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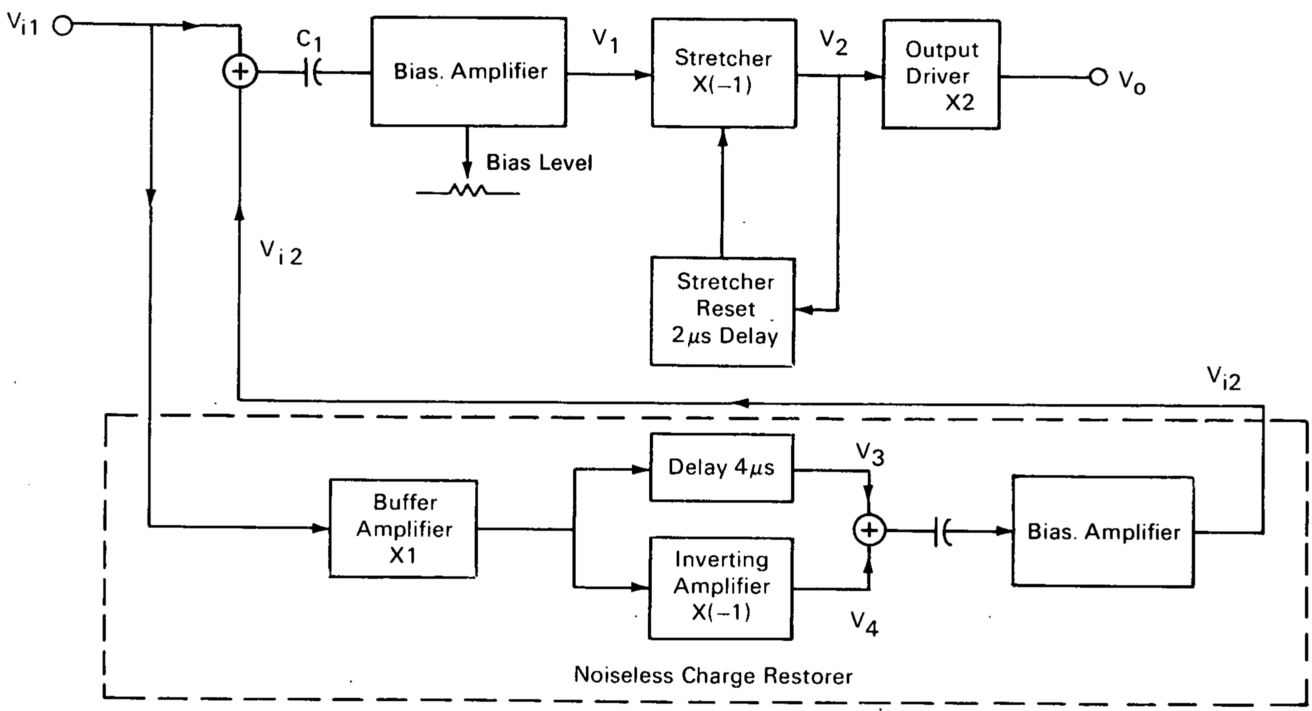
AEC-NASA TECH BRIEF

Highly Stable Biased Amplifier and Stretcher System



The problem:

To develop a stable biased amplifier for maintaining resolution levels in spectrum analysis.

Solid state detectors used with low-noise preamplifiers are capable of resolutions less than 2 keV at 1MeV. An analyzer with only a few hundred channels cannot take full advantage of this resolution when the full spectrum is accumulated. Thus, biased amplifiers have been used to analyze a small portion of the spectrum. To avoid spoiling the resolution, however, the biased amplifier must have a highly stable bias level. This level is changed by (1) temperature effects in the elements and (2) fluctuating charge in capacitors because of the randomness of the input signal.

The solution:

A biased amplifier and stretcher system which minimizes thermal effects and compensates for repetition-rate effects. An additional inverting amplifier is used in the system to provide a noiseless charge restorer. The restoration signal is gated to the restoration amplifier, thus removing line noise.

How it's done:

The figure is a block diagram of the biased amplifier system. The input signal V_{i1} feeds through biased

(continued overleaf)

amplifier no. 1, the stretcher, and the output driver before feeding into the multichannel analyzer. Capacitor C_1 isolates the biased amplifier from the preceding stages, thus preventing voltage drifts in the preceding stages from affecting the bias level.

For unipolar pulses which are random in frequency and amplitude, the charge on capacitor C_1 fluctuates. This is equivalent to a fluctuation in the bias level. The purpose of the noiseless charge restorer is to cancel this effect. A delayed and inverted pulse is added at the input to return the capacitor to its original condition. The required pulse could have been generated by a simple unity-gain inverting amplifier and a delay line. However, noise would have been increased when the two signals were added. The problem is obviated by making V_{i2} noiseless during the time the signal pulse is at the input. This is achieved by producing a bipolar pulse at the input of a second inverting biased amplifier. The amplifier, biased at zero level, transmits only the delayed pulse. The inverted pulse V_4 cuts off biased amplifier No. 2, making the output V_{i2} noiseless.

The system was placed inside an environmental chamber to determine the stability of the bias level. The temperature coefficient was 10 ppm/°C, which is an equivalent input bias of 5 volts. The differential linearity of the system is ± 1% over a 94% range.

Overall performance of the system was determined by making highly accurate Fano-factor measurements over a 10-hour period. The absolute stability of the reference pulse generator peak was 64 ppm. This of course, includes the stability of the pulse generator (40 ppm/°C) itself. The data had an rms deviation from an expected straight line of less than 25 ppm at energies of several MeV. These measurements were made without using a stabilizer for the multichannel analyzer.

Note:

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Patent status:

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