Paradigm Wireless Systems, Inc.

Amplifying the Power of Innovation

MAF 900-60S MULTI-CARRIER POWER AMPLIFIER

USER MANUAL

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Section 1 Amplifier System Description

Introduction

This manual contains information and specifications of Paradigm Wireless Systems MAF 900-60S Multi-Carrier Power Amplifier. The purpose of this manual is to familiarize the user to the basic operation and specification of the product. Any misuse of information may lead to partial or total damage to the amplifier. This manual is organized into the following sections:

Section 1 Amplifier System Description
Section 2 Amplifier Specifications
Section 3 Principals of Operation
Section 4 Operating Instructions
Section 5 Installations
Section 6 Maintenance
Section 7 Troubleshooting

1.1 General Description

The Paradigm Wireless Systems MAF 900-60S Multi-Carrier Power Amplifier (MCPA) is designed to operate in the 5 MHz frequency band of 935 MHz to 940 MHz. The MAF 900-60S amplifiers are designed for 2-way paging radio transceiver base stations using GMSK modulation. The MCPA is designed to integrate with a sub-rack system. Total composite output power is 80 Watts from the MCPA.

The MCPA draws +27 Vdc power from the sub-rack. The LED on the front panel of the MCPA will be GREEN during normal operation. Any alarm condition will turn the LED to RED or AMBER. This will indicate an alarm condition within the MCPA. External alarms for connecting to the base station will be sent via the D-subminiature connector through the sub-rack. These are dry contact or RS485.

Fans are used to cool the heat sink to ensure unit performs to specification over the temperature range. Air is pulled from the front of the amplifier and exhausted through the back of the sub-rack. Over temperature alarms will shut down the MCPA when the heat sink temperature reaches 95°C. The amplifier will auto restart when heat sink temperature decreases to 75°C. This will prevent thermal run away of the MCPA.

Each MAF 900-60S MCPA will generate 1900 BTU of heat at full power. Proper cooling and ventilation is essential for continuous operation of the amplifier.

Section 2 MAF 900-60S Amplifier Specification

The MAF 900-60S MCPA series electrical specification:

Frequency Range	935-940 MHz
Channel Spacing	25 kHz
Input Power	+5 dBm
Output Power	80 Watts (49.00 dBm)
Gain	+58 dB
Gain Flatness	±0.2 dB
Normal Operating Voltage	+27 Vdc
Current Consumption	27.5 Amps @ 80 Watts Power Output
Abnormal Operating Voltage	<24 Vdc >28 Vdc
Efficiency	10.77 %
RF Gain Variation over Temperature	±0.5 dB @ 0°-60° C. +27 Vdc
Gain Variation over Dynamic Range	±0.5 dB over 20 dB +27 Vdc
IMD	-65 dBc min @ 25 kHz channel spacing, 75 Watts -63 dBc min @ < 24 Vdc to > 28 Vdc
Modulation Type	GMSK
Output Return Loss	-14 dB minimum
Output Protection	Mismatched Protected
Output Isolation	20 dB minimum
MCPA Front Panel Switch	CKT Breaker +27 Vdc Power Indicator

MAF 900-60S MCPA series mechanical specifications:

Physical Dimension of MCPA	13.82 in. high x 3.90 in. wide x 17.0 in. long			
Weight	31.5 lbs.			
Connector Type	D-Sub, Hybrid, Plug-in Type RF Connector: PKZ 26-0020 series straight plug (Phoenix Co.)			
Connector Description	Pin Outs			
	A1	RF Input (Coaxial Contact)		
	A2	Ground (Power Contact)		
	A3	+27 Vdc (Power Contact)		
	A4	RF Output (Coaxial Contact)		
	1	RX +	10	Reset
	2	RX -	11	Reserved
	3	GND	12	Reserved
	4	TX +	13	Amp Address #1
	5	TX -	14	Amp Address #2
	6	GND	15	Amp Address #3
	7	LPA Detect	16	Reserved
	8	Summary	17	Reserved
	9	DC ON/OFF		
Font Panel LED Display	LED type: SMD			
RUN	GREEN (MCPA enabled for operation)			
ALARM Major	RED (MCPA disabled MAJOR alarm occurred LED is ON)			
ALARM Minor	AMBER (MCPA enabled MINOR alarm)			
ALARM Major	RED (MCPA disabled)			
ALARM Minor	GREEN Blinking (MCPA Standby)			
ALARM Definition (Major)	Over Power, Over Temperature, Loop Fail, DC Fail			
ALARM Definition (Minor)	VSWR			
FCC ID	TBD			
MCPA Captive Fasteners	Spring loaded, positive alignment			

MAF 900-60S MCPA series environmental specifications

Operating Temperature	0° to 60° C.
Storage Temperature	-40° to 80° C.
Relative Humidity	5%-90% RH (non-condensing)
Operating Air Pressure	860 to 1060 mbar
Shock	40 m/s s* @ 22 ms half sinusoid shock
Pressure	Integral forced air cooling must operate correctly at up to 0.3 back
Vibration	Bellcore TR-NWT-000063 (1 m/s*0.1 ~200 Hz)
Corrosion Resistance/Salt Fog	The MCPA shall comply with the requirements of Bellcore Technical Reference TA-NWT-000487, Issue 2 Section 4.12
Altitude	All specifications shall be met at an altitude up to 15,000 feet where the maximum external ambient temperature is decreased by 0.5 C/1000 feet above sea level. The MCPA shall not sustain damage when being transported at altitude up to 40,000 feet or uniformly applied pressure to 30 PSIA.

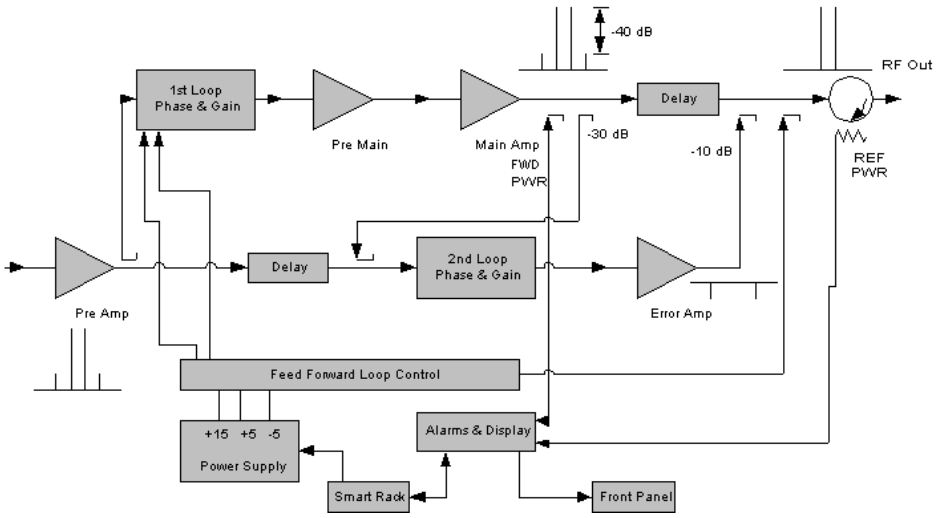
Section 3 Principals Of Operation

3.1 Multi-Carrier Power Amplifier (MCPA) Functional Description

The MAF 900-60S MCPA is a linear, feed-forward multi-carrier power amplifier. The operating frequency of the amplifier is 935 to 940 MHz. The amplifier is designed to operate with a 2-way paging base station radio transceiver using GMSK modulation. Minimum channel spacing is 25 kHz. Each amplifier has a digital control board that controls the amplifiers performance and continuous IMD cancellation over temperature and phase. Continuously comparing active paths with passive references, and correcting for small variations through the RF feedback controls maintain constant gain. An LED on the front panel of the amplifier monitors status of the amplifier. Multi-color LED changes conditions when alarming of the amplifier. When MCPA failure occurs, the alarm signal would be transmitted to the host system via the D-subminiature connector at the rear of the amplifier. The amplifier is compliant to the requirements of FCC Part 90 with respect to spurious emissions.

The amplifier is composed of:

- A preamp
- A pre-main amplifier
- A main amplifier
- A pre-error and error amplifier
- Alarm monitoring and control



Multi-Carrier Power Amplifier Functional Block Diagram

3.2 Pre- Amplifier

The input of the amplifier uses two stages of class AB amplification that provide approximately 13.5 dB of gain in the 5 MHz band from 935 MHz to 940 MHz. The amplifier operates on + 27 Vdc.

3.3 Three-Stage Pre-Main Amplifier

The input of the amplifier uses three stages of class AB amplification, which provide approximately 32 dB of gain in the 5 MHz band from 935 MHz to 940 MHz. The amplifier operates on + 27 Vdc and a bias voltage of + 5 Vdc. The logic controls the +5 Vdc bias that shuts down the amplifier.

3.4 Main Amplifier

The signal provides approximately 11 dB of gain in the 935 MHz to 940 MHz frequency band. The main amplifier operates on +27 Vdc, and a + 5 Vdc bias voltage. The alarm logic controls the +5 Vdc bias voltage.

The main amplifier employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops are used to correct signal non-linearity introduced by the class AB main amplifier. The error amplifier operates in a 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 pre-main amplifier. The output from the pre-main amplifier is fed to the class AB main amplifier.

The signal output from the main amplifier is sampled using a coupler. The sampled 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 signal.

3.5 Pre-Error and Error Amplifier

The pre-error and error amplifiers operate on +27 Vdc, and a +5 Vdc bias voltage. The error amplifier applies approximately 30 dB of cancellation signal to the output of the main amplifier.

3.6 Alarm Monitoring and Control

During routine operation, all normal variations are automatically compensated for by the feed-forward loop control. However, when large variations occur beyond the adjustment range of the loop control, a loop fault will occur. When this happens, the alarm LED will illuminate RED on the front panel of the amplifier. The amplifier will be in the shut down mode of operation. Reset of the amplifier is necessary for normal operation to resume.

3.7 Loop Control Circuit

The primary function of the 1st loop is to provide an error signal for the 2nd loop. The primary function of the 2nd loop is to amplify the error signal to cancel out spurious products developed in the main amplifier. The input signal is amplified by a pre-amplifier 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 1st loop control section phase shifts the main input signal by 180 degrees and constantly monitors the output for correct phase and gain.

The 2nd loop control section obtains a sample of the distortion added to the output signals by the main amplifiers. The signal is phase shifted 180 degrees, then fed to the error amplifier where it is amplified to the same power level as the input sample. The signal is then coupled to the error signal on the main output signal. The final output is monitored by the 2nd loop and adjusted to ensure that the signal distortion and intermodulation distortion (IMD) on the final output is cancelled out.

3.8 Amplifier Module Cooling

Although each amplifier contains it own heat sinks, forced air is required for cooling the heat sinks. This forced air-cooling pulls heat away from the heat sinks maintaining optimum operation of the amplifiers. This ensures that the amplifier will operate to specification across the specified operating temperature ranges.

3.9 Power Distribution

Primary DC power for the amplifier is provided by the host system. The amplifier has a DC/DC converter and voltage regulator that converts the +27 Vdc to +15 Vdc, +12 Vdc, and +5 Vdc, for internal use. +27 Vdc for the MCPA is supplied by the sub-rack, through the D-subminiature connector on the rear of the MCPA.

Section 4 Operating Instructions

4.1 Introduction

This sections contains the general operating instructions for Paradigm Wireless Systems MAF 900-60S MCPA. This will help guide the user on proper operation of the MCPA.

4.2 Initial Start-Up and Operating Procedure

To perform initial start-up, proceed as follows:

1. Carefully remove MAF 900-60S MCPA series from shipping carton
2. Place MAF 900-60S MCPA into sub-rack assembly

Caution

When placing MAF 900-60S MCPA into sub-rack gently slide MCPA into matting connector. Damage can occur to matting connector due to abrupt handling of the unit. To ensure good performance of the unit visual matting is recommended.

Note

All RF connections to the unit will be of 50 ohm. Any changes in impedance will cause severe mismatch and VSWR to occur. Do not operate the amplifier without a load attached to output of sub-rack.

3. Connect all RF input and output cables to the sub-rack.
4. Ensure (Reset) switch to OFF position and source power is un-keyed or turned off.
5. Connect +27 Vdc power source to sub-rack
6. Turn +27 Vdc to ON position. Place (Reset) to ON position.
7. Ensure sub-rack fans are working.
8. Normalize amplifier for 5 minutes in ON position. Monitor for alarms on front panel.
9. Before turning on source power, verify RF level is set to minimum. High source input level can damage amplifier.
10. Turn-on 1 channel from source power. Set power level.

Note

- If operating MAF 900-60S MCPA without sub-rack, individual fans, RF attenuation, and D-Sub connector needs to be assembled for operation. Please contact your representative at Paradigm Wireless Systems for information.

Section 5 Installation

5.1 Introduction

This section contains unpacking, inspection, installation instructions and recommendations for the MAF 900-60S MCPA. It is important that the operator perform the following tasks correctly and in good faith.

1. Carefully read all materials in this section prior to equipment unpacking or installation.
2. Also read and review the operating instructions in Section 4 prior to installing the amplifier.
3. If applicable, carefully review the Federal Communications Commission (FCC) rules and regulation as they apply to your installation

5.2 Site Survey

Paradigm Wireless Systems recommends that a qualified individual or firms prior to equipment ordering or installation perform a site survey. Performing a survey will reduce or eliminate installation and turn-up delays caused by oversights. Attentions to power plant capacity, battery back up, cooling/air conditioning, AC breakers capacity, RF/DC cabling/breaker requirements are essential.

5.3 Electrical Service Recommendations

Paradigm Wireless Systems recommends that:

- Proper AC line conditioning and surge suppression be provided on the primary AC input to the +27 Vdc source.
- All electrical service should be installed in accordance with the National Electrical Code, any applicable state or local codes, and good engineering practice.
- Grounding of all equipment should be in accordance to Bellcore standards.
- Circuit breakers should be thermal type, capable of handling the anticipated inrush current.

5.4 Air Conditioning

Each MAF 900-60S MCPA will generate approximately 1900 BTU of heat. When using more than one amplifier it is recommended that a thermal analysis be performed. Ensuring proper cooling will extend the Mean Time Before Failure of the unit.

5.5 Unpacking and Inspection

This equipment (as applicable) has been operated, tested, and calibrated at the factory. Carefully open and remove the MAF 900-60S amplifier from the shipping container. Retain all packing material and shipping container in the event that the unit must be returned to the factory. Please perform the following steps:

CAUTION

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

1. Visually inspect the MAF 900-60S MCPA for damage that may have occurred during shipment.
2. Check for evidence of water damage, bent or warped chassis, loose screws, nuts or extraneous packing material in the connector(s).

CAUTION

Before applying power, make sure that all connectors to the MAF 900-60S are secure. Make sure that the input and output of the amplifier is terminated to 50 ohms. Do not operate the system without a load attached. Excessive input power may damage the equipment.

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

If the equipment is damaged:

- The carrier is your first recourse.
- A claim should be filed with the carrier once the extent of damage is assessed. Careful, immediate inspection is important if the carrier is suspect of damage.

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

- Contact your Paradigm Wireless Systems representative.
- Paradigm Wireless Systems may not accept returns without an RMA.

5.6 Installation Instructions

Model MAF 900-60S MCPA is designed for use in a 900 MHz 2-way paging transceiver radio base station. The host enclosure must permit access to the sub-rack for DC power, RF and alarm cables as well as proper ventilation of sub-rack the assembly.

WARNING

Verify that all circuit breakers on the MAF 900-60S MCPA is in the OFF position and (Reset) switch is in OFF position before installation in sub-rack. Turn OFF all external power to the sub-rack before installing MAF 900-60S MCPA

1. Install sub-rack into host radio base station and secure it into place using #10 32x1/2 Phillips screws and #10 flat washers.
2. Connect +27 Vdc using #10 gauge wire. 1- Positive (red) 1- Return/Ground (black).
3. Connect RF IN cable to sub-rack
4. Connect RF OUT cable to sub-rack.
5. Connect external ALARM interface to external summary alarm board in host radio base station.
6. Before installing the MAF 900-60S MCPA into the sub-rack, inspect the 21-pin-D-sub combo connector on the rear of each amplifier. Verify that all pins are straight, no pins are recessed, and that the alignment shield is not bent.

WARNING

Do not slam amplifiers into the sub-rack. Forcing the amplifier into the sub-rack at too fast a rate may cause pins on the 21-pin-D-sub connector of the amplifier to become recessed or broken.

7. Continue installing MAF 900-60S amplifiers into sub-rack.
8. Apply +27 Vdc power to sub-rack. Measure with VOM +27 Vdc ± 1.0 Vdc. If the input voltage is above or below the limits. Check DC power rectifier system.
9. Verify cooling fans on sub-rack is operational.
10. Refer to Section 4 for initial turn-on and checkout procedure.

Section 6 Maintenance

6.1 Introduction

This section contains periodic maintenance and performance test procedures for Paradigm Wireless Systems MAF 900-60S Multi-Carrier Power Amplifier.

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 voided. Do not return equipment for warranty or repair service until proper shipping instructions are received from the factory.

6.2 Periodic Maintenance

Periodic maintenance is recommended. Table 6-1 lists the intervals at which the task should be performed.

Table 6-1 Periodic Maintenance

Task	***Interval***	***Action***
Inspection		
Cables and Connectors	3 months	Inspect signal and power cables for frayed insulation. Check RF connectors ensure connectors are tight
Performance Tests	12 months	Annual performance test as outlined in paragraph 6.4
Clean Fans/Heat Sinks	3 months	Inspect for debris. Remove dust with soft cloth, brush or vacuum cleaner.

6.3 Test Equipment Required for Test

Test equipment required to test the amplifier is listed in table 6-2. Equivalent test equipment may be substituted for any item. Use of a thermistor type power meter is recommended for optimum results.

NOTE

All RF test equipment must be calibrated and within the calibration date. Any deviation from the nominal attenuation must be accounted for and factored into all output readings.

Table 6-2 Test Equipment Required

Nomenclature	Manufacturer	Model
Network Analyzer	Agilent	8753 ET
Spectrum Analyzer	Agilent	8560E
Power Meter	Agilent	E4418B
Power Meter/Sensor	Agilent	437B / 8481A
Signal Generator	RDL	IMD-801D-03A
Directional Coupler	Agilent	778D
Attenuator	Weinschel Corp	53-30-34
Attenuator	Narda	766-20

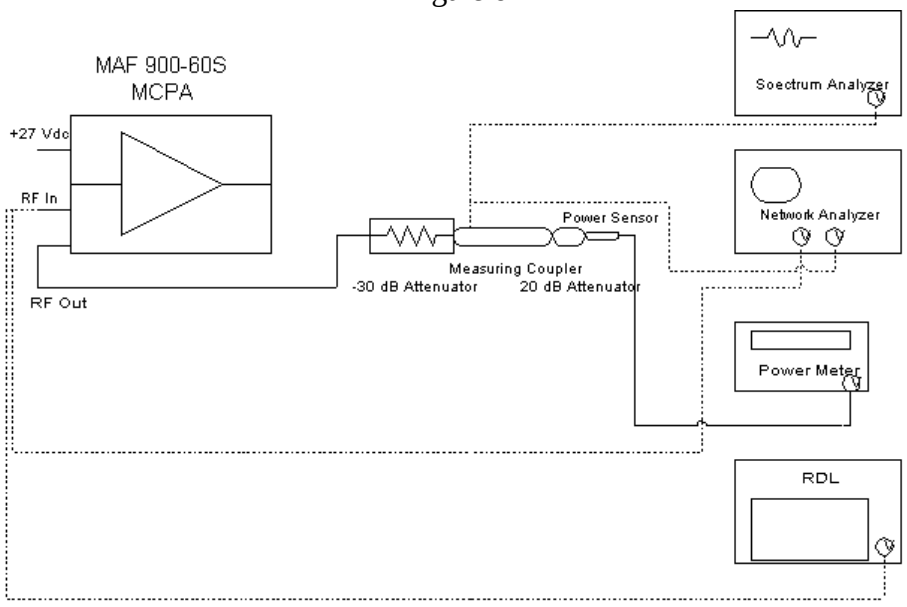
6.4 Performance Test

Performance test should be performed every 12 months to ensure that the amplifier meets the operational specifications.

NOTE

The frequencies used in this test are typically within the operating 5 MHz band of 935 MHz to 940 MHz. Select evenly spaced F1, F2, F3, and F4 frequencies that cover the instantaneous bandwidth of your system.

Figure 6-2



6.5 Amplifier Performance Test

To perform this test proceed as follows:

Connect test equipment as shown in figure 6-2.

WARNING
DO NOT APPLY ANY RF AT THIS TIME

6.6 Amplifier Spurious Emission Test:

Apply +27 Vdc from the power source. Apply 4-15 Watt continuous random tones from the RDL to the MAF 900-60S MCPA. Composite power will be 60 Watts measured from the Power Meter. Setup Spectrum Analyzer for Center Frequency (937.00 MHz), Start Frequency (930 MHz), Stop Frequency (945 MHz) Span (200 kHz) RES BW (1.0 kHz) Video BW (1.0 kHz) Measure and record data on Table 6-3.

6.7 Gain Test:

Disconnect spectrum analyzer from the MAF 900-60S. Connect Network Analyzer to MCPA.

Set Network Analyzer as follows:

a. Normalize Network Analyzer for gain and return loss.
b. Set start frequency to 935 MHz. Set stop frequency to 940 MHz. Setup Network Analyzer for 2- channel measurement. Set markers to 935 MHz, 937 MHz, 940 MHz.
c. Adjust input power of Network Analyzer to measure 60 watts on the Power Meter.
d. Measure and record amplifier gain on Table 6-3.
e. Set marker to 935 MHz scroll marker (delta) across bandwidth to 940 MHz. Measure Gain Flatness and record on table 6-3.
f. With Network Analyzer setup for 2-channel operation measure return loss using S_{11} data Record on. Table 6-3.

Table 6-3 MAF 900-60S MCPA Test Data Sheet

Date_____

Module S/N_____

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

TEST	SPECIFICATION	MIN	MAX	DATA
Spurious Emission	Voltage = +27 Vdc $P(out)$ = 15 Watts per channel 935 MHz-940MHz		-63 dBc	
RF Gain	Voltage = +27 Vdc $P(out)$ = 60 Watts 935 MHz-940MHz	58 dB		
Gain Flatness	Voltage = +27 Vdc $P(out)$ = 60 Watts 935 MHz-940MHz		±0.5 dB	
Input Return Loss	Voltage = +27 Vdc $P(out)$ = 60 Watts 935 MHz-940MHz	-15 dB		

PASS_____ FAIL_____

Tested By:_____

6.8 Field Replacement of the MAF 900-60S

The MAF 900-60S MCPA can be replaced in the field on the site by a qualified technician with experience maintaining RF power amplifiers and radio equipment.

To replace a power amplifier module, proceed as follows:

1. Set ON/OFF switch on front of amplifier to OFF position.
2. Loosen the thumbscrews that secure the amplifier to the sub-rack.
3. Slide amplifier out of sub-rack.

CAUTION

When removing amplifier from the sub-rack, it is important to support the amplifier such that the rear of the module does not suddenly drop when the guide rail disengages from the rack. A drop such as this could damage the rear of the 21-pin-D-sub connector.

4. Replacement of module is done in the reverse order of removal steps 1-3.

Section 7 Troubleshooting

7.1 Introduction

This section contains a list of problems that may occur. Paradigm Wireless Systems has suggested corrective action that may correct the problem. If the suggested corrective action does not eliminate the problem, please contact your Paradigm Wireless Systems representative for further instructions.

NOTE

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

7.2 Troubleshooting

Refer to Table 7-1 for troubleshooting suggestions:

Symptom	Suggested Action
Inoperative	1.Check for proper power supply voltage. 2.Verify all RF connections. 3.Contact your Paradigm Wireless Systems representative.
Over Heating Shut Down	1.Check for operation of fans on sub-rack assembly. 2.Check for debris in heat sink 3.Check air conditioning/venting unit for proper operation. 4.Contact your Paradigm Wireless Systems representative.
Over Power Shut Down	1.Verify host system radio output power level. 2.Verify sub-rack input attenuation. 3.Contact your Paradigm Wireless Systems representative.

7.3 Return for Service Procedures

When returning products to Paradigm Wireless Systems, Inc. the following procedures will ensure response.

7.3.1 Obtaining an RMA (Return Material Authorization)

A RMA number must be obtained prior to returning equipment to the factory for service. Please contact your Paradigm Wireless Systems representative to obtain this number. Failure to obtain this number may result in delays in receiving repair service.

7.3.2 Repackaging for Shipment

To ensure safe shipment of the amplifier, it is recommended that the packaged designed for the amplifier is used. The original packaging material is reusable.