GME1S14

Ultra Short Wave 10kW Transmitter

Technical Manual

1. Overview

1.1 Structure

The GME1S14 10KW ultra short wave transmitter mainly consists of 9 parts: exciter (only 1 total exciter in 4 ultra short wave transmitters), propulsion stage, power amplifier unit, main control unit, electronic control unit, switching power supply, passive components (distributor, synthesizer, filter, directional coupler, etc.), coaxial switching system, cooling system, etc.

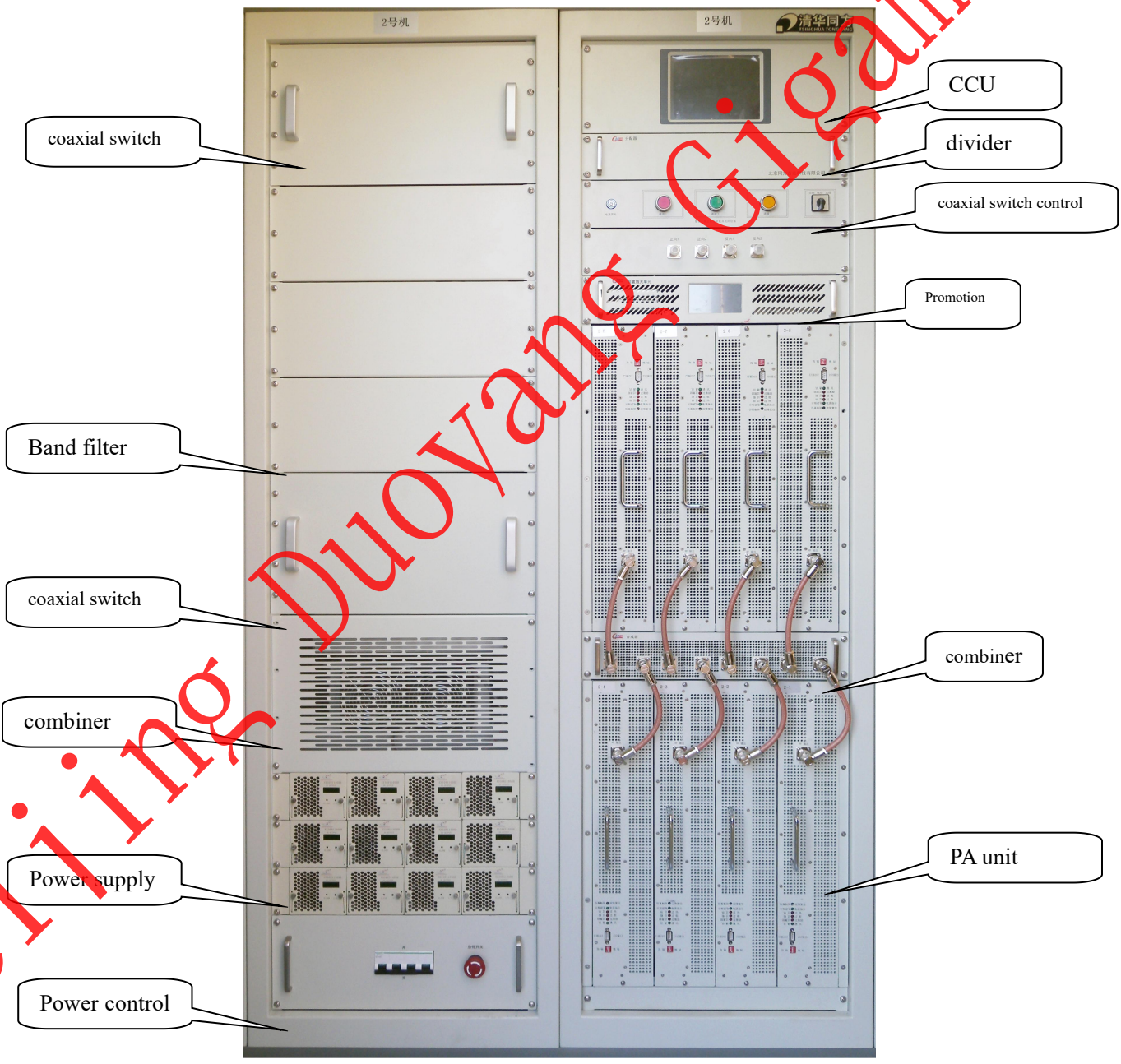


Figure 1-1 Front layout of transmitter

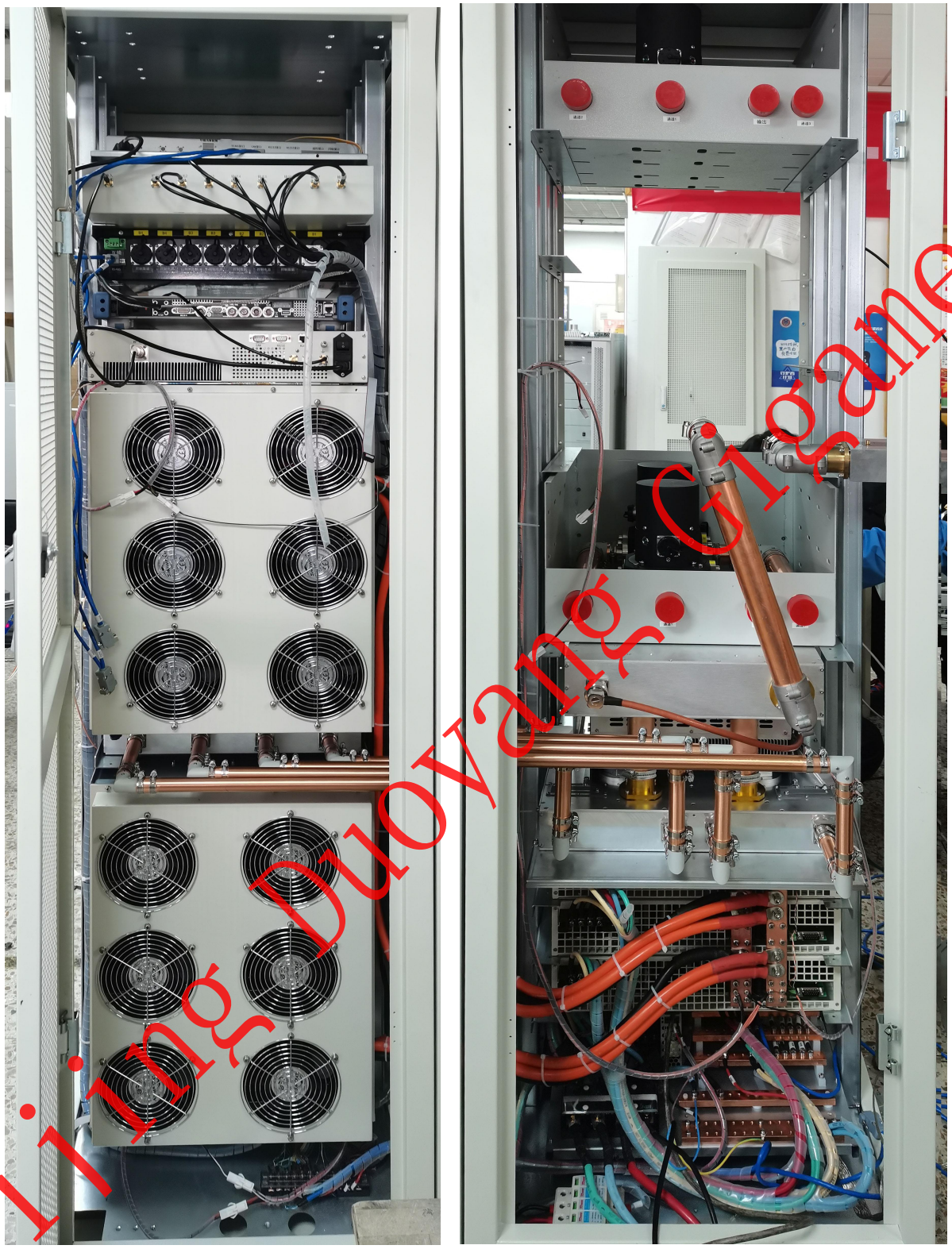


Figure 1-2 Rear layout of control cabinet

1.2 Working Principle

The ultra short wave transmitter is mainly composed of exciter, power amplifier, passive components (including distributor, synthesizer, bandpass filter, directional coupler, etc.), main control unit, power supply and electronic control unit, and air cooling system.

The exciter is highly integrated, with 5 RF outputs, 5 amplitude and phase correction feedback, 5 TTL level outputs, 1 RF input, 1 optical port input, and other interfaces. The monitoring interface of the exciter is a network port, and all parameters of the exciter can be monitored through the network port.

The 2000W power amplifier consists of four final amplifier boards, a current sampling board, a control board, a four distribution and four synthesis board, a TTL control board, a temperature sampling board, and a detection board; Each LD MOSFET and its associated input-output matching circuit form a single tube push-pull power amplifier, and four identical power amplifiers are synthesized through a in-phase four synthesizer for power synthesis. The final field-effect transistor operates in class AB.

Field effect transistor is a voltage controlled device, and its gate bias voltage is provided by a+12V regulated power supply through voltage division.

Each 2000W amplifier has protection functions such as overheating, overexcitation, and overload. Simultaneously display the corresponding status on the panel using light-emitting diodes.

Eight 2000W power amplifiers are synthesized in a 2x4x4 manner to achieve an output power greater than 3KW.

To prevent interference with other frequencies, a band filter is installed at the output end of the whole machine to suppress out of band useless components, ensuring that out of band unwanted emissions meet the technical requirements of the whole machine.

The power supply for 8 power amplifiers is 12 5KW50V AC/DC switching stabilized power supplies, using parallel current sharing power supply. Each 5KW switching power supply has over temperature, over voltage, over current, and short circuit protection functions, and has superior AC low voltage performance, with strong adaptability to changes in the power grid.

The final power output device consists of directional couplers, band filters, etc. Its output RF signal is coupled through the directional coupler and sent to the main control unit for power

indication, while providing RF monitoring signals.

The working status of the transmitter during operation is displayed on the LCD screen of the main control unit. The main control unit consists of a whole machine detection board, a main control board, a LCD screen, etc. The output power and reflected power are displayed on the LCD screen of the main control panel.

1.3 Technical Feature

- The whole machine adopts a fully solid-state design.
- Backup redundancy design to reduce failure rate.
- Backup redundancy design of power amplifier: The whole machine is composed of 8 2000W power amplifier modules; The amplifier module has high consistency and can serve as a backup for each other, allowing for arbitrary replacement.
- Backup redundancy design of power supply: 12*5KW switching power supplies are connected in parallel for current sharing. The microprocessor in the power monitoring module monitors the working status of the power supply and adaptively adjusts the overall working status of the machine.
- This machine realizes intelligent networking and can be remotely controlled by a monitoring computer through a PC interface.
- This machine is equipped with a complete machine data monitoring system and fully functional computer monitoring software.
- All technical parameters can be monitored through the LCD screen on the main control panel.
- The exciter is equipped with a monitoring network port, which allows the monitoring computer to modify and view all parameters of the exciter.
- Complete protective measures to reduce equipment damage in special environments.
- This machine has protection functions such as high standing wave ratio, overheating, overexcitation, phase loss, and lightning protection.
- The switching power supply is equipped with protection measures such as overvoltage,

over current, under voltage, overheating, short circuit, and lightning protection.

■ Hot swappable design; The power amplifier module and switch power supply can be plugged and unplugged, making debugging and maintenance convenient and improving reliability.

■ All power supplies are switch mode power supplies with reliable quality and high stability; High efficiency, good voltage regulation performance, and strong adaptability to external power changes.

■ The cooling method adopts multiple sets of axial variable speed fans for forced air cooling, which can automatically adjust the fan speed according to the temperature of the power amplifier.

2. Technical Index

2.1 RF Parameters

Frequency	30~80MHz
Output power	1≤VSWR≤2.5，≥10kW
	2.5<VSWR≤3.5，≥5kW
Input/Output impedance	50Ω
VSWR	≤1.2
Input level	10dBm±2dBm
harmonic suppression	≥60dB
Stray suppression	≥80dB
Neighborhood inhibition ratio	≥60 dB
phase noise	≤-80dBc/Hz@1Hz
Output amplitude/phase stability	≤0.5dB/12h
	≤1.5°/12h
RF output connection method	Φ40.3

Output amplitude and phase accuracy	≤0.2 dB
Static noise power spectrum	≤0.5°
In band spectral flatness	≤ -150 dBm/Hz
Gain flatness within the working frequency	≤±0.5dB
band	≤ 2dB
Modulation vector error	≤-32dB
With shoulders	≥36 dB
RF response time	≤20us
Cooling method	air cooling

2.2 Power supply and interface

Power supply	380×(1±10%) VAC，50 Hz±3Hz
Input	SMA
Output	IF70
communication interface	LAN

2.5 Work Environment

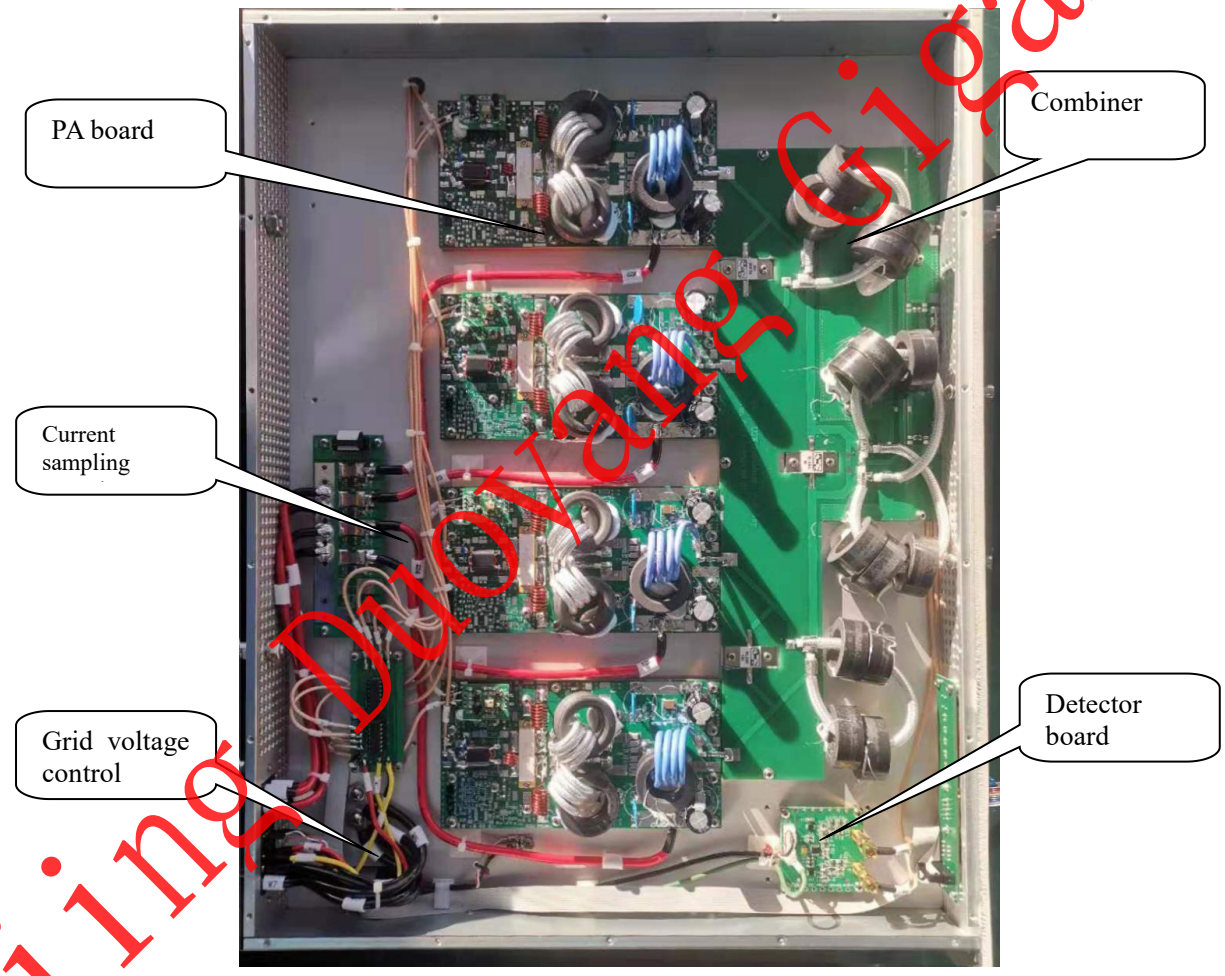
relative humidity	＜95%
Atmospheric pressure	86～106Kpa
Power supply	380VAC±10% 50Hz
power consumption	≤30KW
Dimension	1132mm(w)×1960mm(H)×750mm(D)

3. 2000W PA

3. 1 2000W PA Module

3. 1. 1 Structure

The 2000W power amplifier consists of a gate voltage control board, four final power amplifier boards, a current sampling board, a power amplifier monitoring board, an in-phase four synthesizer, and an in-phase four distributor.



Internal diagram of power amplifier unit

Rear view of power amplifier unit

3.1.2 Working Principle

The final power amplifier board of the 2000W power amplifier module consists of four LD MOS field-effect transistors MRF61K25. Each field-effect transistor and its connected input-output matching circuit form a single tube push-pull amplifier. Four identical final power amplifier boards are combined with a four phase synthesizer for power synthesis, resulting in an output power greater than 2000W.

The 2000W power amplifier module is a high gain, high linearity broadband power amplifier with good consistency and strong interchangeability.

Because LD MOSFETs are push-pull type transistors, each single transistor amplifier has a balanced unbalanced converter in its input and output matching network.

The field-effect transistor adopts a voltage bias method, and its gate bias voltage is formed by the secondary stabilization treatment of the drain voltage.

The monitoring board samples, stores, A/D converts, and processes the working parameters of the power amplifier, and transmits them to the main control unit for monitoring through the RS485 interface. It is equipped with self protection control and status indication circuits for over excitation, overload, and overheating. The current sampling sample is used to supply+50V power to each level, and to provide sampling signals for the working current of each level to the monitoring board.

3.2 Technical Specifications of Power Amplifier Unit

Frequency	30MHz ~ 80MHz
Output power	2000W
Input/output impedance	50Ω/50Ω
Input reflection loss	≤－20 dB
Output reflection loss	≤－20 dB
Gain	≥20dB
working voltage	50V
Static working current	2A
Overheating protection point	80±5°C
Overload protection point	VSWR≥1.5
Over incentive protection point	Increase in incentive power 0.8dB
Phase difference of power amplifier	≤5°
Dimension	577(W)mm×416(D)mm×110(H)mm

3.3 Principle of power amplifier protection

3.3.1 Overheat protection

Temperature sensor, set the operating temperature to 80 ℃± 2 ℃. The sensor is installed on the heat sink of the 2000W power amplifier module. The sensor has a total of 3 wires, one for power supply+5V, one for GND, and the other for the voltage signal transmitted by the sensor. When the voltage of the sensor is 600mV, the corresponding temperature is 0 degrees, and every 10mV increase is 1 degree. The micro controller on the control board samples the voltage of the sensor. According to the temperature set by the software, when the temperature on the sensor is greater than 80 ℃, the micro controller outputs a high level and isolates the output through the gate voltage control board, causing the gate level of the controlled power transistor MRF61K25 to turn off and no driving power output. The 2000W power amplifier module self-protection. When overheated, the red overheating indicator light on the panel flashes simultaneously.

3.3.2 overload protection

The sampling point for overload signals is the detection board. The function of the detection board is to represent the RF power signal of the reflected signal in the form of a voltage signal. The higher the reflected power, the higher the reflected voltage. When the reflected signal is abnormal, the reflected wave voltage increases. When the reflected wave voltage exceeds the set value, the micro controller output is high potential. Through the gate voltage isolation board, the gate level of MRF61K25 is turned off, and there is no pushing power output. The 2000W power amplifier self-protection. The protection points can be set by oneself, and can be adjusted through the adjustment software of the power amplifier module.

4. Main control unit

4.1 Overview

The main control unit is the core module of the transmitter monitoring system, responsible for coordinating the operation of the entire monitoring system and providing external communication interfaces.

4.2 Main functions

4.2.1 Human computer interaction function: Using a touch screen, the system parameters can be viewed and set by touching the corresponding buttons on the screen.

4.2.2 Collecting transmitter data: Collecting overall data and operational data of main components such as power amplifiers, power supplies, etc; The operator can access the above information on the touch screen display.

4.2.3 Control of transmitter on/off modes: The main control unit provides three on/off modes: local control, remote control, and timing

a) Power on/off mode: controlled by the power on/off buttons on the main touch screen;

b) Remote control on/off mode: Control on/off on the monitoring PC;

c) Timed power on/off mode: The time period for turning on and off can be set

on the touch screen. Computer monitoring software can also be used to set power on and off times for 7 days a week and 4 time periods per day; You can choose to execute it on the computer or download the scheduled broadcast schedule to the transmitter for execution.

4.2.4 Transmitter parameter settings: including system time settings, timed power on/off time settings, transmitter IP address settings, etc.

4.2.5 Data display: displayed through the touch screen on the front panel;

a) Time information: system time, scheduled power on/off time, cumulative device working time, etc.

b) Machine information: output power, reflected power VSWR、Complete machine malfunction information, etc.

c) Amplifier information: number of amplifiers, power, voltage, current, and fault information (temperature, overexcitation, overload) of each amplifier.

d) Power information: number of switch power supplies and parameters for each switch power supply.

4.2.6 Communication with Monitoring PC: The monitoring PC can communicate with the main control unit through dedicated monitoring software.

a) Receive query instructions from the PC and report the local status;

b) Accept PC settings: power on/off mode, control parameters, etc;

c) Receive PC control commands, such as on/off operations.

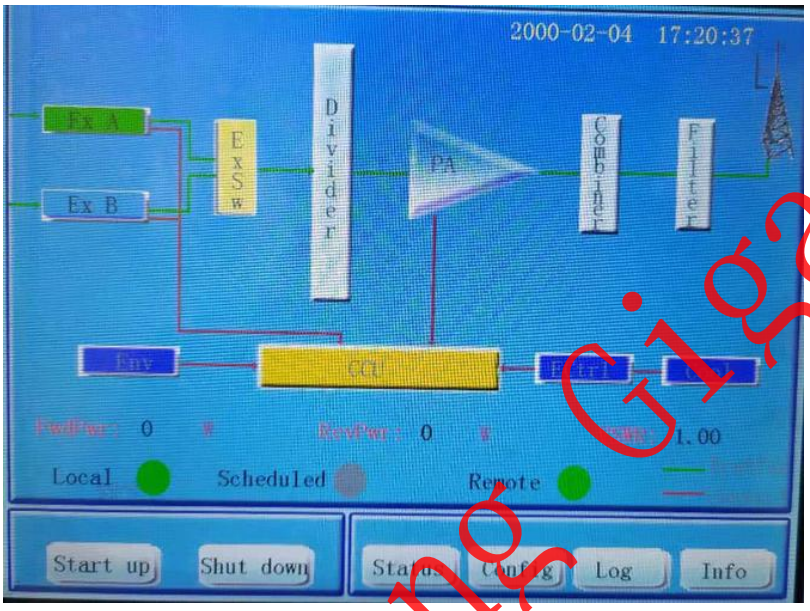
4.3 The principle of CCU

The control motherboard is the core of the main control unit, using ARM as the main control chip, configured with input channels, system clock, memory, RS485 interface, CAN bus interface, RS232 interface, etc.

The control motherboard completes the human-machine interaction function through the connected touch screen, and communicates with the PC and other "lower level machines" inside the device through the CAN bus interface.

4.3.1 Touch Screen

The touch screen displays the main parameters of the transmitter, including output power, reflected power, status of the power amplifier, status of the switching power supply, and parameter settings of the transmitter.



The main interface of the whole machine mainly includes the display of the whole machine system diagram (see the main interface block diagram), which shows the composition of the transmitter in detail through the block diagram, and displays the signal flow direction through interconnection. Display the working status of corresponding components through the colors inside the box. In the middle are the function menu and status. Local represents local control, and displaying green indicates that the current control mode is local control; Scheduled is the timed power on/off mode, displaying gray indicates that the function is not currently enabled; Remote is a remote telemetry function. When it displays green, it indicates that remote control is working and the transmitter switch can be remotely controlled through a PC.

4.3.2 Central Control Board

The main control board is the core of the main control unit, using STM32F407 as the main control chip, equipped with RS232 interface, RJ45 interface, CAN interface, and RS485 interface; Complete human machine interaction function

through RS232 interface, and communicate with other "lower level machines" inside the PC and device through RJ45 interface or RS232.

5. Electric control and distribution unit

5.1 Overview

The electronic control unit consists of two parts: the electronic control processing board and the relay board, which are installed in the 3U chassis at the bottom of the cabinet. Its main function is to receive the power on/off instructions from the main control unit, allocate power supply to each unit, and power on each module according to the required power on sequence.

5.2 Panel layout and functionality

5.2.1 Front panel layout and functions

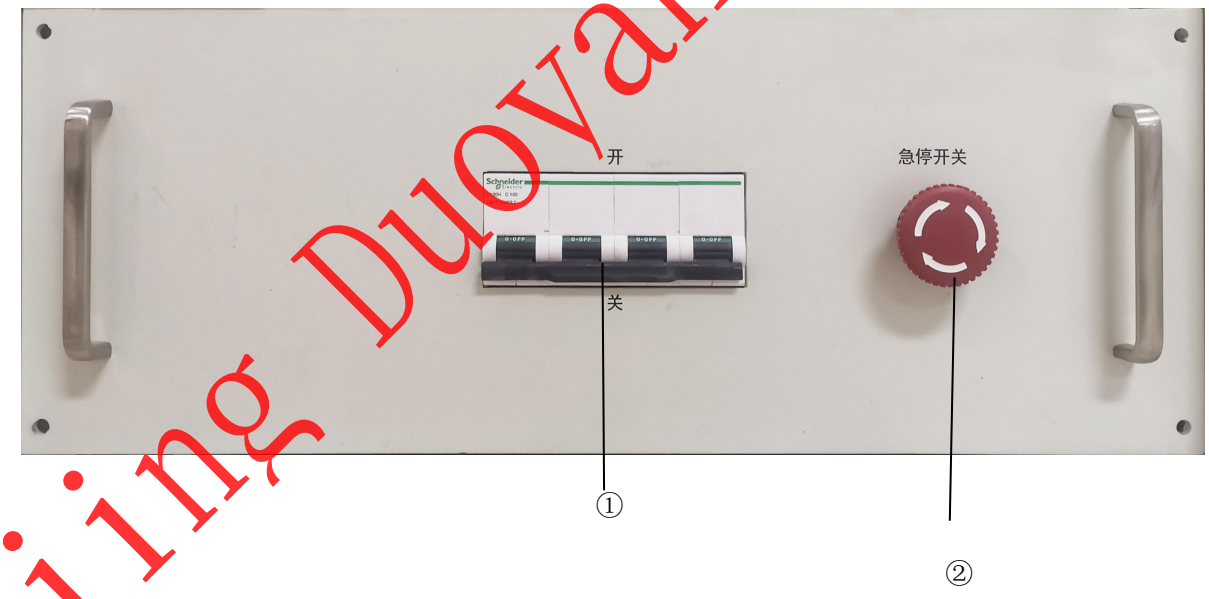


Figure 5-1 Layout of the front panel of the electronic control and distribution unit

① Air switch, AC 380V input main power switch for the whole machine;

② Emergency stop switch, when the transmitter needs to be shut down urgently, press this button to immediately shut down; Clockwise rotation

can restore.

5.3 Layout and functions of electrical control and distribution unit chassis

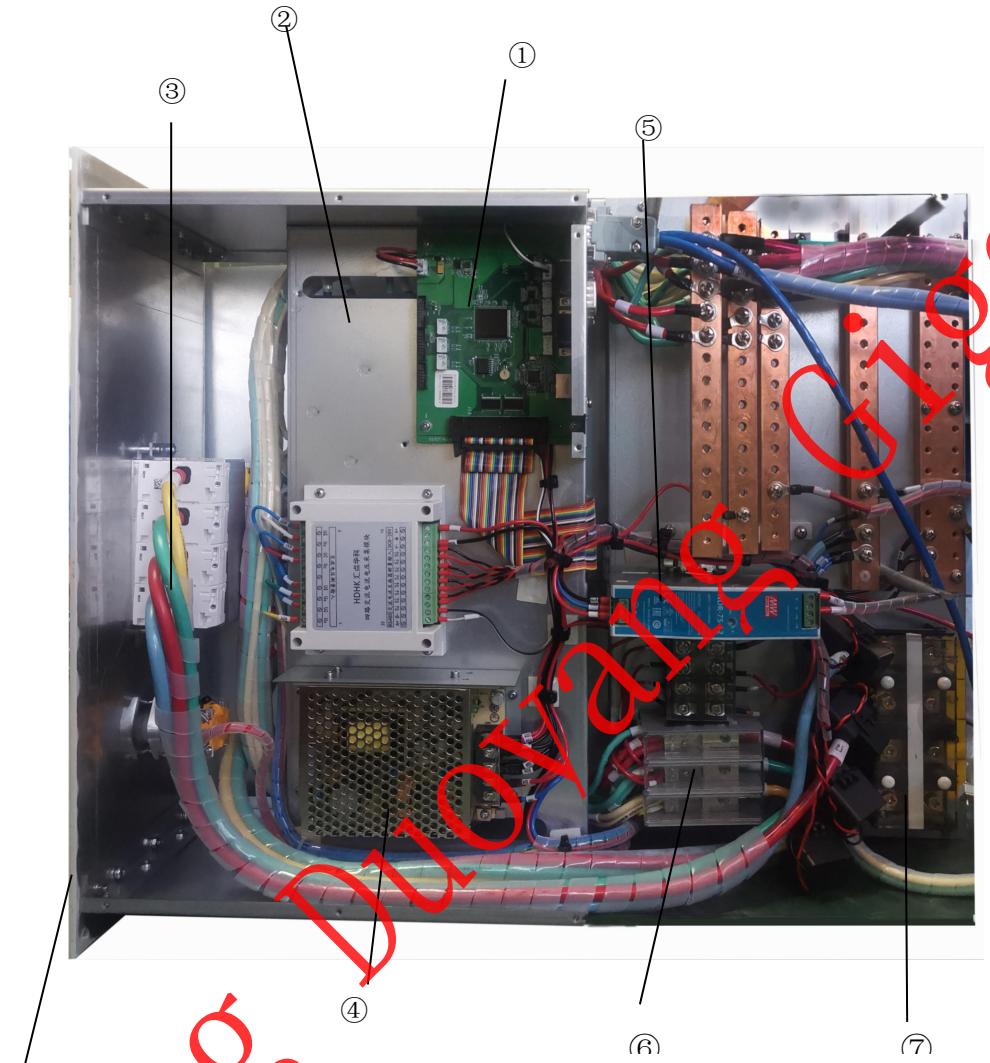


Figure 5-2 Top view of electronic control unit chassis layout

① The electronic control board transmits commands to the relay board.

② Power detection module, used to detect the voltage, current, and whether there are phase loss, undervoltage, and overvoltage signals of three-phase electricity;

③ Air switch, used to control the 380V power supply entering the transmitter.

④ Switching power supply; Provide power to the electronic control board and relay board.

⑤ Switching power supply; Provide power to the control board of the amplifier.

⑥ Splitter; Split the 380V power supply entering the transmitter into multiple channels and send them to the input terminal of the relay board

⑦ Incoming wiring terminal; Used to connect the 380V power supply to the electronic control unit.

⑧ Front panel of the computer case.

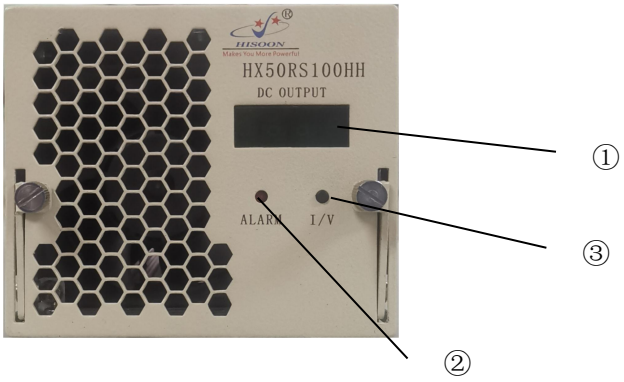
6. Power supply

6.1 Overview

Switching power supply is designed based on the domestic power supply situation and the requirements of the transmitter for power supply. This machine adopts AC380V three-phase four wire balanced input to ensure that the power of each phase is the same.

6.2 Panel layout and functionality

6.2.1 Front panel of switch power supply



① Output voltage/current indication

② Alarm indication

③ Switching of current and voltage display

6.3 Technical index

Output rated voltage	50V
Output rated current	100A
Output voltage regulation rate	≤±0.5%
Output current adjustment rate	≤±0.5%
Peak to peak ripple voltage	≤200mV
Range of input voltage	380VAC±15%(323V~437V)
input under voltage protection point	315V±5V
Output over voltage protection point	54V±1V
Output over current protection point	105A～110A
power factor	≥0.92
Current uniformity accuracy	≥±5%
Output short circuit protection	yes
Lightning protection	yes
conversion efficiency	≥85%
Over temperature protection	80℃±3℃
relative humidity	≤90%
Altitude	≤2000m
Insulation strength	AC1500V

7. Passive Components

7.1 8-way Divider

The whole micro strip eight distributor adopts a multi-stage orthogonal and in-phase cascade method, which can operate over a wide frequency range, Realize uniform synthesis of eight power channels while ensuring high isolation between ports and low reflection coefficient of each port.

Frequency range	30MHz ~ 80MHz
Insertion loss	≤0.35dB(max)
Isolation degree	≥25dB
Reflection loss	≥26dB
Imbalance degree	≤0.2dB (max)
Phase imbalance degree	≤5° (max)

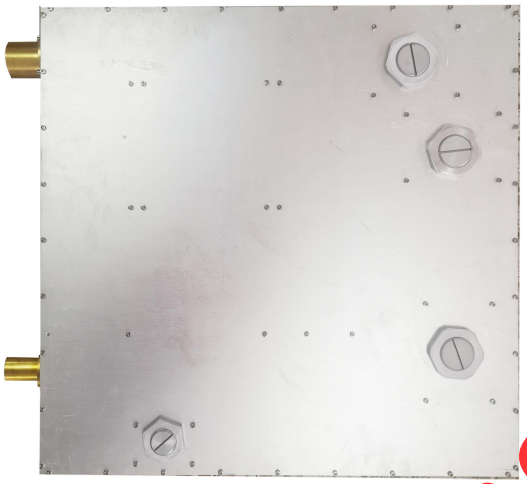
7.2 8-way-Combiner

The strip line eight synthesis also adopts the method of orthogonal and in-phase cascading. Starting from the input port, the first stage is the in-phase synthesis of eight synthesis. Each two inputs are power synthesized through in-phase two synthesis, so there are four outputs at the output terminal. Then, the four outputs are orthogonal synthesized between each two, and then orthogonal synthesized for output.

Frequency	30~80MHz
Insertion loss	≤0.35dB(max)
Isolation degree	≥25dB
Reflection loss	≥26dB
Imbalance degree	≤0.2dB (max)
Phase imbalance degree	≤5° (max)
Input power	≤500W

7.3 Band filter

Using high-order low-pass filters to suppress multiple harmonics, the 30-80MHz frequency band is divided into three sections, with one filter designed for each section. The filter corresponding to the operating frequency is selected through a coaxial switch. Filters can suppress second and higher harmonics, have high power capacity, low insertion loss, and are stable and reliable.



Input output impedance; 50Ω

reflection loss ; ≥ 23dB （VSWR≤1.15 ）

Insert loss; ≤ 0.15dB

Output power(Max); 15KW

Frequency band division of low-pass filter:

The first band: 30MHz ~ 41.6MHz

The second band: 47.6MH ~ 57.7MHz

The third band: 57.7MHz ~ 80MHz

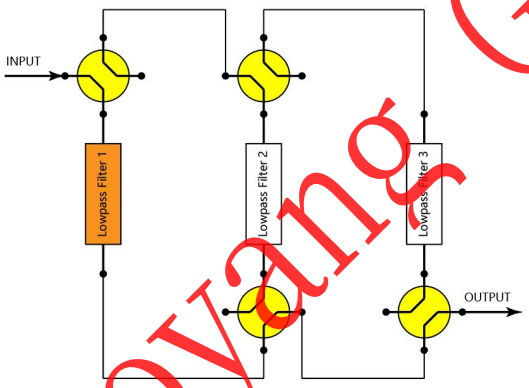
8. Coaxial Switch

8.1 Overview

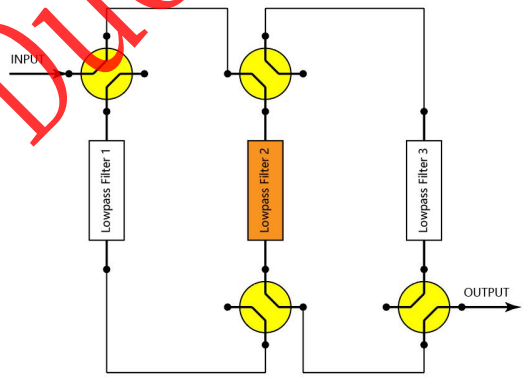
The main function of the coaxial switch group is to be used in conjunction with three low-pass filters to achieve selective connection of the three low-pass filters. Each set of coaxial switch group includes 2 6U coaxial switch cabinets,

each of which contains 2 coaxial switches and a 2U coaxial switch control box. The coaxial switches in the coaxial switch group are made of high-quality copper, silver plated brass, and aluminum alloy, with excellent specifications and extremely low reflection and insertion losses. The coaxial switch group has two switching modes, electric and remote control, and is designed with advanced and complete input and output signal interlocking to enhance the safety and reliability of the entire system. The compact structural design of the entire coaxial switch group has a beautiful appearance.

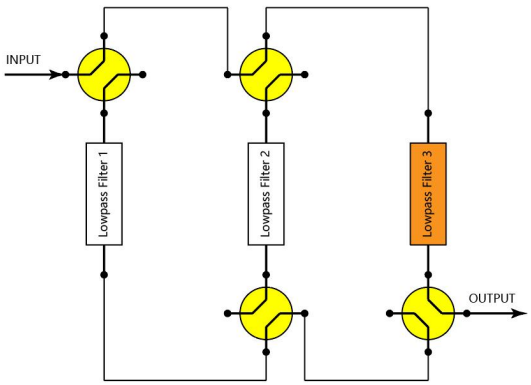
8.2 Schematic diagram of coaxial switch system



Lowpass Filter 1 on-state



Lowpass Filter 2 on-state



Lowpass Filter 3 on-state

9. Cooling system

The cooling of the amplifier unit is achieved by installing multiple axial fans behind the amplifier to extract air and dissipate heat. The cold air from the front panel door inlet of the cabinet is accelerated by the axial flow fan and enters each power amplifier module from the front end face of the power amplifier module heat sink. After heat exchange with the power amplifier module heat sink, the hot air is discharged from the rear door outlet of the cabinet to complete the power amplifier cooling process.