Benchmark Storage Innovations, Inc.

DLT VSTape 160

Design Verification Test (DVT) Report

Initial Release 1.4

Percept Technology Labs
PRODUCT TEST AND COMPLIANCE EXPERTS

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Revision History:

09/27/02	Revision 0.1	Initial Draft release Vic Hudson, Mike Doty, Philip Smith, Glen Davis, Piotr Polanowski
09/28/02	Update Rev 0.2	Vic Hudson updated various sections
10/11/2002	Update Prelim 1.1	Vic Hudson updated section 8.4
10/15/2002	Update to Initial Release 1.0	Vic Hudson updated various sections
10/16/2002	Power Update Release 1.3	Vic Hudson updated power testing
10/29/2002	Regression update Release 1.4	Vic Hudson – added all the regression testing results.

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1 Introduction

1.1 Overview

The DLT VSTape 160 Design Verification Test (DVT) defines and executes a set of repeatable tests and procedures to verify the Benchmark DLT VSTape 160 product complies with the Benchmark DLT VSTape 160 Product Specification and the Benchmark DLT VSTape 160 Small Computer System Interface specification.

The DVT tests and procedures defined in this document are developed, performed and maintained by Percept Technology, Inc., an independent Product Test and Development firm located at 4735 Walnut St., #E, Boulder, Colorado 80301.

Additional agency and external stimulus testing is performed at the labs of recognized testing organizations under the direct supervision of Percept Technology, Inc.

1.2 Assumptions

The Benchmark DLT VSTape 160 drives supplied by Benchmark Storage Innovations, Inc. are representative of their volume manufacturing process.

The Benchmark DLT VSTape 160 Specification is subject to change, and thus changes made by Benchmark Storage Innovations could require changes to this plan. Percept Technology reserves the right to update the DVT testing based on changes made by Benchmark Storage Innovations to their product.

1.3 Company Restricted Information

1.4 Reference Documents

ANSI Small Computer System Interface-3 (ANSI X3.131-1997)

ANSI Small Computer System Interface-2 (ANSI X3.131-1994)

ANSI Small Computer System Interface-1 (ANSI X3.131-1985)

Benchmark Storage Innovations, Inc. DLT VSTape 160 Product Specification

Benchmark Storage Innovations, Inc. DLT VSTape 160 SCSI Specification

2 Executive Summary, DVT Exit Criteria, and Test Coverage

2.1 Executive Summary

Design verification testing of the DLT VSTape 160 product began on June 28, 2002 and completed on October 4, 2002. Seventy two drives were tested across functional, performance, reliability, environmental, and agency compliance categories. Specific definitions of the hardware levels are included in section 2.2

The Benchmark DLT VSTape 160 product has met all electromagnetic compatibility, shock and vibration, and environmental specifications set forth in the product specification.

The product has been approved by Underwriters Laboratories. The product is designed for use worldwide and currently has attained certification from specific governing agencies to allow its use in the U.S., Europe, Japan, and Canada.

The product hardware and firmware levels were selectively changed to manage particular failure modes. Product changes were evaluated and pertinent regression testing was completed for all failure modes.

The Benchmark DLT VSTape 160 has completed DVT testing and has the met exit criteria as defined in each test see Table 1: DVT Testing Coverage, Exit Criteria, and Status below.

Table 1: DVT Testing Coverage, Exit Criteria, and Status

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
3.1	Radiated and Conducted Emissions	Agency	CISPR 22:1997 /EN55022:1998 . DVT goal is 6 dB margin.	Passed	None Required	Passed
4.1	Electrostatic Discharge Immunity	Agency	EN61000-4-2:1995 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
4.2	Radiated Radio-Frequency Field Immunity	Agency	EN61000-4-3:1995 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
4.3	Electrical Fast Transient Immunity	Agency	EN6100-4-4: 1995 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
4.4	Surge Immunity	Agency	EN61000-4-5:1995 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
4.5	Conducted Radio Frequency Field Immunity	Agency	EN61000-4-6:1996 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
4.6	Magnetic Field Immunity	Agency	EN61000-4-8:1993 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
4.7	AC Dips, Interruptions, and Variations	Agency	EN61000-4-11:1995 (EN55024:1998 Immunity standard series for ITE) (CISPR 24:1997)	Passed	None Required	Passed
5.1	Harmonics Currents < 16A	Agency	EN61000-3-2:1995 + A1:1997, + A2:1998 + A14:2000	Passed	None Required	Passed
5.2	Voltage Fluctuations and Flickers < 16A	Agency	EN61000-3-3:1994	Passed	None Required	Passed
6.1	Safety Agency Approvals	Agency	Product approvals from UL, c-UL, TUV, and CB scheme	Passed	None Required	Passed
6.2	Acoustic Emissions	Agency	ISO 7779:1998-06-15 (E) and ANSI S12.10-1985 Limits per BSI spec.	Passed	None Required	Passed
6.3	DC Magnetic Fields emissions	Agency	IATA Dangerous Goods regulations, 30th Edition, 1989-01-01 U.S. CFR 49, paragraph 173.1020, rev. date: 1983-11-01	Passed	None Required	Passed

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
7	Shock and Vibration Testing – Operational; Non-Operational; Packaged	Shock & Vibration	Product exhibits no severity 1 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
8.1	Enclosure Thermal Analysis	Environmental	< 9 deg C delta temperature increase at tape path. No components out of spec	Passed	None Required	Passed
8.2	Temperature and Humidity Operation – External	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Code defect found, code updated, retested at the failing corner with no issues.	Passed
8.4	Temperature and Humidity – Load Cycle	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Verified to be an issue with prototype media. Re-tested to 200,000 cycles with production media. No fails.	Passed
8.6	Temperature and Humidity Operation – Media Interchange	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Original drives failed due to lack of interchange margin. Two issues were the root cause, both have been fixed and validated by considerable offline testing.	Based on engineering judgment this test passed.

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
8.8	Temperature and Humidity –Read Only Format (Backread)	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	After exhaustive offline testing, the VS160 can read DLT1 & VS80 prewritten tapes, and meets all the stated program goals. A separate report from BSI will be issued to discuss the Read Only format.	Testing Incomplete
8.10	Low Humidity Environmental Stress Test	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Drive firmware code deficiency highlighted, code was modified and the drives all passed the test on a rerun. This is an out of spec margin test and a straight forward re-run was considered acceptable for a pass.	Passed
8.12	Temperature and Humidity Ship / Storage Verification	Environmental	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	The BOT sensor failed. This is a one off failure mode not seen in any other EVT or DVT testing. The BSI quality department has worked with the vendor. Full corrective actions are in place.	Passed
9.1	Cartridge Format Exception Testing	Functional	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
9.2	Cartridge Mechanical Exception Testing	Functional	No severity 1,2 or 3 issues generated by testing	Passed	None Required	Passed
9.3	Lost Leader Exception Test	Functional	No severity 1,2 or 3 issues generated by testing	Passed	None Required	Passed
9.4	Code Load Verification	Functional	No severity 1,2 or 3 issues generated by	Passed	None Required	Passed

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
			testing			
9.5	SCSI Specification Compliance Verification	Functional	No severity 1,2 or 3 issues generated by testing	Passed	None Required	Passed
9.6	SCSI Data Transfer Operations	Functional	No severity 1,2 or 3 issues generated by testing	Failed Initial	Due to the hardware issues stated in 8.4 this test originally failed. With corrected hardware there are no failures.	Passed
9.8	Tape Spanning and Data Restore	Functional	No severity 1,2 or 3 issues generated by testing	Passed	None Required	Passed
9.9	SCSI Based Reset and Command Exception Testing	Functional	No severity 1,2 or 3 issues generated by testing	Failed Initial	Regression tests indicated four periods (of 600ms max) during the complete load cycle the drive can not complete a SCSI reset in 250ms. This is recommended and is not mandatory.	Passed
9.11	LVD SCSI Cable Length Verification	Functional	Product meets the 16-bit Ultra SCSI-3 160, (LVD) T-10 specification. No Severity 1, 2, or 3 issues observed.	Passed	None Required	Passed
9.12	Media Capacity	Functional	Meets Product Specification	Passed	None Required	Passed
9.13	Status Indicators / Display Operation	Functional	Meet Product Specification	Passed	None Required	Passed
9.14	Cleaning Tape LED Verification	Functional	Meet Product Specification	Passed	None Required	Passed

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
9.15	Worldwide AC Input Test	Functional	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
9.15	Worldwide AC Input Test	Functional	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
9.16	Power Supply Over & Under Voltage	Functional	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
9.17	Power Consumption (AC & DC)	Functional	Meets Product Specification	Passed	None Required	Passed
9.18	Power Loss / Restore Exception Testing	Functional	No severity 1,2 or 3 issues generated by testing	Passed	None Required	Passed
10.1	Access, Load/Unload & Search Times	Performance	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Passed	None Required	Passed
10.2	Data Transfer Rates	Performance	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Code re-written to provide extra margin. Incorporated improved media management control.	Passed

DVT Doc Section	DVT Test Cases	Test Class	DVT Exit Criteria	Results	Regression Testing Summary	Final Status
10.3	Data Transfer Rates	Performance	Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification	Failed Initial	Mis-interpretation of the VS80 format spec. Drive firmware code fixed, no further issues	Passed

2.2 DLT VSTape 160 Configuration

DLT VSTape 160 Drive Configuration

Mechanism	Revision 3.5 & 4.0
Blulight Card	Version 001807-06 & 001807-07
Tailgate Card	001910-04 rev 01
Firmware	Code Revisions Level 9 -16
Head	*Supplier A - F

Tapes

DLT Type IV Media	*Supplier C and D
Benchmark VS Tape	Revision B205a-B206b

* Manufacturer's names available on request.

2.3 DVT Entrance Criteria

- 72 drives built to customer shippable specifications
- Prototype single-drive, multi-pack and palletized packaging available
- Formal EVT complete
- All EVT sev1 and sev2 issues resolved and\or understood
- External enclosures available for EMI, ESD, Thermal, S&V, and Power testing

2.4 Test Environment

Computer Hardware

The DVT SCSI-based testing using the Percept Technology DVT Test Suite runs on Micron Millennial Pentium-class workstations with processor speeds of at least 667 MHz. Each workstation has a minimum of 384 MB of RAM and runs the NT 4.0 operating system.

DLT VSTape (VS160) and Cleaning Tapes

There is one type of write and read media validated during testing (with the exception of Backread – Section 8.6). The Benchmark VSTape used with the VS160 drive. A goal of this DVT process is the verification of the new Benchmark media in the VS160 drive. There is a separate DVT qualification test for the VSTape media. See "Benchmark Storage Innovations, Inc. VSTape Design Verification Test" document.

Documentation of the specific usage of other media will be included in the individual test sections. The cleaning tapes used are those manufactured for Benchmark Storage Innovations and approved for use by the product specification. The cleaning cartridge is used as described in the user's manual. The cleaning cartridge is used whenever cleaning is requested by the drive.

SCSI Test Hardware

The SCSI test hardware used is primarily Adaptec 29160-type adaptors. An Oppco 1850 test card is used to monitor and perform specific functions - parity, big block, messaging and reset.

The SCSI DVT Test Suite

Over thirty proprietary DVT tests were developed to exercise every possible aspect of drive operation that could be expected in customer installations.

The SCSI DVT Test Suite is designed to fully test the following cases:

- Appends
- Blank tape reporting
- Compression efficiency
- Data integrity
- Fixed / Variable block size mode
- Illegal cartridge reporting
- Inquiry, Request Sense & Log Sense Information
- Load / Unload times
- Logical Block sizes 2 bytes – 16MBytes
- LVD sensing and operation
- Multiple initiator
- Set Marks Response
- Read media error reporting
- Read position reporting
- Reserve & Release command handling
- Persistent Reservation command handling
- Reserved bit verification
- Restore (using CA ARCserve)
- SCSI Commands
- SCSI ID selection
- SCSI Messages reporting
- SCSI Reset & Bus DLT VSTape 160 drive Reset
- Search and Rewind times
- Space & Locate operations
- Synchronous / asynchronous operation
- Tape alert reporting
- Tape capacity
- Tape data compare
- Tape spanning (using CA ARCserve)
- Transfer rates (synchronous / asynchronous)

- Write / Read access times
- Write / Read raw and corrected error rates
- Write media error reporting

NOTE: See test descriptions in Appendix A – Percept DVT Test Suite

Condition continually monitored during DVT Testing

- DLT VSTape 160 drive and host SCSI Bus and Command Protocol
- Read Raw Error Rates
- Write Raw Error Rates
- Mechanical failure
- Media Failure
- Test time variations
- Unexpected indicators
- Consistency of performance from drive to drive
- Unexpected noises

2.5 Issue Severities

DVT testing resulted in issues being identified and classified as described in the table below.

Table 2: Issue Severity Classifications

Severity 1	**Severe** (can include any of the following) • Unrecoverable data or unrecoverable command error • Mechanical failure • Safety issue
Severity 2	**Serious** (can include any of the following) • Recoverable data or recoverable command error • Incorrect response to a valid SCSI command • Drive is unable to perform the function requested
Severity 3	**Moderate** (can include any of the following) • Performance degradation • Specification deviation • Command completed, but failed to meet a specification • Out of specification part

Severity 4	**Minor** (can include any of the following) • Usability error • Documentation error. • Minor anomaly noted during testing.

2.6 Issue List

An internal issue tracking system is used to monitor and track correction of all product performance issues during testing. The tracking system, known as TrackStar, is maintained by Benchmark Storage Innovations. The system maintains a central database of all issues documented and provides a method of documenting completion of corrective actions. For a detailed description of any failure in this report, see TrackStar via the issue number.

All issues (as defined above) noted during DVT testing are logged. Each issue is categorized according to:

- Severity
- Drive/system affected including EC and code level
- Engineering area of issue and engineer responsible
- Date opened / Date closed
- Status (open, closed or evaluate fix)

Also, the drive and tape history is tracked using a Percept database called DriveAlive. The history of testing, failures, upgrades, and current status are all tracked on this database.

3 Compliance Testing - Emissions

3.1 Radiated and Conducted Emissions

Objective:

The objective of these tests is to ensure that the product meets the maximum allowed limits for radiated and conducted emissions as specified by national and various international regulatory agencies.

Date Tested:

21-22 June 2002, 15-16 July 2002

Method:

CISPR 22:1997/EN55022:1998, Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement. Conducted emissions measurements are made on the mains leads and telecommunications lines between 150 kHz to 30 MHz. Radiated emissions measurements are made at 10 meters from 30 MHz to 1000 MHz.

Test Matrix:

Table 1 lists the units to be tested and the respective test voltages to be used. By completing the testing listed, all worldwide voltages and frequencies will be tested and a sampling of 3 external and two internal separate units will be certified.

Three external and two internal units will be available for testing. Testing on the internal and external drive shall be performed on the following configurations:

Table 3: Configurations for Radiated and Conducted emissions

Configuration	Radiated Emissions	Conducted Emissions
Unit #1, Internal	230VAC/50Hz	230VAC/50Hz
Unit #1, External	230VAC/50Hz	230VAC/50Hz
Unit #2, Internal	110VAC/60Hz	110VAC/60Hz
Unit #2, External	110VAC/60Hz	110VAC/60Hz
Unit #3, External	100VAC/60Hz	100VAC/60Hz

EUT Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

Limits of Conducted Electromagnetic Emissions
The EUT must meet the following conducted emissions limits:

Table 4: Conducted Emissions Limits

Frequency Band (MHz)	Class B Equipment	
	Quasi-Peak Measurement (dBuV)	Average Measurement (dBuV)
0.15 – 0.5	66 decreasing linearly with the log of the frequency to 56	56 decreasing linearly with the log of the frequency to 46
0.5 – 5.0	56	46
5.0 - 30	60	50

Limits of Radiated Electromagnetic Emissions
The EUT must meet the following radiated emissions limits:

Table 5: Radiated Emissions Limits

Frequency Band (MHz)	Class B Equipment 10m Measurement Distance (dBuV/m)
30 – 230	30
230 – 1000	37

Exit Criteria:

All of the DLT VSTape 160 products tested must meet CISPR 22 Class B limits for radiated and conducted emissions.

Results:

DLT VSTape 160e external tape drive meets CISPR 22 Class B limits with an additional 5.2 dB margin. See the CISPR 22 emissions test reports numbers 2L0341EEU1 from NEMKO Dallas, Inc., and 02-40ES-067-I, 1196 Percept 160, 1197 from HP Fort Collins Hardware Test Center in the addendums 1-4. (Addendum 1: DLT VSTape 160e CISPR 22B Radiated and Conducted Emissions (230 VAC), Addendum 2: DLT VSTape 160e CISPR 22B Radiated and Conducted Emissions (100 VAC), Addendum 3: DLT VSTape 160e CISPR

22B Radiated Emissions (110 VAC) Addendum 4: DLT VSTape 160e CISPR 22B Conducted Emissions (110 VAC)).

DLT VSTape 160 internal tape drive meets CISPR 22 Class B limits with an additional 2.7 dB margin. See the CISPR 22 emissions test report number BC204750 from TUV Product Service Boulder in the addendum 14. (Addendum 14: DLT VS160 EMC Emissions Test Report).

4 Compliance Testing – Immunity

4.1 Electrostatic Discharge Immunity

Objective:

The objective of this test is to evaluate the performance of the product when subjected to electrostatic discharges. In addition, it includes electrostatic discharges that may occur from personnel to objects near vital equipment.

Date Tested:

18 July 2002, 22-23 July 2002

Method:

EN61000-4-2:1995 (EN55024:1998 Immunity standard series for ITE) Electrostatic Discharge Immunity is the basis for this testing. Electrostatic discharges are applied only to such points and surfaces of the EUT that are accessible to the operator during normal interaction.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Immunity Test Levels:

Table 6: ESD Test Points - Normal Operating test

Test Location	Discharge Voltage +/- (kV)	Exit Criteria
Indirect Contact: HCP	2, 4	Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.
Indirect Contact: VCP	2, 4	
Direct Contact to conductive points	2, 4, 8	
Air Discharges to insulated points	2, 4, 8	
Air Discharges to conductive and insulated points	10, 12, 15	
• 25 discharges shall be applied for each voltage and polarity at each test point.		

Table 7: ESD test points – Hardware Survival test

Test Location	Discharge Voltage +/- (kV)	Exit Criteria
Air Discharges to conductive and insulated points	25	During testing, temporary degradation or loss of function or performance which requires operator intervention or system reset is allowable provided there no electrical damage to the EUT
• 10 discharges shall be applied for each voltage and polarity at each test point.		

Results:

DLT VSTape 160 internal and 160e external tape drives meet Electrostatic Discharge Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder, and Percept Technology Labs ESD Test Report number PRVS160. (Addendum 1: DLT VSTape 160e Engineering Test Report, Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report, and Addendum 17: DLT VSTape 160 ESD Test Report)

4.2 Radiated Immunity

Objective:

The objective of this test is to evaluate the immunity of the product when subjected to radiated RF fields. RF fields represent disturbances from radio transmitters.

Date Tested:

8 July 2002, 22 July 2002

Method:

EN61000-4-3:1995 (EN55024:1998 Immunity standard series for ITE) Radio Frequency Field Immunity is the basis for this testing. The EUT (equipment under test) is tested with the transmit antenna placed in front of the surfaces of the EUT. Testing is done in the frequency range of 80 MHz to 1000 MHz with field strength of 3 Volts/meter.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Immunity Test Levels:

Table 8: Radiated Immunity 80 to 1000 MHz

Frequency Range (MHz)	Test Level (V/m)	Modulation / Sweep
80.0 to 1000.0	3.0	80% AM at 1.0kHz 1% steps with 3s dwell
Clock Frequencies:	3.0	80% AM at 1.0kHz 3s dwell
900	3.0	Pulse modulation at 200Hz, 50% duty cycle 3s dwell

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.

Results:

DLT VSTape 160 internal and 160e external tape drives meet Radiated Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

4.3 Electrical Fast Transients (EFT) Immunity

Objective:

The objective of this test is to evaluate the immunity of product when EFT or bursts are injected into power lines and I/O lines. Burst or electromagnetic fast transients (EFT) represent transients generated from circuit breakers, non-protected relays, etc.

Date Tested:

16 July 2002, 22 July 2002

Method:

EN6100-4-4: 1995 (EN55024:1998 Immunity standard series for ITE) Electrical Fast Transient/Burst Immunity is the basis for this testing. The bursts are injected into both power lines (both common-mode [line to ground] and differential-mode [line to line] and I/O lines (if longer than 3 meters). The pulse amplitude of the transients during the burst is 1kV for power lines and 0.5 kV for I/O lines.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Immunity Test Levels:

Table 9: Fast Transient Immunity

Coupling Mode	Test Voltage +/- kV	Test Time Seconds
AC Line Cord	1.0	60
SCSI Cable	0.5	60

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.

Results:

DLT VSTape 160 internal and 160e external tape drives meet EFT Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

4.4 Surge Immunity

Objective:

The objective of this test is to evaluate the performance of equipment when subjected to high-energy disturbances on the power lines. Surges can be induced in cables by lightning, but might also pop up on the power line when connecting a phase compensating capacitor into the distribution net or when a fuse breaks.

Date Tested:

16 July 2002, 22 July 2002

Method:

EN61000-4-5:1995 (EN55024:1998 Immunity standard series for ITE) Surge Immunity is the basis for this testing. Surges are to be applied on power lines with a defined timing referred to the power-line phase. Line-to-line tests are conducted using a 0.5 kV and 1 kV surges. Line-to-ground tests are conducted using 1kV and 2kV surges.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

Immunity Test Levels:

Table 10: Surge Immunity

Coupling Mode	Test Voltage +/- kV
Differential Mode	0.5, 1.0
Common Mode	0.5, 1.0, 2.0

- Surges shall be coupled at phase angles of 0°, 90°, & 270°
- The delay time between consecutive surges shall be 30 seconds
- Five surges of each voltage, polarity, phase angle & coupling path shall be applied.

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.

Results:

DLT VSTape 160 internal and 160e external tape drives meet Surge Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

4.5 Conducted Immunity

Objective:

The objective of this test is to evaluate the immunity of product when subjected to conducted disturbances induced by radiated fields.

Date Tested:

18 July 2002, 22 July 2002

Method:

EN61000-4-6:1996 (EN55024:1998 Immunity standard series for ITE) Conducted disturbances induced by RF fields is the basis for this testing. Conducted disturbances are induced into AC leads and I/O cables in the frequency range of 0.150-80 MHz at a test level of 3 Volts.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Immunity Test Levels:

Table 11: Conducted Immunity 0.150 to 80 MHz

Test Point / Coupling Method	Frequency Range (MHz)	Test Level (V/m)	Modulation / Sweep
AC Line Cord M3 CDN	0.150 to 80.0	3.0	80% AM at 1.0kHz 1% steps with 3s dwell
	Clock Frequencies:	3.0	80% AM at 1.0kHz 3s dwell
SCSI Cable RF Clamp	0.150 to 80.0	3.0	80% AM at 1.0kHz 1% steps with 3s dwell
	Clock Frequencies:	3.0	80% AM at 1.0kHz 3s dwell

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.

Results:

DLT VSTape 160 internal and 160e external tape drives meet Conducted Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

4.6 Magnetic Field Immunity

Objective:

The objective of this test is to evaluate the immunity of the product when subjected to LF magnetic fields. The test simulates magnetic fields resulting from currents running in power-line systems.

Date Tested:

17 July 2002, 22 July 2002

Method:

EN61000-4-8:1993 (EN55024:1998 Immunity standard series for ITE) Power Frequency Magnetic Field Immunity is the basis for this testing. The drive is subjected to magnetic field level of 10 A/m for the stated duration in three orthogonal positions by using the induction coil.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

Immunity Test Levels:

Table 12: Magnetic Field Immunity

Specification	Operating Axis
50 Hz, 10 A/m	X, Y, and Z axis

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.

Results:

DLT VSTape 160 internal and 160e external tape drives meet Magnetic Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

4.7 AC Dips, Interruptions, and Variations

Objective:

The objective of this test is to evaluate the immunity of product when subjected to voltage dips, short interruptions, and voltage variations.

Date Tested:

16 July 2002, 22 July 2002

Method:

EN61000-4-11:1995 (EN55024:1998 Immunity standard series for ITE) Voltage dips, short interruptions, and voltage variations immunity tests is the basis for this testing. The product is subjected to voltage dips, short interruptions, and voltage variations for the stated duration.

Test Matrix:

One internal and one external drive shall be tested.

Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Once testing is completed, Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

Immunity Test Levels:

Table 13: Voltage Dips, Short Interruptions and Variations Immunity

Voltage Dip (% Ut)	Duration (periods)	Repetitions	Exit Criteria
> 95	0.5 cycle	5	Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test.
30	25 cycles	5	During testing, temporary degradation or loss of function or performance which requires operator intervention or system reset is allowable provided there no electrical damage to the EUT
> 95	250 cycles	2	
• Each voltage dip or interrupt is initiated at a phase angle of 0°			

Results:

DLT VSTape 160 internal and 160e external tape drives meet Voltage Dips, Short Interruptions, and Voltage Variations Immunity requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. and CISPR 24 Immunity Test Report number BC203896 from TUV Product Service Boulder. (Addendum 1: DLT VSTape 160e Engineering Test Report and Addendum 5: DLT VSTape 160 CISPR 24 Immunity Test Report)

5 Compliance – Product Family Specific Tests

5.1 Harmonic Currents < 16A

Objective:

The objective of this test is to measure the harmonic currents injected into the AC mains by the product. It is applicable to electrical and electronic equipment having an input current up to and including 16A per phase, and intended to be connected to public low-voltage distribution systems of between 220V and 250V at 50 Hz line to neutral.

Date Tested:

17 July 2002

Method:

EN61000-3-2:1995 + A1:1997, + A2:1998 + A14:2000, Harmonic Currents is the basis for this testing. The amplitude of each specific harmonic is measured.

EUT Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Exit Criteria:

The product must meet the limits for harmonic emissions as contained in EN61000-3-2:1995

Results:

DLT VSTape 160e external tape drive meets Harmonic Currents requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. (Addendum 1: DLT VSTape 160e Engineering Test Report).

5.2 Voltage Fluctuations and Flickers < 16A

Objective:

The objective of this test is to measure the voltage fluctuations and flickers impressed on the AC mains by the product. It is applicable to electrical and electronic equipment having an input current up to and including 16 A per phase, and intended to be connected to public low-voltage distribution systems of between 220V and 250V at 50 Hz line to neutral.

Date Tested:

17 July 2002

Method:

EN61000-3-3:1994 Voltage Fluctuations and Flickers is the basis for this testing.

EUT Exercising Software:

Prior to and during testing, proper operation of the drive shall be confirmed using Test.exe.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, “General Requirements of Testing and Calibration Laboratories”.

Exit Criteria:

The product must meet limits for voltage flicker as contained in EN61000-3-3:1994

Results:

DLT VSTape 160e external tape drive meets Voltage Fluctuations and Flickers requirements. See the Engineering Test Report number 2L0341EEU from NEMKO Dallas, Inc. (Addendum 1: DLT VSTape 160e Engineering Test Report).

6 Product Safety, Acoustics, and Magnetic Fields

6.1 Safety Agency Approvals

Objective:

The objective of this test is to ensure safety for the operator who may come into contact with the equipment and, where specifically stated, for service personnel. The drives will be submitted for safety testing. The drives must meet all requirements of the UL, c-UL (CSA), and CB Scheme standards currently in effect. Manufacturing facility inspections are an integral part of the safety examination.

Reference Standard (Exit Criteria):

Method:

The following standards are the basis for this testing:

- UL 60950 – US Standard: Information Technology, including Electrical Business Equipment
- CAN/CSA C22.2 NO. 950/UL 60950 – Canadian Standard: Information Technology, including Electrical Business Equipment
- EN60950 – European Standard: Information Technology, including Electrical Business Equipment
- IEC 60950 – International Standard: Information Technology, including Electrical Business Equipment
- 73/20/EEC – Low Voltage Directive for Information Technology, including Electrical Business Equipment
- CB Scheme – The Scheme of the IECEE for Mutual Recognition of Test Certificates for Electrical Equipment.

Results:

Product approvals from UL, c-UL, TUV, and CB scheme have been received for the DLT VS Tape 160 internal and DLT VS Tape 160e external tape drives (Addendum 10: DLT VSTape 160 CB Report and Certificate, Addendum 11: DLT VSTape 160e CB Report and Certificate, Addendum 12: DLT VSTape 160 UL Follow-Up Report, Addendum 13: DLT VSTape 160e UL Follow-Up Report, Addendum 17: DLT VSTape 160 TUV GS Mark Report, and Addendum 18: DLT VSTape 160e TUV BAUART Mark Report).

6.2 Acoustic Emissions

Objective:

The objective of this test is to ensure acoustic levels remain within the pre-defined specification limits.

Date Tested:

07 May 2002

Method:

ISO 7779:1998-06-15 (E) and ANSI S12.10-1985 is the basis for this testing. The tests are performed with the unit under test orientated in the center of the room, at least 4 meters from any reflecting surface. The microphone positions are located on the surface of a hemisphere, one meter from the center of the product, as described in Fig. 4, page 23 of ANSI S12.10-1985. The support equipment is placed in the adjacent room to isolate and thereby remove acoustic emissions from units not under test. The unit is tested in two operating modes and two idle modes as specified in Appendix C.8 of the ISO 7779: 1988 (E) specification. The two operating modes are defined as Read/Write mode and Streaming mode. The two idle modes are defined as Idling unloaded mode and Idling loaded mode.

Exit Criteria:

The drive shall meet the following acoustics emissions limits for sound power level and sound pressure level when tested as described.

Table 14: Acoustic Noise Emissions Limits

Operating Mode	Sound Power Level Limit (B)	Sound Pressure Level Limit (dBA)
Idle / Unloaded	5.4	54.0
Idle / Loaded	5.2	54.0
Operating, Read / Write	5.5	54.0
Operating, Streaming	5.6	54.0

Results:

DLT VSTape 160e external tape drive meets acoustics emissions limits. See the Acoustic Noise Emission report from Percept Technology Labs (Addendum 6: DLT VSTape 160e External Tape Drive Acoustics Emissions Report)

6.3 DC Magnetic Field Emissions

Objective:

The objective of this test is to ensure that the product passes the DC Magnetic Field emissions spec as referenced below.

Date Tested:

25 July 2002

Method:

IATA Dangerous Goods regulations, 30th Edition, 1989-01-01 U.S. CFR 49, paragraph 173.1020, rev. date: 1983-11-01. Equipment is tested in its shipping carton. Maximum observed DC magnetic field intensity emitted from the top, bottom, and side surfaces of the Equipment Under Test, measured at a distance of 7 feet from the tested surface shall not exceed 2 milligauss.

Exit Criteria:

The product must meet the limit for DC magnetic field emissions.

Results:

DLT VSTape 160e external tape drive meets DC magnetic field emissions. See the Magnetic Interference Test reports numbers 1382 and 1383 from HP Fort Collins Hardware Test Center. (Addendum 6: DLT VS160 Magnetic Interference and Addendum 9: DLT VSTape 160e Magnetic Interference Report)

7 Shock and Vibration Testing

Objective:

The testing simulates the environment likely to encountered by the product during shipping, installation, and customer use.

Method:

These tests are to be conducted using the procedures from NTSA Pre-shipment Test Procedures and the Benchmark DLT VSTape 160 Product Specification.

Test Matrix:

Three internal and three external drives shall be tested.

Exercising Software:

Proper operation of the drive shall be confirmed using Test.exe, either during or after testing is completed, as appropriate. Test.exe shall be performed to fully exercise the drive and ensure that no damage has occurred as a result of the test.

Treatment of Test Failures:

DVT level product will be considered to be final release hardware and firmware. Test failures will be returned to the manufacturer for failure analysis.

Test documentation:

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

Date Tested:

May – Sept, 2002

Test Engineer:

John deLassus (of Benchmark) and Pete Richardson (of Storage Tek)

Exit Criteria:

Recoverable error rates are within manufacturer's specifications. No permanent read errors occur. The device operates as intended through out test. There are no broken, loose, or missing parts after test.

Results: The DLT VSTape 160 drive passed the DVT shock and vibration testing. There were no functionality failures and no mechanical failures, as set forth in the Benchmark DLT VSTape 160 Product Specification. Specific test report is included in the addendums (See Addendum 8: DLT VSTape 160 Vibration and Shock Test Report).

8 Environmental Testing

8.1 Enclosure Thermal Analysis

Objective:

To thermally probe selected locations of the external enclosure configuration (DLT VSTape 160e) for characterization of the temperatures within the tape path when exposed to a hot/wet environment of 40°C and 30% Relative Humidity.

Date Tested:

8/14/2002

Test Engineer:

Michael Doty

Method:

After the initial temperature ramp and soak gradients have been performed in accordance with DLT Tape temperature and humidity operating range specifications, monitor continuous thermocouple temperature readings at 40°C while an external (DLT VSTape 160e) drive is performing read and write functions. The program used for this test is the System Performance Test Program. This program performs writing and reading of data to tape.

Test Equipment:

- 1 DLT VSTape 160 External Drive
- Agilent 34970A Data Acquisition.
- Omega type K thermo-couple probes (x4).
- Tenney THJR - Environmental Chamber.

Tape Path Test Points:

- Flipper Head
- BOT/EOT sensor
- Roller #3
- Roller #4

Exit Criteria:

The thermal characteristics of the drive shall not exceed the maximum allowable specification of VSTape160. The drive shall successfully complete a write/read operation to the end of media without failure. Temperatures within the tape path cannot exceed 9°C rise over the specified environmental condition tested of 40°C at 30%RH. Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

The following graph is the temperature readout of each probe at the environmental condition tested. The graph shows the tape path temperature passed the 9°C temperature rise criteria within the tape path. Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification. This test passed and this test is complete.

Graph 1

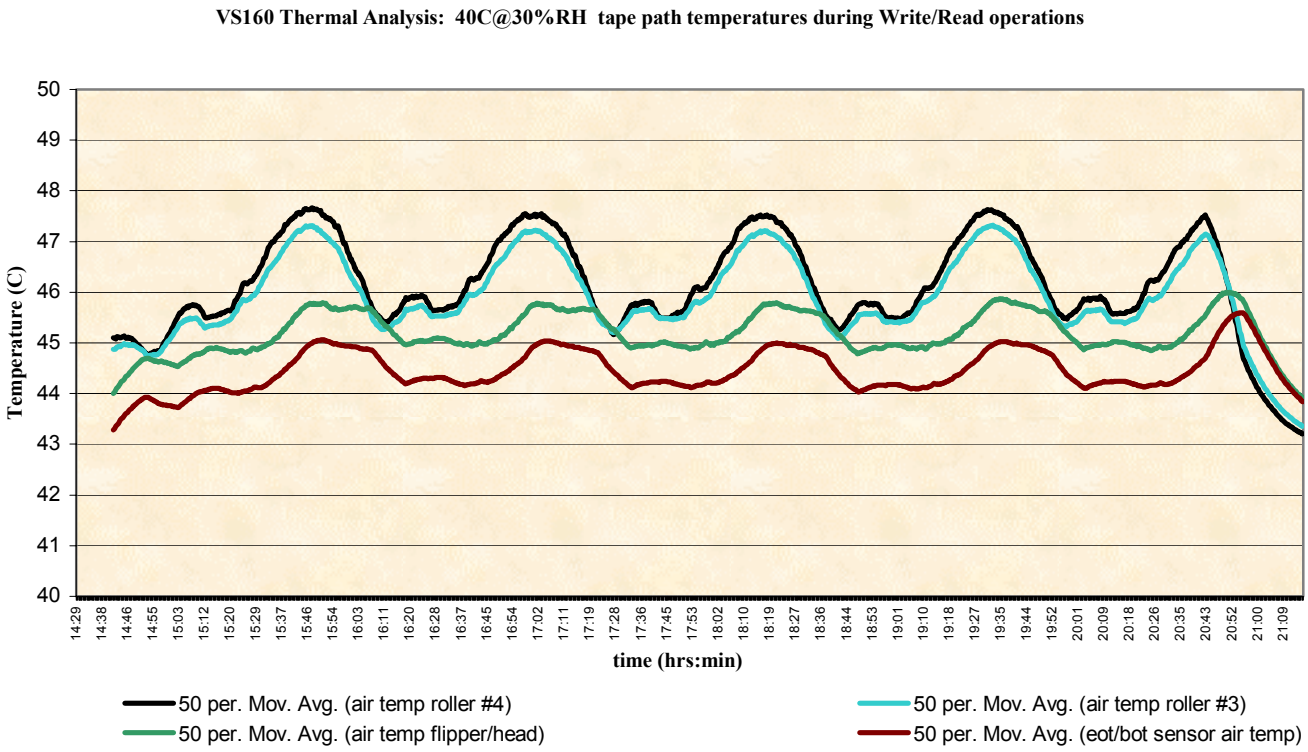


Figure 1: Flipper/head thermocouple probe

Figure 2: Roller #3 Thermocouple probe

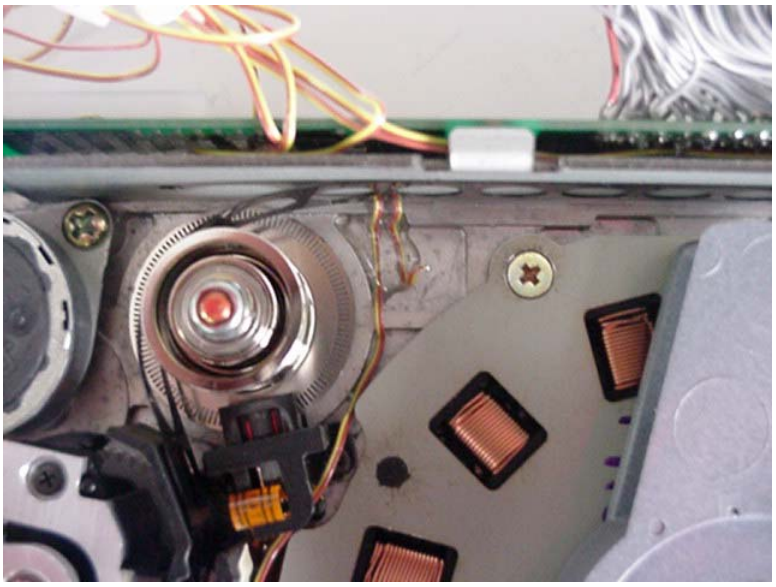


Figure 3: BOT/EOT sensor/roller 1& 2 - thermocouple probe

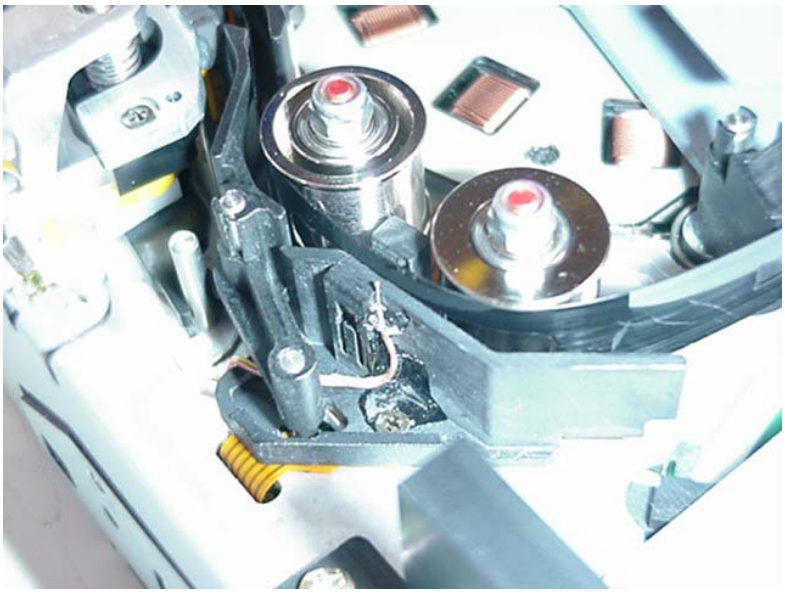


Figure 4: Front bezel

8.2 Temperature and Humidity Operation – External Drive

Objective:

To expose the product, and to verify the operation of the Benchmark DLT VSTape 160, to the environmental operating regions specified in the Benchmark DLT VSTape 160 Product Specification.

Date Tested:

06/29/02 – 07/12/02

Test Engineer:

Michael Doty

Method:

Twenty internal DLT VSTape 160 drives are required to run a test program which writes various block size data, appends data, and performs random file locate commands. The program is set to loop continuously while the drives are run at five corners of the environmental test settings. The product will operate for 24 hours at each corner. The temperature and humidity ramp gradients comply with Benchmark DLT VSTape 160 specifications, all drives are soaked for one hour after reaching each environmental corner before starting the test program.

Test Coverage:

1. Operational Envelope:
    - Temperature Range 10 to 40° C
    - Wet Bulb Temperature 25° C
    - Temperature Gradient 11° C/h (across range)
    - Relative Humidity 20% to 80% non condensing
    - Humidity Gradient 10% /h

2. Environmental test Corners:
    - 10°C @ 20%RH
    - 10°C @ 80%RH
    - 40°C @ 20%RH
    - 40°C @ 30%RH
    - 27.5°C @ 80%RH

3. Test Program Parameters:

- Block Size Step = 8192
- Max block size = 65536
- Min block size = 2048
- Min record size = 1 MB
- Total write data amount = 4096 MB

Exit Criteria:

Product exhibits no permanent read/write errors and meets the DLT VSTape 160 product specification. Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

Twenty drives were tested, 15 passed and 5 failed. The failures occurred during stage 5 (40°C @ 30%RH). For test results see Table **15** below. The five failures resulted in regression testing. See regression test Section 8.3 below.

Table 15

Temperature and Humidity Testing Matrix										
Code: 10.0	1	2	3	4	5	6	7	8	9	10
Supplier Head type	A	A	A	A	A	A	A	A	A	B
Drive # **Group 1**	49	22	65	36	67	61	46	7	102	108
Stage #1 (27.5C@80%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Stage #2 (10C@80%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Stage #3 (10C@20%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
stage #4 (40C@20%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
stage #5 (40C@30%RH) - pass/fail	Pass	Pass	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Fail
Code: 10.0	11	12	13	14	15	16	17	18	19	20
Supplier Head type	B	B	B	B	B	B	B	A	B	B
Drive # **Group 2**	124	156	169	154	31	167	117	39	176	162
Stage #1 (27.5C@80%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Stage #2 (10C@80%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Stage #3 (10C@20%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
stage #4 (40C@20%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
stage #5 (40C@30%RH) - pass/fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Figure 5: Temperature & Humidity test set up

8.3 Regression Test for Temperature and Humidity Operation - Section 8.2

Objective:

To regressively test the product and verify the operation of the Benchmark DLT VSTape 160 to the environmental operating region where the failure in Section 8.2 occurred. As a result of the initial test, BSI found and resolved a code bug. All of the failing drives failed for the same reason. The root cause of the failure was fully understood by BSI.

Date Tested:

08/22/2002 - 08/27/02

Test Engineer:

Michael Doty

Method:

Five of the failing DLT VSTape 160 drives are required to run a test program which writes various block size data, appends data, and performs random file locate commands. The program is set to loop continuously while the drives are at the corner of the environmental test settings. The product will operate for 24 hours at this corner. The temperature and humidity ramp gradients comply with Benchmark DLT VSTape 160 specifications, all drives are soaked for one hour after reaching the environmental corner.

Test Coverage:

2. Operational Envelope:

- Temperature Range 10 to 40° C
- Wet Bulb Temperature 25° C
- Temperature Gradient 11° C/h (across range)
- Relative Humidity 20% to 80% non condensing
- Humidity Gradient 10% /h

2. Environmental test Corners:

- 40°C @ 30%RH

3. Test Program Parameters:

- Block Size Step = 8192
- Max block size = 65536
- Min block size = 2048
- Min record size = 1 MB
- Total write data amount = 4096 MB

Exit Criteria:

Product exhibits no permanent read/write errors and meets the DLT VSTape 160 product specification. Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results Regression:

All of the five drive failed for the same reason. BSI root caused this to a drive firmware code bug. This code bug caused an erosion of the design margin on some drives. The bug was found and fixed and regression tested by the BSI code team. All five drives were then re-tested and passed. No issues occurred on the re-test. **This test has been passed and test is complete.**

Table 16

Drive #	0065	0058	0018	0128	0031
Stage 5 – (40°C @ 30%RH)	Pass	Pass	Pass	Pass	Pass

8.4 Temperature and Humidity Operation – Load Cycle Testing

Objective:

To verify proper operation of the Benchmark DLT VSTape 160 tape drive while loading and unloading a tape at the environmental operating ranges specified in the Benchmark DLT VSTape 160 Product Specifications.

Date Tested:

0628/02 - 07/11/02

Test Engineer:

Glenn Davis

Test Equipment:

- 10 - Load/Unload test fixtures
- 10 - VSTape 160 Tape Drives
- 10 – Benchmark VSTape Cartridges
- Tenney TH27 Thermal Chamber

Test Method:

Ten internal DLT VSTape 160 drives (see Table 17: Drive Configurations) were operated in an environmental chamber (see Figure 6) while performing continuous load cycles on a load/unload load fixture (see Figure 7). The chamber was held at each of five environmental corners for a period of 24 hours. The chamber was ramped from one corner to the next corner following the specifications (see "Coverage and Operational Envelope" in "Test Coverage" below).

A minimum of 1,000 cycles was completed at each corner. The tape drives were operated in the standard horizontal orientation. Each drive has an instruction buffer configured to commence ejecting a tape immediately upon completing a load routine. The tape calibration routine was disabled during this test.

Mechanical load/unload test fixtures were used that automatically detected when the tape cartridge was ejected from the drive (see Figure 8: Load/Unload Fixture). When the cartridge was ejected from the drive, the fixture automatically reinserted the same cartridge back into the drive by means of a pneumatic actuator (see Figure 9: Pneumatic Actuator Retracted & Figure 10: Pneumatic Actuator Extended). A digital counter was imbedded in the fixture to keep track of the number of successful iterations.

Throughout the test, mechanical components were inspected for wear, stress, and any incongruous noises resulting from worn or broken components.

Test Coverage:

1. Operational Envelope:
    - Temperature Range 10 to 40° C
    - Wet Bulb Temperature 25° C
    - Temperature Gradient 11° C/hour (across range)
    - Temperature Shock (non-operating) 10° C (over 2 minutes)
    - Relative Humidity 20% to 80% non condensing
    - Humidity Gradient 10% /hour

2. Environmental test Corners:
    - 10°C @ 20% R.H.
    - 10°C @ 80% R.H.
    - 40°C @ 20% R.H.
    - 40°C @ 30% R.H.
    - 27.5°C @ 80% R.H.

Table 17: Drive Configurations

Drive #	Mechanical Rev	PCBA Rev	Firmware Rev	Tape #
PHJ2F00063	4.0	5.0	9.0	B0205a268
PHJ2F00087	4.0	5.0	9.0	B0205a623
PHJ2F00136	4.0	5.0	9.0	B0205a123
PHJ2F00038	4.0	5.0	9.0	B0205a107
PHJ2F00006	4.0	5.0	9.0	B0205a637
PHJ2F00045	4.0	5.0	9.0	B0205a112
PHJ2F00052	4.0	5.0	9.0	B0205a106
PHJ2F00008	4.0	5.0	9.0	B0205a628
PHJ2F00068	4.0	5.0	9.0	B0205a627
PHJ2F00012	4.0	5.0	9.0	B0205a631

Exit Criteria:

The 10 tape drives must exhibit no load or unload failures. The drives must perform the 1,000 load cycles each with zero misbuckles, stuck tapes, swallowed leaders or eject failures. The Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

Nine drives passed the exit criteria and one drive failed. This failure was documented in TrackStar issue number 1088. There were no abnormal wear conditions noted during the test, see Table 18 for details. The one failure resulted in regression testing. See regression test Section 8.5 below.

Table 18: Temperature and Humidity Load Cycle Test Results

Temperature and Humidity Operation – Load Cycle Testing						
Drive #	Environmental Corner	Cycle Counts	Misbuckles	Stuck Tapes	Swallowed Leaders	Eject Failures
PHJ2F00063	27.5°C @ 80% R.H.	1106	0	0	0	0
PHJ2F00087	27.5°C @ 80% R.H.	1105	0	0	0	0
PHJ2F00136	27.5°C @ 80% R.H.	1000	0	0	0	0
PHJ2F00038	27.5°C @ 80% R.H.	1101	0	0	0	0
PHJ2F00006	27.5°C @ 80% R.H.	1107	0	0	0	0
PHJ2F00045	27.5°C @ 80% R.H.	1112	0	0	0	0
PHJ2F00052	27.5°C @ 80% R.H.	1112	0	0	0	0
PHJ2F00008	27.5°C @ 80% R.H.	1108	0	0	0	0
PHJ2F00068	27.5°C @ 80% R.H.	1107	0	0	0	0
PHJ2F00012	27.5°C @ 80% R.H.	1117	0	0	0	0
PHJ2F00063	10°C @ 20% R.H.	2205	0	0	0	0
PHJ2F00087	10°C @ 20% R.H.	2250	0	0	0	0
PHJ2F00136	10°C @ 20% R.H.	1085	0	0	0	1
PHJ2F00038	10°C @ 20% R.H.	2210	0	0	0	0
PHJ2F00006	10°C @ 20% R.H.	2209	0	0	0	0
PHJ2F00045	10°C @ 20% R.H.	2215	0	0	0	0
PHJ2F00052	10°C @ 20% R.H.	2216	0	0	0	0
PHJ2F00008	10°C @ 20% R.H.	2210	0	0	0	0
PHJ2F00068	10°C @ 20% R.H.	2211	0	0	0	0
PHJ2F00012	10°C @ 20% R.H.	2220	0	0	0	0
PHJ2F00063	10°C @ 80% R.H.	3306	0	0	0	0
PHJ2F00087	10°C @ 80% R.H.	3355	0	0	0	0
PHJ2F00136	10°C @ 80% R.H.	1085	0	0	0	1
PHJ2F00038	10°C @ 80% R.H.	3315	0	0	0	0
PHJ2F00006	10°C @ 80% R.H.	3320	0	0	0	0
PHJ2F00045	10°C @ 80% R.H.	3322	0	0	0	0
PHJ2F00052	10°C @ 80% R.H.	3311	0	0	0	0
PHJ2F00008	10°C @ 80% R.H.	3318	0	0	0	0
PHJ2F00068	10°C @ 80% R.H.	3394	0	0	0	0
PHJ2F00012	10°C @ 80% R.H.	3380	0	0	0	0

PHJ2F00063	40°C @ 30% R.H.	5511	0	0	0	0
PHJ2F00087	40°C @ 30% R.H.	5568	0	0	0	0
PHJ2F00136	40°C @ 30% R.H.	1085	0	0	0	1
PHJ2F00038	40°C @ 30% R.H.	5522	0	0	0	0
PHJ2F00006	40°C @ 30% R.H.	5534	0	0	0	0
PHJ2F00045	40°C @ 30% R.H.	5527	0	0	0	0
PHJ2F00052	40°C @ 30% R.H.	5531	0	0	0	0
PHJ2F00008	40°C @ 30% R.H.	5540	0	0	0	0
PHJ2F00068	40°C @ 30% R.H.	5602	0	0	0	0
PHJ2F00012	40°C @ 30% R.H.	5594	0	0	0	0

Test Setup Photos:

Figure 6: VS160 Drives on Load/Unload Fixtures in Thermal Chamber

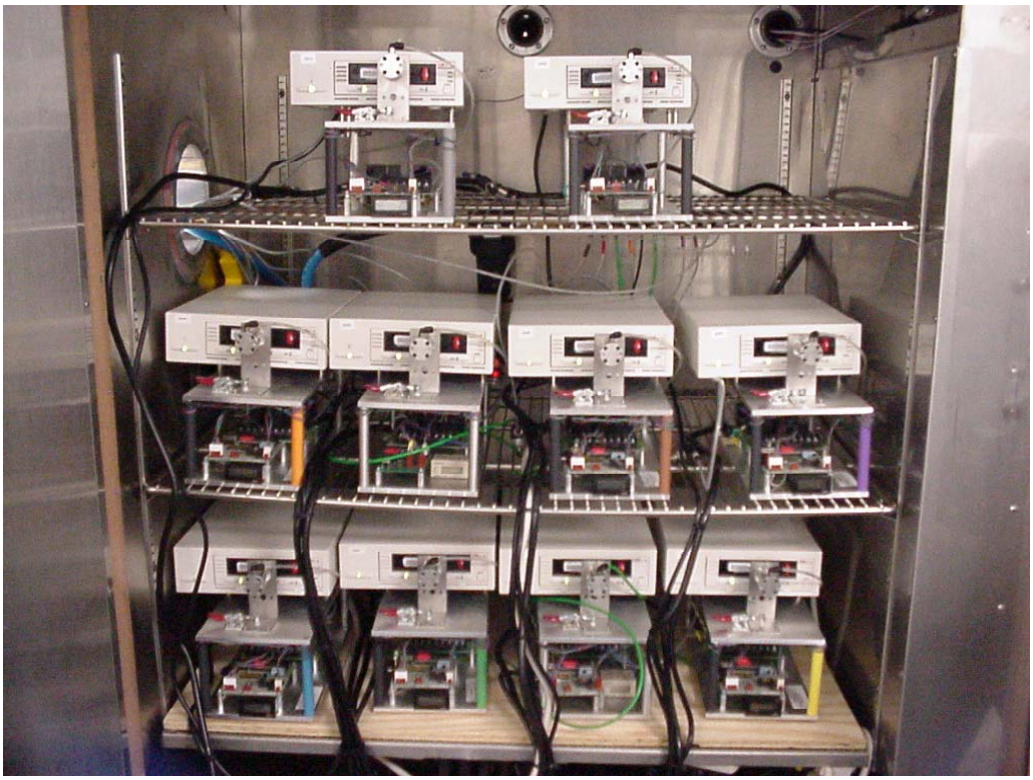


Figure 7: Standard Horizontal Orientation

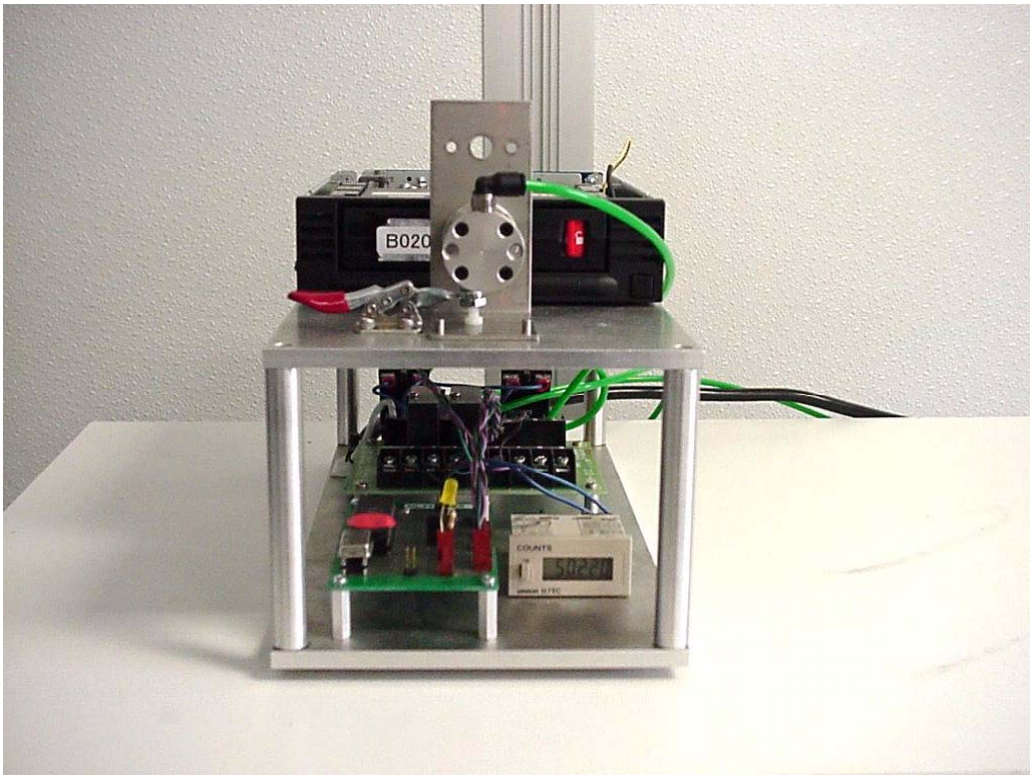


Figure 8: Load/Unload Fixture

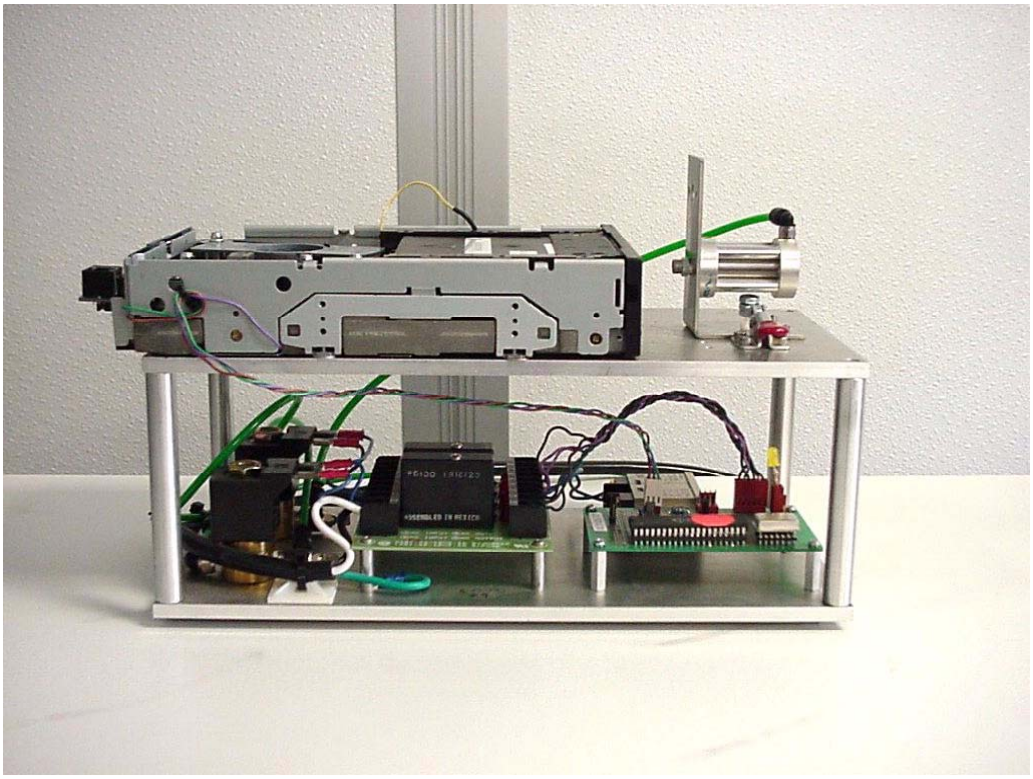


Figure 9: Pneumatic Actuator Retracted

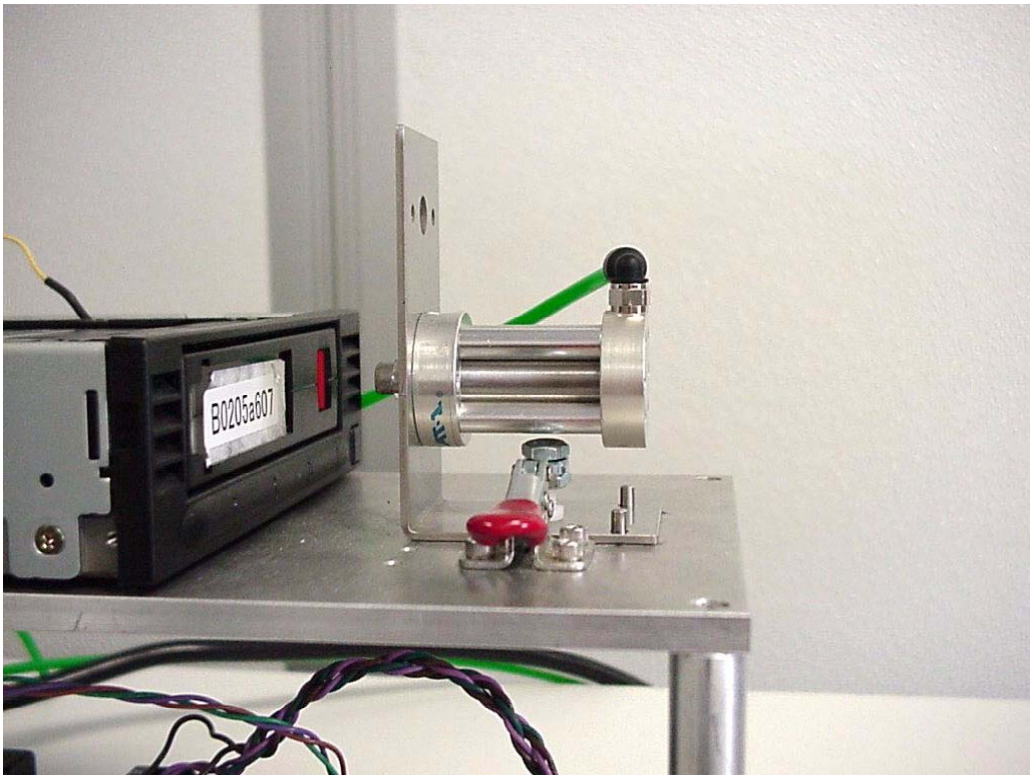
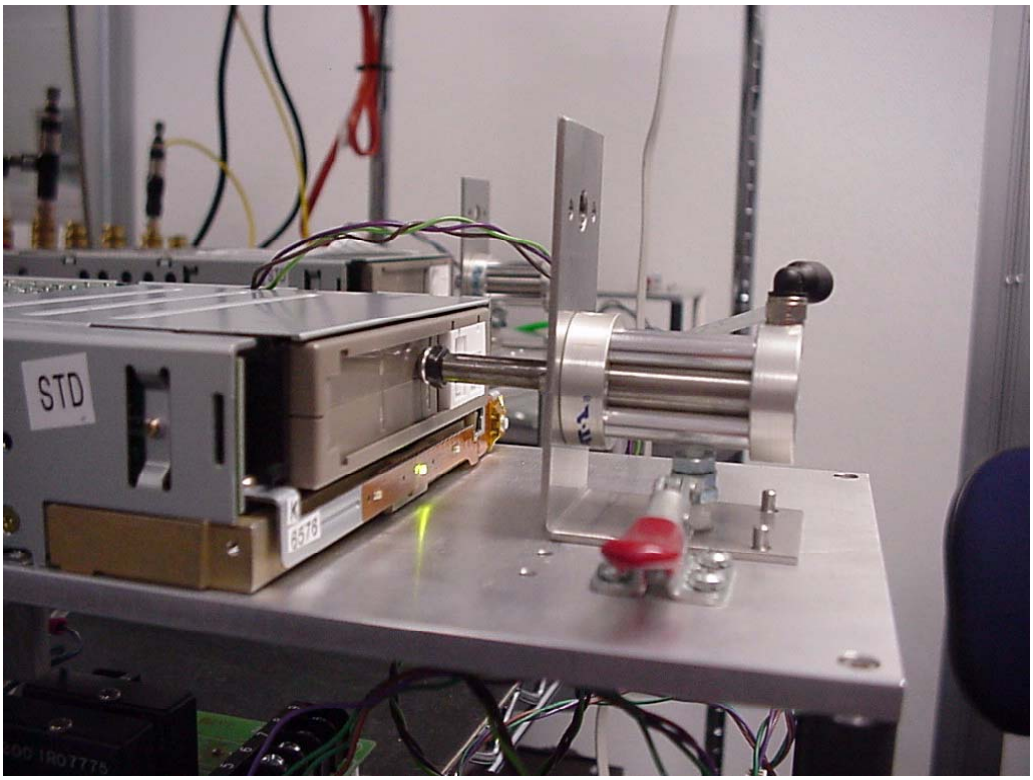


Figure 10: Pneumatic Actuator Extended



8.5 Regression Test for Temperature and Humidity Operation – Section 8.4 Load Cycle Testing

Objective:

This regression test will verify proper operation of the Benchmark DLT VSTape 160 tape drive while loading and unloading a tape at the environmental operating ranges specified in the Benchmark DLT VSTape 160 Product Specifications.

Date Tested:

09/06/01- 09/19/02

Test Engineer:

Glenn Davis

Test Equipment:

- 10 - Load/Unload test fixtures
- 10 - VSTape 160 Tape Drives
- 10 – Benchmark VSTape (Type B) Cartridges
- Tenney TH27 Thermal Chamber

Test Method:

Several tests were run to isolate the issue, see 'Test Results Results' below for details. One of the tests included ten internal DLT VSTape 160 drives (see Table 17: Drive Configurations) which were operated while performing continuous load cycles on a load/unload load fixture (see Figure 7). The drives were tested at 40°C 30%RH.

A minimum of 20,000 cycles were attempted, this is 20x the number attempted in the original test. The tape drives were operated in the standard horizontal orientation. Each drive has an instruction buffer configured to commence ejecting a tape immediately upon completing a load routine. The tape calibration routine was disabled during this test.

Mechanical load/unload test fixtures were used that automatically detected when the tape cartridge was ejected from the drive (see Figure 8: Load/Unload Fixture). When the cartridge was ejected from the drive, the fixture automatically reinserted the same cartridge back into the drive by means of a pneumatic actuator (see Figure 9: Pneumatic Actuator Retracted & Figure 10: Pneumatic Actuator Extended). A digital counter was imbedded in the fixture to keep track of the number of successful iterations.

Throughout the test, mechanical components were inspected for wear, stress, and any incongruous noises resulting from worn or broken components.

Exit Criteria:

The 10 tape drives must exhibit no load or unload failures. Each drive must perform the 20,000 load cycles each with zero misbuckles, stuck tapes, swallowed leaders or eject failures. The Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Result Regression:

The suspected root cause of the problem that occurred during in the first test (Section 8.4) was the media sticking on the head protection mechanism. BSI engineering ran numerous experiments with different media types to determine friction coefficients and the effect of temperature and humidity on these coefficients. The prototype VS tape media originally used for this testing (Type A) has a much greater tendency to stick in the tape path at high temperature and humidity as the environment approaches the dew point. The production version of the media (Type B) does not exhibit this tendency even if the tape is made wet, to simulate being at the dew point.

To verify this conclusion, the test was rerun with Type B media for 34,874 load/unload cycles without a failure. To verify that the failure mode was due to the Type A media, the test was rerun again with the same drives under the same conditions with the Type A media and it again failed after 8412 cycles.

This test concluded with load/unload testing on 10 additional drives with production media (B-type). No failures occurred on this retest during a total of 200,000 cycles. See Table Table 19 – Load / Unload Cycles below.

Conclusion:

The original failure was due to the tendency of the prototype media (Type A) to occasionally stick in the tape path under high temperature and humidity conditions. The regression test verifies that with production media and drives, the problem does not exist. **Based on engineering judgment this test has passed and this testing is complete.**

Table 19 – Load / Unload Cycles

Load Unload Test on VS160		
Cartridge	**Drive**	**Cycles**
Type B-3rd-121	PHJ2F00143	20121
Type B-3rd-122	PHJ2F00052	20055
Type B-3rd-123	PHJ2F00006	20076
Type B-3rd-124	PHJ2F00262	20110
Type B-3rd-125	PHJ2F00193	20020
Type B-3rd-126	PHJ2F00038	20064
Type B-3rd-127	PHJ2F00093	20071
Type B-3rd-128	PHJ2F00182	20036
Type B-3rd-129	PHJ2F00092	20094
Type B-3rd-130	PHJ2F00087	20087

8.6 Temperature and Humidity Operation Media Interchange VSTape 160

Objective:

To validate the performance of the DLT VSTape 160 drive when transferring data to and from VSTape 160 media at each operational environmental test corners.

Dates Tested:

7/13/2002 – 8/01/02

Test Engineer:

Michael Doty

Method:

Part 1: Twenty Benchmark DLT VSTape 160 drives running Interchange test write a minimum of 20 Gb of data at the first of five environmental test corners. The data is read back by the drive that wrote the data at the same corner to verify the write. Next, the tape cartridges of all drives are moved one drive in a round robin fashion, e.g.- from drive number 1 to drive number 2, from drive number 2 to drive number 3, etc. . The tapes are placed in the drive but are not loaded. The chamber is then ramped to the conditions of the next test corner. The loading and calibration of the tape will occur after the next test corner is reached and the soak period has completed. The loaded tape is then calibrated at the soaked corner. After reaching the desired corners profile, soaking, and loading the tape, the drive then reads all the data previously written. The drive then appends a minimum of 20 Gb of data; the append function consists of an overwrite of a minimum of 1 Gb of data. The process is repeated until all five environmental corners have been completed. Read/Write error rates are recorded at each test corner to ensure error rates are within specifications. Upon completion of part 1, 20 tapes, 4 sets of 5, each tape with data from 5 specific drives written at 5 separate environmental conditions will exist. However, each drive will not have had an opportunity to read all corners written from the other 4 drives in it's group of five. Part 2 will accomplish this objective.

Part 2: Verification of interchange read capability at each environmental corner. Since each tape created in part 1 has data written by multiple drives at multiple environmental conditions, Part 2 will consist of a rotation of the tapes from drive to drive in the same fashion as described in part 1, after the tape is loaded a full read back of the tape at each corner will occur. The tapes were created in groups of 5 and will be kept in these groups of 5 for the read back. Because the last drive in section 1 has read back data from the other drives at all the environmental corners, the last corner condition is omitted from the read back. In summary, all tapes are rotated and read by each drive at each of the 5 environmental test corners.

Test Coverage of Tape and Drives:

The same group of 20 drives will be used in each test cycle. The distribution of tapes and formats will be as follows:

20 DLT VSTape 160 drives

20 Benchmark VSTape tapes 80Gb format

Drives are mixed to ensure the following are used on each tape:

- Heads from supplier A and B (10 each of type A & 10 each of Type B)

Environmental test Corners:

- 10°C @ 20%RH
- 10°C @ 80%RH
- 40°C @ 20%RH
- 40°C @ 30%RH
- 27.5°C @ 80%RH

See Figure 11: Media Interchange Test System

Exit Criteria:

No permanent read/write media errors. The product exhibits no load or unloads failures. The Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

The following table (Table 20) is the Interchange results template for each environmental corner and tape shift sequence. There are 4 groups of drives, each group consisting of 5 drives each with tapes. The tapes are color coded for tracking purposes. As each stage is completed, each tape is shifted to the next drive. The progression of the tape shift sequence can be observed in the table as each color coded tape moves sequentially through each group of drives until all ten stages are complete.

There were ten failures during the testing. The failures were logged on TrackStar. The TrackStar issue numbers are - 1089, 1090, 1091, 1093, 1094, 1107, 1172, 1187, 1192, 1209, and 1210. These 10 failures required regression testing. Due to the number of failures, stages 6-10 were not completed during this initial test. Due to the failures, regression testing was required. See regression test Section 8.7 below.

Table 20: VS160 Media Interchange stages 1-5

VS160 Interchange Environmental Testing Matrix Pass 1			Group 1					Group 2		
code level: 10.3										
Drive #	**49**	**108**	**22**	**36**	**154**	**61**	**124**	**7**	**169**	**46**
Interchange #1 (27.5C@80%RH)	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
Tape #	632	561	636	638	577	639	566	635	574	630
	1	2	3	4	5	6	7	8	9	10
Interchange #2 (10C@80%RH)	**Fail**	**Pass**	**Fail**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
Tape #	614	632	561	636	638	577	639	566	635	574
	20	1	2	3	4	5	6	7	8	9
Interchange #3 (10C@20%RH)	**N/A**	**Fail**	**N/A**	**Pass**	**Pass**	**Pass**	**Fail**	**Pass**	**Fail**	**Pass**
Tape #	615	614	632	561	636	638	577	639	566	635
	19	20	1	2	3	4	5	6	7	8
Interchange #4 (40C@20%RH)	**N/A**	**N/A**	**N/A**	**Fail**	**Pass**	**Fail**	**Pass**	**no test**		**Pass**
Tape #	109	615	75	561	632	636	638	577	639	639
	18	19	20	1	2	3	4	5	6	7
Interchange #5 (40C@30%RH)										
Tape #	563	109	615	614	560	561	636	638	577	639
	17	18	19	20	1	2	3	4	5	6

			Group 3					Group 4		
Drive #	**65**	**156**	**167**	**102**	**31**	**67**	**39**	**120**	**176**	**162**
Interchange #1 (27.5C@80%RH)	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
Tape #	633	558	606	640	560	634	563	109	615	614
	11	12	13	14	15	16	17	18	19	20
Interchange #2 (10C@80%RH)	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Fail**	**Fail**
Tape #	630	633	558	606	640	560	634	563	109	615
	10	11	12	13	14	15	16	17	18	19
Interchange #3 (10C@20%RH)	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**n/a**	**n/a**
Tape #	574	630	633	558	606	640	560	634	563	109
	9	10	11	12	13	14	15	16	17	18
Interchange #4 (40C@20%RH)	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**n/a**	**Fail**
Tape #	635	574	630	633	558	606	640	560	634	634
	8	9	10	11	12	13	14	15	16	17
Interchange #5 (40C@30%RH)										
Tape #	566	635	574	630	633	558	606	640	560	634
	7	8	9	10	11	12	13	14	15	16

8.7 Regression Test for Temperature and Humidity Operation Media Interchange VSTape 160 - Section 8.6

Objective:

To regressively test and to validate the performance of the DLT VSTape 160 drive when transferring data to and from VSTape 160 media at each operational environmental test corners.

Dates Tested:

08/20/2002 – 8/28/2002

Test Engineer:

Michael Doty

Method:

Part 1: Twenty Benchmark DLT VSTape 160 drives running Interchange test write a minimum of 20 Gb of data at the first of five environmental test corners. The data is read back by the drive that wrote the data at the same corner to verify the write. Next, the tape cartridges of all drives are moved one drive in a round robin fashion, e.g.- from drive number 1 to drive number 2, from drive number 2 to drive number 3, etc. . The tapes are placed in the drive but are not loaded. The chamber is then ramped to the conditions of the next test corner. The loading and calibration of the tape will occur after the next test corner is reached and the soak period has completed. The loaded tape is then calibrated at the soaked corner. After reaching the desired corners profile, soaking, and loading the tape, the drive then reads all the data previously written. The drive then appends a minimum of 20 Gb of data; the append function consists of an overwrite of a minimum of 1 Gb of data. The process is repeated until all five environmental corners have been completed. Read/Write error rates are recorded at each test corner to ensure error rates are within specifications. Upon completion of part 1, 20 tapes, 4 sets of 5, each tape with data from 5 specific drives written at 5 separate environmental conditions will exist. However, each drive will not have had an opportunity to read all corners written from the other 4 drives in it's group of five. Part 2 will accomplish this objective.

Part 2: Verification of interchange read capability at each environmental corner. Since each tape created in part 1 has data written by multiple drives at multiple environmental conditions, Part 2 will consist of a rotation of the tapes from drive to drive in the same fashion as described in part 1, after the tape is loaded a full read back of the tape at each corner will occur. The tapes were created in groups of 5 and will be kept in these groups of 5 for the read back. Because the last drive in section 1 has read back data from the other drives at all the environmental corners, the last corner condition is omitted from the read back. In summary, all tapes are rotated and read by each drive at each of the 5 environmental test corners.

Test Coverage of Tape and Drives:

The same group of 20 drives will be used in each test cycle. The distribution of tapes and formats will be as follows:

20 DLT VSTape 160 drives

20 Benchmark VSTape tapes 80Gb format

Drives are mixed to ensure the following are used on each tape:

- Heads from supplier A and B (10 each of type A & 10 each of Type B)

Environmental test Corners:

- 10°C @ 20%RH
- 10°C @ 80%RH
- 40°C @ 20%RH
- 40°C @ 30%RH
- 27.5°C @ 80%RH

See Figure 11: Media Interchange Test System

Exit Criteria:

No permanent read/write media errors. The product exhibits no load or unloads failures. The Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Result Regression:

Engineering analysis of the failures from Section 8.6 indicated that there were two issues to be corrected. The surface finish of Roller 3 had changed since the original mechanism build. This was deemed to be the root cause of a large LTM on all of the failing drives. This issue was corrected at the roller vendor and the rollers were replaced on all of the test drives.

In addition, the factory-setting of the head azimuth was found to be incorrect. The head-azimuth station software and the manufacturing process were updated to correct this issue. The LTM and head-azimuth were verified on all of the drives and the test was rerun.

A number of firmware updates to handle certain error conditions were made as well.

Conclusion:

The original failure mode was due to lack of interchange margin. This was due to defective rollers that cause excessive LTM and improperly adjusted azimuth. With the corrections in place, the testing was repeated.

For the results of the twenty drives see Table 21: VS160 Media Interchange Regression, stages 1-5 & Table 22: VS160 Media Interchange Regression, stages 6-10 below. Nineteen drives passed all stages successfully. There was one failure to read a tape during a read back stage. This tape was successfully read at BSI in engineering. Error recovery improvements were made to the read actions, these improvements will accommodate this type of tape. Many additional read passes with this tape yielded success; the failure mode could not be repeated. **Based on engineering judgment, this test passed and this test is complete.**

Table 21: VS160 Media Interchange Regression, stages 1-5

VS160 Interchange Environmental Testing Matrix			Group 1					Group 2		
Code 15.0, drive sequence 1 - 10	1	2	3	4	5	6	7	8	9	10
Drive #	70	113	77	49	7	162	39	16	85	46
Interchange #1 (27.5C@80%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	80	144	79	143	78	141	145	146	147	151
Start: 1630 hrs 8/20/02, Finish 1738 hrs 8/20/02	1	2	3	4	5	6	7	8	9	10
Interchange #2 (10C@80%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	158	80	144	79	143	78	141	145	146	147
Start: 0845 hrs 8/21/02, Finish 1215 hrs 8/21/02	20	1	2	3	4	5	6	7	8	9
Interchange #3 (10C@20%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	159	158	80	144	79	143	78	141	145	146
Start: 1615 hrs, 8/21/2002 Finish: 2122hrs 8/21/2002	19	20	1	2	3	4	5	6	7	8
Interchange #4 (40C@20%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass

Tape #	156	159	158	80	144	79	143	78	141	145
Start: 0800hrs 8/22/02, Finish: 1445 hrs, 8/22/02	18	19	20	1	2	3	4	5	6	7
Interchange #5 (40C@30%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	157	156	159	158	80	144	79	143	78	141
Start: 1545hrs. 8/22/02 Finish: 2115 hrs 8/22/02	17	18	19	20	1	2	3	4	5	6

Groups 3 & 4			Group 3					Group 4		
Code 15.0, drive sequence 11 - 20	11	12	13	14	15	16	17	18	19	20
Drive #	168	102	212	11	99	215	25	2	94	36
Interchange #1 (27.5C@80%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	150	149	155	154	153	152	157	156	159	158
Start: 1630 hrs 8/20/02, Finish 1738 hrs 8/20/02	11	12	13	14	15	16	17	18	19	20
Interchange #2 (10C@80%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	151	150	149	155	154	153	152	157	156	159
Start: 0845 hrs 8/21/02, Finish 1215 hrs 8/21/02	10	11	12	13	14	15	16	17	18	19
Interchange #3 (10C@20%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	147	151	150	149	155	154	153	152	157	156
Start: 1615 hrs, 8/21/2002 Finish: 2122hrs 8/21/2002	9	10	11	12	13	14	15	16	17	18
Interchange #4 (40C@20%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	146	147	151	150	149	155	154	153	152	157
Start: 0800hrs 8/22/02, Finish: 1445 hrs, 8/22/02	8	9	10	11	12	13	14	15	16	17
Interchange #5 (40C@30%RH)	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Tape #	145	146	147	151	150	149	155	154	153	152
Start: 1545hrs. 8/22/02 Finish: 2115 hrs 8/22/02	7	8	9	10	11	12	13	14	15	16

Table 22: VS160 Media Interchange Regression, stages 6-10

VS160 Interchange Environmental Testing Readback stages 6-10			Group 1					Group 2		
Code 15.0	1	2	3	4	5	6	7	8	9	10
Drive #	70	113	77	49	7	162	39	16	85	46
Interchange Readback #1- Stage #6 at (27.5C@80%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	152	157	156	159	158	80	144	79	143	78
Start: 1220 hrs, 8/23/02 Finish: 1817hrs., 8/23/02	16	17	18	19	20	1	2	3	4	5
Interchange Readback #2 - Stage #7 at (10C@80%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	153	152	157	156	159	158	80	144	79	143
Start: 1100 hrs., 8/26/02 Finish: 1800hrs, 8/26/02	15	16	17	18	19	20	1	2	3	4
Interchange Readback #3- Stage #8 at (10C@20%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	154	153	152	157	156	159	158	80	144	79
Start: 1815 hrs, 8/26/02 Finish: 0024 hrs, 8/27/02	14	15	16	17	18	19	20	1	2	3
Interchange Readback #4-Stage #9 at (40C@20%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	155	154	153	152	157	156	159	158	80	144
Start: 0945 hrs, 8/27/02 Finish: 1645 hrs, 8/27/02	13	14	15	16	17	18	19	20	1	2
			Group 3					Group 4		
Code 15.0	11	12	13	14	15	16	17	18	19	20
Drive #	168	102	212	11	99	215	25	2	94	36
Interchange Readback #1- Stage #6 at (27.5C@80%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	141	145	146	147	151	150	149	155	154	153
Start: 1220 hrs, 8/23/02 Finish: 1817hrs., 8/23/02	6	7	8	9	10	11	12	13	14	15

Interchange Readback #2 - Stage #7 at (10C@80%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	78	141	145	146	147	151	150	149	155	154
Start: 1100 hrs., 8/26/02 Finish: 1800hrs, 8/26/02	5	6	7	8	9	10	11	12	13	14
Interchange Readback #3- Stage #8 at (10C@20%RH)	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	143	78	141	145	146	147	151	150	149	155
Start: 1815 hrs, 8/26/02 Finish: 0024 hrs, 8/27/02	4	5	6	7	8	9	10	11	12	13
Interchange Readback #4- Stage #9 at (40C@20%RH)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tape #	79	143	78	141	145	146	147	151	150	149
Start: 0945 hrs, 8/27/02 Finish: 1645 hrs, 8/27/02	3	4	5	6	7	8	9	10	11	12

Figure 11: Media Interchange Test System

8.8 Temperature and Humidity Operation – VS 160 Read Only Supported Format – ' Backread'

Objective:

The Benchmark DLT VSTape 160 is verified to properly read data from all supported read only formatted tapes at the five corners of environmental operation. The VS Tape 160 supports 'backread' of the DLT1 and DLT VSTape 80 drives (DLT 1.5).

Date Tested:

09/13/02 – 09/19/02

Test Engineer:

Mike Doty

Method:

Part 1:

Backread tapes were created with 10 DLT1 drives and 10 VS80 drives, using DLT IV media by vendors F, H, and C. The tapes were created with the drives at 25°C ambient. WinSCSI PFT28 was used to write and read a full tape with 64K uncompressed records using pseudorandom data.

Part 2:

A test set of 20 DLT VSTape 160 drives is used for the verification of back read capability at each environmental corner. Since each tape created in part 1 has data written by multiple drives at multiple environmental conditions, Part 2 will consist of a rotation of the tapes from drive to drive and a full read back of the tape at each corner. The drives being grouped in fives will require 5 tapes for each group. In summary, all tapes are rotated and read by a different drive at each of the 5 test corners.

The drives will consist of an equal mix of heads from Supplier A and Supplier B.

The tapes created will be a mix of Supplier C and D. Thus a total of 10 VSTape 80 written tapes and 10 DLT 1 written tapes will be used.

Environmental test Corners:

- 10°C @ 20%RH
- 10°C @ 80%RH
- 40°C @ 20%RH
- 40°C @ 30%RH
- 27.5°C @ 80%RH

Exit Criteria:

No permanent read errors. No persistent Severity 1, 2, or 3 issues are observed.

Test Results:

Of twenty drives entering the test, there were two failures. The drive firmware revision was 15.6. The two TrackStar issue numbers were 1311 and 1313. As a result of the failures, regression testing is required. See Section 8.9 below for regression test.

8.9 Regression Test for Temperature and Humidity Operation – VS 160 Read Only Supported Format – ' Backread' Section 8.8

Objective:

To regressively test the Benchmark DLT VSTape 160 and verify the ability to read data from all supported read only formatted tapes at all five corners of environmental operation. The VS Tape 160 supports 'backread' of the DLT1 and DLT VSTape 80 drives (DLT 1.5). The performance in reading DLT1 and VS80 prewritten tape has been enhanced throughout the DVT phase.

Before regression testing began, extensive off line testing was conducted both in diagnostic mode and with real customer data and applications. This regression test will verify the work done has improved the ability of the drive to 'backread' DLT1 and DLT1.5 formats.

Date Tested:

9/27/02 – 10/27/02

Test Engineer:

Mike Doty

Method:

Part 1:

Backread tapes were created with 10 DLT1 drives and 10 VS80 drives, using DLT IV media by vendors F, H, and C. The tapes were created with the drives at 25°C ambient. WinSCSI PFT28 was used to write and read a full tape with 64K uncompressed records using pseudorandom data.

Part 2:

A test set of 20 DLT VSTape 160 drives is used for the verification of back read capability at each environmental corner. Since each tape created in part 1 has data written by multiple drives at multiple environmental conditions, Part 2 will consist of a rotation of the tapes from drive to drive and a full read back of the tape at each corner. The drives being grouped in fives will require 5 tapes for each group. In summary, all tapes are rotated and read by a different drive at

The tapes created will be a mix of Supplier C and D. Thus a total of 10 VSTape 80 written tapes and 10 DLT 1 written tapes will be used.

This regression test will increase the number of test passes from the previous test in Section 8.8. The failures from the previous backread testing occurred at 40°C @ 30%RH, therefore this regression test will be increased to seven passes at this corner.

Environmental test Corners:

- 10°C @ 20%RH
- 10°C @ 80%RH
- 40°C @ 20%RH
- 40°C @ 30%RH - 7 times
- 27.5°C @ 80%RH

Exit Criteria:

No permanent read errors. No persistent Severity 1, 2, or 3 issues are observed.

Test Results:

Of twenty drives entering the test, all twenty drives passed. All twenty drives completed eight passes at the 40°C @ 30%RH corner which was the original failing test corner, and passed. **This test is passed, and this test is complete.**

Table 23 – Regression Backread Results

Drive S/N	Test Complete Date	Code Rev.	Test Results
PHJ2F00047	10/27/2002	17.2	Pass
PHJ2F00168	10/27/2002	17.2	Pass
PHJ2F00144	10/27/2002	17.2	Pass
PHJ2F00018	10/27/2002	17.2	Pass
PHJ2F00049	10/27/2002	17.2	Pass
PHJ2F00032	10/27/2002	17.2	Pass
PHJ2F00039	10/27/2002	17.2	Pass
PHJ2F00058	10/27/2002	17.2	Pass
PHJ2F00007	10/27/2002	17.2	Pass
PHJ2F00108	10/27/2002	17.2	Pass
PHJ2F00070	10/27/2002	17.2	Pass
PHJ2F00002	10/27/2002	17.2	Pass
PHJ2F00036	10/27/2002	17.2	Pass
PHJ2F00065	10/27/2002	17.2	Pass
PHJ2F00046	10/27/2002	17.2	Pass
PHJ2F00031	10/27/2002	17.2	Pass
PHJ2F00025	10/27/2002	17.2	Pass
PHJ2F00215	10/27/2002	17.2	Pass
PHJ2F00102	10/27/2002	17.2	Pass
PHJ2F00011	10/27/2002	17.2	Pass

8.10 Low Humidity Environmental Stress Test

Objective:

To document the performance of the product in a low humidity office environment of 20°C @ 0% Relative Humidity (out of spec condition).

Date Tested:

8/5/2002

Test Engineer:

Michael Doty

Method:

Using a test program containing a combination of variable block sizes, appends, and locates, run 5 drives in an environmental test chamber at 20°C and 0% humidity for 24 hours of continuous operation.

- Envirotronics Environmental Chamber
- 5 VS160 Tape Drives – code Level 15.1, Full Upgrades.
- Test Program Parameters:

  Block Size Step = 8192
  Max block size = 262144
  Min block size = 4096
  Min record size = 1 MB
  Total write data amount = 10240 MB

Exit Criteria:

No permanent read or write errors. The product meets the Benchmark DLT VSTape 160 Specification. No persistent Severity 1, 2, or 3 issues are observed.

Test Results:

Four drives passed and one drive failed. The failure was logged as TrackStar issue number 1218. This failure required a regression test. See 'Test Results Regression' below.

Table 24

Drive S/N	Tape Cartridge #	Pass/Fail 24 hr test
PHJ2F00031	B0205b179	Pass
PHJ2F00102	B0205b196	Pass
PHJ2F00065	B0205b121	Fail
PHJ2F00167	B0205b176	Pass
PHJ2F00120	B0205b180	Pass

8.11 Regression Test for Low Humidity Environmental Stress Test – Section 8.10

Objective:

To regressively test the performance of the product in a low humidity office environment of 20°C @ 0% Relative Humidity (out of spec condition).

Date Tested:

9/5/2002

Test Engineer:

Michael Doty

Method:

Using a test program containing a combination of variable block sizes, appends, and locates, run 5 drives in an environmental test chamber at 20°C and 0% humidity for 24 hours of continuous operation.

- Envirotronics Environmental Chamber
- 5 VS160 Tape Drives – code Level 15.1, Full Upgrades.
- Test Program Parameters:

  Block Size Step = 8192
  Max block size = 262144
  Min block size = 4096
  Min record size = 1 MB
  Total write data amount = 10240 MB

Exit Criteria:

No permanent read or write errors. The product meets the Benchmark DLT VSTape 160 Specification. No persistent Severity 1, 2, or 3 issues are observed.

Test Result Regression :

The root cause of the failure from Section 8.10 was a code deficiency; the deficiency caused the drive to invoke excessive error recovery. The code was modified to make the drive more tolerant to this out of spec condition. All drives were retested for the full duration of the original test and all passed. See Table 25 below.

Conclusion:

This is a margin test and runs the drive out of spec. Engineering was satisfied that all the drives passed with the modified code for the rerun and no additional regression was required. **This test has passed and this test is complete.**

Table 25

Drive S/N	Tape Cartridge	Pass/Fail 24 hr test
PHJ2F00049	B0205b124	Pass
PHJ2F00032	B0205b210	Pass
PHJ2F00144	B0205b185	Pass
PHJ2F00007	B0205b201	Pass
PHJ2F00108	B0205b191	Pass

8.12 *Temperature and Humidity Ship / Storage Verification*

Objective:

The Benchmark DLT VSTape 160 is verified for proper operation after being exposed to the Storage/Shipment environmental conditions specified in the DLT VSTape 160 product specification.

Date Tested:

7/2/2002 – 7/11/2002

Test Engineer:

Michael Doty

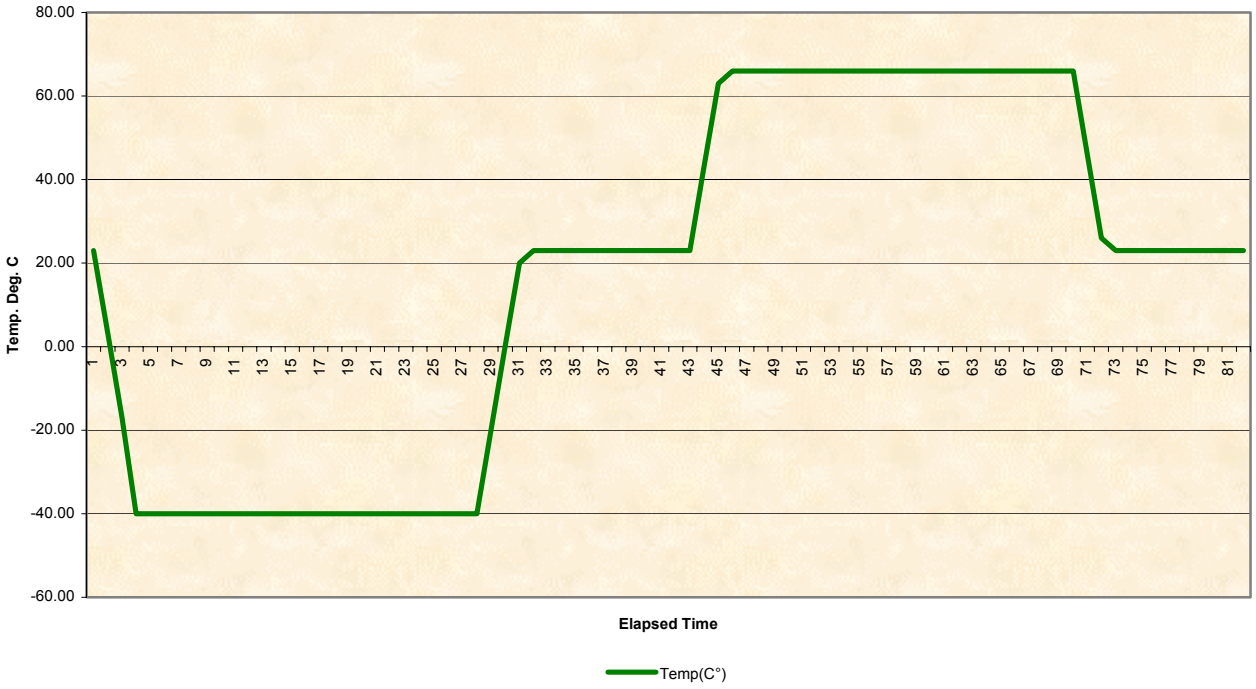
Method:

Five Benchmark DLT VSTape 160 drives are ramped and soaked at the specified temperature gradient to each extreme of the storage and shipment ranges defined in Benchmark DLT VSTape 160 specification (see Table 26 & Graph 1). The drives are soaked for 24 hours and then returned to ambient at the specified temperature gradient and tested for proper functionality with a full tape write/read test program. Part I of the testing is cold soak, and a Part II of the testing is hot soak.

Table 26: Storage/Shipment ranges (unpacked or packed)

Specification Value	
Dry Bulb Temperature	-40 to 66° C
Wet Bulb Temperature	26° C
Temperature Gradient	20° C/h with 5 degree margin (across the range)
Temperature Shock	15° C with 5 degree margin (over 2 minutes)
Relative Humidity	10% to 95% No condensing
Humidity Gradient	10% /h

Graph 1: Storage/Shipment Temperature Profile



Test Equipment:

- Tenney T20RS-1.5 Environmental Chamber
- 5 – VS160 Tape Drives
- User Test Program w /PC

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

Four drives passed, and 1 drive failed the Part I Cold Soak test. The drive firmware revision used during this test was 9.0. Due to the failure in cold soak, hot soak was not completed at that time. Root cause analysis of the failing drives exhibited a hardware failure; the BOT sensor had failed. This failure occurred at, -40°C 24 hr. Cold Soak Test. The failure was logged in TrackStar as issue number 1044. As a result of the failure, regression testing was performed. See 'Test Results Regression' below.

Table 27: Ship/Storage test -40ºC Cold Soak Test, 24hr.

Drive S/N	Tape Cartridge #	Pass/Fail	Write error rates	Read error rates
PHJ2F00047	B0205a567	Pass	0.000969	0.000152
PHJ2F00053	B0205a559	Pass	0.000717	0.000177
PHJ2F00103	B0205a569	Pass	0.001883	0.000228
PHJ2F00011	B0205a565	Pass	0.000391	0.000204
PHJ2F00082	B0205a568	Fail*	0.0	0.0

8.13 Regression Test for Temperature and Humidity Ship / Storage Verification – Section 8.12

Objective:

To regressively test the Benchmark DLT VSTape 160 and verify proper operation after being exposed to the Storage/Shipment environmental conditions specified in the DLT VSTape 160 product specification.

Date Tested:

7/11/2002

Test Engineer:

Michael Doty

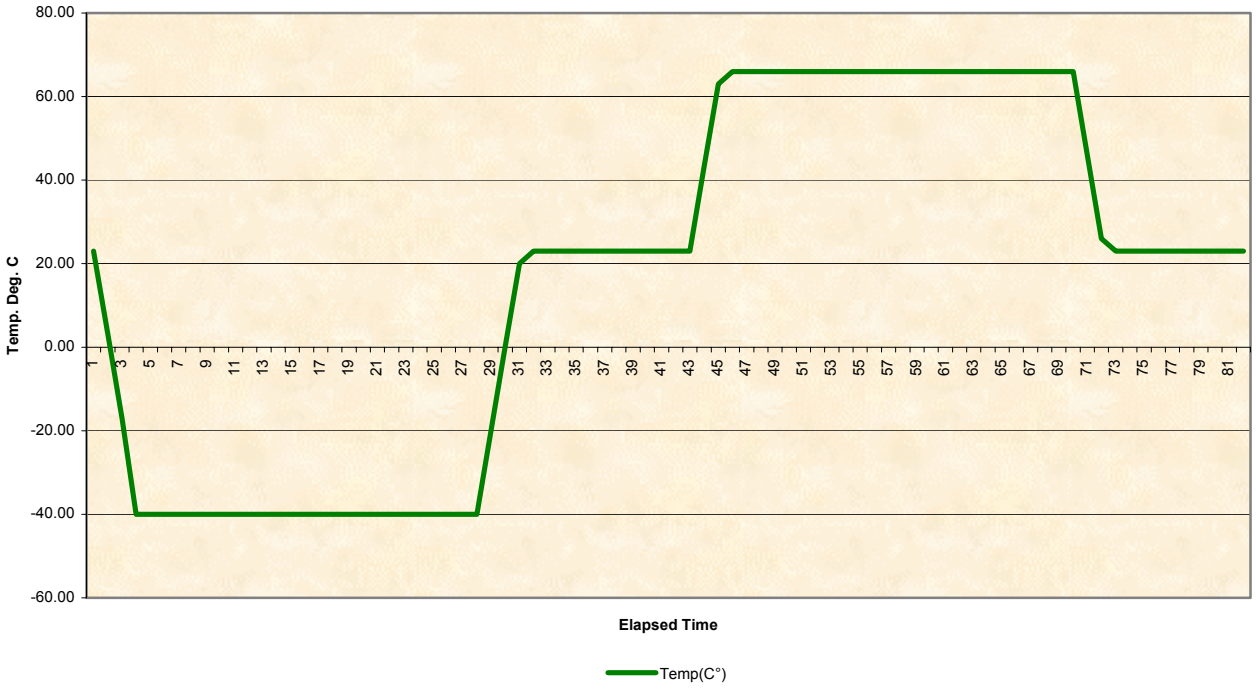
Method:

Ten Benchmark DLT VSTape 160 drives are ramped and soaked at the specified temperature gradient to each extreme of the storage and shipment ranges defined in Benchmark DLT VSTape 160 specification (see Table 28&Graph 2). The drives are soaked for 24 hours and then returned to ambient at the specified temperature gradient and tested for proper functionality with a full tape write/read test program. Part I of the testing is cold soak, and a Part II of the testing is hot soak.

Table 28: Storage/Shipment ranges (unpacked or packed)

Specification Value	
Dry Bulb Temperature	-40 to 66° C
Wet Bulb Temperature	26° C
Temperature Gradient	20° C/h with 5 degree margin (across the range)
Temperature Shock	15° C with 5 degree margin (over 2 minutes)
Relative Humidity	10% to 95% No condensing
Humidity Gradient	10% /h

Graph 2: Storage/Shipment Temperature Profile



Test Equipment:

- Tenney T20RS-1.5 Environmental Chamber
- 5 – VS160 Tape Drives
- User Test Program w /PC

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test result regression:

The failure from the original testing Section 8.12 was a was traced to the EOT/BOT sensor. This part had suffered a hard failure. The part was returned to the vendor for detailed failure analysis. The analysis concluded that an internal wire bond had fractured due to an incorrect loop height, this was a manufacturing processing issue. This was the only failure seen with this part in all of the EVT and DVT testing. Also, this sensor is the same part used in VS80 & DLT1 and no similar issues have been seen with those parts in the field. The vendor has instituted corrective action to ensure the loop height is always correct.

For Part I, cold soak, the failing drive was retested, as well as, an additional test of 10 drives, a total of eleven drives were tested and passed. Fifteen drives were tested for Part II hot soak (hot soak was not attempted in the first pass so five additional drives were added to the ten for regression). During the retest there were no issues and all drives passed the test.

Conclusions

Due to the nature of the failure, and given the fact that there have been no other failures in the whole of EVT and DVT testing with this particular failing part, the risk was considered negligible. **This test is passed and this test is complete.** See Table 29 30 & 31 below.

Table 29: Ship Storage test -40ºC Cold Soak Regression Test

Drive S/N	Tape Cartridge #	Pass/Fail	Write error rates	Read error rates
PHJ2F00082	B0205a568	Pass	0.000130	0.000224

Table 30: Ship/Storage test +66ºC Hot Soak test, 24hr.

Drive S/N	Tape Cartridge #	Pass/Fail	Write error rates	Read error rates
PHJ2F00047	B0205a567	Pass	0.000312	0.000127
PHJ2F00053	B0205a559	Pass	0.000409	0.000143
PHJ2F00103	B0205a569	Pass	0.000331	0.000210
PHJ2F00011	B0205a565	Pass	0.000388	0.000159
PHJ2F00082	B0205a568	Pass	0.000270	0.000492

Table 31 Ship/Storage test -40 ºC Cold Soak Regression Test

Drive S/N	Tape Cartridge #	Pass/Fail	Write error rates	Read error rates
PHJ2F00047	B0205b127	Pass	0.000443	0.001129
PHJ2F00168	B0205b186	Pass	0.000989	0.000772
PHJ2F00144	B0205b195	Pass	0.000353	0.000293
PHJ2F00018	B0205b136	Pass	0.003003	0.002332
PHJ2F00049	B0205b190	Pass	0.000860	0.000335
PHJ2F00032	B0205b198	Pass	0.000878	0.000533
PHJ2F00058	B0205b177	Pass	0.002921	0.003527
PHJ2F00007	B0205b197	Pass	0.001303	0.002342
PHJ2F00108	B0205b149	Pass	0.000601	0.000445
PHJ2F00520	B0205b135	Pass	0.000267	0.000208

9 Functional Testing

9.1 Cartridge Format Exception Testing

Objective:

To determine the proper response to standard types of DLT Media that might be inserted into a DLT VSTape160 drive by an operator or a library.

Dates Tested:

09/04/02

Test Engineer:

Philip J. Smith

Method:

The following cartridges were inserted into to DLT VSTape160 tape drives and the behavior was observed and recorded. The testing was conducted on 20 drives using two different revision of code at ambient room temperature.

- DLT Tape III XT
- DLT Cleaning Tape III
- Digital Compaq Tape III
- SDLT (220 Format)
- SDLT (320 Format)
- SDLT Cleaning Tape
- DLT7000 (Native Format)
- DLT8000 (Native Format)
- DLT8000 (DLT7000 Format)
- DLT7000 (DLT4000 Format)
- DLT8000 (DLT4000 Format)
- DLT4000 Compressed/Non-Compressed Format
- Benchmark Cleaning Tape
- Two suppliers of DLTtape IV (DLT1 and DLT1.5 Format)

Test Setup:

Table 32 Test Cartridges

Cartridge Format Exception Testing	Media Type
DLT tape III XT	Supplier A DLTtape III
DLT Cleaning Tape III	Supplier A DLT Cleaning Tape III
Tape III	Supplier B Tape III
SDLT (220 Format)	Supplier A Super DLTtape I
SDLT (320 Format)	Supplier A Super DLTtape I
SDLT cleaning tape	Supplier A SDLT Cleaning Tape
DLT7000 (Native Format)	Supplier C DLTtape IV
DLT8000 (Native Format)	Supplier C DLTtape IV
DLT8000 (DLT7000 Format)	Supplier C DLTtape IV
DLT7000 (DLT4000 Format)	Supplier C DLTtape IV
DLT8000 (DLT4000 Format)	Supplier C DLTtape IV
DLT4000 Compressed/Non-Compressed Format	Supplier C DLTtape IV
Cleaning Tape	Supplier C DLT1 Cleaning Tape
Tape DLT1 Format	Supplier D DLTtape IV
Tape DLT1 Format	Supplier C DLTtape IV
Tape DLT1.5 Format	Supplier E DLTtape IV
Tape DLT1.5 Format	Supplier C DLTtape IV

Exit Criteria:

All Non-DLT type IV and DLT written formats other than Benchmark's must be ejected from the DLT VSTape160 tape drive. The drive displays correct user patterns for type of Media loaded or ejected. No Severity 1, 2, or 3 issues observed.

Test Results:

With drive firmware revision15.1, all drives were optimized for DLTtape IV tape and the complete set of test cartridges were tested. No failures were observed see Table 33. **This test passed and this test is complete.**

Table 33 Drives Code Revision 15.1 Tested on 09/04/02

DVT Test / Section 9.1	Results	Front Panel LEDS Ready-----Fault-----Clean-----Media				Results
DLT tape III XT	Eject	ON	off	off	BSlow	Pass
DLT Cleaning Tape III	Eject	ON	off	off	BSlow	Pass
Digital Tape III	Eject	ON	off	off	BSlow	Pass
SDLT (220 Format)	Eject	ON	off	off	BSlow	Pass
SDLT (320 Format)	Eject	ON	off	off	BSlow	Pass
SDLT Cleaning Tape	Eject	ON	off	off	BSlow	Pass
DLT7000 (Native Format)	Eject	ON	off	off	BSlow	Pass
DLT8000 (Native Format)	Eject	ON	off	off	BSlow	Pass
DLT8000 (DLT7000 Format)	Eject	ON	off	off	BSlow	Pass
DLT7000 (DLT4000 Format)	Eject	ON	off	off	BSlow	Pass
DLT8000 (DLT4000 Format)	Eject	ON	off	off	BSlow	Pass
DLT4000 Compressed/ Non-Compressed Format	Eject	ON	off	off	BSlow	Pass
Tape DLT1 Format	Load	ON	off	off	ON	Pass
Tape DLT1 Format	Load	ON	off	off	ON	Pass
Tape DLT1.5 Format	Load	ON	off	off	ON	Pass
Tape DLT1.5 Format	Load	ON	off	off	ON	Pass
Cleaning Tape	Load/Clean/Eject	Clean LED During Cleaning				Pass

9.2 Cartridge Mechanical Exception Testing

Objective:

The DLT VSTape160 tape drive will be tested for a several mechanical tape conditions that could be encountered in the field.

Dates Tested:

08/21/02

Test Engineer:

Philip J. Smith

Test Method:

The testing was conducted on 20 drives at ambient room temperature. Tapes in various conditions, as defined below, were inserted into the DLT VSTape 160 drive to ensure the drive remains fully functional and recovers from these abnormal tapes. The tapes were loaded 5 times each per drive for a total of 100 load cycles. Behavior was observed and recorded.

- Completed Leader
- Missing Leader
- Broken Buckle
- Ripped Leader
- Curled Leader
- 1/8” Pullout on standard Leader (x5 per drive)
- 1/4" Leader Pushback on standard Leader (x5 per drive)
- 1/2" Leader Pushback on standard Leader (x5 per drive)
- Jammed Cartridge

Test Setup:

Table 34 Test Cartridges

DVT Test / Section 9.2 Cartridge Mechanical Exception Testing	Media Type	Reference Picture
Completed Leader	VStape	Figure 12
Missing Leader	VStape	Figure 13
Broken Buckle	VStape	Figure 14
Ripped Leader	VStape	Figure 15
Curled Leader	VStape	Figure 16
1/8" Pullout (x5)	VStape	Figure 17
1/4" Leader Pushback (x5)	VStape	Figure 17
1/2" Leader Pushback (x5)	VStape	Figure 17
Jammed Cartridge	VStape	N/A

Complete Leader

Figure 12

Tape has a complete leader in the proper position.

Missing Leader

Figure 13

Tape cartridge is missing the tape cartridge leader.

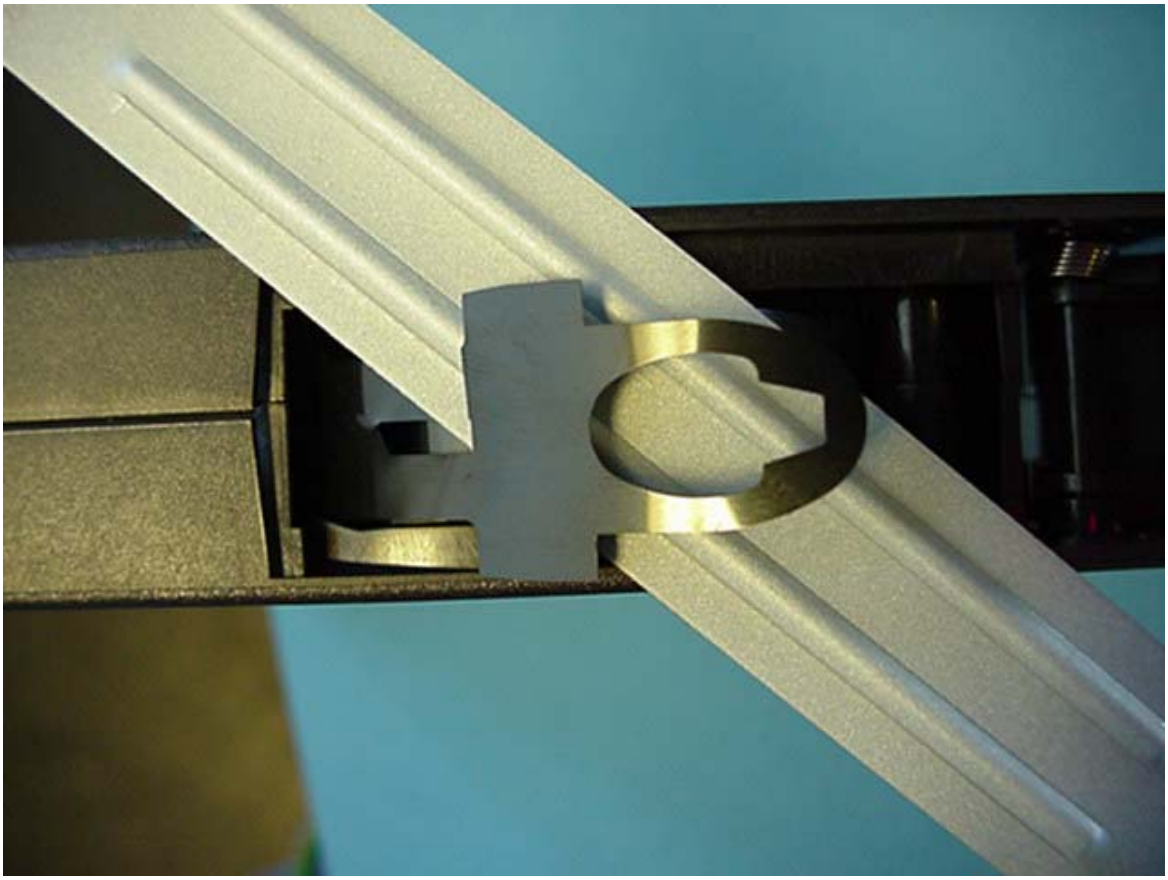
Broken Buckle

Figure 14

Tape has the tip of the buckle broken off.

Ripped Leader

Figure 15



Tape has the leader ripped in half just behind the shoulder.

Curled leader

Figure 16

Tape leader is curled such that it is no longer in the correct position.

Leader Pushed Back

Figure 17

Tape leader is in the correct position but the tape is not wound with the correct tension since the leader has been pushed back into position. The 1/8" test cartridge looks similar except that the leader is to the right by 1/8".

Jammed Cartridge

The jammed tape cartridge has the load hub jammed so it will not rotate. Since it is internal to the cartridge, there is not picture.

Exit Criteria:

Drive should correctly buckle and load tape cartridge or eject the tape cartridge. Drive displays correct user patterns for type of Media loaded or ejected. No Severity 1, 2, or 3 issues observed.

Test Results:

All cartridges were tested on all drives with drive firmware revision 15.0.
All tests passed, see Table 35 below. **This test passed and this test is complete.**

Table 35 Drives Tested Code Revision 15.0 on 08/21/02

DVT Test / Section 9.2 Cartridge Mechanical Exception Testing	Media Type	Results	Front Panel LEDS Ready-----Fault-----Clean-----Media				Test Results
Completed Leader	VStape	Load	ON	off	off	off	Pass
Missing Leader	VStape	Eject	ON	off	off	BSlow	Pass
Broken Buckle	VStape	Eject	ON	off	off	BSlow	Pass
Ripped Leader	VStape	Eject	ON	off	off	BSlow	Pass
Curled Leader	VStape	Eject	ON	off	off	off	Pass
1/8" Pullout (x5)	VStape	Load	ON	off	off	off	Pass
1/4" Leader Pushback (x5)	VStape	Load	ON	off	off	off	Pass
1/2" Leader Pushback (x5)	VStape	Load	ON	off	off	off	Pass
Jammed Cartridge	VStape	Eject	ON	off	off	BSlow	Pass

9.3 *Lost Leader Exception Test*

Objective:

To verify the Benchmark DLT VSTape160 drive can recover from a “lost leader” condition and become ready for the next operator function or SCSI command. A “lost leader” is defined as a condition where the entire takeup leader is pulled into the takeup reel and the mushroom tip of the leader is no longer anchored to the leader buckle. This condition can occur when a misbuckle causes the takeup leader to disengage from the cartridge leader as the takeup motor is winding the leader around the takeup reel.

Date Tested:

Sept 30, 2002

Test Engineer:

Glenn Davis

Test Equipment:

- Benchmark VSTape160 Tape Drive

Serial Number:	PHJ2F00182
Mechanical Rev:	4.0
PCBA Rev:	5.0
Firmware Rev :	15.5

- DLT Tape IV Cartridge: B0205b186

Test Method:

The Benchmark VSTape160 drive is powered on and allowed to initialize and come ready (see Figure 18). With power still on, the takeup leader is removed from the drive. The drive is then powered off and the takeup hub is rotated clockwise until the takeup hub contacts the leader buckle (see Figure 19). The drive is then powered on and allowed to initialize and come ready. A DLT Tape IV cartridge is then inserted. The takeup hub will begin to spin and after several attempts to load the cartridge, the drive should eject the cartridge. The takeup hub is then rotated clockwise until it contacts the leader buckle. The cartridge is then inserted a second time and when the takeup hub begins to spin, power is removed from the drive. The drive is then powered on and after several attempts to load the cartridge, the drive should eject the tape. This procedure is repeated 5 times.

Test Setup:

Figure 18: Drive PHJ2F00136 (take-up leader installed)

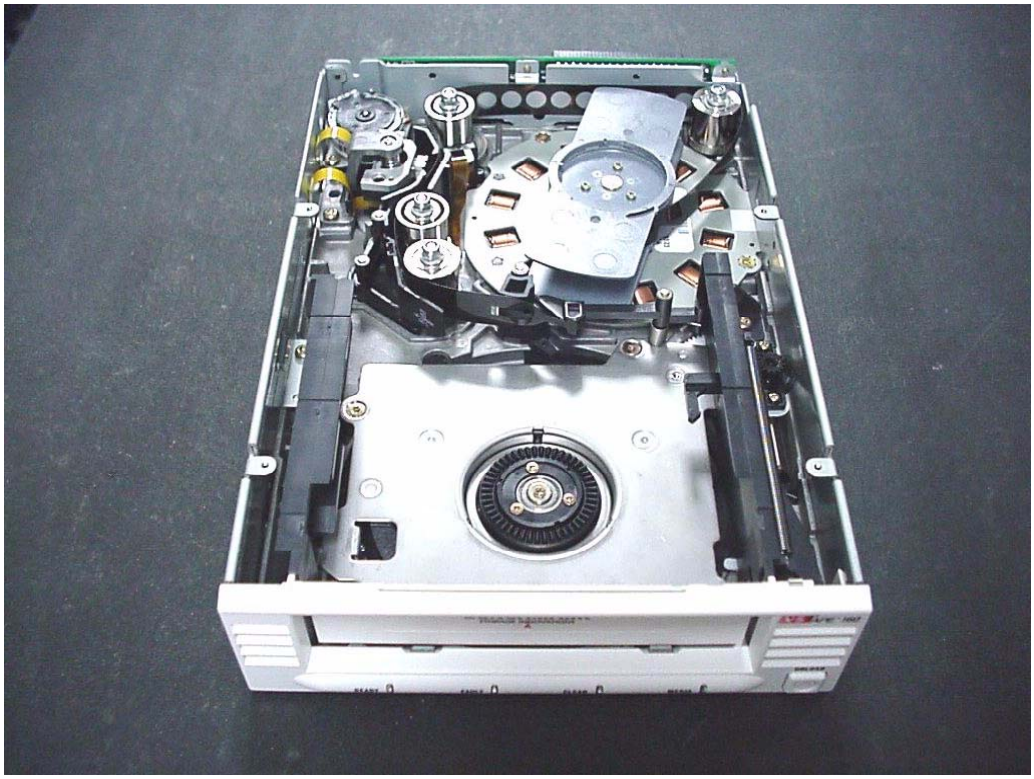
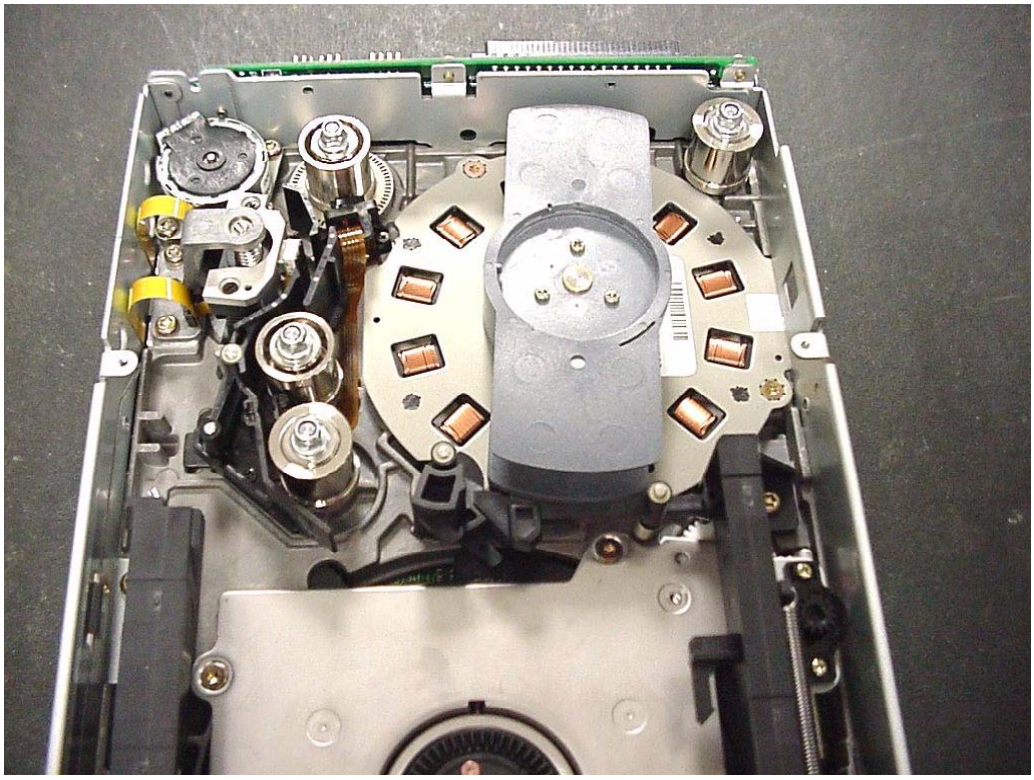


Figure 19: Drive PHJ2F00136 (take-up leader removed-hub at leader buckle)



Exit Criteria:

The tape drive should eject the DLT Tape IV cartridge after several attempts to load. After ejecting the tape, the drive should be ready for the next operator function or SCSI command.

Test Results Regression:

The drives were tested using firmware revision 16.0. The test completed successfully. **This test passed and this test is complete.**

9.4 Code Load Verification

Objective:

The objective of this test is to verify functionality of the firmware upgrade programs provided on the Benchmark Storage Innovations website; specifically, Flash ASPI (Windows), VS160 Drive Diag, DLT CUP(Linux), a Flash ASPI cuptape, and a VS160 Drive Diag cuptape.

Date Tested:

July 10, 2002

Test Engineer:

Glenn Davis

Test Equipment:

3 Benchmark VSTape160 Tape Drives and DLT Tape IV Cartridges

Table 36

Drive #	Mechanical Rev	PCBA Rev	Firmware Rev	DLT Tape IV Cartridge
PHJ2F00147	4.0	5.0	6.0	B0206a214
PHJ2F00200	4.0	5.0	6.0	B0205a122
PHJ2F00182	4.0	5.0	6.0	B0205a121

- Personal Computer Workstation

CPU:	600 MHz, Celeron processor
RAM:	384 MB RAM
SCSI Adapter:	Adaptec 29160 (x2) SCSI card
Dual Boot Operating System:	Microsoft Windows NT
	Linux Mandrake 8.0
Firmware Upgrade Programs:	Flash Aspi (Windows)
	VS160 Drive Diag
	DLT CUP(Linux)
Benchmark VS160 Device Driver:	5.1.118.13 (dlt1vs.sys)

- Serial Interface Program — Tera Term Pro Version 2.3

- Firmware Image Files
  - 64_dlt2_V10_U.image
  - 64_dlt2_V10-1_U.image

Test Method:

The firmware image on the VSTape 160 drive is updated using the following methods:

- Flash Aspi
- VS160 Drive Diag
- DLT CUP(Linux)
- Flash ASPI cuptape
- VS160 Drive Diag cuptape

The firmware version is then verified via the serial port and Tera Term Pro Version 2.3. Testing was done on 3 drives with each method.

Exit Criteria:

The firmware image should be successfully upgraded at the completion of the upgrade process. The tape drive should be ready for the next operator function or SCSI command.

Test Results:

The three drives tested were successfully upgraded and verified using all the above firmware image upgrade methods. The drives met all exit criteria for this test. **This test passed and this test is complete.**

9.5 SCSI Specification Compliance Verification

Objective:

The objective of this test is to verify that the SCSI command set on the Benchmark DLT VSTape160 complies with the Benchmark DLT VSTape 160 SCSI specification and the applicable ANSI SCSI specifications.

Dates Tested:

08/28/02 - 08/30/02

Test Engineer:

Piotr Polanowski

Method:

The DLT VSTape160 tape drive is tested using the SCSI command set verification test suite to validate the product is compliant with the Benchmark SCSI specification.

The test program validates a proper response from the drive in the case of all valid and invalid settings in the command data blocks. See11.1 Appendix A – Percept DVT Test Suite for more information about tests performed as part the compliance suite.

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product and SCSI specifications.

Test Results:

The total of five drives were tested to verify SCSI compliance. Three drives were used to run "Persistent Reserve", "Reserve Release" and "Reports" tests. Two drives were used to perform "Reserved Bits" test. All drives passed the tests without failures. **This test passed and this test is complete.**

9.6 SCSI Data Transfer Operations

Objective:

To verify the Benchmark DLT VSTape 160 drive is capable of performing data transfer to tape within all aspects of the design parameters.

Test Method:

The DLT VSTape 160 tape drive was tested using the PFT and DVT and Compression test suites. These tests verified that the DLT VSTape 160 drive complied with all applicable SCSI specification while in the data transfer mode of operation. All test were performed in Low Voltage Differential (LVD) SCSI Bus mode. In addition, a functional validation subset was done in Single Ended mode (SE).

Drives were tested and configured as follows; a total of 3 Host PCs were used with 2 Host Bus Adaptors (HBA's) per Host, 3 drives attached to each Host Bus Adaptor. Drives were connected to the Hosts using shielded high-density cables and terminated with an active LVD/SE terminator.

A total of 18 drives were tested at ambient temperature using the Acceptance Suite, Product Functionality Test (PFT) and followed with an in depth Advanced Functionality Test (DVT) Suite. Upon successful completion of the PFT/DVT test suite a Compression test suite was completed, see Table 37 & 11.1Appendix A – Percept DVT Test Suite.

A functional validation subset was completed in the Single Ended Mode using 3 drives configured in the same manner as the initial 18 drives with the following exception, drives were terminated with SE terminator. The drives were tested using the PFT Test Suite.

Dates Tested:

07/03/02 - 08/26/02

Test Engineer:

Philip J. Smith

Table 37 PFT/DVT Test Descriptions and Individual Run Times of each Test

PFT Run Time	DVT Run Time	Test Number	Test Description
0:02	0:02	02	Basic SCSI Commands Test.
0:01	0:01	04	Basic Positioning Test.
0:01	0:01	06	More Positioning Test.
1:24	4:45	08	Writing variable size records (to 65534) Test.
0:02	0:02	10	Write/Read Variable (different block sizes) Test.
0:27	1:45	12	Write/Read Incrementing Records, Fixed Mode Test.
2:12	18:02	14	Write Random size Records and Locates Test.
0:16	3:19	16	Write/Read/Append Records Test.
0:01	2:39	18	Write/Read/Locate, Fixed Mode Test.
0:54	17:19	20	Emulate backup applications. Test
0:35	5:42	22	Write/Read Number incrementing, Length decrementing Test.
1:11	16:21	24	Write Read Space Test
0:04	0:04	26	Write Stop Writes and Read Test.
9:52	11:56	28	Write, Read, Locate to EOM Test.
0:38	6:48	32	Appends Test.
0:07	0:34	38	Write Read All Repeat Test.

Test Setup:

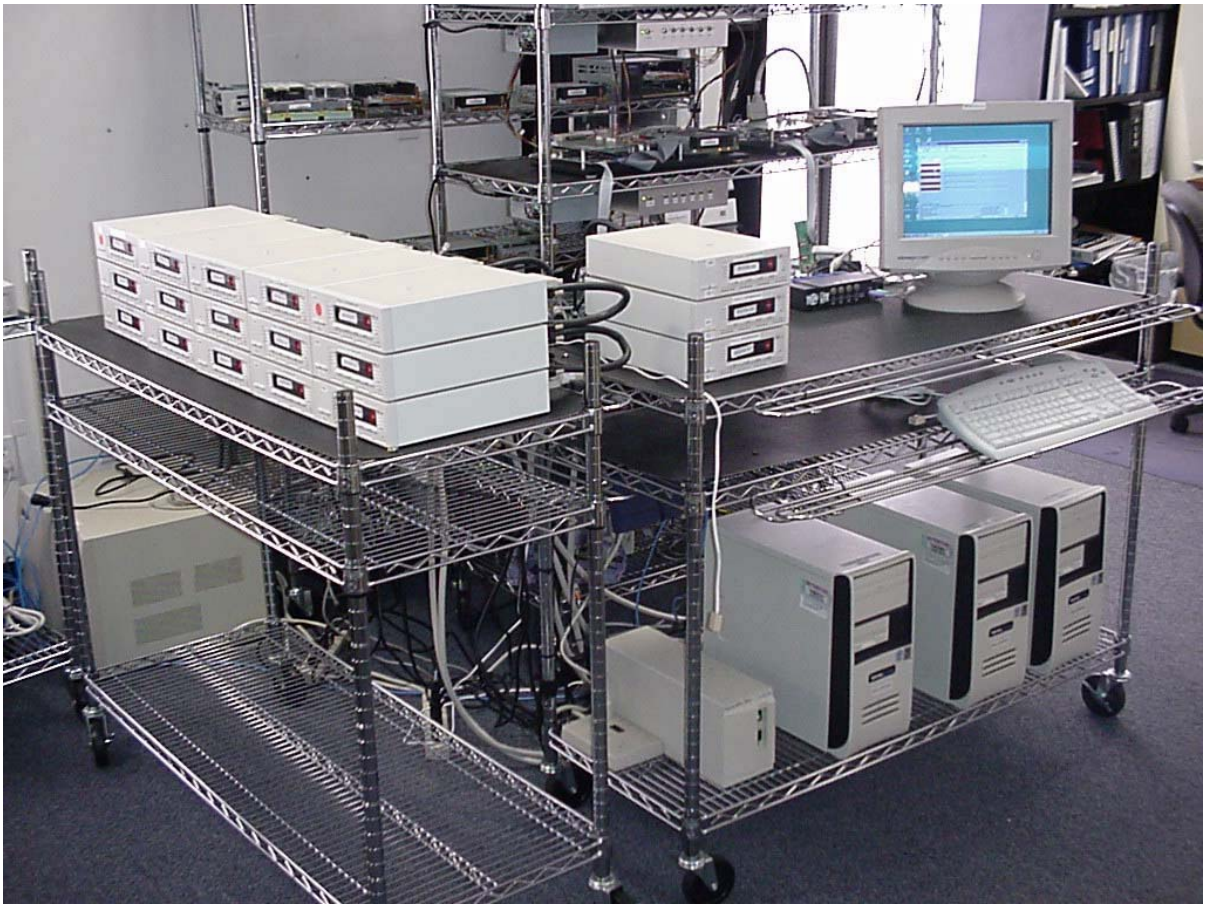
Three Micron PC Millennia PCs each configured with the following hardware

- 600 MHz, Celeron processor
- 384 MB RAM
- Adaptec 29160 (x2) SCSI card

Three Micron PC Millennia PCs each configured with the following Software

- Microsoft Window NT
- WinSCSI / PFT/DVT test designed by Percept Technology for use on Benchmark products.
- TeraTerm/Serial Communication interface used for drive Diagnostics

Table 38 Test Set-up Data Transfer



Exit Criteria:

All drives tested in Low Voltage Differential (LVD) SCSI Bus mode and Single Ended mode must pass without persistent severity 1 or 2 issues and with no permanent read errors. The product meets the DLT VSTape 160 product specifications

Test Results:

Eighteen drives were tested and there were 60 failures during the testing.

Note: Because each failure was logged as a separate TrackStar issue, there are many duplicate failures i.e.- one failure mode can generate many TrackStar issues.

The follow drive firmware revisions were upgraded during the testing to eliminate particular failure modes. As a result of the failures, regression testing was required. See 'Test Results Regression' below.

- Revision 10.0
- Revision 10.1
- Revision 10.3
- Revision 11.0
- Revision 12.1

Table 39 Failure Data on Tested Drives

Drive S/N	Tape S/N	Test Date	Test Run	Firmware Revision	TrackStar Issue #
PHJ2F00068	B0205a629	7/5/2002	PFT Test Suite	10	1046
PHJ2F00071	B0205a576	7/5/2002	PFT Test Suite	10	1046
PHJ2F00087	B0205a623	7/5/2002	PFT Test Suite	10	1046
PHJ2F00136	B0205a624	7/3/2002	PFT Test Suite	10	1046
PHJ2F00002	B0205a578	7/3/2002	PFT Test Suite	10	1047
PHJ2F00016	B0205a564	7/3/2002	PFT Test Suite	10	1048
PHJ2F00016	B0205a113	7/5/2002	PFT Test Suite	10	1053
PHJ2F00038	B0205a625	7/5/2002	PFT Test Suite	10	1055
PHJ2F00045	B0205a626	7/8/2002	PFT Test Suite	10	1055
PHJ2F00077	B0205a571	7/5/2002	PFT Test Suite	10	1055
PHJ2F00099	B0205a562	7/5/2002	PFT Test Suite	10	1055
PHJ2F00094	B0205a619	7/5/2002	PFT Test Suite	10	1056
PHJ2F00063	B0205a622	7/8/2002	PFT Test Suite	10	1058
PHJ2F00252	B0205a612	7/8/2002	PFT Test Suite	10	1059
PHJ2F00252	B0205a612	7/9/2002	PFT Test Suite	10	1062
PHJ2F00038	B0205a625	7/10/2002	PFT Test Suite	10.1	1071
PHJ2F00052	B0205a627	7/10/2002	PFT Test Suite	10.1	1072
PHJ2F00045	B0205a626	7/10/2002	PFT Test Suite	10.1	1075
PHJ2F00087	B0205a623	7/10/2002	PFT Test Suite	10.1	1076

PHJ2F00252	B0205a118	7/11/2002	PFT Test Suite	10.1	1079
PHJ2F00009	B0205a570	7/12/2002	PFT Test Suite	10.3	1081
PHJ2F00045	B0205a112	7/12/2002	PFT Test Suite	10.3	1082
PHJ2F00052	B0205a106	7/12/2002	PFT Test Suite	10.3	1083
PHJ2F00077	B0205a571	7/12/2002	PFT Test Suite	10.3	1084
PHJ2F00094	B0205a114	7/12/2002	PFT Test Suite	10.3	1085
PHJ2F00099	B0205a562	7/12/2002	PFT Test Suite	10.3	1086
PHJ2F00130	B0205a611	7/12/2002	DVT Test Suite	10.3	1087
PHJ2F00016	B0205a108	7/15/2002	DVT Test Suite	10.3	1100
PHJ2F00018	B0205a572	7/15/2002	PFT Test Suite	10.3	1101
PHJ2F00068	B0205a629	7/15/2002	DVT Test Suite	10.3	1102
PHJ2F00077	B0205a571	7/15/2002	PFT Test Suite	10.3	1103
PHJ2F00130	B0205a611	7/15/2002	PFT Test Suite	10.3	1104
PHJ2F00006	B0205a637	7/16/2002	DVT Test Suite	10.3	1109
PHJ2F00038	B0205a107	7/16/2002	DVT Test Suite	10.3	1110
PHJ2F00087	B0205a623	7/16/2002	DVT Test Suite	10.3	1111
PHJ2F00002	B0205a578	7/17/2002	PFT Test Suite	11	1115
PHJ2F00009	B0205a570	7/17/2002	PFT Test Suite	11	1116
PHJ2F00016	B0205a108	7/17/2002	PFT Test Suite	11	1117
PHJ2F00035	B0205a575	7/17/2002	PFT Test Suite	11	1118
PHJ2F00068	B0206a205	7/17/2002	PFT Test Suite	11	1119
PHJ2F00058	B0205a605	7/17/2002	PFT Test Suite	11	1120
PHJ2F00099	B0205a562	7/17/2002	PFT Test Suite	11	1121
PHJ2F00068	B0206a627	7/19/2002	DVT Test Suite	11	1122
PHJ2F00087	B0205a623	7/23/2002	DVT Test Suite	11	1162
PHJ2F00002	B0205a578	7/26/2002	DVT Test Suite	11	1171
PHJ2F00038	B0205a107	7/23/2002	DVT Test Suite	11	1171
PHJ2F00052	B0205a106	7/26/2002	DVT Test Suite	11	1171
PHJ2F00052	B0205a106	7/29/2002	DVT Test Suite	11	1171
PHJ2F00099	B0205a562	7/26/2002	DVT Test Suite	11	1171
PHJ2F00130	B0206a204	7/26/2002	DVT Test Suite	11	1171
PHJ2F00130	B0206a204	7/29/2002	DVT Test Suite	11	1171
PHJ2F00008	B0205a628	7/23/2002	DVT Test Suite	11	1183
PHJ2F00168	B0205a608	7/23/2002	DVT Test Suite	11	1184
PHJ2F00006	B0205a637	7/26/2002	DVT Test Suite	11	1193
PHJ2F00045	B0205a112	7/26/2002	DVT Test Suite	11	1194
PHJ2F00058	B0205a605	7/26/2002	DVT Test Suite	11	1195
PHJ2F00147	B0206a214	7/26/2002	DVT Test Suite	11	1196
PHJ2F00011	B0205a565	7/29/2002	DVT Test Suite	11	1208
PHJ2F00168	B0205a639	7/29/2002	DVT Test Suite	11	1208
PHJ2F00215	B0206b201	8/6/2002	PFT Test Suite	12.1	1220

9.7 Regression Test for SCSI Data Transfer Operations – Section 9.6

Objective:

To regressively test the Benchmark DLT VSTape 160 drive and verify that it is capable of performing data transfer to tape within all aspects of the design parameters.

Test Method:

The DLT VSTape 160 tape drive was tested using the PFT and DVT and Compression test suites. These tests verified that the DLT VSTape 160 drive complied with all applicable SCSI specification while in the data transfer mode of operation. All test were performed in Low Voltage Differential (LVD) SCSI Bus mode. In addition, a functional validation subset was done in Single Ended mode (SE).

Drives were tested and configured as follows; a total of 3 Host PCs were used with 2 Host Bus Adaptors (HBA's) per Host, 3 drives attached to each Host Bus Adaptor. Drives were connected to the Hosts using shielded high-density cables and terminated with an active LVD/SE terminator.

A total of 18 drives were tested at ambient temperature using the Acceptance Suite, Product Functionality Test (PFT) and followed with an in depth Advanced Functionality Test (DVT) Suite. Upon successful completion of the PFT/DVT test suite a Compression test suite was completed, see Table 37 & 11.1Appendix A – Percept DVT Test Suite.

Dates Tested:

08/28/02 - 09/04/02

Test Engineer:

Philip J. Smith

Table 40 PFT/DVT Test Descriptions and Individual Run Times of each Test

PFT Run Time	DVT Run Time	Test Number	Test Description
0:02	0:02	02	Basic SCSI Commands Test.
0:01	0:01	04	Basic Positioning Test.
0:01	0:01	06	More Positioning Test.
1:24	4:45	08	Writing variable size records (to 65534) Test.
0:02	0:02	10	Write/Read Variable (different block sizes) Test.
0:27	1:45	12	Write/Read Incrementing Records, Fixed Mode Test.
2:12	18:02	14	Write Random size Records and Locates Test.
0:16	3:19	16	Write/Read/Append Records Test.
0:01	2:39	18	Write/Read/Locate, Fixed Mode Test.
0:54	17:19	20	Emulate backup applications. Test
0:35	5:42	22	Write/Read Number incrementing, Length decrementing Test.
1:11	16:21	24	Write Read Space Test
0:04	0:04	26	Write Stop Writes and Read Test.
9:52	11:56	28	Write, Read, Locate to EOM Test.
0:38	6:48	32	Appends Test.
0:07	0:34	38	Write Read All Repeat Test.

Test Setup:

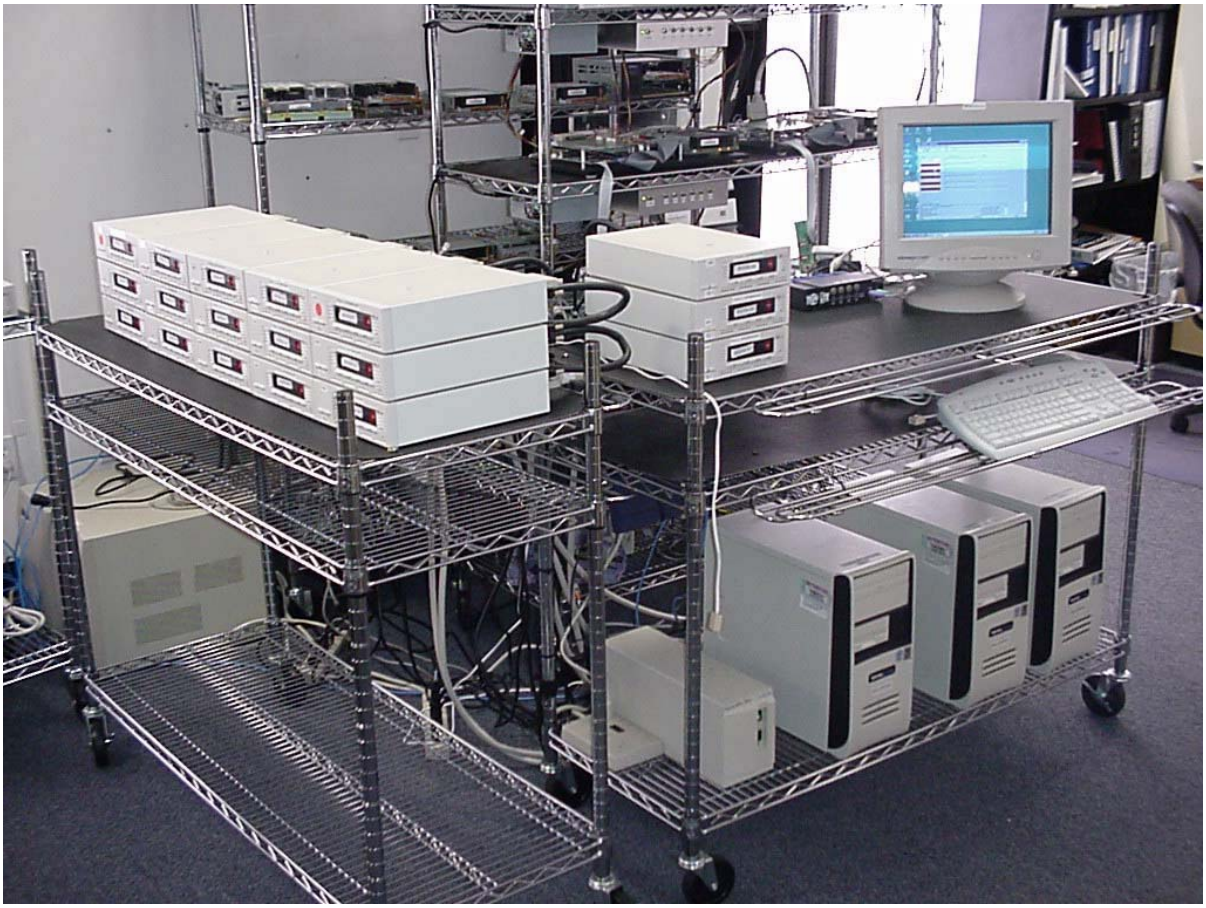
Three Micron PC Millennia PCs each configured with the following hardware

- 600 MHz, Celeron processor
- 384 MB RAM
- Adaptec 29160 (x2) SCSI card

Three Micron PC Millennia PCs each configured with the following Software

- Microsoft Window NT
- WinSCSI / PFT/DVT test designed by Percept Technology for use on Benchmark products.
- TeraTerm/Serial Communication interface used for drive Diagnostics

Table 41 Test Set-up Data Transfer



Exit Criteria:

All drives tested in Low Voltage Differential (LVD) SCSI Bus mode must pass without persistent severity 1 or 2 issues and with no permanent read errors. The product meets the DLT VSTape 160 product specifications

Test Result Regression :

Engineering analysis of drives from the original test failures (Section 9.6) indicated that there were two issues that needed to be corrected. The surface finish of Roller 3 had changed since the original mechanism build. This was deemed to be the root cause of a large LTM on the entire failing drive lot. This issue was corrected at the roller vendor and the rollers were replaced on all of the test drives. In addition, the factory-setting of the head azimuth was found to be incorrect. The head-azimuth station software and the manufacturing process were updated to correct this issue. The LTM and head-azimuth were verified on all of the drives and the test was rerun. A number of firmware updates to handle certain error conditions were made as well.

All eighteen drives passed the full regression test suite. **This test has passed and this test is complete.**

Table 42 Regression SCSI Data Transfer Results

Drive S/N	Test Complete Date	Code Rev.	Test Results
PHJ2F00128	7/5/2002	15.1	Pass
PHJ2F00016	7/5/2002	15.1	Pass
PHJ2F00162	7/5/2002	15.1	Pass
PHJ2F00215	7/3/2002	15.1	Pass
PHJ2F00070	7/3/2002	15.1	Pass
PHJ2F00065	7/3/2002	15.1	Pass
PHJ2F00113	7/5/2002	15.1	Pass
PHJ2F00077	7/5/2002	15.1	Pass
PHJ2F00025	7/8/2002	15.1	Pass
PHJ2F00102	7/5/2002	15.1	Pass
PHJ2F00002	7/5/2002	15.1	Pass
PHJ2F00031	7/5/2002	15.1	Pass
PHJ2F00085	7/8/2002	15.1	Pass
PHJ2F00212	7/8/2002	15.1	Pass
PHJ2F00094	7/9/2002	15.1	Pass
PHJ2F00011	7/10/2002	15.1	Pass
PHJ2F00036	7/10/2002	15.1	Pass
PHJ2F00046	7/10/2002	15.1	Pass

9.8 Tape Spanning and Data Restore

Objective:

To verify the Benchmark DLT VSTape160 drive is capable of performing data transfer to tape within all aspects of the design parameters. To verify the ability to span tape and data recovery from the span using an industry standard backup application.

Date Tested:

09/05/02

Test Engineer:

Neil Simon

Test Equipment:

- Benchmark VSTape160 Tape Drive

Serial Number:	PHJ2F00082
Mechanical Rev:	4.0
PCBA Rev:	5.0
Firmware Rev :	15.1
DLT Tape IV Cartridge:	B0205a619

- Windows 2000 Server

Mainboard:	Intel D850MV
CPU:	Intel Pentium 4 @ 1.6 GHz
RAM:	512 MB @ 800 MHz (RDRAM)
SCSI Drive 1 (boot):	External Seagate 18.4 GB
SCSI Drive 2 (dataset):	External Seagate 18.4 GB
Video Adapter:	Isolated 32 MB AGP
SCSI Adapter 1:	Adaptec 29160
SCSI Adapter 2:	Adaptec 29160
Operating System:	Windows 2000 Server, SP3
ISV Backup Package:	ARCserve 2000 Advanced Edition Ver 7.0, Build 1086
Benchmark VS160 Driver:	5.1.118.13 (dlt1vs.sys)

Test Method:

Span Test – This test performed a backup and restore using a VSTape 160 tape drive and 2 VSTapes. The backup and recovery were accomplished with an ISV backup software package (CA ARCserve) and a source dataset that exceeded the 80 GB capacity of a single VSTape cartridge. The size of the backup dataset for this test was approximately 100 GB. During the ISV backup job, when the first cartridge reached it's capacity, the ISV software requested that a second cartridge be mounted, resulting in the remainder of the source dataset, approximately 20 GB, being written to the second cartridge. This is referred to as a "tape span" condition. Upon completion of the span backup, a restore job was run, ensuring that the spanned data could be successfully restored from tape to disk. This was done by first erasing the entire destination disk data, and initiating the spanned tape restore job. The ARCserve 2000 backup utility generates an output log (ARCserve.log) which documents the backup and restore operation and indicates the outcome of each step in the backup and restore process.

Exit Criteria:

All drives pass without persistent severity 1 or 2 issues and with no permanent read errors. The product must meet the DLT VSTape 160 product specifications.

Test Results:

The span test was accomplished with no errors and after being restored to the original hard drive, the dataset was verified successfully. The VSTape 160 tape drive met all exit criteria for the test. The ARCserve 2000 output log indicated the successful completion of the backup and restore process (see ARCserve Output Log see: Appendix B). **This test passed and this test is complete.**

9.9 SCSI Based Reset and Command Exception Testing

Objective:

The objective of this test is to verify that the DLT VSTape 160 tolerates asynchronous SCSI resets during all phases of Drive functionality.

Method:

A special SCSI-based program tests the drive for asynchronous resets during all phases of drive operation. This will cause a result pulse of at least 100ms to be generated during the following modes of operation: Load, Calibrate, Write, Read, Rewind, and Unload.

SCSI Reset testing is accomplished using the Oppco 1850 Controller card in LVD mode. A minimum of 3 drives will be tested multiple times in the following modes.

All 3 drives will be on the SCSI bus. Tapes are ejected from any Ready drives by the test. The operator is requested to insert the tapes. Test Unit Ready and Request Sense commands are issued while the drives were loading. When the first drive reports tape loading in the Sense Byte 12. The value for no tape present is 3A hex, the value changes to 04 when the drive starts to load. When this change is detected in the first drive, SCSI Bus Resets are issued at 50 and 100 millisecond intervals.

Load – SCSI resets are issued asynchronously while the drives are loading, Resets are issued at 50 and 100 millisecond intervals during the load sequence.

Calibrate – SCSI resets are issued asynchronously while the drives is loading. Resets are issued at 50 and 100 millisecond intervals during the load sequence.

Rewind – All six drives should report good status to Test Unit Ready, all drives successfully complete the load and calibrate sequence, data is then written to move away from the beginning of tape. A Rewind is issued and SCSI Bus Resets are issued at the 50 & 100 millisecond intervals.

Read – The data written to move tape away from the Beginning of Tape is read. While the read is in progress, a Reset is issued from the keyboard. A Test Unit Ready and Request Sense are then issued. All drives are required to report Check Condition and a Sense Key of 06 (Unit Attention).

Write – PFT28W is started on all drives and while the data are being written Resets are issued using the keyboard. A Test Unit Ready and Request Sense were then issued. All drives are required to report Check Condition and a Sense Key of 06 (Unit Attention.)

Exit Criteria:

Product exhibits no persistent severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification

Date Tested:

07/01/02

Test Engineer:

Jim Werder

Results:

The VS160 drive did not pass one phase of reset testing. The failure mode was due to the host issuing SCSI Bus Resets repeatedly during the drives Calibration sequence when loading a tape. In some cases the VS160 would not be available on the bus within the tests recommended 250ms maximum limit. See Section 9.10 below for regression test and root cause results.

9.10 Regression Test for SCSI Based Reset and Command Exception Testing – Section 9.9

Objective:

To regressively test to verify that the DLT VSTape 160 tolerates asynchronous SCSI resets during all phases of Drive functionality.

Method:

A special SCSI-based program tests the drive for asynchronous resets during all phases of drive operation. This will cause a result pulse of at least 100ms to be generated during the following modes of operation: Load, Calibrate, Write, Read, Rewind, and Unload.

SCSI Reset testing is accomplished using the Oppco 1850 Controller card in LVD mode. A minimum of 3 drives will be tested multiple times in the following modes.

All 3 drives will be on the SCSI bus. Tapes are ejected from any Ready drives by the test. The operator is requested to insert the tapes. Test Unit Ready and Request Sense commands are issued while the drives were loading. When the first drive reports tape loading in the Sense Byte 12. The value for no tape present is 3A hex, the value changes to 04 when the drive starts to load. When this change is detected in the first drive, SCSI Bus Resets are issued at 50 and 100 millisecond intervals.

Load – SCSI resets are issued asynchronously while the drives are loading, Resets are issued at 50 and 100 millisecond intervals during the load sequence.

Calibrate – SCSI resets are issued asynchronously while the drives is loading. Resets are issued at 50 and 100 millisecond intervals during the load sequence.

Rewind – All six drives should report good status to Test Unit Ready, all drives successfully complete the load and calibrate sequence, data is then written to move away from the beginning of tape. A Rewind is issued and SCSI Bus Resets are issued at the 50 & 100 millisecond intervals.

Read – The data written to move tape away from the Beginning of Tape is read. While the read is in progress, a Reset is issued from the keyboard. A Test Unit Ready and Request Sense are then issued. All drives are required to report Check Condition and a Sense Key of 06 (Unit Attention).

Write – PFT28W is started on all drives and while the data are being written Resets are issued using the keyboard. A Test Unit Ready and Request Sense were then issued. All drives are required to report Check Condition and a Sense Key of 06 (Unit Attention.)

Exit Criteria:

Product exhibits no persistent severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification

Date Tested:

09/11/02

Test Engineer:

Jim Werder

Issue Resolution:

There are four periods during the VS160 load sequence that if a SCSI Bus Reset is received the drive can't respond within 250ms to a subsequent command. The drive is performing calibration sequences that can't be interrupted at these times. A subsequent command will be accepted within a maximum of 600ms instead of the 250ms expected by the test. However, the ANSI SCSI specification specifies that it is "recommended" that a SCSI device be ready for subsequent SCSI command within 250ms, it is not required. All other reset cases tested meet the "recommended" 250ms. The SCSI Bus Reset Test case was modified to allow a 600ms timing versus the 250ms timing for the 'Reset During Load portion' of the test. Additional test sequences were instituted to simulate real world Host Bus Adapter boot-up while the VS160 is loaded and calibrating. All additional tests passed.

Test Result Regression:

The additional testing ensures the on-bus timing of the VS160 during the load sequence meets and exceeds the requirements of SCSI Host Bus Adapters.

Conclusion

Based on strict interpretation of the ANSI SCSI spec this is considered acceptable. **This test has passed and this test is complete.**

9.11 LVD SCSI Cable Length Verification

Objective:

Test the DLT VSTape 160 Communications interface specification (Ultra SCSI-3 bus,16 bits wide, LVD) ,for maximum cable length and performance.

Date Tested:

7/1/2002

Test Engineer:

Michael Doty

Method:

The following table is the T-10 specifications for maximum cable lengths. Testing will be done on a minimum of 5 drives for each length. Each drive will perform Write/Read/Locate functions at each cable length tested.

Table 43: T-10 Specifications for maximum cable lengths

STA Terms	Max Bus Speed [Mb/s]	Bus Width [bits]	Max Bus Length Single Ended [meters]	Max Bus Length Differential [meters]	Max Bus Length LDV [meters]	Max. Device Support
SCSI-1	5	8	6	25	12	8
Fast SCSI	10	8	3	25	12	8
Fast Wide SCSI	20	16	3	25	12	16
Ultra SCSI	20	8	1.5	25	12	8
Ultra SCSI	20	8	3	25	12	4
Wide Ultra SCSI	40	16	-	25	12	16
Wide Ultra SCSI	40	16	1.5	-	-	8
Wide Ultra	40	16	3	-	-	4

SCSI						
Ultra2 SCSI	40	8	(1)	(1)	12	8
Wide Ultra2 SCSI	80	16	(1)	(1)	12	16

Test Program Parameters: For both 12 meter and 25 meter test.

Block Size Step = 8192

Max block size = 65536

Min block size = 2048

Min record size = 1 MB

Total write data amount = 4096 MB

Exit Criteria:

Product meets the 16-bit Ultra SCSI-3 160, (LVD) T-10 specification for maximum cable lengths. No Severity 1, 2, or 3 issues observed.

Results:

Using tape drive firmware revision 9.0, all drives tested passed Write/Read/Locate functions with no failures or performance loss, see Table 44 below. This test passed and this test is complete

Part I: 12 meter multi drop test with 3 drives per string.

Table 44

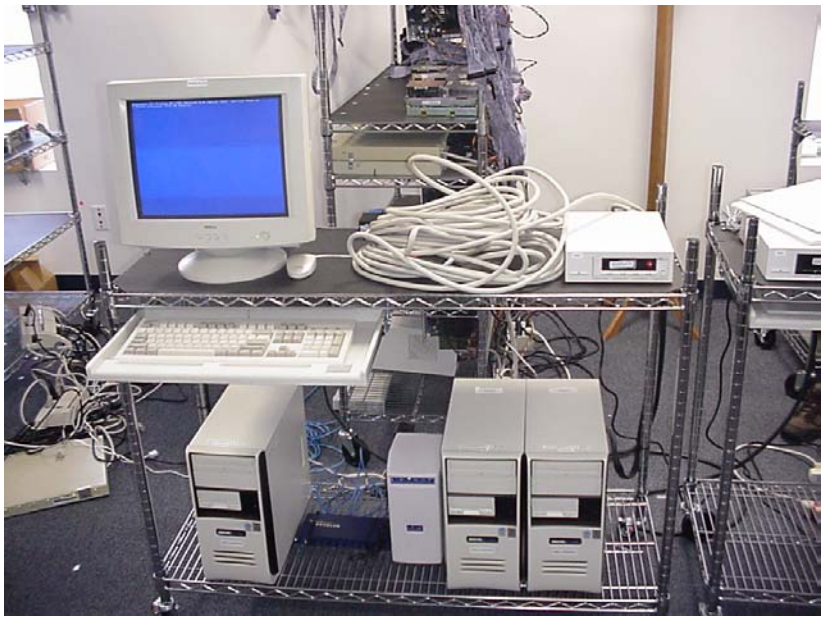
Drive S/N	Tape Cartridge #	12-meter(multidrop), Write/Read/Locate Functions
PHJ2F00035	B0205a575	Pass
PHJ2F00018	B0205a572	Pass
PHJ2F00093	B0205a573	Pass
PHJ2F00009	B0205a570	Pass
PHJ2F00058	B0205605	Pass

Part II: 25 – meter (single drop) test results.

Table 45

Drive S/N	Tape cartridge #	25-meter(singledrop), Write/Read/Locate functions
PHJ2F00035	B0205a575	Pass
PHJ2F00058	B0205a605	Pass
PHJ2F00077	B0205a571	Pass
PHJ2F00009	B0205a570	Pass
PHJ2F00093	B0205a573	Pass

Figure 20: 12 & 25 Meter Cable Length Test



9.12 Media Capacity

Objective:

The DLT VSTape 160 drive shall be verified for proper media capacity as indicated by Benchmark specifications.

Date Tested:

6/29/2002

Test Engineer:

Michael Doty

Method:

Using Benchmark VSTape tapes, test the tapes full data capacity. The test program PFT28 writes 64K blocks to the end of tape. The amount of data written is then measured to determine tape capacities. The Percept test program indicates the total amount of data passed over the SCSI bus that is successfully written to the tape. No additional overhead added by the drive is included in this number. A minimum of 5 tapes of each type will be tested.

- VS160 Functional Specifications:
- Formatted capacity – 80GB with VSTape
- Tape drive firmware revision 9.0

Exit Criteria:

Media capacity is per the product specification. A gigabyte is defined as 1,000,000,000 bytes. No Severity 1, 2, or 3 issues observed.

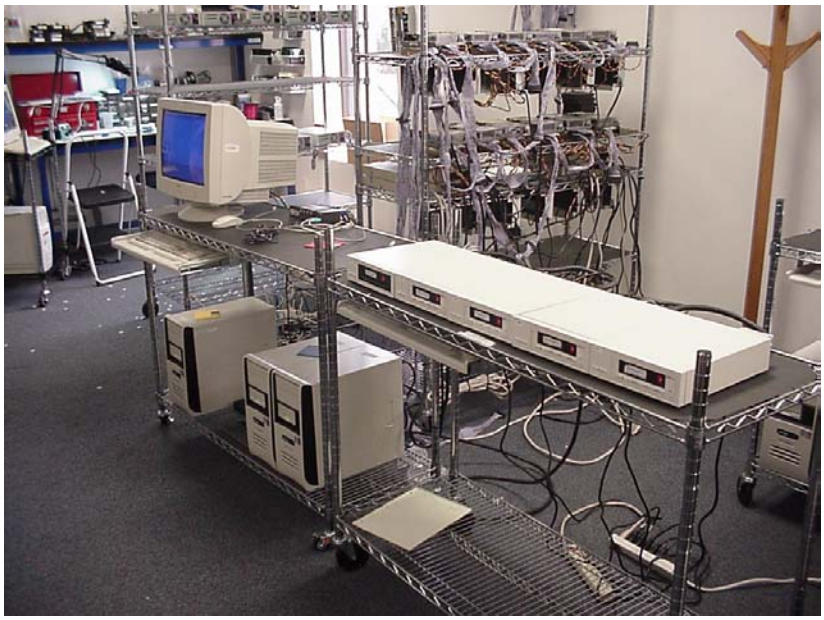
Test Results:

All drives passed Benchmark media capacity specifications for VSTape see Table 46.

Table 46

Drive S/N	Tape Cartridge #	Pass/Fail	Total Data GB Written	Write error rates
PHJ2F00058	B0205a605	Pass	80 GB	0.000443
PHJ2F00018	B0205a572	Pass	80 GB	0.000614
PHJ2F00093	B0205a573	Pass	80 GB	0.000452
PHJ2F00009	B0205a570	Pass	80 GB	0.000542
PHJ2F00077	B0205a571	Pass	80 GB	0.000417

Figure 21: Media Capacity Test Setup



9.13 Status Indicators Display Operation

Objective:

The Benchmark DLT VSTape 160 status indicators (front panel LEDs) are verified for proper operation during the following Benchmark DLT VSTape 160 drive conditions below.

Date Tested:

Tested various dates during DVT testing.

Test Engineer:

Philip J. Smith

Test Method:

Visual observation was used on Benchmark DLT VSTape 160 drives to verify proper operation of the 4 LEDs on the front panel. The LED behavior and error states of the drives were observed and recorded during all phases of DVT testing. A total of 11 drives are listed in report for reference of specific LED state.

The VSTape 160 has four LED's with the following functions:

READY LED	**OFF** = The drive is off
(Green)	**ON** = The drive is on
	FLASHING = Tape is in motion
FAULT LED	**OFF** = No drive errors
(Orange)	**ON** = Internal firmware error
	FLASHING = An unrecoverable (hard) drive error or a POST error occurred – Call Technical Support
CLEAN LED	**OFF** = Cleaning is not required.
(Orange)	**ON** = Drive has exceeded soft error limit. Cleaning required soon. LED is off after completing a cleaning cycle with a ValuSmart Cleaning Cartridge.
	FLASHING = A hard read/write or calibration error has occurred that is probably recoverable. Clean the drive. LED is off after completing a cleaning cycle with a ValuSmart Cleaning Cartridge.
MEDIA LED	**OFF** = Media compatible to use in VSTape 160 or not present.
(Orange)	**ON** = DLT (VS80) formatted tape (DLTtape IV) loaded.
	FLASHING = Cartridge cannot be used in the current condition. Use diagnostic mode for more information.

Note: - The most likely reasons are

- An invalid format (DLT4000, 7000 or 8000) is written on the cartridge.
- You are using an invalid cartridge (DLTIII cleaning tape or Digital compact III or III XT).
- The leader in the cartridge is damaged and is preventing a successful buckle or you are using a SDLT cartridge, which is not supported.

All Four LEDs **ON** = POST is starting. The LED's illuminate from Left to Right in the following sequence:

- Ready – Power to Drive
- Fault – Drive booted from Flash with no issues
- Clean – POST internal to ASIC is completed with no issues
- Media – Post external to ASIC is completed with no issues, drive is loading Servo code

The LEDs will be verified to operate properly in the following conditions:

- Code download in progress, or waiting for CUP tape
- Code image verified, burn part 1 started
- Burn part 2 started
- Burn part 3 started
- Burn part 4 started
- Burn part 4 completed successfully
- Burn completed, rebooting drive. Flashes once
- Bad code update image from SCSI or tape
- Internal firmware error (Bug check)
- Calibration error or permanent (hard) write/read error
- Cleaning required, 250 tape motion hours exceeded
- Cleaning in process
- Drive not optimized for write/read
- Power is off

- Boot code started, flash being checked
- Flash check ok, POST part 1 started
- POST part 1, complete, part 2 started
- POST part 2, complete, part 3 started
- Boot monitor entered
- Internal write/read diagnostic or other diagnostic failed
- Invalid format/cartridge or defective cartridge loaded
- DLT1 (VS80) formatted tape (DLTtapeIV) Loaded
- Optimization failed
- Optimization in process
- Servo or mechanical error
- Tape motion activity or tape load in process
- Power on-no tape loaded, or loaded but no tape motion

Test Setup:

Drives were observed during all phases of DVT testing, no specific test setup was executed.

DLT VSTape 160 firmware revisions used over the test period:

- Revision 9.4
- Revision 10.0
- Revision 11.0
- Revision 12.1
- Revision 15.0
- Revision 15.1
- Revision 15.5

Exit Criteria:

The Drives shall display correct LED User Patterns as defined in the VSTape 160 specification.

Test Results:

All drives observed during the DVT test period displayed the correct User Patterns when performing normal drive operations or when error condition occurred. Error conditions were confirmed by reviewing and comparing error reported by drive diagnostic to LEDs status displayed.

Table 47

DVT Testing Section 9.10 Status Indicators Display Operation

				Ready			Fault			Clean			Media		
Drive S/N	Code Rev.	Date Observed	Description of Error/Event Indicated	On	Flashing	Off	On	Flashing	Off	On	Flashing	Off	On	Flashing	Off
PHJ2F00147	9.4	07/10/02	Code download in progress, or waiting for CUP tape		Bmed				X			X		Bmed	
PHJ2F00147	9.4	07/10/02	Code image verified, burn part 1 started	X			X			X			X		
PHJ2F00147	9.4	07/10/02	Burn part 2 started	X			X			X					X
PHJ2F00147	9.4	07/10/02	Burn part 3 started	X			X					X			X
PHJ2F00147	9.4	07/10/02	Burn part 4 started	X					X			X			X
PHJ2F00147	9.4	07/10/02	Burn part 4 completed successfully			X			X			X			X
PHJ2F00147	9.4	07/10/02	Burn completed, rebooting drive.		Bslow			Bslow			Bslow			Bslow	
PHJ2F00200	9.4	07/10/02	Bad code update image from SCSI or tape	X			X					X		Bfast	
PHJ2F00038	10.0	07/08/02	Internal firmware error (Bug check)		Bslow		X					X			X
PHJ2F00016	10.0	07/05/02	Calibration error or permanent (hard) write/read error	X					X		Bslow				X
PHJ2F00130	11.0	07/23/02	Cleaning required	X					X	X					X
PHJ2F00130	11.0	07/23/02	Cleaning in process	X					X		Bmed				X
PHJ2F00136	11.0	07/30/02	Drive not optimized for write/read	X				Bfast				X		Bfast	
PHJ2F00136	11.0	07/30/02	Power is off			X			X			X			X
PHJ2F00136	11.0	07/30/02	Boot code started, flash being checked	X					X			X			X
PHJ2F00136	11.0	07/30/02	Flash check ok, POST part 1 started	X			X					X			X
PHJ2F00136	11.0	07/30/02	POST part 1, complete, part 2 started	X			X			X					X
PHJ2F00136	11.0	07/30/02	POST part 2, complete, part 3 started	X			X			X			X		
PHJ2F00136	11.0	07/30/02	Boot monitor entered			X	X			X					X
PHJ2F00136	11.0	07/31/02	Internal write/read diagnostic or other diagnostic failed	X				Bslow				X			X
PHJ2F00147	12.1	08/07/02	Invalid format/cartridge or defective cartridge loaded	X					X			X		Bslow	
PHJ2F00031	15.0	08/26/02	DLT1 (VS80) formatted tape (DLTtapeIV) Loaded	X					X			X	X		
PHJ2F00162	15.1	09/04/02	Optimization failed	X				Bfast			Bmed			Bmed	
PHJ2F00016	15.1	09/04/02	Optimization in process			X			X		Bmed			Bmed	
PHJ2H00011	15.1	07/26/02	Servo or mechanical error	X				Bfast				X			X
PHJ2F00077	15.5	09/04/02	Tape motion activity or tape load in process		Bslow				X			X			X
PHJ2F00128	15.5	09/10/02	Power on-no tape loaded, or loaded but no tape motion	X					X			X			X

9.14 Cleaning Tape LED Verification

Objective:

To verify that the cleaning LED turns on after 250 Tape Motion Hours and turns off after using a cleaning tape.

Date Tested:

Tested various dates during DVT testing.

Test Engineer:

Philip J. Smith

Test method:

During DVT testing all drives were monitored to determine when the cleaning light indicates a cleaning request. When the cleaning light comes on the drive was stopped and the Last Clean Time hours are recorded, also the Cleaning Count is also recorded to insure cleaning cycle is incremented. Data is obtained from the serial eerom of drive using TeraTerm / Serial Communication interface used for drive Diagnostics.

Testing was conducted on 12 drives at ambient room temperature.

Test Setup:

Three Micron PC Millennia PCs each configured with the following hardware

- 600 MHz, Celeron processor
- 384 MB RAM
- Adaptec 29160 (x2) SCSI card

Three Micron PC Millennia PCs each configured with the following Software

- Microsoft Window NT
- WinSCSI / PFT/DVT test designed by Percept Technology for use on Benchmark products.
- TeraTerm / Serial Communication interface used for drive Diagnostics.

DLT VSTape 160 Software used over Test period

- Revision 10.3
- Revision 11.0

DLT VSTape 160 Tape Media

- Benchmark VSTape
- Benchmark DLT1 Cleaning Tape

Exit Criteria:

The drives should indicate between 240 and 260 hours since the last cleaning, the cleaning light comes on. The drive was power cycled to ensure the value were maintained in the eerom and the light remained on. A tape cartridge other than a cleaning cartridge is load cycled to verify any tape load does not clear the cleaning light.

A cleaning tape is loaded, LEDs are observed on drive indicating cleaning cycle is in process. Cleaning tape is ejected and cleaning LED is off. Using TerraTerm verify that Last Clean hours are zeroed out and Cleaning Count is incremented by one. No Severity 1, 2, or 3 issues are observed.

Test Results:

All drives were observed during testing for cleaning light LED and for correct operation while the request cleaning mode state. All drives during the DVT test period displayed the correct LED User Patterns, and operated correctly while in the cleaning mode, see Appendix L: Cleaning LED'sfor details. **This test passed and this test is complete.**

9.15 Worldwide AC input test

Objective:

The Benchmark DLT VSTape 160 must continue to function as to specification when operated at each of the voltage and frequencies listed in

Table 48 below.

Date Tested:

7/11/2002

Test Engineer:

Michael Doty

Test Method:

With the unit configured for worst-case power loading, the drive is connected to a programmable AC power supply and operated in an ambient environment of 20 to 25 °C (68 to 77 °F). The drive is cycled through each voltage & frequency combination listed in

Table 48 below. The table represents all combinations the product will support. The drive will write data and operate normally throughout the test. A minimum of five DLT VSTape 160 external drives will be tested.

Table 48: Voltage/Frequency input range

Volts (Vac)	90		100		120		132		180		220		240		264	
Frequency (Hz)	47	63	47	63	47	63	47	63	47	63	47	63	47	63	47	63

Test Equipment:

- California Instruments 801RP Programmable AC power supply with AC Source control software
- 1 PC workstation w/ GPIB interface
- 5 DLTVS160 External Tape drives
- Extech 382860 Multimeter
- See Appendix D for drive, tape, and code detail

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

All five VS160 drives successfully passed the eight separate drive functions at all voltage/frequency combinations. Appendix E lists the voltage and frequency combinations with the drive functions tested. **This test passed and this test is complete.**

9.16 Power Supply Over & Under Voltage

Objective:

The Benchmark DLT VSTape 160 is verified for proper operation while the $5V_{DC}$ and $12V_{DC}$ lines are varied +-5% nominal voltage.

Date Tested:

0 7/26/02 – 07/29/2002

Test Engineer:

Michael Doty

Method:

Power is set to the ± 5% voltage margins on the +5V and +12V DC supplies using a Tektronix PS2521G programmable power supply. Drives are tested during load, unload, idle and write/read functions.

A minimum of 5 DLT VSTape 160 drives is tested.

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification.

Test Results:

The following table describes each voltage margin combination and the drive function tested at each boundary condition. The five units tested passed all drive functions at each voltage margin condition. See Appendix F : Power Supply Over & Under Voltage for details. **This test passed and this test is complete.**

9.17 Power Consumption (AC & DC)

Objective:

The objective of this test is to monitor the Benchmark DLT VSTape 160 and verify that it does not exceed the power consumption specification during the conditions listed below.

Date Tested:

7/18/2002

Test Engineer:

Michael Doty

Method:

Part I:

Power consumption is measured on five Benchmark DLT VSTape 160 external configuration drives at ambient temperature. Each drive is measured while performing the following drive functions:

- Power Up
- Load Tape – cycle measured is from cartridge load to completion of calibration
- Unload Tape – cycle measured is from eject button activation to complete cartridge eject
- Write Tape - streaming
- Read Tape - streaming
- Rewind
- Idle with tape loaded
- Idle with no tape loaded

Current measurements are taken using a LeCroy AP015 Current Probe and LeCroy 9354AL Oscilloscope. Power measurements are taken using an EXTECH 382860 True RMS Power Multimeter.

*All measurements are made with a LeCroy 9354AL Oscilloscope and LeCroy AP015 Current Probe, except the External Power column, which is measured with an EXTECH 382860 True RMS Power Multimeter.

DC power consumption for the internal model will be calculated using the rms current values. A separate column will document the AC power consumption of the power supply & tape drive combined measured with the Extech 382860 True RMS Power Multimeter.

A minimum of 2 DLT VSTape 160 drives are tested.

Part II: For the external drive, the following table will be completed for each of the above operating conditions.

Table 49: Voltage & Frequency States

Volts (Vac)	90		100		120		132		180		220		240		264	
Frequency (Hz)	47	63	47	63	47	63	47	63	47	63	47	63	47	63	47	63

Exit Criteria:

Power consumption shall conform to the specifications stated in the Benchmark DLT VSTape 160 Product Specification see Table 50 below.

Test Results:

The following tables show the AC & DC current and power consumption measured on the two VS160 drives tested.

Five VS160 drives tested passed at or below typical DC current and AC & DC power specifications for the VS160 – see Appendix F : Power Supply Over & Under Voltage for details. **This test passed and this test is complete.**

Table 50 Benchmark VS160 Specifications:

Power Consumption	
Internal	
+5 (+ 10% / -5%) Volt Bus	1.2 A Typical
+12 (± 10%)* Volt Bus	0.5 A Typical
Power Consumption	Less than 14 W
External	
Power Requirements	100-240V (auto-ranging), 50/60Hz, 0.9A
Power Consumption	Less than 35 W

9.18 Power Loss/Restore Exception Testing

Objective:

The Benchmark DLT VSTape 160 is verified for proper operation during a power loss condition.

Dates Tested:

8/12/2002

Test Engineer:

Michael Doty

Method:

Testing includes cycle times of 500 ms, 1 second and 20 seconds. 12V and 5V are cycled together and individually during each operation for the specified time interval. Power is cycled during the following operations on each drive with a Tektronix PS2521G programmable power supply.

- Load during calibration
- Unload
- Rewind
- Write
- Read
- Idle, No Tape Loaded
- Idle, Tape Loaded

A minimum of 5 DLT VSTape 160 drives is tested.

Exit Criteria:

Product exhibits no severity 1, 2 or 3 issues and meets the DLT VSTape 160 product specification

Test Results:

Using drive firmware revision12.1, the five drives passed all power loss conditions while performing the seven different drive functions. **This test passed and this test is complete.**

10 Performance

10.1 Access & Load/Unload Performance

Objective:

To define and measure DLT VSTape 160 access times and load/unload times.

Dates Tested:

Part I - 08/01/02-08/07/02

Test Engineer:

Part I - Piotr Polanowski

Part II –Glen Davis

Part III – Glen Davis

Method:

The following hardware is used during the test:

- WinSCSI test platform with Adaptec 29160
- A minimum of 5 DLT VSTape 160 drives is used for each part of the testing.
- Bus Hound 3.02 SCSI Bus Analyzer Software

Part I – Access Times:

It was determined that approximately 1.2GB of data with a block size of 64k could be written to one-track (4 channels). The test consisted of measuring time required to access 16 equally spaced block locations from the mid-point (0.6GB), BOT and EOD positions on tape. The average and maximum access times will be measured from BOT only.

Part II – Maximum Rewind Times:

The objective of this test was to verify the DLT VSTape 160 maximum rewind time in reference to the Benchmark Product specification. Since the actual capacity of a DLT tape IV cartridge is 84.2GB, the maximum rewind time was measured by first writing 84.2 GB of data to the tape using the WinSCSI System Performance Test. A block size of 65,536 bytes was used with a compression ratio of 1:1. At this point, the WinSCSI System Performance Test automatically initiated a rewind operation and the tape was rewound from EOD to BOT. The time elapsed from the start of the rewind operation until the tape drive stopped at BOT was recorded as “Maximum Rewind Time”. The times were measured with a stopwatch and verified with the times posted in the WinSCSI test logs and in the logs created by Bus Hound 3.02, a SCSI bus analyzer software program. This procedure was performed on a total of 10 drives.

Part III – Load/Unload - BOT Times:

The objective of this test was to verify the DLT VSTape 160 drive average load/unload times in reference to the Benchmark Product specification. The load to BOT time was measured using both new (degaussed) and pre-recorded tapes. The elapsed time from the point where the tape was inserted until the tape stopped at BOT and the drive was ready for the next tape operation was recorded as "Tape Load to BOT 'Ready' Time". With the tape and drive at "BOT Ready", the UNLOAD button was pressed and the time until the tape ejected through drive door was recorded as "Unload to Eject Time". This "Unload to Eject Time" was recorded for both degaussed and pre-recorded tapes. The times were recorded with a stopwatch. This procedure was performed on a total of 5 drives for 5 load and unload cycles each.

Exit Criteria:

Part I – Access time average will be 68 seconds or less. Maximum access time less than 135 seconds. Product exhibits no severity 1, 2 or 3 issues and the drive meets the DLT VSTape 160 product specification.

Part II – Maximum rewind time less than 135 seconds. Product exhibits no severity 1, 2 or 3 issues and the drive meets the DLT VSTape 160 product specification.

Part III – Load/Unload – Load to BOT ready times for previously recorded tapes should not exceed 85 seconds. Unload from BOT should not exceed 25 seconds.

Test Results Part I:

Five drives performed "Seek Time" tests. There were drives that were out of limits, the average access time was below 68 seconds, and the maximum was below 135 seconds. See Appendix H: Access Times for the average of access times from five drives used in this test. **This test passed and this test is complete.**

Test Results Part 2:

The total of 10 drives were used to perform the “Maximum Rewind Test”. All drives performed within the 135 second specification. There were no failures. For details see Appendix I: Rewind Times. **This test passed and this test is complete.**

Test Results Part 3 :

The total of 5 drives were used to perform the “Load/Unload – BOT Times” test. Each drive was loaded and unloaded a total of 5 times. There were no failures recorded during the course of testing. All drives performed within the 85 second specification for load to BOT ready for previously recorded tapes, as well as, the 25 second specification for unload from BOT time. For details see Appendix J: Load / Unload BOT Times. **This test passed and this test is complete.**

10.2 Data Transfer Rates (Supported Write Formats)

Objective:

The objective of this test is to measure Benchmark DLT VSTape 160 tape drives' write/read transfer rates in native mode and compressed mode.

Date Tested:

07/26/02 – 08/03/02

Test Engineer:

Piotr Polanowski

Method:

The following hardware is used during the test:

- WinSCSI test platform with Adaptec 29160
- A minimum of 5 DLT VSTape 160 drives is tested.
- Compressible data set (.89:1, 2:1, 4:1, 29:1 compression ratios & 1;)

Each test case is designed to write and read 1.25 Gigabytes of data with various compressibility, using the following block sizes:

- 2k
- 4k
- 8k
- 16k
- 32k
- 64k
- 128k
- 256k
- 512k

The read/write data rates were measured by the WinSCSI program, System Performance test. All transfer rates are measured in 16-bit Wide Ultra SCSI-3, LVD mode.

Exit Criteria:

Verify that the Benchmark DLT VSTape 160 transfer rate is equal to or greater than transfer rate specification of 8MB/sec and 16MB/second with 2:1 compression ratio data set. Product exhibits no severity 1, 2 or 3 issues and the drive meets the DLT VSTape 160 product specification.

Test Results:

Five drives performed the "System Performance" test. There were 3 failures found during the course of System Performance testing. The failures were documented in TrackStar issue numbers: 1000, 1152, 1197. The failures resulted in regression testing; see 'Test Results Regression' below. Failures were attributed to high-speed SCSI transfers with small block sizes and media usage.

Test Result Regression:

Firmware modifications were made to address small block size handling in busy system environments. Full performance testing was done including small block sizes in the same environment. This regression testing verified closure of TrackStar issue numbers: 1000, 1152, 1197 as noted above.

An additional failure was due to excessive use of media for write/read testing. Procedures were put in place to discard media when the media life specification is exceeded.

Conclusion:

Based on the regression test which demonstrated firmware fixes and the institution of improved media management, no further regression testing was deemed necessary. **This test is passed and this test is complete.**

10.3 Data Transfer Rates (Supported Read Format)

Objective:

The objective of this test is to demonstrate the data transfer rate of Benchmark DLT VSTape 160 tape drives when reading read-only supported data formats.

Date Tested:

08/23/02-09/03/02

Test Engineer:

Piotr Polanowski

Method:

A group of 90 test tapes from 5 different DLT 1 and DLT VSTape 80 drives were created. Each test tape contained 256K of data written with specific block size. The tapes are read back by the test group of 5 DLT VSTape 160 drives. The WinSCSI program System Performance test was used to measure transfer rates.

Exit Criteria:

Transfer rates complied with the Benchmark DLT VSTape 160 Product Specification. No Severity 1, 2, or 3 issues observed.

Test Results:

Six drives were used for the test. There was one failure. The failure was logged in TrackStar issue number 1287. The failure resulted in regression testing; see 'Test Results Regression' below

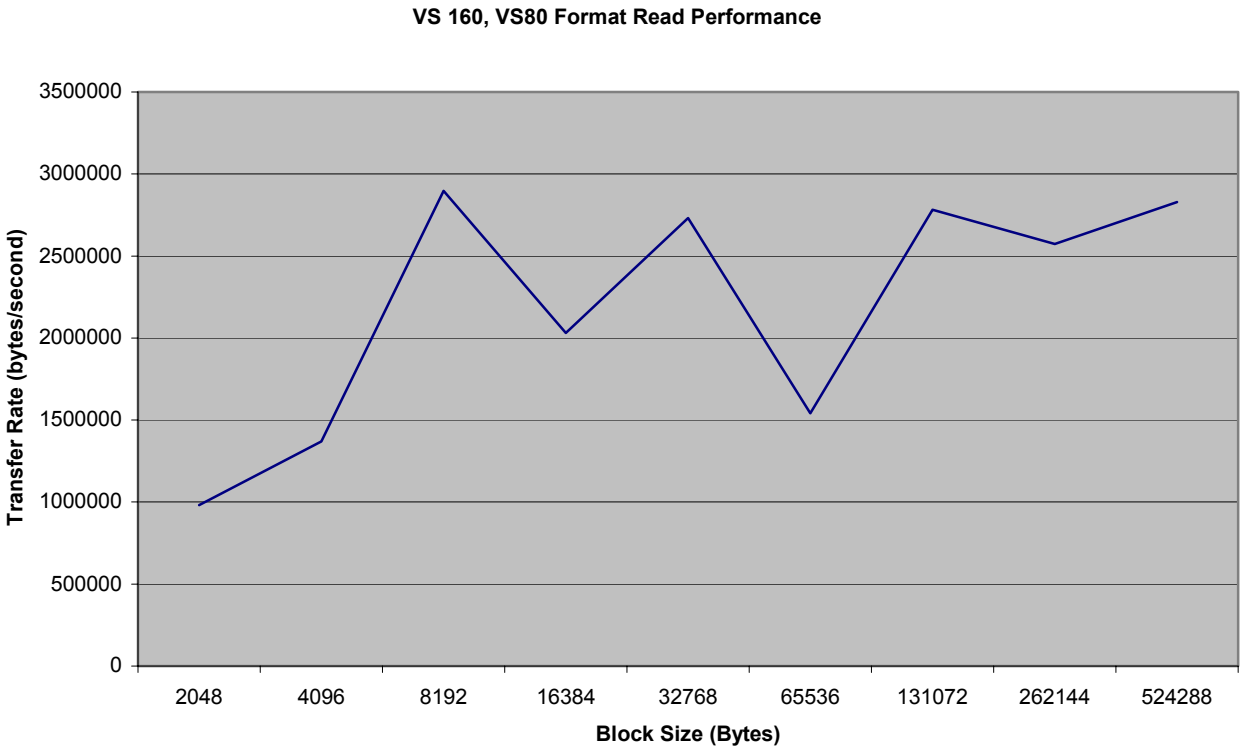
Test Result Regression:

The root cause of this issue related to how the read-only format tape was written. A firmware fix was made and verification was accomplished by repeating the complete performance test sequence with no failures. No further regression testing was deemed necessary.

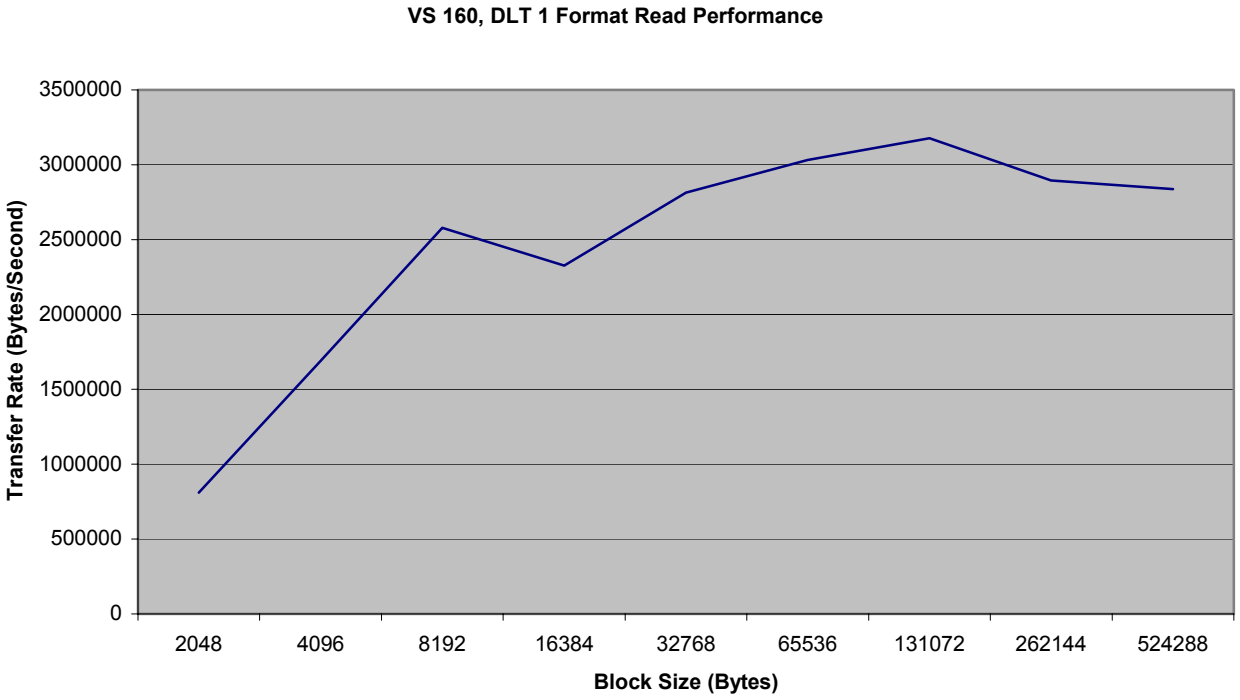
Conclusion:

There were no similar failures during any further testing with 15.1 firmware. **This test passed and this test is complete.**

Graph 3


VS 160, VS80 Format Read Performance
Transfer Rate (bytes/second)
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)

Graph 4


VS 160, DLT 1 Format Read Performance
Transfer Rate (Bytes/Second)
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)

11 Appendices

11.1 Appendix A – Percept DVT Test Suite

SCSI Specification Compliance Verification:

PFT/DVT02 – Basic SCSI Commands

Report SCSI – Report LUNS, Report Density, DeviceID commands test.

Reserved Bits – Issues valid commands with reserved bits sets in both cdb and data reserved fields, verifies appropriate response from the drive.

Persistent Reserve – Verification of proper handling (according to the specification) of Persistent Reserve Out & Persistent Reserve In method of drive reservation management.

Reserve/Release – Verification of proper handling (according to the specification) of Reserve/Release method of drive reservation management.

Compression – Verification of compression ratios

Oppco DVT10W – Write up to 16mByte blocks

Oppco DVT10R – Read up to 16mByte blocks

SCSI Data Transfer Operation:

PFT/DVT04 – Basic SCSI Position commands, writes, write FileMarks, space to EOD

PFT/DVT06 – Basic SCSI Position commands, space FM/blocks with check conditions

PFT/DVT08 – Write/Rea/Locate in Variable Block Mode(4 to 65534), random locates

PFT/DVT10 – Write/Read Variable Block Sizes, compression off (with verification; block Sizes 2bytes – 512KB)

PFT/DVT12 – Write/Read Fixed Block Mode9 4 to 64K)

PFT/DVT14 – Write Random Length Records, Locate between writes, verify tape at correct location by using both data and Read Position cdb.

PFT/DVT16 – Append between Last Two File Marks

PFT/DVT18 – Write Fixed /Locate/Read Variable

PFT/DVT20 – Emulate Backup program

PFT/DVT22 – Write/Read Multiple Blocks / Fixed Mode

PFT/DVT24 – Write/Read Increasing Record Size with Append

PFT/DVT26 – Write/Read with Random Delay

PFT/DVT28 – Write/Read to EOT(full tape), random Locates

PFT/DVT32 – Fixed Block Mode Appends

PFT/DVT38 – Write/Read/Appends

SCSI Based Reset and Command Exception Testing:

Oppco DVT42W – Reset tests

Oppco DVT44W – Parity error tests

Oppco DVT42W – Messaging tests

Specialized:

Interchange – Special write/read/overwrite/read tests

System performance – Measures transfer rates at various block sizes and compression ratios, over the single track.

User Tests – Writes a random mix of filemarks and data blocks, using both fixed and variable modes, including appending. Randomly spaces/locates to valid tape positions and verifies the position by reading data from the tape and comparing to expected data.

Tape spanning and restore – this will be performed using a ISV package for tape backup. For the VS160 CA ARCserve will be used.

11.2 Appendix B ARCserve.log – Backup Log

20020829 112703 JOB Job Engine is Started.
20020829 151530 MSG Message Engine is Started.
20020829 151833 DB Database Engine is Started.(VLDB)
20020829 151837 TAPE NEW DEVICE 3, [BNCHMARKVS160 0F01]
20020829 151837 TAPE Device added to group
20020829 151940 TAPE Tape Engine is Started.
20020829 154611 TAPE Tape Engine finished formatting media.(new name: vstape, old name:)
20020829 154614 TAPE Format Successful!
20020829 154706 TAPE Tape Engine finished erasing media.(old name: vstape)
20020829 154706 TAPE Erase Successful!
20020829 154706 Begin cleaning database.
20020829 154706 End cleaning database. (CLEANED=0)
20020829 155320 TAPE Tape Engine finished formatting media.(new name: vstape, old name:)
20020829 155323 TAPE Format Successful!
20020829 155504 Begin cleaning database.
20020829 155504 TAPE Tape Engine finished erasing media.(old name: vstape)
20020829 155504 TAPE Erase Successful!
20020829 155504 End cleaning database. (CLEANED=0)
20020829 155816 2 Run Backup Job Now.
20020829 155816 2 Start Backup Operation. (QUEUE=1, JOB=1)
20020829 155823 TAPE Tape Engine finished formatting media.(new name: 8/29/02 3:58 PM, old name:)
20020829 155826 TAPE Format Successful!
20020829 155826 2 Use media 8/29/02 3:58 PM, ID 9D64, sequence #1
20020829 155828 2 Source Directory: J:
20020829 155828 2 Back up Session 1 on Media 8/29/02 3:58 PM
20020829 162356 2 Catalog File Backed Up
20020829 162356 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 162356 2 10,588.12 MB Written to Media.
20020829 162356 2 Elapsed Time: 25m 17s
20020829 162356 2 Average Throughput: 418.77 MB/min
20020829 162356 2 Source Directory: K:
20020829 162356 2 Back up Session 2 on Media 8/29/02 3:58 PM
20020829 164923 2 Catalog File Backed Up
20020829 164923 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 164923 2 10,588.12 MB Written to Media.
20020829 164923 2 Elapsed Time: 25m 17s
20020829 164923 2 Average Throughput: 418.77 MB/min
20020829 164923 2 Source Directory: L:
20020829 164923 2 Back up Session 3 on Media 8/29/02 3:58 PM
20020829 171450 2 Catalog File Backed Up

20020829 171450 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 171450 2 10,588.12 MB Written to Media.
20020829 171450 2 Elapsed Time: 25m 17s
20020829 171450 2 Average Throughput: 418.77 MB/min
20020829 171450 2 Source Directory: M:
20020829 171450 2 Back up Session 4 on Media 8/29/02 3:58 PM
20020829 174027 2 Catalog File Backed Up
20020829 174027 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 174027 2 10,588.12 MB Written to Media.
20020829 174027 2 Elapsed Time: 25m 27s
20020829 174027 2 Average Throughput: 416.03 MB/min
20020829 174027 2 Source Directory: N:
20020829 174027 2 Back up Session 5 on Media 8/29/02 3:58 PM
20020829 180801 2 Catalog File Backed Up
20020829 180801 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 180801 2 10,588.12 MB Written to Media.
20020829 180801 2 Elapsed Time: 27m 24s
20020829 180801 2 Average Throughput: 386.42 MB/min
20020829 180801 2 Source Directory: P:
20020829 180801 2 Back up Session 6 on Media 8/29/02 3:58 PM
20020829 183403 2 Catalog File Backed Up
20020829 183403 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020829 183403 2 10,588.12 MB Written to Media.
20020829 183403 2 Elapsed Time: 25m 52s
20020829 183403 2 Average Throughput: 409.33 MB/min
20020829 183403 2 Source Directory: Q:
20020829 183403 2 Back up Session 7 on Media 8/29/02 3:58 PM
20020829 185630 2 Next media 8/29/02 3:58 PM, ID 9D64, sequence #2
20020829 185630 2 Please mount a blank media to continue the backup.
20020829 185630 2 W3828 Unable to find this media or a blank media.
(MEDIA=8/29/02 3:58 PM, SEQ=2)
20020830 095416 2 Resume Backup Operation.
20020830 095755 2 Catalog File Backed Up
20020830 095755 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020830 095755 2 10,588.12 MB Written to Media.
20020830 095755 2 Elapsed Time: 25m 50s
20020830 095755 2 Average Throughput: 409.86 MB/min
20020830 095755 2 Number of Errors/Warnings: 0/1
20020830 095755 2 Source Directory: R:
20020830 095755 2 Back up Session 8 on Media 8/29/02 3:58 PM
20020830 102320 2 Catalog File Backed Up
20020830 102320 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020830 102320 2 10,588.12 MB Written to Media.
20020830 102320 2 Elapsed Time: 25m 15s
20020830 102320 2 Average Throughput: 419.33 MB/min
20020830 102320 2 Source Directory: S:
20020830 102320 2 Back up Session 9 on Media 8/29/02 3:58 PM
20020830 104848 2 Catalog File Backed Up

20020830 104848 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020830 104848 2 10,588.12 MB Written to Media.
20020830 104848 2 Elapsed Time: 25m 18s
20020830 104848 2 Average Throughput: 418.50 MB/min
20020830 104848 2 Source Directory: T:
20020830 104848 2 Back up Session 10 on Media 8/29/02 3:58 PM
20020830 111417 2 Catalog File Backed Up
20020830 111417 2 7 Directories 26 Files (10,587.97 MB) Backed Up to Media.
20020830 111417 2 10,588.12 MB Written to Media.
20020830 111417 2 Elapsed Time: 25m 19s
20020830 111417 2 Average Throughput: 418.22 MB/min
20020830 111417 2 ** Summary for My Computer **
20020830 111417 2 10 Sessions.
20020830 111417 2 70 Directories 260 Files (105,879.77 MB) Backed Up to Media.
20020830 111417 2 105,881.25 MB Written to Media.
20020830 111417 2 Elapsed Time: 4h 16m 16s
20020830 111417 2 Average Throughput: 413.14 MB/min
20020830 111417 2 Number of Errors/Warnings: 0/1
20020830 111641 2 ** Summary for Job **
20020830 111641 2 10 Sessions.
20020830 111641 2 70 Directories 260 Files (105,879.77 MB) Backed Up to Media.
20020830 111641 2 105,881.25 MB Written to Media.
20020830 111641 2 Elapsed Time: 4h 16m 16s
20020830 111641 2 Average Throughput: 413.14 MB/min
20020830 111641 2 Number of Errors/Warnings: 0/1
20020830 111641 2 Backup Operation Successful.

ARCserve.log - Restore

20020905 092112 MSG Message Engine is Started.
20020905 092228 DB Database Engine is Started.(VLDB)
20020905 092233 TAPE Tape Engine is Started.
20020905 092237 JOB Job Engine is Started.
20020905 092448 3 Run Restore Job Now.
20020905 092822 3 Start Restore Operation. (QUEUE=1, JOB=1)
20020905 092947 3 Use media 8/29/02 3:58 PM, ID 9D64, sequence #1
20020905 092947 3 Source Session 7 on Media 8/29/02 3:58 PM
20020905 092947 3 Target Directory: Q:
20020905 095211 3 Next media 8/29/02 3:58 PM, ID 9D64, sequence #2
20020905 095957 3 Resume Restore Operation.
20020905 100330 3 ** Summary for Job **
20020905 100330 3 1 Sessions Found on Media.
20020905 100330 3 6 Directories 26 Files (10,587.97 MB) Restored to Disk.
20020905 100330 3 10,588.12 MB Read from Media.
20020905 100330 3 Elapsed Time: 25m 51s
20020905 100330 3 Average Throughput: 409.59 MB/min
20020905 100330 3 Restore Operation Successful.

11.3 Appendix C – Environmental Definitions

All Ramp Up/Down times are in accordance with the Benchmark DLT VSTape160 Product Specifications (000827-01 Rev. 01) for Temperature and Humidity gradients. Soak times are one hour after each ramp to temperature before test program is run.

Table 51: Environmental Ambient Definition

Temperature	Humidity	State
20° - 25° C	30% - 50%	Hold

Table 52: Environmental Operational Envelope Definition

Temperature	Humidity	State	Time (minimum)
10° C	20%	Ramp Down	1:30
10° C	20%	Hold	1:00
40° C	20%	Ramp Up	3:00
40° C	20%	Hold	1:00
40° C	30%	Ramp Up	1:00
40° C	30%	Hold	1:00
27.5° C	80%	Ramp Down	5:00
27.5° C	80%	Hold	1:00
10° C	80%	Ramp Down	2:00
10° C	80%	Hold	1:00

11.4 Appendix D

Table 53: Worldwide InputTest - Drive S/N's, Tape #'s, and Firmware revision level tested

Drive S/N	Tape Cartridge #	Code Level
PHJ2F00168	B0205a609	11.0
PHJ2F00113	B0205a600	11.0
PHJ2F00144	B0205a601	11.0
PHJ2F00092	B0205a602	11.0
PHJ2F00193	B0205a610	11.0

11.5 Appendix E

Table 54: Worldwide AC Input Test Results

Volts (Vac)	**90**		**100**		**120**		**132**		**180**		**220**		**240**		**264**	
Frequency (Hz)	47	63	47	63	47	63	47	63	47	63	47	63	47	63	47	63
Drive # 0168																
Power Up	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Load Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Unload Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Write Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Read Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (no tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Drive # 0113																
Power Up	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Load Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Unload Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Write Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Read Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (no tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Drive # 0144																
Power Up	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Load Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Unload Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Write Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Read Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (no tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Drive # 0092																
Power Up	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Load Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Unload Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Write Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Read Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (no tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Drive # 0193																
Power Up	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Load Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Unload Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Write Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Read Tape	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Idle (no tape)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

11.6 Appendix F : Power Supply Over & Under Voltage

DLTVS 160 10% Voltage Margining.				
Code Level: 17.2				
	DC Voltage	DC Voltage	DC Voltage	DC Voltage
Drive # PHJ2F0208	low/low	high/high	high/low	low/high
Operation	**10.8V/4.70**	**13.2V/5.5V**	**13.2V/4.7V**	**10.8V/5.5V**
Load	Pass	Pass	Pass	Pass
Unload	Pass	Pass	Pass	Pass
Write	Pass	Pass	Pass	Pass
Read	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass
power up	Pass	Pass	Pass	Pass
Drive # PHJ2F0205	low/low	high/high	high/low	low/high
Operation	**10.8V/4.70**	**13.2V/5.5V**	**13.2V/4.7V**	**10.8V/5.5V**
Load	Pass	Pass	Pass	Pass
Unload	Pass	Pass	Pass	Pass
Write	Pass	Pass	Pass	Pass
Read	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass
power up	Pass	Pass	Pass	Pass
Drive # PHJ2F0505	low/low	high/high	high/low	low/high
Operation	**10.8V/4.70**	**13.2V/5.5V**	**13.2V/4.7V**	**10.8V/5.5V**
Load	Pass	Pass	Pass	Pass
Unload	Pass	Pass	Pass	Pass
Write	Pass	Pass	Pass	Pass
Read	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass
power up	Pass	Pass	Pass	Pass
Drive # PHJ2F0473	low/low	high/high	high/low	low/high
Operation	**10.8V/4.70**	**13.2V/5.5V**	**13.2V/4.7V**	**10.8V/5.5V**
Load	Pass	Pass	Pass	Pass
Unload	Pass	Pass	Pass	Pass
Write	Pass	Pass	Pass	Pass
Read	Pass	Pass	Pass	Pass
Rewind	Pass	Pass	Pass	Pass
power up	Pass	Pass	Pass	Pass

11.7 Appendix G: AC & DC Power Results

Table 56: Drive #0113, 90VAC @ 47hz.

External Drive # 0113 90Vac @ 47Hz Code level: 11.0	Current @ 5VDC (A) max	Current @ 5VDC (A) rms	Current @ 12VDC (A) max	Current @ 12VDC (A) rms	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Power Up	1.592	0.850	0.674	0.278	7.586	7	17
Load Tape	1.430	0.934	2.610	0.616	12.062	16	20
Unload Tape	1.430	0.827	2.450	0.749	13.123	16	21
Write Tape	1.690	1.477	1.300	0.516	13.577	18	20
Read Tape	1.550	1.310	1.300	0.503	12.586	18	19
Rewind	0.873	0.813	1.330	0.580	11.025	15	17
Idle (tape)	0.844	0.815	0.263	0.149	5.863	11	12
Idle (no tape)	0.844	0.825	0.083	0.057	4.809	10	12
* Extech 382860 True RMS power meter							
Averaged values	1.282	0.981	1.251	0.431	10.079	13.875	17.250

Table 57: Drive #0113, 90VAC @ 63hz.

External Drive # 0113 90Vac @ 63hz Code level: 11.0	Current @ 5VDC (A) max	Current @ 5VDC (A) rms	Current @ 12VDC (A) max	Current @ 12VDC (A) rms	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Power Up	1.790	0.876	0.810	0.266	7.572	9	16
Load Tape	1.460	0.952	2.720	0.642	12.464	17	21
Unload Tape	1.450	0.819	2.470	0.716	12.687	16	23
Write Tape	1.680	1.475	1.300	0.510	13.495	19	20
Read Tape	1.570	1.304	1.250	0.493	12.436	18	19
Rewind	0.851	0.798	1.265	0.583	10.986	16	17
Idle (tape)	0.836	0.804	0.546	0.266	7.212	12	13
Idle (no tape)	0.836	0.806	0.081	0.056	4.702	11	12
* Extech 382860 True RMS power meter							
Averaged values	1.309	0.979	1.305	0.442	10.194	14.750	17.625

Table 58: Drive #0113, 100VAC @ 47hz.

External Drive # 0113							
100Vac @ 47hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.005	0.974	0.554	0.284	8.278	8	18
Load Tape	1.567	1.067	2.630	0.659	13.242	19	25
Unload Tape	1.583	0.955	2.600	0.790	14.255	19	25
Write Tape	1.817	1.611	1.319	0.516	14.247	22	23
Read Tape	1.692	1.443	1.319	0.528	13.551	20	21
Rewind	0.974	0.923	1.382	0.620	12.055	18	19
Idle (tape)	0.978	0.956	0.280	0.160	6.700	13	14
Idle (no tape)	0.975	0.957	0.090	0.067	5.589	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.449	1.111	1.272	0.453	10.990	16.375	19.750

Table 59: Drive #0113, 100VAC @ 63hz.

External Drive # 0113							
100Vac @ 63hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.422	0.992	1.964	0.281	8.332	9	18
Load Tape	1.578	1.073	2.440	0.646	13.117	19	24
Unload Tape	1.562	0.965	2.500	0.778	14.161	19	26
Write Tape	1.834	1.621	1.307	0.509	14.213	20	23
Read Tape	1.694	1.443	1.291	0.510	13.335	20	21
Rewind	0.974	0.939	1.322	0.631	12.267	17	19
Idle (tape)	0.972	0.944	0.261	0.182	6.904	13	14
Idle (no tape)	0.969	0.936	0.089	0.063	5.436	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.501	1.114	1.397	0.450	10.971	16.125	19.750

Table 60: Drive #0113, 120VAC @ 47hz.

External Drive # 0113							
120Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.917	0.981	0.802	0.276	8.217	9	18
Load Tape	1.563	1.061	2.710	0.649	13.094	18	24
Unload Tape	1.548	0.949	2.420	0.774	14.033	17	25
Write Tape	1.806	1.612	1.338	0.541	14.552	20	21
Read Tape	1.681	1.441	1.322	0.509	13.315	18	21
Rewind	0.994	0.948	1.354	0.572	11.604	17	19
Idle (tape)	0.978	0.950	0.292	0.166	6.742	13	14
Idle (no tape)	0.994	0.963	0.093	0.069	5.643	11	12
* Extech 382860 True RMS power meter							
Averaged values	1.435	1.113	1.291	0.445	10.900	15.375	19.250

Table 61: Drive 0113, 120VAC @ 63hz.

External Drive # 0113							
120Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.869	0.998	0.848	0.276	8.302	9	18
Load Tape	1.558	1.063	2.510	0.646	13.069	17	23
Unload Tape	1.574	0.961	2.580	0.775	14.105	16	23
Write Tape	1.820	1.613	1.293	0.513	14.221	20	21
Read Tape	1.695	1.441	1.261	0.509	13.313	19	20
Rewind	0.976	0.928	1.339	0.575	11.540	17	18
Idle (tape)	0.975	0.949	0.279	0.160	6.665	12	13
Idle (no tape)	0.978	0.950	0.087	0.065	5.530	11	12
* Extech 382860 True RMS power meter							
Averaged values	1.431	1.113	1.275	0.440	10.843	15.125	18.500

Table 62: Drive #0113, 132VAC @ 47hz.

External Drive # 0113							
132Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.201	0.856	0.541	0.185	6.500	10	18
Load Tape	1.561	1.082	2.590	0.638	13.066	18	25
Unload Tape	1.592	0.980	2.460	0.780	14.260	18	25
Write Tape	1.811	1.614	1.306	0.517	14.274	18	23
Read Tape	1.686	1.444	1.352	0.516	13.412	20	21
Rewind	0.998	0.948	1.290	0.640	12.420	16	20
Idle (tape)	0.981	0.961	0.270	0.157	6.689	13	14
Idle (no tape)	0.974	0.965	0.087	0.064	5.593	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.476	1.106	1.237	0.437	10.777	15.625	19.875

Table 63: Drive #0113, 132VAC @ 63hz.

External Drive # 0113							
132Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.200	0.991	0.814	0.285	8.375	11	19
Load Tape	1.559	1.063	2.450	0.688	13.572	19	25
Unload Tape	1.559	0.958	2.540	0.829	14.738	19	25
Write Tape	1.817	1.610	1.312	0.520	14.292	22	23
Read Tape	1.677	1.435	1.281	0.514	13.345	20	21
Rewind	0.989	0.933	1.343	0.611	11.997	19	20
Idle (tape)	0.987	0.964	0.264	0.148	6.596	13	14
Idle (no tape)	0.978	0.958	0.076	0.053	5.426	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.471	1.114	1.260	0.456	11.043	16.875	20.000

Table 64: Drive #0113, 180VAC @ 47hz.

External Drive # 0113							
180Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.159	1.006	0.814	0.279	8.377	11	19
Load Tape	1.589	1.077	2.580	0.688	13.642	20	25
Unload Tape	1.573	0.962	2.760	0.817	14.614	20	26
Write Tape	1.823	1.625	1.254	0.499	14.111	23	24
Read Tape	1.698	1.445	1.332	0.503	13.260	21	23
Rewind	0.979	0.936	1.348	0.571	11.532	18	20
Idle (tape)	0.994	0.971	0.254	0.146	6.607	13	16
Idle (no tape)	0.978	0.960	0.079	0.055	5.460	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.474	1.123	1.303	0.445	10.950	17.250	20.750

Table 65: Drive #0113, 180VAC @ 63hz.

External Drive # 0113							
180Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.948	1.002	0.589	0.263	8.168	9	18
Load Tape	1.573	1.080	2.580	0.660	13.319	19	25
Unload Tape	1.573	0.971	2.450	0.770	14.095	19	26
Write Tape	1.839	1.628	1.301	0.517	14.342	23	24
Read Tape	1.698	1.954	1.332	0.507	15.853	21	23
Rewind	0.995	0.943	1.364	0.615	12.095	18	20
Idle (tape)	0.994	0.973	0.258	0.156	6.737	14	16
Idle (no tape)	0.975	0.961	0.078	0.055	5.465	13	13
* Extech 382860 True RMS power meter							
Averaged values	1.574	1.189	1.244	0.443	11.259	17.000	20.625

Table 66: Drive #0113, 220VAC @ 47hz.

External Drive # 0113							
220Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) * Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.521	0.989	0.800	0.272	8.209	11	19
Load Tape	1.556	1.067	2.650	0.656	13.205	20	25
Unload Tape	1.595	0.982	2.560	0.751	13.922	21	27
Write Tape	1.842	1.638	1.262	0.496	14.141	22	25
Read Tape	1.720	1.459	1.262	0.503	13.331	22	23
Rewind	1.001	0.949	1.341	0.596	11.897	19	20
Idle (tape)	0.931	0.909	0.265	0.152	6.369	14	16
Idle (no tape)	1.001	0.969	0.076	0.052	5.469	13	14
* Extech 382860 True RMS power meter							
Averaged values	1.521	1.120	1.277	0.435	10.818	17.750	21.125

Table 67: Drive #0113, 220VAC @ 63hz.

External Drive # 0113							
220Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.606	1.001	0.800	0.274	8.295	12	18
Load Tape	1.590	1.077	2.470	0.633	12.983	20	26
Unload Tape	1.590	0.967	2.530	0.769	14.063	19	25
Write Tape	1.824	1.623	1.333	0.512	14.259	23	24
Read Tape	0.996	0.936	1.364	0.622	12.144	19	23
Rewind	1.699	1.450	1.349	0.519	13.480	22	20
Idle (tape)	0.975	0.954	0.275	0.159	6.678	15	16
Idle (no tape)	0.972	0.955	0.094	0.065	5.555	13	14
* Extech 382860 True RMS power meter							
Averaged values	1.532	1.121	1.277	0.444	10.932	17.875	20.750

Table 68: Drive #0113, 240VAC @ 47hz.

External Drive # 0113							
240Vac @ 47hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.620	1.002	0.814	0.278	8.346	13	19
Load Tape	1.573	1.075	2.510	0.648	13.151	22	25
Unload Tape	1.573	0.971	2.610	0.775	14.155	20	27
Write Tape	1.839	1.626	1.254	0.508	14.226	23	25
Read Tape	1.698	1.452	1.286	0.504	13.308	23	24
Rewind	0.995	0.940	1.317	0.601	11.912	19	21
Idle (tape)	0.979	0.950	0.598	0.276	8.062	16	17
Idle (no tape)	0.979	0.957	0.087	0.060	5.505	14	16
* Extech 382860 True RMS power meter							
Averaged values	1.532	1.122	1.310	0.456	11.083	18.750	21.750

Table 69: Drive #0113, 240VAC @ 63hz.

External Drive # 0113							
240Vac @ 63hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	3.073	1.007	0.814	0.269	8.265	13	19
Load Tape	1.573	1.077	2.540	0.639	13.053	20	26
Unload Tape	1.589	0.974	2.450	0.763	14.026	20	26
Write Tape	1.823	1.620	1.270	0.506	14.172	23	25
Read Tape	1.698	1.450	1.301	0.504	13.298	23	24
Rewind	0.995	0.937	1.317	0.626	12.197	17	20
Idle (tape)	0.981	0.959	0.270	0.150	6.595	16	17
Idle (no tape)	0.995	0.958	0.081	0.055	5.450	14	16
* Extech 382860 True RMS power meter							
Averaged values	1.591	1.123	1.255	0.439	10.882	18.250	21.625

Table 70: Drive #0113, 264VAC @ 47hz.

External Drive # 0113							
264Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.922	1.013	0.950	0.266	8.258	N/A**	N/A**
Load Tape	1.581	1.097	2.139	0.638	13.143	N/A**	N/A**
Unload Tape	1.580	0.976	2.520	0.804	14.528	N/A**	N/A**
Write Tape	1.846	1.645	1.332	0.506	14.297	N/A**	N/A**
Read Tape	1.705	1.458	1.286	0.506	13.362	N/A**	N/A**
Rewind	1.002	0.946	1.317	0.626	12.242	N/A**	N/A**
Idle (tape)	0.994	0.971	0.265	0.143	6.571	N/A**	N/A**
Idle (no tape)	0.984	2.964	0.080	0.052	15.444	N/A**	N/A**
**no AC measurements above 240Vac							
Averaged values	1.577	1.384	1.236	0.443	12.230		

Table 71: Drive #0113, 264VAC @ 63hz.

External Drive # 0113							
264Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.698	1.010	0.814	0.269	8.278	N/A**	N/A**
Load Tape	1.558	1.081	2.580	0.623	12.881	N/A**	N/A**
Unload Tape	1.290	0.979	2.450	0.770	14.135	N/A**	N/A**
Write Tape	1.824	1.617	1.317	0.513	14.241	N/A**	N/A**
Read Tape	1.684	1.444	1.254	0.501	13.232	N/A**	N/A**
Rewind	0.996	0.946	1.348	0.596	11.882	N/A**	N/A**
Idle (tape)	0.991	0.963	0.598	0.275	8.115	N/A**	N/A**
Idle (no tape)	0.995	0.961	0.083	0.053	5.441	N/A**	N/A**
**no AC measurements above 240Vac							
Averaged values	1.505	1.125	1.306	0.450	11.026		

Table 72: Drive #0144, 90VAC @ 47hz.

External Drive # 0144							
90Vac @ 47hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.012	1.016	0.800	0.287	8.525	8	18
Load Tape	1.606	1.079	2.620	0.673	13.473	19	25
Unload Tape	1.590	0.971	2.690	0.799	14.443	17	26
Write Tape	1.846	1.637	1.273	0.509	14.295	22	24
Read Tape	1.706	1.456	1.276	0.504	13.330	20	21
Rewind	1.003	0.940	1.304	0.601	11.912	18	19
Idle (tape)	0.991	0.967	0.279	0.158	6.731	13	14
Idle (no tape)	0.981	0.961	0.083	0.061	5.537	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.467	1.129	1.291	0.449	11.031	16.125	20.000

Table 73: Drive #0144, 90VAC @ 63hz.

External Drive # 0144							
90Vac @ 63hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.904	1.008	0.790	0.272	8.305	9	18
Load Tape	1.592	1.082	2.590	0.665	13.391	19	25
Unload Tape	1.592	0.971	2.530	0.774	14.143	16	24
Write Tape	1.841	1.639	1.292	0.503	14.233	22	24
Read Tape	1.856	1.644	1.292	0.492	14.123	23	24
Rewind	0.997	0.941	1.354	0.575	11.605	17	19
Idle (tape)	0.981	0.957	0.276	0.152	6.609	13	16
Idle (no tape)	0.981	0.949	0.086	0.065	5.525	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.468	1.149	1.276	0.437	10.992	16.375	20.375

Table 74: Drive #0144, 100VAC @ 47hz.

External Drive # 0144							
100Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.887	0.992	0.790	0.238	7.816	10	16
Load Tape	1.591	1.088	2.490	0.640	13.120	18	24
Unload Tape	1.591	0.973	2.620	0.775	14.165	17	25
Write Tape	1.841	1.635	1.261	0.492	14.079	21	23
Read Tape	1.700	1.458	1.229	0.492	13.194	19	21
Rewind	0.997	0.942	1.276	0.610	12.030	18	19
Idle (tape)	0.988	0.963	0.255	0.148	6.591	12	14
Idle (no tape)	0.981	0.957	0.076	0.056	5.457	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.447	1.126	1.250	0.431	10.807	15.875	19.375

Table 75: Drive #0144, 100VAC @ 63hz.

External Drive # 0144							
100Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.309	1.013	1.979	0.270	8.305	10	18
Load Tape	1.606	1.090	2.490	0.661	13.382	19	25
Unload Tape	1.591	0.976	2.620	0.767	14.084	18	25
Write Tape	1.841	1.638	1.261	0.496	14.142	22	23
Read Tape	1.700	1.463	1.229	0.500	13.315	20	21
Rewind	0.997	0.943	1.292	0.622	12.179	16	19
Idle (tape)	0.981	0.959	0.271	0.153	6.631	13	14
Idle (no tape)	0.981	0.956	0.073	0.057	5.464	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.501	1.130	1.402	0.441	10.938	16.250	19.750

Table 76: Drive #0144, 120VAC @ 47hz.

External Drive # 0144							
120Vac @ 47hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.101	0.988	0.762	0.274	8.228	8	18
Load Tape	1.569	1.061	2.520	0.657	13.189	18	24
Unload Tape	1.584	0.955	2.430	0.721	13.427	16	23
Write Tape	1.803	1.604	1.296	0.506	14.091	19	21
Read Tape	1.678	1.430	1.296	0.511	13.282	19	20
Rewind	0.974	0.912	1.327	0.577	11.484	17	18
Idle (tape)	0.969	0.947	0.272	0.158	6.631	12	13
Idle (no tape)	0.943	0.919	0.085	0.064	5.363	11	12
* Extech 382860 True RMS power meter							
Averaged values	1.453	1.102	1.249	0.434	10.712	15.000	18.625

Table 77: Drive #0144, 120VAC @ 63hz.

External Drive # 0144							
120Vac @ 63hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.962	0.990	0.770	0.288	8.406	8	17
Load Tape	1.556	1.061	2.440	0.658	13.203	16	22
Unload Tape	1.571	0.959	2.360	0.715	13.375	16	23
Write Tape	1.821	1.614	1.293	0.519	14.296	19	20
Read Tape	1.696	1.442	1.261	0.502	13.233	17	19
Rewind	0.977	0.922	1.308	0.577	11.534	16	17
Idle (tape)	0.963	0.939	0.283	0.155	6.555	12	13
Idle (no tape)	0.977	0.938	0.085	0.065	5.470	11	11
* Extech 382860 True RMS power meter							
Averaged values	1.440	1.108	1.225	0.435	10.759	14.375	17.750

Table 78: Drive #0144, 132VAC @ 47hz.

External Drive # 0144							
132Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.091	1.000	0.550	0.320	8.840	10	18
Load Tape	1.602	1.083	2.620	0.654	13.263	18	24
Unload Tape	1.606	0.989	2.430	0.695	13.285	19	25
Write Tape	1.841	1.644	1.276	0.522	14.484	22	23
Read Tape	1.700	1.460	1.276	0.495	13.240	20	21
Rewind	1.841	1.642	1.245	0.497	14.174	17	23
Idle (tape)	0.991	0.968	0.268	0.153	6.676	13	14
Idle (no tape)	0.975	0.956	0.074	0.054	5.428	12	13
* Extech 382860 True RMS power meter				.			
Averaged values	1.581	1.218	1.217	0.424	11.174	16.375	20.125

Table 79: Drive #0144, 132VAC @ 63hz.

External Drive # 0144							
132Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	1.950	1.021	0.479	0.271	8.357	9	18
Load Tape	1.622	1.100	1.979	0.630	13.060	18	24
Unload Tape	1.606	0.988	2.490	0.747	13.904	17	24
Write Tape	1.872	1.657	1.229	0.495	14.225	19	23
Read Tape	1.716	1.459	1.261	0.491	13.187	20	21
Rewind	0.997	0.941	1.292	0.622	12.169	16	19
Idle (tape)	0.994	0.968	0.265	0.152	6.664	13	14
Idle (no tape)	0.978	0.958	0.074	0.055	5.450	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.467	1.137	1.134	0.433	10.877	15.500	19.500

Table 80: Drive #0144, 180VAC @ 47hz.

External Drive # 0144							
180Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.262	1.002	0.790	0.262	8.154	11	18
Load Tape	1.606	1.085	2.580	0.647	13.189	19	25
Unload Tape	1.591	0.972	2.490	0.762	14.004	17	26
Write Tape	1.841	1.643	1.292	0.494	14.143	19	24
Read Tape	1.700	1.468	1.261	0.493	13.256	22	23
Rewind	0.997	0.941	1.261	0.623	12.181	17	20
Idle (tape)	0.997	0.974	0.288	0.155	6.730	13	14
Idle (no tape)	0.978	0.961	0.074	0.056	5.477	12	13
* Extech 382860 True RMS power meter							
Averaged values	1.497	1.131	1.255	0.437	10.892	16.250	20.375

Table 81: Drive #0144, 180VAC @ 63hz.

External Drive # 0144							
180Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.341	0.997	1.979	0.289	8.453	12	19
Load Tape	1.575	1.069	2.740	0.675	13.445	19	26
Unload Tape	1.575	0.961	2.490	0.782	14.189	18	25
Write Tape	1.841	1.629	1.229	0.501	14.157	20	24
Read Tape	1.700	1.453	1.276	0.506	13.337	22	23
Rewind	0.997	0.936	1.308	0.583	11.676	18	20
Idle (tape)	0.991	0.970	0.262	0.151	6.662	13	14
Idle (no tape)	0.981	0.954	0.069	0.051	5.382	13	14
* Extech 382860 True RMS power meter							
Averaged values	1.500	1.121	1.419	0.442	10.913	16.875	20.625

Table 82: Drive #0144, 220VAC @ 47hz.

External Drive # 0144							
220Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.316	0.985	0.790	0.277	8.249	10	19
Load Tape	1.581	1.062	2.680	0.651	13.123	20	27
Unload Tape	1.566	0.951	2.580	0.773	14.031	20	26
Write Tape	1.817	1.623	1.281	0.509	14.221	22	25
Read Tape	1.692	1.445	1.281	0.514	13.393	23	24
Rewind	0.973	0.924	1.281	0.606	11.892	19	20
Idle (tape)	0.963	0.937	0.296	0.169	6.713	15	16
Idle (no tape)	0.973	0.936	0.094	0.073	5.556	13	14
**no AC measurements above 240Vac							
Averaged values	1.485	1.108	1.285	0.447	10.897	17.750	14.000

Table 83: Drive #0144, 220VAC @ 63hz.

External Drive # 0144							
220Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.356	0.997	0.792	0.280	8.345	11	19
Load Tape	1.575	1.067	2.520	0.652	13.157	20	26
Unload Tape	1.575	0.946	2.610	0.781	14.102	20	25
Write Tape	1.816	1.613	1.281	0.507	14.148	23	25
Read Tape	1.676	1.439	1.312	0.507	13.278	23	24
Rewind	0.972	0.923	1.312	0.612	11.959	19	20
Idle (tape)	0.966	0.942	0.290	0.168	6.726	15	16
Idle (no tape)	0.967	0.935	0.097	0.073	5.551	13	14
* Extech 382860 True RMS power meter							
Averaged values	1.488	1.108	1.277	0.448	10.908	18.000	21.125

Table 84: Drive #0144, 240VAC @ 47hz.

External Drive # 0144							
240Vac @ 47hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.509	1.006	0.796	0.265	8.210	11	19
Load Tape	1.587	1.081	2.710	0.652	13.229	20	26
Unload Tape	1.587	0.972	2.550	0.787	14.304	20	26
Write Tape	1.837	1.637	1.234	0.496	14.137	24	25
Read Tape	1.712	1.458	1.297	0.495	13.230	23	24
Rewind	0.993	0.937	1.297	0.577	11.609	19	21
Idle (tape)	0.994	0.972	0.258	0.150	6.660	16	19
Idle (no tape)	0.977	0.947	0.077	0.058	5.431	14	16
* Extech 382860 True RMS power meter							
Averaged values	1.525	1.126	1.277	0.435	10.851	18.375	22.000

Table 85: Drive #0144, 240VAC @ 63hz.

External Drive # 0144							
240Vac @ 63hz Code level: 11.0	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.404	0.995	0.686	0.277	8.299	12	19
Load Tape	1.592	1.085	2.640	0.674	13.513	19	26
Unload Tape	1.592	0.968	2.580	0.788	14.296	20	26
Write Tape	1.826	1.634	1.281	0.501	14.182	24	25
Read Tape	1.701	1.459	1.265	0.503	13.331	23	24
Rewind	0.998	0.941	1.328	0.630	12.265	20	21
Idle (tape)	0.991	0.969	0.252	0.147	6.609	16	17
Idle (no tape)	0.981	0.959	0.077	0.055	5.455	14	16
* Extech 382860 True RMS power meter							
Averaged values	1.511	1.126	1.264	0.447	10.994	18.500	21.750

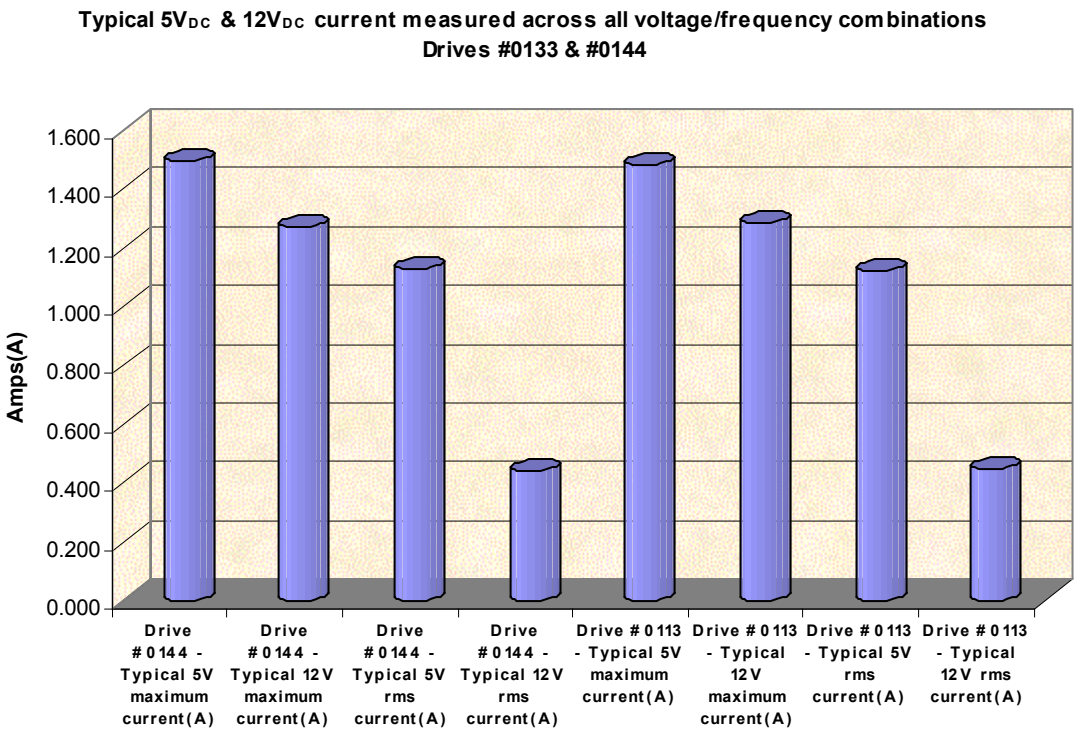
Table 86: Drive #0144, 264VAC @ 47hz.

External Drive # 0144							
264Vac @ 47hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.757	0.973	0.796	0.280	8.225	N/A**	N/A**
Load Tape	1.554	1.033	2.490	0.652	12.989	N/A**	N/A**
Unload Tape	1.554	0.920	2.710	0.781	13.972	N/A**	N/A**
Write Tape	1.851	1.636	1.297	0.507	14.264	N/A**	N/A**
Read Tape	1.711	1.459	1.250	0.507	13.379	N/A**	N/A**
Rewind	0.992	0.936	1.344	0.612	12.024	N/A**	N/A**
Idle (tape)	0.981	0.958	0.274	0.168	6.806	N/A**	N/A**
Idle (no tape)	0.997	0.968	0.080	0.073	5.716	N/A**	N/A**
**no AC measurements above 240Vac							
Averaged values	1.550	1.110	1.280	0.448	10.922		

Table 87: Drive #0144, 264VAC @ 63hz.

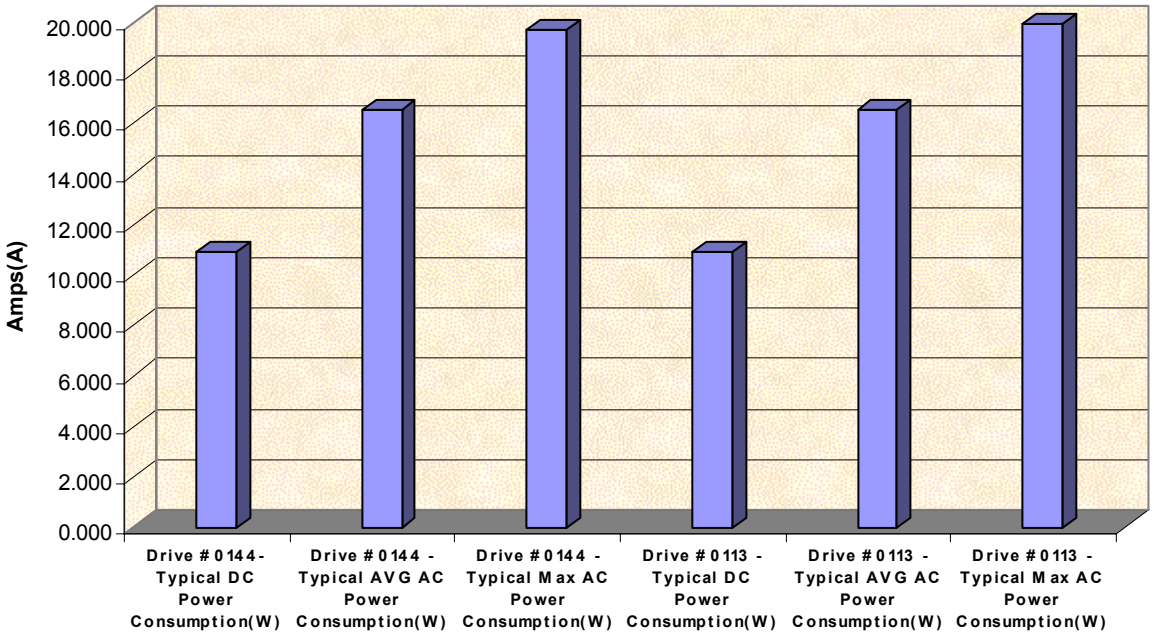
External Drive # 0144							
264Vac @ 63hz	Current @	Current @	Current @	Current @	Drive DC Power VDC x IDC = (W)	External AC Power Con (W) * Average	External AC Power Con (W) *Maximum
Code level: 11.0							
	5VDC (A)	5VDC (A)	12VDC (A)	12VDC (A)			
	max	rms	max	rms			
Power Up	2.591	1.024	0.796	0.268	8.336	N/A**	N/A**
Load Tape	1.587	1.088	2.460	0.630	13.000	N/A**	N/A**
Unload Tape	1.602	0.983	2.550	0.766	14.107	N/A**	N/A**
Write Tape	1.837	1.634	1.266	0.498	14.146	N/A**	N/A**
Read Tape	1.712	1.455	1.234	0.495	13.215	N/A**	N/A**
Rewind	0.933	0.939	1.297	0.598	11.871	N/A**	N/A**
Idle (tape)	0.994	0.964	0.255	0.149	6.608	N/A**	N/A**
Idle (no tape)	0.993	0.950	0.080	0.058	5.446	N/A**	N/A**
**no AC measurements above 240Vac							
Averaged values	1.531	1.130	1.242	0.433	10.841		

Graph 5


Typical 5VDC & 12VDC current measured across all voltage/frequency combinations
Drives #0133 & #0144
Amps(A)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Drive #0144 - Typical 5V maximum current(A)
Drive #0144 - Typical 12V maximum current(A)
Drive #0144 - Typical 5V rms current(A)
Drive #0144 - Typical 12V rms current(A)
Drive #0113 - Typical 5V maximum current(A)
Drive #0113 - Typical 12V maximum current(A)
Drive #0113 - Typical 5V rms current(A)
Drive #0113 - Typical 12V rms current(A)

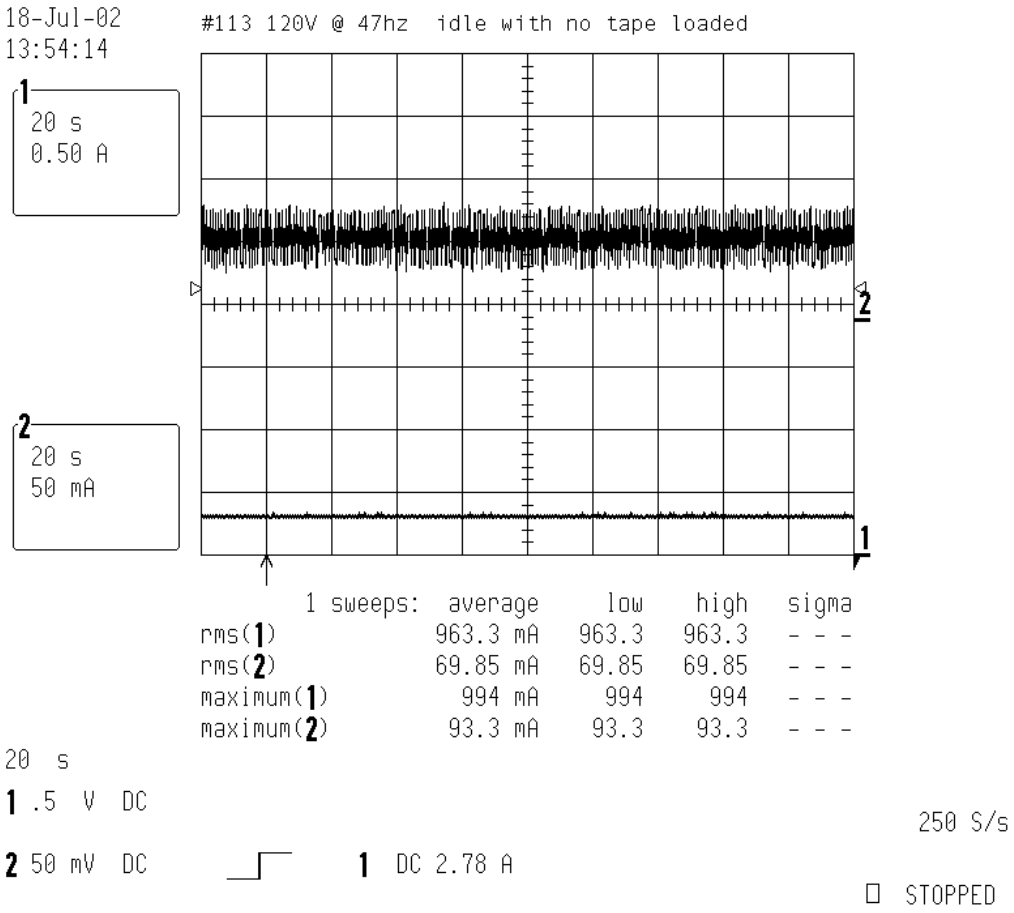
Graph 6

Typical AC & DC power consumption for all Voltage/Frequency combinations, Drives #0144 & #0133



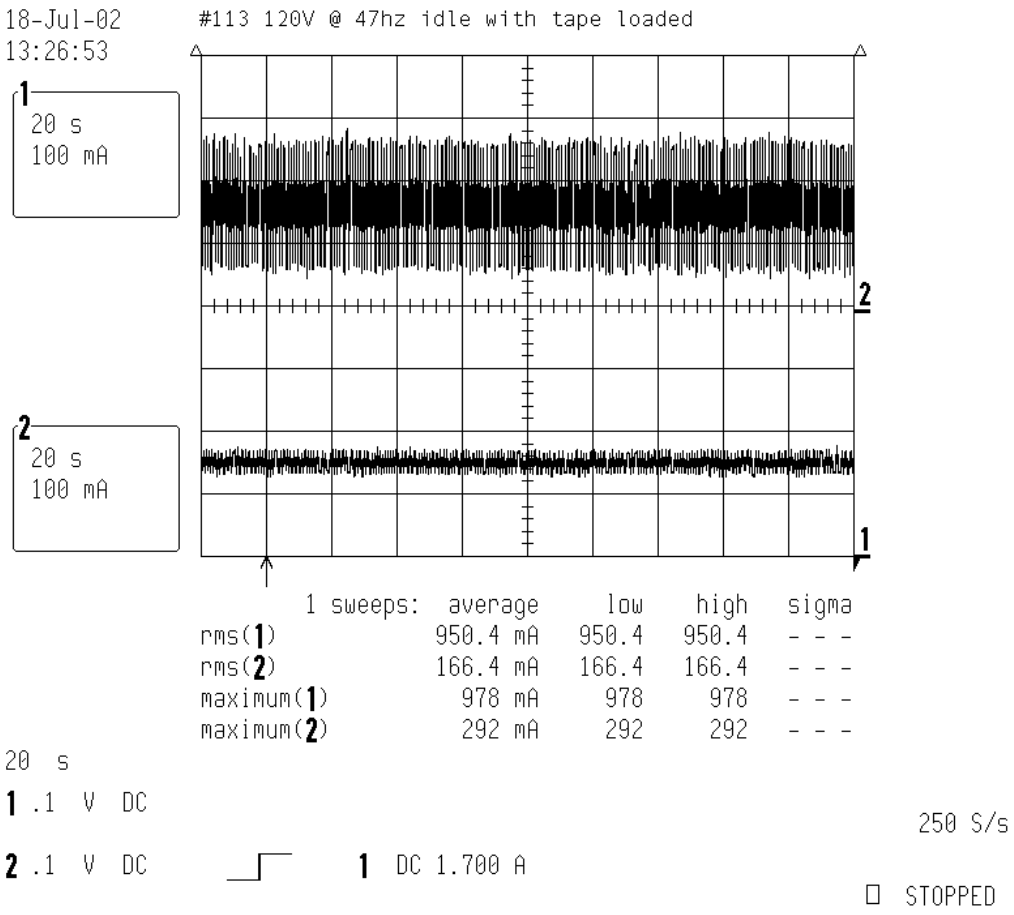
The following charts are LeCroy 9354AL Oscilloscope and LeCroy AP015 Current Probe Current trace plots of Drive #0113 performing drive functions.

Figure 22



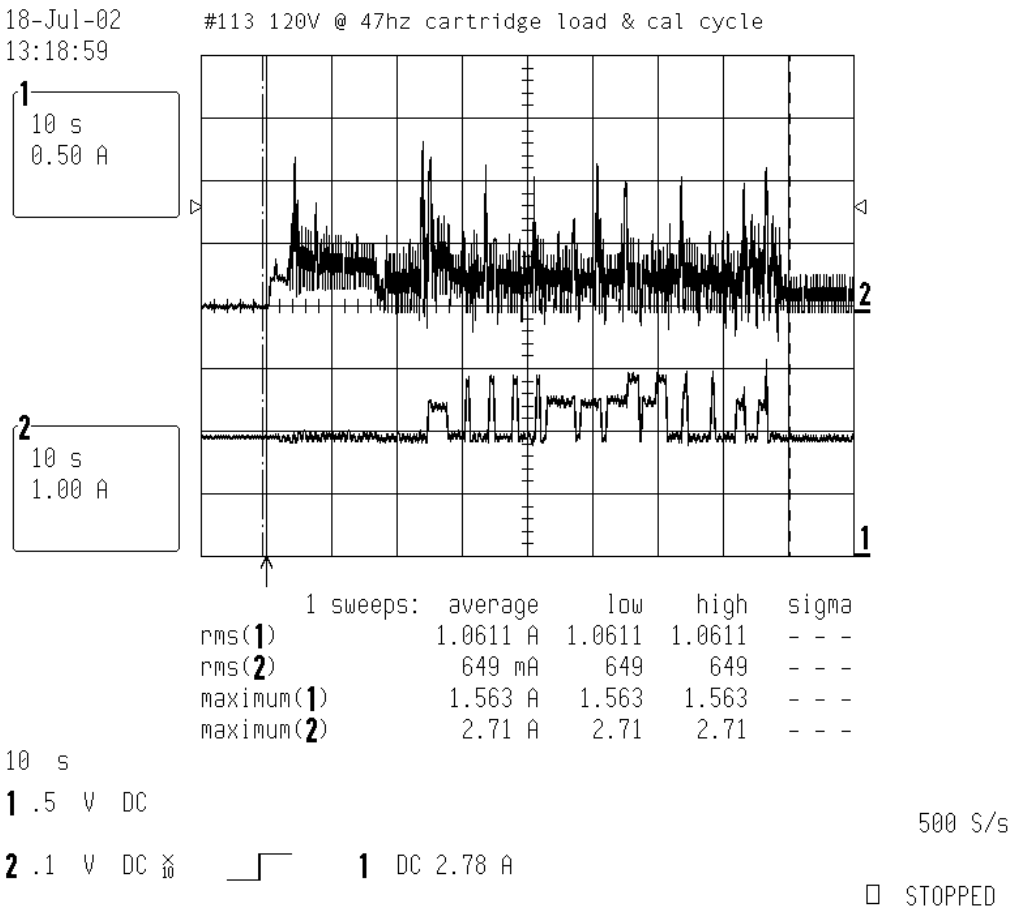
Drive #0113, 120VAC @ 47hz Drive idle with no tape cartridge loaded. Ch1 – 5V, Ch2 – 12V

Figure 23



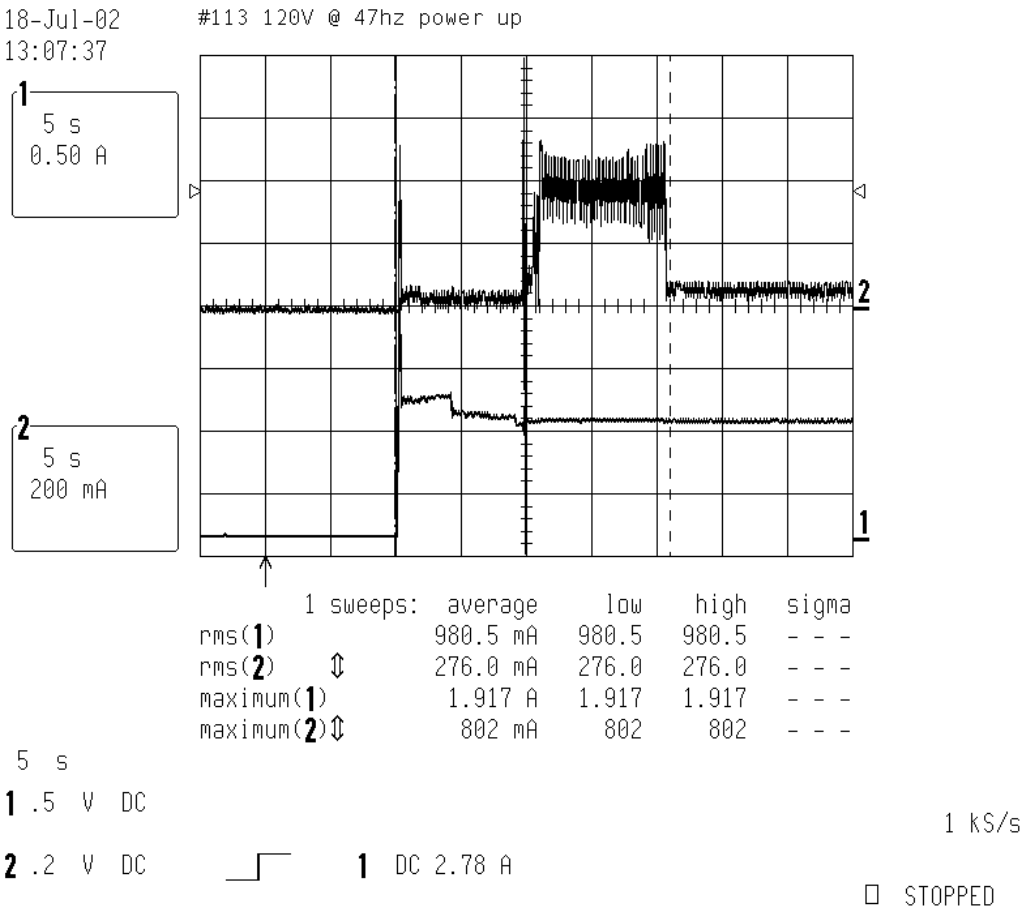
Drive #0113 120VAC @ 47hz, drive idle wiwith tape cartridge loaded. Ch1 – 5V, Ch2 – 12V

Figure 24



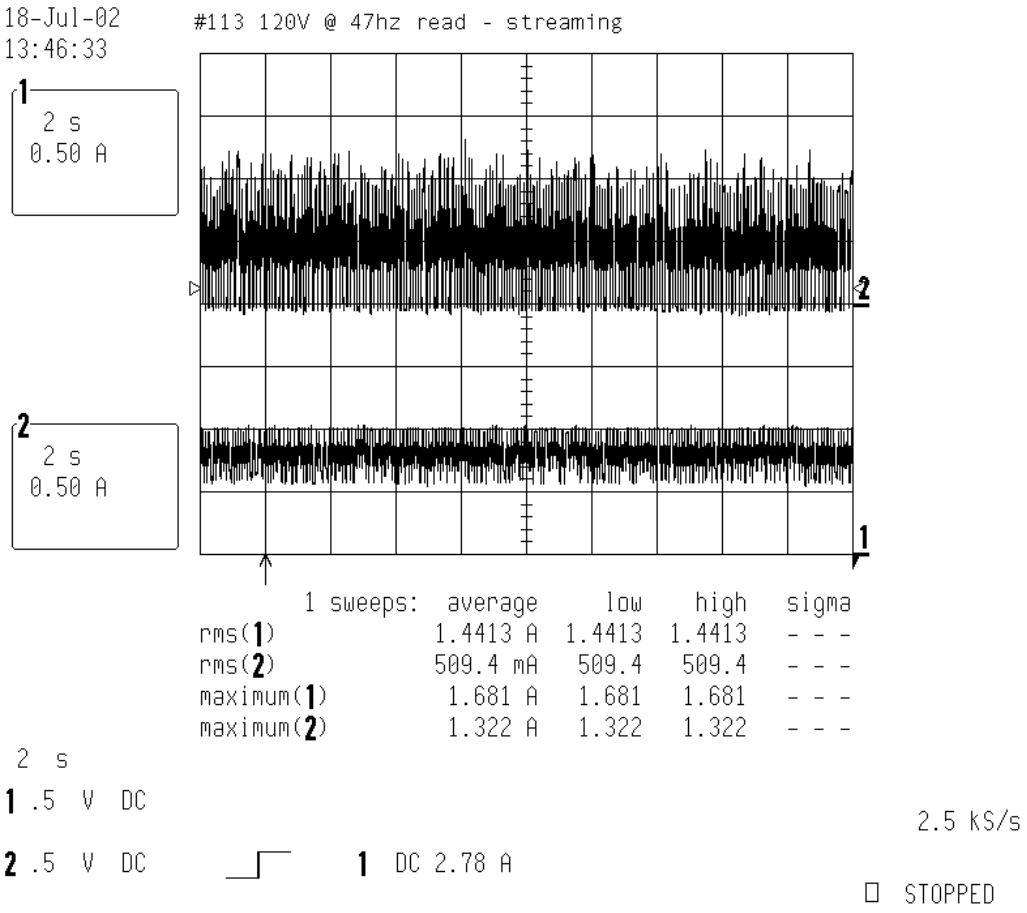
Drive #0113, 120VAC @ 47hz, tape cartridge load and calibrate cycle. Ch1 – 5V, Ch2 – 12V

Figure 25



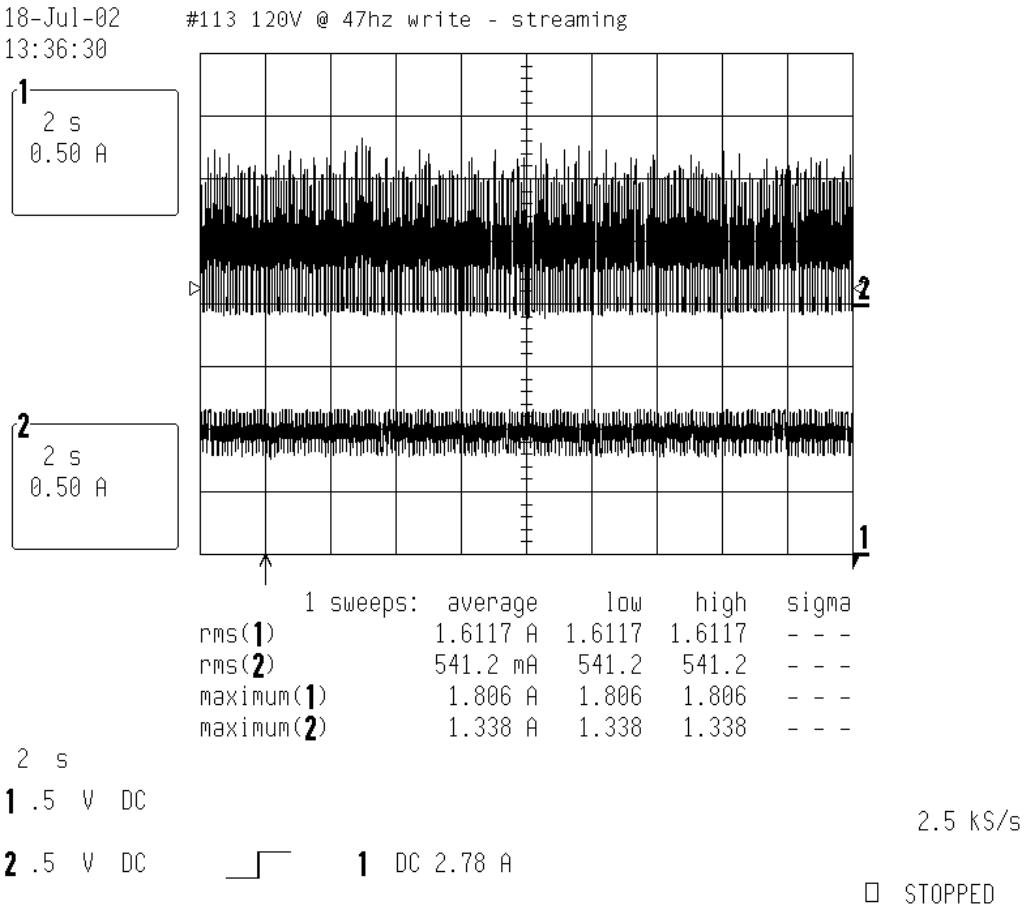
Drive #0113, 120VAC @ 47hz, drive power up cycle. Ch1 – 5V, Ch2 – 12V.

Figure 26



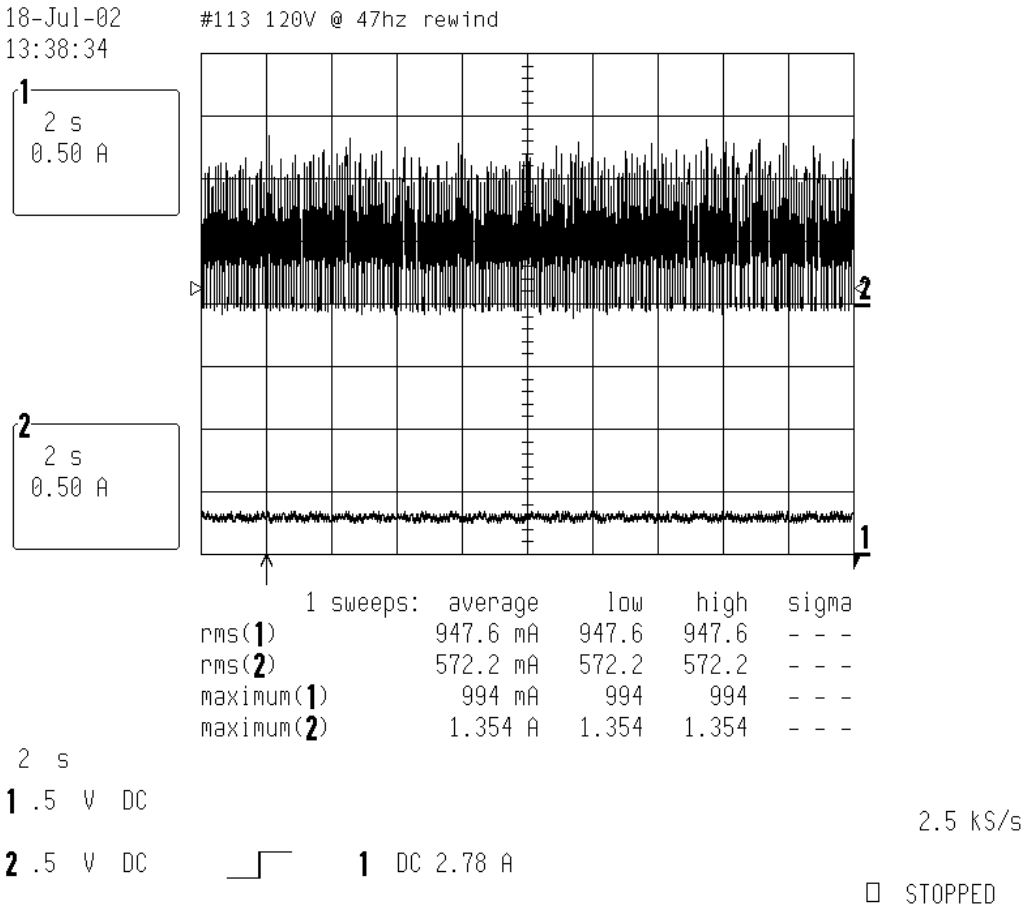
Drive #0113, 120VAC @ 47hz, drive read function - streaming, Ch1 - 5V, Ch2 - 12V

Figure 27



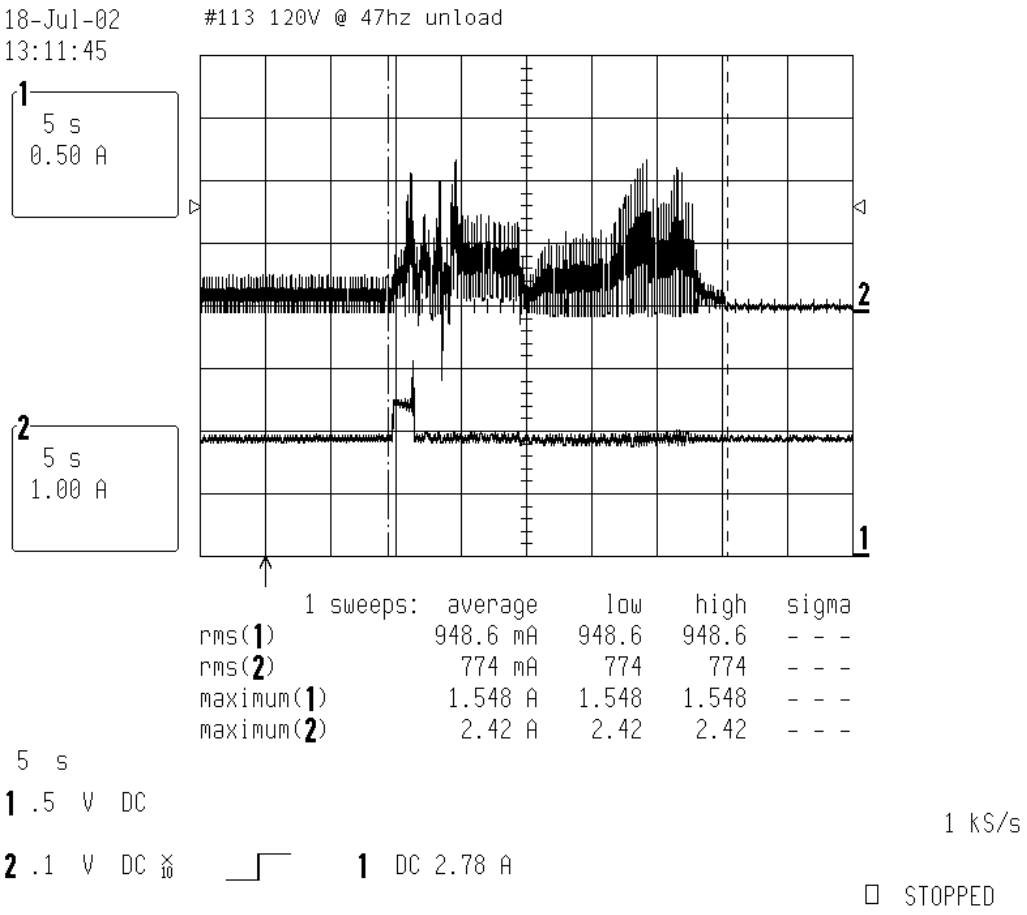
Drive #0113 120VAC @ 47hz, drive write function - streaming, Ch1 - 5V, Ch2 - 12V.

Figure 28



Drive #0113 120VAC @ 47hz, drive rewinding. Ch1 - 5V, Ch2 - 12V.

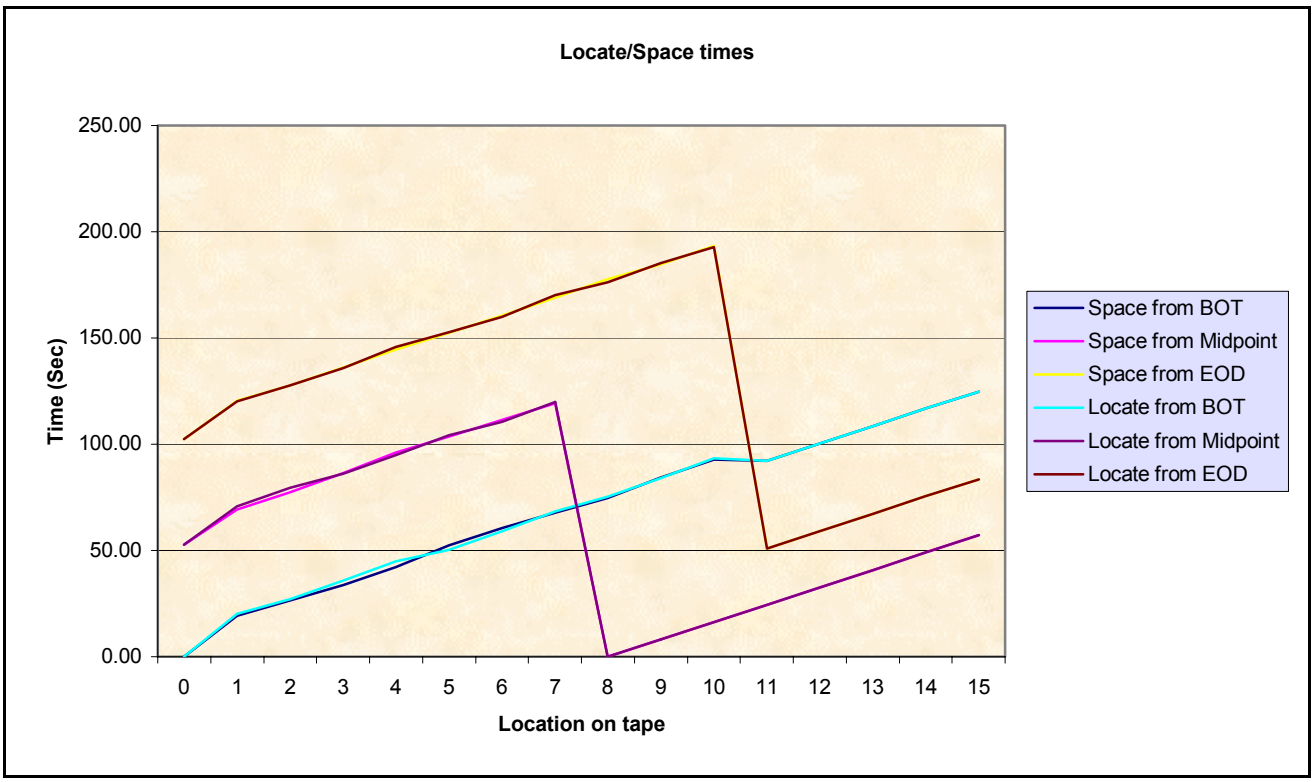
Figure 29



Drive #0113, 120VAC @ 47hz, Drive unload function. Ch1 - 5V, Ch2 - 12V

11.8 Appendix H: Access Times

Graph 7: Locate/Space Times

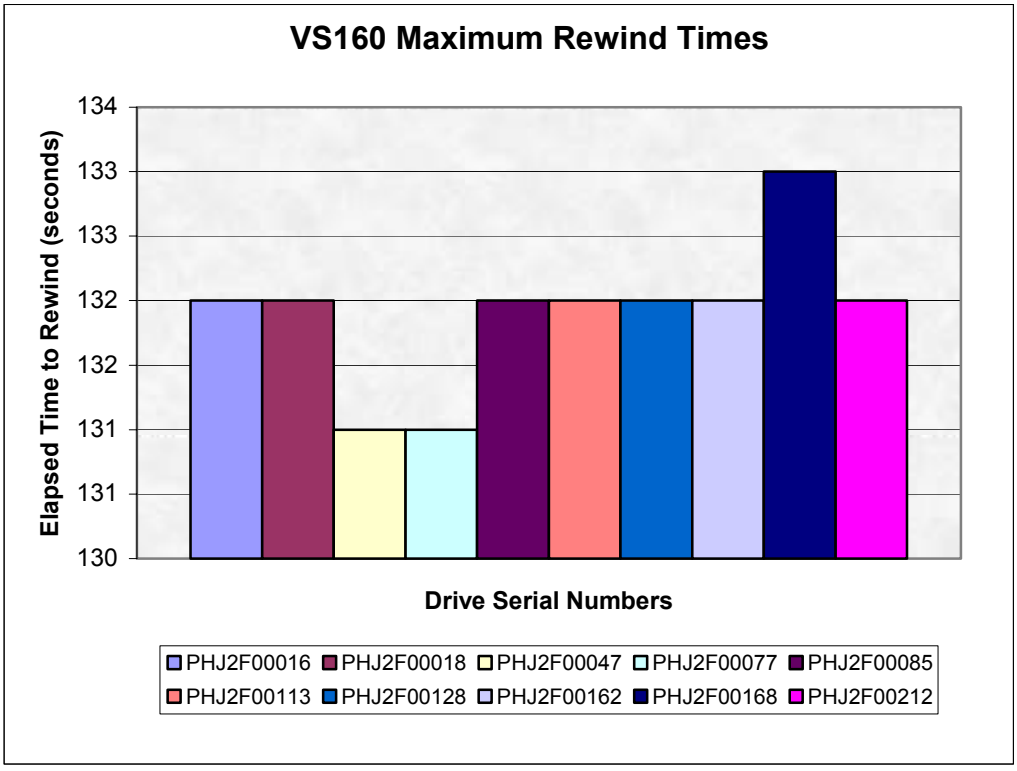


11.9 Appendix I: Rewind Times

Table 88: Maximum Rewind Times

VS160 Maximum Rewind Times		
Drive #	**Tape #**	**Max Rewind (sec)**
PHJ2F00016	B0205b197	132
PHJ2F00018	B0205b181	132
PHJ2F00047	B0205b206	131
PHJ2F00077	B0205b125	131
PHJ2F00085	B0205b122	132
PHJ2F00113	B0205b127	132
PHJ2F00128	B0205b196	132
PHJ2F00162	B0205b178	132
PHJ2F00168	B0205b198	133
PHJ2F00212	B0205b202	132

Graph 8: Maximum Rewind Times

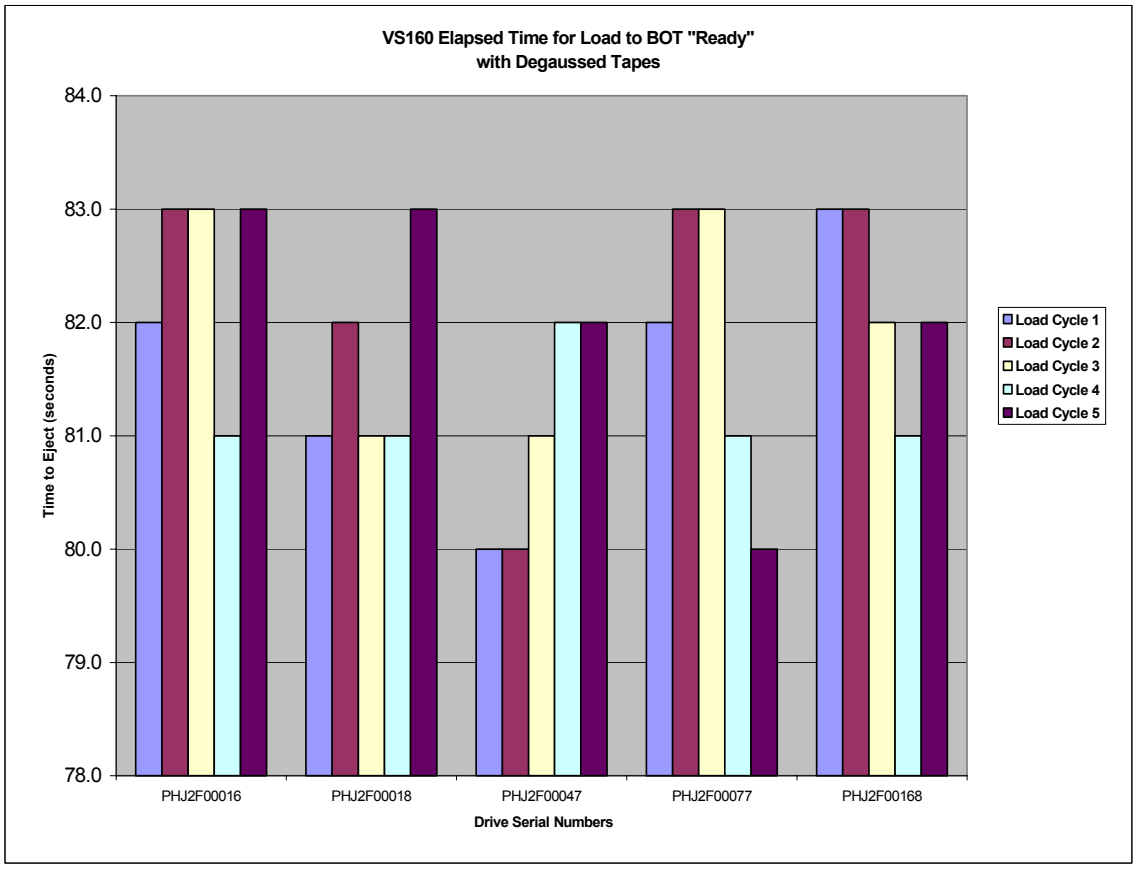


11.10 Appendix J: Load / Unload BOT Times

Table 89: Tape Load to BOT "ready" Times

VS160 Load to BOT "Ready"							
Drive #	Tape #	Tape Status	Load Cycle 1 (seconds)	Load Cycle 2 (seconds)	Load Cycle 3 (seconds)	Load Cycle 4 (seconds)	Load Cycle 5 (seconds)
PHJ2F00016	B0205b197	Degaussed	82	83	83	81	83
PHJ2F00018	B0205b181	Degaussed	81	82	81	81	83
PHJ2F00047	B0205b206	Degaussed	80	80	81	82	82
PHJ2F00077	B0205b125	Degaussed	82	83	83	81	80
PHJ2F00168	B0205b198	Degaussed	83	83	82	81	82
PHJ2F00016	B0205b197	Previously Recorded	137	135	135	136	138
PHJ2F00018	B0205b181	Previously Recorded	137	135	136	136	137
PHJ2F00047	B0205b206	Previously Recorded	135	136	135	137	135
PHJ2F00077	B0205b125	Previously Recorded	137	135	136	137	136
PHJ2F00168	B0205b198	Previously Recorded	138	138	136	135	137

Graph 9: Tape Load to BOT "Ready" with Degaussed Tapes



Graph 10: Tape Load to BOT "Ready" Times for Pre-Recorded Tapes

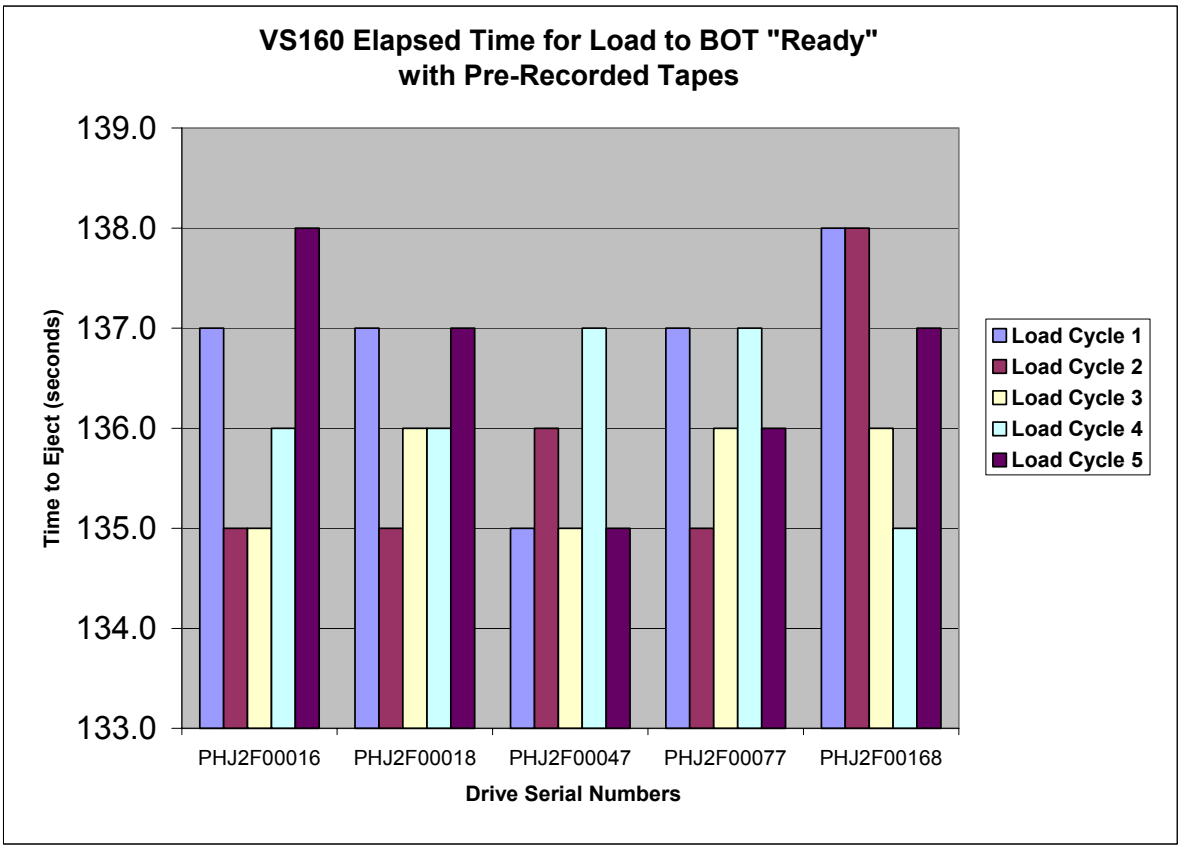
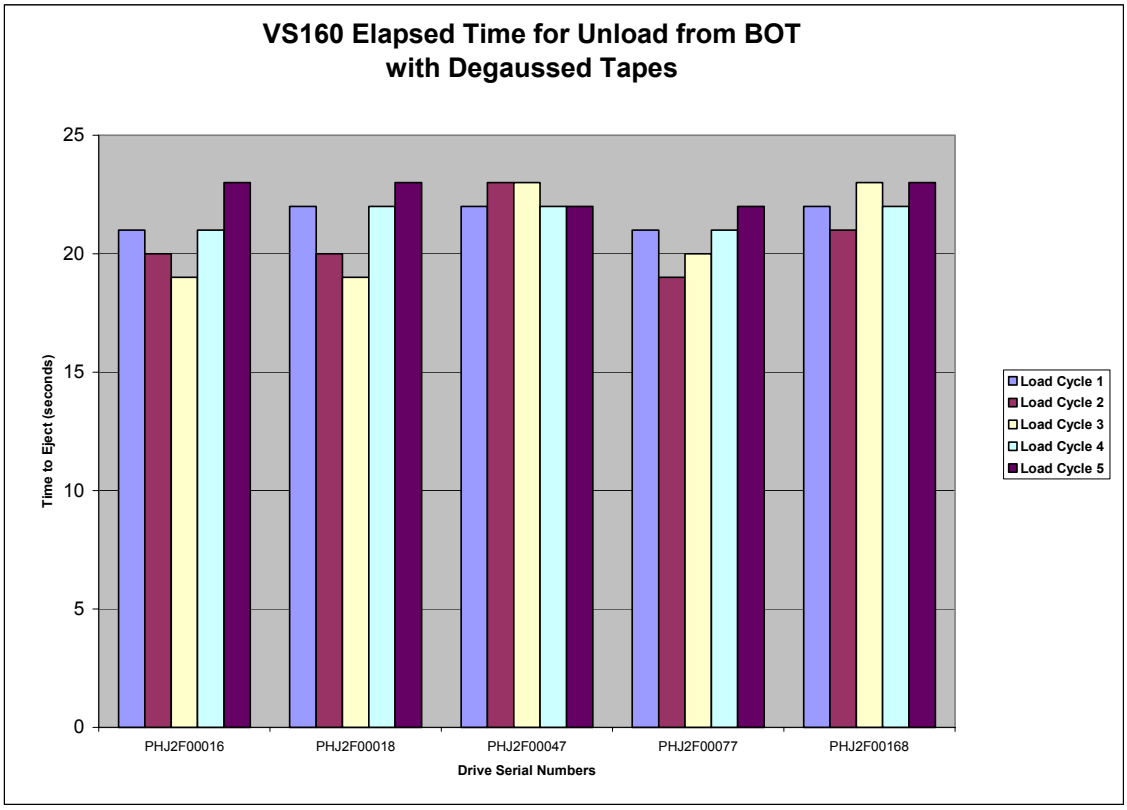


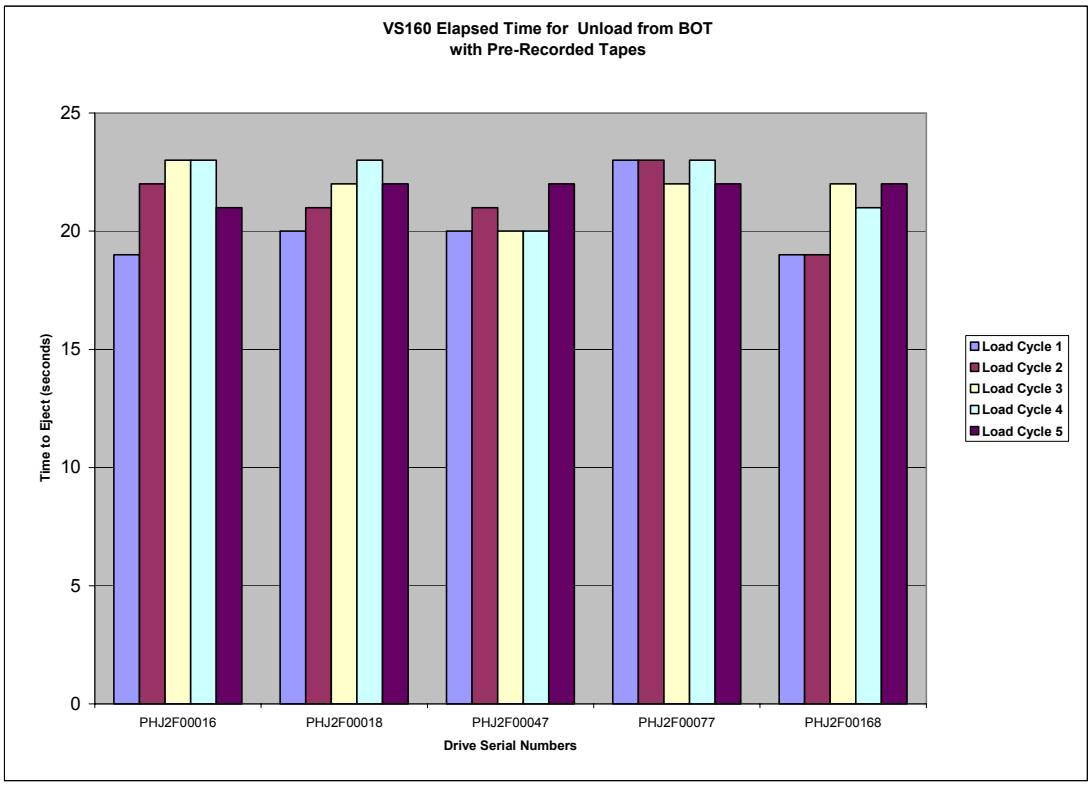
Table 90: Unload to Eject Times

VS160 Elapsed Time for Unload from BOT							
Drive #	Tape #	Tape Status	Load Cycle 1 (seconds)	Load Cycle 2 (seconds)	Load Cycle 3 (seconds)	Load Cycle 4 (seconds)	Load Cycle 5 (seconds)
PHJ2F00016	B0205b197	Degaussed	19	20	19	21	23
PHJ2F00018	B0205b181	Degaussed	20	20	19	22	23
PHJ2F00047	B0205b206	Degaussed	20	23	23	22	22
PHJ2F00077	B0205b125	Degaussed	22	19	20	21	22
PHJ2F00168	B0205b198	Degaussed	20	21	23	22	23
PHJ2F00016	B0205b197	Previously Recorded	19	22	23	23	21
PHJ2F00018	B0205b181	Previously Recorded	20	21	22	23	22
PHJ2F00047	B0205b206	Previously Recorded	20	21	20	20	22
PHJ2F00077	B0205b125	Previously Recorded	23	23	22	23	22
PHJ2F00168	B0205b198	Previously Recorded	19	19	22	21	22

Graph 11: Unload to Eject Times with Degaussed Tapes

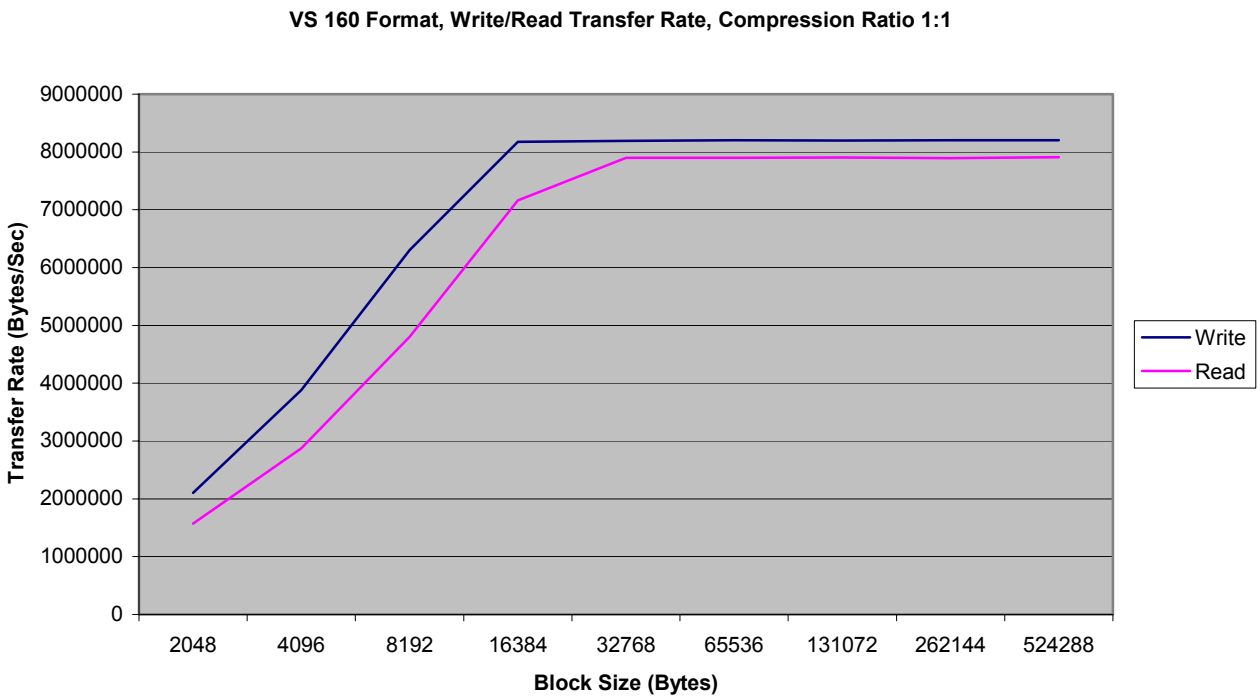


Graph 12: Unload to Eject Times with Pre-Recorded Tapes

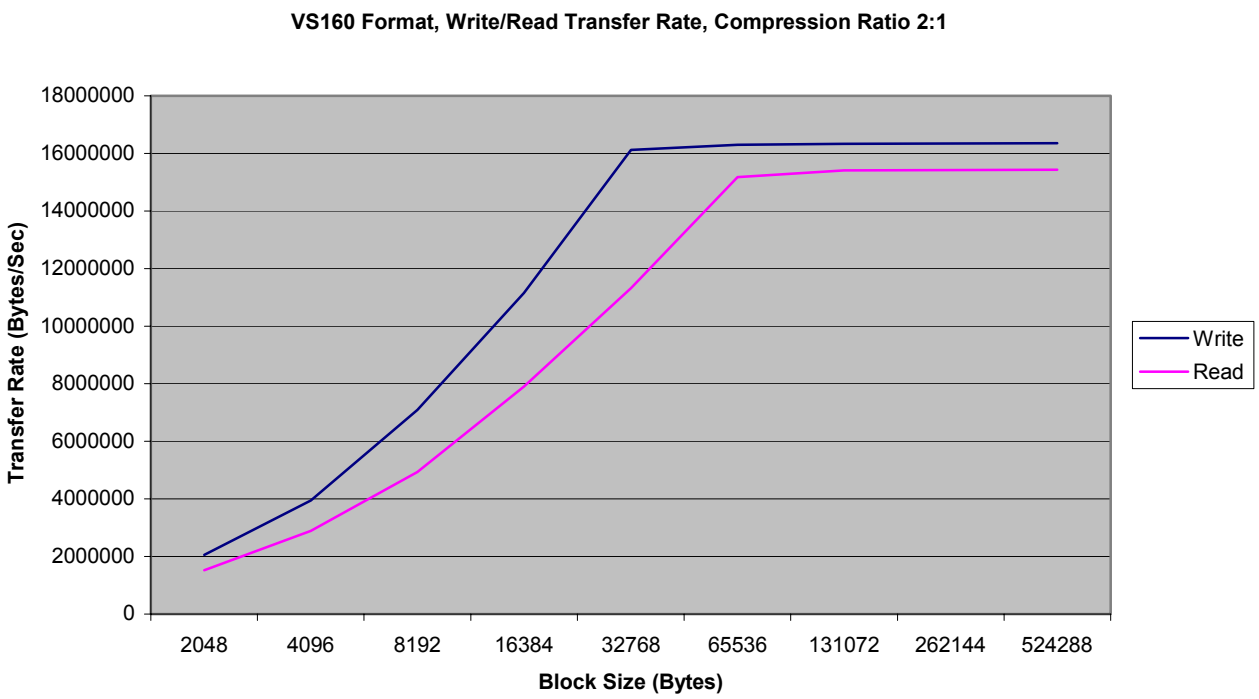


11.11 Appendix K: Transfer rates

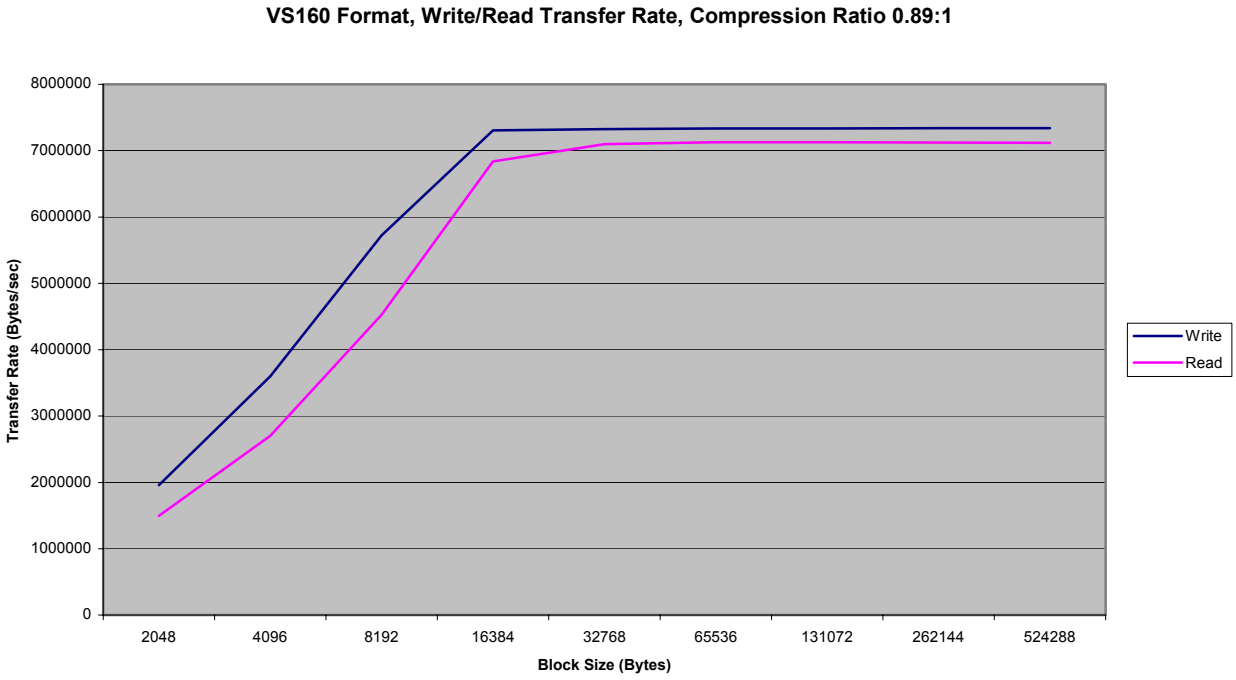
Graph 13



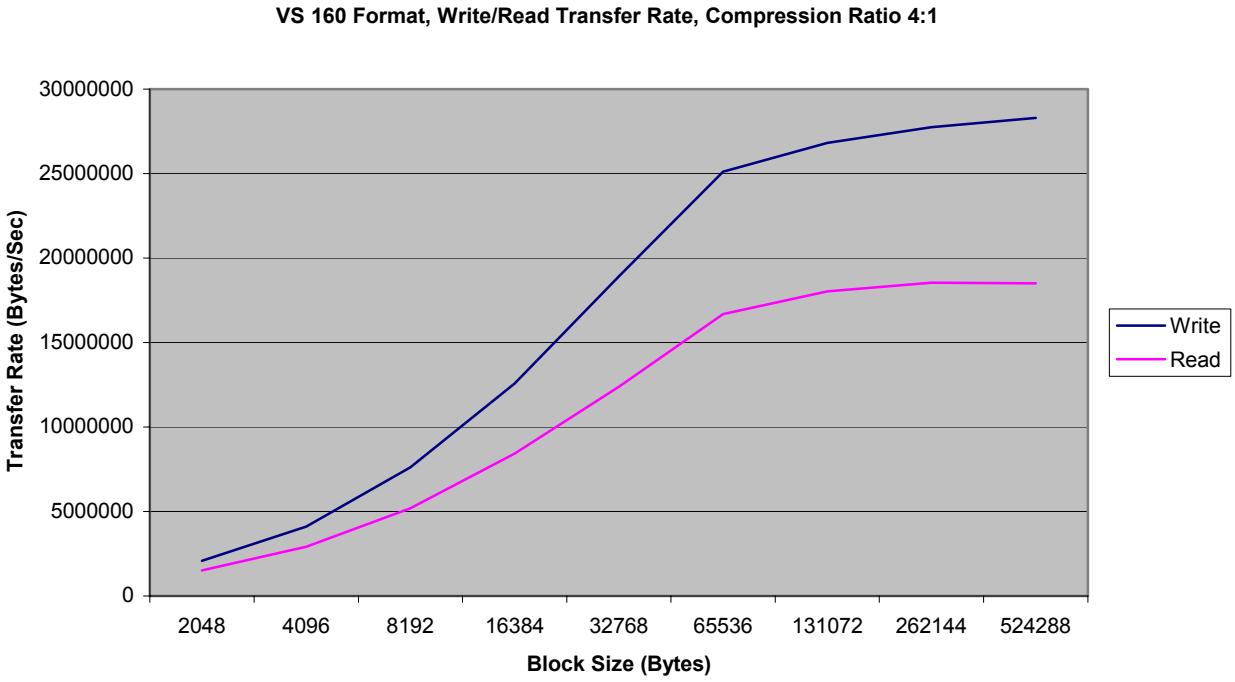
Graph 14


VS160 Format, Write/Read Transfer Rate, Compression Ratio 2:1
Transfer Rate (Bytes/Sec)
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)
Write
Read

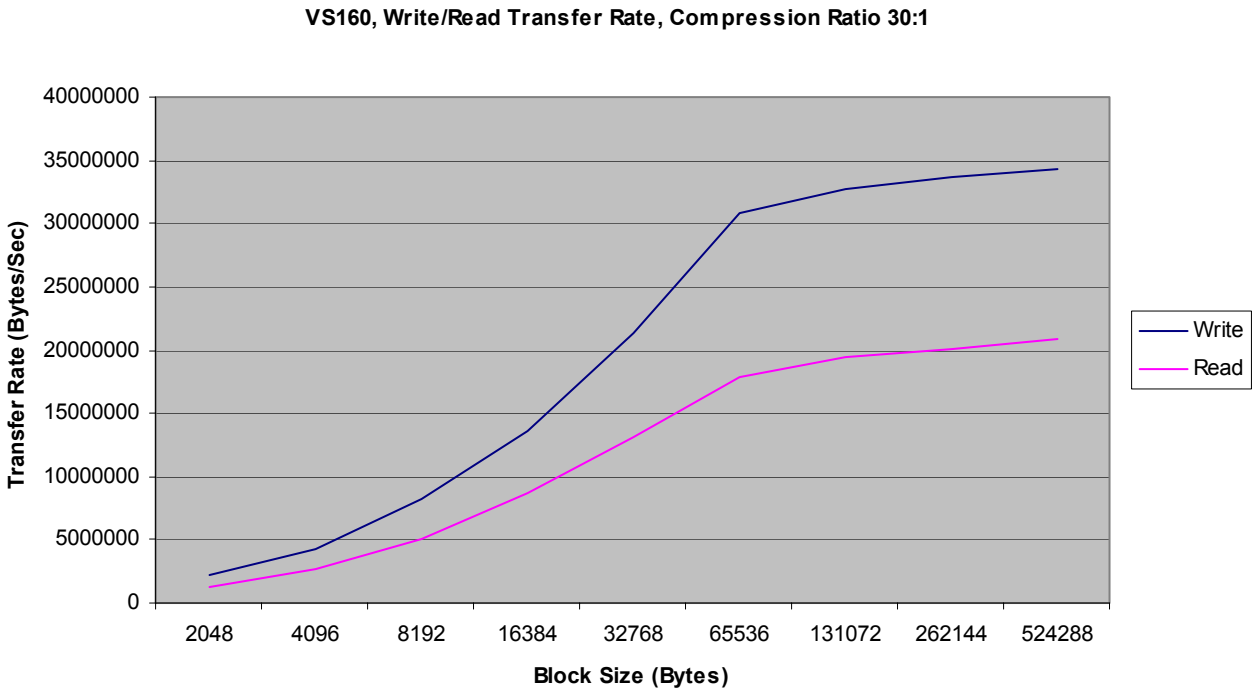
Graph 15


VS160 Format, Write/Read Transfer Rate, Compression Ratio 0.89:1
Transfer Rate (Bytes/sec)
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)
Write
Read

Graph 16


VS 160 Format, Write/Read Transfer Rate, Compression Ratio 4:1
Transfer Rate (Bytes/Sec)
30000000
25000000
20000000
15000000
10000000
5000000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)
Write
Read

Graph 17


VS160, Write/Read Transfer Rate, Compression Ratio 30:1
Transfer Rate (Bytes/Sec)
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
2048
4096
8192
16384
32768
65536
131072
262144
524288
Block Size (Bytes)
Write
Read

11.12 Appendix L: Cleaning LED's

Table 91

DVT Testing Section 9.11 Cleaning Tape LED Verification				
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00002	11.0	07/18/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00006	11.0	07/18/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00009	11.0	07/18/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00038	10.3	07/17/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass

Drive S/N	Code Rev.	Date	Event /Test	Pass/Fail
PHJ2F00045	10.3	07/17/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00052	10.3	07/17/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00068	11.0	07/18/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00077	11.0	07/23/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00087	11.0	07/19/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass

			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass
Drive S/N	**Code Rev.**	**Date**	**Event /Test**	**Pass/Fail**
PHJ2F00094	11	07/23/02	Cleaning Required LED On	Pass
			Cleaning Hours = 250/260	Pass
			Power Cycle Drive Cleaning LED On	Pass
			DLT1 Media Loaded Cleaning LED On	Pass
			Cleaning in Process LEDs ON	Pass
			Cleaning Tape Ejects Cleaning LED Off	Pass
			Last Cleaning Hours = Zero	Pass
			Cleaning Count Incremented	Pass

12 Addendums

Addendum 1: DLT VS160e Engineering Test Report (230 VAC)

Addendum 2: DLT VS160e VCCI Report (100 VAC)

Addendum 3: DLT VS160e FCC (CISPR) Radiated Emissions Report (110 VAC)

Addendum 4: DLT VS160e FCC (CISPR) Conducted Emissions Report (110 VAC)

Addendum 5: DLT VS160 CISPR 24 Immunity Report (230 VAC)

Addendum 6: DLT VS160 Magnetic Interference Report

Addendum 7: DLT VS160e Magnetic Interference Report

Addendum 8: DLT VS160 Shock and Vibration Test Report

Addendum 9: DLT VS160e Acoustics Emissions Test Report

Addendum 10: DLT VS160 CB Report and Certificate

Addendum 11: DLT VS160e CB Report and Certificate

Addendum 12: DLT VS160 UL Follow-up Report

Addendum 13: DLT VS160e UL Follow-up Report

Addendum 14: DLT VS160 EMC Emissions Test Report (110, 230 VAC)

Addendum 15: DLT VS160e FCC DoC

Addendum 16: DLT VS160 FCC DoC

Addendum 17: DLT VS160e ESD Test Report

Addendum 18: DLT VS160 TUV Bauart Mark Report

Addendum 19: DLT VS160e TUV GS Mark Report

Addendum 20: DLT VS160 CE DoC

Addendum 21: DLT VS160e CE DoC