Support Group Application Note
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6502 to ARM Application Note

Applicable Hardware : All RISC machines

Related Application Notes: Archimedes 6502 Emulation
6502 Applications using !65 Host

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CONTENTS

FOREWORD

The term 6502 is used in this document to refer to the following Acorn products based on the 6502 microprocessor:

BBC Model B
BBC Model B+
Acorn Electron
BBC Master 128
BBC Master Compact

ARM is short for Acorn RISC Machine. This is the RISC (Reduced Instruction Set Chip) microprocessor at the heart of the Archimedes architecture.

Products of Acorn Computers Ltd are subject to continuous development and improvment, and so the information contained in this document is subject to change without notice.

Moreover, while every effort has been made for accuracy at the time of writing, it s acknowleged that there may be errors or omissions in this note.

It is inevitable that much of the content of this document is of a technical nature.

INTRODUCTION

This document looks at the issues involved in porting software for Acorn's 6502-based microcomputers onto the Archimedes range of microcomputers. It is written to help you identify which items of software may run on the Archimedes microcomputer, and how to transfer them and get them running. It also covers resources available to help in porting software. It is primarily targetted at the broad base of 6502-based educational software used in schools and colleges.

Before you attempt to port existing software on to the Archimedes microcomputerm you need to consider the following questions:

Is it legal?
Is it likely to run?
How can the software be transferred?
What running instructions are needed?

IS IT LEGAL?

You can ignore this question if it is a program that you have written yourself, but commercial software is sold subject to terms and conditions which you must comply with. This is covered in the chapter entitled LEGAL ISSUES.

IS IT LIKELY TO RUN?

Whether a particular piece of software for a 6502-based machine will run on the Archimedes microcomputer will depend on how the program has been written.

If you are dealing with a number of programs, then it would be worth considering the likelihood of success before spending time transferring and attempting to run the software. Further details are given in the chapter entitled EVALUATION OF PORTABILITY.

WILL IT RUN NATIVE, OR UNDER 6502 EMULATION?

<u>Native:</u> The version of BBC BASIC (BASIC 5) developed for the ARM may be referred to in this document and elsewhere as being native to the Archimedes microcomputer.

You can attempt to run programs written in BASIC for the 6502-based microcomputers, using ARM BASIC on the Archimedes microcomputer, provided that the programs are written entirely in BASIC and contain no Assembler. Further details are given in the chapter entitled ARM BASIC.

<u>6502 Emulation:</u> In addition to program written entirely in BASIC, you can attempt to run 6502 machine code programs and BASIC programs that assemble or call 6502 machine code routines using the 6502 emulator. Further details are given in the chapter entitled 6502 EMULATION.

HOW CAN THE SOFTWARE BE TRANSFERRED?

Before you can attempt to run 6502-based software on the Archimedes microcomputer, you need to find a means of transfer from its current medium (eg 5.25 inch disc in DFS format) to a medium accessible to the Archimedes computer (eg 3.5 inch disc in ADFS format). This is covered in the chapter entitled TRANSFER.

WHAT RUNNING INSTRUCTIONS ARE NEEDED?

You may need to use modified running instructions in order to get the software started on the Archimedes computer. Guidance and suggestions for this are provided in the chapter RUNNING INSTRUCTIONS.

LEGAL ISSUES

COPYRIGHT

Unless you are dealing with software already on 3.5 inch ADFS format disc, attempting to port software to the Archimedes microcomputer will necessarily entail copying the software.

For the purpose of copyright in this country, software is regarded as a work of art. Making an unauthorised copy of an item of software for which you do not hold the copyright is against the law. It is your responsibility to ensure that you comply with the law, and you will need to consider which of the following applies with a particular item of software:

<u>Your own programs</u>: If you have written the program, you automatically hold the copyright unless you assign the right to another party. You are free to copy the program.

<u>Commercial software:</u> It is essential that yo consult the terms and conditions of sale of a particular item of commercially available software. The terms may make provision for making a number of copies (eg under a license scheme within an institution), a single back-up copy, or no copies at all.

Aside from copying, the conditions of sale may specify hardware or mode of use. For example, that you cannot use a disc version on a network.

In general, the conditions will not bar you from running the software on a machine other than that for which it was intended (eg running a package for the BBC Model B on the Archimedes), but consult the section on Support.

<u>Public Domain:</u> Some software is distributed free of charge, or with a nominal charge to cover costs. However, although you will be free to make a copy, there may be futher conditions that you will need to comply with (registering yourself as a use, for example).

Some software is available on a similar basis, but within the confines of the LEA where it was developed.

SUPPORT

In general, there are conditions specifying the guarantee and support that go with the purchase of an item of commercially available software. It is very likely that use of the software on a system other than that specified will void the guarantee and the vendor's obligation to provide support. Thus if you port a title for the BBC Model B onto the Archimedes computer, and find that it does not work, you should not expect any help from the supplier of the software title.

ARM BASIC

Any program written in BASIC for the 6502-based microcomputers will probably run without modification on on the Archimedes microcomputer, provided that it does not exhibit any of the following:

- 6502 assembler, or accessing 6502 machine code.
- assuming the value of PAGE or HIMEM
- using the indirection operators ($, ! and ?) to access locations in the OS workspace
- accessing undocumented OS routines with CALL or USR ( )

- using * commands that require a particular extension (eg *DISC for the DFS).

In addition to these general points, loading or saving screen files to and from screen memory and likewise for user-defined graphics characters to and from Page C will not work.

The way sound is handled is completely different on the Archimedes, so that programs which use sound may produce strange and unexpected effects. The SOUND and ENVELOPE statements are ignored by ARM BASIC.

More information can be obtained in the application note entitled Archimedes 6502 Emulation. This note considers features of 6502 software which would give problems when run native on the Archimedes microcomputer, and indicates if 6502 emulation could provide the solution.

6502 EMULATION

There are two 6502 emulators for the Archimedes computer, called 65Arthur and BBCrun.

[updated stuff needed here]

RUNNING AN APPLICATION

In order to run an application under emulation, you need to invoke the emulator first and then attempt to run the application package. Often, this will amount to running the application;s !BOOT file. Alternatively, you can incorporate invoking the emulator in the applications !BOOT file.

Please note that the instructions for running the application will probably need modification, and this may involve editing the !BOOT file. More information is given in the section entitled RUNNING INSTRUCTIONS.

EVALUATION OF PORTABILITY

INTRODUCTION

The Archimedes microcomputer has a high degree of commonality with the 6502-based machines, so that there is the comfort of familiarity for end-users and programmers alike. However, it is important to remember that the hardware is completely different and this must temper your expectations as regards portability.

Whether a program written for a 6502-based machine will run on the Archimedes depends on how the program has been written and what it is doing at the code level. For this reason, all that can be provided here is a number of generalised statements; we are dealing with 'may' rather than 'can' and for a particular title it is a question of try it and see.

RESOURCES

(see also the section entitled AVAILABLE RESOURCES)

BBCscan: You can use the program BBCscan to help identify potential problems in a BASIC program. This has been written to run across the range of Acorn machines, so that you can assess portability before attempting transfer.

Application Note: The application note Archimedes 6502 Emulation classifies features of 6502 programs at the code level that are likely to cause problems on the Archimedes microcomputer.

GENERAL POINTS

Software that is 'well behaved' an not tied to a particular filing system has a good chance of running on the Archimedes computer. 'Well behaved' means not making assumptions about the hardware and firmware environment, and using the legal interfaces into the operating system. Thus programs, that have been written to run on a range of 6502 microcomputers are more likely to port onto the Archimedes microcomputer than generic versions.

As regards filing systems, software developed for the DFS disc filing system may not port onto the Archimedes, which uses the ADFS (Advanced Disc Filing System). Network versions, on the other hand, are more likely to port. Electron Plus 3 or Master Compact software on disc uses the ADFS, and so is less likely to run into problems owing to the filing system.

65Tube: 65Tube is a second processor emulator, and so programs which are Tube compatible will probably run with 65Tube invoked.

Arcade style games will not run under emulation since they poke the screen for fast animation, but well-written languages will. For example, the Compact View series.

Correctly written ROM images will run, providing that they are not protected in any way, or assume that they are located in ROM or sideways RAM.

TRANSFER

Before you attempt transfer, you must ensure that you are not in breach of copyright (consult the chapter entitled LEGAL ISSUES).

A summary of the possible starting points and methods of transfer is given at the end of this section, which is designed to help you quickly identify the method appropriate to your needs.

How best to transfer your existing 6502 software, so that it can be tried on the Archimedes microcomputer, will depend on the following factors:

- the medium the software is on (eg 5.25 inch disc)
- what 6502 machine(s) you have (eg Master 128)
- the quantity of software involved

The following possibilities, classified according to your starting point, are considered:

- 3.5 inch disc
- network
- 5.25 inch disc
- cassette
- ROM
- other media - eg bar codes

The following hardware routes are considered:

- keyboard
- network
- RS423 cable
- 5.25 inch external drive

The information is summarised at the end of this section in the form of a table.

STARTING POINT

<u>3.5 inch disc:</u> Archimedes ADFS support three formats for floppy discs:

E	800k
D	800k
L	640k

The L format is the same as that for the Master Compact and Electron Plus 3 (or for a Master 128 with a 3.5 inch external drive attachment), and so discs in this format can be read by the Archimedes unless they have been copy-protected.

In general, no transfer is necessary.

<u>Network:</u> An Archimedes can be stationed on an Econet network, for which you need to install an Econet module (the same unit as for the Master 128), connect the Archimedes with an Econet lead, and set its station number. This gives you access to the software on the network medium (hard or floppy disc).

No transfer is necessary.

<u>5.25 inch disc:</u> You will need to consider one of the possible means of transfer in the next section. Do not attempt to transfer software that is copy-protected.

<u>Cassette:</u> Since there is no Tape Filing System or cassette port on the Archimedes microcomputer, there is no direct means of transferring software from cassette.

If you have an Electron Plus 3, use it to copy from cassette to 3.5 inch disc, which can be read by the Archimedes ADFS. Otherwise, you will need to find another route (eg, load the program from cassette into memory, and then transfer via the RS423 ports).

<u>Other media:</u> For software on other media, such as Bar codes, you will need to transfer onto another medium first.

MEANS OF TRANSFER

Keyboard: For a few short BASIC programs, typing them in may be the quickest method of transfer.

Network: Since you can network a BBC Model B or Master series, by using a local disc drive with it you can copy software onto the network medium, and from there to the Archimedes. This provides a ready means of transferring 5.25 inch DFS based software to the Archimedes, providing that the discs are not copy-protected.

RS423 cable:

BBC B, B+ or Master 128	RS423 >> RS423	Archimedes
5.25 inch drive		3.5 inch drive

The RS423 port on the Archimedes microcomputer is designed for connecting a modem. As such, any device connected to the port must appear to the computer as a modem in order that the handshaking runs correctly.

The pinout of the port runs as follows:

Pin 1	DCD	Data Carry Detect
Pin 2	RXD	Receive Data
Pin 3	TXD	Transmit Data
Pin 4	DTR	Data Terminal Ready
Pin 5	GND	Zero Volts
Pin 6	DSR	Data Set Ready
Pin 7	RTS	Ready To Send
Pin 8	CTS	Clear To Send
Pin 9	RI	Phone Line Ringing

The pins are laid out as below, when viewed from the back:

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1           2           3           4     5
      6           7           8        9
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If you want to connect a non-modem device, for example connecting an Archimedes microcomputer back to back with a BBC Model B, athe normal arrangement of connecting RTS on one machine to CTS on the other, and RXD on one to TXD on the other, should be used. Further to this however, DCD, DTR and DSR need all to be tied together in order to simulate a modem.

At high baud rates, problems will arise if the Archimedes own receive and transmit rates are set differently. This is due to the RS423 controller chip only having one baud rate generator so when different rates are required problems arise. If either transmission or reception at a high rate (> 4,800 baud) is required, it is important to set both transmit and receive rates the same even if only one direction is being used.

Further information is available in application notes; consult the section entitled AVAILABLE RESOURCES.

At the time of writing, at least one third party had developed a commercially available RS423 transfer kit for the Archimedes microcomputer.

External 5.25 inch drive: You are advised not to attempt to attach a 5.25 inch drive cable to the current drive unit cable in the Archimedes machine. This may damage a chip, which introduces an undetectable error. Additionally, there can be an excessive load on the Archimedes driver gates from some drives.

At the time of writing at least one independent company was completing work on an external 5.25 inch drive unit, and you should be able to obtain further information from your dealer.

TRANSFER SUMMARY

Medium	Machine	Comment	Transfer
3.5 inch ADFS disc	Master Compact/ Electron Plus 3	may be copy protected	not required
any	any	a few short programs	keyboard entry
Winchester or floppy disc	Econet network	net module in Archimedes required	not required or download onto 3.5 inch disc
5.25 inch DFS disc	Model B, B+, Master 128	may be copy protected	RS423 cable 5.25 inch external drive
Cassette	Electron, Model B, B+, Master 128		RS423 cable
	Electron Plus 3		download onto 3.5 inch disc
ROM	any	32 pin >= 16K	Need ROM expansion card
Other, eg bar code	any	Transfer to other medium first	Via available route above

RUNNING INSTRUCTIONS

The following section is written with a typical eventuality in mind; namely that you have transferred software onto 3.5 inch disc, probably from 5.25 inch disc.

The software start from an EXEC !BOOT file, and you may need to note the contents of this file an edit it as appropriate for starting the application on the Archimedes microcomputer.

GETTING STARTED

BBC Model B etc: The 6502 based microcomputers boot up into BASIC command mode.

It is possible to get software on discs to autoboot, ie so that the user can place the disc in the drive and press SHIFT + BREAK to start the program. Most commercially available disc based software is distrubuted like this.

To do this, the start-up option on the disc needs to be set, and a file name !BOOT provided on the disc. then, in response to SHIFT + BREAK, the computer looks for a !BOOT file and runs it. The !BOOT file will contain a few key instructions needed to get the program running.

If !BOOT is a machine code program, the start up option needs setting to 2. However, you are more likely to encounter !BOOT and an EXEC file, for which the start-up option needs setting to 3.

If !BOOT is an EXEC file, you can list the instructions it contains by typing *TYPE !BOOT, followed by pressing RETURN.

<u>The Archimedes microcomputer:</u> By default the Archimedes microcomputer boots up into the desktop program. There are three routes available to you to get started. the first circumnavigates the desktop altogether.

To get a disc to auto-boot on Archimedes, you need to set the disc option to 2, and you need to provide a !BOOT file which is either ARM machine code or BASIC.

For example, consider a BASIC program called FRIDA which you have transferred onto a 3.5 inch disc:

- place the disc in the disc drive
- exit from the desktop
- set the start-up option on the disc to 2: type *OPT 4,2, then press Return
- provide a BASIC program as the !BOOT file: type 10 CHAIN "FRIDA", then press Return
- type SAVE "!BOOT", then press Return.

Now when you press SHIFT + BREAK, the !BOOT file will be run, which in turn runs your program FRIDA.

The other two routes require you to work from the desktop, and the existence of a !BOOT file is assumed:

- exit from the desktop
- run the !BOOT file by typing in the appropriate commands:
  eg, type CH. "!BOOT" followed by Return in the example above.

OR

- select the disc icon on the icon bar
- select the !BOOT option from the menu of icons available

KEYBOARD

Some changes in the runnin instructions referring to the keyboard may be required. In particular, the red functon key f0 on the Model B keyboard is replace by the PRINT key on the Archimedes keyboard.

AVAILABLE RESOURCES

APPLICATION NOTES

Archimedes 6502 Emulation and the RS423 Application Note are available by writing to:

Customer Services
Fulbourn Road
Cherry Hinton
Cambridge
CB1 4JN

65HOST and 65TUBE are provided on the Archimedes Applications Discs.

BBC Model B Emulator Utilities:

Copies of these utilities can be obtained by writing to Acorn Customer Services at the above address. The programs are:

BBCscan	Searches tokenised BBC BASIC programs and flags lines that may cause problems when porting to ARM computers. Runs on the BBC Model B, B+, Master series, Acorn Electron and Archimedes computers.
PicConv	Converts BBC screen image files and GXR sprites into Archimedes sprites. MODE 7 files are converted for display using *PRINT. Runs on the Archimedes range only.
UdgConv	Converts files of User Defined Graphics characters, for loading into Page C, back into BASIC VDU statements.
DFSConv	Converts an ADFS image of a DFS disc into the form required by 65Host for DFS emulation.