1533).

EcoSystem® Digital Link Wiring

- Ballast *EcoSystem* Digital Link terminals only accept one 18 to 16 AWG (0.75 to 1.5 mm²) solid copper wire per terminal.
- Make sure that the supply breaker to the Digital Ballast and *EcoSystem* Digital Link Supply is OFF when wiring.
- Connect the two conductors to the two Digital Ballast terminals E1 and E2 as shown.
- Using two different colors for E1 and E2 will reduce confusion when wiring several ballasts together.
- The *EcoSystem* Digital Link may be wired Class 1 or Class 2. Consult applicable electrical codes for proper wiring practices.

* *PowPak* dimming module with *EcoSystem* can support 32 ballasts or LED drivers.



To the *EcoSystem* Digital Link Supply

Notes

- The *EcoSystem* Digital Link Supply does not have to be located at the end of the Digital Link.
- *EcoSystem* Digital Link length is limited by the wire gauge used for E1 and E2 as follows:

Wire Gauge	Digital Link Length (max)
12 AWG	2200 ft
14 AWG	1400 ft
16 AWG	900 ft
18 AWG	550 ft

Wire Size	Digital Link Length (max)
4.0 mm²	828 m
2.5 mm²	517 m
1.5 mm²	310 m
1.0 mm²	207 m
0.75 mm²	155 m

Job Name:	Model Numbers:
Job Number:	

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EcoSystem® Ballast Wiring: Line Voltage Dimmers

EcoSystem Ballasts and 3-wire dimmers

- Lutron® 3-wire dimmers only control the ballasts they are wired to; *EcoSystem* ballasts do not support grouping of 3-wire control input.

3-Wire Control Wiring

- Make sure that the supply breaker to the Digital Ballast is OFF when wiring.

- Wire as shown

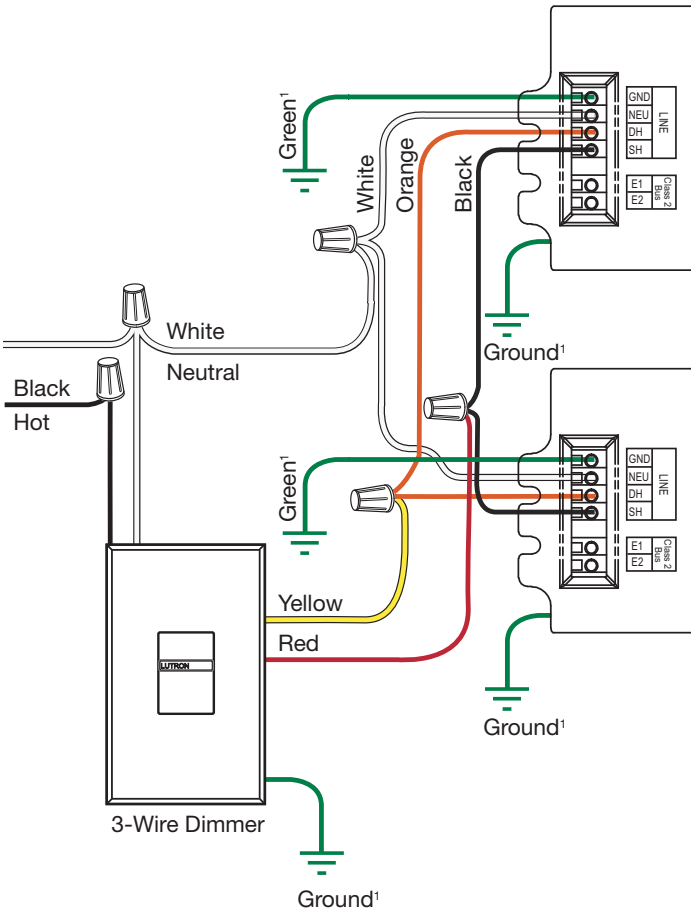
Line input	Connects to
Hot	Dimmer Black Wire
Neutral	Dimmer White Wire

Dimmer wire	Connects to
Yellow	Ballast Orange (DH)
Red	Ballast Black (SH)
White	Ballast White (NEU)
Green	Earth Ground (GND)

- *EcoSystem* ballast line voltage and 3-wire input terminals only accept one 16 AWG (1.31 mm^2) or 18 AWG (0.82 mm^2) solid wire.

Emergency and 3-wire

- *EcoSystem* ballasts controlled by a wallbox dimmer should not be used for emergency/egress lighting unless an external emergency ballast is used in the fixture. See Lutron App Note #50.
- *EcoSystem* ballasts may be used for emergency/egress lighting when controlled by a *Lutron* dimming panel (GP); where the panel is a dedicated emergency panel.



[1] Ballast is grounded via the case or terminal

Notice

3-Wire control turns off digital ballasts when the control is in the off position.

Job Name:	Model Numbers:
Job Number:	

ATTENTION ELECTRICIANS AND CONTRACTORS

Ballast/Socket Leads

Lead lengths from ballast to socket must not exceed 7 ft (2 m) for T8, T5, and T5HO linear lamps.

Lamp Sockets

Lamp sockets as per IEC 60400 are required to ensure positive lamp-pin to socket contact.

Lamp Mounting

Many fluorescent lamp sockets are available with mounting slots to vary the height of the lamp away from the grounded metal surface. Use these slots to get the lamp glass to be 1/2 in ± 1/4 in away from the grounded metal surface for T8 lamps and 3/8 in ± 1/8 in for T5 and T5HO lamps.

Having a fluorescent lamp too close to the grounded metal will make the minimum intensity too low and will reduce lamp life. Having a fluorescent lamp too far away from the grounded metal will make the lamp flicker or not turn on at all.

Ballast Operating Temperature

Ballast case temperature must not exceed 75 °C at any point on ballast.

Wiring and Grounding

Ballast and lighting fixture must be effectively grounded. Ballasts must be installed per national and local electrical codes.

ATTENTION FACILITIES MANAGERS

PERFORMANCE

Lamp Seasoning

Consult lamp manufacturer's recommendations on lamp seasoning prior to dimming.

SERVICE

Replacement Parts

Use replacement parts with exact Lutron model numbers. Consult Lutron if you have any questions.

Further Information

For further information, please visit us at www.lutron.com/ballasts or contact our 24-hour Technical Support Center at 1-800-523-9466.

Job Name:	Model Numbers:
Job Number:	

Hi-lume Overview

Hi-lume architectural electronic dimming ballasts are designed to meet the most demanding lighting requirements. By providing industry leading performance with true full-range 100% to 1% fluorescent dimming, *Hi-lume* ballasts enable you to provide the ideal visual environment for any application.

Features

- Continuous, flicker-free dimming from 100% to 1%
- Standard 3-wire line-voltage phase-control technology for consistent fixture-to-fixture dimming performance
- Models available for T4 triple-tube compact and T5-HO linear lamps
- Programmed rapid start design preheats lamp cathodes before applying full arc voltage
- Lamps turn on to any dimmed level without flashing to full brightness
- Low harmonic distortion throughout the entire dimming range maintains power quality
- Frequency of operation ensures that ballast does not interfere with infrared devices operating between 38 and 42 kHz
- Inrush current limiting circuitry eliminates circuit breaker tripping, switch arcing, and relay failure
- End-of-lamp-life protection circuitry ensures safe operation throughout entire lamp life cycle
- For linear lamps, ballasts maintain consistent light output for different lamp lengths, ensuring fixture uniformity
- Ultra-quiet operation
- Protected from miswires of any input power to control lead, or from lamp leads to each other and/or ground
- 100% performance tested at factory
- 5-year limited warranty with Lutron field service commissioning (3-year standard warranty) from date of purchase

***Hi-lume*, case type A**

3.00 in. W (76 mm) x 1.00 in. H (25 mm) x 4.90 in. L (124 mm)

***Hi-lume*, case type C**

1.18 in. W (30 mm) x 1.00 in. H (25 mm) x 18.00 in. L (457 mm)

Job Name:	Model Numbers:
Job Number:	

Specifications

Performance

- Dimming Range: Hi-lume 100% to 1% measured relative light output (RLO).
- Lamp Starting: programmed rapid start
- Operating Voltage: 120 or 277 V~ at 60 Hz
- Lamp Current Crest Factor: less than 1.7
- Lamp Flicker: none visible
- Light Output Variation: constant ±2% light output for line voltage variations of ±10%
- Lamp Life: average lamp life meets or exceeds rating of lamp manufacturer
- Ballast Factor: greater than .95 for T4 lamps, equal to 1.0 for T5-HO lamps
- Power Factor: greater than .95
- Total Harmonic Distortion (THD): less than 10%
- Maximum Inrush Current: 7 amps per ballast at 120 V, 3 amps per ballast at 277 V~

Environment

- Minimum lamp starting temperature: 50 °F (10 °C)
- Relative humidity: less than 90% non-condensing
- Maximum ballast case temperature: 75 °C (167 °F)
- Sound Rating: Inaudible in a 27 dB ambient

Standards

- UL Listed (evaluated to the requirements of UL935)
- CSA certified (evaluated to the requirements of C22.2 No. 74)
- Class P thermally protected
- Meets ANSI C82.11 High Frequency Ballast Standard
- Meets FCC Part 18 Non-Consumer requirements for EMI/RFI emissions
- T4 and T5-HO ballasts are MIL Std. 461E compliant (meets the requirements of CE101, RE101 and RE102)
- Meets ANSI C62.41 Category A surge protection standards up to and including 6 kV
- Manufacturing facilities employ ESD reduction practices that comply with the requirements of ANSI/ESD S20.20
- Lutron Quality Systems registered to ISO 9001.2000

Ballast Wiring & Mounting

- Ballast is grounded by a mounting screw to the fixture
- Power and lamp wiring terminals accept only one 18 AWG solid wire per terminal

Lamp Seasoning

Refer to the lamp manufacturer's recommendations for lamp seasoning requirements prior to dimming.

Job Name:	Model Numbers:
Job Number:	

Hi-lume Ballast Models

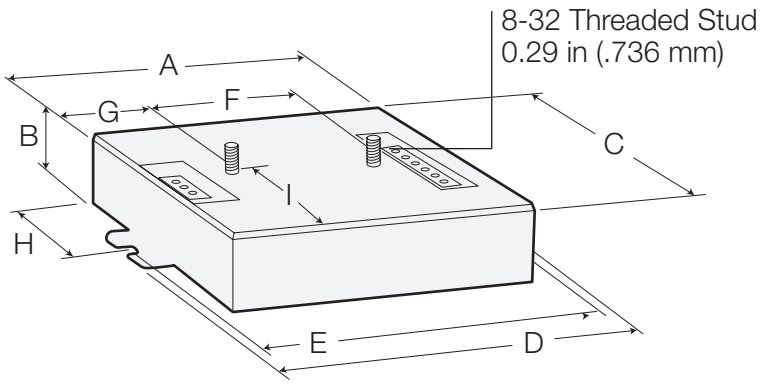
Lamp Type				120 VOLTS		277 VOLTS	
	Lamp Watts (length)	Lamps per ballast	Case Type	Ballast Current (amps)	*Hi-lume* Model Number	Ballast Current (amps)	*Hi-lume* Model Number
T4 Triple-tube 4-pin  1/2 in. diameter	26 W	1	A	.26	HL3-T426-120-1-S[1]	.12	HL3-T426-277-1-S[1]
	32 W	1	A	.31	HL3-T432-120-1-S[1]	.13	HL3-T432-277-1-S[1]
T5-HO Linear High Ooutput  5/8 in. diameter	24 W (21.5 in)	1 2	C C	.31 .62	FDB-T524-120-1 FDB-T524-120-2	.15 .24	FDB-T524-277-1 FDB-T524-277-2
	39 W (33.4 in)	1 2	C C	.38 .76	FDB-T539-120-1 FDB-T539-120-2	.19 .32	FDB-T539-277-1 FDB-T539-277-2
	54 W (45.3 in)	1 2	C C	.58 1.1	FDB-T554-120-1 FDB-T554-120-2	.25 .45	FDB-T554-277-1 FDB-T554-277-2

[1] Mounting studs standard for T4 ballasts. Delete suffix -S in the model number if mounting studs not needed.

Job Name:	Model Numbers:
Job Number:	

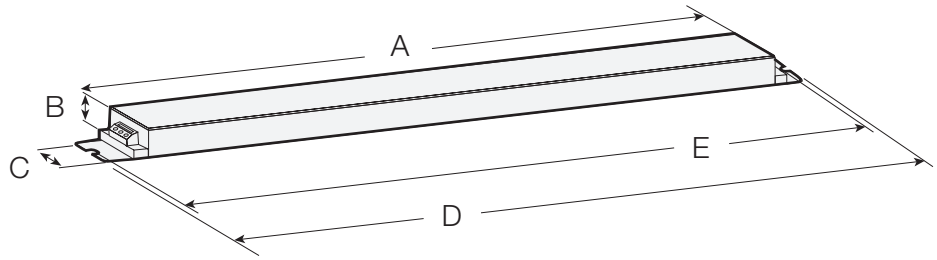
Case Dimensions

A[1]



A	4.20 in (107 mm)
B	1.00 in (25 mm)
C	3.00 in (76 mm)
D	4.90 in (124 mm)
E	4.60 in (117 mm) (mounting centers)
F	2.00 in (51 mm)
G	1.08 in (27 mm)
H	1.60 in (41 mm)
I	1.39 in (35 mm)

C



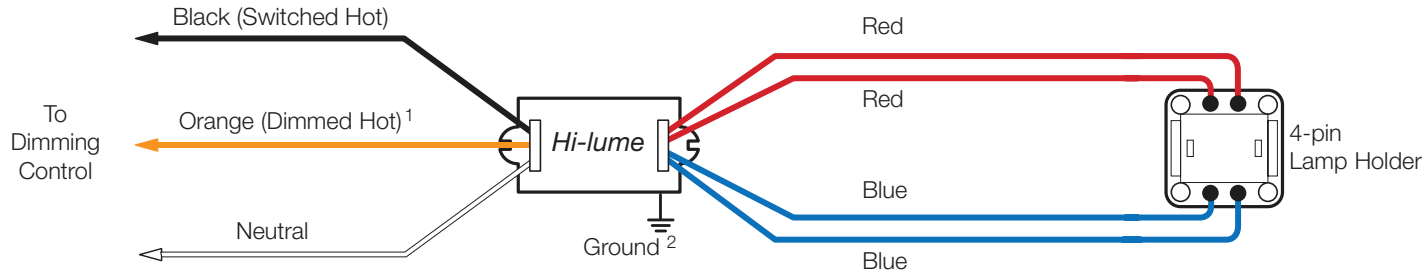
A	16.12 in (409 mm)
B	1.00 in (25 mm)
C	1.18 in (30 mm)
D	18.00 in (457 mm)
E	17.70 in (450 mm) (mounting centers)

[1] Mounting studs standard. When ordering, delete suffix -S in the ballast model number if mounting studs not needed.

Job Name:	Model Numbers:
Job Number:	

Wiring Diagram

One Compact Fluorescent Lamp



[1] Dimming control wire colors may not match ballast wire colors (e.g. control “dimmed hot” may be yellow and ballast “dimmed hot” may be orange). Wire colors shown are for Lutron controls and ballasts only.

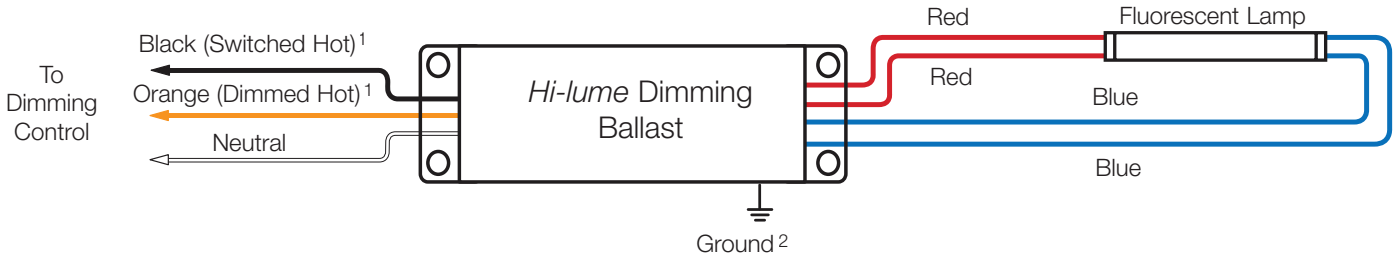
[2] Ballast and lighting fixture must be grounded.

Note: For T4 compact lamps, maximum lamp-to-ballast wire length is 3 feet (1 m).

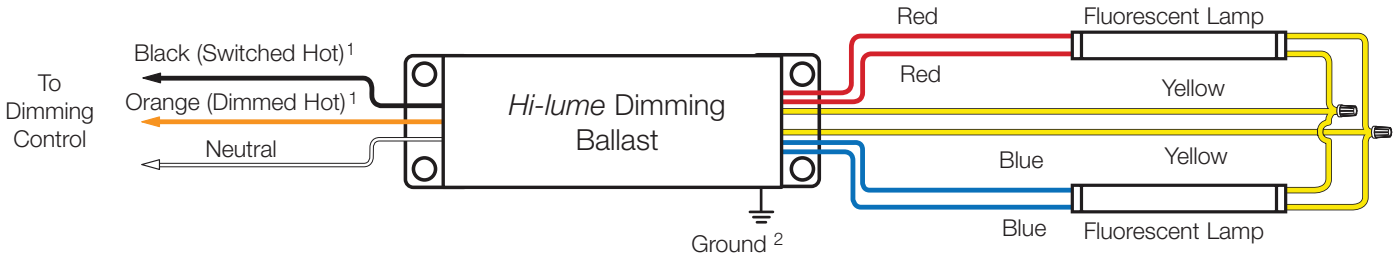
Job Name:	Model Numbers:
Job Number:	

Wiring Diagrams

One T5-HO Lamp



Two T5-HO Lamps



[1] Dimming control wire colors do not necessarily match ballast wire colors (e.g. control “dimmed hot” may be yellow, and ballast “dimmed hot” may be orange). Wire colors shown are for Lutron ballasts and controls only.
[2] Ballast and lighting fixture must be grounded.

Note: For T5-HO lamps, maximum lamp-to-ballast wire length is 7 feet (2 m).

Job Name:	Model Numbers:
Job Number:	

ATTENTION ELECTRICIANS AND CONTRACTORS

Ballast/Socket Leads

Lead lengths from ballast to socket must not exceed 7 ft. (2 m) for T5-HO lamps, and 3 ft. (1 m) for T4 compact lamps.

Lamp Sockets

Lamp sockets as per IEC 60400 are required to ensure positive lamp-pin to socket contact. T5 linear lamps require rotary locking sockets.

Lamp Mounting for T5 and T5-HO

Keep lamps 3/8 in. ± 1/8 in. away from the grounded metal surface.

Having a T5-HO lamp too close to the grounded metal may cause a visible difference in brightness along the length of the lamp.

Ballast Operating Temperature

Ballast case temperature must not exceed 75 °C at any point on ballast.

Wiring and Grounding

Ballast and lighting fixture must be effectively grounded. Ballasts must be installed per national and local electrical codes.

ATTENTION FACILITIES MANAGERS

PERFORMANCE

Lamp Seasoning

Some fluorescent lamp manufacturers recommend that new fluorescent lamps be operated at full output (“seasoned”) before they can be dimmed, to render lamp impurities inert, ensuring proper dimming performance and average rated lamp life. Please contact your lamp manufacturer for seasoning requirements.

SERVICE

Replacement Parts

Use replacement parts with exact Lutron model numbers. Consult Lutron if you have any questions.

Further Information

For further information, please visit us at www.lutron.com/ballasts or contact our 24-hour Technical Support Center at 1-800-523-9466.

Job Name:	Model Numbers:
Job Number:	

Appendix C
Electrical and Controls

GRAFIK Eye 4000 Series Control Unit

Cover (shown open)

Description

- Provides pushbutton recall of four preset lighting scenes, plus Off.
- Allows setup of lighting scenes using buttons on the Control Unit.
- Controls virtually any light source via dimming and switching panels.
- Provides lockout options to prevent accidental changes.
- Includes built-in infrared receiver for operation with an optional remote control.

Models available to:

- Control 2 to 24 zones of lighting.

4000 Series Control Units work with:

- GRAFIK Eye Wallstations
- GP and LP Dimming Panels
- XP Softswitch™ Panels

GRX-4100 Control Units

Provide setup using buttons on the Control Unit.

GRX-4500 Control Units

Provide optional setup using a PC, including setting lighting levels in 1% increments.

Job Name:	Model Numbers:
Job Number:	

Specifications

Power

- Low-voltage type Class 2 (PELV)
  Operating voltage: 24 V Direct Current.

Lighting Sources/Load Types

Controls lighting sources with a smooth, continuous Square Law dimming curve or on a full conduction non-dim basis via GP and LP Dimming Panels and XP Softswitch™ Panels.

Preset Control

- 4 preset lighting scenes and off are accessible from the Control Unit front panel.
- 12 additional scenes are stored in the Control Unit. These scenes are accessible via Wallstations and/or Control Interfaces.
- Light levels fade smoothly between scenes. Fade time can be set differently for each scene, between 0-59 sec. or 1-60 min. Fade time from Off is capped at 5 sec.

Key Design Features

- Meets IEC 801-2. Tested to withstand 15kV electrostatic discharge without damage or memory loss.
- Power failure memory automatically restores lighting to the scene selected prior to power interruption.
- Faceplate snaps on with no visible means of attachment.

System Communications and Capacities

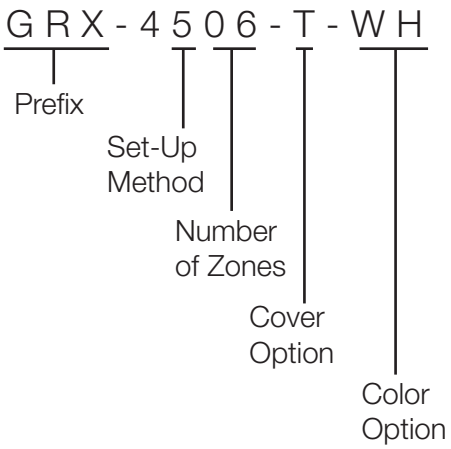
- Low-voltage type Class 2 (PELV) wiring connects Control Units, Wallstations, and Control Interfaces.
- Up to 8 Control Units may be linked to control up to 64 zones.
- Up to 16 total Wallstations and Control Interfaces may be added for a total of 24 control points.

Environment

- 32-104°F (0-40°C). Relative humidity less than 90% non-condensing.

Job Name:	Model Numbers:
Job Number:	

How to Build a Model Number



Prefix:

GRX for GRAFIK Eye 4000 Series Control Units

Set-Up Method:

1 for setup using front panel
5 for PC setup

Number of Zones:

2, 3, 4, 6, 8, 16, or 24

Cover Option:

A for Opaque
T for Translucent Black

Color Option:

See Color Options list

Cover Options

Opaque A
Cover and Base will match.

Translucent Black T
Black Cover and choice of Base color.

Also available:
- Custom controls
- Color matching
- Engraving

These options ship in 4 to 6 weeks.

Color Options

Architectural Matte Finishes
Standard – Ship in 48 hours
Cover Option: A or T

White	WH
Ivory	IV
Beige	BE
Gray	GR
Brown	BR
Black	BL

Designer Gloss Finishes
Ship in 4 to 6 weeks
Cover Option: A only

White	GWH
Ivory	GIV
Light Almond	GLA
Almond	GAL

Satin Color Matte Finishes
Cover Option: A or T

Hot	HT
Ochre	OC
Terracotta	TC
Desert Stone	DS
Stone	ST
Limestone	LS
Blue Mist	BT
Midnight	MN
Taupe	TP
Biscuit	BI
Eggshell	ES
Snow	SW

Architectural Metal Finishes
Cover Option: T only

Bright Brass	BB
Bright Chrome	BC
Bright Nickel	BN
Satin Brass	SB
Satin Chrome	SC
Satin Nickel	SN
Antique Brass	QB
Antique Bronze	QZ

Anodized Aluminum Finishes
Cover Option: T only

Clear	CLA
Black	BLA
Brass	BRA
Bronze	BZA

Model Numbers

Number of Zones	Standard Setup	PC Setup
2	GRX-4102-_-__	GRX-4502-_-__
3	GRX-4103-_-__	GRX-4503-_-__
4	GRX-4104-_-__	GRX-4504-_-__
6	GRX-4106-_-__	GRX-4506-_-__
8	GRX-4108-_-__	GRX-4508-_-__
16	GRX-4116-_-__	GRX-4516-_-__
24	GRX-4124-_-__	GRX-4524-_-__

Job Name:	Model Numbers:
Job Number:	

LP Dimming Panels

LP Dimming Panels are ideal for projects with many small loads. Each panel provides power and dimming for up to 32 dimming legs.

Features

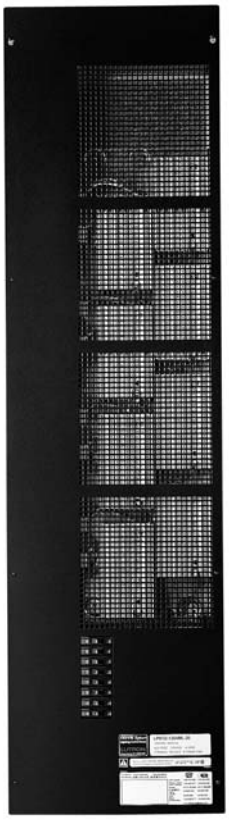
- Work directly with incandescent, magnetic low voltage, and neon/cold cathode lighting, as well as Lutron TuWire™ Fluorescent Dimming Ballasts.
- Work with electronic low voltage lighting via Power Interfaces.
- Work with 3-wire AC motors through motor modules.
- Panels are prewired - just bring in feed and load wiring.
- Surface or recess mount between 16" center to center studs.

Models available with:

- 100-127 V, 220-240 V (non CE), or 230 V (CE) input power.
- 1 to 8 Dimming Modules for 4 to 32 dimming legs.
- Different feed types and breakers.

LP Dimming Panels work with:

- GRX-4000 Control Units.
- GRAFIK 5000™, GRAFIK 6000®, and GRAFIK 7000® Systems.
- GP Dimming Panels and XP Switching Panels.
- DMX512 dimming systems via the 2LINK™ option.



Standard-Size
LP4/28–LP8/32

Mini
LP1/4–LP3/12

Job Name:	Model Numbers:
Job Number:	

Specifications

Standards

- UL Listed (Reference: UL File 42071).
- Complies with CSA, NOM, or CE (where appropriate).

Power

- Input power: 100-127 V, 220-240 V (non CE), and 230 V (CE). All voltages 50/60 Hz, phase-to-neutral.
- Branch Circuit Breakers: UL-rated thermal magnetic.
  AIC ratings:
  100-127 V – 10,000
  220-240 V – 6,000
  230 V (CE) – 6,000
- Lighting strike protection: Meets ANSI/IEEE standard 62.41-1980. Can withstand voltage surges of up to 6000 V and current surges of up to 3000 A.
- 10-year power failure memory: Automatically restores lighting to scene selected prior to power interruption.

Short Circuit Current Ratings (other ratings available)

Panel Type	Voltage	Std. SCCR Rating
LP Main Lug Panels (all sizes)	120	25,000 A

Sources/Load Types

Operate these sources with a smooth continuous Square Law dimming curve or on a full-conduction non-dim basis:

- Incandescent (Tungsten)/Halogen
- Magnetic Low Voltage Transformer
- Lutron Tu-Wire™ Electronic Fluorescent Dimming Ballasts
- Neon/Cold Cathode

Operate these sources via Power Interfaces:

- Electronic Low Voltage Transformer via dedicated internal Dimming Modules or external Power Interfaces.
- Lutron Electronic Fluorescent Dimming Ballasts via external Power Interfaces.

Operate HID sources on a full conduction non-dim basis.

Dimming Modules

- Each Dimming Module can handle a fully loaded electrical circuit - up to four dimming legs per Module.
- Maximum Ratings:

Voltage	Capacity per Dimming Module	Capacity per Dimming Leg
100-127 V	16 A	16 A
220-240 V (non-CE)	16 A	16 A
230 V (CE)	13 A	10 A

- RTISS™ filter circuit technology compensates for incoming line voltage variations: No visible flicker with +/-2% change in RMS voltage/cycle and +/-2% Hz change in frequency/second.

Wiring

- Internal: Prewired by Lutron.
- System communications: Low-voltage Class 2 (PELV) wiring connects Dimming Panels to other components.
- Line (mains) voltage: Feed and load wiring only. No other wiring or assembly required.

Setup

Circuit Selector electronically assigns dimming legs to zones and sources. Permits reassignment of zones and sources without rewiring.

Physical Design

- Enclosure: NEMA-Type 1, IP-20 protection; #16 U.S. Gauge Steel. Indoors only.
- Weight: 27 lb (13 kg) for Mini LP, 63 lb (29 kg) for Standard-Size LP.

Mounting

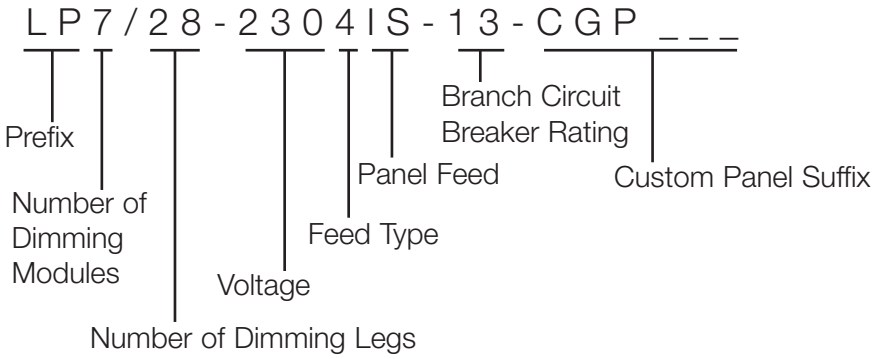
- Surface mount or recess mount between 16 in. (40 cm) studs.
- Allow space for ventilating.

Environment

32-104 °F (0-40 °C). Relative humidity less than 90% non-condensing.

Job Name:	Model Numbers:
Job Number:	

How to Build a LP Model Number



Prefix:

LP for LP Dimming Panel

Number of Dimming Modules:

Indicates number of dimming modules in the panel.
Also indicates number of full load circuits.

Number of Dimming Legs:

Indicates number of dimming legs in the panel.
Each module has four dimming legs.

Voltage:

120 for 100-127 V
230 for 230 V (CE)
240 for 220-240 V (non-CE)

Feed Type:

2 for 1 phase 2 wire
3 for 1 phase 3 wire (split phase)
4 for 3 phase 4 wire

Panel Feed:

ML for Main Lugs only
Mxx for Main Breaker with **xx** = breaker size in Amps (custom panel option)
IS for Isolation Switch (CE/non-CE only)

Branch Circuit Breaker Rating:

20 for 20 A branch circuit breakers (120 V only)
15 for 15 A branch circuit breakers (120 V only)
13 for 13 A branch circuit breakers (230 V CE only)
16 for 16 A branch circuit breakers (240 V non-CE only)

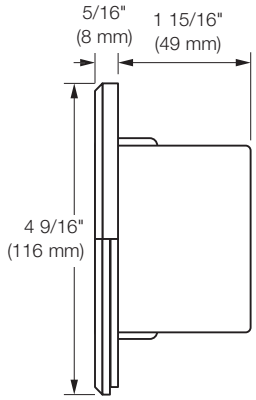
Custom Panel Suffix:

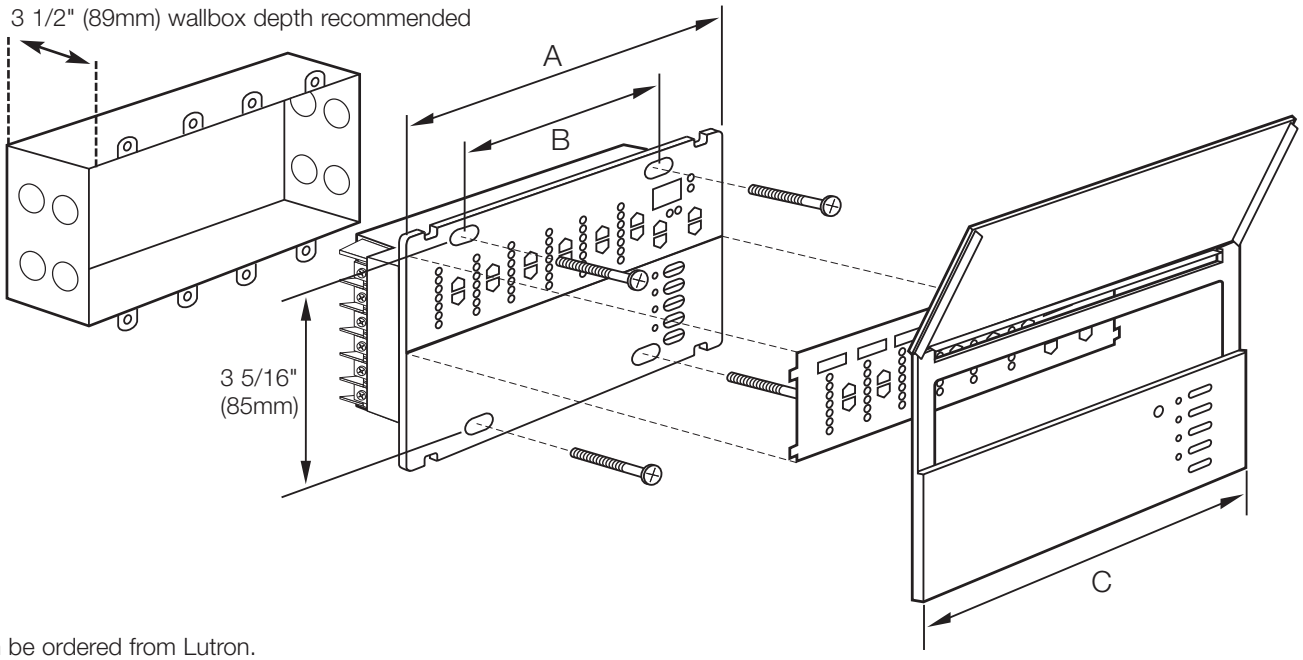
Indicates panel with special options

Job Name:	Model Numbers:
Job Number:	

Dimensions and Mounting

Model	Side View	A	B	C	Wallbox[1] U.S. Size	Depth
2-Zone: GRX-4102 GRX-4502		4 5/16" (123mm)	1 13/16" (46mm)	5.56" (141mm)	2 Gang	3.5" (89mm)
3-Zone: GRX-4103 GRX-4503		6 11/16" (168mm)	3 5/8” (92mm)	7.25” (184mm)	3 Gang	3.5" (89mm)
4-Zone: GRX-4104 GRX-4504		8 5/16” (208mm)	5 7/16” (138mm)	8.94” (227mm)	4 Gang	3.5" (89mm)
6-Zone: GRX-4106 GRX-4506		8 5/16” (208mm)	5 7/16” (138mm)	8.94” (227mm)	4 Gang	3.5" (89mm)
8-Zone: GRX-4108 GRX-4508		8 5/16” (208mm)	5 7/16” (138mm)	8.94” (227mm)	4 Gang	3.5" (89mm)
16-Zone: GRX-4116 GRX-4516		8 5/16” (208mm)	5 7/16” (138mm)	8.94” (227mm)	4 Gang	3.5" (89mm)
24-Zone: GRX-4124 GRX-4524		8 5/16” (208mm)	5 7/16” (138mm)	8.94” (227mm)	4 Gang	3.5" (89mm)





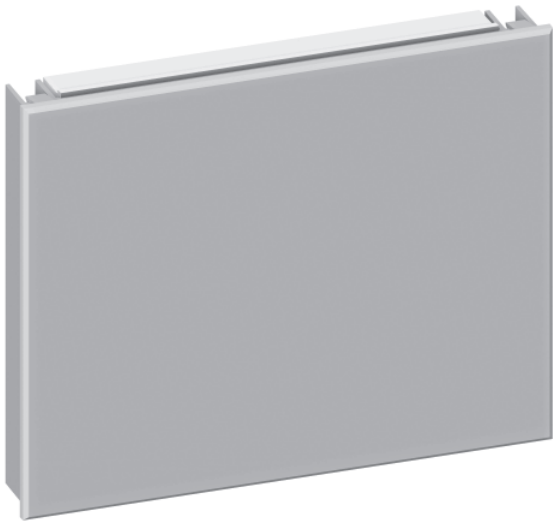
[1] Can be ordered from Lutron.

Job Name:	Model Numbers:
Job Number:	

3-Wire Fluorescent Power Module

Description

- Provides capability for a zone on a GRAFIK Eye® control unit (or other product) to dim fluorescent lights that have Lutron Hi-lume® and Eco-10® (Eco Series) line-voltage control electronic dimming ballasts.
- Utilizes Softswitch® arcless switching technology.
- Up to 3 power modules may be wired on a single GRAFIK Eye® zone.
- Models available for 120 V~ control power.
- Models available for 120 V~ or 120 - 277 V~ load power.



Works with 120 V~ versions of:

- Lutron 3-wire fluorescent dimmers (consult Lutron for Vierti®); see approved list in the dimmers & switches specification guide at www.lutron.com
- GRAFIK Eye® QS control units
- GRAFIK Eye® 3000 Series control units
- LP, LCP, and GP dimming panels
- HomeWorks® and HomeWorks® QS remote power panels

Models and Capacities

Control Power	Load Power	Capacity	Model Number
120 V~	120 - 277 V~	16 A	PHPM-3F-DV-WH
120 V~	120 V~	16 A	PHPM-3F-120-WH

Job Name:	Model Numbers:
Job Number:	

Specifications

Power

- Control voltage: 120 V~
- Load voltage: 120 V~ only for PHPM-3F-120-WH
  120 – 277 V~ for PHPM-3F-DV-WH
- Capacity: Full 16 A
  120 V~: 1920 W
  120 – 277 V~: 1920 – 4432 W
- Frequency: 50 / 60 Hz, phase-to-neutral.
- Load (output) power: Phase independent of control device/control voltage.

Sources/Load Types

- Operates Lutron® Hi-lume®, Eco-10® (Eco Series), Compact SE™, EcoSystem®, and EcoSystem® Compact line-voltage control electronic dimming ballasts with a smooth continuous Square Law dimming curve.

Key Design Features

- Patented RTISS™ circuitry compensates in real time for incoming line voltage variations: Compensates for +/-2% change in RMS voltage/cycle and +/-2% Hz change in frequency/second.
- Provides air-gap off.
- Module protects itself during temporary over-current conditions on dimmed output.
- Two LEDs on front of unit provide diagnostic information (visible when faceplate is removed).

Terminals

- Accept up to two 12 AWG (2.5 mm^2) wires.

Environment

- 32 to 104 °F (0 to 40 °C). Relative humidity less than 90% non-condensing.
- Indoor use only.
- Maximum heat output of module: 15 BTU/hour.

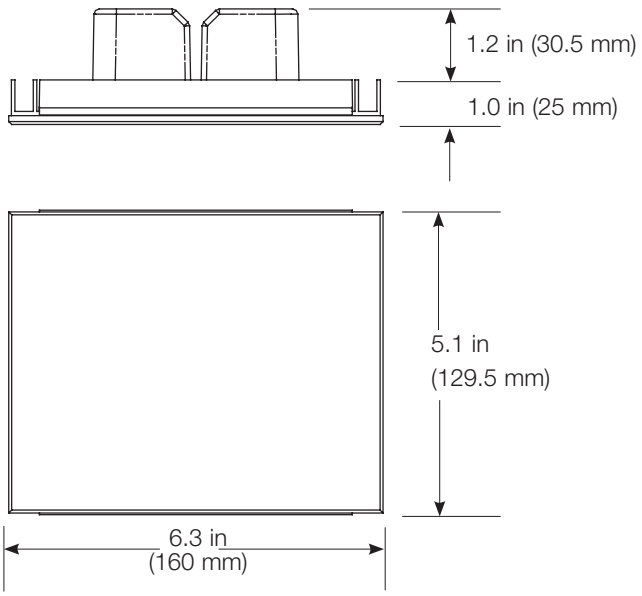
Mounting

- Surface or recess mount.
- Power module is UL tested and approved for use in spaces designed for environmental air handling.

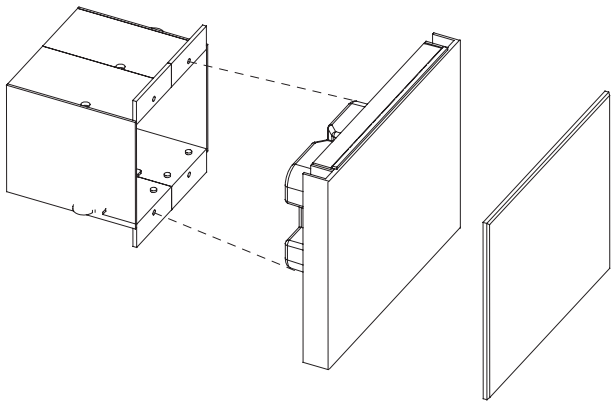
Job Name:	Model Numbers:
Job Number:	

Dimensions and Mounting

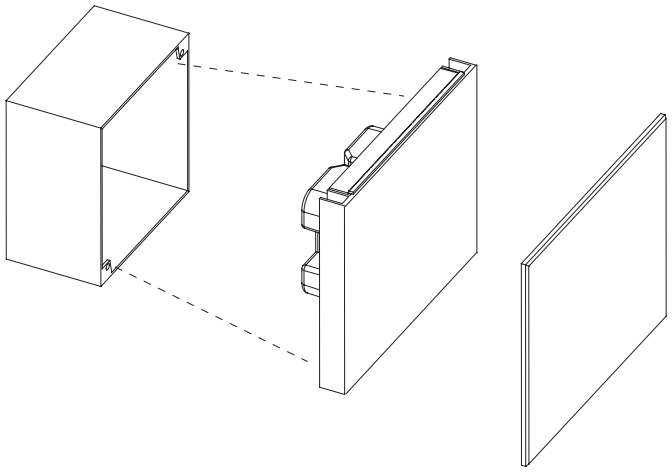
- Mount in 2-gang U.S. wallbox 3.5 in (89 mm) deep or 4 x 4 in (102 x 102 mm) junction box 2.1 in deep (53 mm).
- Indoors only.
- This device generates heat; mount only where ambient temperature is 32 to 104 °F (0 to 40 °C).
- Mount with arrows facing up to ensure adequate cooling.
- Allow 4.5 in (114 mm) above and below unit and between faceplates when mounting several in a vertical layout.
- Mount so line (mains) voltage wiring is at least 6 ft (1.8 m) from sound or electronic equipment and wiring.
- Mount within 7° of true vertical.



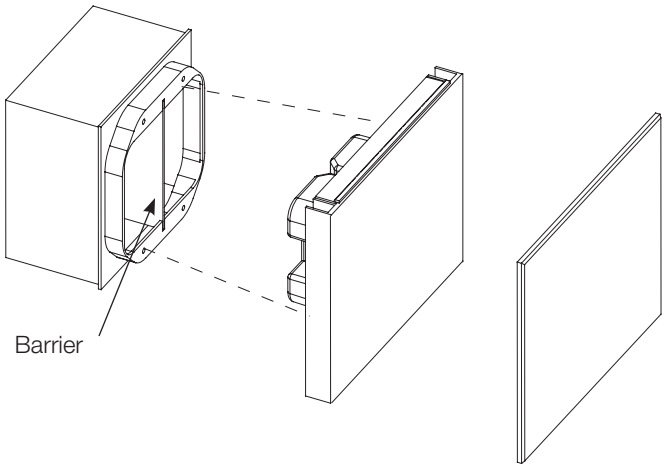
Mount to 2-gang U.S. wallbox



Mount to 4 x 4 in (102 x 102 mm), 2.1 in (53 mm) deep U.S. junction box



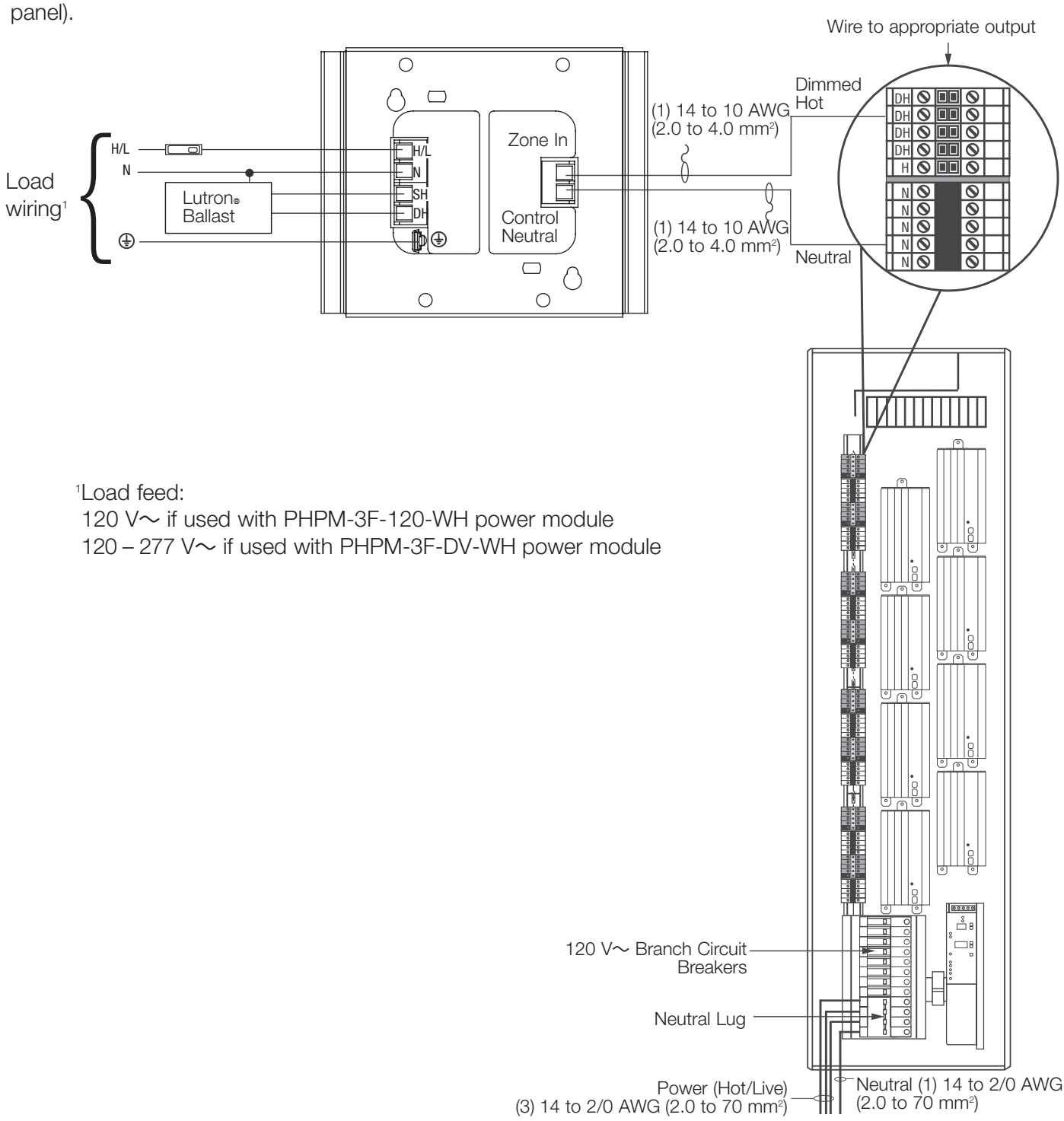
Mount to 4 x 4 in (102 x 102 mm), 2.1 in (53 mm) deep U.S. junction box with barrier
(for 277 V~ model if required by local electrical code)



Job Name:	Model Numbers:
Job Number:	

Wiring a Power Module to an LP, LCP, GP, or HomeWorks® Panel

Up to three 3-wire fluorescent power modules may be wired to an output of a 120 V~ LP or LCP panel. The load type for the output must be set as Eco-10® or Hi-lume® fluorescent load type on the panel's circuit selector (for an LP or GP panel), controller (for an LCP panel), or HomeWorks® software (for a HomeWorks® panel).



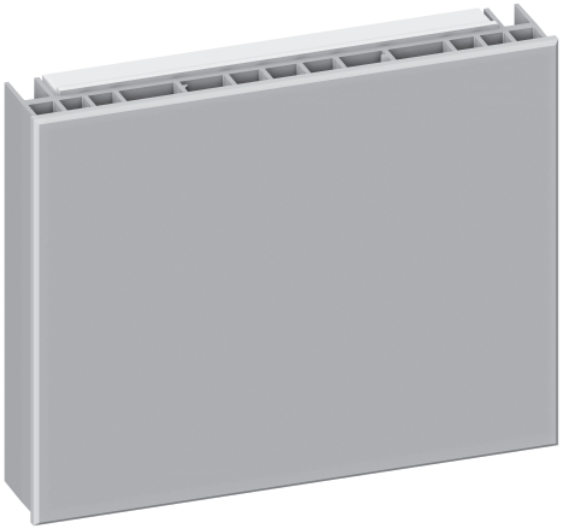
[1]Load feed:
120 V~ if used with PHPM-3F-120-WH power module
120 – 277 V~ if used with PHPM-3F-DV-WH power module

Job Name:	Model Numbers:
Job Number:	

369356 Rev. B 1 09.02.11

Phase-Adaptive Power Module

Description



- Provides capability for a zone on a GRAFIK Eye® control unit (or other product) to dim a fully loaded circuit of lighting.
- May be used to control incandescent, electronic low-voltage, magnetic low-voltage, and neon/ cold cathode lighting sources, as well as Lutron® Tu-Wire® fluorescent dimming ballasts.
- Automatically selects leading-edge or trailing-edge dimming for low-voltage transformers.
- Provides power and dimming for one zone.
- Up to 3 power modules may be wired on a single GRAFIK Eye® zone.
- Models available for 120 V~ control power.
- Models available for 120 V~ or 120 - 277 V~ load power.
- Not for use with non-dim loads.

Works with 120 V~ versions of:

- GRAFIK Eye® QS control units*
- GRAFIK Eye® 3000 Series control units**
- LP, LCP, and GP dimming panels**
- HomeWorks® and HomeWorks® QS remote power panels**
- Lutron® 3-wire fluorescent dimmers (consult Lutron for Vierti®); see approved list in the dimmers & switches specification guide at www.lutron.com

*Set to power module load type

**Set to incandescent load type

Model and Capacities

Control Power	Load Power	Capacity	Model Number
120 V~	120 - 277 V~	16 A	PHPM-PA-DV-WH
120 V~	120 V~	16 A	PHPM-PA-120-WH

Job Name:	Model Numbers:
Job Number:	

Specifications

Power

- Control voltage: 120 V~
- Load voltage: 120 V~ only for PHPM-PA-120-WH
  120 – 277 V~ for PHPM-PA-DV-WH
- Capacity: Full 16 A
  120 V~: 1920 W
  120 – 277 V~: 1920 – 4432 W
- Frequency: 50 / 60 Hz, phase-to-neutral.
- Load (output) power: Phase independent of control device/control voltage.

Sources/Load Types

- Operates these sources with a smooth continuous Square Law dimming curve:
  – Incandescent (tungsten)
  – Halogen
  – Magnetic low-voltage transformer (iron core)
  – Electronic (solid-state) low-voltage transformer (must be manufacturer approved for reverse-phase control dimming)
  – Neon/Cold cathode
  – Lutron® Tu-Wire® fluorescent dimming ballasts
- Incandescent and electronic low-voltage sources may be controlled on the same circuit/control zone. Up to 30% of the unit's capacity may be used for incandescent lighting.
- Incandescent and magnetic low-voltage sources may NOT be controlled on the same circuit/control zone.
- PHPM-PA not for use with non-dim loads. Use switching power module (PHPM-SW-DV-WH) for non-dim loads.
- Minimum load on power module is 10 W.
- Output must be directly connected to the load. Load side switching is not recommended.

Key Design Features

- Automatically selects between forward phase/leading edge (e.g., magnetic low-voltage) and reverse phase/trailing edge (e.g., electronic low-voltage) dimming/output based on connected load.
- Patented RTISS™ circuitry compensates in real time for incoming line voltage variations: Compensates for +/-2% change in RMS voltage/cycle and +/-2% Hz change in frequency/second.
- Provides air-gap off.
- Module protects itself during most temporary over-current and over-voltage conditions.
- Two LEDs on front of unit provide diagnostic information (visible when faceplate is removed).

Terminals

- Each terminal accepts up to two 12 AWG (2.5 mm^2) wires.

Environment

- 32 to 104 °F (0 to 40 °C). Relative humidity less than 90% non-condensing.
- Indoor use only.
- Maximum heat output of module: 135 BTU/hour.

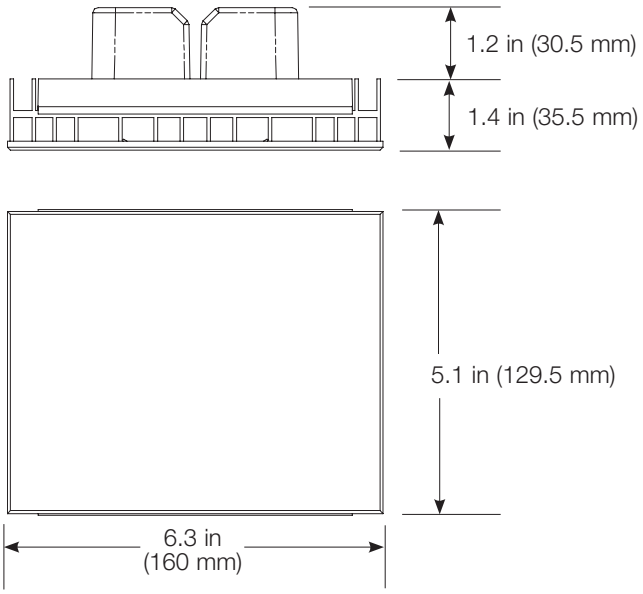
Mounting

- Surface or recess mount.
- Power module is UL tested and approved for use in spaces designed for environmental air handling.

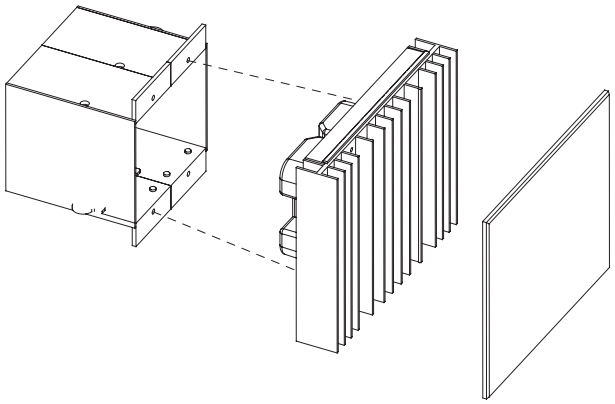
Job Name:	Model Numbers:
Job Number:	

Dimensions and Mounting

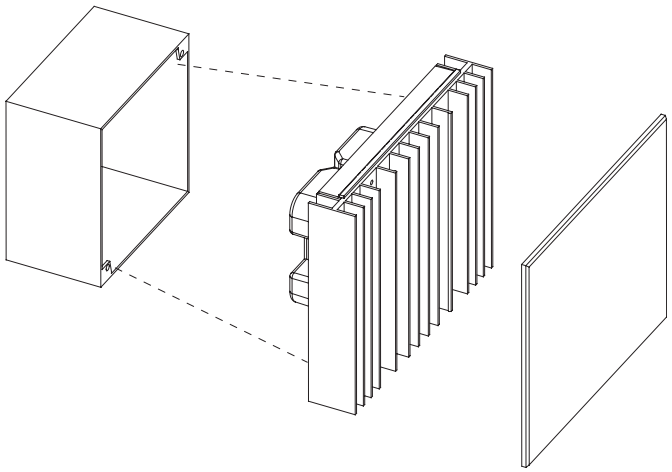
- Mount in 2-gang U.S. wallbox 3.5 in (89 mm) deep or 4 x 4 in (102 x 102 mm) junction box 2.1 in deep (53 mm).
- Indoors only.
- This device generates heat; mount only where ambient temperature is 32 to 104 °F (0 to 40 °C).
- Mount with arrows facing up to ensure adequate cooling.
- Allow 4.5 in (114 mm) above and below faceplates when mounting several modules in a vertical layout.
- Units may butt together when mounted in a horizontal layout.
- Mount so line (mains) voltage wiring is at least 6 ft (1.8 m) from sound or electronic equipment and wiring.
- Mount within 7° of true vertical.



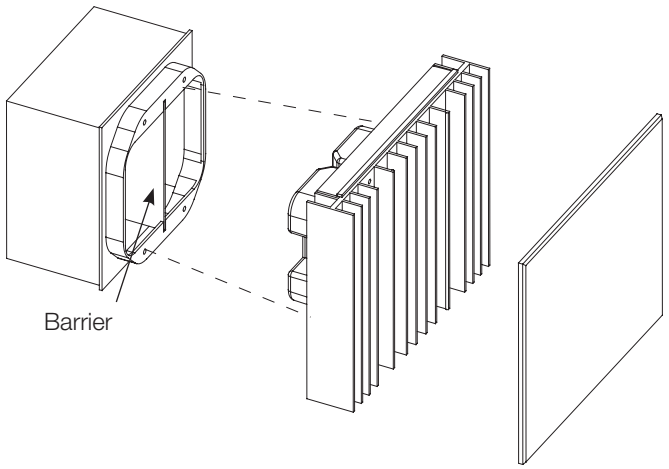
Mount to 2-gang U.S. wallbox



Mount to 4 x 4 in (102 x 102 mm), 2.1 in (53 mm) deep U.S. junction box



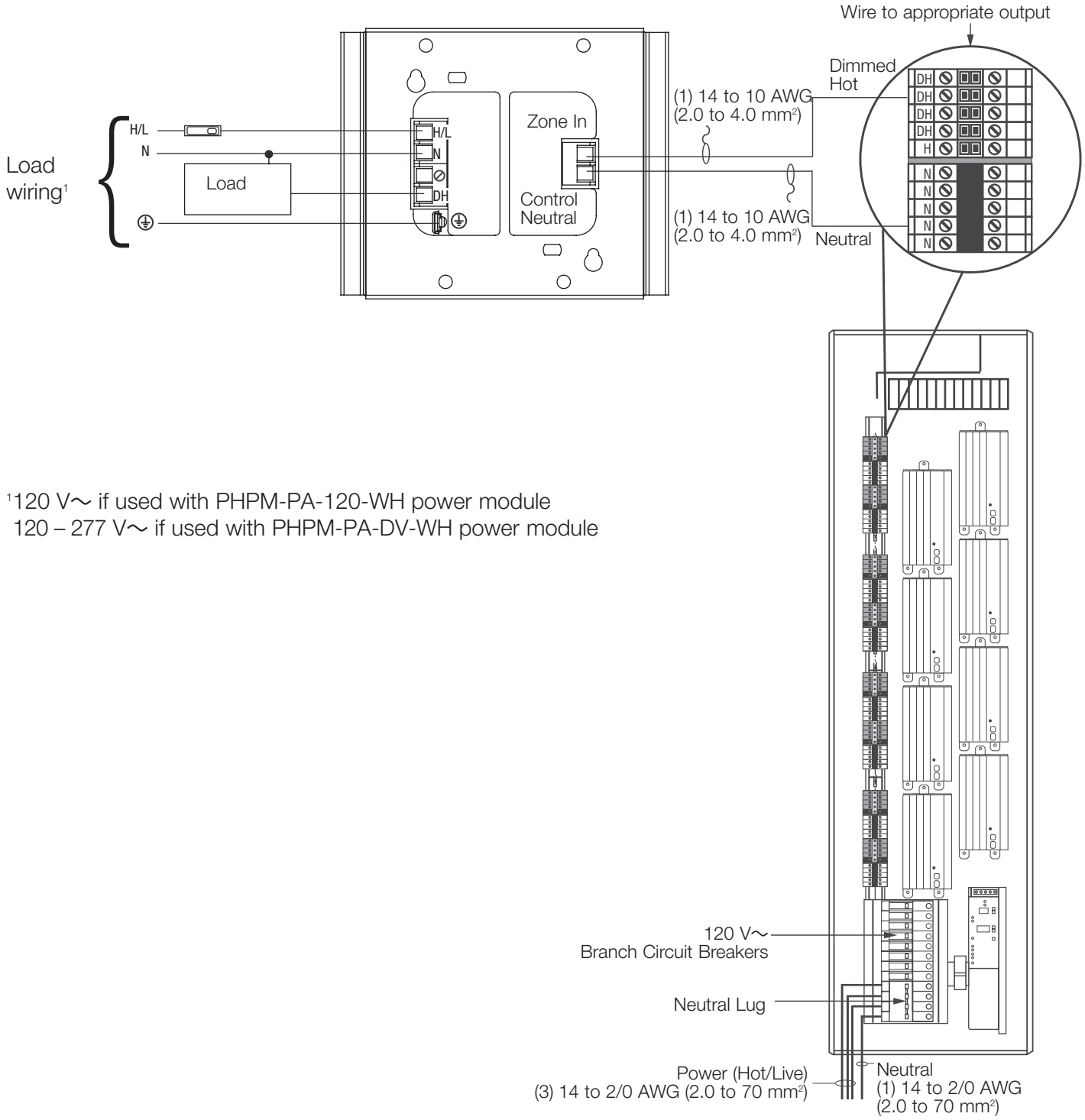
Mount to 4 x 4 in (102 x 102 mm), 2.1 in (53 mm) deep U.S. junction box with barrier
(for 277 V~ loads if required by local electrical code)



Job Name:	Model Numbers:
Job Number:	

Wiring a Power Module to an LP, LCP, GP, or HomeWorks® Panel

Up to three phase-adaptive power modules may be wired to an output of a 120 V~ LP or LCP panel. The load type for the output must be set appropriately on the panel's circuit selector (for an LP or GP panel), controller (for an LCP panel), or HomeWorks® software (for a HomeWorks® panel).



[1]120 V~ if used with PHPM-PA-120-WH power module
120 – 277 V~ if used with PHPM-PA-DV-WH power module

Job Name:	Model Numbers:
Job Number:	