

## HIGH-RESOLUTION SCALE Measures up to 250 lb $\pm 0.01$ lb Detects a Single Bite of Food

by James Williams

At the M.I.T. Nutrition & Food Science Instrumentation Laboratory, a scheme that is straightforward in concept but exacting in execution has resulted in the development of a scale that is both accurate (needing no calibration long-term) and able to measure small increments of weight gain or loss (such as intake of food or loss of water through perspiration).

A carefully-designed nonlinear filter permits large changes of weight to be stably registered within 5 seconds, small changes within one second, and fast disturbances, such as body motions or the pulsation of blood with each heartbeat, to be rejected. (Interestingly, the raw measurement voltage can be filtered by a different scheme to provide a "ballistocardiographic" measure of pulse rate without any electrical connections to the subject\*.)

As Figure 1 shows<sup>1</sup>, the system consists of a high-linearity temperature-compensated bridge — excited by a floating 10.000V reference supply, a noninverting chopper-preamplifier, a level-controlled filter, and an AD2025† 4¼-digit panel meter that permits weight to be read directly up to the system maximum of 250.00 lb, with a resolution of 0.01 lb (4.5g).

The weighing platform is supported by four symmetrically-disposed bonded strain gages, in a bridge configuration. The linearized low-level output is 15mV full-scale; 600nV ( $600 \times 10^{-9}$  V) corresponds to 0.01 lb. To eliminate calibrations after installation the excitation voltage is based on a selected 1N829A that has been aged for 2500 hours, running at a precisely maintained constant current, and buffered from the  $\sim 100\Omega$  load by a boosted AD504† low-drift op amp.

The bridge output, amplified by a 261† non-inverting chopper amplifier, is applied to a nonlinear filter that combines rapid slewing for weights greater than 4 lb. with a 1s-time-constant filter applied to small noise signals.

Because of the low levels, attention to grounding, shielding, and careful component selection are essential in order to obtain the specified performance of absolute accuracy to within 0.02% (0.05 lb.), repeatability and sensitivity of 40 ppm (0.01 lb.), operating temperature range 20° — 30°C, and no field adjustments.

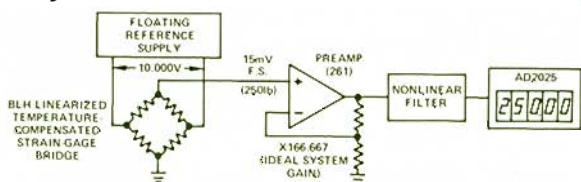


Figure 1. Block diagram of the weighing system.

<sup>1</sup> The system is described in greater detail in an article appearing in EDN magazine (October 5, 1976, Vol. 21, No. 18).

\*Patent applied for.

†For information on ADI products, use the reply card.