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# Low energy LED lighting heat gain distribution in buildings

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**Low energy LED lighting heat gain distribution in buildings**

by

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## LIST OF ACRONYMS

| | |
|---|---|
| ASHRAE | American society of heating refrigerating and air-conditioning engineers |
| CALiPER | Commercially available led product evaluation and reporting |
| CCT | Correlated color temperature |
| CRI | Color rendering index |
| DAS | Data acquisition system |
| DDC | Direct digital control |
| DLC | DesignLights consortium |
| DOE | U.S. department of energy |
| DP | Differential pressure |
| EPA | Environmental protection agency |
| ERS | Energy resource station |
| HVAC | Heating, ventilating, and air conditioning |
| IEC | Iowa energy center |
| IR | Infrared radiant |
| LED | Light-emitting diode |
| LW | Longwave radiation |
| NEEP | Northeast energy efficiency partnerships |
| NIST | National institute of standards and technology |
| QPL | Qualified product list |
| RTD | Resistance temperature detector |
| SR | Shortwave radiation |
| VAV | Variable air volume |

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# CHAPTER 1. INTRODUCTION

The first lighting technology came from Thomas Edison who made the incandescent lighting bulb commercial in the 1880s. Nonetheless, that technology is now on the way out since the devices are too wasteful: 98% of the energy input ends up as heat instead of light. In 2007, Australia became the first country to ban incandescent bulbs entirely. At present, the only technology that is mature enough to take over incandescent light bulbs is fluorescent lighting, which can turn 10-15% of input power into light. But fluorescent lighting has a number of drawbacks. For example, fluorescent lamps do not work well in cold temperatures and their life span can be significantly shortened if they are turned on and off frequently. The worst is each lamp contains a small amount of mercury which is toxic. As an emerging technology, LED has the ability to make up those drawbacks. LEDs are long-lived, robust and roughly twice as efficient as fluorescents. Besides, LEDs are already widely used for computers, television sets and other consumer electronics, and are becoming a market leader for outdoor applications such as traffic lights and indicator lights on cars. (Stefano et al, 2009)

LED lights are solid-state luminaries with extremely high efficacy compared to the conventional lighting fixtures. The U.S DOE (2012) states that if about 49 million LEDs were installed in the U.S., the annual energy cost savings would be about $675 million. Furthermore, switching conventional light to LED in the next two decades could save the U.S. $250 billion in energy costs, reduce electricity consumption for lighting by nearly 50 percent and avoid 1,800 million metric tons of carbon emissions.

Electrical lighting is a major contributor to the heat gain in all buildings. The thermal energy from lights is transferred to the air by convection and to surrounding objects by thermal radiation. Heat transfer by conduction contributions can be ignored (ASHRAE, 2013). As it relates to the cooling load, the convective heat gain is an instantaneous cooling load as the convective energy from the lights causes an immediate increase of air temperature. However, the radiation component of the light energy produces a delayed cooling load on the space. Radiation energy from the lights is absorbed by objects and surfaces in the space causing them to increase in temperature. These objects then transfer heat by convection to the air in the room causing the air temperature to increase at which time it becomes a cooling load. Due to the thermal mass of these objects and surfaces, there is a time-delay from when the radiant energy from the lights is absorbed to the time the heat is convected to the space. To accurately calculate the cooling load on the space due to lights, it is important to know the fraction of lighting energy that is convective and the fraction that is radiative. This is referred to as the convection radiation split. Another key factor to obtain an accurate cooling load calculation is how the thermal energy from the lights is split between conditioned space and ceiling plenum space. Although all lighting energy is converted to the heat gain of surrounding areas, only the heat which is transferred to the conditioned space is considered as cooling load.

Input power to LED lighting luminaires is converted to electrical heat and electromagnetic radiation (Khanna et al, 2014). The electrical heat contributes to the increasing temperature of the LED heat sink by conductive heat, and then promotes heat transfer to surrounding area through convection and radiation. Electromagnetic radiation includes visible light, ultraviolet (UV) and infrared radiant (IR) heat, which is absorbed by the surrounding surfaces and then reemitted to the room through the convection and radiation (Chung et al, 1998). Among electromagnetic radiation, long wave infrared radiation from the lighting is the most significant radiant heat contributing to a building’s cooling load.

There are two methods for cooling load calculation described in 2013 ASHRAE Handbook Fundamentals, the Heat Balance method (HB) and the Radiant Time Series method (RTS). Both methods require knowing the convection radiation split as well as the split between space and plenum. Information about the more traditional and well established lighting systems (such as recessed fluorescent, high intensity discharge, compact florescent, etc.) has been determined and is available in the literature. (ASHRAE Handbook, 2013a). However, because LED light fixtures are an emerging lighting technology, there are no values for these factors. This study was performed at the Iowa Energy Center (Energy Resource Station) and mainly focused on the low energy LED lighting fixtures. There were two main objectives to be achieved in this study. The first objective was to determine the heat split between the conditioned space and ceiling plenum space. The second objective was to determine the fraction between convective heat and radiant heat in the conditioned space.

# CHAPTER 2. LITERATURE REVIEW

General information about LED lighting technology is available in the literature and through various organizations. LED lighting technology is described by Khanna et al. (2014). In the book, the authors discuss the LED family, power conversion for LED lighting fixtures and LED applications. The performance of LED lighting is published through DesignLights Consortium (1996), Energy Star (1992) and LED Lighting Facts (2014). These sources provide various criteria used to evaluate LED lighting fixtures.

The Department of Energy Commercially Available Light-Emitting Diode Product Evaluation and Reporting Program (CALiPER) has been testing general solid-state lighting fixtures since 2006. The program provides detailed LED information and covers a wide range of lighting applications. The CALiPER Program periodically publishes snapshot reports with data from LED Lighting Facts product list that compares the LED performance to standard lighting technologies and summarizes the LED market and its trajectory

For this research project, the literature was reviewed to determine experimental methods which have been used to determine how the thermal energy from lighting fixtures is distributed in a building. Hosni et al. (1997) discussed the test method for measuring the heat gain and radiative/convective split from equipment in buildings. They tested these parameters for various office/laboratory equipment (microcomputer, monitor, printer, copier, scanner, microwave oven, etc.). Fisher et al. (2006) mainly focused on the condition space/plenum space heat split and convective/radiant heat split for conventional lighting fixtures. They built a two-floor test room for calculating the heat balance model and used a net radiometer to measure the radiant heat gain. After review those literatures above, several benefits could be shown:

- A LED marketing research should be easily done based on the qualification institution above.

- The temperature measurement in the test chamber should be intensive and sensitive enough to record the temperature distribution in each critical location and was important not only for conditioned space but also for the ceiling plenum.
- The net radiometer should be able to conduct 3-D scan in order to capture the heat transfer from all sides.

# CHAPTER 3. SELECTON OF LED LUMINAIRES

One of the tasks of this project was to select a representative sample of LED luminaries to test. This was accomplished by reviewing the various standards and programs presently used to evaluate LED luminaries.

## 3.1 Standards and Programs for Evaluating LED Luminaries

### 3.1.1 DesignLights consortium

DesignLights Consortium (DLC) is a program developed by Northeast Energy Efficiency Partnerships (NEEP) in 1996. The DLC promotes quality, performance and energy efficient commercial sector lighting solutions through collaboration among its federal, regional, state, utility, and energy efficiency program members; luminaire manufacturers; lighting designers and other industry stakeholders throughout the U.S. and Canada. DLC has published Product Qualification Criteria to certify high quality and high efficient LED lighting fixtures on their Qualified Product List (DLC QPL, Version 2.1. 2014). The criteria sets minimum requirements for LED lighting from different respects including lumen output, zonal lumen density, luminaire efficacy, correlated color temperature, color rendering index and L70 lumen maintenance. The DLC Product Qualification Criteria is used in this project for selecting LED luminaries. (About DLC 1996)

### 3.1.2 Energy star

The Energy Star program is established by the U.S. Environmental Protection Agency (EPA) in 1992. The main object of this program is to reduce greenhouse gas emissions and hazardous wastes into the environment by setting standards, and to identify and promote energy efficient products.

Energy Star released the Luminaires Eligibility Criteria Version 1.2 on December 21, 2012. It covers conventional lighting and solid-state lighting in both residential and commercial applications. Therefore, Energy Star criteria are used in this project as minimum requirements for LED luminaires. (About Energy Star, 1992)

### 3.1.3 LED lighting facts

The LED Lighting Facts program was created by U.S. Department of Energy (DOE) to assure decision makers that the performance of solid-state lighting (SSL) products is represented accurately as products reach the market. The ENERGY STAR label summarizes and presents key product performance parameters including light output, power input, efficacy, color rendering index, and correlated color temperature.

The LED Lighting Facts label presents key product performance parameters such as lumens, efficacy, power, color rendering index (CRI) and correlated color temperature (CCT). The DOE Commercially Available LED Product Evaluation and Reporting (CALiPER) program periodically publishes snapshot reports with data from LED Lighting Facts product list that compares the LED performance to standard lighting technologies and summarizes the LED market and its trajectory (U.S. DOE CALiPER program, 2014). The majority range and mean value of lumen output, efficacy, CCT, and CRI are statistically presented and compared for each type of indoor LED luminaires. These data are a significant indication for current status of LED market and served as an important reference for selecting the test LED luminaires for this project. (About LED Lighting Facts, 2014)

**3.2 Selected LED Luminaires**

Based on the above selection criteria, fourteen LED luminaires were selected for testing. All the luminaires meet the minimum requirements of DLC and Energy Star, and in general fit the majority range of LED Lighting Facts.

Luminaires No. 1 and No. 2 are high-bay fixtures. No. 1 is a cone shape fixture with aluminum reflector and No. 2 is a rectangular-shape fixture with direct optics. These two high-bay fixture types cover common applications in large commercial and industrial space where geometry necessitates high-lumen sources. (U.S. DOE Solid-State Lighting CALiPER Program, 2011)

Luminaries No. 3 through No. 8 are recessed troffers which incorporate the three major aperture styles: No. 3 and No. 4 have a partial aperture diffuser with curved lens, No. 5 and No. 6 have a uniform diffuser, and No. 7 and No. 8 have a diffuser with linear details. The different aperture styles cover the optic options for troffers currently available in the market, and were also the major categories defined in DOE CALiPER program (U.S. DOE Solid-State Lighting CALiPER Program, 2013). The troffers tested are both the common 2-ft×2-ft and 2-ft×4-ft fixture size for each aperture style. Recessed troffers comprise the majority of the fixtures tested because they encompass 50% of the market share of commercial luminaires, and they are the most common commercial lighting fixtures.

Luminaires No. 9 and No. 10 were linear pendant fixtures which are the two most common lighting distribution styles. NO. 9 is an indirect/direct type, and No. 10 is a direct type fixture (U.S. DOE Solid-State Lighting CALiPER Program, 2012). There are a large number of linear pendent LED fixtures on the market, but the two chosen for testing are among the most common types that appeared in the CALiPER testing program (U.S. DOE Solid-State Lighting

CALiPER Program, 2012). The heat gain testing results should be generally applicable to most LED linear pendants.

Luminaire No. 11 is an LED downlight with a 6-inch diameter. This is a common size for recessed downlights (U.S. DOE Solid-State Lighting CALiPER Program, 2011). The downlight model tested is a GE DI6R which has a higher efficacy (52 lm/W).  It also meets the ENERGY STAR requirements, and it was one of the winners of Next Generation Luminaries Indoor 2014 Competition.

Luminaire No. 12 is a 150 lm/W fixture, and it has one of the highest efficacies for indoor illumination available in the market. Luminaires No. 13 is a color turning lighting fixture. Luminaries No. 14 is a LED retrofit kit for a 2-ft×4-ft recessed troffer. Table 3.1 lists the detailed manufacture LED lighting fixture which were tested in this project.

Table 3.1 Selected LED luminaires for testing

| NO. | Category | Model | Lumen | Efficacy (Lm/W) | CRI | CCT (K) | Lumen Maintenance | Zonal Lumen | Installation | Input Power, W |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | High-bay | Cree CXB | 18000 | 113 | 80 | 5000 | 100,000 L80 | 20-50°, 74% | Exposed | 160 |
| 2 | High-bay | Columbia LLHP | 14350 | 101 | 70 | 5000 | 60,000 L90 | 20-50°, 48.1% | Exposed | 142 |
| 3 | Troffer 2×4 Partial Aperture Diffuser | Columbia LTRE 24 | 4978 | 120 | 82 | 4000 | 60,000 L80 | 0-60°, 76% | Ceiling Recessed | 41 |
| 4 | Troffer 2×2 Partial Aperture Diffuser | Columbia LTRE 22 | 3881 | 108 | 82 | 4000 | 60,000 L80 | 0-60°, 77.1% | Ceiling Recessed | 36 |
| 5 | Troffer 2×4 Uniform Diffuser | Columbia LLT 24 | 3856 | 95 | 82 | 3500 | 50,000 L80 | 0-60°, 82.2% | Ceiling Recessed | 40.8 |
| 6 | Troffer 2×2 Uniform Diffuser | Columbia LLT 22 | 2520 | 94 | 82 | 3500 | 50,000 L80 | 0-60°, 82.7% | Ceiling Recessed | 26.7 |
| 7 | Troffer 2×4 Diffuser with Linear Details | Finelight HPR-HO 2x4 | 5928 | 105 | 83 | 4000 | 168,000 L70; 100,000 L90 | 0-60°, 82.5% | Ceiling Recessed | 56.2 |
| 8 | Troffer 2×2 Diffuser with Linear Details | Finelight HPR-HO 2x2 | 4969 | 88 | 83 | 4000 | 100,000 L70 | 0-60°, 82.4% | Ceiling Recessed | 56 |
| 9 | Linear Pendant Indirect/Direct | Finelight HP-4 ID | 3127 (55% up, 45% down) | 86 | 83 | 4000 | 168, 000 L70; 100,000 L90 | 0-60°, 35.5% | Pendent | 36 |
| 10 | Linear Pendant Direct | Philips Ledalite 1201 | 2383 | 86 | 82 | 4000 | 60,000 L80 | 0-60°, 95% | Pendent | 27.8 |
| 11 | Downlight | GE DI6R | 1650 | 52 | 90 | 3500 | 50,000 L70 | 0-60°, 99% | Ceiling Recessed | 32 |
| 12 | High Efficacy Troffer | Cree ZR24 HE | 4000 | 150 | 90 | 4000 | 100,000 L70 | 0-60°, 73% | Ceiling Recessed | 26 |
| 13 | Color Tuning Troffer | Sigma STL100 | 3954 | 89 | 89 | 3000-6500 | 50,000 L70 | 0-60°, 80% | Ceiling Recessed | 45 |
| 14 | Retrofit kit 2X4 | MaxLite RKT | 4275 | 95 | 82 | 3500 | 103,000 L70 | 0-60°, 87.5% | Ceiling Recessed | 45 |

CRI is the Color Rendering Index

CCT is the Color Correlated Temperatur

# CHAPTER 4. EXPERIMENTAL DESIGN

## 4.1 Technical Approach

Testing was performed at the Iowa Energy Center's Energy Resource Station (ERS) located on the DMACC campus in Ankeny, Iowa. A test chamber was built in an interior ERS test room by a local construction company. This test chamber mimics a typical office space with ceiling tiles separating conditioned space and plenum space. LED lighting fixtures were placed inside the test chamber. A VAV terminal unit was used to control the temperature inside the test chamber. The terminal unit was located outside the test chamber. The ERS test room is equipped with a unit ventilator which maintains the test room at a fixed temperature. By maintaining the interior of the test chamber at the same temperature, heat transfer through the test chamber walls and floor was minimized.

The test chamber served as a control volume for heat transfer analysis. By identifying all heat transfer paths occurring between the inside of the chamber and its surrounding, a heat balance could be established for the conditioned space and the plenum space. Figure 4.1 illustrates the heat transfer paths involved in the heat balance calculation. The arrows indicated the heat flux direction. All heat transfer was identified as either "entering" or "leaving" the conditioned space and the plenum space, and was arranged accordingly in the heat balance equations. The temperature in the test chamber was controlled as the same as the temperature in the test room. The aim was to minimize heat transfer between test chamber and test room.

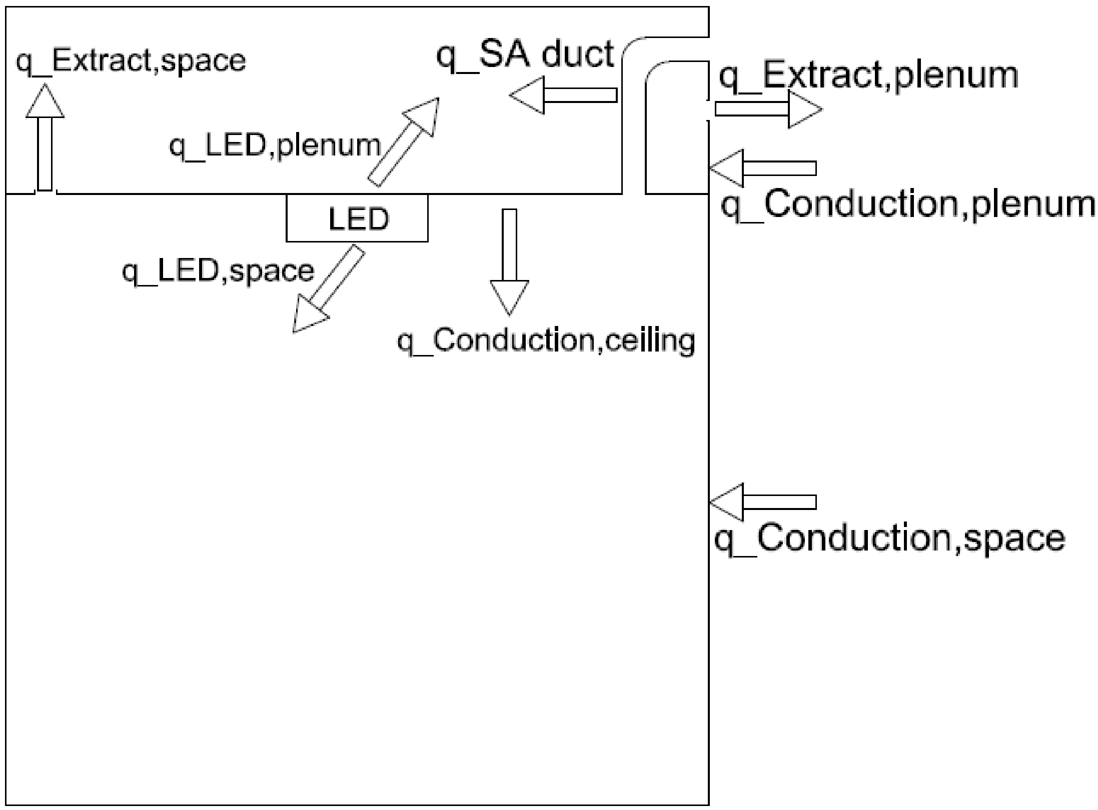



Figure 4-1 Heat transfer in the test chamber

## 4.2 Conditioned Space Heat Balance

The steady-state energy balance for the conditioned space of the test chamber is expressed as Equation 4.1.

$$\dot{q}_{LED,space} + \dot{q}_{cond,space\ surr} + \dot{q}_{cond,ceiling} = \dot{q}_{extract,space} \tag{4.1}$$

Where

$\dot{q}_{LED,space}$ is the LED heat gain to the conditioned space.

$\dot{q}_{cond,space\ surr}$ is the heat conduction through the chamber surroundings.

$\dot{q}_{cond,ceiling}$ is the heat conduction through the ceiling tiles.

$\dot{q}_{extract,space}$ is the heat extracted by the HVAC system.

The heat extracted from the space is calculated using Equation 4.2

$$\dot{q}_{extract,space} = \rho_{SA} \cdot \dot{Q}_{SA} \cdot C_{SA}(T_{return} - T_{supply}) \qquad (4.2)$$

Where

$\rho_{SA}$ is the supply air density.

$\dot{Q}_{SA}$ is the volumetric airflow rate of the supply air and is measured by the flow station.

$C_{SA}$ is the specific heat of air based on the supply air temperature.

$T_{return}$ is the return air temperature measured at the return grille.

$T_{supply}$ is the supply air temperature measured at the diffuser.

The heat conduction through the chamber walls and floor to the surroundings is computed using Equation 4.3:

$$\begin{aligned} \dot{q}_{cond,space\ surr} &= U_{wall,N}\, A_{chamber\ wall,N}\left(T_{surr,North} - T_{space,North}\right) \\ &+ U_{wall,S}\, A_{chamber\ wall,S}\left(T_{surr,South} - T_{space,South}\right) \\ &+ U_{wall,E}\, A_{chamber\ wall,E}\left(T_{surr,East} - T_{space,East}\right) \\ &+ U_{wall,W} A_{chamber\ wall,W}\left(T_{surr,West} - T_{space,West}\right) + U_{floor} A_{floor} (T_{surr,Floor} \\ &- T_{space,Floor}) \end{aligned} \qquad (4.3)$$

Where

$U_{wall,\ N,S,E,W}$ and $U_{floor}$ are the overall heat transfer coefficients of the chamber enclosure.

The U values are determined for each surface based on the materials and construction used for each type of surface.

$A_{chamber\ wall,\ N,\ S,\ E,\ W}$ is the chamber wall areas in the conditioned space below the chamber ceiling grid level.

$A_{floor}$ is the area of the chamber floor.

$T_{space,\ North,\ South,\ East,\ West,\ Floor}$ is the average temperatures of the conditioned spaces.

$T_{surr,\ North,\ South,\ East,\ West,\ Floor}$ is the average temperatures of the chamber surroundings.

Various temperature sensors were placed inside the test chamber to measure the air temperature near each side. Figure 4.2 illustrates the location of these temperature sensors.

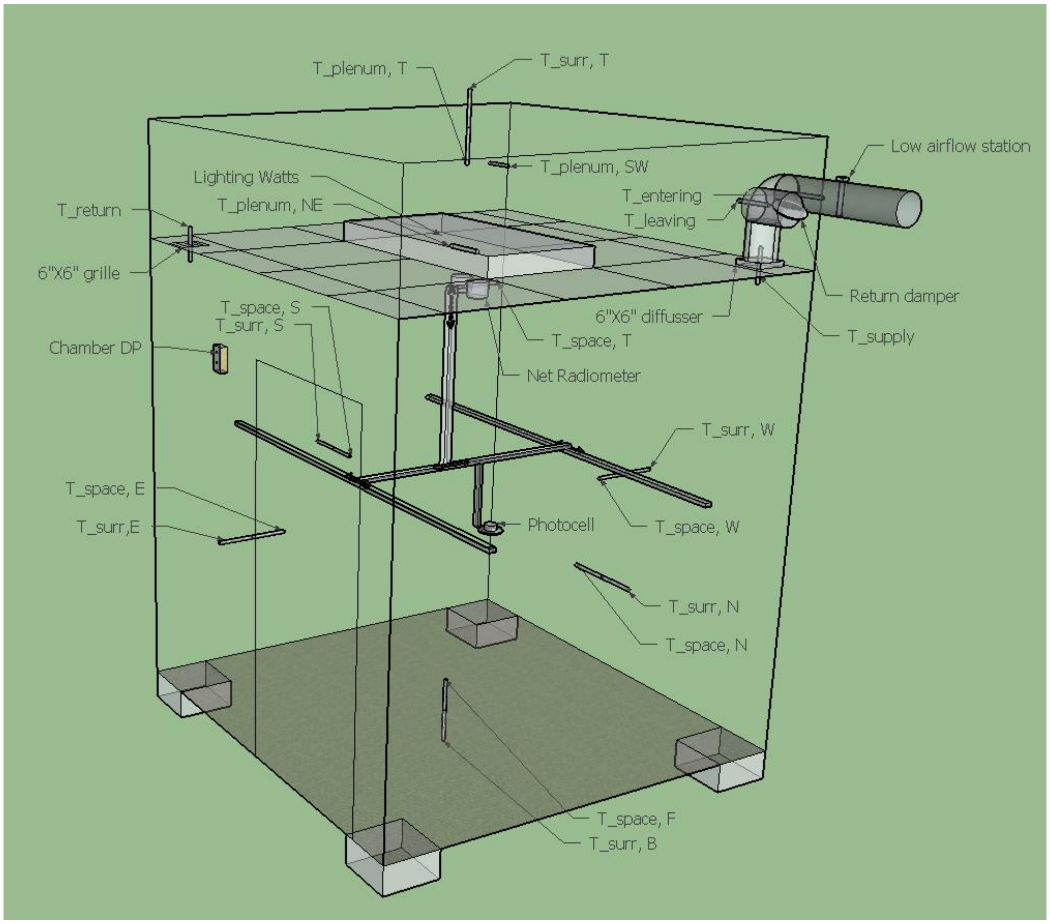



Figure 4-2 Sensor location inside the test chamber

The average air temperature near the six surfaces is calculated as shown below:

$$T_{North} = (T_N + T_T + T_F)/3$$

$$T_{South} = (T_S + T_T + T_F)/3$$

$$T_{East} = (T_E + T_T + T_F)/3$$

$$T_{West} = (T_W + T_T + T_F)/3$$

$$T_{Floor} = (T_N + T_S + T_E + T_W + T_F)/5$$

$$T_{Top} = (T_N + T_S + T_E + T_W + T_T)/5$$

(4.4)

During the test, the average of $T_{North,}$ $T_{South,}$ $T_{East,}$ $T_{West,}$ $T_{Floor,}$ $T_{Top,}$ served as the chamber inside temperature.

The heat conduction through the ceiling tiles at steady state is calculated as follows:

$$\dot{q}_{cond,ceiling} = U_{ceiling} A_{ceiling} \left(T_{plenum} - T_{space,Top}\right) \tag{4.1}$$

Where

$U_{ceiling}$ is the overall heat transfer coefficient of the acoustic ceiling tiles.

$A_{ceiling}$ is the total ceiling grid area.

$T_{space,\ Top}$ is the average space top temperature and is calculated based on Equation 4.4.

$T_{plenum}$ is the temperature of the ceiling plenum space and is the average of $T_{plenum,NE}$ and $T_{plenum,SW}$

**4.3 Plenum Space Heat Balance**

For the plenum space of the test chamber, the following heat balance applies:

$$\dot{q}_{LED,plenum} + \dot{q}_{cond,plenum\ surr} = \dot{q}_{extract,plenum} + \dot{q}_{cond,ceiling} + \dot{q}_{cond,SA\ duct} \tag{4.6}$$

$\dot{q}_{light,plenum}$ is the LED lighting heat gain to the ceiling plenum space.

The heat conduction through the chamber surroundings space at steady-state is calculated as follows:

$$\dot{q}_{cond,plenum\ surr}$$
$$= U_{wall,N}\ A_{plenum\ walls,N}\left(T_{surr,North} - T_{plenum,North}\right)$$
$$+ U_{wall,S}\ A_{plenum\ walls,S}\left(T_{surr,South} - T_{plenum,South}\right)$$
$$+ U_{wall,E}\ A_{plenum\ walls,E}\left(T_{surr,East} - T_{plenum,East}\right)$$
$$+ U_{wall,W} A_{plenum\ walls,W}\left(T_{surr,West} - T_{plenum,West}\right)$$
$$+ U_{roof} A_{roof}(T_{surr,Top} - T_{plenum,Top})$$

(4.7)

Where

$U_{wall,\ N,S,E,W}$ and $U_{roof}$ is the heat transfer coefficients of the chamber enclosure

$A_{plenum\ walls,\ N,\ S,\ E,\ W,}$ is the chamber wall areas in the plenum space.

$A_{roof}$ is the chamber roof area.

$T_{surr,\ North,\ South,\ East,\ West,\ Top}$ is the average temperatures of chamber surroundings.

$T_{plenum,\ North,\ South,\ East,\ West,\ Top}$ is the average temperature of plenum space.

The heat extracted by the HVAC system is calculated as follows:

$$\dot{q}_{extract,plenum} = \rho_{RA} \cdot \dot{Q}_{SA} \cdot C_{RA}(T_{leaving} - T_{return}) \quad (4.8)$$

Where

$\rho_{RA}$ is the return air density.

$\dot{Q}_{SA}$ is the volumetric airflow rate of the supply air measured by the flow station.

$C_{RA}$ is the specific heat of air based on the return air temperature.

$T_{leaving}$ is the return air temperature measured at the return air duct.

$T_{return}$ is the return air temperature measured at the return grille.

The heat gain through the supply air duct is calculated as follows:

$$\dot{q}_{cond,SA\,duct} = \rho_{SA} \cdot \dot{Q}_{SA} \cdot C_{SA}\left(T_{supply} - T_{entering}\right) \quad (4.9)$$

Where

$\rho_{sA}$ is the  supply air density

$\dot{Q}_{SA}$  is the volumetric airflow rate of the

$C_{SA}$ is the specific heat of the air

$T_{supply}$ is the supply air temperature measured at the diffuser.

$T_{entering}$ is the air temperature measured at the point the supply air duct.

Using the conditioned space heat balance (Equation 4.1), the lighting heat gain can be calculated directly from:

$$\dot{q}_{LED,space,dir} = \dot{q}_{extract,space} - \dot{q}_{cond,space\,surr} - \dot{q}_{cond,ceiling} \quad (4.10)$$

Using the plenum space heat balance (Equation 4.6), the LED energy to the plenum can be computed.  Rearranging Equation 4.6 yields:

$$\dot{q}_{LED,plenum} = \dot{q}_{extract,plenum} + \dot{q}_{cond,SA\ duct} + \dot{q}_{cond,ceiling} - \dot{q}_{cond,plenum\ surr} \quad (4.11)$$

Alternatively, the lighting heat gain to the space can be indirectly calculated from

$$\dot{q}_{LED,space,indir} = \dot{q}_{LED} - \dot{q}_{LED,plenum} \quad (4.12)$$

The input power to the LED ($\dot{q}_{LED}$) is measured by the watt transducer.

Ideally, $\dot{q}_{LED,space,dir}$ should be equal to $\dot{q}_{LED,space,indir}$, but the two quantities may differ due to experimental and measurement uncertainties. As was done in ASHRAE RP-1281 (Fisher et al, 2006), a weighting method was adopted to calculate a final space lighting heat gain based on both values as follows:

$$\dot{q}_{LED,space} = W_{dir}\dot{q}_{LED,space,dir} + W_{indir}\dot{q}_{LED,space,indir} \quad (4.13)$$

$W_{dir}$ and $W_{indir}$ are weighting factors and sum to 1.00. Based on the uncertainty analysis, the uncertainty of $q_{LED,\ space,\ dir}$ is larger than $q_{LED,\ space,\ indir}$. Their uncertainty ratio is expressed as 0.57/0.43 for the 2-ft×2-ft troffer and 0.55/0.45 for the 2-ft×4-ft troffer. It was therefore determined the values 0.43 and 0.45 apply to $W_{dir}$, while 0.57 and 0.55 apply to $W_{indir}$, for 2-ft×2-ft troffer and 2-ft×4-ft troffer, respectively.

As a result, the conditioned space heat gain fraction is calculated as follows:

$$F_{LED,space} = \frac{\dot{q}_{LED,space}}{\dot{q}_{LED}} \quad (4.14)$$

### 4.4 Radiative Heat Gain Measurement

The net radiometer is designed to measure the radiative heat generated by the LED lighting fixture in this project. The upward facing pyranometer and pyrgeometer measures the radiation exchange between the LED lighting fixture and the net radiometer and the downward facing pyranometer and pyrgeometer measures the radiation exchange between all other objects/surfaces and the net radiometer. A pyranometer is a device designed to measure the solar radiation flux density (W/m$^2$) and a pyrgeometer is a device designed to measure the infrared radiation flux density (W/m$^2$). Upward value minus the downward value gives the radiative heat between the LED lighting fixture and all other objects/surfaces. Figure 4.3 shows the operating principle of the net radiometer.

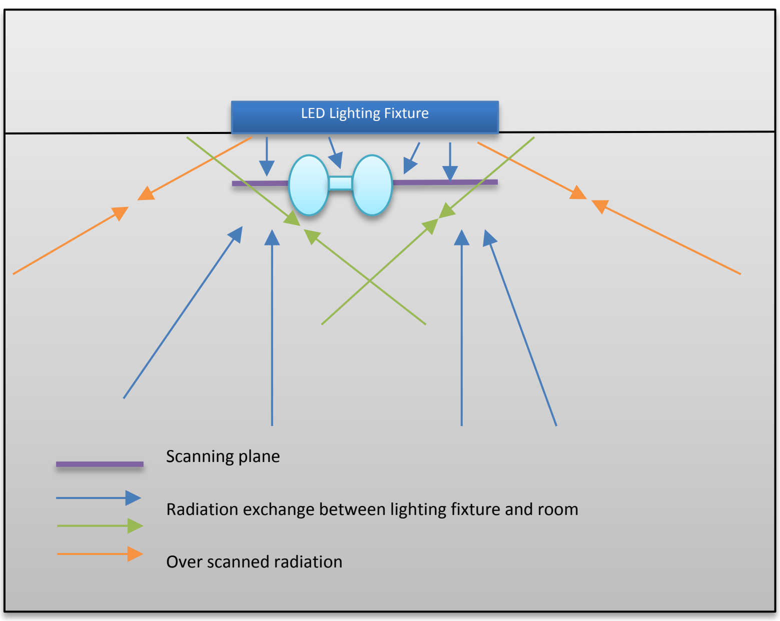



Figure 4-3 Radiative exchange and net radiometer design

**4.5 Radiative Heat Gain calculation**

The radiative heat gain from the LED fixture is calculated as follows:

$$\dot{q}_{rad} = \Delta LW + \Delta SW \tag{4.15}$$

Where

$\Delta LW$ is the longwave infrared radiative heat

$\Delta SW$ is the shortwave solar radiative heat

The pyranometer measures the shortwave within a wavelength range from 0.3 µm to 3 µm and the pyrgeometer measures the longwave within a wavelength range from approximately 4.5 µm to 100 µm. The net radiometer measures upward longwave and downward longwave as well as upward shortwave and downward shortwave radiative heat. $\Delta LW$ is the difference between upward and downward longwave radiation. Slimily, $\Delta SW$ is the difference between upward and downward shortwave radiation.

The net radiometer was used to measure both the long and shortwave length radiation in a plane located below the LED light fixture. The scanning plane was divided into several grid points depending on the type of LED lighting fixtures and measurements were made at each grid point.

As a result, the longwave radiative heat is calculated as follows:

$$\dot{q}_{rad,LW,total} = \sum_{i=1}^{n} \dot{q}_{rad,LW,i} \cdot A_i \tag{4.16}$$

Similarly, the shortwave radiative heat is calculated as follows:

$$\dot{q}_{rad,SW,total} = \sum_{i=1}^{n} \dot{q}_{rad,SW,i} \cdot A_i \tag{4.17}$$

Where

i is the grid point where the measurement was taken.

$\dot{q}_{rad,LW/SW,total}$ is the radiative heat measured at grid point i.

$A_i$ is the differential area associated with grid point i.

N is the total number of grid points.

Therefore, the total radiative heat gain is the sum of the longwave and shortwave radiation heat gain, and is calculated as follows:

$$\dot{q}_{rad,total} = \dot{q}_{rad,LW,total} + \dot{q}_{rad,SW,total} \tag{4.18}$$

The fraction of the total LED energy that is from the short wavelength radiation is:

$$F_{LED,rad,SW} = \frac{\dot{q}_{rad,SW,total}}{\dot{q}_{LED}} \tag{4.19}$$

And, the fraction of the total LED energy that is from the long wavelength radiation is:

$$F_{LED,rad,LW} = \frac{\dot{q}_{rad,LW,total}}{\dot{q}_{LED}} \tag{4.20}$$

Thus, the fraction of LED energy that is radiation for all wavelengths is:

$$F_{LED,rad} = \frac{\dot{q}_{rad,total}}{\dot{q}_{LED}} \tag{4.21}$$

# CHAPTER 5. TEST SETUP

## 5.1 Test Chamber Construction

The test chamber was built in the Interior-A test room at the ERS. Construction was performed by local construction company. The test chamber serves to mimic an office environment. Figure 5.1 shows the detailed dimensions of the interior of the chamber. Figure 5.2 is a partial isometric view of the constructed test chamber. The chamber walls were framed with 22 gauge 2-in × 4-in galvanized steel C studs on 16-in centers and the floor and roof were framed with 16 gauge 2-in × 6-in galvanized steel joists on 16-in centers.

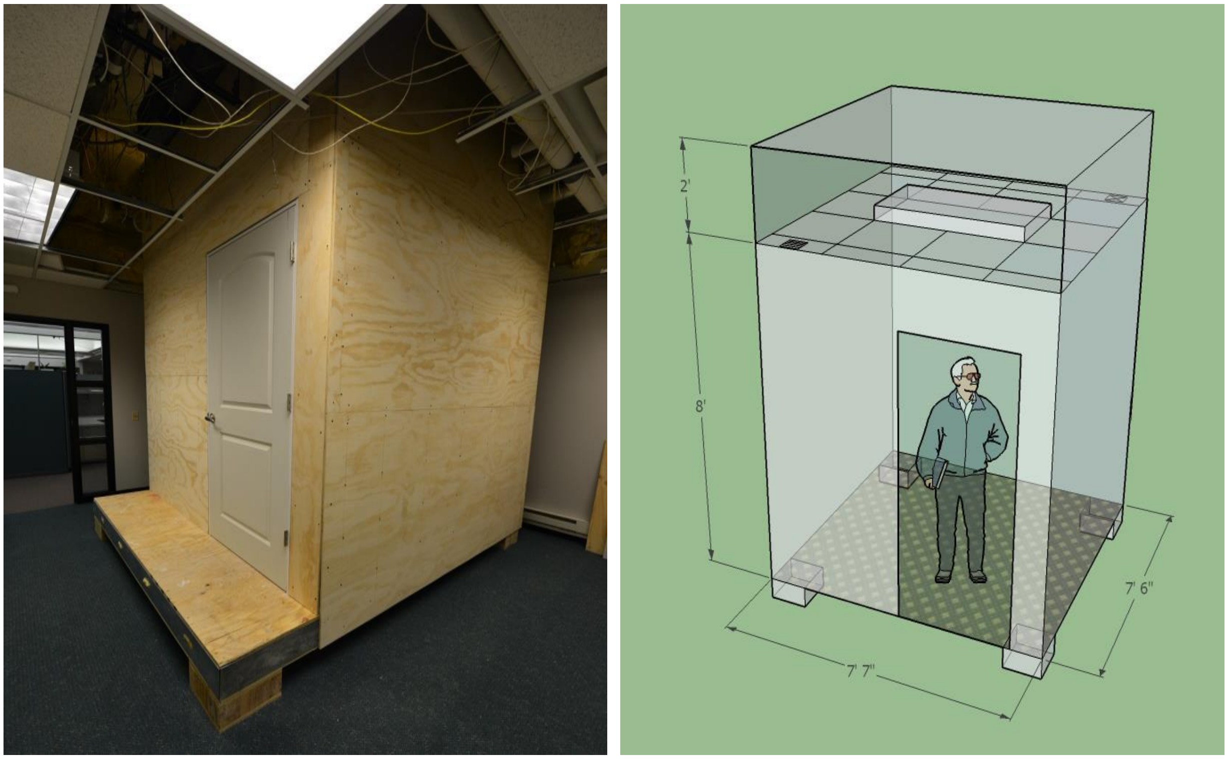



Figure 5-1 Test chamber with detailed dimensions

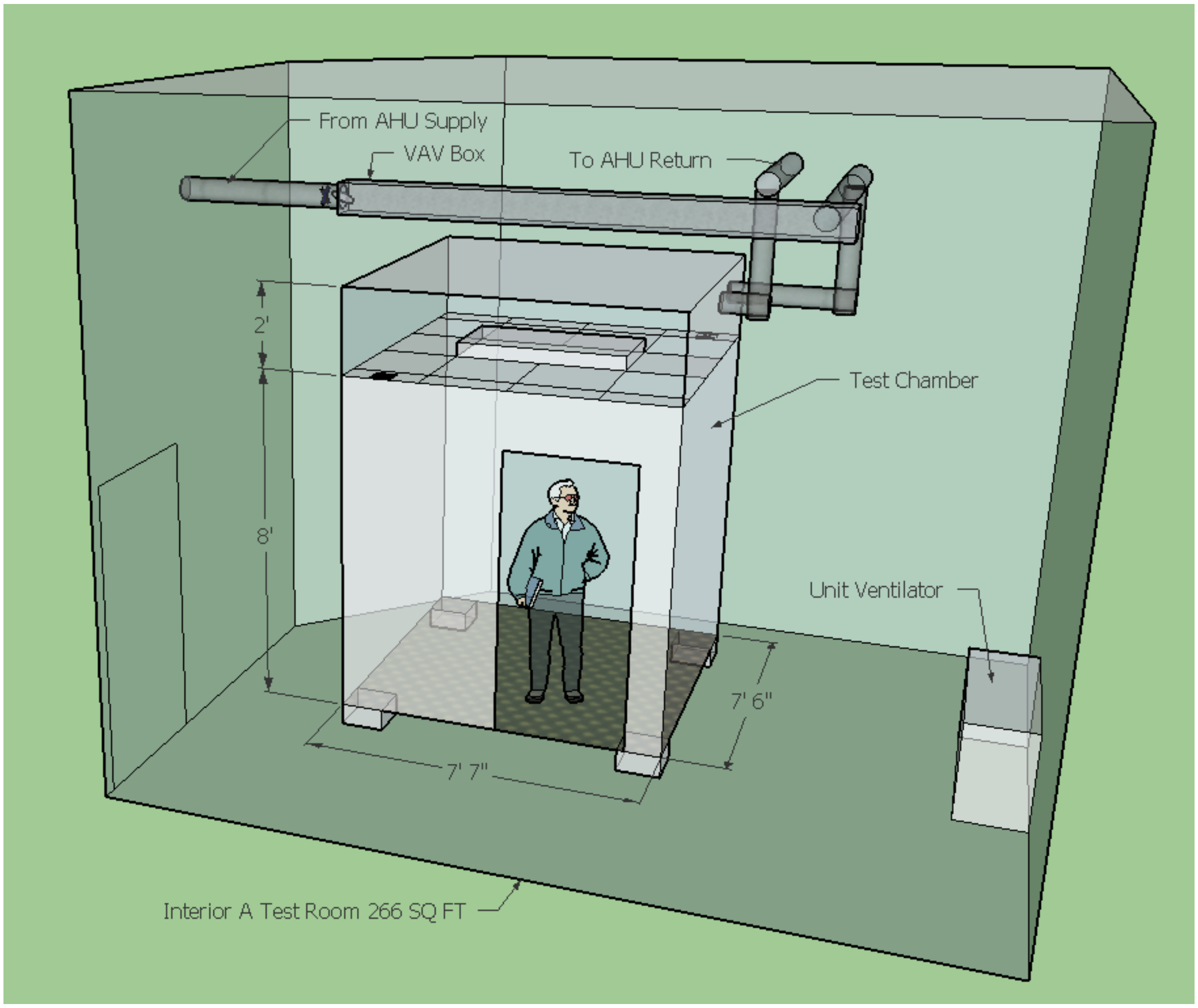



Figure 5-2 Test chamber side view

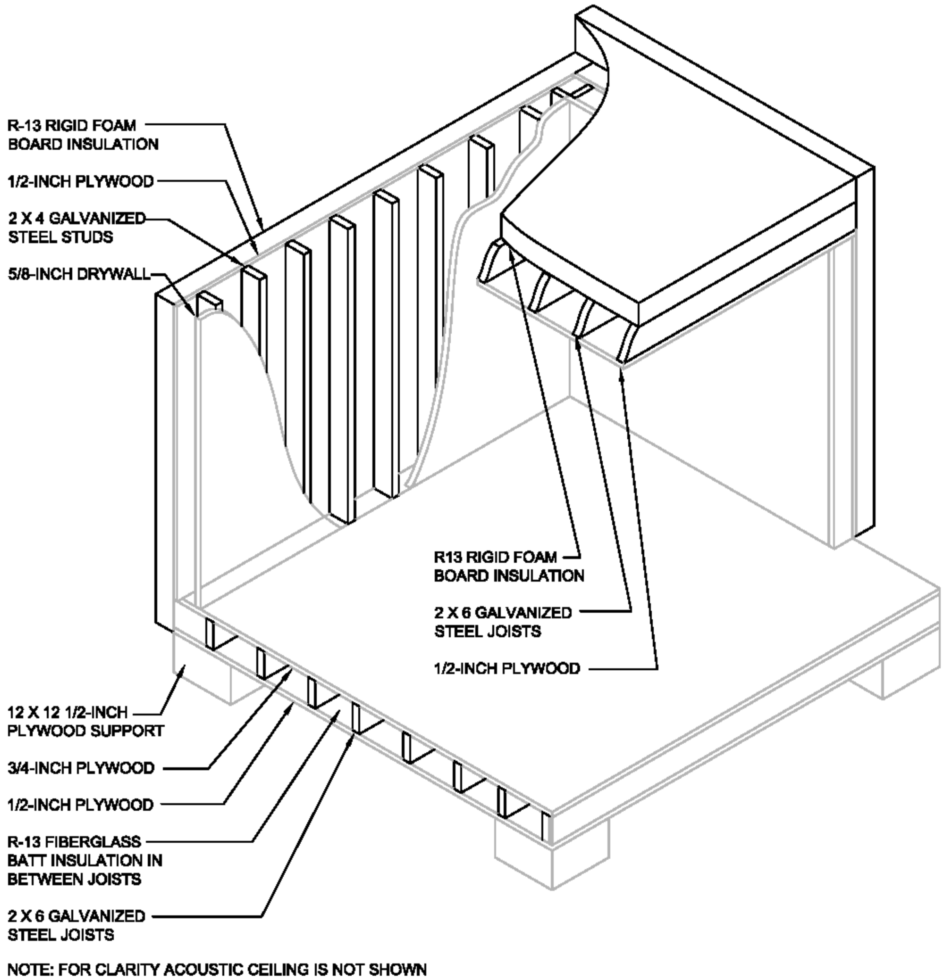



Figure 5-3 Isometric View of Test Chamber

Figure 5.3 shows the Interior-A test room and test chamber plan view. Figure 5.4 shows the Interior-A test room and test chamber elevation view.

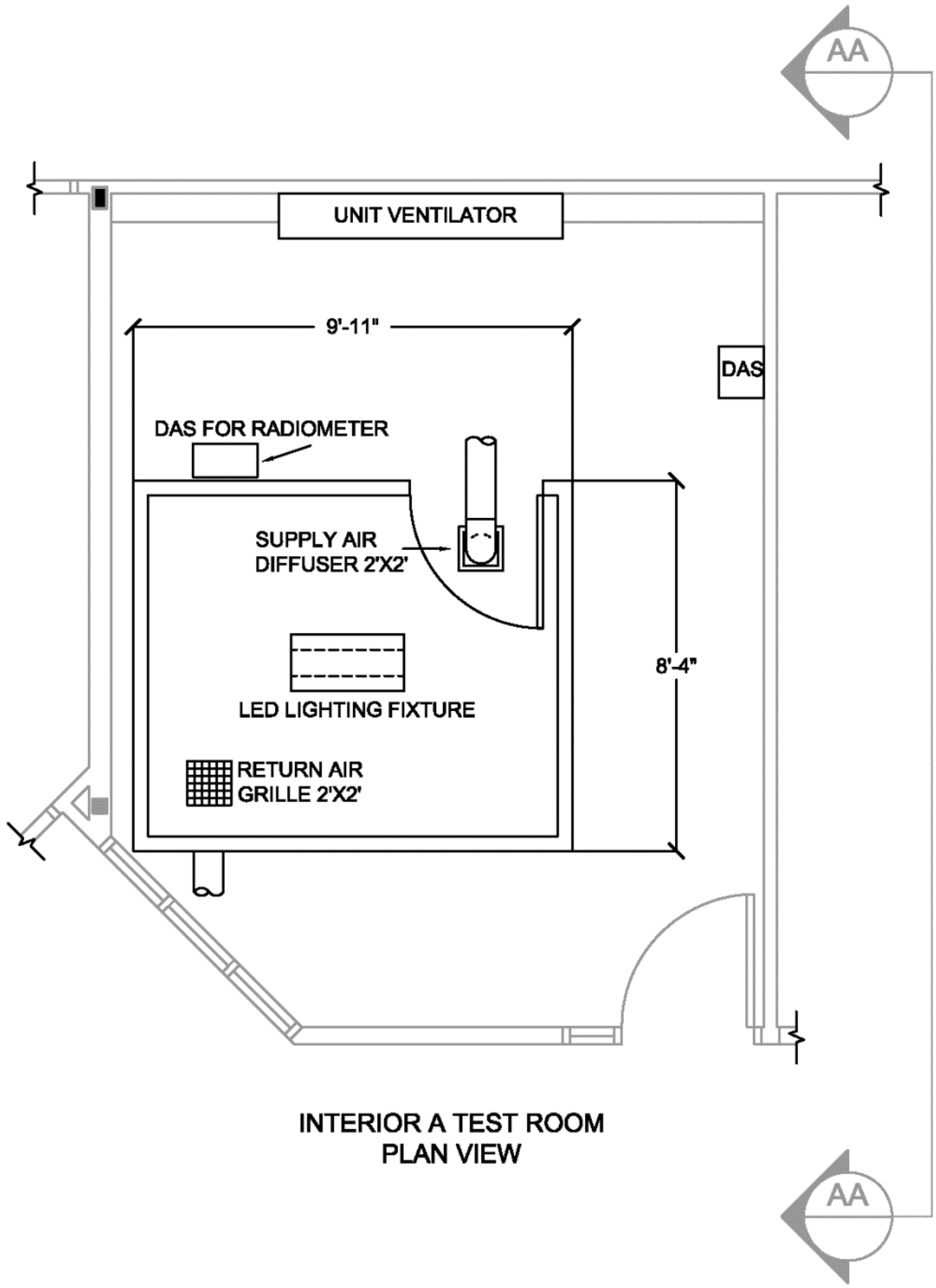



Figure 5-4 Interior-A test room and test chamber plan view

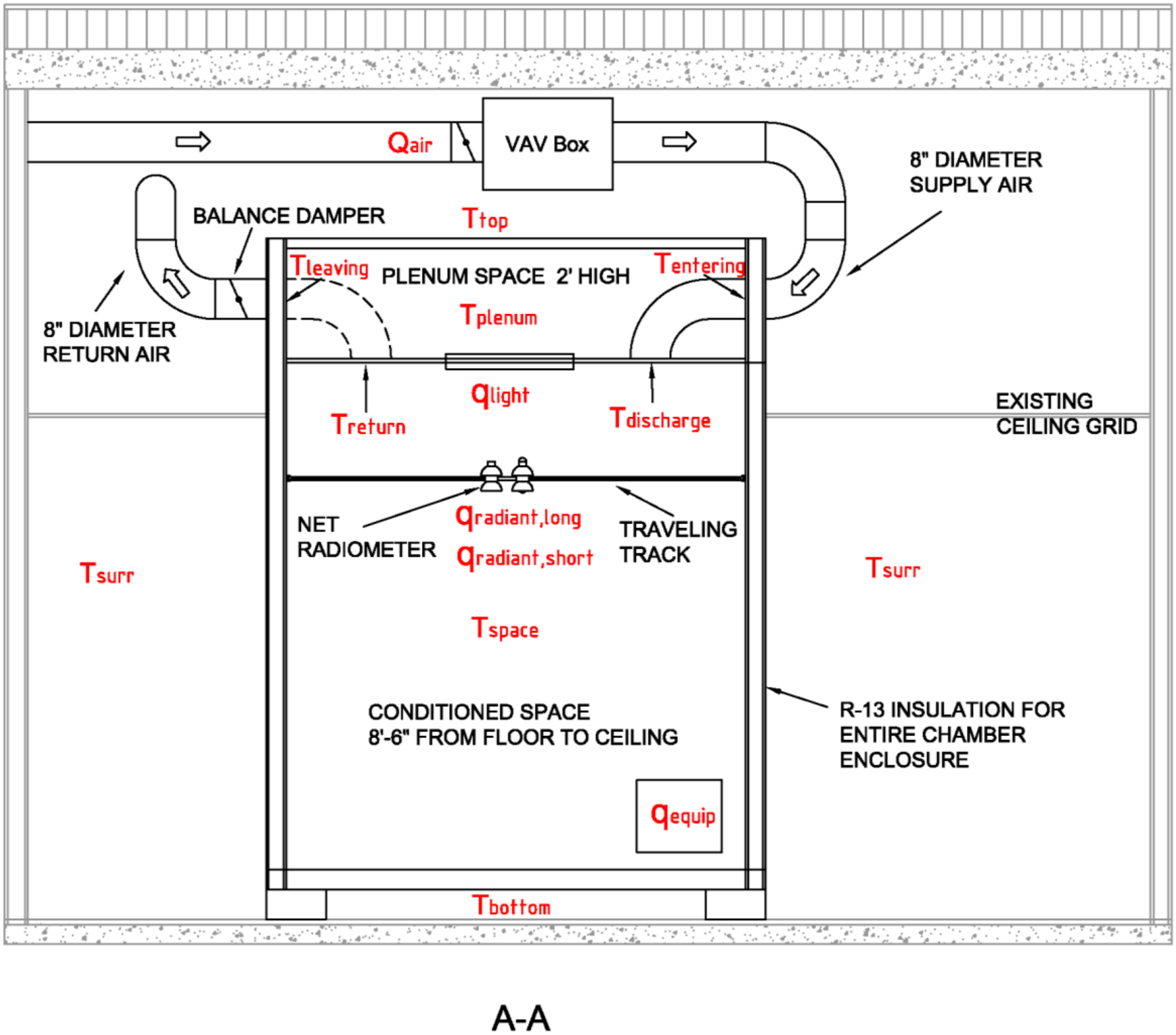



Figure 5-5 Interior-A test room and test chamber elevation view

## 5.2 Chamber U Value

The chamber heat transfer U values were first calculated with eQuest software which follows the method prescribed by ASHRAE (ASHRAE Handbook, 2013b). However, these values produced large errors in the resulting heat balance calculations. It was suspected that a large uncertainty existed with the convection heat transfer coefficient of the air film surrounding the chamber surface. This coefficient is a function of the air velocity around the surface and was difficult to estimate.

In order to obtain more accurate U-values, a factory calibrated heat flux sensor was used to measure the heat flux through the chamber walls, roof, floor and ceiling tiles. The measurement followed the principles outlined in ASTM Standards C1046-95 (Chio et al, 2012) and C1155-95 (Dong et al, 2009). ASTM C1046 – 95 is titled "Standard Practice for In-Situ Measurement of Heat Flux and Temperature on Building Envelope Components" and ASTM C1155-95 is "Standard Practice for Determining Thermal Resistance of Building Envelope Components from In-Situ Data."

During the heat flux measurements the temperature inside the chamber was maintained at 60 $^{o}$F while the temperature in the test room was maintained at 70 $^{o}$F. Heat flux measurements were made at multiple locations on each surface so that an average value for each surface could be calculated. Figure 5.5 illustrates the heat flux sensor used and its application to one of the surfaces of the test chamber. The data were collected under-steady state conditions. From the measured heat flux values, the U values were calculated. The U-values are listed in Table 5.1

Table 5.1 Measured U Values & Equivalent R values in Chamber Sections

| **Chamber Section** | **Calculated U Value, Btu/hr-ft$^2$-°F** | **Equivalent R Value, hr-ft$^2$-°F/Btu** |
|---|---|---|
| Wall | 0.062 | 16.072 |
| Roof | 0.053 | 18.978 |
| Floor | 0.069 | 14.430 |
| Ceiling tile | 0.156 | 6.434 |


Figure 5-6 Heat Flux Sensor & Placement

### 5.3 Net Radiometer Moving Rail Design

The net radiometer was mounted to a moving rail system which allowed the instrument to be automatically controlled. The moving rail is approximately 4.9-ft long (1500 mm), 3.3-ft wide (1000 mm), and 4.9-ft height (1500 mm). Figure 5.7 shows the schematic layout of the rail design. The motion of net radiometer was automatically controlled by Arduino UNO microcontroller. Four NEMA 23 stepper motors were used: two for x-direction, one for y-direction and on the other one for z-direction.

The net radiometer traveling distance of each step was also marked on the moving rail. The control program of the stepper motor was calibrated to ensure the net radiometer reached every marked position precisely. Prior to the formal pilot test, a couple of complete test runs were conducted and all the stops by the net radiometer were observed. If the net radiometer failed to reach the desired position within any cell, the program was recalibrated.

Radiation measurements were made once the test chamber reached steady-state conditions. For this research, steady-state conditions are defined in Section 5.4.

For recessed troffer and downlight fixtures, the net radiometer only needed to travel in an x-y plane below the light fixture. For high-bay and linear pedant suspended fixtures, the z-direction motion was required. The scanning area for radiative heat measurement was proportional to the actual LED fixture’s area. The scanning area was discretized into a number of cells as illustrated in Figure 5.6. For the case of a 2-ft×2-ft fixture, the number of cells in the y-direction followed that of 2-ft x4-ft fixture, while the number of cells in the x-direction was only half of 2-ft×4-ft fixture. The red dash line in Figure 5.6 indicates the mid-point of 2-ft×4-ft fixture. At each cell, the net radiometer stayed in the center of the cell for two minutes for data collection. The 2-minute duration is based on ASHRAE RP-1282 (Fisher et al, 2006) which measured conventional lighting heat gain.

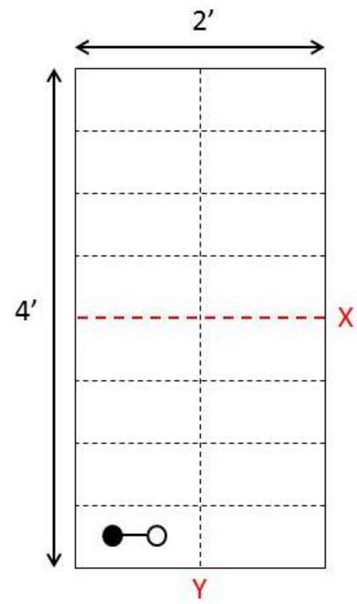



Figure 5-7 Scanning Area of Rectangular LED Troffer Fixtures

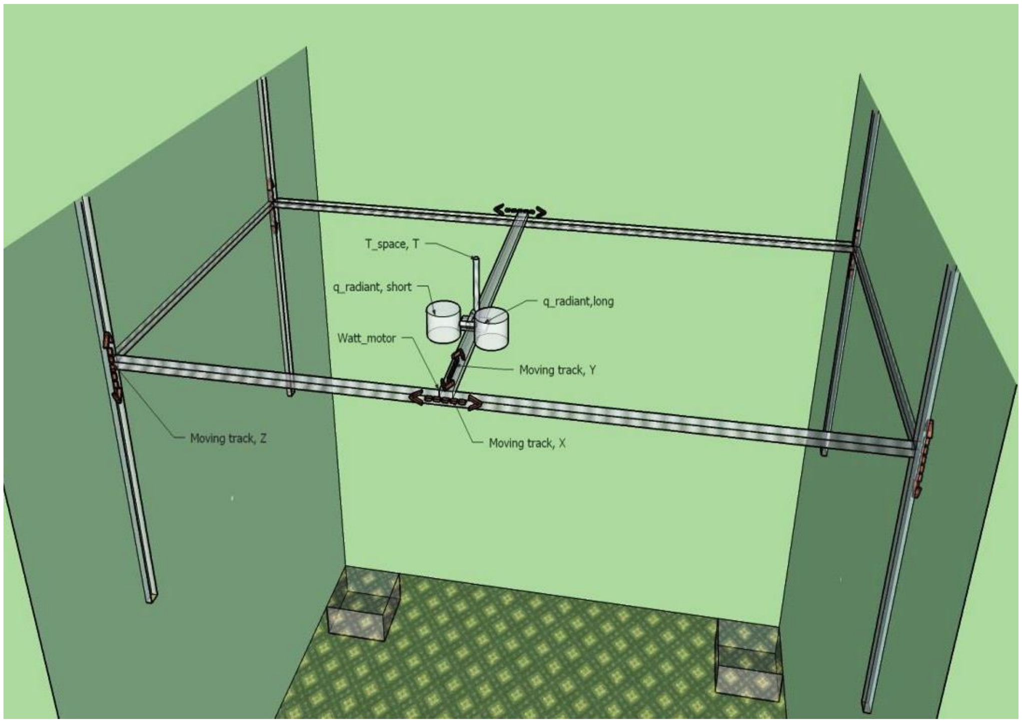



Figure 5-8 The schematic layout of the rail design

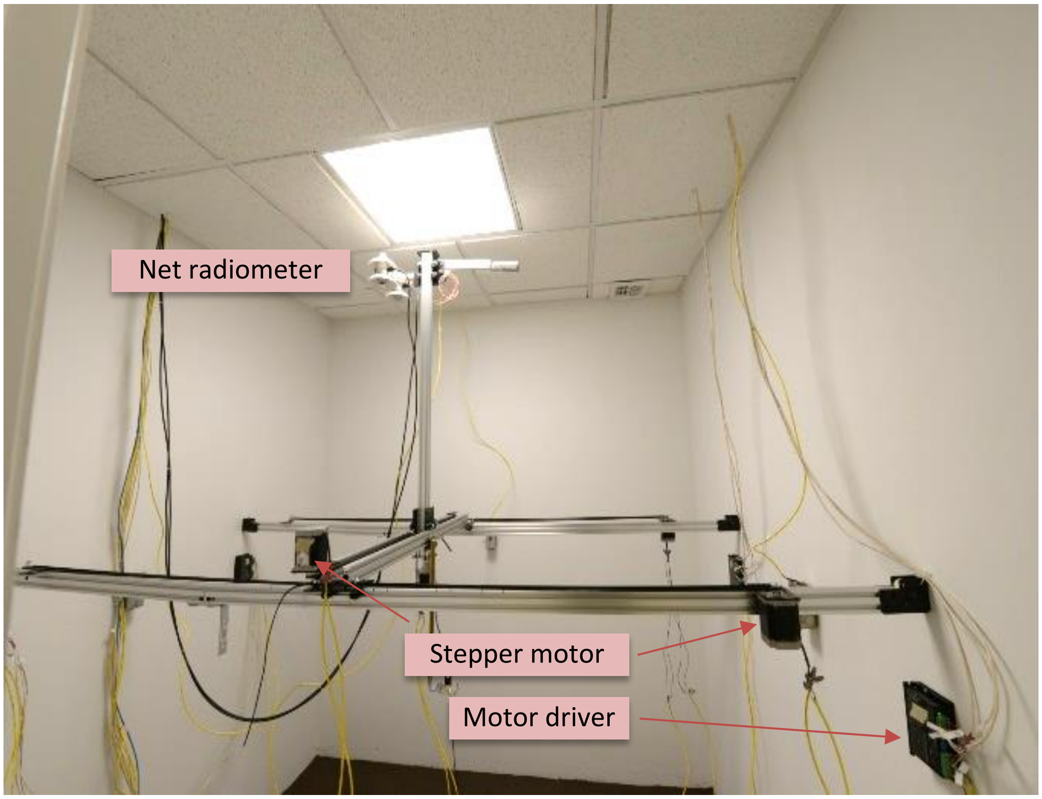



Figure 5-9 Net Radiometer Setup

**5.4 Steady state determination**

Theoretically, when a system reaches steady state, the variable under examination does not change with time. It can be expressed mathematically as the derivative of the variable under examination over the change in time and is equal to zero.

$$\frac{dV}{dt} = 0 \tag{5.1}$$

In reality, a dynamic system cannot maintain absolute zero rate of change, but the change rate should be within a certain range. In this project, the following definition was used to determine if the temperature or airflow rate had reached steady state.

$$\left|\frac{V_{t+1} - V_t}{V_t}\right| \times 100\% < TD1 \tag{5.2}$$

and

$$\left|\frac{V_t - V_{mean}}{V_{mean}}\right| \times 100\% < TD2 \tag{5.3}$$

where

$V_t$ is the variable reading at the time t

$V_{t+1}$ is the variable reading at the time t+1. For 1-minute sampling rate, $V_{t+1}$ is the data collected at 1 minute later with respect to Vt.

$V_{mean}$ is the average value of the variable over the time period under examine, which is 2 hours for this project.

TD1 and TD2 is the percentage thresholds.

It was quite challenging to control a low airflow equal to 60 cfm using only a VAV box, and so a relatively large oscillation on the airflow rate was expected. The threshold values for the entering airflow rate were set 18% for TD1 and 15% for TD2. The temperatures could be controlled with smaller oscillation via the AHU and unit ventilator, so both TD1 and TD2 were set at 0.8% which is 0.48 °F at 60 °F.

Equation 5.2 ensures the system stays steadily at every minute and there is no sudden change for every data sample. Equation 5.3 examines the deviation of each data sample and ensures the overall average does not change more than the threshold over two hours.

The steady state criterion was applied for each test in this project. If the calculated result exceeded the thresholds, the test result was not valid and needed to be retested. Figure 5.9 shows a typical data trend under steady state.

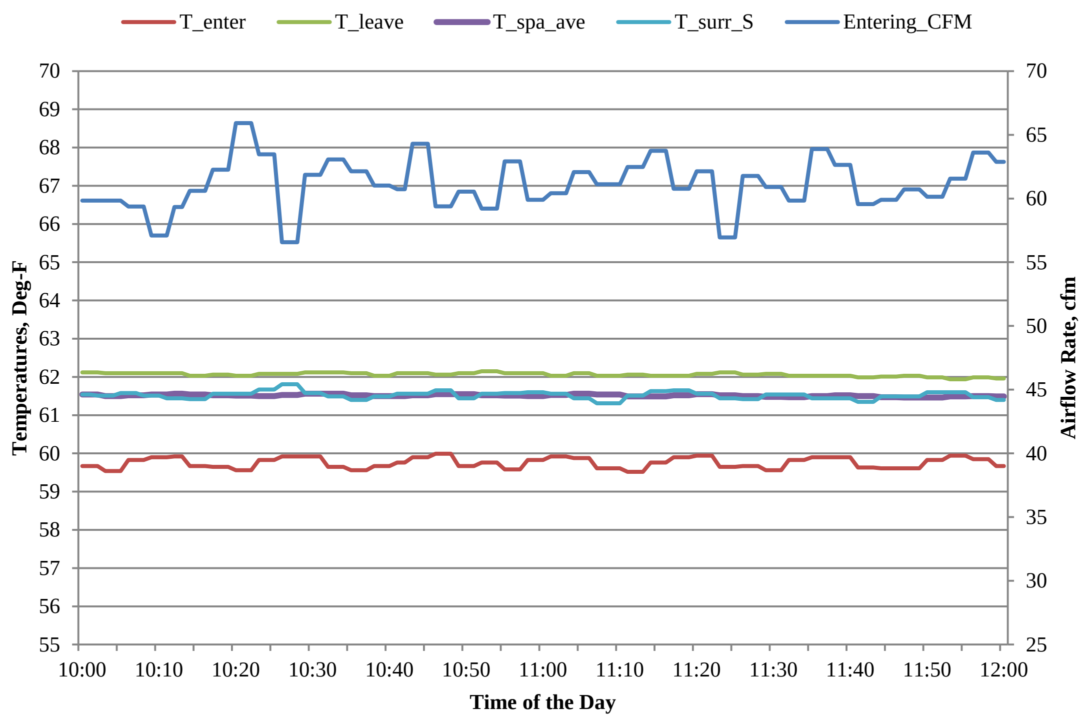



Figure 5-10 Typical Data Trending of Selected Variables at Steady State

## 5.5 Instrumentation and Data Acquisition

The instruments used to measure temperature, differential pressure, airflow rate and electrical power are described in this section along with the data acquisition system used to read and record the data.

### 5.5.1 Temperature

A total of nineteen Resistance Temperature Detectors (RTD) were used for measuring temperature in this project. All of the RTDs were calibrated based on a NIST-traceable temperature reference and their accuracy are $\pm$0.25 °F or better.

The location of the RTDs are shown in Figure 5.10. Six RTDs were used to measure air temperature throughout the chamber, three were used to measure the air temperature in the plenum space, and six were used to measure the temperature of the chamber walls. The remaining four RTDs were used to measure the supply air temperature, the return air temperature, the supply duct air temperature discharged into the chamber, and the return air temperature at the return air grille.

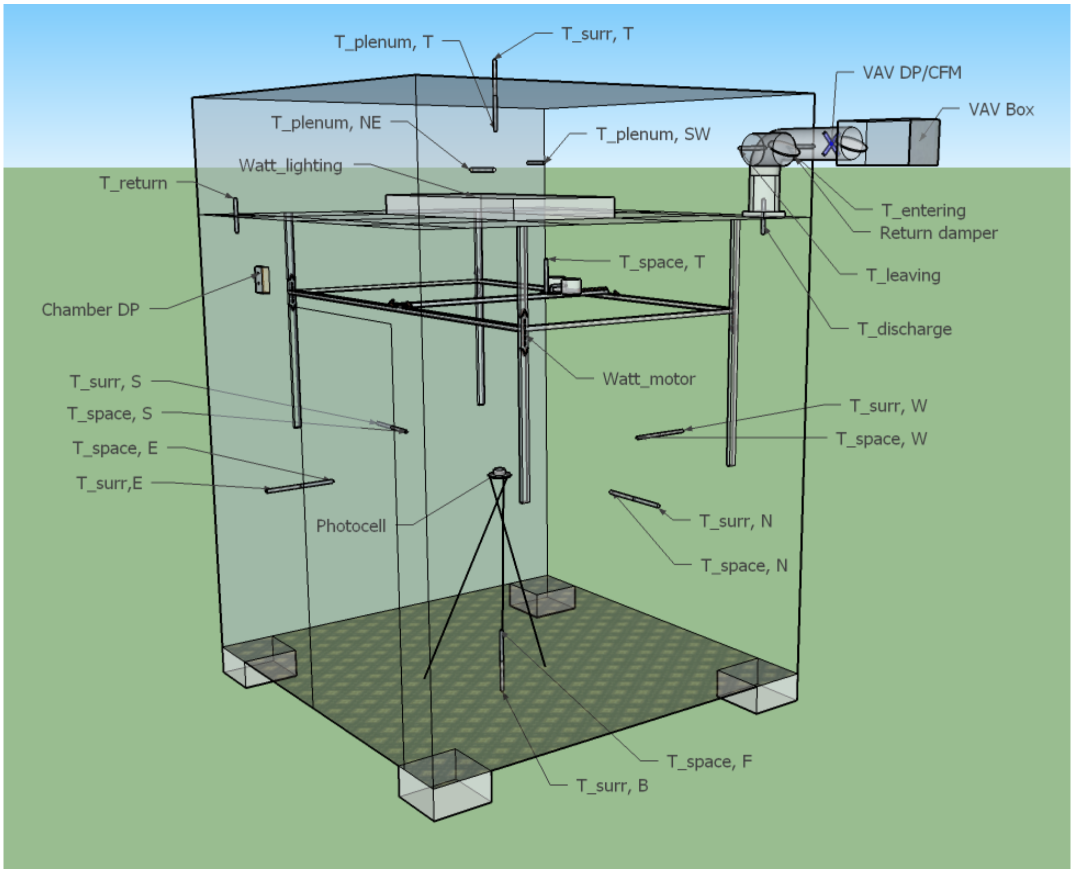



Figure 5-11 Instrumental design

### 5.5.2 Chamber differential pressure

In order to eliminate air infiltration (or exfiltration) from the test chamber, the differential pressure between the interior of the test chamber and the interior of the test room was controlled and maintained at zero. A high-accuracy pressure transducer (±0.02% full span accuracy) was mounted at the east side of exterior chamber wall, see Figure 5.7. A balance damper in the return grille was automatically positioned to control the DP and maintain as zero.

### 5.5.3 Airflow rate

The supply airflow rate entering the chamber was measured by the VAV airflow sensor. At the Energy Resource Station, VAV differential pressures (VAV DP) are measured using high-accuracy pressure transducers.  These pressure readings are converted to airflow rate using calibrated K factors. The pressure transducer was calibrated to have an accuracy of ± 0.25 % of full scale. The VAV box serving the chamber was also balanced to achieve airflow measurement accuracy ± 2% of reading.

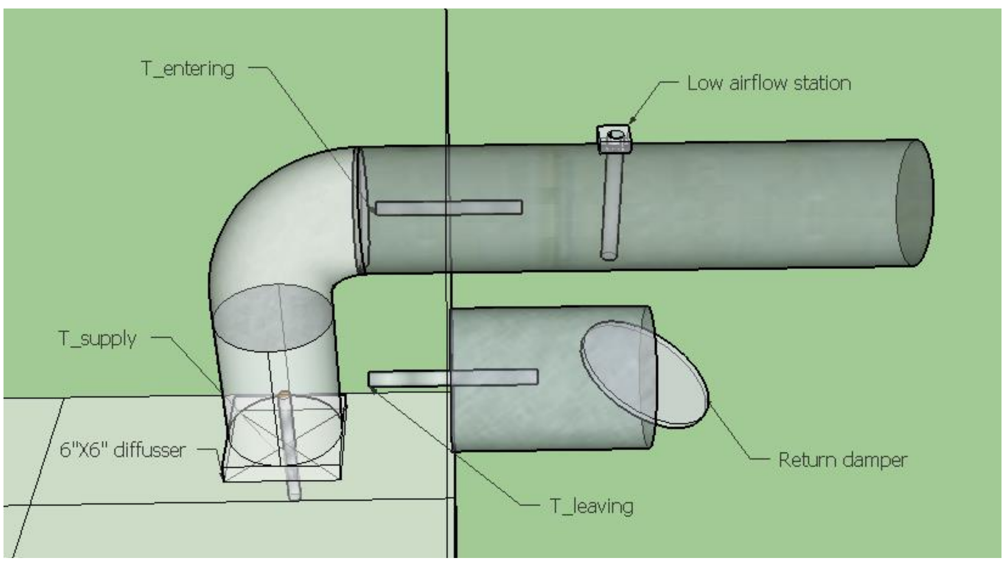



Figure 5-12 Low Airflow Measuring Station

### 5.5.4 Electric power

Watt transducer was used to measure power input to the LED lighting fixture and measurement accuracy is ± 0.2 % of reading.

### 5.5.5 Data acquisition system (DAS)

All above sensors except the net radiometer were connected to the existing ERSTES data acquisition system. The measuring points were trended at 1-minute sampling rate. The net radiometer was connected to National Instruments' FieldPoint modules, which were portable DAS. The sampling rate was also 1 minute.

# CHAPTER 6. UNCERTAINTY ANALYSIS

The uncertainties of the experimental tests and calculation were analyzed base on ASHRAE Guideline Engineering Analysis of Experimental Data 2005.

The uncertainty of a single measured variable can be calculated as follow.

$$u_{MV} = \sqrt{\sum_{i=1}^{n} u_i^2} \tag{6.1}$$

Where,

$u_{MV}$ is the overall uncertainty of a measured variable.

$u_i$ is the individual uncertainty from error source 1 to error source n.

Table 6.1 lists the uncertainties of all directly measured variables in this project.

For a calculated variable, all directly measured variables can propagate their uncertainties to the calculated results. The uncertainty of a calculated variable can be expressed as follows

$$u_{CV} = \sqrt{\sum_{i=1}^{n} (\frac{\partial CV}{\partial MV_i} u_{MV_i})^2} \tag{6.2}$$

Where,

$u_{CV}$ is the overall uncertainty of a calculated variable.

$u_{MVi}$ is the uncertainty of each measured variable from 1 to i that is involved in the calculation of CV.

Table 6.1 Uncertainties of Single Measured Variables

| **Variable** | **Individual error source** | **Individual uncertainty** | **Overall uncertainty** |
|---|---|---|---|
| Temperature | Calibration accuracy | ±0.02 °F | ±0.0202 °F |
| | Reference accuracy | ±0.0026 °F | |
| Airflow rate | Flow station accuracy | 3% of reading | ±3% of reading |
| | DAS sourcing accuracy | 0.08% of reading | |
| | Sourcing device accuracy | 0.01% of reading | |
| Lighting power | Watt transducer accuracy | 0.2% of reading | ±0.21% of reading |
| | DAS sourcing accuracy | 0.07% of reading | |
| | Sourcing device accuracy | 0.01% of reading | |
| Radiative heat | Short wave radiation including calibration uncertainty, sensor directional response, and sensor temperature dependence | Less than 5% of reading | 5% of reading |
| | Longwave radiation including calibration uncertainty, sensor directional response, and sensor temperature dependence | Less than 10% of reading | 10% of reading |
| Heat flux for U value | Heat flux sensor accuracy | 5% of reading | 5% of reading |
| | DAS sourcing accuracy | 0.05% of reading | |
| | Sourcing device accuracy | 0.01% of reading | |
| Chamber DP | Calibration accuracy | ±0.002 in.wc | ±0.002 in.wc |
| | Reference accuracy | ±0.0001 in.wc | |
| Lighting level | Photocell sensor accuracy | ±5% of reading | ±5% of reading |
| | DAS sourcing accuracy | 0.08% of reading | |
| | Sourcing device accuracy | 0.01% of reading | |

The uncertainty of the heat extraction rate was calculated as follows:

$$u_{q\_extract} = \rho_{SA} C_{SA} \sqrt{(\Delta T u_Q)^2 + (\dot{Q} u_{\Delta T})^2} \quad (6.3)$$

Where,

$u_Q$ is the uncertainty of measured supply air flow rate.

$u_{\Delta T}$ is the uncertainty of measured temperature difference.

This equation assumes there are no uncertainties in the air density ρ or the air specific heat C.

The uncertainty of conductive heat rate was calculated as follows: assuming no uncertainties from the chamber superficial areas.

$$u_{F\_q_{LED},space} = \frac{\sqrt{\left(\dot{q}_{LED} u_{qLED,space}\right)^2 + \left(\dot{q}_{LED,space} u_{q_{LED}}\right)^2}}{\dot{q}_{LED}{}^2} \tag{6.4}$$

Where,

$u_{q\_LED,\ space}$ is the uncertainty of the light conditioned space heat gain

$u_{q\_LED}$ is the uncertainty of measured lighting power

For the radiative heat measurement, the discretized cell area were each expected to have an approximate uncertainty of ± $2.52\text{x}10^{-6}$ $m^2$ (1/16 inches for both length and width). This equates to less than 0.01% error and 0.2% error for cell area and total fixture area, respectively. Therefore, the error in the area was ignored when analyzing uncertainties for the radiative heat gain.

The uncertainty for calculated radiative heat gain is given by:

$$u_{rad} = \sqrt{\sum_{i=1}^{n} [(u_{rad,i} \cdot A_i)^2]} \tag{6.5}$$

Where $u_{rad,i}$ is the uncertainty of measured radiant heat at grid point i. Equation 6.5 applies to long wave, short wave, and total radiant heat gain.

The uncertainty of the fraction of radiative heat was then calculated as:

$$u_{F\_rad} = \frac{\sqrt{\left(\dot{q}_{light} u_{rad}\right)^2 + \left(\dot{q}_{rad} u_{q_{light}}\right)^2}}{\dot{q}_{light}{}^2} \tag{6.6}$$

# CHAPTER 7. OFFICIAL TEST

The entire official test was completed and the following section summaries the test results and analysis. This section is divided into two parts: (1) base case test and (2) variance case test.

The base case test applied for all 14 fixtures and the variance case test only applied for fixture No. 3, No. 6, No. 11, No. 14 listed in Table 3.1. Table 7.1 lists all the test cases including the base case.

Table 7.1 LED lighting test case

| **Case** | **Supply air temperature, °F** | **Supply air flow rate, cfm** | **Return air configuration** | **Floor finish** | **Dimming control** |
|---|---|---|---|---|---|
| Base | 60 | 60 | Plenum return | Carpet | Max output |
| Variance by air flow | 60 | 30<br>120 | Plenum return | Carpet | Max output |
| Variance by return air configuration | 60 | 60 | Duct return | Carpet | Max output |
| Variance by supply air temperature | 55<br>65 | 60 | Plenum return | Carpet | Max output |
| Variance by floor finish | 60 | 60 | Plenum return | Wood | Max output |
| Variance by dimming control | 60 | 60 | Plenum return | Carpet | 5V |

**Base Case:**

For the base case, air was supplied at 60 °F and 1.0 cfm/ft$^2$. The return air was plenum return configuration and the floor finish was carpet. Also, the LED was not on the dimming control which means max power was provided to LED luminaires. The ceiling tiles were in place except for the high-bay luminaires. High-bay luminaires are typically free hanging. As a result, the heat split between conditioned and plenum space was not applicable for high-bay fixtures.

**Variance by airflow rate:**

This case was to examine the effect of the supply air flowrate on the lighting heat gain distributions. The supply airflow rate was change to 0.5 cfm/ft$^2$ and 2.0 cfm/ft$^2$, respectively. Other settings remained the same as the base case.

**Variance by return air configuration**

This case was to examine the effect of the return air configuration on the lighting heat gain distributions. In this case, the return air configuration was changed from plenum return to duct return. A 6' flexible duct was installed to connect the return air grille and return outlet of the chamber wall. Other settings remained the same as the base case.

**Variance by supply air temperature**

This case was to examine the effect of supply air temperature on the lighting heat gain distributions. The supply air temperature was maintained at 55 °F and 65°F for each case. Other settings remained the same as the base case.

**Variance by floor finish**

This case was to examine the effect of the floor finish on the lighting heat gain distributions. In this case, the carpet was removed and the wood floor was exposed. A different radiative heat gain was expected because the absorptivity/emissivity is a function of material.

**Variance by dimming control**

Most LED fixtures are able to accommodate dimming control. The dimming control signals range from 0V to 10V as max output. In this case, 5V signal output was adjusted compared to the maximum output. Other settings remained the same as the base case.

## 7.1 Base Case Test

All fourteen fixtures were tested under the base case conditions.

- Supply air temperature 60 °F
- Supply air flowrate 60 cfm
- Plenum return
- Carpet floor finish
- No dimming control

The heat split between conditioned and plenum space as well as the radiative/convective heat split was determined for each LED lighting fixtures. Figure 7.1 and Figure 7.2 illustrates the conditioned space fraction and the radiative fraction for recessed LED fixtures. Figure 7.3 shows the radiative fraction and lighting illuminance for suspended LED fixture.

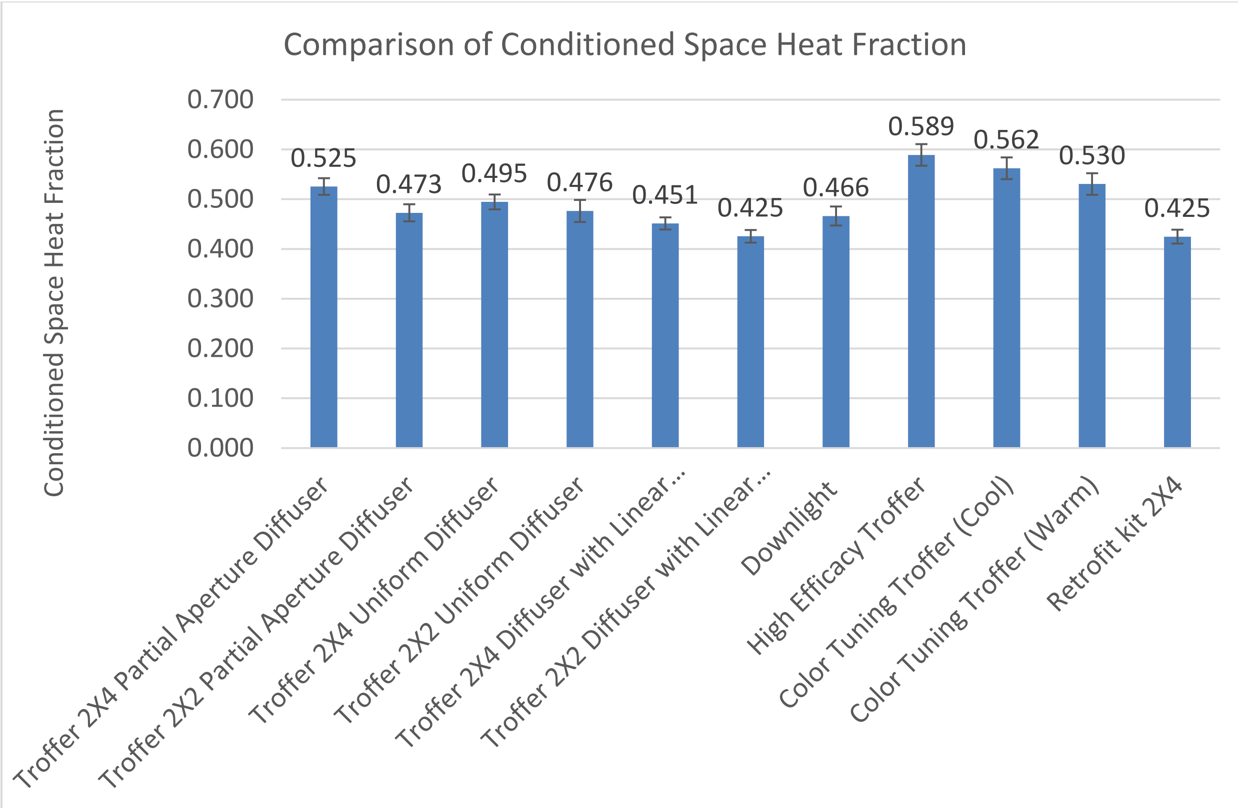



Figure 7-1 Conditioned Space Heat Fractions for All Recessed LED Luminaires

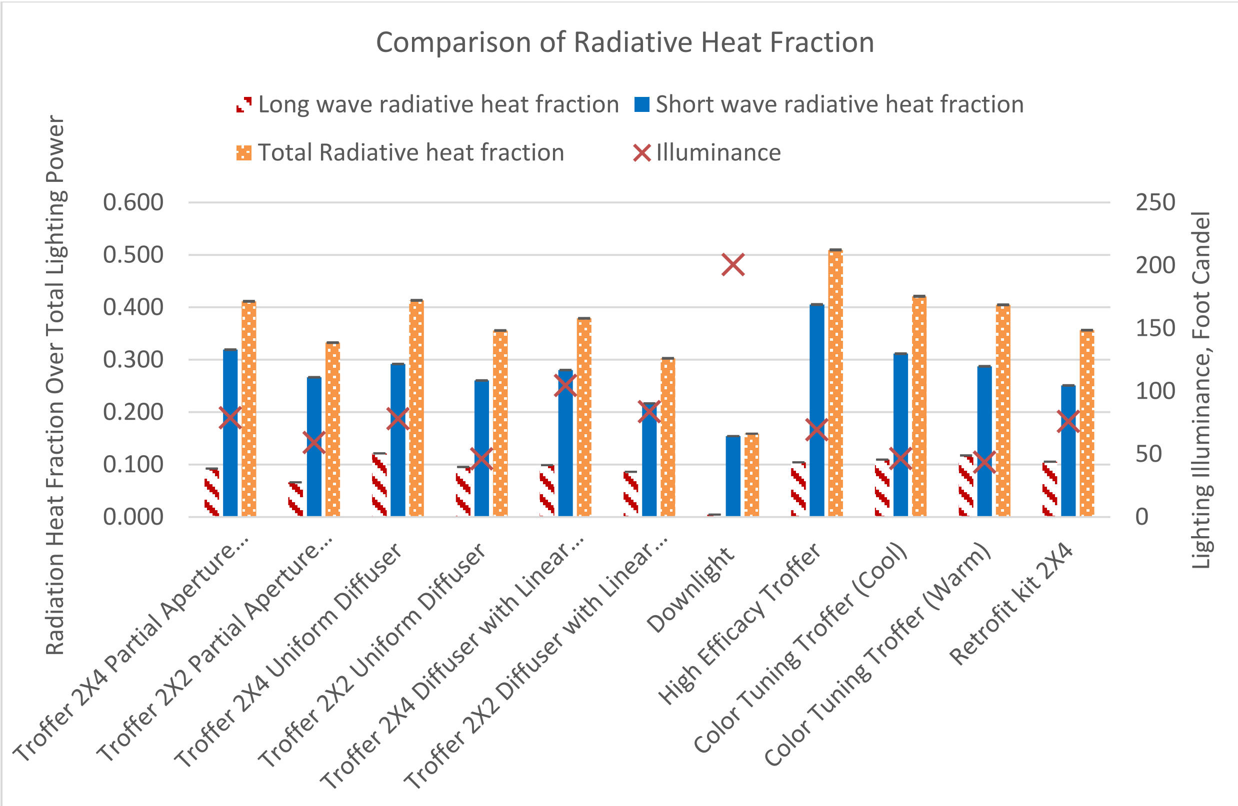



Figure 7-2 Radiative Heat Fractions and Lighting Illuminance for All Recessed LED Luminaires

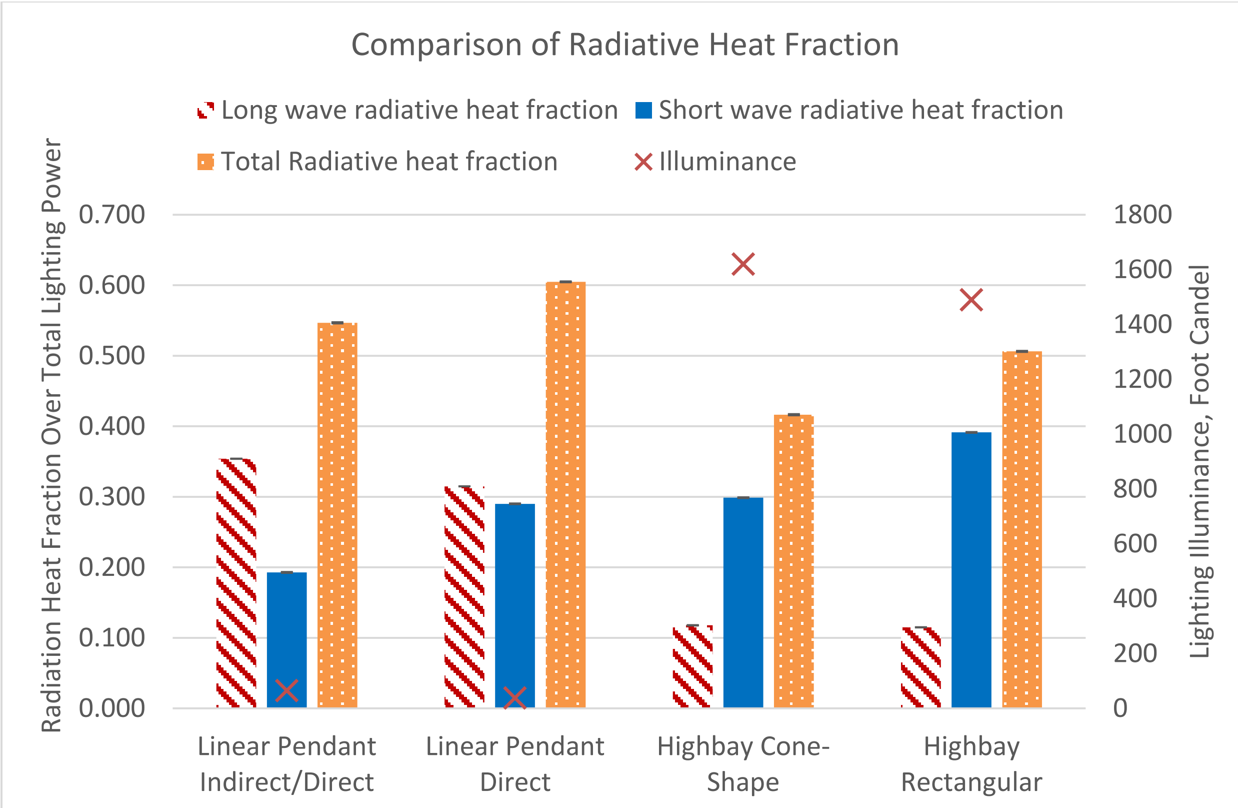



Figure 7-3 Radiative Heat Fractions and Lighting Illuminance for Suspended LED Luminaires

### 7.1.1 High-bay

Two high-bay fixtures (shown in Figures 7.4 and 7.5) were tested in this project. All ceiling tiles were removed to simulate an exposed installation in the real world. A flexible duct was connected directly from the return grille on the ceiling grid to the return cut-out of the chamber. The configuration is a ducted return and prevents possible short circuiting of supply air directly to the return.

Figure 7-4 Cone-Shape High-Bay with Reflector

Figure 7-5 Rectangular-Shape High-Bay with Direct Optics

In order to capture all radiative heat for suspended luminaires, like high-bay and linear-pedant LEDs, 3-D scanning by the net radiometer was required. A rectangular shape scanning area was used in this project. Figure 7.6 illustrates the 3-D scanning area. The suspending lines and wires prevented the net radiometer from travelling on the top of the fixtures. The make-up procedure was to put a 2-ft x4-ft highly reflective material above. The manufacture of this reflect foil states the material reflect 97% of radiative energy. So the net radiometer only needed to travel on one side of X-Z plane but could measure both the bottom and top surfaces of radiative heat. The reflectance of the foil material is considered in the overall measurement uncertainty.

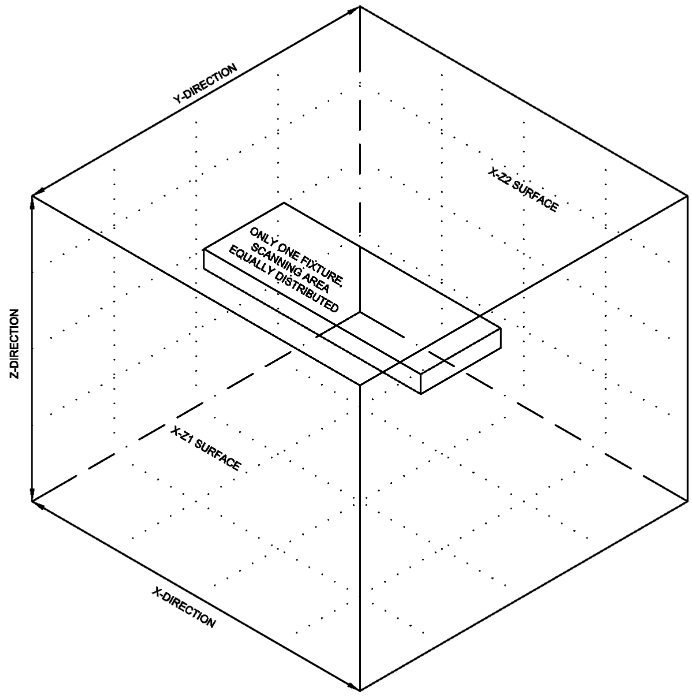



Figure 7-6 3-D Scanning Area of the Net Radiometer for Suspended Luminaires

The test results of high-bay fixtures are summarized in Table 7.2. As for the exposed lighting fixtures, there was no meaning to determine the heat split between conditioned space and plenum space. However, the radiative and convective heat split were determined for these fixtures. As shown in the table, 42% and 51% lighting power was converted to the radiative heat and 30% to 39% was shortwave portion. The rectangular shape high-bay generated about 10% higher fraction of total radiative heat and shortwave heat than cone shape high-bay but the longwave generated by these two fixtures were almost the same.

Table 7.2 Test Result Summary of High-Bays

| LED Fixture | **High-Bay Cone-Shape with reflector** | **High-Bay Rectangular with direct optics** |
|---|---|---|
| Number | 1 | 2 |
| Measured Lighting Power, W | 158.50 | 138.13 |
| Rated Efficacy, Lumen/W | 113 | 101 |
| **Radiative heat fraction over lighting power** | | |
| Long wave radiative heat fraction | 0.118±0.004 | 0.115±0.003 |
| Short wave radiative heat fraction | 0.299±0.006 | 0.391±0.008 |
| **Total Radiative heat fraction** | **0.416±0.01** | **0.506±0.011** |
| **Total Convective heat fraction** | **0.584±0.01** | **0.494±0.011** |
| Illuminance 3 ft. above the floor, Foot-Candle | 1620 | 1490 |
| Illuminance on the floor, Foot-Candle | 348 | 372 |

### 7.1.2 Linear-pedant

Two types of linear-pedant fixtures were tested, one was Direct where only diffused light emanates from the bottom side of the fixture, and the other one was Direct/Indirect where diffused light emanates from both the bottom and the top sides of the fixtures. Linear-pedant fixtures also required 3-D scan which was similar to high-bay test. The same reflect foil was placed above the fixture and the function was the same to the high-bay test. The ceiling tile were put in place to mimic the actual installation of the linear-pedant. Only the heat split between radiative and convective heat was determined, since almost all heat was transferred to the conditioned space. Figure 7.7 shows the Direct fixture and Figure 7.8 shows the Direct/Indirect fixture.

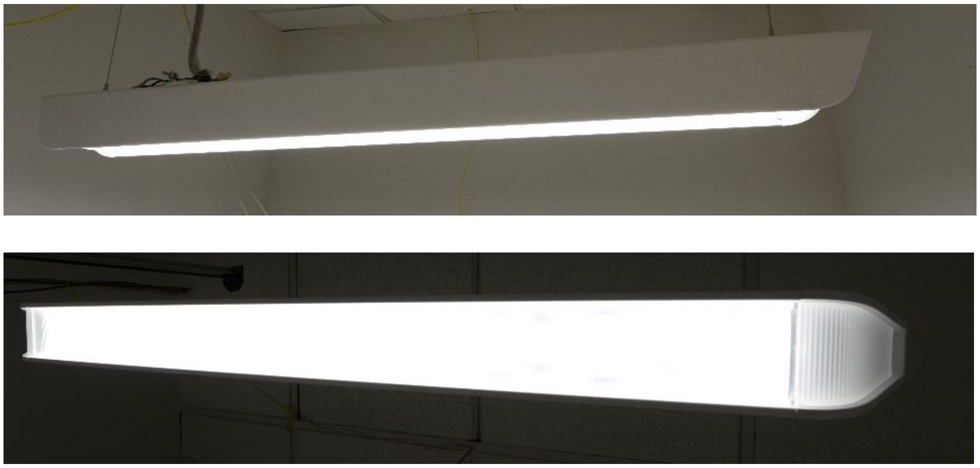


Figure 7-7 Direct Linear Pendant

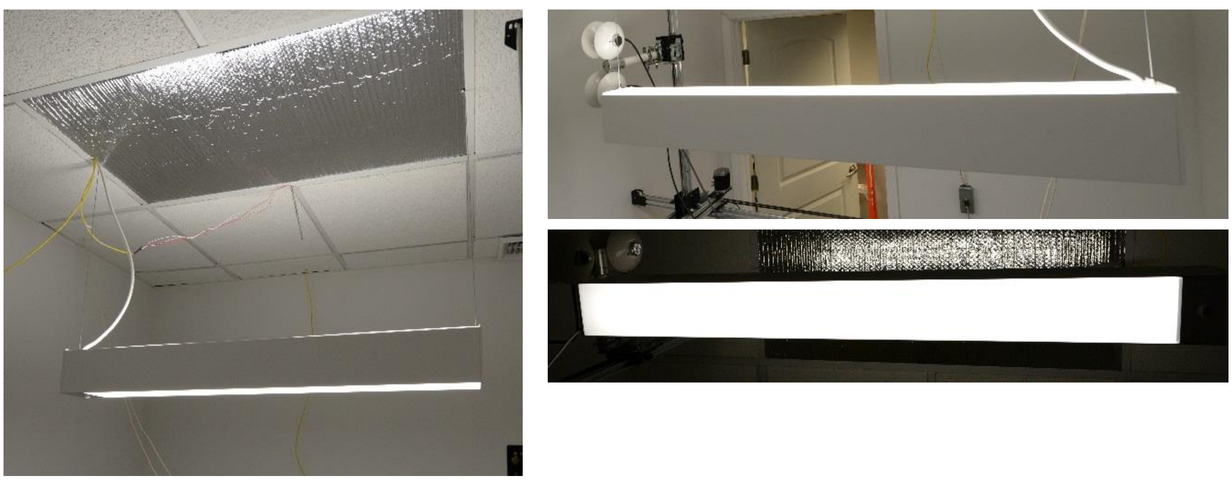


Figure 7-8 Indirect/Direct Linear Pendant

The test result of linear-pedant fixtures were summarized in Table 7.3. The result indicates that 55% to 61% of the total lighting power was converted into radiative energy. The longwave portion was larger than the shortwave portion especially for Direct/Indirect fixture which was 15% higher. This result was contradicted to high-bay fixtures since they were both suspended fixtures.

Table 7.3 Test Result Summary of Linear Pendant

| LED Fixture | **Linear Pendant Indirect/Direct** | **Linear Pendant Direct** |
|---|---|---|
| Number | 9 | 10 |
| Measured Lighting Power, W | 37.58 | 24.26 |
| Rated Efficacy, Lumen/W | 86 | 86 |
| **Radiative heat fraction over lighting power** | | |
| Long wave radiative heat fraction | 0.354±0.008 | 0.315±0.007 |
| Short wave radiative heat fraction | 0.193±0.004 | 0.290±0.006 |
| **Total Radiative heat fraction** | **0.547±0.012** | **0.605±0.013** |
| **Total Convective heat fraction** | **0.453±0.012** | **0.395±0.013** |
| Illuminance, Foot-Candle | 64.45 | 37.75 |

### 7.1.3 Recessed troffers

Six troffers were tested in this project and they were NO. 3, 4, 5, 6, 7, 8 listed in Table 1. There were three 2-ft ×4-ft troffers and three 2-ft ×2-ft troffers, and they had three different diffuser types, e.g. partial aperture diffuser, uniform diffuser and diffuser with linear details, see Figure 7.9 through Figure 7.11. Although the high efficacy troffer, color tuning troffer and retrofit kit troffer are also recessed troffer, they are discussed separately later due to their unique features.

Figure 7-9 2-ft×4-ft and 2-ft×2-ft Troffers with Partial Aperture Diffuser

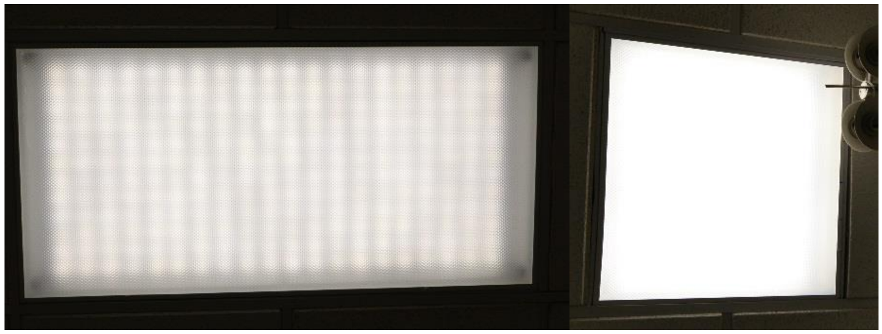


Figure 7-10 2-ft×4-ft and 2-ft×2-ft Troffers with Uniform Diffuser

Figure 7-11 2-ft×4-ft and 2-ft×2-ft Troffers with Linear Details Diffuser

The test results are summarized in Table 7.4. The result shows all six troffers had a conditioned space heat fraction larger than 40% which means more than 40% of the total lighting power was transferred into the conditioned space. With respect to the troffer size, the conditioned space heat fraction for -ft×4-ft troffer was larger than the 2-ft ×2-ft troffer. The diffuser with linear details troffer had a smallest conditioned space heat gain compared to the other two types.

For all troffers, more than 30% of total lighting power was converted into radiative heat energy and the majority was shortwave radiation. In terms of the troffer size, a larger sized troffer generated more radiative heat than a smaller sized troffer. When the conditioned space heat gain was only considered, more than 70% was radiation and almost 60% was shortwave. This result indicates the high efficacy of LED luminaires since the shortwave radiation is correlated to visible light.

Table 7.4 Test Result Summary of Recessed Troffers

| LED Fixture | **Troffer 2-×4 Partial Aperture Diffuser** | **Troffer 2×2 Partial Aperture Diffuser** | **Troffer 2-×4 Uniform Diffuser** | **Troffer 2×2 Uniform Diffuser** | **Troffer 2×4 Diffuser with Linear Details** | **Troffer 2×2 Diffuser with Linear Details** |
|---|---|---|---|---|---|---|
| Number | 3 | 4 | 5 | 6 | 7 | 8 |
| Measured Lighting Power, W | 38.64 | 31.88 | 40.85 | 27.18 | 56.70 | 59.63 |
| Rated Efficacy, Lumen/W | 120 | 108 | 95 | 94 | 105 | 88 |
| **Conditioned space fraction** | **0.525±0.014** | **0.473±0.015** | **0.495±0.022** | **0.476±0.015** | **0.451±0.012** | **0.425±0.013** |
| **Plenum space fraction** | **0.475±0.014** | **0.527±0.015** | **0.505±0.022** | **0.524±0.015** | **0.549±0.012** | **0.575±0.013** |
| **Radiative heat fraction over lighting power** | | | | | | |
| Long wave radiative heat fraction | 0.092±0.002 | 0.066±0.003 | 0.121±0.003 | 0.095±0.003 | 0.099±0.002 | 0.086±0.002 |
| Short wave radiative heat fraction | 0.319±0.007 | 0.267±0.007 | 0.292±0.006 | 0.260±0.007 | 0.280±0.006 | 0.217±0.005 |
| **Total Radiative heat fraction** | **0.412±0.009** | **0.333±0.010** | **0.413±0.008** | **0.356±0.009** | **0.379±0.008** | **0.303±0.007** |
| **Total Convective heat fraction** | **0.588±0.009** | **0.667±0.010** | **0.587±0.008** | **0.644±0.009** | **0.621±0.008** | **0.697±0.007** |
| **Radiative heat fraction over conditioned space heat gain** | | | | | | |
| Long wave radiative heat fraction | 0.176±0.002 | 0.140±0.003 | 0.245±0.003 | 0.200±0.003 | 0.219±0.002 | 0.202±0.002 |
| Short wave radiative heat fraction | 0.607±0.007 | 0.564±0.007 | 0.590±0.006 | 0.546±0.007 | 0.621±0.006 | 0.509±0.005 |
| **Total Radiative heat fraction** | **0.783±0.009** | **0.704±0.010** | **0.836±0.008** | **0.747±0.009** | **0.840±0.008** | **0.711±0.007** |
| **Total Convective heat fraction** | **0.217±0.009** | **0.296±0.010** | **0.164±0.008** | **0.253±0.009** | **0.160±0.008** | **0.289±0.007** |
| Illuminance, Foot-Candle | 78.87 | 59.07 | 78.06 | 46.134 | 104.5 | 83.64 |

### 7.1.4 Downlight

A popular size 6’ downlight (shown in Figure 7.12) was tested in this project.

Figure 7-12 The Downlight Below and Above Ceiling Tile

Table 7.5 summarizes the test results for downlight fixture. Although the downlight has a heat sink on the top, the conditioned space heat gain does not significantly differ from recessed troffers. The test results indicated 47% of the lighting power was transferred into the conditioned space. When considering the radiative energy, only 16% of the lighting power was converted into radiation and the longwave portion was so small it could be ignored.

Table 7.5 Test Result Summary of Downlight

| LED Fixture | **Downlight** |
|---|---|
| Number | 11 |
| Measured Lighting Power, W | 28.81 |
| Rated Efficacy, Lumen/W | 52 |
| **Conditioned space fraction** | **0.466±0.019** |
| **Plenum space fraction** | **0.534±0.019** |
| **Radiative heat fraction over lighting power** | |
| Long wave radiative heat fraction | 0.005±0.000 |
| Short wave radiative heat fraction | 0.154±0.003 |
| **Total Radiative heat fraction** | **0.159±0.003** |
| **Total Convective heat fraction** | **0.841±0.003** |
| **Radiative heat fraction over conditioned space heat gain** | |
| Long wave radiative heat fraction | 0.010±0.000 |
| Short wave radiative heat fraction | 0.331±0.003 |
| **Total Radiative heat fraction** | **0.341±0.003** |
| **Total Convective heat fraction** | **0.659±0.003** |
| Illuminance, Foot-Candle | 200.56 |

### 7.1.5 High efficacy troffer

A 150 lumen/W 2-ft×4-ft high efficacy troffer was tested as an example of an emerging technology, see Figure 7.13. Table 7.6 summarizes the test results and it indicates that the high efficacy troffer has the largest conditioned space fraction, shortwave radiative heat fraction and total radiative heat fraction. 59% of lighting power was transferred to the conditioned space and 51% lighting power was converted into radiative energy. A higher efficacy indicates the LED luminaires can transfer more energy into shortwave radiative heat which is visible light. The high efficacy troffer is the only fixture whose shortwave radiative heat is 40% of lighting power greater than longwave radiative heat.

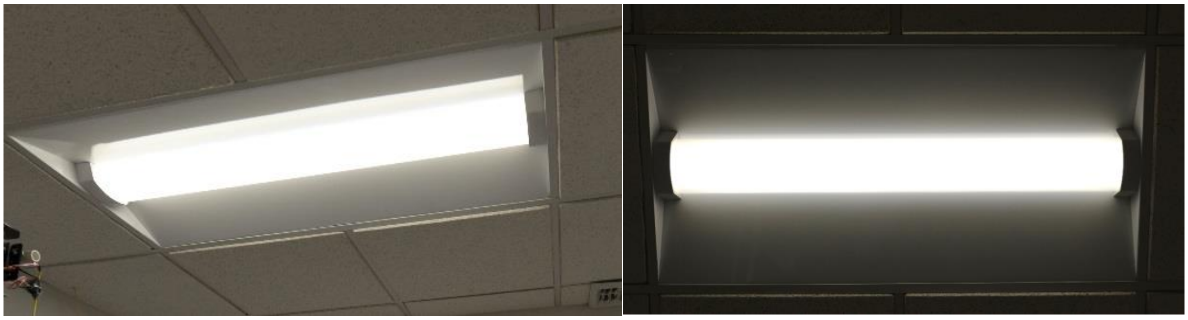


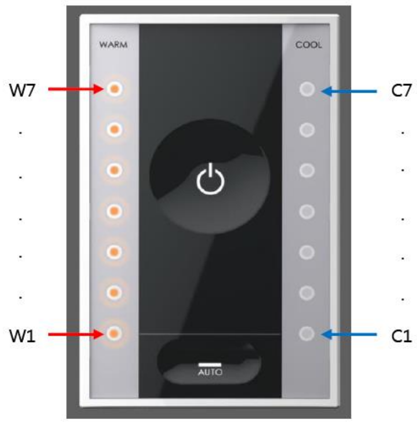
Figure 7-13 High Efficacy Troffer

Table 7.6 Test Result Summary of High Efficacy Troffer

| LED Fixture | **High Efficacy Troffer** |
|---|---|
| Number | 12 |
| Measured Lighting Power, W | 24.78 |
| Rated Efficacy, Lumen/W | 150 |
| **Conditioned space fraction** | **0.589±0.022** |
| **Plenum space fraction** | **0.411±0.022** |
| **Radiative heat fraction over lighting power** | |
| Long wave radiative heat fraction | 0.104±0.003 |
| Short wave radiative heat fraction | 0.405±0.009 |
| **Total Radiative heat fraction** | **0.509±0.012** |
| **Total Convective heat fraction** | **0.491±0.012** |
| **Radiative heat fraction over conditioned space heat gain** | |
| Long wave radiative heat fraction | 0.177±0.003 |
| Short wave radiative heat fraction | 0.688±0.009 |
| **Total Radiative heat fraction** | **0.865±0.012** |
| **Total Convective heat fraction** | **0.135±0.012** |
| Illuminance, Foot-Candle | 69.35 |

### 7.1.6 Color tuning troffer

In addition to the high efficacy troffer, a color tuning troffer was also tested as an emerging technology. The purpose of doing this was to check if color correlated temperature (CCT) affects the lighting heat gain distribution. This fixture is equipped with a control board which can adjust the color. There are 7 levels for each warm and cool colors so totally 49 color combination are available. Figure 7.14 shows the control board and the color combination. Figure 7.15 illustrates the lighting color under different CCT conditions.




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W7 | 3,123 | 3,244 | 3,433 | 3,682 | 3,932 | 4,112 | 4,285 |
| W6 | 3,130 | 3,276 | 3,500 | 3,783 | 4,068 | 4,268 | 4,453 |
| W5 | 3,144 | 3,329 | 3,606 | 3,939 | 4,253 | 4,471 | 4,664 |
| W4 | 3,184 | 3,448 | 3,831 | 4,249 | 4,600 | 4,825 | 5,022 |
| W3 | 3,269 | 3,694 | 4,240 | 4,720 | 5,086 | 5,291 | 5,456 |
| W2 | 3,490 | 4,208 | 4,876 | 5,353 | 5,648 | 5,795 | 5,907 |
| W1 | 4,219 | 5,258 | 5,760 | 6,017 | 6,142 | 6,201 | 6,244 |
| Touch level | C1 | C2 | C3 | C4 | C5 | C6 | C7 |

Figure 7-14 Color Tuning Touch Controller and CCT Combinations

6244 K (C7+W1) 4285 K (C7+W7) 3123 K (C1+W7)

Figure 7-15 Lighting Appearance under Different CCTs

Table 7.7 shows the lighting power and lumen at different CCT combination. Those data are from the manufacturer. In this project, the same lighting power and lumen output were controlled in order to perform the fair comparison. The color tuning troffer generates the same lighting power and lumen level at two different combinations whose CCT are 6244 K and 3213 K. The 6244 K and 3213 K were “cool” and “warm” colors, respectively.

Table 7.7 Lighting Power and Lumen Data at Different CCT Combinations

| Touch Fader 49Point Wattage (W) measure data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| W7 | 22.5 | 23.2 | 24.7 | 27.1 | 30.7 | 35 | 39.1 | 43 |
| W6 | 18.7 | 19.4 | 20.8 | 23.2 | 26.7 | 31 | 35 | 38.8 |
| W5 | 14.9 | 15.6 | 17 | 19.1 | 22.9 | 27.2 | 31.2 | 34.8 |
| W4 | 10.6 | 11.3 | 12.7 | 15.1 | 18.6 | 23 | 27 | 30.5 |
| W3 | 6.8 | 7.5 | 9.1 | 11.5 | 15.2 | 19.5 | 23.5 | 27 |
| W2 | 4 | 4.8 | 6.4 | 9.2 | 12.8 | 17.1 | 21.1 | 24.6 |
| W1 | 2.5 | 3.3 | 4.7 | 7.5 | 11.3 | 16 | 20 | 23 |
| W0 | 1.8 | 2.5 | 4.1 | 6.8 | 10.6 | 15 | 19 | 22.5 |
| | C0 | C1 | C2 | C3 | C4 | C5 | C6 | C7 |

| Touch Fader 49Point Lumen (lm) Measure Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| W7 | 2048 | 2111 | 2248 | 2466 | 2794 | 3185 | 3558 | 3913 |
| W6 | 1702 | 1765 | 1893 | 2111 | 2430 | 2821 | 3185 | 3531 |
| W5 | 1356 | 1420 | 1547 | 1738 | 2084 | 2475 | 2839 | 3167 |
| W4 | 965 | 1028 | 1156 | 1374 | 1693 | 2093 | 2457 | 2776 |
| W3 | 619 | 683 | 828 | 1047 | 1383 | 1775 | 2139 | 2457 |
| W2 | 364 | 437 | 582 | 837 | 1165 | 1556 | 1920 | 2239 |
| W1 | 228 | 300 | 428 | 683 | 1028 | 1456 | 1820 | 2093 |
| W0 | 164 | 228 | 373 | 619 | 965 | 1365 | 1729 | 2048 |
| | C0 | C1 | C2 | C3 | C4 | C5 | C6 | C7 |

Table 7.8 summarizes the test results. The cool CCT had a slight larger conditioned space heat gain than warm CCT. The cool CCT had a slightly smaller longwave heat fraction but larger shortwave heat fraction than warm CCT. When compared with 2-ft ×2-ft troffers, the color tuning troffer had a larger conditioned space heat gain.

Table 7.8 Test Result Summary of Color Tuning Troffer

| LED Fixture | **Color Tuning Troffer (Cool)** | **Color Tuning Troffer (Warm)** |
|---|---|---|
| Number | 13 | 13 |
| Measured Lighting Power, W | 23.84 | 23.43 |
| Rated Efficacy, Lumen/W | 89* | 89* |
| **Conditioned space fraction** | **0.562±0.022** | **0.5302±0.022** |
| **Plenum space fraction** | **0.438±0.022** | **0.4702±0.022** |
| **Radiative heat fraction over lighting power** | | |
| Long wave radiative heat fraction | 0.109±0.003 | 0.117±0.003 |
| Short wave radiative heat fraction | 0.312±0.007 | 0.287±0.007 |
| **Total Radiative heat fraction** | **0.421±0.010** | **0.405±0.010** |
| **Total Convective heat fraction** | **0.579±0.010** | **0.595±0.010** |
| **Radiative heat fraction over conditioned space heat gain** | | |
| Long wave radiative heat fraction | 0.195±0.003 | 0.221±0.003 |
| Short wave radiative heat fraction | 0.554±0.007 | 0.542±0.007 |
| **Total Radiative heat fraction** | **0.749±0.010** | **0.763±0.010** |
| **Total Convective heat fraction** | **0.251±0.010** | **0.237±0.010** |
| Illuminance, Foot-Candle | 46.44 | 43.44 |

*Note the 89 efficacy is based on 4285 K (W7+C7) CCT. The efficacies at other CCT levels are not available

### 7.1.7 Retrofit kit troffer

The retrofit kit LED fixture is considered an economical solution for upgrading traditional lighting to LED lighting. A 2-ft×4-ft traditional recessed troffer was disassembled for this project. The fluorescent lamps were removed from the fixture and the LED strips were installed inside. Figure 7.16 show both previous fixture and upgraded fixture.

Troffer with fluorescent lamps Troffer with LED retrofit kit

Figure 7-16 The 2-ft×4-ft Troffer for Retrofit Kit Testing

The test results are listed in Table 7.9. The results indicate that 43% of lighting heat gain was transferred to the conditioned space and 36% of total lighting power was radiation. Both the conditioned space heat gain and radiative heat gain were slightly smaller compared to 2-ft×4-ft troffer. The lower values were suspected because this upgrade troffer was not initially designed for LED lighting.

Table 7.9 Test Result Summary of Retrofit Kit

| LED Fixture | **Retrofit kit 2×4** |
|---|---|
| Number | 14 |
| Measured Lighting Power, W | 44.91 |
| Rated Efficacy, Lumen/W | 95 |
| **Conditioned space fraction** | **0.425±0.014** |
| **Plenum space fraction** | **0.575±0.014** |
| **Radiative heat fraction over lighting power** | |
| Long wave radiative heat fraction | 0.105±0.003 |
| Short wave radiative heat fraction | 0.251±0.006 |
| **Total Radiative heat fraction** | **0.356±0.009** |
| **Total Convective heat fraction** | **0.644±0.009** |
| **Radiative heat fraction over conditioned space heat gain** | |
| Long wave radiative heat fraction | 0.248±0.003 |
| Short wave radiative heat fraction | 0.591±0.006 |
| **Total Radiative heat fraction** | **0.839±0.009** |
| **Total Convective heat fraction** | **0.161±0.009** |
| Illuminance, Foot-Candle | 75.89 |

## 7.2 Variance Case Test

Four LEDs were tested to examine the effect of supply air temperature, supply airflow rate, duct configuration, floor finish and dimming output on LED lighting heat gains. These LEDs were listed in Table 1: a 2-ft x4-ft troffer with partial aperture diffuser (NO.3), a 2-ft x2-ft troffer with uniform diffuser (NO. 6), the downlight (NO.11) and the 2-ft×4-ft troffer retrofit kit (NO.14). All the test conditions are listed in Table 2. Figure 7.17 through Figure 7.24 shows the test results.

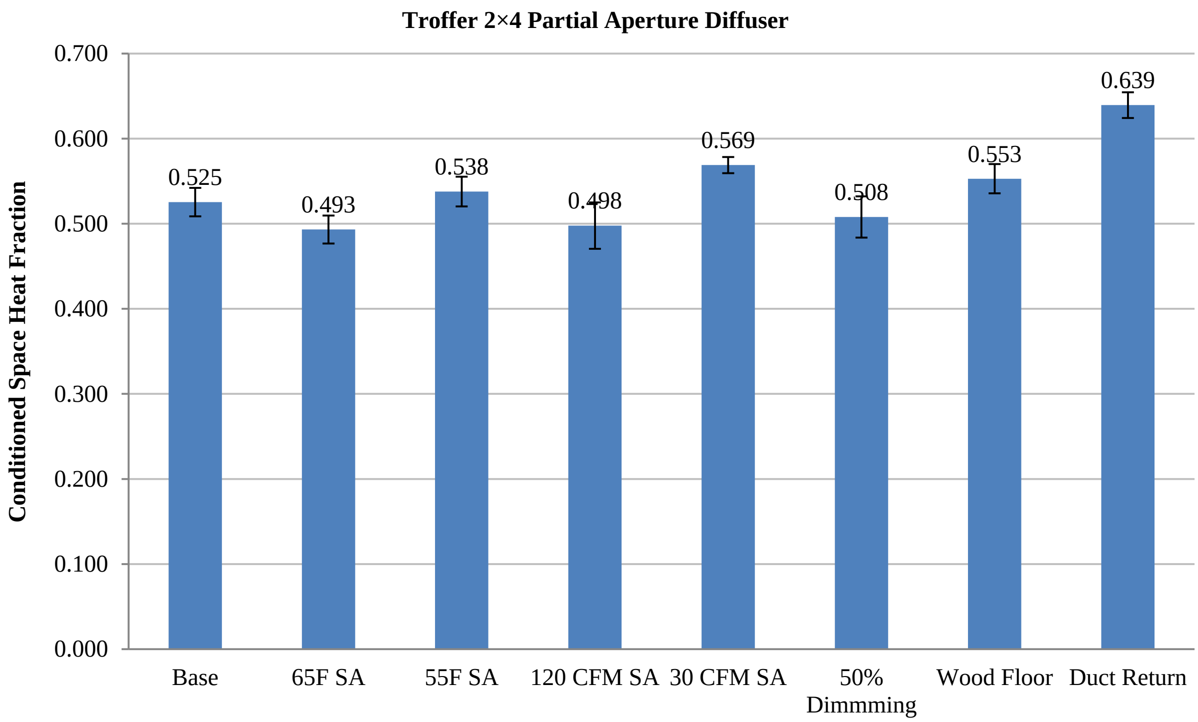



Figure 7-17 Conditioned Space Heat Fraction of 2-ft×4-ft Troffer with Partial Aperture Diffuser

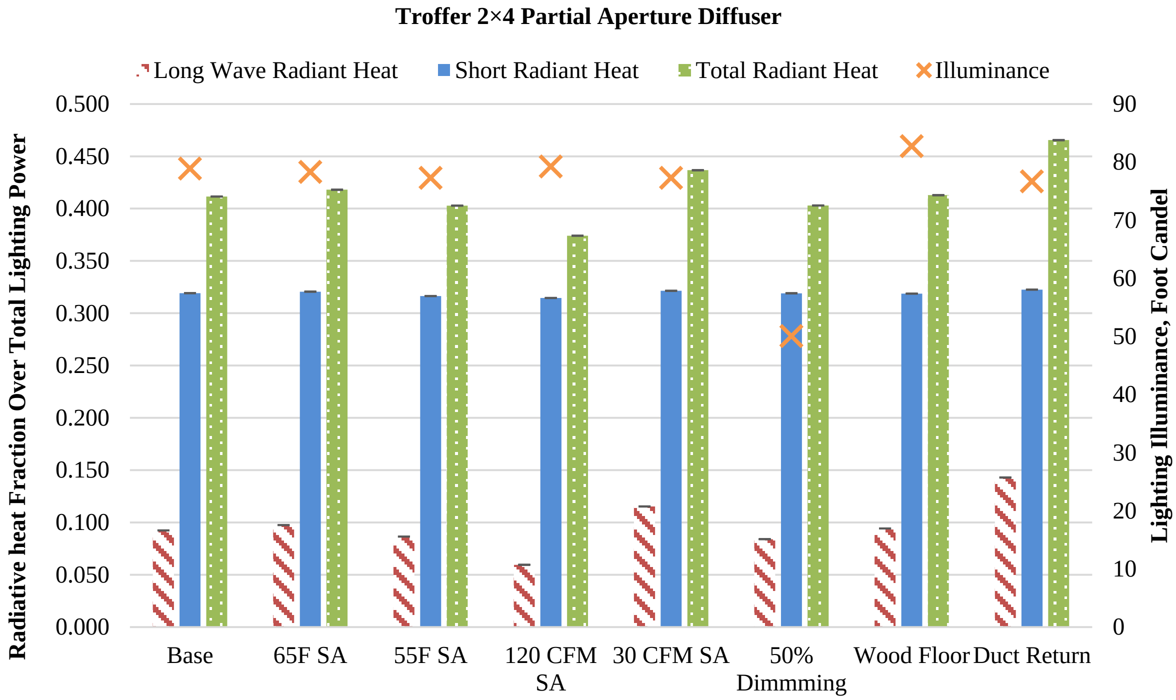



Figure 7-18 Radiative Heat Fraction of 2-ft×4-ft Troffer with Partial Aperture Diffuser

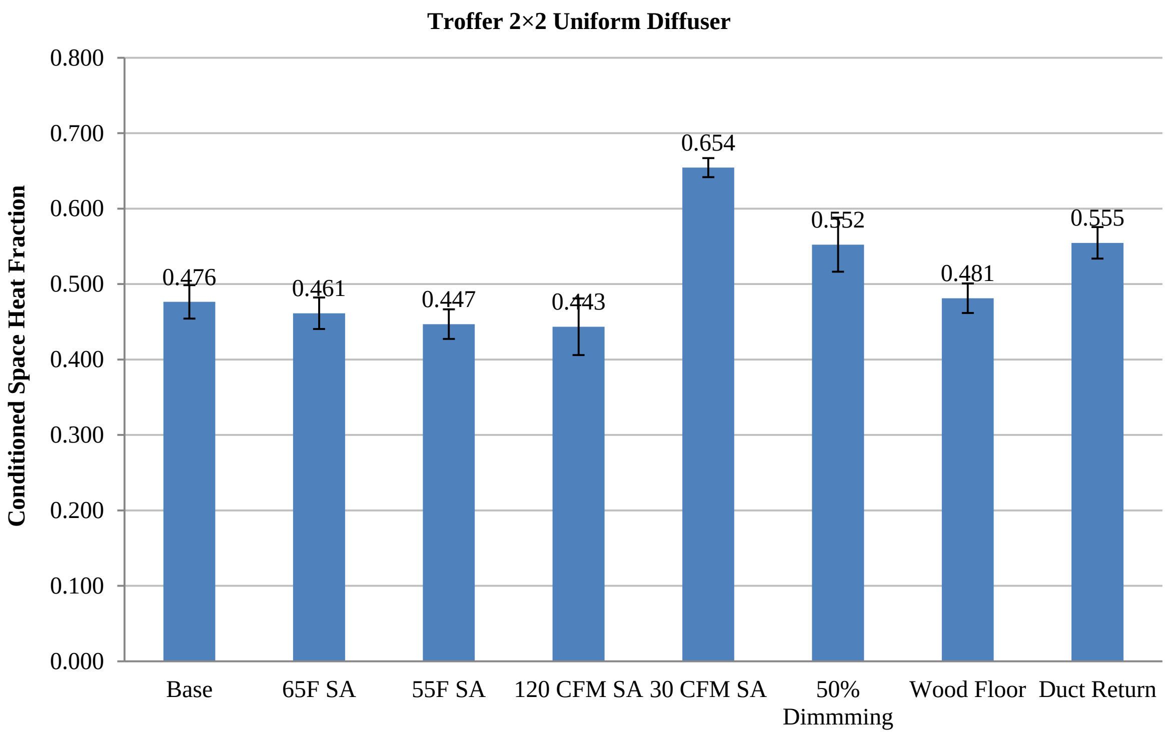



Figure 7-19 Conditioned Space Heat Fraction of 2-ft×2-ft Troffer with Uniform Diffuser

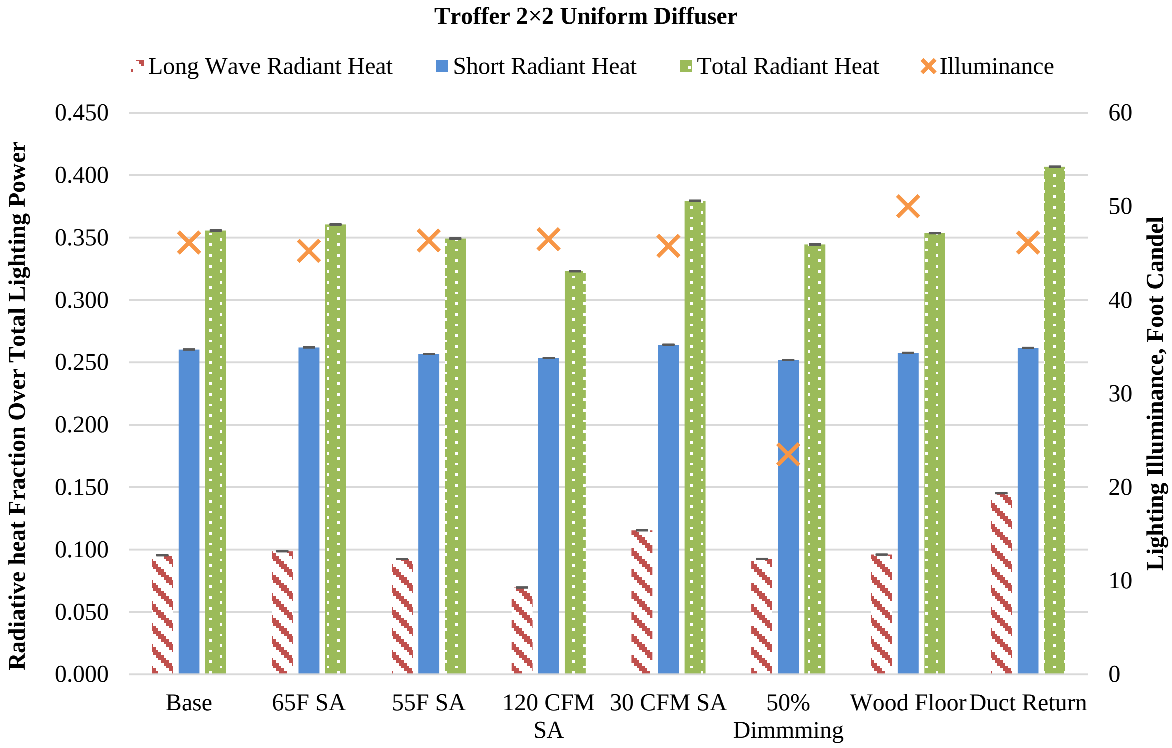



Figure 7-20 Radiative Heat Fraction of 2-ft×2-ft Troffer with Uniform diffuser

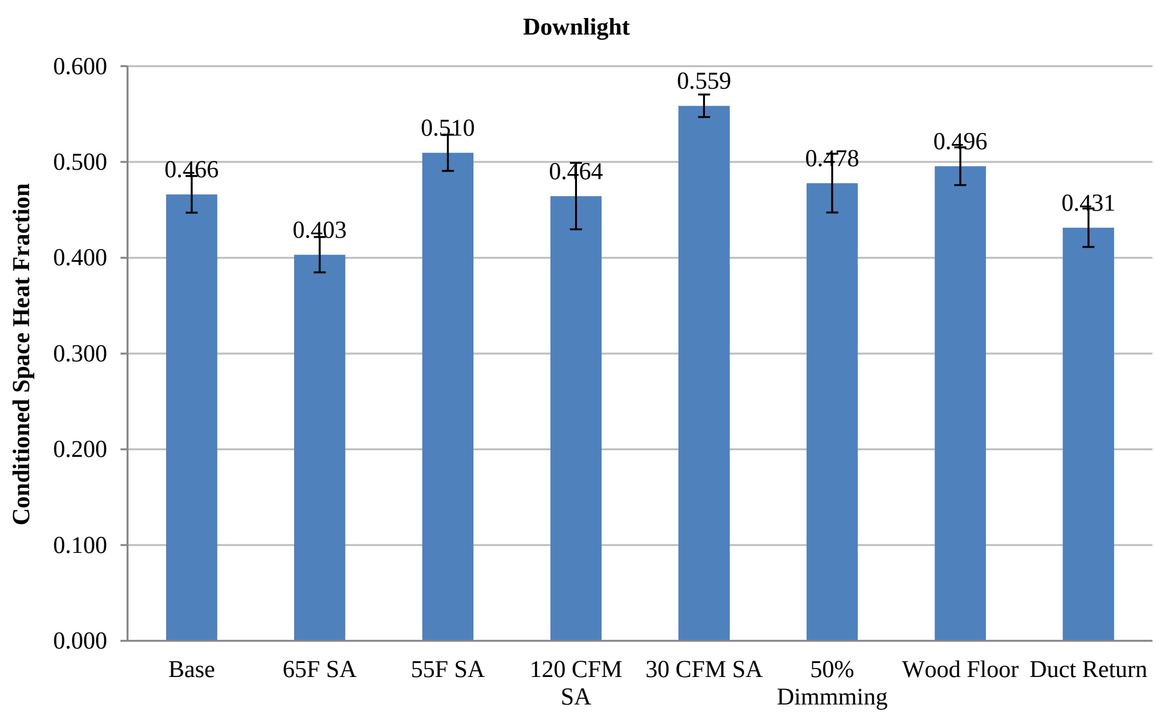



Figure 7-21 Conditioned Space Heat Fraction of Downlight

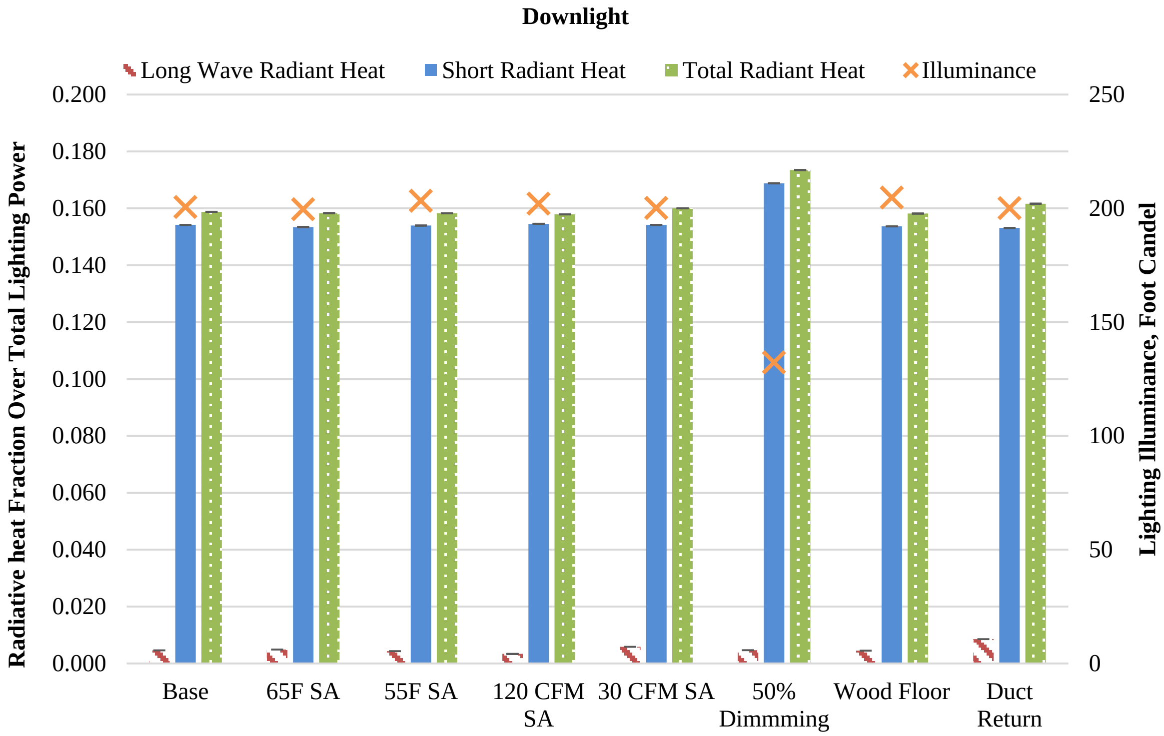



Figure 7-22 Radiative Heat Fraction of Downlight

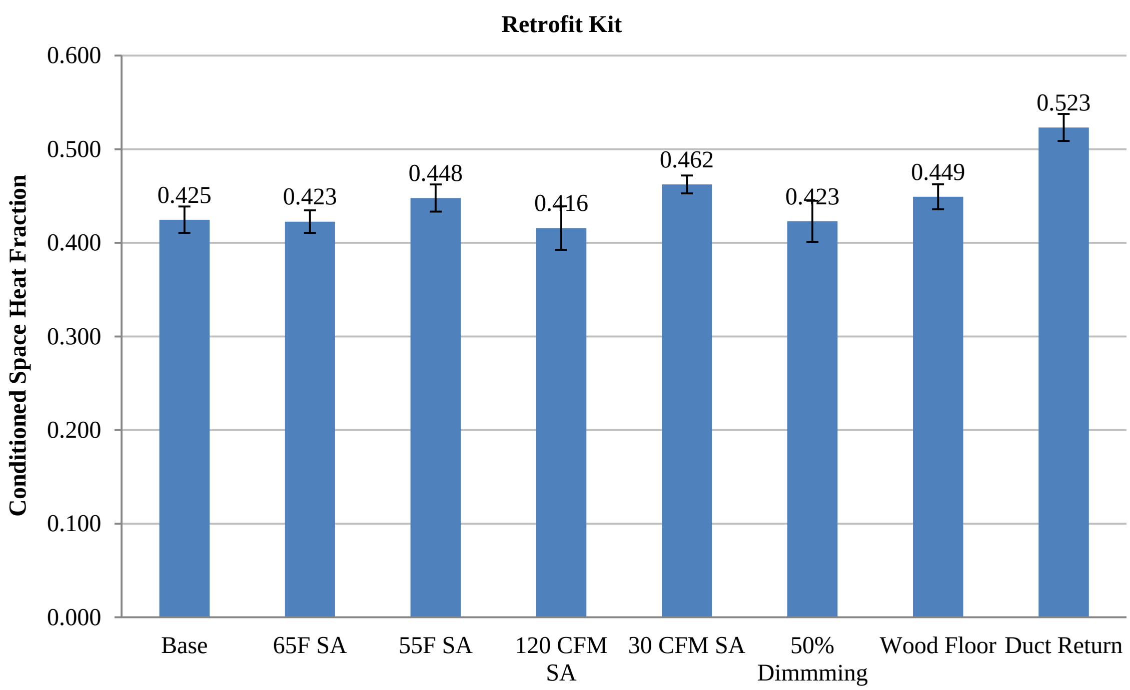



Figure 7-23 Conditioned Space Heat Fraction of Retrofit Kit

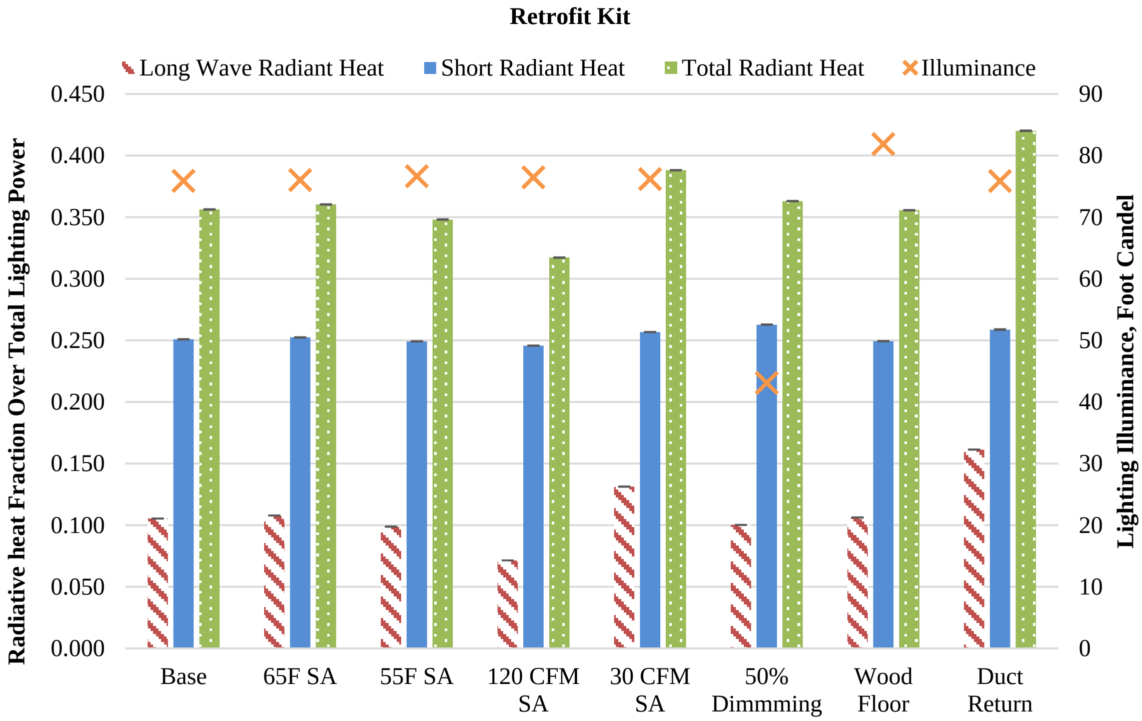



Figure 7-24 Radiative Heat Fraction of the Retrofit Kit

### 7.2.1 Effect of supply air temperature

The supply air temperature was changed from 65 °F to 60 °F and 55 °F. The test result is summarized in Table 7.10. For all luminaires excluding the 2-ft ×2-ft Uniform Diffuser troffer, increasing the supply air temperature tended to decrease the conditioned space fraction. The impact was most significant for downlight which reduced from 51% to 40%. However, the supply air temperature appears to have no significant impact on the 2-ft×4-ft troffer, the 2-ft×2-ft troffer and the retrofit kit troffer since the conditioned space fraction was within the margin of error. The results also show that changing the supply air temperature had no effect on the radiative heat gain for all fixtures.

Table 7.10 Test Result of Varied Supply Air Temperature

| Fixture | Supply Air Temperature | Conditioned Space/Plenum Split | | Radiative/Convective Split | | | Illuminance, foot-candle |
|---|---|---|---|---|---|---|---|
| | | Space | Plenum | Short wave | Long wave | Convective | |
| Troffer 2×4 Partial Aperture Diffuser | 55 °F | 0.538±0.017 | 0.462±0.017 | 0.316±0.007 | 0.086±0.002 | 0.597±0.009 | 77.273 |
| | 60 °F | 0.525±0.014 | 0.475±0.014 | 0.319±0.007 | 0.092±0.002 | 0.588±0.009 | 78.870 |
| | 65 °F | 0.493±0.016 | 0.503±0.016 | 0.321±0.007 | 0.097±0.002 | 0.582±0.009 | 78.300 |
| Troffer 2×2 Uniform Diffuser | 55 °F | 0.447±0.020 | 0.553±0.020 | 0.257±0.002 | 0.092±0.006 | 0.651±0.008 | 46.360 |
| | 60 °F | 0.476±0.022 | 0.524±0.022 | 0.260±0.002 | 0.095±0.006 | 0.644±0.008 | 46.134 |
| | 65 °F | 0.461±0.021 | 0.539±0.021 | 0.262±0.002 | 0.099±0.006 | 0.639±0.008 | 45.243 |
| Downlight | 55 °F | 0.510±0.019 | 0.490±0.019 | 0.154±0.003 | 0.004±0.000 | 0.842±0.003 | 203.290 |
| | 60 °F | 0.466±0.019 | 0.534±0.019 | 0.154±0.003 | 0.005±0.000 | 0.841±0.003 | 200.560 |
| | 65 °F | 0.403±0.018 | 0.597±0.018 | 0.153±0.003 | 0.005±0.000 | 0.842±0.003 | 199.590 |
| Retrofit kit 2×4 | 55 °F | 0.448±0.015 | 0.552±0.015 | 0.249±0.006 | 0.099±0.002 | 0.652±0.008 | 76.640 |
| | 60 °F | 0.425±0.014 | 0.575±0.014 | 0.251±0.006 | 0.105±0.002 | 0.644±0.008 | 75.890 |
| | 65 °F | 0.423±0.012 | 0.577±0.012 | 0.252±0.006 | 0.108±0.002 | 0.640±0.008 | 76.020 |

### 7.2.2 Effect of supply airflow rate

The supply airflow rate was changed from 30 cfm to 60 cfm and 120 cfm in this case. The test results are summarized in Table 7.11. For all luminaires, increasing the supply airflow rate tended to decrease the conditioned space heat fraction. The supply airflow rate test case showed a larger impact when compared with the supply air temperature variation case. The largest variation appeared on Troffer 2-ft×2-ft Uniform Diffuser which was 65% at 30 cfm and 44% at 120 cfm. Increasing the supply airflow rate also caused a deduction in longwave radiative heat fraction but the shortwave portion remained in the same level.

Table 7.11 Test Results of Varied Supply Airflow Rates

| Fixture | Supply Airflow Rate (cfm) | Conditioned Space/Plenum Split | | Radiative/Convective Split | | | Illuminance, foot-candle |
|---|---|---|---|---|---|---|---|
| | | Space | Plenum | Short wave | Long wave | Convective | |
| Troffer 2×4 Partial Aperture Diffuser | 30 | 0.569±0.010 | 0.431±0.010 | 0.321±0.007 | 0.115±0.003 | 0.563±0.010 | 77.273 |
| | 60 | 0.525±0.014 | 0.475±0.014 | 0.319±0.007 | 0.092±0.002 | 0.588±0.009 | 78.870 |
| | 120 | 0.498±0.027 | 0.502±0.027 | 0.315±0.008 | 0.059±0.001 | 0.626±0.009 | 79.250 |
| Troffer 2×2 Uniform Diffuser | 30 | 0.654±0.013 | 0.346±0.013 | 0.264±0.006 | 0.115±0.003 | 0.620±0.009 | 45.765 |
| | 60 | 0.476±0.022 | 0.524±0.022 | 0.260±0.002 | 0.095±0.006 | 0.644±0.008 | 46.134 |
| | 120 | 0.443±0.038 | 0.557±0.038 | 0.253±0.006 | 0.070±0.002 | 0.677±0.008 | 46.495 |
| Downlight | 30 | 0.559±0.012 | 0.441±0.012 | 0.154±0.003 | 0.006±0.000 | 0.840±0.003 | 200.140 |
| | 60 | 0.466±0.019 | 0.534±0.019 | 0.154±0.003 | 0.005±0.000 | 0.841±0.003 | 200.560 |
| | 120 | 0.464±0.035 | 0.536±0.035 | 0.155±0.003 | 0.003±0.000 | 0.842±0.003 | 202.040 |
| Retrofit kit 2×4 | 30 | 0.462±0.010 | 0.538±0.010 | 0.257±0.006 | 0.131±0.003 | 0.612±0.009 | 76.180 |
| | 60 | 0.425±0.014 | 0.575±0.014 | 0.251±0.006 | 0.105±0.002 | 0.644±0.008 | 75.890 |
| | 120 | 0.416±0.023 | 0.584±0.023 | 0.246±0.005 | 0.071±0.002 | 0.683±0.007 | 76.470 |

### 7.2.3 Effect of duct return configuration

A 6-ft flexible return duct was installed above the ceiling tiles as shown in Figure 7.25. The return air configuration was changed from plenum return to duct return in this case. The test results are summarized in Table 7.12. The test results indicate that the duct return configuration significantly increased the conditioned space fraction for the 2-ft×4-ft troffer, 2-ft ×2-ft troffer, and retrofit kit. Since the return air was not passing through the top of the lighting fixtures where the heat sink is located, the LEDs tended to dissipate more energy downward into the conditioned space. The result of downlight was inconsistent with other fixtures due to the small cross section area of heat sink.

The duct return configuration also increased the total radiative heat gain and most was longwave portion. It is suspected that as the rising temperature of LED chips, the LED lightings generated more heat into the ambient environment.

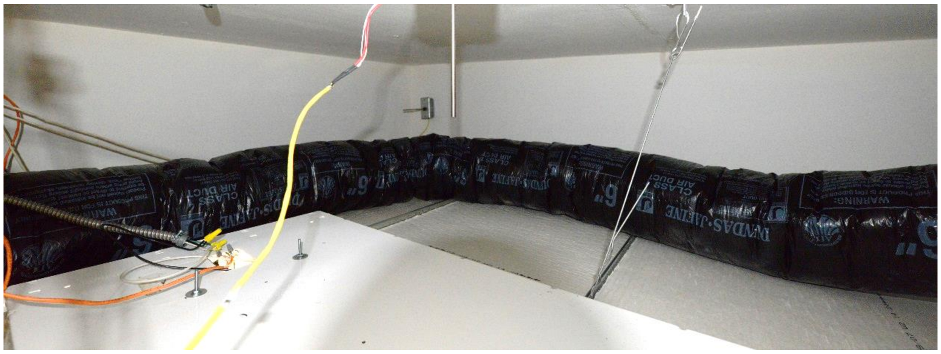


Figure 7-25 Duct Return Configuration

Table 7.12 Test Results of Varied Return Air Configurations

| Fixture | Return Air Configuration | Conditioned Space/Plenum Split | | Radiative/Convective Split | | | Illuminance, foot-candle |
|---|---|---|---|---|---|---|---|
| | | Space | Plenum | Short wave | Long wave | Convective | |
| Troffer 2×4 Partial Aperture Diffuser | Plenum Return | 0.525±0.014 | 0.475±0.014 | 0.319±0.007 | 0.092±0.002 | 0.588±0.009 | 78.870 |
| | Duct Return | 0.639±0.015 | 0.361±0.015 | 0.323±0.007 | 0.143±0.003 | 0.535±0.010 | 76.670 |
| Troffer 2×2 Uniform Diffuser | Plenum Return | 0.476±0.022 | 0.524±0.022 | 0.260±0.002 | 0.095±0.006 | 0.644±0.008 | 46.134 |
| | Duct Return | 0.555±0.021 | 0.445±0.021 | 0.262±0.006 | 0.145±0.004 | 0.593±0.010 | 46.138 |
| Downlight | Plenum Return | 0.466±0.019 | 0.534±0.019 | 0.154±0.003 | 0.005±0.000 | 0.841±0.003 | 200.560 |
| | Duct Return | 0.431±0.020 | 0.569±0.020 | 0.153±0.003 | 0.009±0.000 | 0.838±0.003 | 200.100 |
| Retrofit kit 2×4 | Plenum Return | 0.425±0.014 | 0.575±0.014 | 0.251±0.006 | 0.105±0.002 | 0.644±0.008 | 75.890 |
| | Duct Return | 0.523±0.014 | 0.4770.014 | 0.259±0.006 | 0.161±0.002 | 0.580±0.008 | 75.860 |

### 7.2.4 Effect of floor finish

Different surface materials may differ the radiative heat gain due to differences in absorptivity, emissivity and reflectivity. In this test, two floor finishes was proposed: wood floor and carpet floor shown in Figure 7.26.

Figure 7-26 Wood and Carpet Floor Finish

The test results are summarized in Table 7.13. For all the luminaires, changing the floor finish from carpet to wood slightly increased the conditioned space heat fraction. However, all the space fraction was within the margin of error, so that this increase could be considered insignificant.  Changing floor finish did not show significant change in both longwave and shortwave radiative heat, e.g. they were both remained in the same level.

Table 7.13 Test Results of Varied Floor Finish

| Fixture | Floor Finish | Conditioned Space/Plenum Split | | Radiative/Convective Split | | | Illuminance, foot-candle |
|---|---|---|---|---|---|---|---|
| | | Space | Plenum | Short wave | Long wave | Convective | |
| Troffer 2×4 Partial Aperture Diffuser | Carpet | 0.525±0.014 | 0.475±0.014 | 0.319±0.007 | 0.092±0.002 | 0.588±0.009 | 78.870 |
| | Wood | 0.553±0.017 | 0.447±0.017 | 0.319±0.007 | 0.094±0.002 | 0.587±0.009 | 82.730 |
| Troffer 2×2 Uniform Diffuser | Carpet | 0.476±0.022 | 0.524±0.022 | 0.260±0.002 | 0.095±0.006 | 0.644±0.008 | 46.134 |
| | Wood | 0.481±0.020 | 0.519±0.020 | 0.258±0.002 | 0.096±0.006 | 0.646±0.008 | 50.014 |
| Downlight | Carpet | 0.466±0.019 | 0.534±0.019 | 0.154±0.003 | 0.005±0.000 | 0.841±0.003 | 200.560 |
| | Wood | 0.496±0.020 | 0.504±0.020 | 0.154±0.003 | 0.004±0.000 | 0.842±0.003 | 204.710 |
| Retrofit kit 2×4 | Carpet | 0.425±0.014 | 0.575±0.014 | 0.251±0.006 | 0.105±0.002 | 0.644±0.008 | 75.890 |
| | Wood | 0.449±0.013 | 0.551±0.013 | 0.249±0.006 | 0.106±0.002 | 0.644±0.008 | 81.870 |

### 7.2.5 Effect of dimming control

Since most LED lights are capable of dimming control, this test case was to determine the lighting heat gain at different dimming output. The dimming control signal for the LED is typically a 0-10VDC type where 10 VDC corresponds with the maximum lighting output (no dimming) and 0 VDC as minimum lighting output. A 50% dimming level corresponding to a control voltage equal to 5 VDC was tested in this case in comparison to the no-dimming level implemented in the base case.

The test results are summarized in Table 7.14. The results indicate that the dimming output has no significant impact on the conditioned space fraction for the 2-ft×4-ft troffer, the downlight and the retrofit kit troffer since they were all within the margin of error. However, for the 2-ft×2-ft troffer, the conditioned space heat gain increased when the dimming signal decreased.

Although the visible light is a part of radiative heat, 5V dimming control did not show any significant changes on radiative heat fractions since the lighting power also decreased.

Table 7.14 Test Results of Varied Dimming Outputs

| Fixture | Dimming Output | Measured Lighting Power, Watt | Conditioned Space/Plenum Split | | Radiative/Convective Split | | | Illuminance, foot-candle |
|---|---|---|---|---|---|---|---|---|
| | | | Space | Plenum | Short wave | Long wave | Convective | |
| Troffer 2×4 Partial Aperture Diffuser | 10V | 38.64 | 0.525±0.014 | 0.475±0.014 | 0.319±0.007 | 0.092±0.002 | 0.588±0.009 | 78.870 |
| | 5V | 24.31 | 0.508±0.024 | 0.492±0.024 | 0.319±0.007 | 0.084±0.002 | 0.597±0.009 | 50.064 |
| Troffer 2×2 Uniform Diffuser | 10V | 27.18 | 0.476±0.022 | 0.524±0.022 | 0.260±0.006 | 0.095±0.002 | 0.644±0.008 | 46.134 |
| | 5V | 14.23 | 0.552±0.036 | 0.448±0.036 | 0.252±0.006 | 0.093±0.002 | 0.656±0.008 | 23.496 |
| Downlight | 10V | 28.81 | 0.466±0.019 | 0.534±0.019 | 0.154±0.003 | 0.005±0.000 | 0.841±0.003 | 200.560 |
| | 5V | 16.79 | 0.478±0.031 | 0.522±0.031 | 0.169±0.004 | 0.005±0.000 | 0.827±0.004 | 132.250 |
| Retrofit kit 2×4 | 10V | 44.91 | 0.425±0.014 | 0.575±0.014 | 0.251±0.006 | 0.105±0.002 | 0.644±0.008 | 75.890 |
| | 5V | 24.00 | 0.423±0.022 | 0.577±0.022 | 0.263±0.006 | 0.100±0.002 | 0.637±0.008 | 43.100 |

# CHAPTER 8. CONCLUSIONS

Fourteen LED lighting luminaires were selected and tested in this project to determine the heat split between conditioned space and plenum space as well as the heat split between convective and radiative heat. During the test, all fourteen luminaires were tested under base-case test condition. Furthermore, four selected LED luminaires were tested under variances-case test.

The base-case test results showed all the recessed LED luminaires excluding the emerging technology had a conditioned space heat gain ranging from 43% to 53% over the total lighting power. The conditioned space heat gain fraction for high efficacy troffer and color tuning troffer were 59% and 56% (cool), 53% (warm) respectively. All the recessed troffers showed a total radiative heat fraction ranging from 30% to 41% except for the downlight and high efficacy troffer which were 15% and 52% respectively. The high efficacy troffer had a largest shortwave heat gain. It was discovered the shortwave radiation was highly correlated to the lighting efficacy. For the suspended luminaires, the high-bay converted 42% to 51% of total lighting power into radiative heat while linear-pedant was ranged from 55% to 61%. Overall the linear-pedant generated more radiative heat than high-bay.

The variances-case test was to examine the effect of supply air temperature, supply airflow rate, duct configuration, floor finish and dimming output on LED lighting heat gains. The results showed the supply air flowrate and return air configuration had the most significant impact on conditioned space heat fraction. Increasing the supply airflow rate tended to decrease conditioned space heat gain. Changing from plenum return to duct return also decreased the conditioned space fraction except for downlight. Effect of floor finish and dimming output had no significant impact on conditioned space heat fraction. As for radiative heat fraction, increasing the supply airflow rate and changing from plenum return to duct return tended to increase the longwave radiative heat fraction. Supply air temperature, dimming output and floor finish showed insignificant impact on radiative heat gain fraction.

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# APPENDIX A: SPECIFICATIONS OF LUMINAIRES BEING TESTED

## A1. Cree High-Bay CXB

Iowa Energy Center

### CXB Series
LED Low-Bay/High-Bay Luminaire

#### Product Description

The CXB Series LED Low-Bay/High-Bay luminaire delivers 18,000 median and 24,000 median lumens with illumination performance to allow one-for-one replacement of 250W and 400W HID luminaires and multi-lamp fluorescent low-bay and high-bay fixtures. With exceptional rated lifetimes, zero restrike time and a compact lightweight construction, the CXB Series is a direct replacement for incumbent HID and fluorescent light sources that provides additional benefits of energy savings and significantly reduced relamp maintenance costs. The CXB Series is offered with reflector choices of aluminum, clear and white acrylic with optional bottom lenses — making it ideal for a variety of applications.

**Applications:** Grocery, gymnasium, industrial, retail and warehouse spaces

#### Performance Summary

**Delivered Light Output:** 18,000 or 24,000 median lumens

**Input Power:** 160 or 240 watts

**CRI:** 80

**CCT:** 4000K (+/- 300K), 5000K (+/- 500K)

**Input Voltage:** 120-277 VAC, 347-480 VAC

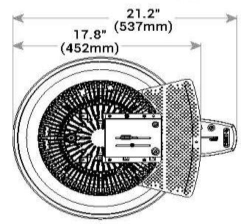
**Limited Warranty†:** 10 years on luminaire

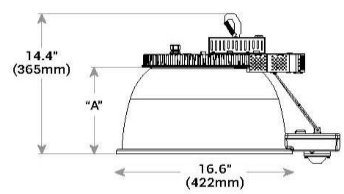
**Mounting:** J-Box, pendant, hook, cord & plug

**Weight:** Maximum 14 lbs (6.4kg)

**Dimming:** 0-10V standard

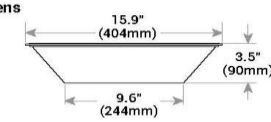
**Aluminum Reflector w/Hook & Cord Mount with ML Option**



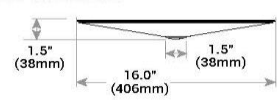




| Reflector | "A" Height |
|---|---|
| CXBA16N (Aluminum) | 9.0" (229mm) |
| CXBP16 (Clear Prismatic) | 9.7" (246mm) |
| CXBW16 (White Acrylic) | 9.7" (246mm) |

**Drop Lens**




**Clear Conical Lens**




#### Accessories

| Reflector | |
|---|---|
| **Wire Guards**<br>WG-A<br>- 16" (406mm) Wire Guard for Aluminum Reflector<br>WG-AP<br>- 16" (406mm) Wire Guard for Acrylic Reflector | **Lenses**<br>DL16<br>- 16" (406mm) Acrylic Clear Prismatic Drop Lens for Acrylic Reflector<br>CL16<br>- 16" (406mm) Acrylic Clear Conical Bottom Lens for Acrylic Reflector |
| **Light Engine** | |
| **Galvanized Safety Cables**<br>SC-5<br>- 5.0' (1.5m) Cable | SC-10<br>- 10.0' (3.0m) Cable |

#### Ordering Information

Fully assembled luminaire is composed of two components that must be ordered separately:
Example: **Reflector:** CXBA16N + **Light Engine:** CXB A HC H 40K 8-UL 10V L715P

| Reflector (Light Engine must be ordered separately) | |
|---|---|
| CXBA16N | |
| **CXBA16N**<br>16" (406mm) Aluminum<br>**CXBP16**<br>- 16" (406mm) Clear Acrylic | **CXBW16**<br>- 16" (406mm) White Acrylic |

| Light Engine (Reflector must be ordered separately) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CXB | A | HC | M | 50K | 8 | – | UL | 10V | 515P | |
| **Product** | **Version** | **Mounting** | **Lumen Output** | **Color Temp** | **CRI** | **–** | **Voltage** | **Controls** | **Factory-Installed Plug (HC Mount Only)** | |
| **CXB** | **A** | **HC**<br>Hook & Cord<br>**JP**<br>J-Box or Pendant | **M**<br>160W, 18,000 Median Lumens, 113 LPW<br>**H**<br>240W, 24,000 Median Lumens, 100 LPW | **40K**<br>4000K<br>**50K**<br>5000K | **8**<br>80 CRI | – | **UL**<br>120-277V<br>**UH**‡<br>347-480V | **10V**<br>0-10V Dimming<br>**ML**‡<br>Multi-Level | **515P**<br>15 amp 120V Straight Blade Plug<br>**L515P**<br>15 amp 120V Twist Lock Plug<br>**L615P**<br>15 amp 240V Twist Lock Plug | **L715P**<br>15 amp 277V Twist Lock Plug<br>**L2420P**<br>20 amp 347V Twist Lock Plug<br>**L820P**<br>20 amp 480V Twist Lock Plug |

† See www.cree.com/lighting/products/warranty for warranty terms
‡ UH voltage available October 2014; ML for UH voltage available December 2014

Rev. Date: V1 09/25/2014

US: www.cree.com/lighting T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

## Product Specifications

### CONSTRUCTION & MATERIALS

- Die cast aluminum heatsink
- Low-profile, lightweight design provides ease of installation
- Mounting choices of direct J-Box/pendant and hook, cord & plug
- JP Mount mounts directly over existing 4" (102mm) single gang square, rectangular and octagonal junction boxes for direct mount
- JP Mount has provision to accept ¾ IP pendant (by others)
- HC Mount is provided with spring lock hook for mounting and factory installed 6' (1.8m) 16/3 AWG power cord and plug
- Factory calibrated to hang straight

### OPTICAL SYSTEM

- 16" (406mm) Anodized Matte Aluminum reflector
- 16" (406mm) Clear Acrylic reflector
- 16" (406mm) White Acrylic reflector
- LED system delivers proper uniformity & spacing

### ELECTRICAL SYSTEM

- Integral, high-efficiency driver and power supply
- **Input Voltage:** 120–277V or 347–480V 50/60Hz
- **Power Factor:** > 0.9
- **Total Harmonic Distortion:** <20%
- **Temperature rating:** Designed to operate in temperatures 0°C–50°C (18,000 median lumen package); 0°C–40°C (24,000 median lumen package)

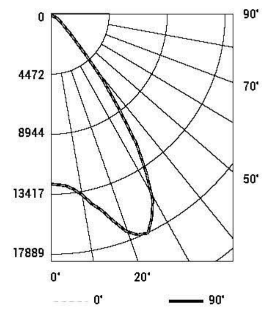
### REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus listed
- Suitable for damp locations
- DLC qualified. Please refer to http://www.designlights.org/QPL for most current information
- IP54 rated driver
- IP65 rated LED optics

## Photometry

**CXBP16/CXBA**H40K8 BASED ON CESTL REPORT TEST #: PL04029-001**

Fixture photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. IESNA LM-79-08 specifies the entire luminaire as the source resulting in a fixture efficiency of 100%.




| Coefficients Of Utilization - Zonal Cavity Method | | | | |
|---|---|---|---|---|
| RC %: | 80 | | | |
| RW %: | 70 | 50 | 30 | 10 |
| RCR: 0 | 119 | 119 | 119 | 119 |
| 1 | 112 | 109 | 106 | 103 |
| 2 | 105 | 100 | 95 | 91 |
| 3 | 99 | 91 | 86 | 81 |
| 4 | 93 | 84 | 78 | 73 |
| 5 | 87 | 77 | 71 | 66 |
| 6 | 82 | 72 | 65 | 60 |
| 7 | 77 | 66 | 59 | 55 |
| 8 | 73 | 62 | 55 | 50 |
| 9 | 68 | 57 | 51 | 46 |
| 10 | 65 | 54 | 47 | 43 |

Effective Floor Cavity Reflectance: 20%

**Average Luminance Table (cd/m²)**

| Vertical Angle | Horizontal Angle | | |
|---|---|---|---|
| | 0° | 45° | 90° |
| 45° | 20315 | 20315 | 20315 |
| 55° | 6999 | 6999 | 6999 |
| 65° | 4486 | 4486 | 4486 |
| 75° | 2346 | 2346 | 2346 |
| 85° | 660 | 660 | 660 |

**Zonal Lumen Summary**

| Zone | Lumens | % Lamp | Luminaire |
|---|---|---|---|
| 0-30 | 13590.3 | N/A | 54.7% |
| 0-40 | 20547.3 | N/A | 82.7% |
| 0-60 | 23667.5 | N/A | 95.3% |
| 0-90 | 24552.8 | N/A | 98.8% |
| 0-180 | 24842.2 | N/A | 100% |

Reference www.cree.com/lighting for detailed photometric data

**Reflector Uplight Illumination Performance**

| Reflector | % of Uplight |
|---|---|
| CXBA16N (Aluminum) | 0% |
| CXBP16 (Clear Acrylic) | 1% |
| CXBP16 + CL16 (Clear Acrylic w/ Conical Bottom Lens) | 5% |
| CXBP16 + DL16 (Clear Acrylic w/ Drop Bottom Lens) | 6% |
| CXBW16 (White Acrylic) | 16% |
| CXBW16 + CL16 (White Acrylic w/ Conical Bottom Lens) | 20% |
| CXBW16 + DL16 (White Acrylic w/ Drop Bottom Lens) | 19% |

**CXB Series Lumen Maintenance[1]**

| Ambient | Initial LMF | 25K hr Projected[2] LMF | 50K hr Projected[2] LMF | 75K hr Calculated[3] LMF | 100K hr Calculated[3] LMF |
|---|---|---|---|---|---|
| 0°C (32°F) | 1.05 | 0.98 | 0.93 | 0.88 | 0.83 |
| 5°C (41°F) | 1.04 | 0.97 | 0.92 | 0.87 | 0.82 |
| 10°C (50°F) | 1.03 | 0.96 | 0.91 | 0.86 | 0.81 |
| 15°C (59°F) | 1.02 | 0.95 | 0.90 | 0.85 | 0.81 |
| 20°C (68°F) | 1.01 | 0.95 | 0.89 | 0.84 | 0.80 |
| 25°C (77°F) | 1.00 | 0.94 | 0.88 | 0.84 | 0.79 |
| 30°C (86°F) | 0.99 | 0.93 | 0.88 | 0.83 | 0.78 |
| 35°C (95°F) | 0.98 | 0.92 | 0.87 | 0.82 | 0.77 |
| 40°C (104°F) | 0.97 | 0.91 | 0.86 | 0.81 | 0.77 |
| 45°C (113°F) | 0.96 | 0.90 | 0.85 | 0.80 | 0.76 |
| 50°C (122°F) | 0.95 | 0.89 | 0.84 | 0.79 | 0.75 |

[1] Lumen maintenance values at 25°C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip)

## A2. Columbia High-Bay LLHP

Columbia LIGHTING

# LLHP

**2' or 3' LED Premium High Bay**

2' High Lumen shown

PROJECT INFORMATION

Project Name

Catalog No.

Type

Date

### FEATURES

- Highly efficient LEDs provide up to 101 lumens per watt at 70 CRI
- Long-life, 60,000 hour LEDs at L90 reduce life cycle maintenance costs
- 2' size provides nominal lumen packages from 12,000 to 27,000
- 3' size provides nominal lumen packages from 37,850 to 42,100
- Three distribution selections: aisle, medium, and wide
- Operates in ambient temperatures from 55°C/131°F down to –40°C/–40°F (0°C/32°F with Occupancy Sensor)
- DesignLights Consortium® (DLC) qualified in 2' size; 3' size pending
- Individual optics for each LED allow for precise control of light distribution
- Extruded aluminum housing acts as heat sink; downward sloping fins minimize debris buildup
- Fixed output or 0-10V dimming available
- Available with 480V or 347V dedicated driver
- Product designed for quick and easy suspension mounting with aircraft cabling
- CSA listed and suitable for damp locations
- Meets the most restrictive lighting power density codes
- Available with exclusive wiHUBB technology preinstalled

### CONSTRUCTION

The LLHP design is based on a one-piece aluminum extrusion that serves as heat sink for the LEDs. Wireway and end caps are heavy gauge, corrosion-resistant galvanneal steel. The top mounted wireway is spaced off the heat sink allowing air flow to carry away heat. Dual 7/8" KOs are located on the top of the wireway. The aluminum fin design creates heat-sink surface area. Downward sloping fins minimize debris buildup.

### OPTICS

LLHP uses individual specialized optics for each LED designed to provide precise control of light from the point source to the work plane. Three distribution choices—narrow, medium, or wide—ensure that each LED operates optimally and distributes the light where it's needed, whether for aisles or open areas.

### FINISH

The housing, wireway, and end caps are standard in matte grey polyester powder coat paint after fabrication applied with a five-stage adhesion process for maximum durability.

### INSTALLATION

The wireway is fitted with two top mounted and two end mounted 7/8" KOs for ease of electrical access. The fixture is fitted with four mounting holes designed for suspension mounting options such as aircraft cabling. Customer supplied mounting hardware must be load rated at 100lbs. per point.

### CERTIFICATION

All luminaires are built to UL 1598 and 2108 standards,and bear appropriate CSA labels. Damp location labeling is standard. DesignLights Consortium® (DLC) qualified in 2' size; 3' size pending. Please refer to the DLC website for specific product qualifications at www.designlights.org.

### WARRANTY

Five year warranty (Terms and Conditions apply).

### ORDERING INFORMATION

EXAMPLE LLHP2-50L-A-EU

LLHP 2 – 50 L – M – ED U –

**MODEL**

| | |
|---|---|
| LLHP | LED Linear High Bay |

**SIZE**

| | |
|---|---|
| 2 | 2' |
| 3 | 3' |

**COLOR TEMP**

| | |
|---|---|
| 30 | 3000K |
| 40 | 4000K |
| 50 | 5000K |

**LUMEN OUTPUT**

| | |
|---|---|
| L | Low Lumen (2'size) |
| H | High Lumen (2'size) |
| VL | Very High Lumen (3'size) |

**DISTRIBUTION**

| | |
|---|---|
| A | Aisle |
| M | Medium |
| W | Wide |

**DRIVER**

| | |
|---|---|
| E | Fixed Output |
| ED | 0-10V Dimming |

**VOLTAGE**

| | |
|---|---|
| U | 120V-277V |
| 120 | 120V |
| 277 | 277V |
| 347 | 347V |
| 480 | 480V |

**OPTIONS**

| | |
|---|---|
| F3C5 | 3-Conductor Cord 5' |
| F3C10 | 3-Conductor Cord 10' |
| F3C15 | 3-Conductor Cord 15' |
| C6TL15 | 6' Cord and Twist-Lock Plug 15A (Add Volt 1=120, 2=277) |
| CP6TL20 | 6' Cord and Twist-Lock Plug 20A (Add Volt 1=120, 2=277) |
| WIH | wiHUBB Enabled[1] |
| WG | Wire Guard (factory installed) |
| OS1 | Occupancy Sensor 120-277 Single Relay |
| LG2EM | Prewired for Dual-Lite LightGear® Inverter, 250 VA/ Watts (purchase separately)[2,3] |

**ACCESSORIES (ORDER SEPARATELY)**

| | |
|---|---|
| CP6TL15 | 6' Cord and Twist-Lock Plug 15A (Add Volt 1=120, 2=277) |
| CP6TL20 | 6' Cord and Twist-Lock Plug 20A (Add Volt 1=120, 2=277) |
| LHVQM5 | Aircraft Cable 5' Pair |
| LHVQM10 | Aircraft Cable 10' Pair |
| LHVQM15 | Aircraft Cable 15' Pair |

**PRODUCT AVAILABILITY**

| DISTRIBUTION | SIZE | LUMEN PACKAGE | NOMINAL LUMENS | NOMINAL WATTS | EFFICACY |
|---|---|---|---|---|---|
| Aisle | 2' | L | 12,950 | 143 | 91 |
| | 2' | H | 24,850 | 281 | 88 |
| | 3' | VL | 37,850 | 425 | 89 |
| Medium | 2' | L | 14,350 | 142 | 101 |
| | 2' | H | 27,750 | 281 | 99 |
| | 3' | VL | 41,800 | 425 | 98 |
| Wide | 2' | L | 13,900 | 143 | 98 |
| | 2' | H | 27,000 | 281 | 97 |
| | 3' | VL | 42,100 | 425 | 99 |

Lumens vary according to color temperatures and other factors. See specific photometric test(s).

[1] In-Fixture Module Antenna adds 2" to overall fixture height at specific location.

[2] LG2EM is prewired for one LED array when applied to high (H) or very high (VL) lumen output.

[3] LG Series must be purchased from Dual-Lite as a separate system. Visit www.dual-lite.com for product details.





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HUBBELL Lighting

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# LLHP

**2' or 3' LED Premium High Bay**

## PHOTOMETRIC DATA

Test **5940** Test Date **10/9/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLHP2-50-H-M-EDU**<br>**LLHP Led High Bay, Industrial 11" x 24" LED with medium distribution optics** |
| Ballast | **(2) TRC-152Q070DT** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **27,674** |
| Watts | **281.20** |
| Mounting | **Pendant** |
| Shielding Angle | **0° = 90 90° = 90** |
| Spacing Criterion | **0° = 0.99 90° = 0.98** |
| Luminous Opening in Feet | **Length: 1.58**<br>**Width: .67**<br>**Height: 0.00** |

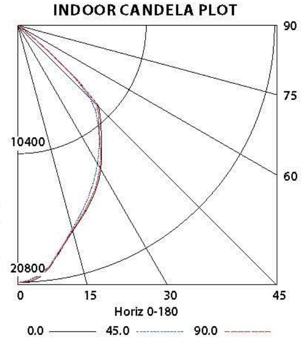
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 13444 | 48.6 | 48.6 |
| 0-40 | 20752 | 75.0 | 75.0 |
| 0-60 | 27307 | 98.7 | 98.7 |
| 0-90 | 27674 | 100.0 | 100.0 |
| 0-180 | 27674 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **98** |
| ANSI/IESNA RP-1-2004 Compliance | **NONCOMPLIANT** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.45 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT




Test **5960** Test Date **10/10/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLHP2-50-H-W-EDU**<br>**LLHP Led High Bay, Industrial 11" x 24" LED with wide distribution optics** |
| Ballast | **(2) TRC-152Q070DT** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **27,068** |
| Watts | **281.00** |
| Mounting | **Pendant** |
| Shielding Angle | **0° = 90 90° = 90** |
| Spacing Criterion | **0° = 1.36 90° = 1.36** |
| Luminous Opening in Feet | **Length: 1.58**<br>**Width: .67**<br>**Height: 0.00** |

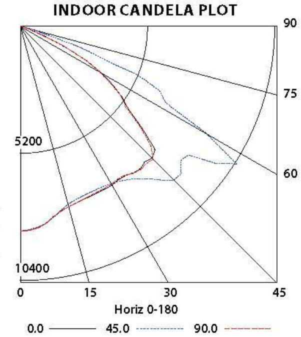
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 6376 | 23.6 | 23.6 |
| 0-40 | 11167 | 41.3 | 41.3 |
| 0-60 | 23257 | 85.9 | 85.9 |
| 0-90 | 27068 | 100.0 | 100.0 |
| 0-180 | 27068 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **98** |
| ANSI/IESNA RP-1-2004 Compliance | **NONCOMPLIANT** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.50 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT




Test **5763** Test Date **9/14/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLHP3-50-H-A-EDU**<br>**LLHP Led High Bay, Industrial 11" x 24" LED with aisle distribution optics** |
| Ballast | **(2) TRC-152Q070DT** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **24,896** |
| Watts | **281.40** |
| Mounting | **Pendant** |
| Shielding Angle | **0° = 90 90° = 90** |
| Spacing Criterion | **0° = 0.94 90° = 0.60** |
| Luminous Opening in Feet | **Length: 1.83**<br>**Width: .77**<br>**Height: 0.00** |

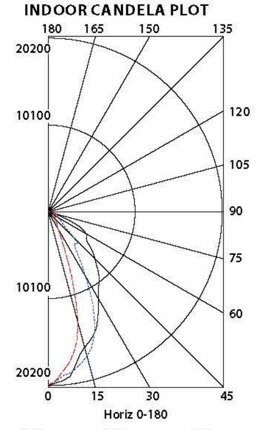
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 11276 | 45.3 | 45.3 |
| 0-40 | 15240 | 61.2 | 61.2 |
| 0-60 | 20981 | 84.3 | 84.3 |
| 0-90 | 24836 | 99.8 | 99.8 |
| 0-180 | 24896 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **88** |
| ANSI/IESNA RP-1-2004 Compliance | **NONCOMPLIANT** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.70 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT







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# LLHP

## 2' or 3' LED Premium High Bay

Test **14.00173** Test Date **8/25/14**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLHP3-50VL-A-EU**<br>**LLHP Led High Bay, Industrial 11" x 36" led with aisle distribution optics** |
| Ballast | **(3) PISE-Z202B** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **37937** |
| Watts | **424.60** |
| Mounting | **Pendant** |
| Shielding Angle | **0° = 90 90° = 90** |
| Spacing Criterion | **0° = 0.52 90° = 0.85** |
| Luminous Opening in Feet | **Length: 0.79**<br>**Width: 3.00**<br>**Height: 0.02** |

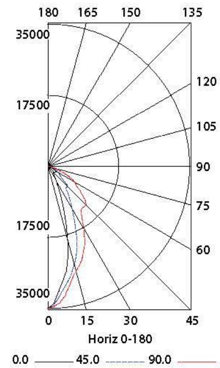
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 16673 | 43.9 | 43.9 |
| 0-40 | 22413 | 59.1 | 59.1 |
| 0-60 | 32116 | 84.7 | 84.7 |
| 0-90 | 37858 | 99.8 | 99.8 |
| 0-180 | 37937 | 100.0 | 100.0 |

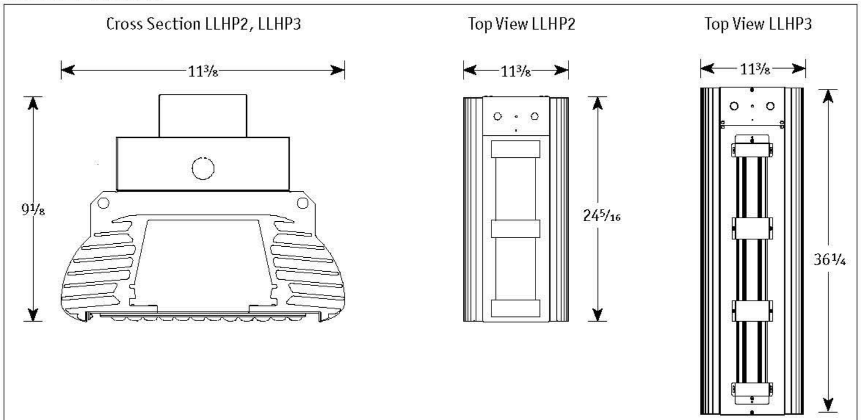
### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **89** |
| ANSI/IESNA RP-1-2004 Compliance | **NONCOMPLIANT** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.70 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT




### DIMENSIONAL DATA




**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

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HUBBELL Lighting

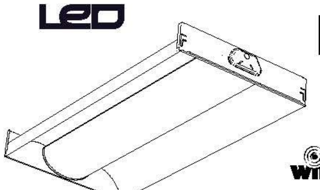
## A3. Columbia LTRE 24

Columbia LIGHTING

# LTRE24

**2' × 4' Transition® LED Enclosed High Efficiency Architectural Lens**

LED



wiHUBB

createchange

| PROJECT INFORMATION | |
|---|---|
| Project Name | Type |
| Catalog No. | Date |

### FEATURES

- Enclosed high efficiency lens features linear prism acrylic and provides visual comfort and high performance without pixelation
- Appropriate for schools, medical facilities, dining areas, locker rooms, and public spaces
- Enclosed lens protects against intrusion of contaminants
- High performance matte white paint standard.
- Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces
- Lens gasket option and wet location listing available
- 60,000 hour LEDs at L80 (up to 150,000 projected life) for reduced life cycle maintenance costs
- Four LED color choices with excellent color consistency and 82 CRI
- Controls compatible for code compliance and energy savings
- Low W/ft² ratio typically meets most restrictive lighting power density codes
- Fixed output, step dimming or 0-10V dimming drivers
- Electrical components accessible from below the ceiling with modular replaceability
- DesignLights Consortium® (DLC) qualified
- Industry's only QR code for easy performance verification and future upgrade capability
- Available with exclusive wiHUBB technology preinstalled
- Five year warranty

### CONSTRUCTION

Luminaire housing and end caps are die formed code gauge cold rolled steel. Reflector is stiffened with linear forms, profiled to a precision curve. High transmission extruded acrylic enclosed lens features linear prisms custom frost for high efficacy without pixelation.

### SHIELDING

Thermoplastic light seals snap into the housing at both ends of the lens to prevent light leaks. Lens hinges down for easy access to LED module and electrical components. Optional gasketing available to surround the lamp cavity (standard when Wet Label option is ordered).

### FINISH

All reflective surfaces are finished after fabrication with unique formula high reflectivity matte white paint for soft, uniform indirect illumination. Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces.

### INSTALLATION

An access plate is furnished with each luminaire for fast wiring access without the necessity to open the fixture or wireway.

### CEILING COMPATIBILITY

Luminaire fits recessed exposed Grid ceilings (G); four integral NEC compliant T-bar clips are standard. Can be placed in Slot Grid (SG) style ceiling with regress ⅜" above ceiling plane. A Flange Kit (FK) accessory is available for recessed hard ceiling applications. Surface Mount (SM) option allows placement below ceiling plane. Cable Mount (CM) option allows suspension below ceiling plane.

### CERTIFICATION

All luminaires are built to UL1598 and 2108 standards, and bear appropriate CSA labels. Damp location is standard. IC label standard. Wet location listing available on all configurations[10]. Emergency-equipped fixtures labeled UL 924 and Dry Location unless specified. Adheres to LM70, LM80, and TM21 industry standards. DesignLights Consortium® (DLC) qualified. Please refer to the DLC website for specific product qualifications at www.designlights.org.

### WARRANTY

Five year warranty (Terms and Conditions apply).

## ORDERING INFORMATION

EXAMPLE LTRE24-35MLG-RFA-ESDU

LTRE 24 – 40 ML G – RFA – ED U –

**MODEL**

| | |
|---|---|
| LTRE | Transition® LED Enclosed High Efficiency Architectural Lens |

**SIZE**

| | |
|---|---|
| 24 | 2' × 4' |

**COLOR TEMPERATURE**

| | |
|---|---|
| 30 | 3000K |
| 35 | 3500K |
| 40 | 4000K |
| 50 | 5000K |

**LUMEN OUTPUT**

| | |
|---|---|
| LW | Low Watt |
| ML | Medium Lumen |
| HL | High Lumen |
| VL | Very High Lumen |
| XL | Extra High Lumen[10] |

**CEILING TYPE**

| | |
|---|---|
| G | Grid Lay-in[1] |
| SM | Surface Mount |
| CM | Cable Mount[2] |

**SHIELDING**

| | |
|---|---|
| RFA | Ribbed Frosted Acrylic |

**DRIVER**

| | |
|---|---|
| E | Fixed Output |
| ESD | Step Dimming[3] |
| ED | 0-10V Dimming |

**VOLTAGE**

| | |
|---|---|
| U | 120V-277V |

**OPTIONS**

| | |
|---|---|
| C388 | 3-Wire Flex |
| C488 | 4-Wire Flex |
| C588 | 5-Wire Flex |
| GLR | Fast Blow Fuse |
| ELL14 | Emergency Battery Pack Installed, 1400 Lumens[4,6,7,9] |
| NYC | NYC Compliant |
| NYCU | NYC Compliant, Union Label |
| WIH | wiHUBB Enabled[6,8] |
| AM | Antimicrobial® Paint[5] |
| G1 | Lens Gasketing |
| WL | Wet Location[6,7,9] |
| EOR | End of Row (SM and CM only. Provides end wiring access for continuous row mounting.) |
| INT | Intermediate (SM and CM only. Provides ends with wiring access for continuous row mounting.) |

**PRODUCT AVAILABILITY**

| SIZE | LUMEN PACKAGE | NOMINAL LUMENS | NOMINAL WATTS | LUMENS PER WATT |
|---|---|---|---|---|
| 24 | LW | 4275-4875 | 38 | 114-130 |
| 24 | ML | 4650-5324 | 41 | 112-129 |
| 24 | HL | 5575-6475 | 52 | 108-126 |
| 24 | VL | 7225-8250 | 67 | 109-124 |
| 24 | XL | 8350-9650 | 81 | 103-119 |

Nominal lumen range represents 3000K through 5000K.
Lumens vary according to color temperatures and other factors.
See specific photometric test(s).

**ACCESSORIES (ORDER SEPARATELY)**

| | |
|---|---|
| FK24 | 2' × 4' Single Flange Kit (Shipped separately) |
| CM48Y2SC3F-KIT | 48" Cable Mount Kit for 2' wide Cable Mount fixtures, 3 Wire |

[1] For drywall order FK24 accessories separately.
[2] Order hanger accessories separately.
[3] Can be converted to fixed output by tying hot leads together.
[4] For compatibility with Dual-Lite LiteGear® inverters in lieu of installed battery pack, contact Hubbell Lighting Representative.
[5] Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces.
[6] Not available with Surface Mount ceiling types.
[7] Not available with Cable Mount ceiling types.
[8] In-Fixture Module Antenna adds 2" to overall fixture height at power feed location.
[9] Wet Location not available with battery packs.
[10] 2x4 XL not available with through wiring





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# LTRE24

## 2' × 4' Transition® LED Enclosed High Efficiency Architectural Lens

## PHOTOMETRIC DATA

Test L071409302 Test Date 8/12/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE24-35MLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 4 led with frosted linear prismed lens |
| Ballast | EVERLINE D15CC55UNVT-C |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 4649 |
| Watts | 41.40 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.19  90° = 1.30 |
| Luminous Opening in Feet | Length: 3.94<br>Width: 1.85<br>Height: 0.00 |

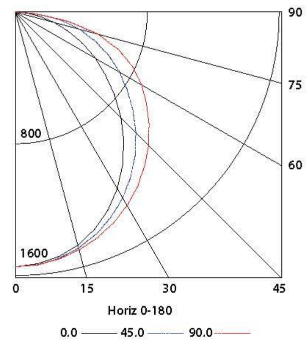
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1198 | 25.8 | 25.8 |
| 0-40 | 1961 | 42.2 | 42.2 |
| 0-60 | 3496 | 75.2 | 75.2 |
| 0-90 | 4649 | 100.0 | 100.0 |
| 0-180 | 4649 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 112 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.12 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




Test L071409304 Test Date 8/13/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE24-35VLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 4 led with frosted linear prismed lens |
| Ballast | EVERLINE D23CC90UNVT-F |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 7243 |
| Watts | 66.68 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.18  90° = 1.31 |
| Luminous Opening in Feet | Length: 3.94<br>Width: 1.85<br>Height: 0.00 |

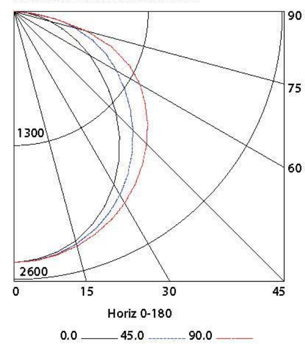
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1886 | 26.0 | 26.0 |
| 0-40 | 3087 | 42.6 | 42.6 |
| 0-60 | 5502 | 76.0 | 76.0 |
| 0-90 | 7243 | 100.0 | 100.0 |
| 0-180 | 7243 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 109 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.02 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




Test L071409305 Test Date 8/13/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE24-35XLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 4 led with frosted linear prismed lens |
| Ballast | EVERLINE D23CC90UNVT-F |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 8353 |
| Watts | 81.23 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.19  90° = 1.31 |
| Luminous Opening in Feet | Length: 3.94<br>Width: 1.85<br>Height: 0.00 |

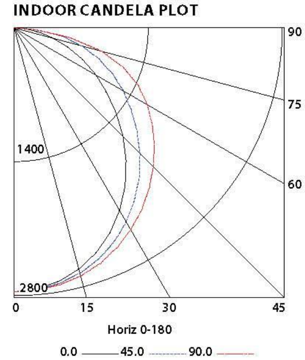
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 2146 | 25.7 | 25.7 |
| 0-40 | 3513 | 42.1 | 42.1 |
| 0-60 | 6271 | 75.1 | 75.1 |
| 0-90 | 8353 | 100.0 | 100.0 |
| 0-180 | 8353 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 103 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.33 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT

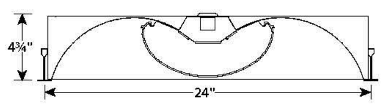


Columbia LIGHTING

# LTRE24

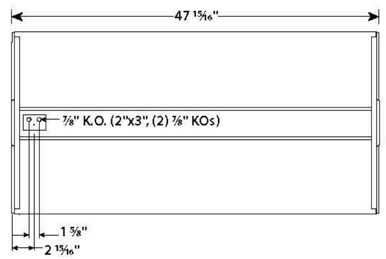
## 2' x 4' Transition® LED Enclosed High Efficiency Architectural Lens

### DIMENSIONAL DATA — GRID



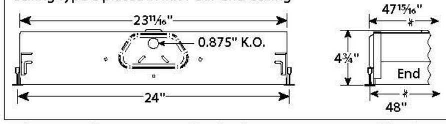

Recessed Section (G)

Back of Housing, Grid



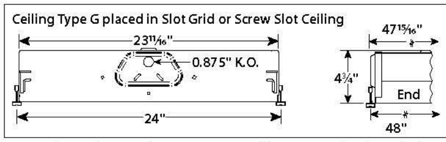

### CEILING COMPATIBILITY

Ceiling Type G placed in flat T-Bar Grid Ceiling



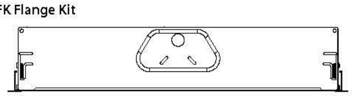

For lay-in installation in exposed grid ceilings. Maximum tee widths of 1" and maximum heights of 1½" allowed.

Ceiling Type G placed in Slot Grid or Screw Slot Ceiling




For 9/16" slot grid type ceilings. Luminaire will be regressed 3/8" from the horizontal surface of the tee.

FK Flange Kit

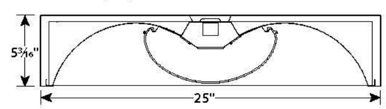


For hard ceiling applications, fixtures must be ordered with a flange kit that wires directly into the concealed ceiling opening for a clean finished appearance. For row configurations contact your local Columbia Representative.

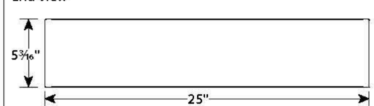
**Flange kit cut out dimension for single FK24: 24 3/8" x 48 3/8"**

### DIMENSIONAL DATA — SURFACE MOUNT

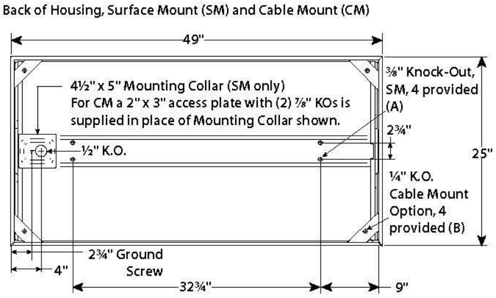
Surface Section (SM)




End View




Back of Housing, Surface Mount (SM) and Cable Mount (CM)




Surface Mount:
Order SM ceiling type. Mounting collar required for surface mounting. (4) Mounting knock-outs, 3/8", provided in center channel as indicated at left, marked "A".

Cable Mount:
Order CM ceiling type.
Use CM48Y2SC3F-KIT 48" Cable Mount Kit for 2' wide SM trim fixtures. Mounting holes are provided in diagonal straps shown at left, marked "B".

**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

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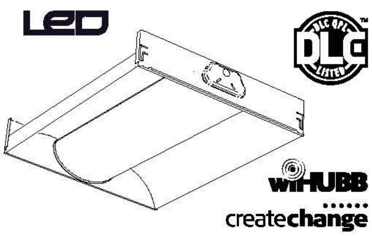
HUBBELL Lighting

## A4. Columbia LTRE 22

Columbia LIGHTING

# LTRE22

**2' × 2' Transition® LED Enclosed High Efficiency Architectural Lens**




**PROJECT INFORMATION**

Project Name ______ Type ______

Catalog No. ______ Date ______

### FEATURES

- Enclosed high efficiency lens features linear prism acrylic and provides visual comfort and high performance without pixelation
- Appropriate for schools, medical facilities, dining areas, locker rooms, and public spaces
- Enclosed lens protects against intrusion of contaminants
- High performance matte white paint standard
- Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces.
- Lens gasket option and wet location listing available
- 60,000 hour LEDs at L80 (up to 150,000 projected life) for reduced life cycle maintenance costs
- Four LED color choices with excellent color consistency and 82 CRI
- Controls compatible for code compliance and energy savings
- Low W/ft² ratio typically meets most restrictive lighting power density codes
- Fixed output, step dimming, or 0-10V dimming drivers
- Electrical components accessible from below the ceiling with modular replaceability
- DesignLights Consortium® (DLC) qualified
- Industry's only QR code for easy performance verification and future upgrade capability
- Available with exclusive wiHUBB technology preinstalled
- Five year warranty

### CONSTRUCTION

Luminaire housing and end caps are die formed code gauge cold rolled steel. Reflector is stiffened with linear forms, profiled to a precision curve. High transmission extruded acrylic enclosed lens features linear prisms custom frost for high efficacy without pixelation.

### SHIELDING

Thermoplastic light seals snap into the housing at both ends of the lens to prevent light leaks. Lens hinges down for easy access to LED module and electrical components. Optional gasketing available to surround the lamp cavity (standard when Wet Label option is ordered).

### FINISH

All reflective surfaces are finished after fabrication with unique formula high reflectivity matte white paint for soft, uniform indirect illumination. Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces.

### INSTALLATION

An access plate is furnished with each luminaire for fast wiring access without the necessity to open the fixture or wireway.

### CEILING COMPATIBILITY

Luminaire fits recessed exposed Grid ceilings (G); four integral NEC compliant T-bar clips are standard. Can be placed in Slot Grid (SG) style ceiling with regress ⅜" above ceiling plane. A Flange Kit (FK) accessory is available for recessed hard ceiling applications. Surface Mount (SM) option allows placement below ceiling plane. Cable Mount (CM) option allows product suspension below ceiling plane.

### CERTIFICATION

All luminaires are built to UL1598 and 2108 standards, and bear appropriate CSA labels. IC Label standard. Damp location label standard. Wet location listing available on all configurations. Emergency-equipped fixtures labeled UL 924 and Dry Location unless specified. Adheres to LM79, LM80, and TM21 industry standards. DesignLights Consortium® (DLC) qualified. Please refer to the DLC website for specific product qualifications at www.designlights.org.www.designlights.org.

### WARRANTY

Five year warranty (Terms and Conditions apply).

## ORDERING INFORMATION

**EXAMPLE LTRE22-35HLG-RFA-ESDU**

LTRE 22 – 40 HL G – RFA – ED U –

**MODEL**

| | |
|---|---|
| LTRE | Transition® LED Enclosed High Efficiency Architectural Lens |

**SIZE**

| | |
|---|---|
| 22 | 2' × 2' |

**COLOR TEMPERATURE**

| | |
|---|---|
| 30 | 3000K |
| 35 | 3500K |
| 40 | 4000K |
| 50 | 5000K |

**LUMEN OUTPUT**

| | |
|---|---|
| ML | Medium Lumen |
| HL | High Lumen |
| VL | Very High Lumen |

**CEILING TYPE**

| | |
|---|---|
| G | Grid Lay-in[1] |
| SM | Surface Mount |
| CM | Cable Mount[2] |

**SHIELDING**

| | |
|---|---|
| RFA | Ribbed Frosted Acrylic |

**DRIVER**

| | |
|---|---|
| E | Fixed Output |
| ESD | Step Dimming[3] |
| ED | 0-10V Dimming |

**VOLTAGE**

| | |
|---|---|
| U | 120V-277V |

**OPTIONS**

| | |
|---|---|
| C388 | 3-Wire Flex |
| C488 | 4-Wire Flex |
| C588 | 5-Wire Flex |
| GLR | Fast Blow Fuse |
| ELL14 | Emergency Battery Pack Installed, 1400 Lumens[4,7,8] |
| NYC | NYC Compliant |
| NYCU | NYC Compliant, Union Label |
| WIH | wiHUBB Enabled[6,7] |
| AM | Antimicrobial® Paint[5] |
| G1 | Lens Gasketing |
| WL | Wet Location[7,8,9] |
| EOR | End of Row (SM and CM only. Provides end wiring access for continuous row mounting.) |
| INT | Intermediate (SM and CM only. Provides ends with wiring access for continuous row mounting.) |

**ACCESSORIES (ORDER SEPARATELY)**

| | |
|---|---|
| FK22 | 2' × 2' Single Flange Kit (Shipped separately) |
| CM48Y2SC3F-KIT | 48" Cable Mount Kit for 2' wide Cable Mount fixtures, 3 Wire |

**PRODUCT AVAILABILITY**

| SIZE | LUMEN PACKAGE | NOMINAL LUMENS | NOMINAL WATTS | LUMENS PER WATT |
|---|---|---|---|---|
| 22 | ML | 2975-3100 | 30 | 100-104 |
| 22 | HL | 3625-3875 | 36 | 101-108 |
| 22 | VL | 4275-4925 | 44 | 98-112 |

Nominal lumen range represents 3000K through 5000K.
Lumens will vary according to color temperatures and other factors.
See specific photometric tests(s)

[1] For drywall order FK22 accessories separately.
[2] Order hanger accessories separately.
[3] Can be converted to fixed output by tying hot leads together.
[4] For compatibility with Dual-Lite LiteGear® inverters in lieu of installed battery pack, contact Hubbell Lighting Representative.
[5] Optional Antimicrobial® paint (AM option) resists bacterial growth on exposed painted surfaces.
[6] In-Fixture Module Antenna adds 2" to overall fixture height at power feed location.
[7] Not available with Surface Mount ceiling types.
[8] Not available with Cable Mount ceiling types.
[9] Wet Location not available with battery packs.

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HUBBELL Lighting

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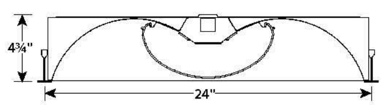
# LTRE22

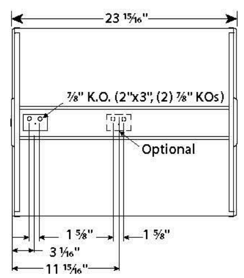
## 2' × 2' Transition® LED Enclosed High Efficiency Architectural Lens

### DIMENSIONAL DATA — GRID



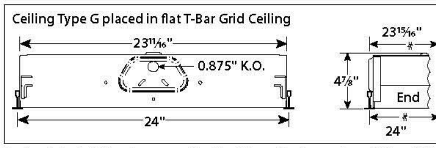

Recessed Section (G)

Back of Housing, Grid



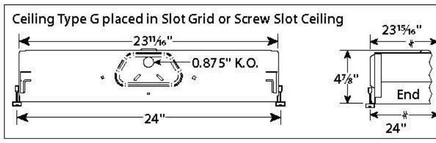

### CEILING COMPATIBILITY

Ceiling Type G placed in flat T-Bar Grid Ceiling



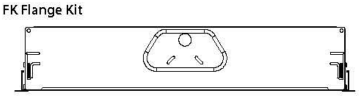

For lay-in installation in exposed grid ceilings. Maximum tee widths of 1" and maximum heights of 1½" allowed.

Ceiling Type G placed in Slot Grid or Screw Slot Ceiling




For 9/16" slot grid type ceilings. Luminaire will be regressed 3/8" above horizontal surface of the tee.

FK Flange Kit

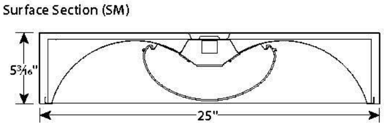


For hard ceiling applications, fixtures must be ordered with a flange kit that wires directly into the concealed ceiling opening for a clean finished appearance. For row configurations contact your local Columbia Representative.

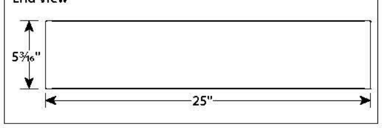
**Flange kit cut out dimension for single FK22: 24 3/8" x 24 3/8"**

### DIMENSIONAL DATA — SURFACE MOUNT & CABLE MOUNT

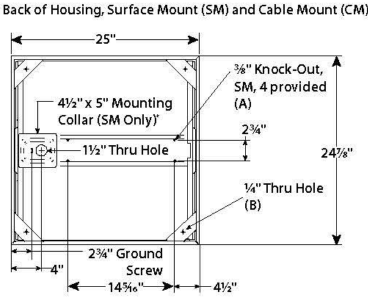
Surface Section (SM)




End View




Back of Housing, Surface Mount (SM) and Cable Mount (CM)




Surface Mount:
Order SM ceiling type. Mounting collar required for surface mounting. (4) Mounting knock-outs, 3/8", provided in center channel as indicated at left, marked (A).

Cable Mount:
Order CM ceiling type.
Use CM48Y2SC3F-KIT 48" Cable Mount Kit for 2' wide CM fixtures. Mounting holes are provided in diagonal straps shown at left, marked (B).

* For Cable Mount a 2" x 3" access plate with (4) 7/8" KOs provided in place of Mounting Collar shown.

**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

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HUBBELL Lighting

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# LTRE22

## 2' × 2' Transition® LED Enclosed High Efficiency Architectural Lens

## PHOTOMETRIC DATA

Test L091401901 Test Date 9/15/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE22-35MLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 2 led with frosted linear prismed lens |
| Ballast | VD EVERLINE D10CC55UNVT-C |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 2988 |
| Watts | 29.23 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.17  90° = 1.30 |
| Luminous Opening in Feet | Length: 1.93<br>Width: 1.93<br>Height: 0.00 |

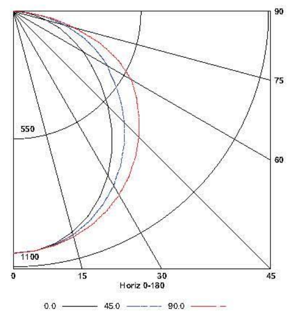
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 803 | 26.9 | 26.9 |
| 0-40 | 1308 | 43.8 | 43.8 |
| 0-60 | 2307 | 77.2 | 77.2 |
| 0-90 | 2988 | 100.0 | 100.0 |
| 0-180 | 2988 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 102 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.33 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




Test L081406001 Test Date 8/21/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE22-35HLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 2 led with frosted linear prismed lens |
| Ballast | EVERLINE D15CC55UNVT-C |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 3640 |
| Watts | 36.17 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.16  90° = 1.29 |
| Luminous Opening in Feet | Length: 1.93<br>Width: 1.93<br>Height: 0.00 |

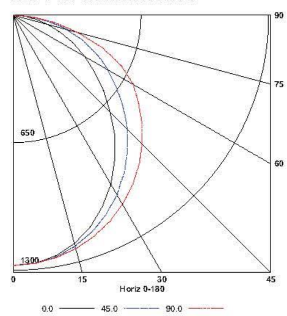
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 982 | 27.0 | 27.0 |
| 0-40 | 1597 | 43.9 | 43.9 |
| 0-60 | 2805 | 77.1 | 77.1 |
| 0-90 | 3640 | 100.0 | 100.0 |
| 0-180 | 3640 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 101 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.38 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




Test L071409403R01 Test Date 8/11/2014

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LTRE22-35VLG-RFA-EDU<br>LTRE Transition Enclosed LED, Recessed Architectural<br>2 x 2 led with frosted linear prismed lens |
| Ballast | D15CC55UNVT-C |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 4278 |
| Watts | 43.80 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.16  90° = 1.30 |
| Luminous Opening in Feet | Length: 1.93<br>Width: 1.93<br>Height: 0.00 |

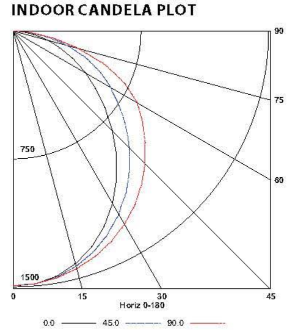
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1152 | 26.9 | 26.9 |
| 0-40 | 1875 | 43.8 | 43.8 |
| 0-60 | 3300 | 77.1 | 77.1 |
| 0-90 | 4278 | 100.0 | 100.0 |
| 0-180 | 4278 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100.0% |
| Total Lumens per Watt | 98 |
| IESNA RP-1-1993 Compliance | Non-Compliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.47 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT







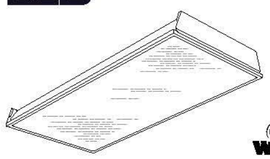

HUBBELL Lighting

## A5. Columbia LLT 24

Columbia LIGHTING

# LLT24

**2' × 4', LED Lensed Troffer with Advanced Solid State Technology**



LED

wiHUBB

createchange

| PROJECT INFORMATION | |
|---|---|
| Project Name | Type |
| Catalog No. | Date |

### FEATURES

- Full distribution provides controlled high angle light for visual comfort
- Long-life, 50,000 hour LEDs at L80 reduce life cycle maintenance costs
- Lens design and materials provide uniform appearance without pixilation
- Two lens choices
- Three door frame choices
- Excellent color consistency and 82 CRI
- Fixed output, step dimming, or 0-10V dimming drivers available
- Hinged optical system allows easy access to LED boards and drivers from below the ceiling; modular replaceability of components
- Low W/ft2 ratio typically meets the most restrictive lighting power density codes
- All models standard with IC rating
- DesignLights Consortium® (DLC) qualified
- Recessed, surface or cable mount
- Available with exclusive wiHUBB technology preinstalled
  – Peer to peer, self-healing wireless mesh network
  – Integrated control system for 0-10V dimming or step dimming, or On/Off

**CONSTRUCTION**
Luminaire housing, end caps, and reflectors are die-formed code-gauge cold-rolled steel. Optical system hinges from either side for easy access to LED module and electrical components. Mechanical light trap prevents light leaks. Spring loaded latches optional on steel door, standard on aluminum doors.

**FINISH**
Door frame is powder coat paint after fabrication. All metal parts processed with a multi-stage phosphate bonding treatment and finished with a high reflectance baked white enamel. For a post painted housing finish suffix catalog number with PAF.

**SHIELDING**
Lenses are high transmission extruded acrylic. Lens selections are Pattern 12 frosted acrylic (A12F) or Pattern 19 frosted acrylic .156" (A19F).

**INSTALLATION**
An access plate or mounting collar is furnished with each fixture for fast wiring connections without the necessity to open the fixture or wireway.

**CEILING COMPATIBILITY**
Luminaire fits recessed exposed grid ceilings (G); four integral T-Bar clips standard. A flange kit (FK) option is available for recessed hard ceiling applications. Surface Mount (SM) option allows placement on ceiling plane. Cable Mount option (CM) allows suspension below ceiling plane. For information on compatibility with specific ceilings, or where plenum depth is a problem, contact your Hubbell Lighting representative.

**CERTIFICATION**
All luminaires are built to UL 1598 and 2108 standards, and bear appropriate CSA labels. Damp location labeling is standard. Emergency equipped fixtures labeled UL924. Adheres to LM79, LM80 and TM21 industry standards. IC rating is standard on all models. DesignLights Consortium® (DLC) qualified. Please refer to the DLC website for specific product qualifications at www.designlights.org.

**WARRANTY**
Five year warranty. (Terms and Conditions Apply)

### ORDERING INFORMATION

**EXAMPLE LLT24-35LWG-FSA12F-EU**

LLT 24 – 35 LW G – FS A12F – ED U –

**MODEL**
- LLT LED Lensed Troffer

**SIZE**
- 24 2' × 4'

**COLOR TEMP**
- 30 3000K
- 35 3500K
- 40 4000K

**LUMEN OUTPUT**
- LW Low Watt
- ML Medium Lumen

**CEILING TYPE**
- G Grid[1]
- SM Surface Mount
- CM Cable Mount[2]

**DOOR**
- FS White Flush Steel
- FA White Flush Aluminum[3]
- RA White Regressed Aluminum[3]

For more door options contact factory.

**SHIELDING**
- A12F Pattern 12 Frosted Acrylic Lens
- A19F Pattern 19 Frosted Acrylic Lens .156"

**DRIVER**
- E Fixed Output
- ESD Step Dimming[4]
- ED 0-10V Dimming

**VOLTAGE**
- U 120V-277V

**OPTIONS**
- C388 3-Wire Flex
- C488 4-Wire Flex
- C588 5-Wire Flex
- ELL14 Emergency Battery Pack Installed, 1400 Lumens[5]
- PAF Paint After Fabrication
- SLL Spring Loaded Latches
- G1 Single Gasket (door to housing)
- G2 Double Gasketing (G1 and lens to door)
- G3 Triple Gasketing (G2 and housing to ceiling)
- GLR Fast Blow Fuse
- NYC NYC Compliant
- WIH wiHUBB Enabled[6,7]

**ACCESSORIES (ORDER SEPARATELY)**
- FK24 2' x 2' Flange Kit, Single Mounting (for rows add FKCR)
- FKCR Flange Kit Row Adaptor
- CM48Y2SC3F-KIT 48" Cable Mount Kit for 2' wide Cable Mount fixtures, 3- Wire Feed Cord

**PRODUCT AVAILABILITY**

| SIZE | OUTPUT | NOMINAL LUMENS |
|---|---|---|
| 2' x 4' | LW | 3900 |
| | ML | 4700 |

[1] For drywall order Flange Kit accessories separately.
[2] Order hanger accessories separately.
[3] Standard with Spring Loaded Latches.
[4] Can be converted to fixed output by tying hot leads together.
[5] For compatibility with Dual-Lite LiteGear® inverters in lieu of installed battery pack, contact Hubbell Lighting representative.
[6] In-Fixture Module Antenna adds 2" to overall fixture height at power feed location.
[7] Not available with Surface Mount ceiling types.

Damp Label - standard. IC Rating - standard.

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HUBBELL Lighting

Columbia LIGHTING

# LLT24

## 2' × 4', LED Lensed Troffer with Advanced Solid State Technology

## PHOTOMETRIC DATA

Test **5602** Test Date **8/17/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLT24-35LWG-A12F-ESD**<br>**LLT LED, Lensed Troffer**<br>**2 x 4 LED with frosted A12 lens** |
| Ballast | **D255CQ42UNVA-A** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **3856** |
| Watts | **40.80** |
| Mounting | **Recessed** |
| Shielding Angle | **0° = 90  90° = 90** |
| Spacing Criterion | **0° = 1.18  90° = 1.17** |
| Luminous Opening in Feet | **Length: 3.81**<br>**Width: 1.81**<br>**Height: 0.00** |

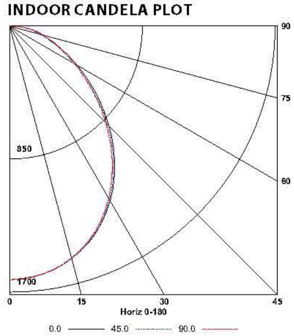
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1223 | 31.7 | 31.7 |
| 0-40 | 1946 | 50.5 | 50.5 |
| 0-60 | 3171 | 82.2 | 82.2 |
| 0-90 | 3856 | 100.0 | 100.0 |
| 0-180 | 3856 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **95** |
| ANSI/IESNA RP-1-2004 Compliance | **Noncompliant** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.55 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT




### AVG. LUMINANCE (Candela/Sq. M.)

| Average Luminance Angle | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 |
|---|---|---|---|---|---|
| 0 | 2530 | 2530 | 2530 | 2530 | 2530 |
| 30 | 2320 | 2320 | 2305 | 2293 | 2284 |
| 40 | 2113 | 2109 | 2086 | 2062 | 2054 |
| 45 | 1982 | 1973 | 1947 | 1920 | 1916 |
| 50 | 1836 | 1826 | 1797 | 1773 | 1770 |
| 55 | 1687 | 1671 | 1641 | 1622 | 1622 |
| 60 | 1539 | 1523 | 1495 | 1486 | 1489 |
| 65 | 1411 | 1392 | 1367 | 1378 | 1389 |
| 70 | 1314 | 1296 | 1278 | 1314 | 1337 |
| 75 | 1266 | 1248 | 1242 | 1303 | 1345 |
| 80 | 1267 | 1258 | 1285 | 1366 | 1420 |
| 85 | 1361 | 1343 | 1415 | 1558 | 1594 |

### COEFFICIENTS OF UTILIZATION (%)

| RC | 80 | | | | 70 | | | | 50 | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70 | 50 | 30 | 10 | 70 | 50 | 30 | 10 | 50 | 30 | 10 | 0 |
| 1 | 109 | 105 | 100 | 97 | 106 | 102 | 99 | 95 | 98 | 95 | 92 | 85 |
| 2 | 100 | 92 | 85 | 80 | 97 | 90 | 84 | 79 | 87 | 82 | 77 | 72 |
| 3 | 92 | 81 | 74 | 67 | 89 | 80 | 73 | 67 | 77 | 71 | 66 | 61 |
| 4 | 84 | 73 | 64 | 58 | 82 | 71 | 64 | 57 | 69 | 62 | 57 | 53 |
| 5 | 78 | 65 | 57 | 50 | 76 | 64 | 56 | 50 | 62 | 55 | 50 | 46 |
| 6 | 72 | 59 | 51 | 44 | 70 | 58 | 50 | 44 | 56 | 49 | 44 | 41 |
| 7 | 67 | 54 | 45 | 39 | 65 | 53 | 45 | 39 | 52 | 44 | 39 | 37 |
| 8 | 63 | 49 | 41 | 35 | 61 | 49 | 41 | 35 | 47 | 40 | 35 | 33 |
| 9 | 59 | 45 | 37 | 32 | 57 | 45 | 37 | 32 | 44 | 37 | 32 | 30 |
| 10 | 55 | 42 | 34 | 29 | 54 | 42 | 34 | 29 | 41 | 34 | 29 | 27 |

RCR (rows)

**RCR** = Room Cavity Ratio

**RC** = Effective Ceiling Cavity Reflectance **RW** = Wall Reflectance

---

Test **5608** Test Date **8/20/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | **LLT24-35MLG-A12F-ESD**<br>**LLT LED, Lensed Troffer**<br>**2 x 4 LED with frosted A12 lens** |
| Ballast | **D310CQ50UNVA-A** |
| Ballast Factor | **1.00** |
| Lamp | **LED** |
| Fixture Lumens | **4696** |
| Watts | **51.40** |
| Mounting | **Recessed** |
| Shielding Angle | **0° = 90  90° = 90** |
| Spacing Criterion | **0° = 1.18  90° = 1.17** |
| Luminous Opening in Feet | **Length: 3.81**<br>**Width: 1.81**<br>**Height: 0.00** |

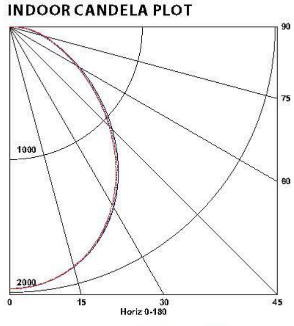
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1489 | 31.7 | 31.7 |
| 0-40 | 2370 | 50.5 | 50.5 |
| 0-60 | 3862 | 82.2 | 82.2 |
| 0-90 | 4696 | 100.0 | 100.0 |
| 0-180 | 4696 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | **100%** |
| Total Lumens Per Watt | **91** |
| ANSI/IESNA RP-1-2004 Compliance | **Noncompliant** |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | **$2.61 based on 3000 hrs. and $0.08 per KWH** |

### INDOOR CANDELA PLOT




### AVG. LUMINANCE (Candela/Sq. M.)

| Average Luminance Angle | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 |
|---|---|---|---|---|---|
| 0 | 3081 | 3081 | 3081 | 3081 | 3081 |
| 30 | 2824 | 2824 | 2808 | 2792 | 2783 |
| 40 | 2573 | 2569 | 2543 | 2512 | 2504 |
| 45 | 2413 | 2406 | 2373 | 2342 | 2335 |
| 50 | 2236 | 2224 | 2188 | 2159 | 2156 |
| 55 | 2055 | 2036 | 2000 | 1976 | 1976 |
| 60 | 1876 | 1854 | 1820 | 1807 | 1814 |
| 65 | 1717 | 1699 | 1666 | 1677 | 1692 |
| 70 | 1602 | 1579 | 1556 | 1597 | 1625 |
| 75 | 1538 | 1520 | 1514 | 1586 | 1628 |
| 80 | 1546 | 1528 | 1564 | 1663 | 1726 |
| 85 | 1666 | 1630 | 1719 | 1881 | 1934 |

### COEFFICIENTS OF UTILIZATION (%)

| RC | 80 | | | | 70 | | | | 50 | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70 | 50 | 30 | 10 | 70 | 50 | 30 | 10 | 50 | 30 | 10 | 0 |
| 1 | 109 | 105 | 100 | 97 | 106 | 102 | 99 | 95 | 98 | 95 | 92 | 85 |
| 2 | 100 | 92 | 85 | 80 | 97 | 90 | 84 | 79 | 87 | 82 | 77 | 72 |
| 3 | 92 | 81 | 74 | 67 | 89 | 80 | 73 | 67 | 77 | 71 | 66 | 61 |
| 4 | 84 | 73 | 64 | 58 | 82 | 71 | 64 | 57 | 69 | 62 | 57 | 53 |
| 5 | 78 | 65 | 57 | 50 | 76 | 64 | 56 | 50 | 62 | 55 | 50 | 46 |
| 6 | 72 | 59 | 51 | 44 | 70 | 58 | 50 | 44 | 56 | 49 | 44 | 41 |
| 7 | 67 | 54 | 45 | 39 | 65 | 53 | 45 | 39 | 52 | 44 | 39 | 37 |
| 8 | 63 | 49 | 41 | 35 | 61 | 49 | 41 | 35 | 47 | 40 | 35 | 33 |
| 9 | 59 | 45 | 37 | 32 | 57 | 45 | 37 | 32 | 44 | 37 | 32 | 30 |
| 10 | 55 | 42 | 34 | 29 | 54 | 42 | 34 | 29 | 41 | 34 | 29 | 27 |

RCR (rows)

**RCR** = Room Cavity Ratio

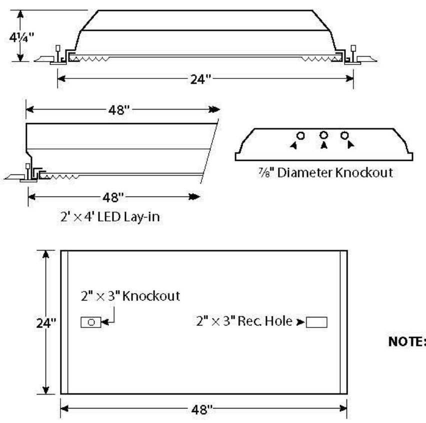
**RC** = Effective Ceiling Cavity Reflectance **RW** = Wall Reflectance

Columbia LIGHTING

# LLT24

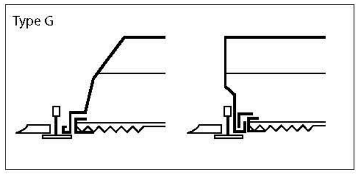
## 2' × 4', LED Lensed Troffer with Advanced Solid State Technology

### DIMENSIONAL DATA

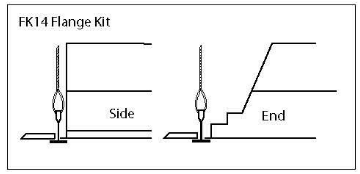



**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

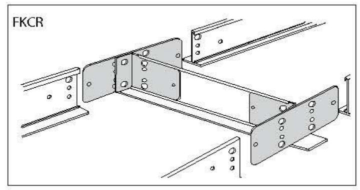
### CEILING COMPATIBILITY




For lay-in insallation in exposed grid ceilings. Maximum tee widths of 1" and maximum tee heights of 2" allowed. Shown with flush lens.




For hard ceiling applications, order FK14 flange kit. Flange kit wires directly into concealed ceiling opening for a clean, finished appearance. Shown with flush lens.

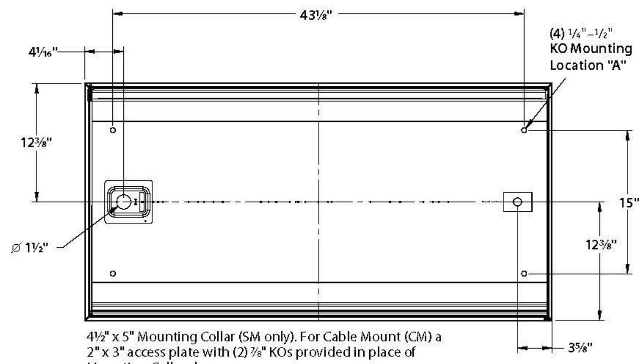



For flanged fixtures in row configurations, the FKCR adapter bracket kit is required in addition to the FK14 kit. Order one less FKCR than the total number of fixtures in row. (Example: Row of two, order (2) FK14 & (1) FKCR)

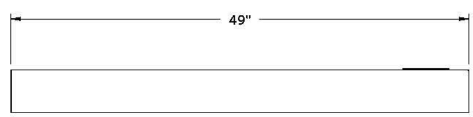
Row cut out dimensions using FK14 & FKCR adapters:
Width 24⅜", Length [48" × (# in row)] + ⅜" = 96⅜"]

Flange kit rough in dimensions for single unit only: 24⅜" x 48⅜"

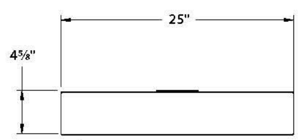
### DIMENSIONAL DATA - SURFACE OR CABLE MOUNT




4½" x 5" Mounting Collar (SM only). For Cable Mount (CM) a 2" x 3" access plate with (2) ⅞" KOs provided in place of Mounting Collar shown.




Side View




End View

**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

**Surface Mount**

Order SM ceiling type. Mounting collar required for surface mounting. (4) Mounting KOs, ¼" to ½" provided as shown at left, marked "A".

**Cable Mount**

Order CM ceiling type. Access plate supplied for cable mounting or suspension. Use CM48Y2C3F-KIT 48" Cable Mount Kit. Includes 3-wire feed cord. For other wiring needs, contact Hubbell representative. Mounting KOs, ¼" to ½", provided as shown at left, marked "A".

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HUBBELL Lighting

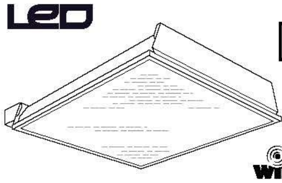
## A6. Columbia LLT 22

Columbia LIGHTING

# LLT22

### 2' × 2', LED Lensed Troffer with Advanced Solid State Technology

LED



wiHUBB

createchange

**PROJECT INFORMATION**

| Project Name | Type |
|---|---|
| Catalog No. | Date |

### FEATURES

- Full distribution provides controlled high angle light for visual comfort
- Long-life, 50,000 hour LEDs at L80 reduce life cycle maintenance costs
- Lens design and materials provide uniform appearance without pixilation
- Two lens choices
- Three door frame choices
- Excellent color consistency and 82 CRI
- Fixed output, step dimming, or 0-10V dimming drivers available
- Hinged optical system allows easy access to LED boards and drivers from below the ceiling; modular replaceability of components
- Low W/ft2 ratio typically meets the most restrictive lighting power density codes
- DesignLights Consortium® (DLC) qualified
- Recessed, surface or cable mount
- All models standard with IC rating
- Available with exclusive wiHUBB technology preinstalled
  - Peer to peer, self-healing wireless mesh network
  - Integrated control system for 0-10V dimming or step dimming, or On/Off

**CONSTRUCTION**
Luminaire housing, end caps, and reflectors are die-formed code-gauge cold-rolled steel. Optical system hinges from either side for easy access to LED module and electrical components. Mechanical light trap prevents light leaks. Spring loaded latches optional on steel door, standard on aluminum doors.

**FINISH**
Door frame is powder coat paint after fabrication. All metal parts processed with a multi-stage phosphate bonding treatment and finished with a high reflectance baked white enamel. For a post painted housing finish suffix catalog number with PAF.

**SHIELDING**
Lenses are high transmission extruded acrylic. Lens selections are Pattern 12 frosted acrylic (A12F) or Pattern 19 frosted acrylic .156" (A19F).

**INSTALLATION**
An access plate or mounting collar is furnished with each fixture for fast wiring connections without the necessity to open the fixture or wireway.

**CEILING COMPATIBILITY**
Luminaire fits recessed exposed grid ceilings (G); for (4) field installable T- Bar clips, order option 4TB. A flange kit (FK) option is available for recessed hard ceiling applications. Surface Mount (SM) option allows placement on ceiling plane. Cable Mount option (CM) allows suspension below ceiling plane. For information on compatibility with specific ceilings, or where plenum depth is a problem, contact your Hubbell Lighting representative.

**CERTIFICATION**
All luminaires are built to UL 1598 and 2108 standards, and bear appropriate CSA labels. Damp location labeling is standard. Emergency equipped fixtures labeled UL924. Adheres to LM79, LM80 and TM21 industry standards. IC rating is standard on all models. DesignLights Consortium® (DLC) qualified. Please refer to the DLC website for specific product qualifications at www.designlights.org.

**WARRANTY**
Five year warranty. (Terms and Conditions Apply)

### ORDERING INFORMATION

EXAMPLE **LLT22-35HLG-FSA12F-EU**

LLT 22 – 35 ML G – FS A12F – ED U –

**MODEL**
- **LLT** LED Lensed Troffer

**SIZE**
- **22** 2' × 2'

**COLOR TEMP**
- **30** 3000K
- **35** 3500K
- **40** 4000K

**LUMEN OUTPUT**
- **LW** Low Watt
- **ML** Medium Lumen
- **HL** High Lumen
- **VL** Very High Lumen

**CEILING TYPE**
- **G** Grid[1]
- **SM** Surface Mount
- **CM** Cable Mount[2]

**DOOR**
- **FS** White Flush Steel
- **FA** White Flush Aluminum[3]
- **RA** White Regressed Aluminum[3]

For more door options contact factory.

**SHIELDING**
- **A12F** Pattern 12 Frosted Acrylic Lens
- **A19F** Pattern 19 Frosted Acrylic Lens .156"

**DRIVER**
- **E** Fixed Output
- **ESD** Step Dimming[4]
- **ED** 0-10V Dimming

**VOLTAGE**
- **U** 120V-277V

**OPTIONS**
- **C388** 3-Wire Flex
- **C488** 4-Wire Flex
- **C588** 5-Wire Flex
- **ELL14** Emergency Battery Pack Installed, 1400 Lumens[5]
- **PAF** Paint After Fabrication
- **SLL** Spring Loaded Latches
- **4TB** Four T-Bar Clips
- **G1** Single Gasket (door to housing)
- **G2** Double Gasketing (G1 and lens to door)
- **G3** Triple Gasketing (G2 and housing to ceiling)
- **GLR** Fast Blow Fuse
- **NYC** NYC Compliant
- **WIH** wiHUBB Enabled[6,7]

**ACCESSORIES (ORDER SEPARATELY)**
- **FK22** 2' x 2' Flange Kit, Single Mounting (for rows add FKCR)
- **FKCR** Flange Kit Row Adaptor
- **CM48Y2SC3F-KIT** 48" Cable Mount Kit for 2' wide Cable Mount fixtures, 3- Wire Feed Cord

**PRODUCT AVAILABILITY**

| SIZE | OUTPUT | NOMINAL LUMENS |
|---|---|---|
| 2' x 2' | LW | 2100 |
| | ML | 2500 |
| | HL | 3300 |
| | VL | 4000 |

[1] For drywall order Flange Kit accessories separately.
[2] Order hanger accessories separately.
[3] Standard with Spring Loaded Latches.
[4] Can be converted to fixed output by tying hot leads together.
[5] For compatibility with Dual-Lite LiteGear® inverters in lieu of installed battery pack, contact Hubbell Lighting representative.
[6] In-Fixture Module Antenna adds 2" to overall fixture height at power feed location.
[7] Not available with Surface Mount ceiling types.

Damp Label - standard. IC Rating - standard.

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HUBBELL Lighting

Columbia LIGHTING

# LLT22

## 2' × 2', LED Lensed Troffer with Advanced Solid State Technology

## PHOTOMETRIC DATA

Test **5366** Test Date **7/9/12**

### LUMINAIRE DATA

| | |
|---|---|
| Luminaire | LLT22-35MLG-A12F-ESD<br>LLT LED, Lensed Troffer<br>2 x 2 LED with frosted A12 lens |
| Ballast | D185CQ30UNVA-A |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 2520 |
| Watts | 26.70 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.16  90° = 1.18 |
| Luminous Opening in Feet | Length: 1.83<br>Width: 1.83<br>Height: 0.00 |

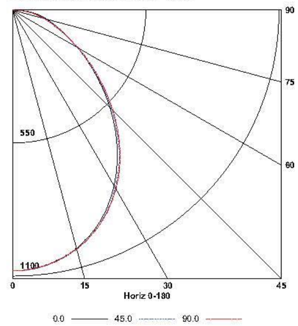
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 812 | 32.2 | 32.2 |
| 0-40 | 1289 | 51.2 | 51.2 |
| 0-60 | 2084 | 82.7 | 82.7 |
| 0-90 | 2520 | 100.0 | 100.0 |
| 0-180 | 2520 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100% |
| Total Lumens Per Watt | 94 |
| ANSI/IESNA RP-1-2004 Compliance | Yes - VDT<br>Normal Use |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.58 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




### AVG. LUMINANCE (Candela/Sq. M.)

| Average Luminance Angle | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 |
|---|---|---|---|---|---|
| 0 | 3465 | 3465 | 3465 | 3465 | 3465 |
| 30 | 3106 | 3121 | 3151 | 3162 | 3170 |
| 40 | 2773 | 2794 | 2832 | 2853 | 2862 |
| 45 | 2573 | 2591 | 2632 | 2650 | 2664 |
| 50 | 2355 | 2370 | 2410 | 2430 | 2445 |
| 55 | 2146 | 2157 | 2185 | 2208 | 2225 |
| 60 | 1961 | 1961 | 1974 | 1993 | 2012 |
| 65 | 1825 | 1810 | 1795 | 1810 | 1833 |
| 70 | 1757 | 1729 | 1663 | 1682 | 1710 |
| 75 | 1763 | 1714 | 1627 | 1614 | 1639 |
| 80 | 1888 | 1795 | 1684 | 1629 | 1666 |
| 85 | 2102 | 2065 | 1881 | 1733 | 1807 |

### COEFFICIENTS OF UTILIZATION (%)

| RC | 80 | | | | 70 | | | | 50 | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70 | 50 | 30 | 10 | 70 | 50 | 30 | 10 | 50 | 30 | 10 | 0 |
| RCR 1 | 109 | 105 | 101 | 97 | 107 | 102 | 99 | 95 | 98 | 95 | 92 | 85 |
| 2 | 100 | 92 | 86 | 80 | 97 | 90 | 84 | 79 | 87 | 82 | 77 | 72 |
| 3 | 92 | 82 | 74 | 68 | 89 | 80 | 73 | 67 | 77 | 71 | 66 | 62 |
| 4 | 84 | 73 | 65 | 58 | 82 | 72 | 64 | 58 | 69 | 62 | 57 | 53 |
| 5 | 78 | 66 | 57 | 51 | 76 | 65 | 57 | 50 | 63 | 55 | 50 | 47 |
| 6 | 72 | 60 | 51 | 45 | 70 | 59 | 50 | 45 | 57 | 50 | 44 | 41 |
| 7 | 67 | 54 | 46 | 40 | 66 | 53 | 45 | 40 | 52 | 45 | 39 | 37 |
| 8 | 63 | 50 | 41 | 36 | 61 | 49 | 41 | 36 | 48 | 41 | 36 | 33 |
| 9 | 59 | 46 | 38 | 32 | 57 | 45 | 38 | 32 | 44 | 37 | 32 | 30 |
| 10 | 55 | 42 | 35 | 30 | 54 | 42 | 35 | 30 | 41 | 34 | 29 | 27 |

**RCR** = Room Cavity Ratio
**RC** = Effective Ceiling Cavity Reflectance **RW** = Wall Reflectance

### LUMINAIRE DATA

Test **5352** Test Date **7/6/12**

| | |
|---|---|
| Luminaire | LLT22-35HLG-A12F-ESD<br>LLT LED, Lensed Troffer<br>2 x 2 LED with frosted A12 lens |
| Ballast | D255CQ42UNVA-A |
| Ballast Factor | 1.00 |
| Lamp | LED |
| Fixture Lumens | 3251 |
| Watts | 35.50 |
| Mounting | Recessed |
| Shielding Angle | 0° = 90  90° = 90 |
| Spacing Criterion | 0° = 1.16  90° = 1.18 |
| Luminous Opening in Feet | Length: 1.83<br>Width: 1.83<br>Height: 0.00 |

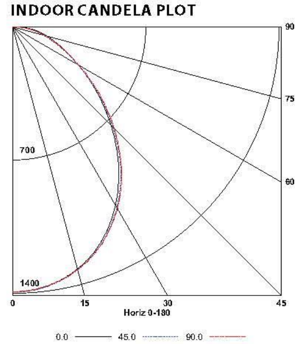
### ZONAL LUMEN SUMMARY

| Zone | Lumens | % Lamp | % Fixt. |
|---|---|---|---|
| 0-30 | 1049 | 32.3 | 32.3 |
| 0-40 | 1665 | 51.2 | 51.2 |
| 0-60 | 2690 | 82.8 | 82.8 |
| 0-90 | 3251 | 100.0 | 100.0 |
| 0-180 | 3251 | 100.0 | 100.0 |

### ENERGY DATA

| | |
|---|---|
| Total Luminaire Efficiency | 100% |
| Total Lumens Per Watt | 92 |
| ANSI/IESNA RP-1-2004 Compliance | Noncompliant |
| Comparative Yearly Lighting Energy Cost per 1000 Lumens | $2.67 based on 3000 hrs. and $0.08 per KWH |

### INDOOR CANDELA PLOT




### AVG. LUMINANCE (Candela/Sq. M.)

| Average Luminance Angle | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 |
|---|---|---|---|---|---|
| 0 | 4477 | 4477 | 4477 | 4477 | 4477 |
| 30 | 4008 | 4027 | 4068 | 4083 | 4090 |
| 40 | 3575 | 3600 | 3650 | 3680 | 3692 |
| 45 | 3318 | 3336 | 3391 | 3423 | 3436 |
| 50 | 3040 | 3060 | 3105 | 3140 | 3150 |
| 55 | 2768 | 2779 | 2819 | 2852 | 2869 |
| 60 | 2520 | 2526 | 2539 | 2571 | 2597 |
| 65 | 2350 | 2327 | 2312 | 2335 | 2365 |
| 70 | 2255 | 2218 | 2143 | 2161 | 2199 |
| 75 | 2285 | 2211 | 2086 | 2086 | 2111 |
| 80 | 2425 | 2314 | 2166 | 2110 | 2147 |
| 85 | 2729 | 2692 | 2434 | 2287 | 2360 |

### COEFFICIENTS OF UTILIZATION (%)

| RC | 80 | | | | 70 | | | | 50 | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70 | 50 | 30 | 10 | 70 | 50 | 30 | 10 | 50 | 30 | 10 | 0 |
| RCR 1 | 109 | 105 | 101 | 97 | 107 | 102 | 99 | 95 | 98 | 95 | 92 | 85 |
| 2 | 100 | 92 | 86 | 80 | 97 | 90 | 84 | 79 | 87 | 82 | 78 | 72 |
| 3 | 92 | 82 | 74 | 68 | 89 | 80 | 73 | 67 | 77 | 71 | 66 | 62 |
| 4 | 84 | 73 | 65 | 58 | 82 | 72 | 64 | 58 | 69 | 62 | 57 | 53 |
| 5 | 78 | 66 | 57 | 51 | 76 | 65 | 57 | 51 | 63 | 55 | 50 | 47 |
| 6 | 72 | 60 | 51 | 45 | 70 | 59 | 50 | 45 | 57 | 50 | 44 | 41 |
| 7 | 67 | 54 | 46 | 40 | 66 | 53 | 45 | 40 | 52 | 45 | 39 | 37 |
| 8 | 63 | 50 | 42 | 36 | 61 | 49 | 41 | 36 | 48 | 41 | 36 | 33 |
| 9 | 59 | 46 | 38 | 32 | 57 | 45 | 38 | 32 | 44 | 37 | 32 | 30 |
| 10 | 55 | 42 | 35 | 30 | 54 | 42 | 35 | 30 | 41 | 34 | 29 | 27 |

**RCR** = Room Cavity Ratio
**RC** = Effective Ceiling Cavity Reflectance **RW** = Wall Reflectance

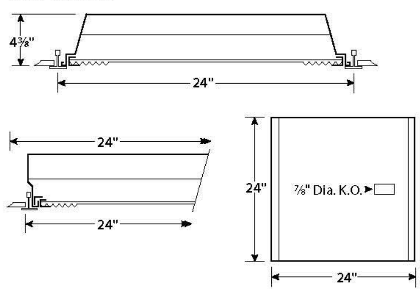
Columbia LIGHTING

# LLT22

## 2' × 2', LED Lensed Troffer with Advanced Solid State Technology

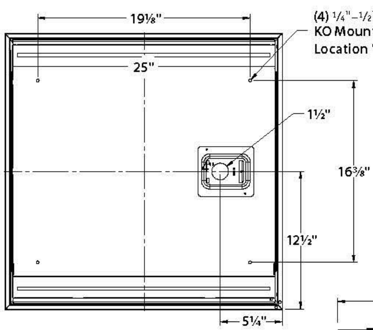
### DIMENSIONAL DATA

2" x 2" LED Lay-In



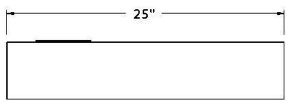

**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

### DIMENSIONAL DATA - SURFACE OR CABLE MOUNT

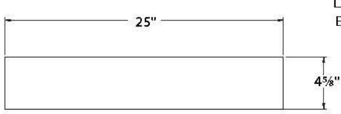



4½" x 5" Mounting Collar (SM only). For Cable Mount (CM) a 2" x 3" access plate with (2) ⅞" KOs provided in place of Mounting Collar shown.

LLT 2X2, ALL DIMENSIONS ARE IN INCHES




End View




Side View

**NOTE:** All dimensions are in inches; dimensions and specifications are subject to change without notice. Please consult factory or check sample for verification.

**Surface Mount**

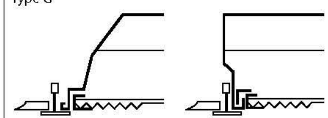
Order SM ceiling type. Mounting collar required for surface mounting. (4) Mounting KOs, ¼" to ½" provided as shown at left, marked "A".

**Cable Mount**

Order CM ceiling type. Access plate supplied for cable mounting or suspension. Use CM48Y2C3F-KIT 48" Cable Mount Kit. Includes 3-wire feed cord. For other wiring needs, contact Hubbell representative. Mounting KOs, ¼" to ½", provided as shown at left, marked "A".

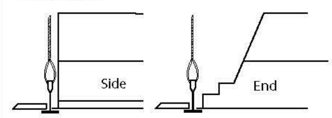
### CEILING COMPATIBILITY

Type G



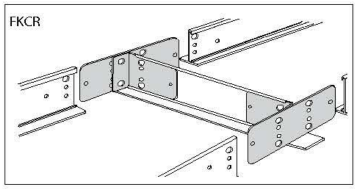
For lay-in insallation in exposed grid ceilings. Maximum tee widths of 1" and maximum tee heights of 2" allowed. Shown with flush lens.

FK14 Flange Kit




For hard ceiling applications, order FK14 flange kit. Flange kit wires directly into concealed ceiling opening for a clean, finished appearance. Shown with flush lens.

FKCR



For flanged fixtures in row configurations, the FKCR adapter bracket kit is required in addition to the FK14 kit. Order one less FKCR than the total number of fixtures in row. (Example: Row of two, order (2) FK14 & (1) FKCR)

Row cut out dimensions using FK14 & FKCR adapters: Width 12⅝", Length [48" × (# in row)] + ⅜" = 96⅜"]

Flange kit rough in dimensions for single unit only: 12⅝" x 48⅝"

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HUBBELL Lighting

## A7. Finelight HPR-HO 24

# FINELITE

LED

BUY AMERICAN ACT OF 2009 COMPLIANT

## High Performance Recessed (HPR-LED) 2x4

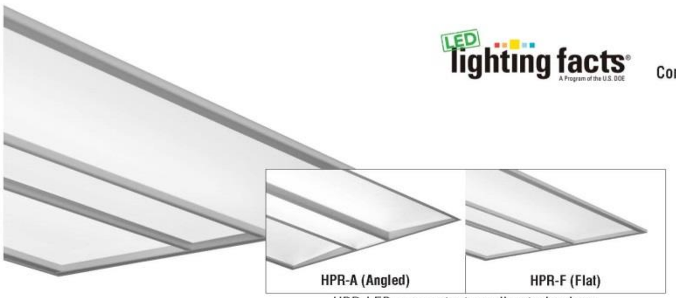
INDUSTRY BEST 10 YEAR WARRANTY HPR-LED

2011 PROGRESS Report SELECTION — **HPR-LED Collection** 2011 IES Progress Report Selection

DESIGNLIGHTS CONSORTIUM Qualified Luminaire

LED lighting facts® A Program of the U.S. DOE

| | |
|---|---|
| Date | |
| Project | |
| Type | |
| Comments | |



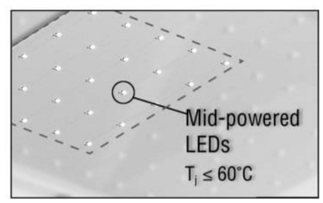

HPR-LED uses patent pending technology

### DESCRIPTION

HPR-LED is a highly effective recessed luminaire delivering excellent visual comfort and outstanding performance for offices, schools, healthcare, and retail applications. Advanced optical designs make HPR-LED a powerful solution for low-ceiling applications and eliminate the shadows common to other LED recessed products. HPR-LED RoHS compliant.

**GLARE-FREE ILLUMINATION:**
A glare-free experience is attained with mid-powered LEDs properly distributed and paired with a precise diffuser to eliminate pixilation.

**100% SERVICEABLE FROM BELOW:**
The light engine and driver can be easily changed from below ceiling – and it's simple to install.




**THERMAL MANAGEMENT:**
Mid-powered LEDs allow heat to be fully dissipated without the need for additional heat sinks.

### ORDERING GUIDE

*Sample Number: HPR - A - 2x4- DCO - LED-SO - 4000K - 277V - SC - C1 - OBD*

HPR – F – 2x4 – DCO – LED-HO – 4000K – 120V – SC – C1 – OBD

- Finelite **Series HPR**
- Luminaire Styles (A-Angled, F-Flat)
- Size (2x4)
- Center Optic (DCO-Diffuse, SCO-Slotted, RCO-Round)
- Light Engine* (LED-SO, LED-HO, LED-VHO)
- LED Color Temperature (3000K, 3500K, 4000K)
- Voltage (120V, 277V)
- Circuiting (SC-Single Circuit)
- Mounting (C1-1" T-Bar, C2-9/16" T-Bar, C3-Screw Slot, DW-Drywall Kit, SM-Surface Mount)
- Integrated Sensors (OBD-Daylight, OBO-Occupancy, OBB-Both)

** SO = Standard Output 3403 lumens (3000K), 3786 lumens (3500K), 3721 lumens (4000K) HO = High Output 4880 lumens (3000K), 5585 lumens (3500K), 5928 lumens (4000K)*
*VHO = Very High Output 6398 lumens (3000K), 6869 lumens (3500K), 7291 lumens (4000K)*

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*Due to continuing product improvements, Finelite reserves the right to change specifications without notice. Please visit www.finelite.com for most current data.*

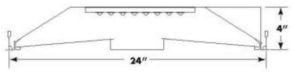
BUY AMERICAN ACT OF 2009 COMPLIANT · IC - RATED

# FINELITE

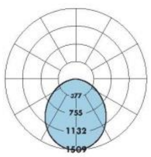
## High Performance Recessed (HPR-LED) 2x4

### PHOTOMETRY

HPR-LED-SO-A-DCO (2x4)
106.1 Lumens Per Watt
3786 Lumens/35.7 Watts
CRI: 83
R9: 11
CCT: 3500K
ITL LM79 Report 72704




— *Refer to www.finelite.com for additional photometry and product information.*



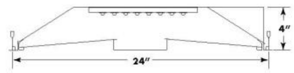


CANDLEPOWER SUMMARY

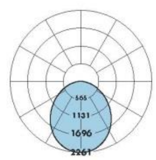
| | 0.0 | 22.5 | 45 | 67.5 | ACROSS | Flux |
|---|---|---|---|---|---|---|
| 0 | 1505 | 1505 | 1505 | 1505 | 1505 | |
| 5 | 1502 | 1500 | 1493 | 1490 | 1487 | 142 |
| 10 | 1477 | 1474 | 1467 | 1462 | 1459 | |
| 15 | 1435 | 1430 | 1423 | 1415 | 1414 | 401 |
| 20 | 1377 | 1370 | 1363 | 1358 | 1353 | |
| 25 | 1304 | 1301 | 1291 | 1286 | 1280 | 595 |
| 30 | 1217 | 1211 | 1201 | 1202 | 1192 | |
| 35 | 1121 | 1112 | 1105 | 1098 | 1095 | 690 |
| 40 | 1007 | 1002 | 996 | 988 | 986 | |
| 45 | 892 | 884 | 877 | 872 | 868 | 679 |
| 50 | 772 | 769 | 759 | 760 | 749 | |
| 55 | 655 | 650 | 644 | 639 | 636 | 576 |
| 60 | 535 | 532 | 527 | 522 | 519 | |
| 65 | 420 | 419 | 416 | 408 | 406 | 412 |
| 70 | 314 | 319 | 308 | 308 | 298 | |
| 75 | 220 | 222 | 214 | 213 | 210 | 228 |
| 80 | 133 | 132 | 128 | 127 | 123 | |
| 85 | 57 | 55 | 55 | 51 | 49 | 63 |
| 90 | 0 | 0 | 0 | 0 | 0 | |

### PHOTOMETRY

HPR-LED-HO-A-DCO (2x4)
97.1 Lumens Per Watt
5585 Lumens/57.5 Watts
CRI: 82
R9: 7
CCT: 3500K
ITL LM79 Report 72830




— *Refer to www.finelite.com for additional photometry and product information.*




CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | ACROSS | Flux |
|---|---|---|---|---|---|---|
| 0 | 2256 | 2256 | 2256 | 2256 | 2256 | |
| 5 | 2250 | 2248 | 2239 | 2232 | 2229 | 212 |
| 10 | 2213 | 2208 | 2195 | 2184 | 2182 | |
| 15 | 2146 | 2139 | 2124 | 2109 | 2101 | 598 |
| 20 | 2058 | 2049 | 2029 | 2009 | 2001 | |
| 25 | 1948 | 1937 | 1908 | 1893 | 1882 | 880 |
| 30 | 1814 | 1805 | 1769 | 1758 | 1745 | |
| 35 | 1671 | 1652 | 1622 | 1600 | 1594 | 1016 |
| 40 | 1509 | 1486 | 1456 | 1439 | 1430 | |
| 45 | 1334 | 1310 | 1283 | 1266 | 1261 | 996 |
| 50 | 1151 | 1140 | 1107 | 1101 | 1087 | |
| 55 | 983 | 961 | 943 | 930 | 923 | 846 |
| 60 | 808 | 791 | 771 | 764 | 759 | |
| 65 | 639 | 620 | 604 | 600 | 592 | 607 |
| 70 | 477 | 471 | 449 | 453 | 437 | |
| 75 | 336 | 324 | 314 | 310 | 303 | 335 |
| 80 | 197 | 192 | 186 | 187 | 179 | |
| 85 | 86 | 85 | 78 | 73 | 71 | 93 |
| 90 | 0 | 0 | 0 | 0 | 0 | |

**Consult www.finelite.com for 3000K and 4000K photometric reports.**

### SPECIFICATIONS

**CONSTRUCTION:** Fixture assembly constructed using die-formed 20-gauge cold-rolled steel housing and ends. All components are hard-tooled to tolerances of 0.010". Driver compartment is accessible from below. High quality, UV stabilized, weather-strip pile gasket with polypropylene backing. Optical system retained using hinged door frame assembly to provide easy access to driver compartment and for servicing from below without the need of tools. Seismic brackets are integrated into the fixture assembly. Additional wire entrances are positioned on the ends of the housing to allow easy wiring access for the installer.

**REFLECTORS:** Die-formed 20-gauge cold-rolled steel reflectors are finished in 96 LG high reflectance matte white powder coat paint.

**OPTICAL SYSTEM:** Optical system components include diffuser panels and a center optic element held in place with a frame constructed from die-formed cold-rolled steel. The diffusers are UV-stabilized and impact-resistant frosted virgin acrylic, 0.120" thick. They are either angled toward the center optic or parallel to the ceiling plane.

*Available options for the center optic elements:*

*Diffuse Center Optic: UV-stabilized and impact-resistant frosted virgin acrylic.*

*Slotted Center Optic: Die-formed cold-rolled steel panel with 1/16" x 1/2" rectangular hole pattern. Virgin acrylic overlay.*

*Round Center Optic: Die-formed cold-rolled steel panel with precision-punched 3/32" round hole pattern arranged in staggered formation. Virgin acrylic overlay.*

**LIGHT ENGINE:** 2X4 HPR-LED-SO (4000K) delivers 3721 lumens at 35.2W, 2X4 HPR-LED-SO (3500K) delivers 3786 lumens at 35.7W, 2X4 HPR-LED-SO (3000K) delivers 3403 lumens at 35.6W, 2X4 HPR-LED-HO (4000K) delivers 5928 lumens at 56.2W, 2X4 HPR-LED-HO (3500K) delivers 5585 lumens at 57.5W, 2X4 HPR-LED-HO (3000K) delivers 4880 lumens at 53.2W, 2x4 HPR-LED-VHO (4000K) delivers 7291 lumens at 74.1W, and 2x4 HPR-LED-VHO (3500K) delivers 6869 lumens at 73.3W, 2x4 HPR-LED-VHO (3000K) delivers 6398 lumens at 74.1W. Light engine is made up of high performance mid-powered LEDs and is designed to distribute heat properly to maximize the life of the LED. LED color temperature: 3000K, 3500K or 4000K. CRI: 83, R9:7 (4000K-VHO), CRI:86, R9: 26 (3500K-VHO), CRI:87, R9: 32 (3000K-VHO), CRI:82, R9: 7 (3500K-HO), CRI:83, R9: 11 (3500K-SO), CRI:87, R9: 32 (3000K-HO), CRI:87, R9: 33 (3000K-SO).

**LUMEN MAINTENANCE:** HPR-LED is rated to deliver 90% lumen maintenance (L90) to 100,000 hours and 70% lumen maintenance (L70) to 168,000 hours.

**DRIVER:** High performance Constant Current Reduction LED driver. Driver is fully accessible from below the ceiling. *120/277v. Power Factor = 98.7% (4000K), 97.4% (3500K-HO), 94.4% (3500K-SO), 96.8% (3000K-HO), 94.2% (3000K-SO), 98.5% (3000K-VHO). Contact factory for Emergency Battery backups. Total harmonic distortion (THD) <20%. Input current (3000K): VHO - 0.626A @ 120V, 0.287A @277V; HO - 0.458A @120V, 0.216A @ 277V; SO - 0.314A @ 120V, 0.141A @ 277V. Expected driver lifetime: 170,000 hours. Lutron driver options: Lut3W- 3-wire driver, LutES - EcoSystem driver, Lut2W - 2-wire driver.

*Driver can be wired as dimming or non-dimming. Dimming is compatible with 0-10v controls with a range of 100-10%.

**ELECTRICAL:** 120V or 277V prewired. Fixture and electrical components are ETL listed conforming to UL 1598 in the U.S.A., and Canada; ETL listed to certified CAN/CSA C22.2 No. 250.0. In accordance with NEC Code 410.73 (G), this luminaire contains an internal driver disconnect. Optional Chicago plenum, and emergency battery backup available. IC Rated.

Daylight Sensor · Occupancy Sensor

**INTEGRATED SENSORS:** HPR-LED can be specified with integrated PIR (Passive Infared) occupancy sensors or daylight sensors. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

**MOUNTING:** Standard flange design works with most lay-in ceiling types. Integral pryout tabs secure luminaire to ceiling grid from above. Fixture offers tie-in locations for tie-wire on all corners. Consult local code for appropriate tie-wire recommendations. Drywall Kit available. Surface mount version available; refer to separate tech sheet.

**AIR RETURN:** Refer to 2x4 Air Return tech sheet for more info.

**FEED:** 18-gauge wire standard.

**FINISH:** Housing and door assembly painted with 96 LG high reflectance matte white powder coat paint. Available in matte white only.

**WEIGHT:** Maximum weight: 2x4 - 33 lbs.

**LABELS:** Fixtures and electrical components are ETL listed conforming to UL1598 in the USA, and Canada and ETL listed certified to CAN/CSA C22.2 No. 250.0. In accordance with NEC code 410.73 (G) this luminaire contains an internal driver disconnect. IC-Rated. Damp location.

**WARRANTY:** HPR-LED comes standard with a 10-year, warranty on all components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

**DLC Qualified:** HPR-LED 2x4 with the VHO, HO, and SO lumen outputs and Diffuse Center Optic (DCO) is qualified under the Designlights Consortium program.

## A8. Finelight HPR-HO 22

LED FINELITE

# High Performance Recessed (HPR-LED) 2x2 High Output (HO)

BUY AMERICAN ACT OF 2009 COMPLIANT

HPR-LED Collection 2011 IES Progress Report Selection

DESIGNLIGHTS CONSORTIUM Qualified Luminaire

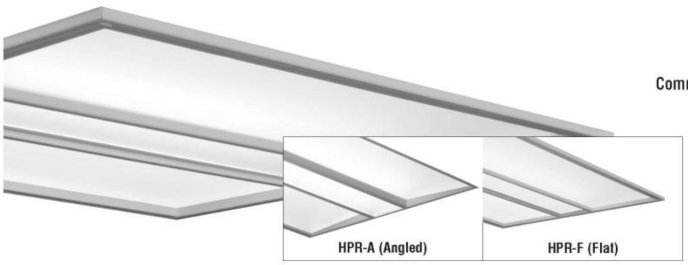
LED lighting facts

Date

Project

Type

Comments



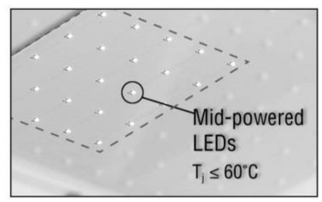

HPR-LED uses patent pending technology

### DESCRIPTION

HPR-LED is a highly effective recessed luminaire delivering excellent visual comfort and outstanding performance for offices, schools, healthcare, and retail applications. Advanced optical designs make HPR-LED a powerful solution for low-ceiling applications and eliminate the shadows common to other LED recessed products. HPR-LED RoHS compliant.

**GLARE-FREE ILLUMINATION:**
A glare-free experience is attained with mid-powered LEDs properly distributed and paired with a precise diffuser to eliminate pixilation.

**100% SERVICEABLE FROM BELOW:**
The light engine and driver can be easily changed from below ceiling – and it's simple to install.




**THERMAL MANAGEMENT:**
Mid-powered LEDs allow heat to be fully dissipated without the need for additional heat sinks.

### ORDERING GUIDE

*Sample Number: HPR - A - 2x2 - DCO - LED-HO - 4000K - 277V - SC - C1 - OBO*

HPR – F – 2x2 – DCO – LED-HO – 4000K – 120V – SC – C1 – OBD

- Finelite **Series HPR**
- Luminaire Styles (A-Angled, F-Flat)
- Size (2x2)
- Center Optic (DCO-Diffuse, SCO-Slotted, RCO-Round)
- Light Engine* (LED-HO)
- LED Color Temperature (3000K, 3500K, 4000K)
- Voltage (120V, 277V)
- Circuiting (SC-Single Circuit)
- Mounting (C1-1" T-Bar, C2-9/16" T-Bar, C3-Screw Slot, DW-Drywall Kit, SM-Surface Mount)
- Integrated Sensors (OBD-Daylight, OBO-Occupancy, OBB-Both)

** HO = High Output 4969 lumens (4000K)*

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LED
# FINELITE

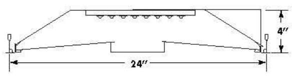
## High Performance Recessed (HPR-LED) 2x2 High Output (HO)

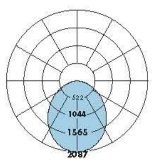
IC - RATED

BUY AMERICAN ACT OF 2009 COMPLIANT

### PHOTOMETRY

HPR-LED-HO-A-DCO (2x2)
88.3 Lumens Per Watt
4969 Lumens/56 Watts
CRI: 83
R9: 13.3
CCT: 4000K
ITL LM79 Report 73598



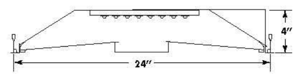

*— Refer to www.finelite.com for additional photometry and product information.*

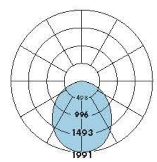
CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | ACROSS | Flux |
|---|---|---|---|---|---|---|
| 0 | 2087 | 2087 | 2087 | 2087 | 2087 | |
| 5 | 2073 | 2073 | 2067 | 2065 | 2062 | 196 |
| 10 | 2036 | 2032 | 2024 | 2016 | 2017 | |
| 15 | 1966 | 1959 | 1950 | 1941 | 1942 | 550 |
| 20 | 1876 | 1865 | 1856 | 1846 | 1848 | |
| 25 | 1764 | 1754 | 1738 | 1735 | 1729 | 802 |
| 30 | 1633 | 1620 | 1603 | 1602 | 1594 | |
| 35 | 1489 | 1473 | 1459 | 1453 | 1455 | 914 |
| 40 | 1330 | 1316 | 1301 | 1295 | 1298 | |
| 45 | 1173 | 1150 | 1137 | 1135 | 1141 | 886 |
| 50 | 1006 | 995 | 976 | 983 | 976 | |
| 55 | 854 | 833 | 821 | 825 | 826 | 742 |
| 60 | 695 | 677 | 666 | 668 | 668 | |
| 65 | 542 | 529 | 518 | 522 | 517 | 522 |
| 70 | 398 | 400 | 383 | 391 | 381 | |
| 75 | 279 | 269 | 264 | 266 | 261 | 283 |
| 80 | 164 | 159 | 154 | 153 | 152 | |
| 85 | 68 | 65 | 62 | 60 | 60 | 75 |
| 90 | 0 | 0 | 0 | 0 | 0 | |

### PHOTOMETRY

HPR-LED-HO-A-DCO (2x2)
84.5 Lumens Per Watt
4834 Lumens/57 Watts
CRI: 85
R9: 21
CCT: 3500K
ITL LM79 Report 74758




*— Refer to www.finelite.com for additional photometry and product information.*

CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | ACROSS | Flux |
|---|---|---|---|---|---|---|
| 0 | 1991 | 1991 | 1991 | 1991 | 1991 | |
| 5 | 1977 | 1977 | 1974 | 1972 | 1973 | 187 |
| 10 | 1938 | 1935 | 1935 | 1933 | 1937 | |
| 15 | 1875 | 1870 | 1871 | 1874 | 1878 | 528 |
| 20 | 1787 | 1785 | 1787 | 1794 | 1797 | |
| 25 | 1677 | 1680 | 1682 | 1697 | 1698 | 776 |
| 30 | 1548 | 1555 | 1559 | 1579 | 1581 | |
| 35 | 1415 | 1413 | 1426 | 1445 | 1451 | 893 |
| 40 | 1260 | 1265 | 1276 | 1296 | 1305 | |
| 45 | 1108 | 1108 | 1125 | 1143 | 1153 | 870 |
| 50 | 944 | 958 | 962 | 988 | 992 | |
| 55 | 797 | 802 | 814 | 829 | 830 | 728 |
| 60 | 651 | 651 | 661 | 673 | 674 | |
| 65 | 504 | 509 | 513 | 521 | 524 | 512 |
| 70 | 369 | 381 | 373 | 390 | 385 | |
| 75 | 255 | 256 | 255 | 261 | 262 | 273 |
| 80 | 146 | 148 | 145 | 149 | 148 | |
| 85 | 58 | 59 | 57 | 55 | 55 | 68 |
| 90 | 0 | 0 | 0 | 0 | 0 | |

**Consult www.finelite.com for 3000K photometric reports.**

### SPECIFICATIONS

**CONSTRUCTION:** Fixture assembly constructed using die-formed 20-gauge cold-rolled steel housing and ends. All components are hard-tooled to tolerances of 0.010". Driver compartment is accessible from below. High quality, UV stabilized, weather-strip pile gasket with polypropylene backing. Optical system retained using hinged door frame assembly to provide easy access to driver compartment and for servicing from below without the need of tools. Seismic brackets are integrated into the fixture assembly. Additional wire entrances are positioned on the ends of the housing to allow easy wiring access for the installer.

**REFLECTORS:** Die-formed 20-gauge cold-rolled steel reflectors are finished in 96 LG high reflectance matte white powder coat paint.

**OPTICAL SYSTEM:** Optical system components include diffuser panels and a center optic element held in place with a frame constructed from die-formed cold-rolled steel. The diffusers are UV-stabilized and impact-resistant frosted virgin acrylic, 0.120" thick. They are either angled toward the center optic or parallel to the ceiling plane.

*Available options for the center optic elements:*

*Diffuse Center Optic: UV-stabilized and impact-resistant frosted virgin acrylic.*

*Slotted Center Optic: Die-formed cold-rolled steel panel with 1/16" x 1/2" rectangular hole pattern. Virgin acrylic overlay. Round Center Optic: Die-formed cold-rolled steel panel with precision-punched 3/32" round hole pattern arranged in staggered formation. Virgin acrylic overlay.*

**LIGHT ENGINE:** 2x2 HPR-LED High Output (3000k) delivers 4351 lumens at 59W. 2x2 HPR-LED High Output (3500K) delivers 4834 lumens at 57W. 2x2 HPR-LED High Output (4000k) delivers 4969 lumens at 56W. Light engine is made up of high performance mid-powered LEDs and is designed to distribute heat properly to maximize the life of the LED. LED color temperature: 3000K, 3500K, and 4000K. CRI: 86 (3000K), 85 (3500K), 84 (4000K). R9: 30 (3000K), 21 (3500K), 13.3 (4000K).

**LUMEN MAINTENANCE:** HPR-LED 2x2 High Output is rated to deliver 70% lumen maintenance (L70) to 100,000 hours.

**DRIVER:** High performance LED driver. Driver is fully accessible from below the ceiling. *120/277v. Power Factor = 95.7% (4000K), 95.5% (3500K), 97.8% (3000K). Contact factory for Emergency Battery backups. Total harmonic distortion (THD) <20%. Input current (3500K): 0.503A @ 120VAC, and 0.238A @ 277VAC. Lutron driver options: Lut3W- 3-wire driver, LutES - EcoSystem driver, Lut2W - 2-wire driver.

*Driver can be wired as dimming or non-dimming. Dimming is compatible with 0-10v controls with a range of 100-10%.

**ELECTRICAL:** Optional Chicago Plenum available. Contact factory.

Daylight Sensor  Occupancy Sensor

**INTEGRATED SENSORS:** Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

**MOUNTING:** Standard flange design works with most lay-in ceiling types. Integral pryout tabs secure luminaire to ceiling grid from above. Fixture offers tie-in locations for tie-wire on all corners. Consult local code for appropriate tie-wire recommendations. Drywall Kit available. Surface mount version available; refer to separate tech sheet.

**AIR RETURN:** Refer to 2x2 Air Return tech sheet for more info.

**FEED:** 18-gauge wire standard.

**FINISH:** Housing and door assembly painted with 96 LG high reflectance matte white powder coat paint. Available in matte white only. Optional adder: Antimicrobial paint is available. Contact factory.

**WEIGHT:** Maximum weight: 2x2 - 16 lbs.

**LABELS:** Fixtures and electrical components are ETL listed conforming to UL1598 in the USA, and Canada and ETL listed certified to CAN/CSA C22.2 No. 250.0. In accordance with NEC code 410.73 (G) this luminaire contains an internal driver disconnect. IC-Rated. Damp location.

**WARRANTY:** HPR-LED 2x2 HO comes standard with a 5-year warranty on all components.

**DLC QUALIFIED:** HPR-LED 2x2 HO with the Diffuse Center Optic (DCO) is qualified under the DesignLights Consortium program.

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## A9. Finelight HP-4 ID

LED

BUY AMERICAN ACT OF 2009 COMPLIANT

# FINELITE High Performance 4" Aperture (HP-4) - Indirect/Direct

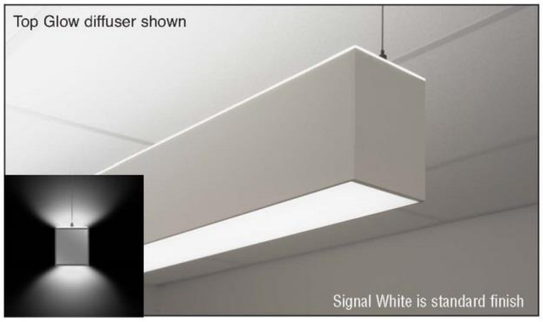
Industry Best 10 Year Warranty HP-4-LED | 2012 Progress Report Selection | PLA 13 Product Innovation Award Winner | NGL '13 Next Generation Luminaire Winner | LED lighting facts

Date

Project

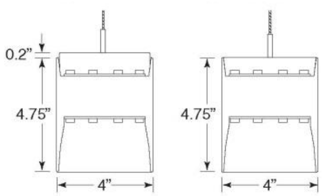
Type

Comments




### DESCRIPTION

High Performance 4" aperture indirect/direct pendant (HP-4 ID) is a patent pending, linear LED luminaire for offices, schools, retail and healthcare facilities. Advanced optical designs and mid-powered LEDs deliver an efficient, long-lasting luminaire free of glare and socket shadows for single and continuous lighting applications. HP-4 ID is RoHS compliant.




Top Glow™ Diffuser (Standard) Flush Uplight Diffuser (Optional)

### DIMENSIONS & DIFFUSER

A glare-free experience is attained with mid-powered LEDs properly distributed and paired with a precise diffuser to eliminate pixilation. Diffusers up to 12' in length.

### INDIRECT/DIRECT DIMMING

Uplight and downlight can be dimmed together or individually for maximum control over your space. 0-10v controls; range 100%-10%.

### SEAMLESS ILLUMINATION

The optical design features seamless lenses up to 12' in length and eliminates socket shadows at joints and corners.

### ORDERING GUIDE

*Sample Number: HP-4 ID - 32' - SO - HO - 3500K - TG- 120V - FA - SC - C1 - OBO*

HP-4 ID | 4' | SO | SO | 4000K | TG | 120V | FA | SC | C1 | OBD

- Finelite **Series HP-4 ID** — HP-4 ID
- Size (4', 8', 12' Multiples Standard) — 4'
- Uplight Engine (SO - Standard Output, HO - High Output) — SO
- Downlight Engine (SO - Standard Output, HO - High Output) — SO
- LED Color Temperature (3000K, 3500K, 4000K) — 4000K
- Uplight Diffuser Option (TG - Top Glow, F - Flush)* — TG
- Voltage (120V, 277V) — 120V
- Mounting (FA - Fully Adjustable) — FA
- Circuiting (SC - Single Circuit, MC - Multi-Circuit) — SC
- Ceiling Type (C1 - 1" T-Bar, C2 - 9/16" T-Bar, C3 - Screw Slot, C4 - Hard Ceiling) — C1
- Intergrated Sensor (OBO - Occupancy Sensor, OBD - Daylight, OBB - Both) — OBD

* Top Glow Diffuser - Standard, Flush Uplight Diffuser - Optional

**Protected by one or more US patents: D702,391; D702,390; D700,732**

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*Due to continuing product improvements, Finelite reserves the right to change specifications without notice. Please visit www.finelite.com for most current data.*

LED

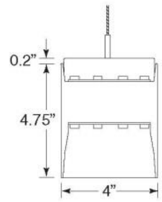
BUY AMERICAN ACT OF 2009 COMPLIANT

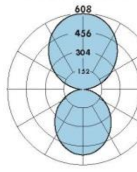
# FINELITE

## High Performance 4" Aperture (HP-4) - Indirect/Direct

### PHOTOMETRY

Standard Output/ Standard Output
Distribution: 55% Up (SO) / 45% Down (SO)
1719 Lumens Up / 1408 Lumens Down
Efficacy (Lumen per watt): 95 LPW Up/ 77 LPW Down
Total luminaire output: 3127 Lumens (782 lumens/foot)
36 Watts (9 watts/foot)
CRI: 83
R9: 9
CCT: 4000K
ITL LM79 Report 74369



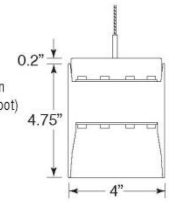

*— Refer to www.finelite.com for additional photometry and product information.*

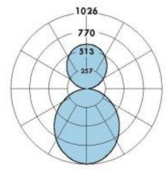

CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | 90 | Flux |
|---|---|---|---|---|---|---|
| 0 | 528 | 528 | 528 | 528 | 528 | |
| 5 | 525 | 526 | 527 | 523 | 521 | 50 |
| 15 | 499 | 502 | 502 | 497 | 494 | 141 |
| 25 | 453 | 459 | 453 | 452 | 447 | 209 |
| 35 | 393 | 397 | 390 | 391 | 387 | 245 |
| 45 | 321 | 325 | 317 | 320 | 316 | 247 |
| 55 | 246 | 250 | 242 | 246 | 241 | 219 |
| 65 | 166 | 171 | 164 | 169 | 164 | 166 |
| 75 | 92 | 97 | 92 | 97 | 92 | 100 |
| 85 | 25 | 29 | 26 | 31 | 26 | 32 |
| 90 | 0 | 5 | 6 | 7 | 8 | |
| 95 | 37 | 44 | 38 | 45 | 39 | 45 |
| 105 | 120 | 125 | 119 | 126 | 120 | 129 |
| 115 | 207 | 215 | 208 | 216 | 208 | 209 |
| 125 | 302 | 306 | 301 | 305 | 300 | 271 |
| 135 | 389 | 395 | 388 | 393 | 387 | 302 |
| 145 | 470 | 472 | 469 | 471 | 467 | 294 |
| 155 | 535 | 539 | 535 | 536 | 532 | 247 |
| 165 | 582 | 584 | 584 | 582 | 580 | 164 |
| 175 | 605 | 606 | 607 | 602 | 602 | 57 |
| 180 | 606 | 606 | 606 | 606 | 606 | |

### PHOTOMETRY

Standard Output/ High Output
Distribution: 38% Up (SO) / 62% Down (HO)
1697 Lumens Up / 2735 Lumens Down
Efficacy (Lumen per watt): 93 LPW Up/ 74 LPW Down
Total luminaire output: 4431 Lumens (1108 lumens/foot)
55 Watts (13.8 watts/foot)
CRI: 84
R9: 10
CCT: 4000K
ITL LM79 Report 74367



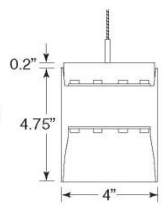

*— Refer to www.finelite.com for additional photometry and product information.*

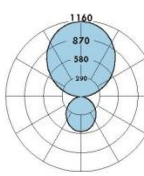

CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | 90 | Flux |
|---|---|---|---|---|---|---|
| 0 | 1023 | 1023 | 1023 | 1023 | 1023 | |
| 5 | 1017 | 1017 | 1022 | 1010 | 1009 | 96 |
| 15 | 969 | 970 | 973 | 960 | 961 | 273 |
| 25 | 883 | 888 | 882 | 873 | 871 | 405 |
| 35 | 767 | 769 | 762 | 756 | 754 | 476 |
| 45 | 630 | 629 | 620 | 617 | 619 | 481 |
| 55 | 481 | 482 | 474 | 475 | 473 | 425 |
| 65 | 330 | 327 | 323 | 325 | 323 | 323 |
| 75 | 184 | 184 | 183 | 184 | 182 | 193 |
| 85 | 53 | 53 | 54 | 57 | 54 | 62 |
| 90 | 0 | 5 | 8 | 10 | 12 | |
| 95 | 31 | 42 | 34 | 43 | 36 | 43 |
| 105 | 113 | 121 | 115 | 122 | 116 | 125 |
| 115 | 201 | 210 | 202 | 212 | 203 | 205 |
| 125 | 296 | 301 | 295 | 302 | 296 | 267 |
| 135 | 382 | 390 | 383 | 389 | 382 | 298 |
| 145 | 465 | 469 | 465 | 468 | 464 | 292 |
| 155 | 531 | 536 | 532 | 535 | 529 | 246 |
| 165 | 578 | 582 | 582 | 580 | 577 | 164 |
| 175 | 603 | 604 | 605 | 601 | 601 | 57 |
| 180 | 604 | 604 | 604 | 604 | 604 | |

### PHOTOMETRY

High Output / Standard Output
Distribution: 70% Up (HO) / 31% Down (SO)
3259 Lumens Up / 1431 Lumens Down
Efficacy (Lumen per watt): 88 LPW Up/ 78 LPW Down
Total luminaire output: 4690 Lumens (1173 lumens/foot)
55 Watts (13.8 watts/foot)
CRI: 83
R9: 10
CCT: 4000K
ITL LM79 Report 74368



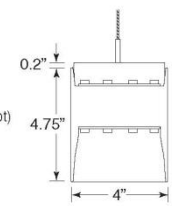

*— Refer to www.finelite.com for additional photometry and product information.*

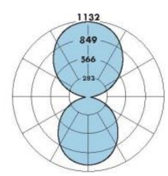

CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | 90 | Flux |
|---|---|---|---|---|---|---|
| 0 | 535 | 535 | 535 | 535 | 535 | |
| 5 | 532 | 534 | 537 | 533 | 530 | 51 |
| 15 | 506 | 512 | 512 | 507 | 504 | 143 |
| 25 | 459 | 467 | 461 | 460 | 454 | 212 |
| 35 | 398 | 404 | 397 | 398 | 392 | 249 |
| 45 | 325 | 330 | 323 | 325 | 320 | 251 |
| 55 | 247 | 253 | 244 | 249 | 244 | 221 |
| 65 | 168 | 174 | 166 | 171 | 166 | 168 |
| 75 | 93 | 99 | 93 | 99 | 94 | 101 |
| 85 | 25 | 31 | 27 | 33 | 30 | 34 |
| 90 | 0 | 4 | 7 | 9 | 12 | |
| 95 | 69 | 77 | 72 | 80 | 73 | 83 |
| 105 | 230 | 233 | 231 | 231 | 231 | 243 |
| 115 | 399 | 402 | 398 | 402 | 400 | 396 |
| 125 | 579 | 577 | 573 | 576 | 573 | 514 |
| 135 | 742 | 745 | 738 | 743 | 736 | 572 |
| 145 | 893 | 895 | 892 | 891 | 890 | 559 |
| 155 | 1021 | 1022 | 1021 | 1017 | 1012 | 469 |
| 165 | 1110 | 1111 | 1112 | 1104 | 1103 | 313 |
| 175 | 1155 | 1156 | 1157 | 1147 | 1148 | 110 |
| 180 | 1157 | 1157 | 1157 | 1157 | 1157 | |

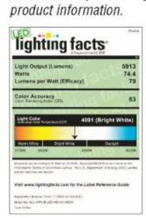
### PHOTOMETRY

High Output / High Output
Distribution: 54% Up (HO) / 46% Down (HO)
3188 Lumens Up / 2725 Lumens Down
Efficacy (Lumen per watt): 86 LPW Up/ 73 LPW Down
Total luminaire output: 5913 Lumens (1478 lumens/foot)
74 Watts (18.5 watts/foot)
CRI: 83
R9: 9
CCT: 4000K
ITL LM79 Report 74181




*— Refer to www.finelite.com for additional photometry and product information.*




CANDLEPOWER SUMMARY

| | 0.0 | 22.5 | 45 | 67.5 | 90 | Flux |
|---|---|---|---|---|---|---|
| 0 | 1016 | 1016 | 1016 | 1016 | 1016 | |
| 5 | 1013 | 1013 | 1017 | 1007 | 1006 | 96 |
| 15 | 965 | 968 | 971 | 958 | 958 | 272 |
| 25 | 879 | 883 | 879 | 869 | 867 | 403 |
| 35 | 764 | 763 | 757 | 750 | 751 | 473 |
| 45 | 626 | 626 | 617 | 612 | 615 | 478 |
| 55 | 479 | 477 | 472 | 470 | 472 | 423 |
| 65 | 328 | 327 | 321 | 321 | 320 | 321 |
| 75 | 187 | 185 | 183 | 186 | 184 | 194 |
| 85 | 55 | 57 | 57 | 58 | 57 | 64 |
| 90 | 0 | 7 | 8 | 12 | 14 | |
| 95 | 69 | 74 | 70 | 76 | 72 | 80 |
| 105 | 222 | 224 | 225 | 225 | 226 | 237 |
| 115 | 385 | 392 | 388 | 394 | 391 | 387 |
| 125 | 565 | 562 | 562 | 562 | 560 | 503 |
| 135 | 727 | 730 | 727 | 727 | 720 | 561 |
| 145 | 876 | 876 | 877 | 872 | 871 | 548 |
| 155 | 999 | 1001 | 999 | 995 | 992 | 460 |
| 165 | 1086 | 1086 | 1088 | 1081 | 1081 | 306 |
| 175 | 1129 | 1128 | 1130 | 1121 | 1123 | 107 |
| 180 | 1128 | 1128 | 1128 | 1128 | 1128 | |

**Consult www.finelite.com for 3000K and 3500K photometric reports.**

**Protected by one or more US patents: D702,391; D702,390; D700,732**

Finelite, Inc. • 30500 Whipple Road • Union City, CA 94587-1530 • 510 / 441-1100 • Fax: 510 / 441-1510 • www.finelite.com

*Due to continuing product improvements, Finelite reserves the right to change specifications without notice. Please visit www.finelite.com for most current data.*

LED

BUY AMERICAN ACT OF 2009 COMPLIANT

# FINELITE High Performance 4" Aperture (HP-4) - Indirect/Direct

## SPECIFICATIONS

**CONSTRUCTION:** Precision cut 6061-T6 extruded aluminum body. Internal joiner system, plug-together wiring standard.

**ENDCAPS:** Diecast aluminum endcap. Adds 0.25" to each end.

**REFLECTORS:** Die-formed 20-gauge cold-rolled steel reflectors are finished in 96 LG high reflectance matte white powder coat paint.

**UPLIGHT DIFFUSER:** Top Glow™ lens frost white standard, 73% transmissive, 99% diffusion. Optional: Flush frost white snap-in lens, 73% transmissive, 99% diffusion.

**DOWNLIGHT DIFFUSER:** Flush frost white snap-in lens, 73% transmissive, 99% diffusion.

**LIGHT ENGINE:** HP-4 is available with a choice of four distributions. Both the Indirect and Direct distribution can be specified in Standard Output (SO) or High Output (HO). The chart below summarizes the lumen distribution and wattage. LM79 test reports are available for each distribution. Light engine is made up of high performance mid-powered LEDs and is designed to distribute heat properly to maximize the life of the LED.

**LED COLOR TEMPERATURE:**
Available in 3000K, 3500K, and 4000K. See chart below.

**DRIVER:** High Performance constant current reduction LED Driver. 120/277v. Power factor = **(3000K)** 98% - HO/HO, 96.3% - HO/SO, 96.6% - SO/HO, 95% - SO/SO, **(3500K)** 97.7% - HO/SO, 96.3% - HO/SO, 97% - SO/HO, 94% - SO/SO and **(4000K)** 97.4% - HO/HO, 96.4% - HO/SO, 96.7% - SO/HO, 93.1% - SO/SO. Total Harmonic Distortion <20%. Input Current (120v): **3000K**: HO/HO = 0.631A, HO/SO = 0.474A, SO/HO = 0.478A, SO/SO = 0.315A. **3500K**: HO/HO = 0.632A, HO/SO = 0.474A, SO/HO = 0.477A, SO/SO = 0.32A. **4000K**: HO/HO = 0.636A, HO/SO = 0.473A, SO/HO = 0.475A, SO/SO = 0.325A. Lutron driver options: Lut3W- 3-wire driver, LutES - EcoSystem driver, Lut2W - 2-wire driver.
*Driver is wired for dimming or non-dimming. Dimming is compatible with 0-10v controls with a range of 100-10%. Separate dimming for uplight and downlight.

**LUMEN MAINTENANCE:** HP-4 ID is rated to deliver 90% lumen maintenance (L90) to 100,000 hours and 70% lumen maintenance (L70) to 168,000 hours.

**ELECTRICAL:** 120V or 277V prewired. Optional Adders: emergency circuits, emergency battery packs, step dimming drivers. Minimum of 3' fixture length for battery packs. Maximum of one battery pack per 3' of fixture. Contact factory.

Daylight Sensor Occupancy Sensor

**INTEGRATED SENSORS:** HP-4 LED can be specified with integrated PIR (Passive Infared) occupancy sensors or daylight sensors. Refer to Occupancy Sensor and Daylight Sensor tech sheets for more info.

**MOUNTING:** (FA) 50" fully adjustable aircraft cable standard with safety stop. Contact factory for additional lengths up to 150".

**FINISHES:** Finelite Signal White standard. Optional Adders: 185 colors available from Tiger Drylac's RAL color chart.

**SUPPORT CABLES:** Plated steel cable and hardware.

**FEED:** Standard with one 18 gauge/5 conductor single circuit feed controlling uplight and downlight together (power and dimming). Specify dual feeds for independent control of uplight and downlight. 14 gauge feed cord used when fixture current exceeds 5 amps.

**LENGTHS:** Standard 4', 8', and 12' section lengths can be combined to make longer runs. Contact factory for lengths in increments of 1' or down to the 1/16 an inch.

**WEIGHT:** Fixture weight = 3.4 lb/ft.

**LABELS:** Fixture and electrical components are ETL listed conforming to UL 1598 in the U.S.A., and Canada; ETL listed to certified CAN/CSA C22.2 No. 250.0. Fixtures will bear ETL labels.

**WARRANTY:** HP-4 ID comes standard with a 10-year warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

**LED Color Temperature (CRI & R9)**

| | ↑ SO/SO ↓ | ↑ SO/HO ↓ | ↑ HO/SO ↓ | ↑ HO/HO ↓ |
|---|---|---|---|---|
| **3000K CRI/R9** | 87/35 | 87/34 | 87/34 | 87/34 |
| **3500K CRI/R9** | 85/19 | 85/21 | 85/21 | 84/18 |
| **4000K CRI/R9** | 83/9 | 83/10 | 84/10 | 83/9 |

**Lumen Distribution - Per 4' Section (4000K)**

| | ↑ SO/SO ↓ | ↑ SO/HO ↓ | ↑ HO/SO ↓ | ↑ HO/HO ↓ |
|---|---|---|---|---|
| **Uplight lumens** | 1719 | 1697 | 3259 | 3188 |
| **Uplight watts** | 18.2 | 18.3 | 37 | 37.2 |
| **Lumens per watt** | 95 | 93 | 88 | 86 |
| **Downlight lumens** | 1408 | 2735 | 1431 | 2725 |
| **Downlight watts** | 18.2 | 37 | 18.3 | 37.2 |
| **Lumens per watt** | 77 | 74 | 78 | 73 |

**Protected by one or more US patents: D702,391; D702,390; D700,732**

Finelite, Inc. • 30500 Whipple Road • Union City, CA 94587-1530 • 510 / 441-1100 • Fax: 510 / 441-1510 • www.finelite.com

## A10. Philips Ledalite 1201

# Are you ready to jump?

**JUMP**
SUSPENDED LED

DIRECT, RIBBED MESOOPTICS LENS - SOLIDSIDE
CRI >80 4000K, 2400 lm/4ft

**Project:**

**Spec Type:**

**Catalog No:** 1201LAGQE

**Qty**

**Line Notes:**

### Ordering guide

| Product Type | Source | Color Temp * | Lumens * | Lower Optics | Upper Optics | Run Length | Wiring † | Voltage ‡ | Driver ‡ | Finish |
|---|---|---|---|---|---|---|---|---|---|---|
| 1201 | L | A | G | Q | E | 04 | 7 | 1 | E | W |
| JumpSymmetric | L LED | A 4000K<br>B 3500K<br>C 3000K | G 2400 lm/4ft<br>E 3600 lm/4ft | Q MesoOptics Lens | E No Perf<br>P PixelPerf<br>S SplashPerf | 04 4'<br>08 8' | 1 1 cct<br>3 1 cct w/ EM cct<br>5 1 cct w/ BP<br>7 1 cct w/ Dimming<br>8 1 cct w/ TW<br>B 2cct A/B | 1 120V<br>2 277V<br>3 347V | E Standard | W White<br>T Titanium Silver<br>B Black<br>C CustomColor |

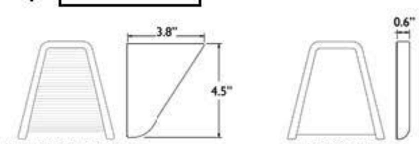
* Nominal values within a range. Consult ies file for exact color temp and lumens † Consult website for complete list of standard wiring options

**Mounting Hardware**

Mount Type
Consult separate mounting spec sheet for mount type options

Suspension Length
Distance from ceiling to top of luminaire in inches

**Endcaps** -




LUMINOUS ENDCAP FLAT ENDCAP

**Integrated Controls** Please indicate with check mark.

Response Daylight Single Zone (DS)



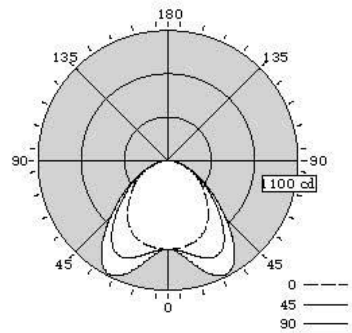


PHILIPS LEDALITE

# JUMP
## SUSPENDED LED

DIRECT, RIBBED MESOOPTICS LENS - SOLIDSIDE

### Photometry




0% Up / 100% Down

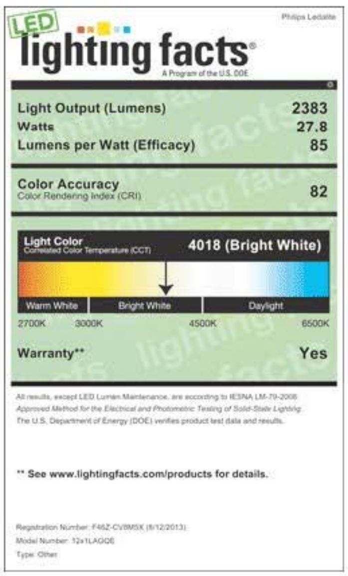
| | |
|---|---|
| Total Output | 2383 lm |
| Efficacy | 85.7 lm/W |
| CCT | 4018K |
| CRI | 82 |
| R9 | 17 |
| Distribution | 0% Up / 100% Down |
| Spacing Criteria (0/90/180°) | 1.27/1.68/NA |
| Meets RP-1-04 recommendations for VDT-Normal spaces | |

Values per 4ft unit

Fixture photometry has been conducted by an NVLAP accredited testing laboratory in accordance with IESNA LM-79:2008

Lumen maintenance of the LEDs has been tested by the manufacturer in accordance with IESNA LM-80:2008

IES files for this and other photometric options can be downloaded online at www.lightingproducts.philips.com




#### Candela Distribution

| Vertical Angle | Horizontal Angle 0 | 22.5 | 45 | 67.5 | 90 | Zonal Lumens |
|---|---|---|---|---|---|---|
| 0 | 754 | 754 | 754 | 754 | 754 | 0 |
| 5 | 753 | 750 | 768 | 772 | 772 | 74 |
| 15 | 737 | 760 | 834 | 902 | 926 | 237 |
| 25 | 691 | 754 | 908 | 1086 | 1081 | 411 |
| 35 | 592 | 668 | 829 | 946 | 984 | 501 |
| 45 | 456 | 505 | 601 | 665 | 689 | 453 |
| 55 | 338 | 356 | 391 | 414 | 423 | 346 |
| 65 | 214 | 219 | 227 | 233 | 236 | 225 |
| 75 | 99 | 99 | 108 | 105 | 106 | 110 |
| 85 | 21 | 22 | 22 | 19 | 16 | 25 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 |
| 95 | 0 | 0 | 0 | 0 | 0 | 0 |
| 105 | 0 | 0 | 0 | 0 | 0 | 0 |
| 115 | 0 | 0 | 0 | 0 | 0 | 0 |
| 125 | 0 | 0 | 0 | 0 | 0 | 0 |
| 135 | 0 | 0 | 0 | 0 | 0 | 0 |
| 145 | 0 | 0 | 0 | 0 | 0 | 0 |
| 155 | 0 | 0 | 0 | 0 | 0 | 0 |
| 165 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 0 | 0 | 0 | 0 | 0 | 0 |
| 180 | 0 | 0 | 0 | 0 | 0 | 0 |

#### Coefficients of Utilization (%)

| RCR | Ceiling 80 / Wall: 70 | 50 | 30 | 10 | Ceiling 70 / Wall: 70 | 50 | 30 | Ceiling 50 / Wall: 50 | 30 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 119 | 119 | 119 | 119 | 116 | 116 | 116 | 111 | 111 | 111 |
| 1 | 110 | 105 | 102 | 98 | 107 | 103 | 100 | 99 | 96 | 93 |
| 2 | 101 | 93 | 87 | 81 | 98 | 91 | 85 | 88 | 83 | 78 |
| 3 | 92 | 82 | 75 | 68 | 90 | 81 | 74 | 78 | 72 | 67 |
| 4 | 85 | 73 | 65 | 59 | 82 | 72 | 64 | 69 | 63 | 57 |
| 5 | 78 | 66 | 57 | 51 | 76 | 65 | 57 | 63 | 55 | 50 |
| 6 | 72 | 59 | 51 | 45 | 70 | 58 | 50 | 57 | 49 | 44 |
| 7 | 67 | 54 | 45 | 39 | 65 | 53 | 45 | 52 | 44 | 39 |
| 8 | 62 | 49 | 41 | 35 | 61 | 48 | 41 | 47 | 40 | 35 |
| 9 | 58 | 45 | 37 | 32 | 57 | 45 | 37 | 43 | 36 | 31 |
| 10 | 55 | 42 | 34 | 29 | 53 | 41 | 34 | 40 | 33 | 28 |

#### Avg. Luminance (cd/m2)

| Vertical Angle | Horizontal Angle 0 | 45 | 90 |
|---|---|---|---|
| 55 | 4970 | 5749 | 6220 |
| 65 | 4271 | 4530 | 4710 |
| 75 | 3226 | 3356 | 3454 |
| 85 | 2082 | 2129 | 1548 |

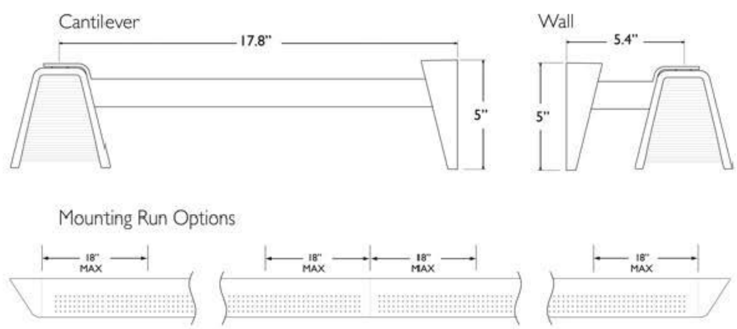
### Electrical Specifications

| | |
|---|---|
| Input Voltage | 120V |
| Input Power | 27.8W |
| Input Current | 0.236A |
| Power Factor | 0.981 |
| Tested values – contact technical support for rated values. Off state power zero unless certain controls are specified. | |

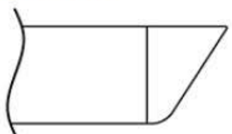
# JUMP
## SUSPENDED LED

DIRECT, RIBBED MESOOPTICS LENS - SOLIDSIDE

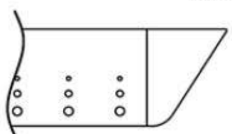
### Options and Details

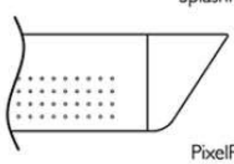

### Optics & Styles



SolidSide



SplashPerf



PixelPerf

### Housing

20 gauge cold-rolled steel precision formed and welded with optional perforated patterns.

### Weight

Maximum 3.5lb/ft.

### Optical System

White light emitted from the LED sources passes through a biconvex lens where it is internally reflected and laterally refocused. Light is then redirected by Miro Silver reflectors and exits through the optical lens assembly. The optical lens assembly consists of an acrylic extrusion with a ribbed profile holding a layer of MesoOptics film. MesoOptics homogenizes the light and color to ensure consistency while controlling high angle glare and creating an optical batwing distribution.

### Standard Driver

Dimming 0-10V, 5-100% Output is Class 2 rated.

### Lumen Maintenance

At an ambient temperature of 25°C, the LED lumen maintenance expectation is $L_{80}$ (12k) >60,000 hrs.

### Mounting

Variable position mounts are supplied for each joint and end. The mounts can be installed up to 18" from joints and end locations. Tamper-resistant aircraft cable grippers provide infinite vertical adjustment capability. Aircraft cable, crimp and cable gripper are independently tested to meet stringent safety requirements.

### Joints

Self-aligning joining system with hands-free pre-joining wire access.

### Endcaps

Endcaps are diecast aluminum, available in luminous sculpted (standard) or flat (optional).

### Electrical

Factory pre-wired to section ends with quick-wire connectors.

### Approvals

Certified to UL, CSA and IES standards.

### Finish

High quality powder coated, available in matte white, black or titanium silver. Other factory and custom colors available on request.

### Environment

Rated for dry or damp locations in operating ambient temperatures 0-40°C (32-104°F). Certain luminaire components may be adversely affected by contaminants. Damage caused by sulfur, chlorine, petroleum based solutions or other contaminants are not covered under warranty.

Due to continuing product improvements, Philips Ledalite reserves the right to change the specifications without notice.





Philips Lighting
North America Corporation
200 Franklin Square Drive
Somerset, NJ 08873
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Philips Lighting Company
281 Hillmount Road
Markham ON, Canada L6C 2S3
Phone: 800-668-9008

## A11. GE DI6R

# Lumination™ LED Luminaires

Downlights Powered by Infusion™
DI6R - 6" Round Aperture

Project name Iowa Energy Center
Date ____________
Type ____________

### Product Description:

Lumination DI Series LED downlights are powered by the Infusion™ downlight module for exceptional efficacy and color rendering. Designed for new construction applications, the DI6R is available in four color temperatures and five lumen packages, all with 90+ CRI. Matching custom engineered reflectors ensure a 45 degree cutoff. The twist-in Infusion DLM LED module allows for tool-free replacement and upgrade as LED technology advances, ensuring the lowest total cost of ownership.

### Targeted Performance Summary:

**Distribution Patterns:** Narrow, Wide
**Input Voltage:** 120, 277V
**Standard Dimming Controls:** 0-10V to 10%
**CCT:** 2700K, 3000K, 3500K, 4000K
**CRI:** 90
**Color Consistency:** 4 Step MacAdam Ellipse
**Lifetime Rating:** 50,000 Hours
**Input Frequency (Hz):** 60Hz
**Power Factor:** >0.9
**Mounting Options:** Hanger bars for grid or drywall ceilings
**Weight:** 6.1 lb
**IC Rating:** Non-IC Rated
**Limited Warranty:** 5 years system
**Files Available:** LM79, LM80, IES, Revit

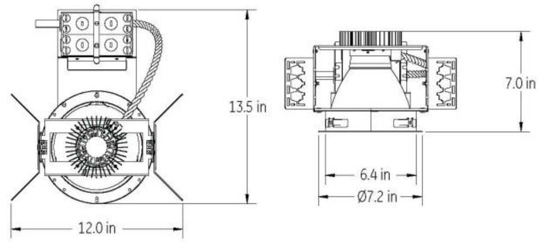
| Nominal Module Lumens | 1000 | 1500 | 2000 | 3000 | 4000 |
|---|---|---|---|---|---|
| Delivered Lumen Output | 830 | 1220 | 1650 | 2480 | 3250 |
| System Input Power | 18 | 25 | 32 | 43 | 56 |
| System Efficacy (LPW) | 46 | 49 | 52 | 58 | 58 |
| Emergency Mode Lumens | 585 | 650 | 710 | 750 | 750 |

Listings: • UL and cUL Listed.
• Suitable for damp locations.

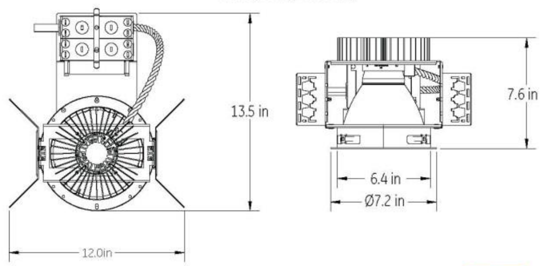
Awards: Next Generation Luminaires Indoor 2014

### Product Dimensions:

**DI6R (1000, 1500, 2000 lm)**




**DI6R (3000, 4000 lm)**




a product of ecomagination

ENERGY STAR

### Ordering Information: A complete fixture consists of a **Housing + Reflector**

For shortest lead times, order **standard reflector options shown in bold.**

**1. Housing – Example: DI6R209351V10**

DI __ 6R __ 20 __ 935 __ 1V __ 10 __ __

| LUMINAIRE SKU | | | | | | |
|---|---|---|---|---|---|---|
| INTERNAL CODE | FIXTURE TYPE | MODULE LUMEN OUTPUT | CRI/CCT | VOLTAGE | DRIVER | OPTIONS |
| DI | **6R** = 6 inch round downlight | **10** = 1000 LM<br>**15** = 1500 LM<br>**20** = 2000 LM<br>**30** = 3000 LM<br>**40** = 4000 LM | **927** = 90CRI, 2700K<br>**930** = 90CRI, 3000K<br>**935** = 90CRI, 3500K<br>**940** = 90CRI, 4000K | **1V** = 120V<br>**2V**³ = 277V | **10** = 0-10V Dimming Driver | **(blank)** = None<br>**EL**³ = Bodine Emergency Backup with Remote Test Switch |

**Accessories**

| ACCESSORIES | DESCRIPTION CODE | PRODUCT CODE |
|---|---|---|
| C-Channel Bar Hangers 25 1/4" | BH3 | 94890 |

**2. Reflector - Example: RDI6RWSDWT**

R __ DI6R __ N __ SP __ __ __ MR __

| REFLECTOR SKU | | | | | |
|---|---|---|---|---|---|
| REFLECTOR | HOUSING TYPE | BEAM SPREAD | REFLECTOR FINISH | REFLECTOR COLOR | FLANGE FINISH |
| **R** = Reflector | **DI6R** = 6" Round | **W** = Wide<br>**N** = Narrow | **SD** = Semi-diffused<br>**DF** = Diffused<br>**SP** = Specular | **Blank** = Clear (no color)<br>**WE**¹ = Wheat<br>**PW**¹ = Pewter<br>**GO**¹ = Gold<br>**BL**² = Black<br>**WT** = White Paint | **WT** = White Paint<br>**MR** = Match Reflector |

**Ordering Notes:**
1. Wheat, pewter, and gold anodized reflector colors available in SD = Semi-Diffuse reflector finish only
2. Black anodized reflectors available in DF = Diffused finish only
3. 277V input, 1000 lumen version and all EL versions are not Energy Star certified.

imagination at work

# Housing-Only Option

Lumination DI series fixtures without LED modules are stocked in GE distribution centers for quick shipment. These fixtures can be shipped directly to job sites for rough-in, and then later fitted with the appropriate Infusion LED module and trim kit to complete the installation.
The unprecedented interchangeabiltiy and flexibility of the Infusion LED module makes this possible.

**With the Housing-Only option, distributors can:**

- Order just the housings for stock, and then complete the order with the appropriate Infusion LED module and reflector at a later date
- Order the stocked housing, module, and reflector all at once for a complete fixture in under 2 weeks

---

For the housing-only option: A complete fixture consists of a **Housing + Infusion LED Module + Reflector**

## 6" Round Housing-Only Fixtures & LED Modules

| Downlight Housing-Only | | | Compatible LED Modules | | |
|---|---|---|---|---|---|
| PRODUCT CODE | DESCRIPTION CODE | PRODUCT DESCRIPTION | PRODUCT CODE | DESCRIPTION CODE | PRODUCT DESCRIPTION |
| **83630**<br>**83632** | DI6RLL1V10HO<br>DI6RLL2V10HO | 6" Round Housing-Only, 120V, Low Lumen Platform, 0-10V<br>6" Round Housing-Only, 277V, Low Lumen Platform, 0-10V | **99607** | DLM1000/927 | 1000 LM, 90 CRI, 2700K |
| | | | **99608** | DLM1000/930 | 1000 LM, 90 CRI, 3000K |
| | | | **99609** | DLM1000/935 | 1000 LM, 90 CRI, 3500K |
| | | | **99610** | DLM1000/940 | 1000 LM, 90 CRI, 4000K |
| | | | **99611** | DLM1500/927 | 1500 LM, 90 CRI, 2700K |
| | | | **99612** | DLM1500/930 | 1500 LM, 90 CRI, 3000K |
| | | | **99613** | DLM1500/935 | 1500 LM, 90 CRI, 3500K |
| | | | **99614** | DLM1500/940 | 1500 LM, 90 CRI, 4000K |
| | | | **99615** | DLM2000/927 | 2000 LM, 90 CRI, 2700K |
| | | | **99616** | DLM2000/930 | 2000 LM, 90 CRI, 3000K |
| | | | **99617** | DLM2000/935 | 2000 LM, 90 CRI, 3500K |
| | | | **99618** | DLM2000/940 | 2000 LM, 90 CRI, 4000K |
| **83633**<br>**83638** | DI6RHL1V10HO<br>DI6RHL2V10HO | 6" Round Housing-Only, 120V, High Lumen Platform, 0-10V<br>6" Round Housing-Only, 277V, High Lumen Platform, 0-10V | **99619** | DLM3000/927 | 3000 LM, 90 CRI, 2700K |
| | | | **99620** | DLM3000/930 | 3000 LM, 90 CRI, 3000K |
| | | | **99621** | DLM3000/935 | 3000 LM, 90 CRI, 3500K |
| | | | **99622** | DLM3000/940 | 3000 LM, 90 CRI, 4000K |
| | | | **99623** | DLM4000/927 | 4000 LM, 90 CRI, 2700K |
| | | | **99624** | DLM4000/930 | 4000 LM, 90 CRI, 3000K |
| | | | **99625** | DLM4000/935 | 4000 LM, 90 CRI, 3500K |
| | | | **99626** | DLM4000/940 | 4000 LM, 90 CRI, 4000K |

## 6" Round Stocked Reflectors

| PRODUCT CODE | DESCRIPTION CODE | PRODUCT DESCRIPTION |
|---|---|---|
| **93988** | RDI6RNSDMR | 6" Round Reflector, Narrow Distribution, Semi-Diffuse, Polished Flange |
| **93989** | RDI6RNSDWT | 6" Round Reflector, Narrow Distribution, Semi-Diffuse, White Flange |
| **93990** | RDI6RWSDMR | 6" Round Reflector, Wide Distribution, Semi-Diffuse, Polished Flange |
| **93991** | RDI6RWSDWT | 6" Round Reflector, Wide Distribution, Semi-Diffuse, White Flange |

# Photometric Data: Lumination™ DI6R Series Downlights

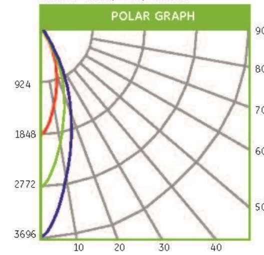
## Narrow Distribution

COEFFICIENTS OF UTILIZATION

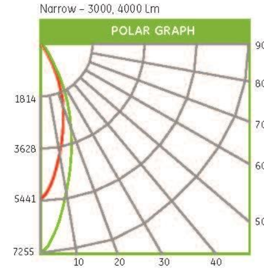
| RC | 80% | | | | 70% | | | | 50% | | | 30% | | | 10% | | | 0% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70% | 50% | 30% | 10% | 70% | 50% | 30% | 10% | 50% | 30% | 10% | 50% | 30% | 10% | 50% | 30% | 10% | 0% |
| 0 | 119 | 119 | 119 | 119 | 116 | 116 | 116 | 116 | 111 | 111 | 111 | 106 | 106 | 106 | 102 | 102 | 102 | 100 |
| 1 | 114 | 112 | 109 | 107 | 112 | 110 | 108 | 106 | 106 | 104 | 102 | 102 | 101 | 99 | 98 | 97 | 97 | 95 |
| 2 | 109 | 105 | 101 | 98 | 107 | 103 | 100 | 97 | 100 | 98 | 95 | 97 | 95 | 93 | 95 | 93 | 91 | 90 |
| 3 | 105 | 99 | 95 | 91 | 103 | 98 | 94 | 91 | 95 | 92 | 89 | 93 | 90 | 88 | 91 | 88 | 86 | 85 |
| 4 | 100 | 94 | 89 | 85 | 99 | 93 | 88 | 85 | 91 | 87 | 84 | 89 | 85 | 83 | 87 | 84 | 82 | 81 |
| 5 | 96 | 89 | 84 | 80 | 95 | 88 | 83 | 80 | 86 | 82 | 79 | 85 | 81 | 78 | 83 | 80 | 78 | 76 |
| 6 | 92 | 85 | 79 | 76 | 91 | 84 | 79 | 75 | 82 | 78 | 75 | 81 | 77 | 74 | 80 | 77 | 74 | 73 |
| 7 | 89 | 81 | 75 | 72 | 87 | 80 | 75 | 72 | 79 | 74 | 71 | 78 | 74 | 71 | 77 | 73 | 70 | 69 |
| 8 | 85 | 77 | 72 | 68 | 84 | 76 | 71 | 68 | 75 | 71 | 68 | 74 | 70 | 67 | 73 | 70 | 67 | 66 |
| 9 | 82 | 73 | 68 | 65 | 81 | 73 | 68 | 65 | 72 | 68 | 65 | 71 | 67 | 64 | 71 | 67 | 64 | 63 |
| 10 | 79 | 70 | 65 | 62 | 78 | 70 | 65 | 62 | 69 | 65 | 62 | 68 | 64 | 62 | 68 | 64 | 61 | 60 |

**NOTE**: Floor Cavity Reflectance : 20%

Narrow – 1000, 1500, 2000 Lm




Narrow – 3000, 4000 Lm




ZONAL LUMEN SUMMARY

| | NOMINAL MODULE LUMENS | | | | | |
|---|---|---|---|---|---|---|
| | 1000 | 1500 | 2000 | 3000 | 4000 | |
| Zone | Lumens | Lumens | Lumens | Lumens | Lumens | % of Fixture |
| 0 - 30° | 716 | 1057 | 1432 | 2148 | 2811 | 85.7 |
| 0 - 40° | 812 | 1198 | 1623 | 2435 | 3186 | 97.2 |
| 0 - 60° | 832 | 1227 | 1663 | 2495 | 3264 | 99.6 |
| 0 - 90° | 835 | 1232 | 1670 | 2505 | 3278 | 100 |

CANDLEPOWER SUMMARY

| | NOMINAL MODULE LUMENS | | | | |
|---|---|---|---|---|---|
| | 1000 | 1500 | 2000 | 3000 | 4000 |
| Angle | Candela | Candela | Candela | Candela | Candela |
| 0 | 1841 | 2717 | 3682 | 5523 | 7227 |
| 5 | 1698 | 2507 | 3397 | 5095 | 6668 |
| 10 | 1389 | 2050 | 2777 | 4166 | 5452 |
| 15 | 1101 | 1625 | 2202 | 3303 | 4323 |
| 20 | 833 | 1229 | 1665 | 2498 | 3268 |
| 25 | 601 | 887 | 1202 | 1803 | 2359 |
| 30 | 347 | 512 | 694 | 1041 | 1362 |
| 35 | 148 | 218 | 295 | 443 | 580 |
| 40 | 56 | 83 | 113 | 169 | 222 |
| 45 | 17 | 26 | 35 | 52 | 68 |
| 50 | 9 | 14 | 18 | 27 | 36 |
| 55 | 5 | 8 | 11 | 16 | 21 |
| 60 | 3 | 5 | 7 | 10 | 14 |

CONE OF LIGHT

| | NOMINAL MODULE LUMENS | | | | | |
|---|---|---|---|---|---|---|
| | 1000 | 1500 | 2000 | 3000 | 4000 | |
| Height | fc | fc | fc | fc | fc | Dia. (ft.) |
| 6' | 51 | 75 | 102 | 153 | 201 | 3.9 |
| 8' | 29 | 42 | 58 | 86 | 113 | 5.2 |
| 10' | 18 | 27 | 37 | 55 | 72 | 6.5 |
| 12' | 13 | 19 | 26 | 38 | 50 | 7.8 |
| 14' | 9 | 14 | 19 | 28 | 37 | 9.1 |
| 16' | 7 | 11 | 14 | 22 | 28 | 10.4 |
| 18' | 6 | 8 | 11 | 17 | 22 | 11.7 |
| 20' | 5 | 7 | 9 | 14 | 18 | 13.0 |

APPLICATION REFERENCE (Open Space)

| | NOMINAL MODULE LUMENS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 | | 1500 | | 2000 | | 3000 | | 4000 | |
| Spacing | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² |
| 4' x 4' | 53.6 | 1.08 | 79.0 | 1.50 | 107.1 | 1.92 | 141.5 | 2.58 | 185.1 | 3.36 |
| 6' x 6' | 25.0 | 0.50 | 36.9 | 0.70 | 50.0 | 0.90 | 66.0 | 1.20 | 86.4 | 1.57 |
| 8' x 8' | 13.4 | 0.27 | 19.8 | 0.38 | 26.8 | 0.48 | 35.4 | 0.65 | 46.3 | 0.84 |
| 10' x 10' | 8.9 | 0.18 | 13.1 | 0.25 | 17.8 | 0.32 | 23.6 | 0.43 | 30.8 | 0.56 |
| | 10' ceiling, Open Space: 50' x 40' x 10' | | | | | | | | | |

LLF: 1.0 Initial, 80/50/20 Reflectances, 2.5' workplane

20' ceiling, Open Space: 50' x 40' x 20'

APPLICATION REFERENCE (Corridor)

| | NOMINAL MODULE LUMENS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 | | 1500 | | 2000 | | 3000 | | 4000 | |
| Spacing | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² |
| 4' on ctr. | 25.8 | 0.75 | 38.1 | 1.04 | 51.6 | 1.33 | 55.2 | 1.79 | 72.2 | 2.33 |
| 6' on ctr. | 17.6 | 0.51 | 25.9 | 0.71 | 35.1 | 0.91 | 37.5 | 1.22 | 49.1 | 1.59 |
| 8' on ctr. | 12.4 | 0.36 | 18.3 | 0.50 | 24.8 | 0.64 | 26.4 | 0.86 | 34.5 | 1.12 |
| 10' on ctr. | 10.3 | 0.30 | 15.2 | 0.42 | 20.6 | 0.53 | 22.1 | 0.72 | 28.9 | 0.93 |
| | 10' ceiling, Corridor: 6' W x 100' L | | | | | | 20' ceiling, Corridor: 6' W x 100' L | | | |

LLF: 1.0 Initial, 80/50/20 Reflectances, Light levels on the ground

Spacing Criteria: DI6R - Narrow = 0.58

# Photometric Data: Lumination™ DI6R Series Downlights

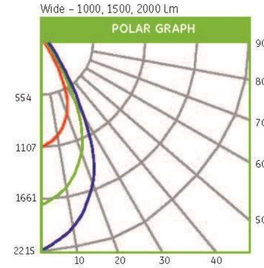
## Wide Distribution

**COEFFICIENTS OF UTILIZATION**

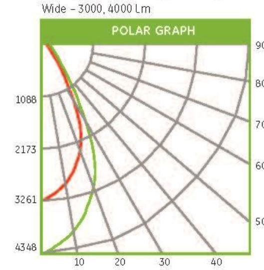
| RC | 80% | | | | 70% | | | | 50% | | | 30% | | | 10% | | | 0% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | 70% | 50% | 30% | 10% | 70% | 50% | 30% | 10% | 50% | 30% | 10% | 50% | 30% | 10% | 50% | 30% | 10% | 0% |
| 0 | 119 | 119 | 119 | 119 | 116 | 116 | 116 | 116 | 111 | 111 | 111 | 106 | 106 | 106 | 102 | 102 | 102 | 100 |
| 1 | 114 | 111 | 109 | 107 | 111 | 109 | 107 | 105 | 105 | 103 | 102 | 101 | 100 | 99 | 98 | 97 | 96 | 94 |
| 2 | 108 | 104 | 100 | 97 | 106 | 102 | 99 | 96 | 99 | 96 | 94 | 96 | 94 | 92 | 93 | 91 | 90 | 88 |
| 3 | 103 | 97 | 93 | 89 | 101 | 96 | 92 | 88 | 93 | 90 | 87 | 91 | 88 | 85 | 89 | 86 | 84 | 82 |
| 4 | 98 | 91 | 86 | 82 | 97 | 90 | 85 | 82 | 88 | 84 | 81 | 86 | 83 | 80 | 84 | 81 | 79 | 77 |
| 5 | 94 | 86 | 80 | 76 | 92 | 85 | 80 | 76 | 83 | 79 | 75 | 82 | 78 | 75 | 80 | 77 | 74 | 73 |
| 6 | 89 | 81 | 75 | 71 | 88 | 80 | 75 | 71 | 79 | 74 | 71 | 77 | 73 | 70 | 76 | 72 | 70 | 68 |
| 7 | 85 | 77 | 71 | 67 | 84 | 76 | 71 | 67 | 75 | 70 | 66 | 73 | 69 | 66 | 72 | 69 | 66 | 64 |
| 8 | 82 | 72 | 67 | 63 | 80 | 72 | 67 | 63 | 71 | 66 | 63 | 70 | 65 | 62 | 69 | 65 | 62 | 61 |
| 9 | 78 | 69 | 63 | 59 | 77 | 68 | 63 | 59 | 67 | 62 | 59 | 66 | 62 | 59 | 66 | 62 | 59 | 57 |
| 10 | 75 | 65 | 60 | 56 | 74 | 65 | 60 | 56 | 64 | 59 | 56 | 63 | 59 | 56 | 63 | 59 | 56 | 54 |

**NOTE**: Floor Cavity Reflectance : 20%

Wide – 1000, 1500, 2000 Lm




Wide – 3000, 4000 Lm




**ZONAL LUMEN SUMMARY**

| | NOMINAL MODULE LUMENS 1000 | 1500 | 2000 | 3000 | 4000 | |
|---|---|---|---|---|---|---|
| Zone | Lumens | Lumens | Lumens | Lumens | Lumens | % of Fixture |
| 0 - 30° | 651 | 961 | 1302 | 1953 | 2556 | 78.9 |
| 0 - 40° | 782 | 1153 | 1563 | 2345 | 3068 | 94.8 |
| 0 - 60° | 820 | 1210 | 1640 | 2460 | 3219 | 99.4 |
| 0 - 90° | 825 | 1218 | 1650 | 2475 | 3239 | 100 |

**CANDLEPOWER SUMMARY**

| | NOMINAL MODULE LUMENS 1000 | 1500 | 2000 | 3000 | 4000 |
|---|---|---|---|---|---|
| Angle | Candela | Candela | Candela | Candela | Candela |
| 0 | 1088 | 1606 | 2177 | 3265 | 4273 |
| 5 | 1067 | 1574 | 2133 | 3200 | 4188 |
| 10 | 1007 | 1486 | 2014 | 3021 | 3953 |
| 15 | 925 | 1366 | 1850 | 2776 | 3632 |
| 20 | 818 | 1207 | 1636 | 2453 | 3211 |
| 25 | 670 | 989 | 1340 | 2010 | 2630 |
| 30 | 433 | 639 | 866 | 1299 | 1699 |
| 35 | 213 | 314 | 426 | 639 | 836 |
| 40 | 94 | 139 | 188 | 282 | 368 |
| 45 | 37 | 55 | 74 | 111 | 145 |
| 50 | 19 | 29 | 39 | 58 | 76 |
| 55 | 11 | 16 | 22 | 33 | 43 |
| 60 | 6 | 9 | 13 | 19 | 25 |

**CONE OF LIGHT**

| | NOMINAL MODULE LUMENS 1000 | 1500 | 2000 | 3000 | 4000 | |
|---|---|---|---|---|---|---|
| Height | fc | fc | fc | fc | fc | Dia. (ft.) |
| 6' | 30 | 45 | 60 | 91 | 119 | 6.2 |
| 8' | 17 | 25 | 34 | 51 | 67 | 8.2 |
| 10' | 11 | 16 | 22 | 33 | 43 | 10.3 |
| 12' | 8 | 11 | 15 | 23 | 30 | 12.3 |
| 14' | 6 | 8 | 11 | 17 | 22 | 14.4 |
| 16' | 4 | 6 | 9 | 13 | 17 | 16.4 |
| 18' | 3 | 5 | 7 | 10 | 13 | 18.5 |
| 20' | 3 | 4 | 5 | 8 | 11 | 20.6 |

**APPLICATION REFERENCE (Open Space)**

| | NOMINAL MODULE LUMENS 1000 | | 1500 | | 2000 | | 3000 | | 4000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Spacing | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² |
| 4' x 4' | 52.4 | 1.08 | 77.3 | 1.50 | 104.7 | 1.92 | 135.9 | 2.58 | 177.8 | 3.36 |
| 6' x 6' | 24.5 | 0.50 | 36.1 | 0.70 | 48.9 | 0.90 | 63.5 | 1.20 | 83.0 | 1.57 |
| 8' x 8' | 13.1 | 0.27 | 19.3 | 0.38 | 26.2 | 0.48 | 34.1 | 0.65 | 44.6 | 0.84 |
| 10' x 10' | 8.8 | 0.18 | 12.9 | 0.25 | 17.5 | 0.32 | 22.7 | 0.43 | 29.6 | 0.56 |
| | 10' ceiling, Open Space: 50' x 40' x 10' | | | | | | 20' ceiling, Open Space: 50' x 40' x 20' | | | |

LLF: 1.0 Initial, 80/50/20 Reflectances, 2.5' workplane

**APPLICATION REFERENCE (Corridor)**

| | NOMINAL MODULE LUMENS 1000 | | 1500 | | 2000 | | 3000 | | 4000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Spacing | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² | Avg. fc | W/ft² |
| 4' on ctr. | 23.9 | 0.75 | 35.2 | 1.04 | 47.7 | 1.33 | 48.0 | 1.79 | 62.8 | 2.33 |
| 6' on ctr. | 16.2 | 0.51 | 23.9 | 0.71 | 32.4 | 0.91 | 32.6 | 1.22 | 42.6 | 1.59 |
| 8' on ctr. | 11.5 | 0.36 | 16.9 | 0.50 | 22.9 | 0.64 | 23.0 | 0.86 | 30.0 | 1.12 |
| 10' on ctr. | 9.6 | 0.30 | 14.1 | 0.42 | 19.1 | 0.53 | 19.2 | 0.72 | 25.1 | 0.93 |
| | 10' ceiling, Corridor: 6' W x 100' L | | | | | | 20' ceiling, Corridor: 6' W x 100' L | | | |

LLF: 1.0 Initial, 80/50/20 Reflectances, Light levels on the ground

## Spacing Criteria: DI6R - Wide =.90

## Product Specifications:

### Construction:

- 16 gauge galvanized steel housing
- 16 gauge reflectors resist dents during transporation and installation
- Custom engineered heat sinks for passive cooling at all lumen options
- Galvanized steel junction box with multiple knockouts

### Installation:

- Universal mounting brackets with over 3" of vertical adjustment accommodate several types of hanger bars
- Accommodates ceilings up to 1.5" thick
- Mount in T-bar grid or drywall ceilings
- LED module twists in at time of trim installation, preventing damage to module during ceiling installation

### Optical System:

- Custom engineered reflectors for precise beam distributions and 45° cutoff to light source and source image
- Self-flanged design with white painted or reflector-matching trim
- Standard semi-diffuse finish for ideal combination of optical efficiency and low glare

### Electrical System:

- Infusion DLM LED module for exceptional performance and tool-free upgradeability
- Standard 0-10V dimming, high efficiency drivers
- Thermal protection feature in module protects LEDs from overheating in abnormal conditions

For more information and access to all of our resources, including our design tool visit: **www.gelighting.com**

www.gelighting.com



IND083 (Rev 10/15/14)

# A12. Cree ZR24 HE

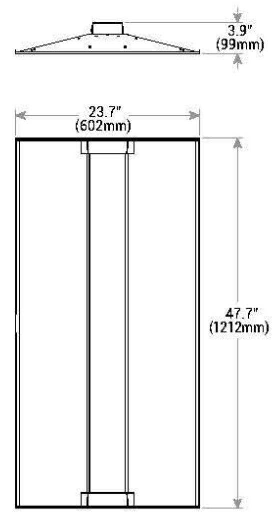
## ZR Series

ZR24™ 2'x4' LED Troffer

Iowa Energy Center

### Product Description

The ZR24™ LED troffer delivers 4000 lumens of superior 90 CRI light quality and is perfect for both new construction and renovation. Powered by Cree TrueWhite® Technology, the slim and lightweight ZR24™ LED troffer boasts an efficacy of up to 150 LPW along with 0-10V dimming to meet local energy codes. The ZR24™ LED troffer embodies a breakthrough in balancing energy savings, visual comfort and initial cost.




### Performance Summary

| |
|---|
| Utilizes Cree TrueWhite® Technology |
| **Efficacy:** 90-150 LPW |
| **Delivered Light Output:** 4,000 lumens |
| **Input Power:** 26-44 Watts |
| **CRI:** 90 |
| **CCT:** 3500K; 4000K |
| **Input Voltage:** 120-277 VAC |
| **Limited Warranty**[†]**:** 10 years on luminaire |
| **Controls:** 0-10V Dimming to 5%* |
| **Mounting:** Recessed** |
| **Lifetime:** Designed to last from 75,000 hours L70 (standard), 100,000 hours L70 (HE) |

### Accessories

| Accessories | |
|---|---|
| **DGA-24WHT**<br>- Drywall Grid Adaptor | **CIF-10V**<br>- Wireless 0-10V Dimming/Switching Interface with Cree Smartcast™ Technology |

### Ordering Information

Example: ZR24 40L 40K 10V

| ZR24 | 40L HE | 40K | | 10V | |
|---|---|---|---|---|---|
| **Product** | **Initial Delivered Lumens** | **CCT** | **Voltage** | **Controls** | **Options** |
| **ZR24** | **40L**<br>44W, 4000 Lumens - 90 LPW<br>**40L HE**<br>26W, 4000 Lumens - 150 LPW | **35K**<br>3500K<br>**40K**<br>4000K | **Blank**<br>120-277V | **10V**<br>0-10V Dimming 5%* | **EB14*****<br>Emergency Backup |

† See www.cree.com/lighting/products/warranty for warranty terms
* Reference www.cree.com/lighting/Products/Indoor/Troffers/ZR-Series for recommended dimming controls and wiring diagrams
** Acceptable for use with standard 9/16 T-Bar or larger when installed per installation instructions. Consult factory for non-standard grid applications
*** EB option available in US only & not available with HE types

Rev. Date: V1 09/30/2014

US: www.cree.com/lighting T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

ZR24™ 2'x4' LED Troffer

## Product Specifications

**CREE TRUEWHITE® TECHNOLOGY**

A revolutionary way to generate high-quality white light, Cree TrueWhite® Technology is a patented approach that delivers an exclusive combination of 90+ CRI, beautiful light characteristics, and lifelong color consistency, all while maintaining high luminous efficacy – a true no compromise solution.

**CONSTRUCTION & MATERIALS**

- Durable cold rolled steel housing provides strength and uniformity
- Ultra-thin 3.9" (99mm) fixture height and lightweight design effectively target a broad range of plenum spaces and allow for easy installations
- Fixture is pre-painted for enhanced smooth finish
- Provided t-bar clips and holes for mounting support wires enable recessed or suspended installation
- Fixture sides and ends are hemmed in for safe, easy handling

**OPTICAL SYSTEM**

- Unique fixture design creates perfect balance of both horizontal and vertical illumination
- Optimized smooth lens eliminates pixelation and delivers a low-glare, diffused light distribution

**ELECTRICAL SYSTEM**

- Cree born components including highly efficacious Cree® LED chips along with an integral high-efficiency Cree® driver
- **Power Factor:** = 0.9 nominal
- **Input Power:** Stays constant over life
- **Input Voltage:** 120-277V, 50/60Hz
- **Battery Backup:** Consult factory
- **Operating Temperature Rating:** Designed to operate in temperatures 0-35°C and below room side and plenum side
- **Total Harmonic Distortion:** < 20%

**CONTROLS**

- Continuous dimming to 5% with 0-10V DC control protocol
- For use with Class 2 dimming systems only. Reference www.cree.com/Lighting/Products/Indoor/Troffers/ZR-Series for recommended dimming controls and wiring diagrams

**REGULATORY & VOLUNTARY QUALIFICATIONS**

- UL924 (EB option)
- cULus listed
- Suitable for damp locations
- Designed for indoor use
- DLC qualified when ordered with 40L Initial Delivered Lumens. Please refer to http://www.designlights.org/QPL for most current information

## Application Reference

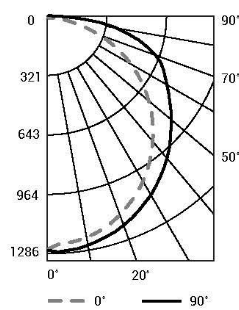
| Open Space | | | | | | |
|---|---|---|---|---|---|---|
| Spacing | Initial Delivered Lumens | Lumens | Wattage | LPW | w/ft² | Average fc |
| 8 x 8 | 40L HE | 4,000 | 26 | 154 | 0.39 | 56 |
| | 40L | | 44 | 91 | 0.66 | 56 |
| 8 x 10 | 40L HE | 4,000 | 26 | 154 | 0.33 | 46 |
| | 40L | | 44 | 91 | 0.55 | 46 |
| 10 x 10 | 40L HE | 4,000 | 26 | 154 | 0.26 | 37 |
| | 40L | | 44 | 91 | 0.44 | 37 |
| 10 x 12 | 40L HE | 4,000 | 26 | 154 | 0.21 | 30 |
| | 40L | | 44 | 91 | 0.35 | 30 |

9' ceiling: 80/50/20 reflectances; 2.5' workplane, open room. LLF: 1.0 Initial
Open Space: 50' x 40' x 10

## Photometry

**ZR24-40L-40K BASED ON CESTL REPORT TEST #: PL02014-0005**

Fixture photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. IESNA LM-79-08 specifies the entire luminaire as the source resulting in a fixture efficiency of 100%.




| Coefficients Of Utilization - Zonal Cavity Method | | | | |
|---|---|---|---|---|
| RC %: | 80 | | | |
| RW %: | 70 | 50 | 30 | 10 |
| RCR: 0 | 119 | 119 | 119 | 119 |
| 1 | 107 | 102 | 97 | 93 |
| 2 | 97 | 88 | 80 | 74 |
| 3 | 88 | 76 | 68 | 61 |
| 4 | 80 | 67 | 58 | 51 |
| 5 | 73 | 60 | 50 | 43 |
| 6 | 68 | 54 | 44 | 38 |
| 7 | 63 | 49 | 40 | 33 |
| 8 | 58 | 44 | 36 | 29 |
| 9 | 55 | 41 | 32 | 26 |
| 10 | 51 | 37 | 29 | 24 |

Effective Floor Cavity Reflectance: 20%

| Average Luminance Table (cd/m²) | | | | |
|---|---|---|---|---|
| | | Horizontal Angle | | |
| | | 0° | 45° | 90° |
| Vertical Angle | 45° | 1,642 | 1,772 | 1,899 |
| | 55° | 1,580 | 1,788 | 2,014 |
| | 65° | 1,480 | 1,886 | 2,341 |
| | 75° | 1,276 | 2,240 | 2,819 |
| | 85° | 952 | 2,498 | 3,203 |

| Zonal Lumen Summary | | | |
|---|---|---|---|
| Zone | Lumens | % Lamp | Luminaire |
| 0-30 | 990 | N/A | 24.4% |
| 0-40 | 1,628 | N/A | 40.1% |
| 0-60 | 2,949 | N/A | 72.6% |
| 0-90 | 4,064 | N/A | 100% |
| 0-180 | 4,064 | N/A | 100% |

Reference www.cree.com/Lighting/Products/Indoor/Troffers/ZR-Series for detailed photometric data

| ZR24™ Lumen Maintenance[1] | | | | | | |
|---|---|---|---|---|---|---|
| Ambient | Initial Delivered Lumens | Initial LMF | 25K hr Projected[2] LMF | 50K hr Calculated[2,3] LMF | 75K hr Calculated[3] LMF | 100K hr Calculated[3] LMF |
| 0°C (32°F) | 40L HE | 1.05 | 0.99 | 0.94 | 0.90 | 0.87 |
| | 40L | 1.05 | 0.99 | 0.93 | 0.89 | 0.84 |
| 5°C (41°F) | 40L HE | 1.04 | 0.98 | 0.94 | 0.90 | 0.86 |
| | 40L | 1.04 | 0.98 | 0.93 | 0.88 | 0.83 |
| 10°C (50°F) | 40L HE | 1.03 | 0.97 | 0.93 | 0.89 | 0.85 |
| | 40L | 1.03 | 0.97 | 0.92 | 0.88 | 0.82 |
| 15°C (59°F) | 40L HE | 1.02 | 0.96 | 0.92 | 0.88 | 0.84 |
| | 40L | 1.02 | 0.96 | 0.91 | 0.87 | 0.82 |
| 20°C (68°F) | 40L HE | 1.01 | 0.95 | 0.91 | 0.87 | 0.83 |
| | 40L | 1.01 | 0.95 | 0.90 | 0.86 | 0.81 |
| 25°C (77°F) | 40L HE | 1.00 | 0.94 | 0.90 | 0.86 | 0.82 |
| | 40L | 1.00 | 0.94 | 0.89 | 0.85 | 0.80 |
| 30°C (86°F) | 40L HE | 0.99 | 0.93 | 0.89 | 0.85 | 0.82 |
| | 40L | 0.99 | 0.93 | 0.88 | 0.84 | 0.79 |
| 35°C (95°F) | 40L HE | 0.98 | 0.92 | 0.88 | 0.84 | 0.81 |
| | 40L | 0.98 | 0.92 | 0.87 | 0.83 | 0.78 |

[1] Lumen maintence values at 25°C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. packaged LEDchip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. packaged LED chip)

**A13. Sigma STL100**

# COLOR TUNING LED TROFFER
STL100 45W-CT

### DESCRIPTION

The STL100 45W-CT represents a new approach to lighting - an approach that's dynamic, not static. No longer does your space have to look and feel the same day after day.

The STL100 45W-CT can tune the color temperature from 3000K to 6500K as well as dim the light output. This can be done using the manual touch fader, the IR remote control and occupancy sensor, or a programmable DMX controller.

The STL100 45W-CT can work individually or in groups through DMX, RS485, DALI, or IR Remote. 256 gray dimming and color temperature control is available in all networks.

The STL100 is fantastic for areas where color rendering is of the utmost importance, areas with minimal natural light, or any space that you want to make more versatile.


### PRODUCT SPECIFICATIONS

| | |
|---|---|
| Frame/Cover | A13104 / Powder coating, white |
| Light Plane | Polycarbonate |
| Mounting | Recessed |
| Size (W × H × D) | 23.7in x 23.7in x 1.6in (fixture) 1.28in (Power) |
| Weight | 5.07 lbs. |
| Power | 45W |
| Lifetime | 50,000+ Hours |
| Warranty | 5 Years |
| Certification/Award | UL, CE, FCC, LM79, LM80 |

For ordering information please visit
www.sigmaluminous.com
734.402.8587

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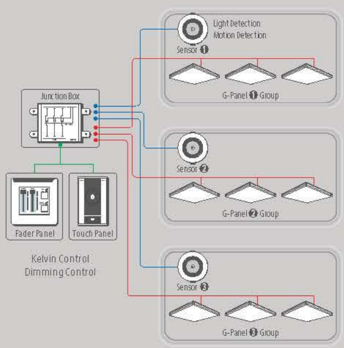
PAYBACK STARTS NOW™

## MODE TYPES

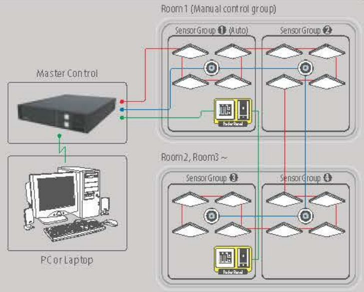
**• Local Mode System Block Diagram**

- 3 Lighting group connection lines
- 3 Sensor connection lines
- Fader or Touch selection

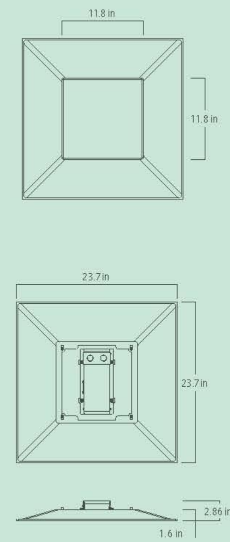



**• Intelligent Mode System Block Diagram**

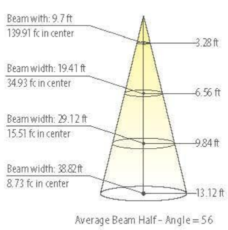
- Set up or change address & group through PC
- Fader or Touch control



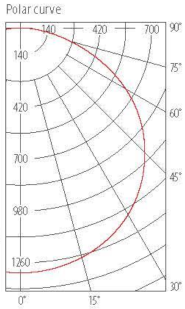

| Features | Description |
|---|---|
| Mode selection | Auto mode or Manual mode |
| Grouping function | Randomly combine sensor, G-panel, and fader to form a group ex) sensor x 2, G-Panel x 4, Fader x 1 |
| | Controllable per group |
| | Max & Min Brightness adjustable per group |
| Status check function | Sensor or fader module info check |
| | Sensor operation status check |
| | Fader operation status check |
| | Individual sensor or fader manual rebooting |
| Parameter setup | Exclusive PC program<br>- Mode setup (Auto or manual)<br>- Max & Min Brightnes setup<br>- Group setup<br>- Time schedule setup |




Cone diagram




Polar curve




Intensity (candlepower) summary

| ANGLE | ALONG | 25 | 45 | 65 | ACROSS |
|---|---|---|---|---|---|
| 0 | 1310 | 1310 | 1310 | 1310 | 1310 |
| 5 | 1310 | 1310 | 1310 | 1310 | 1310 |
| 15 | 1270 | 1280 | 1280 | 1280 | 1280 |
| 25 | 1200 | 1200 | 1210 | 1210 | 1200 |
| 35 | 1080 | 1090 | 1100 | 1100 | 1090 |
| 45 | 930 | 943 | 949 | 950 | 942 |
| 55 | 751 | 767 | 776 | 775 | 762 |
| 65 | 538 | 561 | 577 | 569 | 549 |
| 75 | 291 | 320 | 340 | 328 | 297 |
| 85 | 50.5 | 81.8 | 107 | 87 | 50.1 |
| 90 | 2.3 | 3.3 | 3.9 | 3.6 | 1.0 |

Zonal lumens and percentages

| ZONE | LUMENS | % LUMINAIRE |
|---|---|---|
| 0-30 | 1201 | 29.3 |
| 0-40 | 1902 | 46.4 |
| 0-60 | 3285 | 80.1 |
| 0-90 | 4100 | 100 |
| 40-90 | 2198 | 53.6 |
| 60-90 | 815 | 19.8 |
| 90-180 | 0 | 0 |
| 0-180 | 4100 | 100 |

Efficacy (lumens per watt): 90.0

## PRODUCT SPECIFICATIONS

| | |
|---|---|
| Color Temperature | 3,000K - 6,500K |
| CRI(Ra) | 80~87 (CCT Dependant) |
| Beam Angle | 112° |
| Luminous Flux (lm) | 3,900 |
| Luminous Efficacy | 91 |
| Illumination @1m(lx) | 1,400 |
| Protection | IP20 |
| Mode Types | DMX/0-10V/Remote |
| Recycling | (Enclosure) |
| Networking | (max.100EA & max.distance 100m recommended) |
| Dimming Control | (256 Step / DMX512) |
| Dimming Algorithm | 1 ~ 100%, Gamma=2.2 |

## ELECTRICAL SPECIFICATIONS

| | Condition | Min | Typical | Max |
|---|---|---|---|---|
| Power Consumption (W) | Max Lighting | 42 | 45 | 48 |
| Input Voltage (V) | AC | 90 | 100 ~ 277 | 300 |
| Power Factor | | 0.9 | - | - |
| Operating Temperature (°F) | | -4 | 77 | 113 |

For ordering information please visit
www.sigmaluminous.com
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# A14. MaxLite RKT

maxLED by MaxLite

PROJECT NAME: Iowa Energy Center CATALOG NUMBER:

NOTES: FIXTURE SCHEDULE:



## RKT - Recessed Troffer Retrofit Kits

RKT SERIES

20"

45"

### PRODUCT DESCRIPTION:

MaxLite's troffer retrofits offer service professionals an economical solution to safely upgrade fluorescent luminaires to include an LED light source. The installation process is quick and easy and does not require the installer to remove the existing fixture.

### FEATURES:

- Pre-punched holes for easy handling
- Includes Thermal Dot indicators to quickly validate application suitability
- Custom CCTs available upon request, please contact your MaxLite sales representative for quotations
- LM-80 chip yields over 103,000 hour L70 lifetime using TM-21 extrapolation

### CONSTRUCTION:

- Galvanized steel body
- Reflective finish improves retrofit efficacy
- Integrated tunnel cover houses driver and will enclose most existing linear fluorescent ballasts
- 'S' hook supplied for temporary hanging during installation

### CONTROL:

- RKT Troffer Retrofit Kits are supplied with a 0-1-10v simple dimming driver Compatible with standard 0-10v dimming controls
- Simple dimming driver is supplied with an auxiliary output wire (yellow wire) which can be used with MaxLite's MLFPIRK wireless remote dimming kit.

**MODEL SELECTION** (Full list of order codes on pg. 2) Typical order example: RKT4514U4535DV

| RKT | | 14 | U | | | DV |
|---|---|---|---|---|---|---|
| **FAMILY** | **NOMINAL LENGTH** | **NOMINAL WIDTH** | **INPUT VOLTAGE** | **INPUT WATTAGE** | **CCT** | **DIMMABILITY** |
| **RKT=** LED Troffer Retrofit Kit | **20=** 20"<br>**45=** 45" | **14=** 14" | **U=** 120-277V | **40=** 40 watts<br>**45=** 45 watts | **35=** 3500K<br>**41=** 4100K<br>**50=** 5000K | **DV=** 0-10V Dimmable |

| ACCESSORIES | | | |
|---|---|---|---|
| **ORDER CODE** | **MODEL NUMBER** | **DESCRIPTION** | |
| 71583 | MLFPIRK | Infrared Remote Control |  |
| 70691 | MLFPRWP | Remote Control Wall Plate |  |

Add MaxLite's Infrared Remote Control to maximize efficiency without increasing labor costs. The IR remote control offers continuous dimming down to 10% and can even shut the retrofit off entirely, without requiring any additional wiring from the switch to the existing fixtures. Add the MLFPRWP wall plate to holster the remote control.

Scan the QR code with a smartphone to view the installation video or visit the following link: http://bit.ly/ledRKT maxLED by MaxLite

# RKT - Recessed Troffer Retrofit Kits

RKT SERIES



## SPECIFICATIONS:

| ITEM | SPECIFICATION | RKT2014U4035DV | RKT2014U4041DV | RKT2014U4050DV | RKT4514U4535DV | RKT4514U4541DV | RKT4514U4550DV |
|---|---|---|---|---|---|---|---|
| | | DETAILS | | | | | |
| GENERAL PERFORMANCE | Color Temperature (CCT) | 3500K | 4100K | 5000K | 3500K | 4100K | 5000K |
| | Lumens Delivered | 3,630 | 3,580 | 3,935 | 4,275 | 4,275 | 4,500 |
| | Efficacy | 91 lm/w | 90 lm/w | 98 lm/w | 95 lm/w | 95 lm/w | 100 lm/w |
| | Lumen Maintenance (L70) | 103,000 hours | | | | | |
| ELECTRICAL | Power Consumption | 40W | | | 45W | | |
| | Power Factor | > .90% | | | | | |
| | Input Voltage | 120V-277V | | | | | |
| PHYSICAL | Dimensions | 20.75" x 13.75" | | | 43.75" x 13.75" | | |
| | Weight | 2.85 lb | | | 5.25 lbs | | |
| | Mounting | Self tapping hex head (4) | | | Self tapping hex head (6) | | |
| | Ambient Temperature | 0-104F | | | | | |
| CERTIFICATION | Certification | cETLus, DLC, FCC, LM-80 | | | | | |
| | Material Usage | RoHS compliant; no mercury | | | | | |
| | Environment | Indoor | | | | | |
| | Warranty | 10 year when installed in accordance with factory supplied instruction manual | | | | | |

## ORDERING*:

| ORDER CODE | MODEL | WATTS | SIZE | INPUT VOLTAGE | COLOR TEMPERATURE (CCT) |
|---|---|---|---|---|---|
| 72683 | RKT2014U4035DV | 40 | 2 X 2 | 120-277V | 3500K |
| 72684 | RKT2014U4041DV | | | | 4100K |
| 72685 | RKT2014U4050DV | | | | 5000K |
| 72937 | RKT4514U4535DV | 45 | 2 X 4 | 120-277V | 3500K |
| 72938 | RKT4514U4541DV | | | | 4100K |
| 72939 | RKT4514U4550DV | | | | 5000K |

**Lighting layouts and spacing criteria available upon request**
***Please contact your MaxLite representative to order products that don't have order codes listed here.**

# APPENDIX B: BASE CASE TEST RESULTS

## B1. Cree High-Bay CXB

| NO.1 Cree High-bay | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 494.25 / 144.86 | Btu/hr / Watt | 3.02% |
| Total heat conduction | -5.69 / -1.67 | Btu/hr / Watt | -9.04% |
| LED fixture power | 540.80 / 158.50 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 1620 / 17438 | Foot-candle / Lux | |
| Illuminance at lighting center on the floor | 348 / 3746 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **N/A** | | % |
| | | | |
| Longwave radiant heat | 63.70 / 18.67 | Btu/hr / Watt | 1.37% |
| Shortwave radiant heat | 161.56 / 47.35 | Btu/hr / Watt | 0.69% |
| Total radiant heat | 225.24 / 66.01 | Btu/hr / Watt | 1.53% |
| | | | |
| Long wave radiant heat fraction (total) | 0.12 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.30 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.42** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | N/A | | % |
| Short wave radiant heat fraction (conditioned space) | N/A | | % |
| **Total Radiant heat fraction (conditioned space)** | N/A | | % |

## B2. Columbia High-Bay LLHP

| NO.2 Columbia High-bay LLHP | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 414.64 / 121.52 | Btu/hr / Watt | 3.03% |
| Total heat conduction | -21.33 / -6.25 | Btu/hr / Watt | -2.42% |
| LED fixture power | 471.33 / 138.13 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 1490 / 16038 | Foot-candle / Lux | |
| Illuminance at lighting center on the floor | 372 / 4004 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **N/A** | | % |
| | | | |
| Longwave radiant heat | 54.15 / 15.87 | Btu/hr / Watt | 0.55% |
| Shortwave radiant heat | 184.45 / 54.06 | Btu/hr / Watt | 1.48% |
| Total radiant heat | 238.64 / 64.94 | Btu/hr / Watt | 1.58% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.39 | | 0.08% |
| **Total Radiant heat fraction (total)** | **0.51** | | 0.11% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | N/A | | % |
| Short wave radiant heat fraction (conditioned space) | N/A | | % |
| **Total Radiant heat fraction (conditioned space)** | **N/A** | | % |

## B3. Columbia LTRE 24

| NO.3 Columbia LTRE 24 (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 129.40 / 37.92 | Btu/hr / Watt | 3.33% |
| Total heat conduction | -25.72 / -7.54 | Btu/hr / Watt | -2.22% |
| LED fixture power | 131.83 / 38.64 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 79 / 849 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.525** | | 2.67% |
| | | | |
| Longwave radiant heat | 12.18 / 3.57 | Btu/hr / Watt | 0.43% |
| Shortwave radiant heat | 42.07 / 12.33 | Btu/hr / Watt | 0.74% |
| Total radiant heat | 54.25 / 15.90 | Btu/hr / Watt | 0.86% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.41** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.18 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.61 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.78** | | % |

## B4. Columbia LTRE 22

| NO.4 Columbia LTRE 22 | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 83.98 / 24.61 | Btu/hr / Watt | 3.55% |
| Total heat conduction | -15.80 / -4.63 | Btu/hr / Watt | -2.59% |
| LED fixture power | 108.76 / 31.88 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 59 / 635 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.473** | | 3.59% |
| | | | |
| Longwave radiant heat | 7.20 / 2.11 | Btu/hr / Watt | 0.36% |
| Shortwave radiant heat | 29.00 / 8.50 | Btu/hr / Watt | 0.73% |
| Total radiant heat | 36.17 / 10.60 | Btu/hr / Watt | 0.81% |
| | | | |
| Long wave radiant heat fraction (total) | 0.07 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.27 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.33** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.14 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.56 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.70** | | % |

## B5. Columbia LLT 24

| NO.5 Columbia LLT 24 | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 108.24 / 31.72 | Btu/hr / Watt | 3.68% |
| Total heat conduction | -15.35 / -4.50 | Btu/hr / Watt | -2.65% |
| LED fixture power | 139.40 / 40.85 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 78 / 840 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.495** | | 3.03% |
| | | | |
| Longwave radiant heat | 16.92 / 4.96 | Btu/hr / Watt | 0.59% |
| Shortwave radiant heat | 40.71 / 11.93 | Btu/hr / Watt | 0.71% |
| Total radiant heat | 57.63 / 16.89 | Btu/hr / Watt | 0.93% |
| | | | |
| Long wave radiant heat fraction (total) | 0.12 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.29 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.41** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.25 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.59 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.84** | | % |

## B6. Columbia LLT 22

| NO.6 Columbia LLT 22 (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 54.29 / 15.91 | Btu/hr / Watt | 6.63% |
| Total heat conduction | -26.26 / -7.70 | Btu/hr / Watt | -2.16% |
| LED fixture power | 92.74 / 27.18 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.476** | | 4.62% |
| | | | |
| Longwave radiant heat | 8.84 / 2.59 | Btu/hr / Watt | 0.44% |
| Shortwave radiant heat | 24.16 / 7.08 | Btu/hr / Watt | 0.60% |
| Total radiant heat | 33.00 / 9.67 | Btu/hr / Watt | 0.74% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.55 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

## B7. Finelight HPR-HO 24

| NO.7 Finelight HPR-HO 24 | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 162.66 / 47.67 | Btu/hr / Watt | 3.10% |
| Total heat conduction | -10.37 / -3.04 | Btu/hr / Watt | -3.52% |
| LED fixture power | 193.47 / 56.70 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 105 / 1124 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.451** | | 2.67% |
| | | | |
| Longwave radiant heat | 19.11 / 5.60 | Btu/hr / Watt | 0.68% |
| Shortwave radiant heat | 54.18 / 15.88 | Btu/hr / Watt | 0.96% |
| Total radiant heat | 73.32 / 21.49 | Btu/hr / Watt | 1.17% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.28 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.38** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.22 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.62 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.84** | | % |

**B8. Finelight HPR-HO 22**

| NO.8 Finelight HPR-HO 22 | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 171.02 / 50.12 | Btu/hr / Watt | 3.44% |
| Total heat conduction | -20.72 / -6.07 | Btu/hr / Watt | -2.45% |
| LED fixture power | 203.47 / 59.63 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 84 / 904 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.425** | | 3.07% |
| | | | |
| Longwave radiant heat | 17.50 / 5.13 | Btu/hr / Watt | 0.87% |
| Shortwave radiant heat | 44.08 / 12.92 | Btu/hr / Watt | 1.10% |
| Total radiant heat | 61.59 / 18.05 | Btu/hr / Watt | 1.40% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.22 | | 0.05% |
| **Total Radiant heat fraction (total)** | **0.30** | | 0.07% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.51 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.71** | | % |

**B9. Finelight HP-4 ID**

| NO.9 Finelight HP-4 ID | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 109.09 / 31.97 | Btu/hr / Watt | 4.13% |
| Total heat conduction | -9.52 / -2.79 | Btu/hr / Watt | -3.46% |
| LED fixture power | 128.22 / 37.58 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 64 / 693 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **N/A** | | % |
| | | | |
| Longwave radiant heat | 45.38 / 13.30 | Btu/hr / Watt | 0.46% |
| Shortwave radiant heat | 24.70 / 7.24 | Btu/hr / Watt | 0.12% |
| Total radiant heat | 70.08 / 20.54 | Btu/hr / Watt | 0.47% |
| | | | |
| Long wave radiant heat fraction (total) | 0.35 | | 0.08% |
| Short wave radiant heat fraction (total) | 0.19 | | 0.04% |
| **Total Radiant heat fraction (total)** | **0.55** | | 0.12% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | N/A | | % |
| Short wave radiant heat fraction (conditioned space) | N/A | | % |
| **Total Radiant heat fraction (conditioned space)** | N/A | | % |

**B10. Philips Ledalite 1201**

| NO.10 Philips Ledalite 1201 | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 52.41 / 15.36 | Btu/hr / Watt | 4.96% |
| Total heat conduction | -22.37 / -6.56 | Btu/hr / Watt | -2.24% |
| LED fixture power | 82.77 / 24.26 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 38 / 409 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **N/A** | | % |
| | | | |
| Longwave radiant heat | 26.07 / 7.64 | Btu/hr / Watt | 0.26% |
| Shortwave radiant heat | 24.02 / 7.04 | Btu/hr / Watt | 0.14% |
| Total radiant heat | 50.09 / 14.68 | Btu/hr / Watt | 0.30% |
| | | | |
| Long wave radiant heat fraction (total) | 0.31 | | 0.07% |
| Short wave radiant heat fraction (total) | 0.29 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.60** | | 0.13% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | N/A | | % |
| Short wave radiant heat fraction (conditioned space) | N/A | | % |
| **Total Radiant heat fraction (conditioned space)** | **N/A** | | % |

**B11. GE DI6R**

| NO.11 GE DI6R (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 88.02 / 25.80 | Btu/hr / Watt | 3.67% |
| Total heat conduction | -13.23 / -3.88 | Btu/hr / Watt | -3.05% |
| LED fixture power | 98.29 / 28.81 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 201 / 2159 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.466** | | 4.08% |
| | | | |
| Longwave radiant heat | 0.44 / 0.13 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.15 / 4.44 | Btu/hr / Watt | 0.15% |
| Total radiant heat | 15.59 / 4.57 | Btu/hr / Watt | 0.15% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.33 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.34** | | % |

**B12. Cree ZR24 HE**

| NO.12 Cree ZR24 HE | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 70.57 / 20.68 | Btu/hr / Watt | 3.93% |
| Total heat conduction | -14.74 / -4.32 | Btu/hr / Watt | -2.63% |
| LED fixture power | 84.56 / 24.78 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 69 / 742 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.589** | | 3.74% |
| | | | |
| Longwave radiant heat | 8.82 / 2.58 | Btu/hr / Watt | 0.31% |
| Shortwave radiant heat | 34.27 / 10.04 | Btu/hr / Watt | 0.64% |
| Total radiant heat | 43.08 / 12.63 | Btu/hr / Watt | 0.71% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.41 | | 0.09% |
| **Total Radiant heat fraction (total)** | **0.51** | | 0.11% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.18 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.69 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.87** | | % |

**B13. Sigma STL100 (Cool)**

| NO.13 Sigma STL100 (Cool) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 71.81 / 21.05 | Btu/hr / Watt | 3.54% |
| Total heat conduction | -11.36 / -3.33 | Btu/hr / Watt | -3.05% |
| LED fixture power | 81.34 / 23.84 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.562** | | 3.91% |
| | | | |
| Longwave radiant heat | 8.91 / 2.61 | Btu/hr / Watt | 0.44% |
| Shortwave radiant heat | 25.34 / 7.43 | Btu/hr / Watt | 0.71% |
| Total radiant heat | 34.25 / 10.04 | Btu/hr / Watt | 0.83% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.31 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.42** | | 0.10% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.19 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.55 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

**B14. Sigma STL100 (Warm)**

| NO.13 Sigma STL100 (Warm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 60.13 / 17.63 | Btu/hr / Watt | 3.84% |
| Total heat conduction | -12.73 / -3.73 | Btu/hr / Watt | -2.85% |
| LED fixture power | 79.93 / 23.43 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 43 / 463 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.53** | | 4.16% |
| | | | |
| Longwave radiant heat | 9.37 / 2.75 | Btu/hr / Watt | 0.47% |
| Shortwave radiant heat | 22.97 / 6.73 | Btu/hr / Watt | 0.63% |
| Total radiant heat | 32.34 / 9.48 | Btu/hr / Watt | 0.79% |
| | | | |
| Long wave radiant heat fraction (total) | 0.12 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.29 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.40** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.22 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.54 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.76** | | % |

**B15. MaxLite RKT**

| NO.14 MaxLite RKT (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 119.25 / 34.95 | Btu/hr / Watt | 3.61% |
| Total heat conduction | -15.62 / -4.58 | Btu/hr / Watt | -2.70% |
| LED fixture power | 153.23 / 44.91 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 76 / 818 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.425** | | 3.29% |
| | | | |
| Longwave radiant heat | 16.17 / 4.74 | Btu/hr / Watt | 0.57% |
| Shortwave radiant heat | 38.45 / 11.27 | Btu/hr / Watt | 0.67% |
| Total radiant heat | 54.59 / 16.00 | Btu/hr / Watt | 0.88% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.25 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.59 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.84** | | % |

# APPENDIX C: VARIANCE TEST RESULTS

## C1. Columbia LTRE 24

| NO.3 Columbia LTRE 24 (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 129.40 / 37.92 | Btu/hr / Watt | 3.33% |
| Total heat conduction | -25.72 / -7.54 | Btu/hr / Watt | -2.22% |
| LED fixture power | 131.83 / 38.64 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 79 / 849 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.525** | | 2.67% |
| | | | |
| Longwave radiant heat | 12.18 / 3.57 | Btu/hr / Watt | 0.43% |
| Shortwave radiant heat | 42.07 / 12.33 | Btu/hr / Watt | 0.74% |
| Total radiant heat | 54.25 / 15.90 | Btu/hr / Watt | 0.86% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.41** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.18 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.61 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.78** | | % |

## C2. Columbia LTRE 24 @ 65F

| NO.3 Columbia LTRE 24 (65F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 138.07 / 40.47 | Btu/hr / Watt | 2.99% |
| Total heat conduction | -18.04 / -5.29 | Btu/hr / Watt | -2.44% |
| LED fixture power | 131.47 / 38.53 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 79 / 849 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.493** | | 3.25% |
| | | | |
| Longwave radiant heat | 13.83 / 3.76 | Btu/hr / Watt | 0.40% |
| Shortwave radiant heat | 42.14 / 12.35 | Btu/hr / Watt | 0.66% |
| Total radiant heat | 55.97 / 16.11 | Btu/hr / Watt | 0.77% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.42** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.65 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.85** | | % |

**C3. Columbia LTRE 24 @ 120 cfm**

| NO.3 Columbia LTRE 24 (120 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 109.44 / 32.08 | Btu/hr / Watt | 4.23% |
| Total heat conduction | -22.07 / -6.50 | Btu/hr / Watt | -2.26% |
| LED fixture power | 132.23 / 38.75 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 79 / 849 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.498** | | 5.42% |
| | | | |
| Longwave radiant heat | 7.86 / 2.31 | Btu/hr / Watt | 0.25% |
| Shortwave radiant heat | 41.59 / 12.19 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 49.45 / 14.50 | Btu/hr / Watt | 0.69% |
| | | | |
| Long wave radiant heat fraction (total) | 0.06 | | 0.01% |
| Short wave radiant heat fraction (total) | 0.31 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.37** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.12 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.63 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

## C4. Columbia LTRE 24 @ Wood Floor

| NO.3 Columbia LTRE 24 (Wood Floor) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 159.97 / 46.88 | Btu/hr / Watt | 2.86% |
| Total heat conduction | -22.56 / -6.61 | Btu/hr / Watt | -2.31% |
| LED fixture power | 131.84 / 38.63 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 83 / 893 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.553** | | 3.07% |
| | | | |
| Longwave radiant heat | 12.42 / 3.64 | Btu/hr / Watt | 0.38% |
| Shortwave radiant heat | 42.01 / 12.31 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 54.43 / 15.95 | Btu/hr / Watt | 0.76% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.41** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.17 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.58 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

## C5. Columbia LTRE 24 @ 50% Dimming

| NO.3 Columbia LTRE 24 (50% Dimming) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 99.23 / 29.08 | Btu/hr / Watt | 3.54% |
| Total heat conduction | -15.10 / -4.43 | Btu/hr / Watt | -2.65% |
| LED fixture power | 82.94 / 24.31 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 50 / 538 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.508** | | 4.72% |
| | | | |
| Longwave radiant heat | 6.96 / 2.04 | Btu/hr / Watt | 0.22% |
| Shortwave radiant heat | 26.48 / 7.76 | Btu/hr / Watt | 0.41% |
| Total radiant heat | 33.44 / 9.80 | Btu/hr / Watt | 0.47% |
| | | | |
| Long wave radiant heat fraction (total) | 0.08 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.40** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.17 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.63 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.79** | | % |

## C6. Columbia LTRE 24 @ 55F

| NO.3 Columbia LTRE 24 (55F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 115.26 / 33.78 | Btu/hr / Watt | 4.09% |
| Total heat conduction | -21.91 / -6.42 | Btu/hr / Watt | -2.42% |
| LED fixture power | 132.16 / 38.73 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 77 / 828 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.538** | | 3.16% |
| | | | |
| Longwave radiant heat | 11.43 / 3.35 | Btu/hr / Watt | 0.35% |
| Shortwave radiant heat | 41.83 / 12.26 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 53.22 / 15.60 | Btu/hr / Watt | 0.74% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.40** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.16 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.59 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

## C7. Columbia LTRE 24 @ 30 cfm

| NO.3 Columbia LTRE 24 (30 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 53.53 / 15.69 | Btu/hr / Watt | 4.35% |
| Total heat conduction | -31.17 / -9.14 | Btu/hr / Watt | -2.07% |
| LED fixture power | 131.63 / 38.58 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 77 / 828 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.569** | | 1.76% |
| | | | |
| Longwave radiant heat | 15.18 / 4.45 | Btu/hr / Watt | 0.47% |
| Shortwave radiant heat | 42.31 / 12.40 | Btu/hr / Watt | 0.66% |
| Total radiant heat | 57.49 / 16.85 | Btu/hr / Watt | 0.81% |
| | | | |
| Long wave radiant heat fraction (total) | 0.12 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.44** | | 0.10% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.56 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.77** | | % |

## C8. Columbia LTRE 24 @ Ducted Return

| NO.3 Columbia LTRE 24 (Ducted Return) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 103.12 / 30.22 | Btu/hr / Watt | 2.74% |
| Total heat conduction | -21.16 / -6.20 | Btu/hr / Watt | -2.48% |
| LED fixture power | 131.54 / 38.55 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 77 / 828 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.639** | | 2.35% |
| | | | |
| Longwave radiant heat | 18.80 / 5.51 | Btu/hr / Watt | 0.58% |
| Shortwave radiant heat | 42.41 / 12.43 | Btu/hr / Watt | 0.66% |
| Total radiant heat | 61.25 / 17.95 | Btu/hr / Watt | 0.88% |
| | | | |
| Long wave radiant heat fraction (total) | 0.14 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.32 | | 0.07% |
| **Total Radiant heat fraction (total)** | **0.47** | | 0.10% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.22 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.50 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.73** | | % |

## C9. Columbia LLT 22

| NO.6 Columbia LLT 22 (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 54.29 / 15.91 | Btu/hr / Watt | 6.63% |
| Total heat conduction | -26.26 / -7.70 | Btu/hr / Watt | -2.16% |
| LED fixture power | 92.74 / 27.18 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.476** | | 4.62% |
| | | | |
| Longwave radiant heat | 8.84 / 2.59 | Btu/hr / Watt | 0.44% |
| Shortwave radiant heat | 24.16 / 7.08 | Btu/hr / Watt | 0.60% |
| Total radiant heat | 33.00 / 9.67 | Btu/hr / Watt | 0.74% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.55 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.75** | | % |

**C10. Columbia LLT 22 @ 65F**

| NO.6 Columbia LLT 22 (65F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 77.45 / 22.70 | Btu/hr / Watt | 3.89% |
| Total heat conduction | -14.23 / -4.17 | Btu/hr / Watt | -2.65% |
| LED fixture power | 92.70 / 27.17 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.461** | | 4.62% |
| | | | |
| Longwave radiant heat | 9.14 / 2.68 | Btu/hr / Watt | 0.40% |
| Shortwave radiant heat | 24.29 / 7.12 | Btu/hr / Watt | 0.53% |
| Total radiant heat | 33.43 / 9.80 | Btu/hr / Watt | 0.67% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.21 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.57 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.78** | | % |

### C11. Columbia LLT 22 @ 120 cfm

| NO.6 Columbia LLT 22 (120 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 88.59 / 25.96 | Btu/hr / Watt | 4.50% |
| Total heat conduction | -4.15 / -1.22 | Btu/hr / Watt | -7.04% |
| LED fixture power | 92.84 / 27.21 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.443** | | 8.58% |
| | | | |
| Longwave radiant heat | 6.45 / 1.89 | Btu/hr / Watt | 0.28% |
| Shortwave radiant heat | 23.54 / 6.90 | Btu/hr / Watt | 0.52% |
| Total radiant heat | 29.99 / 8.79 | Btu/hr / Watt | 0.59% |
| | | | |
| Long wave radiant heat fraction (total) | 0.07 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.32** | | 0.07% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.16 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.57 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.73** | | % |

## C12. Columbia LLT 22 @ Wood Floor

| NO.6 Columbia LLT 22 (Wood Floor) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 64.52 / 18.91 | Btu/hr / Watt | 3.60% |
| Total heat conduction | -15.39 / -4.51 | Btu/hr / Watt | -2.61% |
| LED fixture power | 92.79 / 27.19 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 50 / 538 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.481** | | 4.16% |
| | | | |
| Longwave radiant heat | 8.91 / 2.61 | Btu/hr / Watt | 0.39% |
| Shortwave radiant heat | 23.89 / 7.00 | Btu/hr / Watt | 0.52% |
| Total radiant heat | 32.79 / 9.61 | Btu/hr / Watt | 0.65% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.35** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.20 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.54 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.73** | | % |

## C13. Columbia LLT 22 @ 50% Dimming

| NO.6 Columbia LLT 22 (50% Dimming) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 27.54 / 8.07 | Btu/hr / Watt | 6.81% |
| Total heat conduction | -16.41 / -4.81 | Btu/hr / Watt | -2.52% |
| LED fixture power | 48.56 / 14.23 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 24 / 258 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.552** | | 6.52% |
| | | | |
| Longwave radiant heat | 4.50 / 1.32 | Btu/hr / Watt | 0.20% |
| Shortwave radiant heat | 12.25 / 3.59 | Btu/hr / Watt | 0.27% |
| Total radiant heat | 16.72 / 4.90 | Btu/hr / Watt | 0.33% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.34** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.17 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.46 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.62** | | % |

### C14. Columbia LLT 22 @ 55F

| NO.6 Columbia LLT 22 (55F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 61.97 / 18.16 | Btu/hr / Watt | 3.92% |
| Total heat conduction | -27.57 / -8.08 | Btu/hr / Watt | -2.17% |
| LED fixture power | 92.89 / 27.22 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.447** | | 4.47% |
| | | | |
| Longwave radiant heat | 8.60 / 2.52 | Btu/hr / Watt | 0.38% |
| Shortwave radiant heat | 23.85 / 6.99 | Btu/hr / Watt | 0.52% |
| Total radiant heat | 32.45 / 9.51 | Btu/hr / Watt | 0.65% |
| | | | |
| Long wave radiant heat fraction (total) | 0.09 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.35** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.21 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.57 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.78** | | % |

### C15. Columbia LLT 22 @ 30 cfm

| NO.6 Columbia LLT 22 (30 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 61.18 / 17.93 | Btu/hr / Watt | 2.88% |
| Total heat conduction | -42.69 / -12.51 | Btu/hr / Watt | -1.99% |
| LED fixture power | 92.80 / 27.20 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.654** | | 1.99% |
| | | | |
| Longwave radiant heat | 10.71 / 3.14 | Btu/hr / Watt | 0.47% |
| Shortwave radiant heat | 24.50 / 7.18 | Btu/hr / Watt | 0.54% |
| Total radiant heat | 35.21 / 10.32 | Btu/hr / Watt | 0.71% |
| | | | |
| Long wave radiant heat fraction (total) | 0.12 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.38** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.18 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.40 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.58** | | % |

## C16. Columbia LLT 22 (Ducted Return)

| NO.6 Columbia LLT 22 (Ducted Return) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 57.17 / 16.76 | Btu/hr / Watt | 4.65% |
| Total heat conduction | -28.32 / -8.30 | Btu/hr / Watt | -2.25% |
| LED fixture power | 92.80 / 27.20 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 46 / 495 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.555** | | 3.78% |
| | | | |
| Longwave radiant heat | 13044 / 3.94 | Btu/hr / Watt | 0.58% |
| Shortwave radiant heat | 24.26 / 7.11 | Btu/hr / Watt | 0.53% |
| Total radiant heat | 37.70 / 11.05 | Btu/hr / Watt | 0.79% |
| | | | |
| Long wave radiant heat fraction (total) | 0.15 | | 0.04% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.41** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.26 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.47 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.73** | | % |

## C17. GE DI6R

| NO.11 GE DI6R (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 88.02 / 25.80 | Btu/hr / Watt | 3.67% |
| Total heat conduction | -13.23 / -3.88 | Btu/hr / Watt | -3.05% |
| LED fixture power | 98.29 / 28.81 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 201 / 2159 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.466** | | 4.08% |
| | | | |
| Longwave radiant heat | 0.44 / 0.13 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.15 / 4.44 | Btu/hr / Watt | 0.15% |
| Total radiant heat | 15.59 / 4.57 | Btu/hr / Watt | 0.15% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.33 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.34** | | % |

**C18. GE DI6R @ 65F**

| NO.11 GE DI6R (65F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 68.19 / 19.99 | Btu/hr / Watt | 3.92% |
| Total heat conduction | -15.02 / -4.40 | Btu/hr / Watt | -2.78% |
| LED fixture power | 97.89 / 28.69 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 200 / 2153 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.403** | | 4.47% |
| | | | |
| Longwave radiant heat | 0.48 / 0.14 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.01 / 4.40 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.59 / 4.54 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.38 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.39** | | % |

## C19. GE DI6R @ 120 cfm

| NO.11 GE DI6R (120 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 113.14 / 33.16 | Btu/hr / Watt | 4.74% |
| Total heat conduction | -4.87 / -1.43 | Btu/hr / Watt | -6.66% |
| LED fixture power | 98.60 / 28.90 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 202 / 2174 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.464** | | 7.54% |
| | | | |
| Longwave radiant heat | 0.34 / 0.10 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.25 / 4.47 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.59 / 4.57 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.33 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.34** | | % |

## C20. GE DI6R @ Wood Floor

| NO.11 GE DI6R (Wood Floor) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 70.27 / 20.59 | Btu/hr / Watt | 4.81% |
| Total heat conduction | -18.43 / -5.40 | Btu/hr / Watt | -2.57% |
| LED fixture power | 98.21 / 28.78 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 205 / 2206 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.496** | | 4.03% |
| | | | |
| Longwave radiant heat | 0.44 / 0.13 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.08 / 4.42 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.52 / 4.55 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.31 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.32** | | % |

**C21. GE DI6R @ 50% Dimming**

| NO.11 GE DI6R (50% Dimming) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 31.35 / 9.19 | Btu/hr / Watt | 7.91% |
| Total heat conduction | -18.55 / -5.44 | Btu/hr / Watt | -2.48% |
| LED fixture power | 57.27 / 23.92 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 132 / 1421 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.478** | | 6.49% |
| | | | |
| Longwave radiant heat | 0.27 / 0.08 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 9.66 / 2.83 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 9.92 / 2.91 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.17 | | 0.04% |
| **Total Radiant heat fraction (total)** | **0.17** | | 0.04% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.35 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.36** | | % |

**C22. GE DI6R @ 55F**

| NO.11 GE DI6R (55F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 57.66 / 16.90 | Btu/hr / Watt | 5.20% |
| Total heat conduction | -36.67 / -10.75 | Btu/hr / Watt | -2.11% |
| LED fixture power | 98.76 / 28.94 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 203 / 2185 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.510** | | 3.73% |
| | | | |
| Longwave radiant heat | 0.44 / 0.13 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.22 / 4.46 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.66 / 4.59 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.00 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.30 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.31** | | % |

## C23. GE DI6R @ 30 cfm

| NO.11 GE DI6R (30 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 39.58 / 11.60 | Btu/hr / Watt | 4.61% |
| Total heat conduction | -33.57 / -9.84 | Btu/hr / Watt | -2.15% |
| LED fixture power | 98.07 / 28.74 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 203 / 2185 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.559** | | 2.15% |
| | | | |
| Longwave radiant heat | 0.58 / 0.17 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 15.12 / 4.43 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.70 / 4.60 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.01 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.01 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.28 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.29** | | % |

## C24. GE DI6R @ Ducted Return

| NO.11 GE DI6R (Ducted Return) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 53.11 / 15.57 | Btu/hr / Watt | 5.16% |
| Total heat conduction | -29.92 / -8.77 | Btu/hr / Watt | -2.38% |
| LED fixture power | 97.92 / 28.70 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 200 / 2153 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.431** | | 4.64% |
| | | | |
| Longwave radiant heat | 0.85 / 0.25 | Btu/hr / Watt | 0.00% |
| Shortwave radiant heat | 14.98 / 4.39 | Btu/hr / Watt | 0.07% |
| Total radiant heat | 15.83 / 4.64 | Btu/hr / Watt | 0.07% |
| | | | |
| Long wave radiant heat fraction (total) | 0.01 | | 0.00% |
| Short wave radiant heat fraction (total) | 0.15 | | 0.03% |
| **Total Radiant heat fraction (total)** | **0.16** | | 0.03% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.02 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.35 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.37** | | % |

## C25. MaxLite RKT

| NO.14 MaxLite RKT (BASE) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 119.25 / 34.95 | Btu/hr / Watt | 3.61% |
| Total heat conduction | -15.62 / -4.58 | Btu/hr / Watt | -2.70% |
| LED fixture power | 153.23 / 44.91 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 76 / 818 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.425** | | 3.29% |
| | | | |
| Longwave radiant heat | 16.17 / 4.74 | Btu/hr / Watt | 0.57% |
| Shortwave radiant heat | 38.45 / 11.27 | Btu/hr / Watt | 0.67% |
| Total radiant heat | 54.59 / 16.00 | Btu/hr / Watt | 0.88% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.25 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.59 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.84** | | % |

## C26. MaxLite RKT @ 65F

| NO.14 MaxLite RKT (65F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 98.04 / 28.73 | Btu/hr / Watt | 2.78% |
| Total heat conduction | -12.65 / -3.71 | Btu/hr / Watt | -2.80% |
| LED fixture power | 152.58 / 44.76 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 76 / 818 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.423** | | 2.84% |
| | | | |
| Longwave radiant heat | 16.48 / 4.83 | Btu/hr / Watt | 0.40% |
| Shortwave radiant heat | 38.52 / 11.29 | Btu/hr / Watt | 0.66% |
| Total radiant heat | 55.00 / 16.12 | Btu/hr / Watt | 0.77% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.26 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.60 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.85** | | % |

## C27. MaxLite RKT @ 120 cfm

| NO.14 MaxLite RKT (120 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 136.93 / 40.13 | Btu/hr / Watt | 4.10% |
| Total heat conduction | -3.23 / -0.95 | Btu/hr / Watt | -9.02% |
| LED fixture power | 153.84 / 45.09 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 76 / 818 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.416** | | 5.53% |
| | | | |
| Longwave radiant heat | 10.99 / 3.22 | Btu/hr / Watt | 0.25% |
| Shortwave radiant heat | 37.80 / 11.08 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 48.83 / 14.31 | Btu/hr / Watt | 0.69% |
| | | | |
| Long wave radiant heat fraction (total) | 0.07 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.05% |
| **Total Radiant heat fraction (total)** | **0.32** | | 0.07% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.17 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.59 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.76** | | % |

### C28. MaxLite RKT @ Wood Floor

| NO.14 MaxLite RKT (Wood Floor) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 130.12 / 38.14 | Btu/hr / Watt | 3.04% |
| Total heat conduction | -18.81 / -5.51 | Btu/hr / Watt | -2.45% |
| LED fixture power | 153.25 / 44.91 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 82 / 883 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.449** | | 2.90% |
| | | | |
| Longwave radiant heat | 16.31 / 4.78 | Btu/hr / Watt | 0.38% |
| Shortwave radiant heat | 38.21 / 11.20 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 54.52 / 15.98 | Btu/hr / Watt | 0.76% |
| | | | |
| Long wave radiant heat fraction (total) | 0.11 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.24 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.56 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.79** | | % |

## C29. MaxLite RKT @ 50% Dimming

| NO.14 MaxLite RKT (50% Dimming) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 52.86 / 15.49 | Btu/hr / Watt | 4.91% |
| Total heat conduction | -9.14 / -2.68 | Btu/hr / Watt | -3.57% |
| LED fixture power | 81.90 / 24.00 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 43 / 463 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.423** | | 5.20% |
| | | | |
| Longwave radiant heat | 8.22 / 2.41 | Btu/hr / Watt | 0.22% |
| Shortwave radiant heat | 21.53 / 6.31 | Btu/hr / Watt | 0.41% |
| Total radiant heat | 29.75 / 8.72 | Btu/hr / Watt | 0.47% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.36** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.24 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.62 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.86** | | % |

### C30. MaxLite RKT @ 55F

| NO.14 MaxLite RKT (55F) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 117.08 / 34.31 | Btu/hr / Watt | 3.88% |
| Total heat conduction | -10.36 / -3.04 | Btu/hr / Watt | -3.67% |
| LED fixture power | 153.95 / 45.12 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 77 / 829 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.448** | | 3.35% |
| | | | |
| Longwave radiant heat | 15.22 / 4.46 | Btu/hr / Watt | 0.35% |
| Shortwave radiant heat | 38.39 / 11.25 | Btu/hr / Watt | 0.65% |
| Total radiant heat | 53.60 / 15.71 | Btu/hr / Watt | 0.74% |
| | | | |
| Long wave radiant heat fraction (total) | 0.10 | | 0.02% |
| Short wave radiant heat fraction (total) | 0.25 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.35** | | 0.08% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.22 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.56 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.78** | | % |

**C31. MaxLite RKT @ 30 cfm**

| NO.14 MaxLite RKT (30 cfm) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 94.20 / 27.61 | Btu/hr / Watt | 3.39% |
| Total heat conduction | -30.34 / -8.89 | Btu/hr / Watt | -2.13% |
| LED fixture power | 153.95 / 45.12 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 77 / 829 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.462** | | 2.16% |
| | | | |
| Longwave radiant heat | 20.06 / 5.88 | Btu/hr / Watt | 0.47% |
| Shortwave radiant heat | 38.24 / 11.50 | Btu/hr / Watt | 0.66% |
| Total radiant heat | 59.30 / 17.38 | Btu/hr / Watt | 0.81% |
| | | | |
| Long wave radiant heat fraction (total) | 0.13 | | 0.03% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.39** | | 0.09% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.28 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.56 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.84** | | % |

## C32. MaxLite RKT @ Ducted Return

| NO.14 MaxLite RKT (Ducted Return) | | | |
|---|---|---|---|
| **Variables** | **Results** | **Unit** | **Uncertainty** |
| Total heat extraction | 111.98 / 32.82 | Btu/hr / Watt | 3.21% |
| Total heat conduction | -24.13 / -7.07 | Btu/hr / Watt | -2.83% |
| LED fixture power | 152.41 / 44.67 | Btu/hr / Watt | 0.22% |
| Illuminance at lighting center 3 ft. above floor | 76 / 818 | Foot-candle / Lux | |
| **Conditioned space lighting heat gain fraction** | **0.523** | | 2.68% |
| | | | |
| Longwave radiant heat | 24.60 / 7.21 | Btu/hr / Watt | 0.38% |
| Shortwave radiant heat | 39.44 / 11.56 | Btu/hr / Watt | 1.31% |
| Total radiant heat | 64.04 / 18.77 | Btu/hr / Watt | 1.36% |
| | | | |
| Long wave radiant heat fraction (total) | 0.16 | | 0.04% |
| Short wave radiant heat fraction (total) | 0.26 | | 0.06% |
| **Total Radiant heat fraction (total)** | **0.42** | | 0.10% |
| | | | |
| Long wave radiant heat fraction (conditioned space) | 0.31 | | % |
| Short wave radiant heat fraction (conditioned space) | 0.49 | | % |
| **Total Radiant heat fraction (conditioned space)** | **0.80** | | % |