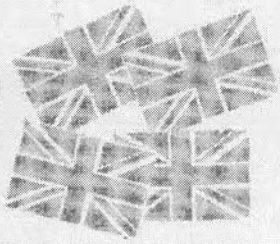
HAND BOOK

British Home MICROCOMPUTER



NASCOM 1

CONSTRUCTION NOTES

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NASCOM 1 MICROCOMPUTER CPU BOARD HANDBOOK Issue 1: February 1978

INTRODUCTION

The Nascom 1 was designed with the hobbyist in mind. However, the ameteur at home is a professional during the day, in most cases, and the computer you are about to build has been constructed to top commercial standards. It has been designed with expansion in mind and we hope you will expand your system once you have decided your area of interest. We also hope you will join the Nascom Users' Club.
This handbook together with circuit diagrams, "NASBUG" monitor software listing, operating instructions and Z80 Microprocessor Technical Manual provide all the fundamental information needed to assemble and operate an extremely powerful yet relatively simple Microcomputer System.
Those who have bought the Nascom 1 ready built and tested should simply disregard the assembly instructions enclosed.

Naturally this handbook will be read by purchasers from widely varying backgrounds, so those new to digital electronics (and perhaps even to the soldering iron) should take very great care over construction and not, repeat not, attempt to rush it. Conversely, those new to software should read up carefully as much background information as they can find in the British and American magazines, in the Amateur Computing Club Newsletter, in the Z80 programming manual and in the example programmes to be made available via the Nascom Users' Club.

CONTENTS

SUPPLIED SEPARATELY

1. Latest Sales Leaflet (For a friend)
2. Customer Further Order Form.
3. MK 3880/Z80 CPU Technical Manual
4. MK 3881/Z80 PIO Technical Manual
5. IM 6402 UART Data Sheet
6. CPU Board and Keyboard Circuit Diagrams.

PART 1: IMPORTANT NOTES FOR CONSTRUCTORS

1. Do not begin construction now. Read through all the documentation at least twice before starting in order to ensure that no fundamental and expensive errors are made.

2. Do not leave MOS integrated circuits out of their anti-static packing. (See MOS handling instructions). If in doubt leave all IC's in their tubes at present.

3. Keep the box in which the Nascom 1 was delivered in case it should have to be returned for repair.

4. Do not attempt to use too large a soldering iron. Utmost care must be taken in soldering as a single dry or unsoldered joint or short circuit can prevent the board from working and can be very difficult to find.

5. Be certain to fit all components on the correct side of the board (The side with the printed information) and to solder them on the other side.

6. Be certain to fit all integrated circuits, transistors, diodes and tantalum bead electrolytic capacitors in the correct locations and the correct way round. Do not hurry over this. Cross check each time between the component lists and the layout drawing.

7. Be certain to connect the power supplies the right way round and with the correct voltages (otherwise all IC's could be damaged).

8. Do not attempt to remove or plug in integrated circuits or perform any soldering with the power supplies to the CPU board switched on.

9. If any difficulty is experienced when plugging an IC into its socket do not use extreme force, although the 40 pin IC's especially require quite firm pressure for final insertion after all pins are correctly aligned. If in doubt remove the IC; check that the pins are straight and parallel and start again. A plastic IC insertion tool may be found useful. Note that all IC's are manufactured with the leads spread apart by a few degrees to suit mechanised handling equipment. They can be bent parallel with care using small pliers or one row at a time by pressing down sideways with care on a flat surface. There should be no bend in the leads at the point where they narrow down - the full 90 degree bend should occur beside the body of the IC. If care is taken no difficulty will be experienced.

10. Before switching on any power supplies hold the board up against a powerful lamp and inspect both sides closely with a magnifying glass for solder splashes, strands of wire, excess solder causing short circuits to nearby tracks, unsoldered joints, incorrectly oriented components and bent IC pins. (To check for the latter look at all IC's end-on).

11. Despite all the warnings given above, the writer has built two Nascom 1's at home without any equipment more sophisticated than a cheap multimeter and a couple of soldering irons. Upon switch-on one worked first time whereas the other required five minutes inspection to discover a 16 pin IC with only 15 pins in the socket. The moral is: more haste, less speed.

12. Do not attempt to work more than 2 or 3 hours at a stretch. A reasonable time for construction would be 20 hours (say a week of evenings) although it may take from under 10 to 40 hours or more depending on previous experience. These times are in addition to the initial "reading, considering and inwardly digesting" time for which at least another 10 hours should be allowed. We repeat that we do not advise construction to begin at all until a few days after receipt of the kit and full reading of the documentation.

13. GOOD LUCK!

PART 2: IMPORTANT NOTES FOR ALL NASCOM USERS

1. The Nascom 1 CPU board and keyboard may be operated on any non-conductive dry, flat surface (e.g. cloth, paper, etc.). Care must be taken however to avoid any short circuits either under the board or on the component side caused by strands of wire, blobs of solder, spilt liquids or dropped coins, pens, or any other metallic objects.

2. When switched on do not place any pieces of paper or cloth over the components as this can cause localised component over-heating and failure.

3. If making a box to house the CPU board remember that it dissipates some 10 Watts of power and so requires good ventilation. If mounted horizontally air must enter at about the level of the board and leave the box as high as possible to allow good convection. Keep the area above the components clear for at least 2 inches. If the power supply is also in the box remember that it will dissipate about as much heat again.

4. The CPU board may be mounted on pillars using the 4 large holes provided near the corners. Take care not to short to printed circuit tracks if metal pillars are used. (E.g. use insulated washers).

5. Let us know how you get on. Write to the Nascom Users' Club with any comments, hardware modification suggestions, useful subroutines (however trivial) programmes, etc. for consideration/ publication. Only with the aid of positive feedback can useful information transfer occur between our relative addresses.

PART 3: DESIGN OF THE NASCOM 1 MICRO COMPUTER *

This article describes the system by first examining the I/O, then memory and lastly the microprocessor itself.

The design aim for the hardware was to include as many features for programme development while keeping the total cost of the components to a minimum. This aim was approached by designing from the peripherals towards the central processor. The peripherals chosen were: Keyboard, serial I/O device, visual display and 16 line parallel I/O. Since price is a function of hardware and this can be minimised by increasing software it would seem that the software should be maximised. There is a feature of software which has to be borne in mind which is that EPROM'S occur in units of 1024 bytes. Again for cost reasons the maximum software monitor programme allowed was decided at 1024 bytes, i.e. the software (or strictly speaking firmware) would be contained in a single type 2708 8 x 1024 bit EPROM.

Peripheral 1 - The Keyboard (Port 0)

The original keyboard design envisaged a single 4017 CMOS counter IC plus 6 transistors as the only active components. Without increase in price it has been found possible to supply a ready built solid state LICON keyboard which uses the magnetic saturation of a pulse transformer in each switch to avoid the use of mechanical contacts and provide virtually unlimited life. It is arranged as a single port peripheral and the port address has been chosen as zero. The hardware realisation shows two IC packages on the CPU PCB to obtain latched outputs and gated inputs thus 14 lines are available for port zero (P0), 8 in and 6 out. Further use has been made of the output lines by choosing a 6 bit latch and using only two of them for the keyboard. These two lines drive the clock and reset inputs of a counter decoder package (KBD IC.4) whose outputs are connected (via KBD IC.5) to columns of keys. The matrix of keys is completed by 6 row pulse sensing lines each driving a transistor amplifier (Within KBD IC's 1 & 9 - monolithic transistor arrays type CA 3086) which is connected via the output flip-flops (KBD IC's 2, 7 and 8) and the keyboard cable to the port input transmission gate. Thus output commands to P0 cause the data bus to be latched in IC 41 while input commands cause the keyboard row lines to drive the data bus. (See also keyboard and CPU board circuit diagrams and section on I/O port addressing).

Thus the CPU has the opportunity to determine which keys on the keyboard are pressed and it is left to software to perform contact bounce elimination and to determine change of state and hexadecimal code assignment for each key according to its position in the effective 8 x 6 matrix in which it is wired.

There are one or two other features of note concerning port 0. IC 40 is an 8 bit buffer so that 2 bits are available to the user and do not interfere with normal keyboard operation. On the output side the other bits of port 0 from IC 41 are used as follows:

Q2 (DB2)	available to user
Q3 (DB3)	a low to high transition on Q3 initiates the hardware single step logic described later.

* This is a modified version of Dr. C.D. Shelton's articles on Microcomputer Design appearing in "Wireless World".

Q4 (DB4)	when Q4 is high a transistor is energised to drive an LED ("DRIVE"). The software uses this to indicate that the user should turn on the tape cassette drive. This can be modified to drive a relay to perform the drive start automatically. (A reed relay consuming less than 60mA at 5V should be used).
Q5 (DB5)	available to user.

Peripheral 2 - the serial I/O device (Port 1 for data + Port 2 for Status)

Since the data in the computing system is organised in bytes 8 bits wide, some method of converting this to use a single wire circuit is extremely useful. The basic requirement is a method for shifting a byte sideways into the single circuit. Such an operation appears identical from the outside whether performed by software shift instructions or by means of a hardware shift register. The availability of the appropriate shift registers at very low cost and the limitation of software space combined to make the decision to use hardware for the parallel to serial conversion. The device chosen is known as a UART (Universal Asyncronous Receiver - Transmitter). It consists essentially of two shift registers, one to transmit and the other to receive, thus transmission and reception can take place simultaneously. To the processor the device is made to appear as two ports: P1 and P2. Data for transmission is output to port 1. Similarly received data is available by taking it from port 1. Port 2 has no output significance but an input command causes UART status to be transferred to the data bus. The main signals of the status word are:

1)	bit 7	signifies that data has been received and can be obtained from P1 ("Data Received").
2)	bit 6	signifies that the transmitter is free to be loaded with data on port 1 ("Transmitter Buffer Register Empty").

Three other bits are connected to the data bus to indicate faulty reception if needed by the software. (See UART data sheet).

The rate at which data is shifted is determined by applying a clock to the receiver and transmitter clock inputs. The source of this clock can be from one of three generators. There is a divider chain operating from a 16 MHz crystal oscillator elsewhere in the system and a 3.90625 kHz clock is taken from this chain for operating the UART at 244.14 bits per second. (The UART always divides its clock frequency by 16 to obtain the bit rate). Since a stop bit and a start bit are added to the byte there are 10 bits in each word transmitted. (By applying +5 volts to pin 36 - i.e. removing LK.2 - this can be increased to 11 bits by adding another stop bit). Note that the Baud rate is 8 x 24.414 whereas the bit rate is 244.14 bits/sec. Since a Baud is a bit/s of information, the start and stop bits should not be included. Thus the transmission rate is 24.414 bytes per second using this clock. The second clock oscillator is a simple 555 timer (IC.33) which can be adjusted using VR.1 to operate at 1760 Hz which, when two stop bits are sent, formats the data for use with teletypes (Bit rate = 110 Hz). The third clock source is simply any clock the user may care to apply via solder post P.1 "Ext. Serial Clock".

Serial Data Signal Conditioning

There are basically two types of device which will be connected to the serial I/O system. These are cassette recorders on the one hand and conventional teletypes or VDUs or serial data inputs to other computers on the other. For cassettes, a modulated tone is required and this is obtained by gating half the 3.9 kHz clock frequency (i.e. 1.95 kHz) with the serial data and this can be attenuated if necessary by the user to suit his audio cassette recorder. The playback signal from such a recorder is a series of tone bursts corresponding to the serial data stream. A tone detector circuit is made up from IC 30 and its associated components to recover conventional logic levels from the tone signal. The serial input to the UART may not be derived from two sources and so the input must be linked to the data source chosen by the user. Conventional serial devices use one of two conventions for data transmission, either RS-232 or 20mA current loop. Both these interfaces are provided by discrete components and can be taken via SK2.

Peripheral 3 - Parallel I/O (Ports 4 & 5 for data, 6 & 7 for control)

The parallel I/O Controller MK 3881 is an LSI package from the Z-80 set. The PIO has its registers' addresses defined by hardware select logic but its function is programmable. The device interfaces the Z-80 to the user's circuits by providing 16 lines via SK.A and SK.B which may be either input or output together with additional handshake signals. The PIO has interrupt logic to deviate programme execution on a change of external logic state if required. (See PIO technical manual for further details).

This concludes description of the port peripherals and their software significance can be summarised by the table headed "I/O Port Addressing".

Peripheral 4 - Visual display

It is required in any computer system of this type that the user be presented with data from the machine. For programme development this may require the presentation of several hundred characters. At the same time the cost of displaying alpha-numeric characters should be minimised. The method chosen for this project is a memory plane peripheral and is not sited on ports as conventional I/O but consists of logic which shares a section of the memory. This logic is designed to present an r.f. modulated composite video signal to a domestic TV receiver in such a way that the contents of this memory section are interpreted as characters. Any possible conflict of access to the memory between the processor and the logic has been resolved by giving the processor absolute priority. As a concession to appearance the video signal is blanked during CPU access. It is as though a section of memory is exactly mapped on to a visible plane. The position of a symbol is a function of the address in memory and the symbol itself is a function of the least significant 7 bits of the data at that location. Extensive software routines have been written in the 'NASBUG' monitor to present data of the right type in the right locations to give the appearance that the TV is acting as a VDU. This assumes that the memory section is not required for any other purpose but if it is it behaves to the CPU like normal memory and the user would not be any the wiser if he turns off his TV. This section is called a video RAM. (See chart headed "Video RAM Display Addressing.").

The video RAM is operated by switching the memory IC address lines between the CPU address bus and a counter/divider chain so that hardware continuously cycles the address lines to the memory. The memory packages themselves are continuously selected so that their output is always available. It is prevented from jamming the CPU data bus by placing a transmission gate, IC.28, between the data bus and the output pins. For each address the output is latched in IC.17 and used as the address of a large ROM called a character generator (IC.16). The output of this ROM has been programmed to be the video dot pattern of part of a character depending on the raster row number and the character. The 8 bit output is loaded into IC 15 (a parallel-in serial-out shift register). The output of this is the black and white information for the TV. ICs 1 - 4, 18 and 19 divide the 16 MHz crystal oscillator to provide the correct cycling of the memory address lines, the shifting of video from IC.15 and by means of other gates they generate video blanking, frame sync and line sync at the appropriate intervals. Compatability with a TV is further assured by the UHF oscillator constructed around Tr.9. Since R 10 is 82 Ohms composite video is available for driving a TV monitor which would give a sharper image. The character organisation and size has been carefully designed to optimise legibility on a domestic TV. ICs 12, 13 and 14 are normally held in the state which connects the memory address lines to the counter/dividers. If the CPU requires to read from or write to the memory these ICs switch the memory address lines to the CPU address bus.

Memory Organisation - See "Memory Map".

Since the first instruction for the Z80 immediately after having been reset is fetched from location 0000H there must be some memory at this address. Since it must always be an instruction it follows that the memory type in this region must be ROM. It is therefore usual to position the firmware starting at 0000H and to position RAM after the firmware has ended.

As has been mentioned before the software for this project has been confined to 1024 bytes and is thus 1K of firmware contained in a single 2708 EPROM which must be selected at 0000H. Since a select signal is required for a 1K block the appropriate address lines A10 and upwards must be decoded appropriately to produce it. If follows that a select line is easily produced for each 1K block and so the choice of 1K memory packages leads to the organisation of the memory plane in 1K increments. In this system the 4 lowest 1K blocks are fully decoded and are assigned as follows:

0-3FFH	1K of firmware - 2708 EPROM containing "NASBUG".
400H-7FFH	1K socket for future additional firmware (optional 2708).
800H-BFFH	video RAM (also available to user).
C00H-FFFH	user RAM (bottom 10% normally used by "NASBUG") (N.B. H = Hexadecimal notation. Initial Zero's have been omitted).

The selection for each of these 1K components is made by a 2 line to 4 line decoder which itself is selectable. (IC36a). In the basic system the select for the decoder is permanently selected so that the 4K of addressing will repeat throughout the memory plane thus the contents of 5F23H will be in fact selected from the memory packages located at F23H, for example. To enable the memory to be extended the decoder $\overline{\text{SELECT}}$ is linked via LK.5 (Memory select) either to ground or is available on the edge connector so that it can be selected by an external decoder working from the higher order address lines. It will be seen that the decoder (IC.36a) is selected via IC.44a which has as its other input $\overline{\text{MREQ}}$ so that the decoder is enabled only when the CPU wishes to fetch from memory.

The RAM packages used in this system were chosen for lowest cost bearing in mind that a separate hardware configuration is required for the video RAM. Thus 2102A-4 MOS packages are used in arrays of 8 for each of the RAM blocks. Each block requires an output buffer to prevent bus conflict (IC 28 and IC 47).

I/O Selection

The low order address lines A0 and A1 are used to drive a 2 line to 4 line decoder (IC 36b) which is itself enabled by $\overline{\text{IORQ}}$ and a choice of either A2 or an external select input via LK.1 (Port Select) in a very similar manner to that described above for the memory selection. A2 is inverted and used to select the PIO package which performs its own selection from A0 and A1.

Central Processor (Z80/MK 3880)

The CPU itself (IC 37) has only two sections connected to it which have yet to be described. These are CPU clock and $\overline{\text{NMI}}$ logic. The CPU clock is driven from a conventional TTL buffer with a 330 ohm pull up as required by the package. The input to the buffer can be selected from points on the video RAM divider chain which is driven from a 16 MHz crystal and the frequency select link (LK.8) has been chosen to be set to either 1, 2 or 4MHz. (2 MHz is the intended clock frequency. The other positions are provided for experimental purposes only).

Interrupts

Logic has been designed to exploit the $\overline{\text{NMI}}$ facility of the Z-80 for a very special purpose and that is for a combination of hardware and software to give this particular microcomputer system one of the most powerful features required in programme development and that is single step. By utilising external logic to interrupt the processor a fixed number of M1 cycles after a known command has been executed, programme execution can be halted by causing the interrupt to occur during a particular instruction. Software arranges successive instructions in a programme to be interrupted and immediately after the interruption all major registers are mapped into the video RAM and are thus displayed on the TV. The software will then wait for a specific keystroke to move the next instruction into the interrupting position. All this is necessary because instructions can be of differing lengths and unless a huge search table is provided to establish the lengths of each of the 158 different Z80 instructions, the software has no other means of knowing which bytes are instructions, which are data and which are operands.

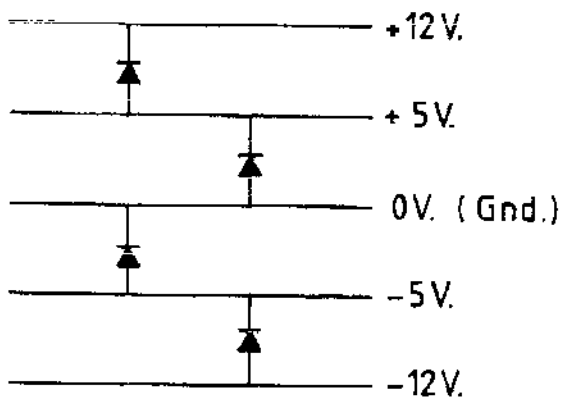
The particular method chosen for this system is to cause an $\overline{NMI}$ interrupt on the fourth M1 after the low to high transition of bit 3 of port 0. The counting and blocking of the interrupt is performed by IC.42, 43 and associated gates. This system is also reset by CPU $\overline{RESET}$.

Practical Details

The entire microcomputer is on a single 12" by 8.125" card which contains all 55 integrated circuits. The keyboard is a separate item and contains the scan logic and can be located some 4 feet from the main card using screened multicore cable. Coaxial cable is wired directly from the main card to the coaxial plug for the aerial socket of the TV. Most users will probably connect 3.5mm jack plugs or DIN connectors to the audio cassette I/O pins to record and play back their programmes. What is not provided is power. This must be as follows:

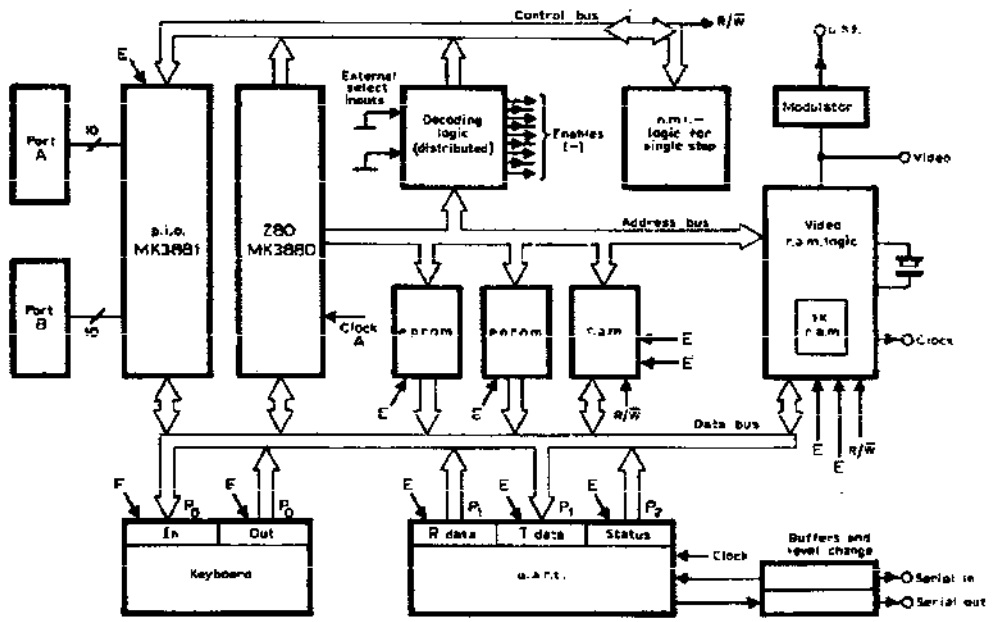
+12V	150mA
+5V	2A
-5V	90mA
-12V	12mA (required only for RS-232)

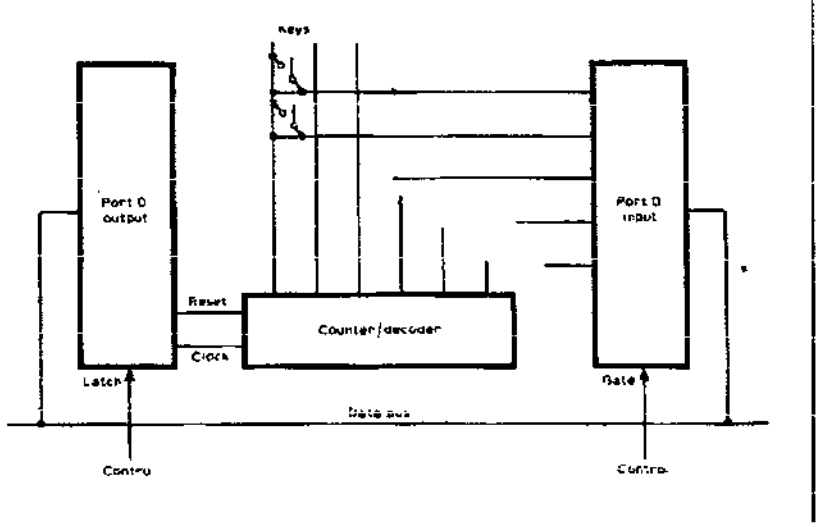
Care must be taken with power supplies to make sure that during power up and power down the voltages do not cross over each other. This could cause substrate reversal in some of the integrated circuits and destroy them. If there is any doubt it is as well to connect diodes between all power lines and ground as shown below:



A cable is required between two identical 16 pin header plugs to connect the keyboard to the main card. Only pins 1 to 6, 9 to 12 and 16 need be wired. About a third of the strands of the cable screen should be soldered to pin 9 (0V) at each end. For the other pins any core of the cable may be used so long as the same colour wire goes to the same number pin at each end of the cable. The spare cores may be tied back or cut off. Take care (or use insulating tape) to prevent any short circuits e.g. to the cable screen.

The main card should be assembled with all passive components first, i.e. all resistors, transistors, diodes, IC sockets, capacitors, the LEDs and most important, the option links must all be soldered and checked before soldering or plugging in any IC's. All IC's except those made by the MOS process should next be fitted. In other words IC's 16, 20 to 27, 48 to 55, 37, 38, 29 and 35 should be the last components to complete the card and should be added in that order. The most costly items are the MK3880 (Z-80), MK3881 and 2708 (EPROM). The Video Ram will operate without any of these and so it is advisable first to turn on the power without them. The TV set should be tuned right through the UHF band for strongest signal. The display will represent the random initial values of the memory packages. Before inserting the Z-80 CPU and EPROM monitor programme, make sure the power lines are at ground potential.





NASCOM 1
BLOCK
DIAGRAM

KEYBOARD
SCANNING
SYSTEM

PART 4:

CPU BOARD COMPONENT LIST (IN COMPONENT REFERENCE ORDER)

Integrated Circuits		Resistors		Capacitors		Transistors	
IC	TYPE	R	Value	C	Value	Tr.	Type
1.	74LS163	1.	15K	1	47nF Ceramic	1	NAS 1-05 (PNP)
2.	"	2	1KO	2	10nF "	2	NAS 1-03 (NPN)
3.	"	3	470R	3	47nF "	3	NAS 1-01 (NPN)
4.	"	4	1KO	4	1nF "	4	NAS 1-05 (PNP)
5.	74LS20	5	1KO	5	8.2pF "	5	NAS 1-01 (NPN)
6.	74s04	6	4K7	6	2.2pF "	6	NAS 1-05 (PNP)
7.	74LS123	7	"	7	12pF "	7	NAS 1-01 (NPN)
8.	74LS30	8	150R	8	47nF "	8	NAS 1-01 (NPN)
9.	"	9	330R	9	" "	9	NAS 1-04 (NPN VHF)
10.	74LS00	10	82R	10	" "	10	NAS 1-05 (PNP)
11.	74LS11	11	470R	11	10nF "		
12.	74LS157	12	2K2	12	22nF Plastic		

Signal Diodes	
D	Type
1	IN 4148
2	"
3	"
4	"
5	"
6	"
7	"

Zener Diodes	
Z	Type
1	3.3V (0.3/0.4W)
2	6.8V "

Light Emitting Diodes	
LED	
1	TIL209 (0.125" Red)
2	" "

Inductor	
L	Type
1	Made using enamelled wire supplied. (See instructions).

Variable Resistor	
VR	Type
1	10K Cermet 43P

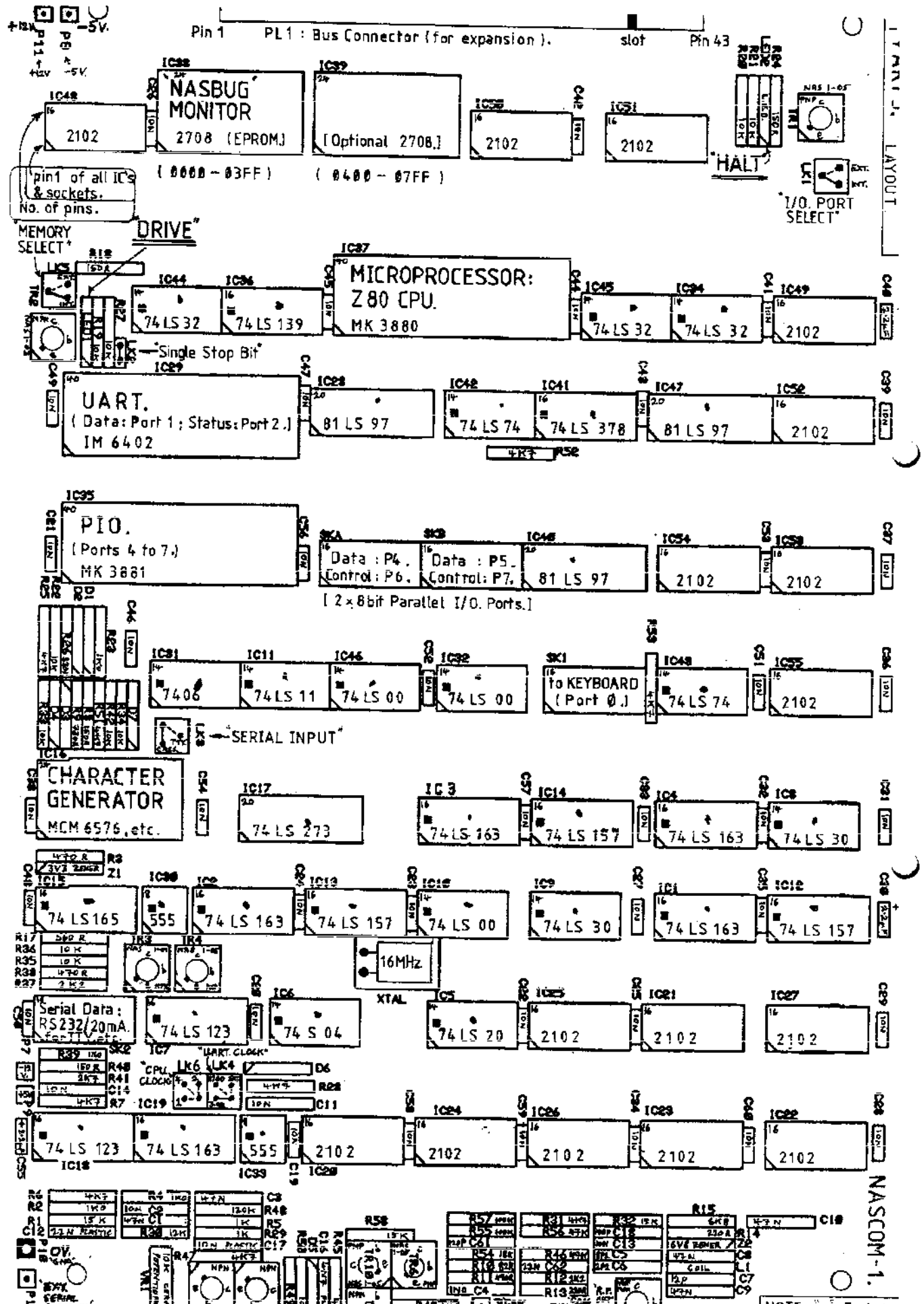
Crystal	
XTAL	Type
1	16 MHZ

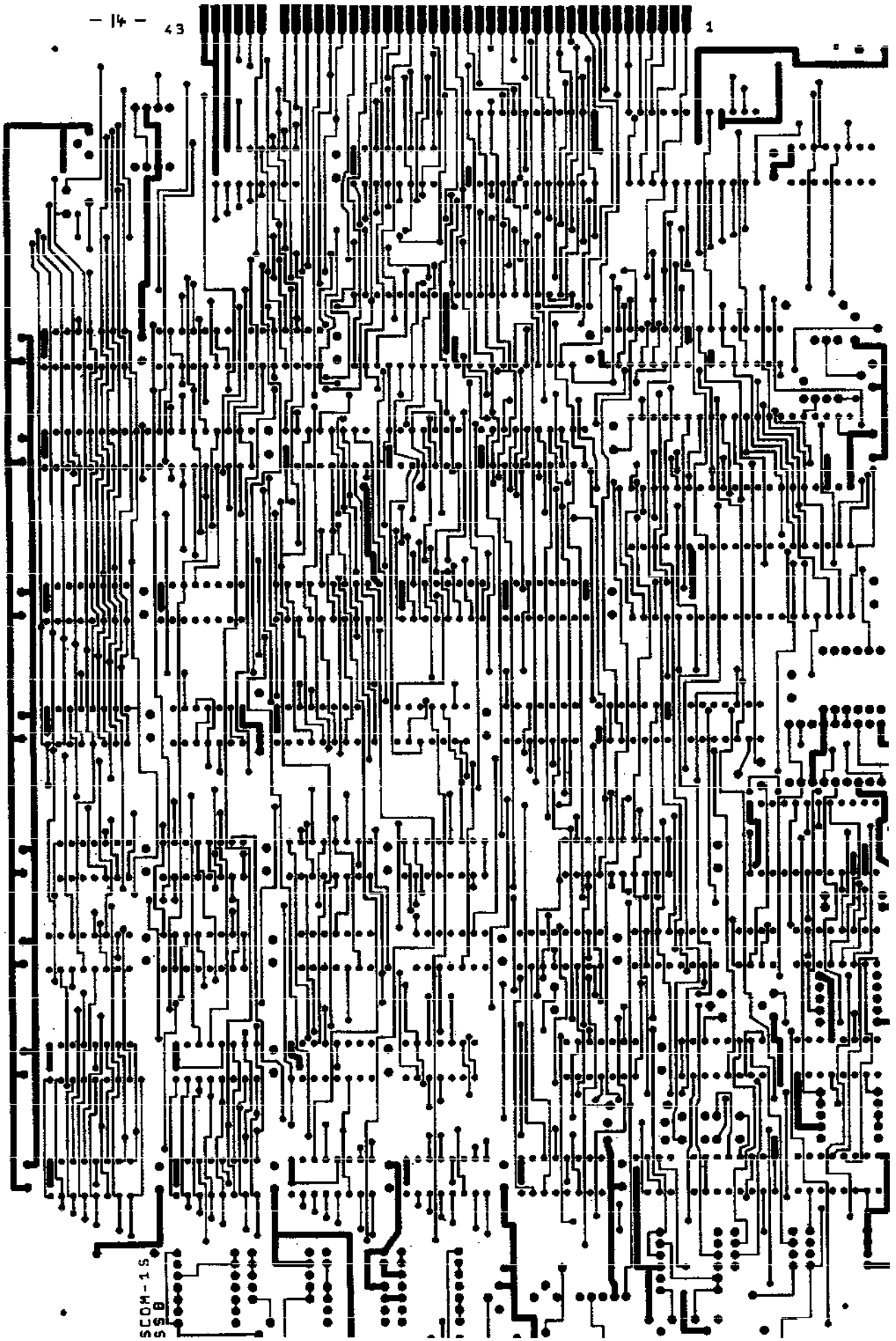
13.	"	13	220R	13	10nF Ceramic		
14.	"	14	220R	14	" "		
15.	74LS165	15	6K8	15	2.2nF "		
16.*	MCM6576P	16	2K2	16	4.7nF Plastic		
17.	74LS273	17	560R	17	10nF Plastic		
18.	74LS123	18	150R	18	100pF Ceramic		
19.	74LS163	19	10K	19	10nF Ceramic		
20.*	2102AN-4L	20	"	20	" "		
21.*	"	21	"	21	" "		
22.*	"	22	"	22	" "		
23.*	"	23	1KO	23	" "		
24.*	"	24	150R	24	" "		
25.*	"	25	4K7	25	" "		
26.*	"	26	330R	26	" "		
27.*	"	27	10K	27	" "		
28.	81LS97	28	4K7	28	" "		
29.*	IM6402	29	1KO	29	" "		
30.	NE555	30	12K	30	2.2µF Tantalum		
31.	7406	31	4K7	31	10nF Ceramic		
32.	74LS00	32	15K	32	" "		
33.	NE555	33	10K	33	" "		
34.	74LS32	34	10K	34	10nF Ceramic		
35.*	MK3881N	35	"	35	" "		
36.	74LS139	36	"	36	" "		
37.*	MK3880N	37	2K2	37	" "		
38.*	2708	38	470R	38	" "		
39.*	(* option)	39	1KO	39	" "		
40.	81LS97	40	150R	40	2.2µF Tantalum		
41.	74LS378	41	2K7	41	10nF Ceramic		
42.	74LS74	42	10K	42	" "		
43.	"	43	"	43	" "		
44.	74LS32	44	470K	44	" "		
45.	"	45	4K7	45	" "		
46.	74LS00	46	47K	46	" "		
47.	81LS97	47	4K7	47	" "		
48.*	2102AN-4L	48	120K	48	" "		
49.*	"	49	100K	49	" "		
50.*	"	50	"	50	" "		
51.*	"	51	4K7	51	" "		

IC	TYPE	R	Value	C	Value
52.*	2102AN-4L	52	4K7	52	10nF Ceramic
53.*	"	53	4K7	53	" "
54.*	"	54	18K	54	" "
55.*	"	55	100K	55	2.2uF Tantalum
		56	47K	56	10nF Ceramic
		57	100K	57	" "
		58	15K	58	" "
				59	" "
				60	" "
				61	120pF Ceramic
				62	22nF "

* = MOS IC.
(See handling instructions)

Connectors	
PL/SK	Type/Purpose
PL.1	42 way + slot (Bus for Memory Expansion, etc.) -Part of CPU PCB.
SK.1	16 way DIL (for Keyboard:Port 0)
SK.2	16 way DIL (for TTY 20mA loop/RS232 Serial Data:Port 1)
SK.A	16 way DIL (for Parallel data in/out: Port 4).
SK.B	16 way DIL (for Parallel data in/out: Port 5).


Pin 1
PL1 : Bus Connector (for expansion).
slot
Pin 43
NASBUG MONITOR
2708 (EPROM)
(Optional 2708.)
2102
HALT
I/O. PORT SELECT
pin1 of all IC's & sockets.
No. of pins.
MEMORY SELECT
DRIVE
MICROPROCESSOR: Z80 CPU. MK 3880
74 LS 32
74 LS 139
Single Stop Bit
UART. (Data: Port 1; Status: Port 2.) IM 6402
81 LS 97
74 LS 74
74 LS 378
PIO. (Ports 4 to 7.) MK 3881
Data : P4. Control: P6.
Data : P5. Control: P7.
[2 x 8 bit Parallel I/O. Ports.]
7406
74 LS 11
74 LS 00
to KEYBOARD (Port 0.)
SERIAL INPUT
CHARACTER GENERATOR MCM 6576, etc.
74 LS 273
74 LS 163
74 LS 157
74 LS 30
74 LS 165
555
74 LS 04
74 LS 20
16MHz.
XTAL
Serial Data: RS232/20mA.
UART CLOCK
CPU CLOCK
74 LS 123
2102
NASCOM-1.
NOTE: ■ = Sockets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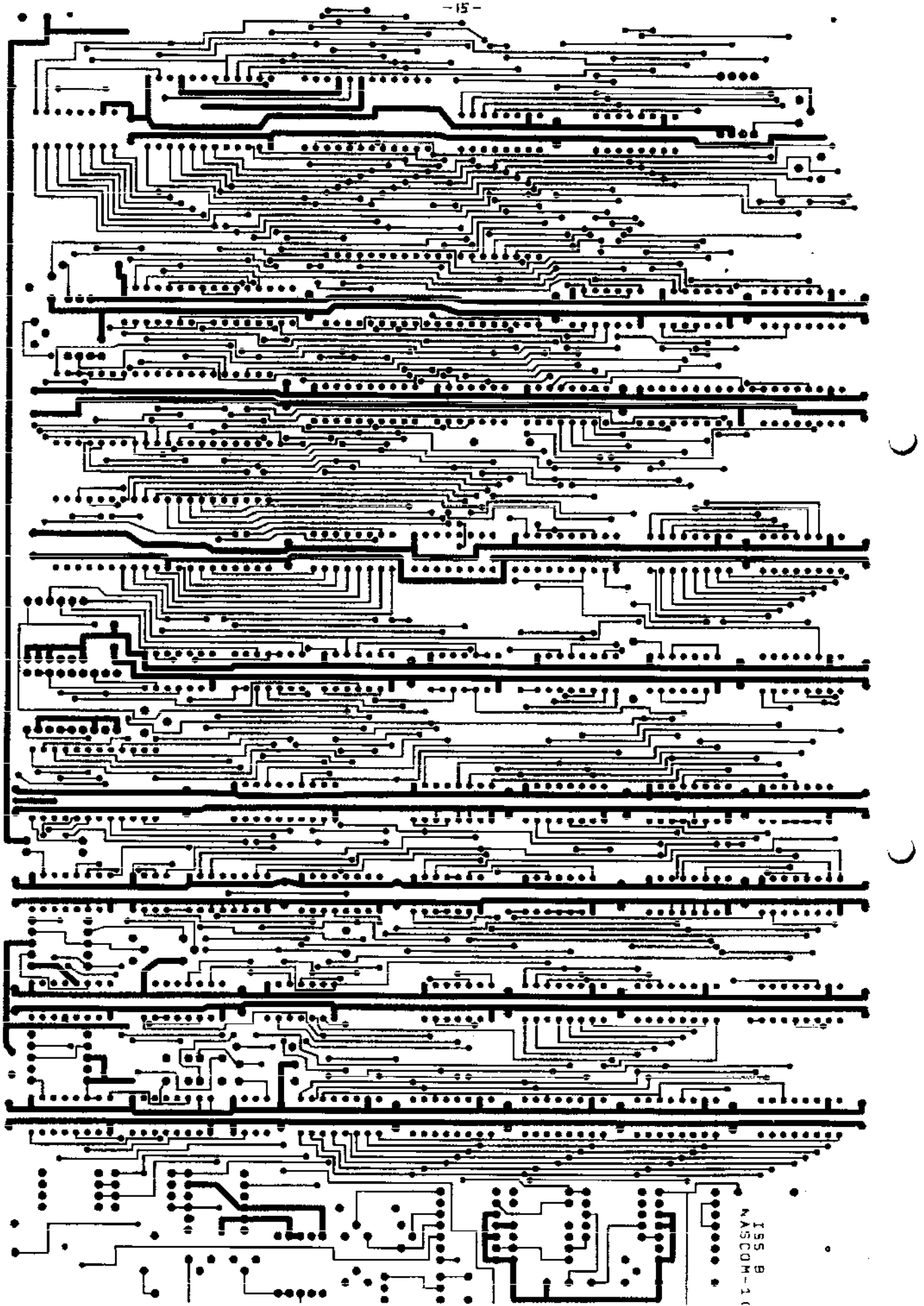
SSB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PART 6: NASCOM 1 MICROCOMPUTER KIT - COMPONENTS SUPPLIED

SECTION A: INTEGRATED CIRCUITS (In Numerical Order)

NO. USED.	TYPE	PINS	CIRCUIT REF.	DESCRIPTION
LINEAR IC's	**(SOCKETS OPTIONAL - PROVIDED IN SOCKET PACK)**			
2x	NE555	8	IC.30,33	Timer
MOS IC's (SEE HANDLING INSTRUCTIONS - SOCKETS PROVIDED WITH MAIN KIT)				
16x	2102AN-4L	16	IC.20-27, 48-55	1024 bit static RAM
1x	2708	24	IC.38 (+39 for Users Option)	8 x 1024 bit EPROM (Programmed with "NASBUG")
1x	MK3880N	40	IC37	Z80 CPU (Microprocessor)
1x	MK3881N	40	IC35	Z80 PIO
1x	IM6402	40	IC29	UART (for Serial I/O) (CMOS
1x	MCM65/6P	24	IC16	UK. ASCII 7 x 9 Segment 128 Character Generator.
TTL IC's (SOCKETS OPTIONAL - PROVIDED IN SOCKET PACK)				
3x	74LS00	14	IC.10,32,46.	Quad. 2 input NAND Gate.
1x	74S04	14	IC.6	Hex (6x) Inverter (Shottky)
1x	7406	14	IC.31	Hex (6x) 30V Inverter with open collector outputs (Standard TTL)
1x	74LS11	14	IC.11	Triple 3 input AND Gate
1x	74LS20	14	IC.5	Dual 4 input NAND Gate
2x	74LS30	14	IC.8, 9	8 input NAND Gate.
3x	74LS32	14	IC.34,44,45.	Quad 2 input OR Gate.
2x	74LS74	14	IC.42,43	Dual D flip-flop (edge triggered).
2x	74LS123	16	IC,7,18	Dual monostable.
1x	74LS139	16	IC.36	Dual 2 to 4 line decoder.
3x	74LS157	16	IC.12,13,14.	Quad 2 input multiplexer. (4 pole c/o digital switch)
5x	74LS163	16	IC.1,2,3,4,19	Synchronous 4 bit counter (÷16).
1x	74LS165	16	IC.15	8 bit shift Register.
1x	74LS378	16	IC.41	Hex (6x)D flip-flop registe with enable.
LARGE TTL IC's (SOCKETS PROVIDED WITH MAIN KIT)				
1x	74LS273	20	IC.17	Octal D flip-flop register with clear.
3x	81LS97	20	IC.28,40,47.	Octal buffer with tri-state output.

SECTION B: TRANSISTORS AND DIODES

4x	NAS 1-01	Tr. 3,5,7,8.	General purpose NPN Transis
1x	NAS 1-03	Tr. 2	NPN Transistor
1x	NAS 1-04	Tr. 9	NPN VHF Transistor
4x	NAS 1-05	Tr. 1,4,6,10.	General purpose PNP Transis
7x	IN4148	D1-7	Signal Diode (Colour coded yellow/brown/yellow/grey: W yellow band indicates catho
1x	BZY88C3V3	Z1	3.3V Zener diode}Wide band
1x	BZY88C6V8	Z2	6.8V Zener diode}indicates cathodes.
(N.B. Either Zener may be BZX83C Series)			
2x	TIL209	LED 1,2,	0.125" Light Emitting Diode (Red). (Shorter lead and notch in skirt indicate cathode).

SECTION C: RESISTORS
(ALL ¼ WATT 5% TOLERANCE HIGH STABILITY CARBON FILM TYPES EXCEPT FOR VR.1)

NO. USED	VALUE	CIRCUIT REF.	MARKING
1x	82R (82 ohms)	R10	GRY/RED/BLK/GOLD
4x	15OR	R8,18,24,40.	BRN/GRN/BRN/GOLD
2x	22OR	R13,14.	RED/RED/BRN/GOLD
2x	33OR	R9,26.	OR/OR/BRN/GOLD
3x	47OR	R3,11,38.	YLW/PUR/BRN/GOLD
1x	56OR	R17	GRN/BLU/BRN/GOLD
6x	1KO (1.0 k ohms)	R2,4,5,23,29,39	BRN/BLK/RED/GOLD
3x	2K2	R12,16,37	RED/RED/RED/GOLD
1x	2K7	R41	RED/PUR/RED/GOLD
10x	4K7	R6,7,25,28,31,45, 47,51,52,53.	YLW/PUR/RED/GOLD
1x	6K8	R15	BLU/GRY/RED/GOLD
18x	10K (10 K ohms)	R19,20,21,22,27, 33,34,35,36,42,43. Plus two to be added to keyboard circuit board	BRN/BLK/OR/GOLD
1x	12K	R30	BRN/RED/OR/GOLD
3x	15K	R1,32,58	BRN/GRN/OR/GOLD
1x	18K	R54	BRN/GRY/OR/GOLD
2x	47K	R46,56	YLW/PUR/OR/GOLD
4x	100K (100 K ohms)	R49,50,55,57	BRN/BLK/YLW/GOLD
1x	120K	R48.	BRN/RED/YLW/GOLD
1x	47OK	R44	YLW/PUR/YLW/GOLD

VARIABLE RESISTOR:			TYPE
1x	10K Linear	VR.	Cermet 43P

NOTE ON STANDARD COLOUR CODE:

First band = 1st significant digit
Second band = 2nd significant digit
Third band = multiplier (No. of additional zero's)
Fourth band = tolerance (silver = 10%, Gold = 5%, Red = 2%, etc.)
Although the body colour of the resistor is immaterial care should be taken not to confuse e.g. brown with grey or purple for those with an overall reddish lacquer coating. (The standard code is sometimes adapted for use with other components such as capacitors, diodes and multicore cables).

SUMMARY:-	COLOUR	FIGURE
	BROWN (BRN)	1
	RED (RED)	2
	ORANGE (OR)	3
	YELLOW (YLW)	4
	GREEN (GRN)	5
	BLUE (BLU)	6
	PURPLE (PUR)	7
	GREY (GRY)	8
	WHITE (WH)	9
	BLACK (BLK)	0

SECTION D: CAPACITORS

NO. USED	VALUE	CIRCUIT REF.	TYPE
1x	2.2pF (2P2)	C6	Ceramic
1x	8.2pF (8P2)	C5	"
1x	12pF (12P)	C7	"
1x	100pF (100P)	C18	"
1x	120pF (120P)	C61	"
1x	1nF (1N0=1000P)	C4	"
1x	2.2nF (2N2)	C15	"
43x	10nF (10N=0.01µF)	C2,11,13,14,19-29, 31-39,41-54,56-60.	"
1x	22nF (22N=0.022µF)	C62	"
5x	47nF (47N=0.047µF)	C1,3,8,9,10.	"
1x	4.7nF (4N7) ±20%	C16.	Plastic
1x	10nF (10N) ±20%	C17	"(BRN/BLK/OR/BLK/RD e.g
1x	22nF (22N) ±20%	C12	"(RED/RED/OR/BLK/RD e.g
3x	2.2µF Electrolytic	C30,40,55	Tantalum Bead (RED)

(These three Electrolytic capacitors must be fitted the correct way round. The marking on the bead must face the right hand long edge of the printed circuit board.)

NOTE ON CAPACITOR MARKINGS

As indicated above it is possible for capacitors of the same value to be marked in several different ways. These comments may be found useful in identifying components from any source.

For example the following alternatives can be found amongst others:

(a) 100pF = 100 µµF = 0.1 nF = n10 = 100P = 100 = 100 Π (Russian 'P')
(b) 2.2nF = 2200pF = 0.0022µF = 2n2 = 2N2 = 2200 = 2H2 (H = Russian 'N')
(c) 10nF = 10,000 pF = 0.01µF = 10n = 10N = 10000 = 0.01 = 10K = 10H etc.

Note that n, N, H and K are interchangeable and that the location of a letter may indicate the decimal point. The Greek letter mu (µ) may appear as a u or, like P, be omitted altogether. Capacitors may also be colour coded (the value in pF being given by the top 3 bands in the same manner as a resistor is marked in ohms). Disregard the 4th and 5th bands (tolerance and voltage rating) and also any single coloured stripe on top of a ceramic capacitor (temperature coefficient). Just to make confusion complete some capacitors are now marked in figures in a manner imitating the colour coding system using the third digit to indicate the number of additional zeroes. For example '103' (as used on the Licon keyboard) means 10nF and '121' means 120pF.

SECTION E: IC SOCKETS PROVIDED WITH MAIN KIT

These are provided for all MOS Devices (which are expensive and can be damaged by static electricity during handling or soldering), for the 20 pin TTL IC's and for the four external connection sockets. If the socket pack is not purchased care should be taken to fit the 16 pin sockets in the correct locations (i.e. for the Memory IC's 20-27 and 48-55 plus SK.1, SK.2, SK.A & SK.B).

NO. USED	TYPE
3x	40 PIN
3x	24 PIN
4x	20 PIN
20x	16 PIN (See note above).

SECTION F: KEYBOARD

NO. USED	DESCRIPTION
1x	Built and tested solid-state Licon keyboard with 47 keys (including space bar), 9 IC's, etc.
1x	Hamlin reed switch type AKS (to be added to the above).
1x	Keytop type F marked 'RS' (for RESET function).

SECTION G: MISCELLANEOUS ITEMS

NO. OR AMOUNT USED	DESCRIPTION
1x	12" x 8.125" double sided through plated printed circuit board with solder resist mask both sides and silk-screening on component side.
1x	16MHz Crystal (XTAL 1)
1x	Portion of double sided foam based sticky tape. (To mount XTAL 1 on Board)
11x	Solder posts (push fit in 1 mm dia. hole) (P1-P11). (For power supply, video, RF and cassette connections).
5x	VA16P/02 16 way DIP header plugs. (2 for keyboard cable plus 3 for serial and parrallel interface connections).
4 ft.	15 way multicore screened cable (for keyboard). (Alternative: 9 way).
6 ft.	Coax cable to TV set aerial socket.
1x	Belling-lee coax plug (for above).
1 ft.	PVC sleeving (to prevent short circuits between capacitor leads, etc.).
8 inches	0.8 mm (approx. 21 swg) self-fluxing enamelled wire. (3 open-wound turns of ¼" internal dia. make coil L1).
6½ yds.	22 gauge solder with multicore flux.

NOTE As many different connectors are to be found on domestic tape recorders no cable has been included for the cassette interface. A suitable lead (Phono, DIN 3.5 mm. jack, etc.) with an unwired end can be obtained from any good hi-fi dealer. Where separate input and output plugs are required a single plug-plug lead may be obtained and cut in half.

SECTION H: SOCKET PACK (OPTIONAL EXTRA)

This enables all IC's on the CPU board (including TTL and Linear) to be socketed.

NO. USED	TYPE
13x	16 PIN
14x	14 PIN
2x	8 PIN

SECTION I: NASCOM 1 POWER SUPPLY - SUGGESTED PARTS LIST (OPTIONAL EXTRA)

NO. USED.	CIRCUIT REF.	TYPE & DESCRIPTION
1x	T1	70VA Mains Transformer, (Primary 0-220-240V, Secondaries 0-9V @ 2.5A and 15-0-15V @ 1A+1A).
1x	B1	2.5A,50V Bridge Rectifier (Square configuration with leads - not tags).
1x	IC1	+5V ± 5%, 100mA, Voltage Regulator (TO-92 plastic package). (E.g. 78L05).
1x	IC2	+ 12V., 1A Voltage Regulator (Plastic package) (E.g. LM340T-12; 7812).
1x	IC3	-5V., 1A Voltage Regulator (Plastic package) (E.g. LM320T-5.0 or 7905).
1x	IC4	-12V., 1A Voltage Regulator (Plastic package) (E.g. LM320T-12 or 7912).
1x	HS1	TO-3 Heatsink.
3x	HS2-4	TO-220 Heatsink.
4x	R1-4	2R2 (2.2 Ohms) 1W. Wirewound resistors.
1x	R5	15R (15 Ohms) 1W. Wirewound resistor.
1x	R6	10R (10 Ohms) 4W. Wirewound resistor.
1x	R7	2R2 (2.2 Ohms) 4W. Wirewound resistor.
9x	D1-9	IN4001 Rectifier Diode.
1x	Tr.1	PNP TO-5 Medium Power Transistor.
1x	Tr.2	NPN TO-3 Power Transistor.
2x	C1,2	3300µF. 16V. Electrolytic Capacitor (e.g. ITT. EN12-12, 3300/16).
3x	C3,6,7.	2.2µF. 35V. Tantalum bead Electrolytic capacitor.
2x	C4,5	1000µF.25V, electrolytic capacitor (e.g. ITT, EN12-12 1000/25).
1x	—	4.5" x 7.75" single-sided printed circuit board.
5 sets	—	Nut,bolt, washer, lock washer (e.g. 4B.A. or 3mm)
6 ft.	—	3 Core 2A, mains cable.
2 x 18"	—	16/0.2mm Stranded wire (1 length both of Red and Black),
3 x 18"	—	7/0.2mm stranded wire (1 length each of Blue, Pink and Violet).

PART 7: Assembly Instructions for NASCOM 1 MICROCOMPUTER KIT

Section A - 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.) We would recommend the use of two soldering irons or a single 15 watt iron with two interchangeable bits of around 1/32" and 1/16" diameter. (The only combination likely to prove suitable for all purposes would be a thermostatically controlled iron with a tapering bit.)

4. A damp sponge or cloth - to keep soldering iron bit clean.

5. A powerful light source - for example, an angle-poise lamp.

6. A magnifying glass may prove useful.

7. A multimeter - not necessary but useful to check component values and correct polarity of power supplies, etc.

Section B - Preliminary

1. Unpack kit and check components against the parts list. Return all MOS integrated circuits to their antistatic packing immediately after checking.

2. Inspect printed circuit board and keyboard assembly for signs of any damage.

3. Read through all literature provided before beginning construction. (Also consider the implications of any intended hardware modifications. For example, if it is intended to use the UART with word lengths other than eight bits it would be advisable before beginning construction to cut the tracks on the component side of the PCB linking IC.28 pins 34, 37, 38 and 39 to the plus 5 volt rail as these links are covered by the 40 pin IC socket when soldered into position.)

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 provided is identified by the yellow silk-screening and the letter C after the words NASCOM 1 etched in the copper cladding. The letter S indicates the side on which all soldering is to take place.

6. All resistors and capacitors (apart from the three tantalum bead electrolytics) and the crystal may be inserted either way round. The orientation of all other components is vital and is indicated on the PCB silk screening. The three tantalum capacitors are mounted with the plus sign or other marking facing the right hand long edge of the board. The end of all diodes and zeners marked with a wide ring should be mounted next to the diagonal line in the component box marked on the board. For LEDs the small nick in the plastic skirt should be fitted next to the diagonal line. For transistors the emitter is marked "e" on the board - this is also the pin nearest the tab on the metal casing. The diagonal line in the

corner of all integrated circuit boxes indicates the location of pin one. All integrated circuits are mounted with the same orientation. Every IC or IC socket has pin one indicated either by a small nick in the corresponding end of the IC, a circular mark close to pin one or, in the case of IC sockets, additional orientation marks in the plastic moulding, numbers marked by some of the pins or a chamfered corner.

7. All resistors, diodes and capacitors (except for decoupling capacitors C19 to C80) may be prepared for soldering by bending or spreading the leads to a separation of ½". This may be done with the aid of the long nose pliers, care being taken not to damage the component by bending leads too close to the component body. In the case of the small capacitors it may be found useful to fit short lengths of the sleeving provided to the leads to prevent any possibility of short circuits. After inserting any components in the board they may be held in position prior to soldering by bending the leads about 45° in opposite directions. Components' leads should never be bent over 90° (flat against the board) as there may be severe damage to the PCB should the component ever need to be removed. After soldering leads should be cut off about 0.1" from the underside of the board.

Section C - Suggested Order of Construction (Starting with Low Profile Items)

1. Resistors R1 to R58. Double check correct location for each value.

2. Diodes D1 to D7. (All 7 are the same type). Check orientation.

3. Zener diodes Z1 and Z2. Ensure both are oriented correctly.

4. Links LK1 to LK6 (see diagram for standard positions in following note 3.)

5. IC sockets. (Before mounting sockets check that no pins are bent. Note that the 40 and 24 pin sockets may be a fairly tight fit in the board. When inserting take care not to bend any pins. If the socket pack has not been purchased check the list of devices to ensure that the twenty 16 pin sockets provided are inserted in the correct holes - i.e. for the 16 1K RAMs and the 4 peripheral sockets.)

6. Potentiometer VR1.

7. 16 MHz crystal. This should be mounted on the board (in the rectangle indicated) by bending the leads at 90° and sticking the crystal to the board with the aid of a small piece of the thick double sided adhesive tape provided.

8. Transistors TR1 to TR10. Ensure correct types and orientation.

9. Light Emitting Diodes LED 1 and LED 2. (Care should be taken not to bend the leads too close to the device or to bend them too sharply.) Use sleeving on the leads to avoid short circuits.

10. Solder posts P1 to P11. (Unlike any other component these should be soldered on both sides of the board in case the through plating was damaged during insertion which may require some force.)

11. Tantalum bead electrolytic capacitors C30, C40 and C55. (Great care should be taken to mount these the correct way round with the plus sign or other marking facing the right hand long edge of the board as viewed from above with "NASCOM 1" in the bottom right hand corner.)

12. The remaining 39 10nF decoupling capacitors C19 to C60 (except C30, 40 and 55).

13. Capacitors C1 to C18, C61 and C62. Double check correct locations.

14. Coil L1. (This is made up from three turns of the poly urethane-coated wire supplied with an internal diameter of ¼". These may be close wound on any circular object of the right size and then spread apart to fit the ½" mounting holes. The capacitors on either side of the coil should be bent over to about 45° so that it may be mounted fairly close to the board.

15. Make up interconnection cables for keyboard and TV. The multicore 15 way cable should be carefully wired, pin to pin, between the two header plugs. Pin 1 to pin 1, pin 2 to pin 2 etc. Only pins 1 to 8, pins 9 to 12 and pin 16 need be wired. Some strands of the cable screen should be soldered to pin 9 at both ends of the cable (for 0V.) Great care must be taken that the same pins are connected between the two ends of the cable. Fit coax plug at one end of coax cable and solder other end to pins on the board. (See connection chart.)

16. Solder the reset switch into the keyboard PCB. (Two plastic lugs on the base of the switch should be removed first with a sharp knife.) Also add two 10K resistors as shown on layout drawing.

17. At this stage constructors having a multimeter available may wish to connect power supplies to the main PCB in order to check that the polarities are correct and that there are no short circuits between the supply rails. If, however, this is done it must be noted that supplies must be switched off whenever integrated circuits are plugged into or removed from the board or any soldering is carried out. A delay of several seconds must be allowed after switching off the mains supply to allow the reservoir capacitors to discharge. A check may also be made at this stage that the RF modulator is oscillating by plugging the RF output from the NASCOM 1 into a TV set and tuning through the UHF band. Although there is no modulation on the UHF harmonic outputs the fact that the modulator is oscillating should be clear by the appearance of a number of tuning points at which on-screen video noise is reduced. These are being generated by the NASCOM 1 if the noise returns some seconds after the power supply is switched off.

18. TTL integrated circuits: IC 1 to 15, 17 to 19, 28, 30 to 34, 36, 40 to 47. (If no socket pack has been purchased these are to be soldered into the PCB.) If sockets are provided then the pins of the ICs should be carefully straightened and made parallel so as to plug into the sockets without any undue force. Great care must be taken to ensure that the right integrated circuit is plugged into the right hole and the right way round by checking with all lists and diagrams available.

19. Connect power and check for stable display raster. Turn off.

20. Plug in character generator IC 16 and check for characters. Turn off.

21. Plug in 8 1K memories IC 20 to IC 27. Proceed slowly and with great care.

22. Check for random character display. Turn off.

23. Plug in 8 1K RAMs IC 48 to 55. (Do not proceed if there is no display)

24. Check for no change. Turn off.

25. Plug in Z80 CPU (MK 3880): IC 37 and 8K bit EPROM (2708): IC 38. Check for no change. Turn off.

26. Plug in keyboard. (WARNING: On some keyboards the 16 way DIP socket is fitted upside down. Pin 1 is bottom left regardless).

27. Check all basic functions are operating. (Do not plug in UART IC 29 or PIO IC 35 unless system operates as there is no point in proceeding beyond this stage if the basic system is not fully working). Turn off.

28. Plug in UART (IC 29) and PIO (IC 35).

29. If problems are encountered at any stage switch off and stop to think. Read through all the relevant information. Inspect the board closely for short circuits, unsoldered joints, etc. Repeat the process. If at length you achieve no success decide either to seek advice from other nearby members of the Nascom Users Club (or of the Amateur Computing Club) or to return the unit to us in the original packing (complete with keyboard) with a remittance for the appropriate repair fee. Include any IC's (in their anti-static packing) that have not yet been plugged in.

30. To connect to cassette interface see connection chart. Note however that the input and output levels will require some adjustment to suit any particular tape recorder. At the 'Cassette Out' post P4 the signal level is about 4 volts pk-pk however an average tape recorder may require only one tenth or less of this for the 'AUX' input or one ten-thousandth for the 'MIC' input. As the output impedance is about 15k ohms any potientiometer of the order of 10K to 1 Megohm (or 2 fixed resistors) may be used to obtain the desired recording level.

31. If the output from the tape recorder line or monitor output is insufficient to overcome the hysteresis of the input circuit (Tr.6. Tr.10 and Tr.5) some resistor values will have to be changed. The simplest modification is to swop R57 (100k) and R58 (15k). If this is not satisfactory increase R44 (470k) to, say, 1.5 Megohms.

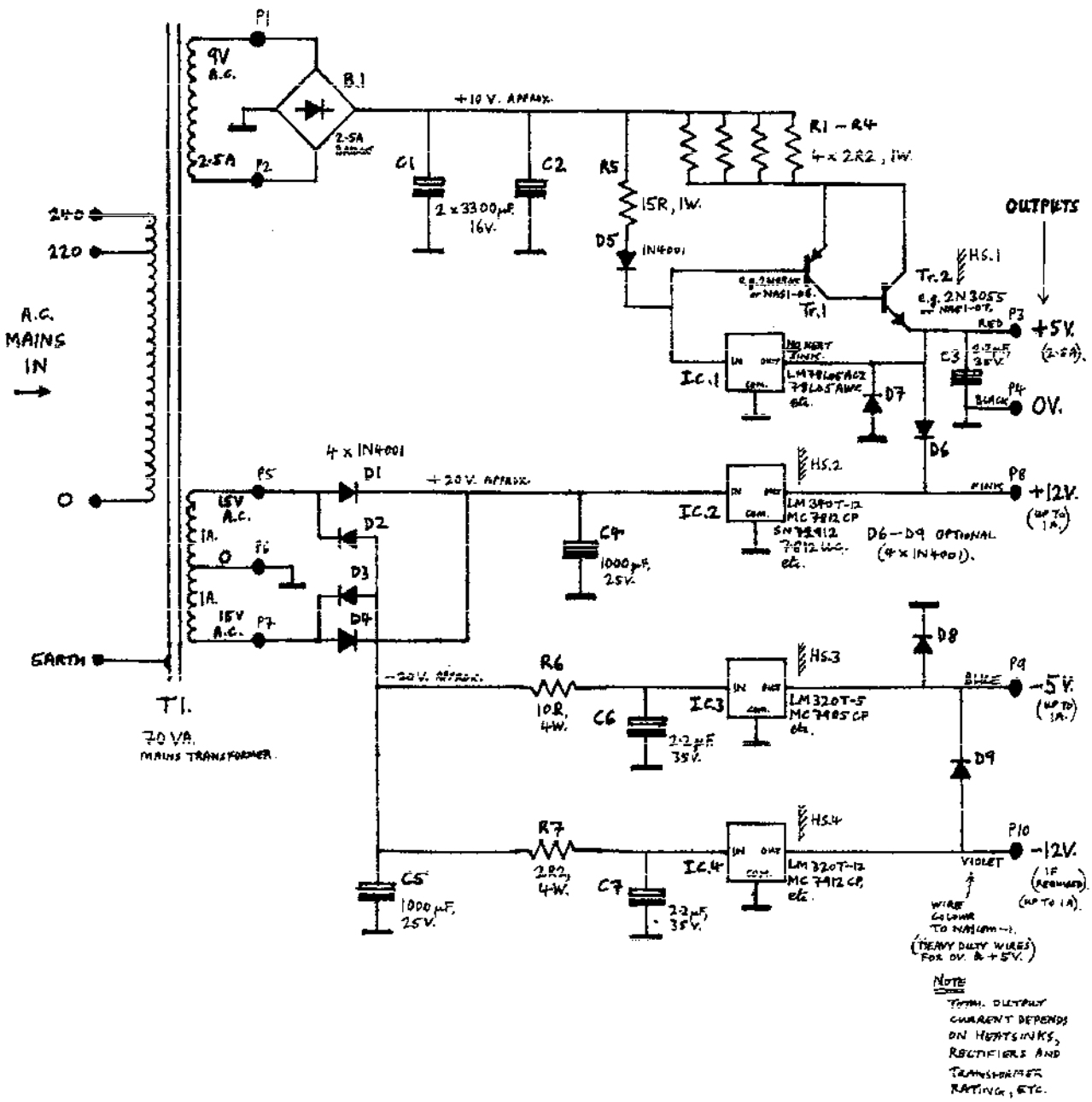
POWER SUPPLY REQUIREMENTS

+ 12V	@	150mA
+ 5V	@	2A
- 5V	@	90mA
- 12V	@	12mA (Required only for RS 232 interface).

PART 8:

NASCOM - 1

SUGGESTED POWER SUPPLY CIRCUIT



NOTE

THERM. OUTPUT CURRENT DEPENDS ON HEATSINKS, RECTIFIERS AND TRANSFORMER RATINGS, ETC.

THE ABOVE CIRCUIT IS INTENDED TO SUPPLY THE MAIN NASCOM 1 CPU. BOARD PLUS AT LEAST ONE COMPLETE MEMORY EXPANSION BOARD.

DMMS

This covers all facilities on the main PCB including the second EPROM option. It does not allow for additional boards. The Optional Power supply kit makes + 5V @ 2.5A and over 500mA at each of the other 3 potentials available in order to supply at least one full expansion board as well as the main board.

If the wires connecting the power supply unit to the main PCB exceed 18" in length then additional electrolytic decoupling capacitors should be fitted to all four supply rails on the board. Very thick wires should be used especially for the 0V and + 5V supplies in order to avoid significant voltage drop between the supply and the CPU board. Each supply should be correct to within 5%.

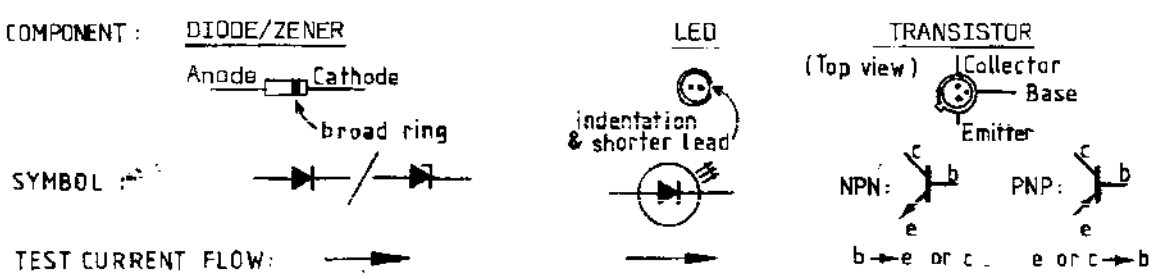
PART 9: NOTES ON ASSEMBLY GUIDE

Note 1: Multimeter

If using a meter to check diode polarity, etc. remember that most multimeters set to an Ohms range produce reverse polarities (from the internal battery) via the test leads. Thus the black lead will be the more positive and current will flow from it to the red lead to measure an external resistance, etc. Therefore when testing diode or transistor junctions (base and collector or base and emitter) current should flow (giving about ½ to ¾ scale deflection - the resistance indicated is irrelevant) when the connections are as follows:-

METER :	BLACK LEAD	RED LEAD
Device:-		
Diode or Zener	ANODE	CATHODE (End with broad ring on body)
LED	ANODE	CATHODE (Shorter lead/ indentation in skirt).
NPN Transistor	BASE	EMITTER OR COLLECTOR
PNP Transistor	EMITTER OR COLLECTOR	BASE

With the meter leads reversed from the above table nil or very slight deflection should occur (except for the 3.3 volt Zener which may be seen to conduct appreciably in both directions). In order not to exceed device current or voltage ratings do not make these tests on the "Ohms x 1" range of any meter. Nor should the highest range of an Avometer be used as the battery produces 15 volts. If you are new to electronics do not be surprised by the orientation of the zener diodes in the circuit. In normal operation it is the reverse breakdown property that is used rather than the forward junction conduction so it may appear to be fitted back to front at first sight.



NOTE 2: SOLDERING

Half the readers of this guide will reply "Teach your Grandmother" to the above heading. The other half please read on:

(a) Use the thin resin-cored solder supplied.

(b) Use a low wattage iron (not more than 15 to 25 watts) with a suitable bit see assembly guide.

(c) A number of components may be soldered in one go if desired. To keep IC's or IC sockets in place when the board is turned upside down bend two leads at opposite corners over by 45°.

(d) Keep the bit clean with a damp sponge or cloth.

(e) Be sure you are soldering the right component in the right place. To remove an incorrect component first use desoldering braid or a sucker and then great care (so as to avoid lifting the copper tracks off the fibreglass board).

(f) Solder only on the bottom (non-component) side of the board. (Except for the 11 solder posts - incidentally if these are too tight a fit the splines can be partially flattened with a pair of pliers).

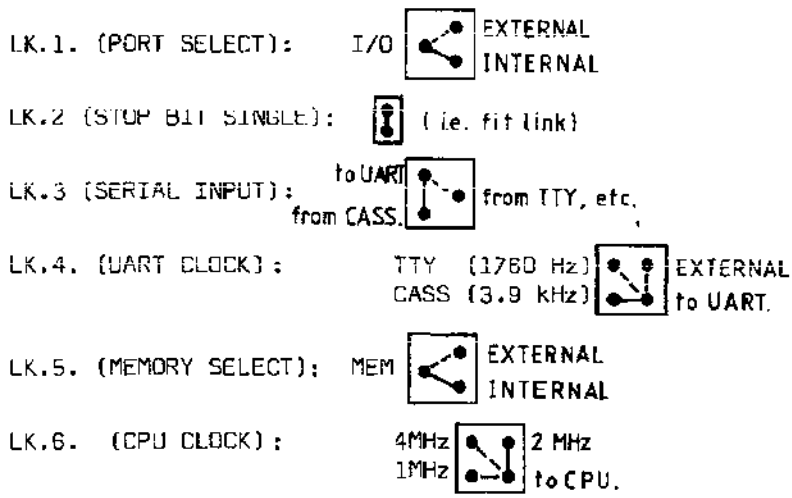
(g) For each joint first apply the iron to the appropriate place immediately followed by the solder. The solder should melt immediately and enough should be applied to fill the hole and leave a symmetrical conical mound with flat sides, neither concave (too little solder) nor convex (too much), between the tinned copper pad on the circuit board and the component lead. To fill the larger component holes ¼" or more solder may need to be applied. Do not be concerned about the appearance of the component side of the hole so long as there is no extreme surplus of solder likely to cause a short circuit to adjacent components, etc. To avoid overheating sensitive components 2 to 3 seconds is the longest time that the iron should remain on any one joint. If the result is not correct first time return to the joint some 15 seconds later. To avoid leaving tails or spikes of solder jutting out from the sides of a joint always remove the solder first and then the iron within a second.

(h) There are about 1300 joints to be soldered on the NASCOM 1 CPU Board. Although it is possible to solder several hundred in an hour do not try to do too many in one go. By taking it easy and doing the work in several batches fewer (or no) mistakes will be made and the chances of the unit working first time greatly enhanced. When tired: —STOP!

(j) The other 700 holes in the CPU board are through-plated connections between the two sides and require no action from the constructor.

NOTE 3: LINKS LK.1 - LK.6: STANDARD POSITIONS

If normal operation is required at present (Serial interface used with cassette recorder, single stop bit, no external memory or I/O port boards and 2 MHz clock rate) then the 6 links should be fitted as shown below:



Fit only one wire per link as shown by the thick lines. The dotted lines indicate alternative connections.

Use discarded lengths of component lead or the remainder of the enamelled copper wire (After coil L1 has been wound) to make the links.

NOTE 4: MOS IC HANDLING PRECAUTIONS

The 5 large (24 or 40 pin) IC's and the 16 1k RAM's (i.e. IC's 16, 20-27, 29, 35, 37, 38, 48-55) are MOS devices in which the gate oxide layer can be destroyed by static electricity discharges with a potential as low as 80 volts. To be on the safe side therefore we recommend that the following precautions be adopted:

(a) Try not to work in a dry or cold atmosphere that favours the build up of static electricity.

(b) Avoid wearing silk or nylon clothing.

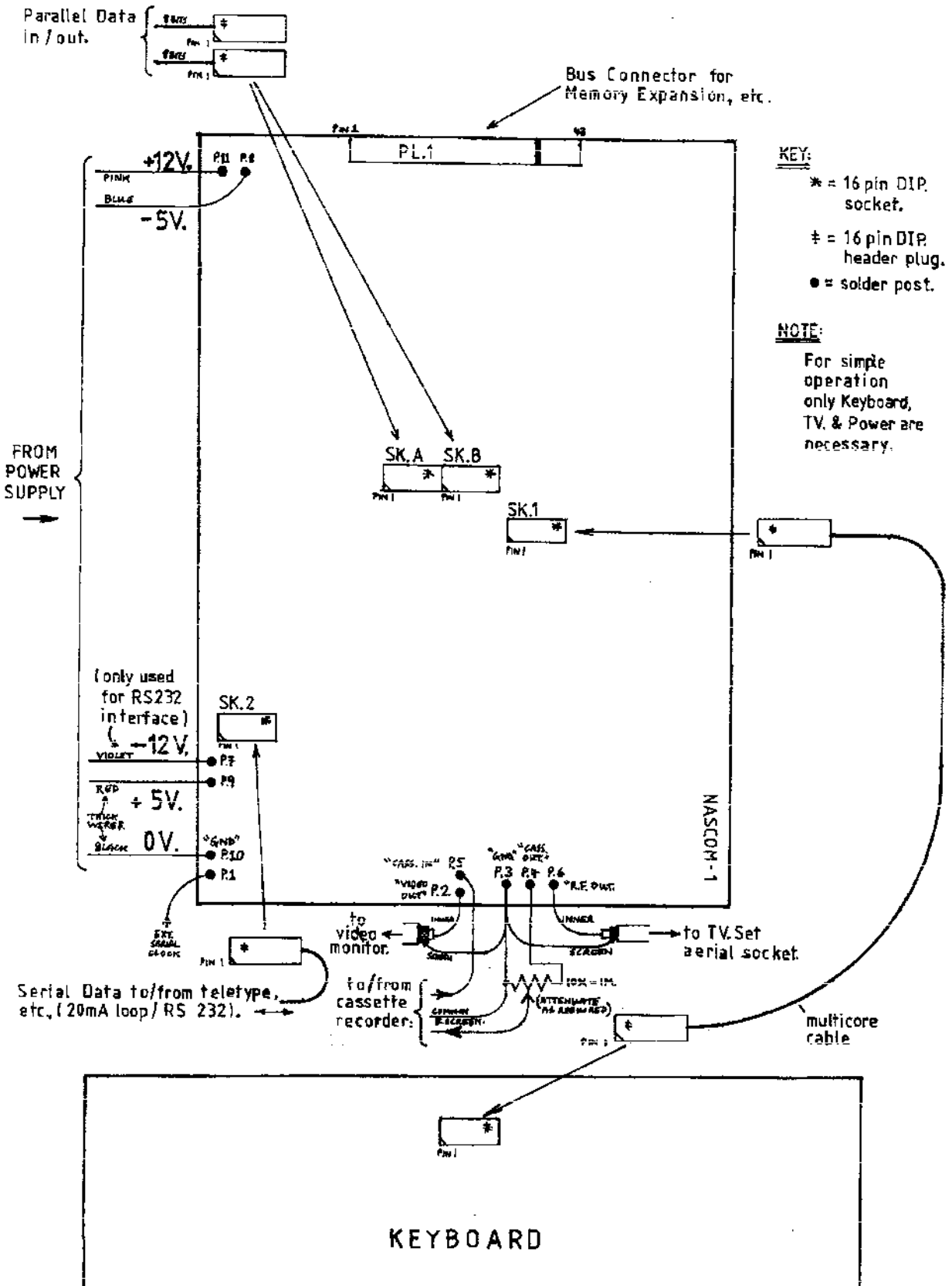
(c) Connect together board 0V line, soldering iron body and Mains Earth. Also connect this via a 1 Megohm resistor to a strap of stripped stranded wire loosely wrapped round one wrist.

(d) Whenever MOS devices are out of their special packing but not plugged in the board work on and place them on a conductive surface (such as aluminium foil). Be sure to move the foil away from the underside of the CPU Board before switching on any power, however.

(e) Discharge any metal object (e.g. with a damp finger) before bringing it in contact with the leads of a MOS IC. (e.g. Pliers with insulated handles).

NASCOM-1

CPU. BOARD CONNECTION CHART



D.R.W.
Feb. 78.

PART 11: I/O PORT ADDRESSING

PORT	DB bit/Output		DB bit/Input	
P0	7	Not available	7	User (Spare)
	6	Not available	6	User (Spare)
	5	User (Spare)	5	S_3 — Sense outputs from KBD. (Via SK.1)
	4	Tape DRIVE (LED)	4	S_5
	3	Single Step logic	3	S_4
	2	User (Spare)	2	S_0
	1	Reset KBD Counter	1	S_2
	0	Clock KBD Counter	0	S_1
P1	7	MSB — DATA TO UART (IC.29)	7	MSB — Data from UART (IC.29)
	6		6	
	5		5	
	4		4	
	3		3	
	2		2	
	1		1	
	0	LSB	0	LSB
P2	7	NOT ASSIGNED	7	Data Received — STATUS FROM UART (See data sheet).
	6		6	TBR Empty
	5		5	Not Assigned
	4		4	Not Assigned
	3		3	F Error
	2		2	P Error
	1		1	O Error
	0		0	Not Assigned

P3 - NOT ASSIGNED -

P4	PIO (IC.35.)	DATA FOR SK.A in/out	
P5		DATA FOR SK.B in/out.	
P6		CONTROL FOR PORT 4	SEE PIO TECHNICAL MANUAL.
P7		CONTROL FOR PORT 5	

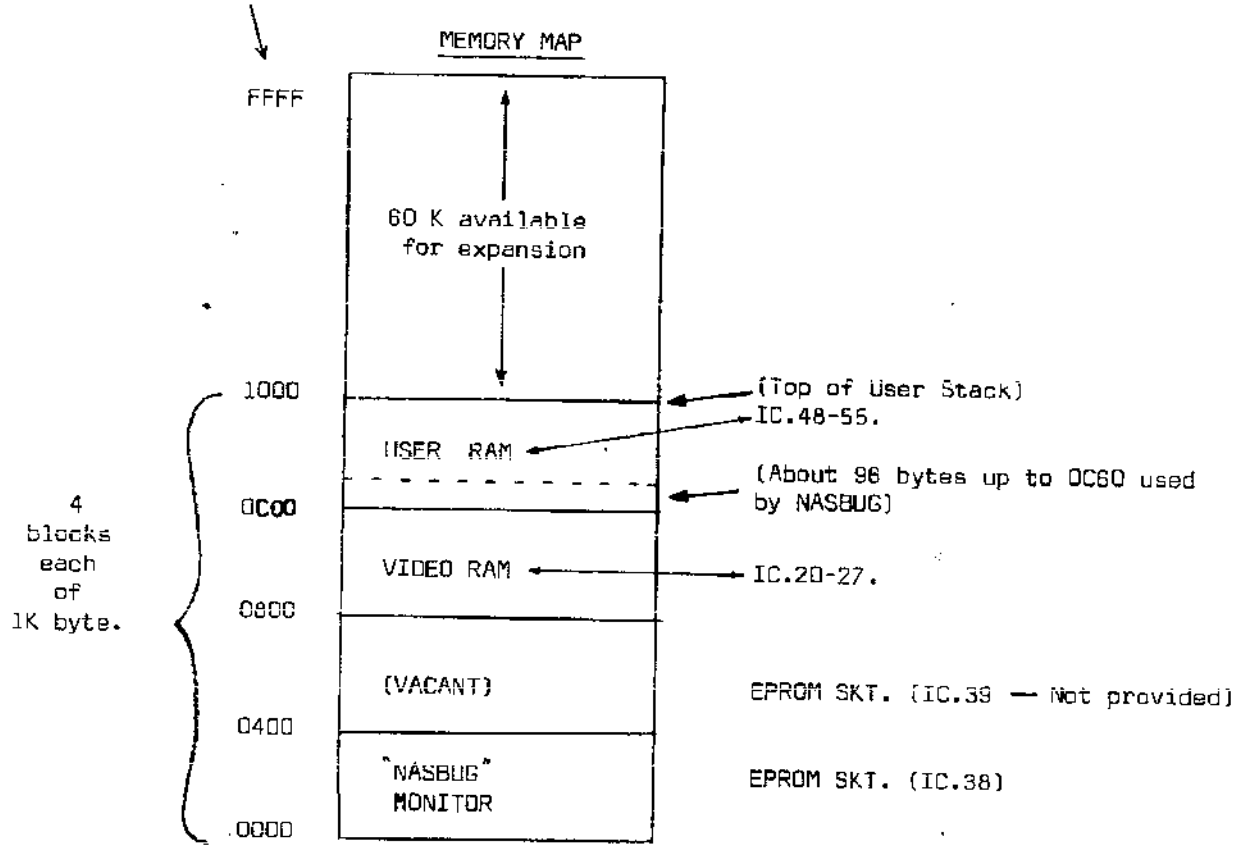
REMAINDER (P8—PFF): Higher level port decoding will be on the expansion board so with the "PORT SELECT" link (LK.1) on the CPU PCB set to "INTERNAL" the above group of 8 addresses will be found to repeat a total of 32 times up to the total 256 Port addressing capability of the Z80 CPU.

PART 12: MEMORY ADDRESSING

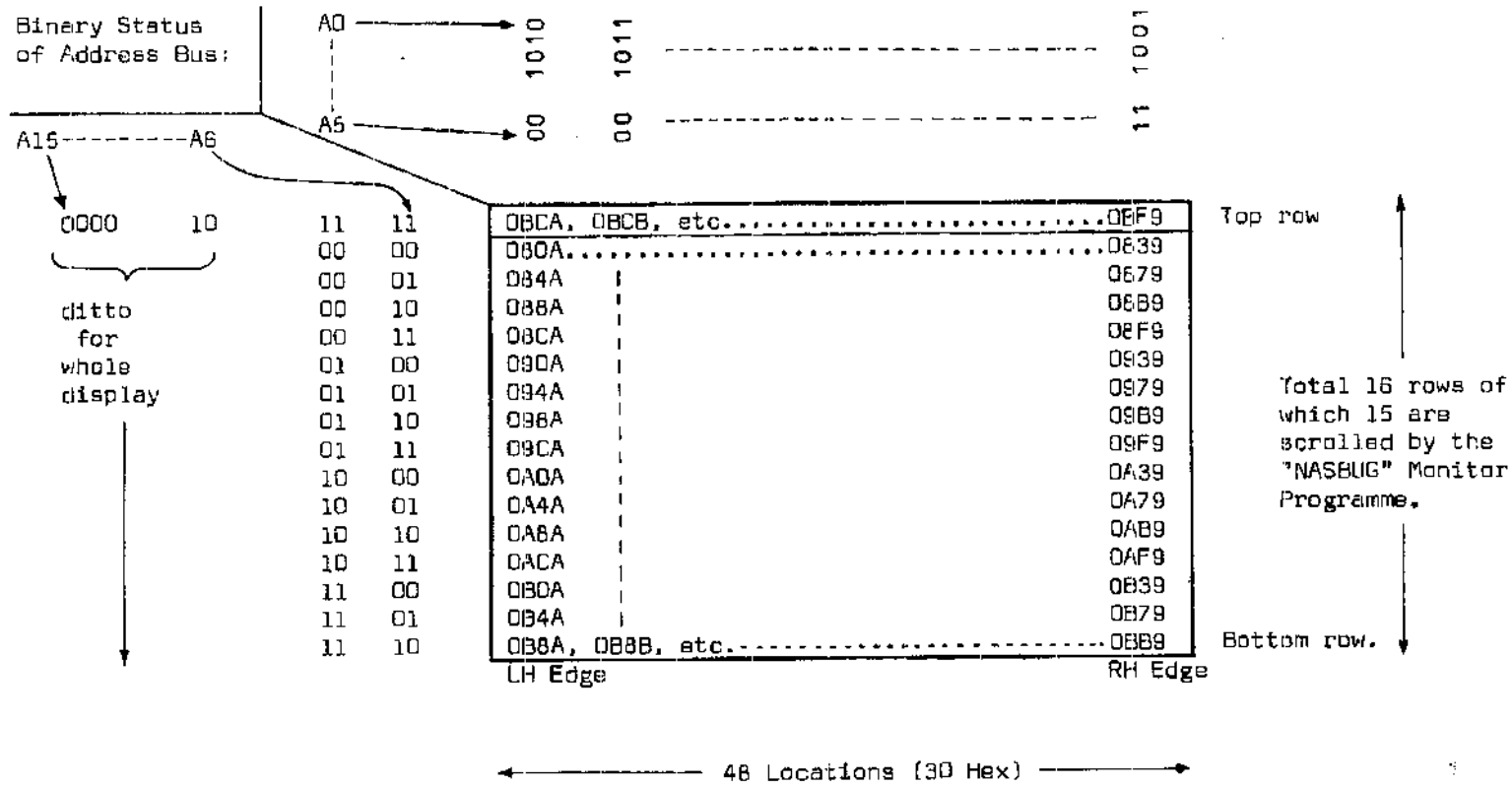
0000 - 03FF:	'NASBUG' Monitor programme in 2708 1k byte EPROM [IC.38].
0400 - 07FF:	Option socket [IC.39] for additional 2708 or 2704 EPROM or 2308 ROM. [Suggestions giving useful additional routines for an expanded monitor programme will be welcome via the Nascom Users' Club).
0800-08FF:	Video RAM. As detailed on the following chart 768 (300 Hex) of these locations are mapped on to the video display.
0C00-0FFF:	User RAM. Note that the first 96 bytes approximately are used as a scratchpad and for register storage by the monitor so that user programming must begin no earlier than address 0C60. The monitor also sets the Stack Pointer at 1000 during RESET so the user must leave as much of the top end of RAM clear [for use as the stack) as his own programming may require [depending on the depth of subroutine nesting, number of PUSH & POP instructions, etc.).
REMAINDER (1000-FFFF):	High level address decoding will be on the expansion board so with the "MEMORY SELECT" Link [LK.5] on the CPU. PCB set to "INTERNAL" the above 4k group of addresses will be found to repeat a total of sixteen times up to the total 64k memory addressing capability of the Z80 CPU.

2 Byte Address in Hexadecimal Code.

MEMORY MAP



VIDEO RAM DISPLAY ADDRESSING



NOTES

1. 256 Bytes of the 1024 in the Video RAM block are lost in the margins and are therefore not displayed. These comprise the initial 10 memory locations (0800-0809), the last 6 (0BFA-0BFF) and 15 groups of 16 bytes between lines. (Note that the Monitor programme affects these locations during scrolling, Reset, etc.)

2. The top display row is cleared by RESET or CLEAR SCREEN (Shift + Backspace) but is not scrolled upwards during monitor operation. It is therefore suitable for stable headings or titles. Its address locations follow those of the bottom row (as shown above).

PART 14: CHARACTER GENERATOR MCM 6576P

The characters available are shown on the chart below. There is only room in the 1k byte "NASBUG" monitor programme for the middle four rows (up to 'Z') to be typed directly from the keyboard. Any of the 128 characters shown can however be generated by a programme instruction using the hexadecimal code for the character. This is given by the row digit followed by the column digit shown below. Thus "A" = 41, "a" = 61, "5" = 35, "space" = 20, etc. The top two rows replace the ASCII control codes.

Nascom users, especially those outside the U.K., may be interested to know that alternative Motorola IC's in the same series may be obtained of which the following are a few examples:

MCM 6571A: Greek lower case in place of control symbols. Hash in place of £ sign.

MCM 6573: Upper case plus Japanese characters.

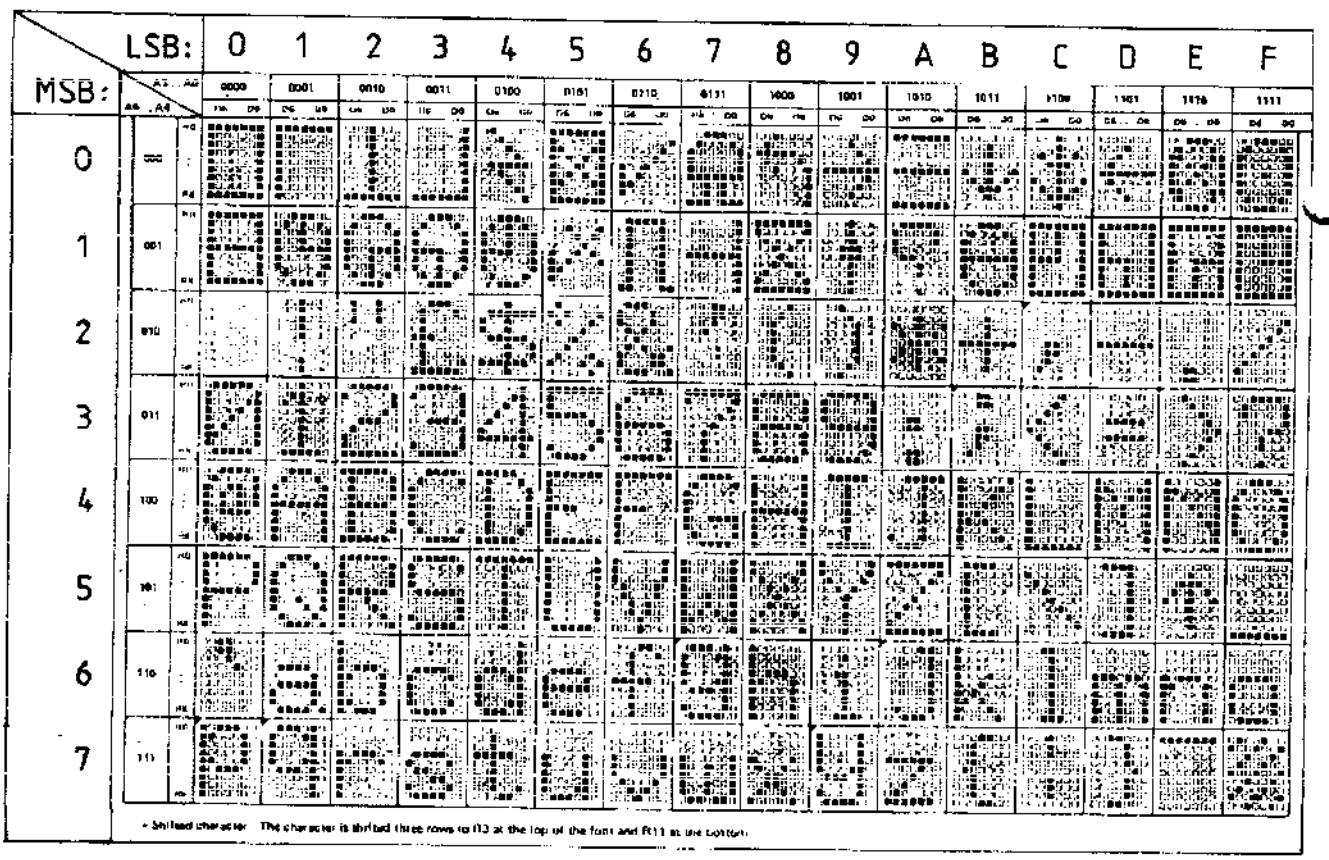
MCM 6574: US. ASCII. Hash in place of £ sign.

MCM 6577: German Characters.

MCM 6578: French Characters.

MCM 6579: All European Characters from Scandinavia to Spain.

Technically all these devices are 8192 bit row-select ROM's organised as 128 characters x (9 rows x 7 columns + 1'shift lower case down 3 rows' bit) = 128 x (63 + 1) = 8192 = 8 k bits.



PART 15: SOME USEFUL ABBREVIATIONS

AB	Address bus (16 bits: AB0 to AB15)
ALU	Arithmetic & Logic Unit (Part of CPU)
ASCII	American Standard Code for Information Interchange
BCD	Binary Coded Decimal (4 bits per decimal digit)
BIT	Binary Digit
BYTE	A word (of 8 bits for the Nascom 1)
CAS	Column address strobe (for Dynamic RAM)
CMOS	Complementary MOS (e.g. UART IM 6402) Uses very little power.
CPU	Central Processing Unit (E.G. Z80)
DB	Data Bus (8 bits: DB0 to DB 7)
DIP	Dual-in-Line Package
EPROM	Ultra-violet eraseable, electrically programmable ROM.
Hex or H	Hexadecimal (To number base sixteen) E.G. 10 Hex = 16 decimal.
Hex	Times six (for TTL buffer IC's)
IC	Integrated circuit (E.G. TTL, LS TTL, LINEAR or MOS, etc.)
I/O	Input/output
KBD	Keyboard
K BIT	Kilo-Bit (= 1024 bits)
K BYTE	Kilo-Byte (= 1024 bytes each of 8 bits)
LED	Light-emitting diode.
LS	Low-power shottky (Faster than standard TTL logic IC's)
LSB	Least significant Bit (usually called Bit Zero)
LSI	Large scale Integration (E.G. Z80, Memories, Etc.)
MPU	Microprocessor Unit (= CPU)
MSB	Most Significant Bit.
MSI	Medium Scale Integration (E.G. 74LS163 Counter/Divider)
MOS	Metal Oxide Semiconductor (Slower than Bipolar but uses much less power)
PCB	Printed Circuit Board (Formed by Photographic Etching)
PIO	Parallel Input-output Controller (E.G. MK3881)
PROM	Programmable Read Only Memory (See EPROM)
RAM	Random Access Memory (i.e. READ/WRITE MEMORY)
RAS	Row Address Strobe (for Dynamic RAM)
RF	Radio Frequency (E.G. VHF or UHF)
ROM	Read-Only Memory (Programmed during manufacture)
SIO	Serial Input-output (Using a UART in Nascom 1)
TTL	Transistor-Transistor Logic.
TTY	Teletype
UART	Universal Asynchronous Receiver - Transmitter
UHF	Ultra-High Frequency (Used in U.K. and elsewhere for 625 Line TV Transmissions). 300 MHz-3GHz.
VHF	Very High Frequency. (30 MHz - 300 MHz).

(Programming, Component and Z-80 Control abbreviations not covered above).