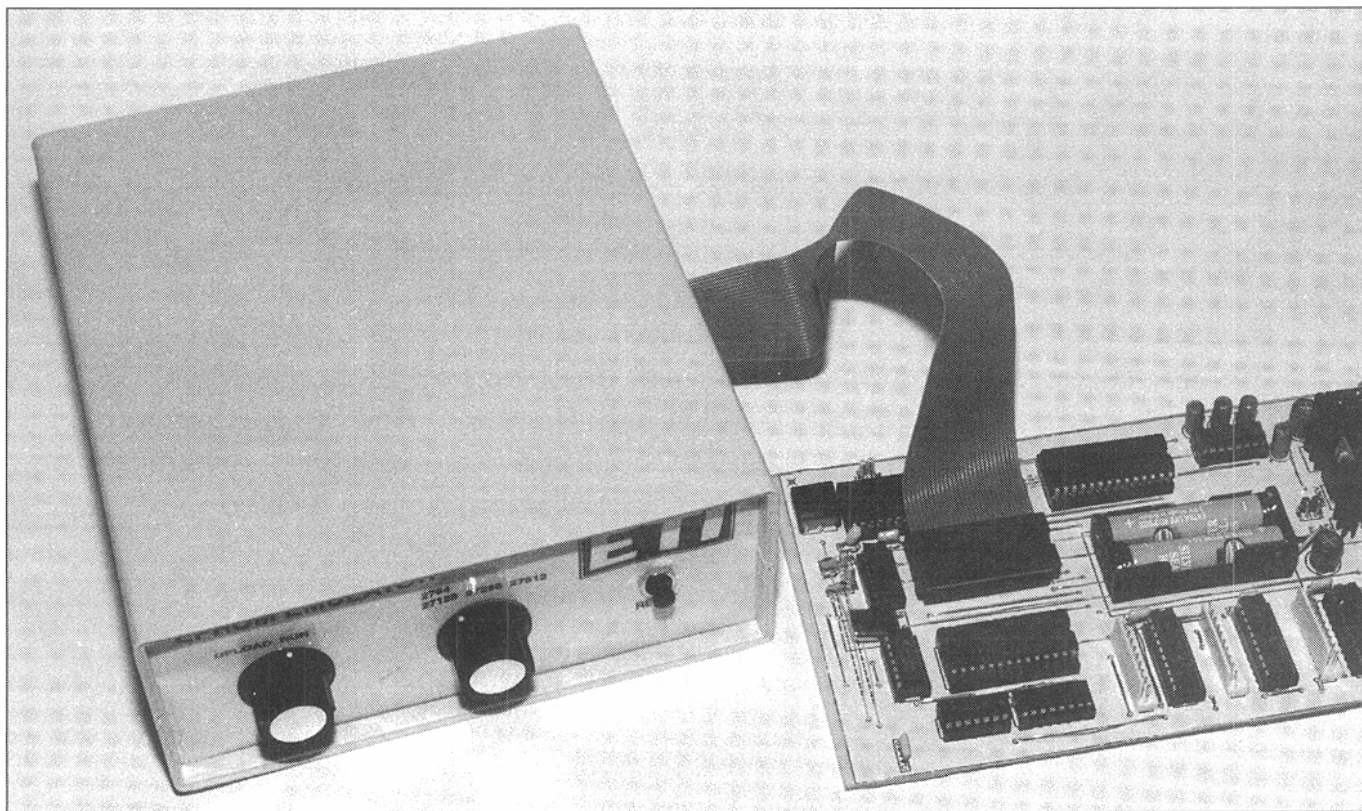


EPROM EMULATOR



To accompany the EPROM Programmer featured in last month's ETI, Paul Stenning has designed a versatile EPROM emulator which will remove a lot of the effort from system development

This EPROM Emulator was designed to complement the EPROM Programmer published last month. An EPROM Emulator can save a vast amount of time when developing software, compared to programming and erasing EPROMs. This is because it is a RAM-based memory that just looks like an EPROM to the system into which it is plugged.

The unit presented here will emulate the standard 27 family of devices, from 2764 to 27512, and can be used with an IBM PC compatible computer. The smaller 24 pin devices in this family (2708, 2716 and 2732) are almost obsolete and are now more expensive than a 2764. I did not feel it necessary to accommodate these devices in this design since they would

significantly increase the complexity.

This design uses readily available components to reduce the likelihood of obsolescence. The unit is powered from either an external PSU or the circuit under development - the supply requirement being 5V @ 100mA. The power supply design published last month for use with the EPROM Programmer will also power this unit if an external supply is needed.

The emulator itself is dumb and is controlled by the host computer via the RS232 serial port (COM1 or COM2). Device selection and operation mode is set by front panel switches.

The accompanying software is available on disk from the author. The software will operate on any PC running MS-DOS or PC-DOS version 3.0 or later and having at least 512K of RAM and one RS232 serial port. A hard disk and a colourmonitor are strongly recommended. The software is written in Microsoft QuickBASIC V4.5, and the full source code is supplied for those wishing to enhance or modify it. This source code is also compatible with QBASIC, as supplied with MS-DOS 5.0 and later. You do not need QuickBASIC or QBASIC to use this disk. The disk also contains the software for the EPROM Programmer published last month. A description of the software operation is

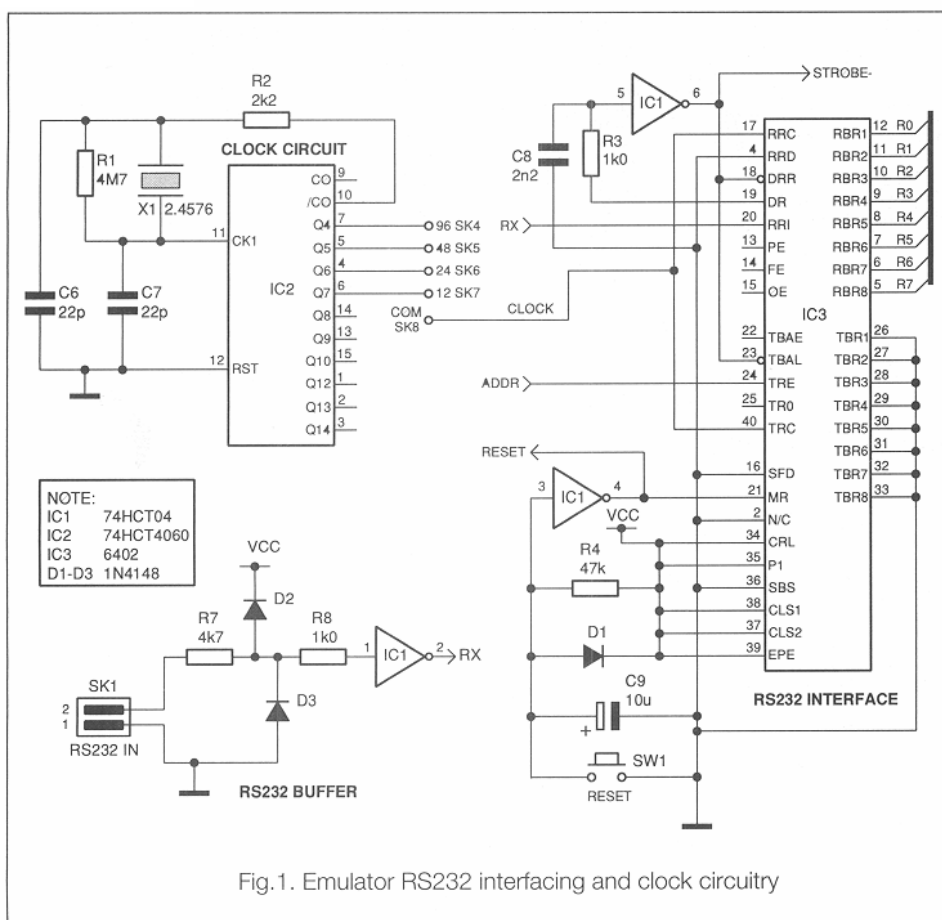


Fig.1. Emulator RS232 interfacing and clock circuitry

given later.

The unit may also be suitable for use with other types of home computer having an RS232 serial port, although this has not been tested and no software is available. It will definitely not work with Commodore Amiga computers, due to a peculiarity in the serial port handling.

How it Works

The circuit diagram is spread over a number of illustrations. Although it may initially look complex, it is in fact relatively straightforward. When a "-" follows a signal name (for example STROBE-), this shows that the line is active low. When a number is followed by an "h" this indicates that the number is hexadecimal.

The RS232 (serial) interface, buffering and clock are shown in figure *. IC3 (6402) is a UART (Universal Asynchronous Receiver/Transmitter) which basically converts serial data to parallel and vice-versa. The device supports most common serial data formats, in this application it is configured to give eight data bits, one stop bit and no parity checking. The data rate is set by the crystal-controlled clock circuit (IC2), which in most cases will be set to 9600 Baud. Since this unit is designed to

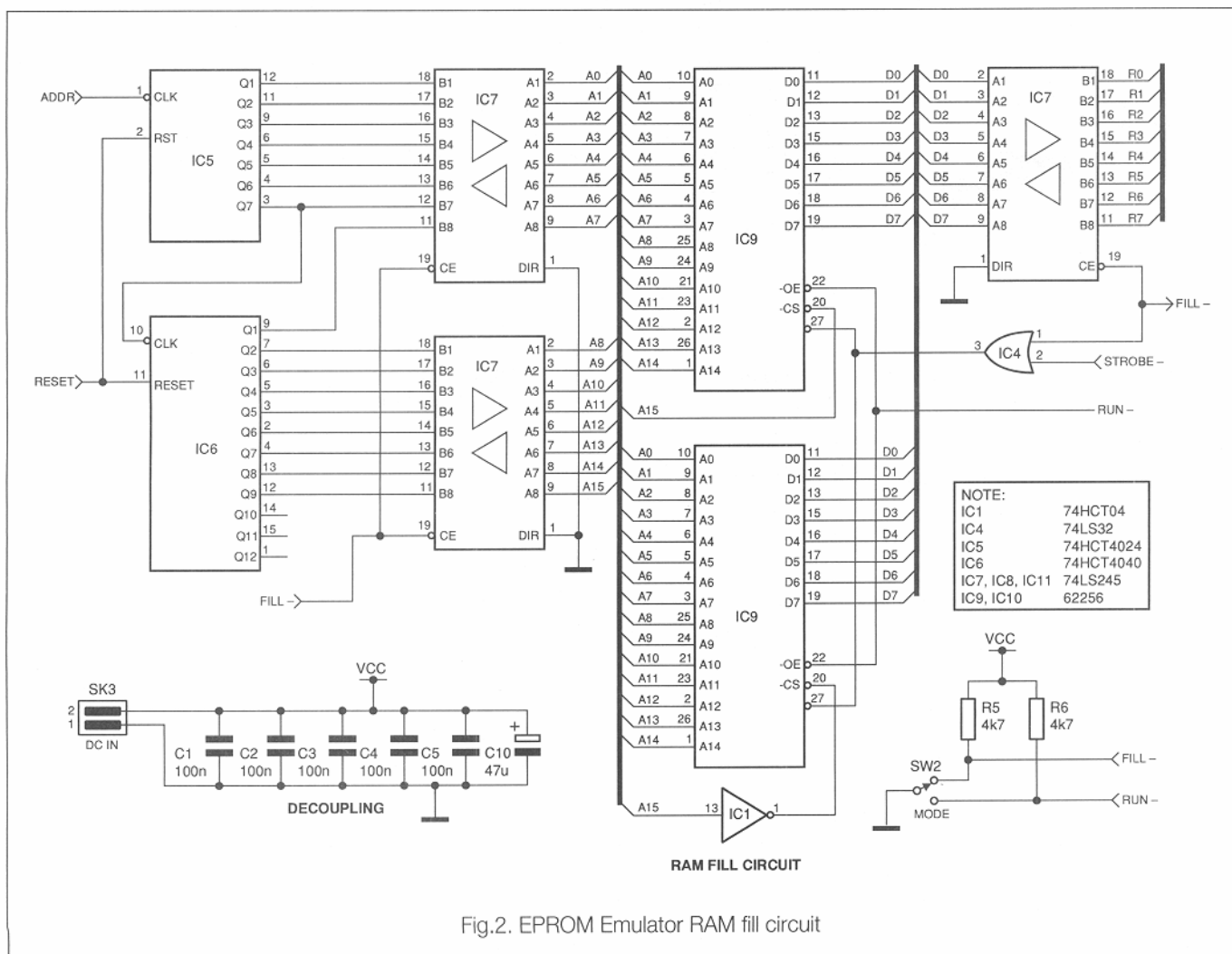
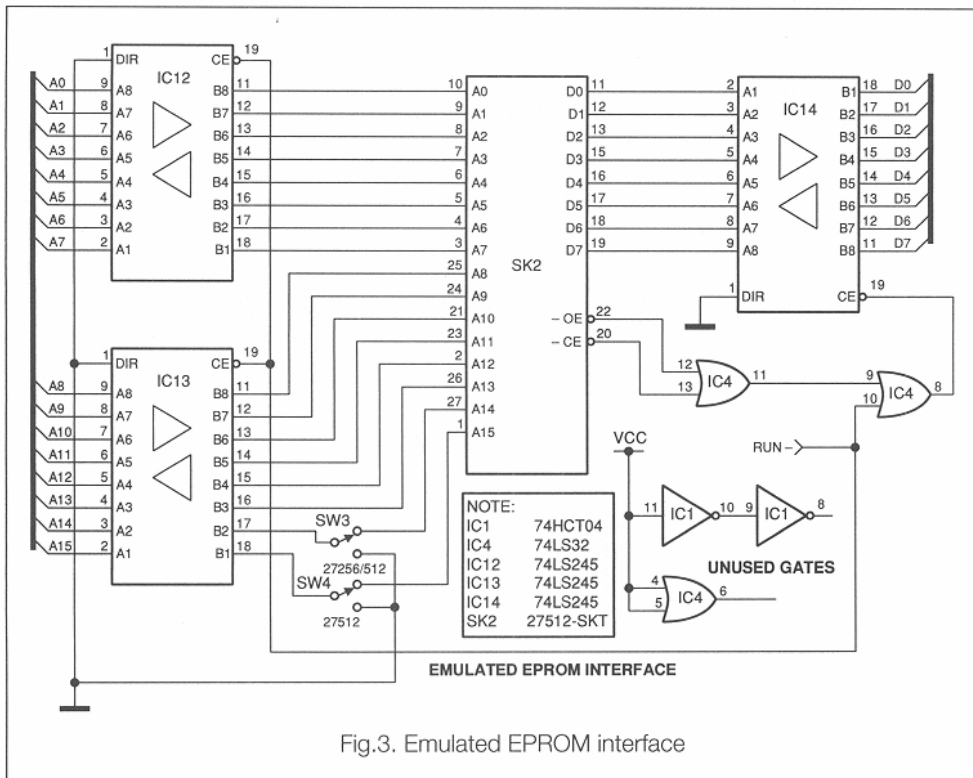


Fig.2. EPROM Emulator RAM fill circuit



the data is sent, pin 24 will pulse, incrementing the address counters IC5 and IC6. The section of the UART is used to merely apply a suitable delay before the address is incremented, to ensure the data is correctly stored.

When the next byte of data is received, it will be loaded into the next memory location, and so on. As long as the user presses the Reset button when prompted by the software, the data will arrive in the correct places. The software simply sends the data to the emulator one byte at a time; you could alternatively simply copy a binary image file to the COM port.

Two 256K x 1 Bit (32K x 8 Bit) RAM devices are used, to obtain the full 64K addressing range of a 27512 EPROM. The CS lines are used in conjunction with an inverter on the A15 line to select which device is used at a particular time.

Now assume that SW2 is in the

receive data only, the parallel input lines (pins 26 to 33) are held low and the serial data output line (pin 25) is not connected.

A gate in IC1 is used as the RS232 buffer, converting the +/- 10V RS232 standard data from the PC to a 5V pulse train suitable for the UART. The diodes restrict the RS232 voltage to within the 0-5V range, the remainder is dropped across R7.

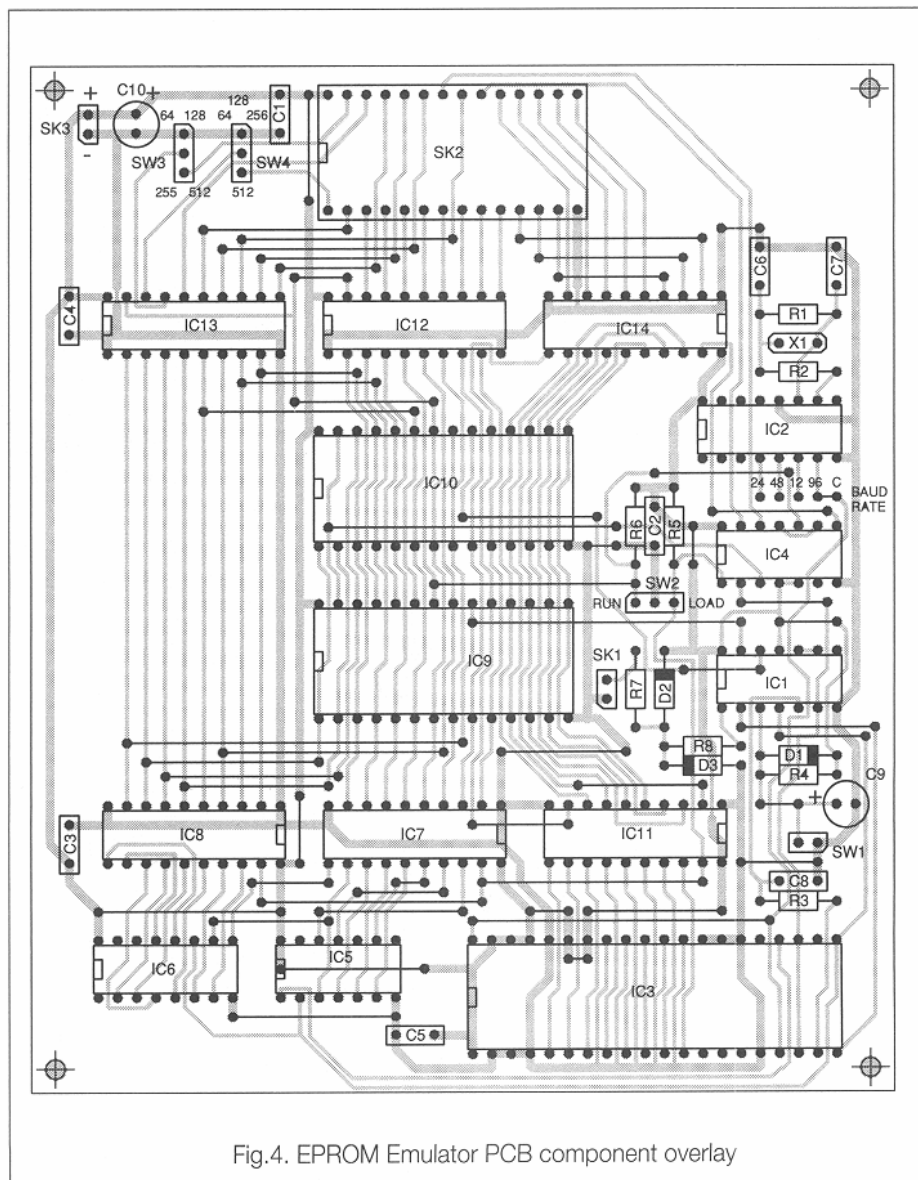
A byte of serial data arriving on pin 20 of IC3 will be converted to parallel data, which will appear on pins 5 to 12. Pin 19 will go high, and no further data can be received until pin 18 is taken low momentarily. One gate of IC4 causes this to happen, R3 and C8 create a slight delay giving a STROBE- pulse with adequate width for clocking other devices.

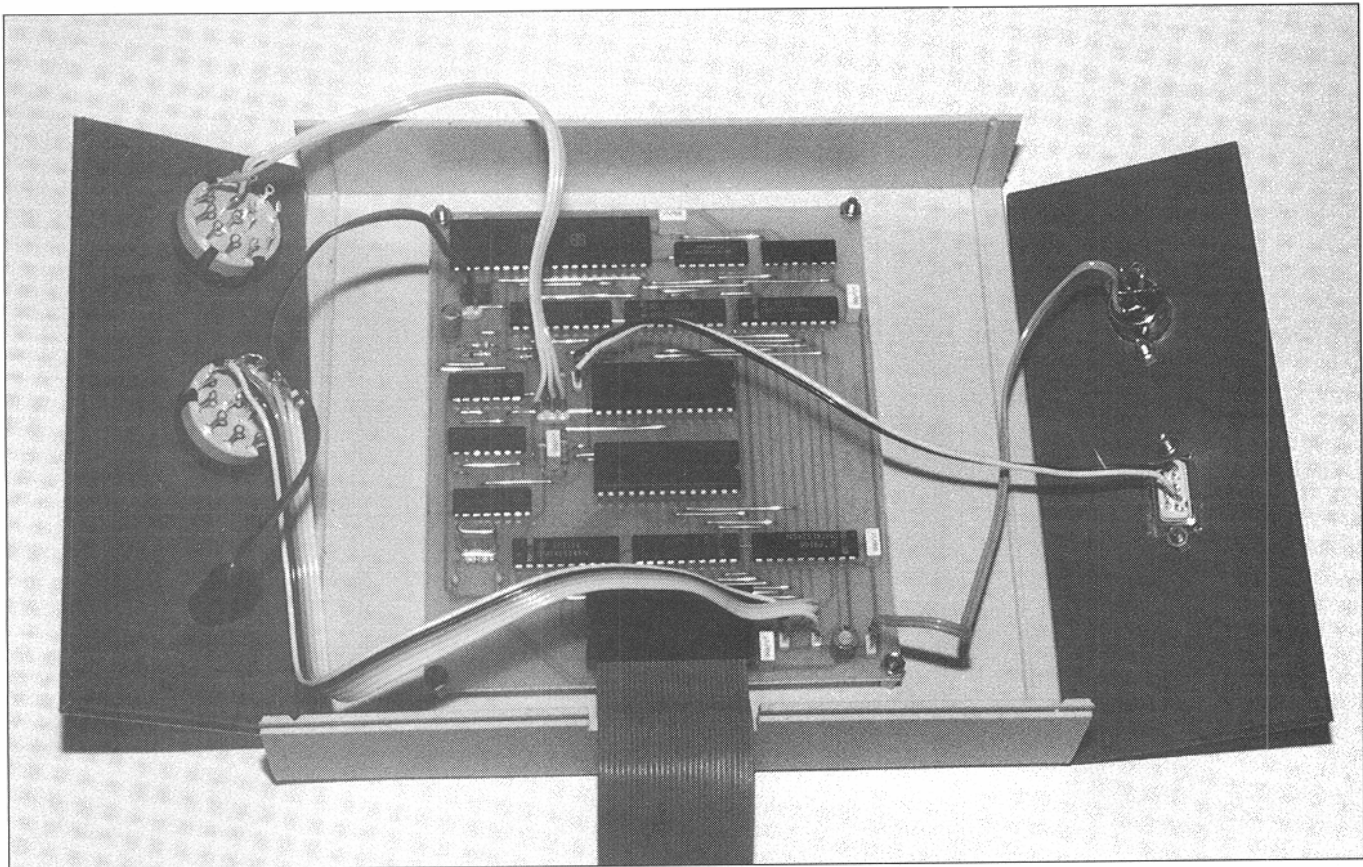
R4, D1, C9 and one gate of IC4 produce the power-on reset pulse for IC3, IC5 and IC6. SW1 allows the circuit to be re-set again as required.

Assume SW2 is in the upper position (Upload), so Fill- is low and Run- is high. IC12, IC13 and IC14 are disabled, so the 'EPROM' socket SK1 is isolated from the RAM. IC7, IC8 and IC11 are all enabled, effectively connecting the RAM (IC9 and IC10) to the address counters (IC5 and IC6) and the UART.

When a byte of data is received, the Strobe- line will pulse low as described previously. This is connected to the Write Enable- (pin 27) on the RAM IC's so the received data will be written to the current memory location.

The Strobe- signal is also connected to pin 23 of the UART. This will cause the transmission section of the device to go through its motions (even though nothing is listening!). As





lower (Run) position. IC7, IC8 and IC11 are now disabled, isolating the RAM from the upload circuitry. IC12 and IC13 are enabled, effectively connecting the RAM address bus to the 'EPROM' socket. SW3 and SW4 select the EPROM type, and set any unused RAM address lines low. When pins 22 and 24 of the 'EPROM' are both low, IC14 is enabled (via IC4) connecting the RAM data lines to the 'EPROM'.

The prototype has not yet been tested on a speed-critical microprocessor system. The interface electronics should add no more than 20ns to the access time of the RAM devices used. Therefore with 100ns RAM chips, the unit should be able to emulate a 120ns EPROM, and will definitely emulate a 150ns device. If speed is critical, fit the fastest RAM chips you can get - 35ns devices are available if you are prepared to pay for them!

Construction

The unit is assembled on a single sided PCB, which is available from the ETI PCB service. The copper track layout is shown in figure * and the component overlay is shown in figure *.

A number of wire links are required, which should be fitted before any components, since some pass underneath ICs. I would suggest that the resistors are fitted next, followed by the ICs, then the capacitors, then the remaining parts. Fit a link wire between COM and 96 to set the Baud rate to 9600. Fit SIL header strip or Veropins for the off-board connections.

I would suggest that sockets are used for the RAM chips and the UART, in view of their cost. It would also be a good idea to use sockets for IC4, IC12, IC13 and IC14, since these interface to the outside world and could be damaged if there is a problem on the system being tested. The sockets allow for ease of changing if the worst happens.

If you do not plan to emulate 27512 EPROMs, you could save a few pounds by omitting IC10 (it can always be added later). The unit will then emulate up to 27256 devices, so move the stop on the Device switch to prevent the 27512 option being selected.

Fit a 28-way IC socket in SK2 position. A 300mm (or shorter) length of 28 way ribbon cable should be fitted with a 28 way DIL connector on each end. These can be readily pressed together in a vice or WorkMate, if three thicknesses of Veroboard are used to protect the connector pins. Take care when doing this, as it is not easy to get the connector apart again if something goes wrong. One end of this cable plugs onto SK2; make sure the edge of the cable with the different colour goes to pin 1.

When you receive these connectors from your supplier, please make sure the two parts are not pressed fully together before removing from the polythene packing. If they are, send them back. The two I purchased from Maplin were fully assembled and I managed to break one while disassembling them.

The interwiring is shown in figure *. This should be carried out at this stage, since it is necessary for testing. After testing, the board can be fitted into the case.

The connections for both 9 and 25 way serial connectors, use whatever matches the socket on your computer. On the prototype a 9 way D connector (serial) and a 6 way DIN socket (DC input) were fitted to the case. The rotary switch connections are shown by giving the pin number or letter marked on the switch body.

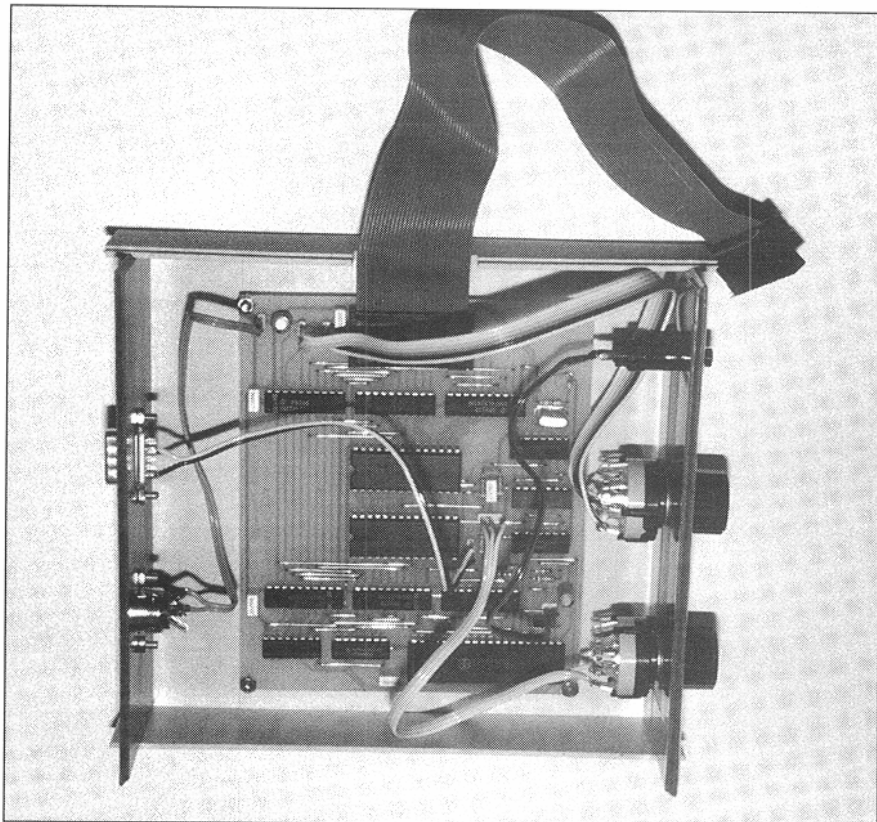
Testing

Connect the unit to a 5V supply and the serial port on your PC, and run the program "SER-TEST.EXE" on the software disk. When prompted, type "1" or "2" followed by Enter to say which serial port you are using. The program does nothing more exciting than wait for you to enter a 2-digit hex number (followed by Enter) and then sends it to the emulator. It then attempts to read back a number; if it's successful it prints the number otherwise it prints "****". Since the emulator does not transmit any data, the software will always respond with "****". To exit just press Enter on its own. All the responses in this section will be shown with quotes (") around them - just type the

number (followed by Enter); don't type the quotes.

Switch the emulator to 27512 and Upload, and press Reset. Type "00" on the computer, and the software should respond with "***". Using a logic probe, test meter or oscilloscope, check the logic levels on pins 9, 10, 11, 13, 14, 15, 16 and 17 of IC9. They should all be low. If you type "01", pin 9 should be high, and the others should remain low. Now enter "02", "04", "08", "10", "20", "40" and "80" in turn. After each entry, check the logic levels on the data pins; only one should be high in each case - 10, 11, 13, 14, 15, 16 and respectively.

Press Reset on the programmer. Press Enter on its own to quit the software then run "ADR-TEST.EXE", which is also on the disk. Since the address counters are incremented when a byte is sent, it would take a long time to get the count to 65535 manually! ADR-TEST does it automatically, and pauses at four points to allow you to check the logic levels. Follow the instructions on screen. The table below shows the expected logic levels on the address pins of the IC9 at the four pause points.



Addr Line	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
IC9 Pin	20	27	26	2	23	21	24	25	3	4	5	6	7	8	9	10
Count	Expected Logic Level															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21845	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
43690	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
65535	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

If these readings are OK, and the preceding tests were also successful you can be fairly confident that the unit is working correctly. It is not so easy to check emulation part of the unit, but providing the unit was carefully constructed the chances of problems are unlikely.

If you have a microprocessor system and a suitable hex file, you can try emulating a known good EPROM using the information given shortly.

The Case

The prototype was constructed in a plastic case, 190mm * 165mm * 68mm, see parts list for details. A suitable overlay for the front panel is shown in figure *. Two photocopies may be taken (enlarge to 162mm * 64mm), one can then be used as a drilling template while the other may fixed to the front panel with clear self-adhesive vinyl.

A suitable notch should be cut in the right side of the case for the ribbon cable to pass through. The power and RS232 connectors mount on the rear panel.

Software

The software for this project is supplied on one 3.5" 720K disk. Please note that this disk also contains the software for the EPROM Programmer, published last month.

Since the various programs extend to over 2500 lines of BASIC source code, it would make boring reading to print it in

the magazine. A printed listing is not available since it would be more expensive than a disk to produce.

The software is supplied 'as-is', and neither Paul Stenning or Electronics Today International can accept any liability for any loss or damage however caused. The source code is supplied so that you may modify the software for your own use only. The software may not be redistributed in either its original or in a modified form. If you cannot accept these conditions please do not order the software

disk. That's the legal bit done!

A batch file is supplied on the disk to simplify installation. Insert the disk in the drive, type "A:" then "INSTALL", and the batch file will make a \EPROM directory on your drive C:, and copy the software to there. If you do not have a hard disk, make a working copy of the disk using DISKCOPY, then put the original away. Do not write-protect your working copy or the software will not work.

If you are using Windows, suitable icon, PIF and group files are supplied on the disk. Some parts of the software will operate much slower under Windows, particularly the initialisation when the serial port is opened. However it will run in the background (probably very slowly) if you are using 386 Enhanced Mode.

The main software of interest for this project is spread over two programs, "EMULATE.EXE" and "HEX-CONV.EXE". The first of these is the main control software for the emulator, while the second converts various industry standard hex file formats to and from the EPROM emulator format.

Additional programs on the disk are "PROGRAM.EXE" which controls last month's EPROM Programmer, and "SPLIT2.EXE" & "SPLIT4.EXE" which divide Intel hex files into 2 or 4 files for 16 and 32 bit systems respectively. Since the full BASIC source code is given for all of these programs, it would be possible to create one large program containing all the facilities - if someone had more time than me! I would be interested to see

Resistors

R1	4M7
R2	2K2
R3,8	1K0
R4	47K
R5,6,7	4K7

Capacitors

C1,2,3,4,5	100n
C6,7	22p
C8	2n2
C9	10u
C10	47u

Semiconductors

IC1	74HCT04
IC2	74HCT4060
IC3	6402
IC4	74LS32
IC5	74HCT4024
IC6	74HCT4040
IC7,8,11,12,13,14	74LS245
IC9,10	43256-10
D1,2,3	1N4148

Miscellaneous

XT1	2.4576MHz
SK1	9 or 25 way D connector
SK3	DC INPUT
SW1	Push to Make
SW2	4 pole 3 way rotary
SW3 and SW4	one 4 pole 3 way rotary
PCB, Case, knobs, wire, ribbon cable, two 28 way DIL ribbon connectors	

any enhanced versions.

When "EMULATE.EXE" is started, the Device Selection Menu will appear. From here you choose the type of device you will be using, either 2764, 27128, 27256 or 27512.

Once you have chosen the device required, the Main Menu will appear. Option 1 allows you to upload hex data to the emulator. The hex data is saved and loaded ASCII-Text format which is peculiar to this software. "HEX-CONV.EXE" will convert to and from this format.

When Option 1 is selected, you will be told where to set the switches on the emulator. You will then be asked for a filename; simply enter

8 the alpha-numeric characters - the extension is fixed to .HEX and does not need to be typed. Now sit back and wait; the progress will be shown on the screen.

Option 2 allows you to change the EPROM type as previously. Option 3 lets you run the Hex File Converter program, "HEX-CONV.EXE" and option 4 lets you access a DOS Shell; type "EXIT" to return to the emulator. To quit the emulator, press Escape.

The Hex File Converter was described in detail last month, so I won't bore you by repeating it here!

Emulating

The emulator may be powered by the microprocessor circuit being tested if there is sufficient capacity in the power supply. This will happen by default, via pins 14 and 28 of SK2.

If you need to power the emulator separately, you will need to isolate pin 28 of SK2 from the circuit under test, to prevent the two power supplies conflicting. This is easily achieved by removing pin 28 from a spare IC socket, and then fitting this onto the free end of the ribbon cable before plugging it into the test circuit.

The 300mm length of ribbon cable should not cause any problems unless the microprocessor system is very fast. In this case, try making another cable just long enough to reach.

The ICs interfacing this unit to the outside world are 74LS TTL devices, since these are somewhat more robust than 74HCT, and the inputs are not so static-sensitive. For speed-critical systems you may need to use a different logic family here.

When the unit is not in use, it's a good idea to plug the end of the ribbon cable into a piece of anti-static foam. This helps protect the electronics from static, and prevents the pins from being bent.

The plastic case used for the prototype is made by Bafbox, and is available from RS/Electromail, stock no 506-788. The software for this EPROM Emulator and last month's EPROM Programmer are available on one disk from the author. Please send a blank PC formatted 720K 3.5" disk; the price for the software is £10. If you do not have a suitable disk, send £12 and one will be supplied. Please add an extra £1 if within Europe, or £2 elsewhere, to cover the additional postage.

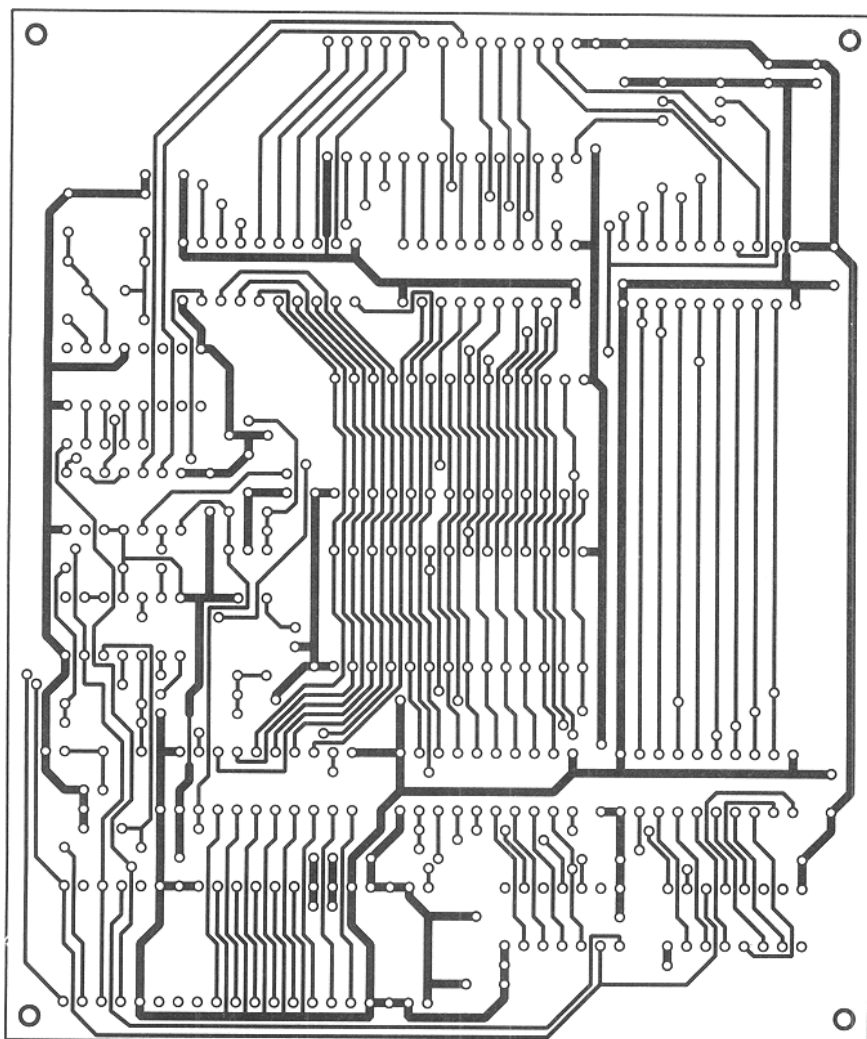
The author can also supply PCBs for the EPROM programmer, the PSU, and next month's project, the EPROM emulator. The EPROM PCB is priced at £12, the PSU PCB at £5, and the Emulator PCB at £15, or if you want to buy all three then they are available at £30. Do not forget to add P&P: £1.50 in the UK and £2.50 elsewhere. If you would like to purchase either the software or the PCBs then send a cheque or postal order for the appropriate amount made payable to "Paul Stenning", plus a return address label to the following address:

Paul Stenning, [REDACTED]

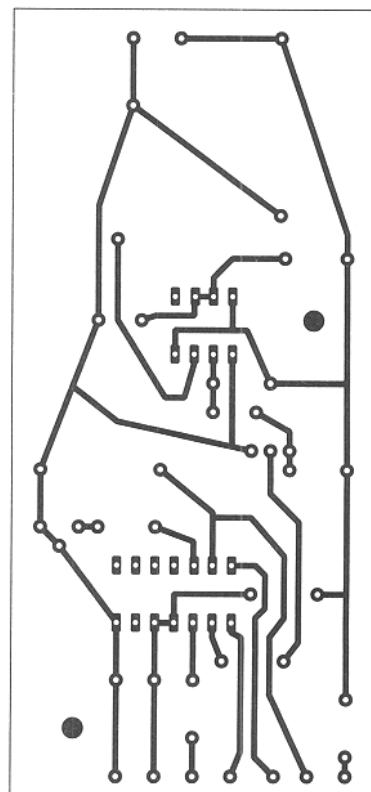
If ordering from outside the UK, please make sure your cheque is in Pounds Sterling and is drawn on a UK bank. The author will be making up PCBs in batches so please be patient, cheques will not be cashed until the boards are dispatched.

The above offers from the author are only valid until the end of March 1995. After that date, please contact him first before sending any cash.

Foils for this issue



Eprom Emulator



Mini Enlarger Timer