BASF 6180

5.25" FIXED DISK DRIVE

TECHNICAL MANUAL

VID-WMS
Mannheim, November 1982

Part No.: 80307-057
Rev. 02

REVISION	RECORD OF REVISION	REMARKS
01	RELEASE	
02	UPDATE	BASF 6184 INCLUDED

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1

GENERAL INFORMATION

1.1. SCOPE

This manual contains all information necessary for installation, operation, and maintenance of the BASF 6180. The manual is divided into four sections:

- General Information
- Installation and Operation
- Theory of Operation
- Maintenace

1.2. RELATED DOCUMENTATION

BASF 6180 - 5.25" FIXED DISK DRIVE - PRODUCT SPECIFICATION Spec. 80 307-054

Schematics: Read-Write-Control PCB 82434-001

Schematics: Motor-Control PCB 82432-001

Spare Parts Catalog - BASF 6180 5.25" FIXED DISK DRIVE

1.3. MODELS AND OPTIONS

The BASF 6180 Series is a family of 5.25" Fixed Disk Drives. The family consists of three models with different capacities, the BASF 6182 with 6.38 MBytes, the BASF 6183 with 9.57 MBytes, and the BASF 6184 with 14.35 Mbytes. (All capacities refer to an unformatted drive.)

A number of option switches within the control electronics allow different user selectable configurations and operational characteristics of the drive. For details refer to Section 2.1.9.

1.4. GENERAL DESCRIPTION

The BASF 6180 is a small size, low cost, and high performance random access storage device. It is the optimal solution in applications, for which these requirements are critical. Examples are Desk Top Computer Systems, Intelligent Terminals, etc. For applications that require removable media, such as for program loading, data interchange, archieving, and backup, the BASF family of 5.25" Mini Disk Drives is the ideal complement.

The BASF 6180 uses the industry standard interface which allows daisy chaining of up to four drives. The drive requires two DC supply voltages only, +5 Volts and +12 Volts.

The BASF 6180 stores the data on either two (BASF 6182) or three (BASF 6183 and 6184) iron oxide coated 130 mm (5.25") diameter disks. The disks are directly driven by a brushless DC-motor. Data is recorded on both surfaces of each disk in 153 cylinders (BASF 6182 and 6183) or 230 cylinders (BASF 6184). The track density is 10 tracks per mm (254 tpi) and the maximum bit density is 303 bits per mm (7690 bpi - BASF 6182 and 6183) or 367 bits per mm (9332 bpi - BASF 6184). This high recording density is accomplished by using "Winchester" technology heads flying at a distance of about 0.5 micrometers above the disk surface. The head assembly which contains one head for each disk surface is driven by a linear steel band actuator and a five phase stepper motor.

Disks and heads are located in an extremely clean and hermetically sealed environment. To maintain the cleanliness the air inside the drive is continuously circulated through an absolute filter. The air circulation is accomplished by the pumping action of the rotating disks. A breather filter allows for balancing with different outside air pressure.

The Spindle Motor/Disk Assembly, the Head/Carriage Assembly, and the Stepper Motor are mounted on an aluminum molded base plate. This complete assembly is very often referred to as Head Disk Assembly (HDA). To isolate external shocks from the heads and disks the HDA is mounted in a frame using rubber shock absorbers.

The drive electronics is located on two easily accessible and replaceable PCB's mounted on the HDA.

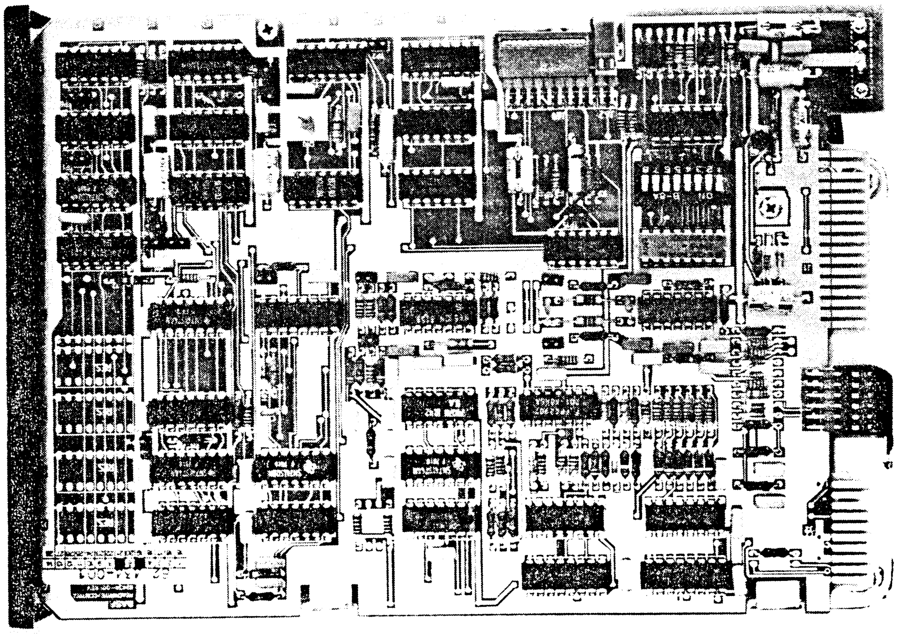


FIGURE 1 - 1 : BASF 6180 5.25" FIXED DISK DRIVE (TOP VIEW)

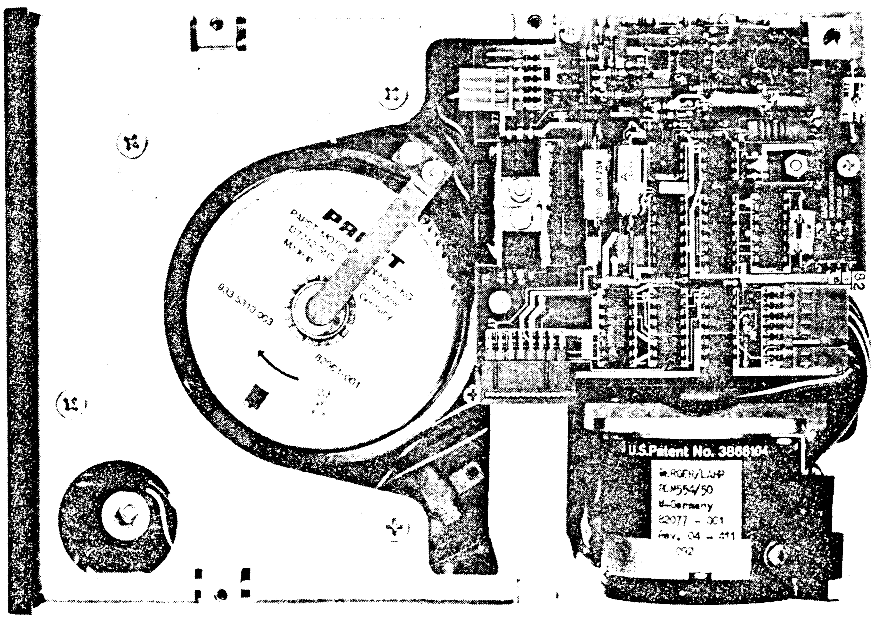


FIGURE 1 - 2 : BASF 6180 5.25" FIXED DISK DRIVE (BOTTOM VIEW)

1.5. SPECIFICATION SUMMARY

6185?

1.5.1. CAPACITY

	BASF 6182	BASF 6183	BASF 6184
Disks	2	3	3
Read/write heads	4	6	6
Cylinders	153	153	230
Capacity Unformatted			
Per drive	6.38 Mbytes	9.57 Mbytes	14.35 Mbytes
Per surface	1.59 Mbytes	1.59 Mbytes	1.59 Mbytes
Per track	10.4 Kbytes	10.4 Kbytes	10.4 Kbytes
Capacity Formatted			
Per drive	5.64 (5.0) Mbytes	8.46 (7.5) Mbytes	12.72 (11.3) Mbytes
Per surface	1.41 (1.25) Mbytes	1.41 (1.25) Mbytes	2.12 (1.9) Mbytes
Per track	9.2 (8.2) Kbytes	9.2 (8.2) Kbytes	9.2 (8.2) Kbytes
Per sector	1024 (256) bytes	1024 (256) bytes	1024 (256) bytes
Sectors per track	9 (32)	9 (32)	9 (32)
Disk media defects	7 max.	10 max.	15 max.

1.5.2. PERFORMANCE SPECIFICATION

Transfer rate	5 Mbits/sec	5 Mbits/sec	5 Mbits/sec
Access time (head settling and latency time not included)			
Track to track	1.2 msec	1.2 msec	1.2 msec
Average	61 msec	61 msec	92 msec
Maximum	182 msec	182 msec	275 msec
Head settling time	15 msec	15 msec	15 msec
Average Latency	8.3 msec	8.3 msec	8.3 msec
Motor start time (one start per 6 minutes maximum)	15 sec	15 sec	15 sec
Motor Stop time	12 sec	12 sec	12 sec

1.5.3. FUNCTIONAL SPECIFICATION

Rotational speed	3600 rpm +/- 1 %	3600 rpm +/- 1 %	3600 rpm +/- 1 %
Recording density	7690 bpi	7690 bpi	9332 bpi
Flux density	7690 fci	7690 fpi	9332 fci
Track density	254 tpi	254 tpi	254 tpi

1.5.4. PHYSICAL SPECIFICATIONS

The physical specifications apply for all three models.

Environmental limits (operation)

Ambient temperature	4 to 50 degr. C
Temperature gradient	15 degr. C / h max.
Relative humidity (no condensation)	15 to 80 %
Dew point temperature	25 degr. C max.

DC-voltage requirements

+12 Volts +/- 5% (4.5 A during motor start)	2.4 A typ.
+ 5 Volts +/- 5%	0.9 A typ.
Power dissipation	33 Watts typ.

Mechanical dimensions

Height	82.55 mm (3.25 inches)
Width	146.0 mm (5.75 inches)
Depth (Face Plate not included)	209.0 mm (8.23 inches)
Weight	2.8 kg (6.2 lbs)

1.5.5. RELIABILITY SPECIFICATION

MTBF (under typical usage)	11000 POH
MTTR	30 minutes
Preventive maintenance	none
Designed lifetime	5 years

Error rates

Soft read errors	1 per 10^10 bits
Hard read errors	1 per 10^12 bits
Seek errors	1 per 10^6 seeks

SECTION 2

INSTALLATION AND OPERATION

2.1. INSTALLATION

2.1.1. SCOPE

Section 2 provides information about handling, installation, configuration, and operation of the BASF 6180 Fixed Disk Drive. It should be read carefully before using the BASF 6180 to avoid any possible damage to the drive.

2.1.2. UNPACKING

The BASF 6180 Disk Drives are packed in specially designed shipping cartons which includes foam rubber liners to minimize shipping damages. The procedure for unpacking a drive is as follows:

a.) Inspect the carton for obvious damage. If it is found later, that a damage to the drive is related to a damage of the carton, then the 'carrier' should be held accountable for the damage.

b.) Remove shipping list from the carton. Check that the correct drive has been shipped. Do this by comparing part and model number on the shipping list with the label affixed to the carton and with the 'open' purchase order. If the part numbers do not match, do not open the carton, before the dicrepancy is resolved.

c.) Place the carton in the upright position. Open the carton and remove the top foam rubber insert.

d.) Carefully take the Disk Drive out of the shipping carton. Do not grasp the Damping Element of the Stepper Motor when lifting the drive. Handle the drive gently and minimize the amount of shock to which the drive is exposed. Also avoid any rotating movement which could cause the disks to spin.

e.) Set the drive on a stable surface in the same position that it came out of the shipping carton.

f.) Check all items against the shipping list. Discrepancies, missing items, damages, etc. should be reported to the responsible BASF Sales Representative.

g.) Save the shipping carton for possible future use in returning drives for repair or for further shipping of drives in house or to end users.

2.1.3. INSPECTION

After unpacking the drive should be visually inspected for any obvious damage as follows:

- Check for any damage to mechanical parts such as Face Plate, Chassis, Stepper Motor with Light Gate and Damping Element, Ground Spring, etc.

- Check for loose screws; tighten them if necessary.

- Check for any damage to electronic components on the PCB's, to the PCB's themselves, to the interconnect cables etc.

- Check for any loose or broken parts in the plastic bag which encloses the drive.

- While installing and testing the drive check if any problems occuring may be caused by shipping damages.

All claims for shipping damages should be filed directly with the 'carrier' involved.

2.1.4. HANDLING

Like all 'Winchester' Disk Drives the BASF 6180 is a very delicate instrument. It should be handled very carefully in order to avoid any damage. This section provides some warnings and recommendations for proper handling.

- Under no circumstances loosen or open the cover of the HDA. This would contaminate the HDA and result in severe damage to heads and disks. Repair of the HDA is only possible at the factory.

- Do not grasp the Damping Element of the Stepper Motor when handling the drive. A misalignment resulting in malfunction may occur.

- Do not move the head carriage by turning the Damping Element of the Stepper Motor unless the Spindle Motor is at full speed and the heads are flying.

- Do not manually rotate the Spindle Motor. If it is necessary for a particular reason (e.g. to check the performance of the Spindle Motor Brake) avoid to rotate the disks in the wrong direction. The correct direction in which the motor also rotates in normal operation is indicated with an arrow on the Spindle Motor.

- When handling the drive avoid sudden turns which can result in a disk rotation.

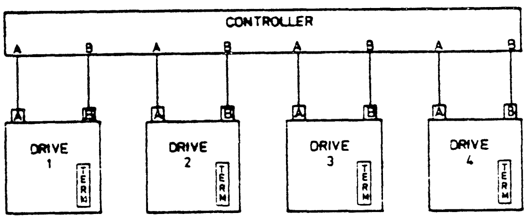
- Avoid hard shocks to the drive, e.g. when putting the drive on a table etc.

- Before shipping the drive position the actuator to cylinder 173 (BASF 6182 and 6183) or to cylinder 250 (BASF 6184) and fix the Stepper Motor with adhesive tape to avoid any carriage movement during transportation.

- Before shipping or handling the drive make sure that the Spindle Motor Brake is engaged.

- Before shipping the drive, fix the Spindle Motor with adhesive tape.

STAR CABLED SYSTEM



DAISY CHAINED SYSTEM

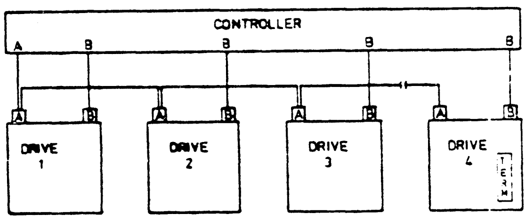


FIGURE 2 - 1 :
INTERFACE SIGNAL CABLE CONFIGURATIONS
(TERM = Terminator 2F installed)

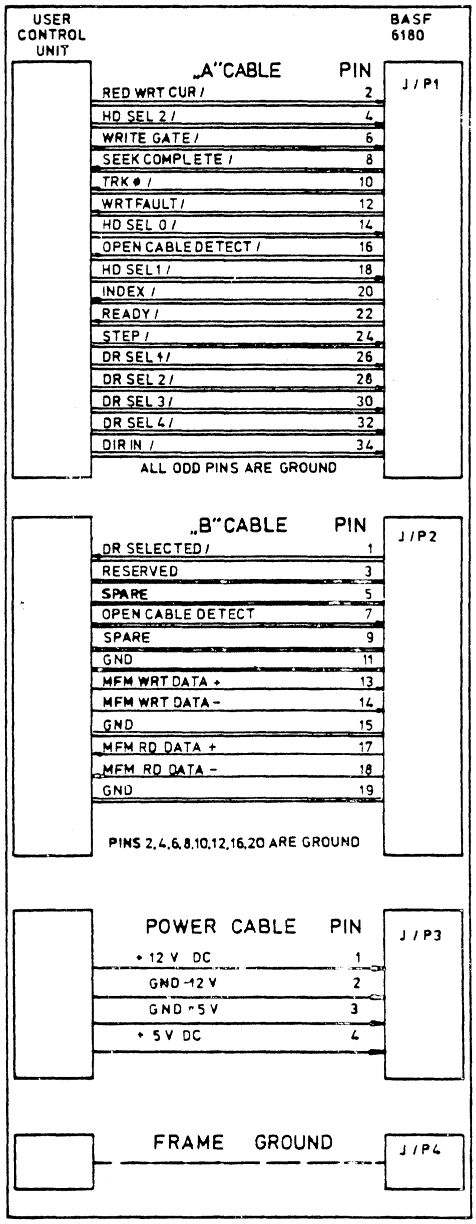


FIGURE 2 - 2 : CONNECTING CABLES

2.1.5. CONNECTING CABLES

The BASF 6180 is connected to the host by three cables. There are two signal cables and one power cable. The two signal cables are called 'A'-cable and 'B'-cable. An optional fourth cable may be used for Frame Ground connection (see section 2.1.8.).

The 'A'-cable has 34 lines and is used for transfer of control and status information. It may be a flat ribbon

CAUTION
SHIPPING PROTECTION
FOR SEPARATE
SHIPMENT ONLY

2.1.7. TERMINATION

All signal lines must be properly terminated as defined in the BASF 6180 Product Specification. For signals from the host controller to the drive all necessary termination is provided on the Read-Write-Control PCB.

Termination for the 'A'-cable control lines is contained in a DIP-resistor-pack mounted in a socket at location 2F of the Read-Write-Control PCB (see figure 2-4). Drives shipped from the factory have always the resistor pack installed. It must be removed in daisy-chain configurations from all but the physically last drive connected to the 'A'-cable. Systems with a single drive or with multiple drives connected in radial mode must have the resistor pack installed in all drives.

2.1.8. GROUNDING

Grounding of the drive is normally achieved through the Ground lines of the signal and power cables. Additional grounding of the HDA can be provided through the Frame Ground connector J4 (see figure 2-4). The recommended mating connector for J4 is AMP P/N 62187-1 or equivalent. The HDA is normally electrically connected to logic ground through a soldered jumper wire JJ2 at location 1G on the Read-Write-Control PCB close to the option switches. This jumper should be removed when using J4 in order to avoid ground loops.

The mounting frame is isolated by the rubber shock absorbers from the HDA.

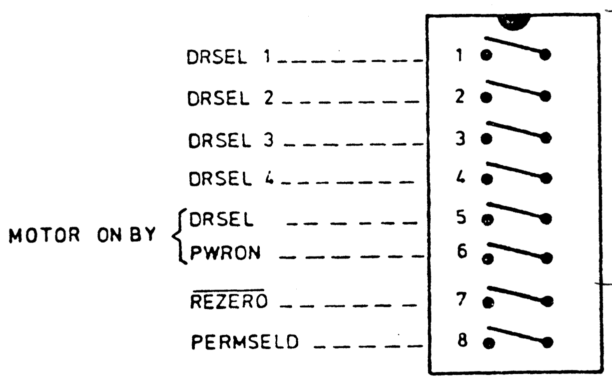


FIGURE 2 - 5 : OPTION SWITCHES

2.1.9. USER SELECTABLE OPTIONS

The BASF 6180 has 8 switches for user selection of different drive options/configurations. The switches are contained in a DIP switch pack at location 2G of the Read-Write-Control PCB (see figure 2-4). Switch number 1 is the one closest to connector J1. The assignment of the switches is shown in figure 2-5. The on position of the switches is marked on the switch housing.

2.1.9.1. DRIVE ADDRESS SELECTION

Switches 1 to 4 are used to set the drive address for drive selection. Only one of the four switches may be set to the ON position. This switch determines which one of the four interface Drive Select lines (DR SEL 1 to DR SEL 4) selects this particular drive. If for instance, in a given drive, switch 1 is ON (switches 2 to 4 of that drive must be OFF) that drive is selected whenever the signal DR SEL 1/ is low active.

The drive address assignment is independent of the drive's position on the daisy-chained 'A'-cable.

2.1.9.2. SPINDLE MOTOR START CONTROL

Switches 5 and 6 control the condition for the Spindle Motor start. Only one of the two switches may be set to the ON position.

If switch 6 is ON (and switch 5 OFF) the Spindle Motor is started as soon as power is provided to the drive.

If switch 5 is ON (and switch 6 is OFF) the Spindle Motor does NOT start with power on. It starts however with the first low active going edge of the Drive Select signal corresponding to that drive. This feature allows sequencing of the motor start in multiple drive configurations in order to reduce the total load to the power supply caused by the high current during the Spindle Motor start.

The motor start condition is undefined if both switches 5 and 6 are in the OFF position.

or twisted pair cable with a maximum total length of 6 meters (20 feet). If more than one drive is attached to the system, the 'A'-cable may be connected either in daisy-chain or radial configuration (see figure 2-1).

The 'B'-cable has 20 lines and is mainly used for transfer of Read/Write information. It is recommended to use twisted pair cables for the 'B'-cable, especially if its length exceeds 1 meter (3 feet). The 'B'-cable is always connected in radial mode. The maximum length of each 'B'-cable is 6 meters (20 feet).

The power cable should always be connected in radial mode in order to minimize voltage drop across the cable. Wire size and cable length must be determined in such a way to ensure that the supply voltage specifications (see section 1.5.4.) are met at the drive power connector under all operating conditions.

2.1.6. CONNECTORS

The pin and signal assignment of the connectors for the two signal cables and the power cable is shown in figure 2-2 and listed in Appendix D.

The 'A'-cable is connected through the 34 pin connector J1 to the drive. The recommended mating connector is AMP P/N 88373-3 or equivalent.

The 'B'-cable is connected through the 20 pin connector J2 to the drive. The recommended mating connector is AMP P/N 88373-6 or equivalent.

Both signal connectors J1 and J2 are industry standard card edge connectors with double-sided PCB pads on 2.54 mm (0.1") pad center spacing. A full specification of the connectors is provided in the BASF 6180 Product Specification. Both connectors J1 and J2 are located at the rear end of the Read-Write-Control PCB (see figure 2-4). The odd numbered pins are located on the component side with pin 1 specially labeled. Both connectors have a key-slot for polarization between pins 3/4 and 5/6. It is recommended to install a key in the mating interface connector to avoid accidentally wrong insertion of the connectors.

The power cable is connected through the 4 pin connector J3 to the drive. The recommended mating connector is AMP P/N 1-480424-0 with pins P/N 350078-4 or equivalent.

The pin numbering and voltage assignment for the power connector J3/P3 is shown in figure 2-3. J3 is located on the rear edge of the Read-Write-Control PCB close to the Stepper Motor. The connector housing is located at the solder side of the PCB. Pin 1 (12 VDC) which is also labeled on the PCB is located closest to the outside corner of the PCB. Extreme care must be taken when fabricating the power cable. Reversing the +5 VDC and +12 VDC supply voltages results in severe damage to the drive.

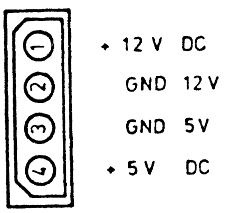


FIGURE 2 - 3 : POWER CONNECTOR J3
(as seen on PCB solder side - looking at connector pins)

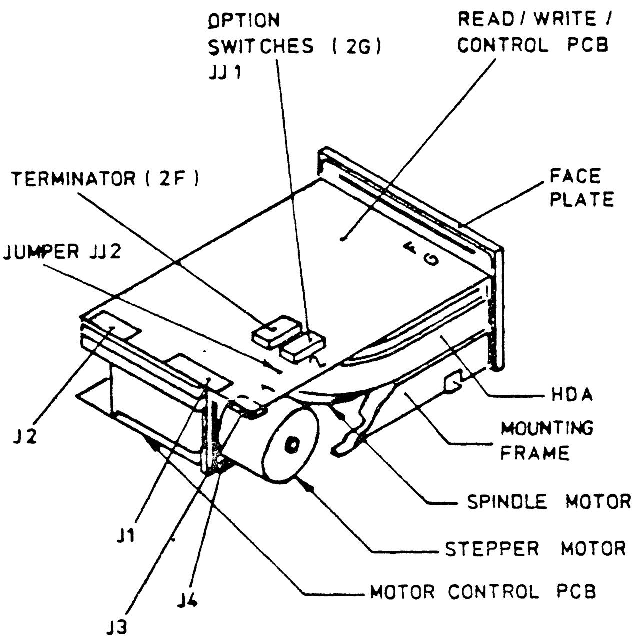


FIGURE 2 - 4 :
CONNECTOR, TERMINATOR, AND OPTION SWITCH LOCATION

The BASF 6180 may be mounted in three different orientations. When looking at the Face Plate the Read-Write-Control PCB may either be on top, on the rigth side or on the left side of the drive (see figure 2-7). The maximum angle for the drive mounting from the horizontal level is 13 degrees.

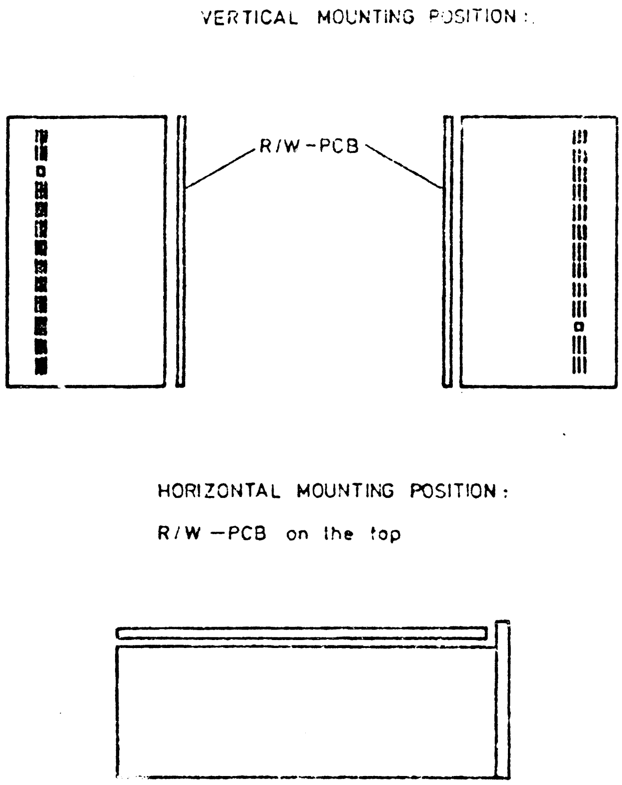


FIGURE 2 - 7 :
RECOMMENDED MOUNTING ORIENTATIONS

The following general recommendations for mounting the drive in a system should be observed:

- The drive should be mounted with four screws, either to the four bottom mounting holes or to the four mounting holes on the two sides.

- A clearance of at least 4 millimeters should be provided in all directions around the HDA (see dimension P in figure 2-8). This space is required to

	mm	in.
C	146 ±0,5	5,748 ± 0.020
L	147 +0,5	5,787 + 0.020
M	154	6,063
N	84 +0,5	3,307 + 0.020
P	4	0,1575

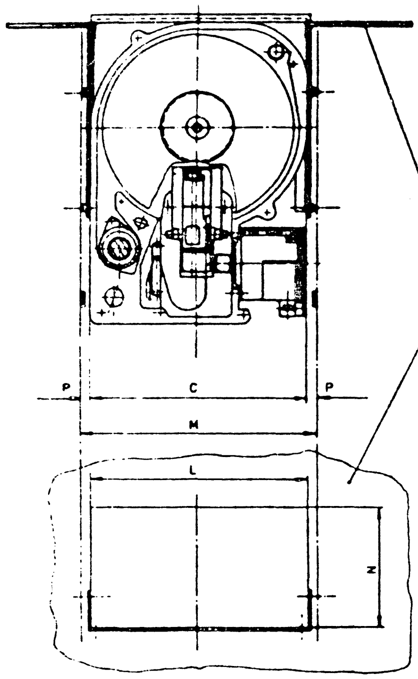


FIGURE 2 - 8 : MOUNTING RECOMMENDATION

allow the HDA to swing on the shock absorbers if the system is exposed to external vibrations or shocks. The dimensions L and N show the recommended size of the opening in the host system front panel for mounting of the drive.

- The mounting of the drive must allow sufficient air flow for its cooling. The environmental temperature specified for the drive refers to the air immediately surrounding the drive. This value (50 degr. C) must not be exceeded under any operating condition or temperature outside of the system.

- If the drive is mounted close to devices which radiate a very high level of electrical noise (such as switched mode power supplies, CRT displays etc.) it may be advisable to provide a shielding between those devices and the disk drive.

2.1.9.3. AUTOMATIC REZERO

If switch 7 is in the OFF position, the drive performs an automatic Rezero operation after power is provided to the drive and the Spindle Motor is up to full speed. (Note that the Spindle Motor may not start before the first selection if switch 5 is ON.) The interface Ready signal goes low active after the automatic Rezero is completed. The interface Seek Complete signal goes high inactive during the Rezero operation.

If switch 7 is in the ON position the drive does NOT perform an automatic Rezero operation, this must be done however by the host controller. In this case the interface Ready signal goes active after the Spindle Motor is up to speed.

2.1.9.4. PERMANENT SELECTION

If switch 8 is in the ON position, the drive is permanently selected. This means that the drive responds to the interface control lines independent of the position of switches 1 to 4 and independent of the status of the four interface Drive Select signals. Nevertheless one of the four address switches S1 to S4 (normally S1) should be set to the ON position. The In-Use indicator is NOT permanently lit for Permanent Selection. It is only turned on when the interface Drive Select signal corresponding to the address of that drive is active.

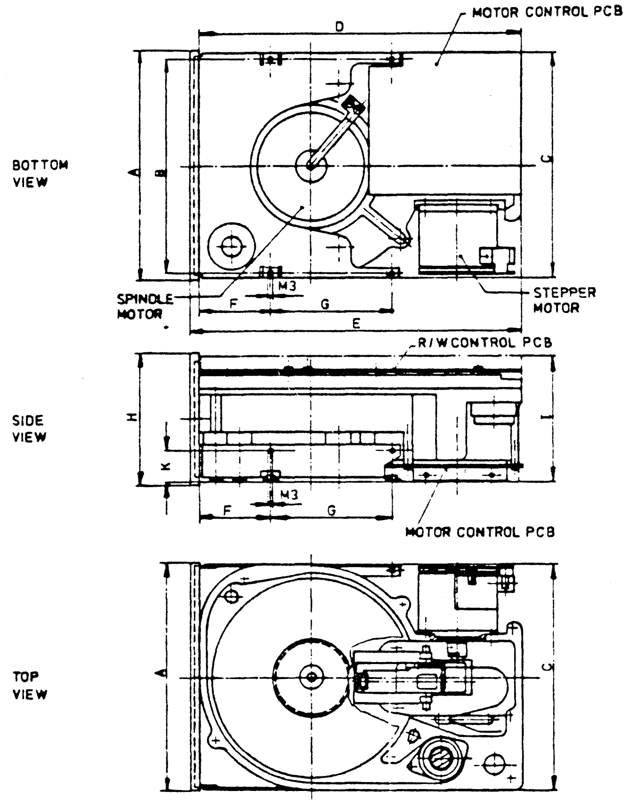
If the Permanent Select option is set, switch 5 must be OFF and switch 6 must be ON otherwise the Spindle Motor would never start.

Permanent selection may not be used in a daisy-chain configuration because two or more drives would respond to the same interface commands.

If switch 8 is in the OFF position, selection of the drive is under control of one of the four interface Drive Select lines according to the setting of switches 1 to 4.

2.1.10. MOUNTING

The overall and mounting dimensions of the BASF 6180 are shown in figure 2-6 with the following dimensions being specified:



	mm	in.
A	149,4 ± 0,25	5,882 ±0,010
B	139,7 ± 0,5	5,500 ±0,020
C	146 ± 0,5	5,748 ±0,020
D	209 ± 1	8,228 ±0,040
E	215 ± 1,2	8,465 ±0,048
F	47,4 ± 0,4	1,866 ±0,016
G	79,2 ± 0,3	3,118 ±0,012

	mm	in.
H	85,9 ± 0,25	3,382 ±0,010
I	82,55 ± 1,2	3,250 ±0,047
K	21,8 ± 0,3	0,858 ±0,012

FIGURE 2 - 6 : DRIVE PHYSICAL DIMENSIONS

- A Face Plate Width
- B Distance between Bottom Mounting Holes
- C Mounting Frame Width
- D Overall Length (excluding Face Plate)
- E Overall Length (including Face Plate)
- F Distance from Back of Face Plate to Mounting Holes
- G Distance between Mounting Holes
- H Face Plate Hight
- I Overall Hight (except Face Plate)
- K Distance from Bottom of Mounting Frame to Side Mounting Holes

There are a total of eight mounting holes in the mounting frame, four in the bottom and two on either side. All mounting holes have M3 threads (metric 3 mm diameter).

- Mount the drive in the system. If the drive is tested outside the system, make sure that the recommended mounting orientations are still met.

- Verify that the interface signal and power cables are correctly wired. (Reversing of the two power supply voltages would cause severe damage to the drive.)

- Connect the interface signal and power cable. If interface cables without polarization keys are used, verify that the interface conectors are installed in the correct orientation.

- Remove the adhesive tape from the Spindle Motor.

- Provide power to the drive. Watch that the brake is disengaging and the Spindle Motor starting to rotate. Wait until the Spindle Motor has reached full speed.

- Remove the adhesive tape from the Stepper Motor.

- Turn power off. Watch that the brake is engaging.

- Set the option switch 7 to the OFF position.

- Turn power on again. Watch that the drive performs the automatic rezero after the Spindle Motor is at full speed.

- Turn power off.

- Set the option switches as required for normal system operation (see section 2.1.9.).

- Perform a normal system power on procedure.

2.2.5. PREPARATION FOR SHIPMENT

In cases where it is possible that the specified limits for vibration and shock (see the BASF 6180 Product Specification) may be exceeded during shipping of the complete system, then it is recommended to ship the drive separately in the original shipping carton and to install it at the end user site into the system. The following procedure is recommended for preparing the drive for the shipment:

- Provide power to the drive.

- Position the heads to cylinder 173 (BASF 6182 and 6183) or to cylinder 250 (BASF 6184).

- Lock the Stepper Motor by putting adhesive tape across the Stepper Motor housing and the Damping Element.

- Turn power off. Watch that the brake engages.

- After the Spindle Motor has stopped, fix the rotor of the Spindle Motor with adhesive tape.

2.2. OPERATION

This section provides information about the operation of the BASF 6180.

2.2.1. CONTROLS AND INDICATORS

The BASF 6180 has no manual controls for operation of the drive. All functions are controlled by the host system through the drive interface. Refer to the Product Specification and Theory of Operation for a detailed description of the interface operation.

The BASF 6180 has one indicator in the face plate, wich is called the 'In-Use' indicator. This indicator is lit while the drive is selected through one of the interface Drive Select signals.

If the Permanent Select option is set with option switch 8, the In-Use indicator is not permanently lit. However the Drive Select line corresponding with the address of that drive may be used to turn on and off the In-Use indicator. In Permanent Select mode the interface Drive Select lines have no other effect.

2.2.2. POWER UP PROCEDURE

There is no manual interaction required for powering up the drive, except for the first time after shipment (see section 2.2.4.). The action which the host controller has to take after power on depends on the options selected (see section 2.1.9.).

Note that because of limited heat dissipation the time between two Spindle Motor starts should not be less than six minutes. (Two or three starts with a cold drive as for section 2.2.4. is acceptable.)

2.2.3. POWER DOWN PROCEDURE

There is no manual interaction required for powering down the drive, except for the last time before shipment (see section 2.2.5.).

Although the minimum time between two starts is six minutes, it is recommended not to turn power off, if the system/drive is not used for a short period of time (e.g. less than an hour).

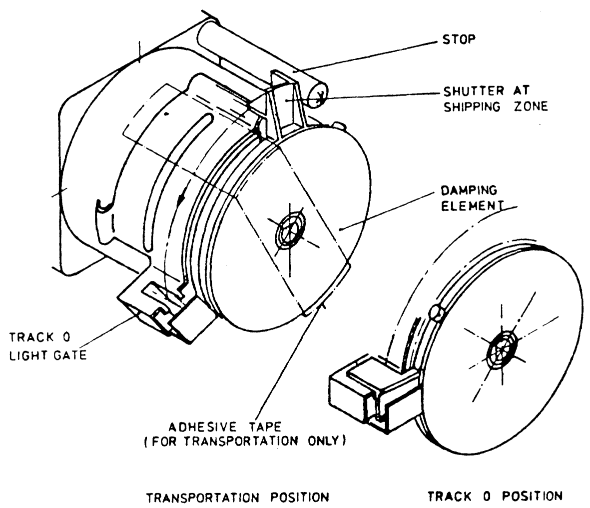


FIGURE 2 - 9 :
STEPPER MOTOR
TRANSPORTATION AND TRACK 0 POSITION

2.2.4. INITIAL POWER ON

This section gives a recommendation for a setup and checkout procedure when powering up a drive for the first time after shipment. In multi drive configurations it is recommended to check each drive individually.

- Set the option switches as follows:

1-5,8	OFF
6,7	ON

- Install or remove the terminator pack as required (see section 2.1.7.).

- Verify that the connectors of all interconnect cables in the drive are firmly seated.

SECTION 3

THEORY OF OPERATION

3.1. SCOPE

Section 3 provides complete information about the mechanical and electrical components of the BASF 6180. All functions are described in such detail necessary as a basis for troubleshooting and repair of the drive.

3.2. MECANICAL DESCRIPTION

The BASF 6180 consists of the following major assemblies:

- Chassis Assembly
- Spindle Motor / Disk Assembly
- Motor Brake / In-Use Indicator Assembly
- Stepper Motor Assembly
- Carriage Assembly
- Magnetic Heads Assembly
- Filter Assembly
- Face Plate Assembly
- Read-Write-Control PCB
- Motor-Control PCB

Figure 3-1 shows the location of the major components.

3.2.1. CHASSIS ASSEMBLY

The Chassis of the BASF 6180 consists of a single aluminum molded part. The Chassis forms an enclosure which contains disks and heads and which is covered by an aluminum plate. Spindle Motor and Stepper Motor are mounted at the outside of the Chassis to allow for a better heat dissipation.

The Chassis, completely assembled with Spindle Motor, Disks, Stepper Motor, Carriage, Heads, and Cover is called the Head Disk Assembly (HDA). The HDA is hermetically sealed to prevent any contamination from the outside. This allows that the BASF 6180 can be used in a normal office environment without any special requirement to the cleanliness of the air.

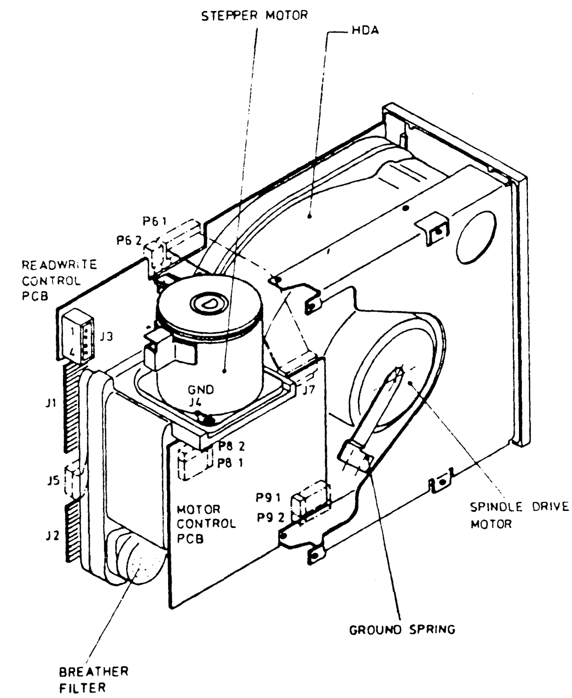


FIGURE 3 - 1 :
MAJOR COMPONENT LOCATIONS

3.2.2. SPINDLE MOTOR/DISK ASSEMBLY

The disks are directly driven by the Spindle Motor at a speed of 3600 rpm +/- 1%. Directly driven means that the disks are mounted directly to the shaft of the Spindle Motor. This concepts avoids belts and pulleys and thus increases the reliability of the drive considerably.

The Spindle Motor is a brushless DC motor with the coils in the stator and a four pole permanent magnet in the rotor as shown in figure 3-2. The motor shaft which carries the rotor is supported by two ball bearings. On top of the upper bearing a ferrofluidic seal prevents any contamination to pass between the motor shaft and the Chassis into the inside of the HDA. The bottom end of the motor shaft is conical to provide contact to a metal spring (the Ground Spring) for grounding and electrostatic discharge of the rotor.

Two hall sensors in the stator generate reference

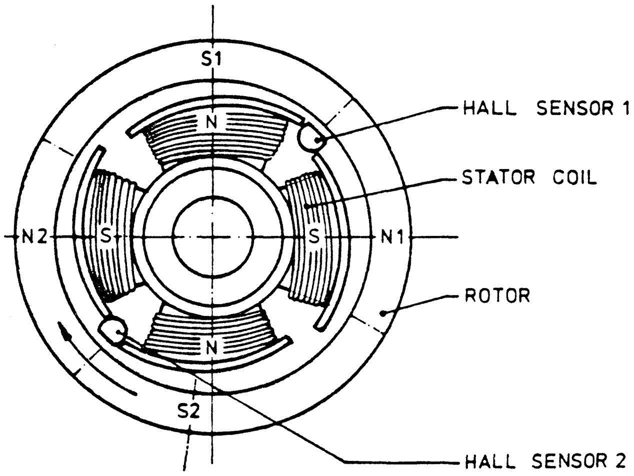


FIGURE 3 - 2 :
SPINDLE MOTOR DESIGN

signals required for the commutation of the current through the motor coils. The commutation together with the speed control is performed by electronic circuitry located on the Motor-Control PCB.

The BASF 6180 incorporates either three disks (BASF 6183 and 6184) or two disks (BASF 6182). The disks have an outside diameter of 130 mm (5.25") and an inside diameter of 40 mm (1.6"). The disks are coated on both sides (surfaces) with an iron oxide covered by a thin layer of lubricant. The lubricant is required to allow the in contact take-off and landing of the heads. During normal operation the heads fly in a very low distance above the disks.

Two different zones are used on each disk surface, the data recording zone and the shipping zone. The data recording zone has 230 tracks (BASF 6184) or 153 tracks (BASF 6182 and 6183) with a track spacing of 0.1 mm (0.004"). The tracks are numbered 0 through 229 or 152 respectively with track 0 being located at the outside circumference. All tracks with the same number on the different surfaces are referred to as Cylinder. The shipping zone is accessed when the heads are positioned at cylinder 250 (BASF 6184) or cylinder 173 (BASF 6182 and 6183).

3.2.3. MOTOR BRAKE/IN-USE INDICATOR ASSEMBLY

The BASF 6180 is equipped with a brake for the Spindle Motor in order to reduce the stop time of the Spindle Motor after power off. The Motor Brake is mounted to the HDA Chassis and acts on the outside circumference of the rotor drum of the Spindle Motor.

When the Spindle Motor is started the solenoid of the brake is energized which causes the brake to disengage. When power is removed from the motor the solenoid is deenergized which causes the spring loaded brake pad to engage. The friction between the brake pad and the rotor drum causes the Spindle Motor and disks to decelerate.

The Motor Brake and the In-Use Indicator form one assembly because they share the same connector. The In-Use Indicator LED is mounted into the Face Plate.

3.2.4. POSITIONING SYSTEM

The positioning system consists of the Stepper Motor and the Carriage Assembly. Its function is to move the magnetic heads to the desired cylinder. The basic design of the positioning system is shown in figure 3-3 and figure 3-4.

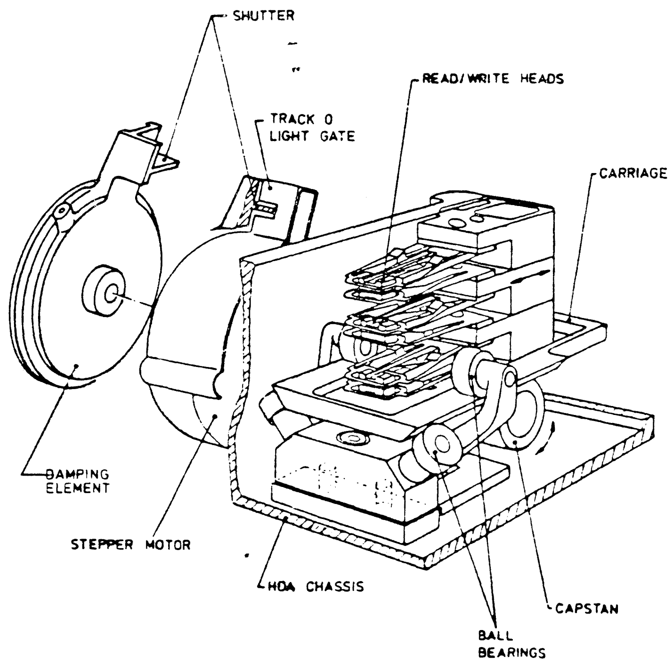


FIGURE 3 - 3 :
POSITIONING SYSTEM (TOP VIEW)

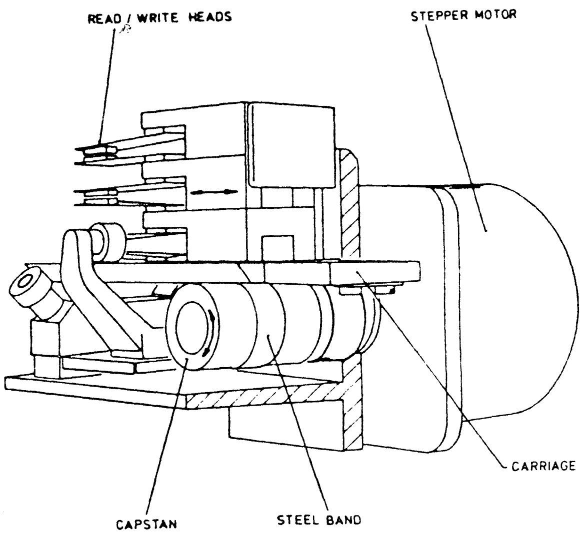


FIGURE 3 - 4 :
POSITIONING SYSTEM (BOTTOM VIEW)

The BASF 6180 uses a five phase Stepper Motor with a step angle of 0.72 degree which is equivalent to 500 steps per revolution. The distance between two tracks which is crossed by one step of the Stepper Motor is 0.1 mm (0.004"). The rotary motion of the Stepper Motor is transformed into a linear motion of the Carriage through the capstan and a steel band. The Carriage is supported by four ball bearings and the capstan. Two of the ball bearings are spring loaded to assure a play-free guidance of the Carriage.

A Damping Element is mounted to the shaft of the Stepper Motor. Its purpose is to reduce the settling time of the Head/Carriage Assembly after a Seek. Without the damping the Carriage and the heads would oscillate for some time around the center of the track accessed with a seek. The time until the heads would be in a stable position and data could be accessed would then be much longer.

To provide an absolute reference of the head position the BASF 6180 has a Track 0 detection. It consists of a Light Gate mounted to the housing of the Stepper Motor and a Shutter which is part of the Damping Element housing. When the heads move to Track 0 the Shutter enters the Light Gate, interrupts the light, and the phototransistor of the Light Gate turns off. When the heads move away from Track 0 the Shutter moves out of the Light Gate, which enables the light to turn on the phototransistor.

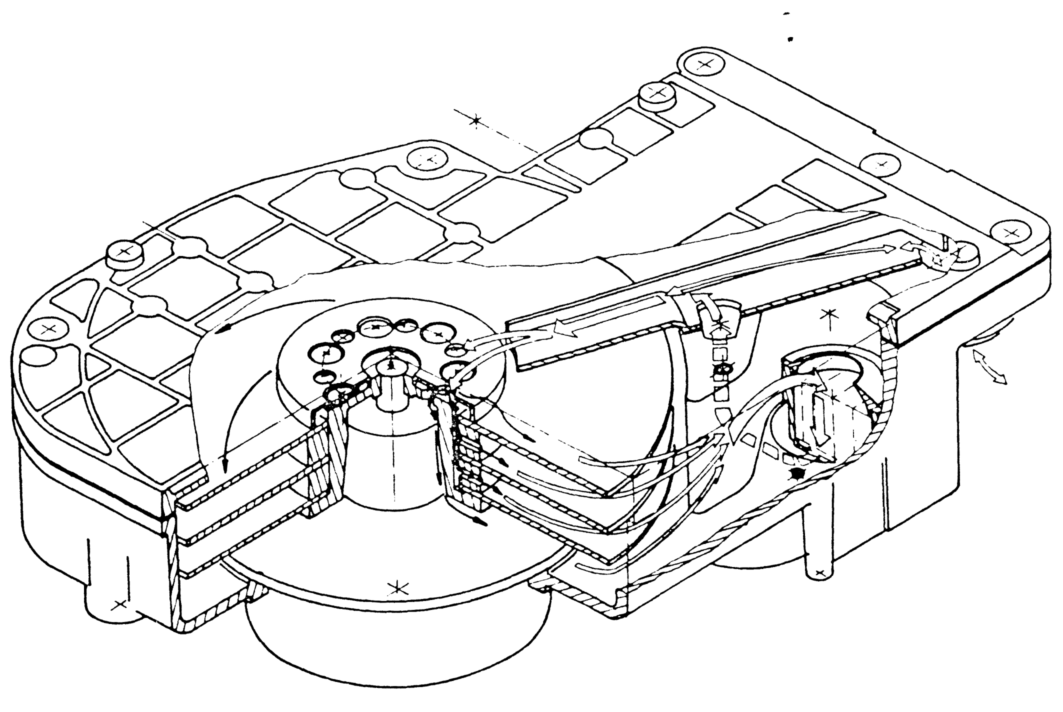


FIGURE 3 - 5 : AIR CIRCULATION AND FILTRATION

3.2.5. MAGNETIC HEADS ASSEMBLY

The BASF 6180 has one magnetic head per disk surface (four heads for BASF 6182 and six heads for BASF 6183 and 6184). The heads are assembled in a head stack and then mounted onto the Carriage. The electrical connection between the heads and the electronics is achieved by a flexible cable.

The heads are numbered from 0 through 3 or 5 respectively with head 0 being the one closest to the Carriage. Only one of the heads is used at a time. All tracks of one cylinder can be accessed by just selecting the corresponding head. The selection of the desired head is performed by a diode matrix mounted directly on the flexible cable at the head stack.

The magnetic heads which are used in the BASF 6180 for writing and reading of the data are of the "Winchester" technology type. Such heads allow a very high recording density and in-contact take-off and landing on the disk surface. These features are achieved by very short gap length, low flying height, and low head loading force. The low flying height of about 0.5 micrometer is smaller than most dust particles in the normal air. This is the reason why the HDA is hermetically sealed and may not be opened in the field. Any contamination from the outside with dust particles greater than the flying height would cause head crashes resulting in severe damages to heads and disks.

3.2.6. FILTER ASSEMBLY

For proper operation of the drive it is essential to maintain the absolute cleanliness of the air within the HDA. In the BASF 6180 this is achieved by continuously recirculating and filtering the air inside the HDA. The air flow which is shown in figure 3-5 is caused by the pumping action of the rotating disks. The air flow passes an absolute filter which collects any particles that may penetrate from outside into the HDA or that may originate from inside the HDA.

An additional filter which is called the breather filter provides an air-path between the inside of the HDA and the outside to allow for air pressure equalization.

3.2.7. FACE PLATE ASSEMBLY

The Face Plate Assembly consists of the face plate itself and the mounting frame. The HDA is mounted with four Shock Absorbers to the mounting frame. The In-Use Indicator LED is mounted in the Face Plate but is not part of the Face Plate Assembly.

3.2.8. READ-WRITE-CONTROL PCB

The Read-Write-Control PCB contains the interface and read/write electronics. It is mounted to the top of the HDA. An insulating sheet between the HDA cover and the PCB is used to prevent accidental shorts between component pins on the PCB solder side and the metal cover of the HDA. The mounting screw close to connector J1 provides an electrical contact from the HDA to a metal pad on the PCB. Jumper JJ2, if installed, provides the connection between this pad and the logic ground on the PCB.

The location of the electrical components and test points on the Read-Write-Control PCB is shown in figure A-1. Locations of IC's and other components are identified in a matrix form. Locations are numbered from A to I in one direction and from 1 to 12 in the other direction. For example location 3C is the quadrant at the crossing of row 3 and column C. IC pin numbers are appended to the location, e.g. 3C12 is pin 12 of the IC at location 3C.

3.2.9. MOTOR-CONTROL PCB

The Motor-Control PCB contains the control electronics and power amplifiers for the Spindle Motor and the Stepper Motor. It is mounted to the bottom of the HDA. The physical separation of the read and power electronics provide an optimal noise immunity. The Motor-Control PCB is completely isolated from the HDA, except through the Read-Write-Control PCB.

The location of the electrical components and test points on the Motor-Control PCB is shown in figure A-2. Component locations on the Motor-Control PCB are not identified in a matrix form. The IC's are numbered IC1 to IC8 with a pin designation like IC3-12.

3.2.10. INTERCONNECTING CABLES

The interconnection between the PCB's and other electrical components in the drive is achieved by six different cables. A diagram of the interconnection is provided in figure 3-6. All cables are equipped with connectors at least on one end to allow fast and simple replacement of defective components.

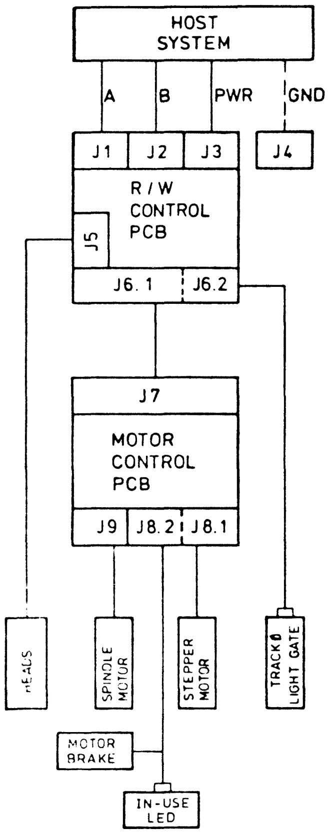


FIGURE 3 - 6 :
INTERCONNECTION DIAGRAM

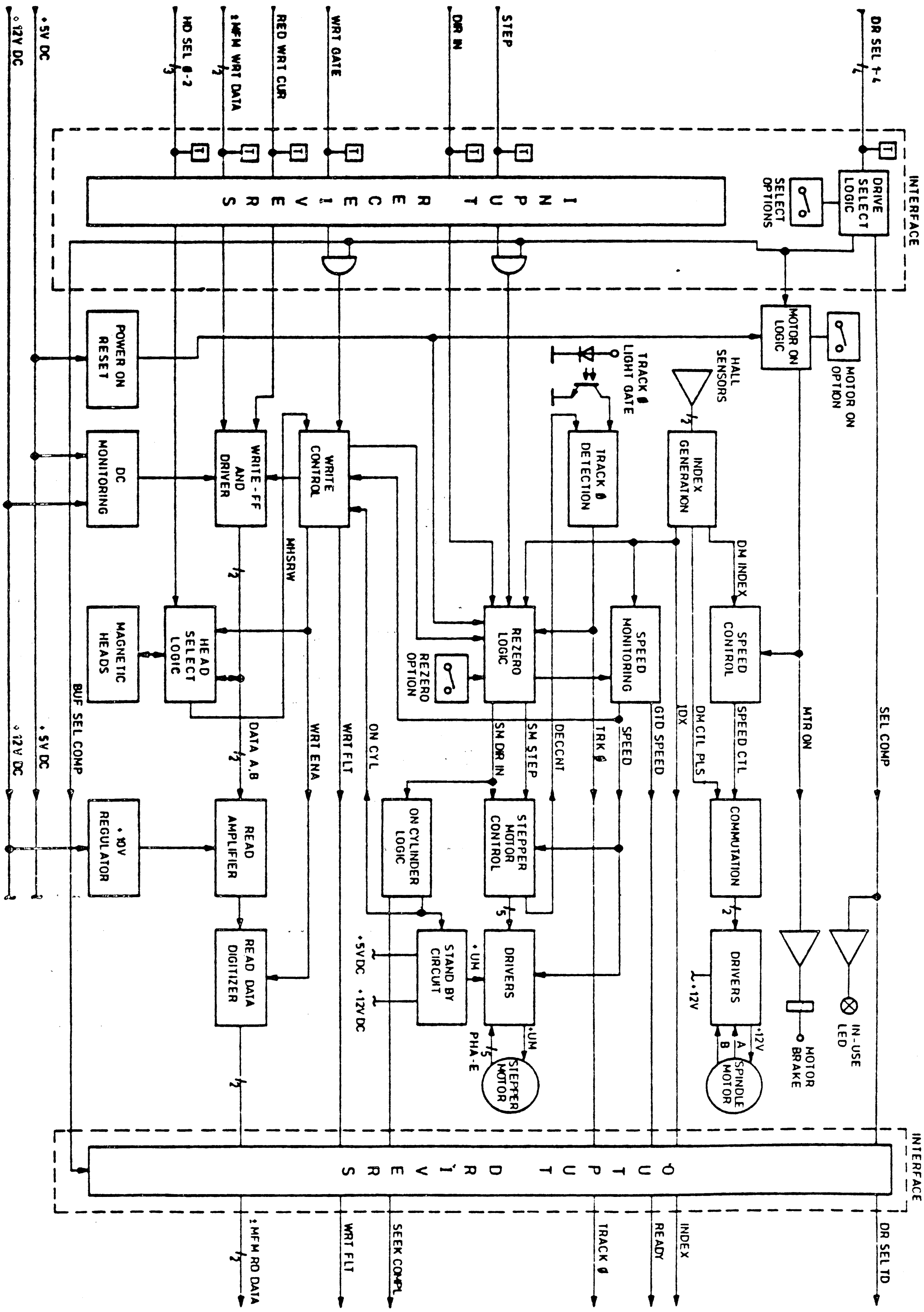


FIGURE 3 - 7 : BLOCK DIAGRAM

3.3. ELECTRICAL DESCRIPTION

3.3.1. GENERAL

The following sections describe the electrical functions of the BASF 6180. An overview of the electronics is given in the block diagram in figure 3-7. The complete detailed schematics are available as a separate document. For better understanding the circuitry is partioned in this manual into functional blocks independent of their physical location. Each functional block is shown on a separate circuit diagram which is explained in detail. Referencing between the circuit diagrams is done by connectors labelled A to Z and AA to FF.

A list of the abbreviations used for signal names and their meaning is provided in Appendix B.

The two logical states, that digital signals can have are called 'active' and 'inactive'. The active state corresponds to the state expressed by the signal name, e.g. the Ready signal is in the active state when the drive is ready. The relation between logical states and electrical voltage levels is defined by the following convention. Signal names which have an '/' appended indicate a low active signal. This means that an active state corresponds to a low voltage level (less than or equal 0.8 Volts for TTL) and an inactive state corresponds to a high voltage level (greater than or equal 2.0 Volts for TTL). A signal name which does not have a '/' appended indicates a high active signal for which the active state corresponds to the high voltage level and the inactive state to the low voltage level.

Transitions are called 'active going' or 'inactive going'. An 'active going' transition means the transition from the inactive to the active state which is a low to high transition for a high active signal etc. If transitions refer directly to voltage levels they are called 'high going' or 'low going' where 'high going' means a low to high transition.

The function of the interface signals is described together with the functional blocks where they are used. A summary of the functional description of the interface signals is provided in the Product Specification.

3.3.2. POWER CIRCUITS

The BASF 6180 requires two DC supply voltages (+ 5 Volts and + 12 Volts) which must be provided by the host system. The two voltages together with two corresponding return lines are supplied through the Power Connector J3 (see section 2.1.6.) to the Read-Write-Control PCB. Through connectors J6/J7 the supply voltages are also provided to the Motor-Control PCB. An adequate number of capacitors which are distributed over the two PCB's is used for filtering and suppression of noise.

Three special circuits are used for voltage generation and monitoring. All three are located on the Read-Write-Control PCB.

3.3.2.1. READ/WRITE VOLTAGE GENERATION

Figure 3-8 shows the circuit for the generation of voltages for the read/write circuitry. The incoming 12 Volts are first filtered through inductor L1 and capacitors C60 and C62 to become +12V RW. This voltage is used for the write circuitry, as reference for the voltage monitoring circuit, and as input voltage for the +10 Volt regulator.

A regulated voltage of +10 Volt is used as supply voltage for the analog read circuitry in order to make it independent of supply voltage variations. The regulation is achieved through transistor T1 using D9 and D3 as a reference. Diode D3 is also used for temperature compensation. C20 is used for filtering the reference voltage and C21, C35, C44, and C45 for filtering the output voltage.

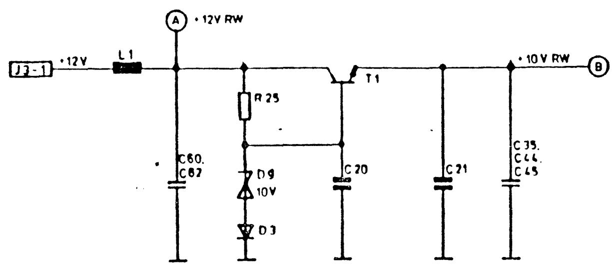


FIGURE 3 - 8 :
READ/WRITE VOLTAGE GENERATION

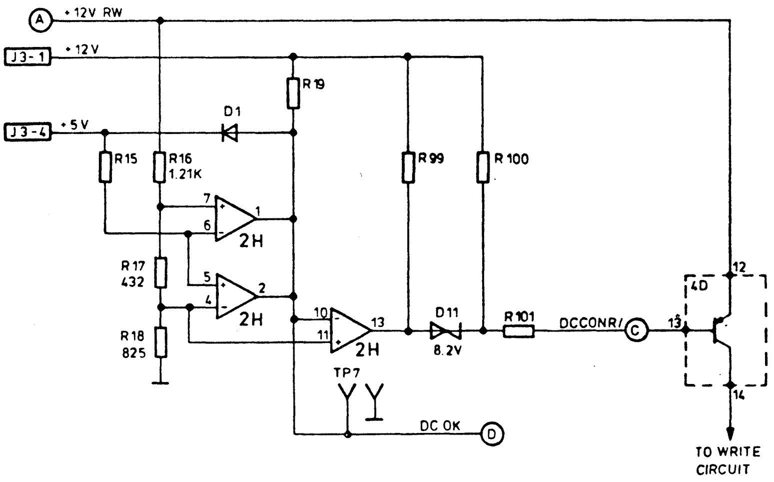


FIGURE 3 - 9 : DC VOLTAGE MONITORING CIRCUIT

3.3.3.2. DC VOLTAGE MONITORING

Figure 3-9 shows the DC voltage monitoring circuit. The purpose of this circuit is to disable critical functions (such as writing) if the supply voltages are not within acceptable limits and proper operation of the drive is not achievable.

The comparators 2H used in the circuit have an open collector output. The voltage divider consisting of R16, R17, and R18 generates the threshold voltages. If the supply voltages are within their specified limits, the +5 Volts (inputs 2H5 and 2H6) are lower than the upper threshold (input 2H7) and higher than the lower threshold (input 2H4). In this case the output transistors of both comparators are turned off and the wired ORed outputs 2H1 and 2H2 go high, which is the active state for the signal DC OK. The line is pulled high by R19 with D1 limiting the output voltage to about 5.7 Volts.

If the +5 Volts are too high or the +12 Volts are too low, the output transistor of comparator 2H1 is turned on forcing DC OK to a low inactive state. If in the opposite case the +5 Volts are too low or the +12 Volts are too high, comparator 2H2 causes DC OK to go low inactive.

The remainder of the circuitry on figure 3-9 is used for an additional protection for writing, since the previously described circuit does not detect if both voltages are too low.

The comparator with output 2H13 is used to invert the DC OK signal. If DC OK is active high, the output 2H13 goes low. Only if the +12 Volts are higher than about 9 Volts the zener diode D11 and the transistor in IC 4D are turned on and enable the write current. The transistor is not turned on, thus disabling writing, if either DC OK is low inactive (2H13 high) or if the +12 Volts supply voltage is below 9 Volts.

3.3.2.3. POWER ON RESET

The Power On Reset pulse generated by the circuitry shown in figure 3-10 is used to set the drive logic into a well defined state after Power On. After the +5 Volts have been provided to the drive, C14 is slowly charged through R20. As long as the voltage at C14 is lower than the threshold voltage of IC 6G3 the PWR ON RST/ signal is low active. After approximately 150 milliseconds the voltage at C14 goes higher than the

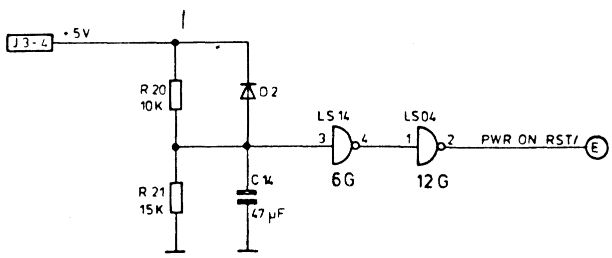


FIGURE 3 - 10 :
POWER ON RESET GENERATION

threshold of 6G3 which causes PWR ON RST/ to go high inactive. Diode D2 is provided for a fast discharge of C14 in case of short power drops.

3.3.3. DRIVE SELECT LOGIC

The Drive Select Logic is shown in figure 3-11. Drive Selection means to condition a drive to respond to the controller commands and perform the desired functions.

The BASF 6180 allows two different modes of selection. In systems with a single drive or in sytems with multiple drives that are attached in radial mode, the drive(s) can be permanently selected. In systems with multiple drives in daisy chain configuration the controller has to appoint through the interface which drive has to execute the desired functions. Each drive is assigned a unit address in the range of 1 to 4 by closing the corresponding address switch S1 through S4 of the option switches (see section 2.1.9.1.). To select a drive with a given unit address the controller has to activate the corresponding Drive Select line. Since only one drive may be selected at a time only one address switch may be closed in each drive.

Permanent selection is achieved by closing option switch S8. This causes 8G10 to go low and the signal BUF SEL COMP to go high active independent of the state of the Drive Select signals. The signal BUF SEL COMP is used throughout the drive logic to enable the interface input command and output status signals.

For non-permanent selection switch S8 must be open and one of the address switches S1 through S4 must be closed. The Drive Select lines are terminated in the last drive connected to the A-cable which has the terminator pack installed. Closing one address switch connects the corresponding Drive Select line to input 6G1. If this input goes low active, output 6G2 goes high causing three different functions:

1.) Provided the PWR ON RST/ pulse has passed, the drive returns a low active state on DR SELTD/ to the host as an acknowledge for the Drive Select signal.

2.) Through driver IC3 output 6 on the Motor-Control PCB the In-Use Indicator LED is turned on.

3.) The low state on input 8G9 forces the BUF SEL COMP signal high active and enables all drive functions.

A directly wired connection between A-cable connector J1-16 and B-cable connector J2-7, the OP CBL DET signal, allows the host controller to verify that both cables are connected. In the controller one line is permanently wired to ground and the other via a pull up resistor to +5 Volts. If the second signal is low, both cables are properly connected. If it is high, then an open cable condition has been detected.

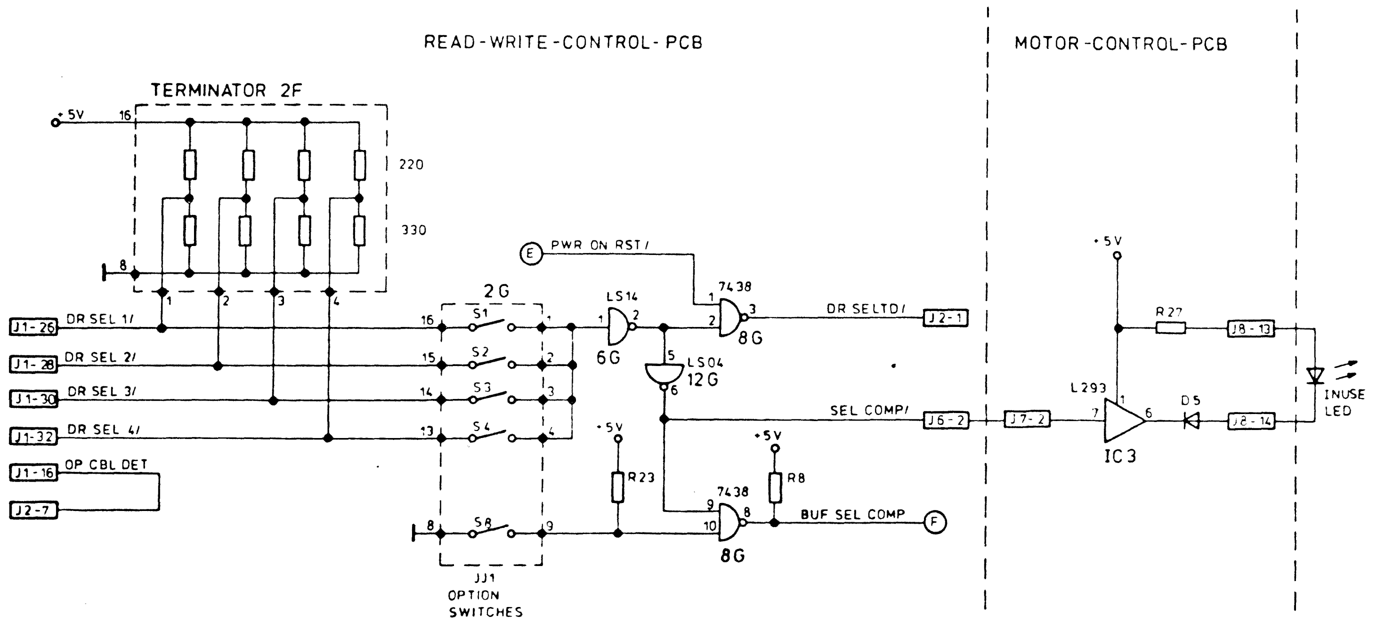


FIGURE 3 - 11 : DRIVE SELECT LOGIC

3.3.4. INDEX GENERATION

The index generation logic is shown in figure 3-13 and the timing in figure 3-14. The BASF 6180 provides one index pulse per revolution of the disks as an angular reference to indicate the beginning of the tracks.

The index pulse is derived from the output signals of the two Hall Sensors shown in figure 3-12. The characteristics of the sensors is such that if a north pole passes the sensor, the sensor output goes high, and if a south pole passes the sensor, the sensor output goes low. The two Hall Sensors are mounted symmetrically in the stator of the Spindle Motor. If the poles of the permanent magnet in the rotor would also be symmetrical, both Hall Sensors would generate identical signals. However south pole S2 is slightly asymmetrical so that the sensor output goes low at least 100 microseconds earlier than nominal.

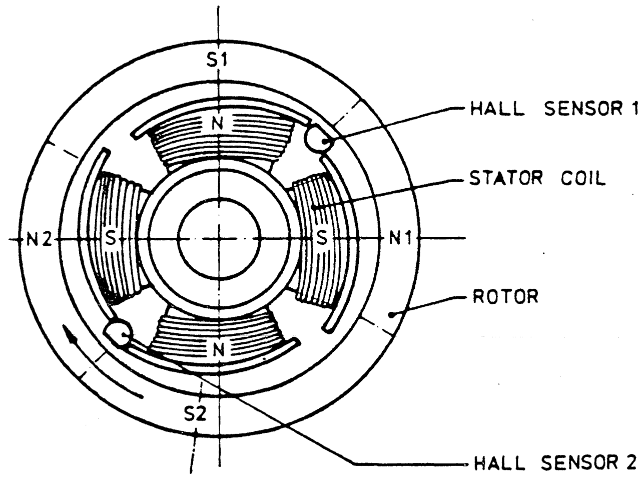


FIGURE 3 - 12 : SPINDLE MOTOR POLARITIES

Hall Sensor 1 output DM CTL PLS1/ is connected to the Reset/ input 13 of one-shot IC4 enabling the one-shot when the signal is high. The output of Hall Sensor 2 DM CTL PLS2/ is connected to the inverting trigger input 11 of the one-shot. The low going edge of DM CTL PLS2/ at 0 degree occurs when the Reset/ signal is high allowing the one-shot to be triggered and a 200 microsecond pulse DM INDEX/ to be generated. The DM INDEX/ pulse may be shorter than 200 microseconds but not shorter than 100 microseconds if the displacement of south pole S2 is less than 200 microseconds. In such case the one-shot is cleared through the Reset/ input 13 by the low state of DM CTL PLS1/. At 180 degree the Reset/ signal is low at the time of the low going edge of DM CTL PLS2/ disabling the triggering of the one-shot.

The two Hall Sensor output signals are ORed through diodes D3 and D4 to become the signal DM CTL PLS/ which is used for the commutation of the Spindle Motor (see figure 3-18). The index pulse DM INDEX is used for the speed control (connector "G" to figure 3-16). The inverted pulse DM INDEX/ is connected to the inverting trigger input 5 of the 10 microsecond one-shot 6J. Output 6 is gated with BUF SEL COMP and amplified with a line driver to become the interface signal INDEX/.

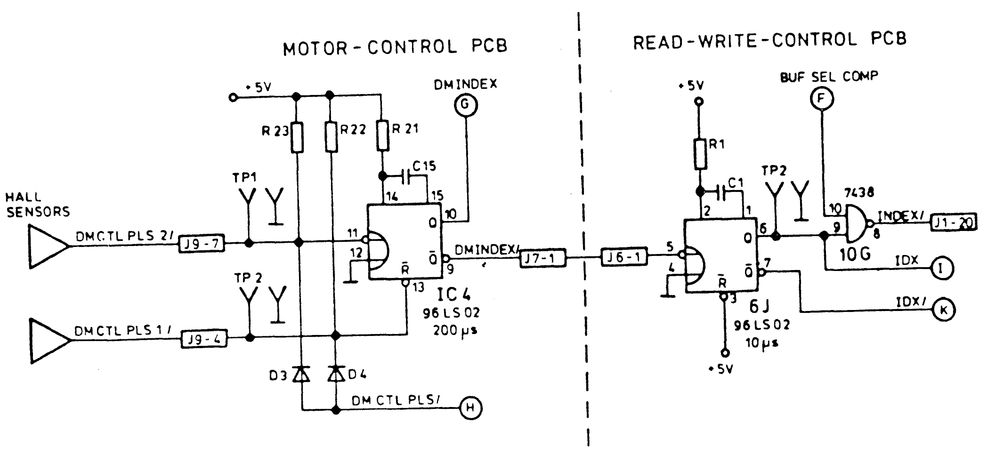


FIGURE 3 - 13 : INDEX GENERATION LOGIC

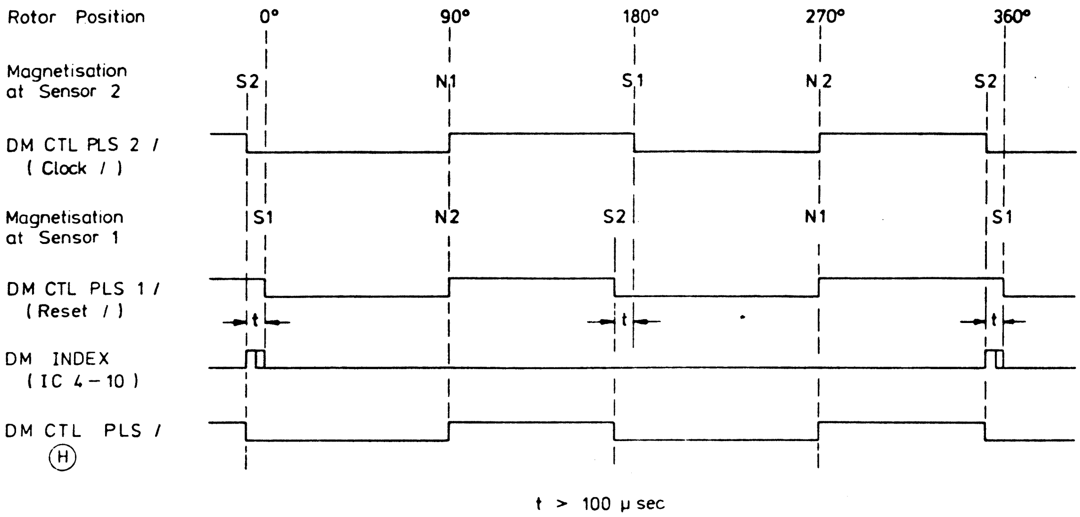


FIGURE 3 - 14 : INDEX GENERATION TIMING

3.3.5. SPINDLE MOTOR CONTROL

The Spindle Motor control circuit is divided into three parts, the Motor On Control (figure 3-15), the Speed Control (figures 3-16 and 3-17), and the Commutation (figure 3-18).

3.3.5.1. MOTOR ON CONTROL

The Spindle Motor of the BASF 6180 may be started in two different ways, either as soon as power is provided to the drive or with the first active going edge of the Drive Select signal corresponding to that drive. The second method is preferrable for multiple drive systems. It allows to sequence the start of the Spindle Motors in order to avoid that the high starting current of all drives coincide.

Spindle motor start with Power On is achieved when option switch S6 is closed and S5 is open. S6 permanently connects the Set/ input 10 of flip-flop 10J

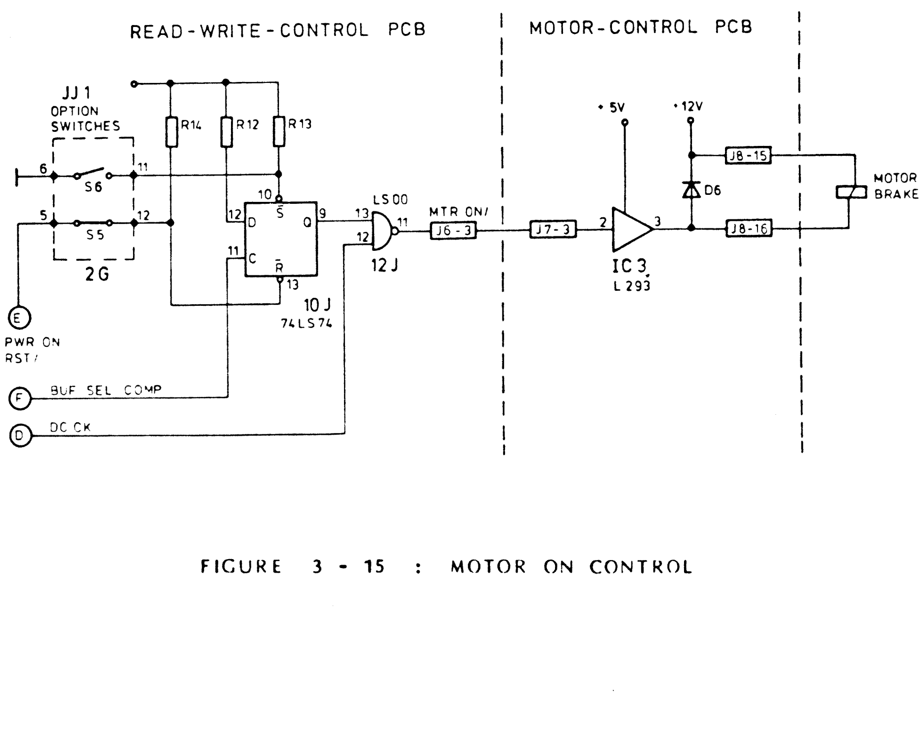


FIGURE 3 - 15 : MOTOR ON CONTROL

to ground forcing the Q output 9 to go high. When the signal DC OK is high active, the signal MTR ON/ goes low active. This turns on driver IC3 (output 3 going low), energizes the solenoid of the motor brake, and disengages the brake. The active state of the MTR ON/ signal also starts the Spindle Motor (see figure 3-16).

To allow sequencing of the Spindle Motor start under control of the Drive Select signals option switch S6 must be open and S5 must be closed. This connects PWR ON RST/ to the Reset/ input 13 of flip-flop 10J, causing the Q output 9 to go low on Power On, disabling the start of the Spindle Motor. The first active going edge of the Drive Select signal corresponding with the drive's address results in a high going edge of BUF SEL COMP at the Clock input 11 of flip-flop 10J. This edge, together with the D input 12 being permanently high, sets the flip-flop and causes the motor to start and the brake to disengage.

3.3.5.2. SPEED CONTROL

The function of the speed control circuit is to maintain the Spindle Motor speed within the required tolerance independent of load, temperature and supply voltage variations. The time between index pulses DM INDEX which is nominally 16.67 milliseconds is used as a measure for the actual motor speed. If the time is too long which means that the motor is too slow, more power is provided to the motor for acceleration. If in the opposite case the time is too short which means a too high motor speed, the power to the motor is reduced which results in a deceleration.

The whole speed control circuit is supplied with a stabilized voltage of 6.2 Volts generated with R9 and Zener-Diode D2 and filtered with C5.

The 200 microseconds wide index pulse DM INDEX (see (G) in figure 3-13) is first differentiated with C1 and R2. The high going, leading edge of DM INDEX results in a positive spike at the base of T1 which turns on T1 and causes an almost instantaneous discharge of C2 through the low resistance collector-emitter path of T1. The negative spike at the trailing edge of DM INDEX has of course no effect.

Between two index pulses C2 is charged with a time constant T=C2•(R3+R5) where R3 is the speed adjustment potentiometer. As soon as the voltage at C2 exceeds the threshold of about 4 Volts, defined by the voltage divider R4 and R6, the output 1 of comparator IC 7 goes low. At nominal speed it remains low typically for about 240 microseconds before the next index pulse causes the discharge of C2 resulting in IC7-1 to go high again. If the motor is too slow and the time between index pulses is too long, than the time at which IC7-1 is low is longer than at nominal speed. In the opposite case where the motor is too fast resulting in a shorter time between index pulses, the low time of IC7-1 is shorter than at nominal speed. If the speed further increases IC7-1 does not at all go low because C2 is already discharged before its voltage would reach the threshold voltage. The length of the low going pulse at IC7-1 therefore is a direct measure for the speed error.

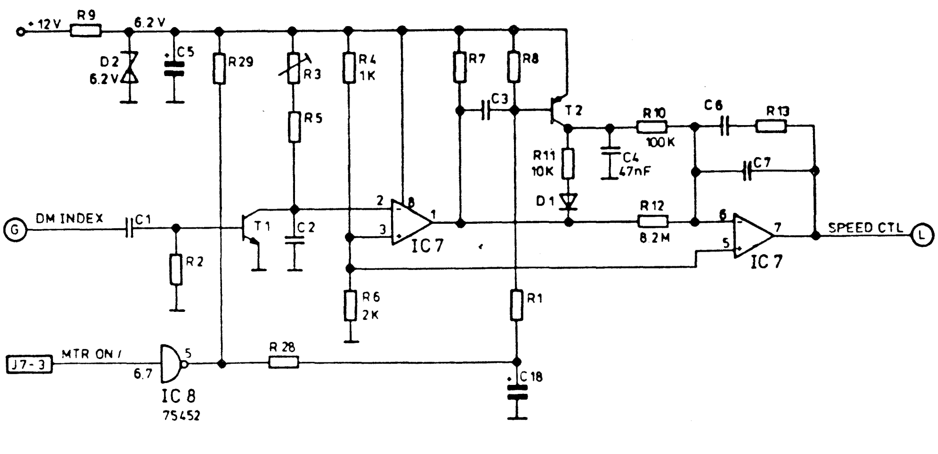


FIGURE 3 - 16 : SPEED CONTROL CIRCUIT

As next function the output signal of IC7-1 is differentiated through C3 and R8. The low going edge of IC7-1 causes a negative spike at the base of T2 which turns on T2. The low resistance emitter-collector path of T2 causes an almost immediate charging of C4 to 6.2 Volts. When C3 is discharged through R8 transistor T2 turns off. C4 is discharged through R11 and D1 as long as IC7-1 is low. The resulting voltage at C4, which remains at the same level for the rest of the revolution until the next index pulse, depends on the time that IC7-1 is low. Like the length of the low time of IC 7-1, the voltage at C4 is now also a direct measure for the speed error. The polarity is such that a too slow speed causes a lower voltage and a too high speed causes a higher voltage at C4.

The voltage at C4 is then fed through R10 to IC7-6. This operational amplifier works as an integrator in order to smoothen the signal at the time when C4 is charged. Since the input signal is fed to the inverting input 6, the signal SPEED CTL (output IC7-7) has the opposite polarity then IC7-6. The signal SPEED CTL is lower than nominal for a too high speed and is higher than nominal for a too low speed. This causes the Spindle Motor to decelerate or accelerate respectively in order to derive nominal speed.

Three special cases must be explained for the speed control circuit:

1.) If the MTR ON/ signal is high inactive, output IC8-5 goes low. This turns on T2 permanently resulting in SPEED CTL to become zero volts which stops the Spindle Motor.

2.) When the MTR ON/ signal goes low active the open collector output IC8-5 goes high enabling the normal function of the speed control. During the start up time of the Spindle Motor the time between the index pulses is very long. This allows very long low times at IC7-1, very long discharge times for C4, and low voltage levels at C4. This low level integrated over a long period forces the operational amplifier into saturation which causes a high voltage level of SPEED CTL for maximum acceleration.

3.) The function of R12 is to prevent a motor runaway. At very high speeds C4 is never charged to 6.2 Volts. Without R12 capacitor C4 would slowly discharge through the input resistance of IC7-6 to 0 Volts. This would cause that the speed control signal would go high and even further accelerate the motor. The complete circuit would latch at the maximum possible motor speed. R12 prevents that possibility.

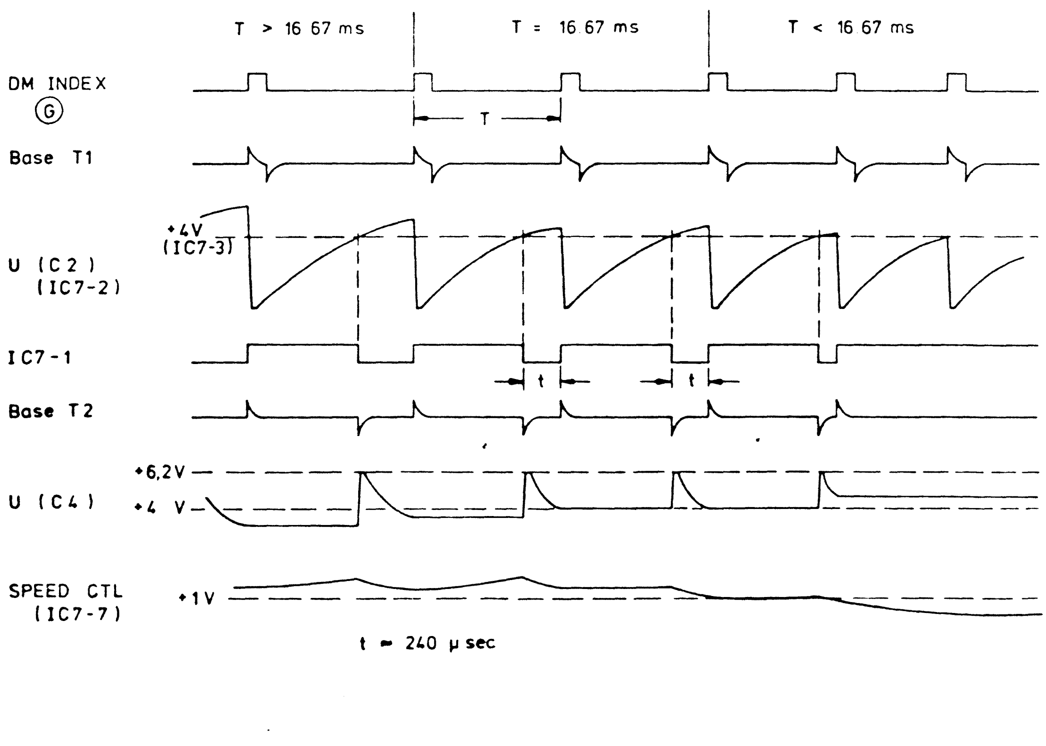


FIGURE 3 - 17 : SPEED CONTROL TIMING

3.3.5.3. COMMUTATION

The purpose of the circuit shown in figure 3-18 is to drive the current through the coils of the Spindle Motor and to control its direction and amount.

The Spindle Motor has a bifilar winding on each of its four stator poles (see figure 3-12). The four windings are connected in series in such a way that adjacent poles have opposite magnetic polarity. The center tap of the resulting winding is connected to +12 Volts. The other ends are the lines A COIL ACTIVE/ and B COIL ACTIVE/. Grounding alternatively either one of the two lines causes the magnetic flux through the poles to be reversed. The proper timing for the flux reversal, the commutation, is controlled by the signal DM CTL PLS/ which is generated by the Hall Sensors.

DM CTL PLS/ is a digital signal. If it is high, darlington transistor T7 is enabled and T3 is turned off disabling T6. If DM CTL PLS/ is low, T7 is disabled and transistor T3 is turned on enabling T6.

The amount of current which determines the speed of the motor is controlled by the analog signal SPEED CTL. The lower the voltage of SPEED CTL the more current draws the (PNP!) transistors T4 or T5 away from the darlington transistors T6 or T7 respectively, resulting in a lower current through the motor and the desired deceleration. If SPEED CTL is higher T4/T5 draw away less current, resulting in a higher current through the Spindle Motor and an acceleration.

3.3.6. SPEED MONITORING

The Speed Monitoring circuit determines when the Spindle Motor has reached full speed after Power On and detects an excessive drop in the Spindle Motor speed during normal operation. The speed monitoring circuit is completely located on the Read-Write-Control PCB and is shown in figure 3-19. The timing is shown in figure 3-20.

The internal index signals IDX and IDX/ (see (I) in figure 3-13) are used as a reference for the spindle speed. At nominal speed the time between two index pulses is 16.67 milliseconds.

The low active index pulse IDX/ is connected to the inverting trigger input 11 of the 17.5 milliseconds retriggerable one-shot 8J. If the time between index pulses is greater than 17.5 milliseconds (i.e. the Spindle Motor is too slow), the Q output 10 of one-shot 8J goes high with the leading edge of index for 17.5 milliseconds. After that time it goes low until the next index pulse. If the time between the index pulses is shorter than 17.5 milliseconds (i.e. correct speed), the one-shot is always retriggered before its time is elapsed and therefore the Q output stays permanently high. The Q output 10 is connected to the Reset/ inputs 3 of one-shot 8J and 1 of flip-flop 10J.

The second one-shot is triggered on its inverting input 5 with a delayed index signal. This delay is required to allow the Reset signal to go high inactive before the

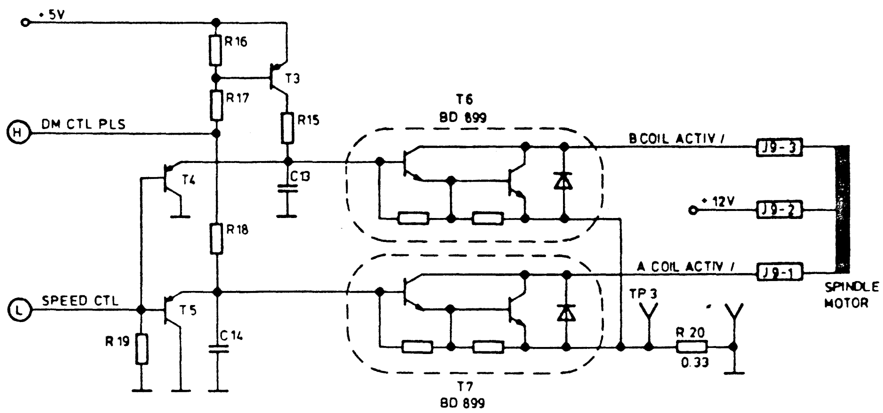


FIGURE 3 - 18 : SPINDLE MOTOR COMMUTATION

one-shot is triggered. As long as the Q output 6 is high, retriggering of the one-shot is disabled due to the connection of the Q output 6 to the non-inverting input 4. A high going edge of the Q/ output 7 sets the flip-flop through the Clock input 3 with the D input being permanently high, provided the Reset signal is not active.

If the motor speed is too slow, the low active Reset pulses at 8J3 and 10J1 prevents that the Speed signal can go high active. When the time between index pulses becomes shorter than 17.5 milliseconds, the Reset signals stay high inactive enabling the one-shot to stay active for its full delay time of 2.2 seconds. If this time is elapsed the Q/ output 7 of one-shot 8J goes high inactive setting the Q output 5 of flip-flop 10J which is the SPEED signal to a high active state.

The SPEED signal is gated with REZERO/ and BUF SEL COMP to become GTD SPEED. This signal is gated again with BUF SEL COMP and amplified with a line driver to become the READY/ signal. Therefore READY/ indicates that the Spindle Motor is at full speed, the automatic rezero (if enabled) has been completed, and the drive is selected.

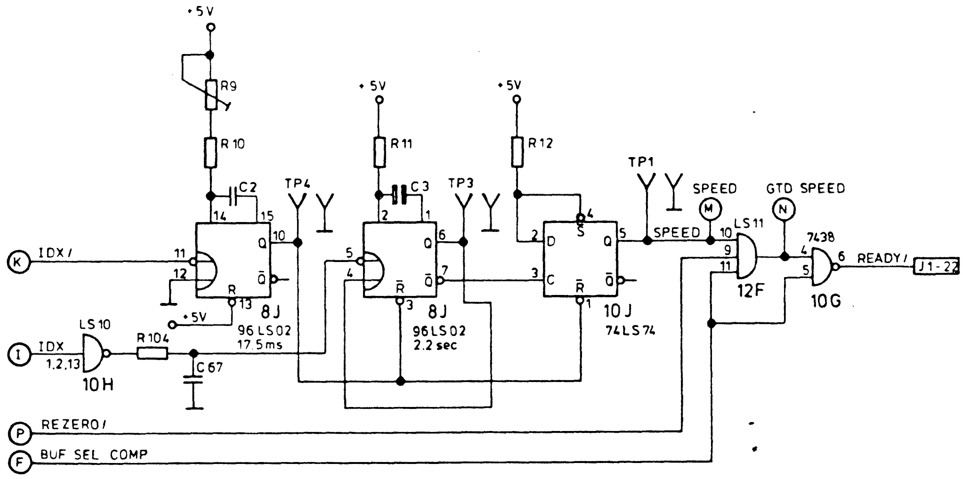


FIGURE 3 - 19 : SPEED MONITORING CIRCUIT

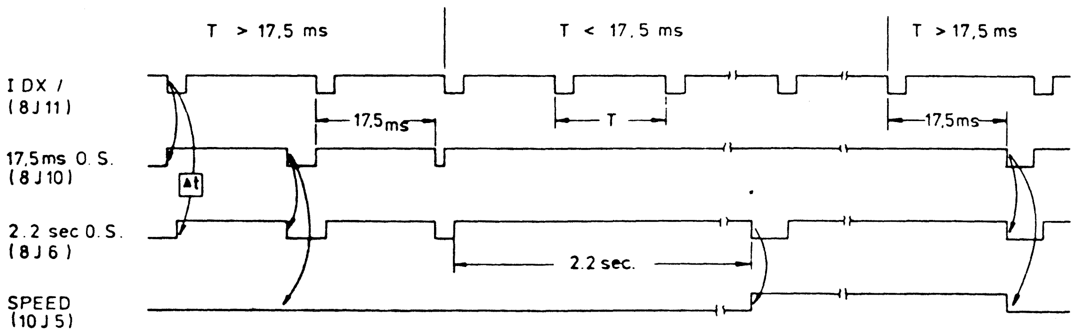


FIGURE 3 - 20 : SPEED MONITORING TIMING

3.3.7. TRACK 0 DETECTION

The Track 0 detection is required as an absolute reference for head positioning. The mechanical position is sensed with a Light Gate which is mounted on the Stepper Motor and then analysed by a circuit which is located on the Read-Write-Control PCB and shown in figure 3-21.

If the heads are positioned at Track 0, the Shutter has entered the Light Gate and disables the flow of light. This turns off the phototransistor and raises input 9 and output 14 of comparator 2H to the high active level. When the heads are positioned away from Track 0, the Shutter leaves the Light Gate allowing the light flow to turn on the phototransistor. Input 2H9 and output 2H14 now go low.

Because of mechanical and electrical tolerances and the hysterisis imposed by R7, the signal 2H14 does not always switch precisely between tracks 0 and 1. It is therefore gated with the signal DECCNT (see figure 3-22). The signal DECCNT is active only every ten tracks (i.e. at 0, 10, 20, etc) and inactive at all other tracks. The resulting signal TRK0 is therefore active only at Track 0 and inactive at all other tracks.

The TRK0 signal is gated with BUF SEL COMP and amplified with a line driver to become the interface signal TRACK 0/.

3.3.8. STEPPER MOTOR CONTROL

The Stepper Motor Control Logic controls the head positioning and drives the Stepper Motor. The logic diagrams for the Stepper Motor Control consists of two diagrams: the Control Logic and the Driver Circuits.

3.3.8.1. CONTROL LOGIC

The Stepper Motor Control Logic is shown in figure 3-22.

The main control signals for the positioning are the interface signals DIR IN/ and STEP/. If DIR IN/ is low active, the heads are moved with each pulse on the STEP/ signal to the next track in inwards direction (i.e. towards the center of the disks or to higher track numbers). If DIR IN/ is high inactive, the step pulses move the heads in the opposite direction. Both signals are terminated with the resistor pack 2F installed in the last drive on the A-cable and are buffered with inverters with Schmitt-trigger inputs. The STEP signal is then gated with BUF SEL COMP to ensure that the drive positions the heads only when it is selected.

A special feature of the BASF 6180 is the possibility to perform an automatic rezero function after Power On. To enable this feature option switch 7 must be

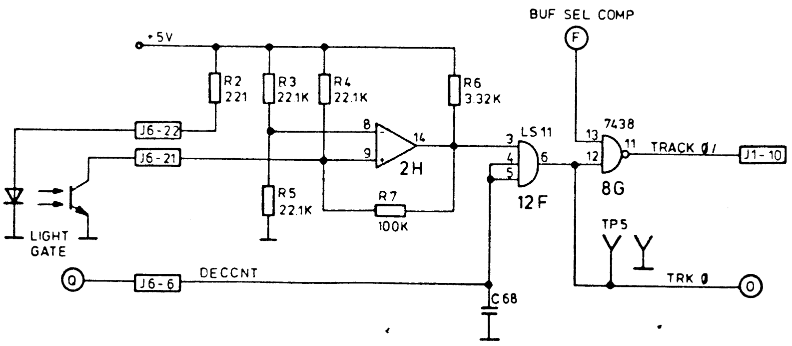


FIGURE 3 - 21 : TRACK 0 DETECTION

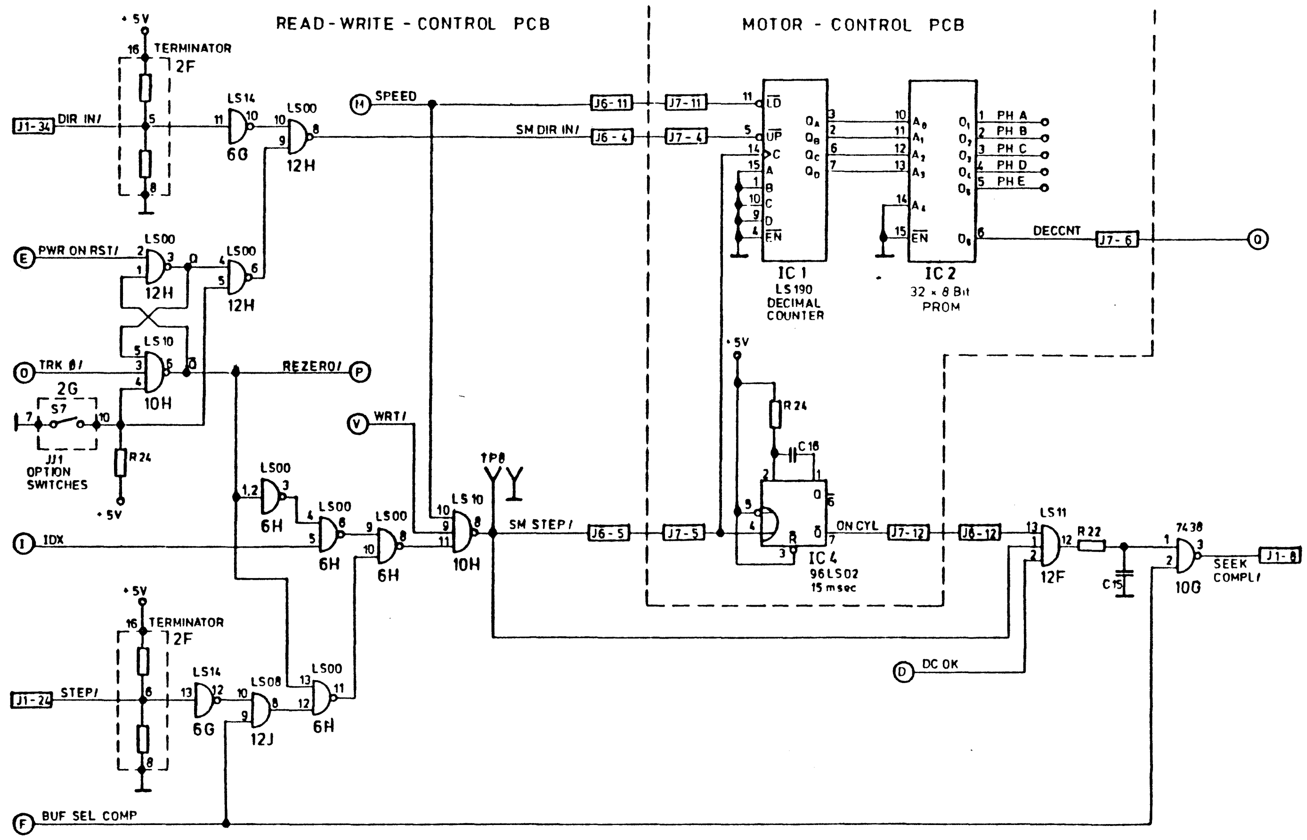


FIGURE 3 - 22 : STEPPER MOTOR CONTROL LOGIC

open. The signal PWR ON RST/ then sets the REZERO flip-flop Q output 12H3 to a high state and accordingly the Q/ output 10H6 to a low state (provided the drive is not already positioned at Track 0). Q output 12H3 is gated with the switch output and is then connected to input 9 of NAND gate 12H. This gate forces the signal SM DIR IN/ to a high inactive state in order to position the heads during the automatic rezero in the outwards direction as required. The Q/ output 6 of flip-flop 10H (REZERO/) disables the interface STEP signal through gate 6H13 and enables the index signal through gate 6H4 to become the source of the step signals for the automatic rezero. The positioning actually starts when the SM STEP/ pulses are enabled after the Spindle Motor has reached full speed (SPEED = 10H10 going high) and provided the controller does not attempt to write (WRT/ = 10H9 being high inactive).

As soon as the heads reach Track 0, the REZERO flip-flop is reset through 10H3. This disables the index as source for the step pulses and enables the interface signals DIR IN/ to become SM DIR IN/ and STEP/ to become SM STEP/ for normal operation. Through connector (P) to gate 12F9 (figure 3-19) the signals GTD SPEED and READY/ is now enabled.

If option switch S7 is closed, the REZERO FF is held reset which disables the automatic rezero.

The circuit on the lower right hand part of figure 3-22 is used to generate the interface signal SEEK COMPL/. If this signal is low active the drive has completed a seek and the controller is allowed to read or write. During the seek and including the head settling time, it is high inactive. According to the interface specification the SEEK COMPL/ signal must go

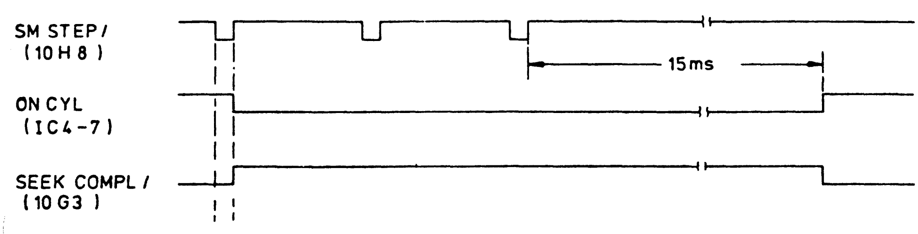


FIGURE 3 - 23 : SEEK TIMING

high with the leading edge of the STEP pulse. However, the positioning is triggered with the trailing edge of the STEP pulse. Therefore the length of time for which SEEK COMPL/ goes high (15 milliseconds for the BASF 6180) starts also with the trailing edge of the STEP pulse. For a multitrack seek SEEK COMPL/ must go high inactive with the leading edge of the first step pulse and must stay high until 15 milliseconds after the trailing edge of the last step pulse as shown in figure 3-23. This signal is generated by ORing the SM STEP/ signal and output 7 of the 15 milliseconds retriggerable one-shot IC4 with gate 12F inputs 1 and 13. Because of the delay time of the one-shot there can be a short spike between the trailing edge of SM STEP/ (12F1) and the leading edge of ON CYL/ (12F12). This spike is suppressed by R22 and C15. The resulting signal is gated with BUF SEL COMP and amplified with a line driver to become the interface signal SEEK COMPL/.

The upper right hand part of figure 3-22 shows the generation of the phase signals PH A through PH E that control the motion of the Stepper Motor. The SM STEP/ signal is connected to the Clock input 14 of the decimal up/down counter IC1. The SM DIR IN/ signal is connected to the UP/ input 5 of the counter to control whether the counter is counting up or down corresponding to a forward or backward motion of the Stepper Motor. The SPEED signal is connected to the LOAD/ input 11 of the counter. When the Spindle Motor is not at full speed and SPEED is low inactive the counter is disabled and reset by loading all zeroes.

STATE NO.	Spare O8	Spare O7	DECCNT O6	Phase E O5	D O4	C O3	B O2	A O1	PROM ADDR (hex)	DATA (hex)
0	L	L	H	H	L	H	L	H	00	35
1	L	L	L	H	L	H	L	L	01	14
2	L	L	L	H	L	H	H	L	02	16
3	L	L	L	H	L	L	H	L	03	12
4	L	L	L	H	H	L	H	L	04	1A
5	L	L	L	L	H	L	H	L	05	0A
6	L	L	L	L	H	L	H	H	06	0B
7	L	L	L	L	H	L	L	H	07	09
8	L	L	L	L	H	H	L	H	08	0D
9	L	L	L	L	L	H	L	H	09	05

TABLE 3 - 1 : PROM ENCODING

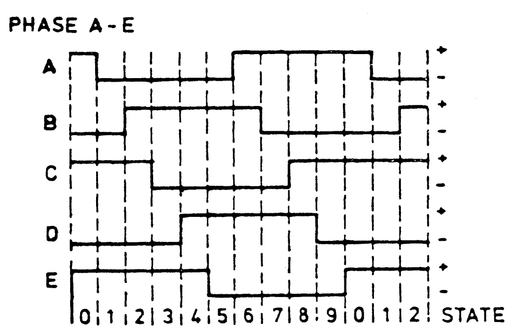


FIGURE 3 - 24 :
STEPPER MOTOR TIMING

The outputs of the counter are connected to the address lines of a 32*8 bit PROM. The PROM encodes the ten decimal input states (0 through 9) into the required states of the phase signals. It also generates the DECCNT signal which is high active only in state 0. The encoding of the PROM is shown in table 3-1 and the resulting timing of the phase signals for a forward seek is shown in figure 3-24.

3.3.8.2. STEPPER MOTOR DRIVERS

The Stepper Motor Drivers are shown in figure 3-26.

The phase signals are amplified with the push-pull drivers IC 3 and IC 5 to drive the 5 coils of the Stepper Motor. The drivers are enabled with the SPEED signal. The diode network IC6 is used for clamping off the pulses induced by the counter EMF when switching off individual coils.

The wiring of the five coils of the Stepper Motor and the resulting currents for state 5, as an example, are shown in figure 3-25.

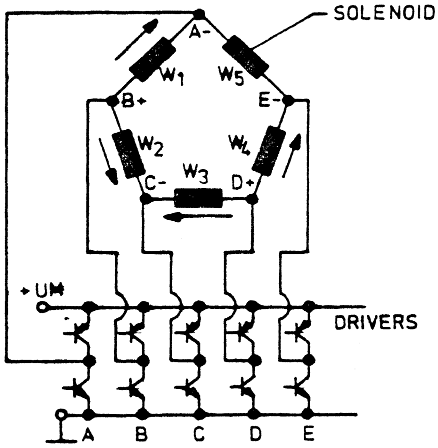


FIGURE 3 - 25 :
STEPPER MOTOR POLARITIES

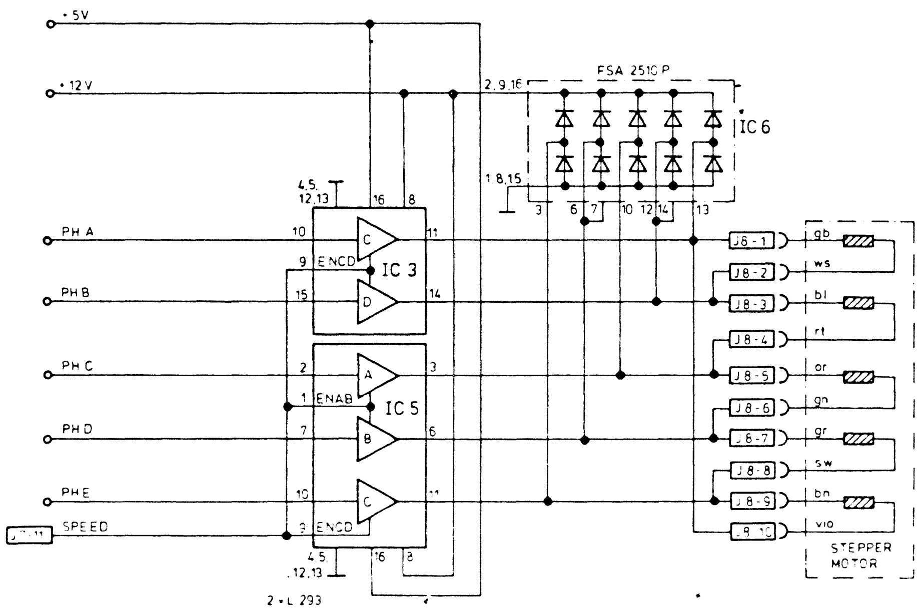


FIGURE 3 - 26 : STEPPER MOTOR DRIVERS

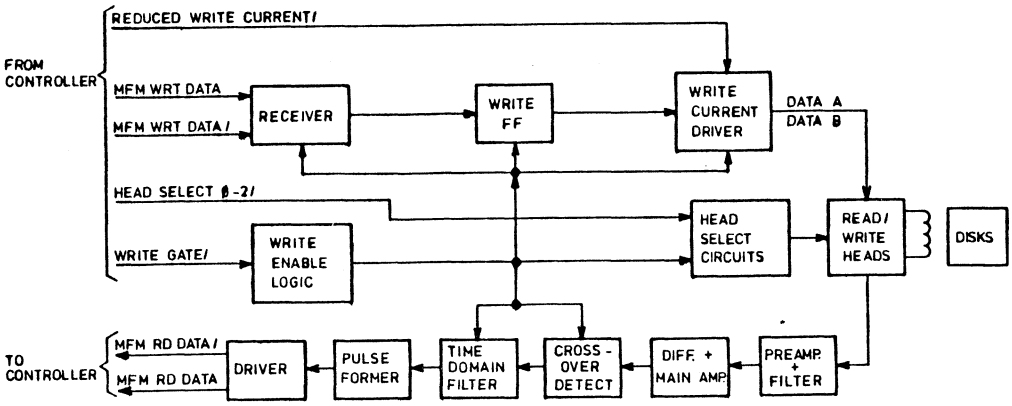


FIGURE 3 - 27 : READ/WRITE CIRCUIT BLOCK DIAGRAM

3.3.9. READ/WRITE OPERATION

Recording of data onto the disks and the reading of data from the disks is controlled by the Read/Write Circuits. A block diagram of the Read/Write Circuits is shown in figure 3-27.

To perform writing on a selected drive, the Host Control Unit must select the desired head (see 3.3.11.), set WRITE GATE/ to a low active state, and transmit the write data across the differential MFM WRT DATA lines. The BASF 6180 is designed to record data in MFM encoded form, however, all the formatting and encoding must be done in the Host Control Unit. The drive just converts each pulse on the MFM WRT DATA lines into a flux reversal on the disk. In this way the BASF 6180 is completely transparent to the recorded data allowing maximum flexibility in the Host System design.

If the WRITE GATE/ signal is high inactive, the drive reads the data with the selected head and transmits it across the differential MFM RD DATA lines. Each flux reversal on the disk is converted back into a pulse on the MFM RD DATA lines. Thus the same pulse pattern that has been transmitted to the drive during a write operation is returned to the Host System during a read operation. Then the Host System has to perform the data separation, MFM decoding, and the retrieval of the actual data.

The nominal transfer rate of the BASF 6180 is 5 Mbits/sec. With the MFM recording this is equivalent to a spacing between two flux reversals on the disks or data pulses on the interfaces lines of 200, 300, or 400 nanoseconds nominal. The resulting maximum flux density is 7690 fci at track 152 (BASF 6182 and 6183) or 9332 fci at track 229 (BASF 6184).

3.3.10. READ/WRITE HEADS

Each head of the BASF 6180 has two coils with a center tap. The coils are wound in a bifilar way on a single core.

During a write operation the write current flows through one of the two coils causing the magnetic flux through the head and the disk surface in one direction. Switching the write current to flow through the other coil causes the magnetic flux in the opposite direction. The disk that passes the head gap is magnetized in the direction of the magnetic flux at this moment. At the time when the write current is switched from one coil to the other, a flux reversal results in the magnetization on the disk.

During reading, each flux reversal passing the head gap induces a voltage into the Read/Write Head. The output signal of both coils of the Head is used differentially. This Read Signal is then amplified and digitized.

3.3.11. HEAD SELECTION

The Head Select logic is shown in figure 3-28. Except for the diode network which is mounted on the flex cable within the HDA, the Head Select logic is located on the Read-Write-Control PCB.

The Head Selection is explained for the BASF 6183 and 6184 which have six heads. The function for the 6182 is exactly the same except that heads 4 and 5 do not exist.

The Head Selection is basically achieved with the diodes shown at the right hand side of figure 3-28. The select signal (SEL 0/ to SEL 5/) of the head to be selected is made low enough compared to DATA A and DATA B so that the diodes connected to that head are forward biased and conducting. The select signals of all other heads are higher than DATA A and DATA B so that the diodes connected to those heads are reverse biased and non-conducting.

For writing, the select signal for the selected head is switched to Ground. For reading, the select signal is switched through a voltage divider to about 5 Volts. The select signal for all unselected heads is about 10 Volts.

The Head Selection and the generation of the necessary voltages for the select signals is accomplished by a BCD to decimal decoder and a resistor network. Two IC;s 7445 (2B and 4B) are cascaded to provide the required twelve output signals of the decoder.

The WRT ENA signal is connected to the A input (least significant position) of the BCD to decimal decoder.

If WRT ENA is low inactive which is equivalent to the read mode, one of the even numbered outputs (0 - 7) is switched to Ground. The voltage of the corresponding select signal is equal to the voltage drop across the 392 Ohms resistor (R51 to R56) which is about 5 Volts. If WRT ENA is high active which is equivalent

HD SEL 2/	HD SEL 1/	HD SEL 0/	WRT ENA	LOW OUTPUT	HEAD SELECTED	MODE
H	H	H	L	2B-0	0	READ
H	H	H	H	2B-1	0	WRITE
H	H	L	L	2B-2	1	READ
H	H	L	H	2B-3	1	WRITE
H	L	H	L	2B-4	2	READ
H	L	H	H	2B-5	2	WRITE
H	L	L	L	2B-6	3	READ
H	L	L	H	2B-7	3	WRITE
L	H	H	L	4B-0	4	READ
L	H	H	H	4B-1	4	WRITE
L	H	L	L	4B-2	5	READ
L	H	L	H	4B-3	5	WRITE
L	L	x	x		none	

TABLE 3 - 2 : HEAD SELECT DECODING

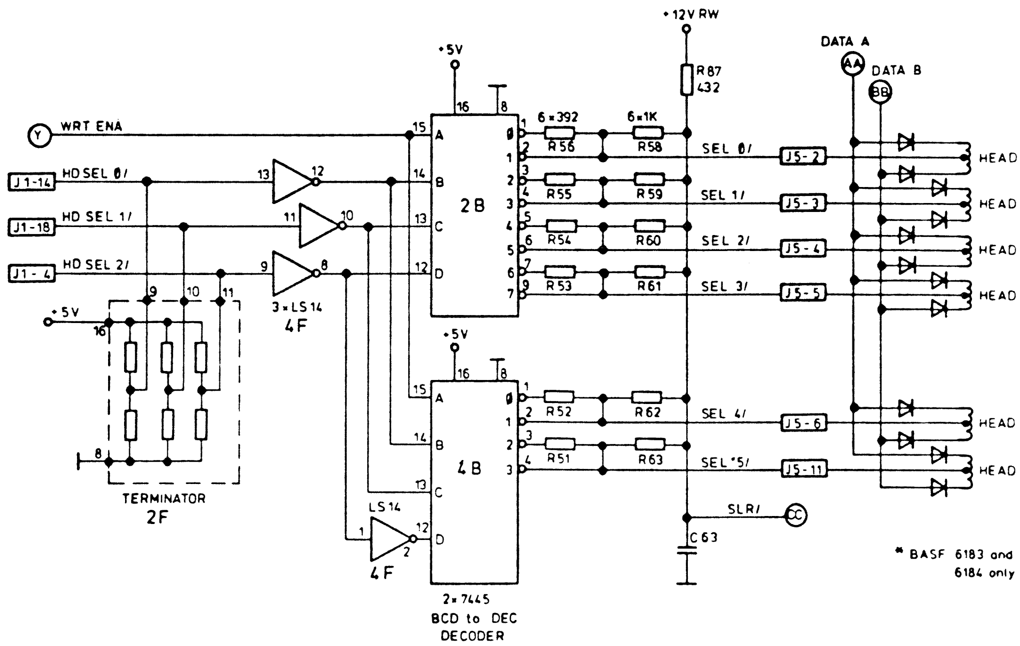


FIGURE 3 - 28 : READ/WRITE HEADS AND HEAD SELECTION

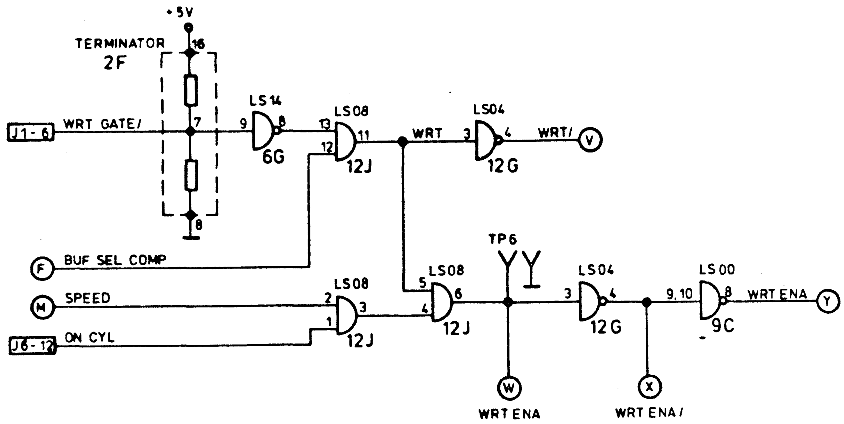


FIGURE 3 - 29 : WRITE ENABLE LOGIC

to the write mode, one of the odd numbered outputs and with it that select signal is switched to Ground.

The three interface Head Select signals (HD SEL 0 to 2) are connected to the inputs B to D of the BCD to decimal decoder. The Head Address signals together with the WRT ENA signal are decoded according to Table 3-2 in order to select the desired head and operating mode.

The signal SLR/ (see figure 3-28) is used to detect if two or more heads are selected simultaneously because of a hardware malfunction. In such case the voltage drop across R87 would be greater than normal which would be detected by a comparator in the Write Fault Logic.

3.3.12. WRITE CIRCUITS

The function of the Write Circuits is to control and monitor the recording of data onto the disks. The Write Circuits are completely located on the Read-Write-Control PCB. The schematics of the Write Circuits are divided into three parts: the Write Enable Logic, the Write-FF and Drivers, and the Write Fault Logic.

3.3.12.1. WRITE ENABLE LOGIC

The Write Enable Logic is shown in figure 3-29. Its function is to check all conditions for a valid write operation. Writing is enabled by setting WRT ENA to a high active state if:

- The interface WRT GATE/ signal is low active.

- The drive is selected (BUF SEL COMP high active).

- The Spindle Motor is at full speed (SPEED high active).

- The drive is not seeking (ON CYL high active).

The signal WRT/ (connector V) is used to disable seeking during a write operation (see section 3.3.8.1.).

3.3.12.2. WRITE-FF AND DRIVERS

The Write-FF and the Write Drivers are shown in figure 3-30. This circuit controls the actual writing by providing the Write Current to the heads.

In addition to WRT ENA being high active two more conditions must be met in order to allow writing:

- The DC voltages must be within their specified tolerances (see section 3.3.2.2.). In this case the signal DC CONR/ pulls the base 13 of transistor 4D low to turn on the transistor.

- No Write Fault condition must exist (WFLT/ high inactive - see section 3.3.12.3.). WFLT/ is gated with WRT ENA using NAND gate 9C inputs 12 and 13. If no Write Fault exists and Writing is enabled 9C11 goes low. This low state has two consequences:

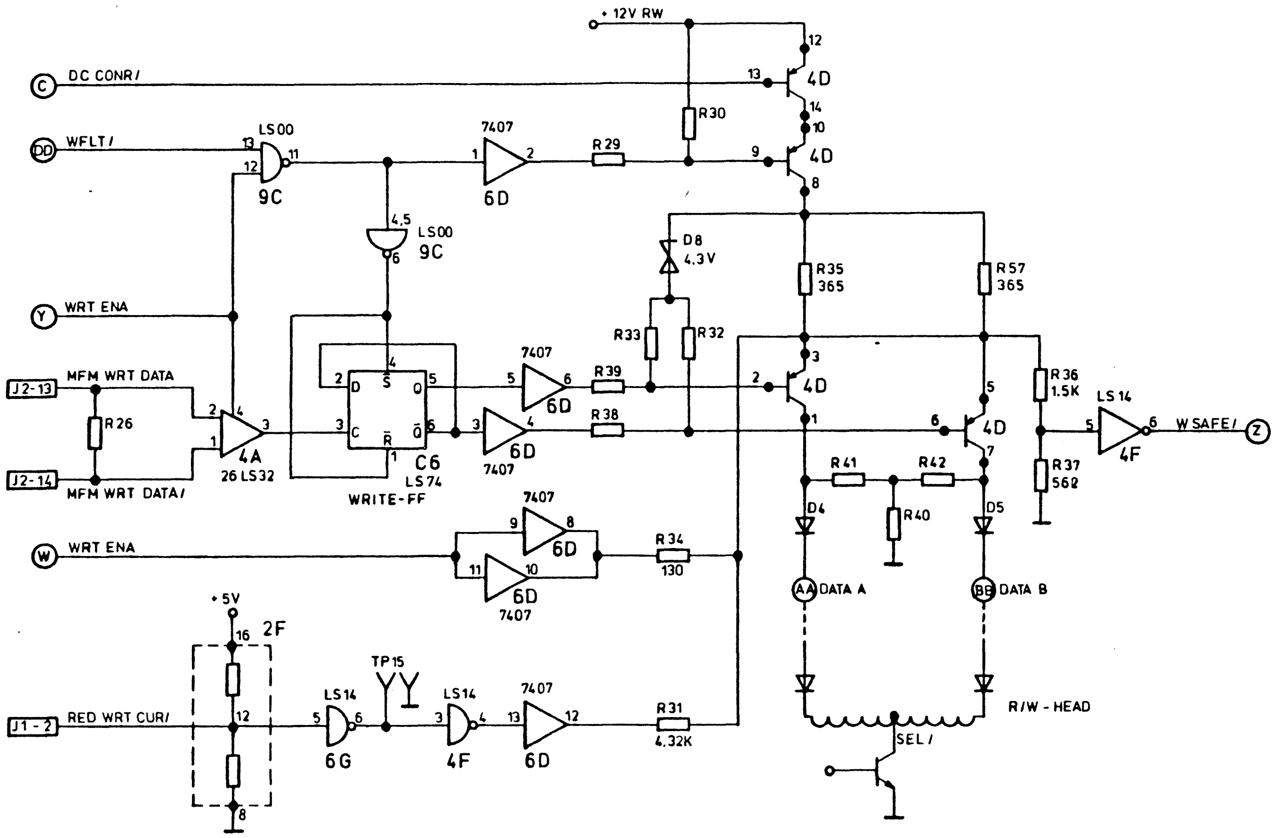


FIGURE 3 - 30 : WRITE-FF AND DRIVERS

a.) The output 2 of driver 6D goes low and pulls the base 9 of transistor 4D low, which turns on that transistor.

b.) The Set/ input 4 and the Reset/ input 1 of the Write-FF C6 go high inactive in order to allow normal operation of the flip-flop. If either a Write Fault condition exists or writing is not enabled, both the Set/ input and the Reset/ input of the Write-FF are low active. This causes that both the Q output 5 and the Q/ output 6 go high which causes that both Write Transistors 4D1-3 or 4D5-7 are turned off.

If writing is enabled as described above, the signal flow for the write information is as follows. The differential interface signal MFM WRT DATA is connected to the inputs 1 and 2 of receiver 4A. The output 3 of the receiver is connected to the Clock input 3 of the Write-FF C6. The D input 2 of the Write-FF is connected to the Q/ output 6. So each pulse on the MFM WRT DATA line toggles the Write-FF. In each state of the Write-FF one of the Write Transistors 4D1-3 or 4D5-7 is turned on while the other one is turned off. This causes the Write Current to flow through one of the two coils of the selected Read/Write Head. The transistor shown at the center tap of the coils is the output transistor of the BCD to decimal decoder for the selected head (see figure 3-28). The complete write function is now that each MFM WRT DATA pulse toggles the Write-FF which causes to switch the Write Current from one coil to the other resulting in a flux reversal as required.

The diodes D4 and D5 are used to isolate the Write Circuits from the Read/Write Heads during reading. When not writing the resistors R40 to R42 pull the anodes of D4 and D5 to Ground. DATA A and DATA B being positive during a read operation cause D4 and D5 to be reverse biased and non-conducting.

The two parallel drivers 6D outputs 8 and 10 are used to decrease the Write to Read Recovery Time. This is achieved by pulling the emitters 3 and 5 of the Write Transistors 4D to Ground when WRT ENA is switched from the active to the inactive state.

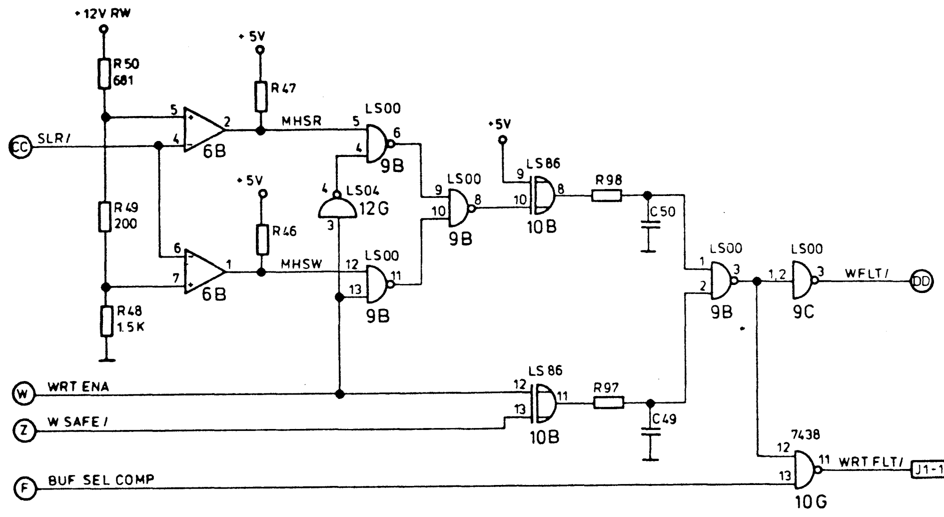


FIGURE 3 - 31 : WRITE FAULT LOGIC

The amount of Write Current is determined by the resistors R35 and R57. On cylinders equal to or greater than 128 the Host System must set the RED WRT CUR/ signal to a low active state. This causes that R31 is switched in parallel to the heads resulting in a reduction of the Write Current. The reduction of the Write Current is required to increase the read voltage of high frequency signals at the inner tracks.

The signal WSAFE/ monitors if the Write Current is enabled, so that writing actually can take place. During writing the collector 8 of transistor 4D is high. This pulls the input 5 of inverter 4F high which causes WSAFE/ to go low active. If one or both of the transistors is turned off which disables the Write Current, then 4F5 goes low and WSAFE/ goes high inactive.

3.3.12.3. WRITE FAULT LOGIC

The Write Fault Logic (figure 3-31) checks for any condition that could cause improper writing. Any one of the following conditions are considered as a Write Fault and cause the WFLT/ signal to go low inactive.

a.) Multiple heads (two or more) selected during writing.

b.) Multiple heads selected during reading.

c.) Writing enabled but Write Current not enabled.

d.) Writing disabled but Write Current enabled.

Multiple head selection is detected by monitoring the SLR/ signal (see section 3.3.11.).

If two or more heads are selected during a read operation, then the voltage of SLR/ goes below the threshold at 6B5 causing MHSR (6B2) to go high.

If two or more heads are selected during a write operation, then the voltage of SLR/ goes below the threshold at 6B7 causing MHSW (6B1) to go high.

MHSR is then gated with WRT ENA/ and MHSW is gated with WRT ENA and the two signals are ORed with gate 9B inputs 9 and 10.

The cases c.) and d.) are covered by an exclusive OR of WRT ENA and WSAFE/ with gate 10B inputs 12 and 13.

The two R/C networks R98/C50 and R97/C49 are used to suppress glitches that may occur during state transitions (e.g. when selecting a different head).

A short Write Fault is latched in the Write Fault Logic. To clear the Fault, Write Enable and/or Drive Select must be made inactive.

WFLT is gated with BUF SEL COMP and amplified with a line driver to become the interface signal WRT FLT/.

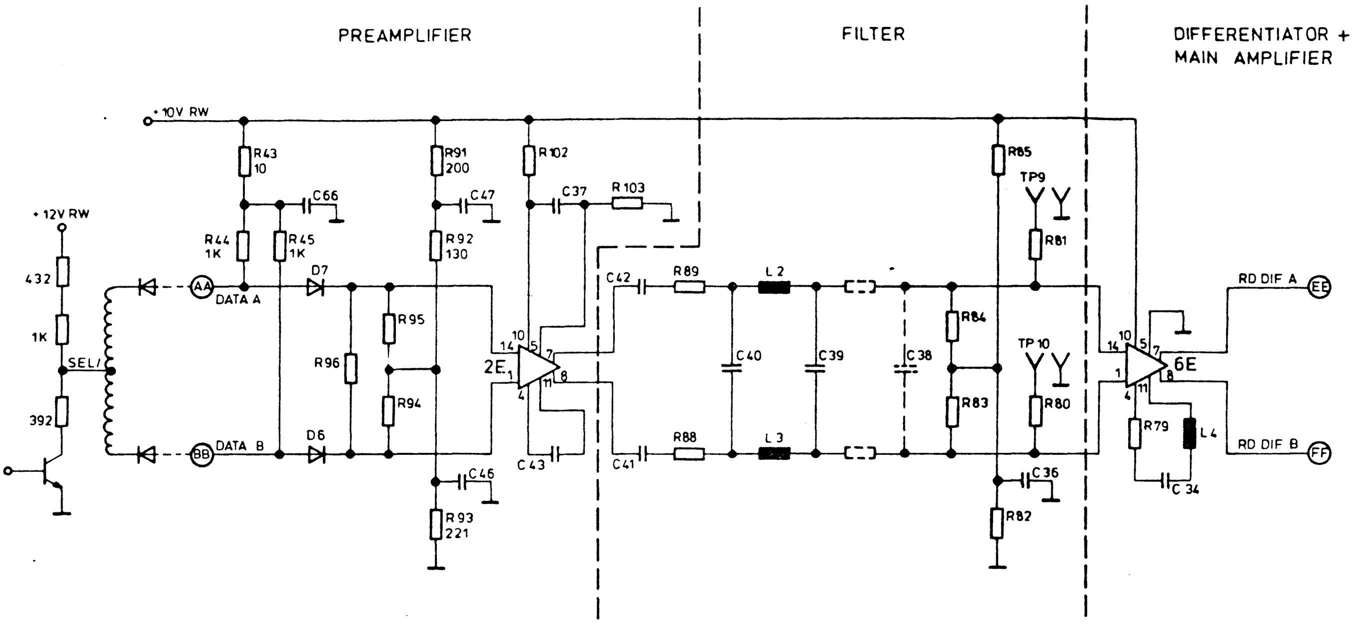


FIGURE 3 - 32 : READ AMPLIFIER

3.3.13. READ CIRCUITS

The function of the Read Circuits is to amplify and digitize the signals read from the disks. The Read Circuits are completely located on the Read-Write-Control PCB. The schematics are divided into two parts: the Read Amplifier and the Read Data Digitizer.

3.3.13.1. READ AMPLIFIER

The Read Amplifier is shown in figure 3-32. It consists of three functional blocks: the Preamplifier, the Filter, and the Differentiator and Main Amplifier.

On the left hand side of the schematics the Head Select Logic for the currently selected head is shown (see section 3.3.11.). The resistors R43 to R45 are used to forward bias the select diodes by making the signals DATA A and DATA B more positive than the SEL/ signal.

The diodes D6 and D7 are used to isolate and protect the Read Circuit from the Write Circuit during a write operation. In this case the cathodes of D6 and D7 are more positive than their anodes which are pulled towards Ground so that the diodes are reverse biased and non-conducting.

The differential read signal from the heads is amplified with the Preamplifier 2E. The output of the Preamplifier is AC-coupled through C41 and C42 to the low-pass filter consisting of R88, R89, C40, L2, L3, and C39. The purpose of the filter is to suppress high frequency noise on the read signal.

The Main Amplifier 6E further amplifies and differentiates the read signal. The differentiation is achieved by R79, C34, and L4. The read signal from the head has the maximum amplitude at the time when a flux reversal on the disk passes the head gap. The differentiation causes a 90 degree phase shift of the read signal which converts the maximum amplitude into a zero crossing. This is done because it is much easier and more reliable to detect zero crossings than it is to detect points of maximum amplitude.

3.3.13.2. READ DATA DIGITIZER

The Read Data Digitizer is shown in figure 3-33. It consists of four functional blocks: the Crossover Detector, the Time Domain Filter, the Pulse Former,

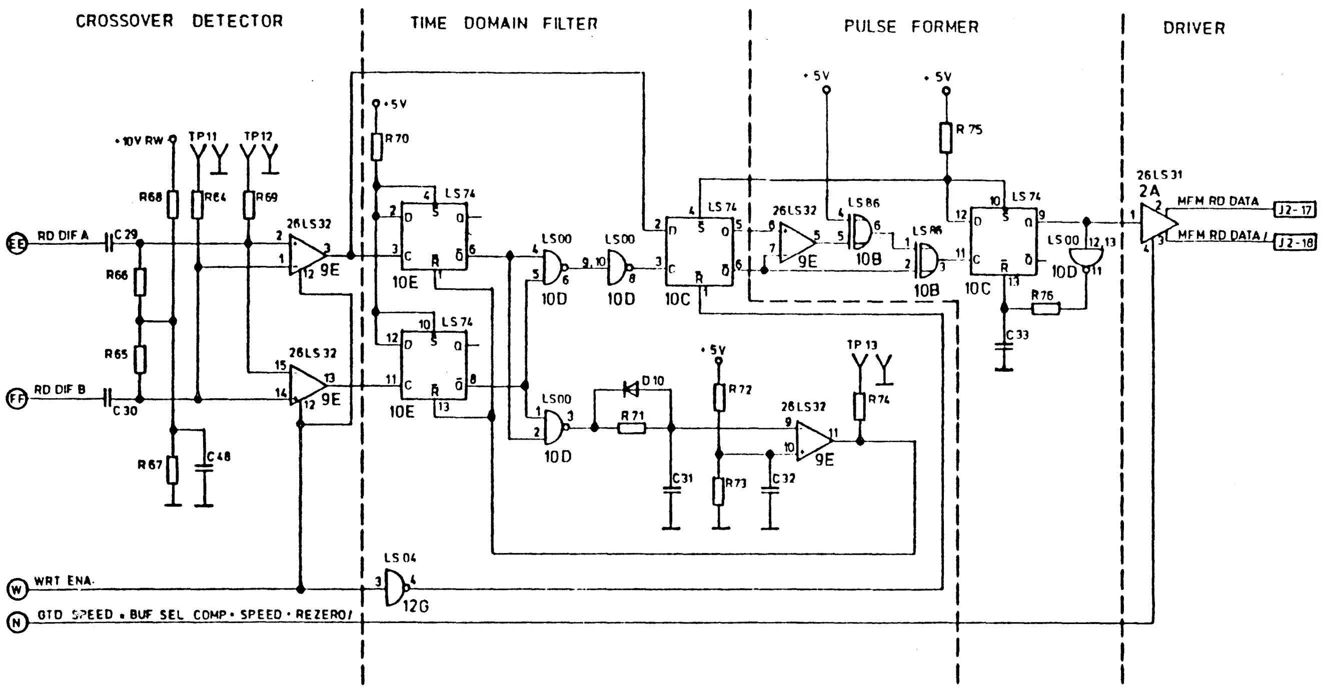


FIGURE 3 - 33 : READ DATA DIGITIZER

and the Interface Line Driver. A timing diagram of the read data recovery is shown in figure 3-34.

a.) The Crossover Detector consists of the two comparators 9E outputs 3 and 13. Output 9E3 is high when the "+" input 9E2 is higher than the "-" input 9E1. In the opposite case output 9E3 is low when the "+" input is lower than the "-" input. The other comparator has the "+" and "-" inputs reversed so that 9E13 is the inverse signal of 9E3. Both outputs make a transition for each zero crossing of the differentiated read signal which corresponds to a maximum of the original read signal or to a flux reversal recorded on the disk. These transitions represent already the digital read data, however they may contain false pulses caused by shouldering in the original read data.

b.) The purpose of the Time Domain Filter is to suppress such false pulses. This is achieved by sampling the Crossover Detector output signal at a certain time (the time domain delay - delta t in figure 3 - 34) after each zero crossing. For regular zero crossings which are at least 200 nanoseconds apart, the Crossover Detector output has not changed between the zero crossing transition and the sample time, so that the transition is passed to the output of the Time Domain Filter. False zero crossings are always close together resulting in short pulses on the Crossover Detector output. Since these pulses are shorter than the time domain delay, the Crossover Detector output has regained the state that it had before the false pulse when it is sampled. Therefore the output of the Time Domain Filter does not change for false pulses.

The detailed function of the time domain filter is as follows. The two flip-flops 10E act together as a bidirectional one-shot which is set with each transition of the Crossover Detector output. The upper flip-flop is set with a positive crossover, while the lower flip-flop is set with a negative crossover. The two Q/ outputs 6 and 8 are ORed with 10D inputs 1 and 2. A low going edge on any one of the two Q/ outputs starts the time domain delay which is determined by R71 and C31. When the voltage at 9E9 exceeds the threshold voltage at 9E10, the output 11 of the comparator 9E goes low and clears the two flip-flops. This in turn causes the Q/ outputs to go high and 10D3 to go low. A fast discharge of C31 is provided through D10 in order to achieve a short recovery time of the circuit.

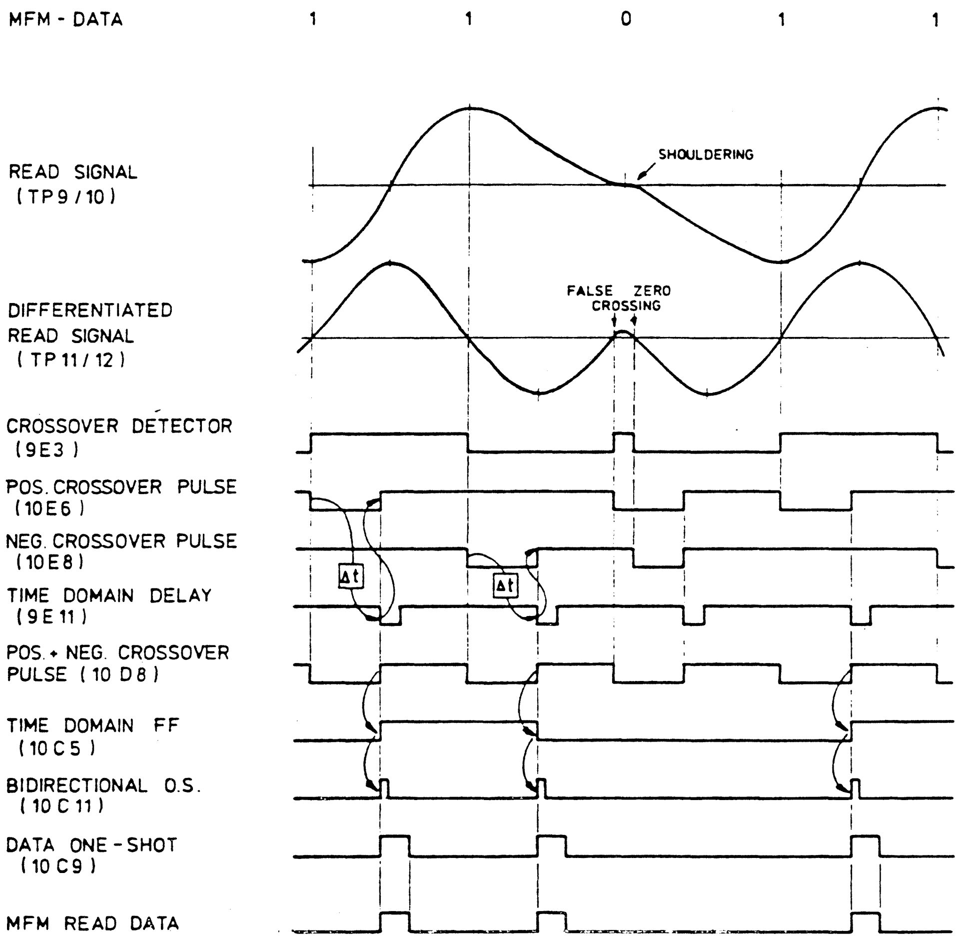


FIGURE 3 - 34 : READ TIMING

The high going edge of the ORed Q/ outputs (10D8) is used to clock the Time Domain FF 10C. At this time the output of the Crossover Detector which is connected to the D input 2 of the Time Domain FF is sampled and its state is transferred to the O output.

The inactive state of WRT ENA disables the Crossover Detector (9E12) and the Time Domain FF (10C1).

c.) The next functional block is the Pulse Former. Its purpose is to generate a 50 nanoseconds Read Data pulse for each transition of the Time Domain FF.

The comparator 9E (output 5) and the two exclusive OR gates 10B (outputs 6 and 3) form together a bidirectional one-shot. Each transition on the outputs 5 and 6 of the Time Domain FF 10C causes a short high going pulse at 10B3. The input signal at 10B1 is delayed by the propagation delay time of the comparator and the exclusive OR gate 10B (output 6). Within that delay time after a transition of the Time Domain FF outputs, the inputs 1 and 2 of 10B have opposite polarity causing a high state at the output 10B3 for the duration of the delay time.

Each pulse on 10B3 sets the Data One-Shot (flip-flop 10C) through the Clock input 11 (the D input 12 is permanently high). After a delay time of about 50 nanoseconds which is determined by R76 and C33 the flip-flop is cleared through the Reset/ input 13.

d.) The output of the Data One-Shot is connected to input 1 of the interface line driver 2A which is enabled with the signal GTD SPEED (see section 3.3.6.). The differential outputs of the line driver are the interface signals MFM RD DATA.

SECTION 4

MAINTENANCE

4.1. GENERAL

Section 4 contains information and procedures for performing operational checks, adjustments, and component replacement for the BASF 6180 Fixed Disk Drive. A catalog of the spare parts for the BASF 6180 is provided as a separate document.

Since the BASF 6180 does not require preventive maintenance, the information is only required for repair in the case of equipment malfunction.

```
****************************************
*                                      *
*              WARNING!                *
*                                      *
*  Do not open the Head-Disk Assembly! *
*                                      *
****************************************
```

4.2. TOOLS AND TEST EQUIPMENT

The following tools and test equipment are required for proper maintenance and repair of the BASF 6180:

- Common Hand Tools
- Feeler Gauge Set
- Voltohmmeter
- Oscilloscope
- Frequency Counter

For the adjustment of the Track 0 Light Gate it is necessary to manually step the actuator. If this cannot be done through diagnostic software, a simple exerciser can be built according to figure 4-1. Switch S1 is used to generate the Step pulses and should be a momentary switch. The direction of the stepping is controlled by switch S2. The flip-flop is required for the debouncing of switch S1. If the BASF 6180 is operated with such exerciser, it should be set up for Permanent Selection and for Motor On by Power On (see section 2.1.9.).

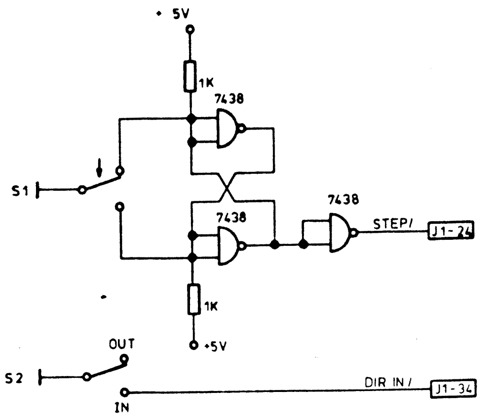


FIGURE 4 - 1 : MINI EXERCISER

4.3. CHECKS, ADJUSTMENTS, AND REPLACEMENTS

4.3.1. INTRODUCTION

The field replaceable components of the BASF 6180 are shown in figure 4-2. They are:

- Read-Write-Control PCB (1)
- Isolation Sheet (2)
- Motor-Control PCB (3)
- Interconection Cable (4)
- Face Plate Assembly (5)
- Shock Absorbers (6)
- Motor Brake Assembly (7)
- Ground Spring (8)
- In-Use LED (9)
- Track 0 Light Gate (10)

All replacements should be performed with power removed from the drive.

For the replacement of electronic components on the PCB's only original BASF spare parts should be used.

4.3.2. READ-WRITE-CONTROL PCB

To replace the Read-Write-Control PCB proceed according to the following procedure:

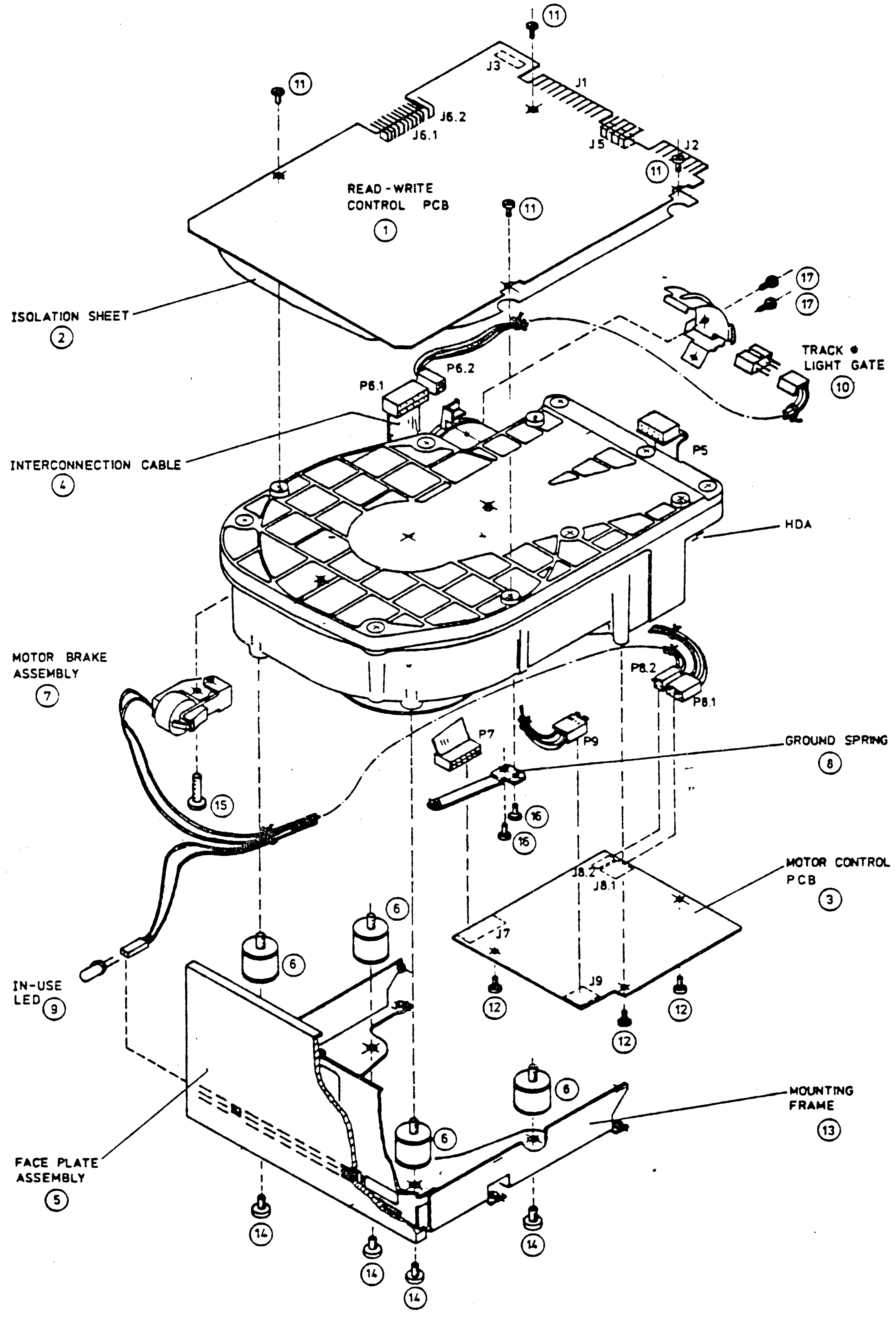


FIGURE 4 - 2 : FIELD REPLACEABLE COMPONENTS

1. Unplug the connectors P1, P2, P3, P5, P6.1, and P6.2.

2. Unscrew the four mounting screws (11).

3. Remove the old PCB.

4. Check the Isolation Sheet (2) and replace it if necessary.

5. Reverse steps 3. to 1.

6. Check the Speed Monitoring and adjust it if necessary (see section 4.3.5.).

4.3.3. MOTOR-CONTROL PCB

To replace the Motor-Control PCB proceed according to the following procedure:

1. Unplug the connectors P7, P8.1, P8.2, and P9.

2. Unscrew the three mounting screws (12).

3. Replace the old PCB.

4. Reverse steps 2. and 1.

5. Adjust the spindle motor speed (see section 4.3.4.).

4.3.4. SPINDLE MOTOR SPEED

The nominal spindle motor speed is 3600 rpm. It is measured by measuring the time between two index pulses. For nominal speed it is 16.67 milliseconds.

A readjustment of the speed is required after replacing the Motor-Control PCB or a component in the speed control circuit. Because the adjustment must be performed with a tolerance of plus or minus 0.1% a frequency counter is required.

a. Setup

1. Connect a frequency counter to TP2 (signal IDX) on the Motor-Control-PCB. Alternatively the time between index pulses may be measured through the interface on J1-20 (signal INDEX/).

2. Set up the counter to measure time periods between two high going (low going on J1-20) edges.

3. Provide power to the drive and wait until the spindle has reached full speed.

b. Speed Check

1. Verify that the speed is within a tolerance of plus or minus 1%. This is equivalent to a time between index pulses from 16.50 to 16.83 milliseconds.

c. Speed Adjustment

1. The tolerance for the speed adjustment is plus or minus 0.1%! The counter should show a reading between 16.650 and 16.683 milliseconds for correct speed.

2. If the speed is out of tolerance readjust with R3 on the Motor-Control PCB.

4.3.5. SPEED MONITORING

For checking/adjusting the Speed Monitoring it is necessary to measure the output pulses of the 17.5 milliseconds one-shot 6J6 (see section 3.3.6.). Note that the one-shot output is permanently high at full speed. It is therefore necessary to make the check/adjustment at reduced speed during the spindle motor start time according to the following procedure:

1. Connect a frequency counter to TP4 on the Read-Write-Control PCB.

2. Set up the counter to measure time intervals from a high going to a low going edge.

3. Turn off power for about 5 seconds to allow the spindle motor to decelerate.

4. Turn power on again and watch the frequency counter.

5. The frequency counter should show a reading between 17.2 and 17.8 milliseconds.

6. If the reading is outside the tolerance, readjust with R9 on the Read-Write-Control PCB.

7. Make sure that the frequncy counter is still triggered during the measurements, otherwise it may show a false reading and the procedure should be repeated from step 3. on.

4.3.6. FACE PLATE ASSEMBLY

Note that the plastic Face Plate cannot be replaced alone. It is only possible to replace the complete Face Plate Assembly consisting of the Face Plate itself and the Mounting Frame (13). Note also that the In-Use LED is not included in the Face Plate Assembly.

1. Unscrew the four mounting screws (14).

2. Lift the Face Plate Assembly and pull the LED out of the plastic Face Plate (do not unplug the LED).

3. Check that the four Shock Absorbers (6) are fastened.

4. Insert the LED into the new Face Plate Assembly.

5. Reinstall the new Face Plate Assembly with the four mounting screws (14).

4.3.7. SHOCK ABSORBERS

To replace the Shock Absorbers proceed according to the following procedure:

1. Remove the Face Plate Assembly according to section 4.3.6. steps 1. and 2.

2. Replace the Shock Absorbers (6) as required.

3. Reinstall the Face Plate Assembly according to section 4.3.6. steps 3. to 5.

4.3.8. SPINDLE MOTOR BRAKE

The spindle motor brake is shown in figure 4-3. The gap between the brake pad and the rotor should be between 0.25 and 0.4 mm when the solenoid is energized and the brake is disengaged. The gap must be adjusted after the brake assembly has been replaced or in case of wear of the brake pad. The adjustment must be made with power removed from the drive.

1. Remove the Face Plate Assembly according to

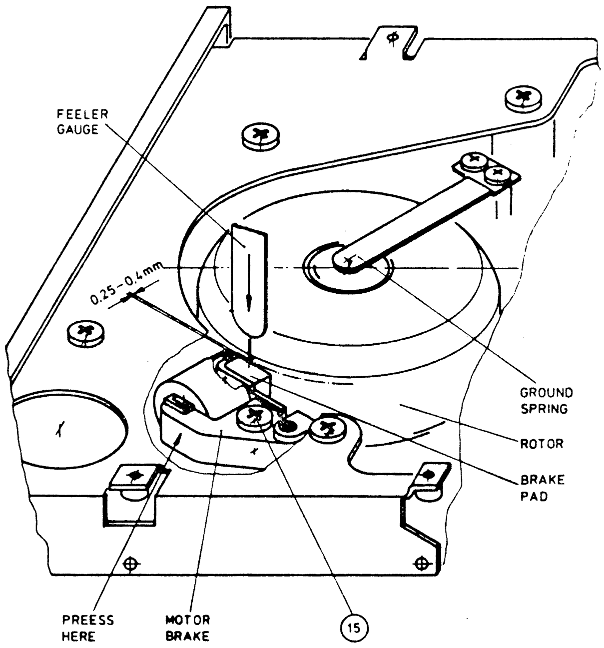


FIGURE 4 - 3 :
SPINDLE MOTOR BRAKE ADJUSTMENT

section 4.3.6. steps 1. and 2.

2. If only adjustment is required jump to step 7.

3. Unscrew the Motor Brake mounting screw (15).

4. Replace the Motor Brake Assembly (7).

5. Reinstall the Motor Brake but do not fasten the mounting screw (15).

6. Jump to step 8.

7. Loosen the motor brake mounting screw (15).

8. Insert a 0.4 mm feeler gauge between the brake pad and the rotor.

9. Press the Brake Assembly towards the rotor as shown in figure 4-3 until it has fully overcome the load spring and the brake pad just starts to be squeezed a little bit.

10. Fasten the motor brake mounting screw (15).

11. Reinstall the Face Plate Assembly according to section 4.3.6. steps 3. to 5.

4.3.9. GROUND SPRING

To replace the Ground Spring proceed according to the following procedure:

1. Unscrew the two mounting screws (16).

2. Replace the Ground Spring (8).

3. Fasten the Ground Spring with the two mounting screws (16) and watch that the cone of the Spindle Motor shaft is centered to the round contact plate of the Ground Spring.

4.3.10. IN-USE LED

To replace the In-Use LED proceed according to the following procedure:

1. Remove the Face Plate Assembly according to section 4.3.6. steps 1. and 2.

2. Replace the LED (9). Watch the polarity of the LED (one lead is wider than the other).

3. Reinstall the Face Plate Assembly according to section 4.3.6. steps 3. to 5.

4.3.11. TRACK 0 LIGHT GATE

The light gate needs adjustment only if it is defective and has to be replaced. The light gate should not be readjusted under any other circumstances.

1. Turn power off.

2. Unscrew the two Light Gate mounting screws (17) and remove the light gate (10).

3. Disable the Automatic Rezero by setting option switch 7 to the ON position.

4. Connect channel 1 of an oscilloscope to the SPEED signal (TP1 on the Read-Write-Control PCB) and channel 2 to the DECCNT signal (IC 12F5 on the Read-Write-Control PCB). Set the oscilloscope to automatic triggering and 2 Volts per division.

5. Manually turn the stepper motor very gently counterclockwise until it reaches a mechanical stop. Hold the stepper motor in this position until the Speed signal (TP1) goes high (see step 6).

6. Turn power on and wait until the Speed signal (TP1) goes high.

7. Make ten steps in IN direction. Verify that the DECCNT signal (12F5) goes high with the last step.

8. Make two steps in OUT direction.

9. Install the new Light Gate (10) with the two mounting screws (17) and adjust the Light Gate so that it touches the shutter, but that the shutter is not moved from the position that it reached in step 8.

10. Fasten the two mounting screws (17).

11. Make two steps in IN direction. Verify that the DECCNT signal (12F5) goes high with the last step.

12. Step in OUT direction until the shutter hits the Light Gate (it acts also as a mecahnical stop). This must happen with the second or third step, if not repeat the adjustment from step 1. on.

13. Step in IN direction until the DECCNT signal (12F5) goes high.

14. Connect channel 1 of the oscilloscope to the TRK0 signal (12F3 on the Read-Write-Control PCB).

15. Make ten steps in IN direction. Verify that the TRK0 signal (12F3) goes low between step 3 and step 7. Verify that the DECCNT signal (12F5) goes high with the last step.

APPENDIX A

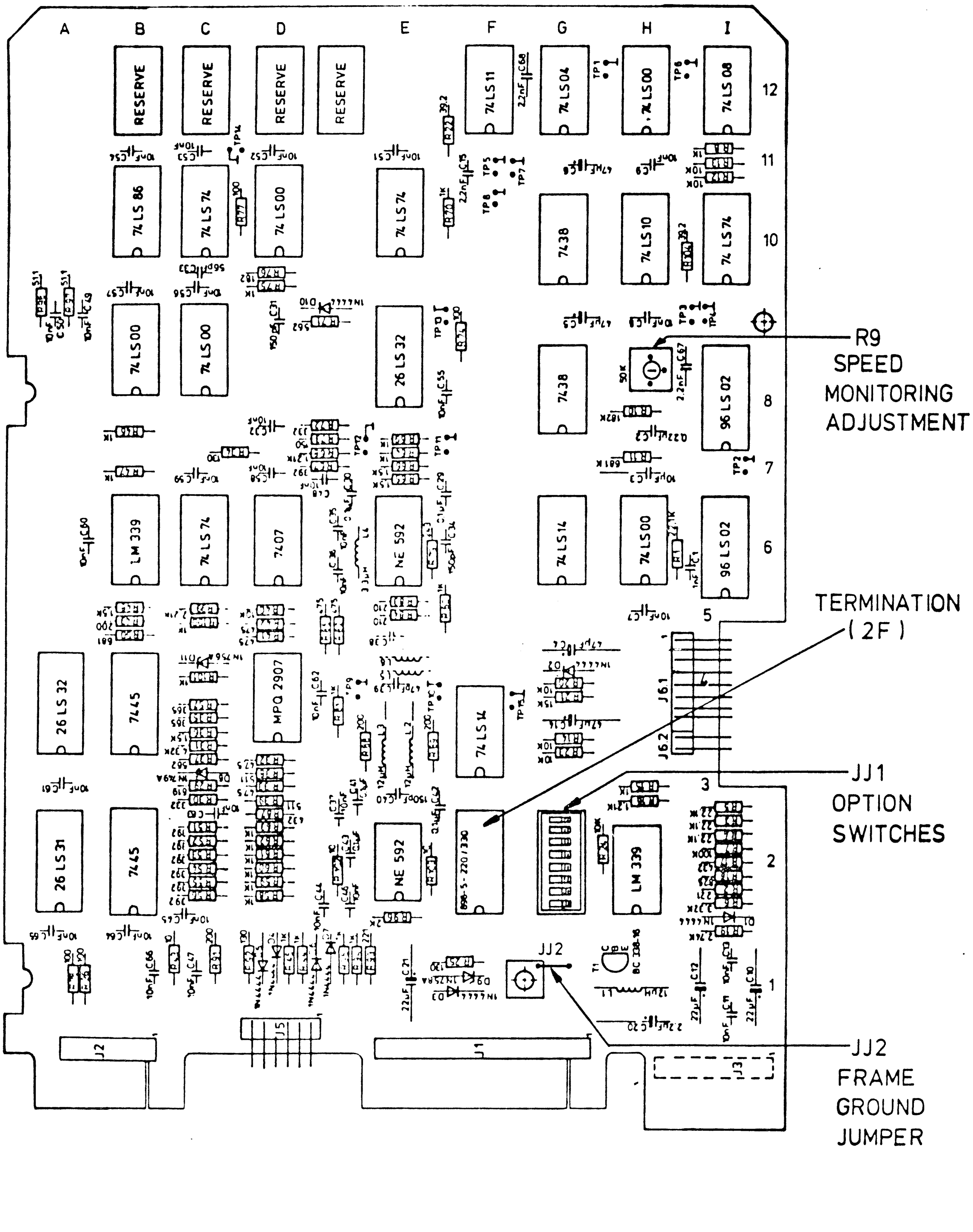


FIGURE A - 1 : READ-WRITE-CONTROL PCB COMPONENT LOCATION

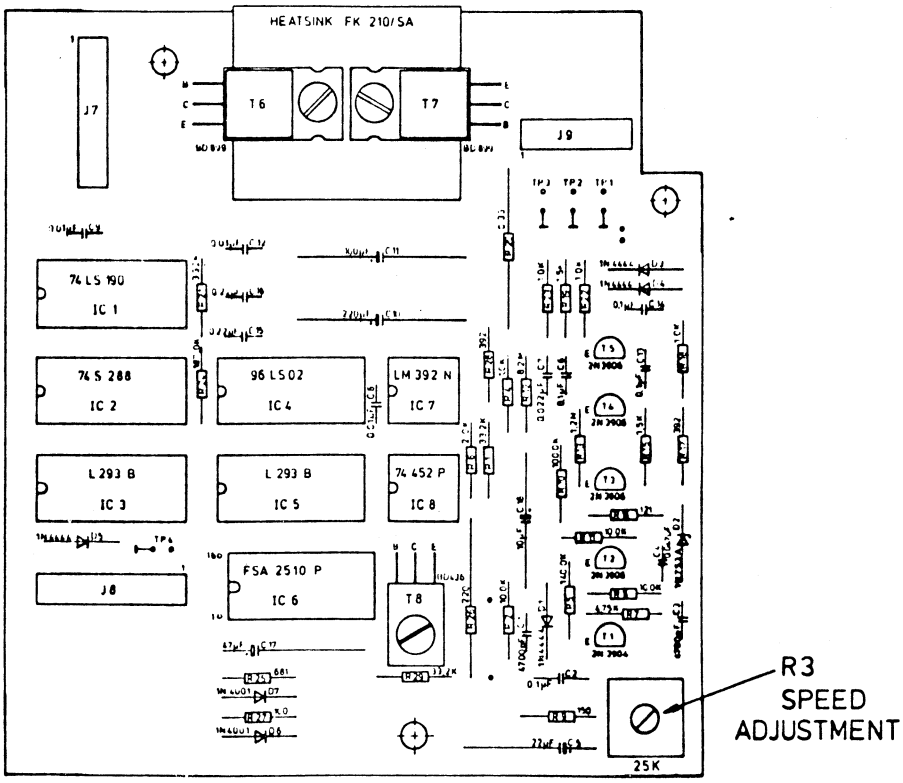


FIGURE A - 2 : MOTOR-CONTROL PCB COMPONENT LOCATION

APPENDIX C

TEST POINT	LOCATION	SIGNAL	SOURCE
1	G/H12	SPEED	10J5
2	I7	IDX	6J6
3	H/I9	2.2 sec O.S.	8J6
4	I9	17.5 msec O.S.	8J10
5	F11	TRK 0/	12F6
6	H/I12	WRT ENA	12J6
7	F11	DC OK	2H2
8	F10	SM STEP/	10H8
9,10	E4	filtered read signal	L2,L3
11,12	E7	differentiated read signal	6E7,8
13	E/F9	time domain delay	9E11
14	C/D11	RD	10C9
15	F/G4	RED WRT CUR	6G6

TABLE C - 1 : READ-WRITE-CONTROL PCB TEST POINTS

TEST POINT	LOCATION	SIGNAL	SOURCE
1	besides J9	DM CTL PLS 2/	Hall Sensor 2
2	besides J9	DM CTL PLS 1/	Hall Sensor 1
3	besides J9	Spindle Motor Current	R20
4	besides J8	+ UM	T8

TABLE C - 2 : MOTOR-CONTROL PCB TEST POINTS

APPENDIX B

BRK ACTIV	- Brake Activ
BUF SEL COMP	- Buffered Select Compare
DC CONR	- DC (Write) Control
DC OK	- DC (Voltages) OK
DEC CNT	- Decimal Count
DIR IN	- Direction In
DM CTL PLS	- Drive Motor Contol Pulse
DM INDEX	- Drive Motor Index
DR SEL	- Drive Select *
DR SELTD	- Drive Selected
GND	- Ground
GTD SPEED	- Gated Speed
HD SEL	- Head Select
IDX	- Index **
LED	- Light Emitting Diode
MFM RD DATA	- Modified Frequency Modulation Read Data
MFM WRT DATA	- Modified Frequency Modulation Write Data
MHSR	- Multi Head Select Read
MHSRW	- Multi Head Select Read/Write
MHSW	- Multi Head Select Write
MTR ON	- Motor On
ON CYL	- On Cylinder
OP CBL DET	- Open Cable Detect
PERM SELD	- Permanently Selected
PH	- Phase
PWR MTR ON	- Power Motor On
PWR ON RST	- Power On Reset
RD DIF A	- Read (Signal) Differentiated A
RD DIF B	- Read (Signal) Differentiated A
RED WRT CUR	- Reduced Write Current
SEEK COMPL	- Seek Complete *
SEL	- (Head) Select
SEL COMP	- Select Compare
SM DIR IN	- Stepper Motor Direction In
SM STEP	- Stepper Motor Step
SPEED CTL	- Speed Control
TRK 0	- Track 0 **
WEN	- Write Enable
WFLT	- Write Fault **
WRT ENA	- Write Enable
WRT FLT	- Write Fault *
WRT GATE	- Write Gate
WRT PROTD	- Write Protected *
WRT PRT	- Write Protected **
WSAFE	- Write Safe
10 V RW	- 10 Volts for Read/Write Logic
12 V RW	- 12 Volts for Read/Write Logic

Notes: * = Interface Signal
** = Internal Signal

TABLE B - 1 : SIGNAL NAME ABBREVIATIONS

APPENDIX D

PIN	SIGNAL
2	RED WRT CUR/
4	HD SEL 2/
6	WRT GATE/
8	SEEK COMPL/
10	TRACK 0/
12	WRT FLT/
14	HD SEL 0/
16	OP CBL DET
18	HD SEL 1/
20	INDEX/
22	READY/
24	STEP/
26	DR SEL 1/
28	DR SEL 2/
30	DR SEL 3/
32	DR SEL 4/
34	DIR IN/

PIN SIGNAL

All odd numbered PINs are GROUND.

TABLE D - 1 :
J1/P1 INTERFACE "A" - CABLE CONNECTOR

PIN	SIGNAL
1	DR SELTD/
2	GND
3	RESERVED
4	GND
5	SPARE
6	GND
7	OP CBL DET
8	GND
9	SPARE
10	GND
11	GND
12	GND
13	MFM WRT DATA
14	MFM WRT DATA/
15	GND
16	GND
17	MFM RD DATA
18	MFM RD DATA/
19	GND
20	GND

TABLE D - 2 :
J2/P2 INTERFACE "B" - CABLE CONNECTOR

PIN	SIGNAL
1	+12V
2	GND 12
3	GND 5
4	+5V

TABLE D - 3 :
J3/P3 POWER CONNECTOR

PIN	SIGNAL
11	SEL 5
1	FRAME GROUND

TABLE D - 4 :
J4/P4 FRAME GROUND CONNECTOR

PIN	SIGNAL
1	GND
2	SEL 0
3	SEL 1
4	SEL 2
5	SEL 3
6	SEL 4
7	GND
8	DATA A
9	DATA B
10	GND
12	GND

TABLE D - 5 :
J5/P5 HEAD CONNECTOR

PIN	SIGNAL
1	DM INDEX/
2	SEL COMP/
3	MTR ON/
4	SM DIR IN/
5	SM STEP/
6	DEC CNT
7	GND 12
8	+12V
9	+12V
10	GND 12
11	SPEED
12	ON CYL
13	+5V
14	GND 5
15	+5V
16	GND 5
17	NOT USED
18	NOT USED
19	GND
20	GND
21	TRK 0
22	LED

Connector P6.1 uses pins 1 - 16.
Connector P6.2 uses pins 19 - 22.

TABLE D - 6 : J6 / P6.1 / P6.2
PCB INTERCONNECTION / LIGHT GATE CONNECTOR

PIN	SIGNAL
1	DM INDEX/
2	SEL COMP/
3	MTR ON/
4	SM DIR IN/
5	SM STEP/
6	DEC CNT
7	GND 12
8	+12V
9	+12V
10	GND 12
11	SPEED
12	ON CYL
13	+5V
14	GND 5
15	+5V
16	GND 5

TABLE D - 7 :
J7/P7 PCB INTERCONNECTION

PIN	SIGNAL
1	PH 1
2	PH 1 RET
3	PH 2
4	PH 2 RET
5	PH 3
6	PH 3 RET
7	PH 4
8	PH 4 RET
9	PH 5
10	PH 5 RET
11	NOT USED
12	NOT USED
13	VCR 100
14	LED IN USE/
15	+12V
16	BRK ACTIV/

Connector P8.1 uses pins 1 - 10.
Connector P8.2 uses pins 13 - 16.

TABLE D - 8 :
J8/P8.1/P8.2 STEPPER MOTOR / IN USE LED / MOTOR BRAKE CONNECTOR

PIN	SIGNAL
1	A COIL ACTIV
2	+12V
3	B COIL ACTIV
4	DM CTL PLS 1/
5	GND 5
6	+5V
7	DM CTL PLS 2/
8	SPARE
9	GND
10	+5V
11	DM INDEX
12	SPARE

Connector P9 uses pins 1 - 8.
Pins 9 - 12 are used for testing.

TABLE D - 9 :
J9/P9 SPINDLE MOTOR CONNECTOR

APPENDIX E

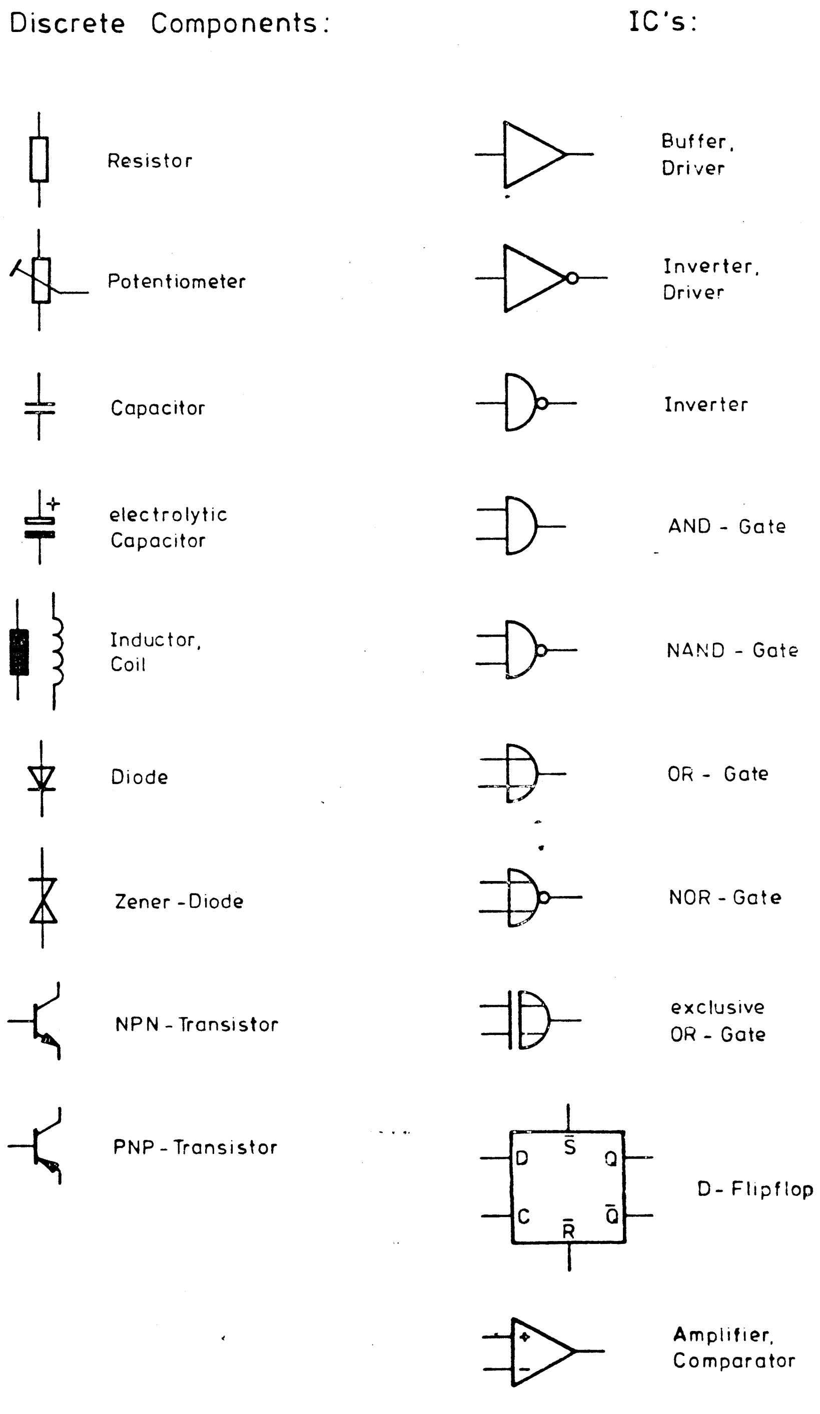


FIGURE E - 1 : LOGIC SYMBOLS