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NASA TECH BRIEF

Langley Research Center

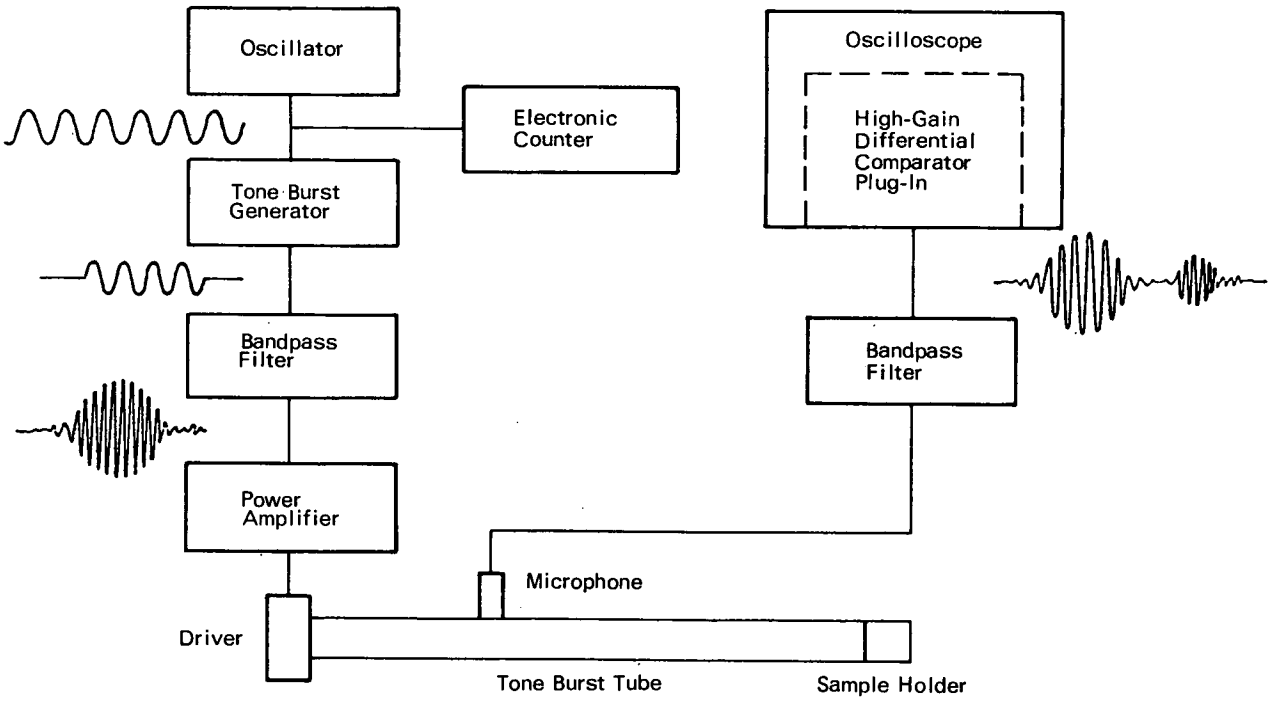
Tone-Burst Technique Measures High-Intensity Sound Absorption

The problem:

To measure the sound absorbing capacity of materials used in jet engine noise abatement. Sonic intensities greater than 170 dB can occur in jet engine inlet ducts. The measurement of sound absorption characteristics at these high intensities has previously been difficult because conventional laboratory apparatus generally cannot reliably reproduce such high sound pressure levels, and because sound absorption characteristics commonly become nonlinear at sound pressure levels above about 120 dB. An extrapolation of the results obtained from lower intensity (linear) sound absorption measurements does not yield an accurate prediction of the high-intensity characteristics.

The solution:

A new tone-burst technique, in which a narrow-bandwidth, short-duration sonic pulse is propagated down a standing-wave tube. The tube is calibrated by terminating it with a rigid metal surface and measuring the ratio of reflected to incident pulse amplitude. The rigid termination is then replaced by a test sample and the measurement is repeated. A comparison of the two sets of data eliminates the effects of tube losses, and yields the normal-incidence absorption coefficient of the specimen.



(continued overleaf)

How it's done:

The system shown in the block diagram is used for tone-burst measurements. The sine wave oscillator output goes to a commercially available tone generator, which is essentially a gate that passes a predetermined number of oscillation cycles when triggered. Each series of cycles starts and ends with a zero crossing. The one-third octave bandpass filter passes a narrow-bandwidth wave packet, which is amplified and then applied to an electrodynamic driver (loudspeaker) at one end of the tube. The counter is used to match the oscillator frequency with the filter's center frequency.

The acoustic tone burst from the driver propagates down the tube, passes a microphone, reflects from the end of the tube, and again passes the microphone. The microphone output signal is fed through another one-third octave filter identical to the first, and is read out on an oscilloscope with a differential comparator plug-in unit. The second filter reduces the effects of loudspeaker distortion, background noise and tube resonance.

This technique has been successfully employed in evaluating the absorption characteristics of various materials in the frequency band from 0.5 to 10 kHz, at peak sound pressure levels up to 170 dB.

Notes:

1. With the tone burst technique, the continuous power ratings of the various components, particularly the driver, can be considerably exceeded without damage. For example, loudspeakers rated at 40 Wrms can be driven successfully with tone bursts up to 600 W peak.
2. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA CR-1698 (N71-16660), Techniques for Evaluating the Sound Absorption of Materials at High Intensities

Patent status:

No patent action is contemplated by NASA.

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