Technical Manual

8"

MODEL 6104 LSI

FLOPPY DISK DRIVE

PART No. 80307-048

REVISION	RECORD OF REVISION	REMARKS
01	LSI – G	VALID FOR LSI-VERSION
02	LSI – G	CORRECTIONS
03	LSI – G	CORRECTIONS
REVISION	RECORD OF REVISION	REMARKS

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SECTION I
INTRODUCTION

1.1.   GENERAL

This manual contains descriptive material and procedures to aid personnel in the installation, operation , maintenance and repair of the BASF 6104 double sided floppy disk drive.

1.2.   RELATED DOCUMENTATION

Interface specification no. :

Parts catalog (attachment).

1.3.   DESCRIPTION

This manual describes an enhanced version of the BASF 6104 drive.
The BASF 6104 writes and reads in single (FM) or double density (MFM or M2FM) on one side of a standard diskette or on both sides of a two sided diskette. The storage capacity (unformatted) of the BASF 6104 is 800 kbytes by using a single sided diskette and 1600 kbytes by using a double sided diskette. The BASF 6104 is media compatible with the IBM 3740 and S/32 single sided drive as well as with the IBM 4964 and 3600 series two sided units by using the postcompensation option. This option allowes the recording of double density diskettes without using of any precompensation.
The diskette is rotated at 300 rpm yielding a data transfer rate of 250 kbit/s in single density and 500 kbit/s in double density recording. The stepper motor positions the read / write heads with a track to track access time of 3 ms. The loading and unloading of the read/write heads are improved by using of a liquid damper , which results in a high life time of the heads and the diskette. In the electronic, a large scale integrated circuit (LSI) is used, which contains most of the digital control logic of the drive. The LSI increases the reliability of the electronic and decreases the repair time.
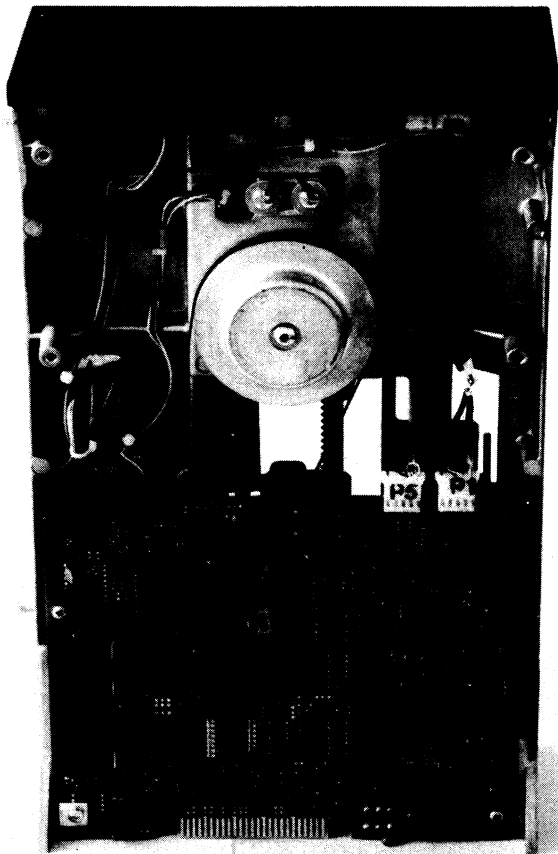
FIGURE 1 - 1 : MODEL BASF 6104 DOUBLE SIDED FLEXY DISK DRIVE

1.4. SPECIFICATION SUMMARY

A comprehensive list of principal specifications are provided in Table 1-1 . The list defines both single-density and double-density characteristics , both disk drive and interface logic levels, and all physical and electrical parameters.

PERFORMANCE SPECIFICATIONS

CAPACITY	Single Density	Double Density
Unformatted		
per Disk	800 kilobytes	1 600 kilobytes
per Surface	400 kilobytes	800 kilobytes
per Track	5.2 kilobytes	10.4 kilobytes
IBM Format (128 byte sectors)		
per Disk	500 kilobytes	1 000 kilobytes
per Surface	250 kilobytes	500 kilobytes
per Track	3.33 kilobytes	6.66 kilobytes
TRANSFER RATE	250 kilobits/sec.	500 kilobits/sec.
Latency (Avg.)	83 ms	83 ms
ACCESS TIME		
Track to Track	3 ms	3 ms
Average (including settling)	91 ms	91 ms
Settling Time	14 ms	14 ms
Head Load Time	40 ms	40 ms

FUNCTIONAL SPECIFICATIONS

	Single Density	Double Density
Rotational Speed	360 rpm ± 2,5 %	360 rpm ± 2,5 %
Recording Density (inside track)	3 408 bpi	6 816 bpi
Flux Density	6 816 fci	6 816 fci
Track Density	48 tpi	48 tpi
Cylinder	77	77
Tracks	154	154
Heads	2	2
Sector	hard or soft	hard or soft
Index	1	1
Encoding Method	F M	M F M / M^2 F M
Media	BASF Flexy Disk 2	BASF Flexy Disk 2D

TABLE 1 - 1 . SPECIFICATION SUMMARY

PHYSICAL   SPECIFICATIONS

Environmental Limits

Ambient Temperature	10° C	to	50° C	
Relative Humidity	20 %	to	80 %	
Maximum Wet Bulb	25° C			

AC Power Requirements

50 Hz ± 2% Single Phase	220 VAC ± 10%	0.3	A (Start-up 0.6 A)

DC Voltage Requirements

+24 VDC ± 5%	1.3	A typical
+ 5 VDC ± 5%	0.8	A typical
- 5 VDC ± 5%	0.05	A typ.
	(option - 7 to - 16 VDC)	

Mounting Dimensions *

Width	4	5/8	in.	(110 mm)
Height	10	1/2	in.	(220 mm)
Depth	14	1/4	in.	(360 mm)
Weight	11,0		lbs.	(5 kg)

* [Optional mounting available to allow
installation of 2 drives side by side
in RETMA 19 rack.]

Heat Dissipation   300   BTU / hr. typical

RELIABILITY   SPECIFICATIONS

M T B F	:	6 000	POH
M T T R	:	30	minutes
Useful Life	:	5	years or 20. 000 hours

Error Rates   :

Soft Read Errors	:	1 per 10^{9}	bits read
Hard Read Errors	:	1 per 10^{12}	bits read
Seek Errors	:	1 per 10^{6}	seeks

TABLE   1 - 1 . SPECIFICATION SUMMARY (contd.)

1.5. OPTIONS SUMMARY

There are different options available for the BASF 6104. Most of the options are selectable by jumpers on the printed circuit board (PCB). Some options must be ordered with the drive or can be installed by the customer. The following tables list all the different options.

1.5.1. JUMPER SELECTABLE OPTIONS

The options of table 1-2 are selectable by setting of jumpers on the PCB.

O P T I O N S	F U N C T I O N
RADIAL SELECT	Allows the connection of 4 drives to the host system. Each drive has its own address (0, 1, 2, 3) selectable by a jumper.
SIDE SELECT|	The head 1 of the drive can be selected in 3 modes : - using SIDE SELECT signal - using STEP IN signal - using SELECT 0-3 signals
HEAD LOAD	Loading of the heads can be accomplished in three modes: - selected heads load (SELECT . HDLOAD) - auto heads load (SELECT) - radial heads load (HDLOAD)
AUTO ERASE	The erase turn-on and erase turn-off delays are internally generated.
WRITE PROTECT	The WRITE PROTECT signal is used for designating of special diskettes and not for write protecting.

O P T I O N S	F U N C T I O N
DOOR LOCK LATCH	Allows locking of the door without maintaining the IN USE signal activated by storing the state of the IN USE signal into the IN USE - flip flop.
ACTIVITY INDICATOR AND DOOR LOCK	Lighting of the activity LED and locking of the door can be accomplished as follows : 1. if the heads are loaded 2. if the drive is selected 3. if the drive is ready 4. by the IN USE-signal 5. by the IN USE-FF (DOOR LOCK LATCH OPTION) 6. if one of 1 to 3 or 4 is active 7. if one of 1 to 3 or 5 is active 8. if one of 1 to 3 or 4 or 5 is active
HARD SECTOR	For separating of INDEX and SECTOR pulses. Usefull only for hard sector diskettes.
- 5 V REGULATOR	-5 V output voltage is generated when an input voltage between -7 V and -16 V is applied.
RADIAL READY	The READY signal is not gated by SELECT.
RADIAL INDEX/SECTOR	The INDEX and SECTOR signals are not gated by SELECT.
RADIAL STEP	The STEP and the STEP IN signals are not gated by SELECT.

TABLE 1 - 2 . OPTIONS SUMMARY

1.5.2. FACTORY INSTALLED OPTIONS

The following options are installed in the drive at the factory or may be installed by the customer.

O P T I O N S	F U N C T I O N
BINARY SELECT	Up to 8 drives may be multi-plexed.
16 OR 8 SECTOR DIVIDER	Divides the 32 SECTOR pulses of the hard sectored diskette by 2 or by 4.
TRUE OR FALSE DATA SEPARATOR	For single density recording (FM) only ! If the true data separator is selected, IBM 3470 format is accepted. The circuit works as a simple one shot separator if the jumper is switched to the false data separator.
POSTCOMPEN-SATION	This option allows reading and writing of double density formatted diskettes without using of any precompensation. The drive is able to read double density diskettes written on IBM systems.
DOOR LOCK SOLENOID	Locks the front door as long as the solenoid is activated.

TABLE   1 - 3 .   FACTORY   INSTALLED   OPTIONS

1.6.   RECORDING MEDIA

The BASF 6104 uses a removable single sided or double sided diskette as storage medium. Fig. 1 - 2 shows construction and dimensions of a typical diskette.

The diskette is an oxide coated flexible disk enclosed in a protective plastic envelope with apertures for head contacts, index detection and spindle loading. The dimensions of single sided and the double sided diskette differs only in the location of the index / sector holes.

The optional write protect hole is used to protect the written data on the diskette.

FIGURE 1 - 2 . FLEXIBLE DISK CONSTRUCTION AND DIMENSION

1.7. RECORDING FORMATS

The format of the data recorded on the
diskette depends on the host system.
There are two encoding schemes used
for the BASF 6104:

- F M (Frequency Modulation)
  for single density.

- M F M (Modified Frequency Mo-
  dulation)
  for double density.

1.7.1. F M - ENCODING

This scheme utilizes clocks to define
bit cell times. The presence of a
flux reversal between clock pulses is
defined as a "one" bit. The absence
of a flux reversal between clocks is
defined as a "zero" bit. On the
write data and read data interface
lines between disk drive and host sys-
tem every pulse represents a flux
reversal on the diskette.
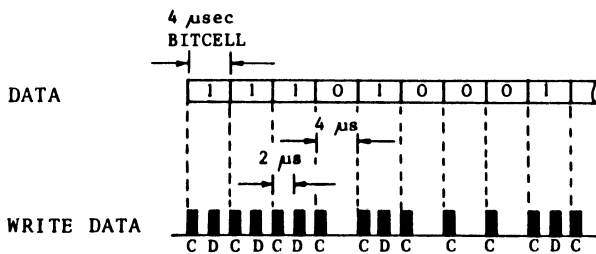
1.7.2. M F M - ENCODING

A flux transition is always recorded
at the center of the bitcell for each
"one" data bit. No flux transition is
recorded for a "Zero" bit unless it
is not followed by another "Zero" bit.
In this case the flux transition is
provided at the end of the first bit
cell.

FIGURE 1 - 3 . FM - ENCODING
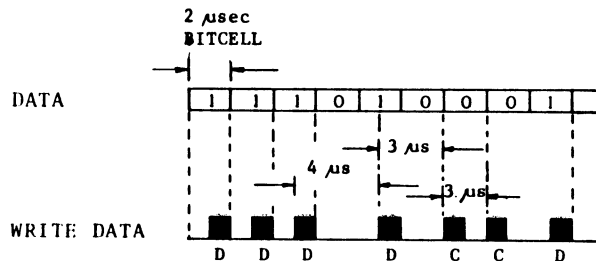
FIGURE 1 - 4 . MFM- ENCODING

1.8. TRACK FORMAT

The flexible disk contains 77 cylinder on one diskette. The first (outside) cylinder is Cylinder 0, the last (inside) cylinder is cylinder 76.

A cylinder consists of 2 tracks, one track on side 0 and one track on side 1 (see fig. 1-5).

```
CYL 0              CYL 76           CENTER
                                    OF THE
                                    DISKETTE
TRACK 0  4         TRACK 76
SIDE 0   0         SIDE 0
```
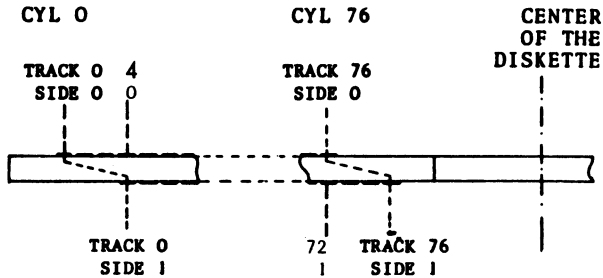
FIGURE 1 - 5 . CYLINDER AND TRACKS

These tracks may be formatted in numerous ways, depending on the formatter of the host system. The BASF 6104 can write and read hard- and soft sectored track formats in single or double density.

1.8.1. SOFT SECTORED TRACK FORMATS

In a soft sectored track format the user may record one long record or several smaller records on a track. The most common soft sectored track formats are described in the following chapters.

1.8.1.1. IBM FORMAT FOR SINGLE DENSITY (F M)

This format is schown on fig. 1-6 . It is used for two sided diskettes for single density (FM - Recording)

and also for TRACK 0 on two sided diskettes for double density.

The beginning of a track is indicated by a physical index pulse. Every record is preceded by a unique record identifier. Record identifiers and data fields are separated by gaps.

The gaps are necessary to allow the updating of a data field without disturbing adjacent fields.

INDEX GAP

This gap starts with the index pulse and is always 73 bytes in lenght. It is not affected by any update write. First 40 bytes FF ar written followed by 6 Bytes of 00. Then the Index address Mark is written (see Chapter Addressmarks) followed by 26 Bytes FF.

IDENTIFIER GAP

This gap consists of 11 bytes FF_x and may vary slightly in length after the data field has been updated.

DATA BLOCK GAP

This gap separates the data field from the following ID- field and is 27 bytes in length. It will vary slightly in length after the data field has been updated.

TRACK GAP

The gap between the last data field and the index pulse is defined as Track Gap. It varies slightly in length, due the write frequency tolerance and the disk speed tolerances. It is nominally 101 bytes in length.

ADDRESS MARK (AM) - BYTES

The soft sectored track format needs unique bit patterns to identify the beginning of ID and Data Fields for synchronizing the deserializer circuit in the host system. The unique bit pattern are called Address Marks (AM). AM- patterns do not contain clock bits in all bit cells (all other data bytes must have clock bits in every bit cell !).
There are four different AM- patterns used:

- INDEX- AM   within the INDEX GAP.

- ID- AM   in front of a ID Field.

- DATA- AM   in front of a Data Field.

- DELETED DATA- AM   in front of a Deleted Data Field.

These AM are shown on Fig. 1-6.

SECTOR IDENTIFIER

The sector identifier consists of the identifier mark, the address identifier and the EDC pattern.

IDENTIFIER MARK

This field comprise 7 bytes (see fig. 1 - 6).
The 6 bytes of zeros in front of the address mark byte are for synchronisation of the data separator in the host system. The ID- AM- byte contains a data pattern of FE where the clock bits C6, C5 and C4 missing as explained before.

ADDRESS IDENTIFIER

The address identifier comprises the following 6 bytes.

CYLINDER ADDRESS

This byte represents in binary notation the cylinder address from 00 for the outermost cylinder to 76 for the innermost cylinder.

SIDE ADDRESS

Represents in binary notation the side Address (00 or 01) of the diskette.

SECTOR ADDRESS

Represents in binary notation the sector address starting from 01 for the 1st sector.

SECTOR LENGTH

This byte determines the length of the data field as follows :

00_x = 128 01_x = 256
02_x = 512 03_x =1024

EDC - BYTES

These two bytes are hardware generated from the host system by shifting serially the bits of the sector identifier starting with the ID- AM and ending with the 4th byte of the sector identifier through a 16- bit shift register described by the generator polomial:

$$x^{16} + x^{12} + x^5 + 1.$$

(For more details read chapter EDC- implementation!)

INDEX GAP	SECTOR IDENTIFIER	IDENTIFIER GAP	FIRST DATA BLOCK	DATA BLOCK GAP		LAST DATA BLOCK	DATA BLOCK GAP	TRACK GAP
73 BYTES	13 BYTES	11 x F F	137 BYTES	27 x F F		137 BYTES	27 x F F	247 x FF

|←————————— 1 th SECTOR ——————————————————————————→| ⌐—— 26 th SECTOR ————————→|

INDEX PULSE

INDEX GAP :

40 x F F	6 x 00	FC 1) / D7 2)	26 x F F

SECTOR IDENTIFIER:

IDENTIFIER MARK		ADDRESS IDENTIFIER				E D C
6 x 00	FE 1) / C7 2)	CYL	SID	SEC	LEN (00)	2 BYTES

ID-AM

DATA BLOCK:

DATA MARK		DATA FIELD	E D C
6 x 00	FB 1)* / C7 2)	1 2 8 B Y T E S	2 BYTES

DATA-AM

1 BYTE

INDEX - AM :

SEP CLOCK (D7) $C_8\ C_7\ C_6\ C_5\ C_4\ C_3\ C_2\ C_1\ C_8$

SEP DATA (FE) $D_8\ D_7\ D_6\ D_5\ D_4\ D_3$

ID - AM :

SEP CLOCK (C7) $C_8\ C_7\ C_6\ C_5\ C_4\ C_3\ C_2\ C_1\ C_8$

SEP DATA (FE) $D_8\ D_7\ D_6\ D_5\ D_4\ D_3\ D_2$

DATA - AM :

SEP CLOCK (C7) $C_8\ C_7\ C_6\ C_5\ C_4\ C_3\ C_2\ C_1\ C_8$

SEP DATA (FB) $D_8\ D_7\ D_6\ D_5\ D_4\ D_2\ D_1$

DEL.DATA-AM :

SEP CLOCK (C7) $C_8\ C_7\ C_6\ C_5\ C_4\ C_3\ C_2\ C_1\ C_8$

SEP DATA (F8) $D_8\ D_7\ D_6\ D_5\ D_4$

1) DATA PATTERN
2) CLOCK PATTERN
* DELETED AM : F8

FIGURE 1 - 6 . SOFT SECTORED TRACK FORMAT FOR SINGLE DENSITY (FM)

DATA BLOCK

The data block contains the data mark, the data field and the EDC- bytes.

DATA MARK

This field comprises 7 bytes(see Fig. 1 - 6). The 6 bytes of zeros in front of the data address mark are for synchronisation of the data separator circuit in the host system. The data address mark byte contains F B in front of a normal data field. When a deleted data field follows, F 8 must be written. The clock pattern of the data address mark is C 7 (C 6 , C 5 and C 4 missing).

DATA FIELD

This field comprises the data bytes. Remaining positions can be filled with zeroes.

EDC - BYTES

These two bytes are hardware generated by the host system by shifting serially the bits of the data block starting with the Data- AM and ending with the last byte of the data field through a 16-

bit shift register described by the following generator polinomial:

$$x^{16} + x^{12} + x^5 + 1$$

EDC IMPLEMENTATION

Fig. 1-7 is a simplified logic of a shift register, which may be used to generate the EDC bytes.
Prior to the operation, all positions of the shift register are set to ONE. Input data are added (exclusive OREO) to the contents of position C_{15} of the register to form a feedback. This feedback is in turn added (exclusive OR) to the contents of position C_4 and position C_{11} .
On shifting, the outputs of the exclusive OR gates are entered respectively into positions C_0 , C_5 and C_{12}. After the last data bit has been added, the register is shifted once more as specified above.
The register then contains the EDC bytes. If further shifting is to take place during the writing of the EDC bytes, the control signal inhibits exclusive OR operations.
To check for errors when reading, the data bits are added into the shift register in exactly the same manner as they were during writing. After the data field, the EDC bytes are also entered into the shift register as the data bytes.
After the final shift, the register contents will be all ZERO if the record does not contain errors.
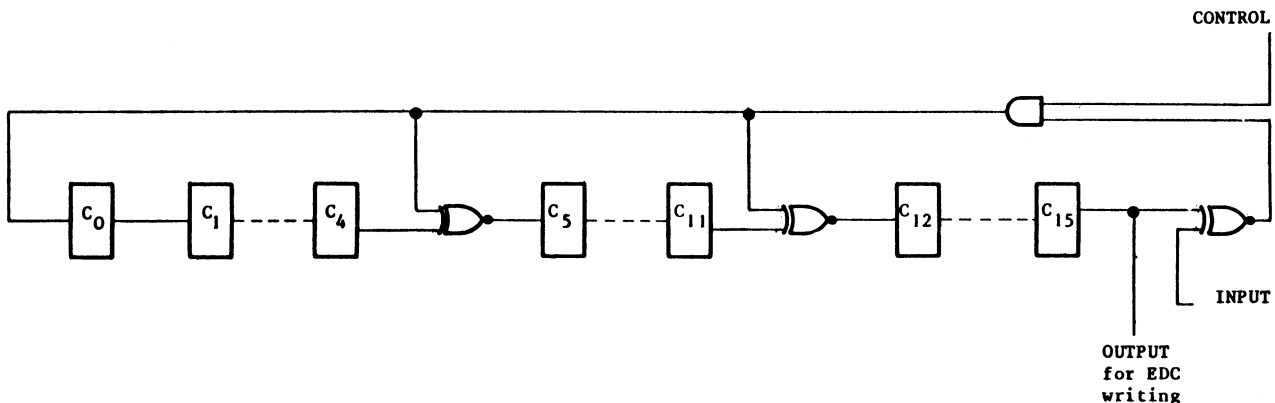
FIGURE 1 - 7 . SIMPLIFIED EDC SHIFT REGISTER

1.8.1.2. IBM - FORMAT FOR DOUBLE DENSITY (MFM)

On two sided diskettes for double density track 0 on side 0 is recorded in FM. Especially for this track is the previous described track format for single density valid. All other tracks on the diskette are recorded in MFM. For these tracks the following track format will be valid (see fig. 1 - 8).

The lenght of the data blocks and gaps is doubled to 256 bytes. Because by use of MFM recording the bit density is also doubled, the count of the sectors will be the same as in single density format. The meaning of the different fields and the generation of the EDC- Bytes are the same as in single density recording. Only the address mark pattern are different.

INDEX GAP	SECTOR IDENTIFIER	IDENTIFIER GAP	FIRST DATA BLOCK	DATA BLOCK GAP	LAST DATA BLOCK	DATA BLOCK GAP	TRACK GAP
146 BYTES	22 BYTES	22 x 4E	274 BYTES	54 x 4E	262 BYTES	54 x 4E	598 x 4E

——————— 1 th SECTOR ——————→ ├ 26 th SECTOR ———————┤

INDEX - PULSE
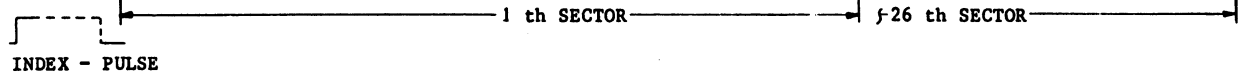
INDEX GAP :

80 x 4E	12 x 00	3 x C2 1)	FC	50 x 4E

1) MISSING CLOCK TRANSITIONS BETWEEN BITS 5 and 4.

INDEX - AM :

SECTOR IDENTIFIER :

IDENTIFIER	MARK		ADDRESS IDENTIFIER				E D C
12 x 00	3 x A1 2)	FE	CYL	SID	SEC	LEN (01)	2 BYTES

2) MISSING CLOCK TRANSITIONS BETWEEN BITS 4 and 3.

ID - AM :

DATA BLOCK :

DATA	MARK		DATA FIELD	E D C
12 x 00	3 x A1 2)	FB 3)	256 BYTES	2 BYTES

2) MISSING CLOCK TRANSITIONS BETWEEN BITS 4 and 3.
3) DELETED RECORD : F8
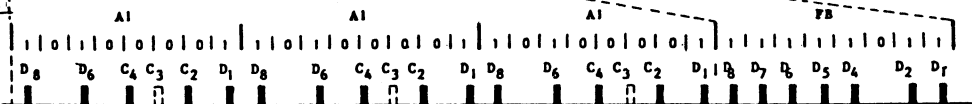
DATA - AM :

DELETED DATA - AM :
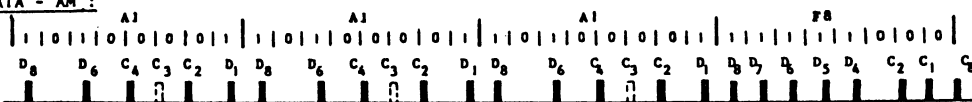
FIGURE 1 - 8 . SOFT SECTORED TRACK FORMAT FOR DOUBLE DENSITY (MFM)

2.1. GENERAL

This section contains descriptive information on each function of the disk drive and detailed theorie of operation of mechanism and the drive electronics.

2.2. FUNCTIONAL DESCRIPTION

The BASF 6104 comprises the following functional systems :

- spindle drive system
- spindle system
- read/write heads positioning system
- heads load system

2.2.1. SPINDLE DRIVE SYSTEM

The spindle drive system provides rotational movement of the spindle using a single- phase motor selected to match primary power. Rotation of the spindle is provided by a belt and pulley connected to the drive motor rotor shaft

2.2.2. SPINDLE SYSTEM

The spindle system consists of a spindle and a centering cone mounted on the deck and carrier,respectively.In the unload postion, the centering cone carrier is pivoted open, creating an aperature through which the flexible disk is inserted. In this position , the centering cone is lifted, disengaging the disk from the spindle hub.

To load a disk, the operator inserts the flexible disk then closes the handle, which latches the carrier in the operating mode. The centering cone is attached to the carrier and is an open-splined nylon device that performs two functions :

- Aligns the disk media to the spindle hub

- Engages the disk media to the spindle drive system

As the carrier is pivoted to the load position, the centering cone enters the flexible disk center. Just prior to the fully closed position of the handle, the centering cone expander is automatically activated to expand the centering cone, which grips and aligns the flexible disk to the spindle, thus centering the disk on the spindle.

2.2.3. POSITIONING SYSTEM

The positioning system comprises a carriage assembly , the read / write heads , a bidirectional stepper motor and lead screw (see Fig. 2 - 1).The stepper motor rotational movements are converted to linear motion by driving the lead screw and carriage assembly. The read/write heads carriage rides on the lead screw shaft and is held in horizontal alignment.When the stepper motor is pulsed, the lead screw rotates clockwise or counterclockwise , moving the carriage in or out , respectively.

A four phase stepper motor is used. In detent current flows in one winding and maintains the rotor in electromagnetic detent. For positioning, the windings are driven se - quentially, causing the rotor to rotate through detent positions until the STEP/ commands are halted. The rotor then locks in that position, with the last winding being driven.

The sequence in which the stepper motor windings are pulsed dictates rotational direction and,subsequently, higher or lower track addressing from a relative position.

2.2.4. HEADS LOAD MECHANISM

The head load mechanism consists of the heads load solenoid, a liquid damper, and the heads load actuator (see fig. 2-1). When activated by a heads load command the spring loaded upper head is released and the disk is pressed between the bottom (head 0) and the upper head (head 1). The pressure pad foam holds the flexible disk flat against the align - ment block of the casting (PLATEN). The minimize disk wear normally the heads load command is gated by select. In deselect or idle mode the heads will be unloaded.
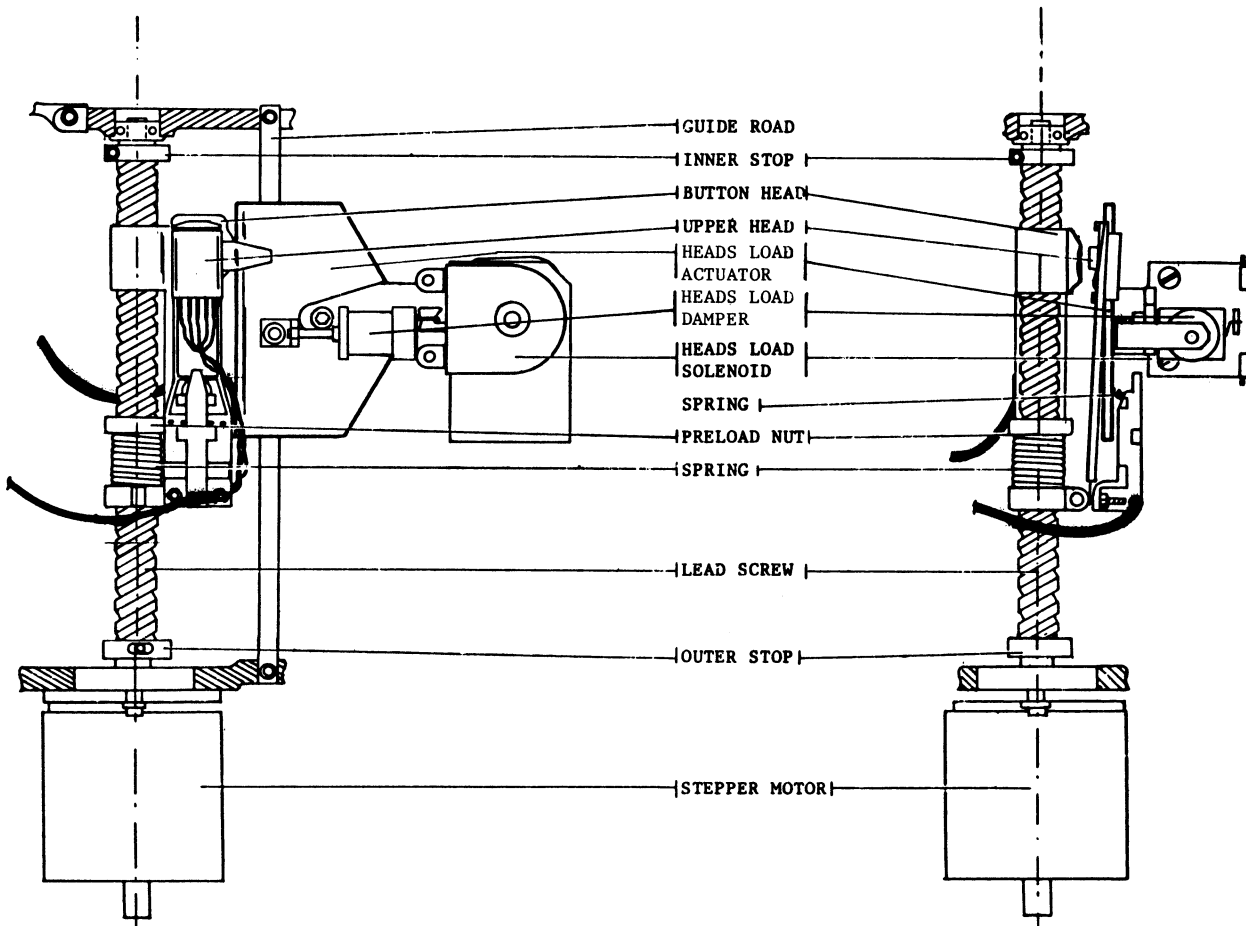
FIGURE 2 - 1 . POSITIONING SYSTEM AND HEADS LOAD MECHANISM

SECTION II
THEORY OF OPERATION

2.3. DRIVE ELECTRONIC DESCRIPTION

2.3.1. BLOCK DIAGRAM

Figure 2-2 is a block diagram of the drive control logic. The logic is divided into the following parts :

- input interface
- write control logic *
- side control logic *
- index/dual-side detection and ready monitor *
- sector separator *
- disk change logic *
- stepper motor control *
- track zero detector *

* All these circuits are included in the BASF 81041-001 LSI-Chip.

- read/write circuits
- postcompensation (optional)
- true/false-data separator (optional)
- side select logic
- sector divider (optional)
- stepper motor drivers
- head load driver
- activity LED/door lock-driver
- DC-control logic
- output interface

2.3.2. LARGE SCALE INTEGRATED CIRCUIT BASF 81041-001

The BASF FDD/MDD-LSI is a 40 pin NMOS large scale integrated circuit, designed for controlling of 8" and 5 1/4" floppy disk drives. The use of this circuit simplifies the electronic board and increases the reliability of the electronics.
The chip is programmed by 2 type select pins on the PCB for the different drives to be used.
The 3.2768 MH_2 crystal is used by the LSI-chip for generating the different time delay circuits (one shots) inside the chip. Other inputs (WRTPROTOPT, AUTO ERASE, HARDSECTOR) are used to enable or disable the different options included in the LSI-chip.
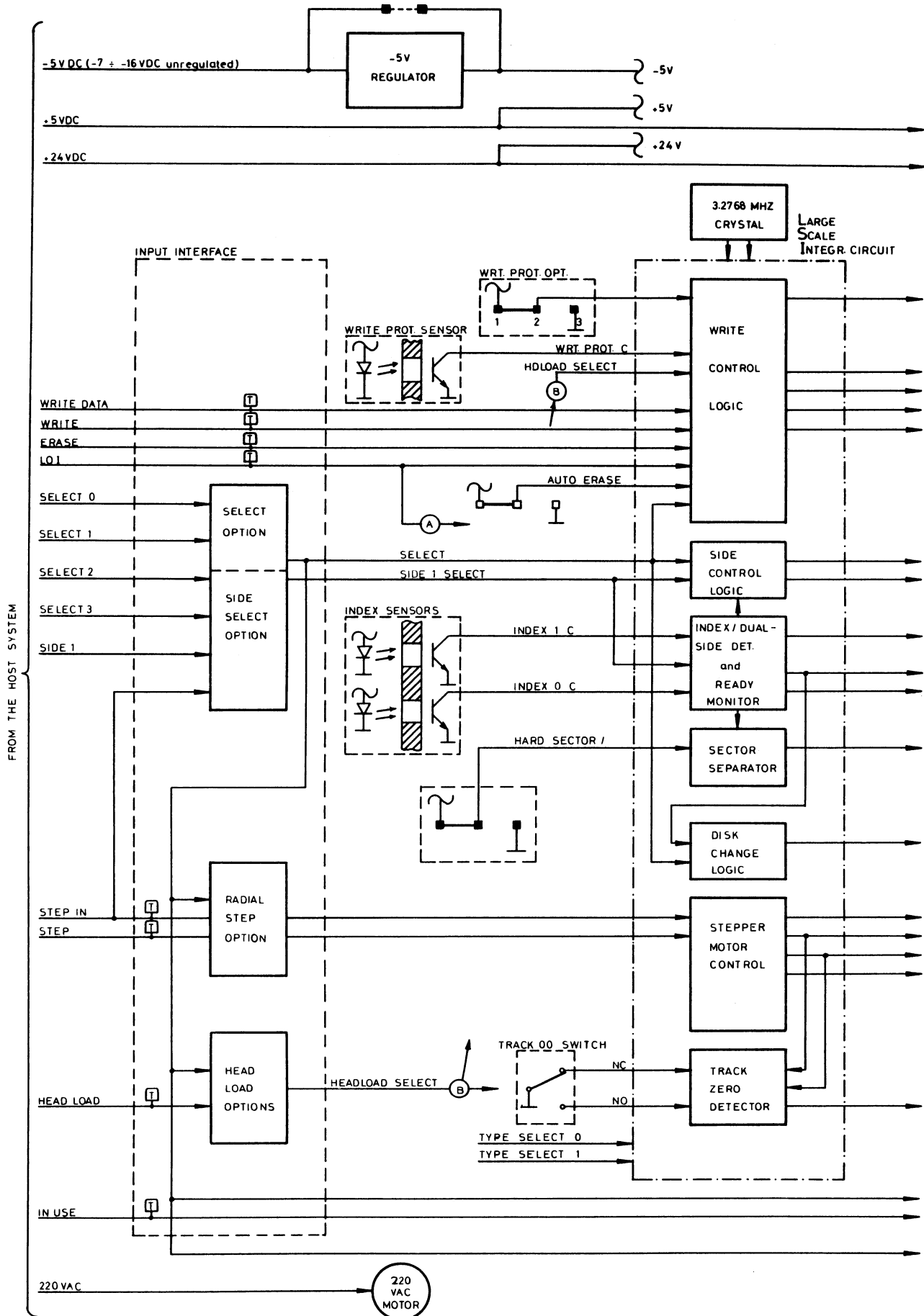
FIGURE 2 - 2 : BLOCK DIAGRAM BASF 6104 LS1
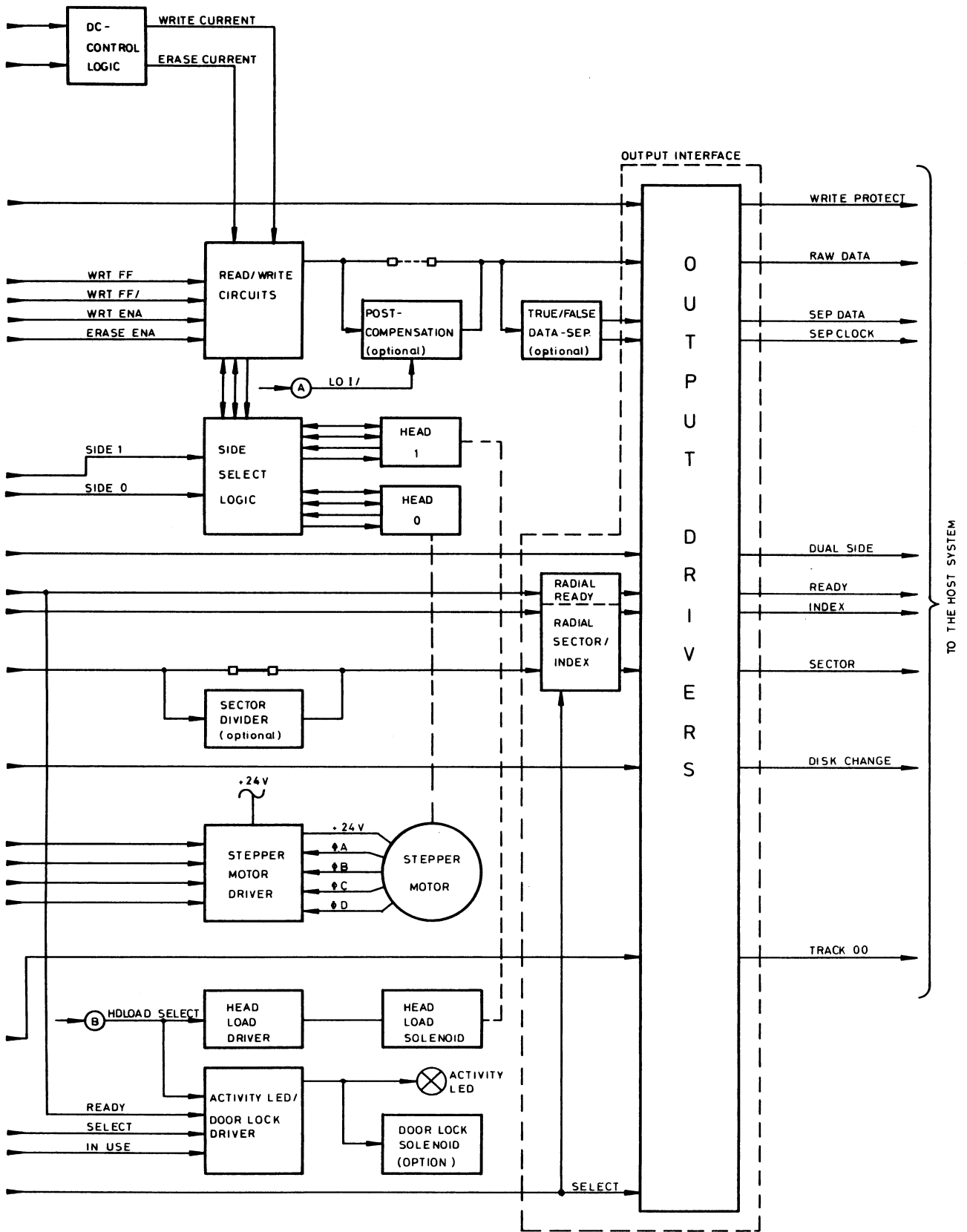
FIGURE 2 - 2 : BLOCK DIAGRAM BASF 6104 LSI

2.3.3. INPUT INTERFACE

2.3.3.1. INPUT SIGNALS DEFINITIONS AND TERMINATION

The input interface receives the signals from the host system. All inputs signals are listed and de-nined in table 2-1.
The input lines are terminated as shown in figure 2-3.
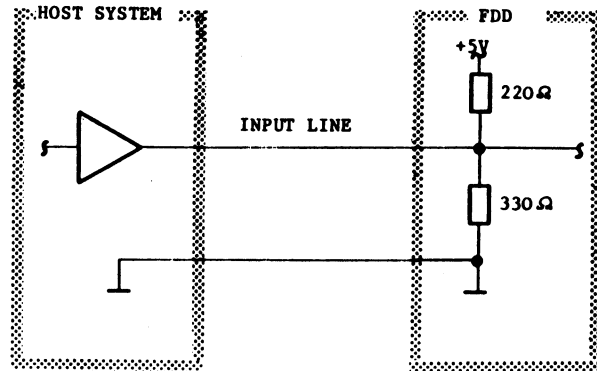
FIGURE 2 - 3 . INPUT SIGNAL TERMINATION

SIGNAL NAME	DEFINITION
SELECT (0 - 3) /	Radial Select : One line is assigned to each disk drive . A low selects the corresponding drive and enables the interface logic . Binary Select : (Option) SELECT 0/ low enables unit se-lection. SELECT 1/ ÷ 3 contain 3-bit binary code to select the unit.
SIDE SELECT /	This line defines wether side 0 or side 1 of the diskette is used. A high selects side 0 a low selects side 1. Two optional methods of side se lection are available by setting of jumpers (see 2.2.1.3.).
STEP IN /	Defines motion of the read/write heads when the STEP /- line is pulsed. LOW = IN (towards Cyl. 76) HIGH = OUT (towards Cyl. 0)
STEP /	Used in conjunction with STEP IN/ and causes the read/write heads to be moved from cylinder - to - cylinder.
WRITE /	Low input enables recording of WRITE DATA on diskette. High input enables reading from the diskette.

SIGNAL NAME	DEFINITION
ERASE /	Low input causes erase current to turn on. Timing considerations must be met. This line is not necessary if the auto erase option is installed.
LO I/	Write operation : Low input causes reduced write current. Should be activated from CYL 44 to CYL 76. Read operation : Low input switches the postcom-pensation filter (PCF) into the read chain when installed. It is recommended to activate the PCF from CYL 60 to CYL 76. The LO I/-signal has no effect during read operation on a drive without PCF.
WRITE DATA /	This line provides the data to be written on the diskette. Each transition from high to low will cause the current through the read/write head to be reversed, there by writing a data bit.This line is enabled by WRITE/ being active.
HDLD /	A low causes the read/write heads to be loaded against the disket-te. Auto Head Load: If this option is installed this line is not used, because then the heads are loaded by selecting of the drive.
IN USE / (optional input)	This signal, when enabled by a jumper, will turn on the activi-ty light and locks the door.

TABLE 2 - 1 . INPUT SIGNALS

2.3.3.2. SELECT OPTIONS

There are two options used to select the drive

- Radial Select
- Binary Select

RADIAL SELECT OPTION

This is the most used fashion to se-lect the drives. A maximum of four drives dan be connected for the host system. The SELECT-lines are used to select the drives :

SELECT 0 for drive 0

SELECT 1 for drive 1,

etc...

To enable the Radial Select Option, the jumper JJ1 (5 - 6) must be ins-talled (see figure 2 - 4).

BINARY SELECT OPTION

This option allows the connection of up to eight drives to the host system. With this option installed,the SELECT lines are not dedicated but are used to contain a binary select code. The SELECT 0/ line is used to enable/dis - able unit selection, while the SELECT 1/ , SELECT 2/, and SELECT 3/ lines contain a binary code between 0 and 7. When the SELECT 0/ line is low (true), a decoder in the binary SELECT option logic decodes the select code from the controller, as follows (see Table 2-2):
To enable the binary select option , the jumper JJ 1 (7 - 8) must be ins-talled (see figure 2 - 5).
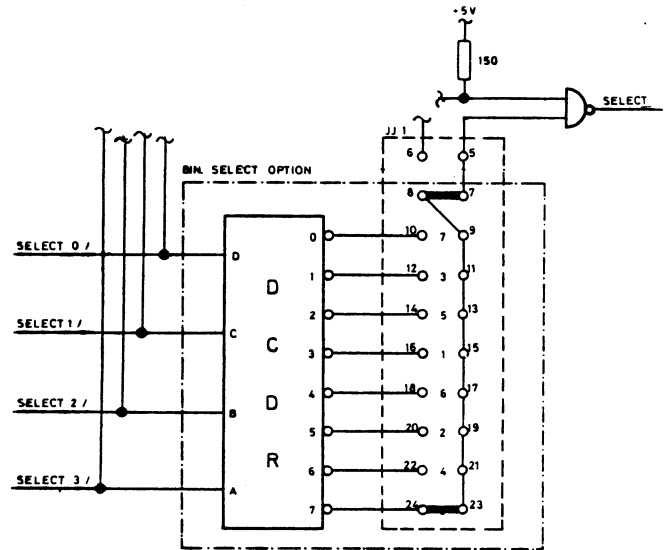
FIGURE 2 - 5 : BINARY SELECT OPTION
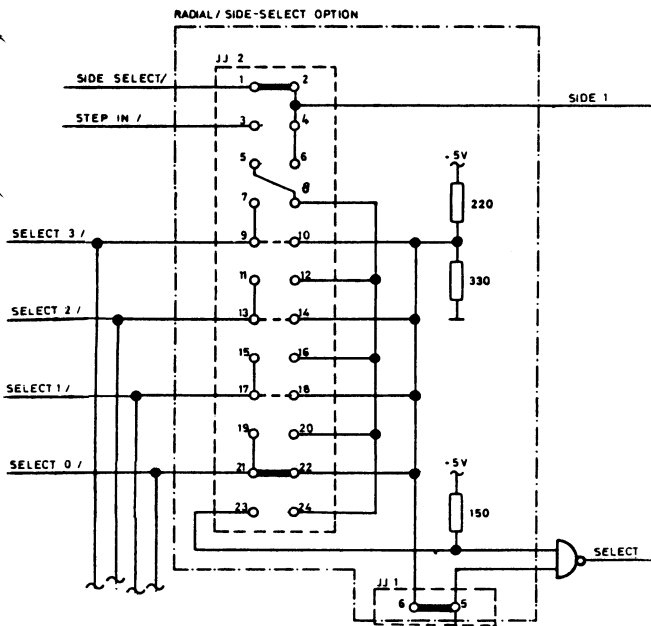
FIGURE 2 - 4 . RADIAL SELECT OPTION

SELECT LINES				DRIVE SELECTED
3 /	2 /	1 /	0 /	
X	X	X	H	-
H	H	H	L	0
H	H	L	L	1
H	L	H	L	2
H	L	L	L	3
L	H	H	L	4
L	H	L	L	5
L	L	H	L	6
L	L	L	L	7

TABLE 2 - 2 . DECODING OF THE SELECT LINES
BY THE BINARY SELECT OPTION

2.3.3.3. SIDE SELECT OPTIONS

There are three possibilities for the user to select the side of the disk during read or write operations:

- Selecting by a separate
    SIDE SELECT

- Selecting by
    STEP IN

- Selecting by the
    SELECT LINES

USING THE SEPARATE SIDE SELECT LINE :

This is the standard configuration of the drive. The SIDE SELECT - signal defines which side of the two sided disk is used. If SIDE SELECT/ is Low side one of the disk is selected, if SIDE SELECT / is high, side zero of the disk is selected.

USING STEP IN :

Because the STEP IN signal is only used for seek operations (step in or step out) it can be used to carry the side select information during read and write operations. To implement this option JJ1 (3 - 4) must be connected by the side select jumper.
Side 0 of the disk will be selected when STEP IN / is high. Side 1 of the disk will be selected when STEP IN / is low.
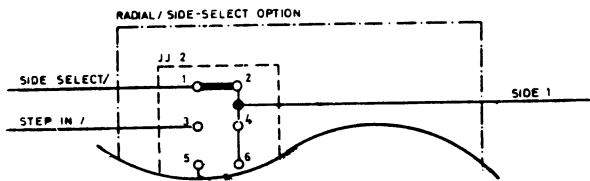
FIGURE   2 - 6   :   SIDE SELECTION USING THE
                    SIDE SELECT SIGNAL
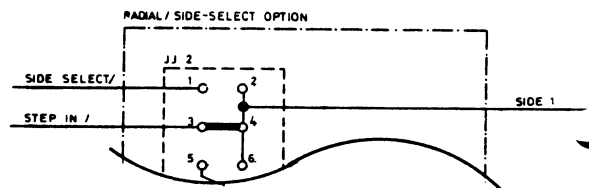
FIGURE   2 - 7   :   SIDE SELECTION BY STEP IN

SIDE SELECTION USING THE SELECT
0 $\doteq$ 3 - LINES

In this option each drive gets two
addresses, one for side 0 and the
other for side 1. Radial selection
or binary selection can be used.

RADIAL SELECTION

If radial selection is used, only
two drives can be connected to the
host system (see table 2 - 3). The
jumpers for the drive 1 (addresses
0 and 1) and drive 2 (addresses 2
and 3) are shown on figure 2 - 8 .

SELECT LINES				DRIVE SELECTED	SIDE SELECTED
3/	2/	1/	0/		
X	X	X	X	-	-
H	H	H	L	0	0
H	H	L	H	0	1
H	L	H	H	1	0
L	H	H	H	1	1

TABLE 2 - 3 : SIDE SELECTION
USING THE SELECT LINES AND RADIAL
SELECT

D R I V E   0   D R I V E   1
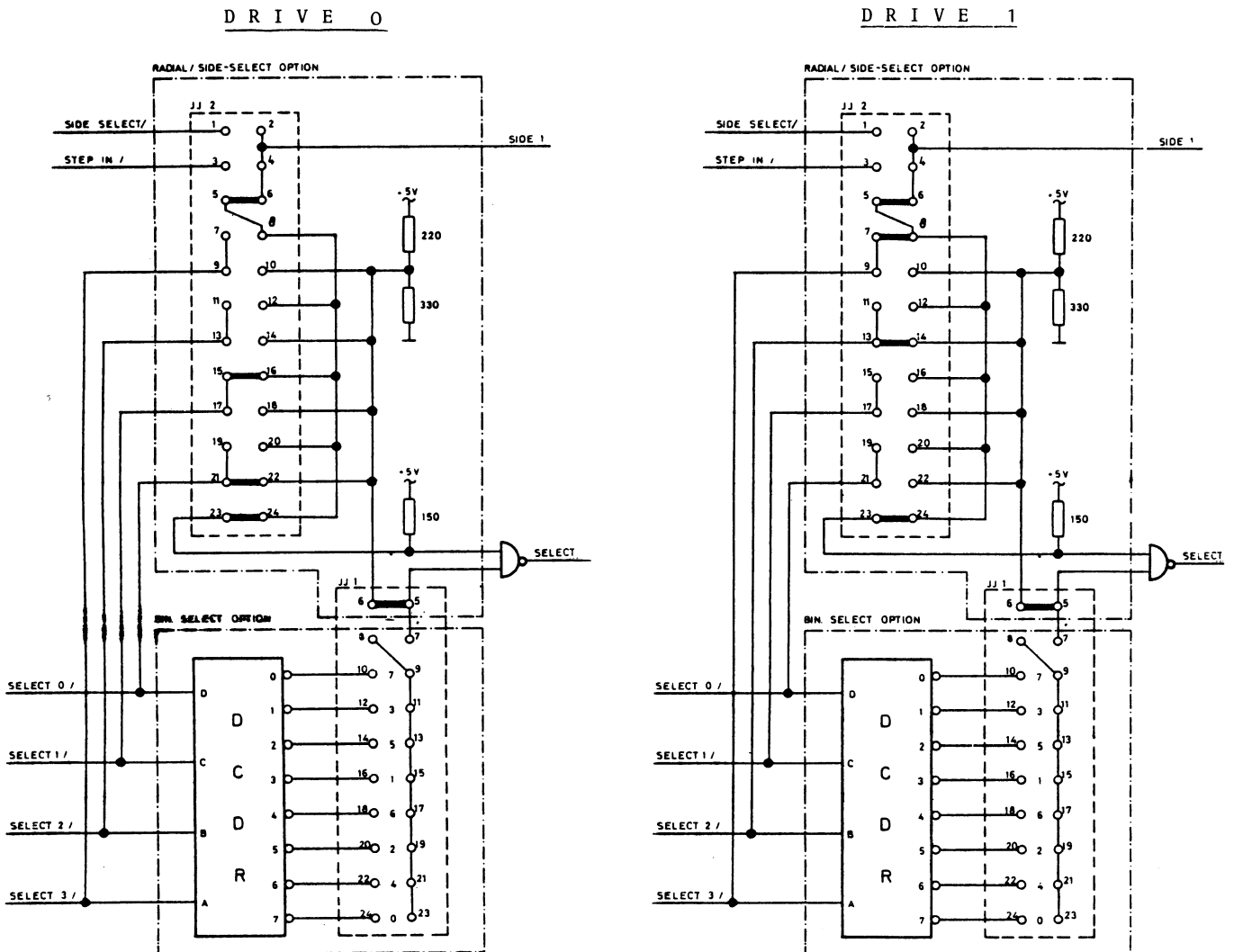
FIGURE 2 - 8 :   SIDE SELECTION USING THE SELECT LINES AND RADIAL SELECT

BINARY SELECTION

If binary selection of the drives is used up to four drives can be connected to the host system when side selection by the SELECT lines is accomplished. If SELECT 1/ is used as side selection the jumpers must be connected as shown on Fig. 2 - 11 . Each drive has an odd and an even address. The even address then always selects side 0 of the disk the odd address selects side 1 of the drive (see Table 2 - 4). In the binary select option always two jumpers with successive numbers must be installed.

SELECT LINES				DRIVE SELECTED	SIDE SELECTED
3 /	2 /	1 /	0 /		
X	X	X	H	-	-
H	H	H	L	0	0
H	H	L	L	0	1
H	L	H	L	1	0
H	L	L	L	1	1
L	H	H	L	2	0
L	H	L	L	2	1
L	L	H	L	3	0
L	L	L	L	3	1

TABLE 2 - 4 . DRIVE AND DISK SIDE WHEN USING SELECT 1/ AS SIDE SELECT AND BINARY SELECT

——— drive 0
– – – drive 1
—·—· drive 2
······ drive 3
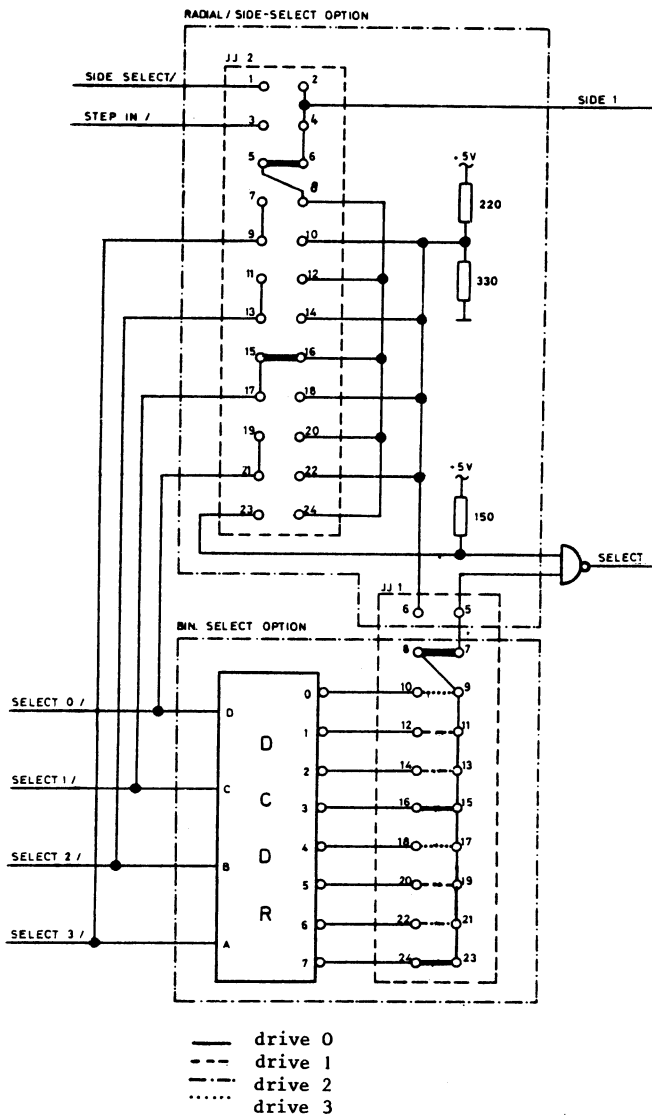
FIGURE 2 - 9   SIDE SELECTION USING THE SELECT 1/ LINE AND BINARY SELECT

2.3.3.4. HEAD LOAD OPTIONS

There are three possibilities for
the user to load the heads :

- selected heads load
  (standard)

- auto heads load

- radial heads load

SELECTED HEADS LOAD

This is the standard configuration
of the head load logic. The drive
must be selected and the head load-
signal active for loading the heads
(see figure 2 - 10).
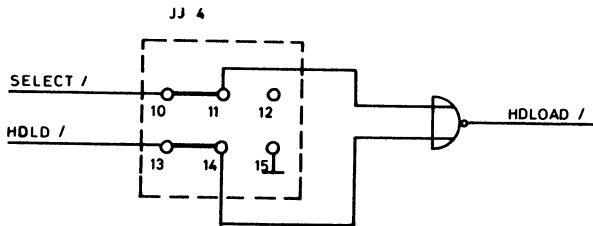
FIGURE 2 - 10 . SELECT HEADS LOAD

AUTO HEADS LOAD OPTION

The Auto Heads Load option allows the
user the read/write heads to be load-
ed as soon as the disk drive is selec-
ted. If automatic heads load is de-
sired the jumpers must be changed as
shown in the Fig. 2 - 11 .
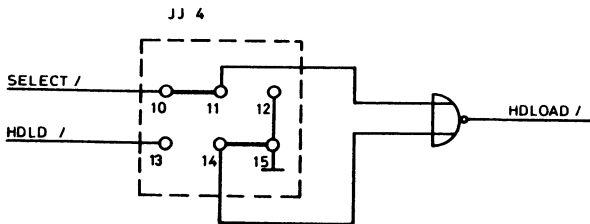
FIGURE 2 - 11 . AUTO HEADS LOAD

RADIAL HEADS LOAD OPTION

This option allows the user to keep
the heads loaded without selection of
the drive. The 40 msec heads load
time are then eliminated. To install
this option, the jumper must be set
as shown on figure 2 - 12.
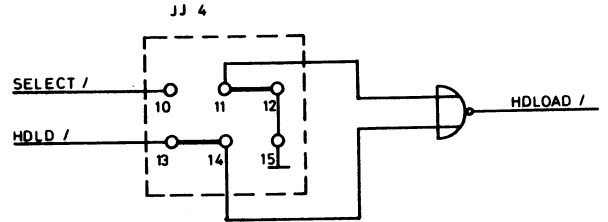
FIGURE 2 - 12 . RADIAL HEADS LOAD

2.3.3.5. RADIAL STEP OPTION

As shipped from the factory the stepper motor control signals STEP / and STEP IN / are gated by SELECT. The stepper motor can be postioned only if the drive is selected. By cutting the existing connection and installing a jumper to the alternate pin (dashed line) the STEP IN / and STEP / - signals are always enabled (see Fig. 2-13). This allows the host system to step the stepper motor without selection of the drive.
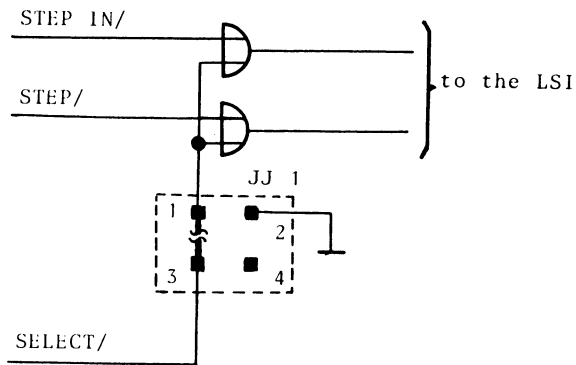
2 - 13 : RADIAL STEP OPTION

2.3.4. OUTPUT INTERFACE

2.3.4.1. OUTPUT SIGNALS DEFINITIONS

The output interface sends the read
data pulses and the status signals
to the host system.
Table 2 - 5 lists and describes all
the different signals. The output
signals are driven by the output dri-
vers SN 7438.

SIGNAL NAME	DEFINITION
RAW DATA /	This line provides the flux changes on the diskette as de- tected by the read/write cir- cuits.
SEP DATA / (only if data separator opti- on installed)	This line carries the separa- ted data bits for FM- recording separated by the data separator.
SEP CLCK / (only if data separator op- tion installed)	This line carries the separated clock bits for FM- recording se- parated by data separator.
TRACK 00 /	This line indicates that the read/write heads are positioned at track 00.
WRITE PROTECT /	Low active status indicates that a write protect diskette is installed. Under normal opera - tion, the drive then will inhi- bit writing. For other methods using the WRITE PROTECT signal see 2.2.1.3.
DUAL SIDE /	This signal indicates whether a two - sided (output - low) or a single - sided (output - high) diskette is installed.
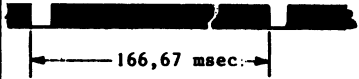
SIGNAL NAME	DEFINITION
INDEX /	The leading edge of this signal indicates the beginning of the track. |◄———166,67 msec.—►|
SECTOR / (hard sector option must be activated)	A low active pulse indicates the beginning of the next sector. Normally there are 32 sector pulses per revolution. If the 16 / 8 sector option is instal- led, the diskette can be divided in to 16 or 8 sectors by setting of a jumper.
READY /	This line indicates that the in- serted diskette has reached more than 75 % of full operating speed and three consecutive INDEX pul - ses have been sensed. If a single sided diskette is installed READY will be active only if SIDE 0 is selected.
DISK CHANGE /	A active (low) signal is provided when the drive select line is ac- tivated, if while deselected the drive has gone from a READY to a Not Ready condition.

TABLE 2 - 5 . OUTPUT SIGNALS

2.3.4.2. OPTIONS OF THE OUTPUT INTERFACE

RADIAL INDEX / SECTOR OPTION

This option is useful, if the user wishes to monitor the INDEX and SECTOR signals without selecting the drive, so that the drive may be selected just prior to the sector that is to be processed. To install this option, the existing connection must be cut and the dashed connection installed, as shown on figure 2 - 14.

The INDEX and SECTOR pulses are now presented on the interface, when the drive is ready.

RADIAL READY OPTION

If this cut trace option is used, READY will be presented to the host system as soon as the drive is ready without selection. To install this option, JJ 3 2 - 3 must be cut and JJ 3 1 - 2 must be shorted.
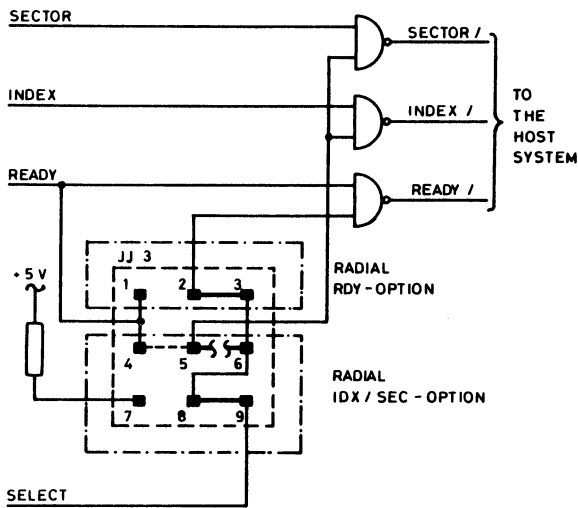
FIGURE 2 - 14 :
RADIAL INDEX/SECTOR OPTION

2.3.5. STEPPER MOTOR LOGIC

The stepper motor logic controls the motion of the read/write heads. For each STEP- pulse from the host system rotates the stepper motor for one step. Each step corresponds to a rotating angle of 15°. The rotation of the stepper motor is converted to a linear motion of the read/write heads by a spindle. The direction of the motion of the read/write heads depends on the input signal STEP IN/. If this signal is active (low) the read/write heads will be moved in (towards cyl. 76).

The read/write heads moves out by each STEP- pulse, when STEP IN/ is in a high state. Multiple track positioning is attained by the host system issuing a series of STEP- pulses at 3 msec intervals..

The stepper motor logic comprises the following circuits (see Fig. 2 - 15):

● Step counter and decode ⎫ located
● Step control   ⎬ in the
● Stepper motor drivers   ⎭ LSI-chip
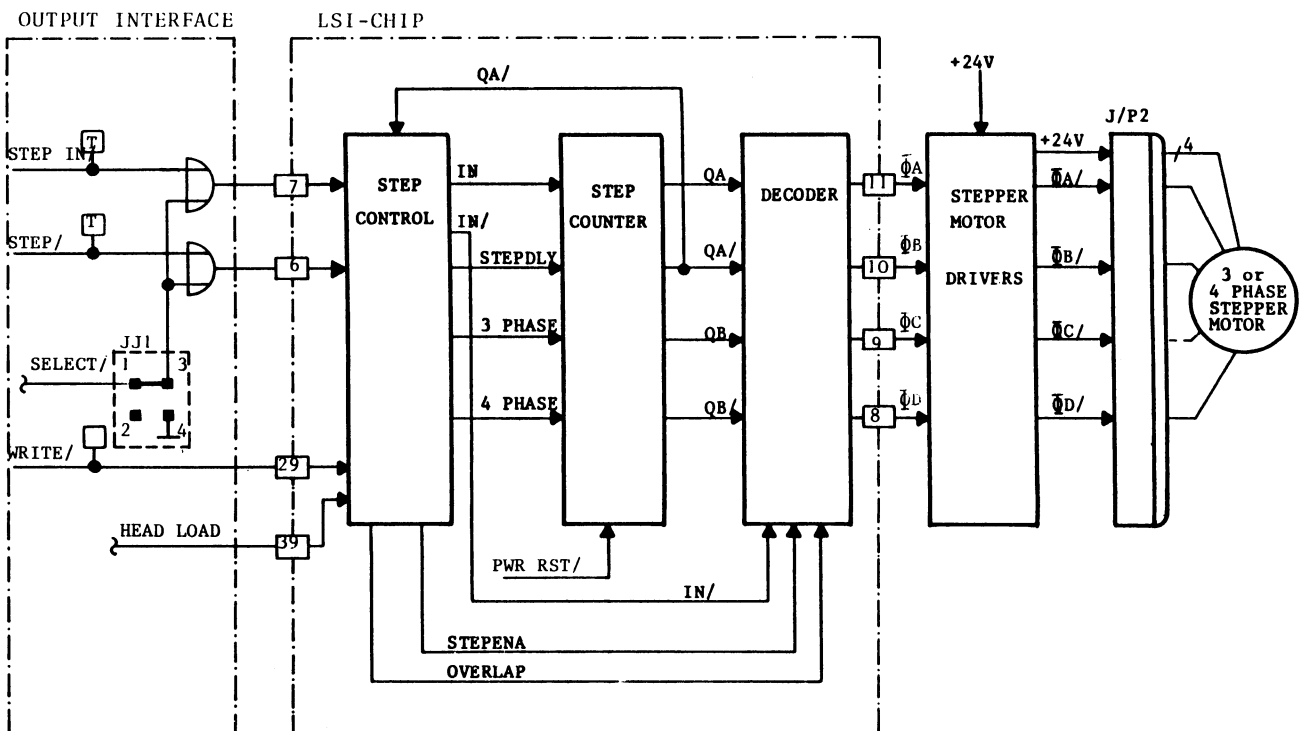
FIGURE 2 - 15 . BLOCK DIAGRAM STEPPER MOTOR LOGIC

2.3.5.1. STEP CONTROL, STEP COUNTER AND DECODE

The step counter is a programmable counter and consists of two D-type flipflops. The step counter works as a divide by 4 up/down counter, when 4-PHASE is active. If 3-PHASE is active, the step counter works as a divide by 3 counter. Direction of counting depends on the IN-signal, which stores the state of the STEP IN signal from the host system.

The 3-PHASE, respectively 4-PHASE signal depends on the state of the TYPE SELECT 0 and 1 pins of the LSI-chip. These signals are set by the manufacturer on the PCB and should not be changed , except if the stepper motor is replaced by a different type of motor. The STEPENABLE-signal enables the stepper motor as soon as the step operation starts and holds the stepper motor activated for 34 msec after the last STEP pulse has occured.

For read/write operations, the stepper motor will be also enabled as long as the heads are loaded (HDLOAD active).

During a write operation, the step-control inhibits any step operation. The OVERLAP-signal is used for the overlap-mode of the stepper motor. In this mode, 2 phases of a 4-phase stepper motor are overlapped for 1ms. This allows a more smoothly motion of the stepper motor.

2.3.5.2. MODES OF THE STEPPER MOTOR LOGIC

The following table shows the different possible modes and their jumper configuration on the PCB.

STEPPER MOTOR MODE	TYPE SELECT	
	0	1
4-PHASE motor		
one phase on with 1ms overlap (standard configuration)	+ 5 V	open
one phase on	G N D	open
two phases on	open	open
3-PHASE motor		
one phase on	+ 5 V	G N D

TABLE 2 - 6 :   STEPPER MOTOR LOGIC MODES AND JUMPER CONFIGURATION

The following figures 2 -16 to 2 - 19 are the corresponding timing diagrams to the modes shown in table 2 - 6.
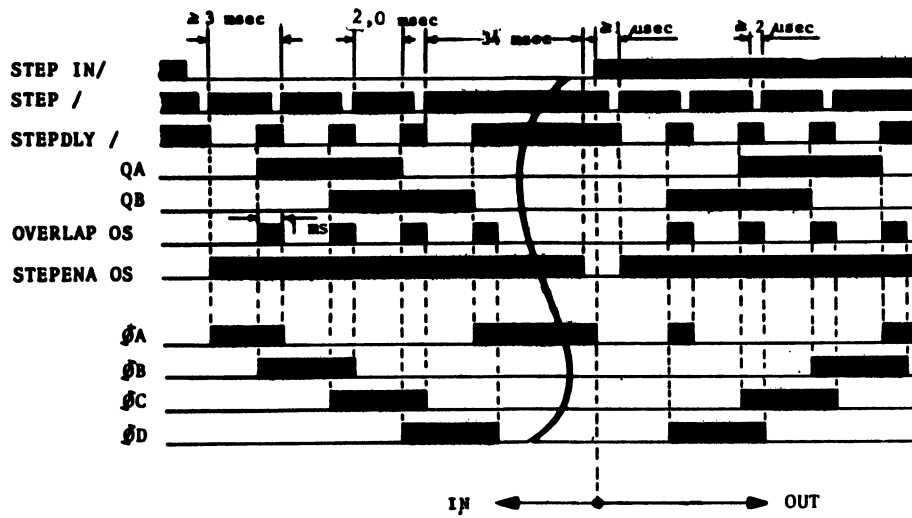
FIGURE   2 - 16   : STEPPER MOTOR TIMING FOR 1 OF 4 PHASES ON WITH OVERLAP
                       (STANDARD CONFIGURATION)
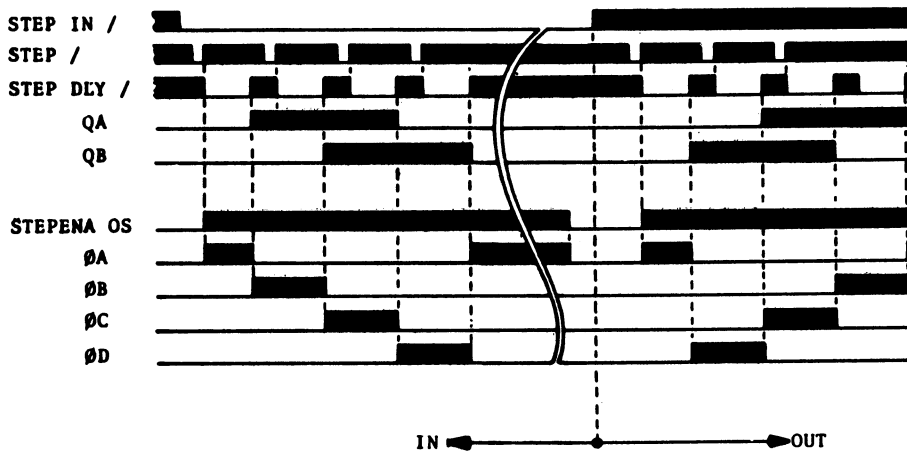
FIGURE   2 - 17   :   STEPPER MOTOR TIMING FOR 1 OF 4 PHASES ACTIVE
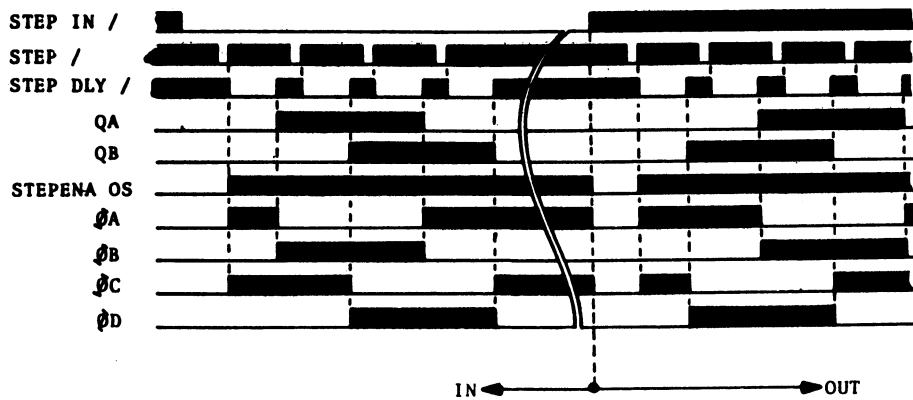
FIGURE   2 - 18   :   STEPPER MOTOR TIMING FOR 2 OF 4 PHASES ACTIVE

```
STEP IN /
STEP /
STEP DLY /
QA
QB

STEPENA OS
ØA
ØB
ØC
ØD
```

IN ◄────●────► OUT
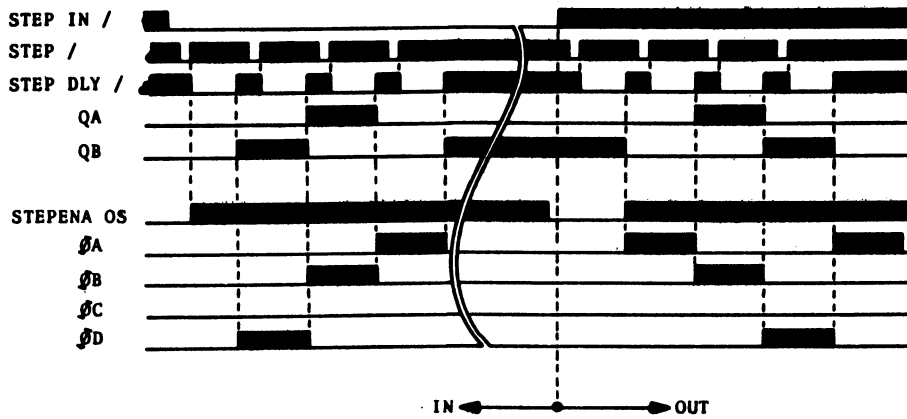
FIGURE 2 - 19 : STEPPER MOTOR TIMING FOR 1 OF 3 PHASES ACTIVE

2.3.5.3. STEPPER MOTOR DRIVERS

The stepper motor drivers are four identical circuits which drives the windings of the four phase or three phase variable reluctance stepper motor. Fig . 2 - 20 shows the circuit for phase A.

The phase A of the stepper motor is turned on by the power transistor QA when ØA of the LSI-chip goes high. When the phase A of the stepper motor is switched of, the zenerdiode ZW5,1 and the diode are used as suppression circuit which limits the dissipation of the magnetic energy of the switched off phase A.
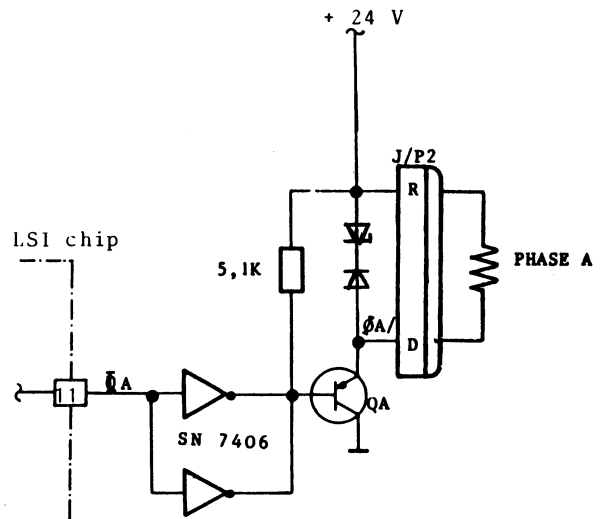
FIGURE 2 - 20 . STEPPER MOTOR DRIVER CIRCUIT

2.3.6. TRACK ZERO DETECTOR

The track zero detector monitors the position of the read/write-heads and signals the host system , when the heads are positioned at track zero. The host system uses this signal to recalibrate the positioning system , when the read / write-heads position is unknown. It sends step out pulses, until the TRACK 0/- signal goes low. There are two different track zero sensors used , a mechanical micro-switch on the earlier drives and an optical sensor on the later drives. The connections of these different sensors and a principle circuit diagram are shown on figure 2 - 21. The track zero detector comprises the mechanical or optical sensor, a comparator, a debounce circuit and a phase detector. The track zero sensor mounted on the deck assembly is activated by the head carriage. When the stepper motor drives the head carriage out (towards track zero), the track zero sensor switches as soon as track zero is approached (TRACK 00SW/ low). Because the track zero sensor switches about two tracks before track zero, a phase detector is used. This circuit monitores the QA and QB-flipflop of the step counter and generates the TRACK 00-signal when the stepper motor activates the right phase for positioning on track zero. If the host system tries to pass track zero,the outer stop holds the read / write heads near track zero and the TRACK 0/signal is deactivated,because the phase of the stepper motor has changed (QA / + QB / = low).When a four phase stepper motor is installed after four more steps out,the phase of the stepper motor is correct again. The read/write heads are positioned at track zero and the TRACK 0/signal is activated. If a three phase stepper motor is used, the correct phase will occur every three steps.
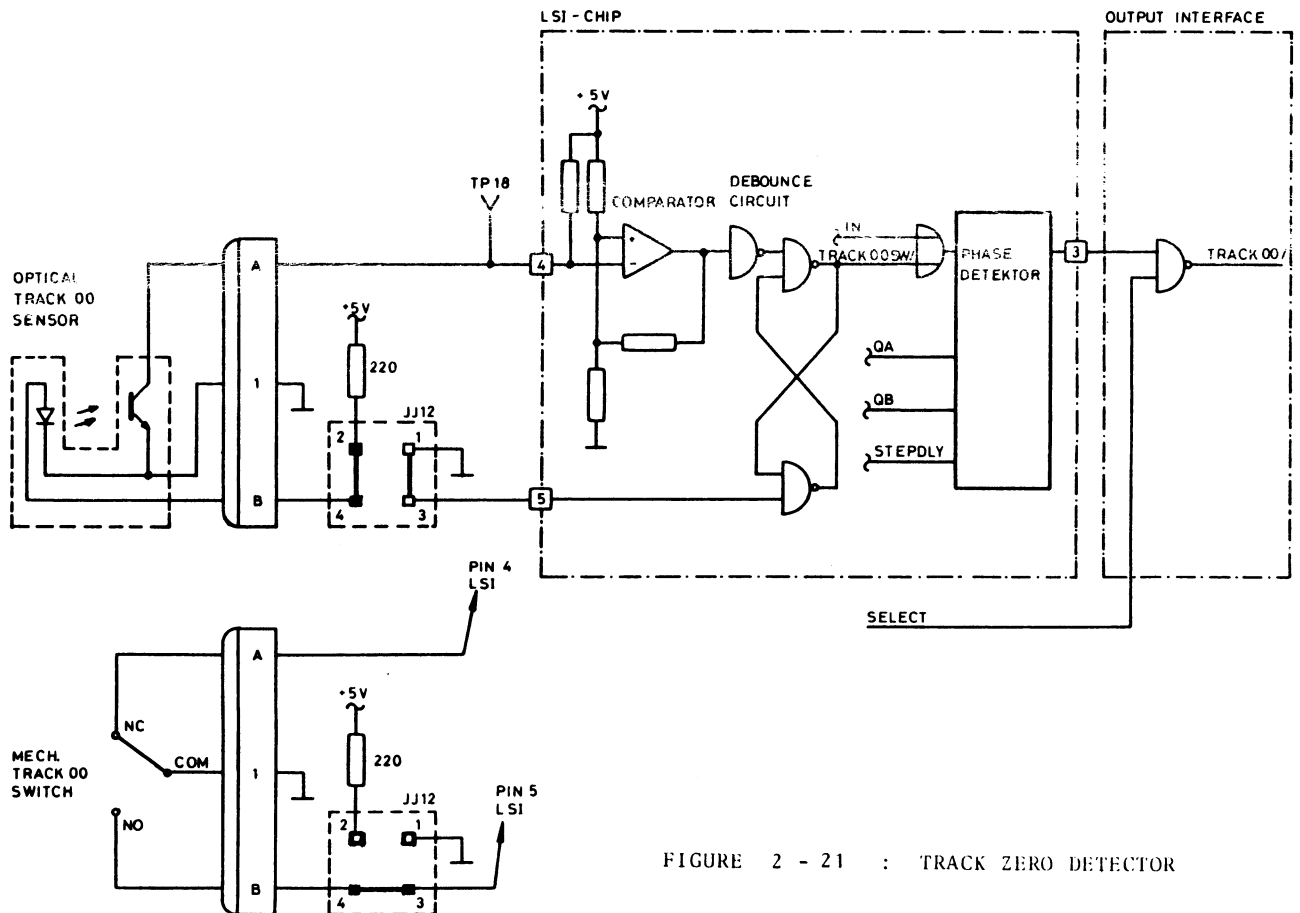
FIGURE 2 - 21 : TRACK ZERO DETECTOR

2.3.7.   INDEX/DUAL SIDE DETECTOR AND
READY MONITOR

2.3.7.1.   INDEX/DUAL SIDE DETECTOR

There are two index detectors in the BASF 6104 drive, one for the use of one sided diskettes and one for the use of double sided diskettes. Only one of these index detectors are used during operation, because the cartridge of the diskette has only one index hole. The position of this index hole is slightly different between one sided and double sided diskettes. An index detector consists of a LED with appropriate phototransistor and a schmitt trigger. If a one sided diskette is inserted, INDEX 0 pulses are generated and the DUAL SIDE-FF will be reset. If the host system tries to select side 1 of the diskette (SIDE 1/ $\longrightarrow$ L), the ready monitor will be disabled by the READY INHIBIT/-signal. The READY/-line to the host system goes high and prevents from writing on side 1 of the single sided diskette. If a double sided diskette is inserted, the generated INDEX 1 pulse sets the DUAL SIDE FF. The signal DUAL SIDE/ indicates to the host system that two sides on the disk are usuable.
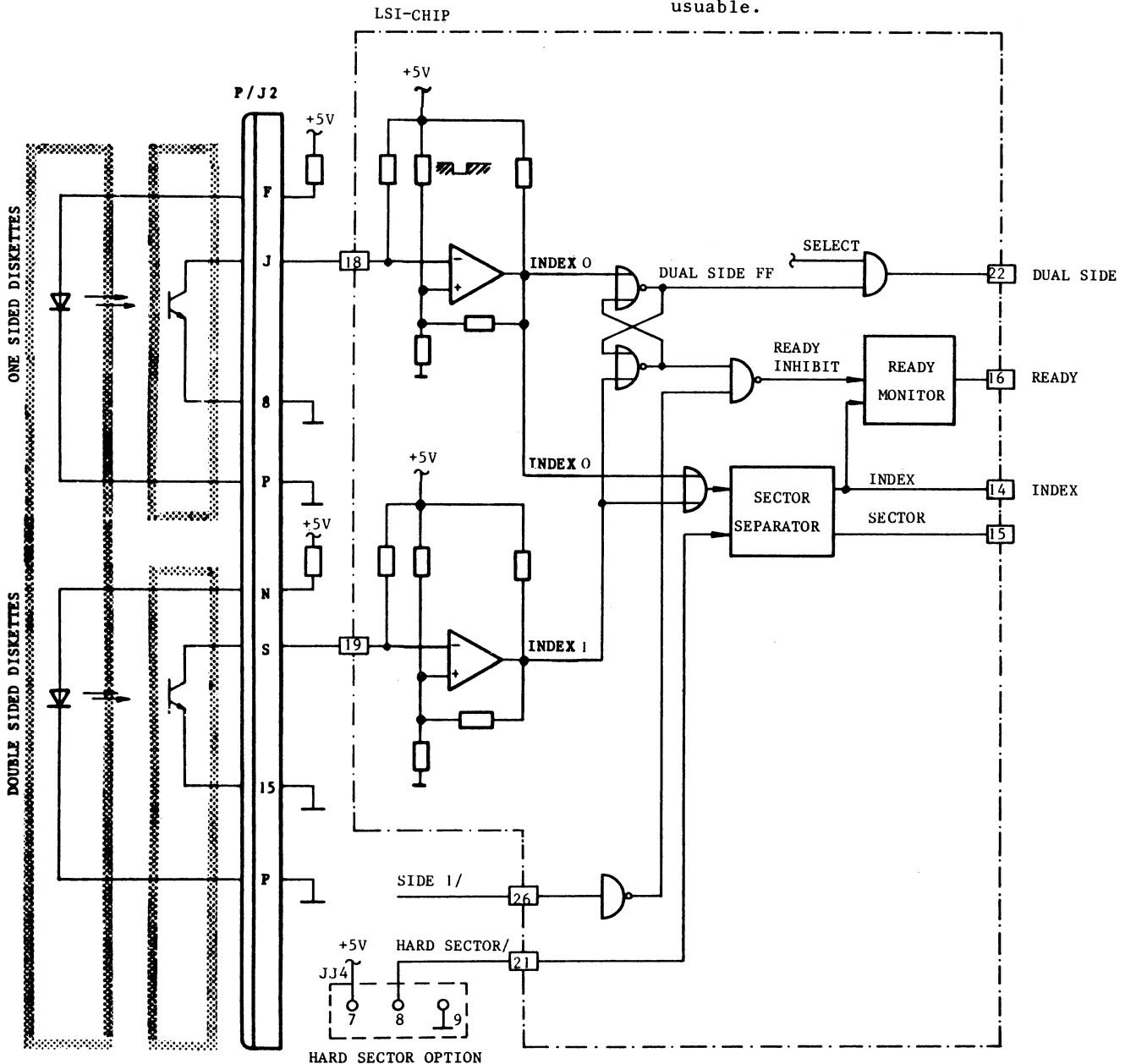
FIGURE 2 - 22 :   INDEX AND DUAL SIDE DETECTOR

2.3.7.2. READY MONITOR

The ready monitor is used to monitor the INDEX pulses for the rotational speed of the disk. The INDEX pulses are input to the 434 msec hold- over one shot. When the time between to succesive INDEX pulses is greater than 434 msec,the index counter is held reset. If the time between two INDEX pulses is less than 434 msec the hold - over one shot output remains high and enables the index counter. After three consecutive INDEX pulses have clocked the index counter,the READY/ signal is activated and sent to the host system (see Fig. 2 - 23). The READY signal is inhibited by the dual side de- tector when the host system tries to select side 1 of a installed single sided diskette .
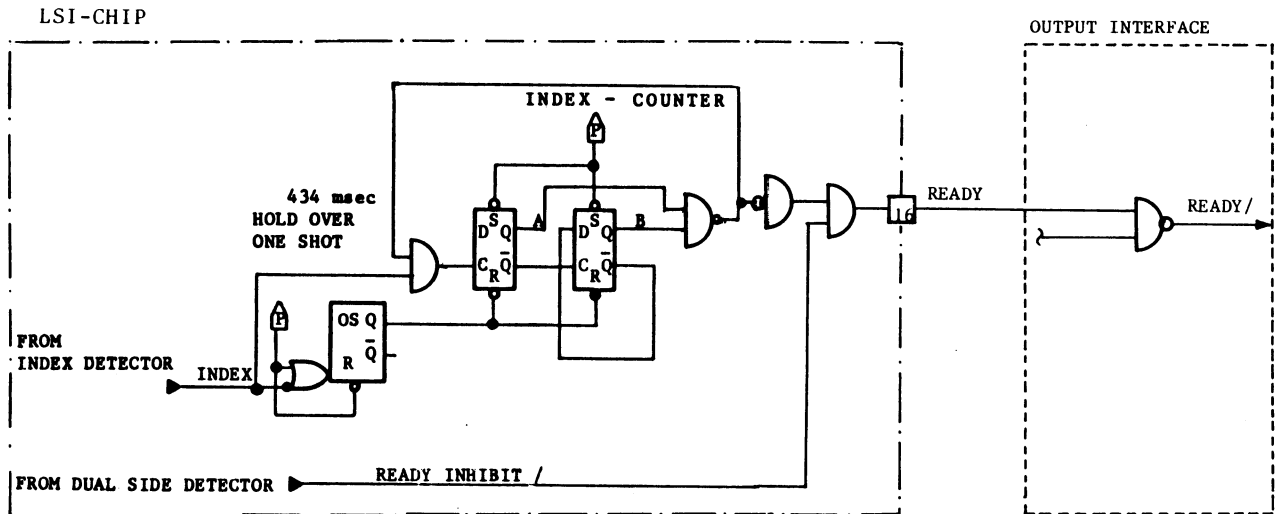
FIGURE 2 - 23   READY MONITOR
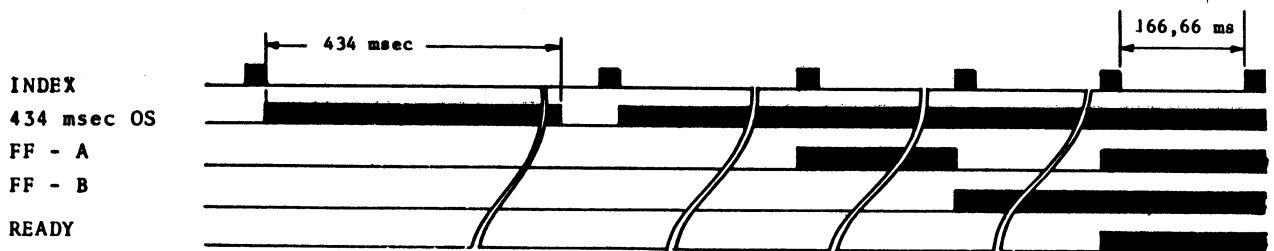
FIGURE 2 - 24 . READY TIMING

2.3.8. SECTOR SEPARATOR (HARDSECTOR OPTION) AND SECTOR DIVIDER OPTION (FIGURE 2 - 25)

2.3.8.1. SECTOR SEPARATOR

The sector separator is used for hard sector applications only.
A hard sectored disk contains 32 sector holes and one index hole in the middle between two sector holes. The INDEX/SECTOR separator logic separates the INDEX pulse from the 32 SECTOR pulses by an 3,6 msec one shot, which is triggered by the trailing edge of the 0,4 msec one shot (see timing diagram fig.2-26). Also the INDEX pulse width is limited to 0,4 ms.

2.3.8.2. SECTOR DIVIDER OPTION

This factory installed option works in conclusion with the sector separator. The sector divider divides the 32 SECTOR pulses by 2 or 4 selecting by jumpers. This is useful for hard sector applications by use of 16 or 8 sectors on one track.
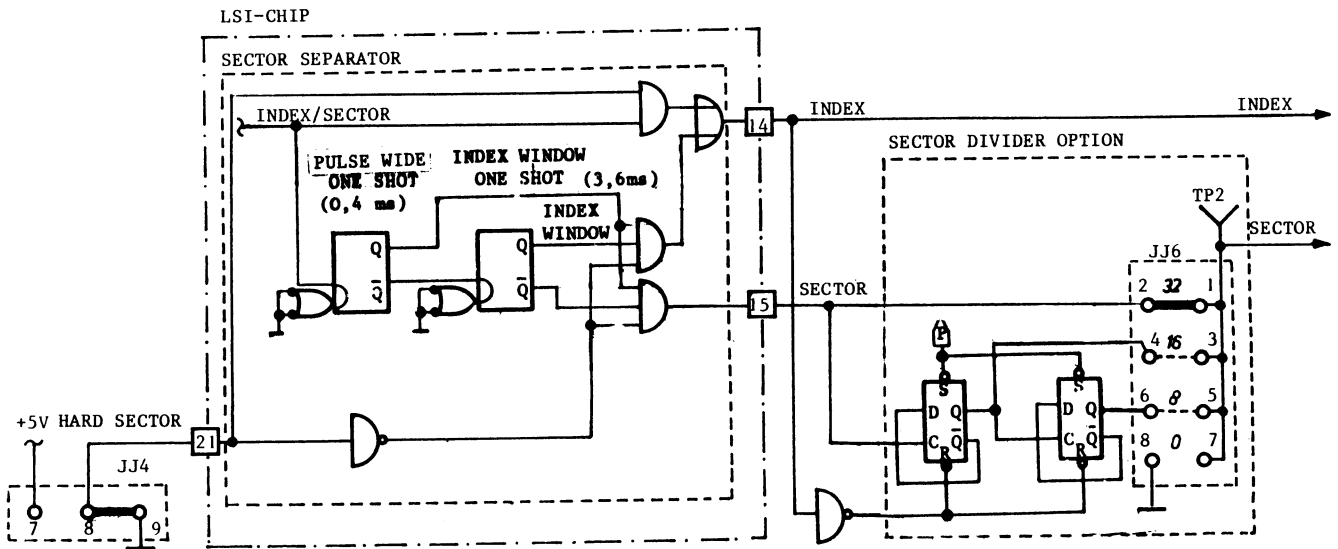
FIGURE 2 - 25 : SECTOR SEPARATOR AND SECTOR DIVIDER OPTION
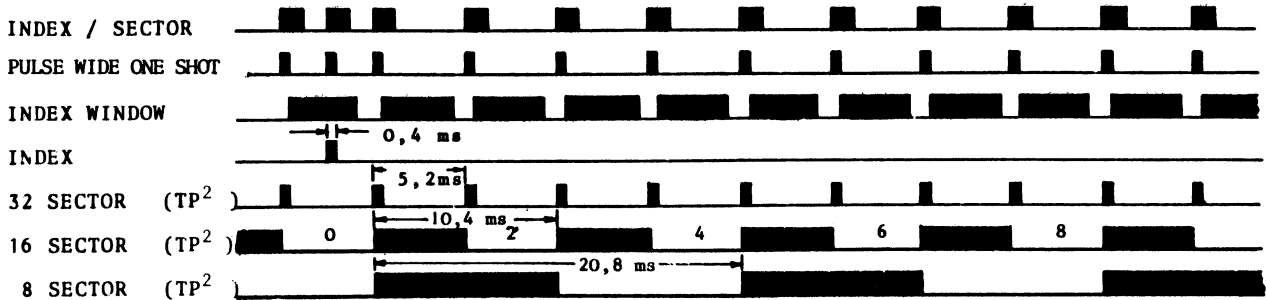
FIGURE 2 - 26 . TIMING DIAGRAM INDEX- HARD SECTOR- AND SECTOR DIVIDER OPTIONS

2.3.9. DISK CHANGE LOGIC (Fig. 2-27)

This logic notifies the host system that the diskette has been changed, even if the drive was deselected. As soon as READY drops when the disk is exchanged the UNCHANGED- flipflop is reset. The DISK CHANGE- signal is sent to the host system when the drive is se-

lected. The DISK CHANGE- signal is de-activated by the trailing edge of the. SELECT/- signal when the host system, deselects the drive. Fig. 2 - 28 shows the timing diagram for the disk change logic.
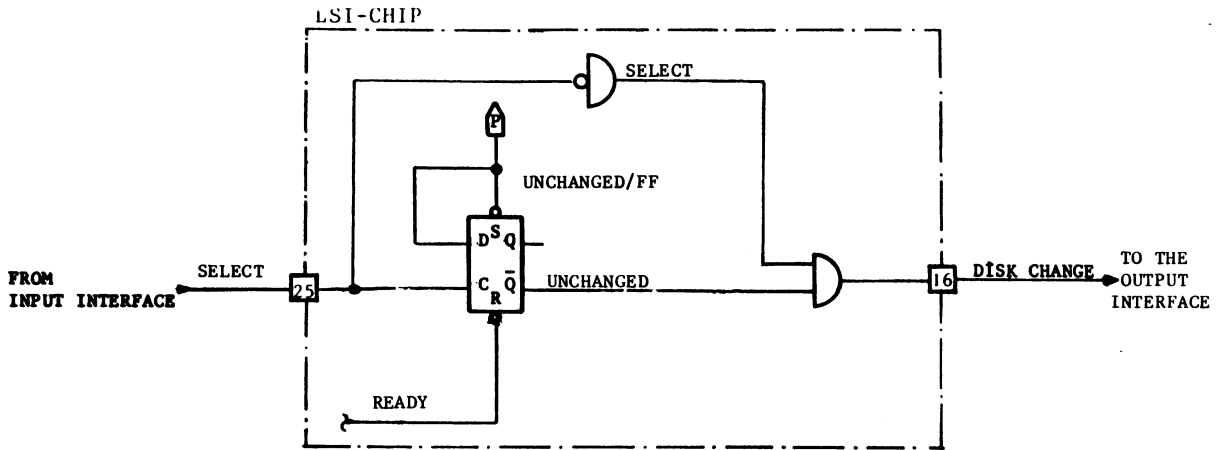
FIGURE 2 - 27 . DISK CHANGE LOGIC
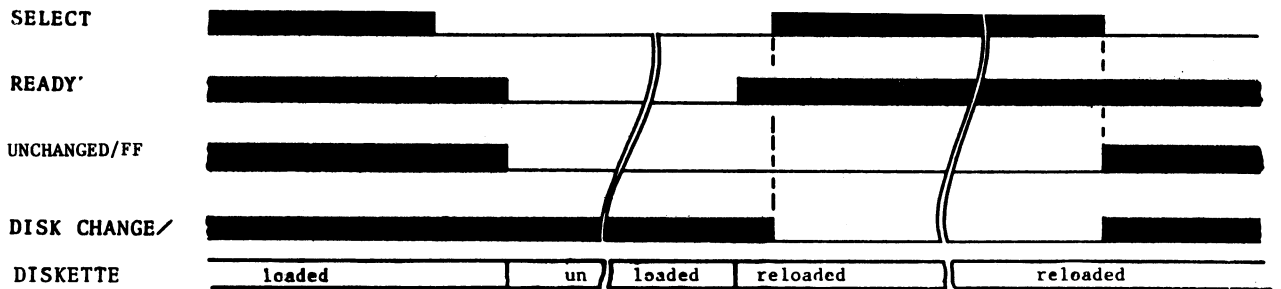
FIGURE 2 - 28 . TIMING DIAGRAM DISK CHANGE

2.3.10. HEADS LOAD, DOOR INTERLOCK AND ACTIVITY LED DRIVERS

2.3.10.1. HEADS LOAD DRIVER

For loading the heads, a SN 75453 is used. The heads load solenoid is activated as shown in table 2 - 7 by the HDSOL/ signal. HDSOL/ is low either when the driver is selected and the HDLD/ signal is active (Standard) or when the drive is selected (auto heads load option), or when the HDLD/ signal is active without any regard to the selection of the drive (radial select option). A fourth possibility is loading the heads like in the radial select option, but the stepper motor is enabled by the SELECT signal.

OPTION	LOADING THE HEADS	STEP MTR ENABLE
SELECTED HEADS LOAD	HDLD - SELECT	HDLD - SELECT
AUTO HEADS LOAD	SELECT	SELECT
RADIAL HEADS LOAD	H D L D	H D L D
RADIAL HEADS LOAD WITH STEP MTR ENABLE BY SELECT	H D L D	SELECT

TABLE 2 - 7 : HEAD LOAD OPTIONS

2.3.10.2. DOOR LOCK AND ACTIVITY DRIVER

For the activity LED and door lock solenoid, the second driver of the SN 75453 driver chip is used. Both, the activity LED and the door lock solenoid are activated by the following signals selectable by jumpers :

1. HEAD LOAD   JJ 5 - (1-2)

2. SELECT   JJ 5 - (5-6)

3. READY   JJ 5 - (3-4)

4. IN USE   JJ 5 - (9-10)

5. HEAD LOAD ∨ IN USE

6. SELECT   ∨ IN USE

7. READY   ∨ IN USE

There is also third or-condition - jumper JJ5-(7-8) and JJ5-(13-14)- to activate the LED and the door lock solenoid by the IN USE-FF (see the following chapter).

2.3.10.3. DOOR LOCK LATCH OPTION

This option allows the latching of the door lock solenoid under control of the SELECT and IN USE signals without maintaining the IN USE signal activated. The IN USE-FF stores the state of the IN USE- signal when the drive is selected (see Fig.2-29). When the door lock solenoid is activated the activity LED is illuminated.The door lock solenoid and the activity LED remain activated even if the drive is deselected. To deactivate the door lock the drive must be selected again with IN USE/ inactive (high).

The door lock latch option is enabled by the jumper JJ5-(8-9) and JJ5-(13-14).
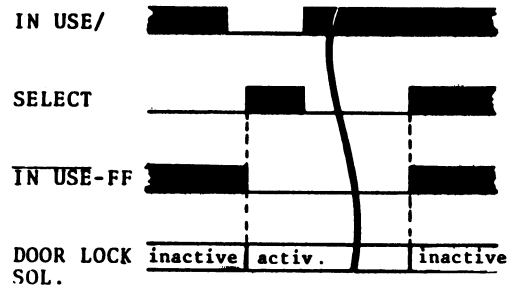
FIGURE 2 - 29 . TIMING DIAGRAM
DOOR LOCK LATCH OPTION
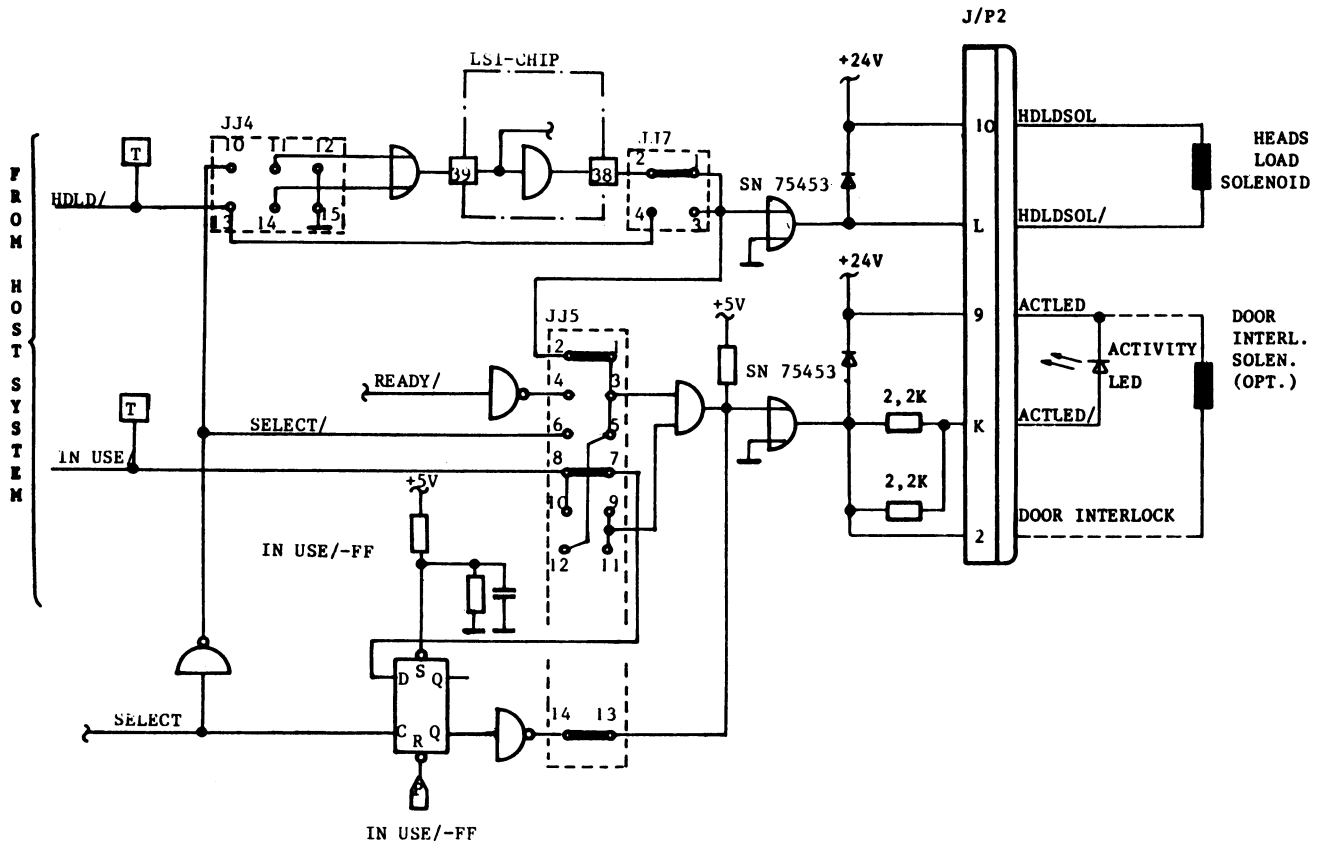
FIGURE 2 - 30 : HEADS LOAD , ACTIVITY-LED/DOOR LOCK DRIVERS

The side select circuits comprises the side control logic in the LSI-chip and the side select logic outside of the LSI and selects either head 0 or head 1 depending wether the SIDE 1 signal from input interface is high or low. The side select logic consists of two head select switches (Q 9, Q 10 and associated circuits) and a diode matrix (CR 13 ÷ CR 18).

If side 1/ is high when the drive is selected or as long as the drive is unselected, transistor Q 9 is closed and head 0 is selected. The voltage at CT 0/ is 0,9 V and developes a forward bias to diodes CR 19 - CR 15. In a read operation the read signal induced in the read/write coils of head 0 is transfered through the diodes CR 14, 15 to the read circuits. In a write operation, the write current genera-ted in the write circuit flows through these diodes into the read/write coils. The erase current is fed to the erase coil through the diode CR 13. At the same time, the diodes CR 16 - CR 18 are blocked, because transistor Q 10 will close only if SIDE 1 SEL goes high while the drive is selected. Q 9 is then open.

The state of the SIDE 0 SEL and SIDE 1 SEL signals depends either on :

- SIDE SELECT

- or STEP IN

- or SELECT LINES

Which of these signals determines the selection of the heads, depends on the jumpers of the SIDE SELECT option. For explanation see SIDE SELECT OPTIONS of this manual.
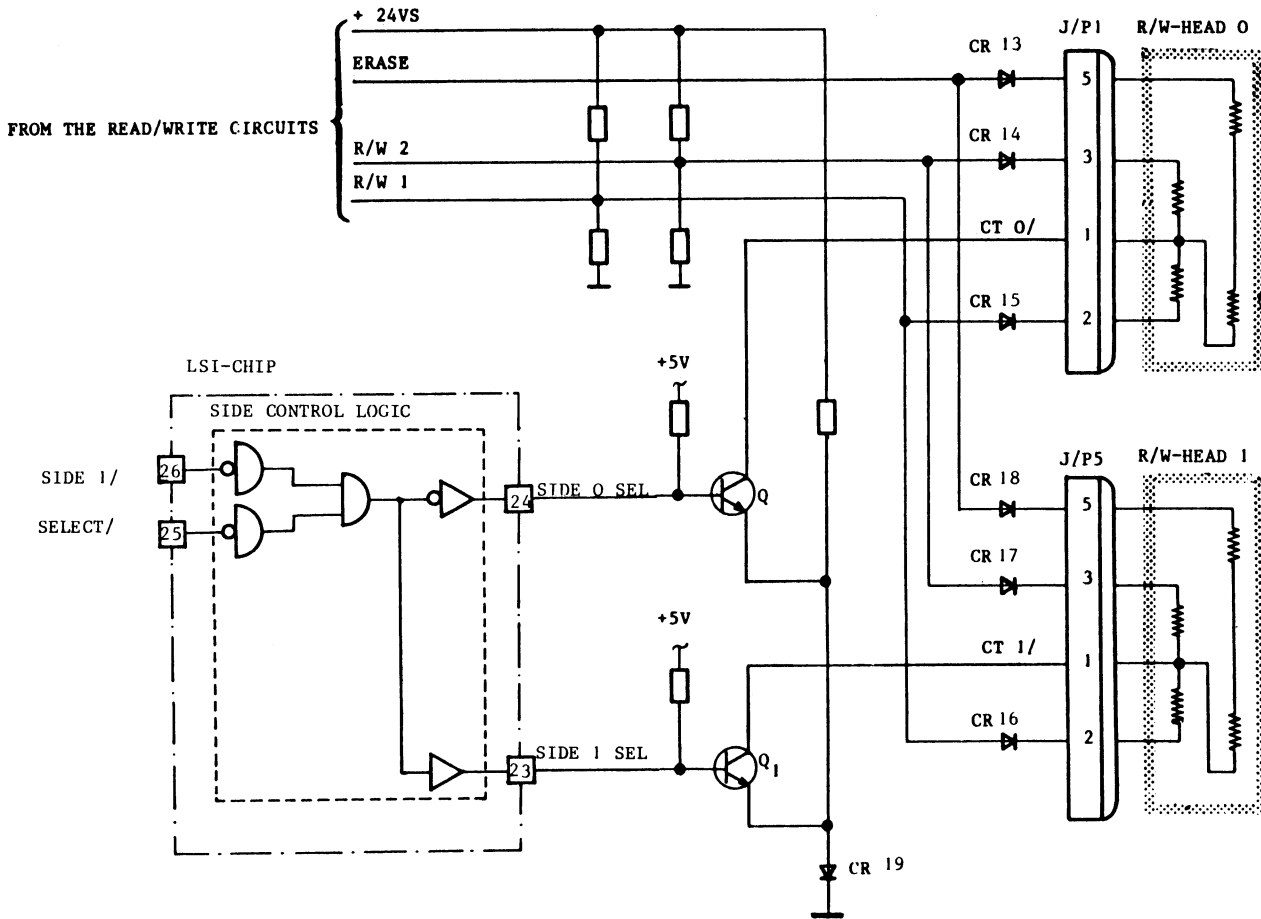
FIGURE 2 - 31 . SIDE SELECT

2.3.12. READ/WRITE CIRCUITS

2.3.12.1. READ/WRITE HEAD

The read/write head used in the BASF 6104 is a tunnel erase type ceramic head . It records and reproduces data at a flux density of 6536 flux changes per inch (fci)using FM or MFM recording technique. The nominal frequencies for MFM measured on the read/write heads are 125 kHz , 166 2/3 kHz or 250 kHz. The nominal times between flux reversals ar 2 μs, 3 μs or 4 μs.

The radial density is 48 tracks per inch (tpi). This gives 0,0208 inch nominal track to track spacing. The tunnel erase gaps trims the track width from 0,014 inch after write to 0,012 inch after erase (see Fig. 2-32).

The read / write head contains three coils: two read / write coils and the erase coil. The erase coil is energized during every write operation and limits the track width and provides low noise guard bands on each side of the recorded track. The two read/write coils are wound on a single core and are center tapped. The electrical connections of the read/write head are shown on Fig. 2 - 33 .

During a write operation the WRTDATA-Signal will be directed alternately to one of the two read/write coils by a flipflop. This cause a flux change to be recorded for every pulse of the WRTDATA- Signal. The old data on the track will be overwritten by the new data stream.

On a read operation an output voltage is induced in the read/write head by every flux change that passes the gap of the read/write head. This voltage is used by the read circuits to recover the written data.

FIGURE 2 - 32 . TRACK GEOMETRY
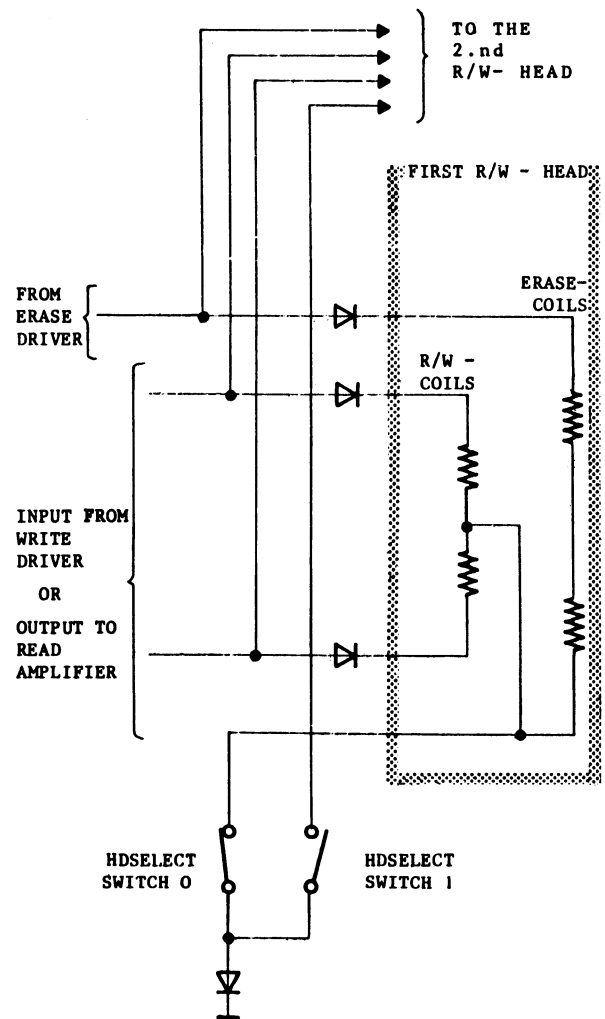
FIGURE 2 - 33 . ELECTRICAL CONNECTION OF THE READ/WRITE HEADS

2.3.12.2. WRITE CIRCUITS

The write circuits encode serial data from the host system to magnetic flux patterns recorded on the diskette.
A write operation is initiated by the host system activating the following input lines (see Fig. 2 - 34).

- **SELECT** selects the drive and loads the heads if AUTO LOAD Option is installed.

- **HDLD** LOADS the heads.

- **WRITE** turns on the write circuits.

- **ERASE** turns on the erase current , only ecessecary if Auto Erase Option not installed.

- **WRT DATA** FM or MFM - Write Data.

A simplified logic of the write circuits is shown on Fig. 2 - 35 . The write circuits are activated by WRT ENA, which is active when the host system sends the WRITE - signal and the drive is selected and not write protected. The data stream of the host system is divided by the write flipflop (Fig.2-36).The output of the write flipflop alternately turns on transistor Q 6 and Q 7 . The write current I_W respectively I_W I which is determined by the resistor R29 flows then alternately through the windings W_1 and W_2 of the selected read/write head. If the input signal LOI is activated current flows also through resistor R28 . This current reduces the current through the read/write head. LOI is normally activated for read/write head positions above TRACK 43. The erase current I_E is turned on by the transistor Q 8 when ERASENA is high. The write and erase current are blocked by the DC - control logic if a power failure have been detected.
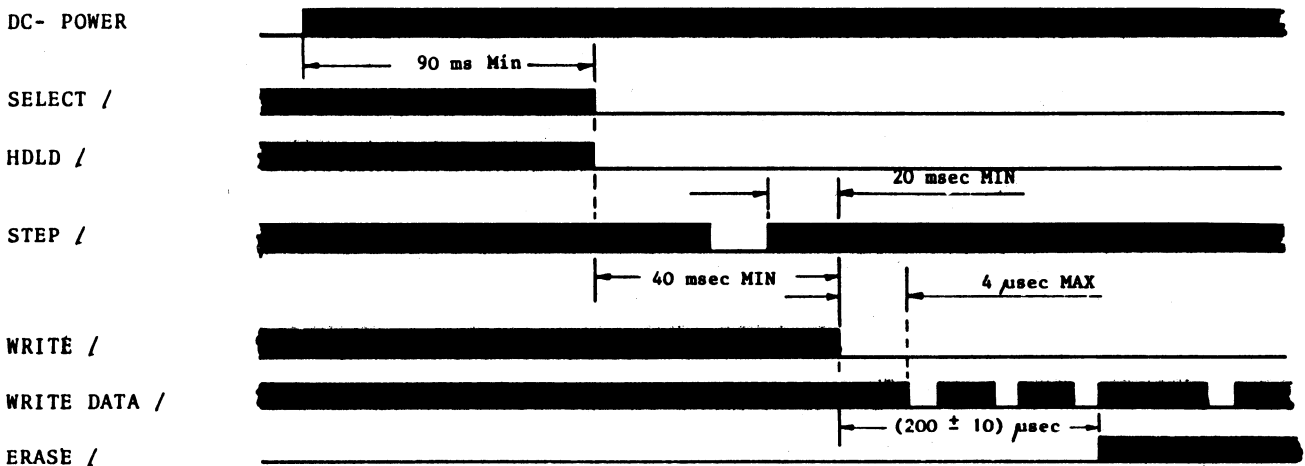
FIGURE 2 - 34 . WRITE INITIATE TIMING
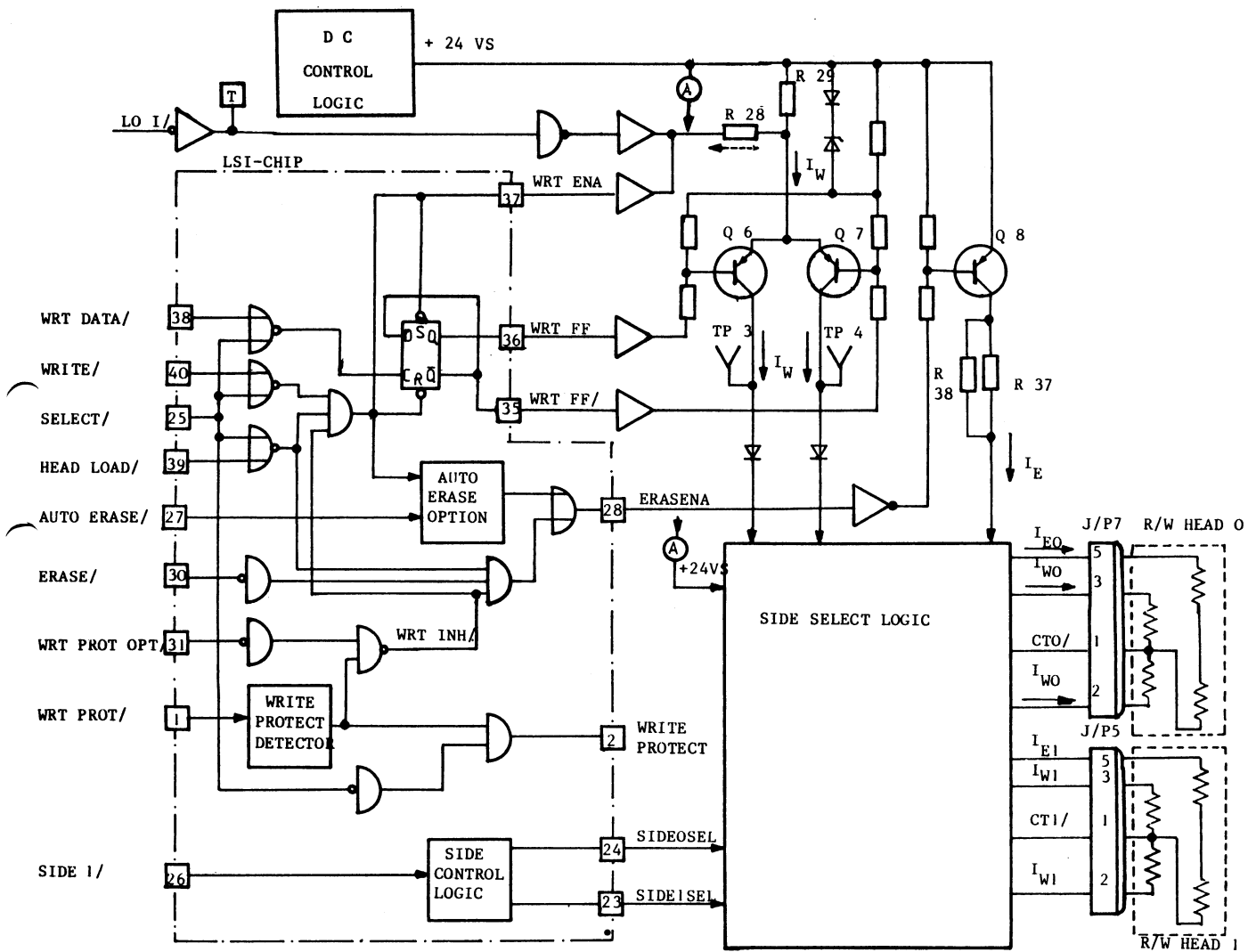
FIGURE 2 - 35 . SIMPLIFIED WRITE CIRCUITS
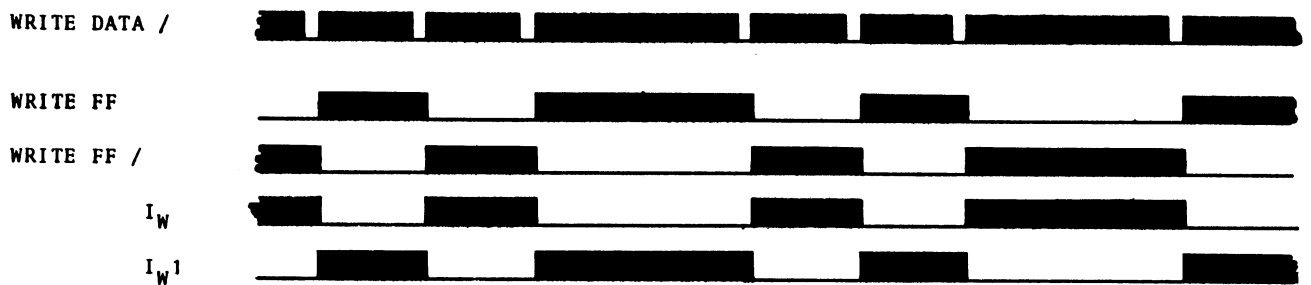
FIGURE 2 - 36 . TIMING DIAGRAM WRITE OPERATION

2 - 31

2.3.12.3. AUTO ERASE OPTION

The erase current shall be switched on (off) after the write current has been switched on (off). This delay between write current switching and erase current switching is necessary for tunnel erase typ read/write heads. The auto erase option in the LSI comprises two one shots, one for the erase on delay time, the other for the erase off delay time (see fig. 2-37). These one shots are enabled when the AUTO ERASE signal is active by the jumper JJ4-(4-5). The ERASE ENABLE - FF is set when the ERASE ON DLY - one shot times out, it is reset when the ERASE OFF DLY - one shot times out (see figure 2 - 38).

The ERASE ENA - FF is reset during power on by the PWR ON R/signal and also by AUTO ERASE low. In this case, the ERASE ENA signal can be generated by the ERASE line from the host system.
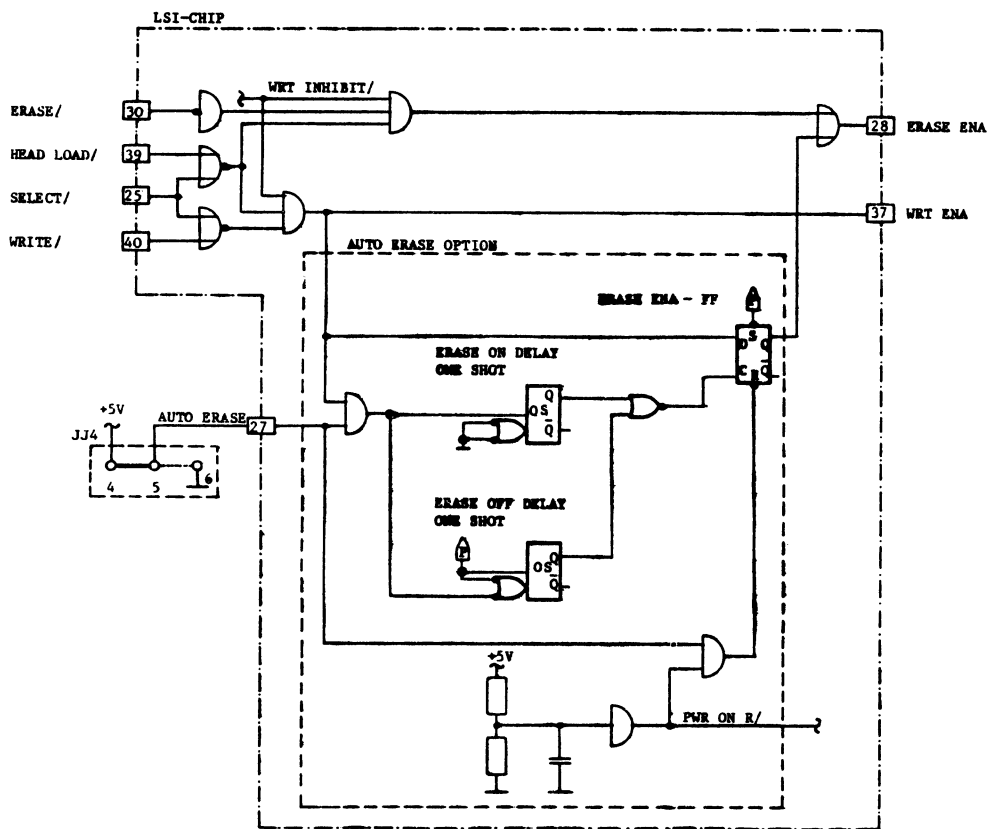
FIGURE 2 - 37 : AUTO ERASE OPTION
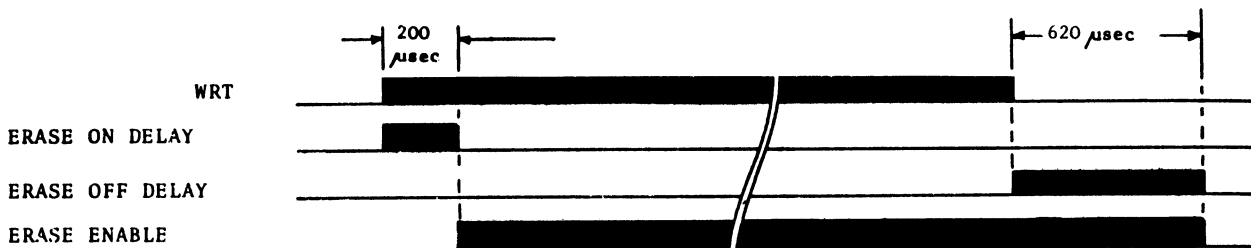
FIGURE 2 - 38 . ERASE DELAY TIMING

2.3.12.4. WRITE PROTECT DETECTOR AND WRITE PROTECT OPTION

The write protect detector comprises a LED mounted on the deck assembly , a phototransistor and a comparator circuit.

When a " write protected " diskette is inserted, the phototransistor will sense the light of the LED causing the negative input to the comparator to go low.   The comparator output NOTCH OPEN will go high,   and   the WRITE PROTECT   signal is sent to the host system when the drive is selected to indicate that a " write protected " diskette is inserted. Writing on the diskette is inhibited, if the jumper of the write protect   option is jumpered from JJ 4 - (2 - 3). If the user wishes to use the WRITE PROTECT-signal only for identifying special use diskettes without inhibiting writing, the write protect option must be connected from JJ 4 - (1 - 2).
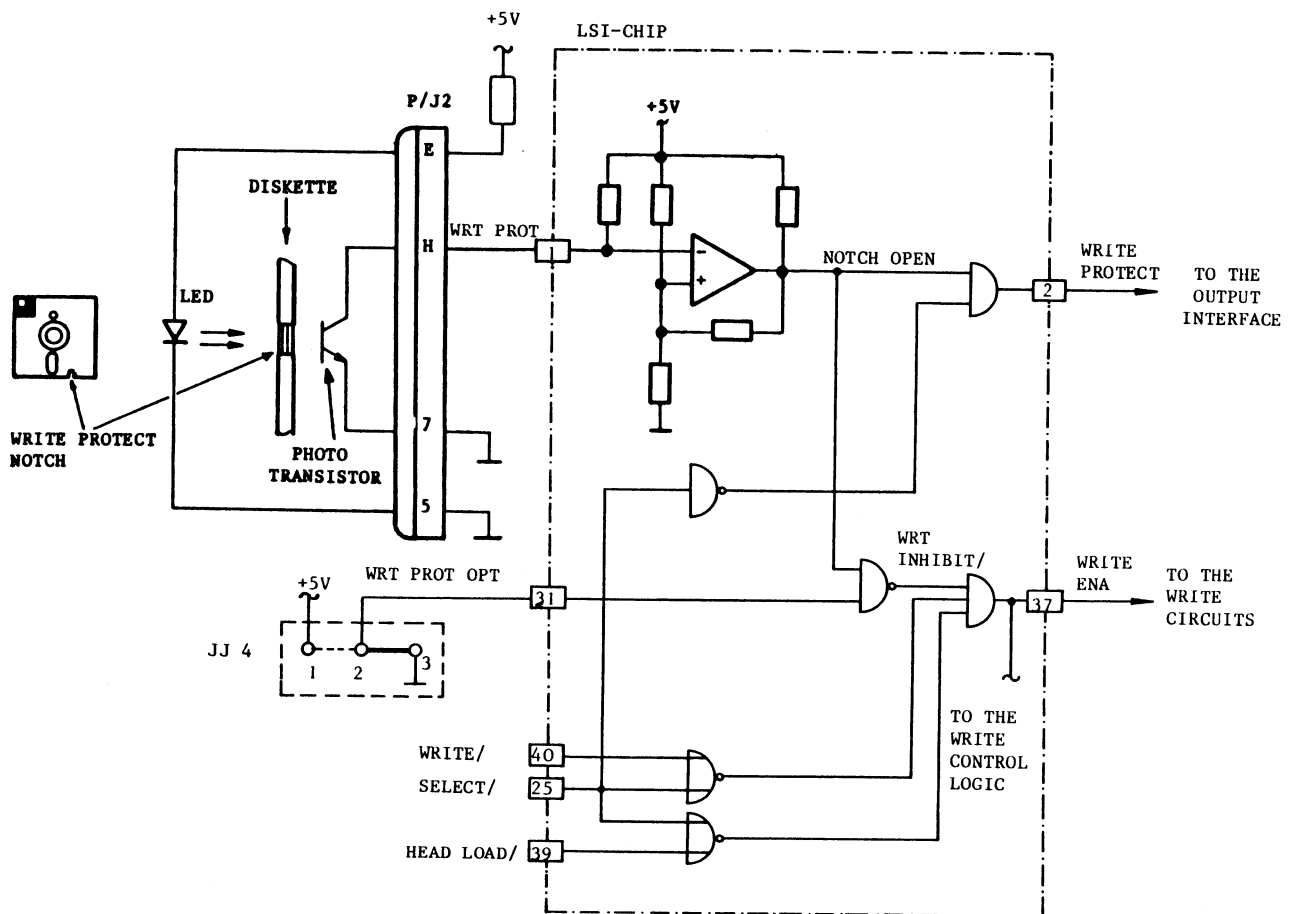
FIGURE   2 - 39   :   WRITE   PROTECT   DETECTOR

2.3.12.5. READ CIRCUITS

The read circuits recover data recorded on the diskette by a write operation. A read operation is initiated from the host system by activating the following lines:

- **SELECT** selects the drive and loads the heads if Auto Head Load Option is used,
- **HDLD** Loads the heads.

The signal WRITE GATE/ must be inactive to enable the read circuits. Also the heads must be loaded and the drive must be selected (HDLD:SELECT active). The postcompensation filter (PCF), if installed, is switched on by an active LOW I-signal.
Fig. 2 - 41 shows the read initiate timing. Fig. 2 - 40 is a simplified diagram of the read circuits.
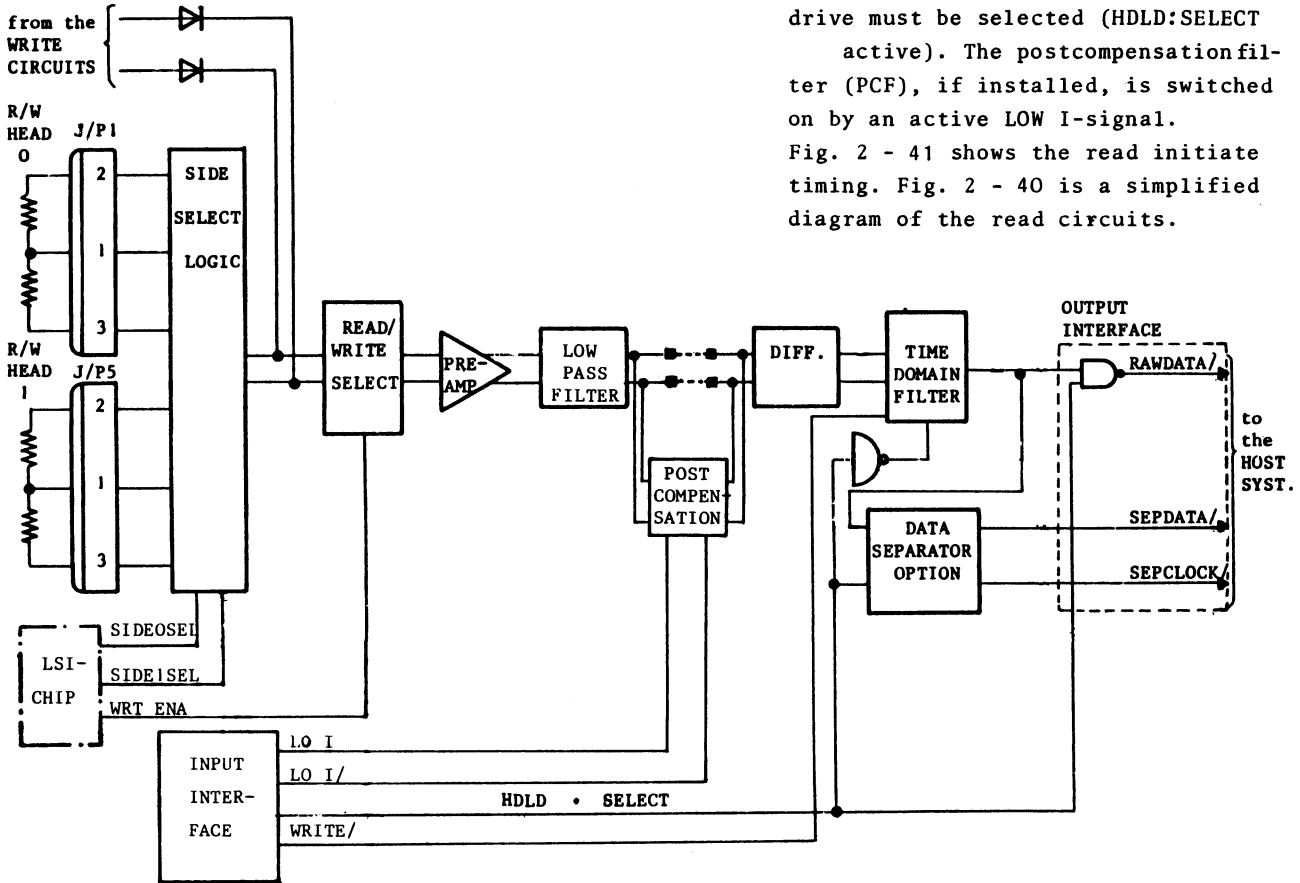
FIGURE 2 - 40 . READ CIRCUITS (simplified
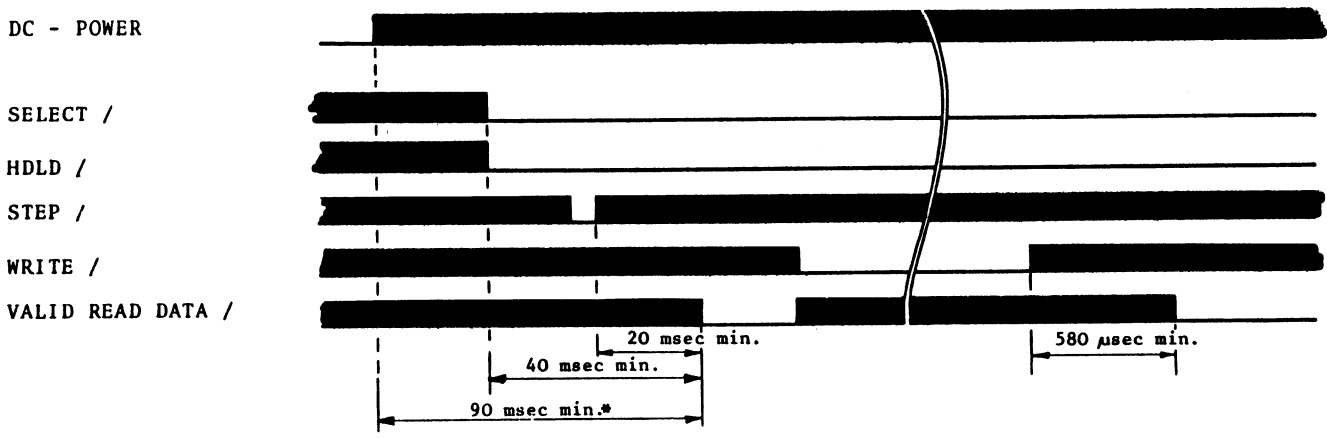
FIGURE 2 - 41 . READ INITIATE TIMING

READ / WRITE SELECT

The read/write select circuit comprises two MOS-FET switches. The inputs of the switches are connected to the read/write coils of the selected read write head. The outputs of the switches are connected to the read preamplifier (see Fig. 2 - 42).

READ PREAMPLIFIER AND FILTER
(Fig. 2 - 43)

Read preamplifier is a high-gain linear amplifier used to increase the read data signal amplitude by a gain of 100. The preamplifier outputs are used to drive a filter network. The filter is a 3-pole linear- phase bandpass type and has -3 dB bandwidth of 800 kilohertz.
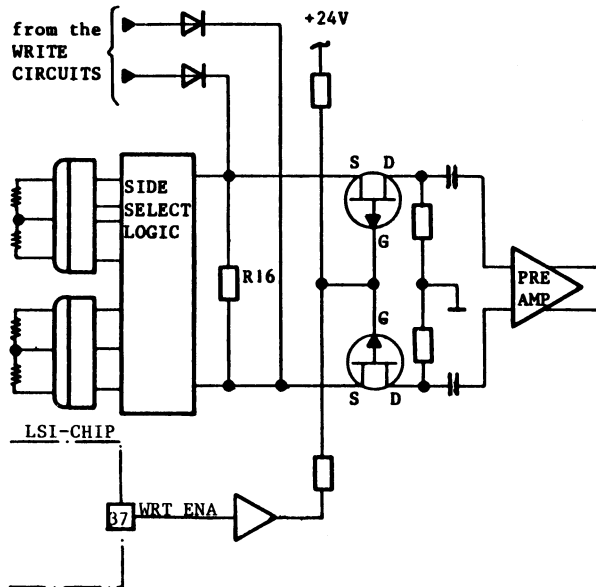
FIGURE 2 - 42 . READ/WRITE SELECT LOGIC
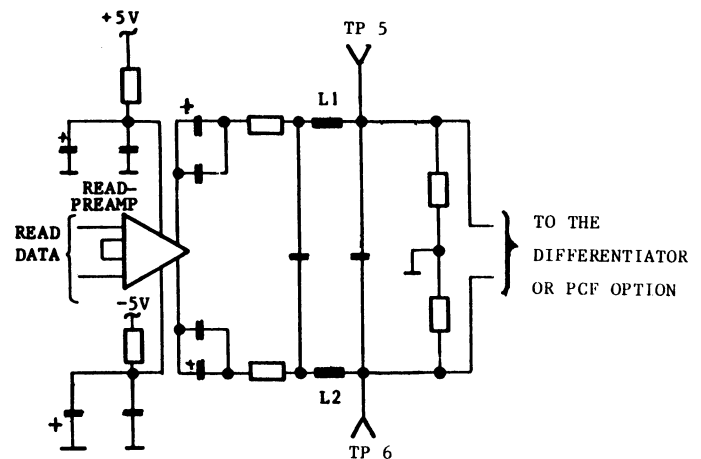
FIGURE 2 - 43 . READ PREAMPLIFIER AND FILTER CIRCUIT

When the disk drive is operating in the WRITE- mode, WRT ENA is high and the FET's are open. The read/write coils are isolated from the read preamplifier. In the Read- mode (WRTENA low) the output signal of the selected read write head is switched to the read preamplifier.

DIFFERENTIATOR

The output signal of the bandpass rea-
ches always a maximum when a magnetic
flux change of the disk passes the read/
write gap of the read/write head. To
detect these maximums, the differen-
tiator is used. The differentiator con-
sists of the NE 592 amplifier wired up
with a series-resonant circuit (R.L.C.)
which determines the characteristic of
the differentiator. Zero crossings are
produced for every flux change. Because
the gain of the differentiator is high-
er for the frequency 2f as for 1f, the
lower output of the read/write head
for higher frequencies are partially
compensated.

CROSSOVER DETECTOR AND TIME DOMAIN FILTER (FIG. 2 - 45)

The crossover detector consists of a
bidirectional one shot, which gene -
rates a 1/usec output pulse for each
zero crossing on its input and a com-
parator which converts the analog in-
put signal into a digital output sig-
nal. Both circuits are located in the
integrated circuit 8T20.
The purpose of the time domain filter
is to disregard false crossovers
caused by shouldering in the diffe-
rentiated read signal. This will hap-
pen on outer tracks of high resolu-
tion disks, when the drive is equip-
ped with high resolution heads.
Also this can occur when the post-
compensation filter is switched on
track between track 43 and 60. The
time domain filter acts as follows:
the state of the comparator output
is stored into the TD-flipflop
1/usec after the zero crossing by
the trailing edge of the Q-output
of the bidirectional one shot. Be-
cause false zero crossings always
exist for a shorter time than the
pulse duration of the Q-output, the
TD- FF will not change when it is
clocked and false crossovers are
eliminated.
The CHANGE-flipflop is always tog-
gled when the TD- FF changes are
state. The CHANGE-flipflop and the
two RC-circuits are necessary for
generating trigger pulses for the
data pulse one shot at every tran-
sition of the TD-flipflop. The data
pulse one shot extends its trigger
pulses to the required pulse width
of 200 nsec.
Fig. 2 - 46 is a timing diagram of
the whole read circuits and illus-
trates the function of the time do-
main filter.

FIGURE 2 - 44 : DIFFERENTIATOR
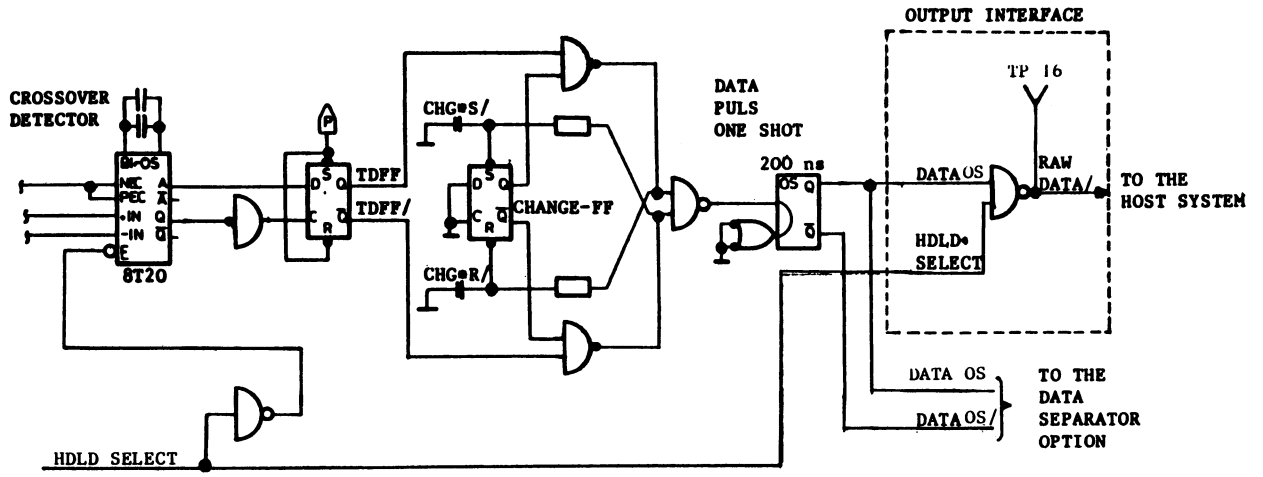
FIGURE 2 - 45 . CROSSOVER DETECTOR AND TIME DOMAIN FILTER
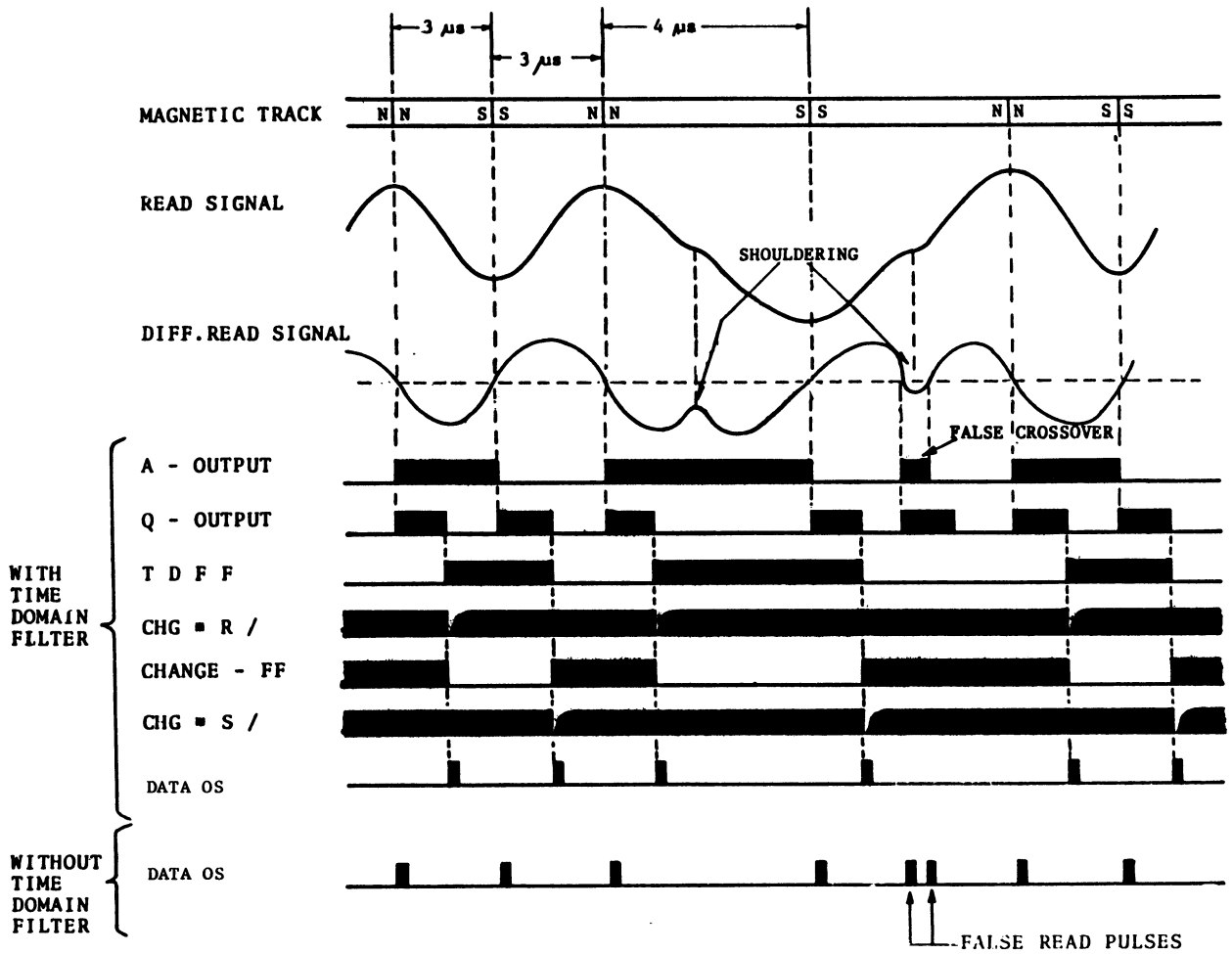
FIGURE 2 - 46 . READ CHAIN TIMING DIAGRAM

2.3.13. POSTCOMPENSATION OPTION

For MFM-recording on flexy-disks, the peakshift must be compensated by one of the following compensation methods:

- Precompensation

- Postcompensation

Precompensation is used during the write operation and precompensates the magnetic flux change in the opposit direction as the expected peakshift . This has to be done by the disk controller, which generates the transition of the WRT DATA signal earlyer, later or normal depending on the write pattern.

The postcompensation is used during reading for disks recorded without precompensation. This is the MFM-recording and data retrieval on IBM-systems. So the postcompensation option is necessary when IBM - compatibility is needed. Also the postcompensation is helpful when a precompensation circuit is not implemented in the disk con - troller.

The postcompensation circuit consists of an amplifier, the postcompensation filter (PCF) and a quad analog switch as shown in figure 2 - 47.

The amplifier has a gain of 20 and compensates the attenuation of the PCF. The PCF is a passive symmetrical lattice network with a transfer function which narrows the read pulses to about ahalf of its original width. Also the peakshift of the read signal is decreased. The PCF is switched into the read chain between low pass filter and differentiator by an analog switch, when the LOW I signal is activated.As long as LOW I is inactive, the normal read chain is used. It is recommanded to use the PCF during reading on the tracks 60 - 76.
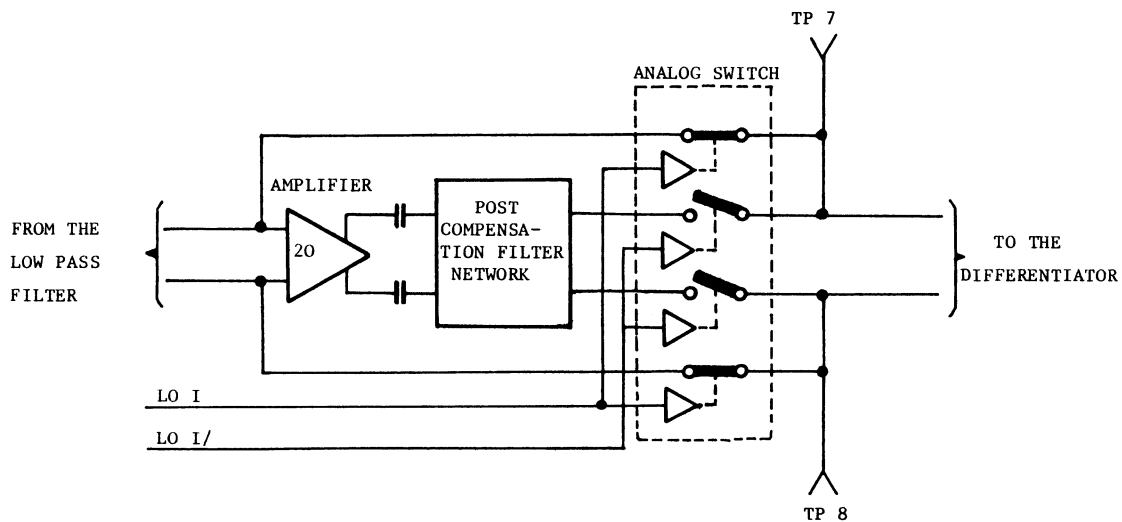
FIGURE   2 - 47   :   POSTCOMPENSATION   OPTION

2.3.14. DC- CONTROL AND POWER ON RESET LOGIC

The DC - Control logic is shown on Fig. 2 - 48 . This logic monitors the DC- Voltages +5 V and +24 V. If one of these voltage are missing or out of limits the write and erase current source is blocked and the write operation is inhibited.
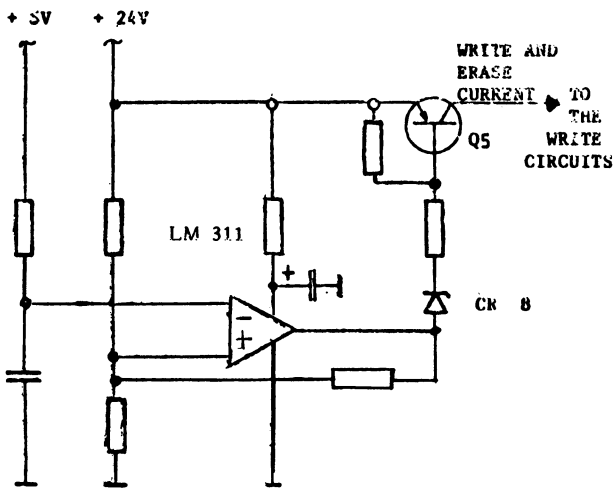
FIGURE 2 - 48 . DC - CONTROL LOGIC

2.3.15. - 5 VOLT REGULATOR

The disk drive logic operates from - 5.0 volt +/- 5 %, supplied from the host controller. If the voltage is not available, the - 5 V regulator must be enabled (see fig. 2 - 49). When the - 5 V regulator is used, the controller can supply an unregulated input from - 7 V to - 16 V. Regulator 10 A provides a - 5 V output, regulated to +/- 5 percent.
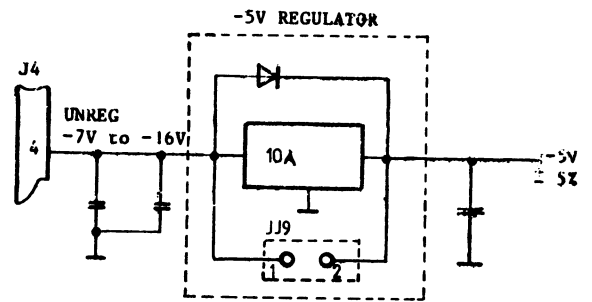
FIGURE 2 - 49 . - 5V REGULATOR
SIMPLIFIED DIAGRAM

2.3.16. DATA SEPARATOR OPTION

The data separator option is useful on-
ly for single density recording (FM -
encoding) and can be **jumpered to two**
different circuits :

    - false data separator

    - true data separator

The false data separator is suited for
hard sector applications with no mis-
sing clocks in the data format, the true
data separator is usuable for IBM 3740 FM
data formats with missing clocks. The
data separator option (see fig. 2 - 50)
consists of an adinstable oneshot, the
SYNC-counter, the RESYNC oneshot and the
RESYNC-FF and can be switched to one of
the two circuits by a jumper on JJ-10.

FALSE DATA SEPARATOR

For this circuit, the jumper must be
connected from JJ-10(2-3). This holds
the SYNC-counter and the RESYNC-oneshot
reset. So only the DATA SEP-oneshot is
used. It is triggered by the SEP CLOCK/-
signal and if a FILE DATA-pulse occurs
as long it is fired, a SEP DATA/-pulse
is generated (see timing diagram 2-51).
The false data separator is synchroni-
zed by the first "0" (4 /usec). But if
one clock pulse is missing, a data er-
ror will occur.

TRUE DATA SEPARATOR

The true data separator is enabled by
a jumper from JJ-10(1-2).This enables
the SYNC-counter and the RESYNC- one-
shot. The RESYNC-oneshot is triggered
by every SEP DATA/-pulse, also the SYNC-
counter is incremented. But with the
next SEP CLOCK/-pulse, both are reset.
The RESYNC-FF will be reset by the SEP
CLOCK/-pulse, also the timing diagram
on figure 2 - 52 shows the function of
the true data separator circuit. When
a read operation is started in an all
ones area and the data separator is
wrong synchronized, the circuit will
be in sync in an all zeroes area after
4 false SEP DATA/-pulses are detected
in sequence. The SYNC-counter which
contains three D-type-flipflops is in-
cremented by the SEP DATA/-pulse to 4.
The signal FOUR/ of the SYNC-counter
goes active and helds the DATA SEP -
oneshot for one trigger pulse reset .
This changes the phase to the FILE DATA-
pulse and with the next SEP CLOCK/ -
pulse which now occurs the SYNC-counter
and the RESYNC-FF will be reset.
When the true data separator is cor-
rectly synchronized and an address
mark on the IBM-data format will be
read, three consecutive clock pulses
can be missing.
The SYNC-counter will be counted to
three, but with the next SEP CLOCK/ -
pulse, the RESYNC operation will be
stopped.
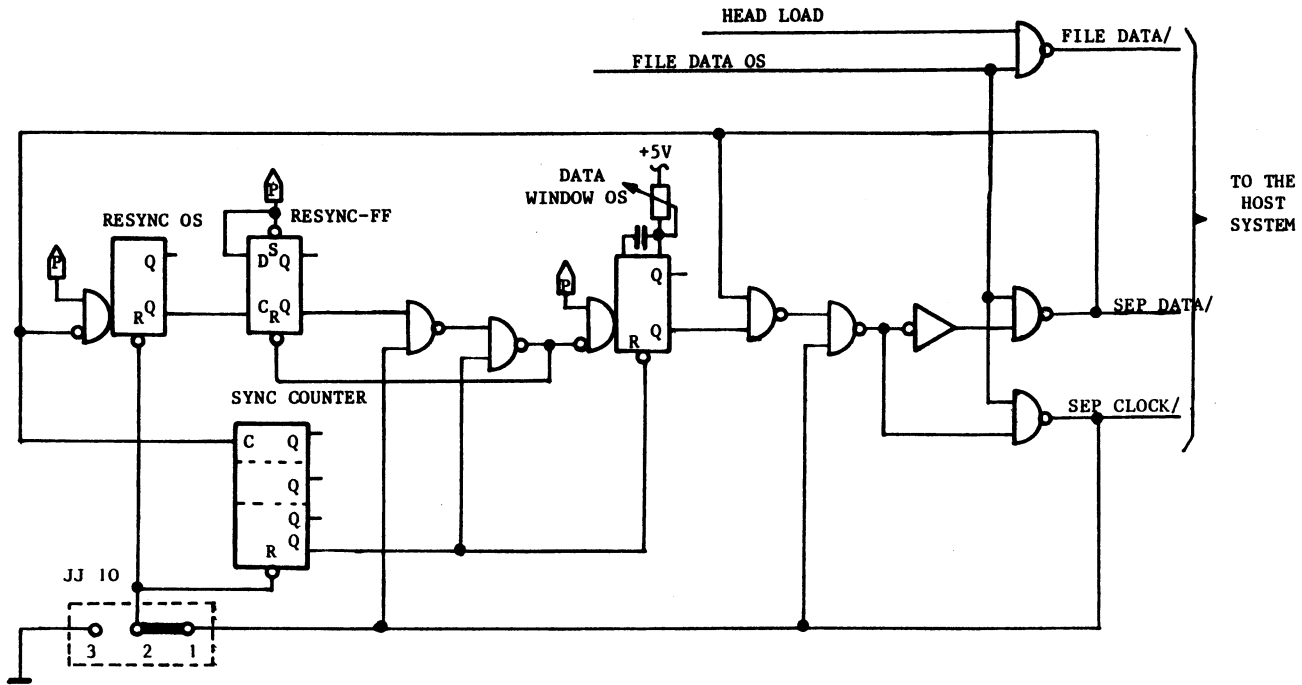
FIGURE   2 - 50   :   TRUE/FALSE   DATA   SEPARATOR   CIRCUIT
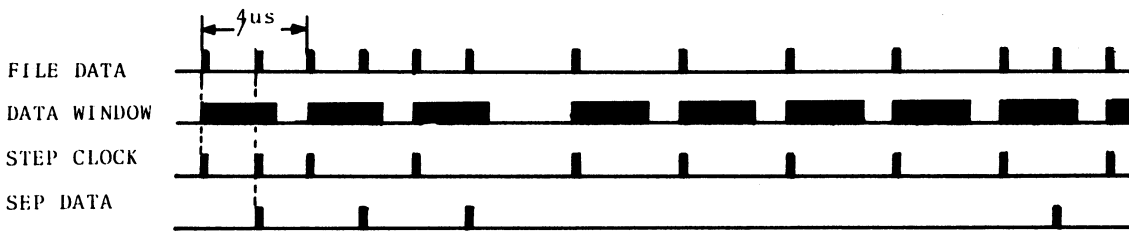
FIGURE   2 - 51   :   TIMING DIAGRAM / FALSE DATA SEPARATOR
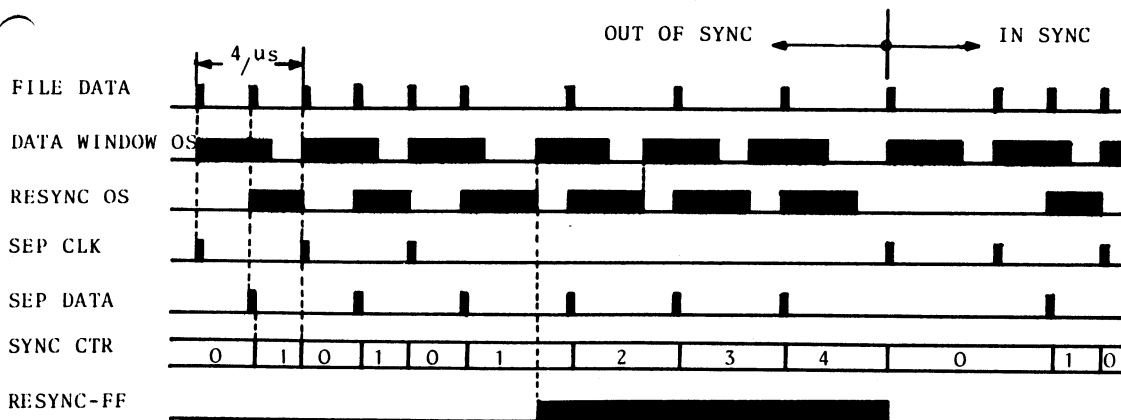
FIGURE   2 - 52   :   TIMING DIAGRAM TRUE DATA SEPARATOR

SECTION III
INSTALLATION AND OPERATION

3.1. INSTALLATION

3.1.1. GENERAL

This section provides information for
installation and possible configura -
tions of the disk drive.

3.1.2. UNPACKING AND INSPECTION

The 6104 disk drive is packaged in
heavy duty containers, designed to en-
sure adequate protection during ship-
ping and handling. A special shipping
disk and shipping protection clip sa-
ve the read/write head from damaging.

Use the following procedure during un-
packing and inspection :

- remove contents of shipping contai-
  ner and inspect for in-transit da-
  mage. If damage is evident, notify
  the carrier and BASF.
  Specify nature and extent of dama-
  ge ;

- verify that contents of shipping
  container agree with shipping list.
  Notify a BASF representative if a-
  nything is missing ;

- verify that model designation and
  serial number agree with those on
  the shipping invoice ;

- remove shipping disk and shipping
  protection clip as shown on fig.
  3 - 1 ;

- store shipping disk, shipping pro-
  tection clip and containers for a
  possible future use ;

- inspect assemblies for loose hard-
  ware. Tighten hardware if necessa-
  ry ;

- remove unused springs, if necessa-
  ry for the used mounting position
  of the drive.
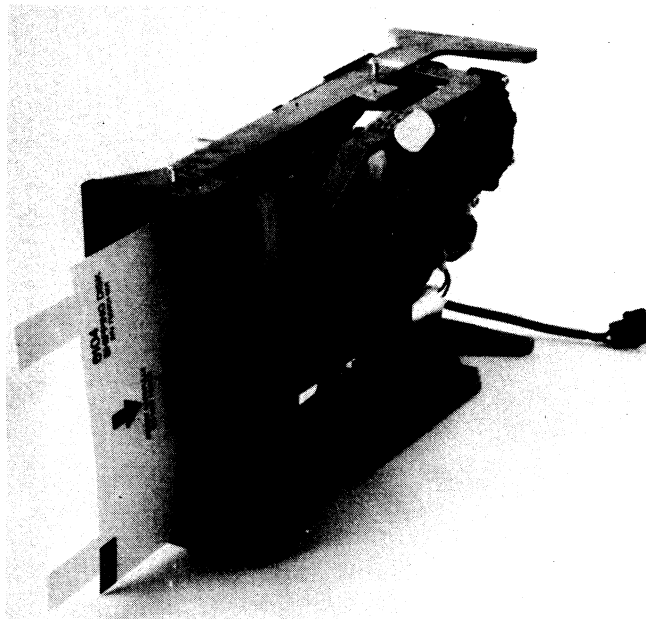
FIGURE   3 - 1   :   REMOVE OF SHIPPING DISK AND SHIPPING PROTECTION CLIP

3.1.3. CONNECTING CABLES

The disk drive is connected to the host controller by three connecting cables. The ac and dc cables are independent cables requiring direct connection to each disk drive, regardless of connecting configuration. However, the interface signal cable is connected according to the various connecting configurations, and should not exceed 10 feet in length. The cables are connected directly to the disk drive, and are identified as follows:

- J3, Interface Signals
  (Input Commands and Write Data,
  Output Status and Read Data).

- J4, DC Power
  (Electronics and Stepper Motor)

- J5, AC Power
  (Spindle Drive Motor)

3.1.4. CONNECTORS

3.1.4.1. AC- POWER CONNECTOR

AC- Power is connected to the disk drive connector J6 AMP P/N 0-350767-1 with pins P/N 0-350851-1 . The recommended mating connector P 6 is AMP P/N 0-350766-1 .
Both utilizing pins P/N 0-350689-1 .
The AC Power input connector J 6 is mounted inside the frame and next to the drive motor capacitor.
Figure 3 - 2 shows connector J 6 as seen from the rear of the drive.
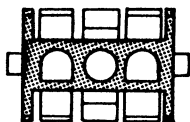
FIGURE 3 - 2 . AC CONNECTOR J 6

The input pin assignments and voltage requirements are listed in table 3-1.

PIN No.	Voltage	Tolerance	Current
1	220 VAC	$\pm$ 2 %	0,3 A
2	FRAME GND	-	-
3	220 V RET	-	-

TABLE 3 - 1 . AC - VOLTAGE REQUIREMENTS

3.1.4.2. DC- POWER CONNECTOR

DC power is connected to the disk drive through connector J4 (AMP P/N 380 999-0). The recommended mating connector is AMP P/N 1-480270-0 utilizing AMP pins 60619-1. DC power input connector J4 is mounted on the noncomponent side of the PCB, just below the drive motor capacitor and the stepper motor. The 6- pin connector is soldered directly to the PCB.

FIGURE 3 - 3 . DC CONNECTOR J4

The input pin assignments and voltage requirements are listed in Table 2 - 2

PIN No.	DC- Voltage	Tolerance	Current
1	+ 24 VDC	$\pm$ 1,2 VDC	1,3 A Typ
2	+ 24 VDC Ret	-	-
3	-5V Ret	-	-
4	-5VDC -7 to -16 VDC (Optional)	$\pm$ 0,25 VDC NA	0,08 A Typ Typ
5	+5 VDC	$\pm$ 0,25 VDC	0,8 A Max.
6	+5V Ret	-	-

TABLE 3 - 2 . DC - POWER REQUIREMENTS

3.1.4.3.SIGNAL- CONNECTOR

The signal cable is connected to the
disk drive through connector J3.Con-
nector J3 is a 50 pin PCB edge card
connector located on the rear of the
disk drive.   The pins are numbered
from 1 to 50 with the even pins   on
the component side.A key slot is provi-
ded between pins 4 and 6 for connec-
tor keying. Recommended mating con-
nectors for J3 are listed in Table 3-3.

TYPE OF CABLE	MANUFACTURES	CONNECTOR P/N	CONTACT P/N
Twisted pair 26	AMP	1-583717-1	1-583616-1 (crmp)
Flat cable	3 M "scotch-flex"	3415-0001 — 3415-0000	N A

TABLE   3 - 3   :   RECOMMENDED   J3   MATING   CONNECTORS

3.1.4.4. INTERCONNECTING DIAGRAM

Fig. 3 - 4 is provided as an intercon-
necting diagram showing the connec-
tions directly to or from the PCB.

Connectors J1, J2, J5 are for internal
drive use, connector J5, J3 and J4
are from the controller.

81 001 - 007

J3

OPTIONAL INPUTS — 4
SELECT 0/ — 26
SELECT 1/ — 28
SELECT 2/ — 30
SLELCT 3/ — 32
SIDE SELECT — 14
IN USE / — 16
STEP IN / — 34
STEP / — 36
HDLD / — 18
WRT DATA / — 38
WRT / — 40
ERASE / — 6
LO I / — 8
— 2

READY / — 22
SECTOR / — 24
INDEX / — 26
TRACK 00 / — 42
WRT PROTECT / — 44
RAW DATA / — 46
SEP DATA / — 48
SEP CLOCK / — 50
DUAL SIDE / — 10
DISK CHANGE — 12

ALL ODD NUMBERS

J4

+ 24 VDC — 1
+ 24 VDC RET — 2
+ 5 VDC — 5
+ 5 VDC RET — 6
- 5 VDC — 4
- 5 VDC RET — 3

J6

220 VAC — 1, 3
CHASSIS GND — 2

DRIVE MOTOR

J1/P1 — R/W- HEADS ASSY

1 — CTO/
2 — R/W
3 — R/W
5 — ERASE
HD 0

J5/P5

1 — CT1
2 — R/W
3 — R/W
5 — ERASE
HD 1

+24V

J2/P2

R —
12 —
13 —
14 —
D — Ø A /
3 — Ø B /
C — Ø C /
11 — Ø D /
STEPPER MOTOR

P —
F — + LED 0
N — + LED 1
INDEX 0 and INDEX 1 LED' S

+5V

J — C
8 — E
INDEX 0 PHOTOTRANSIST.

S — C
15 — E
INDEX I PHOTOTRANSIST.

+5V

E — +
5 — -
WRITE PROTECT LED

H —
4 —
WRITE PROTECT PHOTOTRANSIST.

A — NC
I —
B — NO
TRACK ZERO SWITCH

+24V

10 — + HDLDSOL
L — - HDLDSOL
HEAD LOAD SOLENOID

+24V

9 — + ACT LED
K — - ACT LED
ACTIVITY LED

7 — - DOOR INTERLOCK
DOOR LOCK SOLENOID

FIGURE 3 - 4 . INTERCONNECTING DIAGRAM

3 - 6

3.1.5. LOGIC LEVELS AND TERMINATION

Interface signals to and from connector J3 have the logic levels represented by Fig. 3 - 5. All signal inputs are terminated by a 220/330 resistor network chip (position 1D). This chip is removable for a daisy chain configuration in which only the last disk drive needs a terminator. The BASF 6104 uses SN 7438 as output drivers. As input receivers SN 7432 or equivalent are used.

Fig. 3 - 6 shows the recommended interface logic.

3.1.6. CONNECTING CONFIGURATION

The BASF 6104 can be connected to the host system in different configurations.

● Single Drive Configuration

● Multi- drive Configuration
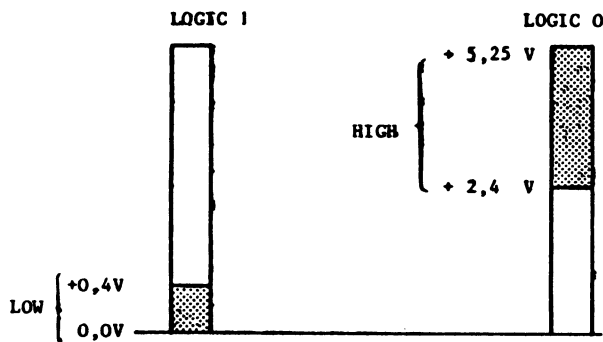
FIGURE 3 - 5 . INTERFACE LOGIC LEVELS

3.1.6.1.SINGLE DRIVE CONFIGURATION

When a single disk drive is to be used with the host system, all cables are connected directly to the disk drive. The unit must be selected to accept commands and respond with status signals. In this application, all input signal lines are terminated by an integrated circuit containing the terminating networks.
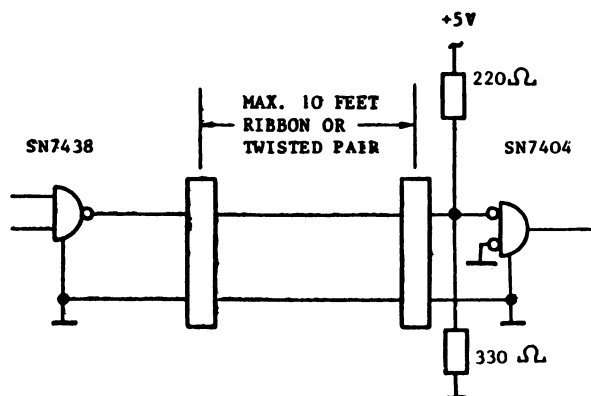
FIGURE 3 - 6 . RECOMMENDED DRIVER / RECEIVER CIRCUIT
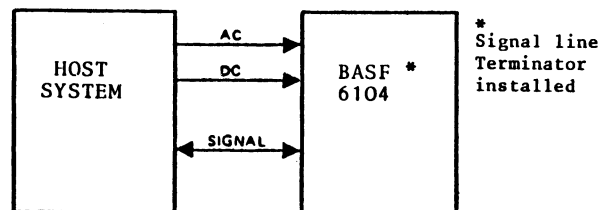
FIGURE 3 - 7 . SINGLE DRIVE CONFIGURATION

3.1.6.2. MULTIPLE DRIVE CONFIGURATION

In multi- drive configurations more than one drive are connected to the host system. The following multi-drive configurations are possible:

- Radial Select

- Daisy Chain

- Daisy Chained Radial Select

Radial Select (Fig. 3 - 8)

An this configuration all disk drives need terminator networks. A maximum of four disk drives can be connected to the host system.

Daisy Chain Configuration

In this configuration all signal and status lines are gated by the SELECT lines. Only the last drive needs a terminator chip. If the Binary Select Option is used up to eight disk drives may be connected to the host system.

* TERMINATOR INSTALLED
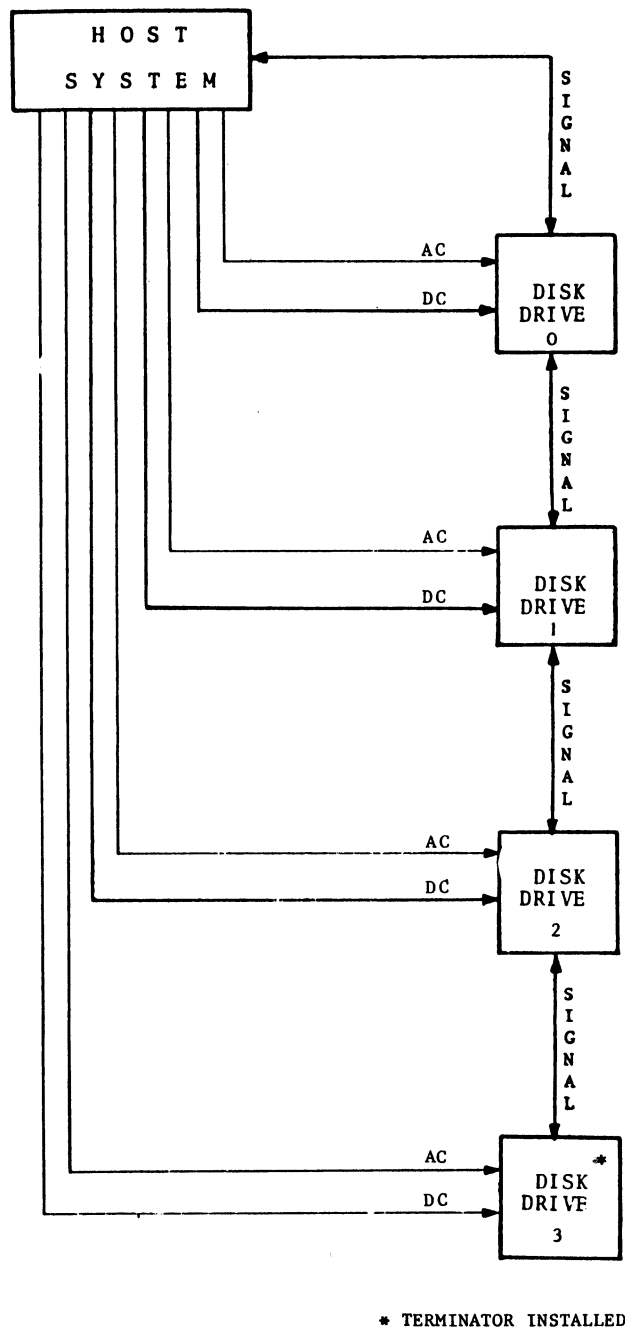
FIGURE 3 - 9 . DAISY CHAIN CONFIGURATION

* TERMINATOR CHIP INSTALLED

FIGURE 3 - 8 . RADIAL SELECT CONFIGURATION

3 - 8

3.1.7. SELECTION OF THE DESIRED OPTIONS

3.1.7.1. SELECT OPTIONS

RADIAL SELECT

In the basic configuration, a dedicated SELECT/ line is provided for each disk drive. The assigned SELECT/ line must be jumpered for connection to the interface. The unit is supplied from the factory with a jumper accross pin 1 and pin 22 for drive 0. For the drives 1, 2 and 3 the jumper must be moved as shown in table 3 - 4.

Option \ Jumper		JJ2				JJ1
		21-22	17-18	13-14	9-10	5 - 6
radial select	drive 0	x				x
	drive 1		x			x
	drive 2			x		x
	drive 3				x	x

TABLE   3 - 4   :   RADIAL   SELECT   OPTION   JUMPERING

BINARY SELECT

When the binary select option is used up to 8 drives can be connected to the host system.

The jumper connections of the different drives are shown on table 3 - 5.

Option \ Jumper		JJ1								
		9-10	11-12	13-14	15-16	17-18	20-19	21-22	24-23	8 - 7
Binary Select	Drive 0								x	x
	Drive 1				x					x
	Drive 2						x			x
	Drive 3		x							x
	Drive 4							x		x
	Drive 5			x						x
	Drive 6					x				x
	Drive 7	x								x

TABLE   3 - 5   :   BINARY   SELECT   OPTION   JUMPERING

3.1.7.2. SIDE SELECT OPTIONS

The desired side of the diskette can
be selected in different ways :

- selecting by SIDE SELECT

- selecting by STEP IN

- selecting by the SELECT- linses

The following table shows the jumper
connections for these options. Also
there is a detailed description of the
side select options in chapter 2.3.3.3.
of this manual.

1.= drive   2.= drive address

OPTION	JUMPER 1.	2.	JJ2 1-2	3-4	5-6	7-8	13-14	15-16	21-22	23-24	JJ1 5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24
Side select by SIDESEL	1÷4	0÷3	x																	
Side select by STEP IN	1÷4	0÷3		x																
Side select by SELECT 0÷3 (radial select)	0	0,1*			x			x	x	x	x									
	1	2,3*			x	x	x			x	x									
Side select by SELECT 0-3 (binary select)	0	0,1*			x			x			x				x					x
	1	2,3*			x			x			x			x					x	
	2	4,5*			x			x			x					x			x	
	3	6,7*			x			x			x	x						x		

* The odd address selects side 1, the even address side 0 of the diskette

TABLE   3 - 6   :   SIDE   SELECT   OPTIONS   JUMPER   TABLE

3.1.7.3. HEAD LOAD OPTIONS

There are 4 head load options :

- selected head load
  HEAD LOAD = SELECT . HDLD

- auto head load
  HEAD LOAD = SELECT

- radial head load
  HEAD LOAD = HDLD

- radial head load with stepper
  motor enabled by select :
  this mode allows radial head/
  load operation without enabl-
  ing of the stepper motor. As
  soon as the drive will be se-
  lected, the stepper motor is
  enabled.

The corresponding jumper configu-
rations are shown on table 3 - 7.

Option \ Jumper Pin	J J 4				J J 7	
	13-14	15-14	10-11	11-12	1 - 2	3 - 4
Selected head load	x		x		x	
Radial head load	x			x	x	
Radial head load (stepper motor enabled by select)		x	x			x
Auto head load		x	x		x	

TABLE   3 - 7   :   HEAD LOAD OPTIONS JUMPER TABLE

3.1.7.4. RADIAL STEP OPTION

To install this option, the existing
jumper must be changed as follows :

- cut the etched circuit jumper of
  JJ 1-(1÷3) and install a jumper
  wire from JJ 7-(2÷3).

3.1.7.5. RADIAL READY OPTION

To install this option provides the
following :

- cut JJ 3-(8-3) and install jumper
  wire JJ 3-(1-2)

3.1.7.6. RADIAL INDEX/SECTOR OPTION

To install this option provides the
following :

- cut JJ 3-(5-6) and install jumper
  wire JJ 3-(4-5)

3.1.7.7. HARD SECTOR AND SECTOR DIVIDER OPTION

If sectored diskettes are used, hard
sector option must be selected. The
generated sector pulses may ba   also
divided by an ÷ 2, ÷ 4 counter.

Option \ Jumper Pin		J J 4		J J 6			
		7-8	8-9	1-2	3-4	5-6	7-8
hard sector	not active	x					x
	active		x				
sector divider	SECTOR PULSE 0		x				x
	8		x			x	
	16		x		x		
	32			x			

TABLE   3 - 8 : HARD SECTOR AND SECTOR DIVIDER
                JUMPERING

3.1.7.8. ACTIVITY INDICATOR / DOOR LOCK OPTIONS

The activity indicator and the door lock solenoid can be switched on by the following conditions shown on table 3 - 9.

Option \ Jumper		JJ5 1 - 2	3 - 4	5 - 6	8 - 7	10-9	12-11	13-14
1. DOOR LOCK =	HEAD LOAD	x						
	SELECT			x				
	READY		x					
2. DOOR LOCK = IN USE						x		
3. DOOR LOCK=IN USE FF (door lock latch)					x			x

TABLE 3 - 9 : ACTIVITY INDICATOR / DOOR LOCK OPTIONS

It is possible to create a lot of or-conditions for locking the door by u-sing table 3 - 9. On signal of group 1 can be ored with the IN USE and IN USE FF. In this case, all jumpers for the different signals must be in-serted, for example :

    DOOR LOCK = SELECT + IN USE FF +
                IN USE

Insert the following jumpers :

    JJ5-(5-6), (8-7), (13-14), (9-10)

3.1.7.9. AUTO ERASE OPTION

To enable the AUTO ERASE OPTION, jumper JJ4-(4-5) must be connected. This is standard on the BASF 6104. To dis-able the AUTO ERASE OPTION, open JJ4-(4-5) and connect JJ4-(5-6).

3.1.7.10. TRUE/FALSE DATA SEPARATOR OPTION

If the true data separator is used, IBM 3740 FORMAT is accepted. The cir-cuitry may also work as a simple one-shot separator by switching one jumper for the false data separator (see table 3 - 10).

Option \ Jumper	JJ10 1 - 2	2 - 3
thrue data separator	x	
false data separator		x

TABLE 3 - 10 : TRUE/FALSE DATA SEPARATOR JUMPER SETTINGS

3.1.7.11. - 5 V REGULATOR

If a -5V supply voltage is not avail-able but a negative voltage in the range from -7 to -16 volts, the -5V regulator must be enabled by remo-ving the jumper JJ9-(1-2). If a -5V supply voltage is connected to the drive, the jumper JJ9-(1-2) must be inserted.
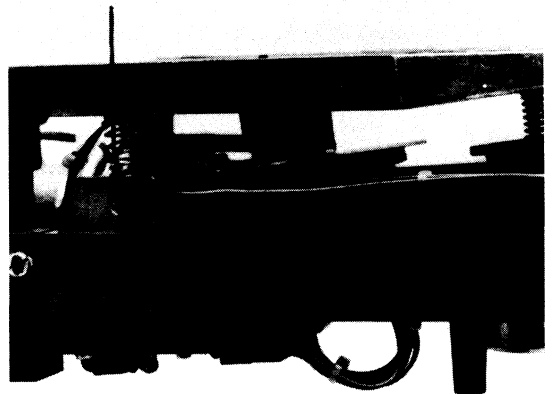
3.1.8. DRIVE MOUNTING

3.1.8.1. MOUNTING POSITIONS

carrier spring

The BASF 6104 may be mounted in one of the following positions :

- VERTICAL
  door opening to the left of right

- HORIZONTAL
  door opening up

- UPRIGHT
  door opening towards front or rear

3.1.8.2. USE OF CARRIER SPRINGS

The BASF 6104 has two carrier springs installed (see fig. 3 - 10), which are helpful to opening the frontdoor for the horizontal mounting position.

FIGURE 3 - 10 : CARRIER SPRING

For other mounting positions, one or both carrier springs must be removed. Table 3 - 11 shows the use of the carrier springs for the different mounting positions and two different BASF 6104 designs.

MOUNTING POSITION	6104 DESIGN	CARRIER SPRING NO.	CARRIER SPRING QUANTITY
horizontal door opening up	low profile	370749-001	2
	rounded	370750-001	2
vertical door opening left or right	low profile	370749-001	1
	rounded	----	-
up right	low profile	----	-
	rounded	-----	-

TABLE 3 - 11 : USE OF CARRIER SPRINGS

3.1.8.3. MOUNTING DIMENSIONS

The mounting dimensions of the BASF
6104 low profile design and rounded
design are shown on the figures 3-11
and 3 - 12. For more information,
see specification no. 81010-001.
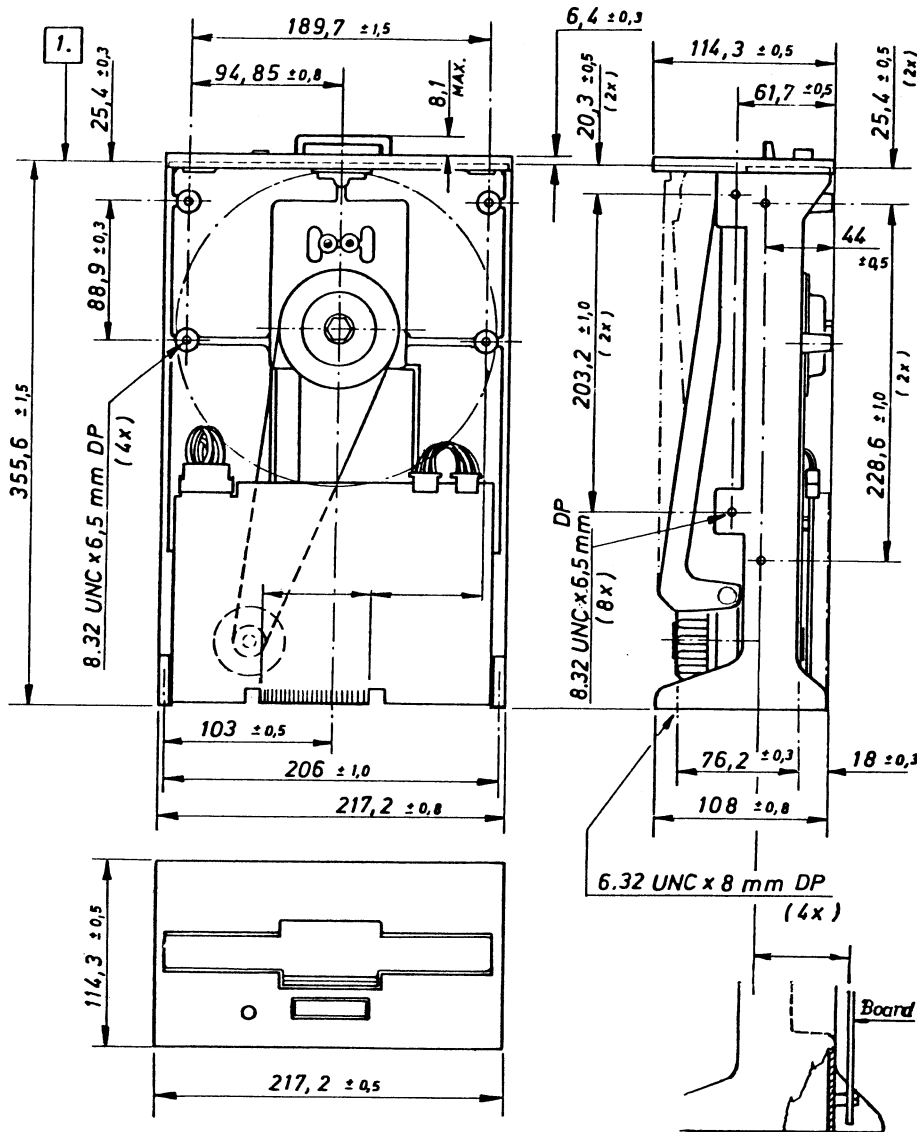
1. Dimensions are from end of base casting
2. All dimensions are in millimetres, screw threads are in inches
3. Standard color of front bezel, handle und button : black

FIGURE 3 - 11 : MOUNTING DIMENSIONS BASF 6104 LOW PROFILE DESIGN

1. Dimensions are from end of base casting
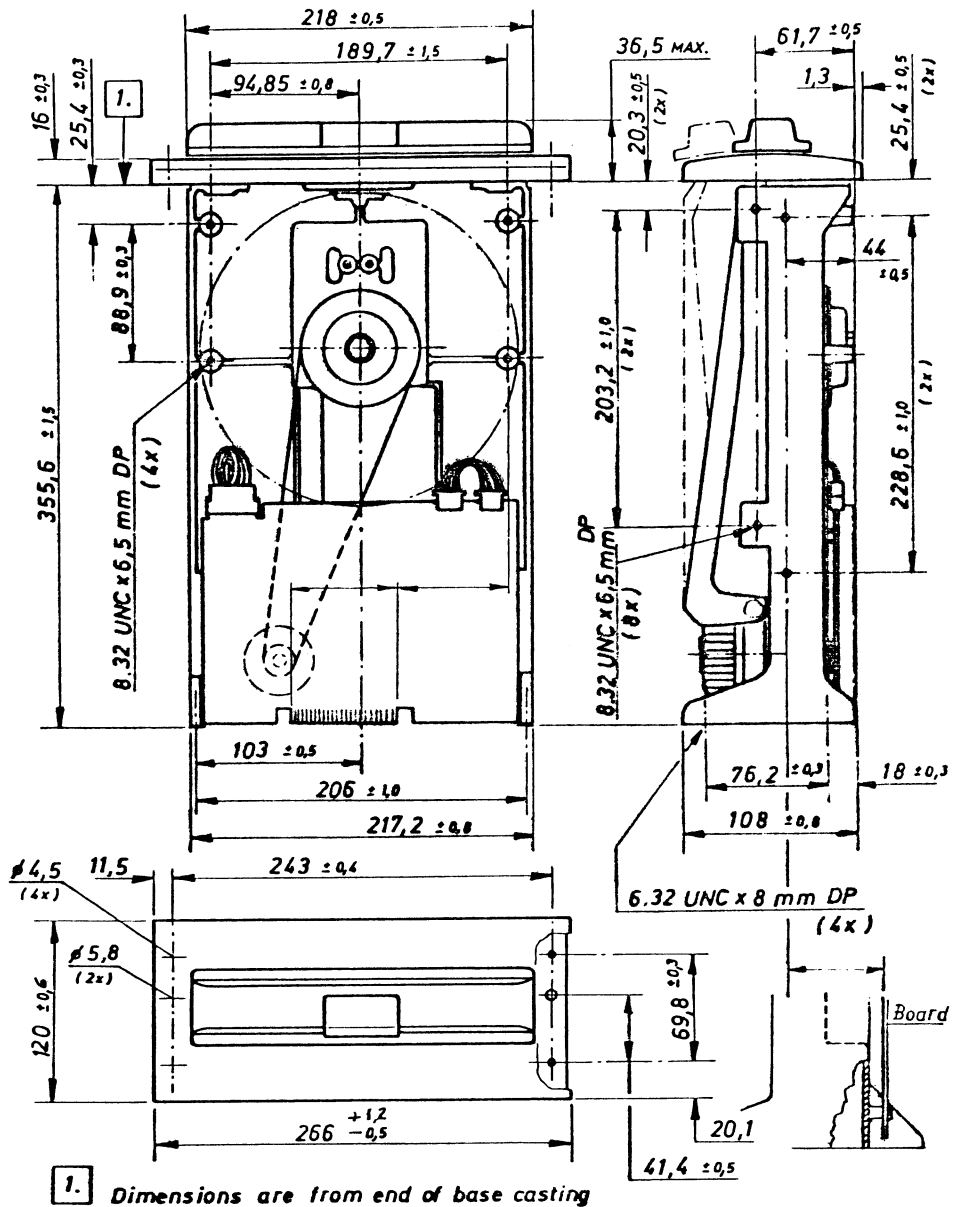
2. All dimensions are in millimetres, screw threads are in inches

3. Standard colors : front bezel p/n 240319 -Z42 : black
   handle   p/n 240321 -041 : black
   button   p/n 240322 -051 : gray
   Assy Handle p/n 200200 -002

FIGURE 3 - 12 : MOUNTING DIMENSIONS BASF 6104 ROUNDED DESIGN

3.2. OPERATION

3.2.1. GENERAL

Disk drive operates under complete control of the host controller, after a flexible disk has been manually inserted. Only one front panel indicator is required for operating status.

3.2.2. DISKETTE STORAGE AND HANDLING

The following are essential requirements for diskette storage and handling:

- The diskette should be stored in an enviroment that is clean and free from all magnetic influences.

- The diskette should be in same temperature and humidity enviroment as the disk drive for a minimum of five minutes prior to use.

- Return diskette to protective envelope when not in use.

- Never place heavy objects on the diskette.

- Never touch the diskette trough the cartridge opening when handling.

- Never attempt to clean the diskette.

- Do not bend of fold the diskette.

- Do not use rubber bands or rubber bands or paper clips on the diskette.

- Never write on cartridge (use labels).

- Do not expose diskette to excessive heat or sunlight.

3.2.3. DISKETTE LOADING AND UNLOADING

Proper loading of the diskette is vital to the operation of the diskette and disk drive. Fig. 3-13 shows the proper loading of the diskette. Procedures for loading and unloading the diskette are given in tables 3-12 and 3-13 respectively. The diskette can be loaded with all power on and spindle drive rotating.

insert fully before closing front panel
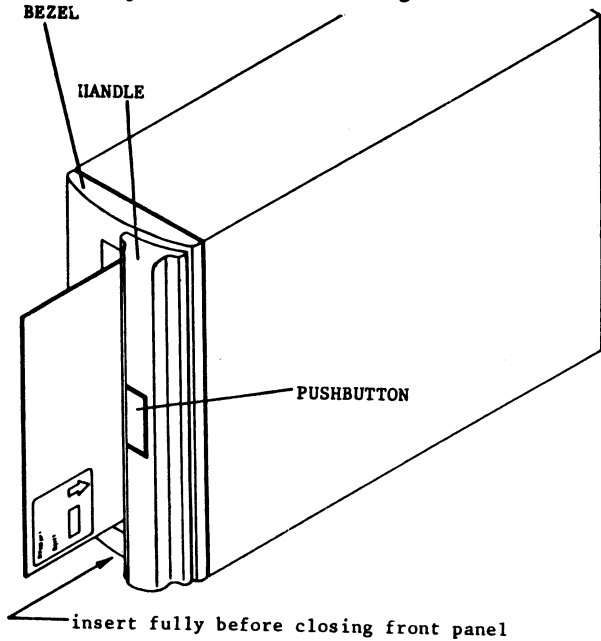
FIGURE 3 - 13. DISKETTE LOADING

STEP	ACTION
1	Press push button noting handle moves to open position
2	Insert diskette, label towards handle into slot fully until stopped
3	Close handle until latched

TABLE 3 - 12 : DISKETTE LOADING

STEP	ACTION
1	Press push button notinh handle moves to open position
2	Remove diskette from disk drive

TABLE 3 - 13 : DISKETTE UNLOADING

3.2.4. WRITE PROTECT

The data stored on the diskette can
be saved against destruction or over-
writing by the write protect circuits
when a write protected diskette is
used. A write protected diskette will
have an open notch as shown on figure
3 - 14. If this notch is covered with
an adhesive opaque tab, writing on
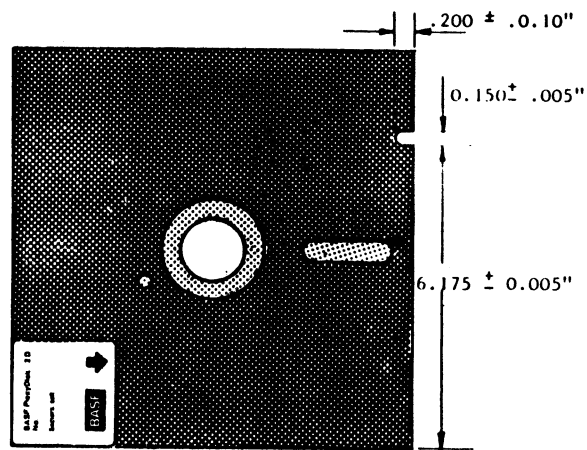the diskette will be allowed.

FIGURE 3 - 14 : WRITE PROTECTED DISKETTE
WITH WRITE PROTECT NOTCH

SECTION IV
MAINTENANCE

4.1. GENERAL

This section contains preventive and corrective maintenance information necessary to maintain the disk drive.

4.2. TOOLS AND TEST EQUIPMENT

To perform proper maintenance of the disk drive, certain tools, test equipment and supplies are required.A list of standard tools and test equipment is provided in table 4 - 1. Special Tools and test equipment are shown on table 4 - 2.

```
Common hand tools
Freon
Molykote " G Rapid Paste "
Cotton-tipped swabs (Q-tips)
Soft lint-free cloth (gauze)
Voltohmmeter
Oscilloscope
Flashlight
Inspection Mirror
```

TABLE 4 - 1 . STANDARD TOOLS AND
TEST EQUIPMENT

```
BASF CE - DISK
BASF CLEANING DISK S
EXERCISER BASF 2001-8
```

TABLE 4 - 2 . SPECIAL TOOLS AND
TEST EQUIPMENT

4.3. PREVENTIVE MAINTENANCE

Preventive maintenance of the disk drive is minimal due to the efficient design, reliability and manner in which the unit is operated. The operating environment to the disk drive and the flexible disks must be kept clean and within required temperature and humidity limits. The read/ write heads must be kept free from contamination by dust, smoke, or moisture.
Periodic inspections and checks to ensure optimum performance of the disk drive are listed in table 4-3.

MAINTENANCE PERIODE		PREVENTIVE MAINTENANCE	CHAPTER
3 month	6 month		
x		Visual Inspection and Cleanliness	4.3.1.
x		Lead Screw Lubrication	4.3.2.
	x	Read/Write Heads Cleaning	4.3.3.
	x	Track Adjustment Check	4.4.3.1.
	x	Read Amplitude Check	4.4.5.1.

TABLE 4 - 3 . PREVENTIVE MAINTENANCE PROCEDURE

During normal operating conditions, periodically inspect the unit for signs of dirt, wear, or loose latching hardware on the handle. When servicing the unit, check all areas for signs of loose connections, abnormal wear , and dirt accumulation on the flexib - le disk guide.

A clean disk drive, external and internal, will extend the operating life of the equipment and enhance the appearance. The importance of periodic visual inspection and normal cleanliness of the unit cannot be over - emphasized.
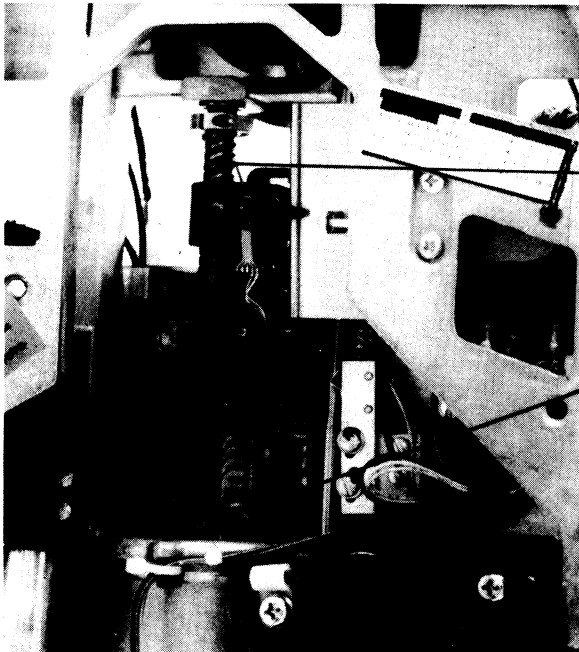
4.3.2. LEAD SCREW LUBRATION

a. Clean lead screw with gauze and freon.

b. Lubricate lead screw with moly- cote by using a small brush.

c. Move carriage several times up- and downwards by turning outer stop. Remove superfluous moly- cote with gauze.

> **CAUTION!**
>
> Clean lead screw carefully and use molycote safely. Only a thin film of molycote shall cover the surface of lead screw. By using too much molycote it will clasp to the car- tridge and produce read errors.

4.3.3. READ/WRITE HEADS CLEANING

The easiest method to clean the read/ write heads is using a cleaning disk (4.3.3.1.). But there exists another possibility, without using a cleaning disk (4.3.3.2.).

4.3.3.1. READ/WRITE HEADS CLEANING WITH BASF CLEANING DISK P/N

a. Read use instructions on the cover of the cleaning disk *

b. Turn on AC-power (spindle motor is turning)

c. Insert cleaning disk and clean head 0

d. Remove cleaning disk after recom - mended cleaning time

e. Turn cleaning disk

f. Insert cleaning disk and clean head 1

g. Remove cleaning disk after recom - mended cleaning time

```
* CAUTION !

Observe the recommended
cleaning times !
```

4.3.3.2. READ/WRITE HEADS CLEANING WITHOUT CLEANING DISK

a. Move carriage in lowest position by turning outer stop. Don't touch lead screw.

b. Lift uper head by opening the handle.

c. Clean head surfaces with gauze saturated with freon.

d. Wipe heads surfaces dry with gauze.

e. Inspect head surface to ensure head is clean and free of resi- due.

```
CAUTION !

Do not touch heads surfaces!
```

4.4. CHECKS, ADJUSTMENTS AND REPLACEMENTS

4.4.1. PCB REPLACEMENT

   a. Turn off DC-voltages

   b. Remove P1 ÷ P5

   c. Remove the 4 mounting screws

   d. To reinstall, reverse the above

   e. Check the jumper configuration of
      the new PCB

   f. Correct the jumper configuration
      if necessary

   g. Check the read amplitude and the
      index pulses if a new PCB was ins-
      talled

   h. Check and readjust if necessary
      the data separator when this op-
      tion is installed on the new PCB

4.4.2. SPINDLE DRIVE SYSTEM

4.4.2.1. DRIVE MOTOR AND DRIVE BELT CHECKS

   a. Turn off all AC- and DC-input
      power

   b. Rotate drive motor manually and
      inspect drive belt for wear,
      cracks or fraying edges. Drive
      belt, if necessary. Refer to drive
      belt replacement procedure

   c. Rotate motor manually and inspect
      for bearing noises or binding. Re-
      place drive motor, if necessary.
      Refer to drive motor replacement
      procedure.

   d. Turn on AC-line power to disk drive

   e. Verify that the drive motor and the
      drive belt operate normally, and that
      drive belt tracks smoothly and evenly
      in center of both pulleys

4.4.2.2. DRIVE MOTOR SPEED CHECK

   a. Load a diskette

   b. Connect a frequency counter or an
      oscilloscope to TP 12

   c. Check the time between consecutive
      index pulses for 166,67 msec +/- 2,5 %

4.4.2.3. DRIVE BELT REPLACEMENT

a. Turn off ac input power and stop drive motor.

b. Carefully remove drive belt from the spindle pulley.

c. To reinstall the drive belt put it first on the drive motor pulley and then on the spindle pulley. Don't overtight the drive belt, because this can damage the drive belt which causes bad tracking of the pulleys.

d. Provide drive motor speed check (4.4.2.2.)

4.4.2.4. DRIVE MOTOR REPLACEMENT

a. Disconnect all cables, remove disk drive from mounting, and place on clean work surface.

b. Remove PCB. Refer to printed circuits board replacement procedure.

c. Remove drive belt. Refere drive belt replacement procedure.

d. Identify and remove quick- disconnent wires from ac line filter capacitor.

e. Remove four (4) pan- head screws and grounding lug. Drive motor is now loosened from disk drive.

f. Place new drive motor in same position as loosened motor.

g. Fasten new drive motor using four (4) pan head screws and grounding lug.

h. Connect ac input wires to ac line filter capacitor.

i. Install drive belt and verify correct tracking.

k. Install PCB.

4.3.3. POSITIONING SYSTEM

The positioning system consists of
the stepper motor with spindel, the
head carriage assembly, the inner
and outer stop and the track zero
switch assembly. Because on the
BASF 6104 an optical or mechanical
track zero switch can be used, the
maintenance of both will be des-
cribed.

4.4.3.1. TRACK ADJUSTMENT CHECK
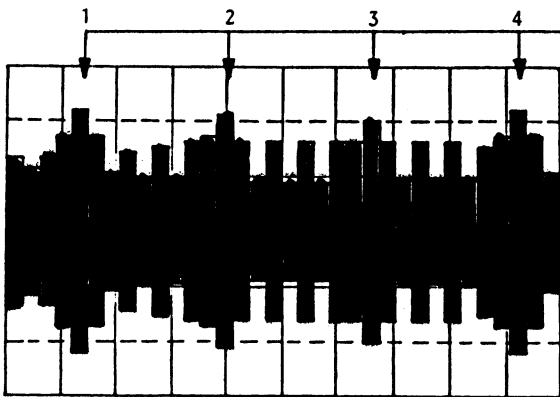
a. Load a BASF CE DISKETTE.

b. Select Head 0.

c. Allow ten minutes warm up time,
then step to track 36.

d. Measure with oscilloscope

```
SYNC:EXT.POS.   TP 1          INDEX
CH1 :AC 50mV    uncalibrated inverted TP 5
CH2 :AC 50mV    uncalibrated          TP 6
MODE:ADD
TIME
BASE:10 ms/div uncalibrated
```

e. Monitor the read signal on the
screen and adjust the time base
of the scope until four orien-
tation bursts are shown.
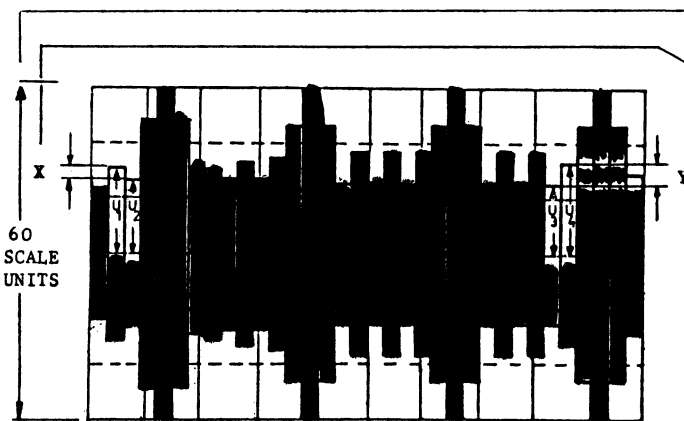
f. Turn the variable gain poten-
tiometer until the amplitude of
the first orientation burst rea-
ches 60 scale units.

g. Determine X and Y. (see Example!)

$X = U_1 - U_2$ Caution: Pay atten-
tion sign

$Y = U_3 - U_4$

h. Calculate Z

$Z = X + Y$

i. If Z exceeds 15 scale units
proceed with pont e. of track
adjustment procedure (4.4.3.2.)

k. Step to track 00.

l. Remove the CE Diskette, turn it
and insert it again. Head 1
touches now the alignment
surface.

m. Select Head 1
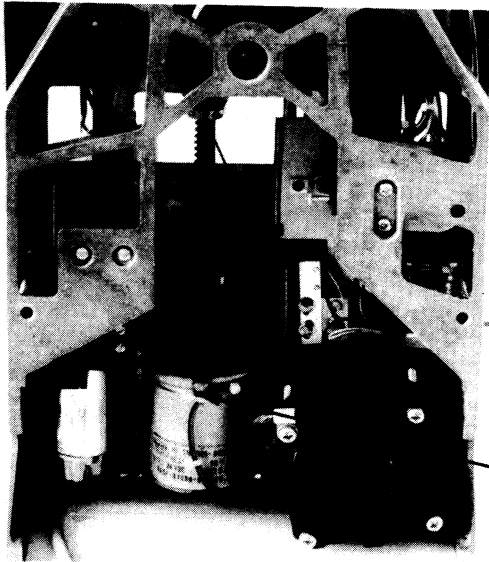
n. Step to track 32 and provide
point f ÷ h for head 1.

o. If 2 exceed 15 scale units pro-
cedure. If 2 is lower than 15
scale units track adjustment is
o.k.

EXAMPLE:

$X = U_1 - U_2 = + 2$ scale units
$Y = U_3 - U_4 = - 4$ scale units
$Z = X + Y = + 2 - 4 = - 2$ scale units

4.4.3.2. TRACK ADJUSTMENT

a. Load a BASF CE Diskette .

b. Select Head 0

c. Allow 10 minutes warm up time then step the carriage to track 16.

d. Measure with oscilloscope

SYNC:EXT.POS.	TP 1	INDEX
CH1 :AC 50mV	uncalibrated inverted	TP 5
CH2 :AC 50mV	uncalibrated	TP 6
MODE:ADD		
TIME		
BASE:10 ms/div uncalibrated		

e. Loosen the mounting screws of the stepper motor and rotate body of the stepper motor until the maximum amplitude of the orientation bursts is reached.
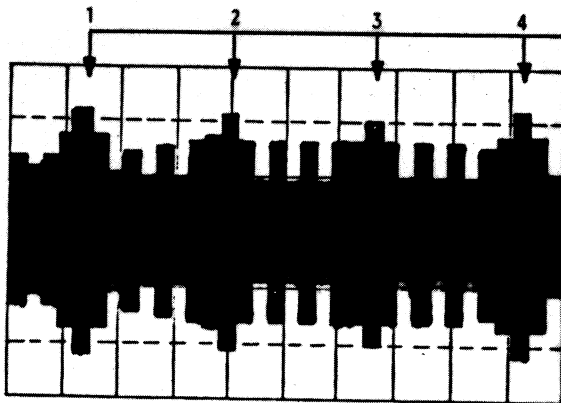
f. Monitor the read signal on the screen and adjust the time base of the scope until four orientation bursts are shown.

g. Turn the variable gain potentiometer until the amplitudes of the first orientation burst reaches 60 scale units.

h. Rotate the body of the stepper motor until the X and Y has the same value but opiste sign, or both are zero.

i. Tighten the mounting screws of the stepper motor.

k. Recheck the adjustment. If X+Y exceeds 4 scale units readjust the stepper motor (Pay attention to sign!).

l. Step to track 0

m. Remove the CE- Diskette, turn it and insert it again.
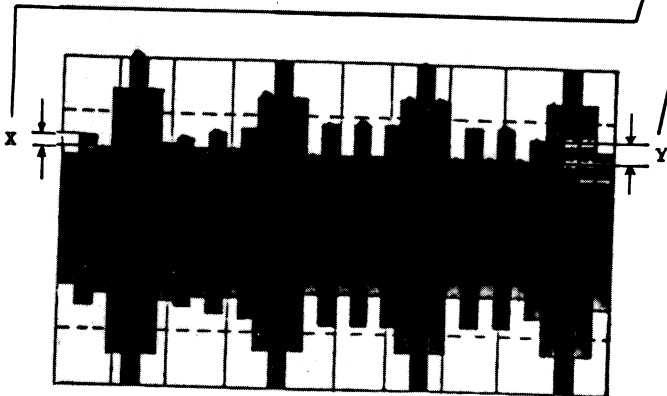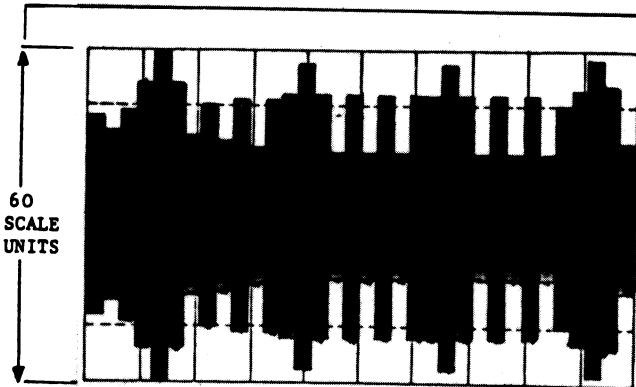Head 1 touches now the alignment surface.

n. Select Head 1.

o. Step to track 36.

p. Provide point q and h.

q. Messure X+Y. It must be lower than 12 scale units.

r. Perform track zero switch adjustment check.

4.4.3.3. TRACK ZERO SWITCH ADJUSTMENT CHECK

I - MECHANICAL TRACK ZERO SWITCH

a. Load CE Diskette

b. Select Head 0

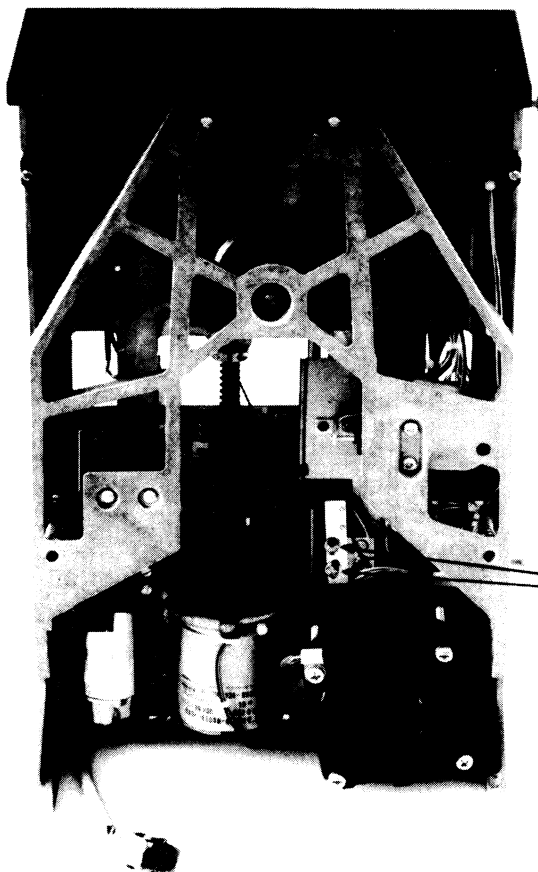c. Measure with oscilloscope

    SYNC : AUTO
    CH 1 : AC   50 mV/div   TP 5
    CH 2 : DC   2 V/div TP 18 TR00-SW-NC
    MODE : CHOP
    TIME BASE : 10 msec/div

d. Step out until read signal(CH1)
   occurs. This is track 0.   When
   the carriage reaches the outer
   stop before the read signal
   occurs, the outer stop must be
   readjusted.

e. Monitor CH2. It must be high.If
   not perform the track zero ad-
   justment.

f. Check if the track zero switch
   closes (CH2 → HIGH) between
   track 3 and 2 when stepping to-
   wards track 0 and opens
   (CH2 → Low) between track 2
   and 3 when stepping from
   track 0 to track 4.

II - OPTICAL TRACK ZERO SWITCH

TO BE SUPPLIED !

4.4.3.4. TRACK ZERO SWITCH ADJUSTMENT

I - MECHANICAL SWITCH

a. Load CE Diskette.

b. Select Head 0.

c. Measure with oscilloscope

```
SYNC :    Auto
CH 1 :    AC 50 mV/ div      TP 5
CH 2 :    DC  2 V/ div  TP 18 TRK-OOSW-NC

MODE :    CHOP
TIME
BASE :    10 msec/ div
```

d. Step out until read signal at CH1 occurs. This is track 0. If outer stop is reached before the read signal occurs the outer stop must be readjusted.

e. Loosen the track zero switch and adjust it that it will close (CH 2 — HIGH) between track 3 and track 2 when stepping towards track 0 and opens (CH2 —► Low) between track 2 and 3 when stepping from track 0 to track 4.

f. Tighten the track switch and recheck the adjustment.

II - OPTICAL SWITCH

TO BE SUPPLIED !

4.4.3.5. TRACK ZERO SWITCH REPLACEMENT

I - MECHANICAL TRACK ZERO SWITCH

    a. Turn off all AC and DC input power

    b. Remove track zero switch assembly (track zero switch + holding plate)

    c. Remove wires from track zero switch assembly

    d. Connect wires to the new track zero switch assembly

    e. Install track zero switch assembly

    f. Provide track zero switch adjustment

II - OPTICAL TRACK ZERO SWITCH

TO BE SUPPLIED !

~0,5mm

STOP DOG (R/W- Head)

SETSCREW
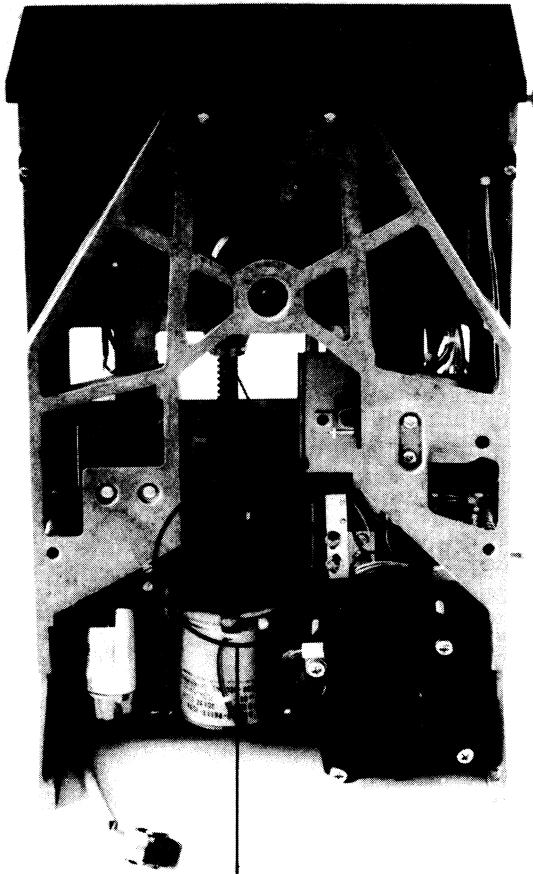
OUTER STOP

4.4.3.6. OUTER STOP ADJUSTMENT CHECK

a. Step to track O.

b. Verify that the outer stop does not touches the head carriage when positioning to track O. If this happen provide outer stop adjustment.

c. Step to track-1 (one step out side of track O).

d. The outer stop should now taches the stop dog of the head carriage. Between the outer stop and the body of the head carriage must be a space of about 0,5 mm. if necessary read-adjust the outer stop.
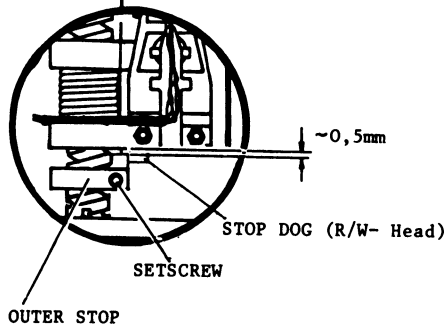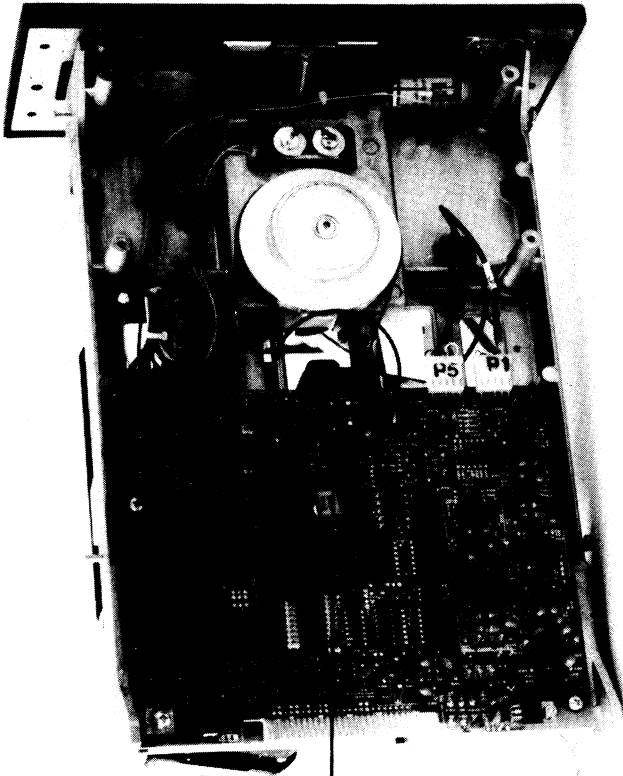
4.4.3.7. OUTER STOP ADJUSTMENT

a. Loosen the setscrew of the outer stop.

b. Move the outer stop towards the stepper motor housing.

c. Step to track -1 (one step out-side of track O).

d. Turn the outer stop that it touches the stop dog on the head carriage and a space of ~ 0,5 mm exists between the body of head carriage and the outer stop.

e. Tighten the setscrew of the outer stop.

4.4.3.8. INNER STOP ADJUSTMENT CHECK

a. Step to track 76 and verify that the outer stop does not touch the head carriage. Provide the inner stop adjustment if necessary.

b. Step to track 77. The inner stop should touch now the head carriage. Readjust when necessary.

4.4.3.9. INNER STOP ADJUSTMENT

a. Loosen the setscrew of the inner stop .

b. Move the inner stop to the end of the spindle.

c. Step to track 77.

d. Move the inner stop against the head carriage and turn it to right, until the stop dog touches the head carriage also.

e. Tighten the setsrew of the inner stop.

SETSCREW

STOP
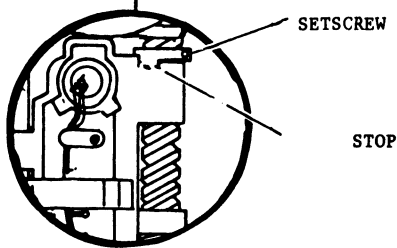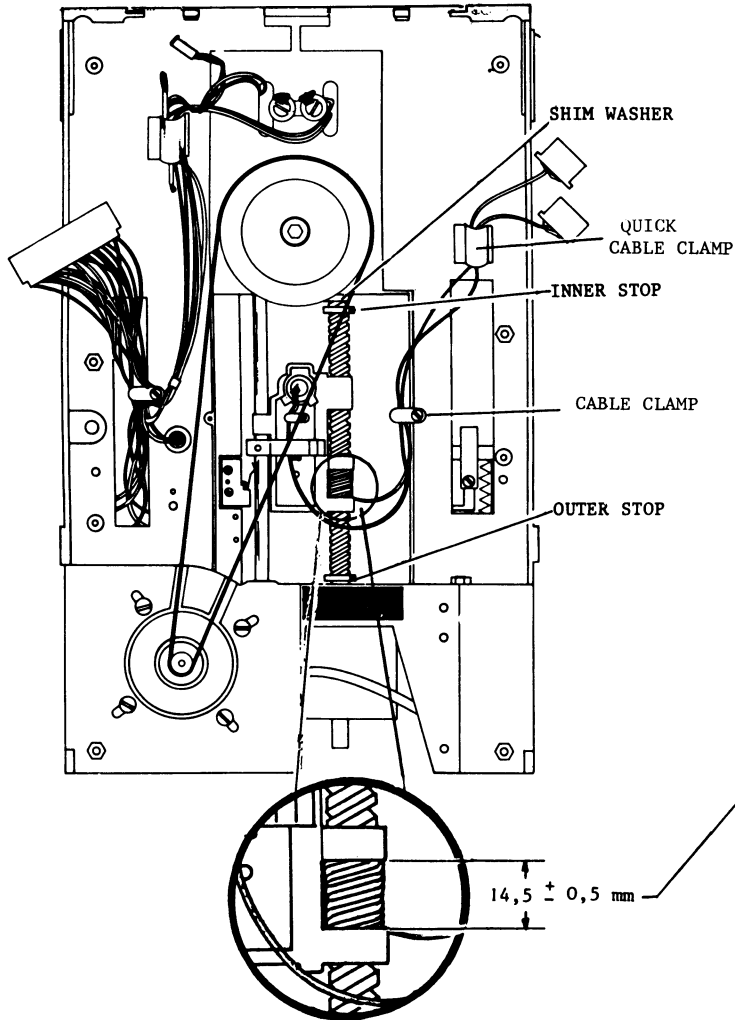
a. Remove disk drive from mounting and place it on a clean working surface.

b. Close carrier.

c. Remove PCB.

d. Remove cable clamp of R/W head cable.

e. Open "quick" cable clamp.

f. Positioning R/W-heads to track zero by turning the stepper motor shaft clockwise.

g. Loosen holding screws of head load solenoid slowly and remove head load actuator under neath upper head.

```
CAUTION !

Do not clap the upper head against

the bottom head !
```

h. Loosen inner stop stet screw.

1. Remove 3 mounting srews of stepper motor.

m. Turn outer stop manualy counter clock wise until shim washer inner stop and head carriage cames off.

n. Replace head carriage.

o. Install the new head carriage by reversing the above procedure. The compression spring should be compressed by positioning the preload nut that the space between the nut and the botton of the carriage is within 14,5 ± 0,5 mm.

p. Perform track adjustment (4.4.3.2.)

q. Perform Outer stop adjustment check (4.4.3.6.)

r. Perform inner stop adjustment (4.4.3.8.)

s. Perform track zero switch adjustment (4.4.3.4.)

t. Perform index detector adjustment (4.4.6.4.).

SHIM WASHER

QUICK CABLE CLAMP

INNER STOP

CABLE CLAMP

OUTER STOP

14,5 ± 0,5 mm

4.4.4. HEADS LOAD MECHANISM

4.4.4.1. HEADS LOAD ACTUATOR CHECK
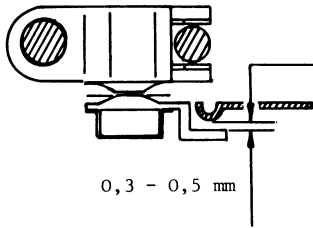
a. Step to track 0.

b. Load the heads.

c. Verify the gap between head Load actuator and head 1 load pin for 0,3÷0,5mm. Perform heads load actuator adjustment if necessary.

d. Step to track 76 (heads loaded) and verify that head 1 does not touches the heads load actuator. Perform heads load actuator adjustment if necessary.

0,3 - 0,5 mm

4.4.4.2. HEADS LOAD ACTUATOR ADJUSTMENT

a. Step to track 0.

b. Load the heads.

c. Adjust the heads load actuator setscrew for a clearance of 0,4 mm between head load actuator and head 1 load pin.

4.4.4.3. HEAD LOAD SOLENOID REPLACEMENT

a. Remove the disk drive from mounting and place it on a clean working surface.

b. Close carrier.

c. Positioning R/W - heads against the outer stop by turning the motor shaft clockwise.

d. Loosen holding screws of head load solenoid slowly and remove the head actuator underneath upper head.

```
CAUTION !

Do not clap the upper head
against the bottom head
```

e. Remove holding screws of head load solenoid.

f. Remove head load solenoid from carrier carefully.

g. Disconnect cable terminals.

h. To reinstall the new head load solenoid, reverse the above.
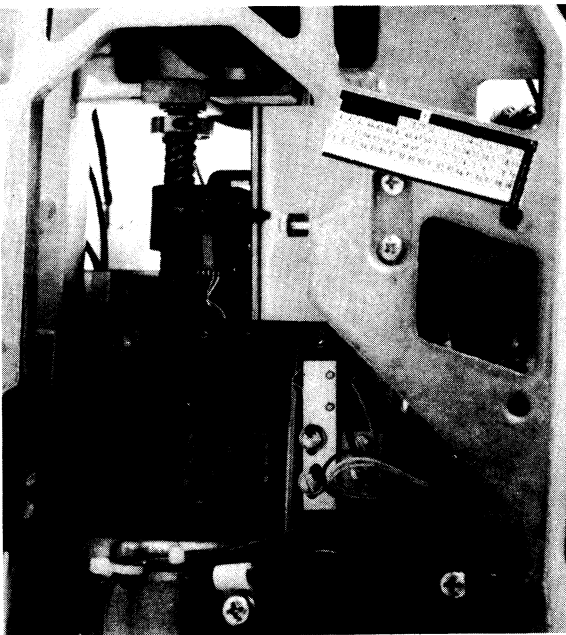
4.4.5. READ/WRITE ELECTRONICS

4.4.5.1. READ AMPLITUDE CHECK

a. Load BASF Disk

b. Measure with oscilloscope.

SYNC : EXT.POS. TP1 INDEX
CH 1 : AC 20 mV inverted TP 5
CH 2 : AC 20 mV   TP 6
MODE : ADD
TIME
BASE : 20 msec/div.

c. Step to track 76

d. Select Head 0

e. Write all ones

f. Check the read amplitude on the scope for 100 mV minimum.

g. Select Head 1

h. Write all ones

i. Check the read amplitude on the scope for 100 mV minimum.

k. Replace the head carriage if the measured read amplitude for head 0 or head 1 is lower than 100 mV.

100 mV min

4.4.5.2. DATA SEPARATOR ADJUSTMENT CHECK

a. Load scratch diskette.

b. Write all Zeroes.

c. Measure with oscilloscope

SYNC :POS CH1
CH1 :2V/div 6 B 5 DATA WINDOW
MODE :CH1 only
TIME
BASE :500 nsec/div.

d. Verify a positive pulse of 3 /usec +/- 0,1 /usec duration on CH 1. Adjust, if necessary.
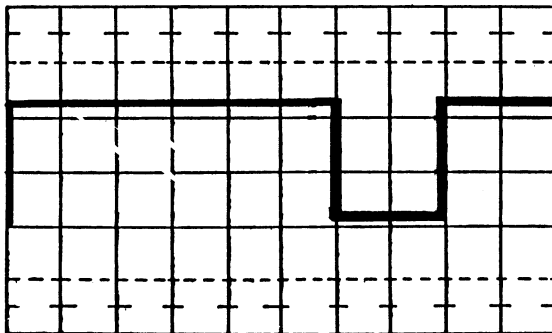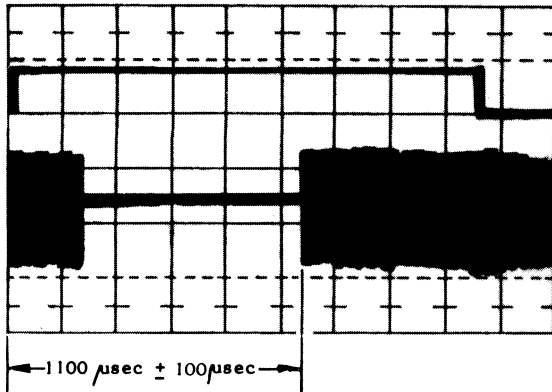
4.4.5.3. DATA SEPARATOR ADJUSTMENT (OPTION)

a. Load scratch diskette

b. Write all Zeroes

c. Measure with oscilloscope

SYNC :POS CH 1
CH 1 :2V/div 6 B 5 DATA WINDOW
MODE :CH 1 Only
TIME
BASE :500 nsec/div.

d. Adjust poti R 37 for a puls width on CH 1 of 3 /usec.

←—1100 μsec ± 100 μsec—→

←————— 8,3 msec ± 100 μsec —————→

4.4.6. PHOTO TRANSISTOR AND LED'S

4.4.6.1. INDEX DETECTORS ADJUSTMENT CHECK

a. Load BASF CE-Diskette with INDEX I-hole covered by an opaque tab.

b. Measure with oscilloscope

    SYNC : POS. CH 1   INDEX
    CH 1 : DC 5V/div TP1   INDEX
    CH 2 : AC 50 mV/div TP 5
    MODE : Chopped
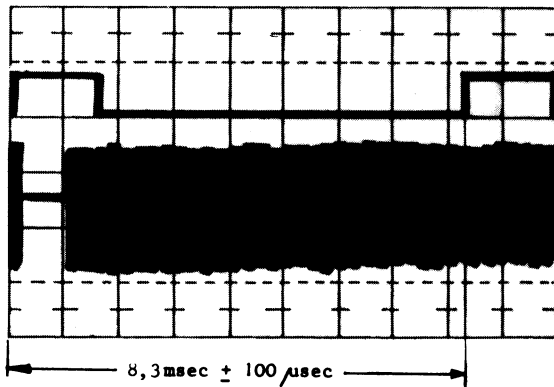   TIME
    BASE : 200 usec/div

c. Step to track 0 0

d. SELECT Head 0

e. Check on scope the time for the leading edge of the index puls to the start of the read amplitude for 1100 usec ± 100 usec. Readjust, if necessary

f. Remove the CE- Diskette and remove opaque tab from INDEX I-hole. Reload CE-Diskette.

g. Change Time Base of oscilloscope to 1 msec/ div

h. Check time between the leading edges of INDEX pulses on CH 1 for 8,3msec ± 1 msec. Perform index detector adjustment, if necessary.

4.4.6.2. INDEX DETECTORS ADJUSTMENT

a. Load BASF CE-Diskette with INDEX-I hole covered by an opaque tab.

b. Measure with oscilloscope

    SYNC : POS. CH 1
    CH 1 : DC 5V/div TP 1   INDEX
    CH 2 : AC 50 mV/div TP 5
    MODE : Chopped
    TIME
    BASE : 200 usec/div.

c. Step to track 0 0

d. Select head 0

e. Loosen holding screws of index detectors

f. Adjust Index 0 - detector for 1100 usec delay of start of the read amplitude or CH 2 from the leading edge of the INDEX- pulse on CH 1.

g. Thighten index 0 - detector

h. Remove CE- Diskette and remove opaque tab from INDEX-I hole. Reload CE-Diskette.

i. Change time base of oscilloscope to 1 msec/div.

k. Adjust time between the leading edges of index pulse to 8,3 msec ± 100 usec by moving index-I detector.

l. Tighten index- I detector.