



High-powered solutions for RF and microwave applications

# ***Helius™***

***13.56 MHz RF Power System***

***Models H30013 - H60013 - H1K13***

***OWNERS MANUAL***

# **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.

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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.

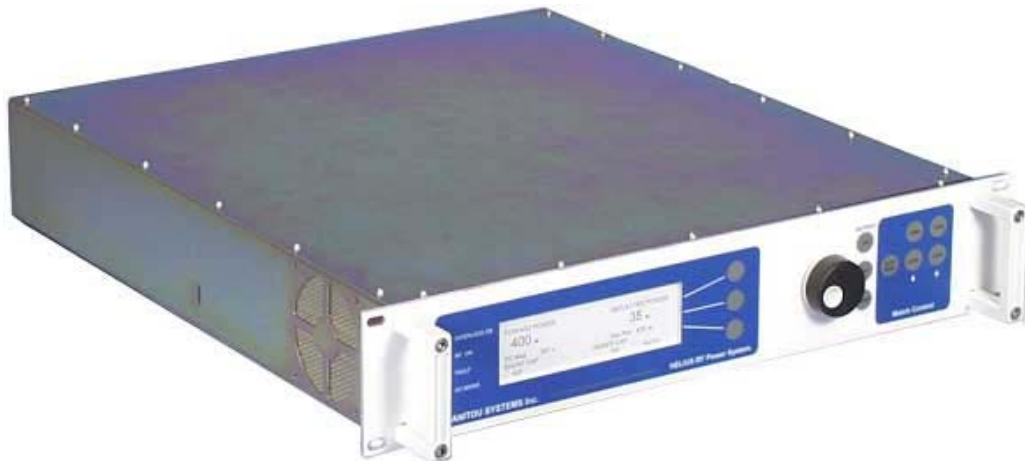
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# INTRODUCTION      SECTION 1

- 1.1 GENERAL DESCRIPTION
- 1.2 ICON EXPLANATIONS
- 1.3 MECHANICAL DESCRIPTION
- 1.4 TECHNICAL SPECIFICATIONS
- 1.5 SAFETY PRECAUTIONS
- 1.6 THEORY OF OPERATION

## 1.1 GENERAL DESCRIPTION

The **Helius** RF power system is specifically designed for continuous use in semiconductor and industrial plasma processing applications. Proven push-pull RF amplifier topology enables stable output into dynamic plasma load and high reflected power conditions. A power factor corrected, high current switch mode power supply module is employed to convert the AC mains power into the low voltage required by the RF amplifier while ensuring compliance with international standards.

The **Helius** control system is built around a high-speed microprocessor and memory module. This allows for accurate process control and active hardware management. Many internal operating parameters and all soft (or hard) faults may be monitored and used for process control when directed to the process system controller via the various interface ports. Connectivity to the user's system is made possible via analog, RS232, DeviceNet or Profibus interfaces. The **Helius** product platform is compliant with typical industry accepted regulations including NRTL and CE. Internal RF control sensors are optimized for each power level resulting in a high degree of control vs. output linearity.

All subsystems are designed to withstand the rigors of 100% duty cycle industrial environments; heat sinks are constructed from bonded copper plate, enclosures are manufactured from chemically treated metals and electrical components selected to operate well within their typical ratings. Active thermal management coupled with tight control leads to an unparalleled MTBF rating.

The user may select from various modes of operation by using the front panel GUI (graphical user interface) or through external serial bus control. All critical operating parameters in addition to many internal diagnostics are available to the user via the system's software menus.

# INTRODUCTION SECTION 1

## 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 19" W x 2RU (3.5") H x 22" D. This cabinet is constructed from chemically treated steel sheet metal. The top cover is removable to provide access to system components and adjustments.

The **Helius** can be mounted into an electronics rack enclosure by the 4 obround holes on the front panel. It must be supported on a shelf or other horizontal support structure. Cooling air is drawn in through both sides and the upper rear louver. The warm exhaust air exits via two rear panel louvers.

All operator controls, indicators and LCD graphical interface are mounted on the front panel. AC mains input power, RF output power, remote control connectors, matching network interface and the interlock connector are grouped together on the rear panel.

Descriptions and explanations of individual controls and features are available within the body of this manual.

Shipping Weight	H30013	45 lbs.
	H60013	48 lbs.
	H1K13	50 lbs.

# INTRODUCTION      SECTION 1

## 1.4 TECHNICAL SPECIFICATIONS

## SYSTEM LEVEL

Input Power	H30013 H60013 H1K13	187>240 VAC, 50/60 Hz, 1 Phase, 500VA 187>240 VAC, 50/60 Hz, 1 Phase, 1000VA 187>240 VAC, 50/60 Hz, 1 Phase, 1870VA
Power Factor	0.95 > 0.99	
Fuses	2 each - 5 X 20 mm Located on rear panel	H300    3 amp H600    7amp H1K     10 amp
Compliance	CE and NRTL	
Cooling	Forced air via 3 temperature / speed controlled fans.	
Operating Environment	Maximum 90% relative humidity (non-condensing) & 100 degrees F ambient temperature.	
RF Output Power	300, 600 or 1000 watts into a 50 ohm load	
Reflected Power Tolerance	25% of forward power (maximum)	
Output Frequency	13.56 MHz +/- .005%	
Output Impedance	50 ohms resistive	
Output Connector	Type "N" female	
Common exciter I/O	2X Type SMA female	
	<p>Square wave input: The CEX Input compliance is 250 ohms. The signal should be 0 to +5V <b>Never exceed -0.5 to +5.5V</b></p> <p>50 ohm input: +5 to +8 dBm (Note: there will be a mismatch.)</p> <p>Square wave output: 0 to +5V</p> <p>(Note: this output is available only when using the internal oscillator. An external CEX input signal will cause this output to turn off.)</p>	
RF Output Regulation Stability	+/- 1% of set-point	
External Interfaces	Analog RS-232 DeviceNet Profibus Accu-Match Interlock	D-Sub 25 male D-Sub 9 male Special connector - Optional D-Sub 9 female - Optional D-Sub 25 female Mate-n-lock

# INTRODUCTION      SECTION 1

## 1.4      **TECHNICAL SPECIFICATIONS**                      **SYSTEM LEVEL**

Front Panel Displays	Backlit LCD graphical display, 240 x 64 pixels Four individual high brightness LED function indicators
Front Panel Controls	Indexed "modify" rotary switch with rotation & push action Multiple soft touch key switches
Micro controller	25 MHz 16 bit uP 256k RAM 256k EPROM for program storage (Field replaceable) EEPROM for non volatile storage of setup parameters

## 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.

# INTRODUCTION      SECTION 1

## 1.6 THEORY OF OPERATION

The **Helius** RF power system is a combination of a narrow band RF amplifier, fixed frequency or frequency agile exciter section, high current switch mode power supply and an integrated microprocessor controller / graphical user interface.

### Oscillator / Exciter Section

This section starts with a fixed frequency clock oscillator that is filtered and amplified to drive the high power RF amplifier stages. This clock oscillator module is connected through a detector/switch that will automatically sense the presence of an external frequency source (Common Exciter Input) and disconnect the internal oscillator. The common exciter input will then drive the amplifier chain. A second external connection is the Common Exciter Output. The CEX Output is a buffered square wave at the same frequency as the internal clock oscillator. All RF devices in the exciter chain operate in the linear range.



Please note that the Common Exciter Output is active ONLY when the internal clock oscillator is active. System configurations where more than two Helius RF generators are used will require the use of a separate multi-output common exciter module.

### RF Power Amplifier

The RF exciter output and is fed directly to the gates of a class B-C push-pull FET RF power amplifier. The ruggedized power amplifier section is an optimized broadband design. The RF output is further filtered through the use of a 3 section PI filter. This power amplifier produces an RF output of 300, 600 or 1000 watts maximum based on the model. The entire circuit is mounted on a massive finned heat sink and forced air-cooled.

### High Current DC Power Supply

The +48VDC variable power section supplies all of the necessary power to the RF exciter / amplifier sections. It includes a power factor corrected front end and a reliable convection cooled power conversion section. Its output is varied from 10 > 100% to effectively adjust the drive level on the RF amplifier stage. Output current (to one or two amplifier sections) and voltage are continuously measured and may be viewed on the front panel display. An AC fuse / filter entry module is provided on the Helius rear panel to protect the entire system.

### Control DC Power Supply

A separate  $\pm 15$ VDC switch mode power supply module is provided to power the front panel controls, microprocessor circuits and low voltage drive to the RF exciter. A fuse is provided on this board for its own protection.

### Microprocessor Control Panel / Display

Operation and programming of the **Helius** is accomplished through the use of the touch switches and three axis rotary encoder wheel. The encoder's push motion is used to scroll through the various display screens while the rotary action is used for selecting the values. Membrane touch switches are also used during programming as well as to actuate the RF Output, Reset Faults and manually operate the **Accu-Match** automatic impedance matching network module,

Display of critical operating values and diagnostics is accomplished via a high contrast graphical LCD display. Discrete, multi colored LED indicators are provided on the left side of the panel to indicate faults and system status.

## 1.6 THEORY OF OPERATION

### **Interface Module**

The module includes circuits designed to provide linearization of the detected RF signals, RF output control, metering and external interface functions. It first linearizes both forward and reflected RF power signals (coming from the RF detector module). This circuit also provides analog 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 external interface section of this module includes provisions for analog and serial bus interfaces. All user accessible connectors are located on the rear panel. This module also includes cooling fan sensors and drivers that enable all fans to operate at full speed only when needed.

The **Helius** includes as standard both Analog & RS232 I/O connections. Profibus and DeviceNet interfaces are offered as an option. The serial interfaces offer both system control as well as a streaming data output of critical operating and diagnostic parameters. The analog I/O affords an inexpensive method by which the **Helius** can be connected to a process system controller.

Typical Analog signals are: RF On, Selection of output regulation, Fault, RF output metering, DC Bias level metering, Output level set, RF On/Off, and Pulse mode input. The serial interface includes the signals same as the Analog port in addition to: Internal temperature measurements, RF amplifier operating voltage & currents, Internal "soft" failure activities, cooling fan rotation faults, and other software programmable diagnostics.

Accu-Match (when connected) diagnostic and operational signals are also typically available via the **Helius** serial interfaces.

### **RF Power Detector**

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

### **Interlocks – Safety & Functional**

An external interlock is provided to enable the user to inhibit operation of the Helius. This contact closure is accessible on the rear panel. If it is left open, the microprocessor will not boot – or inhibit operation of the system.

There are various internal sensors that provide protection of the system against misuse and other external operating conditions. These include over temperature of the RF and High current DC sections, over current of the DC power supply section and high reflected RF power.

All temperature interlock circuits are sensed by thermistors located on critical heat generating surfaces or in the air flow streams. If an out of range temperature condition exists, the circuit will shut off the RF power output. An over current condition will either turn off the RF output or limit it to a safe level.

## INSTALLATION      SECTION 2

- 2.1 UNPACKING YOUR **HELIUS**
- 2.2 SYSTEM COMPONENTS LIST
- 2.3 MECHANICAL INSTALLATION
- 2.4 ELECTRICAL INSTALLATION
- 2.5 EXTERNAL CONNECTIONS

### 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. **HELIUS** System
- B. DB-25 User Interface Connector and Hood
- C. AC Mains cord
- D. Mate-n-lock plug (AMP PN 172166-1 MSI PN 00001639)
- E. Mate-n-lock sockets 3ea (AMP PN 770986-1 MSI PN 00001642)
- F. Owners Manual on CDROM
- G. Final test document

### 2.3 MECHANICAL INSTALLATION

The **HELIUS** RF power system is designed to mount in an electronics rack enclosure utilizing 2RU (3.5") of vertical height. It may be fastened to the enclosure using the four (4) obround mounting holes located on the front panel. The enclosure's bottom surface has two raised metal surfaces to allow the unit to slide in and out of the rack enclosure.



Always provide a shelf type support underneath the **Helius** chassis.



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. Ensure that the warm exhaust air is not recycled into the unit's cooling air supply louvers.

## INSTALLATION      SECTION 2

### 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 earth ground. The **Helius** should be grounded through its rear panel ground stud to the equipment rack that it is mounted in. 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. Please visit the Manitou Systems website for additional application information and FAQs.

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 it's 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.**

## INSTALLATION      SECTION 2

### 2.4 ELECTRICAL INSTALLATION

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

1. The **Helius** is connected to an AC power source, 187>240 VAC single phase, 50/60 Hz via the included three (3) conductor (grounded) cord. The user is required to install the proper mating plug on the "user" end. The AC mains power source should be capable of supplying the proper AC mains current and voltage.
2. A solid copper ground strap is used to connect the **Helius** to the system ground point. Refer to "**Rear Panel**" drawing for details.
3. Dress all RF carrying cables away from all other control and sensor cables.
4. All remote connections are made via the DB type connectors on the back of the enclosure. Use shielded cable for these connections. Refer to the "Remote / User **Helius** Connections" drawing for details.



The external interlock is the only function that must be satisfied before using the system.

### 2.5 EXTERNAL CONNECTIONS

This section contains tables describing the attributes and pin outs of each rear panel mounted interface connector.



- Use high quality, shielded connecting cables for all analog and serial interface connections. All cables must be compliant with CE & NRTL regulations concerning conducted emissions. Failure to provide compliant cables may lead to RF interference to and from the **Helius** chassis.
- Please note that the **Helius** software provides diagnostics and a display of operating data originating in the complementary **Accu-Match** impedance matching network. If the **Accu-Match** is not connected, the data will not appear on the display or a typical displayed value may be erroneous.

External Interlock	Mate-n-lock Connector		J4
Pin #	Description	Type	Signal
1	Interlock input		Contact closure
2	Not used	---	---
3	+VCC output		Contact closure

**Notes:** Connect pins 1 to 3 satisfy the external interlock. Use an AMP Mate-n-lock type connector PN 172166-1 and sockets PN 770986-1 these connections. Connect to system interlock control or cathode water flow switch.

## INSTALLATION      SECTION 2

### 2.5 EXTERNAL CONNECTIONS

RS232 Interface	DB9 Male Connector		J5
Pin #	Description	Type	Signal
1	Not used	---	---
2	Receive (Input to Helius)	Digital	+12V
3	Transmit (Output from Helius)	Digital	+12V
4	Not used	---	---
5	Ground	---	---
6	Not used	---	---
7	Not used	---	---
8	Not used	---	---
9	Not used	---	---

**Notes:** The interface parameters are defined as: 9600 Baud, 8 Bit, No Parity, 1 Stop bit. This serial interface is used to provide various control functions of the **Helius**.

Analog Interface	DB25 Male Connector		J7
Pin #	Description	Type	Signal
1	RF power limit reached	Output – digital	
2	Hard fault	Output – digital	
3	Soft fault	Output – digital	
4	RF state – on / off	Output – digital	
5	Signal ground	Signal Ground	
6	Matching state – manual / automatic	Input – digital	
7	Series capacitor position	Output – analog	0 > +10 VDC
8	Shunt capacitor position	Output – analog	0 > +10 VDC
9	Chassis ground	Ground	
10	Blanking (pulse)	Input – digital	
11	RF ON	Input – digital	
12	Remote activate	Input – digital	
13	Output level set (0>100%)	Input – analog	0 > +10 VDC
14	External voltage	Input	
15	Ground	Ground	
16	Series capacitor low limit	Output – digital	
17	Series capacitor high limit	Output – digital	
18	Shunt capacitor low limit	Output – digital	
19	Shunt capacitor high limit	Output – digital	
20	Plasma sense	Output – analog	0 > +10 VDC
21	Series capacitor position set point	Input – analog	0 > +10 VDC
22	Shunt capacitor position set point	Input – analog	0 > +10 VDC
23	DC Bias: +10V = 100% (4kV)	Output – analog	0 > +10 VDC
24	Reflected RF power: +10V = 100%	Output – analog	0 > +10 VDC
25	Forward RF power: +10V = 100%	Output – analog	0 > +10 VDC

**Notes:** This analog interface is used to provide various control functions of the **Helius**.

## INSTALLATION      SECTION 2

### 2.5 EXTERNAL CONNECTIONS

Accu-Match Interface	DB25 Female Connector		J8
Pin #	Description	Type	Signal
1	Ground	Chassis ground	
2	Magnitude signal output	Output – analog	0 > +10VDC
3	Phase signal output	Output – analog	0 > +10VDC
4	Series capacitor @ Low limit	Output – digital	Opto isolator low = @ limit
5	Series capacitor @ High limit	Output – digital	Opto isolator low = @ limit
6	Series capacitor position - actual	Output – analog	0 > +10 VDC = 0 > 100% of position
7	Series position set point input	Input – analog	0 > +10 VDC
8	Series servo current	Output – analog	0 > +10 VDC
9	Shunt capacitor @ Low limit	Output – digital	Opto isolator low = @ limit
10	Shunt capacitor @ High limit	Output – digital	Opto isolator low = @ limit
11	Shunt capacitor position - actual	Output – analog	0 > +10 VDC = 0 > 100% of position
12	Shunt position set point input	Input – analog	0 > +10 VDC
13	Shunt servo current	Input – analog	0 > +10 VDC
14	Ground	Chassis ground	
15	+15VDC output (unregulated)		Do not exceed 100mA
16	Interlock OK	Output – digital	
17	Relay select 1	Output – digital	
18	Relay select 1 or RF ON input	Output – digital	
19	Auto / Manual select	Output – digital	
20	Servo active indicator	Output – analog	0 > +10 VDC
21	Locked cooling fan rotor	Input – analog	0 > +10 VDC
22	Over temperature fault	Input – analog	0 > +10 VDC
23	DC Bias signal input	Input – analog	0 > +2 VDC (= 0>4kV)
24	Plasma sense input	Input – analog	0 > +10 VDC
25	Digital I/O common	Input – analog	0 > +10 VDC
<b>Notes:</b> This analog interface connection is used to provide various control functions of the <b>Accu-Match™</b> when connected to the <b>Helius</b> .			

## INSTALLATION SECTION 2

### 2.5 EXTERNAL CONNECTIONS

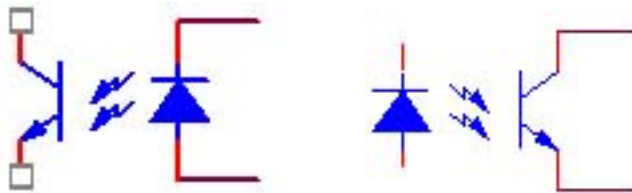
ProfiBus Interface	DB9 Female Connector		J6
Pin #	Description	Type	Signal
1	Not used		RS485
2	Not used		
3	Data receive & transmit	Digital	Positive
4	Not used	---	---
5	Data ground		
6	Supply voltage		+5VDC
7	Not used	---	---
8	Data receive & transmit	Digital	Negative
9	Not used	---	---

**Notes:** This *optional* serial interface is used to provide complete control of the **Helius**.

DeviceNet Interface	Special Connector		J9
Pin #	Description	Type	Signal
1			Data
2			
3			
4	Not used		
5	Not used		

**Notes:** This *optional* serial interface is used to provide complete control of the **Helius**.

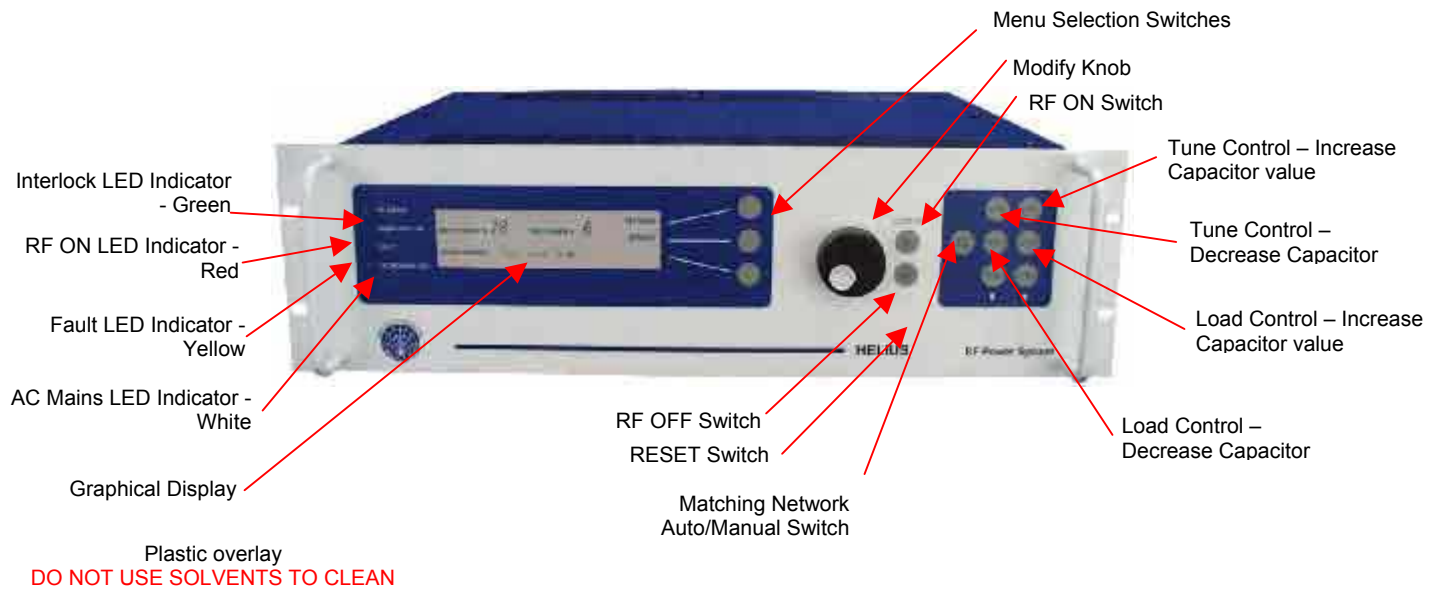
Below, please find examples of the I/O circuits used inside the Helius connecting to the **Analog** Interface.



## OPERATION SECTION 3

- 3.1 FRONT PANEL / OPERATOR CONTROLS & DISPLAY
- 3.2 REAR PANEL CONTROLS AND CONNECTIONS
- 3.3 PRELIMINARY OPERATOR CONTROL SETTINGS
- 3.4 PRELIMINARY CHECKS BEFORE STARTING THE RF OUTPUT POWER
- 3.5 STARTING THE RF OUTPUT POWER

### 3.1 FRONT PANEL / OPERATOR CONTROLS & DISPLAY



### HELIUS Front Panel / Operator Controls & Display

## OPERATION SECTION 3



**GRAPHICAL DISPLAY:** This back lit LCD display is considered the main visual output device. All programming, operational and diagnostic data can be displayed by pressing the menu selection switches and scrolling through the various menus.

**MENU SELECTION SWITCHES:** These tactile momentary switches will enable the user to select various menu functions during the programming process and operation. The switch function will appear to the left of the switch on the graphical display.

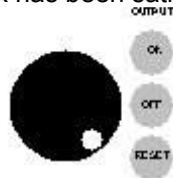
**FAULT LED:** This yellow indicator displays a fault condition. A steady light indicates a “hard” fault. This is typically a component failure fault and will shut off the RF output power until the fault is cleared or the unit is repaired.

A flashing light indicates a “soft” fault. This state indicates a fault that is not damaging to the unit however the operator should be made aware of its appearance. **This fault indication will self clear once the soft fault goes away. All fault events will remain in the non-volatile memory for display and review. The memory buffer will automatically clear after 30 RF On/Off cycles.**

**RF ON LED:** This red indicator displays the RF output state. A steady light indicates the output is ON.

**AC MAINS LED:** This white indicator displays the AC mains state. A steady light indicates the AC mains power is flowing to the internal circuits and powering the control power supply.

**INTERLOCK LED:** This green indicator displays the external interlock state. A steady light indicates the interlock has been satisfied.



**MODIFY KNOB:** This knob is used to modify operating values and program process set points into the **Helius** micro controller. It has 3 axes of movement: CW, CCW and Push.

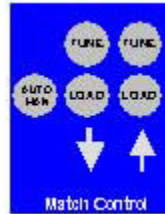
This knob will default to *programming* the RF output power level in the RF OFF state and *adjusting* the RF output level in the RF ON state. Please note that a slow rotation (in either direction) will raise (clockwise) or lower (counter clockwise) the power by 1 watt increments while faster rotation will change the value by 10 or 50 watt increments.

**RF POWER OUTPUT SWITCHES:** Pressing either of these tactile momentary switches will turn the RF output power on or off. The red LED on the left side of the panel indicates an "RF ON" state.


**RESET SWITCH:** Pressing this tactile momentary switch will reset or clear a fault condition. The yellow LED on the left side of the panel indicates various states of fault conditions.


## OPERATION SECTION 3

### 3.1 OPERATOR CONTROLS & DISPLAY



**TUNE & LOAD CONTROL SWITCHES:** These tactile momentary switches will enable the user to operate the motorized, variable capacitors in the complementary **Accu-Match™** impedance matching network when the unit is placed into the Manual state. The actual capacitor position values can be read on the graphical display.

Pressing either  switch will turn the capacitors CCW (toward minimum capacitance) until they hit the electronic low limit. The servo motors will start moving slowly and increase speed as long as the switch is depressed.

Pressing either  switch will turn the capacitors CW (toward maximum capacitance) until they hit the electronic high limit. The servo motors will start moving slowly and increase speed as long as the switch is depressed.

**MATCHING NETWORK AUTO/MANUAL SWITCH:** This tactile momentary switch will enable the user to change the **Accu-Match™** operation from automatic to manual operation. It will function in RF ON and RF OFF screens.

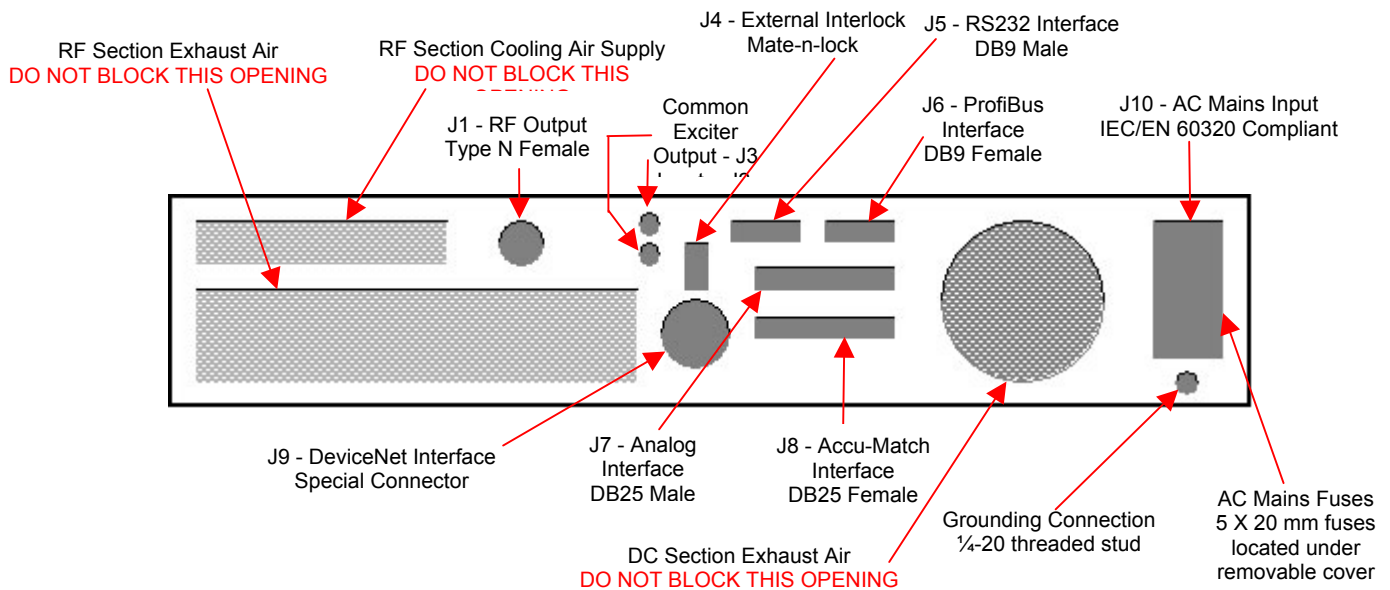
## OPERATION SECTION 3

### 3.2 REAR PANEL CONTROLS & CONNECTIONS

Please refer to previous section for detailed descriptions of the connections.

**AC Mains Entry Filter / Fuse Module:** This module has a switch that is used to turn the AC mains off and on manually. It also includes 2 fuses that provide a measure of safety should an overload condition exist. The fuses can be replaced by removing the fuse access cover. The internal filter ensures that any internally generated electrical noise is not conducted out of the unit.

**Grounding Stud:** Connect this stud to the system ground using a solid silver plated copper strap. It is a PE (protective earth) connection.



**HELIUS** Rear Panel Controls & Connections

## OPERATION SECTION 3

### 3.3 PRELIMINARY OPERATOR CONTROL SETTINGS

Please refer to the attached "Final Test" documentation for actual preset parameters.

Prior to turning on the **AC Mains Power** and **RF Output Power** we recommend presetting the controls to the following:

- A. Output power setting to 000
- B. Matching network operation to Manual
- C. AC Mains switch (rear panel) turned off.
- D. Impedance matching network capacitor positions (and tapped inductors) are properly preset.



- Ensure that the matching network output is connected to the vacuum chamber's RF feed-through.
- Connect the AC Mains to the proper voltage source – 187 > 240 VAC 50/60 Hz 1 phase.
- Connect the External Interlock to an appropriate safety interlock circuit or switch.

#### **CAUTION**

- Ensure that the RF Output connection is properly connected to the matching network RF Input via a known good 50 ohm coaxial cable.
- Verify that the cooling air supply louvers on the sides and rear are not obstructed.

### 3.4 PRELIMINARY CHECKS BEFORE STARTING THE RF OUTPUT POWER



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



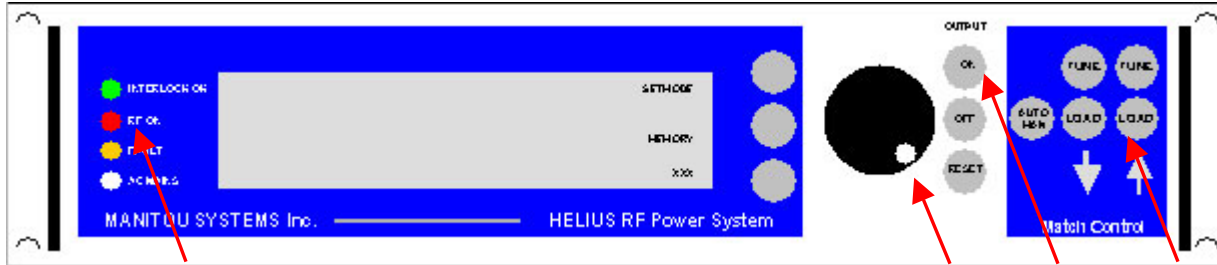
- Turn on all cooling water channels (to electrode or cathode).
- Preset the impedance matching network to a known plasma ignition point or to a initial start point as described in the Accu-Match owners manual.
- Ensure that all RF connections and system grounds are tight. Turn on the AC Mains Switch.

It is a good procedure to allow at least 5 minutes of warm-up and stabilization time for the **HELIUS**.

Check to see that the external interlock has been satisfied. The **Helius** software will not boot past the interlock fault test. Check to see that the green LED is lit (located on the left side of the panel). This indicates that the system has a satisfied interlock. (If this LED is not lit, check the external interlock device or connection.)

## OPERATION SECTION 3

### 3.5 STARTING THE RF OUTPUT POWER

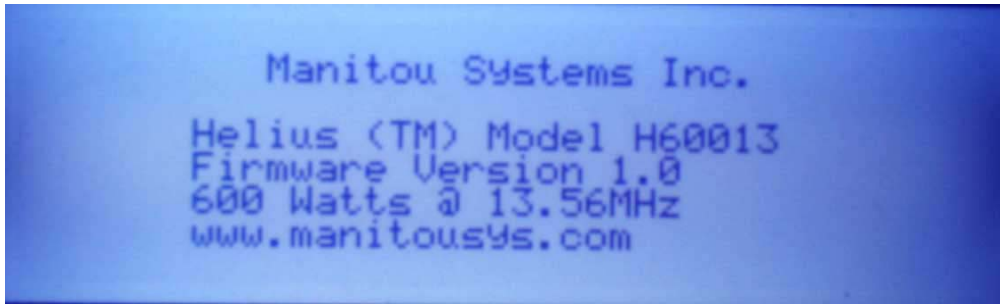


- Press the **Output “ON”** switch to place the system in the RF ON mode. The red LED indicator on the left side of the panel will light to indicate the ON state.
- Turn the **Modify** knob a few turns and check to see that the display indicates that FORWARD RF power is being delivered to the load. The reflected power will also indicate a small value.
- Continue to raise the output power to the typical plasma starting point.
- Either adjust the matching network manually or switch to automatic operation to reduce the reflected power. Adjust the TUNE and Load capacitors for minimal Reflected power.
- The operator will now be able to view an active glow discharge (plasma) in the vacuum chamber.

## OPERATING SOFTWARE SECTION 4

- 4.1 SOFTWARE IDENTIFICATION SCREEN
- 4.2 MAIN SCREEN (factory default mode)
- 4.3 PROGRAMMING A MEMORY LOCATION
- 4.4 SELECTING A PRE-PROGRAMMED MEMORY LOCATION
- 4.5 REVIEWING OPERATING PARAMETERS
- 4.6 SELECTING DIAGNOSTIC SCREENS

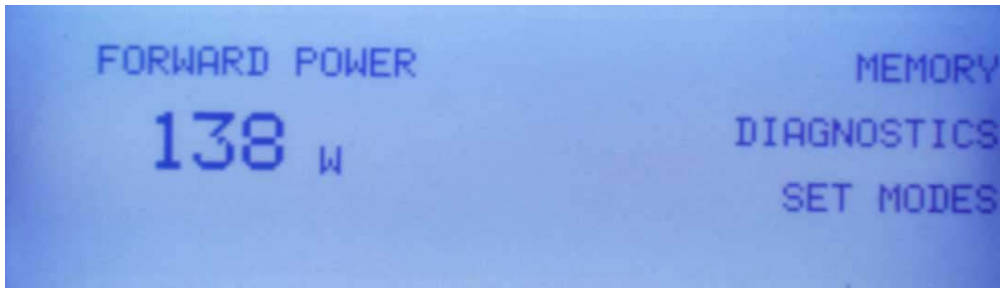
### 4.1 SOFTWARE IDENTIFICATION SCREEN



The screen shown above will display for about 3 seconds after the AC mains is turned on. It will identify the installed software version in addition to the following information:

- Product Model Name
- Operating Frequency
- Maximum RF Power Output Rating
- Firmware Version

### 4.2 MAIN SCREEN (factory default mode)



Once the software identification screen has timed out, the **MAIN SCREEN** (above) will appear. From this screen, the user is able to operate the Helius in the factory programmed mode by setting the RF power output level and pressing the RF ON switch.

The factory default mode is set as follows:

- FORWARD RF power regulation mode selected
- All MEMORY locations empty
- Maximum Reflected power limit
- Automatic matching mode set to ON
- Ramp & Pulse modes set to OFF
- External Interlock set to a Hard Fault

The user can also operate any of the eight (8) memory located processes by selecting **MEMORY**, view the system diagnostics (faults) by selecting **DIAGNOSTICS**, or enter new program parameters in **SET MODES**.

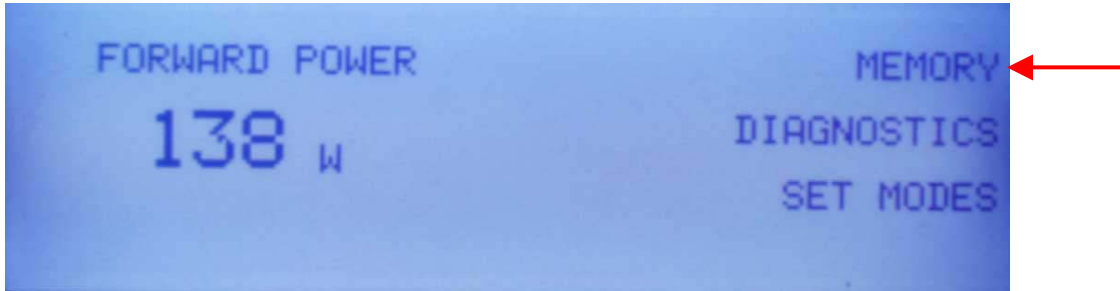
A description of these screens will follow on the next pages.

## OPERATING SOFTWARE SECTION 4

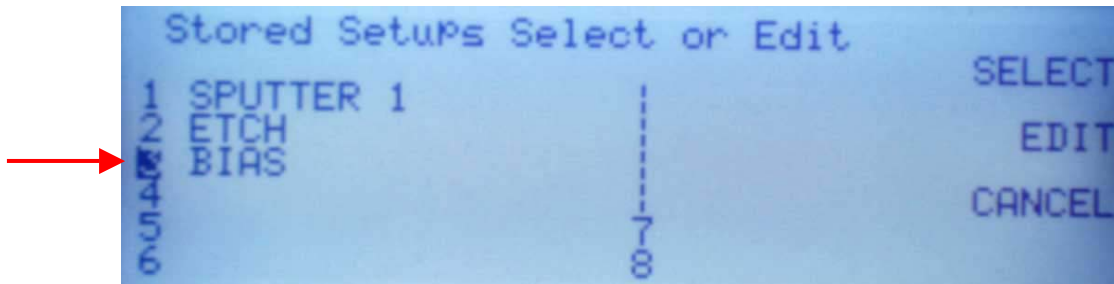
### 4.3 PROGRAMMING A MEMORY LOCATION

- Naming the memory location

The Helius software features up to 8 programmable process presets. These memories can be programmed by pressing the **MEMORY** switch from the main screen (indicated below). The system is delivered with all locations blank.



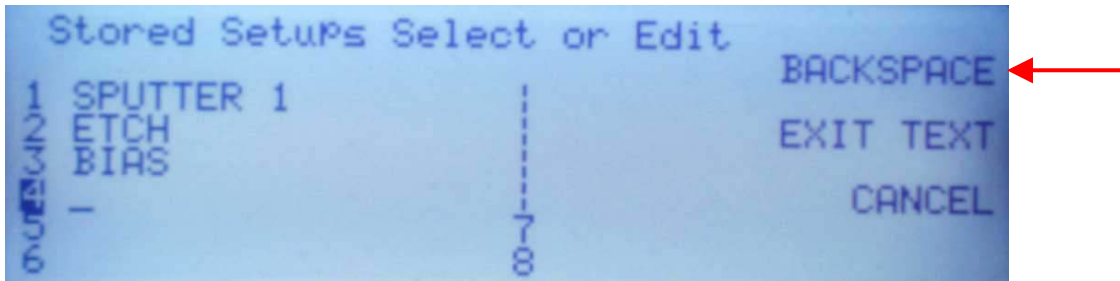
The screen below will now appear.



The first step is to select a memory position and name it by rotating the Modify knob to one of the eight (8) memory locations. Make sure that the cursor is placed over the memory location of choice and then press the modify knob in to enter the text mode.

The following characters are available (please note that the blank space is located in between the Z and the ! characters):

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z blank  
! " # \$ % & ' ( ) \* + , - . / 0 1 2 3 4 5 6 7 8 9 ; : < = > ? @**



The cursor will be in the 1<sup>st</sup> (of 18) character positions. Rotate the knob to select the character of choice and press the knob to program and move to the next position. Rotate the knob again and repeat the process until the entire name is selected and displayed. The **BACKSPACE** switch may be used to move and edit the previous character. Press **EXIT TEXT** to save this name and return to the **STORED SETUPS** (previous) screen. Additional memories can be programmed or press **CANCEL** to

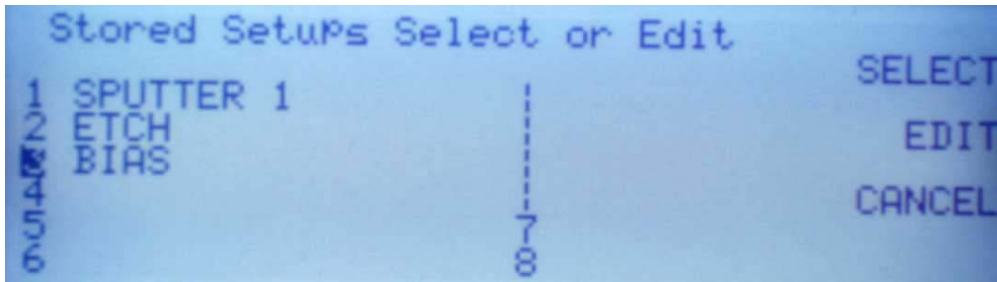
return to the operating screen.

## OPERATING SOFTWARE SECTION 4

### 4.3 PROGRAMMING A MEMORY LOCATION

- Programming the memory location parameters and values

From the screen below, press the **EDIT** button to enter the memory edit mode.



The software can now be scrolled through the typical control mode screens. These screens can be modified or kept as originally programmed. Simply use the modify knob to select the new parameters and values or press the **NEXT** button to skip the screen. The screen parameter and value(s) will be maintained through the programming process and ultimately saved by rotating the knob until the cursor is over the **SAVE AS <#>**

(the number indicates the memory location) and then pressing the knob.

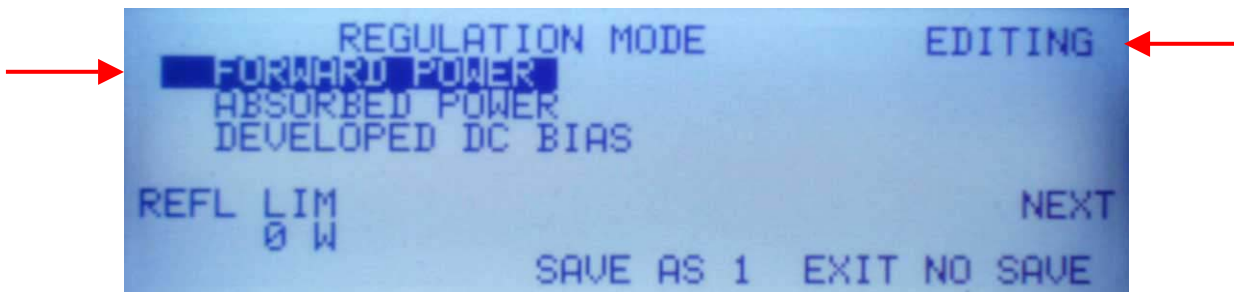
The **EXIT NO SAVE** command can be selected with the modify knob to return to the last known operating condition without saving the data.

#### **Regulation Mode Select**

After pressing the **EDIT** switch, the (1<sup>st</sup>) screen below will appear:

Please note that exiting the **EDIT** mode requires the user to either use the **SAVE AS <#>** command or the **EXIT NO SAVE** command. In both cases, press the modify knob to make your choice. The system will then return to the main screen with the last programmed operating mode. To select a new operating mode memory, press the **MEMORY** switch from the main screen.

Pressing the **PREVIOUS** switch will enable the user to back out of the current screen to the previous screen.



The first screen to edit will always be the RF output **REGULATION MODE**. From this screen, the user can select from **FORWARD POWER**, **ABSORBED POWER** or **DC BIAS** output regulation. Select the desired regulation mode by rotating the Modify knob and then pressing it to store the mode. A small cursor will remain at the selected mode.

Continue rotating the knob to either set additional parameters such as **REFLECTED POWER LIMIT** and **FORWARD POWER LIMIT**, **SAVE AS <#>** or, **EXIT NO SAVE**.

Remember, the **NEXT** or **PREVIOUS** switches enable this or any screen to be

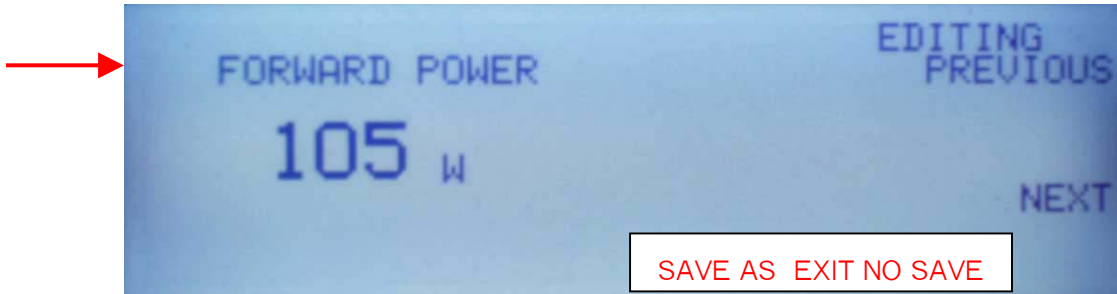
bypassed without modification.

## OPERATING SOFTWARE SECTION 4

### 4.3 PROGRAMMING A MEMORY LOCATION

To continue programming, press the **NEXT** switch, which will enable the user to enter data on the next screen and so on. When the user is finished modifying all desired parameters, rotate the Modify knob to **SAVE AS <#>** and then press the knob to complete the programming process.

If the user wishes to discard any changes and revert to the previously programmed values, rotate the Modify knob to **EXIT NO SAVE** and press the knob to exit without saving.

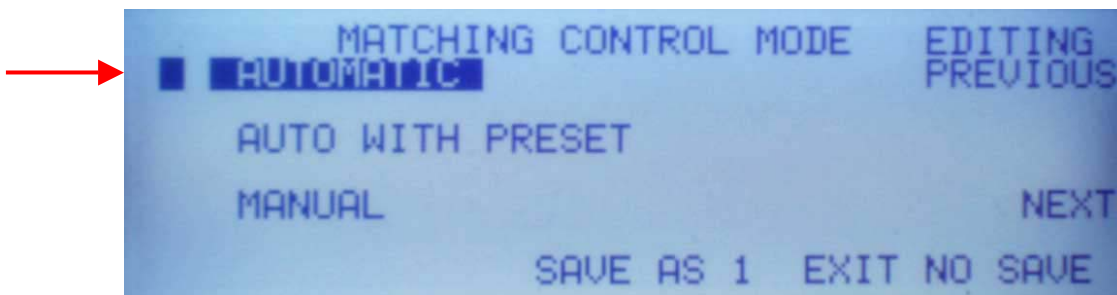


#### Output Power Value Select

The screen above represents the **FORWARD POWER EDITING** screen. This is the 2<sup>nd</sup> **EDITING** screen. Use the Modify knob to program the desired Forward power value. Pressing the **NEXT** switch will move to the next **EDITING** screen.

#### Matching Control Mode Select

The 3<sup>rd</sup> screen (shown below) enables programming of the complementary Accu-Match impedance matching network. Simply rotate the Modify knob to the desired mode and press to select it. Continue rotating the knob to either set additional parameters such as **SHUNT / SERIES CAPACITOR PRESET POSITIONS** and **SAVE AS <#>** or, **EXIT NO SAVE**.



## OPERATING SOFTWARE SECTION 4

### 4.3 PROGRAMMING A MEMORY LOCATION

#### Pulse Control Mode Select

The screen below represents the **PULSE CONTROL MODE EDITING** screen. This is the 4<sup>th</sup> **EDITING** screen. The user can turn the **PULSE ON** or **OFF**, select the pulse **FREQUENCY**, the pulse **DUTY CYCLE**, whether to **START** (the RF output) **IN CW** (continuous wave) and automatically switch to pulse, the **IGNITION TIME**, and finally, the RF ON **TIMER** value.

Rotate the Modify knob to select the desired operating function, press the knob to make the selection and rotate it again to set the desired value.

Pressing the **NEXT** switch will move to the next **EDITING** screen.

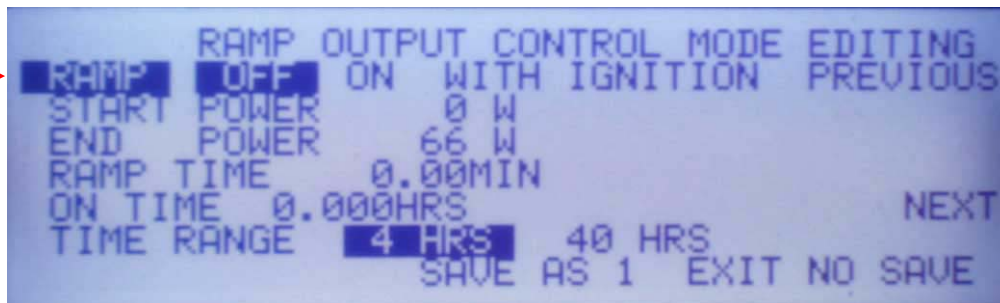


#### Ramp Output Control Mode Select

The screen below represents the **RAMP OUTPUT CONTROL MODE EDITING** screen. This is the 5<sup>th</sup> **EDITING** screen. The user can turn the **RAMP OFF**, **ON** or **ON WITH IGNITION** pulse, select the **START POWER** level, the **END POWER** level, the **RAMP TIME** value, the **ON TIME VALUE**, and the **TIME RANGE**.

Rotate the Modify knob to select the desired operating function, press the knob to make the selection and rotate it again to set the desired value.

Pressing the **NEXT** switch will move to the next **EDITING** screen.



## OPERATING SOFTWARE SECTION 4

### 4.3 PROGRAMMING A MEMORY LOCATION

#### CW Ignition Mode Select

The screen below represents the **CW IGNITION MODE EDITING** screen. This is the 6<sup>th</sup> (and last) **EDITING** screen. The user can turn the **CW IGNITION MODE** OFF and ON, select the **IGNITION POWER** level and the **IGNITION TIME** value.

Rotate the Modify knob to select the desired operating function, press the knob to make the selection and rotate it again to set the desired value.

Rotate the Modify knob to either **SAVE AS <#>** or **EXIT NO SAVE** and press to finish this **EDITING** sequence. **SAVE AS <#>** will enter the programmed data from all **EDITING** screens into this memory location. **EXIT NO SAVE** will return the user to the Main Screen and all programmed data will be deleted (the desired memory location will however, retain the last entered data).

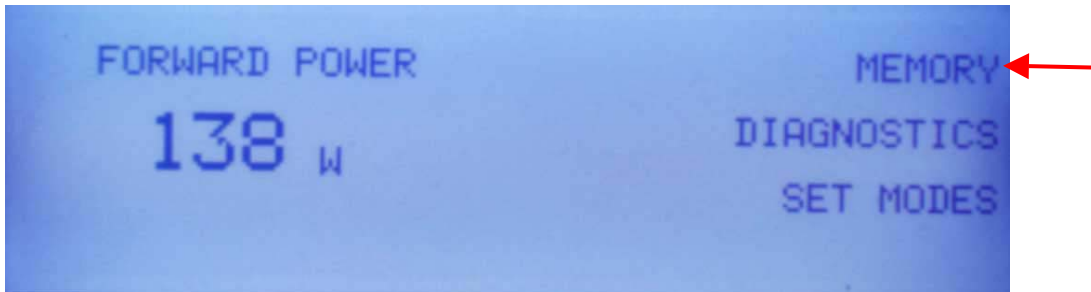
Pressing the **PREVIOUS** switch will return the user to the previous **EDITING** screen.



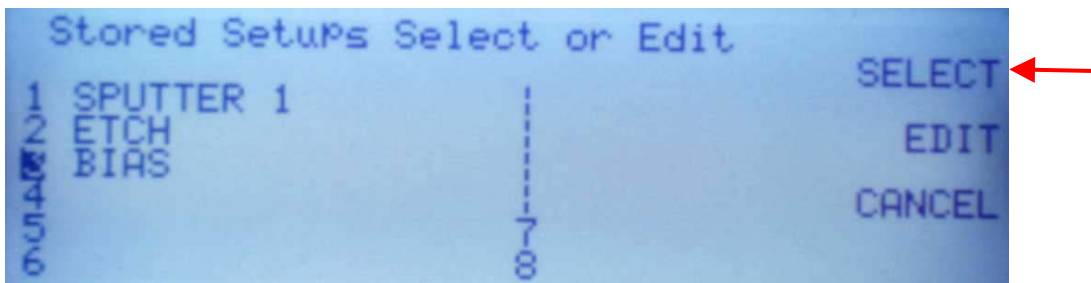
## OPERATING SOFTWARE SECTION 4

### 4.4 SELECTING A PRE-PROGRAMMED MEMORY LOCATION

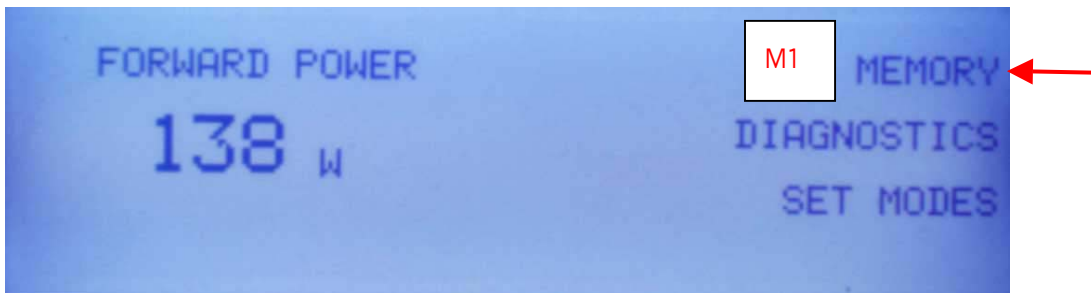
The user can easily access the eight (8) memory locations by selecting the **MEMORY** switch from the main screen (indicated below).



Simply rotate the modify knob to scroll through the 8 memory selections. Press the **SELECT** switch to select the desired operating memory.



The display will now change back to the main screen (RF OFF state) and the Helium will now operate using the parameters programmed into that memory location. The operating memory location will be displayed to the left of the **MEMORY** switch.



### 4.5 REVIEWING OPERATING PARAMETERS

#### Current operating mode

From the main screen, simply select the **SET MODES** switch and scroll through the various programming screens. At the last (or any) screen, you have a choice to either back out of the Set Modes screens to the main screen or press the **RF ON** switch to operate the unit.

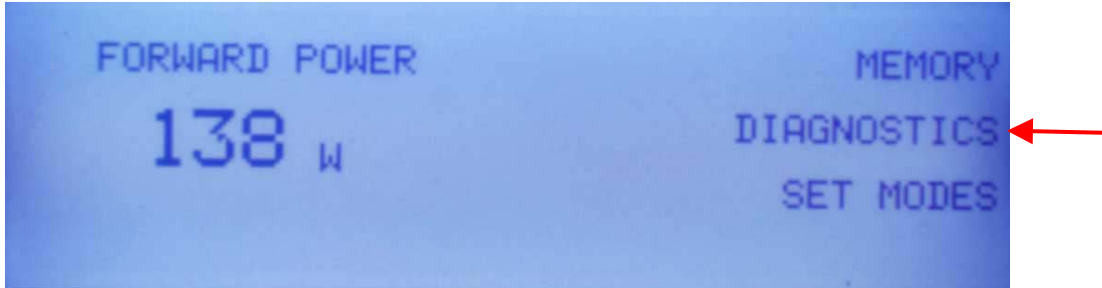
#### Pre-Programmed Memory Locations

Select the **MEMORY** switch, rotate the Modify knob to place the cursor over the desired memory location, select the **EDIT** switch, and use the **NEXT** switch to scroll through and review the programmed parameters and values. At the last (or any) screen, you have a choice to either select **EXIT NO SAVE** or if you have changed any parameter and you wish to save it, select the **SAVE AS <#>** by pushing the Modify knob.

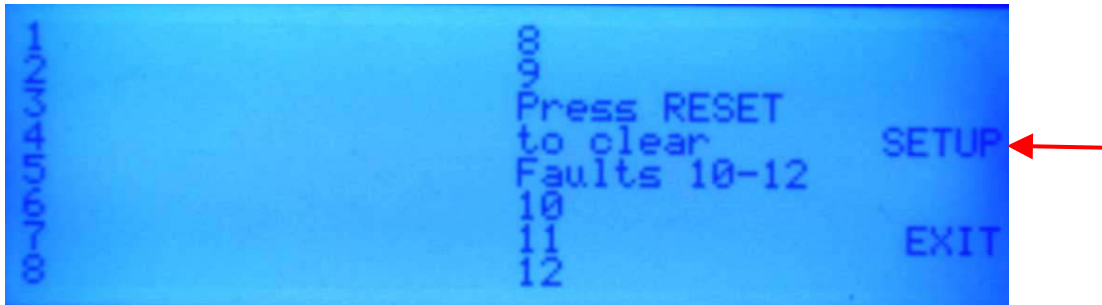
## OPERATING SOFTWARE SECTION 4

### 4.6 SELECTING DIAGNOSTIC SCREENS

The Helius has three (3) **DIAGNOSTIC** screens that enable the user to interrogate the unit's internal operating parameters, diagnose faults and pre-set fault modes. From the main screen, select **DIAGNOSTICS** to enter the diagnostics screen.



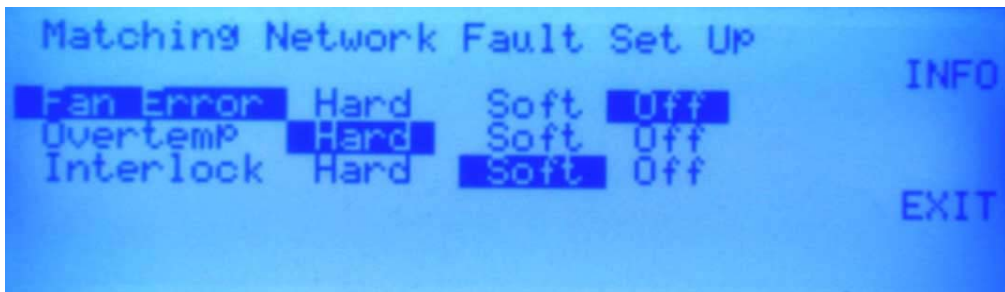
The **DIAGNOSTICS** (fault) screen below displays various RF Generator & Impedance matching network fault conditions. Pressing **EXIT** will return the software to the main screen.



This chart describes the system faults.

1	DC Fan Error	7	
2	RF Fan Error	8	
3		9	
4		10	Matching Network Fan Error
5		11	Matching Network Overtemp Error
6		12	Matching Network Interlock Error

The **Matching Network Fault Set Up** screen is accessed by pressing the **SETUP** switch on the RF Generator fault screen. The matching network faults indicated in the screen above can be toggled between **HARD** (shuts off RF output upon activation), **SOFT** (flashes fault lamp located on the front panel) or **OFF** (no action).

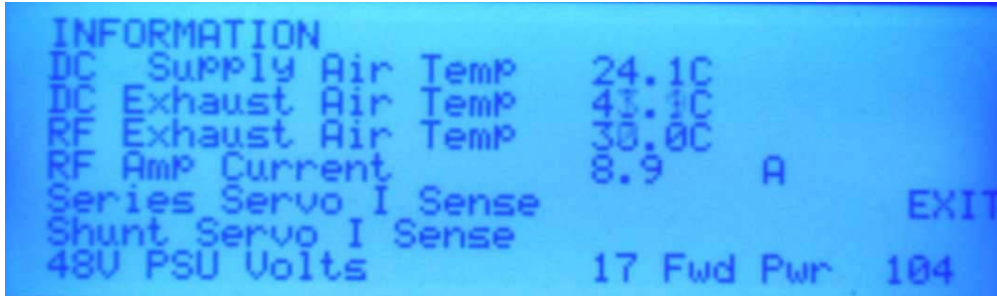


## OPERATING SOFTWARE SECTION 4

### 4.6 SELECTING DIAGNOSTIC SCREENS

The **INFORMATION** screen below displays RF generator and matching network operating parameters.

It can be accessed by selecting the **INFO** switch in the RF ON screen.

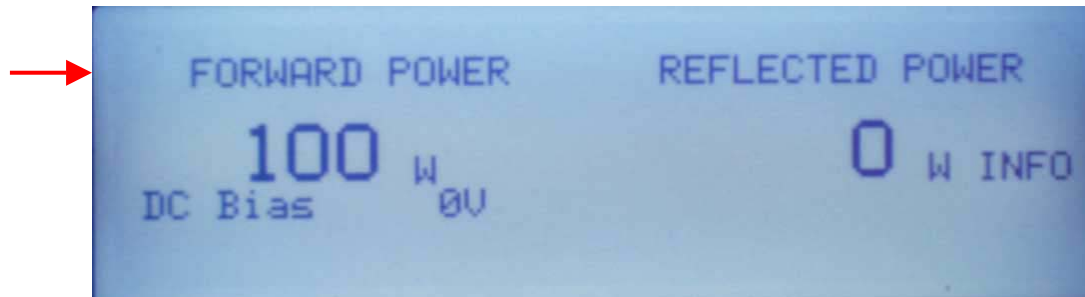


INFORMATION			
DC Supply Air Temp	24.1C		
DC Exhaust Air Temp	43.1C		
RF Exhaust Air Temp	38.0C		
RF Amp Current	8.9	A	
Series Servo I Sense			EXIT
Shunt Servo I Sense			
48V PSU Volts	17	Fwd Pwr	104

- The **DC Supply Air Temperature** (degrees C) is sensed by a thermistor mounted on the cooling fan in the DC section. The fan is mounted on the left side of the chassis. Typical cabinet temperatures can be measured with this sensor. The value can be used with the two measured exhaust values to determine the Helius thermal efficiency while tracking long term changes in its operating performance.
- The **DC Exhaust Air Temperature** (degrees C) is sensed by a thermistor mounted on the cooling fan located at the rear of the chassis. This thermistor measures the temperature coming out of the DC section. The following components are considered heat generators; 48VDC switch mode power supply module, control power supply and the front panel/control electronics. The 48V power supply is the main heat generator however.
- The **RF Exhaust Air Temperature** (degrees C) is sensed by a thermistor mounted in the exhaust air stream in between the heat sink and the rear of the chassis. This thermistor measures the exhaust air temperature. All RF section components will add to the heat load measured by this sensor.
- The **RF Amp Current** (DC amps) is measured by a shunt resistor in series with the 48VDC power supply. This value enables the user to determine the current draw of the RF amplifier. This is another value that can be used to track changes and performance of the Helius RF section.
- **Series and Shunt Servo Current Sense** (DC mA) provides an average measurement of servo motor current in the Accu-Match impedance matching network. These measurements are useful when tracking the performance of the servo mechanics. As the motors and capacitors age, they will require additional torque to turn – this is a result of wear on the bearings and hardening of the lubricants. Monitoring the long term current draw trend may suggest a proper maintenance time.
- The **48VDC Power Supply Unit** (DC volts) output voltage measurement enables the user to monitor the exact voltage level being supplied to the RF amplifier section. This value combined with the RF amp current and the RF output power results in a power conversion efficiency measurement. This is another data point that can be tracked to determine long term performance trends of the Helius, Accu-Match and the plasma process.
- The **Forward RF Power** value is the actual output of the Helius RF generator.

## OPERATING MODES SECTION 5

### 5.1 FORWARD POWER REGULATION MODE



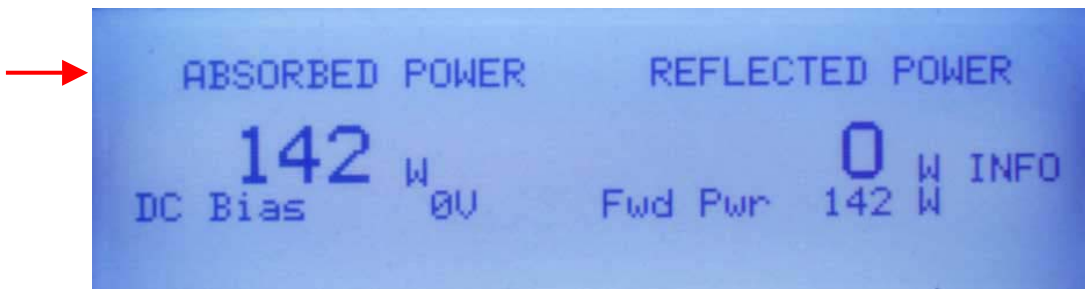
The **Forward Power** regulation mode is the most commonly used regulation mode to power processes such as sputtering and etching. The Heliuss will regulate the forward RF power based on the front panel or remote set point. The output power will be held constant as long as the reflected power remains lower than the rated maximum.

In the event that the reflected power rises to the limit, the forward power will fold back to a safe level. The Reflected power limit can be adjusted downward (by the front panel control) from maximum to protect sensitive plasma processes.

The following data is displayed on the front panel:

- Forward Power (watts)
- Reflected Power (watts)
- DC Bias (volts – small font) Available when used with the Accu-Match matching network

### 5.2 ABSORBED POWER REGULATION MODE



The **Absorbed Power** regulation mode provides output regulation based on a calculated Forward minus (-) Reflected value. For example, if the Absorbed power set point is 200 watts and the measured reflected power is 10 watts, the actual forward power will be 210 watts. This mode enables a constant power level to be delivered to the plasma load.

This mode also includes provisions to adjust the reflected power limit.

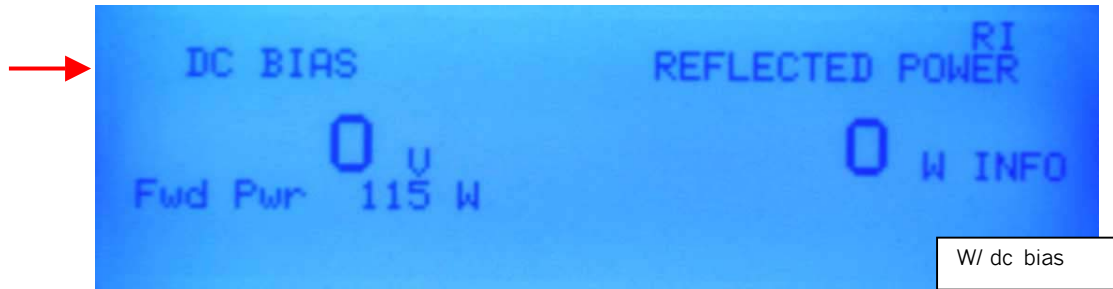
Absorbed power regulation is applicable when used with fixed (or manually adjusted) impedance matching networks that are connected to stable and narrow bandwidth processes. It should be known that the complementary impedance matching network must be well designed for repeatable and stable operation. Contact Manitou Systems engineers to discuss your application.

The following data is displayed on the front panel:

- Absorbed Power (watts)
- Forward Power (watts small font)
- Reflected Power (watts)
- DC Bias (volts – small font) Available when used with the Accu-Match matching network

## OPERATING MODES SECTION 5

### 5.3 DC BIAS REGULATION MODE

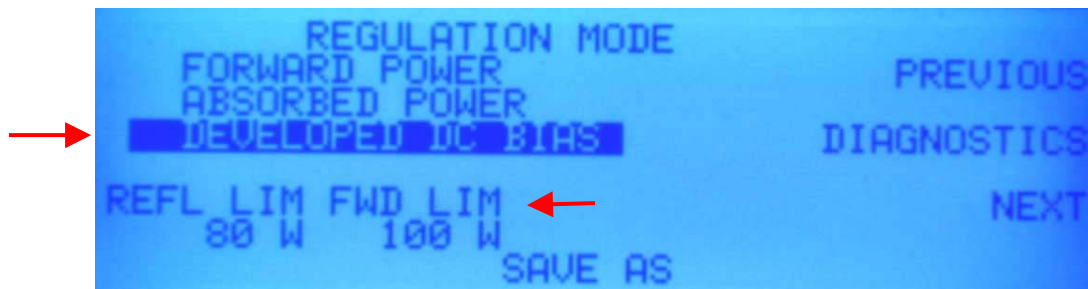


The **DC Bias** regulation mode provides output regulation based on a feedback signal originating in the plasma reactor. The plasma discharge will rectify the RF voltage. The Accu-Match impedance matching network comes equipped with a DC bias probe that will strip the developed DC bias signal of the RF voltage and divide down the input voltage resulting in a 0-2V output (for a 0-4000V input). This conditioned (positive) signal is fed into the Helius control circuit to be used as the *error* signal.

This regulation mode is typically used in substrate bias and etching applications. When operating, the RF power will rise or fall to maintain a constant DC bias signal on the plasma electrode. Like the control modes above, the forward power will be limited if the reflected power is not managed.

This regulation mode includes a forward power limit set point. This is useful when providing RF substrate bias. In normal operation there may be instabilities or arcing on this electrode. When an arc forms, the DC bias will suddenly go low causing the RF power to rise to maximum. This in turn causes the automatic impedance matching network to move away from its optimal tune point. Once the arc clears, then the entire control loop tries to stabilize.

This run away condition can be minimized or eliminated by setting the forward power limit to a value just above the maximum process value.



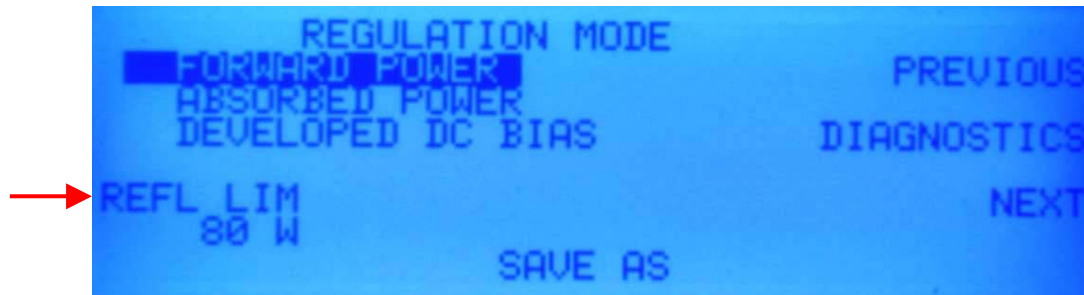
The following data is displayed on the front panel:

- DC Bias (volts) Available when used with the Accu-Match matching network
- Forward Power (watts small font)
- Reflected Power (watts)

## OPERATING MODES SECTION 5

### 5.4 REFLECTED POWER SETPOINT

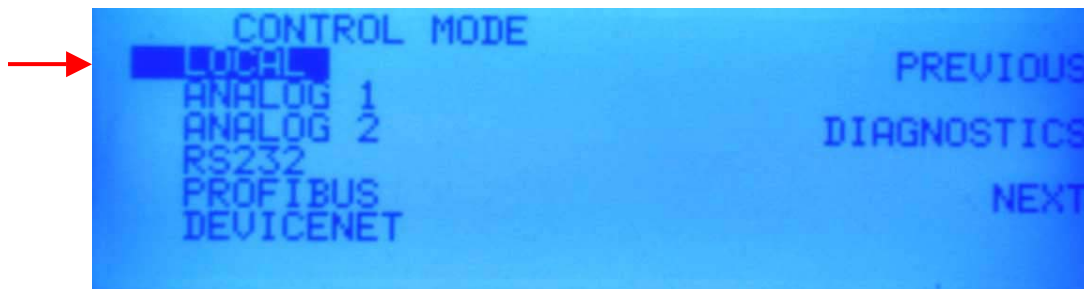
The Helius software includes a [Reflected power limit](#) set point. This setting is accessible on each of the three (3) [Regulation Mode](#) screens. The Helius has a factory setting (maximum safe operating limit) however this set point enables the user to select the point at which the forward power should fold back. The set point can be adjusted downward from this setting.



### 5.5 EXTERNAL CONTROL MODES

The Helius RF generator has five (5) available remote control modes and the [Local Control Mode](#). The [Analog](#) modes enable connection to a PLC or a computer controller with an A>D converter. The [RS232](#), [Profibus](#) and [DeviceNet](#) interfaces provide direct connection to a host computer. These serial interfaces also offer the most flexibility and data I/O.

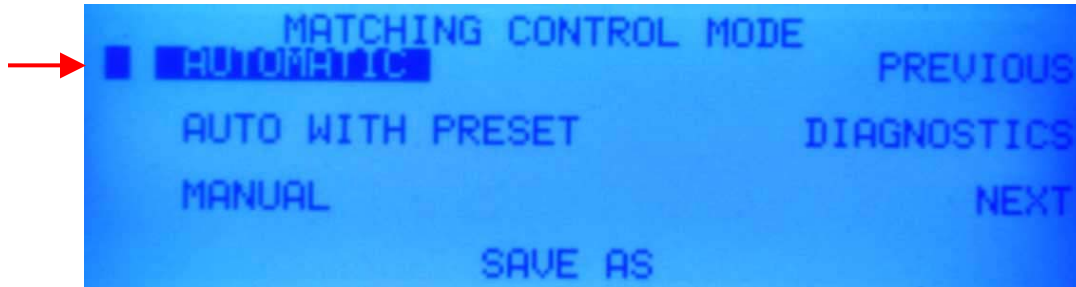
- The [Local](#) control mode enables the user to completely control the Helius via the front panel Modify knob and key switches.
- The [Analog 1](#) mode enables *only* the RF ON/OFF function to be operated remotely.
- The [Analog 2](#) mode disables the front panel controls. All functions can be operated remotely. The Diagnostic screens are still available for use.
- The [RS232](#), [Profibus](#) and [DeviceNet](#) control modes enable full control and data acquisition by a host computer. All user controls and functions will be disabled.



## OPERATING MODES SECTION 5

### 5.6 MATCHING NETWORK CONTROL MODES

The complementary Accu-Match automatic impedance matching network can be used with the Heliuss to provide a complete RF delivery system. The Accu-Match can be operated using various control schemes based on the software and settings.



The screen above represents the **MATCHING CONTROL MODE EDITING** screen. The user can select from **AUTOMATIC**, **AUTOMATIC WITH PRESETS** or **MANUAL** operation. Rotate the Modify knob to select the desired operating mode and press the knob to complete the programming process.

- Selecting the **AUTOMATIC** mode will keep the **Accu-Match** in completely automatic operation at all times. The variable capacitor positions will remain at their last setting when the RF power is cycled OFF and back ON again.



- Selecting the **AUTOMATIC WITH PRESETS** mode will keep the **Accu-Match** in automatic operation when the RF power is ON and switch the operation to manual when the RF power cycles OFF. The variable capacitor positions will always return to the preset settings when the RF power is cycled OFF.
- Selecting the **MANUAL** mode will always keep the **Accu-Match** in manual operation. The variable capacitor positions can be moved using the front panel switches.

Please note that the Manual matching function includes a 2-step servo motor speed control. The slow speed will operate for the first 1.5 seconds (when pressing and holding any Match Control switch) and automatically go to high speed (10 X slow speed).

## OPERATING MODES SECTION 5

### 5.7 PULSE CONTROL MODE

The Helius offers a variable output **Pulse Control Mode**. Pulsing of the RF signal is useful in certain types of plasma process where the plasma heating is to be kept to a minimum. The parameters can be adjusted to suit the particular plasma process.

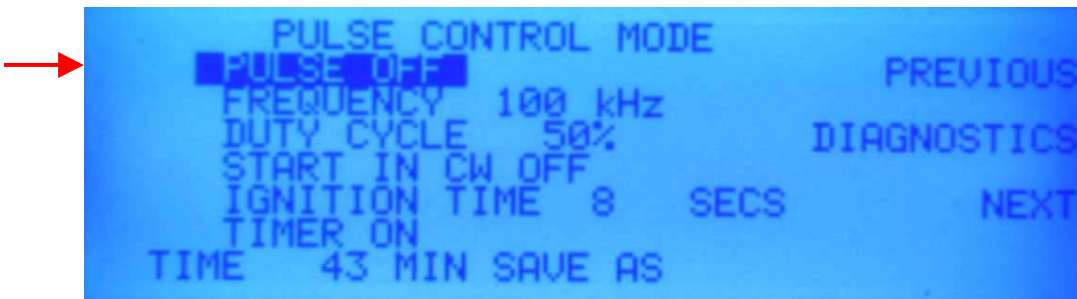
The Pulse mode can be programmed to start immediately upon closure of the RF ON switch or after an initial burst of CW (continuous wave) power. This CW ignition burst enables easy and reliable plasma ignition and automatic impedance matching before returning to the pulse mode.

The following values need to be entered into the screen below:

- Frequency (kHz)
- Duty Cycle (%)
- Start in CW ON – OFF
- Ignition Time (seconds)
- Process Timer ON – OFF
- Time Duration (mins)

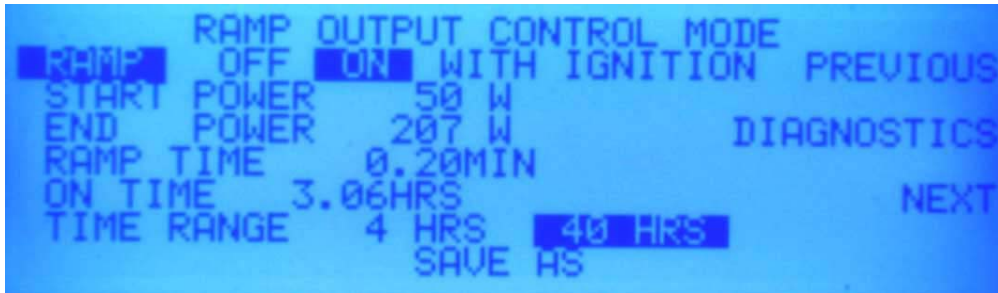


Note: when operating the Helius in the PULSE MODE, the RAMP MODE will not operate.



## OPERATING MODES SECTION 5

### 5.8 RAMP OUTPUT CONTROL MODE



The screen above represents the **RAMP OUTPUT CONTROL MODE EDITING** screen. The user can turn the **RAMP OFF**, **ON** or **ON WITH IGNITION** pulse, select the **START POWER** level, the **END POWER** level, the **RAMP TIME** value, the **ON TIME VALUE**, and the **TIME RANGE**. This feature is useful when conditioning new sputtering targets as a slow power ramp minimizes arcing.

Simply rotate the Modify knob to select the desired operating function, press the knob to make the selection and rotate it again to set the desired value.



Note: when operating the Helios in the RAMP MODE, the PULSE MODE will not operate.

## OPERATING MODES SECTION 5

### 5.9 CW IGNITION MODE

This mode of operation will pulse the RF output to a value higher than the continuous output power at the start of each RF ON cycle. The power level and duration of the ignition pulse can be set using the modify knob.

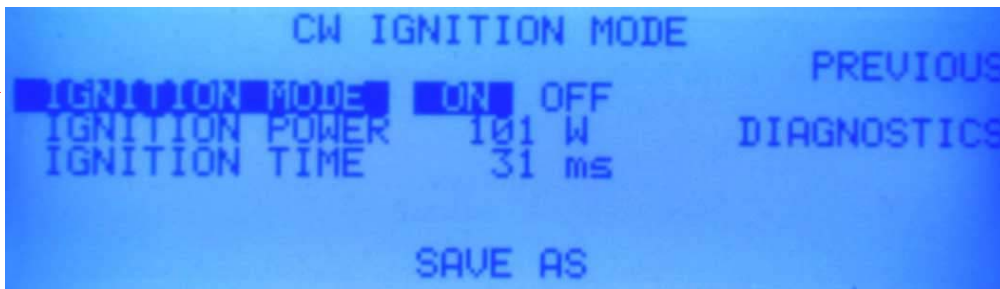
This mode of operation is useful when powering plasma processes that require low average RF power. The ignition pulse and impedance matching network presets are unique to the Helius system enabling smooth plasma ignition, tuning and stable plasma operation.



*Please note that both the ignition pulse and the continuous output power are CW (continuous wave) signals.*

The screen below represents the **CW IGNITION MODE EDITING** screen. The user can turn the **CW IGNITION MODE** OFF and ON, select the **IGNITION POWER** level and the **IGNITION TIME** value.

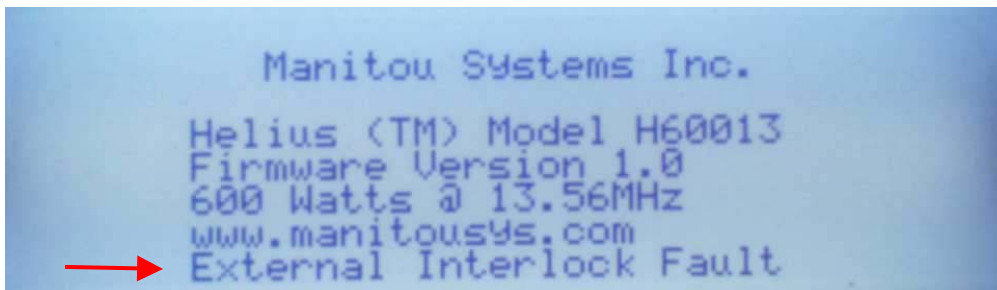
Rotate the Modify knob to either **SAVE AS <X>** or **EXIT NO SAVE** and press to finish this **EDITING** sequence. **SAVE AS <X>** will enter the programmed data from all **EDITING** screens into this memory location. **EXIT NO SAVE** will return the user to the Main Screen and all programmed data will be deleted (the desired memory location will however, retain the last entered data).



## TROUBLESHOOTING PROCEDURES SECTION 6

### 6.1 RF GENERATOR PROBLEMS

- If the cooling fan does not start check the AC mains circuit. Is it operational? Is the HELIUS power cord inserted properly into the rear panel connector? Is the rear panel circuit breaker turned on? If all of the answers are yes, the problem may be a blown fuse on the control power supply. This fuse may be replaced removing the top cover and looking for the fuse on the top surface under the ribbon cables.
- **Interlock Fault** If the cooling fan is running and the Interlock LED indicator does not light, there is a possibility that the external interlock connection is not closed. Please check that the interlock connector on the rear panel is correctly inserted and the connections are per the drawing. The screen below will indicate that the interlock is not functional.



When the external interlock is broken during normal RF ON operation, the RF output will shut off and the screen above (Software ID) will appear. The system will automatically revert back to the RF OFF state screen once the interlock is satisfied. In addition, the red Fault LED on the left side of the front panel will light steadily.

## TROUBLESHOOTING PROCEDURES SECTION 6

### 6.2 IMPEDANCE MATCHING NETWORK PROBLEMS

Please follow the following 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 too 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 than 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), 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.

## DRAWINGS & PHOTOS    SECTION 7

- 7.1    **HELIUS** MOUNTING INFORMATION
- 7.2    **XXX**

## **MAINTENANCE PROCEEDURES      SECTION 8**

- 8.1      CLEANING OF DEBRIS
- 8.2      FRONT PANEL CLEANING

### **8.1      CLEANING OF DEBRIS**

After continued use, the **Helius** will build up 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 **Helius** is used in a very dusty location, the top cover may be removed to facilitate the cleaning of the interior components. Use compressed air (less than 20 psi) to blow out the dust.

### **8.2      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.

- 9.1 RS-232 INTERFACE
- 9.2 PROFIBUS INTERFACE
- 9.3 DEVICENET INTERFACE
- 9.4 ANALOG INTERFACE

**SECTION 9.1 RS232 INTERFACE**

This RS232 user interface connection offers a method to control and monitor the operation of the Helius RF power system.

Its communication commands are compliant with other industry standard products in addition to offering new commands to provide advanced diagnostics.

The command set can be programmed to provide an ECHO on (verbose) mode or ECHO off (terse) mode. The verbose mode answers a command call with an Alpha response while the terse mode answers with a simple numeric response.

**SECTION 9.2 PROFIBUS INTERFACE****SECTION 9.3 DEVICENET INTERFACE****SECTION 9.4 ANALOG INTERFACE**

The following is a detailed description of each I/O signal on the Analog User Interface connector.

- Pin 1 RF power limit reached
- Pin 2 Hard fault
- Pin 3 Soft fault
- Pin 4 RF state – on / off
- Pin 5 Signal ground
- Pin 6 Matching state – manual / automatic
- Pin 7 Series capacitor position
- Pin 8 Shunt capacitor position
- Pin 9 Chassis ground
- Pin 10 Blanking (pulse)
- Pin 11 RF ON
- Pin 12 Remote activate
- Pin 13 Output level set
- Pin 14 External voltage
- Pin 15 Ground
- Pin 16 Series capacitor low limit
- Pin 17 Series capacitor high limit
- Pin 18 Shunt capacitor low limit
- Pin 19 Shunt capacitor high limit
- Pin 20 Plasma sense
- Pin 21 Series capacitor position set point
- Pin 22 Shunt capacitor position set point
- Pin 23 DC Bias – 10V = 100% (4kV)
- Pin 24 Reflected RF power – 10V = 100%
- Pin 25 Forward RF power – 10V = 100%