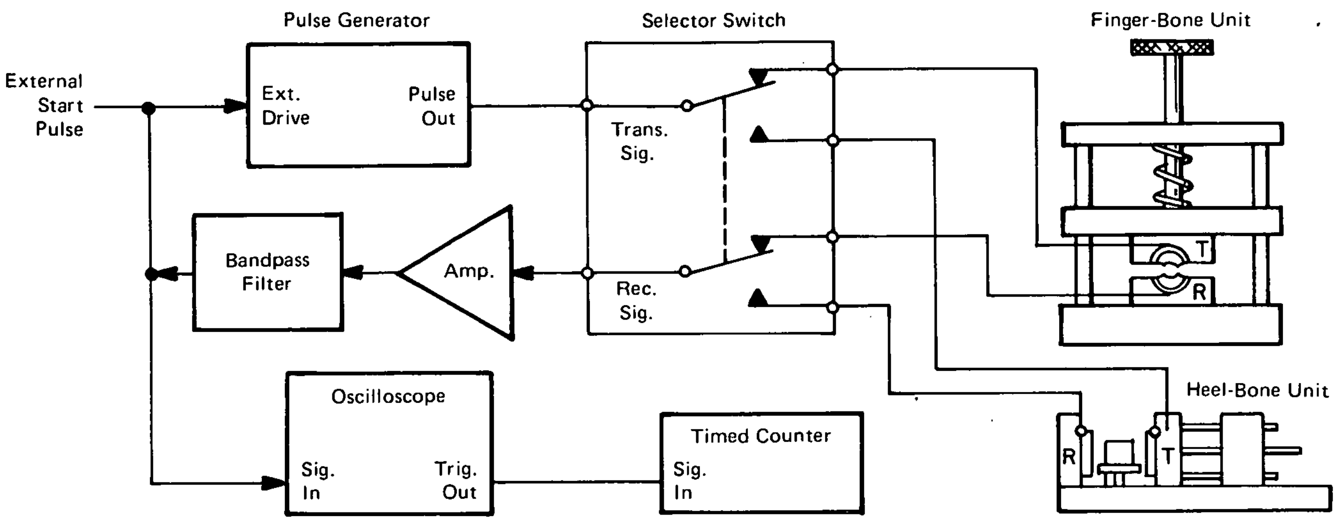
NASA TECH BRIEF
Marshall Space Flight Center

Ultrasonic Bone Densitometer



Changes in the density of human bones can be rapidly and accurately determined by an ultrasonic device that was originally developed for in-flight testing of astronauts' bones during extended space missions. Comparable in size, weight, and power consumption to a portable television set, the device may also be used in hospitals for monitoring the skeletal condition of patients immobilized for long periods.

Human bones require frequent mechanical stress in order to maintain a normal mineral balance. Prolonged lack of stress causes decalcification and weakens the skeletal structure. Although this condition can be, and often is, monitored radiographically, the ultrasonic technique employs simpler, more compact apparatus, requires less operating power, and presents no radiation hazard.

The heel bone *(os calcis)* and the second joint of the third finger, left hand (finger phalanx L-4-2) are used for measurement; the one represents a normally active, high stress bone, and the other a normally inactive, low stress bone. The specially designed clamps hold the bones in a constant, repeatable orientation with respect to pairs of ultrasonic transducers. The transducers, made of fiberboard-backed PZT ceramic, are coated with silicone rubber and lightly spring loaded to aid coupling.

Bone density information is derived using the "sing-around" technique. Named for its regenerative, cyclic mode of operation, the sing-around technique actually determines the ultrasonic pulse repetition rate. Measurement of this parameter is far simpler, more repeatable, and more reliable than any direct measurement of ultrasound transmission time.

The circuit shown in the figure operates as follows: The selector switch is set for either finger or heel measurement. After the human member is clamped in the appropriate unit, an external start pulse triggers the pulse generator, which produces a short burst of rf. The transmitting transducer converts the rf to ultrasound, which passes through the finger or heel to the receiving transducer.

The reconverted electrical signal passes back through the selector switch to the amplifier and bandpass filter.

(continued overleaf)

The filter prevents oscillation at the transducer's natural frequency. The amplified signal is coupled to the oscilloscope and also fed back to the external drive input of the pulse generator to begin a new cycle. Besides serving to monitor the operation of the circuit, the oscilloscope generates an internal sync pulse, which triggers the timed counter.

The pulse rate is the reciprocal of the average total time delay between pulse generation and retriggering. Since the electronic delay is very small, essentially the entire delay is due to the ultrasonic transmission time through bone and flesh. Empirical calibration can relate this time to bone density.

Note:

Requests for further information may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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