



# Genvolt

High Voltage Power Supplies



## ESP03

High Frequency, High Voltage Power Supply



## Product Brochure

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## ESP03 – High Frequency, High Voltage Power Supply



### Summary

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The ESP03 is a new type of high voltage power supply for electrostatic precipitators developed by Genvolt, this high frequency, high voltage power supply is an upgraded product of the traditional SCR working frequency power supply, this product has achieved a qualitative change, thus showing a revolutionary significance in energy saving and efficiency increasing.

When compared with the traditional SCR working frequency power supply, the ESP03 has many outstanding advantages, including: great improvement of dust collection efficiency, small output DC voltage ripple, high average voltage, small size, light weight, integrated structure, high conversion efficiency and power factor, balanced three-phase supply and slight influence on power grid, etc.

The major switching devices of this high frequency and high voltage power supply integrate the most reliable components and are designed with full digital control. With a variety of communication methods, the centralized management and control can be realized.



## Features:

▲ **Better Energy-saving Effect:** With the high power conversion efficiency, this product has a smaller input power than that of the conventional power supply under the same power required by the electric field, thus realizing the energy-saving effect. Besides, this product can greatly reduce the power of the electric field while ensuring the full charge of dust with better charging strength.

▲ **Balanced Three-phase Supply:** Designed in three-phase input, this product can realize a balanced three-phase supply. Moreover, it has a high power factor without grid pollution.

▲ **Enhanced Corona Power:** The tiny output voltage ripple can greatly enhance the corona power and improve the charging capacity and driving velocity of the dust, thus enhancing the efficiency of dust collection. What's more, the enhancement in corona power will cause the increase in corona current, as a result of which the charging probability of the dust will be improved to further enhance the efficiency of dust collection. Therefore, this product is particularly suitable for the contexts with a high concentration of dust.

▲ **Better Power Adaptation:** This product has a better power adaptation compared with the working frequency power supply. Its output is composed of a series of high-frequency impulses, so this product can provide the most suitable voltage waveform according to the operating condition of electrostatic precipitators. For the pulse energization, the width of supply pulse (duty ratio) can be adjusted. That is to say, this product has a more flexible duty ratio combination, so that the phenomenon of back corona can be controlled effectively. It is particularly suitable for the operating contexts with high specific resistance dust.

▲ **Better Spark Control:** The spark of this product can be shut off quickly. Both the small spark energy and the fast-recovered electric field contribute to the improvement of electric field's average voltage, thus enhancing the efficiency of dust collection.

▲ **Perfect Protective Function:** This product is equipped with many protective functions to ensure the safe and reliable operation, including the protections of input over-current, IGBT over-current, open circuit output, short circuit output, low DC bus voltage, IGBT and transformer oil, high tank pressure and low oil level.

▲ **Convenient Debug Interface:** Installed on the top of precipitators, this product has a LCD touch human-computer interface, allowing the user to turn it on/off, set the parameter and examining various operating parameters in-place. Thus equipment debugging can be realized conveniently.

▲ **Standard Communication:** The MODBUS protocol is applied to communicate with the host system, thus realizing the remote management and system integration.

▲ **More Convenient Installation:** This product has a smaller size and lighter weight because of the integrated structure. Directly installed on the top of precipitators, not only the space in the switching room and most signal cables and controlling cables, but also the installation fees can be saved. The positions of the high voltage outlet and the wheel are just the same with that of the working frequency rectifier transformer, which is suitable for the modification of power supply.



## Technical Specification

### Input and Output parameters

Serial No.	Installed Capacity	AC Input Voltage	AC Input Current	DC Output Voltage	DC Output Current	AC Input Power	DC Output Power
		(V)	(A)	(KV)	(A)	(kVA)	(kW)
1	0.2A/72kV	380	24	72	0.2	15	14.4
2	0.4A/72kV	380	47	72	0.4	31	28.8
3	0.6A/72kV	380	71	72	0.6	46	43.2
4	0.8A/72kV	380	94	72	0.8	62	57.6
5	1.0A/72kV	380	118	72	1	77	72
6	1.2A/72kV	380	141	72	1.2	93	86.4
7	1.4A/72kV	380	165	72	1.4	108	100.8
8	1.6A/72kV	380	188	72	1.6	124	115.2
9	1.8A/72kV	380	212	72	1.8	139	129.6
10	2.0A/72kV	380	235	72	2	155	144
11	2.2A/72kV	380	259	72	2.2	170	158.4
12	2.4A/72kV	380	282	72	2.4	186	172.8
13	0.2A/80kV	380	26	80	0.2	17	16
14	0.4A/80kV	380	52	80	0.4	34	32
15	0.6A/80kV	380	78	80	0.6	52	48
16	0.8A/80kV	380	104	80	0.8	69	64
17	1.0A/80kV	380	131	80	1	86	80
18	1.2A/80kV	380	157	80	1.2	103	96
19	1.4A/80kV	380	183	80	1.4	120	112
20	1.6A/80kV	380	209	80	1.6	138	128
21	1.8A/80kV	380	235	80	1.8	155	144
22	2.0A/80kV	380	261	80	2	172	160
23	2.2A/80kV	380	287	80	2.2	189	176
24	2.4A/80kV	380	313	80	2.4	206	192

Figure 1: Input / Output Parameter List of High Frequency and High Voltage Power Supply for Electrostatic Precipitators



## Technical Specification

### Service Conditions

1. The environment temperature shall be -20 - 40°C.
2. The gas around the equipment shall be without conductive dust; the gas insulating materials or the gas corroding the metal and steam are not permitted around the equipment.
3. The alternating voltage shall meet the following stipulations: the waveform shall be the sine wave; the frequency shall be 50Hz; the wave range cannot exceed 2%.
4. This product cannot be placed in explosive environment and cannot be sharply shocked or impacted. The vertical inclination cannot exceed 5%.
5. The ground wire of this product is the braided bare copper wire whose section is equal to or more than  $25\text{mm}^2$  ( $\geq 25\text{mm}^2$ ) or the galvanized band iron (3mm×30mm). The ground resistance is under  $2\Omega$  ( $< 2\Omega$ ). So it can be connected to the ground securely.

### Display of Operating and Setting Parameters

This equipment can display the operating and setting parameters below:

- ▲ Input primary voltage
- ▲ Input primary current and rated value
- ▲ Operating and setting values of secondary voltage
- ▲ Operating and setting values of secondary current
- ▲ Operating and setting values of transformer oil's temperature
- ▲ Operating and setting values of IGBT case's temperature
- ▲ Operating and setting values of flash-over frequency
- ▲ Setting value of power-on time for pulse energization
- ▲ Setting value of power cycle for pulse energization
- ▲ Setting value of operation mode

### Protective and Warning Functions

This equipment possesses the following protective and warning functions:

- ▲ Open circuit output protection
- ▲ Short circuit output protection
- ▲ Low DC bus voltage protective alarm
- ▲ Over-current protective alarm for Input primary current
- ▲ Pre-alarm for excessive transformer oil temperature
- ▲ Protective alarm for excessive transformer oil temperature
- ▲ Protective alarm for excessive IGBT case temperature
- ▲ Protective alarm for excessive IGBT temperature
- ▲ Over-current protective alarm for IGBT
- ▲ Protective alarm for high transformer tank pressure
- ▲ Protective alarm for low transformer oil level



## Installation

### Unpacking

- ▲ After being unpacked, please check whether the parts, accessories, spare parts and technical documents are complete.
- ▲ Please check whether the equipment is in good condition after transportation, and please check whether the fasteners or other components are loose. The abnormal phenomena shall be timely dealt with. For the damage which cannot be repaired, please directly contact our company.
- ▲ Please check whether the transformer tank and porcelain insulator are damaged or leaked.

### Installation

- ▲ After checking, this equipment can be installed on the rail or channel steel. If such equipment is installed in the open air, it is suggested to set up a simple roof over it to avoid being exposed to the sun and rain.
- ▲ The connection shall be based on the drawing. And it shall be noted that the wire with suitable section shall be selected as the incoming power line according to the rated current.
- ▲ The damping resistance shall be tightly and reliably installed on the wall bushing.
- ▲ The ground terminal and the body shall be reliably grounded.

### Debugging

Please debug the equipment according to the following steps after installation:

1. Ensure a correct connection according to the connection diagram.
  2. Power on the current to the high frequency and high voltage power supply under the condition of disconnected main circuit. Switch on the circuit breaker to make the control circuit normal charged.
  3. Check the screen of the human-computer interface to ensure a normal display.
  4. Under the premise that nobody is in the electrostatic precipitator and in the case of safety, the electric field can be added to the high frequency and high voltage power supply.
  5. Switch on the main circuit, and press the start key on the screen of the human-computer interface. Then the operating status will be displayed. The user can observe the changes of the primary current, secondary voltage and secondary current on the screen.
  6. Debug the communication control with the upper computer after successfully debugging the screen of the human-computer interface. The specific operation of the upper computer shall refer to **Operating Instruction for Upper Computer**.
  7. If all the items that mentioned above are normal, the operation of this high frequency and high voltage power supply shall be done through the upper computer in general.
- Note: the specific operation of the screen of the human-computer interface shall refer to **Operating Instruction for Human-computer Interface Screen**.



## Use:

After the debugging, the user can turn on/off the equipment through the upper computer (do not conduct such operation through the high frequency and high voltage power supply as much as possible), and observe the operating parameters on the high frequency and high voltage power supply.

### Turning-on

1. Switch on the high frequency and high voltage power supply at switching room.
2. Turn on the high frequency and high voltage power supply through the upper computer.

### Turning-off

1. Turn off the high frequency and high voltage power supply through the upper computer.
2. Power off the high frequency and high voltage power supply at the switching room.

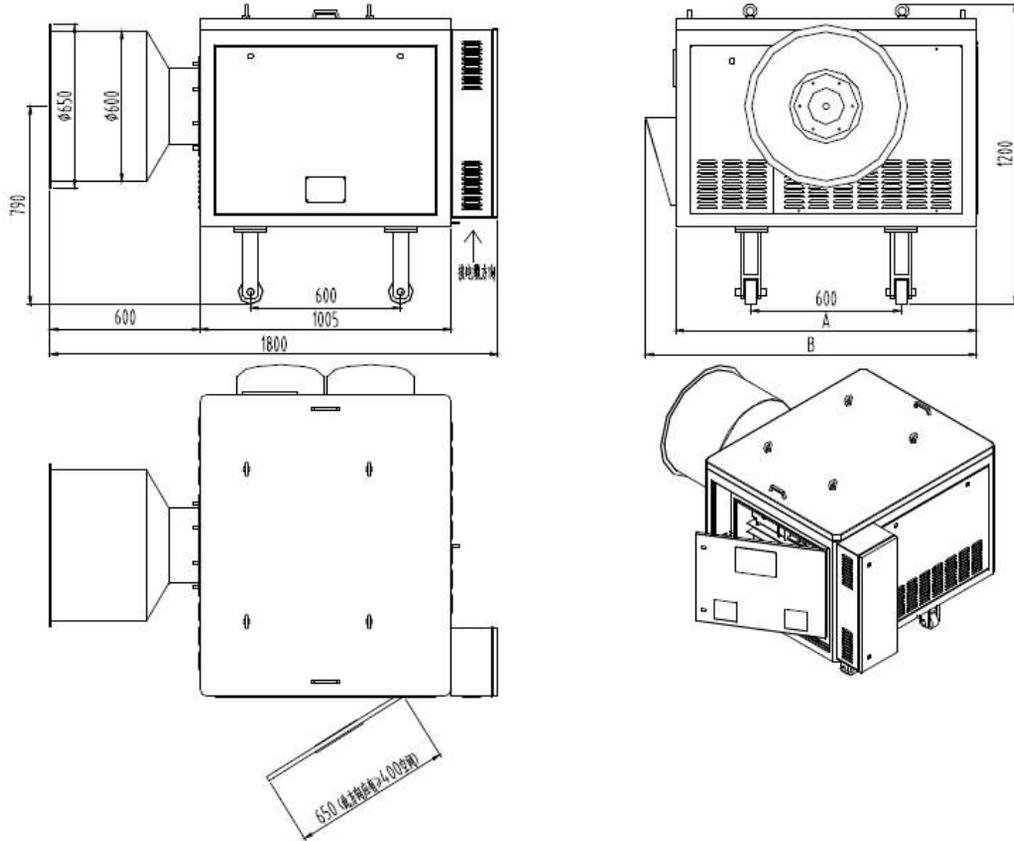
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## Care and Maintenance

1. Regularly check whether there is an oil leakage on the high frequency power supply.
2. Regularly clean the inlet air net to keep an unblocked airflow.
3. Regularly check whether the high frequency power supply has an abnormal noise during the operation and whether there is an abnormal discharging at the high voltage terminal.
4. For each overhaul or minor repair, please wipe the high-voltage porcelain through insulator and the body to keep the surface clean.
5. For each overhaul or minor repair, please check the contact of the power cable
6. For each overhaul or minor repair, please remove the upper cover and side plate of the enclosure to clean the dust. The oil cooler shall be particularly blown with the blower.
7. For each overhaul or minor repair, please measure and ensure that the ground resistance connected to the high-frequency electric source is equal to or less than  $2\Omega$  ( $\leq 2\Omega$ ).
8. For each overhaul or minor repair, please check whether there is an abnormal phenomenon in the control cabinet and IGBT inverter, after which the door of the control cabinet and IGBT inverter shall be well closed.
9. For each overhaul or minor repair, please check the insulation of the electric field. The resistance value shall be equal to or more than  $100M\Omega$  ( $\geq 100M\Omega$ ).



## Mechanical Details



**Note: the trundle can realize 90° rotation**

### Dimensions:

Specification	A	B	Weight (Kg)
0.4-1.0A/(60-80)kV	905	1025	495
1.2-1.6A/(60-80)kV	1205	1325	685
1.8-2.0A/(60-80)kV	1205	1325	710
2.2-2.4A/(60-80)kV	1505	1625	920



## Operating Instruction for Human-computer Interface Screen

The human-computer interface applies a 7-inch 65535-bit true colour TFT LCD display screen equipped with high-bright LED backlights (resolution ratio: 800×480), 4-wireresistive touch screen (resolution ratio: 1024×1024). This is an embedded high-powered integrated touch screen basing on embedded and low-powered ARM9 core (basic frequency: 400MHz).

### Image Display

When the equipment is powered up, the start screen (as shown in Figure 1) will be displayed after 8 seconds. Then it will automatically enter the instrument display (As shown in Figure 2) after 12 seconds. The specifics are as follows:

### Display of Station Number and Specification

The logo of Genvolt, station number and specification of the equipment are displayed on the top left corner of the screen. The form is as follow: [30/1], the station number, means that the station number of PORT1 and PORT2 of Genvolt high frequency power controller respectively are 30 and 1; [1600mA/72kV], the specification, means that the rated output secondary and rated output secondary voltage respectively are 1600mA and 72kV. The communication station number and specification of the Genvolt high frequency power controller are set by our company in the factory, so the user has no need to reset such data.

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**CPU\_Ver:14112:** This is the version number of the application program of Genvolt high frequency power controller.

**Screen\_Ver:1411.4:** This is the version number of the application program of the human-computer display screen.

**Primary Voltage:** The operating value is the actual input value, and the set value is the rated input line voltage.

**Primary Current:** The operating value is the actual input value, and the set value is the rated incoming current. If the operating value exceeds the set value, the primary over-current protective alarm will be sent. The set value of the primary current cannot be modified.

**Secondary Voltage:** The operating value is the actual secondary voltage output, and the set value is the limit value of secondary voltage output. The setting range of secondary voltage is between 10kV and its rated value.

**Secondary Current:** The operating value is the actual secondary current output, and the set value is the limit value of secondary current output. The setting range of secondary current is between 10mA and its rated value.

**Transformer Oil Temperature:** The operating value is the current transformer oil temperature, and the set value is the upper temperature limit of the transformer oil temperature when the equipment is running (70°C). The pre-alarm for excessive transformer oil temperature will be sent when it exceeds 65°C. While the equipment will be stopped and the protective alarm for excessive transformer oil temperature will be sent when it exceeds 70°C.



**IGBT Case Temperature:** The operating value is the current temperature of IGBT radiator, and the set value is the upper temperature limit of the IGBT radiator when the equipment is running (60°C). The pre-alarm for excessive IGBT case temperature will be sent when it achieves 55°C. While the equipment will be stopped and the protective alarm for excessive IGBT case temperature will be sent when it achieves 60°C(the set value).

**Flash-over:** The operating value is the current flash-over times within one minute, and the set value is the limit value of the flash-over times within one minute when the equipment is running. The range of the set value is from 1 to 60 time(s)/minute.

**Pulse Width:** The operating value is the set value. It means the time width of power supply within a pulse period under the condition of pulse energization. The time setting range is 1-1000mS and the default set value is 5mS.

**Pulse Period:** The operating value is the set value. It means the period of pulse energization. The time setting range is 1-1000mS. Note: this time value must be greater than pulse width. Otherwise, the equipment will be operated in the mode of full wave power supply.

**PORT1 Station Number:** This is the address of PORT1 COM port of Genvolt high frequency power controller. Its range is 1-31.

**PORT2 Station Number:** This is the address of PORT2 COM port of Genvolt high frequency power controller. Its range is 1-31.

**Rated Secondary Voltage:** This is the rated secondary voltage output by the equipment whose range is 10-150kV. This parameter is modified by the manufacturer's technicians and is configured before leaving the factory.

**Rated Secondary Current:** This is the rated secondary current output by the equipment whose range is 10-2700mA. This parameter is modified by the manufacturer's technicians and is configured before leaving the factory.

**High-energy Frequency:** This is the operating frequency within the pulse duration under pulse energization. Its setting range is 1000-2000Hz and the default set value is 15000Hz.

**Low-energy Frequency:** This is the operating frequency after subtracting the pulse duration within the pulse period under pulse energization. Its setting range is 15-20000Hz and the default set value is 1500Hz.

**Manual Frequency:** This frequency is used under manual fixed frequency mode, and the operation shall be based on its set value. Its setting range is 15-20000Hz and the default set value is 5000Hz.

**Vibration Step-down Voltage:** The operation shall be based on this set voltage under vibration step-down.

**Note: if such voltage is equal to or less than 5kV ( $\leq 5kV$ ), the voltage will not be decreased when starting the vibration step-down. Instead, the operation will be suspended.**

**Time for Vibration Step-down:** It refers to the step-down time after starting such function. The equipment will return to the operating status before step-down when such time runs out.

**Step-down Cycle Time:** It is not used temporarily.



## Turning-on/Turning-off

The user can turn on/off the equipment, increase/decrease the secondary voltage and suspend the operation through the follow keys in the windows of Instrument Display, Trend Display and Alarm Display:



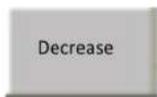
press this key under the **down** state the equipment will begin to operate.



press this key under **operating or suspended state**, the equipment will enter the down state.



press this key at manual setting, then the increase or decrease in secondary voltage will be suspended temporarily.



press this key at manual setting, then the secondary voltage will be decreased.



press this key at manual setting, then the secondary voltage will be increased to the maximum limit value.

**Operation Mode:** It includes 0-Spart Rate Setting, 1-Pulse Energization and 2-Manual Fixed Frequency. The user can select one of them in the pull-down menu.

**0-Spart Rate Setting:** if this mode is selected, the operation will be restricted by the set secondary voltage and secondary current. Besides, the operation will also be controlled by the flash frequency under flash-over.

**1-Pulse Energization:** if this mode is selected: (1) the operation will be based on the setting parameters of pulse width, pulse period, high-energy frequency and low-energy frequency;(2) the operation will be restricted by the rated secondary voltage and rated secondary current; (3) the operation will be controlled by the flash frequency under flash-over.

**2-Manual Fixed Frequency:** if this mode is selected: (1) the operation will be based on the set value of manual frequency; (2) the operation will be restricted by the rated secondary voltage and rated secondary current; (3) the operation will be controlled by the flash frequency under flash-over.



The windows of Instrument Display, Parameter Display and Alarm Display can be switched as required.



Figure 1 Start-up Screen



Figure 2 Instrument Display

### Operating Status Display

**Operating Status:** It includes operating, halt, fault, suspension and communication failure. If there is a communication failure, the words "**Communication Failure**" will be displayed and flashing on the screen, and the equipment cannot be operated through the human-computer interface at this time. If the word "**Fault**" is displayed and flashing on the screen, the user can examine the fault type and its generation time through the Alarm Display Window. The equipment cannot be started under faulty condition. So the user shall press the key of "**Alarm Acknowledge**" in the Alarm Display Window to restart it. If the word "**Halt**" is displayed on the screen, please restart the equipment after ensuring the equipment is in a good condition.



Figure 3 Parameter Display



Figure 4 Alarm Display

### Parameter Display and Setting

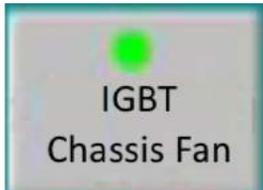
The parameter list above, which can be found in each parameter display window, is used to examine and set the operating parameter. The corresponding set value will be changed when pressing the set value.



## Test of Fans of Oil Tank and IGBT Case

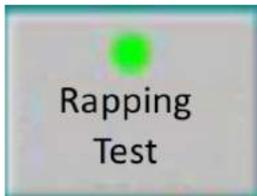


Press this key, then the fan of the oil tank will operate and the indicator light will turn red from green. Press this key again to end the test. And the indicator light will turn green from red.



Press this key, then the fan of the IGBT case will operate and the indicator light will turn red from green. Press this key again to end the test. And the indicator light will turn green from red.

## Test of Vibration Step-down



Press this key to enter the step-down test when the equipment is running. The equipment will return to the operating status before step-down when such time runs out. This key does not work under halt mode.



## Oil Filling Instructions:

*Please note that Genvolt and Genvolt both recommend that the ESP03 is transported with the oil already filled at the factory. However, in the rare event that the unit is transported without oil the client takes on full responsibility for the process. Failure to follow procedures correctly could result in product fault or failure. In case you are unsure please always seek guidance from trained Genvolt or Genvolt Engineers.*

- 1. Clean Oil.** Before filling the oil into tank, make sure the oil is clean: the breakdown test voltage must be 60kV/2.5mm minimum. We recommend to use an oil filter machine with vacuum and heating system to process the oil.
- 2. Air release.** After filling the tank with oil, loosen the pipe connected to the pump to release the air, and then tighten it again. Then, wire the input mains and connect the power supply to the load. Keep the inverter circuit breaker off, switch on the control circuit breaker, the pump will then start to work, leave it running for 5 minutes, to release the air that may be hidden in heat exchanger, pump, transformer etc..
- 3. Enable the high voltage.** Switch on the main circuit breaker, then set the output voltage. The first time the high voltage is switched on, increase voltage output slowly, this helps squeeze air from the winding. It's better to take at least 10 minutes the first time the high voltage ramps from zero to full rating.



## Common Fault Handling:

### Open Circuit Output:

Conditions: The open circuit output alarm will be sent after 30-second delay in the following conditions: The secondary voltage has reached 90% of the rated secondary voltage or the set secondary voltage; the secondary current is equal to or less than 5mA ( $\leq 5\text{mA}$ ).

Causes: (1) The damping resistance is burned-out; (2) the disconnecter is open; (3) the incoming line of the electric field is open.

Handling Methods: (1) Replace the damping resistance; (2) check the disconnecter; (3) check the incoming line of the electric field.

### Short Circuit Output:

Conditions: The short circuit output alarm will be sent after 30-second delay in the following conditions: The secondary voltage is equal to or less than 5KV ( $\leq 5\text{KV}$ ); the secondary current has reached 50% of the rated secondary current or the set secondary current.

Causes: (1) The disconnecter is grounded; (2) the short circuit exists in the electric field.

Handling Methods: (1) Check the disconnecter; (2) check the electric field.

### Over-current of Primary Current:

Condition: The input primary current is greater than the set value.

Causes: (1) Incorrect display of the primary current; (2) abnormal transformer; (3) unbalanced three-phase input power.

Handling Methods: (1) Correct the primary current; (2) check the transformer; (3) check the three-phase input power.

### Low DC Bus Voltage:

Condition: The DC bus voltage is less than 100V ( $< 100\text{V}$ ).

Causes: (1) The circuit breaker is not switched on; (2) the three-phase rectifier module is damaged; (3) the short circuit exists in filter condenser or IGBT.

Handling Methods: (1) Switch on the circuit breaker; (2) check the three-phase rectifier module; (3) check the filter condenser and IGBT.

### High Transformer Oil Temperature

Conditions: The pre-alarm for excessive transformer oil temperature will be sent when it exceeds 65°C. While the equipment will be stopped and the protective alarm for excessive transformer oil temperature will be sent when it exceeds 70°C.

Causes: (1) The oil pump fails to operate; (2) the fan of the cooler fails to operate; (3) the oil pump idles.

Handling Methods: (1) Check the power supply circuit and F1 fusible core of the oil pump; (2) check the power supply circuit and F2 fusible core of the fan; (3) check the oil pump.



## Common Fault Handling continued:

### High IGBT Case Temperature:

The pre-alarm for excessive IGBT case temperature will be sent when it achieves 55°C. While the equipment will be stopped and the protective alarm for excessive IGBT case temperature will be sent when it achieves 60°C.

Cause: The fan of the IGBT case fails to operate.

Handling Method: Check the power supply circuit and F3 fusible core of the fan.

### IGBT Protection:

Condition: The driving isolation board outputs a fault signal.

Causes: (1) Over-current and overheating exist in IGBT; (2) IGBT is damaged; (2) IGBT driver is damaged.

Handling Methods: (1) Check whether the driving isolation board is normal; (2) check IGBT.

### High IGBT Temperature:

Condition: The baseboard's temperature of IGBT is too high ( $> 100^{\circ}\text{C}$ ).

Causes: (1) Over-current exists in IGBT; (2) The screws fixing IGBT are loose; (3) the copper bar screws connected to IGBT are loose.

Handling Method: Check whether the fitting screws of IGBT are loose.

### Low Transformer Oil Level:

Condition: Switch on/off the oil level in the tank.

Causes: (1) The oil level in the tank is low; (2) Incorrect operation towards the oil level switch.

Handling Methods: (1) Check whether the tank is leaked; (2) check the oil level switch.

### High Transformer Tank Pressure:

Condition: Switch on/off the oil pressure switch.

Causes: (1) The pressure in the tank is greater than 40KPa ( $> 40\text{KPa}$ ); (2) incorrect operation towards the oil pressure switch.

Handling Methods: (1) Check the pressure in the tank; (2) check the oil pressure switch.



## Global Presence



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