6809-BASED MICROCOMPUTER

Dave Rumball and Gary Mills conclude their description of the workings of the computer before going on to consider the choices facing constructors and the assembly of the two boards.

The real time clock, IC27, is a 146818. This part is designed for a multiplexed processor address/data bus, but here is used with a non-multiplexed processor by means of a separate address decode for the address and data strobes. The CE line is grounded by a transistor which is held on by the main +5V rail. When the system power fails, the chip is disabled in order to prevent corruption of the data. The clock has its own internal oscillator which is driven by a 32.768 kHz crystal to reduce power consumption. Power for the clock is provided by a trickle-charged NiCad battery when the main power is off.

The 146818 also contains 64 bytes of CMOS RAM which are used to hold various system parameters, such as the serial baud rates, video timing parameters etc. An RC network on the PS input gives an indication of battery failure. The software checks for this condition on power up and loads a default set of system parameters if the battery power has failed.

The Display Section

The display section consists of three parts, the NEC7220A graphics controller IC34, a 128K bank of DRAM, ICs47–62 (not part of the processor address space), and some control logic. The NEC7220A does 98% of the work in producing the video. It generates the correct display address for the RAM, master timing strobes for reading and writing to the RAM, and display blanking and synchrony signals. The sixteen bit display address is multiplexed onto the eight bit RAM address by

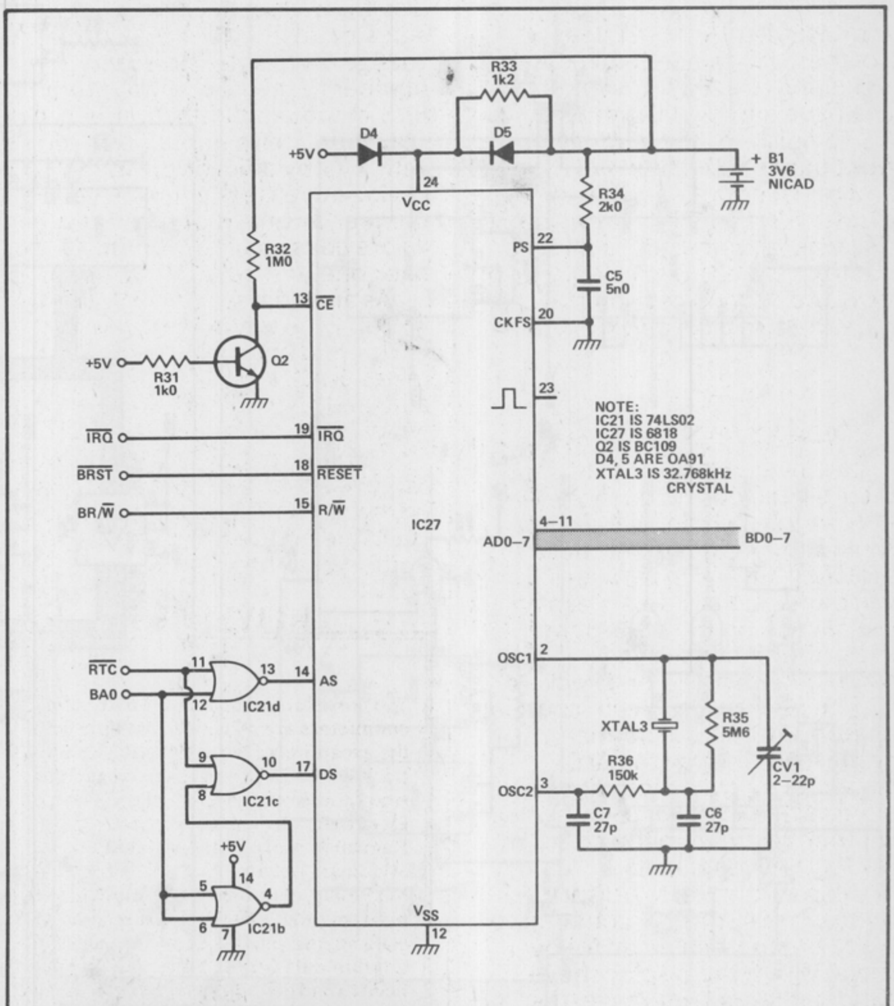


Fig. 1 Circuit diagram of the real time clock.

OOPS!

A capacitor should be added to the serial interface controller oscillator circuit shown in Fig. 4 on page 38 of last month's issue. The capacitor is C30, a 27p polystyrene type, and should be connected between pin 32 of IC20 and the 0V line. It has been included in the overlay diagram and the parts list in this article.

In Fig. 2 on page 37 of the January issue, XTAL1 is listed as a 10MHz crystal. It should be a 16.000MHz crystal, as stated in the parts list in this article.

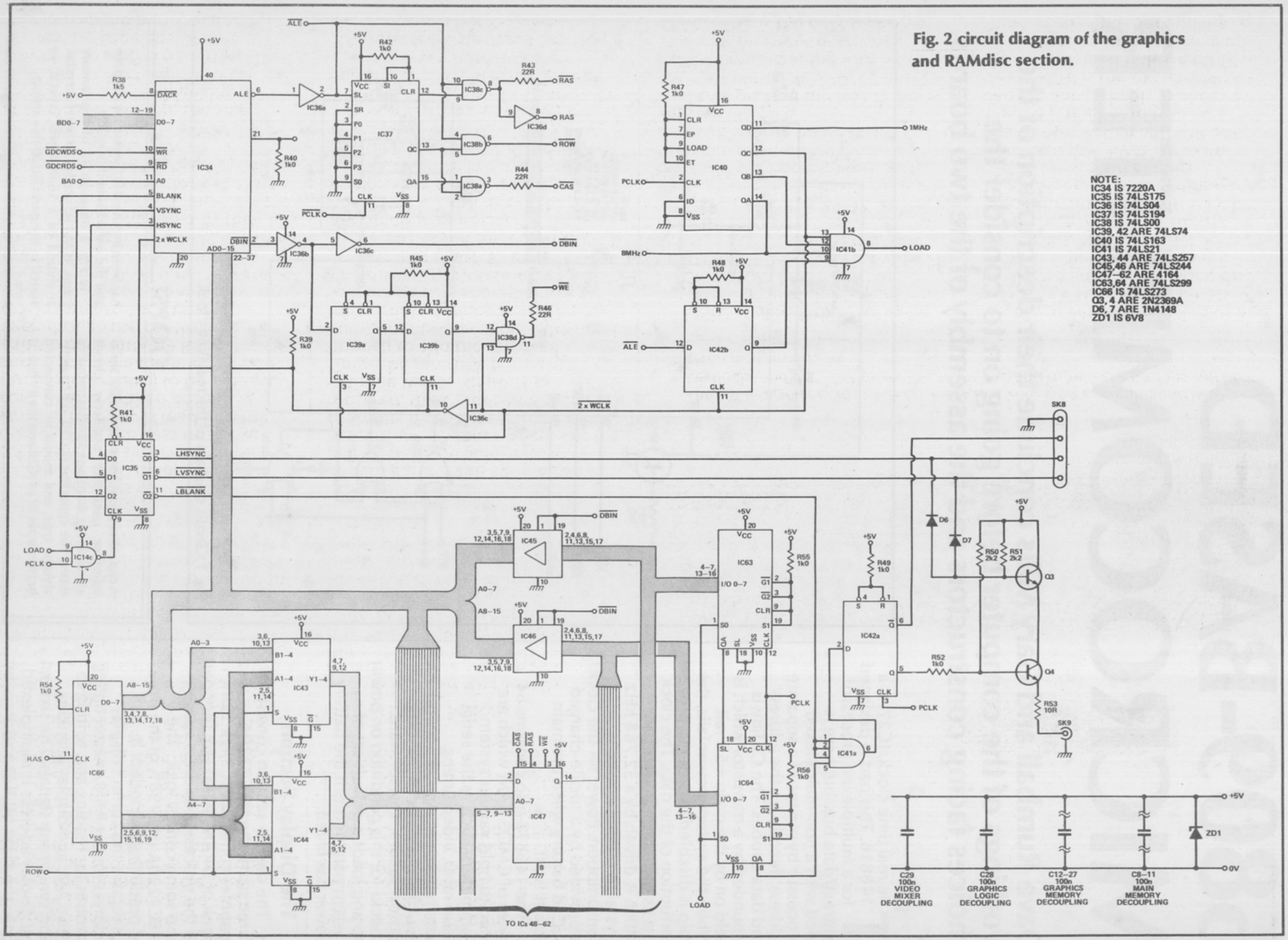


Fig. 2 circuit diagram of the graphics and RAMdisc section.

NOTE:
IC34 IS 7220A
IC35 IS 74LS175
IC36 IS 74LS04
IC37 IS 74LS194
IC38 IS 74LS00
IC39, 42 ARE 74LS74
IC40 IS 74LS163
IC41 IS 74LS21
IC43, 44 ARE 74LS257
IC45,46 ARE 74LS244
IC47–62 ARE 4164
IC63,64 ARE 74LS299
IC66 IS 74LS273
Q3, 4 ARE 2N2369A
D6, 7 ARE 1N4148
ZD1 IS 6V8

IC43 and IC44. IC66 latches the low order address lines so that they are stable during the later part of the memory cycle when the graphics controller is putting data onto the address/data bus.

The control strobes for the display DRAM are derived from the master timing signal ALE from the controller. This signal is clocked along a shift register by the pixel clock, to form a digital delay line. Various signals from the shift register are gated to provide the RAS and CAS strobes for the DRAM, and the row select signal for the multiplexer. The WE strobe for the DRAM is derived by delaying the DBIN signal from the graphics. The DBIN signal also gates read data from the DRAM to the controller data lines via tristate buffers IC45 and IC46. Note that the graphics controller data bus is sixteen bits wide.

The graphics controller draws by using a 'read-modify-write' cycle. First the draw address is output, then the data from that word of memory is read into the controller, modified according to the particular pixel to be plotted, and in the same memory cycle, written back into the RAM. Thus, even though the controller only draws one pixel at a time, it operates only on sixteen bit words. Every sixteen pixel times, data from the DRAMs is loaded into two shift registers IC63 and IC64. The load signal is produced by the counter IC40, which generates the graphics controller clock at 2MHz and an 8MHz clock used by the floppy disc controller.

The video data is clocked out at the pixel rate from the shift registers through a blanking gate IC41, and a latch which forces the blanking to a pixel boundary. The resulting video signal is then mixed with the horizontal and vertical syncs and converted to an impedance of 75 ohms by the video buffer. TTL level sync and video signals are also taken out for use with non-standard monitors. The graphics controller is only allowed to access the display memory during line and field blanking times, so there are no flashes on the screen during plotting.

System Choices

The basic kit supplied by Micro Concepts includes the main printed circuit board, the EPROM disc board, a programmed monitor EPROM (IC3), a diskette of system-related software and the necessary documentation. The remaining parts must be obtained from other sources by the constructor.

If cost is an important consideration, construction of certain parts of the system can be left for the time being and only the heart of the system assembled. For example, if serial interfacing is not required, the circuitry associated with the two serial ports can simply be omitted. It is easy enough to add the required components later should the need for a serial interface arise. The following notes should help you decide which components to include and which to omit.

Video output: the board will not function correctly if IC34 is not fitted, but the rest of the graphics circuitry is only required if a video monitor is to be used. If you plan to use the system with a terminal instead, ICs 35, 45, 46, 63, 64 and 47–62 can safely be omitted, along with SK8 and SK9 and the circuitry around Q3 and Q4. However, note that the RAMdisc facility will not function if the memory is not installed.

The 6809-based microcomputer fitted in a Vero case and equipped with a keyboard and 3.5" disc drive. Details of this and other case options will be given next month.

EPROM disc: if this facility is not needed, all of the components on the plug-in board can be omitted (ICs 29–33, RP3 and SK7) along with IC28 and SK6 on the main board.

Floppy disc: ICs 24–26, RP2, R27–30 and SK5 can be omitted if this facility is not required. Note that only the monitor mode is accessible if the board is run without discs.

Serial ports: if the RS232 ports are not needed, ICs 20, 22 and 23 can be omitted along with SK3 and SK4 and the circuitry around XTAL2. This is the only section of the board which uses the plus and minus 12V supplies so, unless these rails are required for a disc drive or other peripheral unit, dispensing with the serial ports will reduce the power supply requirements to a single +5V rail.

A number of other components can be omitted in certain circumstances. SW2 is the on-board reset switch and will only be needed if the board is to be used free-standing (that is, without a case). SK10 is the expansion bus socket and need only be fitted if the expansion bus is to be used. Some or all of the decoupling

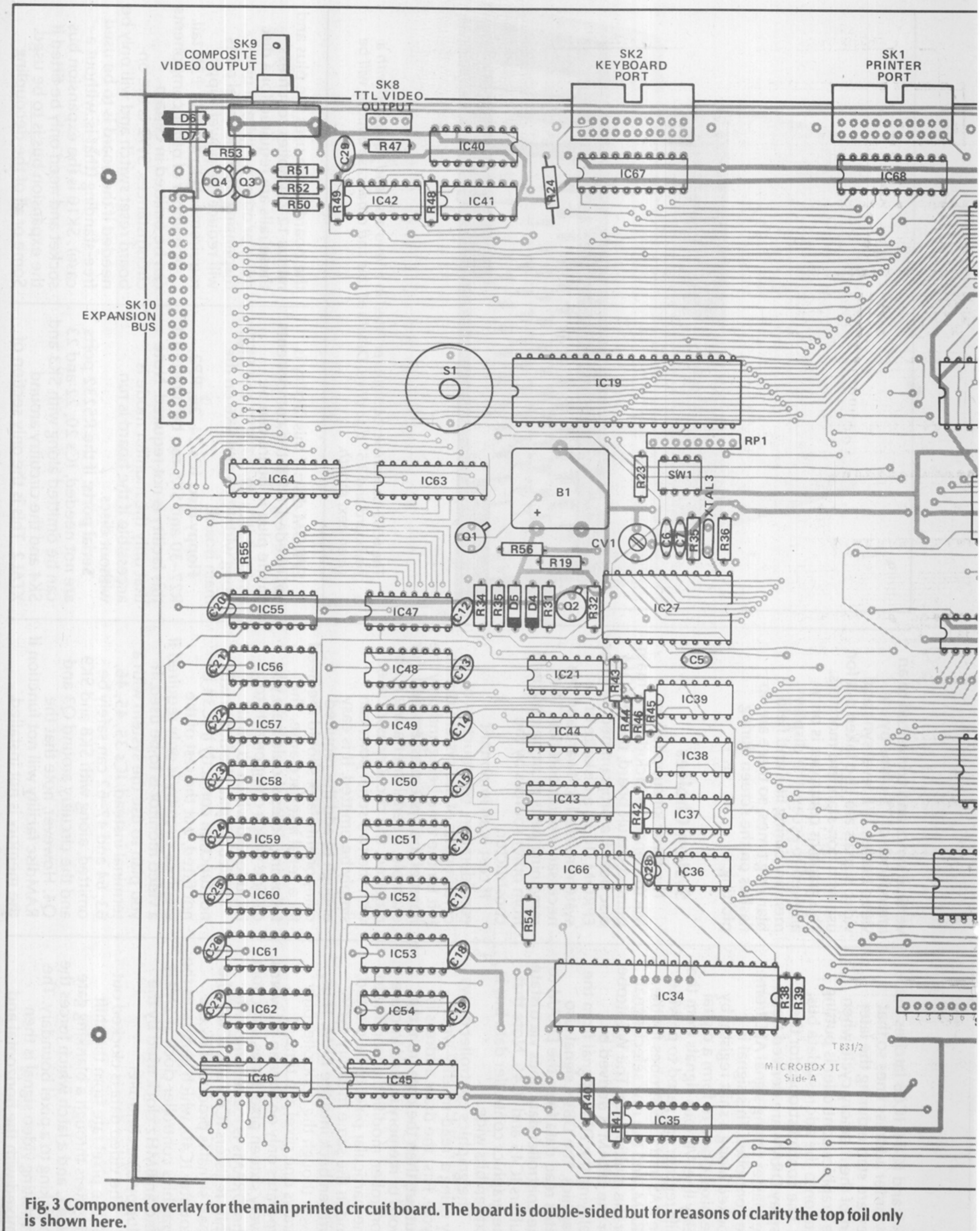
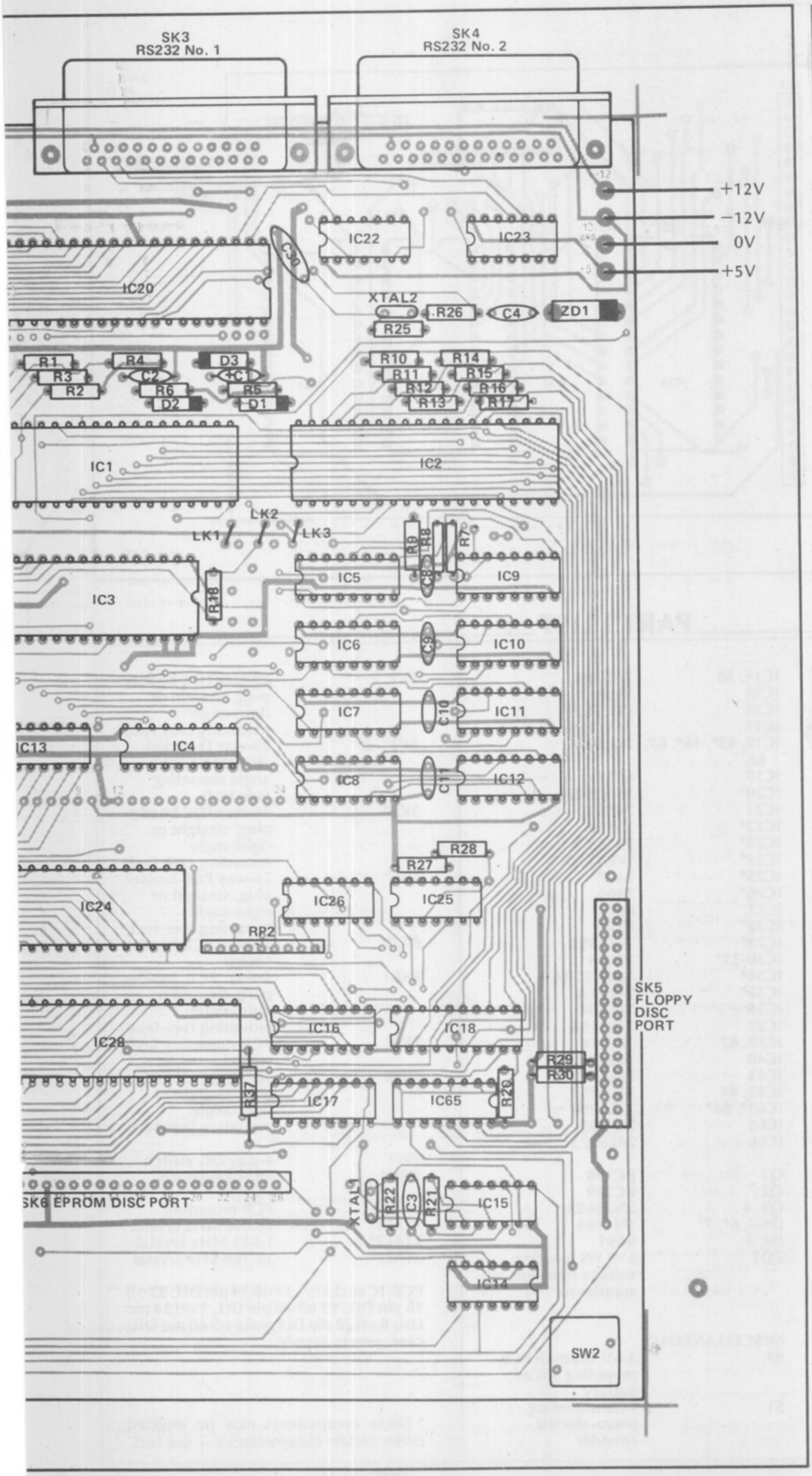


Fig. 3 Component overlay for the main printed circuit board. The board is double-sided but for reasons of clarity the top foil only is shown here.



capacitors around the graphics memory and logic (Cs 12–29) can be left off if this circuitry is to be omitted and of course, IC sockets will not be required for ICs which are not to be fitted.

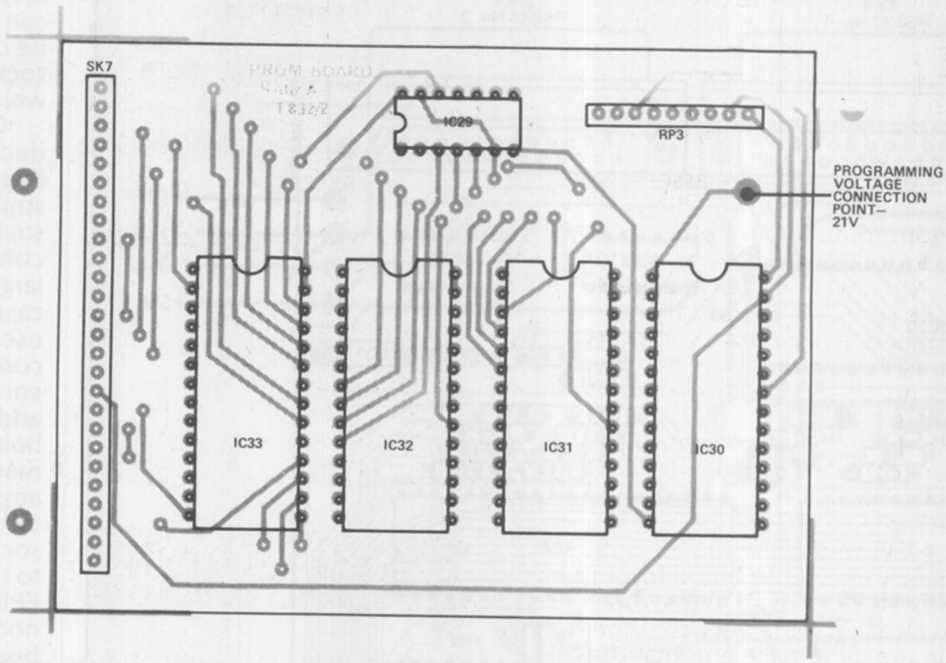
One more thing has to be decided before construction can begin, and that is whether to use straight or right-angled plugs and sockets for the various connections to the board. This will largely depend on the choice of case. Whatever size of case is used, it will probably be most convenient to use right-angle connectors at the rear of the board and poke them directly through holes in the back of the case. It may also be possible to use right-angle connectors for the floppy disc port and expansion bus socket and bring these out directly to the sides of the case. The EPROM disc socket, however, is not adjacent to the edge of the board, and it may be easier to use a straight connector here and punch a slot in the top of the case to provide access. Those who really want to keep costs to a minimum may decide to use the board without a case, thus removing all constraints on the angling of the connectors. One of the prototypes has been working perfectly in this way for some time now, fixed vertically to a wall above the workbench.

Construction

The boards supplied by Micro Concepts are electronically tested for shorted and broken tracks before despatch. However, given the complexity of the board, it is a good idea to examine it carefully against a strong light before starting since any errors which have slipped through will be much more difficult to identify once all the components are in place. It is also a good idea to check that the larger components fit comfortably into their holes. If necessary, the holes can be enlarged slightly with a drill, but bear in mind that this will remove the through-hole plating and make a note to solder carefully on both sides of the board at such points.

Begin by installing the IC sockets. Although most of the ICs have to be inserted with pin 1 towards the left-hand side of the board (the side on which the video outputs and the battery are located), a number of them face in

Fig. 4 Component overlay for the plug-in EPROM disc board. This board is also double-sided and again, only the upper foil is shown.



PARTS LIST

RESISTORS

R1-5	10k
R6	100k
R7-17, 43, 44, 46	22R
R18	68R
R19, 20, 23, 24, 26*, 31, 39-42, 45, 47-49, 52*, 54-56	1k0
R21, 22, 27-30*	330R
R25*, 32	1M0
R33	1k2
R34	2k0
R35	5M6
R36	150k
R37	3k9
R38	1k5
R50*, 51*	2k2
R53*	10R
RP1	10k x 7SIL resistor pack
RP2*	1k0 x 7 SIL resistor pack
RP3*	10k x 8 SIL resistor pack

CAPACITORS

C1	47u 6V tantalum
C2	100n 63V polyester
C3	10n polystyrene
C4*	56p polystyrene
C5	5n0 polystyrene
C6, 7, 30*	27p polystyrene
C8-29*	100n ceramic
CV1	2-22p trimmer

SEMICONDUCTORS

IC1	68B09E
IC2	6883
IC3	2764 (monitor EPROM)
IC4	74LS465
IC5-12, 47-62*	4164
IC13	74LS245
IC14, 38	74LS00
IC15	7404
IC16	74LS139
IC17	74LS138
IC18, 45*, 46*, 67, 68	74LS244
IC19	68B21
IC20*	WD2123
IC21	74LS02
IC22*	75188
IC23*	75189
IC24*	WD1770
IC25*	7407
IC26*	7406
IC27	6818
IC28*	8255
IC29*	74LS393
IC30-33*	27128
IC34*	NEC7220A
IC35*	74LS175
IC36	74LS04
IC37	74LS194
IC39, 42	74LS74
IC40	74LS163
IC41	74LS21
IC43, 44	74LS257
IC63*, 64*	72LS299
IC65	74LS85
IC66	74LS273
Q1	BC108
Q2	BC109
Q3, 4	2N2369A
D1-3, 6*, 7*	1N4148
D4, 5	0A91
ZD1	6V8 PN junction voltage transient suppressor

MISCELLANEOUS

B1	3.6V 100mAh PCB-mounting NiCad battery
S1	PCB-mounting piezo-electric sounder
SK1, 2	20-way IDC header plug, straight or right-angle mounting (see text)
SK3*, 4*	25-way D socket, straight or right-angle mounting (see text)
SK5*	36-way IDC header plug, straight or right-angle mounting (see text)
SK6*	26-way PCB header plug, straight or right-angle mounting (see text)
SK7*	26-way PCB header socket
SK8*	4-way PCB header plug, straight or right-angle mounting (see text)
SK9*	PCB-mounting BNC socket
SK10*	40-way IDC header plug, straight or right-angle mounting (see text)
SW1	4-way DIL switch
SW2*	SPST keyboard switch, PCB-mounting
XTAL1	16.000MHz crystal
XTAL2*	1.843 MHz crystal
XTAL3	32.768 kHz crystal

PCB; IC sockets*: 13 off 14 pin DIL, 32 off 16 pin DIL, 10 off 20 pin DIL, 1 off 24 pin DIL, 6 off 28 pin DIL and 6 off 40 pin DIL; case; power supply.

* These components may be omitted under certain circumstances — see text.

the opposite direction. Check carefully against the overlay diagram as you work and check again afterwards just to make sure. When all the sockets are in place, check each one carefully for solder splashes between pins, bad joints and so on.

Continue with the assembly by installing the three wire links, the various input and output sockets, the switches, the piezo-sounder, the resistors and the capacitors. Make sure that you install the tantalum capacitor, C1, and the three resistor packs the right way around. Solder the diodes and transistors into place, again taking care that they are the right way around, but do not insert the ICs or the Nicad battery. Finally, install the three crystals.

Now comes the tedious bit! Visually check the board for solder bridges and missed joints, then check again that every component is in the right place and that the critical components are all the correct way around. Using a multimeter, carefully check the following buses for continuity and for short circuits between adjacent lines:

the address lines between the CPU (IC1), the SAM (IC2) and the EPROM (IC3);

the data lines between the CPU (IC1), the EPROM (IC3) and the buffers (IC4 and IC13);

the data lines between the buffers (IC13) and the various peripheral device controllers (ICs 19, 20, 24, 27 and 34);

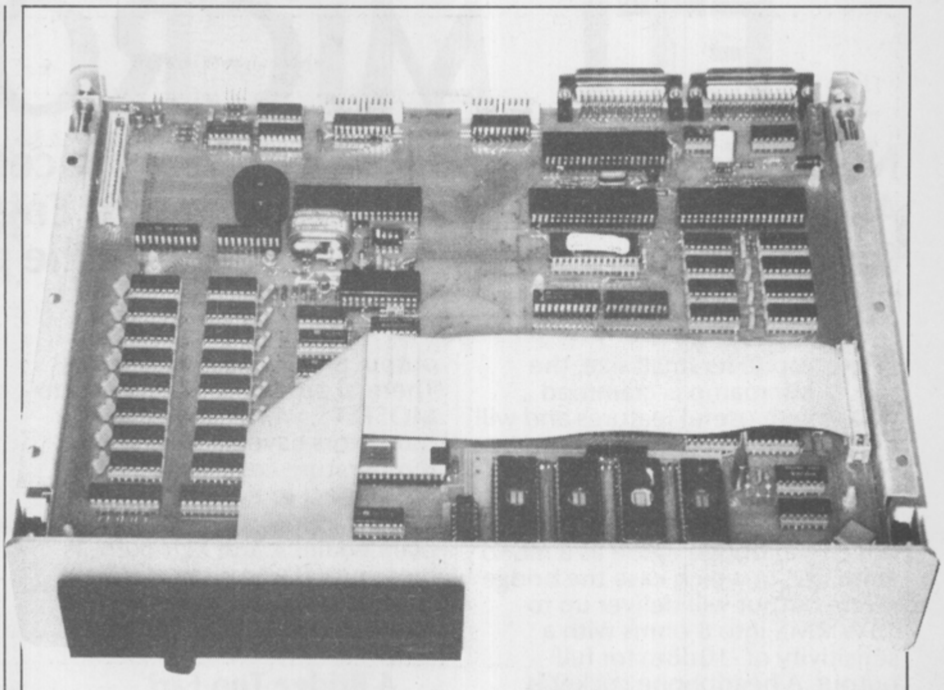
the address and data lines between the controllers and their associated circuitry (eg., between IC19 and the buffers IC67 and IC68);

the main (64K) RAM address lines;

the graphics (128K) RAM address lines.

Connect up a supply of +5V to the board and check that the IC sockets all have +5V and 0V appearing on the correct pins. Repeat the procedure with the +12V and −12V rails. If all is well, insert the ICs into their sockets, taking great care that each IC is in the correct socket and the right way around.

Construction of the plug-in EPROM disc board should present no problems at all, but again, it is a good idea to check the bare PCB before starting and the usual care should be taken with the orientation of the resistor pack and the ICs. One refinement worth considering here is the use of a ZIF (zero insertion force) socket in the IC30 position. This is the position in which EPROMs can be programmed, and the additional cost of a ZIF socket may well be justified if you plan to make extensive use of this facility.



Another view of the cased board. Note that the EPROM disc board shown here (lower centre-right) is a prototype.

BUYLINES

Almost all of the integrated circuits are available from Technomatic, but there are a number of exceptions. The WD2123 and WD1770 (IC20 and IC24) are available from Pronto Electronics Systems Ltd, 466–478 Cranbrook Road, Gants Hill, Ilford, Essex IG2 6LE, tel 01–554 6222. Pronto currently offer the two chips together at a discount (the WD2123 is very expensive) and you should contact them for details. Note that there are two versions of the disc controller, the WD1770 which supports stepping rates from 6 to 30ms and the WD1772 which supports stepping rates from 2 to 6ms. Both versions will work on this board. Pronto can also supply the 68B09E (IC1) and the 68B21 (IC19).

The NEC7220a graphics controller chip is available from Semi Components Ltd, Vine House, 104 Ashley Road, Walton-on-Thames, Surrey KT12 1HP, tel 0932–241866. There are two versions of this chip, the 7220 and the 7220A. Only the 7220A will work in this design. The MC6883 SAM chip (IC2) can be obtained from Jermyn Distribution Ltd, Vestry Estate, Sevenoaks, Kent, tel 0732-450144. Note that this device is also known as the 74LS783. The transient suppressor ZD1 is an RS part, stock number 283–255. RS Components will only supply to trade and professional customers but Crewe-Allan & Company of 51 Scrutton Street, London EC2 or Trilogic Ltd of 29 Holm Lane, Bradford, will obtain parts from them on payment of a small handling charge.

The resistors and capacitors are all widely available from our advertisers and the usual mail order suppliers. Eight-resistor SIL packs are easy to obtain but seven-resistor ones are not. You can either obtain them from RS via one of the suppliers mentioned above or use eight-resistor packs and cut off one pin. The 2-22p trimmer is also an RS part but similar devices from other suppliers should prove suitable provided their pin-out matches the holes in the board. The same applies to the 3.6V NiCad battery. The basic kit, which includes the PCBs and IC3, is sold by Micro Concepts, 2 St Stephens Road, Cheltenham, Gloucestershire GL51 5AA, tel 0242 – 510525. The PCBs will not be available from our PCB Service.

● Next month's article will cover the choice of case, power supply, keyboard and monitor for use with the board and the testing and setting up of the system.

ETI