

A woman with short brown hair, wearing a pink long-sleeved top, is smiling and looking down at a cutting board in a kitchen. She is holding a knife and appears to be slicing a loaf of bread. The kitchen features wooden cabinets, a stainless steel range hood, and a countertop with various items including a glass pitcher and a white cup. The overall scene is warm and inviting.

Downlighting Your Home

About Downlighting

In recent years downlighting has become the most popular method of lighting our homes. The term downlighter really refers to any light fitting which has the main direction of its light output going down. However in the context of lighting for homes it has come to be used principally to describe circular halogen fittings recessed into the ceiling.

Originally (back in the 80s) all downlights were low voltage (usually 12v) and worked off large conventional transformers, requiring electricians to correctly calculate cable thicknesses and voltage drop over their length for a good installation. Things became much simpler with the introduction of electronic transformers (usually 1/fitting) and mains (240v) voltage halogen which did not require transformers at all.

Halogen downlighting has attracted a lot of criticism in recent years from lighting designers and the environmental caucus, which is conscious of energy consumed in these schemes.

This document is intended to provide some useful guidance on creating more attractive and ecological schemes that will also cost less to own.

Choosing your light source

Light source means bulb or, the lighting industry's preferred term, lamp. However "light source" is more technically correct because we now include solid state lighting such as LEDs (Light Emitting Diodes) which are really not lamps and often cannot be replaced in their fittings.

The choice of light source is important because they will determine many of the key aspects of your scheme and are usually not interchangeable. Below is a quick overview of the current state of each generic technology and our opinion of each for home use:



Halogen

We will come back to halogen on the following pages, because it is still our preferred technology. The general reasons for this are it has the best light quality, a good range of suppliers, multiple beam angles and with the best equipment can be quite efficient. The problems of transformers are much reduced and the lifetime/ecological costs can be reduced with good application practice.



Compact Fluorescent (CFL)

CFL is all the rage at the moment for use a replacement for standard (incandescent) domestic light bulbs. It is a *diffuse* source, meaning that the light is emitted in all directions, that is suited to wide beam (and non-directional) fittings. Fluorescent is an efficient basic technology, but it requires an electronic ballast to be very efficient. It also does not compress easily into a small fittings. The current CFL lamps available for downlights are no more effective than good halogen and are certainly no match in light output or quality.

Light Emitting Diode (LED)



LED is the buzz technology and as such receiving huge marketing hype. This will definitely be one of the major light sources for many applications around the home. The technology is progressing at high speed, but at this point (March 2008), except in very narrow beam applications, struggles to match halogen for downlighting. The LEDs available in sizes that will fit a typical downlight are under 10w, with outputs still considerably below and costs considerably above, halogen. The lifetimes quoted are sometimes misleading because LEDs do not die like conventional lamps, but lose their output over time usually depending on their running temperature. The heat sinks required for high power LEDs (above 3w) get large and many products have inadequate heat sinks to keep their running temperature down. In these cases their useful life will be similar to that of long life halogen and sometimes rather shorter. The more efficient low voltage LEDs require *drivers* that are similar to transformers for halogen and these need to be matched to the LED. Already widely used for highlighting applications, LEDs will not be a serious downlighting challenge to the best halogen for another year or two.

Halogen

12v Halogen

12v IRC (InfraRed Coated) halogen is still our preferred technology. The general reasons for this are it has the best light quality, multiple beam angles and is quite efficient, especially when you consider effective light output and not just lumens per watt. The problems of transformers are much reduced and the lifetime/ecological costs can be reduced with good application practice.

Mains (240v) Voltage Halogen

This appears a easy solution, because not having a transformer is seen as an advantage and installers like them because they are quick to put in. However this convenience comes at substantial cost. The light quality is often not as good, the range of beam angles is not available, lamps do not last as long and - they produce much less light/watt of electricity than the IRC products. This can mean a lot of added cost over time for what seems cheap at first.

The analysis below looks at the 5 year cost of fitting a 12 downlight kitchen with 3 different halogen options with virtually identical light output:

Mains voltage requires 50w and costs £1,185 over 5 years, the standard 12v uses 35w lamps and costs £781 and the best technology 12v IRC (Infra Red Coated) lamps use only 20w and cost only £468. For high use areas such as kitchens IRC technology not only makes good sense for the planet, but offers major and immediate cost saving as well.

| Lamp Type | Watts | Brightness | Life 50% rated | Beam ° | Hours/yr | KwH/yr watts x hrs | Elec rate per KwH | 1 year cost electricity | 5 yr lamps | 5y COO* per light | 5Y kitchen COO 12 |
|----------------------------|-------|------------|-------------------|--------|----------|--------------------------|----------------------|----------------------------|------------|----------------------|----------------------|
| Osram Halopar 240v Halogen | 50 | 950cd | 2000h | 35 | 3500 | 175 | £0.09 | £15.75 | 8 | £98.75 | £1,185.00 |
| Philips Diamondline Pro | 35 | 1000cd | 4000h | 36 | 3500 | 122.5 | £0.09 | £11.03 | 4 | £65.13 | £781.50 |
| Osram Decostar IRC | 20 | 1000cd | 5000h | 36 | 3500 | 70 | £0.09 | £6.30 | 3 | £39.00 | £468.00 |

*Cost of Ownership (COO) assumes lamp cost of £2.50/each and includes electricity at constant prices

Transformers and dimmers

One of the most common errors on downlighting schemes is not to use dimmer switches or a control system. Dimmed lamps have a pleasant warm glow and last longer. Being able to dim a room, especially when using multiple individually dimmable circuits, provides flexibility of mood and function as well as energy savings.

Dimming low voltage downlights requires suitable dimmer switches that are compatible with electronic transformers – please note these are not the same as standard dimmers, although these will sometimes work. The dimmer must not be overloaded (check the VA – Volt Amp – rating is not exceeded) or the dimmer may be damaged (the first sign of this often a audible buzzing noise). We recommended that you use a transformer that will work with both ‘leading edge’ and ‘trailing edge’ dimmers, as some will only work with one or the other.

Transformer size can be important in that replacement is much easier if the transformer is able to be removed from the ceiling void through the downlighter.

An alternative to dimmer switches in a kitchen is to have up to 4 circuits controlled by a simple control system. These can be quite cost effective and some will fit into a double gang socket backbox without the need for a separate rack.

The advantage of one of these control systems is that ‘scenes’ can be set up, which in a kitchen are typically ; daytime scene, night working, intimate dining and entertaining. Other advantages of some control systems is a soft start (kinder to lamps and transformers) and a neat appearance on the plate.



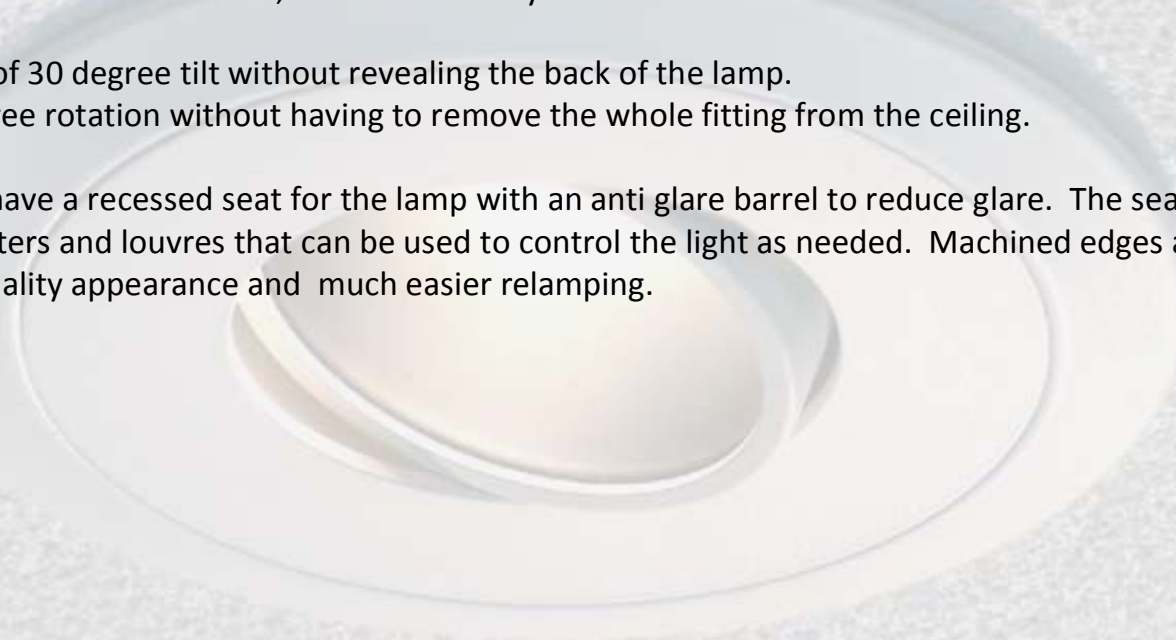
Downlights

Halogen downlights come in a wide variety . The fittings themselves are often very cheap, but this is misleading because the main cost will be the electricity consumed by the overall lighting scheme.

Cheap fittings should be restricted to areas where a few fittings are being used just to light the floor. They should not be used important space, because they do not allow for a good light scheme. To allow for proper downlighting an *architectural downlighter* should be used, which at the very least should have two critical characteristics:

- A minimum of 30 degree tilt without revealing the back of the lamp.
- Full 360 degree rotation without having to remove the whole fitting from the ceiling.

The best downlights have a recessed seat for the lamp with an anti glare barrel to reduce glare. The seat also provides a location for lenses, filters and louvres that can be used to control the light as needed. Machined edges and magnetic surrounds create a quality appearance and much easier relamping.



Downlighting schemes

Downlighting is an extremely effective way of lighting a domestic space. However the normal downlighting scheme is not a scheme at all – just a symmetrical array of flood width beams of light pointing at the floor. The result is poor, with underlit walls and ceiling, unnecessary glare and bland uniformity.

A good downlighting scheme has distinct elements, normally on separate circuits, which follow a simple process of defining a layout:

- 1. Start with the walls** – position downlights (usually 450-600mm) from the vertical wall surface, ideally where there are pictures or interesting features to be highlighted. These lights are called wall wash or picture lights. They are usually a mid beam (24-38°) and will be tilted 20-25°, sometimes with an additional lens to shape the light.
- 2. Think about functions** – position lights a little to the side and forward of where tasks will need to be done. These are often narrow beam (8-12°) to provide the higher intensity that tasks demand.
- 3. Define corners, boundaries and entrances** as appropriate so that the space can be either spacious or intimate depending on the level of these fittings. As these fittings are dimmed, the space will feel smaller and more intimate.
- 4. Lastly highlight the focal point(s)** of the room to direct attention to where you wish people to look and away from less interesting parts of the room.

These four elements form a simple four circuit scheme, with usually 2-8 lights on each circuit. With 20w IRC lamps you will be well under the typical dimmer/control channel rating of 250va/channel.

This system can apply to any room, but four channels are often unnecessary. The most common room where it works well is the typical kitchen/dining/family room.

Lenses

An architectural downlight should have a facility to hold a lens or baffle (a honeycomb material) in front of the lamp. Lenses are used in combination with lamps of different beam angles to shape the light to the desired effect as shown below.



Linear spread



























Prismatic diffusion



Softening diffusion



Frosted diffusion

| | 8° Lamp | 24° Lamp | 36° Lamp |
|---|---|---|---|
|  No Filter |  |  |  |
|  Linear Diffusion (Vertical) |  |  |  |
|  Linear Diffusion (Horizontal) |  |  |  |
|  Prismatic Diffusion |  |  |  |
|  Softening Diffusion |  |  |  |
|  Frosted Diffusion |  |  |  |

Ecology

The ecology of lighting is complex. It is not simply a case of switching from standard to energy saving bulbs (CFLs) as will become clear as the public debate becomes more informed. In the interests of impartiality we will just list main issues that are involved.

1.Light source efficacy. This means the efficiency of the bulb (or more correctly lamp) at converting electricity into light. It is usually measured in *lumens/watt*, but you will often see that directional lamps (halogen/LEDs) often describe their output in *candela*, which is only meaningful if you are comparing lamps with the same beam angle.

2.Spectrum. The quantity of light is only part of the story, quality is also important. Quality in this instance means how well balanced is the light across the visible spectrum. A guide to this is something called CRI number(colour rendering index where daylight = 100). For example, a sodium streetlight is very efficient and produces a lot of light, but you cannot read by the light because the CRI is so low.

3.System losses. This is the power lost in the electrical driver, ballast or transformer running the lamp. These are generally not quoted and are sometimes significant. Lighting systems also have power factor losses creating higher, sometimes much higher volt/amp (VA) requirements than the consumed load in Watts (w). Since Kva is what generators actually produce and therefore this has implications for CO2 emissions.

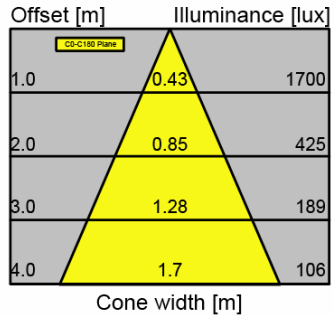
4.Optical losses. These are light losses within the fitting that effects it capacity to fulfil its function. Light Output Ratio (LOR) is the percentage of light that actually leaves the fitting. For instance CFL is not a good directional source and so a good reflector is needed to for it to be effective. Again this issue is rarely considered in residential lighting.

5.Toxicity and waste. There are several common toxic elements used in lighting products, most notably mercury (Hg) in fluorescent lamps. There is a significant body of opinion that believes that the toxicity inherent within CFL waste makes them a poor ecological option.

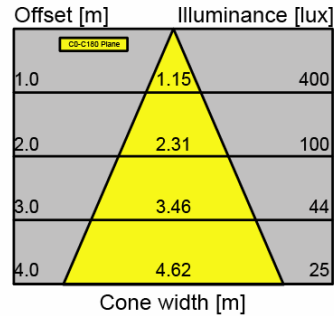
When all of the above is considered, it is our opinion that in 2008, halogen IRC (typically around 25 l/w life at 4000h life) should be considered alongside the *best* CFL options for most residential applications. LEDs will become a serious option in 2009.

MR16 Halogen Cone Diagrams

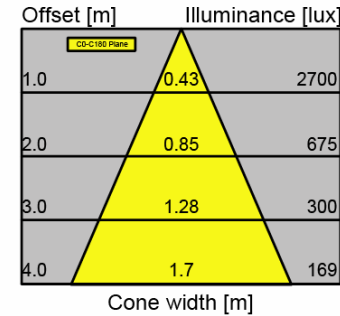
35w, 24degrees



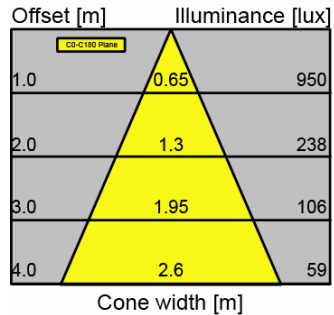
35w, 60degrees



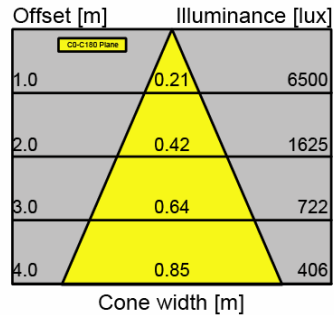
50w, 24degrees



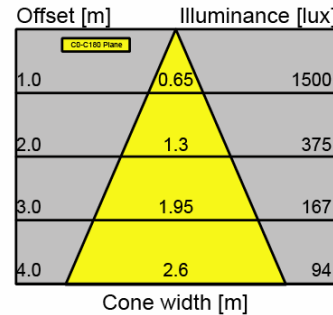
35w, 36degrees



50w, 12degrees



50w, 36degrees



50w, 60degrees

