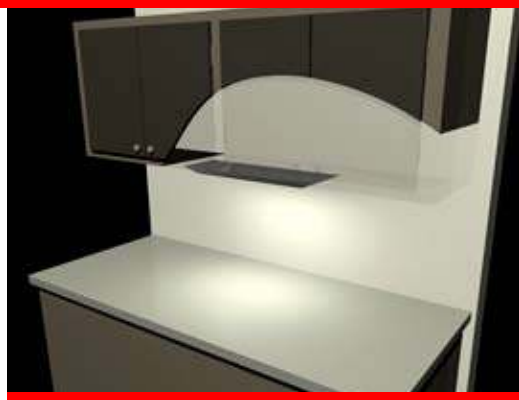
LED Application Series:

Kitchen Undercabinet Lighting

Undercabinet lighting is a growing application for LEDs, taking advantage of their directionality and small size. This fact sheet looks at undercabinet lighting specifically for residential kitchens, and presents information on the performance of several LED fixtures suited for this application.



Undercabinet lighting is used in kitchens to provide task lighting and to supplement the overall ambient lighting for the space. Undercabinet lights illuminate the horizontal task surface used for food preparation, reading cookbooks and food packages, cooking, and clean-up, and provide vertical illuminance on the wall behind the counter. Color temperature for residential kitchens is typically 3000K or lower, providing a warm look. Color rendering is important for evaluation of the appearance of food, for social interaction, and for complementing decorative finishes used in kitchens. The task plane is typically 20 to 22 inches in depth and the length varies in relationship to the upper and lower cabinets. Uniform illumination is important to prevent shadows and give the perception of a larger space.

Typical fixtures designed for use with halogen or fluorescent sources range from about 30% to 50% efficient, which means that half or more of the light produced by the lamps never leaves the fixture. The inherent directionality of LEDs can provide a distinct advantage, allowing them to compete with traditional light sources in this application. The table below presents energy and light output data for several traditional fixtures, two currently available LED-based undercabinet fixtures and one LED-based prototype. The LED fixtures tested are all more efficacious than halogen, and two of the three are approximately the same or more efficacious than the fluorescent fixture, on a luminaire basis.

Photo credit: PLS Undercabinet by Finelite

Examples of Undercabinet Lighting Performance Using Different Light Sources

	Incandescent Halogen†	Fluorescent*	LED 1*	LED 2*‡	LED 3*
CCT	3000K	3015K	2767K	3358K	3352K
CRI	100	84	70	83	71
Luminaire Lumens	540	682	265	528	384
Luminaire Watts	60	19	8.7	21	8
Luminaire Length	4.0 ft	4 ft	2 ft	4.0 ft	1.9 ft
Lumens Per Linear Foot	230	230	133	527	194
Luminaire Efficacy (lm/W)	9	36	31	25	48

† Based on photometric data for commonly available products. Actual product performance depends on reflectors, trims, lamp positioning, and other factors. Assumptions available from PNNL.

** Based on photometric testing of CFL and LED undercabinet fixtures July 2007. Except as noted, fixtures tested were purchased through normal market channels.*

**‡ This sample was a prototype submitted by the manufacturer.*

Term

Luminaire – a complete lighting unit including lamp(s), ballast(s) (when applicable), and the parts designed to distribute the light, position and protect the lamps, and connect to the power supply.

Luminaire (fixture) efficiency – the ratio of luminous flux (lumens) emitted by a luminaire to that emitted by the lamp or lamps used therein; expressed as a percentage.

Luminaire efficacy – total light output (lm) provided by the luminaire divided by the total wattage (W) drawn by the fixture, expressed in lumens per watt (lm/W).

Directionality – Luminaires designed to take advantage of LED directionality can be more energy efficient than those using traditional light sources. For example, most incandescent and fluorescent lamps emit light in all directions. In typical undercabinet fixtures, only about half the light produced by the lamp actually comes out of the fixture; the remainder is absorbed within.

CCT – Correlated color temperature indicates the relative color appearance of a white light source, from yellowish-white or "warm" (2700-3000 K) to bluish-white or "cool" (5000 K).

CRI – Color rendering index is a measure of the ability of a light source to render colors, compared to a reference source (incandescent or daylight), on a scale of 0 to 100, with 100 being identical to the reference source.

Luminaires for undercabinet applications are usually linear in design although "puck" style products are available as well. Luminaires were compared on a per-linear foot basis as products are sold in varying lengths with varying light outputs. Compared to the traditional fixtures, the LED fixtures provided equivalent or more lumens per linear foot. One of the LED fixtures produced more than two times the lumens per linear foot than the traditional fixtures. The bottom line of the table shows LED luminaire efficacy similar or better than the high performing fluorescent fixture. The three LED fixtures all have similar CCTs to both the halogen and the fluorescent fixtures although their CRIs are lower. One important caveat: lumen depreciation (useful life) data is not presently available for LED luminaires.

Potential for use of LEDs in kitchen undercabinet lighting

LEDs are a natural fit for undercabinet lighting. The ability to string LEDs in a linear array or to cluster them in a puck-like fashion provides options to lighting designers to imitate the form factor of linear fluorescent lamps or the single lamps of a halogen or xenon fixture. The efficacy of newer high-powered LEDs is approaching that of fluorescent lamps with a wider choice of color temperatures available. The inherent directionality of LEDs allows a larger proportion of the available light to be directed where it is needed and not lost within the fixture.

Comparison of Undercabinet Fixture Options

	Advantages	Disadvantages
Fluorescent	• High efficacy • Long life (10,000 hours) • Inexpensive	• Dimming expensive
Halogen	• Dimmable • High color rendering	• Short life (2000 hours) • Runs hot • Low efficacy
Xenon	• Dimmable • High color rendering • Long life (8,000 hours)	• Replacement lamps can be difficult to find • Low efficacy
LED	• Can be energy efficient • Can be dimmable • Potentially longest life (35-50,000 hours) • Directional light source	• High initial cost • May have poor color quality* • May have shadowing problems

**Color quality of white LEDs continues to improve, with warmer color temperatures and better color rendering. Warm white LEDs (2700-3000K) from the leading LED device manufacturers are now available with CRI of 80.*

LED undercabinet fixtures are more expensive than most other fixtures, but they continue to improve in performance as well as price. As new LED-based undercabinet lights enter the market, users should keep the following in mind:

- LED luminaires must be engineered to mitigate heat. This can be accomplished by adding heat sinks or utilizing the fixture chassis as a heat dissipation mechanism.
- Beam patterns must be considered; the luminaire should provide uniform illumination, both on the horizontal and vertical surfaces.
- Although LED color quality continues to improve, individual products should be evaluated carefully. Some commercially available products have very high color temperature (i.e., the light appears blue/cool), noticeable color variations across the product, and/or very low color rendering.
- Some LED undercabinet luminaires have excessive shadowing caused by the arrangement of the LEDs in the fixture. This can be distracting depending on the type of task surface and is most noticeable on single-color, matte finishes.

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