

Softswitch™ Technology

One-million-cycle, arcless relay circuit

Technical white paper
May 1999 version 1.0

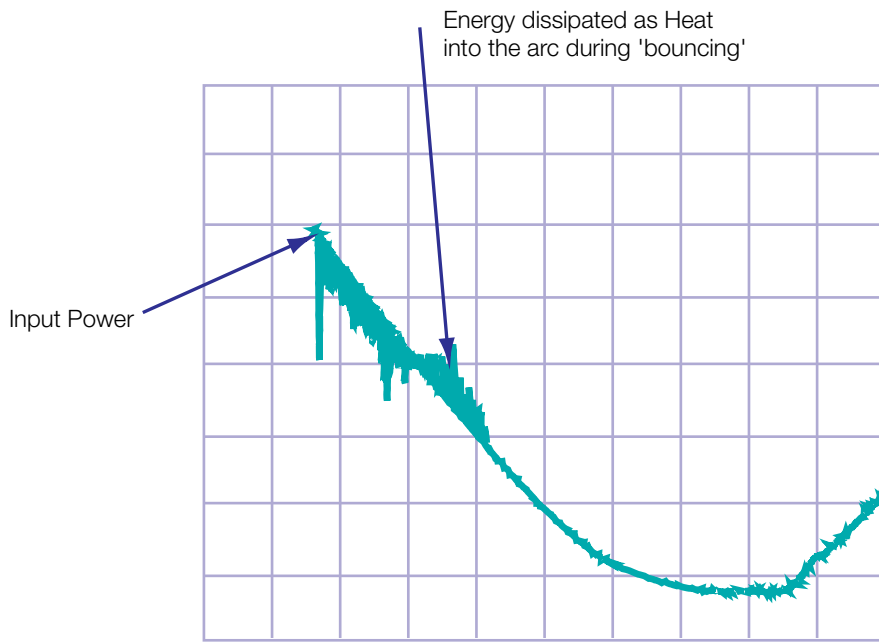


Figure 1

I. Introduction

Up until the early 1990's, relays needed to be concerned with only incandescent and inductive loads. The worst case inrush for these load types was 10X and the relays were designed accordingly.

Unfortunately, the advent of electronic ballasts changed the 'rules' as the inrush for these loads can be as high as 50X, more typically 25-40X. At these levels of inrush, the relays that were designed for 10X will typically experience a lower life. In some cases, this could be only weeks after initial operation.

The primary cause of relay failure is heat which is caused when the typical relay is closed during turn on. An arc is created as the relay contacts close, 'bouncing' several times before finally closing. As Figure 1 shows, this results in wasted energy that is dissipated in the contacts of the relay as heat. The higher the inrush, the more heat is created. Ultimately, this heat causes the contacts to weld and become inoperative.

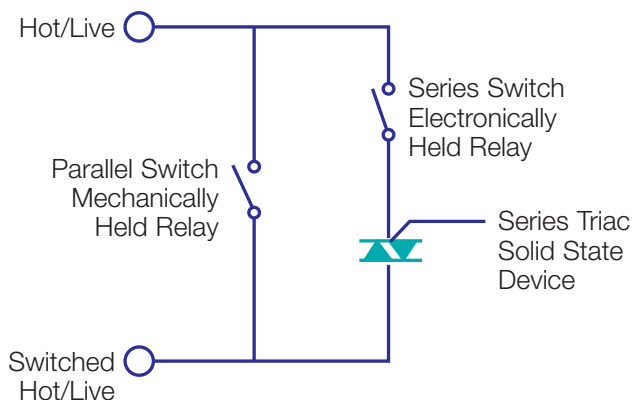


Figure 2A – Softswitch™ Circuit

This is the circuit prior to activation. Three components are shown – a mechanically held relay, an electronically held relay, and a solid-state triac.

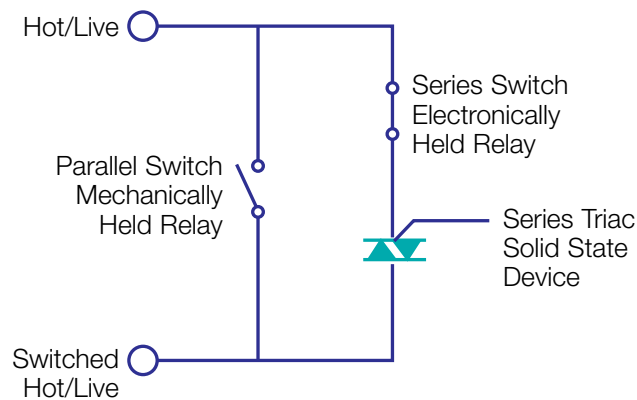


Figure 2B – Softswitch Circuit

Upon activation, the electronically held relay is closed and then the triac begins conducting. Once the load is energized, inrush is passed through the triac (the closed relay is not affected).

II. Lutron's Solution

Knowing that heat was the source of relay impairment, Lutron's approach was aimed at reducing the heat by eliminating the root cause - the arc.

Figure 2A shows three components—a mechanically held relay (which is the primary component of other relays), an electronically held relay, and a solid-state triac. When signalled to close (or turn on), the electronically held relay is closed before the triac is signalled to begin conducting (Figure 2B). Once the electronically held relay is closed, the triac begins conducting, energizing the load. Any inrush at this point is passed through the triac. (Triacs are inherently more capable of handling surges than relays because they have no moving parts and therefore no arc.) Since the electronic relay is already closed, it is not affected by any inrush.

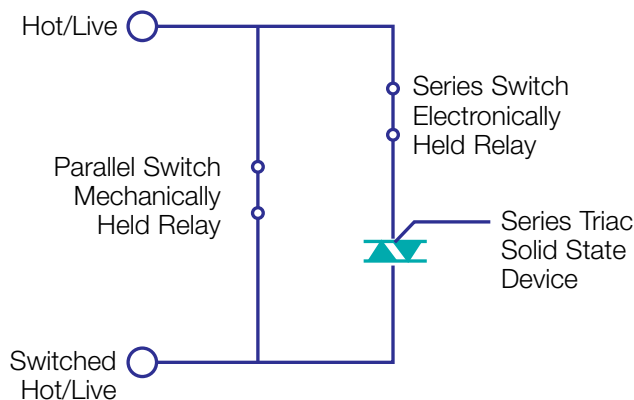


Figure 2C – Softswitch™ Circuit

Now the mechanically held relay closes as well. Because of the higher resistance than the electronically held relay, no current passes through the mechanically held relay, resulting in no arc.

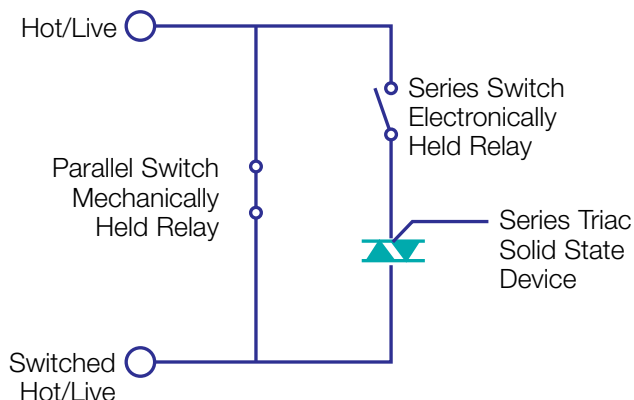


Figure 2D – Softswitch Circuit

The electronically held relay now opens and the triac is removed from the circuit. When the circuit is turned off, both relays open again providing an air gap.

At this point, the mechanically held relay is closed (Figure 2C). When the contacts for this relay ‘bounce’, there is no current passing through the contacts because the ‘bouncing’ contacts have a higher resistance than the already completed circuit passing through the electronically held relay and triac. Accordingly, this relay closes without an arc. Figure 3 reflects this.

Finally, the electronically held relay opens (Figure 2D) and takes the triac (and any heat or inefficiency—most triacs are 2-3% inefficient) out of the circuit. The notch in the waveform in Figure 3 is the triac remaining in the circuit. The electronically held relay opens after 10 line cycles, removing the triac from the circuit.

In turning off the circuit, both relays are opened using the same sequence in reverse, ensuring an air gap off that is consistent with all Lutron products.

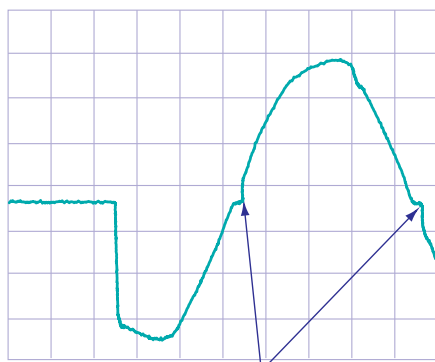


Figure 3 – Triac in Circuit

(will be removed from circuit after 10 cycles)

Lutron Patented Switching Scheme

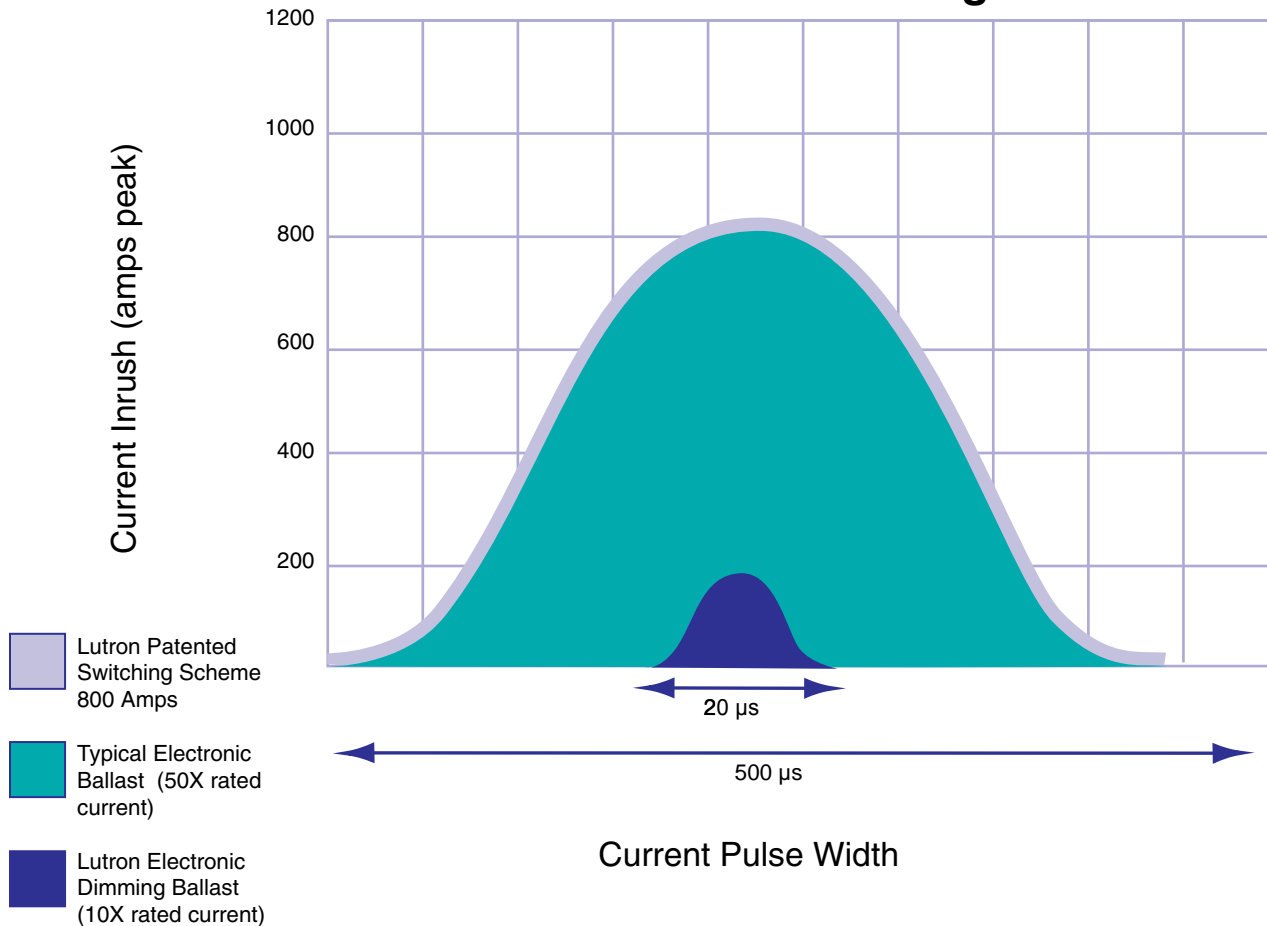


Figure 4 – Lutron’s Patented Switching Scheme

IV. Summary

With the Softswitch™ design, the average rated life of a relay is extended to 1,000,000 cycles. It is also independent of source – resistive, inductive, or capacitive – where most other relays are rated for resistive only. Figure 4 shows the various levels of typical inrush and Lutron’s solution which is capable of handling 50 times inrush.

Another ‘new’ relay circuit introduced recently is a ‘zero cross relay’. These relays are supposed to reduce the inrush by turning on where the power sine wave crosses zero. These relays do reduce the inrush but

there is still inefficiency in this operation. Figure 1 on page one is a zero cross relay. Other common relays would be far worse. Zero cross switching is implemented in order to minimize the effects of arcing. With Lutron’s Softswitch technology there are no moving parts to protect due to the triac; therefore, zero cross switching is not necessary.

One last comment is that many facilities have not experienced a problem with traditional relay operation. There are several factors that can contribute to

this. The two most common are: circuits that are not fully loaded and line impedance (longer wire runs as an example). It is important to note that Lutron had the same perspective four years ago. Because we do operate some circuits as nondim, we began to witness issues with our circuits (and components) that led us to this solution. With this solution in place, we have not experienced any problems.

Tel: 610.282.3800
International: +1 610.282.3800

For more information about choosing
the best lighting control system for your
stadium or arena project, contact your local
Lutron representative:

World Headquarters
Lutron Electronics Co., Inc.
7200 Suter Road
Coopersburg, PA
18036-1299 USA

Barcelona +34 93 496 5742
Beijing +86 10 8525 1867
Berlin +49 30 9710 4590
Hong Kong +852 2104 7733
London +44 (0) 207 702 0657
Madrid +34 91 567 8479
Paris +33 1 44 70 71 86
Shanghai +86 21 6288 1473
Tokyo +81 3 5575 8411

www.lutron.com
©2004 Lutron Electronics Co. Inc.

