BASF Aktiengesellschaft

BASF 6185

5.25" FIXED DISK DRIVE

PRODUCT SPECIFICATION

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1. INTRODUCTION

1.1. GENERAL DESCRIPTION

The BASF 6185 stores the information on up to 3 non-removable disks and up to 440 cylinders.

The BASF 6185 uses the industry standard interface and dimensions to ease system integration. Up to four BASF 6185 may be connected to one controller. For systems requiring removable media it is recommended to use the BASF 6185 in combination with BASF Mini Floppy Disk Drives, which offer a capacity of up to 1 MByte.

The use of proven and highly reliable Winchester-Technology disks and heads together with a closed-loop air filtering system guarantees a maintenance-free operation throughout the drive´s lifetime and results in a MTBF of 11,000 working hours.

Reliability and low cost are the result of mechanical simplicity and drive ruggedness, containing such features as a highly reliable brushless DC-drive motor, a stepper motor for an increased lifetime of the steel band actuator, and a built in shock absorber system.

Summary of main features:

- Storage capacity up tp 27,5 mesabytes unformatted
- Highly reliable Winchester-Technology
- Steel band actuator and fast access stepper motor
- Directly driven spindle with brushless DC-motor
- Integrated shock absorber system
- Spindle brake for reduction of stop time
- Industry standard interface and dimensions
- Microprocessor control
- Ramp mode

1.2. SPECIFICATIONS

1.2.1. PERFORMANCE SPECIFICATIONS

Model	BASF 6185	BASF 6186
Disks	3	2
Cylinders	440	

Capacity Unformatted

Per drive (MBytes)	27.5	
Per surface (MBytes)	4.58	
Per track (KBytes)	10.4	

Capacity Formatted

Per drive (MBytes)	21.6	14.3
Per surface (MBytes)	3.6	
Per track (KBytes)	9.2	
Per sector (Bytes)	1024	
Sectors per track	9	

Transfer rate (Mbits/sec)	5

Cylinder Access time :

Single step mode:	(1.2 msec - 3.1 msec)
track to track:	15 msec (average)
average:	191 msec (1.2 msec step rate)
maximum:	542 msec (1.2 msec step rate)
	(440 cylinder)
Ramp mode :	(10 microsec to 200 microsec)
average:	127 msec
maximum:	297 msec
	(440 cylinder)

Average latency (msec)	8.3
Head settling time (msec)	15
Start-up time (sec)	15
Stop time (sec)	10

1.2.2. FUNCTIONAL SPECIFICATIONS

Model	BASF 6185
Rotational speed (rpm)	3600 +/-1 %
Recording density(bpi)	8853
Flux density (fci)	8853
Track density (tpi)	508
Index (per rev.)	1
Encoding method	MFM

1.2.3. RELIABILITY SPECIFICATIONS   All Models

Mean Time Between Failure (MTBF)	11,000 hours *
Mean Time to Repair (MTTR)	30 minutes
Preventive Maintenance (PM)	none required
Designed lifetime	5 years

Error rates

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

Disk Media Defects

Disk drives are allowed to have the following number of media defects when leaving the factory:

BASF 6185	15 max.

Cylinder zero is delivered error free.

Note: * Power On time under typical usage.

1.2.4. PHYSICAL SPECIFICATIONS

Voltage requirements (measured at BASF 6185 DC power connector J3)

	AC
	none
+ 12 VDC +/- 5 %	2.4 A max.
	4.5 A during spindle motor startup
+ 5 VDC +/- 5 %	0.9 A max.

Ripple	50 mV peak to peak max. *
Noise	50 mV peak to peak max. *
Heat dissipation	33 Watts max.

Mechanical dimensions

Height	82.55 mm (3.25 inches)
Width	146 mm (5.75 inches)
Depth **	209 mm (8.23 inches)
Weight	2.8 kg (6.2 lbs)

Safety requirements: in accordance with UL

Mounting orientation:

The BASF 6185 may be operated only when the Face Plate is in a
vertical plane. The maximum deviation is an angle of 13 degrees.
From the remaining four possible orientations only three are
allowed for operation. These are with the Read-Write-Control PCB
either on the left or right side or on top of the drive.
Operation with the Read-Write-Control PCB at the bottom of the
drive is not allowed.

Notes: * No combination of ripple and noise shall exceed the
           supply tolerances.
       ** Face plate not included.

1.2.5.   ENVIRONMENTAL SPECIFICATIONS

1.2.5.1.   OPERATING

The BASF 6185 shall work as specified when operated under the
following environmental conditions:

Temperature	4 to 50 degr.C
Temperature gradient	15 degr/h max.
Relative humidity	15 to 80 % (no condensation)
Dew point temperature	25 degr.C
Atmospheric pressure	84 to 110 x 10^{-3} N/m^2
	(-300 m to 3000 m)
Vibration: 5 to 50 Hz:	0.075 mm peak displacement
50 to 500 Hz:	1.0 g accel. (all directions)

Shock: Impact shocks of up to 3 g acceleration and
              up to 11 msec duration at least 10 sec apart.

Purity of surrounding air: Normal office conditions

1.2.5.2.   STORAGE AND TRANSPORT (without packaging)

The BASF 6185 shall not show any damages or defects when the
following conditions are met during shipment and storage.

Temperature	-40 to +70 degr.C
Temperature gradient	20 degr/h
Relative humidity	5 to 95 % (no condensation)
Altitude range	-300 m to 14000 m
Single shock	max.10 g acceleration
Periodical shocks	max. 5 g acceleration Vibration
(up to 500 Hz):	1 g acceleration

During transportation and storage the heads should be positioned
at the innermost cylinder.

2. FUNCTIONAL CHARACTERISTICS

2.1. BASIC FUNCTIONAL UNITS

2.1.1. DRIVE MECHANISM

A "disk pack" consisting of a hub with 3 disks is mounted on a
spindle which is directly rotated at 3600 rpm by a brushless 12
VDC motor. The motor current is commutated by Hall Sensors and
related control electronics. This circuit also generates the
Index pulse.

2.1.2. HOUSING

The sealed module consists of an aluminium molded chassis and
cover. A closed loop air filtering system inside constantly
cleans the air of particles which may be generated by head to
disk interference. An absolute breather filter for pressure
equalization with the ambient air pressure protects against
environmental contamination.

2.1.3. POSITIONING

The carriage on which the read/write heads are mounted is driven
by a stepper motor via a capstan and a metal band. The carriage
itself is precision mounted and guided by ball bearings.

2.1.4. DISKS

The disks are "Winchester" type and have an outside diameter of
130 mm and an inner hole diameter of 40 mm. They are coated with
a thin layer of magnetic oxide on an aluminium substrate and are
additionally lubricated for head wear protection during incontact
start and stop operation.

2.1.5. BRAKE

For further protection of heads and disks in applications where
the system is switched on and off very often a mechanical brake
is installed to reduce the stop time to 10 sec.

2.1.6. READ/WRITE HEADS

Heads are "Winchester" type with minor modifications for track
width and flying height adjustment with respect to a different
relative head to disk velocity.

2.1.7. CONTROL ELECTRONICS

Control and read/write electronics are packaged together on a
single printed circuit board and are located on the top side of
the drive, while power electronics for both Spindle and Stepper
Motor are located on a separate small printed circuit board on
the other side of the drive to avoid electric interferences.

The control electronics fullfills the following functions:

- Drive Selection (one out of four) and indication
- Permanent Spindle Motor speed check
- Index generation
- Stepper Motor Control including velocity ramp and hysteresis
  elimination
- Track Zero detection
- DC Voltage monitoring
- Automatic rezero after power on
- Microprocessor control of interface lines
- Error detection and display on front panel

2.1.8. READ/WRITE ELECTRONICS

Besides the usual read and write function the Read/Write
electronics performs error detection such as write fault and
selection of multiple heads during reading and writing.

2.2. FUNCTIONAL OPERATION

2.2.1. SPINDLE MOTOR START

The spindle motor of the BASF 6180 may be started in two ways:
either by applying the DC-voltages to the drive or through the
interface DR SEL (Drive Select) signal. This feature allows
sequential start up in case several drives are connected to the
system in order to reduce start up current.

2.2.2. DRIVE SELECTION

Each drive is assigned an address by setting the corresponding
Drive Select switch in the drive. Drive selection is done by
activating the corresponding DR SEL (Drive Select) signal through
the control unit. The selected drive responds then to all input
signals and enables its output drivers.

Alternatively the drive may be permanently selected through an
option switch if only one drive is connected to the controller.

2.2.3. Recalibrate / Restore

After Power On the drive's positioning system is recalibrated by
performing an automatic seek to Track Zero. There are also other
possibilities to perform Restore operations depending on
different controllers.

2.2.4. SEEK

In order to reach data on a specific track the controller has to
position the heads to that track by providing or receiving the
following information after drive selection:

- check that WRT GATE (Write Gate) is inactive
- check that READY is active
- select the desired direction
- provide STEP pulses
- wait for SEEK COMPL (Seek Complete) active

Each STEP pulse causes a head movement by one track. The head
movement is initiated by the trailing edge of the pulse. The BASF
6185 has two possibilities of step functions:

- single step mode
- buffered step mode

2.2.5. HEAD SELECTION

Each one of the six heads is selected by applying the binary head
address to the three HD SEL (Head Select) lines.

2.2.6. WRITE OPERATION

To perform a write operation, the appropriate track and head must
be accessed and WRT FLT (Write Fault) must be inactive. Writing
is then accomplished by activating WRT GATE (Write Gate) and
transmitting data on the MFM WRT DATA (MFM Write Data) lines.

2.2.7. READ OPERATION

The drive is always in read mode when WRT GATE (Write Gate) is
inactive. For reading it is only necessary to access the
appropriate track and head.

2.3. USER SELECTABLE OPTIONS

The BASF 6185 has 6 switches for the selection of different
options:

Four switches (1 - 4) are used to set the drive address. Drive
selection is performed when the DR SEL (Drive Select) signal
corresponding to the switch setting is active.

Switch 6 is used to control the condition for the spindle motor
start. Depending on the switch setting the Spindle Motor is
started either with the first active going edge of the
corresponding DR SEL (Drive Select) signal or when DC power is
provided to the drive.

Switch 5 allows to select a drive permanently and independent of
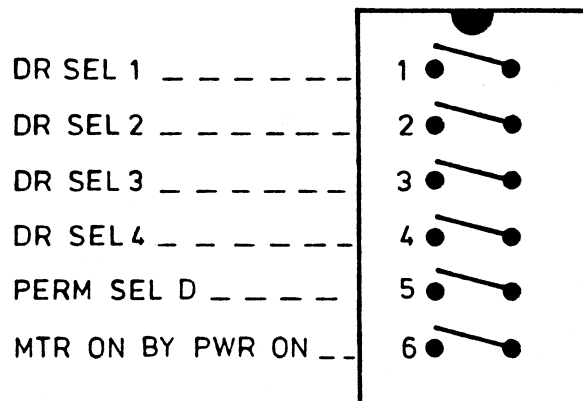the state of the DR SEL (Drive Select) signals.

```
DR SEL 1 _ _ _ _ _ _     1 ●―――●
DR SEL 2 _ _ _ _ _ _     2 ●―――●
DR SEL 3 _ _ _ _ _ _     3 ●―――●
DR SEL 4 _ _ _ _ _ _     4 ●―――●
PERM SEL D _ _ _ _       5 ●―――●
MTR ON BY PWR ON _ _     6 ●―――●
```

FIGURE 2 - 1 : OPTION SWITCHES

2.4. FAULT-CODES

The Select-LED is used to flash error-messages in case certain
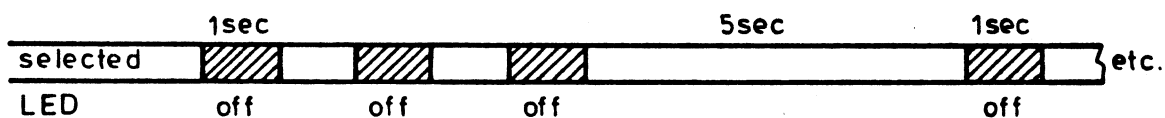fault conditions should arise

e.g. Code 3

FIGURE 2 - 2 : ERROR INDICATION

ERROR-CODES: 1   DC ERROR
2   Motor Speed outside - 10 % and Motor stop
3   STEP received while WRITE GATE is active
4   Motor Speed outside + 1 %
5   REZERO fails after POWER ON
6   Microprocessor self test fail
7   WRITE FAULT

3. DRIVE INTERFACE

3.1. INTERFACE SIGNALS

The drive interface consists of three kinds of interface signals:
control input signals, status output signals, and data transfer
signals.

Low active signals are identified with a "/" appended to the
signal name.

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/

All odd numbered PINs are GROUND.

TABLE 3 - 1 :
J1/P1 INTERFACE "A" - CABLE CONNECTOR

Data transfer signals are differential and transmit MFM raw data
between the drive and the controller via the interface "B"-cable.

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 3 - 2 :

J2/P2 INTERFACE "B" - CABLE CONNECTOR

3.2. ELECTRICAL REQUIREMENTS

3.2.1. SINGLE ENDED SIGNALS

All control input signals and status output signals are single
ended and low active (except OP CBL DET). They must meet the
following electrical specifications:

    Active: 0.0 to 0.4 V DC   I = 40 mA max.
    Inactive: 2.5 to 5.25 V DC   I =   0 mA (open)

Figure 3-1 shows the recommended drivers, receivers, and
termination for the single ended signals. Status output signals
must be terminated in the controller. Control input signals must
be terminated in the last drive connected to the interface
"A"-cable. In a daisy chain configuration, the termination
resistor pack at location 2F on the Read-Write-Control PCB must
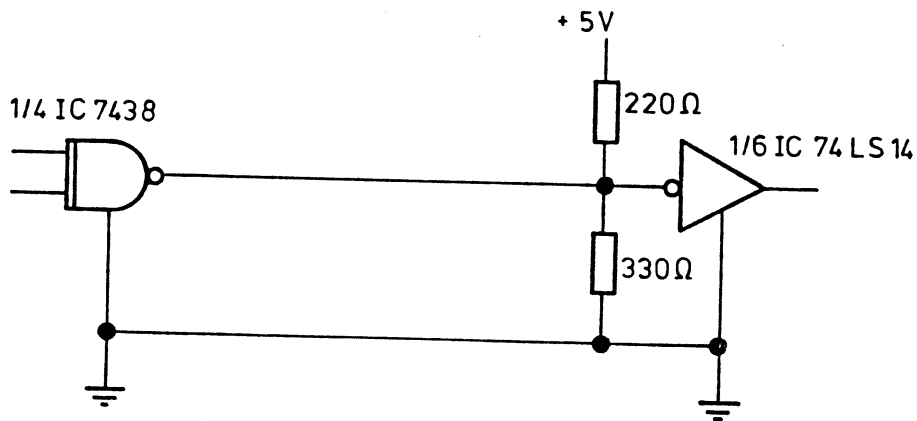be removed from all but the last drive connected to the interface
"A"-cable.

FIGURE 3 - 1 : CONTROL/STATUS LINE CONFIGURATION

3.2.2. DIFFERENTIAL SIGNALS

The data lines between drive and controller are differential. The
logic state for the two pairs of lines MFM WRT DATA and MFM RD
data is defined as follows:

The signal is in an active state if the high active line (without
"/" appended) is more positiv than the low active line (with the
"/" appended); and the signal is in an inactive state if the low
active line is more positiv than the high active line.

Figure 3-2 shows the recommended drivers, receivers, and
termination for the differential signals. Termination must be
provided on the receiver side of the lines. For MFM RD DATA the
termination must be provided in the controlled; MFM WRT DATA is
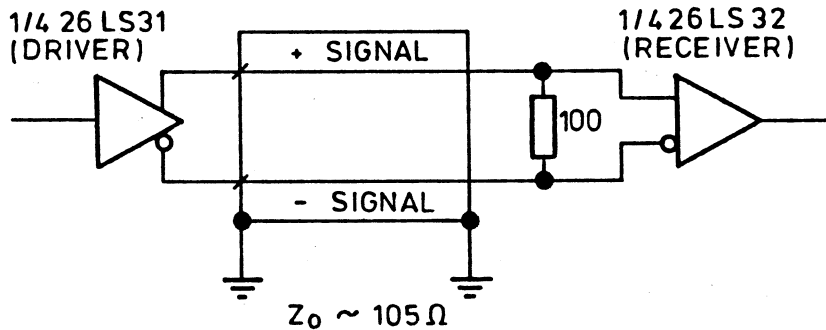terminated in each drive.

FIGURE 3 - 2 : DATA LINE CONFIGURATION

3.2.3. POWER SEQUENCING

Power Up and Power Down may be done with any sequence of the
supply voltages. Microprocessor control logic prevents any
erroneous writing during Power Up or Power Down. The interface
signal WRT GATE (Write Gate) must be kept high inactive during
any power sequence.

3.3.   SIGNAL DEFINITION

3.3.1.   CONTROL INPUT SIGNALS

The control input signals transmit commands from the controller
to the drive.

3.3.1.1.   DR SEL 0 - 3   (Drive Select 0 - 3)

These control signals are used for drive selection together with
the drive address switches on the Read-Write-Control PCB. An
active DR SEL signal selects the drive with the same address. A
selected drive enables its input receivers and output drivers and
turns on the IN-USE indicator which is mounted in the face plate.
When the DR SEL signal is inactive, the drive is deselected and
the input receivers and output drivers disabled.

Note: To be valid, only one of the signals DR SEL 0, DR SEL 1, DR
SEL 2, and DR SEL 3 may be held active at any one time.

The DR SEL signals may also be used to switch on the spindle
motor. The first low going edge of the appropriate DR SEL signal
starts the motor. A switch is applied to disable this function if
the motor on function cannot be handled by the controller.

3.3.1.2.   DIR IN   (Direction In)

This line controls the moving direction of the read/write head
assembly driven by the stepper motor, when the STEP line is
pulsed. If the DIR IN signal is active and the STEP line is
pulsed the head assembly moves towards the disk center, which is
defined as "in"; if the DIR IN signal is inactive, the head
assembly is moved "out" towards track 0. The DIR IN signal must
not change while the signal SEEK COMPL is inactive.

3.3.1.3.   STEP

Together with the DIRECTION IN-line this signal causes the
read/write head assembly to move in the direction defined by the
DIR IN signal. Each STEP pulse causes a head movement across one
cylinder, n pulse a movement across n cylinders. Depending on the
pulse rate the drive has two operation modes

> a) ramp mode
> b) single step mode

These modes are automatically selected by the drive by sampling
the pulse rate.

3.3.1.3.1   Ramp mode

If the time between successive step pulses is between 10 microsec
and 200 microsec and the seek length is greater than 11 steps
then the drive accelerates and decelerates the head tower over a
well- defined velocity ramp. If the seek length is less or equal
11 steps the head tower will be stepped at a 1.2 msec rate.

3.3.1.3.2   Single step mode

If the time between successive pulses is between 1.2 msec and 3.1
msec the drive performs the step operation at the given step rate.

3.3.1.4.   HD SEL 0 - 2   (Head Select 2^0 - 2^2)

Through these signals each one of the six read/write heads can be
selected in a binary coded form. HD SEL 0 is the least
significant line and HD SEL 2 the most significant. When all HD
SEL signals are inactive, head 0 is selected.

3.3.1.5. WRT GATE (Write Gate)

When WRT GATE is active, the data transmitted across the MFM WRT
DATA lines is written onto the disk. When WRT GATE is inactive,
data is read from the disk and transmitted across the MFM RD DATA
lines to the controller.

3.3.1.6. RED WRT CUR (Reduced Write Current)

The signal RED WRT CUR is used to reduce the write current when
writing data on inner tracks, where flux densities are higher and
head flying heights are lower. This signal should be activated
when writing on cylinders equal to or greater than 256.

3.3.1.7. OP CBL DET (Open Cable Detect)

Connector "A"-Cable, Pin 16 and "B"-Cable, Pin 7 are connected on
the drive-side to allow the controller to check if the cables are
plugged correctly.

3.3.2. STATUS OUTPUT SIGNALS

The status output signals transmit status information from the
drive to the controller.

3.3.2.1. DR SELTD (Drive Selected)

The signal DR SELTD is provided together with the data signals
through the star connected the "B"-cable. It returns the
selection status of the drive connected to this cable.

3.3.2.2. READY

If both, the READY and the SEEK COMPL line, are active, the drive
is ready for writing, reading, or executing a seek operation. If
the READY line is inactive, writing and stepping are inhibited.

During power up three conditions must be met for READY
switching to a true state

- track zero recalibration is completed
- Motor speed tolerance less than 1 % of nominal
- WRITE FAULT conditions is false

READY goes away if any one of these three conditions is not
fulfilled.

3.3.2.3. TRACK 0

This signal is in an active state when the selected drive's read/
write head assembly is positioned at the outermost data track of
the disk, which is defined as Track 0. The signal is at the
inactive state as soon as the head assembly is positioned at any
other track.

3.3.2.4. SEEK COMPL (Seek Complete)

The signal SEEK COMPL is active when the read/write head assembly
is positioned on the predetermined track and the heads are
settled. Writing is inhibited as long as SEEK COMPL is inactive.

SEEK COMPL is inactive during a seek or rezero operation. It goes
inactive 100 nanoseconds after the leading edge of the first step
pulse. For single step operation it stays inactive until 15 msec
after the trailing edge of the last step pulse. In ramp mode
operation it stays inactive until 15 msec after the last
performed step.

SEEK COMPL is also inactive during the automatic Rezero operation
after Power On.

3.3.2.5. INDEX

This pulse occurs on this line once per each spindle revolution.
It is derived from a sensor mounted inside the Spindle Motor. The
purpose of this signal is to indicate the beginning of the track.
INDEX is defined as the leading edge of this pulse.

3.3.2.6. WRT FLT (Write Fault)

WRT FLT is indicated whenever a condition exists, that causes
improper writing. The following conditions can cause a write
fault condition:

- More than one head selected
- No write current in write mode
- Write current in read mode
- DC voltage out of tolerance

Each of these conditions prevents writing.

To clear a write fault condition, DR SEL and/or WRT GATE must be
made inactive.

3.3.3. DATA SIGNALS

The data signals transmit the raw MFM data between the controller
and the drive. Data separation, encoding, and decoding is
provided in the controller.

3.3.3.1. MFM WRT DATA   (MFM Write Data)

While WRT GATE is active the controller transmits the MFM encoded
data across the pair of differential MFM WRT DATA lines. Each
pulse on the interface lines causes one flux reversal on the disk.

The write data must be pre-compensated on all tracks greater than
127. The optimum amount of pre-compensation is +/- 12 ns.

3.3.3.2. MFM RD DATA   (MFM Read Data)

While WRT GATE is inactive, the drive transmits the data it reads
with the selected head across the pair of differential MFM RD
DATA lines. Each flux reversal which is read from the disk
generates one active going pulse on the interface lines.

3.4. TIMING REQUIREMENTS

SEEK COMPL.

HDSEL /

20 µs MAX.

MFM RD DATA valid

WRTGATE /

20 µs MAX.

460 ns MAX.

MFM WRT DATA
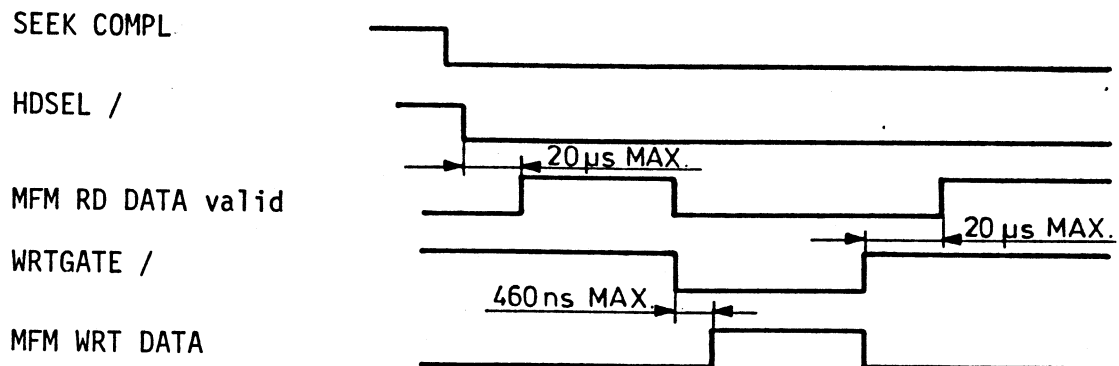
FIGURE 3 - 3 : READ/WRITE TIMING REQUIREMENTS

Standardized Data

BIT CELL TIME = 200 ns TYP.

MFM WRT DATA

115 ns TYP.

MFM WRT DATA /
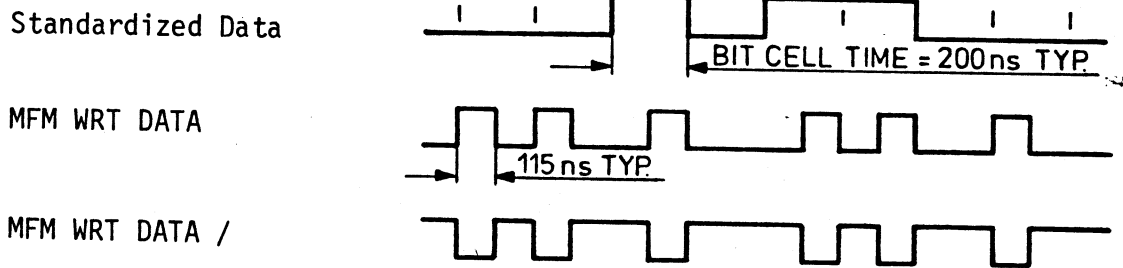
FIGURE 3 - 4 : MFM WRITE DATA TIMING

MFM RD DATA

50 ns TYP.

MFM RD DATA /

Standardized Data

BIT CELL TIME = 200 ns TYP.
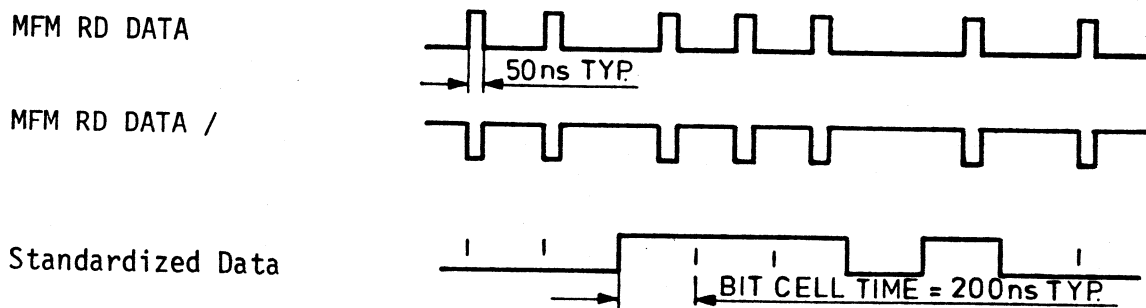
FIGURE 3 - 5 : MFM READ DATA TIMING
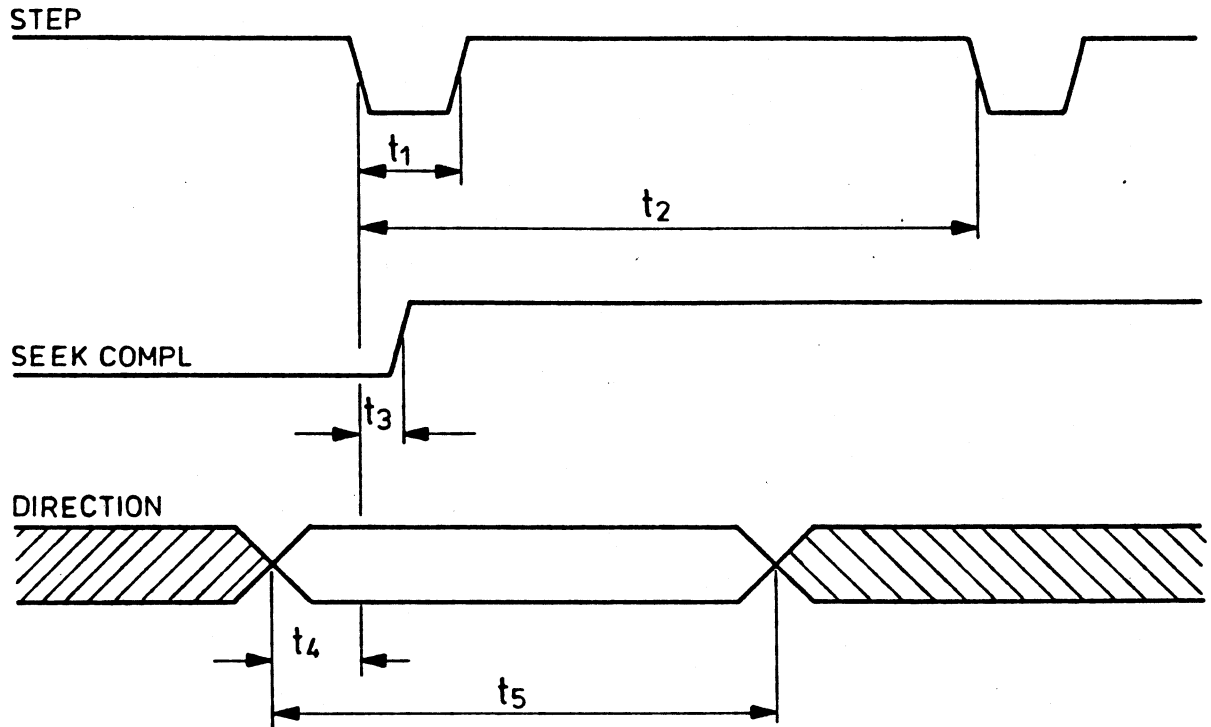
Label	Description	Min.	Typ.	Max.	Units
t1	Width of step pulse	0.5	5	–	us
t2	Time between step pulses				
	RAMP-Mode	10	–	200	us
	Single-Step-Mode	1200	–	3100	us
t3	Time from first step to Seek Complete inactive	–	70	–	ns
t4	Direction to first step	0	–	–	
t5	First step to Direction change	50	–	–	us

FIGURE   3 - 6   :   STEP PULSE TIMING
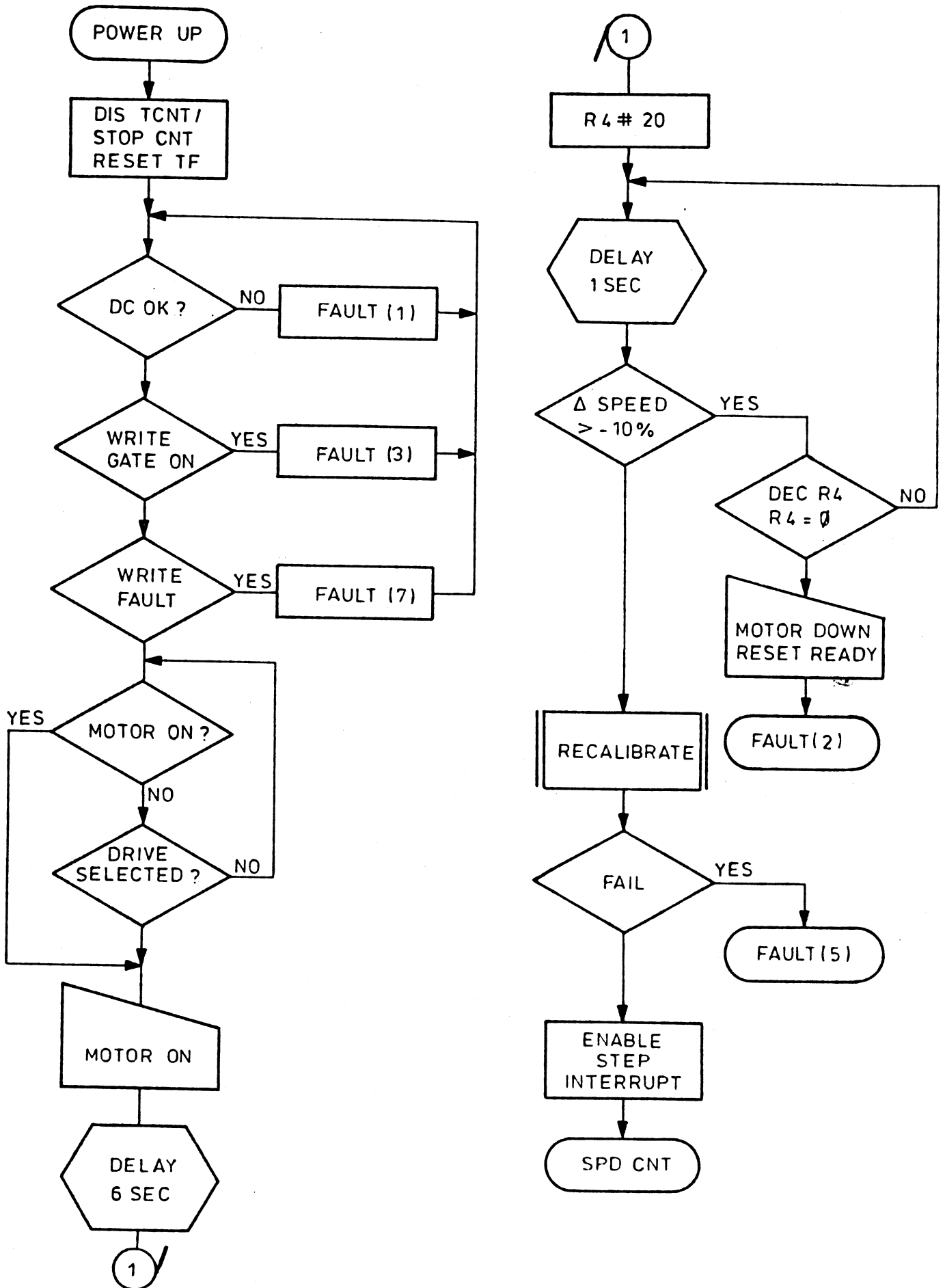
FIGURE 3 - 7 : POWER UP SEQUENCE
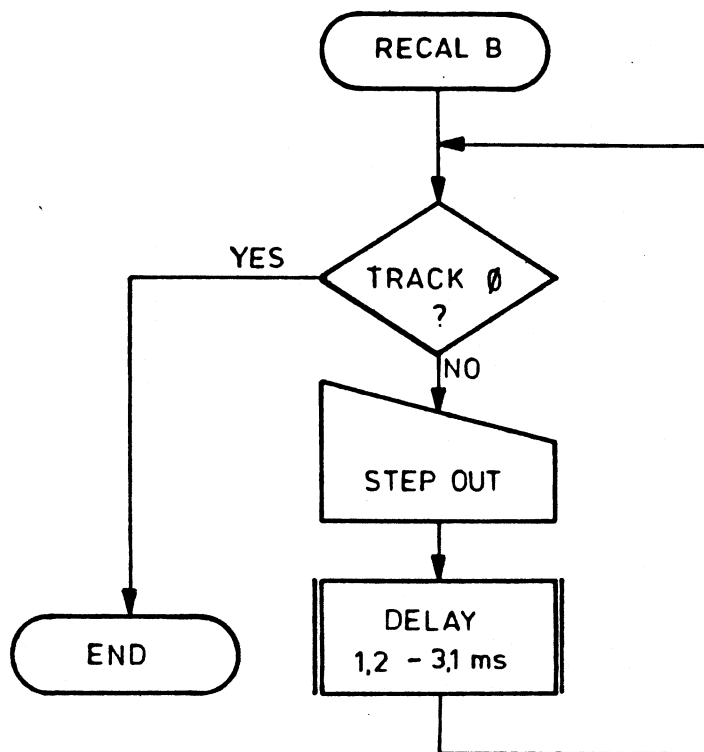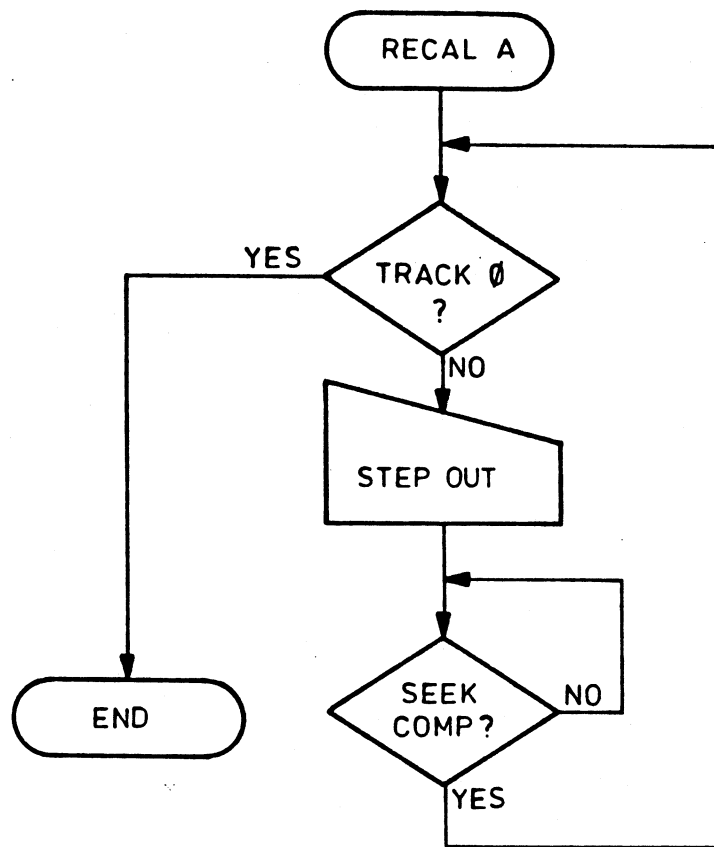
FIGURE   3 - 8   :   RECALIBRATION SCHEMES

3.5. PHYSICAL INTERFACE

The physical interface between the BASF 6185 and the controller
is done via three or four connectors. One provides the control
and status lines through the "A-cable which may be daisy chained.
The second one provides the read/write signals to the star
connected "B"-cable. The other connectors are used to supply DC
power and for optional frame grounding. All dimensions in the
figures are given in millimeters.

3.5.1. INTERFACE CONNECTOR J1, "A"-CABLE

The "A"-cable is connected to the PC-board via a 34 pin card edge
connector. Recommended mating connector is AMP P/N 88 373-3, or
equivalent.

The "A"-Cable may be daisy-chained if more than one drive is
connected to the controller. The cable may be flat ribbon or
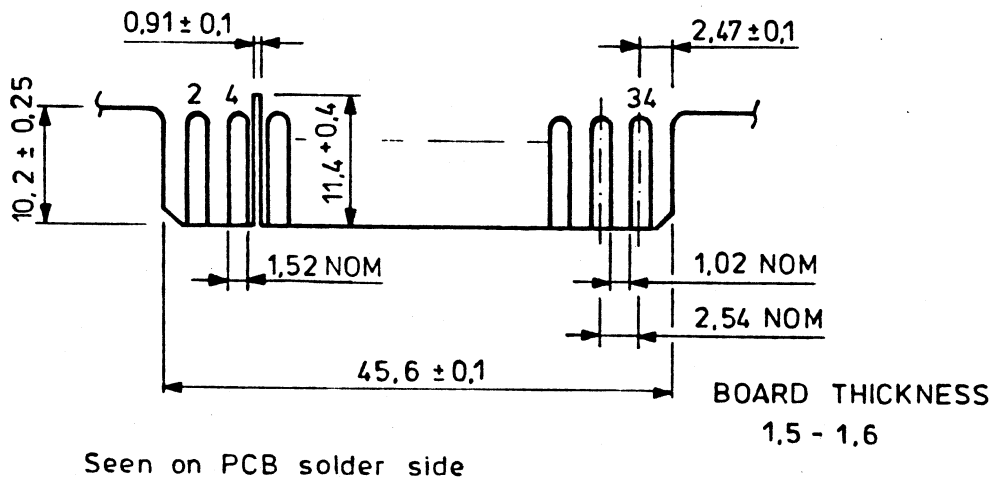twisted pair with a maximum total length of 6 m (20 ft).

Seen on PCB solder side

FIGURE 3 - 9 : J1 CONNECTOR DIMENSIONS

3.5.2. INTERFACE CONNECTOR J2, "B"-Cable

The "B"-cable is connected to the PC-board via a 20 pin card edge connector. Recommended mating connector is AMP P/N 88 373-6, or equivalent.

The "B"-Cable must be radially connected if more than one drive is connected to the controller. The cable may be flat ribbon or twisted pair with a maximum total length of 6 m (20 ft). The cable impedance should be around 105 Ohms.
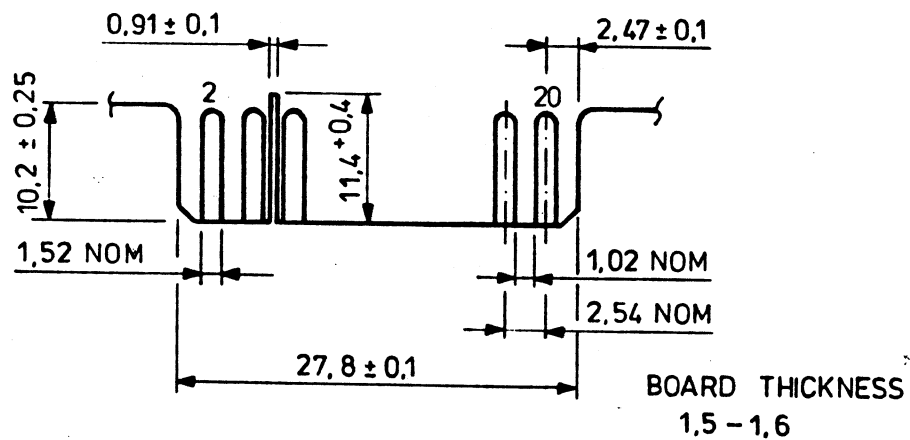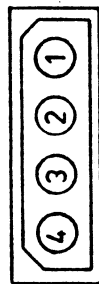

Seen on PCB solder side

FIGURE 3 - 10 : J2 CONNECTOR DIMENSIONS

3.5.3.   POWER CONNECTOR J3

The DC-power connector is a four pin connector. Recommended mating connector is AMP P/N 1-480424-0 with pins 350078-4, or equivalent.

Pin	Signal
1	• 12V DC
2	GND 12V
3	GND 5V
4	• 5V DC

J3 connector as seen on Drive PCB solder side

FIGURE   3 - 11   :   J3 CONNECTOR

3.5.4.   FRAME GROUND CONNECTOR J4

The frame of the BASF 6185 may be connected to the system ground through a separate cable connected to J4. Normally the frame of the BASF 6185 is connected to logic ground. If J4 is used, then the trace JJ2 at location 1G of the Read-Write-Control PCB should be removed in order to avoid ground loops.

Recommended mating connector for J4 is AMP P/N 62187-1 or equivalent.
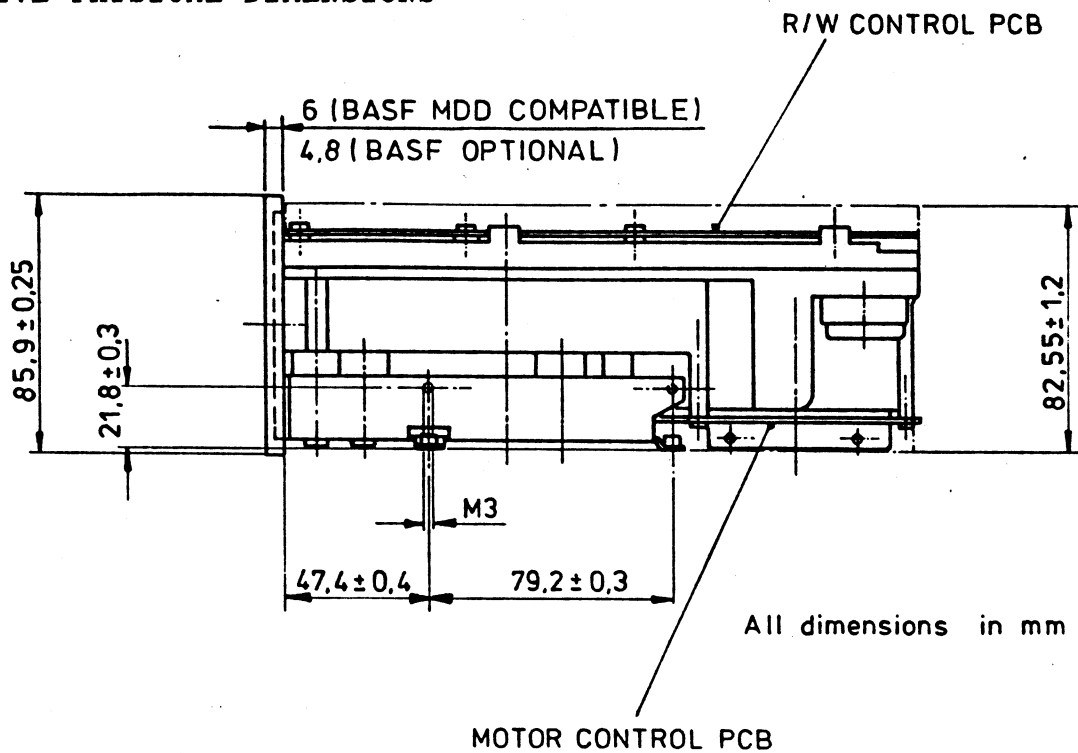
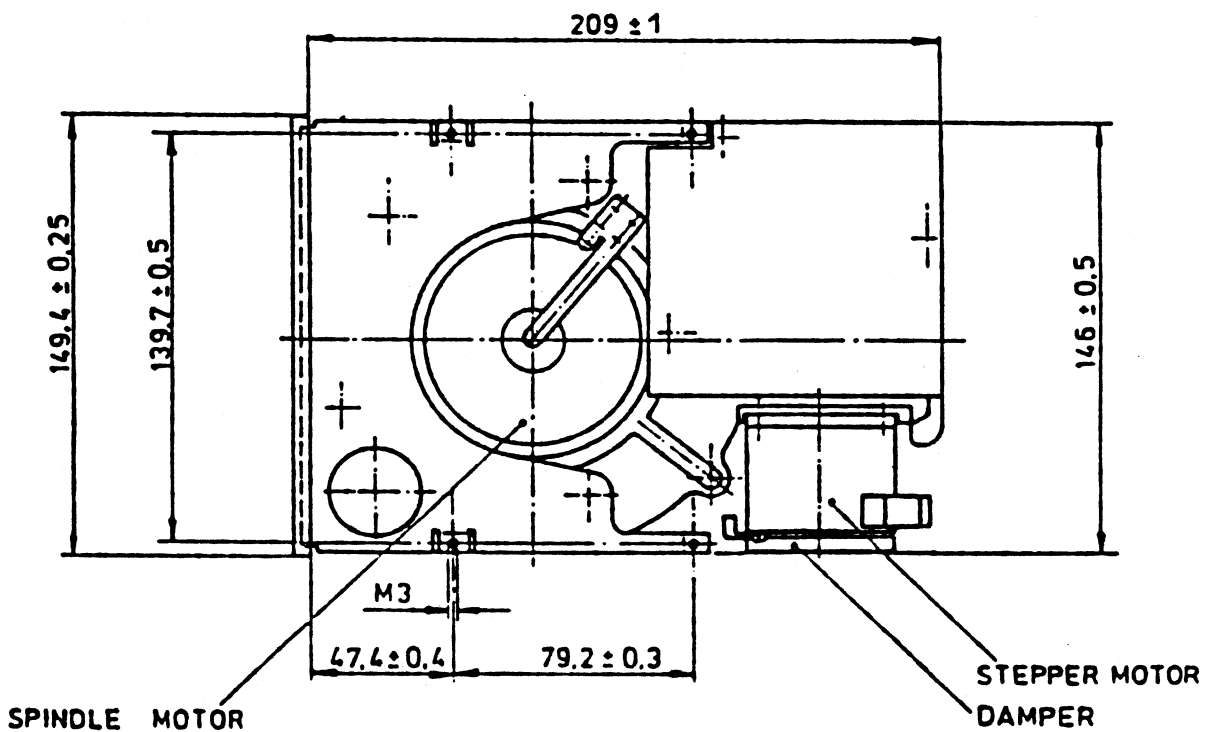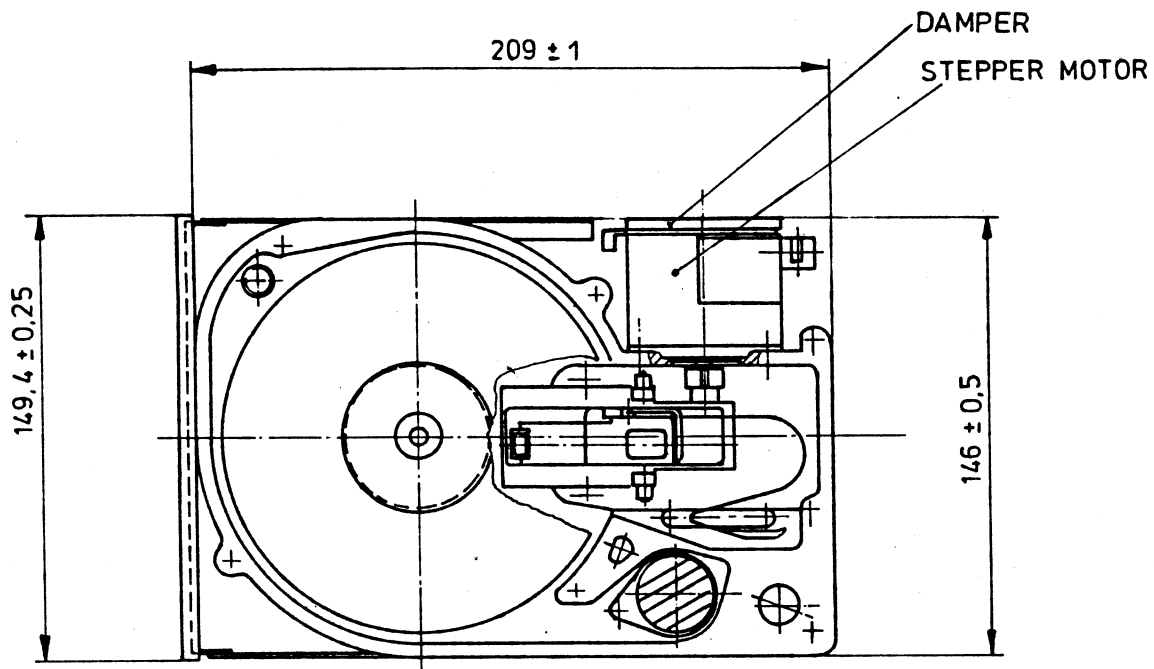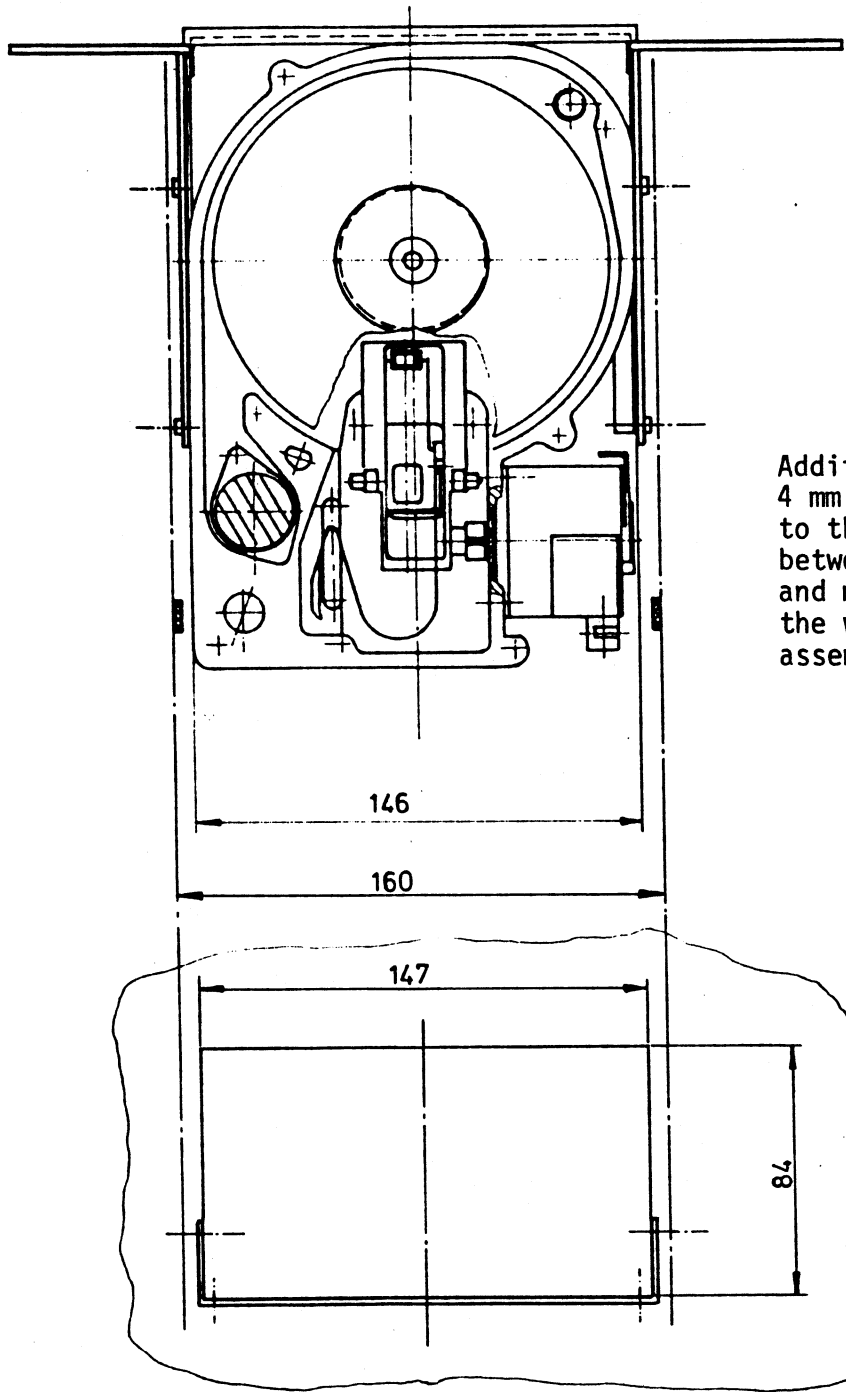## 4. DRIVE PHYSICAL DIMENSIONS

FIGURE 4 - 1 :   SIDE VIEW

FIGURE 4 - 2 : BOTTOM VIEW

DAMPER

STEPPER MOTOR

209 ± 1

149,4 ± 0,25

146 ± 0,5

All dimension in mm

FIGURE 4 - 3 : TOP VIEW

Additional space of
4 mm is needed, due
to the shockmounting
between diecasting
and mounting frame
the whole head-disk-
assembly may swing.

146

160

147

84

All dimensions
in mm

FIGURE 4 - 4 : MOUNTING RECOMMENDATION

STEPPER MOTOR

HDA

P6.1

P6.2

READWRITE
CONTROL
PCB

1
4
J3

4

J1

GND
J4

J7

J5

P8.2
P8.1

MOTOR
CONTROL
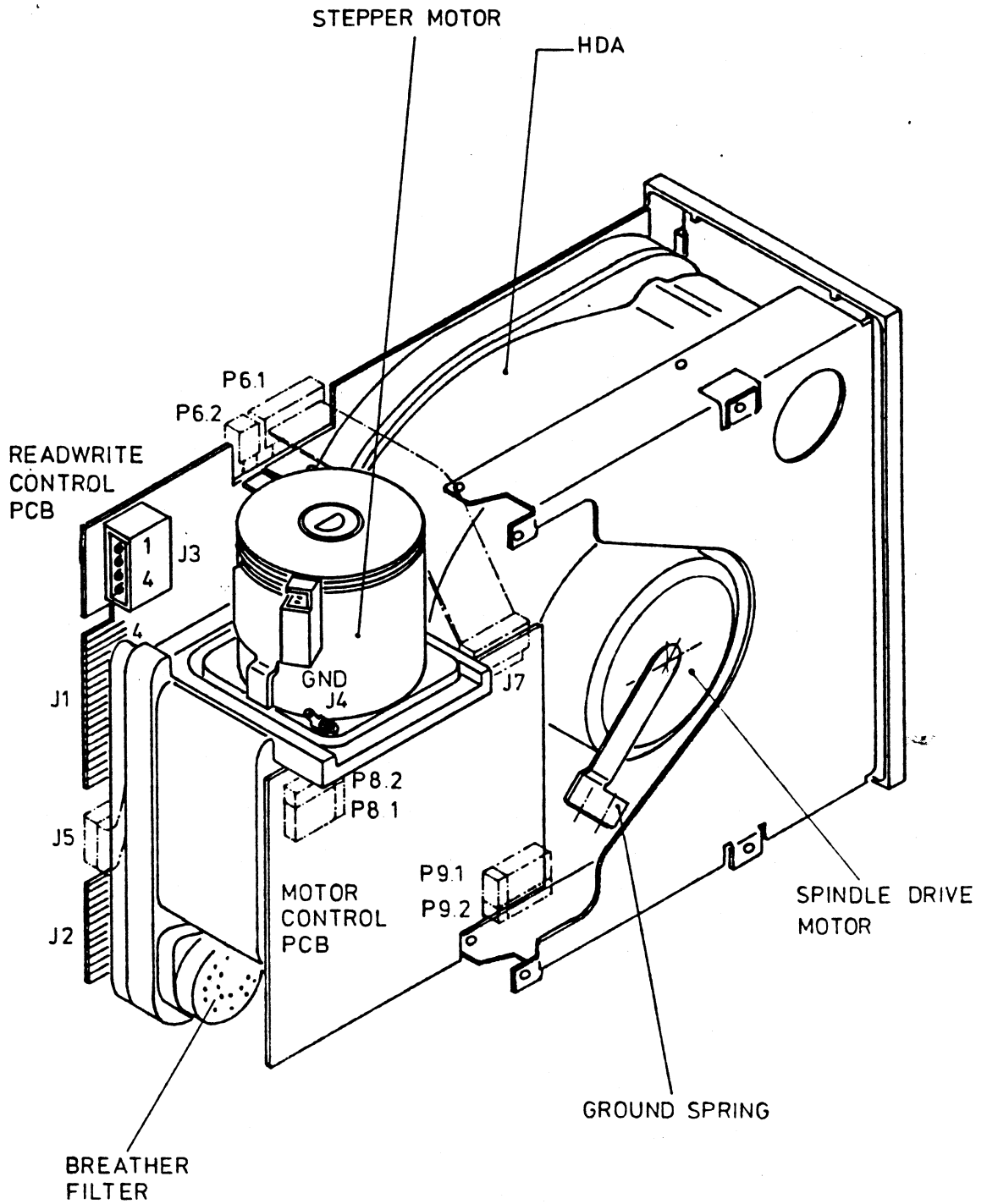PCB

P9.1
P9.2

J2

SPINDLE DRIVE
MOTOR

GROUND SPRING

BREATHER
FILTER

FIGURE 4 - 5 :   CONNECTOR LOCATIONS