Signalite
APPLICATION NEWS
A General Instrument company

Vol. 7, No. 3

MULTILAYER BOARD CHECKER

By· Donald R. Dupree
George C. Marshall Space Flight Center
National Aeronautics and Space Admin.

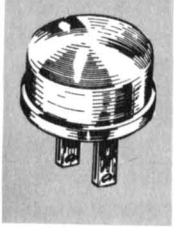
Many electronic circuit packages, especially aerospace, now use multilayer printed circuit boards to accomplish the interconnection and routing of signals. These boards are comprised of layers of printed circuits (≈.004") which are laminated together and interconnected by plated through holes.

In a particular application at Marshall Space Flight Center, Huntsville, Alabama, a digital differential analyzer was to be fabricated utilizing the multilayer boards technology. As a result, a method of testing was needed which would yield a reliable product at a reasonable expense, since the total number of boards needed was small.

The major requirements for the testing system were:

1. To insure that each conductor was routed properly to the correct points.
2. To insure that stray nets resulting from foreign particles, material flaws, etc., and improper etching, etc., do not exist.

Also in this issue . . .
DIAGNOSING A COMPUTER WITH NEONS, see page 340



Yours free . . . for telling us how you use or would like to use neon glow lamps

You can get a free Signalite Owl Eye Nite Lite simply by sending us an application for neon glow lamps, a problem or solution on their use Each reader will receive the Nite Lite whether or not his letter is used in the Application News. In addition we welcome longer articles for feature treatment which we will also place in a leading technical magazine in your name.

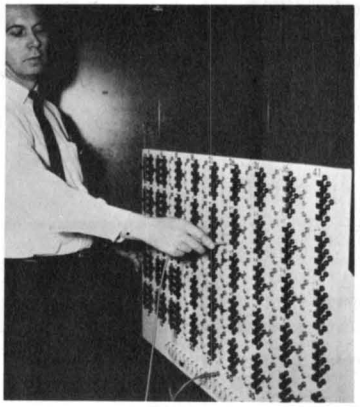


Figure 1

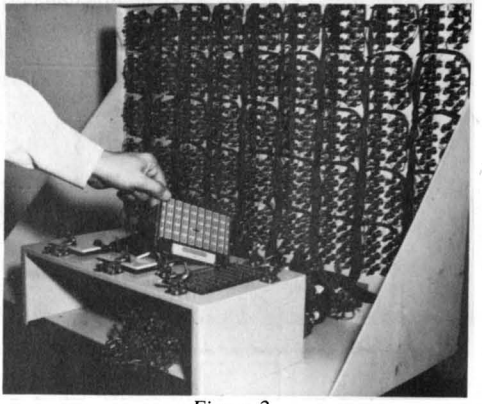


Figure 2

To accomplish these objectives, a test fixture was designed using neon lights. The fixture (Figures 1 and 2) consisted of 691 neon lights, one for each separate connection on the multilayered board. If one attempted to check these points with a continuity checker from each point to every other point, it would take 239,086 separate measurements.

$$\leq = \frac{X\ (X \quad 1)}{2}$$

Using the neon light method, and depending on the circuit routing, one measurement may check a number of points so the number of operations necessary for checking one board was only about 125. The testing time for a board, which would hold 45 integrated circuits, was about 4 man-hours.

Holding fixture for multilayer board checker

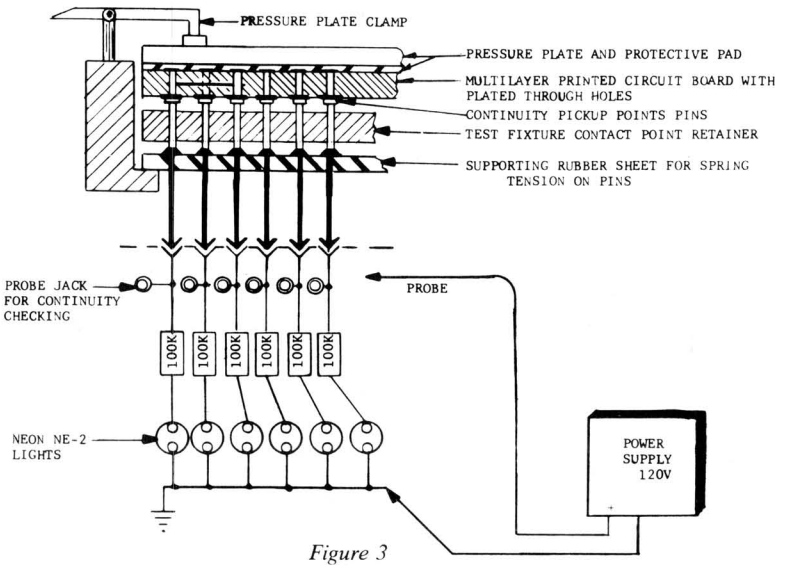


Figure 3

Multilayer Printed Circuit Board continuity checker. When voltage is applied to probe points, all points common to probed point will light the bulbs. This indicates that circuit lines within the multilayer board are connected and are making contact to all points specified by drawings.

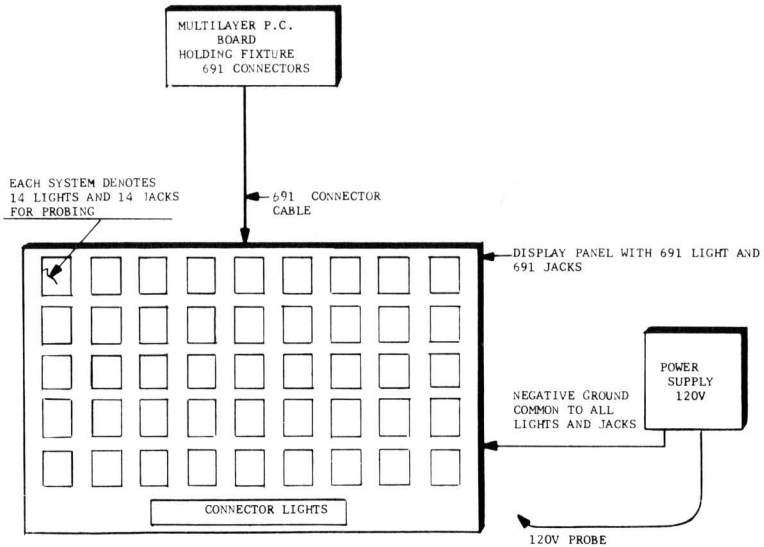


Figure 4

A holding fixture (See Figure 3) was constructed with press pickups at each plated through hole which corresponds to each lead on the then to be mounted integrated flatpacs.

From each pickup, a wire was routed through a resistor to a terminal and to a light. These lights were grouped to correspond with the flatpacs on the multilayer board.

The neon bulbs had one side common and connected to one side of a 120V power supply (See Figure 4).

To check a circuit or net, the other terminal of the 120V supply was connected to the terminal at the neon light, which provided a closed circuit through the multilayer board, and through the interconnect wires lighting each neon to which it was connected.

Points which were connected to each other could be identified by observing the lights on the panel.

Points connected by error were easily recognized. It was found that a NE2 neon bulb would light with a 3 megohms resistance between connectors so even a high resistance incorrect connection would be found.

Neon bulbs used as indicators also have an advantage over incandescent bulbs, because the current is limited by the series resistor, and is not of sufficient magnitude to stress the multilayer board connections.

DIAGNOSING A COMPUTER WITH NEONS

By Charles N. Thompson, Jr
Federal Aviation Administration

Because many people seem to attribute near-human qualities to computers, it is sometimes difficult to remember that these are simply machines (albiet complex ones) and, as such, are totally logical in their behavior. Realization of this fact makes diagnosis of various troubles and the status of various sections easily accomplished using simple circuitry and neon lamps.

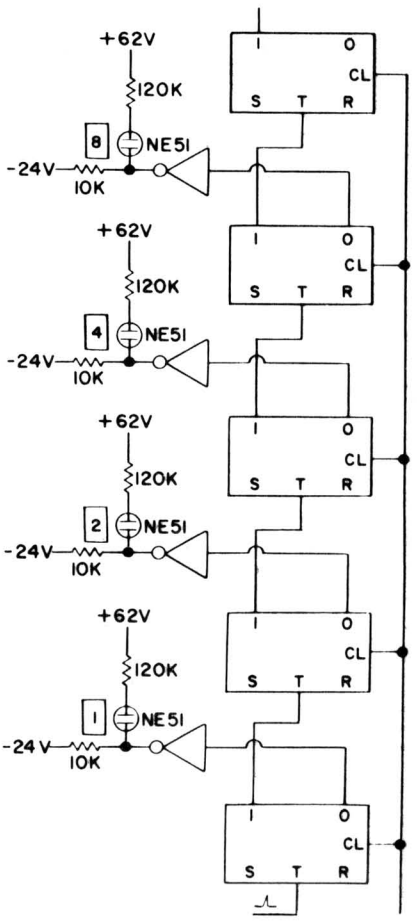


Figure 1 Counter

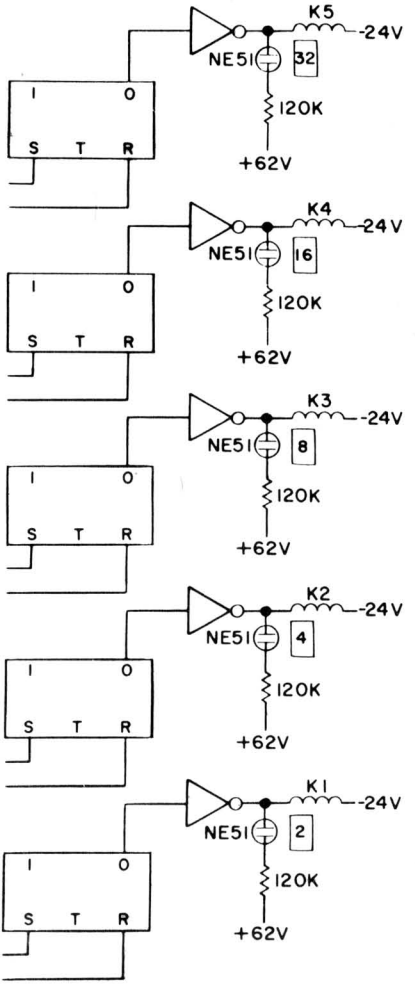


Figure 2 Storage Register

With the low speed computer at our facility we use neon lamps to indicate:

(1) data in counters
(2) malfunction of a counter
(3) data in the storage register
(4) state of the storage register relays.

The data in the counter is determined by means of the circuit shown in Figure 1, and is simply the sum of the numbers adjacent to the ionized lamps. For example, assume the lamps numbered 1 and 4 are glowing. This means that the data in the counter are 5.

To check the operation of the counter we observe the sequence of ionization and de-ionization of the lamps. The normal sequence is shown in Table I. If lamp 2 remains lit and the following lamps remain extinguished, we then suspect flip-flop number 2.

NUMBER OF INPUT PULSES	LAMPS			
	#1	#2	#4	#8
ZERO	OFF	OFF	OFF	OFF
ONE	ON	OFF	OFF	OFF
TWO	OFF	ON	OFF	OFF
THREE	ON	ON	OFF	OFF
FOUR	OFF	OFF	ON	OFF
FIVE	ON	OFF	ON	OFF
SIX	OFF	ON	ON	OFF
SEVEN	ON	ON	ON	OFF
EIGHT	OFF	OFF	OFF	ON
NINE	ON	OFF	OFF	ON
TEN	OFF	ON	OFF	ON
ELEVEN	ON	ON	OFF	ON
TWELVE	OFF	OFF	ON	ON
THIRTEEN	ON	OFF	ON	ON
FOUR-TEEN	OFF	ON	ON	ON
FIFTEEN	ON	ON	ON	ON
SIXTEEN	OFF	OFF	OFF	OFF

Table I

The number of bits stored in the Storage Register are determined by the circuit shown in Figure 2. In this circuit we add the numbers of the unlit lamps to obtain the necessary information. All lamps are lit with no bits in storage. If the lamps numbered 4, 8, and 16 are not glowing, we can determine the number of bits by adding 4 plus 8 plus 16 which equals 28 bits.

The lamp drivers (inverters) are combined ten to a printed circuit board. The schematic of one inverter with its lamp is shown in Figure 3. The nominal input voltage is from zero to minus twelve volts from the flip-flop. The transistor is cut off with 0 volts input.

Assume at turn-on that zero volts remains at the input. This applies about 86 volts across the neon lamp, and the lamp ionizes. When the input level changes to minus twelve volts the transistor is forward biased and is conducting heavily The potential at the

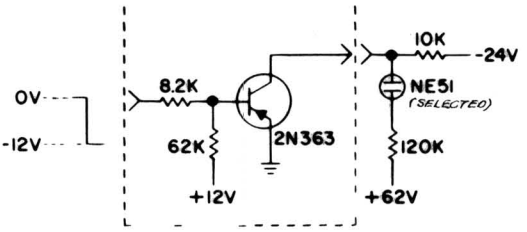


Figure 3 Lamp driver

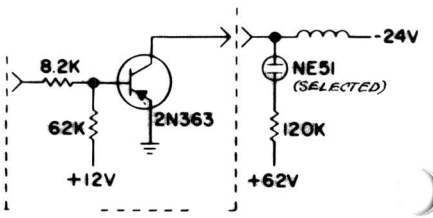


Figure 4 Lamp and relay driver

junction of the selected NE51 lamp the 10KΩ resistor is less than one volt above ground potential. When this occurs the voltage across the lamp is below the minimum required to maintain ionization and the lamp, therefore, extinguishes.

Figure 4 shown the inverter with the lamp and relay In this circuit the lamp is glowing and the relay is de-energized when the transistor is cut off. When the transistor turns on, the relay energizes and the lamp ceases glowing.

These neon lamps are a great aid in rapidly diagnosing our computer when it malfunctions as well as giving us status information at any given time.

RED FACE DEPARTMENT

Several of our eagle-eye readers have called our attention to a misprint on page 326 in the last issue of Signalite Application News (Vol. 7 No. 2), where we noted that standard brightness lamps are designed for a life of 25,000 years. It would be nice if this were so, but not many of us would be around to verify it. Actually, the time period is *hours*, not *years*, but we still think this is a pretty long time, especially when you consider that the lamp does not consume any of its effective lifetime unless it is on, and in most applications it is on only for short periods of time.

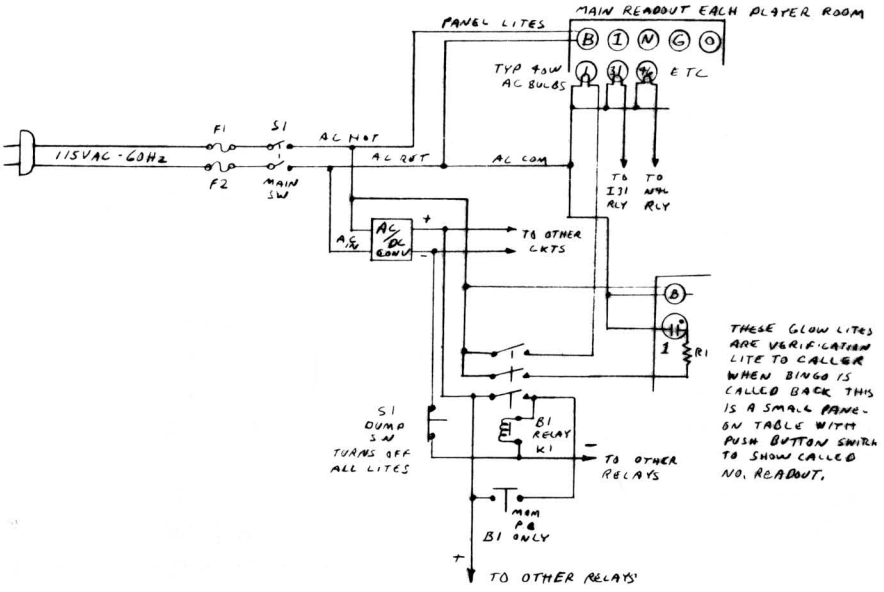
YOUR GLOW LAMP APPLICATION FORUM

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.

BINGO!

Dear Sir·

Here is sort of an odd ball use of neon glow lamps. I have been building these things for years for church and other organizations where they are legal Of course I have improved on them thru the years.



To pay off, Bingo must be mechanized and yet simple enough for everyone to keep up. Basically you need a light display in each calling room, and the caller can't see any of the big displays normally To keep DC and building cost to a minimum, the alpha-numerical glow lamps are on a panel with the push buttons. As he calls a number, he punches this button, which in turn lights all room displays and the glow lamp. After the Bingo read back, which he checks against the glow lamps, he punches the dump button turning all lights out.

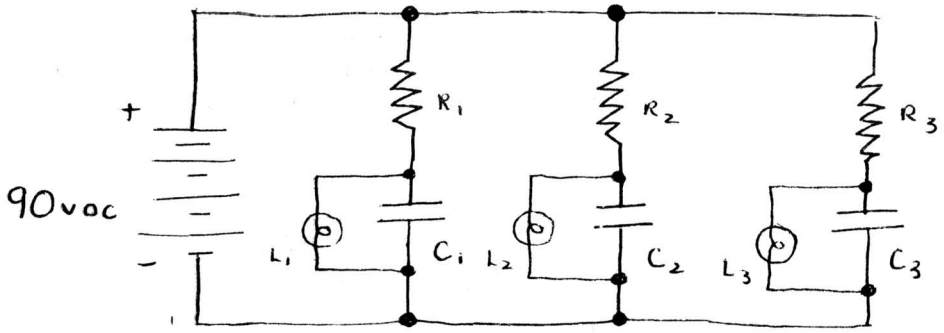
Yours very truly,

Robert C. Burks
Hughes Aircraft Company

HASN'T MISSED A BLINK

Dear Sir·

We use your neon bulbs exclusively in all of our power supplies (we build our own), but the use I am going to describe is mainly for attention. I built a circuit to be semi-perpetual to draw attention to a "no smoking" sign.



So far this circuit has run continuously for 2 years without any circuit components being replaced. The neon bulbs haven't missed a blink, and the battery is still going strong.

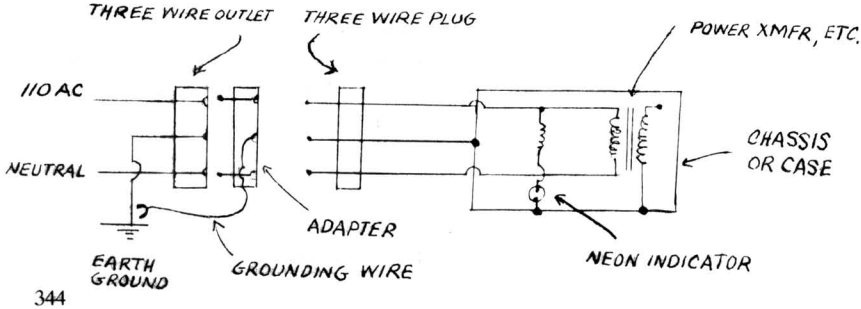
Charles DeShon

Mid-Continent Lab.

THE THIRD WIRE THEME

Gentlemen

In our line-operated equipment we have standardized on three-wire operation and we often find that our customers do not have three-wire systems in their place of business. We therefore supply a three-wire adapter to them. Inevitably they call us to find out what to do with the third wire and how do they know they have hooked it up properly.



For the past two years we have included the following simple wiring procedure such that the neon pilot light will also serve as an indicator of correct grounding procedure. The lamp will not operate unless the equipment *is* grounded and *properly* grounded.

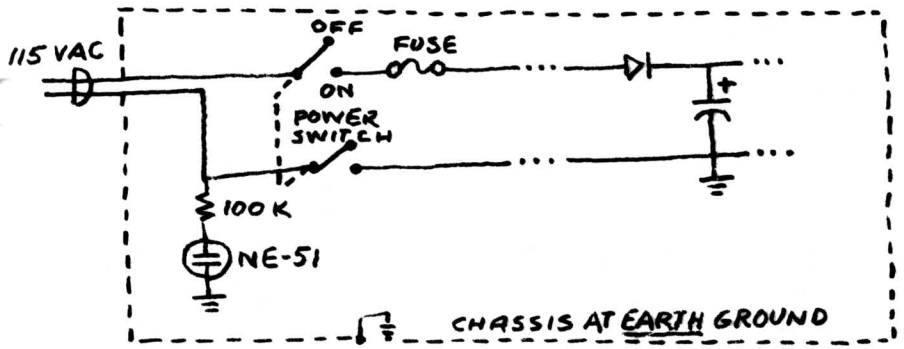
Yours truly,

W H Wandell, Jr
The Vicon Instrument Company

(Ed. Note.

This same basic approach can also be used on a two-wire system to check for polarity as shown in the following letter)

This circuit is useful with portable equipment in which one side of the AC line is connected to the chassis when the equipment is on. To avoid electrical shock to the operator of the device and/or to avoid blown fuses the AC plug is plugged into the receptacle with the "Power Switch" in the OFF position. If the neon bulb lights, the plug is in-



correctly polarized in the AC receptacle and will have to be reversed. If the bulb does not light when the AC plug is plugged into the receptacle, polarization is OK and it is safe to turn on the device. It is assumed that one leg of the AC line is at ground potential

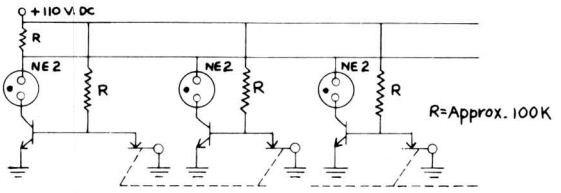
D. T Walker, P E.

RELAY SEQUENCE OPERATION REVISITED

(Ed. Note. In our last issue we published Mr. James Laino's circuit and description for determining the opening sequence of a relay's contacts. Several readers, including Mr Laino himself, have written to point out that the circuit as shown would not perform the function claimed. The following letter, which shows the corrected circuit, is typical.)

Dear Mr. McKendry:

By this time you are probably aware that Mr James E. Laino's circuit for indicating the first of multiple relay contacts to "open", as indicated on Page 335 of *Signalite Application News (Vol 7, No. 2),*



will not work because the circuit associated with each relay contact is completely independent except for a common voltage supply).

For proper operation, all neon bulbs should be supplied through a common resistor as shown in the schematic diagram, below

Respectfully submitted,

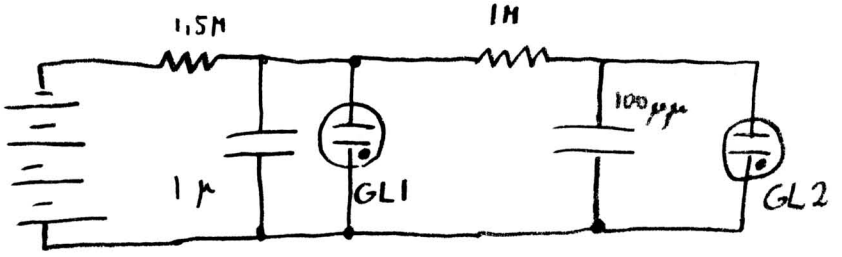
Louis F Mayle

Magnavox Consumer Electronics Co.

NEON LAMP HOWLER

Gentlemen:

This is an audio frequency oscillator, whose supply voltage is modulated by another slow relaxation oscillator It is essential that



the ignition voltage of GL2 is appreciably lower than that of GL1

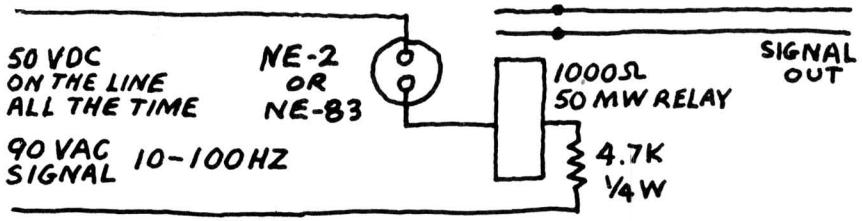
Yours truly,

Joseph Braunbeck
Western Germany

SENSES INCOMING AC SIGNALS

Gentlemen

(Below) is a drawing of a different use of a neon glow lamp. We are presently manufacturing a device which needed to sense incoming



AC signals of about 90 VAC between 10 100 Hz. At the same time, there is approximately 50 DC standing on the signal pair

As you can see this is definitely a job for a neon glow lamp.

Thank you,

Eric P Yeasel
Cyco Electronics

Ed. Note.

If lamps are used which have a low maintaining voltage, once ignited they will stay on. To avoid this a lamp with a maintaining voltage rating in excess of 50 volts should be used.

GENERAL INSTRUMENT EOPG ADDS ANOTHER UNIT

Alvin W Gershon, Group Vice President of the Electro-Optical Products Group of General Instrument Corporation, has announced the acquisition of Nore Electric Co., Ltd., manufacturers of miniature automotive lamps and gaseous discharge noise sources.

The addition of Nore Electric, located in Southend-On-Sea, Essex, England, is the third company in England to be acquired, and the fifth member of the recently formed EOPG Headquarters for the group is in Neptune, New Jersey

"The product lines of Nore are ideally suited for inclusion in the Group," Mr Gershon noted. "The miniature automotive lamps complement the product line of Vitality Bulbs in England which we acquired recently The gaseous discharge noise sources and solid state noise generators complement the lines produced by Signalite here in the United States."

The other members of the Electro-Optical Products Group are Chicago Miniature Lamp Works, Chicago, Ill., Hivac, Ltd., England, Vitality Bulbs, Ltd., England, and Signalite Inc., Neptune, N.J

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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.

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

* * * * *

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