

Acorn Computers Ltd, System 2 Technical Manual, issue 1, January 1980.
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SYSTEM 2 TECHNICAL MANUAL

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The Acorn system 2 is a complete micro-computer available in kit form or fully assembled and tested. Using the popular Euro cards (100 x 160mm) an easily expanded system concept has been created and system 2 itself may be produced as an expansion of the two card system 1. The cards are housed in a 19" card frame with a backplane using DIN standard two part connectors. No peripheral devices are supplied with the basic system 2, it being left to the user to select the ASCII keyboard, CRT display, cassette tape recorder and power supplies best suited to the application. These parts are, of course, available with the system if required. The system may be furnished with professional connectors, front panels and a 19" case if desired.

At the heart of system 2 is the Cassette Operating System (C.O.S.) software and the Acorn BASIC interpreter. This resident software provides powerful high level language facilities ideally suited for all applications.

Chapters 2, 3 and 4 of this manual need to be referred to only if the system is in kit form. Chapters 9, 10 and 11 need only be referenced in case of system expansion. The Acorn BASIC is described in its separate manuals.

Chapter 2 - System 2 Parts List

Unpack the kit carefully and ensure that no components are concealed within the packing materials.

6502 C.P.U. card

PCB	Printed Circuit Card	200,000 issue 3 or later
IC1	6502 micro processor	and 40 pin socket
IC2	INS 8154 RAM/IO	"
IC3	2114 RAM	and 18 pin socket
IC4	2114 RAM	"
IC5	Not supplied	
IC6	Not supplied	
IC7	OS ROM	and 24 pin socket
IC8	INS 8154 RAM I/O not supplied	but 40 pin socket is
IC9	74LS20	and 14 pin socket
IC10	74LS139	and 16 pin socket
IC11	74LS04	and 14 pin socket
IC12	74LS00	and 14 pin socket
XTAL	1MHz crystal	
R1-4	4 off 4K7 resistor	
C1-2	47 or 100 nF capacitor	
C5-8	"	
C9	15 uF electrolytic capacitor	

NB C3, C4, C10, IC5, IC6, and IC13 are not fitted.
IC8 is available as an accessory.

Cassette Interface

PCB	Printed Circuit Card	200,001 issue 2 or later
IC1	CD4024B	and 14 pin socket
IC2	CD4024B	"
IC3	CD4011B	"
IC4	CD4013B	"
IC5	CD4001B	"
IC6	CD4024B	"
IC7	LM358	and 8 pin socket
R1	3K9 resistor	
R2	47K resistor	
R3	4K7 resistor	
R4	1K resistor	
RS	10K resistor	
R6	4K7 resistor	
R7	4K7 resistor	
R8	47K resistor	
R9	4K7 resistor	
R10	4K7 resistor	
R11	10K resistor	
R12	47K resistor	
R13	4K7 resistor	
R14	470K resistor	
R15	4K7 resistor	
R16	4K7 resistor	
C1	100pF capacitor	
C2	1nF capacitor	
C3	10nF capacitor	
C4	1nF capacitor	
C5	15uF electrolytic capacitor	
C6	47 or 100 nF capacitor	
C7	Not fitted	
C8	22nF capacitor	
C9	47 or 100 nf capacitor	
C10	47 pr 100 nF capacitor	

Visual Display Unit Interface

PCB	Acorn Computers Ltd. pt no 200,002	
IC1	74LS139 decoder	and 16 pin socket
IC2	74LS02 NOR gate	and 14 pin socket
IC3	74LS13 Schmitt trigger	and 14 pin socket
IC4	MC6845 C.R.T. controller	and 40 pin socket
IC5, 6 & 7	74LS157 data selector	and 16 pin socket
IC8 & 9	2114-3 R.A.M.	and 18 pin socket
IC10	74LS174 hex flip-flop	and 16 pin socket
IC11	INS 8208 buffer	and 20 pin socket
IC12	74LS86 excl. OR gate	and 14 pin socket
IC13	SAA5050 character generator	and 28 pin socket
IC14	74LS00 NAND gate	and 14 pin socket
Q1	BC197 transistor	
D1	1N4148 diode	
R1	1K resistor	
R2	1K resistor	
R3	470 R preset potentiometer	
R4	10K resistor	
R5	4K7 resistor not supplied	
R6	22K resistor	
R7	4K7 resistor	
R8	10K resistor	
R9-12	4 off 10K resistors	
R13	4K7 resistor	
R14	10K resistor	
R15	470R resistor	
R16	82R resistor	
R17	18K resistor not supplied	
R18	10K resistor	
R19	10K resistor not supplied	
R20-22	3 off 10K resistors	
C1	10 or 15 uF electrolytic capacitor	
C2-7	6 off 47 nF capacitors	
C8	100 pF capacitor	
C9	150 pF capacitor	
NB	For IC11 INS208 is equivalent to DP8304	

Memory Board (issue 2)

PCB	Printed Circuit Card	200,003 issue 2 of later
IC3-10	2114 RAM	and 18 pin socket
IC1, 2,		
11-16	18 pin sockets supplied for extension RAM	
IC17	BASIC ROM and 24 pin socket	
IC18	24 pin socket supplied for extension ROM	
IC19	74LS42 and 16 pin socket	
IC20	74LS00 and 14 pin socket	
IC21	81LS95 or 97 and 20 pin socket	
IC22	INS8208 and 20 pin socket	
IC23	81LS95 or 97 and 20 pin socket	
IC24	74L42 and 16 pin socket	
IC25	74LS00 and 14 pin socket	
R1	1K resistor	
C1-7	7 off 47 or 100 nF capacitors	
C8	15uF electrolytic capacitor	

NB IC24 is a 74L42 from National Semiconductor only

Also supplied for system 2 is

1 off Card Frame	173-12501L
4 off 64 way plugs	17-3704L
4 off 64 way sockets	17-3705F
8 off card guides	173-12553G
1 off Back-plane PCB -	200,011
Earthwire and solder tag	
16 off 2.5 mm x 10 mm screws	
8 off 2.5 mm nuts	

Chapter 3 - Electrical Assembly

Assembly Technique

Four Eurocards and a backplane board have to be assembled for system 2, the components for each card are packed separately in plastic bags or on conducting foam.

Before attempting to assemble each card check that all the component parts are present and that none have been damaged. It is worthwhile taking a few minutes to make sure that all the components can be identified. Sometimes components will be substituted in case of supply difficulties. For instance, 0.047 uF capacitors may replace 0.1 uF capacitors shown on the parts list. The components substituted will in no way be detrimental to the system's operation. Also some manufacturers have similar but different type numbers e.g. for the CMOS a CD4011 from R.C.A. may be replaced by an MM5611 from National Semiconductor.

For capacitors note that the value may be expressed in one of two ways:-

100	nF	=	0.1	uF	
10	nF	=	0.01	uF	
1	nF	=	1000	pF	
0.1	nF	=	100	pF	etc.

Capacitors supplied with the Acorn cards are usually identified by a 3 digit number, the first two digits being the first two digits of the value and the third being the number of following zeros eg.

101	=	10 and one zero ie. 100 pF
103	=	10 and three zeroes ie. 10000 pf = 10 nF
473	=	47 and three zeros i.e. 47000 pF = 47 nF = 0.047 uF.

If in doubt about the capacitor values, count the number of each of type supplied in the kit and then identify them using the parts list quantities.

3-1

The resistor colour code is shown here.

[Picture removed from ASCII version]

The first and second bands give the resistor value and the decade band shows the number of zeros following:-

0	Black	
1	Brown	
2	Red	
3	Orange	e.g. Yellow, Violet, Orange
4	Yellow	is Yellow, Violet = 4,7 and
5	Green	Orange = 3 zeros i.e. 000.
6	Blue	So the value is 47000 ohms,
7	Violet	i.e. 47 kilo-ohms or 47K.
8	Grey	
9	White	

The tolerance band is red for +/- 2%, gold for +/- 5% or silver for +/- 10%.

Assembling the cards will require a considerable amount of soldering and a small electric soldering iron is essential with a diameter at the end of the bit not exceeding 0.1 inches. The iron should be rated between 10 and 30 watts and fine 22 gauge flux cored solder should be used. If you have never soldered before we advise you not try to assemble the cards without assistance as Acorn Computer Ltd. cannot accept responsibility for kits which have been improperly assembled. When soldering make sure the component is well pushed on

to the board as shown, use a minimum of solder and once the solder has run remove the iron.

[Picture removed from ASCII version]

Some of the integrated circuits used in the system employ M.O.S. technology and they can be damaged by static electricity. As a general rule if there is no noticeable static charge in the area and no nylon clothes or carpets are present all will be well. An earthed soldering iron should be used when soldering on a board containing M.O.S., I.C.'s and the I.C.'s should be kept on the conducting foam on which they are supplied until required.

The Acorn Printed Circuit cards are double sided, through hole plated glass fibre and are manufactured to the highest standards. A layer of green solder resist ensures that accidental solder splashes do not stick to the tracks and a clearly marked white silk screen indicates component positions. Examine the cards for faults or damage before proceeding. It is not necessary to solder through holes which connect one side of a board to the other and do not have a component lead in them and attempting to do so can break the through hole plating and thus the connection. All soldering should only be done on the opposite side of the board to the components (i.e. side 1).

The cards are each supplied with a full set of integrated circuit sockets. The sockets must be fitted the right way round, on the circuit board viewing it from the top. Pin 1 of an I.C. is identified as shown:-

[Picture removed from ASCII version]

3-3

The sockets will have either a 45 degree chamfer for pin 1 or a semi circular cut out as shown:-

[Picture removed from ASCII version]

Note that on the Central Processor Unit IC1 is the opposite way round to the other sockets nearby. Fit the sockets one at a time and ensure that they are pressed fully down with no leads bent under the socket before first soldering two diagonally opposite pins at the corners. Check that the socket is the right way round and successfully fitted before soldering the rest of the pins.

There is no need to snip off the excess of the socket pins.

After the I.C. sockets the resistors and capacitors are fitted to the circuit cards. Identify the component from the component list and fit it to the board. Some capacitors will need to be fitted as shown.

[Picture removed from ASCII version]

Do not crack the capacitor body when bending the leads.

3-4

The electrolytic capacitors are polarised and the positive end marked + must be located as indicated on the circuit cards.

The crystal on the C.P.U. card is fitted as shown:-

[Picture removed from ASCII version]

Again bend the leads away from the component body and lay the Crystal down on the board before soldering. Snip off any excess leads under the board.

The connector is fixed to a card using two 2.5 mm screws and nuts before soldering the pins. When all of the components are soldered the integrated circuits may be fitted in their sockets, pin 1 is identified by either a semicircle or a dot as shown:-

[Picture removed from ASCII version]

Identify the I.C. type from the components list and plug it into the appropriate socket. If the leads are splayed out press them all in together as shown until the I.C. fits easily to the socket.

[Picture removed from ASCII version]

Take care that no I.C. pins get bent under the I.C. when inserting and remember that I.C.1 on the C.P.U. card is the opposite way round to its neighbours.

6502 C.P.U.

Printed circuit cards at issue 3 or later are supplied with complete systems. The NMI, IRQ and RST switches are not required. Also not supplied or required are I.C.'s 5 and 6 together with their 16 pin sockets and the 5 volt regulator, I.C. 13. The electrolytic decoupling capacitor is fitted at C8 and C10 must not be used. This allows the Block zero signal to be connected to the backplane by fitting a wire link to the right hand side of I.C.13 as marked on the silk screen.

The INS 8154 RAM/IO chip is fitted at I.C. 2 and the ASCII keyboard connects to port B of it. A 20 way right angled header may be fitted for connecting the keyboard or wires can be soldered directly to the edge fingers. I.C. 8 is not used in the system but a second INS 8154 can be fitted here giving 16 I/O lines for user definition and so a socket for it is supplied.

[Picture removed from ASCII version]

The operating system ROM is fitted in I.C. 7 and to use it the correct address selection links are required:-

[Picture removed from ASCII version]

To produce this a track must be broken on side 2 of the card as shown:-

[Picture removed from ASCII version]

and a wire link must be fitted from pin 5 to pin 9 of the ADR SEL location. The ROM IC marked COS (Cassette Operating System) can now be fitted in I.C. 7.

In system 2 three connections from I.C. 2 to the backplane are required in order to connect to the cassette interface. On issue 3 boards these must be made with three pieces of fine insulated wire and they are as follows:-

I.C. 2 pin 16 to backplane plug pin B 19 for CASIN
I.C. 2 pin 17 to backplane plug pin B 20 for CASOUT
I.C. 2 pin 18 to backplane plug pin B 21 for NHITON

Cassette Interface

Printed Circuit Cards at issue 2 or later are supplied with complete systems. I.C. 8, the 8 digit display and the small keypad are not required for system 2.

Before fitting the 64 way plug the following pins MUST be cut off the plug as close to its body as possible. The pin numbers are marked on the body of the plug:-

A2 - 31 inclusive
B1
B21 - 31 inclusive

A wire link is required from I.C. 6 pin 3 to pin B 14 of the connector for the Not High Tone signal.

[Picture removed from ASCII version]

V.D.U. Interface Card

R5 is not required on this card.

[Picture removed from ASCII version]

Memory Card

This card carries the 4K of user RAM in I.C.'s 3, 4, 5, 6, 7, 8, 9 and 10 and to address it a link must be fitted in position RAM 1. A further 4K of RAM (8 x 2114's) may be added at anytime and the extra sockets are supplied as standard.

If an issue 1 memory card is supplied the BASIC will be in a pair of EPROM's. The low one is fitted in I.C. 17 and the high one in I.C. 18, a link must then be fitted in position ROM 6.

Eventually all systems will be supplied with issue 2 memory cards and the BASIC in a single ROM. This ROM is fitted in I.C. 17 and again a link must be fitted in position ROM 6.

[Picture removed from ASCII version]

If desired a write protect switch for the RAM may be fitted by breaking the track marked between I.C.'s 15 and 21 and fitting a SPST switch across it.

Back Plane

The backplane has provision for eight 64 way Euro card sockets and two 32 way power supply sockets. Side A is connected from pin to pin right across the back plane and carries the computer data bus, address bus, control lines, clock and power. Side B is left unconnected and may be wire wrapped to configure a user defined system of additional boards, extra I/O, interrupt priorities etc.

The left hand 64 way card location has its 16 bit address bus isolated from the other cards, and so it may not be used for system 2. System 2 connectors are fitted as shown:

[Picture removed from ASCII version]

Ensure that the connectors have pin 1 at the top and push their pins through the backplane. With each connector pushed hard against the backplane solder pins A1 and A32, check that the connectors are all lying flat on the back plane before soldering the rest of side A. The side B pins should not be soldered at all.

Four connections are necessary to connect the 6502 C.P.U. card to the cassette interface. These may be made with soldered links but preferably are wire-wrapped. Simple hand wire-wrapping tools are available for about £5.00. The connections are:-

C.P.U. card pin A29	to cassette interface pin B11,	02 clock
" B19	" "	B12, CASIN
" B20	" "	B13, CASOUT
" B21	" "	B14, NHITON

Finally a wire link is soldered on the left of the back plane to connect the system 0volts to the earthing wire. The earthing wire is soldered into the backplane and using a solder tag it is connected to the card frame metal work by the top left tie bar screw after the backplane has been mounted in the frame.

The backplane is now ready for use in system 2.

Chapter 4 - Mechanical Assembly

The Eurocard frame kit contains two end plates, two end plate front angles, two front tie bars with tapped strips, two rear connector mounting rails and eight fixing screws. Assemble the frame as shown:-

[Picture removed from ASCII version]

Note that viewing the frame from the front the 83rd guide position is on the right.

The standard allocation of the front of the cardframe is as shown:-

[Picture removed from ASCII version]

The 2.8" space is for a 5/12 volt power supply. Seven Eurocards spaced at 1" are allowed for with another one occupying part of the 7" space for a floppy disc controller. The left hand Eurocard location is reserved for the C.P.U. card when bus buffers are fitted to the backplane. The four card system 2 does not require buffers and so the cards are fitted as follows:

- 2.8" Space (power supply)
- 1" Space
- 1" C.P.U.
- 1" cassette interface
- 1" V.D.U. interface
- 1" memory board
- 1" Space
- 1" Space
- 7" Space (Floppy disc controller)

Take the backplane board with its four connectors and lay it so that the board is between the upper and lower rear tie bars with the connector mounting ears on the front of the tie bars. Pin 1 of the connectors should be at the top i.e. the bus buffer I.C. locations are to the left hand side. Using eight of the 2.5 mm screws provided fix the connectors into the tapped holes on the rear tie bars that are numbered 21, 26, 31 and 36. Check that the power bus lines on the backplane are not shorted to the tie bars.

[Picture removed from ASCII version]

With the backplane mounted in the frame take care that the protruding connector pins are not damaged in any way.

Card and module guides may be fitted at multiples of 0.2" spacings by either clipping them into the holes, or onto the metal between the holes, of the tie bars:-

[Picture removed from ASCII version]

Note the guides are fitted with the flat side to the left and the stepped side to the right. To fit the guides place them in the appropriate location on the rear tie bar and then push them onto the front tie bar where they snap into position.

[Picture removed from ASCII version]

To remove the guides push them to the rear whilst unclipping them from the front tie bar. Top and bottom pairs of guides are fitted into positions 20, 25, 30 and 35.

It should now be possible to slide the four boards into the guides with their components facing to the right. The connectors should mate together but it may be necessary to loosen the screws securing the backplane connectors and move the backplane fractionally to allow the connectors to mate freely.

With a fully expanded system card guides are fitted in positions 15, 20, 25, 30, 35, 40 and 45 with the slimmer module guides in positions 2, 12, 51 and 82.

The Eurocard frame may be fitted in a 19" case giving protection for the printed circuit cards. Two front handles supplied with the case are positioned behind the card frame angles and four screws with plastic washers secure the frame and handles into the case.

One inch front panels may be fitted to the Eurocards, these are available with holes already cut for suitable front connectors for each board. The memory board only requires a blank panel. The front panel is fixed to the board using two plastic brackets also supplied as shown:-

[Picture removed from ASCII version]

Chapter 5 - Peripheral Devices

Power Supply

System 2 requires a 5 volt stabilised supply at a current rating of not less than 1.5 amps (2 amps with 8K of RAM). This supply may be connected with two pieces of wire to the holes provided on the backplane (see page 3-11). If the 0 volt line of the supply is not earthed a safety earth should be connected to the card frame metalwork which is in turn connected to the earth connection on the backplane. If available a 5 volt - 3 amp module may be fitted in the left of the rack using four module guides and a 32 way socket on the left of the backplane.

Keyboard

A parallel ASCII keyboard is required to be fitted on the front of C.P.U. card. A 5 volt supply for the keyboard is available and the board requires a 'low for key depressed' strobe signal. The connections may be soldered to the front of the board as follows:-

(top)	20	+ 5 volts
	19	Reset
	18	Key strobe
	17	Data bit 6
	16	Data bit 5
	15	Data bit 4
	14	Data bit 3
	13	Data bit 2
	12	Data bit 1
	11	Data bit 0
	10	-
	9	-
	8	-
	7	-
	6	-
	5	-
	4	-
	3	-
	2	-
(bottom)	1	0 volts

The reset is provided by a simple push button connected to 0 volts. This is often available as an extra key on ASCII keyboards.

If desired a 20 way pcb header to the C.P.U. card in which case the keyboard connections are as follows:-

20 Data bit 5	19 Data bit 6
18 Data bit 4	17 Key strobe
16 Data bit 3	15 Reset
14 Data bit 2	13 + 5 volts
12 Data bit 1	11 0 volts
10 Data bit 0	9 -
8 -	7 -
6 -	5 -
4 -	3 -
2 -	1 -

When connecting ribbon cable sockets to the headers ensure that the pin 1 identification arrows are together.

Cassette Recorder

System 2 uses a standard Audio Cassette Recorder for program and data storage. On the cassette interface card is a Computer Users Tape Standard interface which connects to the recorder as shown:-

[Picture removed from ASCII version]

This recorder output consists of one of two tones, 2.4 KHz represents a logic 1 and 1.2 KHz a logic 0. Each bit i.e. 0 or 1 lasts for 3.3 mS giving an operspeed of 300 bits/ second.

Both recording and playback are crystal controlled giving a low error rate and except on very cheap recorders whose speed may vary, no trouble should be experienced in transferring tapes from one machine to another.

We recommend the use of a recorder with an input and output dedicated to external connection to an amplifier as opposed to the microphone and external loudspeaker connections on the cheaper recorders. These types usually have a 3 or 5 pin circular DIN connector which is wired as shown above. The input and output recorder levels as supplied are both 300 mV r.m.s. The output may be adjusted by changing R3 and input by changing R12 on the keyboard. The output should be adjusted so that the tones play back at a comfortable audio volume without excessive distortion. The input is then adjusted for reliable operation or using an oscilloscope, to give a waveform at pin 7 of I.C. 7 which is in excess of 2 volts peak to peak but is not being clipped.

Visual Display Unit

The V.D.U. interface drives a raster scanned cathode ray tube display device e.g. a monitor or a television. The format is 40 characters on 25 lines with teletext colour graphics.

The standard output is a 1 volt/75 ohm composite video signal available on pin 15 on the front of the V.D.U. card with a 0 volt return on pin 14. A 75 ohm coaxial cable connected to this will drive a monitor directly. Also this signal may be used to drive a UHF modulator as shown below giving an interface to a standard television.

[Picture removed from ASCII version]

Using the composite video output the different colours available from the VDU card will appear as different shades of grey, even on a colour monitor or television.

To obtain a colour display the Red, Green and Blue drive signals from the card together with the required synchronising signals must be fed to either a T.T.L. level input colour monitor or a colour encoder/UHF modulator system.

Note that if a BNC connector is mounted on an optional front panel for the video output the body of the connector i.e. 0v should be insulated from the panel.

After switching on and entering the COS R3 on the V.D.U. card is adjusted to give stable characters of the correct width on the screen.

Chapter 6 Cassette Operating System

This is a 2K byte program resident in ROM on the 6502 C.P.U. card. It provides support for other programs e.g. a BASIC interpreter by dealing with peripheral devices and allowing programs to be filed on cassette tapes. It is specifically written for the system 2 and it interfaces to the teletext Visual Display Unit interface, a parallel ASCII keyboard and a centronics parallel printer.

To start system 2 enter the COS by pressing the reset button (break) on the keyboard. If the system is working the COS will display on the V.D.U. : -

Acorn Cos

*

The star is the COS prompt indicating that it is waiting for the user to type in a command. To the right of it is the flashing cursor at which the characters typed are displayed.

Commands must be typed in capital letters only and many keyboards feature a Capital Lock button so that the alphabetic keys always produce an upper case output whilst the numeric and symbolic keys continue to work in shifted or un-shifted mode as usual.

On typing a character the V.D.U. will display that character and advance the cursor along one position to the right. Another character may then be entered. Should a character be typed in error it may be corrected by pressing the delete (back space or rub out) key in which case the character to the left of the cursor is erased and the cursor moved back to that position.

If desired the whole line may be thrown away by entering control X ie. pressing the control key and X together. A new cursor is displayed and a new line of text can then be entered. After typing a word or some words separated by spaces the displayed text may be entered to the COS by typing return.

6-1

If the text is not a command recognised by the COS it will respond with

Com?

*

The user may then type in more text. If the COS recognises the command but it is not presented in the correct way i.e. its syntax is wrong the display will show

Syn?

*The COS recognises the following commands any of which

may be abbreviated by entering enough of the characters to distinguish it from any other command followed by a full stop. Spaces are used to separate the arguments, unless otherwise stated leading zeroes are not required.

The commands are listed giving the command, its full name and its shortest possible abbreviation:-

BASIC

This command causes execution of the Acorn BASIC interpreter if it is present. Refer to the BASIC manual for explanation of how to use it. If BASIC is not present either in ROM or RAM then the system crashes and must be re-set.

LOAD Load from Tape L.

The syntax of this command is as follows:LOAD "FILENAME" XXXX

The name of the file to be loaded is inside double quotes and may be up to sixteen characters long. Files are normally loaded to where they were originally saved from. The optional four digit hexadecimal address allows relocation to a new section of memory starting at the address specified. On pressing RETURN the COS will respond with

6-2

Play drive 0

The user should now start the cassette recorder in play mode at the desired position on the tape and press the space bar on the keyboard to indicate to the COS that this has been done. The COS will display the names of any files that are on the tape between the starting position and the file that it is searching for. When the file to be loaded is found it is loaded and the COS will then display the * prompt indicating that the loading process is complete and that the recorder may now be stopped and that new commands may now be entered.

Files are stored as a number of 256 byte blocks each of which is identified on the tape. If the file to be loaded is part way past the tape heads this is detected at the start of the next block. Loading ceases and the COS displays

Rewind drive 0

The user should then stop the tape, rewind it and then press the space bar to which the COS will respond with

Play drive 0

The loading process should then be repeated.

One error message may be produced sum

This indicates that the checksum has failed at the end of a block i.e. a byte or some bytes have not loaded correctly. The * prompt is displayed and the user may rewind the tape and try to re-load if desired.

The loading operation may be aborted by pressing the space key. When the COS reaches the end of the block it is loading, loading ceases and the * prompt appears.

6-3

When entered program execution is transferred to the address specified which is obligatory.

SAVE Save on Tape S.

The syntax of this command is as follows:SAVE "FILENAME" XXXX YYYY ZZZZ

The name that the file is to be saved under is inside double quotes and may be up to sixteen characters long. This must be followed by two hexadecimal addresses, the start address and the end address plus one of the section of memory to be saved. The optional third address specifies where execution is passed to after loading the file back using the RUN command. On pressing return the COS will respond with

Record drive 0

The user should now start the cassette recorder in record mode at the desired position on the tape and press the space bar on the keyboard to indicate to the COS that this has been done. After the

COS has finished outputting to the tape it will respond with the * command and the recorder may then be stopped. The escape does not allow the save sequence to be aborted.

Tapes may be created in the system 1 format by omitting the filename, the third address has no significance in this case

```
SAVE XXXX YYYY
DRIVE  Drive select  D.
```

The syntax of this command is

```
DRIVE N
```

where N is 0, 1, 2 or 3. This command is included to maintain compatibility with more advanced operating systems and has no effect in the COS except to change the number printed on the screen which is initially set to 0.

```
6-5
MON  Messages on    MO.
```

When entered this command allows messages from the COS to appear in the output stream to the V.D.U. and printer. This is the usual condition after reset. Possible messages are: Rewind drive N

Play drive N

Record drive N

```
F ILNAME
NOMON  Messages off  N.
```

This command turns off the messages enabling the V.D.U. contents to be preserved and stopping unwanted printouts.

```
CAT  Catalogue      I.
```

This command allows the display of information about the files on a cassette tape. When entered it will respond with

Play drive 0

and after starting the recorder in play mode and pressing the space bar the following display format is produced

```
FILNAME AAAA ZZZZ BBBB CC
```

This is produced everytime the COS encounters the start of a block. AAAA is the start address of the block. ZZZZ is the execution address of the file as used by RUN. BBBB is the block number, blocks are numbered in a file starting at zero. CC is the number of valid bytes in the block, minus one. All these are, of course, in hexadecimal. When a system 1 file is encountered the display is

```
XXXX  YYYY
```

6-6
Here XXXX is the start address and YYYY the end address plus one of the file as used in SAVE.

To stop the flow of information press the space bar and stop the recorder.
FLOAD Finish loading F.

The syntax of this command is

FLOAD "FILENAME" XXXX

The normal LOAD demands that files are loaded from the start of the first block and will request that the tape is re-wound if started in the middle of the file. FLOAD allows loading to commence from the start of any block in the file. The optional hexadecimal address XXXX specifies the memory address to which the start of the first block is loaded if relocation is required.

This is useful after a checksum error has been encountered. The tape may be stopped and re-wound to anypoint prior to the block which produced the error. FLOAD is then used to allow loading to continue and the block identifiers will ensure that blocks are loaded in the correct place. However if the file was being relocated the block identifiers do not specify the correct memory address for that block. In this case CAT can be used to find out which block is next on the tape. Knowing how many 256 byte blocks have been loaded the optional start address for the next block can be calculated and entered in the FLOAD command.
USE Use qualifier U.

The syntax of this command is

USEQ

This command is included to maintain compatibility with other operating systems and has no effect at all in the COS Note that the syntax demands that there is no space between USE and the specified qualifier which may be any ASCII character.

6-7

MEM Memory examine-edit M.

The syntax of this command is

MEM XXXX

On pressing return the display will show the address followed by its contents in hexadecimal. If the specified address is in RAM new hexadecimal data may be entered or the return key may be used to obtain a * prompt. Also after MEM either U or V may be entered which increment or decrement the address being examined. In this way machine code programs such as the cassette test may be entered and then executed using the GO command.

Chapter 7 COS Control Characters Screen Editor

Five keys on the ASCII keyboard allow cursor movement and editing anywhere on the V.D.U. screen. These are

Control A	-	cursor left
Control S	-	cursor right
Control W	-	cursor up
Control Z	-	cursor down
Control Q	-	read character

Pressing the control key and the A, S, W or Z keys move the cursor around the screen but do not send any new characters down the input channel.

Once the cursor is positioned over the desired character, this character may be sent down the input channel using control Q, the cursor is then moved one space to the right automatically.

For example, suppose it is required to edit a BASIC line:LIST

```
10    REM EXAMPLE
20    FOR I = 0 TO 50
30    PRINT "ORANGES AND LEMONS"
40    NEXT I
50    END
>
```

After listing the program the screen is as above with the cursor at the bottom following the BASIC prompt.

First move the cursor to the start of the line to be edited using control A, S, W and Z :LIST

```
10    REM EXAMPLE
20    FOR I = 0 TO 60
30    PRINT "ORANGES AND LEMONS"
7 - 1
40    NEXT I
50    END
```

Now use control Q to re-enter the line number and first part of line 30 :LIST

```
10
20
30 PRINT "ORANGES AND LEMONS"
40
50
```

Next the new output required is typed:LIST

```
10
20
30 PRINT "APPLE OR PLUM "MONS"
40
50
```

And as no more of the old line is required the return key is now pressed and the program may

be listed again.

Printer and Screen Control

The following ASCII control characters affect the V.D.U. screen when they are output. They are listed together with their keyboard key and decimal value. The operating system also provides for a printer which may be connected using an extra interface card. Control characters for this printer stream are also listed: -

7-2

STX (ctrl B, 2) Start Printer

This starts the printer output stream but is not sent out to the printer. It also sets alphanumerics green on the

V.D.U.

ETX (ctrl C, 3) End Printer

This ends printer output stream. It also sets alphanumerics yellow on the V.D.U.

ACK (ctrl F, 6) Start Screen

This starts the output stream to the V.D.U. screen, which is the normal condition initially set by the COS.

BD (ctrl H, 8) This moves

HT (ctrl I, 9) This moves

LF (ctrl J, 10) This moves

VT (ctrl K, 11) This moves
Cursor Back

the cursor back one character position

Cursor Forward

the cursor forward one character position

Line Feed the cursor down one line.

Vertical Tab the cursor up one line.

FF (ctrl L, 12) Form Feed

This clears the screen and moves the cursor to the top left hand corner.

CR (ctrl M, 13) Carriage Return

This moves the cursor to the start of the current line.

NAK (ctrl U, 21) End Screen

 This ends the output stream to the V.D.U.

RS (ctrl , 30) Home Cursor

 This moves the cursor to the top left hand corner of the screen.

DEL (DEL, 127) Delete

 This backspaces the cursor and deletes the character at that position.

7-3

 Printers connected to the system printer port will often respond to other control characters in the output stream so refer to the relevant printer manual. Note that some of these other control characters may produce a response on the V.D.U. if its output stream is enabled.

 Because some printers will initiate the printing of a line in response to either a carriage return or a line feed character in the output stream the operating system prevents the character specified by location 254 in zero page from reaching the printer. This character is initialised on reset to be a line feed but it may be changed by altering the contents of location 254. Thus it is possible to stop any one character from being printed but note that if neither line feed nor carriage return are specified some printers will do a double line feed after printing.

The teletext standard V.D.U. in the system produces coloured alphanumerics and graphics as well as some other features in response to some control codes. These codes are listed in decimal as follows:-

129	Red	alphanumerics	145	Red Graphics
130	Green	"	146	Green "
131	Yellow	"	147	Yellow "
132	Blue	"	148	Blue "
133	Magenta	"	149	Magenta "
134	Cyan	"	150	Cyan "
135	White	"	151	White "
136	Flash		152	Conceal display
137	Steady		153	Contiguous Graphics
138	End Box		154	Separated Graphics
139	Start Box			
140	Normal Height		156	Black background
141	Double Height		157	New background
			158	Hold graphics
			159	Release graphics

These characters affect the characters displayed to the right of them on a line, and provide the following options:-

ALPHA (COLOUR) causes following characters on the line to be in the colour specified.

GRAPHICS (COLOUR) In Graphics mode each character space displayed is divided into 6 cells. Each cell is illuminated, in the specified colour, if a corresponding binary bit in the code stored at that location is set. The bit assignments are:-

8-1

Bit 5 in the byte is always set for a graphics character, if bit 5 is clear then the upper case, alphabet and characters

, , , , # , @ are available in the same colour.

FLASH causes the following characters on the line to flash.

STEADY
terminates the flash option on a line

END BOX & START BOX

DOUBLE HEIGHT

Are options for using the circuit to superimpose text onto a normal TV picture.

Must appear on two consecutive lines followed by the same characters in which case the characters fill the two lines specified.

NORMAL HEIGHT Clears the double height option on a line.

CONCEAL DISPLAY Switches off the characters on a line. These can only be revealed by applying a signal to the character generator chip (or deleting the CONCEAL character).

CONTIGUOUS GRAPHICS In this mode the graphics cells in a character are joined up.

SEPARATED GRAPHICS In this mode the graphics cells are separated by one character bit width.

NEW BACKGROUND Sets the background to the colour of the last colour specifying character.

8-2

BLACK BACKGROUND HOLD GRAPHICS

RELEASE GRAPHICS

Resets the back ground colour to black.

Causes the last graphics character to be displayed when a control character is entered.

Causes a space (Background colour) to be displayed when a control character is entered.

The character generator assumes an initial setting at the start of each line of: ALPHA WHITE, STEADY, END BOX, NORMAL HEIGHT.

CONTIGUOUS GRAPHICS, BLACK BACKGROUND, RELEASE GRAPHICS.

The characters produced by the V.D.U. and their decimal codes are tabulated here:-

32	space	64	@	96	
	4@9633!	65	A	97	a
34	' '	66	B	98	b
35	£	67	C	99	c
36	\$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	'	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44		76	L	108	l
45		77	M	109	m
46		78	N	110	n
47	/	79	0	111	0
48	0	80	P	112	p
44	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58		90	Z	122	z
59	;	91	<-	123	l
					/
					4
60	<	92	_	124	11
61		93	->	125	3
					/
					4
62	>	94		126	/
63	?	95	!=		

