

X3T9.2/88-002

Doc: X3T9.2/88-002r0

01/06/88

To: X3T9.2 Membership

From: Jeff Stai, Western Digital Corp.

Subject: Search Command Modifications

This proposal is a continuation of the work begun by Paul Nitza of Emulex (X3T9.2/87-128r0). As I recall, the proposal was accepted with some suggested modifications. Here, then, is the result of that work for your approval...

In today's operating system environment the allocation of logical blocks is normally done using a first fit or first available algorithm. As the file system is used, fragmentation occurs and blocks are not normally allocated on a contiguous basis. This proposal provides the means for the target to search logical blocks which are not contiguous on the device for a given pattern, yet maintains backwards compatibility with SCSI-1 and will not effect current products.

## Proposed Search Command Modifications

01/06/88

## SEARCH DATA Commands

Peripheral Device Type: Direct Access, Write-Once Read-Multiple, and Read-Only Direct Access  
Operation Code Type: Optional

## SEARCH DATA Commands

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (30h 31h 32h)							
1	Logical Unit Number			Invert	NonCon	Reserved	SpnDat	RelAdr
2	(MSB)							
3								
4	Logical Block Address							
5								(LSB)
6	Reserved							
7	(MSB)							
8	Transfer Length							(LSB)
9	Control Byte							

The SEARCH DATA commands (Table 8-38) search one or more logical blocks for equality or inequality to a data pattern. The concept of records within a logical block is used to allow multiple records within a logical block to be searched.

A Non-Contiguous (NonCon) bit of zero indicates that the search is to be performed on a set of contiguous logical blocks. No Search Block Descriptor list is sent during the DATA OUT phase. The search operation starts at the Logical Block Address specified in the CDB and continues for the number of contiguous blocks specified in the Transfer Length field or until the number of specified records have been searched.

A NonCon bit of one indicates that the search is to be performed on a set of non-contiguous logical blocks. One or more Search Block Descriptors are sent during the DATA OUT phase. The target shall not use the Logical Block Address and Transfer Length fields in the CDB. The target shall use the Search Block Descriptor in the parameter list to determine which on logical blocks to perform the search operation. The initiator should set the Logical Block Address and Transfer Length to zero. If the Logical Block Address and/or Transfer Length are not zero, the target shall return CHECK CONDITION status and set the sense key to ILLEGAL REQUEST.

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The invert bit determines whether the search condition is to be inverted. See 8.1.17.1 through 8.1.17.3 for a description of the search conditions for the individual SEARCH DATA commands.

A spanned data (SpnDat) bit of zero indicates that each record shall be wholly contained within a single block. Any space at the end of a block that is smaller than the record length is ignored by the SEARCH DATA commands. A SpnDat bit of one indicates that records span contiguous block boundaries. Thus, a record may start in one block and end in the next or a subsequent contiguous block.

A transfer length of zero (and the NonCon bit set to zero) indicates that no data shall be searched. This condition shall be treated the same as an unsatisfied search.

A link bit of zero indicates a nonlinked command and if the search is satisfied, the command shall be terminated with a CONDITION MET status. A REQUEST SENSE command can then be issued to determine the logical block address and record offset of the matching record. If the search is not satisfied and no error occurs, the command shall be terminated with GOOD status.

A link bit of one indicates a command is linked to the SEARCH DATA command and if the search is satisfied, CONDITION MET status is returned and the next command is executed. If the RelAdr bit in the next command is one, the logical block address of the next command is used as a displacement from the logical block address at which the search was satisfied. If a linked search is not satisfied, the command is terminated with a CHECK CONDITION status. A REQUEST SENSE command may then be issued.

A REQUEST SENSE command following a satisfied SEARCH DATA command shall:

(1) Return a sense key of EQUAL if the search was satisfied by an exact match. If the search was satisfied by an inequality then a sense key of NO SENSE shall be returned.

(2) Return the valid bit set to one.

(3) Return the logical block address of the logical block containing the first matching record in the information bytes.

(4) Return the record offset of the matching record in the first four bytes of additional sense bytes.

A REQUEST SENSE command following an unsatisfied SEARCH DATA command shall:

(1) Return a sense key of NO SENSE, if no errors occurred during the command execution.

(2) Return the valid bit set to zero.

The SEARCH DATA parameter list is shown in Table 8-. The parameter list contains a fourteen byte header, followed by one or more search argument descriptors, followed by zero or one eight byte search block descriptor header, followed by zero or more search block descriptors. The search block descriptor header and the search block descriptors are included only if the NonCon bit in the CDB is one.

The SEARCH DATA parameter list (Table 8-39) contains a fourteen-byte header, followed by one or more search argument descriptors.

#### SEARCH DATA Parameter List

Bit	7	6	5	4	3	2	1	0
Byte								
0 - 13	Parameter List Header							
0 - n	Search Argument Descriptor(s)							
0 - 7	Search Block Descriptor Header							
0 - n	Search Block Descriptor(s)							

#### SEARCH DATA Parameter List Header

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB)							
3	Logical Record Length							(LSB)
4	(MSB)							
7	First Record Offset							(LSB)
8	(MSB)							
11	Number of Records							(LSB)
12	(MSB)							
13	Search Argument Length							(LSB)

The logical record length field specifies the record length in bytes.

The first record offset field specifies the number of bytes that shall be ignored in the first logical block before the search begins. The value in the first record offset field shall not exceed the length of the logical block.

Subsequent logical blocks shall be searched beginning with the first byte in the logical block. This permits one or more records to be skipped initially.

The number of records field specifies the maximum number of records that shall be searched by this command. An unsatisfied search shall terminate when the number of records or the number of blocks (from the command descriptor block) have been exhausted.

The search argument length specifies the length in bytes of all the search argument descriptors that follow. Since the pattern length can vary, there is no fixed multiple of the search argument descriptor to determine the search argument length.

#### SEARCH DATA Search Argument Descriptor

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB)							
3	Displacement							
	(LSB)							
4	(MSB)							
5	Pattern Length							
	(LSB)							
6 - n	Pattern							

The search argument descriptors specify one or more search conditions to execute within a single record in order to satisfy the search. Each search argument descriptor is made up of a displacement, a pattern length, and a pattern.

The displacement field specifies the displacement in bytes of the first byte of the data to be compared from the start of the logical record.

The pattern length field specifies the length in bytes of the pattern that follows.

The pattern specifies the data to compare to the logical record.

[the following tables are new, no underscore]

#### SEARCH DATA Search Block Descriptor Header

Bit Byte	7	6	5	4	3	2	1	0
0	Search Block Descriptor Format							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)	Search Block Descriptor Length						(LSB)
7								

The search block descriptor format specifies the format of the search block descriptors that follow, as defined in Table 8--.

The search block descriptor length specifies the length in bytes of all the search block descriptors that follow. A search block descriptor length of zero indicates that no data shall be searched. This condition shall be treated the same as an unsatisfied search.

#### Search Block Descriptor Formats

Search Block Code	See Table	Description
00h	8--	Bit Map format
01h	8--	Segment format
02h-FFh		Reserved

## Search Block Descriptor - Bit Map Format

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB)	Logical Block Address						(LSB)
3								
4	(MSB)	Bit Map Length						(LSB)
7								
8 ~ n	Bit Map							

The logical block address specifies where the search operation shall begin.

The bit map length specifies the length in bytes of the bit map that follows.

The bit map specifies which blocks shall be searched by the target. Each bit corresponds to a logical block following the logical block address specified. A bit set to zero specifies that the block shall not be searched. A bit set to one specifies that the block shall be searched. Bit 7 of the first byte of the bit map refers to the logical block address specified. Bit 6 of the first byte of the bit map refers to the next logical block following the logical block address specified. Bit 7 of the second byte of the bit map refers to the logical block address specified plus eight.

A bit map with all bits zero indicates that no data shall be searched. This condition shall be treated the same as an unsatisfied search.

## Search Block Descriptor - Segment Format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	Logical Block Address						-
3	-							(LSB)
4	(MSB)	Number of Blocks						-
7	-							(LSB)

The logical block address specifies where the search operation shall begin.

The number of blocks specifies the number of contiguous logical blocks which shall be searched. A number of blocks of zero indicates that no data shall be searched. This condition shall be treated the same as an unsatisfied search.

## SEARCH DATA HIGH Command

The SEARCH DATA HIGH command (Table 8-38, operation code 30h) shall be satisfied by the first logical record searched that contains data that satisfies all of the search argument descriptor(s). If the invert bit in the command descriptor block is zero, the search argument descriptor(s) shall be satisfied by data in the logical record being greater than the data in the pattern. If the invert bit is one, the search argument descriptor(s) shall be satisfied by data in the logical record being less than or equal to the data in the pattern. (See 8.1.17.)

## SEARCH DATA EQUAL Command

The SEARCH DATA EQUAL command (Table 8-38, operation code 31h) shall be satisfied by the first logical record searched that contains data that satisfies all of the search argument descriptor(s). If the invert bit in the command descriptor block is zero, the search argument descriptor(s) shall be satisfied by data in the logical record being equal to the data in the pattern. If the invert bit is one, the search argument descriptor(s) shall be satisfied by data in the logical record being not equal to the data in the pattern. (See 8.1.17.)

## SEARCH DATA LOW Command

The SEARCH DATA LOW command (Table 8-38, operation code 32h) shall be satisfied by the first logical record searched that contains data that satisfies all of the search argument descriptor(s). If the invert bit in the command descriptor block is zero, the search argument descriptor(s) shall be satisfied by data in the logical record being less than the data in the pattern. If the invert bit is one, the search argument descriptor(s) shall be satisfied by data in the logical record being greater than or equal to the data in the pattern. (See 8.1.17.)