NASA TECH BRIEF

Digital-Voltage Curve Generator

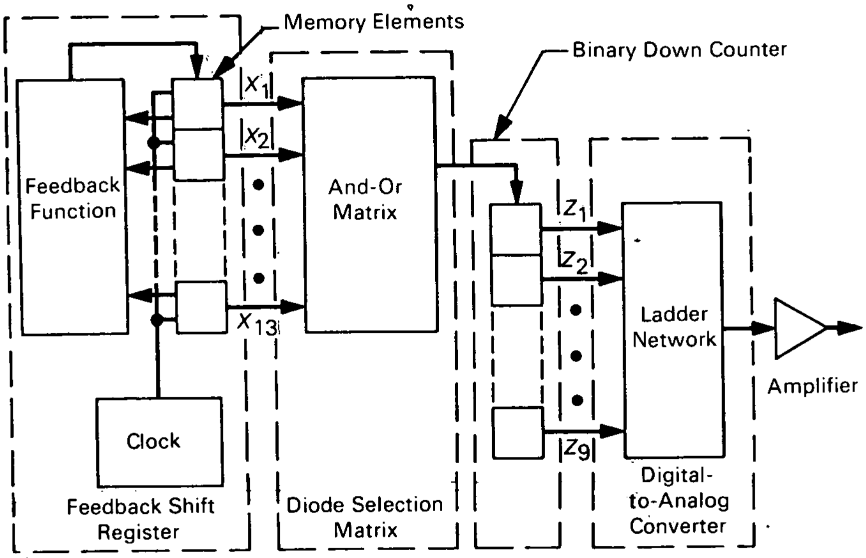

Figure 1

The problem:

To provide a curve generator that will produce an easily controlled, precisely repeatable curve for any single-valued function of voltage versus time. In addition, this generator should be capable of generating complex curves such that its output could compensate for distortions in the responses of associated apparatus.

The solution:

A digital approach, implemented by means of a clocked feedback shift register, a large scale integrated circuit diode matrix comprising about 12,000 diodes, a counter, and a digital-to-analog converter, is used for the curve generator. An operational amplifier could follow the converter to produce the voltage level required for specific applications.

How it's done:

A block diagram of the curve generator is shown in Figure 1. Equal changes of voltage, small enough in value and in sufficient number to reflect small changes in the curve, are held for varying time durations in accordance with the desired shape of the curve. In the array illustrated in Figure 1, nine variables are easily manipulated in the diode matrix. Heretofore, it was not possible to generate sufficient quanta (weighted numbers) to describe a complex curve, because of the large number of independent Boolean variables involved.

Time is quantized by a feedback shift register and a 9×1 diode selection matrix which generates designated output states in accordance with a feedback function. Entries in this matrix are the selected states of the shift register which will decrement the counter. Successive states appear for a fixed duration of a time, whereas selected states are separated in time in accordance with the desired curve (See Figure 2). The quantity $\tau(k)$ represents the time in quanta.

(continued overleaf)

The number of feedback shift register states required to describe a curve adequately can be determined either graphically or algebraically. In the graphical method, the desired curve is plotted on rectangular coordinates. Parallel, equally spaced lines are drawn perpendicular to the ordinate. From the points where these lines cross the curve, lines are drawn perpendicular to the abcissa, which is linearly scaled with the maximum number of feedback shift register states required to quantize time. The intersections of these lines with the X axis, then, determine the states of the feedback shift register that must decrement the counter. The shift register is shown in Figure 1, for the purposes of illustration, with 13 stages.

An algebraic determination of the complexity required of the feedback shift register can also be made if the curve can be expressed algebraically. The number of shift register stages required to quantize time in order to show a change in the dependent variable is derived from the desired quantization of voltage.

One or more 3-in. × 3-in. large-scale integrated circuits comprise the AND/OR diode selection matrix. The purpose of this matrix is to convert the nonweighted code of a feedback shift register to a series of nonuniformly spaced time pulses. The output of the matrix decrements a binary down counter, for example, to produce the monotonically decreasing hyperbolic curve of Figure 2. The counter, however, could be an up-down counter capable of producing non-monotonic curves. In this case, the up- or down-sense is derived from the diode selection matrix.

The output of the binary counter is applied to a digital-to-analog converter to derive an analog equivalent of the binary signals. An analog output amplifier is used to set the operating levels over which the curve will vary. This is provided to accommodate matching to external circuits.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP70-10590

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

Source: M. Perlman of Caltech/JPL under contract to NASA Pasadena Office (NPO-11104)

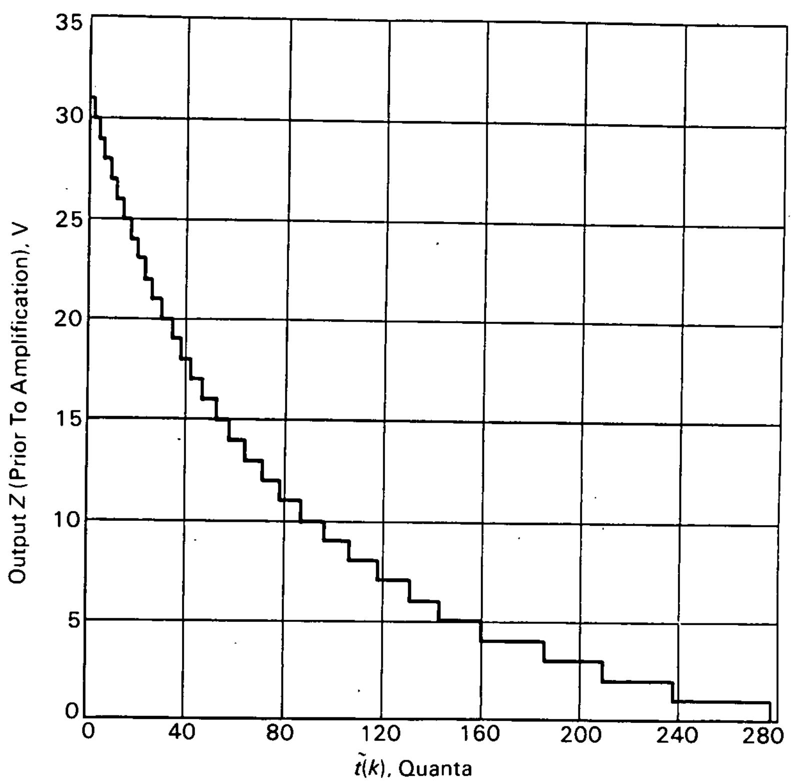

Figure 2