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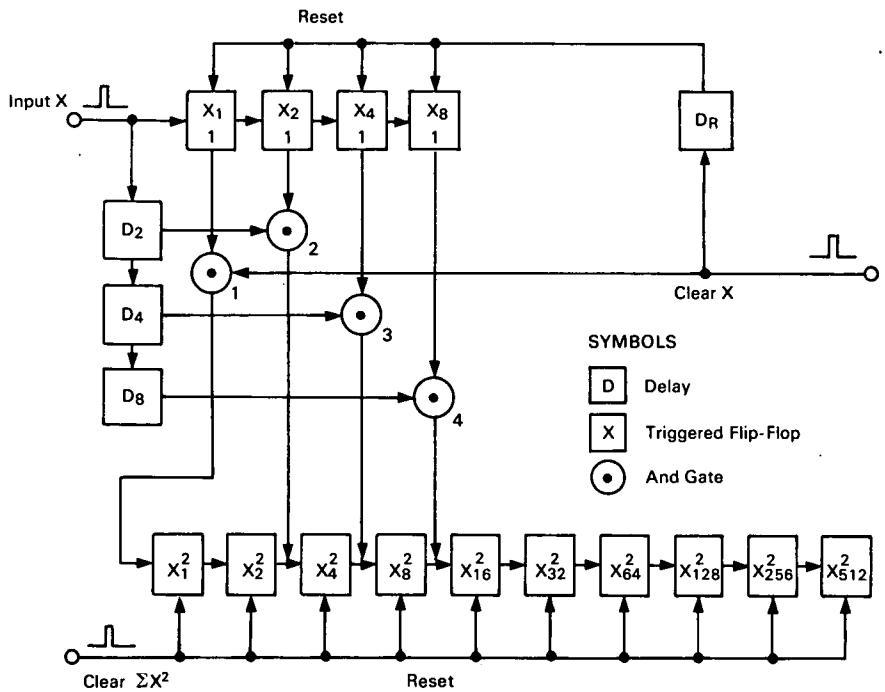
Simple Pulse Counting Circuit Computes Sum of Squares



The problem: To calculate the sum (Σ) of the squares (X^2) of numbers represented by a series of pulse trains. Previous circuits designed to calculate ΣX^2 required the conversion of the pulse trains to binary representation and then the performance of standard computer squaring and adding processes. Where it is desired to display the results instantaneously, such as in a digital readout meter, standard computer techniques are not adequate.

The solution: A pulse counting circuit that includes an additional chain of flip-flops, delay lines plus and/gates to instantaneously compute the sum of the squares of the pulse sequences.

How it's done: The circuit configuration shown uses 4 flip-flops to count up to 15 and 10 additional flip-flops to store the sum of the squares. The four primary counting flip-flops are reset by a pulse on the clear X line after each sequence of pulses. At the end of the summation, the 10 summing flip-flops are cleared by a pulse on the clear ΣX^2 line.

In a typical operation, three sequential pulses arrive at the input X terminal and the first turns on flip-flop

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X_1. The second pulse turns X_1 off, X_2 on, and also travels through delay line D_2 to trigger flip-flop X^2_4. The third pulse, in a similar manner, causes X^2_4 to turn off and X^2_8 to turn on. Before the primary counter is reset, the ΣX^2 counter differs from the actual sum of the squares by one if the number of input pulses is odd. This is corrected when the clear X pulse arrives and triggers the X^2 flip-flop. For an even number of input pulses, the clear X pulse is not passed by and gate 1 because flip-flop X_1 is off.

Notes:

1. Approximately $\log_2$ N gates and delay lines and 3 $\log_2$ N flip-flops would be required to compute the sum of the squares up to N pulses.
2. The advantage of this system is that, as a pulse train is completed, summation of the squares of the pulses is simultaneously completed.
3. This invention should be of interest to manufacturers of analog-to-digital converters and digital voltage and power meters.
4. Inquires concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10260

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

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(GSFC-391)