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PERFORMANCE TESTING OF LIDAR RECEIVERS

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In addition to the considerations about the different types of noise sources, dynamic range, and linearity of a lidar receiver, one requires information about the pulse shape retaining capabilities of the receiver. For this purpose, relatively precise information about the height resolution as well as the recovery time of the receiver, due both to large transients and to fast changes in the received signal, is required. As more and more analog receivers using fast analog-to-digital converters and transient recorders will be used in the future lidar systems, methods to test these devices are essential.

The method proposed for this purpose is shown in fig. A. Electronic circuits and the laser diode transmitter generate an optical pulse of the shape of a lidar return signal, with a single transient or a set of transients superimposed on it. The width, height, and the period of these transients can be varied. Also the total range of the lidar type pulse can be varied. To generate the lidar signal, the electronic circuits obey the common lidar equation for the power received by the detector for the range R due to elastic scattering:

$$P(\lambda_L, R) = P_L \frac{A_0}{R^2} \xi(\lambda_L) \beta(\lambda_L, R) \xi(R) \frac{c\tau_L}{2} e^{-2\int_0^R K(\lambda_L, R) dR}$$

In the case of a transient or a single pulse, the pulse function $f(R)$, for a pulse of height P_P and of duration ΔR is

$$f(R) = \frac{1}{2\pi} \int_{-\infty}^{\infty} g(\omega) \cdot e^{j\omega R} \cdot d\omega$$

where

$$g(\omega) = \int_{-\infty}^{\infty} f(R) \cdot e^{-j\omega R} \cdot dR = \frac{P_P}{j\omega} \left[e^{\left(j\omega \frac{\Delta R}{2}\right)} - e^{\left(-j\omega \frac{\Delta R}{2}\right)} \right]$$

If the transients possess a period T, then the function $f'(R)$ representing the transients is:

$$f'(R) = \frac{P_P \Delta R}{T} \left[1 + 2 \sum_{1}^{\infty} \frac{\sin(n\omega \Delta R/2)}{n\omega \Delta R/2} \cdot \cos n\omega R \right]$$

The signal emitted from the transmitter is received by the fast diode (calibrated) and the test receiver. The output signals are displayed optically as well as plotted. By changing the parameters of the transients (such as width, period, and height), the limitations of a given receiver can be determined.

Tests were carried out using LCW-10, LT-20, and FTVR-2 as optical parts of the optical pulse generator circuits. A commercial optical receiver, LNOR, and a transient recorder, VK 220-4, were parts of the receiver system.

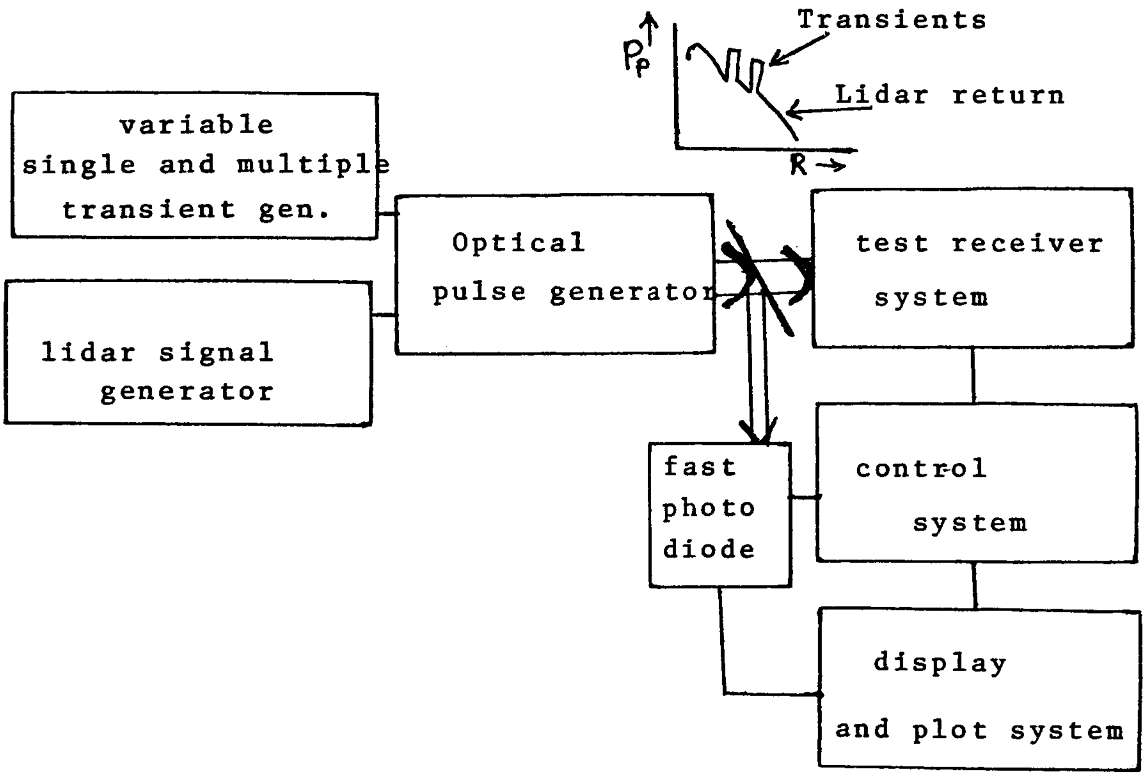

FIG. A