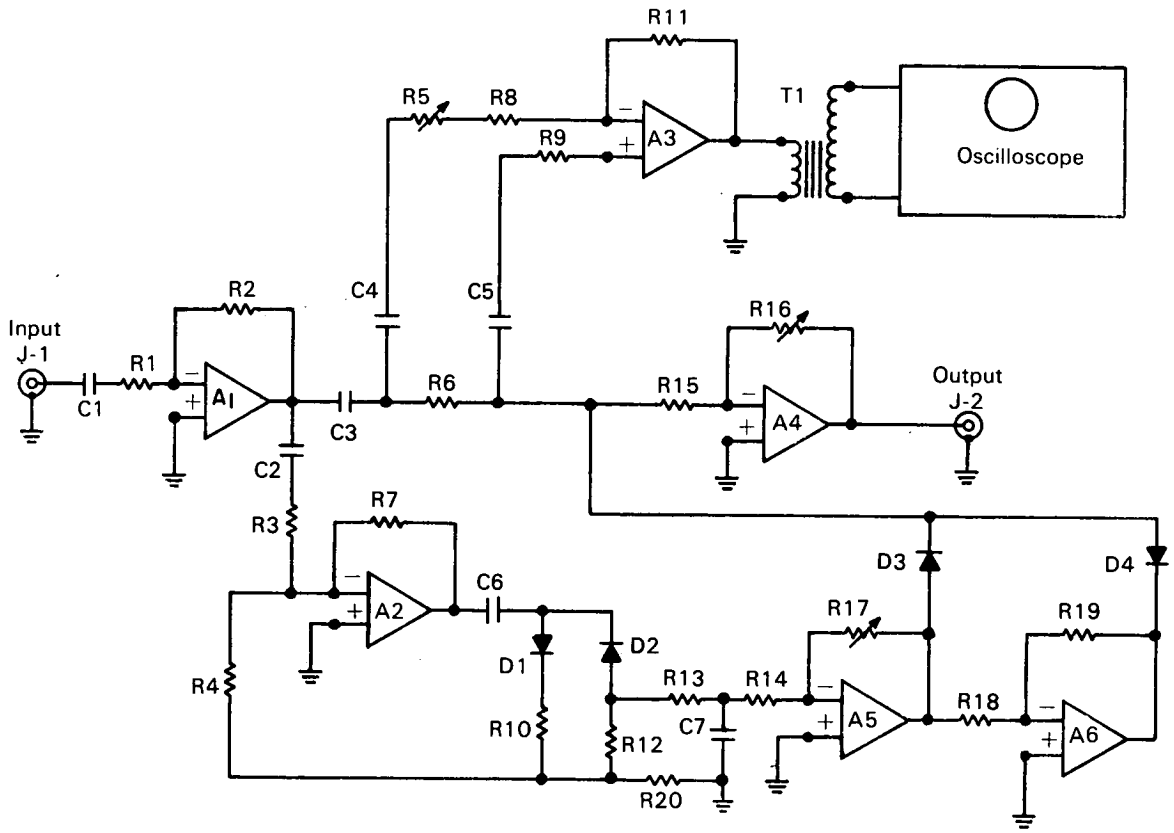
September 1969

Brief 69-10349

NASA TECH BRIEF

Automatic Gaussian Random-Noise Limiter



This circuit has been designed to limit the positive and negative peaks of a random-noise signal. Limiting is held to a value not exceeding 3 times the rms value of the random-noise signal. The circuit can be used to limit the peak acceleration automatically and continuously during random-noise vibration testing to a value no greater than 3 times the rms acceleration level.

The advantage of this circuit is that it accurately establishes a known limiting level relative to any given rms value of the random-noise signal input. The feature that achieves this result lies in the method of back-biasing diodes by means of an operational rectifier that establishes the conduction point of the diodes with respect to the instantaneous random-signal level. Fixed-level limiters, which have pre-

(continued overleaf)

viously been used, cannot establish the maximum limiting level reference to all possible rms values of the random-noise signal.

The random-noise signal is normally applied to input J-1 of the Automatic Noise Limiter (ANL); the gain of the overall system, from J-1 to J-2 (the output) is unity. All six amplifiers used in the system are standard linear operational amplifiers (op-amp) provided with one inverting input designated (—) and one noninverting input designated (+); each amplifier has overall negative feedback applied externally to fix or adjust the gain of each amplifier. The input signal is fed through C1 and R1 to op-amp A1 on through C3, R6, R15 and op-amp A4 to the output jack J-2. C1, C2, and C3 provide dc isolation. R6 is a sensing resistor to provide a signal indication whenever diodes D3 or D4 conduct; this signal is monitored via op-amp A3 used as a differential amplifier. The output of A3 is coupled to T1, a line to grid transformer to provide isolation between the ANL and the oscilloscope. R6 provides sufficient resistance between op-amp A1 and the op-amp A4 to permit proper limiting action of diodes D3 and D4, hence effecting higher signal current through R6 when the diodes conduct. The gain of op-amp A4 is adjusted by R16 to effect unity gain from J-1 through J-2, with diodes D3 and D4 disconnected from the circuit, and op-amp A1 having a fixed gain or amplification of 10 from J-1 through C3. (Note: After adjustment, the gain of op-amp A4 may be as low as 0.1.) The output of op-amp A1 is coupled through C2 and the feed forward resistor R3 to op-amp A2 of the limiter circuit. The output of A2 is capacitively coupled to diodes D1 and D2 to, in effect, gate the positive and negative going portion of the signal to a voltage divider (R10, R12, and R20); the divided signal is placed in a negative feedback loop via R4 to compensate for diode nonlinearities in the conduction mode. Diodes D1 and D2 are referred to as operational rectifiers. The half-wave signal at the junction of D2 and R12 is fed into an averaging network R13 and C7; R14 feeds the negative dc signal from the averaging network to op-amp A5; A5 inverts the signal to provide a back bias to D3. A5 also feeds, via R18, a positive signal to op-amp A6, which inverts the signal and provides a back bias to D4. (Note: A6 has a fixed gain of unity.)

The circuit is calibrated by applying Gaussian noise between 0.1 and 1.0 volt rms to the input J-1 and establishing a known rms level at the output J-2. A probability density analyzer is connected to output J-2. The gain of amplifier A5 is adjusted by resistance R17 to back-bias the diodes D3 and D4 to a value that permits forward conduction when positive and negative noise peaks exceed the back-bias voltage. This voltage is determined by the required signal-limiting level, which is confirmed by the probability density analyzer. The normal sigma limiting range is adjustable by the resistor R17 from 1.75 to 3 sigma. The limiting point is established by the ratio of the rms noise voltage at the output of amplifier A1 and the rectified dc voltage at the output of amplifier A5. The limiting point depends only on the ratio of these two voltages and not on their magnitudes.

Limiting occurs when diode D3 or diode D4 conducts because of the voltage divider created by resistance R6 and the forward conduction impedance of diode D3 or diode D4. During limiting, the current through resistor R6 creates a voltage across resistor R6 which is amplified by differential amplifier A3. This voltage is applied to an oscilloscope to indicate the occurrence of limiting.

Notes:

Documentation is available from:
Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151
Price $3.00
Reference: TSP69-10349

Patent status:

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Source: Raymond C. Woodbury of
Jet Propulsion Laboratory
under contract to
NASA Pasadena Office
(NPO-10169)