KONAN™

The DJ 210
3.5" Controller

SASI/XSASI TO ST506/412 Hard Disks

OEM REFERENCE MANUAL

DJ 210 REFERENCE MANUAL

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A	25 March 85	Initial release
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B	28 October 85	Addition of error codes

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Introduction

The DJ 210 Controller

The DJ 210 is an intelligent, 3-1/2" general purpose Winchester controller board designed to be compatible with SASI/XSASI systems.

A proprietary Konan (LSI) chip has improved the reliability of the DJ 210 by reducing the number of components. A (LSI) Data Separator has also been included, making the DJ210 adjustment free. Several features of the product are listed below. See Specifications Section for additional information.

Additional Features

LOW POWER	4.5 Watts Optional SCSI terminator draws an additional 1.8 Watts
3-1/2"	4" x 5.75" Dimensions Two Drive Capability Industry Standard ST506/ST412 Interface* 16 Head Addressing 2048 Cylinder Addressing 16, 17, or 18 512 Byte Sectors per track 32 256 Byte Sectors per track Selectable Seek Rate Buffered Seeks
SASI/XSASI	Up to 833K Byte Per Second Transfer Rate Optional Terminator Addressable With Any Of 8 Possible Addresses
PERFORMANCE:	Programmable Interleave Individually Programmable Drive Characteristics Implied Seeks Multiple Block Transfers Overlapped Seeks
DATA INTEGRITY:	Automatic 11 bit Error Correction Programmable Correction Span Extensive Error Recovery Automatic Flaw Map Interpretation Ability to append Flaw Map as Drive ages Internal Diagnostics 12 ns Write Precomp
LOW COST AND MAINTENANCE:	Low Parts Count No Adjustments Extensive Testing & Burnin

* ST506/412 are Seagate Technology Tradenames

The DJ 21Ø Manual

This manual is designed to aid in the integration of the DJ 21Ø into a target system. It should also serve as a guide for answering questions about the features and design of the controller.

Section 1, **INSTALLATION,** describes how to install the DJ 21Ø, including information on jumpers and connecting cables. This information may be the only required reading if a SASI product is being used with the controller.

Section 2, **SPECIFICATIONS,** provides physical and technical data as well as specifications on connector and pin assignments that will aid installation. A reference for additional information is also given to assist integration. Further details, including schematics, can be obtained by completing a non-disclosure agreement.

Section 3, **THEORY OF OPERATION,** offers a look at the background philosophy that has gone into the design of the DJ 21Ø. Descriptions of several key functions are also given. This material should offer insight into how the controller works.

Section 4, **HOST INTERFACE,** explains the command and status functions of the host interface in general. Details of each specific command are also given. This section will be of importance to anyone who is designing an interface to the DJ21Ø.

Section 5, **WARRANTY/MAINTENANCE,** details the DJ 21Ø warranty as well as maintenance philosophy and warranty validation procedures.

User Notes:

1.Ø Installation

1.1 Board Setup

The following procedures should be observed before installing the DJ 21Ø.

The DJ 21Ø supports one of eight unique device addresses. The factory-installed jumper at JU1 sets the DJ 21Ø's address to zero. This is the position used when running a single controller. Figure 1.1 shows the factory-installed jumper.

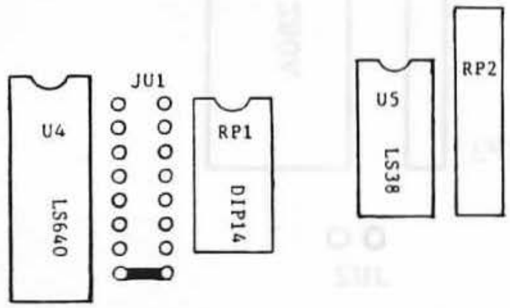


Figure 1.1
Factory-Installed Address Jumper

When more than one controller is used in a system, the address jumper must be changed. To do this, the factory-installed jumper must be cut and a new jumper installed at the appropriate unit number. Figure 1.2 shows the address jumper changed from address zero (Ø) to address two (2).

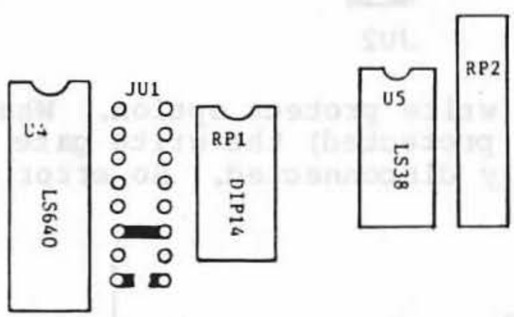
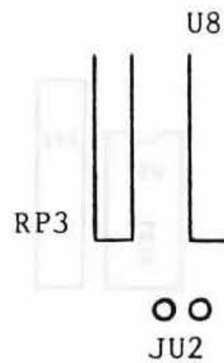


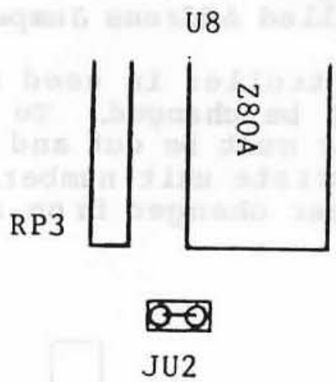
Figure 1.2
Changed Address Jumper

Notice the terminators, resistor packs RP1 and RP2, on Figures 1.1 and 1.2. When multiple controllers are used, the terminator must be installed in <u>only</u> the last board of the daisy chain. Only terminator RP1 is required for most installations because it terminates all XSASI lines normally terminated at the controller end. RP2 terminates output lines only. While the DJ 21Ø is guaranteed to drive dual terminators (host and last controller), other controllers on your bus may not have this capability. See Section 4.1, Host Interface Description.

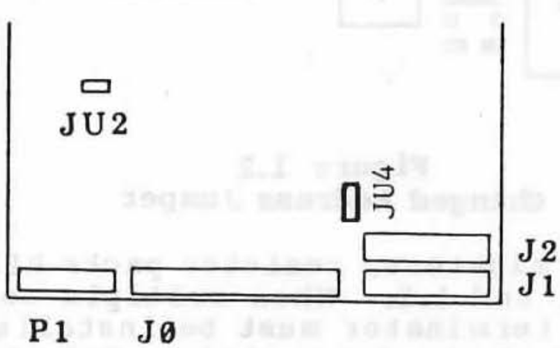
JU2 is left disconnected at the factory for 512 byte sectors.



For 256 byte sectors connect JU2 as illustrated:



JU4 is a physical write protect option. When this jumper is removed (write protected) the write gate signal to the drive is physically disconnected. No error will be reported by the controller.



1.2 Connecting Cables

The cables to the drive and host must be connected before the DJ 21Ø can be operated. Figure 1.3 shows the connector locations. The cables used are listed below:

J0 Control cable (DJ 21Ø to last drive: maximum 2Ø feet)
J1 Data cable: maximum 2Ø feet
J2 Data cable: maximum 2Ø feet (optional second drive)
P1 Power cable
J3 Host Interface cable: maximum 15 feet

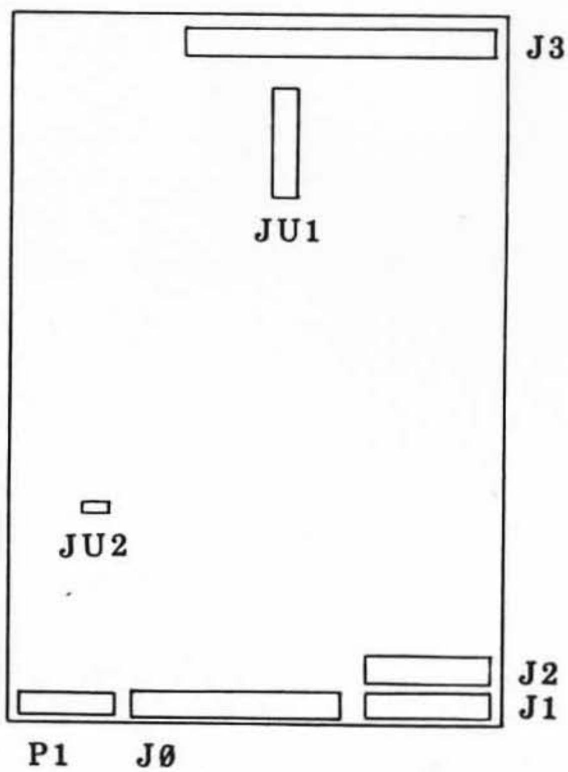


Figure 1.3
Cable, Connector and Jumper Locations

1.3 Mounting Precautions

It is suggested that non-conductive (nylon) hardware be used to mount the DJ 21Ø. Using metal fastening devices through the mounting holes in the PCB could cause shorts.

2.0 Specifications

2.1 General Specifications

Host Data Transfer:

8-bit parallel
833K bytes per second maximum data rate

Disk Data Transfer:

Modified Frequency Modulation
12 nsec Precompensation
5 MHz data rate
32 bit Error Correction Code
Up to 11 bit Burst Error Correction

Disk Control Capabilities:

ST506/ST412 Industry Standard Interface
Individually Programmable Drive Characteristics
Units = 2
Heads = 16
Tracks = 2048
Sector Size = 256 or 512
Sectors Per Track = 16, 17 or 18 for 512
= 32 for 256

Cooling:

Same as required for the hard disk

2.2 Power Requirements

+5.0 ± .25V at 1.0 amps max (unterminated)
+5.0 ± .25V at 0.4 amps additional for terminator
No other voltage is required

2.3 Board Dimensions

Width = 4.0 inches
Length = 5.75 inches
Height = 0.75 inches

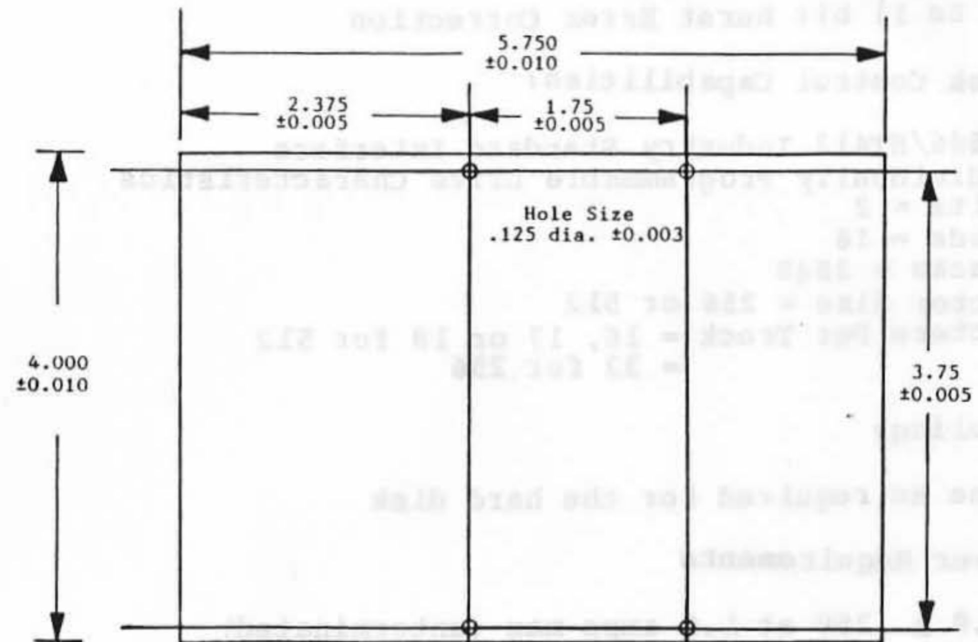


Figure 2.1
Board Dimensions

2.4 Connectors

Table 2.1 lists the controller mating connectors.

Designation	Function	Type/Source (or equivalent)
JØ	Drive control signals	AMP 88373-3
J1,J2	Drive data signals	AMP 869Ø4-1
P1	Power Supply (housing)	AMP 1-48Ø424-Ø
	(pins)	AMP 35ØØ78-4
J3	Host interface signals	AMP 86916-1

Table 2.1
Controller Mating Connectors

2.5 Connector Pin Assignments

Table 2.1 through Table 2.5 list the DJ21Ø pin assignments. Definitions of the signals are contained in sections 4.1 (Host Interface) and 1.2 (Connecting Cables)

Signal Pin	Ground Return	Signal Name
1	2	Drive Selected
3	4	Reserved
5	6	Write Protected (J1 Only)
7	8	Reserved
9	1Ø	Cartridge Changed (J1 Only)
11	12	Ground (GND)
13		MFM Write Data+
14		MFM Write Data-
15	16	Ground (GND)
17		MFM Read Data+
18		MFM Read Data-
19	2Ø	Ground (GND)

Table 2.2
Connectors J1 and J2,
Disk Serial Data Pin Assignments

Signal Pin	Ground Return	Signal Name
2	1	Reduced Write Current/Head Select 2^3
4	3	Head Select 2^2
6	5	Write Gate
8	7	Seek Complete
1Ø	9	Track ØØ
12	11	Write Fault
14	13	Head Select $2^Ø$
16	15	Reserved
18	17	Head Select 2^1
2Ø	19	Index
22	21	Ready
24	23	Step
26	25	Drive Select 1
28	27	Drive Select 2
3Ø	29	Reserved
32	31	Reserved
34	33	Direction In

Table 2.3
Connector JØ,
Disk Control Signal Pin Assignments

Signal Pin	Ground Return	Signal Name
2	1	DATA0-
4	3	DATA1-
6	5	DATA2-
8	7	DATA3-
10	9	DATA4-
12	11	DATA5-
14	13	DATA6-
16	15	DATA7-
18	17	Spare
20	19	Spare
22	21	Spare
24	23	Spare
26	25	Spare
28	27	Spare
30	29	Spare
32	31	ATN-
34	33	Spare
36	35	BUSY-
38	37	ACK-
40	39	RST-
42	41	MSG-
44	43	SEL-
46	45	C-/D
48	47	REQ-
50	49	I-/O

Table 2.4
Connector P3,
Host Interface Pin Assignments

Pin Number	Voltage
1	No connection
2	Ground return
3	Ground return
4	+5 VDC

Table 2.5
Connector P1, Power Supply
Pin Assignments

2.6 References

Schematics for the DJ 21Ø can be obtained by completing a non-disclosure agreement with Konan Corporation. Please call our marketing department at (6Ø2)269-2649 for further details.

Please reference the operating manual for the particular drive that is to be interfaced to the DJ 21Ø.

SASI/XSASI is a subset of SCSI with minor modifications, most notably the last byte (byte 5) of each command. This modification is articulated in the specific commands offered in the Host Interface section of this manual. With this in mind the following document should be helpful:

American National Standards Committee
X3T9.2 SCSI Specification

Available from:
X3 Secretariat/CBEMA
311 First St. NW, Suite 5ØØ
Washington, D.C. 2ØØ01

3.Ø Theory Of Operation

3.1 The Processor

The processor in the DJ 21Ø is a Z8ØA CPU, with 4K of PROM for firmware and 1K of RAM for variable data. Collectively, the above components constitute the "intelligence" of the controller.

The design that has gone into this aspect of the controller has been to enhance performance and increase flexibility while reducing cost.

As a result, the majority of operations have been placed in firmware. The only functions performed by "hardware" are those that are too fast for the processor.

The Z8ØA CPU and its associated Prom and RAM collectively perform the following functions:

1. Power up initialization
2. Diagnostics
3. Error recovery
4. Error reporting
5. Error correction
6. Command processor
7. Disk select
8. Seek
9. Write precomp select, reduced write current
10. Head select
11. Mapping
12. Logical to physical address translation
    Physical to logical address translation

3.2 The DJC Custom Chip

The DJC is a custom LSI chip. It has been designed to handle all serial data, state machine and DMA functions as described below.

ERROR CORRECTION CODE

The error correction polynomial is a 32-bit code capable of correcting up to 11-bit burst errors.

In keeping with the overall design philosophy, the ECC circuitry generates the write syndrome and validates the read without requiring the processor to handle the data. Calculating this polynomial with the processor would seriously degrade the performance of the DJ 21Ø.

ERROR CORRECTION CODE (Continued)

Calculating the reverse polynomial to correct bad data is done by the processor. It is accomplished without any measurable effect on performance because the operation is only done after multiple retries and as such is seldom necessary.

HEADER VERIFICATION

Once a disk has been formatted, the DJC converts the desired record number from the host to the pre-recorded address on the disk. The conversion is done in terms of head, track and sector address, with a CRC code tested to further insure positional integrity. A compare is then made of the header before a read or write function is performed.

TWO INDEX TIMEOUT

This function insures accurate control over the number of attempts to find a header (i.e., it is not "misled" by counting false address marks).

SCSI INTERFACE

SCSI unit select and handshake are primarily contained within the DJC.

MFM ENCODE

The DJC converts all parallel data to serial and then to MFM. This function is followed by Precomp, if selected. (See page 4-27)

3.3 Selectable Precomp

In Precomp, a "string" of pulses is analyzed to determine if they are arranged in the unique manner that could cause them to crowd once written on the disk. It also determines which way the crowding would distort the pulses when read. The write pulse stream is then shifted, early or late, to compensate for the crowding conditions, which normally occur on the innermost tracks of the drive.

Under the processor's control, the DJC precomps the disk MFM data by using external inductive delays. Precomp is selectable and is designed to shift the MFM data early or late by 12 nanoseconds to improve read margins.

The use of this feature should be performed in conjunction with the particular drive manufacturer's specifications.

3.4 Host SASI

The host logic contains the SASI/SCSI compatible drivers and receivers. REQ/ACK handshake and SCSI select circuitry are contained in the DJC.

3.5 Disk I/O

This block consists of the drivers and receivers required to control the disk drive's cables. These drivers and receivers are controlled and interpreted by the Z8ØA, via the DJC.

3.6 MFM Decode

Data received from a disk drive is MFM, a self-clocking serial data stream which must be separated from the clocks. This is done by the 846Ø data separator chip which contains a phase locked loop, lock detect, missing clock detect and the data separator.

When the DJC asserts Read Gate, the 846Ø will attempt to lock its phase locked loop on the read data. If this does not occur within 4.8 usec, the DJC will turn off Read Gate, causing the 846Ø to relock on 1Ø MHz. Read Gate is then turned back on until the 846Ø locks on a preamble. The 846Ø is then placed into the low track rate for increased stability.

The MFM data is now decoded into NRZ data and clock for the DJC. The 846Ø decodes a missing clock bit and a hexidecimal A1, FD or an A1, F8 in the sync field. This data indicates the start of a valid header or data field. Receiving any other data causes the DJC to abort the read. Another read would be tried after resyncing the 846Ø to 1Ø MHz.

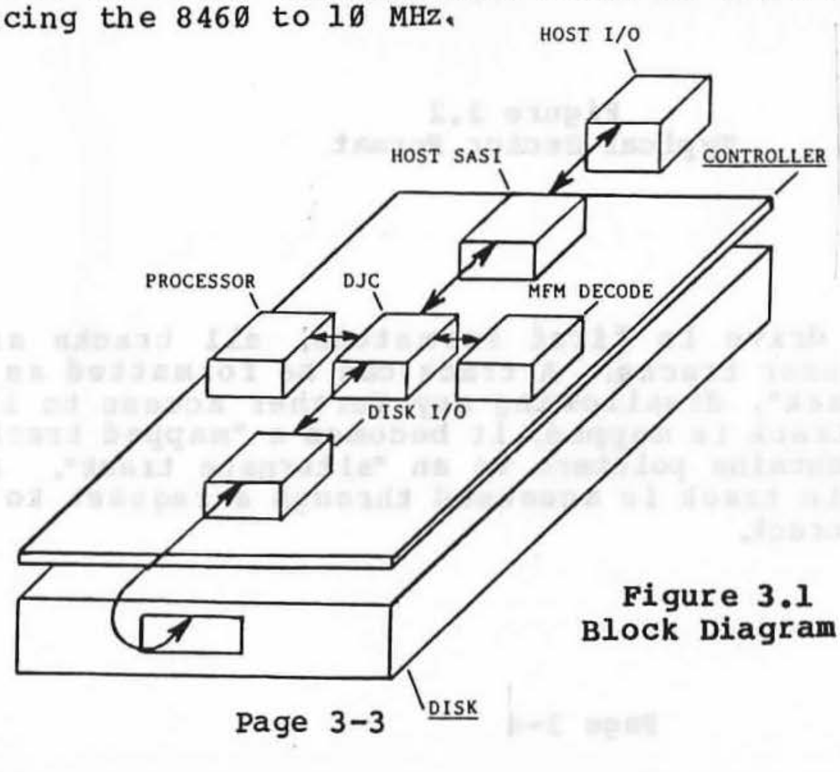
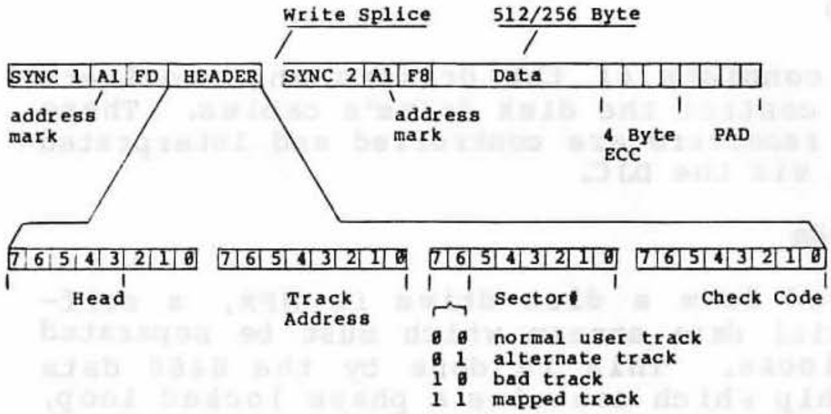


Figure 3.1
Block Diagram

3.7 Sector Format

Figure 3.2 describes the format of a typical sector.



Note: 1. Address Mark is a Hex Al with a missing clock pulse.
2. SYNC field 1 is comprised of 16 bytes of zeros.
3. SYNC field 2 is comprised of 15 bytes of zeros.

Figure 3.2
Typical Sector Format

When a drive is first formatted, all tracks are normal user tracks. A track can be formatted as a "bad track", disallowing any further access to it. When a track is mapped, it becomes a "mapped track" which contains pointers to an "alternate track". An alternate track is accessed through a request to a mapped track.

3.8 Error Recovery Philosophy

Extensive measures have been taken in the design of the DJ 21Ø to insure reliable data. Selectable precompensation circuitry and a sophisticated data separator with two tracking rates are a few examples. Additional effort has been made to reduce the probability of miscorrection (of having bad data flagged as corrected) through design and **options made available to the systems integrator.**

In a write operation the DJ 21Ø only precomps the unique combinations of data that might cause crowding conditions on the disk. Shifting data early or late by 12 nsec is done to retain as much of the 5Ø nsec data window as is possible. This reduces the probability of errors occuring.

In a read operation the data separator phase lock loop (PLL) provides two tracking rates, a high and a low, which allows for quick synchronization with the header address in the first case and stable data transfer in the second. The DJ 21Ø only contributes a maximum of 6 nsec (typically 3 nsec) of window error out of the allowable error window of 5Ø nsec This allows the disk drive to have up to 44 nsec of jitter before error recovery/correction is needed.

The DJ 21Ø uses a 32-bit error correction code that enables an error correction span of up to 11 bits. This computer-generated code is considered superior to fire codes because it substantially reduces the chances of miscorrection while providing the full 11-bit correction span.

Figure 3.3, Data Recovery, defines the data recovery and error correction procedures followed by the DJ 21Ø. In this operation, the ECC syndrome must be stable in order to perform a correction. This insures that multiple attempts are made to recover marginal data before correction is applied and further reduces the probability of miscorrection on long (greater than 12-bit) error bursts.

The significance of not correcting data unless the ECC syndrome is stable is that 1) noise induced errors are not corrected and 2) real errors are corrected quickly without wasting time on useless retries.

The user can improve data reliability by mapping tracks with flaws and by reducing the error correction span. The latter reduces the odds of miscorrection on large errors (greater than 12 bits) and provides for early detection of a degrading

(Error Recovery Philosophy - Continued)

media. The DJ 21Ø can be programmed to report or not report "soft" errors, on reads that took multiple tries but did not need correction.

Monitoring soft errors is probably the best method of early detection. **A correction span of seven (7) bits is thereby suggested as an optimum in data integrity.** An alternate eleven (11) bit correction span could be used as a means to retrieve the data before the track is mapped.

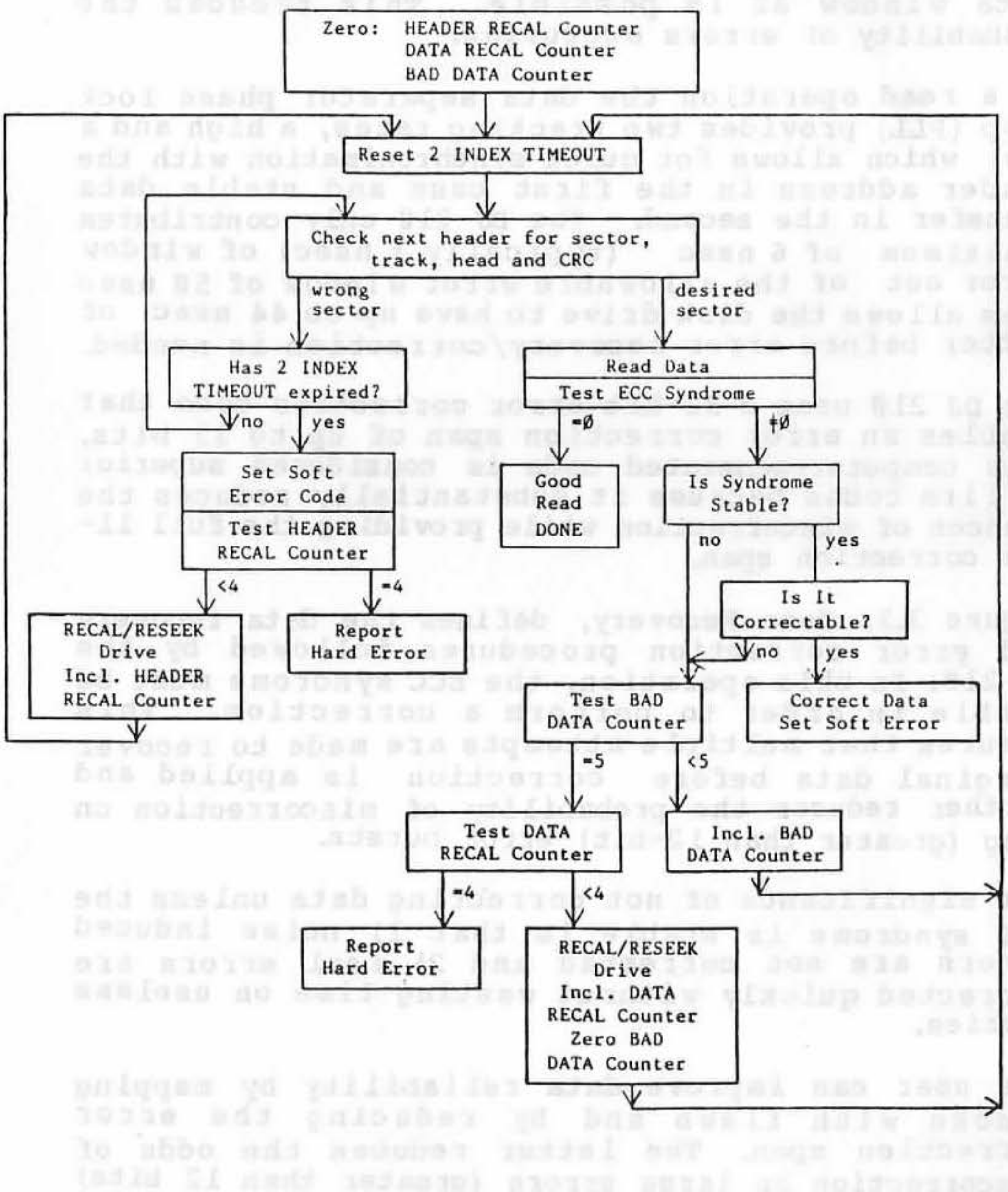


Figure 3.3
Data Recovery

3.9 Sector Interleaving

Interleaving is a matter of placing the logical sectors on a drive in non-sequential manner. When using a fully buffered device, such as the DJ 21Ø, it is not possible to read adjacent sectors on a single revolution. Only one transfer can occur at a time and it takes one "sector time" to fill the buffer from the disk. The host can empty the buffer in about the same length of time if it is fast enough. This means that every other sector can be transferred sequentially on one revolution of the disk.

In an optimum environment the user should utilize an interlace of two (2) which would appear as follows:

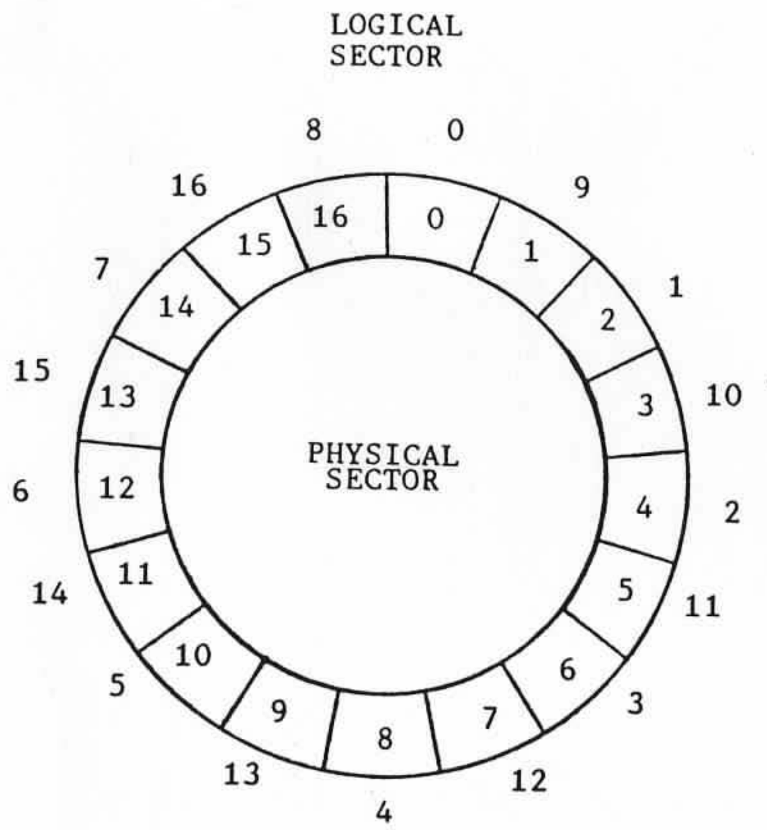


Figure 3.4
Logical Sector Diagram

In order to take advantage of the DJ 21Ø's performance it is necessary to do multiple sector transfers. When doing reads and writes with block counts of 1 the interlace will probably not matter.

User Notes:

4.Ø Host Interface

4.1 Host Interface Description

The host interface contains nine control signals and eight data signals. Table 4.1 Host Interface Pin Assignments, shows the pinouts of the host connector.

Signal Pin	Ground Return	Type	Optional Termination	Signal Name
2	1	Tri-state	22Ø/33Ø	DATAØ
4	3	Tri-state	22Ø/33Ø	DATA1-
6	5	Tri-state	22Ø/33Ø	DATA2-
8	7	Tri-state	22Ø/33Ø	DATA3-
1Ø	9	Tri-state	22Ø/33Ø	DATA4-
12	11	Tri-state	22Ø/33Ø	DATA5-
14	13	Tri-state	22Ø/33Ø	DATA6-
16	15	Tri-state	22Ø/33Ø	DATA7-
32	31		*	ATN-
36	35	O.C. Output	*	BUSY
		L.S. Input		
38	37	L.S. Input	22Ø/33Ø	ACK-
4Ø	39	L.S. Input	22Ø/33Ø	RST-
42	41	O.C. Output	*	MSG-
44	43	L.S. Input	22Ø/33Ø	SEL-
46	45	O.C. Output	*	C-/D
48	47	O.C. Output	*	REQ-
5Ø	49	O.C. Output	*	I-/O

Table 4.1
Host Interface Pin Assignments

NOTE: 22Ø/33Ø resistors shown are at RP1. Asterisk (*) signals are optionally terminated by RP2.

Each of the signal descriptions are described as follows:

<u>DATAØ- DATA7-</u>
These are eight data bits (lines) of the host bus (DBØ=LSB). Each line can also be used as an address bit to select a controller. The normal address connection (hard wired on board) is to DBØ- which is the address of controller Ø. Any other connection requires cutting the existing jumper on the board and adding a new wire. (See Section 1.1)

<u>ATN-</u>
This signal is not required for SASI compatibility. It is received by the DJ 21Ø for future expansion, ie. SCSI.

BUSY-
Busy is an active low signal. It is generated by the DJ 21Ø when it is selected. Busy is a wired OR signal and is asserted whenever any controller is selected. The DJ 21Ø can independently drive and read this line.

ACK-
This signal is driven by the host system to acknowledge the DJ 21Ø's REQuest for a transfer. In a transfer to the host, asserting ACK- (low) indicates the host has accepted the data. The DJ 21Ø will then deactivate it's REQ- and wait for the host to deactivate it's ACK- before starting a new transfer. In a transfer from the host, for instance issuing a command, the host asserts this signal in response to REQ to indicate a byte is valid.

RST-
This signal is used to perform a "hard" reset on the DJ 21Ø. The pulse must be at least 5ØØ nsec but has no maximum. The DJ 21Ø can be selected 5Ø usec after a reset. Reset deactivates all drive and host signals and returns the DJ 21Ø to a power up state. This resets all INIT parameters to power on defaults.

MSG-
This signal is asserted by the DJ 21Ø during a message phase. The message phase is only used at command completion and always with the I-/O signal asserted to allow status bytes to be returned. This signal is qualified by REQ-.

SEL-
This signal is received by the DJ 21Ø. The DJ 21Ø uses the leading edge of this signal (falling edge) to latch in the data bit selected as its address.

C-/D
This signal is controlled by the DJ 21Ø whenever it is selected. It is asserted when control information is on the bus and not asserted when data is on the bus. This signal is qualified by REQ-.

REQ-
The DJ 21Ø uses this line to request an information transfer. The type of transfer is identified by the MSG-, I-/O, and C-/D signals.

I-/O
This signal is driven by the DJ 21Ø whenever it is selected. It is asserted (low) when the flow of information is IN; that is, data/status to the host. When not asserted (high), data/commands are from the host (OUT). This signal is qualified by REQ-.

4.2 Device Control Block

The Device Control Block (DCB) is a 6-byte block sent to the controller by the host to specify an operation. Figure 4.1, Device Control Block, shows the control block. The text that follows defines the bytes that make up the Device Control Block.

BIT	7 6 5	4 3 2 1 0
BYTE 0	CMD CLASS	OPCODE
BYTE 1	LUN	HIGH ADDRESS
BYTE 2	MIDDLE ADDRESS	
BYTE 3	LOW ADDRESS	
BYTE 4	INTERLEAVE OR BLOCK COUNT	
BYTE 5	CONTROL FIELD	

Figure 4.1
Device Control Block

Byte Ø Bits 7,6 and 5 identify the class of the command. Bits 4 though Ø contain the opcode of the command.

Byte 1 Bits 7,6 and 5 identify the logical unit number (LUN). Bits 4 through Ø contain logical block address 2.

Byte 2 Bits 7 through Ø contain logical block address 1.

Byte 3 Bits 7 through Ø contain logical block address Ø (LSB).

Byte 4 Bits 7 through Ø specify the interleave or block count.

Byte 5 Bits 7 through Ø contain the control field.

4.2.1 Command Class

There are eight classes of commands Ø-7; class Ø commands are data, non-data transfer and status commands. Classes 1-6 are reserved, class 7 commands are diagnostic.

4.2.2 Opcode

These 5 bits, along with the command class, define the type of command to be performed. Supported commands are listed in Section 4.5 (Specific Commands).

4.2.3 Logical Unit Number

Bits 7 through 5 are reserved for the logical unit number. A LUN of ØØØ selects unit Ø; a LUN of ØØ1 selects unit 1. Note that bits 6 and 7 must be Ø when selecting disk drives.

4.2.4 Logical Block Address

The logical block address consists of 21 bits of address. This allows over 2 million blocks of data to be addressed, or over 1 gigabyte with 512 sectors. The DJ 21Ø converts the logical block address to a physical address on the disk. The conversion is done by the following procedure:

$$\mathrm{INT}\ \frac{\mathrm{LBA}}{\#\mathrm{HEADS}\cdot\#\mathrm{SECTORS}} = \mathrm{TRACK}\#$$

$$\mathrm{INT}\ \frac{\mathrm{LBA} - (\mathrm{TRACK}\#\cdot\#\mathrm{SECTORS}\cdot\#\mathrm{HEADS})}{\#\mathrm{SECTORS}} = \mathrm{HEAD}\#$$

$$(\mathrm{LBA} - \mathrm{TRACK}\#\cdot\#\mathrm{SECTORS}\cdot\#\mathrm{HEADS}) - \mathrm{HEAD}\#\cdot\#\mathrm{SECTORS} - 1 = \mathrm{SECTOR}\ \#$$

Performing this algorithm does take some time. This is partially why multi-sector transfers are much faster than single-sector transfers. On a multiple sector transfer the calculation is only done once. Very fast "next" routines are used for subsequent sectors, and the logical address is incremented. To address a physical spot on the disk, use the following algorithm to calculate a logical address:

(cylinder address • # of heads + head address) • # of sectors per track + sector address

4.2.5 Block Count/Interleave

Byte 4 is used for read and write commands to indicate the number of blocks to be transferred. Bits 4 through Ø of byte 4 are used to set the interleave in format commands.

4.2.6 Control Byte

Byte 5 of the device control block is the control byte. It is used to select several different drive options. The byte is defined as follows:

BIT	7	6	5	4	3	2	1	0
BYTE 5	R	A	x	0	S	S	S	S

R = retries

R is normally set to zero (0). A one (1) in this bit disables retries. This bit is normally used for diagnostics.

A = immediate ECC

If set to 1, do not retry before attempting to correct bad data with the ECC code. This bit should normally be set to a 0.

X = not currently used. Can be a 0 or 1.

S = seek mode

Bits 3 through 0 of byte 5 define the step mode as follows:

Description		Bits 3	2	1	0
Default 3msec step rate		0	0	0	0
TBA		0	0	0	1
3 msec		0	0	1	0
3 msec		0	0	1	1
200 usec buffered step		0	1	0	0
60 usec buffered step		0	1	0	1
30 usec buffered step		0	1	1	0
11 usec buffered step		0	1	1	1
TBA		1	0	0	0
3 msec step		1	0	0	1
TBA		1	0	1	0
	thru	1	1	1	1

4.3 Status Bytes

Two bytes of status are returned at the end of each command. The first byte informs the host if any error occured and identifies the drive number. The last byte is an all zero byte that indicates the command is complete.

First Status Byte

BIT	7	6	5	4	3	2	1	0
	LUN			0	0	0	ERR	0

Bits Ø, 2-4	Set to zero
Bit 1	When set, error occurred during command execution.
Bit 7-5	Logical Unit Number of drive.

Last Status Byte

BIT	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0

Bits Ø-7	Set to zero

4.4 Handshaking and Timing

4.4.1 Controller Selection

All controller functions begin with a selection. The SASI interface will accomodate one host and eight controllers. Each controller has a unique data bit assigned to it to allow it to be selected. In order to select a controller the host activates (lowers) one and only one data line and then lowers the SEL- line. The controller assigned this address line responds by asserting busy. Selection is then complete. It is recommended that the SEL- line be deactivated at the same time or before the first command byte is sent to the controller. With selection complete the DJ 21Ø enters the command phase.

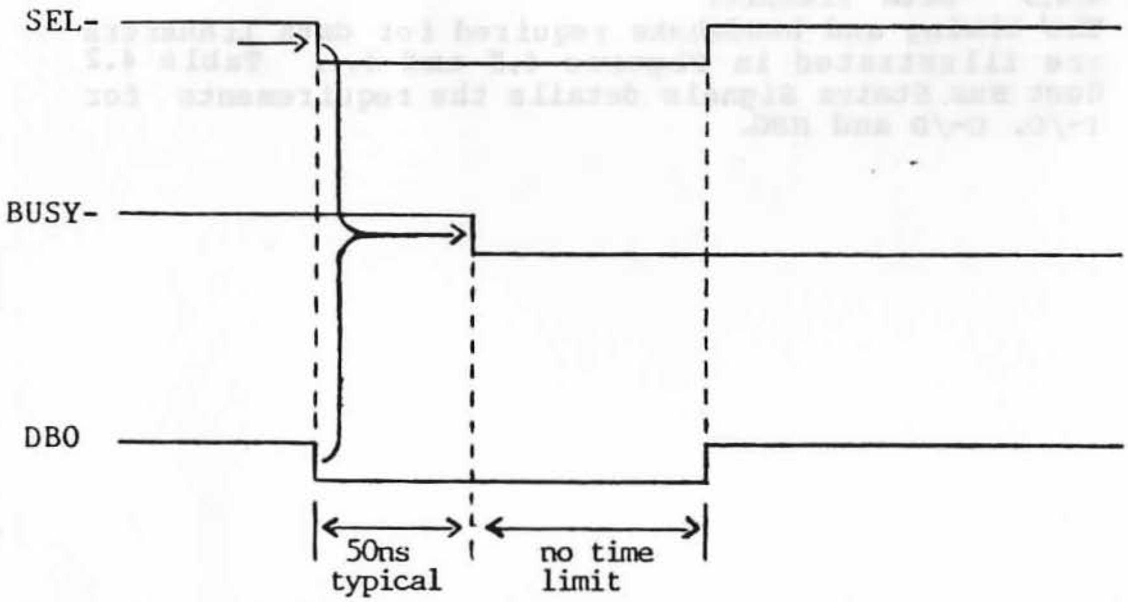
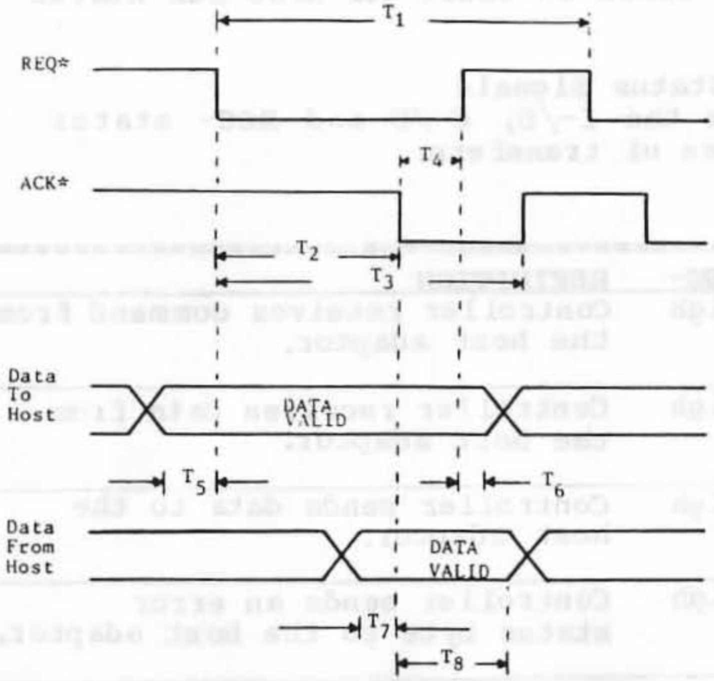


Figure 4.2
Controller Select Timing

4.4.2 Command Transfer
The DJ 21Ø receives commands from the host by using a REQ-/ACK- handshake. After the selection phase, the DJ 21Ø will place a high level on the I-/O line to indicate that data is to be output from the host system and activates (a low level) the C-/D line to indicate the DJ 21Ø is in the command mode. The MSG- line is left deactivated, high.

The DJ 21Ø then activates the REQ-. When a command byte is ready for the controller the host adaptor responds by activating the ACK- signal. The command byte placed on the data bus by the host must be stable within 25Ø nanoseconds after the ACK- signal is activated. The command byte must be held stable until REQ- is deactivated. The host deactivates ACK- after REQ- goes high. This completes the handshake for the first command byte. Each succeeding command byte from the host adaptor requires the same complete handshake sequence. See Figures 4.3 and 4.4 for data bus, REQ-, and ACK- timing. See Table 4.2 Host Bus Status Signals for I-/O, C-/D, and MSG- definition.

4.4.3 Data Transfer
The timing and handshake required for data transfers are illustrated in Figures 4.3 and 4.4. Table 4.2 Host Bus Status Signals details the requirements for I-/O, C-/D and MSG.



Definition:

REQ* ACK*

T_1 = 1.2 usec min, no max
T_1 = 1.2 usec if $T_2 \leq 700$ nsec and
$T_3 \leq 1$ usec

If $T_2 > 700$ nsec or $T_3 > 1$ usec then T_1 is expanded as required in 300 nsec increments.

$T_4 \leq 100$ nsec

Data To Host

T_5 = 150 nsec min
T_6 = 0 nsec min

Data From Host

T_7 = 0 nsec min
T_8 = 100 nsec min

Figure 4.3
Data Transfer To Host Timing

4.4.4 Status Bytes

The contents of the status bytes are defined in Section 4.4. The REQ-/ACK- timing is shown in Figure 4.3 Data Transfer to Host Timing. Control of I-/O, C-/D, and MSG- is shown in Table 4.2 Host Bus Status Signals.

4.4.5 Host Bus Status Signals

Table 4.2 defines the I-/O, C-/D and MSG- status lines for all types of transfers.

I-/O	C-/D	MSG-	DEFINITION
High	Low	High	Controller receives command from the host adaptor.
High	High	High	Controller receives data from the host adaptor.
Low	High	High	Controller sends data to the host adaptor.
Low	Low	High	Controller sends an error status byte to the host adaptor.
Low	Low	Low	Controller informs the host adaptor that it has completed the current command.

Table 4.2
Host Bus Status Signals

4.5 Specific Commands

This subsection details each individual command. Table 4.3 is a summary of all commands.

Command Name	(hex) Command	Block Address	Byte 4	Options	Number of Data Bytes	Direction
Test Drive Ready	ØØ	–	–	–	–	–
Recalibrate	Ø1	–	–	R,S	–	–
Request Sense Status	Ø3	–	–	–	4	to host
Format Drive	Ø4	LT	I	R,S	–	–
Check Track Format	Ø5	LT	I	R,S	–	–
Format Track	Ø6	LT	I	R,S	–	–
Format Bad Track	Ø7	LT	I	R,S	–	–
Read	Ø8	L	BC	R,A,S	sector	to host
Write	ØA	L	BC	R,S	sector	to DJ21Ø
Seek	ØB	LT	–	R,S	–	–
Initialize Drive Characteristics	ØC	–	–	–	8	to DJ21Ø
Read ECC Burst Length	ØD	–	–	–	1	to host
Format Alternate Track	ØE	LT	I	R,S	3	to DJ21Ø
Write Sector Buffer	ØF	–	–	–	sector	to DJ21Ø
Read Sector Buffer	1Ø	–	–	–	sector	to host
Extended Initialize	11	–	–	–	16	to DJ21Ø
RAM Diagnostic	EØ	–	–	–	–	–
Drive Diagnostics	E3	–	–	R,S	–	–
Controller Internal Diagnostics	E4	–	–	–	–	–
Read Long	E5	L	BC	R,S	sector +4	to host
Write Long	E6	L	BC	R,S	sector +4	to DJ21Ø

L = logical block address
LT = logical block address used only to specify track address
I = interlace
BC = block count
S = step rate
A = attempt immediate correction
R = retry enable (disable)

Table 4.3
Summary of Commands

4.5.1 Test Drive Ready (class Ø, opcode ØØ)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	0	0	0
BYTE 1	LUN			–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	–	–	–	–	–	–	–	–

LUN = Logical Unit Number

Action
Select drive and determine whether or not it is ready. For drives supporting buffered seeks this command is useful for determining the first drive to reach its target track.

Possible Error Codes

No Error
Drive Not Ready
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)

4.5.2 Recalibrate (class Ø, opcode Ø1)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	0	0	1
BYTE 1	LUN			–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	R	0	0	0	S	S	S	S

LUN = Logical Unit Number
R = retries
S = step option

Action
Position the heads to cylinder Ø.

Possible Error Codes

No Error
Drive Not Ready
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
No Seek Complete

4.5.3 Request Sense Status Command (class Ø, opcode Ø3)

Immediately upon receipt of an error condition, the host must send this command causing the controller to return four bytes of drive and controller status.

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	0	1	1
BYTE 1	LUN			–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	–	–	–	–	–	–	–	–

LUN = Logical Unit Number

The first byte returned is the error code. Tables 4.4, 4.5, 4.6, and 4.7 define all the error codes in all four types of errors.

7	6	5	4	3	2	1	Ø
A	Ø	Error Type		Error Code			
LUN			High Block Address				
Middle Block Address							
Low Block Address							

LUN = Logical Unit Number
A = address valid

The block address is required to identify where an error occured in a multiblock command. When A is true (1) the following block address is valid. The address will be valid (A=1) in error status that follows commands with block numbers. In the case of format commands or the check track format, the block address returned by the DJ 21Ø points to one sector beyond the last track formatted or checked in the absence of any errors. If there was an error the block address returned points to the track in error.

Hex Code	Error	Definition
Ø		The previous operation was error free.
1	No Index	The DJ 21Ø does not detect index signals from the drive.
2	No Seek Complete	After selecting the drive, asserting any seeks and waiting for drive ready, the DJ21Ø did not get a seek complete signal from the drive within the time out period. The time out for seek complete is 3 milliseconds times the number of seek tracks plus 1ØØ milliseconds head settle time.
3	Write Fault	The DJ 21Ø detected a write fault from the drive during the last operation.
4	Drive Not Ready	After selecting the drive and asserting any seeks, the DJ21Ø did not get a drive ready signal from the drive within the time out period. The time out for drive ready is 4Ø seconds.
5	No Select	No drive selected.
6	No Track Zero	After stepping the maximum number of cylinders, the DJ 21Ø did not receive a track ØØ signal from the drive.
7	Multiple Drives Selected	Multiple drives selected.
9	Cartridge Changed (Drive Ø Only)	Cartridge changed. Drive zero only.
F	Drive Mis-selected	Drive mis-selected.

Table 4.4
Type Ø Error Codes, Disk Drive

Hex Code	Error	Definition
Ø	ID Read Error	The DJ21Ø could not find any valid sector IDs on the target track.
1	Data Error	The controller detected an error span in the data field that was greater than the ECC Burst Length defined in byte 7 of the configuration parameter block.
2	No Address Mark	The controller could not find any address marks on the target track.
3		Not Used.
4	Sector Not Found	The DJ 21Ø found the correct cylinder and head but not the target sector.
5	Seek Error	After receiving a drive ready and seek complete signal from the drive, the DJ21Ø detected a track zero signal from the drive when the destination cylinder was not zero.
6		Not Used.
7	Write Protected	The write protect input to the DJ 21Ø is asserted.
8	Correctable	The DJ 21Ø detected a correctable ECC Data Error in the target data field, and has corrected the data. This is the only error condition for which data is sent to the host.
9	Bad Track Error	The target track was flagged as bad.
A	Format Error	During Format command(s) the DJ21Ø detected that data was not written to the disk. During Check Track Format the controller detected that the sector interleave on the target track did not match that specified by byte 4 of the command block.

C	Direct Access to Alternate Track	The target track was flagged as alternate.
D	Alternate Used	On a format alternate track command, the requested alternate track has already been assigned as an alternate, or is flagged as a bad track.
E	Alternate Track Not Found	The target track was flagged as mapped and the alternate track was not flagged as alternate.
F	Alternate Equals Bad	During a Format Alternate command, the alternate track equaled the bad track.

Table 4.5 Type 1 Error Codes, Controller

Hex Code	Error Type	Error	Definition
Ø	2	Invalid Command	The DJ 21Ø has received an invalid command from the host.
1	2	Illegal Disk Address	The DJ 21Ø detected a block address that is greater than the maximum.
Ø	3	RAM Error	The DJ 21Ø detected a data error during the RAM diagnostic.
1	3	ROM Checksum Error	During internal diagnostic, the DJ 21Ø detected a ROM checksum error.
Ø	4	Time Out Circuit Error	Read ID time out circuit error.

Table 4.6
Type 2, 3 and 4 Error Codes,
Command and Miscellaneous

The following is a summary of the error codes returned as a result of the Request Sense Status Command.

NOTE: The address valid bit (bit 7) may or may not be set and is not included here.

(hex) Error Code	Meaning
ØØ	No error
Ø1	No index pulses
Ø2	No seek complete from disk drive
Ø3	Write fault from disk drive
Ø4	Drive not ready after select
Ø5	Drive not selected
Ø6	Track ØØ not found
Ø7	Multiple drives selected
Ø9	Cartridge changed (drive Ø only)
ØF	Drive mis-selected
1Ø	ID field read error
11	Uncorrectable data error
12	Address mark not found
14	Sector not found
15	Seek error
17	Write protected
18	Correctable data error
19	Bad track flag detected
1A	Format error
1C	Illegal access to alternate track
1D	Alternate track already used
1E	Alternate track not marked as alternate
1F	Alternate track equals bad track
2Ø	Invalid command
21	Illegal disk address
3Ø	RAM diagnostic failure
31	ROM checksum failure
4Ø	Read ID time out circuit error

Table 4.7
Summary of Request Sense Status Error Codes

4.5.4 Format Drive (class Ø, opcode Ø4)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	1	0	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	0	0	0	INTERLEAVE				
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step option

Action
Format the disk from the specified track to the end of the disk. The previous contents of the formatted tracks are lost. All data fields are set to 6C hex. The interleave can be from 1 to N + 1 where N equals the number of sectors per track.

Possible Error Codes

No Error
Drive Not Ready
Seek Error
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
To Track Zero Signal
Drive Write Protected
Drive Write Faulted
No Seek Complete
Format Error (Cannot Write Disk)

4.5.5 Check Track Format (class Ø, opcode Ø5)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	1	0	1
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	0	0	0	INTERLEAVE				
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step option

Action
This command is used to verify the specified track for valid headers and data.

Possible Error Codes

No Error
Seek Error
Format Error (Sector Interleave Wrong)
Drive Not Ready
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
No Seek Complete
Accessed Alternate Track
Accessed Bad Track
Alternate Not Alternate
Sector Not Found
Uncorrectable Data Error
ECC Corrected Data Error

4.5.6 Format Track (class Ø, opcode Ø6)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	1	1	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	0	0	0	INTERLEAVE				
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step option

Action
The specified track is formatted with the specified interlace. The previous data content of the track is replaced with 6C hex data. The interleave can be from 1 to N + 1 where N equals the number of sectors per track.

Possible Error Codes

No Error
Seek Error
Drive Not Ready
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
Drive Write Protected
Drive Write Faulted
No Seek Complete
Format Error (cannot write disk)

4.5.7 Format Bad Track (class Ø, opcode Ø7)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	1	1	1
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	0	0	0	INTERLEAVE				
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step option

Action
The specified track is formatted as bad. The previous contents of the track are destroyed. No mapping function is performed.

Possible Error Codes

No Error
Drive Not Ready
Seek Error
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
Drive Write Protected
Drive Write Faulted
No Seek Complete
Format Error (Cannot Write Disk)

4.5.8 Read (class Ø, opcode Ø8)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	0	0	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	BLOCK COUNT							
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = retry disable (normally Ø)
A = immediate ECC correction (normally Ø)
S = step option

Action
Read the specified number of sectors (block count) starting with the specified address.

Possible Error Codes

No Error
Drive Not Ready
Seek Error
Accessed Bad Track
Accessed Alternate Track
Alternate Not Alternate
Uncorrectable Data Error
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
No Seek Complete
Sector Not Found
ECC Corrected Data Error

4.5.9 Write (class Ø, opcode ØA)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	0	1	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	BLOCK COUNT							
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number

R = retry disable (normally Ø)
A = Ø
S = step option

Action
Write the specified number of sectors (block count), starting with the specified address.

Possible Error Codes

No Error
Drive Not Ready
Seek Error
Accessed Bad Track
Accessed Alternate Track
Alternate Not Alternate
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
Drive Write Protected
Drive Write Faulted
No Seek Complete
Sector Not Found

4.5.1Ø Seek (class Ø, opcode ØB)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	0	1	1
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = retry disable (normally Ø)
A = Ø
S = step option

Action
The DJ 21Ø will seek to the specified track. The seek rate is established by the "S" field in the last byte of the device control block. The seek rates available are:

	S_3	S_2	S_1	$S_Ø$	Step Rate
	Ø	Ø	Ø	Ø	Default 3msec
	Ø	Ø	Ø	1	TBA
	Ø	Ø	1	Ø	3msec
	Ø	Ø	1	1	3msec
	Ø	1	Ø	Ø	2ØØusec buffered
	Ø	1	Ø	1	6Øusec buffered
	Ø	1	1	Ø	3Øusec buffered
	Ø	1	1	1	11usec buffered
	1	Ø	Ø	Ø	TBA
	1	Ø	Ø	1	3msec step
	1	Ø	1	Ø	TBA
through	1	1	1	1	

Step rates Ø1ØØ through Ø111 are buffered. The step pulses are sent to the disk at the specified rate and then a status is returned in a message phrase. Any error in this message indicates the seek could not be done. The drive may be tested for Ready by issuing the Test Drive Ready command. When both drives on a single DJ 21Ø are seeking Test Drive Ready, commands can be alternated between the drives to find the first ready unit. This allows seeks to be overlapped. If a new command is issued (ie. read or write) before the seek is complete the DJ 21Ø will wait with busy asserted for seek complete and then execute the command. Non-buffered seeks are completed prior to refreshing the status. The seek command only positions the heads; the headers are not checked until a subsequent read or write.

Possible Error Codes

No error, invalid disk address, drive not ready, drive not selected, drive mis-selected, multiple drives selected, cartridge changed (drive 0 only), time out circuit error, no index from drive, no track zero signal, no seek complete, seek error.

4.5.11 Initialize Drive Characteristics (class 0, opcode 0C)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	1	0	0
BYTE 1	–	–	–	–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	–	–	–	–	–	–	–	–

Action
Set the following parameters for both of the Winchester drives (logical units 0 and 1): number of cylinders, number of heads, starting reduced write current cylinder, starting write precompensation cylinder, and the maximum length of an error burst to be corrected. These parameters are sent by the host to the DJ 210 in a parameter block after sending the initialize drive characteristic command. The parameters are:

0 Most significant byte of number of cylinders.
1 Least significant byte of number of cylinders.
2 Bits 4-7 must be zero
Bits 0-3 = number of heads
3 Most significant byte of starting reduced write current cylinder.
4 Least significant byte of starting reduced write current cylinder.
5 Most significant byte of starting write precompensation cylinder.
6 Least significant byte of starting write precompensation cylinder.
7 Bits 4-7 must be zero
Bits 0-3 = maximum length of an error burst to be corrected.

4.5.11 Initialize Drive Characteristics cont'd

Power up and reset set these parameters to the following defaults.

153 = Number of cylinders
4 = Number of heads
128 = Starting reduced write current cylinder
64 = Starting write precompensation cylinder
11 = Maximum length of an error burst to be corrected

The acceptable range of values for these parameters are as follows:

1 - 2048	Number of cylinders
1 - 16	Number of heads
0 - 2047	Starting reduced write current cylinder
0 - 2047	Starting write precompensation cylinder
0 - 11	Maximum length of error burst to be corrected

If one of these parameters is out of range, then the entire block of parameters is rejected. The error code for this error is "invalid command".

Possible Error Codes

No Error
Invalid Disk Address
Invalid Command (Parameter Error)

4.5.12 Read ECC Burst Length (class Ø, opcode ØD)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	1	0	1
BYTE 1	–	–	–	–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	–	–	–	–	–	–	–	–

Action
Send the host one byte of data containing the length of the most recently corrected error burst. If no error burst has been corrected since the last power up or reset, then a length of zero is sent to the host.

Possible Error Codes
No error codes.

4.5.13 Format Alternate Track (class Ø, opcode ØE)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	1	1	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	0	0	0	INTERLEAVE				
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step option

Action
Following the device control block the DJ 21Ø will request three more bytes of data. The track address in the device control block specifies the address of the bad track and the three bytes following specify the address of the alternate track. The bad track is formatted as a bad track with multiple pointers to the alternate track. The alternate track is also reformatted. Data on both tracks is lost.

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	HIGH ADDRESS				
BYTE 1	MIDDLE ADDRESS							
BYTE 2	LOW ADDRESS							

Possible Error Codes

No Error
Invalid Disk Address
Drive Not Ready
Alternate Track Already Assigned or Flagged Bad
Seek Error
Drive Write Faulted
Alternate Track Equals Bad Track
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
Drive Write Protected
No Seek Complete
Format Error (Cannot Write Disk)

4.5.14 Write Sector Buffer (class Ø, opcode ØF)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	1	1	1
BYTE 1	–	–	–	–	–	–	–	–
BYTE 2	–	–	–	–	–	–	–	–
BYTE 3	–	–	–	–	–	–	–	–
BYTE 4	–	–	–	–	–	–	–	–
BYTE 5	–	–	–	–	–	–	–	–

Action
Write data from the host to the DJ 21Ø sector buffer. The host must send as many bytes as there are in a sector. This command is only used for diagnostic purposes. This data is not written to any disk.

Possible Error Codes
No error codes.

4.5.15 Read Sector Buffer (class Ø, opcode 1Ø)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	1	0	0	0	0
BYTE 1	-	-	-	-	-	-	-	-
BYTE 2	-	-	-	-	-	-	-	-
BYTE 3	-	-	-	-	-	-	-	-
BYTE 4	-	-	-	-	-	-	-	-
BYTE 5	-	-	-	-	-	-	-	-

Action
Send the host the current contents of the DJ 21Ø sector buffer. The number of bytes transferred equals the number of bytes in a sector.

Possible Error Codes
No error codes.

4.5.16 RAM Diagnostic Command (class 7, opcode EØ)

Possible Error Codes

No Error
RAM Read-Write Error

4.5.17 Drive Diagnostic Command (class 7, opcode E3)

TBA

4.5.18 Controller Internal Diagnostic Command (class 7, opcode E4)

Possible Error Codes

No Error
ROM Checksum Error
RAM Read-Write Error

4.5.19 Read Long (class 7, opcode E5)

BIT	7	6	5	4	3	2	1	0
BYTE 0	1	1	1	0	0	1	0	1
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	BLOCK COUNT							
BYTE 5	R	A	0	0	S	S	S	S

LUN = Logical Unit Number
D = drive number
R = Ø
A = Ø
S = step rate

Action
Read the specified sector(s) along with four bytes of ECC per sector. No error correction is performed. This command is useful only as a diagnostic.

Possible Error Codes

No Error
Invalid Disk Address
Seek Error
Drive Not Ready
Accessed Bad Track
Illegal Access To Alternate Track
Alternate Track Not Marked As Alternate
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
No Seek Complete
Sector Not Found

4.5.2Ø Write Long (class 7, opcode E6)

BIT	7	6	5	4	3	2	1	0
BYTE 0	1	1	1	0	0	1	1	0
BYTE 1	LUN			HIGH ADDRESS				
BYTE 2	-	MIDDLE ADDRESS					-	
BYTE 3	LOW ADDRESS							
BYTE 4	BLOCK COUNT							
BYTE 5	R	0	0	0	0	S	S	S

LUN = Logical Unit Number
R = Ø
A = Ø
S = step rate

Action
Write the specified sector(s) using four additional bytes supplied from the host in place of the four bytes normally supplied by the ECC hardware on the DJ 21Ø. This command is useful only as a diagnostic.

Possible Error Codes

No Error
Invalid Disk Address
Drive Not Selected
Drive Mis-selected
Multiple Drives Selected
Cartridge Changed (Drive Ø Only)
Time Out Circuit Error
No Index From Drive
No Track Zero Signal
Seek Error
Drive Not Ready
Accessed Bad Track
Illegal Access To Alternate Track
Alternate Track Not Marked As Alternate
Drive Write Protected
Drive Write Faulted
No Seek Complete
Sector Not Found

4.5.21 Extended Initialize (class Ø, opcode 11)

BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	1	0	0	0	1
BYTE 1	LUN			-	-	-	-	-
BYTE 2	-	-	-	-	-	-	-	-
BYTE 3	-	-	-	-	-	-	-	-
BYTE 4	-	-	-	-	-	-	-	-
BYTE 5	-	-	-	-	-	-	-	-

LUN = Logical Unit Number

Action

Set the following parameters for the specified Winchester drive (logical units Ø and 1): number of cylinders, number of heads, starting reduced write current cylinder, starting write precompensation cylinder, and the maximum length of an error burst to be corrected. These parameters are sent by the host to the DJ 21Ø in a parameter block after sending the extended initialize command. The parameters are:

PARAMETER BLOCK DESCRIPTION:

BIT NO.	7	6	5	4	3	2	1	Ø	
BYTE Ø	C	C	C	C	C	C	C	C	high byte (Cylinders)
BYTE 1	C	C	C	C	C	C	C	C	low byte
BYTE 2	Ø	Ø	Ø	Ø	H	H	H	H	(Heads)
BYTE 3	W	W	W	W	W	W	W	W	high byte (RW Current)
BYTE 4	W	W	W	W	W	W	W	W	low byte
BYTE 5	P	P	P	P	P	P	P	P	high byte (Pre-comp)
BYTE 6	P	P	P	P	P	P	P	P	low byte
BYTE 7	Ø	Ø	Ø	Ø	E	E	E	E	(ECC burst)
BYTE 8	Ø	Ø	Ø	Ø	S	S	S	S	(Step Mode)
BYTE 9	Ø	Ø	Ø	N	N	N	N	N	(Sectors/track)
BYTE A	Ø	Ø	Ø	Ø	A	A	A	A	(Map cylinders)
BYTE B	M	M	M	M	M	M	M	M	(Mode switches)
BYTE C	F	F	F	F	F	F	F	F	(Format fill byte)
BYTE D-F	SET TO Ø, RESERVED FOR FUTURE								

4.5.21 Extended Initialize cont'd

PARAMETER BLOCK DEFINITION:

C = Number of cylinders
H = Number of heads
W = Cylinder to start REDUCE WRITE CURRENT
P = Cylinder to start WRITE PRE-COMPENSATION
E = ECC burst length
S = Step mode
N = Number of sectors per track
A = Number of MAP cylinders (auto mapping)
M = Mode switches

FIELD DEFINITION:

SSSS - This field is reserved for future implementation, SCSI. The step field in SASI commands override this parameter.

NNNN - The number of sectors per track is fixed at 32 for 256 byte sectors and as such is ignored.

The number of sectors per track is 16, 17 or 18 for 512 byte sectors. A default of 17 sectors per track will be used if the paramater is out of range.

AAAA - If this field is zero Auto Mapping is disabled. If it is non-zero, Auto Mapping is enabled and the value specifies the number of spare innermost cylinders allocated to Mapping.

MMMM - Bits 7 to 1 are reserved and should be set to zero (Ø). Bit Ø is a full reveal bit. Setting this bit true will cause the controller to report soft data and header errors.

PARAMETERS:

Ø	Most significant byte of number of cylinders.
1	Least significant byte of number of cylinders.
2	Bits 4-7 must be zero Bits Ø-3 = number of heads
3	Most significant byte of starting reduced write current cylinder.
4	Least significant byte of starting reduced write current cylinder.
5	Most significant byte of starting write precompensation cylinder.
6	Least significant byte of starting write precompensation cylinder.
7	Bits 4-7 must be zero Bits Ø-3 = maximum length of an error burst to be corrected.

4.5.21 Extended Initialize cont'd

Power up and reset set these parameters to the following defaults.

153 = Number of cylinders
4 = Number of heads
128 = Starting reduced write current cylinder
64 = Starting write precompensation cylinder
11 = Maximum length of an error burst to be corrected

The acceptable range of values for these parameters are as follows:

1 - 2Ø48	Number of cylinders
1 - 16	Number of heads
Ø - 2Ø47	Starting reduced write current cylinder
Ø - 2Ø47	Starting write precompensation cylinder
Ø - 11	Maximum length of error burst to be corrected

If one of these parameters is out of range, the entire block of parameters is rejected. The error code for this error is "invalid command".

Possible Error Codes

No Error
Invalid Disk Address
Invalid Command (Parameter Error)

5.0 Warranty/Maintenance

5.1 Warranty

THE DJ 210 WARRANTY

KONAN Corporation offers a repair or replacement warranty, on any DJ 210 controller it has manufactured, for a period of ninety (90) days following the date of shipment from Konan Corporation. Under the conditions of this warranty, Konan will either repair or replace, at its own option and expense, any defective DJ 210 controller that fails to perform in accordance with Konan's published specifications.

In order to validate this warranty and assure prompt service the buyer must:

1) Request return material authorization number(s) (RMA) from Konan Corporation prior to returning any defective controller.

2) Complete and enclose the failure report (from Section 5 of this manual) with defective controller.

3) Display RMA numbers on all shipping containers with DJ 210 controllers authorized for return.

4) Return the defective DJ 210 controller and enclosed failure report to Konan freight prepaid.

In return Konan Corporation will promptly issue RMA tracer numbers and, at its own option, will either:

1) Repair defective DJ 210 controllers upon receipt and return to buyer or

2) Replace defective DJ 210 controllers and return to buyer.

The above warranties are contingent upon proper use in the application for which the DJ 210 controller was intended and does not cover any DJ 210 controller which was modified without KONAN's approval or subjected to unusual physical or electric stress.

EXCEPT FOR THE EXPRESS WARRANTIES SET FORTH ABOVE, KONAN GRANTS NO OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED, ON PRODUCT, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND THE STATED EXPRESS WARRANTY IS IN LIEU OF ALL LIABILITIES OR OBLIGATIONS OF SELLER FOR DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES OCCURING OUT OF OR IN CONNECTION WITH THE USE OF OR PERFORMANCE OF KONAN'S PRODUCT.

5.2 Maintenance Philosophy

The DJ 21Ø requires no preventative maintenance. Konan's suggested method of repair is board replacement. If a board failure or any other board problem occurs, replace the faulty board with a good board and return board to Konan for repair.

5.3 Return Material Procedures

To help Konan provide you with prompt, high quality service, please follow these procedures when returning a board.

1. Call Konan Corporation (6Ø2) 345-13ØØ to get a RMA (Return Material Authorization) number. The RMA number indentifies your board while it is at Konan for repair.

2. Konan tests the DJ21Ø with default strapping. You thereby will need to record your strapping information in order to correctly restrap your board upon return.

2. Copy and enclose the Problem Description Form and describe all the information about the problem. If the problem applies to a specific situation, be sure to give as much information as possible.

5.4 Problem Description Form

F A I L U R E   R E P O R T

P R O B L E M   D E S C R I P T I O N   F O R M

RMA Number ______________________

Company Name ____________________

Person to Contact ________________

Phone ________ ________________
Area Code Number

Address ____

____

Bill Attention of ________________

Number of Boards enclosed _________

List Serial Number of each board _______________,

_______________, _______________

Describe the Problem (use back of sheet if necessary)

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