



## PAR SERIES AC Dielectrist Testers

Using Parallel Resonant Technology

*Test High Capacitance Loads with less Power - Current - Cost*

### Product Line Overview

The PAR Series models are high voltage AC Dielectric Test Sets used for testing many types of utility substation apparatus, aerial lifts, cables, and other loads requiring AC voltage to perform Withstand/Proof testing and Diagnostic testing: Partial Discharge and Tan Delta/Power Factor testing. This model line provides a high power and high voltage AC output like conventional 50/60 Hz. test sets. However, the PAR Series is of unique design intended to test highly capacitive apparatus and cables. Its design tests these loads while minimizing the input power, size, weight, and cost of the supply. The PAR Series uses Resonant Technology, specifically: Variable Inductance Parallel Resonance.

### Technology Overview

Resonance Technology is used to AC test highly capacitive electrical apparatus or power cable using 50/60 Hz. power frequency. The charging currents of these capacitive loads are typically very high, requiring AC hipots to be rated for hundreds of kVA in power. Resonant technology uses basic and long proven electrical principles for its design and operation to reduce the levels of power consumption needed, permitting high voltage AC testing to be performed more economically than otherwise possible. Using the PAR Series, the input current required of the supply is typically 10x – 30x less than if conventional fixed inductance power supplies were used. The HV transformer, or reactor, design includes a variably adjustable air gapped steel core to alter the Inductance of the system to compensate for the Capacitance of the load tested. The intention is to create a controlled resonance situation where  $L = C$ , leaving only the resistive elements of the load needing current/power from the test set.

### Models & Specifications

The model ratings offered by HVI are designed to be optimal for factory or field testing motors and generators as well as substation apparatus like switchgear, bus ducts, arrestors or bushings, and shorter MV cable lengths. Other sizes are available on a custom basis. (HVI produces only Parallel Resonant, no Series)

Model	Output				Input				
	Voltage	Voltage	kVA	Amps	Voltage		kVA	Amps	Freq.
PAR-1680FC5	0 - 16 kVac	@	80 kVA	5 A	230 V	@	10 kVA	45 A	50/60 Hz.
PAR-32/16160FC5	0 - 32 kVac	@	160 kVA	5 A	230 V	@	20 kVA	90 A	50/60 Hz.
	0 - 16 kVac	@	160 kVA	10 A	230 V	@	20 kVA	90 A	50/60 Hz.
PAR-32250FC5	0 - 32 kVac	@	250 kVA	8 A	230 V	@	20 kVA	90 A	50/60 Hz.
PAR-50250FC5	0 - 50 kVac	@	250 kVA	5 A	230 V	@	20 kVA	90 A	50/60 Hz.
PAR-100100FC5	0 - 100 kVac	@	100 kVA	1 A	230 V	@	10 kVA	45 A	50/60 Hz.

See individual model brochures or visit [hvinc.com](http://hvinc.com) for more details.

## Variable Inductance Resonant Technology

is for high voltage testing Generation, Transmission, and Distribution Assets of high capacitance



### Model PAR-50250

Output: 0 - 50 kVac @ 5A, 250 kVA  
Input: 230 V 100 A, 1 Ph, 50/60 Hz  
Controls via Programmable PLC  
HV Output is 50' shielded cable



HVI offers a dual mode controller design. A Programmable Logic Controller is provided to permit the user to program all the operational test automation and data logging necessary, as well as offering a Manual mode of operation.

### System Features

PLC Controller supplied  
Auto/Manual Output Mode selection  
Continuously adjustable motorized output voltage  
Programmable output Rate of Rise: 500 – 5000 volts/second  
Fixed primary current overload, factory set to 120% of current  
Adjustable secondary current overload: 10-110% of rating.  
“Zero Start” and External Interlock provision.  
Secondary connected volt and current meters

### Controls: Manual of Automatic via Programmable Logic Controller

HVI offers a dual mode controller design. The PLC supplied can be user programmed to fully automate repetitive testing in automatic mode or perform simple hipot tests in manual mode. Test profiles for automatic mode can be preset at the factory or can be entered via the front panel touch screen control or a remote PC. Operation is easily modified using Ladder Logic Programming.

### Features Include

Automatic or Manual Mode  
320 x 240 large color touch display  
Output voltage/current graphically display  
Complete graphical display at test end  
Test report generation  
Save and recall test profiles

### User Setting Parameters

Automatic or Manual mode  
Voltage set point  
Over current set point  
Test Dwell Time  
Voltage Rate of Rise (10-100 sec.)

### Other AC Dielectric Test Sets

HVI Offers several model lines of AC high voltage test sets. Each is designed to be best suited for certain applications, usually designated by the current or kVA needed based on the capacitance of the load tested.

- PFT Series: Portable hipots for field use. 10 kVac - 100 kVac, 1 kVA – 3 kVA.
- FPA Series: Field portable hipots: 5 kVac - 50 kVac, 3 kVA – 20 kVA
- HPA Series: For factory and field use: 3 kVac – 400 kVac, up to 40 kVA
- PAR Series: For high capacitance loads: 16 kVac – 100 kVac, 80 kVA – 250 kVA
- VLF Series: 0.1 Hz. AC Very Low Frequency hipots, 30 kVac – 200 kVac, up to 50 uF

### Selecting an AC Test Set kVA Rating

The voltage rating of the instrument needed is know by the test specification or standard followed. The current rating required must be determined. Based on the capacitance of the load, use the following formula to calculate the load current:

Amps =  $wCV$ , or,  $A = 2\pi fCV$ ,  $w$  (omega) =  $2\pi f$   
f = frequency (Hz.) C = load capacitance (farads) V = test voltage (volts)

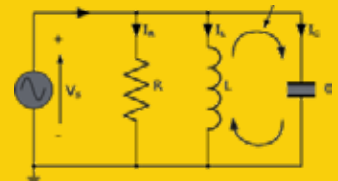
### Parallel RLC Resonant Circuit

In Parallel Resonant circuits, resonance occurs when the Inductive Reactance (XL) of the variable inductor resonant set is “tuned” to match the Capacitive Reactance (XC) of the load, in effect canceling out the capacitive nature of the load leaving only the resistive elements. The total circuit current is then “in-phase” with the supply voltage as the two equal and opposite reactive components cancel each other out.

$$\text{Resistance} = R \quad X_L = wL \quad X_C = 1/wC$$

$$w = 2\pi f \text{ (f = frequency)}$$

$$w \text{ for } 50 \text{ Hz.} = 314 \text{ w for } 60 \text{ Hz.} = 377$$



### Quality Factor “Q”

The Quality “Q” Factor is a measure of the level of power input reduction to the test set to deliver the power needed for a test.

The Q, or quality, factor of a resonant circuit is a measure of the purity, or quality, of a resonant circuit. Q is the ratio of power stored (reactance) to power dissipated (resistance).

$$Q = P_{\text{stored}} / P_{\text{dissipated}} = I^2 X / I^2 R = X/R$$

where X = Capacitive or Inductive reactance.

In a parallel resonant circuit, the power, or kVA, across the load is approximately Q times the total system input power. For example:

1. A circuit with a Q of 20 would draw 1 kVA of input power from the mains for approximately 20 kVA of reactive power across the load.
2. A parallel resonant set, rated for 50 kVac @ 5 A output, tuned to the capacitive reactance of a bus duct or switchgear could deliver 250 kVA of apparent power to the load while drawing less than 10 kVA of power from the utility mains.
3. A generator stator winding, with a typical Q of 10, would draw less than 11 kVA from the mains while 100 kVA of reactive power is applied to the coils.