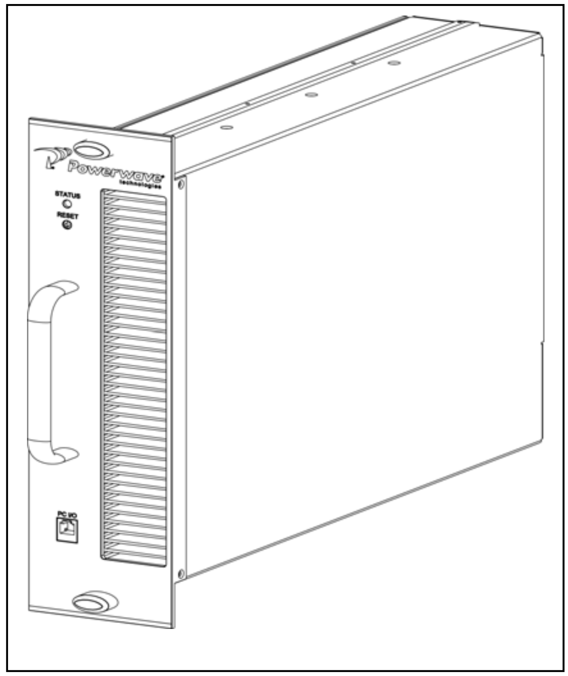

G3L-850-135 Multi-Carrier Power Amplifier

Service and Installation Manual

044-05117

December 2004

Powerwave technologies

This Powerwave product is designed to operate within the Normal Operating (typical operating) ranges or conditions specified in this document. Operation of this equipment beyond the specified ranges in this document may cause (1) spurious emissions that violate regulatory requirements; (2) the equipment to be automatically removed from service when maximum thresholds are exceeded; or (3) the equipment to not perform in accordance with its specifications. It is the Operator's responsibility to ensure this equipment is properly installed and operated within Powerwave operating specifications to obtain proper performance from the equipment and to comply with regulatory requirements.

Warnings, Cautions, and Notes

Warnings, cautions, and *notes* are found throughout this manual. The associated icons in warnings and cautions are used to quickly identify a potential condition that could result in the consequences described below if precautions are not taken. Notes clarify and provide additional information to assist the user.

WARNING This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.

CAUTION This caution symbol means *reader, be careful*. In this situation, the user might do something that could result in equipment damage or loss of data.

Note This note symbol means *reader, take note*. Notes contain helpful suggestions or references to material not covered in the document. Procedures are not contained in notes.

Revision Record

Revision Record

Revision Letter	Date of Entry	Reason for Change
A	December, 2004	Original version of product

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Chapter 1 General Description

1-1 Introduction

This manual contains information and procedures for installation and servicing of Powerwave's G3L-850-135 Amplifier. The manual is organized into two chapters as follows:

Chapter 1	General Description	Chapter 4	Principles of Operation
Chapter 2	Installation	Chapter 5	Maintenance
Chapter 3	Operating Instruction	Appendix A	Glossary of Terms

1-2 General Description

The G3L-850-135 Power Amplifier, shown in Figure 1-1 - Figure 1-5, operates in the 25 MHz frequency band from 869 MHz to 894 MHz with an instantaneous bandwidth of less than 25 MHz. The instantaneous bandwidth is the maximum frequency band in which any two or more signals can occupy .The amplifier's instantaneous bandwidth is set automatically and does not require any manual setup. The amplifier is modular in design. Table 1-1 gives additional essential operating specifications.

Table 1-1. General Operating Parameters

Characteristic	Performance	Remarks
Operating Frequency Band	869 MHz to 894 MHz	
Instantaneous Bandwidth	25MHz	
Gain	63 dB	
Spurious Performance	ITU-R SM329-9, Category A	Non-carrier related
Receive Band Noise	-98 dBm/Hz	In RX channels associated with RF input terminated into 50 Ω.
Supply Voltage	21 Vdc to 30 Vdc	Nominal +27 Vdc. Degraded mode of operation at less than 26 Vdc.
Heat Output	3,074 BTU	At full rated power
Carrier Types	GSM (up to 12 carriers) or EDGE +GSM (up to 4 carriers for each) WCDMA (up to 4 carriers)	GSM 11.21 TS 25.141 3GPP2 C.S0010-B
Storage Temperature	-40 - +85 °C	
Ambient Temperature	-33 - + 50 °C	
Altitude	-50 - +4,000 m	

1-3 Functional and Physical Specifications

Electrical, mechanical, and environmental specifications for the G3L-850-135 amplifier are listed in Table 1-2.

Table 1-2. G3L-850-135 Amplifier Specifications

Frequency Range	869-894 MHz; 25 MHz bandwidth (lowest to highest transmitted frequency)
Minimum Channel Spacing	1 to 8 GSM carriers
Total Maximum Input Power	-12.21 dBm @ 135 Watts (to achieve rated power); -11.91 dBm max. -6.0 dBm or greater causes input overdrive shutdown.
Total Output Power	[illegible] Watts (7GSM and 1EDGE) @27Vdc [illegible] Watts (GSM/EDGE) @26Vdc to 30Vdc 110 Watts (W-CDMA) @26Vdc to 30Vdc
Intermodulation Distortion and In-Band Spurious:	-65 dBc (Min) @ +26 to +28 Vdc @ 135 Watts; 600 KHz channel spacing within 25 MHz bandwidth*
RF Gain at 869 to 894 MHz	63 dB ±1 dB
Gain Flatness:	±0.5 dB @ 27 Vdc ±1 Vdc
Gain Variation Over Temperature:	±0.5 dB from 26 Vdc to 28 Vdc over -20° to +50° C
Output Protection:	Mismatch protected
Input Port Return Loss:	Equal to or greater than 14dB
Out of Band Spurious:	Better than -60 dBc, +26 Vdc to +28 Vdc
Duty Cycle:	Continuous
DC Input Power:	+27 Vdc ± 1 Vdc, 34.1 Amps typical, 36 Amps max @ 135 Watts; operational range +21.0 Vdc to 30 Vdc amplifier will disable at < 20.5 Vdc or > +30.5 Vdc.
Operating Temperature:	-33 ºC. to +50 ºC.
Storage Temperature:	-40 ºC. to +85 ºC.
Operating Humidity:	5 % to 95 % relative humidity (non-condensing)
Storage Humidity:	5 % to 95 % relative humidity (non-condensing)
RF Input / Output / Status / Alarm / Control / DC Input Connectors:	21-Pin D-Subminiature combo connector
Maintenance Port	RJ-11, RS-232 signaling (for factory use only)
Switches	Reset/On/Off Switch
Indicators: STATUS	LED; Green (normal), Yellow (minor alarm), Red (critical alarm)
Dimensions:	35.46 cm wide, 9.56 cm high, 45.0 cm deep (including handles)
Weight:	12.97 kg

Note This Powerwave product is designed to operate within the normal operating (typical operating) ranges or conditions specified in this document. Operation of this equipment beyond the specified ranges may cause (1) spurious emissions that violate regulatory requirements; (2) the equipment to be automatically removed from service when maximum thresholds are exceeded; or (3) the equipment to not perform in accordance with its specifications. It is the operator's responsibility to ensure this equipment is properly installed and operated within Powerwave operating specifications to obtain proper performance from the equipment and to comply with regulatory requirements.

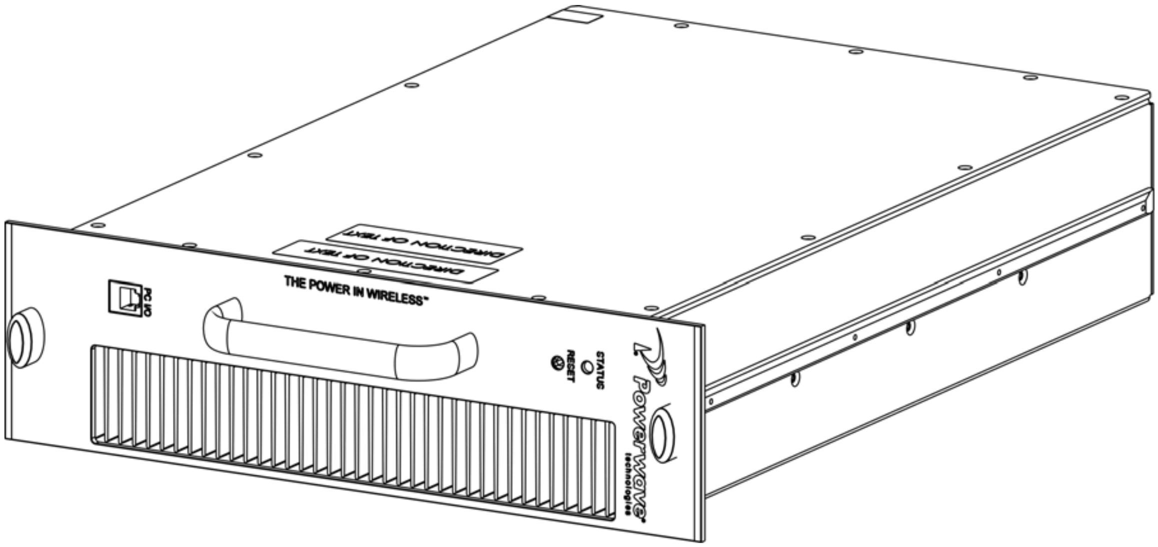

Figure 1-1. Model G3L-850-135 Amplifier Front Isometric View

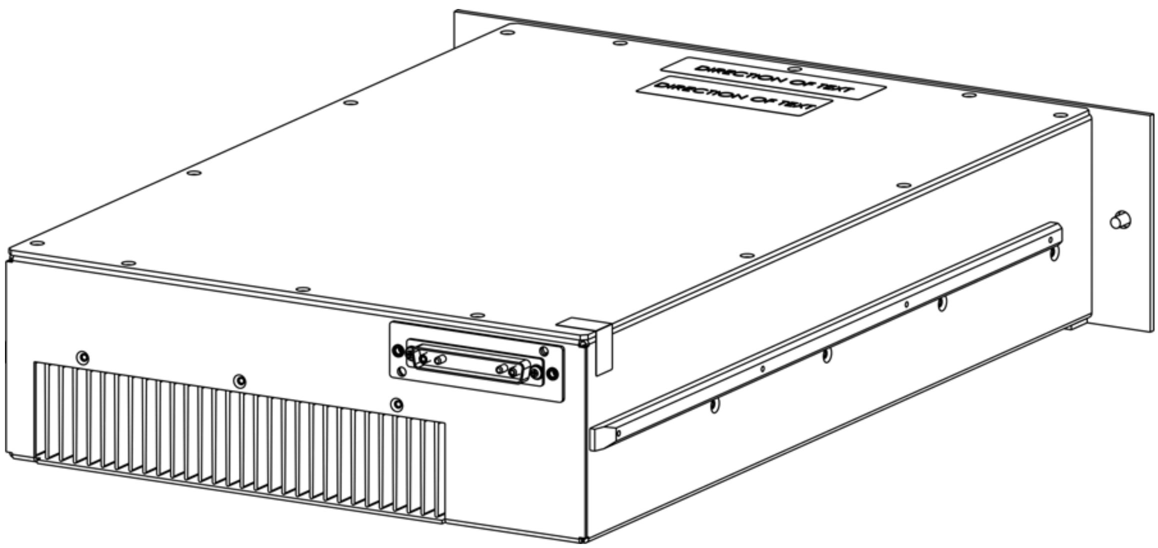

Figure 1-2. Model G3L-850-135 Amplifier Rear Isometric View

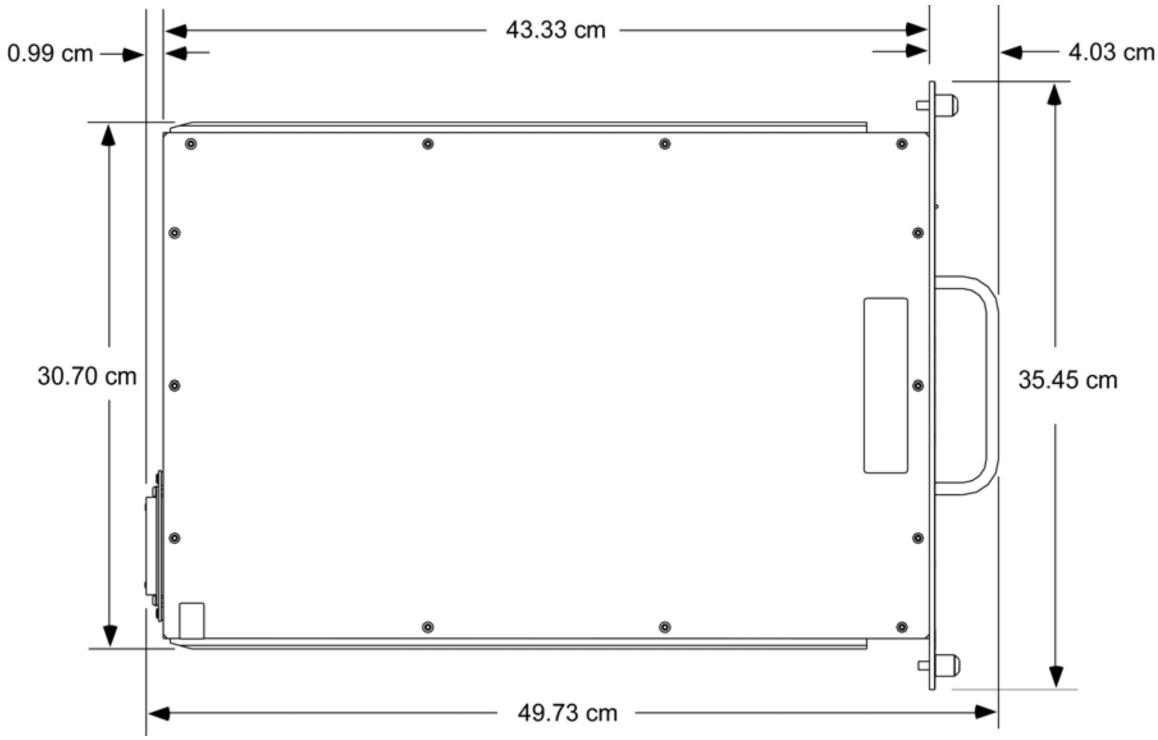

Figure 1-3. Model G3L-850-135 Amplifier Side View

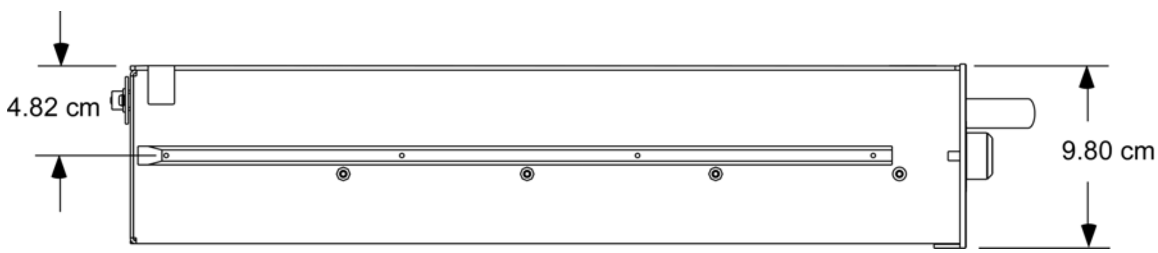

Figure 1-4. Model G3L-850-135 Amplifier Bottom View

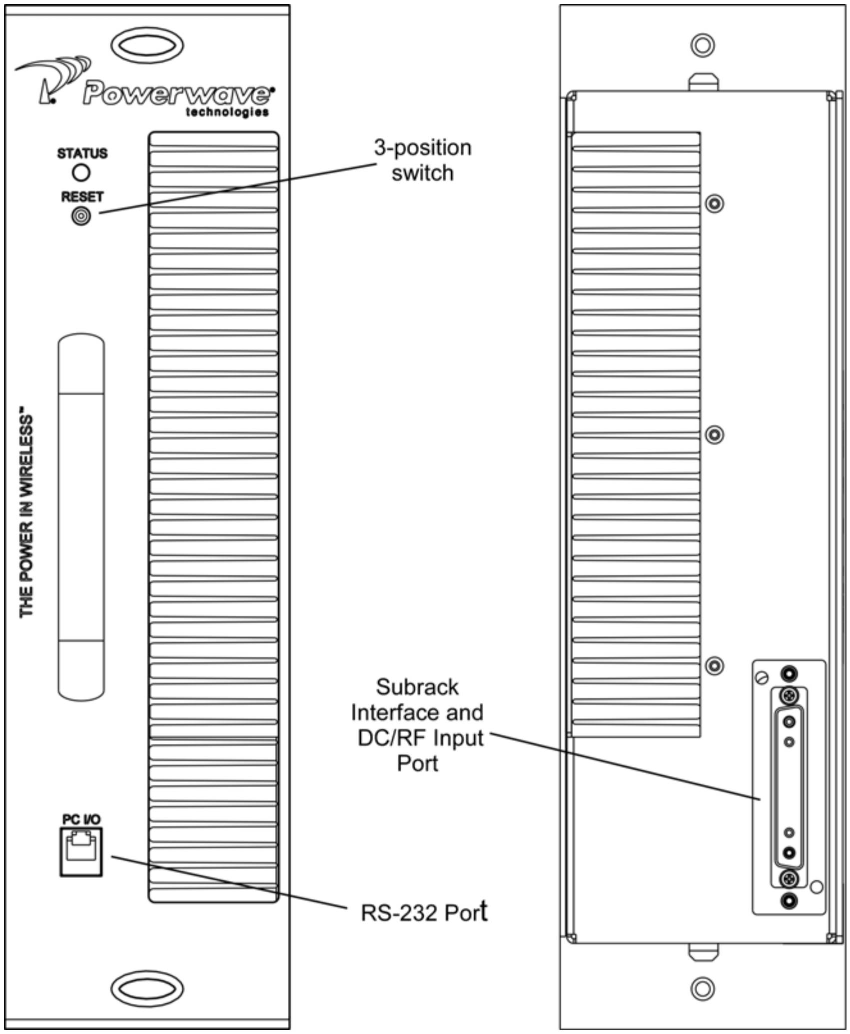

Figure 1-5. Model G3L-850-135 Amplifier Front Panel

1-4 Ordering Information

Table 1-3 lists major system component numbers and descriptions for use in ordering amplifiers or components.

Table 1-3. Major System Components

Model Number	Description
G3L-850-135	135-Watt Amplifier, +27 Vdc
*MCR41927-1-4	4-way Combining Amplifier Subrack
*MCR41928-4-4	4-In/4-Out Non-combining Amplifier Subrack
*MCR41970-4-4	4-In/4-Out N+1 Non-combining Amplifier Subrack

*Amplifier subracks sold and described separately

1-5 General Safety

This paragraph describes safety practices when handling certain components.

1-5.1 Lifting Standards

The handling of the power amplifier cabinet and its subassemblies involves heavy lifting. Various methods of lifting must be employed to safely and properly install this equipment. The following web site addresses are provided as references to OSHA personnel lifting guidelines:

http://www.osha.gov/SLTC/etools/electricalcontractors/materials/heavy.html

http://www.cdc.gov/niosh/pdfs/94-110.pdf

Lifting of heavier modules may require two people in awkward work environments, whereas only one person might otherwise be able to safely lift the module. Be aware of the environmental impact on lifting and twisting while moving heavier materials.
The Amplifier weighs 12.97 kg (28.5 lb) and can normally be lifted by one person.

1-5.1.1 Power Plant

Only qualified electricians, certified to work on high voltages (176 to 264 Vac; 150 A), should perform installation and maintenance to the cabinet and rectifier inputs. Failure to follow safe practices may result in equipment damage, personal injury or death.

Never remove bare DC power wires from equipment or allow bare DC voltage wires to dangle freely in the cabinet. Prior to removal of equipment that necessitates dangling of DC wires, disconnect DC power at the LVD and turn the rectifiers off. Verify with a voltmeter that DC power is removed prior to disconnecting equipment.

Refer to NEC Article 810, for clearances from power and lightning conductors, mounting, and grounding.

1-5.1.2 Electronic Modules

Electronic modules should be turned off before removal, when an on/off switch is provided. For example, the amplifier module draws up to 26 amperes of current with no RF energy applied. Failure to turn the amplifier module off before removal will cause arching between the amplifier module and the amplifier subrack, resulting in damage to both pieces of equipment.

RF energy should be turned off before removal or installation of RF cables. Failure to RF energy may result in equipment damage or personal injury.

Electronic modules should be turned off before removal or installation of electronic interconnecting cables.

1-5.1.3 Electrostatic Discharge

The power amplifier cabinet contains modules and components that are sensitive to static electricity. Two Electrostatic Discharge (ESD) service points are incorporated in the cabinet frame. One service point is located in the interior front electronics compartment about half way down the right hand vertical rail. The other service point is located in the interior rear electronics compartment about half way down the left hand vertical rail.

ESD protective devices must be properly worn and connected to one of the cabinet ESD service points by technicians and installers during the performance of maintenance activities.

Chapter 2 Installation

2-1 Introduction

This chapter contains unpacking, inspection, and installation instructions for the G3L-850-135 Multi-Carrier Power Amplifier (MCPA). It is important that the licensee perform the following tasks correctly. Carefully read all material in this chapter prior to equipment unpacking or installation. Also, read and review the operating procedures in chapter 3 prior to installing the equipment. 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 reduces or eliminates 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 Technologies recommends that proper AC line conditioning and surge suppression be provided on the primary AC input to the +27 Vdc power source. Install all electrical service in accordance with applicable local codes and good engineering practice. Give special consideration to lightning protection of all systems, given 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.

The information in Table 2-1 is provided as a guideline. Follow the appropriate standards in the *National Electrical Code* (NEC) and codes for your area, and observe the cable manufacturer's recommendations for proper cable selection.

Table 2-1. Sample of DC Cable Ratings

mm^2	Copper						Aluminum					
	3 Cond. In Raceway		Single Conductor In Free Air				3 Cond. In Raceway		Single Conductor In Free Air			
	90°C	110°C	90°C	110°C	125°C	200°C	90°C	110°C	90°C	110°C	125°C	200°C
2	25	30	30	40	40	45	--	--	--	--	--	--
3	30	35	40	50	50	55	25	25	30	40	40	45
5	40	45	55	65	70	75	30	35	45	50	55	60
8	55	60	75	85	90	100	40	45	55	65	70	80
13	70	80	100	120	125	135	55	60	80	95	100	105
21	95	105	135	160	170	180	75	80	105	125	135	140
34	125	135	185	210	225	240	100	105	140	165	175	185
42	145	160	215	245	265	280	110	125	165	190	205	220
53	165	190	250	285	305	325	130	150	190	220	240	255

Based on ambient temperature of 30°C (86°F) 100% Load Factor

Source: Industrial Electric Wire & Cable Inc., Technical Guide Vol. 4M 11/99, Table III Suggested Ampacities - All Types of Insulations; Based on National Electric Code

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. Powerwave recommends that a 50 A circuit breaker be installed in the power distribution unit for each amplifier. DC wire smaller than 8 mm^2 90°C copper should not be installed. Each amplifier should have its own DC cable pair. Refer to Table 2-1.

According to the laws of probability used to formulate Erlang tables, rarely are all channels transmitting at the same time. We can use Erlang tables to predict typical maximum current usage. Table 2-2 and Table 2-3 describe the current load (at 120 Watts typical) for a 3 sector (70%), 2 sector (80%) and omni (90%) site in two different configurations. Based on table 2-2, a 600-ampere power plant may suffice in a macro-cell site, whereas, a 200-ampere or smaller power plant may be adequate in a micro-cell site, based on the equipment configuration.

Battery backup or UPS systems should be installed in remote sites or in sites that experience brownout conditions or generator switchovers. Adding this equipment should eliminate the need for site visits by technicians after brownouts or power outages. Battery backup systems also provide excellent DC filtering as a side benefit.

Table 2-2. 4-Way Combining Averaged DC Current Load

Amplifier Power	No. Of Amplifiers	3-Sector (70%) Averaged Current	2-Sector (80%) Averaged Current	1-Sector (90%) Averaged Current	100% Typical
120	12	*348 A			409 A
120	8	*232 A	*254 A		273 A
120	4	*116 A	*127 A	*130 A	136 A
120	1	*29 A	*32 A	*33 A	34 A

* typical, based on given % of output power)

Table 2-3. 4-In/4-Out Non-combining Averaged DC Current Load

Amplifier Power	No. Of Amplifiers	3-Sector (70%) Averaged Current	2-Sector (80%) Averaged Current	1-Sector (90%) Averaged Current	100% Typical
120	4	*99 A			*114 A
120	3	*87 A	*95 A		*102 A
120	2	*58 A	*63 A	*65 A	*68 A
120	1	*29 A	*32 A	*33 A	*34 A

* typical, based on given % of output power)

2-4 Air Conditioning

Each G3L-850-135 amplifier generates 3,074 BTUs of heat at full 135-Watt power. A 1-ton air conditioner offsets 12,000 BTU’s of heat. The G3L-850-135 amplifier is designed to operate within the extended low temperature and high temperature environments defined in table 1-2.

In keeping with Paragraph 2-3, Table 2-4 and Table 2-5 describe the heat load (at 120 Watts typical) for a 3-sector (70%), 2-sector (80%), omni (90%), and typical (100%) site. Perform a site survey to determine actual air conditioning needs.

Table 2-4. 4-Way Combining Averaged Heat Loading

Amplifier Power	No. Of Amplifiers	3-Sector (70%) Averaged BTU/hour	2-Sector (80%) Averaged BTU/hour	1-Sector (90%) Averaged BTU/hour	100% Typical BTU/Hour
120	12	28,791			32,793
120	8	19,194	20,638		21,862
120	4	9,597	10,319	10,514	10,931
120	1	2,399	2,580	2,629	2,733

* typical, based on given % of output power

Table 2-5. 4-In/4-Out Non-combining Averaged Heat Loading

Amplifier Power	No. Of Amplifiers	3-Sector (70%) Averaged BTU/hour	2-Sector (80%) Averaged BTU/hour	1-Sector (90%) Averaged BTU/hour	100% Typical BTU/Hour
120	4	9,585			10,585
120	3	7,198	7,739		8,198
120	2	4,799	5,160	5,257	5,465
120	1	2,399	2,580	2,629	2,733

* typical, based on given % of output power

2-5 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 unpack each piece of equipment after it has reached the installation site and is approximately in place. Carefully open the several amplifier system containers and remove the contents. Inventory all items to ensure all needed materials have been delivered.

Retain all packing material to support any claim of shipping damage or for use in the event that the equipment must be returned to the factory.

CAUTION Exercise care in handling equipment during inspection to prevent damage caused by rough or careless handling. Some components are heavy. Follow the guidelines set forth in Paragraph 1-5.1 when lifting heavy components.

Visually inspect the Amplifier 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 connectors or fans. Inspect male connectors on modules and harnesses for bent connector pins.

Perform the following steps:

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* Table 1-2 *for input power requirements. Excessive input power may damage the equipment.*

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.

2-6 Installation Instructions

Install the G3L-850-135 amplifier as follows:

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

2-6.1 Installing the Amplifier into the Subrack

1. For each Amplifier:
   a. Inspect the 21WA4 male combo connector on the rear of each amplifier. Verify that all pins are straight, no pins are recessed, packing material is removed, and that the alignment shield is not bent.
   b. Set the amplifier power Reset/On/Off switch to “Off” (down position) as shown in Figure 2-1.

CAUTION Do not slam or force the amplifier into the subrack. This may cause the pins on the 21-D sub connector of the amplifier to become recessed or broken.

Note Non-combining subracks are typically sector specific; ensure the amplifier is installed to support the appropriate sector.

   c. With the thumbscrews in the unlock position, install the amplifier(s) into the subrack. There are no slot priorities in a combining subrack, so all slots function equally. To secure the amplifier(s) in the subrack, turn the top and bottom thumbscrews to the lock position as shown in Figure 2-1.

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

2. 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 an electrician before you turn on your amplifier system.

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

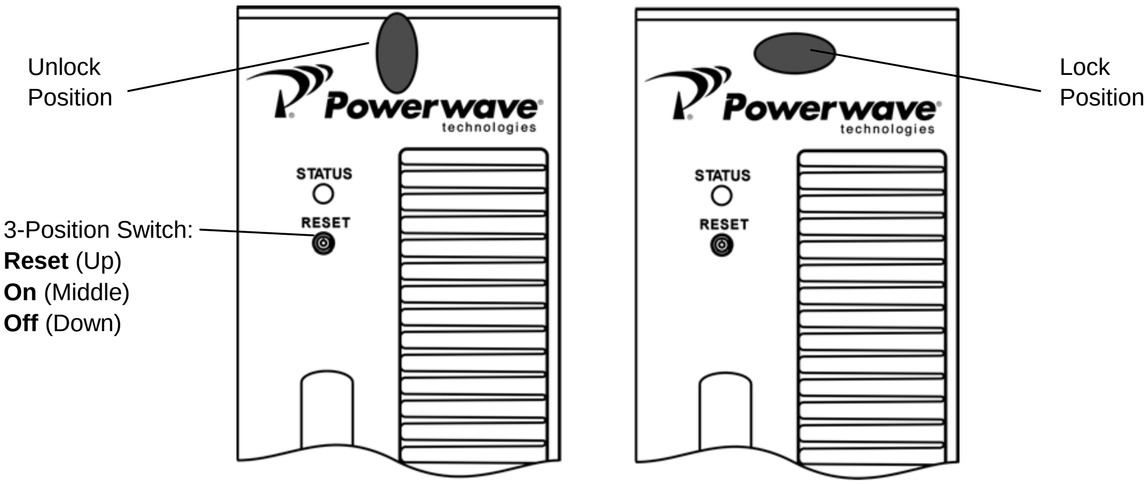

Figure 2-1. Power Switch Functions and Unlocking/Locking Thumbscrews

2-6.2 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. Pins are listed and described in Table 2-6. Alarms are interpreted by the amplifier subrack and reported to the base station as a system level alarm.

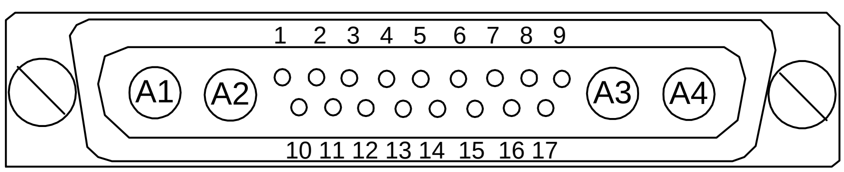

Figure 2-2. DC and Logic Connector (Male, on Rear of G3L-850-135 Amplifier Module)

Table 2-6. G3L-850-135 Amplifier Combo Connector Specifications

	Pins/Signal Names			
21WA4 Connector Description	A1	RF Input (Coaxial Contact)		
	A2	+27 Vdc (Power Contact)		
	A3	Ground (Power Contact)		
	A4	RF Output (Coaxial Contact)		
	1	TX H (RS-485)	10	System Reset TTL
	2	TX L (RS-485)	11	NC
	3	GND	12	NC
	4	RX H (RS-485)	13	AMP AO
	5	RX L (RS-485)	14	AMP A1
	6	GND	15	AMP A2
	7	MOD_DET	16	NC
	8	Summary Fault	17	MCPA Temp
	9	DC (On/Off)		

Chapter 3 Operating Instructions

3-1 Introduction

This chapter contains a description of the G3L-850-135 Multi-Carrier Power Amplifier (MCPA) controls, indicators, and initial start-up and operating procedures.

3-2 Controls and Indicators

The controls and indicators for the G3L-850-135 Power Amplifier consist of the primary power RESET toggle switch, the LED STATUS indicator, and the RJ-11 PC Interface as shown in Figure 3-1.

3-2.1 RESET Switch

The RESET Switch, located on the front panel, has three positions, each with its own function.

- The momentary up position resets fault indications and returns the Amplifier to normal operation if a critical or hard fault does not prevent such operation. When the switch is released, it automatically returns to the middle position.
- The middle position allows normal operation. If no critical faults are present, the Amplifier operates normally.
- The down position is used to turn the amplifier off. The Amplifier remains disabled until the switch is manually returned to the middle position.

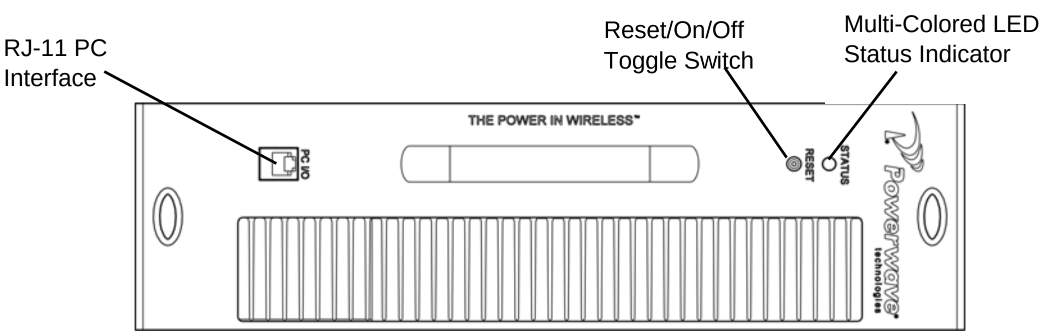

Figure 3-1. G3L-850-135 Controls and Indicators

3-2.2 LED Status Indicator and RESET/On/Off Toggle Switch

The status indicator, located on the front panel, is a single, tri-color LED. Status is indicated by a combination of color and intermittent/steady operation. 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 and Status

Control/Indicator	Description	
STATUS (Multi-colored LED Indicator)	LED Color	MCPA Status
	Green (solid)	RF enabled, Reset/On/Off switch set to On (middle position).
	Green (blinking)	Standby.
	Yellow (solid)	Minor* alarm - APC function enabled.
	Red (solid)	Major* alarm – Critical fault present. If present on only one amplifier, amplifier replacement required. If present on all amplifiers in a subrack, a fault exists in the subrack or in the RF load attached to the subrack.
	Red/Yellow (alternating)	Downloading. Do not interrupt power.
Toggle Switch positions		
RESET (Up)	Amplifier in RESET mode. LED indicates Boot mode, then turns solid green.	
On (Middle)	Amplifier enabled. LED indicates solid green	
Off (Down)	Amplifier disabled. LED Indicates solid red.	

* See Table 4-1 for an explanation of major and minor alarms.

3-2.3 RJ-11 PC Interface

The RJ-11 PC Interface connector, located on the Front Panel, is for updating the amplifier's firmware, and is for factory use only.

3-3 Initial Start-Up and Operating Procedures

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

1. For each Amplifier:
   a. 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 1-2 for input power requirements. Excessive input power may damage the MCPA.*

Note *The amplifiers must be warmed up for a minimum of 5 minutes prior to setting power levels. Failure to properly warm the amplifiers may result in lower output power, once the amplifiers reach operating temperature.*

   b. Turn on the supply that provides +27 Vdc to the amplifier.

c. Place the power 3-position (Reset/On/Off) switch on the amplifier front panel to the On (middle) position.

2. Allow the amplifiers to warm up for at least 5 minutes before taking power readings.

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Chapter 4 Principles of Operation

4-1 Introduction

This chapter contains a functional description of the G3L-850-135 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 Table 1-2

4-3 RF Output Load

For good power transfer to the RF load, the load impedance should be as closely matched to the output impedance of the amplifier as possible. A VSWR of less than 1.5:1 across the working band of frequencies is satisfactory. If the amplifier is operated into a filter, it maintains its distortion characteristics outside the signal band even if the VSWR is infinite. 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 Functional Description

The Multi-Carrier Power Amplifier (MCPA) is a linear, feedforward amplifier that operates in the frequency band from 869 MHz to 894 MHz with an instantaneous bandwidth of less than 25 MHz (refer to Table 1-2 for amplifier specifications). The instantaneous bandwidth is the maximum frequency band that a set of two or more signals can occupy .The amplifier's instantaneous bandwidth is set automatically and does not require any manual setup. The amplifier provides a gain of 63 dB. Typical outputs for different carrier types are specified in Table 1-2.

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 a 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-sub 21WA4 connector located 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.

Refer to Figure 4-1 for the amplifier functional block diagram. The amplifier consists of the following major functional blocks:

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

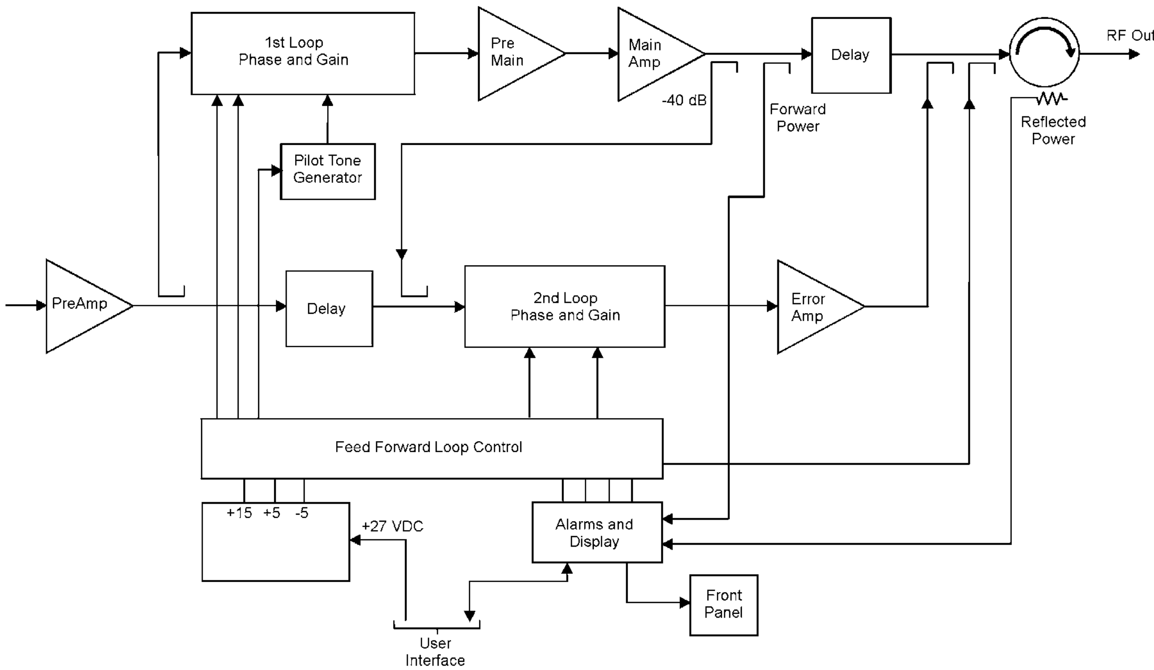

Figure 4-1. Functional Block Diagram

4-4.1 Preamplifier

The RF carriers are applied to the input port of the amplifier, where they are fed to the preamplifier stage. The preamplifier provides two stages of class-A mode-amplification. 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 the balance of gain and power (refer to Table 1-1 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 distortion introduced by non-linearity in 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 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, 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 amplify the carrier signals and isolate 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

A Pilot Tone is an internally generated signal, who's precise frequency, phase, and amplitude is known. The basic idea of injecting a pilot tone is that if the pilot signal is suppressed at the amplifier output, then the distortion created by the main amplifier is also suppressed. To accomplish this, the pilot tone signal is injected into the first loop and then detected at the feedforward output of the second loop. The pilot tone is coupled off of the main amplifier, thus creating a second pilot tone, attenuated and phase shifted 180 degrees to be used as the reference. This second pilot tone is then amplified in the error amplifier and mixed with the signals from the main signal path. Ideally, the two pilot tones, both amplified, should cancel each other out. If they do not cancel each other out, as determined by an output detector, the information is fed back to control the gain and phase of both the main and error amplifier paths 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 external fans mounted on the MCPA subrack. 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.

4-7 Amplifier Alarms

Causes for MCPA alarms are given in Table 4-1. Conditions external to the amplifier should be investigated before replacing the amplifier, particularly if more than one amplifier exhibits a critical alarm. Alarm conditions are reported to the amplifier subrack via RS-485 or TTL interfaces. Other than the front panel LEDs (described in chapter 3), there are no other visual aids for the technician.

Table 4-1. G3L-850-135 Alarm States

***Major Alarm** - Causes MCPA RF section to be disabled*			***Minor Alarm** - Does not cause MCPA RF section to be disabled*	
Amplifier Alarm	**Definition**	**Amplifier Mode**	**Auto-Recovery**	**Event/Fault Log**
Output Overpower	Disable the MCPA immediately if the output power is >2 dB over rated power.	Major	No auto recovery. Requires manual reset. Output power must be decreased to < 2 dB over rated power.	Records output overpower event after system disabled
Automatic Power Control (APC)	Enabled if the output power is > 50 dBm Note: If the MCPA cannot compensate the gain to maintain compliance, the Output Overpower or Input Overdrive Faults will protect the MCPA.	Minor (Yellow LED display)	Amplifier auto-recovers when the output power drops below the rated maximum output power.	Records APC event and auto-recovery event if auto-recovery successful
Input Overdrive	Disable the MCPA immediately if the input RF power is > -6.0 dBm	Major	No auto recovery. Requires manual reset. Input power must be decreased to < -6.6 dBm.	Records input overdrive event, system disable event, each auto recovery event*
High Temperature	Sensor temperature is > +88° C	Major	Amplifier auto-recovers when the sensor temperature drops to < +73° C.	Records over temperature event, system disable event, each auto recovery event,
Reflected Power	Reverse RF output power is > +47.8 dBm for a duration of 1-minute	Major	No auto-recovery. Requires manual reset. Reverse power must be < 50% of the maximum rated forward output power.	Records high reflected power event, each auto recovery event*
High Voltage	Disable the MCPA immediately if the supply DC voltage > +30.5 Vdc	Major	Auto-recovery when the supply voltage drops to < +30.0 Vdc	Records supply DC fault event, system disable event, each auto recovery event*
Low Voltage	Disable the MCPA immediately if the supply DC voltage < +20.5 Vdc	Major	Auto-recovery when the supply voltage increases to > +24 Vdc	Records low voltage event, system disable event, each auto recovery event*

Major Alarm *- Causes MCPA RF section to be disabled*		***Minor Alarm*** *- Does not cause MCPA RF section to be disabled*		
Amplifier Alarm	**Definition**	**Amplifier Mode**	**Auto-Recovery**	**Event/Fault Log**
Loop Fail	Loop convergence fail	Major	Loop converges. Tries to auto recover 10 times before permanent shut down. 2 minutes and 5 seconds for each try.	Records internal DC fault event, system disable event, each auto recovery event*
Internal DC Fail	Internal voltages fail or out of range	Minor (no LED display)	Auto-recovery once the voltage is within the range. No shutdown until Linearization alarm occurs.	Records internal DC fail event, system disable event, each auto recovery event*
Device Fail	One or more output power devices fail	Minor (no LED display)	No auto-recovery. No shutdown until Linearization alarm occurs.	Records device fault event

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Chapter 5 Maintenance

5-1 Introduction

This chapter contains periodic maintenance and performance test procedures for the G3L-850-135 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 resolutions. 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	Agilent	8656B
20 dB Attenuator, 250 Watt	Bird	
20 dB Attenuator, 20 Watt (2 each)	Bird	Tenuline
Spectrum Analyzer	Agilent	8560E
Coax Directional Coupler	Agilent	778D
Power Meter / Sensor	Agilent	437B / 8481A
Arbitrary Waveform Generator	Sony	AWG2021
Network Analyzer	Agilent	8753C

* Any Equipment substitutions should have equivalent specifications.

5-4 Amplifier 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 Table 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.

To check amplifier performance, proceed as follows:

WARNING Do not apply any RF signals to the amplifier input until instructed to do so.

CAUTION Ensure that the correct amount of attenuation is used between the amplifier RF connections and the test equipment to prevent overdrive of the amplifier or the test equipment.

5-4.1 Amplifier Spurious Emissions Test:

1. Connect the test equipment as shown in Figure 5-1.
2. Configure the signal source to produce four frequencies evenly spaced across the instantaneous bandwidth to be used for the amplifier under test.
3. Adjust the output of the signal source to excite the amplifier to its rated output.
4. Use the spectrum analyzer to measure the spurious emissions performance.
5. Record test data in Table 5-3. Verify that the data are within the specifications shown in Table 1-2.
6. Reduce the output of the signal source to minimum.

7. Switch off the Main Power Switch on the amplifier under test.

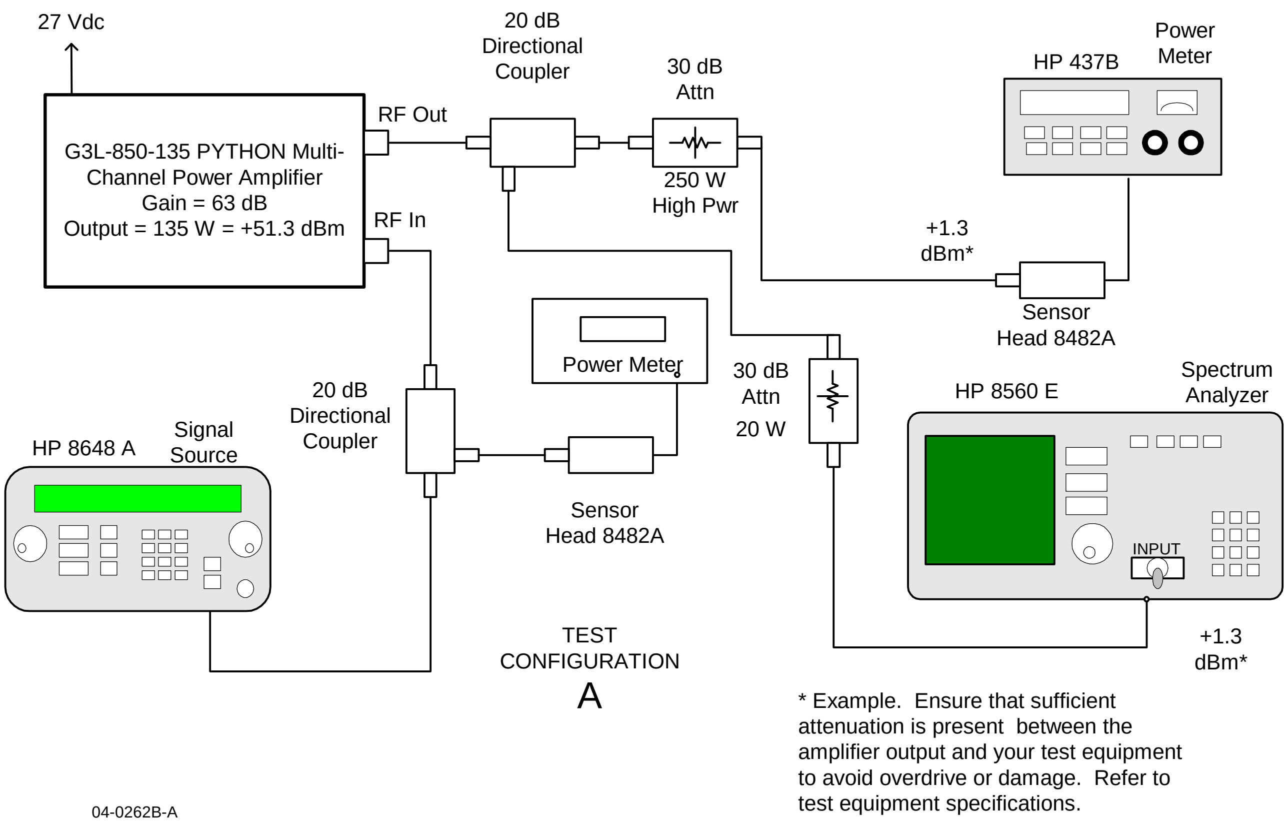

Figure 5-1. Amplifier Test Setup Diagram – Configuration A

5-4.2 Gain Test:

1. Disconnect:
   a. Spectrum analyzer
   b. Signal source.
   c. Power Meter and Sensor Head.
2. Connect the network analyzer as shown in Figure 5-2.
3. Set network analyzer as follows:
   a. Power output to -11 dBm max.
   b. Frequency start to 869 MHz.
   c. Frequency stop to 894 MHz.
   d. Normalize the network analyzer for gain and return loss.
4. Switch on the amplifier under test, and ensure that the STATUS switch is in the center position.
5. Check the amplifier gain across the band from 869 MHz to 894 MHz. Gain should be as specified in Table 1-2. Record test data in Table 5-3.

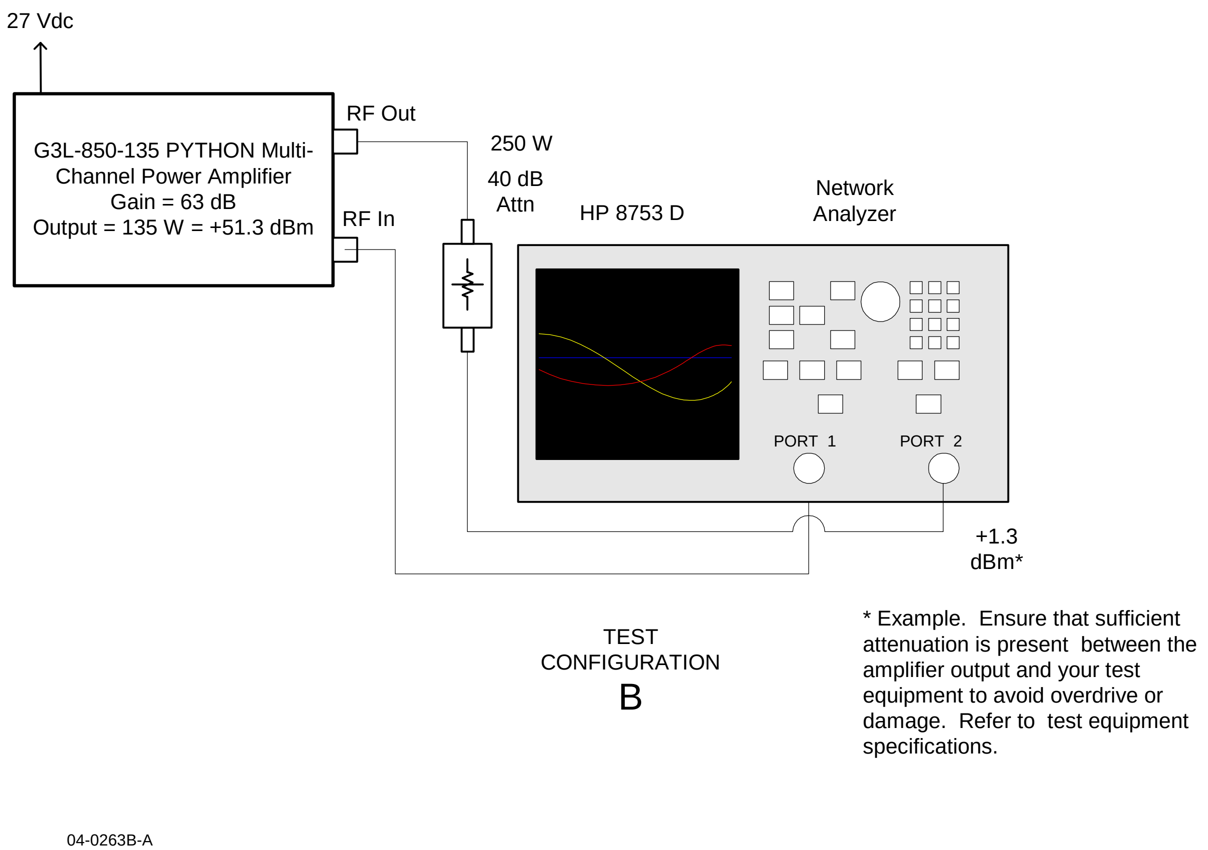

Figure 5-2. Amplifier Test Setup – Configuration B

5-4.3 Input Return Loss:

1. Retain the test configuration shown in Figure 5-2.
2. Read and record the S_{11} return loss measurement on network analyzer. Record test data in Table 5-3.
3. Switch off the amplifier under test.
4. Disconnect the test equipment.

5-4.4 Test Data Sheet

Record the amplifier's performance test data below.

DATE__________________________ MODULE S/N_______________________

Test Conditions:

Load and Source Impedance: 50 Ohms

VSWR: < 1.5:1

Supply Voltage: +27 Vdc ±0.1 Vdc

Table 5-3. Amplifier Performance Data

Test	Specification	Min	Max	Data
RF Gain	Vcc = 27 Vdc PO = See table 1-4 Freq. = 869 – 894 MHz	62.5.0 dB	63.5 dB	
Spurious Emissions	Vcc = 27 Vdc PO = See table 1-2 869 – 894 MHz Band		-62 dBc	
Gain Flatness	Vcc = 27 Vdc PO = See table 1-2 869 – 894 MHz Band		±0.5 dB	
Input Return Loss	Vcc = 27 Vdc PO = See table 1-2 869 – 894 MHz Band		-16 dB	

PASS ____ FAIL _____

Tested by _

5-5 Return For Service Procedures

When returning products to Powerwave, the following procedures will ensure optimum response.

5-5.1 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.

5-5.2 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.

Appendix A Abbreviations and Acronyms

Below is a list of the abbreviations and acronyms used in the industry.

Abbreviation/ Acronym	Definition
ACLR	Adjacent Channel Leakage Power Ratio
ACP	Adjacent Channel Power
A/D	Analog-to-Digital Conversion
ADC	{Analog-to-Digital Converter
	{Automatic Data Collection
AM	Amplitude Modulation
AMPS	Advanced Mobile Phone System
ANSI	American National Standards Institute
APC	Automatic Power Control
APTT	Analog Push To Talk
ASG	Applications Support Group
ASIC	Application Specific Integrated Circuit
ATE	Automatic (Automated) Test Equipment
ATP	Acceptance Test Procedure
ATTEN	Attenuator
BER	Beyond Economical Repair
BOM	Bill Of Materials
BPF	Band Pass Filter
BS	Base Station
BTS	Base Transceiver Station (System)
BW	BandWidth
°C	Degrees Celsius
CAD	Computer Aided Design
CCA	{Circuit Card Assembly
CCW	Counter ClockWise
CDMA	Code Division Multiple Access
CDPD	Cellular Digital Packet Data
CTRL	Control
CW	{ClockWise

Abbreviation/ Acronym	Definition
	{Continuous Wave
dB	deciBels
dBc	Referenced to a carrier level
dBm	Reference to one milliwatt
dBw	Reference to one watt
DIN	Deutsches Insitut für Normung eV
DLNA	Duplexer Low Noise Amplifier
DPTT	Digital Push To Talk
DQPSK	Differential Quadrature Phase Shift Keyed
DSP	Digital Signal Processing
DUT	Device Under Test
ECD	Estimated Completion Date
ECM	Electronic Counter Measure
EDGE	Enhanced Data for GSM Evolution
EEPROM	Electrically-Erasable Programmable Read-Only Memory
EIA	Electronic Industries Association
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EPROM	{Electrically Programmable Read-Only Memory
	{Erasable Programmable Read-Only Memory
ESD	ElectroStatic Discharge
ESG	Electronic Signal Generator
ETDMA	Extended Time Division Multiple Access
ETSI	European Telecommunications Standard Institute
EUT	Equipment Under Test
FAR	Failure Analysis Report
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FET	Field Effect Transistor
FHMA	Frequency Hopping Multiple Access
FM	Frequency Modulation
FRU	Field Replaceable Unit
FSK	Frequency Shift Key modulation
GHz	Gigahertz
GMSK	Gaussian Minimum Shift Keying
GOLAY	See GSC
GSC	Golay Sequential Code

Abbreviation/ Acronym	Definition
GSM	Global System for Mobile Communications
HPF	High Pass Filter
HW	Hardware
Hz	Hertz
IAW	In Accordance With
IC	Integrated Circuit
IMD	InterModulation Distortion
IRL	Input Return Loss
IS-54	Interim Standard 54 for TDMA
IS-95	Interim Standard 95 for CDMA
ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific and Medical unlicensed frequency bands
ISO	{International Organization for Standardization
	{ISOlator
kHz	Kilohertz
LDA	Linear Discrete Amplifier (Class A or AB)
LGL	Lower Guardband Limit
LMR	Land Mobile Radio
LMS	Land Mobile Systems
LNA	Low Noise Amplifier
LO	Local Oscillator
LPA	Linear Power Amplifier
LPF	Low Pass Filter
LSL	Lower Specification Limit
LVD	Low Voltage Disconnect
MC	MultiChannel
MCA	MultiChannel Amplifier
MCPA	{MultiCarrier Power Amplifier
	{MultiChannel Power Amplifier
MCR	MultiChannel Rack
MFRM	{Multiple Frequency Radio Mobile
	{Multifunction Frequency Radio Modulation
MHz	Megahertz
MSO	Master Switch Office
MTBF	Mean Time Between Failures
MTSO	Master Telephone Switch Office
MU	Measurement Uncertainty

Abbreviation/ Acronym	Definition
M&TE	Measuring and Test Equipment
NAMPS	Narrow Analog Mobile Phone System
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute for Standards and Technology
NMT	Nordic Mobile Telephone
NVM	NonVolatile Memory
OEM	Original Equipment Manufacturer
OFDM	Orthogonal Frequency Division Multiplexing
OMS	Operational Method Sheet
OOB	Out Of Box
O/P	Output
OSHA	Occupational Safety and Health Administration
PA	Power Amplifier
PAF	Powerwave Amplifier Frame
PAR	Peak to Average Ration
PCB	Printed Circuit Board
PCMCIA	Personal Computer Memory Card International Association
PCN	Personal Communications Network
PCS	{Personal Communications Services
	{Personal Communication System(s)
PDA	Personal Digital Assistant
PEP	Peak Envelope Power
PF	PicoFarads
PHS	Personal Handyphone System – Japan
PLC	Product Life Cycle
PLL	Phase Locked Loop
PM	{Phase Modulation
	{Preventive Maintenance
PMR	Peak to Minimum Ratio
PO	Purchase Order
PPM	Parts Per Million
PSC	{PCS Single Channel
	{Product Serialization Code
PSTN	Public Switched Telephone Network
PTI	Powerwave Technologies, Inc.
PTT	Push To Talk
PWAV	PowerWAVe

Abbreviation/ Acronym	Definition
QA	Quality Assurance
QAM	Quadrature Amplitude Modulation
RBW	Resolution BandWidth
RF	Radio Frequency
RFI	Radio Frequency Interference
RFQ	Request For Quotation
RFS	RF Solutions
RFSU	RF Switching Unit
RGO	Return Goods Order
RH	Relative Humidity
RL	Return Loss
RMA	{Rack-Mounted Amplifier
	{Return Material Authorization
RMP	Reliability Monitoring Plan (Procedure)
RMS	Root Mean Square
RSS	Root Sum Square
Rx	Receive, Receiver
SCHPA	Single-Channel High Power Amplifier
SCPA	Single Channel Power Amplifier
SIM	System Interface Module
SMA	SubMiniature Type A (coaxial connector)
SMT	Surface Mount Technology
SN	Serial Number
SO	System Outage
SOE	Sequence of Events
SW	SoftWare
TBC	To Be Confirmed
TBD	To Be Determined (To Be Defined)
TCXO	Temperature Controlled crystal Oscillator
TD	{Temperature Drift
	{Temporary Deviation
TDMA	Time Division Multiple Access
TRU	Transmit Receive Unit
TRX	Transceiver (Transmit / Receiver) Unit
Tx	Transmit, Transmitter
UAI	Use As Is

Abbreviation/ Acronym	Definition
UART	Universal Asynchronous Receiver Transmitter
UCL	Upper Control Limit
UCLR	Upper Control Limit for Range
UGL	Upper Guardband Limit
UL	Underwriters Laboratories
UMTS	Universal Mobile Telecommunications System
UNL	Unit Nominal Level
URG	Unit Reference Gain
USL	Upper Specification Limit
UUT	Unit Under Test
VADJ	Voltage ADJust (signal name frequently found on schematic or block diagrams)
VBW	Video BandWidth
VCO	Voltage Controlled Oscillator
VFWD	Voltage ForWarD (signal name frequently found on schematic or block diagrams)
VREFL	Voltage REFLected (signal name frequently found on schematic or block diagrams)
VSWR	Voltage Standing Wave Ratio
VVA	Voltage Variable Attenuator
WCDMA	Wideband Code Division Multiple Access
XMT	Transmit
XMTR	Transmitter

Appendix 2 General Site Survey Form

1 *Name of Operator: Brand Name:*

Date: ____________________ Info Source: ____________________________ Tel: ______________

Your Name:__________________________ Tel: ________________________ Email: ____________

BTS

Type / Supplier: _________________ Sectors(S) To Be Equipped: _______________________

Downlink Frequencies in use ____________________ MHz to_______________________MHz.

Uplink Frequencies in use ______________________ MHz to______________________ MHz.

Ant 0 Signals

BCCH present?________________________________ TRXn _______________________

Ant 1 Signals

BCCH sometimes present? ______________________TRXn

Plans to add additional TRX during trial? ________________

Feedline

Size:__________ Length____________, dB Loss estimate ___________

For existing sites: BTS jumper from BTS top to feedline on tower: _________

Shelter exit on up tower: ____________

Jumper to antenna: ________________

Overall feedline loss estimate from BTS to Antenna ______________________________dB

Jumpers

From power amplifier cabinet to feedline for tower required:

Length _______, Connector Type ________, and Gender ____________,

Location

On Roof Near Antenna? ____________ On Ground? ______ Type of raised platform? _____

Adequate space including ½ meter min jumper bend radius at power amplifier left side? _____

Is a structural analysis needed? __________

Network Link Budget

RF carrier power (each TRX) at BTS top connector (in dBm)? ___________________________

Desired RF carrier power (each TRX) at power amplifier cabinet output connector (in dBm)? ____
Current system uplink and downlink balance or difference? _________________________________
Is discontinuous transmit (DTX) feature used? ____

Power
AC Voltage available for power amplifier at site: ___________ Vac;__________________ Amps

Singe Phase or Three Phase? (circle one)

Main Panel or Sub Panel? (circle one)

Required RF Jumpers (8x8x8 configuration)

9 pieces Type N male to Type N male, ½" Heliax jumper - BTS top to power amplifier cabinet input

Length: __________

6 pieces 7/16 DIN male to 7/16 DIN male, ½" Heliax jumper - power amplifier cabinet output to antenna feedline

Length: __________

Other? (Type & Length)_________

Required Cables (non-RF)

AC wiring from panel to power amplifier cabinet. Length: ________

Interconnecting alarm wire and connection. Length: ____________

Ground bus wiring and attachment. Length: ___________________

Host is Responsible for

- Installing power mains panel
- Contractor management of cabinet mounting, installation and coax seal weatherproofing.
- Location preparation: structural analysis, platform installation, building code conformance, site security

Photos Required

- BTS top connection
- BTS front inside showing TRX unit and number of TRX
- Wide view of BTS and proposed power amplifier cabinet location in same photo
- Proposed power amplifier cabinet location shown with a 1 meter long ruler in view nearby

- Existing feedline cable to antenna (where power amplifier cabinet output will connect to)
- Power mains circuit breaker panel (shows adequate capacity for breakers)
- Misc. pictures showing tower and site access.

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