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Dimming Electronic Transformers Explained.

The History.

Originally Electronic Transformers were designed to be an economical replacement for wire wound transformers. They offered such benefits as, guaranteed 11.5 volts, short circuit protection, a compact design with less heat to dissipate and some offered soft start, all at a reduced cost. Predictably, as soon as they were available, there was a requirement for them to be dimmed. However, the dimmers available at the time proved to be unsuitable.

The ensuing race to successfully dim electronic transformers was on. Some dimmer designers developed the Trailing Edge dimmer which successfully dimmed electronic transformers however when this technology hit the market it was expensive. Meanwhile Transformer manufacturers continued to look for a way to have their product dimmed by the cheaper leading edge dimmer. Also the leading edge dimmers were going through design changes to comply with the new RFI regulations. These changes made dimming electronic transformers with leading edge dimmers more difficult. Added to this was the inevitable reduction in cost of trailing edge technology.

There was little to no consultation between the various designers and so a situation has arisen where there are many claims and a lot of confusion when it comes to dimming electronic transformers.

Many problems such as flickering lights, humming of either the transformer or dimmer, loss of lamp brilliance, power spikes and induced DC have been experienced when dimming electronic transformers. Some applications have been dimmed using leading edge dimmers and seem to work well but what is really happening in these circuits. Just because we don't see flicker or hear a hum, does not mean all is ok.

What causes these effects, what are they doing to the components within a circuit, and what solutions KIWI offers is the focus of this article.

What is an electronic transformer?

Before we can discuss any issues with dimming electronic transformers, it is important to know how they are different from wire wound transformers.

An electronic transformer is primarily an isolating transformer. Basically it is a small wire wound transformer with electronics designed and built around it. On the primary, there is a capacitor for RFI filtering and on the secondary, is the electronic circuitry which switches semiconductors at high speeds, supplying the halogen lamp its guaranteed 11.5 volts.

The capacitor on the primary of this circuit ensures the electronic transformers capacitive load rating. A capacitive load rated circuit, is a circuit where the voltage is delayed in respect to the current. The result of these circuits is the opposite of what is found in inductive loads (i.e. wire wound transformers). For these capacitive loads the voltage is constantly lagging behind the current. The circuit has power factor. Power factor could be thought of as the amount of delay between the voltage and current in respect to each other.

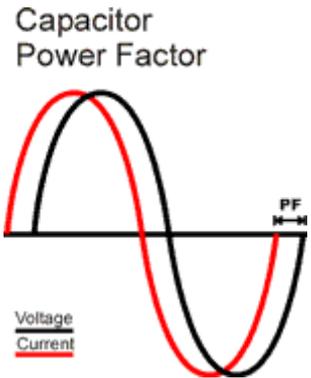
The electronic transformer should not be blamed for being capacitive. The fact is, electronic transformers must be capacitive to achieve their purpose. However this capacitance is the cause of many issues when it comes to dimming and should be remembered when choosing a method of doing this.

Understanding the issues.

1. Capacitive loads.

When electronic transformers are wired together to make a circuit, they are connected in parallel. A capacitor connected to another capacitor in parallel, increases the overall capacitance. The total capacitance of a circuit will determine the circuits' power factor (in this instance, the degree the voltage lags the current).

Added to this, the capacitance of an electronic transformer increases as it is unloaded. For example, a 60va transformer, with a 20va lamp has greater capacitance than the same transformer with a 50va lamp attached. If a lamp blows the capacitance of the transformer, and therefore the whole circuit, will increase; the power factor will increase. If the dimmer attached to the circuit does not adjust for the changing power factor of the circuit, then there is no guarantee the lamps won't flicker and the circuit won't experience problems.



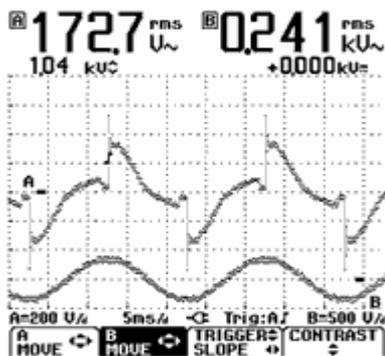
2. Voltage spikes and electronic circuits don't mix.

To comply with RFI regulations, most leading edge dimmers have been designed to include an inductor in line with the load. Primarily, the purpose of this inductor is to slow down the rise of current typical of a leading edge, triac driven device. However, switching an inductor in series with a capacitive load (such as an electronic transformer) will generate voltage spikes.

During tests, all triac driven dimmers tested on electronic transformers recorded voltage spikes. These spikes ranged from 800 to 1140 volts; where as the line voltage should be no more than 640 volts peak to peak. To clarify, that is a guaranteed voltage spike on every half wave, and on a 50 Hz supply, that equates to 100 spikes per second.

These voltage spikes pass across the small internal wire wound transformer, through the low voltage electronic circuitry and out to the lamp itself. The voltage spikes increase the peak voltage and current throughout the circuit, including at the lamp. You might not see them but the electronic components in you circuit will.

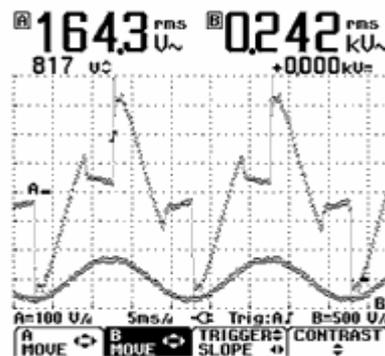
Voltage spikes will degrade lamp life, shorten the life of electronic components, and cause premature failure of either the dimmer, electronic transformer or lamp. This is guaranteed, how long it takes is the only unknown factor.



Example 1.

Leading Edge Dimmer on a market leading brand electronic transformer.

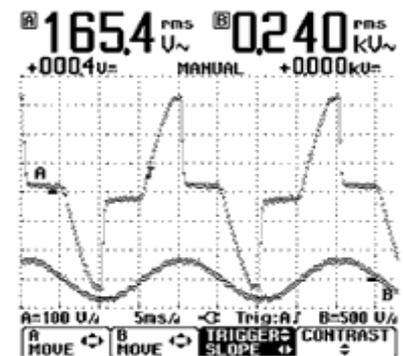
1040 volts peak to peak instead of 640.



Example 2.

Leading Edge Dimmer on a market leading brand electronic transformer.

817 volts peak to peak instead of 640.



Example of a KIWI.

Trailing Edge Dimmer on the same market leading brand electronic transformer.

No spikes exist.

3. Radio Frequency Interference.

All electronic devices must be tested and approved to current RFI (radio frequency interference) standards. However, electronic transformers are not required to be tested while being dimmed. If an electronic transformer is dimmed incorrectly, this can lead to increased RFI. Interference may be experienced under these conditions on the consumers' radio, television or other electronic devices. This effect is not present when using a trailing edge dimmer.

4. Audible noise

An electronic circuit should not produce any audible noise. When an electronic circuit is operating outside the ratings of its individual components, audible noise is quite often the result.

The most common components in electronic circuits to create unwanted noise are capacitors and inductors. Capacitors and inductors are passive components and by their very nature do not produce noise to fulfil their purpose. For audible noise to be present there must be vibration. The foils of a capacitor or the windings of an inductor are not designed to move. Movement causes wear against insulation.

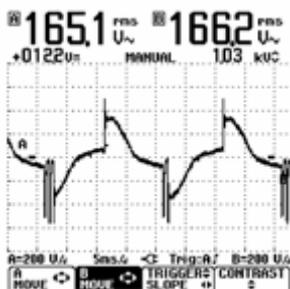
If either the dimmer or electronic transformer is noisy, then problems exist and these problems will eventually lead to failure. While Trailing Edge dimmers are the best way to dim Electronic Transformers, there is no guarantee that the transformer won't hum when being dimmed. This differs from transformer to transformer. However if a transformer hums while being dimmed with a trailing edge dimmer, results of tests have shown the hum will be louder when dimming the transformer using a leading edge dimmer.

5. The danger of DC

Inducing DC into an inductor generates heat, and quite often audible noise is a by product. Remember, an electronic transformer is an isolating transformer. The method of isolating the secondary of an electronic transformer is actually the small inductive wire wound transformer the electronic components are attached to.

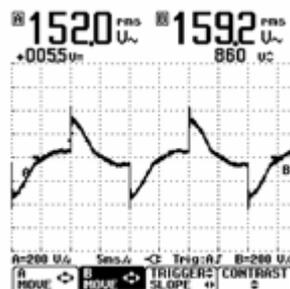
The heat generated by inducing DC into an inductor can be severe, melting plastic housings and causing surrounding parts to work outside their temperature ratings. This leads to premature component failures.

The standard leading edge dimmer does not adjust for power factor, either inductive or capacitive. Therefore, it can not guarantee a DC free supply to a load with power factor, including either wire wound or electronic transformers.



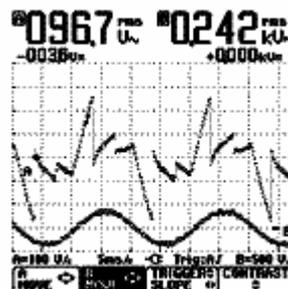
Example 1.

12 volts DC due to false triggering of the leading edge dimmer.



Example 2.

5.5 volts DC due to an inability to allow for the Power Factor.



Example 3.

3.6 volts DC from this Trailing Edge Dimmer.



Example of a KIWI.

On the same market leading brand electronic transformer, No DC in the circuit and capacitance under control.

6. Lamp Brilliance.

To solve the power factor problems and the issues they cause, dimmer designs often retard the maximum phase angle. This allows for the maximum power factor expected at the VA rating of the dimmer.

Unfortunately the cost of this solution is a loss of lamp brilliance. The result is that typically, a 240volt supplied dimmer puts out a maximum of 220volts. At the retarded phase angle, the current is also reduced. The effect of this is the lamps are not being supplied full voltage and current and therefore can not reach their full brilliance. This can be understood using the following basic calculation; Volts x Current equals VA.

For example, a dimmer connected to a 240volt supply, with a phase angle retarded to an output of 220volts, will only drive the lamps to the following VA ratings.

450va example

Not dimmed

$$240v \times 1.87a = 450va$$

Typical Trailing Edge Dimmer

(450va model)

$$220v \times 1.70a = 374va$$

KIWI Trailing Edge Dimmer

(400va model)

$$235v \times 1.62a = 380va$$

1000va example

Not dimmed

$$240v \times 4.16a = 1000va$$

Typical Trailing Edge Dimmer

(1000va model)

$$220v \times 3.70a = 814va$$

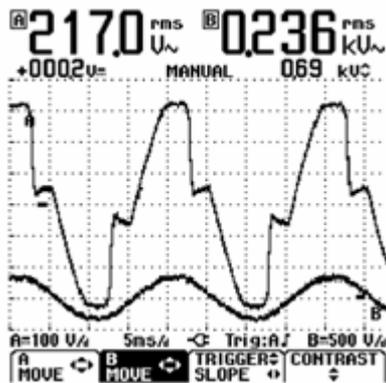
KIWI Trailing Edge Dimmer

(1000va model)

$$235v \times 4.10a = 963va$$

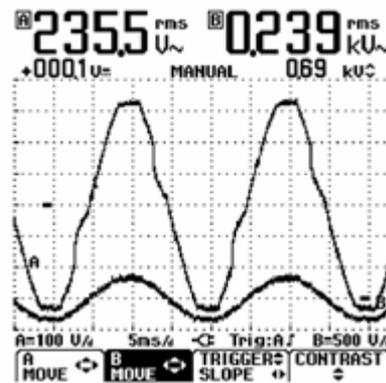
Other trailing edge dimmer

without the ability to adjust for power factor only goes as high as 217 volts with a supply voltage of 236v. See below.



KIWI trailing edge dimmer

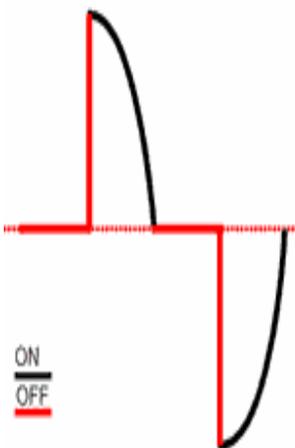
adjusting for the power factor is able to adjust all the way to 235 volts with a supply voltage of 239v. See Below



Clearly, the lamps are not being driven to full and to gain the same lux output from the lighting circuit, more transformers are required when dimmed by a dimmer that does not allow for power factor. KIWI Trailing Edge Dimmers allow for the capacitive power factor of the circuit and adjust for it.

Dimmers: How they work and their limitations.

Leading Edge Dimmers

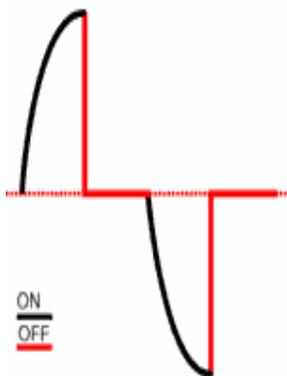


Standard leading edge dimmers change the voltage and current to the load by delaying the turn on every half wave, until the phase angle set by the dimmer knob is reached. They then naturally turn off at the current zero crossing, due to the characteristics of the semiconductor used, a triac.

This dimmer derives the phase angle to switch at from simple circuitry, a capacitor charged through a variable resistor (the pot and knob). While standard leading edge dimmers do a good job on resistive loads (incandescent lamps), their circuitry has no ability to allow for power factor. If a leading edge dimmer tries to turn on when the current is not present, it will false trigger (fail to turn on). The user will see the lamp flickering when this occurs.

Using multiple electronic transformers in a circuit, increases the power factor and therefore increases the likelihood of spikes and lamp flicker. Some dimmers or electronic transformers specify the maximum number of electronic transformers that can be attached to the dimming product. This is a very rough way of keeping the maximum power factor within the limits of the dimmers trigger circuit. It offers no guarantees, especially considering the effect on the power factor when the lamp fails. Nor does it deal with the issues of spikes, audible noise or inducing DC.

Trailing Edge Dimmers.



Trailing Edge Dimmers work in the opposite half of the sine wave to Leading Edge Dimmers. They change the voltage and current to the load by, turning on at voltage zero crossing and then delay turning off until the phase angle set by the dimmer knob, is reached. However, like the leading edge dimmers, the basic Trailing Edge Dimmer also derives its phase angle to switch at from simple circuitry, a capacitor charging through a variable resistor (the pot and knob).

Once again, this simple circuitry has no ability to allow for power factor. However, having no sharp rising edges of current in the circuit, the basic trailing edge dimmer does solve the issues of spikes and often audible noise.

Trailing Edge dimmers are purpose built to control capacitive loads. They do not have an inductor. By the nature of their design Trailing Edge dimmers turn the current off and therefore it is impossible for them to produce spikes.

Instead of the capacitor, resistor partnership, the KIWI Trailing Edge Dimmer uses a resistor feeding into a micro processor, which accepts input from the pot and knob. By using a micro processor the KIWI Trailing Edge Dimmer is able to look and adjust for power factor. This ensures the KIWI will not induce DC and allows the KIWI to take the lamps to full brilliance.

phase angle to switch at from simple circuitry, a capacitor charging through a variable resistor (the pot and knob). Once again, this simple circuitry has no ability to allow for power factor. However, having no sharp rising edges of current in the circuit, the basic trailing edge dimmer does solve the issues of spikes and often audible noise.

The Solution

As for any task it is always best to use the product that has been purpose built for the situation. This is also true when dimming electronic transformers. Here it is important to remember which half of the sine wave you are controlling and switch it correctly. Trailing Edge dimmers have been purpose built for these capacitive loads and therefore should be used at all times with Electronic Transformers.

The KIWI Trailing Edge Dimmer range has load ratings ranging from the 400va KIWI UNIVERSAL DIMMER in trailing edge mode, to the 500, 750 and 1000va Trailing Edge Dimmers. All adjust for power factor, solve DC issues, get rid of spikes, noise and allow lamps to reach their full brilliance.

When you take into account all the issues of dimming electronic transformers, how to avoid them and the availability in the market of trailing edge dimmers, you would have to ask yourself, why dim Electronic Transformers any other way?

For 100% compatible KIWI product where ALL the issues of electronic transformers have been addressed, please visit the www.kiwielectronics.co.nz the "Transformer Guide" section or contact KIWI direct on 0800 820 821.

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