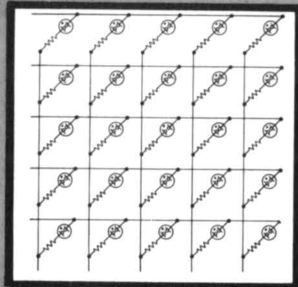
Signalite

APPLICATION NEWS

A General Instrument company



Vol 6, No. 2

NEONS IN PHOTOCONDUCTIVE CHOPPERS

By: G.S. Talbot
Leeds & Northrup Company

Photoconductive choppers are finding increasing popularity in electronic circuitry for electro-optical switching because these units have extremely low noise levels and can be electrically isolated from other parts of the circuit. While either incandescent or neon lamps can be used in the design of choppers, the inherent breakdown characteristics of the neon which provide for a sharp threshold of light when ignited make the neon a better choice for switching applications.

In addition, since the photoconductive chopper is provided in an encapsulated package, it is essential that the lamp have a long lifetime. Neons characteristically last 25,000 to 30,000 hours of operation. Obviously, when the lamp is not on, it is not consuming any of its lifetime, and the service life of the chopper will be many times the 4 to 5 years of its operating life.

For years choppers of various types have been the standard method to convert low level dc to a form of ac for more convenient amplification and utilization. Until recently most of these have been electromechanical relays of vibrators driven by line frequency. To overcome some of the limitations inherent in the electromechanical design, a variety of new approaches have been tried, among which are magnetic modulators, diodes, transistors, and most recently, FET's and MOST's. Consideration of these various types points out that while each has certain advantages, each is also subject to certain limitations.

The electromechanical chopper is a true on-off switch with effectively infinite resistance when open and zero resistance when closed. However, as a mechanical device it is subject to contact bounce and contact contamination. Contact and spring materials must be selected to avoid spurious thermo-electric and/or contact potentials. Other factors which must be considered when using electromechanical choppers are phase lag caused by carrier coil inductance, sensitivity of the contact configuration to the carrier coil magnetic field on very low level signals and capacitive coupling between the signal circuit and the carrier circuit when high common mode voltage rejection capability is required.

Diodes and diode bridges have been used in modulators for a generation or more (carrier telephony). More recently transistors and their successors in the more exotic solid state realm have been applied to this function. However, the solid state modulators generally do not offer high isolation afforded by electro-mechanical choppers; nor do they provide the zero and infinite resistance limits.

An ideal modualtor would generate no signal of its own and its ac output would be zero with no input signal. Signal output in the absense of an input signal is called "offset" In component descriptions, offset is usually defined as the signal required to bring the modulator output to zero. Offset is an error signal. However, if it is constant, it can be compensated in the equipment and its effects eliminated.

Solid state modulators, which include non-linear junctions, are generally prone to offset. Moreover, the magnitude of this offset is a function of the junction temperatures. Uncompensatable offset sets a lower limit to the level of signals which may be detected and measured. The offset generally associated with solid state modulators is in the range of a few to tens of microvolts. A large proportion of industrial low level dc applications requiring modulation are in temperature measurement by thermocouples, and a 10 microvolt offset corresponds to 1° C for a platinum to platinum rhodium thermocouple. This is an acceptable error in many industrial control processes.

The intermittently illuminated photoconductor provides the basis for the electro-optical photochopper These choppers provide good electrical isolation between the signal and carrier circuits since the only coupling is optical. Electrostatic shielding prevents capacitive coupling between the lamp and the photo-conductive element in the signal circuit.

The alternating illumination required for the SPDT photochopper may be obtained in any of several ways. When power line frequency is the carrier, the simplest method utilizes two neon lamps, Type AO83 produced by Signalite Inc., Neptune, N J., operated on alternate half cycles. (See Figure 1). Other carrier frequencies may be generated by

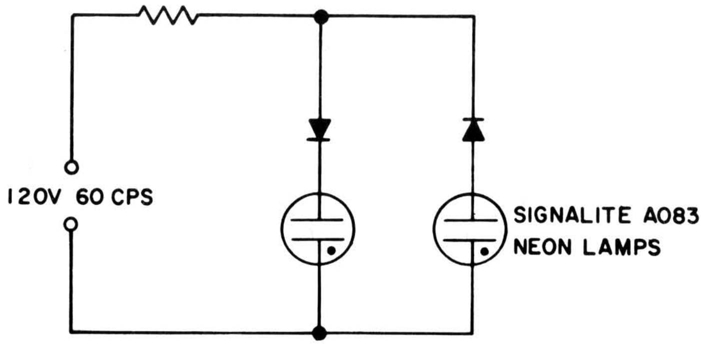


Figure 1 A method for providing alternating illumination in a photochopper.

separate oscillators or conveniently by utilizing a two-lamp relaxation oscillator wherein the neon lamps act as both oscillator and illuminating lamps. (See Figure 2). If two additional cells are photo-coupled to these

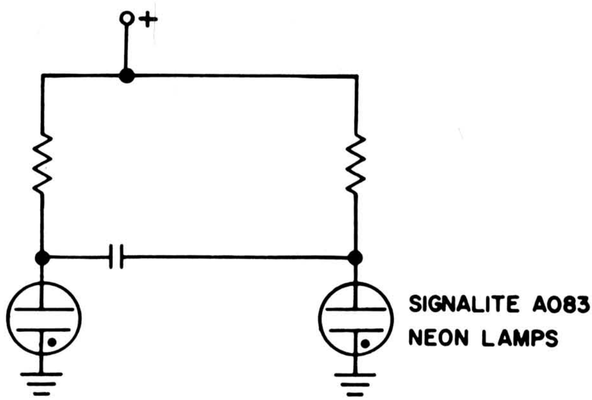


Figure 2 Utilizing neon lamps as both oscillator and illumination.

neon lamps and used as a demodulator (synchronous rectifier), the carrier frequency may be selected (within the frequency capabilities of the neon lamps, the photocells, and the amplifier) to provide greatest immunity to power line and other extraneous pickup sources.

When using photoconductive choppers in electronic circuitry it is essential that the performance of each unit be uniform with every other. Selection of both the photocell and the neon lamp is critical in this respect. In our applications we require neon lamps, for example, which have highly uniform and constant maintaining voltages, and which exhibit no tendency to flicker when operated with a current low enough to insure the 25,000 hour minimum life.

The SPST and SPDT photochoppers discussed here are designed to operate with good efficiency into a wide range of circuit impedances in various circuit configurations, including full-wave transformer inputs. The SPST unit is a tubular design consisting of a neon lamp and a cadmium selenide photocell. They are encapsualted so that the photocell is activated by light emitted from the end of the neon lamp. The SPDT unit is a flat-package plug-in design consisting of neon lamps, an internal lamp circuit and cadmium sulpho-selenide photocells.

The Signalite neon lamps for this unit have 180° of their circumference sprayed white to increase their effective brightness (see Figure 3). Both models are designed for 60-cycle operation.

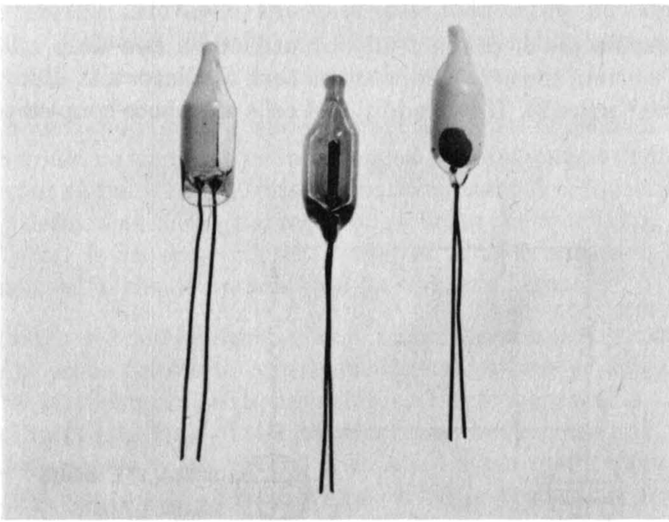


Figure 3 Side-looking Signalite A083 lamps have 180 of their circumference coated with a highly reflective white coating.

An application for the SPST unit is shown in Figure 4. This chopper-stabilized amplifier reduces the drift of the main ac-dc amplifier to a very low level. The ac signals are coupled through C_1 to the main amplifier. The dc signals are amplified by the chopper amplifier and fed directly to the main amplifier. The gain of the chopper amplifier corrects the inherent drift to the main amplifier.

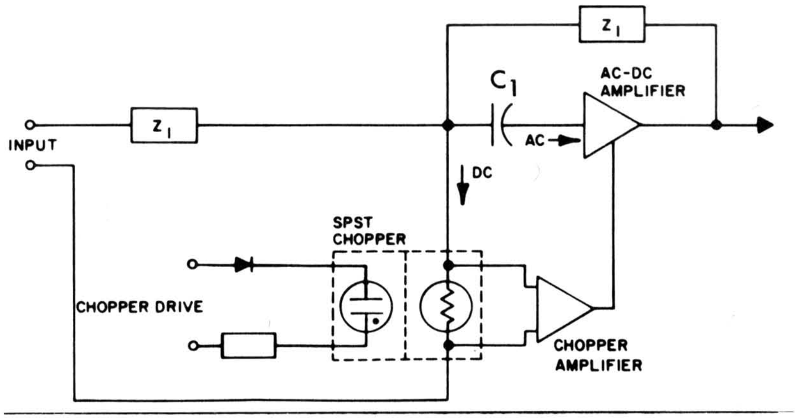


Figure 4 SPST photoconductive chopper used in a high-gain chopper stabilization operational amplifier.

In Figure 5 the SPDT chopper is shown replacing a conventional electro-mechanical chopper in a typical low-level, dc servo amplifier circuit. The 60-cycle switching circuit for the neon lamps is furnished as an integral part of the chopper package.

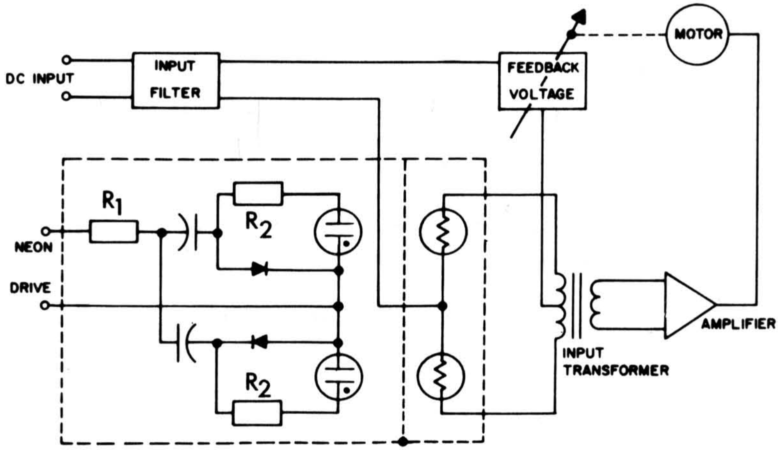


Figure 5 SPDT photochopper used in a low-level dc servo amplifier.

The drive circuit, U.S. Pat. #3,283,157, D.E. Blackmer, is 120 V, 50-60 Hz. The initial resistor R_1 and the two capacitors serve to adjust the phase of the chopped dc in the signal circuit to match the phase of the ac line. The two resistors R_2 in series with the neon lamps, control the lamp current to provide extended life. These resistors are so chosen that flickering of the lamp will not occur.

Only one lamp fires at a time. The second lamp is shorted out by its paralleled rectifier which charges its associated capacitor during the half cycle that it is forward biased.

When the line polarity reverses at the beginning of succeeding half cycles, each rectifier reverses its bias condition.

The rectifier in parallel with the second lamp now becomes reverse biased and its associated capacitor discharges in series with the line through the second neon lamp. In the meantime, the original lamp is turned off because its paralleled rectifier is forward biased and charges its associated capacitor.

This circuit serves to turn on each photoconductive cell alternately for almost 100% of each half cycle. Furthermore, it provides a step function of light when the lamp turns on near the beginning of the cycle to reduce the turn-on time of the photoconductive cell to a minimum.

As each photoconductive cell alternately reduces its resistance, a current flows alternately in opposite halves of the primary of the input transformer in synchronism with the line voltage and they are thus 180 degrees out of phase with each other. The resultant ac secondary signal is coupled through an amplifier to a motor This motor is mechanically coupled to a device which controls the feedback signal.

The signal circuit is isolated from the drive circuit by the use of a transparent gold coating on the inside of the photocell glass U.S. Pat #3,283,237, Williams & Polster

There are many applications for photochoppers including series modulation, series shunt circuitry for low frequency applications, modulation and demodulation, in regulated power supplies, sequential switching and on and on. The long life, low noise, and small size in addition to their greater stability against mechanical shock and vibration make them an ideal component for many uses.

CAN YOU SOLVE THIS ? ?????

LOW COST PRIORITY CALL

Gentlemen:

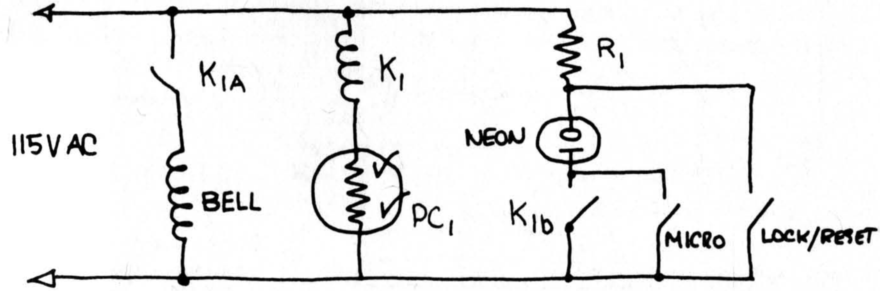
The following presents a problem that may be readily solved with logic or a "lock out" switching system. The real problem is to keep the cost down—say under $20.00 for an assembly of five stations. Problem On a production line with a number of stations that may call for the service of an inspector at the same time it is necessary to assign priority on a "first call—first served" basis. Therefore, the indicator lights would have to indicate the stations that called as first call, second call, third, etc. Each station would have a switch to provide power to the indication lights. Reset of that station would be obtained, for example, by de-actuation of that switch.

Very truly yours,
Arthur F Hackman
Bendix, Kansas City Division

ANSWER TO CAN YOU SOLVE THIS: Vol. 5, No. 2

INTRUDER ALARM

Possible solution to David Fiedler's problem·



Closing the micro switch fires the neon. Light from neon lowers resistance of photocell. K now operates closing bell circuit and "latches" neon to line. Lock/reset switch when closed will shunt current around neon turning it off Photocell resistance increases dropping K_1 out. Resistor R_1 limits neon current and current through lock switch.

K_1 should be a 115 VAC sensitive type. Photocell PC_1 must be able to carry K's current. Neon lamp should be mounted as close as possible to PC_1, and both mounted in light tight box.

Joseph S. Hayhurst
National Cash Register Co.

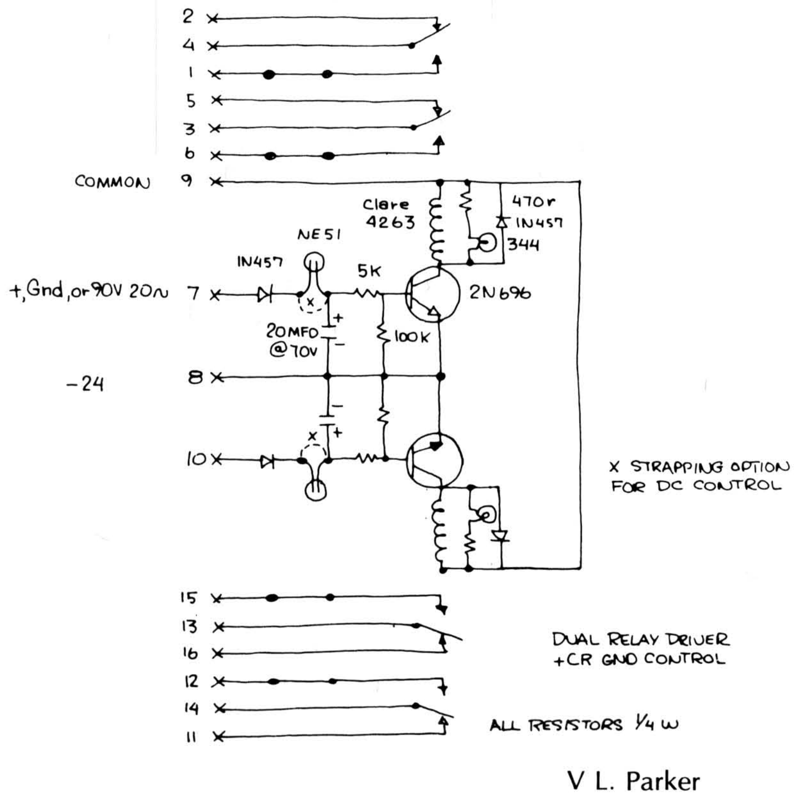
TELEPHONE LINE DUAL RELAY DRIVER

Dear Sir·

The attached circuit was used to signal control circuitry from a telephone line.

The NE51 ionized when ringing current is applied but provides essentially an open circuit in a standby condition and does not load the telephone line.

The NE51 passes ringing current on to be rectified and to bias the transistor into conduction causing the relay to energize.



V L. Parker
Barstow, California

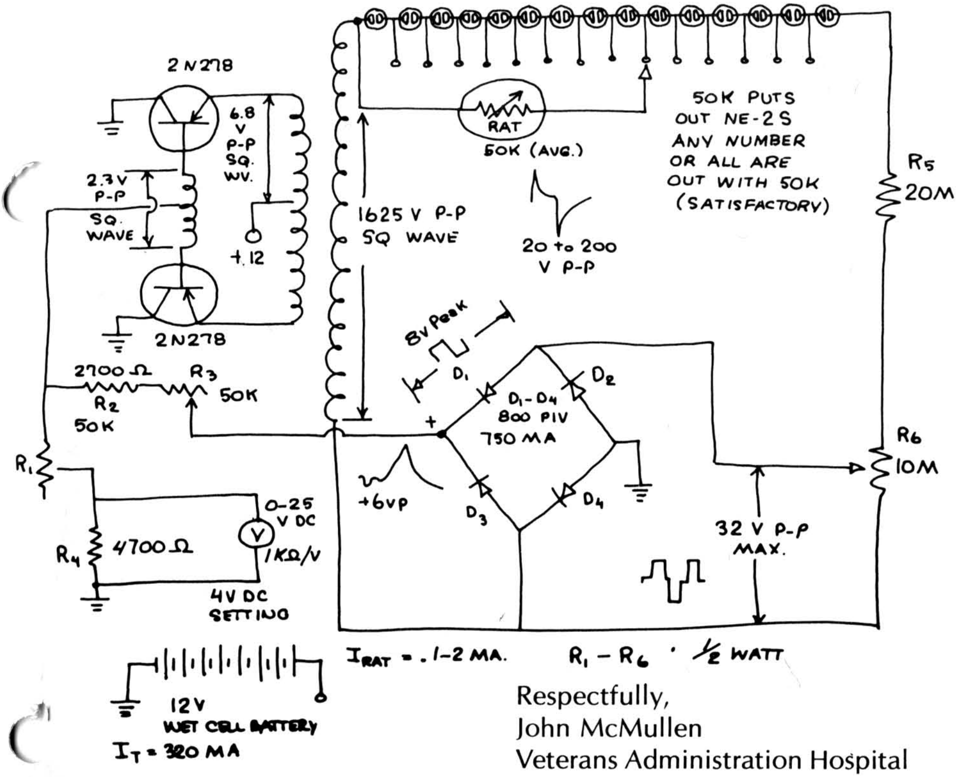
RATS!

Gentlemen

The circuit (below) operates satisfactorily for behavioral experiments in our psychology research laboratories. It involves shocking rats on horizontally spaced metal rods. The terminals on the NE-2 bulbs go to the rods. As the rat moves, it shorts any number of rods and puts out the NE-2 bulbs. The rat's average resistance is 50K. We would like to have a bulb that would go out when the rat increases his resistance to 500K or 1 meg-ohm by his behavior

R_1 adjusts current through the rat. Voltage drops across the rat are from 20-200 volts peak to peak. Current range is .1-2 ma peak 1-2 ma r.m.s.

Any information will be appreciated concerning circuit changes or a bulb to go out at higher rat resistances.

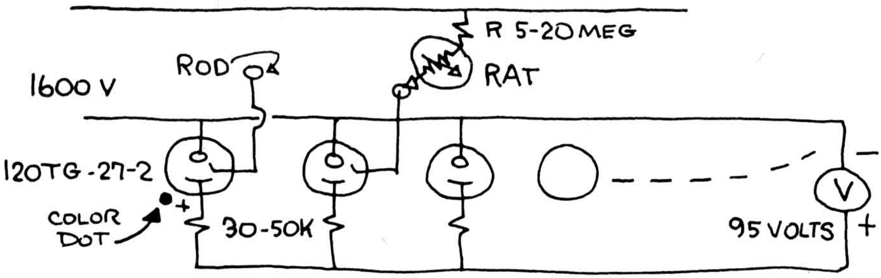


Respectfully,
John McMullen
Veterans Administration Hospital

Ed. Note:

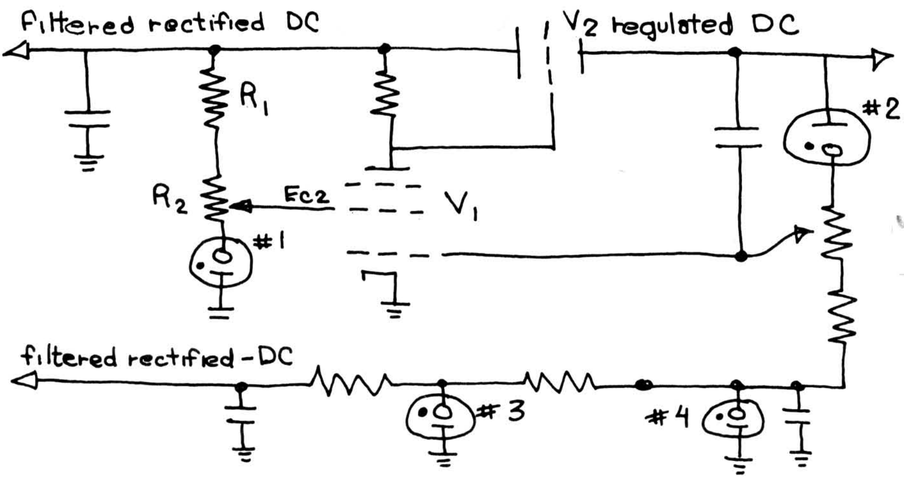
Below is a circuit which should perform the function you desire. We have chosen to use three-element devices rather than the diodes that you were using. This circuit differs from yours in that the lamps will *come on rather than go off as in your circuit. It also requires an additional power supply which may be AC or DC, but for latching purposes should be DC.*

The three-element devices are our type 120TG-27-2. The circuit should operate as follows. The high voltage supply is connected through a 5-20 meg resistor through a connection to the rat. The rat will be in touch with one of the horizontal bars you use for shocking purposes. This bar is connected to the trigger of the 120TG-27-2. When the rat is in touch with the bar, current will flow between the trigger and cathode of the device. The anode to cathode will have an initial bias voltage slightly below the breakdown voltage of the lamp 95VDC. When sufficient current flows between the trigger and cathode, the breakdown voltage between the anode and cathode is lowered, and the device will turn on. The resistor in series with the lamp is necessary to limit the current flow when the device is on to .5ma.



IMPROVED REGULATION

Below is a simple schematic and write-up using neon tubes in a voltage regulator circuit. I built such a device and was delighted with the results. The use of R_2 and reference tube #1 are probably the only



non-standard usage, but its effectiveness surprised me and my associates. Hope this curcuit can be of value to someone else.

#1 reference tube provides the approximate desired EC2. With R_2 properly adjusted the regulated DC output will have essentially zero variation and zero ripple voltage.

#2 reference tube permits a greater portion of change in the regulated DC to be felt at V_1 control grid and hence improves regulation. #4 reference tube paralleling #3 reference or regulator tube is a fairly common means of developing a stable reference voltage.

S.C. Blum
NASA, Wallops Station

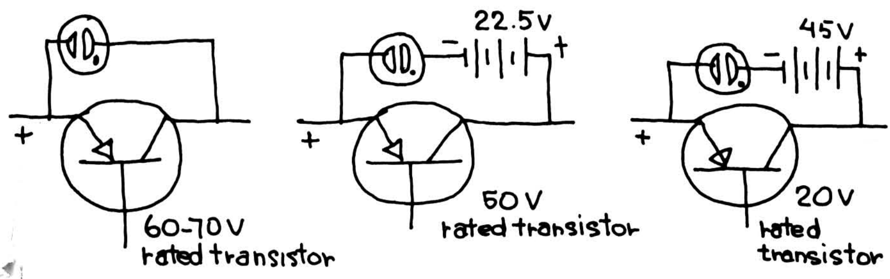
PROTECT THE TRANSISTOR!

Dear Sir·

In your article (Overvoltage Indicator) in Vol. 2, No. 1 of Application News you mentioned that the voltage breakdown of a neon was too high to prevent damage to the transistor before the neon ignites. This can be corrected by use of a battery or other DC source in series with the neon.

For high voltage transistors (60-70 volt) the battery is not necessary For lower voltage one of the following pictures may be self explanatory The battery plus transistor breakdown voltage should slightly exceed neon firing voltage.

This should also short out most RF spikes before any transistor damage is done.



G.H. Zentz
Montana-Dakota Utilities Co.

Ed. Note.

Gas devices require a finite time to turn on with excess voltage. Consequently, certain types of transistors may still be damaged using the above circuitry.

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Drop Us A Line.

If you have an interesting application of neon glow lamps in your circuitry. . . or a problem concerning the use of neon lamps, drop us a note telling about it. Interesting letters will be published in a future issue of the **Application News**—and we will send you an Owl Eye Nite Lite for your home.

Applications which in the opinion of Signalite have significant interest will also be brought to the attention of the editors of leading technical publications for consideration as articles and featurettes. If you would like help in preparing your material for publication, just send us the facts and data. We will put it in the correct form for publication. Your by-line and company credit will be given with your permission.

For immediate technical application or circuit design assistance, you may contact Signalite directly at:

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