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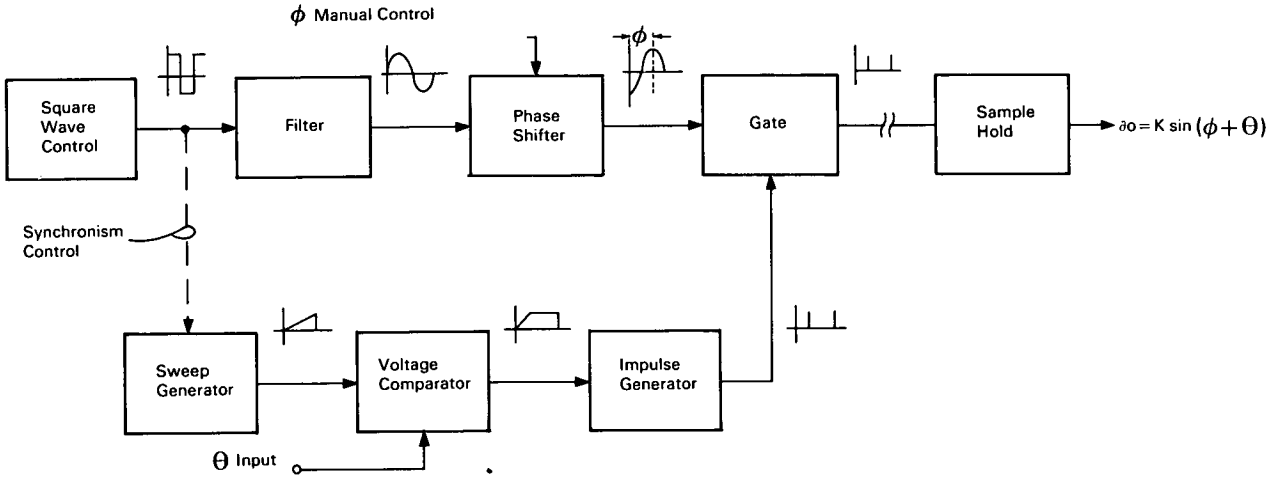
NASA TECH BRIEF

Circuit Operates as Sine Function Generator



The problem: To provide an electrical signal whose magnitude is proportional to the trigonometric sine of a given angle Θ, plus or minus a fixed phase angle ϕ, when Θ is linearly proportional to the magnitude of an input electrical signal. Prior methods have used rotating electromechanical components whose dynamic accuracy is limited by the slow response time of servo controls.

The solution: A circuit that samples the magnitude of a sine wave at a point in its period determined by the magnitude of the input signal.

How it's done: The output of a square wave generator is filtered in order to recover the fundamental, which is a sine wave of the same frequency as the square wave. Simultaneously, the square wave is used to synchronize a sawtooth sweep generator. The synchronized sweep signal is one input to a voltage comparator that also receives a voltage which is linearly proportional to Θ. At a point in time when the value of Θ is equal to the magnitude of the sweep voltage, the output of the voltage comparator drives the impulse generator, which in turn opens an electronic gate for a short interval. The sine wave obtained from the filter is phase shifted through a predetermined angle ϕ by the phase shifter and this signal is passed through the gate when the impulse generator signal is applied. Thus an impulse whose magnitude is proportional to $\sin(\Theta + \phi)$ is applied to the sample hold. This sample is the output voltage, $e_o = K \sin(\Theta + \phi)$, which is maintained until the next sample is taken. The synchronism control determines the frequency of sampling, which is designed for the anticipated maximum rate of change of the input Θ, and may be as great as the fundamental frequency of the square wave. The greater the sampling rate, the more accurately the output will represent $K \sin(\Theta + \phi)$ as Θ varies with time.

(continued overleaf)

Notes:

1. The advantages of this innovation are summarized as follows:
   a. There are no moving parts, and consequently no mechanical wear, no backlash, and no dynamic lags as a result of friction and inertia.
   b. A considerable savings is realized in size, weight, and reliability over the corresponding characteristics of a mechanical system.
   c. The static accuracy is not limited by the resolution (number of turns) of a nonlinear potentiometer.
   d. The accuracy does not depend on the length of the interval over which it is desired to generate the function.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   P.O. Box 1537
   Houston, Texas, 77001
   Reference: B66-10038

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated by NASA.

Source: Theodore Bogart, Jr. of
North American Aviation, Inc.
under contract to
Manned Spacecraft Center
(MSC-255)