POWERWAVE TECHNOLOGIES

INSTALLATION & SERVICE MANUAL

MCR3303-3-1 SUBRACK
MPA9600-25 AMPLIFIER

MULTICARRIER PCS AMPLIFIER SYSTEM

1970-1990 MHz
25 TO 75 WATTS AVERAGE POWER
-60 dBc INTERMODULATION DISTORTION

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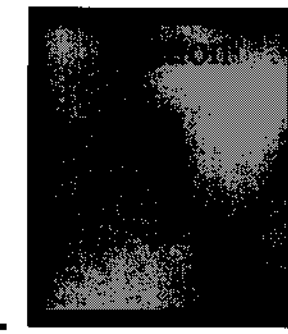


GENERAL DESCRIPTION

1-1. INTRODUCTION

This manual contains information and procedures for installation, operation, and maintenance of Powerwave's multicarrier PCS amplifier system. The manual is organized into six 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

1-2. GENERAL DESCRIPTION

The MPA9600-25 amplifier (figure 1-1) is a linear, feed-forward power amplifier that operates in the 20 MHz frequency band from 1970MHz to 1990MHz. The amplifier can simultaneously transmit multiple frequencies, with better than -60 dBc third order intermodulation distortion (IMD). The amplifier system is modular in design, and is ideally suited for use in AMPS/TDMA/CDMA base stations. The plug-in Model MPA9600-25 amplifier modules can each provide 25 watts of power and function completely independently of each other. The amplifier modules are designed for parallel operation to produce high peak power output and backup redundancy for remote applications. The system is housed in the MCR3303-3-1 subrack (figure 1-2) which holds up to three MPA9600-25 amplifiers to produce up to 75 watts output. All solid-state, the system is designed to provide trouble-free operation with minimum maintenance. The system's modular construction and unique and highly effective LED-based operational status and fault indicators help minimize down-time. The turn-on and turn-off sequences of voltages are fully automatic, as is overload protection and recycling. Inadvertent operator damage from front panel manipulation is virtually impossible.

Notice

To comply with FCC regulations, no channels existing within 200 kHz spacing from the edges of any frequency block are to be used for transmission.

The MCR3303-3-1 subrack contains an RF power splitter/combiner and a summary logic module that monitors the functional status of all plug-in amplifiers. The rear panel of the subrack has the

system RF I/O connectors, an RF output sample connector, and DC power input terminals. The front panel of each amplifier module has unit level status/fault indicators and a power on/off circuit breaker. Primary power for the amplifier system is +27 Vdc. Cooling for each plug-in amplifier module is provided by two fans mounted on the front and one on the rear of the module. The fans draw outside air through the front of the module and exhaust hot air out through the rear of the module.

1-3. FUNCTIONAL AND PHYSICAL SPECIFICATIONS

Functional and physical specifications for the amplifier system are listed in table 1-2.

1-4. EQUIPMENT CHANGES

Powerwave Technologies, Inc. reserves the right to make minor changes to the equipment, including but not necessarily limited to component substitution and circuitry changes. Changes that impact this manual may subsequently be incorporated in a later revision of this manual. To that end, we ask that you, our customer, share with us any information acquired in field situations that would enhance this manual.

1-5. ORDERING INFORMATION

Table 1-1 following gives the part numbers and descriptions to be used when ordering either an entire system or individual major components that comprise the system.

Table 1-1. Major System Components

SYSTEM ORDER NUMBER	DESCRIPTION OF SYSTEM NUMBER	SUB-COMPONENT MODEL NUMBER	QTY PER SYSTEM	DESCRIPTION OF SUB-COMPONENT MODEL NUMBER
MCR3303-3-1	75 W 1970-1990 MHz PCS System for Base Station Equipment.	MPA9600-25	3	25 W 1970-1990 MHz PCS Module.
		MCR3303-3-1	1	3-Way 17" Subrack.
		600-229-4	1	Front fan assembly, large.
		800-00547-001	1	Front fan assembly, small
		800-00745-001	1	Rear fan assembly.

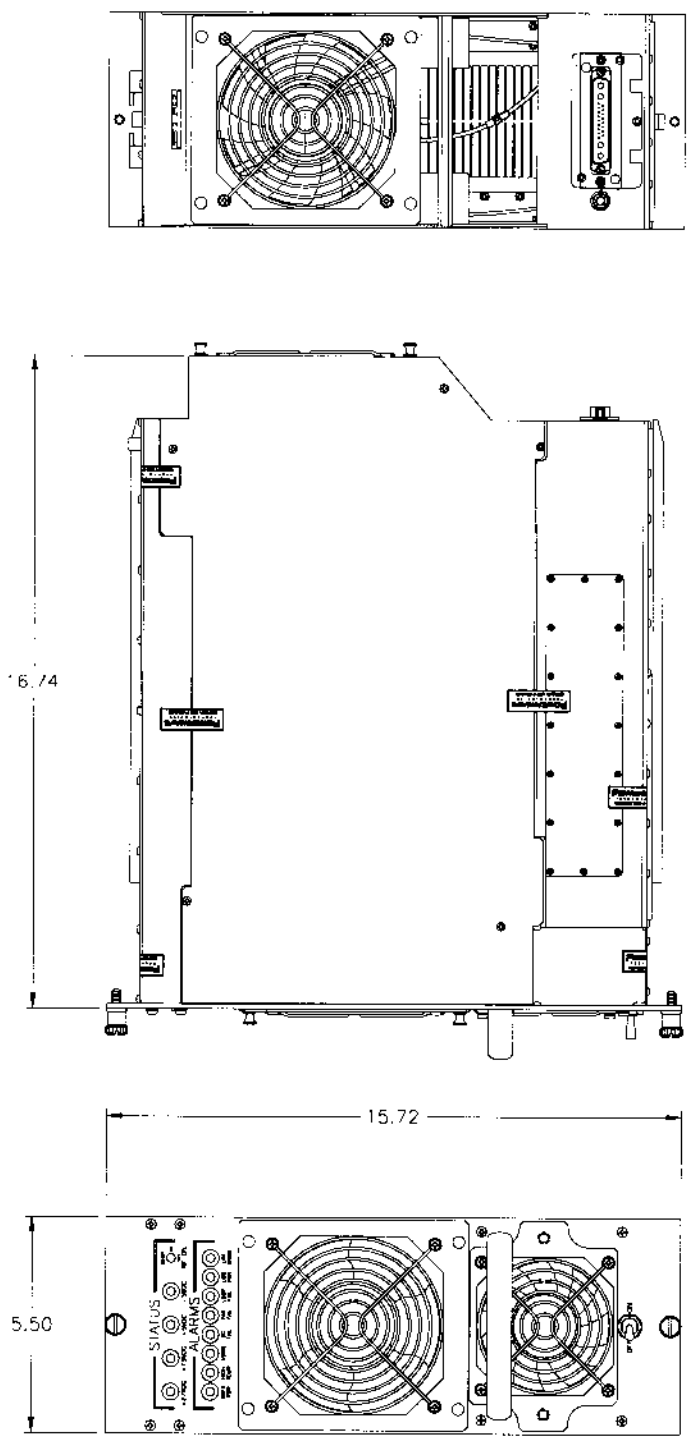


Figure 1-1. MPA9600-25 Amplifier

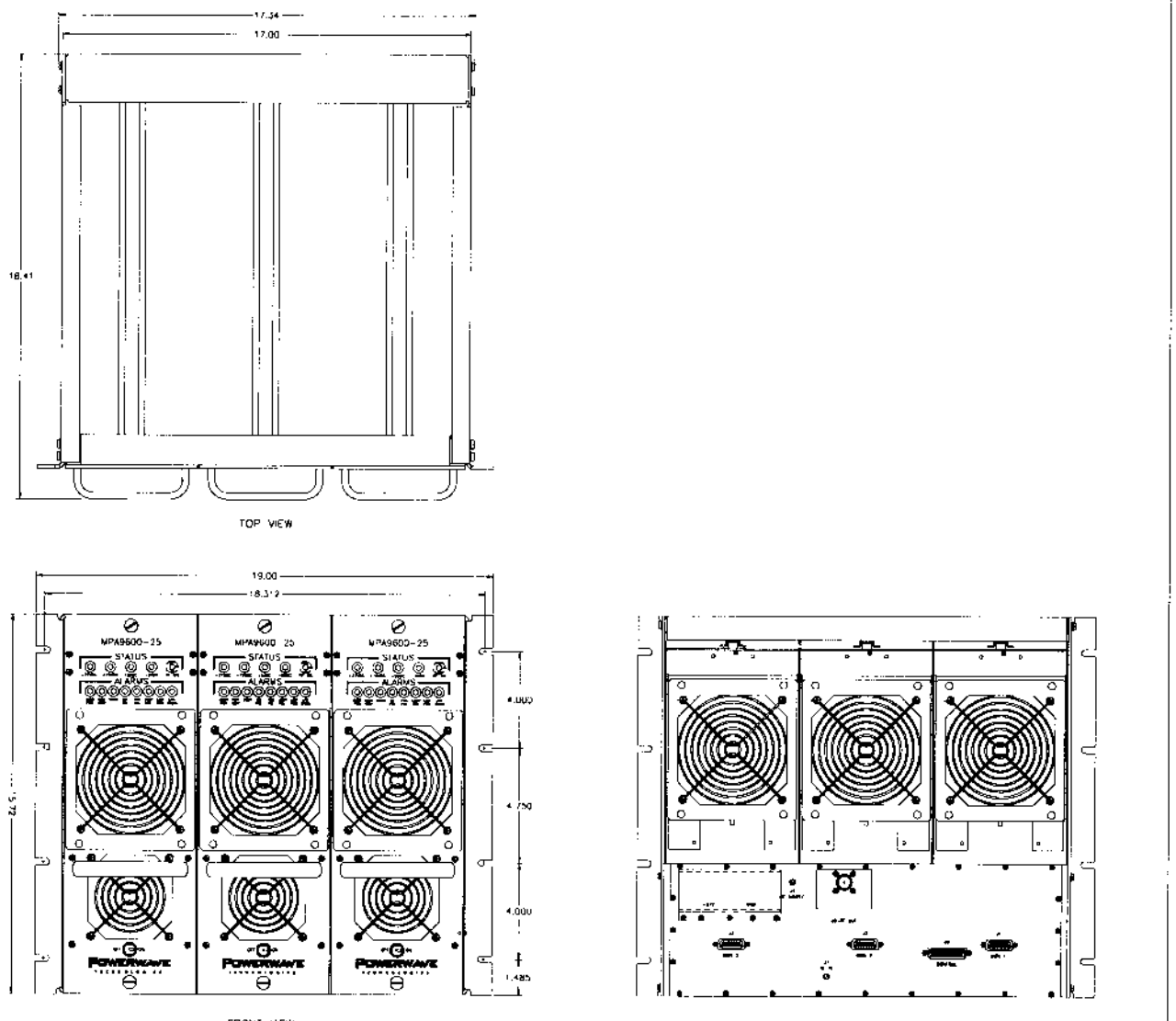
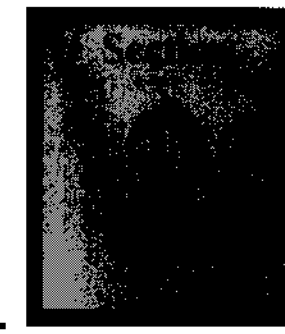


Figure 1-2. MCR3303 3-1 Subrack

Table 1-2. Multicarrier PCS Amplifier System Functional Specifications

Frequency Range	1970-1990 MHz
Total Maximum Input Power	0 dBm
Total Output Power (Minimum) in MCR3303-3-1 System	25 W typical (1 Module) 50 W typical (2 Modules) 75 W typical (3 Modules)
Intermodulation Distortion and In-Band Spurious:	1 Module : -60 dBc (Max) @ +24 to +28 Vdc @ 25 Watts 2 Modules: -60 dBc (Max) @ +24 to +28 Vdc @ 50 Watts 3 Modules: -60 dBc (Max) @ +24 to +28 Vdc @ 75 Watts (-55 dBc(Min) @ +23 to +24 Vdc)
RF Gain at 1980 MHz (without RF input filter)	59.5± 0.5dB (1 Module) (without RF filter at input) 59.5± 0.5dB (2 Modules) (without RF filter at input) 59.5 ±0.5dB (3 Modules) (without RF filter at input)
Gain Flatness:	± 0.7 dB @ 27 Vdc ±1 Vdc
Gain Variation Over Temperature:	± 1.0 dB @ 27 Vdc ±1 Vdc ± 1.5 dB @ 24 to 26 Vdc
Output Protection:	Mismatch Protected
Input Port Return Loss:	-14 dB (Min)
Harmonics:	Better than -45 dBc
Out of Band Spurious:	Better than -60 dBc
Duty Cycle:	Continuous
DC Input Power:	+27 Vdc ± 1 Vdc, 28 Amps Max per module @ 25 Watts Operational +23 Vdc to 30 Vdc
Operating Temperature:	0 °C. to +50 °C.
Storage Temperature:	-40 °C. to +85 °C.
Operating Humidity:	5% - 95% Relative Humidity (Non-Condensing)
Storage Humidity:	5% - 95 % Relative Humidity (Non-Condensing)
DC Input Connectors:	Threaded Studs, 5/16 - 18 thread.
Fan/Summary Alarm Connector:	Six position terminal block
RF Input Connector:	SMA Female
RF Output Connector:	Type "N" Female*
RF Output Sample Connector:	SMA Female
Dimensions: MPA9600-25 Amplifier: MCR3303-3-1 Subrack:	 15.72" High, 5.50" Wide, 16.74" Deep 15.72" High, 17.00" Wide,18.41" Deep (with input filter)



INSTALLATION

2-1. INTRODUCTION

This section contains installation recommendations, unpacking, inspection, and installation instructions for the Multicarrier PCS Amplifier System. Carefully read all material in this section prior to equipment unpacking or installation. Also read and review the operating procedures in Section 3 prior to installing the equipment. Section 3 contains applicable standards imposed by the Federal Communications Commission. It is important that the licensee perform these tasks correctly and in good faith. Carefully read Parts 73 and 74 of the FCC rules to determine how they apply to your installation. DON'T TAKE CHANCES WITH YOUR LICENSE.

2-2. ELECTRICAL SERVICE RECOMMENDATIONS

Powerwave Technologies 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. Special consideration should be given to lightning protection of all systems in view of the vulnerability of most transmitter sites to lightning. Lightning arrestors are recommended in the service entrance. Straight, short ground runs are recommended. The electrical service must be well grounded.

Each amplifier system should have its own circuit breaker, so a failure in one does not shut off the whole installation. Circuit breakers should be thermal type, capable of handling the anticipated inrush current, in a load center with a master switch.

2-3. UNPACKING AND INSPECTION

This equipment has been operated, tested, and calibrated at the factory. Only in the event of severe shocks or other mistreatment should any substantial readjustment be required. Carefully open the containers and remove the subrack and amplifier modules. Retain all packing material that can be reassembled in the event that the unit must be returned to the factory.

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

Visually inspect the amplifier subrack and modules for damage that may have occurred during shipment. Check for evidence of water damage, bent or warped chassis, loose screws or nuts, or extraneous packing material in connectors or fans. Inspect all connectors for bent connector pins. If the equipment is damaged, 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 possible, inspect the equipment in the presence of the delivery person. If the equipment is damaged, the carrier is your first area of recourse. If the equipment is damaged and must be returned to the factory, write or phone for a return authorization. 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.

2-4. INSTALLATION INSTRUCTIONS

The MCR3303-3-1 19-inch subrack, which holds up to three amplifier modules, is designed for installation in a rack or cabinet that permits access to the rear of the amplifier system for connection of DC power, RF, and control and monitor cables. The location and function of the system interface connectors are shown in figures 2-1, 2-2, and 2-3, and are described in tables 2-1, 2-2, and 2-3. The plug-in amplifier module connector is shown in figure 2-4 and is described in table 2-4.

Table 2-1. MCR3303-3-1 Subrack Power, Monitor, Control, and Input/Output Connectors

NO.	NAME	FUNCTION
1	+27V and GND Terminals	Input terminals for primary +27 Vdc source voltage and its return.
2	J1 MON 1 thru J3 MON 3 Connectors	15-pin female D-Sub connectors (refer to figure 2-2 and table 2-2 for individual pin signals).
	J4 - RF SAMPLE connector	SMA female coax connector. RF output signal is at -40±1.0dB of signal output to antenna.
3	J5 CONTROL Connector	25-pin female D-SUB connector (refer to figure 2-3 and table 2-3 for individual pin signals.).
4	J6-RF OUT Connector	Extended TYPE N female coax connector. Output to antenna. Refer to table 1-2 for power output level of one to three amplifier module systems.
5	J7 RF IN Connector	SMA female coax connector. Refer to table 1-2 for power input level to amplifier module system.

To install the amplifier system proceed as follows:

1. Install subrack in equipment rack or cabinet and secure in place with eight screws
2. Refer to figure 2-1 for the location of all subrack input/output connectors.
3. Connect control cable to J5 CONTROL connector on rear of subrack (refer to figure 2-2 and table 2-2 for J5 definition).
4. Connect monitor cables for amplifiers 1 through 3 to connectors J1 MON 1 through J1 MON 3 respectively on rear of subrack (refer to figure 2-3 and table 2-3 for J1 – J3 definition).
5. Connect antenna cable to J6-RF OUT connector on rear of subrack.
6. Connect transceiver or exciter output to the input terminal J7 RF IN on the rear of the sub-rack.
7. If being used, connect the RF sampling cable to J4 RF SAMPLE.

WARNING

Turn off external primary DC power before connecting DC power cables.

8. Remove protective cover on power terminal block; do not discard. Connect positive primary power to +27V terminal and negative primary power to GND terminal.

WARNING

Replace protective cover on DC terminal block. Failure to replace cover properly could result in personal injury and

damage to equipment in the event of a short circuit.

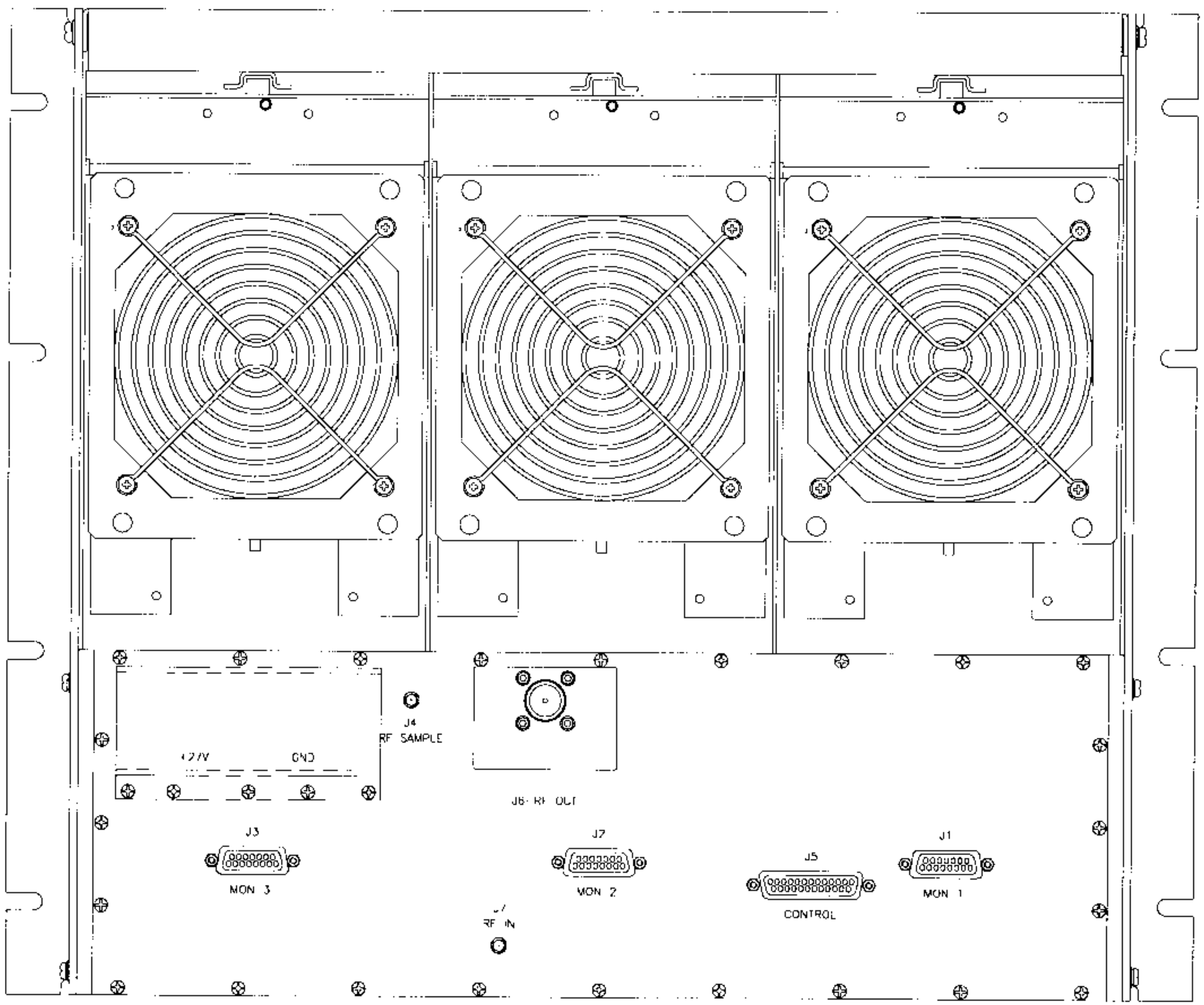


Figure 2 1. Subrack Rear Panel

CAUTION

Verify that all circuit breaker switches on the front panels of the amplifiers are in the left (OFF) position.

8. Install the plug-in amplifier modules in the slots of the subrack.

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

10. Measure primary DC input voltage. DC input voltage should be +27 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.

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

2-5. SUBRACK CONNECTORS J1 MON 1 THROUGH J3 MON 3

Connectors J1 MON 1 through J3 MON 3 on the rear of the MCR3303-3-1 subrack are 15-pin female D-sub connectors that permit monitoring various alarm signals for each amplifier in the subrack. Refer to figure 2-2 and table 2-2 for connector definition.

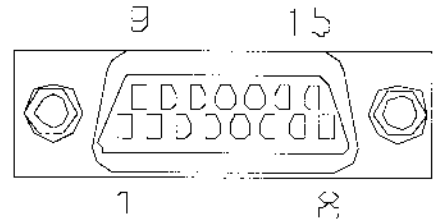


Figure 2-2. Connectors J1 MON 1 Through J3 MON 3

Table 2-2. Connectors J1 MON 1 Through J3 MON 3 Definition

PIN	SIGNAL	I/O	NOTES
1	Ground		
2	Over Power Fault	TTL Output	Normally low; high if over power fault
3	High Temp Fault	TTL Output	Normally low; high if high temp fault
4	VSWR Fault	TTL Output	Normally low; high if VSWR fault
5	DC Fault	TTL Output	Normally low; high if DC fault
6	Loop Fault	TTL Output	Normally low; high if loop fault
7	Low Power Fault	TTL Output	Normally low; high if low power fault
8	Fan Fault	TTL Output	Normally low; high if fan or fans fault
9	Ground		
10	Fwd Mon	Analog Out	4.0 V @ 50 W_{avg} power
11	Rev Mon	Analog Out	Ground pin for a high, float for a low
12-15	N/A		

2-6. SUBRACK CONNECTOR J5

Connector J5 CONTROL on the rear of the MCR3303-3-1 subrack is a 25-pin female D-sub connector that supports the RS-485 communications function. Refer to figure 2-3 and table 2-3 for connector definition.

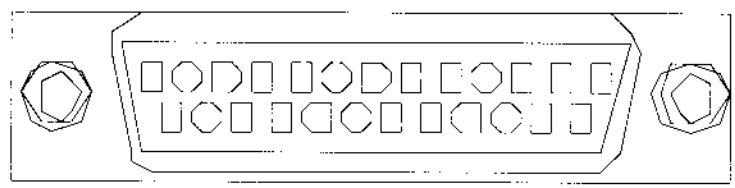


Figure 2-3. Connector J5

Table 2-3. Connector J5 Definition

PIN	SIGNAL
1	RS485 RxD+
2	RS485 RxD–
3	RS485 TxD+
4	RS485 TxD–
5	Ground
6	DC On/Off
7-23	Not Used
24	Mode Select A
25	Mode Select B

2-7. AMPLIFIER MODULE STATUS, ALARM, CONTROL, AND POWER CONNECTOR

Each amplifier in the subrack has a separate remote alarm and control connector which may be used by the host system to monitor and control the individual amplifier modules. The status, alarm, control, and power connections on the amplifier connector are made through a 21-pin male D-Sub combo connector (figure 2-4) and are listed and described in table 2-4.

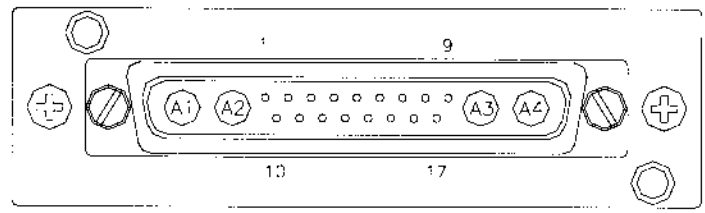


Figure 2-4. Amplifier Connector (on Rear of MPA9600-25 Module)

Table 2-4. Amplifier Module Status, Alarm, Control, and Power Connections

PIN NUMBER	FUNCTION	DESCRIPTION
A1	RF Input	Coaxial Contact
A2	Power Input	+27 Vdc (Power Contact)
A3	Ground	Ground (Power Contact)
A4	RF Output	Coaxial Contact
1	Ground	Ground
2	NC (No Connection)	
3	NC (No Connection)	
4	NC (No Connection)	
5	NC (No Connection)	
6	NC (No Connection)	
7	NC (No Connection)	
8	Fan Fail	TTL signal normally low. A high level indicates that one or both of the fans have failed.
9	Forward Power Monitor	An analog DC signal representing the RF output power of the MCA. The voltage is 4 volts ± 100 mV at the maximum rated output power.
10	NC (No Connection)	
11	Average Power Input	An analog DC voltage representing the average detected power of all the MCAs in a rack. This voltage is derived from dividing the sum of all the forward power voltages in a rack by the number of enabled MCAs. This voltage is used by the MCA to determine a low power fault.
12	NC (No Connection)	
13	Summary Fault	TTL signal normally low. A high level indicates that the MCA has been disabled by a recurring alarm fault.
14	NC (No Connection)	
15	Module Detect	Ground potential. Informs the rack that an MCA is plugged in.
16	Bias Input*	TTL signal normally low for an enabled MCA. A high level will disable the MCA.
17	FP Disable Output	TTL signal, low if the front panel switch is in the ON position. A high level indicates the front panel switch in the OFF position.

Section 3

OPERATING INSTRUCTIONS

3-1. INTRODUCTION

This section contains operating instructions for the Multicarrier PCS Amplifier System.

3-2. LOCATION AND FUNCTION OF AMPLIFIER MODULE CONTROLS AND INDICATORS.

The location of the plug-in amplifier module controls and indicators is shown in figure 3-1. Their functions are described in detail in table 3-1.

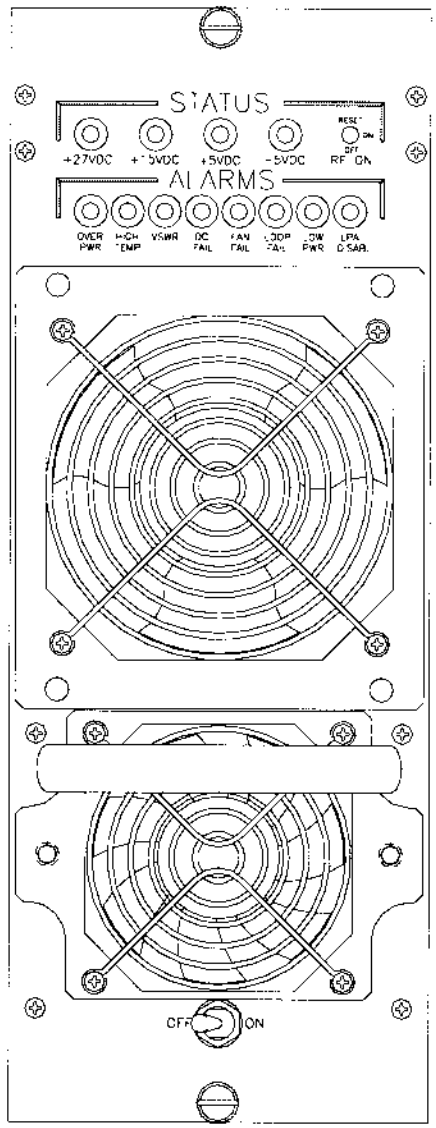


Figure 3-1. MPA9600-25 Amplifier Module Controls and Indicators

Table 3-1. Amplifier Module Control and Indicators

NO.	NAME	FUNCTION (Note: MPA = Multicarrier PCS Amplifier)
1	+27VDC Indicator	Green LED. When lit, indicates that the +27 Vdc supply is greater than +23 Vdc and less than +30 Vdc. The LED will blink if the voltage is 28 Vdc to 30 Vdc. If the +27 Vdc indicator goes out, the DC FAIL indicator will illuminate. This indicates that the +27 Vdc voltage dropped below +23 Vdc. A timer is started and the DC fail counter is incremented. After five seconds the fault is analyzed and if it exists the counter is incremented. If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero. If the DC input voltage exceeds +30 volts, the MPA will be disabled instantaneously, as indicated by the illumination of the LPA DISAB. LED. A timer is started and the DC fail counter is incremented. After five seconds the voltage is measured. If the fault exists the counter is incremented.* If the count equals five before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will remain disabled. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.
2	+15VDC Indicator	Green LED. When lit, indicates that the +15 Vdc supply is greater than +14 Vdc and less than +16 Vdc. If the +15 Vdc indicator goes out, the DC FAIL indicator will illuminate. This indicates that the +15 Vdc voltage dropped below +14 Vdc or increased above +16 Vdc. A timer is started and the DC fail counter is incremented. After five seconds the fault is analyzed and if it exists the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
3	+5VDC Indicator	Green LED. When lit, indicates that the +5 Vdc supply is greater than +4.5 Vdc and less than +5.5 Vdc. If the +5 Vdc indicator goes out, the DC FAIL indicator will illuminate. This indicates that the +5 Vdc voltage dropped below +4.5 Vdc or increased above +5.5 Vdc. A timer is started and the DC fail counter is incremented. After five seconds the fault is analyzed and if it exists the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
4	-5VDC Indicator	Green LED. When lit, indicates that the -5 Vdc supply is greater than -5.5 Vdc and less than -4.5 Vdc. If the -5 Vdc indicator goes out, the DC FAIL indicator will illuminate. This indicates that the -5 Vdc voltage dropped below -5.5 Vdc or increased above -4.5 Vdc. A timer is started and the DC fail counter is incremented. After five seconds the fault is analyzed and if it exists the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

NO.	NAME	FUNCTION (Note: MPA = Multicarrier PCS Amplifier)
5	RF ON Switch	Three position switch: OFF (down position) - Turns off amplifier module. ON (center position) - Normal amplifier on position. RESET (up position) - When toggled to reset position, all the green LED indicators will turn off and all the red LED indicators will illuminate momentarily (LED test); this will also reset the fault latches. Then a series of fault LEDs will illuminate for 2 seconds to illustrate configuration type. If the switch is held in the reset position, a microcontroller reset will occur. This will be verified by the LEDs toggling state again. The switch is spring loaded to return to the normal ON position when released. If a fault occurs and the MPA is disabled, the alarms can be cleared and the MPA enabled by this reset position. The functions of the switch are disabled for five seconds after a power-up condition.
6	OVER PWR Fault Indicator	Red LED. When lit, indicates the output power from the amplifier exceeded 50 watts. If an over power condition occurs the MPA is immediately disabled. A timer is started and the over power fault counter is incremented. After five seconds the MPA is enabled and the fault is analyzed. If the fault exists, the MPA is again disabled and the counter is incremented.* If the count equals five before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.
7	HIGH TEMP Fault Indicator	Red LED. When lit, indicates that the amplifier heat sink temperature has exceeded 80 °C. If a high temp condition occurs a timer is started and the high temp fault counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
8	VSWR Fault Indicator	Red LED. When lit, indicates that the reflected power detected at the amplifier output exceeds 25 watts. If a VSWR condition occurs a timer is started and the VSWR fault counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

NO.	NAME	FUNCTION (Note: MPA = Multicarrier PCS Amplifier)
9	DC FAIL Fault Indicator	Red LED. When lit, indicates that one of the internal DC voltages dropped below or exceeded the safe threshold level (+23 V<+27 V<+30 V, +14 V<+15 V<+16 V, +4.5 V<+5 V<+5.5 V, or -5.5 V<-5 V<-4.5 V). If a DC fail condition occurs a timer is started and the DC fail counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur. The fault indicator will latch on and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero. If the DC input violates the +30 volt threshold, the MPA is immediately disabled. A timer is started and the DC fault counter is incremented. After five seconds the fault is analyzed. If the fault exists the counter is incremented* If the count equals five before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will remain disabled. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.
10	FAN FAIL Fault Indicator	Red LED. When lit, indicates that one or both of the fans has failed. If one fan fails, the FAN FAIL indicator will light. If both fans fail, the FAN FAIL indicator will light, a timer is started, and the fan fail counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
11	LOOP FAIL Fault Indicator	Red LED. When lit, indicates that one of the loop control voltages has transitioned above or below safe operating limits. If a loop fail condition occurs a timer is started and the loop fail counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
12	LOW PWR Fault Indicator	Red LED. When lit, indicates that the RF power output from the amplifier dropped -2dB (-1,+0dB) below the average power output of all amplifier modules in the rack. If a low power condition occurs a timer is started and the low power fault counter is incremented. After five seconds the fault is analyzed. If the fault exists, the counter is incremented.* If the count equals 25 before the timer reaches 15 minutes, a summary fault will occur, the fault indicator will latch on, and the MPA module will be disabled. Toggling the reset switch will enable the MPA. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.
13	LPA DISAB. Fault Indicator	Red LED. When lit, indicates that MPA is manually switched off using the front panel RF ON switch, or disabled by a summary alarm.
14	ON - OFF Circuit Breaker	50 amp circuit breaker. Controls +27 Vdc primary power to the amplifier module.

*While the fault is in evaluation, the LED will blink at a 1 Hz rate.

3-3. INITIAL START-UP AND OPERATING PROCEDURES

Each amplifier module has two operating controls, both located on the front face of the module: the power ON - OFF switch and the RF ON - ON/OFF/RESET switch. To perform the initial start-up, proceed as follows:

1. 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 amplifier are properly terminated at 50 ohms. Do not operate the amplifier without a load attached. Refer to table 1-2 for input power requirements. Excessive input power may damage the amplifier

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.

2. Verify that all amplifier front panel switches are in the OFF position.

3. Turn on supply that provides +27 Vdc to the amplifier system. Do not apply an RF signal to the amplifier system

4. One at a time, place the ON - OFF circuit breaker on each amplifier in the ON position. Visually check the indicators on each amplifier module, and verify that the following indicators are on:

    a. LOOP FAIL indicator (red) should be on.
    b. LPA DISAB. indicator (red) should be on.
    c. The +27VDC, +15VDC, +5VDC and -5VDC indicators (green) on the amplifier module should be on.

5. Set all RF ON switches to the ON (center) position. All red LEDs should turn off after ten seconds.

6. Turn on external exciter/transceiver and apply RF input signals.

7. Manually reset each amplifier module by momentarily switching the RF ON - ON/OFF/RESET switch to RESET position.

PRINCIPLES OF OPERATION

4-1. INTRODUCTION

This section contains a functional description of the Multicarrier PCS Amplifier System.

4-2. RF INPUT SIGNAL

The maximum input power for all carrier frequencies should not exceed the limits specified in table 1-2. For proper amplifier loop balance, the out of band components of the input signals should not exceed -30 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

The amplifier system is comprised of an MCR3303-3-1 subrack and up to three MPA9600-25 plug-in power amplifiers. The MPA9600-25 amplifier is a linear, feed-forward power amplifier that operates in the 25 MHz frequency band from 1970 TO 1990MHz. A typical three module system is shown in figure 4-1. Power output specifications for one to three module systems are listed in table 1-2. Each amplifier is a self-contained plug-in module and is functionally independent of the other amplifier modules. The amplifier modules are designed for parallel operation to achieve high peak power output, and for redundancy in unmanned remote locations. The subrack houses a three-way power splitter/combiner, summary alarm logic, and a voltage regulator. The rear panel of the subrack has I/O connectors that interface with the host system, RF signal source, system antenna, and the system DC power source . The amplifier system can simultaneously transmit multiple carrier frequencies, at an average total power output of 25 watts (one amplifier module in a subrack unit) to 75 watts (3 amplifier modules), with -60 dBc third order intermodulation distortion (IMD).

The RF input (carrier frequencies) to the power splitter will vary depending on the number of amplifier modules in the system. In a three module system, the signal will be split into three signals of equal power and input to the plug-in amplifier modules. The output from each amplifier is an amplified composite signal of approximately 25 watts before combiner losses. All phase and gain corrections are performed on the signal(s) in the individual amplifier modules. The amplifier outputs are fed to a power combiner and combined to form a composite RF output of up to 75 watts. Each amplifier module has an alarm and display board that monitors the amplifier performance. If a failure or fault occurs in an amplifier module, it is displayed on the individual amplifier front panel and the summary form C contact will activate.

The fan/summary alarm module in the subrack is the system fault monitor. When an amplifier is turned off, it is physically disconnected via relays from the combiner. The purpose of the summary alarm board is to control the turn-on and turn-off sequence of the amplifiers and

splitter/combiner, and calculate the average power output from all amplifier modules in the system. Timing of fault signals is performed by the system alarm board in the amplifier modules.

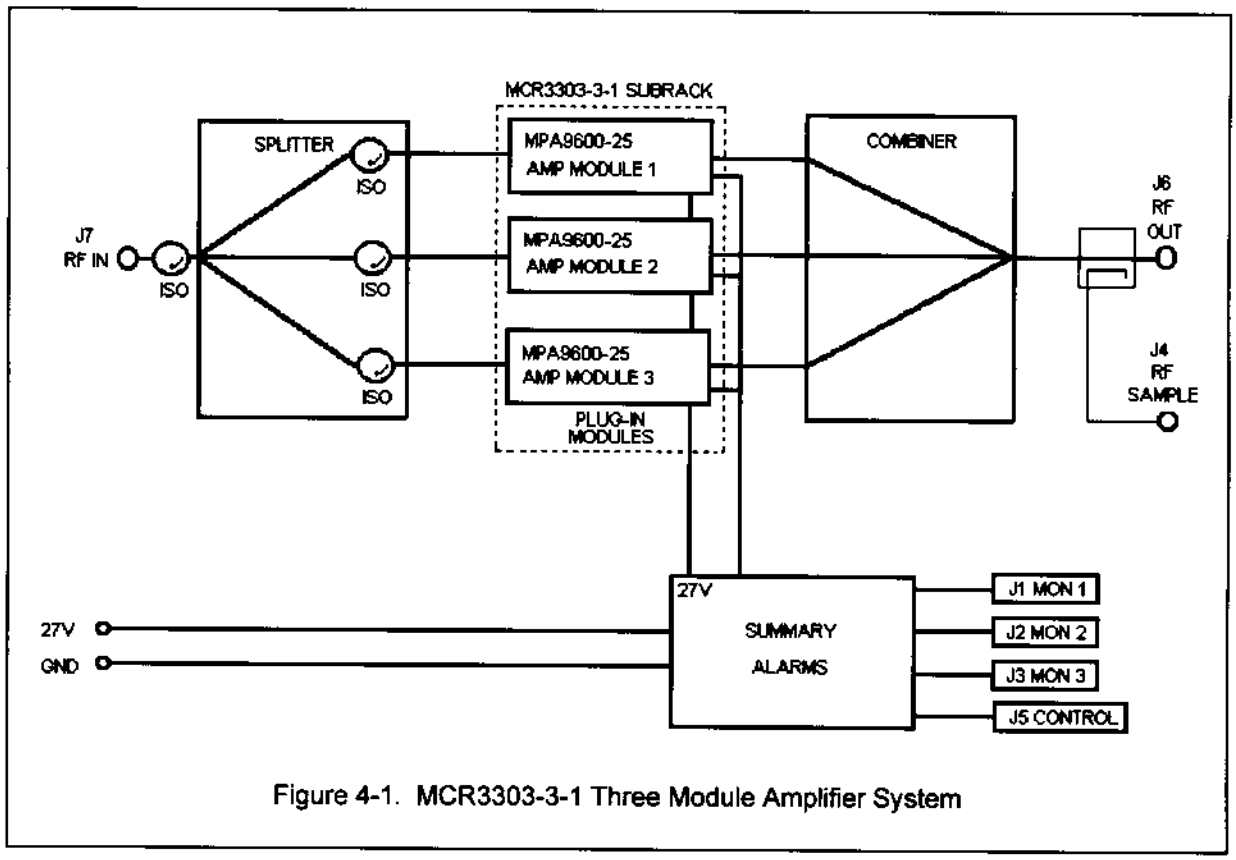


Figure 4-1. MCR3303-3-1 Three Module Amplifier System

4-5. MCR3303-3-1 SUBRACK

The MCR3303-3-1 subrack (see block diagram figure 4-1) are not field repairable. The subrack contains a three-way RF power splitter/combiner, voltage regulator, and summary alarm board. The splitter/combiner has an input splitter and an output combiner, which provide good VSWR and ensure low insertion loss. The splitter/combiner has relays that are activated and deactivated by the summary alarm board when a plug-in amplifier is power sequenced on or is shut down. The voltage regulator provides +5 Vdc and +15 Vdc power to the summary alarm board. The primary function of the summary alarm board is to control the amplifier turn-on and turn-off sequence. Other functions include calculating the average power output from the amplifiers and controlling the relays in the combiner. Additionally, the summary board also controls the form C contacts whose output terminals are connected to rear panel connector J5 CONTROL (see figure 2-3 and table 2-3).

4-6. MPA9600-25 AMPLIFIER MODULE

The amplifier module, figure 4-2, has an average power output of 60 watts (500 watts peak power) with intermodulation products suppressed to better than -60 dBc 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. All gain and phase variations, for example

those due to temperature, are reduced to the passive reference variations. The amplifier module is comprised of:

Preamplifiers
Main amplifier
Error amplifier
Two feed-forward loops with phase-shift and gain controls
DC/DC power regulator
Alarm monitoring, control and display panel

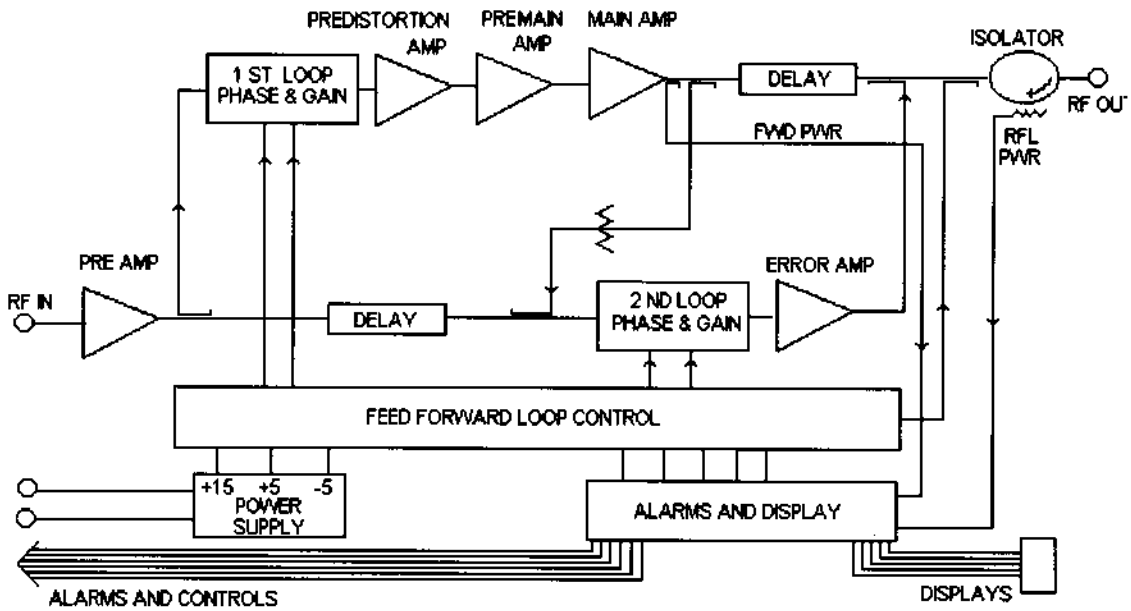


Figure 4-2. MPA9600-25 Power Amplifier Module Functional Block Diagram

The main amplifier employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops are employed to correct signal nonlinearities introduced by the class AB main amplifier. The error amplifier operates in class A mode. The RF input signals are amplified by a preamp and coupled to an attenuator and phase shifter in the first feed-forward loop. The main signal is phase shifted by 180 degrees and amplified in the premain amplifier. The output from the premain amplifier is fed to the class AB main amplifier. The output from the main amplifier is typically 25 watts. The signal is output to several couplers and a delay line.

The signal output from the main amplifier is sampled using a coupler, and the sample signal is combined with the main input signal and input to the second feed-forward loop. The error signal is attenuated, phase shifted 180 degrees, then fed to the error amplifier where it is amplified to a level identical to the sampled output from the main amplifier. The output from the error amplifier is then coupled back and added to the output from the main amplifier. The control loops continuously make adjustments to cancel out any distortion in the final output signals.

The primary function of the first loop is to provide an error signal for the second loop. The primary function of the second loop is to amplify the error signal to cancel out spurious products developed in the main amplifier. The input signal is amplified by a preamplifier and fed to a

coupler and delay line. The signal from the coupler is fed to the attenuator and phase shifter in the 1st loop The first loop control section phase shifts the main input signals by 180 degrees and constantly monitors the output for correct phase and gain.

The 2nd loop control section obtains a sample of the distortion added to the output signals by the main amplifier, phase shifts the signals by 180 degrees, then feeds it to the error amplifier. It is then amplified to the same power level as the input sample and coupled onto the main output signal. The final output is monitored by the 2nd loop and adjusted to ensure that the signal distortion and IMD on the final output is canceled out.

4-6.1. MAIN AMPLIFIER

The input and output of the amplifier employ three-stage, class AB amplifiers which provide approximately 20dB of gain in the 25 MHz frequency band from 1970 TO 1990MHz. The amplifier operates on +27 Vdc, and a bias voltage of +5 Vdc, and is mounted directly on a heat sink. The alarm logic controls the +5 Vdc bias voltage which shuts down the amplifier.

4-6.2. ERROR AMPLIFIER

The main function of the error amplifier is to sample and amplify the signal distortion level generated by the main amplifier, to a level that cancels out the distortion and IMD when the error signal is coupled onto the main signal at the amplifier output. The error amplifier is a balanced multistage, class AB amplifier, has 44 dB of gain and produces a 40-watt output. The amplifier operates on 10 Vdc and a bias voltage of -5 Vdc, and is mounted directly on a heat sink which is temperature monitored by a thermostat. If the heat sink temperature exceeds 80 °C, the thermostat opens and a high temperature fault occurs.

4-6.3. AMPLIFIER MONITORING

In the main and error amplifier modules, all normal variations are automatically compensated for by the feedforward loop control. However, when large variations occur beyond the adjustment range of the loop control, a loop fault will occur. The alarms are displayed in the front panel indicators and output via a 21-pin connector on the rear of the module to the subrack summary board for subsequent remote monitoring via J1 through J3. Refer to paragraph 2-5 as well as figure 2-2 and table 2-2 for a description of the J1 through J3 connectors.

4-6.4. AMPLIFIER MODULE COOLING

Although each amplifier module contains its own heat sink, it is cooled with forced air. Three fans are used for forced air cooling and redundancy. The fans, located on the front and rear of the amplifier module, draw air in through the front of the amplifier and exhaust hot air out the back of the module. The fans are field replaceable.

4-7. POWER DISTRIBUTION

Primary DC power for the system is provided by the host system to the MCR3303-3-1 subrack. The subrack supplies each amplifier module with +27 Vdc directly and via the RF power splitter/combiner. The amplifier module has a DC/DC converter that converts the +27 Vdc to +15 Vdc, +5 Vdc and -5 Vdc.

4-8. INTERMODULATION

The MPA9600-25 amplifier is designed to deliver a 25-watt composite average power, multicarrier signal, occupying a bandwidth less than or equal to 20 MHz, in the bandwidth from 1970-1990 MHz. The maximum average power for linear operation, and thus the amplifier efficiency, will depend on the type of signal amplified.

4-8.1 TWO TONE INTERMODULATION

When measured with two equal CW tones spaced anywhere from 30 kHz to 20 MHz apart, and at any power level up to the peak power, the third order intermodulation products will be below -60 dBc

4-8.2 MULTITONE INTERMODULATION

Adding more tones to the signal will lower individual intermodulation products. If the frequencies are not equally spaced, the level of intermodulation products gets very low. When the frequencies are equally spaced, those products fall on top of each other on the same frequency grid. The average power of all intermodulation beats falling on the same frequency is called the composite intermodulation; it is -60 dBc or better.

4-9. ALARMS

The presence of several plug-in amplifier alarms can be detected at the J1 MON 1 through J3 MON 3 connectors on the subrack rear panel. Refer to table 2-2 and figure 2-2 for a description of the connectors.

MAINTENANCE

5-1. INTRODUCTION

This section contains periodic maintenance and performance test procedures for the Multicarrier PCS Amplifier System. 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 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

Test equipment required to test the amplifier system is listed in Table 5-2. Equivalent test equipment may be substituted for any item, keeping in mind that a thermistor type power meter is required.

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
Signal Generator	H.P.	8656B
20 dB Attenuator, 250 Watt	Tenuline	
20 dB Attenuator, 20 Watt (2 each)	Tenuline	
Spectrum Analyzer	H.P.	8560E
Coax Directional Coupler	H.P.	778D
Power Meter/Sensor	H.P.	437B/8481A
Network Analyzer	H.P.	8753C
Current Probe		

5-4. CLEANING 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 20 MHz band from 1970 MHz to 1990 MHz. Select evenly spaced F1, F2, F3, and F4 frequencies that cover the instantaneous bandwidth of your system.

5-5.1. AMPLIFIER SYSTEM PERFORMANCE TEST.

This test is applicable to the MCR3303-3-1 subrack with one to three plug-in MPA9600-25 amplifier modules. Perform the tests applicable to your system. Refer to table 1-2 for RF power input levels for systems with one to three amplifier modules. To perform the test, proceed as follows:

1. Connect test equipment to the subrack as shown in figure 5-1.

NOTE

Do not apply any RF signals at this time.

2. Turn on all four signal generators and set frequency F1 to 1974 MHz, F2 to 1978 MHz, F3 to 1982 MHz, and F4 to 1986 MHz. Adjust each signal generator output so that the sum power output from all four signal generators equals -4 dBm at the output of the 4-way combiner.

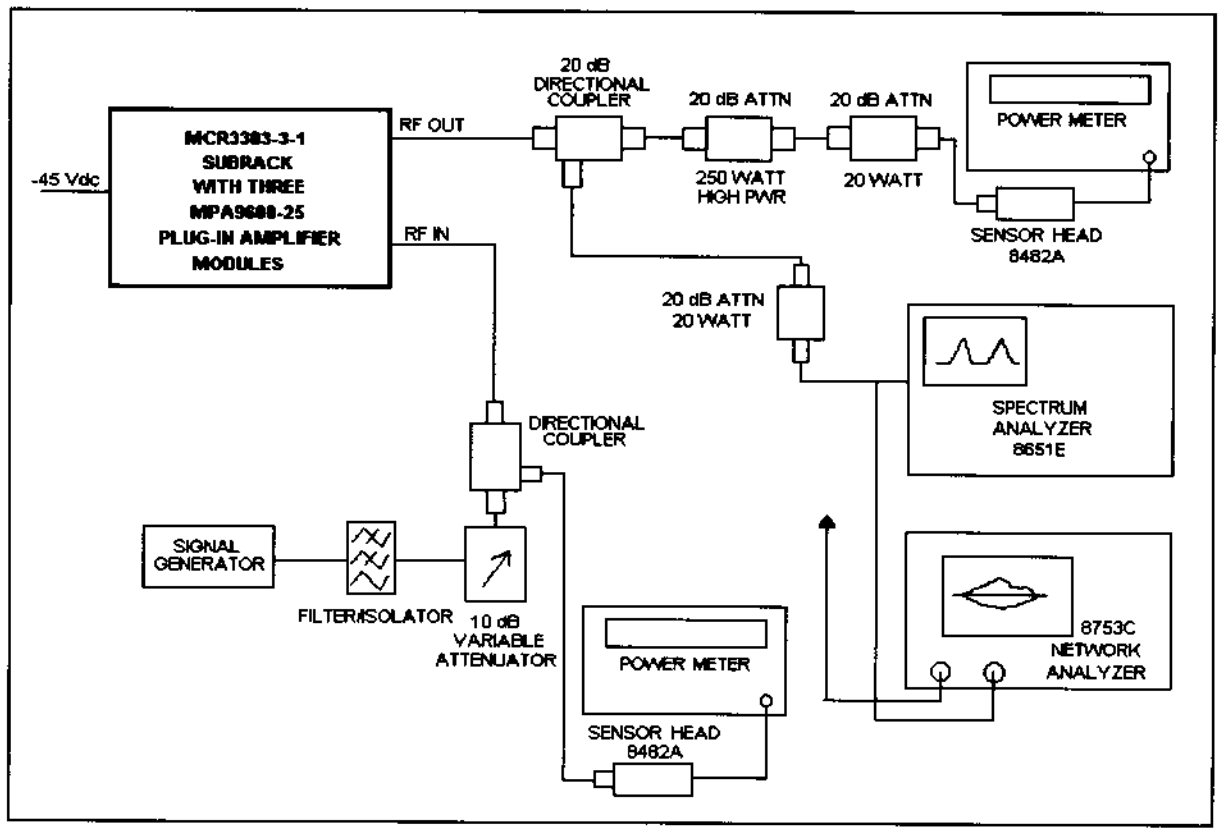


Figure 5-1. Amplifier System Test Setup Diagram

SINGLE AMPLIFIER IMD TEST:

3. Adjust attenuator for an input signal at -I0 dBm. Reset amplifier with the front panel ON/OFF/RESET switch, and set switch to ON. Adjust variable attenuator to set amplifier power output on power meter to 25 watts. Measure IMD on spectrum analyzer. IMD should be -60 dBc min. Record test data in table 5-3. Switch tested amplifier to OFF.

4. Repeat step 3 for amplifiers 2 and 3, as applicable, for each plug-in amplifier module.

TWO AMPLIFIER IMD TEST:

5. Reset and turn on channel 1 and 2 amplifier modules, and turn off channel 3 amplifier. Adjust the variable attenuator to set power output on power meter to 50 watts. Measure IMD on spectrum analyzer. IMD should be -60 dBc min. Record test data in table 5-3.

6. Reset and turn on channel 1 and 3 amplifiers, and turn off channel 2. Adjust the variable attenuator to set power output on power meter to 50 watts. Measure IMD on spectrum analyzer. IMD should be -60 dBc min. Record test data in table 5-3.

7. Reset and turn on channel 2 and 3 amplifiers, and turn off channel 1. Adjust the variable attenuator to set power output on power meter to 50 watts. Measure IMD on spectrum analyzer. IMD should be -60 dBc min. Record test data in table 5-3.

THREE AMPLIFIER IMD TEST.

8. Reset and turn on channel 1, 2, and 3 amplifiers. Adjust the variable attenuator to set power output on power meter to 75 watts. Measure IMD on spectrum analyzer. IMD should be -60 dBc min. Record test data in table 5-3.

GAIN TEST:

9. Disconnect spectrum analyzer from test setup, and connect the network analyzer.

10. Set network analyzer as follows:
    - Power output to 11 dBm.
    - Frequency start to 1970 MHz.
    - Frequency stop to 1990 MHz.
    - Normalize the network analyzer for gain and return loss.

11. Reset and turn on the channel 1 amplifier; turn off channel 2, and 3 amplifiers. Check the gain across the band from 1970 MHz to 1990 MHz. Gain should be 59.5 ±0.5 dB. Record test data in table 5-3.

12. Turn off the channel 1 amplifier and reset and turn on the channel 2 amplifier. Check the gain across the band from 1970 MHz to 1990 MHz. Gain should be 59.5 ±0.5 dB. Record test data in table 5-3.

13. Turn off the channel 2 amplifier and reset and turn on the channel 3 amplifier. Check the gain across the band from 1970 MHz to 1990 MHz. Gain should be 59.5 ±0.5 dB. Record test data in table 5-3.

14. Refer to table 5-3. Collectively reset and turn on the amplifier modules in groups of two and three, as shown in table 5-3, and check the gain of each group. The gain of each group of amplifiers should be 59.5 ±0.5 dB. Record test data in table 5-3.

HARMONICS TEST

15. With the power set at 75 watts power output, use the spectrum analyzer and check the frequency band from 1970 MHz to 1990 MHz for harmonics. Harmonics should be -45 dBc maximum. Record test data in table 5-3.

SPURIOUS TEST

16. With the power amplifier set at 75 watts power output, use the spectrum analyzer and check the frequency band from 1970 MHz to 1990 MHz for spurious signals. Spurious signals should be -60 dBc maximum. Record test data in table 5-3.

INPUT RETURN LOSS TEST:

17. Reset and turn on all amplifier modules in the subrack. Read and record the S_{11} return loss measurement on network analyzer. Input return loss should be –14 dB minimum. Record test data in table 5-3.

Table 5-3. Multicarrier PCS Amplifier System Test Data Sheet

DATE _____

MCR3303-3-1 SUBRACK S/N _____

MODULE #1 S/N _____ MODULE #2 S/N _____

MODULE #3 S/N _____

TEST CONDITIONS:
Load and Source Impedance: 50 Ohms
VSWR: < 1.2:1
Supply Voltage: +27 Vdc ±1.0 Vdc

TEST	SPECIFICATION	MIN	MAX	DATA		
4-TONE IMD One Module	Vcc = 27 Vdc PO = 25 W Freq.: 1974, 1978, 1982, and 1986 MHz	-60 dBc		1	2	3
4-TONE IMD Two Modules	Vcc = 27 Vdc PO = 50 W Freq.: 1974, 1978, 1982, and 1986 MHz	-60 dBc		1,2	1,3	2,3
4-TONE IMD Three Modules	Vcc = 27 Vdc PO = 75 W Freq.: 1974, 1978, 1982, and 1986 MHz	-60 dBc		1,2,3		
RF Gain One Module	Vcc = 27 Vdc PO = 25 W Freq. = 1980 MHz	59 dB	60 dB	1	2	3
RF Gain Two Modules	Vcc = 27 Vdc PO = 50 W Freq. = 1980 MHz	59 dB	60 dB	1,2	1,3	2,3
RF Gain Three Modules	Vcc = 27 Vdc PO = 75 W Freq. = 1980 MHz	59 dB	60 dB	1,2,3		
Gain Flatness	Vcc = 27 Vdc ±1 Vdc PO =75 W 1970-1990 MHz Band		±0.7 dB	All		
Harmonics	Vcc = 27 Vdc PO = 75 W 1970-1990 MHz Band		-45 dBc	All		
Spurious	Vcc = 27 Vdc PO =75 W 1970-1990 MHz Band		-60 dBc	All		
Input Return Loss	Vcc = 27 Vdc PO = 75 W 1970-1990 MHz Band	-14 dB		All		
DC Power	Vcc = 27 Vdc PO = 75 W 4 Tones		84 Amps	All		

PASS _____ FAIL _____

Tested by _____

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:

1. MPA9600-25 power amplifier modules
2. Cooling fans

5-6.1. MPA9600-25 POWER AMPLIFIER MODULE

To replace a power amplifier module, proceed as follows:

1. Set RF ON ON/OFF/RESET and the power ON/OFF switches on the front panel of the amplifier module to OFF.

2. Loosen two screws that secure amplifier module to subrack.

3. Use handle on front of module, and with a steady even pressure, pull module out of chassis.

CAUTION

When removing the amplifier from the subrack, it is very important to support the amplifier such that the rear of the module does not suddenly drop when the guide rail disengages from the track. A drop such as this could damage the rear multipin connector.

5-6.2. COOLING FANS

To replace a cooling fan, proceed as follows:

1. Remove amplifier module from subrack; see paragraph 5-6.1 preceding.

2. Loosen four snap fasteners that secure fan to amplifier module. Disconnect fan power connector from amplifier module.

3. Install replacement in reverse order of steps 1 and 2 above.

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
Any voltage indicators (green) are not lit or blinking	1. Check that subrack power connection is secure. 2. Check for proper power supply voltage. 3. Check fuses or circuit breakers on amplifier or subrack. 4. Verify that amplifier is fully inserted into subrack.
HIGH TEMP alarm (red) is lit	1. Verify fan(s) are operating properly. 2. Check ambient temperature (not to exceed spec – see table 1-2).
OVER PWR alarm (red) is lit	Verify RF input level does not exceed spec – see table 1-2.
VSWR alarm (red) is lit	Check output connections and cables for integrity and tightness.
LOW PWR alarm (red) is lit	Contact Powerwave field representative or factory.

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 Customer Service Department at (949) 757-0530 to obtain this number. Failure to obtain this RMA number will result in considerable 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 be used. The original packaging material is reusable. If it is not available, contact Powerwave's Customer Service Department for packing materials and information.