Powerwave Technologies, Inc.

MCA9000-400 SERIES
AMPLIFIER SYSTEMS

SERVICE & INSTALLATION MANUAL

September 10, 1996

MULTI-CHANNEL, LINEAR, FEED FORWARD AMPLIFIER SYSTEMS

800 - 960 MHz
32 TO 135 WATTS AVERAGE POWER
-65 dBc INTERMODULATION DISTORTION

- PLUG IN DESIGN
- EXPANDABLE (32 WATTS TO 135 WATTS)
- REMOTE STATUS/FAULT MONITORING
- FIELD REPLACEABLE AMPLIFIER MODULES AND FANS
- EASY MAINTENANCE

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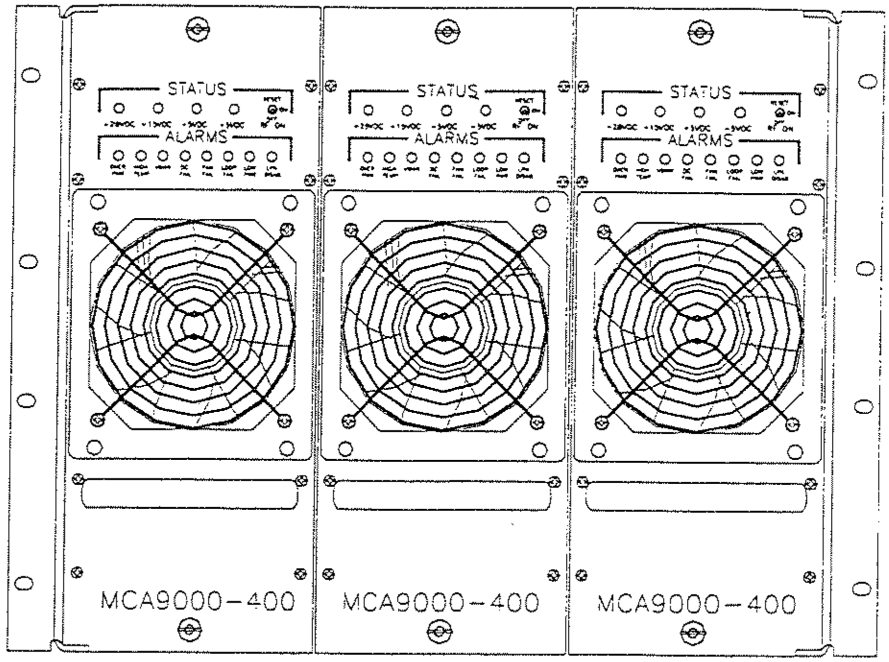


Figure 1-1.MCR3000 Main Frame (Front View)

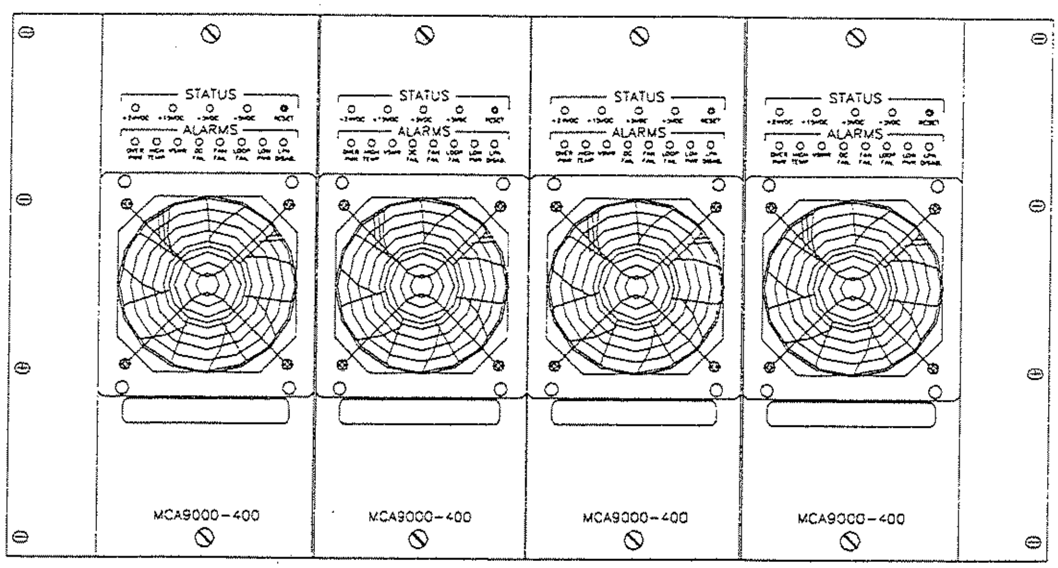


Figure 1-2. MCR4100 Main Frame (Front View)

Table 1-1. MCA9000-400 Series Multi-Channel Amplifier System Functional Specifications

Frequency Range	800-960 MHz (25 MHz Bandwidth)
Total Output Power (Minimum) Installed in MCR3000 or MCR4100	32W (1 Module) 70W (2 Modules) 100W (3 Modules) 135W (4 Modules)
Intermodulation Distortion and In-Band Spurious:	1 Module : -65 dBc (Min) @ +24 to +28VDC,@ 32 Watts 2 Modules: -65 dBc (Min) @ +24 to +28VDC,@ 70 Watts 3 Modules: -65 dBc (Min) @ +24 to +28VDC,@ 100 Watts 4 Modules: -65 dBc (Min) @ +24 to +28VDC,@ 135 Watts (-55 dBc(Min) @ +23 to +24VDC)
RF Gain at 880 MHz	53.6 dB, ±1.0 dB (1 Module) MEASURED = 51dB 53.6 dB, ±1.0 dB (2 Modules) 53.6 dB, ±1.0 dB (3 Modules) 53.6 dB, ±1.0 dB (4 Modules)
Gain Flatness:	± 0.7 dB @ 27VDC ±1VDC
Gain Variation Over Temperature:	± 1.0 dB @ 27VDC ±1VDC ± 1.5 dB @ 24 to 26VDC
Output Protection:	Mismatch Protected
RF Power Input per Channel	-10 dBm Max for a One Channel One Module System -7 dBm Max for a Two Channel Two Module System -5 dBm Max for a Three Channel Three Module System -4 dBm Max for a Four Channel Four Module System
Input Port Return Loss:	-18 dB (Min)
Harmonics:	Better than -45 dBc
Out of Band Spurious:	Better than -60 dBc
Duty Cycle:	Continuous
DC Input Power:	+27VDC ± 1VDC, 22 Amps Max per module @ 40 Watts Operational +23VDC to 30VDC
Module Alarm:	Module Disabled if Alarm is Continuous for 5 Seconds
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
Module Interface Connector:	15-Pin D-Sub (Female)
System Interface Connector	25-Pin D-Sub (Female)
RF Output Connector:	Type N Female
RF Input Connector:	SMA Female
Dimensions: • MCR3000 Rack: • MCR4100 Rack:	 13.97" High, 19" Wide,16.10" Deep 14" High, 26.77" Wide,16.10" Deep

SECTION 2
INSTALLATION INSTRUCTIONS

2-1. INTRODUCTION.

This section contains installation recommendations, unpacking, inspection and installation instructions for the MCA9000-400 Series 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 +27VDC 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 an inrush current of 125 Amps, 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. The amplifier system is shipped in two containers. Check the outside of each for instructions regarding unpacking. Carefully open the containers and remove the rack and amplifier modules. Retain all packing material that can be reassembled in the event the that the unit must be returned to the factory.

CAUTION

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

Visually inspect the amplifier rack 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 (See figure 3-1)

There are two configurations of the amplifier system: MCR3000 with 19-inch main frame and three amplifier modules, and MCR4100 with 26-inch rack with four amplifier modules. Both systems are designed for installation in a rack that permits access to the rear of the amplifier system main frame for connection of DC power, RF and control and monitor cables.

To install the amplifier system proceed as follows:

1. Install main frame in equipment rack, and secure in place with eight screws.
2. Refer to figure 3-1 for the location of all input/output connectors.
3. Connect antenna cable to RF OUT connector on rear of main frame.
4. Connect transceiver or exciter input to RF IN on rear of main frame.
5. Connect +27VDC and GROUND to appropriate terminals on the main frame rear panel (figure 3-1).

WARNING
The MCR3000 and MCR4100 racks do not have an internal power disconnect. Turn off external primary DC power before removing covers or disconnecting DC power cables.

6. Install the plug-in amplifier modules in the slots of the main frame.
7. Check your work before applying DC voltage to the amplifier. Make certain all connections are tight and correct.
8. Measure primary DC input voltage. DC input voltage should be +27VDC ±1.0VDC. If the DC input voltage is above or below the limits, call and consult Powerwave before you turn-on your amplifier.
9. Refer to section 3 for initial turn-on and check-out procedures.

2-5. AMPLIFIER MODULE STATUS AND ALARM CONNECTOR.
Each amplifier in the main frame has a separate remote alarm connector that is used by the host system to monitor the individual amplifier modules. The MCR3000 main frame has connectors J1-J3. The MCR4100 main frame has four connectors, J1-J4. The status and alarm signals output on the amplifier connectors and listed and described in table 2-1

Table 2-1. Amplifier Module Remote Alarm Interface Connector J1-J4

J1-J4 D-Sub 15 Pin Female	FUNCTION	DESCRIPTION
1	Ground	Ground
2	OVER POWER Alarm Output	Normally TTL Low. If power amplifier module exceeds 42-45 Watts output power the Over Power LED on front panel will illuminate and this signal will go TTL High. If this condition continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled.
3	HIGH TEMP Alarm Output	Normally TTL Low. If power amplifier module heat sink temperature exceeds 80°C High Temp LED on front panel will illuminate and this signal will go TTL High. If this continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled. Temperature sensing is performed with a thermal switch.

Table 2-1. Amplifier Module Remote Alarm Interface Connector J1-J4 (Continued)

J1-J4 D-Sub 15 Pin Female	FUNCTION	DESCRIPTION
4	VSWR Alarm Output	Normally TTL Low. If power amplifier module heat sink temperature exceeds 80°C High Temp LED on front panel will illuminate and this signal will go TTL High. If this continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled. Temperature sensing is performed with a thermal switch.
5	DC FAIL Alarm Output	Normally TTL Low. If +27V supply drops below 19V, internal +15V drops below +14V, internal +5V drops below 4.5V or internal -5V increases above -4.7V the DC Fail LED on front panel will illuminate, the Status LED for that specific voltage will turn off and this signal will go TTL High. If this condition continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled.
6	LOOP FAIL Alarm Output	Normally TTL Low. If loop control voltages increase or decrease over their limits the Loop Fault LED on front panel will illuminate and this signal will go TTL High. If this condition continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled.
7	LOW POWER Alarm Output	Normally TTL Low. The forward power of each amplifier module is summed and the average power is compared with each amplifier module. If one power amplifier module's output power drops below -2dB (-1, +0dB) of the total average power the front panel Low Power LED will illuminate and this signal will go TTL High. If this condition continues for 5 seconds a summary alarm will occur and the amplifier module will be disabled.
8	FAN FAIL Alarm Output	Normally TTL Low. If one fan fails the Fan Fail LED on front panel will illuminate and this signal will go TTL High. A summary alarm will not occur unless both fans fail. If both fans fail, a summary alarm will occur and the amplifier module will be disabled.
9	Ground	Ground
10	Forward Power Monitor Output	A DC voltage proportional to the forward power output of the amplifier module. 3.6 - 4.4VDC at 40 watts output power.
11	Reverse Power Monitor Output	A DC voltage proportional to the power reflected back into the output of the amplifier module. 3.6 - 4.4VDC at 40 watts open load.
12	Open	Open
13	Open	Open
14	Open	Open
15	Open	Open

2-6. MCR3000 AND MCR4100 MAIN FRAME STATUS, ALARM AND CONTROL CONNECTOR (J5). Each main frame has a separate status, alarm and control connector that is used by the host system to monitor and control the system. The MCR3000 main frame has connector J3 and the MCR4100 main frame has connector J5. The status, alarm and control signals input/output on system connectors J4 and J5 listed and described in tables 2-2 and 2-3. The signal levels for tables 2-2 and 2-3 are defined below:

1. All output signal lines are from open collectors with pull-up resistors. The resistors are 5.1K ohm to a 5VDC source voltage.

2. All fault signals except fan fault, will latch on after 5 seconds of a continuous fault condition. All signal faults after 5 seconds of a continuous fault, will generate a summary fault and disable the amplifier.

3. If a summary alarm occurs, all fault states (except the fan fault) will be latched to that state and the amplifier module will be disabled. The latch can be reset with a power interrupt or a front panel or remote reset signal. When a fault is latched, the corresponding front panel LED lights and the corresponding signal is high. Possible subsequent faults are ignored.

4. When an amplifier module is disabled, the following sequence takes effect in 1 second intervals:
   1. The RF input is turned off.
   2. The bias to the main and error amplifiers is reduced to 0VDC.
   3. The RF output relay in the power combiner is opened.

5. When an amplifier module is enabled, the following sequence takes effect in 1 second intervals:
   1. The RF output relay in the power combiner is closed.
   2. The bias for the main and error amplifiers is turned on.
   3. The RF input is turned on.

6. TTL high = 2-5V. TTL low = 0-800mV

Table 2-2. MCR3000 Main Frame Status, Alarm and Control Signals (J4)

J5 D-Sub 25-Pin Female	FUNCTION	DESCRIPTION
1	Ground	Ground
2	Summary Alarm For Amplifier Module 1 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
3	Summary Alarm For Amplifier Module 2 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
4	Summary Alarm For Amplifier Module 3 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
5		Open
6	Module Detect for Amplifier Module 1 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
7	Module Detect for Amplifier Module 2 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
8	Module Detect for Amplifier Module 3 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
9		Open

Table 2-2. MCR3000 Main Frame Status, Alarm and Control Signals (J4) (Continued)

10	Module Disable for Amplifier Module 1 (Input)	A TTL high input will enable the amplifier module. A TTL low will disable the amplifier module. If no signal is supplied, the amplifier will be enabled because of a pull-up resistor to 5V.
11	Module Disable for Amplifier Module 2 (Input)	A TTL high input will enable the amplifier module. A TTL low will disable the amplifier module. If no signal is supplied, the amplifier will be enabled because of a pull-up resistor to 5V.
12	Module Disable for Amplifier Module 3 (Input)	A TTL high input will enable the amplifier module. A TTL low will disable the amplifier module. If no signal is supplied, the amplifier will be enabled because of a pull-up resistor to 5V.
13		Open
14	Module Reset for Amplifier Module 1 (Input)	This input should be a TTL high for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL low to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL high is not supplied, the amplifier will be enabled because it has a pull-up resistor to 5V.
15	Module Reset for Amplifier Module 2 (Input)	This input should be a TTL high for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL low to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL high is not supplied, the amplifier will be enabled because it has a pull-up resistor to 5V.
16	Module Reset for Amplifier Module 3 (Input)	This input should be a TTL high for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL low to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL high is not supplied, the amplifier will be enabled because it has a pull-up resistor to 5V.
17		Open
18	Disable Signal from Amplifier Module 1 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
19	Disable Signal from Amplifier Module 2 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
20	Disable Signal from Amplifier Module 3 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
21		Open
22	Forward Power Monitor (Output)	A DC voltage proportional to the forward power at the output of the amplifier main frame 4.0 to 5.0VDC.
23	Reflected Power Monitor (Output)	A DC voltage proportional to the reflected power at the output of the amplifier main frame. 4.0 to 5.0VDC.
24	Ground	Ground
25	Mainframe DC Monitor	A DC voltage equivalent to the +5V rail in the mainframe.

Table 2-3. MCR4100 Main Frame Status, Alarm and Control Signals (J5)

J5 D-Sub 25-Pin Female	FUNCTION	DESCRIPTION
1	Ground	Ground
2	Summary Alarm For Amplifier Module 1 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
3	Summary Alarm For Amplifier Module 2 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
4	Summary Alarm For Amplifier Module 3 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
5	Summary Alarm For Amplifier Module 4 (Output)	Normally TTL low with or without a module plugged in. If a summary alarm occurs this signal goes TTL high and the corresponding amplifier Module is turned off.
6	Module Detect for Amplifier Module 1 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
7	Module Detect for Amplifier Module 2 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
8	Module Detect for Amplifier Module 3 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
9	Module Detect for Amplifier Module 4 (Output)	If an amplifier module is present and plugged into this slot, the signal will be a TTL low. If the slot is vacant, the signal will be a TTL high.
10	Module Disable for Amplifier Module 1 (Input)	A TTL low input will enable the amplifier module. A TTL high will disable the amplifier module. If no signal is supplied, the amplifier will be disabled.
11	Module Disable for Amplifier Module 2 (Input)	A TTL low input will enable the amplifier module. A TTL high will disable the amplifier module. If no signal is supplied, the amplifier will be disabled.
12	Module Disable for Amplifier Module 3 (Input)	A TTL low input will enable the amplifier module. A TTL high will disable the amplifier module. If no signal is supplied, the amplifier will be disabled.
13	Module Disable for Amplifier Module 4 (Input)	A TTL low input will enable the amplifier module. A TTL high will disable the amplifier module. If no signal is supplied, the amplifier will be disabled.
14	Module Reset for Amplifier Module 1 (Input)	This input should be a TTL low for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL high to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL low is not supplied, the alarm circuit will not latch for any faults and a summary alarm will not occur.

Table 2-3. MCR4100 Main Frame Status, Alarm and Control Signals (J5) (Continued)

15	Module Reset for Amplifier Module 2 (Input)	This input should be a TTL low for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL high to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL low is not supplied, the alarm circuitry will not latch for any faults and a summary alarm will not occur..
16	Module Reset for Amplifier Module 3 (Input)	This input should be a TTL low for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL high to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL low is not supplied, the alarm circuitry will not latch for any faults and a summary alarm will not occur.
17	Module Reset for Amplifier Module 4 (Input	This input should be a TTL low for normal amplifier operation. If a summary alarm occurs, this signal should be transitioned to a TTL high to reset the amplifier latch logic. If a fault is still present after the reset is received, the amplifier will automatically shut down five seconds after the reset is received. If a TTL low is not supplied, the alarm circuitry will not latch for any faults and a summary alarm will not occur.
18	Disable Signal from Amplifier Module 1 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
19	Disable Signal from Amplifier Module 2 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
20	Disable Signal from Amplifier Module 3 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
21	Disable Signal from Amplifier Module 4 (Output)	If the amplifier module is enabled, this output signal will be a TTL low. If the amplifier is disabled by the front panel ON/OFF switch, by a summary alarm or by a remote disable signal, this signal output will be a TTL high.
22	Forward Power monitor Output	A DC voltage proportional to the forward power at the output of the main frame; 4.0 to 5.0VDC @ full power.
23	Reflected Power Monitor (Output)	A DC voltage proportional to the power reflected power back to the output of the amplifier main frame; 4.0 to 5.0VDC @ full power.
24	Ground	Ground
25	Mainframe DC Monitor (+5VDC = OK)	A DC voltage equivalent to the +5V rail in the mainframe.

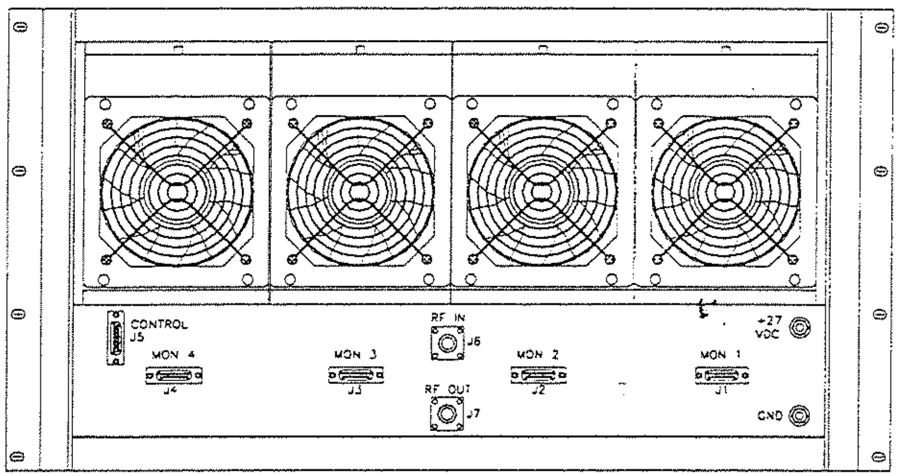
SECTION 3
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

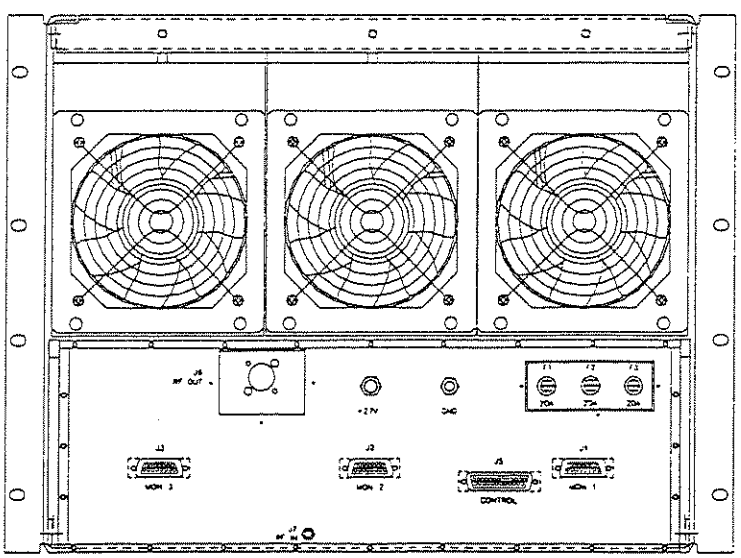
This section contains operating instructions for the MCA9000-400 Series Amplifier Systems.

3-2. LOCATION AND FUNCTION OF MAIN FRAME AND AMPLIFIER CONTROLS AND INDICATORS.

The amplifier system main frames are rack mountable chassis. The location and function of the system interface connectors are shown in figure 3-1 and described in table 3-1. The plug-in amplifier module controls and indicators, are shown in figure 3-2 and are described in detail in table 3-2.



MCR4100 Rear View



MCR3000 Rear View

Figure 3-1. MCA9000-400 Amplifier Systems

Table 3-1. MCR3000 & MCR4100 Main Frame Fuses and Input/Output Connectors

NUMBER	NAME	FUNCTION
1	F1, F2, F3 and F4	Main frame mounted 30 amp fuses (MCR4100). The fuses are in line with the +27V DC source voltage supplied to each plug-in amplifier module.
2	+27V DC Input Terminal GROUND Terminal	Input terminals for primary +27V DC source voltage and ground.
3	RF OUT Connector	Type N female coax connector. Output to antenna. Refer to table 1-1 for power output level of three/four amplifier module systems.
4	J1-MON1 through J4-MON4 on MCR4100. J1-MON1 through J3-MON3 on MCR3000.	Remote monitor output connectors. 15 pin, female type D-SUB connectors. I/O interface to host system for each of the plug-in amplifier modules. Refer to table 2-1 for a description of the signals
5	J5 -CONTROL Connector	Remote control input connector. 25 pin, female type D-SUB connector. Receives system and plug-in amplifier module signals from host system. Refer to table 2-3 for a description of the signals.
6	J7 -RF IN Connector	SMA female coax connector. Refer to table 1-1 for power input level to three/four amplifier module systems.
7	RF SAMPLE Port on MCR3000. (Optional port on MCR4100)	SMA female coax connector. RF output signal is at -40 dB of signal output to antenna.

Table 3-2. Amplifier Module Controls and Indicators

STATUS INDICATORS		
NUMBER	NAME	FUNCTION
1	+27V DC Indicator	Green LED. When lit, indicates that the +27V DC supply is greater than +19V DC. If the +27V DC indicator goes out, it indicates that the +27V DC voltage dropped below +19V DC. If the low voltage condition prevails for over 5 seconds, the alarm logic generates a DC fault signal, illuminates the DC FAIL indicator, then turns off the power amplifier module.
2	+15V DC Indicator	Green Led. When lit, indicates that the regulated +15V in the power amplifier module is at a nominal level. If the +15V DC indicator goes out, it indicates that the +15V DC voltage dropped below +14V DC. If the low voltage condition prevails for over 5 seconds, the alarm logic generates a DC fault signal, illuminates the DC FAIL indicator, then turns off the power amplifier module.
3	+5V DC Indicator	Green Led. When lit, indicates that the regulated +5V in the power amplifier module is at a nominal level. If the +5V DC indicator goes out, it indicates that the +5V DC voltage dropped below +4.5V DC. If the low voltage condition prevails for over 5 seconds, the alarm logic generates a DC fault signal, illuminates the DC FAIL indicator, then turns off the power amplifier module.
4	-5V DC Indicator	Green Led. When lit, indicates that the regulated —5V in the power amplifier module is at a nominal level. If the -5V DC indicator goes out, it indicates that the -5V DC voltage increased above -4.7V DC. If the high voltage condition prevails for over 5 seconds, the alarm logic generates a DC fault signal, illuminates the DC FAIL indicator, then turns off the power amplifier module.

Table 3-2. Amplifier Module Controls and Indicators (Continued)

6	OVER POWER Fault Indicator	Red LED. When lit, indicates the output power from the amplifier exceed 42-45 watts. If the over power condition prevails continuously for over 5 seconds, the alarm logic will turn off the amplifier module. The fault indicator will go out when the RESET button is toggled or a remote reset is received from the host system.
7	HIGH TEMP Fault Indicator	Red LED. When lit, indicates that the amplifier heat sink temperature has exceeded 80° C. If the over temperature condition prevails for longer then five seconds, the alarm logic generates a summary fault signal, and turns off the amplifier module.
8	VSWR Fault Indicator	Red LED. When lit, indicates that the reflected power detected at the amplifier output exceed 4.0:1. If the VSWR condition prevails continuously for longer then 5 seconds, the alarm logic generates a summary fault signal and turns off the amplifier module.
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 (+27V below 19V, +15V below 14V, +5V below 4.5V, or -5V above -4.7V). If the condition prevails continuously for longer then five seconds, the specific green LED will turn off, and the fault logic will generate a summary alarm and shut off the amplifier module.
10	FAN FAIL Fault Indicator	Red LED. When lit, indicates that one or both of the fans has failed. If one fans fails, the FAN FAIL indicator will light. If both fans fail, the FAN FAIL indicator will light, and the fault logic will generate a summary alarm and shut off the amplifier module.
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 the condition prevails continuously for longer then five seconds, the fault logic will generate a summary alarm and shut off the amplifier module.

Table 3-2. Amplifier Module Controls and Indicators (Continued)

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 the condition prevails continuously for longer then five seconds, the fault logic will generate a summary alarm and shut off the amplifier module.
13	LPA DISAB Fault Indicator	Red LED. When lit, indicates that the amplifier module has been remotely disabled by the host system, or manually switched off using the front panel RF ON/OFF switch, or disabled by a summary alarm.

3-3. INITIAL START-UP AND OPERATING PROCEDURES.

The only operating control on each amplifier module is the 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.

WARNING

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 1-1 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 front panel switches are in the OFF position.

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

4. Visually check the indicators on the amplifier modules, and verify that the following indicators are on:

   a. LOOP FAIL Indicator (red) should be on.
   b. LPA DISABLE Indicator (red) will illuminate 5 seconds later.
   c. The +27V, +15V, +5V and -5V indicators (green) on all amplifier modules should be on.

5. Turn on all front panel switches. All red LEDs should illuminate. (You may have to Reset the system to initiate operation).

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

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

8. The LOOP FAIL and LOW POWER indicators should turn off.

SECTION 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION
This section contains a functional description of the MCA9000-400 series linear amplifier systems.

4-2. RF INPUT SIGNAL.
The maximum input power for all carrier frequencies should not exceed the limits specified in table 1-1. For proper amplifier loop balance, the out of band components of the input signals should not exceed -40dBc. 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 dose not exceed 1 watt. A parasitic signal of less than 1 watt incident on the output, will not cause distortion at a higher level than the normal forward distortion (i.e. -60dBc).

4-4. SYSTEM FUNCTIONAL DESCRIPTION
The amplifier system is comprised of an MCR3000 or MCR4100 main frame and one to four MCA9000-400 plug-in power amplifiers. The MCA9000-400 Series amplifier system is a linear, feed-forward power amplifier that operates in any 25 MHz frequency band from 800 MHz to 960 MHz. Typical three and four module systems are shown in figures 4-1 and 4-2. Power output specifications for one to four module systems are listed in table 1-1. 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 main frame houses a three or four way power splitter/combiner, summary alarm logic and a voltage regulator. The rear panel of the main frame 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 40 watts (1 amplifier module, stand-alone mode) to 135 watts (4 amplifier modules), with -65dBc 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 four module system, the signal will be split into four signals of equal power and input to the plug-in amplifier modules. The output from each amplifier, is an amplified composite signal of approximately 40 watts. 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 135 watts. A dual directional detector in the main frame, samples the forward and reflected power at the system RF output connector. 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 failure/fault signal is output to the summary alarm and control module in the main frame.

The summary alarm module in the main frame is the system fault monitor and controller. Some failure/fault signals are passed directly through the summary module and are output to the host system via connectors J1-J4 (table 2-1). When an amplifier is turned off, it is physically disconnected via pin diodes and relays from the splitter/combiner. The purpose of the summary alarm board is to control the turn-on and turn-off sequence of the amplifiers and splitter/combine, 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.

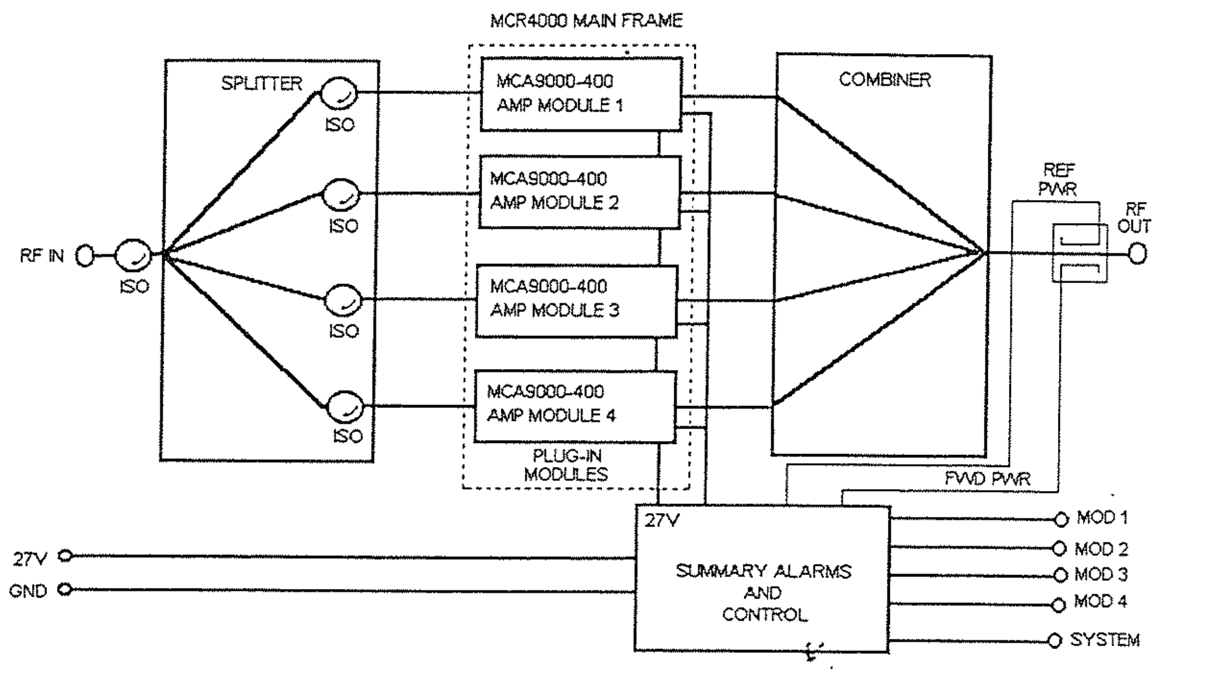


Figure 4-1. MCA9000-400 Series Four Module Linear Amplifier System

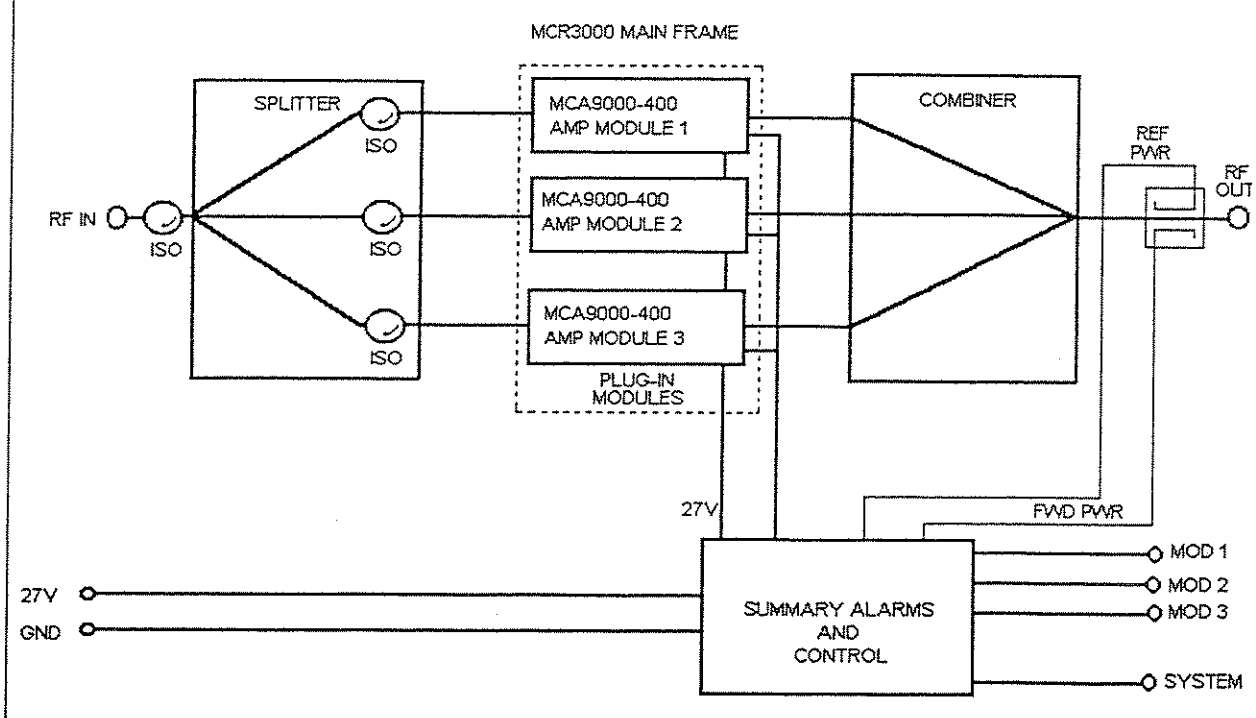


Figure 4-2. MCA9000-400 Series Three Module Linear Amplifier System

4-5. MCR3000 and MCR4100 MAIN FRAMES.

The MCR3000 and MCR4100 main frame, figures 4-1 and 4-2, is not field repairable. The main frame contains a three or four way RF power splitter/combiner, voltage regulator, summary alarm board, and a dual directional detector. The splitter/combiner has an input splitter and an output combiner, which provide good VSWR and system redundancy. The splitter/combiner has switches and 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 +5V DC and +15V DC 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 passing all fault signals to the rear panel, calculating the average power output from the amplifiers and controlling the relays and switches in the splitter/combiner. It also provides signal routing and is the I/O interface to the input signal generator (exciter or transceiver) and system antenna. The summary board also has four or five status/control connectors that interface with the host system. The mod 1-3 and 1-4 connectors (table 2-1), provide status and fault data from the three/four amplifier modules to the host system. The system connector (table 2-2) outputs system level data such as module summary alarms and system forward/reflected power. The system connector (J5) is also the remote interface connector for remote monitoring and control of the amplifier system.

4-6. MCA9000-400 SERIES AMPLIFIER MODULE

The amplifier module, figure 4-3, has an average power output of 40 watts (400 watts peak power) with intermodulation products suppressed to better than -60dBc below carrier levels. The amplifier provides an amplified output signal with constant gain and phase by adding approximately 30dB 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:

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

The main amplifier employs class AB amplifier for maximum efficiency. The error amplifier and feed forward loops are employed to correct signal non-linearities 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 pre-main amplifier. The output from the pre-main amplifier is fed to the class AB main amplifier. The output from the main amplifier is typically 40 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 1st loop is to amplify and phase shift the RF input signal. The primary function of the 2nd loop is to alternately sample the distortion and IMD on the final output from the amplifier. A time base generator in the second loop controls the sample rate of the RF output and the correction rate of the variable attenuators and phase shifters. 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° and constantly monitors the output for correct phase

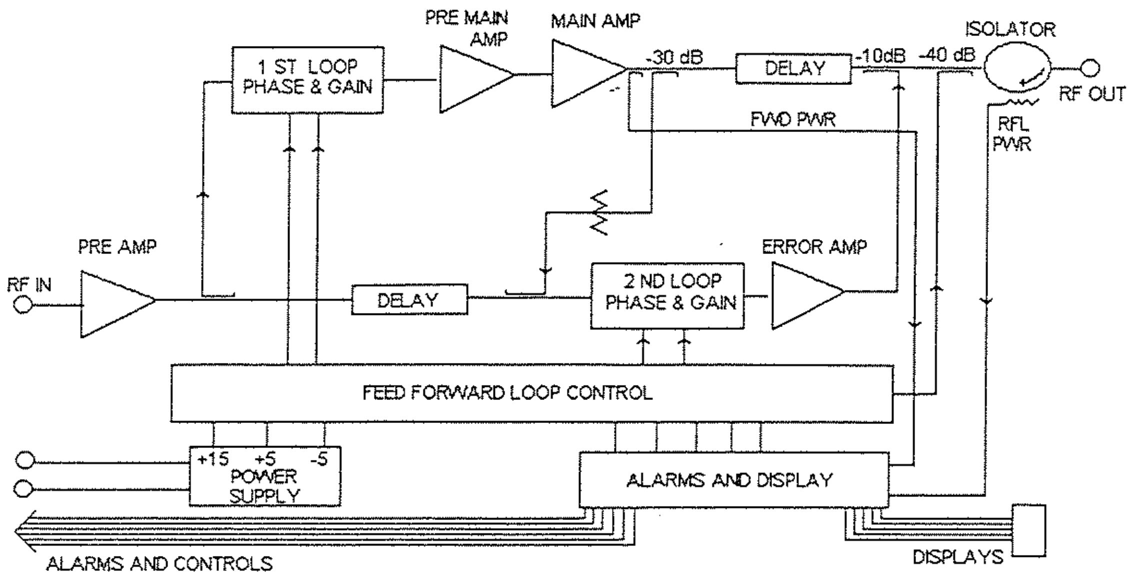


Figure 4-3. MCA9000-400 Series Power Amplifier Module Functional Block Diagram

and gain. The 2nd loop control section obtains a sample of the distortion added to the output signals by the main amplifiers, phase shifts the signals by 180°, then feeds it to the error amplifier where it is amplified to the same power level as the input sample, then couples the error signal on to 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 54 dB of gain in any 25 MHz frequency band from 800 MHz to 960 MHz. The amplifier operates on +27V DC, and a bias voltage of +5V DC and is mounted directly on a heat sink. The alarm logic controls the +5V DC 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 multi-stage, class A amplifier, has 40 dB of gain and produces a 30 watt output. The amplifier operates on +27V DC, and a bias voltage of +15V DC 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 lights the HI TEMP indicator on the amplifier front panel. It also outputs a fault to the alarm collection logic. The alarm logic shuts off the +15V DC bias voltage which shuts down the amplifier. When the amplifier has cooled down, it can be turned on by toggling the RESET button. The amplifier can also be reset via the remote interface connector.

4-6.3. AMPLIFIER MONITORING.

In the main and error amplifier modules, all normal variations are automatically compensated for by the feedback controls however, when large variations occur the modules generate alarm outputs. The alarms are displayed in the front panel indicators and output via a 15 pin remote alarm connector (J1-J4) on the rear of the rack for remote monitoring. Refer to table 2-2 and 2-3 for a detailed description of the amplifier module error signals.

4-6.4. AMPLIFIER MODULE COOLING.
Although each amplifier module contains its own heat sink, It is cooled with forced air. Two fans for are used for forced air cooling and redundancy. The fans are located on the front and rear of the amplifier module and 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 MCR3000or MCR4100 main frame. The main frame supplies each amplifier module with +27V DC and via the RF power splitter/combiner. The amplifier module has a DC/DC converter that convert the +27V DC to +15V DC, +5V DC and -5V DC.

4-8. INTERMODULATION
The MCA9000-400 series is designed to deliver a 40 watt composite average power, multicarrier signal, occupying a band width less or equal to the instantaneous band width (25MHz), and located anywhere in the bandwidth from 800-960 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 5kHz to 25MHz apart, and at any power level up to the peak power, the third order intermodulation products will be below -65dBc. As the 2 tones are spaced more closely, the intermodulation tends to improve due to the effect of the first loop controls. At 25kHz spacing, the third order intermodulation products are typically below -70dBc.

4-8.2 MULTI-TONE 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 (-70dBc). 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 and it is -65dBc or better. The average is usually achieved by using a narrow video filter, typically 1 kHz.

4-9. ALARMS.
A number of plug-in amplifier and system parameters and alarms can be remotely monitored on the remote alarm connectors. Refer to tables 2-2 and 2-3 for a description of the parameters and alarms.

SECTION 5
MAINTENANCE

5-1. INTRODUCTION

This section contains periodic maintenance and performance test procedures for the MCA9000-400 Series Amplifier Systems. 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 may 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.

CAUTION
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 MCA9000-400 Series 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 (4 each)	H.P.	8656B
20 dB Attenuator, 250 Watt	Tenuline	
20 dB Attenuator, 20 Watt	Tenuline	
(2 each)		
Spectrum Analyzer	H.P.	8560E
Coax Directional Coupler	H.P.	778D
Power Meter/Sensor	H.P.	437B/8481A
Four Tone Combiner		
Network Analyzer	HP	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 25 MHz band from 869 MHz to 894 MHz. Select evenly spaced F1, F2, F3, and F4 frequencies, that cover the instantaneous bandwidth of your system in the 800 to 960 MHz band.

5-5.1. AMPLIFIER SYSTEM PERFORMANCE TEST.
This test is applicable to both the MCR3000 and MCR4100 main frames with one to four plug-in MCA9000-400 amplifier modules. Perform the tests applicable to your system. Refer to table 1-1 for RF power input levels for systems with one to four amplifier modules. To perform the test, proceed as follows:

1. Connect test equipment to the main frame 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 880 MHz, F2 to 883 MHz, F3 to 886 MHz, and F4 to 889 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.

SINGLE AMPLIFIER IMD TEST:

3. Adjust attenuator for an input signal at -l0 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 32 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc max. Record test data in table 5-3. Switch tested amplifier OFF.

4. Repeat step 3 for amplifiers 2, 3 and 4, if the system has four plug-in amplifier modules

TWO AMPLIFIER IMD TEST:

5. Reset and turn on channel 1 and 2 amplifier modules, and turn off channel 3 and 4 amplifiers. Adjust the variable attenuator to set power output on Power Meter to 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. 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 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

7. Reset and turn on channel 1 and 4 amplifiers and turn off channel 3. Adjust the variable attenuator to set power output on Power Meter to 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

8. 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 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

9. Reset and turn on channel 2 and 4 amplifiers, and turn off channel 3. Adjust the variable attenuator to set power output on Power Meter to 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

10. Reset and turn on channel 3 and 4 amplifiers, and turn off channel 2. Adjust the variable attenuator to set power output on Power Meter to 70 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

THREE AMPLIFIER IMD TEST.

11. Reset and turn on channel 1, 2 and 3 amplifiers, and turn off channel 4. Adjust the variable attenuator to set power output on Power Meter to 100 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

12. Reset and turn on channel 1, 2 and 4 amplifiers, and turn off channel 3. Adjust the variable attenuator to set power output on Power Meter to 100 watts. . Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

13. Reset and turn on channel 1, 3 and 4 amplifiers, and turn off channel 2. Adjust the variable attenuator to set power output to 100 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

14. Reset and turn on channel 2, 3 and 4, and turn off channel 1. Adjust the variable attenuator to set power output on Power Meter to 100 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

FOUR AMPLIFIER IMD AND CURRENT TEST:

15. Reset and turn on channel 1, 2, 3 and 4 amplifiers. Adjust the variable attenuator to set power output on Power Meter to 135 watts. Measure IMD on Spectrum Analyzer. IMD should be -65 dBc maximum. Record test data in table 5-3.

16. With the power amplifier set at 135 watts power output, use the Current Probe (magnetic field type) and measure the dc current flow from the +27V DC power source. Current should be 88 Amps maximum. Record test data in table 5-3.

HARMONICS TEST

17. With the power amplifier set at 135 watts power output, use the Spectrum Analyzer and check the frequency band from 869 MHz to 894 MHz for harmonics. Harmonics should be -45 dBc maximum. Record test data in table 5-3.

SPURIOUS TEST

18. With the power amplifier set at 135 watts power output, use the Spectrum Analyzer and check the frequency band from 869 MHz to 894 MHz for spurious signals. Spurious signals should be -65 dBc maximum. Record test data in table 5-3.

GAIN TEST:

19. Disconnect Spectrum Analyzer from test set-up, and connect the Network Analyzer.

20. Set Network Analyzer as follows:
    a. Power Output to 11 dBm.
    b. Freq. Start to 869 MHz.
    c. Freq. Stop to 894 MHz.
    d. Normalize the Network Analyzer for gain and return loss.

21. Reset and turn on the channel 1 amplifier, turn off channel 2, 3 and 4 amplifiers. Check the gain across the band from 869 MHz to 894 MHz. Gain should be in the range of 52.6 dB minimum and 55.6 dB maximum. Record test data in table 5-3.

22. Turn off the channel 1 amplifier and reset and turn on the channel 2 amplifier. Check the gain across the band from 869 MHz to 894 MHz. Gain should be in the range of 52.6 dB minimum and 55.6 dB maximum. Record test data in table 5-3.

23. Repeat steps 21 and 22 and individually check and record the gain of each amplifier module in the system. Record test data in table 5-3.

24. Refer to table 5-3. Collectively reset and turn on the amplifier modules in groups of two three and four, as shown in table 5-3, and check the gain of each group. The minimum/maximum gain of each group of amplifiers, should be within the limits shown in table 5-3. Record test data in table 5-3.

INPUT RETURN LOSS TEST:

25. Reset and turn on all amplifier modules in the main frame. Read and record the S_{11} return loss measurement on Network Analyzer. Record test data in table 5-3.

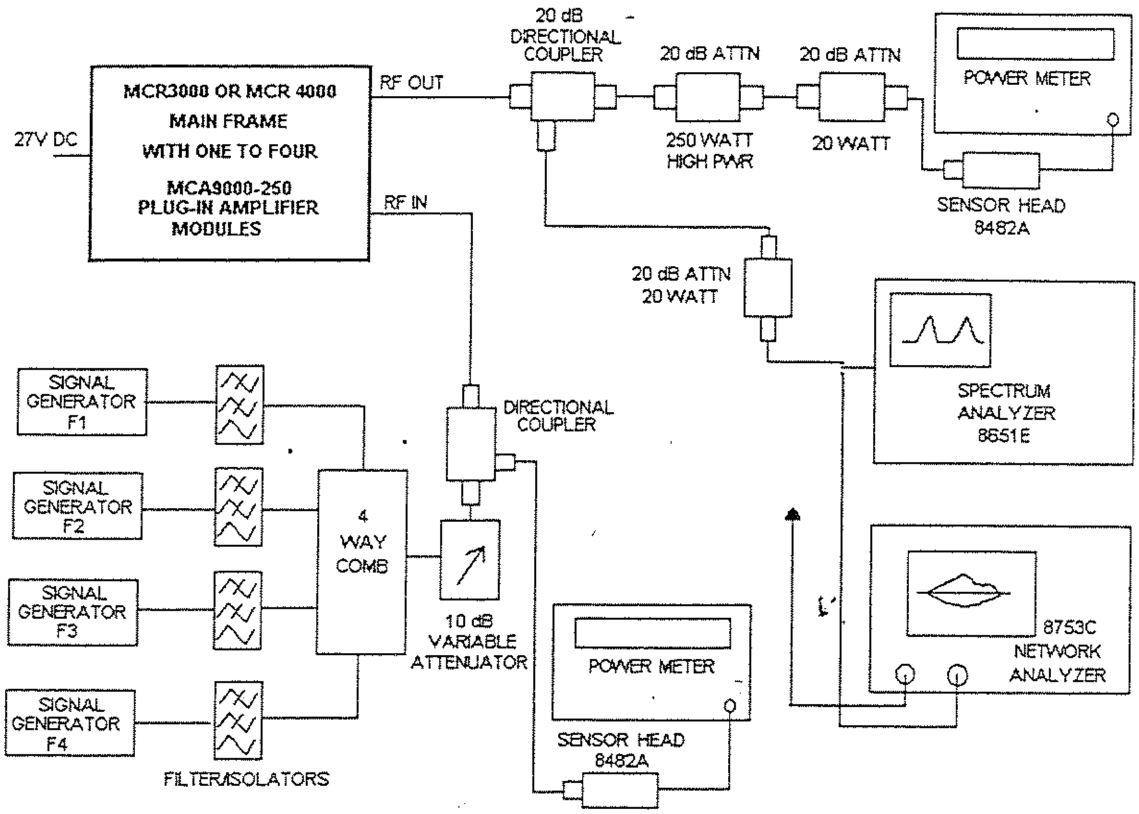


Figure 5-1. Amplifier System Test Setup Diagram