PHILIPS Data Systems

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Field Support Manual
Mini Flexible Disk Drives
X3111/12/13/14

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TABLE OF CONTENTS

1 GENERAL DESCRIPTION

LIST OF ILLUSTRATIONS

1.1 INTRODUCTION

The Philips X3111/2/3/4 Mini Flexible Disk drives are designed to provide low cost, random access storage, with high performance and reliability.

Reliability is enhanced by the simplicity of both electronic and mechanical design.

These 'slimline' drives ($^2/_3$ the height of standard mini flexible drives) are fitted with a screen which makes them less susceptible to noise from external sources.

All drives are capable of single density (FM) or double density (MFM) recording modes.

Unformatted data capacities are from 125K bytes to 1M byte, depending on the drive type and the recording method.

Commonality of components is achieved by using one basic drive ordered with the four possible combinations of 48 or 96 tracks per inch stepper motor, and single or double sided head arrangement. Door lock, disk ejector and electrical head load options are available for all 4 drives.

A single PCB carries all the electronic components. Only the heads, motors, sensors and indicators are mounted on the chassis.

Moving the heads to a required track, loading and selecting heads, writing and reading are all controlled via signals from the host system, therefore the operation and formatting are completely flexible within the limits imposed by the disk drive specifications.

The interface is based on the industry standard and is compatible with current major OEM drives. A number of plug-in straps allow the interface to be configured in several ways.

Operator features include an activity LED to show that the disk loading door is, or is not locked, an optional, disk ejector and a facility to run the motor temporarily each time a cartridge is inserted, thus correctly centreing the disk.

1.2 PHYSICAL DESCRIPTION (FIGURES 1.1 AND 1.2)

The drives, which weigh 1.3 Kg, are based on a 20cm x 14.5cm x 5.3cm alloy casting on which are mounted the spindle, spindle motor, head carriage, stepper motor and head load mechanisms. Head assembly, stepper motor and head load mechanisms vary according to the model and the factory option.

In the mechanical head load version, a spring-loaded, hard plastic moulding holds the head(s) away from the disk when the disk loading door is open. When the door closes, a push-rod operates a lever which compresses the spring and allows the heads to load. The same push-rod operates a switch which indicates that the loading door is closed. In the electrical head load version, the head(s) are loaded by the action of a solenoid.

The door lock/unlock function is decided by the mounting position of the solenoid (figure 1.2b). Reversal is a simple matter.

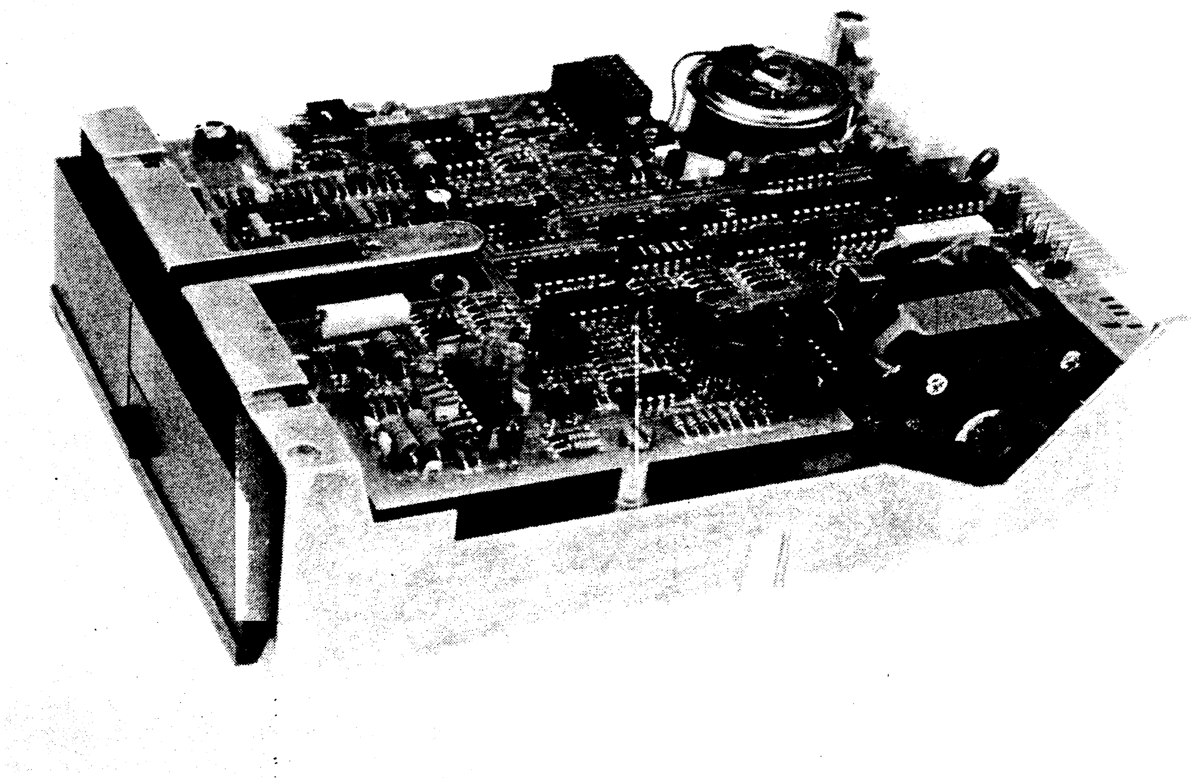


Figure 1.1 X3114 MINI FLEXIBLE DISK DRIVE

The spindle, which is belt driven by the spindle motor, has a stroboscopic disk on the underside. This provides a visual guide to spindle speed (assuming the local mains frequency is reliable).

The head carriage assembly is mounted on two steel bars which are positively located against the casting. Connection to the pulley of the stepper motor is by a spring-steel bit.

A 4 phase stepper motor, which is mounted on a sliding bracket, drives the carriage in order to access the required track or cylinder. The sliding bracket is used during radial alignment of the heads.

All electronic circuits are mounted on a single PCB which is fixed on top of the frame by 3 screws. Connection to the chassis-mounted components is via 4 plugs and sockets at the rear of the board.

Connection to the outside world is via ST1, thirty four-way interface plug and by ST2, four-way power plug. These items are mounted at the rear of the board. Write protect and index LEDs, track 0 detector, and a socket for the activity LED loom (MFDF), which connects these items to ST5. The "door closed" and "door lock/unlock" elements can be easily soldered to connection points on the loom.

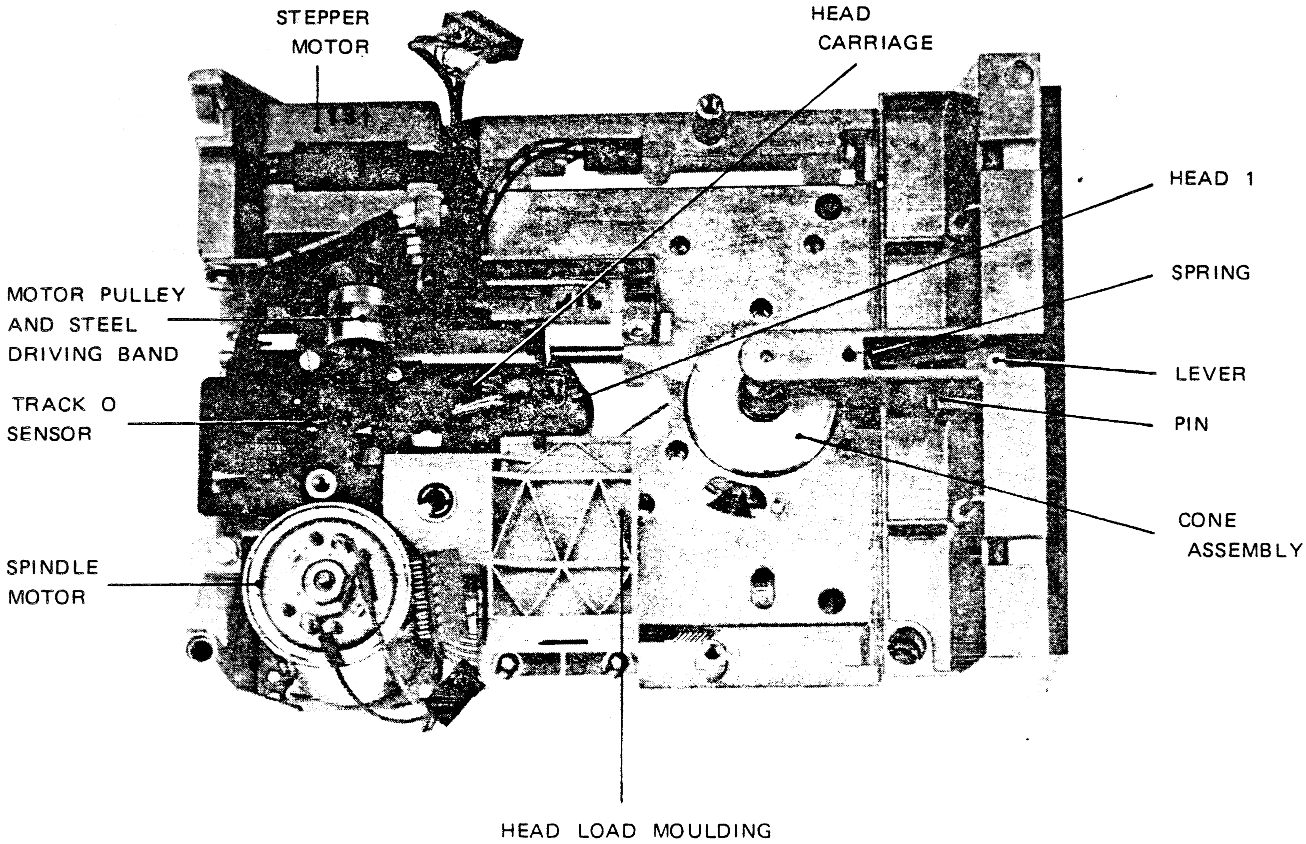


Figure 1.2a

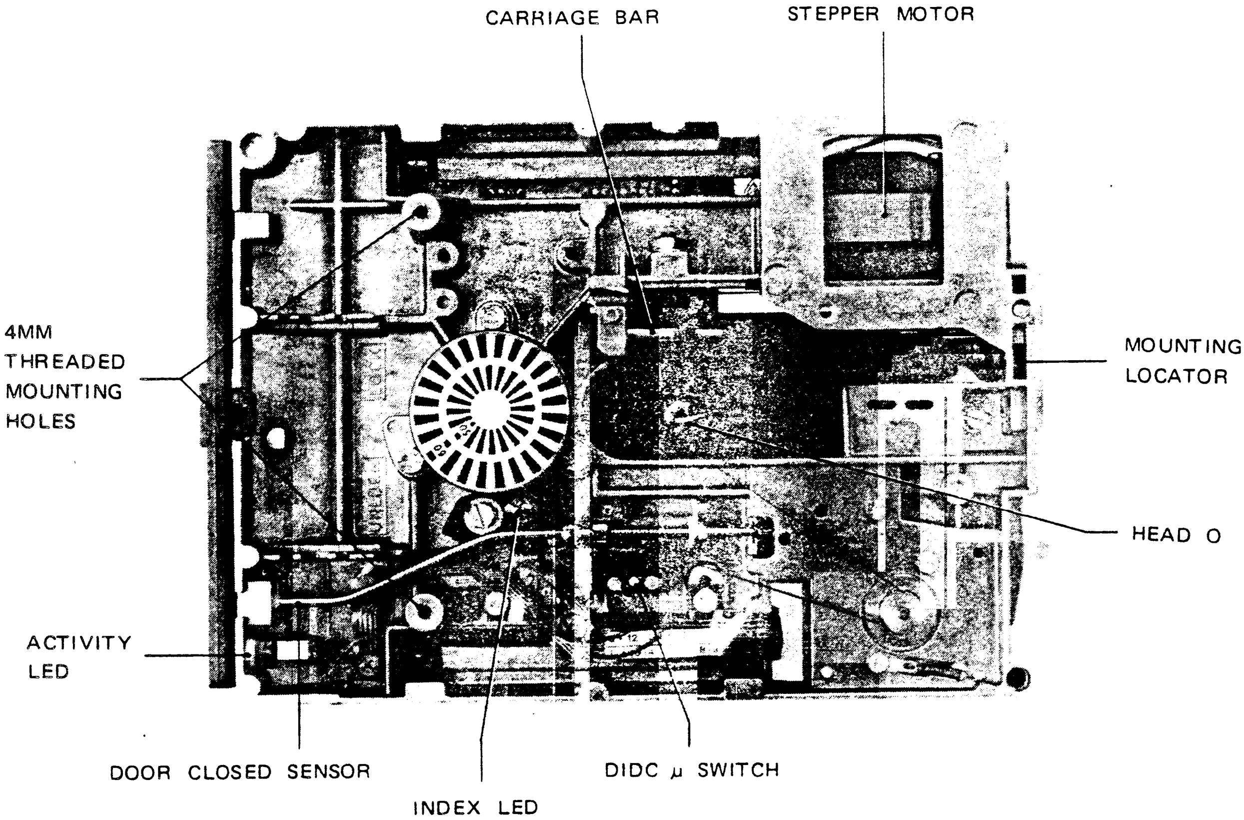


Figure 1.2b

Figure 1.2 PHYSICAL ARRANGEMENT

1.3 TECHNICAL DATA

1.3.1 PERFORMANCE DATA

Cartridge size	133.35mm (5.25 inch)
No. of disks	1
No. of surfaces	X3111/3 1 X3112/4 2
Tracks/inch	X3111/2 48 X3113/4 96
Tracks/surface	X3111/2 40 X3113/4 80
Data Kbytes/track	6.2 (MFM), 3.1 (FM)
Data Kbytes/surface	X3111/2 250 (MFM), 125 (FM) X3113/4 500 (MFM), 250 (FM)
Total capacity (K bytes)	X3111 250 (MFM), 125 (FM) X3112 500 (MFM), 250 (FM) X3113 500 (MFM), 250 (FM) X3114 1000 (MFM), 500 (FM)
Bit density (MFM)	7958 flux transitions/radian
Bit density max.	X3111/2 5676 flux reversals/in (TK39) X3113/4 5876 flux reversals/in (TK79)
Data transfer rate (MFM)	250 K bits/sec.
Rotation speed	300 rpm. ± 3% overall
Latency	100 msecs.
Track/positioning time	5 msecs/track, plus 15 msecs.
Ave positioning time	80 msecs. (X3111/2) 147 msecs. (X3113/4)
Max. positioning time	210 msecs. (X3111/2) 410 msecs. (X3113/4)
Spindle up to speed	500 msecs.
Head load (option)	30 msecs. (max.).

1.3.2 POWER REQUIREMENTS

+ 5V ±5%   less than 0.55 A.

+12V ±5%; current dependent on the factors as listed below:

No write Heads loaded Stepper stationary Spindle motor on Door lock solenoid de-energised	)	Less than .9A
Spindle motor switch-on surge	:	Less than 1.7A for 50 msecs (at 10° C)
Stepper motor max. current	:	500mA (48TPI)) at 10°C 550mA (96TPI))
Door lock	:	Less than .2A
Total dissipation	:	Less than 12 watts

1.3.3 PHYSICAL CHARACTERISTICS

Dimensions : 21.6 cm x 15 cm x 5.75 cm

Weight : 1.3 Kg.

1.3.4 ENVIRONMENTAL CONDITIONS

Operating Environment :	Temperature	: 10° to 45° C
	Temperature change	: 10° C/hour
	Relative humidity	: 20% to 80%
	Max. dewpoint temperature	: 28° C

Providing that no condensation forms on any part of the drive or media.

Storage Environment :	Temperature	: -40° to +70° C
	Relative humidity	: 5% to 95%
	Max. dewpoint temperature	: 28° C

Providing that no condensation forms on any part of the drive or media.

1.4 INTERFACE

1.4.1 GENERAL

This section describes the interface between the mini flexible disk drive and its control unit.
Pin assignments are tabulated in figures 1.3. Drives with which this interface is compatible, are tabulated in figure 1.4.
All interface signals are TTL compatible. Logic true is +0.4 V maximum and logic false is +2.4 V minimum.

DIRECTION (controller)	SIGNAL FUNCTION	SIGNAL NAME	P1 PIN NO.
	Ground		1
to	Unit ready status*	URDY-N	2
from	Load head(s)*	HLD -N	
	Ground		3
from	In use (door lock/unlock)	DUN -N	4
	Ground		5
from	Unit select 4*	US4 -N	6
to	Unit ready status*	URDY-N	
from	Spindle motor on*	MTRN-N	
	Ground		7
to	Index pulses	IND -N	8
	Ground		9
from	Unit select 1	US1 -N	10
	Ground		11
from	Unit select 2	US2 -N	12
	Ground		13
from	Unit select 3*	US3 -N	14
from	In use (door lock/unlock)*	DUN -N	
	Ground		15
from	Spindle motor on	MTRN-N	16
	Ground		17
from	Stepper direction in	DIR -N	18
	Ground		19
from	Step	STP -N	20
	Ground		21
from	Composite write data	WRDA-N	22
	Ground		23
from	Write gate	WREN-N	24
	Ground		25
to	Track 00	TK00-N	26
	Ground		27
to	Write protect	WRP-N	28
	Ground		29
to	Composite read data	RDA-N	30
	Ground		31
from	Select head 1	HDS-N	32
	Ground		33
from	In use (door lock/unlock)*	DUN-N	34
to	Disk change*	DISK CHANGE-N	

Note: One only, of functions marked * may be strap selected at a time. See strap settings section 1.6.1.

Figure 1.3 X3111/2/3/4 INTERFACE CONNECTIONS

Drive TYP	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	User Selectable Options
									PIN									
Shugart SA 400	-	-	-	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-	-	Head Load with Select Line
Shugart SA 450	-	-	-	Index	Select 4	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	Head Select	-	Head Load with Motor On Line
Shugart SA 410	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-		Motor On with Select Load
Shugart SA 460	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	Head Select	-	Motor On with Motor On Line
BASF 6106	Head Load	-	Ready	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-	In Use Disk Change	Head Load with:1. Head Load 2. Select 3. Head Load + Select Door Lock with:1. In Use
BASF 6108	Head Load	-	Ready	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Wrire Gate	TK00	Write Protect	Read Data	Head Select	In Use Disk Change	2. Door Lock Latch Op 3. Select 4. Head Load Write Protect: Notch open or covered
CDC 9408	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-	-	Head Load with Select Line
CDC 9409	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	Head Select	-	Head Load with Motor On Line
MPI Model 51	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-	-	Head Load with Select
MPI Model 52	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	Head Select	-	
Philips X3111/X3113	-	In Use	Select 4	Indxex	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	-	-	Head Load with:1. Ready 2. Motor On 3. Select
Philips X 3112/X3114	-	In Use	Select 4	Index	Select 1	Select 2	Select 3	Motor On	Direc- tion	Step	Write Data	Write Gate	TK00	Write Protect	Read Data	Head Select	-	4. Head Load Door Lock with:1. Door Lock 2. Door Lock + Select 3. Door Lock Latch Op

Figure 1.4 POSSIBLE INTERFACE CONFIGURATIONS

1.4.2 CONTROL AND DATA LINE FUNCTIONS

URDY- N	Drive loaded, up to speed and selected (only when electrical head load option is used)
HLD - N	Load head(s)
DUN - N	Lock/unlock loading door, and/or light busy LED
US1-4-N	Enable control and status lines of drives 1-4
MTRN- N	Run the spindle motor
IND - N	Index pulses
DIR - N	Select direction of carriage movement
STP - N	Move one track in direction indicatd by DIR-N
WRDA- N	Write data and clock pulses
WREN- N	Enable write circuits, disable read WREN-N also generates the erase signal ERASE via a delay circuit
TK00- N	Heads are over track 00
WRP - N	Write protected disk loaded
RDA - N	Read data and clock pulses
HDS - N	Select head 1

IN USE-N/DISK CHANGE-N This optional function is included on pin 1/34 to provide compatibility with B.A.S.F. mini flexible interfaces. It allows pin 34 to be used for a latched, door lock/unlock signal, or as an indication of change of ready status (see section 3.15).

Note: Except for the special case of IN USE/DISK CHANGE, interface lines are not latched, so the DC levels on HLD, DIR, WREN, US, MTRN, HDS and DUN must be maintained as necessary.

Figure 1.5 CONTROL AND DATA LINE FUNCTIONS

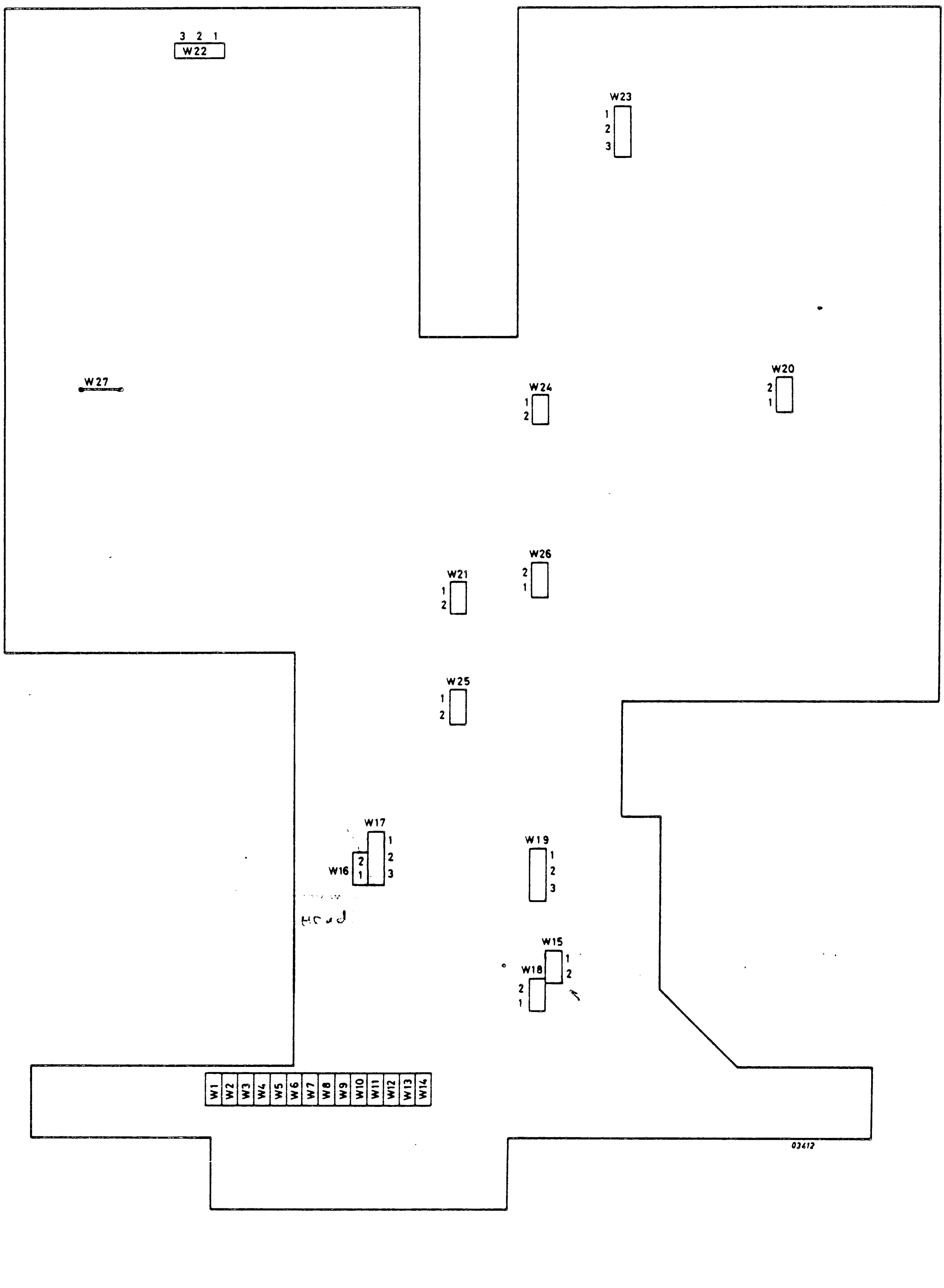


Figure 1.6 TEST POINT AND STRAP LOCATIONS

1.5 APPLICATION NOTES

These drives are designed for general OEM use. The adaptable, industry standard interface, and the range of data capacity and options, makes them ideal for this purpose.

The slimline dimensions ($^2/_3$ the height of standard mini flexible drives) and extra screening, suit typical desk-top applications.

1.6 INSTALLATION DATA

1.6.1 STRAP SETTINGS

FUNCTION	LINE	STRAPS	STRAPS NOT TO BE INSTALLED	
Unit Select 1	10	12	6/8/13/14	
Unit Select 2	12	13	6/8/12/14	
Unit Select 3	14	8	6/7/12/13/14	
Unit Select 4	6	6	4/5/8/12/13/14	
Continuous Select	-	14	6/8/12/13	
Motor On 1	16	9, 20	4	
Motor On 2	6	4, 20	5/6/9	
Motor On Continuous	-		20	
Ready 1	2	1	2	
Ready 2	6	5	4/6	
Disk Change	34	11	10	
Head Load	2	2	1	
Door Lock	4	3, 19 (1-2)	7/10/24)	MAY BE 'ANDED'
Door Lock	14	7, 19 (1-2)	3/8/10/24)	WITH 'US' BY
Door Lock	34	10, 19 (1-2)	3/7/11/24)	INSTALLATION
Door Lock Continuous		24, 19 (1-2)	3/7/10)	OF W18 ALSO

Note: Door Lock = Door Lock/unlock and/or busy LED.

Figure 1.7 INTERFACE FUNCTION STRAPS

Strapping tables should be interpreted as follows:

0 = STRAP REMOVED
1 = STRAP INSTALLED
X = STRAP DEFINED ELSEWHERE

STRAPS				FUNCTION
W16	W15	W17 1-2	W17 2-3	
X	X	0	1	HEAD LOAD WITH 'UP TO SPEED'
X	X	1	0	HEAD LOAD WITH 'MTRN-N'
X	0	X	X	HEAD LOAD INDEPENDANT OF 'US'
X	1	X	X	HEAD LOAD DEPENDANT ON 'US'
0	X	X	X	HEAD LOAD INDEPENDANT OF INTERFACE SIGNAL
1	X	X	X	HEAD LOAD DEPENDANT ON INTERFACE SIGNAL

Figure 1.8 HEAD LOAD FUNCTION STRAPS

STRAPS			FUNCTION
W19 1-2	W19 2-3	W18	
1	0	0	DOOR LOCK FROM INTERFACE SIGNAL ALONE
1	0	1	DOOR LOCK BY I/F SIGNAL AND 'US'
0	1	X	DOOR LOCK SIGNAL LATCHED BY 'US'

Figure 1.9 DOOR LOCK FUNCTION STRAPS

STRAPS	FUNCTION
W21	TEST POINT - 96 TPI MONO-FLOP OUTPUT
W22	TEST POINT - ANALOGUE READ SIGNAL
W23	TEST POINT - NTROO (pin 3) and INDX (pin 2)
W26	TEST POINT - READY MONO-FLOP OUTPUT
W27	SINGLE SIDED DRIVE - (STRAP IN)
	DOUBLE SIDED DRIVE - (STRAP OUT AND IC17 IN)
W25	48 TPI DRIVE - (STRAP IN)
	96 TPI DRIVE - (STRAP OUT AND IC17 IN)

Figure 1.10 TEST POINTS AND CONFIGURATION STRAPS

1.6.2 MOUNTING (SEE FIGURES 1.11 AND 1.12)

CHASSIS

The chassis is drilled and tapped for mounting by means of a stepped, locating cavity (C) at the rear and two 4 mm tapped holes at 10 cm centres (A).

As an option, four 6mm threaded holes to a depth of 10 mm can be provided (B). Further mounting options may be possible on request.

FRONT PANEL

A removable front panel, or mask, clips around the loading door. Two sizes are available to provide compatibility with major OEM dimensions:

a) Height 86.5 mm   Width 150 mm   Thickness 6 mm
b) Height 57.5 mm   Width 150 mm   Thickness 6.5 mm

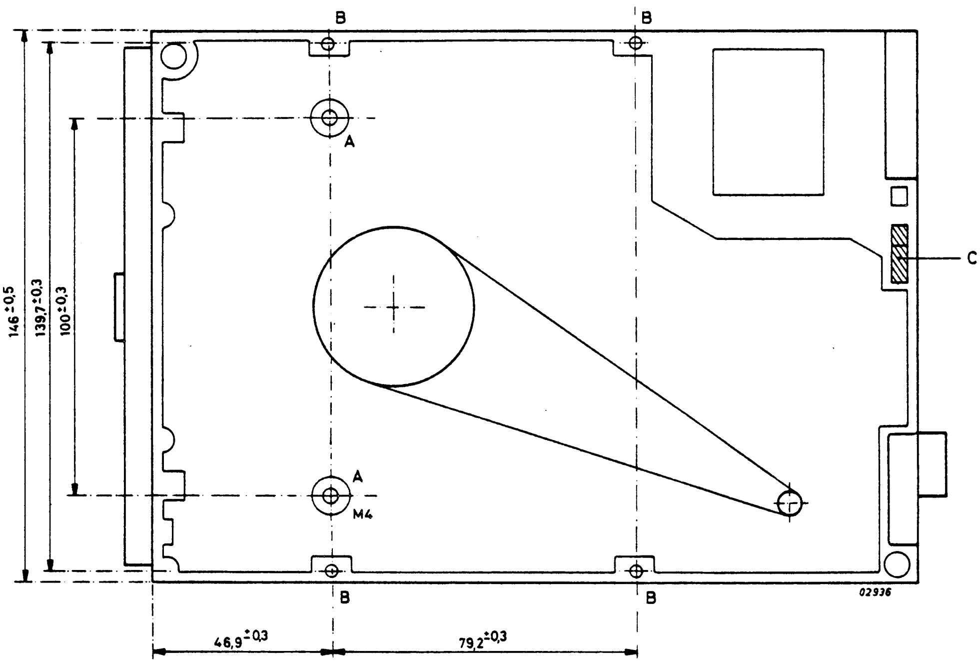


Figure 1.11 CHASSIS MOUNTING DETAILS

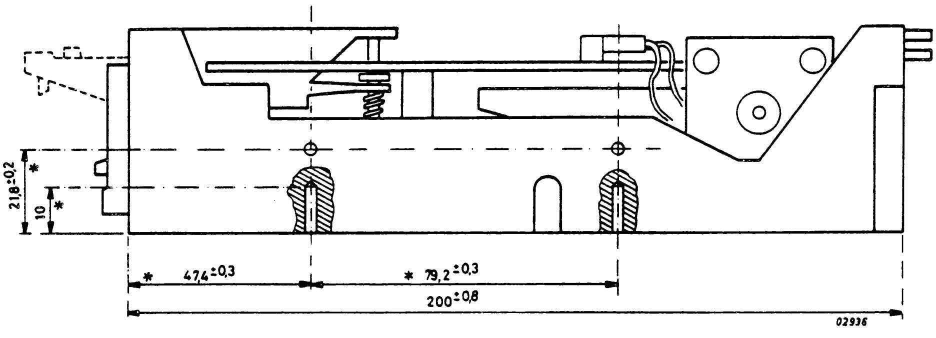
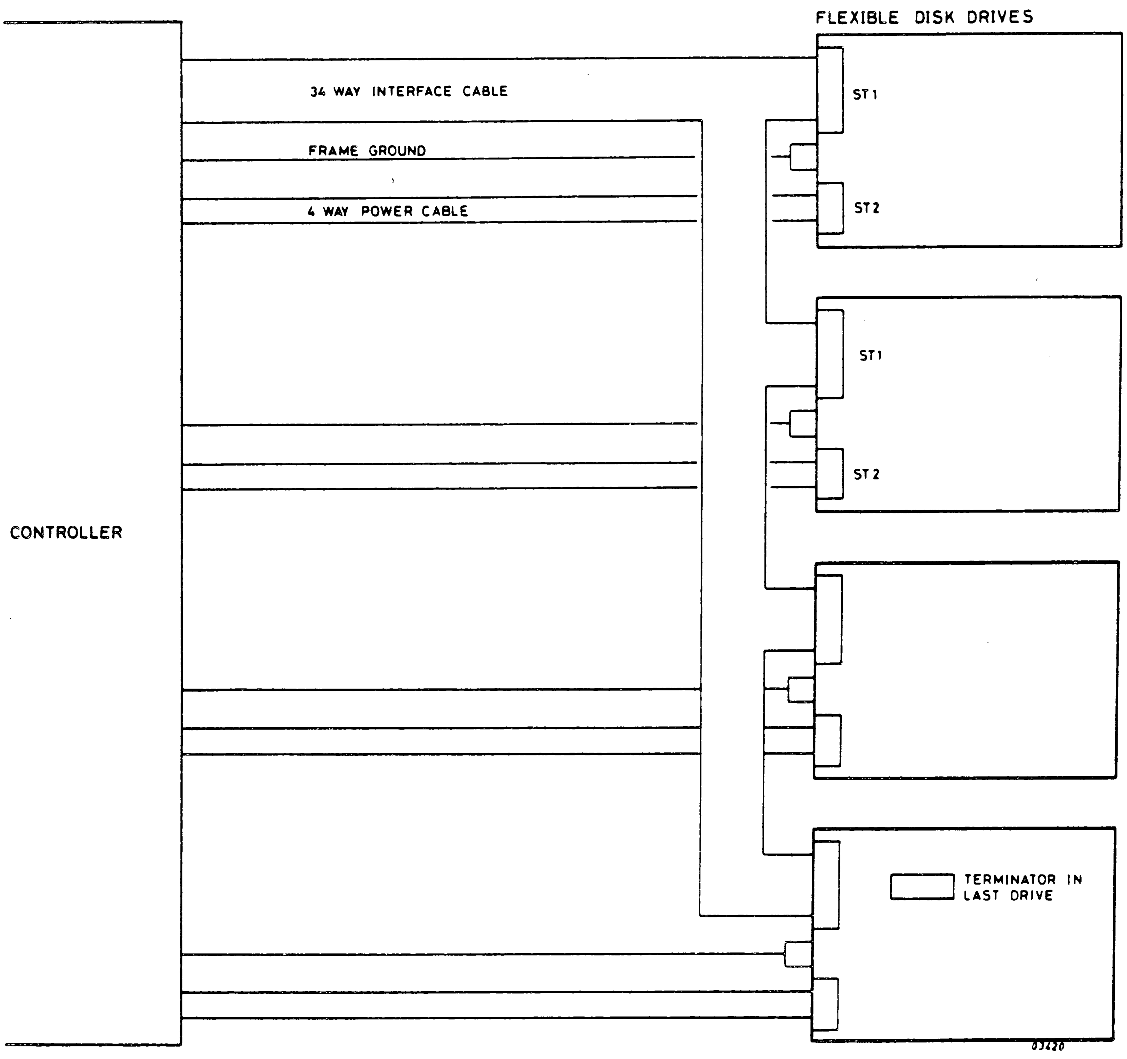


Figure 1.12 6 mm UNC 6-32 THREAD OPTION

1.6.3 INTERCONNECTIONS



Note 1: Full complement of 4 drives shown connected.

Note 2: A terminator must be installed in the final drive only.

Figure 1.13 INTERCONNECTION DIAGRAM

I/O CABLE AND CONNECTOR

Command status and data are transmitted between the host controller and the drive by flat ribbon cable.

I/O Cable and connector is 34 Pin, 3M connector 3463-0001 with 3M flat cable 3365-34.

Note: A plug in terminator chip (supplied) must be inserted in the last drive in a chain. This will terminate all the receive lines with 132 Ohm.
Similar termination must be provided by the controller on each input signal line from the drive.

DC CABLE AND CONNECTOR

The mFD utilizes an AMP 1-480424-0 (socket) and 1-480426-0 (plug on PCB) receptacle (see figure 1.15). Pin assignments for the DC-connetor are:

Pin	Use
1	+12V
2	+12V RETURN
3	+ 5V RETURN
4	+ 5V

FRAME GROUND

The drive frame ground is connected to the system ground, by means of a plug on the mFD, and can be carried in the DC cable to the system (see figure 1.16).
Plug on the Drive is of the type Fast-ON-Tab AMP-PIN 61664-1, with mating connector AMP PIN 60972-1.

MFD PLUG ASSIGNMENTS

ST1 - Interface connections
ST2 - Power connections
ST3 - Head connections
ST4 - Stepper motor connections
ST5 - Chassis sensors, leds and solenoids
ST6 - Spindle motor and head load solenoid

Note: For plug locations see figures 4.2 to 4.4.

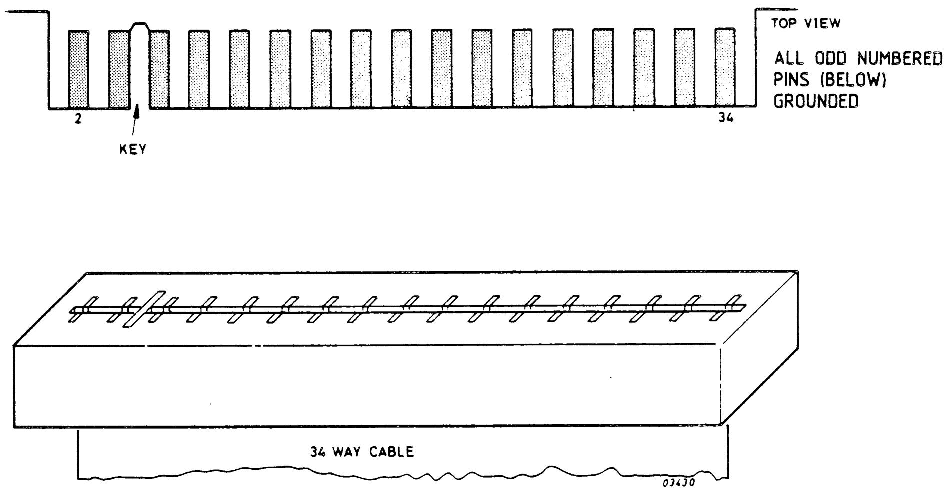


Figure 1.14 I/O CABLE AND CONNECTOR

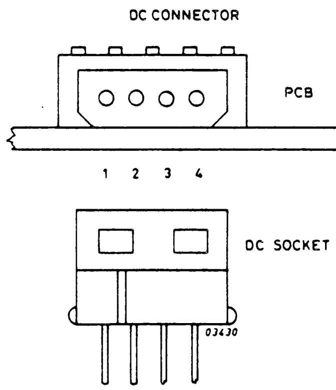


Figure 1.15 DC CABLE AND CONNECTOR

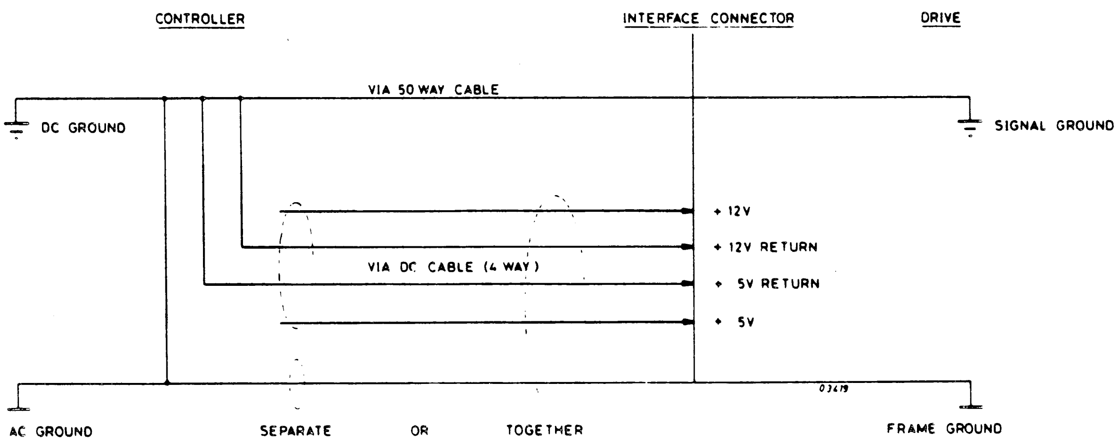


Figure 1.16 SYSTEM GROUNDING

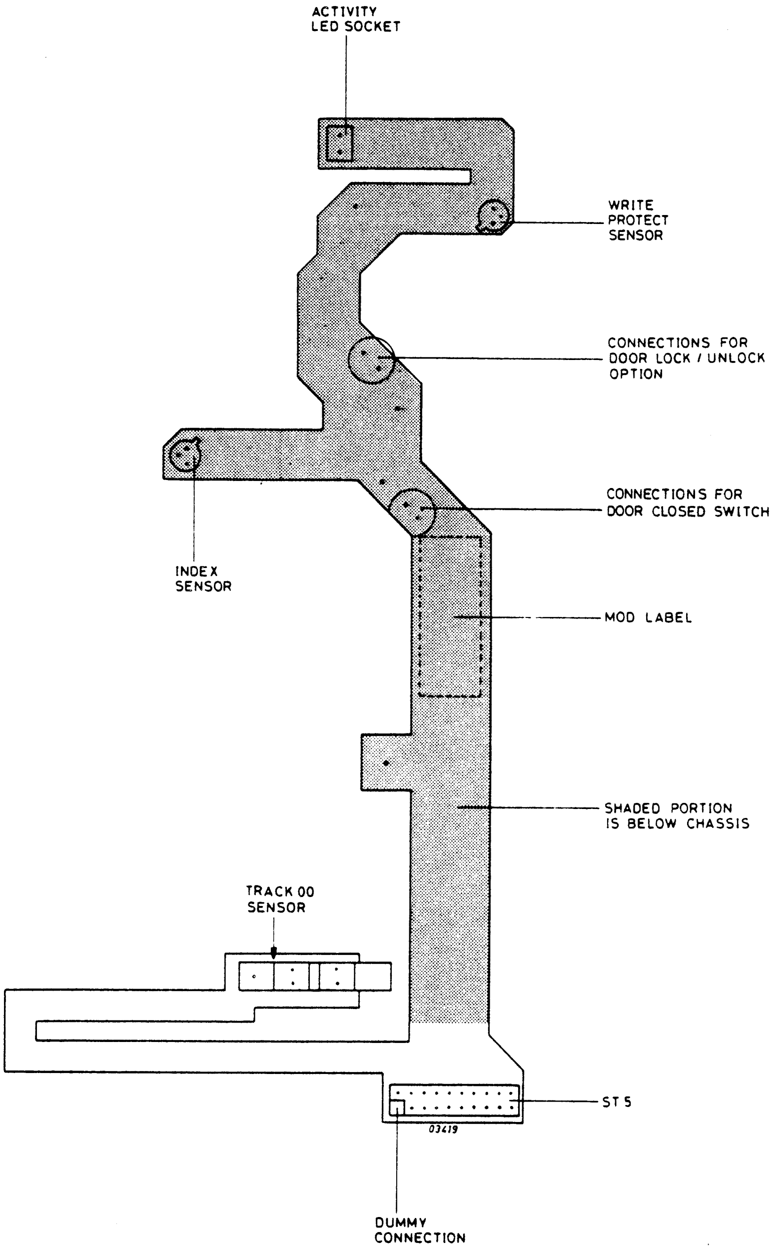


Figure 1.17 WIRING LOOM MFDF

1.6.4 COMPATIBILITY

Not applicable.

1.6.5 PACKING AND UNPACKING

The drive is supplied in a plastic bag inside two halves of a styrofoam shell.
This is then placed in a cardboard box.
Outside dimensions of the package are: 280 mm x 196 mm x 123 mm.
The packing should be kept for future transport.

2 FUNCTIONAL DESCRIPTION

LIST OF ILLUSTRATIONS

2.1 DISKETTE AND CARTRIDGE

2.1.1 PHYSICAL AND ELECTROMECHANICAL CHARACTERISTICS

Diskettes should conform to ECMA 66 (single sided) or ECMA 70 double sided) Diskette and cartridge details are shown in figure 2.1.

The index hole and the write enable slot are optically detected.

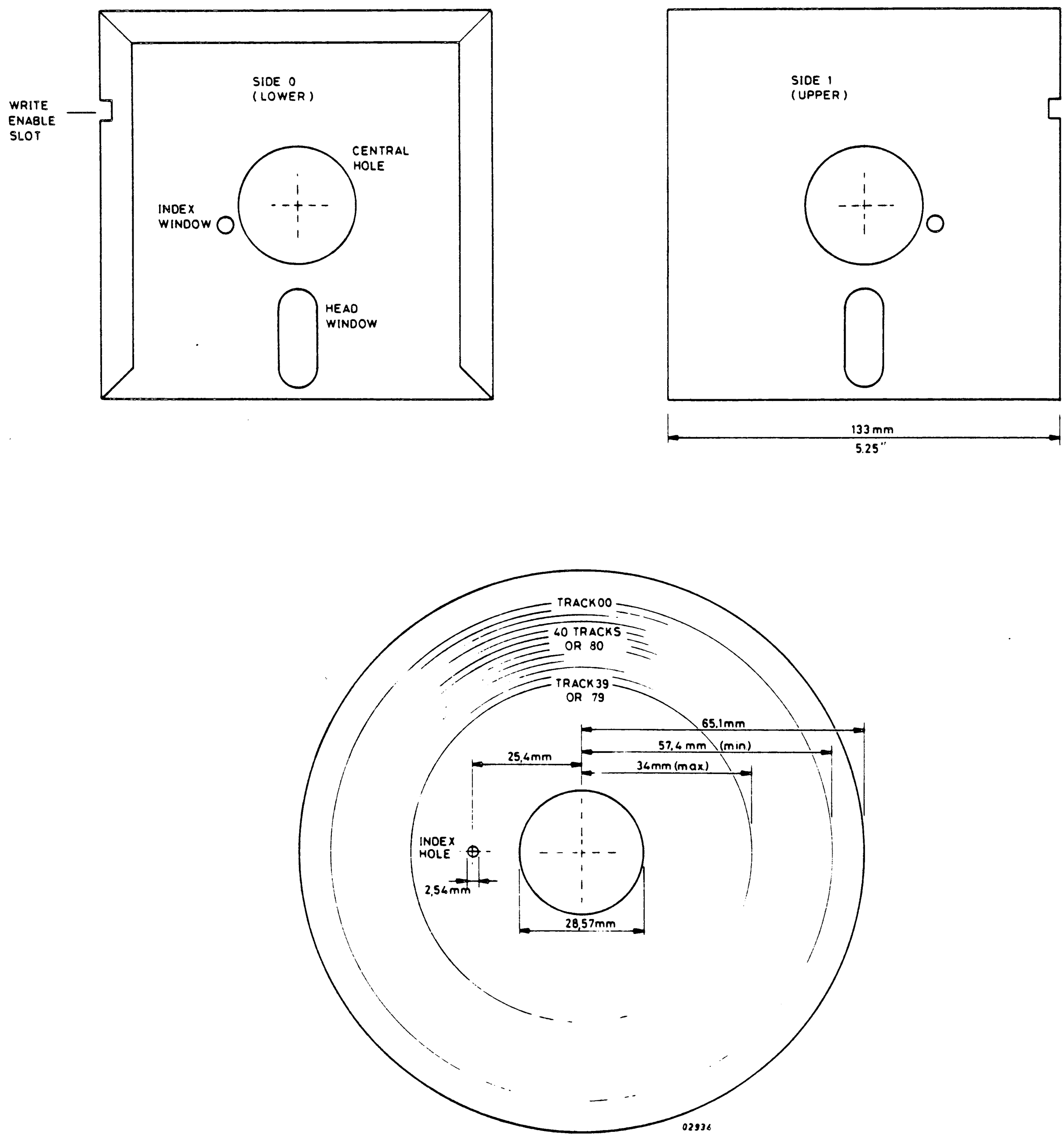


Figure 2.1 DISKETTE AND CARTRIDGE

2.1.2 DISKETTE FORMAT (FIGURE 2.2)

The number of sectors/track, and the diskette format used is customer dependent, however, an explanation of the ECMA 70 recommended format is given as an example.

2.1.3 TRACK DENSITY

Track 00, side 0 is recorded by the frequency modulation (FM) method. All other tracks are recorded by the modified frequency modulation (MFM) method. Refer to section 2.2 for further detail.

2.1.4 SECTOR FORMATTING (FIGURE 2.2)

Except that an index gap occurs before the first sector, and a track gap occurs after the last sector, all sectors have the same format.

2.1.5 GAPS

The gaps are filled with a number of bytes, all recorded as:

TRACK 00, SIDE 0 = FF Hex
All Other TRACKS = 4E Hex

2.1.6 SECTOR IDENTIFIER

This block contains the following information:

MARK	- indicates beginning of block
CYLINDER NUMBER	- 00 to 34
SIDE NUMBER	- 0 or 1
SECTOR NUMBER	- 01 to 16
ERROR DETECTION CHARACTERS	

2.1.7 DATA BLOCK

Consists of:

MARK	- indicates beginning of block
DATA	- 256 (MFM) or 128 (FM) bytes
ERROR DETECTION CHARACTERS	

2.1.8 INDEX GAP

This allows time, considering the ± 3% speed tolerance, for the index pulse to be recognised, and provides a recognisable pattern, different from the identifier mark.

2.1.9 IDENTIFIER GAP

Provides separation between identifier and the data block, to prevent accidental partial overwriting of data.

2.1.10 DATA BLOCK GAP

Separates blocks to prevent accidental partial overwriting.

2.1.11 TRACK GAP

Fills the space between the last sector and the index hole.

SECTOR SEQUENCE	TRACK 00, SIDE 0	ALL OTHER TRACKS
INDEX GAP	16 x FF_h	32 x $4E_h$
SECTOR IDENTIFIER	13 BYTES	22 BYTES
IDENTIFIER GAP	11 x FF_h	22 x $4E_h$
1ST DATA BLOCK	137 BYTES	274 BYTES
DATA BLOCK GAP	24 x FF_h	50 x $4E_h$
BLOCK		
DATA BLOCK GAP	24 x FF_h	50 x $4E_h$
TRACK GAP	149 x FF_h (nom)	330 x $4E_h$ (nom)

Figure 2.2 SECTOR FORMAT

2.2 MODULATION METHODS

2.2.1 (FM) FREQUENCY MODULATION ENCODING (SINGLE DENSITY)

This method of encoding uses clock bits to define a 'bit cell'. If a data bit occurs between clock bits, it is recognised as a '1'. If no data bit occurs, this is recognised as a '0'.

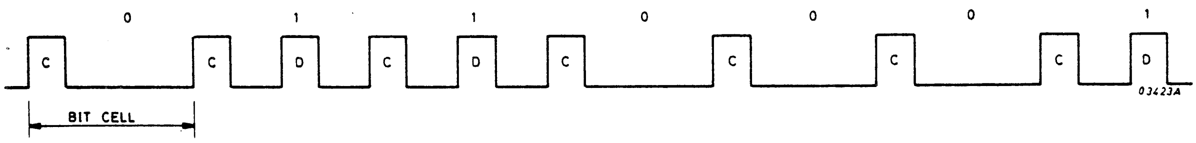


Figure 2.3 FM ENCODING

Clocks are recorded for every cell, so in order to record data at say 125 Kbits/sec., the heads, media, etc. must be capable of handling 250 Kbits/sec.

The rules for this method of recording are:
   Write clock bits at the beginning of each bit cell.
   Write data bits in the centre of the cell.

2.2.2 (MFM) MODIFIED FREQUENCY MODULATION ENCODING (DOUBLE DENSITY)

This method of encoding defines a bit cell by means of clock bits as before but the clock bits are not recorded unless no data bit is present.

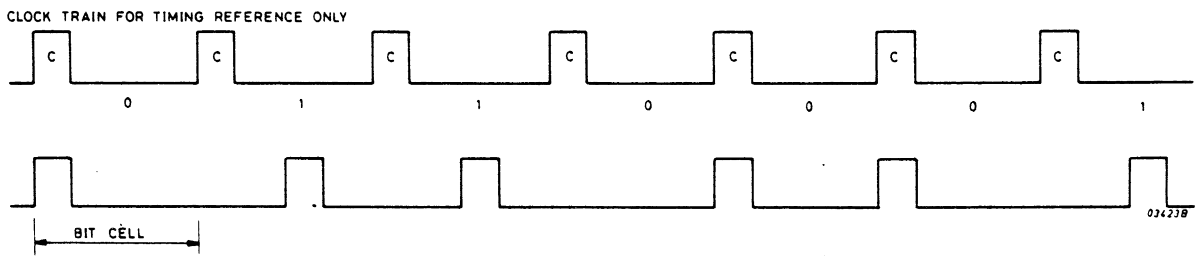


Figure 2.4 MFM ENCODING

The rules for this method of encoding are:
   Write data bits at the centre of the bit cell.
   Write clock bits at the beginning of the cell if:
   1) no data is written in the previous cell, and
   2) there will be no data bit written in the present cell.

By not producing unnecessary clocks, the MFM method allows the clock frequency to be doubled and the data packed closer together. Thus for the same heads, media, etc. as FM, data can be recorded at twice the frequency. Hence the designations single density and double density.

2.2.3 RECORDING ON THE DISK

Data is passed from the controller to the drive as a series of pulses in either FM or MFM coding. The drive converts each pulse into a current reversal in the heads, which creates a flux reversal on the disk (figure 2.5). When reading back, the flux reversals will be converted to pulsed form by the drive. Decoding is performed by the controller.

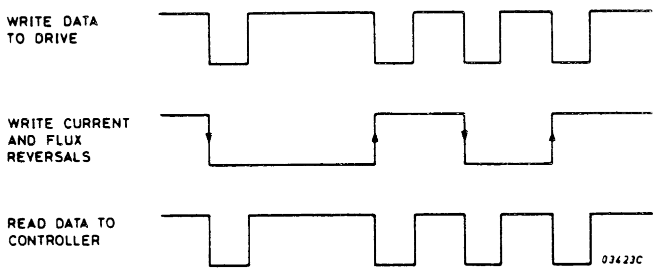


Figure 2.5 NON-RETURN TO ZERO RECORDING AND RECOVERY

2.2.4 WRITE - PRE - COMPENSATION

For MFM pre-compensation during the write process shall be incorporated to minimize the peak shift.
The pre-compensation shall be 250 nsec starting at track 20 for X3111/12 and starting at track 43 for X3113/14.
The following patterns have to be compensated in the direction of the arrow.

LATE	EARLY
X 0 1 1	X 1 1 0
1 0 0 0	0 0 0 1

X = don't care.

2.3 GENERAL

The flexible disk drive, can be considered as having 4 functions:

1. Control function - maintaining overall control of drive activities- ensuring the integrity of data - inhibiting invalid operations.
2. Disk rotation function - switching the spindle motor on and off in response to interface commands - controlling spindle speed.
3. Head positioning function - loading the heads against the disk - moving the heads to the tracks chosen by the controller - alerting the controller that the heads are on a reference track.
4. Data transfer function - converting write data pulses to magnetic transitions on disk - converting information from the disk, into the original pulsed form.

2.3.1 CONTROL (SEE SECTION 1.4 AND FIGURES 2.6a and 2.6b)

The drive uses a number of sensors to monitor whether a disk is loaded and up to speed, whether it is write protected and whether the heads are on track 00. Using this information, the hardware protects the carriage mechanism and prevents accidental erasure of data.

However, the main control is provided by software via the controller.

The master control line is UNIT SELECT which, if false, inhibits all those lines marked with an asterisk. Thus if a particular drive is not enabled by the controller, heads cannot be stepped to a required track, no writing or reading can take place, and drive status signals are inhibited.

The only input lines not effectively inhibited are MOTOR ON, HEAD SELECT and WRITE DATA.
All output lines are dependant on UNIT SELECT.

None of the control signals are latched, thus UNIT SELECT, HEAD LOAD (if used) and WRITE ENABLE, if writing, must be held true for the the duration of the activity.

2.3.2 DISK ROTATION

When MOTOR ON goes true, the spindle motor will start. Its speed will be controlled by the spindle motor control circuit. A timer ensures that once the motor has been started, it will run for at least a minute.

A connection to the write protect logic causes the motor to start (if not already running) during the loading of a disk. This ensures that the disk is correctly centred on the spindle.

The motor control circuit gives rapid initial acceleration before stabilising the disk at around 300 rpm. This brings the disk up to speed very quickly.
MOTOR ON false will stop the motor (subject to the timer operation).

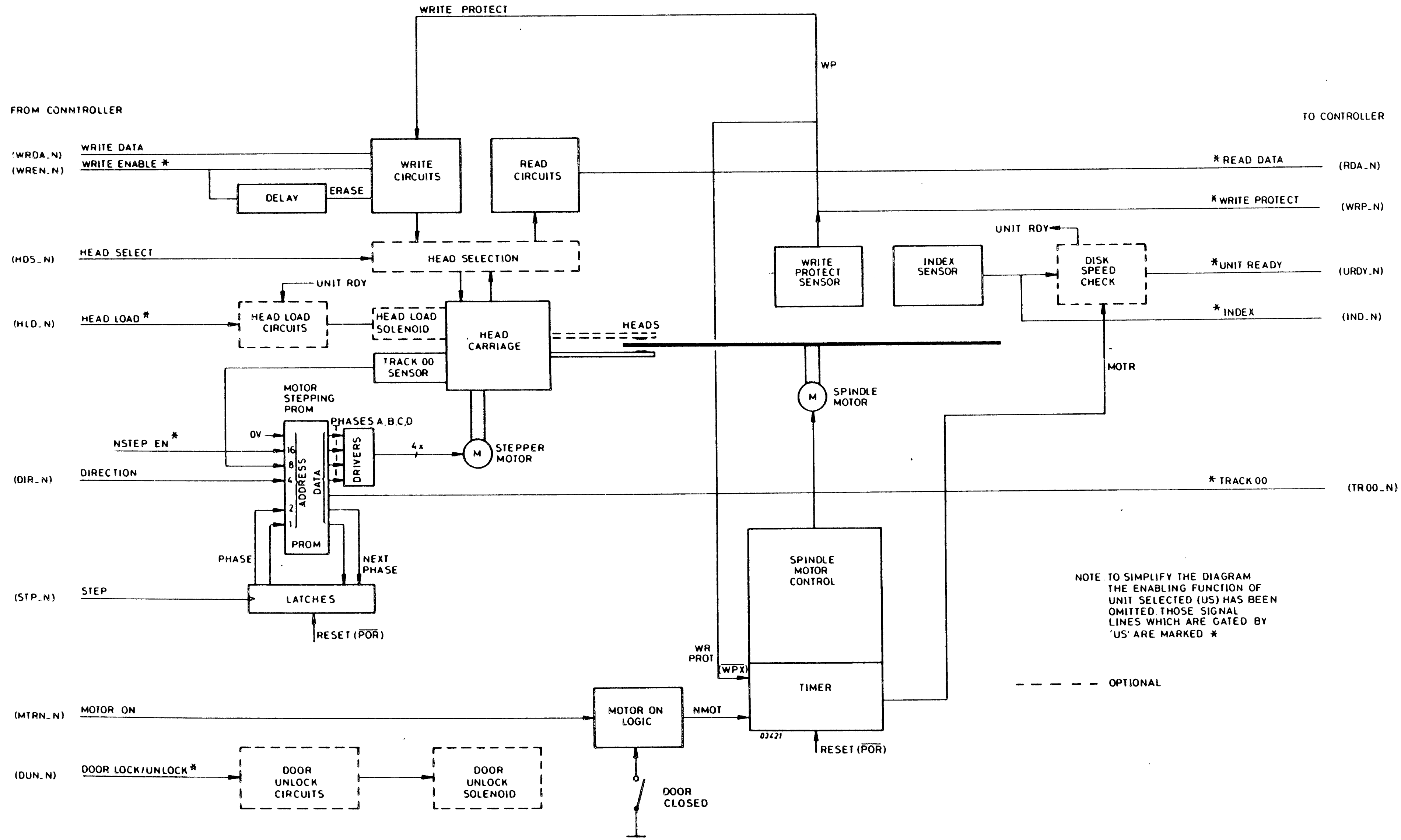


Figure 2.6a FUNCTIONAL DIAGRAM FD

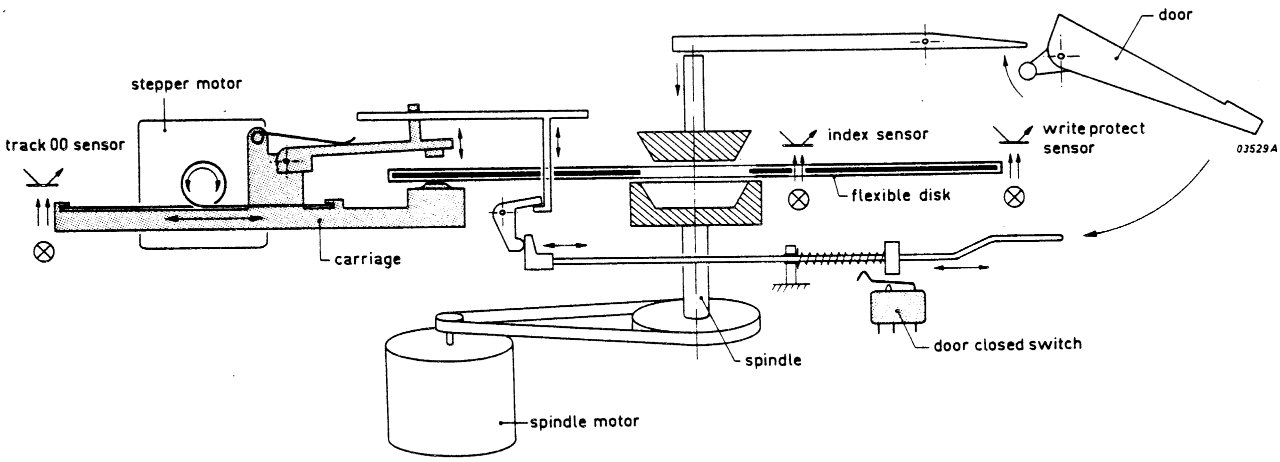


Figure 2.6b FUNCTIONAL DIAGRAM FD

2.3.3 HEAD POSITIONING

In drives without the electrical head load option, closure of the front door allows the heads to load under spring tension.
In drives which use the option, head loading is achieved by operating a solenoid which, when unenergised, holds the heads apart.

Carriage positioning is achieved by supplying a sequence of four 'phases' (A, B, C and D) to a stepper motor which moves the carriage. When true (low), DIRECTION selects a sequence to move the carriage forward; when false, it selects a sequence to move the carriage in reverse.

Each time STEP goes true, the next phase of the sequence is selected and the carriage moves forwards or backwards, one track.

The track 0 sensor advises the controller that track 00 is under the heads and that no further reverse steps should be taken.

2.3.4 DATA TRANSFER

Before transfer of data to or from the controller, the drive must be selected. A disk must be installed and up to speed, and the heads must be loaded, positioned, and in the double sided models, selected.

If writing, WRITE ENABLE must be true and WRITE PROTECT must be false.
As previously mentioned, the composite data and clock information (WRITE DATA and READ DATA) is in pulsed form and will be converted to or from NRZ transitions on the disk.

2.4 POWER ON

When power is applied, a reset signal (NPOR) prevents the timer from starting the motor accidentally. NPOR also clears the Motor Stepping Prom latches, thus selecting the A phase.

Unit ready (URDY-N) will be false.

2.5 MOTOR START

2.5.1 MOTOR START BY DISK INSERTION

If a disk is loaded, the write protect sensor will generate NWP and thus start the motor.
The disk will be up to speed in 500 msecs.

In the absence of a motor-on signal (MTRN-N) the disk will stop after approximately one minute.

If MTRN-N goes true, the motor will continue to run.

2.5.2 MOTOR START BY MOTOR ON SIGNAL

If MOTOR ON (MTRN-N) goes true, the motor will run until MTRN-N goes false or the timer resets, whichever is later.
Figure 2.7 shows details of motor-on timing.

Note: MTRN-N is inhibited if the loading door is open.

2.6 SPINDLE MOTOR CONTROL

When a DC motor is running, it generates a back emf which increases the effective resistance of the motor. This back emf is proportional to speed. Thus when under load, such a motor is running slowly, the voltage across it is low and the current is high. As the motor speeds up, the voltage rises and current falls. This principle is used to control the speed of the spindle motor.

A differential amplifier (figure 2.8) controls V20 which in turn, controls the motor. Inputs to the amplifier are:

a) the sum of a fixed reference voltage and the voltage (VfdbkV) across the motor.
b) the sum of an adjustable reference voltage and a voltage (VfdbkI) derived from motor current.

When the differential amplifier is first enabled, the motor voltage (VfdbkV) is low and current feedback is high. This is a positive feedback state which drives V20 full on, causing the motor to accelerate quickly.

As the motor speeds up, VfdbkV rises and IfdbkI falls. Therefore the motor acceleration reduces.

Eventually a speed is reached where the reference voltages and the feedback voltages balance. If the adjustable voltage has been correctly adjusted, this stable speed will be 300 rpm ±3%.

If the motor runs over speed, the feedback will be negative and the motor will be slowed down to normal.

2.7 DRIVE READY

There is only a speed check if the electrical head load option is used.
Once the disk is rotating, the index hole will be sensed. The output from the index sensor is checked against a timing element (F/F) with a duration of 250 msecs. When index pulses are spaced by 250msecs or less, the disk is at least up tO 80% of nominal speed. This condition causes URDY-N to go true.

URDY-N alerts the controller, and may be used to enable the head load circuits (figure 2.6).

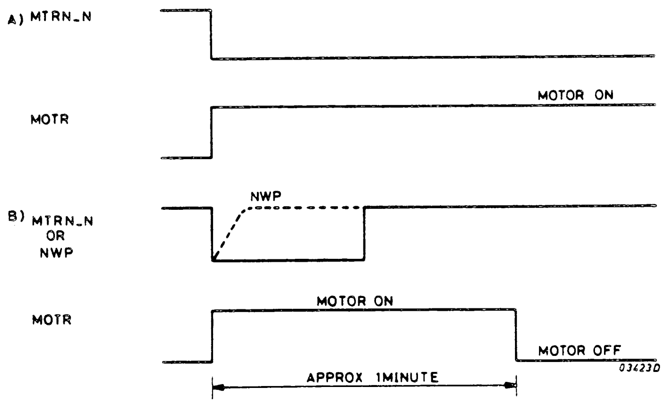


Figure 2.7 MOTOR-ON TIMING

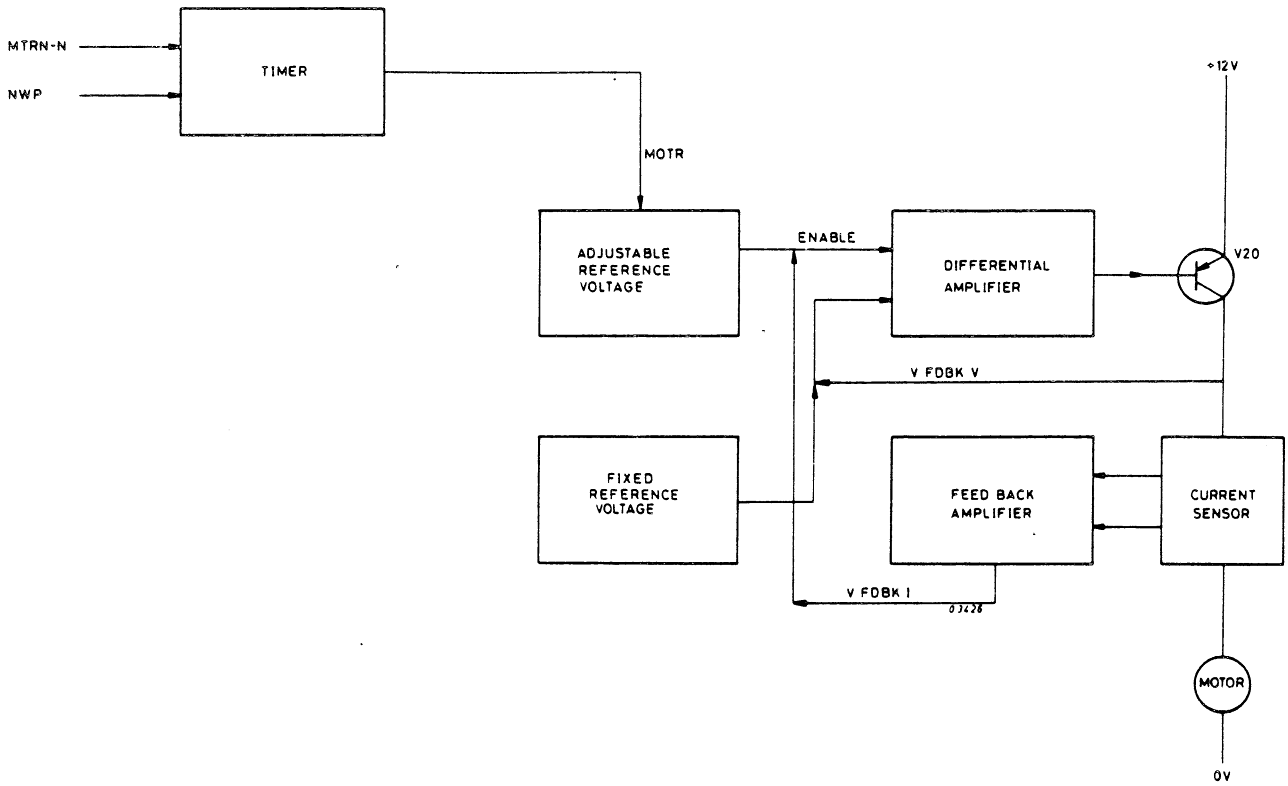


Figure 2.8 MOTOR SWITCHING AND SPEED CONTROL

2.8 UNIT SELECT (FIGURES 2.6 AND 2.9)

Note: To simplify diagram 2.6a, the unit select function is not shown.

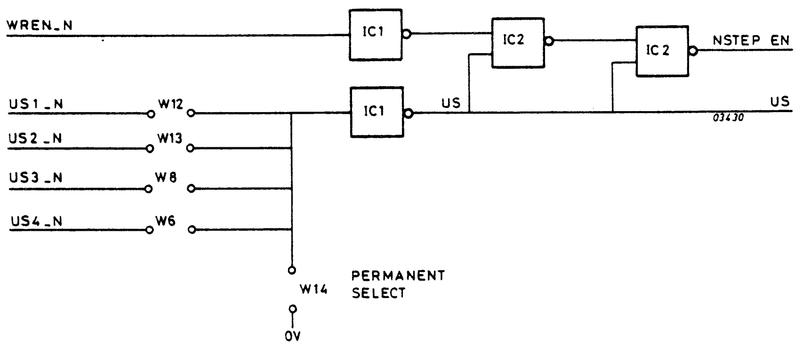


Figure 2.9

Four discrete select lines, each with a strap, allow the drive to be selected as drive 1, 2, 3 or 4. A further strap allows the drive to be permanently selected. 'US', when true, enables the index, write protect, track 00 and read data outputs. It also enables the write gate input and the stepper logic.

2.9 SEQUENCE OF OPERATION

Once the drive is selected and ready, the head must be stepped to the required track, loaded and selected before a read or write operation can take place.
The sequence of stepping, loading and selecting depends entirely on the controller.

2.10 HEADS LOADING

Mechanical head loading is standard in all 4 drives but there is also an electrical head load option. Mechanical head load is described in section 1.2.

Electrical head load may be operated by various combinations of US-N, URDY-N (see 1.6.1). These signals generate the +ve signal HEAD, which controls the head load circuits.

2.11 STEPPER MOTOR PRINCIPLES

The stepper motor is driven by a series of repeatable current phases A, B, C and D supplied by the stepper motor PROM. Each phase represents a defined state of currents in the stepper motor coils.
Figure 2.10 is a functional diagram of the stepper motor rotor and its relationship to a point X on the frame.
If current phase A is supplied to the stepper, the rotor will align the nearest 'A' pole, with point X (as shown).
If phase B current is now supplied, the nearest 'B' pole will align with X, thus moving the rotor 1 track in the FWD direction. If phases C, D, A, B etc. are generated in succession the motor will continue to step in the forward direction.
A phase sequence of D, C, B, A, D etc. will move the rotor in the reverse direction.

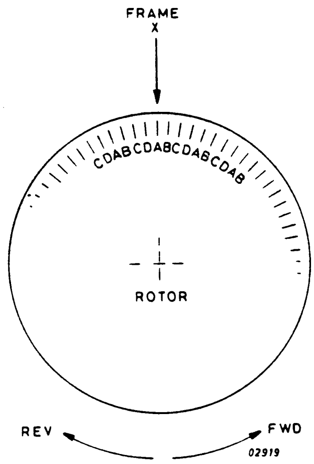


Figure 2.10 STEPPER MOTOR PRINCIPLES

Direction is thus a matter of providing the correct sequence. DIR-N selects this sequence by addressing the motor stepping PROM.

Note: Phase A is energised when the heads are on track 00 and on every 4th track therefrom, i.e. 4, 8, 12, 16 etc. Phase B occurs at 1, 5, 9, 13 etc. and so on for phases C and D.

2.12 MOTOR STEPPING PROM

Figure 2.6a shows how the motor stepping PROM (IC14) is connected. NSTEP EN, NTROO and DIR-N provide the higher address numbers and the lower 2 bits of the data byte provide the low numbers. Thus for each combination of the 3 high address lines, the lower 2 lines will address a table of 4 bytes. For example, if the 3 higher lines are all true (low), the 2 lower lines will address 0-3 and if DIR-N changes state, 4-7 will be addressed.
Refer to figures 2.6 and 2.11 during this explanation.

With the lower data bits fed back to the input, each data byte out of the PROM provides the required phase and the address of the next required phase. STEP merely transfers this address onto the address line.

When forward direction is selected the sequence A, B, C, D, A, etc. is followed. For example, address 0 suplies phase A and the next address is '1'; the address of phase B. Reverse direction selects phases in reverse order.

A track 00 output for the controller is only produced when NTROO is sensed and phase A is selected.

ADDRESS LINE STATES	ADDRESS	DATA OUT		
		TRACK 00	PHASE	NEXT ADDRESS
DIR = FWD.	0	YES	A	1
NTROO SENSED	1		B	2
UNIT SELECTED	2		C	3
	3		D	0
DIR=REVERSE	4	YES	A	7
NTROO SENSED	5		B	4
UNIT SELECTED	6		C	5
	7		D	6
DIR = FWD	8		A	9
NTROO NOT SENSED	9		B	10
UNIT SELECTED	10		C	11
	11		D	8
DIR = REVERSE	12		A	15
NTROO NOT SENSED	13		B	12
UNIT SELECTED	14		C	13
	15		D	14
DIR = FWD	16	YES	A	16
NTROO SENSED	17		B	17
UNIT NOT SELECTED	18		C	18
	19		D	19
DIR = REVERSE	20	YES	A	20
NTROO SENSED	21		B	21
UNIT NOT SELECTED	22		C	22
	23		D	23
DIR = FWD	24		A	24
NTROO NOT SENSED	25		B	25
UNIT NOT SELECTED	26		C	26
	27		D	27
DIR = REVERSE	28		A	28
NTROO NOT SENSED	29		B	29
UNIT NOT SELECTED	30		C	30
	31		D	31

Figure 2.11 MOTOR STEPPING PROM

NSTEP EN is gated by US, thus when the drive is selected, NSTEP EN is true (low) and the lower locations of the PROM are addressed.

When the unit select line goes false (high), locations 16-31 are addressed. In each of these locations the next address is the same as the present address. For example, address 18 supplies the phase C, and the next address is 18.

In this condition, STP-N transfers the same address each time so the phase does not change. This prevents step pulses for other drives from stepping an unselected drive.
The drivers convert the data from the PROM, into stepper motor drive current.

2.13 STEPPER TIMING

A timing sequence is shown in 2.12. Note that a 10 ms delay must occur between the last step in one direction and the first step in the other direction.

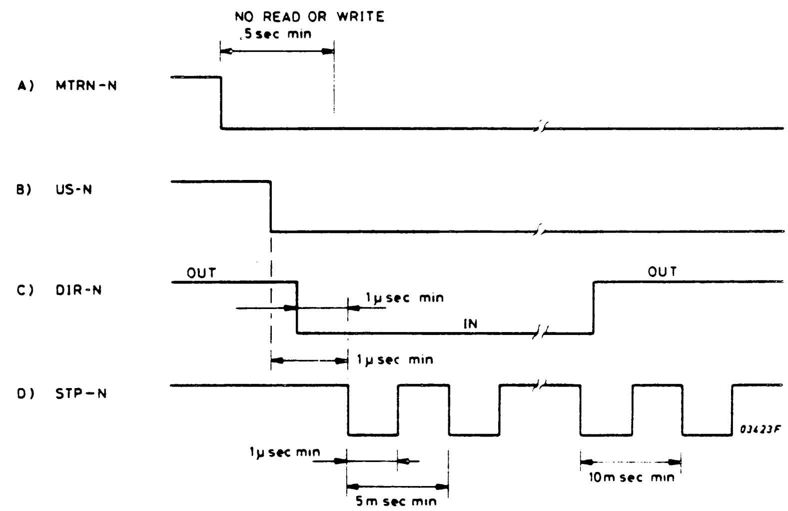


Figure 2.12 TRACK ADDRESS TIMING

2.14 HEAD SELECTION

In the one sided drives X3111 and 3113, the head (0) is permanently strap selected and the HDS-N line is not used.

The two-sided drives have head select logic and a second head. In this case the state of HDS-N determines which head is selected. Logic '0' (high) selects head 0.

2.15 READ OPERATION

With the drive selected and up to speed, the heads loaded on the correct track, and the required head selected, the drive will now be reading data from the disk. The read circuits will convert the data to pulsed form and transfer it as REDA-N to the controller.

Thus for reading, it is merely a matter of the controller or the system, interpreting and selecting the data on the line.
An example of read timing can be found in figure 2.13.
Note: 30 msec MAX shown between HLD-N and the beginning of a read action indicates the time required for the electronic head load versions to load and stabilise the heads.

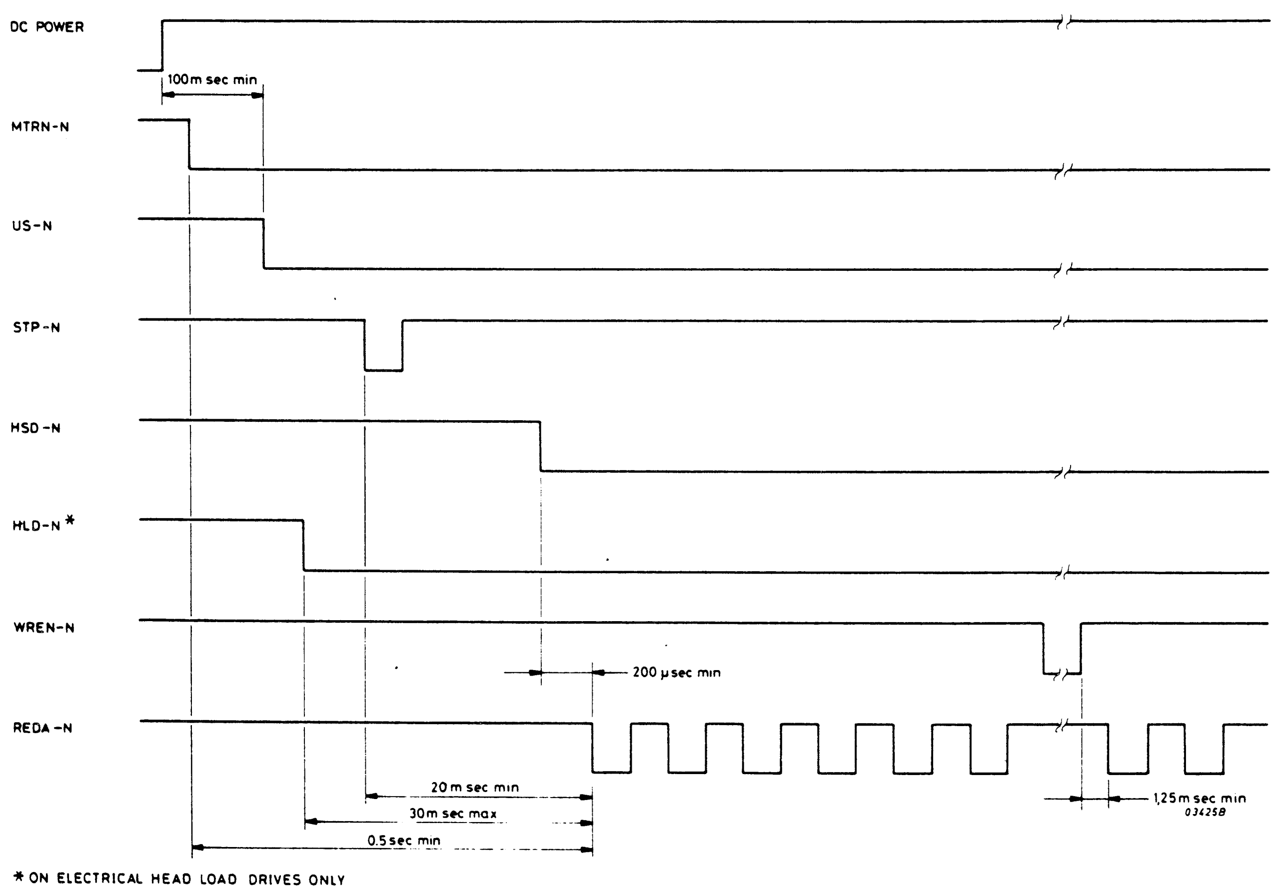


Figure 2.13 READ INITIATE TIMING

2.16 WRITE OPERATION (FIGURE 2.14)

If the drive is selected and ready, the heads loaded on the correct track, and the required head selected, the drive will be, as previously stated, in the read state.

By taking WREN-N true, the read circuits will be disabled and the write circuits enabled. The data to be written should be supplied on WRDA-N within 8 usecs of WREN-N going true.

The figures marked 'min' on figure 2.14 indicate the minimum periods which the controller must allow between actions.

Within the drive, tunnel erase is generated from the WREN-N signal, ERASE is delayed 450 usecs after WREN-N goes true and is held on for 850 usecs after WREN-N goes false.

It is the responsibility of the controller to read the cylinder, side and sector information (figure 2.2), enable the write circuits, and write the new data block.

Note: When WREN-N goes false at the end of a write operation, a delay of at least 1.25 msecs must be allowed before trying to read data, or before changing MTRN-N, US-N or STP-N. This delay is to allow the normal operation of delayed erase and to allow the read circuits to stabilise.

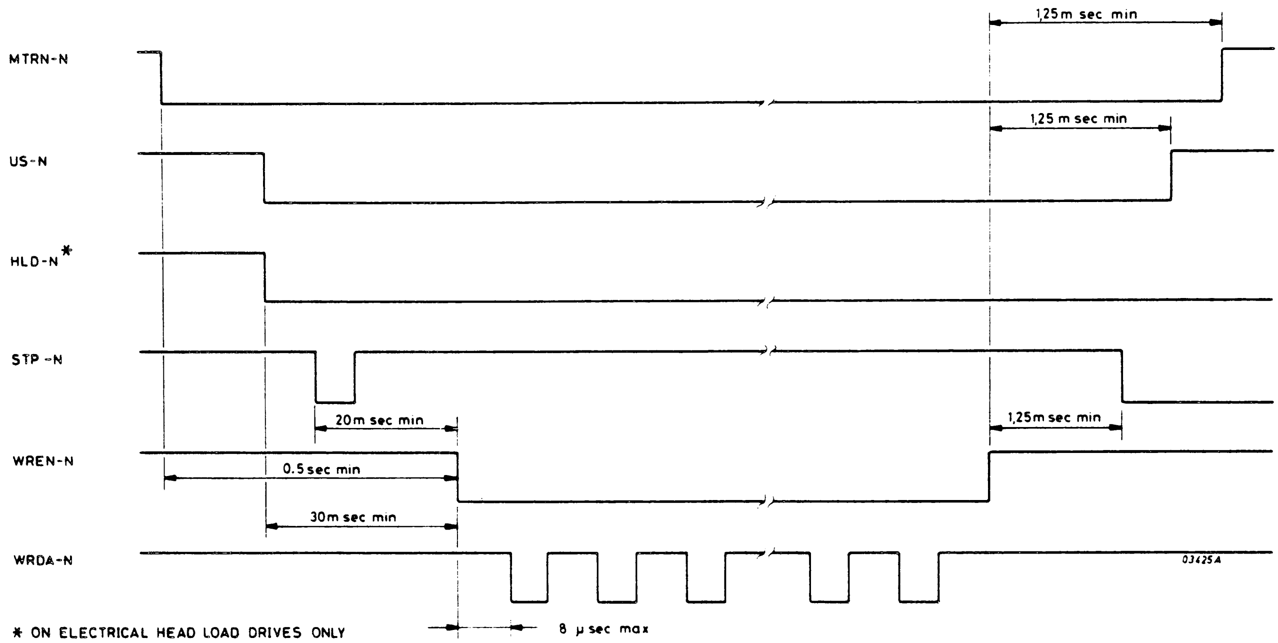


Figure 2.14 WRITE INITIATE TIMING

2.17 WRITE PROTECT

If a write protected disk is sensed, WREN-N is inhibited and WRP-N indicates the situation to the controller.

2.18 READ AND WRITE DATA

WRDA-N pulses must conform to figure 2.15.
REDA-N will be as for figure 2.16.
Note: These examples show single density encoding.

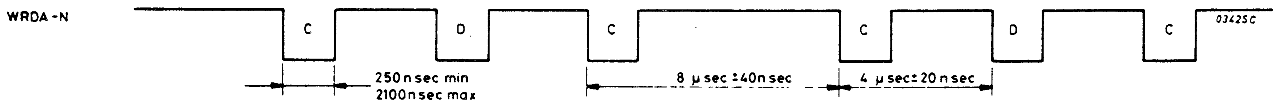


Figure 2.15 WRITE DATA TIMING

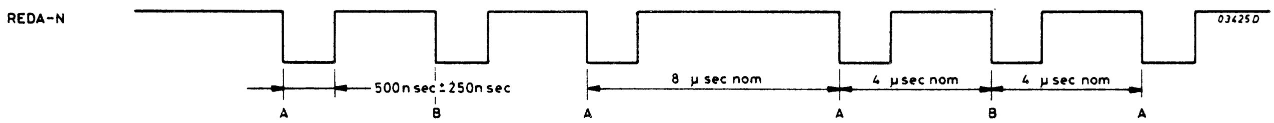


Figure 2.16 READ DATA TIMING

3 DETAILED DESCRIPTION

LIST OF ILLUSTRATIONS

3 DETAILED DESCRIPTION

Refer to figures 4.6/1, 4.6/2 and 4.6/3 during this section and note that circuits indicated by the option symbols will be absent if that option is not supplied.

3.1 POWER-ON RESET (NPOR) (FIGURES 4.6/1 and 4.6/2)

As soon as power is applied to the drive, the +5V and +12V will begin to rise from 0V, NPOR however, cannot rise until V10 conducts. The operation is as follows:

Until the +5V line rises to 3.3V, V7 will be cut off. When it rises above this level, V7 will begin to conduct. However, V9 requires approx +0.6V on the base, and so will not conduct until the +5V reaches approx +4V.

A similar circuit controls the conduction of V10 which can only conduct if the +5V supply is above +4V and the +12V supply is above approx +9V. At this point, NPOR will become false, thus releasing the stepper latches and the motor timer, as well as several other F/Fs.

PS12, which is delayed to prevent accidental writing at switch-on, is generated at the same time.

3.2 MOTOR-ON DELAY (FIGURE 4.6/1)

IC12 forms the delay circuit for the motor control circuit which is shown in 2.6. A low pulse on pin 2 will cause the output pin 3 to go high for a period determined by the values of R53 and C14.
If pin 2 is held low, pin 3 will remain high, making MOTR true.

3.3 MOTOR SPEED CONTROL

Refer to section 2.6 and figures 2.8 and 4.6/1 during this description.

3.3.1 CONFIGURATION

With reference to figure 2.8; IC11-1 to 7 forms the differential amplifier and IC11-8 to 10 is the feedback amplifier.

The junction of R57 and V18 provides the fixed reference voltage (+7.5V).

The adjustable reference voltage is set by the wiper of the motor speed adjustment potentiometer R58.

VfdbkV is via R68, VfdbkI via R62.

3.3.2 OPERATION

When MOTR is false, IC11-6 and 2 are clamped to 0V, pins 1 and 7 are high and V20 is cut off. Due to the VfdbkV connection via R68, the non-inverting inputs (pins 5 and 3) are approx. +3.5V.

When MOTR goes true, the clamping action of V19 is released allowing IC11-2 and 6 to rise above the voltage of pins 3 and 5. V20 is switched on.

The voltage across R69, generated by the initally high motor current, is input to the feedback amplifier, driving IC11-8 high and increasing the transistor base drive via the differential amplifier. The motor accelerates, aiming at a very high speed.

As the motor speeds up, VR69 falls, making IC11-2 and 6 less positive. VfdbkV via R68 rises, taking pins 3 and 5 move positive. This change in feedback level reduces the base drive of V20 and reduces the aiming speed of the motor. Therefore, although the motor continues to speed up, the acceleration rate falls.

Eventually, as VfdbkV continues to rise and VfdbkI falls, a balance is achieved between the fixed inputs and the feedback. At this point, acceleration is zero and motor speed should be 300 rpm.

Using a zener diode (V18) to supply the reference voltage, provides an element of temperature compensation for the motor.

If the zener was not installed, the motor as it warmed up, would take less current (due to the temperature/resistance coefficient of the windings) and would therefore slow down. However, a reference diode of 7.5V also has a positive temperature coefficient, therefore, under the influence of motor temperature, the reference voltage also rises.

The higher reference voltage provides more base drive to V20 and therefore counteracts some of the effect of winding temperature.

3.4 INDEX AND SPEED CHECK (FIGURES 4.6.2 AND 4.6/1)

Positive INDX pulses at IC9-2, are generated as the index hole is sensed by the index sensor. These pulses are gated to the controller via IC10. They are also feed to the speed check circuit, when electrical head load option is used.

In the absence of INDX pulses, IC5-13 is held low (reset) by IC4-13. Pulses on IC4-2, drive pin 13 high for 250 msecs, thus releasing the reset on IC5-13. If another INDX pulse arrives before IC4 'times out', IC5-9 will be set. If the pulse arrives after IC4 times out, IC4 will be triggered again and IC5 will remain reset.

It should be clear that INDX pulses spaced by 250 msecs (240 rpm) or less, will set IC5-9. If US is true, IC6-3 will go low to indicate a READY (disk loaded and up to speed) condition.

An 'up to speed' condition, may (via W17) also be used to generate HEAD, which operates the electrical head load option.

3.5 ELECTRICAL HEAD LOAD OPTION (FIGURE 4.6/1)

The signal HEAD, which operates the head load circuits, may be generated as just described or by an HLD-N signal on the URDY-N line (ST1, pin 2). Naturally, if the line is used for the READY function, it can not be used for HEAD LOAD.

Due to the physical characteristics of a solenoid, greater power is required to operate it, than is required to hold it operated. Thus to load the heads, the head load circuits generate a large current pulse, and then a lower, steady hold current.

Ideally, heads should be loaded quickly and yet gently, and in spite of changes in temperature or supply voltage, the head loading time should be consistent. This ideal is approached by use of feedback between the head load solenoid and the head load timing circuits.

When HEAD goes true, IC4-10 is triggered, driving pin 5 high. V15 will remain off but V13 and V14 will be switched on and will operate the head load solenoid. V14 is a power transistor which provides the high current necessary to operate the solenoid.

The solenoid, which initially has a low impedance and thus a low voltage, starts to close quickly. As it closes, its impedance (and thus voltage) begins to rise. When the voltage reaches approx. +9.5 volts, zener diode conducts, thereby providing a second discharge path for C12. Thus the period of IC4 is controlled by head load action. If the head tends to load too quickly, the action is slowed down by the early discharge of C12. If the head load action is too slow, discharge is delayed and head load speeded up.

After approx. 10 msecs, IC4 will 'time out'. V15 will be switched on, and V13 and V14, off. V15 provides the lower current which is sufficient to hold the solenoid operated.

If HEAD goes false, V15 will be disabled and the head load solenoid released.

3.6 UNIT SELECT (FIGURES 4.6/1 AND 2.9)

A US-N signal generates US which, 'anded' with WREN-N false, produces NSTEP EN to enable the stepper logic. US also enables UNIT READY (IC6-2), HEAD (IC2-9) and DOOR LOCK/UNLOCK (IC2-13), and is monitored by the DISK CHANGE circuits which indicate a change of state on the UNIT SELECT line.

The status outputs of IC10 are also gated by US.

3.7 STEPPING

Motor stepping principles are covered in 2.11 and 2.12

3.7.1 MOTOR DETAIL (FIGURES 3.1, 3.2 AND 4.6/1)

The stepper motor which drives the head carriage has two windings (X and Y) on four, stator poles. These are wound as in figure 3.1.

When the current in X and Y is in the direction shown in 3.1, the poles will have the following polarity:

1 = N
2 = neutral (fields cancel)
3 = S
4 = neutral (fields cancel)

If current is reversed in winding Y, the poles will now have polarity as follows:

1 = neutral
2 = S
3 = neutral
4 = N

Thus with the correct, current phase sequence, the N and S poles can be made to move in one direction or the other.

The rotor consists of two shaped pole pieces fastened to the N and S poles of a permanent magnet. Our views in figure 3.1 and 3.2 are from the south pole side. Figure 3.2 shows the poles in more detail, in a position related to current in figure 3.1.

The rotor being a S pole will be attracted to a N and repelled by a S. Thus it will adopt the position shown with N-S poles as close as possible, and S-S poles as far apart as possible.

If the phases are changed so that pole 2 becomes N, the rotor will move 1 step clockwise. If the phases are changed so that pole 4 becomes N, the rotor will move 1 step anti-clockwise.

Note: The terms clockwise and anti-clockwise relate to the diagrams and not necessarily to the motor.

3.7.2 MOTOR DRIVE (FIGURES 3.3 AND 4.6/2)

The precise configuration of motor drive circuits is dependant on which stepper motor is used. This is because in order to provide satisfactory positioning characteristics, the 96 TPI stepper motor used in X3113/4 requires a higher run voltage than the 48 tpi version. The stepping operation however, is exactly the same for all models.

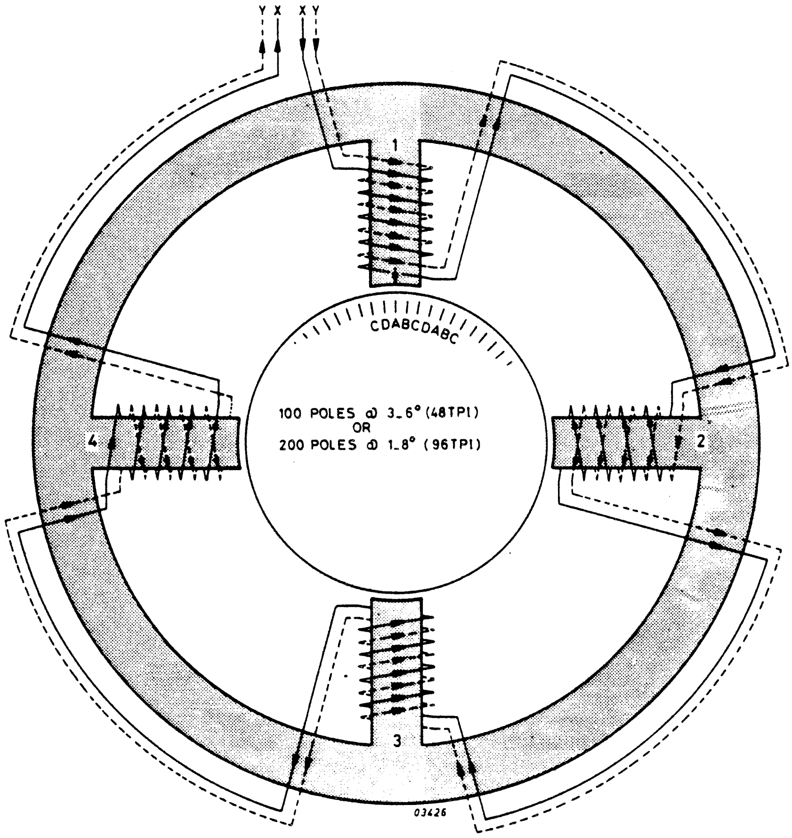
Figure 3.3 shows how one of the stepper coils is connected.

Assuming the E = 1 and F = 0, V24 will be cut off and V25 on. This will take point G to 0V. At the same time, V28 will be on and V29 off, thus connecting point H to the +12V supply via R80. Current through the stepper coil will be as shown by the full arrows.

Reversal of polarities at E and F will cause current flow as per the dotted arrows.

In the 96 tpi models, V21 is included as a bypass.

Before stepping the motor, V21 is switched on in order to short out R80. This action connects the full +12V to the driver transistors and thus increases stepper coil current. Approx. 100 usecs later, the stepper phase (in this case E and F) is changed, causing a step action. This delay is to allow the higher voltage across the stepper drivers, to stabilise.



POLES 1 AND 3
WINDINGS X AND Y
IN SAME DIRECTION

POLES 2 AND 4
WINDINGS X AND Y
IN OPPOSITE DIRECTIONS

Figure 3.1 MOTOR WINDINGS

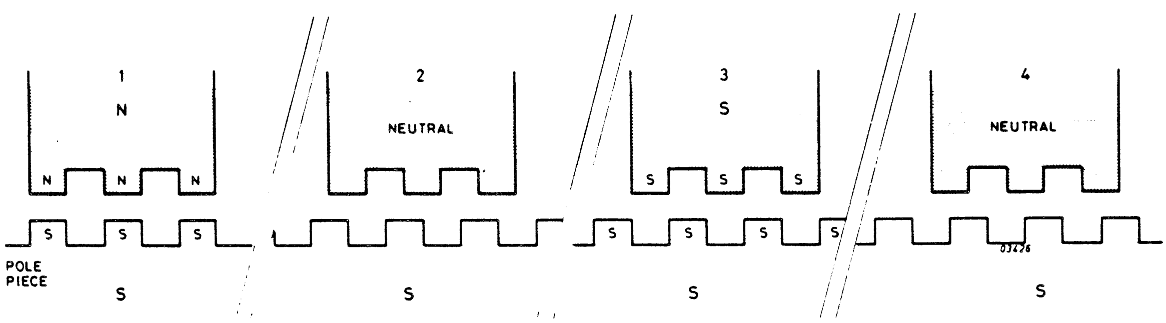
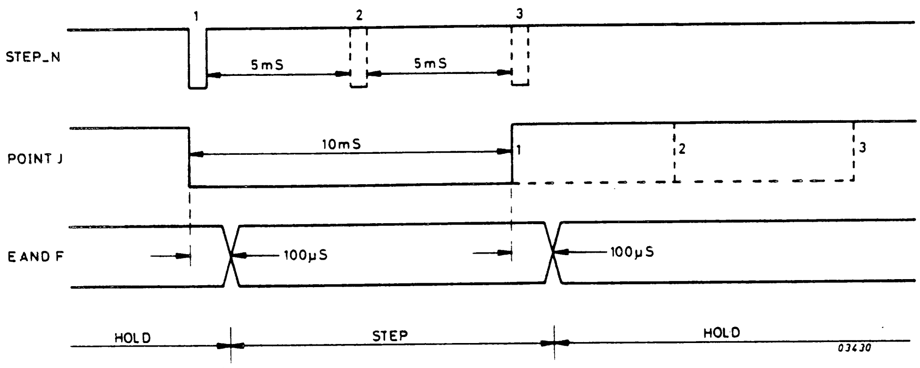


Figure 3.2 POLE DETAIL



WAVE FORMS 96TPI STEPPER CIRCUITS

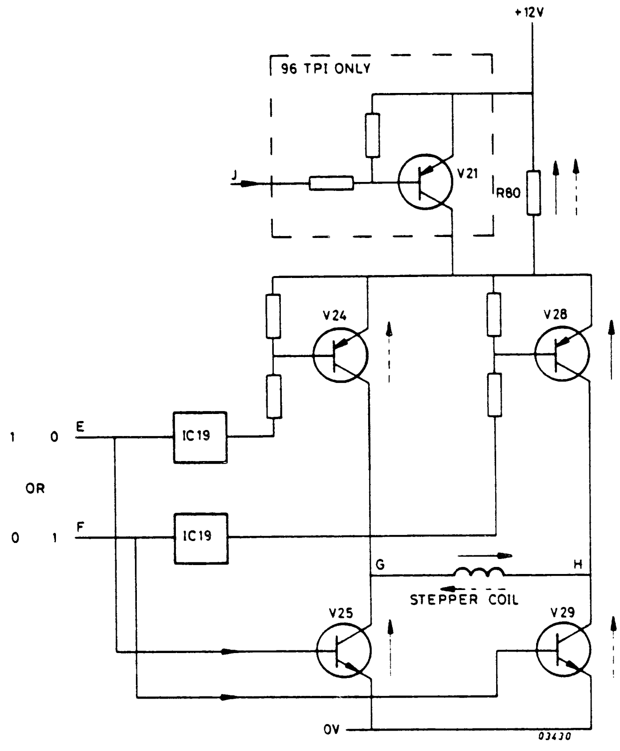


Figure 3.3 STEPPER MOTOR DRIVES

The operation is as follows: (see waveforms of figure 3.3).

STP-N triggers monostable IC13-1, which has a period of 10 msecs. Pin 4 goes low for that period, switching on V21. If another STP-N pulse occurs before IC13 times out, the F/F will be re-triggered. Thus V21 will be on from the first STEP-N pulse, until 10 msecs after the last STEP-N pulse.

STEP-N also triggers monostable IC13-9, which has a period of 100 usecs. Pin 12 goes low (which has no effect on IC15 latches), and then goes high 100 usecs later, thereby latching the address of the next phase.

The new phase, supplied by the PROM, will change the state of the driver inputs.

Note from figure 3.3, that a defined stepper coil changes state on alternate STP-N pulses. Thus for the pulse marked 2, the other stepper coil will be affected.

Models X3111/2 do not need a higher voltage during the stepping process and therefore do not need delay circuits to allow the voltage to stabilise. In this case, STP-N is routed directly to the step latches. Therefore E and F change state on the leading edge of STP-N.

Note: The value of R80 is different for the two versions.

3.8 TRACK 00 (FIGURES 4.6/2 AND 2.11)

The track 0 sensor, which is mounted on the chassis behind the head carriage, is a complete unit consisting of light source and sensor. When the carriage is forward, NTR00 is high. When the head is on track 0, 1 or 2; NTR00 will be low (assuming the unit is correctly adjusted). NTR00 provides bit 8 of the stepping PROM address. When NTR00 is true and phase A is selected, TR00X is generated and gated as TK00-N to the controller.

3.9 READ CIRCUITS (FIGURES 3.4 AND 4.6/3)

One of the heads will always be selected. In models X3111 and 3113, the head will be permanently selected by link W27. In models X3112 and 3114, one of the pins 3 or 5 of IC17 will be low, depending on the state of HDS-N. A low on the centre-trap of a head winding, enables that head.

When write enable (WE) is low (false) and heads are loaded, drive enabled etc., the drive will be reading.

WE false, disables V6 (erase driver), V38 and V39, and enables V40 AND V41. The selected head therefore, is connected via V40 and V41 to the monolithic, read amplifier IC16.

As the disk spins under the heads, alternate flux reversals generate voltages in the head windings. These are coupled via V34/V35 and V41 or V33/V36 and V40, to the read amplifier.

Amplified analogue read data and clock is available at W22 for test purposes. It is also amplified and impendance matched by V30/V31, and then fed into the discriminator circuits of the MC3470.

The discriminator converts analogue data and clock (NRZ) to pulsed data and clock at pin 10 (data out). This is gated to the interface by US.

R98, which forms a cross-connection between the two halves of the internal discriminator, is used for read symmetry adjustments (Section 7.2.7). This resistor should not be touched except during the adjustments of 7.2.7.

Variable values of C30 and C31 are mounted to account for the different peak shift characteristics of the 48TPI head and the 96TPI head. Changing C31 to 470 pF and removing C30, reduces peak shift effects on the 96TPI head. X3113 however, also uses the 96TPI head but X30 and C31 are not changed. The necessary peak shift correction may, in this case, be provided by floppy disc controller belonging to the system.

Another variable occurs in head symmetry adjust network. L3 is installed on 96TPI versions, in order to reduce the bandwidth of the discriminator. This has the effect of improving the noise characteristics of the 96TPI head.

3.10 WRITE CIRCUITS (FIGURES 4.6/3 AND 3.4)

Before writing, WP must be low (false) and WREN-N must be taken low. This will make WE true.

WRDA-N may now be pulsed with write data.

Note: WREN-N should precede pulses on WRDA-N by 8 usecs or less.

3.10.1 WRITE ENABLE (FIGURES 4.6/1 AND 4.6/3)

With US-N and WREN-N true and WP false, WE will be high.

IC5-5 and 6, which were forced high by WE false, are released, causing this D latch to adapt a set or reset condition, thus causing one of the write drivers (V38 or V39) to conduct. It will remain in this state until toggled by WRDA-N pulses.

'WE' will also generate the delayed ERASE signal via ICs 8 and 9, and V6.

3.11 ERASE

The erase delay circuit uses the fact that the output circuits of ICs 8 and 9 are switched off when high and on when low; to create 2 different delays. ERASE goes high 450 usecs after WE goes true, and goes low 850 usecs after WE goes false.

When WE goes true (high), IC8-12 is high impedance and IC9-14 is low impedance. Thus the delay between WE high and IC9-13 low is governed by the two, time constants, C3/R13 and C4/R16. The delay between WE low and IC9-13 high, is controlled by C3/R12 and C4/R15/R16.

When the base of V6 is low, V6 will conduct, thereby connecting the tunnel erase coils to PS12. Note that different values of R21/22 are inserted to match either the wide-track head used with a 48TPI stepper, or the narrow-track head used with the 96TPI stepper. This gives erase currents of 80mA for the 48TPI head, or 30mA for the 96TPI head.

To prevent accidental writing on erasure during the switching-on process, PS12 is delayed until the +5V and +12V is almost stable. As a further precaution, ERASE is inhibited during switch-on, by holding IC9-10 low for a period dependant upon C5 and R17. During this period, IC9-13 will be high and V6 will be cut off.

V4 allows rapid discharge of C4 when power is swiched off.

3.12 WRITE OPERATION

'WE' release IC5-1 and 3 and switches off V40 and V41, isolating the read amplifier. WRDA-N pulses toggle IC5 which alternately switches V38 and V39. This toggling action converts the pulsed data into NRZ form.

V38 and V39 alternately draw current from the OR driver (IC17) of the selected head. In the X3111 and the X3113, head 1 and IC17 do not exist. The centre tap arrangement for X3111 and X3113 is shown dotted in figure 3.4.
Different values of R115 and R118 provide 8mA write current for the 48TPI head, and 6.2mA for 96TPI head.
One of the write current paths for head 0 is shown in figure 3.4.

3.13 WRITE PROTECT (FIGURE 4.6/2)

When the LED is obscured by either a disk being loaded, or by a disk with the write enable slot covered, WP goes high. This action disables WE at IC3-1 and generates NWP at IC11-14.

If the motor is stopped NWP triggers the timer IC12, thus switching on the spindle motor for about 1 minute.

WP is also gated by US to provide WRP-N to the controller.

3.14 INTERFACE TERMINATION

7438 quad-2-input drivers or equivalent are used as line drivers in the mFD. Low-power Schottky 7404 six-1-input inverters (or equivalent) are used generally as line receivers.

All signal lines are terminated (in the last drive) with an impedance of 150 Ohms. Equivalent termination must be provided by the controller on each input line from the mFD (See figure 1.6).

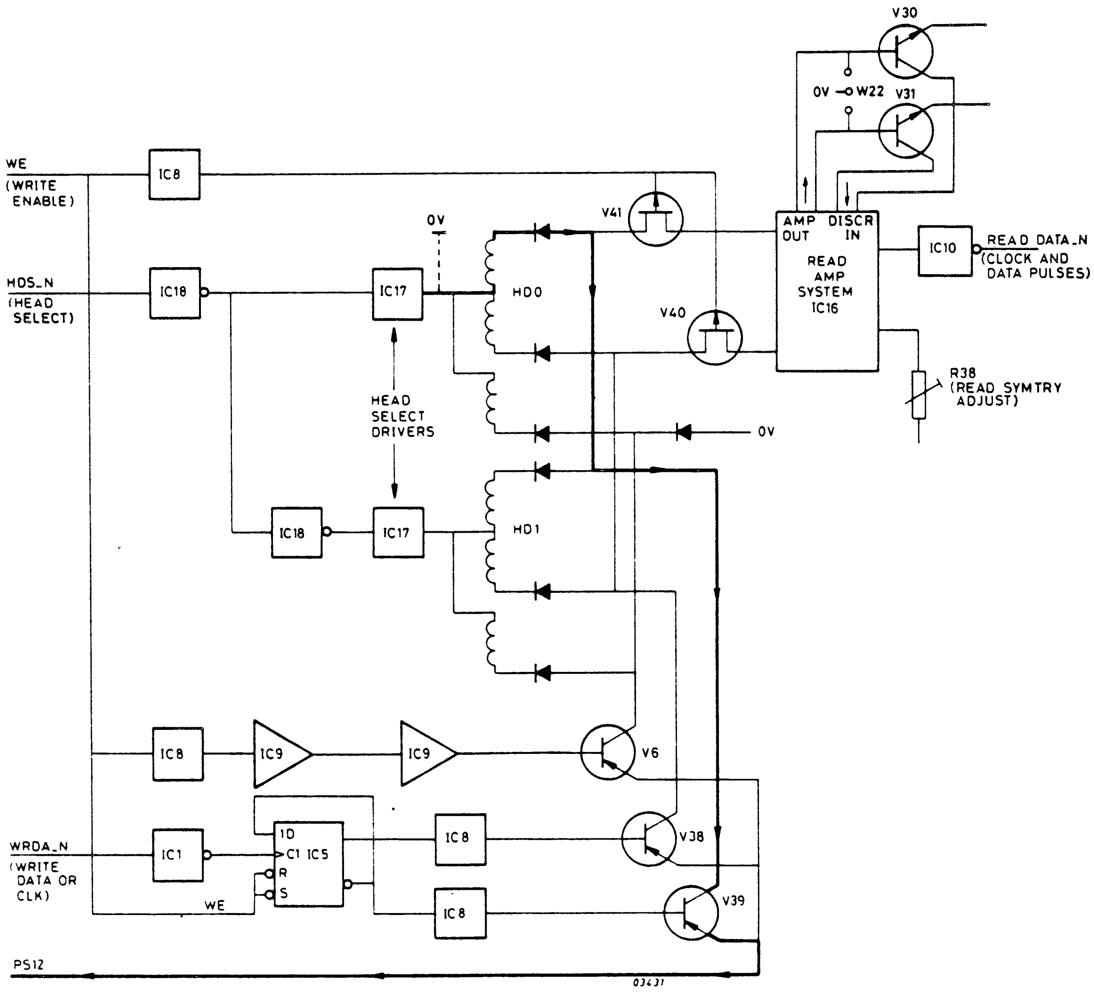


Figure 3.4 READ AND WRITE CIRCUITS SIMPLIFIED

3.15 IN USE/DISK CHANGE OPERATION (FIGURE 4.6/1)

If ST1-34 is used for the DISK CHANGE function, the IN USE (door lock/unlock) function if used, must be connected to ST1 pin 4 or 14. In this case, the state of DUN-N is latched by the leading edge of US at IC7-3.
If DUN-N is true when US goes high, IC3-12 will be driven low to energise the solenoid.

URDY-N is gated by US. Therefore if the drive became 'unready', and then ready again while the drive was unselected, there would be no indication that the change had taken place.

The signal DISK CHANGE-N indicates that such a change has occurred.

DISK CHANGE option provides a compatible signal for BASF interfaces.
Operation as follows:
When a drive is deselected (US-N high), NUS clocks a 0 to IC7-9. DISK CHANGE-N (IC6-8) goes high.
If whilst the drive is unselected, RDY goes false; IC7-9 will be set to "1".
When US goes true again, DISK CHANGE-N will also go true.

PLUG ST1

34	DISK CHANGE-N	OV	33
32	HDS -N	OV	31
30	RDA -N	OV	29
28	WRP -N	OV	27
26	TRO -N	OV	25
24	WREN-N	OV	23
22	WRDA-N	OV	21
20	STP -N	OV	19
18	DIR -N	OV	17
16	MTRN-N	OV	15
14	US3 -N	OV	13
12	US2 -N	OV	11
10	US1 -N	OV	9
8	IND -N	OV	7
6	US4 -N	OV	5
4	DUN -N	OV	3
2	URDY-N	OV	1

PLUG ST3

(X3112 AND X3114)

	b	a
1	HDOE	HD1O
2	HDOF	HD1S
3	HDOC	HD1C
4	HDOS	HD1F
5	HDOO	HD1E
6	X	

(X3111 AND X3113)

	b
1	HDOE
2	HDOF
3	HDOC
4	HDOS
5	HDOO
6	

PLUG ST2

1	+12V
2	+12V RETURN
3	+ 5V RETURN
4	+ 5V

PLUG ST4

	b	a
1	STM 2	STM1
2	STM 4	STM3
3	X	+12V

PLUG ST5

	b	a
1	NDUNX	+12V
2	NLED	WPX
3	S1-NC	+12V
4	OV	S1-NO
5	S1-C	NINDX
6	TRO	OV
7		TROO
8	X	

PLUG ST6

	b	a
1	SPM2	OVP
2	SPM1	LHDX
3		OVP

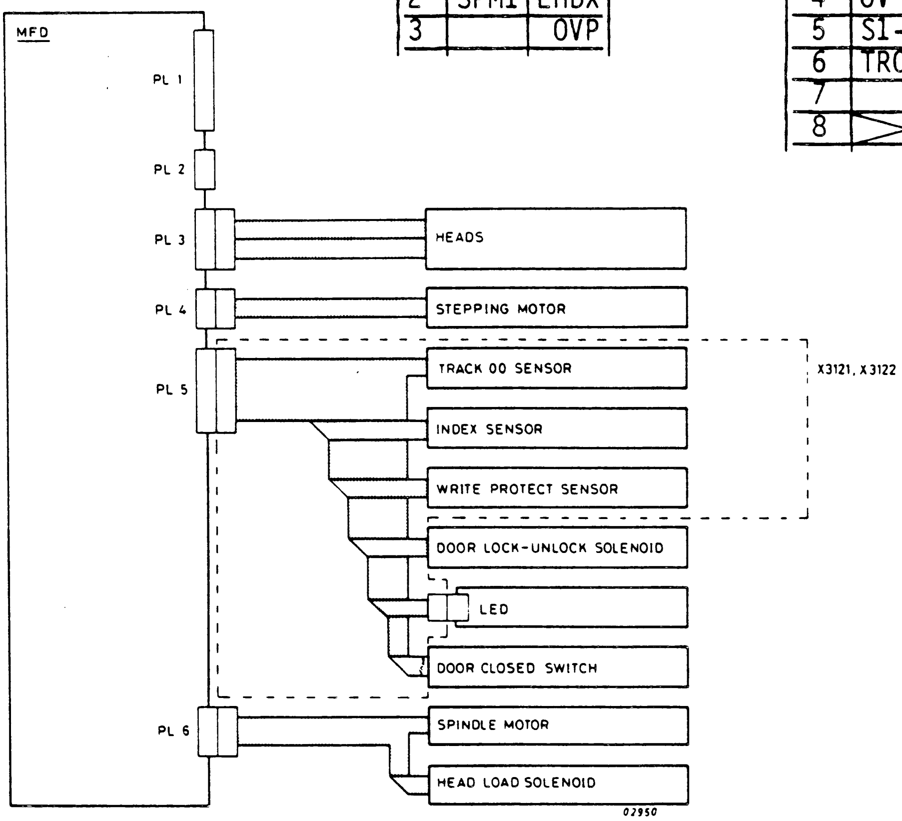
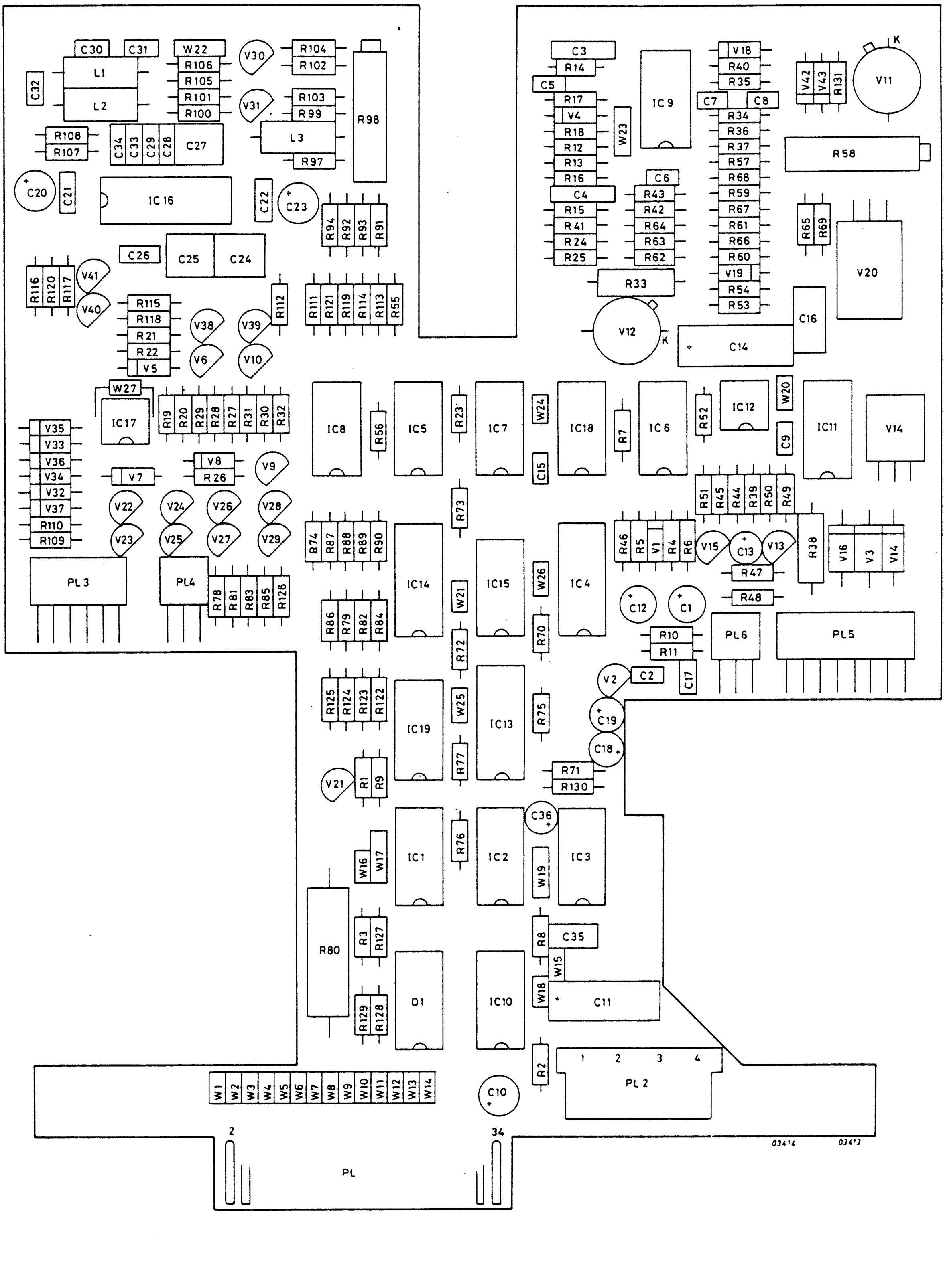


Figure 4.1 INTERCONNECTION DIAGRAM



Note: For X3112/14 - IC17 is mounted.
For X3111/13 - Link W27

Figure 4.2 PCB LAYOUT

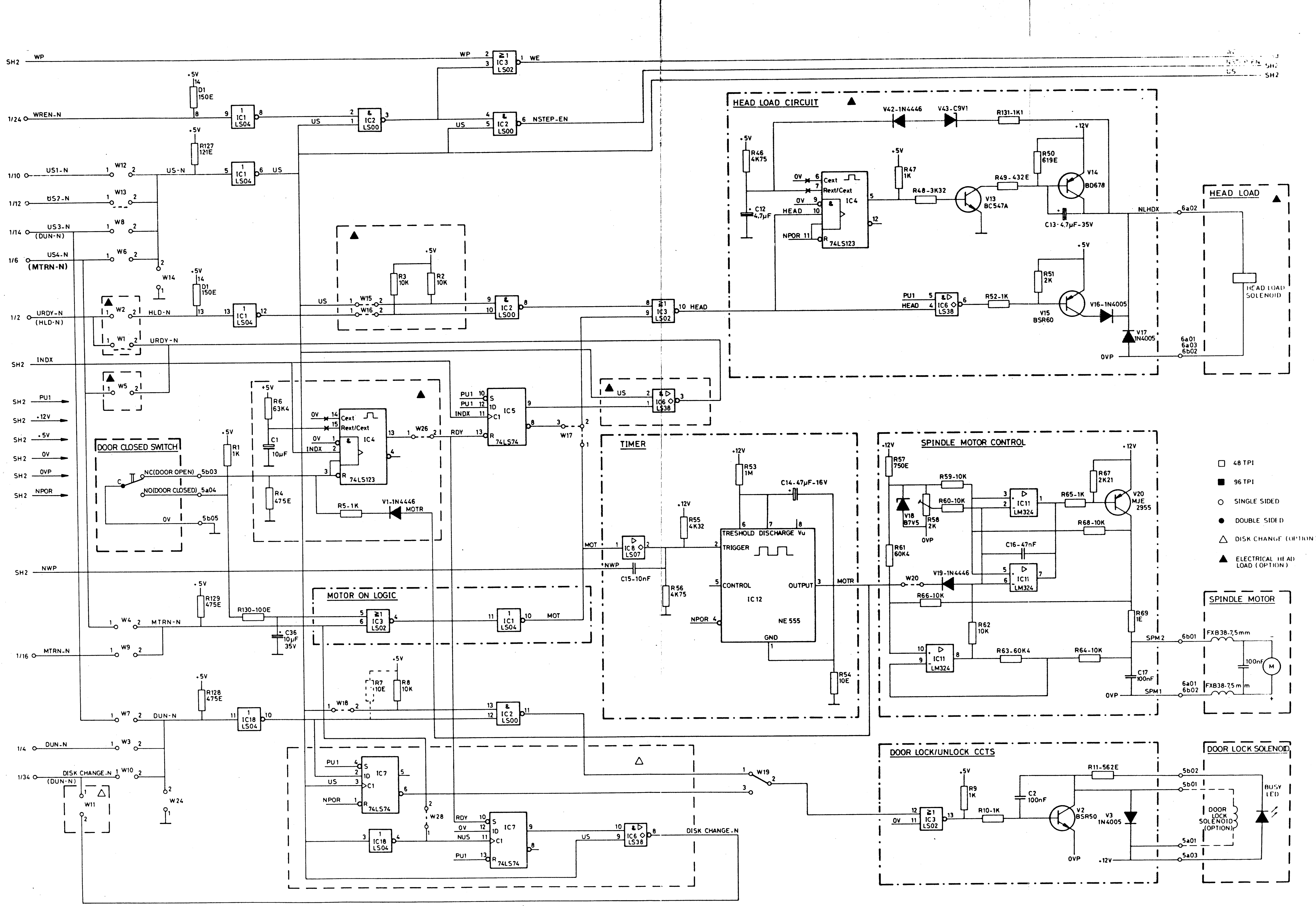
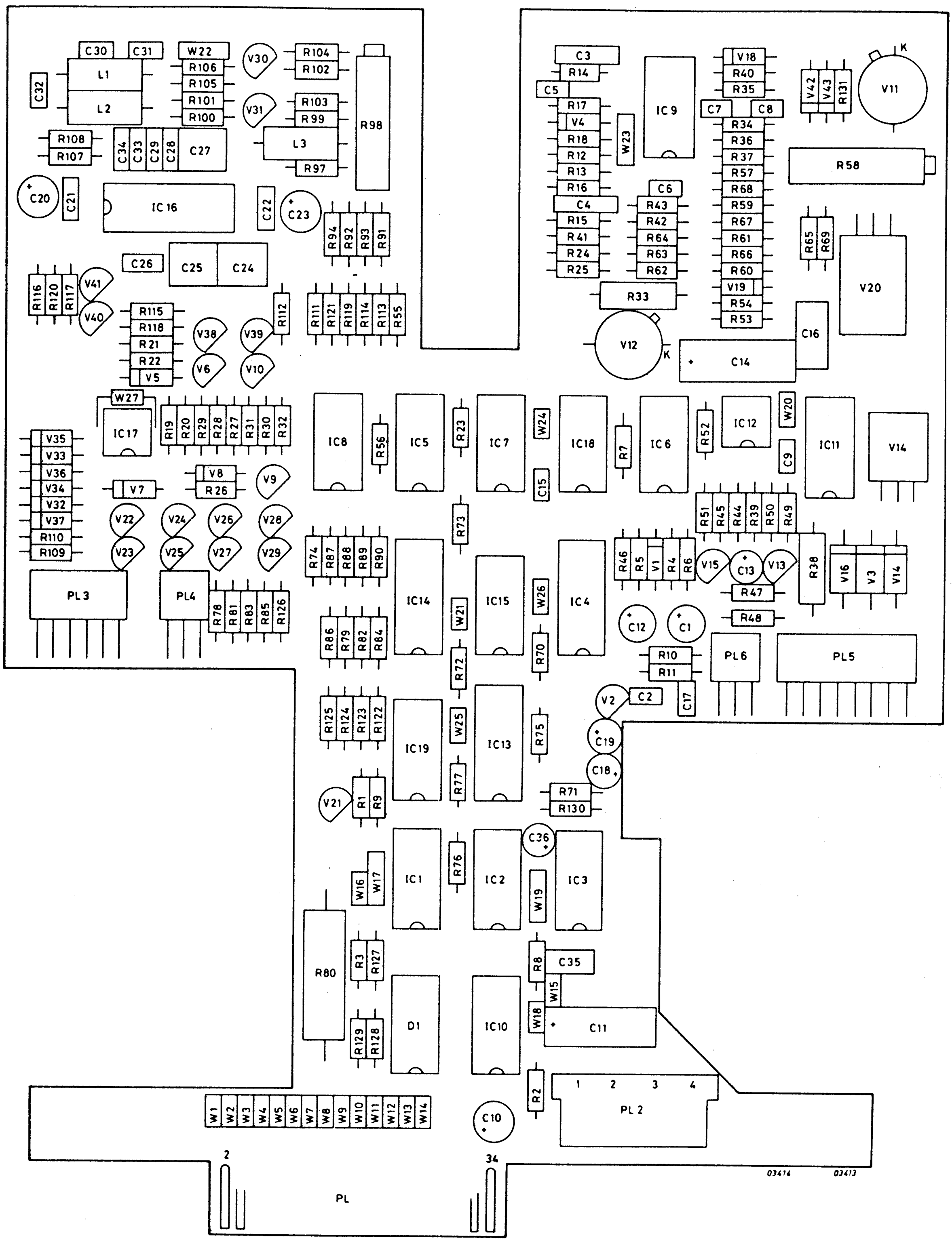


Figure 4.6/1 SCHEMATIC X3111/2/3/4 SHEET 1



Note: For X3112/14 - IC17 is mounted.
For X3111/13 - Link W27

Figure 4.3 PCB LAYOUT

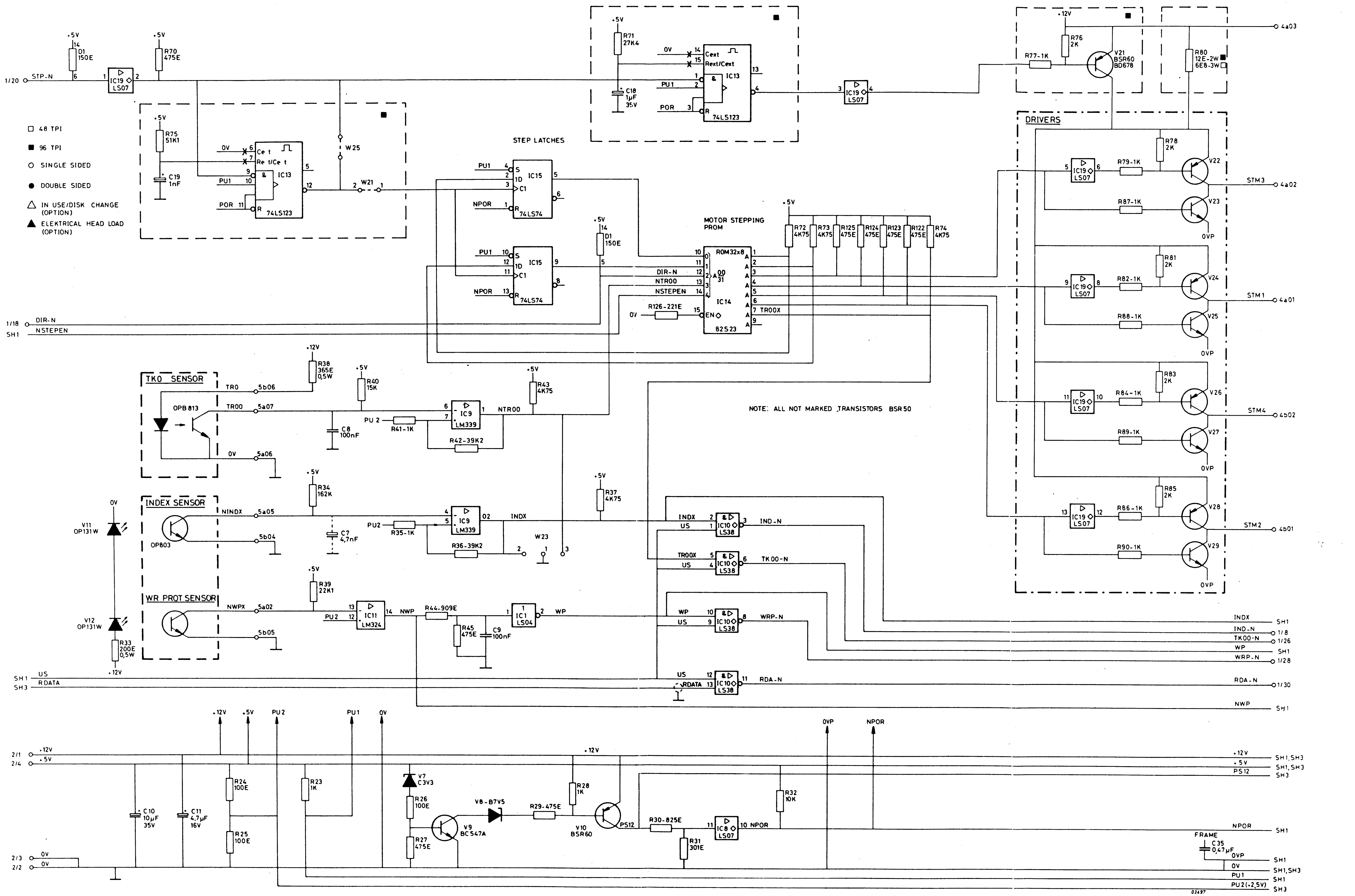


Figure 4.6/2 SCHEMATIC X3111/2/3/4 SHEET 2

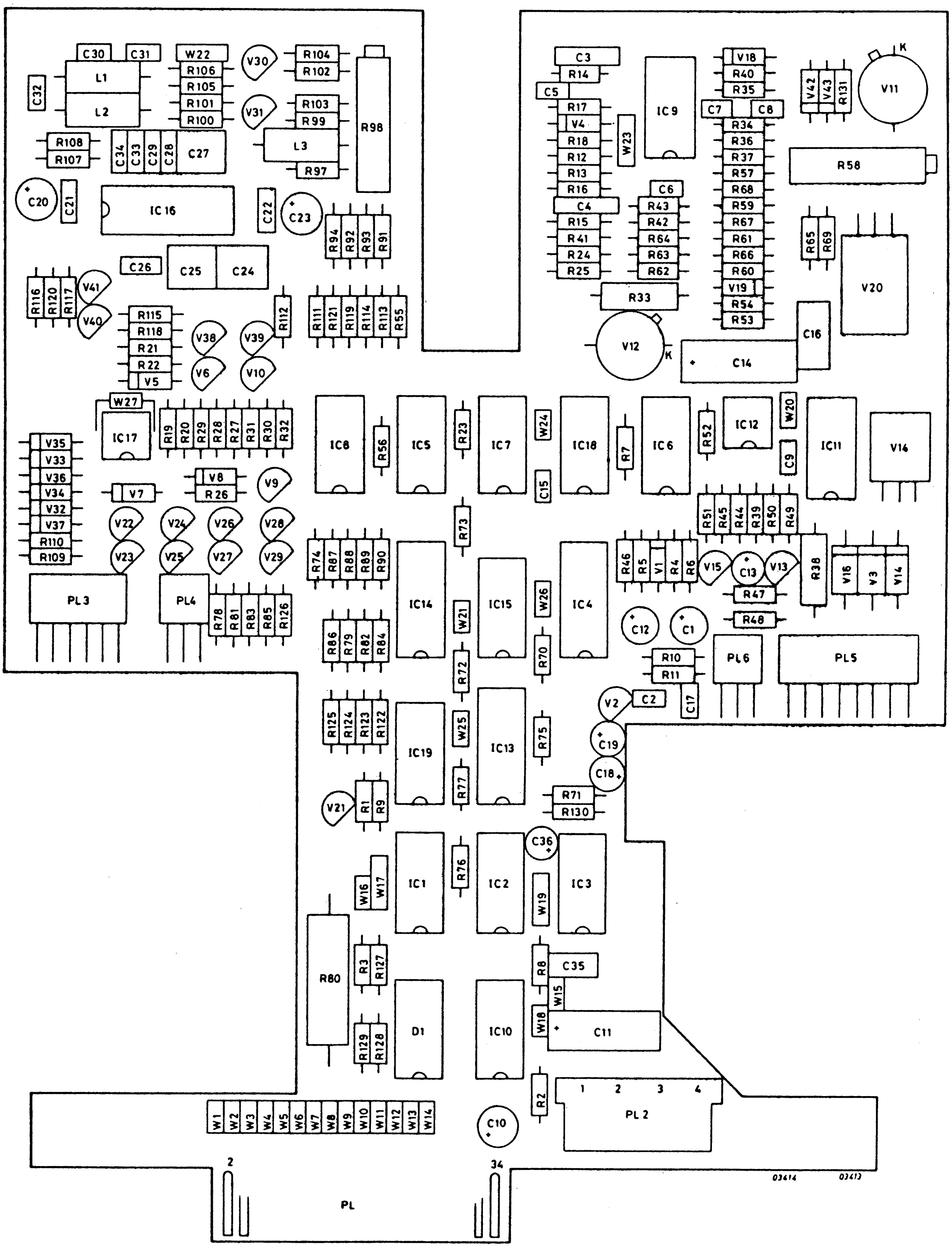
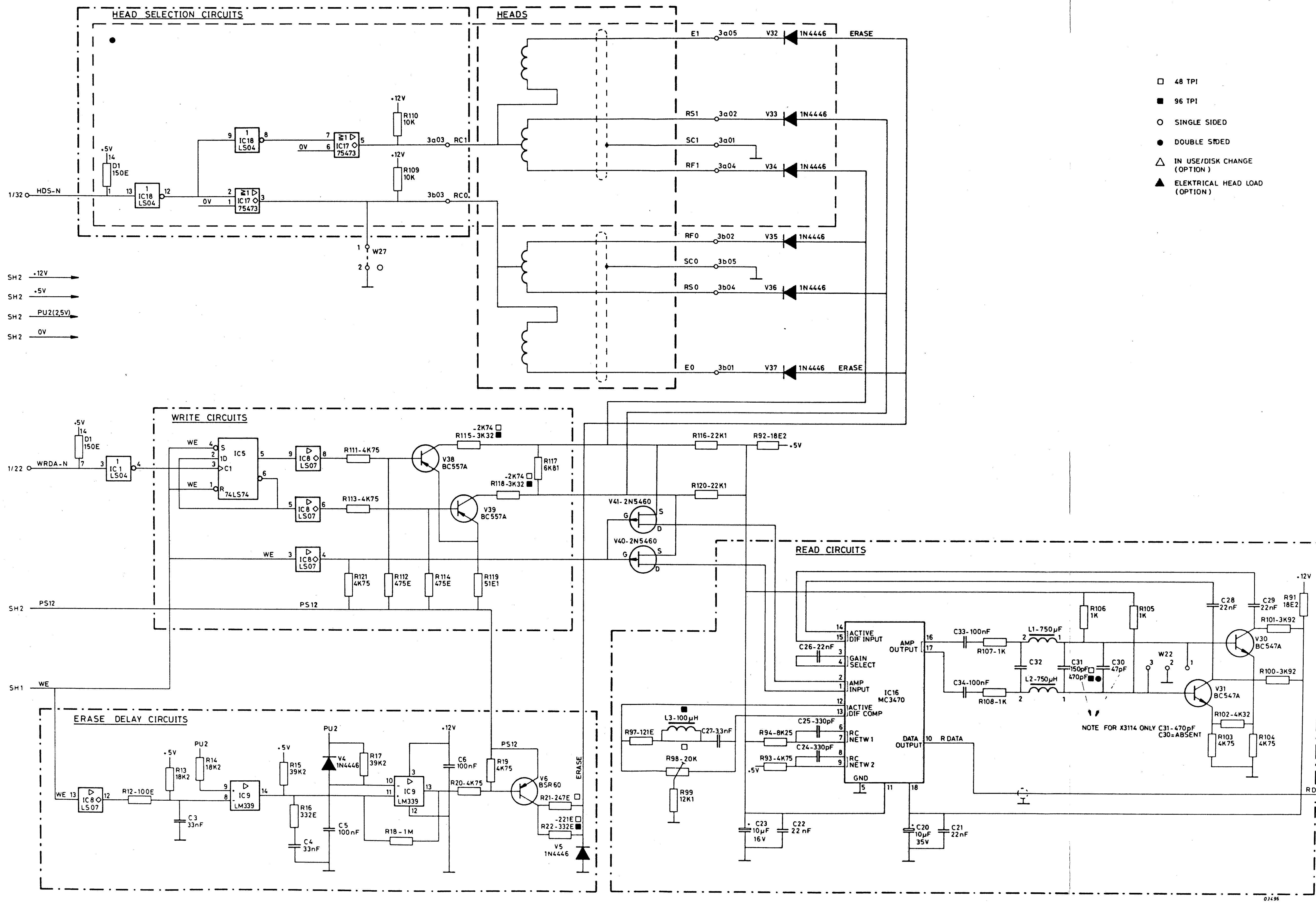


Figure 4.4 PCB LAYOUT



□ 48 TPI
■ 96 TPI
○ SINGLE SIDED
● DOUBLE SIDED
△ IN USE/DISK CHANGE (OPTION)
▲ ELEKTRICAL HEAD LOAD (OPTION)

Figure 4.6/3 SCHEMATIC X3111/2/3/4 SHEET 3

5 PROM CONTENTS

SECTION 5.1	MOTOR STEPPING PROM 82523N	PAGE 5-2

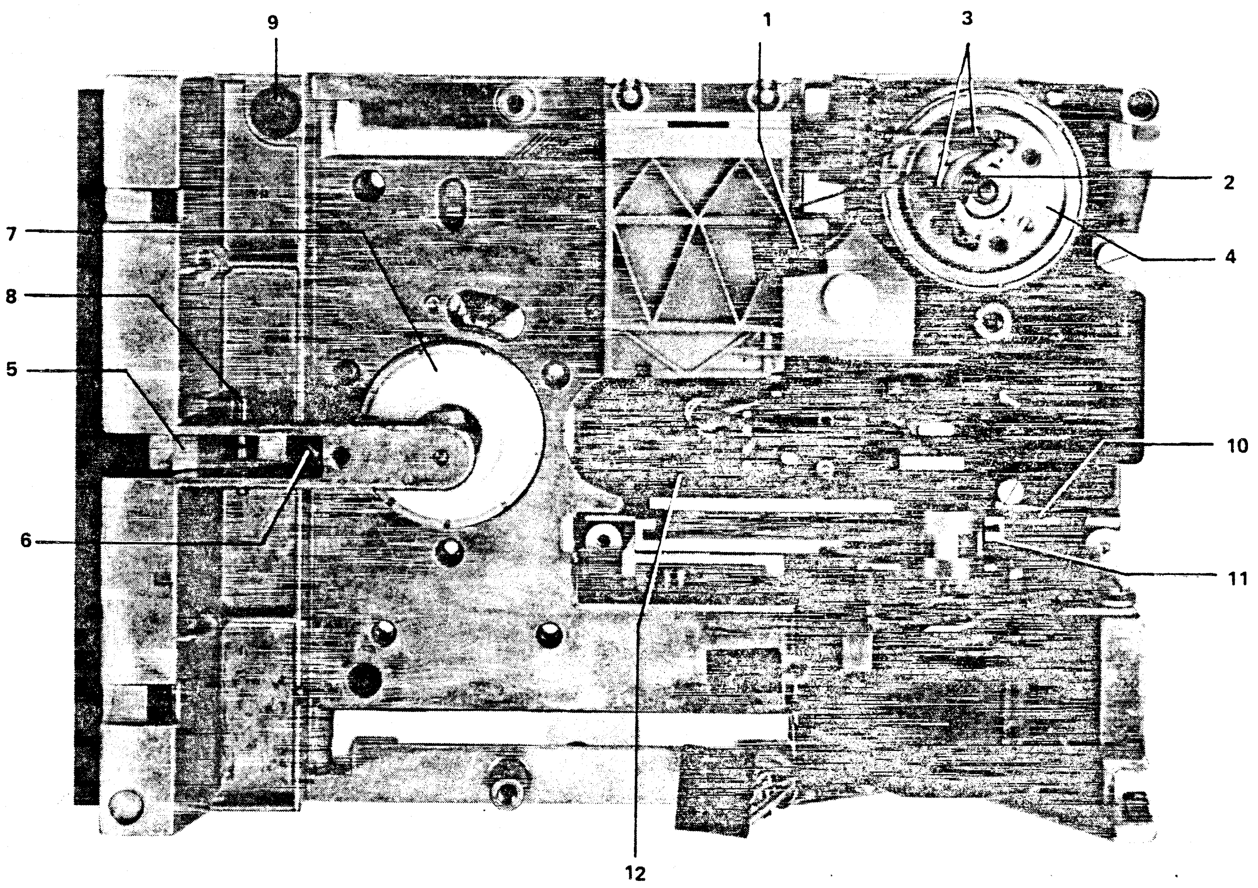
5.1 MOTOR STEPPING PROM 82523N

ADDRESS (DECIMAL)	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8
0	X		X			X	X	
1		X	X	X				
2	X	X		X	X			
3					X	X		
4	X	X	X			X	X	
5			X	X				
6	X			X	X			
7		X			X	X		
8	X		X			X		
9		X	X	X				
10	X	X		X	X			
11					X	X		
12	X	X	X			X		
13			X	X				
14	X			X	X			
15		X			X	X		
16			X			X	X	
17	X		X	X				
18		X		X	X			
19	X	X			X	X		
20			X			X	X	
21	X		X	X				
22		X		X	X			
23	X	X			X	X		
24			X			X		
25	X		X	X				
26		X		X	X			
27	X	X			X	X		
28			X			X		
29	X		X	X				
30		X		X	X			
31	X	X			X	X		

X = HIGH LEVEL

6 PARTS LIST

SECTION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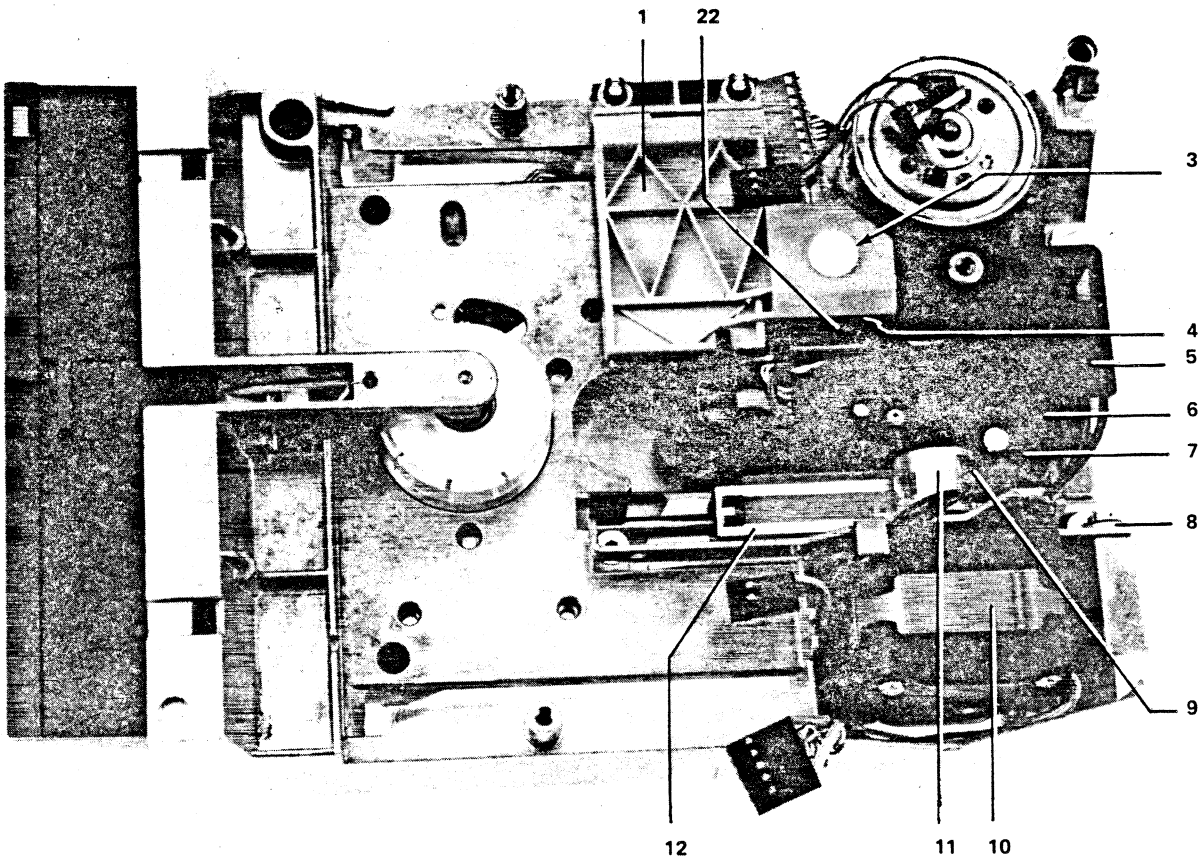
Pos.	Code Number	Description	
A	5112 291 66610	MFD-X3111 compl.	
	5112 291 66620	MFD-X3112 compl.	
	5112 291 66630	MFD-X3113 compl.	
	5112 291 66640	MFD-X3114 compl.	
1B	5112 280 02991	Cable	X-3111/12/13/14
2B	2022 562 00009	Capacitor 100nF	X-3111/12/13/14
3B	4312 020 31331	Bush core	X-3111/12/13/14
4B	5112 291 49970	Motor assy	X-3111/12/13/14
5B	5112 211 62410	Lever	X-3111/12/13/14
6B	5112 200 06401	Tension spring	X-3111/12/13/14
7B	5112 291 49960	Cone assy	X-3111/12/13/14
C	5112 211 57020	Bush	X-3111/12/13/14
C	2622 115 10012	Cupped spring washer	X-3111/12/13/14
C	5112 200 06431	Compression spring (small)	X-3111/12/13/14
C	2522 630 02004	Ring	X-3111/12/13/14
C	5112 291 49950	Cone flange assy	X-3111/12/13/14
D	5112 211 57010	Cone flange	X-3111/12/13/14
D	2622 001 30343	Ball bearing	X-3111/12/13/14
C	5112 200 06711	Compression spring (big)	X-3111/12/13/14
C	5112 211 57030	Cone	X-3111/12/13/14
8B	5112 211 62220	Pin	X-3111/12/13/14
9B	5112 211 71900	Bush	X-3111/12/13/14
10B	5112 211 62130	Shaft	X-3111/12/13/14
11B	5112 211 62480	Rotary spring	X-3111/12/13/14
12B	5112 291 53420	Carriage compl.*	X-3111
	5112 291 53160	Carriage compl.*	X-3112
	5112 291 53430	Carriage compl.*	X-3113
	5112 291 53590	Carriage compl.*	X-3114

Note: * For break-down carriage see page 6-8, 6-9.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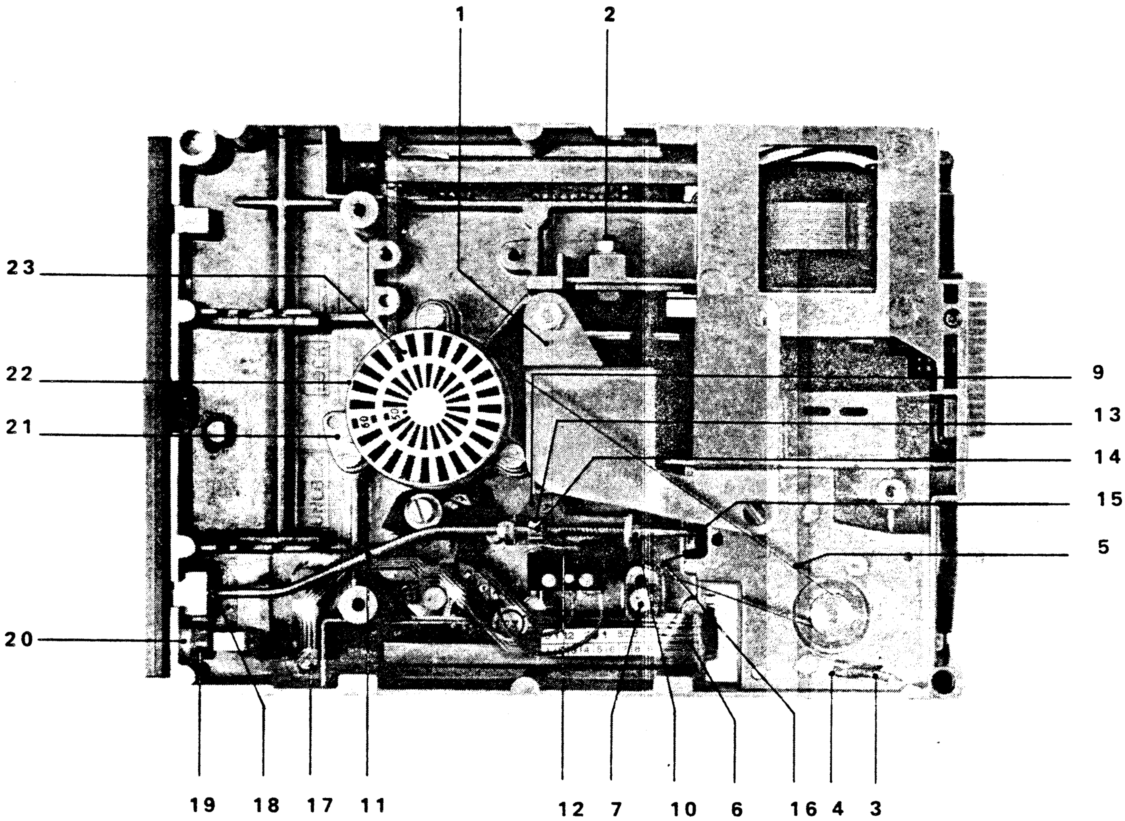
Pos.	Code Number	Description	
1B	5112 291 53080	Lifting bracket compl.	X-3111/12/13/14
2B	5112 211 72080	Tab	X-3111/12/13/13
3B	2612 115 02044	Compression spring	X-3111/12/13/14
4B	5112 291 53270	Lever compl.	X-3111/12/13/14
5B	5112 211 71940	Stop	X-3111/12/13/14
6B	5112 211 71950	Loading place	X-3111/12/13/14
7B	5112 211 59610	Hold plate	X-3111/12/13/14
8B	2622 115 10001	Cupped spring washer	X-3111/12/13/14
9B	5112 211 62150	Bracket	X-3111/12/13/14
B	5112 291 53360	Stepping motor assy 3,6	X-3111/12
	5112 291 53340	Stepping motor assy 1,8	X-3113
	5112 291 53550	Stepping motor assy 1,8	X-3114
10C	5112 291 53500	Stepping motor 3,6	X-3111/12
	5112 291 67170	Stepping motor 1,8	X-3113/14
11C	5112 211 62160	Pulley	X-3111/12
	5112 211 84170	Pulley	X-3113/14
C	2522 043 14038	Pin	X-3111/12/13/14
12B	5112 211 62140	Steel band	X-3111/12/13/14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Pos.	Code Number	Description	
1B	5112 211 84180	Protection cover	X-3111/12/13/14
2B	5112 211 62260	Screw bolt	X-3111/12/13/14
3B	5112 200 06591	Tension spring	X-3111/12/13/14
4B	2412 015 01242	Solder tag	X-3111/12/13/14
5B	5112 200 06231	Belt	X-3111/12/13/14
6B	5112 291 66570	Flex. printer circuit MFDF	X-3111/12/13/14
7B	2513 700 03543	Solid rivet	X-3111/12/13/14
8B	5112 211 57080	Holder	X-3111/12/13/14
B	5112 291 53290	Slider assy	X-3111/12/13/14
9C	5112 211 72030	Bearing plate	X-3111/12/13/14
10C	5112 211 62350	Bush	X-3111/12/13/14
11C	5112 211 72090	Sliding rod	X-3111/12/13/14
12C	5112 200 06631	Pressure spring	X-3111/12/13/14
13C	2522 640 20002	Adjusting ring	X-3111/12/13/14
14C	2522 043 14016	Pin	X-3111/12/13/14
15C	2612 115 02511	Presure spring	X-3111/12/13/14
16C	5112 211 72070	Slider	X-3111/12/13/14
17B	5112 291 60770	Diode holder	X-3111/12/13/14
18B	5112 211 62350	Bush	X-3111/12/13/14
19B	9390 243 50112	Mounting ring	X-3111/12/13/14
20B	9332 589 00112	Diode LED 16	X-3111/12/13/14
B	5112 291 49940	Disk assy	X-3111/12/13/14
21C	5112 211 56950	Flange	X-3111/12/13/14
C	2622 001 30596	Ball bearing	X-3111/12/13/14
C	2522 629 01011	Ring	X-3111/12/13/14
C	2512 700 01494	Disk	X-3111/121/31/4
C	2612 115 10106	Cupped spring washer	X-3111/12/13/14
22C	5112 211 56970	Pulley	X-3111/12/13/14
23C	5112 211 58310	Stroboscope disk	X-3111/12/13/14

CARRIAGE X-3111

Pos.	Code Number	Description	
B	5112 291 53420	Carriage mounted 2	X-3111
C	5112 291 53400	Carriage mounted 1	X-3111
D	5112 291 52910	Carriage assy	X-3111
E	5112 211 60263	Carriage	X-3111
E	2512 700 09067	Screw	X-3111
D	8212 220 30311	Button head	X-3111
D	5112 211 84110	Feed adjustment cable	X-3111
D	2422 034 10788	Plug contact	X-3111
D	2422 034 11935	Connector housing 5 pol.	X-3111
D	5112 211 84130	Screen ring	X-3111
C	5112 291 53440	Felt holder assy	X-3111
D	5112 211 71980	Felt holder	X-3111
D	5112 210 30321	Felt	X-3111
C	5112 211 62470	Pressure arm	X-3111
C	5112 211 62540	Tension spring	X-3111
C	5112 211 62180	Damping	X-3111

CARRIAGE X-3112

Pos.	Code Number	Description	
B	5112 291 53160	Carriage mounted 3	X-3112
C	5112 291 52930	Carriage mounted 2	X-3112
D	5112 291 52920	Carriage mounted 1	X-3112
E	5112 291 52910	Carriage assy	X-3112
F	5112 211 60260	Carriage	X-3112
F	2512 700 09067	Screw	X-3112
E	5112 211 62550	Feed adjustment head	X-3112
E	5112 211 84130	Screen ring	X-3112
D	5112 291 52940	Upper arm mounted	X-3112
E	5112 291 52900	Upper arm	X-3112
F	5112 211 62100	Leaf hinge	X-3112
	1322 952 13009	Makrolon	X-3112
E	5112 211 62590	Feed adjustment upper head	X-3112
D	5112 211 62110	Clamp block	X-3112
D	5112 211 62540	Torsion spring	X-3112
D	5112 211 62580	Feed adjustment cable	X-3112
D	2422 034 10788	Plug contact	X-3112
D	2422 034 11764	Connector housing 12 pin	X-3112
D	5112 211 00860	Dummy	X-3112
C	5112 211 62180	Damping	X-3112

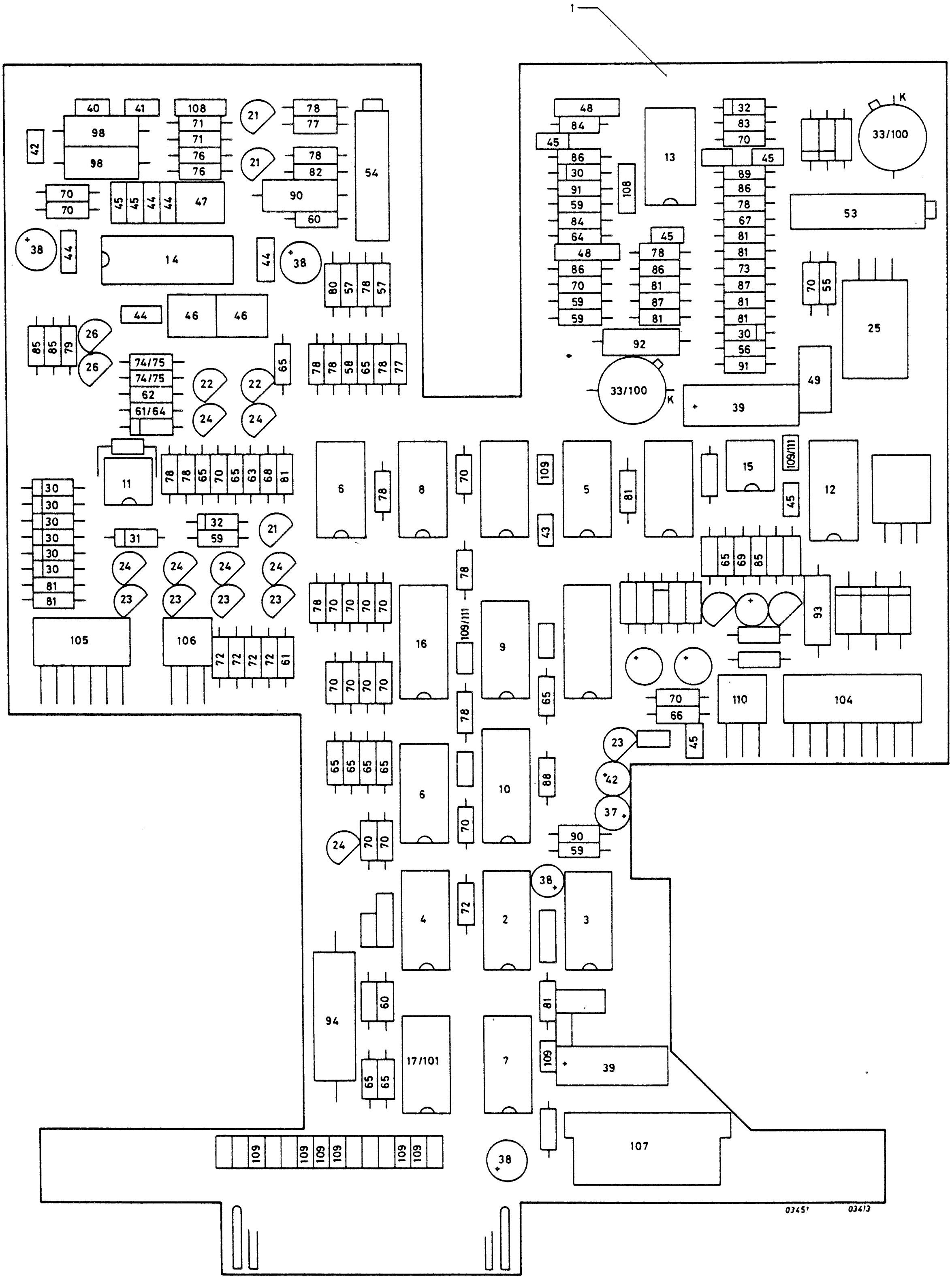
CARRIAGE X-3113

Pos.	Code Number	Description	
B	5112 291 53430	Carriage mounted 2	X-3113
C	5112 291 53410	Carriage mounted 1	X-3113
D	5112 291 52910	Carriage assy	X-3113
E	5112 211 60260	Carriage	X-3113
E	2512 700 09067	Screw	X-3113
D	8212 220 30301	Button head	X-3113
D	2422 034 16788	Plug contact	X-3113
D	2422 034 11764	Connector housing 12 pin	X-3113
D	5112 211 00860	Dummy	X-3113
D	5112 211 84130	Screening	X-3113
C	5112 291 53440	Felt holder assy	X-3113
D	5112 211 71980	Felt holder	X-3113
D	5112 210 30321	Felt	X-3113
C	5112 211 62470	Pressure arm	X-3113
C	5112 211 62540	Torsion spring	X-3113
C	5112 211 62180	Damping	X-3113

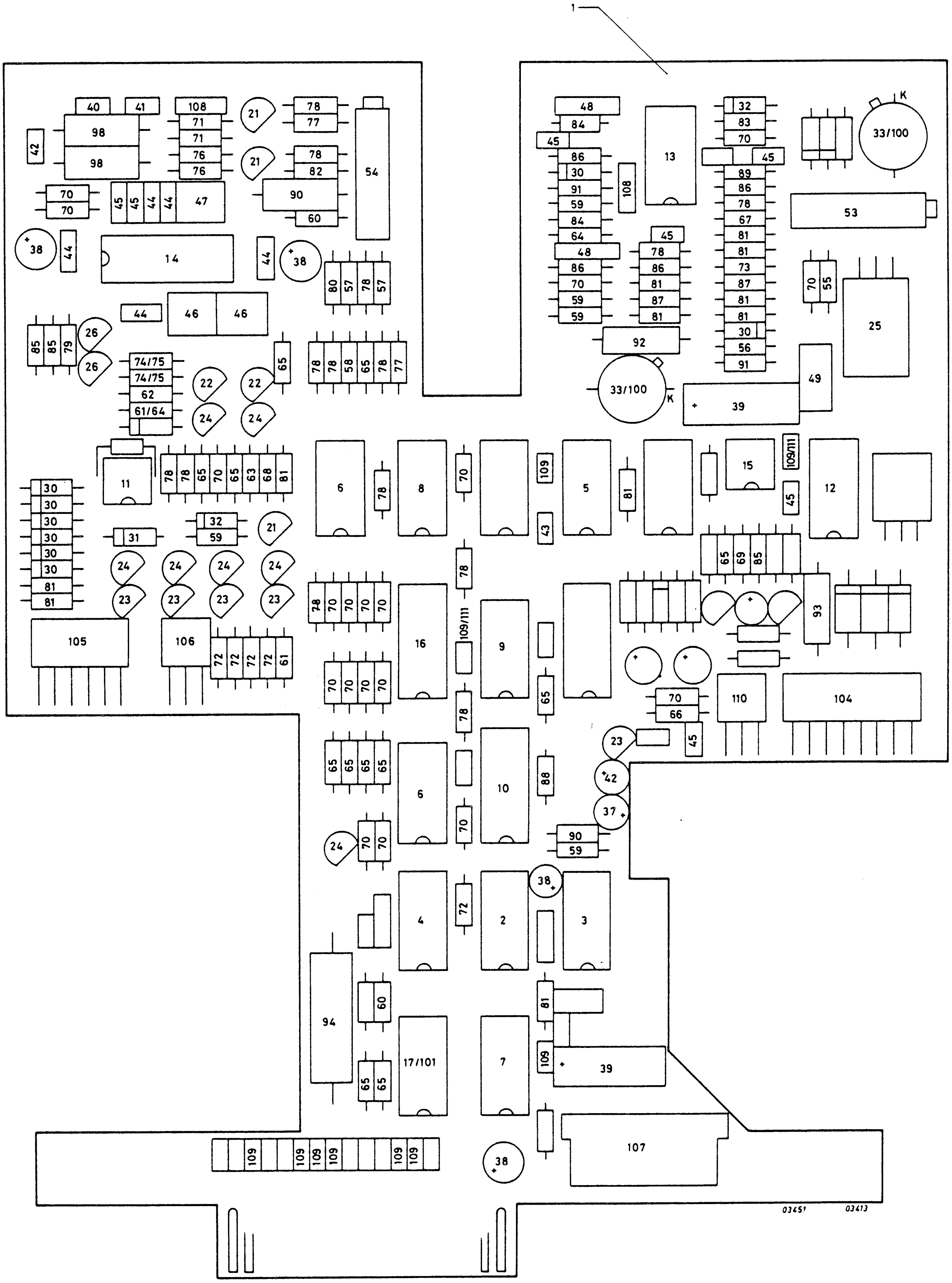
CARRIAGE X-3114

Pos.	Code Number	Description	
B	5112 291 53590	Carriage mounted 3	X-3114

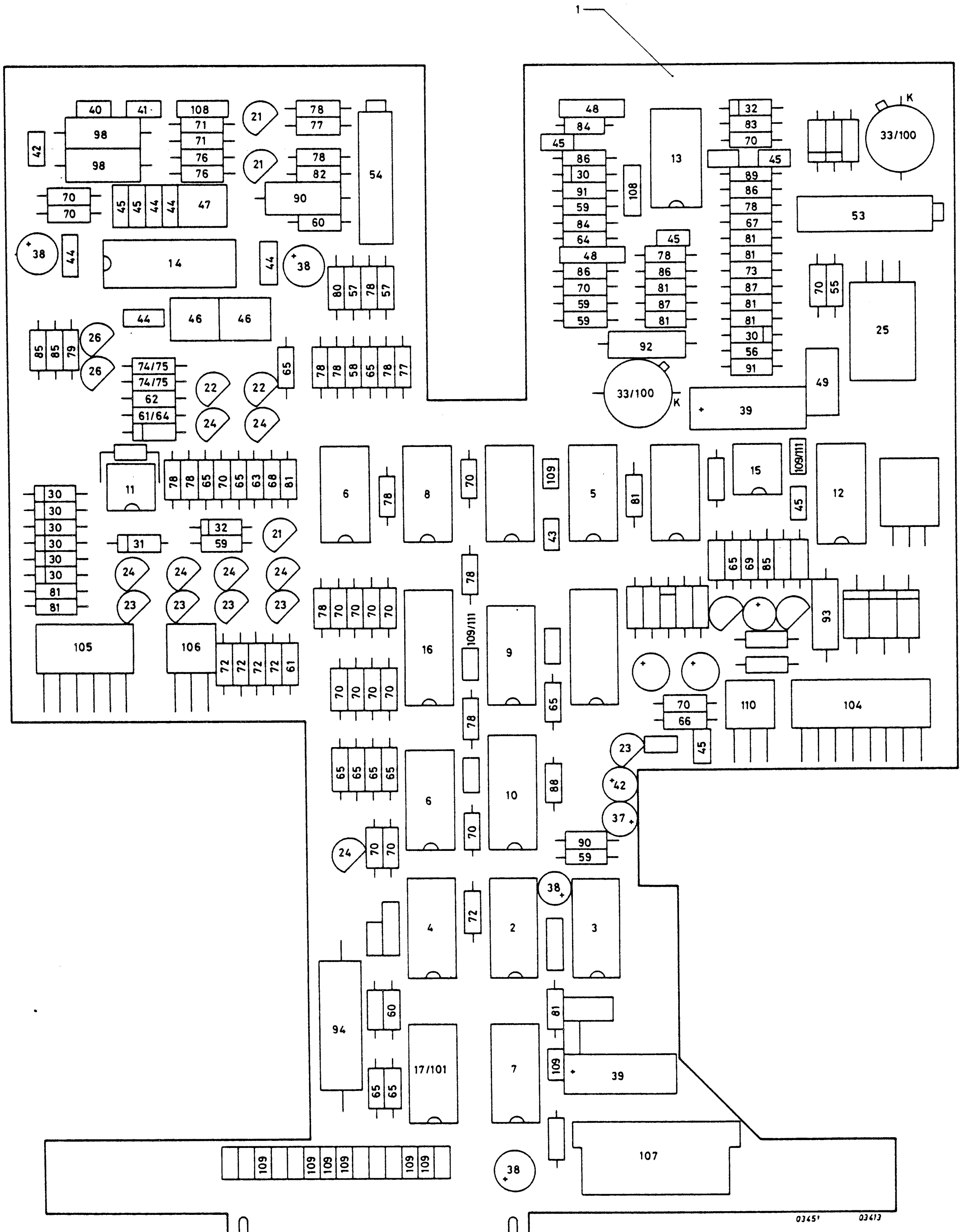
t.b.f.



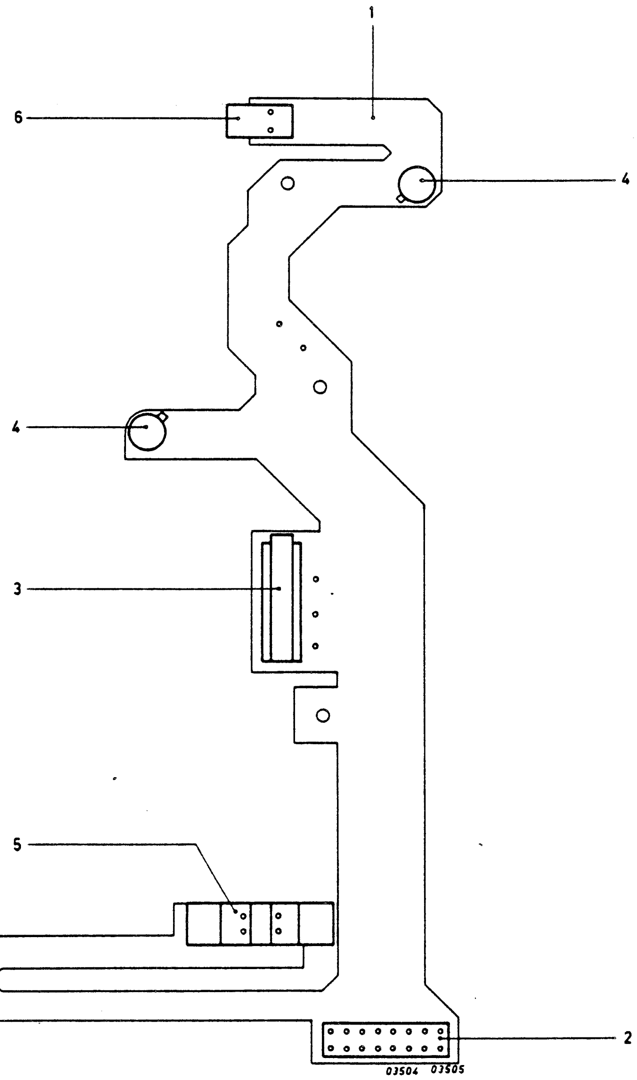
Pos.	Code Number	Description	
1B	5112 291 67230	PCB SMFD 3-1 compl.	X-3111
	5112 291 67240	PCB SMFD 3-2 compl.	X-3112
	5112 291 67250	PCB SMFD 4-1 compl.	X-3113
	5112 291 67260	PCB SMFD 4-2 compl.	X-3114
2C	9332 315 90112	IC SN74LS00N	X-3111/12/13/14
3C	9331 529 00112	IC SN7402N	X-3111/12/13/14
4C	9331 398 50112	IC SN7404N	X-3111/12/13/14
5C	9332 316 00112	IC SN74LS04N	X-3112/13/14
6C	9331 713 30112	IC SN7407N	X-3111/12/13/14
7C	9331 719 20112	IC SN7438N	X-3111/12/13/14
8C	9331 211 50112	IC SN7474N	X-3111/12/13/14
9C	9332 316 50112	IC SN74LS74N	X-3112/13/14
10C	9332 746 80772	IC SN74LS123N	X-3113/14
11C	9335 273 80682	IC SN75473P	X-3112/14
12C	9335 004 40112	IC LM324N	X-3111/12/13/14
13C	9333 485 60112	IC LM339AN	X-3111/12/13/14
14C	9334 704 90112	IC MC3470P	X-3111/12/13/14
15C	9332 243 90112	IC NE555N	X-3111/12/13/14
16C	5112 209 13891	IC N82S23B/MFD1-I	X-3111/12/13/14
17C	2122 118 00753	IC 314A151	X-3111/12/13/14
21C	9331 976 20112	Transistor BC547A	X-3111/12/13/14
22C	9331 977 20112	Transistor BC557A	X-3111/12/13/14
23C	9333 266 20112	Transistor BSR50	X-3111/12/13/14
24C	9333 266 50112	Transistor BSR60	X-3111/12/13/14
25C	9334 972 40112	Transistor MJE2955T	X-3111/12/13/14
26C	9333 893 20112	Transistor 2N5460	X-3111/12/13/14
30C	9331 126 60112	Diode IN4446	X-3111/12/13/14
31C	9332 262 70112	Diode ZPD3V3	X-3111/12/13/14
32C	9331 668 40112	Diode BZX79B7V5	X-3111/12/13/14
33C	9335 286 70112	Diode OP131W	X-3111/12/13/14
37C	2012 198 07108	ELCO 1uF 35V	X-3113/14
38C	2012 198 07109	ELCO 10uF 35V	X-3111/12/13/14
39C	2222 015 26479	ELCO 47uF 25V	X-3111/12/13/14
40C	2222 641 34479	Capacitor 47pF	X-3111/12/13/14
41C	2222 641 34151	Capacitor 150pF	X-3111/12/13
42C	2222 630 05102	Capacitor 1nF	X-3111/12/13/14
43C	2222 629 05103	Capacitor 10nF	X-3111/12/13/14
44C	2222 629 05223	Capacitor 22nF	X-3111/12/13/14
45C	2022 552 00524	Capacitor 100nF	X-3111/12/13/14
46C	2012 331 00084	Capacitor 330pF	X-3111/12/13/14
47C	2012 331 00045	Capacitor 3,3nF	X-3111/12/13/14
48C	2012 310 03108	Capacitor 33nF	X-3111/12/13/14
49C	2012 318 11006	Capacitor 47nF	X-3111/12/13/14
53C	2122 350 00493	Pot. meter 2K lin.	X-3111/12/13/14
54C	2122 350 00376	Pot. meter 20K lin.	X-3111/12/13/14



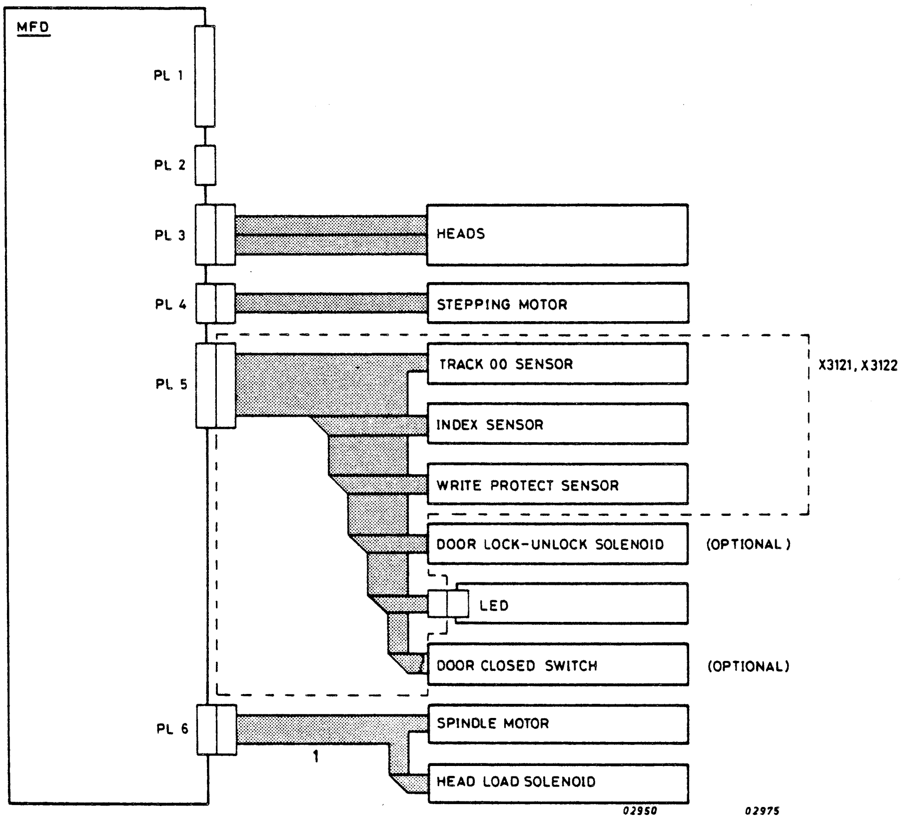
Pos.	Code Number	Description	
55C	2322 151 51008	Resistor 1E	X-3111/12/13/14
56C	2322 151 51009	Resistor 10E	X-3111/12/13/14
57C	2322 151 51829	Resistor 18E2	X-3111/12/13/14
58C	2322 151 55119	Resistor 51E1	X-3111/12/13/14
59C	2322 151 51001	Resistor 100E	X-3111/12/13/14
60C	2322 151 51211	Resistor 121E	X-3111/12/13/14
61C	2322 151 52211	Resistor 221E	X-1111/12/13/14
62C	2322 151 52741	Resistor 274E	X-3111/12/13/14
63C	2322 151 53011	Resistor 301E	X-3111/12/13/14
64C	2322 151 53321	Resistor 332E	X-3111/12/13/14
65C	2322 151 54751	Resistor 475E	X-3111/12/13/14
66C	2322 151 55621	Resistor 562E	X-3111/12/13/14
67C	2322 151 57501	Resistor 750E	X-3111/12/13/14
68C	2322 151 58251	Resistor 825E	X-3111/12/13/14
69C	2322 151 59091	Resistor 909E	X-3111/12/13/14
70C	2322 151 51002	Resistor 1K	X-3111/12/13/14
71C	2322 151 51102	Resistor 1K1	X-3111/12/13/14
72C	2322 151 52002	Resistor 2K	X-3111/12/13/14
73C	2322 151 52212	Resistor 2K21	X-3111/12/13/14
74C	2322 151 52742	Resistor 2K74	X-3111/12
75C	2322 151 53322	Resistor 3K32	X-3113/14
76C	2322 151 53922	Resistor 3K92	X-3111/12/13/14
77C	2322 151 54322	Resistor 4K32	X-3111/12/13/14
78C	2322 151 54752	Resistor 4K75	X-3111/12/13/14
79C	2322 151 56812	Resistor 6K81	X-3111/12/13/14
80C	2322 151 58252	Resistor 8K25	X-3111/12/13/14
81C	2322 151 51003	Resistor 10K	X-3111/12/13/14
82C	2322 151 51213	Resistor 12K1	X-3111/12/13/14
83C	2322 151 51503	Resistor 15K	X-3111/12/13/14
84C	2322 151 51823	Resistor 18K2	X-3111/12/13/14
85C	2322 151 52213	Resistor 22K1	X-3111/12/13/14
86C	2322 151 53923	Resistor 39K2	X-3111/12/13/14
87C	2322 151 56043	Resistor 60K4	X-3111/12/13/14
88C	2322 151 55113	Resistor 51K1	X-3113/14
89C	2322 151 51624	Resistor 162K	X-3111/12/13/14
90C	2322 151 52743	Resistor 27K4	X-3113/14
91C	2322 151 51005	Resistor 1M	X-3111/12/13/14
92C	2322 152 52001	Resistor 200E	X-3111/12/13/14
93C	2322 152 53651	Resistor 365E	X-3111/12/13/14
94C	2113 256 00924	Resistor 6E8	X-3111/12
95C	2108 251 00192	Resistor 12E	X-3113/14
98C	2422 535 98278	Coil 750uH	X-3111/12/13/14
99C	8212 221 04111	Coil 100uH	X-3113/14
100C	5112 211 62380	Lampholder	X-3111/12/13/14
101C	2422 549 13505	IC socket 14 pol	X-3111/12/13/14


1
40 41 108 71 71 76 76 78 77 78 82 54 21 21 98 98 42 90 60
70 70 45 45 44 44 47
38 44 14 44 38 80 57 78 57
44 46 46
85 85 79 26 26 74/75 74/75 62 61/64 22 22 24 24 65 78 78 58 65 78 77
48 84 45 86 30 91 59 84 64 48 86 70 59 59 108 13 45 78 86 81 87 81
32 83 70 45 89 86 78 67 81 81 73 87 81 81 30 56 91
33/100 K 53 70 55 25 92 33/100 K 49 39
11 78 78 65 70 65 63 68 81 6 78 8 70 109 5 81 15 109/111 12 45
30 30 30 30 30 30 81 81 31 32 59 21 43
24 24 24 24 23 23 23 23 65 69 85
78 70 70 70 70 16 78 109/111 9 93
105 106 72 72 72 72 61 70 70 70 70
65 70 66 110 104
78 23 45
65 65 65 65 6 10 88 42 37
24 70 70 70 90 59
4 72 2 38 3
94 60 81
17/101 7 109 39
65 65
109 109 109 109 109 109 38 107
0345' 03413

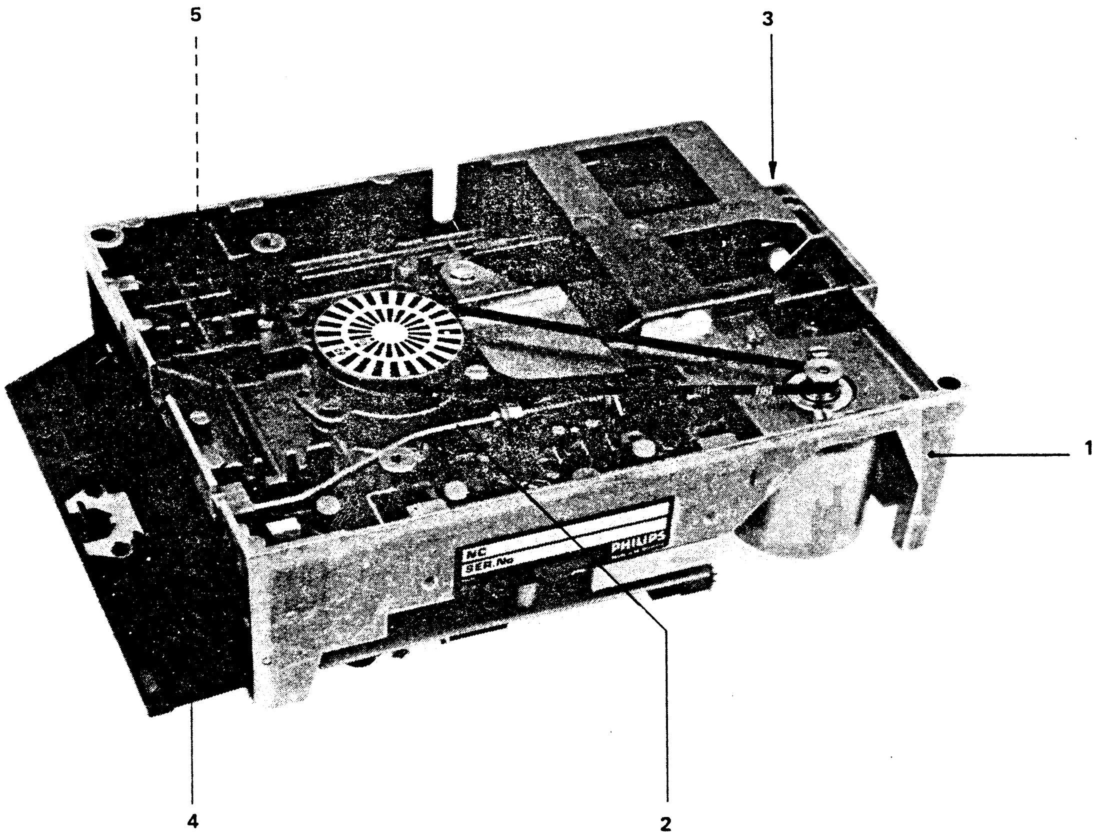
Pos.	Code Number	Description	
104C	2422 023 98184	Connector 15 pol	X-3111/12/13/14
105C	5112 211 59400	Connector 5 pol	X-3111/12/13/14
106C	5112 209 04731	Connector 5 pol	X-3111/12/13/14
107C	2422 025 04227	Connector 4 pol	X-3111/12/13/14
108C	5112 211 03270	Connector 3 pol	X-3111/12/13/14
109C	5112 211 06040	Connector 2 pol	X-3111/12/13/14
110C	5112 211 59390	Connector 2 pol	X-3111/12/13/14
111C	2422 024 88003	Jumper	X-3111/12/13/14


1
6
4
4
3
5
2
03504 03505

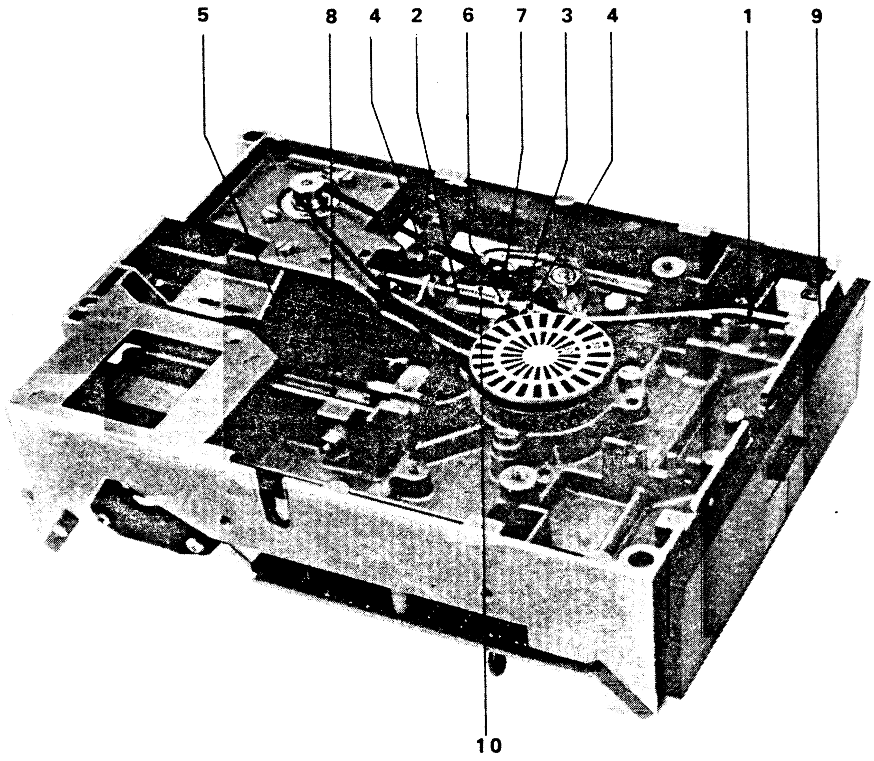
Pos.	Code Number	Description	
1B	5112 291 66570	PCB MFDF compl.	X-3111/12/13/14
2C	2422 062 00812	Connector 16 pol.	X-3111/12/13/14
3C	5112 209 18242	Micro switch	X-3111/12/13/14
4C	9335 302 30112	Transistor OP803	X-3111/12/13/14
5C	9335 306 10112	Optical switch	X-3111/12/13/14
6C	2422 025 01687	Connector 2 pol.	X-3111/12/13/14


MFD
PL 1
PL 2
PL 3
HEADS
PL 4
STEPPING MOTOR
PL 5
TRACK 00 SENSOR
X3121, X3122
INDEX SENSOR
WRITE PROTECT SENSOR
DOOR LOCK-UNLOCK SOLENOID
(OPTIONAL)
LED
DOOR CLOSED SWITCH
(OPTIONAL)
PL 6
SPINDLE MOTOR
1
HEAD LOAD SOLENOID
02950
02975

Pos.	Code Number	Description	
1B	5112 280 02991	Cable to spindle motor and head Solenoid	X-3111/12/13/14


5
3
1
4
2
NC
SER.No
PHILIPS

Pos.	Code Number	Description
B	5112 291 53070	Frame assy
	5112 291 53260	Frame M3 assy
	5112 291 53300	Frame UNC-6 assy
1C	5112 211 62310	Frame
	5112 211 72020	Frame M3
	5112 211 84100	Frame UNC-6
2C	2622 006 40084	Ball bearing
3C	2522 671 07061	Pin
B	5112 211 57060	Front cover small
B	5112 211 57070	Front cover large
4B	5112 291 71130	Cover assy (black)
	5112 291 71140	Cover assy (beige)
5B	5112 209 19031	Door unlock magnet 12V (Option)


5
8
4
2
6
7
3
4
1
9
10

Pos.	Code Number	Description
B	5112 291 53140	Ejector assy
C	5112 291 53060	Slider assy
1D	5112 211 62370	Pressure spindle
2D	2612 115 02045	Compression spring
3D	5112 211 62340	Bearing house
4D	5112 211 62350	Bush
5D	5112 211 62280	Slider
D	2522 677 01002	Spring dowel
D	5112 211 62300	Handle
D	2522 672 01024	Pin
D	2612 115 00179	Tension spring
6D	2522 640 20002	Adjusting ring
7D	2522 043 14016	Bolt
8C	5112 291 53050	Motor plate assy
D	5112 291 53040	Motor plate
D	5112 211 62320	Rest spring
D	5112 211 62290	Spindle
D	5112 211 62330	Ejector
D	5112 200 06491	Compression spring
D	5112 200 06501	Pipe
B	5112 291 62060	Disk in assy
9C	5112 211 62350	Bush
10C	5112 291 53180	Switch assy
D	5112 211 62370	Compression rod
D	5112 200 06631	Compression spring
D	5112 211 62500	Bearing house
D	5112 211 62350	Bush
D	2622 080 90803	Ring
D	.5112 211 62510	Handle
D	5112 209 14811	Micro switch
D	5112 211 05450	Plate
D	5112 211 62520	Spring
D	2622 006 40071	Ball bearing

CONVERSION LIST(S)

TYPNUM	TYPE-DESCRIPTION	URGNTI	SRVKLS
X 3113	LIST OF MFD-UNITS FROM E'FELD	1	4

VRSVLG	TYPE/VERSION	TPSERIE	TRSERIE	SAG	VRKDAT
—0	X 3113	0005000	0000000	08250	82071
1	X 3121	0005000	0000000	08250	82121
2	X 3122	0005000	0000000	08250	81381

LINE	FACTORYCODE	SERVICECODE	FP	FR	DESCRIPTION R C M D S PER MAG UN HIG	ART.SPECIFIC.
00010	5112 291 67250	5322 216 21124	11	000	PRINTED CIRCUIT PCB MFD 4-1 0 0 0 0 0 000 0 13	
00020	5112 291 66580	5322 216 21123	11	000	PRINTED CIRCUIT MFD2 0 0 0 0 0 000 0 13	
00030	5112 291 59350	5322 214 45378	11	000	BOARD,PRINTED 1 0 0 0 0 000 0 13	
00040	5112 291 66570	5322 216 21122	12	000	PRINTED CIRCUIT PCB MFD-F 0 0 0 0 0 000 0 13	
00050	5112 291 53430	5322 691 60031	12	000	SEGMENT 0 0 0 0 0 000 0 13	SLIDE ASSY 96TPI/OS
00060	5112 291 53160	5322 218 74548	13	000	SLIDE 0 0 0 0 0 000 0 13	
00070	5112 291 53340	5322 361 41001	12	000	MOTOR,STEPPER 0 0 0 0 0 000 0 13	STEPMOTOR 96TPI/1,8%
00080	5112 291 53360	5322 361 41002	12	000	MOTOR,STEPPER 0 0 0 0 0 000 0 13	
00090	5112 291 49970	5322 361 24212	12	000	MOTOR 0 0 0 0 0 000 0 13	MAIN MOTOR ASSY
00100	5112 291 53080	5322 405 40046	12	000	LEVER 0 0 0 0 0 000 0 13	LANDING LEVER
00110	5112 211 62140	5322 405 46409	12	000	BRACKET 0 0 0 0 0 000 0 13	STEELSTRAP
00120	5112 200 06231	5322 358 24162	12	000	BELT 0 0 0 0 0 000 0 13	BELT 3X308
00130	5112 291 49940	5322 528 10419	12	000	DISC,REEL 0 0 0 0 0 000 0 13	SPINDLE ASSY
00140	5112 291 49960	5322 691 60029	12	000	CONE 0 0 0 0 0 000 0 13	CONE ASSY

7 MAINTENANCE

LIST OF ILLUSTRATIONS

7 MAINTENANCE

The maintenance philosophy for the drives is customer dependant, however, if the logic board is replaced, or even slackened, it is recommended that all the drive parameters are checked as per this section. If the board is moved, the index sensor position cannot be guaranteed.

7.1 TOOLS

In addition to a normal range of flat bladed screwdrivers and a micrometer, the following tools will be required:

a) 2.5 mm Allen key (for carriage mounts)
b) 7 mm open ended or ring spanner ('catseyes' adjustment)
c) Alignment diskettes

- X3111/X3112 - partnumber 8709 010 92411
- X3113 - partnumber 8709 010 92421
- X3114 - partnumber 8709 010 92461

d) Head cleaning kit FD-05- Innovative Computer Product
e) MFD exerciser No. 8709-010-92291
f) Oscilloscope to the following minimum specification:
dual channel
invert and add facility
10 MHz bandwidth
50 mV/div sensitivity
external trigger facility
g) frequency counter with .1 msec resolution (min.)

Note 1: A battery powered, test oscillator with integral matching network is to be released shortly for read symmetrie adjustments on the read amplifier.
Note 2: The test oscillator and item c will be supplied as a tool kit under No. 8709-010-92301.

7.2 SETTING UP

In these setting up instructions, a letter alone - a), b), c) etc, refers to all drivers. A letter followed by a number or numbers - a1), b3), c1,2 etc., refers to one or more particular drives, as follows: 1 = X3111
2 = X3112
3 = X3113
4 = X3114

7.2.1 BELT TENSION (SEE FIGURE 7.1)

a) Remove power from the drive.
b) Slacken screws 'D' and 'E' just enough to tension the spring 'F'.
c) Tighten D
d) Tighten E

7.2.2 SPINDLE SPEED ADJUSTMENT

Before beginning this adjustment ensure that belt tension is correct, and belt is unworn and undamaged.
The drive should be at room temperature (approx 20° C).

a) Power on drive
b) Start motor (if not already started)
c) Connect the index O/P from the test box to the frequency counter
d) Push in alignment diskette, position on track Ø and load head
e) Adjust R58 (figure 4.6/1) until the counter reads a period of 199 msecs ± 1 msec.

Note: This adjustment allows for increase in motor temperature when the drive is in its operating environment, thus the stroboscopic disc on the underside of the motor provides a guide only.

7.2.3 WRITE PROTECT SENSOR CHECK

Insert and remove a non write protected diskette and check that the write protect LED on the text box switches on and off. Check that the LED is off when the diskette is fully inserted.

Procedure:

a) Check that W20 is installed.
   Switch off motor and wait for it to stop.
   Note 1: The motor may continue to run for a minute or so.
b) Insert a diskette. The motor should run for approx one minute.
   Note 2: The motor will also run for a minute if a non write-protecte diskette is removed.

7.2.4 HEAD ALIGNMENT (FIGURES 7.2 AND 7.3)

The adjustment requires an oscilloscope, MFD exerciser and the appropriate alignment diskette (see section 7.1).
Oscilloscope setting (guide only)

Both channels 50 MV/div, AC coupling
One channel inverted
Add function selected
Timebase 20 msec/div.
External trigger +ve.

Connect the external trigger to the INDEX socket of exerciser. Connect probes to pin 1 and pin 3 of W22.

Procedure:

a) Remove copper screen from below chassis.
b) Set track 0 sensor screw ('A', figure 7.2) and stepper motor nut ('B', figure 7.3) to the middle of their respective slots.
c) Press RESET button on exerciser. (Carriage will retrack).
d) Select HD 0, READ
e1,2) Step to tracks 16, 20 and 24 in turn. Note which track gives nearest picture to catseyes of figure 7.3. Step to that track.
e3,4) Step to tracks 32, 36 and 40 in turn. Note which track gives nearest picture to catseyes of figure 7.3. Step to that track.

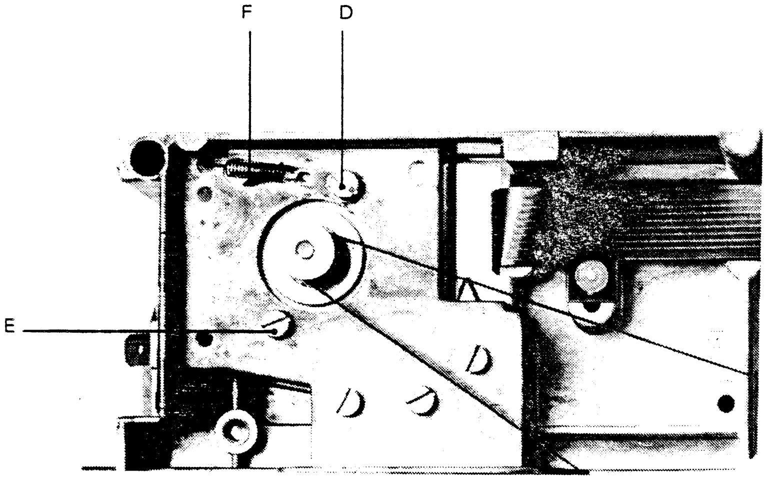


Figure 7.1 BELT TENSION

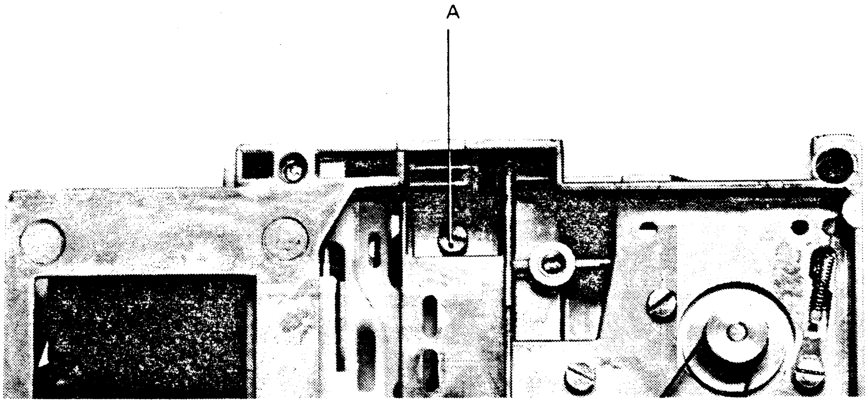


Figure 7.2 TRACK 0 SENSOR ADJUST

f) Slacken motor plate (nut B) and adjust with a screwdriver, for 100% catseyes. Lock nut B.

g2,4) Select head 1.
Check that at least 80% catseyes is achieved. If not, readjust motor plate so that each head gives 80% or better.

Note: A reduction in signal level can be expected on head 1 due to its physical position never to the centre of the disk.

h) Step to present track, plus 2, and return.
Step to present track, minus 2, and return.
On both heads, at least 80% catseyes must be achieved after the return step.

j) The values indicated only apply in connection with a certified alignment diskette at an environment temperature of 21° ± 2° and 50% ± 5% relative humidity.

k) Carry out Track ØØ sensor adjustment of 7.2.5.

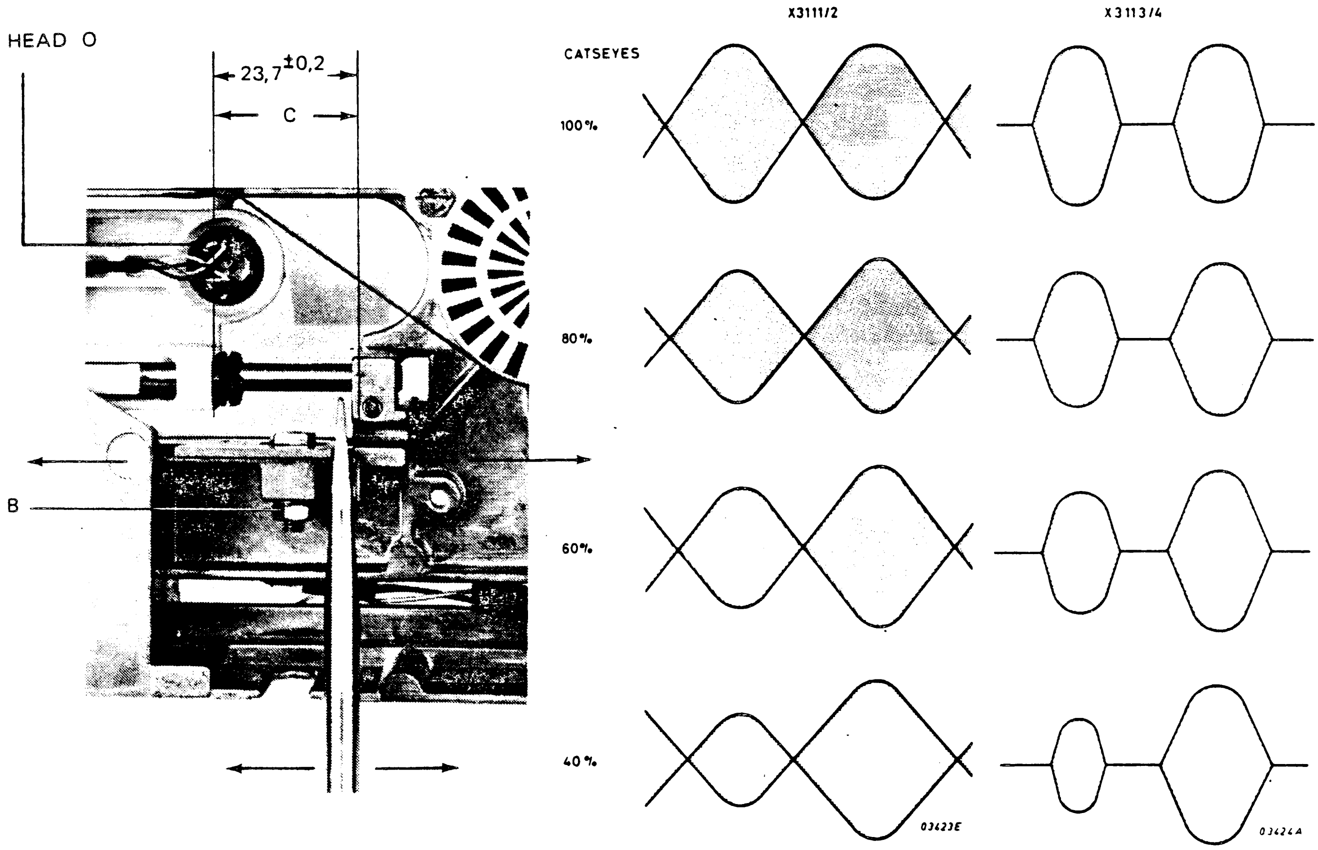


Figure 7.3 HEAD ALIGNEMNT

7.2.5 TRACK OO SENSOR ADJUSTMENT

Note: If an exerciser is not available, this adjustment can be adequately carried out by following this section, a) to g) inclusive, and then stepping to the reference track (16 or 32) to check for catseyes. If catseyes have disappeared, repeat section 7.2.4 and 7.2.5.
Do not forget to replace the copper screen.
After the adjustment of track Ø, it is absolutely necessary to check the eject function.

Before carrying out this adjustment, the reference track (16 or 32) must be correctly established by the head alignment procedure of 7.2.4. The alignment disk must still be loaded.
Set oscilloscope as follows: (guide only)

Sensitivity 2V/div, DC coupled.
Timebase 50 msecs/div.
Auto trigger

Connect probe to W23, pin 3 (NTR00).

Procedure:
a1,2) Step to present track, minus 14 (Actual track 2).
a3,4) Step to present track, minus 30 (Actual track 2).
b) Slacken TRACK 00 sensor (A, figure 7.2) and move it forward until voltage level at W23, just switch from a high level to a low level.
Lock A.
c) Press RESET button on exerciser.
d) Step to track 3, NTR00 should go high
e) Step to track 2, NTR00 should go low.
f) If d) or e) not satisfactory, adjust screw 'A' until change occurs between tracks 2 and 3.
Lock A.
g) Press reset button.
h) Set oscilloscope to normal trigger, internal and +ve.
j) Select track 4 on address switches.
Select repetitive seek mode.
k) Adjust oscilloscope for steady pattern (square wave).
l) Unlock screw 'A' and adjust carefully for equal mark/space ratio.
Lock A.
m) Press RESET button.
n) Set oscilloscope as for HEAD ALIGNMENT (Section 7.2.4).
p) Step to reference track (16 or 32) and check that catseyes are OK. If not, repeat 7.2.4 and 7.2.5.
q) Replace the copper screen.

7.2.6 INDEX TO BURST ADJUSTMENT (FIGURES 7.4 AND 7.5)

Before commencing this adjustment, the HEAD ALIGNMENT adjustment previously described should have been carried out.
Oscilloscope settings are as follows: (guide only)

Both channels 200 mV/div, Ac coupling
One channel inverted
Add function selected
Timebase 50 micro-secs/div
External trigger +ve.

Procedure:
a) A and B probes to pins 1 and 3 of W22.
b) Trigger from INDEX socket on exerciser
c1,2) Step to track 1, select head 0.
c3,4) Step to track 8, select head 0.
d) Check distance between start of trace and start of burst is 200 µsecs ± 100 µsecs (figure 7.5).
e) If not, slacken screw 'G' (figure 7.4) and adjust index LED.
f) Tighten screw 'G' and check that the timing is still within specification.

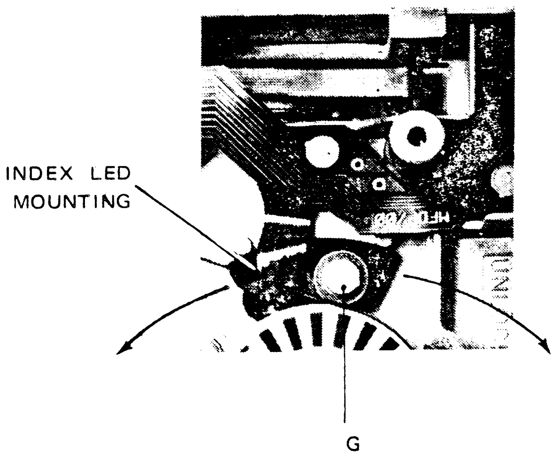


Figure 7.4 INDEX TO BURST ADJUSTMENT

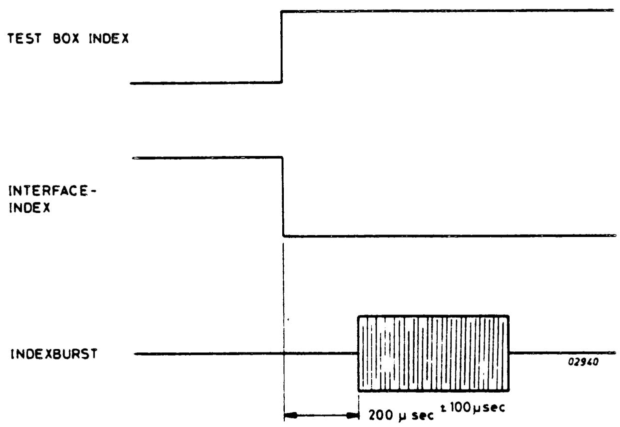


Figure 7.5 INDEX TO BURST CHECK

7.2.7 READ SYMMETRY ADJUSTMENT (FIGURE 7.6)

This adjustment is done with the PCB disconnected from the drive. The exerciser is connected in the usual way and the appropriate drive No selected.
Oscilloscope settings are as follows: (guide only)

Channel 'A' selected
Trigger 'A', +ve
Sensitivity 1V/div, Ac coupled, non-invert
Timebase 1 microsec/div.

Procedure:
a) Connect read data O/P on exerciser, to channel 'A'.
b) Connect test oscillator to plug ST3.
c) Adjust oscilloscope so that at least part of the triggering pulse is useable and also the next two pulses, as in figure 7.6-d.
d) Adjust R98 so that the second pulse is steady and is equally spaced between the other two.

Note: This adjustment is to counteract the effect of imbalance in the diode and FET network which connects the heads to the read amplifier. The imbalance effectively creates DC bias which causes the zero crossing points, even for a perfect input signal, to be recognised unequally (figure 7.6-b and c).

In setting up the drive, the 'perfect' sine wave is provided by a test oscillator. The adjustment is simply to produce equally spaced output pulses on the read data line.

When viewed on an oscilloscope, two kinds of picture are possible, depending on the triggering; these are:

Every second pulse jittering as figure 7.6-'d'.
Steady picture with unequal displacement as figure 7.6-'c'.

R98 is adjusted to bring the jittering pulses together (d), or to shift every second pulse (c). In both cases the result is 'e'.
The ceramic, long-life heads are manufactured to a specification which will not introduce significant amounts of shift when connected to a correctly adjusted PCB.

7.2.8 DOOR CLOSED SWITCH CHECK (FIGURE 7.8)

Note: This is an 'eyeball' check which requires no feeler gauges.

a) Whilst monitoring output terminals of the microswitch, close the loading door slowly until the switch contact makes.
Note the position (dotted) of the lever.
b) Close the door fully and check that the end of the lever has moved at least 0.5mm from the noted position.
c) In the closed position, a gap of 0.2mm (min) must exist between the lever and the switch body.
d) With an oscilloscope, the function of the switch is to be checked.

7.2.9 HEAD CLEANING

To clean the heads the customer will use the head cleaning kit specified in the tools list in section 7.1.

Instructions for use are included in the kit.
A cleaning program will be used; ensure that the heads keep stepping during the cleaning process. This causes even, cleaning diskette, wear. To simulate this program, when the unit is connected to a test box, the engineer should step the heads using the track select switches.

The useful life of the cleaning diskette is 26 cleanings (maximum) so a record of use must be kept.

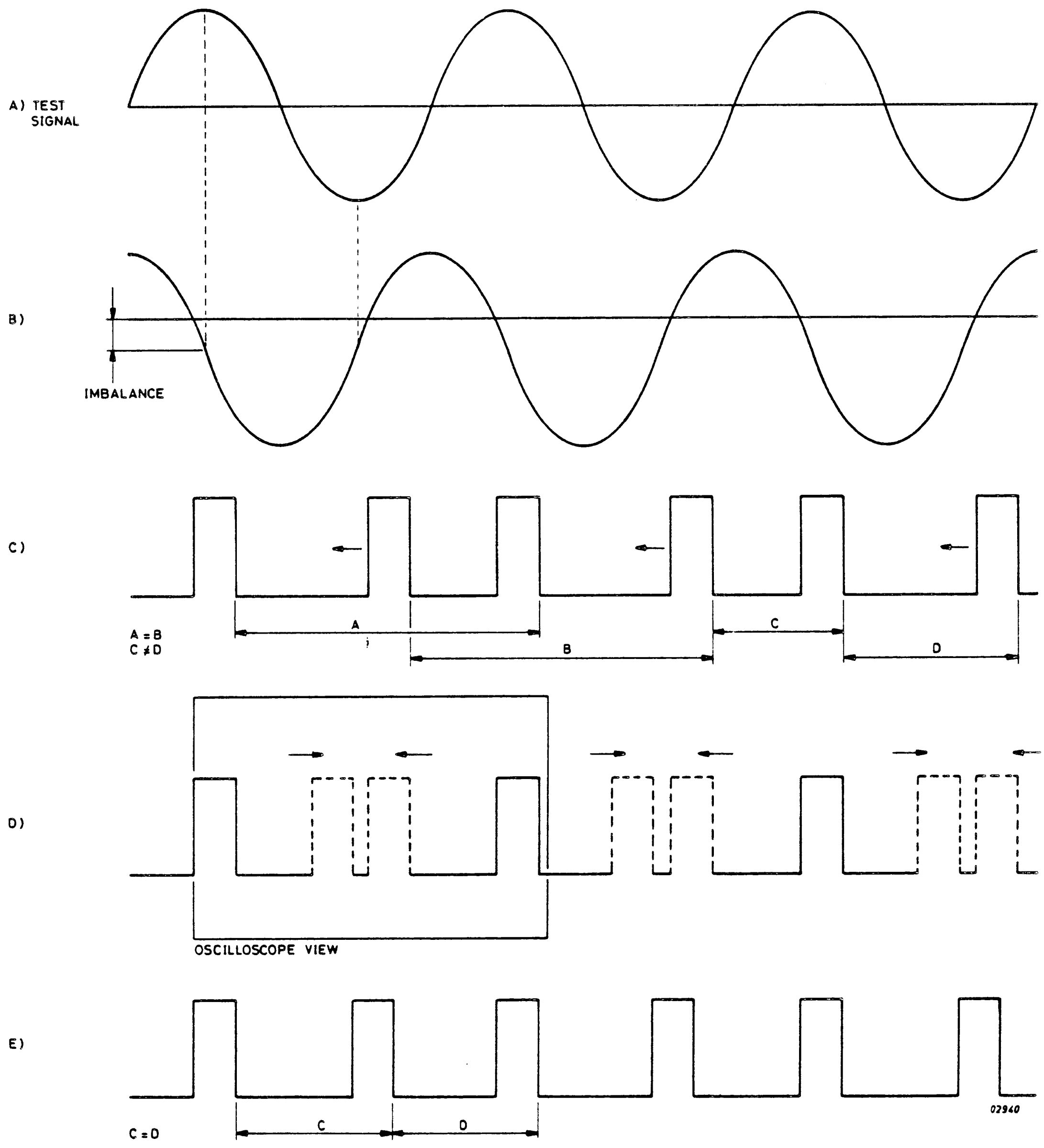


Figure 7.6 READ SYMMETRY ADJUSTMENT

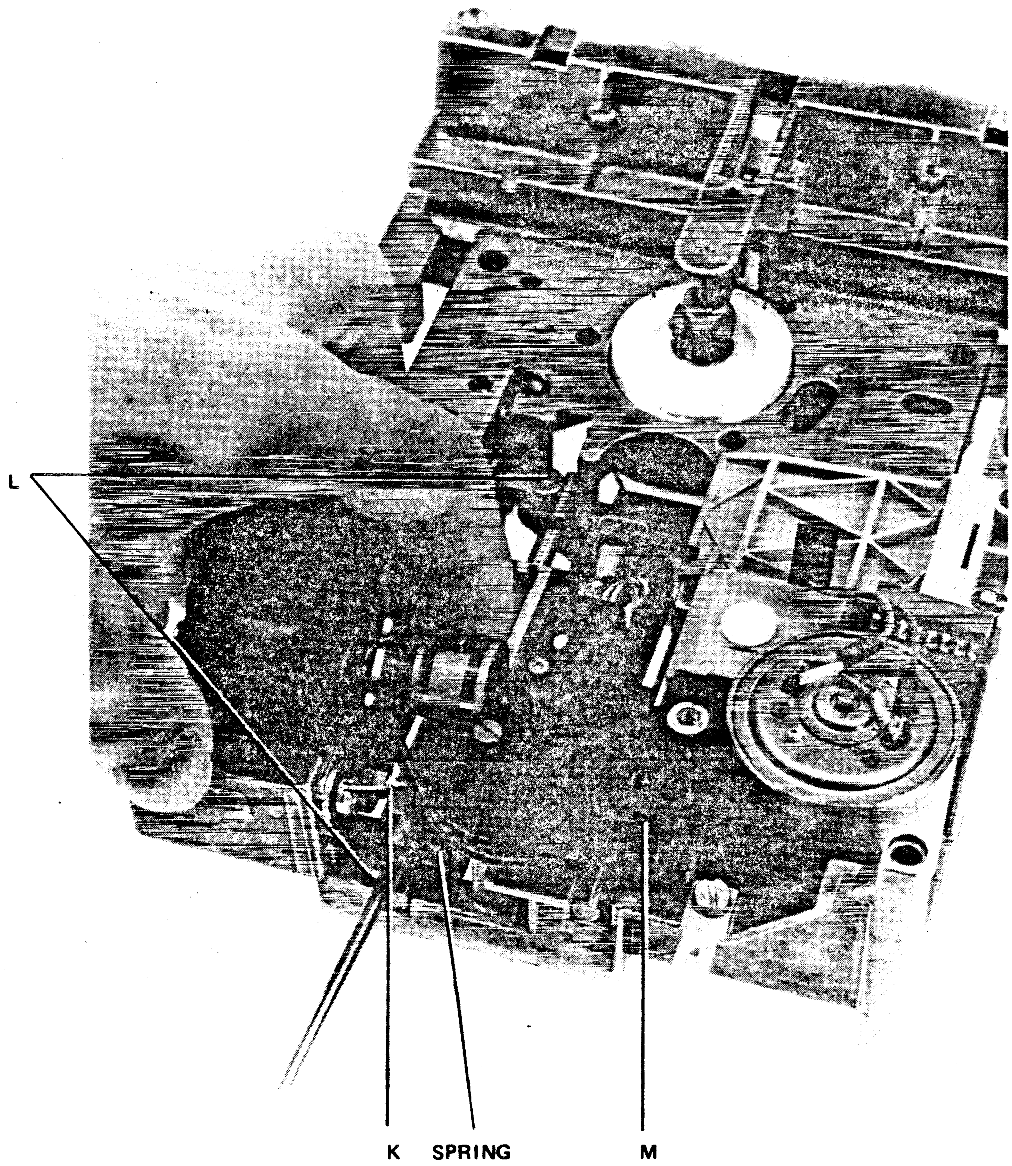


Figure 7.7 BAND REMOVAL

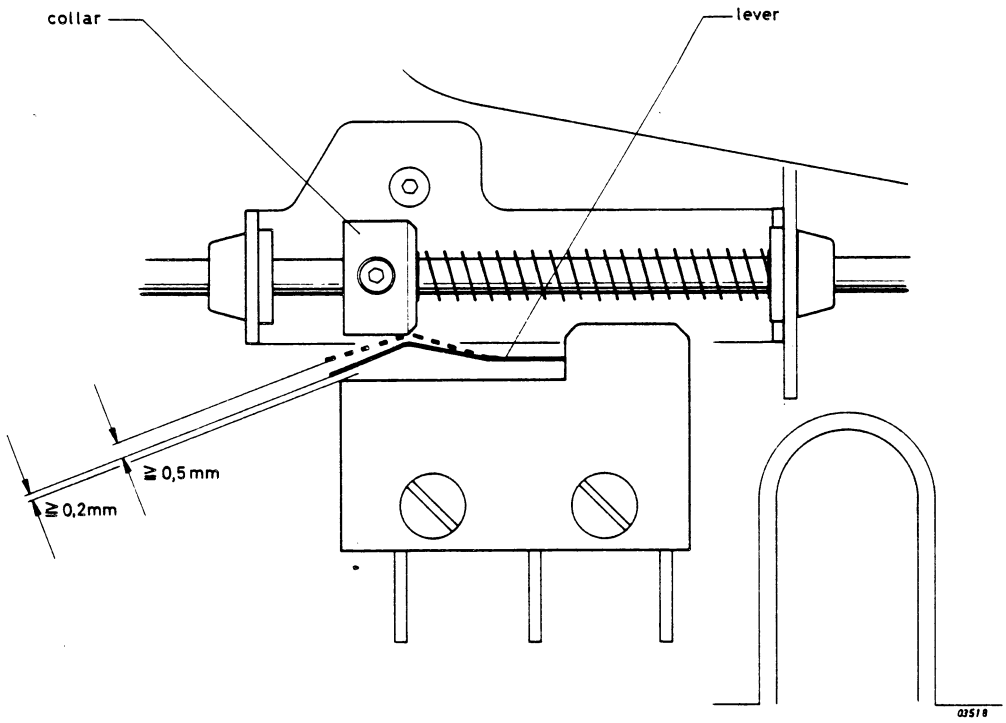


Figure 7.8 DOOR CLOSED SWITCH CHECK

7.3 REMOVALS AND REPLACEMENTS

7.3.1 PCB - REMOVAL

a) Disconnect plugs ST3-6 and remove the 3 fixing screws shown in figure 1.10.
b) Slide the board back slightly and then lift out.

REPLACEMENT

Opposite to previous sequence.

7.3.2 BELT - REMOVAL

a) Slacken screws D and E of figure 7.1, push the pulley towards the spindle.
b) Slide belt off the spindle.

REPLACEMENT

Opposite to previous sequence, see 7.2.1 Belt Tension.

7.3.3 SPINDLE MOTOR - REMOVAL

Note the connections to the tags of the motor. The terminals are marked + and -.
a) Remove the belt (section 7.3.2).
b) Unsolder the loads.
c) Remove screws D and E of figure 7.1.
d) Lift out the spindle motor.
Note: Avoid stretching the spring, or belt tension will be upset.

REPLACEMENT

Opposite to previous sequence.

7.3.4 STEPPER MOTOR - REMOVAL

a) Remove the PCB (section 7.3.1).
b) Locate the front face of the drive against a firm, flat surface.
c) Hold the carriage in its retracted position.
d) Place the blade of a screwdriver between the steel band and the carriage (figure 7.7) and push forward to release the band.
e) Remove nut and bolt ('B' figure 7.3).

f) Swing the motor up slightly to allow the band to be pulled carefully out of its slot (figure 7.9) with a pair of tweezers.
Note 1: If the band is kinked it will have to be replaced.

g) Remove screw ('K' figure 7.7). Note that the spring washers are dished to provide spring tension during head alignment.
h) Lift out the motor.

REPLACEMENT

Note: If the band has been removed or even slackened, screw and clamp J (figure 7.9) should not fully tightened until this assembly procedure is complete. This is to allow the band to align with the carriage and the pulley.

a) Wrap the band around the pulley and hold it in position.
b) Locate the slide of the stepper motor over its locating peg at the rear of the chassis.
c) Lower the motor into position and replace screw K.
d) Locate the front of the band as per figure 7.9.
e) Install nut and bolt B. Do not tighten.
f) Replace spring (figure 7.7) on its peg.

g) With the front of the drive against a firm, flat surface and the carriage held in the retracted position, push against the spring with a screwdriver (as in removal procedure) and slip the slot in the band over the spring.
h) Slide the motor mount until nut and bolt 'B' (figure 7.3) are in the middle of the slot.
i) Tighten 'B' and 'K'.
j) Move carriage fully in and out a couple of times to line up the band.
k) Tighten the screw and clamp 'J'.
l) Load an alignment diskette and carry out head alignment and track 00 adjustments (section 7.2.4 and 7.2.5).

7.3.5 HEAD CARRIAGE - REMOVAL

a) Remove PCB and stepper motor (sections 7.3.1 and 7.3.4).
b) Remove the 2 countersunk screws (L of figure 7.7) with a 2.5 mm Allen key but merely slacken screw 'M', taking care not to damage the MFDF wiring loom.
c) Slide the two round bars out through the rear of the drive. Warning - avoid scratching the bars.
d) Remove the carriage.

REPLACEMENT

Reverse the previous procedure.
Allow sufficient cable for full carriage travel.

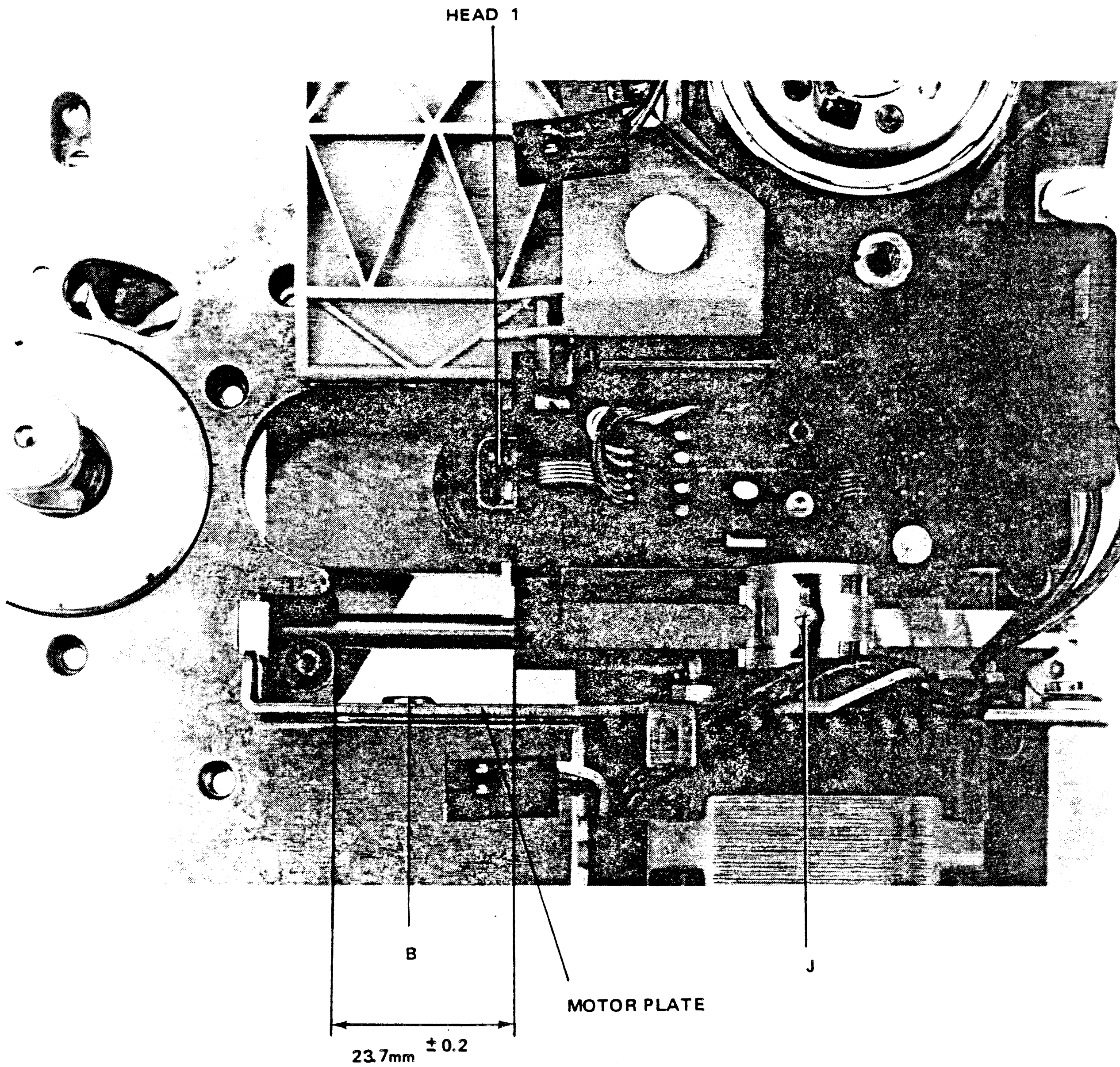


Figure 7.9 BAND POSITION

7.3.6 HEAD LOAD SOLENOID - REMOVAL

The head load assembly consists of the head load solenoid, the head load moulding, and a cable guide. The cable guide, which also fixes the head unload gap, is a plastic moulding which mounts on a stand-off pillar alongside the spindle motor. It is fastened by a single screw on the underside of the chassis.

a) Remove cable guide fixing screw.

Note how the spring is positioned under the head load moulding and then remove the 3 circlips.

b) Remove head load moulding and cable guide.
c) Remove the two screws holding the solenoid to the chassis.

REPLACEMENT

a) Remount the solenoid to the chassis.
b) Replace the core and stand the spring on its peg alongside the solenoid.
c) Replace the head load moulding by the following sequence:
 - Slide the moulding under the lifting arm of the upper head
 - Locate the spring on the peg underneath the moulding.
 - Slip the moulding onto its 2 locating pegs.
 - Replace the 3 circlips.
d) Replace the cable guide.

7.3.7 MFDF - REMOVAL (FIGURE 1.17)

a) Remove PCB (section 7.3.1)
b) Remove the circlip from the top of the track 0 sensor and screw 'A' (figure 7.2). Unscrew 'A'.
c) Pull out the 3 white plastic pegs holding the loom to chassis.
d) Remove screw 'G' (figure 7.4).
e) Gently prise the activity LED plug and socket apart. Carefully pull out the write protect LED.
f) Lift the index LED assembly.
g) Remove the MFDF completely.

REPLACEMENT

Reverse previous procedure. Note that there is a peg to locate the track 0 sensor.

7.3.8 SPINDLE ASSEMBLY - REMOVAL

a) Remove belt (section 7.3.2).
b) Remove the three screws holding the spindle assembly. Note the position of the flange.
c) Lift out, taking care not to lose the two, shim washers under each screw.

REPLACEMENT

Reverse previous procedure.
Adjust belt tension as per section 7.2.1.

7.3.9 CONE ASSEMBLY (FIGURE 1.2) - REMOVAL

Note carefully the physical arrangement of the assembly (figure 1.2) before attempting removal.
a) Remove spindle (section 7.3.8).
b) Remove PCB (section 7.3.1).
c) Rotate the pin so that the gap in its circlip is facing down.
d) Using a pair of snipe-nosed pliers, pull off the circlip and slide the pin out.
e) Release the lever by closing the front door.
   The assembly will now be free.
   Note: Do not remove the spring unless necessary.

REPLACEMENT

a) Replace and slide the forked end of the lever into position.
b) Push the other end of the lever into its slot and open the loading door to hold it in position.
c) By pushing down the forked end, it should be easy to line up the holes in the casting and the lever.
d) Replace pin and circlip.
e) Replace spindle assembly (section 7.3.8).