XI. SEMICONDUCTOR NOISE

Prof. R. B. Adler
Prof. J. B. Wiesner
L. Bess*
J. B. Cruz, Jr.
J. Gross
J. Hilibrand
J. G. Ingersoll
D. I. Kosowsky
R. E. Lull
A. L. McWhorter

A. MODIFICATION OF NOISE ANALYZER

Studies were made on compressing the frequency scale at the higher end of the plot of the noise spectrum analyzer (1, 2) in order to shorten the time for each test run.

The present local oscillator of the analyzer uses a motor-driven signal generator (GR-805C) with a resulting frequency scale that is almost linear.

Although a logarithmic frequency scale is most desirable, the possibility of using standard capacitor characteristics in either LC or RC oscillators was also investigated. However, the resulting frequency scales were not sufficiently compressed.

To realize a fairly logarithmic frequency scale, a special inductance, capacitance, or resistance has to be used. It was found that a logarithmic potentiometer in parallel with a constant resistance generates the desired function of R with respect to shaft rotation (or time) in an RC oscillator.

A Wien bridge oscillator with special R-tuning is therefore being constructed to replace the present GR-805C generator. It will be mechanically driven, and it is expected to sweep the noise spectrum logarithmically from 1 kc/sec to 60 kc/sec, and almost linearly from 20 cps to 1 kc/sec.

J. B. Cruz, Jr.

References

1. Quarterly Progress Report, Research Laboratory of Electronics, M.I.T., Jan. 15, 1954, pp. 47-48.
2. Quarterly Progress Report, Research Laboratory of Electronics, M.I.T., July 15, 1954, pp. 65-67.

B. EQUIPMENT FOR NOISE AMPLITUDE PROBABILITY DISTRIBUTION MEASUREMENTS

Equipment for measuring amplitude probability densities is being constructed. A block diagram of the system is shown in Fig. XI-1. There are essentially two independent systems here: the probabiloscope (1), which yields the amplitude density in photographic form directly; and the moments-measurement system.

Essentials of the probabiloscope are shown in Fig. XI-2. A very high contrast film is used so that (idealizing slightly) the film is either fully exposed or unexposed. The

*Lincoln Laboratory

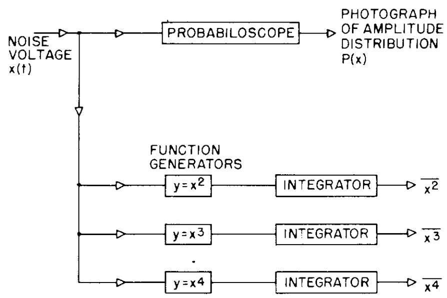

Fig. XI-1
Amplitude measurement system.

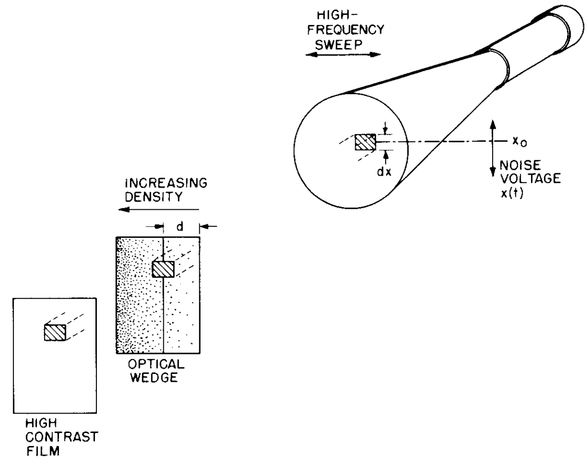

Fig. XI-2
Essentials of the probabiloscope.

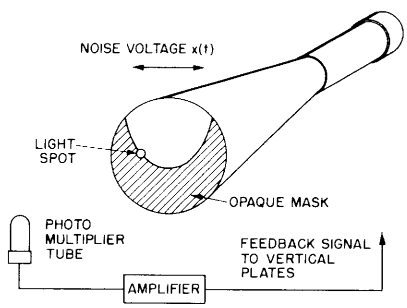

Fig. XI-3
Essentials of the function generator.

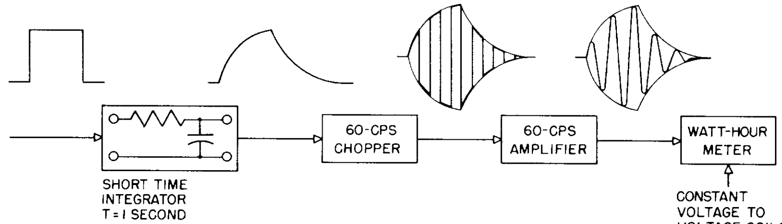

Fig. XI-4
Essentials of the integrator.

percentage of incident light transmitted by the optical wedge drops exponentially toward the left. Considering a small area on the film, the integrated light transmitted to it is a linear function of the time the noise voltage spends in that particular range dx at the amplitude level x_o and an exponential function of the distance from the right edge of the film d. On developing the film (by suitable techniques for increasing the contrast) a curve will be obtained that will be the desired amplitude distribution plotted to a logarithmic scale. Normalizing the area under the curve and replotting on a linear scale will yield the desired amplitude distribution.

The moments of the noise voltage will be used as criteria for the departure from gaussian of the amplitude density. The essentials of the function generators (2) used to obtain the moments are shown in Fig. XI-3. The noise voltage is applied to the horizontal deflection plates of a cathode-ray tube. A mask cut to the desired functional relation shields a part of the face of the tube. The output from the photomultiplier tube is amplified and applied to the vertical plates so that the spot is kept just below the face of the mask. This feedback signal is then the desired function of the input.

It is necessary to use long integration times, especially on the higher order moments, if we wish to use the system at low frequencies. For a 95 per cent probability of $\pm$5 per cent accuracy of the fourth moment, an input 1/f frequency spectrum, and a low-frequency cutoff of 0.2 cps, a 30-hour integration period has been found necessary. An electromechanical arrangement designed for very long integration times is shown in Fig. XI-4.

The high-frequency limit of the function generators will probably be 40 kc/sec because of the phosphor persistence of the cathode-ray tube used. The low-frequency limit will be imposed by the more stringent of: (a) the length of integration time, or (b) the low-frequency response of the noise preamplifier.

J. Hilibrand

References

1. E. R. Kretzmer, Bell System Tech. J. 31, 751-763 (1952).
2. A. B. Macnee, Sc. D. Thesis, Department of Electrical Engineering, M.I.T. (1948).