- **5-Channel 3,200V 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-1600A
Dielectric Test System

DTS-1600A Dielectric Test System

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-1600A 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-1600A 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-1600A can reduce the test time from days per sample to minutes per sample (time-to-failure with the DTS-1600A 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 environ-

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ment in which time-to-failure is repeatable within statistically allowable differences. For all practical purposes, inverters do not offer this capability.

In addition, the DTS-1600A 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-1600A was developed in collaboration with the U.S. Electrical Motors Division of Emerson Electric, utilizing a patented test technique developed by USEM(1).

OPERATIONAL OVERVIEW

The DTS-1600A is designed to meet the testing requirements of magnet wire manufacturers, motor designers and manufacturers, and manufacturers of varnish and insulating materials.

The DTS-1600A 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, and programmed for current trip threshold and voltage rise and fall time. The pulse frequency, pulse width, amplitude (voltage) and oven temperature are shared by all five channels.

The system can simultaneously pulse five capacitive samples of 50pF (a typical twisted pair) per

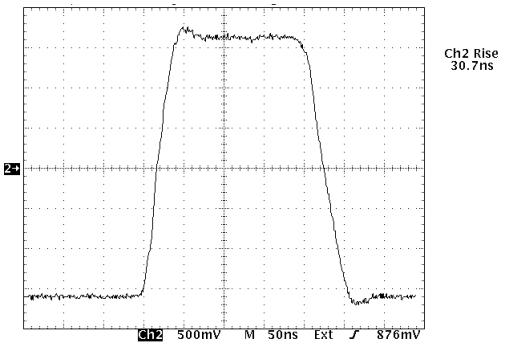

Figure 1
Typical rise time (~31ns) on fastest rise time setting, driving a twisted pair (~50pF), ±1600V

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

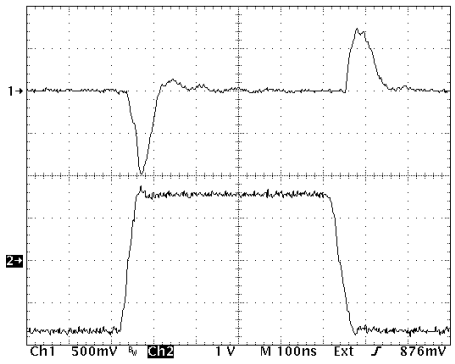

Figure 2
Typical current (top trace) and voltage (bottom trace) waveforms, driving a twisted pair (~50pF), ±1600V

sample or three samples of 350pF each (a typical motorette) at 20KHz frequency at ±1600V (3200V 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 3.5µs pulse width and 1600V (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.

The DTS-1600A is controlled by its control computer and GUI, which provides the interface be-

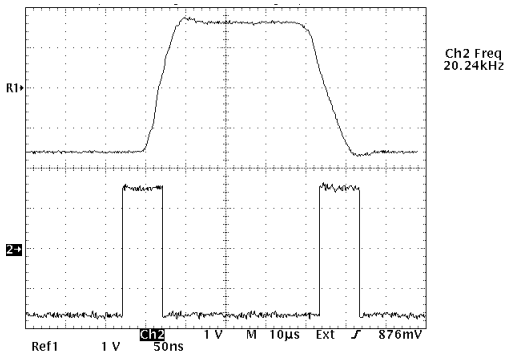

Figure 3
Typical voltage waveform (top trace) at 20KHz repetition rate (bottom trace), driving a twisted pair (~50pF), ±1600V

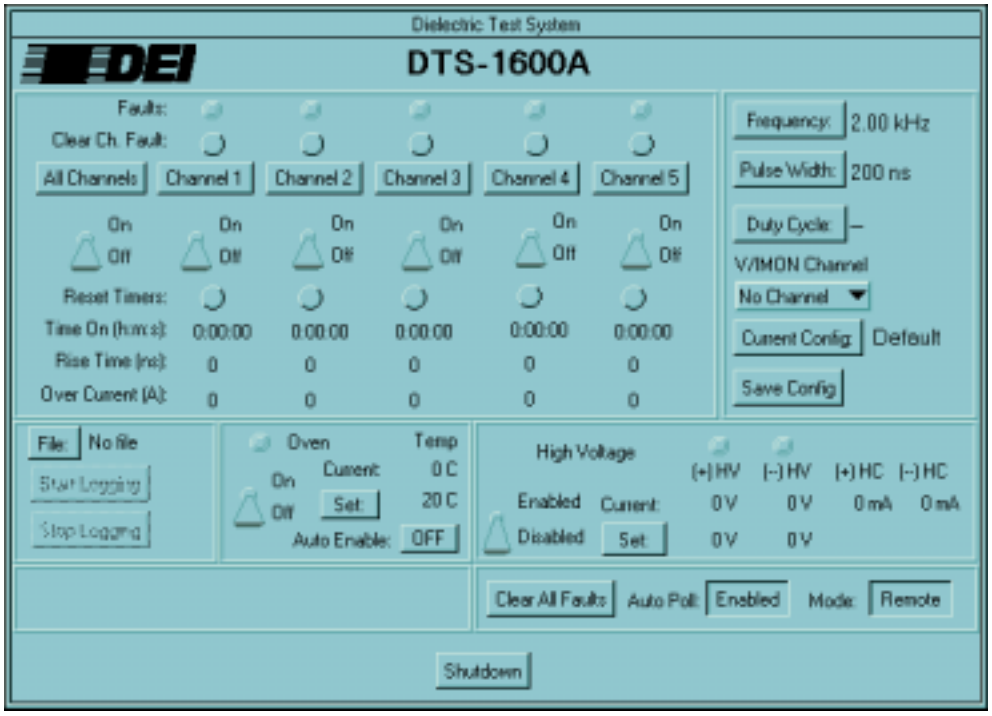

Figure 4
GUI Main Control Panel

tween the system and the user. Designed with 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 95, 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-1600A.

The GUI provides control over the following parameters:

- Output Voltage from 0 to ±1600V
- Pulse Width from 1µs to 4.75ms
- Pulse Frequency from 200Hz to 20KHz
- Oven temperature from ambient to 180°C
- Enable/disable testing of each sample
- Pulse rate-of-rise time for each sample
- Current trip setpoint for each sample
- File logging of all test data

Test data are logged in a standard ASCII text file. 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 or Lotus 1-2-3.

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

The DTS-1600A 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-1600A system consists of three basic modules. The first module is the Pentium processor-based control computer and General Purpose Interface Bus (GPIB). The computer and GUI operate as the master control unit, and allow the user to interface with the system. Using software created in the National Instruments LabWindows/CVI environment with custom defined functions, the user has complete control of the system from this location. The control computer interfaces to the slave control unit over a GPIB bus.

The rack-mounted slave control unit and high voltage section is the second module. It consists of a GPIB interface, a microcontroller and pulse generator, five ±1600V pulser modules, oven control circuitry, front panel interface, and high voltage and support power supplies. The internal microcontroller is responsible for decoding the software commands from the control computer and implementing them in hardware. It communicates with all peripheral cards via an internal RS-485 interface.

The third and final module is the oven and test fixturing. This is where the actual samples under test are placed. The oven is a Blue M model MO1420A (or equivalent), forced air convection oven, proportionally regulated to a maximum of 180°C. The forced air convection oven provides adequate air flow to dissipate ozone build up in the oven created by corona during testing.

The system is housed in a standard 19" equipment rack, 31" deep and 36" high. Included in the rack are the slave controller and pulse generator, five high voltage pulser modules and control circuitry, high voltage DC and support power supplies, a universal input voltage transformer, and a rack circuit breaker. The benchtop oven sits on top of the rack, and interconnects with the pulser and control circuitry with an umbilical cable. The control computer and monitor are a standard Pentium-based desktop PC, that connect to the rack with a 2 meter GPIB cable (included with the system). This allows the test station to be a complete stand-alone instrument.

For operator safety, the oven door is interlocked. The system features front panel status indicators, and an emergency stop button to allow immediate shutdown of the system, if necessary.

ORDERING INFORMATION

The DTS-1600A 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 3,200V peak-to-peak (±1600V)
Pulse Frequency	Variable from 200Hz to 20Khz
Pulse Width	Variable from 1µs to 4.75ms
Duty Cycle	Variable from 0.002% to 95%
Pulse Rise and Fall Times	Variable from 50ns to 200ns (1)
Load	Capacitive (twisted pairs or motorettes): Max 5 twisted pair (50pF each) or 3 motorettes (350pF each) at 20KHz frequency, ±1600V (2) Inductive (stator): 3mH at 3.5µs pulse width, 1600V unipolar, 20KHz
Oven Specifications	
Min. Temperature	Ambient
Max. Temperature	180° Celsius
Monitor Signal Specifications	
Voltage Monitor	1000 Volts/Volt into 50 Ohms
Current Monitor	10 Amps/Volt into 1 Meg-Ohm
Sync	TTL into 50 Ohm
Control Computer Specifications	
General Specifications	733 MHz Pentium, 64MB RAM, 10GB HDD, CD ROM, 3½" FDD, 15" Monitor, Mouse & Keyboard (3)
Power Specifications	
AC Input	100/120VAC @ 20A, 50/60Hz 208/220/240VAC @ 10A, 50/60Hz

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Notes:

(1) Specified into a 50pF load (typical twisted pair) installed in an oven fixture. Actual rise and fall times will vary somewhat based upon load capacitance. The rise and fall time are user selectable in 8 steps.

(2) Maximum load capacitance is limited by the power dissipation of the system. Higher load capacitances can be driven at derated voltages and/or frequency.

(3) 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.

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