SOLIDISK SIDEWAYS RAM

PLEASE READ THIS MANUAL THOROUGHLY BEFORE YOU RING US UP!

SOLIDISK BBC SIDEWAYS RAM

Contents:

WHAT IT IS, HOW IT WORKS AND WHAT IT DOES.

1.1.PRELIMINARY:

The sideways RAM system consists of:

- A cartridge base which provides easy access to the computer address, data and control buses.
- A mini ROM cartridge which accommodates and protects any ROM from being damaged through handling.
- A sideways Ram card which conveniently replaces any ROM.
- A Solidisk Extension card which is basically more Sideways Rams (optional).
- A SWR system disc which contains utility programs such as MENU, STL150, SILEX, INDEX, PRINTER, STLOEOO etc..(The supplied disc is formatted as single density, 40 tracks or 80 tracks to Acorn's DFS specifications).

1.2 COMPATIBILITY WITH OTHER DEVICES.

1.2.1 COMPATIBILITY WITH ACORN COMPUTERS ADD-ONS:

Solidisk hardware is completely compatible with all add-ons produced by Acorn Computers for the BBC micro, including Teletext Adapter, Econet, IEEE Interface Controller, 6502 Second Processor, Z80 Second Processor, Joystick and Ink Jet Printer.
On the Software side, the BBC micro fitted with Sideways RAM will run ALL commercially available software, from Acornsoft and other main producers.
It will also run MOST of the Specially Written Programs.
Some Specially Written Programs (as detailed in chapter 3 require a standard DISK INTERFACE.

1.2.1 STANDARD DISK INTERFACE:

The standard disk interface is the SINGLE DENSITY DFS, based on the INTEL 8271 Disk controller.
This system is the ONLY official one. It can be supplied by Acorn, Watford Electronics, Pace, Cumana, Viglen etc.. They all are the same EXCEPT for the Disk Filing System EPROM (DFS), which for reasons of copyright cannot be the same as Acorn own products. Here are some Single Density DFSs: Acorn version .90, .98, .9a, .9f, .9v, DNFS (as supplied with the Second Processors), DFS1.3 (Watfs), C.U.C. DOS and AMCOM.

1.2.2 DUAL DENSITY DISK INTERFACE:

This system is NOT official. The dual density disk·

interface allows you to select either single density or double density to store your software onto disk. Double density means that you can store twice as much data and programs onto the same diskette. In single density mode, it allows you to run all commercial software diskettes.

THE DUAL DENSITY DISK INTERFACE IS NOT COMPATIBLE WITH
SOME IMPORTANT SPECIALLY WRITTEN PROGRAMS.

These are:
- The STLOE00, STL150, STLDISC and VMP1.2.

Some Dual Density Disk Interfaces are: LVL, OPUS, MICROWARE, KENDA.

***NOTE: KENDA PROFESSIONAL DFS IS NOT AT ALL COMPATIBLE WITH
SOLIDISK HARDWARE. PLEASE REFER TO OUR SALES OFFICE IMMEDIATELY.

The Solidisk Software Support Service will support Dual Density Disk Interfaces EXCEPT Kenda's . The Kenda problem is hardware related.

1.2.3 THE 6502 SECOND PROCESSOR:
The 6502 Second processor comes with 2 new sideways ROMs: the DNFS and the High BASIC. The DNFS will replace the old DFS ROM and the High Basic the old Basic ROM.

SET UP YOUR SIDEWAYS FIRMWARE (SEE SECTION 3.1) THEN
SWITCH ON THE SECOND PROCESSOR. HOLD THE CONTROL KEY
DOWN WHILE PRESSING THE BREAK KEY.

STLOE00, STL150, STLDISC and in general all other filing system will not operate with the Second Processor.

Solidisk will release Specially Written programs for the Second Processor in September.

1.2.4 THE Z80 SECOND PROCESSOR:
The Z80 Second Processor is quite a different animal, it will not run any of the existing software except Basic programs.
None of the Specially Written Programs will run on the Z80 processor. Solidisk Software Support Service will provide the RAM disk facility to Z80 users in September.

1.2.5 THE SIDEWAYS RAM IS NOT COMPATIBLE WITH ANY SIDEWAYS ROM
EXTENSION BOARDS:
It will be explained later, in section 1.3.2 why Sideways RAM is not compatible with any Sideways ROM extension board, including boards made by SIR, Watford Electronics, APTL and Rqmex.

1.2.6 THE MACE JOYSTICK AND OTHER INSTRUMENT CONNECTED TO THE
USER PORT:

Devices making use of the user port are not compatible
with Solidisk's 32K system or larger. It is possible
to switch off (and/or disconnect) the external
devices, set up all Sideways Software as per section
3.1 then reconnect or switch on the external device.
It must be pointed out that the RAM disk facility will
not work with any external devices connected to the
user port.

1.2.7 WRITE PROTECT THE SIDEWAYS RAM CONTENTS:

You should not write protect the Sideways RAM as all
specially written programs will not work. Under some
circumstances, you may need to write protect it.
Connect an external switch in series on the WRITE
signal so that you can turn it off.

1.2.8 COUNT UP TO 10 BEFORE YOU SWITCH ON THE COMPUTER.

This is to destroy the contents of Sideways RAM before
the machine is powered. Always unlock the disk drive
door if the machine is left unattented.

1.3 HOW DOES THE SIDEWAYS RAM WORK?

If you are already familiar with memory addressing on
the BBC computer, please skip paragraphs 1.3.1 and
1.3.2

1.3.1 MEMORY ADDRESSING ON THE BBC COMPUTER:

The BBC computer is built around the 6502 CPU, IC1 on
the main processor board. The 6502, like many other
CPUs uses 16 bits to address its memory. Each bit is
capable of being either 0 or 1 resulting in the number
of 2 (for zeroes and ones) to the power of 16 (for its
16 bits). In other words, it can address
$2x2x2x2x2x2x2x2 \quad x2x2x2x2x2x2x2x2=65,536$ locations or
bytes. To make it simpler, one can count in chunks of
1024 bytes or Kilobytes or Kbytes. 65,536 are equal to
64k bytes.

The BBC 64k bytes are divided into three main areas:
from the bottom up: the RAM area, 32k bytes, then the
Sideways ROM area, 16k bytes, and the MOS area, the
remaining 16k bytes.

The term RAM stands for Random Access Memory or memory
that you can write to and read from. ROM is, on the
contrary, Read Only Memory or permanent memory, non-
eraseable and written only once in the manufacturing
process. The term MOS stands for Machine Operating
System. Inside the BBC computer, each memory area has
a predetermined role: the RAM is the general working

4

space for all sorts of programs, the Sideways ROM area
usually contains BASIC, Disk Filing System (DFS),
Wordprocessor, etc., whereas the MOS keeps the machine
busy and responsive.

On page 498 of your USER GUIDE, you will find a map
showing the RAM on the right hand side of the computer
board and the ROMs just below it.

1.3.2 THE SIDEWAYS ROMS

If you open the computer case and remove the keyboard,
you will notice that the ROM area actually has 5
sockets. Probably 3 of them are factory fitted: the
leftmost one is the MOS, next to it is the BASIC ROM
and the DFS ROM. They are all essential to the
computer.

You could compare the MOS with a landlord, controlling
some 32k bytes of land (RAM) and a row of 4 socket/
shops (Sideways ROMs).
The socket/shops may be occupied (by BASIC, DFS etc)
or empty.
Every time you power on or press the BREAK key, the
MOS landlord checks on his tenants: he looks and tries
to identify a copyrighted ROM. If this copyright
(denoted by the word '(c)' programmed onto the ROM) is
there, the socket/shop is occupied, otherwise it is
empty.

The socket/shops are organised in a row. The MOS
handles the task of choosing a particular shop at any
time to be placed in the 6502 memory, in the manner of
a slide projector. The 6502 then 'sees' that socket/
shop-slide. The hardware and software to perform all
this Sideways ROM slide show is quite complex but as
far as the user is concerned, the service shop/program
such as Wordprocessing, electronic filing, Speech,
Graphic etc..is brought to him/her automatically by
the MOS upon request.

Although only 4 socket/shops are provided on the
standard BBC computer, the MOS is capable of
controlling up to 16 socket/shops. In other words,
there is still commercial land to build an extra 12
shops. You guess that many firms will try to supply
the extra socket/shops. They can be REAL socket/shops
(such as on Sideways ROM extension boards), similar to
the ones already installed or MUTANT socket/shops such
as the Sideways RAM system.
The difference is: you PLUG ROM SOFTWARE CHIPS into
REAL sockets, you LOAD the same software from your
DISKETTES into Sideways RAM which then MUTATE into ROM
chips.

This explains why you cannot have BOTH an extension ROM board and the Sideways RAM system. This is like selling the same land to 2 different companies.

1.3.3 WHERE IS THE SIDEWAYS RAM ON THE MEMORY MAP?

The Sideways RAM system consists of additional RAM sharing the same sideways area (&8000 to &BFFF) in the BBC computer with Sideways ROMs.

Unlike Sideways ROMs, the contents of Sideways RAM have to be loaded from disk (or tape or Econet) and will be lost when the power goes off. If you load into Sideways RAM memory the image of a Sideways ROM, the Sideways RAM will then be identical to the ROM, a little like a video cassette recorder.
You can also load into Sideways RAM specially written programs such as those supplied by the Software Support Service.

Figure 1 illustrates the memory map of a BBC computer fitted with Solidisk Sideways system.

1.3.4 READING AND WRITING INTO SIDEWAYS RAMS

Under normal circumstances, you should not be concerned with reading or writing into Sideways RAMs. This job can be left to the MOS alone. You simply select the program/software and it loads (writes) itself in 1-2 seconds. Unlike having a ROM extension board, you lose one second each time but there is no limit to the number of programs you can use.

The built-in hardware to select any one of the Sideways RAM is the pair &F4-&FE30 for reading, &FE62-&FE60 for writing. This dual selection allows one Sideways RAM or ROM to load software into another Sideways RAM.
If you are writing your own system software, the rule is simple: to load software into a particular Sideways RAM, store 15 into &FE62 and the Sideways RAM number into &FE60. To read out the contents of any ROM or RAM, store the Sideways RAM number into &F4 and &FE30. For more technical details, please refer to the SOLIDISK TECHNICAL MANUAL.

1.4 USES OF SIDEWAYS RAM:

The first use of Sideways RAM is to run Sideways Software.
Broadly speaking, there are 2 categories of Sideways software: Sideways ROMs and Specially Written Programs

(SWPs).

Sideways ROMs are commercially available. You will
have to transfer them to disk before using them with
the Sideways RAM system.
Specially Written Programs (SWPs) are available only
on diskettes, ready for use with your Sideways RAM
system. At present, most SWPs are supplied by the
Solidisk Software Support Service. They are originally
developed by Solidisk's engineers to support the
products but almost all new material is bought from
Sideways RAM users.

1.5 FREE SOFTWARE FROM SOLIDISK:

It is important that you know about the Solidisk
Sideways RAM Software Support Service.

For every Sideways RAM board sold, #1.00 is spent on
SWPs. When you buy your Sideways RAM system, you
receive 1 free diskette. After copying it onto your
own disks, you can exchange it for another one, then
another one etc.. Alternatively, you can buy extra SWR
UTILITY DISKS to complete your collection. SWR UTILITY
DISKs are organised in volumes, Volumes 3 and after
have their own SUPPLEMENT to this MANUAL. Software
available on these disks is not for sale: it is free
to any user and is given with as much explanation as
possible.
Each month, it is estimated that more than 500 man
hours are spent on SWPs, all paid for by new Sideways
RAM users.

Specially Written Programs fall into 4 main categories:

1) ROM overlays: such as the STL150 program. They add
extra facilities and commands to existing ROMs. These
programs are only useful if you possess the relevant
ROMs. For STL150 you will need the Acorn DFS version
.90.

2) Language and Service Programs: such as the Keyboard
program, the STLOEOO or the Printer program. They are
structurally similar to ROM software and will run on
any BBC computer.

3) Modular or Procedural programs: such as the
Solidisk Datafile and the Macro Basic. These programs
consist of several disk resident modules (Solidisk
Datafile) or libraries of Procedures (Macro Basic)
copied into Sideways RAM. These programs work with
MAINFRAME methods: they download wanted PROCEDURES
from Sideways RAM and are capable of outperforming the
6502 Second Processor. Their use requires the SOLIDISK

7

to be installed.

4) Fast disk access programs: such as Silexicon and WORD64. These programs depend heavily on the speed of accessing a great number of small portions of data so that although you can use them with twin disk drives, they are 100 times faster when using the SOLIDISK.

NB:--
All ROM software can have a SWP version but no SWP will work in ROM form.--

If you would like to contribute your own program please ring Southend (0702) 354 674. The usual rate of payment is #1.00 for every 4 bytes of machine code.

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**********************************
* CHAPTER 2: SYSTEM INSTALLATION *
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INSTALLATION OF THE SIDEWAYS RAM

-Check the utility disk.
-Open the computer and instal the Sideways RAM.
-Test the Sideways RAM.

2.1 CHECK THE UTILITY DISK

2.1.1 BOOT UP THE UTILITY DISK.
Insert the utility disk and boot up the disk by holding down the Shift key while powering on the computer. Alternatively, you can hold the shift key down while pressing the BREAK key.
If a disk error occurs, check the disk label. The disk label SWR40T requires a 40 track disk drive, SWR80T an 80 track disk drive. Switch your drive if necessary and repeat.

You should see:

BBC Computer
Acorn DFS
BASIC

CHAIN "MENU"

PLEASE WAIT....

The MENU program is a sort of HELLO program. Its purpose is to illustrate the way the Sideways RAM is integrated into your computer. More about the MENU

8

program later on.

2.1.2 MAKE ONE OR SEVERAL BACKUPS OF THE UTILITY DISK.
Label one of these the 'LANGUAGE DISK'. Then *WIPE out
all files on this disk except:
-!BOOT
-MENU

2.1.3 TRANSFERING ROMS TO THE LANGUAGE DISK:
Boot up the LANGUAGE disk as in 2.1.1

You should now see:

SIDEWAYS SOFTWARE FIRMWARE INSTALLED

_____

0	1	2	3
4	5	6	7
8	9	A	B
C BASIC*	D DFS *	E (*)	F (*)

----
                 0 Sideways RAM bank(s) available

                        SWR40/01/07
                       DISK DIRECTORY

A !BOOT	B MENU	C	D
E	F	G	H
I	J	K	

New disk, press ?   Save SWR, press @

Enter letter _

(*)NB:
This MENU refers to the BBC computer before the base unit is
installed. After this installation, BASIC and DFS will be moved
up 4 lines i.e. occupying box 0 and box 1.

Secondly, the positions of the different ROMs may be different,
depending on the actual setting of your machine. For example, if
you have TORCH Z80 card, the MCP chip would appear in box 2 or 3.

PRESS THE '@' KEY.

The computer prompts

@- From SWR slot (0 to F)?_

Look at the top part of the screen. Choose 'D' for
example.

You should see:

SAVING DFS in red.

The screen refreshes. The disk directory will now contain DFS. If you want to save any SWR onto disk, CHOOSE '@' and then SUPPLY the BOX NUMBER as it appears in the TOP PART. Please note that the only acceptable reply in this section is 0...9 then A,B,C,D,E or F in·capital letters. Giving a box number which does not contain a name results in an error.

Repeat the previous step several times to get used to the system.

2.2 CHECKING THE BASE UNIT
The base unit is a module measuring about 2" x 2" x 2" with either 6 wires (6 wire base unit) or 11 wires (11 wire base unit as we call them). The base unit is meant to be plugged into the rightmost ROM socket and the wires connected to the main computer board.

Check all the coloured wires against diagram 2. Check all pins are straight; press them against a flat surface to straighten the pins if necessary.

2.3 CHECKING THE MINI ROM CARTRIDGE
The Mini ROM cartridge is a small PCB with only one 28 pin socket soldered to it. The card has a double row of 'fingers' and is meant to be inserted into the (black) edge connector of the BASE unit. The finger portion also has a slot which will mate with the plastic key position on the edge connector. Later on, with the slot towards the South, you MUST instal your ROM so that the notch on the ROM is facing NORTH. We cannot assume any responsibility for damage caused to your ROMs by wrong positionning.

2.4 CHECKING THE RAMCARD
The RAMCARD is the long board containing all the chips with a double row of 'fingers' on the right hand side. Check that there is not wrapping foil stuck to any part of the card.

WRONG CONNECTION WILL NOT DAMAGE YOUR COMPUTER BUT MAY LOCK IT UP. ALWAYS PROCEED ONE STEP A TIME. CHECK CAREFULLY BEFORE MOVING TO THE NEXT ONE. YOU MAY SEND US THE COMPUTER AND #8.00 FOR SECURICOR COLLECTION OR EVEN BETTER, BRING YOUR COMPUTER TO US FOR FREE FITTING. NOTE OUR TELEPHONE NUMBER: SOUTHEND 354 674

NOTE: if the coloured wires do not match diagram 2, either return the base unit for replacement or mark the wires according to their position in diagram 2, thereby disregarding the colours.

2.5 REMOVE THE TOP CASE.

2.5.1 Undo the 4 screws labelled 'FIX', 2 at the rear of the computer, 2 under the keyboard.

2.5.2 Undo the 2 fixing bolts. Slide the keyboard to the front revealing the ROM sockets. They are found in the right hand corner. 3 of them are factory fitted with from left to right: the MOS, the BASIC (black plastic ROM) and DFS ROM (usually a brown ceramic EPROM with a sticker over the glass window). If you have already got all 5 sockets filled up, remove the least frequently used (NOT any of the 3 above) to make room for the base unit. However, copy it onto the language disk using the MENU program (SEE SECTION 2.1).

2.6 INSTAL THE BASE UNIT

The base unit plugs into the rightmost sideways ROM socket on the computer board.
Check all the pins of the base unit. Straighten them if necessary.

*** If you have an issue 3 board , you will notice that below the rightmost ROM socket there is a small resistor (R153 or R163-100 Ohm 1/4 watt) not found on the issue 4 boards and later boards. If you have a soldering iron, you may cut R163 and bridge the two ends. Otherwise, simply bend it down VERY gently until there is enough clearance for the base unit. If you also have a long blue capacitor in the vicinity, you may simply cut it out. The resistor and capacitor are suppressed on later issue boards.

POSITION the base unit so that the card connector (colour black) is to the right and all the pins are just above the socket receptacles. If the pins are slightly splayed out', press them against a flat surface like the edge of a table to get them exactly in line. Press the base unit firmly down.

** When pressing down the base unit, the computer board may flex a little bit because there is no spacer support right at the corner.
Power on. The Base unit should not have any effect on the computer.

2.7 USE THE MINI ROM CARTRIDGE

The MINI ROM cartridge provides an easy way of inserting and removing Sideways ROMs. When installing any ROM onto the cartridge, CHECK:
a) No IC pin is bent or lies outside the socket.
b) The ROM has the same orientation as if it were socketted on the computer board. The BOTTOM of the cartridge has the word STL and the key slot.
Insert any sideways ROM or even the Basic ROM into the Mini ROM cartridge. Insert the cartridge into the

card connector. Make sure that the ROM is orientated
in the same way as it was when installed on the BBC
board, ie with the notch facing NORTH. Power on the
computer. Your Sideways ROM should still be running.
If not, check for bent pins on the base unit, bent IC
pins on the Mini ROM cartridge, and/or repeat the
operation with another ROM. If you are unsuccessful,
ring us for advice.
If all is well, and the Sideways ROM is still running,
enter:

*BASIC

Insert the LANGUAGE DISK and do Shift-Break to boot it
up.

Use option'@' to save this ROM onto disk.

** NOTE: at this point, 28 pins of the base unit have been proved
to be making good contact with the rightmost ROM socket. However,
the Sideways RAM system requires another 4 signals as we shall
see later.

Power off the computer and remove the Mini ROM
cartridge.

** NOTE: The base unit is simply inserted into the ROM socket.
Therefore it is advisable that you keep the base unit steady in
the ROM socket with one finger while pulling out the mini ROM
cartridge. This will prevent the base unit from being
unnecessarily detached from the socket.

2.8 CONNECT THE CONTROL WIRES OF THE BASE UNIT

a) 3WIRES TO THE 6522 (IC69):
pins 10,11 and 12: Locate IC69 (6522, south of IC1).
Remove it with a small screwdriver, push the green
(pin 10), yellow (pin 11) and orange wires (pin 12)
into the socket. Then line up the left row of IC pins
in the socket so that the 3 coloured wires are held in
place, together with the IC pins 10,11 and 12. Exert a
little pressure on the right of the IC to align the
righthand row of pins then press down firmly. The
wires will be retained in the socket at the same time
as the IC pins.
This operation is in fact quite easy but if you are
really wary, simply raise the IC about 5 mm so that
the pins are still lined up. Push the wires in
carefully and press down on the chip. This method does
not ensure you a 'tight fit' but is perfectly adequate
in our experience.

b) 2 WIRES TO THE 74LS163 (IC 76):
These are pins 11 (3rd up on the right) and 12 (4th
up). Locate IC76 (74LS163 under the keyboard tail).
Remove or raise the IC, push the 2 wire terminals into

12

the IC socket (yellow to pin 12, orange to pin 11) and press the IC down into the socket. If this IC is soldered to the board (issues 4 and 7), use the blue socket to extend the legs of the IC and simply, while holding the socket with 2 fingers, push the wires into the same position (see diagram).
This is the trickiest operation on the whole, so take your time to make sure that the blue socket legs are all correctly mating the IC legs and that the wires are not too loose. If you have a soldering iron, solder the wires directly to the IC legs.
You have gone through the worst and are left with only 6 wires. They are all common to both the simple 6 wire base unit (for the SWR16) and the 11 wire unit.

c) 2 WIRES TO THE 6502 (IC1):

2 of them, yellow and orange, will go to the 6502 processor chip, North of the 6522 (IC69, see section 2.8.a). The orange wire will be attached to pin 39, second down, on the right hand side. The yellow wire will be attached to pin 34, the 7th pin down, on the right hand side. Raise the IC, push in the 2 wires and press down on the IC exactly as per section 2.8.a above.

c) 4 WIRES TO S20 and S22:

Locate the 2 jumper blocks labelled S20 and S22 on the BBC board. They are about 1/2" to the left of the 6522 (IC69). S20 is South of S22. Remove the jumpers (colour black or blue – they are both initially in the north position). Replace them with the white ended plugs.

d) DECISIVE TEST: POWER ON THE COMPUTER!

WATCH OUT FOR THE DREADFUL 'Language?'

If you get 'Language?', then:

2.8.1 The base unit was pulled sligthly out of the ROM socket when you removed the Mini ROM cartridge.

2.8.2 you may have put the white end plugs the wrong way round.

2.8.3 the step (on IC76) failed. Possible causes: loose blue socket, reversing the yellow and orange wires or one of them has been detached.

Go back to the previous step, if you are not successful, send back the base unit for replacement.

Power off the computer. Keep the 2 jumpers in a safe place.

2.9 INSTAL THE RAM CARD:

        Insert the RAM CARD in place of the Mini ROM cartridge. Power on. The RAM card should not affect the computer.

2.10 TESTING THE SIDEWAYS RAM.

        Insert the utility disk and press Shift Break to boot it up.
        Just under the 'Sideways Firmware Installed' panel, you will notice the number of Sideways RAMs in your system. If you have a SWR16, this number is 1, a SWR32 gives 2 and a Solidisk gives 8.
        If this number differs, the installation is not right. Check as follows:

2.10.1 MENU SHOWS 0 SWR BANK

        Check the 2 wires going to the 6502. Make sure that the ORANGE wire goes to pin 39, North of the YELLOW wire. Make sure that none of them is detached from the IC socket.

2.10.2 MENU SHOWS 1 SWR BANK WITH THE SWR32 OR THE SOLIDISK:

        Check that the GREEN wire is not detached from pin 10 of the 6522, (IC69) or connected to a wrong place.

2.10.3 MENU SHOWS 2 SWR BANKS WITH THE SOLIDISK:

        Check that the YELLOW wire is not detached from pin 11 of the 6522, (IC69) or connected to a wrong place.

2.10.4 MENU SHOWS 4 SWR BANKS WITH THE SOLIDISK:

        Check that the orange wire is not detached from pin 12 of the 6522.

2.10.5 MENU STILL DOES NOT SHOW THE RIGHT NUMBER OF SWR BANKS:

        Ring us for technical advice. (Between 4.30-5.30 pm).

2.10.6 TESTING ONE SWR BANK (STANDARD TEST FOR SWR16):

        Power on the computer and. enter:
*PRINTER <RETURN>
        You should see:
BBC computer
Printer Buffer
Acorn DFS
BASIC
>
        Now enter:
OLD <RETURN>
<control>-B
LIST <RETURN>
        The MENU program will be listed. Do not turn on your printer. The listing will be then forced into the printer buffer. LIST it again a second time and a 3rd time. The Shift lock light will then be lit,

signalling that the Printer Buffer is full.
Now turn on your printer, it will start printing
immediately.
To stop printing, press the BREAK key.
A faulty RAM card will not go through this test and
will 'hang' the computer.

2.10.7 TESTING THE SOLIDISK:

If you have the ACORN .90 DFS, choose the STLDISC
program from the MENU. The screen should show'100k
available as drive 1'.
Press the function key 'f2'. You should see:
VERIFY OK.
Power off.
2.10.8 REPLACE THE KEYBOARD AND THE TOP CASE.

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* CHAPTER 3: SOLIDISK SPECIALLY WRITTEN PROGRAMS. *
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**NOTE: Certain programs are overlays for Sideways ROM software
such as STL150 for the Acorn .90 DFS and WORD64 for Computer
Concepts, due to their popularity. Their use implies that the
above mentioned ROMs be installed on your system. They are
not in anyway essential to the performance of Solidisk Sideways
RAM system. They merely add some desirable facilities to the
existing features of these ROMs. The advertisement of these
programs does not infringe the Sale of Goods act with regard
to the description of the merchandise.

Specially written programs as supplied free to all Sideways RAM
users are divided into volumes. Each volume is recorded on a 40
track single density disk format, compatible with all versions of
Acorn disk filing systems. In some circumstances, we may be able
to supply these volumes on 80 track diskettes each containing 2
consecutive volumes. Volumes 1 to 10 are intended to be the basic
software library for the Solidisk Sideways RAM system, volumes 11
and above are Source Code and Technical Documentation, they are
very useful if you intend to write your own Sideways Software.
At present, volumes 1 and 2 are out, volume 3 is under
preparation, volumes 4,5 and 6 constitute the Silexicon package,
Volumes 11 to 16 are the Source Code for all programs contained
in volumes 1 and 2.

Although the software is free as it is paid for every month by
new Sideways RAM users, the media (diskettes) are not. Solidisk
Software Support Service will charge #2.00 for every new diskette
to cover the cost of the media. Packing and postage for any
number of diskettes is fixed at #1.00 per parcel.
However, you may return any software disk for replacement with
another volume. You are naturally free to make your own back up
copy. Please ensure that disks are well wrapped in unbendable

15

carton. We shall then only charge #1 for post and packing.
If you need to enquire about the Software Support Service, please
ring Southend (0702) 354 674 preferably in the afternoon, between
3.30 PM to 5.30 PM. Do not worry about the phone lines being
jammed – we now have 10 lines open for customer enquiries.

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VOLUME 1
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3.1 THE MENU PROGRAM:

3.1.1 THE MENU PROGRAM AND THE COMPUTER RESSOURCES:

The MENU program presents the computer resources in 3 parts:
- The Sideways Firmware Installed, the top part.
- The number of Sideways RAM banks still available and
  the disk title, the middle part.
- The disk directory, the bottom part.

3.1.1.1 FIRST THE SIDEWAYS SYSTEM:

The BBC computer can use up to 16 Sideways ROMs or
RAMs. The Sideways ROMs are normally inserted into
Sideways ROM sockets. The Sideways RAMs do not have
sockets of their own but use the rightmost socket
collectively. The machine does not make any
distinction between ROMs or RAMs. If there is any
Sideways System software in the socket, the name of
the software will be displayed in the corresponding
box. For example the above screen shows that the BASIC
ROM is in the leftmost socket (number=0), the Acorn
DFS ROM is in the next socket (number= 1). When you
power on the computer, there is no SWP or ROM program
loaded into Sideways RAM and 13 boxes from 3 to F are
empty. Later on, when you load in any Sideways program
such as STLOE00, the name of the RAM (or 'ROM') will
be in one of the 8 boxes from 8 to F.
**NOTE: When the 208K Solidisk becomes available in July, 13
boxes from 3 to F will all be used. Boxes 0, 1 and 2 are normally
reserved for Sideways Roms, but will be made switchable under
software control for the 256K Solidisk.

3.1.1.2 THE SIDEWAYS RAM BANK(S) AVAILABLE.

This information shows you how many 'Languages' or
'Services' you can instal into your system before you
start using the computer.
Please read section 3.1.5 below for more details.

3.1.1.3 THE DISK TITLE:

The disk title contains the creation date of your
Utility disk.
This User Manual refers to the current diskette (JULY
84)

3.1.1.4 THE DISK DIRECTORY:

This is the middle part of the screen. All disk

filenames are displayed in alphabetical order. A green
letter to the left of each filename facilitates your
choice.

3.1.2 SELECTING A PROGRAM:

To select a file, press the corresponding green
letter. If the file is a text file, it will be
printed, a Basic program CHAINED, a machine code
program will be RUNned or loaded depending on other
criteria. Sideways software is treated differently. It
will be loaded one program at a time into consecutive
Sideways RAM banks (or boxes), starting at the lowest
priority bank (or box). As soon as a sideways software
is loaded, the name will appear in the corresponding
box. When you finish choosing your software, press the
BREAK key. But try this first:

1) Press the letter A.
You should see:

A-PRINT !BOOT (Y/N)_

2) Press Y
The !BOOT file will be displayed on the screen i.e.

"PAGE=&1900:CHAIN "MENU""

3)Press the letter K

K-PRINT help!(Y/N)_

4) Press Y
The help! text will be displayed.

5) Insert the LANGUAGE DISK. Press the ?
You will see printed: New disk, please wait...
The top part of the screen does not change but the
directory of the new disk will be displayed.

3.1.3 RUNNING ROM BASED SOFTWARE:

3.1.3.1 LOADING SIDEWAYS SOFTWARE:

Under the 'Sideways Firmware Installed' panel, you
will find the number of Sideways RAMs available or the
number of Languages and Services you can select from
your diskettes to be part of your machine at any time.
You can choose any language or service in direct mode
or set up everything you need using the MENU program.

3.1.3.2 DIRECT LOADING OF SIDEWAYS SOFTWARE:

Ideal for the 16K sideways RAM (SWR16) and quite
useful with larger units, the direct mode loads into
Sideways RAM bank (or box) F, the last one.
Note that you do not have to load into Sideways RAM
everything before you start using the computer. To
load any Language or Service, enter '*' followed by
the filename. The screen will then be cleared and the

Sideways RAM 'F' loaded.
Evoke the Language or Service with the appropriate *
command as usual.
Example:
To load and run STLOE00, enter:

*STLE00 <RETURN>
To load and run VMP1.0:

*VMP1.0 <RETURN>
etc..

3.1.3.3 USING THE MENU PROGRAM TO SET UP SIDEWAYS SOFTWARE:
The MENU program helps to set up the computer
resources BEFORE you start using it.
Enter:

CHAIN"MENU" <RETURN>

In the disk directory section, there is a green letter
in front of each filename.
Press the letter in front of any Sideways ROM file.
Your disc should whir away a couple of seconds and the
name of the Sideways ROM should appear in box 8 if you
have a Solidisk, in box E if you have a SWR32 and in
box F if you have a SWR16. That is now part of your
Sideways Firmware. Choosing a second Sideways ROM file
will load it automatically into the next Sideways RAM
i.e. box 9 (or F with the SWR32). As more Sideways
ROMs are being loaded in successive banks, the number
of Sideways RAMs is decreased each time until reaching
1 (box F). This Sideways RAM box is always kept open,
like a free port. You can always load into it anything
at any time. To warn you that the system is reaching
its free port, a message will be displayed.

3.1.3.4 CHANGING THE SIDEWAYS RAM BOX:
If you want to load your Sideways Software in a
particular 'box', you can use the left or right
triangular brackets (they are on the left of the '?'
key). The selected box will be indicated just below
the number of Sideways RAMs.
To leave the MENU program, simply press the BREAK key.

Now enter:

*HELP <RETURN>

All your software titles should be displayed.

3.1.4 MODIFYING THE MENU PROGRAM:
If you have a double sided disk drive, you may want to
change line 120 to read PROCdrive(2) after formatting
and saving some programs on the second side of the
diskette. Please remember not to copy this modified

18

MENU onto single sided diskettes as it may look in vain for a non existent directory.

3.2 THE PRINTER BUFFER PROGRAM:

You can load the Printer Buffer program from the Menu or directly by: *PRINTER
The program intercepts the put, remove and count characters sent to the printer. The Printer Buffer will feed your printer in the background, so that you can use your computer immediately. It's very useful for any application.
Your printer is turned on by Control-B (or VDU2) and off by Control-C (or VDU3) as usual. The Break key will stop printing and clear the printer buffer.

You cannot have 2 Printer Buffers at the same time.

3.3 THE INDEX PROGRAM

3.3.1 USE:

This program allows you to set up a 'Mailing List' as simply as possible. You can also use the program for similar 'look-up' applications such as price list, stock inventory, patient prescriptions etc. You can INDEX any data file containing up to 1,100 records of any length.

3.3.2 DATAFILE FORMAT

Data files that can be indexed are pure ASCII or textfiles and should be created by a wordprocessor such as Wordwise. Some wordprocessors require you to SCREEN or to EXEC (other words for *SPOOL text to disk). You can also make up an indexable datafile using existing databases by *SPOOLing all the records required to disk. You then get a printout of it, count the number of fields etc and give appropriate answers to the INDEX program.
There is a sample datafile 'MAIL' on your utility disk, in which:
- Every record is in plain ASCII. Each record is separated from the next one by double carriage return.
- The first field ('name') is used for indexing, 7 characters or spaces are skipped before the Most Significant Letter' is picked up for sorting. Other fields like address, town etc can be anything and any number and organised in any manner.

3.3.3 INDEX IS A SEQUENTIAL FILING SYSTEM.

The difference between INDEX and other databases is that INDEX accepts any number of fields and any record size as far as the number of records does not exceed 1100. Fields are written successively, as are records. Any character -such as the carriage return-

can be used to separate fields. Any 2 characters such
as /<RET> or 2 field delimiters (empty field) can be
used to separate records. The INDEX allows you to lay
out your datafile exactly as if you would do on a
piece of paper.

3.3.4 HOW TO USE INDEX?

Copy INDEX and MAIL to a blank formatted disk.
CHAIN"INDEX" as with any ordinary BASIC program. Press
<RETURN> to each question as it is set up already for
use with the default parameters.
You should then see:

BBC Computer
MAIL:INDEX
Acorn DFS
BASIC
>

MAIL is the datafile chosen by default. The Index file
of MAIL is now created in Sideways RAM. Later on, when
you use the program with your own datafiles, you may
wish to make up Index files for STOCK, PRICES, PRSCRPT
etc..

Now enter: *INDEX
The disc drive will be whirring for about 15 seconds.
Index searches through 'MAIL' for records and
field delimiters, saves these in Sideways RAM and
copies itself to your disk under SI.MAIL (SI stands
for Sequential Index).
You can check this point by *CAT.

Now enter: *LIST
You should see all records displayed in alphabetical
order.
Switch off the computer.

3.3.5 INDEX IS ALWAYS READY:

Switch on the computer and enter *SI.MAIL.
Your computer is ready.

INDEX has some built-in 'star' commands. Please try:

3.3.6 *LIST

This command will list your datafile in alphabetical
order according to the criteria input to the INDEX
program.
In the MAIL example, the default sort criterion was
the SURNAME. In field 0, skip 7 characters, including
spaces, after the beginning of the record. E.g: Mr J F
Kennedy's record will be sorted by the letter K.(There
are seven characters, including spaces, before the
letter K of Kennedy). Note that upper and lower case
do not matter. If you wish to sort MAIL by the town,

20

answer 5 to field, 0 to 'before the Most Significant Letter'.

3.3.7 *GET

This command displays the next record in order. You would say that *LIST actually performs *GET from the beginning to the end of the file. There is a little bit more to *GET. If a name (or a town in the second example) is also given, *GET will rather display the best matching record. So *G. K (or *G. KEN or *G. KENNEDY) would display:

Mr J F Kennedy
13 Friday Road
Danbury
Essex SS2 7JQ

Other variations of these 2 commands are:

*LIST <n.mail>

This command will list MAIL but also spool the output to the file <n.mail> for other use such as mail merge.

*PRINT

This is identical to *LIST but activates also the printer.

*STEP

This is opposite to *GET, this command will display the record before the last one.

3.3.8 ADDING MORE NAMES AND ADDRESSES:

The MAIL sample datafile is done with WORDWISE. You can edit it as you like. Other Wordprocessors will require that you create a new document and MERGE the MAIL file. For compatibility, you must SPOOL your datafile to disk before indexing it.

For example, you want to keep a diary about everybody you know. First, using a wordprocessor, alter all the names and addresses to real names and addresses of people you know. Every time you need to refer to Mrs X, simply enter *G. X.

Every time something happens to Mrs X, use your wordprocessor and simply add extra text lines to her record.

**NOTE You will have to *INDEX every time the datafile is changed as the places where INDEX expects to find your records are changed.

3.4 THE STLOE00 PROGRAM:

3.4.1 STLOE00 IS A DISK FILING SYSTEM.

The STLOE00 is only compatible with the Single density 8271 disk controller as with all Acorn Disk System (not with any Double Density controller). STLOE00 is not capable of loading Sideways Software.

21

You can load STLOE00 from the MENU or simply by:

*STLOE00 <RETURN>

4.4.2 STLOE00 SETS PAGE=&E00

The normal DFS requires memory workspace between &0E00 to &1900 and sets PAGE at &1900. STLOE00 uses Sideways RAM for its workspace, thus leaving PAGE at the lowest possible value of &E00, increasing memory for BASIC, VIEW, BEEBCALC etc..and allowing tape based programs to run on disk system.

4.4.3 STLOE00 HAS EXTRA DFS UTILITIES.
Enter *HELP DFS and *HELP UTILS. The list of DFS commands and utilities will be displayed.
You will notice that STLOE00 has 3 extra commands:
*F40 (disk formatter for 40 track drive), *F80 and *VERIFY.

To format a disk, switch on the computer and enter:
*STLOE00 <RETURN>
Insert a blank disk into drive 0. Enter:
*ENABLE <RETURN>
*F40 <RETURN>
To 'kill' it, enter:
?&8006=0 <RETURN>
<BREAK>
To revive it, enter:
?&8006=130 <RETURN>
<BREAK>

This method is correct for all types of Software running in Sideways RAM. If you want to kill any language or service program in the Sideways RAM system, store 0 at &8006 and to revive it, store 130. For example: to kill the STLDISC in Sideways RAM number 8, do the following:
?&FE62=15:?&FE60=8
?&8006=0
<BREAK>

3.5 THE STL150 PROGRAM:

3.5.1 STL150 IS AN OVERLAY FOR ACORN .90 DFS.
The STL150 therefore requires Acorn DFS .90.

3.5.2 STL150 ALLOWS UP TO 150 FILENAMES PER SIDE:
Word processor users can take advantage of more directory entries, up to 150 per side. This process is absolutely transparent to normal LOAD and SAVE. Diskettes formatted with STL150 are fully compatible with other DFS's.
The extra capacity of the directory comes from the use of 5 ordinary catalogs: STL0 to STL4 occupy the totality of track 0. STL150 uses these catalogs in a

22

'tree' structure.

When a filename is requested, STL150 looks first in
the current catalog. If the filename is not there, it
goes back to the 'root' of this catalog which can only
be one of STL0 to STL4. It then tries other roots
until either the filename is found or will have to be
created. This process is transparent and extremely
fast. STL150 will create as many roots as required.

Each root STLx has its own domain on the disk and is
protected against accidental DELETE.

STL150 has its own *FORM40 and *FORM80 commands to
prepare your blank diskettes. STL150 can read and
write normally formatted disks but cannot extend their
directories. Other DFS can only read and write
specially formatted disks in their current domain.

You MUST NOT *compact an STL150 disk using another
DFS. The disk is normally protected against accidental
destruction but we cannot guarantee that it is
tamperproof.

The command *STL x will move the partial directory
STLx to be stored in sectors 0 and 1 of the disc, thus
making it accessible to any other DFS. It will not
affect the STl50 as the latter scans all 5 directories
before every file operation. For example: if you want
to let your friend use your disc on his BBC to read
files held in part 3 of your disc, do *STL3. If this
STL3 has not been created, you will get 'Bad Cat'
Error. STL150 has a very fast *COMPACT to enable it to
cope with large disk size and large number of files.
The disc head does not return to track 0 while
COMPACTING. Therefore, you should never press the
BREAK key while *COMPACTING.

3.5.4 FAST LOADING STL150

While STL150 is still in your computer, save it with:

*SAVE STL150C 8000 BFFF D9CD

You can give any other suitable name to avoid the
original STL150 program being deleted. From now on,
simply enter:

*STL150C <RET>

STL150 should be re-installed in your machine.

3.6 THE STLDISC PROGRAM:

3.6.1 THE STLDISC PROGRAM IS AN ADVANCED DISK FILING SYSTEM.

The disk filing system is an important part of your
computer. It handles program loading, saving and many
other functions of storage and retrieval of your
software and data.

The STLDISC program has all the usual facilities of a

good disk filing system such as speed of operation,
informative directory display, fast BPUT and BGET,
built-in disk formatter and verifier. It also handles
the RAM DISK or Solidisk.

3.6.2 THE SOLIDISK AS AN EXTRA DISK DRVE.

The Solidisk is a large Sideways RAM system of 128k
bytes, represented as 8 banks of Sideways RAMs (box 8
to box F on the MENU screen). You can use the Solidisk
to load your Sideways Software, up to 8 different
languages and services at any time. You can also use
some of the Sideways RAM banks (or boxes) as an extra
disk drive or RAM disk.
The RAM disk in its function as a storage device is
identical to a floppy disk drive, just a lot faster
(as there is no mechanical movement involved).
The differences with a real disk drive are:
- The contents of the RAM disk is lost if the power is
lost.
- The contents of the RAM disk have to be copied (or
backup-ed) from a real disk.
- The nominal drive number of the RAM disk can be
altered at will, without affecting its contents. The
normal drive numbers for a real drive are 0, 1, 2 and
3. The RAM disk can be given 0, 1, 2, 3 and 4. The
command *OPT2,<drive number> is used to attribute any
other number than 1.
- The size of the RAM disk depends on the box you
choose to instal the STLDISC program. If STLDISC is
loaded into box E, its size will be bigger than if it
is loaded into box F, smaller than if it is loaded
into box D. In any case, the size of the RAM disk will
be displayed with its directory.

3.6.3   SETTING UP THE SOLIDISK:

You can choose STLDISC by *EXEC the loader program
('L' on your utility disk), this is the normal way
when you want the biggest possible Solidisk.
You can also load the STLDISC with the MENU program.
This is the correct way when you do not have the full
128k Solidisk.
If you enter:

*E.L <RETURN>

You should see a text informing you that 8 function
keys are set up to use the Solidisk. They are as
follows:
f0= Backup drive 0 to drive 1. This key duplicates the
disk in drive 0 onto the Solidisk. This operation is
performed in only 13 seconds and requires that the
disk in drive 0 is formatted in 40 tracks, i.e. its
capacity cannot be bigger than 100k bytes.
f1= Copy every file from drive 0 to drive 1. This key

copies as many files as there is still space in the
Solidisk, from drive 0 to the Solidisk (drive 1). The
order in which files are copied across is 'last in
first copied' (not very clever is it?). The disk in
drive 0 can be 40 or 80 tracks. You cannot backup an
80 track disk onto the Solidisk which has only the
capacity of 40 track recording. You will get 'Disk
full' error.

f2= Catalog both drive 0 and drive 1, the Solidisk.

f3= Performs verify. It is useful sometimes to verify
the contents of the Solidisk, especially before making
a hard backup.

f4= Run Silexicon. The Silexicon disk must be in
drive-0.

f5= Run WORD64. The WW64 disk must be in drive 0. We
shall see later how to prepare the Silexicon disk and
the Word64 disk.

f6= *DRIVE 0 <RETURN>, select drive 0 as the current
drive.

f7=*DRIVE 1<RETURN>, select the Solidisk (drive 1) as
current drive.

We shall come back with more details on many aspects
of the Solidisk and the use of the function keys.
You should now see:

"Press any key when ready"

Press the space bar (or any other key).
You should now see:

BBC Computer 32k
STLDISC
BASIC
>

It can now be said that the Solidisk is created from
Sideways RAMs and its presence is indicated on the
screen. Drive 0 is still the same, drive 1 is the
Solidisk. If you have a twin disk system, the physical
drive 1 is now disabled. If you did not have a twin
disk drive before, you have now.

NOTE: The drive number 1 is attributed to the STLDISC is simply
for covenience. If you wish to use 4 real drives together with
the STLDISC, enter *OPT2,4 <RETURN>. If you need to disable the
STLDISC, you may enter *OPT2,255 <RETURN>. This command is only
added for completeness.

3.6.4 A QUICK DEMONSTRATION WITH THE SOLIDISK:

(This demonstration is only relevant to the 128k
Solidisk or above).

You have seen previously that 8 function keys (the red
keys in the top row of the computer keyboard) f0 to f7
are programmed for the Solidisk. Insert the Sideways
40 track diskette into drive 0. Press the 'f0' key.
You should see:

25

*EN.
*BAC.01

Key f0 is simply programmed to type in your computer
*ENABLE <RETURN> followed by *BACKUP 01 <RETURN>,
exactly as you would do with a twin disk system.
Now remove your diskette and insert into drive 0 and
enter:

*ENABLE <RETUN>
*BACKUP10 <RETURN>

You will hear drive 0 spinning and immediately see:

COPYING FROM DRIVE 1 TO DRIVE 0

Then drive 0 stops. You have made a backup of the
original diskette. The Solidisk allows you to work
fast with disk systems.

3.6.5 ANOTHER DEMONSTRATION WITH THE SOLIDISK:
Now place the SWR UTILITY disk into drive 0. Press the
'f4' key. You should see:
*COPY 01 T1
*COPY 01 DIC
*:0.SILEX

The Silexicon program will ask for the filename of the
text that you wish to spellcheck. Please enter:
help! <RETURN>
Note the bargraph at the bottom of the screen. It
indicates the remaining length of file help! and goes
on diminishing. At the same time, the score of mis-
spelt words clocks up at an alarming rate. The
Silexicon scans help! in just under 15 seconds.
Press the <ESC> and choose option 3.

3.6.6 MAKING A SILEXICON DISK AND A WW64 DISK.
It is convenient to have disks specially made up for
use with your Solidisk for applications such as
Silexicon, WW64, Solidisk Datafile, Macro Basic and
VMP. Other disks could be made for Beebug Masterfile,
Starbase, View, Ultracalc etc.. They all have the same
!BOOT file and STLDISC program. Each of them will then
have other appropriate files. Start by CHAIN"STLDISC".
Next enter:
*BUILD !BOOT <RETURN>
1-*KEY0 etc...
2- *KEY1 etc..
3- etc..
4-?&FE62=15:?&FE60=8:*STLDISC

<ESCAPE>
Enter now:
*COPY 0 1 STLDISC <RETURN>
*OPT 4,3 <RETURN>

Make a backup of this disk as by section 3.6.5

Repeat as many times as you wish to prepare Solidisk diskettes.

To make the WW64 disk, switch off the computer, place the SWR utility disk in drive 0, CHAIN "WORD64". When the prompt 'Press any key when ready' appears, place a Solidisk diskette in drive 0 and press <RETURN>. *TITLE this disk S/D-WW64.
Solidisk diskettes made for Silexicon is SWR UTILS VOLUME 2, for MACRO BASIC and Virtual Memory is VOLUME 3, for Solidisk Datafile is VOLUME 7.

3.6.7 THE SOLIDISK AND THE INDEX PROGRAM:

The Solidisk is a very good tool for any database program, specially when sorting datafile using either a conventional database program or the INDEX program. Copy the relevant datafile and its associated 'SI' file (such as MAIL and SI.MAIL).
Boot up the Solidisk as usual by Shift-Break. Press the 'f0' key to duplicate your diskette to Solidisk. You can make a sorted list for printout or mailmerge as follows:
Place a FORMATTED disk in drive 0. Enter:

*DRIVE 1
*LIST :0.SRTMAIL <RETURN>

The Mail (or any other datafile) will be sorted in alphabetical order and spooled onto drive 0 under filename SRTMAIL at around 200 characters a second. It must be the fastest method of sorting on earth.
With other databases, refer to the appropriate manual.

3.6.8 THE SOLIDISK AT WORK:

3.6.8.1 SOLIDISK WITH VIEW OR SCRIBE:

You can create documents, search and replace, merge texts etc much, much faster if the document is in Solidisk.
Start the Solidisk with *E.L <RETURN> as usual. Type in *SCRIBE <RETURN> for Scribe or *WORD <RETURN> for View. Give drive 1, the Solidisk to create a new document. Alternatively, save intermediate text onto Solidisk with View.

IMPORTANT: ***** BACKUP THE SOLIDISK BEFORE YOU SWITCH OFF *****

3.6.8.2 SOLIDISK WITH MASTERFILE OR STARBASE:

Beebug's Masterfile and the more recent GCC's Starbase are popular databases. They require that drive 0 must be used. Start with *E.L <RETURN> as usual. Press f0 key. Now enter: *OPT2,0 <RETURN>
The Solidisk is then ready as drive 0. You can then

27

enter 'CHAIN "MF" or *STARBASE <RETURN>
When you have finnished with the programs, quit as
usual and then enter *OPT2,1 to reselect Solidisk as
drive 1 before backup.

Note that the use of the Solidisk with databases has a
degree of risk to destroy you database due to
miskeying. As the Solidisk is so fast, and silent,
it can wipe clean your database even before you remove
the finger from the wrong key. Therefore, we strongly
advise to retrict the use of the Solidisk to viewing
records, sorting or printing databases, Solidisk is
most valuable in those areas.

IMPORTANT: ***** BACKUP THE SOLIDISK BEFORE YOU SWITCH OFF *****

3.6.8.3 SOLIDISK IN DISK COPYING:
When you are using the BBC computer not only for fun
but to make a living (like me), your Solidisk can be
very helpful.
One of the uses is disk copying.
You can make up a loading file as follows:
*BUILD SPEC.L
1-*K.O *EN.//M*F400//M*EN.//M*BAC.40//M
2-*K.2 *EN.//M*F401//M*EN.//M*BAC.41//M
3-*K.9 *EN.//M*BAC.01//M*OPT2,4
4-?&FE62=15:?&FE60=8:*STLDISC

Line 4 loads the STLDISC, line 3 copies the contents
of your master disk into the Solidisk, lines 1 and 2
deal with formatting and copying blank diskettes in
drives 0 and 1. Start by *E.SPEC.L <RETURN>, place the
master diskette in drive 0, press f9.
Remove the master diskette.
Place blank diskettes into drives 0 and 1, press f0
and f1 alternatively for maximum production speed.
Anybody can produce more than 100 diskette an hour.

3.6.8.4 SOLIDISK FOR MACHINE CODE PROGRAMMERS:
To assemble very long programs, one often uses overlay
technique (see the Technical Manual, it has lots of
pages on overlay).
All sections or modules to be assembled are on disk.
They must be under 16k bytes, starting with
"DEFPROCpart1" (or 2, 3 etc) and ending with ENDPROC.
You will then enter the following program:
REM "ASS"
1 LOMEM=&4B00
10 FOR pass=0 TO 2 STEP 2
20 *LOAD part1 1B00
30 PAGE=&1B00:PROCpart1:PAGE=&1900
40 *LOAD part2 1B00
50 PAGE=&1B00:PROCpart2:PAGE=&1900
60 REM repeat any number of the previous sequence for
other 'parts'.

28

The reason for using DEFPROC is that the Virtual
Memory Processor (VMP) will normally take care of your
DEFPROCs, so you will not even have to write the 'ASS'
program.

3.6.8.6 SOLIDISK AND THE VMP:

2 versions of Virtual Memory Processors are supplied:
VMP1.0 and VMP1.2. Version 1.0 can control only 14k of
extra program length, version 1.2 uses the Solidisk as
storage thus capable of controlling up to 240k of
extra program length, using the biggest Solidisk.
Either versions will run with the 128k Solidisk. Only
VMP1.0 runs on smaller units.
It is not pratical to use VMP1.2 on any ordinary disk
drive.

3.7 THE WORD64 PROGRAM

3.7.1 WORD64 IS AN OVERLAY FOR WORDWISE 1.17:

Word64 requires that Wordwise is present on your
computer.

3.7.2 WORD64 CAN EDIT FILES AS LONG AS 64K:

WORD64 uses the a second disk as a text buffer.
WORD64 will execute all Wordwise commands except 'Load
text to cursor' (option 4).

3.7.3 RUNNING WORD64 THE FIRST TIME:

Place the SWR utility disk in drive 0. Enter:

CHAIN"WORD64" <RETURN>

If Wordwise is not present on your system, there will
be a warning message.
When WW64, the code, is generated, the computer will
prompt you to 'Press any key when ready'. Place a
Solidisk diskette or the Language disk in drive 0 then
press <RETURN>.

WW64 is different from you Wordwise chip only in the
size of text it can handle.

To load WW64, enter *WW64 <RETURN>

3.7.4 WAITING FOR A COMMAND:

When using WW64 for the first time, you will be
surprised to find that you will have to wait 5 to 10
seconds even for simple commands such as Preview text
(option 7) or Save text (option 1). The reason is that
WW64 has to update the buffer in drive 1 before it can
execute your command. The reward is startling: preview
text of any size, Search and replace, print text etc..

3.7.5 GETTING STARTED WITH WW64:

I am presuming you have made a WW64 disk in accordance
with section 3.7.3. Place this disk in drive 0 and do
Shift-Break to boot up STLDISC. Enter:
OLD <RETURN>
*SPOOL :0.SAMPLE <RETURN>
LIST <RETURN>
RENUMBER 20000 <RETURN>
LIST <RETURN>
*SPOOL <RETURN>
*INFO :0.SAMPLE <RETURN>
You should see:
$.SAMPLE 0000 0000 B895
The SAMPLE text is roughly 48,000 characters.
Press the 'f5' function key.
Choose option 2. Aswer "SAMPLE" to the prompt.
You should see created and deleted 'WORD64T' which
will be the buffer for WW64. Then the file 'SAMPLE' is
copied to the Solidisk and the activity ceases.
You can press the <ESC> to go to 'EDIT' mode.
Now go back to the Wordwise menu and choose option 7,
preview text. The command line will flash for a while
and the the text will be displayed, continuously from
begin to end. You can for example do a Search and
Replace the word '&FE30' by 'ROMnumber', you will be
surprised how fast it can do.

We use WW64 for editing Indexed Datafiles and for
writing MACRO Basic programs.

**NOTE: Word 64, Silexicon. Dic and T1 all require SOLIDISK

3.8 THE KEYBOARD PROGRAM:

Keyboard is a music making program. You call it up by
*MUSIC. It will then turn the computer keyboard to an
electric organ keyboard with the function keys used as
envelope generators. Use Caps-Control to   change
octaves, and use all letters from Z to / to make up
the lower keyboard. Letters Q to Cursor Down are for
the upper keyboard.
Pressing the Escape key will stop the music.
Holding the M key down while pressing the BREAK key
will start the music again.
The Help menu is displayed with *Help Keyboard.

===
VOLUME 2: THE SILEXICON PROGRAM
===

3.9 THE SILEXICON PROGRAM

3.9.1 A SPELLING CHECKER REQUIRING FAST DISK ACCESS:

This program is a VERY FAST Spelling Checker to out-

perform all other spelling checkers when used with the
Solidisk. SILEXICON scans texts at more than 1,000
words a minute and is made from 3 components: SILEX
the program itself, T1 the 'tree table' to find the
word address in DIC, which is the dictionary. Do not
try to read what is in DIC as all words are joined
together by 5 bit-letters making them much shorter and
unreadable. The DIC must be allowed to expand with new
words and should be the last file on your SILEX disk.

3.9.2 MAKING A SPELLING CHECKER DISK:
Copy to a blank formatted disk in order:
-SILEX
-T1
-DIC

3.9.3 GETTING STARTED:
Insert this disc in DRIVE 1 and enter *:1.SILEX.
The SILEXICON screen will come up. The first thing
Silexicon will do is checking that both T1 and DIC are
present on drive 1.
It then asks for the text filename.
You can insert the SWR utility disk in drive 0 and
type in: help!.
Texts are supposed to be in drive 0 but you can
override this by entering :2.BIGTEXT for example.
The text will be then scanned. Each word is compared
against words held in DIC. All mismatches are picked
up. You are then requested to give your verdict.

3 situations will occur:
-The word is good although not found in DIC. Add it to
DIC. (answer Y for yes).
- The word is good but not to be added to DIC. (answer
P for pass).
- The word is bad. Mark for correction. (aswer N for
no good).
If you are unsure, press the space bar and Silexicon
will display the line on which the mismatch word is
found.

Misspelt words are marked by the hash sign '#'. You
can use a wordprocessor to search and replace '#' with
correctly spelt words. Users of Wordwise can use f2 to
move automatically to the next occurrence of '#'.

The DIC is automatically updated UPON COMPLETION with
more words as you use it. Always exit by option 3,
QUIT as it will properly close T1 and DIC.

3.9.4 SILEXICON AND SOLIDISK
I bet you are not impressed by the experience of
section 3.6.3.
Now using Silexicon with Solidisk is quite a different
story.

31

Start by running the STLDISC program. When the screen
is clear, press the function key 'f4' (the red one on
the top row, not the F and the 4).
Give the same filename help! and watch it running!

**NOTE although DIC and Tl are updated with extra words but they
are still on drive 1, the Silicon drive. Should you require the
updated DIC and Tl, copy them to your Spelling Checker disk.
If you use several dictionaries, you must keep one diskette per
DIC-Tl as they go together.

3.10 THE STLRFS PROGRAM:

3.10.1 STLRFS IS A FILING SYSTEM.
The STLRFS is Solidisk RAM/ROM filing system.
STLRFS is capable of LOAD and SAVE programs in Basic
or Machine Code in a Sideways ROM format, suitable for
making Sideways ROM with any program less than 15k
bytes.

3.10.2 STLRFS ADDS A SIDEWAYS ROM HEADER TO ANY PROGRAM.
Take an example: you have a contract to implement
'Star Trek' on the BBC or the Electron for as little
as possible. Place the disk containing 'Star Trek' in
drive 0 and enter:

LOAD "STARTREK" <RETURN>
Place a COPY of the SWR UTILITY disk in drive 0 and
enter:
*STLRFS <RETURN>
OLD <RETURN>
SAVE "STARTREK" <RETURN>
*DISK <RETURN>
CHAIN"MENU" <RETURN>
You should now see 'STLRFS' in Sideways RAM box 'F'.
Press the '@' key.
Give box number 'F' to save 'STLRFS' onto your disk.

3.10.3 TESTING THE STLRFS:
Switch off the computer and switch it on again.
Enter:
*STLRFS <RETURN>
CHAIN"STARTREK" <RETURN>
Your Star Trek program should be running.

3.10.4 STLRFS CAN PROVIDE LOW COST SOLUTIONS:
The previous experiment can be repeated with any Basic
or Machine Code program (change LOAD to *LOAD, SAVE to
*SAVE and CHAIN to *RUN). The result is a ROM that can
run itself, without cassette recorder or disk drive.
To complete your project, order an Eprom programmer
and tell it to put STLRFS onto Eproms for you.
STLRFS is ideal for programs around 7k bytes or 15k
bytes to fit into either a 2764 or a 27128 Eprom.

It is of no use if you do not own an EPROM Programmer.

3.11 SWR UTILS.

RUTILS is a suite of utilities specially made for the Sideways RAM system. *HELP SWR will list all the *commands available, mainly:

*RX lists all ROMs and RAMs in your computer.

If a name is preceeded by *, the ROM is temporarily disabled by *RZAP (see below). The ROM in purple is the one having RUTILS 'glued' to it.

*RLOAD <filename> <RAM number>, example *RLOAD TOOLKIT E will load TOOLKIT into bank E.

*RSAVE <filename> <ROM-RAM number> <size 1,2,3 or 4> will save the designated ROM/RAM without wiping any program in memory. The size of the wanted RAM/ROM is in mutiple of 4k bytes.
Ex: *RSAVE DFS150 F 4: Save 16k in bank F to disk as DFS150.

*RZAP <number>: disable any ROM/RAM in that socket or bank.
Ex.: *RZAP 1. Disable the ROM in socket no 1.

*RRES <number>: restore a zapped ROM/RAM.

*UNLANG <number>: the designated ROM can no longer be selected as a language.

*LANG <number>: restore an UNLANGed ROM.

*EXCEPTION <number> <new name> allows you to rename temporary a ROM that does not follow the normal naming rule.

*LINK <filename>: glue RUTILS to that file so that it does not take too much space on your disk.

*CLX: clear all exceptions (new names attributed to odd chips).

*BYE disables RUTILS.

==
VOLUME 3
==

Volume 3 deals with programmming facilities offered by the Sideways RAM system. There are ways to deal with oversized programs and 'No room' error message. One is explained in section 3.6.8.6 using the Silicon disk. Volume 3 contains a more general approach that we hope the educationalist will favour - that is structured programming.

If you can divide a problem into a number of smaller problems and each can be solved by a PROCEDURE or a FUNCTION or a SUBROUTINE then Virtual Memory Processor and Macro Basic is for you.

The Virtual Memory is an aid to Acorn BASIC 2 (1982). It 'drops on demand' a DEFPROC (DEFinition of PROCedure) somewhere between TOP and LOMEM if BASIC fails to find it. Since DEFPROCs and DEFFNs (DEFinition of FuNction) constitute the largest part of any structured program, it is easily understood that the computer can cope with programs much larger than its memory size. There is no limit to the size of the program (Megabytes are no limit).

Macro Basic on the other hand is a program generator.

Primarily, it finds any missing DEFPROCs and DEFFNs in
your program, locates them somewhere in other
programs and appends them to your program. The result
is a 'Basically' perfect program which will run on any
BBC computer.
Secondly, Macro Basic translates MACROs into Basic
statements. Macros are subroutines that you create
from PROCs, FNs, machine code or other programs.
Macros need to be defined once. The result can be used
over and over again, like DEFPROCs and DEFFNs with
VMP.
The difference between Macro Basic and VMP is that
Macro Basic appends PERMANENTLY ALL the missing
DEFPROC where as VMP does it TEMPORARILY and one at a
time. Macro Basic does not need Sideways RAM to run,
VMP and VMP programs do.

3.12 MACRO BASIC.
Macro Basic is the program that writes programs using
material found in other programs.
The MACRO BASIC disk has the following programs:
MBASIC (MACRO BASIC)
LINKEDT (LINKER-EDITOR)
VMP1.0 (VIRTUAL MEMORY PROCESSOR VERSION 1.0)
VMP1.2
LIB10 (LIBRARY OF PROCEDURES)
LIB30 (MORE LIBRARY)
LIB (SAMPLE LIBRARY)
TS100 (SAMPLE MACRO BASIC PROGRAM, which is not
different from any other program but cannot run
without MBASIC or VMP)
TV100 (SAMPLE VMP PROGRAM)
TB100 (SAMPLE BASIC PROGRAM AS GENERATED BY MBASIC)
M.VIRTUAL (Sample Macro file)

3.12.1 SOURCE PROGRAM FORMAT:
There is a sample program on the disk, 'TS100' (Test,
Source, 100 passes). Load it and list it.
You will notice that line 60 reads: 60 PROCabc. There
is no DEFPROCabc in this program. The same thing
happens at line 70:
70 PROCghk, no DEFPROCghk in sight.
So the Source File format is the same as any Basic
program except that DEFPROCs and DEFFNs are allowed to
be missing.

3.12.2 LIBRARY FILE FORMAT:
Load in the 'LIB' program and list it. You will see
that DEFPROCabc, def and ghk are all in LIB.
So the library file format is the same as any Basic
program, complete with DEFPROCs and DEFFNs. This
explains why ANY program can be a LIBRARY, as far as
it contains some useful DEFinitions.

3.12.3 MACRO BASIC IN ACTION:

34

Now enter:

CHAIN "MBASIC" <RETURN>

The computer expects a filename:

'Source filename, please? ...... Type in:
TS100 <RETURN>
'Output filename, please?...... Type in:
TB100 <RETURN>
'>>WARNING: file TB100present<<'
'Automatic Link-Edit of program?..Type in (for yes)
Y <RETURN>
'Library name (/ to end)...... Type in:
LIB <RETURN>
'Library name (/ to end)...... Type in:
/ <RETURN>
'Simple line renumbering?..... Type in:
Y <RETURN>
'Automatic run of output program?. Type in:
Y <RETURN>

- In less than 5 seconds, MBASIC (and LINKEDT) generates
  the program and runs it for you. The copy of the
  generated program is 'TB100', It will run perfectly on
  any BBC computer, even without Sideways RAM.
  List 'TB100'. You will find that 'TB100' is composed
  of 'TS100' and the missing 'DEFs' borrowed from 'LIB'.

3.12.4 MACRO BASIC AND LINK-EDITOR FOR THE TECHNICAL MINDED:
Macro Basic scans the 'Source Program' or 'Macro
file' and translates all MACROs (see below) and text
into a Basic program.
Macro Basic is flexible enough to accept text files
produced by a wordprocessor as Source files. Users of
Scribe and View please note that Text Files must be
spooled to disk to strip all control characters
related to the particular wordprocessor you are using.
Examples of Macros are illustrated in the M.VIRTUAL
file.
The previous 'TS100' is a trivial example as there is
no 'Macro' present.
Usually, automatic link-edit is assumed. After
generating the program from the 'Source', MBASIC
repetitively calls 'LINKEDT' to scan the librar(ies)
to pickup any DEFPROC or DEFFN that are still missing.
For example, although PROCdef was not called in the
Source program, it is called by PROCabc. So LINKEDT
must scan the output program until it is satisfied
that all missing 'cues' are found.
How to write your own Macros is explained in the
Technical Manual. It is beyond the scope of this
Manual. Solidisk Support Service will attempt to build
up a library of programs, subroutines, DEFPROC, DEFFNs

etc for the BBC computer . Instead of typing DEFPROCs
and DEFFNs, you may just leave it to MACRO BASIC and
Solidisk program database.

But there is more to it: if the program size exceeds
24k, it won't fit into any BBC computer! You will then
need VMP, the Virtual Memory Processor.

3.13 SOLIDISK VIRTUAL MEMORY PROCESSOR:

Switch off your computer and switch it on again.
Enter:

```
*VMP1.0 <RETURN>
CHAIN "TV100" <RETURN>
```

'TV100' is equivalent to 'TB100' or 'TS100' but
only runs with the help of VMP1.0
'TV100' calls 100 times PROCabc, which calls PROCdef,
TV100 will then call PROCghk and loop back. The time
do do all that is 6 secs 890 millisecs.
On exit, TV100 chains 'TB100', the Basically perfect
program that can run alone, the time for calling 300
DEFPROCs is then just 6 secs 190 millisecs.
One can estimate that VMP is capable of serving any
DEFPROC missing in just under 2.2 milliseconds.

3.13.2 WRITING VMP PROGRAMS:

VMP is ideal whenever you run out of memory for your
program.
To use VMP facilities, you MUST raise LOMEM by a
statement like this:

```
10 LOMEM=TOP+&400
```
The headroom limit is up to you. Estimate it at any
realistic value to provide for the largest DEF that
you may need. If LOMEM is reached, VMP will stop
serving any more DEF and you will get 'No such PROC/FN
error.
When VMP is first loaded, it says 'No file', i.e. it
contains no library.
Make line 20 like this:

```
20 *VMP LIB
```

Any BASIC program can be used as library. For exmple,
if you are going to need DEFFNsquare, and you know
that it is in the 'Maths1' program, do 20 *VMP Math1.

You can also replace the library any time you need.

For example:
```
10 *VMP L.entry
20 etc....
1000 *VMP L.valid
```

```
1010etc..
2000 *VMP L.print
2010etc..
```
If the requested PROC is not in the VMP memory, it
will answer ' No such PROC/FN .
The number of DEFs that VMP1.0 can handle is limited
to 255 for any library.

3.13.3 USE OF THE VMP:

The VMP system could well be a standard method of
writing programs and teaching programming to students
on the BBC computer because of its simplicity. Any
program can be broken down into several logical
building blocks, each block is a library. Only the
main block has to be in memory as main programs. Other
blocks are simply loaded into the VMP in turn and only
when needed.

3.14 SOLIDISK DATAFILE:

Solidisk Datafile is a general database management
program. Options include: Access password, Create a
datafile, Enter a record, View a record, Selective
Viewing and Printing, Field caculation, Fuzzy Search,
Date stamping and more. You can create 'screen
template' for data entry and report form for output.

===
3.15   VOLUMES 4,5 AND 6: THE SILEXICON PACKAGE.
===

The Silexicon package consists of 3 diskettes, each
contains the Silex program, the Generator program and
a specially compiled Dictionary/Tree. The dictionaries
are English, French and German. There will be other
languages later on. Due to considerable delay on
dictionary compilation, delivery will commence in
early AUGUST.

===
3.16   VOLUMES 11,12 AND 13: THE SOURCE CODE.
===

The Source Code is the original material as it is sent
to us by the authors of the programs published in
other volumes. They include authors' own annotations.
You can not only modify these original programs to
suit a particular situation (such as running Silexicon
with a single disk drive) but also learn programming
techniques from their authors, especially those of you
who want to write your own Sideways Software.
We are sure that this work will provoke interest in
many users with regard to programming in machine code.

3.16 THE COST OF EXTRA DISKETTES:

All programs written for Sideways RAM may be copied for personal use. The source code may be obtained if not already present on your disc. Any extra diskette costs #2.00. Allow #1.00 for p&p.
It must be understood that although the software is free, the diskettes are not. Sideways RAM software will take several diskettes to store and only the first diskette is included in the sale price.
Specially written programs are divided into volumes:
-Volume 1: labelled SWR40T.
-Volume 2: labelled Silexicon. Note that the SWR80T comprises Volumes 1 and 2.
-Volume 3: labelled VMP. It contains MACRO BASIC, LIBS/1, VMP and some program libraries.
-Volumes 4, 5 and 6: labelled English, French and German. They constitute the Silexicon package. The price of this package (including Manual) is #10.00.
-Volumes 11 to 13 are the Source Code. Most of the programs supplied in volumes 1, 2 and 3 are machine coded and cannot be altered even by experienced users. On the contrary, the source code programs (which once run yield the machine code) are written in Basic. You can list them, add extra lines to them, modify them etc.. Listings of these programs are included in the Technical Manual.
Volumes 11 to 13 are recorded on 80 track diskettes. The price of the Technical Manual and Source Code diskettes (3) is #10.00.

We would like to thank all those who have contributed towards our software support in general and also to this manual. Any suggestions and constructive comment are always welcome and we look forward to valuable participation in the future.

S20 S22

6 WIRE BASE UNIT
DIAGRAM

IC1
6502

orange
yellow

green
S22
blue
S20
mauve
grey

IC69
6255

base unit

(keyboard tail)

Use the IC socket if IC76
is soldered.   YELLOW
ORANGE

top of
IC

socket

IC76

S22

S20

IC
76

(orange)

(yellow)

IC1
6502

Base unit.

GREEN
MAUVE   BLUE
GREY

(green)

(yellow)11 10
12

(orange)

IC69
6522

(the keyboard tail)
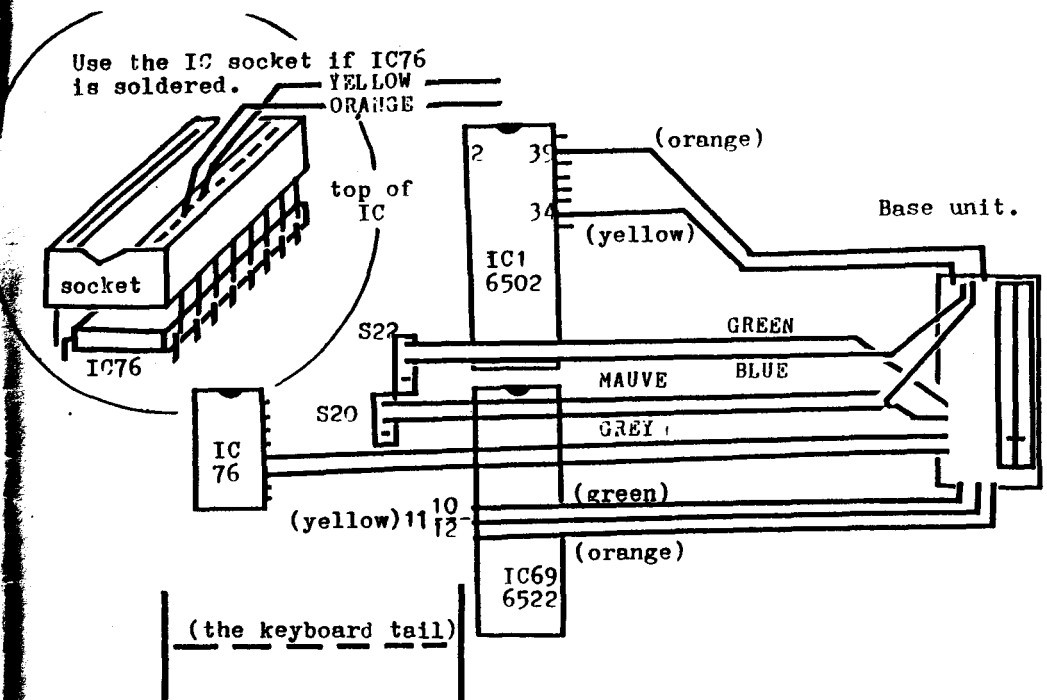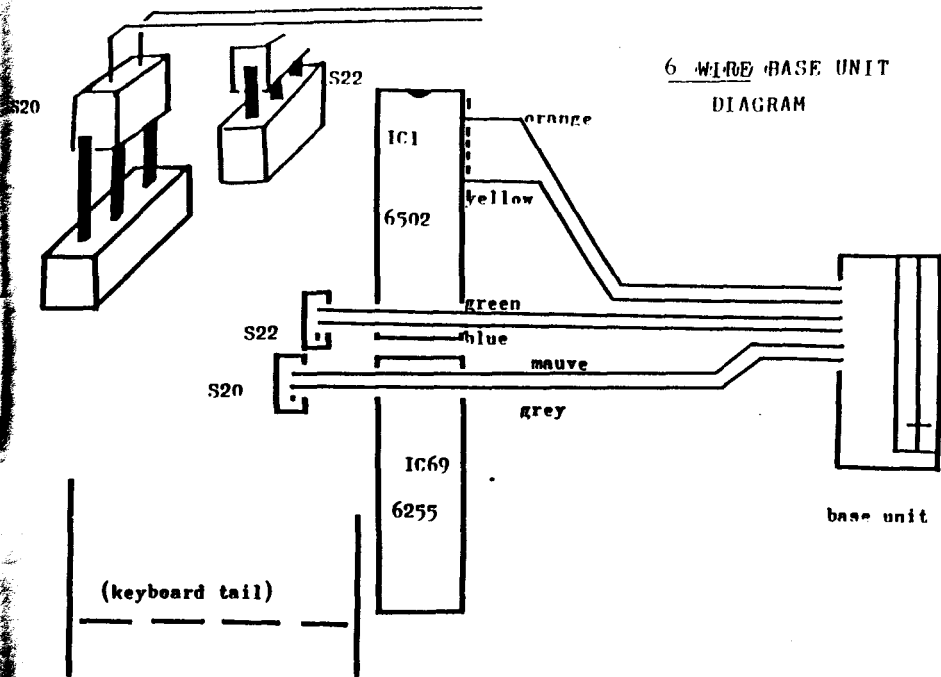
MEMORY MAPS (SIMPLIFIED) WITH ADDRESSES AND BANK NUMBERS IN HEX

```
a) Standard Machine - 32 K                                        ___  &FFFF
                                                                 :MOS:
                   KEY                                           :ROM:
                                                                 :    :
   MOS - Machine Operating System ROM                    _____:___:&C000
                                                        :WP :BAS:DFS: S :
   WP  - Word Processor ROM                             :ROM:ROM:ROM:ROM:
                                                        : C : D : E : F :
   BAS - BASIC Language ROM                             :___:___:___:___:&8000
                                                                 :    :
   DFS - Disc Filing System ROM                                  :RAM:
                                                                 :    :
   S   - Spare ROM Socket                                        :___:&4000
                                                                 :    :
   RAM - Screen and Program RAM                                  :RAM:
                                                                 :    :
   DFS+P - Disc Filing System + "Patch" in RAM bank              :___:&0000


b) With Solidisk SWR128 installed                                ___  &FFFF
   - configured as 8 Sideways RAM banks                          :MOS:
                                                                 :ROM:
                                                                 :    :
 _____ :___:&C000
:WF :BAS:DFS:   :   :   :   :   :8  :Sid:ewa:ys :  R:AM : Ba:nks:
:ROM:ROM:ROM:   :   :   :   :   : * : * : * : * : * : * : * : * :
: 0 : 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : A : B : C : D : E : F :
:___:___:___:___:___:___:___:___:___:___:___:___:___:___:___:___:&8000
                                                                 :    :
                                                                 :RAM:
                                                                 :    :
                                                                 :___:&4000
                                                                 :    :
                                                                 :RAM:
                                                                 :    :
                                                                 :___:&0000


c) With Solidisk SWR128 installed                                ___  &FFFF
   - configured as a RAM Disc of 100 K + 1 Sideways RAM bank     :MOS:
                                                                 :ROM:
                                                                 :    :
 _____ :___:&C000
:WF :BAS:DFS:   :   :   :   :   :DFS:   :RAM: Di:sc :100: K : 1 :
:ROM:ROM:ROM:   :   :   :   :   :+P*:***:***:***:***:***:***:RAM:
: 0 : 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : A : B : C : D : E : F :
:___:___:___:___:___:___:___:___:___:___:___:___:___:___:___:___:&8000
                                                                 :    :
                                                                 :RAM:
                                                                 :    :
                                                                 :___:&4000
                                                                 :    :
                                                                 :RAM:
                                                                 :    :
                                                                 :___:&0000
```

Fig. 1.