High-powered solutions for RF and microwave applications

OWNERS MANUAL

PROCESS OPTIMIZED RF POWER SYSTEMS AND COMPONENTS

SERIES PB-3

13.56 MHz RF POWER SYSTEM

OWNERS MANUAL

CUSTOMER _____

DATE _____

SERIAL # _____

Part # 04-000150-02 File # PB3 manual- 100_300W digital AJA

WARNING

Lethal RF and DC voltages are present in this system.

Only qualified personnel should install and service this equipment.

Prior to installation and operation of this system, this instruction manual should be consulted to ensure that the installation and operation are in accordance with **Manitou Systems**' recommendations.

Failure to properly install or operate this unit will result in voiding the equipment warranty.

This owner's manual is provided to enable the user to safely install, operate and service the equipment described.

Manitou Systems, Inc. reserves the right to make product changes and enhancements without notification or obligation.

For more information, please write Manitou Systems, Inc. 12 South Street Danbury, CT 06810 USA or contact us via:

- Telephone at (203) 792-8797
- FAX at (203) 792-7097
- e-mail info@manitousys.com
- Website at www.manitousys.com.

Published in the United States of America.

TABLE OF CONTENTS

INTRODUCTION SECTION 1

1.1 GENERAL DESCRIPTION

The budget minded **SERIES PB-3** is specifically designed for continuous operation in gas plasma process applications.

The RF power generator and manual impedance matching network are housed in a single, compact enclosure.

The RF generator provides precise process control - even in the varying environment of plasma processes. Ruggedized output transistors are used to ensure reliability during 100% duty-cycle operation. A high current switch mode DC power module provides all necessary support power.

The system's control circuitry offers fine control resolution: A ten (10) turn control pot is used to provide 1% resolution.

A manually controlled impedance matching network provides the user with a broad tuning range. The network includes a tapped, field changeable series inductor and optional fixed shunt capacitor(s) enabling the unit to match a wide range of plasma electrode impedances.

An optional common exciter input enables the PB-3 to be used in multiple cathode and substrate bias applications.

External analog user interface connections enable the PB-3 to be controlled via the user's PLC or computer.

1.2 ICON EXPLANATIONS

WARNING This symbol is used only where an immediate hazard exists. When this word is used, immediate danger exists and special precautions are necessary to prevent possible injury, death or significant property damage.

CAUTION This symbol is used when unsafe operating or service practices could result in damage to the equipment

This icon means "NOTE" or the information following should be mentally highlighted.

The finger-pointing icon is used to indicate a procedure or step required before powering on the system.

1.3 MECHANICAL DESCRIPTION

The system's overall footprint measures 12" W x 7" H x 16" D. This cabinet is constructed from chemically treated aluminum components. The front panel and top cover are removable to provide access to system components and adjustments.

The PB-3 can be mounted to a flat surface using screws through the 4 mounting holes in its baseplate. The holes are threaded and accept 10-32 screws.

Cooling air is drawn in through the rear panel inlets and exhausted through a side panel louver.

All operator controls are mounted on the front panel.

AC mains input, RF power output, common exciter in/out and a remote control connector are grouped together on the rear panel.

The internal matching network is connected to the generator's output by a short coaxial cable (terminated with a BNC male connector) that protrudes from the rear of the unit. The matching network may be bypassed by disconnecting this short cable from the generator's output and connecting the load in its place.

1.4 TECHNICAL SPECIFICATIONS: SYSTEM LEVEL

Input Power	PB3/100	110 VAC, 50/60 Hz, 1 Phase, 5A Max
	PB3/100	220 VAC, 50/60 Hz, 1 Phase, 2.5A Max
	PB3/300	220 VAC, 50/60 Hz, 1 Phase, 5A Max
Cooling	Forced air via a 110-CFM fan. Maximum 90% relative humidity & 100 degrees F ambient temperature.	
System Footprint	12-1/4" W x 6" H x 16" D with a 7" high, 19" rack mount front panel.	
Shipping Weight	Approximately 25 lbs.	
RF Output Power	100 or 300 watts into a 50 ohm load	
Output Frequency	13.56 MHz +/- .005%	
Output Impedance	50 ohms resistive	
Output Connector	BNC female	
Output Power Stability	+/- .5% of set-point	

TECHNICAL SPECIFICATIONS: IMPEDANCE MATCHING NETWORK

RF Output Connection	HN female coaxial cable connector
RF Input Connector	BNC male coaxial cable connector

Matching Network
Circuit Topology"L" using a variable shunt capacitor and a
tapped series fixed inductor & variable capacitor
Additional fixed shunt capacitance may be added
to match low impedance loads.

Matching Network Element Values	Shunt Capacitor:	1000 pF
	Series Capacitor:	488 pF
	Series Inductor:	2.5 uH
Output Impedance	Wide range - will match to all sputtering sources and plasma etching / deposition electrodes	

1.5 SAFETY PRECAUTIONS

SAFE OPERATION IS THE RESPONSIBILITY OF THE USING ORGANIZATION AND ITS PERSONNEL. READ THIS OWNERS MANUAL AND UNDERSTAND HOW TO AVOID HAZARDS PRIOR TO OPERATING THIS UNIT.

Your compliance with the following safety practices is expected:

1. Never work alone on live electrical circuits. You must be within sight or calling distance of another employee who has the following qualifications:

   A. Knows how to remove power from the equipment.
   B. Knows how to apply artificial respiration.
   C. Is acquainted with emergency procedures, first aid locations and the use of fire extinguishers.

2. Do not wear rings, wristwatches or other jewelry on your person while working on live electrical circuits.

3. Wear eye protection while working on live electrical circuitry where a flash might occur. **DO NOT WEAR CONTACT LENSES**.

Because currents of 40 ma or greater across the chest can be fatal, read this manual to find out, before working on the equipment, how much current is present in each circuit. **BE EXTRA CAREFUL!**

4. Replace all safety shields after completing system setup, trouble shooting and maintenance procedures.

5. Immediately report to your supervisor any unsafe conditions that exist.

WARNING Proper use and safe operating practices with respect to this system are the responsibility of the user of this system. Manitou Systems, Inc. provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices; take appropriate action to protect personnel and property from hardware failure. All personnel who work with or are exposed to this system must take precautions to protect themselves against possible serious and/or fatal bodily injury. **DO NOT** be careless around this system.

1.6 THEORY OF OPERATION

The Series PB-3 is a fixed frequency plasma power system consisting of an RF generator and a manual impedance matching network.

RF GENERATOR

The RF generator is comprised of a DC power section, operator/control panel, switch mode RF power generator module and an RF power detector module.

Switch Mode RF Power Generator Module

The operating frequency (13.56 MHz) is fixed using a crystal oscillator. Its output drives a TTL integrated circuit, which produces a square wave output that is fed directly to the gates of a class D-E resonant FET RF power amplifier.

This ruggedized power amplifier produces an RF output of 100 or 300 watts maximum based on the model. The entire circuit is air-cooled.

DC Power Section

The DC power section supplies all of the necessary DC power to the front panel/control board and the RF section. A fused, switched power entry module is provided on the PB-3 rear panel to protect the entire system. A fuse is present on the control power supply board for its own protection.

Operator/Control Panel

The operator/control board contains the basic controls, circuits and switches required to preset, control, and monitor the PB-3's forward and reflected RF output power. The adjustment knobs for the impedance matching network are also included on this panel.

The front panel circuit board also includes circuits designed to provide linearization, RF control, metering and user interface functions. It first linearizes both forward and reflected RF power signals (coming from the RF detector module). This circuit also provides protection for the RF power amplifier module and its transistors in the event of a mismatched plasma load (i.e. high-reflected power or an over current condition). The DC drive signal and subsequent RF output level is limited under these fault conditions. The user interface section of the module contains a provision for programming the RF power set point input signal. This input is switched between Local and Remote by a small toggle switch on the mainboard; to gain access to this switch, remove the top cover of the generator. When the switch lever is pointed towards the front of the generator, it is in local control mode (Setpoint adjusted using the front panel knob); when it is pointed towards the rear of the generator it is in remote control mode (setpoint controlled using an external 0-5Vdc input signal fed into the interface connector). All outputs are available at the DB-25 connector regardless of the Local/Remote switch position. All signals are buffered by op-amp devices.

1.6 THEORY OF OPERATION

RF Power Detector

The power detector is used to provide the control circuits with DC signals corresponding to the forward and reflected power detected at the generator's output.

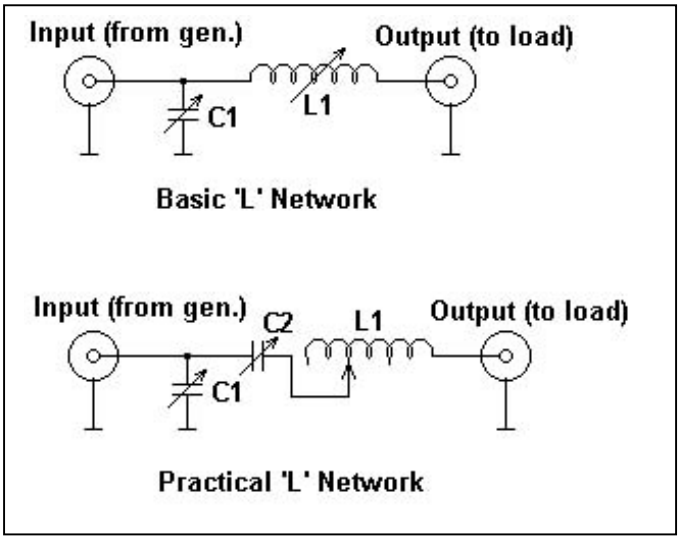
Matching Network

The manual impedance matching network built in to the PB-3 utilizes an "L" circuit topology, so named because of the configuration of the elements used (see figure below, Basic 'L' Network). The basic 'L' type match network requires only two components, a variable shunt (parallel) capacitance (C1) and a variable series inductor (L1).

In actual practice, however (see figure below, Practical 'L' Network), a fixed inductor (L1) is typically used (it is difficult or impossible to obtain a variable inductor with a sliding contact capable of carrying the high RF currents that are present in a plasma application) with a variable capacitor (C2) connected in series with it. The variable capacitor is then used to tune *out* part of the series inductance, the net effect being the same as a tunable inductor but without the inherent current-carrying problems noted above. C1 performs the shunt function, as in the basic network.

These three elements are used to match the complex plasma impedance and present the RF generator with a 50 Ω resistive load. As delivered, this network exhibits a wide range output impedance and will match to most sputtering sources and plasma etching / deposition electrodes

Many matching networks (this one included) use a fixed inductor with several manually changeable taps to allow a greater range of load impedances to be matched. An additional fixed shunt capacitance may also be added if necessary to match loads with very low impedances.



When the external interlock connection is satisfied, the green LED on the RF power on/off switch will illuminate indicating the unit is in a standby condition.

The over temperature interlock is controlled by a thermostat located on the RF generator's heat sink surface. If an over temperature condition exists, this thermostat will break the RF power set point circuit. There are no operator indicators connected to this circuit. The PB-3's front panel indicators will appear normal, but NO output power will be available. The user should wait until the system cools down, check for cooling vent obstructions & fan operation and re-start the system.

INSTALLATION SECTION 2

2.1 UNPACKING

Remove the unit from its packing and shipping material. Inspect for any damage and contact **Manitou Systems Inc.** and the shipping company if any is found.

2.2 SYSTEM COMPONENTS LIST

A. PB-3 System
B. DB-25 User Interface Connector with Hood
C. BNC-M to BNC-M Common Exciter jumper cable, ~6" long
C. Owners Manual

2.3 MECHANICAL INSTALLATION

The **Model PB-3** RF power system is designed to mount near the vacuum chamber RF feed-through in a standard 19" rack. It requires 7" of height in the rack. Alternately, it may be fastened to the system chassis using the four (4) 10-32 mounting holes in the baseplate.

☞ **Connect the BNC Male "Pigtail Coax" (Matching Network Input) to the female BNC connector (RF Generator Output).**

☞ **Connect the BNC to BNC jumper cable (~6" long) between the CEX OUT and CEX IN jacks on the rear panel. For normal stand-alone operation, this connection must be made.**

✎ Always provide continuous airflow through any enclosed electronics rack cabinet containing heat generating equipment. Exhaust fans mounted in the cabinet's top surface and a filtered inlet at the bottom will provide the correct enclosure cooling.

2.4 ELECTRICAL INSTALLATION

WARNING Please review the following initial checkout procedure. Follow these steps prior to normal system operation.

1. The high voltage in this system can cause instant electrocution upon contact or, under some

circumstances, even close proximity to contact. Except as specified in this manual, never open the system covers or panels without disconnecting the AC input power at its wall source and also attaching a grounding rod to the high voltage circuit.

2. The system's radio frequency power is transferred to the vacuum chamber through a shielded vacuum feed through. Harmonic RF energy generated in the plasma discharge and will radiate if the vacuum chamber is not well grounded. Install a low impedance ground strap between the chamber and PB-3 and earth ground. This strap should be constructed from silver plated copper sheet. The width should be 1" to 2" wide X .020" thick. Keep these connections as short as possible.

3. Before operating the power supply for the first time, it is essential to insure that ground connections have been installed as specified, that all interlocks are verified to be working properly and that all high voltage and RF carrying conductors are shielded from human contact. Every precaution must be taken to install and operate the system in accordance with this manual.

4. In a faulty circuit, operational voltages can be retained internally even after the source of the power is shut off. Always insure that all filter capacitors are discharged after disconnecting source power and before examination. Don't assume the power is off until it is checked.

5. If you must examine the system or its AC source with the power on, have another person present, use the schematics, lock out any power that is not needed, and attach test meter leads **before** turning the power on. NEVER, UNDER ANY CIRCUMSTANCES, REACH INSIDE THE POWER SUPPLY WITH THE POWER ON.

CONNECTING THE PB-3

The following installation steps will help the user understand how to connect the **PB-3** to a plasma processing system.

1. The **PB-3** is connected to an AC power source, 115 VAC or 220 VAC (depending upon the model, see the spec information on the back panel of the generator for the proper voltage), 50/60 Hz via its three conductor grounded cord. This power source should be capable of supplying at least 5 amps.

2. A solid copper ground strap is used to connect the enclosure to the chamber and system ground point. Refer to "**Rear Panel**" drawing for details.

3. ☞ The output of the impedance matching network is connected to the electrode using a coaxial cable.

4. Dress all RF carrying cables away from all other control and sensor cables.

5. All remote connections are made via the DB-25 connector on the back of the enclosure. Use a shielded cable for these connections. Refer to the following list and to "**Remote / User PB-3 Connections**" drawing for details. ☞ **The factory supplied shorting plug must be installed for proper operation if no external control functions are to be utilized.**

Connections to 25 pin d-sub connector on rear of generator:

Pin:	Function:
1	Ground/common
2	External interlock- tie to pin 1 to enable.
3	External Setpoint In (0 to 5 Vdc)- reference to pin 1.
6	Remote RF on- Tie to pin 1 for normal operation, switch to enable remote on/off.
7	Forward Power Out signal (0 to 5 Vdc representing 0-100% power)- reference to pin 1
9	Reflected Power Out signal (0 to 5 Vdc representing 0-100% reflected power)- reference to pin 1
23	DC Bias out signal (optional) (0 to 5 Vdc = 0 to 1000V of bias)- reference to pin 1.

The external interlock must be satisfied before using the system. Connect an external interlock switch to user interface connector between pins 1 & 2. Contact closure is necessary to satisfy the interlock.

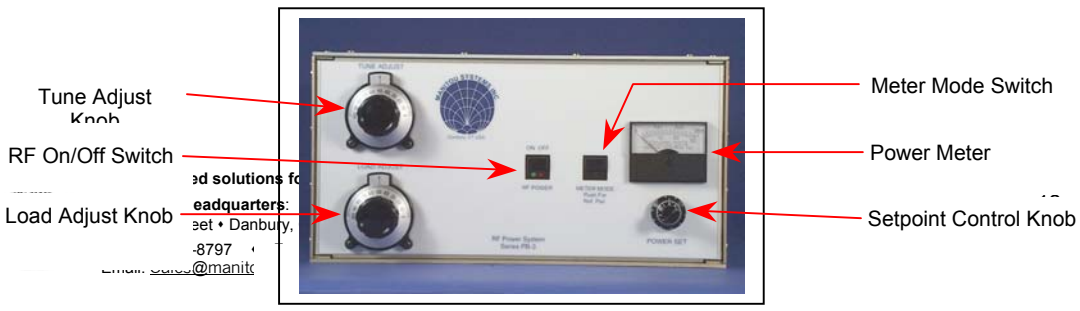
0 to +5VDC output signals are present at the interface connector for the Forward & Reflected RF output power, and DC bias (optional). (0 to 5V represents 0-100% of the value)

A 0 to +5VDC input signal is required for remote control of the forward power/ DC bias preset if external control is to be used.

A continuous contact closure is required to control the RF on/off function. This switch is connected to the user interface connector between pins 1 & 6. These pins should be jumped to enable operation of the front panel mounted RF ON/OFF switch. The front panel mounted RF ON/OFF switch must be set in the "ON" position (pushed in) when using a remote switch. The interface plug as shipped has this connection made, allowing use of the front panel switch without further wiring being needed.

OPERATION SECTION 3

3.1 OPERATOR CONTROLS & METERING



RF On/Off Switch: This alternate-action switch is used to turn the RF power off and on from the front panel, and also houses two status LEDs. Pressing this switch toggles the RF power output between off and on. (RF power is turned on when the switch is in its 'in' position.) The green LED indicates the status of the interlock loop (the LED illuminates when the interlock is satisfied); the red LED illuminates when the RF power is on. The switch must be in its 'in' position if RF on/off is to be controlled through the external interface.

Meter Mode Switch: This momentary switch determines whether the forward or reflected power level is indicated on the analog meter. The normal display is forward RF power; when the switch is pressed and held the reflected power level is displayed. When pressure on the switch is released, the meter reverts to indicating forward power.

Setpoint Control Knob: This ten (10) turn control pot enables the operator to set and vary the Forward RF Power output when the generator is operated in local control.

Load & Tune Adjust Knobs: These knobs are used to adjust the position of the tuning capacitors in the matching network. Turning the knob clockwise increases the capacitor setting, turning it counterclockwise decreases it. The knobs are vernier drive to allow for finer tuning, and have reference scales calibrated from 0-100.

3.2 REAR PANEL CONTROLS & CONNECTIONS

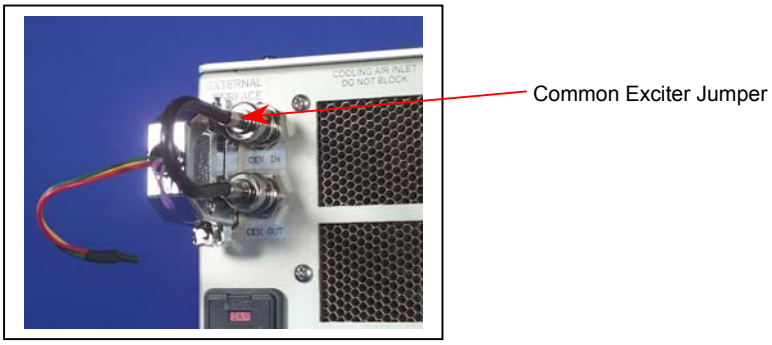
Power Entry PB3 Rear Panel eft corner of the generator (as viewed from the rear) contains the line fuses, line filter, main power switch and detachable power cord. The fuse(s) are accessed by removing the power cord and opening the protective door, then removing the red fuse carrier. The fuse value is noted on the red carrier. 120V units are single-fused; 208V units are double fused. All fuses are slow-blow types. The main power switch is located in the middle of the powerline entry module, 0 is off and 1 is on. The detachable power cord in connected to the IEC320 receptacle at the bottom of the module.

Interface Connector: A DB-25 female connector is provided for interfacing the supply's various Inputs and Outputs to a user's process controller.

- Pin 1 Common

- Pin 2 External Interlock connection (connect to pin 1 to operate generator)
- Pin 3 External 0 to +5 VDC setpoint input
- Pin 6 External RF ON/OFF (connect to pin 1 to operate generator)
- Pin 7 External Forward Power signal 0 to +5 VDC (0 to full power)
- Pin 9 External Reflected Power signal 0 to +5 VDC (0 to 30 watts)
- Pin 23 External DC Bias signal 0 to +5 VDC (0 to 1kV bias) (optional)

Common Exciter I/O: Two BNC jacks located next to the Interface Connector are provided to permit two or more PB-3's to operate in synchronization for applications requiring multiple plasma sources in a single chamber. (For further information regarding the use of multiple generators in a single chamber, see the application note at the end of this manual.) For use as a stand-alone (single) generator, these two jacks must be connected together. A 6" BNC to BNC cable is included with the unit for this purpose. It is installed as shown in the image below.



Common Exciter jumper cable installation

RF OUTPUT: The RF Output connector is a BNC jack located just above and to the right of the center of the rear panel of the generator. It is connected to the output of the VSWR board inside the generator, and allows the RF output to be directly accessed without the match network intervening. It is intended to be connected to a 50 ohm resistive load.

MATCHNET INPUT: The matchnet input connection is a short pigtail terminated in a male BNC connector. For normal operation, it is connected to the RF OUTPUT jack mentioned above. The pigtail connects to a quarter-wave cable coiled inside the cabinet in the matching network compartment, the distal end of which is connected to the input side of the matching network.

MATCHNET OUTPUT: The matchnet output is a female HN connector located on the upper right side of the rear panel of the generator. It connects to the output side of the internal matching network, and is to be connected to the load via a heavy-duty coaxial cable. The connection between the matchnet output and the plasma load should be kept as short as possible.

3.3 PRELIMINARY OPERATOR CONTROL SETTINGS

Prior to turning on the **AC Main Power** and **RF Output Power** in an unknown load situation, we recommend presetting the controls as follows (once preliminary operating parameters such as a known plasma ignition tuning point and power level have been determined, those settings should be used for startup):

A. **Power Set** pot to 0.00
B. **Mains switch** (rear panel) turned off.

☞ Ensure that the matching network output is connected to the vacuum chamber's RF feed-through, the matching network input is connected to the generator output and that the common exciter I/O's are connected.

3.4 PRELIMINARY CHECKS BEFORE TURNING ON THE RF POWER

✎ Prior to turning the RF Power On, preset and stabilize all process parameters such as vacuum chamber pressure and process gas flow.

☞ Turn on all cooling water channels (to electrode or cathode).

☞ Ensure that all RF connections and system grounds are tight. Turn on the Main Power Switch.

Allow at least 5 minutes of warm-up and stabilization time for the **PB-3**.

Check to see that all interlocks have been satisfied. The RF power *cannot* be turned on in an unsatisfied condition.

Check to see that the green LED (located on the RF Power switch) is lit. This indicates that the system interlocks are satisfied and it is in the ready state.

If this LED is not lit, check the external interlock devices or connections.

3.5 TURNING THE RF ON

Preset the impedance matching network capacitor positions a known plasma ignition point or to 50%.

Press the **RF Power** switch to turn the RF output ON. The red LED indicator will light to indicate this state.

Turn the **Power Set** control clockwise 1-2 turns and check to see that the forward power meter indicates that a small amount of FORWARD RF power is being delivered to the load.

Adjust the TUNE capacitor for a small peak in the indicated FORWARD power. This peak indicates the plasma strike point. (Plasma ignition can be confirmed by the indication of bias on the DC Bias output if the generator is so equipped.)

At this time, adjust the LOAD capacitor position to obtain a null in the REFLECTED power. (View the reflected power on the meter by pressing and holding the meter mode switch.)

The operator will now be able to view an active glow discharge in the vacuum chamber.

Adjust the power level to the desired value while continuing through a number of **TUNE & LOAD** control iterations until a minimum **Reflected Power** reading is achieved. If the plasma extinguishes, the generator may need to be re-started (using the **RF ON** switch), but plasma can usually be reestablished by detuning slightly.

The PB-3 will protect itself during a miss-match by folding back the forward power to a safe level.

The operator will notice that a glow discharge can be ignited and the tune & load controls adjusted for maximum preset forward power. The matching network will then need to be tweaked for minimum reflected power.

3.6 OPTIMIZING THE MATCHING NETWORK FOR A GIVEN LOAD

As a general rule, a small electrode typically requires greater series inductance than a large one. 1 to 1-1/2" sputter guns will probably tune best with the movable tap positioned towards the front of the match network (high inductance), while 2 to 3" ones will operate with the tap connected more to the middle to low inductance range.

Further determination of the correct series inductance value can be achieved once plasma ignition has been established by noting the position of the series (TUNE) capacitor when the network has been adjusted to achieve the minimum reflected power. Ideally, when the load is tuned the tune capacitor should be positioned somewhere between 15-20% and 75-80% of its adjustment range, the closer to the middle the better. This will allow the widest variation in load conditions to be tuned without the need to further adjust the inductor.

To optimize the inductor setting, turn on the RF and establish a plasma under normal operating conditions if possible, if not then under conditions as close to those desired as possible with the network in its present state. Tune for minimum reflected power, and note the position of the TUNE (series) and LOAD (shunt) capacitors. The TUNE capacitor position will determine what to do with the series inductance, and the LOAD capacitor position will determine if additional fixed shunt capacitance must be added.

If the minimum reflected power is obtained with the TUNE capacitor set towards the bottom of its range (minimum 'C', maximum X_c), this is an indication that the series inductor is too large (as mentioned previously in the 'theory of operation' section, the series capacitor's reactance, being 180° out of phase with the inductor's reactance, is used to cancel out some of the inductive reactance.) If this is the situation, move the tap on the inductor towards the rear of the match network (fewer turns).

If minimum reflected power is obtained with the TUNE capacitor adjusted towards the top of its range (maximum 'C', minimum X_c), this indicates that the series inductor is too small. If this is the case, the tap on the inductor should be moved towards the front of the network (more turns). In rare cases, it may be necessary to install additional series inductance- should this possibility arise, contact Manitou Systems for further information.

Systems with large electrodes, the use of long cables running between the match network and load (longer than perhaps 4' or so), or parallel output cables (used with some manufacturer's sputter guns) *may* necessitate the installation of additional fixed shunt capacitance in the network. To determine if additional shunt capacitance is required, note the position of the LOAD (shunt) capacitor when the system is adjusted for minimum reflected power. If the LOAD capacitor is adjusted to a position greater than 80-90%, additional fixed shunt C is likely required. Contact Manitou Systems for further information; a fixed shunt capacitor kit is available for the PB3.

TROUBLESHOOTING PROCEDURES SECTION 4

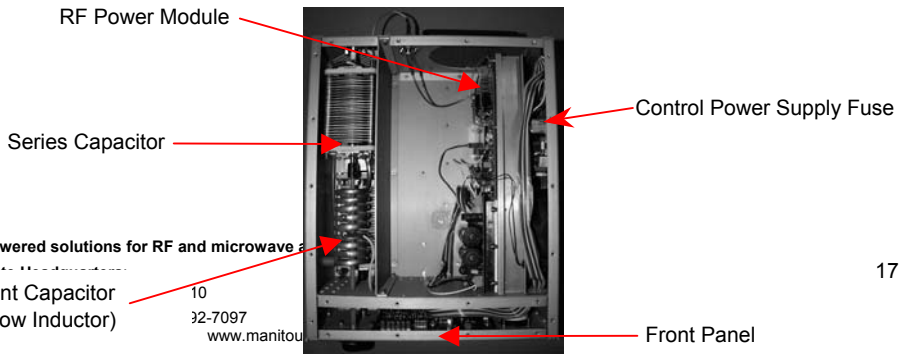
4.1 RF GENERATOR PROBLEMS

- If the cooling fan does not start check the AC mains circuit. Is it operational? Is the PB3 power cord inserted properly into the rear panel connector? Is the AC Mains switch turned on? If all of the answers are yes, the problem may be a blown fuse in the power entry module or on the control power supply. The powerline entry module fuses are accessed by disconnecting the AC Mains cable from the rear of the generator, then gently prying open the hinged cover that retains the red fuseholder. There is a slot at the top if the module that allows the cover to be pried open with a small screwdriver. The red fuseholder can then be removed and the fuse(s) checked. Installation is the reverse of removal. The control power supply fuse may be accessed by removing the top cover from the generator and looking for the fuse on the small power supply board on the right wall. The fuse is near the top of the board, just beneath the orange AC mains connector.

- If the cooling fan is running and the green LED indicator does not light, there is a possibility that the external interlock connection is not closed. Please check that the DB25 connector on the rear panel is correctly inserted and the connections are correct.

- If the red LED does not light, the problem may be in the external interface connector. The contacts must be jumped (just like the external interlock contacts) to enable the RF to start.

PB3 Chassis top view



- If there is no indication of Forward RF power (with the red LED lit) there is a possibility that the generator's temperature overload thermostat has tripped. Please look for the possibility that the cooling fan is not operational or that one of the cooling air openings is blocked.
- If there is no (100 & 300W units) or approximately half of maximum (300W units) forward power (and the generator is not in reflected power foldback in the case of half-max power for 300W units), then it is possible that a fuse on the RF deck's SMPS module(s) has blown. If the fuse on the driver module (the one closest to the top of the heatsink) fails, the result will be no RF output; if the fuse for the booster module fails (300W units only), the result will be that something less than maximum RF output power is available even with the control turned up fully and a properly tuned load. The fuses utilized on the SMPS modules are Buss PC-Tron types, 3A for 208V generators and 5A for 120V generators.

4.2 IMPEDANCE MATCHING NETWORK/TUNING PROBLEMS

The PB3 impedance matching network incorporates two variable capacitors and a fixed (tapped) inductor to enable matching to all types of plasma loads including small sputtering guns and substrate bias stages. The factory pre-sets and tests the system using a 3" magnetron sputtering gun, but the user may need to adjust the network to operate with their particular process load.

It should be noted that the PB3 is designed to mount close to the plasma source and utilize a coaxial output cable not longer than 6' in length. (Manitou Systems offers high current Teflon based cables in various lengths and with various connector styles to complement the user's application. Please consult the factory for availability.)

The typical cable furnished is a type RG-393 cable with a type HN male connector mounted on the PB3 side and either a type HN or N connector on the distal end to connect to the plasma load. Other cable types may be used, however we caution against using cables with polyethylene or foam insulation cables as there are high RF circulating currents which can cause heating of the center conductor and possible melting and degradation of the insulator over time. The result is an unstable match and the possibility of a short circuit. Please consult the factory if you require a longer cable.

Please follow these procedures if the tuner will not match to the load (achieve minimum reflected power):

- Does the plasma ignite? If so, is the tuner unable to reach a null in the reflected power? The series inductor in the tuner module may need to be adjusted. Remove the top cover and change the tap setting and repeat the tuning process.

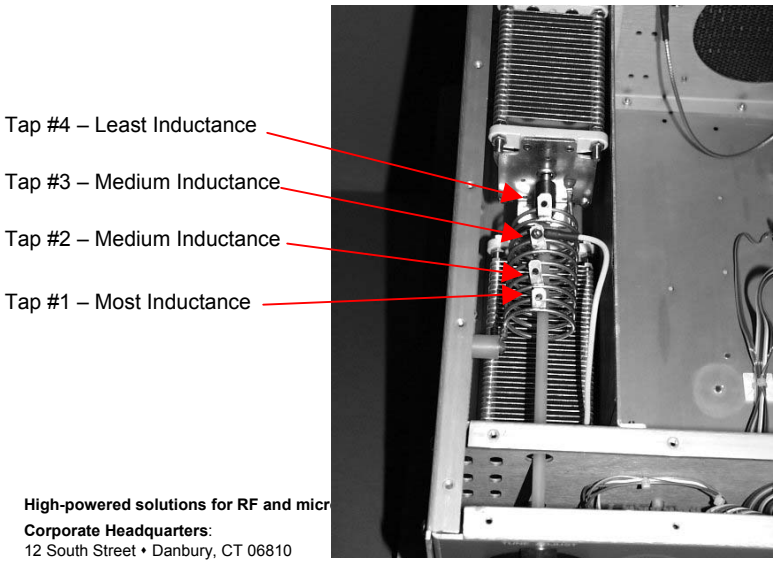
  The rule of thumb for the inductor position is maximum inductance for a small cathode surface area and minimum inductance for a large area cathode surface area. If the inductance is too low, the TUNE (or series) capacitor will try to tune towards 100%. If the inductance is to high, the tune capacitor will tune towards 0%.

- If the plasma lights and the network's LOAD capacitor adjusts for minimum reflected power at the high end of its range, there may be the need for additional shunt capacitance. This is accomplished by adding a fixed high current (doorknob) type capacitor in parallel with the larger variable capacitor. Please consult the factory for availability of the kit.

  Another rule of thumb is that the load capacitor will need to be increased if an output cable longer that 6 feet is used to connect the plasma load. This is because the load capacitor is trying to tune out the fixed capacitance of the coax cable.

  In some applications it may be possible to tune into a long output cable with a low reflected power and NO plasma ignition.

- If there is no plasma ignition, check to see if all chamber parameters are OK. These may include the presence of process gas, proper vacuum pressure (or vacuum level ~ 3-4 microns), and proper shutter position as a shutter that is too close to the target surface may not allow gas flow to the target surface.
- A verification of the plasma load may include a quick continuity check across the input connector to see if there is an internal short circuit. The measurement in ohms should be very high (Meg ohms). If it is low (ohms) there may be a metal flake across the dark space shield to the target surface.



PB3 Matching Network Section Inductor Tap Selection (100W unit shown)

MAINTENANCE PROCEDURES SECTION 5

5.1 CLEANING OF DEBRIS

With continued use, the PB-3 may accumulate dust and debris around the air intake and exhaust positions. Use a vacuum cleaner with a soft brush attachment to gently remove the dust build up from these areas.

If the PB-3 is used in a very dusty location, the top cover may be removed to facilitate the cleaning of the interior components. Use compressed air (at less than 20 psi) to blow out the dust.

5.2 FRONT PANEL CLEANING

The plastic front panel overlay may be cleaned using a mild detergent mixture (dish washing liquid is acceptable). Gently wipe the surface and switch operators with a dampened cloth to remove dirt and finger oil buildup. Under NO circumstances use any solvents as these chemicals will destroy the plastic surfaces.