

**MultiRead Specifications  
for CD-ROM, CD-R,  
CD-R/RW and DVD-ROM Devices**



**MultiRead**

**Revision 1.11**

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## ABSTRACT

This specification defines the MultiRead Specification for a MultiRead device. The applicable clauses of this specification containing the word “**shall**” are the requirements to be MultiRead compliant. The Annexes are part of this document but are not required for compliance.

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## Purpose

The purpose of this document is to specify the compatibility requirements of a MultiRead device (see Definitions and Terms below) working with computer operating systems. It is intended as a specification for CD and DVD Drive Manufacturers, Personal Computer Manufacturers and Operating System Software Developers. MultiRead (MR) is the ability of any drive to read all of the following types of media: CD-DA, CD-ROM, CD-R and CD-RW.

Developers of CD discs and drive products have Red, Yellow, Orange Books and other related documents. However, PC manufacturers and software developers normally do not have these documents. This document is provided to help alleviate the need to purchase these specifications in order to specify MultiRead requirements. Additionally many producers of CD-ROM and DVD-ROM devices have requested guidance and clarification of the MultiRead compatibility requirements as a summary of the many specifications available. These companies have provided their expert advise and a number of very important ideas have been included within this specification.

This specification describes the complete device requirements of the MultiRead Specification. It covers logical device and physical requirements for a MultiRead device. This includes CD-DA, CD-ROM, CD-R and CD-RW disc requirements.

## Related Documents

Other industry standards and specifications were reviewed and consulted in the development of this specification. They are directly related to Compact Disc-Digital Audio (CD-DA), Compact Disc-Read Only Memory (CD-ROM), Compact Disc-Recordable (CD-R), and Compact Disc-ReWritable (CD-R/RW and CD-RW) and Digital Versatile Disc-Read Only Memory (DVD-ROM) devices. These documents include:

ANSI X3T10-1048D-MMC	SCSI Multimedia Commands, Version 9.0 or higher.
ATAPI SFF 8020i	ATA Packet Interface for CD-ROMs, Version 2.6 or higher.
ATAPI SFF 8080	ATA Packet Interface for CD-R/RW Devices, Version 1.2 or higher.
ATAPI SFF 8090	ATA Packet Interface for DVD-ROMs, Version 0.99 or higher.
IEC 908:1987	Compact Disc Digital Audio System Description (Philip and Sony Corp. Red Book).
ISO 9660:1988	Information Processing - Volume and File Structure of CD-ROM for Information Interchange.
ISO/IEC 10149:1993	Information technology - Data Interchange on read-only 120mm optical data discs (CD-ROM based on the Philips and Sony Corp. Yellow Book).
ISO/IEC 13346:1995	Volume and File structure of Write-Once and ReWritable Media using Non-Sequential Recording for Information Interchange.
Multisession Compact Disc Orange Book Part-II	Multisession for CD-ROM and CD-R discs, Version 1.0 or higher.
Orange Book Part-III	Recordable Compact Disc System Part-II, Philips and Sony Corp., Version 2.0 or higher.
Orange Book Part-III	ReWritable Compact Disc System Part-III, Philips and Sony Corp., Version 1.0 or higher.
OSTA UDF	OSTA Universal Disk Format, including support for CD-ROM, CD-R and CD-R/RW and DVD-ROM devices, Version 1.5 or higher. OSTA UDF is also called UDF.

## Terms

May	Indicates an action or feature that is optional.
Optional	Describes a feature that may or may not be implemented. If implemented, the feature <b>shall</b> be implemented as described.
<b>Shall</b>	Indicates an action or feature that is mandatory and must be implemented to claim compliance to this specification.
<i>Should</i>	Indicates an action or feature that is optional, but its implementation is strongly recommended.
Reserved	A reserved field is reserved for future use and shall be set to zero. A reserved value is reserved for future use and shall not be used.
or higher	Applies to version of standards, specification or documents that include a version number. It implicitly applies to any version number. New versions which conflict with older versions are exceptions which would require an update of this MultiRead Specification.
Drive/Device	For the purposes of this document the words, drive and device are used interchangeably.

## Scope

This document defines the MultiRead Specification. MultiRead is the ability of any drive to read all of the following types of media: CD-DA, CD-ROM, CD-R and CD-RW.

A MultiRead drive **shall** support different media reflectivity's.

A MultiRead drive **shall** be capable of reading all User Data Blocks on CD-ROM, CD-R and CD-RW media.

A MultiRead drive **shall** pass the contents of the User Data Blocks unmodified to the drive interface. The scope of this document is:

- 1) To specify requirements to promote data interchange in a conforming MultiRead drive.
- 2) To define important parameters such that a conforming MultiRead drive **shall** be capable of reading all User Data Blocks on CD-ROM, CD-R, and CD-RW media.
- 3) To require that a conforming MultiRead drive **shall** be able to read and play, Audio Tracks and CD-DA discs.

MEDIA		CD-ROM Drive	CD-R Drive	CD-R/RW Drive	DVD-ROM Drive
M	CD-DA Disc	YES	YES	YES	YES
E	CD-ROM Disc	YES	YES	YES	YES
D	CD-R Disc	YES	YES	YES	YES
I	CD-RW Disc	YES	YES	YES	YES
A					

## Examples of MultiRead Device Types

YES - A MultiRead drive shall read this medium.

## Revision History

Revision 0.50 - Initial Version. 08 Oct 1996  
Revision 0.60 - Second Version. 18 Oct 96  
Revision 0.70 - Third Version. First public version. 31 Oct 96  
Revision 0.80 - Fourth Version. Ray Freeman's administrative changes. 13 Nov 96  
Revision 0.90 - Fifth Version. Final draft for public review version. 06 Feb 97  
Revision 0.91 - Sixth Version. Removed CD-R media for public review version. 28 Feb 97  
Revision 0.92 - Seventh Version. Added CD-R media back, added playing CD-DA back from the MR subcommittee meeting, and the marked changes approved during the first public review 21 Mar 97  
Revision 0.93 - Eighth Version. Added additional document clarifications and Blanked definition. 25 Mar 97  
Revision 0.94 - Ninth Version. Added Toshiba's comments on Method 1 Addressing for Fixed Packets. Added Sony's comments on document clarification. 02 Apr 97  
Revision 0.95 - Tenth Version. Moved Part 1 to Annex A per MR ad hoc meeting on 01 Apr 97. 11 Apr 97  
Revision 0.96 - Eleventh Version. Added Section 1.8 and Annex F on testing per MR ad hoc meeting. 18 Apr 97  
Revision 0.97 - Twelfth Version. Additional document clarifications. 21 Apr 97  
Revision 0.98 - Thirteenth Version. Added Ricoh, Sony and HP clarifications, removed Blanked definition. 20 May 97  
Revision 1.00 - Fourteenth Version. Added clarifications from OSTA MR subcommittee meeting. Removed Annex D - Illegal Discs and F - Simplified Logo Verification Process. 10 June 97.  
Revision 1.10 - Fifteenth Version. Removed requirement to read "identify" Disc and Section at once discs in Section 1.1.2 and limit this identification to CD-R and CD-RW discs. Added requirement for reading a CD-R disc with Fixed Packets in Section 1.2. Added clarification of session requirements to Section 1.6. Added Method 2 Addressing clarifications.  
Revision 1.11 - Sixteenth Version. Added NEC HE clarifications in Section 1.3.2, in Section B.1, and in Section E.2.1.

It is anticipated that this specification may be updated periodically in response to technological advances.

## Definitions, abbreviations and symbols

Certain words and terms used in this specification have a specific meaning beyond the normal English meaning. These words and terms are defined either in this section, in Terms above, or in the text where they first appear. Lowercase is used for words having the normal English meaning.

### Definitions

**Absolute Time In Pre-Groove (ATIP)** - A 22.05 Khz wobble that is FM-modulated with time information.

**Audio Track** - A Track that contains CD digital audio information according to the Red Book.

**Blank Disc** - Only the ATIP is present; no Eight to Fourteen Modulation (EFM) or EFM data mode zero is recorded on a CD-R or CD-RW disc. See Red Book for details on EFM.

**Block** - Normally the same as a complete CD Sector, 2352 total bytes.

**Compact Disc (CD)** - Generic class of all devices that conform to the Red Book specification. See IEC 908:1987.

**Complete Session** - A Session that contains a written or stamped Lead-in and Lead-out as well as the Program Area.

**Data Track** - A Track that contains Sectorized data according to the Yellow Book.

**Defect Management** - A method to replace Packets which exceeds a defined error threshold to be rewritten (e.g. CD-RW media) to a different area on the disc which does not exceed this threshold.

**Disc at once (DAO) recording** - A recording that completes an entire disc operation in one step, so that no additional data can be recorded, yet the data may be read in any CD device.

**Drive** - An active part of a computer system that contains the mechanisms for spinning a disc and moving a read-write head over the disc surface. (see Terms)

**Finalize** - The process in which the Lead-in and Lead-out areas for a Session are recorded or overwritten with the appropriate Table of Contents (TOC) subcode on the disc.

**Fixed Packet recording** - Recording that completes a Packet which is constant in length. Also the Packet size is encoded in the pre-gap as required by the Orange Book.

**Frame** - A Sector on CD media; or the F field unit of a Minute, Second, Frame (MSF) CD address. The smallest addressable unit in the main channel.

**Incomplete Disc** - A disc in which the last session written does not contain a written Lead-in and Lead-out.

**Lead-in** - The area that contains the Table of Contents (TOC) data and precedes each Program Area. The main channel in the Lead-in area contains audio or data null information. This area is coded as track zero. The Q sub-channel in this area is coded with the Table of Contents information.

**Lead-out** - The area that follows each Program Area. The main channel in the Lead-out area contains audio or data null information. This area is coded as track AA h. The command READ CD CAPACITY's returned data is the first logical block address of the last Lead-out area minus one.

**Link Block** - The first block in a Variable Packet or Fixed Packet.

**Logical Block** - A host addressable CD sector.

**Method 1 Addressing** - An addressing method which has a one-to-one relationship of the logical block number to the physical block number.

**Method 2 Addressing** - An addressing method which provides a contiguous address space within a Fixed Packet written track. The logical block number has a linear relationship to the physical block number.

**Mode** - A type of CD block per the Yellow Book. Mode 1 and Mode 2 Form 1 are the most common for user data.

**Minute, Second, Frame (MSF) address** - The physical address, expressed as a Sector count relative to either the beginning of the medium (absolute) or to the beginning of the current Track (relative). As defined by the CD specifications, each F field unit is one sector; each S field unit is 75 F field units; each M field unit is 60 S field units.

**MultiRead (MR)** - The ability of any drive to read all of the following types of media: CD-DA, CD-ROM, CD-R and CD-RW.



**Orange Book Part-II & Part-III** - Specifications developed by Philips & Sony Corp. to define the requirements to write CD-R & CD-RW discs respectively.

**Packet** - A set of blocks which includes a Link Block, four Run-in Blocks, two Run-out Blocks and User Data Blocks. The number of User Data Blocks in a Packet is called the Packet size.

**Post-Gap** - A transition area at the end of a Data Track .

**Pre-Gap** - A transition area at the beginning of a Data Track.

**Program Area** - It contains the user data. It is made up of one or more User Data Blocks.

**Program Memory Area (PMA)** - Contains information about the recordings on a Writable Disc.

**Read Only Memory (ROM)**- For CD or DVD read only or writer devices, discs that can be read but can not be written.

**Red Book** - A specification developed by Philips and Sony Corp. to define the requirements to read CD-DA discs.

**Run-in Blocks** - Four blocks, blocks 2-5 in a Packet.

**Run-out Blocks** - The last two blocks in a Packet.

**Sector** - It is a unit addressed by a Frame. Data Sectors are also called data blocks.

**Session** - A contiguous area of a disc that contains a Lead-in area, a Program Area, and a Lead-out area.

**Session at once (SAO) recording**- A recording that completes an entire Session operation in one step, however additional data may be recorded, yet the disc may be read in any CD device.

**Sub-Channel** - CD media has a main channel and a Sub-Channel. The Sub-Channel area has eight parts called P, Q, R, S, T, U, V, and W. The Q Sub-Channel contains information very useful to the Drive, such as the control field and MSF addresses. The data rate of each Sub-Channel (P, Q, etc.) is 1/192nd of that of the main channel data rate.

**Table of Contents (TOC)** - The TOC has information describing the type of Session and the starting address of the Track. This information is encoded in the Q Sub-Channel, in the Lead-in area.

**Track** - A logical sub-division of the CD media. Up to 99 Tracks per CD are allowed.

**Track Descriptor Block (TDB)** - Contains information on the attributes of the current Track contained in the Pre-Gap of a Data Track. The TDB is made up of the track descriptor table and the track descriptor unit. The track descriptor unit includes the Track number and the Write Method.

**Track at once (TAO) recording** - Recording where the complete Track must be written without interruption.

**Transition area** - Sectors at the beginning or end of Tracks. (e.g. Pause Area, Pre-Gap, Post-Gap)

**Universal Disk Format (UDF)** - File System developed by OSTA to provide file interchange between different operating systems for optical products including CD-ROM, CD-R, CD-R/RW and DVD-ROM devices.

**User Data Blocks** - Those blocks which contain the user data in a Track or Packet.

**Variable Packet recording** - Recording that completes Packets which may be of various lengths on a given Track.

**Writable Disc** - A disc that is Blank, or contains a reserved track or an Incomplete Session.

**Write Method** - Variable Packet, Fixed Packet and Track at once recording are types of Write Method.

**Yellow Book** - A specification developed by Philips and Sony Corp. to define the requirements of CD-ROM discs.

### Abbreviations and symbols

Numbers that are not immediately followed by lowercase "b" or "h" are decimal values. Numbers followed by lowercase "b" (xxb) are binary values. Numbers followed by lowercase "h" (xxh) are hexadecimal values.

## 1.0 Specifications for a MultiRead Device

This specification provides the complete requirements for developers of a MultiRead device used in computer systems. MultiRead is the ability of any drive to read all of the following types of media: CD-DA, CD-ROM, CD-R and CD-RW.

### 1.1 Logical Disc Requirements

#### 1.1.1 MultiRead Disc Detection, Detection Time and Blank Discs

A MultiRead drive *should*, when the disc is inserted, detect the presence of a CD-DA, CD-ROM, CD-R, or CD-RW disc, read its Table of Contents on a single Complete Session disc within 15 seconds and be ready to process additional drive commands. A MultiRead drive *should* detect a Blank CD-RW or Blank CD-R Disc. Media access commands *should* report BLANK CHECK when a Blank Disc is loaded.

#### 1.1.2 Write Method Requirements

A MultiRead drive **shall** read the following write methods: Track at once, Variable Packet or Fixed Packet for CD-R and CD-RW discs. It may support multiple recording methods per disc. The Track write method (Track at once or Packet) is encoded in the track descriptor unit of the main channel. The track descriptor unit in the Track Pre-Gap **shall** be used by the drive to determine Packet type and Packet size for a Packet recorded disc. (see Annex B)

### 1.2 Requirements for Reading CD-R or CD-RW Packets

A MultiRead drive reading CD-R and CD-RW media **shall** support both Variable Packets and Fixed Packets.

Figure 1.1 shows a 64 KB Packet. The first block is called the Link Block, followed by four Run-in Blocks. Then come 32 User Data Blocks and finally two Run-out Blocks.

Figure 1.1 A 64 KB Packet



#### 1.2.1 Fixed Packet Size Requirements

A Fixed Packet size of 32 User Data Blocks **shall** be supported. Other Fixed Packet sizes *should* also be supported.

### 1.3 Addressing Methods Requirements

A MultiRead drive **shall** support at least one addressing method for Data Track(s) per disc. It may support multiple addressing methods per disc. As previously described, there are two types of Packet written tracks: Variable Packets and Fixed Packets. Both Packet types incur the physical overhead of the blocks between User Data Blocks, however, there is a difference in how blocks in Variable Packets and Fixed Packets are addressed.  
(see Annex E for examples of Addressing Methods)

#### 1.3.1 Packet Addressing Requirements

The addressing method gives the relationship between the logical block address (LBA) and the physical block address (PBA) which is in the block header. However, physically both have the same Minute, Second, Frame (MSF) form. Discs read with Variable Packets **shall** use Method 1 Addressing. Discs read with Fixed Packets **shall** use Method 2 Addressing.

#### 1.3.2 Method 2 Addressing with a Device Driver

Discs read with Fixed packets using Method 2 Addressing **shall** be used in concert with an operating system device driver provided by the MultiRead device manufacturer, when the MultiRead device supports only Method Addressing 1. To provide detection of Packet types by the device driver, either the READ TRACK INFORMATION command or the capability of reading the Track Descriptor Block **shall** also be provided to the operating system device driver by the MultiRead drive.

#### 1.3.3 Method 2 Addressing without a Device Driver

Method 2 Addressing, which is handled completely by the MultiRead device, adds a level of indirection that hides the Link Block, Run-in Blocks and Run-out Blocks from the operating system.

### 1.4 Drive Command Requirements

A MultiRead device **shall** support the X3T10-1048D-MMC Specification (MMC). The ATAPI SFF 8020i Specification (8020), or ATAPI SFF 8080 Specification (8080) or the ATAPI SFF 8090 Specification (8090) may also be supported. Any conflicts regarding these specifications *should* be resolved in favor of the MMC Specification. (see Scope for version numbers of the specifications)

#### 1.4.1 Method 2 Bit Requirements

The Method 2 bit as defined on the MODE SENSE command Page 2A (called CD Capabilities and Mechanical Status Page in the MMC Specification) **shall** be supported.

## 1.5 Read Ahead Caching by the Device Requirements

Read ahead caching may be performed in a MultiRead device and/or in the operating system. A MultiRead drive **shall** return read requests for Link Blocks, Run-in Blocks and Run-out Blocks. However, these requests may normally result in an error. If the drive returns an error, it *should* return MMC or ATAPI SFF read error codes. The drive *should* limit the retry algorithm of read requests to Link Block, Run-in Blocks and Run-out Blocks to a 5 second time period.

### 1.5.1 Read Errors on Non-requested Block Requirements

A MultiRead drive **shall** return errors only for blocks requested by the operating system. To further clarify, errors encountered when a MultiRead drive performs read ahead operations **shall** be ignored unless the operating system requests those blocks be read.

## 1.6 Session Requirements

A MultiRead drive **shall** support reading CD-ROM discs with a single Complete Session. A MultiRead drive **shall** support reading CD-R and CD-RW discs both with a single Complete Session and with all finalized sessions on a multisession disc.

## 1.7 Audio Track Disc Requirements

Discs with Audio Tracks and CD-DA discs **shall** be read and played on a MultiRead device.

## 1.8 MultiRead Test Requirements

The MultiRead test requirements for the MultiRead Specification are very precise. These test requirements apply only to the actions or features in the MultiRead Specification which are indicated by the word “**shall**” above.

## **Annex A - Operating System Support**

Annex A provides additional information and compatibility requirements for developers of the OSTA Universal Disk Format (UDF) File System for a MultiRead device.

### **A.1 Universal Disk Format Requirements**

The operating system shall support the OSTA Universal Disk Format (UDF) for reading media in a MultiRead device. A MultiRead drive shall be capable of reading at least the UDF File System on CD-ROM, CD-R and CD-RW media. The operating system may also support other file systems in addition to the UDF for reading media in a MultiRead device.

#### **A.1.1 Requirements for Operating Systems that support UDF**

The operating system shall support at least UDF read access to a MultiRead device as a standard block device.

#### **A.1.2 Requirements for Discs with Complete Sessions**

The operating system shall support reading CD-ROM, CD-R, and CD-RW discs with a Complete Session or complete multisessions finalized to UDF for interchange in a MultiRead device.

#### **A.1.3 Requirements for CD-RW Discs with Defect Management**

The operating system shall support reading of CD-RW discs written with Defect Management according to UDF.

#### **A.1.4 Requirements for Variable Packets**

The operating system that supports UDF shall be responsible for locating and reading the User Data Blocks for all Variable Packets.

### **A.2 Drive Command Requirements**

The operating system shall support a MultiRead device that uses the X3T10-1048D-MMC Specification (MMC). The ATAPI SFF 8020i Specification (8020), or ATAPI SFF 8080 Specification (8080) or the ATAPI SFF 8090 Specification (8090) may also be supported. Any conflicts regarding these specifications should be resolved in favor of the MMC Specification. (see Scope for version numbers of the specifications)

#### **A.2.1 Method 2 Bit Requirements**

The Method 2 bit as defined on the MODE SENSE command Page 2A (called CD Capabilities and Mechanical Status Page in the MMC Specification) shall be supported.

### **A.3 Requirements for Read Ahead Caching by the Operating System**

The operating system that supports UDF should not request Link Blocks, Run-in Blocks, nor Run-out Blocks during normal read operations. The operating system that requests these blocks should limit the retry algorithm of read requests to a 5 second time period.

### **A.4 Requirements for ISO 9660 Compatibility**

The operating system that supports reading with the UDF File System shall detect a CD-ROM, CD-R, CD-RW disc written in the ISO 9660:1988 File System with at least Level 1 support and automatically provide read support. Media containing both file systems shall be read with the UDF File System.

## **Annex B - Write Method Detection**

### **B.1 Track Type Detection**

Identification detection is performed by decoding the control field. The control field of the Q Sub Channel defines the track type. It describes both Audio and Data Tracks. The Encoding Identification is part of the control field, and is described in the Orange Book.

### **B.2 Write Method Detection**

The Write Method describes in further detail how a track is written. A track may be written as one single operation, this is called Track at once recording. Also, a track can be written with multiple operations (packets), these can be of two types: Variable Packets allow for different packet sizes on a track, where Fixed Packets require a single packet size for every packet on a track. This detection is described below.

### **B.3 The Pre-Gap**

The MultiRead drive detects the Pre-Gap and proceeds to locate the Track Descriptor Block and Write Method for the current track. A Pre-Gap is recorded at the beginning of each track. The Pre-Gap is at least 3 seconds in length, of which the second part of the Pre-Gap is at least 2 seconds in length. In the second part of the Pre-Gap, one packet is recorded, with one or more Track Descriptor Blocks (TDB) such that after its writing the first User Data Block starts at the beginning of user data addressing as stored in the TOC.

### **B.4 The Track Descriptor Block**

The Track Descriptor Block (TDB) contains information about the current track attributes. It is desirable to read the current track's Track Descriptor Block on the initial reading of each track. For non-packet written tracks the TDB may not be present.

### **B.5 The Write Method of the Track**

The Write Method of the Track is found in byte 1 of the Track Descriptor Unit which is a part of the TDB. It indicates how that track was written: Track at once recording, Variable Packets, Fixed Packets, etc.

## **Annex C - Mode Types**

### **C.1 Identification of the Mode Types**

Identification of the Mode Types and block types are located in the block header, which is at the beginning of a block. The block header is normally read with a READ HEADER command.

### **C.2 Layout of a Data block**

A data block contains a sync block field, a block header field, a User Data Block field and an auxiliary data block field. The block header contains a Minutes byte, a Seconds byte, a Frames byte and a Mode Type byte. The Mode Type describes the mode and the type of block. Mode 1 or Mode 2 Form 1 modes as described in the Yellow Book should be used.



## **Annex D - Adding CD-RW support to MultiRead drives**

### **D.1 Hardware Adaptations**

#### **D.1.1 Servo-gain Setting**

Many drives do not provide normalization for radial tracking or focus. For a drive that does not provide normalization, one solution is to use two servo-gain settings. One setting for CD-DA, CD-ROM and CD-R discs is called G1 and a second setting for low reflectivity CD-RW discs is called G2. In this case,  $G2 = 4 * G1$ .

#### **D.1.2 HF Gain**

A second gain setting (G2) for High Frequency (HF) can be added, as described above, or the designer can use an Automatic Gain Control (AGC). One AGC solution could be to reprogram the parameters of a digital amplifier to provide this automatic gain control.

#### **D.1.3 LF-Filter Threshold**

The drive designer could define a threshold for the Low Frequency (LF)-filtered sum signal as a condition for focus acquisition. This threshold should be scaled with G1 for CD-DA, CD-ROM and CD-R discs and scaled with G2 for CD-RW discs.

### **D.2 Drive Start-up Sequence**

#### **D.2.1 Disc Detection**

First, set the servo and HF channel mode (G1) for CD-DA, CD-ROM and CD-R discs. Next, attempt to load the media. If it fails, switch to the CD-RW disc mode (G2) and re-attempt to load the media and continue.

### **D.3 Read Channel Verification**

#### **D.3.1 Run-in Error Condition**

If there are more errors in the first few User Data Blocks of a packet than in other blocks in the packet, the channel has a "Run-in" error condition. This can be caused by not getting the Phase Lock Loop (PLL) locked fast enough on the average high frequency pattern. The PLL normally should re-synchronize on decode during the first two Run-in Blocks in a packet.

## Annex E - Addressing Types

### E.1 Method 1 Addressing

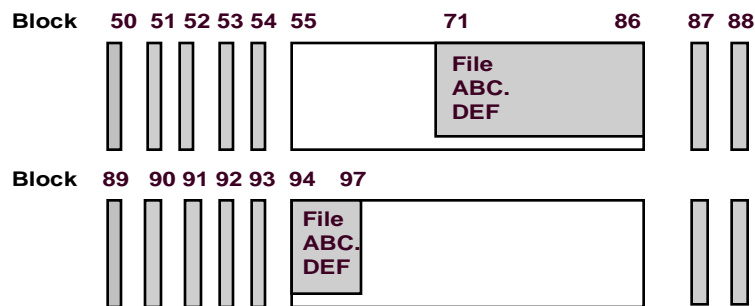
The algorithm to calculate a drive's logical block address (LBA) is:  $\text{DriveLBA} = (((M * 60) + S) * 75 + F) - 150$ . Where M is minutes, S is seconds, and F is frames.

The following example illustrates Method 1 Addressing:

The host needs File ABC.DEF, 40 KB long (20 blocks), recorded with Variable Packets, starting at block 71.

The host first requests 16 blocks starting at block 71. The host then requests 4 blocks starting at block 94.

**Figure E.1 - Method 1 Addressing**



Obviously, a more efficient Variable Packet Method 1 Addressing implementation would select a packet size equal to the file size. However as the file size may exceed the drive's internal buffer size, buffer under-runs become possible.

Note: Blocks 50 and 89 are Link blocks, blocks 51-54 and blocks 90-93 are Run-in Blocks and blocks 87-88 are Run-out Blocks.

## E.2 Method 2 Addressing

The algorithm to calculate a drive's PBA (Physical Block Address) is:

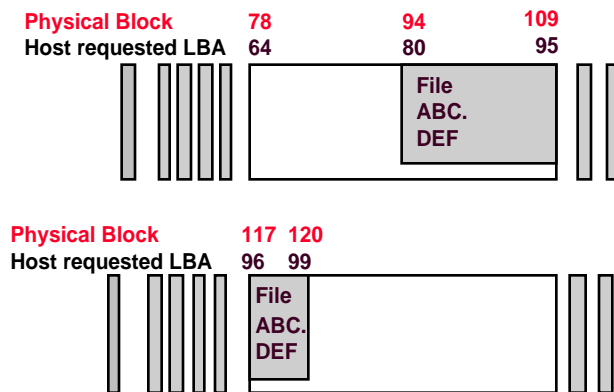
$$\text{DrivePBA} = \text{HostLBA} + ((\text{HostLBA} - \text{StartofTrack}) / \text{PacketSize}) * 7.$$

Where the result of the  $(\text{HostLBA} - \text{StartofTrack}) / \text{PacketSize}$  is an integer part. HostLBA is the requested LBA. StartofTrack is the address of the first block in the track that contains the HostLBA. Note: the StartofTrack can be determined simply by comparing the HostLBA to the track start address in the TOC. The PacketSize is the number of User Data Blocks in the packet. The minimum PacketSize is one.

The following example illustrates Method 2 Addressing:

The host needs File ABC.DEF, 40 KB long (20 blocks), recorded with 64 KB Fixed Packets, starting at block (HostLBA) 80. One host request at block 80 for 20 blocks (blocks 80-99).

**Figure E.2 - Method 2 Addressing**



### E.2.1 Example of Fixed Packet Method 2 Addressing with a Driver

When the MultiRead drive supports Method 1 Addressing only for Fixed Packets, the Method 2 bit in Mode Page 2A is set to zero. In Figure E.2 above, the File System requests 20 blocks to read starting at LBA 80, the device driver converts the request into two separate READ commands to the drive. The first command is set to read 16 blocks, starting a PBA 94 (LBA 80), and the second command is set to read 4 blocks, starting at PBA 117 (LBA 96). In this example, the device driver supplies the required mapping to Method 2 Addressing.

### E.2.2 Example of Fixed Packet Method 2 Addressing without a Driver

When the MultiRead drive supports Method 2 Addressing for Fixed Packets, the Method 2 bit in Mode Page 2A is set to one. In Figure E.2 above, the File System requests 20 blocks to read starting at LBA 80, the device driver, if present, will pass the same command forward to the drive. The drive converts the requested starting LBA 80 to PBA 94 and reads 16 blocks. Internally, the drive automatically skips over the 7 Link Blocks to PBA 117 (LBA 96) and reads the remaining 4 blocks.