

Replacing MR16 halogen lamps with LEDs

LED technology, because of its energy efficiency and other advantages, is rapidly replacing older halogen lamp technologies. However swapping new for old may not be straightforward. Physical and electrical compatibility between the technologies is far from guaranteed. The implications can vary from annoying (such as flicker, or not fitting properly) though to the very serious (such as fire).

Halogen technology

The common 50W or 35W MR16 dichroic 12V halogen lamp has been a key component of lighting systems in retail, hospitality, residential and museum applications since the 1980s. There are around 300 million installed in Australia in a wide variety of luminaires such as downlights, wall lights and track lighting. They may be running in conjunction with simple wire wound (ferromagnetic) transformers or a formidable array of electronic transformers with many connected to various switches, timers and dimmers. Halogen lamp technology is simple, well known, stable and forgiving with an established size and basic operation characteristics that provide a high level of compatibility, even when used with the extensive range of luminaires, transformers and other control gear available.

The most common multi-faceted reflector MR-type lamp is the MR16, so named because it has a diameter of 16/8^{ths} of an inch, or 2 inches (50.8mm). MR16 halogen lamps are typically designed to operate at a low voltage (usually 12V), because of the optical advantage gained through the use of a small filament. The 2 pin base connection is known as a GU5.3 or GX5.3 (the pins are 5.3mm apart).

LED MR16 lamps

The LED MR16 lamp is a retrofit product, meaning that it is designed to replace a halogen MR16 lamp used in a luminaire such as a downlight using the existing transformer and dimmer (if installed). In changing to an LED MR16, the aim should be to achieve improved safety and performance, reduced energy consumption and overall cost savings.

Compatibility issues

When comparing LED MR16 and halogen products, not only the usual performance characteristics should be evaluated but their interaction with any electronic components must be seriously considered. Compatibility is a concern for both retrofit applications and new installations. It should be noted that few LED MR16 lamp suppliers will guarantee the compatibility of their retrofit lamp with the wide range of transformers and dimmers installed in Australian homes and commercial premises.

Other factors

LED technology provides a versatility that has not been available previously. However, the MR16 halogen lamp is one of the most difficult lamps for LED technology to successfully replicate. The small form makes it problematic for LED MR16 manufacturers to design a product with comparable light

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output to their halogen equivalent. The task of delivering sufficient light becomes even more difficult in producing the warm colour temperatures characteristic of halogen lamps.

Low-voltage operation introduces an additional level of complexity. LED MR16 lamps can present challenging electrical loads to the transformer, resulting in electrical and/or thermal stresses, which can cause early LED and transformer failure if not managed. This is especially relevant for multi lamp or track lighting systems, where multiple lamps on a single circuit must interact with other electronic components.

Ideal characteristics of LED MR16 lamps

LED MR16 lamps should be:

- simple to install
- direct replacements for 12V MR16, GU5.3 or GX5.3 base halogen lamps in luminaires such as downlights
- compatible with magnetic transformers and a wide variety of electronic transformers
- compatible with commonly used dimmers
- dimmable
- compatible for use in most fixtures

Installation—who may install?

The 12 Volt (output) connection to a transformer is considered a 'safe' connection and lamp replacement may be undertaken by unskilled workers when the power is turned off at the switch. However the mains 240V (input) connection is dangerous and should only be serviced by a licensed electrician. This means:

- If the lamp has failed it may be replaced by the user.
- If the lamp holder has failed it may be replaced by the user.
- If the transformer has failed it can only be replaced by an electrician.
- If the dimmer or timer has failed it can only be replaced (or wiring repaired) by an electrician.

Principles to follow when replacing MR16 halogen lamps with LED MR16 lamps

- Ensure an LED MR16 lamp is only used in luminaires such as downlights that specify MR16, 12 Volt GU5.3 or GX5.3 type halogen lamps. (This does not apply to MR16 mains voltage (240V) lamps with GU10 base or Edison screw base.)
- One LED MR16 lamp per 50W transformer

should be used wherever possible.

- Luminaires with multiple halogen lamps must have all lamps replaced with MR16 LED lamps.
- All halogen lamps connected to the same transformer must be replaced (do not mix).
- Where LED lamps are used with a dimmer, follow the dimmer manufacturer's recommendations. It may be necessary to install several LED MR16 lamps per dimmer to provide sufficient load for the dimmer to operate properly. Also ensure all transformers are of the same type.
- Although LED MR16 lamps run cooler than halogen MR16s, it is necessary to maintain clearance from insulation and ensure adequate airflow around the LED MR16 lamp to ensure long life. Refer to the manufacturer's installation guide.
- Do not touch the inside of the reflector as fingerprints can reduce performance.

Basic installation instructions

1. Always turn off the power before touching lamps, transformers etc.
2. Check all existing lamps are operational. This is a perfect opportunity to check the general condition of the light fittings, lamp holders, connectors and cabling as all these can deteriorate over time.
3. If any halogen lights are not working, insert a working halogen lamp into the light fitting to check the transformer/dimmer operation.
4. Check the selected LED MR16 actually fits. Some are taller than MR16 halogen lamps.
5. If there are serious concerns, fit or compatibility issues you may need to consider replacing the light fittings. In this case it is suggested dedicated LED light fittings be used rather than retrofit LED MR16 lamps.
6. If a halogen light fitting is found not to be working, replace the faulty lampholder/connector and/or transformer with a type known to work with the LED lamp to be installed (refer to the manufacturer's compatibility chart).
7. It is the installer's responsibility to ensure compatibility between existing components and the new lamp.
8. Allow the 12V halogen lamp to cool before attempting to remove.
9. Remove halogen lamp from light fitting.
10. Disconnect halogen lamp from the lampholder.
11. Insert LED lamp correctly into lampholder.
12. Re-assemble light fitting.

LED MR16 and MR16 halogen lamp comparison

Characteristic	LED MR16 	MR16 Halogen 
<p>12V MR16 Lamp (GU5.3 or GX5.3)</p> <p>Designed to be used in wide variety of luminaires, downlights, reflectors, wall sconces, cable and track lights</p>	<p>Yes. Retrofit lamp. Not always compatible due to shape alterations and the wide variety of transformers and dimmers installed in Australia. Check compatibility to ensure new lamp fits/operates in the luminaire.</p>	<p>Yes. Designed to be 100% compatible with internationally agreed MR16 mounting, reflector shape, pins and length.</p>
<p>Lamp on existing transformers/dimmers</p>	<p>Compatibility with existing transformer and dimmer (if used) must be determined.</p>	<p>Full compatibility with all transformers/dimmers designed for halogen technology.</p>
<p>Lamp shape/length</p>	<p>May only be compatible with front edge mounting and lamp holder connection. Not 100% compatible with MR16 agreed shape or length. May not fit luminaire.</p>	<p>Designed to be 100% compatible with internationally agreed MR16 mounting, reflector lamp shape, pins and length.</p>
<p>Lamp power consumption (excludes transformer power consumption)</p>	<p>An LED MR16 lamp should consume less than 1/5th of the power of an equivalent light output halogen lamp—e.g. a LED MR16 lamp producing 462 lumens should use approximately 8W* or less.</p>	<p>The sale of 50W halogen lamps in Australia is now restricted by legislation. 35W lamps are readily available.</p>
<p>Light output</p>	<p>No minimum value required by legislation.</p>	<p>462 lumens (lm) is the minimum value required under legislation for 35W lamps. 35W MR16 halogen lamps typically measure 500-650 lm.</p>
<p>Beam angle</p>	<p>Manufacturer specified. Few LED MR16 lamps match their claimed MR16 halogen equivalent in light output at same beam angle.</p>	<p>Manufacturer specified.</p>
<p>Colour—CCT</p>	<p>2700K to 6000K in discrete values - 2700K, 3000K, 3500K, 4000K, 5000K etc.</p>	<p>3000K</p>
<p>Colour—CRI</p>	<p>Nominally 60 to 98</p>	<p>100</p>
<p>Colour change as lamp dims?</p>	<p>Yes – marginal. Colour change ('tuneable') technology can allow a wide range of colour change but this is unusual with LED MR16 retrofit lamps.</p>	<p>Yes. Colour will change toward 1800K as lamp is dimmed.</p>

LED MR16 and MR16 halogen lamp comparison (cont.)

Characteristic	LED MR16 	MR16 Halogen 
Colour—general	To match the colour appearance of halogen lamps specify CRI 2700K or 3000K. A CRI between 80 and 85 has become the de-facto standard for integral LED lamps. Higher CRI lamps are available.	
Life The light output of all light sources depreciates with use. Lumen maintenance is the term used when measuring this decay. The lumen maintenance (L70) value is a prediction of the number of hours an LED light source will operate before its light output falls below the point at which the decay is easily noticed; the value is 70% of initial light output. It corresponds to the practical end-of-life for the LED chip itself. While many use the L70 value as an indicator for life (probably since it is expressed as a large number, for example 50,000 hours), it is not lamp life. This is determined by the weakest component - perhaps the power supply or failure of water proofing. Lamp life may be considerably shorter than the L70 value claimed.	Lamp life to complete failure is rarely specified. Instead, the LED chip L70 lumen depreciation value is often quoted. This can be 25,000 - 40,000 hours (10+ times longer than most halogens). While this implies LED MR16s will significantly outlast halogen lamps, it should not be confused with lamp life which is very susceptible to the higher temperatures experienced during operation in a light fitting. Brand and warranty are presently the best indicators of a lamp manufacturer's confidence in the product. Long life lamps will considerably reduce maintenance costs in commercial applications.	1,000 - 5,000 hours to failure.
Compatibility with ferromagnetic and electronic transformers	Must be checked by user via on-site test (worst case) or by reference to information supplied by the manufacturer or laboratory test. Reputable manufacturers publish compatibility charts for various transformers – ensure the transformer used is listed in such charts. If the transformer is not listed you should replace the transformer to ensure long operational life of both the LED MR16 lamp and the transformer.	Should be fully compatible with magnetic & electronic transformers. Check supplier's compatibility information.

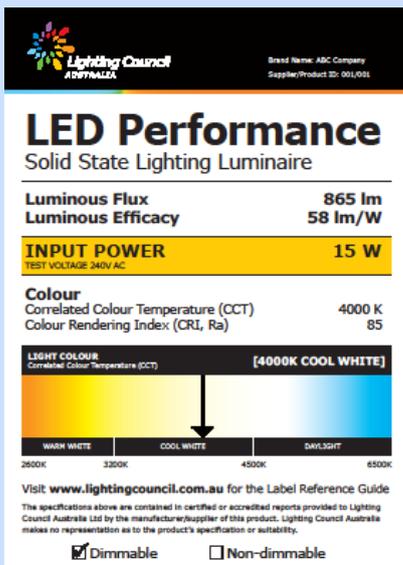
LED MR16 and MR16 halogen lamp comparison (cont.)

Characteristic	LED MR16 	MR16 Halogen 
Dimming	<p>There is no internationally agreed methodology to establish dimming, especially with respect to older design transformers and dimmers. Manufacturers of high quality LED MR16 lamps publish compatibility charts for various dimmers and these should be observed. Due to lamp, transformer and dimmer compatibility issues a new dimmer may be required. Follow the compatibility chart; otherwise use of a universal dimmer will be appropriate for magnetic and most electronic transformers</p> <p>Manufacturers may stipulate a minimum number of LED MR16 lamps to be used per dimmer. This is to provide the appropriate load to the dimmer and prevent flickering (especially at lower dim levels).</p>	Should be fully compatible with magnetic & electronic transformers using reputable dimmers (usually 2 wire phase angle dimmers).
Dimmer used with ferromagnetic transformer	Should operate satisfactorily. May require several LED lamps to provide sufficient load for reliable dimming.	Should be fully compatible.
Dimmer used with electronic transformer	Compatibility unknown. May require several LED lamps to provide load. Retrofit lamps with incompatible transformers may flicker or switch off with delayed restart. May also over heat dimmer resulting in dimmer failure or fire.	Should be fully compatible.

LED MR16 and MR16 halogen lamp comparison (cont.)

Characteristic	LED MR16 	MR16 Halogen 
Fire risk in ceiling installations with or without insulation	LED lamps run at low temperatures. However it is important to maintain clearance from insulation and ensure adequate airflow around the LED MR16 lamp to ensure long life.	Halogens operate at high temperatures and have been a cause of domestic/commercial fires, especially near thermal insulation.
Continuous running costs (electricity) per lamp Assumptions: - \$0.25/kWh - 24 hours x 365 days	\$12.05/year	\$76.65/year (35W)

* The 8W, 57 lm/W value is based on average results from the U.S. Department of Energy's CALiPER 22 report of June 2014.



Lighting Council Australia
Brand Name: ABC Company
Supplier/Product ID: 001/001

LED Performance

Solid State Lighting Luminaire

Luminous Flux 865 lm
Luminous Efficacy 58 lm/W

INPUT POWER 15 W
TEST VOLTAGE 240V AC

Colour
Correlated Colour Temperature (CCT) 4000 K
Colour Rendering Index (CRI, Ra) 85

LIGHT COLOUR
Correlated Colour Temperature (CCT) [4000K COOL WHITE]

WARM WHITE | COOL WHITE | DAYLIGHT
2800K | 3200K | 4000K | 4500K | 5000K

Visit www.lightingcouncil.com.au for the Label Reference Guide

Dimmable Non-dimmable

Lighting Council Australia has now extended its Solid State Lighting Quality Scheme to include LED MR16 lamps. The SSL Quality Scheme is a voluntary industry program that provides confidence to the market that an LED product carrying the Scheme's label (sample opposite) matches certain critical performance claims made by the supplier (energy efficiency, light output, colour temperature and CRI). Registered products appear on a searchable database on Lighting Council Australia's website (www.lightingcouncil.com.au).