80120

The extremely popular 2114 RAM IC has four times the memory capacity of the type used for the original (4 k) RAM card. This means that a card with twice the memory capacity can be constructed with half as many ICs. It will be apparent that this leaves a certain amount of 'free space' on the actual board. Why not fill it up with EPROM? By doing this we can kill two birds with one stone – there is no Elektor EPROM card as such for any of the Elektor computer systems.

8K RAM + 4,8 or 16K EPROM on a single card

Many readers have requested that the 4 k RAM card for the Elektor SC/MP system be updated. The new card presented here contains a total of 8 k of RAM, up to 16 k of EPROM and can be used with either of the Elektor SC/MP systems or the Junior Computer.

The 27xx series of EPROM was chosen as the 2708, 2716 and 2732 are all pin compatible (1 k, 2 k and 4 k EPROMS respectively). Obviously, to be 'universal' certain connections have to made 'programmable' (see circuit diagram in figure 1). The address decoding and the logic level on the chip select inputs depend on the particular type of EPROM used. These connections can be altered by means of wire links on the printed circuit board (figure 2).

The decoder (IC5) divides the entire address range into 4 k 'pages'. Each memory section (including the RAM area) can be placed anywhere within the 64 k address range. When 2708 s are used for the EPROMs, they can be positioned on any page by connecting a single link from IC5 to both inputs of N1. Two pages are required if 2716 s are used and this involves installing two wire links between IC5 and N1. If, however, 2732 s are used, one complete page can be allocated to each EPROM. This will be explained in detail further on.

The next step in the address decoding is to enable the individual memory ICs. As far as the RAM is concerned this will be in sections of 1 k (two ICs per section). The EPROMs, on the other hand, will be in sections of 1 k, 2 k or 4 k (for 2708 s, 2716 s and 2732 s respectively). The RAM section is taken care of by the 3 to 8 line decoder IC6. One half of a similar IC, IC7 (2 to 4 line decoder) is used to select the EPROMs. Wire links are included to pre-program the A and B inputs of IC7 for the particular type of EPROM to be used (see table 1). The order of addressing will be slightly different when 2716 s are used, but this should not cause any problems in practice, provided the EPROMs are programmed (and installed) in the correct order. Table 2 gives an example of the relevant addresses and connections for when the RAM section is placed on pages 1 and 2 followed sequentially by the EPROM sections.

The memory card is completely buffered to keep the load on the bus system to a minimum. The address bus is buffered by IC1 and IC2. These are uni-directional buffers which have PNP inputs requiring a very low input current. The same is true of the data bus buffers (IC3 and IC4). These are bi-directional, the direction of data transfer being controlled by the logic level on the common select line. When this line is low the buffers enable the transfer of information into the RAM section, and when the select line is high the data contained in the RAM/EPROM sections can be read out.

While the memory card is not being addressed the data bus buffers are held

Table 1

EPROM type	input A	input B	address order	
2708	A10	A11	IC25-26-27-28	
2716	A12	A11	IC25-27-26-28	beginning at an even page
2716	A12	A11	IC26-28-25-27	beginning at an odd page

2732: IC7 deleted (see text).

Table 1. This table shows the connections to the A and B inputs of IC7 for the different types of EPROM.

Table 2

RAM		EPROM		
		2707	2716	2732
1k0 = 1000 . . . 13FF	IC25 =	3000 . . . 33FF	3000 . . . 37FF	3000 . . . 3FFF
1k1 = 1400 . . . 17FF	IC26 =	3400 . . . 37FF	4000 . . . 47FF	4000 . . . 4FFF
1k2 = 1800 . . . 1BFF	IC27 =	3800 . . . 3BFF	3800 . . . 3FFF	5000 . . . 5FFF
1k3 = 1C00 . . . 1FFF	IC28 =	3C00 . . . 3FFF	4800 . . . 4FFF	6000 . . . 6FFF
1k4 = 2000 . . . 23FF				
1k5 = 2400 . . . 27FF				
1k6 = 2800 . . . 2BFF				
1k7 = 2C00 . . . 2FFF				
connect pins 9 and 5 of IC5 to inputs of N2		connect pin 14 of IC5 to inputs of N1	connect pins 14 and 3 of IC5 to inputs of N1	connect pins 14, 3, 11 and 7 of IC5 to pins 9 . . . 12 of IC7 (IC7 is deleted!).

Table 2. An example of the possible address format when the RAM section is sequentially followed by the EPROMs.

1

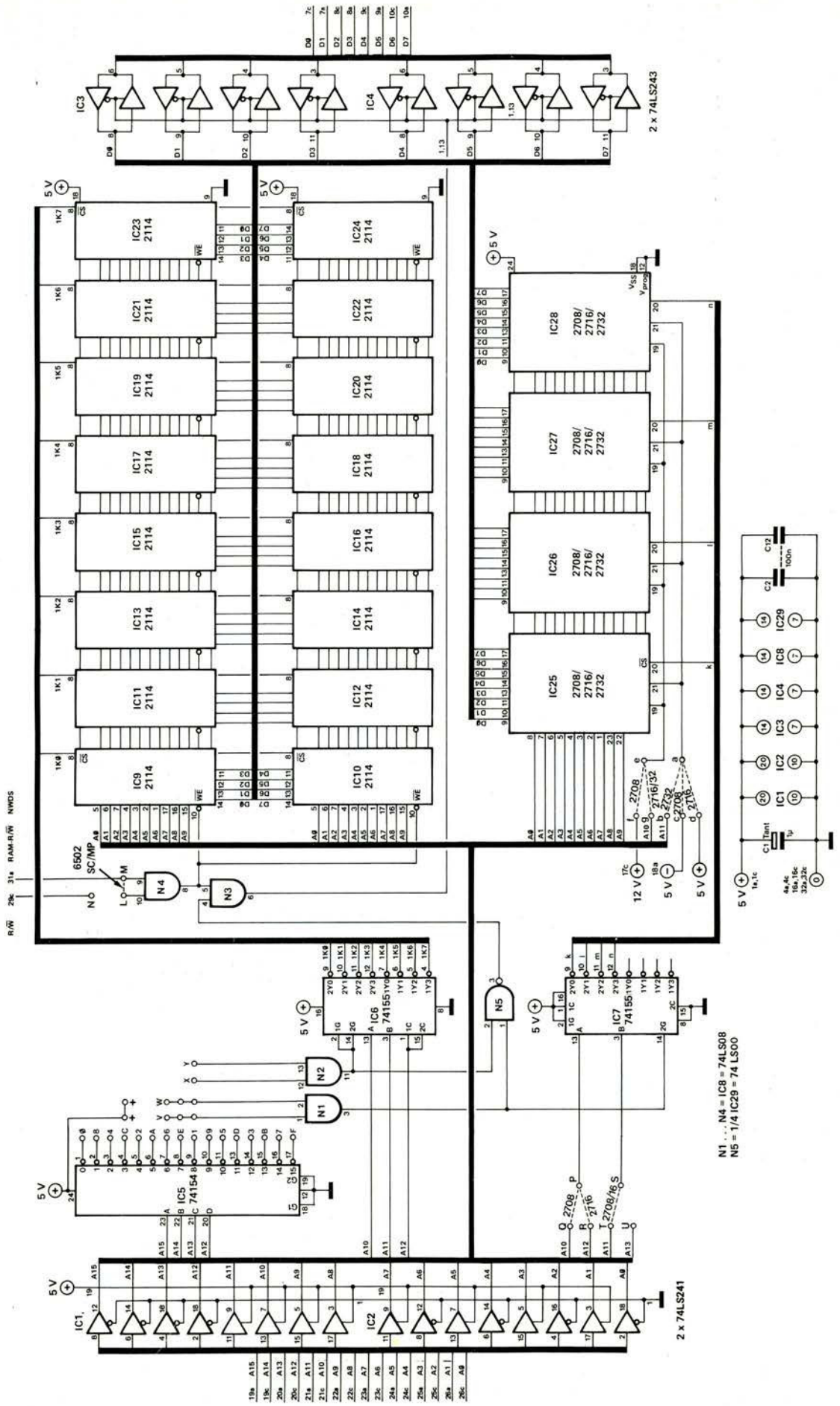


Figure 1. Complete circuit diagram of the RAM/EPROM card. The connections which need to be mounted for the various types of EPROM are clearly shown.

2

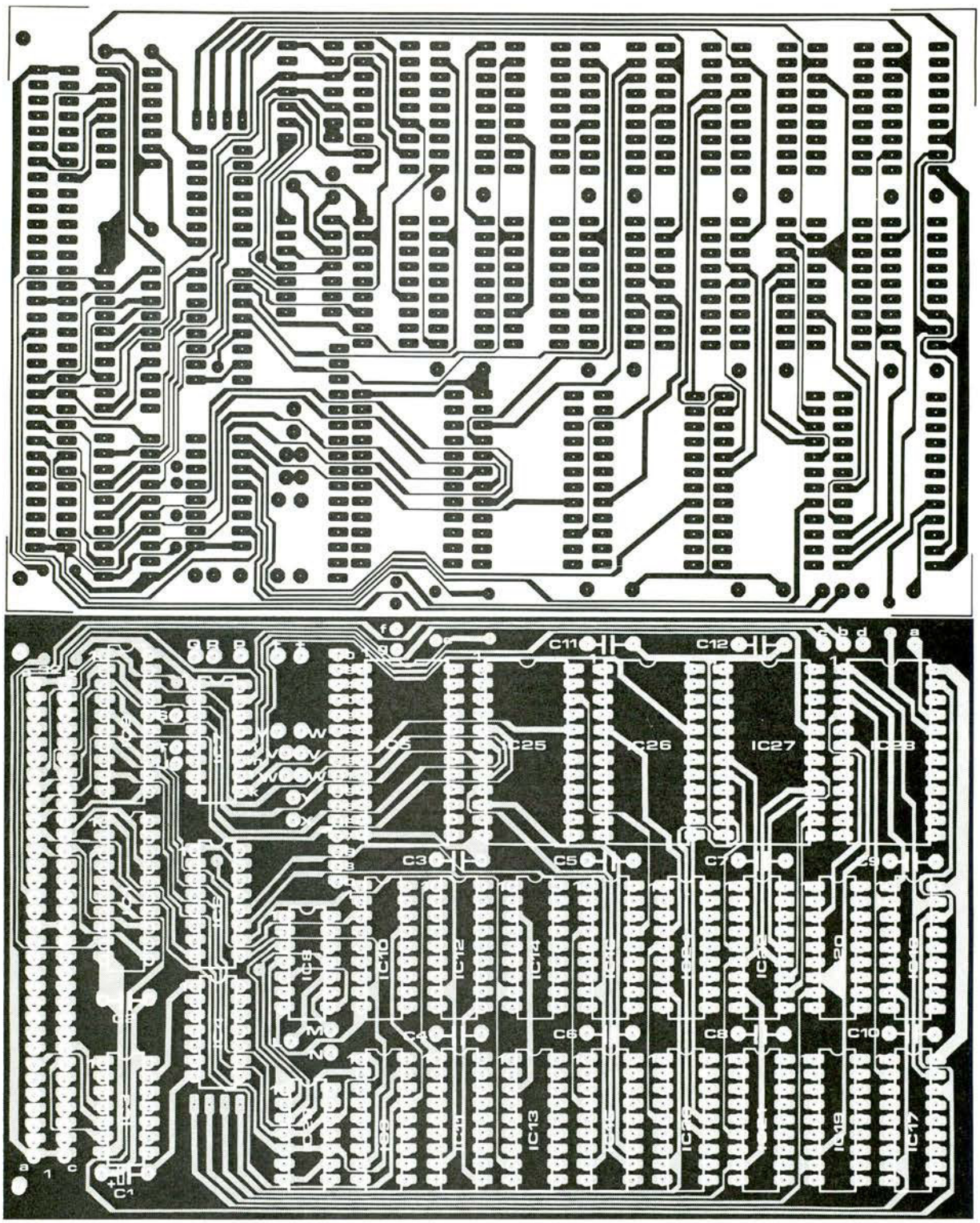


Figure 2. The printed circuit board and component layout for the RAM/EPROM card. There is room for 8 k of RAM and up to 16 k of EPROM on the (double sided) board.

Parts list

Capacitors:
C1 = 1 μ/10 V tantalum
C2 . . . C12 = 100 n

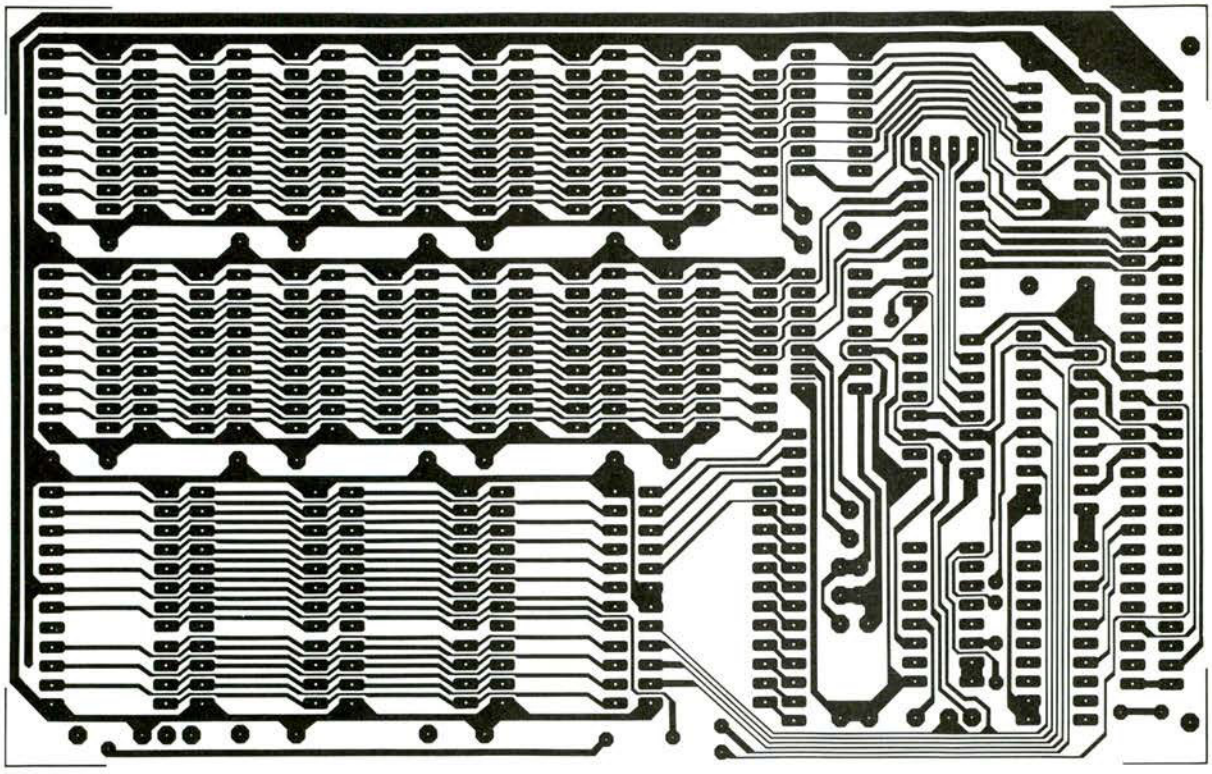
Semiconductors:
IC1,IC2 = 74LS241
IC3,IC4 = 74LS243
IC5 = 74154
IC6,IC7 = 74(LS)155
IC8 = 74LS08
IC9 . . . IC24 = 2114 (RAM)
IC25 . . . IC28 = 2708, 2716 or 2732 (EPROM see text)
IC29 = 74LS00

(All parts available from Technomatic)

in the write mode (via gates N3 and N5) to ensure that the card is unable to interfere with the data bus. When the card is being addressed, the buffers are switched to the read mode. Data can then only be entered into the RAM section when a WRITE signal is present (via N4). The two wire links shown at the inputs to N4 enable the memory card to be used with the Elektor SC/MP system or the Junior Computer (both inputs connected to 31a), or with most other microprocessor systems.

Arranging the memory blocks

The way in which the address decoding is done on this card makes for a large degree of flexibility — provided you



know what you're doing! The first thing to realize is that IC5 divides the address area into 4kByte blocks, and that N1 (with inputs V and W) selects one or more of these for the EPROMs, whereas N2 (inputs X and Y) selects two 4kByte blocks for the RAM. In general:

IC5 output	4kByte address block	2x 4kByte RAM area selected by: X	Y
Ø	ØØØØ . . . ØFFF	Ø	
1	1ØØØ . . . 1FFF		1
2	2ØØØ . . . 2FFF	2	
3	3ØØØ . . . 3FFF		3
4	4ØØØ . . . 4FFF	4	
5	5ØØØ . . . 5FFF		5
6	6ØØØ . . . 6FFF	6	
7	7ØØØ . . . 7FFF		7
.	.	.	
.	.	.	
.	.	.	
F	FØØØ . . . FFFF		F

For each type of memory block, some specific points must be noted:

RAM area

Two 4kByte blocks are required, one for IC9 . . . IC16 and one for IC17 . . . IC24. One of these blocks must be on an even-numbered page (Ø, 2, 4, etc.) and the other on an odd page. For example, X = 4 and Y = 5 would define a consecutive RAM area from 4ØØØ . . . 5FFF.

EPROMs type 2708

For four of these 1kByte EPROMs, a 4kByte address field is required. This is selected by connecting one of the outputs from IC5 to N2 ('V'); the other input to N2 ('W') is either connected to V or, via a wire link, to positive supply. The 4kByte field is further subdivided by IC7 (connected to address lines A10 and A11), to select the EPROMs as follows:

IC25 VØØØ . . . V3FF
IC26 V4ØØ . . . V7FF

4kByte EPROM area for 2708s V	2x 4kByte EPROM area for 2716s V	W
Ø	Ø	
1		1
2	2	
3		3
4	4	
5		5
6	6	
7		7
.	.	
.	.	
.	.	
F		F

IC27 V8ØØ . . . VBFF
IC28 VCØØ . . . VFFF

EPROMs type 2716

An 8kByte address field is required in this case (4 x 2kByte). The same principles apply as discussed above for the RAM area: V must be connected to an even-numbered output from IC5, and W to an odd-numbered output. For example, if V = 2 and W = 7, the four EPROMs will correspond to the following address fields:

IC25 2ØØØ . . . 27FF
IC26 7ØØØ . . . 77FF
IC27 28ØØ . . . 2FFF
IC28 78ØØ . . . 7FFF

Note that IC25 and IC27 form a 4kByte pair, as do IC26 and IC28.

EPROMs type 2732

Each of these ICs corresponds to a 4kByte address field – in other words, to one output from IC5! In this case, no further subdivision of this field is required, so that IC7 becomes redundant! N1 is not required either, but its two inputs (V and W) must be connected to +5 V by means of wire links.

The four 4kByte blocks required can be programmed by wire links direct from the corresponding outputs of IC5 to the holes intended for pins 9 . . . 12 of IC7 (k . . . n). Pin 9 (k) corresponds to IC25, pin 10 (l) to IC26, etc. This means that if, say, IC28 is to be located on the last page, a wire link must be taken from output F of IC5 to pin 12 (n) of the IC7 position.

Wire links and unused positions

An important point to note is that unused inputs should not be left floating. This was already mentioned above, as regards N1 and N4. The same obviously applies to N2, if the total RAM area is not to be used as yet: unused inputs must be connected either to +5 V or to an unused output from IC5.

Particular care should also be taken with the wire links at the inputs to IC7 and IC25 . . . IC27. These depend on the type of EPROM used, as follows:

2708: P-Q, S-T, e-f, a-c.
2716: P-R, S-T, e-g, a-d.
2732: e-g, a-b.

Finally, it should be noted that the supply common (0 V) connection to the board must be applied via two sets of connector pins: 4 a/c + 16 a/c *and* 32 a/c. These two sets are *not* interconnected on the board!