DIGITAL EQUIPMENT CORPORATION
MAYNARD, MASSACHUSETTS

ENGINEERING SPECIFICATION

DATE

TITLE   TU16 Tape Transport Specification

REVISIONS

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DEC   16-(392)-1079-N971
DRA 107

1.0   General Description

The TU16 is an industry-compatible tape transport capable of reading and writing on ½" magnetic tape at 1600 BPI (PHASE-ENCODED) and 800 BPI (NRZ) in 9-track versions and 800, 556, 200 BPI (NRZ) in 7-track versions. The transport consists of a tape deck with associated reel and capstan motors, H606 motor driver module, transformer and capacitor assembly, a logic box which integrates the read/write electronics, the control electronics and the power supply regulator, and a vacuum system assembly. An off-line TEST FUNCTION generator is included in the control package which allows most maintenance procedures to be completed off-line. Detailed interface information such as cable pinning, timing diagrams, and driver and receiver specification is presented in the TU16 Maintenance Manual.

1.1   Hardware description

1.1.1   Tape motion is by a single servo-controlled capstan. Buffering is done in vacuum columns for all tape motion.

1.1.2   DEC H757 power supply generates all voltages required in the transport.

1.1.3   The magnetic head assembly consists of a 7- or 9-channel, dual-gap, read during write head, and a D.C. erase head.

1.1.4   Manual operation is done by means of the Control/Indicator panel as described in Section 2.

1.1.5   Electro mechanical detection of standard write protect ring insures protection of permanent files.

1.2   TU16 Model Designation

Control Unit	115V, 50/60 Hz	230V, 50/60 Hz
9-track Transport	TU16-AA	TU16-AB
7-track Transport	TU16-BA	TU16-BB

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2.0   Controls

    2.1   Off-line Controls

        2.1.1   PWR ON/PWR OFF - In PWR ON position, line voltage is applied to the power transformer. The switch is ineffective when the unit is on-line.

        2.1.2   LOAD/BR REL - This switch is ineffective when unit is on-line.

            2.1.2.1   Center position - vacuum motor is off, brakes are full-on.

            2.1.2.2   LOAD position - enables vacuum motor; initiates tape being drawn into the buffer columns.

            2.1.2.3   BR REL position - vacuum motor is disables; brakes are off.

        2.1.3   ON LINE/OFF LINE - Enables remote (controller) or local (control panel) operation.

        2.1.4   FWD/REW/REV - Selects but does not initiate tape motion when transport is off-line.

        2.1.5   START/STOP -

            2.1.5.1   START position - Initiates tape motion selected by FWD/REW/REV when transport is off-line.

            2.1.5.2   STOP position - Causes any tape motion to cease when off-line.

        2.1.6   UNIT SLECT PLUG - Selects the transport's on-line address. The presence of this plug is necessary for on-line operation.

    2.2   Indicators

        2.2.1   PWR - Indicates line voltage has been applied to the power transformer.

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2.2.2   LOAD - Indicates that vacuum in on, and the tape is loaded into the buffer columns.

2.2.3   RDY - Indicates that the tape transport is ready to accept a command.

2.2.4   LD PT - Indicates that the tape is at load point.

2.2.5   END PT - Indicates that the tape is at or beyond end point.

2.2.6   FILE PROT - Indicates that write operations are inhibited because the write enable ring is not mounted on the file reel.

2.2.7   OFF-LINE - Indicates local operation by the control box is enabled.

2.2.8   SEL - Indicates that the transport is loaded on-line and that the select lines match the UNIT SELECT PLUG.

2.2.9   WRT - Indicates that the program has initiated a Write command.

2.2.10   FWD - Indicates that a Forward command has been issued.

2.2.11   REV - Indicates that a Reverse command has been issued.

2.2.12   REW - Indicates that a Rewind command has been issued.

2.3   On-line commands accepted by the transport.

2.3.1   Write
2.3.2   Read Forward
2.3.3   Read Reverse
2.3.4   Write Filemark
2.3.5   Space Forward
2.3.6   Space Reverse
2.3.7   Erase 3"
2.3.8   Rewind to beginning of tape
2.3.9

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3.0   Environment

    3.1   Temperature

        3.1.1   Operating 60°F - 95°F

        3.1.2   Non-operating 30°F - 150°F

    3.2   Humidity

        3.2.1   Operating 20% - 80% with no condensation

        3.2.2   Non-operating 5% - 95%

4.0   Shock

                        We will investigate TU16 conformance with DEC Standard 102.

5.0   Vibration

6.0   Electrical Requirements

    6.1   115/230 VAC ± 10%

    6.2   50/60 Hz

    6.3   1000 W. Max.

    6.4   Nominal current -

    6.5   Start current -

7.0   Mechanical

    7.1   Transport less cabinet, less vacuum system

        7.1.1   Depth, 25"

        7.1.2   Width, 19"

        7.1.3   Height, 26"

        7.1.4   Weight, 150 lbs.

    7.2   With H950 cabinet

        7.2.1   Depth, 30"

7.2.2   Width, 21"

7.2.3   Height, 72"

7.2.4   Weight, 450 lbs.

7.3   Vacuum System - Mounts below the transport assembly in a 19" cabinet and requires 8 inches of vertical cabinet space.

7.4   Installation requirements - Power and signal cable connectors shall be through the base of the machine. Three feet of access space at the front and rear of the machine is sufficient to permit surface to any parts of the machine without difficulty. (Also standing room next to the extended unit. The maximum floor space required with all doors extended shall be 22¼" by 85 1/8".

8.0   Performance Specification

8.1   Tape Characteristics - The TU16 shall run reliably using any 1.5 mil base 800 f.c.i. ANSI-compatible tape that meets the requirements of DEC Specification #A-SP-1809 543.

8.2   Tape reels - The TU16 reel hubs accept ANSI compatible reels up to 10.5 inches in diameter..

8.3   Tape Speed - TU16 operates at a tape spped of $45\pm.9$" per second. It shall have a maximum rewind time of 3.5 minutes for a 2400-foot reel.

8.3.1   Long-term speed variation - 2% (averaged over 1-second interval)

8.3.2   Short-term speed variation - 2% (averaged over 20-millisecond interval)

8.4   Tape Motion Characteristics

8.4.1   Start Time - measured from initiation of command until tape velocity has reached operating value of 9 milliseconds maximum.

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8.4.2   Stop Time - 8 milliseconds maximum.

8.4.3   Inter-record gaps - 7-track 0.75", Nom .95"
                             9-track 0.5", Nom .65"

8.5   Interlocks - TU16 includes interlocks which dis-
engage the tape drive mechanism and reel motors
when vacuum has been lost in the vacuum columns.

8.6   Tape Packing - The tape handling system provides
consistent packing of the tape on the supply and
take-up reels during any operational mode of the
transport.

8.7   Error Rates

8.7.1   Read-recoverable read error rate shall not
exceed one error in 10^8 bits.

8.7.2   Write - The tape transport shall write in-
formation with a recoverable read-after-
write error rate not to exceed 4 errors in
10^8 bits. This test must be run with a
certified tape for a minimum of 3 passes.

8.7.3   Non-recoverable errors - Read or write errors
which exist after four retires, excluding
errors due to damaged oxide or included
foreign particles, shall be defined as
equipment failures.

8.8   Skew

8.8.1   Static Skew - Adjusted static skew shall be
less than .45 μsec when measured with IBM
SKEW TAPE.

8.8.2   Dynamic Skew - Dynamic skew shall be less than
4 μsec.

9.0   Interface

9.1   Transport Bus - Maximum TU16 bus configuration is
8 transports per controller and a maximum cable
length of 75 feet. Cables are as follows:

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FROM	TO	PART NO.	QTY.
TU16	TU16, TM02	(internal cabinet)	3
		(free-standing cabinet)	1

$$XX = \begin{array}{l} 10 \text{ (10-foot cable)} \\ 15 \text{ (15-foot cable)} \\ 25 \text{ (25-foot cable)} \end{array}$$

9.1.1   Transport Bus Signals - All signals are either gnd (0.v to 0 or +3
The transport bus signals are listed and described briefly below.

9.1.1.1   Nine (9) WD (SB) L lines - Write data lines from the controller to the TU16.

9.1.1.2   REC (SB) L - Record pulse to the transport which initiates
write skew delay sequence in transport.

9.1.1.3

SS (SB) 0 L   Decoded output of these 3
SS (SB) 1 L   levels allows the selection of
SS (SB) 2 L   1 transport out of a maximum
of 8 that may be connected to
the controller.

9.1.1.4   DEN (SB) 0 H   Density selection
DEN (SB) 1 H   lines decode as
DEN (SB) 2 H   follows:

	DEN (SB) 2 H	DEN (SB) 1 H	DEN (SB) 0 H
200 BPI	0	0	0
556 BPI	0	0	1
800 BPI	0	1	X
1600 BPI	1	X	X

9.1.1.5   EMD (SB) L - Asserted by controller to enable the coded motion delay on the read lines.

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9.1.1.6   ACCL (SB) L - Asserted by the controller from the end of the deceleration delay of an operation to the end of the acceleration delay of the following operation. Not asserted while the I.D. burst is being written.

9.1.1.7   LRC STRB (SB) L - Asserted by the TM02 prior to the REC (SB) L pulse that writes the LRC character.

9.1.1.8   STOP (SB) L - Asserted at the end of an operation to stop tape motion except when transport is OFF-LINE or REWINDING.

9.1.1.9   WRT CLK (SB) L - A pulse train generated in the transport which controls the write timing frequence/ of WRT CLK (SB) L is a function of/ the density select lines. WRT CLK is inhibited during gap.

9.1.1.10   CLOCK (SB) - A pulse train generated in transport present at all times when the unit is on-line. The frequency of CLOCK H is twice the 1600 BPI data rate.

9.1.1.11   TUR (SB) L - Asserted by a selected transport to indicate tape motion has stopped and the unit is ready to accept a command.

9.1.1.12   SDWN (SB) L - Asserted from time motion command, and is negated until the transport has stopped. New commands requiring change of direction may not be issued during SDWN (SB) L.

9.1.1.13   7 CH (SB) L - Asserted if a 7-track rather than a 9-track head is installed on the transport. Also asserted by 9-track drives in PE mode to represent tape speed.

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9.1.1.14 SLAVE SET PULSE (SB) L - Asserted
by TM02 to initiate the operation
specified by command lines. Minimum
width is 500 nsec.

9.1.1.15 BOT (SB) L - Asserted when the tape
is positioned at LOAD point.

9.1.1.16 EOT (SB) L - Asserted when the end-
point flip flop is set.

9.1.1.17 WRL (SB) L - Asserted when the tape
unit detects that the write enable
ring has been removed by the tape
reel.

9.1.1.18 RWS (SB) L - Asserted by the trans-
port when a rewind operation is in
process.

9.1.1.19 RSD0 (SB) L - A read strobe pulse
generated by the transport at the
end of the skew delay in NRZ mode.

9.1.1.20 Nine (9) RD (SB) L - Read data lines
from TU16 to the controller.

9.1.1.21 FWD (SB) L   Four (4) command
          REV (SB) L   lines asserted by
          RWD (SB) L   TM02 and strobed into
          WRE (SB) L   the slave by SLAVE
                          SET PULSE.

9.1.1.22 SPR (SB) L - SLAVE PRESENT is asserted
by a TU16 in response to a match
between its address and the slave
select lines - SPR does not depend
on the slave power supply.

9.1.1.23 MOL (SB) L - Medium on-line is
asserted by the TU16 when selected
on-line and tape loaded in the
vacuum columns. Unless MOL is
asserted, a slave can assert only
SPR and respond only to INIT.

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9.1.1.24   IRO(SB) L - Asserted by controller in conjunction with a read command to set skew delays and thresholds to the values used during writing.

9.1.1.25   PES (SB) L - Asserted by a 9-track TU16 in response to the assertion of DEN 2. Never asserted by a 7-track TU16.

9.1.1.26   SET UPE (SB) L - Asserted by TU16 during an NRZ write operation or an interchange read if data from a track occurs in approximately 30% of each data or immediately following the skew delay.

9.1.1.27   0-15 (SB) L - The four least significant bits of DEC serial number of the TU16 are transmitted to the controller on 16 (BCD) lines.

9.1.1.28   DT 0 (SB) L   In the TU16 these
                  DT 1 (SB) L   3 bits are always
                  DT 2 (SB) 1   asserted as follows:

                       DT 2
                       DT 1
                       DT 0

9.1.1.29   SLA (SB) - Slave attention is asserted by an on-line TU16 at the completion of a REWIND or when the slave comes on-line.

9.1.1.30   SET SSC (SB) - Set slave status change is asserted when SLA is asserted. Bit is also pulsed as the transport goes Off-line, or the power fails.

9.1.1.31   DRV CLR PLS (SB) 1 - When asserted by the controller, DRV CLR PLS clears SLA in the selected slave.

9.1.1.32   INIT PLS (L) - When asserted by the controller, INIT PLS L clears SLA

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and terminates tape motion except rewinds in all on-line transports.

The controller also supplies through the cable +5 to power the terminator networks located in the last until on the bus and the unit select circuit in each drive.

10.0   Referenced Documents

10.1   ANSI Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), Doc. No. X3.22-1967.

10.2   DEC Purchase Spec ½" by 2400 feet, Doc. No. A-PS-1809543.

10.3   Proposed ANSI "Unrecorded Magnetic Tape for Information Interchange (9-track, 200 and 800 CPI, NRZI and 1600 CPI P.E.), Doc. No. ANSI X3.2.1/402.

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