DEC STANDARD 144

TITLE: Disk Standard for Recording and Han ng Manufacturing Detected Bad Sectors

ABSTRACT: This standard is both a hardware an software standard. It specifies the hardware disk forma controller requirements and software handling of manuf turing site determined bad sectors of the RK06 and RK data cartridges and future disks. Conformance to th standard will result in improving reliability for the com ned hardware/software system as experienced by our custome .

This standard defines the format use at the manufacturing site to record the locations of sect s containing disk surface errors. The highest numbere track of the cartridge is used to record track, cyli er, and sector location of the error in both 20 and 22 ector format. Provision is also made for recording se al numbers and other pertinent manufacturing information. In addition, errors found at the time of manufacture and rrors found in subsequent field use are indicated by mea of good sector flags in word 2 of the header. This stand d specifies two operating system techniques for hand ng these bad regions: one for small systems and one for la e systems. Both techniques prevent the user from usi the bad sectors detected at the manufacturing site.

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1.0 INTRODUCTION

1.1 Motivation

The RK06 and RK07 cartridges will be a DEC manufactured and controlled proprietary media. It is anticipated that the manufacturing process will include a determination of error type and location on the cartridge. Furthermore, it is anticipated that most cartridges will not have error-free surfaces. It is the intent that errors will be flagged by a carefully margined and calibrated tester such that the use of flagged sectors will permit any drive to operate within the error spec for that drive. It is desired to communicate this error information in a uniform way to the appropriate operating system. This standard specifies the responsibilities of the hardware and software in order to obtain reliable handling of manufacturing site determined bad sectors.

1.2 Goals

1.2.1 Specify the respective responsibilities for manufacturing, engineering, and operating system software so as to create a reliable hardware/software system. Specifically, the operating system must never receive an error condition because of an attempt to read or write a manufacturing determined bad sector.

1.2.2 Specify the format for information written on the RK06 and RK07 cartridges at the manufacturing site which identifies bad disk surface regions.

1.2.3 Specify the requirements for controllers to handle error information.

1.2.4 Specify the software handling of this error information on DECsystem 10, PDP-11, and PDP-15.

1.2.5 Specify a technique which can be extended to all future disks and controllers.

1.2.6 Specify software techniques which are reasonable for small and large systems.

1.3 Non-Goals

1.3.1 The software is not required to make bad sectors appear good to a user who allocates contiguous sectors.

1.3.2 This standard does not address the handling of additional sectors which are found bad after the disk leaves manufacturing, but allocates a header bit and spare sectors on the highest numbered track for the extension of this standard to flagging of errors from field use.

1.4 Scope

The standard specifies how manufacturing will identify bad surface regions on the disk cartridge. The standard specifies how RK06 and RK07 controllers and future controllers will handle this bad region information. The standard applies to all operating systems using the RK06 and RK07 and future disks.

1.5 Previous Standardization Efforts

There have been no previous standards.

1.6 Related Current Standards

There are no generally accepted or published related standards. Reference to parts of this standard may be found in the specification for the RK06 drive, cartridge and controllers.

1.7 Future Standards Activities

Due to incompatibilities with existing software, this standard will not apply to RP04, RP05, and RP06. The RL01 will implement the last track error list but not the good sector flags. Other future drives will implement this standard but may change the specific RK06/RK07 format.

1.8 Incompatibilities

The only known incompatibilities with current software are that certian systems may assume all sectors available.

2.0 DEFINITIONS

Cylinder - Two or more tracks which are physically located at the same radii and can thus all be accessed without head movement.

Track - A track is the region encompassed on one surface by one revolution of the disk with the head stationary.

Sector - A track is made up of fixed length sectors. A sector is the smallest unit which can be read or written.

20 Sector Format - The format used for sectors with 128 36-bit words, as on the DEC system 10, or 256 18-bit words as on the PDP15.

22 Sector Format - The format used for sectors with 256-16-bit words, as on the PDP-11.

Error - Failure of a sector to meet the missing bit, extra bit or timing requirement of cartridge specification.

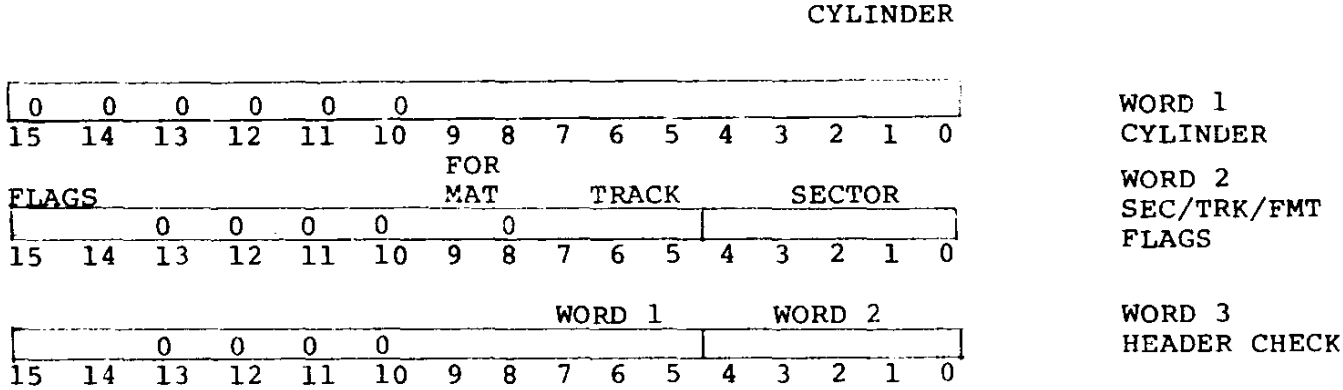
3.0 DEFINITION OF THE STANDARD OF THE CARTRIDGE SPEC

This standard defines the recording format which is used for identifying bad sectors on the RK06 and RK07 disk cartridge when it leaves manufacturing. Bad sectors are identified in two ways; by clearing a good sector flag in the header of the bad sector and by listing the bad sectors in a file recorded on the highest number track in the cartridge. The use of the good sector flag in each header prevents software from accidently trying to access a bad region and is especially useful to small systems which cannot follow the large system handling technique. These are described in detail below.

NOTE: Neither method is hardware protected and may be accidently overwritten by software. It is a violation of this standard to overwrite the first 10 sectors of the highest track.

3.1 Good Sector Flags

Each sector on every track contains a header consisting of three 16-bit words regardless of data format (20 or 22 sector).



These header words are defined in the RK06 UNIBUS Disk Subsystem Specification. When a cartridge is shipped from Manufacturing, bit 14 of word 2 will be a one. This bit is reserved for System Software to clear in order to indicate that the associated sector has gone bad in use. However, this standard does not require software to clear this bit. Software is prohibited from using it for any other purpose. Bit 15 will be set to zero in every sector found to be bad during the verification and formatting operation in Manufacturing. It will be set to one in every sector of good track.

During normal read and write operations a bad sector error will occur if either of the two error header bits is zero. The controller will not read or write the data in such a sector, but will instead indicate an error to the software. All controllers will indicate a bad sector error

whenever bit 15 or 14 is zero. These good sector flags may be set or reset only by reformatting the entire track. If the cartridge is reformatted, the formatting program must look up the appropriate sector in the bad sector file and set bit 15 of word 2 to zero if that sector appears in the bad sector file.

3.2 Bad Sector File

The bad sector file is a list of the bad sectors in the cartridge and is recorded on the highest number track and cylinder on the cartridge. This track is written in 22 sector 16-bit word format, so that it can be read on DECsystem 10's, PDP-11's, and PDP-15's.

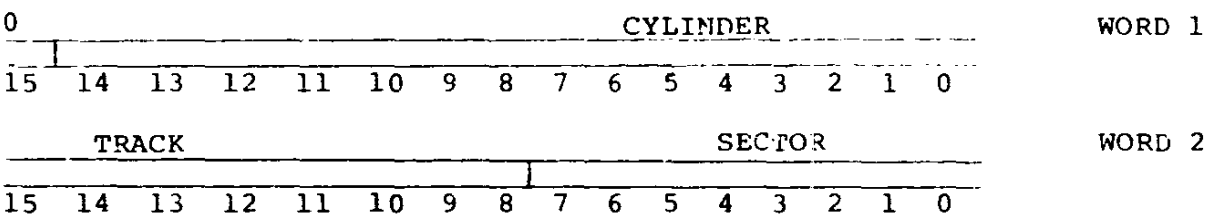
3.2.1 Data Field Format

The data field in the first sector of the last track has the following format and is repeated in the following nine sectors.

WORD	
0	Cartridge
1	Serial Number
2	Unused
3	Written with Zeros for Data Cartridge, all ones for alignment cartridge
4	Bad
5	Sector
6	Bad
7	Sector
.	
.	
.	
.	Last Bad
.	Sector
.	Ones
.	Ones
.	
.	
.	
254	Ones
255	Ones

Words Ø and 1 contain the serial number of the disk cartridge. Word 2 is reserved for possible future use and is written with zeros. Word 3 is written with all zeros for a data cartridge and all 1's for an alignment cartridge. After this is the list identifying bad sectors (if any) with two words for each sector. The list will be in ascending order (cylinder, track, sector).

Note - This implies no more than 126 sectors can be bad.



After the pair of words identifying the last bad sector, the remainder of the data field is written with ones, which correspond to no actual sector and therefore identify the end of the bad sector list.

3.2.2 Track Format

All the sectors of the last track are written with the bad sector files in the data field format described in 3.2.1. The sector format contains the same preambles, gaps, EEC and post amble as those on any other track. Tracks other than the last track may be written in either of two different formats (see example in section 3.3). For this reason, sectors 0, 2, 4, 6, and 8 of the bad sector file track will contain sector numbers identifying bad sectors when the remainder of cartridge is formatted in 22 sector 16-bit format and sectors 1, 3, 5, 7, and 9 will contain sector numbers identifying bad sectors when the remainder of cartridge is formatted in 20 sector 18-bit format.

The remaining sectors on the track (sectors 10-21) will be recorded as described in 3.2.1 with no bad sectors identified (i.e. words 4-225 all ones). These are reserved to operating systems to create a similar list of sectors which become bad during use. However, use of this area is not a requirement for conformance to this standard. Software is prohibited from using the remaining sectors for other purpose.

The header flag bits defined in 3.1 will be recorded on this track in the normal manner. Manufacturing guarantees that at least two even sectors and two odd sectors must be error-free out of the first 10 sectors and two even and two odd sectors of the last 12 sectors must be error-free.

3.3 Example

Assume a cartridge with one error near the end of cylinder 5 track 1. This track can be written in the two formats:

	Error		Index
22 Sector 16-Bit	Sector 20	Sector 21	Sector 0
20 Sector 18-Bit	Sector 18	Sector 19	Sector 0

In the 22 sector format the error falls in sector 20 and bit 15 in the second header word of this sector will be cleared as in section 3.1. In the field, if the pack were reformatted to the 20 sector format the error falls in sector 18 and the flag bit will be cleared by the formatter program.

The bad sector file on the last track would in this case be:

Sectors 0, 2, 4, 6, 8

Word		
0	Cartridge #	
1		
2	000000_8	
3	000000_8	
4	000005_8	Cyl 5
5	000424_8	Track 1
6	177777_8	Sector 20
7	177777_8	10
255	177777_8	

Sectors 1, 3, 5, 7, 9

Word		
0	Cartridge #	
1		
2	000000_8	
3	000000_8	
4	000005_8	Cyl 5
5	000422_8	Track 1
6	177777_8	Sector 18
7	177777_8	10
255	177777_8	

Sector 10 to 21

Word	
0	Cartridge #
1	
2	000000_8
3	000000_8
4	177777_8
5	177777_8
6	177777_8
7	177777_8
255	177777_8

4.0 OPERATING SYSTEM CONFORMANCE

4.1 Small Operating System Conformance

Small systems must provide a utility which allocates all of the bad sectors to a file or set of files which the user will not access or delete. This program must be run whenever the disk is refreshed. Thus, the user will never allocate or access a bad sector found at the manufacturing site.

4.2 Large Operating System Conformance

Large systems must mark off the bad sectors as in use whenever the disk is refreshed. Thus, the user will never be allowed to allocate or access a bad sector found at the manufacturing site.

4.3 No system is required to remap bad blocks so that the user who is allocating contiguous space is unaware of the bad sectors.