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From keypad to display using IC's

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LET'S TAKE A LOOK AT TWO EXCITING digital IC's from National Semiconductor; The MM74C922 16-key encoder that outputs binary code from a 4 × 4 row-column matrix of switches, and the MM74C912, a 6-digit BCD-display decoder/driver that does all the housekeeping for a 6-digit by 7-segment-plus-decimal-point display.

The MM74C922 encoder scans columns in a 4 × 4 16-key keyboard with a 2-bit counter and then reads out rows with a 4-line 2-bit encoder. A single capacitor completes the on-chip clock circuit, or an external clock can be used. When the 2-bit column clock counter, which is decoded to four discrete lines, scores a "hit" in the row encoder, a key-detect plus is sent through an on-board key-bounce eliminator and provides a strobe for the data available pin. It also latches the 4-bits (2 from the counter, 2 from the row encoding logic) of BCD data near the output. These latches are followed by on-chip Tri-state buffers that can disable or enable the data-output lines. The row encoding logic also incorporates a two-key rollover.

The MM74C912 decoder/driver accepts a 4-bit binary input (plus a decimal-point control line) and a 3-bit address, plus write enable, chip enable, and two output and multiplex-scan oscillator-enable control lines. The 3-bit digit address loads the appropriate latch of six 5-bit latches with the BCD-plus-decimal-point data strobed into the IC. An on-chip oscillator (requiring only an external capacitor) drives a count-to-6 counter. This both selects the digit that is being driven by the digit driver and multiplexes the appropriate latch's 4 data bits (the decimal point is driven separately with its own line) into a 16-line by 7-bit ROM. The ROM outputs segment information (and the decimal-point control line) to an array of NPN segment drivers that can typically output 80 mA. And, according to Na-

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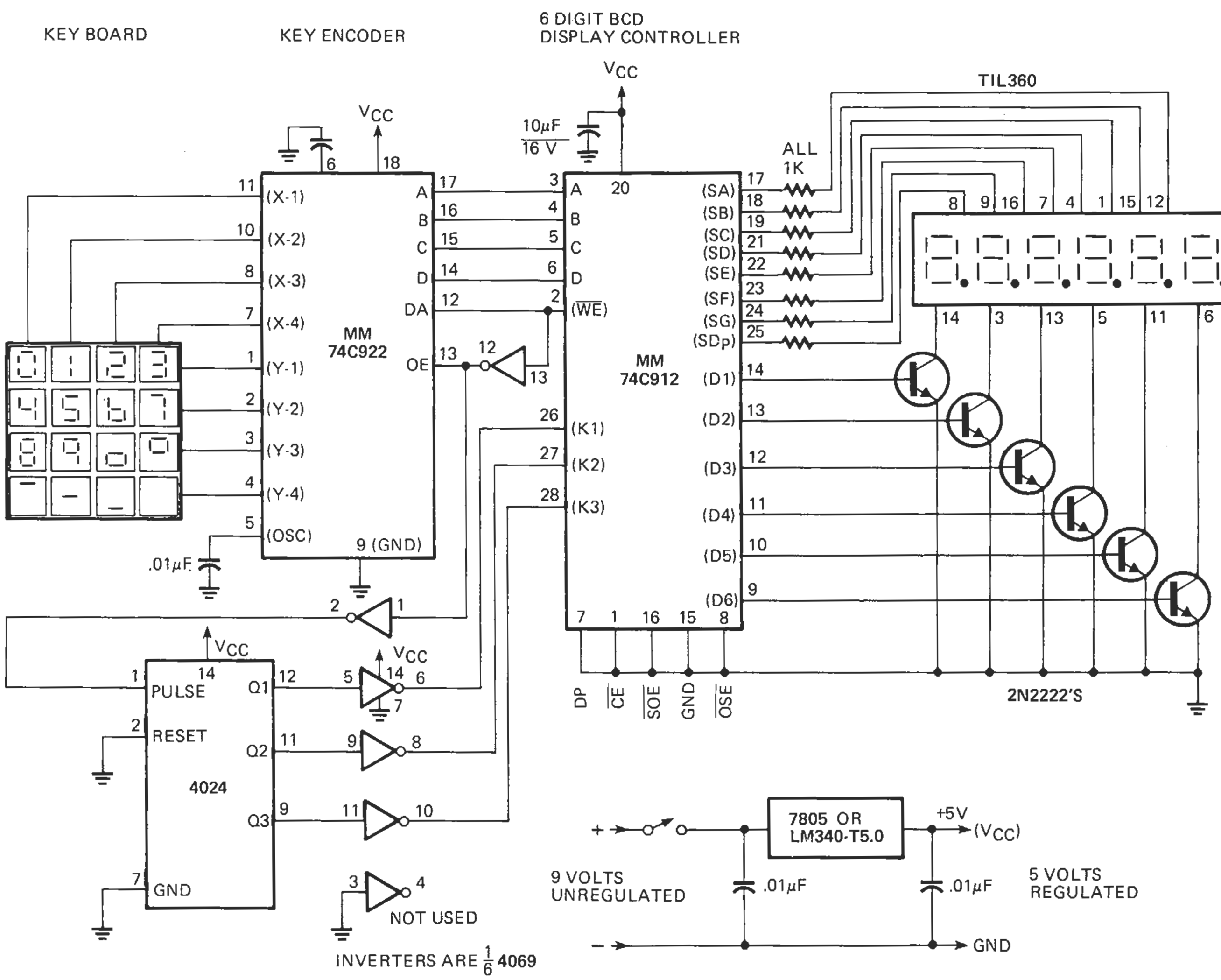

FIG. 1—THE KEYBOARD/DISPLAY circuit displays inputs from the keyboard on the 6-digit LED readout.

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tional, there's enough dead time between digits to allow multiplexing gas-discharge displays.

We've breadboarded a little circuit (Fig. 1) to exercise these IC's. The circuit simply displays what is entered on the keyboard. Each time an entry is made, the display shifts one digit to the right and the new entry appears in the left-most display digit. The circuit accepts keyboard data entry, encodes it to binary, and counts digits (we cheated, the circuit accepts 8 key strokes but we only drive 6 digits; so after the 6th digit, two more key strokes are required before we reload the first digit). The circuit provides the data to the display controller, limits current to the segments, and uses 2N2222's as digit drivers. We used a 7805 (or a LM340-T5.0) to regulate the voltage at 5.0 DC from our 9-volt battery supply.

The *Digitran* 4 × 4 16-key keyboard provides a path from the row-output pin (there are four) to the column-output pin (of which there are also four) when a key at any row-column intersection is pressed. This data is encoded by the 74C922 into a 4-bit binary code. The data available strobe is used three times: first, via an inverter, to enable the output of the 74C922; second, through a second inverter, to advance the count of the three least-significant stages of 4024-type 7-stage binary counter; and third, without any inverter, to drive the write enable control of the 74C912. The 74C912 drives 6 digits of a 6-digit LED counter through 2N2222 drivers. Segment currents are limited through 1000-ohm resistors.

Note that the 4024 Q_n outputs are inverted before driving the 74C912 address lines. If they were not inverted, digits would load from right to left. Five sections of a 4069-type hex inverter are used. **R-E**

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21-c). If we plot the power (i.e., product of Figs. 21-a and 21-c), then we will obtain the power-vs-time waveform of Fig. 21-d. Notice that, for substantial periods during the cyclic excursion, the power is negative—meaning that the device is oscillating and will deliver energy to the external tank circuit. There is only a brief period in which the terminal current and terminal voltage are both positive and that will limit the efficiency of the BARITT oscillator.

The BARITT device is a low-power microwave energy source, and is considered superior to the Gunn device for many applications. **R-E**