Installation & Service Manual

Powerwave® technologies

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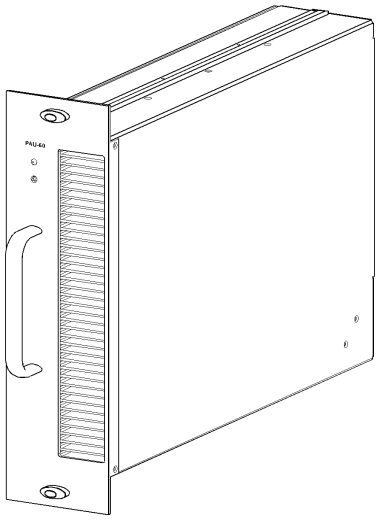

G3L-1929- Multi-Carrier Power Amplifier

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Preliminary

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Section 1. General Description

1-1 Introduction

This manual contains information and procedures for the installation and operation of Powerwave Technologies, Inc.'s G3L-1929-120 Multi-Carrier Power Amplifier (MCPA). This manual is organized into the following sections:

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 G3L-1929-120 Power Amplifier shown in figures 1-1 through 1-6, operates in the 60 MHz frequency band from 1930 MHz to 1990 MHz with channel spacing of 12.5 kHz. The amplifier provides a typical gain of 60 dB to produce a typical output of 60 Watts (47.8 dBm). The G3L-1929-120 amplifier generates approximately 2300 BTUs of heat at full power. The amplifiers are modular in design, and ideally suited for use in GSM base stations.

1-3 Ordering Information

Table 1-1 lists major system component numbers and descriptions for use in ordering booster amplifiers or components.

Table 1-1 Major System Components

Component Number	Description
G3L-1929-120	120-Watt Amplifier, +27 VDC

1-4 Functional and Physical Specifications

Electrical, mechanical, and environmental specifications for the G3L-1929-75 amplifier are listed in tables 1-2, 1-3, and 1-4 respectively.

1-5 Equipment Changes

Powerwave Technologies, Inc. reserves the right to make minor changes to the equipment, including but not limited to component substitution and circuitry changes. Changes that impact this manual may be incorporated in a later revision of the manual.

Table 1-2 G3L-1929-75 Amplifier Electrical Specifications

Frequency Range	1930 - 1990 MHz
Channel Spacing	12.5 KHz
Output Power:	+50.8 dBm (120 Watts)
Input Power	-10.0 dBm max.
RF Gain	+60 dB ±1.0 dB @ +27Vdc, 25° C
RF Gain Flatness over the operating frequency range	±0.1 dB over any 1.25 MHz (over the frequency range).
Gain Flatness:	±0.5 dB (1930 MHz – 1990 MHz)
Normal Operating Voltage	+27 Vdc ±1V Nominal (±5%) 1Vpp ripple (100-120 Hz) max.
Current Consumption:	27.5 Amps @ 27 Vdc, 25 °C, Prf = 60 Watts average 32 Amps @ 27 Vdc, 25 °C, Prf = 75 Watts maximum
Abnormal Operating Voltage	+21 Vdc to below +26 Vdc. Above +28 Vdc to +29 Vdc.
RF Gain variation by Temp & Voltage	±1dB; 0 to 50°C
Gain Variation Over Dynamic Range	±0.5 dB max./20 dB for 0 to -20 dB rated power output
Intermodulation Distortion In-Band Spurious	-65 dBc min. (Main signal power to Spurious @ (12.5 kHz) -55 dBc min @ +23 to +24 Vdc
Input/Output VSWR.	1.5**:** 1 max @ 65° C
Load Stability	Infinite VSWR. all phases
Output Isolation	20 dB min.

Table 1-3 G3L-1929-120 Amplifier Mechanical Specifications

Physical Dimension of MCPA (inches)	Front panel: 13.98 W x 3.90 H x 0.118 D Body: 11.61 W x 3.75 H x 17.56 D			
Weight	Approximately 28.6 pounds (13 killograms)			
Connector Type	D-sub, Hybrid, Plug-in Type RF connector: PKZ 26-0020 series straight plug type (Phoenix Co.) refers to attached drawing.			
MCPA Front Panel Switch	On/Off Switch and +27 Vdc Power Indicator			
21WA4 Connector Description	Pin Outs			
	A1	RF Input	(Coaxial Contact)	
	A2	+27 Vdc	(Power Contact)	
	A3	Ground	(Power Contact)	
	A4	RF Output	(Coaxial Contact)	
	1	TX H	10	+27 V
	2	TX L	11	COM SV
	3	GND	12	AMP AO
	4	RX H	13	AMP A1
	5	RX L	14	AMP A2
	6	GND	15	AMP A3
	7	HERE LPA	16	NC
	8	FF LPA	17	NC
	9	RESERVED		
Front Panel LED Display:	LED type: SMD			
RUN	Green (When MCPA is enabled)			
ALM	Red (When any alarm occurred, LED is on)			
DC	Green (When DC Power is ON, LED is on)			

Table 1-4 G3L-1929-120 Amplifier Environmental Specifications

Operating Temperature	-10 to + 60° C
Storage Temperature	-40 to + 85° C
Relative Humidity	5 to 95% RH (non-condensing)

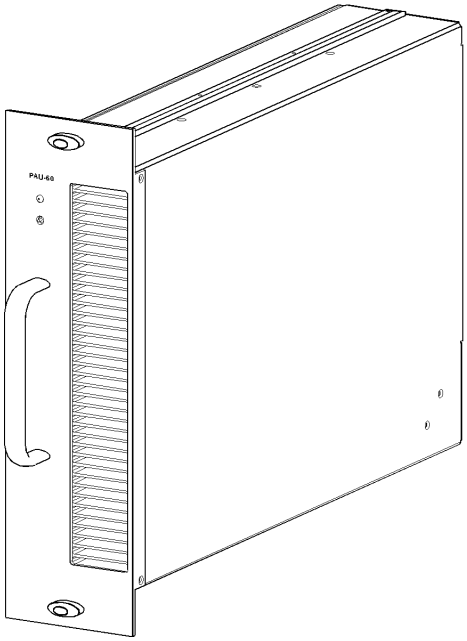

Figure 1-1 Model G3L-1929-120 Amplifier Front Isometric View

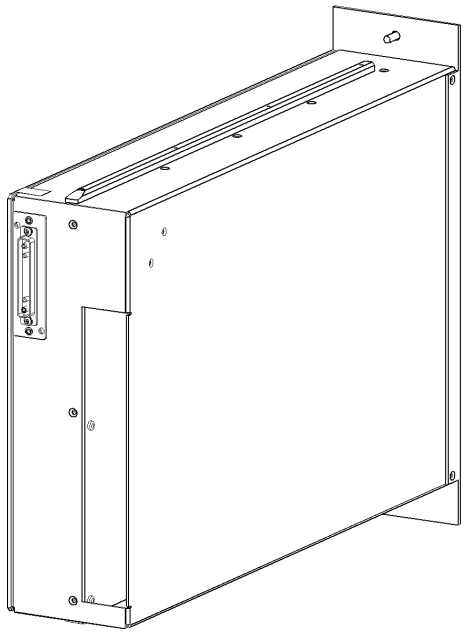

Figure 1-2 Model G3L-1929-120 Amplifier Rear Isometric View

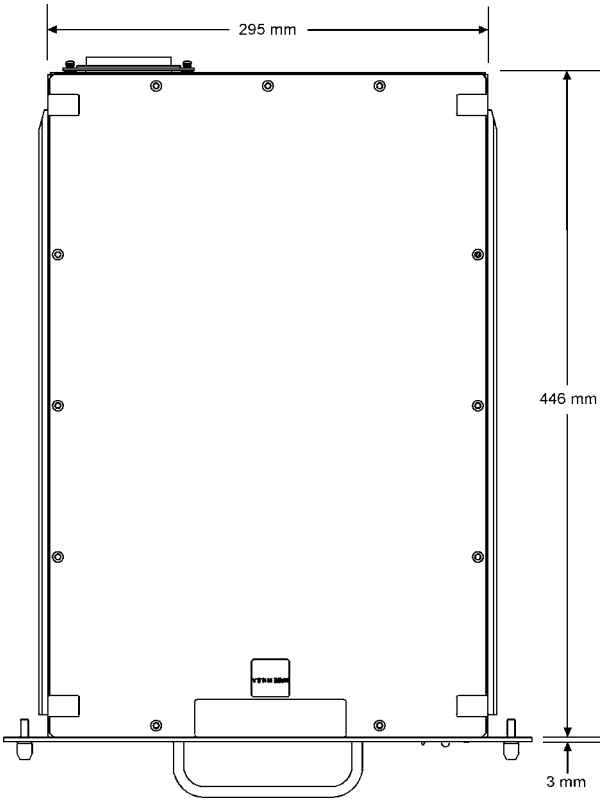

Figure 1-3 Model G3L-1929-120 Amplifier Top View

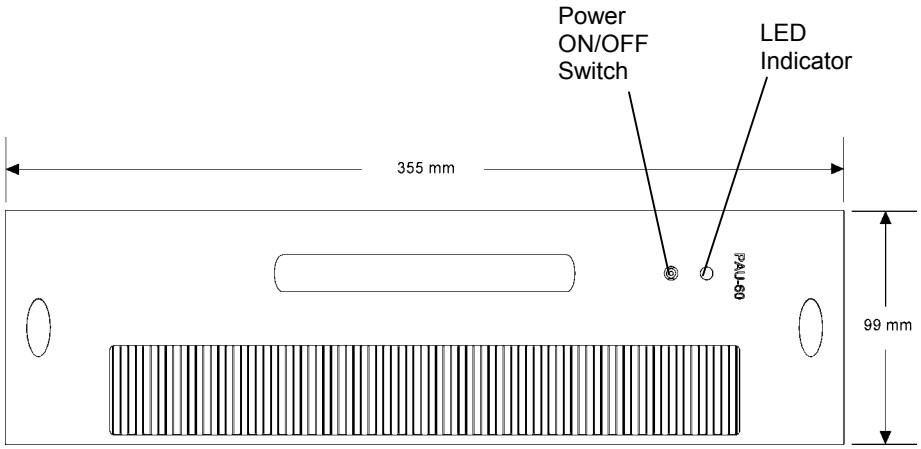

Figure 1-4 Model G3L-1929-120 Amplifier Front Panel

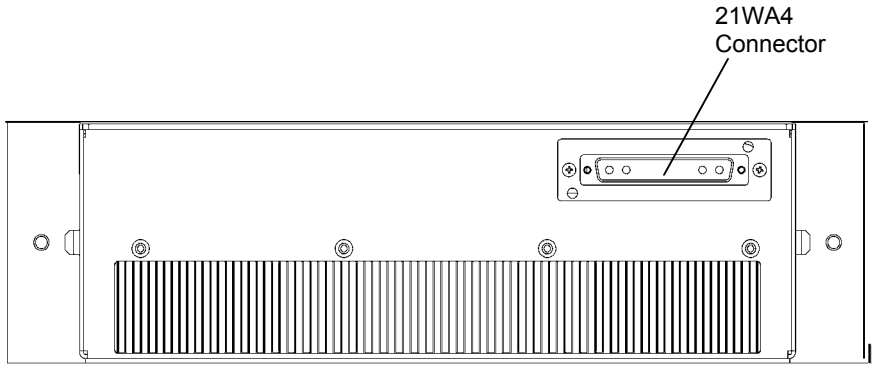

Figure 1-5 Model G3L-1929-120 Amplifier Rear Panel

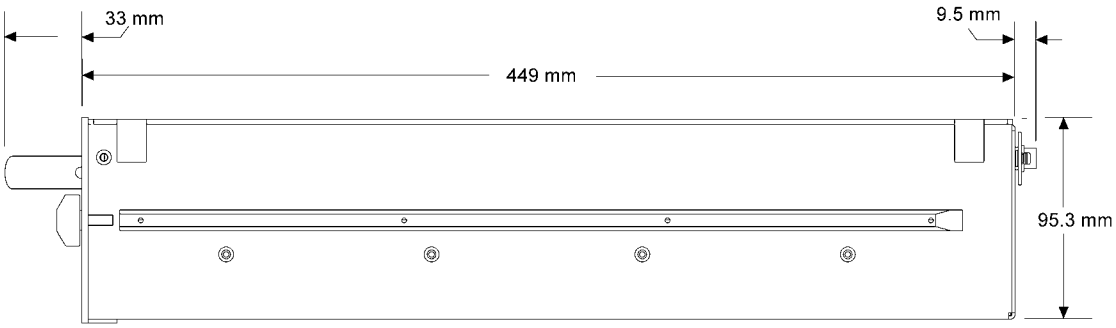

Figure 1-6 Model G3L-1929-120 Amplifier Side View

Section 2. Installation

2-1 Introduction

This section contains unpacking, inspection, installation instructions and recommendations for the G3L-1929-120 Multi-Carrier Power Amplifier (MCPA). It is important that the licensee perform the following tasks correctly.

1. Carefully read all material in this section prior to equipment unpacking or installation.
2. Also, read and review the operating procedures in section 3 prior to installing the equipment.
3. If applicable, carefully review the government and local codes as they apply to your installation.

2-2 Site Survey

Powerwave Technologies recommends that site surveys be performed by qualified individuals or firms prior to equipment ordering or installation. Performing a detailed site survey will reduce or eliminate installation and turn-up delays caused by oversights. Pay particular attention to power plant capacity, air conditioning needs, and RF/DC cabling/breaker requirements.

2-3 Electrical Service Recommendations

Powerwave recommends that:

- Proper AC line conditioning and surge suppression be provided on the primary AC input to the +27 Vdc power source.
- All electrical service should be installed in accordance with any applicable codes, and good engineering practice.
- Straight, short ground runs be used.
- 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 capable of handling the anticipated inrush current, in a load center with a master switch.

2-4 Air Conditioning

Each G3L-1929-120 amplifier generates approximately 2300 BTUs of heat at full power. A 1-ton air conditioner sufficiently handles 12,000 BTUs of heat.

2-5 Unpacking and Inspection

This equipment (as applicable) has been operated, tested and calibrated at the factory. Carefully open and remove the MCPAs from their respective containers. Retain all packing material that can be reassembled in the event that the unit must be returned to the factory. Please perform the following steps:

CAUTION

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

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

CAUTION

Before applying power, make sure that all connectors are secure. Make sure that the input and output are properly terminated at 50 ohms. Do not operate the system without a load attached. Refer to section 1, table 1-2 for input power requirements. Excessive input power may damage the equipment.

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

If the equipment is damaged:

- The carrier is your first area of recourse.
- A claim should be filed with the carrier once the extent of any damage is assessed. We cannot stress too strongly the importance of IMMEDIATE careful inspection of the equipment and the subsequent IMMEDIATE filing of the necessary claims against the carrier, if necessary.

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

- Please write or phone for return authorization.
- Powerwave may not accept returns without a return authorization.

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

2-6 Installation Instructions

Proceed with the installation of the G3L-1929-120 Amplifier as follows:

WARNING

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

1. Inspect the 21WA4 male 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.
2. Place the amplifier power On/Off switch in the “Off” position (figure 2-1).

CAUTION

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

3. Install the amplifier(s) into their respective subrack. There are no slot priorities, so any slot will function equally. Tighten the thumbscrews to secure the amplifier(s) to the subrack.

WARNING

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

4. 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.
5. Refer to section 3 for initial turn-on and checkout procedures.

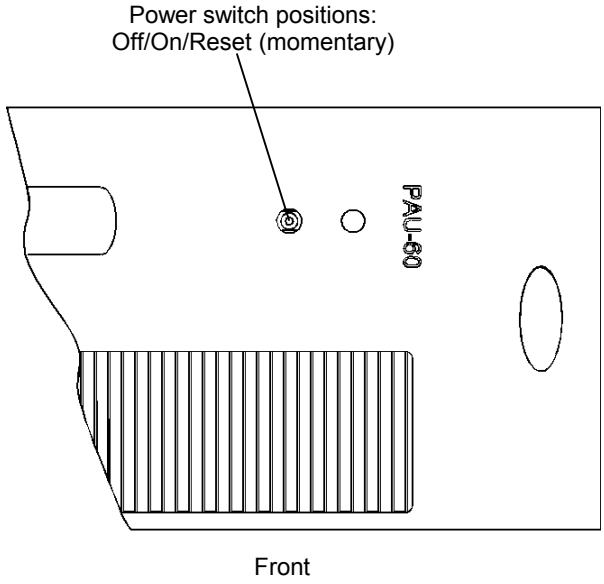

Figure 2-1 G3L-1929-120 Power Switch Functions

2-7 Amplifier Module Power, Alarm, Control, and RF Connector

The power, alarm, control, and RF connections on the amplifier are made through a 21WA4 male connector, located on the rear of the amplifier, and are listed and described in table 2-1 below.

Table 2-1 G3L-1929-120 MCPA Alarms & Controls

Items	Specifications	Remarks
Alarms & Controls	TTL Level; +5 Volts Buffer: 74ABT244 (5 V) - recommended	
Deletion Alarm	When unit does not exist (HEAR_PAU) Equipped: GND Deletion OPEN	D-Line
Function Fail Alarm	When unit does not exist (HEAR_PAU) Normal: High Abnormal GND	D-Line
VSWR Alarm	3:1 (6 dB ± 1dB) @ 35 dBm-48 dBm Output Power. PAU remains normal operation when this alarm condition disappears (NOT shutdown)	RS-485
High Temp. Alarm	This alarm only at +75 ºC +5 ºC/-0 ºC (heat-sink temp.)	RS-485
Over Power Output Alarm	Output power is greater than +48.5 dBm ±0.5 dB (70.8 W). MCPA recovers when the alarm condition disappears. (NOT shutdown).	RS-485
DC Fail Alarm	+20.5 Vdc ± 0.5V or +29 Vdc ± 0.5V. When this alarm occurs the MCPA shuts down	RS-485
Loop Fail Alarm	When an alarm occurs on the feed forward path.	RS-485
EN/DISABLE	Reserved	RS-485

Section 3. Operating Instructions

3-1 Introduction

This section contains a description of the G3L-1929-120 Multi-Carrier Power Amplifier (MCPA) controls and indicators and initial start-up and operating procedures.

3-2 Controls and Indicators

The controls and indicators for the G3L-1929-120 Power Amplifier consist of the primary power On/Off/Reset switch and status indicator LED as shown in figure 3-1.

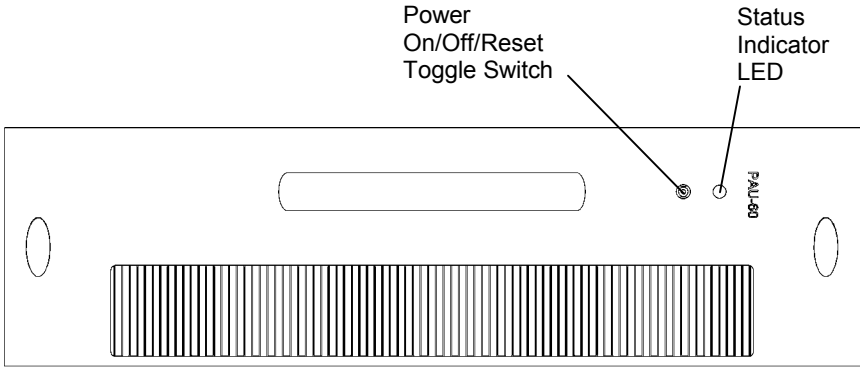

Figure 3-1 G3L-1929-120 Controls and Indicators

3-2.1 Status Indicator LED

The status indicator LED is located on the MCPA front panel as shown in figure 3-1. The LED has tri-color capability: red, yellow, and green. The LED's blinking frequency is 0.5 – 1 Hz with a duty cycle of 45 – 55%. The LED indicates the status of the MCPA as listed in table 3-1.

Table 3-1 Status Indicator Colors

LED Color	MCPA Status
Red (stable)	Manual main-switch turned standby and no TCP/UDB connection established
Red (stable) LED lighting period 1.5±0.5 sec	Manual main-switch turned ON or MCPA is resetting
Yellow (blinking)	MCPA in self-heating state
Yellow (stable)	In startup phase, MCPA is in standby state and before state change message from MCPA
LED state as it was before disconnection	TCP/IP connection is lost for two minutes
Yellow (stable)	TCP/IP connection is lost and MCPA is in standby state

3-3 Initial Start-Up and Operating Procedures

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

1. Verify 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 1-1 for input power requirements. Excessive input power may damage the MCPA.

NOTE

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

2. Turn on the supply that provides +27 Vdc to the amplifier.
3. Place the power On/Off/Reset switch on the amplifier front panel to the On (middle) position.
4. Allow the amplifiers to warm up for at least 20 minutes before taking power readings.

Section 4. Principles of Operation

4-1 Introduction

This section contains a functional description of the G3L-1929-120 Multi-Carrier Power Amplifier (MCPA).

4-2 RF Input Signal

The maximum input power for all carrier frequencies to the amplifier should not exceed the limits specified in the appendix A specifications.

4-3 RF Output Load

The load impedance should be as good as possible (VSWR of 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 Multi-Carrier Power Amplifier (MCPA) Functional Description

The MCPA is a linear, feed-forward multi-carrier power amplifier that operates in the 60 MHz frequency band from 1930 MHz to 1990 MHz (refer to table 1-4 for amplifier specifications). The amplifier provides a gain of 60 dB to provide a typical output of 70 watts (48.8 dBm). Refer to figure 4-1 for the amplifier functional block diagram. Each amplifier is a self-contained module and is functionally independent of any other MCPA in a system. The amplifiers are designed for parallel operation to achieve high peak power output. Each MCPA has an alarm board that monitors the amplifier performance. If a failure or fault occurs in an MCPA, it is transmitted to a subrack system via the D-subminiature 21WA4 connector at the rear of the module. The subrack reports all alarms to the host system.

Continuously comparing active paths with passive references, and correcting for small variations through RF feedback controls maintain constant gain. All gain variations, for example those due to temperature, are reduced to the passive reference variations. The amplifier consists of the following major functions:

- Preamplifier
- Main amplifier
- Error amplifier
- Alarm monitoring and control
- First and second loop control circuits
- Pilot tone generator

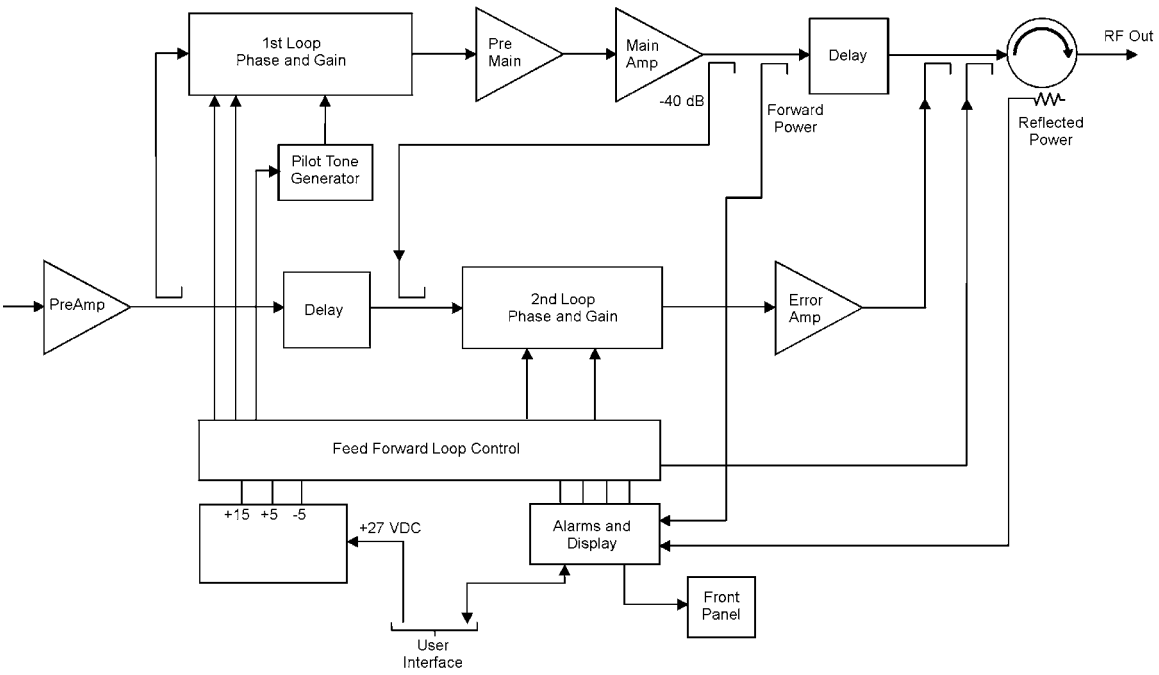

Figure 4-1 Multi-Carrier Power Amplifier Functional Block Diagram

4-4.1 Preamplifier

The carrier is applied to the input port of the amplifier. This signal is fed to the preamplifier stage where it is amplified using two stages of class A mode amplifiers. The output of the preamplifier is then split into two paths, one to the main amplifier and one to the error amplifier.

4-4.2 Main and Error Amplifiers

The main amplifier provides approximately 14.5 dB of gain in the 1930 to 1990 MHz frequency band (refer to table 1-2 for amplifier specifications). The main amplifier employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops are used to correct signal non-linearity's introduced by the class AB main amplifier. The error amplifier operates in class A mode. The RF signal from the preamp is coupled to an attenuator and phase shifter in the first feed-forward loop where it 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 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 sample 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.

4-4.3 Alarm Monitoring and Control

The alarm logic controls the +5 Vdc bias voltage that shuts down the amplifier. 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 occurs. When this happens, an alarm indicator is illuminated on the front panel of the subrack. The fault is transmitted back to an external summary module via the external alarm interface connection on the front panel of the subrack.

4-4.4 First and Second Loop Control Circuits

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 first loop. The first loop control section phase shifts the main input signals by 180 degrees and constantly monitors the output for correct phase and gain.

The second 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 of the main amplifier output. The final output is monitored by the second loop and adjusted to ensure that the signal distortion and intermodulation distortion (IMD) on the final output is cancelled out.

4-4.5 Pilot Tone Generator

The basic idea of injecting a pilot tone is that if the pilot signal is suppressed, then the distortion from the main amplifier is also suppressed. To accomplish this, the pilot tone generator signal is injected into the first loop and then detected at the feedforward output using the original pilot tone as a reference. The information is then fed back to control the gain and phase such that the output distortion is minimized.

4-5 Amplifier Module Cooling

The amplifier is cooled by forced air flowing over its heat sink, which is provided by two fans mounted on the front of the subrack. The fans draw air through the front of the system and exhaust hot air out the back. The fans are field replaceable. Each amplifier, when properly cooled, maintains the amplifier within the specified operating temperature range. Six inches of free space are required at both the front and rear panels of the subrack to allow adequate air volume to circulate over the heat sinks.

4-6 Power Distribution

Primary DC power for the amplifier is provided by the host system. The amplifier module has a DC/DC converter and voltage regulator that converts the +27 Vdc to +15 Vdc, +5 Vdc, and -5 Vdc for internal use.

Section 5. Maintenance

5-1 Introduction

This section contains periodic maintenance and performance test procedures for the G3L-1929-120 Multi-Carrier Power Amplifier (MCPA).

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 and the intervals at which the tasks should be performed are listed in table 5-1.

Table 5-1 Periodic Maintenance

Task	Interval	Action
Inspection: Cables and Connectors	12 Months	Inspect signal and power cables for frayed insulation. Check RF connectors to ensure that they are tight.
Performance Tests	12 Months	Perform annual test per paragraph 5-4.
Clean Fans/Heat Sinks	3 Months	Inspect for debris. Remove dust with a soft cloth/brush or vacuum cleaner.

5-3 Test Equipment Required For Test

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

Table 5-2 Test Equipment Required

Nomenclature	Manufacturer	Model
Signal Generator	H.P.	8656B
20 dB Attenuator, 250 Watt	Bird	Tenuline
20 dB Attenuator, 20 Watt (2 each)	Bird	Tenuline
Spectrum Analyzer	H.P.	8560E
Coax Directional Coupler	H.P.	778D
Power Meter / Sensor	H.P.	437B / 8481A
Arbitrary Waveform Generator	Sony	AWG2021
Network Analyzer	H.P.	8753C

5-4 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 60 MHz band from 1930 MHz to 1990 MHz. Select evenly spaced F1, F2, F3, and F4 frequencies that cover the instantaneous bandwidth of your system.

5-4.1 Amplifier Performance Test

To perform these tests, proceed as follows:

Connect test equipment as shown in figure 5-1.

WARNING

Do not apply any RF signals at this time.

5-4.1.1 Amplifier Spurious Emissions Test:

With the RF input signal to the amplifier set to be as shown in Figure 5-1, use the spectrum analyzer to measure the spurious emissions performance. Record test data in Table 5-3. Verify that it is within the specifications shown in table 1-2. Switch tested amplifier to OFF.

5-4.1.2 Gain Test:

1. Disconnect spectrum analyzer from test setup, and connect the network analyzer.
2. Set network analyzer as follows:
   A. Power output to -10 dBm max.
   B. Frequency start to 1930 MHz.
   C. Frequency stop to 1990 MHz.
   D. Normalize the network analyzer for gain and return loss.
3. Check the amplifier gain across the band from 1930 MHz to 1990 MHz. Gain should be as specified in table 1-1. Record test data in table 5-3.

5-4.1.3 Input Return Loss:

Read and record the S_{11} return loss measurement on network analyzer. Record test data in table 5-3.

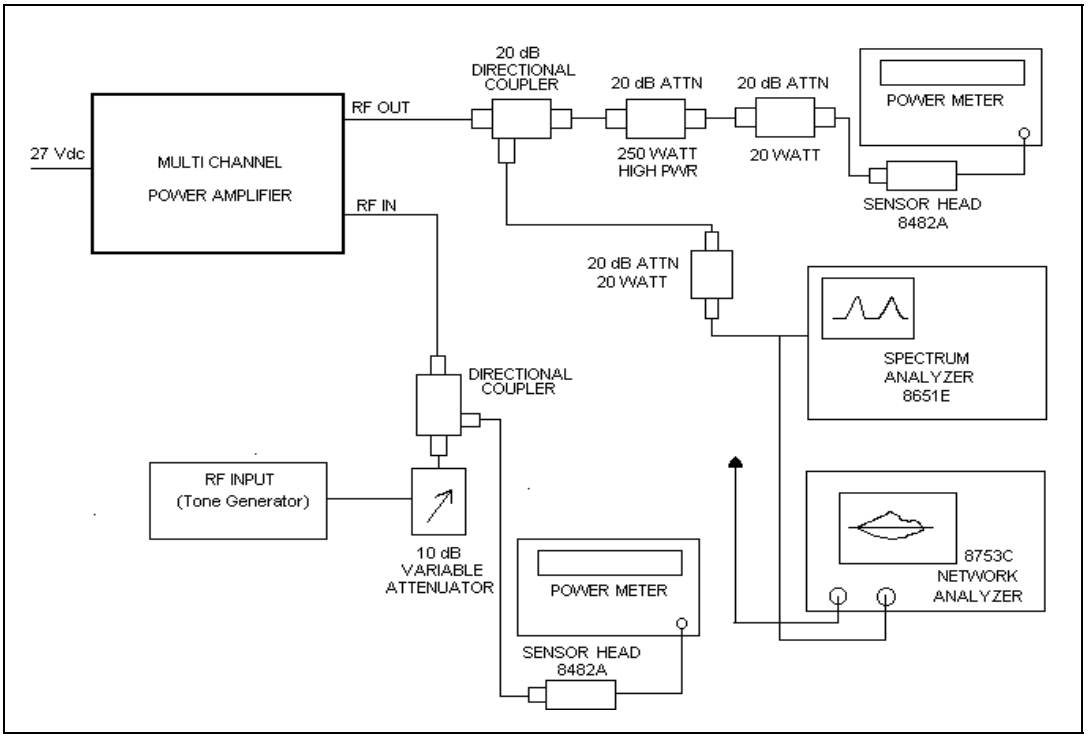

Figure 5-1 Amplifier Test Setup Diagram

Table 5-3 G3L-1929-120 Amplifier Test Data Sheet

DATE _____ MODULE S/N _____

Test Conditions:

Load and Source Impedance: 50 Ohms
VSWR: < 1.5:1
Supply Voltage: +27 Vdc ±0.1 Vdc

Test	Specification	Min	Max	Data
RF Gain	Vcc = 27 Vdc PO = See table 1-4 Freq. = 1930 – 1990 MHz	57.0 dB	58.0 dB	
Spurious Emissions	Vcc = 27 Vdc PO = See table 1-4 1930 – 1990 MHz Band		-65 dBc	
Gain Flatness	Vcc = 27 Vdc PO = See table 1-4 1930 – 1990 MHz Band		±0.5 dB	
Input Return Loss	Vcc = 27 Vdc PO = See table 1-4 1930 – 1990 MHz Band		-14 dB	

PASS _____ FAIL _____

Tested by _____

5-5 Field Replacement of the Module

The GL3-1929-120 multi-carrier power amplifier module can be replaced in the field on site by a qualified technician with experience maintaining RF power amplifiers and similar equipment:

To replace a power amplifier module, proceed as follows:

1. Set On/Off switch on the front panel of the amplifier module to Off (down).
2. Loosen the two thumbscrews that secure amplifier module to the 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 21WA4 multipin connector.

3. With steady even pressure, use handle on front of amplifier to pull module out of subrack.
4. Install replacement in reverse order of steps 1 through 3 above.

Section 6. Troubleshooting

6-1 Introduction

This section contains a list of problems that could occur and a few suggested actions that can 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 (refer to paragraph 6-3).

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.

Problem	Suggested Action
G3L-1929-120 Inoperative	1. Set On/Off/Reset toggle switch momentarily to Reset. 2. Check for proper power supply voltage. 3. Verify all RF connections. 4. Verify that unit does not have a major fault (red LED on front panel of subrack). 5. Contact your 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 (714) 466-1000 to obtain this number, or FAX your request to (714) 466-5800. Failure to obtain this RMA number may result in delays in receiving repair service.

6-3.2 Repackaging For Shipment

To ensure safe shipment of the amplifier, it is recommended that the original package designed for shipping the amplifier be reused. If it is not available, contact Powerwave's Customer Service Department for packing materials.