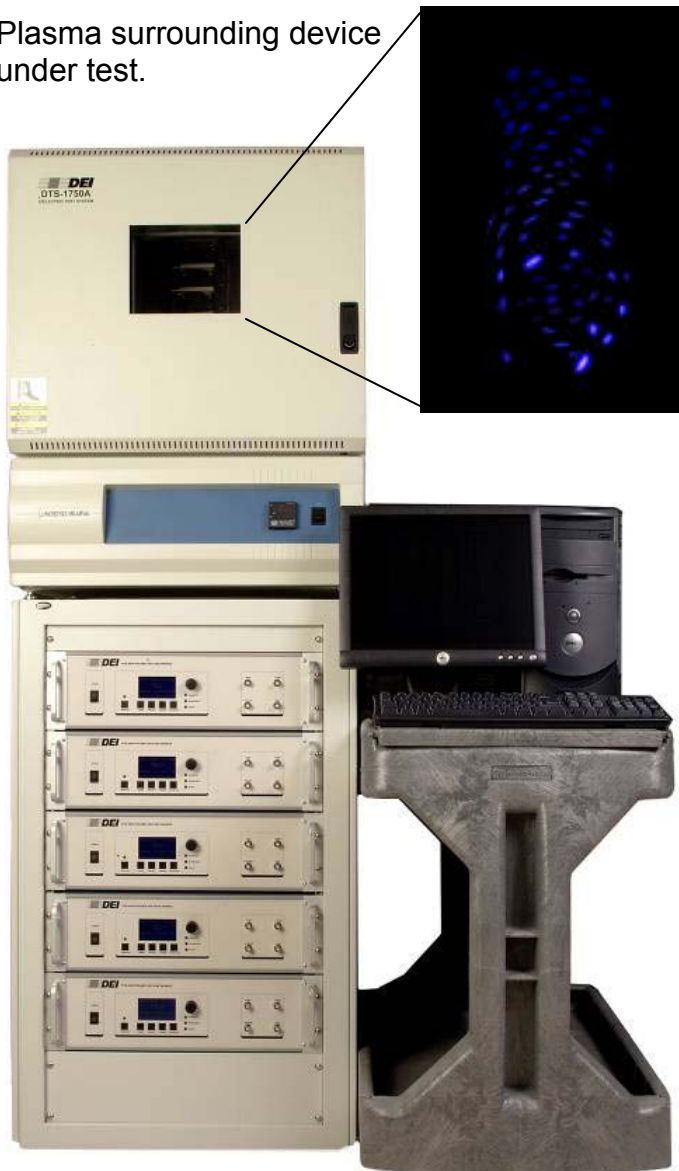


- 5-Channel 3,500V Pulsed Test System for Accelerated Breakdown Testing of Motorettes, Twisted-Pair and Dielectric Materials
- Variable Output Voltage, Pulse Rate-of-Rise Time, Frequency, Duty Cycle and Temperature
- Graphical User Interface and Computer Control and Logging Of Test and Oven Parameters



# DTS-1750A Dielectric Test System

Plasma surrounding device under test.



The use of Pulse Width Modulated (PWM) types of adjustable speed drives (ASD) in the electric motor industry has caused an increased incidence of premature wire insulation failure. The DTS-1750A is an integrated test system designed to test the failure behavior of insulation by simulating, under controlled and accelerated conditions, the electrical and thermal stresses that characterize PWM (inverter) motor controllers.

The DTS-1750A test system is designed to vary and monitor the electrical and thermal test parameters for up to five samples simultaneously, including voltage, current, pulse width, frequency, voltage rate-of-rise time, duty cycle and temperature. The control and monitoring of these parameters allows the user to study the insulation failure mechanisms common to PWM applications. This data can then be used in the development of new motor designs and insulation that will overcome these failure modes.

Compared to testing with an inverter, the DTS-1750A can reduce the test time from days per sample to minutes per sample (time-to-failure with the DTS-1750A is typically 1,000 times faster than with an inverter), dramatically reducing research and development time for new insulating materials. Equally important, full control over the electrical and thermal test parameters provides a reproducible test environment in which time-to-failure is repeatable within statistically allowable differ-



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ences. For all practical purposes, inverters do not offer this capability.

In addition, the DTS-1750A offers other advantages over testing using an inverter. These advantages include:

- Capable of testing up to 5 samples simultaneously.
- User-controlled, variable voltage, current trip-point, pulse width, frequency, duty cycle, voltage rise and fall time and sample temperature.
- Computer control and logging of the test parameters and failure data.

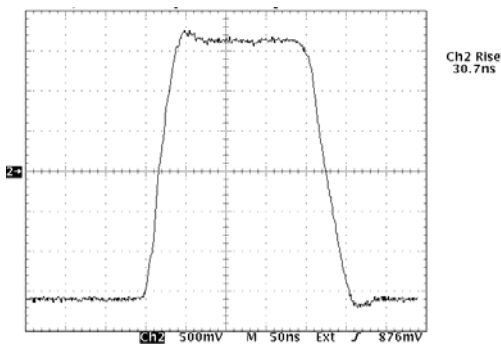
The DTS-1750A was developed in collaboration with the U.S. Electrical Motors Division of Emerson Electric, utilizing a patented test technique developed by USEM<sup>(1)</sup>.

## OPERATIONAL OVERVIEW

The DTS-1750A is designed to meet the testing requirements of magnet wire manufacturers, motor designers and manufacturers, and manufacturers of varnish and insulating materials.

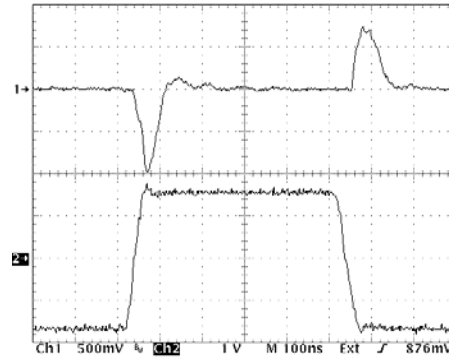
The DTS-1750A will test up to five samples (twisted pairs, motorettes or dielectric material) simultaneously. The samples are installed in the oven to facilitate testing at controlled and elevated temperatures. The test parameters are controlled and monitored through the control computer. Each channel can be individually enabled or disabled. The oven temperature is shared by all five channels.

The system can simultaneously pulse five capacitive samples of 50pF (a typical twisted pair) per sample or three samples of 350pF each (a typical motorette) at 20KHz frequency at  $\pm 1750V$  (3500V



**Figure 1**

Typical rise time (~31ns) on fastest rise time setting, driving a twisted pair (~50pF),  $\pm 1600V$



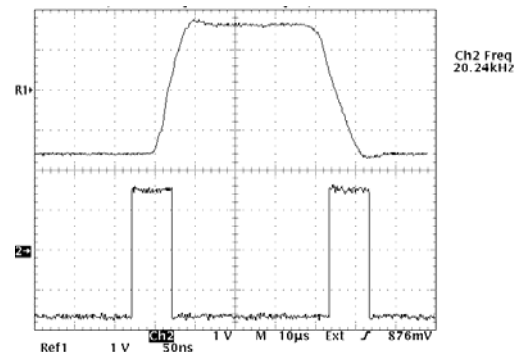
**Figure 2**

Typical current (top trace) and voltage (bottom trace) waveforms, driving a twisted pair (~50pF),  $\pm 1600V$

peak-to-peak) in bipolar mode. (Higher capacitance loads can be driven at derated voltage and/or frequency.) It can also drive an inductive load, such as a motor stator, of 3mH at up to 3.5 $\mu s$  pulse width and 1750V (typical operating parameters) in unipolar mode. Typical output wave forms are shown in Figures 1, 2 and 3.

When a sample under test fails (the charging current exceeds the current threshold, indicating the sample has shorted or arced), the channel is disabled, and the failure information is logged to a text file and displayed on the Graphical User Interface (GUI) monitor. In addition to the parameters displayed and controlled through the GUI display, each channel has current and voltage monitor outputs that can be monitored using an oscilloscope or digitizer for real-time data acquisition of the voltage and current profiles for each sample during operation. Monitored parameters are polled at a set interval by the GUI.

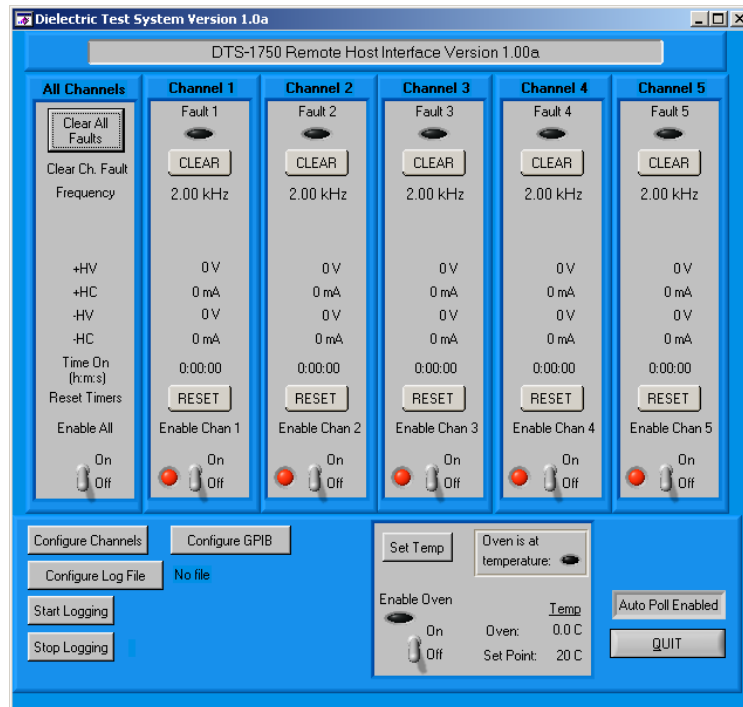
The DTS-1750A is controlled by its control computer and GUI, which provides the interface between the system and the user. Designed with



**Figure 3**

Typical voltage waveform (top trace) at 20KHz repetition rate (bottom trace), driving a twisted pair (~50pF),  $\pm 1600V$

(1) Licensed under US Patent #5,648,725 and Copyright of the Emerson Electric Company, 1996



**Figure 4**  
GUI Main Control Panel

the research and manufacturing environments in mind, the GUI allows the user to configure and monitor all samples under test. Created with National Instruments LabWindows under Windows XP, the control screens appear like the front panel of a test instrument. Using a mouse and keyboard, the software is intuitive and easy to learn, requiring very little time and energy to become proficient in the control of the DTS-1750A.

The GUI provides control over the following parameters:

- Output Voltage from 0 to  $\pm 1750\text{V}$
- Pulse Width from  $1\mu\text{s}$  to 950ms
- Pulse Frequency from 1Hz to 20KHz
- Oven temperature from ambient to  $200^{\circ}\text{C}$
- Enable/disable testing of each sample
- File logging of all test data

Test data are logged in a standard ASCII text file that is tab delimited. From this file, the user can retrieve data corresponding to the start of each sample test, failures of individual samples, as well as periodic test parameter updates. The log file can be imported into and analyzed using a spreadsheet program such as Microsoft Excel.

The main GUI control screen is shown in Figure 4 above.

The DTS-1750A is a fully integrated test system,

ready for use. The control software is designed to enable immediate use of the system, without additional programming on the part of the user.

## **SYSTEM OVERVIEW**

The DTS-1750A is designed using a modular approach. The pulse generator section for each sample is a stand-alone PVX-4440 or PVX-4450 pulse generator. The complete system is comprised of the following modules:

### **Pulsar Section**

Any combination of up to five PVX-4440 or PVX-4450, 3500V pulse generators, one for each test channel (one sample requires one test channel).

### **Base System**

- One 19" equipment rack to house the PVX-4440 or PVX-4450 pulse generators.
- One Lindburg/Blue-M oven modified to accommodate up to five sample test fixtures, with computer-control interface.
- The control software and Graphical User Interface (GUI) to provide data logging and error reporting for the pulse generators and oven.
- The Windows control computer.

## Test Fixtures

Test fixtures for twisted pair, motorettes and dielectric materials are available. One fixture for each channel is required.

This modular design of the DTS-1750A provides several advantages over previous DTS systems:

- Each channel is fully self-contained and independent. Each channel can be operated at different voltages, pulse widths, frequencies and duty cycles from the other channels.
- The system may be purchased with one to five output channels, allowing the user to best tailor the system to their requirements. If less than five channels are purchased initially; additional channels may be added in the future simply by purchasing additional PVX-4440 or PVX-4450 pulse generators.
- Installation of the system is as simple as connecting the computer interface cables from the computer to the pulse generator and oven, routing the output cables of the PVX-4440/PVX-4450s to the oven, and applying AC power. Therefore on-sight installation by DEI personnel typically is not required.
- In the unlikely event of a failure of one of the pulse generator channels, just the PVX-4440 or PVX-4450 for the failed channel can be returned to DEI for repair. This reduces shipping and repair costs. The other channels can continue to be operated while the failed channel is being repaired.

## ORDERING INFORMATION

The DTS-1750A is delivered as a fully integrated, turnkey system complete with control computer and software, oven, slave controller/high voltage sections and equipment rack, ready for immediate use. Test fixtures for twisted pair, motorettes and dielectric samples are available through DEI.

For further information and for price and delivery, contact the factory, or the DEI representative in your area.

## References And Related Papers

"Aging Of Magnet Wire In The Presence Of Variable Frequency, High Rise Time And High Voltage Pulses", V. Divljakovic, J. Kline, D. Barta, D. Floryan, CEIDP 1994.

"Pulse Width Modulated Aging Twisted pairs, Motorettes. And Motors", J. Kline, V. Divljakovic, G. Krausse, EMCW 1996.

"Available Insulation Systems For PWM Inverter-Fed Motors", A. Bonnett, IEEE Industry Applications Magazine, January/February 1998

## SPECIFICATIONS

Pulse Specifications	
Pulse Amplitude	Variable from 0 to 3,500V peak-to-peak ( $\pm 1750V$ )
Pulse Frequency	Variable from 1Hz to 20KHz
Pulse Width	Variable from 1 $\mu$ s to 950ms
Duty Cycle	Variable from 1% to 95%
Pulse Rise and Fall Times	$\leq 50ns$
Load	Capacitive (twisted pairs or motorettes): Max 5 twisted pair (50pF each) or 3 motorettes (350pF each) at 20KHz frequency, $\pm 1750V$ <sup>(1)</sup> Inductive (stator): 3mH at 3.5 $\mu$ s pulse width, 1750V unipolar, 20KHz
Oven Specifications	
Min. Temperature	Ambient
Max. Temperature	200° Celsius
Monitor Signal Specifications	
Voltage Monitor	1000 Volts/Volt into 1 Meg-Ohm
Current Monitor	10 Amps/Volt into 1 Meg-Ohm
Sync	TTL into 50 Ohm
Control Computer Specifications	
General Specifications	2GHz Pentium, 128MB RAM, 20GB HDD, CD ROM, 3½" FDD, 15" Monitor, Mouse & Keyboard <sup>(2)</sup>
Power Specifications	
AC Input	100/120VAC @ 20A, 50/60Hz 208/220/240VAC @ 10A, 50/60Hz

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Notes:

- (1) Maximum load capacitance is limited by the power dissipation of the system. Higher load capacitances can be driven at derated voltages and/or frequency.
- (2) Minimum specifications. Computer may have better specifications, depending upon configurations available at time of order.

DEI supplies solutions for the generation, delivery and measurement of high power, high fidelity electrical pulses. Applications include lasers, test and measurement, mass spectroscopy, radar and acoustics.

Please call, FAX or email for applications assistance or information on other DEI products.



spdts1750a Rev 1

*The Pulse Of The Future* Page 4