

Nascom Microcomputers

NASCOM
MEMORY BOARD
CONSTRUCTION NOTES

<u>CONTENTS</u>	<u>PAGE</u>
Tools needed	2
Preliminary	2
Parts List	3
Layout Diagram	5
Construction	6
Appendices	
1 Link Options	10
2 Power Requirements	11
3 Memory Tests	12

Supplied Separately

Nascom Memory Board Functional Specification

IMPORTANT

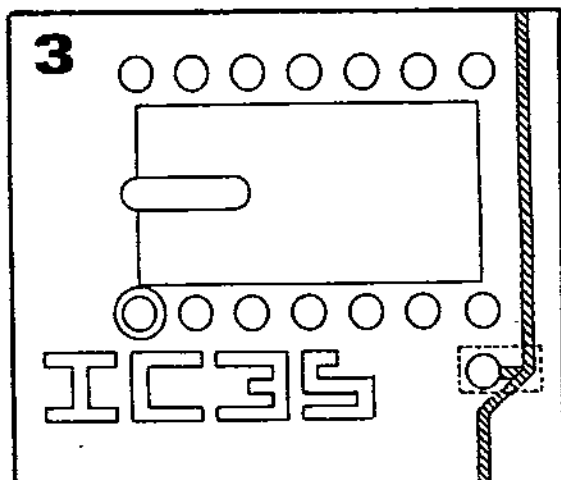
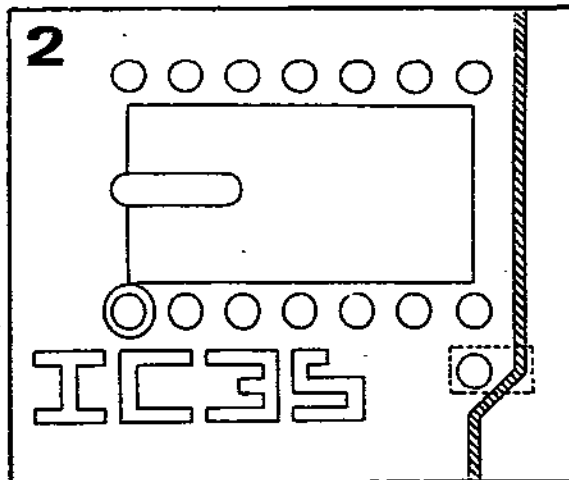
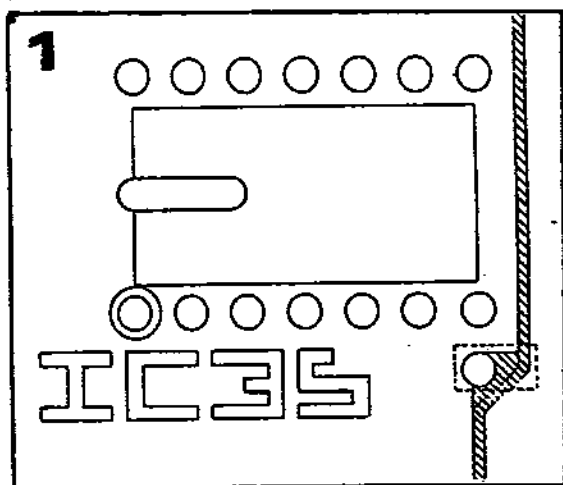
NASCOM RAM BOARD - PCB MODIFICATION

This RAM board has been etched in a manner that does not make a connection necessary for the operation of 4116 devices. Should it be required of the board that these devices be supported, a modification should be made as follows:

The through-plated hole affected is approximately 2mm from pin 7 of IC35 (see diagrams). It is shown enclosed by a dotted rectangle. The hole should have been connected to the track passing immediately to its right (board in normal orientation; diagram 1). The unmodified board is shown in diagram 2.

It is recommended that the solder resist covering the area enclosed by the dotted rectangle be removed by scraping with a small blade, and that, with a very small piece of wire OR a conductive film deposition agent such as RS silver paint, a link be made between track and hole as in diagram 3.

This modification need be implemented only in the case of boards supporting 4116 devices; 8K boards do not need the link to be added.



Nascom Microcomputers

21 High Street, Berkhamsted, Herts, HP42D, UK

Telephone: 07442370843 Telex: 837571

92 Broad Street,
Chesham, Bucks.

Tel: 02405 75151

Tools Needed

1. Long nose pliers
2. Side cutters
3. Soldering iron/bits. (The maximum bit size advisable for use on the integrated circuits is 1/16", although a 1/8" bit could be used on the component leads).
4. A damp sponge or cloth - to keep the soldering iron bit clean.
5. A powerful light source - for example, an angle-poise lamp.
6. A magnifying glass may prove useful.

Preliminary

1. Unpack kit and check components against the parts list. Brackets () are provided along side the list to tick as the components are checked. Do not handle the memory devices (4027/4116) any more than is necessary. If possible check them in their antistatic packing; if not, return them to their packing immediately after checking.
2. Inspect the printed circuit board carefully for signs of damage.
3. Read carefully through all literature provided before beginning construction.
4. Note that no additional flux should be used with the resin-core solder provided.
5. The component side of the double-sided through-plated printed circuit board is identified by the silk-screening. The other side, with the gold-plated edge connector, is the side on which all soldering is to take place.
6. Brackets () are provided alongside the various stages of the construction guide to assist in checking off each stage of assembly. Grid references are also given to assist in locating each device, and refer to the diagram on page 5 .

PARTS LIST - ALL MEMORY KITS

Integrated Circuits

CHECK	NO. USED	TYPE	PINS	CIRCUIT REF.	DESCRIPTION
()	1	74LS00	14	IC37	Quad.2 input NAND gate
()	2	7402	14	IC32,33	Quad.2 input NOR gate
()	1	74LS04	14	IC34	Hex inverter
()	1	7406	14	IC35	Hex inverter buffer driver
()	1	74LS20	14	IC36	Dual 4 input NAND gate
()	1	74LS74	14	IC31	Dual D type flip-flop
()	1	74LS75	16	IC25	Quad bistable latch
()	2	74LS156	16	IC22,23	Dual 1 of 4 decoder
()	1	74LS139	16	IC24	Dual 1 of 4 decoder
()	2	74157	16	IC20,21	Quad 2 input multiplexer
()	1	74LS367	16	IC3	Hex buffer (tri-state)
()	3	81LS97	20	IC1,2,26	Octal buffer (tri-state)

Resistors

(All $\frac{1}{4}$ Watt, 5% Tolerance, High Stability Carbon Film)

CHECK	NO. USED	VALUE	CIRCUIT REF.	MARKING
()	9	33R (33 ohms)	R7,8,9,10,11, 12,13,14,17	OR/OR/BLK/GOLD
()	4	1K0(1.0k ohms)	R1,2,15,16	BRN/BLK/PED/GOLD
()	1	2k2	R5	RED/RED/RED/GOLD
()	1	4k7	R6	YLW/PUR/RED/GOLD

CAPACITORS

CHECK	NO. USED	VALUE	CIRCUIT REF.	TYPE
()	11	10nF	-	Ceramic disc
()	40	100nF (=0.1uF)	A,B,C,	Ceramic disc
()	4	2.2uF	D,E	Tantalum Bead

Sockets

CHECK	NO. USED	TYPE	CIRCUIT REF.
()	7	14 Pin	IC. 31-37
()	23	16 Pin	IC. 3-25
()	3	20 Pin	IC. 1,2,26
()	4	24 Pin	IC. 27-30

Miscellaneous

CHECK	NO.	DESCRIPTION
()	1	8" x 8" double sided through plated printed circuit board with solder resist mask on both sides and silk screening on component side.
()	1	80 Way connector.
()	1	length of 22 gauge solder with multicore flux.

Parts list - Options

8k Memory kit - As basic, plus:

CHECK	NO.	TYPE	PINS	CIRCUIT REF.	DESCRIPTION
()	16	4027	16	IC's 4-11, 12-19	4096 bit dynamic RAM

16k Memory kit - As basic, plus:

()	8	4116	16	IC's 4-11	16,384 bit dynamic RAM
-----	---	------	----	-----------	------------------------

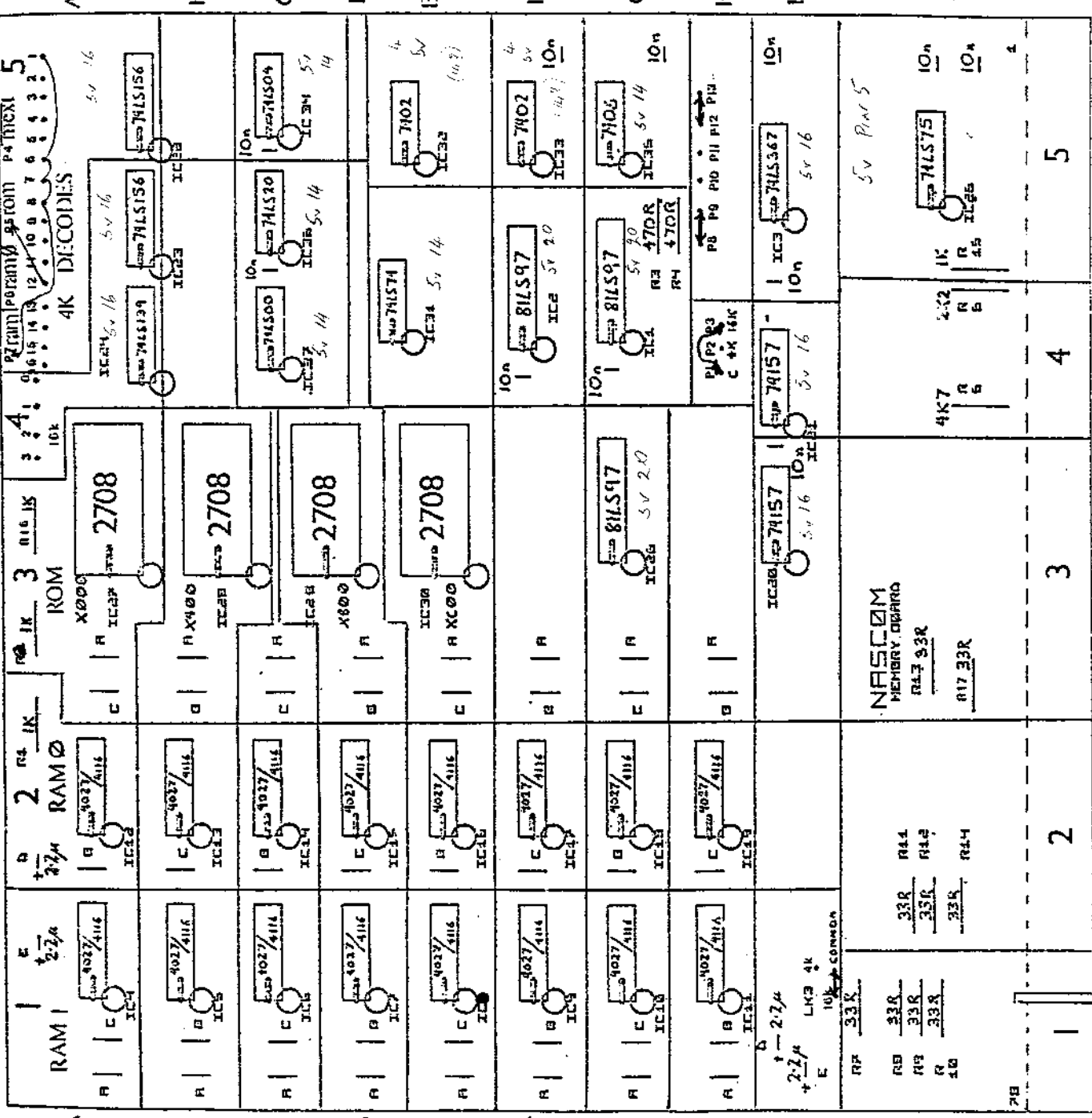
32k Memory kit - As 16k memory kit plus:

()	8	4116	16	IC's 12-19	16,384 bit dynamic RAM
-----	---	------	----	------------	------------------------

EPR0M options

()	Up to 4	2708	24	IC's 27-30	8x1024 bit EPROM
-----	---------	------	----	------------	------------------

φ



CHECK PARTS
CONNECTION OF DC CAP

5	4	3	2	1
---	---	---	---	---

C C C C C C C C C C

Construction

Resistors

All resistors may be inserted either way round. They may be prepared for soldering by bending the leads to a separation of $\frac{1}{2}$ ". This can be done with the aid of long nose pliers, care being taken not to damage the component by bending leads too close to the component body. After soldering, leads should be cut off about 0.1" from the underside of the board.

<u>Check</u>	<u>Resistor No.</u>	<u>Value</u>	<u>Colour Code</u>	<u>Board location</u>
()	R1	1K0	BRN/BLK/RED/GOLD	A2
()	R2	1K0	BRN/BLK/RED/GOLD	A3
	*R3	470R	YLW/PUR/BRN/GOLD	G4
	*R4	470R	YLW/PUR/BRN/GOLD	G4
()	R5	2K2	RED/RED/RED/GOLD	J4
()	R6	4K7	YLW/PUR/RED/GOLD	J4
()	R7)	33R	OR/OR/BLK/GOLD	J1
()	R8)			
()	R9)			
()	R10)	33R	OR/OR/BLK/GOLD	J2
()	R11)			
()	R12)			
()	R13	33R	OR/OR/BLK/GOLD	J3
()	R14	33R	OR/OR/BLK/GOLD	J2
()	R15	1K0	BRN/BLK/RED/GOLD	J5
()	*R16	1K0	BRN/BLK/RED/GOLD	A3
()	R17	33R	OR/OR/BLK/GOLD	J3

*These resistors are not supplied, as they are not required for the 4027 or 4116 dynamic RAMs. They should be fitted only for memory devices requiring a +12V RAS signal.

On the PCB there are three through plated holes in line with the silk-screen legend for R16. The two outside holes should be used for mounting R16.

Links

There are several links on the board to select between the various types of memory device and to locate the memory blocks at various locations. See "Link Options" on page 10 for a fuller description of these.

<u>CHECK</u>	<u>DESCRIPTION</u>	<u>BOARD LOCATION</u>
()	68R Link 1 - RAS option (normally P8-P9)	H5
()	68R Link 2 - RAS option (normally P12-P13)	H5
()	Link 3 - 4K/16K device select	I1
()	Link 4 - 4K/16K device select	H4
()	P4 Nascom 1 MEXT select	A5
()	P5 4K ROM block select	A5
()	P6 RAMs IC12-19 select	A5
()	x P7 RAMs IC4-11 select	A5

I.C. Sockets

On the PCB pin 1 of each I.C. is indicated by a circle at one corner. All integrated circuits are mounted with the same orientation. Pin 1 of each socket is usually indicated by orientation marks in the plastic moulding. When inserting the sockets take care not to bend any pins.

<u>Check</u>	<u>Socket No.</u>	<u>No. of pins</u>	<u>Board location</u>
()	1,2	20	G5, F5
()	3	16	I5
()	4-11	16	A1-H1
()	12-19	16	A2-H2
()	20,21	16	I3, I4
()	22-24	16	A3, A4, A4
()	25	16	J5
()	26	20	G3
()	27-30	24	A3-E3
()	31-35	14	E4, E5, F5, C5, G5
()	36, 37	14	C4

Capacitors

All capacitors (apart from the four tantalum bead electrolytics) may be inserted either way round. The four tantalum capacitors are mounted with the plus sign or other marking facing away from the edge of the board with the gold-plated edge connector. If a multi-meter is available all capacitors should be tested for short circuits before insertion.

<u>Check</u>	<u>Value</u>	<u>Board marking</u>	<u>Board location</u>
()	2.2u F Tantalum	D	A2
()		E	A1
()		D, E	I1
()	10u F Ceramic	-	C4, C5, F4, F5
()			G4, G5, I3
()			I5, I5, J5, J5
()	100n F Ceramic	A, B, C	2 x A1-H1
()			2 x A3-H3
()		B, C	A2-H2

Note: The markings (ABCDE) on the board denote which supply rail the capacitor is decoupling.

- A=0.1u OV to + 5V
- B=0.1u OV to + 12V
- C=0.1u OV to - 5V
- D=2.2u OV to -5V
- E=2.2u OV to + 12V

The mark (-) denotes a 10uF capacitor. OV to + 5V

() Test 1 At this stage the memory board should be plugged into the Nasbus and the power switched on (see "power requirements" on page 11). The voltages of the nasbus should be checked to ensure that there are no short circuits on the board between the supply rails. The power should then be switched off and the board removed from the nasbus.

TTL Integrated Circuits.

All integrated circuits are mounted with the same orientation. On the PCB, pin 1 of each I.C. is indicated by a circle in one corner. Each IC has pin 1 indicated either by a small nick in the corresponding end of the IC or a circular mark close to pin one.

<u>Check</u>	<u>Circuit Ref.</u>	<u>I.C. Type</u>	<u>Board Location</u>
()	IC1	81LS97 -	G4
()	IC2	81LS97 -	F4
()	IC3	74LS367 -	I5
()	IC20	74157 -	I3
()	IC21	74157 -	I4
()	IC22	74LS156 -	A5
()	IC23	74LS156 -	A4
()	IC24	74LS139 -	A4
()	IC25	74LS75 -	J5
()	IC26	81LS97 -	G3
()	IC31	74LS74 -	E4
()	IC32	7402 -	E5
()	IC33	7402 -	F5
()	IC34	74LS04 -	C5
()	IC35	7406 -	G5
()	IC36	74LS20 -	C4
()	IC37	74LS00 -	C4

- () Test 2. The decoding can be partially tested at this stage. First of all link 5 on the NASCOM 1 should be changed from internal memory to external memory. The memory card should be plugged into the NASBUS and the system powered up. The screen should clear, with the prompt and cursor in the bottom left hand corner as normal. All commands should operate as normal. However, instead of the NASCOM 1 4K memory block being repeated every 4K, it should appear only once, from 0000 to 0FFF. Therefore, tabulating 0 to 60 will give the first 96 bytes of NASBUG (i.e. 31 33 ØC 21 etc) whereas tabulating 1000 to 1060, 2000 to 2060, etc.. will not any more.
- () Switch off the power and remove the memory board.

Memory devices

The dynamic RAMs supplied with the memory kit are MOS devices and the MOS IC handling precautions outlined in the NASCOM 1 Construction Notes (Page 28, Note 4) should be adhered to. These are expensive devices and great care should be taken with them.

8K or 32K Option

- () The 16 memory I.C's (4027 or 4116) should be inserted in IC positions 4-11 and 12-19.

16K Option

- () The 8 memory I.C's (4116) should be inserted in IC positions 4-11.

The memory board is now complete and can be plugged into the NASBUS for final testing. Comprehensive test routines are listed in the Appendix.

APPENDIX 1

Link Options

A full description of all link functions and address selection is given in the Memory Card Functional Specification. Listed below is a summary of the linking required for each memory board option, and the recommended addressing structure for the first memory card in an expanded system.

8K Memory Board (16 x 4027)

Link 1 - RAS option	P8-P9		
Link 2 - RAS option	P12-P13		
Link 3 - 4K/16K device select	Common	- 4K	
Link 4 - 4K/16K " "	P1-P2		
Nascom MEM select	P4-5		(0000 - 0FFF)
4K Rcm Block select	P5-12 10		(F000 - FFFF)
RAMs IC4-11 select	P7-6		(1000 - 1FFF)
RAMs IC12-19 select	P6-7		(2000 - 2FFF)

16K Memory Board (8 x 4116)

Link 1 - RAS option	P8-P9		
Link 2 - RAS option	P12-P13		
Link 3 - 4K/16K device select	Common	- 16K	
Link 4 - 4K/16K " "	P1-P3		
Nascom MEM select	P4-5 16K nascom 2		(0000 - 0FFF)
4K Rcm Block select	P5-12 10		(F000 - FFFF) (D000 - 0FFF)
RAMs IC4-11 select	P7-6,7,8,1		(1000 - 4FFF)

32K Memory Board (16 x 4116)

As 16K above plus:

RAMs IC12-19 select	P6-2,3,4,13		(5000 - 8FFF)
---------------------	-------------	--	---------------

APPENDIX II

Power Requirements

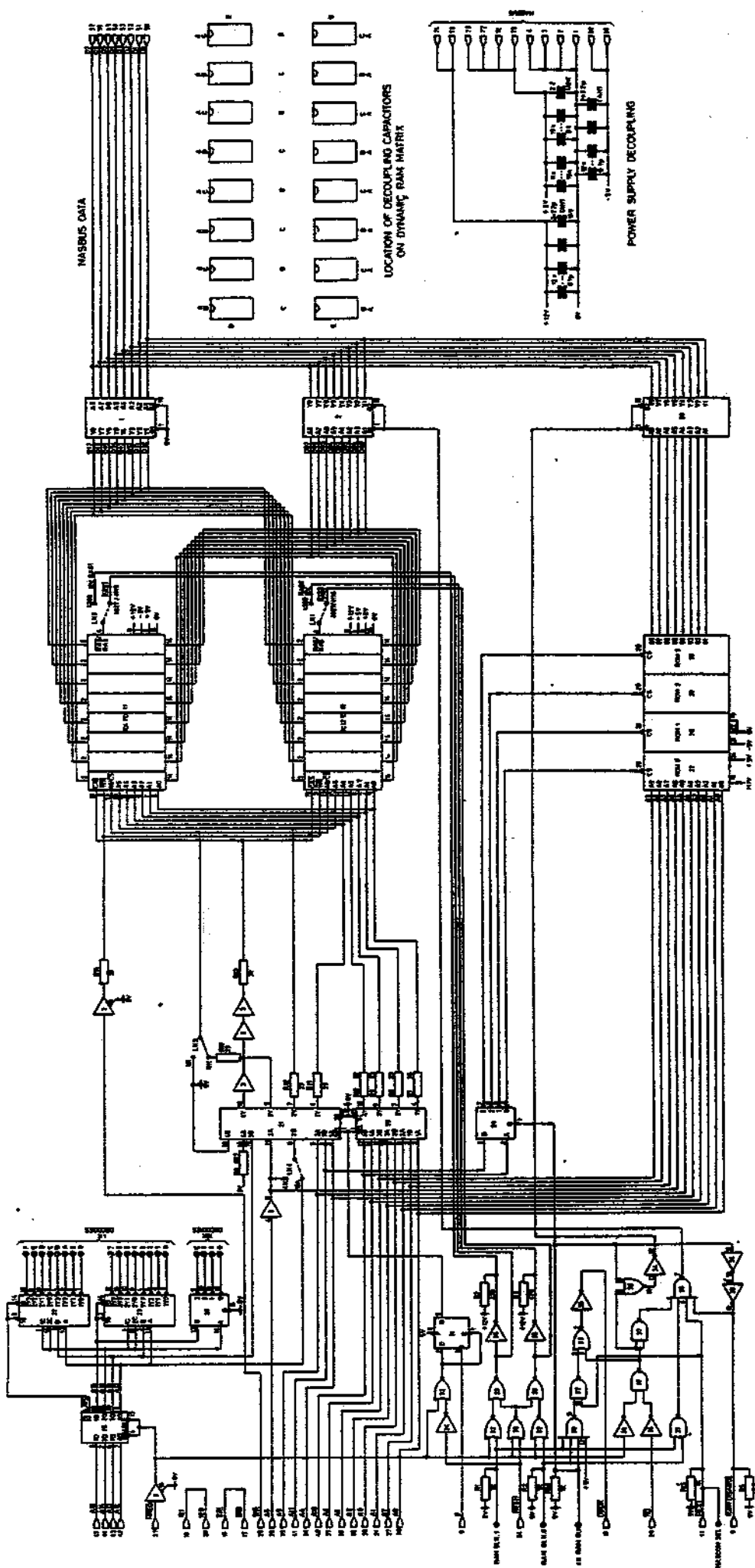
The power requirements for a Nascom 1 with extended memory are listed below:

<u>Nascom 1</u>	+12V	100mA
(with 2 EPROMS)	+ 5V	820mA
	- 5V	40mA
	-12V	15mA

<u>Buffer Board</u>	+ 5V	200mA
---------------------	------	-------

Ram Board

with 32K and 4K EPROMS	+12V	200mA
	+ 5V	170mA
	- 5V	70mA



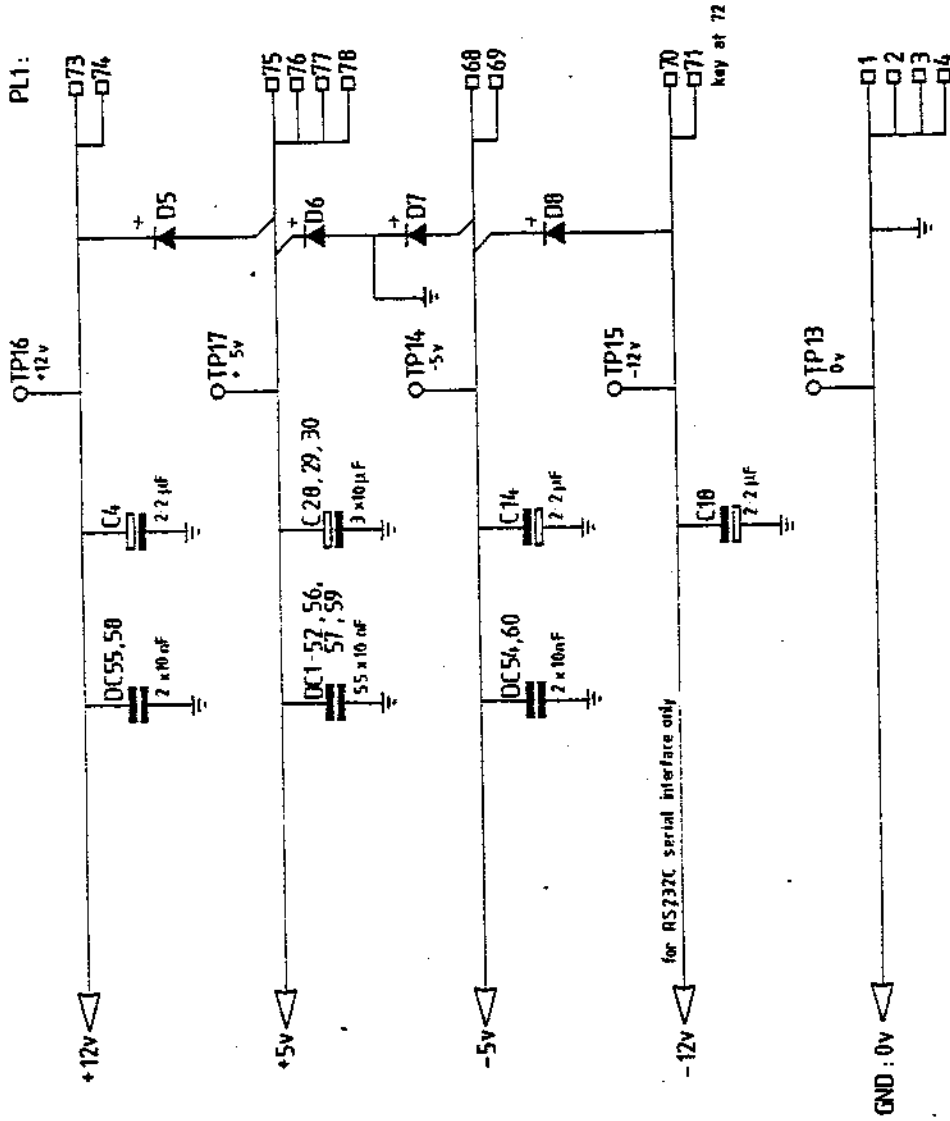
NASBUS DATA

LOCATION OF DECOUPLING CAPACITORS ON DYNAMIC RAM MATRIX

POWER SUPPLY DECOUPLING

RAM BOARD

NASCOM MICROCOMPUTERS
 16 BIT MICROCOMPUTER SYSTEM
 1977



D5-7: 4 x 1N4001

Nascom Microcomputers 121 High Street Berkmansd Herts		NASCOM 2-Power Distribution		Issue 6	Sheet 5 of 5	Drawn	Checked	Date 11-10-79
				Revisions:		Drawing no. 4-022-103		

Handwritten marks and signatures are present on the right side of the page, including a large '5' and a signature.

4. SUMMARY OF WIRE LINK OPTIONS4.1 4k/16 select

For 4k chips	Link P1 to P2	Link 3	Common to 4k
For 16k chips	Link P1 to P3	Link 3	Common to 16k

4.2 Memory Block Selects

P4	Nascom MEM	select	<i>NOT REQUIRED FOR NASCOM 2</i>
P5	4k ROM block	select	
P6	RAMS IC 12-19	select	
P7	RAMS IC 4-11	select	

4.3 Row Address Strobe options

For 'normal' RAS (4027/4116)	ICs 4-11	Link P12-13	<i>68K</i>
For 'normal' RAS (4027/4116)	ICs 12-19	Link P 9-P8	<i>68K</i>
For +12V RAS	ICs 4-11	Link P12-P11	
For +12V RAS	ICs 12-19	Link P 9-P10	

TABLE 3.1

4k memory decode pads

<u>Pad No.</u>	<u>4k Block Memory Address (Hexadecimal)</u>
1	4000-4FFF
2	5000-5FFF
3	6000-6FFF
4	7000-7FFF
5	0000-0FFF
6	1000-1FFF
7	2000-2FFF
8	3000-3FFF
9	C000-CFFF
10	D000-DFFF
11	E000-EFFF
12	F000-FFFF
13	8000-8FFF
14	9000-9FFF
15	A000-AFFF
16	B000-BFFF

TABLE 3.2

16k memory decode pads

<u>Pad No.</u>	<u>16k Block Memory Address (Hexadecimal)</u>
0	0000-3FFF
1	4000-7FFF
2	8000-BFFF
3	C000-FFFF

TABLE 3.3

'Wired-OR' Address Selection for 16k Chips

<u>Memory Block Addresses (Hexadecimal)</u>	<u>4k decodes linked together</u>
0000-3FFF	5,6,7,8
1000-4FFF	6,7,8,1
2000-5FFF	7,8,1,2
3000-6FFF	8,1,2,3
4000-7FFF	1,2,3,4
5000-8FFF	2,3,4,13
6000-9FFF	3,4,13,14
7000-AFFF	4,13,14,15
8000-BFFF	13,14,15,16
9000-CFFF	14,15,16,9
A000-DFFF	15,16,9,10
B000-EFFF	16,9,10,11
C000-FFF	9,10,11,12

APPENDIX III

Memory Tests *NOT NASCOM 2 (CALLS TO MONITOR NEED ALTERNATE)*

Attached are two test routines to verify correct operation of the memory.

The first test writes into each location of memory a byte which is related to the address of that location and then checks, byte by byte, that the same data reads back. This test therefore checks that each byte is uniquely addressable.

The second test writes all 256 byte combinations (i.e. 00 to FF) into each memory location and checks that the same data reads back. This test therefore checks that every bit of the memory can be set or reset.

Execution

After loading either program, execution is started by typing:

1000 4FFF
ED~~00~~ XXXX YYYY (New line)

where XXXX is the address of the first location to be tested, and YYYY the address of the last location.

Note that these tests destroy any data or program in the tested memory area.

After either program has cycled through the specified memory once, an asterisk "*" will be printed on the screen to indicate that one 'pass' has been completed. The test is repeated indefinitely until the user resets the Nascom.

Error Printouts

If an error is found the following printout occurs:

AAAA EE DD

where AAAA is the address of the byte in error, EE is the data written to that address (and expected back), and DD is the actual data read back. A delay of approximately one second is included in the error printout.

Program running indicator

When testing a large amount of memory both programs will run a long time before printing the first asterisk. The program should therefore be tested on a small area of memory (say OE00 to OE20), before testing the complete memory board.

During running the first memory test routine has a "program running indicator" which appears in the centre of the screen on the top line. This takes the form of a O alternating with a ⊙ and so gives the impression of a O with a dot flashing in the centre of it.

```

0001 ;
0002 ; MEMORY TEST PROGRAM FOR NASCOM
0003 ; BASED ON TEST IN MOSTEK 1978
0004 ; MEMORY DATA BOOK & DESIGNERS
0005 ; GUIDE PAGE 225.
0006 ;

```

```

0007 ORG 0000H
0008 TEST: LD B,0 ;PATTERN MODIFIER
0009 LD A,4FH ;SET UP SCREEN FLAG
0010 LD (0BE0H),A ;PUT IT THERE
0011 LOOP: LD HL,(0C0EH) ;GET START ADDRESS
0012 LD DE,(0C10H) ;GET END ADDRESS
0013 INC DE ;DE=END+1
0014 PUTIN: LD A,L ;CALCULATE DATA
0015 XOR H ; FROM ADDRESS &
0016 XOR B ; PATTERN MODIFIER
0017 LD (HL),A ;PUT IT IN MEMORY
0018 INC HL ;INC POINTER
0019 OR A ;CLEAR CARRY
0020 SBC HL,DE ;COMPARE HL & DE
0021 ADD HL,DE
0022 JR NZ,PUTIN ;Z MEANS WE'VE DONE
0023 LD HL,(0C0EH) ;GET START AGAIN
0024 RDBACK: LD A,L ;CALCULATE DATA
0025 XOR H ; FROM ADDRESS &
0026 XOR B ; PATTERN MODIFIER
0027 LD C,A ;SAVE IN C
0028 LD A,(HL) ;GET DATA FROM MEMORY
0029 CP C ;SEE IF IT'S OK
0030 CALL NZ,ERROR ;ANY ERRORS?
0031 INC HL ;INC POINTER
0032 OR A ;CLEAR CARRY
0033 SBC HL,DE ;COMPARE HL & DE
0034 ADD HL,DE
0035 JR NZ,RDBACK ;Z MEANS WE'VE DONE
0036 LD A,(0BE0H) ;GET SCREEN FLAG
0037 XOR 40H ;TO SHOW ACTIVITY
0038 LD (0BE0H),A ;PUT IT BACK
0039 DJNZ LOOP ;CHANGE PATTERN MODIFIER
0040 RST 28H ;PRINT A '*' FOR
0041 DB '*' ,0 ;END OF PASS
0042 JR TEST ;DO IT ALL AGAIN

```

```
0043 ;
```

```
0044 ; ERROR PRINTOUT
```

```
0045 ;
```

```
0046 ; ADDR EXPECTED FOUND
```

```
0047 ;
```

```

003C E5 0048 ERROR: PUSH HL ;SAVE ALL REGISTERS
003D D5 0049 PUSH DE
003E C5 0050 PUSH BC
003F F5 0051 PUSH AF
0040 7C 0052 LD A,H ;A=HI BYTE OF ADDR
0041 CB4402 1903 0053 CALL 244H ;PRINT IT IN HEX
0044 7D 0054 LD A,L ;A=LO BYTE OF ADDR
0045 CB4402 1903 0055 CALL 244H ;PRINT IT IN HEX
0048 CB3E02 0603 0056 CALL 23CH ;SPACE
0049 79 0057 LD A,C ;A=EXPECTED DATA

```

```
CROMENCO CDS Z80 ASSEMBLER version 02.15
```

```
PAGE 0002
```

```

004C CB4402 1903 0058 CALL 244H ;PRINT IT IN HEX
004F CB5E02 0603 0059 CALL 23CH ;SPACE
0052 F1 0060 POP AF ;A=DATA FOUND
0053 CB4402 1903 0061 CALL 244H ;PRINT IT IN HEX
0056 CB4402 1103 0062 CALL 240H ;NEW LINE
0059 010000 0063 LD BC,0 ;DELAY LOOP
005C 0B 0064 WAIT: DEC BC ;COUNT DOWN BC
005D 78 0065 LD A,B ; UNTIL ZERO
005E B1 0066 OR C
005F 20FB 0067 JR NZ,WAIT
0061 C1 0068 POP BC ;RESTORE REGS
0062 B1 0069 POP DE
0063 E1 0070 POP HL
0064 C9 0071 RET
0065 (0000) 0072 END

```

```

0001 ;
0002 ; MEMORY TEST PROGRAM FOR NASCOM
0003 ;
0004 ORG 0000H
0005 KTEST: LD C,0 ;C HOLDS DATA
0006 OUTER: LD HL,(000EH) ;GET START ADDRESS
0007 LD DE,(0010H) ;GET END ADDRESS
0008 INC DE
0009 INNER: LD A,C
0010 LD (HL),A ;PUT INTO MEMORY
0011 LD B,(HL)
0012 CP B
0013 CALL NZ,ERROR
0014 INC HL
0015 OR A
0016 SBC HL,DE
0017 ADD HL,DE
0018 JR NZ,INNER ;KEEP FILLING
0019 INC C
0020 LD A,C
0021 OR A ;SET FLAGS
0022 JR NZ,OUTER
0023 RST 28H
0024 DB ' ',0
0025 JR OUTER
0026 ;
0027 ; ERROR PRINTOUT
0028 ;
0029 ; ADDR EXPECTED FOUND
0030 ;
0031 ERROR: PUSH HL
0032 PUSH DE
0033 PUSH BC
0034 LD A,H
0035 CALL 244H
0036 LD A,L
0037 CALL 244H
0038 CALL 23CH
0039 LD A,C ;EXPECTED
0040 CALL 244H
0041 CALL 23CH
0042 LD A,B ;FOUND
0043 CALL 244H
0044 CALL 240H
0045 LD BC,0
0046 WAIT: DEC BC
0047 LD A,B
0048 OR C
0049 JR NZ,WAIT
0050 POP BC
0051 POP DE
0052 POP HL
0053 RET
0054 END

```

Errors 0

MEMORY PLAGUE

"Memory Plague" is a euphemism for the unexplained failure of about 10% of Nascom memory boards, and its causes are to say the least obscure. It would seem that noise caused by switching transients from the data latches (81LS97) and the address multiplexers (74LS157) may be breaking onto the data bus via IC2. Board layout may be to blame, in conjunction with chips that just happen to be on the low side of average for noise immunity.

Identifying "Memory Plague" is not as easy as it would at first appear because a memory suffering from mild plague may pass both memory test programs in the construction manuals with flying colours and run Tiny Basic with little difficulty. This is because both memory tests and Tiny Basic are loading operands to memory, and not actually executing M1 (op-code fetch) cycles. M1 cycles are more critical on timing and hence more susceptible to corruption caused by noise. Likewise "Memory modify" and "Copy" commands are unlikely to cause problems except in severe cases. So the only thing likely to reveal "Memory Plague" is a program with lots of M1 cycles and filling a sizeable chunk of memory. ZEAP is ideal for this. If you do not have ZEAP, then write a simple relocatable program that may be copied throughout memory, finishing with the printing of an * then looping back to the start. Leave this running as long as possible. If the program "crashes", then provided you have eliminated mains noise as the cause, then its likely that "Plague" has struck.

None of the cures for this are technically elegant, but they do work. They should be tried in order until the problem is cured. Don't go in for overkill, as this is unnecessary and undesirable.

1. Go for a National 81LS97 in the IC2 position (AMD devices seem to have lower noise immunity although AMD deny this). You have 7 81LS97s in total, 3 on the Nascom, 1 on the buffer, and 3 on the memory. One of these at least is likely to be made by National. Swap these ICs about for the best results in the IC2 position.

2. Grid off the Ground and +5 volt supplies. On the underside of the pcb it will be noted that the GND and +5V rails supplying the TTL ICs terminate at the end of each row. Wire links can be fitted to connect these rails to the equivalent rails supplying the RAM chips, thus completing the "grid" on the power supply rails, thereby reducing power supply noise. Take care not to short out the power supply rails by "gridding" to the wrong tracks.

3. The 74LS04 on the buffer board may be replaced with a 74S04. Unfortunately this increases the loading on the Z80 but it does tidy up the MREQ waveform.

4. On ICs4-11 only, fit a 4K7 resistors from pin 9 to pin 14 of each chip, thus pulling the outputs of the RAMs to +5V.

5. On ICs4-11 only, in addition to 4 (above), fit 47pF ceramic capacitors from pin 14 to pin 16, thus producing a time constant on the RAM output.

Various combinations of these cures have been tried with 100% success on the faulty boards that we have examined and, although not 'elegant' solutions, they have transformed unreliable memory boards into fully functional units.

All Nascom Distributors are aware of these problems and if you have any difficulty they will be more than willing to assist you in finding a solution.