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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 emphasizes

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- If power is disrupted, the cartridge may (without tools) be withdrawn from the locking mechanism by grasping the cartridge and overcoming the spring retention forces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 structures: Parallel 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: Parallel 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 identical 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.
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, continuously 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

Start/stop time (at 30 ips): Command ramp: 23 ms ± 10%
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.
1.8

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 bpi (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 Read " : 20% of Standard Reference Amplitude
                          "    : 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.)
NOTE:
All dimensions in mm (inches)

Slide mount area

Single drive table top

Dual drive, table top

Dual drive rack mount
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:**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Frequency</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>115 V, and 230VRMS ± 10%</td>
<td>48 to 440 Hz</td>
<td>25 W avg. with 1 drive at synchronous speed, 80 W with 2 drives, formatter and worst case programming</td>
</tr>
</tbody>
</table>

**Output voltage, non-regulated:**

- ± 20V ± 10%, 2A peak in 70 ms, 1.5 A continuous (for servo and regulator input)
- +10V ± 10%, 4A continuous (for regulator input)

**Output voltage, regulated:**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Tolerance</th>
<th>Load current</th>
<th>Load and line regulation</th>
<th>Noise and hum</th>
</tr>
</thead>
<tbody>
<tr>
<td>+12V</td>
<td>+1% (after initial adjustment)</td>
<td>1.0 A max.</td>
<td>50 mV total</td>
<td>10 mV pp.</td>
</tr>
<tr>
<td>-12V</td>
<td>+5%</td>
<td>0.2 A max.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
+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 dm² (150 in²) 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 acceleration 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 environment. If it is used in particular dusty
areas, more frequent cleaning of the head is required. Alternatively, the equipment
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 separate 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 Parallel 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>102 x 154 x 17 mm (4 x 6 x 0.665&quot;)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>270 gram</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Metal reference plane with high-impact plastic and automatic door covering the head location area.</td>
</tr>
<tr>
<td><strong>Outside label</strong></td>
<td>Along front edge and top of plastic cover. (Fully visible when operating inside TDC3000 drive).</td>
</tr>
<tr>
<td><strong>Tape type</strong></td>
<td>Standard computer-type oxide, thin coating on a back-coated base.</td>
</tr>
<tr>
<td><strong>Tape width</strong></td>
<td>6,30 mm (0.246 ± 0.002&quot;)</td>
</tr>
<tr>
<td><strong>Tape length</strong></td>
<td>91,4 m (300 feet)</td>
</tr>
<tr>
<td><strong>Tape speed</strong></td>
<td>2,29 m/s (90 ips) maximum</td>
</tr>
<tr>
<td><strong>Maximum acceleration</strong></td>
<td>500 m (2000 inches) per second²</td>
</tr>
<tr>
<td><strong>Tape tension</strong></td>
<td>42 gram (1.5 oz) nominal</td>
</tr>
<tr>
<td><strong>Maximum recording density</strong></td>
<td>3200 flux reversals per inch</td>
</tr>
<tr>
<td><strong>Short term jitter</strong></td>
<td>± 4%</td>
</tr>
<tr>
<td><strong>Drive ratio, tape to pulley surface</strong></td>
<td>0.78:1</td>
</tr>
<tr>
<td><strong>Tape markers</strong></td>
<td>BOT, LP, EW and EOT holes in the tape are sensed optically. The location of the markers are shown on the next page.</td>
</tr>
</tbody>
</table>
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

Dimensions in mm except as noted

Forward direction of tape travel (oxide side shown)

TAPE MARKERS AND RECORDING AREA
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** (Tape Mark, File Mark): Preamble + 16 "ZERO" bits + 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, see 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 termination networks in Dual-In-Line packages: One network with thirteen 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 Parallel 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 interfaces different types of connectors can be used.
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 approximately 1 second, the Unload sequence will be initiated, and the indicator will be lit. A new momentary push will cancel the Unload command, but the drive remains in the Rewind mode.

Rewind or Unload commands may be initiated 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 operator to assign each individual unit as number 1, 2, 3, 4 or none (disconnected).

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 unintentionally 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.
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 cartridge 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.
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 performed 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 observed behind the label (illuminated by the tape marker lamp).

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 inconsistent with the protection.

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 corresponding 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 theUnload command was unintentional (only wanted Rewind), the Unload can be terminated by a second momentary push on the button.

3.3. Malfunction

a. PRIMARY POWER FAILURE

If the primary input power fails, the cartridge will be retained in the mechanism. 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 automatically resets itself to the unlocked position.

b. DRIVE : If a drive fails in such a way that it is potentially dangerous to the written information 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 cylindrical, stainless 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 positive 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 spring loaded 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 available, 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 regulator 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

HEAD/WRITE

4-32

HEAD ASSEMBLY

TRACK WRITE INHIBIT

UNIT SELECT

CONTROLS & INDICATORS

SENSORS

LOCKING MECHANISM

REGENERATOR

DC POWER INPUT

DC POWER

POWER SUPPLY

FORMATTER

I/O CONTROL

TO SECOND DRIVE

DC/DC CONVERSER

TDC3000

MAIN BLOCK DIAGRAM
BLOCK DIAGRAM, MOTION CONTROL PCB
SERVO PCB

- 4.8 -

BLOCK DIAGRAM SERVO 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

![Diagram showing line characteristics and termination](image)

Cartridge drive or Formatter

Twisted pairs or transmission line with impedance ~100Ω

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 Formatter or to an external controller. The bus consists of 11 command 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 similar 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, permitting up to 4 drives on one Formatter, coded:

<table>
<thead>
<tr>
<th>SLAC</th>
<th>SLBC</th>
<th>DRIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

TRAC (level) \(\{\) Track select lines A and B, permitting one of 4 tracks to be used for writing or reading, coded:

<table>
<thead>
<tr>
<th>TRAC</th>
<th>TRBC</th>
<th>TRACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

REVC (level) : Reverse, complement of Forward command
FSTC (level) : Fast, complement of Slow command
RUNC (level) : Run, complement of Stop command
REWC (level or pulse) : Rewind command, sets Rewind mode and 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:
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, an 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 • REV$ • 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 negative true polarity magnetizing the tape in the polarity of the gap.

DATA OUTPUT LINES:

RD (level): Decoded read data (NRZ, logic 1 is negative 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.
LOAD AND REWIND TO LP SEQUENCE.

UNLOAD SEQUENCE.

<table>
<thead>
<tr>
<th>General tolerances</th>
<th>General tolerance</th>
<th>Overladebelægning</th>
<th>Surface treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Material</th>
<th>Overladebeskrivelse</th>
<th>Surface finish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1) Roll set not this time.

Note 2) Motion stopped and carriage unloaded.

Tandhegge Radiomobillikk N.K. 1949-4550, Rolle, Kjære, Fall, 2.
NOTE 1: \( \text{BIT TIME} = \frac{625}{V} \) [μs] \( \text{WHERE } V = \text{Tape Speed} \) [ips]
\[ \text{= 20.8 } \mu\text{S at 30 IPS} \]

NOTE 2: \text{THE BUILT-IN FORMATTER DOES NOT USE TIMING, BUT THE TRAVELLED DISTANCE OF 20.65" BEFORE INITIATING THE PREAMBLE.}

\text{WRITE TIMING}
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 150US (NOMINAL) AFTER THE END OF THE BLOCK.

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

READ TIMING,
SEARCH SPEED
5.4. WIRING CHART, DEVICE BUS AND DRIVE POWER CONNECTORS

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

**DEVICE BUS CONNECTOR**

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

**CONNECTOR:**
PC edge, 2.54 mm (0.100") pitch

2 x 25 PIN, i.e. CANNON G03D050A2BABL (solder terminals), or equivalent.

**DRIVE POWER CONNECTOR:**

**CONNECTOR:**
PC edge, 3.96 mm (0.156") pitch

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

Key:

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
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 formatter, when reading, will recognize a tape mark (TM) if present, and indicate this. No data will be presented on the data output 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 within 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 bpi, 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 Parallel 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.
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.
**NOTES:**

1) TAIRK START LINE SET TRUE AND FENY SET FASE AT THIS TIME (NOT SIMULTANEOUSLY.)

2) DOTTED LINE INDICATES TRUE MOTION WHEN TM IS NOT RECOGNIZED AT ENDUERING SPEED. (CONTINUE SEARCH AT END SPEED.)

3) POSITION OF NEND-GAP AT END OF SEARCH ROUTINE (SAME STATED.) OR STOP FOR DINNER MRS.
NOTES

1) THINK STATUS LINE SET TRUE AND FASY SET FALSE AT THIS TIME. (NOT SIMULTANEOUSLY) OR STOP GIVEN IF ERROR.
2) THINK STATUS LINE SET FALSE AND FASY SET TRUE AT THIS TIME.
3) IF NO TM IS RECOGNIZED AT THIS MACH SPEED, THINK STATUS LFP IS NOT SET TRUE AND FASY IS NOT SET FALSE AT (1).
NOTES:

1) TANK STATUS LINE SET TRUE AND FSBY SET FALSE AT *ALARM TIMING* (NOT SIMULTANEOUSLY) OR STOP GIVEN IF ERROR.

2) TANK STATUS LINE SET FALSE AND FSBY SET TRUE AT THIS TIME.

3) IF NO TANK IS RECOGNIZED AT COMPARISON SPEED,
   TANK STATUS LINE IS NOT SET TRUE AND FSBY 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, however, contains all circuits that may differ from one system application 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 constructed 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 contains 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 synchronous bit serial data output and input are needed.

This I/O controller is similar to the Parallel 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 Parallel Interface Controller, except one separate Data in line (DIN) and one Data out line (DOT) are provided, and the Last Byte In line is changed to a Last Bit In line.

B) PARALLEL INTERFACE CONTROLLER.

This I/O controller has data byte packing, and unpacking circuits. The data in/out format of this controller is 8 bits parallel. 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 respectively, are provided. Both the Serial and Parallel Con-
controller are designed to operate into 100Ω unbalanced transmission lines. All interface lines are TTL compatible low-true with logic levels of:

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

As for the Serial Interface Controller, the Parallel 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 Parallel Interface Controller interface lines is listed on the following pages.

A simplified block diagram of the Parallel Controller is found in the formatter description, paragraph 5.5.
PARALLEL I/O CONTROLLER SIGNAL DESCRIPTION

Logic is Negative True

<table>
<thead>
<tr>
<th>NAME</th>
<th>MNEMONIC</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT LINES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input bit 0</td>
<td>INBIT0</td>
<td>Input lines for address/command and data lines.</td>
</tr>
<tr>
<td>Input bit 7</td>
<td>INBIT7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the ASTR line is pulsed, the data on the INBIT 0-3 lines are taken as address bits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the CSTR line is pulsed, the data on the INBIT 4-7 lines are taken as command bits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the WSTR line is pulsed, the data on the INBIT 0-7 lines are taken as data input lines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INBIT LINES, ADDRESS FUNCTION:</th>
<th>TRACK ADDRESS LINES:</th>
<th>UNIT ADDRESS LINES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input bit 0</td>
<td>INBIT0</td>
<td>TRACK NO.</td>
</tr>
<tr>
<td>Input bit 1</td>
<td>INBIT1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Input bit 2</td>
<td>INBIT2</td>
<td>UNIT NO.</td>
</tr>
<tr>
<td>Input bit 3</td>
<td>INBIT3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>NAME</td>
<td>MNEMONIC</td>
<td>FUNCTION</td>
</tr>
<tr>
<td>---------------</td>
<td>----------</td>
<td>---------------------------------</td>
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<tr>
<td>INBIT LINES,</td>
<td></td>
<td>COMMAND FUNCTION:</td>
</tr>
<tr>
<td>Input bit 4</td>
<td>INBIT4</td>
<td>COMMAND LINES (Coded):</td>
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<tr>
<td>Input bit 5</td>
<td>INBIT5</td>
<td></td>
</tr>
<tr>
<td>Input bit 6</td>
<td>INBIT6</td>
<td></td>
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<tr>
<td>Input bit 7</td>
<td>INBIT7</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>ADDRESS STROBE</td>
<td>ASTR</td>
<td>Used to strobe the address on the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>INBIT 0-3 lines into the Address</td>
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<tr>
<td></td>
<td></td>
<td>Register. The leading edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>enables the address lines and the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>trailing edge strobes the address</td>
</tr>
<tr>
<td></td>
<td></td>
<td>into the Address Register.</td>
</tr>
<tr>
<td>COMMAND STROBE</td>
<td>CSTR</td>
<td>Used to strobe the command on the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>INBIT 4-7 lines into the Command</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Register. The trailing edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strobes the command into the Command</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Register and initiates operation.</td>
</tr>
<tr>
<td>INBIT LINES,</td>
<td></td>
<td>DATA FUNCTION:</td>
</tr>
<tr>
<td>Input bit 0</td>
<td>INBIT0</td>
<td>Data input lines (One byte parallel)</td>
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<td>Input bit 1</td>
<td>INBIT1</td>
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<td>Input bit 2</td>
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<td>Input bit 3</td>
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<td>Input bit 4</td>
<td>INBIT4</td>
<td></td>
</tr>
<tr>
<td>Input bit 5</td>
<td>INBIT5</td>
<td></td>
</tr>
<tr>
<td>Input bit 6</td>
<td>INBIT6</td>
<td></td>
</tr>
<tr>
<td>Input bit 7</td>
<td>INBIT7</td>
<td></td>
</tr>
<tr>
<td>WRITE DATA</td>
<td>WSTR</td>
<td>Answer pulse to a WSREQ (Write</td>
</tr>
<tr>
<td>STROBE</td>
<td></td>
<td>Service Request) Indicates that</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the data on the INBIT-lines are</td>
</tr>
<tr>
<td></td>
<td></td>
<td>valid input data. Must be kept</td>
</tr>
<tr>
<td></td>
<td></td>
<td>true until the trailing edge of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the WSREQ-signal. The data on the</td>
</tr>
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<td></td>
<td></td>
<td>INBIT0-7 lines must be valid</td>
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<tr>
<td></td>
<td></td>
<td>input data no later than the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>leading edge of WSTR and stay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>valid as long as WSTR is true.</td>
</tr>
<tr>
<td>NAME</td>
<td>MNEMONIC</td>
<td>FUNCTION</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Last byte in</td>
<td>LBIN</td>
<td>This line is sampled at the trailing edge of the WSTR-signal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Indicates that this is the last byte in this block (when writing).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Indicates the termination of the erase variable length command (when erasing).</td>
</tr>
<tr>
<td>Read data strobe</td>
<td>RSTR</td>
<td>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.</td>
</tr>
<tr>
<td>Master reset</td>
<td>MRST</td>
<td>Resets the formatter and I/O controller to the initial state.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The CSTR signal must be false when a MRST signal is given.</td>
</tr>
<tr>
<td>Read test</td>
<td>RTEST</td>
<td>Sets the formatter in the read test mode:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Write test</td>
<td>WTEST</td>
<td>Sets the formatter in the write test mode:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

**OUTPUT LINES**

<p>| Data out 0            | DOT 0    | Data output lines (One byte parallell)                                  |
| Data out 1            | DOT 1    | DOT0 = LSB                                                               |
| Data out 2            | DOT 2    | DOT7 = MSB                                                               |
| Data out 3            | DOT 3    |                                                                          |
| 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. |</p>
<table>
<thead>
<tr>
<th>NAME</th>
<th>MNEMONIC</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data error</td>
<td>DATAERR</td>
<td>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.</td>
</tr>
<tr>
<td>Timing error</td>
<td>TIMEERR</td>
<td>Indicates that an input or output data transfer timing error has occurred. Reset by MRST or new command.</td>
</tr>
<tr>
<td>Ready status</td>
<td>RDYS</td>
<td>Same as RDYS of addressed drive</td>
</tr>
<tr>
<td>Online status</td>
<td>ONLS</td>
<td>&quot; &quot; ONLS &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Write permit status</td>
<td>WPS</td>
<td>&quot; &quot; WPS &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Runs status</td>
<td>RUNS</td>
<td>&quot; &quot; RUNS &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Reverse status</td>
<td>REVS</td>
<td>&quot; &quot; REVS &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Fast status</td>
<td>FAST</td>
<td>Indicates that tape speed exceeds approximately 1,15 m/s (45 ips).</td>
</tr>
<tr>
<td>Tape mark</td>
<td>TMRK</td>
<td>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.</td>
</tr>
<tr>
<td>Early Warning status</td>
<td>EWS</td>
<td>Set true when the Early Warning tape mark is sensed going forward, set false when the EW is sensed going in reverse.</td>
</tr>
<tr>
<td>End of tape status</td>
<td>EOT</td>
<td>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.</td>
</tr>
<tr>
<td>Drive unsafe status</td>
<td>DRUS</td>
<td>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.</td>
</tr>
</tbody>
</table>
RESET AND COMMAND TIMING

MST

INHIT1

INHIT 2

O STR

FBSY

NOTES:
1. MEASURED AT % CONTROL CONNECTOR.
2. SIGNS MAY CHANGE. SIGNS MUST BE VALID.
3. COMMAND INITIATED AT TRAVELING EDGE OF CS72
4. FBSY SET TRUE IF COMMAND IS ACCEPTED, FBSY IS NOT SET TRUE FOR THE "REWIND TO CP" AND "UNLOAD" COMMANDS.
5. CS72 MUST BE FALSE WHEN MST IS TRUE.
6. THE CS72 AND ADDRESS STROBE (HST) MAY BE GIVEN SIMULTANEOUSLY.

17-1-77 SL
ADDRESS TIMING

\[ I \]

\[ I' \]

\[ ASTR \]

\[ ASTR \]

Notes:

1. MEASURED AT **TO CONTROLLER CONNECTOR**

2. **SIGNALS MAY CHANGE**

3. **IF THE INBITO - INBIT3 SIGNALS ARE NOT**
   **SAME AT THE LEADING EDGE OF ASTC THE ADDRESSED**
   **DEVICE AND TRACK WILL CHANGE AS INBITO - INBIT3**
   **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 ASTC OR FROM THE TIME INBITO - INBIT3**
   **HAVE STABILIZED, WHATEVER OCCURS LAST.**

5. **THE TRAILING EDGE OF ASTC STROBS THE**
   **ADDRESS ON INBITO - INBIT3 INTO THE ADDRESS**
   **REGISTER.**

---

**Diagram**

- **INBITO - INBIT3**
- **ASTR**
- Timing intervals indicated:
  - Greater than 100 ns
  - Less than 300 ns

**Notes**

1. Measured at the controller connector.

2. Signals may change.

3. If the INBITO - INBIT3 signals are not the same at the leading edge of ASTC, the addressed device and track will change as INBITO - INBIT3 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 ASTC or from the time INBITO - INBIT3 have stabilized, whichever occurs last.

5. The trailing edge of ASTC strobes the address on INBITO - INBIT3 into the address register.

---
DATA INPUT TIMING

WSREQ

WSTR

NOTES:

1. MEASURED AT 50 CONTROLLER CONNECTOR

2. Signals may change, signals must be valid.

3. $t_a = \frac{5000}{v} \mu s$, $t_b = \frac{3125}{v} \mu s$, $t_c = \frac{234}{v} \mu s$; $v$ is instantaneous data speed (inches/mercury) (inches/minute)

4. TIMING ERRORS OCCUR HERE.

5. TIMEERR IS SET HIGHS BY NOST OR CSTE.

6. THE WSREQ - WSTR SIGNAL SEQUENCE MUST ALSO BE MAINTAINED DURING THE SAME VARIABLE LENGTH COMMAND (YOU BE USED FOR THIS DATA INTERFACE).
DOA OUTPUT TIMING.

NOTES:
1. MEASURED AT TL CONTROLLER CONNECTOR.
2. Signals may change.
3. \( t_a = \frac{5000}{u} \) \( \mu s \) \( u \) = instantaneous tape speed (inches/\text{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.
OUT ONE BLOCK FWD. OR REV. (16 bytes)

1. METERED AT TO CONTROLLER CONNECTOR.

2. SIGNALS MAY CHANGE SIGNALS MUST BE VALID.

3. TIMEERR SET WHEN TIMING ERROR OCCURS.

4. DATHERR SET HERE IF CRC OR PATTERN ERROR.

5. BOTH ERR SIGNALS SET FALSE BY CSTO OR MEST.

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.
CLOSE ONE BLOCK FIND OR MARK (TAPE MARK).

NOTES:
1. MEASURED AT 70 CONTROLLER CONNECTOR.
2. Signals may change. Signals must be valid.
3. DATASER SET HERE IF CRL OR POSTAMBLE PATTERN EXISTS, SET FALSE BY CSKR OR MNT.
4. IF RTEST IS TRUE WHEN READING A TAPE MARK, TMRK IS NOT SET TRUE. TWO DATA BYTES AFTER PRESENTED AT DOT 10-7 (SEE READ ONE BLOCK FIND OR MARK) CONTAINING ALL ZEROS, TIMERK AND DATASER INDICATE ERRORS IF DETECTED.
5. SIGNAL IS NOT NEGATIVE TRUE, FIGURE NOT TO SCALE.
Dead Cont. FWD. or REV.

**Table Contents**

<table>
<thead>
<tr>
<th>Tape</th>
<th>BLOCK (n+1)</th>
<th>BLOCK (n+1)</th>
<th>BLOCK (n)</th>
<th>BLOCK (n)</th>
</tr>
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<tbody>
<tr>
<td>CSTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FBSY</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BKEE</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ESTR</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DATA</td>
<td></td>
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<td>FROM</td>
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<tr>
<td>DATA</td>
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<tr>
<td>TIMBER</td>
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<tr>
<td>UNTHRLK</td>
<td></td>
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</tr>
<tr>
<td>TMLK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

1. [[ inactive ]]

2. Full details see separate timing diagram.

3. If error occurs, tape stops at first inter-block gap (10μs).

4. If the reading shall be stopped after block (n) this can be done by giving a KEND ONE BLOCK FWD. or REV. command after block (n-1) or a halt command within 300μs after the trailing edge of FBSY at the end of block (n). This procedure will position the head-gaps properly in the 18G.

5. Signals are negative true, figure not to scale.
Search to first time mark FMA or REV.

CSTR

FASY

ESREQ

RSTR

DOT0-7

TIMERK

DATHERR

DATHACK

Notes:
1. Signals may change.

2. If CEC or Postamble Pattern Error Occurs, this will be indicated by DATHERR, and tape will stop in the 1CG following the block where the error occurred.

3. Signals are negative true. Figure not to scale.
Notes

1. Signals may change

2. If CLC or postamble pattern error occurs, this will be indicated by DSTR, and Tape will stop in the 18G following the block where the error occurred.

3. If the search shall be stopped after TM(n), this can be done by giving a SEARCH to first TM(1) FWD, or REV, command after TM(n-1) or a HALT command within 300 ms after the trailing edge of FASY at the end of TM(n). This procedure will position the head-guns properly in the 18G. The TM's can be counted by counting FASY or TAIRK transitions.

4. Signals are negative true. Figure not to scale.
WRITE ONE BLOCK OR ERASE VARIABLE LENGTH.

6. WHEN ERASING:
FASY IS SET FALSE AS INDICATED. NO RSEQ OR DTO-7 SIGNALS ARE GENERATED AND THE DATA ON INBITO-7 ARE IGNORED.
THE WSEQ - WSTR SEQUENCE MUST BE MAINTAINED OR ELSE TIMING OCCURS.
THE WSEQ - WSTR SEQUENCE CAN BE USED TO MEASURE ERASING TIME LENGTH.

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

NOTES:
1. SIGNALS MAY CHANGE
   Signals must be valid.

2. FOR DETAILS SEE SEPARATE TIMING DIAGRAMS.

3. TIMESCK SET WHEN TIMING ERROR OCCURS.

4. DATHERRK SET HERE IF CRC OR POSTMABLE PATTERN ERROR DURING READ AFTER WRITE.

5. IF WTEST IS TRUE THE LAST TWO BYTES PRESENTED ON INBITO-7 HAVE BEEN WRITTEN AS THE CRC CHARACTER, NO OTHER CRC IS WRITTEN.
1. Signals may change
2. If no tape mark is detected during read after write, DATERR is set true here.
3. WTEST may be true or false. T1 will always be written.
4. When exiting, no talk signal is generated.
Nomenclature

<table>
<thead>
<tr>
<th>Pin</th>
<th>Nomenclature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FAST</td>
</tr>
<tr>
<td>2</td>
<td>WSREQ</td>
</tr>
<tr>
<td>3</td>
<td>EOT</td>
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<td>4</td>
<td>DOT 3</td>
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<td>5</td>
<td>DOT 2</td>
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<td>DOT 1</td>
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<td>7</td>
<td>DOT 0</td>
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<td>DOT 5</td>
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<td>11</td>
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<td>REVS</td>
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<td>13</td>
<td>WPS</td>
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<td>14</td>
<td>RUNS</td>
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<tr>
<td>15</td>
<td>DATAERR</td>
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<td>16</td>
<td>TMRI</td>
</tr>
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<td>17</td>
<td>EWS</td>
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<td>18</td>
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<tr>
<td>19</td>
<td>TIMEERR</td>
</tr>
<tr>
<td>20</td>
<td>RSREQ</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Pin</th>
<th>Nomenclature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>XXXX (Blank)</td>
</tr>
<tr>
<td>2</td>
<td>DRUS</td>
</tr>
<tr>
<td>3</td>
<td>FBSY</td>
</tr>
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<td>RDYS</td>
</tr>
<tr>
<td>5</td>
<td>RTEST</td>
</tr>
<tr>
<td>6</td>
<td>WTEST</td>
</tr>
<tr>
<td>7</td>
<td>CSTR</td>
</tr>
<tr>
<td>8</td>
<td>ASTR</td>
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<tr>
<td>9</td>
<td>RSTR</td>
</tr>
<tr>
<td>10</td>
<td>INBIT 3</td>
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<td>11</td>
<td>INBIT 2</td>
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<td>INBIT 0</td>
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<td>17</td>
<td>INBIT 7</td>
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<tr>
<td>18</td>
<td>MRST</td>
</tr>
<tr>
<td>19</td>
<td>WSTR</td>
</tr>
<tr>
<td>20</td>
<td>LBIN</td>
</tr>
</tbody>
</table>

NOTES:

1. All signals are LOW true.

2. Connector shown as seen from PCB side.

3. Connector type:
   3M Co. No. 3464 (or standard type 2 x 20 pin: 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 use cable type:
   3M Co. No. 3476/40.
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 asynchronously 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 synchronous 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.