TANDBERG
TDC 3000
DIGITAL CARTRIDGE RECORDER
Reference Manual

TANDBERG TDC 3000
DIGITAL CARTRIDGE RECORDER

| LOADED | WRITE PERMIT | REWIND UNLOAD | ON-LINE |

TDC 3000 R E F E R E N C E   M A N U A L

Date: January, 1977

LIST OF CONTENTS

1.   GENERAL INFORMATION

1.1. Introduction and applications

The Tandberg series TDC3000 Digital Cartridge Recorder is a
data storage device for serial data. The medium is the 3M
Co's "DC300A Data Cartridge" with 1/4" tape and a capacity
up to 2,5 million characters. The performance of the TDC3000
together with the capabilities of the cartridge results in a
very efficient device for

-      Minicomputer input/output (paper tape replacement)
-      Peripheral storage for minicomputer systems
-      Software distribution
-      Peripheral storage for terminals (text editing, forms etc.)
-      Data transmission
-      Data entry via keyboard (punched card environment)
-      Local data collection
       (industrial processes, warehouse data, point-of-sale etc.)

The 3M Cartridge is unique in several respects:

-      Technical solution is very good (tape transport and guiding,
       tape strength, spooling characteristics,
       mechanical tolerances etc.)
-      Large storage capacity
-      High data rate
-      High search speed

These characteristics enable the TDC3000 to be a high performance
product with a large degree of flexibility to suit a given
application.

The TDC3000 follows the proposed ANSI and ECMA standards for
recording format (1600 bpi phase-encoded), data organization
and mechanical referencing.

1.2.   Product Features

The design of the TDC3000 emphasize

OPERATOR CONVENIENCE

- The cartridge is easy to insert and with very low counter
  force
- The locking is positive and gives tactile feedback
- The entire cartridge label can be read when the cartridge
  is inserted
- The movement of the tape packs can be observed when in
  operation
- Local or Remote Unload command will eject the cartridge
  in a controlled manner for quick operator notice
- If power is disrupted, the cartridge may (without tools) be
  withdrawn from the locking mechanism by grasping the cart-
  ridge and overcoming the spring retention forces
- Unit Select and individual Track Write Protect switches
  located on a sub front panel (optional) for easy access by
  the operator

RELIABILITY

- All important mechanical tolerances on one precision machined
  and rigid aluminium casting
- No mechanical tolerance build-up or adjustments in assembly
- Electromechanical cartridge locking mechanism uses 3-point
  referencing, is quiet and has strong retention forces for
  reliable operation in vibrating environments
- Capstan motor with optical encoder for precise velocity
  feedback and measurement of tape displacement for accurate
  formatting (especially important when updating old files)
- Generation of an internal Drive Unsafe signal will inhibit
  tape motion in order to protect written data
- Motor and servo designed for no programming restrictions

COST EFFECTIVENESS

- Modular product organisation enable the user to tailor the product to his exact needs.
- Built-in power supply.
- Built-in complete tape Formatter plus an exchangeable Input/ Output Control card to suit several interface structurs: Parallell interface for minicomputer applications, Modem Interface with optional buffer, etc.

1.3   Product Organization

In order to satisfy the many requirements for packaging, the product is organized in the following manner:

a.   Single drive, table top

This consists of:

- mechanism, based upon a rigid aluminium casting

- electronics package with servo, local motion control and read/write electronics (3 printed circuit boards on a motherboard)

- control panel

- magnetic head (1, 2 or 4 track)

- cabinet, consisting of sidepanels (serve as mounting for the mechanism and the electronics), front panel, rear panel with integral heatsink and top and bottom covers.

The basic product may be broken down into smaller parts for built-in requirements.

The size of this product   is 210 mm (8 1/4") wide (half rack width behind mounting), 130 mm (5 1/4") high (3 rack increments) and 395 mm (14 1/4") deep.

The single drive may get expanded capabilities by internally mounting a

b.   Powersupply   with regulator (for 2 drives)

c.   Formatter with complete tape motion control and data handling, including CRC generation and check (for 4 drives)

d.   Input/Output Control card to customize the formatter for the I/O structure required: Parallell for minicomputer applications, serial with optional buffer for Teletype/terminal applications, etc.).

This fully built-up model offers high performance in a small volume and contains all the necessary electronics for direct connection to for instance a terminal.

To use it together with a minicomputer, a CPU interface card in the I/O slot is required. This will only contain addressing, CPU timing, word packing/unpacking and flags. Interface cards for several minicomputers will be available.

The formatter is electrically connected to the motherboard through a Device Bus, and each drive is individually addressable through fixed jumpering or a Unit Select switch located on a sub front panel. In this way, up to 4 drives may be connected to the bus. Also, the Device Bus is available externally if the formatting is to be done elsewhere.

e. Dual drive, table top

This model is built-up with a second basic unit, a common front panel of 420 mm (16 1/2") width and a single-piece top cover. The Device Bus interconnection is done internal to the product.

f. Dual drive, rack mount

This is indentical to the table top version, except the front panel has a full 483 mm (19") width. Further, it has slide-mount for easy service access.

g. Single drive, rack mount

The single drive model with a 483 mm (19") full front panel.

If 3 or 4 drives is required, a second product may be installed below the first and interconnected by the external Device Bus. Also, a second power supply must be added.

SINGLE DRIVE

POWER SUPPLY

MECHANISM

ELECTRONICS

BUFFER (Optional)

Alternative 1 SERIAL I/O CONTROL

FORMATTER

TERMINAL

2 DRIVE PRODUCT

DRIVE

MECHANISM

ELECTRONICS

DEVICE BUS

Alternative 2 PARALELL I/O CONTROL

External connection

ADDITIONAL 1 OR 2 DRIVES

MECHANISM

ELECTRONICS

INTERFACE CARD

I/O Slot

MINICOMPUTER

MECHANISM

ELECTRONICS

POWER SUPPLY
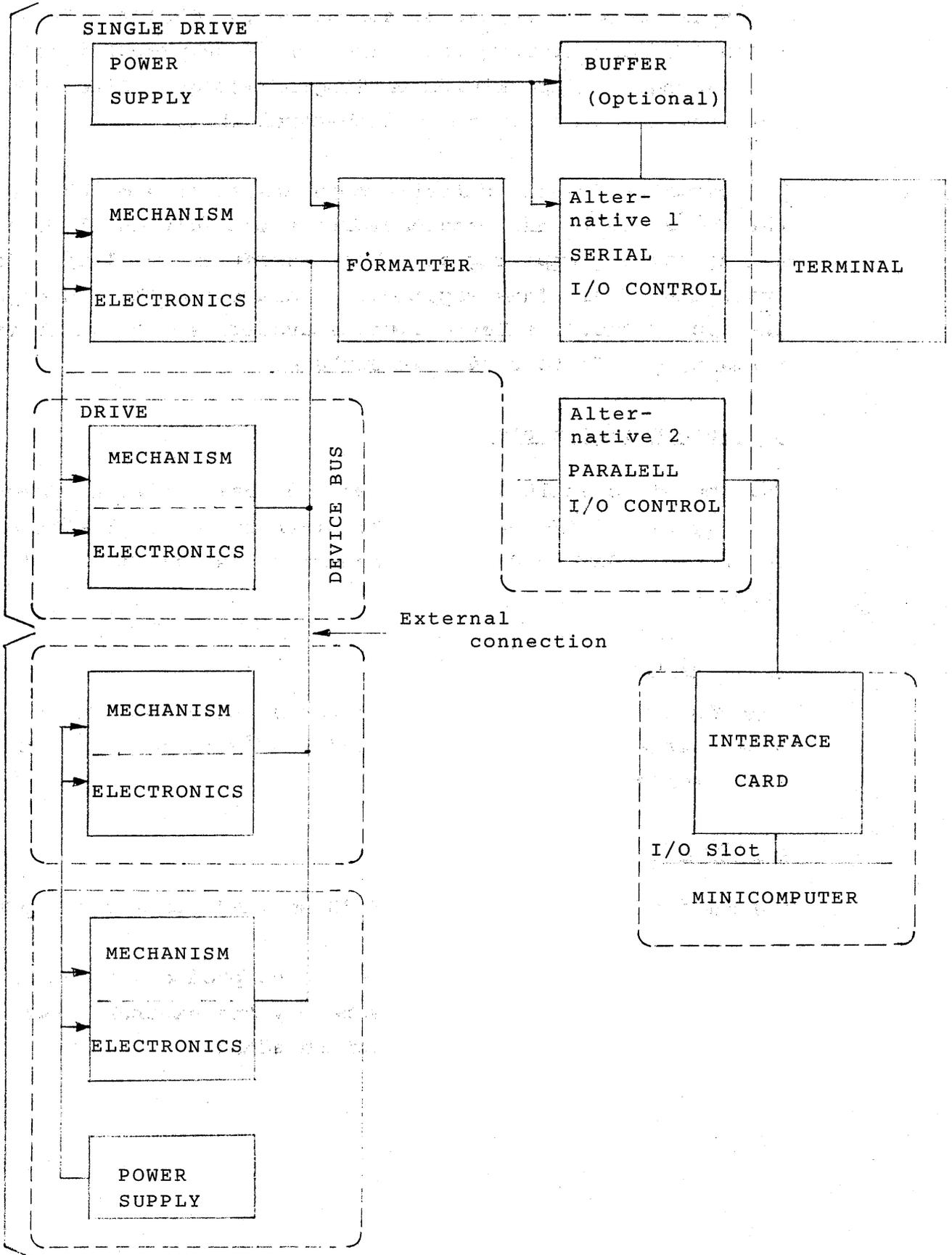
SYSTEM BLOCK DIAGRAM

1.4 Product Specifications

1.4.1. Drive Performance Specifications

Cartridge type	:	DC 300A with 91 m (300 feet) of 6,30 mm (1/4") tape.
Tape drive	:	Single capstan motor drives roller inside the cartridge (no contact between tape and capstan).
Capstan Servo	:	Velocity feedback, generated from optical encoder.
Tape speed, synchronous	:	0,25 to 0,76 m/s (10 to 30 ips) forward and reverse, continously adjustable.
Tape speed, search	:	2,29 m/s (90 ips), ± 5%, forward and reverse.
Rewind speed	:	Same as reverse search speed (different command).
Speed variation, synchronous	:	± 3% long term
	:	± 5% short term (measured as the average jitter of 4 bits, referred to the long term speed).

Start/stop time   :   Command ramp   : 23 ms ± 10%
(at 30 ips)   Capstan movement : 25 ——"——
                                   Tape displacement: 26 ——"——

Start distance	:	7,6 mm (0.30") max.
		5,1 mm (0.20") min.
Stop distance	:	10,2 mm (0.40") max.
		7,6 mm (0.30") min.

Note: Capstan displacement and direction can be measured by counting the output from the optical encoder with pulse spacing corresponding to 8 data bits on the tape.

Start/stop time to
search speed   :   70 ms nominal

Start/stop distance to
search speed   :   75 mm (3,0") nominal

Rewind time   :   40s nominal for full length of tape

Drive reliability   :   5000 h MTBF

1.4.2. Drive Data Specifications

Packing density   :   63 bpmm (1600 bpi)

Recording code   :   Phase Encoded (Bi-Phase Level)

Data rate   :   48 k bits/second at 0,76 m/s (30 ips).

Input to write electronics: Encoded data, no clock.

Output from read
electronics   :   Decoded data
                                    Decoded read clock
                                    Data Detect status line

The decode electronics require that the encoded data is formatted
with a preamble according to the proposed ANSI/ECMA specifications.

Capacity of one cartridge :   23 million bits, unformatted.

Capacity per track   :   638 k bytes at 88,7% utilization (with
                                    maximum blocks of 2048 bytes)
                                    165 k bytes at 25% utilization:
                                    2066 lines or 86 pages of 80 characters
                                    by 24 lines each (one block per line).

Data reliability   :   Better than 1 permanent error in 10^8 bits

Write threshold   :   20% of Standard Reference Amplitude
Read   "   :   10% "   "   "   "
Head assembly, track width :

Erase   :   1.37 mm (0.054")

Write   :   1.22 " (0.048")

Read   :   0.66 " (0.026")

1.4.3. Drive Power Requirements

Servo power:

+ 20V, ± 10% non-
regulated

: 1,6A peak (in 70 ms max.) 0,5A
average in Run, 16 V min. in valley
of ripple

- 20V, ± 10%, non-
regulated

: Same as for + 20V, except peak current
does not occur simultaneously.

Regulated power:

+ 12V, ± 4%   : 0,4A
- 12V, ± 4%   : 0,05A
+ 5V, ± 4%   : 1,0A

1.4.4. Mechanical Specifications

Mechanical dimensions   : Refer to Outline
Drawing on next page.

Mounting   : The front of the rack mounted drive
has a height of 3 rack increments
(5 1/4") and has mounting holes in
the standard locations. Also, rack
slides may be supplied for easy
access when servicing.

Weight:

Mechanism   : 1,5 kg (3.3 lbs.)

Power Supply and
Regulator   : 2,0 kg (4.4 lbs.)

Single drive with power
supply in cabinet   : 6,7 kg (14.8 lbs.)

Dual drive with formatter : 12,4 kg (27.3 lbs.)

1.10

M5, 3 spaces

mounting brace
(3 spaces)

110 (4.33)

203
(8.0)

20
(0.8)

395
(15.6)

Single drive
table top

132
(5.2)

270
(8.27)

395
(15.6)
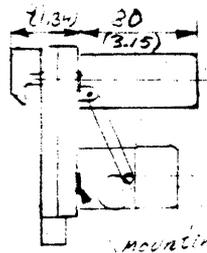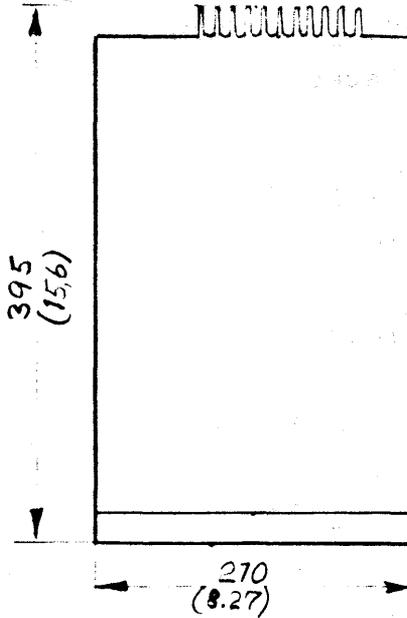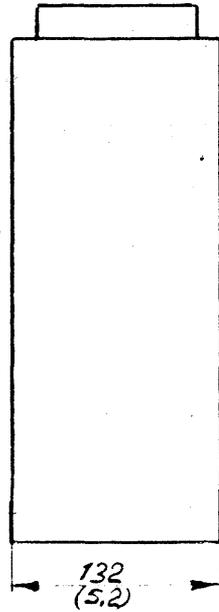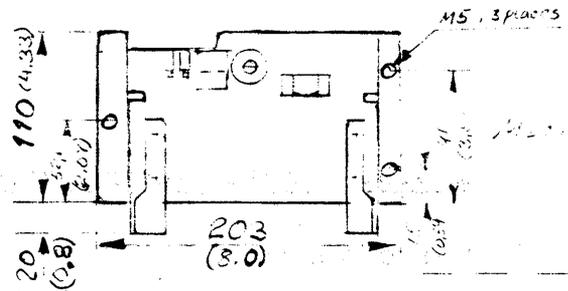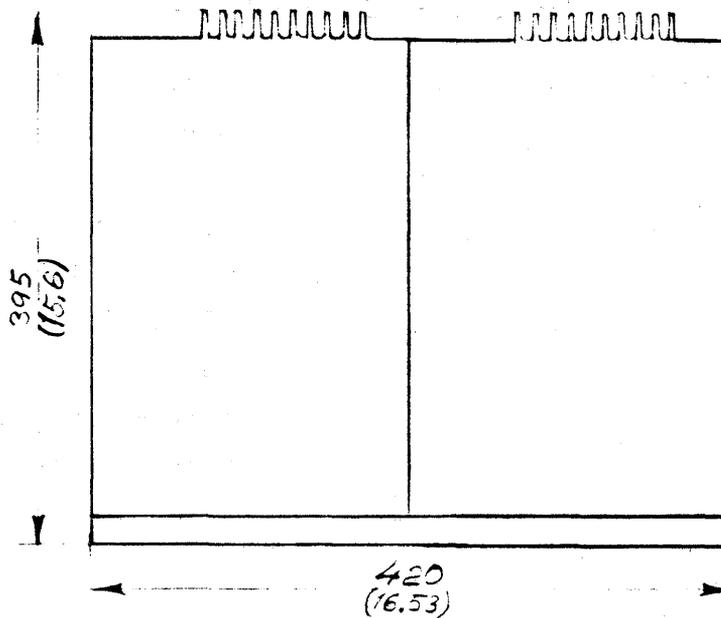
Dual drive,
table top

NOTE:
All dimensions
in mm (inches)

Slide mount area

420
(16.53)

345
(14.8)

132 (5.2)

20 (0.8)

483 (19.0)
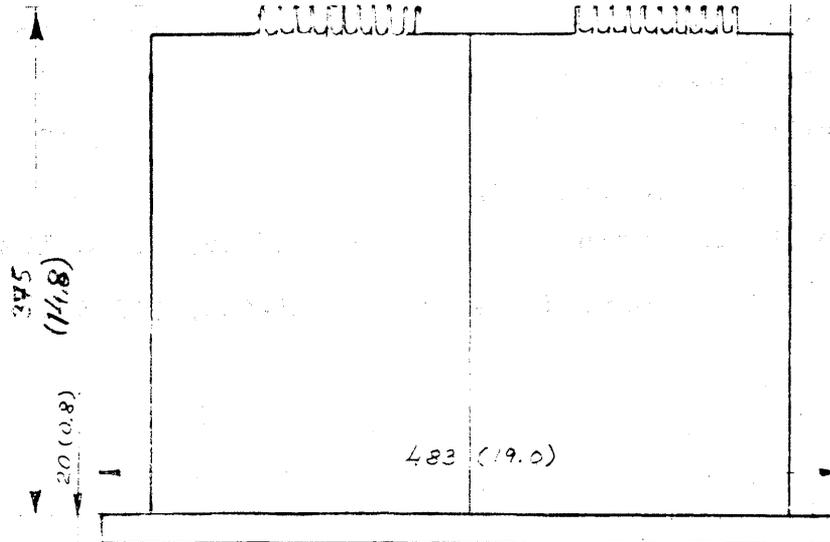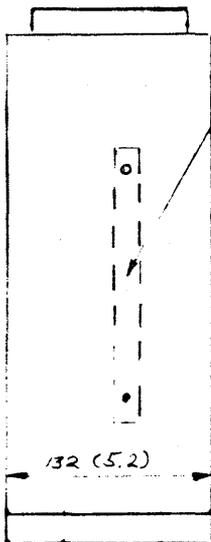
Dual drive
rack mount

MECHANICAL OUTLINE

1.4.5. Power Supply Specifications

The optionally built-in power supply consists of two separate assemblies:

Power module with transformer, rectifiers, capacitors and power input hardware, and a Regulator. The regulator plugs into the electronics motherboard and supplies the regulated voltages with no additional wiring. The input voltage to the regulator may be supplied from the outside via a 10 pin edge connector or from the power module via the motherboard.

The total power supply is designed to deliver electronics power for up to 2 drives plus formatter, and servo power, for 1 drive in start/stop operation plus 1 drive in rewind or stop.

Input power:

Voltage	:	115, and $230V_{RMS} \pm 10\%$, single phase
Frequency	:	48 to 440 Hz
Power	:	25 W avg. with 1 drive at synchronous speed, 80 W with 2 drives, formatter and worst case programming
Output voltage, non-regulated	:	$\pm$ 20V $\pm$ 10%, 2A peak in 70 ms, 1,5 A continous (for servo and regulator input)
		+10V $\pm$ 10%, 4A continous (for regulator input)
Output voltage, regulated:		
+12V	:	Tolerance $\pm$ 1% (after initial adjustment) Load current: 1,0 A max. Load and line regulation: 50 mV total Noise and hum: 10 mV pp.
-12V	:	Tolerance: $\pm$ 5% Load current: 0,2 A max.

+ 5V   : Tolerance: ± 2%

Load current: 4A max

Load and line regulation: 100 mV total

Noise and hum: 50 mV pp.

Note: The regulators have current limiting for short circuit protection. Additionally, the +5 V is protected against over-voltage by a "crowbar" circuit.

Heat Sink required: Normally the regulators are thermally connected to the rear-end extruded heatsink of the drive. If mounted differently, a total area of 10 dm^2 (150 in^2) must be provided when cooled by convection.

Safety:

Primary leakage   : 2,0 mA at 253V, 50 Hz.

1,2 mA max. at 127V, 60 Hz.

IEC   : Meets IEC requirements for input power connection

UL   : UL approval as a system component

Note: When the Power Supply is not installed, all input and internal voltages in the product are below $30V_{RMS}$.

1.4.6. Environmental Specifications

For the assembled systems, the following specifications
apply:

Temperature, operating   :   0 to + 50°C, hardware limited

+ .5 to + 40°C, cartridge limited

Temperature, non-operating: - 40 to + 65°C, hardware

+ 5 to + 45°C, cartridge storage

- 40 to + 45°C, cartridge transportation

Humidity   :   10 to 95% RH, hardware

20 to 80% RH, cartridge

Altitude, operating   :   3000 m (10.000 feet)

Altitude, non-operating   :   12.000 m (40.000 feet)

Vibration, operating   :   Tested with 0,5 G accelleration from
10 - 60 Hz

Shock, non-operating   :   Tested with 50G, 10 ms, half sinewave

Operating attitude   :   Any, however, the cartridge entrance
must be horizontal or point upwards
to prevent the cartridge from falling
out after ejection.

Electromagnetic ·
Compability   :   Meets MIL Std. 461A for Interference
(conducted and radiated) and
Susceptibility (conducted and radiated).

Dust environments   :   The drive is designed to withstand the
dust level of a typical office environ-
ment. If it is used in particular dusty
areas, more frequent cleaning of the head
is required. Alternatively, the equip-
ment should be protected by a cover door.

If the mechanism and related electronics is to be mounted inside other equipment, the following apply:

Temperature, operating   : 0 to + 60°C, hardware limit
                           · + 5 to 45°C, cartridge limit

1.4.7. Formatter Specifications

The Formatter and the companion I/O Controller are two separeate printed circuit cards designed to fit together edgewise. These two cards can be placed in any drive underneath the top cover. The cards can be positioned upright along one edge for servicing of the cards themselves and the mechanism electronics.

Connection to the formatter is done via the Device Bus.
Power is supplied separately. The adjacent drive in a two-drive product can be daisychained to the formatter with an internal cable.

Connection to the I/O Controller is made at the rear of the product. For the Parallell Interface Controller, the connector is a 2 x 40 pin edge connector, 2,54 mm (0,100") pitch.

Size: : 197 x 300 mm (7.76 x 11.8"), Formatter
                       plus Controller.

Weight   : 1,0 kg (2.2 lbs.) with fan

Power required   : + 5V ± 4%, 1,9 A
                       ± 12V ± 4%, 0,1 A if the I/O Controller
                       has a buffer.

For detailed description and specifications, see INTERFACING, 5.5.

1.4.8. Options and Product Versions

A. Basic product

The basic product is a single mechanism with local motion
control, capstan servo, read/write electronics and a 1
track Read-after Write magnetic head mounted in a table-top
cabinet.

B. Options to the basic product:

- Without cabinet for built-in use
- Different head assemblies:
  1, 2 and 4 track Read-after-Write with and without
  selective erase head
- Unit Select switch and Track Write Inhibit switches on
  a sub front panel
- Alternativ servo cooling (on a heatsink separated from
  the electronics)

C. Additions to the basic product (can be mounted inside):

- Power Supply and regulator with power for 2 drives & formatter
- Formatter plus I/O Controller (different versions to
  suit different applications; see paragraph 5.6)

D. Models:

1 drive table-top
2 drives table-top
1 drive rack mount
2 drives rack mount

Slides are available for rack mounted model

Custom color of exterior surfaces

1.5. Cartridge Specification

Size   :   102 x 154 x 17 mm (4 x 6 x 0.665")

Weight   :   270 gram

Construction   :   Metal reference plane with high-
                                              impact plastic and automatic door
                                              covering the head location area.

Outside label   :   Along front edge and top of plas-
                                              tic cover. (Fully visible when
                                              operating inside TDC3000 drive).

Tape type   :   Standard computer-type oxide,
                                              thin coating on a back-coated
                                              base.

Tape width   :   6,30 mm (0.246 $\pm$ 0.002")

Tape length   :   91,4 m (300 feet)

Tape speed   :   2,29 m/s (90 ips) maximum

Maximum acceleration   :   500 m (2000 inches) per second^2

Tape tension   :   42 gram (1.5 oz) nominal

Maximum recording density   :   3200 flux reversals per inch

Short term jitter   : $\pm$ 4%

Drive ratio, tape to pulley   :   0,78:1
surface

Tape markers   :   BOT, LP, EW and EOT
                                              holes in the tape are sensed
                                              optically

                                              The location of the markers are
                                              shown on the next page.

File protect   : Plug on the cartridge rotated to
                                         the "SAFE" position

Temperature, operating and
storage   : +5 to +45°C

Temperature, transportation   : -40 to +45°C

Humidity   : 20 to 80%, non-condensing

Operating life   : 5000 full passes minimum

Storage life   : 5 years minimum

Tested recording area

Usable recording area

915 max   152   686
                 min   min

EOT holes   BOT holes

                 EW   LP

TR.3
TR.2
TR.1
TR.4

457 457   991 min
+76 +76   1220 +76   91,4 +3, -0 m   914 +76   457 457
                                                      ±76 ±76

(300 +10, -0 feet)
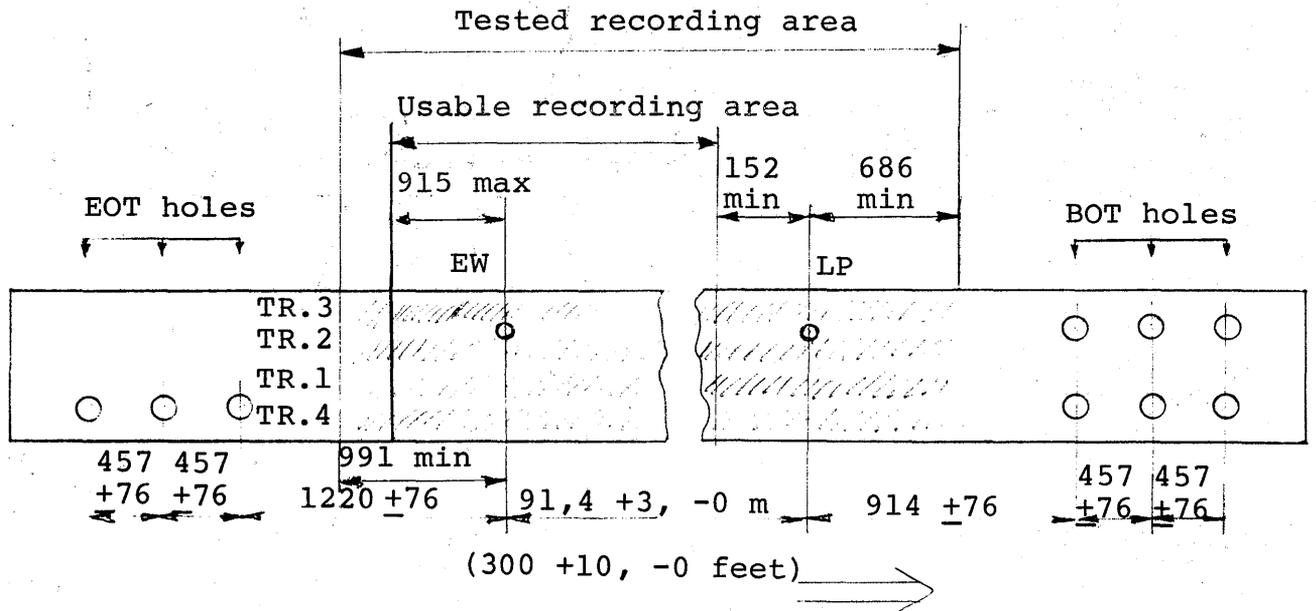
Dimensions in mm   Forward direction of tape travel
except as noted   (oxide side shown)

TAPE MARKERS AND RECORDING AREA

BELT GUIDE ROLLERS (2)

FLAT DRIVE BELT

SUPPLY HUB
TAPE SHOWN IN
B.O.T. POSITION

TAKE-UP HUB

READ/WRITE
HEAD

BELT CAPSTAN

RUBBER COVERED
DRIVE ROLLER

DRIVE MOTOR

FILE
PROTECT

TAPE PATH
(OXIDE OUT)

FIXED TAPE
GUIDES (2)

LIGHT SENSING

DIRECTION OF FORWARD
TAPE MOTION
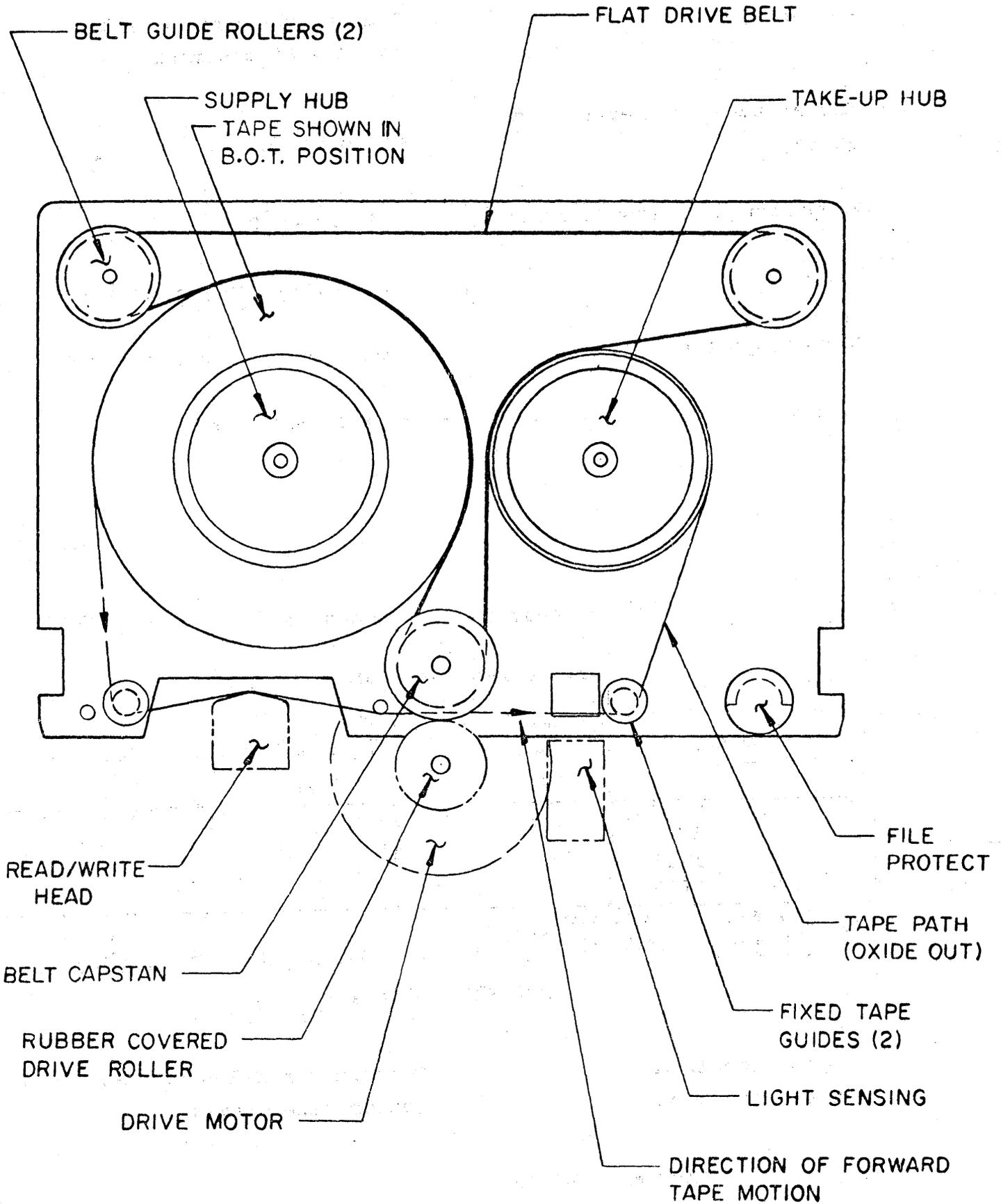
3M CARTRIDGE DIAGRAM

1.6. Format Specifications

The following is an excerption of the format proposed as the
ANSI/ECMA standards:

Preamble   : 15 "ZERO" bits plus 1 "One" bit

Data   : 6 8-bit bytes minimum
                                       2048 8-bit bytes maximum

CRC   : Cyclic redundancy check, 16 bits
                                       following the last data and
                                       generated by the polynominal
                                       $x^{16} + x^{15} + x^2 + 1$

Postamble   : 1 "One" bit plus 15 "ZERO" bits

Data Block   : Preamble + Data + CRC + Postamble

Control Block   : Preamble + 16 "ZERO" bits +
(Tape Mark, File Mark)   Postamble

Initial Gap   : 152 mm (6.0") from Load Point (LP)
                                       to first block

Inter Block Gap (IBG, IRG)   : 30,5 mm (1.2") minimum
                                       1,22 m (48")   maximum

                                       Note: The built-in formatter
                                       generates gaps 33 mm (1.3")
                                       nominal.

2. INSTALLATION

2.1. Environment

Before installation, it is important to know the extremes of the environment in which the product will be used (refer to Specifications for minimum and maximum values). The hardware is designed with wider tolerances than the cartridge itself. This provides greater reliability and leaves room for improvement of the medium.

2.2. Mounting details

Dimensions for mounting of the mechanism and the rack-mountable drives are given on figures on page 1.10. Slides are recommended for rack-mount, as these will simplify servicing.

2.3. Power and Cooling

The level of dissipated power will strongly depend on the actual usage of the drives. The servo dissipates little power in stop and continuous run, but high power in worst case start/stop. A single drive in standby will dissipate approximately 15 W, and a double drive with formatter will dissipate maximum 80 W. The rear end with the integral heatsink is designed to handle both the servo and the regulator, provided the natural air convection past the heatsink is not blocked.

In addition to the heatsink, natural air circulation through the drive must be allowed. On tabletop models, the bottom cover and the rear panels are ventilated. On rack-mounted models the side panels are also perforated. This allows mounting other products directly below or above the drive.

In built-in applications, the servo transistors which normally are mounted directly on the servo PC board, may be located on a heatsink separated from the electronics.

2.4. Cables and Connectors

Power:

Power may be supplied to the drive in several ways:

- Servo power and regulated power supplied from an external power
  supply via the Drive Power connector.
- External servo power and internal regulator.
- Built-in power module and regulator supplies all necessary power
  for up to 2 drives and 1 formatter.

The Drive Power connector is a PC edge, 2 x 10 pin with 3,96 mm
(0.156") pitch. Pin numbers are given on the connector wiring
chart, paragraph 5.4, page 5.7.
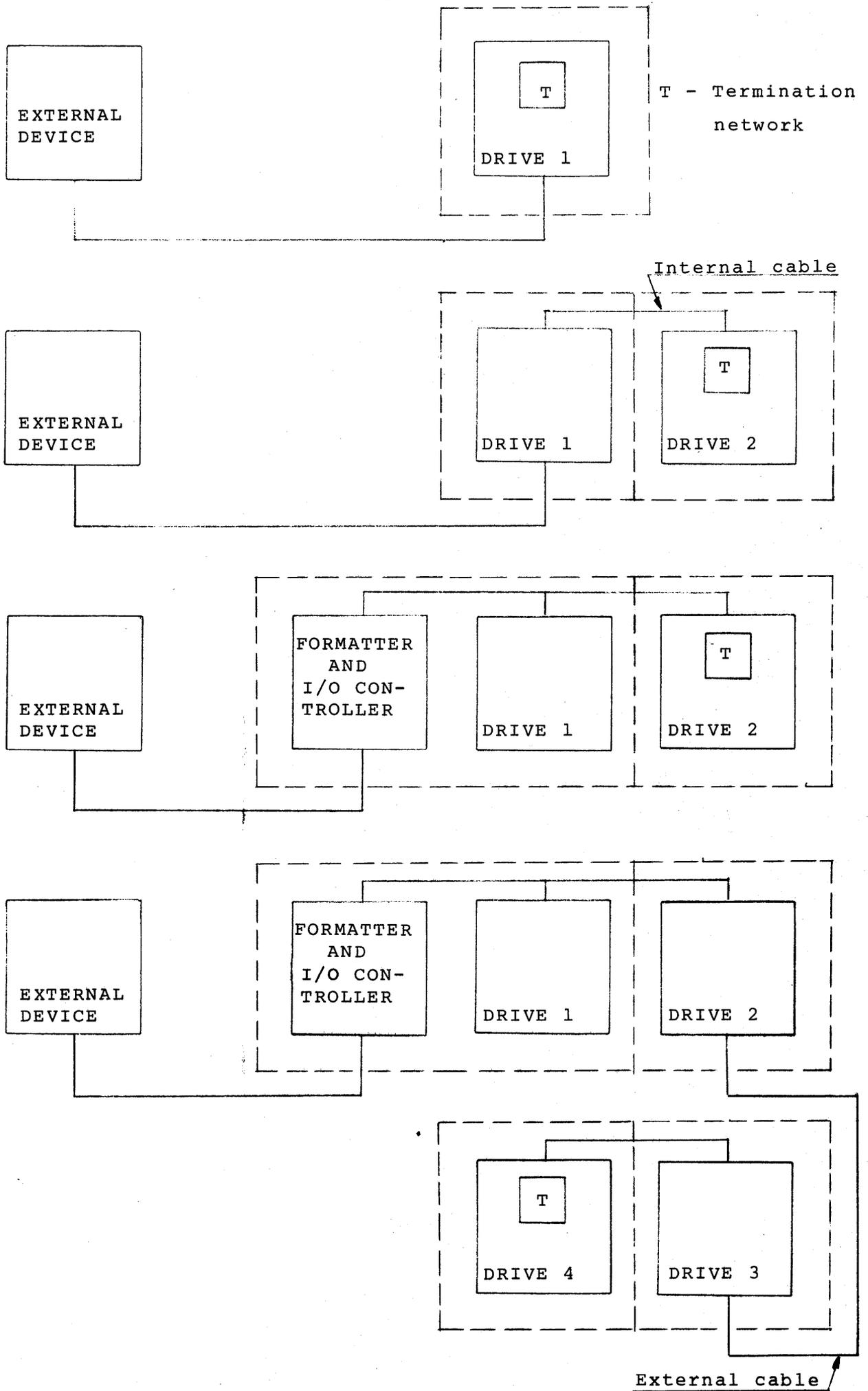
Signals, Device Bus:

The Device Bus connector is a PC edge, 2 x 25 pin , 2,54 mm pitch.
The drive has 11 input lines and 11 output lines. A 23 line flat
cable (Ansley, "Black Magic" 93 ohm transmission line) can be
connected to an adapter card with the proper PC edge connector.
Inside the cabinet the Device Bus can be connected to the
Formatter or another drive with a 50-line flat cable. For connector
wiring, se page 5.7.

Termination must be added to the last drive on the bus. On each
Motherboard there are 2 DIP sockets, connected to accept termi-
nation networks in Dual-In-Line packages: One network with thirtee
4,7 k ohm transmitter pull-up resistors and one network with 220/
330 ohm receiver terminations.

Signals, Formatter:

Connection to the formatter depends on the I/O Control Card used.
In case of the Parallell Interface, the connector will be a PC
edge, 2 x 40 pins, 2,54 mm (0.100") pitch with provision for
securing the connector directly to the PC board. For other inter-
faces different types of connectors can be used.

T - Termination
network

Internal cable

| EXTERNAL DEVICE | | DRIVE 1 [T] |

| EXTERNAL DEVICE | | DRIVE 1 | DRIVE 2 [T] |

| EXTERNAL DEVICE | | FORMATTER AND I/O CONTROLLER | DRIVE 1 | DRIVE 2 [T] |

| EXTERNAL DEVICE | | FORMATTER AND I/O CONTROLLER | DRIVE 1 | DRIVE 2 |

| DRIVE 4 [T] | DRIVE 3 |

External cable

FORMATTER AND DRIVE CONFIGURATIONS

3.   OPERATION

3.1.   Controls and Indicators

When delivered in a standard cabinet, each drive will be equipped
with the following controls and indicators on the front panels:

a. LOADED   : Indicator. When lit, the cartridge
                           is securely locked in the mechanism.

b. WRITE PERMIT   : Indicator, Lit if the cartridge Write
                           Plug is in the Unsafe position.

                           Note: If a single track is write
                           protected (see below), and that track
                           is addressed, the indicator will go
                           off (and the Write Permit Status go
                           false).

c. REWIND/UNLOAD   : Push-button and indicator. After the
                           unit is placed OFF-LINE, a single push
                           on the button will initiate a Rewind
                           sequence. The indicator will stay off.

                           If the button is pressed for approxi-
                           mately 1 second, the Unload sequence
                           will be initiated, and the indicator
                           will be lit. A new momentrary push will
                           cancel the Unload command, but the
                           drive remains in the Rewind mode.

                           Rewind or Unload commands may be ini-
                           tiated anywhere on the tape.

d. ON-LINE   : Push-button and indicator. After the
                           cartridge is loaded, a single push on
                           the button will place the unit ON-LINE,
                           and the indicator will be lit. The

unit will now only respond to remote
commands (inhibiting the REWIND/UNLOAD
button), provided it is addressed.

A new push on the button will cancel
the ON-LINE status, then the indicator
will go off.

As an option the following controls can be provided on a sub-
panel behind a swing-down door on the front panel:

e. UNIT SELECT   : Unit address selector, permits the ope-
                         rator to assign each individual unit
                         as number 1, 2, 3, 4 or none (discon-
                         nected).

f. TRACK WRITE PROTECT: Individual switches for each of the
                         4 tracks can hardware protect a written
                         track even if the cartridge Write Plug
                         is in the Unsafe position (required
                         if writing on a second track is desired).

                         If a protected track is addressed, the
                         Write Permit Status (WSP) will go false,
                         and WRITE PERMIT indicator will go off.
                         This will alert the operator if he un-
                         intentionally protected a track he
                         wanted to write on.

                         If all tracks are protected, the indicator
                         will also go off when OFF-LINE.

                         Note: If the UNIT SELECT and WRITE
                         TRACK PROTECT is not supplied, the unit
                         may be permanently addressed or track
                         write protected by hard wiring jumpers
                         on the Motion Control and the Read/Write
                         PC Boards.

UNIT SELECT
WRITE PERMIT
1 2 3 4
PROTECT
LOADED WRITE PERMIT REWIND UNLOAD ON-LINE

Indicators ⇡ ⇡ ⇡ ⇡ Controls and Indicators

FRONT PANEL LAYOUT

3.2. Operation

a. POWER : If the drive is equipped with an internal
power supply, this can be switched on at the
rear panel. The tape marker lamp, visible
in the opening for the cartridge will indicate
that power is connected.

b. WRITE PROTECT: Before inserting a cartridge, the entire cart-
ridge may be protected from writing by
rotating the plug on the cartridge to the SAFE
position.

If writing is desired on one or all tracks,
the write plug must be in the Unsafe position.
If write protect is desired on a single track,
this can be done by sliding the Track Write
Protect switch on the sub panel to the
PROTECTED position.

c. LOADING   : The cartridge can be loaded by placing the front
                  side on the guides and pushing it in until it
                  is flush with the front outline of the drive.
                  When the drive senses the cartridge, the locking
                  mechanism is activated, and a slight click
                  will be heard. Also, the LOADED indicator
                  will go on.

                  If the cartridge write plug was set in the
                  Unsafe position, the WRITE PERMIT indicator
                  will go on.

                  The servo will then start and automatically
                  move the tape to the Load Point. This is per-
                  formed in less than 1 second.

                  In the loaded position, both the front and the
                  top part of the cartridge label can be read,
                  and the movement of the tape packs can be ob-
                  served behind the label (illuminated by the
                  tape marker lamp).

d. ON-LINE   : After the cartridge is loaded, the drive
                  may be placed On-Line by pressing the ON LINE
                  button. The corresponding indicator will go
                  on.

                  By pressing the button a second time, the
                  drive will go Off-Line, and the indicator
                  will go off.

                  When a drive is in the On-Line mode and
                  a write-protected track is addressed, the
                  Write Permit indicator will go off, notifying
                  the operator that the addressing is incon-
                  sistent with the protection.

e. REWIND   : If rewind to Load Point is desired, the
                  drive must first be placed Off-Line.
                  The REWIND/UNLOAD button may then be

pressed momentarily, initiating the
rewind. The indicator will not go on,
but the status will easily be detected
by a higher sound level from the
cartridge itself.

At any time after rewind is initiated,
the ON LINE button may again be pressed.

The rewind time is about 40 seconds
for the whole tape length.

f. UNLOAD : To unload a cartridge, the drive must
first be Off-Line and then the REWIND/
UNLOAD button pressed until the corres-
ponding indicator turns on. The tape
will then rewind past Load Point to
BOT, and the cartridge will be ejected
1 to 2 cm by the locking mechanism.

The LOADED indicator will go off, and
the cartridge will be visible to the
operator outside the front outline of
the drive.

If the Unload command was uninten-
tional (only wanted Rewind), the Unload
can be terminated by a second momen-
tary push on the button.

3.3. Malfunction

a. PRIMARY POWER : If the primary input power fails, the
    FAILURE   cartridge will be retained in the mecha-
                 nism. When power returns, the logic
                 will be preset to the ON TAPE status.

If the primary power does not return and the
operator wants to retrieve the cartridge, he
can do so by firmly grasping the label side of
the cartridge and withdraw it from the spring
loaded retention mechanism.

The cartridge cannot be reinserted until primary
power returns and the locking mechanism auto-
matically resets itself to the unlocked posi-
tion.

b. DRIVE : If a drive fails in such a way that it is
potentially dangerous to the written informa-
tion on the tape, all tape motion will be
halted. The cartridge can only be retrieved
by overcoming the spring retention forces.

There is one exception: If the drive failure
is caused by lack of Write Voltage after
Write Enable command is issued, the drive may
be placed Off-Line, and the cartridge unloaded
the normal way.

4. DESCRIPTION

4.1. Description of Mechanical Assemblies

The main mechanical assemblies within the drive are

    A. Baseplate with cartridge referencing
    B. Cartridge locking mechanism
    C. Capstan motor with encoder
    D. Magnetic head assembly
    E. Cabinet with front panel

A. BASE PLATE

The base plate is cast aluminium with sturdy ribs for very high
stiffness. It is CNC milled, and the only critical surfaces are
finished in a single set-up: The cartridge reference surface and
the head mounting platform are machined with very small tolerances.

The cartridge reference surface is extended with sylindrical, stain-
less steel pins which are clamped to the casting. In this way
there is no mechanical tolerance build-up (beyond the machining
tolerance between the two critical surfaces), and assembly or field
repairs can be done without affecting the accuracy. The three
reference pins are located according to the interchange standard.

The casting is mounted on the side panels by vertical screws -
no machining of the casting sides or side panels is required.
Further, only three screws with 3-point contact is used, thereby
preventing possible twist of the side panels from distorting the
casting.

The cartridge is guided to the reference pins with tough, low-
friction slides.

B. CARTRIDGE LOCKING MECHANISM

This locks the cartridge in place when so commanded and ejects it
after use. The mechanism meets all the objectives as described
in paragraph 1.2 Product features:

- low counter force when inserting
- electrical lock and unlock
- the locking is very positiv and gives tactile feedback
- if power is disrupted, the cartridge can be removed by the operator without using any tools
- the locking is quiet

All this is accomplished through the use of a DC motor driving a torque shaft via a worm gear (self locking). When locking the cartridge, the shaft operates two springloaded levers with ball bearings as rollers on the ends. These in turn engage the cartridge baseplate in the front notch, forcing the cartridge forward and up against the reference pins. After that motion is completed, a spring loaded lever pushes the cartridge up against the third reference pin.

When unlocking, the three spring loaded arms retract. At the same time a small lever (brought into position during the locking cycle) engages the inner edge of the cartridge and pulls it out.

The position of the driving shaft is detected optically using LED's and photodetectors.

C. CAPSTAN MOTOR WITH ENCODER

The motor has permanent magnets and ball bearings for long life. The inertia of the motor with capstan is matched to the load for minimum power dissipation. On the motor shaft is mounted an optical encoder with 400 lines. The capstan diameter is selected such that the spacing between each pulse from the encoder corresponds to 8 data-bits on the tape.

The encoder has two detectors in quadrature for   sensing of true direction.

The motor is mounted on pivots and spring loaded against the cartridge belt capstan with the proper force. The pivot line goes through the center of gravity for the complete assembly, thus preventing any movement or variation in capstan force during vibration in any of the orthogonal axis.

D. MAGNETIC HEAD ASSEMBLY

The head assembly is machined to proper track height and gap
azimuth. It mounts directly on the precision milled platform
on the casting. Thus no adjustments are necessary or made avail-
able, and field replacement is very simple.

The head is available with 1,2,or 4 tracks Read-after-Write,
with or without a piggy-back erase head (also individual tracks).

E. CABINET WITH FRONT PANEL

The cabinet is made of extrusions, including the rear panel which
is an integral heatsink for the servo transistors and the regu-
lator transistors (if so equipped). The front panel has a spring
loaded door that gives access to the optional Unit Select switch
and Track Write Inhibit switches. The controls and indicators
are also mounted on a PC board behind the door with the lights
and buttons extending through the door.

4.2. Description of the electronics

The main electronic assemblies are

    A. Motherboard
    B. Servo PC board
    C. Motion Control PC board
    D. Read/Write PC board
    E. Sensor PC board
    F. Controls and indicator board
    G. Power supply
    H. Regulator

A. MOTHERBOARD

This serves as mounting and interconnection between the main
electronics PC boards. On one edge of the board a tongue (2 x
25 pin, 0.100" pitch) extends to the rear, providing access to
the Device Bus from the outside. On the board are two DIP-

sockets for plugging in line-terminations (Dual-in-Line thick film packs). The inner edge of the board has another tongue to accept the internal Device Bus cable (2 x 25 lines).

Physically the motherboard extends from side-to-side in the drive and is mounted in slots in the side extrusions. For built-in use, the board size can be reduced.

B. SERVO PC BOARD

This contains the servo velocity commands, ramp circuit, servo compensation, power amplifier, encoder signal processing circuits and tachometer voltage generation. Also, it contains the electronics for the cartridge locking mechanism.

C. MOTION CONTROL PC BOARD

This contains Unit Addressing, tape marker decoding and tape position register, load and unload sequences, on-line, rewind, and unload buffering, and automatic Load Point search.

D. READ/WRITE PC BOARD

This contains track selection, write circuits, read circuits and read data decoding. The head connector plugs directly into the board.

E. SENSOR PC BOARD

This is mounted on the rear edge of the casting and contains micro-switches for sensing of the cartridge and the write permit plug. Also it serves as the mounting for the tape marker detectors and the associated lamp.

F. CONTROLS AND INDICATORS

These are mounted on a small PC board located behind the front panel. The controls consists of micro-switches operated by a

hinged plastic cover that also serves as a diffuser for the
light and has space for the legend. The hinged covers make
lamp replacement from the front very easy.

For built-in use, the PC board may be located at some distance
from the drive by plugging a 20 line cable onto the motherboard,
and different controls altogether may be employed.

This board will be equipped with the Unit Select and Track
Write Protect switches if so desired (option).

G.   POWER SUPPLY

The power supply is a self-contained unit that can be added
to the drive. It consists of a bracket, onto which are
mounted

    power input hardware
    transformer
    PC board with rectifiers
    filter capacitors

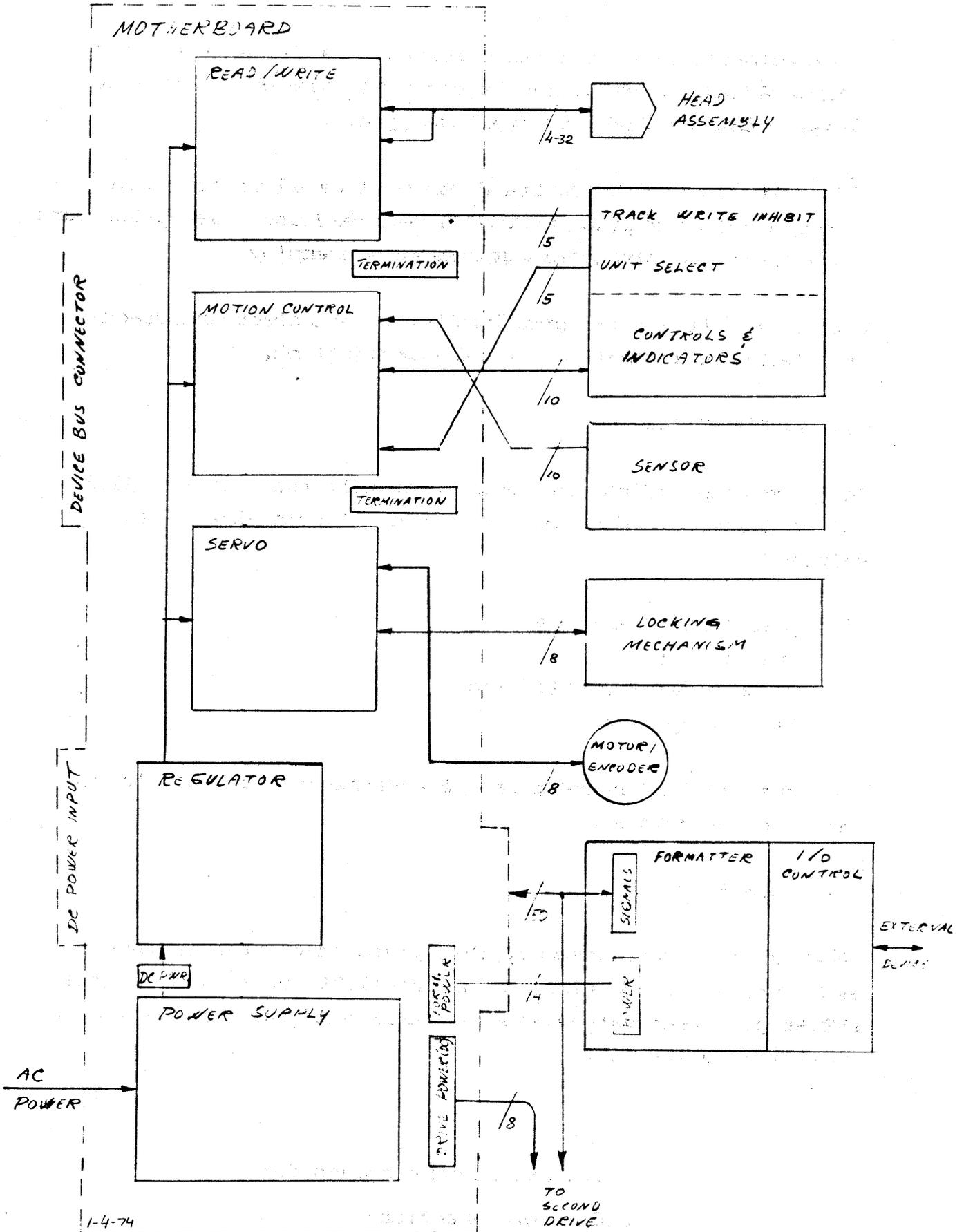From the small PC board there is a cable that can be plugged
into the motherboard.

H.   REGULATOR

This is a separate assembly that plugs into the motherboard
and contains the regulators for the ±12 V and the +5 V. The
series pass transistors are heat sunk onto the rear heat sink
of the drive itself.

4.3.   Block Diagrams

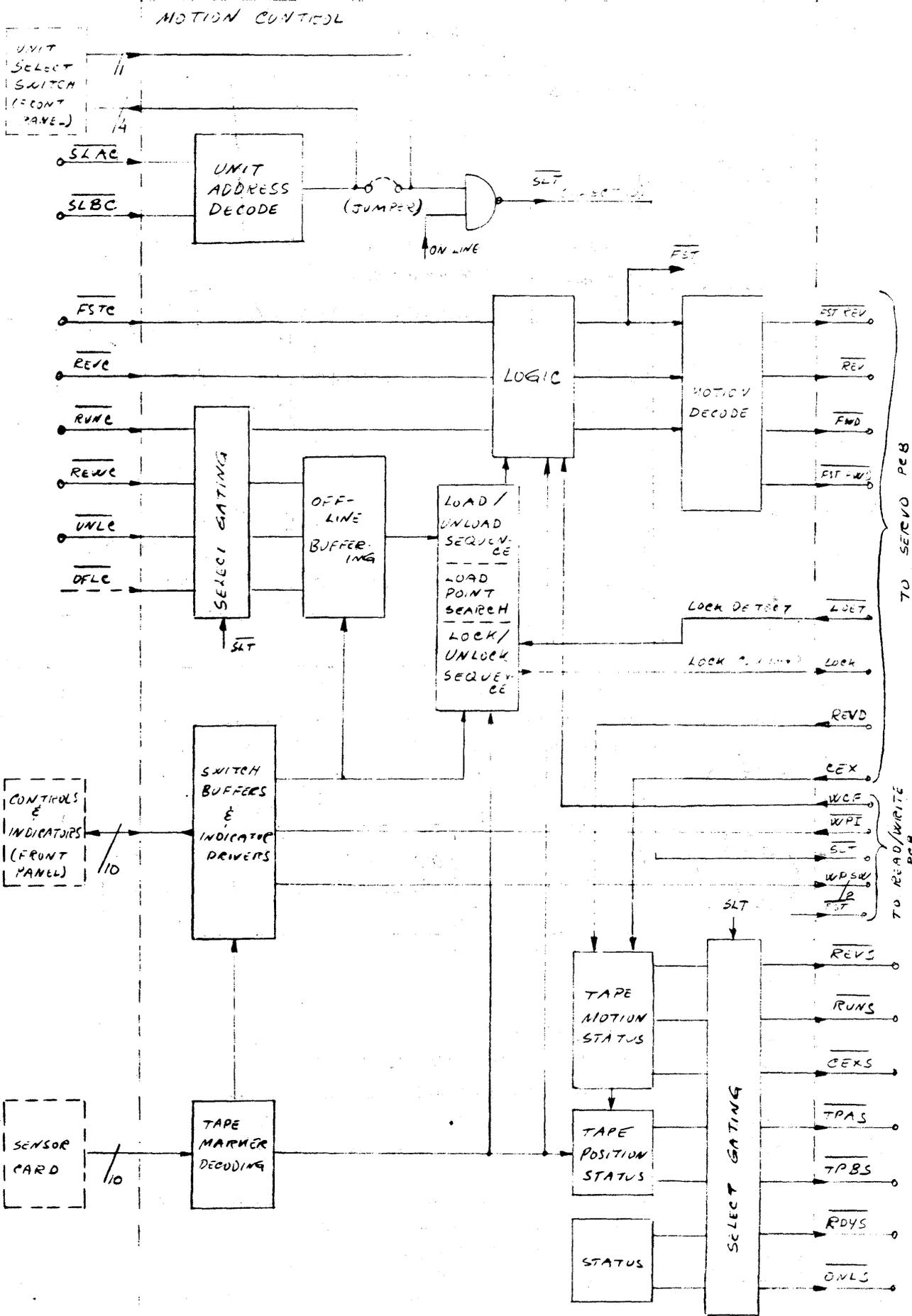On the following pages are block diagrams for

    Motherboard and interconnections
    Motion Control printed circuit board
    Servo printed circuit board
    Read/Write printed circuit board

MOTHERBOARD

READ/WRITE

HEAD ASSEMBLY

/4-32

TERMINATION

TRACK WRITE INHIBIT

UNIT SELECT

/5

/5

MOTION CONTROL

CONTROLS & INDICATORS

/10

TERMINATION

SENSOR

/10

SERVO

LOCKING MECHANISM

/8

DEVICE BUS CONNECTOR

MOTOR/ ENCODER

/8

REGULATOR

DC POWER INPUT

FORMATTER

I/O CONTROL

SIGNALS

/3

EXTERNAL DEVICE

POWER

DC PWR

/4

POWER SUPPLY

DRIVE POWER

DRIVE POWER (A)

/8

AC POWER

TO SECOND DRIVE

1-4-74

TDC 3000

MAIN BLOCK DIAGRAM

BLOCK DIAGRAM, MOTION CONTROL PCB

SERVO PCB

FST REV

REV

FWD

FST FWD

VELOCITY COMMANDS

RAMP GENERATOR

POWER AMPLIFIER

CAPSTAN MOTOR

COMPENSATION

CURRENT FEEDBACK

VOLTAGE FEEDBACK AT STOP

VELOCITY FEEDBACK

LED

LED

ENCODER DETECTORS

DETECTOR ELECTRONICS

DETECTOR ELECTRONICS

FREQUENCY TO VOLTAGE CONVERTER

DIRECTION SENSE

POLARITY SWITCH

CEX

$|V_{TACH}|$

KEVD

LOCK

LOCK / UNLOCK COMMAND

LOCK MOTOR

UNLOCK DETECTOR

/3

ELECTRONICS

LOGIC

MOTOR DRIVE

LOCK DETECTOR

/3

ELECTRONICS

LOCK DETECT

$\overline{LDET}$
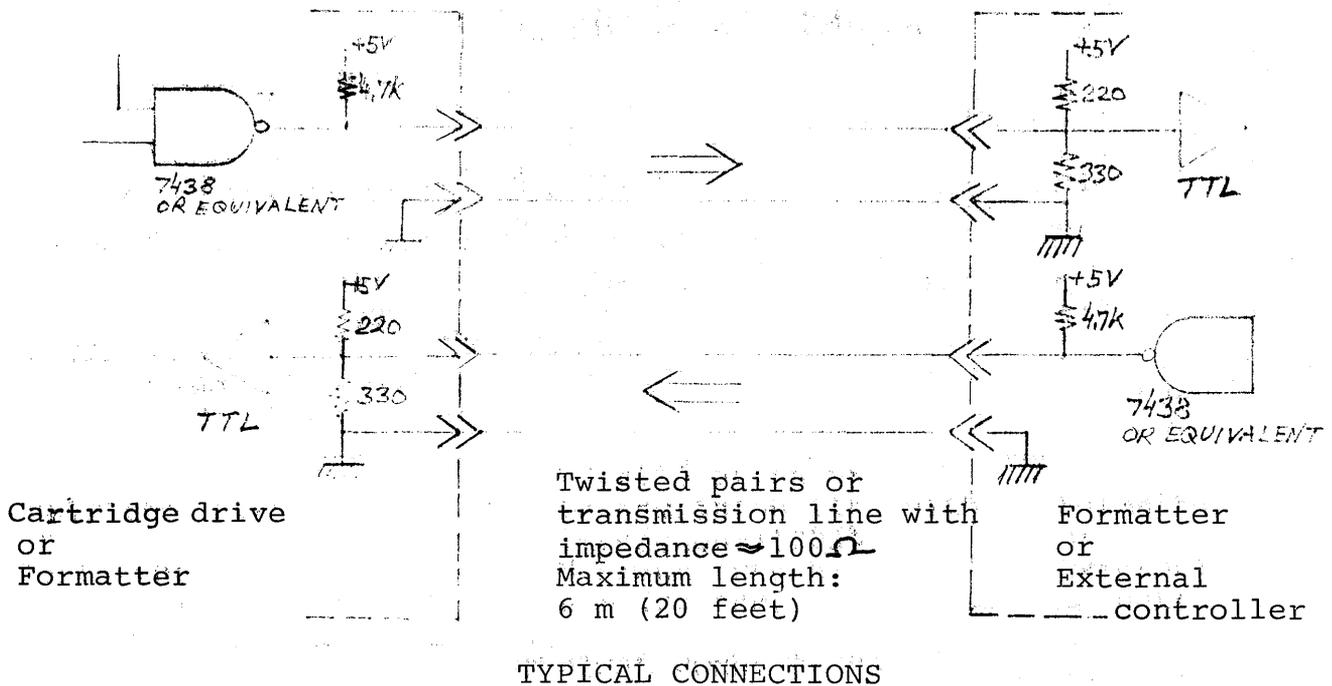
1-4-74

BLOCK DIAGRAM SERVO PCB
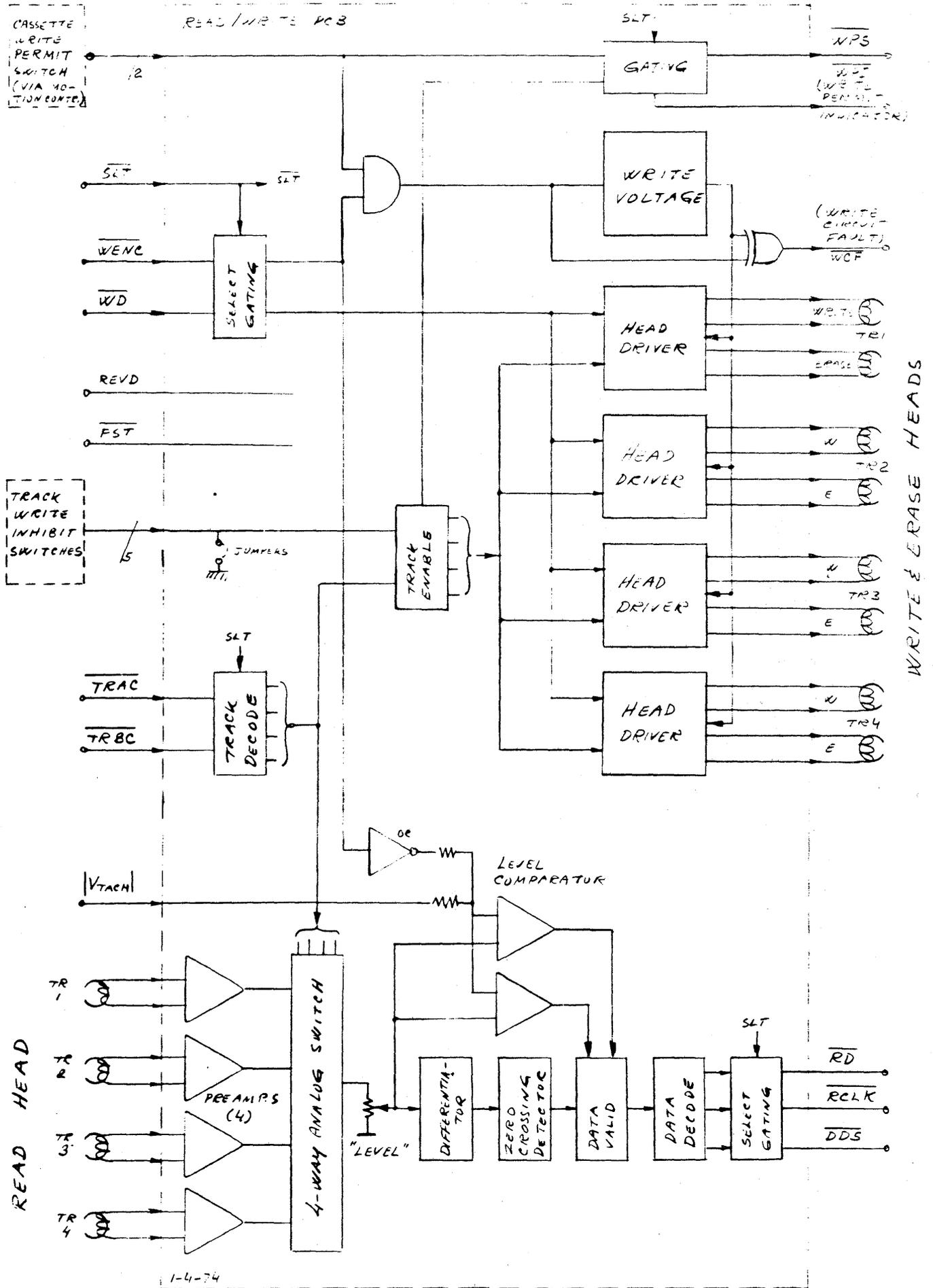
BLOCK DIAGRAM, READ/WRITE PCB

5.   INTERFACING

Interfacing can be done on the Device level, or to the built-in
Formatter with its exchangeable I/O control Card.

5.1. Line characteristics and termination

Cartridge drive
or
Formatter

Twisted pairs or
transmission line with
impedance ≈ 100 Ω
Maximum length:
6 m (20 feet)

Formatter
or
External
controller

TYPICAL CONNECTIONS

5.2. Description of the Device Bus

The Device Bus interconnects up to 4 drives to the internal For-
matter or to an external controller. The bus consists of 11 com-
mand and data input lines, 11 status and data output lines,
and 3 spares.

Connection to the Device Bus from an external device can be made
at the motherboard of any of the four drives. The motherboards
have a tongue, accessible at the rear of the drive, and onto
which a 2 x 25 (or 30) pin, 0.100" pitch PC edge connector can
be plugged. The drives can be connected internally, and on the
last drive the bus termination can be plugged in.

If an internal Formatter is used, connection is done in a simu-
lar way at the other end of the drive motherboard. A second
drive may be daisy-chained on the internal cable.

5.3. Specifications for Device Bus

All command lines : Postscript C

All status lines   : Postscript S

Logic is Negative True (Logic 1)

COMMAND LINES:

SLAC (level)   ⎫   Drive select lines A and B, permit-
                    ⎬ :   ting up to 4 drives on one Formatter,
SLBC (level)   ⎭   coded:

SLAC	SLBC	DRIVE
0	0	1
0	1	2
1	0	3
1	1	4

TRAC (level)   ⎫   Track select lines A and B, permit-
                    ⎬ :   ting one of 4 tracks to be used for
TRBC (level)   ⎭   writing or reading, coded:

TRAC	TRBC	TRACK
0	0	1
0	1	2
1	0	3
1	1	4

REVC (level)   : Reverse, complement of Forward command

FSTC (level)   : Fast, complement of Slow command

RUNC (level)   : Run, complement of Stop command

REWC (level or   : Rewind command, sets Rewind mode and
     pulse)   resets Ready status (RDYS).
                          The tape will rewind to Load Point (LP)
                          and stop (after again sensing LP going
                          forward at slow speed), thus again
                          enabling RDYS.

If Rewind is desired manually, the drive must first be placed OFF-LINE, then the REWIND/UNLOAD button pressed momentarily.

The drive may again be placed ON-LINE any time after the rewind sequence is initiated, but RDYS is inhibited until the Rewind sequence is terminated.

UNLC (level or pulse) : Unload command.
The unload sequence is initiated by UNLC or by a pulse from the REWIND/UNLOAD push-button on the front panel after the drive manually has been placed in the OFF-LINE status. UNLC also resets the ON-LINE status.

By pressing the REWIND/UNLOAD button until the indicator turns on (approx. 1 sec.), the unload sequence is initiated. The tape then rewinds to Beginning of Tape (BOT) and stops, the cartridge is subsequently ejected, and the "LOADED" indicator goes off (all indicators are now off).

OFLC (level or pulse) : Off-Line command.
Normally, UNLC will be used instead. However, if OFF-LINE is desired from the program without rewinding the cartridge, this command line may be connected to the spare pin 23 B on the Device Bus Connector.

Note: ON-LINE status is set by a pulse from ON-LINE push-button on the front panel, reset by a second pulse from the front panel, by UNLC, or by OFLC.

STATUS LINES:

RDYS (level) : Ready status. True when On-Line status is true and tape is on or after Load.

Point (LP) and the internal Drive Safe is true and not in Rewind mode.

Note: Drive Safe is false if the Write Voltage is on without WENC; WENC is true without Write Voltage on, the +5 V is outside specified limits, or if lamp failure is detected in the tape marker sensing circuit. This condition prevents any tape motion, and the cartridge can then be manually removed from the drive by overriding the cartridge retention springs. If Drive Safe is false because of missing Write Voltage, the drive will respond to any command except Write Enable.

ONLS (level)   :   ON-LINE status, true if set manually after the cartridge is inserted. ONLS inhibits commands from the REWIND/UNLOAD push-button.

TPAS (level)   :   Tape Position A Status is set by the first forward command after the Load Point (LP) marker has been sensed when going forward, or when the End-of-Tape (EOT) marker is sensed going in reverse, and reset by the LP marker going in reverse or by the EOT marker going forward. The LP search is done automatically after the cartridge is inserted.

TPBS (level)   :   Tape Position B Status is set when the Early Warning (EW) marker is sensed going forward and reset when the EW marker is sensed going in reverse.

Note: The TPAS, TPBS and RDYS lines will indicate these tape positions:

RDYS	TPBS	TPAS	POSITION	
0	0	0	ON LEADER TAPE	
1	0	0	AT LP	
1	0	1	ON TAPE	
1	1	1	ON EW TAPE	
1	1	0	END OF TAPE	
0	1 + 1		RUNS=0	DRIVE UNSAFE
0	REVS=1	RUNS=1	REWINDING	

When power is turned on and the cartridge is in place, the tape position status is preset to the ON TAPE state.

Note: When the EOT (End-Of-Tape) marker is sensed going forward, an unconditional stop occurs and further forward motion is inhibited.

BOT (Beginning-Of-Tape) is not an output state. If the BOT marker is sensed going in reverse, and unconditional stop occurs and further reverse motion is inhibited. BOT is reset when sensed going forward.

REVS (level) : Reverse status, derived from the true direction of the capstan encoder.

RUNS (level) : Run status, derived from sensed motion. Same information can be derived from measuring the time between CEX pulses.

CEXS (pulse) : Capstan encoder zero crossings. Distance between two pulses corresponds to 0.127 mm (0.005") of tape travel, which again corresponds to 8 data-bits.

Note: Fast status is not an output line, but can be derived from the time between CEX pulses.

Note: Rewind status is not an output
line, but can be decoded from RUNS ⁏ REVS ⁏
$\overline{\text{RDYS}}$ = 1 (see previous page).

WPS (level)   : Write Permit Status, true if the Write
                                Plug on the loaded cartridge is in the
                                Unsafe position.

                                Note: If a single track is write protected
                                (see 3.2 Controls and Indicators), WPS
                                will go false if that track is addressed.

DATA INPUT LINES:

WENC (level)   : Write Enable Command. It is anded with
                                the Write Permit Status (WPS), and this
                                turns on the head drive at the time of
                                the Run command.

WD (level)   : Encoded write data, the negativ true
                                polarity magnetizing the tape in the
                                polarity of the gap.

DATA OUTPUT LINES:

RD (level)   : Decoded read data (NRZ, logic 1 is
                                negativ true).

RCLK (pulse)   : Decoded read clock (3 us delay, 3 us width).

DDS (level)   : Data detect status, false when reading
                                gaps (9 bits turn-on delay, 150 us turn-
                                off delay).

Note: Alternative operation of the ON-LINE/OFF-LINE status:
       Normally the drive is reset to the off-line status at
       power-on and can only be placed on-line by the front
       panel push-button. By inserting jumpers, the following
       operations will be performed:
       a)   The drive is forced on-line whenever a cartridge is
            loaded and off-line when unloaded. The front panel
            push-button is now inoperative.
       b)   The drive is forced on-line at power-on if the
            cartridge is in place.
       c)   The ON LINE/OFFLINE push-button is inhibited as
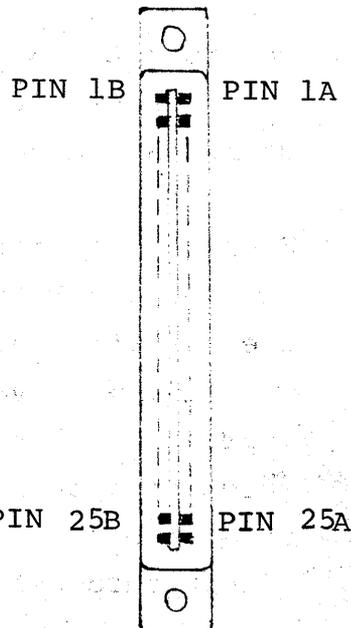   long as the drive is selected.

A   B   D   E

BOT   LP

90 ips
FWD

30 ips
FWD

STOP

30 ips
REV

90 ips
REV

①

LOAD AND REWIND TO LP SEQUENCE.

NOTE
1) RDYS SET
AT THIS
TIME.

BOT   LP

30 ips
FWD

STOP

30 ips
REV

90 ips
REV

②

2) MOTION
STOPPED
AND
CARTRIDGE
UNLOADED.

UNLOAD SEQUENCE.

Generell toleranse General tolerance			Overflatebehandling Surface treatment		Sammenst. Assembly	
					Erstatn. for Repl. for	
					Erstattet av Replaced by	
Materiale Material			Overflatebeskaffenhet Surface finish		Partnr. Part no.	Indeks Index
Dimensjoner– uten overfl. beh. Dimensions– ex surface coating	Europ. proj.	Målestokk Scale	Anvendelse Use	Partnavn Partname	Tegning nr. Drawing no	Korr. nr. Corr. no.

Enhet mm   Tandbergs Radiofabrikk A/

GAP | PREAMBLE | DATA

0_1 | 0_2 -- 0_{15} | 1 | 1 | 0

WENC

WD

TAPE SPEED

25 ms

35 ms

②

①

NOTE ① : BIT TIME = $\frac{625}{V}$ [μS] WHERE V = TAPE SPEED IN IPS

= 20,8 μS AT 30 IPS

NOTE ② : THE BUILT-IN FORMATTER DOES NOT USE TIMING, BUT THE TRAVELLED DISTANCE OF ≈0.65" BEFORE INITIATING THE PREAMBLE.

WRITE TIMING

GAP | PREAMBLE | DATA | CRC | POST-AMBLE | GAP

0_1 --- 0_9 | 0_{10} -- 0_{14} | 0_{15} | 1 | 1 | 0 --

25 ms

TAPE SPEED

RUNS

DDS

RD

RCLK

150 μS
NOMINAL TURN-OFF DELAY

RD

RCLK

MIN 3 μS

MIN 3 μS

BIT TIME
(20,8 μS @ 30 IPS)

READ TIMING, SYNCHRONOUS SPEED

						7-12-74	78

Timing diagram signals: $\overline{FSTC}$, TAPE SPEED (90 IPS, 0), $\overline{RUNS}$, DATA BLOCKS, $\overline{DDS}$, $\overline{RD}$, $\overline{RCLK}$

13 ms MIN (AT 90 IPS)

BIT 9

①

TURN-OFF DELAY 150 us NOMINAL

②

NOTE ① : DDS GOES TRUE ON THE 9TH. BIT IN THE BLOCK (IF THE
SIGNAL ALSO SATISFIES THE REQUIREMENTS FOR
AMPLITUDE AND ENERGY).

DDS GOES FALSE 150 us (NOMINAL) AFTER THE END OF
THE BLOCK.

NOTE ② : IF SEARCH IS DISCONTINUED IN THE MIDDLE OF A BLOCK,
THE RD AND RCLK LINES WILL BE ACTIVATED.
THE SIGNALS MUST THEN BE CONSIDERED AS NOISE.

READ TIMING,

SEARCH SPEED

7-12-74 HB

Generell toleranse General tolerance	Overflatebehandling Surface treatment		Sammenst. Assembly	
			Erstatn. for Repl. for	
			Erstattet av Replaced by	
Materiale Material	Overflatebeskaffenhet Surface finish		Partnr. Part no.	Indeks Index
Dimensjoner- uten overfl. beh.	Europ. proj.	Målestokk Scale	Anvendelse Use 7.2	Partnavn Partname READ TIMING	Tegning nr. Drawing no.	Korr. nr. Corr. no.
Dimensions- ex. surface coating	◁ ⊙		TDC 3000	AT SEARCH SPEED, DEVICE BUS		

5.4. WIRING CHART, DEVICE BUS AND DRIVE POWER CONNECTORS

PIN NUMBER	COMPONENT SIDE (B-SIDE)	CIRCUIT SIDE (A-SIDE)
1	SLAC	SIGNAL GND.
2	SLBC	
3	TRAC	
4	TRBC	
5	WENC	
6	WD	
7	WPS	
8	DDS	
9	RD	
10	RCLK	
11	REVC	
12	FSTC	
13	RUNC	
14	REWC	
15	UNLC	
16	RDYS	
17	ONLS	
18	TPAS	
19	TPBS	
20	REVS	
21	RUNS	
22	CEXS	
23	SPARE	
24	SPARE	
25	SPARE	SIGNAL GND.

Key (between 6 and 7), Key (between 15 and 16)

1	Regulator GND
2	+ 5 V
3	+12 V
4	-12 V
5	+10 V
6	+20 V
7	-20 V
8	Servo GND
9	Regulator GND
10	Regulator GND

Key (between 3 and 4)

A and B sides

DEVICE BUS CONNECTOR

Note:
Signals on pins 1 - 22 B are all negative true

PIN 1B   PIN 1A

PIN 25B   PIN 25A

CONNECTOR:

PC edge, 2,54 mm (o.100") pitch

2 x 25 PIN, i.e. CANNON G03D050A2BABL (solder termi- nals), or equivelant.

2 x 25 PIN
3M type 3415-0001 (For 50 line flat cable)

DRIVE POWER CONNECTOR:

CONNECTOR:
PC edge, 3,96 mm (0,156") pitch

2 x 10 PIN, i.e.
BURNDY PCCD 10 S 04 GEOO, or equivalent,

5.5. Description of the FORMATTER

This formatter can handle from one to four tape drives, giving a total of 16 addressable tape tracks.

The formatter will read and write tape according to the proposed ECMA/ANSI standards.

The formatter will respond to an eight bit address and command word. Four bits are used for addressing and four are used for commands. A description of the commands will be given later.

When in the write mode, the formatter automatically generates the correct Inter-Block Gap and Preamble (start character). Then the formatter asks for data input. When all data belonging to that block have been written, a CRC - (Cyclic Redundancy Check) character is automatically written on the tape and the block is terminated by a Postamble (stop character). A read after write is always performed by the formatter, and if the recording has been unsuccessful, an error will be signaled by the formatter.

When in the read mode, the formatter separates the start-, CRC- and stop-characters from the data characters, and only the data characters are presented as valid data at the formatter data-output.

The CRC character is checked, and if this check fails, an error is signaled by the formatter at the end of that block. The tape can be read both in the forward and reverse tape direction. The for-matter, when reading, will recognize a tape mark (TM) if present, and indicate this. No data will be presented on the data out-put in this case.

The formatter can, upon command, search for a Tape Mark (TM) in both tape directions, and the tape can be erased over a fixed or variable tape length.

Only one drive can be serviced by the formatter at a time. The "Rewind to LP" and "Offline and Unload" commands, however, need only be initiated by the formatter. The formatter is then free

to service another drive while one or more of the remaining are rewinding.

The formatter is contained on one printed circuit board, that can be housed withing the single (or double) tape drive enclosure. Power is supplied by the tape drive's power supply.

The tape drives are connected to the formatter via a common Device Bus. Drives connected to the same formatter may be operated at different synchronous tape speeds (10 ips - 30 ips). The formatted data written on the tape will always have the specified 1600 b p i, Phase-Encoded, density.

The formatter is designed to operate with an I/O controller unit. A simplified block diagram of the formatter and I/O controller is given below. The I/O controller indicated is the Parallell Interface Controller.

The following should be noted about the formatter operation:

1)   Start and stop tape distances are not derived from time constants. These distances are actually measured by the tape displacement register. The tape displacement register is clocked by the encoder signal generated by the optical encoder connected to the capstan motor. This gives a very accurate control of start and stop distances at all tape speeds.

2)   The write clock is locked to the same encoder signal. This makes the formatter able to work with drives having different synchronous tape speeds without any modifications or adjustments of the formatter - I/O controller circuits. Actually, drives having different tape speeds can be connected to the formatter at the same time, and the tapes will always be written in the specified 1600 bpi density. (This remark holds for tape speeds in the 10 - 30 ips range).

Formatter commands description

HALT.

Unconditional stop. Immediately stops all tape motion. NOTE: This command must be used with care, because the tape head gaps may be positioned anywhere in the inter-block gap or in the block when the tape has come to stand still.

Address register

Command register and decoder

Status circuits

I/O control

Write control

Pre., post., TM and CRC generator

Read control

Data byte unpacking

Pre., post., TM and CRC detector

Data byte packing

Tape motion control

Tape displacement register

Write clock generator

Phase encoder

I/O bus drivers and receivers

Device bus drivers and receivers

Status lines

I/O control lines

Input lines (Data and commands)

Data out lines

Parallell I/O bus

Parallell interface controller

Formatter

Address lines

Command lines

Status lines

Capsten encoder lines

Write data line

Read data lines

Device bus

REWIND TO LP.

A rewind to load point (LP) command is sent to the drive. (See drive description) ≠

UNLOAD.

An unload command is sent to the drive. (See drive description) ≠

≠ These commands are stored and performed by the addressed drive electronics without formatter supervision; the formatter is now free to service other drives. These commands cannot be interrupted by the HALT command.

READ ONE BLOCK FWD.

One block is read, tape moving in the forward direction, from the addressed track. Drive will stop at the inter-block gap (IBG) following the block.

READ ONE BLOCK REV.

Same as above, except tape motion is reversed. The drive will stop at the IBG in front of the block just read.

NOTE:

In this mode the data bytes presented on the data output will be time reversed. I.e., the first byte on the data output is the last recorded data byte in that block (recording is always done in the forward direction). However, the bits in each byte are presented in the correct positions.

This command can also be used as a "backspace one block"-command and the data on the data output ignored.

READ CONT. FWD.

Same as Read one block fwd. except the drive will not stop at next IBG. Data will be read until the formatter receives a new command (normally Read one block fwd.), or an error occurs.

READ CONT. REV.

Same as Read one block rev. except the drive will not stop at IBG. Data will be read (in reversed byte order) until

the formatter receives a new command (normally Read one block rev.), or an error occurs.

SEARCH FWD. TO FIRST TM.

Tape will move forward at high speed until the next tape mark is detected. Tape will be stopped at the IBG following the tape mark.

SEARCH REV. TO FIRST TM.

Same as above except the tape moves in reverse direction. Tape will be stopped at the IBG following (in forward direction) the tape mark.

SEARCH CONT. FWD.

The tape will move forward at high speed. When a tape mark is detected, this will be signaled. Tape motion will continue until the formatter receives a new command (normally Search fwd. to first TM).

SEARCH CONT. REV.

Same as above, except the tape moves in the reverse direction.

WRITE ONE BLOCK

One complete block is written incl. proper IBG, start, stop and CRC characters. Data must be presented at the data input at the correct time. Last byte is indicated by the LAST BYTE line.

WRITE TAPE MARK.

One complete tape mark is written. If a tape mark is not successfully written, a "data error" will be signaled by the formatter.

ERASE VAR. LENGTH.

The tape is magnetized in the defined "gap" direction. The erase operation is terminated by making the LAST BYTE line true.

ERASE FIX LENGTH.

The tape is magnetized in the defined "gap" direction over a length of tape equal to the length of a tape mark (and IBG; appr. 1.3".

NOTE: The WRITE and ERASE commands will always cause the tape to move in the forward direction.

SEARCH END TO FIRST TM

90 ips
FWD

②

30 ips
FWD
STOP

30 ips
REV

①   ③

90 ips
REV

PREV BLOCK   IBG ≥ 1.2"   IRG ≥ 1.2"   NEXT BLOCK

TM

NOTES:

1) TMRK STATUS LINE SET TRUE AND FRDY SET FALSE AT THIS TIME.(NOT SIMULTANEOUSLY.)

2) DOTTED LINE INDICATES TAPE MOTION WHEN TM IS NOT RECOGNIZED AT SYNCHRONOUS SPEED. (CONTINUE SEARCH AT HIGH SPEED.)

3) POSITION OF READ-GAP AT END OF SEARCH ROUTINE. (TAPE STOPPED.) OR STOP FOR DITHERKNOB.

SEARCH REV. TO FIRST TM

- 5.12c -

90 μs — FWD

30 μs FWD STOP

30 μs REV

90 μs REV

① ②

③

PREV. BLOCK   IBG ≥ 1.2"   IBG ≥ 1.2"   NEXT BLOCK

TM

NOTES:

1) TMRK STATUS LINE SET TRUE AND FBSY SET FALSE AT THIS TIME. (NOT SIMULTANEOUSLY.)

2) DOTTED LINE INDICATES TAPE MOTION WHEN TM IS NOT RECOGNIZED AT SYNCHRONOUS SPEED. (CONTINUE SEARCH AT HIGH SPEED.)

3) POSITION OF READ-GAP AT END OF SEARCH ROUTINE. (TIME STOPPED.) OR STOP FOR DATAERROR.

SEARCH UNIT FWD.

- 5,12d -

90 ips FWD

30 ips FWD
STOP
30 ips REV

90 ips REV

PREV. BLOCK | IBG ≥ 1.2" | IBG ≥ 1.2" | NEXT BLOCK

TM

①
②

NOTES:

1) TMRK STATUS LINE SET TRUE AND FBSY SET FALSE AT THIS TIME. (NOT SIMULTANEOUSLY.) OR STOP GIVEN IF ERROR.

2) TMRK STATUS LINE SET FALSE AND FBSY SET TRUE AT THIS TIME.

3) IF NO TM IS RECOGNIZED AT SEARCHING SPEED, TMRK STATUS LINE IS NOT SET TRUE AND FBSY IS NOT SET FALSE AT ①.

SEARCH CONT. REV.

- 5.12e -

90 ips
FWD

30 ips
FWD
STOP

30 ips
REV

90 ips
REV

PREV. BLOCK | IBG ≥ 1.2" | IBG ≥ 1.2" | NEXT BLOCK

TM

NOTES:

1) TMRK STATUS LINE SET TRUE AND FBSY SET FALSE AT THIS TIME. (NOT SIMULTANEOUSLY.) OR STOP GIVEN IF ERROR.

2) TMRK STATUS LINE SET FALSE AND FBSY SET TRUE AT THIS TIME.

3) IF NO TM IS RECOGNIZED AT CONTINUOUS SPEED, TMRK STATUS LINE IS NOT SET TRUE AND FBSY IS NOT SET FALSE AT (1).

5.6. Description of the I/O CONTROLLERS

The general data formatting and tape control functions have been
implemented on the formatter p.c. board. The I/O controller, how-
ever, contains all circuits that may differ from one system appli-
cation to another. The I/O controller is designed as a plug in
"extension" p.c. board to the formatter. This separation makes
up a very flexible system. The I/O controller can be optimized
for the particular system requirements, and no external "adapter"-
or "transmitter"-boxes will be needed.

The I/O controller will typically contain line receivers and
drivers, data byte packing and unpacking circuits, data buffers,
control circuits and occasionally special tape motion control
circuits. Some standard I/O controllers will be described below.
For special applications custom I/O controllers can be construc-
ted and, both electrically and mechanically, easily connected
to the formatter p.c. board, as mentioned above.

A) SERIAL INTERFACE CONTROLLER.

This I/O controller is the simplest possible; it just con-
tains line receivers and termination for the Command and
Data In lines, line drivers for the Status and Data Out
lines and some I/O control circuits. It is used when syn-
chronous bit serial data output and input are needed.

This I/O controller is similar to the Parallell Interface
Controller (below) except it contains no data byte packing
and unpacking circuits. All the input/output lines are
the same as described for the Parallell Interface Controller,
except one separate Data in line ($\overline{DIN}$) and one Data out line
($\overline{DOT}$) are provided, and the Last Byte In line is changed
to a Last Bit In line.

B) PARALLELL INTERFACE CONTROLLER.

This I/O controller has data byte packing, and unpacking
circuits. The data in/out format of this controller is
8 bits parallell. Eight input lines are used for both address/
command and data input transmission. Eight separate lines
are used for data output. Line drivers and receivers and
termination for the Status and Command/Address lines respec-
tively, are provided. Both the Serial and Parallell Con-

troller are designed to operate into 100 Ω unbalanced transmission lines. All interface lines are TTL compatible low-true with logic levels of:

    FALSE 'O' :   2,4 V to 5,0 V
    TRUE '1' : -0,5 V to 0,8 V

As for the Serial Interface Controller, the Parallell Controller transfers data synchronously. This means that the controllers have to be serviced by the outside world within specific time intervals if data should not be lost. If this timing fails, the controllers will generate a "data transfer timing error" signal, indicating that data has been lost.

A signal description of the Parallell Interface Controller interface lines is listed on the following pages.

A simplified block diagram of the Parallell Controller is found in the formatter description, paragraph 5.5.

PARALLELL I/O CONTROLLER SIGNAL DESCRIPTION

Logic is Negative True

NAME	MNEMO-NIC	FUNCTION
INPUT LINES		
Input bit 0 ─ Input bit 7	INBIT0 INBIT7	Input lines for address/command and data bits. If the ASTR line is pulsed, the data on the INBIT 0-3 lines are taken as address bits. If the CSTR line is pulsed, the data on the INBIT 4-7 lines are taken as command bits. If the WSTR line is pulsed, the data on the INBIT 0-7 lines are taken as data input lines.

INBIT LINES, ADDRESS FUNCTION:

| Input bit 0 | INBIT0 | TRACK ADDRESS LINES: |
| Input bit 1 | INBIT1 | |

TRACK NO.	INBIT1	INBIT0
1	0	0
2	0	1
3	1	0
4	1	1

| Input bit 2 | INBIT2 | UNIT ADDRESS LINES: |
| Input bit 3 | INBIT3 | |

UNIT NO.	INBIT3	INBIT2
1	0	0
2	0	1
3	1	0
4	1	1

NAME	MNEMO-NIC	FUNCTION
INBIT LINES, COMMAND FUNCTION:		COMMAND LINES (Coded):
Input bit 4	INBIT4	
Input bit 5	INBIT5	
Input bit 6	INBIT6	
Input bit 7	INBIT7	

COMMAND LINES (Coded):

INBIT7	INBIT6	INBIT5	INBIT4	FUNCTION
0	0	0	0	Halt
0	0	0	1	Rewind to LP
0	0	1	0	Unload and off-line
0	0	1	1	Halt
0	1	0	0	Read one block fwd.
0	1	0	1	Read one block rev.
0	1	1	0	Read cont. fwd.
0	1	1	1	Read cont. rev.
1	0	0	0	Search fwd. to first TM
1	0	0	1	Search rev. to first TM
1	0	1	0	Search cont. fwd.
1	0	1	1	Search cont. rev.
1	1	0	0	Write one block (fwd.)
1	1	0	1	Write tape mark (TM)
1	1	1	0	Erase var. length
1	1	1	1	Erase fix. length

NAME	MNEMONIC	FUNCTION
Address strobe	ASTR	Used to strobe the address on the INBIT 0-3 lines into the Address Register. The leading edge enables the address lines and the trailing edge strobes the address into the Address Register.
Command strobe	CSTR	Used to strobe the command on the INBIT 4-7 lines into the Command Register. The trailing edge strobes the command into the Command Register and initiates operation.

INBIT LINES, DATA FUNCTION:

NAME	MNEMONIC	FUNCTION
Input bit 0	INBIT0	Data input lines (One byte parallell)
Input bit 1	INBIT1	
Input bit 2	INBIT2	INBIT0 = LSB
Input bit 3	INBIT3	INBIT7 = MSB
Input bit 4	INBIT4	
Input bit 5	INBIT5	
Input bit 6	INBIT6	
Input bit 7	INBIT7	
Write data strobe	WSTR	Answer pulse to a WSREQ (Write Service Request) Indicates that the data on the INBIT-lines are valid input data.
		Must be kept true until the trailing edge of the WSREQ-signal. The data on the INBIT0-7 lines must be valid input data no later than the leading edge of WSTR and stay valid as long as WSTR is true.

NAME	MNEMO- NIC	FUNCTION
Last byte in	LBIN	This line is sampled at the trailing edge of the WSTR-signal. 1. Indicates that this is the last byte in this block (when writing). 2. Indicates the termination of the erase variable length command (when erasing).
Read data strobe	RSTR	Answer pulse to a RSREQ-signal (Read Service Request). Indicates that the data on the DOT-lines has been accepted. Should be set false when the RSREQ-signal goes false.
Master reset	MRST	Resets the formatter and I/O controller to the initial state. The CSTR signal must be false when a MRST signal is given.
Read test	RTEST	Sets the formatter in the read test mode: The last two bytes of a block outputted on the DOT-line is the CRC-character of that block (Fwd.). If a CRC,error is detected, this will also be signaled by the DATAERR line.
Write test	WTEST	Sets the formatter in the write test mode: No CRC-character is generated by the formatter. The last two bytes of a data block inputted on the INBIT-lines are written as the CRC-character of that block. If the read after write operation of the formatter detects a CRC-error, this will be signaled by the DATAERR line.

OUTPUT LINES

Data out 0	DOT 0	Data output lines (One byte parallell)
Data out 1	DOT 1	
Data out 2	DOT 2	DOT0 = LSB
Data out 3	DOT 3	DOT7 = MSB
Data out 4	DOT 4	
Data out 5	DOT 5	
Data out 6	DOT 6	
Data out 7	DOT 7	
Read Service Request	RSREQ	Indicates that a data byte is ready on the data output (DOT) lines.
Write Service Request	WSREQ	Indicates that the formatter-I/O controller is requesting another byte of input data on the Input (INBIT) lines.
Formatter busy	FBSY	Indicates that the formatter is performing a command. FBSY is set true no later that 1 µS after the trailing edge of the CSTR signal if the command is accepted by the formatter.

NAME	MNEMO-NIC	FUNCTION
		FBSY is set false when the command is completed and the formatter is ready to accept a new command.
		The REWIND TO LP and UNLOAD commands do not set FBSY true.
		When the formatter is performing a "CONTINUOUS" command, FBSY is set false in the inter-block gap following the block (when reading cont.) or tape mark (when searching cont.). FBSY is set true when the next block is detected.
		A new command should normally not be given when FBSY is true.
Data error	DATAERR	Indicates CRC or postamble pattern read error. If no tape mark is read when performing a WRITE TAPE MARK command, this line is set true.
		Reset by MRST or new command.
Timing error	TIMEERR	Indicates that an input or output data transfer timing error has occured. Reset by MRST or new command.
Ready status	RDYS	Same as RDYS of addressed drive
Online status	ONLS	" " ONLS " " "
Write permit status	WPS	" " WPS " " "
Runs status	RUNS	" " RUNS " " "
Reverse status	REVS	" " REVS " " "
Fast status	FAST	Indicates that tape speed exceeds approximately 1,15 m/s (45 ips).
Tape mark	TMRK	Indicates that a Tape mark has been detected When searching, the TMRK is set true when the drive is stopping at the IBG, following the tape mark. TMRK is set false when the next block is detected,by a new command or MRST.
Early Warning status	EWS	Set true when the Early Warning tape mark is sensed going forward, set false when the EW is sensed going in reverse.
End of tape status	EOT	Set true when End Of Tape mark is sensed going forward, (no further forward tape motion possible). Set false when the EOT is sensed going in reverse.
Drive unsafe status	DRUS	Indicates faults in the addressed drive:
		The Write Voltage is on without a WENC (Write enable command) given, WENC is true without Write Voltage on, the +5V is outside specified limits or that a lamp failure is detected in the tape marker sensing circuit.

RESET AND COMMAND TIMING

NOTES.

1. MEASURED AT $^I/_0$ CONTROLLER CONNECTOR.

2.

3. COMMAND INITIATED AT TRAILING EDGE OF CSTR

4. FBSY SET TRUE IF COMMAND IS ACCEPTED,
   FBSY IS NOT SET TRUE FOR THE "REWIND TO
   LP" AND "UNLOAD" COMMANDS.

5. CSTR MUST BE FALSE WHEN
   MRST IS TRUE.

6. THE CSTR AND ADDRESS STROKE (ASTR)
   MAY BE GIVEN SIMULTANEOUSLY.

Generell toleranse / General tolerance	
Materiale / Material	

Overflatebehandling / Surface treatment	
Overflatebeskaffenhet / Surface finish	

Sammenst. / Assembly	
Erstatn. for / Repl. for	
Erstattet av / Replaced by	

Partnr. / Part no.	Indeks / Index

17-1-77	SL

| Dimensjoner- uten overfl. beh. / Dimensions- ex. surface coating | Europ. proj. | Målestokk / Scale | Anvendelse / Use TDC 3000 PARALLELL I/O CONTROLLER | Partnavn / Partname TIMING DIAGRAM | Tegning nr. / Drawing no. | Korr. nr. / Corr. no. |

ADDRESS TIMING

INBIT 0 -
INBIT 3

ASTR

③

>50nS   >30nS

>100nS   ⑤

<300nS   ④

NOTES:

1. MEASURED AT I/O CONTROLLER CONNECTOR

2. SIGNALS MAY CHANGE
   SIGNALS MUST BE VALID

3. IF THE INBIT 0 - INBIT 3 SIGNALS ARE NOT STABLE AT THE LEADING EDGE OF ASTR THE ADDRESSED DEVICE AND TRACK WILL CHANGE AS INBIT 0 - INBIT 3 CHANGES IN THIS INTERVAL.

4. THE STATUS OF THE ADDRESSED DEVICE IS VALID AFTER THIS DELAY. THE DELAY IS MEASURED FROM THE LEADING EDGE OF ASTR OR FROM THE TIME INBIT 0 - INBIT 4 HAVE STABILIZED, WHATEVER OCCURS LAST.

5. THE TRAILING EDGE OF ASTR STROBES THE ADDRESS ON INBIT 0 - INBIT 4 INTO THE ADDRESS REGISTER.

26-5-75 Jr

General toleranse / General tolerance	Overflatebehandling / Surface treatment	Sammenst. / Assembly	
		Erstatn. for / Repl. for	
		Erstattet av / Replaced by	
Materiale / Material	Overflatebeskaffenhet / Surface finish	Partnr. / Part no.	Indeks / Index
Dimensjoner- uten overfl. beh. / Dimensions- ex. surface coating	Europ. proj.	Målestokk / Scale	Anvendelse / Use TDC 3000 PARALLELL I/O CONTROLLER	Partnavn / Partname TIMING DIAGRAM	Tegning nr. / Drawing no.	Korr. nr. / Corr. no.

DATA INPUT TIMING

NOTES.

1. MEASURED AT I/O CONTROLLER CONNECTOR

2. [signals illustration]

   SIGNALS MAY CHANGE
   SIGNALS MUST BE VALID

3. $t_a = \dfrac{5000}{v}\,\mu S$, $t_b = \dfrac{312.5}{v}\,\mu S$, $t_c = \dfrac{234}{v}\,\mu S$; v = instantaneous tape speed $\left(\dfrac{inches}{u S}\right)$

4. TIMING ERROR OCCURS HERE.

5. TIMEERR IS SET FALSE BY NRST OR CSTR.

6. THE WSREQ - WSTR SIGNAL SEQUENCE MUST ALSO BE MAINTAINED DURING THE ERASE VARIABLE LENGTH COMMAND. (CAN BE USED FOR TAPE DISTANCE MEASUREMENT)

DMA OUTPUT TIMING,

Signals:
- $\overline{RSREQ}$
- $\overline{RSTR}$
- $\overline{DOT\,0}$ – $\overline{DOT\,7}$
- $\overline{TIMEERR}$

Annotations on diagram:
- > 0
- $< (t_a - 4.5)\,\mu S$
- $< 0.3\,\mu S$
- $> (t_a - 4.5)\,\mu S$
- $< (t_a - 2)\,\mu S$
- $> 2\,\mu S$
- $(t_a - 3)\,\mu S$ nomin
- ④
- ⑤

NOTES:

1. MEASURED AT I/O CONTROLLER CONNECTOR.

2.

   SIGNALS MAY CHANGE

   SIGNALS MUST BE VALID.

3. $t_a = \dfrac{5000}{v}\,\mu S$ $v =$ instantaneous tape speed (inches/sec).

   $t_a = 130\,\mu S$ FOR THE LAST BYTE IN THE BLOCK.

4. TIMING ERROR OCCURS HERE.

5. TIMEERR IS SET FALSE BY MRST OR CSTR.

READ ONE BLOCK FWD. OR REV. (16 bytes).

Timing diagram signals:
- CSTR — < 1µS
- FBSY
- RSREQ — ⑥
- RSTR
- DOT0-7
- TIMEERR — ③ ⑤
- DATAERR — ④
- RTEST — ⑥

NOTES.

1. MEASURED AT I/O CONTROLLER CONNECTOR.

2. (diagram) — SIGNALS MAY CHANGE — SIGNALS MUST BE VALID.

3. TIMEERR SET WHEN TIMING ERROR OCCURS.

4. DATAERR SET HERE IF CRC OR POSTAMBLE PATTERN ERROR.

5. BOTH ERROR SIGNALS SET FALSE BY CSTR OR MRST.

6. IF RTEST IS TRUE THE LAST (WHEN FWD) OR FIRST (WHEN REV) TWO
   BYTES ARE THE CRC-CHARACTER.

7. SIGNALS ARE NEGATIVE TRUE, FIGURE NOT TO SCALE.

READ ONE BLOCK FWD. OR REV. (TAPE MARK).

CSTR

FBSY

RSCEQ

RSTR

DOT 0-7

TIMEERR

DATAERR ③

TMRK

RTEST ④

NOTES.

1. MEASURED AT IO CONTROLLER CONNECTOR.

2.

SIGNALS MAY CHANGE
SIGNALS MUST BE VALID

3. DATAERR SET HERE IF CRC OR POSTAMBLE PATTERN ERROR, SET FALSE BY CSTR OR MRST.

4. IF RTEST IS TRUE WHEN READING A TAPE MARK, TMRK IS NOT SET TRUE. TWO DATA BYTES ARE PRESENTET AT DOT 0-7 (SEE READ ONE BLOCK FWD OR REV.) CONTAINING ALL ZEROES. TIMEERR AND DATAERR INDICATE ERRORS IF DETECTED.

5. SIGNALS ARE NEGATIVE TRUE, FIGURE NOT TO SCALE.

READ CONT. FWD. OR REV.

TAPE CONTENTS	IBG	BLOCK (n-3)	IBG	TM	IBG	BLOCK (n-1)	IBG	BLOCK (n)	IBG	BLOCK (n+1)

(n-2)

CSTR ④ ④

FBSY

RBREQ ②

RSTR

DOT 0-7 — DATA — DATA — DATA

TIMBER ③

DATHER'K ③

TMRK

NOTES:

1. Signals may change / Signals must be valid

2. FOR DETAILS SEE SEPARATE TIMING DIAGRAM.

3. IF ERROR OCCURS TAPE STOPS AT FIRST INTER-BLOCK GAP (IBG)

4. IF THE READING SHALL BE STOPPED AFTER BLOCK (n) THIS CAN BE DONE BY GIVING A READ ONE BLOCK FWD OR REV. COMMAND AFTER BLOCK (n-1) OR A HALT COMMAND WITHIN 300 uS AFTER THE TRAILING EDGE OF FBSY AT THE END OF BLOCK (n). THIS PRO-CEDURE WILL POSITION THE HEAD-GAPS PROPERLY IN THE IBG.

5. SIGNALS ARE NEGATIVE TRUE. FIGURE NOT TO SCALE.

PARALLEL TDC 3000 PARALLEL I/O CONTROLLER PULSE DIAGRAM

9-3-76
7-5-77

SEARCH TO FIRST TAPE MARK FWD OR REV.
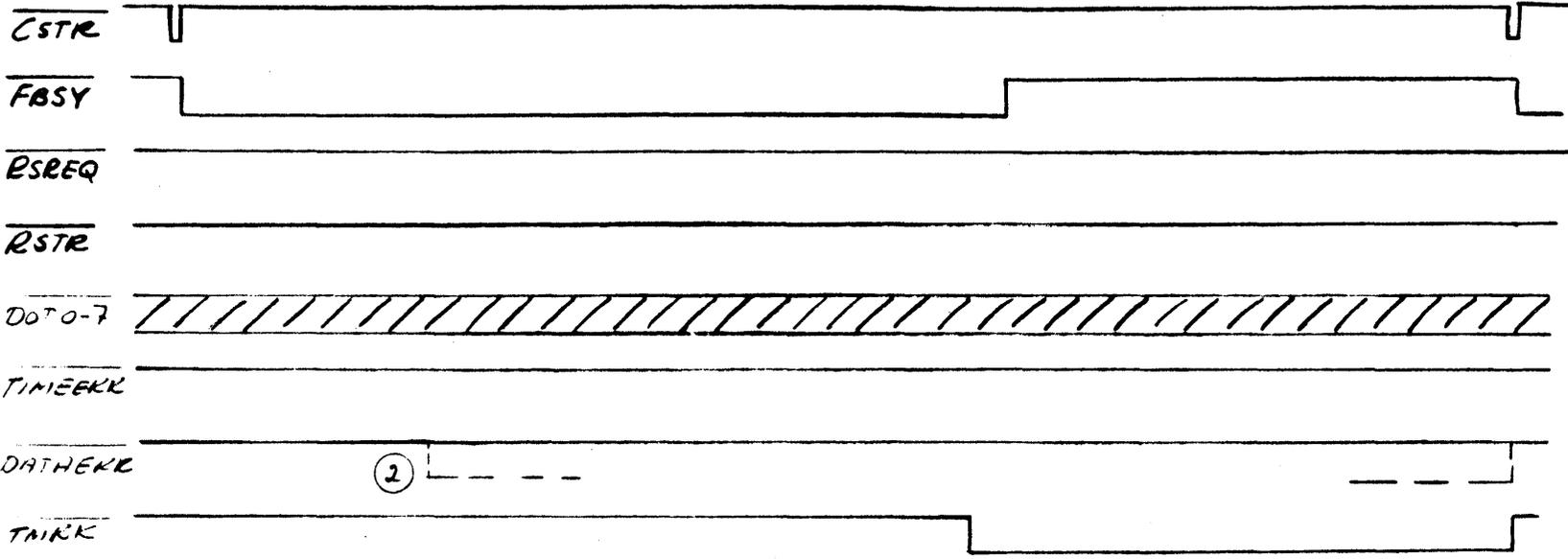
CSTR

FBSY

ESREQ

RSTR

DOT 0-7

TIMEERR

DATAERR   ②

TMRK

NOTES

1. ///////////   SIGNALS MAY CHANGE.

2. IF CRC OR POSTAMBLE PATTERN ERROR OCCURS
THIS WILL BE INDICATED BY DATAERR, AND TAPE WILL
STOP IN THE IBG FOLLOWING THE BLOCK WHERE THE ERROR OCCURED.

3. SIGNALS ARE NEGATIVE TRUE. FIGURE NOT TO SCALE.

TAPE CONTENTS

| IBG | B | IBG | B | IBG | IBG | B | IBG | IBG | B | IBG | IBG | B | IBG | IBG | B | IBG |

TM(n-3)   TM(n-2)   TM(n-1)   TM(n)

CSTR ③ ③

FBSY

ESLFQ

CSTR

DOT 0-7

TIMGERR

DATHERR ②

TMRK

NOTES

1. [hatched pattern] SIGNALS MAY CHANGE

2. IF CRC OR POSTAMBLE PATTERN ERROR OCCURS THIS WILL BE INDICATED BY DATHERR, AND TAPE WILL STOP IN THE IBG FOLLOWING THE BLOCK WHERE THE ERROR OCCURED.

3. IF THE SEARCH SHALL BE STOPPED AFTER TM(n) THIS CAN BE DONE BY GIVING A SEARCH TO FIRST TM FWD. OR REV. COMMAND AFTER TM(n-1) OR A HALT COMMAND WITHIN 300μS AFTER THE TRAILING EDGE OF FBSY AT THE END OF TM(n). THIS PROCEDURE WILL POSITION THE HEAD-GAPS PROPERLY IN THE IBG. THE TM'S CAN BE COUNTED BY COUNTING FBSY OR TMRK TRANSITIONS.

4. SIGNALS ARE NEGATIVE TRUE. FIGURE NOT TO SCALE.

WRITE ONE BLOCK OR ERASE VARIABLE LENGTH.

Signal traces (top to bottom):
CSTR, FBSY, WSREQ ②, WSTR, INBIT0-7 — DATA (WRITE), LBIN, RSREQ ②, RSTR, DOT0-7 — DATA (READ), TIMEERR ③, DATAERR ④, WTEST

⑥ (on CSTR trace)
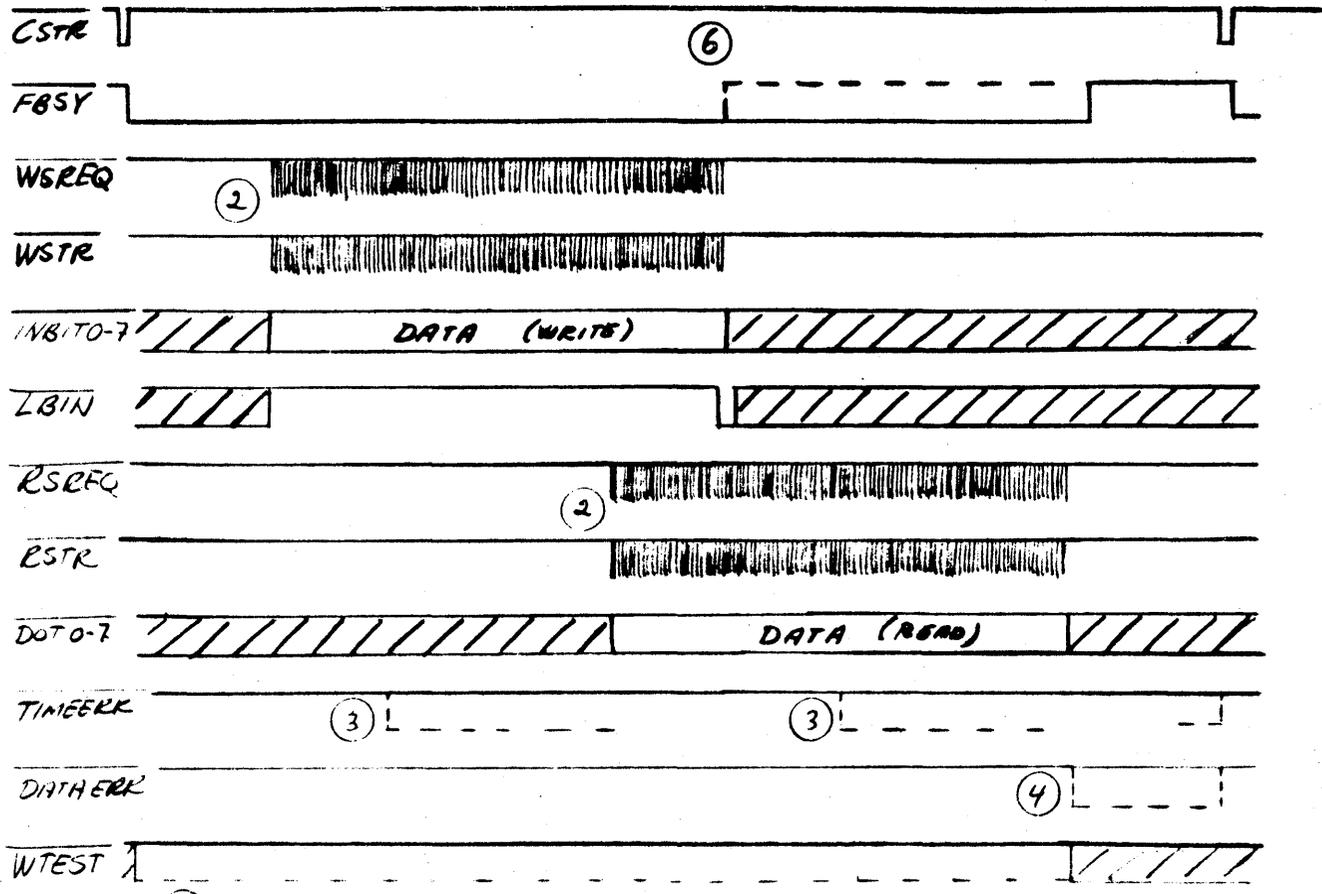
NOTES:

6. WHEN ERASING FBSY IS SET FALSE AS INDICATED. NO RSREQ OR DOT0-7 SIGNALS ARE GENERATED AND THE DATA ON INBIT0-7 ARE IGNORED.
THE WSREQ-WSTR SEQUENCE MUST BE MAINTAINED OR ELSE TIMEERR OCCURS. THE WSREQ-WSTR SEQUENCE CAN BE USED TO MEASURE ERASED TAPE LENGTH.

7. SIGNALS ARE NEGATIVE TRUE. FIGURE NOT TO SCALE.

⑤

SIGNALS MAY CHANGE

SIGNALS MUST BE VALID.

NOTES: 1.

2. FOR DETAILS SEE SEPARATE TIMING DIAGRAMS.

3. TIMEERR SET WHEN TIMING ERROR OCCURS.

4. DATAERR SET HERE IF CRC OR POSTAMBLE PATTERN ERROR DURING READ AFTER WRITE.

5. IF WTEST IS TRUE THE LAST TWO BYTES PRESENTED ON INBIT0-7 ARE WRITTEN AS THE CRC-CHARACTER, NO OTHER CRC IS WRITTEN.

WRITE TAPE MARK OR ERASE FIXED LENGTH.

Signal names (left labels, top to bottom):
- CSTR
- FBSY
- WSREQ
- WSTR
- WDTO-1
- LGIN
- RSLEQ
- RSTR
- DTO-7
- TMERR
- DATAERR
- TMRR
- WTEST
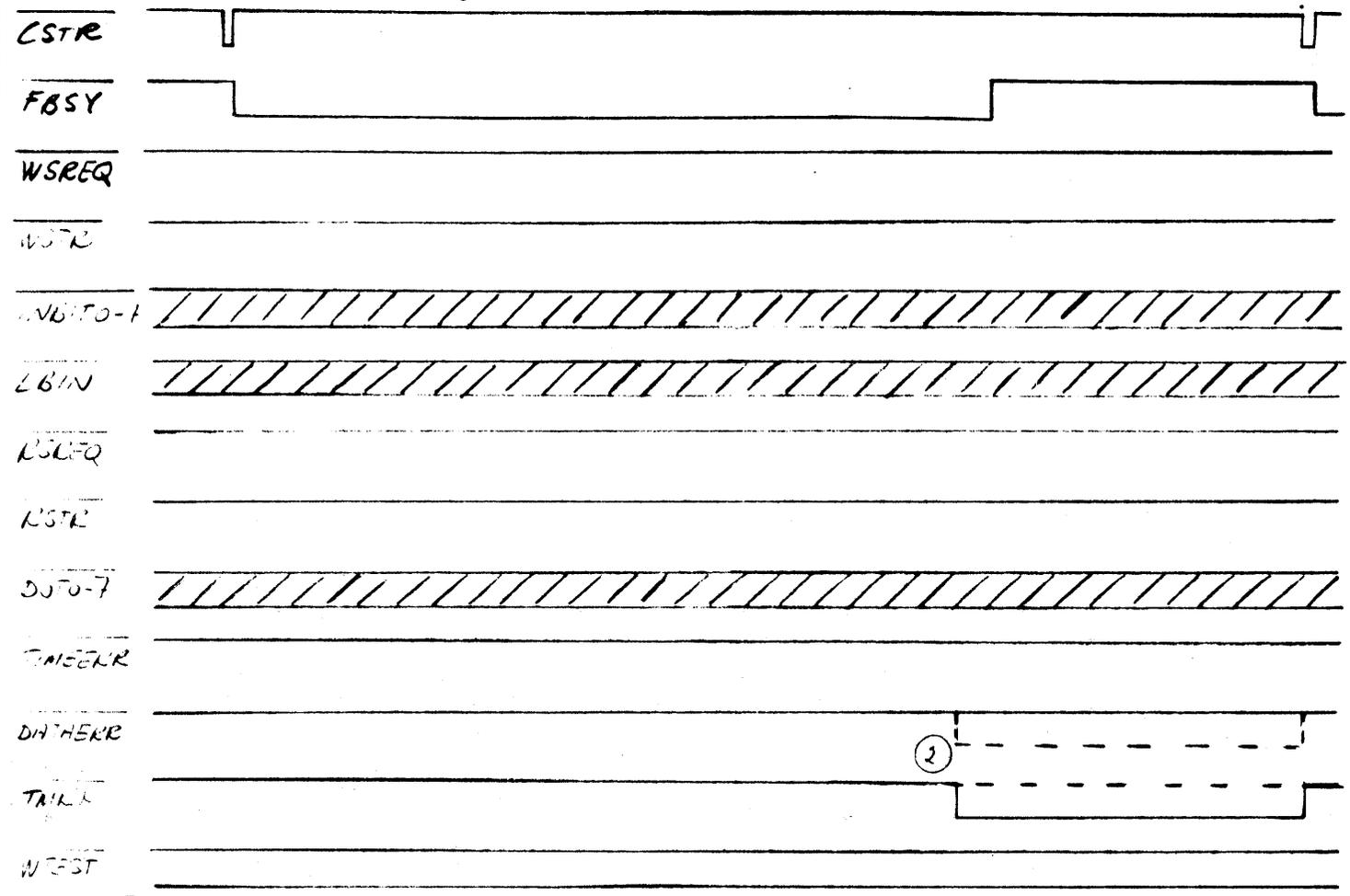
NOTES:

1. _____ SIGNALS MAY CHANGE

2. IF NO TAPE MARK IS DETECTED DURING READ AFTER WRITE DATAERR IS SET TRUE HERE.

3. WTEST MAY BE TRUE OR FALSE. TM WILL ALWAYS BE WRITTEN.

4. WHEN ERASING NO TMRR SIGNAL IS GENERATED.

P2-A		P2-B
Pin	Nomenclature	
1	$\overline{\text{FAST}}$	grnd
2	$\overline{\text{WSREQ}}$	
3	$\overline{\text{EOT}}$	
4	$\overline{\text{DOT 3}}$	
5	$\overline{\text{DOT 2}}$	
6	$\overline{\text{DOT 1}}$	
7	$\overline{\text{DOT 0}}$	
8	$\overline{\text{DOT 7}}$	
9	$\overline{\text{DOT 6}}$	
10	$\overline{\text{DOT 5}}$	
11	$\overline{\text{DOT 4}}$	
12	$\overline{\text{REVS}}$	
13	$\overline{\text{WPS}}$	
14	$\overline{\text{RUNS}}$	
15	$\overline{\text{DATAERR}}$	
16	$\overline{\text{TMRK}}$	
17	$\overline{\text{EWS}}$	
18	$\overline{\text{ONLS}}$	
19	$\overline{\text{TIMEERR}}$	
20	$\overline{\text{RSREQ}}$	

P3-A		P2-B
Pin	Nomenclature	
1	XXXX (Blank)	grnd
2	$\overline{\text{DRUS}}$	
3	$\overline{\text{FBSY}}$	
4	$\overline{\text{RDYS}}$	
5	$\overline{\text{RTEST}}$	
6	$\overline{\text{WTEST}}$	
7	$\overline{\text{CSTR}}$	
8	$\overline{\text{ASTR}}$	
9	$\overline{\text{RSTR}}$	
10	$\overline{\text{INBIT 3}}$	
11	$\overline{\text{INBIT 2}}$	
12	$\overline{\text{INBIT 0}}$	
13	$\overline{\text{INBIT 1}}$	
14	$\overline{\text{INBIT 4}}$	
15	$\overline{\text{INBIT 5}}$	
16	$\overline{\text{INBIT 6}}$	
17	$\overline{\text{INBIT 7}}$	
18	$\overline{\text{MRST}}$	
19	$\overline{\text{WSTR}}$	
20	LBIN	

20B   1B

20A   1A

NOTES:

1. ALL SIGNALS ARE LOW TRUE.

2. CONNECTOR SHOWN AS SEEN FROM P.C.B. SIDE.

3. CONNECTOR TYPE: 3M Co. NO. 3464 (OR STANDARD TYPE 2×20PIN. 0.1" PITCH EDGE CONNECTOR.)

4. KEYS ARE BETWEEN PINS 5 AND 6 AND 13 AND 14. KEY TYPE: 3M Co No. 3439

5. FOR CONNECTOR 3464 USE CABLE TYPE: 3M Co. NO. 3476/40

3-11-	SL			
17-10-15	SL			

Generell toleranse / General tolerance		Overflatebehandling / Surface treatment	Sammenst. Assembly	
			Erstatn. for / Repl. for	
			Erstattet av / Replaced by	
Materiale / Material		Overflatebeskaffenhet / Surface finish	Partnr. / Part no.	Indeks / Index
Dimensjoner– uten overfl. beh. / Dimensions– ex. surface coating	Europ. proj. / Målestokk Scale	Anvendelse / Use TDC 3000 PARALLEL I/O CNTR.	Partnavn / Partname CONNECTOR WIRING	Tegning nr. / Drawing no.
Enhet / Unit : mm		Tandbergs Radiofabrikk A/S		Korr. nr / Corr. no 1

C) EIA COMMUNICATIONS CONTROLLER

This controller is designed to interface equipment in accordance
with EIA Standard RS-232-C and CCITT Standard V.24 or a 20mA
(60mA optional) "current loop". Data is transmitted asynchro-
nously in half or full duplex. Two interface connectors are
provided so that the recorder can be connected both to a local
teletype-writer or video display terminal (such as the TANDBERG
TDV 2000 Video Display Unit) and a modem making up a complete
remote terminal.
The controller will respond to control characters from the
local terminal or modem. These characters control the tape
drives (up to four).
Special binary modes are provided for reading and recording
binary information on the tape. When in the binary mode, all
control characters are ignored, making the controller
"transparent" to all data.
The communications controller may also be OEM-customer
programmed for special requirements such as generation of
communication protocols, format checking etc.

Because of the asynchronous transmission mode and the synch-
ronous data flow of the cartridge recorder, a data buffer has
to be included in this controller. The buffer size may be
selected between 256 bytes and 1024 bytes.
The transmission baud rate is selectable from 75 to 9600 Bauds.
Odd, even or no parity and one or two stop bits are selectable.

For further information on the Communications Controller see
separate specifications document; "Specifications for TDC 3025.
Communications interface for Tandberg TDC 3000 Digital Cartridge
Recorder."

6. MAINTENANCE

6.1. Preventive Maintenance

The product is designed for no preventive maintenance except periodical cleaning of the head assembly.

For cleaning, Freon TF or isopropyl alcohol is recommended. Dampen a Q-tip or lint-free cotton and wipe the head without touching with fingers or sharp tools.

6.2. Corrective Maintenance

The product is designed with easy and fast servicing in mind. The electronics is separated in logical blocks, each located on pluggable printed circuit boards.

When the top and bottom covers are removed, the electronics and the mechanism respectively is exposed. The head cable plugs directly into the Read/Write PC board. This and the other two main PC boards can then be removed.

If a drive is equipped with a Formatter, this is mounted underneath the top cover. The external cable connects directly to the board via a connector. For servicing the board may be positioned on one edge, giving full access to the board itself and the electronics below. When doing this, the cable may remain in place and thus provides good strain relief.