# Pocket calculator converts to keyboard entry station

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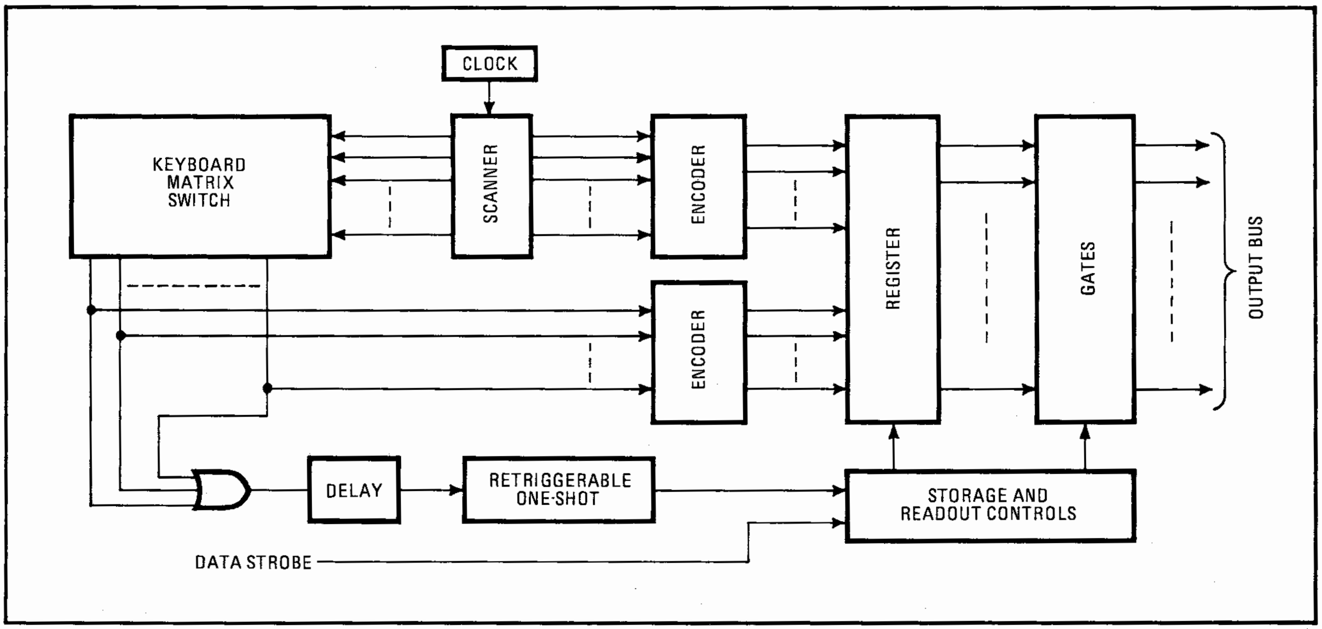
A low-cost data-entry device can be built from a pocket calculator, without disturbing its calculator functions, by connecting a few wires from easily located internal points to a few simple logic circuits.

In a typical calculator, the keyboard is a matrix switch. When power is on, the rows of the keyboard are rapidly and continuously scanned in sequence. Depressing any key makes a connection from one row circuit to one column circuit; the particular combination of row and column identifies the key and, in the calculator, initiates a function such as entering a digit into a register or executing an arithmetic operation on previously entered numbers.

Bringing the row and column signals outside the calculator to similar external logic circuits permits the key to be similarly identified and can initiate another function.

As shown in Fig. 1, two 1-out-of-N encoders convert the row and column signals into unique combinations of bits. All column signals go through an OR or NOR gate, then through a delay, and finally to a retriggerable one-shot circuit. The delay insures that the column signal is neither a legitimate key depression that has just caught the trailing edge of a scanning pulse, nor a spurious noise pulse. As long as any key is held down, the one-shot is repeatedly retriggered, providing an n-key rollover function to protect against accidental



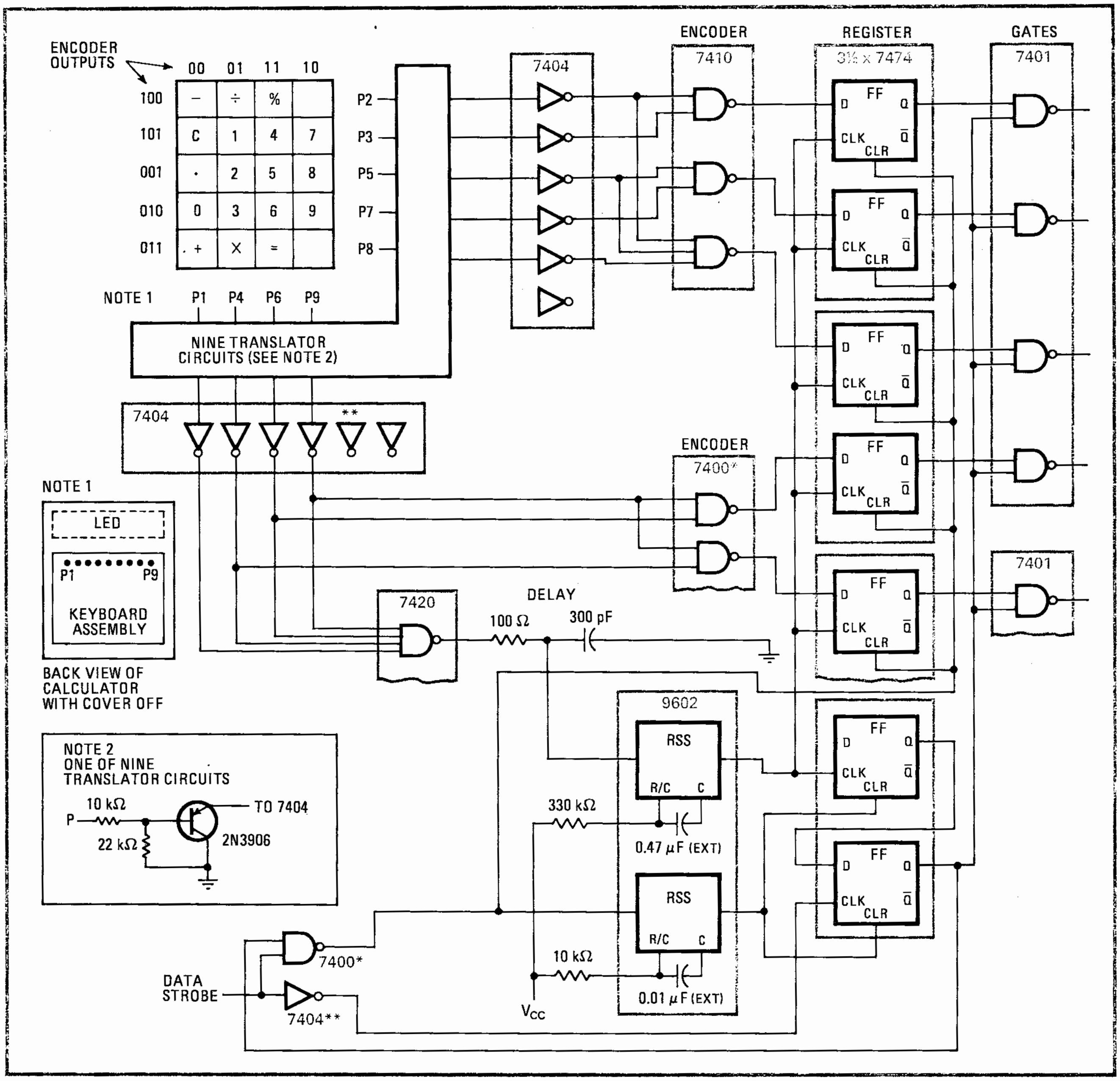

**1. Keyboard functions.** Standard row-and-column signals from a calculator keyboard can be encoded into a data word and stored in a register for gating onto a bus to any kind of digital system. All added components are standard integrated circuits.

multiple key depressions. The rise of the one-shot's output stores the encoded data corresponding to the key depressed—the first, if more than one—into a set of flip-flops. From these the data is available for use in any system requiring the keyboard entry.

A specific interface based on a Bowmar MX-50 calculator is shown in Fig. 2. The keyboard on this calculator has 18 keys in a 5-by-4 matrix, requiring a total of nine external connections to bring out the row and column signals. These are numbered P1 through P9, left to right as seen on the keyboard with the display facing up, after the calculator's cover is removed.

Each of the nine lines is connected to a voltage divider and a transistor to convert the calculator's MOS signal level to TTL. The new levels are inverted and encoded by five NAND gates in two ICs—all of a triple 3-input and half of a quadruple 2-input—and stored by five D-type flip-flops (two per IC package) in such a way that every key turns on at least one flip-flop, as shown by the encoder output listings in Fig. 2.

Meanwhile the four column lines are delayed by an RC network that filters out any spurious or trailing-edge pulses and triggers the one-shot. Its rise stores the data in the five flip-flops, and turns on a sixth flip-flop to indicate that the data word has been stored. An external-data strobe signal repeatedly attempts to set a seventh flip-flop, but is unable to do so until the latter has been conditioned by the sixth one. The seventh flip-flop transfers the data onto an external bus through a set of open-collector gates, and indirectly clears the whole register and, via another one-shot, prepares the data entry station for another key signal. □




**2. Implementation.** Parts of 12 integrated circuits packages, plus a few discrete components, bring keyboard signals out to external bus. Only one external signal—the data strobe—is required; it sets the data on the bus and clears the register.