System Integration Manual

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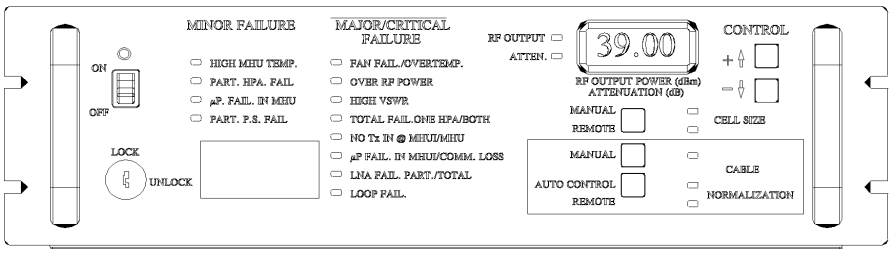

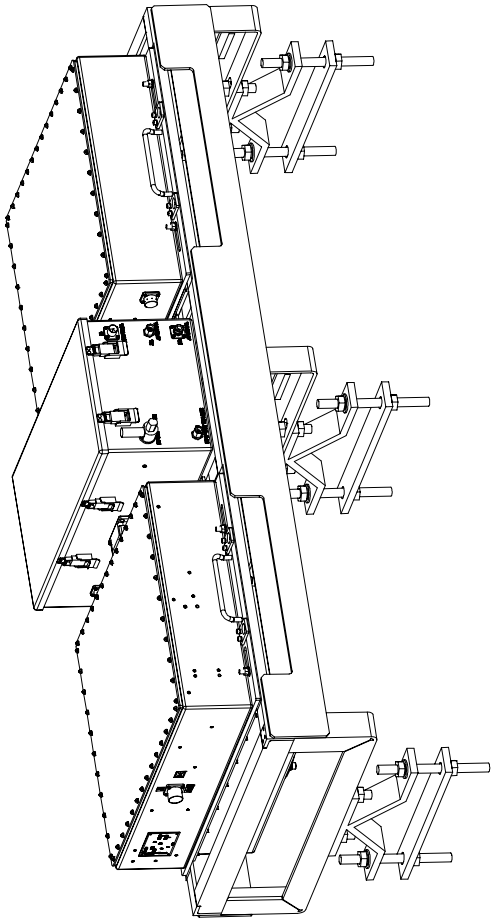

Radio Frequency Front End
Multi-Carrier Power Amplifier System

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Section 1 General Discription

1-1 Introduction

This manual contains information and procedures for installation, operation, and maintenance of the Radio Frequency Front End (RFFE) Multi-Carrier Power Amplifier (MCPA) System. This manual is organized into sections as follows:

Section 1.General Description
Section 2. Installation
Section 3. Operating Instructions
Section 4. Principles of Operation
Section 5. Maintenance
Section 6. Troubleshooting

Appendix B: Amplifier Power Setting Procedure
Appendix C: General Site Survey Form

1-2 General Discription

Designed to compensate for cable loss due to long cable runs, the RFFE uses an AB amplifier that utilizes a pre-distortion technique for linearization (see figure 4-3 for the amplifier block diagram). Designed as a two unit system and equipped with a space diversity path to reduce fading, the RFFE operates in the PCS frequency range of: 1850MHz to 1910MHz (receive) and 1930MHz to 1945MHz (transmit): The system consists of.

- The Masthead Unit (MHU)
- The Masthead Unit Interface (MHUI)

1-2.1 The Masthead Unit

The primary function of the MHU is to provide maximum RF output power (not to exceed 100 Watts) with multiple CDMA carries into a matched 50 Ohm load while maintaining the spectral regrowth and spurious requirements (see table 1-2). Supported by a mounting frame (see figure 1-2), the Mast Head Unit (MHU) is mounted on the antenna tower near the antenna and consists of three modular components; the common box and two RF transmit (Tx) modules. each module is encased in a weatherproof (NEMA 4) housing (refer to table 1-2 for environmental specifications).

1-2.1.1 The Common Box

The common box (see figure 1-4) connects to both Tx modules via blind mate connectors (refer to figure 1-1 and table 1-1). It houses a redundant LNA path, two input duplexers, two output duplexers, two 27VDC (scalable up to 1200Watts) power supplies, and a control board.

1-2.1.2 The Transmitt Modules

Powered by 220VAC from the host breaker panel, the two RF transmit modules are used for redundancy in the system. Each module houses one MPA9505-55 MCPA and a rectifier circuit that reduces the 220VAC to the 27VDC required to operated the amplifier. To aid in maintaining the system's operating temperature, each amplifier is mounted on a heat sink and is equipped with a 220VAC variable speed fan. Refer to figure 1-5.

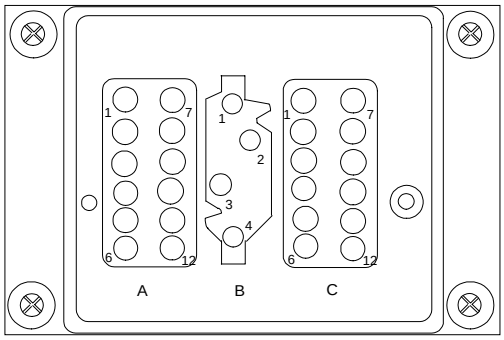
The MHU connects to the Masthead Unit Interface (MHUI) by two RF cables, and one CONTROL cable. Refer to figure 2-6.

1-2.1.3 Masthead Unit Interface

The Masthead Unit Interface (MHUI) interfaces the MHU to the host base station. It provides a user friendly control panel for power level adjustment and display. The control panel is key activated and displays major, critical and minor alarm conditions via LED displays. Refer to section 2 for a more detailed description of the MHUI controls.

The enclosure houses a low power duplexer, a control board, the control panel, cell size variable attenuators (both Rx and Tx) and a preamp. The system reports and displays alarm faults to the external summary module via an RS-485 bus or form C dry contact relays. Refer to figure 4-4 for the MHUI functional block diagram.

The MHU-MHUI pair operates between 1dB and 16dB of cable loss in the transmit/receive coaxial cable. Therefore, the maximum distance between the MHU and MUI depends on the cable type used (e.g. 7/8", 1/2" or 1/4" foam-dielectric coaxial cable).



Note: The Connector Identification (A,B and C) is for reference only and not necessarily labled on the actual connector

Figure 1-1 Masthead Unit Blind mate Connector Interface

Table 1-1 Blindmate Connector Pin Designation

Pin	Function
1A	+26 VDC
2A	+12 VDC
3A	-8 VDC
4A	COM
5A-12A	Not used
1B	Not used
2B	TX IN
3B	TX OUT
4B	Not used
1C	Mute
2C-4C	Not used
5C	RS-485H
6C	RS-485L
7C	COM
8C-12C	Not used

Table 1-2 System Specifications with the MPA9505-55 MCPA

Frequency: Receive Transmit	 1850-1910 MHz 1930-1945 Mhz
RF Input Power	3dBm (2 milliWatts)
RF Output Power:	55 Watts (47.40 dBm) Max./ 7carriers
Nominal Gain	40 dB ±1.0 dB
Typical Gain Flatness	±0.2 dB (over any 2.0 MHz in band)
Gain Variation Over Temperature	1.0 dB @ -20 to 80 ºC Base Plate
IMD Spurious Emissions @ 7 carriers (Room Temperature): Frequency Off-Set ± 885 KHz Frequency Off-Set ± 1.25 MHz Frequency Off-Set ± 2.25 MHz	 -47 dBc max (30 KHz BW) -13 dBm max (12.5 KHz BW) -40 dBc (marker to marker)
IMD Spurious of MCPA in MHU @ Antenna Port: 885 KHz, 30 KHz BW 1.98 MHz, 30 KHz BW 2.25 MHz, 1 MHz BW	 -47 dBc -57 dBc -15 dBm
Spectrum Regrowth of MCPA in MHU @ Antenna Port: 885 KHz 1250 MHz 2250 KHz	 -47 dBc -13 dBm -13 dBm
Tx Noise in Rx Band @ MCPA Output:	-122 dBm/Hz (max.)
Tx Power in Rx Band @ MHUI Rx Output	-110 dBm @ Rated Output Power
Input/Output VSWR	1.3 : 1
Output Protection	Mismatch Protected
DC Power	27 VDC ± 1.0 VDC @ 24 Amps max.
Sample Port	-40 dB ±1.0 dB
Operating Temperature	-20 °C to 85 °C Base Plate
Storage Temperature	-40 ºC to 85 °C Base Plate
Operating Humidity	0-95% (Non Condensed)
Operating Vibration	1.0 GHz from 10 Hz to 150 Hz
Wind Load	125 mph (min.)
NEMA Rating	4
Remote Alarm Reporting	RS-485, Form-C
Receive Band Noise @ MCPA Output	-122 dB
Tx-Rx Rejection	>75 dB
Dimensions	10(H)x24(W)x48(D) inches
Weight (Fully assembled)	29 lbs (13kg)

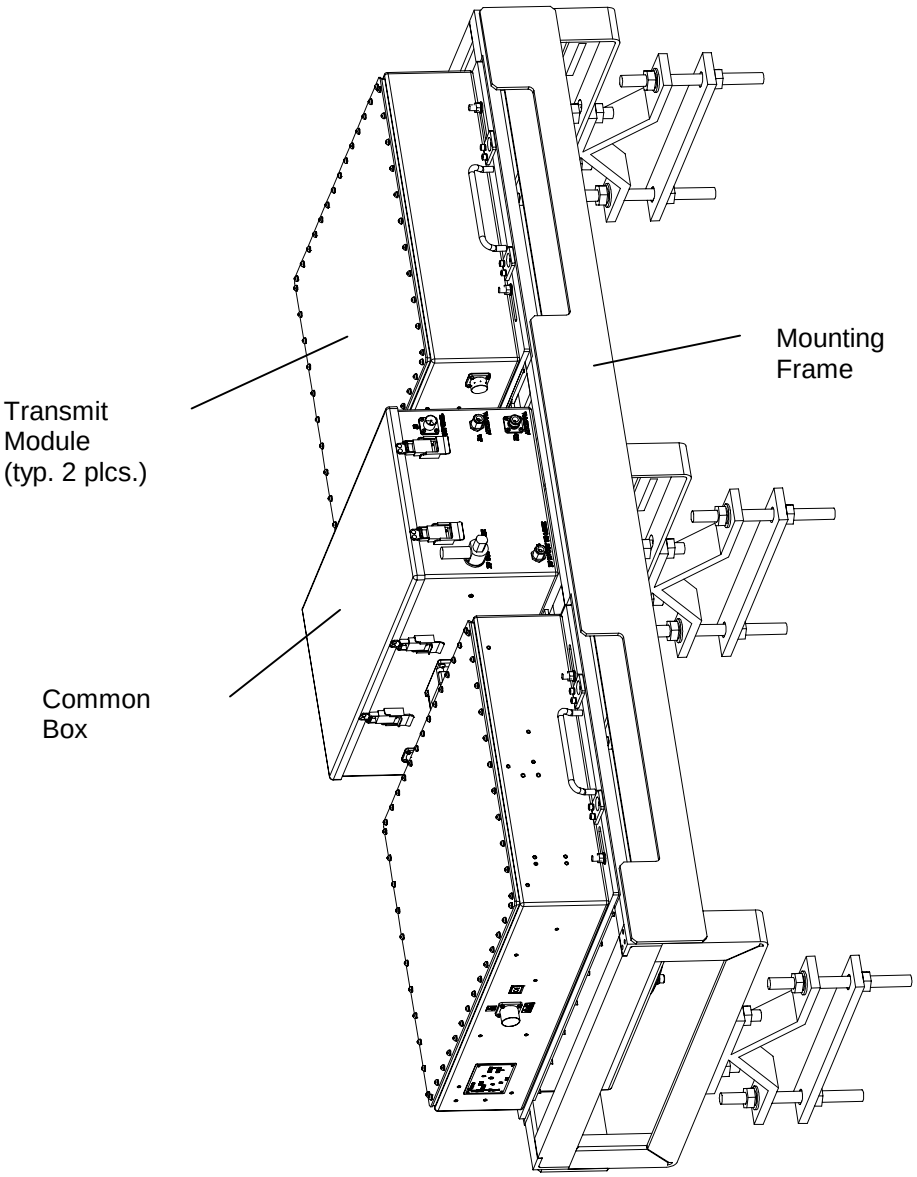


Figure 1-2 The Mast Head Unit with Two Transmit Modules

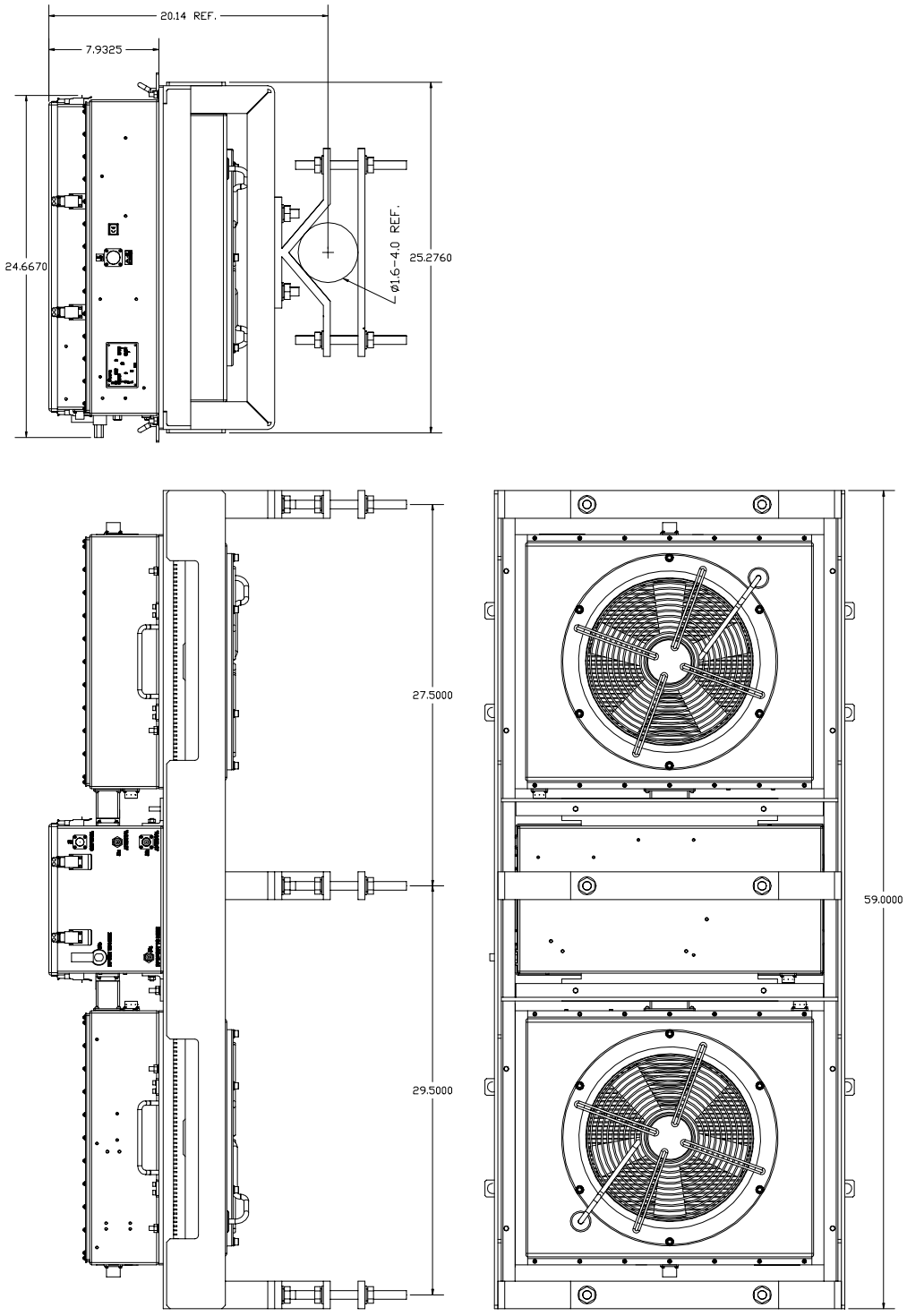


Figure 1-3 Masthead Unit Assembly

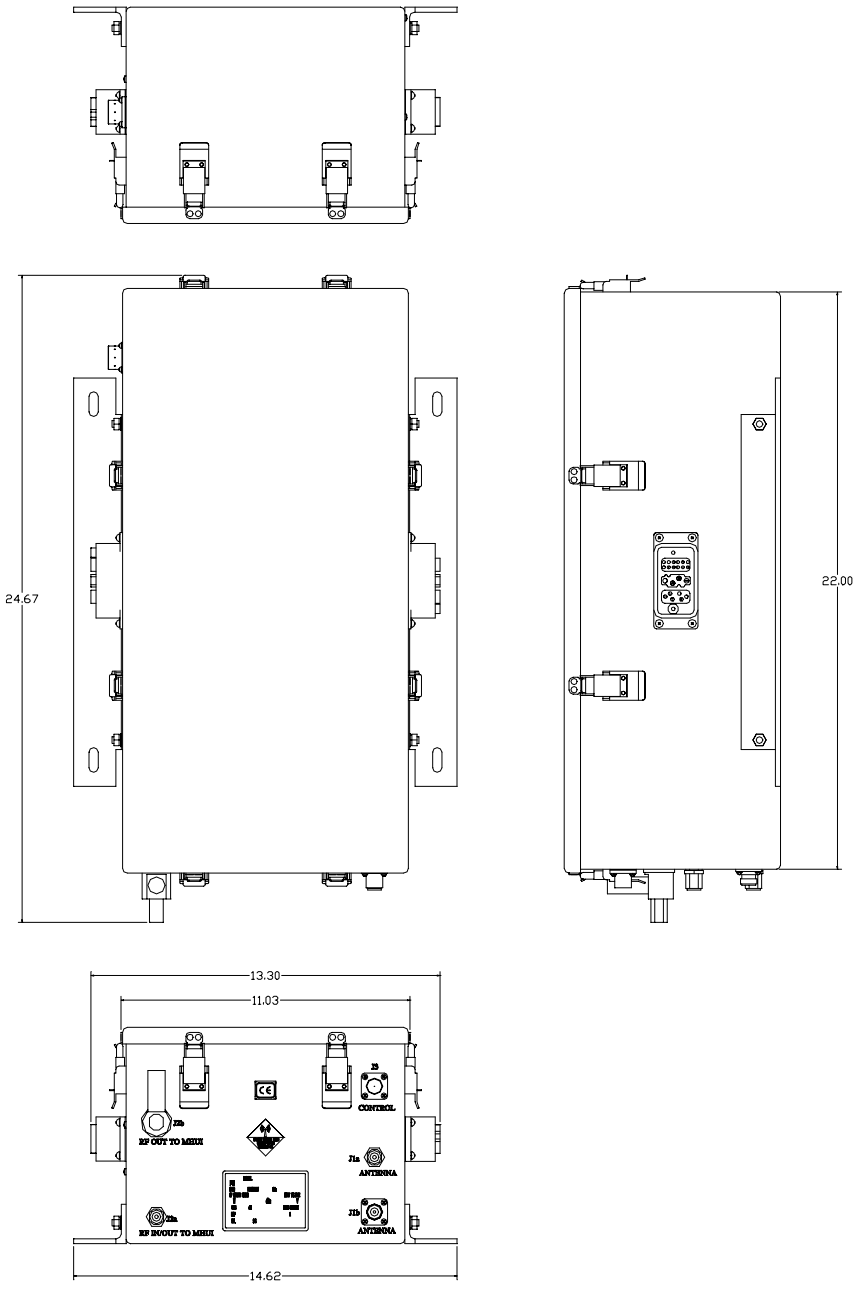


Figure 1-6 The Common Box Assembly

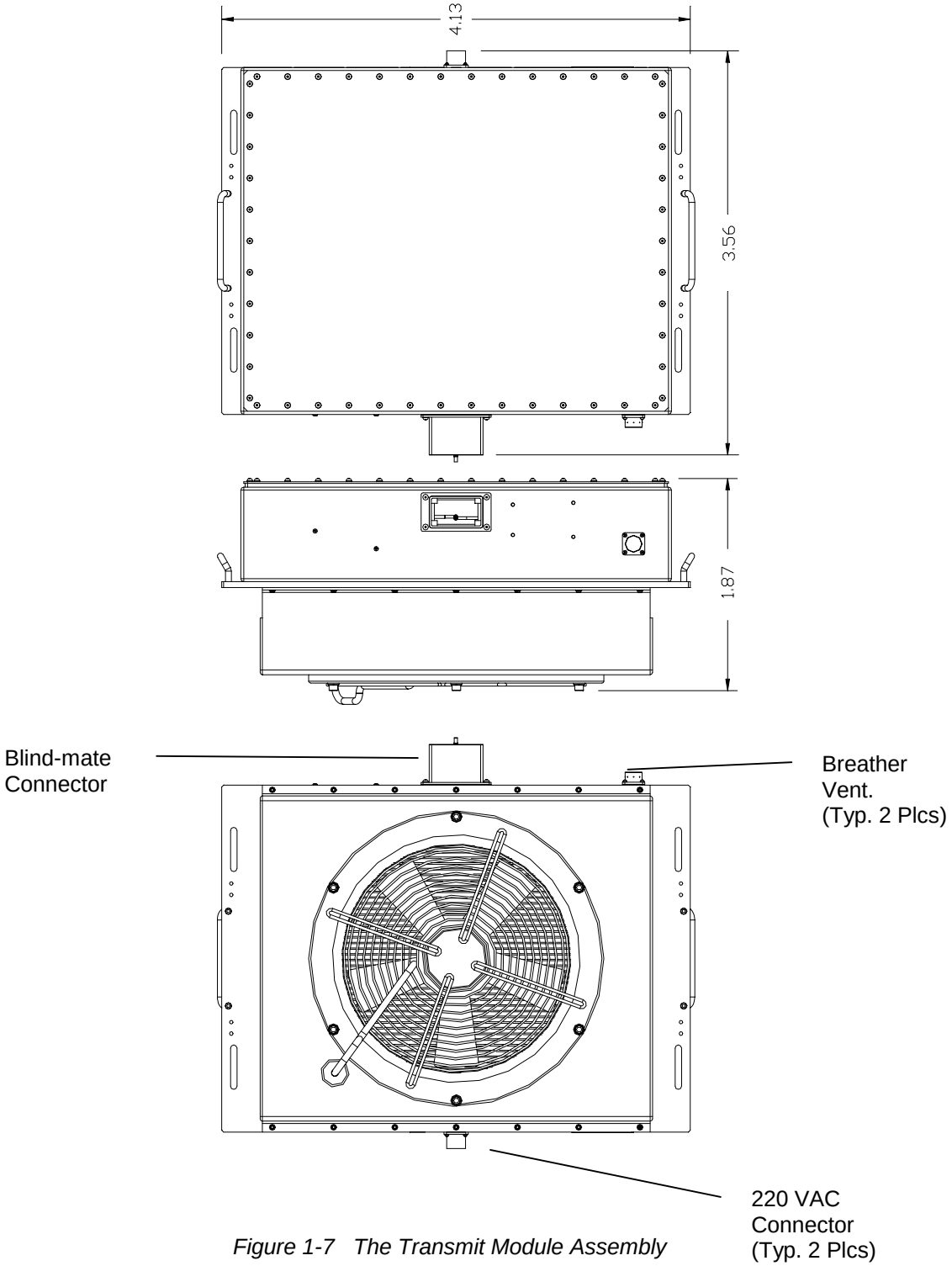


Figure 1-7 The Transmit Module Assembly

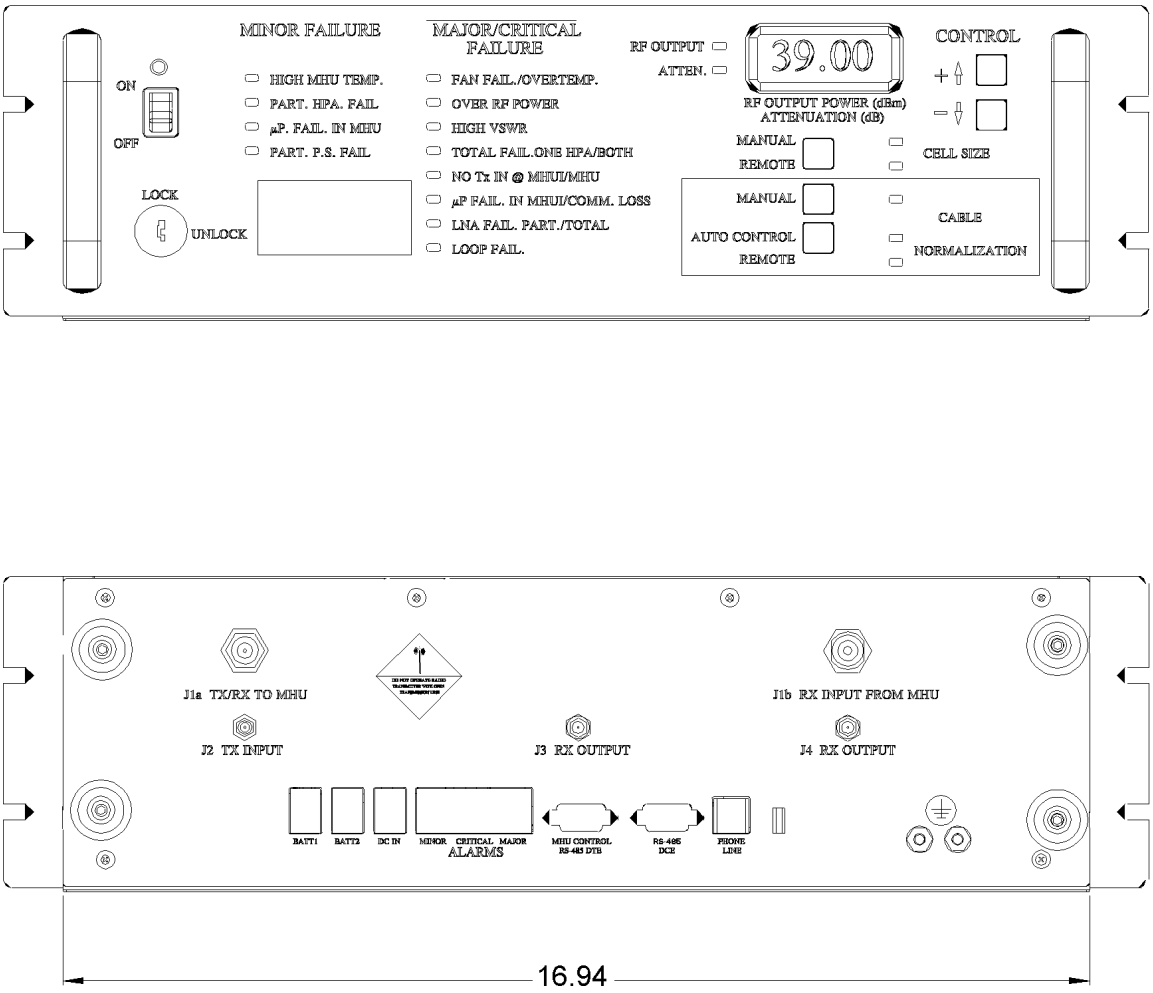


Figure 1-8 Masthead Unit Interface Front and Rear Views.

Section 2 Installation Instructions

2-1 Introduction

This section contains unpacking, inspection, installation instructions and recommendations for the RF Front End (RFFE) System. It is important that the licensee perform the following tasks correctly and in good faith:

1. Carefully read all material in this section prior to equipment unpacking or installation.
2. Also, read and review the operating procedures in section 3 prior to installing the equipment.
3. If applicable, carefully review the Federal Communications Commission (FCC) rules as they apply to your installation. DON'T TAKE CHANCES WITH YOUR LICENSE.

2-2 Site Survey

Powerwave Technologies recommends that site surveys be performed by qualified individuals or firms prior to equipment ordering or installation. Performing a detailed site survey will reduce or eliminate installation and turn-up delays caused by oversights. A general site survey form is provided in appendix B. This form is commonly used by Powerwave field engineers and may be used as a guide. Pay particular attention to power plant capacity, air conditioning needs, RF and AC/DC cabling/breaker requirements.

2-3 Electrical Service Recommendations

Powerwave recommends that:

- Proper AC line conditioning and surge suppression be provided on the primary AC input to the +27 VDC power source.
- All electrical service should be installed in accordance with the National Electrical Code, any applicable state or local codes, and good engineering practice.
- Straight, short ground runs be used.
- The electrical service must be well grounded.

Circuit breakers should be capable of handling the anticipated inrush current, in a load center with a master switch.

2-4 Air Conditioning

An air-conditioning unit is not required for this Powerwave Equipment.

2-5 Unpacking And Inspection

This equipment (as applicable) has been operated, tested and calibrated at the factory. Carefully open and remove the Masthead Unit (MHU) components (2 transmit modules, 1 common box and 1 mounting frame assembly with associated mounting hardware) and Masthead Unit Interface (MHUI) from their respective containers. Retain all packing material that can be reassembled in the event that the unit must be returned to the factory. Please perform the following steps:

CAUTION

Exercise care in handling equipment during inspection to prevent damage caused by rough or careless handling.

1. Visually inspect the MHU components and the MHUI for damage that may have occurred during shipment.
2. Check for evidence of water damage, bent or warped chassis, loose screws or nuts, or extraneous packing material in the connector(s).

CAUTION

Before applying power, make sure that all connectors to the Units are secure. Make sure that the input and output of the units are properly terminated at 50 ohms. Do not operate the system without a load attached. Refer to section 1, table 1-1 for input power requirements. Excessive input power may damage the equipment.

If possible, inspect the equipment in the presence of the delivery person.

If the equipment is damaged:

- The carrier is your first area of recourse.
- A claim should be filed with the carrier once the extent of any damage is assessed.

We cannot stress too strongly the importance of IMMEDIATE careful inspection of the equipment and the subsequent IMMEDIATE filing of the necessary claims against the carrier if necessary.

If the equipment is damaged and must be returned to the factory:

- Please write or phone for return authorization. Refer to section 6-3.1 for instructions.
- Powerwave may not accept returns without a return authorization.

Claims for loss or damage may not be withheld from any payment to Powerwave nor may any payment due be withheld pending the outcome thereof. WE CANNOT GUARANTEE THE FREIGHT CARRIER'S PERFORMANCE

2-6 Installation Instructions

The RFFE Mast Head Unit (MHU) is designed for installation on the antenna tower. The host equipment must permit access to the MHU for AC, monitor and RF cables. Proper ventilation is also required. Powerwave recommends that the MHU be clamped directly to the antenna pole (see figure 1-3 for mounting frame dimensions). A pole extension may be necessary for some cell sites. However, if the MHU is mounted to a surface, ensure that there is a minimum clearance of six inches between the mounting surface and the fans to allow for proper air circulation.

The RFFE Mast Head Interface (MHUI) is mounted in the host base station cabinet or rack. The base station enclosure must permit access to the MHUI for; DC power, RF and monitor cables. Proceed with the installation instructions as follows:

WARNING

Verify that the ON/OFF switch on the MHUI is in the OFF position. Turn off external primary AC and DC power before connecting power cables.

1. Install the MHUI into the host base station and secure it into place using #10x32x1/2 Phillips screws and #10 flat washers.
2. Before assembling the MHU, inspect the blind mate connector on the common box and transmit modules. Verify that the pins are straight, and that the alignment shield is not bent.
3. Turn off the 220 VAC circuit breaker that feeds the transmit modules.

WARNING

Do not slam the transmit modules into the common box. Forcing the modules into the housing at too fast a rate may cause inproper connection or damage to the connector.

4. Clamp the MHU frame to the antenna tower (see figure 1-4 for frame dimensions).
5. Place the common box into it's location on the MHU frame (see fiqure 1-1). Secure in place with the supplied screws.
6. Place a transmit module on the MHU frame. Slide the module toward the common box until it locks into place with the blind mate connector on the common box. Tightened down with the supplied screws.
7. Repeat step 5 for the second transmit module.
8. Connect the RF cables to the MHU.
9. Connect the 220 VAC power cable from the host base station's AC power breaker panel to the MHU. Refer to figure 2-1 and xx and table 2-1 for pin designations.
10. Connect the TX/RX TO MHU (J1a) on the MHUI to the RF IN/OUT TO MHUI (J2a) port on the common box.
11. Connect the RX INPUT FROM MHU (J1b) port on the MHUI to the RF OUT TO MHUI (J2b) port on the MHU.
12. Connect the TX INPUT (J2) port on the MHUI to the TX IN port of the host base station.
13. Connect the RX OUTPUT (J3) on the MHUI to the Rx OUT port of the host base station.
14. Connect the J4 RX OUTPUT on the MHUI to the Rx DIVERSITY OUT on the host base station.
15. Connect the MHU CONTROL cable on the MHUI to the CONTROL (J3) port on the MHU. Refer to figures 2-1 and 2-2 and tables 2-2 and 2-5 for pin locations and pin designations.
16. Lift the safety cover on the MHUI DC IN terminal board and connect the dc power cable. There is no polarity on the terminal board, therefore it doesn't matter which pin you connect to. Refer to figure 2-5 and table 2-6. Replace the safety cover.
17. Remove the safety cover from the BATT1 terminal board and connect the host battery back-up cable. There is no polarity on the terminal board, therefore it doesn't matter which pin you connect to. Refer to figure 2-1 and table 2-1. Replace the safety cover.
18. Repeat step 17 for the BATT2 connection.
19. Remove the plastic cover from the alarms terminal board. Connect the alarm cables to their appropriate terminal. See figure 4-4 for pin locations designation.

WARNING

Check your work before applying AC and DC voltage to the system. Make certain all connections are tight and correct.

Measure primary DC input voltage. DC input voltage should be +26 VDC ±1.0 Vdc. If the DC input voltage is above or below the limits, call and consult Powerwave before you turn on your amplifier system.

Refer to section 3 for initial turn-on and checkout procedures.

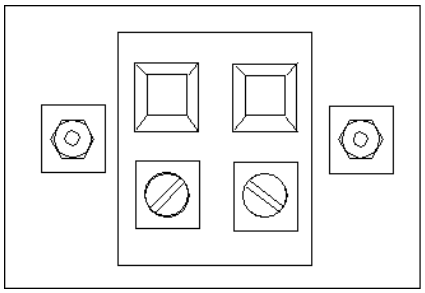


Figure 2-1 DC IN, BATT1, BATT2 Terminal Board Layout

Table 2-1 DC IN, BATT1, BATT2 Terminal Designations

Terminal Point	Designation
No Polarity	27VDC
No Polarity	27VDC RTN

2-7 MHU Power, Alarm, Control, and RF Connector

2-7.1 MHU Power

The system 220VAC power is routed to the MHU via the host circuit breaker panel then to the J5 connector on the Tx module (refer to figure 1-5 for the connector location and figure 2-1 and table 2-1 for the connector pin location and designation. The 220VAC is internally routed to the fans and the module's rectifier (power supply) circuit that reduces the 220VAC signal to the 27VDC needed to power the amplifier. The power supply circuit also generates the +12VDC and –8VDC used to power the MHU internal components.

The amplifier alarm system from the MHU to the MHUI is routed by way of the common box assembly. Connections on the amplifier are made through the blind mate connector. Refer to table 2-3 for a description of the alarms and controls.

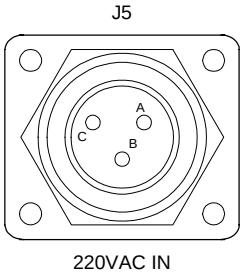


Figure 2-2 220VAC Input Connector

Table 2-2 220VAC Pin Designation

Pin	Designation
A	Line
B	Line
C	Neutral

Table 2-3 MCPA Alarms & Controls

Items	Specifications	Remarks
Alarms & Controls	TTL Level; +5 Volts Buffer: 74ABT244 (5V) - recommended	
Deletion Alarm	When unit does not exist (HEAR_PAU) Equipped: GND Deletion OPEN	D-Line
Function Fail Alarm	When unit does not exist (HEAR_PAU) Normal: High Abnormal GND	D-Line
VSWR Alarm	3:1 (6dB ± 1dB) @ 35dBm-48dBm Output Power. PAU remains normal operation when this alarm condition disappears (NOT shutdown)	RS-485
High Temp. Alarm	This alarm only at +75ºC. +5 ºC/-0 ºC	RS-485
Over Power Output Alarm	@output power is greater than +48.5 dBm ±0.5dB. MCPA will recover when the alarm condition disappears. (NOT shutdown).	RS-485
DC Fail Alarm	@ +20.5 Vdc ± 0.5V or +29 Vdc ± 0.5V. When this alarm occurs the MCPA shall shut-down	RS-485
Loop Fail Alarm	When an alarm occurs on the feed forward path.	RS-485
EN/DISABLE	Reserved	RS-485

The Alarm Interface connector on the back of the MHUI is a 9-pin female D-sub connector that permits serial interface with the external alarm monitor. Refer to figure 2-3 and table 2-3 for connector pin definition.

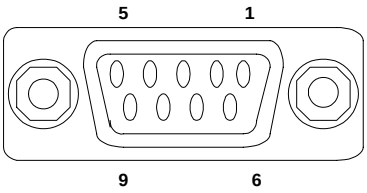


Figure 2-3 MHU Control, RS-485 DTE Connector

Table 2-4 MHU CONTROL Connector Pin Designations

Pin	Designation
1	RS-485H
2	RS-485L
3	Common

2-8 Remote Control and Status

2-8.1 RS-485 Physical Layer

The MHUI supports an RS-485 differential serial asynchronous communications link operation at 9600 baud, 1 bit start, 8 bit data, 1 bit parity, 1 bit stop bit, no parity. The MHUI port supports redundant RS-485 drivers and receivers; the active driver and receiver pair shall be selected by the state of the supplied RS_485_SEL lines available at the MHUI alarm terminal board. The MHUI serves Addreses 10h to 13h. The MHUI terminates the RS-485 differential receive and

transmit lines with 120 ohms. Because this communications bus is also shared with other system resources, the MCPA supports the following asynchronous packet format communications protocol.

The Low Speed Bus (LSB) 1 and 2 are selected by the following truth table:

Table 2-5 The LSB 1 and LSB 2 Selection Truth Table

LSB	RS_485_SEL_H	RS_485_SEL_L
1	1	0
2	0	1

2-8.2 Asynchonous Packet Protocol

The following protocol or similar to support duplex operations of two antennas. The packet format used for both commands and responses is as follows:

Table 2-6 Asychronous Packet Protocol

Byte	Field	Description
0	Source ID	Address of Source
1	Destination ID	Address of Destination
2	CMD/ECHO	Command/Echo field
3	LEN	Length of transparent binary Data field bytes
4	ADDITIVE CSUM	Checksum of all preceding and Data bytes
5 to 4+ LEN	Data	LEN data bytes for LEN>0, LEN<256

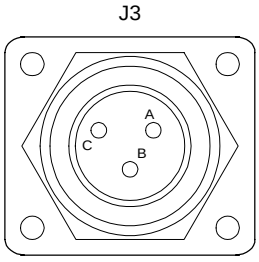


Figure 2-4 J3 CONTROL Connector

Table 2-7 J3 CONTROL Connector Pin Designation

Pin	Designation
A	RS-485H
B	RS-485L
C	Common

2-9 Commands to the MHUI

The CMND/ECHO byte is used to send commands from the host to the MHUI as follow:

Table 2-8 CMND/ECHO comands from the Host to the MHUI

Byte	Command
LEN=00H; CMND/ECHO=	
00H	Report base status
01H	Enable HPA in MHU and report and report base status
02H	Disable HPA in MHU and report base status
03H	Report extended status
04H	Interrogation of temperature in MHU at HPA heat sink
05H	Interrogation of RF-output power at MHU HPA output
06H	Interrogation of RF-input power at the MHU HPA input
07H	Interrogation of RF-input power in the MHUI at TX path after the cell size attenuator
08H	Interrogation of current cable normalization attenuator settings in MHUI
09H	Interrogation of current cell cell size attenuator settings in the MHUI
0AH	Interrogation of current MHUI attenuator control status for cell size and cable normalization
0BH	Interrogation of (last) manual adjustment value for the cable normalization
0CH	Interrogation of (last) manual adjustment value for the cell size attenuator
0DH	Switch off remote control of cable normalization attenuators, switch on manual mode and and report ext. status. The LED for remote control shall be switched off and the LED for manual controll shall be switched on. Use last stored manual adjustment value.
0EH	Switched off remote control of cable normalization attenuators, switch on automatic mode and report ext. status. The LED for remote control shall be switched off and the LED for auto control shall be switched on. Use last stored value calculated by the automatic control alogorithm.
0FH	Switch off remote control of cable normalization attenuators, switch on mode, which was valid before switching to remote control and report ext. status. The LED for remote control shall be switched off and the LED for automatic control or manual control shall be switched on. Use last stored manual adjustment value.
10H	Switch Cell Size control to manual and report ext. status. Illuminate front panel LED for manual cell size setting, switch off front panel LED for remote cell size setting. Use last stored manual adjustment value.
11H	Report extended Status and then rest MHUI and MHU. Restart with default settings.
LEN=01H CMD/ECH=	
12H	Remote control of cable normalization attenuator: Stop automatic or manual setting of the attenuator and use fixed value in data byte. Illustratie front panel LED for remote cable normalization. Store current attenuator value for later usage.
13H	Remote control of cell size attenuator: Stop manual control of cell size attenuator use value in data byte. Illuminate front panel LED for remote cell size setting Store current attenuator value for later usage.
CMD/ECH= 14h-FFH	Reserved

2-9.1 Responses from the MHUI

The MHUI responses always echo the received CMND byte as the ECHO byte of the response packet. Amplifier base status is reported by setting the LEN field to 01H and reporting the following bit mapped byte in the data field of the response packet for CMD==00h, 01h, 02h base status.

Table 2-9 Bit Mapped Byte in the Data Field fo Response Packet for CMD==00h, 01h, 02h Base Status

Byte	Specification
b0	1=High VSWR shutdown/0=normal
b1	1=High Temperature condition/0=normal
b2	1=Over-temperature shutdown/0=normal
b3	1=Partial Power supply fail at MHU/0=normal
b4	1=Fan fail at MHUI, if fan is implemented/0=normal
b5	1=Over Power shutdown/0=normal
b6	1=Fan ON/0=Fan OFF (if fan is implemented in the MHUI, else 0)
b7	1=Amplifier Enable/0=Amplifier Disabled

NOTE

In case of RF overpower and high VSWR the shutdown condition will be alarmed only after three unsuccessful attempts of self recovery.

Table 2-10 Bit Mapped Byte in the Data Field for Response Packet for CMD==03H, 0DH, 0EH, 0FH, 10H or 11H Report Extended Status

Byte	Specification
b0	1=partial failure HPA/0=normal
b1	1=partial failure LNA/0=normal
b2	1=total failure HPA/0=normal
b3	1=total failure LNA/0=normal
b4	1=Loss of communication between the MHUI and MHU/0=normal
b5	1=High VSWR warning (>3:1)/0=normal
b6	1=No TX input signal at MHUI/0=normal
b7	1=No TX input signal at MHU/0=normal

For CMD=04…0CH the data field contains the according value with the least significant bit at b0. Depending on the length not used higher bits are filled with0.

Reply for command 0H4 (data field):

00H= -40 ºC, 1 ºC steps, 88H = +90 ºC

FEH< -40 ºC , FFH > +90 ºC

Reply for commands 05H, 06H and 7H (data field):

00H= -10 dBm, ¼ dB steps, FFH = 53 ¾ dBm

Reply for commands 08H, 09H, 0BH and 0CH (data field):

Cell size attenuator:

00H= full attenuation 20dB, FFH= no attenuation 0dB, step size 20/255 dB

Cable normalization attenuator:

00H= full attenuation 20 dB, FFH= no attenuation 0dB, step size 20/255 dB

For commands 12H and 13H the value in the data byte is defined in the same way as above for cell size and cable normalization respectively.

Table 2-11 MHUI Attenuator Control Status for: CMD==0AH

Byte	Specification
b0	1=manual cell size control on/0=normal
b1	1=remote cell size control on/0=normal
b2	0=normal
b3	1=remote manual cable normalization on/0=normal
b4	1=automatic cable normalization algorithm on/0normal
b5	1=remote cable normalization on/0 =normal
b6	0=normal
b7	0=normal

For RF output power, temperature and attenuator values the MHUI shall submitt a rounded value as long as the exact value is not available.

MHUI responses MUST commence within 50 ms (0.050 sec.) of reception of a valid command (poll).

2-9.2 Hardware Reset

Reset both MHU and MHUI and restart with default settings. Refer to table 2-12.

Table 2-12 Default Settings

Reset	**Default Setting**
Power Recovery	Last known status
Hardware Reset	Last known status
Manual Reset by Front Panel Bottons	Press manual buttons for cell size adjustment, manual button for cable loss normalization and the button for automatic control simultaneously Reset to initial factory preset
Software Reset via RS-485	Last known status
Initial Factory Preset	Cell Size Attenuator and Cable loss normalization attenuator at max. attenuation (20dB for cable normalization attenuator, 20dB for cell size attenuator) Set front panel display to FFF No LED is illuminated

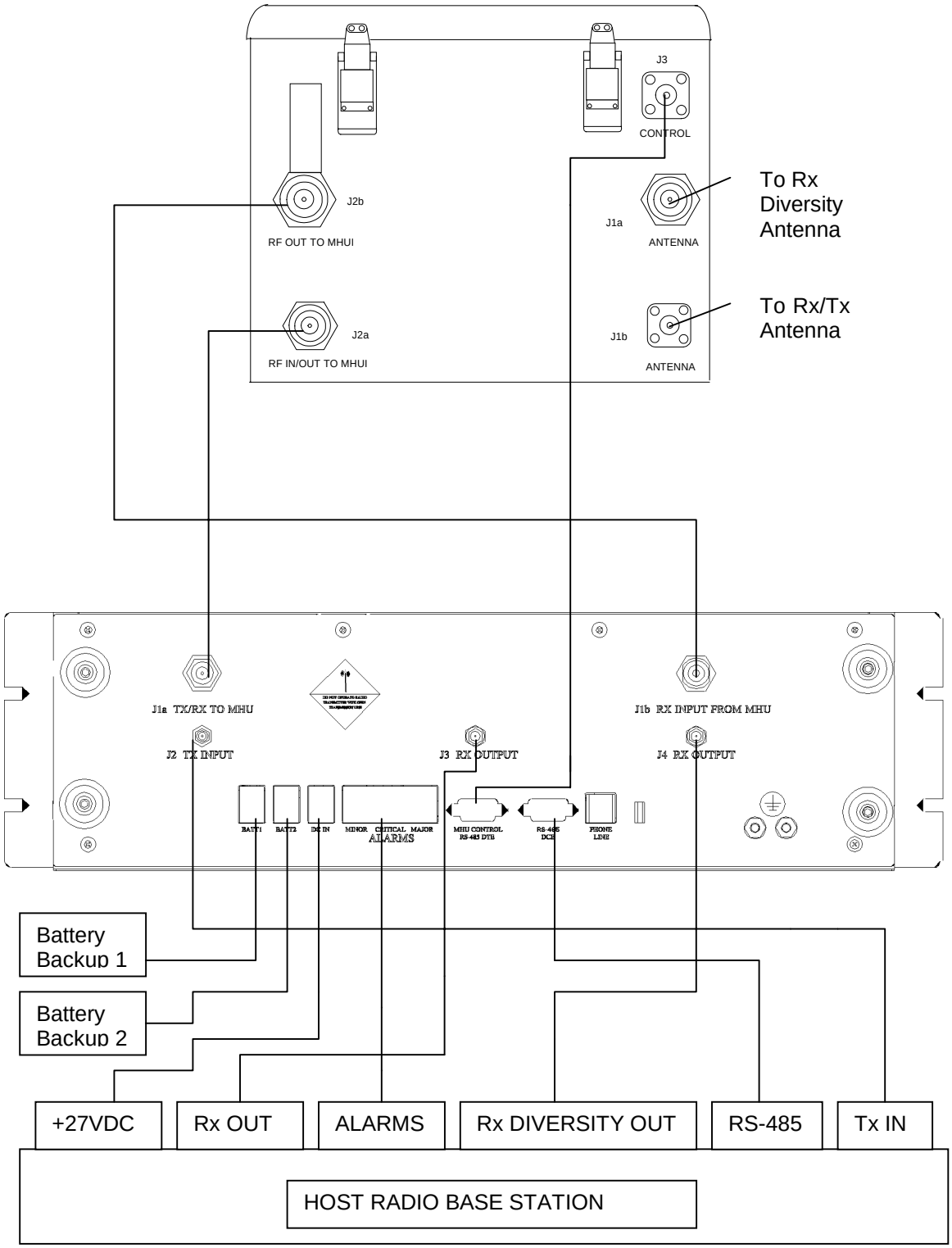


Figure 2-5 System Interconnect Diagram

Section 3 Operating Instructions

3-1 Introduction

This section contains operating instructions for Powerwave's RF Front End system.

3-2 Location and Function of the MHU and MHUI Controls and Indicators

The Masthead Unit (MHU) is not equipped with controls or indicators. Instead, the MHU interfaces with the host base station by way of the Masthead Unit Interface (MHUI). The location of the controls and indicators for the MHUI are shown in figure 3-1. And described in detail below.

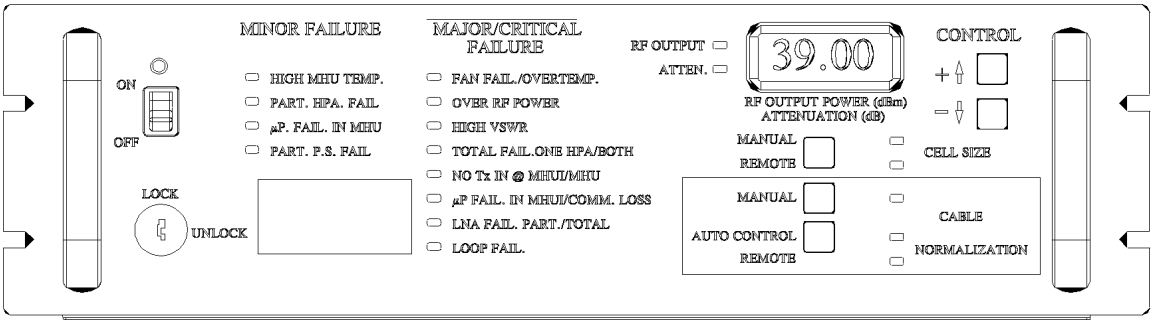


Figure 3-1 MHUI Control Panel

3-2.1 Main Power

The MHUI has a main power switch/circuit breaker and a +24 VDC power indicator (LED) to indicate the power is cycled on the MHUI:

- The MHU amplifier alarm signal enters the amplifier in the DISABLED state and reports the status as amplifier disabled.
- Except when the service loop shows continuity, in which case the MHU alarm signal will enter the amplifier in the ENABLED state, unless faults or alarms would prohibit entry to such state.

3-2.2 Enable/Disable of Front Panel Functions

The front panel functions of the MHUI are key protected with the exception of the output power display, monitoring alarms and main power switch.

3-2.3 MHUI Cell Size Attenuator Settings

The MHUI cell size setting is performed either manually or by remote control. This is indicated by one of two LEDs illuminated.

At the front of the MHUI a push-button switch is used to enable RF power adjustments for cell size. If the cell size is controlled by remote and if there is any manual adjustment via the front-panel, the mode will be manual until a new RS-485 command is received. The attenuator adjustment range is between 0 and 20dB.

3-2.4 MHUI Cable-Normaliztion-Attenuators Settings/Cable-Normalization-Mode Selection Buttons

The MHUI cable normalization attenuator setting is performed either manually or by remote control or by an automatic control algorithm. This is indicated by one of three LEDs illuminated.

At the front of the MHUI a push-button switch is used to enable the manual setting of the cable loss normalization attenuators, which are adjusted together with the same push-button switch as used for manual cell size adjustment.

At the front of the MHUI a push-button switch is used, which enables the automatic control algorithm for cable normalization. If the cable normalization attenuator is being controlled by remote and if there is any manual adjustment via the front-panel or a manual switch to the automatic control algorithm, then the mode will be manual or automatic control until a new RS485 command is received.

If the mode is manual and if the front-panel push-button switch for automatic control is pressed, the new mode will be automatic control. If the mode is automatic control and if the front-panel push button for manual adjustment is pressed, the new mode will be manual.

3-2.5 MHUI Alarm Indicators

Front-panel LED's at the MHUI front-panel will show the alarms of MHU and MHUI. All of these alarms can be interrogated via RS-485. There are three types of alarms indicated by contact closures; Minor, Major, and Critical

The alarm types are identified by their associated LED color. They are:

- Minor Alarm (Yellow)
- Major Alarm (Flashing Red)
- Critical Alarm (Solid Red)

The following table identifies the alarm number and its related function.

Table 3-1 Alarms and Related Function

Alarm	Function
1	• High temperature condition at the MHU • Fan fail at MHU • Over-temperature shutdown at MHU
2	• • Over RF power shutdown • High VSWR shutdown at antenna port of MHU
3	• Partial fail of one MCPA in MHU • Total fail of one MCPA in MHU • Total Fail of both MCPA in MHU
4	• • No TX input signal at MHUI • No TX input signal at MHU
5	• Microprocessor in MHU not working • Microprocessor in MHUI not working • Loss of communication between MHUI and MHU
6	• Partial power supply failure at MHU • Partial fail of LNA in MHU • Total fail of LNA in MHU

The alarm indicators show the instantaneous condition of the MHU and MHUI.

3-2.5.1 RF overpower

- The MHU-MHUI-system waits 500ms,
- then it will reduce the gain by 3 dB and then
- makes 3 attempts to recover the gain at 500ms intervals without submitting an alarm via RS485 until (if not successful) it holds the current gain setting and reports an RF overpower shutdown. The unit will still be transmitting.

3-2.5.2 RF Overpower **(with reduced gain)**

- The MHU-MHUI-system will wait 500ms until it shuts down.
- Three attempts are made to recover from shutdown at 500ms intervals without submitting an alarm via RS-485
- If not successful, it makes a final shutdown and reports final status via the RS-485.

3-2.5.3 High VSWR (> 5:1)

- The MHU-MHUI-system will wait 500ms until it shuts down
- Three attempts are made to recover from shutdown at 500ms intervals without submitting an alarm via RS-485.
- If not successful, it makes a final shutdown and reports final status via the RS-485.

3-2.5.4 Loss of communication between MHU and MHUI (5 seconds without communication)

- The MHUI will switch off the MHU and turn it on later again for resetting the MHU controller.
- If the MHU responds, no alarms have to be submitted via RS-485 but an internal count must be incremented.
- If this count exceeds 3, an alarm will be submitted via RS-485.
- The MHU will resume at previous status. The incremental count will then return to 0.
- If the MHU does not respond, an alarm will be activated via the RS-485 at the MHUI. The MHU will then shut itself down.

3-2.6 The Digital Display

A digital display consisting of three seven segment LEDs is used to display the RF output power of the MHU in dBm.

The display is also used for manual adjustment of the cell size and the cable normalization attenuators. When the corresponding front panel push-buttons for manual adjustment are pressed, the current attenuation value in dB is displayed with a minimum resolution of 1dB.

Th same digital display shows temperature in degrees C when a temperature push-button is pressed. When released, the display reverts to output power.

3-3 Initial Start-Up and Operating Procedures

To perform the initial start-up, proceed as follows:

- Double check to ensure that all input and output cables are properly connected.

CAUTION

Before applying power, make sure that the input and output of the amplifiers are properly terminated at 50 ohms. Do not operate the amplifier without a load attached. Refer to Table 1-1 for input power requirements. Excessive input power may damage the MCPA.

NOTE

The output coaxial cable between the amplifier and the antenna must be 50 ohm coaxial cable. Use of any other cable will distort the output.

- Place the power ON/OFF switch on the MHUI front panel in the “ON” position.
- Allow the amplifiers to warm up for at least 5 minutes before taking power readings.
- Refer to Appendix A for the power setting procedure.

Section 4 Principles of Operations

4-1 Introduction

This section contains a functional description of the Powerwave RFFE MCPA System. Refer to figure 4-1 and figure 4-3 for the system and amplifier functional block diagrams respectively.

4-2 RF INPUT Signal

The maximum input power for all carrier frequencies should not exceed the limits specified in section 1, table 1-1 of this manual. For proper amplifier loop balance, the out of band components of the input signals should not exceed -60 dBc. The input VSWR should be 2:1 maximum (or better).

4-3 RF OUTPUT Load

The load impedance should be as good as possible (1.5:1 or better) in the working band for good power transfer to the load. If the amplifier is operated into a filter, it will maintain its distortion characteristics outside the signal band even if the VSWR is infinite, provided the reflected power does not exceed one Watt. A parasitic signal of less than one Watt incident on the output will not cause distortion at a higher level than the normal forward distortion (i.e. -60 dBc).

4-4 System Functional Description

A two unit configuration, the RFFE is comprised of a weatherproof (NEMA 4 rating) outdoor Masthead Unit (MHU) booster system and an indoor rack mount Masthead Unit Interface (MHUI). The MCPA system operates in the PCS frequency range of: 1850MHz to 1910MHz (receive) and 1930MHz to 1945MHz (transmit).

4-4.1 The MHU

The MHU has two solid-state power amplifiers for the transmit signals and low noise amplifiers for the receive function. Both transmit and receive systems are redundancy protected, and in addition, there is space diversity provided for the receive system (see figure 1-1). The MHU employs a common box unit that interfaces the two transmit modules to the MHUI. Signals to and from the MHU interconnect to the base station transceivers through the indoor MHUI control.

4-4.2 The MHUI

The MHUI is the interface between the MHU system and the host base station. The MHUI reports alarms via the RS-485 bus or form-C interface (see figures 2-3, 2-4, 4-4 and tables 2-3 and 2-6) and displays alarms using an LED display (see figure 1-1 and 3-1). The MHUI houses a low power duplexer, control board, the system control panel, a preamp, and the cell size variable attenuators (both transmit and receive).

The composite RF signals from the base station radios are applied to the J1a (TX/RX TO MHU) connector at the rear of the MHUI. From there the signal passes through a combiner a voltage variable attenuator (VVA) for cell size setting, a second attenuator for cable loss normalization a diplexer, a third VVA for cable loss normalization, then out through a two-way splitter. Each leg of the splitter passes through an isolator, then the blind-mate connector to interface with the MCPA. The signal returns to the MHUI via the blind-mate connector after being amplified by the MCPA modules. The active power combiner combines the two high-power signals. The active power combiner has the capability of switching MCPA channels off-line by the use of RF switches. If an MCPA is not present, turned off, or faulted, the switch will open in that channel and physically disconnect that MCPA. The combiner maintains its low insertion characteristics when used in the

single path configuration. Note that the splitter is not switched, therefore the power is automatically reduced by 3 dB, thus eliminating an output overdrive condition. The output of the combiner is fed through a coupler, then a receive-band filter. The amplified RF signal is available for use at the output of the receive-band filter (J2). The coupler is used to sample the output power to the true RMS detector. The true RMS detector will supply the micro controller with an accurate average power regardless of the signal modulation type. The dynamic range is 25 dB. The power reading is used during the gain initialization phase when deploying the system or monitoring to detect excessive output power. In both cases the VVA will be adjusted accordingly.

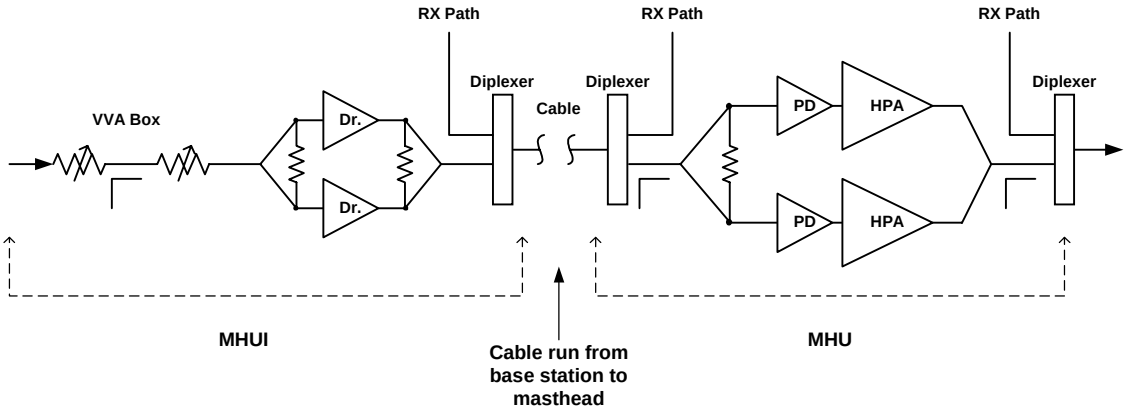


Figure 4-1 RF Front End System Functional Block Diagram

4-4.3 Transmit Modules

Power output specifications for a two module system is listed in section 1, table 1-1. Each module houses an MPA9505-55 MCPA and one 27VDC 1200 Watt power supply. It is a self-contained plug-in unit and is functionally independent of the other transmit module. The transmit modules are designed for parallel operation to achieve high peak power output, and for redundancy in unmanned remote locations.

4-4.3.1 MPA9505-55 MCPA

The MCPA is an AB amplifier that utilizes pre-distortion technology for linearization. The pre-distortion technique is effective because it compensates for the non-linear amplification characteristics of the power amplifier. The amplifier module, figure 1-6, has an average power output of 55 Watts maximum with intermodulation products suppressed to better than -40 dBc (at ±2.25 MHz from Fc) below carrier levels. The amplifier provides an amplified output signal with constant gain and phase by adding approximately 30 dB of distortion cancellation on the output signal. Constant gain and phase is maintained by continuously comparing active paths with passive references, and correcting for small variations through the RF feedback controls (refer to figure 4-3 for the amplifier's functional block diagram). All gain and phase variations, for example those due to temperature, are reduced to the passive reference variations

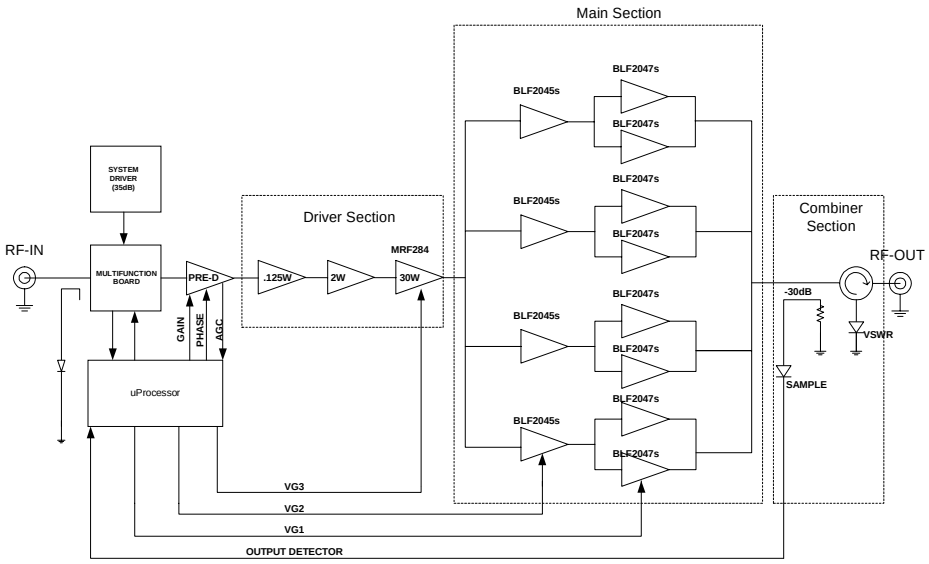


Figure 4-2 MPA9505-55 MCPA Functional Block Diagram

4-4.4 Power Distribution

Primary AC and DC power for the RFFE system is provided by the host system. Each Tx module on the MHU has its own +27VDC power supply, powered by 220VAC from the host circuit breaker panel. The Tx power supply also produces the ±20VDC, +12VDC, and -8VDC for the systems internal components.

4-4.5 Alarms

The presence of the two plug-in amplifier alarms can be detected at the ALARMS terminal board at the rear of the MHUI control panel. Refer to figure 4-3 for a description of the connector and pin designations.

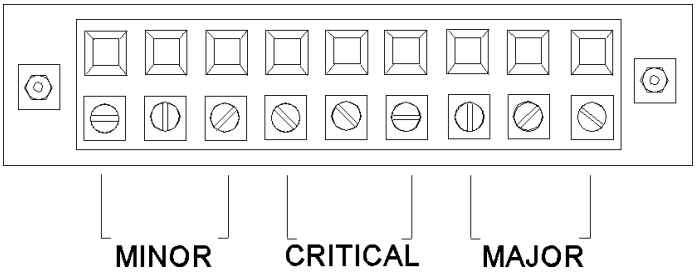


Figure 4-3 Form C Dry Contacts Alarms Terminal Board

4-4.6 Amplifier Module Cooling``

To maintain operating temperature, each transmit module is equipped with its own heat sink and 220 VAC cooling fan. Mounted at the back of the module (see figure 1-7), the fan forces outside air onto the enclosure housing. The fans are field replaceable. Refer to section 5 for replacement procedure.

Section 5 Maintenance

5-1 Introduction

This section contains periodic maintenance and performance test procedures for the RF Front End (RFFE). It also contains a list of test equipment required to perform the identified tasks.

NOTE

Check your sales order and equipment warranty before attempting to service or repair the unit. Do not break the seals on the equipment under warranty or the warranty will be null and void. Do not return equipment for warranty or repair service until proper shipping instructions are received from the factory.

5-2 Periodic Maintenance

Periodic maintenance requirements are listed in table 5-1. Table 5-1 also lists the intervals at which the tasks should be performed.

WARNING

Wear proper eye protection to avoid eye injury when using compressed air.

Table 5-1 Periodic Maintenance

Task	Interval	Action
Cleaning: Air Vents	30 Days	Inspect and clean per para. 5-4.
Inspection: Cables and Connectors	12 Months	Inspect signal and power cables for frayed insulation. Check RF connectors to be sure that they are tight.
Performance Tests:	12 Months	Perform annual test per para. 5-5.

5-3 Test Equipment Required For Test

NOTE

All RF test equipment must be calibrated to 0.05 dB resolution. Any deviation from the nominal attenuation must be accounted for and factored into all output readings.

Table 5-2 Test Equipment Required

Nomenclature	Manufacturer	Model

5-4 Clean Air Inlets/Outlets

The air inlets and outlets should be cleaned every 30 days. If the equipment is operated in a severe dust environment, they should be cleaned more often as necessary. Turn off DC power source before removing fans. If dust and dirt are allowed to accumulate, the cooling efficiency may be diminished. Using either compressed air or a brush with soft bristles, loosen and remove accumulated dust and dirt from the air inlet panels.

5-5 Performance Test

Performance testing should be conducted every 12 months to ensure that the amplifier system meets the operational specifications listed in table 5-3. Also verify system performance after any amplifier module is replaced in the field. The test equipment required to perform the testing is listed in table 5-2, and the test setup is shown in figure 5-1.

NOTE

The frequencies used in this test are typical for an amplifier with a 15 MHz band from 1930 MHz to 1945 MHz. Select evenly spaced F1, F2, F3, and F4 frequencies that cover the instantaneous bandwidth of your system.

5-6 Field Replaceable Parts and Modules

The following parts and modules can be replaced in the field on site by a qualified technician with experience maintaining RF power amplifiers and similar equipment:

- Transmit Modules
- Cooling Fans

5-6.1 Replacing a Transmit Module

The To replace a power amplifier module, proceed as follows:

1. Turn off the 220 VAC circuit breaker that feeds the MHU
2. Loosen the four screws that secure the amplifier module to the MHU chassis.
3. Carefully slide the amplifier away from the common box.
4. Install the replacement amplifier in reverse order.

CAUTION

To avoid damage to the module and blindmate connector, care must be taken as not to drop the module when removing it from the MHU support frame. The amplifier weighs approximately 10 lbs.

5-6.2 Replacing the Cooling Fans

5-6.2.1 To replace a front cooling fan, proceed as follows:

1. Turn off the 220 VAC power to the MHU.
2. Unplug the power line to the fan.
3. Remove the six screws holding the fan to its chassis (you may be required to remove the MHU from the mounting pole to gain access to the fan.
4. Pull fan out.
5. Install the replacement fan in reverse order of steps 1, 2, 3 and 4 above.

Section 6 Troubleshooting

6-1 Introduction

This section contains a list of problems which users have encountered and a few suggested actions that may correct the problem. If the suggested corrective action does not eliminate the problem, please contact your Powerwave field representative or the factory for further instructions.

Note

Check your sales order and equipment warranty before attempting to service or repair the unit. Do not break the seals on equipment under warranty or the warranty will be null and void. Do not return equipment for warranty or repair service until proper shipping instructions are received from the factory.

6-2 Troubleshooting

Refer to table 6-1 for troubleshooting suggestions.

Table 6-1 Troubleshooting

Symptom	Suggested Action
The voltage indicator (green) is not lit or blinking	1. Check that the MHU-MHUI power connectors are secure. 2. Check for proper power supply voltage.
High Temp alarm LED is lit	1. Verify fan(s) are operating properly. 2. Check ambient temperature (not to exceed spec. See table 1-1).
Over Pwr alarm LED is lit	Verify RF input level does not exceed spec. See table 1-1.
VSWR alarm LED is lit	Check output connections and cables for integrity and tightness.

6-3 Return For Service Procedures

When returning products to Powerwave, the following procedures will ensure optimum response.

6-3.1 Obtaining an RMA

A Return Material Authorization (RMA) number must be obtained prior to returning equipment to the factory for service. Please contact our Repair Department at (714) 466-1000 to obtain this number, or FAX your request to (714) 466-5800. Failure to obtain this RMA number may result in delays in receiving repair service.

6-3.2 Repackaging for Shipment

To ensure safe shipment of the amplifier, it is recommended that the package designed for the amplifier is used. The original packaging material is reusable. If it is not available, contact our Repair Department for packing materials and information.