A Simple TL Detector Using A Photoresistor

MASTER

by

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Most TL readers use photomultiplier tubes as the light sensitive element, two disadvantages of PM tubes are their high cost and their need for a high voltage power supply. A simple reader with an inexpensive CdS photoresistor* as the light sensitive element and an operational amplifier** for the amplification of the signal was built. Photoresistors have the additional advantage of the spectral response extending to longer wavelengths; thus they match the emission of some phosphors better.

The circuit diagram of the reader is shown on Figure 1. The TL material is heated in a silver pan on a nichrome strip, which is connected to a 5 V ac power supply. The photoresistor, whose resistance depends on the intensity of the light illuminating it, detects the light emitted by the phosphor. The resistance ranges from a very high value in the total darkness to $\sim 55 \text{ k}\Omega$ at 2 foot candles for the particular photoresistor being used. The photoresistor controls the current flowing from an 18 V battery into the operational amplifier. This current, i_{in} , produces an output voltage, V_{out} , given by the following equation:

$$V_{out} = i_{in} \cdot R_F$$

* CLAIREX CL5M2 - peak spectral response 5150 Å, 0.55" diameter

** ANALOG DEVICES 105: power requirements + 15V and -15V

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where R_F is the feedback resistor of the operational amplifier.

Since the input current is in the region of a few micro-amperes the feedback resistor has to be very large in order to get the output voltage in Volts. The output of the detector is either measured by a conventional voltmeter or used to drive a chart recorder and extends from the offset voltage of the operational amplifier to + 15 V where the saturation of this operational amplifier occurs. The offset voltage depends on the feedback resistor and has the value of 1.5 V at $R_F = 10\text{ M}$ for this particular amplifier with the positive input grounded. The offset voltage was lowered to a constant value of 25mV by putting a $12.5\text{ M}\Omega$ resistor between the positive input of the amplifier and the ground.

Exposures of a few hundreds of R on 30mg of TLD-100 were easily detected by a conventional voltmeter on a 10 V scale. When a chart recorder was connected into the circuit as indicated in Figure 1, glow curves of several phosphors were obtained as shown in Figure 2. Because the peak sensitivity of the photoresistor being used is at $5150\text{ \AA}$, certain phosphors such as $\text{CaSO}_4:\text{Mn}$ with the maximum in the emission spectrum at $5000\text{ \AA}$ and CaF_2 with the peak emission at $5500\text{ \AA}$ would be expected to be more sensitive than the phosphors with different spectra. For this reason exposures of as low as 1 R were observed with $\text{CaSO}_4:\text{Mn}:\text{Na}$. Note in Figure 2 that 25 mg of $\text{CaSO}_4:\text{Mn}:\text{Na}$ exposed to 1 R has a signal of about 75 mV. This voltage can be measured easily with a sensitive voltmeter,

leading to the possibility of extending the measurements to lower exposures. The total part cost of this reader without the chart recorder is less than \$50.00. It is simple to construct and should be useful for teaching and demonstration purposes. If the heater is run on a battery the unit might serve as a simple design for a Civil Defense unit.

Figure 1 - Block diagram of the simple TL detector.

Figure 2 - Glow curves of some phosphors obtained with the simple TL reader.