PAR Series - AC Dielectric 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 Voltage	kVA	Amps	INPUT 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 @	20 kVA	90A	50/60 Hz.

SIZE & WEIGHTS (approximate)

10 KVA Input Models
Controller:	21"w x 25.5"d x 31"h,	210 lbs.	53w x 65d x 79h cm,	95 kg
HV Tank:	28"w x 28"d x 37"h,	800 lbs.	71w x 71d x 94h cm,	364 kg

20 KVA Input Models
Controller:	22"w x 25.5"d x 47.5"h,	310 lbs.	56w x 65d x 121h cm,	141 kg
HV Tank:	30"w x 30"d x 52"h,	1100 lbs.	76w x 76d x 132h cm,	499 kg

** See individual model brochures for details.

Resonant Operation

If the capacitive nature of the load can be compensated for by inserting an equivalent inductance in series or parallel, then the input power and current required to the supply is greatly reduced. By "tuning" the inductance of the test set to match the capacitance of the load, a controlled Resonance is achieved. High voltage can be applied with far less current and power from the test set and power source than otherwise possible.

For more technical details explaining resonance technology, please contact HVI at: **sales@hvinc.com**

Parallel RLC Resonant Circuit

In Parallel Resonant circuits, resonance occurs when the Inductive Reactance (X_L) of the variable inductor resonant set is "tuned" to match the Capacitive Reactance (X_C) 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.

Resistance = R, $X_L = \omega L$, $X_C = 1/\omega C$
$\omega = 2\pi f$ (f = frequency)
ω for 50 Hz. = 314 ω for 60 Hz. = 377
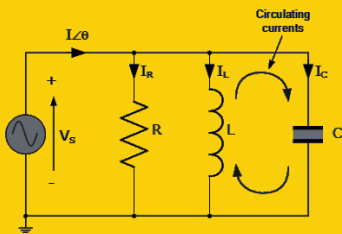
Quality Factor "Q"

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).

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

PAR Series - AC Dielectric Testers

Controls: Manual or Automatic via Programmable Logic Controller

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 or 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 Settable 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:

$$Amps = \omega C V, \ \text{or}, \ A = 2\pi f C V, \quad \omega \ (omega) = 2\pi f$$

f = frequency (Hz.)   C = load capacitance (farads)   V = test voltage (volts)