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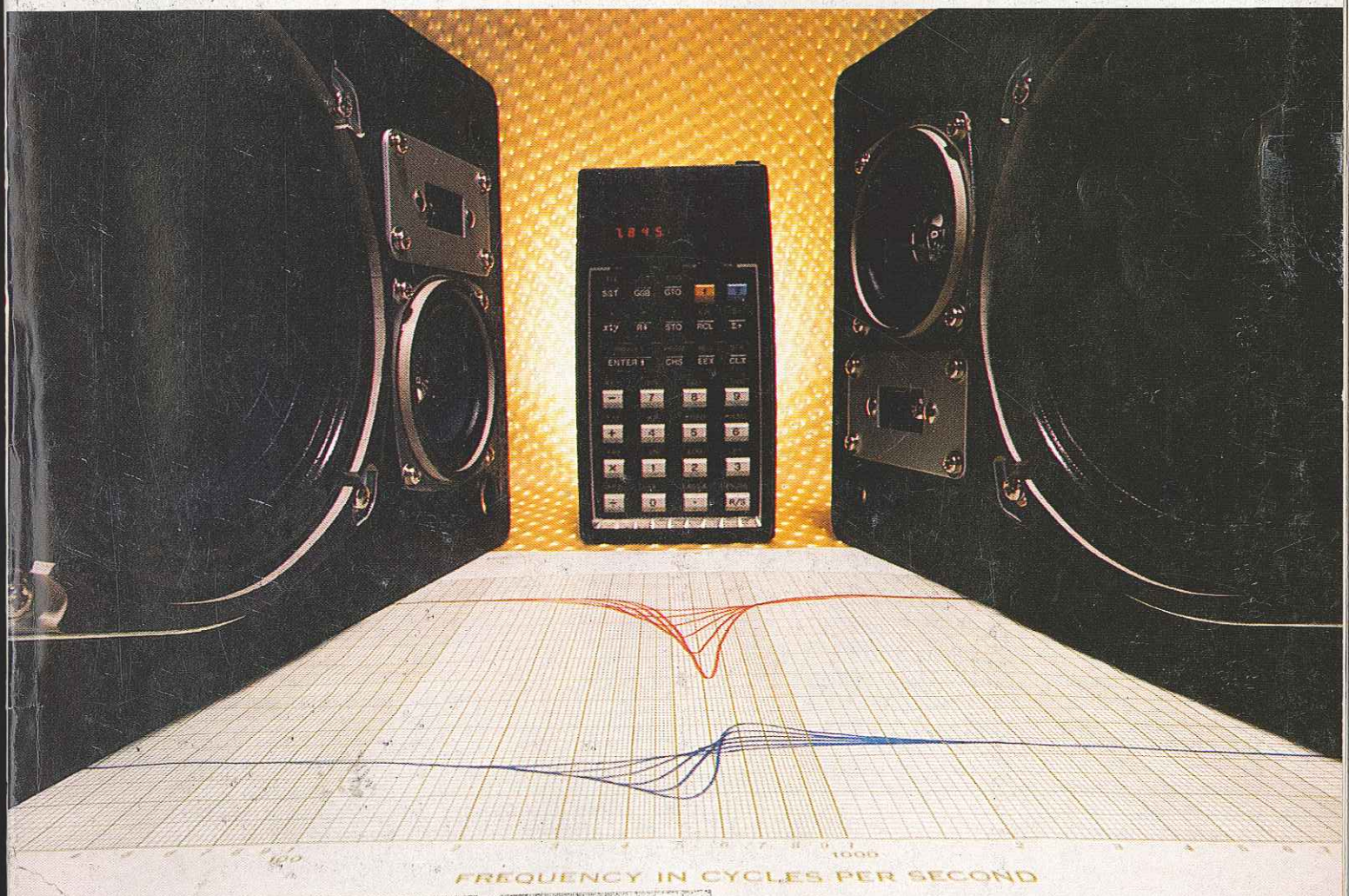

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Extra Keyboards for Microcomputers

BY ADOLPH A. MANGIERI

A keyboard can be connected directly in tandem with the main board of most computers to expand operating versatility.

AN ADDITIONAL keypad or keyboard in tandem with the main keyboard of a computer can have a myriad of uses. A small numeric keypad can be convenient for entering arithmetic data and allows players to enter game moves easily. A full typewriter keyboard duplicating the main one makes one computer setup almost as useful as two for group use and instruction. In any case, a second keyboard, can be used for remote data entry.

The tandem keyboard connects directly to the computer keyboard matrix lines and requires no additional components. Once the warranty on your computer expires, there is no reason why you should not open the cabinet and bring out the keyboard matrix lines. It's both safe and simple. Details are given here for the Radio Shack TRS-80 computer, but the modification can be applied to many other makes.

Circuit Operation. Most computer keyboards employ normally-open spst keyswitches wired with keyboard characters assigned to row and column lines of a matrix. As shown in the diagram, the TRS-80 keyboard is arranged as an 8 ×8 matrix. The eight D0 through D7 column lines connect to column line output buffers (not shown) that, in turn, connect to the data bus. The eight A0 through A7 row lines are driven by row-line buffers connected to the address bus. Each intersection of the matrix has an spst keyswitch, as shown for column lines D0 and D7. When the A key is pressed, row line A0 and column line D1 are connected to each other to generate an output on column line D1 and the appearance of character A on the monitor screen.

To add a remote keypad or a full keyboard in tandem, you merely carry out the required row and column lines to the switches of the remote keyboard. Just how the computer encodes key closure is not material. In the TRS-80, encoding of the keyboard is accomplished with a program in ROM. (See the TRS-80 Microcomputer Technical Reference Manual for details.) Many computers employ a chip encoded keyboard.

The only consideration to be taken into account when connecting a tandem keyboard into an existing microcomputer system is whether cable capacitance and stray pickup will affect computer operation. Fortunately, almost any keyboard can tolerate several feet of connecting cable to the tandem keyboard.

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Before you install the connecting socket on the computer, make temporary connections to a row and column line to determine whether this method is suitable for your keyboard. Once you have determined that your computer can, indeed, tolerate a tandem keyboard, you can proceed to modify it.

Cable Connections. Open the TRS-80's cabinet, following instructions detailed in the Technical Reference Manual. Carefully raise the keyboard to avoid any strain on the short ribbon cable that connects the two boards. Pull off the board spacers and set the keyboard on its keytops in front of the cabinet with the main circuit board riding loosely in the bottom half of the cabinet. Although the CPU and several other MOS devices wired into the circuit are largely protected from static discharge, it still pays to observe standard handling precautions when working with MOS circuits.

Locate the eight column line resistors, which are clearly identified on the keyboard. Mark the solder pad at the lower end of each resistor with its associated column line. You may or may not be able to locate row lines at row-line buffers because some buffers were interchanged in some keyboard models. A better approach would be to identify row lines directly at the key terminals.

For the TRS-80, touch the negative (COM) lead of an ohmmeter set to a medium range, to limit current, to column line D1 at the lower end of resistor *R5* and the other test lead to either terminal of keyswitch A (see board labelling). If you obtain a zero resistance reading, the remaining terminal is row line A0; but if resistance is infinite, the terminal being tested is row line A0. Label the solder pad as A0. Similarly, select other keys and locate all row lines. Keyboard ground is line 19 on the board's interconnect cable. Line 1 is at the extreme edge of the keyboard. Trace ground to a convenient solder pad location.

Decide how you wish to route a cable from the computer's or terminal's cabinet. There is ample unused space at the edges of the keyboard in the TRS-80 for installation of an internal disconnect. For a clean cable exit away from heat sinks and main-board adjustment pots, locate the disconnect at the front edge and pass the cable through the front.

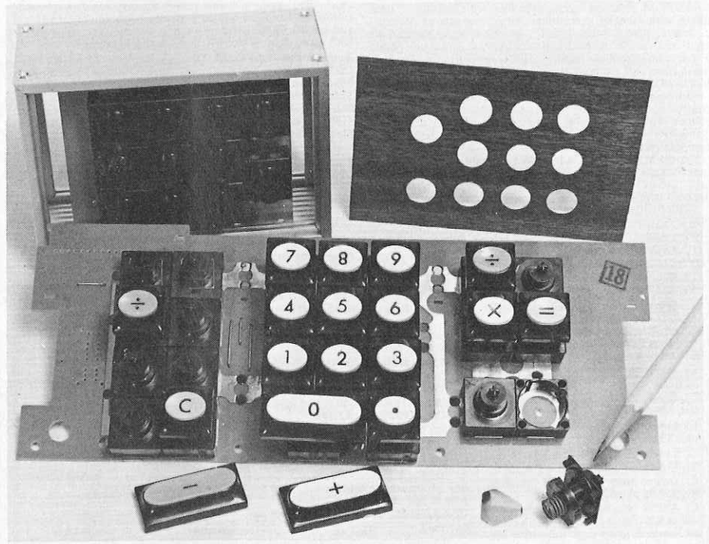
A 16-pin DIP socket that mates with a DIP patchcord is very easy to install. When not in use, the exposed male pins at the other end of the patchcord can be protected with a DIP socket. Less easily installed is a male IDC (insulation displacement connector) made up of Wire Wrap posts inserted on the keyboard to allow use of female IDC patchcords. Also, IDC cables are more rugged, easy to assemble and patch end-to-end with homemade adapters.

Cover the main circuit board to exclude debris and solder splatter. With a wood-block backup, drill the keyboard to accept the 16-pin socket, using p-pattern board retained with double-stick tape as a drilling template. For the male IDC, drill 0.042″ (1.1-mm) holes to accept 20 Vector No. T46-5-9 wrap posts. For front exit, position the disconnect as far from the edge as possible, but do not drill into board traces! Normally, the male IDC is formed using the No. MB45-20 perforated alignment block to back up the board and maintain the installed pins perpendicular. However, to use this block, you must remove both boards from the cabinet to obtain clearance. Lacking the alignment block, use a hardwood block for board backup, keeping it very close to the pin. If you remove the main board from the cabinet, do not disturb trimpots on it.

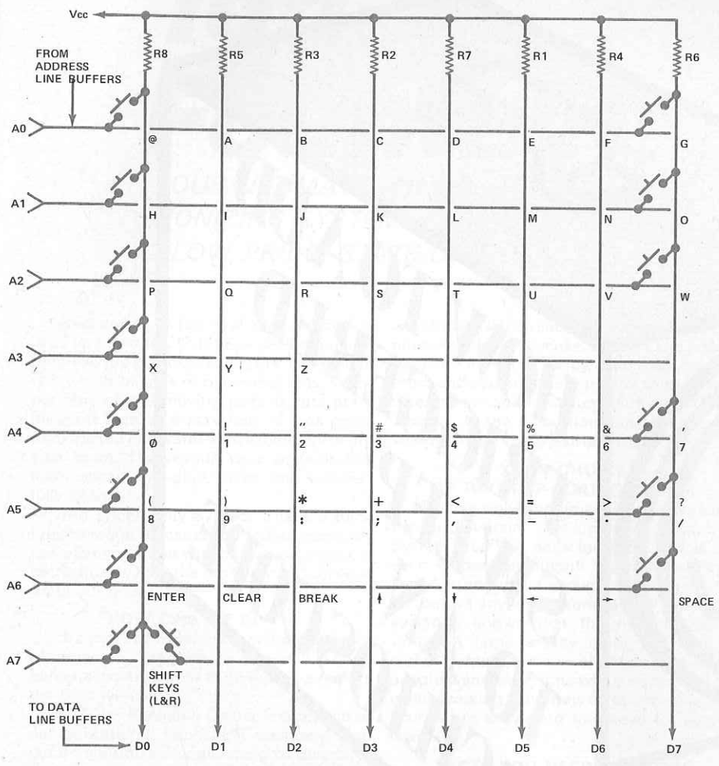
Use a Vector No. P205 board-pin insertion tool to install No. T46-5-9 wrap posts for the male IDC. This tool eases installation of pins with cross bars in alignment as required to accept a female IDC plug. Lacking this tool, overdrill board holes slightly to ease pin insertion and install using longnose pliers. Wire the connections to the marked row and column lines. Use the four extra wires on the 20-conductor IDC cable as a ground screen. Assign the outermost and two intermediate conductors to ground. Check soldered connections for presence of solder splatter and excessive solder. Install the keyboard into the cabinet and straighten any misaligned wrap posts on the top with longnose pliers.

Install a 12″ (305-mm) cable for front exit. Fabricate the IDC cable using Vector No. KS2-20 20-pin female IDC plugs and mating cable No. KW2-20-10. Press the IDC plug onto the end of the cable using a smooth-acting vise or use the P187 IDC fixture. For a longer cable run, make a second 24″ (610-mm) cable and fabricate a male IDC adaptor to join IDC cables end to end. Cut the top half or long end of the No. T46-5-9 wrap post down to 1/4″ (6.4 mm), round off the burr and install posts on a small piece of perforated board. Note: you can face IDC plugs the same way or one up and one down on a cable. If you use a cable-splice adaptor in lieu of changing the entire cable, you must use the adaptor in every setup because cable line transpositions occur at the splice.

Keyboard Assembly. Inexpensive surplus desktop calculator keyboards as shown in the photos are suitable for tandem hookups and require only slight alterations. The key bodies are thermally staked to the phenolic board, and one terminal of each switch is available on the bottom. A top-side circuit made up of thin brass stampings serves as switch contacts and interconnecting lines to form key strings that have a common connection. The top portion of each switch is removable to reveal the working parts and snap-action disc.



Desktop calculator keyboard can be cut apart to make smaller keypads. The pencil at right points to removed top part of keyswitch. Topside brass stampings form part of switch and key strings.



Schematic shows 8 × 8 matrix layout of the TRS-80 keyboard, which is typical of boards of this type. A keyswitch is located at each intersection of the matrix to generate an output for a specific character.

Let us implement a numeric keypad for the TRS-80. From the keyboard matrix diagram, keys 0 through 7 require a 1 × 7 matrix or key string, with the common side of the switches connected to row line A4 and the isolated side of the switches connected to the column lines. Keys 8, 9, and decimal point require a 1 × 3 key string, with the common side of the switches connected to row line A4 and the isolated side of the switches connected to the column lines. Keys 8, 9, and decimal point require a 1 × 3 key string, with the common side of the switches connected to row line A5 and remaining switch terminals connected to column lines D0, D1, and D6. The numeric set of this keyboard was a 1 × 10 key string, with keys 8, 9, and decimal point at one end of the string.

To separate the required 1 × 3 key string, cut off four plastic nubs on the bottom and remove the number 7 key body. Use a fine-toothed, broken-off hacksaw blade to cut the metal band alongside key 8 and remove the top part of the switch body. Sparingly, apply epoxy cement to the plastic pegs of the key body and install using a clamp for a tight fit. Clean switch parts with alcohol and reassemble the switch.

Trim and install the keypad in a small case. The numeric keypad shown is housed in a Vector No. W20-46-31B Multi-Mod case. The trimmed keypad slides into case-card grooves. Punch holes in the panel using a Greenlee chassis punch to pass the key shanks. Using the full keyboard, install in the Vector No. 51X-1 aluminum frame. Trim the keyboard to length to fit frame grooves and cut a top panel to size. Secure the keyboard to the punched panel using four machine screws and extra nuts for spacing. Finally, mark keyswitch terminals with the required row and column lines and wire to an IDC male connector or DIP socket. The aluminum frame accepts the M6088-3-1 perforated bottom plate; otherwise, cut a plate to size and install.

Assign extra keys to any desired matrix character or command. Six keys already wired in a 1 x 6 key string provide hex letters A through F. With some trace cutting, remaining keys can be assigned to the TRS-80 T-Bug monitor commands. Two keys on this keyboard were latching on/off switches. We removed the top part and snap disk from two switches of a spare keyboard and installed them in the on/off switch bodies. Then we relabelled keytops.

Keyswitches on a full typewriter keyboard are usually fully isolated, normally-open spst types, but check before you buy. The surplus typewriter keyboard may differ in some respects and may contain extra keys and keytop label variations. With some relabelling of keys, these make excellent tandem keyboards that allow a student and instructor to operate the same computer from different locations.

The possibility of connecting several additional keyboards in tandem may occur to some readers. However, you cannot run long lengths of ribbon cable with wild abandon. Our tandem keyboard was tested using 10′ (about 3 meters) of KW2-20 ribbon cable with four lines assigned as a ground screen. This is not good practice because the lengthy cable is not adequately buffered and is not fully ground-planed. Also, its lines are not terminated. The TRS-80 performed satisfactorily but in all likelihood with a reduction in noise margin. It is recommended that cable length be limited to 4′ or 5′ (1.2 to 1.5 m) and no more than required in any case.

Conclusion. From the foregoing, you can readily see that adding a keyboard in tandem with one in an existing computer system or terminal is a relatively simple matter. Although we used a Radio Shack TRS-80 computer to demonstrate how to perform the modification, the procedure is readily adaptable to most other types of personal computer systems. ◇