

Q200 Series™ Intelligent Disk Drives

MAR 19 1986

Defect Handling

To ensure long-term data integrity, Quantum's Q200 Series intelligent disk drives incorporate media defect handling and error correcting code capabilities. These integrated features eliminate the need for user defect maps, the need for writing dedicated utility software for defect mapping, and help reduce testing time required during system integration at an OEM site. In addition, after system integration and during regular use, the Q200 continues to scan and compensate for any new defective sectors on the disks.

Defect Management

Factory Found Defects

Q200 Series disk drives will be scanned in the factory for defective sectors on the disks. Those defective sectors will be deallocated prior to shipment. An In-Line Defect Map, duplicated on multiple tracks, will contain the locations of all defective sectors found in the drive.

Two sectors are allocated per cylinder as replacement sectors. Defects found at the factory are eliminated using an "In-Line" sparing method, which replaces each bad block with the next block on the track (see Diagram 1). In the rare instance where more than two defects are found within the same cylinder, the additional defects will be mapped into the nearest adjacent cylinder with spare sectors available.

This approach minimizes media used for replacement and reduces access time to the replacement sector. In addition, cylinder boundaries are well defined, with a simple relationship between each initial sector's physical and logical block addresses — thus providing the host a method to ensure that file records can be stored within cylinder boundaries.

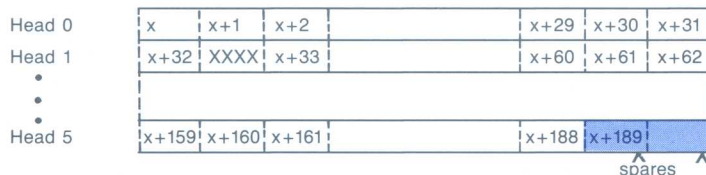


Diagram 1: Factory Found Defects

x = logical block address of initial sector
(Q280: cylinder number x190; Q250: cylinder x126)
XXXX = deallocated sector

Field Found Defects

Q200 Series disk drives also contain a Replacement Sector Map in the event additional defects are found during drive usage. Field found defects are also mapped into the two replacement sectors located at the end of each cylinder. However, field defects are mapped directly into the spare sector locations (without shifting subsequent logical blocks, as in the case of the In-Line sparing method); see Diagram 2. Similar to the factory sparing method, in the rare instance where there are more than two defects per cylinder, the additional defects will be mapped into the nearest adjacent cylinder with spare sectors available. This approach ensures that in most cases, a long seek to an alternate cylinder will not be necessary in order to manage additional defects found during drive usage.

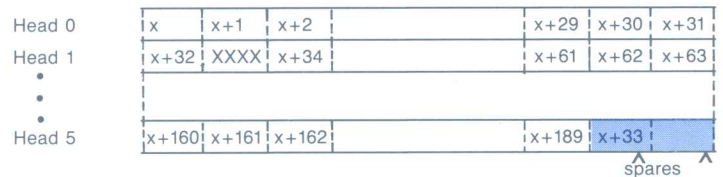


Diagram 2: Field Found Defects

Two software configuration "switches" (Post Error and Automatic Reallocation) are available for host control of the field replacement operation. Post Error determines whether or not the Q200 will notify the host every time corrected data is passed from the drive. Automatic Reallocation determines whether or not, when corrected data is passed to the host, the Q200 will automatically add the physical location of that sector onto the Replacement Sector Map, move that sector of data into a replacement sector, then verify that the sector was properly duplicated. These two software switches allow the selection of four possible options by the host. The option desired by the host will be specified via the SCSI Mode Select command.

Option 1 (Post Error off, Automatic Reallocation off):

This is a "no action" option. That is, the host will not be informed that corrected data is being passed, nor will the Q200 take any action to map out the suspect sector.

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Option 2 (Post Error off, Automatic Reallocation on):

This is a transparent replacement option. When corrected data is passed from the Q200, it will not notify the host of the action. However, the Q200 will automatically add the physical location of the sector containing the corrected data onto the Replacement Sector Map, move that sector of data into a replacement sector, then verify that the move was completed correctly.

Option 3 (Post Error on, Automatic Reallocation off):

Every time corrected data is passed to the host, the Q200 will notify the host of the recovered error. The Q200 will not take action to map out the suspect sector.

By logging suspect block addresses passed from the Q200, the host can use the SCSI Reassign Blocks command or the Format Unit command to manage new defects. The Reassign Blocks command can be used to add new defective block locations to the Replacement Sector Map and move the data from those sectors into replacement sectors. Alternately, the drive can be reformatted using the logged suspect block addresses with the Format Unit command (see Reformatting).

Option 4 (Post Error on, Automatic Reallocation on):

Every time corrected data is passed to the host, the Q200 will notify the host of the recovered error. Also, the Q200 will automatically add the physical location of that sector onto the Replacement Sector Map, move that sector of data into a replacement sector, and verify that the move was completed correctly.

Reformatting

The SCSI Format Unit command issued from the host will cause the Q200 to reorganize data on the disk in a manner identical to the way it was formatted in the factory (i.e., using an In-Line sparing method). In addition to using the original factory In-Line Defect Map and the field Replacement Sector Map, the reformatting operation can also be performed using a host-supplied list of defective logical blocks.

Error Correcting Code

Quantum's Q200 Series implementation of Error Correcting Code is a byte-based Reed-Solomon ($t = 2$) Double Burst Correcting Code with an interleave of 3. This code allows correction of any sector with one burst of 17 bits incorrect, and detection of any sector with up to 3 bursts of 17 bits incorrect. In addition, a retry/correction strategy is used to prevent using ECC on soft errors.

Operation of ECC

1. If syndrome is 0 (no errors), then data is passed to the SCSI bus.
2. If syndrome is not 0 (an error has occurred), then correct data and store in less than one revolution, and re-read the sector.
3. Compare the second syndrome with the original syndrome and if:

2nd syndrome = 0	Pass second data to SCSI bus. (2nd try had no errors)
2nd = 1st	Pass already corrected sector to SCSI bus. (Hard error)
2nd not = 1st	Retry again. (Soft error)

Options

The Q200 can be configured to either report to the host every time corrected data has been passed, or not to report this information. The option desired by the host will be specified via the SCSI Mode Select command.

Specifications subject to change without notice.

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Printed in the U.S.A. 10/85 7.5M 002

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