POWERWAVE.
TECHNOLOGIES

# INSTALLATION & SERVICE MANUAL

## MODEL MCA9129-90
## MULTICARRIER CELLULAR AMPLIFIER

## 869-894 MHz
## 100 WATTS AVERAGE POWER
## -65 dBc INTERMODULATION DISTORTION

**10 February 1999**

**Powerwave Technologies, Inc.**
**2026 McGaw Avenue**
**Irvine, CA 92614**

**Tel: (949) 757-0530**
**Fax: (949) 757-0941**
**Web Site: www.powerwave.com**

044-05060 Rev. A

# TABLE OF CONTENTS

## TABLE OF CONTENTS (Continued)

## LIST OF ILLUSTRATIONS



## LIST OF TABLES

# GENERAL DESCRIPTION

## 1-1. INTRODUCTION

This manual contains information and procedures for installation, operation, and maintenance of Powerwave's MCA9129-90 multicarrier cellular amplifier. 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 MCA9129-90 (see figure 1-1) is a linear, feed-forward power amplifier that operates in the 25 MHz frequency band from 869 MHz to 894 MHz. The amplifier can simultaneously transmit multiple frequencies, with better than -65 dBc third order intermodulation distortion (IMD). It is designed for use in an amplifier system that is modular in design, and is ideally suited for use in AMPS/TDMA/CDMA base stations. When used in a subrack employing four MCA9129-90 amplifiers, the system offers up to 360 watts output. The plug-in Model MCA9129-90 amplifier modules can each provide 100 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. 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 downtime. 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.

Each amplifier module has a status connector that allows the host system to monitor the amplifier module performance. The front panel of each amplifier module has unit level status/fault indicators and an RF on/off/reset switch. Primary power for the amplifier is +27 Vdc. Cooling for each plug-in amplifier module is provided by three fans, two 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 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.

## 1-5. ORDERING INFORMATION

Table 1-1 following gives the part numbers and descriptions to be used when ordering either an entire amplifier or replacement fans.

Table 1-1. Major Amplifier Components

| MODEL NUMBER | DESCRIPTION |
|---|---|
| MCA9129-90 | 100 W 869-894 MHz MCPA Module. |
| 800-01024-001 | Front fan assembly, large. |
| 800-01025-001 | Front fan assembly, small |
| 800-00781-002 | Rear fan assembly. |

Table 1-2. MCA9129-90 Multicarrier Cellular Amplifier Functional Specifications

| | |
|---|---|
| Frequency Range | 869-894 MHz (25 MHz Bandwidth) |
| Total Maximum Input Power | -12 dBm |
| Total Output Power | 100 W typical (1 Module) |
| Intermodulation Distortion and In-Band Spurious: | -65 dBc (Min) @ +24 to +28 Vdc @ 100 Watts (-55 dBc (Min) @ +23 to + 24 Vdc) |
| RF Gain at 880 MHz | 62 dB |
| Gain Flatness: | ± 0.7 dB @ 27 Vdc ±1 Vdc |
| Gain Variation Over Temperature: | ±0.3 dB from 23 to 30 Vdc |
| Output Protection: | Mismatch Protected |
| Input Port Return Loss: | -14 dB (Min) |
| Harmonics: | Better than -50 dBc |
| Out of Band Spurious: | Better than -60 dBc |
| Duty Cycle: | Continuous |
| DC Input Power: | +27 Vdc ± 1 Vdc, 45 Amps Max @ 100 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 (Noncondensing) |
| Storage Humidity: | 5 % - 95 % Relative Humidity (Noncondensing) |
| DC Input, Summary Alarm, and RF Input / Output Connectors: | 21-Pin D-Subminiature Combo Connector plus single-pin D-Sub connector for additional DC capability. |
| Dimensions: | 15.72" (9U) High, 5.50" Wide, 17.11" Deep |

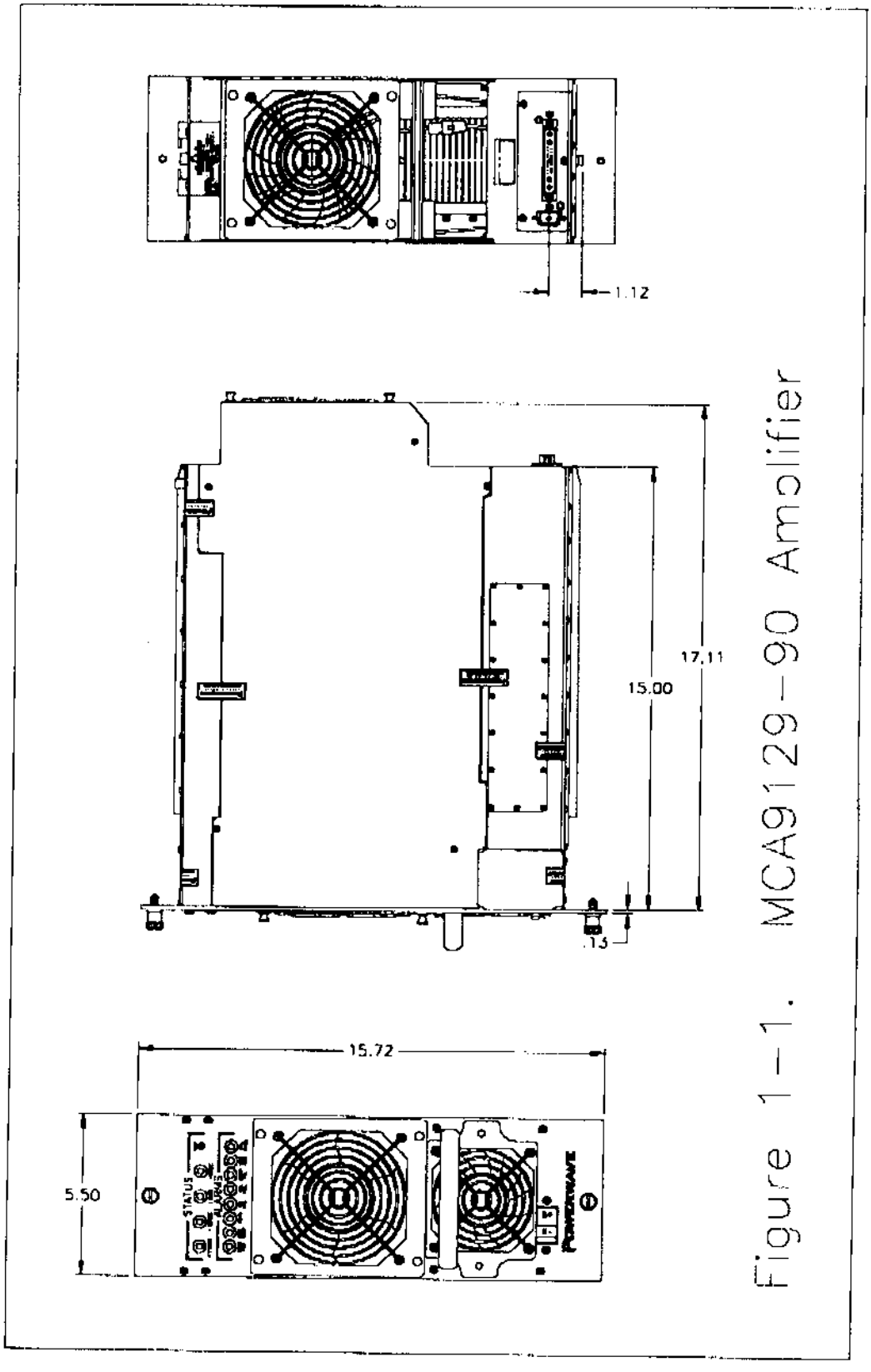
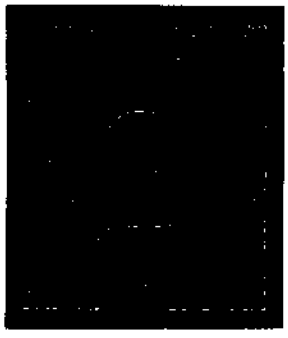



Figure 1-1. MCA9129-90 Amplifier



# INSTALLATION

## 2-1. INTRODUCTION

This section contains installation recommendations, unpacking, inspection, and installation instructions for the Multicarrier Cellular Amplifier. 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. It is important that the licensee perform these tasks correctly and in good faith. If applicable, carefully read Parts 73 and 74 of the Federal Communications Commission (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 container(s) and remove the amplifier module(s). 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 module 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 the connector or fans. Inspect the rear panel connector 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** (Refer to figures 1-1 and 2-1)
The MCA9129-90 amplifier module is designed for installation in a subrack that permits access to the rear of the subrack for connection of DC power, RF, and monitor cables.

To install the amplifier proceed as follows:

1. Install subrack in equipment rack and secure in place.
2. Connect antenna cable to rear of subrack.
3. Connect the transceiver output(s) to rear of subrack.
4. Connect alarms cable(s).

**WARNING**

**Verify that all circuit breaker switches on the rear panel of the subrack are in the OFF position. Turn off external primary DC power before connecting DC power cables.**

7. Connect positive primary power and negative primary power to the subrack. Tighten the subrack power connections.
8. Install the plug-in amplifier module(s) in the subrack. Tighten top and bottom thumbscrews.
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 system.
11. Refer to section 3 for initial turn-on and checkout procedures.

**2-5. AMPLIFIER MODULE STATUS, ALARM, CONTROL, AND POWER CONNECTORS**
The status, alarm, control, and power connections on the amplifier connectors are made through a 21-pin D-Sub male combo connector and supplemental single-pin male D-Sub connector (figure 2-1) and are listed and described in table 2-1.

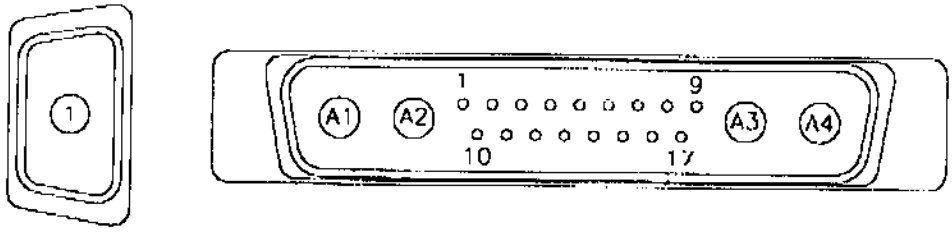



Figure 2-1. Amplifier Connectors (on Rear of MCA9129-90 Module)

Table 2-1. Amplifier Module Status, Alarm, Control, and Power Connections

| PIN NUMBER | FUNCTION | DESCRIPTION |
|---|---|---|
| **21-Pin D-Sub Male Combo** | | |
| 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 | RS 485 +RxD | Serial Communication Data In |
| 3 | RS 485 –RxD | Serial Communication Data In |
| 4 | RS 485 +TxD | Serial Communication Data Out |
| 5 | RS 485 –TxD | Serial Communication Data Out |
| 6 | NA | |
| 7 | NA | |
| 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 | NA | |
| 11 | Average Power Input | An analog DC voltage representing the average detected power of all the MCAs in a subrack. This voltage is derived from dividing the sum of all the forward power voltages in a subrack by the number of enabled MCAs. This voltage is used by the MCA to determine a low power fault. |
| 12 | Address A0 | Amp Address A0; Ground for high, float for low |
| 13 | Summary Fault | TTL signal normally low. A high level indicates that the MCA has been disabled by a recurring alarm fault. |
| 14 | Address A1 | Amp Address A1; Ground for high, float for low |
| 15 | Module Detect | Ground potential. Informs the subrack that an MCA is plugged in. |
| 16 | NA | |
| 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. |
| **Single-Pin D-Sub Male** | | |
| 1 | Power Input | +27 Vdc (Power Contact) |

# OPERATING INSTRUCTIONS

## 3-1. INTRODUCTION

This section contains operating instructions for the Multicarrier Cellular Amplifier.

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

The location and function of the plug-in amplifier module controls and indicators is shown in figure 3-1 and is described in detail in paragraphs 3-3 through 3-3.14.

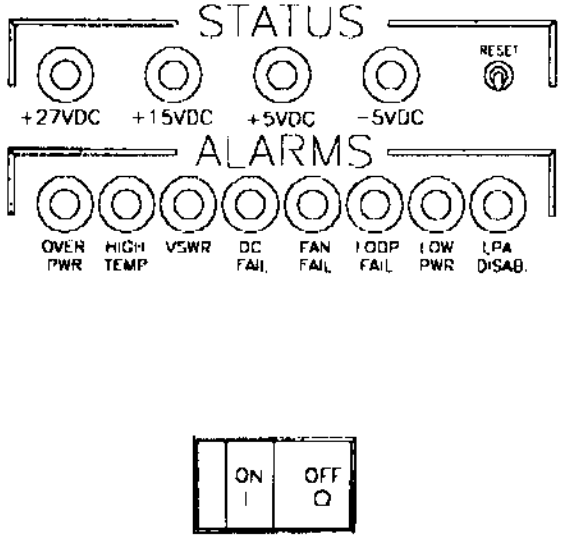



Figure 3-1. MCA9129-90 Amplifier Module Controls and Indicators

## 3-3. CONTROLS AND INDICATORS

### 3-3.1 27V Indicator (+27VDC)

Green LED. When lit, indicates that the +27Vdc supply is greater than +21Vdc and less than +30Vdc. The indicator will blink if the voltage is 28Vdc to 30Vdc. If the voltage source drops below +21V a timer is started and the DC fail counter is incremented. After five seconds the voltage is analyzed, if still faulted the counter is incremented. If the count equals 25 before the timer reaches 15 minutes, the MCPA will enter fault mode. Fault mode will disable the MCPA. The +27V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. 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 MCA will be disabled instantaneously, as indicated by the illumination of the LPA DISAB indicator. The +27V and DC FAIL indicators will alternatively blink at a 1Hz rate. 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, the MCPA will enter fault mode. The +27V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.

### 3-3.2 +15V Indicator (+15VDC)

Green LED. When lit, indicates that the +15Vdc supply is greater than +14Vdc and less than +16Vdc. If the voltage source varies out of its operating window, a timer is started and the DC fail counter is incremented. After five seconds the voltage is analyzed, if still faulted the counter is incremented. If the count equals 25 before the timer reaches 15 minutes, the MCPA will enter fault mode. Fault mode will disable the MCPA. The +15V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.3 +5V Indicator (+5VDC)

Green LED. When lit, indicates that the +5Vdc supply is greater than +4.5Vdc and less than +5.5Vdc. If the voltage source varies out of its operating window, a timer is started and the DC fail counter is incremented. After five seconds the voltage is analyzed, if still faulted the counter is incremented. If the count equals 25 before the timer reaches 15 minutes, the MCPA will enter fault mode. Fault mode will disable the MCPA. The +5V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.4 –5V Indicator (–5VDC)

Green LED. When lit, indicates that the -5Vdc supply is greater than -5.5Vdc and less than -4.5Vdc. If the voltage source varies out of its operating window, a timer is started and the DC fail counter is incremented. After five seconds the voltage is analyzed, if still faulted the counter is incremented. If the count equals 25 before the timer reaches 15 minutes, the MCPA will enter fault mode. Fault mode will disable the MCPA. The -5V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.5 RF ON Switch (RESET / ON / OFF)

Three position switch:

OFF (down position) - Turns off bias within amplifier module, thereby blocking RF passthrough and amplification.

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 MCA is disabled, the alarms can be cleared and the MCA enabled by this reset position. The functions of the switch are disabled for five seconds after a power-up condition.

### 3-3.6 Over Power Indicator (OVER PWR)

Red LED. When lit, indicates the output power from the amplifier exceeded 240-260 Watts for 90W modules or 110-120 Watts for 60W modules. If an over power condition occurs the MCA is immediately disabled. The LPA DISAB indicator will illuminate and the OVER PWR indicator will blink at a 1Hz rate. A timer is started and the over power fault counter is incremented. After five seconds the MCA is enabled and the fault is analyzed. If the fault exists, the MCA is again disabled and the counter is incremented. If the count equals five before the timer reaches 15 minutes, the MCPA will enter fault mode. Fault mode will disable the MCPA. The OVER PWR and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.

### 3-3.7 High Temperature Indicator (HIGH TEMP)

Red LED. When lit, indicates that the amplifier heat sink temperature has exceeded 70 °C. If a high temperature condition occurs a timer is started and the high temperature 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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The HIGH TEMP and LPA DISAB indicators will illuminate

and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.8 VSWR Indicator (VSWR)

Red LED. When lit, indicates that the reflected power detected at the amplifier output exceeds 70 watts for 90 W modules and 35 watts for 60 W modules. 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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The VSWR and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.9 DC Fail Indicator (DC FAIL)

Red LED. When lit, indicates that one of the internal DC voltages dropped below or exceeded the safe threshold level (+21 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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The green indicator representing the invalid voltage will turn-off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. 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 MCA will be disabled instantaneously, as indicated by the illumination of the LPA DISAB indicator. The +27V and DC FAIL indicators will alternatively blink at a 1Hz rate. 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, the MCPA will enter fault mode. The +27V indicator will turn off, the DC FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches five, the counter and timer will reset to zero.

### 3-3.10 Fan Fail Indicator (FAN FAIL)

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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The FAN FAIL and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero. Indicator is applicable to the large front and rear fans, not to the small front fan.

### 3-3.11 Loop Indicator (LOOP FAIL)

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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The LOOP and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.12 Low Power Indicator (LOW PWR)

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, the MCPA will enter fault mode. Fault mode will disable the MCPA. The LOW PWR and LPA DISAB indicators will illuminate and a summary fault will occur signaling the shelf that the MCPA is disabled. In fault mode the LED indications are latched. Toggling the reset switch will enable the MCPA and clear the summary alarm and latched indicators. If 15 minutes elapse before the counter reaches 25, the counter and timer will reset to zero.

### 3-3.13 LPA Disable Indicator (LPA DISAB.)

Red LED. When lit, indicates that the MCPA was disabled due to an internal fault or by the shelf performing the sleep mode function. If a fault indicator does not accompany the LA DISAB indicator, the sleep mode function is active.

### 3-3.14 Power Circuit Breaker (OFF / ON)

Rocker style circuit breaker which controls DC power to amplifier.

## 3-4. INITIAL START-UP AND OPERATING PROCEDURES

The only operating controls on each amplifier module are the rocker-style power switch and the 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 the front panel power rocker switch of each amplifier is in the OFF position.

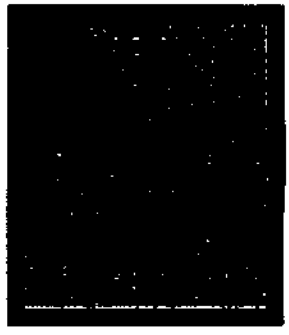
3 Turn on supply that provides +27 Vdc to the amplifier system. Do not apply an RF signal to the amplifier system

4 Set front panel power rocker switch to on position.

5 Visually check the indicators on each amplifier module, and verify that the following indicators are as follows:

a. LPA DISAB. Indicator (red) should turn off after 2.5 seconds.
b. The +27VDC, +15VDC, +5VDC and -5VDC indicators (green) on all amplifier modules should be on.

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



# PRINCIPLES OF OPERATION

## 4-1. INTRODUCTION

This section contains a functional description of the Multicarrier Cellular Amplifier.

## 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 -40 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. -65 dBc).

## 4-4. SYSTEM FUNCTIONAL DESCRIPTION

The MCA9129-90 amplifier is a linear, feed-forward power amplifier that operates in the 25 MHz frequency band from 869 MHz to 894 MHz. A typical four-module system is shown in figure 4-1. The power output specification is 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. Each amplifier in the system can simultaneously transmit multiple carrier frequencies, at an average total power output of 90 watts (1 amplifier module in a subrack unit) to 360 watts (4 amplifier modules), with -65 dBc third order intermodulation distortion (IMD).

The output from each amplifier is an amplified composite signal of approximately 100 watts before combiner losses. All phase and gain corrections are performed on the signal(s) in the individual amplifier modules. In a four -module system, the amplifier outputs are fed to a power combiner and combined to form a composite RF output of up to 360 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.

## 4-5. MCA9129-90 AMPLIFIER MODULE

The amplifier module, figure 4-2, has an average output of 100 watts power (1000 watts peak power) with intermodulation products suppressed to better than -65 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

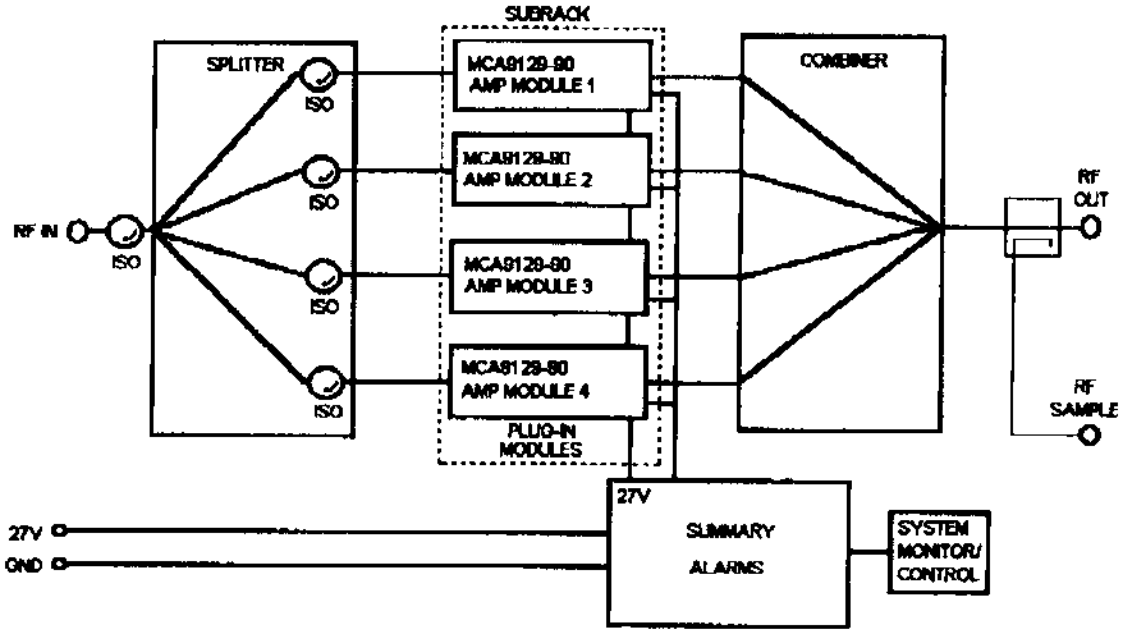



Figure 4-1. MCA9129-90 Four Module Amplifier System

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 AB 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 100 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.

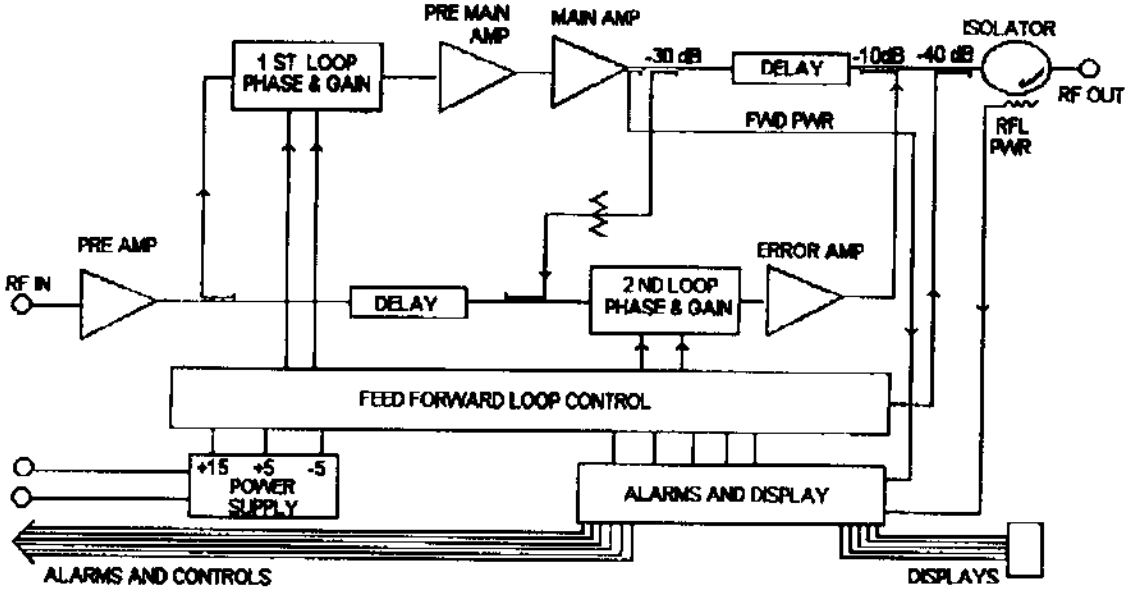



Figure 4-2. MCA9129-90 Power Amplifier Module Functional Block Diagram

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 degrees, then feeds it to the error amplifier. There it is amplified to the same power level as the input sample and coupled 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.

### 4-5.1. MAIN AMPLIFIER

The input and output of the amplifier employ three-stage, class AB amplifiers which provide approximately 30 dB of gain in the 25 MHz frequency band from 869 MHz to 894 MHz. The amplifier operates on +27 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 92 °C, the thermostat opens and a high temperature fault occurs. The alarm logic controls the +5 Vdc bias voltage that shuts down the amplifier.

### 4-5.2. 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 class A amplifier, has 50 dB of gain. The amplifier operates on +27 Vdc and a bias voltage of +15 Vdc and is mounted directly on a heat sink.

### 4-5.3. 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.

### 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, draw air in through the rear of the amplifier, and exhaust hot air out the front of the module. The fans are field replaceable.

## 4-6. POWER DISTRIBUTION

Primary DC power for the system is provided by the host system to the 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.

## 4-7. INTERMODULATION

The MCA9129-90 amplifier is designed to deliver a 100-watt composite average analog power, multicarrier signal, occupying a bandwidth less than or equal to 25 MHz, in the bandwidth from 869-894 MHz. The maximum average power for linear operation, and thus the amplifier efficiency, will depend on the type of signal amplified.

### 4-7.1 TWO-TONE INTERMODULATION

When measured with two equal CW tones spaced anywhere from 30 kHz to 25 MHz apart, and at any power level up to the peak power, the third order intermodulation products will be below -65 dBc

### 4-7.2 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 -65 dBc or better.

# MAINTENANCE

## 5-1. INTRODUCTION

This section contains periodic maintenance and performance test procedures for the Multicarrier Cellular Amplifier. 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 paragraph 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 paragraph 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

| MENCLATURE | MANUFACTURER | MODEL |
|---|---|---|
| Signal Generator (4 each) | 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 |
| Four Tone Combiner | | |
| 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 cleaning 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.

5-5.1. AMPLIFIER PERFORMANCE TEST.

This test is applicable to a subrack equipped with one to four plug-in MCA9129-90 amplifier modules. Perform the tests applicable to your system. 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 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 –I2 dBm. Reset channel 1 amplifier with the front panel ON/OFF/RESET switch, and set switch to ON. Set amplifiers 2, 3, and 4 to OFF. Adjust variable attenuator to set amplifier power output on power meter to 90 watts. Measure IMD on spectrum analyzer. IMD should be -65 dBc max. Record test data in table 5-3. Switch tested amplifier to OFF.

4. Repeat step 3 for amplifiers 2, 3, and 4, 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 and 4 amplifiers. Adjust the variable attenuator to set power output on power meter to 180 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 180 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 180 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 180 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 180 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 180 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 270 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 270 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 on power meter to 270 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 amplifiers, and turn off channel 1. Adjust the variable attenuator to set power output on power meter to 270 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 360 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 360 watts power output, use the current probe (magnetic field type) and measure the dc current flow from the +27 Vdc power source. Current should be 180 amps maximum. Record test data in table 5-3.

HARMONICS TEST

17. With the power amplifier set at 360 watts power output, use the spectrum analyzer and check the frequency band from 869 MHz to 894 MHz for harmonics. Harmonics should be -50 dBc maximum. Record test data in table 5-3.

SPURIOUS TEST

18. With the power amplifier set at 360 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 setup, and connect the network analyzer.

20. Set network analyzer as follows:
    a. Power output to -4 dBm.
    b. Frequency start to 869 MHz.
    c. Frequency 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 as specified in table 1-2 ±1 dB. 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 as specified in table 1-2 ±1 dB. 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.

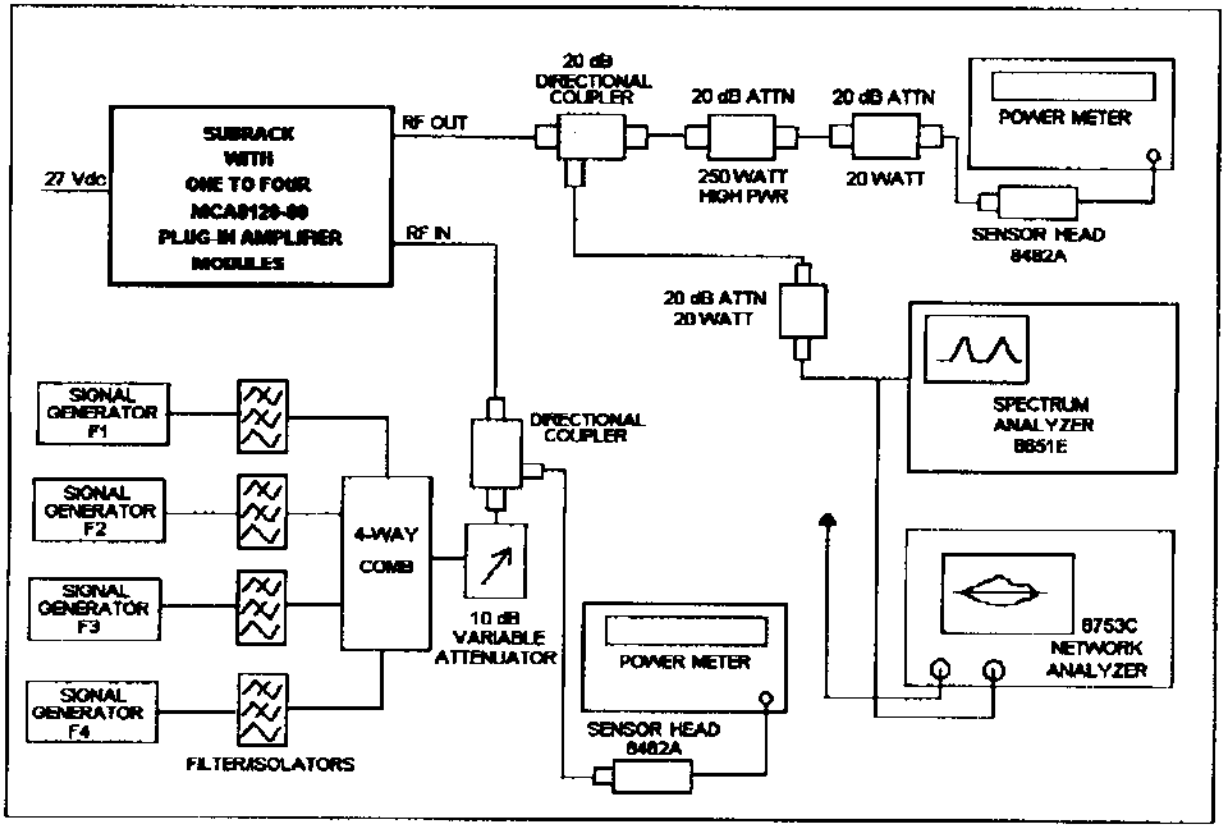



Figure 5-1. Amplifier System Test Setup Diagram

Table 5-3. Multicarrier Cellular Amplifier Test Data Sheet

DATE _____

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

MODULE #3 S/N _____ MODULE #4 S/N _____

TEST CONDITIONS:
Load and Source Impedance: 50 Ohms
VSWR: < 1.2:1
Supply Voltage: +27 Vdc ±0.1 Vdc

| TEST | SPECIFICATION | MIN | MAX | DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4-TONE IMD One Module | Vcc = 27 Vdc<br>PO = 90 W<br>Freq.: 880 883 886 889 MHz | | -65 dBc | 1 | 2 | 3 | 4 | | |
| 4-TONE IMD Two Modules | Vcc = 27 Vdc<br>PO = 180 W<br>Freq.: 880, 883 886 889 MHz | | -65 dBc | 1,2 | 1,3 | 1,4 | 2,3 | 2,4 | 3,4 |
| 4-TONE IMD Three Modules | Vcc = 27 Vdc<br>PO = 270 W<br>Freq.: 880 883 886 889 MHz | | -65 dBc | 1,2,3 | 1,2,4 | 1,3,4 | 2,3,4 | | |
| 4-TONE IMD Four Modules | Vcc = 27 Vdc<br>PO = 360 W<br>Freq.: 880 883 886 889 MHz | | -65 dBc | All | | | | | |
| RF Gain One Module | Vcc = 27 Vdc<br>PO = 90 W<br>Freq. = 880 MHz | Table 1-2 -1 dB | Table 1-2 +1 dB | 1 | 2 | 3 | 4 | | |
| RF Gain Two Modules | Vcc = 27 Vdc<br>PO = 180 W<br>Freq. = 880 MHz | Table 1-2 -1 dB | Table 1-2 +1 dB | 1,2 | 1,3 | 1,4 | 2,3 | 2,4 | 3,4 |
| RF Gain Three Modules | Vcc = 27 Vdc<br>PO = 270 W<br>Freq. = 880 MHz | Table 1-2 -1 dB | Table 1-2 +1 dB | 1,2,3 | 1,2,4 | 1,3,4 | 2,3,4 | | |
| RF Gain Four Modules | Vcc = 27 Vdc<br>PO = 360 W<br>Freq. = 880 MHz | Table 1-2 -1 dB | Table 1-2 +1 dB | All | | | | | |
| Harmonics | Vcc = 27 Vdc<br>PO = 360 W<br>869 - 894 MHz Band | | -50 dBc | All | | | | | |
| Spurious | Vcc = 27 Vdc<br>PO =360 W<br>869 - 894 MHz Band | | -65 dBc | All | | | | | |
| Gain Flatness | Vcc = 27 Vdc<br>PO =360 W<br>869 - 894 MHz Band | | ±0.7 dB | All | | | | | |
| Input Return Loss | Vcc = 27 Vdc<br>PO = 360 W<br>869-894 MHz Band | -18 dB | | All | | | | | |
| DC Power | Vcc = 27 Vdc<br>PO = 360 W<br>4 Tones | | 180 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. MCA9129-90 Power Amplifier Modules
2. Cooling Fans

### 5-6.1. MCA9129-90 POWER AMPLIFIER MODULE

To replace a power amplifier module, proceed as follows:

1. Set ON/OFF/RESET switch on the front panel of the amplifier module to OFF.

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

**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.

3. With steady even pressure, use handle on front of amplifier to pull module out of subrack.

### 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. Pull out 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.<br>2. Check for proper power supply voltage.<br>3. Check fuses or circuit breakers on amplifier or subrack.<br>4. Verify that amplifier is fully inserted into subrack. |
| HIGH TEMP alarm (red) is lit | 1. Verify fan(s) are operating properly.<br>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 Repair Department at (949) 757-0530 to obtain this number. Failure to obtain this RMA number may result in delays in receiving repair service.

### 6-3.2 Repackaging for Shipment

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