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How to Select Residential LED Under-cabinet Lighting

Volume 2, Issue 2
2007

A publication of the Alliance for Solid-State Illumination Systems and Technologies

Lighting Research Center

Rensselaer

Published by the Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union St., Troy, New York, USA.

http://www.lrc.rpi.edu

This *ASSIST recommends. . .* was prepared by the Lighting Research Center at the request of the Alliance for Solid-State Illumination Systems and Technologies (ASSIST). The recommendations set forth here are developed by consensus of ASSIST sponsors and the Lighting Research Center. ASSIST and the Lighting Research Center may update these recommendations as new research, technologies, and methods become available.

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Introduction

The growth of LED lighting in recent years has made it a popular choice for many types of task lighting. LED fixtures for kitchen and display cabinets have become more readily available, with several products now featured at home improvement centers. Despite claims that LED lighting can easily replace other types of traditional lighting, all lighting is not the same. From one fixture to the next, there may be differences in light output, light color, lighting distribution or uniformity, fixture life, and wattage, to name a few. So what can you expect from LED under-cabinet lighting, and how can you pick the best LED lighting for your needs?

This guide discusses issues to consider when selecting LED under-cabinet lighting fixtures for your home. For more about under-cabinet lighting in general, see *ASSIST recommends…A Homeowner's Guide to Residential Under-cabinet Lighting: Getting Good Lighting for Your Kitchen Counters*.

A variety of LED under-cabinet lighting fixtures.

Important Questions to Ask

- What is the cost?
- What is the quality and quantity of the light? Is it sufficient for the application?
- How long will it last? Will replacements be available several years after purchase? If not, what happens?
- Is there a warranty, and what does it cover?
- How easy is it to install?

Cost

What is the lifecycle cost of an LED system compared with other lighting technologies?

While the easiest way to compare lighting fixtures is by the initial purchase price, that measure does not provide the complete story on how much it will cost to own the fixture. The lifecycle cost considers the overall price of a lighting fixture or system, including initial purchase cost, installation cost, and operating cost over the life of the system.

At the present time, most LED lighting fixtures have a higher initial purchase cost than incandescent or fluorescent fixtures, approximately one to five times more. The higher cost is due to its newness in the market, technology costs, and its novelty factor. However, as with most technologies, LED fixture prices are expected to drop as the technology matures.

The operating cost over life takes into account the overall power usage of the system, the average life of the fixture, the need for lamp replacement, and other maintenance. A well-made LED fixture may last more than 10 years without replacing a lamp, making its expected life much longer than that of incandescent or fluorescent fixtures. Its power use is generally lower than that of incandescent fixtures (and lower than fluorescent in some cases), bringing down its cost to operate. Overall, the total lifecycle cost of certain LED fixtures can be the same or lower than that of certain incandescent fixtures at the present time.

For more information about the lifecycle costs of under-cabinet lighting fixtures, see *ASSIST recommends…A Homeowner's Guide to Residential Under-cabinet Lighting: Getting Good Lighting for Your Kitchen Counters*.

Quality

Does the LED fixture provide the lighting quality desired?

Your satisfaction with a particular under-cabinet lighting fixture will depend heavily on its lighting quality. Lighting quality refers to:

- Light level – How much light is the fixture producing?
- Lighting uniformity and distribution – How even is the lighting and how much coverage is there over the counter or work space?
- Lighting color – Is the light a yellowish-white, bluish-white, or neutral white? How do the colors of objects underneath the light appear? Can the color change for the purpose of mood lighting?
- Application efficacy – how many lumens are reaching your application area?

How Much Light?

The Illuminating Engineering Society of North America recommends a light level of 500 *lux* (a unit of light measurement) on kitchen counters for critical tasks, such as cooking and chopping.

To get the best lighting for kitchen counters, an LED fixture should have a minimum of 4–10 watts per foot with 5 mm LEDs, or a minimum of 20 W per foot with high-power LEDs.

Light level

The amount of light exiting the fixture and falling on the counter will differ with the type of lamp and the design of the fixture. Fixtures made of smaller, 5 millimeter (mm) LED lamps typically require more lamps than those made of larger, high-power LEDs. Fixtures with 5 mm LEDs, which require 1/10 of a watt (W) each, use many low light-output lamps clustered together. Those with high-power LEDs, which require 1/2 W to 1 W each, will have fewer lamps with higher light output spaced evenly apart.

The photos below show linear fixtures with 5 mm and high-power LEDs.

5 mm LED linear under-cabinet fixture

High-power LED linear under-cabinet fixture

It is important to understand that LED lamps and fixtures marketed as replacements for incandescent often do not provide the same amount of light as the original lamp. Using these lamps or fixtures can lead to light levels that are too low to be useful for many tasks, like reading, or too dangerous for some critical tasks, such as chopping and dicing. Side-by-side comparisons are usually needed to make this determination.

Lighting uniformity and distribution

The ideal lighting from under-cabinet fixtures is a smooth, even illumination that covers the entire counter and that washes the backsplash. The uniformity and distribution often depend on the fixture design and placement.

Some LEDs cast a narrow beam of light and can create bright spots and reflections on counters. Fixtures with 5 mm LEDs may provide a more uniform distribution, though individually they usually have a more concentrated distribution. Therefore, if the fixture is not designed properly, the distribution will be mostly downlight and not uniform, and the backsplash will remain relatively dark. A frosted lens covering the LED lamps can provide better uniformity and a more diffuse light. A secondary effect of having multiple point sources in a fixture is the potential for them to cast numerous shadows.

Lighting color

The color appearance of a white lamp can be yellowish to neutral white to bluish. One measure of color appearance is correlated color temperature (CCT). The choice of CCT is a matter of personal preference, but it also depends on the décor and finishes used in the kitchen.

White LEDs tend to cast a bluish light, though warm white LEDs are becoming more common. One caveat, however, is that the term “warm white” is not standardized. Manufacturers may label their products, like the ones shown below, as “warm white” yet each has a light color that is markedly different.

What Color Light?

For wood tones, warm-colored tiles, copper-toned metal backsplashes or warm-toned walls, look for warm CCTs in the 2700–3500 kelvin (K) range.

For decorative glass tiles, glass shelves, cool-toned tiles or gray-toned metal colors, look for cool CCTs in the 3500–5000 K range.

Some manufacturers label their products with the CCT. If the products are not labeled, look for in-store displays where you can see the color of the lighting first-hand.

24 in. high-power LED “warm white” fixture

24 in. 5 mm LED “warm white” fixture

One benefit of LEDs is that the lighting color can be more than just white. LED fixtures containing a mix of red, green, and blue LEDs can create any color of light desired (including white), giving them a decorative advantage over traditional white lighting fixtures. Color-changing LED fixtures may be desirable for parties and other mood-setting needs.

The best way to evaluate the lighting quality of a fixture is to see it first-hand. Look for lighting showrooms and in-store displays where you can compare the lighting quality of different fixtures. For more about lighting quality and getting the best lighting for your kitchen counters, see *ASSIST recommends…A Homeowner’s Guide to Residential Under-cabinet Lighting: Getting Good Lighting for Your Kitchen Counters*.

Application efficacy

As important as how many lumens a fixture produces is where the lumens are going, or the application efficacy. This is calculated by taking the total luminous flux reaching the application area and dividing it by the fixture input power. The following sample data sheet offers an example of the information that should be provided with the fixture. The sample data sheet shows the light levels distribution and how to determine how many lumens will reach each part of your counter and backsplash, and lists the application efficacy of the fixture in the summary.

Sample data sheet

Product information: **Date:** March 10, 2007

Luminaire description and catalog number	LRC LED undercabinet lighting prototype	
Light source	Five 1-W white LEDs	
	Correlated color temperature	7542
	Color rendering index	71
	Chromaticity coordinates (CIE 1931 xy)	(0.3015, 0.3035)
Fixture length (in)	12 inches	

Photometric testing:

Grid size 4-in. by 4-in.

Vertical test area	20-in. by 36-in.
Vertical overall average illuminance	22.0 fc
Vertical luminous flux	110.0 lm

Vertical surface

2.32	4.09	6.41	3.81	4.74	4.55	3.53	7.0	4.18
9.2	16.7	31.2	49.4	59.6	53.9	42.1	24	13
11.4	19.6	31.8	44.6	52.9	49.3	39.2	27	14.9
11.2	16.5	23.3	29.7	33.8	33.3	28.1	20.9	13.6
9.29	12.7	16.8	20.4	21.7	22.4	19.3	15.1	11.2

4-in. (width) 4-in. (height) 20-in.

Horizontal test area	24-in. by 36-in.
Horizontal overall average illuminance	29.1 fc
Horizontal luminous flux	174.6 lm

Horizontal surface

16.1	20.6	27.6	33.6	36.8	35.8	30.9	25.2	17.9
16.6	25	33.6	41.6	46.5	45.2	39.3	30.2	19.1
17.4	26	36.1	45.8	50.9	49.4	42.6	31.7	19.7
16.8	24.3	34	42.9	47.5	46.2	39.8	26.3	18.3
14	20.4	27.7	34.5	38.1	37.2	31.9	21	15.3
11.3	15.8	20.4	24.6	26.1	25.8	22.6	15.5	11.8

24-in. 36-in.

SUMMARY:

Total luminous flux reaching the application area	284.6 lm
Fixture input power	7.6 W
Application Efficacy	37.4 lm/W
Fixture input voltage	120.1 V
Fixture input current	0.07 A
Ambient temperature	22.7 ºC
Fixture operating temperature (Ts)	35.5 ºC

Reliability

What are the rated life and the manufacturer's guarantee for the LED fixture?

How Long Will It Last?

You can calculate the life of a fixture using the manufacturer's life rating. For example, if your under-cabinet lights will be turned on for 3 hours a day on average, an LED fixture designed to operate 30,000 hours before reaching 70% of its initial light level theoretically will last about 27 years.

In reality, though, other components within the fixture may burn out earlier, giving the fixture a shorter life than calculated.

Rated life and replacement timeframe

Because LEDs fade over time rather than burn out, at some point the amount of light coming from the fixture will be too low to be useful. This point is considered as the LED's end of "useful life." While there presently is no standard for an LED's end of life, the general consensus is that the LED fixture should be replaced when it has reached 70% of its initial light level. When selecting an LED fixture, look for products that list the average life in hours based on the 70% timeframe.

Heat and thermal management issues

Under perfect operation, LEDs may operate 50,000 to 100,000 hours. But in reality, LEDs can have drastically shortened lives as a result of poor fixture design or installation. The most common threat to LED life is heat. Heat buildup inside the fixture can affect the useful life of the LED lamps and cause their color to change. A well-built system uses proper thermal management techniques, including heat sinks, to extract the heat. Fixtures with 5 mm LEDs tend to have better heat sinking and thermal management, but the lamps themselves do not have internal heat sinks (as high-power LEDs do). Therefore, 5 mm LED fixtures may not last as long as fixtures with high-power LEDs.

Proper installation can also have a positive or negative impact on fixture life. Certain applications may require special consideration during fixture installation. For example, under-cabinet fixtures installed near the stovetop range will likely experience more heat than other fixtures.

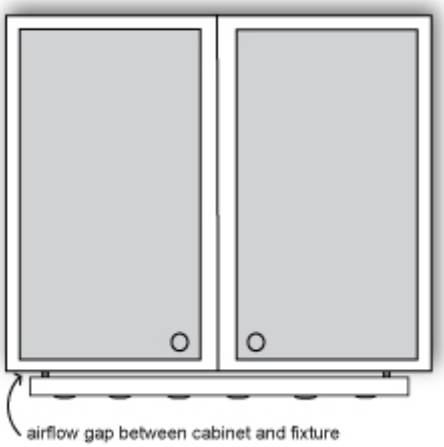
Warranty

Warranty may be an important factor for LEDs because of the reasons mentioned above. Find out about the warranty for the fixture you are considering to purchase. For example, if the manufacturer rates the life of the fixture at 50,000 hours, will they warranty the product for that entire period (e.g., 6 years under the worst-case scenario of 24 hours per day of use)? Will this warranty include materials plus labor for replacing the product? If a similar replacement fixture is not available, will the warranty cover replacement of all the fixtures?

Installation

How easy is the LED fixture to install?

In general, LED fixtures are installed in the same manner as other types of lighting fixtures. But because heat is more of an issue for LEDs than for incandescent or fluorescent lamps, certain installation techniques may help extend the life of these fixtures. For under-cabinet LED fixtures, leaving a gap between the fixture and the cabinet to allow air to flow around the fixture, rather than mounting it flush against the cabinet, will help more heat to escape.



Creating an airflow gap between the cabinet and the fixture will help heat to escape, extending the life of the fixture.

Replacement and Availability

Will the LED system be easy to replace if one fixture burns out? Will the manufacturer have replacement products available at the end of the fixture's rated life?

Ease of replacement

Unlike incandescent and fluorescent fixtures, LED fixtures do not have lamps that can be replaced. When the light from an LED fixture diminishes too much to be useful, the entire fixture needs to be replaced. Long-life LEDs extend the time between fixture replacements to more than 10 years. Nevertheless, it should be easy to replace the fixture if necessary, especially in the case of a faulty product.

Availability of products in the long-term

Under-cabinet fixture designs using mature light source technologies (e.g., incandescent, linear fluorescent) generally have replacement lamps and other parts available over an extended period of time because these fixtures are commonplace in the market. Burned-out lamps are easily replaced using a standard lamp from one of many manufacturers. If one fixture fails completely or is damaged after several years of use, a replacement fixture can be purchased from the same manufacturer, or a similar fixture can be purchased from a different manufacturer.

Under-cabinet fixtures featuring alternative light source technologies, such as LEDs, often boast long life and the advantages of reduced maintenance and potentially lower lifecycle costs compared with established lighting technologies. The disadvantage of less mature light sources, however, is the possibility that replacement products will not be available in the long-term. Technological advances may render older designs obsolete, prompting manufacturers to discontinue products in favor of newer and better designs with more advanced lamps. If a homeowner installs several LED-based under-cabinet fixtures and one fails after several years, the homeowner may be in the position of replacing all the fixtures because a matching product can no longer be found. Even if a

replacement product is found, the variability found among LEDs in terms of lighting color and light output may make the new fixture stand out as different from the rest.

To reduce the cost and potential hassle of replacing all fixtures, ask whether the manufacturer guarantees the availability of the same or relatively similar products over at least a five-year period.

Resources

ASSIST. 2007. *ASSIST recommends… A Homeowner's Guide to Residential Under-cabinet Lighting: Getting Good Lighting for Your Kitchen Counters*. Vol. 2, Issue 1. Troy, N.Y.: Lighting Research Center, Rensselaer Polytechnic Institute.

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About ASSIST

ASSIST was established in 2002 by the Lighting Research Center at Rensselaer Polytechnic Institute to advance the effective use of energy-efficient solid-state lighting and speed its market acceptance. ASSIST's goal is to identify and reduce major technical hurdles and help LED technology gain widespread use in lighting applications that can benefit from this rapidly advancing light source.