A keyboard for your data terminal

In this article, the author describes how to add a keyboard and encoder, a 20mA serial interface, a VHF modulator and a power supply to the video display unit described in the February 1978 issue. Details are given showing how to use it as either a TV typewriter or a microprocessor-compatible video data terminal.

by DAVID EDWARDS

The video display unit PCB assembly described in the February issue accepts a 7 bit parallel ASCII coded digital word, and converts it into a standard video signal, suitable for displaying on a video monitor or surplus TV receiver. In order to use this assembly as either a TV typewriter or a data terminal, it is necessary to provide a keyboard and the appropriate encoder.

If you want to use a standard unmodified TV set for the display, a VHF modulator is also required. Similarly, a parallel-to-serial and serial-to-parallel converter is required for use with a microprocessor, so that signals can be passed to and from the VDU in standard 20mA loop format. This latter feature is not required for the TV typewriter.

The final requirements are a suitable power supply, and a case in which to enclose the separate assemblies. All of these additional requirements are described in this article.

The VHF modulator we have used is based on the modulator used for the video ball game described in the May 1976 issue. It is a self contained assembly, and will be described fully later in the article. All the remaining circuitry is accommodated on a single PCB, coded 78ut4, and measuring 121 x 132mm.

Referring now to the circuit diagram, we can discuss the various sections of the circuit.

The keyboard encoder is based on a National Semiconductor MOS LSI device, the MM5740AAF. This is a scanning type encoder, capable of dealing with up to 90 keyswitches arranged in an X-Y matrix. It provides for 7-bit ASCII encoding, with automatic code changing for shift and control modes.

The MM5740AAF scans all the keyswitches at a high rate, and when a key is depressed, it generates the appropriate code and makes it available at the data outputs, B1 to B7. At the same time a data strobe pulse is generated at the DS output, to indicate that a key has been pressed.

Two clock signals are required for the encoder, one a nominal 100kHz signal to drive the keyboard scanner, and the other a nominal 10Hz signal to implement the keyboard "repeat" function. These can both be derived from the main VDU board, thus saving the cost of two 555 oscillators as used in our previous VDU design (February 1977).

The outputs from the encoder use active-low logic levels, and thus require inversion using 7404 hex inverters. The inverter outputs are connected to the parallel inputs of the transmit section of the universal asynchronous receiver transmitter (UART), which then transmits them in serial form.

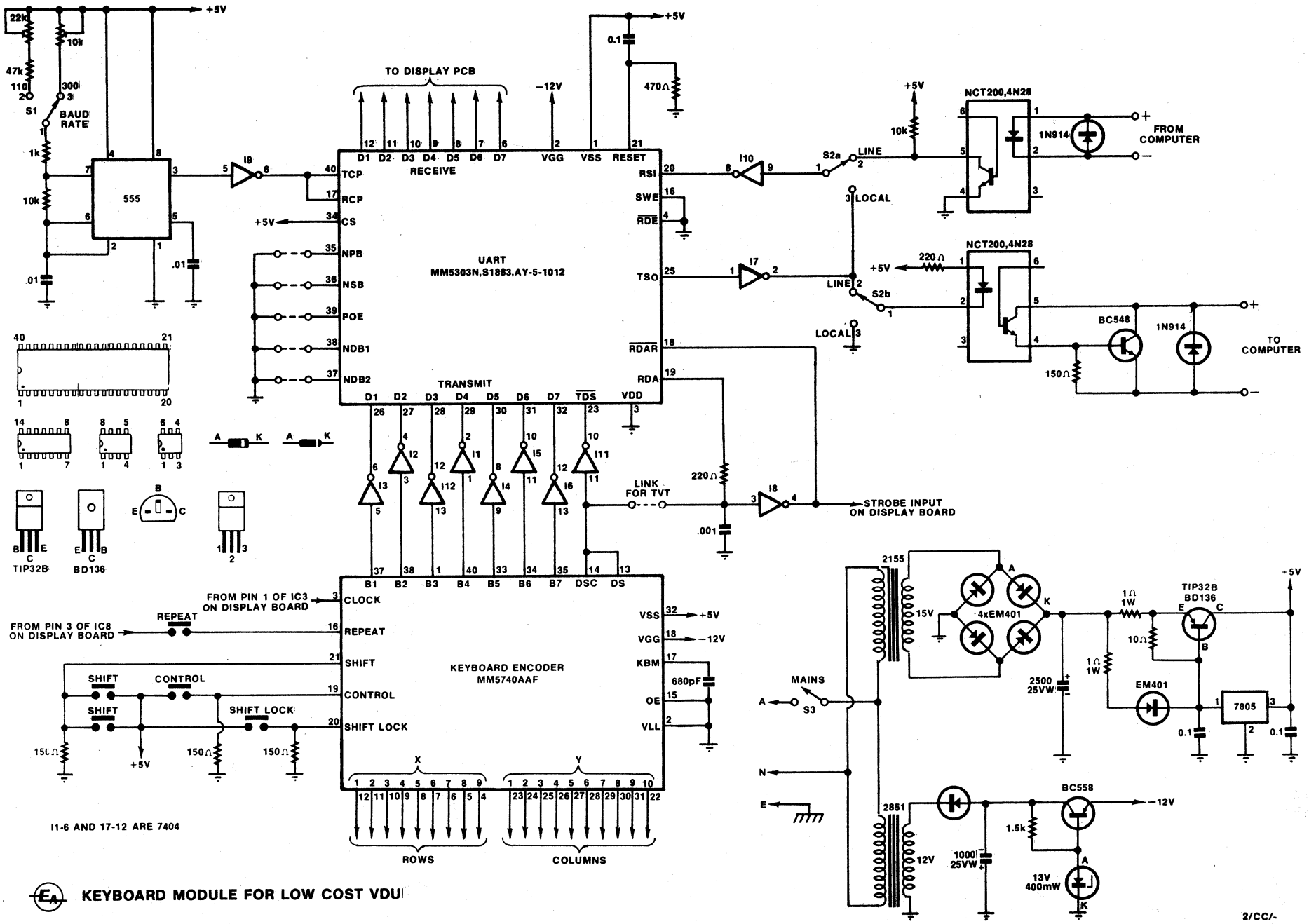
A 555 timer is used to generate the clock signals required by the UART. It is switch selectable for either a 110 or 300 baud communication rate, the two speeds being adjusted by preset pots.

Two optocouplers are used to buffer the serial input and output of the UART, to allow full isolation of the terminal from whatever system it is used with. The circuit used with the optocouplers is intended for use with 20mA current loops.

The receiver side of the UART is used to convert the serial signal returning to the terminal into the parallel signals required by the VDU board (D1 — D7). The receive data available (RDA) signal

LEFT: The way in which a small TV set sits on top of the chassis can be seen in this photograph.

On the page opposite is the circuit diagram for the keyboard encoder and the serial to parallel interface.



KEYBOARD MODULE FOR LOW COST VDU

from the UART is inverted and used to drive the strobe line of the VDU board.

Switching has been provided to enable the terminal unit to operate in either a "local" mode or a "line" mode. In the local mode, the serial output of the UART is connected directly to the serial input, allowing the unit to be used as a TV typewriter.

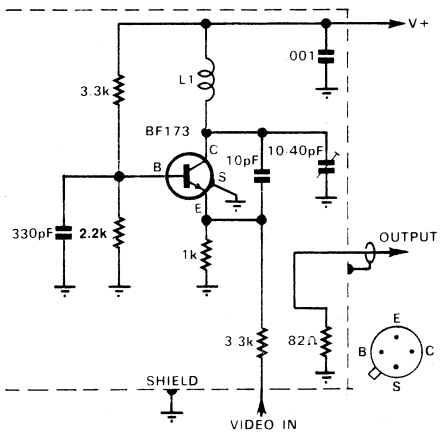
If the unit is to be used as a TV typewriter only, it is possible to dispense with the UART and its associated components. Only the keyboard encoder, the two hex inverters and the power supply components are required.

The power supply circuit is a little unusual. A total of 1.5A at 5V is required for the VDU board and the interface board, along with a —12V substrate bias supply. Two commonly available transformers are used rather than a single larger, and more expensive, unit.

The —12V supply is generated from a 2851 type transformer, with a simple active regulator to stabilise and regulate the output. The 5V supply uses a 2155 type transformer, with the regulation achieved by a three terminal IC regulator aided by a pass transistor.

With adequate heatsinking, this regulator is capable of supplying currents of up to 2A, but is limited in the present case by the transformer to just over 1.5A.

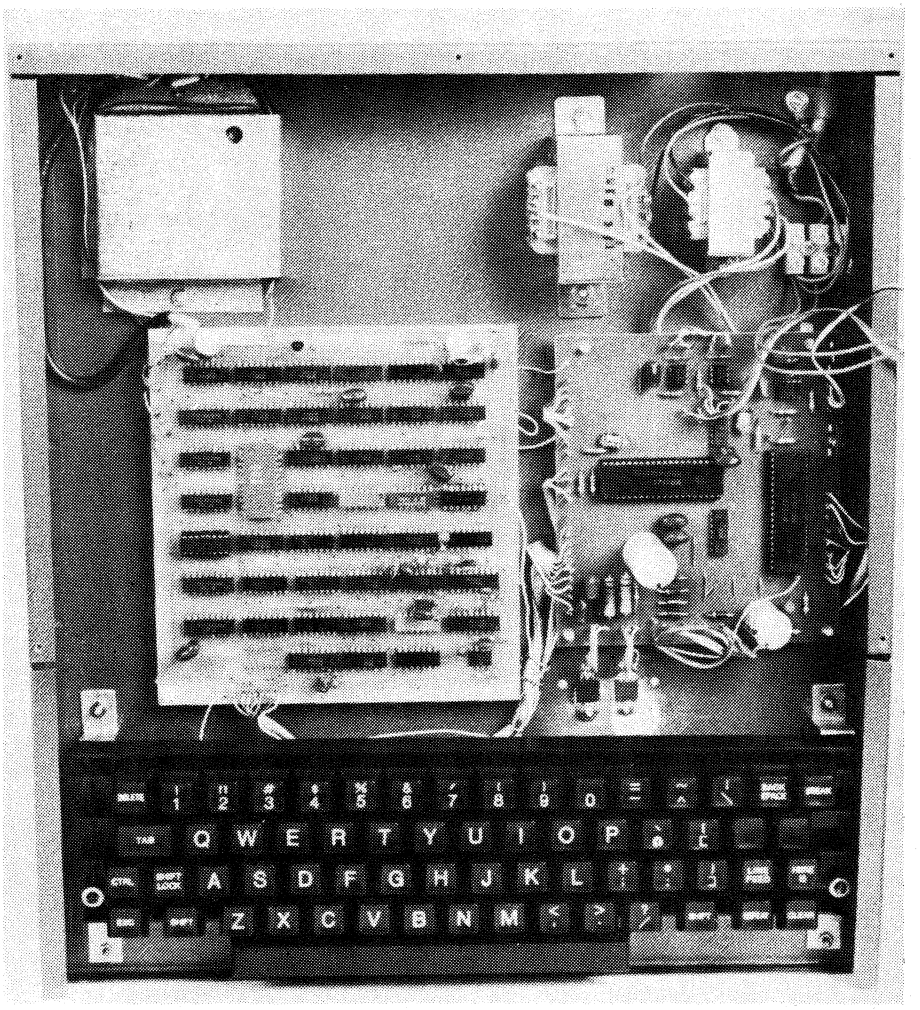
As stated earlier, the modulator used is based on one of our previous designs, and uses the same PCB. This is coded 76m5. All components are soldered to the copper side of the PCB, which is then bolted directly to the bottom of the case. A small tinplate shield is then fitted over the complete assembly, to minimise spurious radiation.



L1 10T. 22 B & S ENAMELLED COPPER WIRE. 3mm DIAMETER. SEE TEXT.

EA VIDEO MODULATOR

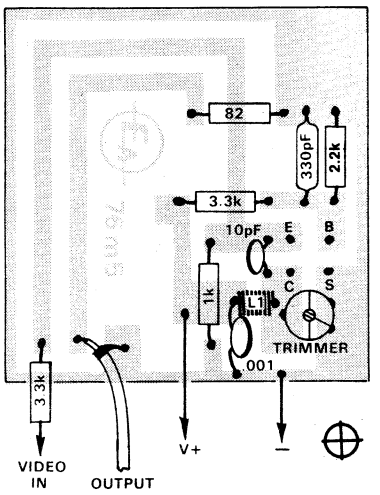
ABOVE and RIGHT: The modulator circuit diagram and overlay diagram. Note the transistor orientation.



This view shows how the keytops are arranged, and the internal layout of the unit. Note the modulator shield.

As can be seen from the photographs, the construction of the prototype is based on the metalwork and associated components used in our first video terminal, presented in the January and February 1977 issues.

The prototype case was kindly supplied by Cowper Sheetmetal and Engineering, of 11 Cowper Street, Granville, NSW 2142. It measures 360mm x 400mm 60mm, and has a sloping front with a cutout to match commonly available keyboards. The case is designed to allow a small portable TV or monitor to be placed on top, to form a complete video terminal.



The keyboard used in the prototype was supplied by Dick Smith Electronics Pty Ltd, and features gold plated contacts. It has most of the keytops required, apart from "carriage return". However two blank keytops are present, one of which can be pressed into service.

Commence construction by fitting the hardware to the case, using the photographs as a guide. The keyboard is mounted on two brackets, and should be fitted carefully so that all keys clear the cover cutout. Note that it may be necessary to extend the cutout slightly in the top right hand corner.

The two main PCBs are mounted on standoffs, immediately behind the keyboard. The transformers are mounted in the rear right hand corner, along with the associated mains wiring. The three miniature toggle switches are mounted on the lid of the case, just above the right hand side of the keyboard.

The modular PCB mounts in the rear left hand corner, near the two coaxial

connectors. It is bolted to the case using a single machine screw and nut, which must pass through the earthy pattern.

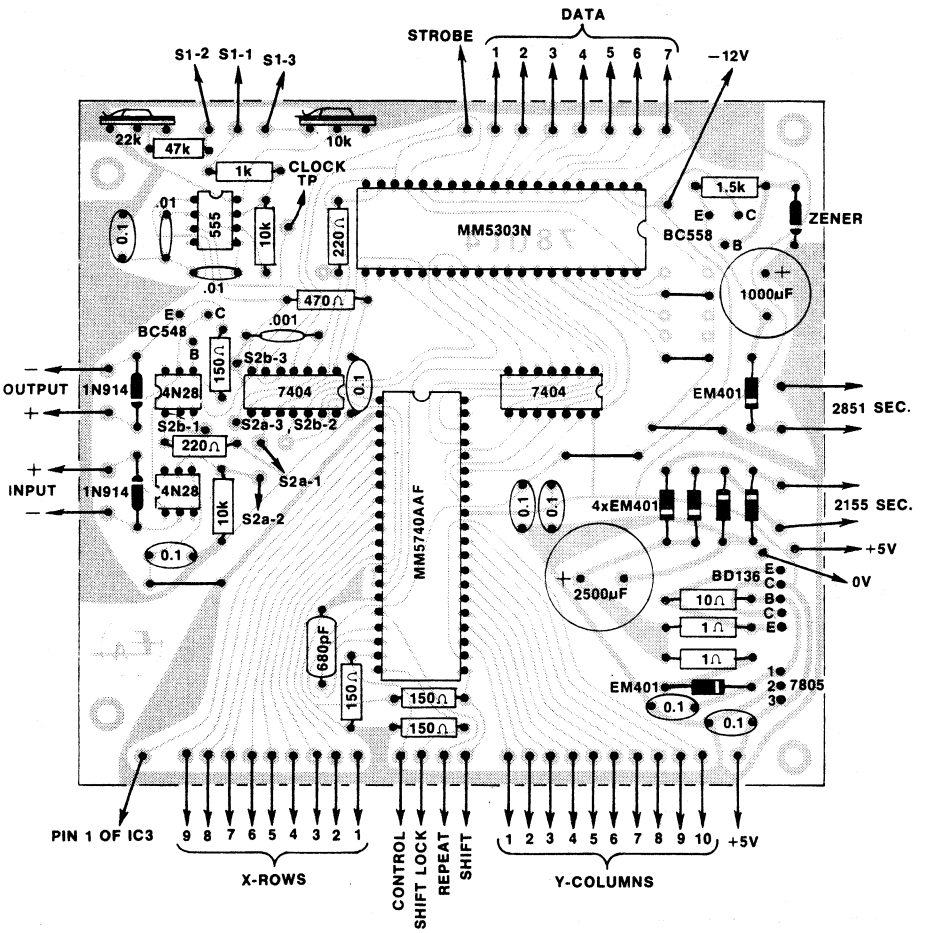
Once all the hardware is complete, the PCBs can be assembled. If you use sockets for the two 40 pin devices on the keyboard PCB, make sure they are of good quality. Sockets should not be necessary for the TTL ICs, the 555 or the optocouplers. We recommend that PCB pins be used for all external connections.

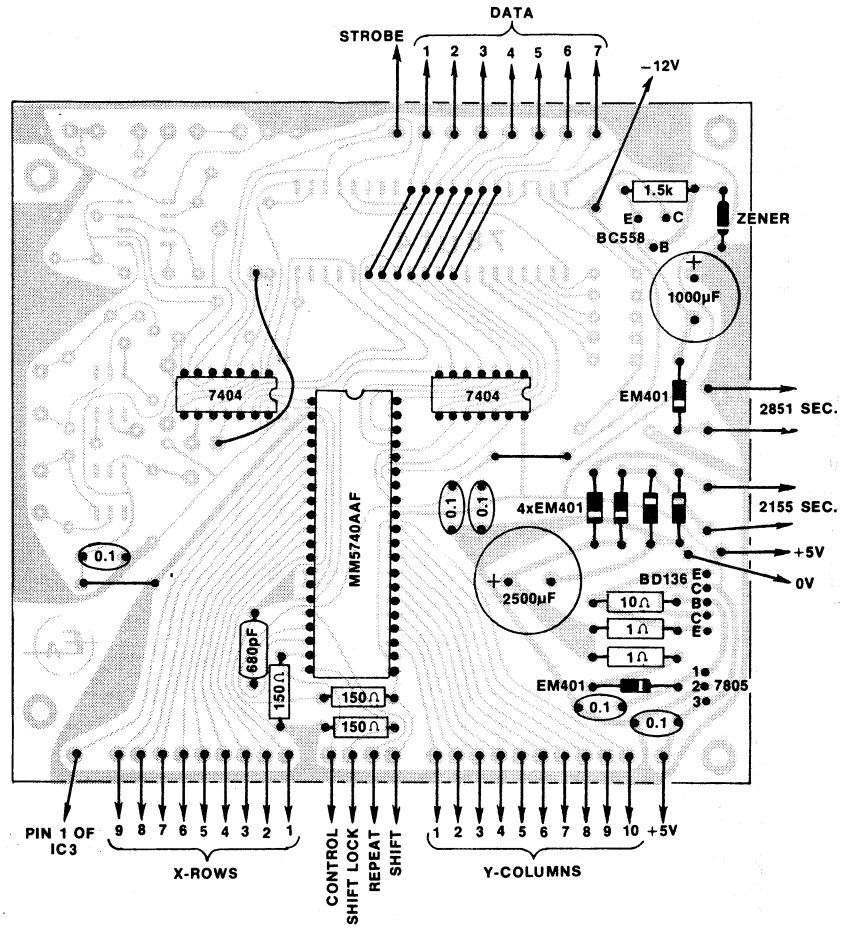
The three-terminal regulator and the pass transistor must be mounted on the base of the case, to provide adequate heatsinking. Use steel wool or emery paper to clean the paint off, to improve thermal conductivity, and use silicone grease if possible. The pass transistor must be insulated from the case, using the appropriate mica washer and insulated bush.

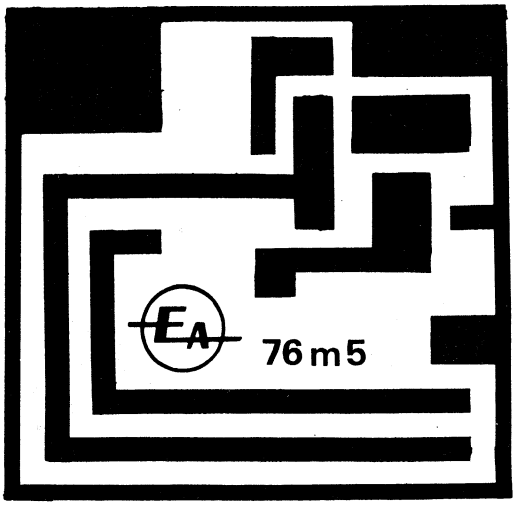
Note that the base connections of the two transistors specified are different. The BC136 mounts as shown in the overlay diagram, while the TIP32B mounts to the three lower holes of the group of five.

Before commencing to wire the keyboard, ensure that all the keytops are in the correct locations. Then wire the eight X rows and the 10 Y columns, using the keyboard wiring diagram as a guide. Use tinned copper wire, with insulation sleeves where crossovers are required. Use a small soldering iron, and do not heat the contacts unnecessarily, as the plastic of the switches may distort and upset the switching action.

ABOVE RIGHT: Use this overlay diagram if you are building the complete terminal.
RIGHT: Use this overlay for the TV typewriter-only version.
BELOW: This is the PCB pattern for the modulator, shown actual size.







ADDITIONAL PARTS REQUIRED FOR DATA TERMINAL

SEMICONDUCTORS
1 MM5303N, S1883, AY-5-1012 or similar UART
1 MM5740AAF keyboard encoder
2 7404 inverters
1 555 timer
2 4N28, NCT200, TIL114 or similar optocouplers
1 7805 5V three terminal regulator
1 BD136, TIP32B or similar PNP transistor
1 BC558 or similar PNP transistor
1 BC548 or similar NPN transistor
2 1N914 or similar silicon diodes
6 EM401 or similar silicon diodes
1 13V 400mW zener diode

RESISTORS
(all ¼W unless stated otherwise)
1 10k trimpot
1 22k trimpot
2 1 ohm 1W, 1 10 ohm, 4 150 ohm, 2 220 ohm, 1 470 ohm, 1 1k, 1 1.5k, 2 10k, 1 47k

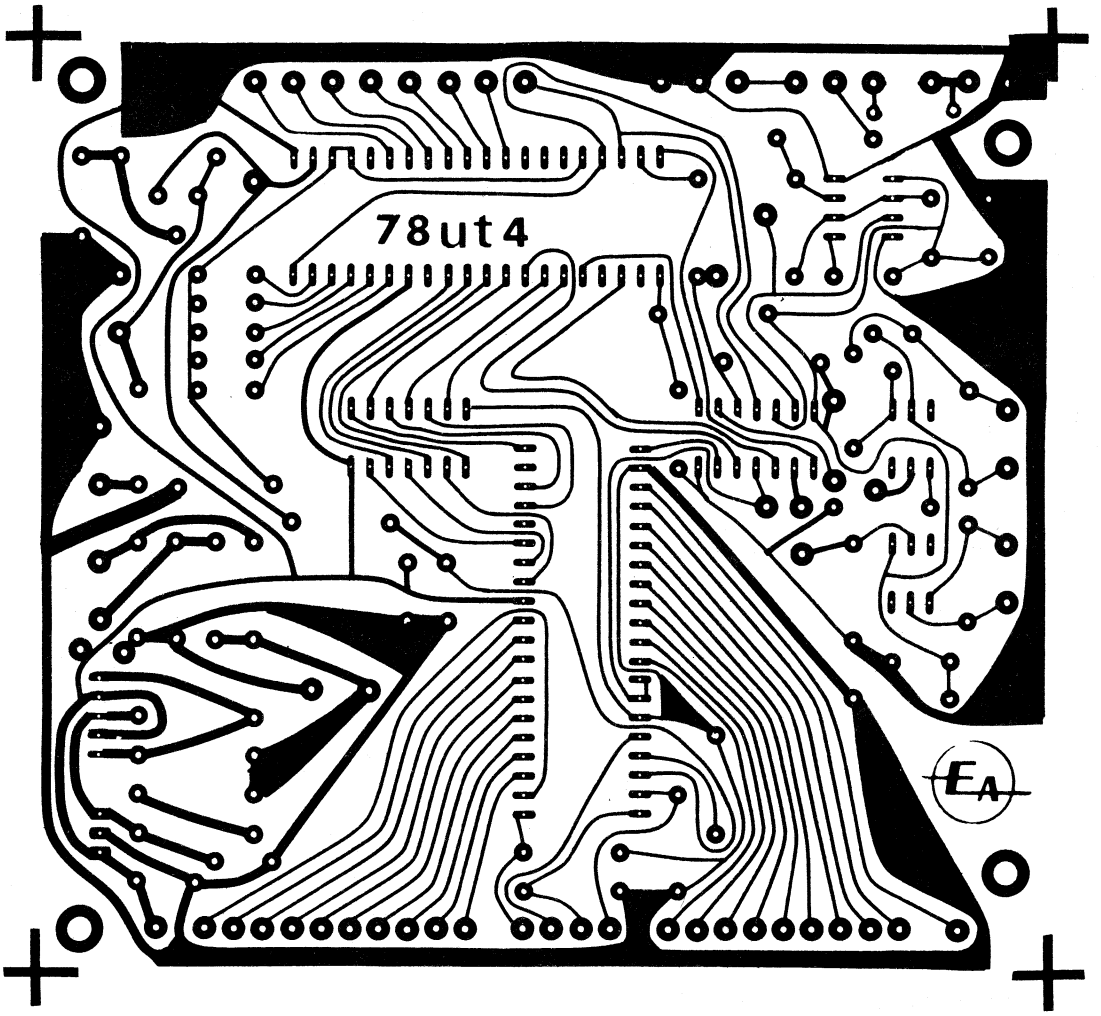
CAPACITORS
1 680pF polystyrene
1 0.001uF polyester
2 0.01uF polyester
7 0.1uF polyester
1 1000uF 25VW PCB electrolytic
1 2500uF 25VW PCB electrolytic

MISCELLANEOUS
1 printed circuit board, coded 78ut4, 121 x 132mm
1 ASCII-type keyboard assembly (see text)
1 Case, 400 x 360 x60 mm with sloping front (see text)
2 SPDT miniature toggle switches
1 DPDT miniature toggle switch
2 40 pin DIL sockets
2 Belling-Lee RF connectors
1 Output connector (see text)
1 Transformer, 240V to 15V @ 1A, DSE2155, A&R 2155 or similar
1 Transformer, 240V to 12V @ 150mA, DSE 2851, A&R 2851, PF 2851 or similar
8 PCB standoffs
4 rubber feet
1 Mains cord, 3 pin plug, grommett, cord clamp and terminal block Rainbow cable, tinned copper wire, shielded cable, hookup wire, solder, machine screws and nuts, insulated mounting kit for plastic power transistor, silicon grease (heat sink compound)

ADDITIONAL PARTS REQUIRED FOR MODULATOR
1 Printed circuit board, coded 76m5, 65 x 65mm
1 BF173 NPN transistor
1 82 ohm, 1 1k, 1 2.2k, 2 3.3k ¼W resistors
1 10pF NPO ceramic capacitor
1 0.001uF ceramic capacitor
1 10 — 40pF trimmer capacitor
1 330pF polystyrene or ceramic capacitor
1 tinplate shield (see text)
22 B & S enamelled copper wire

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used provided they are physically compatible.

BELOW: This is the PCB pattern for the encoder board, shown actual size.



DATA TERMINAL

Complete the connections to the encoder board using rainbow cable, being careful to connect the right pads to the right rows or columns.

The signal for the repeat key is obtained from IC8 on the display board. This is the 555 timer which determines the cursor flashing rate. In order to provide a more acceptable repeat rate, R12 can be reduced from 120k to 33k.

The clock input to the encoder IC is obtained from pin 1 of IC3 on the display board. Run a flying lead between the two boards.

Connect a shielded cable from the video output of the display board to the video output socket on the rear panel, and a second shielded cable from the modulator output to the remaining coaxial socket. The input to the modulator is taken directly from the collector of the video output transistor (T1) on the display board, via a 3.3k series resistor. Extend the resistor leads with tinned copper wire, so that they will reach the distance.

The remaining connections can all be made with rainbow cable. An eight way cable is required between the display board and the encoder board, as well as a three way cable for the power supplies.

Once construction is complete, the unit can be tested. Connect the modulator output to a standard TV set, and switch on. Adjust the trimmer capacitor so that a signal is obtained on a vacant channel. This adjustment is fairly coarse, and it may be necessary to adjust the fine tuning of the TV set.

Then adjust the trimmer capacitor on the display board, (if one is fitted), to obtain a steady display on the screen. You should not need to alter the horizontal and vertical hold controls, however the brightness and contrast may need to be adjusted to obtain the most readable picture.

At this stage the display should be filled with characters at random, with a flashing cursor on the bottom line. Operating the clear keyswitch should clear the screen, and a carriage return should return the cursor to the bottom left hand corner. Note that these tests should be carried out in the "local" position.

Now exercise the keyboard, and check that all keys function correctly. Any errors will most likely be due to incorrect wiring of the keyboard, or a transposition error in the cable leading to the keyboard or the cable between the encoder board and the display board.

In order to set the baud rates to the correct values, you will need either a frequency counter or a correctly operating microprocessor system. If you have access to a frequency meter, set the clock frequency to 1760Hz for the 110 baud rate, and 4800Hz for the 300 baud rate.

If you only have access to a microprocessor system, switch to "line", and program it to send strings of characters. Then simply adjust the trimpot for the appropriate baud rate until the terminal correctly decodes the characters.

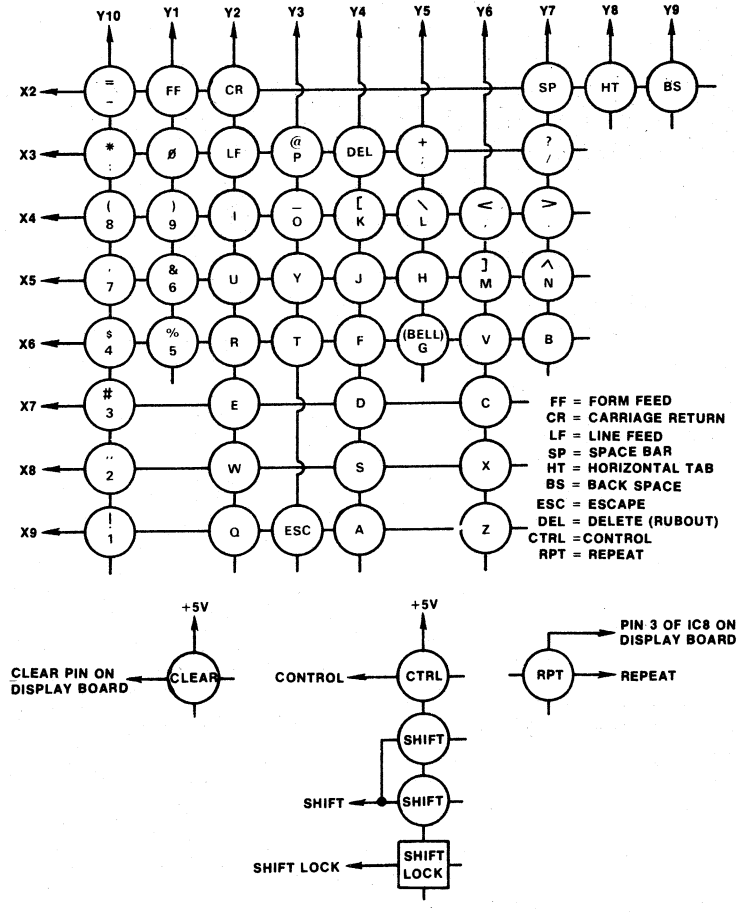
If you wish to use the unit only as a TV typewriter, wire in only those components shown on the appropriate overlay diagram. The only setting up adjustments required in this case will be the modulator frequency and the display unit clock frequency.

Finally, some comments concerning the video display board described in the February issue. In order to achieve fully reliable operation, several small component changes are required.

C10 should be increased in value to 470pF, while C12 should be reduced in value to 33pF. If modifying an existing board, it may be satisfactory to simply interchange C10 and C12.

A 0.001uF capacitor should be fitted between pin 2 of IC21 and pin 7 (earth) of IC21. This will remove small glitches from the output of the comparator IC37, which may cause faulty character deposits into the memory.

It may also be necessary to fit 0.001uF capacitors between pins 6 and 8 of IC15 and earth (pin 7 of IC15), to remove possible glitches at these points.



ABOVE: The keyboard wiring diagram. Check first that the keytops are correctly positioned.

BELOW: The modulator shield, which can be cut from a 116mm square piece of tinplate.