HECTOR FINCH

LIGHTING

Phase control dimmers

Phase control dimmers work by chopping out parts of the voltage and reducing power to the light source. The two types of phase control dimmer available are 'trailing-edge' and 'leading-edge'. These two different types work in different ways. Because they work differently, this ultimately affects their compatibility with certain light forms:

- **Leading-edge:** inductive loads (e.g. magnetic low voltage transformers), resistive loads (e.g. incandescent).
- **Trailing-edge:** capacitive loads (e.g. electronic low voltage transformers, LED drivers), resistive loads (e.g. incandescent).

There are also other differences between the two types of dimmers...

Leading-edge dimmers (TRIAC dimmers)

Leading-edge dimmer switches are cheaper and simpler than trailing-edge, and were used originally to dim incandescent and halogen bulbs or wirewound magnetic transformers. They use a 'TRIAC' (Triode for Alternating Current) switch to control power, and are sometimes called TRIAC dimmers.

Many existing leading-edge dimmer switches have a relatively high minimum load, which often rules out their use with modest LED or CFL lighting circuits. However, leading-edge dimmers are by far the most common dimming control in existence.

One example of an excellent leading-edge dimmer switch is the BG Screwless 1-Gang 2-Way 400W Dimmer, which is perfect for LED, incandescent and halogen dimming circuits with a 60-400W minimum/maximum load.

Trailing-edge Dimmers (Reverse phase dimmers)

Trailing-edge dimmers are more sophisticated than leading-edge dimmers, and usually use a MOSFET (Metal Oxide Semiconductor Field Effect Transistor) or IGBT (Insulated Gate Bipolar Transistor) switch rather than a TRIAC and coil. This benefits the user with smooth, silent dimming control, absent of any buzzing noise.

A trailing-edge dimmer has a lower minimum load (often 10W) than leading-edge dimmers, making it a better choice for dimming modestly sized low-powered lighting circuits.

Particularly beneficial for incandescent and halogen bulbs is the 'soft start' feature in trailing-edge dimmers, which prevents filament bulbs from dying or exploding of thermal shock when first switched on.

LED lights and dimming

Unlike incandescent bulbs, which are all dimmable by default, LED retrofit bulbs have a built-in driver in their base. The driver converts AC power to DC power and maintains a constant current to the LED. This is at odds with a phase control dimming system, since the driver attempts to compensate for the sliced out portions of input voltage.
LED fixtures such as downlights usually include an external driver, either of a 'constant current' or 'constant voltage' type, depending on the LED array design. In either case, the same issue arises: the LED driver or power supply will try to patch up the missing parts of input voltage.
In theory LEDs should be fully dimmable, and they are when paired with a compatible driver. In fact they're impressive when everything is working right; they maintain their luminous efficacy when dimmed (unlike incandescent sources) and barely shift in colour, plus they last longer by running cooler.

Widespread LED compatibility problems exist, with supposedly dimmable LED driver designs often only working with selective dimming control systems. These problems show up in a number of ways, including flickering, flashing, dead travel, ghosting, dropout, pop-on, and popcorning.

How to avoid LED dimmer compatibility issues

For an LED lamp or luminaire to be functional with a phase control dimmer, the electronics of its driver have to be compatibly adapted.

Leading-edge dimmer switches are sometimes called 'incandescent dimmers', because they were originally designed to handle the resistive load of incandescent light. Existing dimmer switches tend to have high minimum loads and may require multiple LED lamps in order to even have a chance of working.

For an increased chance of compatibility, trailing-edge dimmer switches tend to work better with the capacitive load of an LED driver.

Research & investment

If you're installing a dimmable LED circuit from scratch, it's worth checking out the bulbs you're likely to buy and looking online for a list of tested dimmer switches. Most leading bulb manufacturers test their dimmable lamps with a variety of switches and publish lists of known compatible models.

Similarly, you can upgrade your existing dimmers to completely avoid compatibility headaches. Such an investment is likely to extend the lifespan of the lamps you buy, too, so there is a payback.

Remember, also, that LED bulbs are more complex than incandescent, so sticking to the same model of bulb is advisable when you find a winning formula. Once you have everything working, the many benefits of LED dimming will become apparent, to you and your business!

How trailing edge and leading edge dimmers work

Before getting to the intricacies we need to understand the basis of mains power:

Mains power consists of an alternating current that flows in one direction and then another at a UK frequency of 50 cycles per second (50 Hz). When viewed on a graph, each cycle is shown as a sine wave, resembling an 'S' on its side, with a horizontal line drawn straight through its centre.

Every time the sine wave (representing alternating current) decreases in amplitude it returns back to the horizontal line, where no voltage is present (known as the 'zero crossing point'), and it is around that point that phase control dimmers strike.

A trailing-edge dimmer fades voltage by applying resistance as the sine wave decreases in amplitude and falls back to the zero crossing point (zero volts) whilst a leading-edge dimmer chops voltage abruptly at the zero crossing point and as the sine wave increases in amplitude.