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Brief 71-10157

NASA TECH BRIEF

NASA Pasadena Office

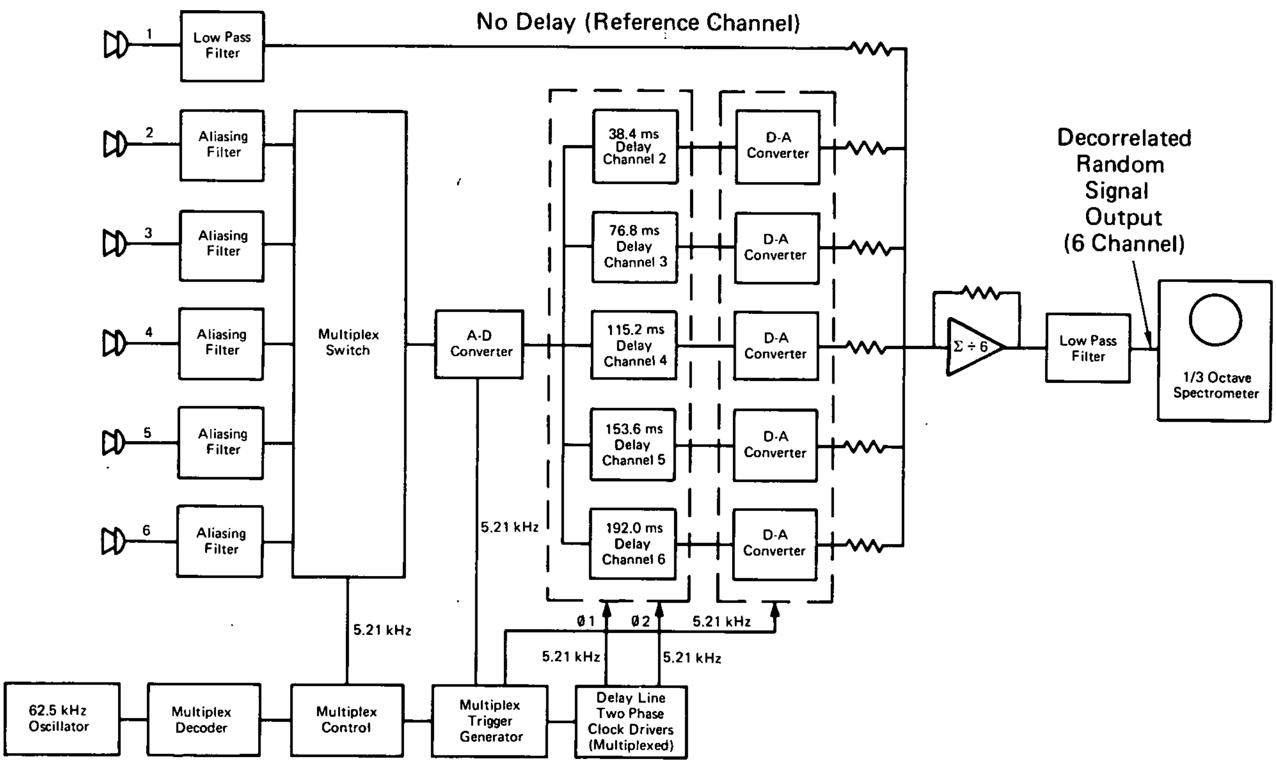
Digital Decorrelator Saves Time and Expense in Acoustic Testing of Structures

The problem:

Devise a technique which will save time and money on acoustic energy absorption tests on structures such as aircraft or spacecraft assemblies.

Because of the transmission characteristics of a reverberation room, the sound pressure level in the room is a function of measurement position and frequency. Also, a large test object absorbs sound, distorting the field. These problems make it impossible to describe the sound field in terms of a single point of measurement.

Spatial averaging with respect to time and frequency in one-third octave bands is required to define the sound field accurately. This can be achieved by using a traversing microphone, or by using several microphones to measure the sound pressure level in one-third octave bands and then averaging the readings with a computer or desk calculator. Both techniques are expensive in terms of machine costs or operator time; neither technique allows real time presentation of data; and neither is adapted to use in servo control systems. Aver-



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aging the instantaneous signals by means of direct summation or scanning devices fails because of unresolvable vectorial addition errors associated with the coherent characteristics of the sound field.

The solution:

Instantaneous signals selected from a coherent random sound field are summed and are time delayed to avoid introducing vectorial addition errors. (The amount of delay is equal to or greater than $T_n = n/2B$, where n is the n^{th} spatial measurement point and B is the lowest one-third octave band of interest.) The resultant statistically independent signals are applied to a spectrometer. The displayed sound pressure level is proportional to the square root of the sum of the squares of the sound pressure levels taken over the frequency range of interest. This is possible because averages and variances are both additive for statistically independent signals.

How it's done:

Microphones (typically six) are strategically placed about the test object in the reverberation room. Channel 1 carries the undelayed reference signal. Channels 2 through 6 are first filtered to prevent aliasing, then digitized after selection by the multiplex switch, and finally passed to appropriate delay registers. These dynamic shift registers introduce delays of from 38.4 to 192.0 milliseconds, in 38.4 ms increments, to ensure decorrelation in the 50Hz one-third octave band. After digital-to-analog conversion, all channels are summed and are divided by 6 to give an average sound field level with unity weighting. The resultant ensemble of statistically independent signals is analyzed and then displayed on a one-third octave spectrometer. Since the delays introduce a lag of less than 0.2 second, changes in the sound field can be observed in virtually real time, permitting servo control of the sound field.

Notes:

1. Although the method is described here for acoustical testing, the concept is also adaptable to multipoint vibration testing using random noise excitation.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP71-10157

Patent status:

No patent action is contemplated by NASA.

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