

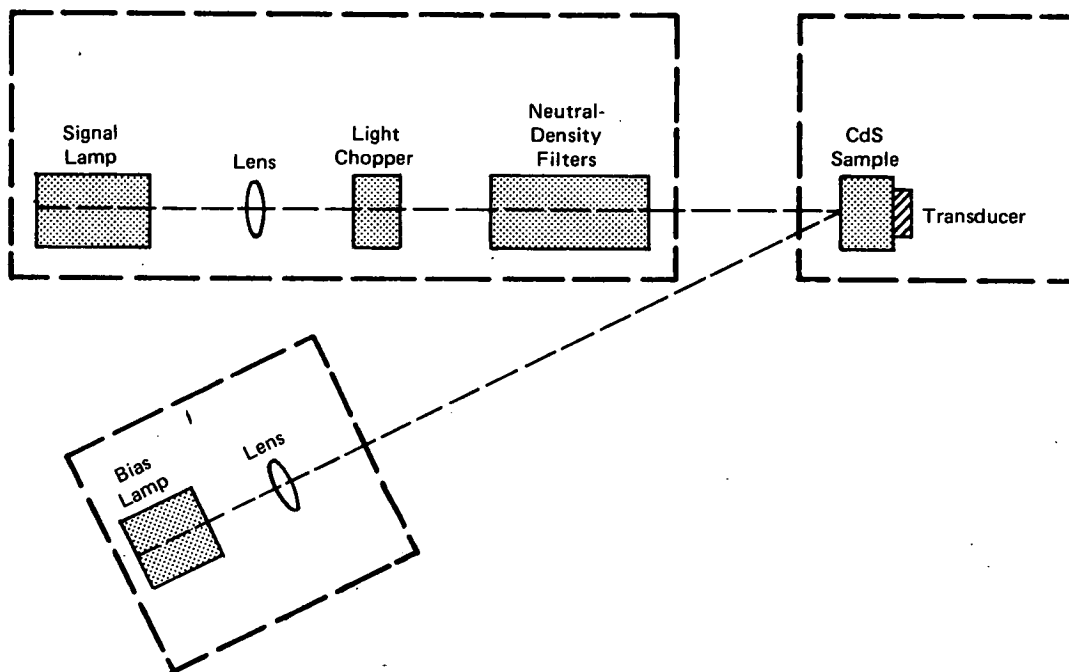
# NASA TECH BRIEF

## Langley Research Center



NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

### Ultrasonic Calibration Device



Ultrasonic Calibration Instrument

The ultrasonic calibration device illustrated is an instrument for producing known changes in both acoustic absorption and phase velocity. The calibration signal arises from an actual change of acoustic parameters, not from an electrical simulation. Changes in ultrasonic time-domain decay rates or frequency-domain line widths are produced. Thus, the instrument is able to simulate not only changes in ultrasonic absorption and phase velocity but also in the sensitivity enhancement achieved by the use of ultrasonic resonators. The latter simulation cannot be achieved using electrical calibration techniques.

The components of this ultrasonic calibration device are shown in the illustration. The composite resonator consists of a CdS crystal bonded to an appropriate transducer. The flat and parallel single crystal of CdS is prepared from a high-purity photoconducting material.

Light from both the bias and the signal lamps, which are powered by constant-current sources, is focused on the CdS crystal. A light chopper and a platform carrying neutral-density filters are in the optical path of the signal lamp. The entire assembly is housed in a lighttight case, external to which are controls that insert or retract various combinations of neutral-density filters.

The physical basis for the calibration scheme is as follows. Because CdS is a good photoconductor, light incident on the crystal can change its electrical conductivity by many orders of magnitude. Since the charge carriers are coupled to the elastic properties of CdS by the piezoelectric mechanism, changes in electrical conductivity result in changes in ultrasonic phase velocity and absorption.

(continued overleaf)

The intensity of the bias lamp is adjusted to produce a background ultrasonic absorption,  $\alpha_0$ , equal to that of the specimen being simulated. By adjusting the bias light level,  $\alpha_0$  can be varied by nearly two orders of magnitude (from about  $0.03 \text{ cm}^{-1}$  to  $1.6 \text{ cm}^{-1}$ ; or  $0.1 \text{ dB}/\mu\text{s}$  to  $6 \text{ dB}/\mu\text{s}$ ), which will permit the  $\alpha_0$  of many specimens of ultrasonic interest to be simulated.

After the appropriate  $\alpha_0$  is selected, initial calibration of the instrument is achieved by comparison with external standards, a precision attenuator for the case of absorption and a frequency counter for the case of dispersion. Once this simple initialization procedure has been carried out, the instrument is capable of producing accurately known changes in ultrasonic attenuation and phase velocity over a wide dynamic range.

For dc-coupled systems, the light chopper is switched off. Changes in ultrasonic parameters are produced by the appropriate insertion, or removal, of neutral-density filters in the signal-lamp optical path. For ac-coupled systems, the light chopper produces a modulation of ultrasonic absorption and/or dispersion at the chopping frequency. Calibrated changes in the amplitude of this modulation are achieved with the aid of the neutral-density filters.

**Note:**

Requests for further information may be directed to:  
Technology Utilization Officer  
Langley Research Center  
Mail Stop 139-A  
Hampton, Virginia 23665  
Reference: B73-10420

**Patent status:**

Inquiries concerning rights for the commercial use of this invention should be addressed to:

Patent Counsel  
Langley Research Center  
Mail Stop 456  
Hampton, Virginia 23665

Source: Joseph S. Heyman  
Langley Research Center and  
J. G. Miller of  
Washington University  
under contract to  
Langley Research Center  
(LAR-11435)