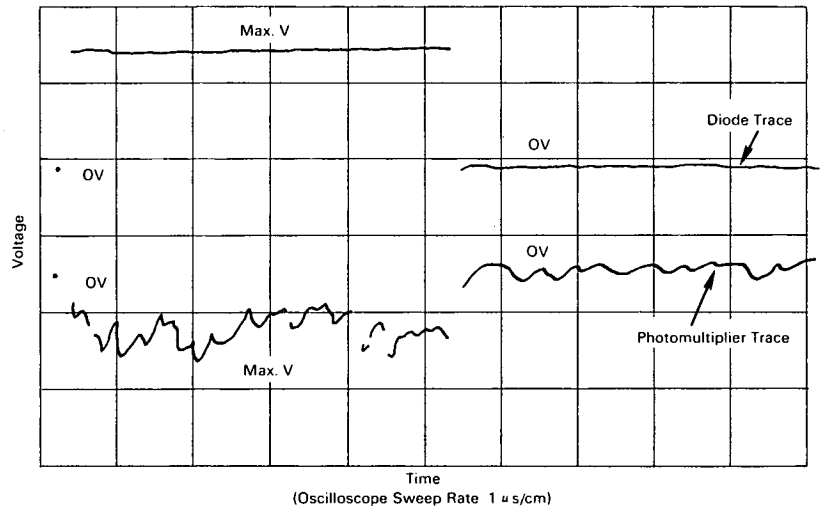
NASA TECH BRIEF

System Measures Response Time of Photomultiplier Tubes



OSCILLOSCOPE TRACES OF GALLIUM PHOSPHIDE DIODE (LAMP) AND PHOTOMULTIPLIER TUBE

A calibration system has been devised to enable precise determination of the rise time of photosensitive detectors, such as multipliers. (Rise time is defined as the time required for the voltage output pulse to rise from 10% to 90% of its final value when a photosensitive detector is instantaneously exposed to a constant-level light source.) The system is capable of measuring rise times in the range of 10^{-7} to 10^{-5} second. To perform a calibration, the time–voltage curve of the excitation voltage for a light source is compared with the time–voltage curve of the voltage output from a photomultiplier tube or other photosensitive detector which is responding to the light.

In one previous method of measuring rise times, a chopping device (a rapidly rotating mirror or a fast shutter in the light path between a constant-level light source and the photosensitive detector) was used to pulse the light from the light source. The light pulses produced by the chopping device are not of an ideal shape and are usually not satisfactory for rise times much faster than 10^{-5} second. In another method, an oscilloscope beam is pulsed as the light source. With the normally available oscilloscope tubes, the method is satisfactory to about 5×10^{-6} second.

The light source of the new system, a gallium phosphide diode, is driven by an electrical square wave pulse generator. Within 10^{-8} second after current is applied to the diode (lamp), it emits yellow-green light at 5600 angstroms. The pulse generator voltage input to the lamp is simultaneously recorded

(continued overleaf)

on an oscilloscope. The photomultiplier tube to be calibrated is positioned to intercept the light pulse from the diode light source; the light pulse duration is adjusted so that the output voltage from the photomultiplier tube has time to reach a fixed maximum value. The output voltage curve of the photomultiplier is also simultaneously recorded on the oscilloscope. A comparison of the two oscilloscope traces (see sketch) gives a measure of the photomultiplier rise time. The total time response of the system is the sum of the following:

(1) time delay between generator pulse emission to output from the light source (less than 10^{-8} second);

(2) time delay between light pulse and photomultiplier's initial sensing (less than 10^{-8} second); and

(3) time delay or rise time of photomultiplier (10^{-7} to 10^{-5} second).

Notes:

1. In performing a calibration, it should be observed on the oscilloscope trace at the end of the generator voltage pulse that the light seems to extinguish as fast as it appeared.
2. In experiments with this system, it was found that when the generator pulse is of constant maximum voltage, the light pulse reaches a constant intensity within a very short time.
3. Details may be obtained from:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10382

Patent status:

No patent action is contemplated by NASA.

Source: M. R. Lauver
(LEW-10437)