

AMSTRAD ROM EXPANSION

BY SIMON DEAN

96K OF ROM IN ONLY SIX BITS?

One answer to a shortage of memory space in a computer is to add sideways rom expansion. The system described here can handle up to 252 roms, but for the sake of practicality the design is based around a six-rom unit.

WHEN the Amstrad CPC range of computers were conceived, their designers built in tremendous capabilities. I refer in particular to the provision for adding expansion (sideways) roms to enhance the already powerful operating system. Adding these roms is much simpler and cheaper than most people imagine, and certainly within the abilities of most home constructors. The rom expansion board described here was built for around £14.00 excluding pcb and case and allows up to six external roms to be added.

EXPANSION ROM

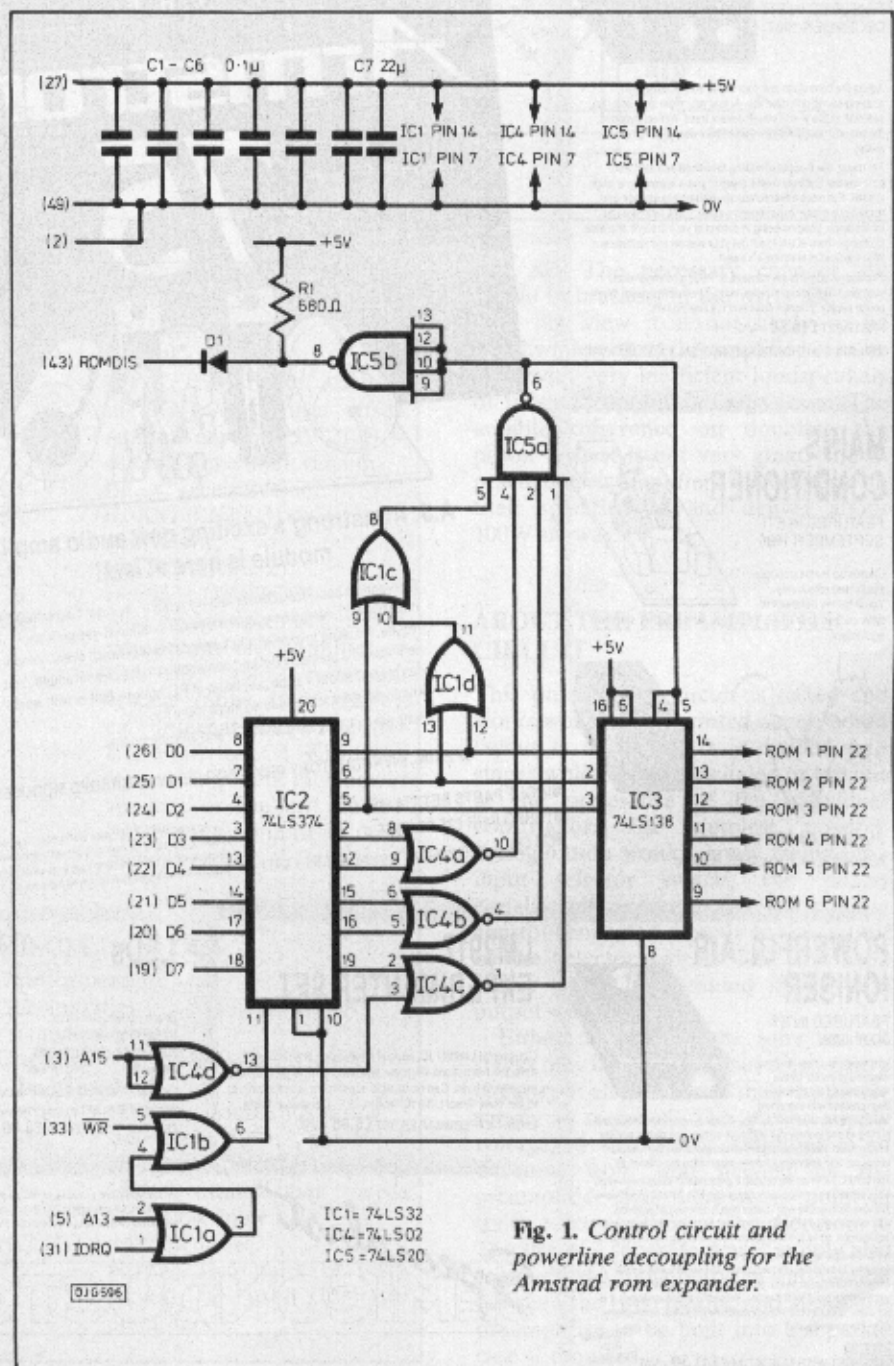
An expansion rom is a 16K read only memory chip containing a program (or programs) which can be made to replace the on board Basic rom. It follows from this that all roms are mapped in the area of memory normally occupied by the Basic rom ie &C000-&FFFF. Up to 252 roms can theoretically be added to the system, and these can be split into two types:-

(a) **Foreground roms** - These usually contain one large program which replaces the Basic rom completely, such as, for example, another high level language like Pascal.

(b) **Background roms** - These provide additional commands to augment the existing operating system, rather like rxxs (resident system extensions). The disc operating system is one such rom.

Of the 252 possible roms, only seven (15 on 664 and 6128 machines) may be of the background type, the rest must be foreground. It is expected that most users will not require more than six expansion roms, background or otherwise, not least because these tend to be a little expensive, and for this reason and to keep the additional circuitry simple, only six sockets are provided on this board.

The main advantage of storing programs in rom is that none (or very little) of the ram of the computer is taken up by the program itself. This is very



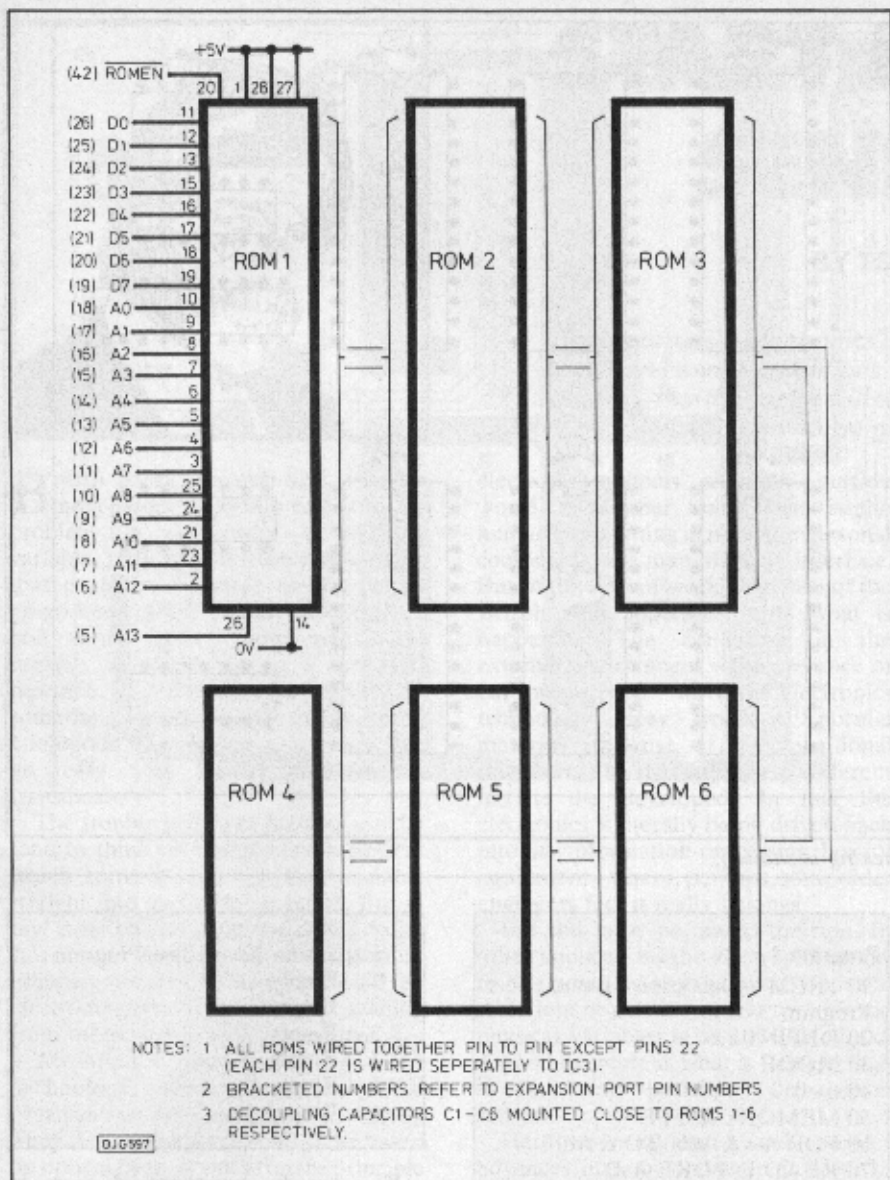


Fig. 2. Extension roms connections.

noticeable with word processing programs, which if ram based, allow only a small amount of the system's ram to be used to store the text. Rom based word processors (such as Protext - used to write this article!) allow almost all the computer's ram to be used to store text (typically 38K or more). Programs in rom are also instantly available, without having to wait while the program loads.

THE CIRCUIT

The computer chooses which rom is selected by writing the rom select address to I/O location &DF00. If a rom is fitted at that address, all further READ operations from the top 16K of memory will be from that rom. If no rom is present, then the on-board Basic rom is read.

As can be seen in Fig.1, the circuit is quite simple. IC1a and IC1b detect the presence of I/O address &DF00 on the bus, and latch the rom select address

(present at the time on the data bus), into IC2. Note that because of the way that the Amstrad computers use the I/O space, it is only necessary to detect address line A13 going low to know that the address is &DF00, greatly simplifying the decoding process. Most hardware supported by the system is mapped in this way, each with a different address line in the low state.

If the rom select address is between one and seven inclusive, the output of IC5a goes low, enabling decoder IC3. The outputs from this decoder select the respective rom by pulling its OE (output enable) pin low. IC5b provides a high level on the ROMDIS pin to disable the internal rom. The circuit is so arranged to ensure that ROMDIS is asserted *before* the external rom is selected to avoid contention between internal and external roms as switching takes place.

Whenever the operating system is using the firmware (lower) rom, all other roms (including external roms) must be disabled. This is achieved simply by

including address lines A15 in the external rom enable/disable circuitry on the expansion board. Whenever the lower rom is in use, A15 will be low, since the rom occupies address 0000-3FFFH, this low level disables external rom decoder IC3 via IC5a.

By now, some of you may have realised that the disc rom is normally rom seven, and that the computer will receive a response both from this rom and from our expansion board when a rom search takes place. This will not cause any problems in practice since the computer cannot actually tell that ROMDIS has been asserted by more than one device, but obviously a rom must not be fitted at this address.

CONSTRUCTION

The expansion box may be wired on a prototyping board, although in view of the large number of connections, and because wiring errors can prove fatal to the computer, the use of the double sided printed circuit board in Fig.2 is strongly recommended. The component layout is shown in Fig.3. Care should be taken to ensure that the transparencies used to expose the board are accurately aligned, since errors could result in the pads being drilled away on one side of the board. All holes are 0.8mm except for the 50 way pcb header connector holes which are 1.0mm.

If the board is not plated through, it will be necessary to use pins, or short lengths of tinned copper wire soldered both sides. Where a change of layer occurs, in all, 99 pins are required. Some of these soldered joints are very close together, so great care will be needed to avoid shorts between adjacent conductors. IC1 to IC5 may be soldered

COMPONENTS

RESISTORS

R1 680Ω 0.25Watt

CAPACITORS

C1-C6 100n ceramic (six off)

C7 22μ elect

SEMICONDUCTORS

IC1 74LS32

IC2 74LS373

IC3 74LS138

IC4 74LS02

IC5 74LS20

D1 1N4148 or similar

MISCELLANEOUS

Printed circuit board, 28pin ic sockets (6 off), 50-way pcb mounting header, 50-way female socket connector (idc), 50-way card edge connector, 75mm length of 50 way ribbon cable, approx 100 pcb pins (see text).

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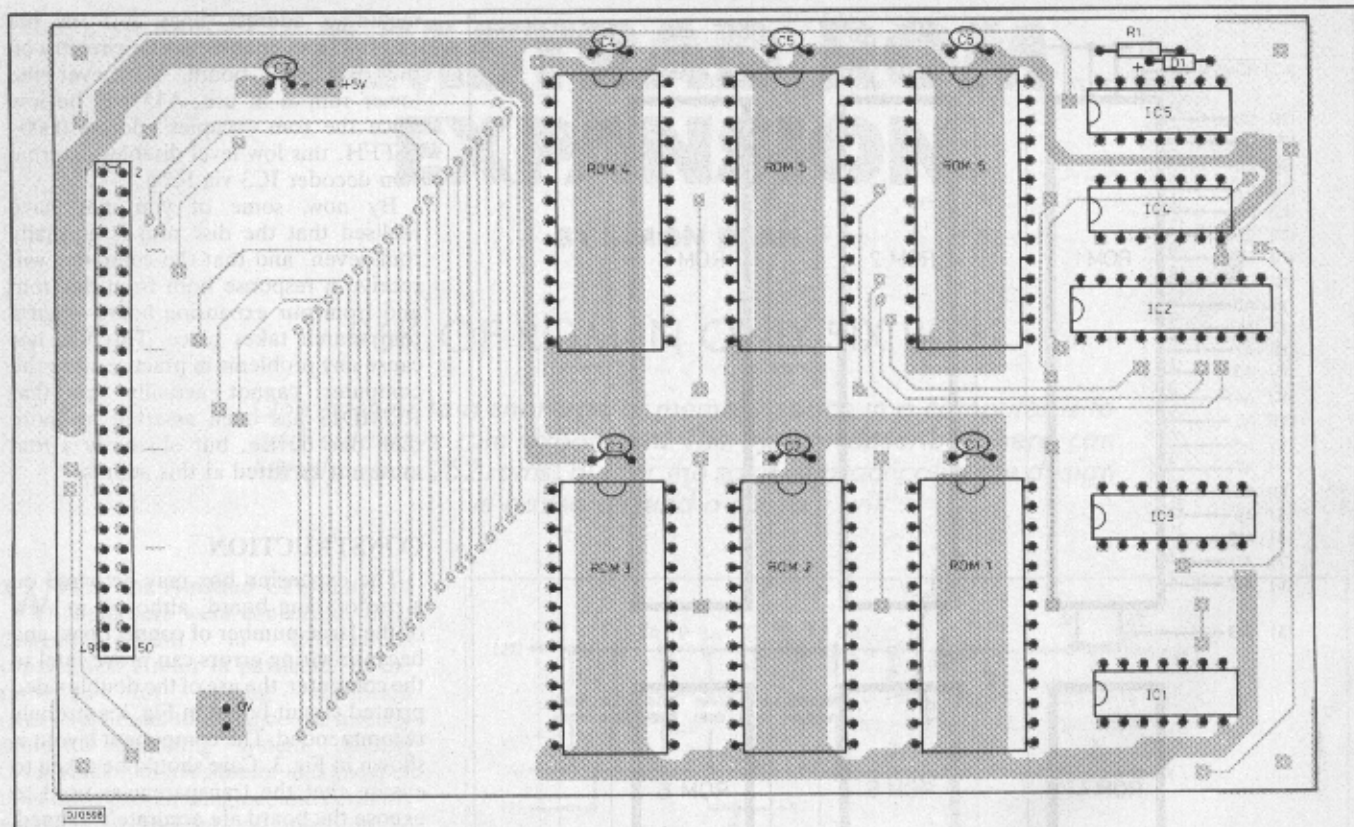


Fig. 3. Component layout details (only top tracking is shown).

directly into the board, but 28 pin dil sockets should be used for the six roms since these will probably be removed and re-inserted from time to time. The wires of decoupling capacitors C1-C6 should be soldered on both sides of the board, since in some cases they are used to connect the layer together.

The board is fitted with a 50-way pcb header allowing connection to the computer to be quickly and neatly made. A short length (approximately 2-3 inches) of 50-way ribbon cable is required, fitted with a matching female socket connector at one end and a 50-way card edge connector at the other (to fit the Amstrad's expansion connector). This method of connection is not the cheapest way to connect the board to the computer, but it makes further expansion of the system very neat and simple. The card edge connector should ideally be fitted with a locating peg in the position shown in the Amstrad user instructions, to make it impossible to insert the connector into the expansion socket upside down. Users of the DD1 disk interface will unfortunately have to provide a through connection of the bus to allow both units to be used simultaneously.

TESTING

Remove any roms from the board, and connect it to the computer's expansion connector *with the power switched off*. Switch on the computer, and watch for the normal Amstrad start up message.

Program 1

```

10 REM Expansion Board Test
   Program
20 DEFINT a,b
30 MODE 1
40 b=0
50 MEMORY &9FFF
60 FOR A=&A000 TO &A010
70 READ D:POKE A,D
80 NEXT
90 DATA ,&DD,&4E,0,&CD,&15,
   &B9, &DD,&6E,2,&DD,&66,3,
   &77, &23,&36,0,&C9
100 PPINT "Expansion ROM Test
   Program": PRINT
110 FOR a=1 TO 7
120 CALL &A000,@b,a
130 PRINT a;:IF b=0 THEN
   PRINT"...Foreground" ELSE IF
   b=1 THEN PRINT"...Background"
   ELSE IF b=80 THEN PRINT"...
   Empty"
140 NEXT

```

If no power-up message appears or random patterns appear on the screen, *switch off immediately* and check all wiring and joints carefully. When all appears to be well, type in Program 1 and save it. The program calls jumpblock entry &B915 - KL PROBE ROM for each of the six sockets, and tests the result to decide which type of rom, if any, is present.

RUN the program, and the following message should appear on the screen:-

Expansion Board Test Program

```

1....Empty
2....Empty
3....Empty
4....Empty
5....Empty
6....Empty

```

If a ready programmed rom is available, it can now be inserted (remember to switch off the power whenever roms are fitted or removed). If the power is then applied, the normal power up message should appear, and if Program 1 is re-loaded and run, the rom type should appear against the socket number in which the rom is fitted. You may wish to try the rom in each socket to test the board fully. All that remains is to type in the command(s) required to activate the ROM, and make use of your new found power! **PE**

POINTS ARISING

Egg Timer Jan 88.

The PCB track shown for Fig. 2 should be amended so that: IC4 pins 9 and 13 are connected: IC2 pin 2 goes to IC2 pin 10 and not to Pin 11. Polarity of D1 and D2 should be reversed. In Fig 4 labels to TR9, 10, 16, 15, 14, 13, 12, 11 should read TR 16, 15, 14, 13, 12, 11, 10, respectively.