

In the Name of Allah

Pulse Modulator Catalogue





1. Introduction

1.1 Model and name of the product

PN-PFNM-46k /110 high voltage pulse modulator.

1.2 Main technical indicators and parameters

- a) Pulse voltage: 40 ~ 46kv;
- b) Pulse current: 110A;
- c) Pulse width (50%): 4.2 μ s;
- d) Pulse front edge: 0.8 μ s ~1.1 μ s (10%~90%);
- e) Pulse trailing edge: < 1.2 μ s (20%~80%);
- f) Top unevenness: $\leq \pm 1\%$;
- g) Stability: $\leq \pm 1\%$;
- h) Repetition frequency: 50Hz ~ 250Hz, continuously adjustable;
- i) Magnetic filament power supply: DC 8.5v/9A;
- j) Gun filament power supply: AC 7.5v/2.2A;
- k) Vacuum pump power supply: 3.5kv ~ 4.2kv adjustable.

1.3 Working environment

- a) Operating ambient temperature: - 5 °C ~ + 55 °C;
- b) Ambient relative humidity: 95% \pm 2% (30°C).



1.4 Product composition

See Table 1 for the composition of PN-PFNM-46k /110 pulse modulator.

Table 1- Composition of modulator

S/N	Name	Code	Overall dimension length×wide×height (mm)	QTY
1	Modulator	05	780mm×1000mm×1433mm(±3mm)	1
2	AFC unit	01	483 mm×333.5 mm×222 mm	1
3	Gun power unit	02	483 mm×333.5 mm×222 mm	1
4	Control Unit	03	483 mm×333.5 mm×222 mm	1
5	Filament Unit	04	483 mm×333.5 mm×222 mm	1
6	Charging Unit	06	605 mm×482.6mm×311 mm	1
7	Wave head matching box	08	334mm×230 mm×320 mm(±3mm)	1
8	Vacuum pump power supply	09	176 mm×180 mm×120 mm(±3mm)	1
9	Pulse transformer		450 mm×246 mm×450mm(±3mm)	



1.5 Extension, plug-in code, name and location
See Figure 1 and table 2 for location distribution.

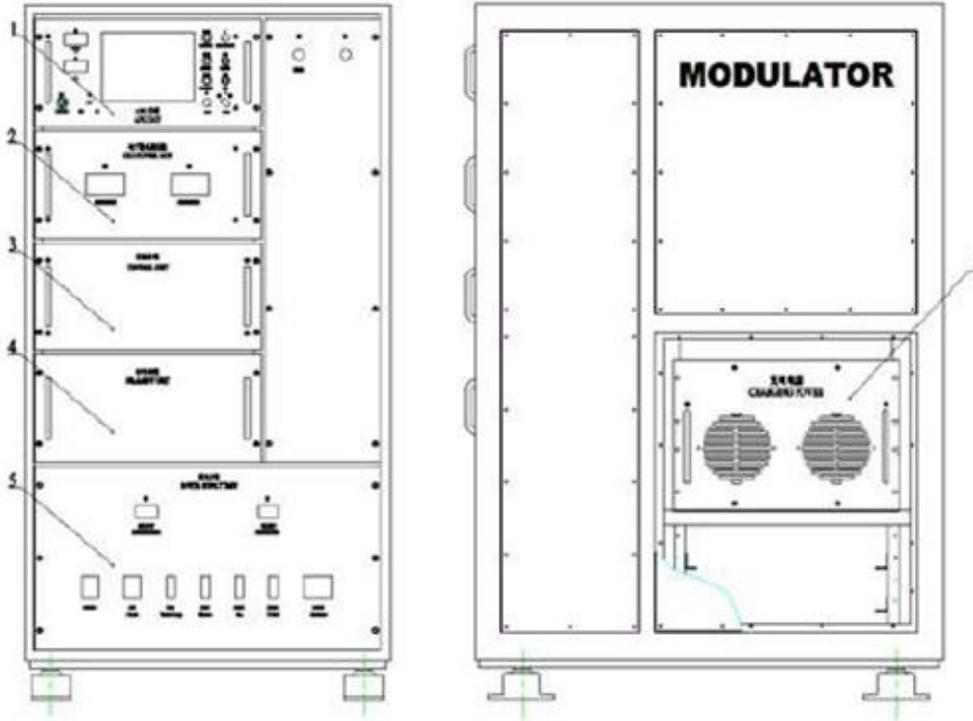


Figure 1- location distribution

Table 2- code and installation position of each component

Serial number	Name	Number or code	Installation location code
1	AFC extension	01	1
2	Electron gun power supply unit	02	2
3	Control unit	03	3
4	Filament unit	04	4
5	Power distribution part	05	5
6	Charging unit	06	6
7	Wave head matching box	08	Independent installation
8	Vacuum pump power supply	09	Independent installation
9	Pulse transformer		Independent installation



1.5.1 Panel diagram and function description

1.5.1.1 Schematic diagram and function description of AFC unit panel

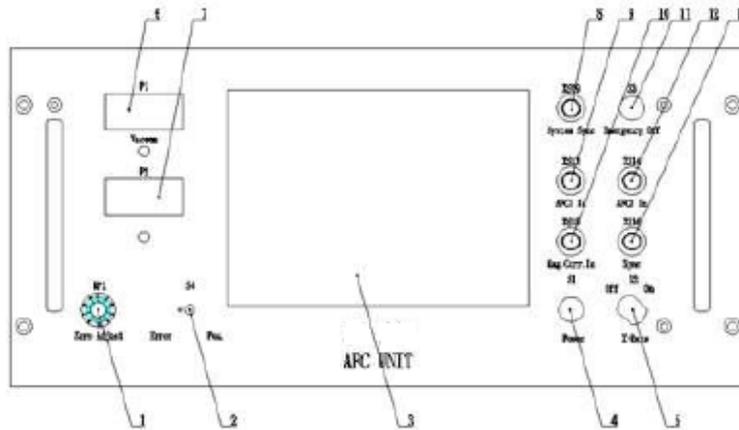


Figure 2- Schematic diagram of AFC Unit panel

- 1) Zero adjustment potentiometer: AFC zero adjustment.
- 2) Error / position switch: switch error / position indication.
- 3) Touch screen: local control operation interface of modulator; including the control of modulator and its status display.
- 4) Start switch: controls the power supply of the modulator.
- 5) Key switch: modulator safety interlock switch. When this switch is in "off" state, there is no high voltage output.
- 6) Current display of vacuum pump: unit: "μA"
- 7) Error / position display: AFC error / position indicator.
- 8) Synchronization signal observation: used to observe the synchronization signal of the modulator.
- 9) AFC 1 signal observation: used to observe AFC1 signal.
- 10) Magnetron pulse current observation: used to observe magnetron pulse current signal.



- 11) Emergency stop button: press this button and the modulator will stop working.
- 12) AFC1 signal observation: used to observe AFC2 signal.
- 13) External synchronization signal observation: used to observe external synchronization signal.

1.5.1.2 Schematic diagram and function description of electron gun power unit panel

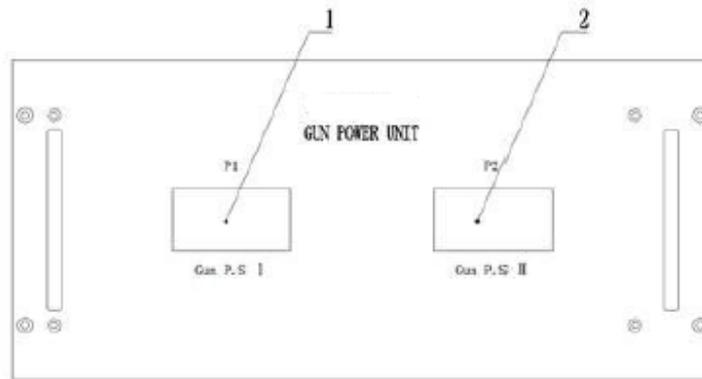


Figure 3- Schematic diagram of electron gun power supply panel

- 1) Gun voltage indication: DC voltage indication of electron gun power supply I.
- 2) Gun voltage indication: DC voltage indication of electron gun power supply II.



1.5.1.3 Schematic diagram and function description of power distribution panel

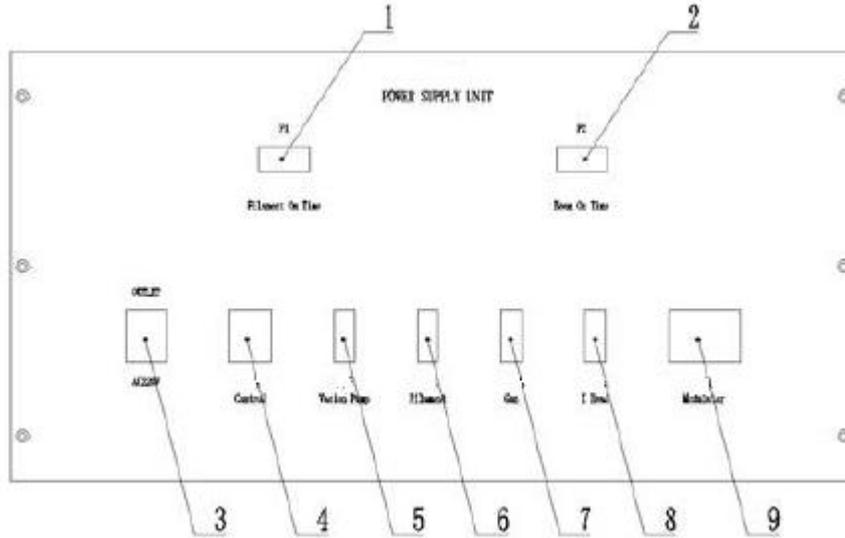


Figure 4- Schematic diagram of power distribution panel

- 1) Low voltage chronometer: displays the low voltage working time of the modulator, in "H".
- 2) High voltage chronometer: displays the high voltage working time of the modulator, in "H".
- 3) 220V power supply socket: it provides AC 220V power supply and can supply small power instruments as power supply.
- 4) Control power supply circuit breaker: after the circuit breaker is closed, the control unit and AFC unit start to supply power.
- 5) Vacuum pump power supply circuit breaker: after the circuit breaker is closed, the vacuum pump unit starts to supply power.
- 6) Filament power supply circuit breaker: after the circuit breaker is closed and the low voltage is started, the filament unit starts to supply power.
- 7) Electron gun power supply circuit breaker: after the circuit breaker is closed and the low voltage is started, the electron gun extension starts to supply power.



- 8) X head power supply circuit breaker: after the circuit breaker is closed and the low voltage is started, X machine head starts to supply power.
- 9) High voltage power supply circuit breaker: close the circuit breaker and high voltage modulator to have high voltage output.

1.6 Staffing requirements and responsibilities

Warning

The use and maintenance personnel must pass the safety technical training before taking the post. Safety regulations must be strictly observed during operation.

Warning

Non-professional personnel are strictly forbidden to repair the machine, otherwise it may cause accidental injury or electric shock!



2 Working principle

The high voltage pulse modulator is mainly composed of control module, auxiliary power module, charging power module and discharge part; The control part mainly completes the power on control of the modulator and various control and protection functions of the modulator; The auxiliary power supply provides the necessary low-voltage power supply for the modulator load. The charging module uses the series resonant constant current charging mode to charge the manual line of the modulator. After charging, the load is discharged through the discharge circuit, and the pulse high voltage is generated through the pulse transformer to the magnetron load.

3 Installation and commissioning

3.1 Safe connection between three-phase four wire power supply line and modulator

Connect the three-phase four wire power supply line (single wire diameter shall be 6mm and above) to the terminal of terminal block XT0 on the distribution board at the lower right side of the modulator cabinet, the live wire shall be connected to L1, L2 and L3 respectively, and the zero wire shall be connected to N, then connect the cable plug according to the identification of the power distribution panel.



Figure 5- three- phase input terminal



3.2 Cabinet grounding

In order to ensure the reliable grounding of the modulator system, a grounding copper bar with "PE" mark is set on the bottom frame behind the modulator cabinet, which is connected with the copper plate of the thyatron base with copper sheet. The user can use copper braided wire and connect it to the grounding copper bar with copper screws to keep the modulator in good contact with the earth. Cabinet grounding is shown in Figure 6.



Figure 6- Cabinet grounding

3.3 Install the high voltage line

Connect the high-voltage cable with the modulator cabinet, thread it from the top plate of the modulator cabinet, connect the core of the high-voltage cable through the high-voltage plug base to the terminal PFN2, and connect the shielding layer to the copper plate of the top plate through the locking device of the high-voltage plug base, so as to connect it to the copper plate of the thyatron. The other core is connected to the P2 terminal of the pulse transformer, and the shielding layer is connected to the P1 terminal of the pulse transformer.

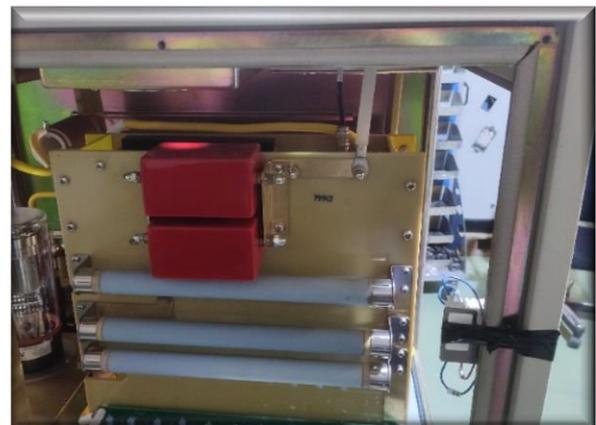


Figure 7- high voltage connection



3.4 Installation of thyatron

First, fix the thyatron on the thyatron copper plate with copper screws, connect the high-voltage yellow wire with small inductance of artificial wire to the thyatron anode, connect the two self-contained yellow wires under the thyatron base as filaments to the terminal filaments 1 and 2 on the terminal board in the thyatron box, connect the white wire to the second grid terminal, and connect the green wire to the first grid terminal. Installation of thyatron is shown in Figure 8.



Figure 8- Installation of thyatron

3.5 LAN Installation

All AFC and control LAN output are connected to the main hub.



4 Usage and operation method

4.1 requirement

In order to prevent electrical fire, the distribution box and cabinet of pulse modulator shall meet the following requirements:

- a) The distribution box and cabinet shall meet the national and local quality acceptance specifications and the requirements of the power supply bureau. All indexes of the plate of the distribution box and cabinet must meet the relevant national requirements, and the metal part of the distribution box and cabinet shall be well grounded;
- b) In order to meet the stable operation of pulse modulator, the circuit breaker shall meet: rated voltage $\geq 400V$, rated current $\geq 100A$; In order to prevent short circuit, the circuit breaker with strong rated short circuit section capacity and rated short circuit making capacity shall be selected. If the making and breaking capacity of the circuit breaker is not enough, the protection circuit shall be added, or the current limiting circuit breaker or the circuit breaker with large capacity shall be selected;
- c) To prevent heating from damaging components, components with high temperature resistant materials shall be selected during model selection.

4.2 Check before startup

Please confirm before startup:

- a) The AC 380V power supply cable shall be accurately connected to the corresponding terminal of the terminal block on the power distribution adapter board;
- b) All air switches on the charging power distribution panel are in "off" status;
- c) The power cabinet and control cables, charging cables and other connecting wires of each extension shall be installed correctly according to the appendix 1: wiring schematic;
- d) All high voltage cables are installed correctly;
- e) One point grounding and good grounding.

Warning

Arbitrarily adjusting or modifying the parameters of electronic components in the power supply may cause damage to electronic components or make the charging power supply unable to work normally! Or pose a great potential safety hazard!



4.3 Power on

4.3.1 Standby start

All controls of the modulator are realized on the touch screen, and its control interface is shown in Figure 9.

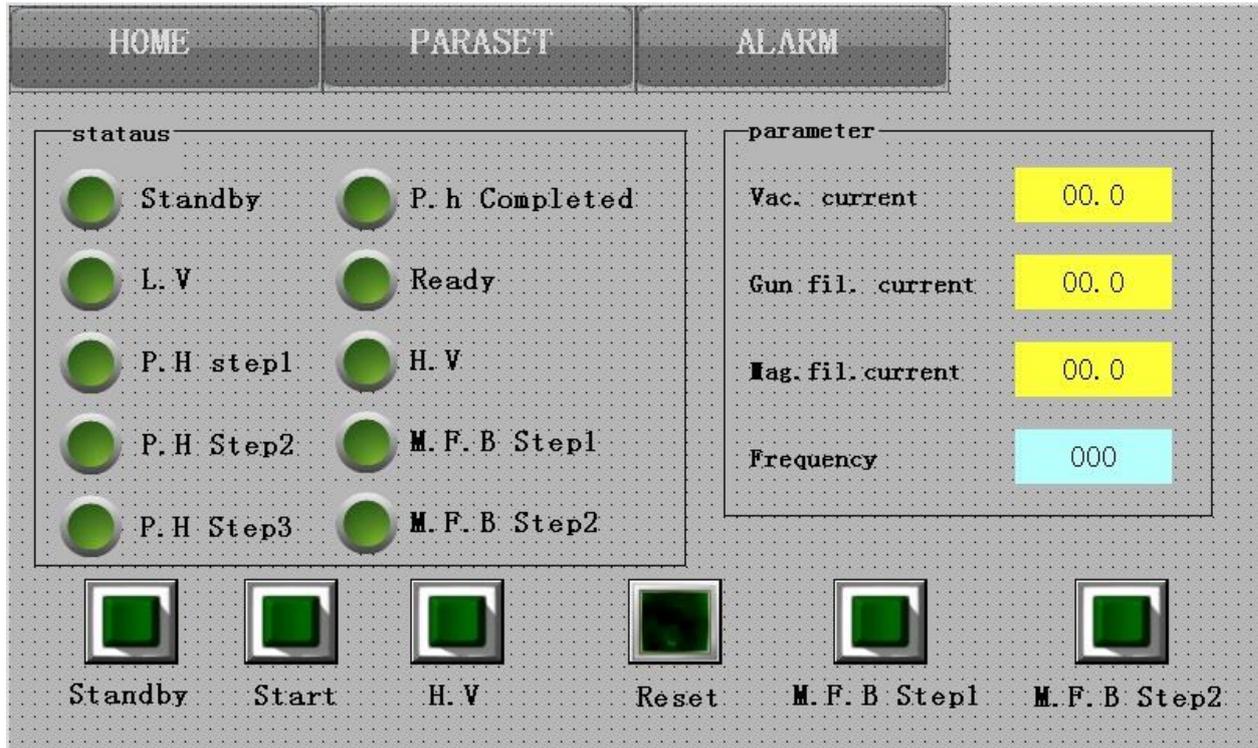


Figure 9- Touch screen control interface

Press the "standby" button on the touch screen control interface, the modulator filament starts the first gear preheating, and the standby indicator light and the first gear preheating indicator light are on. The preheating time can be set by p.h.time1 (s) on the interface in Figure 10. 'trigger select' is the modulator trigger selection, choose your own software control frequency or external frequency signal. Modulator when selecting the control, the touch screen can directly set trigger parameter, when selecting remote control, external trigger signal can be sent through XS16 on the front panel of AFC. When selecting the control, the external trigger signal is directly connected to the side panel of the electronic gun XS02 or XS03. Gun trig select is the trigger choice for the electron gun, same as trigger select.

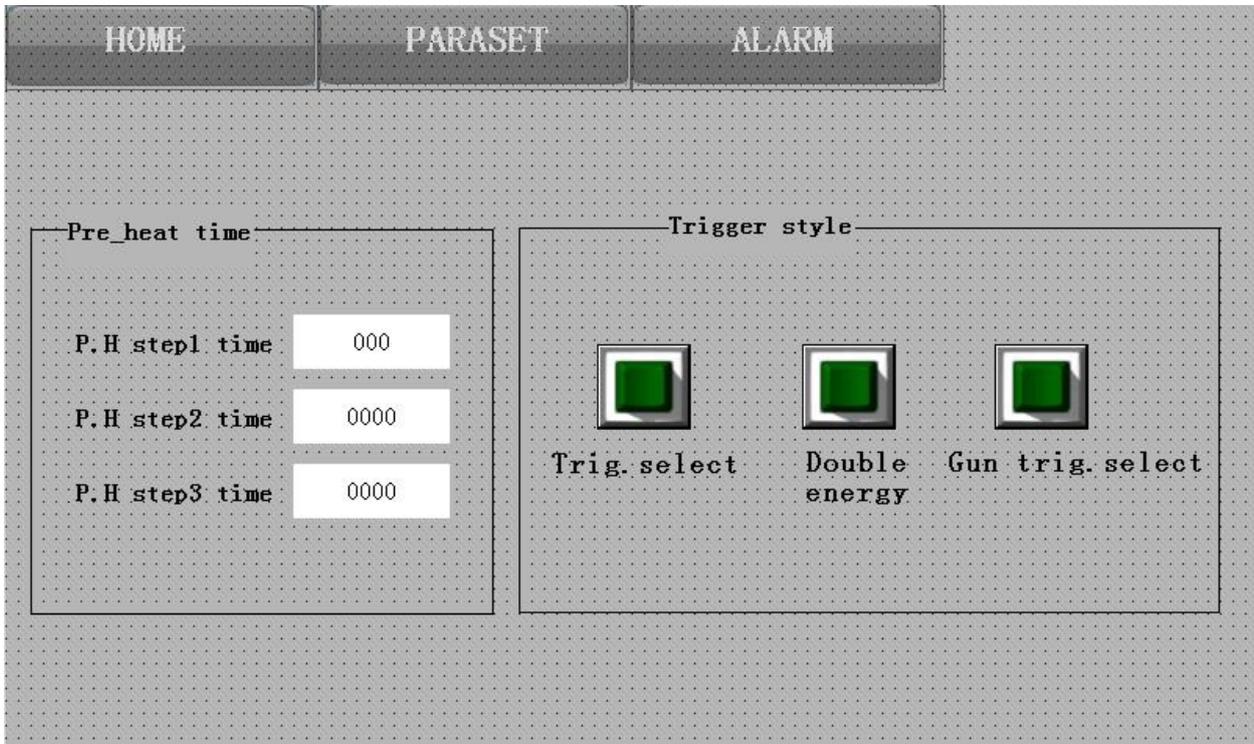


Figure 10- Setting control interface

4.3.2 Low voltage start

Press the "start" button on the touch screen control interface, the modulator filament starts to warm up in gear 2 and 3, and the start indicator light is on, and the warm-up indicator light in gear 2 is on. The preheating time can be set by p.h.time2 (s) and p.h.time3 (s) in Figure 6. After the second gear is preheated, the third gear indicator light is on; After startup, use a multimeter to measure whether the thyatron filament voltage is AC 6.3V. The filament voltage can be changed by properly adjusting the potentiometer RP1 on the thyatron box.

Warning

Under low-voltage condition, non-professionals are not allowed to touch or remove any low-voltage components to prevent electric shock from low-voltage power supply or low-voltage energy storage components! Cause casualties!



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4.3.3 System ready

15 minutes after the low-voltage start, the system starts to detect the working state of the magnetic filament power supply. After the magnetic filament power supply is preheated in the third gear, it sends the preheating completion status signal. At this time, the system is preheated. If there is no fault in the modulator system, the modulator is ready, and the "ready" indicator light is on. No matter any fault occurs, the system cannot be ready. The faults are latched. After troubleshooting, it must be "reset" before the system can be ready.

4.3.4 Start high voltage:

Under the system ready condition, turn off the "modulator" air switch on the power distribution control panel and press the "high pressure" button on the touch screen control interface. The discharge switch is wrapped in A1 line and the discharge switch is in a disconnected state. After 1 second, the K4 is pulled in, and then the modulator outputs the high voltage pulse signal after another 1 second. See appendix 2 for startup and operating the device.

M.F.B step1 and M.F.B step2 are the magnetic filament detent, divided into two. Indicator light of M.F.B step1 and M.F.B step2 is on, when the magnetic filament is unwinding. The magnetron 5193, for example, has an operating voltage of 46kV and a current of 110A, in the case of half width $4\mu\text{s}$, frequency 100Hz, the average power of $46 \times 110 \times 4 \times 100$ is 2kW, at this time, the magnetic filament retreat on can be pressed, when the average power reached 3kW. Press the magnetic filament back to the second gear on, the power drop in the reverse operation, less than 3kW greater than 2kW, the filament back by first gear, and the order cannot be wrong, otherwise useless.

DANGER

Do not touch or remove any high voltage components by non-professionals under high voltage! Prevent electric shock from power supply or low-voltage energy storage elements! Cause casualties!



4.3.5 Cut off high voltage

In the high voltage state, press the "high voltage" button on the touch screen control interface again, then K4 is disconnected. After a delay of 1 second, the wire package of discharge switch A1 is powered off, the discharge switch is in the connected state, and the system is automatically discharged through the discharge resistance. If the modulator has no fault, the modulator is in the ready state.

4.3.6 Cut off low voltage

Press the "start" button on the touch screen control interface again, and the modulator will cut off the low voltage.

4.3.7 Cut off standby

Press the "standby" button on the touch screen control interface again, and the modulator will cut off the filament power supply.

4.3.8 System power failure

Disconnect the three-phase power supply of the modulator, and the system will be in the power-off state.

5 Environmental operation control requirements

The disposal methods of waste components, waste PCB boards and other wastes must comply with relevant national regulations, by using special collection containers for centralized storage, making clear marks, and being centrally treated by qualified recycling units to prevent secondary pollution.

6 Maintenance and service

The system equipment not only needs correct operation, but also needs regular maintenance and routine inspection. Maintenance and routine inspection are very important for the safe, effective and stable operation of the equipment. The personnel performing maintenance and repair must be qualified.

Please fix the door panel and top cover to avoid electric shock; please pay attention to moisture-proof and dust-proof of high-voltage equipment to avoid high-voltage corona and creepage, which will affect the working reliability and stability of the whole machine.



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7 Fault analysis and troubleshooting

7.1 Operation flow of fault analysis and troubleshooting

Whenever it is necessary to open the modulator cabinet door for test or commissioning maintenance, be sure to turn off the high voltage according to the correct operation process, and then discharge the PFN capacitor and other parts of the modulator with the specified high voltage discharge rod before accessing the modulator. When it is necessary to test or debug the printed board and other low-voltage components, or when it is necessary to remove the printed board, be sure to turn off the high voltage, discharge the power, turn off the low voltage, and then remove the printed board for test and maintenance. If it is necessary to repair the inside of the charging unit, it is necessary to ensure that the filter capacitor is discharged before it is repaired.

7.2 Common fault analysis and troubleshooting

See Table 3 for common fault analysis and troubleshooting methods.

Table 3- fault analysis and troubleshooting

Serial number	Fault phenomenon	Cause analysis	Exclusion method
1	Charging fault	Over temperature and overcurrent	Check whether the drive line is loose
2	Contact failure No suction	Check whether the	power supply of wire package is normal
3	Door fault	The panel is not fixed properly	Tighten the panel fixing screws around
4	High pressure start no response	Not ready	Start after reset

Appendix 2: start up and operation procedure

location	key	Function	Description
Power distribution panel	Control air switch	Close the air switch	The control unit and AFC unit start to power supply
Power distribution panel	Vacuum and filament air switch	Close the air switch	
Power distribution panel	Emergency keys	All emergency keys should be open	
Panel	Power on	Standby start	
HMI	Set preheating 1,2 and 3, 60s, 120s, 120s respectively		
HMI	Reset	All faults are eliminated	
HMI	Standby	First gear preheating is start	



HMI	Start	The modulator filament start to warm up in gear 2 and 3	The start indicator light in on, the warm up indicator light in gear2 is on. 15 minute after the low-voltage start, at this time, the system is preheated. If there is no fault in the modulator system, the modulator is ready, and the ready indicator light is on.
Power distribution panel	Modulator air switch	Close the air switch	
AFC panel	x-ray switch	Close the air switch	No matter AFC fault occurs
HMI	High voltage	Connected high voltage	The discharge switch is wrapped in A1 line and the discharge switch is in a disconnected state. After 1 second, the K4 is pulled in, and then the modulator outputs the high voltage pulse signal after another 1 second