



DFS COMMAND PERFORMANCE

175

How does Acorn's disc filing system software compare with five competitors? Vincent Fojut gives his verdict

THE first enhancement you're likely to consider for your BBC micro is upgrading to disc operation. A

disc upgrade can be broken down into two elements — the hardware, ie, the disc drives and disc interface circuitry, and the software (or firmware), ie, the ROM or EPROM to interpret the extra commands needed to interact with the drives. This firmware is referred to as the disc filing system (DFS).

This review will concentrate on the increasing choice of DFS packages available for the Beeb.

A disc upgrade kit consists of a set of chips which plug into vacant sockets on the BBC micro printed circuit board (PCB). One of these devices is the floppy disc controller (FDC), and only certain types are capable of supporting double-density operation. The standard package of disc interface circuitry is based on the Intel 8271 FDC chip. This has been in short supply and consequently very expensive, but the situation is said to be improving. While it performs its function perfectly acceptably, the 8271 is a rather old design, and doesn't support double-density format. A double-density disc system requires replacement hardware based on a totally different FDC chip.

Finally, we come to the software element. The role of the DFS is to provide commands to read and write data to and from disc, and perform various 'housekeeping' functions, such as displaying file information, locking/unlocking files, copying files from one drive to another, etc. Six different DFSs are under scrutiny—three more or less 'standard' single-density systems, and three double-density systems, incorporating alternative disc controller hardware.

A series of tables provide a variety of data to allow an 'at-a-glance' Comparison between the salient features of each DFS.

Differences in speed and command-sets are also highlighted. The programs used for the benchmarks (table 4) are loosely based on those devised by Joe Telford (*Acorn User*, April '83) with one or two changes and additional tests. For the record, the configuration used for all benchmarks (and reviews) was a BBC model B (issue 7), fitted with Basic 2 and OS 1.2, using two 5.25in TEAC FD55 single-sided, 40-track drives.

Acorn DFS

Like it or not, Acorn's DFS is the 'standard' disc filing system for the BBC micro. In common with the Basic and OS chips, more than one version is in circulation, from 0.90 to 0.98 (the '0.9 series'). The version examined here is release 0.98.

Acorn's design philosophy behind its disc software is not without its detractors. A common bugbear is the amount of RAM which is claimed by the DFS for workspace (&E00 to &18FF), ie, the default value of PAGE, at switch-on, changes from &E00 to &1900 when a standard disc upgrade is fitted. Also, the catalogue structure, which imposes a maximum of 31 files per disc surface, can be a severe limitation.

The DFS is housed in an 8k EPROM (half the size of more recent alternatives) and offers the range of commands outlined in table 1. All other DFSs which claim compatibility must also have the same commands within their repertoire. Indeed, many have added new commands, and even enhanced existing functions, as we

shall see later. Although a good number of other commands are used with discs (eg, "CAT, *LOAD, *SPOOL), these are not listed here, since they are Machine Operating System (MOS) commands and are not strictly part of the DFS.

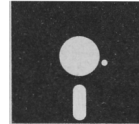
Two crucial commands in any disc system are a formatting command (without this new discs would be unusable), and a verify command, to check a disc for any data corruption. Acorn do not supply either of these commands in their DFS EPROM, and the separate utility disc provided needs to be used for both these functions.

Surprisingly, although squeezed into only 8k, Acorn's 0.98 puts in quite a good speed performance. Its other strong point is that of being 'standard', and as such, all disc-based programs should work with it. While other offerings boast (and achieve) a very high degree of compatibility with the standard Acorn DFS, nothing can be more compatible than the original!

As for its restrictions, these can be circumvented to some degree by extra utilities, eg, programs to create dual catalogues, giving double the files per disc. However, such facilities are provided much more conveniently (as part of the DFS software in EPROM) by other systems.

Watford DFS

Watford Electronics was one of the first companies to offer alternative disc filing systems for the Beeb, and as with Acorn, a number of versions have been released, culminating in the 1.41, reviewed here. The use of a 16k EPROM has enabled Watford to incorporate a number of very useful additional commands (table 2) which



are worth further description.

New format commands (FORM35, FORM40 and FORM80) and a VERIFY command eliminate the need for a separate utility disc. A built-in disc sector editor (invoked by *EDIT) is also particularly useful. This allows disc data to be altered subtly, making corrupt files readable, for example. It can even help you 'resurrect' files deleted in error. You can enter changes in either hex or ASCII.

*MLOAD is intended chiefly for tape programs which have been transferred to disc. Once a file is loaded, the command de-activates the disc system and moves the file down to its original load address. *MRUN acts in a similar way, but automatically runs a program once it has been moved down in memory.

*MOVE behaves like the standard *COPY, but displays each file to be copied in turn. This allows you to de-select certain files within a range which you don't wish to copy.

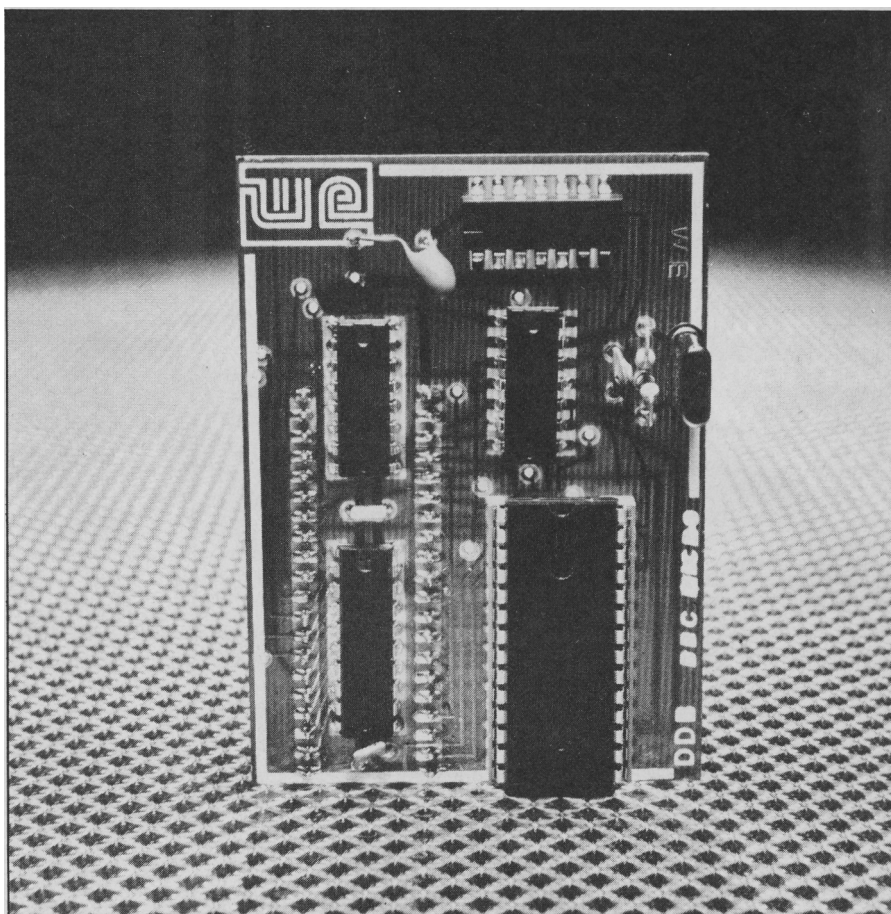
The *WORK command introduces a novel concept of 'work file'. This is a default file name used by the system whenever a name is omitted from a command. For example, *WORK FRED, followed by SAVE "" would effectively save a file called "FRED". The command can also support auto-version numbering, so that subsequent SAVES of the work file would store "FRED001", "FRED002", and so on.

*TIDY performs the same function as Basic's CLOSE#, ie, closing all open files. The advantage is that, being a DFS command, it can be called from languages other than Basic.

Command Function

ACCESS	lock/unlock files
BACKUP	copy entire disc contents
COMPACT	consolidate disc free space
COPY	copy files between drives
DELETE	delete a single file
DESTROY	delete a range of files
DIR	set current directory
DRIVE	set current drive
ENABLE	enable 'dangerous' commands
INFO	display file information
LIB	set current library
RENAME	change file name
TITLE	set disc title
WIPE	selectively delete files
BUILD	build text file
DISC	select disc filing system
DUMP	list any file in hex/ASCII numbers
LIST	list ASCII file, with line numbers
TYPE	list ASCII file, without line numbers

Table 1. 'Standard' kernel of commands, as per Acorn DFS



Watford double-density board: virtually the same as the single-density

Two new words, FILES and SPACE, have special significance, and are used in conjunction with the *HELP command. *HELP FILES displays information on all open files, giving file handle, pointer values, etc. *HELP SPACE lists any gaps between files, which would be removed by *COMPACT, and gives the total free space on disc. The *HELP command has also been enhanced to work with any single DFS command name, eg *HELP DRIVE provides you with the syntax for just that one command.

Apart from its range of new or enhanced commands, one of the Watford DFS's major claims to fame is that it doubles the possible number of files per disc surface to a maximum of 62. 'Normal' 31-file discs can still be created and used with the system, though. If you've ever been frustrated by the amount of space you can lose on a 'full' 31-file disc, then you'll appreciate what a benefit this feature can be.

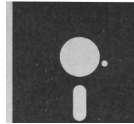
The manual provided with the Watford DFS goes into sufficient depth without being difficult to read. It's structured so as to be of use with the standard DFS as well as Watford's own. Existing DFS users, who wish to change to Watford's version, can get a discount if they submit their current ROM with their order.

During the course of this review I received three versions of the Watford DFS (versions 1.3, 1.4 and 1.41)! The latest was faster than its predecessors in some disc operations but slower in others, resulting in no difference in overall rating. It's impossible to know whether this rapid evolution is due to enhancements or corrections (or perhaps a combination of both).

E00 DFS

Like the standard, the E00 DFS comes in an 8k EPROM which is housed, together with its very own RAM, on a small board measuring some 2in square. The whole assembly plugs into a vacant sideways ROM socket via stand-off pins. A suitable control signal is fed to the on-board logic by means of a flying lead, terminated in a probe. This hooks onto the pin of an IC on the BBC main board, and can be further secured by means of a double-sided sticky foam pad. Though this worked satisfactorily during evaluation, the arrangement might not hold up so well to the rigours of transportation.

As the name implies, the default value of PAGE at switch-on, even with the DFS fitted, remains constant at &E00. The RAM supplied on the plug-in board serves as dedicated, uncorruptible disc workspace, freeing existing



HOW THEY SCORE

	Acorn DFS	Watford DFS	E00 DFS	Watford DDFS	Opus DDOS	Viglen DSDFS
Ease of use	9	8	9	8	8	8
Ease of installation	8	8	7	5	5	5
Range of commands	6	9	6	9	8	9
Range of features	5	7	6	8	9	8
Speed	8	6	5	7	9	7
Standardisation	10	9	9	8	7	8
Overall rating	46	47	42	45	46	45
Marks out of 10. Maximum overall rating is 60						

RAM at &E00 to &1900 for other uses.

Apart from allowing longer programs to be stored, the extra RAM greatly simplifies tape-to-disc transfers. Also, tape programs stored on disc can often be reloaded into memory at their original locations, without the need for the usual 'move' routines required by other systems.

However, there are some penalties to pay for this saving in RAM. First command lines in BUILD files should be less than 100 characters in length. Second, the maximum number of files which you may access at any one time is four (the standard allows five). Unfortunately, the E00 DFS does not prevent you from opening a fifth file, even though it may not be 'safe' to use. The error message 'Too many files appears only when you try to open your sixth file, as occurs with the standard DES. Consequently, you may need to exercise particular care when approaching the maximum permissible number of files in your applications.

In all other respects, all commands are exactly as per the standard Acorn DFS.

The instruction sheets supplied list the minor modifications which may be required if the E00 DFS is used with various ROM expansion boards. In the worst case, the DFS may not be compatible with your make of expansion board. To be sure, check with MRM first.

This DFS is not by any means a total disc upgrade, and needs to be used with an existing disc interface. Prospective customers are presumably existing disc users who wish to gain extra memory with the minimum of inconvenience, simply by changing their current DFS EPROM for the new E00 DFS. MRM will also swap your old EPROM for a fiver.

The three packages examined above are all single-density systems. The Intel 8271 disc controller, at the heart of the standard disc upgrade hardware, can support only single-density. On a standard, single-density BBC disc, each track is divided into ten sectors, or 'blocks' of 256 bytes each.

Some other FDCs can support double-density operation. In this mode, each disc track is divided into 18 sectors, still of 256 bytes in length, thereby increasing disc capacity by an impressive 80 per cent.

The following three systems all support double-density operation and so have a number of features in common. In all cases, the disc interface hardware is based on a different, more appropriate FDC chip. This is housed on a separate circuit board which plugs via pins into the 40-pin socket normally reserved for the 8271 chip in the 'standard' disc upgrade.

Incidentally, don't worry about the various abbreviations in the titles – DDFS, DDOS, DSDFS – they all boil down to the same thing. Strictly speaking, a better term to describe the following packages is dual-density filing system (we'll use DDFS), since they can all operate in either double-density (18 sectors per track) or single-density (the standard, 10 sectors per track). A disc of any density can be inserted in any drive, and files can be copied between discs of different densities. In all cases, the DFS senses a disc's density automatically. If it is unable to read a disc in one density, it switches density and tries again.

Using double-density, the cost per byte of data storage is considerably cheaper. And, not only does double-density offer more space per disc, but disc accesses are also generally faster.

The software for these DDFSs is written to emulate as closely as possible the operation of the Intel 8271 FDC used in the standard upgrade. However, because the registers and commands used by different disc controllers are not identical, it's not possible for any double-density package to guarantee compatibility with all disc programs. It is possible that some programs could confuse a DDFS by overwriting disc workspace, by directly addressing disc controller registers, or by using the 8271's 'read ID' command, which the double-density software cannot emulate.

Watford DDFS

This is virtually identical in function to its single-density cousin, with the added facility of dual-density operation. Indeed, the range and function of commands is so similar to those of the single-density system, that the same manual is recommended for use with both packages, a single sheet covering any additional points concerning compatibility, etc. Installing the modified disc upgrade hardware is a delicate but straightforward operation, given the instructions provided.

As with Watford's single-density implementation, in addition to a variety of new commands, several enhancements to existing ones have been made. Discs may be configured to support 31 or 62 files (the latter option is particularly relevant in a double-density environment). The *CAT command has been expanded appropriately. Not only does it list the relevant number of files allowed on any disc (31 or 62), but it also now reports whether a disc is single or double-density.

When automatically sensing a disc's density, the DDFS starts by assuming that the density is the same as that applied the last time the drive was read. If this fails, the DDFS changes densities and tries again. Consequently, if you swap the densities of discs inserted into one particular drive, a lot of time will be spent by the filing system simply reading in the wrong density and having to change. It will cope, but take a lot longer than if the densities used in any one drive remain the same.

In most other respects, the density used by the filing system is largely transparent to the user.

In the majority of disc operations, Watford's double-density package is a good deal quicker than its single-

Command	Function
FORMnn	format disc to 35, 40 or 80 tracks
MLOAD	load and move down program
MOVE	selective copy
MRUN	load, move and run program
VERIFY	check disc for corruption
WORK	set current work file
HELP	
FILES	display info on open files
HELP	
SPACE	show free memory on disc
EDIT	invoke disc sector editor
TIDY	close all open files

Table 2. Extra commands provided by Watford DFS, Watford DDFS and Viglen systems



density counterpart, yet not as fast as another single-density system, the Acorn DFS 0.98.

Again, I received more than one version during the course of the review (1.50, 1.51 and 1.52). There are a few minor changes in the very latest version — for example, DFS settings are now retained over a Break, and apparently more protected software can be run, though I was unable to check this. Speed was identical to the earlier versions, except in benchmark 11, where the latest release was considerably slower! I was also pleased to see that they managed to get their own name right — version 1.51 greets you with 'Watford Electronics DDFS'!

Viglen DSDFS

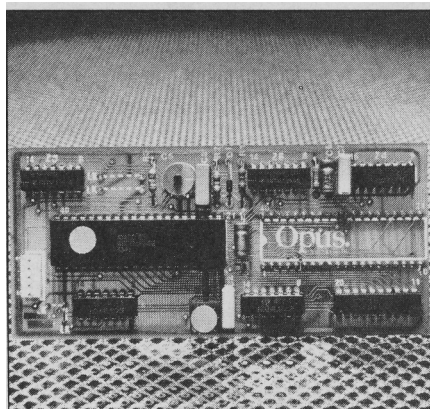
The Viglen DSDFS and Watford DDFS obviously have a common ancestry. Both boast the same enhancements to existing functions, the same new commands and utilities, even identical layout and operation for the disc sector editor. The only superficial difference I detected is that Watford's *HELP SPACE function is renamed *HELP GAPS in the Viglen DSDFS, but it performs in an identical manner. So, for the full range of new commands and utilities provided in the Viglen implementation, refer to the Watford DDFS list in table 2. The comments made in reference to the Watford DDFS apply equally well here. Though the benchmarks figures for the two systems are very similar, they're not identical. One reason for this could be that the Viglen DSDFS is almost certainly based on a different version number to that of the latest Watford DDFS.

Viglen are asking a good deal more for their DSDFS than their competitors, though (as with many suppliers) the price drops if disc drives are bought at the same time.

An interesting booklet was supplied for review with the system. While it gave a very clear and readable guide to using discs with the BBC micro, the document was geared towards the standard DFS, and made no reference to any of the features particular to the Viglen DSDFS.

Opus DDOS

I've already mentioned that the standard limit of 31 files per disc can be restrictive and lead to unusable storage space being left on discs. With a DDFS, a larger catalogue capacity becomes essential to minimise the risk of wasted disc space. While the other DDFSs go some way to improving matters by allowing 62 files per disc, the Opus DDOS adopts a more ambitious approach. The whole of the first track



Opus DDOS: an ambitious approach

on a double-density disc is given over to catalogue information, and can store up to eight directories (called 'volumes'), each of which can hold 31 files. This gives a potential maximum of 248 files per disc.

Each volume could be considered as a distinct 'logical' drive, and is identified by one of eight letters, A to H. A specific volume can be referenced by appending the appropriate letter as a suffix to the drive number, which is used in commands in the usual way, for example:

*LOAD "1C.X.TEST" — load the file called "TEST" in directory "X" in volume "C" on drive 1.

*COPY 0A 0C TEST — copy file "TEST" from volume "A" on drive 0 to volume "C" on drive 0.

If not specified, the volume defaults to A. If the volume suffix is used with single-density discs, it's just ignored, since it has no meaning in such cases.

When a file is formatted, three volumes (A, B and C) are created, sharing the available disc space. The VOLGEN command allows further volumes to be set up (or deleted later) and the disc space available can be re-allocated as appropriate. For example, a volume holding just machine code programs, or short demonstrations,

Command	Function
4080	allow 40-track discs on 80-track drive
DENSITY	(not mentioned in manual)
MCOPY	backup disc to one of different density
SROM	(not mentioned in manual)
STAT	show volume capacity and unused disc space
TAPEDISK	transfer program from tape to disc
XCAT	catalogue all files in all volumes of double density disc
FORMAT	format disc
VERIFY	check disc for corruption
VOLGEN	allocate volumes and/or change their sizes

Table 3. Extra commands in Opus DDOS

may afford to be considerably smaller than a volume holding long, word-processor files (though both volumes may still hold up to 31 files). Whenever VOLGEN performs these adjustments, any files on the disc are lost — so it's best to run it immediately after formatting or backing-up a disc.

Since the normal *CAT command only works on a single volume (default or specified), an extra command *XCAT (eXtended CATalogue) serves to list all files under all volumes on a disc.

Table 3 summarises the extra commands and utilities available with the Opus DDOS (in addition to the 'standard' vocabulary). A manual supplied with the review system gives an adequate description of the commands, but appears to relate to an old (or very new) release of the DFS software, since there are a few discrepancies between the commands in the EPROM (as listed by *HELP) and those in the manual. There was no explanation in the documentation for the 'DENSITY' and 'SROM' commands; conversely, a

	Acorn DFS	Watford DFS	E00 DFS	Watford DDFS	Opus DDOS	Viglen DSDFS
*SAVE 1K	1.3	1.5	1.3	1.2	0.8	1.2
*LOAD 1K	0.3	0.3	0.4	0.2	0.6	0.2
*SAVE 16K	2.9	3.1	3.0	2.0	3.0	2.0
*LOAD 16K	2.2	2.1	2.2	1.0	2.8	1.0
BPUT * 1000	3.5	3.5	4.9	3.0	3.2	3.4
BGET * 1000	2.5	2.5	3.5	2.6	2.1	2.6
PRINT Nos * 1000	6.1	9.7	13.8	8.9	5.9	8.9
INPUT Nos * 1000	4.7	8.5	11.9	8.3	4.9	8.2
PRINT STRING * 100	25.2	44.9	58.8	42.5	23.9	42.4
INPUT STRING * 100	23.2	43.3	55.2	41.6	22.9	41.6
WRITE RANDOM	60.7	67.1	64.7	69.7	49.9	58.4
READ RANDOM	37.7	41.7	43.6	40.7	37.2	40.7
AVERAGE	14.2	19.0	21.9	18.5	13.1	17.6

(Dual-density systems run in double-density mode)

Table 4. Disc benchmarks (rounded to nearest 0.1 second)

further command, 'AUTO40', only appeared in the manual – it's meant to allow both 40 and 80 track discs to be used in an 80-track drive, without any further user intervention.

The Opus DDOS is also notable for its impressive speed – it was the fastest of all systems reviewed.

Conclusion

Of course, everybody's ideal DFS has all the most useful features and utilities you're likely to need, while still retaining 100 per cent compatibility with all disc software. Unfortunately, the best of all possible worlds is not currently obtainable, at least not in one DFS package. If you want to be certain of being able to run *all* disc software, including the increasingly complicated protected discs, the only DFS to offer this security is Acorn's. Admittedly, it's certainly not the best equipped DFS available, but if used together with a suitable disc utility ROM (eg, *Disc Doctor*), its deficiencies can be more than compensated for. Of course, this approach means finding the space and money for two ROMs instead of one, but the combination probably represents the nearest you're likely to get to the 'ideal DFS' outlined above – total compatibility together with an extensive range of facilities.

In the time I had the Watford DFS for review, and with a limited amount of proprietary disc software at my disposal, I did not encounter difficulties with compatibility. Nonetheless, the fact that the product differs from the Acorn standard means that compatibility problems could exist.

Watford operate an upgrade policy, which allows existing Watford DFS users to switch to the latest releases, in return for their old ROM plus a £5 'upgrade fee'. Owners of non-Watford DFS ROMs can also trade these in for a discount.

It must be said that Watford's DFS certainly offers a comprehensive range of facilities at a very attractive price. If you plan to buy each new upgrade however, then (at the rate they are producing them!) you could end up spending as much as you would for a different DFS plus disc utility ROM.

MRM's E00 DFS is very close to the standard, with the exception of the two restrictions mentioned earlier. It's not a particularly fast DFS, but if saving user RAM really is your prime concern, then it may be worth considering.

The BBC B+ is supplied with the new Acorn DFS 2.0. This includes the *FORMAT and *VERIFY commands. In addition, extra commands are provided including *FREE, *MAP and *FROMS. Acorn have given no indication as to when this will be available for BBC B owners.

As for the double-density systems, you're much more likely to encounter compatibility problems with certain protected discs (a number of Acornsoft games, for example). These may constitute a small percentage of available disc software, but if there are one or two specific programs which you simply must be able to use, be sure to check that they will run on any DFS you have in mind.

If you can live with this restriction, then any of the double-density filing systems offers particularly good value, in terms of cost per byte of disc storage. There's virtually nothing to choose between the Watford or Viglen DDFSs, apart from price. However, in spite of no built-in disc sector editor, for my money, the Opus DDOS stands out on two counts. First, it has a greatly increased capacity of 248 files per disc, and second, it's the fastest of all disc systems reviewed.

A couple of recent developments in the Acorn camp are of particular relevance to prospective or existing DFS users.

Any new disc interfaces supplied by Acorn dealers should now include a new software chip, the DNFS. This is a 16k ROM which incorporates two filing systems: DFS 1.2, and the network filing system, NFS 3.6. As the chip comprises two separate filing systems, the initial value of PAGE is set at &1B00, as opposed to &1900.

Version 1.2 is the latest DFS release for a considerable time, and is now to be regarded as the new standard disc filing system. Its most notable advantage over its predecessors is that it's faster, due to reduced disc head loading/unloading during disc operations. Unfortunately, I was not supplied with a DNFS ROM for evaluation in time for the review.

Existing DFS users who wish to upgrade to the DNFS can buy just the ROM

for £20.60 (inc VAT) from any Acorn dealer. (At present, Acorn do not offer a trade-in on existing Acorn DFS ROMs.)

A more radical Acorn development, the ADFS (Advanced Disc Filing System), is already available as an integral part of the Electron's Plus-3 disc expansion unit (see *Acorn User*, page 9, March '85). The ADFS adopts a hierarchical tree-structure for directories, which allows far more files per disc than the existing DFS (see the explanatory article on page -31, *Acorn User*, April '84). Furthermore – at least in the case of the Electron – the system supports both single and double-density discs.

There's every chance that any new BBC model C' will incorporate the ADFS, and that it will be possible to upgrade on the BBC B+ to the ADFS. Existing BBC micro owners may well also be given the chance to upgrade, using a plug-in extension board. We'll just have to wait and see – Acorn is saying nothing yet.

Clearly there are exciting developments afoot, and the DFS ROM market promises to be an interesting and hotly-contested one for quite a long time to come.

SUPPLIERS

Acorn DFS any Acorn dealer.
Watford DFS and DDFS Watford Electronics, 250 High Street, Watford.

E00 DFS MRM, 17 Cross Coates Road, Grimsby, South Yorks.

Opus DDOS Opus Supplies, 55 Orm-side Way, Holmethorpe Industrial Estate, Redhill, Surrey.

Viglen DSDFS Viglen Computer Supplies, Unit 7, Trumpers Way, Hanwell, London W7 2QA.

	Acorn DFS	Watford DFS	E00 DFS	Watford DDFS	Opus DDOS	Viglen DSDFS
Version no.	0.98	1.41	1.20	1.52	3.12	1.00
Single density	●	●	●	●	●	●
Double density				●	●	●
EPROM size	8k	16k	8k	16k	16k	16k
Maximum files open	5	5	4	5	5	5
Page (hex)	1900	1900	E00	1900	1900	1900
Maximum files/disc	31	31/62	31	31/62	31/248	31/62
Format in EPROM		●		●	●	●
Verify in EPROM		●		●	●	●
Disc editor		●		●		●
Price (inc VAT)						
EPROM only	—	£20.70	£24.95	—	—	—
Full upgrade kit	£105 approx	£102.35	—	£97.75	£99.95	£129
Kit if bought with drive(s)	—	—	—	—	£79.95	£105

Table 5. Comparison of various DFS features