



ACORN TECHNICAL MANUAL

Micro-Computer	.....	200,000
Key-Board	.....	200,001

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## INTRODUCTION

The Acorn Micro-Computer employing the 6502 Micro Processor is a versatile circuit board which may be used in at least three ways:-

1. As a Single Board Controller with a program in the pair of 74S571 PROM's or in the EPROM socket which may be 4, 8 or 16 K with single or multiple power supplies. Two RAM/IO IC's may be fitted giving 32 individually programmable IO lines and 256 bytes of RAM. 1K of further RAM may be fitted if required.
2. As a machine code computer with an 8 digit x 7 segment HEX display, HEX keyboard and a cassette interface all on a second board, which is accessed by one of the RAM/IO I.C.'s. Programs are entered and stored in the 1K of user RAM space.
3. As the Central Processing Unit for a complete computing system. All the 6502 data, address and control lines leave the board via a 32 way D.I.N. connector, which will then have access via a parallel back plane to extension memory, a Visual Display Unit, floppy disc drive, etc.. The Key-Board may be retained for its cassette interface and an ASCII Key-Board will also connect on to the HEX keyboard IO part. Systems such as this are capable of supporting high level languages, e.g. BASIC or PASCAL and may be used at home, in business or in the laboratory. Powerful peripherals such as high speed printers may be interfaced and direct control of external apparatus is possible.

Included in this manual are the construction details necessary to assemble the Micro-Computer and Key-Board Kit. Also details on power supplies, cassette interfaces and address configurations which will be required however the Acorn is used.

## CONSTRUCTION PROCEDURE

### Before you start

Before attempting to assemble the Acorn kit 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 you can identify all the components. Sometimes components will be substituted in case of supply difficulties. For instance, ten off 0.047 uF capacitors may replace the ten 0.1 uF capacitors shown on the parts list. The components substituted will in no way be detrimental to the Acorn'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.

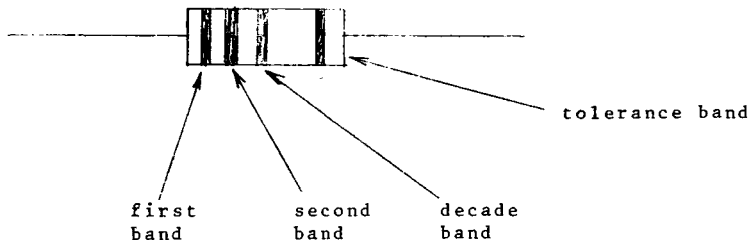
For capacitors note that the value may be expressed in one of two ways:-

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

etc.

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.

The resistor colour code chart is shown here.



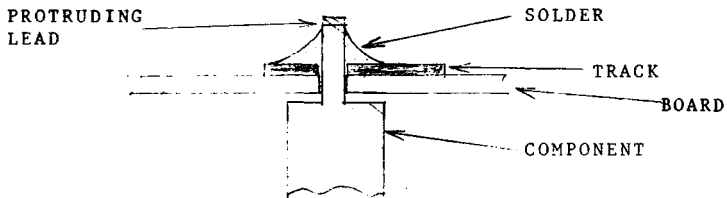
The first and second bands give the resistor value and the decade band shows the number of zeros following:-

0	Black	
1	Brown	
2	Red	
3	Orange	e.g. Yellow, Violet, Orange
4	Yellow	is Yellow, Violet = 4,7
5	Green	and 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%, any of these are suitable for the Acorn kit.

Ensure that no components are concealed in the packing material and retain the packing material in case you have cause to return the kit.

Assembling the Acorn 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 to try to assemble the Acorn without assistance as Acorn Computers Ltd. can not 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.



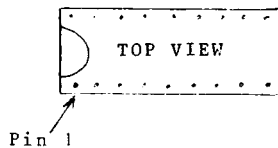
Some of the integrated circuits used in the Acorn employ M.O.S. technology and they can be damaged by static electricity. As a general rule if there is no noticeable static charge in the area and no nylon clothes or carpets are present all will be well. An earthed soldering iron should be used when soldering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

The Acorn Printed Circuit Boards 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 two boards 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. Indeed attempting to do so can break the through hole plating and thus the connection.

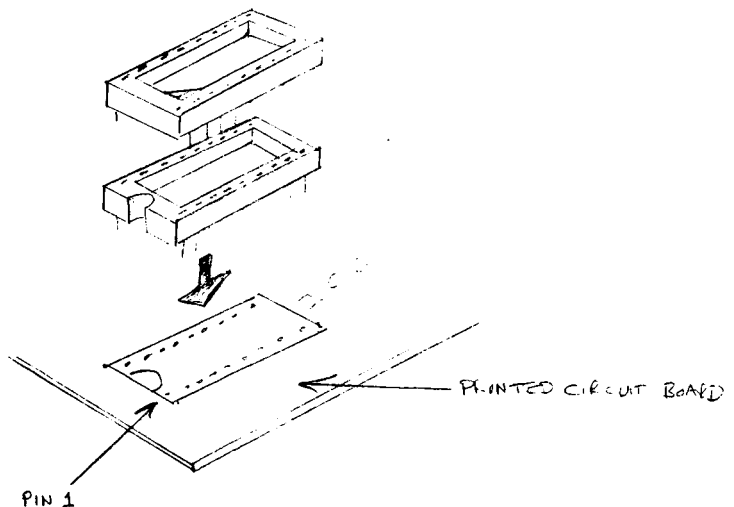
Assembling the Acorn will take an hour or two, so clear a space and continue as follows.

### Integrated Circuit Sockets

The Acorn is supplied with a full set of integrated circuit sockets and these should be fitted to the two circuit boards. 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 -



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



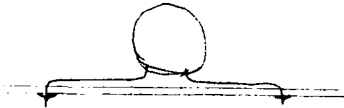
Note that on the Microcomputer board IC1 is the opposite way round to the other sockets nearby. Fit the sockets one at a time and ensure that they are pressed fully down with no leads bent under the socket before first soldering two diagonally opposite pins at the corners. Check that the socket is the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

A socket is also supplied for the Address link selection on the Micro Computer board.

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

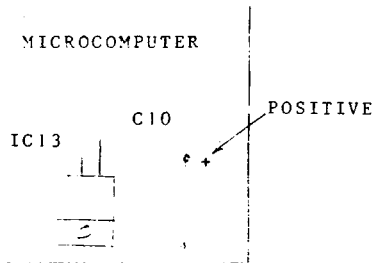
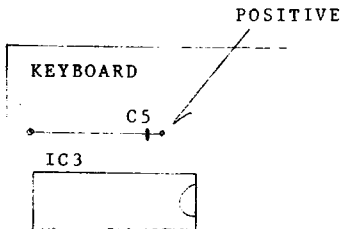
Other Components on the Boards

Resistors and capacitors are next fitted to the circuit boards. Identify the component from the component lists and fit it to the board. Some capacitors will need to be fitted as shown.



Do not crack the capacitor body when bending the leads.

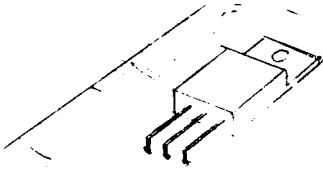
The 15 uF electrolytic capacitors are polarised and the positive end marked + must be located as shown.



After soldering in the capacitors and resistors snip off any excess leads under the boards.

## Voltage Regulator

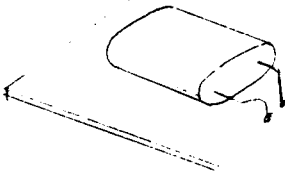
The voltage Regulator is fitted as shown:-



Bend the leads taking care not to snap them off where they enter the body of the regulator. Screw down the regulator with the nut and screw supplied and then solder the three leads under the board. Snip off any excess leads under the board.

## Crystal

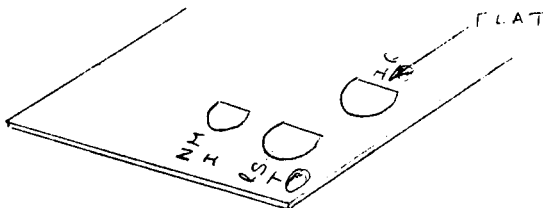
The Crystal is fitted as shown:-



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.

## Switch

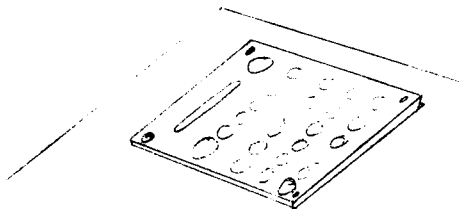
One switch is supplied with the Acorn kit. The essential Reset switch is also on the keyboard and so the switch supplied may be fitted in IRQ, NMI or duplicate RST on the Micro Computer board as required. When fitting ensure that the flat on the switch body faces into the board.



There is no need to fit the switch now if you do not know where you will require it.

### Keyboard

To assemble the keyboard first wipe the circuit board over to remove any dirt and then avoid fingering the area of the board where the keys go. Take the cage and peel off the back covering its adhesive. Carefully stick the cage on to the keyboard so that the four corner screw holes line up precisely.



The key domes may now be located into the holes in the cage, if pressed with a finger a positive click should be felt as the dome contacts to the board.

Check that all the domes are correctly fitted and then peel off the backing of the L shaped adhesive film for retaining the domes. This also acts as a dust cover. Stick the film over the cage thus retaining all the domes. Ensure that none of the domes have moved during this operation.

Next take the keyboard legend panel and lay it face downwards. Trim any excess plastic moulding from the keys and lay them top downwards in the panel. Now place the keyboard on top of the keys and panel and holding them together put two diagonally opposite screws through them and loosely do up two nuts.

With the assembly secured in this way the other two screws may be put through properly with spacers between the keyboard and the top panel, these can now be tightened before undoing the first two screws and re-fitting these with spacers also.

On later issues of the Acorn kits the 25 keys may all be moulded in one piece ready to fit directly into the top panel without separating the keys off individually.

### Display

The Acorn display has 9 digits of which the extreme left hand end one is not used. A short piece of 16 way Spectra-Strip connects the display to the keyboard. First feed the Spectra-Strip



through the slot in the keyboard into the printed circuit board. Solder leads 1 and 16 first and then, if all is well, solder the rest of the leads.

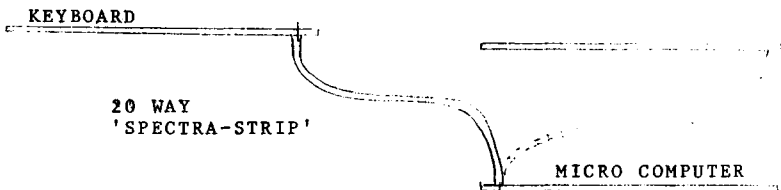


Lay the display face upwards on the Spectra-Strip and solder the strip into the display. Note that the two left hand end connections on the display are not used.

The display may be pushed down on to the keyboard taking care not to over-stress the solder joints on the Spectra-Strip.

#### Connecting the two boards

Connection between the Micro Computer and keyboard is achieved using a piece of 20 way 'Spectra-Strip' approximately 6 inches long. In order that the keyboard can be mounted above the Micro Computer the 'Spectra-Strip' must enter the keyboard from the bottom and the Micro Computer from the top as shown:-

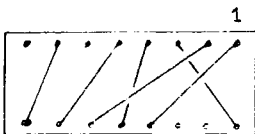


Before insertion check that the ends of the Spectra-Strip are properly stripped off and then with the strip pushed well home

solder the connections to pins 1 and 20 first. If all is well continue and solder the other 18 connections. Repeat for the other end.

### Address Decoding Links

A 16 pin socket enables selection of various Address Decoding configurations. The Acorn kit using the Blue and Yellow Monitor PROM's requires these links to be wired as shown.

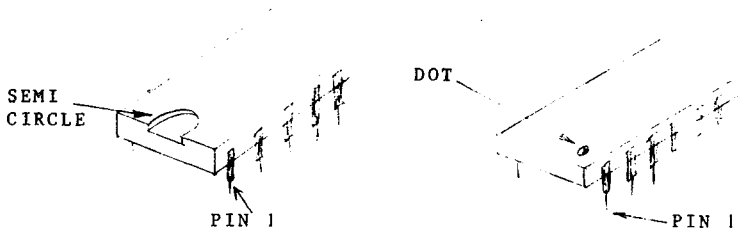


ADR SEL

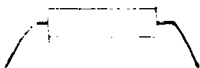
Other configurations are possible; see the section on Address Selection for further details.

### Integrated Circuits

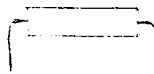
These may now be fitted in their sockets pin 1 is identified by either a semicircle or a dot as shown:-



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.



SPLAYED LEADS



READY FOR INSERTION

Take care that no IC leads get bent under the IC when inserting and remember that IC 1 on the Micro Computer board is the opposite way round to its neighbours.

### Mounting the Boards together

Four sets of screws, nuts and spacers are provided to mount the keyboard on top of the Micro Computer board. This is advisable as it stops the interconnecting 'Spectra-Strip' from being continually flexed and strained.

### Switching On

Check that all components are properly fitted, that all IC's are in the right positions and the right way round. Check that the power supply polarity is correct, as in the section on Power Supplies following.

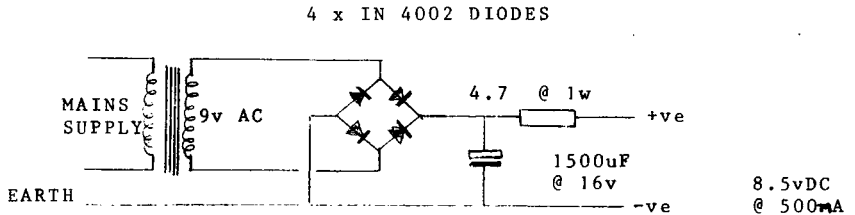
Switch on and press the Reset button, the display should indicate eight dots. If all is well proceed to the programming manual.

Should the kit not function switch off immediately and feel each I.C. to see if it is hot. If any are, check that they are correctly inserted. Check the power connections and check that all the assembly steps have been followed correctly. Do not attempt to unsolder any components or sockets with 4 leads or more as the printed circuit board may suffer. Instead cut out faulty components so that their leads may be removed one at a time.

## Power Supply

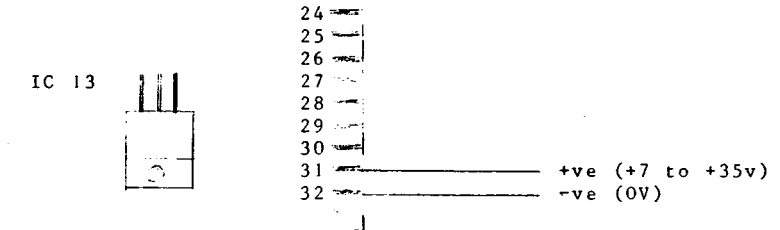
The Acorn Micro Computer and Keyboard require a supply between 7 and 35 v DC at a current rating of 500 mA. A large 9v battery may be used or a suitable mains adaptor is available from Acorn Computers Ltd.

A recommended 'home-brew' circuit is given:-



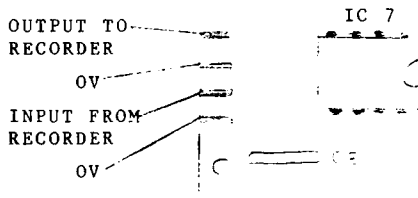
Using other circuits when the supply voltage exceeds 9 volts, or using the above circuit without the 4.7 resistor will require that a heat sink is fitted to the voltage regulator. A piece of aluminium 1" x 2" square is suitable.

Connect the +ve supply to pin 31 of the edge connector and the -ve (0V) to pin 32 as shown.



## Cassette Recorder Interface

Eventually a program that is going to be required again will need to be stored on an Audio Cassette recorder. On the keyboard is a Computer Users Tape Standard interface which connects to the recorder as shown:-



The 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 operating speed 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 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.

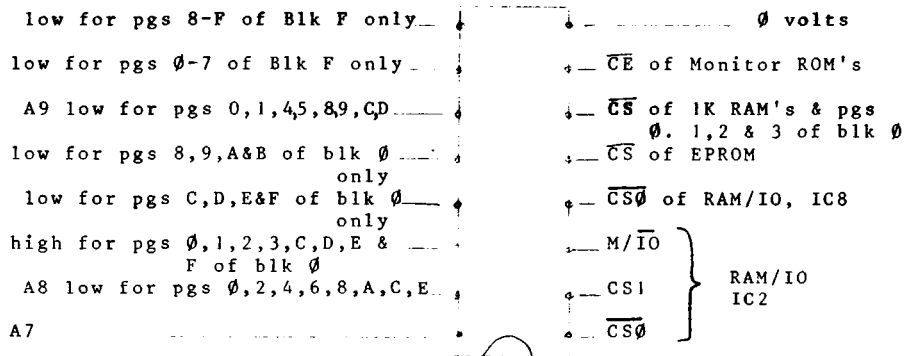
The input and output recorder levels as supplied are both 300 mV r.m.s. The output may be adjusted by changing R3 and input by changing R12 on the keyboard. The output should be adjusted so that the tones play back at a comfortable audio volume without excessive distortion. The input is then adjusted for reliable operation or using an oscilloscope, to give a waveform at pin 7 of IC7 which is in excess of 2 volts peak to peak but is not being clipped.

## Address Selection

The Acorn has a versatile Address Mapping selection system able to support many different operating configurations. The terminology employed is that the 65,536 address's capable of being specified by A0 thro' A15 are denoted by a four digit hexadecimal number in the range 0000 to FFFF. The most significant Hex digit, i.e. A12 thro' A15, specifies one of 16 BLOCKS of addresses, i.e. Block 0 thro' F, and these are further subdivided into pages. There are a total of 256 pages, each of 256 bytes specified by A8 thro' A15, i.e. pages 00 thro' FF.

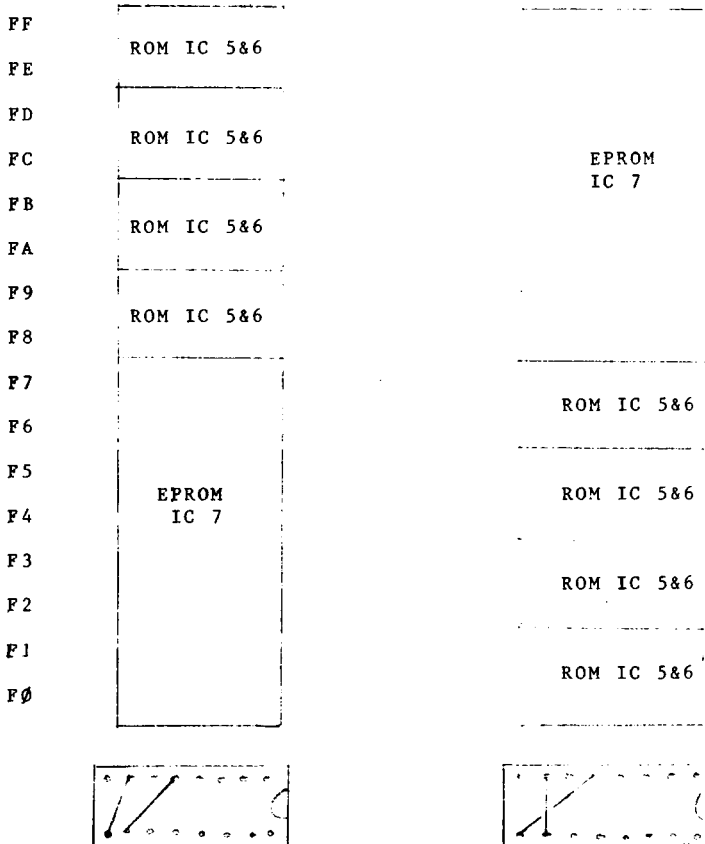
Basically the 6502 Micro Processor requires that page FF is Read Only Memory and in particular address FFFC is used after a reset. Also it requires that page 01 is used for the stack starting at address 01 FF and extending downwards. It is usual to also make pages 00 Random Access Memory as this is particularly easy to access for Scratch Pad use. Note that the bottom 32 bytes of page 00 are reserved for use by the system monitor.

A 16 pin D.I.L. header is used to configure the Address Map. Decoded address signals feed to the header and these are wire linked to the Clip Select lines of the IC's on the board. Using the recommended addressing schemes blocks 0 and F are used for IC's on the circuit board and blocks 1 through E are left completely free for circuits external to the processor board.



CS1 of IC8 is always on A8 i.e. high for pgs 1,3,5,7,9,B,D & F  
M/IO of IC8 is always on A7.

Block F is decoded into two halves of 8 pages i.e. 2048 bytes each. Two schemes are possible giving page FF either in the pair of 74S571 PROMs or in the EPROM.



Note that the 512 Byte ROM's appear four times. A 2048 byte EPROM is fully decoded but if desired a 1024 byte EPROM may be used in which case it will appear twice. In this case A10 is not required and two tracks on the pcb may be broken allowing the supply of +12 & -5v for type 2708 EPROM's; consult the circuit diagram.

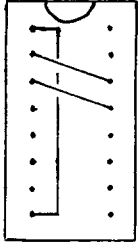
↑  
At in Kit

Block 0 is decoded so that pages 00 and 01 may be Random Access Memory contained in IC's 3 & 4, IC's 2 and 8 or IC 2 alone. When using IC2 alone care must be taken that the stack is not overwritten by the Scratch Pad.

IO IC2
IO IC2
IO IC2
IO IC2
IO IC2
IO IC2
IO IC2
IO IC2

FREE  
IC2 APPEARS  
EIGHT TIMES

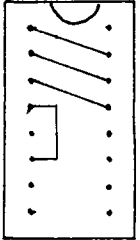
RAM IC2
RAM IC2
RAM IC2
RAM IC2
RAM IC2
RAM IC2
RAM IC2
RAM IC2



FREE
IO IC2
IO IC2
FREE
IO IC2
IO IC2
FREE
IO IC2
IO IC2

IC2 APPEARS  
FOUR TIMES  
IC8 APPEARS  
TWICE

RAM IC8
IO IC8
RAM IC2
RAM IC2
RAM IC2
IO IC8
RAM IC2
RAM IC2



RAM IC 2
IO IC2
RAM IC2
IO IC2
FREE
RAM IC8
IO IC8
FREE
RAM IC8
IO IC8

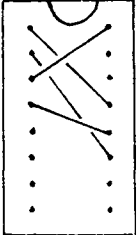
IC2 + IC8  
APPEAR TWICE

IC 2 I.O is  
TO KEYBOARD

FREE

USER'S RAM
STACK
PAGE 0

1K RAM  
IC'S 3+4



TOP VIEW  
OF ADDR SEL

RAM kit





PARTS LIST FOR ACORN MICROCOMPUTER

P.C.B.	...	Acorn Computers Ltd. pt no 200,000
IC1	...	6502 Micro Processor .... and 40 pin socket
IC2	...	8154 RAM/IO .... and 40 pin socket
IC3	...	2114 RAM .... and 18 pin socket
IC4	...	2114 RAM .... and 18 pin socket
IC5	...	74S571 Blue ROM and 16 pin socket
IC6	...	74S571 Yellow ROM and 16 pin socket
IC7	...	2516 EPROM. NOT SUPPLIED IN KIT but 24 pin socket is.
IC8	...	8154 RAM/IO. NOT SUPPLIED IN KIT 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
IC13	...	LM340-T5 ... 5v REGULATOR
XTAL	...	1MHz CRYSTAL
RESET SWITCH	}	SWITCH TYPE D6. ONLY ONE SWITCH SUPPLIED IN KIT
IRQ SWITCH		
NMI SWITCH		

EUROCONNECTOR 32 way PLUG. NOT SUPPLIED IN KIT

Nut and screw for IC13.

16 pin socket for Address links.

R1	...	4K7	0.33 or 0.5 w	5 or 10%
R2	...	4K7	"	
R3	...	4K7	"	
R4	...	4K7	"	
C1	...	100nF		
C2	...	100nF		
C3	...	10nF	}	NOT SUPPLIED IN KIT
C4	...	10nF		
C5	...	100nF		
C6	...	100nF		
C7	...	100nF		
C8	...	100nF		
C9	...	100nF		
C10	...	15uF	@	16 v



Acorn Computers Limited, 4a Market Hill, Cambridge CB2 3NJ, England. Telephone 0223 312772

PARTS LIST FOR ACORN KEY-BOARD

P.C.B.	Acorn Computer Ltd.	pt no 200.001
IC1	CD 4024B	and 14 pin socket
IC2	CD 4024B	and 14 pin socket
IC3	CD 4011B	and 14 pin socket
IC4	CD 4013B	and 14 pin socket
IC5	CD 4001B	and 14 pin socket
IC6	CD 4024B	and 14 pin socket
IC7	LM 358	Dual Op-Amp and 8 pin socket
IC8	7445	and 16 pin socket

DISPLAY NSA 1198

Spectra strip for display

Spectra strip for connecting to Acorn Microcomputer PCB.

Key contact domes, 25 off.

Key Buttons, 25 off.

Key Board cage.

Dome retainer adhesive film.

4 off Keyboard top panel spacers, nuts and screws.

Keyboard top panel (with legend on).

4 off spacers, nuts and screws for mounting to Acorn PCB.

R1	3K9	0.33 or 0.5 w 5 or 10%
R2	47K	"
R3	4K7	"
R4	1K	"
R5	10K	"
R6	4K7	"
R7	4K7	"
R8	47K	"
R9	4K7	"
R10	4K7	"
R11	10K	"
R12	47K	"
R13	4K7	"
R14	470K	"
R15	4K7	"
R16	4K7	"
C1	100pF	
C2	1nF	
C3	10nF	
C4	1nF	
C5	15uF @ 16v	
C6	100nF	
C7	NOT SUPPLIED	
C8	22nF	
C9	100nF	
C10	100nF	



Acorn Computers Limited, 4a Market Hill, Cambridge CB2 3NJ, England. Telephone 0223 312772

PARTS LIST FOR ACORN SINGLE BOARD CONTROLLER

PCB	...	Acorn Computers Ltd. pt no 200,000		
IC1	...	6502 Micro Processor and 40 pin socket		
IC2	...	8154 RAM/10 and 40 pin socket		
IC3	...	2114 RAM NOT SUPPLIED BUT 18 pin socket is.		
IC4	...	2114 RAM	"	18
IC5	...	74S571 ROM	"	16
IC6	...	74S571 ROM	"	16
IC7	...	2516 EPROM.	"	24
IC8	...	8154 RAM/10	"	40
IC9	...	74LS20	.....	and 14 pin socket
IC10	...	74LS139	.....	and 16 pin socket
IC11	...	74LS04	.....	and 14 pin socket
IC12	...	74LS00	.....	and 14 pin socket
IC13	...	LM340-T5	...	5 v REGULATOR
XTAL	...	82pF capacitor supplied instead of Crystal		

RESET SWITCH Switch type D6

IRQ SWITCH Switch type D6

NMI SWITCH Switch Type D6

Nut and screw for IC13

16 pin socket for Address links

R1	...	4K7	0.33 or 0.5 w 5 or 10%
R2	...	4K7	"
R3	...	4K7	"
R4	...	4K7	"
C1	...	100nF	
C2	...	100nF	
C3	...	10nF	} NOT SUPPLIED IN KIT
C4	...	10nF	
C5	...	100nF	
C6	...	100nF	
C7	...	100nF	
C8	...	100nF	
C9	...	100nF	
C10	...	15uF @ 16 v	

N O T E

1. A WIRE LINK should be put in between PIN 9 of IC4 and Pin 1 of IC5 on the Acorn Keyboard.
2. IC Part Number 6-59013 is equivalent to a 4013.
3. IC Part Number 733W02008 is equivalent to a 4011.