

Variable Frequency AC Resonant Test Systems for On-Site GIS Testing

Testing Applications

Variable Frequency Resonant Test Systems are generally used where a lightweight, transportable unit is a requirement. Primary application is GIS / GIL testing. Other test objects which are capacitive in nature such as cables, generators, and motors may also be tested. Non-mobile systems for factory or laboratory use are also available.

- **Lightweight**, transportable, **easy to set-up**
- **HV section power to weight ratio up to 4 times**, compared to conventional fixed-frequency RTs
- **Pure sinusoidal** output voltage
- Complies with **IEC 60517**, **IEC 62271-203**, and **IEC's frequency range** of **45 to 300 Hz**
- Virtually **maintenance free**, no movable internal parts



Theory of Operation

A Variable Frequency Resonant Test System takes advantage of resonance theory. To achieve resonance, the capacitive reactance (test object) has to equal the inductive reactance (high voltage reactor). In a Variable Frequency Resonance System, the reactor is non-variable; therefore, the frequency of the circuit is adjusted until resonance is achieved. This adjustment of the resonant circuit is

commonly referred to as "tuning". Once resonance has been achieved only the resistive (real) losses in the circuit have to be supplied. The output voltage and the incoming power drawn from the mains is a function of the "Q" or quality factor of the circuit. The higher the system Q, the lower the incoming power requirement.



Cylinder Type Reactors

Phenix Technologies' reactors are constructed of an FRP (Fiberglass Reinforced Polymer) cylinder enclosing oil insulated reactor coils. One of the main features of cylinder type reactors is the capability to stack multiple reactors. When multiple reactors are connected in series (cascading), very high voltages can be achieved. The unique reactor coil design is manufactured of radially laminated magnetic cores enclosed by copper windings. The use of high quality materials results in a low loss, high Q reactor. This design provides a lightweight and transportable test system. Cylinder type reactors operate in series resonance mode.



Electronic Power Regulator

At the heart of the system is a specially designed electronic regulator that converts the mains service into a variable voltage, variable frequency power source that is ideally suited for use with a Variable Frequency Resonant Test System. The excellent resolution and frequency stability maintain a reliable, controllable resonant test circuit.

High Accuracy Measurement System

A high precision measuring system is designed to enable accurate measurements of voltages and currents. The metered information is displayed on the Human Machine Interface (HMI). The values displayed on the HMI are performed as a function of the Programmable Logic Controller (PLC).

Our systems function in compliance with IEC 60060, IEEE 4, and other recognized national and international industry testing standards.

Calibration Certificate traceable to NIST (National Institute of Standards and Technology, USA) is issued with every system. ISO17025 traceable voltmeter calibration is available as an option upon request.

High Voltage Protection

High voltage protection or dampening impedances are supplied to provide protection to the system when a test object breakdown or flashover occurs. Fast transients are blocked and shunted to ground without causing damage to the high voltage components.



Designed for Transportation and On-Site Testing

Testing of substation GIS / GIL requires a system that is easily transported and packaged for frequent movement. Transport covers, sturdy shipping boxes, and frames for all components of the Variable Frequency Resonant Test System can be supplied by Phenix Technologies.



Step	Voltage	Current	PD	Gas %	Dwell	Duration
0	0 kV	0 A			00:00:00	00:00:00
1	40 kV	0.3 A			27.8 00:00:15	00:00:03
2	49 kV	0.3 A			27.7 00:00:15	00:00:15
3	59 kV	0.36 A			27.7 00:00:15	00:00:28
4	69.5 kV	0.38 A			27.7 00:00:15	00:00:43
5	69 kV	0.43 A			27.7 00:00:15	00:00:00
6	69.3 kV	0.43 A			27.7 00:00:15	00:01:00
7	79 kV	0.49 A			27.7 00:00:15	00:01:11
8	89 kV	0.5 A			27.7 00:00:15	00:01:26
9	89 kV	0.55 A			27.8 00:00:15	00:01:38

Controls

Phenix Technologies uses the latest development in computer-assisted controls. Our configuration creates ease in set-up and simplicity in testing. The test system features a full-color, liquid crystal display and Ethernet port to select automation modes through a remote personal computer interface. The controls allow the operator to easily perform repeatable testing. All test data is collected by the data acquisition software and stored for later recall or test report generation.



Recipe Configuration:

- Recipe ID: Step
- Description: A step test

Step Test	Start	Unit	Min.	Max.
Start Voltage (kV)	50	Hr.		
Step Voltage (kV)	10	Min.		
Last Step	5	Sec.	15	10
Ramp Rate	20 %			

**Heaviest
Component
of VF RTS**

Model Number	Maximum Test Voltage kV	Current A	Frequency Range Hz	# of Modules in Series	Duty Cycle	HV Module Weight lbs/kg	*Load Capacitance Range nF	HV Section Height ft/m
VRTS8CC200-900-S	200	4.5	[45]..60-300	1	1 Hr ON / 23 Hr OFF	1750 / 795	[106] 2.3-59	7 / 2.1
VRTS8CC200-900-L	200	4.5	[45]..60-300	1	1 Hr ON / 4 Hr OFF	3200 / 1450	[106] 2.3-59	9 / 2.6
VRTS8CC250-750	250	3.0	[45]..60-300	1	1/2 Hr ON / 6 Hr OFF	1780 / 807	[56] 1.3-31	7 / 2.1
VRTS8CC250-1750-L	250	7	[45]..60-300	1	1 Hr ON / 4 Hr OFF	5500 / 2495	[132] 3-74	8 / 2.5
VRTS8CC400-1800-2S	400	4.5	[45]..60-300	2	1 Hr ON / 23 Hr OFF	1750 / 795	[53] 1.1-29	11 / 3.2
VRTS8CC400-1800-2L	400	4.5	[45]..60-300	2	1 Hr ON / 4 Hr OFF	3200 / 1450	[53] 1.1-29	14 / 4.2
VRTS8CC500-1500-2	500	3.0	[45]..60-300	2	1/2 Hr ON / 6 Hr OFF	1780 / 807	[28] 0.7-15	12 / 3.7
VRTS8CC500-3500-2L	500	7	[45]..60-300	2	1 Hr ON / 4 Hr OFF	5500 / 2495	[66] 1.5-37	23 / 6.6
VRTS8CC600-2700-3S	600	4.5	[45]..60-300	3	1 Hr ON / 23 Hr OFF	1750 / 795	[35] 0.8-20	14 / 4.3
VRTS8CC600-2700-3L	600	4.5	[45]..60-300	3	1 Hr ON / 4 Hr OFF	3200 / 1450	[35] 0.8-20	22 / 6.7
VRTS8CC750-2250-3	750	3.0	[45]..60-300	3	1/2 Hr ON / 6 Hr OFF	1780 / 807	[18] 0.4-10	17 / 5.1
VRTS8CC750-5250-3L	750	7	[45]..60-300	3	1 Hr ON / 4 Hr OFF	5500 / 2495	[44] 1-25	24 / 7.3
VRTS8CC800-3600-4S	800	4.5	[45]..60-300	4	1 Hr ON / 23 Hr OFF	1750 / 795	[26] 0.6-14	23 / 6.9
VRTS8CC800-3600-4L	800	4.5	[45]..60-300	4	1 Hr ON / 4 Hr OFF	3200 / 1450	[26] 0.6-14	27 / 8.2
VRTS8CC1000-3000-4	1000	3.0	[45]..60-300	4	1/2 Hr ON / 6 Hr OFF	1780 / 807	[14] 0.3-8	30 / 8.9
VRTS8CC1000-7000-4L	1000	7	[45]..60-300	4	1 Hr ON / 4 Hr OFF	5500 / 2495	[25] 0.75-18	32 / 9.8

*Load Capacitance Range indicated is at maximum output voltage and Load Capacitance shown in brackets [] indicates frequency/reduced voltage operation.

Operator Training/Worldwide Service and Support

Commissioning and training are available to provide your operator with the information and resources they need for efficient and safe use of the test system. Long-term customer support is provided from our fully experienced and knowledgeable staff. Future periodic calibration of the metering is easily accomplished by one of our PHENIX service technicians keeping your system at top performance for many years.



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