Signalite
APPLICATION NEWS
from the desk of Ed Bauman, Chief Engineer

Vol. 4, No. 3

(The following article is an excerpt from one of the chapters in the new book, "Applications of Neon Lamps and Gas Discharge Tubes," by Edward Bauman and just published by Carlton Press. The book contains 160 pages, liberally illustrated with circuit drawings, depicting many practical, down-to-earth applications for neon glow lamps. Copies of this hard cover edition may be obtained from your Signalite representative or by writing directly to Ed Bauman at Signalite Incorporated, 1933 Heck Avenue, Neptune, New Jersey 07753).

NEON LAMPS AS MEMORY SWITCHES

by: Edward Bauman
Chief Engineer, Signalite, Inc.

A memory switch is one which maintains its existing status until driven into the opposite condition. That is, when off, it will stay off until driven on, and when on, it will stay on until driven off. The operating characteristics of neon glow lamps meet this requirement.

Being a bistable device, the neon tube when off generally has an impedance between terminals of between 1,000 and 10,000 megohms shunted by 0.5 micro-microfarad. It can be driven to the on condition by exceeding its breakdown voltage rating. When it is on, it exhibits a series impedance of between 1,000 to 10,000 ohms, and will stay in the on condition as long as current flowing through it is greater than its critical current rating, I_K. It can be turned off by removing the applied voltage.

Or with a constant source voltage, it can be driven off by a negative pulse which reduces the maintaining voltage momentarily, thereby cutting off the neon lamp current.

Figure 1 illustrates a simple neon memory switch which is operated by positive and negative pulses through the capacitor. In this circuit the source voltage, E_B, is at a level slightly below the minimum breakdown value of the lamp, and is greater than the rated maintaining voltage of the lamp. The resistor is equal to $\frac{E_B - M_V}{I}$ where M_V is the maintaining voltage rating of the lamp and I is the desired current of the circuit. Under these static conditions, the neon lamp will stay in the off condition.

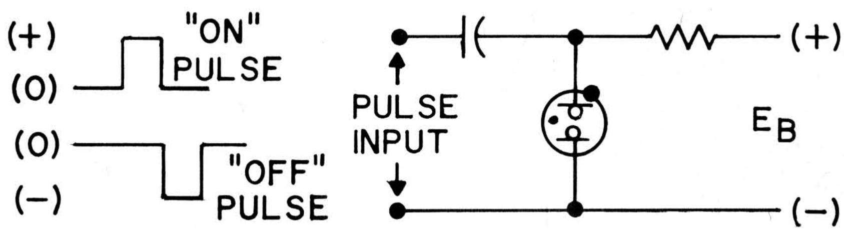


Figure 1

Lamp - Signalite T2 - 27 - 1WR760
E_B - 160 Volts
On Pulse- + 50 volts min.
Off Pulse - -10 volts min.
C - Approximately .01 µfd or determined by pulse width.

In order to turn this circuit on, a positive pulse is supplied to the input capacitor so that the pulse plus E_B exceeds the breakdown voltage rating of the lamp. This will ionize the lamp which will now stay in the on condition. At the same time this produces light output. The current flowing through the lamp is now the design current of the lamp, typically 300 microamps to 1 milliamp, and the voltage across the lamp is equal to the maintaining voltage rating of the lamp.

This memory switch can be turned off in a variety of ways, all of which have a common purpose; this is to reduce the current flowing through the lamp below the critical current rating of the lamp, I_K. The simplest method to accomplish this is to turn off the source voltage, E_B, or remove it from the circuit by switching. This may be done by a reset button or by means of capacitor discharge. Another method would be to introduce a negative pulse to the input circuit so that the voltage across the lamp is driven below its extinguishing voltage momentarily, thereby cutting off the lamp current.

Separate inputs may be employed for the turn-on signal and the turn-off signal as shown in Figure 2. A negative-going on pulse applied between the diode and the neon lamp so that this pulse plus E_B exceeds the breakdown voltage of the tube will turn the memory switch on. The operating current is determined as described for Figure 1. To turn off this tube, a negative-going off signal is applied between the current limiting resistor and the neon lamp so as to drive the voltage across the lamp below its extinguishing voltage rating.

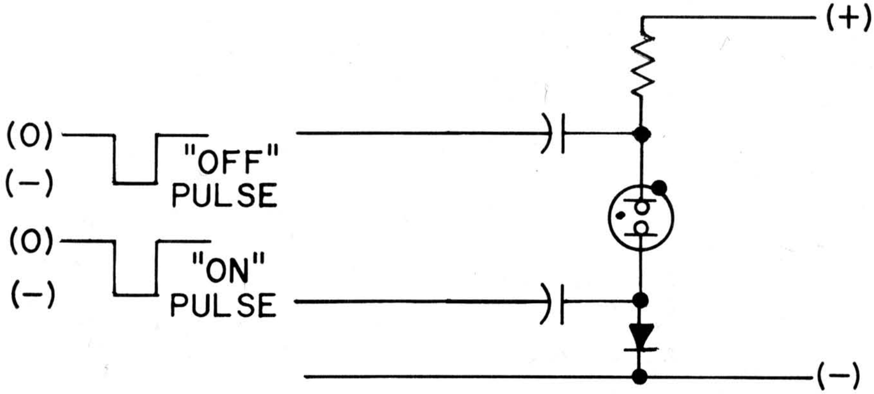


Figure 2

Lamp - Signalite T2 - 27 1WR760
E_B - 160 Volts
R - 33K
On pulse - -50 volts min.
Off pulse - -10 volts min.
C - Approximately .01 μfd or determined by pulse width.

Photocells may also be used to activate the neon memory switch as shown in Figure 3. The conditions required for this circuit are that E_B is greater than the maintaining voltage rating of the lamp but less than its breakdown voltage rating. E_{BB} must be greater than the breakdown voltage rating of the lamp, and the dark resistance of P_1 and P_2 is much greater than the current limiting resistor. Then, light momentarily falling on photocell P_1 will cause the voltage across the lamp to rise to E_{BB} causing the lamp to turn on. Under certain conditions it is advisable that a current limiting resistor be placed in series with photocell P_1. The lamp will stay on, and the current flowing through it is determined as in Figure 1. Light falling on photocell P_2 momentarily will reduce the voltage across the lamp below its extinguishing voltage and the lamp will go off.

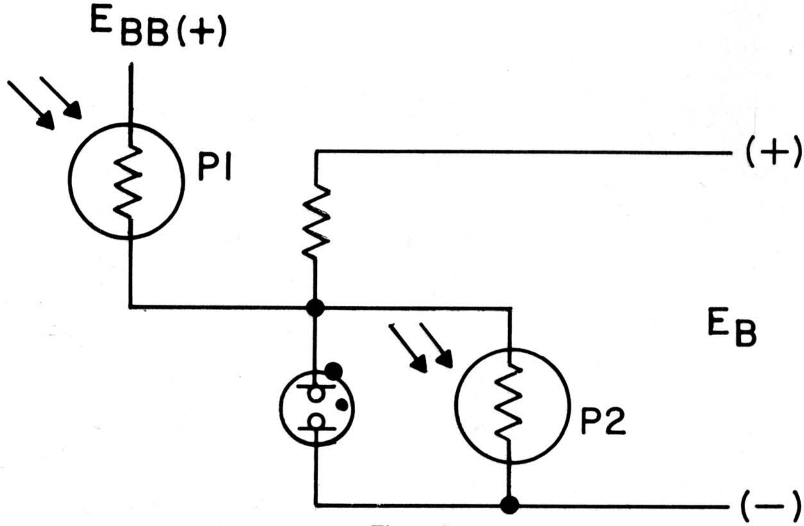


Figure 3

Lamp - Signalite RLT2 - 27 1A
E_B *- 90 volts*
E_{BB} *- 150 volts*
R - 10K
P_1 *&* P_2 *- Shall have dark resistance of 1 meg min.*
Shall have light resistance of 10K max.

Three-electrode neon lamps (cold cathode triodes) are frequently used in memory switch applications. These lamps have an advantage over the two-element lamps in that the input impedance of the turn-on circuit is several orders of magnitude higher than the two-element lamps. Consequently, they will turn on with extremely low input power. Because of the extremely close tolerances of the trigger breakdown voltage and the anode to cathode maintaining voltage, this memory switch can be turned on or off with very low signal voltages. These lamps can handle moderately high currents, in the order of 4 to 6 milliamps, and produce a higher than normal light output when compared to standard two-element neon lamps.

A typical circuit using a three-element trigger tube as a memory switch is illustrated in Figure 4. Here, the applied voltage E_B is less than the anode to cathode breakdown voltage but greater than its maintaining voltage. The trigger electrode is biased close to, but below, the miminum trigger breakdown voltage. The anode resistor, R_L, is equal to the anode to cathode supply voltage (E_B) minus the anode to cathode maintaining voltage rating divided by the desired current of the circuit (design current of the lamp).

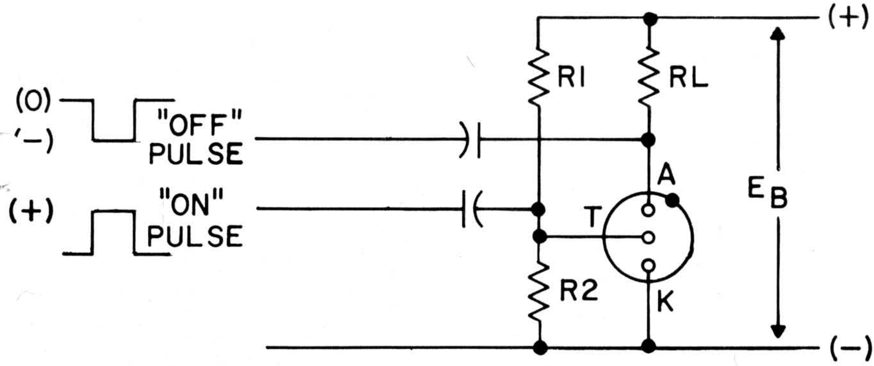


Figure 4

Lamp - Signalite TRQ250
E_B - 180 volts
R_L - 22K
R_1 - 8.2 M
R_2 - 10M
C - Approximately .01 μfd or determined by pulse width.
On pulse - + 25 volts min.
Off pulse - - 10 volts min.

To turn the memory switch on, a positive pulse is applied to the trigger, T, so that the bias on the trigger plus the pulse is greater than the maximum trigger breakdown voltage rating. To turn off the tube, a pulse is applied to the anode reducing the anode to cathode voltage below the tube's extinguishing voltage rating.

Another method for turning on the three-element memory switch is shown in Figure 5. In this method a negative pulse is applied to the cathode so that the sum of the positive bias on the trigger electrode plus the negative pulse to the cathode exceeds the maximum breakdown voltage rating of the trigger to the cathode. The tube is turned off by applying a negative pulse to the anode, reducing the anode to cathode voltage below the extinguishing voltage.

There are many methods for operating the three-element memory switch. Another is to apply a voltage across the anode to cathode elements greater than the anode to cathode maintaining voltage rating of the lamp but less than the anode to trigger turn-on voltage rating. A negative pulse applied to the trigger then, so that the sum of the plus voltage on the anode plus the negative voltage on the trigger exceeds the maximum trigger to anode breakdown voltage, will turn on the tube.

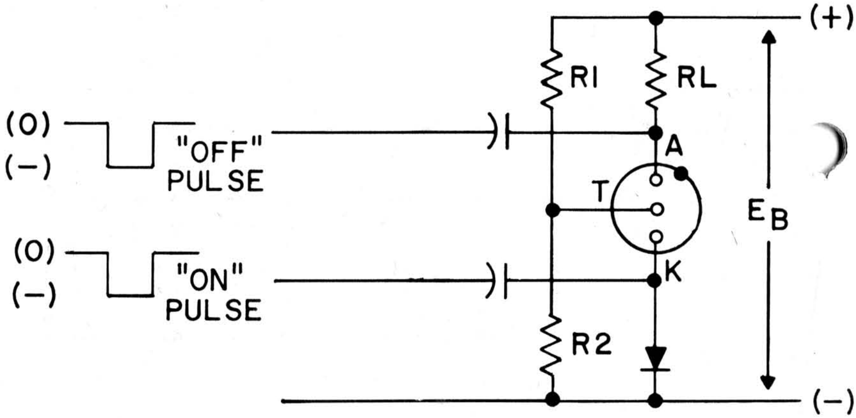


Figure 5

Lamp - Signalite TRJ250
E_B -140 volts
R_L - 22K
R_1 - 470K
R_2 - 1M
On pulse - - 50 volts min.
Off pulse - - 10 volts min.

Also, as shown in Figure 6, photocells may be used to trigger the tube much in the same manner as described earlier for the two-element tube.

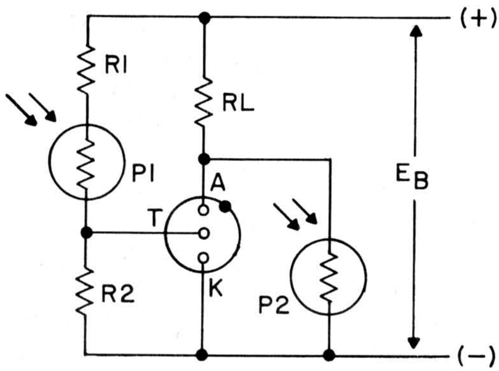


Figure 6

Lamp - Signalite TRQ250
E_B - 180 volts
R_L - 22K
R_1 & P_1 - Dark resistance 10M
R_2 - 10M
P_1 & P_2 - Dark resistance 10M min.
Light resistance 10K max.

If transistors are to be used to operate the memory switch, a circuit such as the one shown in Figure 7 may be used. The transistor is in its normally saturated condition. Hence. R_3 is shorted. R_1 and R_2 divide the supply voltage E_B, so that the voltage applied across the trigger to the cathode is slightly below the triggering voltage for the tube. When a signal is applied to the transistor causing it to cut off, the voltage on the trigger rises to a point determined by R_1 plus the combination of R_2 and R_3. In most applications the voltage across R_3 during the time the transistor is cut off does not exceed 25 volts. This tube may be turned off by any one of the preceeding methods described above. It should be noted that in all cases the three-element tubes, like the two element tubes, may be turned off simply by removing the source voltage, E_B.

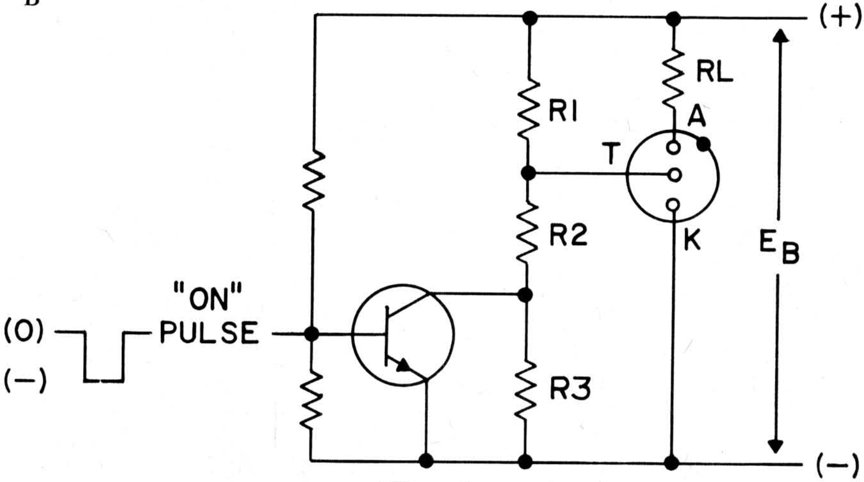


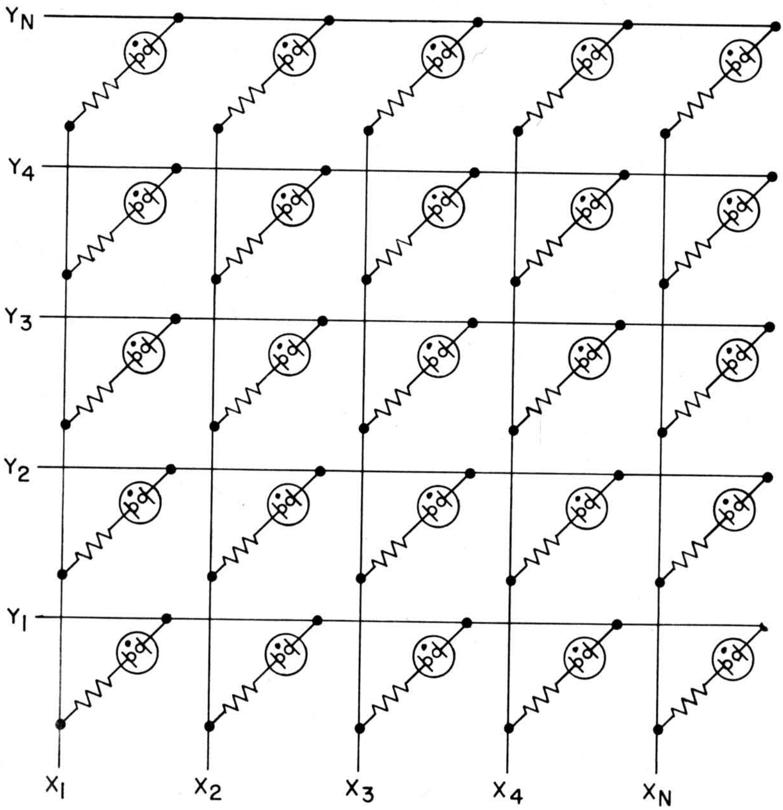
Figure 7

Lamp - Signalite TRJ250
E_B -140 volts
R_L - 22K
R_1 - 470K
R_2 - 1M
R_3 - 270K

Transistor and base circuitry as required.

Neon lamps, either two-element or three-element, can be used in memory switches to perform a variety of functions. These might include for example, timers, ring counters, shift registers, memory cells, computer readouts, alarms, as well as the activation of a variety of other components. The use of neon lamps to serve the memory function in an X-Y matrix is typical of the principles for using these lamps as memories.

Either the two-element or the three-element neon memory switch may be used in an X-Y matrix. In Figure 8 the matrix is shown using two-element tubes. The three-element tube matrix would have advantage of an isolated triggering input due to the triggering characteristics of the additional electrode in the tube, but would be slightly more complex.



ALL LAMPS— T2-27-IWR760
ALL RESISTORS— 22 K

Y NORMAL +60 V
Y "ON" +105 V

X NORMAL −60 V
X "ON" −105 V

The sum of the stand-by voltages on X and Y must be greater than the maintaining voltage and less than the breakdown voltage of the lamps used. In order to activate one lamp in the matrix, the voltage on the Y line to this lamp and on the X line to this lamp each should be increased to a given voltage. The sum of these two new voltages is greater than the breakdown voltage of the selected lamp. However, raising the X line to this greater voltage with no change in the Y line results in a voltage across the lamp which is lower than breakdown voltage. Conversely, increasing the Y line and not the X line also results in a voltage less than breakdown of the lamps. Figure 8 shows a typical operational matrix circuit with Y_N times X_N points. There are basically no limits to the number of points used.

It can be seen, then, that one or all of the lamps in the matrix can be switched on as required. It can also be seen that there are many methods for instant resetting of the matrix. The simplest is to remove both the X and Y voltages momentarily. Another simple method would be to reverse the polarity momentarily along either axis so that the potential difference across the lamp becomes zero.

Information can be fed into the matrix by the use of manually operated X and Y switches to preselect a point, and then raise the voltage on the respective X and Y lines. Or the information can be supplied by an X ring counter and a Y ring counter so that the voltages raise at the proper step or sequence in time.

Typical readouts for an X-Y matrix would be visual or through photocells coupled to individual lamps and transistor circuitry.

CAN YOU SOLVE THIS ? ?????

Mr. Bauman.

'Can you solve this' We have a application to flash a General Electric FT 106 Xenon flash tube at a fixed rate of 60 flashes per minute (1 per second) using one of your neon lamps firing a SCR.

We know the following facts concerning the problem.

(1) power source--6 volts DC @ 1000 MA
(2) discharge capacitor 10 mfds
(3) flash tube FT 106 rated 300 volts max.
(4) flash rate 60 per minute
(5) battery must have capacity and components efficient to last from 7 to 10 hours continuous operation

What we don't know and would like your help

(1) Type of converter (transistorized)
(2) type of power supply, full wave, half wave, doubler etc.
(3) type of neon lamp,

size and weight of the completed unit is very important.

Nathan Eisenstat
EISENSTAT PHOTOGRAPHY

ANSWER TO CAN YOU SOLVE THIS: Vol. 4 No. 2 ....

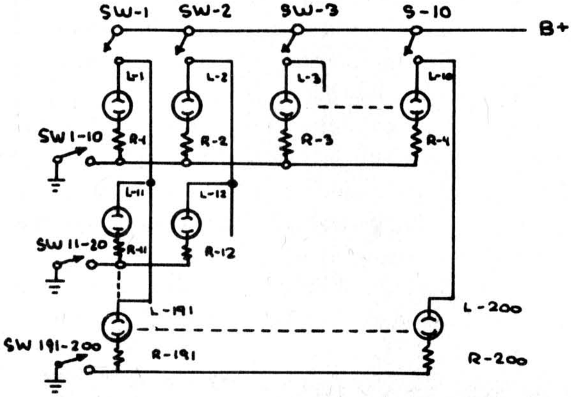
In our last issue (Vol. 4, No. 2, page 179) Richard Valent asked for assistance in designing a 200 - lamp matrix.

Dear Mr. Bauman:

Perhaps Mr. Richard R. Valent will find the arrangement indicated below useful in his need for switching on or off any lamp in a matrix of 200 lamps.

To turn on any lamp close the appropriate decade row switch SW1-10 to SW 191-200 and the desired last digit column switch SW-1 to SW-10. In this way any number of lamps from all 200 to none may be lighted individually. Each lighted lamp will provide the required voltage drop across its grounded resistor.

Matt Jelen



Ed. Note: Matrices are also discussed in our lead article in this issue.

YOUR GLOW LAMP APPLICATION FORUM

It is Signalite's policy to publish letters based on their intrinsic interest only. We do not necessarily agree with all comments and suggested uses and will upon occasion wait for your reaction before taking editorial space for ours.

TRANSISTORIZED ELECTRONIC FLASHER

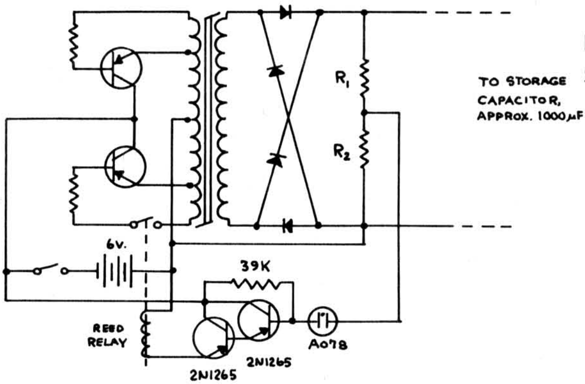
Dear Mr. Bauman:

The enclosed circuit was developed to conserve batteries in an electronic flash. The upper portion of the circuit is a conventional DC-DC converter, powered by four "D" cells in series, charging the storage capacitor to 200-250 volts. The lower portion consisting of the neon bulb, Darlington pair of 2N1265's, bias resistor, and reed relay, are the control circuit.

In normal operation, the 2N1265's are biased into saturation, holding the relay closed. As the storage capacitor charges, the voltage across R_1 and R_2 increases until the A078 ignition applies a reverse bias to the transistors, cutting them off. This allows the relay to drop out, opening the base circuit to one of the inverter transistors, stopping oscillations. If there is a long interval between flashes, the circuit will maintain voltage within a narrow range, by re-starting oscillation when the voltage drops low enough to extinguish the neon.

Use of a tight-tolerance like the A078 assures uniformity of output from flash to flash.

In addition, the bulb could be used as a "ready" light, although I didn't use it as such. The values of R_1 and R_2 were adjusted so that the control circuit fired at the same voltage as the existing ready light.



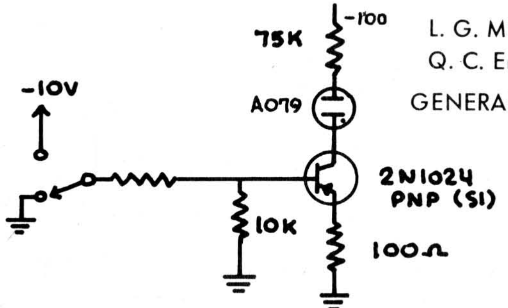
Keith L. Williams
Design Engineer
STACO, INCORPORATED

MORE ON USING NEONS WITH TRANSISTORS

Gentlemen:

Enclosed is a circuit diagram that has stimulated much interest in neon lamps. Listed below are some questions on the matter.

1. Does the neon lamp conduct current before it reaches its firing voltage?
2. With the transistor cut off, is the 100v potential across the neon lamp?
3. Would it be safe to use a transistor with a Vceo of 25 volts? .



L. G. Mullen
Q. C. Engineering
GENERAL ELECTRIC CO.

Ed. Note:

1. No, the pre-ionization current is 10^{-8} *or less and can be treated as neglegible.*

2. No, the highest voltage across the transistor occurs at the instant the transistor is cut off. The voltage appearing across the collector to emitter is as follows:
applied collector voltage (-100v) less the extinguishing voltage or maintaining voltage (50v) leaves 50 volts across the transistor. Since this is a silicon transistor, the collector to base leakage current is too low to allow the neon lamp to turn on. Therefore, the voltage across the transistor is even lower than at the moment of cut off.

3. No, 50 volts.

A more complete discussion of neon lamps with transistors can be found in Volume 2, No. 5 in an article entitled "The Complementary Use of Neons and Transistors".

If you have a circuit design problem involving the use of glow lamps, or have developed a circuit in which glow lamps are important for design and/or economic reasons, we would like to discuss your application in a future issue of this newsletter.

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. Your by-line and company credit will be given with your permission.

* * * * *

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

TWX: 201-775-2255 *TEL: 201-775-2490*

* * * * *

For information about Signalite Neon Glow Lamps for circuit component and/or indicator applications, for specifications on lamps, for general information about Signalite and its products, call us at any of the following telephone numbers:

Anchorage, Alaska	(907) 272-6731	St. Paul, Minn.	(612) 488-7293
Anaheim, Calif.	(714) 537-3194	Grandview, Mo.	(816) 763-3634
Los Altos, Calif.	(415) 967-8998	St. Louis, Mo.	(314) 727-6123
Los Angeles, Calif.	(213) 274-8485	Charlotte, N.C.	(704) 375-8958
Denver, Colo.	(303) 388-4391	Neptune, New Jersey	(201) 775-2490
Sarasota, Fla.	(813) 955-4637	Cincinnati, Ohio	(513) 521-2290
Atlanta, Ga.	(404) 255-0920	Cleveland, Ohio	(216) 333-2585
Chicago, Illinois	(312) 763-2131	Columbus, Ohio	(614) 488-9731
Indianapolis, Indiana	(317) 359-5374	Dayton, Ohio	(513) 298-9546
Fort Wayne, Indiana	(219) 743-4411	Portland, Oregon	(503) 222-7337
Louisville, Kentucky	(502) 893-7303	Pittsburgh, Pa.	(412) 242-0100
Detroit, Michigan	(313) 862-2225	Dallas, Tex.	(214) 528-6286
Benton Harbor, Mich.	(616) 927-2041	Seattle, Washington	(206) 682-7337

Scarborough, Ont. Can.(416) PL 7-3253

Printed in U.S.A.

Signalite Incorporated
Neptune, N.J. 07753