FM Digital Audio Broadcasting 3KW Transmitter

Technical manual

The GME1R33 3KW all solid state stereo FM radio transmitter is a new product . It considers standardization and serialization in appearance and structure, as well as aesthetic effects and practicality. The transmitter has stable and reliable performance, advanced technology, simple operation, and easy maintenance.

1. System Characteristics

- ✧ Advanced technology and design concepts.
- ✧ LDMOS all solid state technology, fully solid state of the whole machine.
- ✧ National patent allocation and synthesis technology.
- ✧ Modular design concept.
- ✧ Parallel redundancy design reduces downtime rate.
- ✧ Parallel redundancy design of power amplifiers: The transmitter has two identical 2000W power amplifiers that can serve as backups for each other and can be replaced at will.
- ✧ Backup redundancy design of power supply: 4 switch power supplies are connected in parallel for current sharing, and the microcomputer monitors the working status of the power supply.
- ✧ Backup redundancy design of exciter: The main exciter and backup exciter are mutually backed up and automatically switched.
- ✧ Intelligent and networked monitoring system.
- ✧ ARM processor control technology with powerful self diagnostic capabilities.
- ✧ Touch screen design, simple and practical operation.
- ✧ Complete data detection technology, monitoring system, and fully functional computer control software.
- ✧ The CAN bus control system is fast and reliable, making it easy to use computer management and monitoring.
- ✧ Complete protective measures to ensure the safe operation of equipment.
- ✧ Adopting high-performance high-power amplifier tubes with an anti standing wave ratio of 65:1.
- ✧ The power amplifier is equipped with protections such as VSWR, temperature, and over excitation.
- ✧ The switching power supply is equipped with over voltage, over current, under

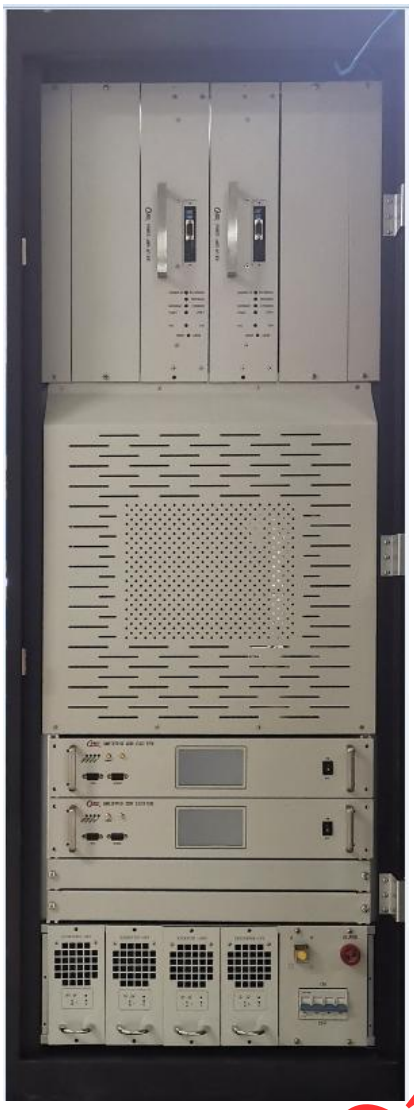
voltage, temperature and other protections.

- ✧ The whole machine is equipped with VSWR, lightning protection, and phase loss protection.
- ✧ Hot swappable technology, convenient for maintenance and operation.
- ✧ Power amplifier unit, hot swappable design for switch mode power supply.

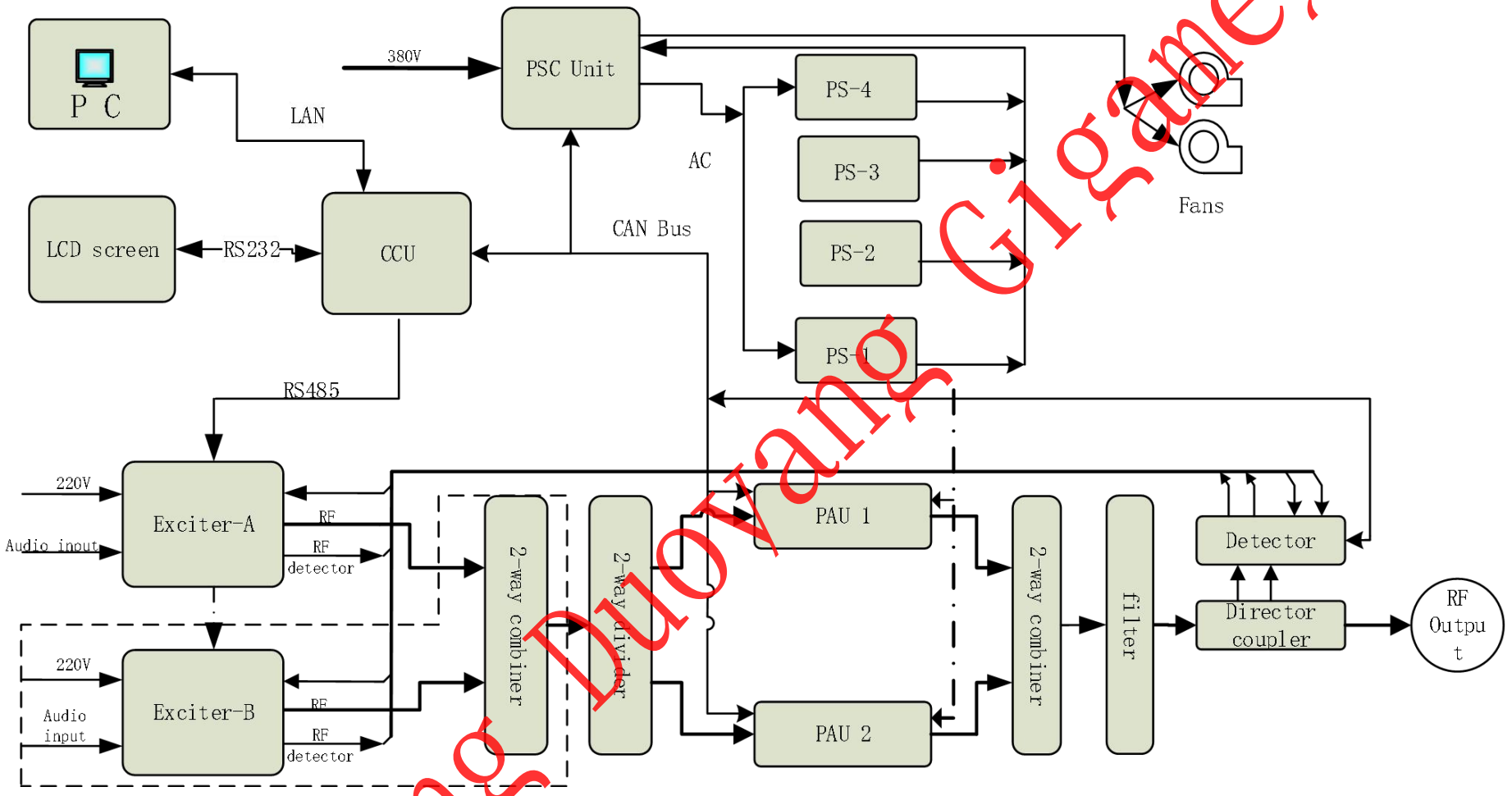
1.1. system composition

The GME1R33 all solid state Digital FM broadcasting transmitter(CDR) mainly consists of five parts: exciter, RF system (including power amplifier, distributor, synthesizer, directional coupler, filter, etc.), control system, air cooling system, and power supply.

Appearance of GME1R33 CDR 3KW transmitter



Internal diagram of GME1R33 CDR 3KW transmitter



Schematic diagram of GME1R33 3KW transmitter

1.2 Technical Parameter

1.2.1 General characteristics

Output power	3KW
Output Impedance	50Ω
Output	EIA 1-5/8"
Frequency	87 -108MHz
Working voltage	380V/50Hz AC
Power consume	≤10KVA
Dimension	600（W）*900(D)*1600(H)mm
Ambient Temperature	5-40℃
Altitude	≤2000m
Relative Humidity	≤95%
Remote	LAN
Audio input	XLR，Balanced or unbalanced
Audio input impedance	600Ω（balance）或 10KΩ
Audio Input Level	-13dBm~+14dBm
AES Input	XLR，110Ω
TS Input 1	LAN
TS 1	BNC，75Ω
10MHz input	BNC，50Ω
1PPS input	BNC，50Ω
TOD input	DB9-K,RS232
Monitor	BNC-K,50Ω
RDS input	BNC 50Ω（optional）

1.2.2 Technical parameters of analog FM stereo broadcasting

No.	Content		Unit	Parameters
1	Residual radiation		dB	<-60
2	Parasitic amplitude modulation noise		dB	<-50
3	Pilot frequency deviation		Hz	0
4	38kHz residual component in S signal		dB	<-45
5	100% modulation frequency offset		kHz	conform to
6	Pre emphasis		50us	conform to
7	Distortion (100% modulation)	L	%	<0.1
		R		<0.1
8	Frequency response (adding/removing duplicates)	L	dB	-0.1~0.1
		R		-0.1~0.1
9	Separation degree of left and right channels Distortion (100%	L	dB	0.0~0.1
		R		0.0~0.1
10	Frequency response (no addition, deduplication)	L	dB	>70
		R		>70
11	Signal to noise ratio (100% modulation)	L→R	dB	>55
		R→L		>55
12	Left and right channel level difference		dB	<0.1

1.2.3 Technical parameters of digital analog working mode

No.	Content		Unit	Parameters
1	Frequency		MHz	87~108
2	Frequency step	MFN	Hz	1
		SFN		1
3	Frequency accurate	MFN	Hz	25
		SFN		10
4	phase noise	@10Hz	dBc/Hz	≤-70
		@100Hz		≤-85
		@1kHz		≤-90
		@10kHz		≤-105
		@100kHz		≤-120
		@1MHz		≤-130
5	Spectrum Mask	-250kHz	dB	≤-90
		-200kHz		≤-89
		-110kHz		≤-85
		-100kHz		≤-50
		100kHz		≤-49
		110kHz		≤-87
		200kHz		≤-90
		250kHz		≤-90
6	In band spectrum compliance		dB	≤0.8
7	Power uniformity between sub bands		dB	≤0.5
8	shoulders		dB	≤-36
9	Out-of-band spurious	Unused transmission power within adjacent channel bands	dB	≤-50
		Unused transmission power outside the adjacent channel band		≤-60
10	RF effective bandwidth		kHz	conform to
11	RF output power stability		dB	-0.2~0.1

12	peak-to-average power ratio	—	conform to
13	MER	dB	≥32

1.3 Exciter (Modulator)

Users can choose to use single or dual exciter configurations. In addition, users can choose other types of actuators as needed, such as CDR standard actuators and other models of actuators provided by the user.

1.4 Control System

The GME1R * * series transmitter control system is a "hierarchical" monitoring system based on CAN and RS485 protocols, Its composition includes:

- First level subsystem: The main control unit (CCU) has CAN, RS485, and RS232 interfaces for lower level subsystems;
- Second level subsystem: amplifier unit, using CAN bus;
- The electronic control unit PCU adopts CAN bus, and its subordinate subsystem is the power management board;
- The output power detection board of the whole machine adopts CAN bus;
- Stimulator (considering the universality of configuring different exciters, RS485 interface is used, and there are two exciters in total);
- Third level subsystem: Switching Power Supply Management Board PSC, which is superior to the Electronic Control Board.
- The GME1R33 control system is the "command" center for the operation of the transmitter, and its functions include transmitter logic control: including on/off operations, etc.
- Equipment fault protection and alarm: such as VSWR, temperature, etc.
- Operation status indication.
- Main working parameter measurement indicators: such as equipment output power, voltage, current, etc.
- Equipment operating parameter settings.
- Communication with remote control device (PC): Receive remote control PC commands, report device working status and parameters.

1.4.1 Central control unit

The central control unit is the center of the entire transmitter control system, responsible for external communication and data collection and control of other sub units within the transmitter. The main control adopts ARM9 as the core processor. The physical structure adopts the method of interface base plate and core small board, which facilitates system maintenance. The main control unit is equipped with the LINUX operating system, so the startup time for power on initialization may be longer than that of a system using a micro controller as the core processing. However, during the operation, multi-threaded work is used, and the real-time processing of problems is stronger than single threaded work of micro controllers.

1.4.2 External interface

The external interfaces of the main control unit include the following types:

1 LAN t: the interface between the transmitter and external monitoring devices, compliant with Ethernet standards.

3 USB : mainly used for downloading software

1 CAN bus interface: used for communication between internal power amplifiers and electronic controls

Data communication (RS485) interface: mainly communicates with the exciter.

Data Communication (RS232) Interface: The main control has three RS232 interfaces for external communication, one of which is used for communication with the touch screen; One is the DEBUG port of the main control, which is also RS232 standard; There is also a reserved interface.

1.4.3 Central control unit function

1. Human computer interaction function: The human-machine interaction of the main control unit can be achieved through the RS232 interface with an external touch screen. By operating the touch screen, one can observe the working parameters of the main components of the system and set the system parameters.

2. Collect transmitter data: Collect overall data and unit data of main components such as

exciters, amplifiers, power supplies, etc; Record transmitter fault information, occurrence time, fault location, and the operator can access the above information from the LCD touch screen display.

3. Control the on/off mode of the transmitter: The GME1R33 transmitter provides two on/off modes, namely manual/automatic mode; In automatic mode, the main control unit provides four on/off modes:

a) Key for power on/off mode: Control the power on/off button on the touch screen;

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

c) Timed power on/off mode TIME: Both the main control unit and the PC can be set for timed power on/off;

d) And there are three modes: "key on/off", "remote on/off", and "timed on/off", which can coexist.

4.User settings

a) System time, accumulated working hours, transmitter local address, transmitter type, exciter type, etc;

The exciter type needs to be manually set, and if set incorrectly, it may cause the transmitter to be unable to read the exciter parameters.

b) Automatic power on/off mode: button KEY, timed TIME, remote REM, and coexistence mode ALL;

c) Timed on/off schedule.

5. Data display: displayed through the touch screen on the front door

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

b) Machine information: power on/off status, incident power, reflected power VSWR、Complete machine malfunction information, etc.

c) Stimulator information: Main state variables of the exciter.

d) Amplifier information: number of amplifiers and power, voltage, current, fault information (temperature, over excitation, VSWR) of each amplifier.

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

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.

d) Operate the exciter, such as changing the operating frequency, output power, etc.

1.5 Electronic Control Unit

1.5.1 Introduction to the functions of the electronic control unit

The external AC 380V three-phase power supply is sent to the transmitter with an AC detection component to test whether the power supply meets the upper and lower voltage limits set by the machine, whether the phase sequence is correct, and whether the power supply is in short supply. If the conditions are met, AC control power supply is allowed to be sent to the electronic control board. The switch power supply provides DC+9V power to the electronic control board and safe low-voltage control DC+12V power to the interlocking relay. Interlocking relays provide users with interlocking contacts to ensure the safety of the transmitter and other equipment used in conjunction during operation. The electronic control board receives instructions from the main controller to control the AC contactor, thereby achieving control over the AC power supply of the entire machine components.

1.5.2 Electric control board

It is the lower computer of the main control unit, and its main functions include:

Whole machine on/off control: In automatic on/off mode, it receives on/off commands from the main control through the CAN bus, outputs on/off control signals to control the corresponding relays in the electronic control unit, and completes the on/off control of various components in the whole machine system. The instructions can be local on/off commands input by the operator through the touch screen, automatic on/off commands timed by the machine, and on/off commands issued by remote control devices,

Data collection for switch mode power supply:

1) Can manage multiple power management boards.

2) Communicate with the power management board through RS485 bus, collect switch power information, and report to the main control.

3) Provide 9V power to the power management board.

Communication with the main control unit: Receive and execute instructions from the main control unit through the CAN bus, and report the on/off status and power supply information to the main control.

1.5.3 Switch control panel

The switch control panel is located at the front and bottom of the device, with three switches and an indicator light installed on the panel. The emission should be placed vertically, with the alarm light at the top and the air switch at the bottom. From left to right are: phase alarm indicator light, automatic/manual switch, and main power switch.

Switch Control Panel

Main power switch: controls the on/off of the AC power supply for the entire machine

Phase alarm indicator light: AC power failure indicator, which is in the "off" state when the power supply is normal. When the AC power supply fails, such as phase loss, phase error, over voltage, under voltage, the indicator light is on.

Automatic/manual switch: GME1R133 provides two on/off modes, namely automatic mode and manual mode. When the switch indicator light is on, it is in automatic mode, and when the indicator light is off, it is in manual mode.

Automatic mode: Perform power on and off operations according to the pre-set program of the device control system, which can be "key control mode", "remote control mode", and "timing mode". Please refer to the introduction of the main control unit.

Manual mode: It is a "life support" power on/off mode designed for equipment. When the equipment control system fails, the power on/off operation can be performed through the

"manual mode". Of course, this mode can also be used when the control system is normal. However, after the "manual mode" is turned on, communication between some units in the equipment and the main control unit is interrupted.

2. RF System

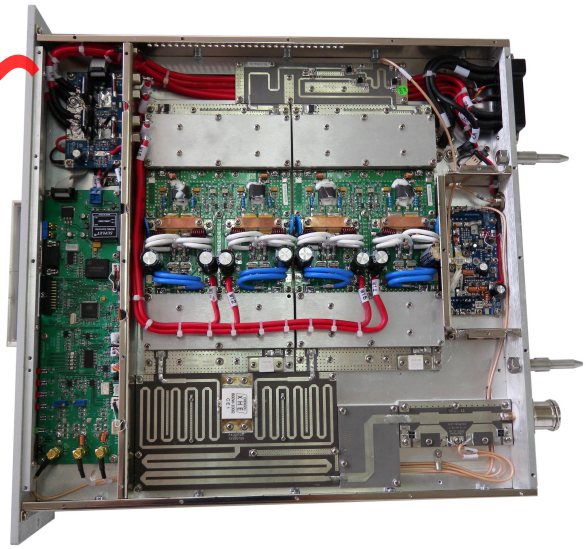
The GME1R33 transmitter RF system can be divided into two parts: active part and passive part; The active part mainly consists of power amplifiers, while the passive part includes distributors, synthesizers, output filters, and directional couplers. In devices with dual exciter configurations, a dual exciter switching unit is required.

2.1 Power Amplifier unit

2.1.1 2kW Power Amplification Unit

The 2kW power amplifier unit mainly consists of RF power amplification, passive power distribution, synthesis, filtering (options), current distribution and sampling, signal detection and control (see amplifier measurement and control instructions), and other parts. As shown in the following figure.

The 2kW amplifier unit(PAU) has temperature, over excitation, overload and other fault protection on the control board. When there is a fault indication, the gate voltage of the excitation amplifier will be turned off to protect the amplifier. Due to the high output power of a single power amplifier unit, the fault protection of the entire system also needs to be coordinated with the exciter interlock.



Inside view of power amplifier unit

frequency range	87~108MHz
Supply voltage	+48V DC
Input interface/impedance	C9-50J
Output interface/impedance	7/8”/50Ω
output power	≥2kW
gain	≥42 dB
efficiency	≥75%
Temperature protection point	70±5ºC
VSWR protection point	VSWR≥2
Over incentive protection point	Increase in incentive power 0.8dB
cooling	Air cooling

2.1.2 Current distribution and sampling

The main function of current distribution and sampling is to divide the DC power supply sent to the power amplifier through the DL29 power supply and signal interface into multiple DC outputs, which are then sampled and supplied to each power transistor separately. The sampling circuit converts the DC current into a voltage signal, which is used to measure the working current of each power transistor.

The GME0R23A power amplifier unit is composed of a front-end power amplifier with a maximum output of 30W, four 600W power amplification modules, and two distributions, synthesis, and directional couplers to form a 2kW power amplifier (please refer to Figure 5-2) with a gain of 42dB and a maximum output power of 2kW. Two of the amplifier tubes are synthesized using an orthogonal bridge method with better isolation characteristics to reduce the mutual influence between the two power amplifier modules.

2.1.3 600W Power amplifier module

The core component of the power amplifier is the LDMOS transistor BLF188XR with 600W output. The circuit is designed in a "push-pull" manner , and the input uses a transmission line transformer to directly convert the single ended signal into a balanced mode. At the same time, it also has impedance transformation function. The output is first impedance

transformed using coaxial wires, and then output through a balanced unbalanced transformation. The system is designed for broadband, with a working voltage of 48V DC, a gain of about 26dB, and a maximum output power of about 600W.

2.2 Passive Components

2.2.1 Divider

The 2-way divider has three ports, one signal input port and two signal output ports. The allocation method adopts orthogonal allocation and in-phase allocation, and uses computer simulation design to achieve uniform distribution of two power channels in a wide frequency range (87-108MHz), with high isolation between each output port and low reflection coefficient at each port.。

- Operating frequency: FM band 87-108MHz
- Insertion loss: ≤ 0.3 dB(max)
- Output port isolation: ≥ 25dB
- Reflection loss: signal input port ≥ 26dB, other ports ≥ 23dB
- Output port amplitude imbalance: ≤ 0.2dB (max)
- Output port phase imbalance: ≤ 5° (max)
- Input power: ≤ 30W
- Signal input/output interface: N-50KF

2.2.2 Combiner

The two in one generator adopts the same working principle as the two in one distributor, with three ports, one signal output port, and two signal input ports. Microwave design software is used for simulation design to achieve one-time synthesis of two power channels over a wide frequency range. The input ports have high isolation and low reflection coefficients. The synthesizer and absorption load are installed in an integrated manner.

- Frequency : FM band 87~108MHz
- Insertion loss: ≤ 0.35dB(max)
- Isolation degree: ≥ 25dB
- Reflection loss: output port ≥ 26dB, other ports ≥ 23dB

- Input power: ⩽ 2kW
- Output power: ⩾ 3kW
- Signal input interface: Direct feed
- Output interface: 1-5/8 " EIA

2.2.3 Pass Filter

- Usage frequency band: 87~108MHz
- Insertion loss: ⩽ 0.15dB
- Standing wave ratio: ⩽ one point one five
- High harmonic suppression: ⩾ 55dB；
- Input/output interface: None (50 ohm microstrip line)

2.2.4 Directional coupler

- Frequency band: FM 87~108MHz
- Coupling degree: Incident sampling and user monitoring sampling: -50dB@98MHz ，
- Reflection sampling: -40dB@98MHz
- Directionality: ⩾ 24dB
- Main road standing wave ratio:< one point zero five
- The input/output ports are 1-5/8 "EIA without flanges
- RF sampling signal interface: BNC-50KF

3. Power supply and cooling system

3.1 Power supply

3.1.1 AC power supply system

The GME1R133 transmitter adopts a 3-phase 4-wire 380VAC power supply, and the AC power supply system includes a distribution unit, a switch control panel, and a lightning arrester on the bottom plate of the equipment. The AC power supply system completes the distribution, control, protection, alarm, and interlocking of the entire machine's AC power supply.

■ Power distribution: The distribution unit provides power to all AC power supply units used in the equipment, including exciters, fans, switch power supplies, etc;

■ Control: The electronic control unit JC2 completes the on/off control of the fan, JC1 completes the switch power supply, and JDQ4 exciter on/off control;

■ Protection: Install a lightning arrester on the equipment base plate to achieve three-level lightning protection for the entire machine; There are phase loss, phase error, AC power over voltage and under voltage protections on the electronic control unit, as well as over voltage, unde rvoltage, and fault protection; In addition, there is an electronic thermal overload relay (electronic over current protection relay) for the fan protection. For detailed settings of electronic thermal load, please refer to the attachment;

■ Alarm: When the AC power supply is protected against phase loss, phase error, ove voltage, and under voltage, the "phase indicator" light on the switch control panel will sound and light an alarm;

■ Interlocking: The design of the electronic control unit ensures the safe operation of the equipment (including the external coaxial switch of the transmitter and the need for load operation), and sets up interlocking contacts. The interlocking contact must be closed when starting up, otherwise the transmitter cannot work, thus protecting the safe operation of the machine and other related equipment. The interlocking contact has a safe 12V voltage.

■ Power on/off: The transmitter can be turned on/off manually or automatically. During automatic operation, the corresponding relay is controlled by the electronic control board to supply power to the corresponding components. In addition, there is a manual emergency power on/off button on the front panel of the cabinet, which is equipped with a light bulb. When the light bulb goes out, it indicates that the transmitter is in the local manual emergency power on state.

3.1.2 Switch Power Supply

The final amplifier of GME1R33 transmitter is powered by a switching power supply, model HX4KVH-50V, input AC 380V 50Hz, maximum output power of 4KW per unit, and efficiency>92%; It has temperature, voltage, current and other protections, and can be hot

swappable; Every switch power supplies can be installed in a power plug-in box (component).

Input voltage: AC 380V

Input power frequency: 50Hz

Maximum output: 80A

Output power: 4000W

Rated output voltage: 50V DC

3.2 Cooling system

The GME1R33 transmitter adopts air cooling , and the components that need to be cooled include the exciter, power amplifier (PA), and+48V switching power supply. The exciter, switch power supply, etc. are equipped with their own internal fans, and the amplifier cooling system fan is located in the middle of the cabinet, using a bottom inlet and top cover outlet method. The main fan adopts a centrifugal fan, which has the advantages of high air volume, high air pressure, and low noise. Considering the stability and redundancy of the transmitter, the 3KW machine adopts two centrifugal fans as backups for each other.