THE HI-RAILERS BUZZ

The Journal of the HiRail Modelers Unlimited and Independent Hi-Railers

A Newsletter for Hi-Rail Train Hobbyists and Module Builders

Editor, Frank E. Qualls, (301)-459-5638

Volume 1, Number 1, April-May, 1999

A New Union and Newsletter

Since starting The HiRail Modelers Unlimited, we have acted as a special interest group with a voice for Hi-Rail hobbyists who model three-rail trains in a scale or prototypical environment. One of the focal points of this group is to use our collective voices as a vehicle to present to manufacturer's ideas for products that closely duplicate scale and prototype equipment. Also, we envisioned using our newsletter as a medium for sharing ideas and modeling tips with other Hi-Rail modelers to use on their layouts. Hi-Rail is inclusive of modelers whose passion for model railroading attempts to replicate the prototype within the confines of the three-rail track used on our layouts. In the past this mostly included permanent type home layouts. However, with the growth of Hi-Rail module groups around the country and in particular those that adhere to the basic specifications of the Independent Hi-Railers, advances in prototype modeling is experiencing a wider presence and gaining a larger audience. In recognition of what these module groups are doing with Hi-Rail modeling, which also translates to home layouts, we have decided to amalgamate our resources as we prepare to move into the new millennium.

Our newsletter is now known as ***"The Hi-Railers Buzz"*** This name originated with the DC Area Independent Hi-Railers as their local newsletter, edited by Frank E. Qualls, which circulated nationally to other Independent Hi-Railers module groups. ***The Hi-Railers Buzz,*** is now "The Journal of the HiRail Modelers Unlimited and Independent Hi-Railers," and the editor will be Frank E. Qualls.

The New Millennium

The final year of this century is here and we are standing at the threshold of the new millennium. Many new and exciting things are happening in our beloved hobby. At no other time in the nearly 100 year history of three-rail O gauge trains have we hobbyists had as wide of a selection of train manufacturers available to choose from. Lionel-the oldest three-rail train manufacturer in our hobby- is being challenged on every front by new entries into the market place. We now have other three-rail manufacturers such as Atlas- O, K-Line, MTH, Third Rail, Weaver, and Williams who are each competing for a share of the market. As hobbyists changing taste in three-rail trains continues to evolve, we are now expecting scale accuracy in what we purchase. Confirmation of these changing demographics within our hobby can be seen by the recent true to scale products offered by Atlas-O and K-Line. Hi-Rail continues to grow and the hobby is moving more towards scale modeling and prototype operating.

Hobbyists are also looking for the latest technological advancements in electronics and train control being incorporated in their train purchases. Higher quality and overall reduction in the prices of trains being produced is expected. Many new train control products are available on the market. Now we have high power sources and remote throttles, being produced by Alltrol, Dallee, Lionel, MRC and MTH. With these new power sources and throttles, the hobbyist has a variety of concepts to choose from for operating and controlling his trains. However, looming on the horizon in the new millennium is the continuing issue of electronic compatibility and the unexpected problem of protecting our onboard train electronics from transient voltage spikes. Both of these are hotly debated topics among hobbyists on the Internet, in the printed press, and at train shows and hobby shops. These issues need addressing and should be worked out amongst the train manufacturers.

Having stated all of the above, as we move forward towards the year 2000 this is possibly the greatest time to be in this hobby. We can all look forward to continued growth and BIG FUN with our trains in the new millennium. FEQ

Setting the Stage

Some of you know that I have worked in the electronics industry as an electronic technician for over twenty years. My career specialty is in radio frequency and microwave theory as used in satellite communications. Over the last five years I have enjoyed a close friendship with Otto Schade, Jr., a fellow Hi-Railer and model train hobbyist. Otto is a retired electrical engineer who enjoyed a long and distinguished career with RCA in semiconductor device and circuit technology. Last year after I read about the problem of transient voltage spikes occurring in model train transformers and the damaging effect they have on train electronics, I began to think about a solution to the problem. I talked with Otto, and we discussed my ideas for a simple solution that could be shared with all Hi-Rail modelers who choose to use it. We collaborated and what follows is our simple solution to transient voltage spikes, which a hobbyist can build. FEQ

Simple Hi-Rail Surge Suppression Circuitry

By

Otto Schade, Jr.

April 15, 1999

Background

On September 30, 1998, QSI (Fred Severson and Jim Christensen) published a technical report which described voltage-spike testing they had performed at QSI in response to an increasing number of electronic reverse-unit field failures. A result of this concern was a "PowerGuard" surge -suppression product and the statement that QSI sound systems could be operated safely with Lionels' ZW and other traditional transformers. The MTH Z-4000 MUST use PowerGuard protection in order for the QSI warranty to be in effect but use of a Z-750 -- as well as other untested electronic power supplies -- VOIDS any warranty. In a January, 1999 addendum, QSI formally stated that further tests showed ALL transformers to be suspect. Unless PowerGuard is used, they will not warranty any products against damage caused by excessive voltage or voltage spikes. The surge-protection circuitry to be described has NOT specifically been tested by QSI, but it does closely adhere to their original T.R.E.O.S. (Three Rail Electrical Operating Specifications) 35-volt spec and later 37-volt "practical" limit. It is presumed that these values have been derived from 35V "working" 40V "absolute max" manufacturers' capacitor specs. The use of a Lionel (DC) whistle/horn button at full throttle may put up to 26Vrms -- i.e., 36.8V peak (minus a 1.5V bridge-rectifier drop) -- on a sound-system power supply bus. There is virtually no design latitude in a practical protection circuit during such operation.

Transient Voltage Suppressors

The Microsemi 1500-Watt series of bidirectional Zeners contains nominal 33- and 36- volt devices. The breakdown-voltage tolerance on the latter part makes it unsuitable for the above spec constraints, narrowing the choice to a MSC 1.5KE33CA device for the proposed application. Its rated peak current of 33 amps (for millisecond-order durations) appears more than adequate, but the 28.2V 5uA "standoff" spec and 31.4 - 34.7V breakdown range must be considered. In addition, a series of heavy-current spikes -- such as could be encountered in a high-speed derailment -- further increases the 34.7V value due to the Zeners' bulk resistance and positive voltage/temperature coefficient. The following circuit approach takes this into account.

Protective Device Tests

To examine the ruggedness of the 1.5KE-series Zener, several were subjected to both single high-current 1000uF capacitor discharges and a 120Hz 1A/3mS pulse string for about 1-2 seconds. The former produced about 2- to 20 amp pulses in the order of 10 to 1mS, and the latter about a 10-watt dissipation for the 1-2 second period. No heat sink was used. The capacitor discharges, simulating the 50 to 60 volt spikes such as displayed in the QSI report, produced no detectable Zener characteristics change. The repetitive pulse string heated the Zener package, but it could still be touched. A rough estimate puts the breakdown-voltage increase due to bulk resistance at 1 volt and the temperature-rise component at 3 volts, for a total of about 4 volts increase caused by the pulse train. This increased clamp voltage on the track appears reduced by about 1.5V on a sound-system supply bus, due to the commonly-employed bridge rectifier. The resulting Zener voltage-range spread appears to the electronics as 33.9 to 37.2V.

The MEASURED performance of a NOMINAL 1.5KE33 was 31.5V referred to the supply bus at mA-level (33V) breakdown and 35.5V with the 120Hz 1A pulse string. Such a nominal Zener permits a 23Vrms maximum sinewave transformer output. In an attempt to increase the value to allow for boost-winding voltage at full throttle, 2 diode-voltage drops (4 diodes total for an AC waveform) can be added in series with the 1.5KE33, raising the nominal breakdown to 34.5V-- permitting a 24.4Vrms transformer output. We still haven't reached the 26Vrms level, and the electronic supply bus is raised to 37V in the pulse environment; essentially the "practical" maximum referred to by QSI. Theoretically, the rule remains: "Don't blow a ZW whistle at full throttle". We will, however, use this augmented 1.5KE33-plus-diode suppressor in a circuit which provides an LED clamp indicator.

A Sanity Check

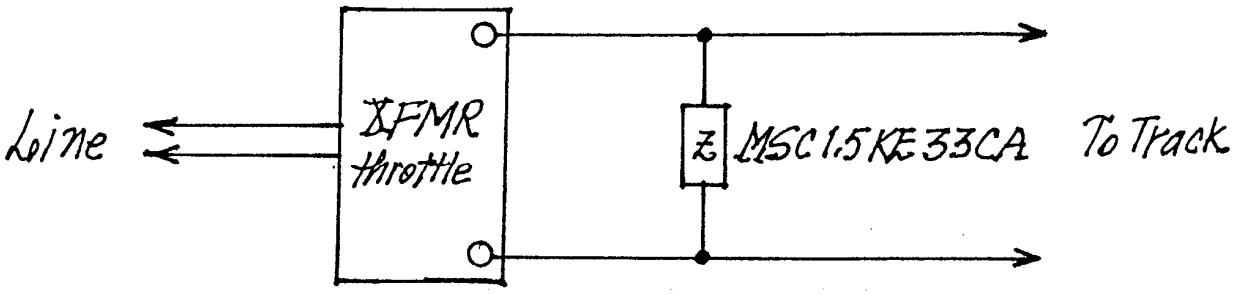
The above study shows that simple inexpensive spike protection can be provided for the voltage-spec levels quoted in QSIs' T.R.E.O.S. and subsequent report(s). Unfortunately, spec calculations show that the traditional Lionel transformer with boost winding should be operated with some discretion to meet those specs, even with selected protection components. The 1.5KE-series suppressor shown in the following circuit schematics is applied to the transformer outputs, but testing suggests it could also be directly installed on train-electronics packages by the manufacturer. Doing so would assure supply-bus spike suppression despite intermittent train/track contact or the characteristics of an "unknown" train transformer. With regard to transformer application, if train controllers are often pushed to their maximum output, the more-complicated LED suppressor circuit should be considered. This situation is the design result of choosing a clamp level that protects expensive train electronics, rather than the $1.00 transient suppressor. Of course, if you wipe out a protection device and don't know it, the electronics may be on thin ice.

Transient suppression protection is just that -- the neutralization of spikes/surges OUTSIDE a systems normal operating mode. The thermal packaging of these devices is not intended for continuous peak clamping of an otherwise normal throttle output -- with or without heat sink. More expensive circuitry having a power transistor and heat sink could routinely perform such function, but to a throttle designer, it is quite inconsistent to generate an output which becomes purposely thrown away. Modern throttle designs and locomotive electronics do not require a boost winding such as used by the ZW for reliable DC generation and detection. Their modest (if any) peak-signal increase can permit the continued use of "35-volt" electronic components in conjunction with spike protection at full 20V throttle.

The 1.5KE33 transient suppressor has been selected without knowledge of QSI's design approach or constraints; or how effective PowerGuard is. It is an independent response to QSIs' concerns and policy, has not been endorsed by them, and the reader is left to his own judgement regarding its use.

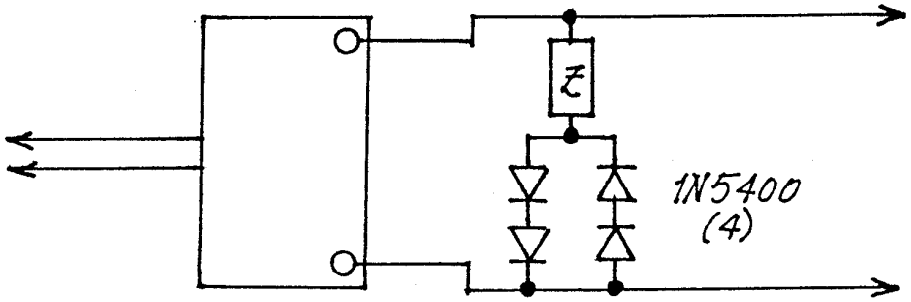
Transient Suppressor Circuits.

The simplest application of the 1.5KE33 connects it directly across the transformer/throttle output going to the track:

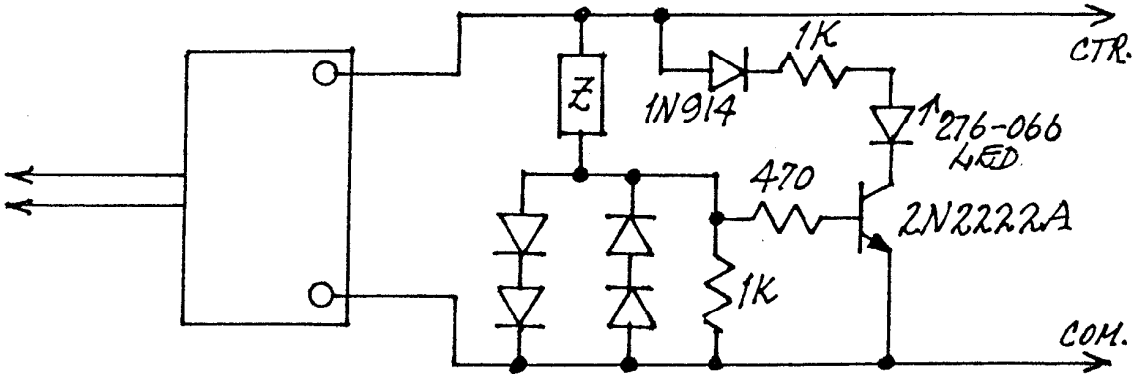


As shown, a maximum sinewave transformer output of 22Vrms can be applied. The whistle/horn button of many traditional Lionel transformers having compensating windings should NOT be used at full throttle, because exceeding this value will result in Zener output clamping and possible loss of protection.

The addition of 3A series diodes increases the maximum sinewave transformer output to 23Vrms:



This is still not enough for full-throttle boost insertion, but is the basis for an LED clamp indicator:



The resistors have a 1/2-watt rating; the LED, diodes and npn transistor are available from Radio Shack. When a milliampere-level current flows through the Zener network, the 2N2222A switch turns on and the LED is lit in a half-wave mode. At such current levels, there is insignificant Zener heating and the change of LED state indicates the initiation of a clamp mode at safe power levels. If in addition the upper track feeder is connected to the center rail, a positive-DC whistle/horn signal convention is sensed by this LED state change, establishing the maximum permissible throttle setting allowed on the Lionel transformer. Given a sufficient throttle output voltage, the procedure tests that a clamp function will occur; at least for low "spike" voltages.

Build A Simple Surge Suppressor

By
Frank E. Qualls
April, 1999

The technical report you just read details what is described as a simple transient voltage Surge Suppressor. This is not a detailed step by step "How To" set of instructions for building this device. The information provided here will give the Hi-Rail hobbyist basic ideas for layout, packaging and parts sources which he can use. Surge protection can be had by simply using a single 33-volt Bi-directional transient voltage suppressor in parallel with each transformer throttle as shown in drawing number 1. The circuit shown in drawing number 2 with the four added diodes is recommended because it uses the voltage suppressor breakdown range to its greatest advantage. Two independent 18-volt load lamps with a common ground can be added in parallel with each TVS for zeroing out the LED meters on the Z-4000. Each of these lamps also serve as track power indicators by illuminating due to transformer voltage and as short circuit indicators by dimming or extinguishing when a short is present on its respective track. They are shown in the following pictorial drawings, which depict the number 3 circuit's project box Top Cover and Perforated Board layouts.

My layout tests have shown that when using the MTH Z-4000 it can be operated at full throttle without illuminating the LED clamp indicator. However, the Lionel ZW illuminates the clamp indicator at 18-volt throttle level when using the whistle controller.

Parts List

1) 1 Project Box, Hosfelt part number JAL-3, 4 1/8" x 2 ¾" x 1 9/16".
   1 Black Banana Plug with setscrew, Hosfelt part number BU-00245-0.
   2 Red Banana Plugs with setscrew, Hosfelt part number BU-00245-2.
   The other parts required for this project are determined by which circuit you choose to build. Please refer to the drawings for the other component part numbers, which are listed in each drawing. The quantity of parts required would be doubled for transformers with dual throttles, which require two common grounded independent circuits. Hosfelt Electronics is a good economical source for all of the above parts and those in the diagrams except for the Transient Voltage Suppressor.

   Please call Hosfelt at 1-800-524-6464 to request a Catalog. Some of the parts for this project are also available from Radio Shack.

2) Microsemi Bi-directional Transient Voltage Suppressor rated at 33v at 1500 watts **P/N 1.5KE33CAMSCT-ND.** Available from Digi-Key Electronics call 1-800-344-4539 to request a catalog. Quantity (2) **Note: A Digi-Key minimum order of $25.00 is required.** Also available from Mouser Electronics as General Semiconductor **P/N 625-1.5KE33CA.** Call Mouser at 1-800-346-6873 to request a catalog. Mouser requires no minimum order.

3) Micro miniature Pre-punched Perforated Board. Radio Shack P/N 276-1396

4) 2 Miniature Lamp Screw Base. Radio Shack P/N 272-356. One 5-position barrier strip.

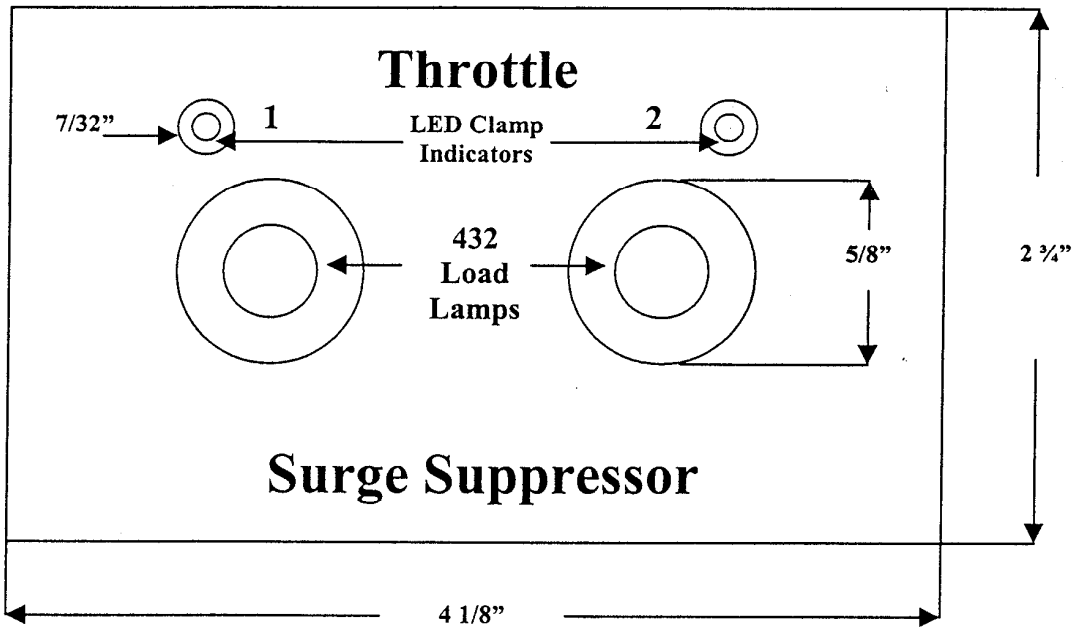
5) 2 Number 432 Lamps 18volts @ 250 ma. 1 Red, 1 Green or 1 Amber Lamp.

Editors Note: **The circuits described have not been approved or sanctioned by QSI as being acceptable protection for their products. They have been designed with regard for the QSI T.R.E.O.S. published specifications and technical reports. I think enough of our testing of the Transient Voltage Suppressors and feel that this approach is sound to consider as protection against voltage spikes for train electronics to have chosen it.**

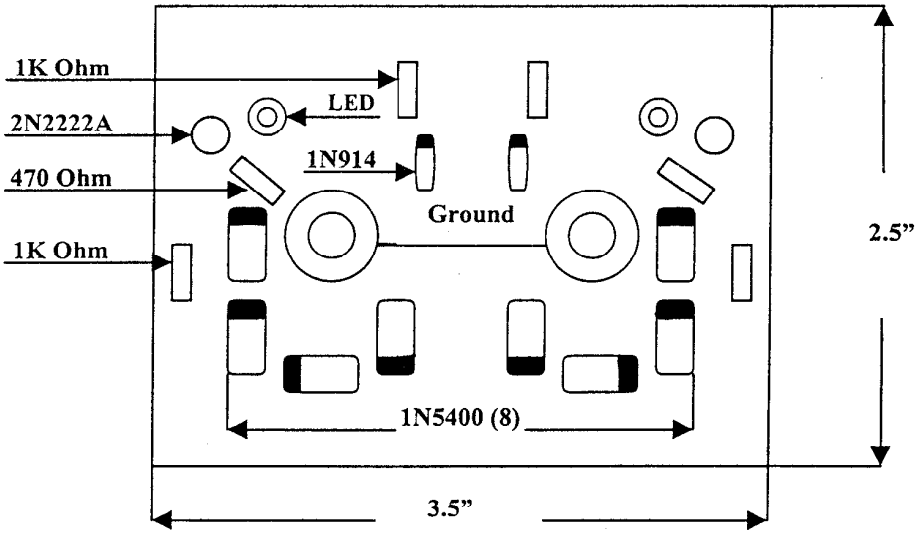
Surge Suppressor Pictorial Drawings

By
Frank E. Qualls
April, 99

Top Cover Layout



Perforated Board Layout



Drawing Note

The Ground wire shown is solid bare bus wire and it ties the grounds of the Lamp Screw Bases together on the board.

Drawings shown are not to Scale