ENI

SERVICE MANUAL

ACG-3 RF Power Generator

WARNING

HIGH RF VOLTAGES MAY BE PRESENT AT THE OUTPUT OF THIS UNIT. All operating personnel should use extreme caution in handling these voltages and be thoroughly familiar with this manual.

CFC's

DO NOT USE ANY CFC (CHLOROFLUOROCARBON) SOLVENT IN THE MAINTENANCE OF THIS PRODUCT. In recognition of our responsibility to protect the environment, this product has been manufactured without the use of CFC's. The no-clean flux now used in all soldering operations may leave a small inert residue which will not affect the performance of the product. The use of CFC's for cleaning or maintenance may result in partial liquification of the no-clean flux residue, which will damage the unit and void the warranty.

ACG-3 Service Manual Order Number: ACG-3-101; Revision Level: A

Warranty

ENI warrants to the original purchaser for a period of one year from the date of delivery, each instrument to be free from defects in materials and workmanship. For a period of one year, ENI will, at its option, adjust, repair, or replace defective parts, without charge to the original purchaser, so that the instrument performs according to its specifications.

When warranty service is required, the instrument must be returned, transportation prepaid, to the factory or to one of ENI's designated service centers. If, in our opinion, the instrument has been damaged by accident, unreasonable use, buyer-supplied software or interfacing, improper site preparation or maintenance, or abnormal conditions of operation, repairs will be billed at standard rates. In this case, an estimate will be submitted before the work is started.

THIS LIMITED WARRANTY IS EXCLUSIVE AND ENI MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AND ALL OTHER EXPRESS ORAL OR WRITTEN WARRANTIES AND ALL WARRANTIES IMPLIED BY LAW, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY ARE EXCLUDED AND DISCLAIMED. IN NO EVENT SHALL ENI BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM BREACH OF ANY WARRANTY, WHETHER EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR FROM ANY CAUSE WHATSOEVER, INCLUDING NEGLIGENCE. Buyer's sole and exclusive remedy under this warranty shall be repair or replacement as set forth above, or if ENI is unable to repair or replace the defective part within a reasonable time, a refund of the price of the part or goods which give rise to the warranty claim.

Service And Technical Assistance

For Service or Repair contact the closest Customer Service Department with the following information:

- Model and serial number
- Purchase order number
- Detailed description of malfunction
- Your company's "Bill To" and "Ship To" address

You will receive a RMA (Return Materials Authorization) number, the warranty status of the unit to be returned and estimated repair charge, if any. The RMA number is your authorization number. Please type this number on your purchase order and shipping label. After ENI receives the unit, a firm quote and estimated date of completion will be given.

For Technical Assistance for your particular application, contact the nearest ENI Sales and Service Center. The following information will help us provide you with prompt and efficient service:

- All of the information contained on the unit's name plate.
- Names and telephone numbers of important contacts.
- Detailed description (i.e. physical damage and/or performance anomalies, quantitative and/or qualitative deviation from specifications), including miscellaneous symptoms, dates and times.
- The environment and circumstances under which the issue developed
- Supporting test data and/or records that can be provided.
- Any previous, related conversations and/or correspondence with ENI.

Sales & Service Locations

ROCHESTER, NY	A Division of Astec America, Inc. 100 Highpower Road Rochester, NY 14623	Tel: (716) 292-7440 Fax: (716) 427-7839 Svc: (716) 292-7478
	Toll Free USA Sales Hotline:	**1-800-267-5362**
	Toll Free USA Service Hotline:	**1-800-724-ENI1 (3641)**
FREMONT, CA	48834 Kato Road, Suite 110A Fremont, CA 94538	Tel: (510) 353-4ENI (4364) Fax: (510) 353-4360
AUSTIN, TX	4150 Freidrich Lane Suite J Austin, TX 78744	Tel: (512) 462-2191 Fax: (512) 462-9411
UNITED KINGDOM	Mundells Court, Welwyn Garden City Hertfordshire AL7 1EN England	Tel: (01707) 371 558 Fax: (01707) 339 286
GERMANY	Sielminger Str. 63 D-70771 Leinfelden- Echterdingen (Stetten) Stuttgart, Germany	Tel: (0711) 947 70 0 Fax: (0711) 947 70 25
JAPAN	541 Aoyogi Kunitachi Tokyo 186 Japan	Tel: (0425) 229 011 Fax: (0425) 222 636
TAIWAN	No. 15, Lane 24, Ming Hsiang 1 Street Hsinchu 300, Taiwan	Tel: (35) 787 762 Fax: (35) 787 760

Product and Applications information also available on the Internet at:

http://www.enipower.com

PRODUCT MANUAL REVISION CONTROL FORM

Title: ACG-3 Service Manual	Part #: ACG-3-101	Final Assy #: ACG-3-11701
	Rev #: A	Eff. Date: 6/7/94

CONTENTS	DESCRIPTION	REV LEVEL
TEXT		A
SPECIFICATION		A
BOARD LAYOUTS		
SCHEMATICS		
ACG-3-SCH-01	SCHEMATIC INDEX	A
ACG-3-SCH-02	BLOCK DIAGRAM	A
ACG-3-SCH-03	BASEPLATE SCHEMATIC DIAGRAM	L
ACG-3-SCH-04	RF CHASSIS SCHEMATIC DIAGRAM	M
ACG-3-SCH-05	FRONT PANEL SCHEMATIC DIAGRAM	L
ACG-3-SCH-06	REAR PANEL SCHEMATIC DIAGRAM	L
ACG-3-SCH-07	TRANSFORMER ASSEMBLY SCHEMATIC DIAGRAM	L
ACG-3-SCH-08	CONTROL BOARD SCHEMATIC DIAGRAM	M

This page left intentionally blank.

Table of Contents

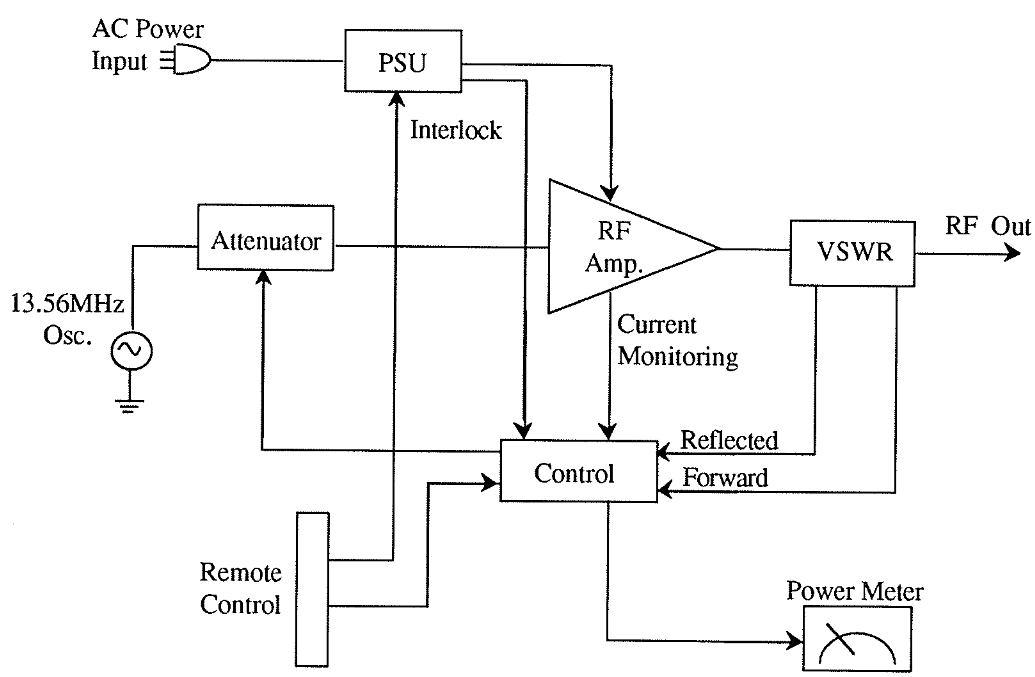
Chapter S1

Technical Description

1.0 System Overview

The ACG-3 consists of four major circuit blocks:

- Power Supply
- RF Chassis
- Control Board Assembly
- Local and Remote Control Interface Circuits



ACG-3 Overall Block Diagram
Figure 1.0

1.1 Power Supply

The Power Supply provides unregulated DC voltage (approximately 40-48 volts) to the RF Chassis Assembly. The circuit is a single phase full wave bridge rectifier, capable of an output current of 15A. The main power transformer has primary winding taps that allow the unit to accept line voltages of 100-120VAC and 200-240VAC. Both sides of the AC Line are fused and a double-pole contactor provides disconnection from the mains within the unit. Initial set-up is aided by a line voltage test that allows the unregulated DC voltage to be read on the power output meter. The power supply also provides bias voltages to the control board.

The main power transformer has two center-tapped secondary windings. Both windings are rectified by separate full wave bridge rectifiers and provide outputs of (+) and (-) 15V. One is referenced to the unregulated DC for biasing the current sensing circuit on the control board. The rectifiers and regulators are located on the control board. A +25 V regulator is located on the RF Chassis Assembly for biasing of the driver amplifier. This regulator is fed from the unregulated supply voltage. An ENI-1 transistor regulator is used for high reliability.

1.2 RF Section

The RF Amplifier Module consists of a Driver Amplifier assembly, Power Amplifier, VSWR Bridge Assembly, Driver Regulator, and the Harmonic Filter.

The Driver amplifies the OdBm RF output from the control board to about 20W to drive the power amplifier. This is a Class A, linear driver with the first two stages operating from the regulated +25 V. The output stage uses the unregulated DC for the collector supply while the base bias is taken from the regulated +25V.
The Power Amplifier operates in push-pull Class B mode and is feedback-stabilized for operation into high VSWR loads without spurious oscillations. Collector bias is unregulated DC at 13.0 A maximum (limited by circuitry on the control board). The resistor used for current sensing is located on the Power Amplifier.

The VSWR Bridge Assembly senses the forward and reverse power simultaneously and provides DC outputs to the control board for monitoring and protection functions. These DC levels are applied to a voltage squaring circuit on the control board so that all control and interface functions are linear and directly proportional to power outputs. The VSWR Bridge was designed specifically for the ACG-3 and has a residual null reading of less than 1W at full output into a 50Ω load. The harmonic filter is a seven-section Chebyshev design using high voltage capacitors for reliable operation into high VSWR loads. The filter insures that all harmonics from the power are more than 55dB below the fundamental.

1.3 Control Board Assembly

The control board consists of the following circuit assemblies:

- Rectifiers and voltage regulators for the ground referenced and DC referenced ±15V bias supplies
- Current Sensing Protection Circuit
- Reverse Power and Protection Circuit
- Forward Power Sensing and Leveling Circuit
- Maximum Power Indicating Circuit
- RF ON Control Logic and Indicating Circuit
- Thermostat Control Interface
- 13.56MHz Oscillator and Buffer Circuits

1.3.1 ±15V Power Supplies

The dual ±15 volt supplies operate from center-tapped windings on the control transformer mounted on the test panel. The Supply used with the current sensing is referenced to the unregulated DC (44 to 48V). The voltage regulator is IC1, MC1468. These voltages are used only with IC2 and Q1.

The other supply is referenced to DC ground and uses 3-terminal IC8 (LM337) and IC9 (LM317). These voltages are used for all other circuitry on the control board except where +25V is used on Q2 and relay K1.

1.3.2 Current Sensing/Protection Circuit

The current sensing and protection operates from the voltage drop across the current sense resistors located on the power amplifier module. The power supply side (high side) of the resistor is connected to the inverting input of an op-amp through a voltage divider. The power amplifier (low side) of the resistor is connected to the non-inverting input. When the current through the sense resistor is less than 13.0A, the output of the op-amp will be high and allow Q1 to remain off. When 13.0A is exceeded, the voltage to the non-inverting input will be less than that to the inverting input and the op-amp output will be driven low, thus turning on Q2 which pulls the attenuator bias line down toward ground and thus reducing the RF output of the attenuator. The net effect is to reduce the drive to the RF module, which reduces the output power sufficiently to limit current to the power amplifier modules to 13.0A.

1.3.3 Reverse Power Sensing

The Reverse Power Sensing and Protection operates from the reverse output of the VSWR Bridge. The control signal is first linearized with respect to power by a squaring circuit IC4. It is then applied to the control amplifier for comparison to the internal reference voltage. If the reverse power signal exceeds this reference, the control amplifier output goes high, which turns on Q3 and pulls the attenuator control line toward ground. The net effect is the same as for current limiting: the drive to the RF module is reduced sufficiently to limit the reverse power to a safe level. This level is normally set to 50W. The output of the squaring circuit is also applied to the linear power meter on the front panel meter and to the accessories connector on the rear panel. This accessories output is 0 to .05V (.05V equals 50W). The output is adjustable from .05-.5V.

1.3.4 Forward Power Sensing and Leveling Circuit

The Forward Sensing and leveling operates from the forward output of the VSWR Bridge. As in the case of reverse power, the control signal is first linearized by a squaring circuit, IC5. It is then applied to the control amplifier for comparison to a reference voltage. This reference can be either the front panel power control (10-turn potentiometer) or an external voltage applied through the accessories connector on the rear panel. This external voltage is applied to an amplifier/limiter circuit such that calibration for 1V per kW can be done. It can be adjusted by R54 for 300W maximum limited output. Additionally, this voltage may be pulsed to any peak power level up to 300W with a pulse width as narrow as 100msec.

The remainder of the circuitry is the same as for the reverse power sensing. The output of the control amplifier turns on Q3, the net effect being to reduce the drive to the RF module and thereby limit the RF output to that set by the variable reference voltage. The control range available extends to typically 60dB below 300W. At 0V control voltage, the RF output is less than 1mW.

1.3.5 Maximum Power Indicating Circuit

The maximum power indicating circuit operates in the absence of forward power leveling control. The maximum power indicator may light even though slightly more RF power may be available from the generator. This is perfectly normal and is due to hysteresis in the threshold detector. It indicates that the generator is not able to produce the output called for by the controlling signal. This situation will occur under high VSWR conditions where either the current sense limiting or the reverse power limiting circuits are operating to protect the unit.

The circuit operates from the output of the forward control amplifier. When this amplifier is not controlling forward power, its output is a negative voltage. This is fed to a threshold detector. The output of the detector then goes high thus enabling the LED indicator on the front panel. A TTL compatible output is also provided to the rear panel accessories connector (+5V = Maximum Power, 0V = Normal Operation. Diode control logic prevents a false indication by sensing the conditions of the RF ON line.

1.3.6 RF ON Control

The RF ON control logic and indicating circuits act upon the 13.56MHz oscillator transistor base bias. When the RF ON line is low (less than 1V) the oscillator is biased off. When the RF ON line is high (4.0 volts to 5.0 volts) the oscillator is biased on. For local control operation this line is opened by the switch on the front panel for RF POWER.

For remote operation, the front panel switch must be in the OFF/REMOTE position where the line is grounded through a 680Ω resistor. When a +5V signal is supplied through the accessories connector PIN 4, it appears across this resistor, thus enabling the RF ON function. The thermostats on the RF Module is diode coupled to the RF ON line to turn off the RF drive in the event of an overheat fault. The RF ON indicator is a simple buffer amplifier responding to the oscillator transistor emitter voltage to light the green LED on the front panel. The RF ON output to the rear panel accessories connector pin 7 is TTL compatible (+5V = RF ON, 0V = RF OFF).

1.3.7 Thermostat Control

The thermostat is located on the front of the RF Chassis Assembly Heatsink. The thermostat is set to disable the "RF ON" circuit when the heatsink temperature reaches 180° Fahrenheit (82.2° C). The unit will operate continually (under normal load conditions) in an ambient temperature of up to 104° Fahrenheit (40° C). When the thermostat closes, it grounds the "RF ON" line, the red "Overheat" LED on the front panel. Diode logic is used to isolate the above functions.

1.3.8 Oscillator Circuit

The 13.56MHz oscillator circuit, with the attenuator and buffer amplifier, is similar to that used in other highly reliable ENI equipment. The oscillator generates a sine wave at precisely 13.56MHz at a maximum power level of 3mW. The output of the attenuator is fed to a buffer amplifier which makes up for the 10dB insertion loss of the attenuator and provides for an overall system gain adjustment.

The low-pass filter attenuates all harmonics of 13.56MHz by a minimum of 50dB and its output is fed to the input of the driver on the RF Assembly.

Chapter S2

Maintenance and Calibration

2.1 Recommended Test Equipment

The following test equipment is recommended to aid in maintenance and calibration of the ACG-3.

Description	Recommended Type	Use
Power Meter	HP435B	Power measurement and meter calibration.
Attenuator, 30dB 2000W	Bird #8329	50Ω load and attenuator for HP-435B.
Digital VOM	Beckman RMS 3030	General voltage and resistance measurements.
50Ω Load	Bird #8251	50Ω Load

Note: The two Bird 4000W attenuators and the 2-way splitter may be replaced by (1) 10kW RF Calorimeter/Load Resistor such as Bird #8631, having accuracy of ±2 1/2% of reading.

2.2 Periodic Maintenance

For optimum performance the ACG-3 calibration should be checked once per year. Before making any adjustments to the unit, first check that it performs to the specification. If this is the case adjustment is unnecessary.

2.3 Cooling

In order to operate properly, the generator must have unrestricted airflow available to the intake and exhaust ports. If the generator is to be surrounded by an external cabinet, provisions must be made so that cool air will be brought to the fan intake and heated exhaust air can be removed from the unit. Under normal load conditions, the maximum ambient air temperature for the ACG-3 is 40° C (104° Fahrenheit).

2.4 RF Calibration

This section outlines how to calibrate the RF Section of the ACG-3. It will help to refer to the technical explanation in Service Section 2.0 and the schematics at the end of this manual.

The RF Section of the ACG-3 consists of:

- RF Driver Amplifier
- RF Power Amplifier
- Low-Pass Filter
- VSWR Bridge Assembly

Problems in these circuits can be isolated with a systematic test procedure. The test equipment shown in Service Section 2.1 will be needed for thorough check-out of the generator.

2.4.1 Driver Amplifier

The Driver Amplifier consists of three amplifier stages, a voltage regulator and a two-way splitter at the output. Bias voltages are as follows:

	EMITTER	BASE	COLLECTOR
Q1	0.4V	1.1V	12V
Q2	0.6V	1.3V	25V
Q3	1.55V	2.3V	42V

Refer to schematic diagrams. The output of the voltage regulator is 25V ± 5% and is controlled by an LM350 integrated circuit. The integrated circuit is mounted on the RF chassis.

To verify proper operation of the driver amplifier and P.A., apply an input of 200µW at 13.56MHz to the driver amplifier (the output of the control board is suitable for this). The output of the unit should be terminated into 50Ω and an output of at least 210W should be read on the power meter.

Most Driver components can be replaced from the top of the RF chassis assembly. This includes Q3 and most resistors, capacitors and transformers. Q1 and Q2 are stud-mounted transistors and cannot be replaced access to the back of the RF heatsink assembly. See section 2.7.6 for details in replacing Q1, Q2, Q3 and Q4.

2.4.2 Power Amplifiers

The power amplifier operates in Class B with the base bias at DC ground. RF gain of the P.A. is approximately 12dB. A faulty module can be isolated by operating the ACG-3 into a 50Ω load monitoring the current into the P.A. A defective P.A. module will consume less than normal current due to the fact that the failure mode of the power transistors is always open-circuit. Normal current in the power amplifier is 10 to 11A at 300W into a 50Ω load. A defective power amplifier will give a current measurement of 0 - 8A.

2.4.3 Low-Pass Filter Assembly

The filter alignment is set at the factory and should be adequate for the life of the equipment. If parts are replaced due to breakage, etc., do not disturb the mechanical orientation of the coils. Check for normal operation by observing normal output power and P.A. module current. Alignment of the filter is beyond the scope of this manual and requires the use of vector impedance measuring equipment. Consult the factory should this be necessary.

2.4.5 VSWR Bridge

The VSWR Bridge consists of a toroidal transformer and various voltage divider, detector, and filter networks. Its function is to provide outputs proportional to the forward and reverse power on the transmission line to the leveling and protection circuits on the control board.

The center conductor of the output transmission line passes through the center of a toroidal transformer and constitutes a single turn primary. Current through the transmission line induces equal voltages in two parts of the center tapped secondary winding. One voltage is in phase with the line current, the other is 180 degrees out of phase with the line current. C3 is part of a voltage divider that provides a reference voltage to the center tap of the transformer. This voltage is in phase with the line voltage. When the load on the ACG-3 is 50Ω resistive there is no reverse power and the output from the VSWR Bridge is a forward power signal only. At all other load impedances there are outputs from the forward power as well as the reverse power port. The only alignment necessary is to null C3 for reverse power when operating into a 50Ω resistive load. This is done as follows:

1) Connect the RF output of the ACG-3 to a 1000W 50Ω dummy load.

2) Turn on the ACG-3 and set the POWER ADJUST for 100W forward power.

WARNING ⚡ WHEN WORKING ON THE ACG-3, PEAK RF VOLTAGES IN EXCESS OF 300 VOLTS MAY BE PRESENT WHILE OPERATING.

Using a long, insulated tuning tool, adjust C3 for minimum reverse power as observed on the front panel meter. Note that the forward power will also change as C3 is adjusted. After the coarse null obtained above, increase the forward power to 300W and carefully null C3 again for minimum reverse power.

WARNING ⚡ HIGH RF VOLTAGES ARE PRESENT ON THE LOW PASS FILTER.

If C3 will not null on the front panel meter, check for a null on PIN 7 of the control board connector using a voltmeter of at least 100kΩ input impedance.

If a null is present at this point, the problem is in the control board. If C3 will not null at PIN 7, remove and inspect the VSWR Bridge. Check diodes D1 and D2, and inspect all components for damage.

3) Following installation of a new or repaired VSWR Bridge, all forward and reverse metering and leveling circuits must be realigned. Follow the procedure in Sections 2.5.3 & 2.5.4 in the section on the control board assembly.

2.5 Control Board Calibration

The Control Board Assembly contains the calibration controls for the protection and logic functions in the ACG-3.

These functions can be grouped as follows:

- Power Supplies for Control Functions
- Current Sensing Protection
- Reverse Power Protection and Metering
- Forward Power Control and Metering
- Maximum Power Indicating Circuit
- RF ON Control Logic and Indicating Circuits
- 13.56MHz Oscillator and Buffer Amplifier

CAUTION !

The ACG-3 is factory calibrated with instruments traceable to the US National Institute of Standards and Technology. Recalibration should not be necessary unless the Directional Coupler/Detector or Control Board Assemblies are replaced or repaired. Accuracy of calibration depends upon the accuracy of the external power and voltage measurement equipment. The following procedure is provided should recalibration be deemed necessary.

2.5.1 Power Supplies for Control Functions

There are two ±15V power supplies on the control board. One is referred to DC ground and provides ±15V for all circuits except current sensing. The output of the supply is nominal and a tolerance of ±10% is acceptable. There are no adjustments provided. If the voltages are outside of the 10% tolerance check for 40V rms AC across the control transformer secondary (PINS 36 and 37). Then check for approximately +23 VDC across C6 and C7. If these voltages are within nominal tolerance, replace IC8 or IC9 for the -15V and +15V supplies respectively.

The other power supply on the control board is also ±15V but is referenced to the unregulated +40V to the Power Amplifier. As a result, this supply floats with changes in the actual +40 to 48 volts depending upon the line voltage and RF power output. This power is used only to bias the current sensing circuit comprised of IC2 and associated components. Measurements made in this circuit as well as this power supply are best referenced to the 40-48V supply of PIN 17 of the control board connector or PIN 1 of IC1. Voltage readings of ±15V ±5% are nominal for the output of IC1 PINS 4 and 11 respectively. As in the section above, check for 40V rms AC across the other control transformer secondary (PINS 18 and 19). If these voltages are nominal and the outputs of IC1 are faulty, replace IC1.

2.5.2 Current Sensing Protection

Current sensing is accomplished by measuring the voltage drop across a 0.01Ω ±1% resistor located on the P.A. module in the RF chassis assembly. This voltage is supplied to IC2 via the control board connector wiring. At IC2 it is compared with a reference voltage of 0.125V set by R2. If the current sense voltage drop exceeds 0.125V, the output of IC2 immediately pulls the base of Q1 low, turning on Q1 and Q2 which pulls the attenuator bias low and reduces the RF output, thus effectively limiting the current to the P.A. module.

The current limit is set to limit the P.A. module to 13.0A ±.2 A. To set this limit use the following procedure:

1) Turn the METER SELECT switch to PA CURRENT position. The front panel meter will read the current draw of the P.A, with an indication of a full scale reading of 17.5A. 13.0A will read just over 260W.

2) Connect the output of the ACG-3 to a 50Ω load and turn R2 on the control board fully CW.

3) Turn R36 fully CW. Turn the POWER ADJUST fully CCW and turn on the ACG-3 AC LINE and RF POWER switches. Slowly increase the forward power while monitoring the current. Increase the power until the front panel meter shows 13.0A (260W on front panel meter).

4) Turn R2 on the control board CCW until limiting is reached. Turn the POWER ADJUST one or two revolutions CW to verify that limiting is effective. It may be necessary to make a slight adjustment of R2. Note that the current limiting is active.

5) Turn the METER SELECT switch to the RF POWER position and adjust R36 MAX POWER so that 310W of forward power is read on the front panel meter with the POWER ADJUST fully CW.

2.5.3 Reverse Power Protection and Metering

CAUTION !

Before making any adjustments to the reverse power protection circuit, the technician should thoroughly understand the operation of the power control loop. Making a guess of critical adjustments may degrade the linear integrity of the unit as well as the ability to sense and protect itself from excessive levels of reflected power.

This circuit obtains its input from the VSWR Bridge. Verify that this is operating properly before troubleshooting the reverse power circuits on control board. Refer to Section 5.3.5. Also refer to Chapter 4, Technical Description. If alignment is necessary, use the following procedure:

1) Connect the ACG-3 to the 50Ω load and RF Power Meter.

2) Connect a digital voltmeter to the reverse power output PIN 2 of the rear panel accessories connector. Zero the front panel meter using the zero adjustment screw just below center of the meter. Turn on the AC LINE Switch and adjust REV NULL control R41 until the front panel meter reads 0 in the reverse Power Meter.

3) Turn on the ACG-3 RF POWER Switch and set the output power to 30W on the RF Power Meter.

4) Turn off the RF POWER Switch and open circuit the RF output of the ACG-3. Turn on the RF ON Switch and set R39 REV. IN. for 0.030V on the digital voltmeter. Adjust R46 REV. Meter for a reading of 30W on the front panel meter.

5) With the output still open circuit, increase the power to 50W reverse and set R43 REV. SET. for limiting at this level. Rotate the POWER ADJUST an additional one or two turns to verify limiting action. If necessary re-adjust R43 for limiting to 50W.

6) This completes the adjustment. Turn off the RF POWER Switch and replace the 50Ω load if additional test or alignment is being done to other circuits.

2.5.4 Forward Power Control and Metering

CAUTION !

Before making any adjustments to the forward power protection circuit, the technician should thoroughly understand the operation of the power control loop. Making a guess of critical adjustments may degrade the linear integrity of the unit which may be difficult to regain.

This circuit obtains its input from the VSWR Bridge. Verify that this is operating properly before troubleshooting the forward power circuits on the control board. Refer to Section 5.3.5. Also refer to Chapter Four, Technical Description. If alignment is necessary, use the following procedure:

1) Connect the ACG-3 to 30dB Attenuator and RF Power Meter.

2) Connect a digital voltmeter to the forward power output PIN 3 of the rear panel accessories connector. Zero the front panel meter using the zero adjustment screw just below center of the meter. Turn on the AC LINE Switch and adjust FWD Null Control R57 until the front panel meter reads 0 in the forward position. Set R36 MAX FWD fully CCW. Set POWER ADJUST to 0.0.

3) Turn on the ACG-3 RF POWER Switch and set the output power to 300W on the RF Power Meter.

4) Set R55 FWD IN for 0.300V on the digital voltmeter while maintaining 300W output with Front Panel POWER ADJUST. Adjust R60 FWD METER for a reading of 300W on the Front Panel Meter.

5) Rotate R36 MAX FWD fully CW and turn the POWER ADJUST to 10.0 (full CW). Slowly, turn R36 CCW to limit forward power to 310W.

6) Reduce forward power to minimum by turning the POWER ADJUST control to 0. Adjust R33 for the lowest possible forward power null using a lower range of the power meter if necessary.

7) Turn off the RF POWER Switch, turn R54 fully CW. Ground PIN 10 of the external accessories jack. Provide a DC control voltage to PIN 5 of the rear panel accessories connector at the level desired for a given peak RF output. (This procedure will describe a set-up for 1V per kW, other calibrations can be used up to 10V). For calibration of 1V/kW this voltage should be 0.300V for 300W.

8) Turn on the RF POWER Switch. Slowly increase the output power by turning R54 until 310W is reached.

9) Turn R49 to reduce power to 300W. Verify control voltage vs. output power tracking by reducing the control voltage to 0.150V. The output power should be 150W. This completes the calibration of the forward power control and metering circuits.

2.5.5 Maximum Power Indicating Circuit

Refer to Service Section 1.3.5 for a description of this circuit as well as the appropriate schematic, located at the back of this manual. Adjust potentiometer R97 for a MAX. PWR indication at 310W. This circuit is activated when IC6 "C" functions as an inverting switch which drives the buffer amplifier IC6 "D". Troubleshooting should be done with a voltmeter having an input impedance of at least 1MΩ.

2.5.6 RF On Control Logic and Indicating Circuit

Refer to Service Section 1.3.6 for a description of this circuit. Diode logic is used to interface with the Oscillator, Driver Amplifier, Maximum Power Circuit and thermostat. Calibration is not necessary and adjustments are not provided.

IC7, "A" drives the RF ON LED **(status)** when there is emitter current in oscillator transistor Q4. Troubleshooting should be done with a voltmeter having an input impedance of at least 1MΩ.

2.5.7 13.56MHz Oscillator and Buffer

The 13.56MHz oscillator and buffer provides a low-level RF signal to the driver amplifier. Refer to schematics. The RF output, when the attenuator bias on Q3 collector is 10V or greater, should be at least 3mW when operating into a 50Ω load. Bias voltages on Q4 and Q5 should be checked with a suitable voltmeter having an input impedance of 100kΩ or greater. Note that Q4 will be off when the RF ON line is low (0.9V) and on when that line is high (2.55V).

2.6 DC Power Supply

The DC power supply consists of the power transformer, rectifiers and filter capacitors (see Service Section 2.1, Power Supply and the appropriate schematic at the back of this manual). The output voltage of the power supply is adjusted by changing the tap on the power transformer (Operation Section 2.4.1). No other adjustments are provided.

The rectifiers are located on the baseplate of the ACG-3, behind the power transformer. Use caution while measuring voltages on the power supply; voltages of up to 240VAC are present on the transformer primary circuit. The transformer secondary winding should read approximately 35V when the rectified DC voltage is 44V.

2.7 Disassembly Procedure

The following disassembly procedures describe the recommended method of removing assemblies and printed circuit modules for the purpose of test, repair and/or replacement. Careful handling should be used to avoid damaging the boards. Generally these procedures can be easily reversed for reassembly.

The Model ACG-3 is assembled with standard hardware. Screw sizes range from #4-40 to #8-32 and are of the Phillips or slotted types. Transformer mounting bolts are 1/4-28. Standard tools required are screwdrivers, nut drivers (1/4" through 7/16"), and open end wrenches (1/4" through 5/8").

A torque wrench with a 3/32 in. allen bit is recommended for proper assembly of RF power devices to the heatsink.

2.7.1 Removal of Cover

Remove five (5) #8-32 screws from each side of the cover. Lift the cover straight up.

2.7.2 Removal of Front Panel

Remove seven (7) #6-32 flat head screws holding the front panel to the baseplate assembly. Unplug two (2) molex connectors and remove the front panel.

2.7.3 Removal of Rear Panel

Disconnect the RF output cable. Remove seven (7) #6-32 panhead screws. Unplug three (3) molex connectors, one (1) coax connector and unbolt the line cord ground from the baseplate. Unsolder the neutral and hot line wires from the line filter and remove rear panel.

2.7.4 Removal of RF Chassis Assembly

Remove seven (7) #6-32 flathead screws mounting the transformer cover, carefully noting placement of screw lengths. Remove eight (8) #4-40 flathead screws from the top of the transformer cover; four (4) screws from the control board mounts and four (4) from the voltage select terminal block mount. Unplug one (1) molex connector and remove the transformer cover. Remove 14 gauge wire from capacitor, coax cable from driver input and four (4) #6-32 panhead screws from bottom of RF Chassis. Unplug one molex connector and remove RF Chassis assembly from unit.

2.7.5 Removal of RF Power Board

It is not necessary to remove the RF Power Board from the RF Chassis to service any components of the RF Chassis assembly. All components can be serviced from the front of the RF Chassis assembly with the exception of Q1, Q2, and the driver regulator IC. These components require access to the back of the RF Chassis assembly in order to be service. Refer to Service Section 2.7.4.

2.7.7 Replacement of RF Power Transistor

Remove the external cover of the ACG-3 by removing ten (10) #8-32 cover screws. To replace the power amplifier transistors, it is not necessary to remove the printed circuit board.

1. Remove the mounting hardware: 2-3/32" Allen head screws in the case of flange mount, #8-32 nut and washers in the case of stud mount..
2. Carefully heat and remove as much solder as possible from each of the four (4) transistor leads. Use care not to damage the printed circuit board.
3. Apply heat to melt the remaining solder and lift the transistor leads one at a time with pliers or a pick. Use de-soldering braid to wick the remaining solder out from under the leads. Repeat this procedure until all leads are free of the circuit board.
4. Lift out the transistor. Thoroughly clean the old thermal grease from the copper heatsink. A properly cleaned surface will be a bright copper color.

Note: There must be NO SIGN of old thermal grease, metal chips or residue of any kind on the mounting surface. A solvent and cotton swab is useful for this process. This cleaning is mandatory to provide the degree of thermal contact necessary.

5. Clip the transistor leads to the same length as those on the defective transistor.
6. Place a small amount of clean thermal grease uniformly on the transistor mounting flange.
7. Place the transistor on the heatsink and secure with the hardware removed in step one. Stud mount transistors should be tightened to not more than 6.5 lbs in order to avoid fracturing the copper stud. The flange transistor should be tightened to 6.0 lb. in.

Note: **DO NOT** solder the transistor before tightening the mounting hardware.

8. Solder all four leads to the circuit board, soldering as close to the transistor case as possible. Use only heat necessary, do not overheat the transistor.

2.8 Troubleshooting

Refer to this simplified table should you believe that the ACG-3 is not functioning properly. This table is an itemized listing of the most frequent type difficulty anyone might encounter while operating the ACG-3.

Refer also to Section 3.2.4 of the Operation Manual, **"Diagnostic Self-Test Circuit."**

The first step in isolating a malfunction is to review the conditions under which the symptoms were observed. Unplug any rear panel interface connectors. Determine that the problem was not due to external cabling or abnormal line voltages. If the equipment is being operated by remote control, verify that proper commands are being received by the ACG-3. After the problem has been definitely attributed to the ACG-3, refer to the Troubleshooting Guide. Note that many of the circuits can be checked without the application of RF Power. A systematic fault-localizing procedure is mandatory for rapid trouble shooting. When the problem has been isolated to a particular circuit, refer to **Theory of Operation** as well as to the appropriate schematic for an explanation of the circuit.

Troubleshooting Guide

Symptoms	Probable Cause	Recommendations
Power lamp does not light	Burned out LED	Check for voltage to LED.
	Faulty 40V or 25V power supply	Check per Service Section 2.5.1
	Defective power relays	Replace relays.
	Defective power switch	Replace switch.
	Blown fuse	See "Blown Fuse" symptom below.
RF ON lamp is dim	Defective RF oscillator or RF ON control circuit	See Service Section 2.5.6.
Low RF Output	Defective RF amplifier	Perform procedure for locating faulty RF module, Service Section 2.4.
	Faulty power supply	Check power supply, Service Section 2.6.
No RF Output	Broken output ,Type. "N" connector	Visually inspect connector for broken pin.
	Defective output cable	Visually inspect cable at output connector.
	ACG-3 is in the opposite control mode (internal/ external)	Check/select proper operating mode.
Blown Fuse	Defective power supply	Check per Service Section 2.6
	Wrong fuse	12 ASB 100-120 VAC 6ASB 200-240 VAC
	Defective line cord or AC wiring	Visually inspect for signs of insulation breakdown.
Power generator overheating	Inadequate intake or exhaust delivery	See Service Section 2.3
	Defective internal fan	Check for proper operation.
	Ambient temp. excessive	Reduce ambient temperature.
Incorrect front panel meter reading	Improper calibration of meter or VSWR bridge	Perform adjustment per Service Section 2.4.5, 2.5.3 and 2.5.4.
	Test switch in wrong position	Move test switch to "RF Power".
	Defective meter	Replace meter.

This page left intentionally blank.