MPRT
Megger Protective Relay Test System

- **The MPRT System consists of a 'Power Box', the TouchView Interface™, and AVTS Software**

- **Unique new TouchView Interface (TVI) simplifies the manual testing of complex relays**

- **Ultra flexible output design provides up to four-phase voltage and current or eight-phase current**

- **User specified configuration. Every system is made to order based on specific customer needs.**

- **Includes fully automated testing capability using AVTS Software (Version 2.0)**

DESCRIPTION

The MPRT System is comprised of:
- **The 'Power Box'**
- **The TouchView Interface (TVI)**
- **AVTS Software**

The 'Power Box' is the heart of the system. It employs a variety of new features including unique Voltage and Current Generator (VI-Gen) components which have been combined into one amplifier package. Using multiple VI-Gens provides the flexibility to deliver four voltages and four currents or eight current channel capability. The MPRT 'Power Box' also incorporates four communication ports, a new Constant Power Output (CPO) capability and every one is made-to-order based on each customer's individual testing requirements.

The TouchView Interface (TVI) device and AVTS Basic Software form the brains of the system. The TVI, with its large full color touch screen allows the user to perform manual and semi-automatic testing quickly and easily, using built-in, preset test routines for most popular relays. Fully automatic testing can also be performed using AVTS Basic Software which comes with the MPRT System.

APPLICATIONS

MPRT is specifically designed to perform routine testing of protective relays used in the operation of electric utilities, power plants and heavy industrials. Other applications include use in government facilities, harbor and airport installations, large building complexes and by testing service companies who are increasingly interested in a highly flexible, easy-to-use relay test instruments that can help them improve their job efficiency.

MPRT SYSTEM COMPONENTS
The 'POWER BOX'

The 'Power Box' is ultra flexible, rugged, lightweight and feature packed. The unique features include:

NEW Constant Power Output (CPO) Capability – Produces improved power output sustainable through the entire "power curve" of a test. With a CPO of 200 VA current per phase and 150 VA voltage it has the flexibility to test any relay.

Unique VI-Gen Internal Design – The Voltage and Current Generator (VI-Gen) components have been combined into one amplifier package. Using multiple VI-Gens the system has the flexibility to deliver four voltages and four currents or eight currents for testing multi-phase differential relays.

Built-in Transducer Testing Capability – Eliminates the need for additional testing equipment or software. The MPRT incorporates higher accuracy amplifiers, a special transducer DC input and test algorithms to test transducers easily and effectively.

Includes Four Communication Ports – More built-in flexibility with a protocol choice of IEEE488, RS232, USB or Ethernet for high-speed download capability and upgrades via the internet.

User Specified Configuration – Every system is made to order based on each customer's testing requirements and budget, with an easy and flexible upgrade path.

Output Capabilities for Worldwide Use – Even more built-in flexibility allows the user to choose from:

- VI-Gen amplifiers rated at 30A @ 200 VA and convertible amplifiers rated at 300V or 5A @ 150 VA.

- VI-Gen amplifiers rated at 15A @ 200 VA and convertible amplifiers rated at 150V or 5A @ 150 VA.

THE TOUCHVIEW INTERFACE (TVI)

Finally...an easier way to perform manual and semi-automatic relay testing. It's all done via a unique hand held controller called the TouchView Interface (TVI). The most significant feature of the TVI is its ability to provide the user with a very simple way to manually test even the most complex relays manufactured today.

Manual operation is simplified through the use of a built-in computer operating system and the TouchView Interface, with a large color LCD touch-screen. The TVI eliminates the need for a computer when testing virtually all types of relays. Menu screens and function buttons are provided to quickly and easily select the desired test function.

**MPRT TouchView Interface™**

Here's how easy it is
From the Preset Menu Screen, shown below, the user simply selects the type of relay to be tested. Built-in test files are for a wide variety of protective relays, including Overcurrent, Differential, etc., see following figure.
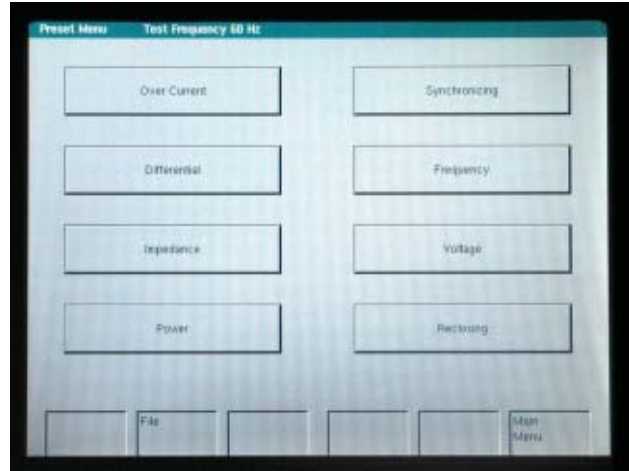
Preset Relay Menu Screen

As an example, touch the 'Overcurrent' button. An Overcurrent Test Menu Screen, shown below, will be displayed showing all necessary functions needed to test that particular type of relay. Next, the user inputs the relay setting values that will be used to conduct the tests, such as Relay Tap value and Time Dial value. These values are used when conducting the pickup and timing tests.

To make it even better, the TVI has both IEEE and IEC time curve algorithms built-in. By entering the appropriate values in the setting screen, when the timing test is conducted, the test results will be automatically compared to the theoretical values from the time curve that was selected.
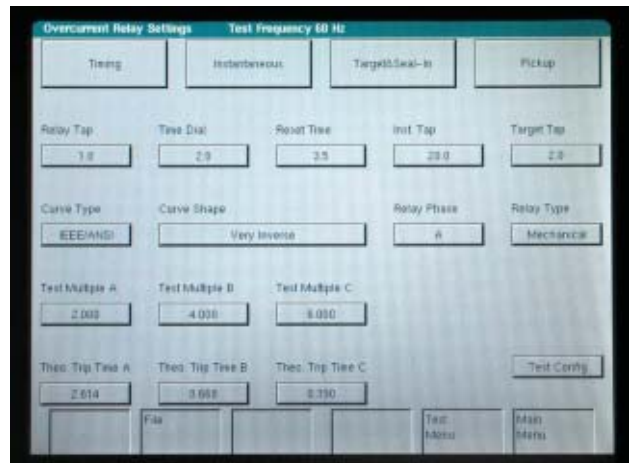
Overcurrent Relay Settings Screen

As shown in the Overcurrent Settings screen, the IEEE Very Inverse time curve was selected. If the Test Multiple is changed, the appropriate theoretical trip time will change automatically.

The TVI also has the ability to do even more complex tests and calculations. For example, the MPRT with three Voltage/Current Modules, can test single-phase, three-phase open delta, and three-phase wye impedance relays using the Impedance relay test screen. The user simply selects different testing applications from a menu screen. For instance, the Reach Test Screen for an impedance relay has been selected as shown below.
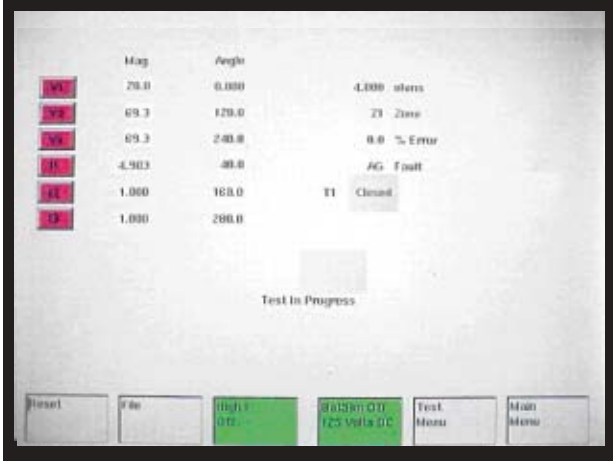
Impedance Reach Test Screen

It should be noted that not only does the display screen show metered values of voltage, current and phase angle, but it also displays the OHMS value where the relay picks up, (different formulas for calculating OHMS are selectable using the touch-screen and rotary knob).

In addition, the zone associated with the result shown, the percent error and the type of fault simulated are displayed. The impedance test screen provides a pre-fault condition for those relays that require a pre-fault load prior to applying the fault. The test automatically determines values like reach, maximum angle of torque, and timing.

Finally, for testing multi-zone relays, the user can select the Pulse-Ramp method to determine operating points without needing to defeat the other zone timers. Test results can be saved to the internal memory for later download and review.

Also easily test relays not on the Preset Menu
Other types of relays or devices not specifically listed in the Preset Menu Screen can be tested using one of the Manual Test screens.

For example, negative sequence under/over voltage, reverse phase, phase sequence, and current balance relays may be tested using the Voltage/Current manual test screen. In addition, manual control of up to four voltages and currents, or up to 8 currents is done using this test screen.

Other devices such as auto-synchronizing, frequency sensitive devices and transducers also have their own individual manual test screens. There are no preset test routines. The user manually selects the parameter(s) to be set or adjusted using the touch-screen and ramp outputs using the control knob. Each test screen has a dynamic enable capability and will either automatically step from a prefault, to fault, to breaker trip, to reclose, or automatically ramp frequency at a preprogrammed Hz/Sec, or time for a given slip frequency, depending on which screen is in use. In the Manual Auto-Synchronizing Test Screen, the advanced closing time and closing angle are automatically done in the dynamic mode.
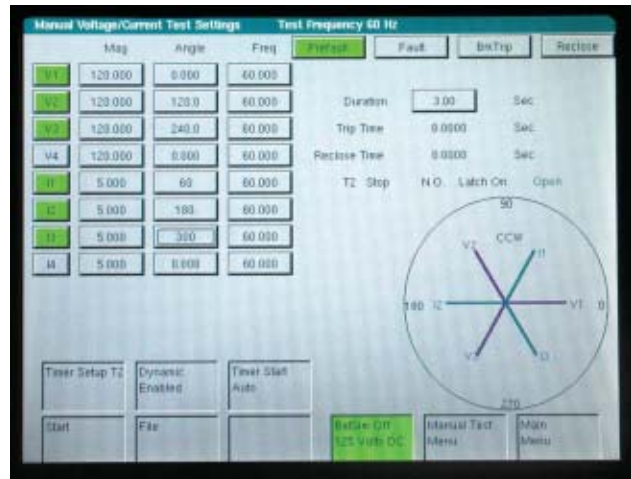

Manual Voltage/Current Test Screen

In the Manual Test Screen shown above, the pre-selected outputs are set. The Green color indicates which output(s) have been selected. When the test is started by pressing the Start button, the selected output indicators will change colors from green to red indicating which outputs are energized. A vector graph indicates the relative phase angles of all of the outputs. All of the outputs are metered and displayed to provide real time verification of all of the selected outputs.

Even perform manual transducer testing
With the built-in transducer test screen, manually testing transducers has never been easier. The user simply selects from a pull-down menu, what type of transducer is being tested and enters information relative to the transducer's inputs and outputs. Upon starting the test, the test set automatically measures and calculates the % error of the device.
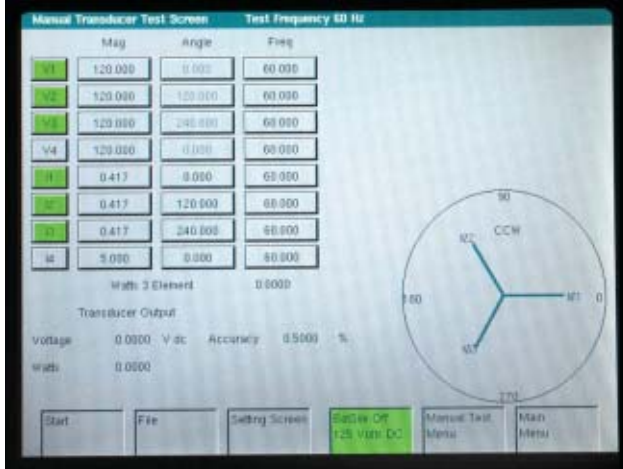
Transducer Test Screen

In the above example, a three-phase, 3 Element Watt Transducer is being tested. The actual output watts is calculated based upon the measured values from the MPRT into the transducer, and the transducer watts is calculated based upon the measured output voltage/current from the transducer. A % error is automatically calculated and displayed. A vector representation of the voltage and current outputs is also displayed.

Use the File Manager to organize all test results
The TVI has sufficient internal memory to save hundreds of test and result files. To manage the tests and results, the MPRT has a File Manager screen.
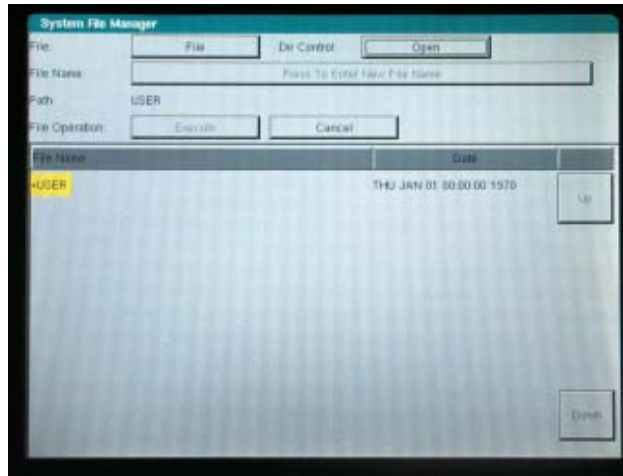

File Manager Screen

From any test screen, the user has access to the Test File Manager Screen. The user can give the test file/result file any name up to a maximum of 99 characters. Once saved, the user can recall the test and execute with the appropriate settings already set, or recall saved test results to download into the AVTS database for storage or for printing.

All output values are metered and displayed
When under automatic computer control (with the AVTS software), the TVI becomes a meter display for all of the MPRT outputs. The metered values are displayed to
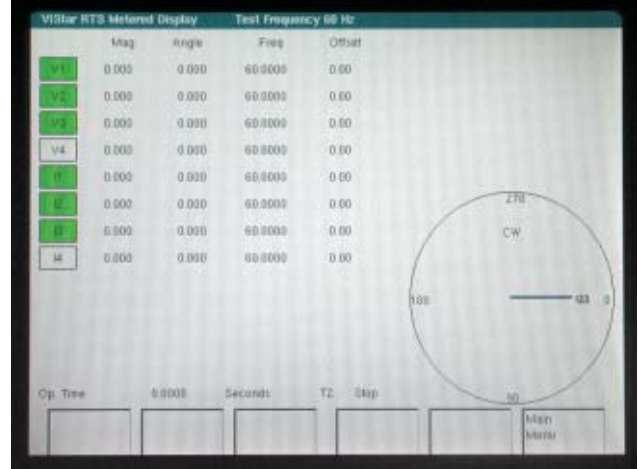
provide continuous real-time verification of the MPRT outputs, even when under automatic control.

Output values are displayed with a vector display, which shows the vector relationship between the output voltage and currents.

User customized configuration
The user may customize how the unit displays phase angles (0-360° Lead/Lag or ± 180°), and set default values of voltages, currents and frequency. The user may also select a language for prompting the operator. Six language choices are currently available, English, French, German, Spanish, Italian and Portuguese.

Meter Display Screen

TVI Default Setting Screen

Other default settings include GPIB and IP addresses, Serial Port settings, Battery Simulator output and screen background colors.

AVTS SOFTWARE
See page 8 for details regarding AVTS Software.

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FEATURES AND BENEFITS

■ **Large Color LCD touch-screen display** - The TVI features an easy to use and read display providing manual control of the test set, and displays **measured** values of voltage, current, along with phase angle and frequency. Calculated values such as Ohms, Watts, VAR's and Power Factor may also be displayed, depending on the test screen in use. Color contrasts accentuate vital information. This reduces human error and time in testing relays.

■ **Constant Output Power** - The new MPRT employees new high powered Voltage-Current amplifiers (VI-Gens), which deliver maximum compliance voltage to the load constantly during the test. Constant output power in many cases eliminates the need to parallel current channels together to test high burden relays.

■ **High resolution and accuracy** - The TVI has **Metered** outputs and a timer to provide extremely high accuracy. High accuracy extends testing capability to other devices such as transducers.

■ **Internal memory** - The TVI provides storage of test set-up screens and test results. Reduces testing time and paper work.

■ **Steady-State and Dynamic testing capability** - The MPRT provides, either through manual control or computer control, both steady-state and dynamic testing of protective relays. This includes programmable waveforms with dc offset and harmonics.

■ **Display screen prompts operator** - The TVI features a display screen that prompts the user with easy to use function buttons. Single button operation saves time in testing relays and minimizes human error.

■ **Display screen provides six different languages** - The TVI display screen prompts the user in English, Spanish, Portuguese, French , Italian or German.

■ **Output current and voltage sinewaves are generated digitally** - MPRT outputs do not vary with sudden changes in input voltage or frequency, which increases test accuracy and reduces testing time.

■ **Memory metering** - Allows the user to set test currents and voltages faster. Reduces heating of device under test.

■ **Digital inputs and outputs** - MPRT has 10 programmable inputs, and 6 programmable outputs provide timing and logic operations in real-time with the output voltage and currents. Binary Inputs can be programmed, using Boolean logic, for more complex power system simulations. This provides a low cost, closed loop, power system simulator.

■ **Circuit breaker simulator** - MPRT's binary outputs provide programmable normally closed and normally open contacts to simulate circuit breaker operation for testing reclosing relays. Sequence of operation, timing, and lockout are easily tested.

■ **Performs transient tests** - Perform acceptance or troubleshooting tests by replaying digitally recorded faults or EMTP/ATP simulations in the IEEE- C37.111, COMTRADE Standard format.

■ **Perform End-to-End tests** - Using AVTS software and a portable GPS satellite receiver, the MPRT performs satellite-synchronized end-to-end dynamic or transient tests. Provides precisely synchronized testing of remotely located complex protection schemes.

■ **Wide-ranging output frequency** - The output frequency of the current and voltage channels can be set for any frequency from dc to 3 kHz. Popular test frequencies such as 25, 50, 60 and 100 Hz are easily set and controlled. Provides ultra-flexability to save time and lower costs.

■ **RS-232 serial port** - The RS-232 port provides a computer interface to perform automatic testing.

■ **USB port** - The USB port provides a computer interface to the test set for computers that do not have RS-232 serial ports.

■ **Ethernet port** - The Ethernet port provides a high-speed computer interface. This can be used to quickly download transient waveform data.

- **IEEE-488GPIB** - The IEEE-488 is an OEM preferred interface for control of the unit. This interface is preferred, when using the unit with other IEEE-488 devices. It can also provide high speed downloading of transient data.

- **Universal input voltage** - Operating from 90 to 264 Vac, 50/60 Hz, the MPRT can use virtually any standard source in the world.

- **Battery simulator** - MPRT's battery simulator provides dc output voltages of 24, 48, 125 and 250 Volts. Eliminates needing a separate dc source for providing logic voltage for microprocessor-based relays.

- **Immediate error indication** - Audible and visual alarms indicate when amplitude or waveforms of the outputs are in error.

- **Modular design** - Output modules plug-in and slide out easily for system re-configuration and maintenance.

- **Ancillary Interface** - Provides interface to other MPRT units.

- **MPRT Model 8430** - Provides up to 300 Volts rms. at 150 VA and 30 Amps rms. at 200 VA per phase. Ample voltage for testing high instantaneous overvoltage relays. The current amplifier has high compliance voltage at low currents for testing ground overcurrent relays. When configured with four channels, the current amplifiers can be paralleled to provide a maximum of 120 Amperes at 800 VA, for testing instantaneous overcurrent relays. With high VA output ratings, the unit can be used for testing a panel of relays.

- **MPRT Model 8415** - Provides up to 150 Volts rms. at 150 VA and 15 Amps rms. at 200 VA per phase. This lower cost unit is ideal for testing relays used with 1 Amp secondary CT's. The current amplifier has high compliance voltage at low currents for testing ground overcurrent relays. When configured with four channels, the current amplifiers can be paralleled to provide a maximum of 60 Amperes at 800 VA, for testing instantaneous overcurrent relays. With high VA output ratings, the unit can be used for testing a panel of relays.

SPECIFICATIONS

Input Power
90 to 264 Volts AC, 1Ø, 50/60 Hz, 2100 VA.

Outputs
All outputs are independent from sudden changes in line voltage and frequency. This provides stable outputs not affected by sudden changes in the source. All outputs are regulated so changes in load impedance do not affect the output. Each output module consists of one current amplifier, and a voltage amplifier. The voltage amplifier may be converted to a current source. Therefore, one amplifier module may be used to test current differential relays, including harmonic restraint.

Output Current
The following specifications cover both Model 8430 and Model 8415 modules. Outputs are rated with the following:

Model 8430

Per phase:

Output Current	Power	Max V
4 Amperes	200 VA	50.0 Vrms
7.5 Amperes	200 VA	26.7 Vrms
15 Amperes	200 VA	13.4 Vrms
30 Amperes	200 VA	6.67 Vrms
DC	200 Watts	

With two currents in parallel:

Output Current	Power	Max V
8 Amperes	400 VA	50.0 Vrms
15Amperes	400 VA	26.7 Vrms
30 Amperes	400 VA	13.4 Vrms
60 Amperes	400 VA	6.67 Vrms

With three currents in parallel:

Output Current	Power	Max V
12 Amperes	600 VA	50.0 Vrms
22.5Amperes	600 VA	26.7 Vrms
45 Amperes	600 VA	13.4 Vrms
90 Amperes	600 VA	6.67 Vrms

With four currents in parallel:

Output Current	Power	Max V
16 Amperes	800 VA	50.0 Vrms
30 Amperes	800 VA	26.7 Vrms
60 Amperes	800 VA	13.4 Vrms
120 Amperes	800 VA	6.67 Vrms

With two currents in series, the compliance voltage doubles to provide 4.0 Amperes at 100 Volts.
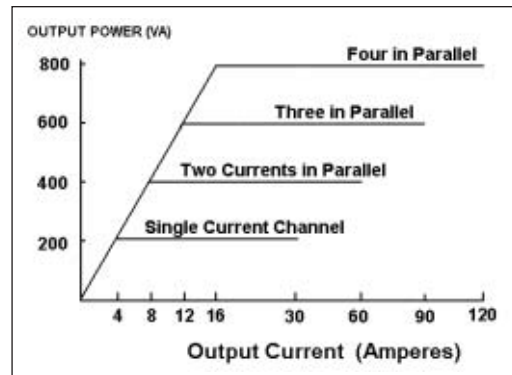
Power Curve for Model 8430

Model 8415

Per phase:

Output Current	Power	Max V
4 Amperes	200 VA	50.0 Vrms
7.5 Amperes	200 VA	26.7 Vrms
15 Amperes	200 VA	13.4 Vrms
DC	200 Watts	

With two currents in parallel:

Output Current	Power	Max V
8 Amperes	400 VA	50 Vrms
15 Amperes	400 VA	26.7 Vrms
30 Amperes	400 VA	13.4 Vrms

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With three currents in parallel:

Output Current	Power	Max V
12 Amperes	600 VA	50 Vrms
22.5Amperes	600 VA	26.7 Vrms
45 Amperes	600 VA	13.4 Vrms

With four currents in parallel:

Output Current	Power	Max V
16 Amperes	800 VA	50 Vrms
30 Amperes	800 VA	26.7 Vrms
60 Amperes	800 VA	13.4 Vrms

With two currents in series, the compliance voltage doubles to provide 4.0 Amperes at 100 Volts.
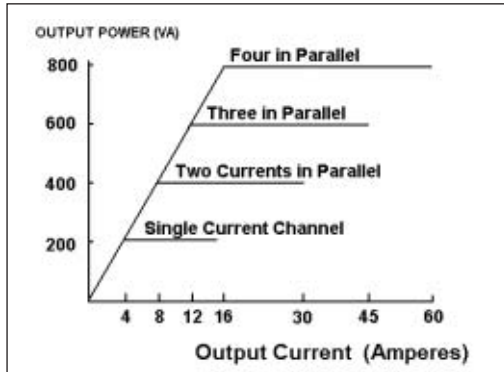
Power Curve for Model 8415

AC Voltage Output

The following specifications cover both the Model 8430 and 8415 modules. Outputs are rated with the following Ranges:

Model 8430

Per phase:

Output Volts	Power	Max I
30 Volts	150 VA	5 Amps
150 Volts	150 VA	1 Amp
300 Volts	150 VA	0.5 A
DC	150 Watts	

With two voltages in series:

Output Volts	Power	Max I
60 Volts	300 VA	5 Amps
300 Volts	300 VA	1 A
600 Volts	300 VA	0.5 A

With three converted sources in parallel:

Output Current	Power	Max V
0 - 15Amperes	450 VA	30 Vrms

Model 8415

Per phase:

Output Volts	Power	Max I
30 Volts	150 VA	5 Amps
150 Volts	150 VA	1 Amp
DC	150 Watts	

With two voltages in series:

Output Volts	Power	Max I
60 Volts	300 VA	5 Amps
300 Volts	300 VA	1 A

With three converted sources in parallel:

Output Current	Power	Max V
15Amperes	450 VA	30 Vrms

Battery Simulator

The battery simulator provides the following DC output: 24, 48, 125 or 250 Volts at 60 Watts. Voltage output is controlled via the Touch-View Interface, or through AVTS software.

Metering

Measured output quantities such as AC Amperes, AC Volts, DC Volts or DC Amperes, and Time may be simultaneously displayed on the large, variable contrast, color LCD screen. The memory feature of the metering provides fast and accurate preset of test values. The AC and DC outputs display the approximate voltage/current output prior to initiation of the outputs. This provides a fast, easy method for preset of outputs. Other values that may be displayed, depending on which test screen is in view, are frequency, Ohms, Watts, VARS and Power Factor. All Accuracies stated are from 10 to 100% of the range at 50/60 Hz.

AC/DC Output Amperes

Accuracy: ±0.05% typical, 0.1 % or ± least significant digit, which ever is greater, guaranteed.
Resolution: .001/.01
Measurements: True RMS

AC/DC Output Volts

Accuracy: ±0.05% typical, 0.1 % or ± least significant digit, which ever is greater, guaranteed.
Resolution: .001/.01/.1
Measurements: True RMS

Phase Angle

Ranges 0 to 359.9 degrees Lead/Lag or ±180.0 degrees
Accuracy: ±0.02° typical
0.1° Guaranteed

Frequency:

The output modules provide a variable sinusodal frequency output with the following ranges and accuracy.

Ranges

DC
0.001 to 3000.0 Hz
The output modules can provide transient signals with a range of DC to 10 kHz.
Resolution: .001 Hz
Frequency Accuracy:
0.5 ppm typical
1.0 ppm at 25° C, ±5° C
5.0 ppm 0° to 50° C
Total Harmonic Distortion:
Less than 0.1 % typical,
2 % maximum at 50/60 Hz.

Power

The Watts displayed is the calculated value based on the displayed formula. Seven different formulas are available.
Range and Resolution 0 to 15 kW, with 0.1 % resolution
Accuracy: ± .5 % of VA ±1 least significant digit

The DC IN input terminals:

DC IN Volts	DC IN Amperes
Range: 0 to ±10 V DC	0 to ±1mA DC
	1 to ±20mA DC
Accuracy: ±0.02%	**Accuracy:** ±0.02 %
Resolution: .0001/.001	**Resolution:** .0001/.001
Measurements: Average	**Measurements:** Average

Timer-Monitor

The Timer-Monitor (Binary Inputs) are designed to monitor and time-tag inputs, as a sequence of events recorder. In addition, the binary input controls enable the user to perform logic AND/OR functions on the inputs, and conditionally control the binary output relays to simulate circuit breaker, trip, reclose and carrier control operation in real-time. The Timer function displays in Seconds or Cycles, with the following range and resolution:
Seconds: 0.0001 to 9999.9 (Auto Ranging)
Cycles: 0.01 to 9999.9 (Auto Ranging)
Accuracy: ±1 least significant digit or ±.001% of reading, whichever is greater.

Binary Inputs- Start/Stop/Monitor Gates:

10 identical, independent, galvanically isolated, Start/Stop or Monitor circuits are provided. To monitor operation of relay contacts or trip SCR, a continuity light is provided for each input gate. Upon sensing continuity the lamp will glow and a tone generator will sound. In addition to serving as Timer/Monitor inputs, the Binary Inputs may be programmed to trigger binary output sequence(s). Binary Inputs can also be programmed using Boolean logic for more complex power system simulations.
Input Rating: up to 300 V AC/DC

Binary Output Relays:

6 identical, independent, galvanically isolated, output relay contacts accurately simulate relay or power system inputs to completely test relays removed from the power system. Binary outputs simulate normally open/normally closed contacts for testing breaker failure schemes. Outputs can be configured to change state based on binary input logic (Boolean logic is available for more complex simulations), or a specified time delay after a logic input condition.
Contact Rating: Up to 400 Volts peak, AC/DC, 1 Amp continuous, 8 Amps Max.

Waveform Generation

Each output channel can generate a variety of output waveforms such as: DC; sinewave; sinewave with percent harmonics at various phase angles; half waves; square waves with variable duty cycles; exponential decays; periodic transient waveforms from digital fault recorders, relays with waveform recording capability or EMTP/ATP programs, which conform to the IEEE C37.111 COMTRADE standard format. In addition, each output channel has input BNC connector for amplification of external analog signals.

Waveform Storage

Each output channel can store waveforms for playback on command. End-to-end playback of stored waveforms is possible, when triggered externally by a GPS receiver. Each channel can store up to 256,000 samples.

Protection

Voltage outputs are protected from short circuits and prolonged overloads. Current outputs are protected against open circuits and overloads.

Ancillary Interfaces

On the back panel of the MPRT are the RS-232, USB, Ethernet, IEEE-488 GPIB, Trigger In, Trigger Out, Clock In, and Clock Out.

Temperature Range

Operating: 32 to 122° F (0 to 50° C)
Storage: -13 to 158° F (-25 to 70° C)
Relative Humidity: 5 - 90% RH, Non-condensing

Dimensions

Unit Enclosure

17.2 W x 8.75 H x 18.5 D* in. (430 W x 218 H x 463 D mm)
*Includes 2.5" depth of floor stand-offs

Weight

Weight varies depending on the number of output modules in the system. The weights shown below are for a complete three-phase test system.

Model 8415:	**Model 8430:**
49.9 lb. (22.7 kg)	49.9 lb. (22.7 kg)

Safety, EMC, RFI and ESD Conformance

IEC 61010-1, Amendments 1 and 2, EN 50081-2, EN 50082-2, EN 55014, EN 55011, EN 60555-2, EN 61000-4-2, IEC 61000-4-2/3/4/5/6/8/11.

Shock, Vibration and Temperature

To simulate the worst field conditions the unit was tested in accordance with Military Standard MIL-STD-810 for temperature, humidity, shock, and vibration.

Enclosure and Transit Cases

The unit comes mounted in a rugged enclosure for field portability. A padded soft-sided carry case is provided with the unit. The soft-sided carry case protects the unit from light rain and dust. The padded sides provide protection while in transit. An optional hard-sided transit case is available. The robust design of the optional hard-sided transit case provides protection when transporting the unit over rugged terrain and long distances.

AVTS
Advanced Visual Test Software Version 2.0
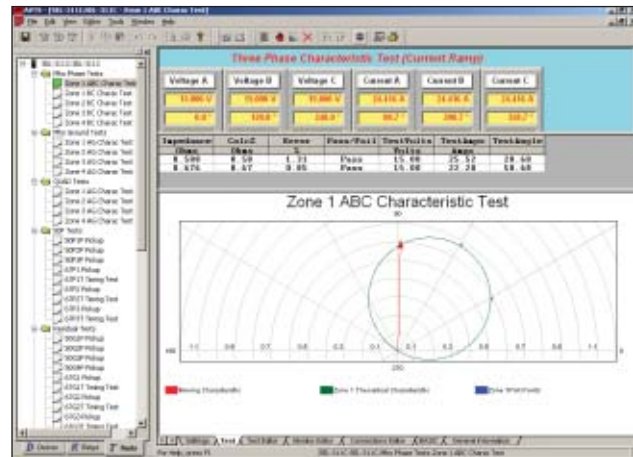
DESCRIPTION

AVTS is a Microsoft® Windows® 98/ME/NT4.0/2000/XP® software program designed to manage all aspects of protective relay testing using the new Megger MPRT or older PULSAR relay test sets. More flexibility has been added as well as some new and powerful features.
AVTS 2.0 comes in three different levels:
- **Basic**
- **Advanced**
- **Professional**

Every MPRT unit comes with AVTS Basic.

The **Basic** version includes Online Vector and Ramp controls, with the ability to import, save and execute test modules. In addition, the Basic version includes enhanced Relay Test Wizards, including new wizards not previously available.

The **Advanced** version includes the Test Editor, Waveform Digitizer and basic programming Tools for creating and editing test modules.

The **Professional** version includes all of the features of the Basic and Advanced versions plus some new and powerful features. It includes the DFR Waveform Viewer and editor, End-to-End test files and the new One-Touch Test™ feature.

APPLICATIONS

Using the Online Ramp Control, traditional steady-state tests are easily performed with AVTS by simply applying test quantities to the device under test and automatically ramping the current, voltage, phase angle or frequency.

Using either the Online Ramp or Vector Controls, Dynamic tests can easily be performed. The dynamic test includes setting a prefault condition and allowing the software to

automatically test/search for the operating characteristic of the relay by selecting one of several available methods. Using Test Wizards or Test Modules, fault types are selected from a pull-down window.

Operating characteristics for virtually any type of relay are easily defined using Mho circles, Lenticular, Tomato characteristics, or a combination of lines, line and slope, time and amplitude, calculated value or theoretical object (a time-current curve may be scanned into the program using the digitizer feature in either the Advanced or Professional versions of AVTS).

The AVTS Test Screen enables the user to view test values (both theoretical and actual) on one screen. For example, the figure on the preceeding page shows test values, both theoretical and actual results, all on one screen.

The following chart provides an easy reference showing the features of each version of AVTS Software:

| | | | Software | |
Feature	Description	Basic	Advanced	Professional
Online Vector Control	The Online Vector Control allows the user to have direct control of the Relay Test System. Up to sixteen vector states may be created and sequenced back through the test system.	•	•	•
Online Ramp Control	Preramp (prefault), Ramp 1 and Ramp 2 are available for use to be played back through the test system. Automatically Ramp or Pulse Ramp outputs. Enable timer control with either ramp.	•	•	•
Import, Save, and Execute Test Modules	Import relay test files and execute selected tests. Save results to built-in Microsoft Access compatible data base, and print results.	•	•	•
Test Report Generator	Print reports in AVTS format or export to Microsoft Word to customize using company logo or standard company format.	•	•	•
DFR Playback	Import and execute relay test modules, which contain DFR playback files created using the DFR Waveform Viewer Tool.	•	•	•
Fault Calculator	Calculate fault values for Ø-Ø, Ø-N, Ø-Ø-N and 3 Ø faults. Use line voltage, line Z and angle, relay volts and angle, relay amps and Z0/Z1.	•	•	•
Overcurrent Wizard	Provides automatic testing of overcurrent relays, including timing characteristic using IEEE / IEC formulas, DC target and seal-in tests.	•	•	•
Over/Under Voltage Wizard	Provides automatic testing of over and under voltage relays, including timing characteristic and DC target and seal-in tests.	•	•	•
Frequency Wizard	Provides automatic testing of over and under frequency relays, including timing characteristic and DC target and seal-in tests.	•	•	•
Differential Wizard	Provides automatic testing current differential relays, including 2nd, 3rd and 5th harmonic restraint tests on transformer differential relays.	•	•	•
Distance Wizard	Provides automatic testing of distance relays. Ø-Ø, Ø-G, and 3 Phase faults are available. Test result graphics are displayed in an R X plane.	•	•	•
Synchronizing Wizard	Provides automatic testing of synchronizing relays	•	•	•
Directional Wizard	Provides automatic testing capability of directional elements.	•	•	•
Test Editor	Provides editing tools for modifying test modules.		•	•
Waveform Digitizer	Provides digitizing tool for digitizing waveforms and trip curves.		•	•
Basic Programming Tool	Provides control tool in the Test Editor. Basic programs can be written using the test system command set for special testing applications. This includes building complex waveforms up to the 50th harmonic.		•	•
Import Aspen Relay Database®	Capability to import relay settings directly from Aspen Relay Database®		•	•
DFR Waveform Viewer and Playback	Import, view, modify and replay Digital Fault Recordings or EMTP/ATP simulations that are in the COMTRADE file format.			•
End-to-End Test	"End-to-End" testing is used to describe the testing of an entire line protection scheme. This includes all protective relays, interface equipment, and any communication equipment.			•
One-Touch Test™	Test Editor control tool, used in conjunction with specific Megger Test Modules, to download relay settings (into AVTS) from microprocessor based relays for full automatic one-touch testing.			•

AVTS BASIC VERSION

There are three versions of AVTS software. **The Basic version is included with each MPRT unit.** The Advanced and Professional versions are optional. The Basic version includes online Vector and Ramp controls, relay testing wizards for most types of relays, the ability to import, save and execute relay specific test modules created either by Megger or someone else with either an Advanced or Professional version of AVTS 2.0. Basic can also playback a DFR file created using the Professional version of AVTS. The following describes the features of the Basic version of AVTS 2.0.
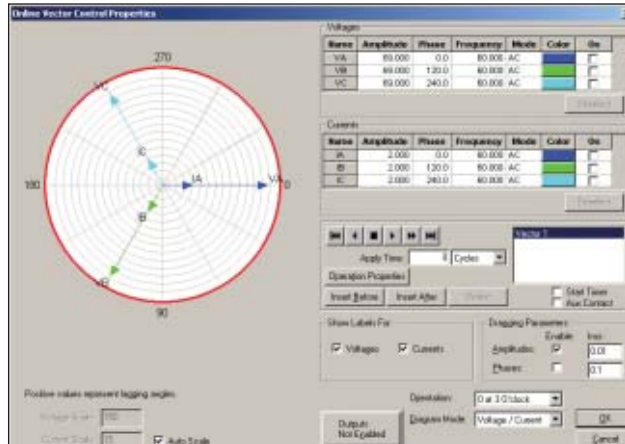
Online Vector Control

The **Online Vector Control**, launched from the AVTS Tools menu item, allows the user to have direct control of the Relay Test System. Up to **sixteen vector states** may be created and played back through the Relay Test System. A **timer control** is available to enable starting the Relay Test System timer at the execution of any one of the vector states. The timer stop is typically controlled by an action from one of a device's outputs connected to the appropriate Relay Test System timer stop gate. The default view of the Online Vector Control remains visible during all use of the control.

For **manual ramping** of amplitudes and phases, a **gang control** is available through the selection of the vectors (Relay Test System amplifiers) to be controlled. The vectors to be controlled in gang are selected by using the mouse to grab and alter the vector(s) parameters. Vector selection is made by clicking on a vector channel name to highlight that vector with its parameters. Should it be desired to simultaneously control more than one vector, the user will need to click on the wanted vectors while holding the keyboard Ctrl key down to highlight all of the selected vectors. The user may then select from the **'Dragging Parameters'** box whether the amplitudes and/or phases of the selected vectors are to be active. Once selected, the user can grab the tip of any of the selected vectors in the polar graph and, while holding the left mouse button down, move the vector(s). The values of the vector(s) will change graphically and numerically, and simultaneously pass the new values directly to the corresponding Relay Test System amplifiers. Some other unique features are:

Aux Contact Check Box- will close an "aux" binary output contact conditional with change from one vector state to another.

Edit Custom Prefix Command- available for each vector state and allows entry of a formula, Relay Test System syntax, or other controlling variable for that selected vector state.

Zoom- enlarges the polar vector diagram to the full dimensions of the dialog box.

Favorites - save a single vector, or a set of multiple vectors, with all the parameters to a desired name for recall at a later time in the Online Vector Control (Basic Version) or the Test Editor Vector Control (requires Advanced version). Save to the name placed in the edit field will retain only the selected vector(s) in the vector list. The Edit Customs Prefix Commands are saved along with the generator parameters.

Set to Variables - selection replaces the numeric values for all the vector parameters to known default variable names. This function is more commonly used for the Vector Control used within a test development in the Test Editor (Advanced Version), where the variable names are given values in the Settings Screen, Variable Watch edit field (a powerful programming tool in the Advanced version) in the Test Screen, or in another control in the Test Editor (Advanced version) Screen prior to the Vector control.

Online Ramp Control

The **Online Ramp Control**, launched from the AVTS Tools menu item, allows the user to have direct real time control of the Relay Test System. This control is very similar to the Online Vector Control. However, where the
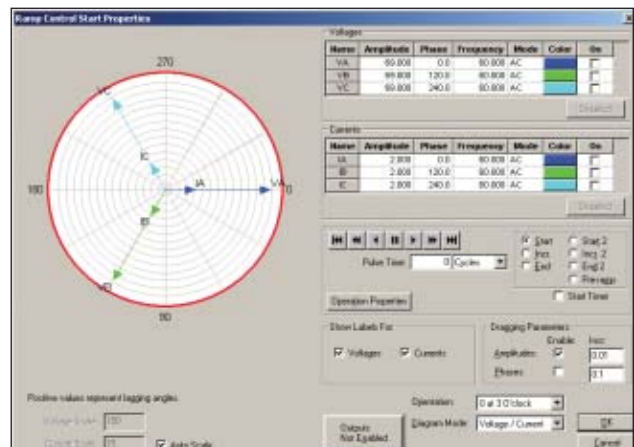

vector control sequences through up to 16 different states, the Ramp Control provides automatic ramping of selected outputs to do pick-up or drop outs tests of amplitude, phase angle or frequency. Pre-ramp, Ramp 1 and Ramp 2 are available for use to be played back through the Relay Test System. A timer control is available to enable starting the Relay Test System timer at the execution of either of the ramp states. The timer stop is typically controlled by an action from one of a device's outputs connected to the timer stop gate.

Similar to Online Vector Control, Online Ramp Control provides manual ramping of amplitudes and/or phases. The gang control is similar through the selection of the vectors (Relay Test System amplifiers) to be controlled. The outputs to be controlled in gang are selected by using the mouse to grab and alter the parameters (see Online Vector Control for more details). Another feature of the Online Ramp Control is the ability to do Pulse Ramping. One advantage of Pulse Ramping is the capability to determine reach points on multi-zone distance relays without needing the defeat the zone timing elements. For relays which require a prefault load condition prior to applying a fault value, the Online Ramp Control has a Pre-ramp (Pre-fault) state. This feature allows the user to apply the appropriate load values before Pulse Ramping begins. After applying a fault value the Ramp Control returns to the Pre-ramp state before the next value is applied. Many of the same features in the Online Vector Control are also available in the Ramp Control, such as the **Zoom**, **Set Variables** and **Favorites**.

Test Wizards

All versions of AVTS software come with test wizards. The wizards walk the user through a step by step procedure to create a relay specific test(s). Wizards are available for the most common types of relays such as, Overcurrent, Over/Under Voltage, Frequency, Differential, Distance, Synchronizing and Directional. The following is a brief description of each test wizard.

Overcurrent Wizard - Provides automatic pickup, instantaneous pickup and timing. IEEE and IEC time curve algorithms are provided for automatic evaluation of the results. Digitized time curves for various electromechanical overcurrent relays are also available. For North American relays, a dc target and seal-in test is available. A test report will provide pass/fail information of the test results.
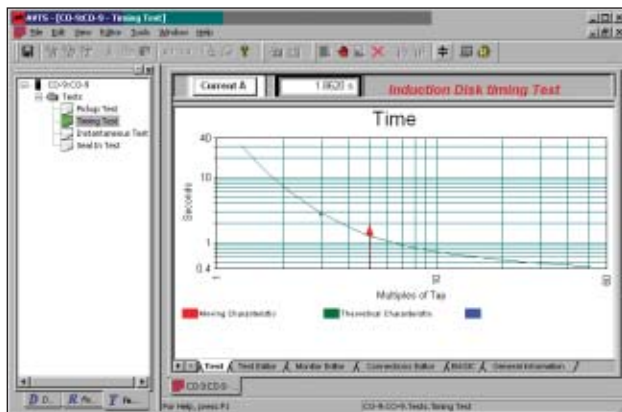
**Timing Test of Overcurrent Relay**

Over/Under Voltage Wizard - Provides automatic pickup and timing. A test report will provide pass/fail information of the test results based on user input.

Frequency Wizard - Provides automatic pickup and timing tests for over or under frequency relays. A test report will provide pass/fail information of the test results based on user input.
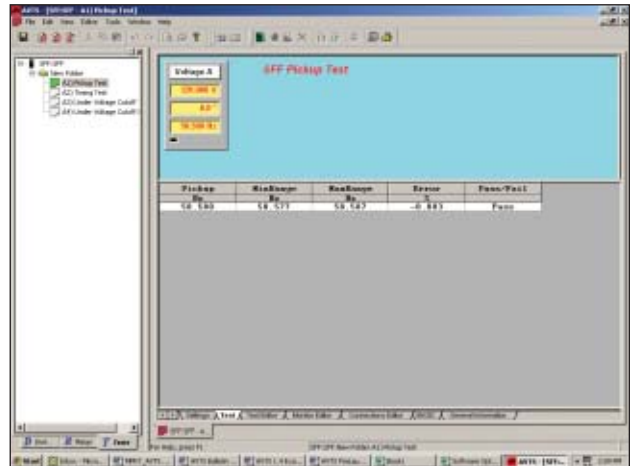
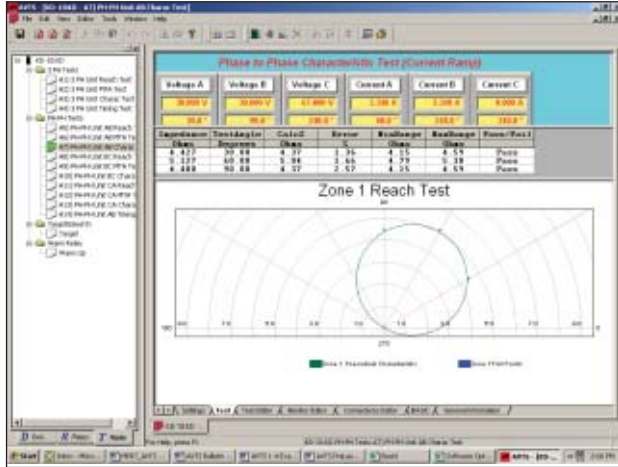
Typical Under Frequency Relay Pickup test

Differential Wizard - Perform automatic winding pickup, differential characteristic (slope) test and harmonic restraint tests. In the figure below, the test result screen was resized using the mouse and the windows drag and drop feature.
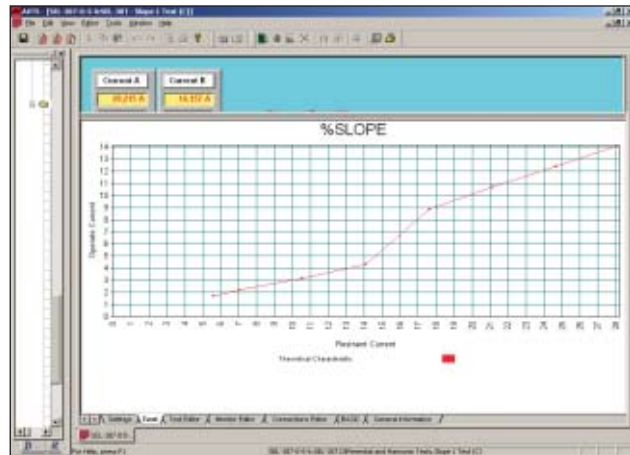
Resized Differential Slope Test Screen

This allows the operator to more closely examine test points and results. The user may then generate a test report with the test results showing pass/fail based upon input by the user.

Distance Wizard - Perform automatic reach, max angle of torque and characteristic tests on single phase, three phase open delta or three phase Y connected relays. User may choose between fixed voltage and vary current or fix current and vary voltage. In addition, the user may select mho, lens, tomato or other basic distance characteristics using a pull-down menu. The test report will provide pass/fail information based upon user data input.

Typical Phase to Phase Characteristic Test

Synchronizing Wizard - Provides automatic closing angle test and timing. A test report will provide pass/fail information of the test results based on user input

Directional Wizard - Perform automatic pickup test on directional elements. A report will provide test result.
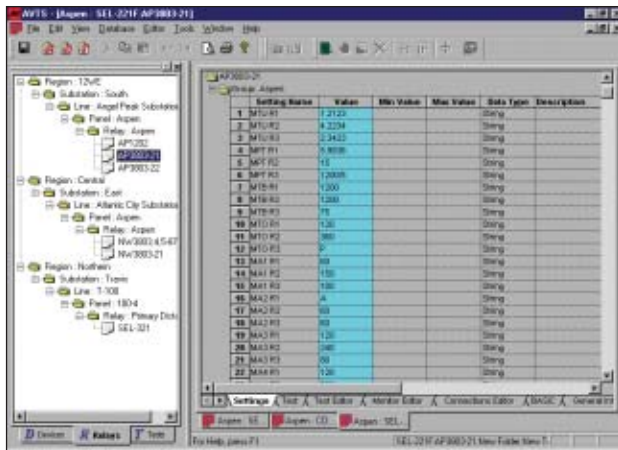
Import, Save, Execute Test Modules

AVTS Basic users can import test modules generated by Megger, or someone else using the Advanced or Professional versions of AVTS. The user can execute the tests, save results and print results. In addition, users can playback a Digital Fault Record, which has been generated by the Professional version of AVTS 2.0.

Database

The database is Windows Access compatible. Data is saved in a conventional tree format to facilitate ease of use.

The following figure illustrates the AVTS navigator Relay tab when AVTS is opened for use. The Relay has been expanded to illustrate the Organization.

The Organization is the method used to geographically locate the relays installed in this database.

This example has the Organization tree by Region, then Substation, then Line, then panel and finally the relay in the panel. The relays installed are then listed under that location. As part of the installation process of AVTS, the default Organization tree comes with three levels and may either be accepted or a new Organization tree may be edited with up to five levels.

In addition to showing the location of the relays in your system, it can also be used to look at the historical test records of any individual relay. By clicking on the box, it expands the selected relay's test history.

Test History for IAC77 Relay

Test Reports

Individual test results can be viewed by double clicking on the desired result file. The test report can either be printed, or exported to Microsoft Word for user customized report generation using company logo, company standard format etc.

Fault Calculator

The Fault Calculator allows the user to automatically calculate fault quantities for phase-to-phase, phase-to-ground, phase-to-phase-to-ground and three-phase faults. The user inputs variables for: line voltage, line Z with angle, relay volts with angle, relay amps and Z0/Z1. The Z0/Z1 system impedance ratio is applied to both the source Z and the line Z for all faults which include ground.

AVTS ADVANCED VERSION

The Advanced version includes all of the features previously described for the Basic version. In addition, it includes the very powerful Test Editor, the Waveform Digitizer, Basic Programming Tool and generic pre-constructed relay test modules. Advanced users can also playback a DFR file created by someone using the Professional version of AVTS. The following describes the additional features of the Advanced version of AVTS 2.0.

Test Editor

The real power of AVTS is in the Test Editor window. No more complicated test macros to write or edit. Instead, the user selects from a variety of icons representing various test macro functions. For example, in the following Figure, certain icons are selected and connected using the mouse. The software takes care of the rest. No more theoretical characteristic macros to write either. Simply click on the appropriate icon and drop into the test editor window. What may have taken days or weeks to "write" using basic programming now takes only minutes!
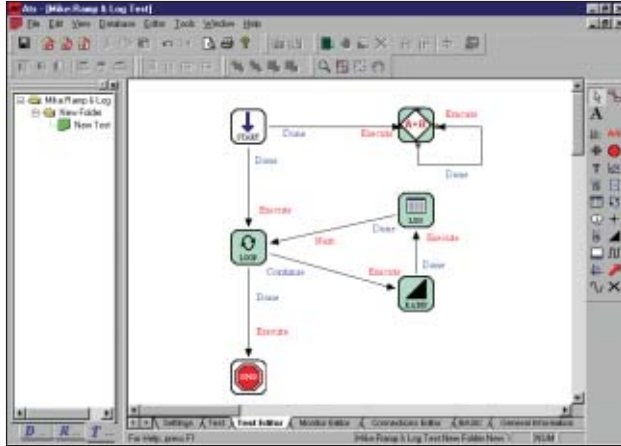
Test Editor Window

In addition, the test wizards automatically assemble and connect the appropriate icons for you. All you need to do is edit the appropriate control function to meet your specific needs. For example, using a right-mouse click on the Ramp Control Icon (in the Test Editor work screen), and then clicking on the Increment button, the user is able to adjust the increment value of each current increment for a pickup test.
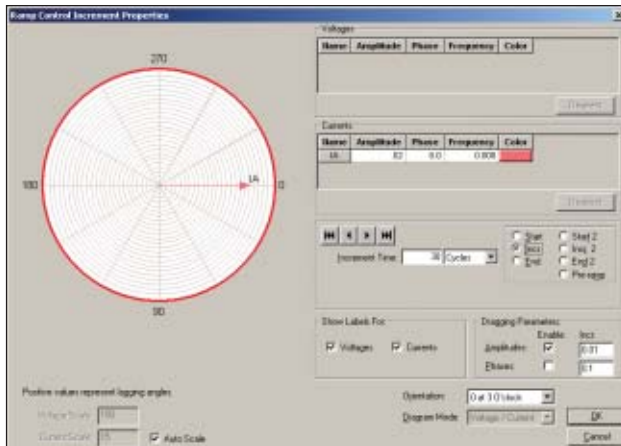
Adjusting Ramp Control- Current Increment

Connections Editor

A picture is worth a thousand words. It seems like modern relays need a thousand connections today, so the Connections Editor is ideal to show how to connect the test system to the device under test. Powerful graphic tools are available to show test connections (see following Figure).
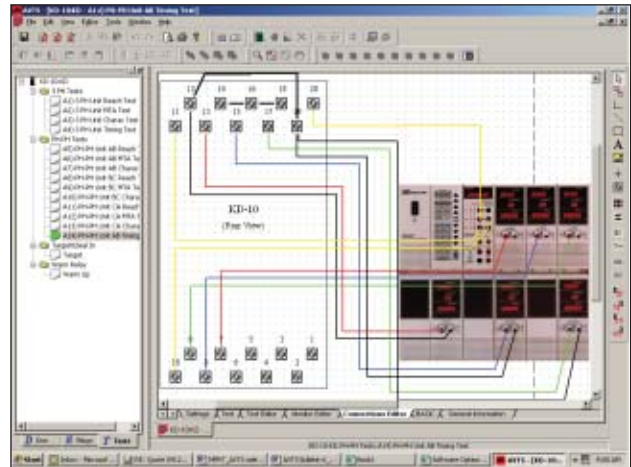

Connections Editor Screen provides relay test connections details

The Connections Images toolbar contains ten available icons for the user to define each as an image bitmap to import into the connection editor screen. This can include schematic internal diagrams of the relays, or other helpful information. In the above figure, a digital picture of the older AVO Pulsar test set has been used to illustrate how to connect to the relay to be tested. Pictures of other test sets may also be used for illustration.

Waveform Digitizer

The AVTS Waveform Digitizer Tool enables the user to digitize waveforms and export them to a COMTRADE *.cfg and *.dat files for playback through the Test System. Waveforms from old strip chart recorders, hand drawn waveforms, and waveforms created by oscillographic functions of the modern microprocessor and numerical relays; any waveform that can be represented in a *.bmp format can be digitize. In addition, electromechanical relay analog time curves, that do not fit numerical algorithms, can be scanned into AVTS. The digitizer can be used to create a virtual time curve to be used in the timing test. For example, AVTS software comes with numerous analog curves already digitized and ready for use.
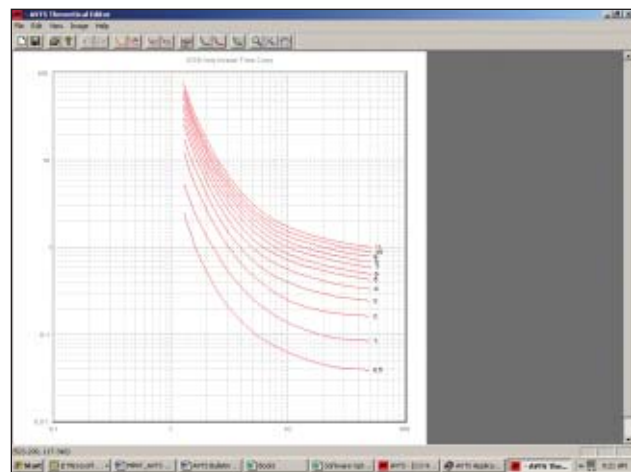
Westinghouse CO-9 Digitized Time-Current Curves

Basic Programming Tool

The Basic Programming Tool provides a means to either import older test macros into AVTS and execute legacy test files, or to send the test system syntax commands to do special test applications not covered by the standard test modules, generic test modules, wizards, DFR playback, vector control or ramp control. For example, special complex waveforms, including DC offsets, can be "built" and played back using the test system command set. These commands can be issued from the Basic Tool icon as part of a special test file. For example, test system commands could be sent to generate an IEC 947 compound harmonic waveforms like the following graphic.
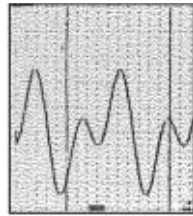
Complex Waveform

Import Aspen Relay Database®

In addition, relay settings may also be imported from other databases. For example, relay settings from the Aspen Relay Database® can be seen in the figure below.
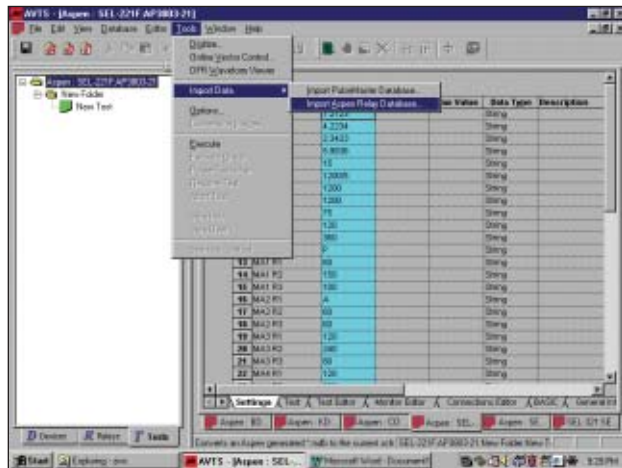
Import Relay Settings From Aspen Database

AVTS PROFESSIONAL VERSION

The Professional version includes all of the features previously described for the Basic and Advanced versions. It also includes special testing and editing tools for playback of Digital Fault Records or EMTP/ATP simulations that are in the IEEE C37.111 COMTRADE format. In addition, it includes the special test macros required for performing End-to-End tests on transmission line protection. Plus, it includes the Test Editor Tool for performing the One-Touch Test™. The One-Touch Test feature is used with those Test Modules that include the script files that automatically download relay settings from

microprocessor based relays into AVTS and automatically tests the relays to the downloaded settings. The following describes the additional features of the Professional version of AVTS 2.0.
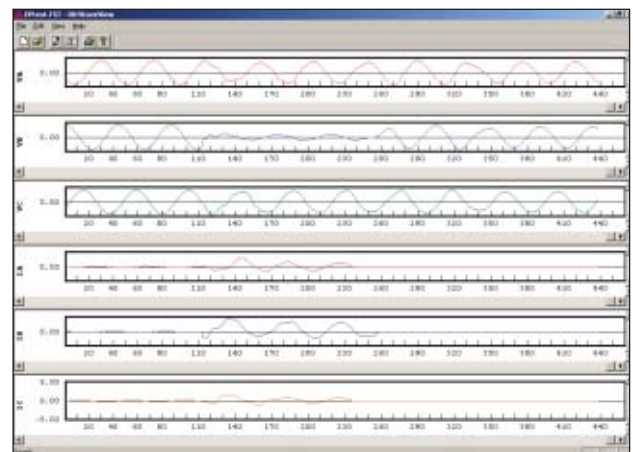
DFR Waveform Viewer and Playback

In addition to performing the steady-state testing, it is increasingly becoming a popular practice to perform dynamic and transient testing on protective relays. AVTS DFR Waveform Viewer has the capability of playing back transient waveform data to the Test System waveform generators. In other words, it can recreate a fault (waveforms...) recorded by a Digital Fault Recorder or simulated fault using EMTP/ATP programs. When DFR Waveform Viewer is invoked from the Tools menu, the screen called DfrWaveView dialog box will appear.

From this dialog box a user can convert digital fault recorder data, in COMTRADE format, to hexadecimal files compatible with the Test System waveform generators, select the channels and ranges to be uploaded, and upload and output the waveforms.
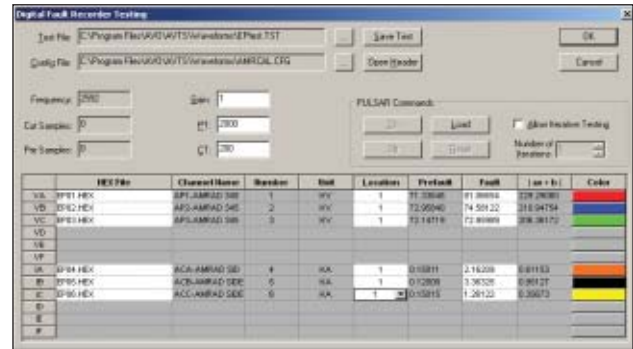
DFR Test Editing Dialog Screen

In addition, special editing capabilities allow the user to replicate the prefault data for as many cycles as desired to insure that the device under test is properly polarized prior to applying the fault. Timing maybe started in conjunction with the fault application, thus timing the replay event. Due to the wide operating bandwidth of the test system, there is no degrading of the recorded samples thus high fidelity of the playback waveforms is insured.

AVTS Professional Waveform Viewer Screen

End-to-End Test Capability

End-to-end testing usually involves the coordinated playback of a digital fault recorder (DFR) record by the test equipment. However, there are occasions when a user- defined single or multi-state data playback may be desired. End-to-End tests are run by using a special macro in AVTS Professional. The macro will allow the user to select the test file (DFR recording) which is then loaded into the test system. The test system then waits for a GPS trigger pulse to begin playing back the recording. If the user desires to perform a state playback rather than a DFR playback, the user simply constructs a test utilizing the **Data** and **End To End** macros. The Data macro can be edited and allows the user to specify the voltage and generator states and time durations for playback. A typical End-to-End test setup would look like the following figure,
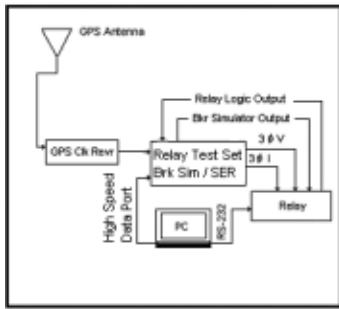
Typical End-to-End Test with MPRT

One-Touch Test™

The One-Touch Test utilizes a Visual Basic® Script Control tool that is only available in the Professional version of AVTS 2.0. The script file works with Megger Test Modules that have been specifically created to make use of this feature, see AVTS Test Modules. The Script file allows AVTS software to communicate to a microprocessor-based relay via ASCII text serial communication, and download the relay settings into the AVTS relay Setting Screen automatically. Then, using the Group Execute feature in AVTS, automatically test the relay to the actual relay settings with one touch of the mouse button.

Log-in for SEL-321 Scripted Test Module

For AVTS 2.0 users who do not have the Professional version, there is a separate SEL-321 test module available without the One-Touch Test script capability. All the tests are the same, however, the user must manually log on to the relay and retrieve and enter relay settings manually.

AVTS TEST MODULES
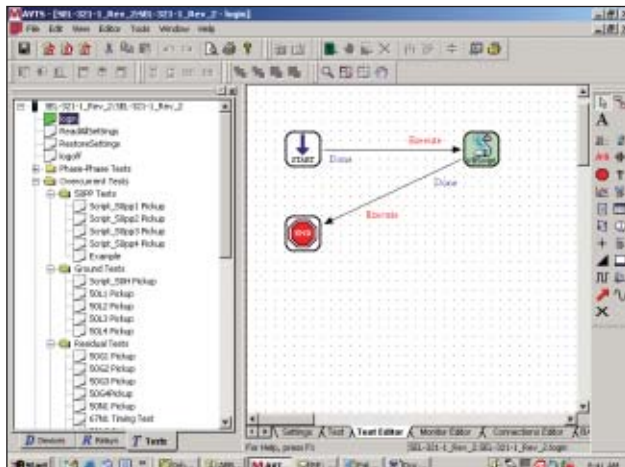## Complex Testing Simplified

Megger has developed a wide variety of relay specific test modules from different relay manufacturers. AVTS Basic Software users can import these test modules, execute, save and print results. Using the Advanced version of AVTS 2.0, users may copy, paste, rename and modify existing test modules to create new relay test modules, which have similar operating characteristics. Contact your local Megger sales office for an up-to-date listing of the available test modules.

Time Saving

Each relay test module is an extremely valuable product for any relay test technician or engineer. It provides the user with a quick, easy way to test a specific relay to the relay manufacture's specifications, as well as eliminates the time and costs associated with users having to create their own test routines.

One-Touch Test Modules

One-Touch Test modules are currently available for a variety of relays. One-Touch Test requires the AVTS Professional version to execute the communication link between AVTS and the relay under test, as well as automatically download relay settings. If you have AVTS Professional, don't forget to ask if the test module you are interested in has the One-Touch Test capability. Test modules, which are One-Touch capable, save the user time, money and removes the possibility of human error when having to read over 100+ relay settings.

ORDERING INFORMATION   STYLE NUMBER IDENTIFICATION

Model Number	MPRT	8	4				T			

Preset Configuration

84 = Maximum Configuration of up to **8** Currents & **4** Voltage Outputs

Output Power Selection

Enter **15** = Lower Output 15 Amps / 150 Volts per amplifier channel

Enter **30** = Higher Output 30 Amperes / 300 Volts per amplifier channel

Enter **R** = Rack-mount Option. Unit comes with hardware for rack mount in 19 in rack
Enter **N** = Standard enclosure

Amplifier Output Modules

Enter **1**, **2**, **3** or **4** for the number of customer selected amplifier modules required

Enter **0** for no customer selected amplifier modules

T = Base Unit with Touch View Interface

Pre-Set Frequency Output Option

Enter **5** = Unit comes pre-set with output frequency of 50 Hz

Enter **6** = Unit comes pre-set with output frequency of 60 Hz

Power Cord Option

Enter **A** = North American Power Cord

Enter **I** = International Power Cord comes with jacket strip international color coded wires ready for installation of desired connector.

Enter **E** = Continental Europe Power Cord comes with CEE 7/7 Schuko plug.

Transit Case Options

Enter **1** = Soft-sided carry case
Enter **2** = Hard-sided transit case

ORDERING INFORMATION

Item (Qty)	Cat. No.
Model 8415, three-phase unit with soft-sided carry case and North American power cord	8415-N3T6A1
Model 8415, three-phase unit with soft-sided carry case and Continental Europe power cord	8415-N3T5E1
Model 8415, three-phase unit with soft-sided carry case and International power cord	8415-N3T5I1
Model 8430, three-phase unit with soft-sided carry case and North American power cord	8430-N3T6A1
Model 8430, three-phase unit with soft-sided carry case and Continental Europe power cord	8430-N3T5E1
Model 8430, three-phase unit with soft-sided carry case and International power cord	8430-N3T5I 1
AVTS, Advanced Version	544245
AVTS, Professional Version	544246

Included Accessories

Model 8415 and 8430 Base Unit

Item (Qty)	Cat. No.
Power Cord - Depending on the style number, the unit will come with one of the following	
Line cord, North American (1 ea.)	801046
Line cord, Continental Europe with CEE 7/7 Schuko Plug (l ea.)	15021
Line cord, International color coded wire (1 ea.)	14525
Instruction manual (1 ea.)	710000
Hand-Held Controller (1 ea.)	710004
Cable Assy, Hand-Held Controller (1 ea.)	620001
RS-232 , Straight 9-pin, male/female, Cable Assy. (1 ea.)	16350
Test lead, red, 200 cm, use with voltage/current (up to 15Amps) outputs and timer (3 ea.) CAT II	684000
Test lead, black, 200 cm, use with voltage/current (up to 15Amps) outputs and timer (3 ea.) CAT II	684001
Lug adapter, red, 6.2 mm, use with voltage outputs and timer (3 ea.) CAT II	684002
Lug adapter, black, 6.2 mm, use with voltage outputs and timer (3 ea.) CAT II	684003
Lug adapter, red, 4.1 mm, use with voltage outputs and timer (3 ea.) CAT II	684004
Lug adapter, black, 4.1 mm, use with voltage outputs and timer (3 ea.) CAT II	684005
Alligator clip, red, use with voltage outputs and timer (3 ea.) CAT II	684006
Alligator clip, black, use with voltage outputs and timer (3 ea.) CAT II	684007

Item (Qty)	Cat. No.
Model 8415 Voltage/Current Output Module **Each output module will come with the following,**	
Test lead, red, 200 cm, use with voltage / current (up to 15Amps) outputs and timer (2 ea.) CAT II	684000
Test lead, black, 200 cm, use with voltage/current (up to 15Amps) outputs and timer (2 ea.) CAT II	684001
Lug adapter, red, 6.2 mm, use with voltage outputs and timer (2 ea.) CAT II	684002
Lug adapter, black, 6.2 mm, use with voltage outputs and timer (2 ea.) CAT II	684003
Lug adapter, red, 4.1 mm, use with voltage outputs and timer (2 ea.) CAT II	684004
Lug adapter, black, 4.1 mm, use with voltage outputs and timer (2 ea.) CAT II	684005
Alligator clip, red, use with voltage outputs and timer (2 ea.) CAT II	684006
Alligator clip, black, use with voltage outputs and timer (2 ea.) CAT II	684007
Model 8430 Voltage/Current Output Module The higher current output module includes 6 mm test leads that are specially made for the higher current of the Model 8430 output module. Each output module will come with the following,	
Test lead, red, 200 cm, use with voltage output and timer (1 ea.) CAT II	684000
Test lead, black, 200 cm, use with voltage output and timer (1 ea.) CAT II	684001
Test lead, red, 6 mm dia., 150 cm long, use with current output (1 ea.) CAT II	15923
Test lead, black, 6 mm dia., 150 cm long, use with current outputs (1 ea.) CAT II	15924
Lug adapter, red, 6.2 mm, use with voltage outputs and timer (2 ea.) CAT II	684002
Lug adapter, black, 6.2 mm, use with voltage outputs and timer (2 ea.) CAT II	684003
Lug adapter, red, 4.1 mm, use with voltage outputs and timer (2 ea.) CAT II	684004
Lug adapter, black, 4.1 mm, use with voltage outputs and timer (2 ea.) CAT II	684005
Alligator clip, red, use with voltage outputs and timer (1 ea.) CAT II	684006
Alligator clip, black, use with voltage outputs and timer (1 ea.) CAT II	684007

Additional Accessories

Item (Qty)	Cat. No.
Unit comes with the soft-sided case. Hard-sided case is optional.	
Rugged, hard-sided transit case (1ea)	684019
Soft-sided transit case (1 ea.)	684011