MULTIPLE SAMPLER CIRCUIT
Giacomo Vargiu, 150 Doherty, Redwood City, Calif. 94061
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3 Claims

ABSTRACT OF THE DISCLOSURE

A high bandwidth signal sampler which separates the signal into two phase related signals and samples each of them at a selected rate, but at times which are delayed by the phase separation of these signals.

This invention relates to signal samplers and has as its main object the provision of a circuit which has higher bandwidth than a conventional signal sampler when operated at a selected signal sampling rate.

This is accomplished according to the illustrated embodiment of the present invention by separating the signal to be sampled into at least two phase-related signals and by sampling each of them at the selected rate but at times which are delayed by the phase separation of these signals.

In the drawing which shows a schematic diagram of the circuit of the present invention, a phase separator 9 is connected to receive signal to be sampled from a source 11 for producing at least two signals at the outputs 13, 15 which are separated in phase by uniform increments but which have the same wave shape as the applied signal. Each of these output signals is applied to a sampler 17, 19 which is rendered momentarily conductive by a sample signal applied thereto from the sample signal generator 21. These sample signals are also separated in time corresponding to the relative phase shift of the signal to be sampled appearing at the outputs 13, 15 of phase separator 9. This produces sample pulses having amplitudes related to the amplitude of the applied signal at the sample instant. The sample pulses from the two samplers 17, 19 are combined in network 23 to produce a train of sample pulses at the input of stretcher circuit 25 which includes twice the sample information per cycle of signal from source 11 as is available using conventional sampling techniques and which contains predominantly only odd harmonics of the frequency of the signal from generator 21.

This multiple sampling technique may be further extended, for example, by sampling at four equally-spaced intervals. There, the applied signal may be selectively transformed as by integration or differentiation to provide a change of signal amplitude per unit time about the additional sample points t2 and t4 which is normally approximately equal to the change of signal amplitude per unit time about the sample points t1 and t3. This provides a plurality of sample pulses per cycle of applied signal having approximately amplitudes which may vary about a normal value in response to phase error and noise at the sampling instant. The increase in sample information per cycle of applied signal results in more rapid response of the output of the pulse stretcher circuit 25 to perturbations in the applied signal from source 11 because the next sample is derived after a time interval which is considerably shorter than the time interval after which another sample would be taken by conventional sampling methods. This produces an effectively higher operating bandwidth for use, as an example, in a phase-locked system with concomitant wider capture range. Improved filtering capabilities also result from the absence of even harmonics in the combined sample pulses from at least two samplers 17, 19. Such a phase-locked system with the sample signal generator 21 operating at the reference frequency is shown as a feedback circuit connected through switches 20, 22 from the output of the pulse stretcher 25 (which maintains a steady output between sample pulses at a value related to the amplitude of a preceding pulse), through a control circuit 27 to the source 11 to maintain the phase of signal from source 11 in a fixed relationship to the signals from generator 21.

Utilization circuit 29 operates on the output signal from stretcher circuit 25, which output signal is proportional to the phase difference between the signal to be sampled from source 11 and the signals from the proper phase-locked operation of the circuit shown. Of course, the signal sampler of the present invention may also be used in other sampler circuits with similar advantages of greater sample information per cycle of applied signal and wider effective operating bandwidth.

1 claim:

1. Signal sampling apparatus comprising: a plurality of samplers, each having an output, an applied signal input and a control signal input and operative to conduct momentarily in response to a signal applied to the control signal input thereof for producing a sample pulse at the output thereof having an amplitude related to the amplitude of signal applied to the applied signal input thereof at the moment of sampler conduction; circuit means having an input and a plurality of outputs connected for applying to the applied signal inputs of the samplers an in-phase signal and an out-of-phase signal which have time-varying amplitudes that are proportional at every instant of time to the time-varying amplitude during a cycle of signal appearing at the input of said circuit means; control signal generating means connected to the control signal inputs of said samplers for applying control signals to said samplers in non-simultaneous succession to render the samplers momentarily conductive in sequence only at substantially the same single portion of the cycle of the phase-separated signals applied to the applied signal inputs of said samplers; and means connected to the outputs of said samplers to produce an output signal related to the combination of signals appearing at the outputs of said samplers.

2. Signal sampling apparatus as in claim 1 wherein: the control signal generating means applies control signals to each of the samplers at times during a cycle of the signal to an applied signal input of a sampler which are separated by equal increments for rendering each of the samplers momentarily conductive during the portions of the cycles of signals at the applied signal input of each of the samplers for which the rates of change with time of the amplitudes of such applied signals are substantially equal.

3. Signal sampling apparatus as in claim 2 comprising: a pair of samplers;
said circuit means produces a pair of out-of-phase signals at the outputs thereof; and
said control signal generating means applies control signals to said samplers in alternating sequence to render said samplers alternately conductive in opposite phase relationship.

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DONALD D. FORRER, Primary Examiner
HAROLD A. DIXON, Assistant Examiner
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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION


Inventor(s) G. Vargiu

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 1, below the title, after the inventor's name, "150 Doherty" should be deleted; after "California" delete -- 94061 -- and substitute -- assignor to Hewlett-Packard Company, Palo Alto, Calif., a corporation of California --.

SIGNED AND SEALED
JUL 14 1970

(SEAL)
Attest:
Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents