

Variable Frequency Resonance System for Power Cable On-site Testing

IEC840,
IEC60840/FDIS,
IEC62067.CD

HFRS-T 51600/2x150

(300kV 172A)

(Tank Type)

Himalayal Corporation Limited



Operating Conditions:**Outdoor use**

Altitude $\leq 1000\text{m}$

Ambient Temperature: $-10^{\circ}\text{C} \sim +50^{\circ}\text{C}$

Max. Daily Temp. Difference $\leq 25^{\circ}\text{C}$

Relative Humidity: $\leq 95\%$ (at 20°C)

Anti Earthquake: \leq Class 8

Geoclimatic Horizontal Acceleration: 3.0m/s^2

Geoclimatic Vertical Acceleration: 1.5m/s^2

Waveform of power supply voltage is sine actually, and the waveform distortion rate is $< 3\%$

Set a reliable earthing section, and its earthing resistance is $< 0.5\ \text{ohm}$

Object parameter calculation
Maximum load of the object cable

Object capacitance (uF)	Test Volt. (kV)	Resonant frequency(Hz)	Resonant current(A)	Resonant inductance (H)
3.75+0.003uFdivider	260	28	171.9	8.6H, two reactors serial connection
4.6+0.003uF divider	216	25.3	158.1	8.6H, two reactors serial connection
4.8+0.006uF divider	132	35	139.7	4.3H, use single reactor
4.8+0.006uF divider	128	35	135.4	4.3H, use single reactor
5.4+0.006uF divider	128	33	143.6	4.3H, use single reactor
4.2+0.006uF divider	80	37.5	79	4.3H, use single reactor

Minimum load of the object cable

Object capacitance (uF)	Test Volt. (kV)	Resonant Frequency(Hz)	Resonant current(A)	Resonant inductance (H)
0.07+0.003uF divider	260	201	24	8.6H, two reactors serial connection
0.045+0.003uF divider	216	247.8	16.1	8.6H, two reactors serial connection
0.045+0.006uF divider	132	340	14.4	4.3H, use single reactor
0.039+0.006uF divider	128	362	13.1	4.3H, use single reactor
0.042+0.006uF divider	128	350.5	13.5	4.3H, use single reactor
0.051+0.006 divider	80	321.6	9.2	4.3H, use single reactor

System Configuration:

No.	Mode	Name	Qty.
1	HFC-750kW	Variable Frequency Power Source (Square wave)	1set
2	YD-750/1.75,2.5, 3.6,4.2	Exciter transformer	1set
3	HFRS-T 25800kVA/150kV	Tank Type Resonant Reactor	2 sets
4	HVF 3000/300	Capacitance Voltage Divider	1set
5	HCC 300-0.02	Compensation capacitor (Use when non-load test)	1set
6	HDR 300-0.01	Current Limiting Resistor	1set

Specification

No.	Name	Mode and specification	Qty
1	Measuring cable and optical cable	/	1set
2	HV bushing	150kV/300A	1set
3	Divider pedestal and compensation capacitor pedestal	/	2sets
4	Divider top electrode and compensation	300kV,150kV Corona ring	2sets

	capacitor top electrode		
5	Divider, Reactor top electrode	300kV	2 sets
6	Variable frequency cabinet lead-in cable	150mm ² x30m	3pcs
7	Variable frequency cabinet lead-out cable	300mm ² x10m	2pcs
		divider packing case	1set
8	Packing case	compensation capacitor packing case	1set
		Cable packing case	1set
9	HV lead wire	Flexible metal syphon bellows (each section striction length: 1meter, Extend to 10 meter), diameterφ100mm, each section has two connector.	1set

Main Equipment Data:**System configuration performance index**

Rated input voltage: 380V ± 10% (three phase); 60Hz

Rated output capacitance: 51800kVA

Variable frequency power source output capacity: 750kW

Rated voltage: 300kV

Rated current: 172A

Single phase

Frequency adjust range: 20-400Hz

Frequency adjust sensitivity: ≤0.1Hz

Frequency instability: ≤0.05%

Resonant voltage waveform is sin wave, waveform deviation ≤1%

Test voltage stability ≤1%

Insulation level: 120% rated voltage, withstand 1 minutes

Sound level: 65dB

Working time: one hour on, one hour off under rated output capacitance, not surpass 3 cycles every day.

Short-circuit resistance ability: under rated capacitance, when reactor output terminal discharge to test object, discharge last 5 cycles, no damage to frequency converter winding.

Quality factor: Q>65 ~120

System performance:

Equip with big LCD displayer, indicate: variable frequency power source output voltage & current; HV test voltage, current; resonant frequency; count down time; over-voltage setting; error info, and so on.

Parameter setting function on test voltage, time, auto/manual test methods selection.

Other requirement:

No leakage phenomenon.

All metal shell are rust-proof and antiseptis treated; main component has stainless nameplate; variable frequency power source, reactor and divider are equipped with dust and rain cover, power control cabinet equips with special shockproof aluminum alloy case.

The system can be stored, equipped and unload **indoor or outdoor**, special treated for hiking up.

Protection function is excellent: we make sure the system control device, exciter transformer and HV reactors will not cause damage to the operating staff and system itself when HV side flashover to the ground under 110% rated voltage.

System component parameter**Variable frequency power source (Square wave)**

Item	Qty.	Description
1	1	Mode: HFC-750kW Rated input voltage: 380V±15% (three phase); 60Hz Rated output power: 750kW

Rated output voltage: single phase, 0-500V continuous adjustable

Rated output current: 1500A

Output waveform: square wave

Output voltage instability: $\leq 1.0\%$

Output voltage stability: $UN \pm 1\%$

Output voltage frequency stability: $f_0 \pm 0.01\%$

Frequency adjusting range: 20Hz~400Hz

Frequency adjusting sensitivity: $\leq 0.1\text{Hz}$, output frequency instability $\leq 0.05\%$

Insulation level: input, output terminal to ground $\geq 2\text{kV/AC/1min}$

Cooling type: forced air cooling

Sound level $\leq 75\text{dB}$

Temperature raise: bridge arm temperature raise $< 40\text{K}$, electric circuit temperature $< 40\text{K}$, main circuit hottest point $< 50\text{K}$;

Working time: continuous working 180min under rated output capacitance;

Frequency adjusts within setting range, voltage output stable.

Variable frequency power source and control cabinet, voltage divider and control cabinet are connected by optical cable, making sure no damage to control cabinet when test object breakdown.

Main body is separated from control, display, protection parts. Main body and protection are in one. Display is in one (separate). Control and display are portable.

Variable frequency power source has the ability of anti anti-electromagnetic interference. Under high field interference, Its measuring accuracy and control protection can meet requirement. It equips with excellent magnetic shielding component. All lead wire are made of high permeability magnetic alloy, no space radiation.



Variable frequency power source**Variable frequency power source control cabinet:**

Item	Qty.	Description
2	1	Equips starting, stop and emergency switch - off button; Equips raise voltage and reduce voltage rough adjustment and fine control button(voltage raise and down speed are settable); Equips frequency rough adjustment and fine control button (Adjusting speed is settable); Cooling fan direction automatically selection; Automatic and manual test selection (Auto tune, automatic raise and reduce voltage); Equip test methods auto selection function, automatic test methods: setting test voltage, test time, auto tune --- auto raise voltage --- auto constant voltage and timing --- auto reduce voltage. Manual test methods also has the selection of auto tune and auto timing; Equips output voltage, over-voltage protection and over-current protection setting value adjusting function; Equips testing time setting function, time setting range: 0-99min, timing accuracy ± 0.1 second, end of setting time has sound reminding.

Variable frequency power source control cabinet display function:

Bridge arm voltage display;

Variable frequency power source input voltage, current, phase position display;

Variable frequency power source output voltage, current, frequency voltage, phase position and output waveform display;

Gateway wind temperature display;

All kinds of protection actions display;



Control panel



Control panel (All panel will be in English) (Cooperate with SIEMENS)

Exciter transformer

Item	Qty.	Description
3	1	<p>Mode: YD-750/1.75, 2.5, 3.6, 4.2</p> <p>Rated frequency: 25Hz</p> <p>Working frequency: 25~400Hz</p> <p>Rated capacitance: 750kVA</p> <p>HV winding is independent winding:</p> <p>HV winding voltage: 1.75kV, 2.5kV, 3.6kV, 4.2kV</p> <p>HV winding current: 178.5A</p> <p>LV winding voltage: 2x450V, 2x500, 2x550V</p> <p>LV winding current: 2x750A</p> <p>Cooling methods: ONAN</p> <p>Heat-resistance: A grade, 25# transformer oil</p> <p>Working time: continuous working 60 min under rated output capacitance, winding≤65K, oil surface ≤ 55K;</p> <p>Sound level: 60dB</p> <p>Impedance level: ≤5%</p> <p>Insulation level: LV winding 3kV/1mn; HV winding 110% rated voltage withstand 60s.</p> <p>Structure requirement: oil immersed shell type; silicon steel plate is DQ130-30 high quality cooling rolling silicon steel plate, Bm value very low; Transformer has double coils, cooper lead wire, Low voltage winding and HV winding, adopt electrostatic shielding between two windings which has the function of isolation filter; equips measuring coil, used to measure HV side voltage; there are oil expansion tank and moister absorber on transformer; Oil temperature thermograph and oil level indicator are set on oil expansion tank; Transformer's spare part and component, e.g. bushing, valve and oil conservator's structure and layout will not affect the transportation. There are also enough safety distance between transformer HV and LV winding, will not cause partial discharge and corona when testing.</p>


Tank Type Resonant Reactor

Item	Qty.	Description
4	2	Reactor parameter: Mode: HFRS-T 25800/150 Single Module Rated voltage: 150kV Rated current: 172A Rated capacitance: 25800kVA Rated inductance: 4.3H±1% Error: <1% Insulation level: withstand 60s under 110% rated voltage Rated frequency: 25-400Hz Quality factor: Q>65~120 Working time: one hour one, one hour off, under rated output capacitance, not surpass 3cycles every day. Temperature raise: winding≤80K, transformer oil≤55K; Surface of epoxy tube temperature raise ≤40K

Two Reactors serial connection parameter:

Item	Qty.	Description
5	1	Mode: HFRS-T 51600/300 Two reactors serial connection Rated voltage: 300kV Rated current: 172A Rated capacitance: 51600kVA Rated inductance: 8.6H±1% Error: <1% Insulation level: withstand 60s under 110% rated voltage Rated frequency: 25-400Hz

Quality factor: $Q > 65 \sim 120$

Working time: one hour on, one hour off, under rated output capacitance, not surpass 3 cycles every day. Temperature raise: winding $\leq 80K$, transformer oil $\leq 55K$; Surface of epoxy tube temperature raise $\leq 40K$

Structure requirement:

There are two reactors, one reactor is supported by insulation support, which can withstand 150kV high voltage and equips necessary corona electrodes, to use when serial connection.

The system adopts iron coil subsection air gap and copper winding structure, reactor adopts copper lead-wire winding, oil immerse self-cooling, oil tank is iron shell structure to increase the system heat dissipation capability, and equips with breathe capsule for transformer oil expanding when testing. Reactor equips reliable hook for suspending.

The inner structure of the reactor is special designed for long distance railway, highway transportation. The system suitable for on-site testing.

Reactor has nameplate for single unit and serial connection: the parameter on nameplate are: Rated voltage, inductance, working frequency, weight, and so on.

Compared with Epoxy tube type structure, the Metal tank structure has better function on heat dissipation. And Tank structure has better performance on on-site testing.

Capacitive Voltage Divider

Item	Qty.	Description
6	1	<p>Mode: HVF 3000/300</p> <p>Single phase</p> <p>Rated Voltage: 300kV</p> <p>Frequency: 25~400Hz</p> <p>Rated capacity: 3000pF (Two stages)</p> <p>Single stage capacitance: 6000pF (Use for object up to 150kV)</p> <p>Two stage serial connection capacitance: 3000pF (For object voltage between 150kV and 300kV)</p> <p>Nominal dividing ratio: 6000:1</p> <p>Voltage ratio error: $\leq 1\%$ (effective value)</p> <p>Insulation level: withstand 60s under 110% rated voltage</p> <p>Dielectric Loss $< 0.5\%$</p> <p>Cooling: ONAN</p> <p>Measuring accuracy: $\leq \pm 1.5\%$</p> <p>Working time: one hour on, one hour off, under rated output capacitance</p> <p>Corona ring: aluminum alloy material, convenient for packing and transportation.</p> <p>Pedestal: has enough stability, removable; voltage is measured via special measuring lead-wire to variable frequency power source; can measure single stage and two stage serial connection voltage; HV connection adopts HV corona-free connection, scalable.</p>

Compensation capacitor (Use when non-load testing)

Item	Qty.	Description
7	1	Mode: HCC300-0.02 Single phase Rated Voltage: 300kV Frequency: 25~400Hz Rated capacity: 20000pF (Two stages) Single stage capacitance: 40000pF Two stage serial connection capacitance: 20000pF Nominal dividing ratio: 6000:1 Voltage ratio error: ≤1% (effective value) Insulation level: withstand 60s under 110% rated voltage Dielectric Loss <0.5% Cooling: ONAN Measuring accuracy: ≤±1.5% Working time: one hour on, one hour off, under rated output capacitance Corona ring: aluminum alloy material, convenient for packing and transportation.

HV Bushing

Item	Qty.	Description
8	1	Mode: GY150-300 Single phase Rated frequency: 25-400Hz Rated voltage: 150kV Rated current: 300A Working time: one hour on, one hour off, under rated output capacitance

Current Limiting Resistor

Item	Qty.	Description
9	1	Mode: HDR300-0.01 Single phase Rated frequency: 25-400Hz Rated voltage: 300kV Rated current: 172A Rated inductance: 10mH Working time: one hour on, one hour off, under rated output capacitance

Delivery and Final Test Items**Complete sets of equipment shall be carried out following the factory test and final acceptance:**

The following items, unless noted, the factory test and final acceptance shall be done, and its standards in accordance with the relevant professional standards and the implementation of the agreement. the factory test and final acceptance results should be no substantive difference.

Test items:**Variable frequency power source**

Item	Qty.	Description
1	1	Test items: (1) Continuous working 60min under full load, and measure below items Measure input, output voltage and current Measure input, output power and efficiency Measure wind cooling inlet and outlet wind temperature Measure frequency adjusting range Inspect each high current connect point heating state (2) Over-voltage setting test (3) Breakdown protection test (4) Emergency shutdown test (5) Auto tune and auto raise voltage test (6) Variable frequency power source outlet short-circuit test: the variable frequency power source fast protection device should act reliable when variable frequency power source bear full load and short-circuit variable frequency power source output end with insulation rod. Repeat the test three times, no abnormal phenomenon.

Exciter transformer

Item	Qty.	Description
2	1	Test items: (1) Measuring winding DC resistance and insulation resistance test (2) Measure voltage ratio (3) Impedance test (4) Withstand test

Serial Resonant Reactor (Tank type)

Item	Qty.	Description
3	1	Test items: (1) Winding resistance measurement (2) Withstand test (3) Inductance measurement

Capacitance voltage divider, Compensation Capacitor

Item	Qty.	Description
4	1	Test items: (1) Measure dielectric loss angle (2) Capacitance measurement, compared with designed value, not surpass $\pm 1\%$ (3) Withstand test (4) Voltage ratio inspection

Current Limiting Resistor

Item	Qty.	Description
5	1	Test items: (1) Appearance inspection (2) Inductance measurement, compared with designed value, not surpass $\pm 1\%$ (3) Withstand test

On-site test:

Do every test you wanna do on power cable after the system successful installed, inspect the whole system's quality on-site.