

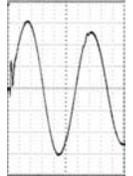
## Why buy a PJ Surge Tester?

...because "PJ" is the **only** manufacturer that makes **Surge Testers!**

*Other manufacturers make Impulse Testers!*

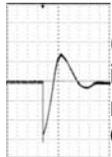
Since 1969, the PJ Electronics High Frequency Surge Tester was the only tester of its kind then, and still is today. The basic technology of an impulse tester has been copied throughout the world, but our unique High Frequency Technology has not.

A PJ High Frequency Surge Tester is not only a Quality Surge Tester for testing turn-to-turn insulation for coils, but it can be used for all of your electrical motor testing.



**ALL** PJ Surge Testers come equipped with Dual Waveform Display presentations: (1) Resonant Current Waveforms for Surge Testing "coil-to-coil" and low impedance windings.

(Figure on right)



(2) Resonant Voltage Waveforms for Surge Testing all types of multi-phase winding insulation systems including the surge testing of Fully Assembled Motors without moving the rotor.

(Figure on left)

### **WHAT'S THE DIFFERENCE BETWEEN AN IMPULSE TESTER AND A PJ HIGH FREQUENCY SURGE TESTER?**

In our High Frequency Surge Testers, coils are pulsed with high capacitor discharge energy that results in a resonant circuit with the coil under test. This test procedure enables the low impedance coils to support high surge voltages by being an integral part of the resonant circuit. PJ Testers cause the load to resonate with the source energy discharge capacitors by being built into a series resonant circuit. The unique feature to our High Frequency Surge Testers is the employment of a bi-directional switch. This switch permits the load coils to resonate with the discharge capacitors, that result in stressing of the coils both in the forward and reverse direction with voltage stressing both positively and negatively during each oscillation.

In an impulse tester, which is employed in all of our competitor's testers, a uni-directional voltage pulse is discharged into the coil under test. This pulse energy causes the coil to resonate only within its natural frequency. This natural coil resonance results in dissipating the pulse energy that was initially applied to the coil. When Impulse Testing, it is very difficult, if not impossible, to establish turn-to-turn voltage distribution when it is subjected to a unidirectional pulse as from an Impulse Tester. Depending on the coils internal distributed capacitance, the pulse voltage will be separated in a non-uniform manner. An Impulse Tester (all competitors) does not permit the coil voltage from oscillating below ground when the pulse voltage is only positive in nature. When coils are subjected to this impulse test, there is no practical way that one can actually verify what this turn-to-turn insulation is seeing.

Our High Frequency Technology is *superior* to Impulse Technology for surge testing / stressing insulation because we use a Bi-Directional Switch and not a Uni-Directional Switch. Our Voltage Rise Time is 0.1 micro-seconds ( $0.1 \times 10$  to the (-6) or 0.0000001 seconds). This means that when our applied surge voltage is across the coils under test, it will take **0.0000001 seconds** for **any** PJ High Frequency Surge Tester to change from 10% to 90% of our maximum applied test voltage. For example, it would take our 50KV PJ High

Frequency Surge Tester 0.0000001 seconds to deliver an output voltage from 5,000 Volts to 45,000 Volts. Our Voltage Rise Time is fixed at 0.1 micro-seconds throughout the surge tester's entire output voltage range. In addition to our Bi-Directional Switch and our fixed 0.1 micro-second voltage rise time, all PJ High Frequency Surge Testers pulse and resonate with the coils under test at 60 Pulses Per Second (60pps @ 60 Hz. and 50 pps @ 50 Hz.). Within each and every pulse, our high frequency discharge energy is cycling and resonating throughout the coils, stressing the coil's turn-to-turn insulation in the forward and reverse direction. After this high frequency burst of energy, the surge tester recycles and regenerates another pulse of high frequency energy every 16 milli-seconds (0.016 seconds). These high frequency bursts of high surge energy continue to stress each and every turn of the coil's insulation unlike no other surge tester on the market today or for the last 40+ years.

PJ High Frequency Surge Testers *outperform* all Impulse Testers due to their Uni-Directional Switch Technology, Variable Voltage Rise Times as slow as 2.0 micro-seconds on coils and a repetition pulse rate as slow as 1 impulse every 2 seconds (0.5 Hz.). The impulse energy does not resonate with the coils, just shocks them and dampens out via the natural frequency of the test coils.

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## TESTING AC ROTATING ELECTRIC MOTORS

When testing phases of a motor, no tester, including our PJ Surge Tester, will uniformly stress the turn-to-turn insulation of every coil in the phase of disassembled or assembled motors. This is why it is imperative to surge test each and every coil prior to installing the coil into the motor. As we stated many times before, there is no better method of checking /stressing the integrity of the coil than with a tester with High Frequency Technology.

But what if you cannot test the coils prior to installation? What if you only have a multi-phase motor to surge test with the rotor removed? Finally, what if you have to surge test a fully assembled motor? All of our competitors claim that they are capable of surge testing multi-phase motors, but they have never explained how the voltage is being applied to the coils in the phases. You may believe that an Impulse Tester can test 3 phase motors, but what do you think it is detecting?

Every PJ High Frequency Surge Tester is capable of effectively surge testing grounded or ungrounded **Fully Assembled Motors without moving the position of the Rotor.**

Since our discharge energy is continuously resonating at 60pps, every cycle of our surge energy is constantly recycling the resonant current and resonant voltage back and forth to our capacitors. The surge energy is contained with high power levels to work through those windings in each phase with sufficient energy and still have the capacity to detect defective insulation.

**An explanation on how our competitor's voltage is being applied to the coils in multi phase motors.** Our surge voltage differs drastically from that supplied by standard impulse testers. Most impulse testers have a pulse repetition rate of 5 pulses per second, i.e., one every 200 milliseconds. When an impulse tester is discharged into a motor winding it contains one and only one burst of energy in which the energy slowly dissipates to zero. The motor is not subjected to another energy burst until a time period of 200 milliseconds has elapsed. When it surges the windings with its relatively slow rate of rise, it gives an unequal distribution of the voltage across the entire phase in only one direction. In a one second time period, the impulse tester subjects the motor windings to 5 and only 5 bursts of surge energy whereas as the **PJ Surge Tester** will have subjected the motor to 60 high frequency bursts of

energy. However, each of our high frequency bursts consist of a decaying oscillation of approximately 5 cycles of energy pulses that gradually dissipates to zero. Under these conditions, the motor would be subjected to 300 energy pulses during the same time period in which the impulse tester would have delivered 5 pulses of energy.

An Impulse Tester does not have the voltage risetime or duration of repetitive peak discharge energy during the unidirectional discharge time period to effectively stress weak turn-to-turn insulation in a single coil, **not to mention an entire phase!**

## **PREDICTIVE MAINTENANCE**

If you were to surge test a fully assembled motor with an Impulse Tester during your scheduled Predictive Maintenance Program, you would first have to rotate the rotor back and forth until you get a presentable waveform for that phase. You may be required to repeat this tedious task again to test the other phases. You may detect a short in the entire phase, if present, but you would not detect or stress weak insulation in the phases. The reason is that once the energy from an impulse hits the coils in the phases, the capacitance in the coils charges up momentarily, then dampens out due to a follow through of the natural frequency of the coils in the phase. Their voltage surge considerably lacks the voltage rise-time listed in the IEEE 522 Standard, that is imperative for stressing weak insulation to the point of break over in the motor winding.

Fully Assembled Motors when connected on-line are subjected to damaging effects of turn insulation if the input leads are struck by lightning strokes, high voltage transient spikes or faulty breaker closures. These are the circuit conditions that subject the motor to excessive steep-front surges. There is a high probability that if the motor is damaged, it is very likely to have occurred under these conditions. The turn insulation can also be weakened by a surge at the machines terminals from normal breaker operations. Repeated on-off breaker cycles with steep surges will weaken poor turn insulation and eventually cause a turn-insulation failure.

When using our PJ High Frequency Surge Tester in a Predictive Maintenance Program you will not have worry about the rotor position, you may test it as is. The peak value of our applied surge test voltage rise time is similar to that of a lightning stroke which will stress the coils to the maximum that they would encounter on abnormal line conditions. A PJ Surge Tester will not harm or damage good insulation if it is surge tested at the proper test voltage for each motor, but it will detect any defective insulation that is present in the winding.

Due to our PJ High Frequency Technology as explained previously, we are capable of stressing the windings of each phase in both directions. When we surge the phase, the energy that is discharged into the windings comes in from one end of the phase. The energy is immediately reversed causing a reversal in polarity of the surge voltage thereby causing a secondary discharge to appear at the opposite end of the phase. This voltage waveform will cause a similar voltage stress to this end of the phase. This permits us to stress the part of the phase that we did not stress initially. The PJ High Frequency phenomena allows us to effectively stress the insulation, providing the proper surge test voltage is applied, **before** it turns into a motor failure.

We at PJ Electronics, believe that using a Surge Tester for your scheduled Predictive Maintenance program should effectively stress the complete phase of your fully assembled motor and detect / uncover damaged and weak insulation throughout the entire phase.

A PJ High Frequency Surge Tester is the only choice for all of your **Preventive** / Predictive Maintenance programs and multi-phase surge testing.

Surge Testing is only one part of a complete Predictive Maintenance Program (PMP). DC Hipot Testing along with Resistance Testing are also important. Our "M" models : Multi-Operational Surge Tester (MOST), High Frequency Surge with DC Hipot, built-in 3 phase transfer switch and optional portable hand held milliohm meter is the ideal package for your PMP. However, we offer you the ability to custom build a tester to meet your testing requirements. Only order the PJ tester with the features that you need.

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## HOW TO SELECT A PJ SURGE TESTER

When you purchase a **P J High Frequency Surge Tester**, you don't have to worry about the Horse Power of the motor that you intend to test. All P J Surge Testers are capable of testing **any** rated HP motor provided that the P J Tester you select has sufficient output voltage required for the test. To compute the voltage needed to surge test a new or rewound electrical motor, you must multiply the line-to-line voltage rating of the motor by 2, add 1000 and multiply that sum by 1.414

$$(2 \times \text{Rated Line Voltage} + 1000) \times 1.414$$

For example, to surge test a 4160 volt AC Motor, you would multiply the line voltage (4160) by 2 to get 8320, then add 1000, the sum would equal 9320; then multiply this number by 1.414 to obtain the surge test voltage. This test voltage would equal 13,178 volts. Any one of our 15 KV Models would be able to perform this test.

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## ARMATURE TESTING

**All** P J Surge Testers are capable of testing DC Armatures. A special tester is not needed!

DC armature testing is accomplished by an Armature Test Yoke Assembly (ATYA) that conveniently applies the test surge voltage to the armature coils via the commutator segments. By providing a proper yoke set-up for supporting the armature and using the three spring-loaded contact fingers for commutator connections, as shown in the picture, the operator can manually rotate the armature and observe the oscillographic wave pattern. Thus, one section of the armature is constantly being compared to a new section of the armature under test. A good armature can be tested in this way in only a couple of minutes by a single operator.

Some of our competitors limit the applied bar-to-bar test voltage to only 900 volts. With a PJ Surge Tester, there is **no** restriction in the magnitude of the applied bar-to-bar voltage. We have had customers inform us that they are testing D.C. Armatures at 1250 to 1500 volts bar-to-bar and they are now uncovering defects that they normally would not have detected at the lower test voltages. By detecting these defects during the test phase, they were able to eliminate costly motor failures in the field.

## FACTS REGARDING CALIBRATING TESTERS...

All P J Surge Testers indicate the value of peak output voltage on a large digital panel meter that is accurately calibrated to be the actual voltage that is applied across the test coils. Our calibration accuracy is Traceable to NIST. Our customers can actually verify the output voltage, as displayed on the panel meter, for themselves at any time. This is accomplished by using an optional calibrated High Voltage Probe in conjunction with our Digital Oscilloscopes that we supply with every one of our testers. This test procedure can be seen by the illustration shown below:



We challenge our competition to **prove** their output voltage under any low inductance load, at any time! None of our competitors explain, illustrate or prove their output voltage. Impulse testers severely regulate under low inductance loads and their output voltage displayed on the meter is **not** the same across the coils. Don't let our competitors insult your intelligence by claiming that they have a "button" to self calibrate their surge testers. Some of our competitors just calibrate the meter movement on their testers or adjust the gains on their oscilloscopes. We calibrate our PJ Surge Testers under actual load conditions throughout the testers entire output voltage range. Future calibrations on all PJ High Frequency Surge Testers should be performed at our factory to conform to NIST. If calibration is performed elsewhere, the calibration agency must employ procedures as recommended by PJ Electronics, Inc.

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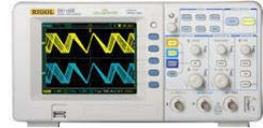
## DIGITAL REAL TIME OSCILLOSCOPES, USB STORAGE, PRINTING, ANALYSIS,...ETC.

All P J High Frequency Surge Testers currently come equipped with a high performance **color** Rigol DSE series storage, programmable oscilloscope with USB Interface Ports, Software, multi-language user interface and a bonus USB Flash Drive for unlimited storage capabilities. These scopes include a USB host port for removable data storage support and USB device port for either PC connectivity or direct print capabilities. It offers a maximum Sampling Rate of 1 GSa/s which provides accurate real-time acquisitions, the opportunity to freeze, store, save/reference and measure waveforms "on screen" for analysis. The digital scopes are all "user-friendly" with on screen menus, traditional buttons and knobs which retain analog simplicity yet gives quick access to the wide range of digital functions.

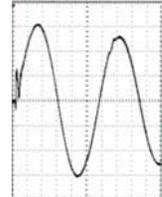


Every oscilloscope is pre-programmed at P J Electronics before it leaves our factory, so that the settings are correctly positioned and ready to display the bright and vivid waveforms on a color liquid crystal display (LCD) screen. You can also pre-program up to 10 different scope set-ups to enable you to quickly get proper waveform patterns for various testing applications. You may also view the scope in one of 10 different languages: English, Spanish, French, German, Russian, Portuguese, Korean, Japanese, Traditional Chinese or Simplified Chinese. In addition, these "state of the art" oscilloscopes offer a 3 year warranty.

**Rainbow of COLORS.** As described above, all of our Model Testers are now equipped with a Rigol **color** oscilloscope. The **color** makes it easier to distinguish good and bad waveforms because channel 1, channel 2, and the reference waveform are in different colors. Everything that is displayed on the colored Oscilloscope may either be printed out, displayed on the PC via the software and/or stored on the USB Flash Drive in **color**, exactly as it appears on the scope.



**Do more with your waveforms with the new Standard Features.** All Oscilloscopes come standard with an accessible front-panel USB host port for an easy way to save data onto the included USB Flash Drive. Use the USB Flash Drive to store, reference, identify and recall virtually an **unlimited** number of waveform data. Once you have loaded the USB Flash Drive with waveform data, you may download the data on various PC formats for analysis (some formats listed below). (*NOTE: No additional software is required when you save waveform data on the USB Flash Drive.*)



**Software included at no additional charge.** The Rigol Scope offers UltraScope software. It provides quick and easy capturing and saving of waveform data and images directly onto a PC (Windows 98, 2000, NT and XP). Truly seamless PC connectivity via a USB device port / USB Plug-and-Play. The software provides the ability to generate reports with Microsoft Word, Excel, Outlook, PowerPoint and WordPad, as well as, with stand-alone desktop application. The software provides live waveform analysis, remote control of oscilloscope and extended analysis capability.

**Innovative direct print capability.** Print directly from the oscilloscope to printer with the push of one button, using our optional **Canon Pixma PictBridge™ Printer**. This high resolution printer is connected to the oscilloscope, stored and mounted in the custom panel sliding drawer of our Console Models (or connected and secured on top of our Portable and Bench Models). The printer will print everything that is seen on the scope's display screen.

These removable oscilloscopes can also be used for trouble shooting motor controllers, power supplies and other electronic circuitry. Most importantly, they can be used to verify the peak output voltage of the test coils, at any time you wish (using a high voltage probe, contact us for details).

## PJ SURGE TESTERS VERSUS ALL COMPETITORS

<b>PJ HIGH FREQUENCY SURGE TESTERS</b>	<b>Impulse Testers (All Competitors)</b>
PJ Electronics only sells DIGITAL High Frequency Surge Testers!	Most competitors still try to sell obsolete Analog testers.
All PJ Testers have dual waveform presentations, very sensitive resonant current waveforms for testing turn-to-turn insulation and resonant voltage waveform display for testing phase to phase winding insulation.	Single impulse voltage waveform display only, lacks sensitivity and surge testing performance.
All PJ Testers designed to surge test Fully Assembled Motors without moving the rotor. ...A standard feature.	Cannot effectively perform this test. Feature not available.
0.1 micro-seconds voltage rise time on all models up to 60KV.	Variable voltage rise time as slow as 2.0 micro-seconds, does not meet IEEE Standard 522-1992.
We oscillate / resonate and stress the windings 50/60 pulses per second* (predicated on input line frequency).	Does not resonate with coils, pulse rates vary from 12 pulses per minute to up to 5-10 pulses per second.



\*The reason our competitors employ a low pulse rate is because they do not have the power capabilities to discharge 60 pulses per second into a low impedance load. The advantages of pulsing load coils at a high repetition rate is that it can uncover a potentially dangerous and weak point in the coil insulation. For example, if a coil has an imperfection in the coil insulation that results in a high concentration of voltage stress, (usually referred to as Corona) our high repetition, high voltage pulse, can cause this coil weakness to increasingly weaken and eventually break-over. This will result in a noticeable fault pattern on the oscilloscope waveform. **This high pulse rate can be classified as an accelerated life test in which the applied test will result in revealing a coil weakness that would not normally be uncovered by an Impulse Tester.**

<b>PJ HIGH FREQUENCY SURGE TESTERS</b>	<b>Impulse Testers (All Competitors)</b>
Our testers stress coils under test both in the forward and reverse direction with voltage stressing both positively and negatively during each oscillation via our High Voltage Bi-Directional switch.	Shocks coils with a uni-directional impulse which does not permit coil voltage reversal. Therefore, the coils turn-to-turn insulation is not effectively stressed.
Our PJ High Frequency Surge Test assimilates the same electrical environment when the rotating electric machine is connected on-line.	Not even close, NO comparison.
PJ Testers can accurately generate voltage to any type of load. Operator can verify his output voltage at any time with an optional H.V. Probe and use the scope inside the tester.	Cannot, it regulates wildly under low inductances. It is impossible to accurately read the testers output voltage via a high voltage probe with their integrated oscilloscope.
All PJ Testers capable of testing very low inductances, series wound DC Armatures, etc. since 1969. Fixed 100 nano-second Voltage Risetime regardless of load impedance of the coil.	Cannot use your Impulse Tester, need a special type of Impulse Tester to check DC Armatures, and low inductance loads. Voltage Risetime will vary under different load impedances.

It doesn't take much energy to uncover a shorted coil, but it takes a fast rise time and a repetitious high voltage pulse to reveal a potentially weak coil condition. When testing with a PJ High Frequency Surge Tester, each test coil is subjected to precise peak pulse powers which are capable of uncovering any insulation weakness that may be present. The peak pulse voltage is accurately controlled and regulated so as not to cause any deleterious effects such as excessive heating or over-voltage stressing.

The competitors are more interested in the automation and computerization of their Impulse Testers than developing proper surge tester technology. What good is the automation and software when the "Hardware" can't do the job?

<b>PJ HIGH FREQUENCY SURGE TESTERS</b>	<b>Impulse Testers (All Competitors)</b>
All PJ Surge Testers come equipped with a Fully Digital, 1 Billion Samples per second real-time, programmable, storage, rack-mounted Rigol DSE series scope.	Most are analog, some digital with an integrated homemade type of oscilloscope with basic scope functions. Repaired by factory only.
Every PJ Tester comes equipped with a Rigol color display oscilloscope. Store, reference, identify and recall an unlimited number of waveforms on the supplied USB Flash Drive. Download the data on various PC formats via software that is included.	Most have no scope upgrades, no color display, and no USB Host Port or USB Flash Drive. Software is needed and is an expensive option.
PJ Testers are capable of energizing at any preset voltage with virtually no overshoot voltage*. A welcomed feature when using the reference waveform. Each surge test can be identically compared to the last surge test. *under 40KV	Most can only be energized at 0 volts, nothing to prevent voltage overshoot, takes longer to surge test, no preset voltage capability.

<p align="center"><b>PJ HIGH FREQUENCY SURGE TESTERS</b></p>	<p align="center"><b>Impulse Testers (All Competitors)</b></p>
<p>PJ Testers with DC Hipot have dual LED panel meters that display leakage Current and Voltage with overcurrent safety Trip.</p>	<p>Most do not have direct readout and does not display voltage and current.</p>
<p>Current resolution on our Hipot is 0.1 and 1 micro-amps. Max current readout is 2000 micro-amps with a overcurrent trip at 2000 micro-amps.</p>	<p>Current resolution is much less sensitive up to 100 micro-amps with an output limited to 1000 micro-amps on most.</p>
<p>All test cables are Color coded. Designated colors for DC Hi-Pot Test Cables.</p>	<p>All one color, very confusing, no separate cables for Hi-Pot testing.</p>
<p>Foot Switch safety interlock <b>Standard</b> on all testers, hands free operation (since 1969).</p>	<p>Most have a foot switch as an option or your finger must stay on the button for the entire test .</p>
<p>Modularized for simplified maintenance which the operator can easily perform.</p>	<p>Are not modularized, service work must be performed by a factory technician.</p>
<p>PJ Surge Testers allow you to pick and choose (<i>practically custom build</i>) your tester with the features that you need. We have more models and voltage ranges from which to choose.</p>	<p>You pay for features that you may not need. There's only a <i>limited</i> selection of output voltage ranges and models from which to choose.</p>
<p>Portable models available in 6, 10, 12 and 15 KV output. Bench Models available in 6, 10, 12, 15 and 20KV output. Rugged industrial consoles with wheels... from 10KV to 60KV.</p>	<p>Most Impulse Testers are only built in Portable cabinets... not suitable for harsh, Industrial environments.</p>
<p>PRICE. All Digital PJ Surge Testers offer more features, versatility, accuracy and performance for several \$1,000's of dollars less than the inferior Impulse Testers!</p>	<p>Are not all Digital, cannot meet voltage risetime standards, have inferior unidirectional switch as the primary discharge, regulates at low inductances, cannot effectively stress turn-to-turn insulation and cost \$1,000's more than PJ Surge Testers.</p>

Now that you learned about the differences, it is very clear that our **PJ High Frequency Surge Testers** are **superior** over **Impulse Testers**.

*It is time to make a decision:*

Your company is in need of a Surge Tester. You have just invested your company's valuable time, large sums of money and hours of labor on your equipment, products or project. Now you owe it to yourself to use a Surge Tester that will give you a high degree of confidence... *confidence* that your products were accurately tested to the test specifications that were specified in the design. When it comes to checking turn-to-turn coil insulation for all applications, the only choice is a PJ High Frequency Surge Tester!

