Support Group Application Note
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CD ROM Drives and their Handling under RISC OS Explained

This Application Note details the interfacing of, and protocols underlying, CD ROM drives and their handling under RISC OS.

Applicable Hardware : All Acorn computers running RISC OS 3.1 or greater

Related Application Notes: 266: Developing CD ROM products for Acorn machines
269: File transfer between Acorn and foreign platforms

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Introduction

Considering the amount of data which has to be stored in today's Multimedia applications (especially those incorporating moving video clips) it is often impractical to distribute the software as a set of floppy discs. For this reason, CD ROM is becoming an increasingly popular distribution medium. Even with the high storage capacity (typically 600 MB) of this medium, however, it is often necessary to feed the raw data through a compression system in order to fit it all on the disc.

This application note aims to explain the terminology, interfacing, and current capabilities of CD ROM drives and their respective data standards, along with details of their software interfacing to RISC OS. Further data on other multimedia capturing and rendering devices, and associated data compression standards, is available in other supporting Application Notes.

Interfacing CD ROM drives

Currently, there are four ways of connecting a CD ROM drive to an Acorn computer. These are:

SCSI: Currently the most popular method. SCSI (Small Computer Systems Interface) is an industry-standard peripheral bus, which can move data around in parallel 8-bit chunks. More recently, SCSI 2 has begun to emerge as a standard on high-end systems, giving an effective near-doubling of data transfer speed. The SCSI bus standard allows up to 7 peripheral devices to be connected to the same bus; if you plan to have more than one CD ROM drive on a given machine, SCSI is the recommended option. The fastest SCSI cards available for Acorn machines can transfer data at a sustained 3.5 MB s^{-1} or so. Acorn SCSI interfaces can be fitted to the Archimedes 300 and 400 series, the R140, A5000 and the Risc PC; the Archimedes 540 and R260 were supplied with a SCSI card as standard. The Acorn card supports ANSI X3.131 1986 and CCS X3T9.2/85-52 Revision 4B of the SCSI standards; check with your drive supplier for compatibility.

IDE: The emerging standard for hard drive interfaces in desktop computers, with the exception of specialised workstations (which mostly use SCSI 2). A number of CD ROM drives equipped with IDE interfaces have been released onto the market, and it is one of these devices which is fitted in the Risc PC 600 CD. As IDE only supports a maximum of two peripheral devices on its data bus, it is only possible to have one IDE CD ROM drive if you already have an IDE hard disc. Bus data transfer speeds are on a par with SCSI 1. Suitable IDE interfaces are fitted as standard to the A4000, A5000 and Risc PC. Although the A3020 also has a suitable interface, cable length limitations imposed by the IDE timing specifications mean that a secondary interface must be used, as the physical size of the A3020 case requires that the drive be housed externally.

Parallel: On Acorn machines equipped with a bidirectional parallel port (these machines being the A3010, A3020, A4000, A5000 and Risc PC), it is possible to interface a CD ROM drive to this port, and use a modified set of drivers to access the drive. The hardware interface between the drive and the computer usually has a "straight-through" parallel connector on it in addition to the CD ROM drive connector, so that a printer may be attached to the computer at the same time. The speed by which signal state can be changed on these lines is sufficiently high that data can be transferred at speed roughly equivalent to a SCSI 1 interface.

Proprietary: Some third party vendors have developed proprietary interfaces for connecting CD ROM drives; the relevant third party should be contacted directly for the latest details regarding data transfer speeds and the number of drives which can be connected via such an interface.

Features of CD ROM Drives

Speed

In all cases of data transfer between peripheral and computer, there is always a "bottleneck," where one part of the system places a fundamental limit on the rate of data transfer. In the case of hard drives, the bottleneck is often the bus interface; this certainly became the case with fast, cached SCSI drives, hence the advent of SCSI 2. In the case of CD ROM drives, however, the physical mechanism of the CD ROM drive is the limiting factor.

The first CD ROM drives were capable of a data access rate of 150K s^{-1}; when compared with the bandwidth sustainable by the SCSI bus, for example, this is very slow. Successors to these drives were classed as "double speed," and implemented such techniques as read-ahead cacheing, increased disc rotation speed and multiple read heads to achieve 300K s^{-1} transfer. Subsequent refinements have resulted in "quad speed" drives, capable of 600K s^{-1}; these are currently the state of the art, but still have a transfer rate well below the bus bandwidth of SCSI or IDE.

Sessioning

A CD ROM drive may be described as either "single session" or "multi-session." This distinguishes the capability of a drive's control logic to access multiple catalogues for different parts of the disc, as they were laid down at the time of mastering. As CD is a "write-once" medium, it is not possible to produce a file catalogue, write the files and catalogue to the disc, and then go back to the disc and add some more files without adding a complete new catalogue after the end of the previously written data to cater for the data being appended; in this circumstance, a "single session" drive would only be able to read the data defined in the first catalogue. Most modern drives are multi-session, but it is always wise to check with the supplier.

Audio Output

Most CD ROM drives are capable of outputting audio information extracted from Red Book Mode 0 (*q.v.*) CDs; this output is usually presented either at a mini-jack on the CD ROM drive suitable for driving a pair of 35 Ohm (input impedance) headphones, or (in the case of a drive fitted with an audio mixer board) on a header plug to feed into the unfiltered external audio output on the computer, or both. In the case of the Risc PC, the header plug can be fitted onto link LK14; this will also allow audio to be produced via the internal speaker.

The quality of sound output from Red Book CDs by the CD ROM drive is determined solely by the Digital to Analogue Converters (DACs) built into it. In the case of White Book (*q.v.*) CD ROMs the audio is converted by the DAC unit on the appropriate expansion card fitted to the computer, and in the case of CD ROMs containing Replay movies or other application-based samples, the audio is converted by the on-board sound system. In all base configurations, the on-board sound system is built around an 8 bit logarithmic DAC, which gives sound output quality, after filtering, roughly equivalent to a 12 bit linear system. The Risc PC, however, may easily be upgraded to a true 16 bit linear audio system, giving CD quality reproduction. Audio upgrades for earlier machines are available via third parties.

CD ROM formatting standards ("Coloured Books")

Red Book
This is the formatting standard which covers "ordinary" audio CDs, and is defined by Philips and Sony. Dedicated audio data is recorded as CD-DA (Compact Disc Digital Audio) in PCM (Pulse Code Modulated) format. Red Book is the standard upon which all subsequent CD ROM standards are ultimately based.

Red Book divides the disc into one or more audio tracks; each track normally comprises a single "track" in the musical sense. These tracks are further divided into sectors (also known as frames); each sector contains sufficient data to supply 1/75 second of music, which at the standard CD digitising rate of 44.1 kHz, works out as 2352 bytes.

In addition to the 2352 bytes of audio data, Red Book provides two levels of error detection code (EDC) and error correction code (ECC) for each sector; if part of a sector cannot be read for some reason, the ECC can be used to reverse-engineer the data. Further to EDC and ECC, 98 control bytes are added to each sector; these bytes contain such information as timing data to enable an audio CD player to display the track playing time.

All CD ROM drives which are compatible with Acorn machines are capable of playing Red Book audio via their own DACs, although most drives cannot allow the computer to "read" CD-DA directly. Acorn's CD ROM Filing System (CDFS) has facility to direct a drive to play a Red Book CD; either the appropriate CD ROM drive icon can be clicked on when the disc is loaded to start it playing from the beginning of the first track, or appropriate *commands may be passed to cause the drive to play a given section of audio (see the CDFS section below)

Yellow Book
This is the first set of standard definitions which detail the use of CDs to store computer data. Yellow Book is based on Red Book, and indeed Yellow Book Mode 0 supplies the same functionality as Red Book.
The Yellow Book standard defines three data modes; CDFS is capable of handling all three, although not all CD ROM drives are capable of handling them all. A CD containing tracks consisting of more than one mode is termed a "mixed-mode CD."

Mode 0: This mode is used to store CD-DA in PCM format. Most drives cannot "read" this data digitally and pass it to a computer, only play it.

Mode 1: This mode is used to store data, and is the normal mode which data is stored in. The Red Book 2352 byte data area is split as follows:

12 bytes of synchronisation
4 bytes of header information
2048 bytes of user data
4 bytes of EDC
8 bytes of blanks
276 bytes of ECC

Mode 1 has an additional layer of ECC, which is included to provide the increased reliability required to store computer data. This mode has an uncorrectable error rate of 1 x 10^{-12} (ie one bit in every 200 CD ROMs). As drives are capable of re-reading the data and correcting the information, the data is hardly ever totally unreadable.

Mode 2: This is another data mode, designed particularly for storage of video picture data and compressed audio data. Mode 2 is used where the primary concern is density of data storage; by sacrificing most of the error correction capability, a Mode 2 disc can store 14% more user data than a Mode 1 disc. A 2352 byte sector is subdivided into:

12 bytes of synchronisation
4 bytes of header information
2336 bytes of user data

The extended error correction codes are missing from this mode so the error recovery is not as good; the uncorrectable error rate is 1×10^{-9}. This mode is not used as often as Mode 1.

In all these modes, data is referenced by its position on the disc in units of minutes, seconds and frames; a frame is a Philips-defined time unit equivalent to 1/75 s.

Mixed Mode discs
As Red Book and Yellow Book use the same underlying sector size, it is possible to produce "mixed mode" discs containing both computer data and CD audio. The most common layout for a mixed mode disc is to have the first track as Yellow Book Mode 1 data, and the remaining tracks as Red Book PCM audio. The two most common methods used in Mixed Mode applications are:

a) To initially load the program into the computer and run it, and then allow the computer to have continuous access to the audio tracks. The limitation with this scheme is that sufficient free RAM must be available for the computer to load all of the application executable and its associated data.

b) To alternately read in portions of executable code and audio data. This relieves the memory constraint above, but entails more track seeking for the CD ROM drive and hence slower operation.

CD ROM /XA (PhotoCD)
This is a further extension of Yellow Book Mode 2. CD ROM /XA is distinct from Yellow Book Mode 2 in that it is specified as suitable for *computer data*, video data and compressed audio data. To do this, CD ROM /XA defines a new track format; an 8 byte subheader is included in the 2352 byte sector, so the sector takes the layout:

12 bytes of synchronisaton
4 bytes of header information
8 bytes of subheader information
2048 bytes of user data
4 byted of EDC
276 bytes of ECC

CD ROM /XA is also known as Mode 2 Form 1; a slightly modified form of this (to allow discs to be read by Philips CD-i machines) is is the standard layout used in the Kodak PhotoCD system, hence CD ROM / XA is readable by Acorn CDFS 2.21. A further iteration of CD ROM /XA, Mode 2 Form 2, also exists; like Yellow Book Mode 2, this omits the ECC, and hence is rarely used.

When compared to Mixed Mode discs, it is very important to note that a Mixed Mode disc is *unable* to access both computer data and audio simultaneously; data of different types must be on separate tracks. CD ROM /XA allows heterogeneous data types to be interleaved within the same track, hence allowing simultaneous access to executable code and audio; this is the principal advantage of this format.

Green Book
This is a proprietary standard used by Philips for encoding computer data, compressed audio and moving video (MPEG) CD ROMs for use with their own CD-i system. Currently, Acorn systems cannot access Green Book CD ROMs.

White Book
This is the new "Open Standard" for storage of digitised video. White Book discs use ISO 9660 (*q.v.*) filenames; the main thrust of the White Book standard is to produce an explicit file hierarchy and filename set, compliant with ISO 9660, into which all video data can be fitted.

Moving video data distributed using the White Book standard can be accessed by CDFS; however, the movies can currently only be played at a suitable frame rate using the Movie Magic card (available from Computer Concepts) and a modified version of Acorn Replay. This modified version of Replay, supplied only with the card, does not incorporate movie-decoding capability within itself, but acts as the user interface to pass the movie data direct to the C-Cube CL450 MPEG decoder chip on the Movie Magic card.

CD ROM data storage standards

High Sierra
This is the earliest standard format utilised by CD ROM for storing computer data in a hierarchical file structure. It has generally been superseded by ISO 9660, which itself evolved from an enhanced High Sierra standard. In addition to ISO 9660, CDFS is able to read most High Sierra CD ROMs.

ISO9660
This has become a de-facto standard as a logical format for information storage and retrieval. The standard defines a hierarchical filing structure for both files and directories. In order for all CD ROM supporting computers to be able to map the names of the files on the CD ROM to their own filing systems, file and directory names on ISO 9660 discs are restricted to:

Capital letters "A-Z"
Digits "0-9"
Underscore "_"

ISO 9660 Level 1 interchange format also restricts the naming system to:

Filenames: Maximum of 8 characters
Filename extensions: Maximum of 3 characters
Directory names: Maximum of 8 characters (no name extensions permitted)

To cater for RISC OS applications, which always exist in a directory beginning with a pling "!", CDs destined specifically for Acorn platforms are mastered with the initial pling replaced by an underscore. When accessing the directory structure of such a CD ROM, CDFS looks for any directories with names beginning with an underscore, and maps this underscore to a pling "on the fly" and before presenting the filer display to the user. Investigating such a CD ROM on another platform will therefore result in application directories being displayed with an initial underscore, and not a pling.

PhotoCD (Image Pac)
PhotoCDs are recorded in CD ROM /XA Mode 2 Form 1 format. Most of the disc is taken up by files containing picture data stored in Photo YCC, which is a Kodak-devised colour encoding metric. Each discrete image is stored 5 (or, exceptionally, 6) times on the disc at different resolutions; the copies of each

image, once they have been fed through a visually-lossless Kodak compression system, form an Image Pac. The Acorn PhotoCD viewer application (!PhotoView) opens the Index on a PhotoCD, which contains the smallest image from each Image Pac, in order to build a contact sheet; when a picture is selected, the appropriate resolution of YCC image is selected from the Image Pac and rendered. Each Image Pac contains scans at the following resolutions:

Base / 16 (thumbnail resolution)	128 x 192
Base / 4	256 x 384
Base (TV resolution)	512 x 768
BaseX4 (HDTV)	1024 x 1536
BaseX16 (photographic)	2048 x 3072
BaseX64 (photographic)	4096 x 6144 (Pro Master PhotoCD only)

PhotoCDs can be produced from ordinary 35mm slides or photographic negatives; in addition to mastering facilities provided by some high-street photographic processors, Kodak has set up a number of image transfer bureaux dedicated to producing PhotoCDs in quantity for the commercial market; these are listed in Appendix B.

Others
As detailed above, High Sierra, ISO 9660 and PhotoCD CD ROMs based on Yellow Book or CD ROM / XA can currently be accessed by Acorn machines, and CD ROM drives fitted to Acorn machines can play audio CDs which conform to the Red Book standard.
Other formats also exist; Apple have a proprietary format (essentially, Yellow Book Mode 1 with their own HFS filing system on top instead of ISO 9660) which is used to produce CD ROMs for their hardware, and high-end dedicated workstations use further specialised formats such as RockRidge. There are also discussions to extend the ISO 9660 standard to cope with higher-capacity CD ROM discs which are under development.

Currently Apple-formatted and RockRidge CDs cannot be accessed using Acorn hardware, and the extended ISO 9660 format has yet to be finalised. More detail on ISO 9660 Levels 2 and 3, and the extended standard once it becomes available, may be obtained from the British Standards Institute; see Appendix C for further details.

CDFS and CD ROM Drivers

Supported Drives
Most CD ROM drives support a common subset of fundamental commands for standard low-level operations. However, for more complex functions, particularly when accessing discs formatted to standards other than Red Book Mode 0, command sets differ between drives; this necessitates that each CD ROM drive have a driver module written for it to interface correctly to CDFS. The difference in command sets is most graphically illustrated by the fact that only some drives are capable of handling PhotoCD.

Drivers are currently available from Acorn for the following SCSI CD ROM drives:

Sony	CDU6111, CDU6211, CDU541, CDU561
Philips	CM131, CM231
Toshiba	XM2200A, 3301
Hitachi	CDR1650S, CDR1750S
Chinon	CDS-431

In addition, there is a modified version of the Sony driver, available via Acorn dealers, which will interface to the Apple CD-300.

PhotoCD support is included with this modified Sony driver (the Apple drive is PhotoCD capable), and with the Sony driver (the CDU561 is PhotoCD capable).

The IDE drive available for the Risc PC is a Panasonic CR 562B unit. This is a dual-speed PhotoCD capable drive, and is supplied with its own driver to enable CDFS to access the IDE interface.

Other software drivers, and CD ROM drives, are available from third parties; please refer to Appendix A for more details.

CDFS appears to the user as an ADFS-like filing system, and supports many of the standard FileCore-compliant commands. In addition, CDFS has a number of commands unique to itself: details of these follow:

***CDDevices** displays all the CD devices connected, their product name, capacity, SCSI ID (displayed as device, Logical Unit Number, and card) and firmware revision.

***CDFS** selects the CD-ROM filing system as the current filing system.

***Configure CDROMBuffers** sets the configured amount of memory reserved for CD-ROM buffering (maximum 512K).
Syntax: *Configure CDROMBuffers <size>K

***Configure CDROMDrives** sets the configured number of CD-ROM drives recognised at power on.
Syntax:*Configure CDROMDrives n

***Eject** activates the eject mechanism (where possible) in the CD ROM drive; this will eject any disc caddy present in the drive if it is a caddy type, or open the loading tray on a non-caddy drive.
Syntax: *Eject [drive]

***Lock** prevents a CD being ejected from the drive, effectively disabling *Eject.
Syntax: *Lock [drive]

***PlayList** lists the tracks - whether audio or data - on the disc in the given CD-ROM drive, together with (on Red Book CDs) their start time and the total CD time.
Syntax:*PlayList [drive]

***PlayMSF** plays a piece of audio from the disc in the given CD-ROM drive. The start and stop times are specified in minutes, seconds and frames from the start of the disc.
Syntax:*PlayMSF mins:secs:frames mins:secs:frames [drive]

***Stop** stops playing the disc in the given CD-ROM drive.
Syntax:*Stop [drive]

***Unlock** reverses the effect of *Lock, re-enabling the functionality of *Eject.
Syntax: *Unlock [drive]

To configure the number of CD-ROM drives, type:

*Configure CDROMDrives n

where n is the number of drives (from 0 to 28).

You will need to configure the size of the CD-ROM buffers, especially if you expect to be using a variety of CDs. Type:

*Configure CDROMBuffers [size]K

where size represents the size of the buffers in K, a number in the range 0-512. 64K or 128K is a good starting buffer size.

Important: Incorrectly setting the number of drives causes the boot up procedure to take longer.

Some Information on Driver Modules

Owing to the differences in command syntax and availability between the different supported CD ROM drives, CDFS does not communicate with a drive directly; it translates user-level calls into a series of SWI calls which are passed to an abstraction layer. This layer is in turn implemented by the driver module, which is responsible for interfacing to the firmware on the drive. As an example of what goes on at the abstraction layer level, the SWIs provided by the Toshiba driver are:

cd_checkdrive	
cd_control	
cd_converttolba	(logical block addressing)
cd_converttomsf	(Minutes, Seconds and Frames)
cd_discused	
cd_driveready	
cd_drivestatus	
cd_inquiry	
cd_lasterror	
cd_opendrawer	
cd_prefetch	
cd_readdata	
cd_reset	
cd_seekto	
cd_stopdisc	
cd_version	
cd_identify	
cd_register	
cd_unregister	

Clearly, the task of writing a CD Driver module is not a trivial one; the command set above, for example, does not cover the PhotoCD extensions. Registered Developers wishing to develop CD ROM drivers should, at the outset, contact Acorn Developer Support.

Multiple Drives on Different Interfaces
It is possible to have multiple CD ROM drives connected using different interfaces; althouh as a rule it is not possible to have multiple SCSI interfaces in a given machine accessing CD ROM drives, it is perfectly acceptable to have both a chain of SCSI CD ROM drives and (for example) a CD ROM drive connected to an IDE interface (where fitted). What actually happens at boot-up is that the driver software, comprising a version of CDFS and copies of the relevant driver modules, for each interface loads in a sequence. The ordering of the sequence is determined by whether the code is on a podule ROM (in which case it loads first), or whether it is in the normal boot sequence, in which case it loads in the order specified. As is normal with relocatable modules, loading of multiple instantiations of a module causes successive overwrites, such that the version of the module which remains loaded once the boot sequence is complete is the last copy of the module to be explicitly loaded.

Once loaded, the specific device driver modules remain loaded throughout the boot sequence, unless subsequently overwritten. When CDFS (version 2.20 or later) executes, it polls the loaded modules to check for the presence of a preamble sequence unique to a CD ROM driver module; if this is present in a given module, that module is invited to register with CDFS. Thus the last-loaded version of CDFS can recognise and interface with all the device-specific modules containing the preamble which were made available during a boot sequence, and hence drive any suitably connected CD ROM drive regardless of the physical interface. It is worth noting, however, that some early third-party driver modules did not have the correct preamble present, and therefore may produce unexpected results when interfacing to a current version of CDFS; if an interface which appears to have a suitable driver module refuses to interface with CDFS, contact the supplier of the driver module quoting the version number of the driver module in question and the version of CDFS.

Accessing Data on CD ROMs Produced for Non-Acorn Hardware

One of the main benefits of standards such as ISO 9660 and the Coloured Books is that, provided you have a driver capable of reading these formats it should be possible to access data intended for use on other platforms.

However, although the raw binary data can be accessed, it is not necessarily possible to make use of it. The likely possibilities are that files of common formats, such as plaintext and graphic formats of types translatable by !ChangeFSI, can be used; also Comma-separated variable (CSV) and Tab-separated variable (TSV) files can be used in Acorn-native applications which are specified to be able to read them. In addition, some third-party programs which perform file compression (eg !SparkFS from David Pilling and !ArcFS from VTI) can recognise and decompress a number of file archives of certain standard formats, eg UNIX tar. If you have such a program, it is worth checking on the formats it understands.

Problems arise when custom filetypes or proprietary codecs are used in the software on the disc; as RISC OS cannot execute the binaries for the decompressors / translators in the manner of the platform they are intended for, it is not possible to extract and make use of files encoded in these ways purely using RISC OS. As some discs use proprietary codecs and others do not, Your Mileage May Vary; if you plan to extract data from a disc designed for another platform, check with the supplier of the disc that the data is in a format you can make use of. Acorn Customer Services Application Note 269 gives further detail on file transfer and translation.

Troubleshooting

In the case of CD ROM drives, it is fortunate that only a relatively small number of problems can arise, and none of these are fatal to the data medium. Perhaps the most common problems are:

A SCSI CD ROM drive reports a target error on access:
There are several reasons for this behaviour, and it is not possible to determine the root cause without examining the machine in question. Reasons for this mode of failure are:

The SCSI bus is incorrectly terminated. Make sure that a pack of terminating resistors is present on both the first and last devices on the SCSI chain (the SCSI card will itself need to be terminated if it is in such a position), and nowhere else.

Two or more SCSI devices have clashing device numbers. This can be diagnosed by issuing a *Devices command, and seeing if any of the returned descriptions appear at odds with the known types and sizes of peripherals on the bus. It is recommended practice, when only one or two CD ROM drives are present on the bus, to start numbering them from Device 6 and move upwards from there.

The installed version of CDFS, or one of its dedicated drivers, is out of date. If a CD ROM drive responds correctly to a *Devices, and if it returns an apparently correct disc size using *Free when a CD ROM has been inserted, it is possible that the drivers are out of date. Contact the supplier of the driver for more details, stating the version numbers of both the driver in question and CDFS itself.

!PhotoView reports an error "CDFS::0.$.PHOTO_CD.OVERVIEW/PCD not found":
!PhotoView is not finding the file containing the index information for the pictures on the PhotoCD. First check that you have a PhotoCD in your drive. Corel Professional PhotoCDs do not have an Overview file on the disc; individual Image Pacs may, however, be accessed using !ChangeFSI. If your PhotoCD is not a Corel disc and the Overview file cannot be found, consult your PhotoCD's supplier.

CD ROM access appears to be very slow:
Remember that CD ROM drives are not high access speed devices! If access is exceptionally slow, try increasing the buffer size allocated to CDFS. The "Configure" submenu accessible from the CD ROM icon bar menu facilitates this.

Appendix A: Useful Contacts

For SCSI, IDE, Parallel and Proprietary CD ROM drives, interfaces, and CDFS Drivers:

Morley Electronics Limited
Morley House
West Chirton Industrial Estate
North Shields
Tyne and Wear
NE29 7TY
Tel: 091 257 6355

Alsystems
47 Winchester Road
Four Marks
Alton
Hampshire
GU34 5HG
Tel: 0420 561111

Beebug Ltd
117 Hatfield Road
St Albans
Herts
Tel: 0727 840303

Computer Concepts
Gaddesden Place
Hemel Hempsted
Herts
HP2 6EX
Tel: 0442 63933

For MPEG rendering hardware (the Movie Magic card):
Computer Concepts (address above)

For Compression and Decompression software:

David Pilling
PO Box 22
Thornton
Cleveleys
Blackpool
FY5 1LR

VTI
The Shopwhyke Centre
Shopwhyke Road
Chichester
West Sussex
PO20 6GD

Appendix B: PhotoCD Mastering Bureaux

UK commercial transfer services, sponsored by Kodak:

Acorn Studios PLC	Tel: 071 837 8667
B & S Visual, Glasgow	Tel: 041 221 8283
Dunn's, Birmingham	Tel: 021 200 3226
Grant's, Dublin	Tel: (from UK) 010 353 1 660 4288
Laserbureau, London	Tel; 071 486 9260
Pro-Vision Digital Imaging	Tel: 0532 454848
Quadrant, Worcestershire	Tel: 0527 71648
Tapestry, London	Tel: 071 437 1821
Wace Group, London	Tel: 071 739 0269

Appendix C: Standards Documents

For copies of the CD ROM Coloured Book (Red, Yellow and White) standards, and SCSI standards:

BSI Standards
Linford Wood
Milton Keynes
MK14 6LE

Tel: 0908 221166