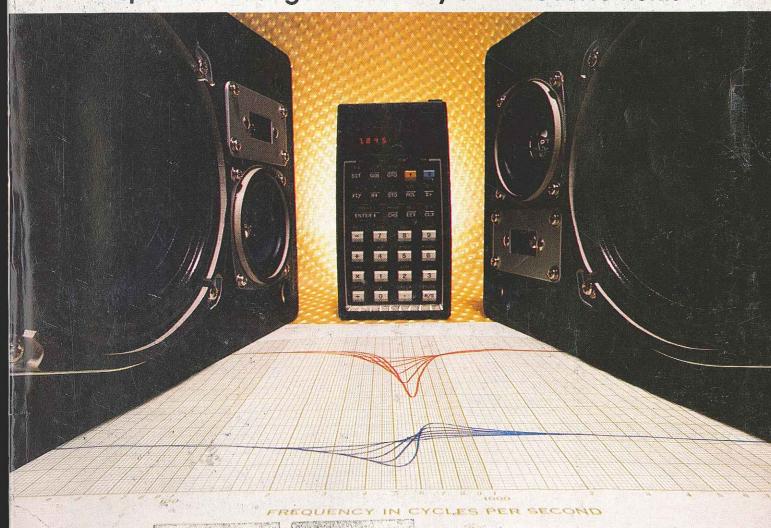
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Extra Keyboards for Microcomputers Build a Vocal "Truth" Analyzer Adding Triggered Sweep to a Scope

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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.

N 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 com-

puter, 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 AO through A7 row lines are driven by rowline buffers connected to the address bus. Each intersection of the matrix has an spst keyswitch, as shown for column lines DO and D7. When the A key is pressed, row line AO 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 moni-

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.

(continued on page 58)

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PC Board: glass epoxy, plated through holes with solder mask

1/0: provisions for 25-pin (DR25) connector for terminal

(DB25) connector for term Level "A" at \$129.95 is a serial I/O, which can also sup-

complete operating system, port a paper tape reader perfect for beginners, hob. ... provision for 24-pin DIP biests, or industrial constroller use. play... cassette tape recorder in put... cassette tape recorder output... speaker output... LED output indicator on SOD output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • Crystal Frequency: 6.144 MHz • Control Switches: reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • Counter/Timer: programmable, 14-bit binary • System RAM: 256 bytes located at F800, ideal for counter for the control of the counter for the counte smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or

K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F0000 leaving 00000 free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling ...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address...move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ... automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that mor

mmunicate with I/O ports.

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Level "C" (S-100 6-card expander)
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registers...single step with register display at each break point ...go to execution address, Level "A" in the Hex Version makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Hex Keypad/Display

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Level"B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks. ... address decoding for onboard 8k EPROM expansion selectable in 8k blocks... address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt



Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and Explorer/85 with I el "C" card cage. cards are neatly contained inside Explorer's deluxe steel cabinet

Level "C" Specifications

Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 00000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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Computer

By Netronics

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display for-

either a 64 of 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTV load, and the ability to mate directly with alpost any computer, including these wares.

directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

The Computer Terminal requires no I/O mapping and included the formula of the computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key roll processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the micro-rocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial 1/O

on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the scree

Video Output: 1.5 P/P into 75 ohm (EIA RS-170) • Baud Rate: *110 and 300 ASCII * Outputs: RS232-C or 20 ma. current loop • ASCII Character Set: 128 printable characters—

a	ΥδεθιλμναΣφφοΩο123⁰²±÷≈[][+	44
	"#\$%&'()++,/0123456789;;<=	>?
G	BCDEFGHIJKLINOPQRSTUWKYZ[\]	^_
1	bcdefghijklmnopqrstuvuxyz{!	/~
T .	UP OF GI	

BAUDOT Character Set; ABCDEFGHIJKLMNOPQ RSTUVWXYZ-?:*3\$#().,9014!57;2/68* Cursor Modes: Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing • Cursor Control: Erase, End of Line, Erase of Screen, Form Feed, Delete • Monitor Operation: 50 or 60Hz (jumper

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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 AO; but if resistance is infinite, the terminal being tested is row line AO. Label the solder pad as AO. 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.

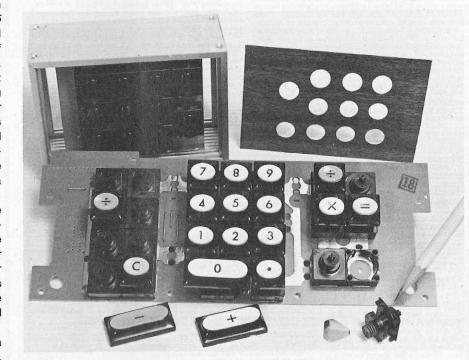
Cover the main circuit board to exclude debris and solder splatter. With a wood-block backup, drill the keyboard to accept the 16-pin socket, using ppattern board retained with double-stick tape as a drilling template. For the male IDC. drill 0.042" (1.1-mm) holes to accept 20 Vector No. T46-5-9 wrap 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 cablesplice 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 tan-



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.

dem 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.

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 switches connected to the switches connected to the column lines. Keys 8, 9, and decimal point require a 1×3 key string, with the APRIL 1980

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, normallyopen 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.